

# Making a Natural Monopoly

The Configuration of a Techno-Economic Order  
in Swedish Telecommunications

Claes-Fredrik Helgesson

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**Claes-Fredrik Helgesson**

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**STOCKHOLM SCHOOL OF ECONOMICS**  
EFI, THE ECONOMIC RESEARCH INSTITUTE



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*To Celine and the memory of Lilian*



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Hökarängen, September 1999

Claes-Fredrik Helgesson



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# I

## Introduction

Why is a particular industry organised in the way it is? Why does an industry change along certain lines and not others? Answers to such questions are recurrently alluded to in discussions concerning the organisation and change of particular fields of economic activity, such as the telecommunications sector, the pharmaceutical sector or the automotive industry. Answers of different degrees of industry specificity are repeatedly forthcoming in economics textbooks, official reports, newspapers and business magazines. Answers are also provided when executives speak about the future of ‘their’ industry and why ‘their’ company is compelled to forge alliances with other companies; when government officials discuss the appropriate regulatory measures to take towards an industrial sector; or when an industry expert comments upon the latest mergers in the industry of his or her expertise.

Two powerful figures of speech (and thought) that crop up from time to time in such discussions are central to this book: the natural order and the inevitable change. When used to characterise the organisation of an industry, the notion of a natural order informs that the given organisation is settled in accordance with underlying inherent factors. Similarly, when the notion of inevitable change is used it communicates that the given change is inevitable due to autonomous forces. As characterisations of order and change, these notions allude to causal laws that transcend time and culture. Indeed, the regular underlying presumption is that order and change in fields of economic activity simultaneously obey and are explained by such things as the (natural) laws of economics and the state and change of relevant technologies.

There are good reasons for not treating assertions evoking the natural and the inevitable as self-explanatory. As long as ten decades ago economist and sociologist Thorstein Veblen critically affirmed that laws of the normal or the natural impute to “things a tendency to work out what the instructed common sense of the time accepts as the adequate or worthy end of human effort.”<sup>1</sup> Such laws, Veblen contended, were

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<sup>1</sup> This specific critique, originally published in 1898, was formulated against the laws formulated by the classical economists, Thorstein Veblen, “Why Is Economics Not an

projections of the accepted ideal of conduct. In more recent decades, there has been a marked interest in pursuing empirical research on order and change in industrial sectors, with a more or less explicit rejection of conjectures alluding to the natural and the inevitable.

Some of this research might be termed as belonging to an emergent sociology of industry.<sup>2</sup> Although far from coherent, this assemblage of research shares an interest in the phenomenon of order and change in fields of economic activity such as industries or industrial sectors. Moreover, it shares a perspective of order and change as being the outcome of iterative processes and acknowledging, albeit with varying emphasis, that industrial sectors are embedded in the social, commercial, scientific, technical, political, and economic. Research within economic sociology on industrial governance, for instance, emphasises the importance of social networks and politics in shaping order and change.<sup>3</sup> Research on organisational fields emphasises the importance of institutions and norms in shaping structure and change.<sup>4</sup> Research on industrial networks emphasises the importance of exchange relationships between firms in shaping both structure and change.<sup>5</sup>

This study aims at participating in such efforts of inquiry into the processes producing order and change, but will do so by using somewhat different means. Although sharing in the rejection of the use of explanations involving the natural and the inevitable, this study additionally aims at exposing the making of such notions *within* the empirical field under inquiry. To this effect and to a significant extent this study draws on methodological approaches elaborated within sociology of science and technology.<sup>6</sup> The reason for this is twofold.

Evolutionary Science?," in *The Place of Science in Modern Civilisation and other Essays* (New York: Russel & Russel, 1961), 56-81, p. 65.

<sup>2</sup> The conception of a sociology of industry was expressed in a recent chapter by economic sociologists Mark Granovetter and Patrick McGuire, Mark Granovetter and Patrick McGuire, "The Making of an Industry: Electricity in the United States," in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 147-173. My conception of what might constitute this emerging sociology is presented at the end of chapter 3.

<sup>3</sup> See, for instance, John L. Campbell, J. Rogers Hollingsworth, and Leon N. Lindberg, eds., *Governance of the American Economy* (Cambridge: Cambridge University Press, 1991).

<sup>4</sup> See, for instance, W. Richard Scott, *Institutions and Organizations* (Thousand Oaks: Sage, 1995).

<sup>5</sup> See, for instance, Björn Axelsson and Geoffrey Easton, eds., *Industrial Networks: A New View of Reality* (London: Routledge, 1992).

<sup>6</sup> This affinity is spelled out in chapter 3. For a few major works see, Harry M. Collins, *Changing Order: Replication and Induction in Scientific Practice*, 2nd ed. (Chicago: University of Chicago Press, 1992), Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Cambridge: Harvard University Press, 1987), Donald MacKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge: MIT Press, 1990), Wiebe E. Bijker, *Of Bicycles, Bakelites and Bulbs: Toward a Theory of Sociotechnical Change* (Cambridge: MIT Press, 1995); for two comprehensive volumes of

First, because such methodological approaches provide tools and insight for how to appreciate the positions and roles of technology in stabilising and destabilising (socio-economic) orders, while not succumbing to technology as a contingent background or an autonomous force. This capacity is critical for the further exploration of order and change in fields of economic activity since technology and technological change are every so often taken as constituting the naturalness of an order and the inevitability of a change. The endeavours within sociology of science and technology to place science and technology inside the rest of the social fabric, with notions such as the seamless web and techno-economic networks, in this respect can bring productive contributions to a sociology of industry as outlined above.<sup>7</sup>

My second motive for drawing on approaches from sociology of science and technology is that they provide attractive and versatile tools for inquiring into the making of the inevitable and the natural. In studies on the making of scientific facts, they have elaborated a methodological stance that fruitfully separates between the stabilised outcome and the making of this outcome. The distinction between 'science in the making' and 'ready-made science' forcefully emphasises the necessity to study the heterogeneously contingent and iterative processes that as an outcome produce distinctions between the true and the false, between knowledge and belief, and between nature and society.<sup>8</sup> Such a stance enables an appreciation of the feat of stabilisation without construing the 'winning' stabilised outcome as self-evident. In this study, such a stance provides a safeguard against the retrospective determinism of a winner's history that would judge the successful stabilisation as representing the inherently natural order brought on by inevitable change. Instead, this methodological stance allows for both an inquiry into order and change in fields of economic activity *and* an inquiry into how notions of the natural and the inevitable are made within the field examined.

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articles within sociology of technology, see Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge: MIT Press, 1987) and Wiebe E. Bijker and John Law, eds., *Shaping Technology/Building Society: Studies in Sociotechnical Change* (Cambridge: MIT Press, 1992). See also the admittedly diffuse collection of articles in Sheila Jasanoff et al., eds., *Handbook of Science and Technology Studies* (Thousand Oaks: Sage, 1995).

<sup>7</sup> The emphasis of the material, the critique of social constructivism, and the rejection of the ontological divide between the technical and the social (and indeed the one between nature and the social) are central to much work within science and technology studies. For two specific discussions on such matters, see Thomas P. Hughes, "The Seamless Web: Technology, Science, Etcetera, Etcetera," *Social Studies of Science* 16 (1986): 281-292 and Bruno Latour, *We Have Never Been Modern*, trans. Catherine Porter (Hempstead: Harvester Wheatsheaf, 1993).

<sup>8</sup> On the distinction between 'science in the making' and 'ready-made science', see the introduction in Latour, *Science in Action*, pp. 1-17.

Thus, in brief, these are the stakes and the general setting with which this book is concerned. The specific case under inquiry is Swedish telecommunications, with a focus on the final creation of a state-owned monopoly in telephone services, broadly covering 1900-1930. Swedish telecommunications is a field of economic activity that together with other infrastructure-related fields has undergone significant regulatory changes in recent decades, changes that have been interpreted at times in Sweden as being motivated by these fields having been natural monopolies now being unmade by technological change.<sup>9</sup> A point of departure for this study is thus the contemporary notion that Swedish telecommunications has been a *natural monopoly* that has gradually been unmade in the last few decades by technological change.<sup>10</sup> The question, then, is what went into the making of this once natural monopoly? In particular, given the role attributed to technology in unmaking it, the focus is on how technological change was interrelated to changes in the economic organisation in the emergence of the monopoly.

### Outline of this Book

The next chapter further introduces the specific field under inquiry. Beginning with the recent changes in Swedish telecommunications, and depicting the role of the concept of natural monopoly in the contemporary understanding of the past of Swedish telecommunications, this chapter takes the first step towards inquiring into the making of the state-owned telephone services monopoly that was run by the Telegraph Administration (the antecedent to present day Telia).

Chapter 3 prepares for the primary inquiry of this study, that is, into how technological change was *interrelated* to changes in economic organisation in the making of the state-owned telephone services monopoly. Here the study's methodological position is presented and related to the problems of stabilisation and technological determinism. To deal with these problems, the inquiry is subsequently rephrased as an inquiry into *how efforts to alter technology were interrelated to efforts to alter the economic organisation in the making of the state-owned monopoly*. To frame these efforts in view of the specific case, the inquiry is further translated by using two contemporary contested issues as a point of entry: the 'telephone issue' that centred

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<sup>9</sup> A recent signed editorial in a major Swedish newspaper provides one example of such an argument. In this editorial against the State as owner of large companies Nils-Erik Sandberg emphasised that the traditional argument favouring the State as legitimate owner of businesses that were natural monopolies had largely become invalid since 'new technologies have altered most of the picture.' "Staten som storföretagare," *Dagens Nyheter* (Stockholm), 23 June 1999.

<sup>10</sup> Natural monopoly is a concept from economics that denotes the notion that certain industries have such characteristics that competition is neither possible nor beneficial. See also the glossary at the end of the book.

on the relation between the two competing operators in Stockholm and the 'switching system issue' that centred on how exchanges in Stockholm, in particular the Telegraph Administration's exchanges, should be constructed and organised. The translated question, then, is how the efforts and controversies related to these two issues were interrelated in the making of the new monopoly order in Swedish telecommunications.

The three chapters that follow represent the core of this study and contain the story of the concurrent controversies and efforts related to the 'telephone issue' and the 'switching system issue'. In chapter 4, many of the main issues and actors are further introduced. The chapter depicts the emergence of the two issues and their relation to the two competing operators in Stockholm and the workings of their exchanges and networks in Stockholm. The main subject of the chapter is one controversy regarding the appropriate design of a new manual telephone exchange, and another regarding the appropriate organisation of the telephone system in Stockholm. The chapter leaves these controversies around 1910, at a point where they were still unresolved. The chapter is concluded by a brief look at the contemporary world of telephony outside Sweden to illustrate that many differing views prevailed elsewhere on issues related to those contested in Sweden. Among other things, this excursion describes the emergence and early conceptions of the notion of natural monopoly in the US in the late 19<sup>th</sup> century.

Chapter 5 focuses on the many further efforts put into settling the 'telephone issue' and the 'switching system issue'. The three projects for developing automatic telephone exchanges which emerged after 1910 are given attention, as are the two operators' continued endeavours to enlarge their networks and to resolve the 'telephone issue'. Recurrent themes in this chapter include the issue of setting tariffs, the patching together of a gradually disintegrating telephone network, the repeatedly delayed work in establishing what an automatic telephone exchange should look like, and the efforts to sustain interest in development projects that repeatedly failed to deliver. Finally, this chapter depicts how the controversies and efforts regarding the 'telephone issue' and 'switching system issue' increasingly became intertwined, a situation that obstructed the resolution of both issues for a time.

Chapter 6 begins with the negotiations that culminated in the Telegraph Administration's acquisition of the network of its competitor Stockholm Telephone in 1918. The acquisition that redrew the organisation of telephone services provision in Stockholm, at least on paper, and meant the beginning of the Telegraph Administration's de facto monopoly in Sweden. The remainder of the chapter then covers some of the organising that went into making this new (paper) organisation more real. It covers the mergers of the two formerly separated networks, how it was established that automatic exchanges should be used and the subsequent introduction of

such exchanges beginning in 1924. It especially focuses on the lengthy discussion regarding what kind of switch should be chosen and the work put into establishing how such a choice should be made. This turned out to be a controversy whose settlement was far from clear-cut. Much heterogeneous work by many parties went into its settlement, and its resolution marked the beginning of a more intimate relationship between the Telegraph Administration and the telecommunications equipment manufacturer LM Ericsson. This chapter further covers some of the efforts to introduce the exchanges into the telephone network. The chapter ends with a brief epilogue depicting how the resolution of the ‘telephone issue, and the ‘switching system issue’ continued to imprint on the order and further change of Swedish telecommunications.

In chapter 7 I discuss the account provided in the three previous chapters with the view of further exploring how efforts to alter technology were interrelated to efforts to alter the economic organisation in the making of the state-owned monopoly. This discussion is set with a gradual movement of the focus from the efforts and controversies, as such, to their consequences in changing Swedish telecommunications. Thus, in the first section the focus is on the dynamics and stabilisation of controversies. In the second section, the focus is firstly on the transformation certain elements of the telephone system went through in the process of making the new order, and secondly on the emergent new order as such in Swedish telecommunications. The chapter is concluded by a brief discussion on what this study may contribute to the subject of order and change in fields of economic activity.

The final chapter is an epilogue that moves this study back to the present. It makes this move by the relating of my account on the emergence of a new order in Swedish telecommunications to the present knowledge that this *was* a natural monopoly now unmade by technological change. The objective of the chapter is to explore the making of the natural and inevitable as opposed to invalidating the concept of natural monopoly or its use in a retrospective characterisation of Swedish telecommunications. The chapter begins with an excursion into the further history of the concept of natural monopoly, and subsequently discusses three aspects of the (retrospective) natural monopoly characterisation. First, it discusses the foundation of the retrospective natural monopoly characterisation. Second, it discusses some of the contrasts that arises when juxtaposing this characterisation with my own account on the emergence of the monopoly. Finally, the chapter discusses some of the consequences of retrospectively characterising the past monopoly as a natural one. In all, this discussion suggests that this usage of the concept of natural monopoly has indeed participated in shaping notions of the natural and inevitable in this particular field of economic activity.

As a source of reference, a glossary briefly describing concepts, persons and organisations central to this study is appended.

## II

# A Natural Monopoly Unmade

An important reason for the early nationalisation of the postal-, tele-, and telephone systems and the so-called public utilities (gas, electricity and water production and distribution) is that they are natural monopolies. These enterprises are such that an optimal size – or, in other words, minimum efficient size – leads to the fact that they will exercise monopoly control over the market. Monopolistic prices cannot be accepted since these goods and services constitute a considerable share of each individual's consumption. We would run the risk of having undesirable social and economic consequences. This is the reason why the state wants to control and/or own these enterprises.

Lennart Waara, et. al., 1978.<sup>1</sup>

### **The Unmaking of a Natural Monopoly as a Point of Departure**

In less than 30 years, much of what were once indisputable facts in Swedish telecommunications have turned into yesterdays' beliefs. In the 1970s, the provision of telephony was a monopoly. Some, as in the quotation above, even called it a natural monopoly, maintaining that it was this that once made the telephone system a state-owned monopoly. This was simply deemed as the most appropriate way to organise the provision of telephony. Ten years later the same monopoly for providing telephony was increasingly seen as problematic. Swedish official reports from the late 1980s and onwards inform that the provision of telephony *had been* a natural monopoly indeed but that was no longer the case. Instead, competition had gradually emerged as an inseparable part of Swedish telecommunications.

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<sup>1</sup> Original sentences (in Swedish): "En viktig orsak bakom de tidiga förstatligandena av post- tele- och telefonväsendet och de s.k. public utilities (gas-, elektricitets- och vattenproduktion och distribution) är att de utgör naturliga monopol. Dessa företag är sådana att en optimal storlek – eller om man så vill, minsta effektiva storlek – medför att de kommer att utöva monopolkontroll över marknaden. De varor och tjänster som produceras utgör en väsentlig del i varje individs konsumtion varför monopolpriser inte kan accepteras. Vi skulle löpa risken att få oönskade sociala och ekonomiska konsekvenser. Det är orsaken till att staten vill ha kontroll och/eller ägande av dessa företag." Lennart Waara et al., *Offentliga sektorns*

Now, at the very close of the 1990s, competition is regularly presented as the most appropriate mode of organising the provision of telephony and other telecommunications services. Several official reports have been commissioned to investigate this significant transformation and to provide advice on policy issues. The predominant interpretation in the great majority of their commentaries and explanations identifies technological change as the primary source for the transformation. Technological change is understood as having the power to unmake organising principles that were natural until recently.

This portrayal of technological change as an autonomous power altering a once natural economic organisation is a major concern of this study. With this study, I aim at contributing to our understanding of order and change in fields of economic activity and in particular at how technological change is interrelated to changes in the economic organisation. This particular interrelation is especially interesting here since in this case it is related to notions of natural order and inevitable change. The transformation of contemporary telecommunications constitutes a point of departure. Or more specifically, the point of departure is provided by an understanding emerging in this transformation that has it that Swedish telecommunication has been a natural monopoly that has been gradually unmade in the last few decades by technological change. The question then is what went into the making of this natural monopoly?

The inquiry is thus pursued in the direction of exploring how the state-owned telephone service monopoly once emerged and later came to be known as a natural monopoly. This is done by an inquiry into how technological change was *interrelated* to changes in economic organisation in the making of the state-owned telephone services monopoly. This inquiry thus sets out on the presumption that technological change may have been important in these matters, but remains open as to how it was related to matters of economic organisation. This serves for a discussion on the role of both technological change and changes in the economic organisation in shaping fields of economic activity, a discussion which ultimately includes the making of notions of natural order and inevitable change.

This study thus takes as a point of departure an understanding emerging in the present transformation of Swedish telecommunications, but sets these contemporary matters aside in the primary inquiry. However, the characterisation of the past as having been a natural monopoly unmade by (inevitable) technological change provides a final point of arrival where this characterisation can be related to my account on the emergence of a new order in Swedish telecommunications. This return to the present,

which happens in the epilogue (chapter 8), allows for a discussion exploring the making of the contemporary notion of a natural (economic) order unmade by inevitable (technological) change.

The remainder of this chapter further presents this study's point of departure. The next section consequently outlines some of the accounts given in a number of Swedish official reports concerning the organisation and change in Swedish telecommunications. This section is followed by a brief historical overview of telephony in Sweden in addition to an even briefer international outlook.

### **The Literal Deconstruction of a National Monopoly**

How have Swedish official reports at different times during the present transformation characterised the past and present of Swedish telecommunications? The aim of this section is to provide a rough answer to this question. In doing this I will look at reports from the 1960s and onwards where issues related to the organisation of telecommunications services provision in Sweden have been discussed, where the starting point is motivated by it being sufficiently prior to the beginning of the present transformation.

The outline thus derived is focused on accounts concerning economic organisation, technology and technological change, and finally on accounts that retrospectively tell of the emergence, sustenance and recent divestiture of the monopoly organisation. A specific concern is how and when the notions of natural monopoly and technological change unmaking a natural monopoly were brought into the series of official reports. First, however, the transformation of Swedish telecommunications is depicted in the shift in their accounts concerning monopoly and competition.

#### **From a de facto monopoly to the necessity of competition**

The issues of monopoly and technological change were not central in official reports in the 1960s. An official report from 1960 on the organisation of state-owned enterprises just mentioned that the Swedish Telecommunications Administration had no legal monopoly in its operations within telecommunication, but that competition nevertheless was limited:

The Telecommunications Administration, contrary to the Post Office Administration, has no legal monopoly on its operations within telecommunication. In practice, however, the Administration is responsible for the main part of the public telecommunication within the country and with other countries. ... The only fields where competition can be said to

occur to some extent are in the reception of meteorological reports and news over radio from abroad.<sup>2</sup>

The main concern of this report was rather the appropriateness of the organisational forms presently used for state-owned enterprises. On this issue it was reported that in 1911 the Telecommunications Administration, then known as the Telegraph Administration, had become transformed from being more of a civil service department into a state-owned public enterprise.<sup>3</sup> The report further mentioned a few financial regulations put on the Administration at that time. For instance, the Administration had to have its operating costs accepted by the government and the volume of investments had similarly to be accepted by the government. The tariffs charged by the Administration, according to this report, were also set with guidance of socially motivated principles:

The guiding principle for setting tariffs for the services the Telecommunications Administration provides is that the Administration's whole operations yield a surplus after deducing operating costs. This surplus shall, with a minor profit margin, cover the State's expense of interest on the funds lent to the Administration's investments.

The tariffs applied at the Telecommunications Administration are largely standard rates, which in individual cases do not cover the Administration's prime costs. This arrangement is dictated by social considerations.<sup>4</sup>

The Telecommunications Administration's obligation to provide services to all was underscored according to the report by its de facto monopoly.<sup>5</sup> The Administration, it was continued, regarded itself obliged to provide the same services at the same prices to all citizens regardless as to whether they lived in a town or in the countryside far removed from the nearest telephone exchange.

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<sup>2</sup> Original sentences (in Swedish): "Televerket har i motsats till postverket icke någon lagstadgad monopolställning på sin verksamhet inom telekommunikationen. I praktiken svarar verket emellertid för huvuddelen av den allmänna telekorrespondensen inom landet och med andra länder. ... De enda områden, där en viss konkurrens kan sägas förekomma, gäller radiomottagning av meteorologiska rapporter och nyhetskommunikéer från utlandet." Finansdepartementet, SOU 1960:32, "Statliga företagsformer (V): Betänkande med förslag till reformering av de nuvarande statliga företagsformerna mm." (Stockholm: Esselte, 1960), p. 41

<sup>3</sup> This was done to give this and some other involved state-owned businesses, such as the Post Office Administration and the Railway Administration, a somewhat greater independence than had ordinary civil service departments. *Ibid.*, p. 20.

<sup>4</sup> Original sentences (in Swedish): "Den ledande principen vid bestämmandet av taxor för de tjänster televerket tillhandahåller är, att verkets rörelse i dess helhet, sedan driftkostnader och avskrivningar blivit täckta, skall lämna ett överskott, som med en mindre vinstmarginal skall täcka statens ränteutgifter för de i verkets anläggningar investerade lånemedlen. De taxor som tillämpas vid televerket är i stor utsträckning enhetstaxor, vilka i de enskilda fallen icke alltid täcker verkets självkostnader. Samhälleliga skäl har förestavat denna ordning." *Ibid.*, p. 42.

<sup>5</sup> *Ibid.*, pp. 59-60.

Neither the monopoly nor technological change were thus given much attention in the report on state enterprises from 1960. The report briefly reported that the Telecommunications Administration itself manufactured a large share of the equipment used in the network, and that it had recently entered into an agreement with LM Ericsson to share research on electronic switching.<sup>6</sup> However, the monopoly with its socially motivated tariff structure was presented as an unproblematic matter without reference to technology or technological change.

This was markedly in contrast with how the issues of monopoly, tariffs and technological change were discussed three decades later. Then, an official report concerning the social and regional issues of the Post Office and Telecommunications Administration suggested that the earlier taking of social and regional considerations in the setting of tariffs in different countries had indeed depended on technological change and the financial development this had created.<sup>7</sup> The existence of a legal or de facto monopoly, this report continued, had further been decisive in making it possible to take such 'non-commercial' considerations. Now technological change had consequences in quite the opposite direction according to the report:

It is again the technological development that is the primary cause, but now it leads to increased competition on the telecommunication market and therefore to demands for levelling prices closer to costs for an increasing share of the telecommunication's services. The competition reduces, in turn, the possibilities for the traditional telecommunication providers to take non-commercial considerations.<sup>8</sup>

In short, the report from 1990 asserted that technological change, in conjunction with a monopoly, had been the premises that historically had made 'non-commercial' considerations in the setting of tariffs unproblematic but that technological change more recently had come to press for competition thus making the previous order problematic and necessary to alter.

This reference to changing conditions affecting the setting of tariffs was well in line with other official reports that had discussed the issues of tariffs and competition since the mid 1980s. The transformation of the tariff structure, for instance, was the subject of an official report from 1986 where it was argued that the present tariff

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<sup>6</sup> Ibid., pp. 41-42.

<sup>7</sup> Kommunikationsdepartementet, SOU 1990:27, "Post och Tele: Affärsverk med regionalt och socialt ansvar: Betänkande av Post- och Teleutredningen," (Stockholm: Allmänna Förlaget, 1990), p. 82.

<sup>8</sup> Original sentences (in Swedish): "Återigen är det den tekniska utvecklingen som är grundorsaken, men nu genom att den leder till ökande konkurrens på telemarknaden och därmed krav på kostnadsanpassning i prissättning för allt större delar av teleutbudet. Konkurrensen leder i sin tur till att de traditionella teleföretagens möjligheter att ta icke-kommersiella hänsyn begränsas." Ibid., p. 83.

structure had to be altered since it would otherwise stimulate inefficient competition.<sup>9</sup> Telephone tariffs at the time were set on the basis of local calls being subsidised by long distance and international calls, revenues from the former being far below and from the latter being far above the marginal cost.<sup>10</sup> Subsequently in the late 1980s the social and regional considerations were included in a set of tele-political objectives where their achievement was positively related to competition.<sup>11</sup> Moreover, in 1996, an official report entitled ‘modern telecommunications for everyone’ reported that competition would continue to be an important means to fulfil the objectives of the telecommunications policy.<sup>12</sup> Competition, the report continued, would both contribute to the provision of a multitude of services and a freedom of choice to the users as well as create efficiency in the provision of these services.

In conclusion, this brief outline depicts a shift in the accounts provided by some official reports. In the report from 1960 neither the monopoly nor the setting of tariffs were considered problematic, whereas several accounts from the 1980s and 90s have presented competition, technological change, and the resetting of tariffs as pivotal issues. In recent accounts competition has furthermore been identified as the necessary means to the end of providing tariffs beneficial to the users in a manner that resembles how previously the monopoly had been identified as central in allowing social and regional considerations to influence the setting of tariffs.

Moreover, technological change is generally given a more central role since the mid 1980s. Technological change has been both depicted as something that in the past has been obedient to the monopoly, making ‘non-commercial considerations’ possible, and as something that more recently has begun unmaking the foundations of the past monopoly, fostering competition instead and thus a rearrangement of how tariffs beneficial to the users are to be achieved. Thus, in such accounts both the past economic organisation and the present changes are depicted as subordinated to technological change.

### **‘Natural monopoly’ entering into the vocabulary of official reports**

The concept of a natural monopoly was not present in the 1960 report. Indeed, the monopoly organisation was hardly accounted as an issue. As late as 1978 an official

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<sup>9</sup> Ibid., p. 14.

<sup>10</sup> Kommunikationsdepartementet, Ds K 1986:1, “Nya taxestrukturer för ett rundare Sverige: Rapport utarbetad av en särskild arbetsgrupp för långsiktiga teletaxefrågor,” (Stockholm: Allmänna Förlaget, 1986), p. 6.

<sup>11</sup> Kommunikationsdepartementet, SOU 1992:70, “Telelag: Betänkande av Telelagsutredningen,” (Stockholm: Allmänna Förlaget, 1992), pp. 169-170.

<sup>12</sup> Kommunikationsdepartementet, Ds 1996:38, “Moderna telekommunikationer åt alla,” (Stockholm: Fritzes, 1996), p. 153.

report concerning state monopolies briefly noted that telecommunications was a field where it was difficult to avoid monopoly for economic reasons.<sup>13</sup> This assertion alluded to a notion of natural monopoly, but the term was not explicitly used nor the concept discussed.

As a concept, natural monopoly gradually entered into the vocabulary of official reports in the mid 1980s, that is, at the same time as the monopoly was considered increasingly problematic. Furthermore, the entrance of the concept into official reports was particularly related to official reports published by *The Expert Group for Studies in Public Economy* (ESO). This group was established in the early 1980s as a means to broaden and deepen the basis for future decisions pertaining to the state budget and the economy of the society.<sup>14</sup> These reports, which have a freer role in relation to the ministries than have ordinary official reports, represent an arena for economists interested in the public economy. The increased use of the concept of natural monopoly in official reports is thus concurrent both with the rise of the issues of monopoly and competition within the field of telecommunications and the establishment of a new forum for economists as experts in discussions related to public policy.

An official ESO report from 1991 on the possible advantages of incorporating certain state-owned public enterprises, including the Telecommunications Administration, provided a definition of what constituted a natural monopoly.

The conditions for actual competition are by definition highly limited on markets with natural monopolies. A natural monopoly is characterised as we know by declining average costs or scale economies which makes it efficient with only one enterprise.<sup>15</sup>

Since its entrance into the official reports, natural monopoly has often appeared in association with discussions about how to re-organise and re-regulate the field of telecommunications in face of technological change. In an official report on the transforming telecommunications sector from 1987 it was, for instance, affirmed that technological change together with an increasingly differentiated demand altered the

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<sup>13</sup> Budgetdepartementet, SOU 1978:48, "Konkurrens på lika villkor: Betänkande av monopolutredningen," (Stockholm: Allmänna Förlaget, 1978), p. 47.

<sup>14</sup> This section on ESO draws on the work of Agneta Hugemark, a sociologist who in her thesis examined the role of how economists in Sweden from 1975 came to frame issues related to the welfare state. On ESO as a positional institutionalisation of economists as experts, see Agneta Hugemark, *Den fängslade marknaden: Ekonomiska experter om välfärdsstaten* (Lund: Arkiv förlag, 1994), p. 160-162.

<sup>15</sup> Original sentences (in Swedish): "Förutsättningarna för faktisk konkurrens är definitionsmässigt starkt begränsade på marknader med naturliga monopol. Ett naturligt monopol karaktäriseras ju av fallande styckkostnader eller skalfördelar som gör att det är kostnadseffektivt med endast ett företag." Finansdepartementet, Ds 1991:77, "SJ, Televerket och Posten - Bättre som bolag? Rapport till Expertgruppen för studier i offentlig ekonomi (ESO)," (Stockholm: Allmänna Förlaget, 1991), p. 25.

conditions for international regulation. Changes in technology and demand, the report stressed, “brings the societal aspects of the telecommunications services to the fore, and especially the arguments related to the ‘natural monopoly’ of the telecommunications network.”<sup>16</sup>

An official ESO report on what businesses the State should own from two years later used natural monopoly to denote infrastructure industries including telecommunication and railroads.<sup>17</sup> The report affirmed that economies of scale in such industries was a prerequisite for efficient and fair provision of services, and that historically the “state ownership also can be explained as a move which would prevent private owners from profiting from the monopoly situation.”<sup>18</sup> Now, the report stressed, the natural monopolies were increasingly exposed to competition.<sup>19</sup> Again technology, together with new methods to organise the production of services, were put forward as a prime force.

In official reports from the 1990s the concept of natural monopoly has furthermore been used in efforts to dissect different parts of the telecommunication system for individual characterisations. In the official ESO report from 1991, for instance, it was affirmed that it was only a certain part of the telecommunication system that could be fully termed as being a natural monopoly:

In the field of telecommunications it is primarily the outer parts of the network, that is, those that connect the customers to the main network, which can be described as a natural monopoly. The demand for traffic on the main network and for international traffic is large enough to neutralise the element of economies of scale and natural monopolies.<sup>20</sup>

The efforts to dissect the field in this manner were closely linked to the issue of competition, or rather obstacles for achieving competition. An official report from 1992 on the transforming field of telecommunications emphasised that the swift

<sup>16</sup> Full sentence (in Swedish): “Dessa förändringar aktualiserar också i allt högre grad de samhällsliga aspekterna på teletjänsterna, särskilt argumenten som har med det naturliga monopoliet för telenätet att göra och fördelarna med att förvaltningarna har en bred verksamhet.” Kommunikationsdepartementet, Ds K 1987:9, “Tele i förändring: Rapport från Kommunikationsdepartementets referensgrupp för telefrågor,” (Stockholm: Allmänna Förlaget, 1987), p. 8.

<sup>17</sup> Finansdepartementet, Ds 1989:23, “Vad ska staten äga? De statliga företagen inför 90-talet: Rapport till Expertgruppen för studier i offentlig ekonomi (ESO),” (Stockholm: Allmänna Förlaget, 1989).

<sup>18</sup> Full sentence (in Swedish): “Statens ägande kan också förklaras av att privata ägare skulle förhindras att utnyttja monopolställningen i eget vinstsyfte.” Ibid., p. 14

<sup>19</sup> Ibid., p. 83.

<sup>20</sup> Original sentence (in Swedish): “För teleområdet är det främst nätets yttre delar, de som ansluter kunderna till huvudnätet, som kan beskrivas som ett naturligt monopol. För trafiken på huvudnätet och för den internationella trafiken är efterfrågan tillräckligt stor för att neutralisera inslaget av skalfördelar och naturligt monopol.” Finansdepartementet, Ds 1991:77, ESO, p. 26.

technological development and changes in demand made it impossible for one actor to meet all demands.<sup>21</sup> Increased competition was therefore according to the report a prerequisite for achieving a telecommunication market that worked well over the long-term.

This official report from 1992 subsequently provided a few specific incidents and labelled these as “examples of different kinds of obstacles to competition on the Swedish telecommunication market with one dominating actor in a well established network where certain parts of the market are characterised by natural monopoly.”<sup>22</sup> The obstacles were according to the report related to the issue of interconnecting traffic and the Telecommunications Administration’s control over the so-called access network.<sup>23</sup> Competitors on long-distance and international telephony had to access their customers through the Administration’s access network, which necessitated interconnection of their networks to the network of the Administration. It was stated in the report that competition on providing alternative access networks would be limited for the foreseeable future. It was therefore pressing, the report stressed, that interconnection to the access network was provided under reasonable conditions.<sup>24</sup>

The concept of natural monopoly thus became through the issue of interconnection conditions linked to questions of enabling competition in other parts of the dissected telecommunication system. In this newer account technological change was not only depicted as a force enabling competition in areas that once had been natural monopolies. Technological change began also to be depicted as a force which required competition to permit the achievement of an efficient provision of services. It was in this latter respect the depiction of the access network as a remaining natural monopoly fitted in. New technologies had not yet, this newer story went, eradicated the natural monopoly of the access network and this situation had to be dealt with since technological change necessitated competition in other parts of the system.

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<sup>21</sup> Kommunikationsdepartementet, Ds 1992:86, “Svensk telemarknad i förändring,” (Stockholm: Allmänna Förlaget, 1992), p. 43.

<sup>22</sup> Original sentence (in Swedish): “De problem som refererats här är exempel på olika typer av konkurrenshinder på den svenska telemarknaden med en dominerande aktör i ett väletablerat nät där vissa delar av marknaden karakteriseras av naturligt monopol.” *Ibid.*, p. 44.

<sup>23</sup> The access network is the part of the telephone network closest to the subscribers. Confer the older notions of local network and local exchange as described in the glossary.

<sup>24</sup> *Ibid.*, p. 7. Interconnection was central in another official report from 1992 that specifically concerned the new telecommunications legislation in preparation. This report considered interconnection an area where conflicts were prone to appear and affirmed that the parties sometimes had opposite interests to defend in the negotiations. This report subsequently spent several pages on discussions on how such conflicts were to be resolved. Kommunikationsdepartementet, SOU 1992:70, pp. 254-264.

The depiction of the access network as a remaining natural monopoly prevails in later reports, although with increasingly explicit reservations about the role further technological change may have. An official ESO report from 1996 on the 'next step in telecommunications policy' noted that new technology may make the notion of natural monopoly completely irrelevant in the field of telecommunications. "Even today many think," the report continued, "that no natural monopolies exist in the field of telecommunication."<sup>25</sup> However, the report was not inclined to go as far in its own conclusions:

Using the concept of necessary facility... as a point of departure, one can define the local networks, access networks, as natural monopolies, at least in the present situation.<sup>26</sup>

### **A few retrospective accounts from official reports**

The official reports, as is already apparent from the above, have to some extent provided accounts concerning the past of Swedish telecommunications. In this, they have thus furnished some bits and pieces from the history of Swedish telecommunications into contemporary discussions. The purpose of this subsection is to present some of these retrospective accounts with the view of depicting what have been taken as formative moments and how the issues of economic organisation and technological change have been understood when looking specifically at the past.

The report from 1987 on the transforming telecommunications sector fixed its retrospective account about the regulation of the Swedish telecommunication market in the prehistory of the state-owned monopoly.<sup>27</sup> The report affirmed that the last time the issues of competition and monopoly had been topical was about 100 years ago and that the present regulations stemmed from that time. It was also reported that telephone co-operatives and telephone companies were established in the 1880s and that there had been several competing telephone networks in Stockholm in 1885. A government notification promulgated in 1883 was furthermore depicted as an important regulation at the time, since to some extent it had limited the possibility for private enterprises to erect private telephone lines without the consent of the government. The report also contains an account of discussions in the late 19<sup>th</sup> century concerning the further

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<sup>25</sup> Full sentences (in Swedish): "Inslaget av naturliga monopol är därmed mindre, och ny teknik gör att begreppet kanske kommer att bli helt irrelevant i sammanhanget. Många menar att det redan i dagsläget inte finns några naturliga monopol på teleområdet." Finansdepartementet, Ds 1996:29, "Nästa steg i telepolitiken: Rapport till Expertgruppen för studier i offentlig ekonomi (ESO)," (Stockholm: Fritzes, 1996), p. 115.

<sup>26</sup> From English summary, *ibid.*, p. 169.

<sup>27</sup> Kommunikationsdepartementet, Ds K 1987:9, pp. 13-15.

regulation towards a state-owned monopoly, but that these had ended without any such legislation being enacted:

The issue lost in importance when the Telegraph Administration increasingly began acquiring the private networks, thus gradually gaining a dominating position without legislation. The government postponed deciding on the matter, and wrote the matter off in 1900. The issue of a legislated Swedish telecommunication monopoly was thereby closed for the present.<sup>28</sup>

Finally, this report affirmed that the “Telecommunications Administration’s de facto monopoly ... has essentially been uncontested since 1918.”<sup>29</sup> A subsequent official report from 1992 on ‘the transforming field of telecommunications’ filled in that there had been two competing telephone operators in Stockholm until 1918, the Telegraph Administration and Stockholm Telephone.<sup>30</sup> In 1918, however, the Telegraph Administration had acquired the network of Stockholm Telephone, an event that thus had marked the beginning of the Administration’s de facto monopoly.

Despite noting that the monopoly had been uncontested after 1918, little has been said in these official reports about the period between 1918 and 1980. Yet, a few pieces can be compiled about this rather long time-span. There have, for instance, been passing references to collaborations between the Telecommunications Administration and LM Ericsson.<sup>31</sup> Moreover, one official report informed that the technical development of the telecommunication network had been gradual since the 1920s:

The technical development of the telecommunication network has been gradual since the beginning of the 1920s with the introduction of automatic switching and billing.<sup>32</sup>

Turning to the recent transformation, the official report from 1996 on ‘modern telecommunications for everyone’ outlined a good account of the transformation prior to 1996. In its account of the pre-history to the telecommunications legislation enacted

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<sup>28</sup> Original sentences (in Swedish): “Med hänsyn till att telegrafverket vid denna tid i allt större utsträckning började köpa in de enskilda näten, och telegrafverket därmed utan lagstiftning fick en allt mer dominerande ställning, förlorade frågan emellertid sin aktualitet. Kungl. Maj:t uppsköt ärendets avgörande för att helt skriva av det år 1900. Därmed var också frågan om ett lagreglerat svenskt telemonopol tills vidare avskrivet.” *Ibid.*, p. 15.

<sup>29</sup> Full sentence (in Swedish): “Televerkets faktiska monopol på att anlägga telenät och bedriva televerksamhet, d.v.s. erbjuda tjänster via nätet, har sedan 1918 varit praktiskt taget obestritt.” *Ibid.*, p. 12.

<sup>30</sup> Kommunikationsdepartementet, Ds 1992:86, p. 31.

<sup>31</sup> See, e.g., Industridepartementet, SOU 1978:85, “Statligt företagande i samhällets tjänst: Betänkande av Statsföretagsutredningen,” (Stockholm: Allmänna Förlaget, 1978), p. 283.

<sup>32</sup> Original sentences (in Swedish): “Den tekniska utvecklingen av telenätet har skett successivt från början av 1920-talet när man började automatisera dirigering och taxering av lokalsamtal.” Kommunikationsdepartementet, SOU 1992:70, p. 66.

in 1993, the report began by characterising the state of things before 1980 as the state-owned monopoly having had a complete monopoly:

The state-owned Telecommunications Administration had essentially a complete monopoly on telecommunication operations up until 1980. The monopoly was maintained by the Administration's exclusive right to connect terminal equipment (telephones, exchanges and computers) to the telecommunication network. This made any monopoly regulation of the services themselves unnecessary.<sup>33</sup>

This report continued by recounting that the connection monopoly had gradually been divested from 1980, where for instance the Administration's monopoly on telephones had been divested in 1985 and its monopoly on private branch exchanges had been divested 1988-1989. By the beginning of the 1990s these divestitures had created, the account continued, a telecommunications market without any actual regulation. An unsatisfactory state of things, according to this account:

This situation was unsatisfactory since the developments in technology and market mean that the provision of telecommunication services *can hardly be considered as a natural monopoly any longer*.<sup>34</sup>

Thus, this concluding retrospective account of the recent transformation reiterated one recurrent way of using the concept of natural monopoly within official reports, that is, as a characterisation of a past order recently undone, or in the process of being undone, by technological change.

### **The accounts contained in official reports as a point of departure**

The above reading of a selection of Swedish official reports depicts a gradual literal deconstruction of the state-owned monopoly in telecommunications services. At the same time as these reports in different ways have been part of this recent transformation, as remnants they also provide accounts about it. A few points regarding these accounts are worth stressing in relation to the inquiry of this study.

According to one account, the era of the complete monopoly was to have ended in 1980. It is interesting to note in this context that it is only after this point in time that technological change as well as the concept of natural monopoly forcefully entered into the official reports. Yet their appearance in reports issued after 1980 not only served to characterise the present. Technological change was also depicted as something that had

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<sup>33</sup> Original sentences (in Swedish): "Det statliga Televerket hade ett i princip fullständigt monopol på televerksamhet fram till 1980. Monopolet upprätthölls genom verkets ensamrätt att ansluta terminalutrustning (telefoner, växlar och datorer) till telenätet. Någon monopolreglering av själva tjänsterna var därmed inte behövlig." Kommunikationsdepartementet, Ds 1996:38, pp. 43-44.

shaped practices of the past monopoly at the same time as it was also depicted as the force that subsequently had unmade the very same monopoly. The concept of natural monopoly, for its part, was used to an extent in characterising different parts of the telecommunications system as well as characterising the past monopoly.

Technological change and the concept of natural monopoly have also repeatedly appeared together in these accounts. There has been several reports especially in the 1990s that have embodied the notion that the past monopoly was a natural monopoly unmade by technological change. This indeed constitutes the contemporary story accounting for the recent transformation of Swedish telecommunications, a story which can be extracted from recent official reports and reformulated into the following minimal story<sup>35</sup>:

A state-owned natural monopoly provided for the telecommunications services in Sweden, then came technological change, and then the provision of telecommunications services was no longer a natural monopoly and the monopoly was gradually divested.

The beginning of this extracted story, then, constitutes this study's point of departure into how this monopoly once emerged. The accounts in the official reports characterising the past as a natural monopoly unfortunately do not specify when or how this natural monopoly emerged. However, retrospective accounts identified the monopoly as essentially uncontested since 1918, when the competition in Stockholm was terminated upon the Telegraph Administration's acquisition of Stockholm Telephone. Retrospective accounts also stressed the introduction of automatic switching as an important technical development that began during the monopoly epoch. Thus these two events are also important in my inquiry into how the state-owned telephone service monopoly emerged.

Before leaving the official reports, a few words on politics are warranted. Taking official reports as informants has its limitations. For instance, these sources contain only scant allusions to politics participating in shaping Swedish telecommunications. Since official reports are part of the political system, however, politics are perhaps too close to home. The reports are made to investigate the state of things and to suggest political action. The very existence of a large number of reports issued in the last two decades on these matters is in itself a manifestation of a political facet. Indeed, as Hannah Arendt

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<sup>34</sup> Emphasis added. Original sentence (in Swedish): "Denna situation var otillfredsställande då den tekniska och marknadsmässiga utvecklingen innebär att tillhandahållandet av teletjänster knappast kunde betraktas som ett naturligt monopol längre." *Ibid.*, p. 44.

<sup>35</sup> On minimal stories and story-making in economics, see D. N. McCloskey, *The Rhetoric of Economics*, 2nd ed. (Madison: University of Wisconsin Press, 1998), pp. 13-15 and D. N. McCloskey, *If You're So Smart: The Narrative of Economic Expertise* (Chicago: University of Chicago Press, 1990), esp. pp. 25-27.

once pointed out, speech and politics are intimately intertwined.<sup>36</sup> Thus, although the reports does not utter much about politics, the political aspect is surely there, albeit difficult to unveil. Although the politics of the present transformation is not within the scope of this study, I will have reason to return to the issue of politics and official reports at the end of the concluding chapter when discussing some consequences of the retrospective natural monopoly characterisation depicted in the minimal story above.

### **Telephony in Sweden, a Few Exterior Facets**

The evolution of national and international telecommunications is one of modern society's greater marvels. With new technologies physically manifested in an interconnected complex of wires, cables, exchanges and terminals people have acquired new ways to communicate within their neighbourhoods and across the globe. During the last one hundred years, the telecommunications network has reached into our offices, homes, and in later years also into our pockets. Telecommunications have evidently permeated most aspects of society, and there are scholarly histories on how the proliferation of telecommunications have influenced and become entwined with the organisation of business, international politics, social life, gender, and culture.<sup>37</sup>

To give a brief but comprehensive overview over the history of telecommunications is virtually impossible, even if focusing on telephony in one country. The aim of this section is simply to provide a few more exterior facets within which the subsequent inquiry takes place. The first part provides some pictures from the history of Swedish telephony as accounted in secondary sources and official statistics. The second part provides a few pictures concerning the field of Swedish telecommunications as embedded in some multinational and international settings.

#### **Some measures of the proliferation of telephony in Sweden**

When the telephone came to Sweden in the late 1870s, Swedish telecommunications was entirely dominated by the telegraph network established and operated by the Telegraph Administration. Soon, however, it was telephony which came to set the pace

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<sup>36</sup> A famous statement of hers is that "...speech is what makes man a political being." Hannah Arendt, *The Human Condition* (Chicago: Chicago University Press, 1958), p. 3.

<sup>37</sup> See, for instance, Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge: Harvard University Press, Belknap Press, 1977); Daniel R. Headrick, *The Invisible Weapon: Telecommunications and International Politics, 1851-1945* (New York: Oxford University Press, 1991); Claude S. Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley: University of California Press, 1992); Michéle Martin, *"Hello, Central?": Gender, Technology and Culture in the Formation of Telephone Systems* (Montreal and Kingston: McGill-Queen's University Press, 1991); and Stephen Kern, *The Culture of Time and Space, 1880-1918* (Cambridge: Harvard University Press, 1983).

in the further development of Swedish telecommunications.<sup>38</sup> The first public telephone network in Sweden was established in Stockholm by a Bell subsidiary in 1880.<sup>39</sup> Soon thereafter companies, municipalities, and co-operative societies established local telephone networks in different parts of Sweden. The Telegraph Administration also gradually began to establish local telephone networks and moreover soon began to acquire some of the other local networks established. There were several hundred local telephone networks in operation by the end of the 1880s, and about 20% of the total number of telephones in Sweden belonged to the Administration's networks. In Stockholm, another company, Stockholm General Telephone (SAT), had established a network in 1883, and by 1888 it had acquired the majority of the shares in Stockholm Bell. These became known as the Stockholm telephone companies, and from 1908, they were completely merged into SAT's new subsidiary Stockholm Telephone.

Figure II-1 provides one picture showing the proliferation of telephones in different networks in Sweden. This picture also represents one important measure devised within the field of telephony, that is, the number of telephones connected to different networks. A number, in its turn, that was regularly and still is taken to represent the size of different networks. The apparently dwindling development of the number of telephones in other public networks from about 1890 had much to do with the Telegraph Administration increasingly acquiring these networks.<sup>40</sup> When the Telegraph Administration acquired the network of Stockholm Telephone in 1918, there were less than 20 other public networks left with a total of around 1,600 telephone sets. The number of other public networks continued to slowly decrease. The longevity of a number of other small public networks after 1918 nevertheless illustrates that the allegedly pure order of the monopoly was not as pure if one takes a closer look. In 1964, however, the order became pure (at least according to the statistics). Then the last but one non-Administration public network ceased, and the volume of official statistics

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<sup>38</sup> As early as 1894 there were more inter-urban telephone calls made than there were telegrams sent. In 1894 there were according to Heimbürger 1.176 million inter-urban telephone calls made, and 875 thousand domestic telegrams sent. It is, however, to simplify to see them as the two competing modes of communication. Firstly, the telegraph continued for a long time to dominate for international communication. Secondly, the telephone became increasingly used for communicating with the telegraph exchange. In 1902, for instance, more than a quarter of all telegrams sent were ordered over telephone. See, Hans Heimbürger, *Det Statliga Telefonväsendet, 1881-1902*, vol. I (Göteborg: Kungliga Telegrafstyrelsen, 1931), p. 139; and Hans Heimbürger, *Svenska Telegrafverket: Det elektriska telegrafväsendet 1853-1902*, vol. II (Göteborg: Kungliga Telegrafstyrelsen, 1938), pp. 404, 494.

<sup>39</sup> This paragraph, unless otherwise indicated, is based on Arne Kaijser, *I Fädrens Spår... Den svenska infrastrukturens historiska utveckling och framtida utmaningar* (Stockholm: Carlsson, 1994), pp. 114-120.

<sup>40</sup> For a study of the Telegraph Administration's acquisition of public networks, see Rikard Skårfors, "Telegrafverkets inköp av enskilda telefontät: Omstruktureringen av det svenska telefonsystemet, 1883-1918," (Uppsala: Uppsala Universitet, 1997).

reported that this meant “that the epoch of privately owned public telephone networks [in Sweden] belongs to history.”<sup>41</sup> The last remaining network accommodated six telephones according to the statistics, and was not mentioned in the official statistical reports after 1964.

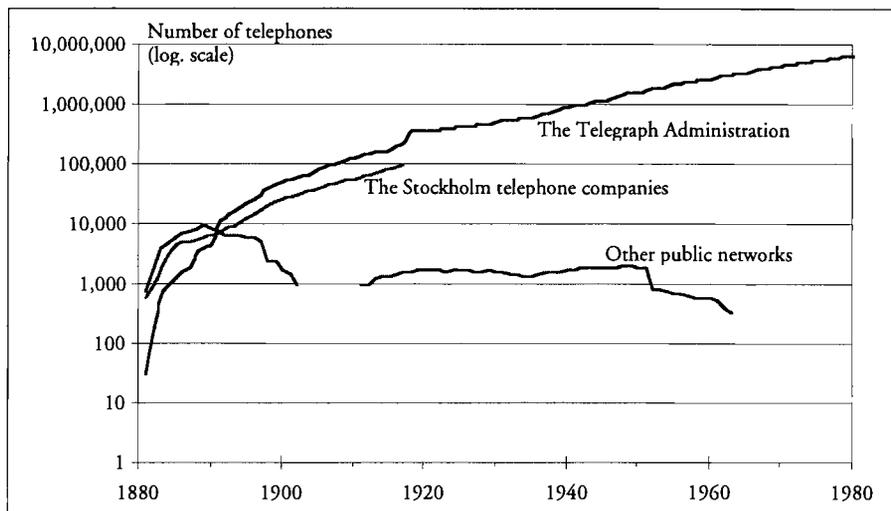


Figure II-1 Number of telephones in different public networks, 1880-1980.<sup>42</sup>

<sup>41</sup> Full sentence (in Swedish): “I och med att Grönlands telefonförening upphört med sin verksamhet, vilket skedde fr.o.m. 1.1.1964, kan man säga, att epoken med privata telefonabonnemått i landet tillhör historien.” Telestyrelsen, *Televerket, 1/7 1963- 30/6 1964*, SOS. (Stockholm, 1965), p. 69.

<sup>42</sup> This chart is based on statistics from several sources. Numbers accounting for the early period have been difficult to obtain, presumably because there was no system in place to produce such numbers.

The numbers for the Telegraph Administration for the period 1881-1902 are from Heimbürger, *Det statliga telefonväsendet, 1881-1902*, pp. 94, 200 and for the period 1903-1910 from Heimbürger, *Svenska Telegrafverket: Telefon, Telegraf och Radio, 1903-1920*, pp. 20, 60 and thereafter from the volumes of official statistics, Sveriges officiella statistik (SOS), published by the headquarters of the Telegraph Administration and from 1954 by the headquarters of the Telecommunications Administration, see: Telegrafstyrelsen, *Telefon och telegraf, 1911-1943*, SOS. (Stockholm, 1912-1944); Telegrafstyrelsen, *Telefon, telegraf och radio, 1944-1951/52*, SOS. (Stockholm, 1945-1953); Telestyrelsen, *Telefon, telegraf och radio, 1952/53-1958/1959*, SOS. (Stockholm, 1954-1960); Telestyrelsen, *Televerket, 1959/60-1971/72*, SOS. (Stockholm, 1961-1973); Televerkets centralförvaltning, *Televerket, 1972/73-1979/80*, SOS. (Stockholm, 1973-1981); and Televerkets huvudkontor, *Televerket, 1980/81*, SOS. (Stockholm, 1982).

The numbers for the so-called Stockholm companies (Stockholm Bell, SAT and Stockholm Telephone) are for the period 1880-1896 taken from a chart in Heimbürger, *Det Statliga Telefonväsendet 1881-1902*, p. 316 and from 1897 to 1917, the last full year Stockholm Telephone operated a network in Stockholm, are from Hemming Johansson, *Telefonaktiebolaget LM Ericsson, del 1 Från 1876 till 1918* (Stockholm: LM Ericsson, 1953), pp. 423, 443.

The numbers for other local telephone networks are hard to establish, and it appears that they were hard to establish also at the time. The numbers for these networks for the period

However, telephone networks cannot be reduced to the number of telephones they accommodate. Where these telephones are located and how they are connected to one another is also important. Their use is to bridge localities, to speak at a distance, and this bridging depends upon the distribution of telephones and the networks connecting them. From 1891, the network of SAT (including Stockholm Bell) was confined to an area defined by a 70-km radius from the city centre of Stockholm. Within this so-called 70 km-zone it operated an impressive network. By the turn of the century, it accommodated about 24,500 telephones.<sup>43</sup> To this should be added the network of the Telegraph Administration which accommodated 9,500 within the same area. In all the 70 km-zone accommodated 46 percent of the total number of telephones in Sweden, which by far surpassed the proportion of the Swedish population living within the 70 km-zone. In the smaller area defined as the city of Stockholm there were about 211 telephones per 1,000 inhabitants in 1911, whereas the corresponding number for the whole of Sweden was 24.7 telephones per 1,000 inhabitants.<sup>44</sup>

The increasing number of telephone sets and telephone calls implied an expanding network of wires, cables, and switches that increasingly pervaded the country. In Sweden in 1900 there were 81,000 telephones wired to one of over 1,000 local exchanges, which in turn were interconnected with almost 30,000 km of inter-urban lines. Thirty years later, the corresponding figures were 522,000 telephones, 4,000 exchanges and 4.8 million km of inter-urban lines. Another thirty years later, in 1960, there were 2.7 million telephones wired to one of 6,900 exchanges and 18.7 million km of inter-urban lines.

The erection of inter-urban lines was a field where the Telegraph Administration dominated at an early stage. The inter-urban network erected by the Administration rapidly reached out to different parts of the country and by 1902 most of the country was already in touch with the inter-urban network.<sup>45</sup> From then on, the expansion of the

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1880-1902 are taken from a chart in Heimbürger, *Det Statliga Telefonväsendet 1881-1902*, p. 316. I have not been able to retrieve statistics on these networks for the period 1903-1910. The numbers for the period 1911-1964 are taken from the volumes of official statistics.

<sup>43</sup> Heimbürger, *Det Statliga Telefonväsendet 1881-1902*, p. 228.

<sup>44</sup> The 70 km-zone had no corollary meaning in census statistics, which makes it difficult to assess the proportion of the Swedish population living within the 70 km-zone. According to the Administration's official statistical report for 1911 the city of Stockholm accommodated 36 percent of the number of telephones in public networks in Sweden, but only 6% of the population. See Telegrafstyrelsen, *Telefon och Telegraf, 1911, SOS* (Stockholm, 1912), p. 36

<sup>45</sup> In the 1890s, it was however not always possible to place calls too far away (>900 km) due to attenuation over long distances. Ironically this meant that people in Stockholm in principle could communicate to people in all parts of Sweden where there were telephones connected to the inter-urban network, while people in the far south could not communicate with people in the far north and vice versa. This was however soon remedied and in the first years of 20th century the country was truly interconnected with inter-urban cables. See, Heimbürger, *Det Statliga Telefonväsendet 1881-1902*, p. 126.

inter-urban network primarily implied repeated increases in capacities. Figure II-2 depicts the geographic extension of the inter-urban network in a few different years, where a line for the years 1890 and 1902 normally represents capacity of one or a few simultaneous telephone calls while a line in 1990 represents a capacity of 1,920 simultaneous telephone calls at the very least.

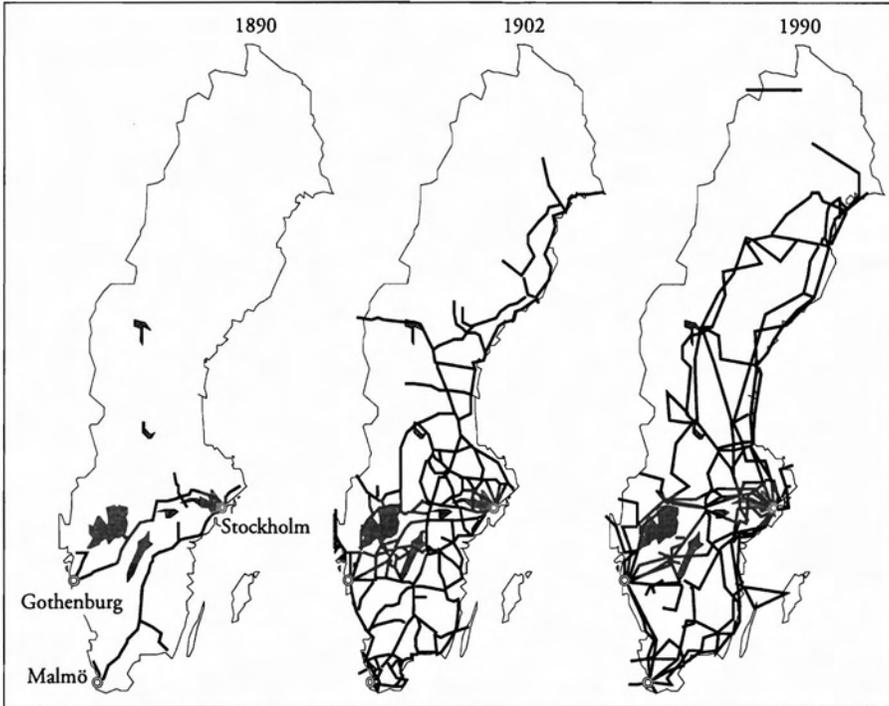


Figure II-2 The Swedish inter-urban telephone network, 1890, 1902 and the digital inter-urban network of 1990.<sup>46</sup>

One transformation of especial importance in this book is the introduction of automatic telephone exchanges and the gradual replacement of the manual exchanges. This transformation was extended over a period of about 50 years, beginning with the putting into operation of the first full-scale automatic telephone exchange in 1924. For several years the automatic operation was limited to local calls. Beginning in the late 1930s subscribers connected to an automatic exchange could gradually make their inter-urban calls by using the dial. Figure II-3 provides one picture of the introduction of automatic exchanges by depicting the number of telephones connected to an automatic and

<sup>46</sup> Sources: Heimbürger, *Det Statliga Telefonväsendet 1881-1902*, pp. 118, 134 and Televerket, Division Telenät, *Riksdigitalen nr 1 (Nit 90 013)*, 1990.

manual exchange respectively. This is the same as the number of telephones from which local calls were ordered by the use of a dial or by talking to an operator.

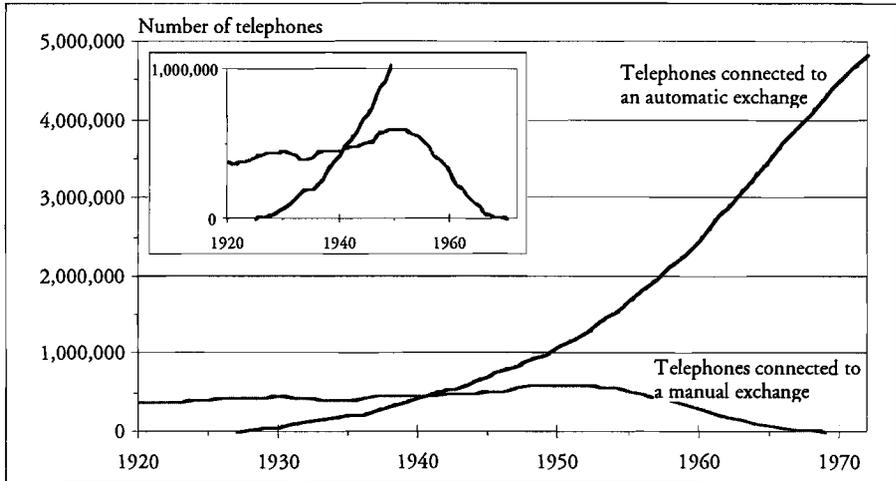


Figure II-3 Number of telephones in the Telegraph Administration's network connected to manual and automatic exchanges respectively, 1920-1972.<sup>47</sup>

Before turning to international dimensions it is worth stressing one salient aspect concerning the sources of the numbers used above. The statistics used here exploit fractions of all the numbers published in a series of official statistics, numbers which moreover were produced and published by the headquarters of the Telegraph Administration and its successor the Telecommunications Administration. In the 1980s, the number of numbers published in this series of official statistical reports gradually declined, and the volumes containing the numbers became ever slimmer. The last volume in this series of statistics was the edition for 1987, and marked the end of a series that had been published as a series of official statistics since 1861.<sup>48</sup> It seems to me that this demise of the long-lived practice of producing official statistics is somehow related to the transformation of Swedish telecommunications. The very existence of the

<sup>47</sup> The graph is based on numbers from the official statistical reports published by the headquarters of the Telegraph Administration, and from 1954 by the headquarters of the Telecommunications Administration. See, Telegrafstyrelsen, *Telefon och telegraf, 1911-1943*, SOS. (Stockholm, 1912-1944); Telegrafstyrelsen, *Telefon, telegraf och radio, 1944-1951/52*, SOS. (Stockholm, 1945-1953); Telestyrelsen, *Telefon, telegraf och radio, 1952/53-1958/1959*, SOS. (Stockholm, 1954-1960); Telestyrelsen, *Televerket, 1959/60-1971/72*, SOS. (Stockholm, 1961-1973); and Televerkets centralförvaltning, *Televerket, 1972/73*, SOS. (Stockholm, 1973).

<sup>48</sup> Recently Statistics Sweden (SCB) have begun to publish a series of statistics entitled *Telecommunications*, and there are moreover an increasing number of companies specialised in producing (often proprietary) numbers on the field of telecommunications.

numbers presented above are then similarly also in a subtler way representing an order now unmade.

### **Some pictures of Swedish telephony in international and multi- settings**

This book is focused on some aspects of the past of telecommunications in Sweden. The field of telecommunications in Sweden has, however, been embedded in multinational and international settings in several ways. The aim of this part is to provide a few facets from some of these settings. First, some multinational comparative facets will be provided. Second, some facets of international connections and associations are briefly touched upon.

Comparisons of the number of telephones in different nations and cities are abundant in the history of telephony. The American Herbert Casson, to take one example from 1910, made the following observations about the proliferation of telephony and the number of telephones in relation to population:

No foreign country has reached the high American level of telephony. The United States has eight telephones per hundred of population, while no other country has one half as many. Canada stands second, with almost four per hundred; and Sweden is third. Germany has as many telephones as the State of New York; and Great Britain as many as Ohio. Chicago has more than London; and Boston twice as many as Paris. In the whole of Europe, with her twenty nations, there are one-third as many telephones as in the United States. In proportion to her population, Europe has only one-thirteenth as many.<sup>49</sup>

Casson further noted, on the basis of such comparisons, that Sweden was the only European country which had “caught the telephone spirit.”<sup>50</sup> The comparison also covered some features of the organisation in different countries and Casson concluded that “[t]oo much Government ... has been the basic reason for failure in most countries.” A similar stance based on similar grounds was taken by Herbert Laws Webb who published *The Development of the Telephone in Europe* in England in 1910, which had a marked pitch against the approaching nationalisation of the private National Telephone Company in Britain.<sup>51</sup> Webb’s survey covered most, if not all, countries in Europe. Countries with a state monopoly in telephony considered were Austria-Hungary, Belgium, Bulgaria, France, Germany, Greece, Italy, Romania, Serbia and Switzerland. On the whole, Webb had little positive to say on what he labelled the

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<sup>49</sup> Herbert N. Casson, *The History of the Telephone* (Chicago: A. C. McClurg & Co., 1910), p. 268.

<sup>50</sup> *Ibid.*, p. 263.

<sup>51</sup> Herbert Laws Webb, *The Development of the Telephone in Europe* (London: Electrical Press Limited, 1910).

‘technical’ and ‘commercial practices’ of these state monopolies, and he affirmed that state control was a curse:

The curse which lies over the telephone business throughout Europe is political control, which absorbs an industry through mere jealousy of its possibilities as a competitor of another State monopoly [the telegraph], only to throttle it and to stunt its growth.<sup>52</sup>

When it came to the Scandinavian countries, Webb declared, that it was in these “...countries that the telephone has had the freest and most rapid development in Europe.”<sup>53</sup> Nevertheless, he admitted, Sweden together with Denmark and Norway had not been complete exceptions to the ‘usual story of political interference’.

Despite criticism such as that provided by Casson and Webb, by 1920 most European countries had state-owned monopolies providing telephone services, which were often operated by the same administration as managed both the telegraph and postal services. Moreover, in the US the Bell Companies at about the same time emerged as a private regulated national monopoly.<sup>54</sup> Although from the vantage point of today the European state-owned monopolies may appear as having been the emergent dominant organisational mode, they had nevertheless been instituted at different points in time and by different means.<sup>55</sup> Moreover, the organisational mode with national monopolies providing telephone services was far from the universal mode of organisation. Indeed, in Denmark, Finland and the Netherlands as well as the municipality of Hull, an organisational mode with local telephone monopolies prevailed after the 1920s.<sup>56</sup>

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<sup>52</sup> Ibid., p. 19.

<sup>53</sup> Ibid., p. 73.

<sup>54</sup> For three accounts of the emergence of this monopoly with somewhat differing interpretations, see Kenneth Lipartito, “System Building at the Margin: The Problem of Public Choice in the Telephone Industry,” *Journal of Economic History* 49 (1989): 323-336; Andrew Davies, *Telecommunications and Politics: The Decentralised Alternative* (London: Pinter, 1994), pp. 41-49, 56-61; and Milton Mueller, *Universal Service: Competition, Interconnection and Monopoly in the Making of the American Telephone System* (Cambridge: MIT Press, 1997), chapters 8-13.

<sup>55</sup> See, for instance, Eli Noam’s accounts on the emergence of the state-owned monopolies in telephony in Germany and Britain, where the German state monopoly on telephony was enacted in a law in 1892 whereas in Britain the state monopoly (except for the Hull telephone system) was created in 1911 subsequent to a period of competition and coexistence of private and public enterprises. Eli Noam, *Telecommunications in Europe* (New York: Oxford University Press, 1992), pp. 10-22. For an overview on the emergence of state-owned national monopolies in Europe, see also Davies, pp. 61-72.

<sup>56</sup> For a discussion of these prevailing decentralised alternatives in the history of telecommunications, see Davies, esp. pp. 72-80. On the differences of regulatory patterns as regards telephony in Denmark, Norway and Sweden up until 1920, see also Lena Andersson-Skog, “The Making of National Telephone Networks in Scandinavia: The State and the Emergence of National Regulatory Patterns, 1880-1920,” in *Evolutionary Economics and Path*

What this discloses is that Swedish telephony at the time of the making of the state monopoly was situated in a world of telephony that was both heterogeneous and changing. Moreover, the books by Casson and Webb represent one kind of connection between the fields of telecommunications in various countries.<sup>57</sup> However, such assessing surveys have not been the only kind of telephone and telecommunications related matter that have travelled across national borders. Engineers, officials, blueprints, telephones, and even telephone exchanges have travelled across national borders since the very beginning of telephony, and some such specific trips involving Swedish telephony are described in chapters 4 through 6. Suffice it to mention here that there has been a conglomerate of cross-traffic between telephony in Sweden and telephony in other countries.

Finally, Swedish telecommunications since the early days of telegraphy have also been situated in a setting of international organisations that have taken part in shaping international connections. For instance, the European and international engineering conferences of which two will appear in chapter 4. Another notable organisation is the International Telegraph Union (ITU), which was founded in 1865.<sup>58</sup> This organisation administered some of the work necessary to make it possible for telegraph transmissions to cross national borders. In the early days of cross border telephony, the work necessary was co-ordinated bilaterally, but in 1924 the International Consultative Committee on Long-Distance Telephone Communications was established to deal with some of the matters related to international telephone traffic.<sup>59</sup> This organisation became later known as CCITT, and was brought into ITU in 1949. CCITT was not only participating in such matters as the setting of technical standards, but has been identified as having been an anchor facilitating bilateral monopolistic bargains in the setting of international tariffs.<sup>60</sup> Thus, in practice CCITT functioned for several decades as a cartel reinforcing national monopolies, a role that has been contested and transformed since the 1980s.

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*Dependence*, ed. Lars Magnusson and Jan Ottosson (Cheltenham: Edward Elgar, 1997), 138-154.

<sup>57</sup> The books by Casson and Webb do not represent the last comparative surveys on telephony that have had ambitions to provide a basis for judgements on the performance of different practices as well as to influence policy. See, for instance, a recent OECD publication on performance indicators that explicitly stated that the indicators presented were developed since "policy makers... need some yardstick by which to evaluate the success or failure of their policies." OECD, "Performance Indicators for Public Telecommunications Operators," (Paris: OECD, 1990), p. 15.

<sup>58</sup> Noam, pp. 293-295

<sup>59</sup> *Ibid.*, pp. 297-298.

<sup>60</sup> Peter F. Cowhey, "The International Telecommunications Regime: The Political Roots of Regimes for High Technology," *International Organization* 44, no. 2 (1990): 169-199, p. 176.

### III

## Inquiring About the Making of a Natural Order

A state-owned natural monopoly provided for the telecommunications services in Sweden, then came technological change, and then the provision of telecommunications services was no longer a natural monopoly and the monopoly was gradually divested.

#### **Framing and Storymaking**

This study focuses on the first part of the above minimal story. The purpose of this chapter is to discuss how to frame the inquiry into the making of the monopoly described, or, in other words, to provide the means of unfolding the story antecedent to the one above, the story which culminates with the state-owned telephone service monopoly firmly rooted.

In the previous chapter I phrased this inquiry as an inquiry into how technological change was *interrelated* to changes in economic organisation in the making of the state-owned telephone services monopoly. The problem with this phrasing is that it upholds a distinction between what constituted technological change and what constituted changes in economic organisation. Although easy to phrase, such a sharp distinction nevertheless severely limits the inquiry in that it presumes in advance that such changes are brought on by essentially different things. Instead, what is called for in guiding the inquiry is a method and a reformulated question that allows for a less pre-compartmentalised inquiry into the composition of the changes that made the monopoly.

This chapter sets forth a position that provides the means for such a subsequent inquiry. In the first section I outline the methodological position taken in this study. In the second section I rephrase the research question of the inquiry by way of a discussion on the specific issues of technological determinism and stabilisation. In the third section I provide some comments on the material used in pursuing the inquiry. In the fourth and

final section I sketch out how this study is situated in, and might contribute to, what I take to be a broader emergent sociology of industry.

## Assuming a Position

### Techno-economic networks

Technology and technological change have often been brought into economic and socio-economic analysis of changes in economic organisation with a sense of uneasiness. As a rule the distinction between what constitutes technology and what constitutes economic organisation is maintained. The result, however, has been a dismal set of ambiguous causations where technological change is interchangeably seen as subservient to the economic organisation and as demanding, forcing the economic organisation to change.<sup>1</sup> Sometimes this conceived duality of subservient and demanding technological change is further conceptually handled by the concepts of normal and extraordinary innovation.<sup>2</sup>

In the socio-technical analysis of technological change, on the other hand, the interwoven, even inseparable, nature of the technical and the social is a central point and has been emphasised by many sociologists and historians of technology, including Bruno Latour, Donald McKenzie and Thomas P. Hughes.<sup>3</sup> The position taken here is to bring such a less compartmentalised posture into the analysis of changes in economic organisation of a field of economic activity, that is, to make the analysis 'techno-economic'.<sup>4</sup> In this, I am principally drawing on notions from the actor-network approach which has been used in the study of both science and technology.<sup>5</sup>

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<sup>1</sup> Cf. the treatment of technological change within some of the official reports as discussed in the previous chapter, where technological change in the past was seen as having been subservient to the monopoly whereas more recent technological change was seen as demanding a divestiture of the monopoly.

<sup>2</sup> These labels have been used, for instance, in discussions about governance transformations in industrial sectors, see John L. Campbell and Leon N. Lindberg, "The Evolution of Governance Regimes," in *Governance of the American Economy, 1880-1930*, ed. John L. Campbell, J. Rogers Hollingsworth, and Leon N. Lindberg, *Structural Analysis in the Social Sciences 5* (Cambridge: Cambridge University Press, 1991), 319-355, pp. 338-339.

<sup>3</sup> For a few important works, see the path-breaking work applying a systems perspective in Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: Johns Hopkins University Press, 1983); the historical sociology in Donald MacKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge: MIT Press, 1990); and the ethnography of high-tech project in Bruno Latour, *Aramis or the love of technology*, trans. Catherine Porter (Cambridge: Harvard University Press, 1996).

<sup>4</sup> The qualifier 'techno-economic' is used instead of the 'socio-technical' that is often used in research within sociology of science and technology precisely to stress my focus on the phenomenon of economic organisation.

<sup>5</sup> See, for instance, Michel Callon, "Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St-Brieuc Bay," in *Power, Action and*

A field of economic activity like Swedish telecommunications is therefore conceived here as a techno-economic network, which denotes the co-ordinated set of *heterogeneous elements* which *interact* more or less successfully in the development, production, distribution and diffusion of goods and services.<sup>6</sup> As opposed to the usual vocabulary of the actor-network approach, the notion of heterogeneous elements is here preferred to the notion of heterogeneous actors.<sup>7</sup> First, since the latter may appear confusing with other conceptions, where the notion of actor is privileged to such entities as organisations or individuals. Second, since the notion of heterogeneous elements leaves more open the question of attribution of agency and action as a collective property.<sup>8</sup>

By heterogeneous elements, this conception emphasises that a field of economic activity is constituted by a conglomerate of elements that often resist being labelled as either social or technical. In one case, for instance, a manual telephone exchange might be identified as having been an element in the techno-economic network constituting Swedish telecommunications. As an element, it then comprised in itself an entire heterogeneous network of switchboards, wiring, jacks, cords, plugs, subscriber's records, operators, supervisors, mechanics, instruction manuals, accounting records, etc., thus opposing the very labelling of the manual telephone exchange as a technical, social or economic element.

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*Belief: a New Sociology of Knowledge?*, ed. John Law (London: Sociological Review Monograph: Routledge & Kegan Paul, 1986), 196-233; Michel Callon, John Law, and Arie Rip, "How to Study the Force of Science," in *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World*, ed. Michel Callon, John Law, and Arie Rip (London: Macmillan Press, 1986), 3-15; and Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Cambridge: Harvard University Press, 1987).

<sup>6</sup> This conception of a techno-economic network is adapted from one provided in Michel Callon, "Techno-economic Networks and Irreversibility," in *A Sociology of Monsters: Essays on Power, Technology and Domination*, ed. John Law (London: Routledge, 1991), 132-164, p. 133.

<sup>7</sup> On the study of science, the actor-network has given rise to criticism from sociologists of scientific knowledge on precisely the notion of heterogeneous actors and the role of the social. Harry Collins and Steven Yearly, two sociologists of scientific knowledge, have accused the actor-network approach as being empiricist, seeing all dichotomies – including the 'Kantian' divide between nature and society – as constructions. Latour and Callon have, in response, accused sociology of scientific knowledge as privileging one ontological position, that of social constructivism. A debate between the two 'camps' is found in the following three chapters: Harry M. Collins and Steven Yearley, "Epistemological Chicken," in *Science as Practice and Culture*, ed. Andrew Pickering (Chicago: Chicago University Press, 1992), 301-326; Callon and Latour, "Don't Throw the Baby Out," in *ibid.*; and Collins and Yearly, "Journey into Space," in *ibid.*, 369-389.

<sup>8</sup> On the issue of action as a collective property see, for instance, Michel Callon and John Law, "After the Individual in Society: Lessons on Collectivity from Science, Technology and Society," *Canadian Journal of Sociology* 22 (1997): 165-182.

Elements are embedded in a network of other elements and they gain their identities and roles from the network.<sup>9</sup> Their *configuration* in terms of how they are defined, enabled and constrained are relational.<sup>10</sup> Moreover, as indicated in the example of a manual telephone exchange, each element is itself constituted by a network of other elements. What in an analysis of changes in a techno-economic network is the appropriate 'level of aggregation' when identifying elements is here not primarily a matter to be assumed in advance by the observer. The detection of elements is rather a matter of what appears as stable elements, what are treated as *black boxes*, in the (empirical) field under inquiry.<sup>11</sup>

This implies, it should be added, that it is also impossible to presuppose a quality of inherent stability in any element. What appears as a stable, black-boxed, element in one instance and from one vantage point may nevertheless appear as a whole gamut of elements in another instance or from another vantage point. The depiction of the manual telephone exchange as having been an element in the past techno-economic network of Swedish telecommunications, to return to the example above, is thus nothing that can be presumed. For instance, in a debate among telephone engineers concerning how the switchboards should be organised, the manual exchange would not be referred to as a single black-boxed element, but the subject would be broken down into several elements.

This way of understanding a field like Swedish telecommunications is quite similar to the notion of technological systems proposed by historian of technology Thomas P. Hughes, and in particular his notion of the seamless web.<sup>12</sup> The conception of heterogeneous elements constituting a techno-economic network is, for instance, in many ways similar to his notion of components constituting a technological system.<sup>13</sup>

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<sup>9</sup> Confer the embeddedness argument in Mark Granovetter, "Economic Action and Social Structure: The Problem of Embeddedness," *American Journal of Sociology* 91 (1985): 481-510.

<sup>10</sup> The notion of configuration draws on Woolgar's notion of configuring the user, Steve Woolgar, "Configuring The User: The case of Usability Trials," in *A Sociology of Monsters: Essays on Power, Technology and Domination*, ed. John Law (London: Routledge, 1991), 57-99, p. 69.

<sup>11</sup> By black box I refer to the notion where a machine, fact or any other heterogeneous entity is come to be counted as one single element. See, for instance, Latour, *Science in Action*, pp. 2-3 and Michel Callon, John Law, and Arie Rip, eds., *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World* (London: Macmillan Press, 1986), p. xvi.

<sup>12</sup> See, for instance, Hughes, *Networks of Power*; Thomas P. Hughes, "The Seamless Web: Technology, Science, Etcetera, Etcetera," *Social Studies of Science* 16 (1986): 281-292; and Thomas P. Hughes, "The Evolution of Large Technological Systems," in *The Social Construction of Technological Systems*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (Cambridge: MIT Press, 1987), 51-82.

<sup>13</sup> Thomas P. Hughes defines technological systems as containing "messy, complex, problem-solving components," and identifies such matters as physical artifacts, organisations,

Moreover, the notion that elements are configured in relation to other elements, has affinities with Hughes' notion of technological style which similarly rejects a reductionist analysis of technology.<sup>14</sup>

The notion of techno-economic networks is also close to the notion of industrial networks introduced by a group of primarily Swedish scholars in industrial marketing, including Jan Johanson, Håkan Håkansson, Anders Lundgren, and Lars-Gunnar Mattsson.<sup>15</sup> The research on industrial networks has developed an appreciation of the mutual embeddedness of technical and economic structures and change in a field of economic activity. Håkan Håkansson and Jan Johanson, for instance, defined an industrial network as interwoven of three networks: a network of actors, a network of heterogeneous and interdependent resources, and a network of transaction and transformation activities.<sup>16</sup> Anders Lundgren, on the other hand, has defined an industrial network as a set "of interrelated actors performing interconnected activities, by transforming and transacting heterogeneous and interdependent resources" and is depicted as "the union of a network of actors and a technological system."<sup>17</sup> Although somewhat different, the notion of an interacting heterogeneous elements recurs in both and the emphasis of the relational feature of economic organisation is at the heart of the notion of industrial networks.<sup>18</sup>

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research programs, and legislation as examples of components that may be part of a technological system. Hughes, "The Evolution of Large Technological Systems," p. 52.

<sup>14</sup> On technological style, see *ibid.*, pp. 68-70.

<sup>15</sup> See, for instance, Jan Johanson and Lars-Gunnar Mattsson, "Interorganizational Relations in Industrial Systems: A Network Approach Compared with the Transaction-Cost Approach," *International Studies of Management & Organization* 17, no. 1 (1987): 34-48; Håkan Håkansson and Jan Johanson, "A Model of Industrial Networks," in *Industrial Networks: A New View of Reality*, ed. Björn Axelsson and Geoffrey Easton (London: Routledge, 1992), 28-34; and Jan Johanson and Lars-Gunnar Mattsson, "Network Positions and Strategic Action: An Analytical Framework," in *Industrial Networks: A New View of Reality*, ed. Björn Axelsson and Geoffrey Easton (London: Routledge, 1992), 205-217. For an overview, see Jan Johanson and Lars-Gunnar Mattsson, "The Markets-as-Networks Tradition in Sweden," in *Research Traditions in Marketing*, ed. Gilles Laurent, Gary L. Lilien, and Bernard Pras, International series in quantitative marketing (Boston: Kluwer Academic, 1994), 321-342.

<sup>16</sup> Håkansson and Johanson, "A Model of Industrial Networks," pp. 28-34. See also an earlier version in Håkan Håkansson, "Introduction," in *Industrial Technological Development: A Network Approach*, ed. Håkan Håkansson (Kent: Croom Helm Ltd, 1987), 3-25, pp. 13-18.

<sup>17</sup> Anders Lundgren, *Technological Innovation and Network Evolution* (London: Routledge, 1995), p. 94.

<sup>18</sup> For discussions on economic organisation as inter-organisational networks, see Johanson and Mattsson, "Interorganizational Relations in Industrial Systems," and Anders Lundgren and Ivan Snehota, "Ekonomisk organisation som nätverk," in *Organisationsteori på svenska*, ed. Barbara Czarniawska (Malmö: Liber, 1998), 9-21.

The notion of techno-economic networks is thus close, but not identical, to the notions of technological systems and industrial networks.<sup>19</sup> There are differences such as the presupposition of an environment outside the system in the systems approach or the distinction between (organisational) actors and resources in the industrial network approach. Yet, these differences should not be overplayed.

In this study I have conceived the notion of techno-economic networks primarily with reference to the actor-network approach, but this notion's focus on a field of economic activity has apparent affinity with the notion of industrial networks. Indeed, the research on industrial networks constitutes a central part of my intellectual heritage. The research on technological systems served, similarly, as an invitation to inquire about technology more seriously than is usual in research on issues pertaining to economic organisation. The above noted differences are not the primary reason for relying on the actor-network. The primary reason is that it provides fruitful tools for inquiring into change without making essentialist assumptions about the different elements involved.

### **Techno-economic controversies and the notion of translation**

How, then, can change in a techno-economic network be analysed, be it the emergence of new knowledge, a new arrangement, or a new machine? This section presents the notions of controversy, translation and scenarios as conceptual tools for investigating this issue. The notion of *translation* is central in the actor-network approach and denotes the various methods where an element (actor) enrolls others. It is thus the essential building block in making concerted action, and hence change, possible.

Let me begin with a reduced illustration of how such a process of translation might appear. Think of the following situation: In an attempt to receive government funding for automatic switches the Telegraph Administration imputes the government to take an interest in improving the telephone service to the subscribers, who are identified as being dissatisfied with the present service. Further, it is asserted that the introduction of automatic switches is the only means by which the service can be improved. What this expresses is an attempt to enrol to allow for concerted action.

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<sup>19</sup> For an explicit discussion of similarities and differences between the actor-network approach and the notion of technological systems, see: Hughes, "The Seamless Web," and Michel Callon, "Society in the Making: The Study of Technology as a Tool for Sociological Analysis," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (Cambridge: MIT Press, 1987), 83-103. Cross-references and discussions on similarities and differences between the industrial networks approach and the actor-network approach are scant, but Easton and Håkansson note an affinity between the two in Geoffrey Easton and Håkan Håkansson, "Markets as Networks: Editorial Introduction," *International Journal of Research in Marketing* 13 (1996): 407-413, p. 412.

Processes of translation involve attempts to define the identity and roles of elements (to be) involved, the delineation of a plot, as well as strategies to realise these attempts.<sup>20</sup> The attempt to define elements and delineate a plot furthermore implies an attempt to establish a specific framing which demarcates those interdependencies within the techno-economic network that are to be taken into account and those to be ignored. In terms of the illustration above, the elements identified are the government, the subscribers, and the automatic switch and their roles are to provide funding, to be dissatisfied with present service, and to provide satisfactory telephone service. The plot is that funding will allow for the introduction of automatic switches which will provide a satisfactory telephone service to the subscribers. Interdependencies accounted for include those between the Administration and the government; and those between the subscribers and the government.

A central moment of translation is the problematisation where an equivalence between two problems is stated so that those interested in solving one problem are enticed to accept a proposed solution for the other.<sup>21</sup> Such a translation of ends into certain means is central where large problems are linked to smaller problems that are held possible to solve. In turn, achieving such a translation presupposes the successful definition of the identity and roles of the elements involved as this is essential in interesting them in participating in the plot. In terms of the illustration the problematisation states an equivalence between the problem of subscribers being dissatisfied with the telephone service and the problem of the Administration needing funds for introducing automatic switches, where the government is enticed to solve the former problem by solving the latter.

Thus far, the attempted enrolment in the illustration has appeared unambiguous. Yet, what if the government resists being interested in solving the problem of dissatisfied subscribers, or if the subscribers resist being identified as dissatisfied with the service in the first place? Or indeed, what if the automatic switch resists in being identified as able to provide satisfactory telephone service? Moreover, unaccounted interdependencies in the techno-economic network might appear as challenging the attempted translations. For instance, what if the telephone operators went on strike in

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<sup>20</sup> Michel Callon actually talks of four different moments of translation: *problematization* as the moment where an actor seeks to become indispensable to other actors; *interessement* as the moment where an actor seeks to lock the other actors into their proposed roles; *enrolment* as the moment where an actor seeks to define and interrelate the various roles proposed; and *mobilisation* as the moment where an actor seeks to ensure that supposed representatives of collectivities are able to represent these collectivities. Callon, "Some Elements of a Sociology of Translation," p. 196.

<sup>21</sup> On problematisation see *ibid.*, pp. 203-206.

resisting the proposed introduction of automatic switches, thus deteriorating the telephone service (even more)?

Since more than one element is involved in translations, their realisation is necessarily iterative where different attempted demarcations of interdependencies and different attempted definitions of elements and plots are set one against the other and negotiated in relation to one another. It is therefore useful to talk of such processes as involving *negotiations*, and to depict the whole process as a *controversy* whose settlement or termination would denote either a stabilisation of thus negotiated translations or the abandonment of the negotiations. This, in turn, implies that the *configuration* of elements, as discussed in the previous section, are the outcome of processes of translations.

In terms of the illustration above it is apparent, for instance, that the efforts to acquire funding for automatic switches would (perhaps) entail negotiations altering the translations were the operators to go on strike. Moreover, if and when automatic exchanges were actually introduced, it would have to be preceded by many more negotiated translations: To translate funds into an operating automatic switch that improves the service in the view of subscribers is no small feat!

In my inquiry I have found it useful to use the concept of *scenario* to outline a negotiated declaration of what constitutes an appropriate (or even inevitable) course of actions and events (a plot) as well as definitions of relevant elements and assertions of how these elements will benefit from the realisation of the scenario.<sup>22</sup> It should be stressed that the notion of a scenario is no more than a convenient label put on a negotiated set of attempted translations requesting further support. However, what it does do is to facilitate in following the sequences of negotiations that prevail in a techno-economic controversy. In terms of the illustration, the original proposal expressed by the Telegraph Administration could thus be characterised as a scenario. It was presumably negotiated before presented to the government, and it would definitely (as I have indicated above) entail further negotiations were it ever to arrive at the putting into operation of automatic switches.

This vocabulary of techno-economic controversies is abstract, but it serves some important purposes. First, this abstract vocabulary serves the purpose of allowing for the same conceptual vocabulary to be used when inquiring into 'different' kinds of attempted translations, be they attempts to establish new knowledge or scientific facts, new organisational arrangements, or new machines, etc. Second, the point is that all

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<sup>22</sup> The notion of scenario can signify an *attempt* to establish an obligatory point of passage. On obligatory point of passage, see Callon, "Some Elements of a Sociology of Translation," pp. 205-206.

elements involved should be treated with a similar language in order not to evoke essentialist distinctions between them. This does not imply, however, that intentionality is extended to things, nor that mechanism is extended to humans.<sup>23</sup> The point is simply to refrain from fixing the identity and role of participating elements if these are still being negotiated. No single element is thus here taken as inherently stable or in a position to orchestrate its own world at will.

The third, and perhaps most important, purpose of this vocabulary is to allow an inquiry into the gradual settlement of controversies – concerning such things as the veracity of a statement, the appropriateness of an arrangement, or the efficiency of a machine – while employing a *principle of symmetry*.<sup>24</sup> This principle prescribes that the same causes should be sought for both true and false statements, for both appropriate and inappropriate arrangements, for both working and non-working machines, and so on. Successfully stabilised statements, arrangements or machines should not be explained as being inherently true, appropriate, or efficient, whereas their failed siblings had the reversed properties.<sup>25</sup> Such characteristics of statements, arrangements and machines should be seen as the outcome, and not the cause, of the settlement of controversies and can thus not be taken to explain their settlement. The above presented vocabulary thus allows for retracing controversies with their attempts of translations and negotiations while not judging the ‘winning’ outcome as inherently true and the cause for the settlement to be achieved. In the words of Bruno Latour:

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<sup>23</sup> Michel Callon and Bruno Latour, “Don’t Throw the Baby Out with the Bath School! A Reply to Collins and Yearley,” in *Science as Practice and Culture*, ed. Andrew Pickering (Chicago: Chicago University Press, 1992), 343-368, p. 353.

<sup>24</sup> The principle of symmetry was formulated by David Bloor in his book *Knowledge and Social Imagery* from 1976 as a part of the strong program within sociology of knowledge and postulated that true and false scientific beliefs should be explained using similar types of causes. See, David Bloor, *Knowledge and Social Imagery*, 2nd ed. (Chicago: University of Chicago Press, 1991), p. 7.

The symmetry principle has found widespread acceptance within recent research within sociology of science and technology. See, for instance, Bruno Latour, *We Have Never Been Modern*, trans. Catherine Porter (Hempstead: Harvester Wheatsheaf, 1993), pp. 91-96. For a discussion on the principle of symmetry applied to technology, see for instance MacKenzie, *Inventing Accuracy*, pp. 9-11.

The symmetry principle referred to here is not to be confused with the symmetry thesis of the hypothetico-deductive model of scientific explanations which states that there is a perfect symmetry between the nature of explanation and the nature of prediction. This debated normative model in philosophy of science is often associated with Carl Hempel. For a discussion of the symmetry thesis and methodological issues in economics, and in particular the positive economics put forward by Milton Friedman, see Mark Blaug, *The Methodology of Economics* (Cambridge: Cambridge University Press, 1980), pp. 4-10, 111-114.

<sup>25</sup> Confer Bruno Latour, “Ethnography of a High-Tech case: About Aramis,” in *Technological Choices - Transformations in Material Culture since the Neolithic*, ed. Pierre Lemonnier (London: Routledge & Kegan Paul, 1993), 372-398, p. 374-377

The fate of facts and machines is in later users' hands; their qualities are thus a consequence, not a cause, of a collective action.<sup>26</sup>

The notions of controversies, negotiations, translations, and configuration of elements are all conceived to allow for making a symmetric inquiry into the making of concerted action and thus change. This, in turn, leads to the issue of *stabilisation*, since change here is a matter of a new stabilisation, of the establishment of chains of translation, of locking elements into place, and of the outcome of controversy. In other words, it leads to the issue of how once frail achievements, through further processes of translation, becomes further negotiated and strengthened.

A once frailly established knowledge claim may, for instance, become incorporated into machines and thus reified it becomes strengthened. One picture to illustrate this: A view won in the 1920s held it impossible to calculate the probability of internal congestion in a certain kind of automatic telephone switch. Despite the fact that a test-exchange of such a system was already switching calls, this knowledge contributed to the refrainment from producing and using this kind of telephone switch for larger exchanges. Instead, a modified version of this system was conceived and employed exclusively for small exchanges, thus reifying the knowledge that it was impossible to calculate the internal congestion for large exchanges using that system.<sup>27</sup> More generally, when strengthened, statements and machines increasingly become black boxes incorporated into other black boxes.<sup>28</sup> Thus, stabilisation is a process that creates and reinforces asymmetries between the true and the false, between the working and the non-working.

From this it follows that resistance becomes increasingly costly as statements and machines are strengthened. This goes for all and everyone, whether they be social scientists, engineers, natural scientists, or average people. Increasingly few have the privilege, that is to say have the necessary resources, to succeed in calling otherwise undisputed statements or machines into question. It is simply increasingly costly to reopen stabilised black boxes. Another picture: A clerk may, for instance, send a telephone bill to a subscriber without referring to the almost endless number of heterogeneous elements and practices that went into the making of it. The bill will

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<sup>26</sup> Latour, *Science in Action*, p. 259.

<sup>27</sup> This example is drawn from the story of the telephone system devised by the Swedish engineer G.A. Betulander and colleagues and will be further described in subsequent chapters. Later, however, it became held possible to make such calculations and factual numbers were produced and reified when larger exchanges of this kind were employed from the late 1930s and onwards.

<sup>28</sup> By black box I refer to the notion where a machine, fact or any other heterogeneous entity is come to be counted as one single entity. See, for instance, Latour, *Science in Action*, pp. 2-3 and Callon, Law, and Rip (eds.), *Mapping the Dynamics of Science and Technology*, p. xvi.

simply state ‘this is the number of calls you made, this is how much you should pay.’ All the elements and practices that went into producing it are safely black-boxed. To dissent, the subscriber will have to impose *trials of strength*, trying to establish, for instance, that the amount shown on the telephone bill does not represent the number on the call meter or that the number on the call meter does not represent the numbers of calls made.<sup>29</sup> As it turns out, it is almost always cheaper to pay the bill than to dispute the validity of the densely knit network establishing the amount on the telephone-account.<sup>30</sup>

### **Economics and techno-economic networks**

As has already been indicated, in this study economics is given a position as potentially being a part of the empirical phenomenon. As a social science of economic organisation, economics cannot be treated as inherently more outside a techno-economic network than any other realm of knowledge that emerges or is brought into the realm of a techno-economic network. In the words of Michel Callon:

Social science is no more outside the reality it studies than are the natural and life sciences. Like natural science, it actively participates in shaping the thing it describes.<sup>31</sup>

How does economics participate in shaping the things it describes? This is ultimately an empirical question. In the economic organisation of fields of economic activity, such things as accounting, official statistics, regulation, and law can be identified as possible mediators linking economic theory to economic practices.<sup>32</sup> More generally, when participating in a techno-economic network, theories and concepts of economic theory frame the network in a manner that makes it intelligible and actionable. In other words, it participates in enacting both the agencies and the organisation of the techno-economic network.

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<sup>29</sup> On trials of strength, see Latour, *Science in Action*, p. 78.

<sup>30</sup> This has not always been the case, as is shown in subsequent chapters.

<sup>31</sup> Michel Callon, “Introduction: The Embeddedness of Economic Markets in Economics,” in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 1-57, p. 29.

<sup>32</sup> See, for instance, the discussion of how certain notions from within economics were brought into the practices of accounting in Peter Miller, “The Margins of Accounting,” in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 174-193, pp. 178-182. See also, the case study on the dual traffic between economics and the US cement industry in Hervé Dumez and Alain Jeunemaître, “The unlikely encounter between economics and a market: the case of the cement industry,” in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 222-243.

From the position of a constructivist sociology, framing is always imperfect and costly, however.<sup>33</sup> Actors cannot be disassociated from the inherently heterogeneous network of interdependencies in which they are enmeshed. The economic practices of exchange within a techno-economic network, for instance, are always much messier than the ideas of the market stemming from economics.<sup>34</sup> Nevertheless, once stabilised and settled, controversies related to the framing by economic theories and concepts seem as having ended in the production of objective truths about an independent economic reality. Or indeed as if this economic reality is speaking with a voice of its own with no interference of economics. Much work within sociology and history of science has rendered doubt to the rationalist epistemological claims in natural and life sciences.<sup>35</sup> Similar approaches can, and increasingly are, applied to economics.<sup>36</sup> To assume such a posture is not to patronise economics and economists, just as sociologists and historians of science are not patronising science and scientists. It is a position assumed to understand the interaction between economics and the things it describes, indeed the position is assumed to further the understanding of the making of order and change in techno-economic networks.

This perspective has at least two prominent consequences. First, it provides a new perspective on controversies between contending claims concerning the economics of a particular field. Indeed, the same vocabulary can largely be used on controversies as can the one presented above. Second, this view on the economic theories and concepts eliminates the possibility to judge their presence in a techno-economic network as inherently true or false. The pertinent questions are instead what work went into the stabilisation of a particular framing, and what consequences it has for shaping order and change in the techno-economic network.

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<sup>33</sup> Michel Callon, "An Essay on Framing and Overflowing: Economic Externalities Revisited by Sociology," in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 244-269, p. 252-255.

<sup>34</sup> Nils Brunsson and Ingemund Hägg, eds., *Marknadens Makt* (Stockholm: SNS, 1992).

<sup>35</sup> See, for instance, Harry M. Collins, *Changing Order: Replication and Induction in Scientific Practice*, 2nd ed. (Chicago: University of Chicago Press, 1992) and Bruno Latour, *The Pasteurization of France*, trans. Alan Sheridan and John Law (Cambridge: Harvard University Press, 1988).

<sup>36</sup> See, for instance, Malcolm Ashmore, Michael Mulkey, and Trevor J. Pinch, *Health and Efficiency: A Sociology of Health Economics* (Milton Keynes: Open University Press, 1989); D. N. McCloskey, *Knowledge and Persuasion in Economics* (Cambridge: Cambridge University Press, 1994); Dumez and Jeunemaître; and Yuval P. Yonay, *The Struggle over the Soul of Economics: Institutional and Neoclassical Economists in America between the Wars* (Princeton: Princeton University Press, 1998).

## Inquiring About the Making of an Order

In this section I rephrase the inquiry on the making of the state-owned monopoly. This is done by way of several steps. The first two steps concern the problems of technological determinism and stabilisation, two issues which are main reasons behind writing this book. The following step presents the general research question of this study, which then is further refined in the final step about the point of entry and exit chosen for the subsequent inquiry.

### The problem of technological determinism

The electromechanical telephone exchange gives you society with a national monopolist; the digital communication technologies, society with competition.<sup>37</sup>

Technological determinism, and problems related to it, has a long varied history within the social sciences and the works of Karl Marx appear every so often in discussions concerning technological determinism.<sup>38</sup> But technological determinism is not solely a long-standing scholarly topic. As Leo Marx and Merritt Roe Smith noted, the "...sense of technology's power as a crucial agent of change has a prominent place in the culture of modernity."<sup>39</sup> Indeed. The story extracted from the official reports can be taken as yet another cultural manifestation portraying technological change as an autonomous force demanding change. On the other hand, it will not do to take this as suggesting that technological change is solely an agent in culturally embedded belief.<sup>40</sup> There is too

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<sup>37</sup> This is my free paraphrase of the famous quote from Karl Marx: "The hand-mill gives you society with the feudal lord; the steam-mill, society with the industrial capitalist." Quoted in Robert L. Heilbroner, "Do Machines Make History?," in *Does Technology Drive History? The Dilemma of Technological Determinism*, ed. Merritt Roe Smith and Leo Marx (Cambridge: MIT Press, 1994), 53-65, p. 54.

<sup>38</sup> For a few discussions about technological determinism and the works of Karl Marx, see (in order of original publication): Heilbroner; Nathan Rosenberg, "Marx as a Student of technology," in *Inside the Black Box: Technology and Economics* (Cambridge: Cambridge University Press, 1982), 34-51, esp. pp. 36-39; Donald MacKenzie, "Marx and the Machine," in *Knowing Machines: Essays on Technical Change* (Cambridge: MIT Press, 1996), 23-47; John Street, *Politics and Technology* (New York: Guilford Press, 1992), pp. 31-32; and Bruce Bimber, "Three Faces of Technological Determinism," in *Does Technology Drive History? The Dilemma of Technological Determinism*, ed. Merritt Roe Smith and Leo Marx (Cambridge: MIT Press, 1994), 79-100, pp. 89-100.

<sup>39</sup> Leo Marx and Merritt Roe Smith, "Introduction," in *Does Technology Drive History? The Dilemma of Technological Determinism*, ed. Merritt Roe Smith and Leo Marx (Cambridge: MIT Press, 1994), ix-xv, p., ix. For an essay specifically on technological determinism in American culture, see Merritt Roe Smith, "Technological Determinism in American Culture," in *Does Technology Drive History? The Dilemma of Technological Determinism*, ed. Merritt Roe Smith and Leo Marx (Cambridge: MIT Press, 1994), 1-35.

<sup>40</sup> Such a reading would suggest that culture is less real than is technology, or conversely that technology is less socially embedded than is culture. In this particular case a 'cultural belief' reduction of technological change as agent would be tantamount to reducing the official reports to being solely cultural artefacts. Indeed I do not imply any such reading of the official

much to show that technology and technological change indeed has effects on society, including the economic organisation of industrial fields.<sup>41</sup> Here is the problem of technological determinism: How to recognise the importance of technological change, while avoiding to impute an autonomous internal dynamic to it.

Several different approaches have been employed to handle the problem of technological determinism. Here I will employ an approach consistent with the actor-network approach. Firstly, I take it that autonomous, determining, technological change is largely an effect of the level of analysis. Here I follow Thomas Misa who argues "...across disciplines, authors affirming some version of technological determinism tend to adopt a macro perspective, while those denying technological determinism tend to adopt a micro perspective."<sup>42</sup> Misa continues that to "...invoke technology, on the macro level of analysis, is to compact into one tidy term a whole host of actors, machines, institutions, and social relations."<sup>43</sup> But, and here I part with Misa and join Michel Callon and Bruno Latour, this consolidation is not simply an effect of the level of analysis. The consolidation is an effect of successful structuring at the micro level. In other words, large-scale sovereign macro agents are effects which elude analysis if we a priori assume them to be essentially different than micro agents are:

*There are of course macro-actors and micro-actors, but the difference between them is brought about by power relations and the constructions of networks that will elude analysis if we presume a priori that macro-actors are bigger than or superior to micro-actors.*<sup>44</sup>

From this it follows that technological change as a large-scale force is as much an effect as are the large-scale structures it is said to act upon. To recover the work producing such macro agents, we have to take an interest in the processes which create asymmetries such as the one of micro and macro agents.<sup>45</sup> This is a crucial point: to recover the creation of any asymmetry or dichotomy it is necessary to start off by

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reports. The program I follow here is one which tries to avoid any such a priori distinctions due to imputed essential differences in such entities as technology or the social.

<sup>41</sup> In the domain of economic analysis, the classical reference to the imperative of innovation in shaping the economic organisation is, of course, the work of Schumpeter with his notion of creative destruction, see Joseph A. Schumpeter, *Capitalism, Socialism and Democracy*, 3rd ed. (New York: Harper & Row, 1950), esp. pp. 81-86.

<sup>42</sup> Thomas J. Misa, "Retrieving Sociotechnical Change from Technological Determinism," in *Does Technology Drive History? The Dilemma of Technological Determinism*, ed. Merritt Roe Smith and Leo Marx (Cambridge: MIT Press, 1994), 115-141, p. 118.

<sup>43</sup> *Ibid.*, p. 141.

<sup>44</sup> Michel Callon and Bruno Latour, "Unscrewing the Big Leviathan: How Actors Macro-Structure Reality and How Sociologists Help Them To Do So," in *Advances in Social Theory and Methodology: Toward an Integration of Micro- and Macro-Sociologies*, ed. Karin Knorr-Cetina and Aron V. Cicourel (London: Routledge & Kegan Paul, 1981), 277-303, p. 280.

<sup>45</sup> *Ibid.*, pp. 285-286.

rejecting the presumption that they are made up of essential differences, that is, that they are different in the nature of things. They are made different.

Here lies another crucial point related to the problem of technological determinism. Technology is in this approach, as was presented in the previous section, not seen as made up of essentially different materials from the social. Socio-technical is the adjective often used to denote this interwoven assembly of 'actors, machines, institutions, and social relations' which sometimes gets compacted into the single noun technology. Again, evoking technology as an entity separate from the social or economic is an effect and not in the nature of things.

The problem of technological determinism is thus here resolved by a change of frame. Technological change in its large-scale sovereign form is the result of a heterogeneous micro-structuring which gives it its purely technological and large-scale appearance. This framing has a methodological implication advising the inquiry to "arrive before the facts and machines are black-boxed or... follow the controversies that reopen them."<sup>46</sup> In other words, to retain the structuring resulting in technologies and macro agents it is necessary to examine the work, the controversies and their settlement, which creates them.

Why this approach to resolve the problem of technological determinism rather than any other? The question is warranted. It is possible, for instance, to employ a dialectic frame where changes in technology act upon socio-economic structures which in their turn act upon the development of technology. However, one major problem with starting with a dialectic frame is that it involves the problem of conceptually stabilising the elements whose stabilisation is under examination.

### **The problem of stabilisation**

Because of technological change the field of telecommunication services provision in Sweden is no longer a natural monopoly.

The statement above is my own. I wrote it a little less than a decade ago, while drafting a course paper for an undergraduate course on economic-political analysis. This single statement is as much the starting point of this study as is the story deriving from recent official reports. The pertinent point here is that this statement of mine differs little from many of the quotes elicited from these official reports. In other words, in 1990 I – or the undergraduate student at Stockholm School of Economics I once was – reinforced what was known in the official reports, in economics textbooks, in the newspapers and so on. I was arriving late, after the fact, and equipped with tools from economics shaping my understanding of what was going on. What else could I possibly have done but to

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<sup>46</sup> Latour, *Science in Action*, p. 258.

simply relay the facts as they were told by others? Here is the problem of stabilisation, or indeed of arriving late: How to recognise the importance of facts and asymmetries, while avoiding becoming enslaved by them.

There are many sides to this problem and it comes under many different names. Historians sometimes speak disparagingly of Whig history, within philosophy one may talk about reification and objectification. In all there is this dual aspect of controversies and their settlement, with the many ambiguities while they are going on coupled with the unambiguous outcomes when they have been settled. This aspect of stabilisation poses a real, but interesting, challenge to anyone wanting to make a reflected inquiry about order and change in fields of economic activity.

Here, the advice to arrive before the black-boxing is complete is helpful: To make a reflected inquiry about order and change implies to inquire into the *making* of order and change. The advice contained in the principle of symmetry is also helpful: an inquiry into the *making* of order and change necessitates empirically inquiring into how such distinctions as the one distinguishing between the appropriate and inappropriate arrangement are negotiated in the controversy prior to its settlement. This implies that in addition to concluding that the appropriate arrangement was the outcome of the controversy, the inquiry must seek to uncover how this asymmetric judgement of the appropriate and inappropriate arrangement was created in the process.

All this has implications on what conceptual tools are possible when framing an inquiry. "The trouble with the light of learning," David Rehn said, "is that we can end up believing both the world and ourselves to be already charted when in fact we have been blinded by the light source itself, with the result that our surroundings seem dark and unfathomable while our own noses are brilliantly illuminated."<sup>47</sup> What kind of investigation into the making of the monopoly could be possible if, for instance, the conceptual tools that come with the concept of natural monopoly were to be used? One can suspect that it would differ little from the stabilised accounts of the official reports: The state-owned monopoly emerged because it was a natural monopoly. To make a perhaps extreme analogy, this would be like having a suspected accomplice drawing the boundaries of a crime investigation.

If we are interested in the making of an order like the state-owned monopoly, it appears prudent to investigate the controversies of which it was an outcome rather than to only reiterate the asymmetric winner's account provided by the concept of natural monopoly. More broadly, this points to the general drawback of imposing a conceptual

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<sup>47</sup> The words are actually of novelist Peter Høeg who wrote of the character David Rehn, a defector of mathematics who went to the Congo, in the short story *Journey into a dark heart*. This quote Peter Høeg, *Tales of the Night* (London: Harvill Press, 1997), pp. 19-20.

framework which stabilises exactly the elements whose stabilisation we want to examine.

Yet, the stabilisation is an unavoidable problem for me, since to write is to objectify. The question is what kind of objectification one does, and especially how it relates to the processes of stabilisation under inquiry. The methodological position set out above is indeed devised as to avoid to anticipate and impute asymmetries while still in the making. What technology was made of, and what economic organisation was made of, are here put as matters for the empirical inquiry. To put it differently, the methodological position implies that the investigator should attempt to be as much a relativist as those involved in the processes of stabilisation.<sup>48</sup>

To conclude, what I have done here is to further motivate and expound on the methodological position taken in this study. A position which furthermore necessitates a reformulation of the research question.

### **Research question and its problems**

The contemporary unmaking of the state-owned monopoly provided an opening for inquiring into its making. From the above I have made clear that an inquiry into the making of this monopoly, or order if you like, implies inquiring into its gradual stabilisation or to follow the controversies that reopened it. This study makes use of both strategies. The contemporary unmaking of the order is what warrants this study, and the aim is to retrace the controversies and their settlement which produced this monopoly as an outcome.

What remains is to present how this point of departure was transformed into a specific research question. Given the methodological position used, the view was to examine the controversies and their settlement that produced the monopoly order, while specifically allowing for an inquiry into any possible interplay between technology and economic organisation. Furthermore, the view was to study controversies and their settlement not taking winning asymmetries as intrinsically given in the nature of things. The research question was therefore:

*How were efforts to alter technology interrelated to efforts to alter the economic organisation in the making of the new monopoly order in Swedish telecommunications?*

But here is still a subtle obstacle: How to à priori pose a question while not imposing a rigid frame of asymmetries on the inquiry? The investigator has to be realist enough to pose a question. Yet, in this question I (again) imposed a conceptual asymmetry of my own making, by differentiating between technology and economic organisation. It had

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<sup>48</sup> Latour, *Science in Action*, pp. 99-100.

to do as a starting point, but nevertheless gave me as a late coming realist the upper hand as opposed to those involved in the making of the new order. The question was therefore further refined for plotting a less imposed point of entry.

### **Plotting a point of entry and a point of exit**

The focus of this study is put on the stabilising economic organisation which largely emerged in the 1920s in Swedish telecommunications. The most important contours of this order are firstly the de facto monopoly which formally came in place in 1918 when the Telegraph Administration acquired its last large competitor – Stockholm Telephone. A second important contour is the introduction of automatic telephone exchanges only a few years later, and the subsequent proliferation of such switches. Switches which, thirdly, were purchased to a large extent from the Swedish manufacturer LM Ericsson. The task of plotting a point of entry is to retrace the processes, the controversies, which preceded the emergence of these contours.

There are a number of secondary sources about this period of history of Swedish telecommunications. Most material, however, was either written by people working within either one of the major organisations concerned or depends to a large extent on these sources.<sup>49</sup> Moreover, these accounts were written long ‘after the event’ and contain in addition a tendency to align and interpret events so as to follow the logic of the stabilised asymmetries. The automatic switching system used in Stockholm, to take one example, is often taken as being the best of the alternative switching systems with

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<sup>49</sup> The chief works on the Telegraph Administration were written in several volumes by the Administration’s statistician, Hans Heimbürger. The three volumes of relevance here are Hans Heimbürger, *Det Statliga Telefonväsendet, 1881-1902*, vol. 1 (Göteborg: Kungliga Telegrafstyrelsen, 1931); Hans Heimbürger, *Svenska Telegrafverket: Telefon, Telegraf och Radio, 1903-1920*, vol. 4 (Göteborg: Kungliga Telegrafstyrelsen, 1953); and Hans Heimbürger, *Svenska Telegrafverket: Telefon, Telegraf och Radio, 1921-1945* (Karlskrona: Televerkets Centralförvaltning, 1974).

The histories of LM Ericsson, SAT and Stockholm Telephone up until 1918 were written by Hemming Johansson, who had been engineer at SAT and later managing director of LM Ericsson, Hemming Johansson, *Telefonaktiebolaget LM Ericsson, del 1 Från 1876 till 1918* (Stockholm: LM Ericsson, 1953). At LM Ericsson’s centenary a three-volume history of the company was published, of which the two first volumes were written by professional historians with access to the company’s archives: Artur Attman, Jan Kuuse, and Ulf Olsson, *LM Ericsson 100 år: Pionjärtid, Kamp om koncessioner, Kris, 1876-1932* (Stockholm: LM Ericsson, 1977); Artur Attman and Ulf Olsson, *LM Ericsson 100 år: Räddning, Återuppbyggnad, Världsföretag, 1932-1976* (Stockholm: LM Ericsson, 1977); and Christian Jacobæus, *LM Ericsson 100 år: Teletekniskt Skapande, 1876-1976* (Stockholm: LM Ericsson, 1977). Hence these volumes differ from the internalist accounts, but on the other hand cover such a vast field that their treatment of the issues important here is limited.

There are also other books on special themes, and a whole host of articles. The story of the development of the automatic switching systems in this respect have been especially often recounted, in the Administration’s own technical journal as well as elsewhere.

It has in many cases been impossible to completely refrain from using these secondary sources. To counter the inherent problems with many of these works I have made an effort to use them with caution especially when they impute motives to certain actors or give asymmetric explanations as to the outcome of a particular controversy.

no thorough discussion as to how it came to be counted as the best switching system. One conspicuous version of this story tells of how the *appropriate* switching system *arrived at precisely the right time* and was hence *chosen* for the automation of the network.<sup>50</sup> There is nothing untrue with this story, but it is definitely a Whig version of what happened. There were at the time controversies behind all these points; controversies concerning such things as what an appropriate system should look like and when was the right time to introduce it. It is the exclusion of these controversies that makes for an account of the winner's history only rather than the history of winning and losing.

Such accounts nevertheless had to serve as my starting point in retracing the controversies which preceded the emergence of the monopoly order of the 1920s. Soon, however, letters, reports, contracts, and other archival material primarily from the archives of the Telegraph Administration were increasingly used in search for a less imposed point of entry.

What I found was two concurrent controversies. One had prevailed with varying intensity and focus since at least 1891 and gradually became known as the 'telephone issue' in Stockholm. This controversy concerned the relation between the Telegraph Administration and the dominant telephone operator SAT and later its subsidiary Stockholm Telephone. It was a controversy on the setting of tariffs and enrolment of new subscribers, and it was furthermore linked to repeatedly failed attempts to alter the prevailing order. A particular heated aspect of this controversy concerned inter-connection between the exchanges of the two operators, and what tariffs should be set on calls connected between the two networks. The other controversy emerged around 1907 within the Telegraph Administration and concerned the merits of different manual telephone switching systems, and in particular what system should be chosen for the Administration's planned new and larger exchange in Stockholm. I have chosen to label this controversy as concerning the 'switching system issue'.

Using these two controversies as a point of entry provided a less imposing framing of the inquiry. With this framing, the actual research question became:

*How were efforts to resolve the 'telephone issue' interrelated to efforts to resolve the 'switching system issue' in the making of a new order in Swedish telecommunications?*

Finding a sufficiently appropriate point of exit is as difficult as finding a point of entry. Orders are never absolute, and there will always be controversies and stabilising work

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<sup>50</sup> See, for instance, Torsten Althin, *Telelandet Sverige: Telegrafverket 100 år* (Stockholm: Kungliga Telegrafstyrelsen, 1953), pp. 98-99.

going on.<sup>51</sup> A deeper look into the Swedish telecommunications of the 1920s and 1930s confirms this. Nevertheless, you have to exit at some point claiming that the controversies followed were sufficiently settled. The point of exit of the primary inquiry is set to the early 1930s, where the introduction of automatic switches was well underway and where a tariff reform had become sufficiently established.

The appearance of an abundance of undisputed statements to the effect that the provision of telephony in Sweden is a natural monopoly would have provided a convenient point of exit. However, I have found no such characterisation of Swedish telephony from this period in time. The concept termed natural monopoly within economics can be dated back to at least the turn of the century, but is absent in the making or early sustenance of the new monopoly order. General claims to the effect that a monopoly is more natural (or unnatural) were sometimes uttered in the, at times, fierce debates concerning the ‘telephone issue’ in Stockholm. There are also sometimes statements that later concluded, when the ‘telephone issue’ had been settled for some time, that the transition from competition to monopoly had been a natural course of events.<sup>52</sup> But the specific concept of natural monopoly was as noticeably absent then as it is omnipresent in the official reports of recent decades. The inquiry into the making of the monopoly order is thus an inquiry into the making of an order susceptible to later becoming known as having been a natural monopoly.

The characterisation of the past as having been a natural monopoly unmade by technological change provides nevertheless a final point of arrival in the epilogue (chapter 8). There this retrospective characterisation is related to my account on the emergence of the monopoly order in Swedish telecommunications. This return to the present allows for a discussion exploring the making of the contemporary notion of a natural (economic) order unmade by inevitable (technological) change.

### **On the Drafts, Documents, and Discussions**

The inquiry into the making of the monopoly order was, as I already have noted above, initially guided by secondary sources.<sup>53</sup> Gradually, however, I came to depend more and more on archival material, press cuttings and official documents for disclosing a

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<sup>51</sup> This implies, as John Law noted, that it is more appropriate to talk of organising and ordering rather than organisation and order. Law talks about recursive processes and notes that “the social world is this remarkable emergent phenomenon: in its processes it shapes its own flows. Movement and the organization of movement are not different.” John Law, *Organizing Modernity* (Oxford: Blackwell, 1994), p. 15.

This implies, in its turn, that one should be careful not to impute any particular structural characteristics to stable patterns of organising and ordering, so as to make organising something different in kind to organisation.

<sup>52</sup> See, for instance, Althin, *Telelandet Sverige*, p. 45.

<sup>53</sup> See note 49 on page 46.

plot of more or less interrelated controversies. I am unable to fully outline how the plot of the subsequent chapters materialised, but I will nevertheless here briefly inform on some pertinent features on the making of this plot.

This study depends to a great extent on the documenting practices of a bureaucracy, the Telegraph Administration. Firstly, the archives most heavily relied on were those of the Telegraph Administration. The repositories there range from hand-written letters, internal memos, contracts, drafts of various kinds, and contain also material (such as contracts or correspondence) involving SAT, Stockholm Telephone, and LM Ericsson. (Blessed are the true bureaucracies of the past!) The process of retrieving documents was truly iterative.<sup>54</sup> The final pile of retrieved material grew through my increasingly cultivated acquaintance with both the emerging plot and the archives, counteracted by the dual exhaustion of both myself and the relevant materials contained in the archives.

Secondly, the Telegraph Administration's repository of press cuttings proved to contain an abundance of press cuttings on what was written in Swedish newspapers in relation to telegraphy and telephony.<sup>55</sup> This repository primarily provided access to voices outside the Administration such as subscribers and telephone operators as well as to the official voices of the Telegraph Administration, the government and Stockholm Telephone.

Other complementary sites included the archives of LM Ericsson<sup>56</sup>, the library of Parliament and the Royal Library. In all, however, it proved difficult to find as rich

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<sup>54</sup> I thoroughly went through the documents of at least 40 archive folders with the help of the list briefly describing the content of each folder. All material I considered at least remotely relating to the evolving plot concerning the 'telephone issue' and the 'switching system issue' were photocopied and filed into a binder. One retrieved document led me on repeated occasions into a search for other documents referred to in the first document. Sometimes I was lucky and the web of documents grew. At other times, cited documents proved hard to find. At times, for instance, answers to letters were not found, or an internal memo in a series of memos debating an issue proved to be beyond my reach. At the end, I had photocopies of close to 450 different documents in binders; documents ranging in size from single page notes to large specifications of more than a 100 pages. The documents were indexed in a computer file, depicting such things as its author, date, title, recipient, as well as its place in both the archives and in own my collection of binders. In addition, I took down a few notes on each document to recollect about its possible place in the emergent plot. Printouts of this list later proved to be invaluable when organising and writing what became chapters 4 through 6. The list was also invaluable in my search at other sites for tying together various loose ends.

<sup>55</sup> This repository is held at Telemuseum (The Telecommunications Museum located in Stockholm).

<sup>56</sup> The archives of LM Ericsson was searched for documents, primarily concerning the development of automatic switching systems and concerning SAT. The overall yield was meagre, however. Partly due to the rather unorganised state of the archives, at least at the time. There I did, however, come upon an important set of files compiled by an engineer at LM Ericsson which shed some additional light on a few controversies related to the development of automatic switching systems. In all, only about 40 documents were copied, filed and indexed in

repositories as those left by the Telegraph Administration. This was especially true for terminated legal entities such as Stockholm Telephone or the small firm New Autotelephone Betulander, but was even true of LM Ericsson's past.

Thus the fragments upon which the subsequent story was made to a significant extent were the fragments supplied by the documenting practices of the Telegraph Administration. The boundary of these practices by the same token significantly provided to the boundary of my inquiry. Nevertheless the rich repository of material from several significant controversies enabled me, I contend, to inquire into the efforts of resolving the 'telephone issue' and the 'switching system issue' in the making of the monopoly order.

### **Towards a Sociology of Industry**

The general phenomenon central to this study is order and change in fields of economic activity. With this phenomenon in focus, I like to think of this study as belonging to an emergent field of research that can be labelled *sociology of industry* to borrow a term recently used by economic sociologists Mark Granovetter and Patrick McGuire. In a recent chapter they argued that economic sociology has given too scant interest to middle levels of aggregation such as industries.<sup>57</sup> Understanding order and change of industrial organisation, they affirm, has been largely left to economists. The sociology of industry has in their words to "be a persuasive alternative based on serious research about particular industries and their evolution, rooted in a coherent view of how people and organizations form and co-operate in such a way as to produce those goods and services that consumers demand."<sup>58</sup>

I take a sociology of industry to focus on order and change in fields of economic activity endorsing the embeddedness of industrial sector in matters of science, technology, politics, and economics. Or, in other words, that both order and change are heterogeneously constituted. With this somewhat extensive view on what might be taken to belong to sociology of industry, there are naturally several studies from different disciplines that provide serious accounts on the emergence and shaping of particular industries. Upon ending this chapter, I want to elaborate what I take as important elements of such a field of inquiry and indicate some previous empirical

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the same manner as I had with the documents from the archives of the Telegraph Administration.

<sup>57</sup> Mark Granovetter and Patrick McGuire, "The Making of an Industry: Electricity in the United States," in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 147-173.

<sup>58</sup> Ibid., p. 147.

studies that can be seen as belonging to such an emergent field, before suggesting what this study may contribute to such a field.

The relational character of both order and change are naturally at the heart of any sociology of industry. Here the work by Granovetter and McGuire emphasising interpersonal relations constitutes one distinct strand.<sup>59</sup> Other studies, and most notably within the Scandinavian tradition focusing on stability and change in industrial networks, the focus has been inter-organisational relations.<sup>60</sup>

Developments within science and technology are every so often taken as determinant forces in shaping domains of economic activity. A serious sociology of industry ought therefore to include some kind of sociology of science and technology. In a sociology of industry, such an inquiry into the making of science and technology is primarily motivated to explore how the organising of economic activity is mutually intertwined with the activities to further science and technology. This primary focus on the structuring of the field of economic activity makes it a vantage point that to some extent differs from work within sociology of science and technology proper. In this domain, I have found some work within history of technology to represent the most fruitful in focusing on the intertwined nature between the ordering of industries and developments within science and technology.<sup>61</sup>

A sociology of industry also has to acknowledge the political embeddedness of industries. Here work with noted institutional perspectives predominate, such as Colleen Dunlavy's rich account of the shaping of early US and Prussian railroads.<sup>62</sup> Last, and in relation to the issues of politics and regulation, a sociology of industry ought to include some kind of sociology of economics, since economics undoubtedly jointly develop with and contribute to the shaping of industries. Such a sociology of economics is thus not primarily a sociology of the development of economic theory, but rather on how economics in various ways interact with and participate in shaping fields

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<sup>59</sup> On the former see, for instance, *ibid.* on the emergence and shaping of the electricity industry in the US.

<sup>60</sup> See, for instance, Anders Lundgren's study on the emergence of an industrial network around digital imaging, in Lundgren, *Technological Innovation and Network Evolution*.

<sup>61</sup> I am here especially thinking on the large technological systems approach as developed and applied to the electricity industry by Thomas P. Hughes and Misa's study of inter-industry dynamics that participated in shaping both science, technology and structure of the US steel industry, Hughes, *Networks of Power* and Thomas J. Misa, *A Nation of Steel: The Making of Modern America, 1865-1925* (Baltimore: John Hopkins University Press, 1995).

<sup>62</sup> Colleen A. Dunlavy, *Politics and Industrialization: Early Railroads in the United States and Prussia* (Princeton: Princeton University Press, 1994), see also the collection of case studies on the governance transformations in John L. Campbell, J. Rogers Hollingsworth, and Leon N. Lindberg, eds., *Governance of the American Economy* (Cambridge: Cambridge University Press, 1991).

of economic activity. This probably represents the most under-explored part of the sociology of industry envisaged.<sup>63</sup>

Now, this study naturally covers only a fraction of the themes that can be taken as being part of such an emerging sociology of industry. Nevertheless, this study's use of a methodological stance that discriminates between the stabilised outcome and the making of this outcome may prove to be useful to others inquiring into the order and change in fields of economic activity. Moreover, this study's ambition to inquire into how technological change and changes in economic organisation are interrelated while in the making, might contribute to a discussion on the benefits of less, rather than more, compartmentalised conceptual models for guiding empirical inquiries into order and change.

Finally, the attempt to explore how notions of the natural and the inevitable are made within a field of economic activity may further contribute to a further discussion on how a sociology of industry fruitfully can explore the making of such notions. Indeed, in this case it brings with it an invitation to further explore how economics participate in shaping order and change in fields of economic activity.

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<sup>63</sup> But see the case study on economists and the US cement industry in Dumez and Jeunemaître.

# IV

## What is Feasible and Appropriate?

### **Taking a Walk in the Centre of Stockholm**

Had we been able to take a walk through the centre of Stockholm in the early years of this century, we would have had no difficulty in noticing the significant marks telephony had set on the urban landscape. We would have noticed the ubiquitous telephone wires run between the rooftops, most of them ultimately ending at the gigantic telephone tower sitting on the top of a building on Malmkillnadsgatan. At street level we would have seen, in the words of Herbert Laws Webb, “telephones literally everywhere, even down to the open-air refreshment stalls in public squares and gardens, and the trestle-benches in the fish market, which are in use only for a few hours each morning.”<sup>1</sup> The telephone system had embraced Stockholm and Stockholm had embraced it.

There were of course other things in this system that were not as easily observed, had we been able to take that stroll down the streets of Stockholm. We would probably have only caught sight of a few people making telephone calls. Most people working within the system – operators, engineers or office staff – would have been there but not evident. Still less apparent would have been such things as instruction manuals and the switches. Nevertheless, all these things were there, contributing to the working of the system, although invisible to us during our imaginary walk or even if we had made a call from one of the many public telephones. To a significant extent much of what constituted the system was indiscernible from the point of view of both user and pedestrian.

Even less discernible were the ongoing controversies concerning how the system should be managed. A few of these controversies, and their resolution, are the subject of

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<sup>1</sup> Herbert Laws Webb, *The Development of the Telephone in Europe* (London: Electrical Press Limited, 1910), pp. 75-76.

this and the next two chapters but to see these we have to step behind the system's facade in order to meet and follow the actors involved.

## Two Controversies Concerning the Workings of Telephone Exchanges

### Introducing the principal players – the two main telephone exchanges

Two main telephone exchanges, together with a number of connected sub-exchanges, play the principal roles in the set of controversies that I have chosen as my point of entry.<sup>2</sup> The first of these had been run by a private enterprise, Stockholm General Telephone (SAT) since 1883, being transferred to Stockholm Telephone, a new subsidiary of SAT, in 1908.<sup>3</sup> During the first few years this main exchange had been located at Oxtorget, but in 1887 it was moved to a new building at Malmskillnads-gatan.<sup>4</sup> The other main exchange in Stockholm was run by the Telegraph Administration. The Telegraph Administration had established a small telephone network, connecting the various state departments in Stockholm to one another, as early as 1881. But in 1889 it had established a public main exchange located at Skeppsbron in the old town.<sup>5</sup>

Although these two main exchanges handled several thousands of telephone calls a day, they were nevertheless at the heart of controversies regarding their workings. One recurrent issue – ‘the telephone issue’ – was centred on whether the switching of telephone calls between the two main exchanges should be allowed or, in the language of telephony, whether interconnection between their two networks should be allowed. Another recurrent issue – ‘the switching system issue’ – was centred on how they should be constructed and organised, and here I will focus primarily on those discussions concerning the Telegraph Administration's exchanges in Stockholm. The aim of this section is to further introduce these two issues as they were discussed in the first decade of the 20<sup>th</sup> century.

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<sup>2</sup> For a map depicting these two main exchanges, as well as additional sub-exchanges, see the glossary under the entry *Telephone exchanges in Stockholm*.

<sup>3</sup> There was actually another company before 1908 titled Stockholm Bell Co also operating in Stockholm. This company was more or less run as a subsidiary of SAT, however, since SAT acquired a majority share of stock in the company in 1888. With the formation of Stockholm Telephone in 1908, SAT's and Stockholm Bell's operations in Stockholm were formally and fully merged. In the text I have simplified matters and will always mean SAT and Stockholm Bell when discussing SAT's operations between 1888 and 1908.

<sup>4</sup> Hemming Johansson, *Telefonaktiebolaget LM Ericsson, del 1 Från 1876 till 1918* (Stockholm: LM Ericsson, 1953), p. 351.

<sup>5</sup> Hugo Lindberg, *Med Fingerskiva: Minnesskrift med anledning av Stockholms telefontäts automatisering* (Stockholm: Telegrafstyrelsen, 1938), p. 11.

**The severance of interconnection in 1903 and an account of the events preceding it**

During the night between the 31 May and 1 June 1903 all trunk lines between the two main exchanges and their respective networks were disconnected. The traffic that had been able to flow between the two networks since 1890 was literally shut down overnight. The original interconnection had been achieved after lengthy negotiations that began as soon as it had become public knowledge that the Telegraph Administration would open a public main exchange in Stockholm.

Plans at the Telegraph Administration to open a public main exchange had begun to take shape in the late 1880s, in connection with the planning for establishing an inter-urban telephone connection between Gothenburg and Stockholm. The Administration's plans for such a connection had in part been motivated by SAT's earlier plans to establish such a line announced in 1888. The Telegraph Administration had thwarted that plan, citing a government notification promulgated in 1883, limiting the possibility for individuals and private enterprises to establish telephone lines that could compete with the State-owned telegraph network.<sup>6</sup> Hence, in 1888, the Telegraph Administration had objected to SAT's application to establish a line between Stockholm and Gothenburg but at the same time had applied to the government for funds to establish its own line between the two cities.

SAT's application was finally rejected in May 1888, while at the same time the government approved a loan to the Telegraph Administration for establishing an inter-urban line between Stockholm and Gothenburg. This turn of events had naturally been a setback for SAT, and in the Autumn of that year SAT requested the government to grant it the right to interconnect its Stockholm network with the new inter-urban lines. In this request SAT offered not to take any surcharges for the interconnected traffic and in addition the company volunteered to refurbish the local network to two-wire circuits for all of its subscribers who would use the inter-urban lines.<sup>7</sup> Officials of the Telegraph Administration viewed this request with mixed emotions and in its reply to the government in February 1889, the Administration requested that local traffic should also be fully interconnected. This request meant that the Administration's planned public main exchange should be allowed to switch calls between the Administration's future subscribers in Stockholm and subscribers connected to SAT's network in

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<sup>6</sup> Hans Heimbürger, *Det Statliga Telefonväsendet, 1881-1902*, vol. 1 (Göteborg: Kungliga Telegrafstyrelsen, 1931), pp. 44-46. The Telegraph Administration had grown out of the government's initiative to establish a telegraph network, work that began in 1853. The Telegraph Administration thus had a monopoly on that service from the beginning of telegraphy. Arne Kaijser, *I Fädrens Spår... Den svenska infrastrukturens historiska utveckling och framtida utmaningar* (Stockholm: Carlsson, 1994), pp. 107-113.

<sup>7</sup> Two-wire circuits were considered necessary to achieve satisfactory audibility of an inter-urban connection.

Stockholm at no extra cost. SAT regarded this request as unacceptable, as it would have strongly promoted the establishment of a public local telephone network in Stockholm by the Administration.

In this locked situation, the Telegraph Administration in the Spring of 1889 nevertheless began building its own local telephone network in Stockholm for those wanting to gain access to the new inter-urban lines to Gothenburg. The main exchange at Skeppsbron was opened for traffic on 1 August<sup>8</sup>, and at the same time the new inter-urban lines were opened for public traffic.<sup>9</sup> The Administration had set the yearly fee in its Stockholm network at 80 kronor, which was considerably lower than the 125 kronor that SAT's subscribers had to pay. By the end of 1889 the new local network had attracted about 60 subscribers, while SAT at that time had more than 5,000 subscribers in its network. In effect this situation meant that the two main exchanges offered completely different services, the one switching calls primarily between Stockholm and Gothenburg, the other switching calls primarily within Stockholm.

The inability of the Telegraph Administration and SAT to reach an interconnection agreement had aroused a fierce debate in the local newspapers and in Parliament. The City Council in Stockholm had also entered the arena in the Spring of 1889, both the Telegraph Administration and SAT having requested permission to run wires under the city streets. In its reply in the following February, the City Council made it a condition that the use of city streets necessitated free interconnection between the two networks, on the grounds that free interconnection lay in the public interest.<sup>10</sup> The pressure to reach an interconnection agreement increased still further when the government instructed the Telegraph Administration to continue to seek an interconnection agreement with SAT. In May 1890 these negotiations led to an agreement where interconnection was to be established on 1 July of the same year.<sup>11</sup>

The conditions agreed upon included a 0.10 krona interconnection fee for each local call between the two networks, and a 0.20 krona interconnection fee for each inter-urban call to be added to the inter-urban fee. All interconnection fees were to be paid to the network receiving the call by the network from which the call originated. In spite of this agreement the City Council in Stockholm was reluctant initially to allow the two operators to run cables under the streets, as the agreement deviated from the

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<sup>8</sup> Lindberg, *Med fingerskiva*, p. 11.

<sup>9</sup> Heimbürger, *Det Statliga Telefonväsendet, 1881-1902*, p. 80.

<sup>10</sup> *Ibid.*, pp. 255-256.

<sup>11</sup> (Hemming Johansson), *LM Ericsson, 1876-1926*, Unpublished manuscript, 1928, p. 33. This manuscript has been retrieved from the archives of LM Ericsson, where it is noted that it was probably written by Hemming Johansson but was never published, either because of a lack

requirement for interconnection with no fees. However, as the Administration had fervently wanted interconnection with no fees, in June 1890 the City Council agreed that the Telegraph Administration should be allowed to run telephone cables in the streets. SAT received similar rights in the following year, that's to say in 1891.<sup>12</sup>

The reconciliation negotiated in May 1890 was of short duration, however, and again inter-urban lines played a major role. The inter-urban lines run by SAT from Stockholm to Norrköping and Västerås were the source of the new conflict. The Telegraph Administration regarded the latter line particularly as contravening the notification of 1883. At the end of 1890 SAT and the Telegraph Administration met to resolve this issue and to prevent possible future conflicts regarding SAT's growing number of inter-urban lines. SAT regarded the 1883 notification as an obstacle to its network expansion while the Telegraph Administration viewed SAT's ambitions to build an inter-urban network as constituting a threat to its own inter-urban network.<sup>13</sup>

After a few months of negotiations the two parties reached an agreement in February 1891 that resolved these issues. According to this agreement SAT became unfettered by the 1883 notification. In return, SAT agreed to give up any present and future telephone operations outside a zone defined by a circle with a 70 km radius of Stortorget in the heart of Stockholm. Within this 70 km-zone SAT acquired the unlimited right to operate a telephone network for 50 years and in return SAT had to sell all of its telephone operations outside this zone to the Telegraph Administration.<sup>14</sup> The agreement also included a new interconnection agreement, where the interconnection fee for inter-urban calls was lowered from 0.20 krona to 0.10 krona.<sup>15</sup> While the agreement regarding the 70 km-zone was for 50 years, the terms of the interconnection agreement had been made renegotiable after 10 years.

The government's approval of the agreements in May 1891 marked the start of fierce competition between SAT and the Telegraph Administration in acquiring small co-operative and private telephone networks still operating within the 70 km-zone. Both had also begun to attract new subscribers to their respective networks by various other means. For instance, both had already abolished all fees for inter-urban calls within the 70 km-zone in 1891 and thereafter both had gradually introduced new kinds of

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of funds or because of the author's bad relations with the then managing director Karl Fredrik Wincrantz.

<sup>12</sup> Ibid.

<sup>13</sup> These are, at least, the interests attributed to the parties by Heimbürger, *Det Statliga Telefonväsendet, 1881-1902*, pp. 160-161.

<sup>14</sup> These operations included local networks in Jönköping and Söderhamn, together with inter-urban lines between Enköping and Västerås and between Gnesta and Norrköping.

<sup>15</sup> Heimbürger, *Det Statliga Telefonväsendet, 1881-1902*, pp. 159-162.

subscriptions with lower subscription fees and higher call fees.<sup>16</sup> Moreover, SAT installed telephones in important state departments at no charge during the 1890s, to give its subscribers the facility of calling these without having to pay an interconnection fee.<sup>17</sup> The Telegraph Administration had applied a somewhat similar scheme in the late 1890s when it offered physicians subscriptions at a reduced rate to recruit them to its network.<sup>18</sup> From 1891 to 1902 both networks in the Stockholm area grew rapidly, see Figure IV-1. This rapid expansion enabled Stockholm to maintain its position as one of the most telephone dense cities in the world.

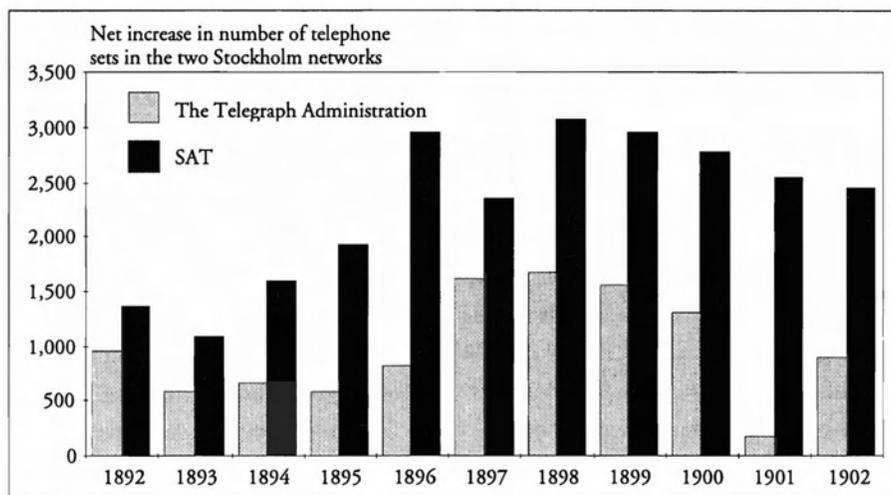


Figure IV-1 The growth of the two large networks within the 70 km-zone, 1892-1902.<sup>19</sup>

The rapid growth had forced both operators to extend their requests for running cables under the streets. In the mid 1890s the City Council for its part had decided the terms under which SAT and the Telegraph Administration could run cables, including the condition that the prevailing interconnection agreement should remain in effect until 4 July 1920. SAT found these terms acceptable and consequently continued to run cables under the streets during the latter part of the 1890s. The Telegraph Administration, on the other hand, looked upon this condition as inhibiting the Administration from gaining a more favourable interconnection agreement in 1901 and therefore

<sup>16</sup> The usual full price subscription had no charge for local calls, but the new subscriptions introduced often had a limited number of free local calls coupled with a lower subscription fee.

<sup>17</sup> Johansson, *Telefonaktiebolaget LM Ericsson*, p. 376.

<sup>18</sup> Heimbürger, *Det Statliga Telefonväsendet, 1881-1902*, p. 234.

<sup>19</sup> *Ibid.*, p. 228.

unacceptable. Therefore, the Telegraph Administration in 1895 had to return to running wires above ground when it expanded its network.<sup>20</sup>

The agreement of 1891 had made the Telegraph Administration the overall dominant provider of telephone services in Sweden with no large competitor outside the 70 km-zone.<sup>21</sup> At the same time the agreement had furnished a zone where competition was intense and where SAT dominated. At the end of 1901 the Telegraph Administration had almost 11,000 telephones in its network within the 70 km-zone, while SAT had almost 30,000 telephones in its network.<sup>22</sup> Taken together the two networks within the 70 km-zone at the time contained almost half of all telephone sets in Sweden.

When the time for renegotiating the interconnection agreement came up in 1901, the Telegraph Administration decided to once again seek to reach an interconnection agreement with no interconnection fees. At SAT, completely free interconnection was still seen as unacceptable and in its tender SAT offered to accept free interconnection for calls to and from the Administration's subscribers outside the 70 km-zone. This bid, in turn, was unacceptable to the Telegraph Administration, and the positions taken resembled the irreconcilable positions taken in the negotiations in 1889. Both operators apparently continued to deem the conditions upon which continued interconnection was to be achieved to be a crucial matter. Their irreconcilable positions further testify to the fact that the two operators were unable to find mutually acceptable terms with which access to their respective networks of subscribers was granted to the other operator.

This time the locked situation moved the two actors into discussing a sale of the private network to the Telegraph Administration. A substantial part of the Administration's early expansion in telephony had been done through the acquisition of local networks, and now this option was introduced to resolve the problem with renewing an interconnection agreement in Stockholm. At the end of 1901 the two parties reached an agreement on a complete sale of SAT's network, but as the deal required substantial government funding, Parliament had to agree and it turned out that it did not.<sup>23</sup> It was not a unified resistance to the acquisition that defeated the proposition in Parliament. Some members asserted that a continued state of competition would be beneficial to the development of the telephone service, whereas others

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<sup>20</sup> Ibid., pp. 259-264.

<sup>21</sup> At the end of 1901 the Telegraph Administration had 45,000 telephones in its networks outside the 70 km-zone, while private and cooperative networks had about 2,000 telephones in the same area. Ibid., p. 316.

<sup>22</sup> Ibid., p. 228.

<sup>23</sup> Ibid., pp. 245-246.

approved of the acquisition as such but opposed the negotiated price.<sup>24</sup> When all was said and done, however, the cancelled acquisition meant that the negotiation of a renewed interconnection agreement had to be resumed, while the interconnection was upheld temporarily.

At one stage in early 1903 the Telegraph Administration offered to let go of its requirement of free interconnection and offered instead to accept half the old fee. SAT found this offer too close to free interconnection, and hence did not accept it. SAT argued that a perceivable interconnection fee was vital for the company's survival. In a reply SAT argued that a reasonable interconnection fee would guarantee that people would subscribe to the network that would satisfy most of their telephone needs.<sup>25</sup> An interconnection fee set too low, the reply continued, would make most people subscribe to the Administration's network as it could afford to set its subscription fees at an unfair low level during a transitory period of competition. When it came to the inter-urban traffic SAT persisted that the company could accept free interconnection on traffic to and from the 70 km-zone, as it did not compete with the Telegraph Administration on this traffic. The company further argued that this kind of interconnection was at least as valuable to the Administration's subscribers outside the 70 km-zone as it was to the company's subscribers. Finally, the company argued, Parliament could not have meant that State funded inter-urban telephone lines should be accessible exclusively to the Administration's own subscribers. The arguments put forward by SAT were designed to mobilise a massive set of supporters, such as the Administration's subscribers outside Stockholm and Parliament and to appeal to the general public's sense of fairness. But SAT nevertheless failed in gaining acceptance of its position in the negotiations and in Spring 1903 the negotiations ultimately broke down.

It was this breakdown in the negotiations between the Telegraph Administration and SAT that lay behind the disconnection of all trunk-lines between the two main exchanges that night between 31 May and 1 June. The year before on average 3,440 calls a day had been switched between the two networks.<sup>26</sup> From 1 June the disconnected trunk-lines were quiet and the Administration's 64,500 telephones and SAT's 33,500 telephones had become isolated from one another. Despite the boldness of this act with its implications for the workings of the two main exchanges and their

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<sup>24</sup> Eric Beckman, "Telefondebatten i riksdagen: En studie i argumentering om statligt engagemang under perioden 1884-1918," (Department of History of Science and Technology, Royal Institute of Technology in Stockholm, 1994), pp. 40-41.

<sup>25</sup> Stockholms Allmänna Telefonaktiebolag, 22 April 1903, TALb; F I A:27.

<sup>26</sup> The daily average for calls switched from SAT's network to the Administration was 1,340 for 1902, while calls switched in the other direction averaged 2,100. Stockholms Allmänna Telefonaktiebolag, *Stockholm Allmänna Telefonaktiebolags styrelse- och revisionsberättelser för år 1902* (Stockholm: 1903).

connected networks, it failed to provide a stable and final settlement of the 'telephone issue'. The continued struggles to reach a settlement of the 'telephone issue' will be returned to further on in this chapter.

### **What kind of manual switching system for large exchanges?**

In the early years of this century there was no general consensus among Swedish engineers on how the switching system of a large exchange should be constructed and organised. And this issue was becoming increasingly pressing as the largest switches grew in size. Not only should an increasing number of subscriber lines be brought together in one building, any subscriber should also be able to be connected to any other. As the number of subscribers connected to one exchange increased, the number of possible connections the switching system had to be able to handle increased even more.<sup>27</sup> This fact had made the issue on how to construct and organise large exchanges a central and demanding problem within telephone engineering, especially since operating costs per subscriber tended to increase as exchanges became larger due to the increased complexity of the switching operations.<sup>28</sup> The need to use manual labour, female operators that is, was still generally agreed upon as an indispensable part of a large switch in the years after 1900.<sup>29</sup> Apart from this stable principle, opinions were divided on a few major issues.

One important issue was whether the speaking circuit should be powered by batteries in each telephone set or whether this circuit should be powered from the switch. Telephone switches of the former construction principle were known as local battery, or LB-, switches and switches working on the latter principle were known as the central battery, or CB-, switches. Soon after 1900 the newer CB-system became generally more favoured as the better solution, especially for large exchanges, as it was deemed easier with the CB-system to fit more subscriber connections into a given space at the switchboards' multiple. It took quite some time, despite this, before any large CB-switches were actually erected in Sweden. There were several reasons for this.

A transition from the widespread LB-system required large investments, not only in new switching equipment and new telephone sets, but also in the local network since the CB-system prescribed better insulated subscriber lines than the LB-system. The

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<sup>27</sup> Let  $N$  be the number of subscribers connected to one exchange, then the number of possible connections within that exchange is  $[N(N-1)]/2$ .

<sup>28</sup> For an excellent description of this phenomena in the US context, see Milton Mueller, "The Switchboard Problem: Scale, Signalling, and Organization in Manual Telephone Switching, 1877-1897," *Technology and Culture* 30 (1989): 534-560.

<sup>29</sup> On the origin and expansion of gender-typed occupations within the Telegraph Administration, see Christina Mårtensson, "Tjänstebefattning som kan för henne vara passande: Uppkomst och utveckling av könsbundna befattningar vid Telegrafverket, 1865-1920" (PhD diss., Göteborgs Universitet, 1999).

necessity to upgrade the local network was not only a financial issue to SAT in 1906 when it decided to gradually refurbish all its exchanges to the CB-system.<sup>30</sup> Upgrading the local network meant replacing above ground open-wire lines with cables run under the streets and the company had lost its right to run cables under the streets since the interconnection had been broken in June 1903. Later in that month the City Council had reiterated its demands, stating that in order to be allowed to use the city streets for running telephone cables, SAT and the Telegraph Administration had to agree before the end of December on interconnection on at least as favourable terms as the old agreement and with a duration until at least 4 July 1920. In stating these terms, the City Council had also stipulated fees per meter of cable run, that the City administration should receive 25 telephones at no cost, and that the fees set by the two operators should not be raised without the consent of the City Council.<sup>31</sup>

It was only in Spring 1907 that the City Council gave in and abandoned its demand for an interconnection agreement as a condition for the two operators to run cables under the streets.<sup>32</sup> After this decision SAT immediately began refurbishing its local network, and the company's first CB-system exchange was taken into operation later the same year.<sup>33</sup> The process of transition was prolonged, however, and the main exchange was not rebuilt to the CB-system until after 1913.<sup>34</sup>

At about the same time, the CB-system became the more favoured system at the Telegraph Administration as well. The first CB-system exchange within the Administration's network was opened in the city of Helsingborg in 1909 and was later followed by others in various cities. Yet the CB-system did not gain entry into the Administration's network in Stockholm, the Administration opting instead for a modified LB-system designed by an engineer at its headquarters, Herman Olson (1872-1934). This modified LB-system, in the same way as the CB-system, made it possible to fit more subscriber connections into a given space, but lacked some other features deemed advantageous with the CB-system. This solution nevertheless saved the Administration from changing all telephone sets and refurbishing the local network. The latter course would have been especially burdensome to the Administration since a

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<sup>30</sup> At that time the company had gained a positive experience of the CB-system from its telephone operations in Moscow and Warsaw. Hans Heimbürger, *Svenska Telegrafverket: Telefon, Telegraf och Radio, 1903-1920*, vol. 4 (Göteborg: Kungliga Telegrafstyrelsen, 1953), p. 13.

<sup>31</sup> *Ibid.*, pp. 180-181.

<sup>32</sup> *Ibid.*, p. 185.

<sup>33</sup> This and the future SAT CB-system exchanges were manufactured by LM Ericsson. Their design had evolved in collaboration between SAT and LM Ericsson and were already in use at the time within the former's telephone networks in Moscow and Warsaw. Johansson, *Telefonaktiebolaget LM Ericsson*, pp. 297-299, 434-435.

<sup>34</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, pp. 13-14.

very large proportion of its local network was run over the rooftops due to the fact that it had not been allowed to run cables under the streets between 1895 and 1907. The first exchanges in Stockholm with this modified LB-system were taken into traffic in April 1909.<sup>35</sup> The Administration's main exchange was not refurbished to the modified LB-system. On the other hand, it was at the centre of a dispute between certain engineers at the Administration regarding another construction principle.

In 1901 the Administration's main exchange in Stockholm had been replaced with a larger switch fitted with the call-distributing system, designed by an engineer at the headquarters of the Telegraph Administration, Anton Avén (1861-1914).<sup>36</sup> The call-distributing system meant that incoming calls were first connected to one of a set of telephone operators who, without speaking to the caller, distributed the call to a free operator who talked to the caller and then set up the desired connection. This deviated from the usual multiple switchboard where the incoming calls from a given subscriber always came to the same operator's position at the switchboard, there to be handled by the operator occupying that particular position. The idea with the call-distributing system was to spread the work-load between the operators making the connections and to facilitate a better adjustment of staff size according to the variations in traffic-load over the hours, but on the cost side there were the extra operators needed to distribute the calls.

In 1907 there began a heated and what became a prolonged debate over the merits of the call-distributing system. The most active in this debate were on one side the proponent Anton Avén and on the other side the head of the Administration's telephone operations in Stockholm, telephone director Axel Hultman (1858-1932), who disputed the alleged advantages of the system.

In a memorandum presented at the headquarters of the Telegraph Administration in 1907, Axel Hultman submitted a *pro et contra* investigation of three different kinds manual switching systems.<sup>37</sup> The paper contained statistics taken from switchboards with the single cord system, the cord pair system, and the call-distributing system and these were used to calculate the time needed to carry out the operations necessary to switch a call in the different systems.<sup>38</sup> The paper also contained calculations showing the investment per subscriber for the three systems.

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<sup>35</sup> Ibid., p. 15.

<sup>36</sup> Erik Ekeberg, *Telefoni*, vol. 1 (Göteborg: Kungl. Telegrafverket, 1920), p. 48.

<sup>37</sup> Axel Hultman, 11 June 1907, "En undersökning öfver fördelar och olägenheter vid några olika slag av växelbord," (An investigation into the advantages and disadvantages of a few different kinds of switchboards), TALb; F I A:30.

<sup>38</sup> In the cord pair system one cord was used for answering calls at an operator's position whereas the other cord was used to connect the caller to the desired subscriber's jack. In the

In the paper Hultman argued that the call-distributing system had the lowest investment cost for very large exchanges (>10,000 subscribers), and that it needed slightly fewer operators for a given traffic load provided one could accept a poorer service level and imposing a very large workload on the operators. Axel Hultman then concluded that the disadvantages of the call-distributing system outweighed its advantages and that the multiple switchboard with single cords was the best solution for large exchanges with heavy traffic, whereas the system with cord pairs was best for small and medium sized exchanges. In a later paper Axel Hultman maintained his position regarding the call-distributing system, and argued that the main exchange in Stockholm should be refurbished to a multiple switchboard with the cord pair system. Axel Hultman also won a minor victory in this controversy in 1908 when a smaller switch with the cord pair system was installed at the main exchange in Stockholm to be used for comparisons with the large switch with the call-distributing system.<sup>39</sup>

The attack on the call-distributing system evidently did not leave the inventor of the system, Anton Avén, untouched. In a paper presented to the heads of the departments at the Administration's headquarters in February 1909, Anton Avén counterattacked the position taken by Hultman.<sup>40</sup> In the paper he stated that he could not accept the shame he would suffer if the system were to be abolished within the Telegraph Administration and more importantly, he could not accept the damages the Administration would suffer as the result of an incorrect decision in this matter. In the paper Anton Avén went on to attack Axel Hultman by arguing that Hultman had a closed mind, that is, he was not interested in learning anything new. To illustrate this he recounted a dialogue he had had with Axel Hultman several years earlier during a study tour he and the late general director Erik Storckenfeldt (1847-1902) had made to Vienna:

On our trip down we met with Axel Hultman in Hamburg, who stated; 'There is nothing to do, there is the single cord system or the cord pair system, horizontal boards or vertical boards.' – I replied: 'I could tell you something new', whereupon Hultman objected: 'I do not want to know anything.' This is the position he took then and still is taking.<sup>41</sup>

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single cord system there was no answering cord and before completing the connection with the cord, the operator receiving the call connected to the caller to get the desired number with a key.

<sup>39</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, pp. 16-17.

<sup>40</sup> Anton Avén, 18 February 1909, "Ingeniör Avéns föredrag den 18 Februari 1909," (The paper delivered by Engineer Avén on 18 February 1909), TALb; F I A:30.

<sup>41</sup> Original sentences (in Swedish): "På nedresan sammanträffade vi i Hamburg med Telefondirektör Hultman, som yttrade ungefär följande. 'Ja, det finnes ingenting att göra, det är enkelsnörsystem eller parsnörsystem, horisontala bord eller vertikala'. – Jag svarade: 'Jag

In the paper Anton Avén also accused Axel Hultman of mismanaging the operations of the switch with the call-distributing system, and he labelled this as “‘director Hultman's, possibly unconscious, attempts to put away” with the call-distributing system.<sup>42</sup> Among the things mentioned to substantiate this accusation were figures showing that the operators working in the switch with the call-distributing system had a documented lower proficiency than those working in the switch with the cord pair system. As the head of the operations in Stockholm, Avén argued, Hultman should have known these figures when arguing against the call-distributing system. On this issue Avén added that the uneven distribution of proficient operators would more than compensate for the difference in performance that Axel Hultman had argued existed when he spoke against the use of the call-distributing system.

To this effect Avén presented figures on calls switched per hour and operator from the main exchange in Gothenburg which was furnished with a switch of the call-distributing system. These figures he then transformed to become comparable with similar figures from the two different switches within the main exchange in Stockholm. He agreed that the cord pair switch had a somewhat higher figure than the Gothenburg exchange during busy hour, 209 and 188 respectively, but argued that this was made possible by unduly exhausting the operators at the cord pair switch in Stockholm. He also noted that it was more important to look at the off rush hour figures, where the Gothenburg exchange outperformed the cord pair switch in Stockholm.

As if this would not have been enough, Anton Avén continued by presenting figures from performance measurements he himself had made secretly in Stockholm according to which the cord pair switch was actually outperformed by the Gothenburg exchange at rush hour as well. These calculations still did not make the switch with the call-distributing system in Stockholm on a par with the cord pair switch, but this, Avén argued, was due to differences in measurement routines which favoured the cord pair switch. He further implied that these differences was intentional on the part of Hultman:

I was present in the office of the controller when director Hultman was presented the lists of measurements taken during January this year. He noted with observable satisfaction that the performance of the call-distributing system during this month had decreased from a previous average of 20% to 35 % below the performance of the cord pair system. For anyone of a somewhat more ‘profound’ nature this alone would have been enough to

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skulle kunna säga dig någonting nytt’, hvarpå Hultman invände: ‘Jag vill ingenting veta.’ Den ståndpunkten intog han då och den intar han allt fortfarande.” *Ibid.*, p. 2.

<sup>42</sup> Full sentence (in Swedish): “Under 1908 märker man de våldsammaste eruptioner – det är Telefondirektör Hultmans aflifningsförsök, om och omedvetna.” *Ibid.*, p. 9.

raise suspicions that there was something wrong with the premises behind the calculations.<sup>43</sup>

Anton Avén concluded his lengthy defence of the call-distributing system by noting that even the premium systems employed to motivate the operators favoured the cord pair switch over the switch with the call-distributing system.

Hultman did not stay quiet long after this major and extensive attack. In a long paper from June 3 of the same year he presented a defence of his position substantiated with an abundance of measurements.<sup>44</sup> The debate, as we have already seen, was not without statements verging on the defamatory. When Anton Avén late in 1909 replied to Hultman's latest and quantitatively loaded paper, he explicitly touched upon this character of the debate and maintained that in this case it was necessary to introduce his opponent's character into the debate.<sup>45</sup>

My opponent has by his character and the way in which he has outlined his case, made the deficiencies in the foundation on which he has built his position impossible to scrutinise without touching upon his character.<sup>46</sup>

As the debate progressed from 1907 and onwards, the contributions became longer and longer, filled with measurements and calculations. At the same time the personal character of the debate flourished rather than faded, and as we momentarily leave this debate there was still no point of consensus or reconciliation in sight.

### The undetermined workings of the telephone exchanges

From the vantage point of the two main exchanges in Stockholm in the early 1900s, it is possible to observe the controversies on how the telephone system should be managed in Stockholm. As I have depicted above, the so-called 'telephone issue' focused on the

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<sup>43</sup> Original sentences (in Swedish): "Jag var närvarande i kontrollörens rum då Telefondirektör Hultman lät förelägga sig listor för januarikontrollerna innevarande år. Han konstaterade då med synbarlig tillfredsställelse att arbetseffekten vid fördelningssystemet under nämnda månad hade sjunkit från förutvarande medeltal af 20% till 35 % under parsnörsystemets motsvarande värde. För hvarje något 'djupare' anlagd natur skulle enbart detta förhållande varit tillräckligt att väcka misstankar det ej allt stode rätt till med beräkningsgrunderna." Ibid., p. 17.

<sup>44</sup> Axel Hultman, 3 June 1909, "Telefondirektör Hultmans föredrag den 3 juni 1909 till Kungl. Telegrafstyrelsen," (Telephone director Hultman's address to the headquarters of the Telegraph Administration on 3 June 1909), TALb; F I A:30.

<sup>45</sup> Anton Avén, December 1909, "Ingenjör Avéns föredrag i december 1909," (Paper delivered by Engineer Avén in December 1909) TALb; F I A:30.

<sup>46</sup> "Jag har hört den anmärkningen ganska allmänt framställas, att jag i mina utredningar går för mycket in på personligheter eller, att jag ej nog skiljer mellan person och sak. Jag kan mycket väl tänka mig sådana fall då ett dylikt åtskiljande ej möter större svårigheter och sålunda är det enda rätta. I det här föreliggande fallet har jag däremot ej kunnat se någon möjlighet härutinnan. Min motpart har nämligen genom sin naturell och sitt framställningssätt gjort bristerna i den grund på hvilken hans ställningstagande är uppbyggt, oåtkomliga för granskning utan tangerande af person." Ibid., p. 39.

topic of interconnection of the two main exchanges and their networks, and involved actors such as SAT, the Telegraph Administration, Parliament, and the City Council. The 'switching system issue' centred, on the other hand, on the topic of what constituted an appropriate switching system for large telephone exchanges. Here I focused primarily on a dispute between two engineers within the Telegraph Administration, where their controversy became increasingly centred on what constituted a proof that a particular switching system was more appropriate for a large telephone exchange.

Although differently focused and to some extent involving different parties it is clear from the above that these two concurrent issues were related. Although absent in the dispute within the Telegraph Administration, it is apparent that the 'telephone issue', through the actions taken by the City Council, influenced the issue of switching systems for at least SAT's exchanges. Moreover, the issues of network size and growth of the Telegraph Administration's telephone network in Stockholm were not only central in the 'switching system issue'. The issues of size and growth of the two networks, as will be recounted in the following section, were also central in the concurrent attempts to resolve the 'telephone issue'. Thus, the issues of network scale and growth were issues that appeared in both controversies, albeit in different guises.

## **Renewed Attempts to Settle the 'Telephone Issue'**

### **Attempting a cartel solution, 1904**

Soon after interconnection had been broken, both operators opened a manual messaging service where for a fee its subscribers could have a telephone operator transfer short messages to subscribers belonging to the other network.<sup>47</sup> However, it did not take long after the cut in interconnection before SAT and the Telegraph Administration resumed negotiations regarding the telephone situation in Stockholm, or the 'telephone issue' as it was often labelled. In February 1904 SAT and the Telegraph Administration signed an agreement that would come into effect on 1 July the same year, if it was approved by Parliament and SAT's shareholders' meeting.<sup>48</sup>

This time the two parties had managed to agree on free interconnection for both local and inter-urban traffic in combination with a division of the 70 km-zone into what can best be described as geographically defined monopolies. In an area defined by a 30 km radius from the centre of Stockholm the two operators were to barter network installations so that each operator obtained a geographically distinct area. In the

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<sup>47</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 163-164.

<sup>48</sup> Contract, 9 February 1904, "Köpe- och Bytesaftal," (Acquisition and Barter Contract), TALb; F I A:27.

remaining part of the 70 km-zone, that is, on the outskirts of the Stockholm region, the Telegraph Administration was to acquire all of SAT's installations. Both parties had also committed themselves to refrain from establishing any telephone operations outside their thus designated territories in the future. The Telegraph Administration would furthermore pay approximately 2.6 million kronor to SAT as a compensation for the fact that the value of the equipment SAT would give up was larger than the value of the equipment it would acquire in this deal. Figure IV-2 displays a map from the contract with the agreed division of the 30 km-zone indicated.

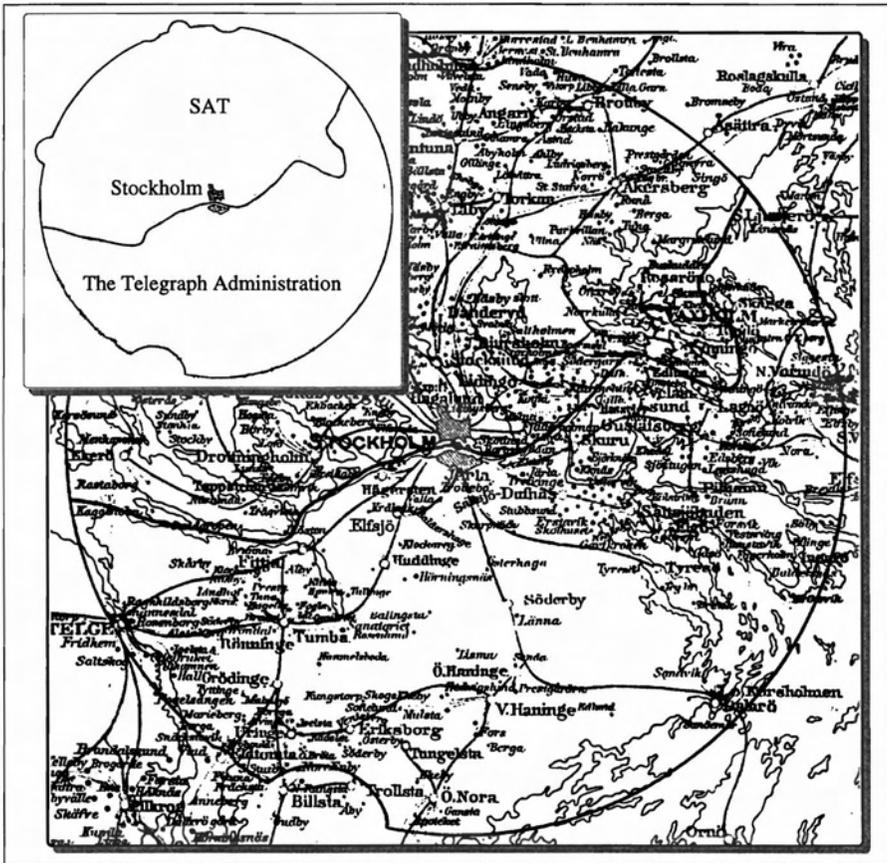


Figure IV-2 Map of the Telegraph Administration's telephone network from the 1904 contract with the division agreed upon indicated.

Furthermore, included in the contract was an agreement on complete co-ordination of tariffs and terms of subscriptions. All telephone subscribers within the 70 km-zone were furthermore to be included in one telephone directory. The parties had consequently been able to agree upon interconnection with no fees when it was combined with geographically distinct monopolies and a co-ordination of tariffs and terms of

subscriptions. In short, SAT and the Administration had been able to agree on free interconnection when it had been combined with a cartel agreement. The contract was approved by an extraordinary shareholders' meeting at SAT on 25 February, 1904.

After that, and in anticipation of approval by Parliament, the two operators began to prepare for carrying through the agreement. For instance early in March SAT ordered a twin-cable with 500 pairs to be used for carrying the interconnection traffic.<sup>49</sup> At the same time an investigation was carried out at the Telegraph Administration to find out how the Administration's exchanges had to be changed to handle the interconnections.<sup>50</sup> The investigation reported that SAT's exchanges had enough excess capacity to handle most of the new lines, while several changes were needed at the Administration's main exchange. At the latter, multiple fields at the local switchboards had to be extended, the switchboards used for toll traffic had to be moved to another room, and new equipment had to be ordered and installed, etc. All these activities were made in vain, however. On 30 April Parliament rejected the agreement, despite the fact that it had been supported by the government.<sup>51</sup>

It was a far from united opposition that had effectively annulled the agreement. The majority of the parliamentary working committee had found it unacceptable that the Telegraph Administration's tariffs in Stockholm were to be set in negotiation with SAT, a position subscribed to by some members of Parliament. However, other objections had also been raised in Parliament in the discussion that defeated the agreement. One member of parliament had asserted the beneficial effects competition had on development. Some members of parliament had raised objections on the grounds that they found the price too high, whereas one had found the agreement too beneficial to SAT and to this effect had accused the government of being subservient to the 'capitalists'. In sum, the agreement – and the scenario it was a part of – had failed despite the absence of a unanimous opposition. A conglomerate of objections had managed just as well in annulling the scenario presented.

### **Drifting from a cartel solution towards a monopoly solution, 1906**

New negotiations were taken up in January 1906. This time three different alternatives were discussed. The first alternative concerned a deal where the Telegraph Administration purchased all SAT's telephone operations in Stockholm, whereas the other two alternatives resembled the arrangements agreed upon in 1904, that is, some

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<sup>49</sup> Letter from Carl Hallén at SAT to Axel Rydin at the Telegraph Administration, 8 March 1904, TALb; F I A:27.

<sup>50</sup> Anton Avén and Knut Ericsson, 14 March 1904, "VPM," (memo), TALb; F I A:27.

<sup>51</sup> Beckman, *Telefondebatten i riksdagen*, pp. 41-43.

sort of cartel agreement with a geographical division of the 70 km-zone.<sup>52</sup> One of these latter alternatives in particular meant that the difference to be paid by the Telegraph Administration to SAT was made very low, something that representatives of SAT argued could make Parliament more favourably inclined towards the deal. SAT also favoured the two alternatives where SAT retained a part of its Stockholm operations, whereas it soon became clear that the Telegraph Administration favoured a complete acquisition of the private network.<sup>53</sup>

During February 1906, these divergent interests became a source of conflict. SAT agreed to negotiate towards a complete sale, but maintained at the same time that it favoured the other alternatives and that these should still be considered. The Telegraph Administration, on the other hand, did not conceal that it favoured a complete purchase. In addition to the normal bargaining on how various parts of the network should be valued, there was therefore a bargaining process as to the kind of agreement sought. The latter issue was the main theme in a correspondence between the founder and managing director of SAT, Henrik Cedergren (1853-1909), and the general director of the Telegraph Administration, Arvid Lindman (1862-1936).

In a letter to Arvid Lindman on 12 February, Henrik Cedergren maintained that it would be valuable for all parties to agree not just on a complete sale, in case Parliament rejected such a solution.<sup>54</sup> An agreement achieved on the other alternatives as well, Cedergren argued, would nevertheless facilitate the possibility of achieving a swift resolution of the 'telephone issue', in case Parliament rejected the idea of an outright purchase. However, this approach towards reaching a resolution of the 'telephone issue' was not appreciated within the Telegraph Administration's headquarters. In a private letter, Lindman informed Cedergren that people at the Administration's headquarters would put a resolute reservation in the official letter to be submitted to the government, in case SAT upheld its position and submitted a proposal for a barter agreement.<sup>55</sup> This would be extremely disadvantageous, Lindman asserted, since such a reservation would certainly have a negative influence on those hesitant towards such a deal.

Perhaps Arvid Lindman's recent experience as a minister added extra credibility to his stated fear that it would be more difficult to persuade Parliament to approve a purchase agreement if it were to be followed by other proposals on which the Administration's headquarters furthermore would lodge a reservation. Lindman also

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<sup>52</sup> See, e.g., Henrik Cedergren (managing director of SAT), 12 February 1906, 'Draft of contract sent to Arvid Lindman (general director of the Telegraph Administration),' TAAb; F I A:229.

<sup>53</sup> See, e.g., n.a. (Henrik Cedergren), 9 February 1906, "PM," (memo), TAAb; F I A:229.

<sup>54</sup> Henrik Cedergren, 12 February 1906, 'Letter to Arvid Lindman,' TAAb; F I A:229.

<sup>55</sup> Arvid Lindman, 24 February 1906, 'Letter to Henrik Cedergren,' TAAb; F I A:229.

informed Cedergren that the headquarters had agreed on a weakly formulated statement regarding the proposed barter deal that would be included in the official letter, on the condition that SAT also accepted the wording and that both parties from then on loyally supported the proposal for a complete acquisition of the private network. For SAT, Lindman clarified, this meant that the company had to agree not to submit any proposal for a barter agreement to the government, to Parliament or to any other party.

Put under this pressure, SAT agreed to refrain from pushing the barter deal in any way during 1906 and to loyally support the agreement on a complete sale of its Stockholm network. During the verbal negotiations following on Arvid Lindman's private letter to Henrik Cedergren, SAT in exchange attained the Administration's consent on an issue important to SAT. During these negotiations it had come out that SAT preferred a barter agreement partly because it wanted continued easy access to telephone exchanges in operation, to be able to perform experiments when developing new technologies within the area of telephony.

This professed need is understandable given SAT's operations apart from its telephone operations in Stockholm. Firstly, SAT at the time had foreign ventures which included full or partial ownership of telephone operations in Moscow and Warsaw.<sup>56</sup> Secondly, SAT had a close business relationship with the equipment manufacturer LM Ericsson from which it procured its switching equipment, among other things, and together with which it was starting a telephone network in Mexico.<sup>57</sup> SAT furthermore held a substantial position in LM Ericsson, an ownership relation which had been initiated in 1901 when SAT had sold its own equipment factory in exchange for shares in LM Ericsson.<sup>58</sup> As a consequence of that deal, Henrik Cedergren had become a member of the board of LM Ericsson in 1902.<sup>59</sup> All in all, there were good reasons for Cedergren trying to secure continued access to telephone exchanges in Sweden for SAT and LM Ericsson, especially since the Telegraph Administration at the time manufactured much of its switching equipment at its own factory and did not have that

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<sup>56</sup> Regarding these foreign operations, see; Johansson, *Telefonaktiebolaget LM Ericsson*, pp. 175-188, 403-407.

<sup>57</sup> The planning for this operation had begun in 1904, and in 1905 a syndicate was formed where LM Ericsson put in 60%, SAT 20% and Marcus Wallenberg the remaining 20%. The network began to operate in 1907. See, Artur Attman, Jan Kuuse, and Ulf Olsson, *LM Ericsson 100 år: Pionjärtid, Kamp om koncessioner, Kris, 1876-1932* (Stockholm: LM Ericsson, 1977), pp. 183-190.

<sup>58</sup> At the end of 1907, for which figures are available, SAT held 33% of the shares in LM Ericsson. See Johansson, *Telefonaktiebolaget LM Ericsson*, pp. 152, 424. However, the shareholding acquired as a consequence of the sale of SAT's equipment factory was lower (appr. 12%), which implies that SAT had gradually acquired more shares in LM Ericsson since 1901. On the sale in 1901, see *ibid.*, p. 106.

<sup>59</sup> Johansson, *Telefonaktiebolaget LM Ericsson*, p. 122.

close a relationship with LM Ericsson. At the end of February, Henrik Cedergren and SAT attained the Administration's consent on future access to the Administration's telephone exchanges if the purchase was carried through.<sup>60</sup>

With these issues settled, the contract regarding a complete sale of the SAT's network in Stockholm was signed on 8 March.<sup>61</sup> The same day the Telegraph Administration submitted the official letter asking the government to give it its approval and to propose to Parliament that it approve the contract and furnish the required funds from the National Debt Office.<sup>62</sup> The official letter contained an elaborate argument justifying the proposed purchase together with an account of the previous attempts to solve the 'telephone issue' in Stockholm. This text therefore provides a refined version on how the Telegraph Administration publicly provided causes for approving the reached acquisition agreement.

*Résumé of official letter to the government, 8 March 1906*<sup>63</sup>

The interconnection issue is brought up straight away, and it is stated that this issue not only concerned Stockholm, but is an issue that concerned the whole country and should therefore not be brushed aside.<sup>64</sup> In the ensuing *narratio*, the letter outlines the previous efforts to settle the 'telephone issue.' The letter hence recounts the twists and turns of the interconnection negotiations in 1901 whereupon it remarks that the outcome of these negotiations had disproved free interconnection as a way to organise the telephone operations. It further asserts that a new agreement on terms similar to the previous 'antiquated' interconnection agreement had been undesirable, as that would have been arduous to both the public and to the Administration's operations.<sup>65</sup> It was this situation, the letter continues, that had forced the Telegraph Administration to try the other available alternative, that is, a purchase of the private network. This resulted in the acquisition agreement of 1901, on which the letter makes a prolonged review, only to end up briefly concluding that it failed in Parliament. Then the letter makes a similar

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<sup>60</sup> See letter confirming this verbal agreement; Henrik Cedergren, 27 February 1906, 'Letter to Arvid Lindman,' TAAb; F I A:229.

<sup>61</sup> Contract, 8 March 1906, TALb; F I A:27.

<sup>62</sup> Official letter: Arvid Lindman et. al., 8 March 1906, *Till Konungen*. The official letter is reproduced in Ministry Proposition 128 (Kungl. Maj:ts Nåd. Proposition N:o 128), 20 April 1906.

<sup>63</sup> Apart from a few deviations, the résumé follows the structure of the official letter. The different parts of the letter have been labelled with terms from the art of disposition in classical rhetoric, to elucidate the letter's rhetoric structure.

<sup>64</sup> Official letter: Arvid Lindman et. al., 8 March 1906, *Till Konungen*, p. 2.

<sup>65</sup> Quote (in Swedish): "Däri genom var alltså frågan om telefonväsendets ordnande på grundvalen af afgiftsfri samtrafik mellan de olika näten förfallen. Den fortsättning af det förra tidsenliga samt såväl för trafikens skötsel som för allmänheten äfven i öfrigt betungande

long recount of the barter deal of 1904, ending with the conclusion that Parliament had rejected it in part on the grounds that it would have deprived the State of its right to change fees without the consent of SAT.<sup>66</sup>

After this narrative, the letter goes into a *confirmatio*, confirming the necessity of altering the present situation. In other words, the letter confirms that something had to be done. To this effect, the letter makes the case that the situation provided technical difficulties to the Telegraph Administration, a waste from the perspective of the national economy and an unsatisfactory situation for the general public. The technical problems emphasised are the obstacles caused by the prohibition to run cables under the streets. This problem was so serious, it is argued, that something had to be done about it:

These difficulties increase for every year, and one may soon stand at the point, where it is no longer possible to overcome the continued accumulation of technical difficulties.<sup>67</sup>

It would therefore, the letter continues, “be highly advantageous if the antiquated, disfiguring and erratic open-wire lines could be replaced with underground cables when expanding the capital’s telephone network, so that the advancements from newer telephone technologies could be put into use.”<sup>68</sup> In connection to this, the letter states that the necessity to run temporary open-wire lines also provided a financial waste to the Telegraph Administration.

Next is the waste to the national economy brought on by the situation as it was. There the letter argues that this waste was produced by the increasing number of lines and cables run parallel to one another, one for each of the two operators, where one would have sufficed in many cases had there been only one operator. The claim that the situation was characterised by unnecessary duplication was not only taken as a case of waste to the national economy, however. The duplication was also claimed to be the cause of an unsatisfactory situation for the public. This is substantiated by the fact that the number of subscribers holding subscriptions in both networks had increased from 2,900 the year before interconnection was broken to 6,300 at the beginning of 1906.

förhållandet, som var att motse i nya samtrafikskontrakt, kunde naturligtvis icke vara önskvärd.” Ibid., p. 5.

<sup>66</sup> Ibid., p. 20.

<sup>67</sup> Original sentences (in Swedish): “ Någoting måste emellertid enligt Telegrafstyrelsens åsikt ovillkorligen göras. Svårigheterna ökas år för år, och man står kanske inom kort på den punkt, att de sig alltmer hopande tekniska svårigheterna med bästa vilja icke längre kunna öfervinnas.” Ibid., p. 21.

<sup>68</sup> Original quote (in Swedish): “...det vore vid utvidgningen av hufvudstadens telefontät uppenbarligen en stor fördel, om de otidsenliga, vanprydande och osäkra luftledningarna kunde få utbytas mot jordkablar, och den nyare telefonteknikens förbättringar därvid komma till användning.” Ibid., p. 21.

This figure, it is asserted, would also continue to increase when smaller businesses also acquired telephones at an increasing rate, which in turn implied that “an increasing number of people will find themselves compelled to pay double subscription fees.”<sup>69</sup> When the two networks were merged, it is concluded, only those using the telephone extensively would have to have more than one telephone subscription.

Having presented certain compelling disadvantages, the letter further confirms that an alteration along the lines of the proposal would be in the expressed interest of both the Telegraph Administration and Parliament. Concerning the Telegraph Administration, the letter explicitly states that “the goal of the Telegraph Administration's efforts has always been to finally bring all telephone operations in the country together and into the hands of the State.”<sup>70</sup> To this it is added that since an acquisition was inevitable in the view of the Administration, for economic reasons it should be done as soon as possible.<sup>71</sup> Parliament's disapprovals of the two earlier propositions, the letter continues, were taken as tokens of Parliament's desire to obtain a complete purchase rather than a barter agreement of the kind proposed in 1904 and its desire to obtain the complete purchase at a lower price than the price agreed upon in 1901.<sup>72</sup> The present purchase agreement, it is then asserted, satisfied these desires and represented a successful resolution of the telephone issue.

The letter acknowledges two possible objections to the proposal, by delivering a *refutatio* refuting each of them. Quite some space is given in the letter to refuting the possible objection that a termination of competition easily could result in inconvenience. This objection against the acquisition of the private network, it is noted, had previously been stressed both in the press and in Parliament. In defence, the letter recounts what the Telegraph Administration already stated on this issue in 1901 in connection with the previous acquisition proposal.

It could not be denied that competition in the field of telephony, within certain limits and in its time, have had a significance through the efforts of progress that is the outcome of all contests. But those times were over and the justified aim of competition was in this sense fulfilled. When the subscription fees had declined to such a low level as was permitted by rational telephone operations, competition had nothing more to achieve from

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<sup>69</sup> Ibid., p. 22.

<sup>70</sup> Full sentence (in Swedish): “Såsom förut framhållits har målet för Telegrafstyrelsens sträfvan den alltid varit att till sist i statens hand föra tillsamman hela telefondriften i riket.” Ibid., p. 20

<sup>71</sup> Ibid., p. 22.

<sup>72</sup> Ibid., p. 25.

an economic point of view. If it continued it would only cause damage, which it also did.<sup>73</sup>

The letter then goes further and expounds on the argument that there never had been any 'mutually stimulating' competition concerning either technological nor administrative matters. The reason given for this was that the Telegraph Administration itself had carried out the most important improvements to be introduced since the Administration seriously took up telephony. This claim is substantiated by examples of technical novelties, including the call-distributing system, where it is asserted that the Telegraph Administration had been a forerunner. The conclusion drawn is that competition in an economic sense no longer existed and that competition in a technical sense never had existed, and that the repeated reference to the necessity of competition was nothing but the uncritical repetition of catchwords. Or, it is added, the reference to the necessity of competition may have its "source in the unjustified disinclination by parts of the public to have confidence in the will and capabilities of the civil service departments to work loyally for a sound and modern development of the enterprises they have been entrusted, without any external stimulation."<sup>74</sup>

The second *refutatio* concerns anticipated objections relating to the price to be paid for the private network. The objection to be refuted is not explicitly stated in the letter, but can be formulated as follows: 'How is it that the company is willing to sell its network if, as the Telegraph Administration claims, the price is so very advantageous to the State?'

The letter states that the more advantageous price agreed upon this time round, in the opinion of the Telegraph Administration, is undoubtedly a consequence of the stronger position held by the Administration in Stockholm. A position, it is added, the Telegraph Administration had gained in the last few years through considerable growth and the break in interconnection. The present agreement had also been made possible, it is admitted, by SAT's willingness to participate in a solution that would improve the present situation that was so unsatisfactory to the public. The advantageous price agreed upon was thus, according to the letter, the outcome of the Administration's improved

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<sup>73</sup> Original sentences (in Swedish): "Det kunde ej förnekas, att konkurrensen på telefonens område inom vissa gränser och på sin tid haft sin betydelse genom de utvecklingssträfvanden, som all täfling framtvingar. Men den tiden var då öfver och det berättigade syfte, konkurrensen så uppfattad eftersträfvat, var nådt. Sedan abonnemangsaftgifterna sjunkit så lågt som en rationell telefondrift medgaf, kunde konkurrensen ur ekonomisk synpunkt icke hafva något mera att uträtta, utan måste om den fortsattes verka till skada, på sätt ock skett." *Ibid.*, p. 23.

<sup>74</sup> Original quote (in Swedish): "...så vida den ej hade sin grund i den oberättigade, men för en viss del af allmänheten kännetecknande obenägenheten att tilltro statens ämbetsverk vilja och förmåga att, utan yttre sporningar, af egen pliktmedvetenhet och intresse arbeta på en sund och tidsenlig utveckling af den verskamhet dem anförtröts." *Ibid.*, p. 24.

position in junction with the cooperative spirit of SAT in participating in a resolution of the telephone issue.

The continuous strengthening of the Administration's position in Stockholm, the letter continues, might easily be taken as supporting the view that it would be better to postpone the acquisition in order to further lower the price. A further lowering of the price, it is then argued, was not very probable and would in any case be outweighed by the costs incurred from further investments in equipment that would become redundant when the two networks were later merged.<sup>75</sup> As an example of this, it is mentioned that SAT had recently decided to spend approximately one million kronor for establishing a new telephone exchange in Södermalm, that is, in the southern part of Stockholm. This exchange if built, it is asserted, would become redundant after a merger of the two networks.

After these two refutations the letter moves into a *probatio* aimed at proving the financial soundness of the acquisition. This proof is provided by rather detailed calculations establishing the profitability of SAT's network after acquisition by the Telegraph Administration. The calculations include estimates of future revenues and costs in the SAT network, as well as costs to be incurred and savings to be made from merging this network with the Administration's own network. The conclusion of these calculations is that the returns from the acquired network would pay for the 3.5 % - 4 % interest on the purchase sum as well as paying off the capital sum in 20 years. The proposal to finance the considerable purchase sum with loans was therefore justifiable from a financial point of view.<sup>76</sup>

In the *conclusio*, the official letter asks the government to give its approval to the acquisition and to propose to Parliament that the contract be approved and that the necessary funds be furnished by the National Debt Office.

*The scenario contained in the official letter*

The official letter presented an extensive web of assertions, all pointing towards the soundness of the proposed acquisition. It defined and outlined several actors and affirmed furthermore that their interests were served by the proposed acquisition. Indeed, in the letter it was stated that "through a thus proposed purchase the interests of all parties – the State, the public and SAT – are gathered on one side."<sup>77</sup> In other words, the official letter contained a scenario and enticed the actors to participate in making it real.

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<sup>75</sup> Ibid., p. 31.

<sup>76</sup> Ibid., p. 41.

<sup>77</sup> Original quote (in Swedish): "...genom ett sådant köp samlas *allas* intressen – statens, allmänhetens och äfven bolagens – på en sida." Ibid., p. 7.

The acquisition is inevitable in the long run, and now is an advantageous point in time to do it. This acquisition is in the interest of the public, the subscribers in Stockholm, SAT, the Telegraph Administration, the national economy, and the technical advancement of the telephone network in the Swedish capital.

Would the scenario receive the support necessary for making it real? SAT had already become aligned to support the purchase when signing the contract and when agreeing to refrain from advancing the barter solution, and further manifested its support when the contract was approved later in March by an extraordinary shareholders' meeting.<sup>78</sup> The official letter constituted, as such proposals normally do, an ambition to align the government and Parliament to support the issue at hand. The question, then, was whether the scenario would entice sufficient support from those representing the different actors identified as benefiting from its realisation.

*Newspapers voicing concerns with the scenario*

Parts of the press were not persuaded to support the purchase. Soon after the contract had been signed and the official letter had been handed in to the government, two articles highly critical of the purchase were published in the liberal daily newspaper *Aftonbladet*.<sup>79</sup> In these two articles it was asserted, firstly that competition was beneficial to the public, secondly that the price was actually higher than it had been in the previous acquisition proposal, thirdly that the calculations establishing the profitability of the acquisition were dubious, and finally that an interconnection agreement was an alternative and better solution to the technical and economic difficulties stressed by the Telegraph Administration. Thus, in sum, these two articles raised four objections, each of which refuted the scenario contained in the official letter.

The first of these two articles firmly disputed the official letter's claim that competition was no longer beneficial:

The advantage of retaining the competition between the State and the private company has, as one should recall, in many places been raised as a powerful motive against a state monopoly on telephone operations. The Telegraph Administration firmly objects to this view, but does it rather unsuccessfully.<sup>80</sup>

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<sup>78</sup> Letters confirming approval by the shareholders' meeting; Letter from Board of Stockholm Bell to the headquarters of the Telegraph Administration, 23 March 1906 & Letter from Board of SAT to the headquarters of the Telegraph Administration, 23 March 1906. Both at TALb; F I A: 27.

<sup>79</sup> Daily newspaper in Stockholm founded in 1830. In the beginning a liberal newspaper for the Opposition, but in 1914 became the newspaper for the Right.

<sup>80</sup> Original sentences (in Swedish): "Såsom man torde erinra sig, har fördelen af konkurrensens bibehållande mellan staten och bolagen på många håll ansetts utgöra ett kraftigt skäl mot statsmonopol på telefondriften. Mot denna uppfattning opponerar sig telegrafstyrelsen

It was maintained in the article that telephone operations remained a prosperous enterprise and thus competition still allowed for substantial returns. Even if competition might not produce even lower charges, it was added, there was still good reason to fear that the creation of a monopoly might result in their increase. In concluding the argument for competition, it persevered in marking that “it cannot be legitimate to assume, as the Telegraph Administration does, that the stimulus now undoubtedly provided by competition will remain and act as strongly when all competition has ceased.”<sup>81</sup>

The article then went on to refute the claim that the price now agreed upon for the acquisition was lower than the price agreed upon in 1901. The calculations used in the official letter to substantiate this claim provided only an illusory lower price, it was argued. The article stressed that the share of subscribers with low subscription fees had increased since the last agreement, a fact which was important since the agreed price per telephone was far above any material value. This meant, the article affirmed, that one got a greater number of telephones of less value, which in reality made the price agreed identical to the price of 1901.

In the follow-up article a few days later, the objection to the ‘lower price claim’ was sharpened further.<sup>82</sup> This time it was argued that the price now agreed upon was actually higher than the price of 1901, since the value of the network in effect had decreased since 1901. Regarding the 6,300 telephones where the subscribers already held a subscription in the Administration's network as well, it was furthermore stated that this meant paying the full price for things that would have no value after the purchase when most of those subscribers cancelled one of their two subscriptions.

The calculations presented in the official letter to verify the profitability of the proposed deal were also subjected to a more general objection in the second article. It was there reported that it was impossible to estimate whether the calculations would stand the test of time given the many years to the repayment date. The calculations were in at least one case too sanguine, it was added. The Telegraph Administration had calculated that most of the subscribers with double subscriptions would keep both their subscriptions and, in the unlikely event that many of them would leave, the addition of new subscribers would compensate for this. This reasoning, it was maintained in the article, was faulty: It was the purchased subscriptions that should provide the necessary

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å det bestämdaste, men knappast lyckligt.” “Det ifrågasatta telefonköpet I,” *Aftonbladet* (Stockholm), 16 March 1906.

<sup>81</sup> Original sentence (in Swedish): “I hvarje fall kan det ej vara berättigadt att i likhet med styrelsen utan vidare antaga, att den sporre som den nuvarande konkurrensen obestriddigen utgör, kommer att verka lika kraftigt, sedan all konkurrens upphört.” *Ibid*.

<sup>82</sup> “Det ifrågasatta telefonköpet II,” *Aftonbladet* (Stockholm), 19 March 1906.

yield. The article continued by stressing that this indicated that the calculations had not been performed with sufficient care, and that the proposed acquisition therefore could not be regarded as “anything but a speculative deal with all the risks that attend such deals.”<sup>83</sup>

The article finally rejected the notion that an acquisition was the only way to reintroduce interconnection. The article acknowledged that the lack of interconnection was unfortunate, but affirmed that the inconveniences of this situation had ceased in later years as one had become accustomed to live with them. In addition to this, it was added that it seemed improbable that the interconnection could not be reintroduced by simpler means than through an adventurous acquisition but there was no sign, however, of any such attempt made by the Telegraph Administration. Maybe such an agreement would become more feasible, the article continued, if SAT came to understand that the State would not purchase its network. Such an agreement, the article concluded, would “terminate all the technical and financial difficulties that Telegraph Administration now complains about, while retaining the competition that is highly valued by the public if not by the Telegraph Administration.”<sup>84</sup> Thus, the two articles in *Aftonbladet* not only objected to the scenario, they presented an alternative scenario which better served the interest of the public.

An article in the more conservative newspaper *Svenska Dagbladet* took a more positive stance towards the proposed acquisition.<sup>85</sup> In this article it was asserted that it was of national concern to resolve the division of the telephone operations that existed, since it affected the subscribers outside Stockholm more severely than it did those living in Stockholm. It was further maintained that the previous interconnection arrangement had only been a “provisional arrangement that badly concealed the actual state of war under which the Telegraph Administration and SAT fought one another with all means made available by competition.”<sup>86</sup>

The article further agreed that the situation as it obtained with two operators, with all the duplications that resulted, was financially wasteful for the nation. In the article objections were made similar to those raised in *Aftonbladet* regarding how the 6,300

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<sup>83</sup> Full sentence (in Swedish): “Härav torde framgå, att beräkningarna icke äro verkställda med den försiktighet, som bör vid kalkylers uppställande iakttagas, och köpet kan icke betraktas annat än som en spekulationsaffär med de risker, som åtfölja sådana.” *Ibid.*

<sup>84</sup> Original sentence (in Swedish): “Då upphöra utan vidare de tekniska och ekonomiska svårigheter, hvaröfver telegrafstyrelsen beklagar sig, men den af allmänheten, om också ej av telegrafstyrelsen högt värderade konkurrensen bibehålles.” *Ibid.*

<sup>85</sup> “Telefonköpets pro et contra,” *Svenska Dagbladet* (Stockholm), 27 March 1906.

<sup>86</sup> Full sentence (in Swedish): “Samtrafiken var ett provisorium allenast, som illa dolde det faktiska krigstillstånd, hvarunder rikstelefon å ena sidan och de förenade bolagen å den andra bekämpade hvarandra med konkurrensens alla medel.” *Ibid.*

subscribers with double subscriptions were accounted for when estimating the profitability of the acquisition. A minor objection, it was maintained, compared to the question of the technical quality and compatibility of SAT's network. This issue, it was stressed, was only touched upon in the official letter which was highly unsatisfactory since possible expensive modifications of the acquired network could become decisive in making the deal profitable or not. The article stressed that the proposed acquisition could enhance the whole nation's telephone operations provided that they were managed with care and in the interest of the public.

If the acquisition is realised, it should be done in the interest of the public, that is, in order to make one of today's best means of communication fully efficient to the entire country.<sup>87</sup>

It was further stressed that the interests of the State were not necessarily at odds with the interests of the public although it was important that not just the financial interests of the State should guide the future management of the telephone operations. In this connection, the article recounted a few complaints made regarding practices employed by the Telegraph Administration outside Stockholm which the article took as illustrations of undesirable practices, deeming it desirable that the Telegraph Administration attended to such complaints, especially if the acquisition came about. Finally it was stressed that the possible monopoly should not be made the object of financial experimentation, for instance by increasing tariffs and fees, as that would inhibit the development of telephony, damaging society and therefore the finances of the State.

*Further trials of the scenario's strength*

Despite the severe critique in the liberal daily *Aftonbladet*, the Liberal Ministry favoured the proposed acquisition and a supporting proposition was presented to Parliament on 20 April. The proposition was accompanied by a presentation made by the Minister of Public Administration, Axel Schotte (1860-1923), in which he extended on some of the arguments in the official letter from 8 March.<sup>88</sup> In his presentation he stressed that the situation at that time was problematic from three points of view.<sup>89</sup>

Firstly, the lack of interconnection was an inconvenience to the public. To this, he added that the positions taken by both parties regarding a possible new interconnection agreement were reasonable, but nevertheless made an interconnection agreement

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<sup>87</sup> Original sentence (in Swedish): "Kommer telefonköpet till stånd, så skall det ske i allmänhetens intresse, nämligen för att göra ett af nutidens yppersta kommunikationsmedel fullt effektivt för hela landet." *Ibid.*

<sup>88</sup> The presentation by the minister of public administration is reproduced in Ministry Proposition 128 (Kungl. Maj:ts Nåd. Proposition N:o 128), 20 April 1906.

improbable. Secondly, he asserted the technical and financial problems incurred by the Telegraph Administration by the current situation. Thirdly, he reiterated the assertion that the current situation was reprehensible to the nation from an economic point of view. The reasoning regarding the agreed price was further extended and in his presentation Axel Schotte argued that the price per telephone was lower compared to the agreement in 1901, while the average income per telephone had increased since 1901.<sup>90</sup> The presentation also included a section where it was stated that SAT's practice involving many kinds of subscriptions would be introduced gradually in the Telegraph Administration network after the purchase:

As the telephone has penetrated further into the large public, it has become clear that there are large differences in how the telephone is needed. It can therefore no longer be regarded as fair that for instance the limited telephone usage of a private person would incur the same yearly fee as the telephone usage of the businessman, whose office telephone makes use of the service on repeated occasions each day. It is, however, not possible to establish a precise scale of subscription fees for all varying conditions. The different fees that have been employed by the telephone company for a long time have nevertheless proved to fit the varying needs within the public very well as it has enabled everyone to choose the kind of subscription that best suits his conditions.<sup>91</sup>

This willingness to adopt SAT's pricing policy had not been mentioned in the official letter from the Telegraph Administration and must have been added subsequent to 8 March and may have been added to deflect some of the criticism raised against the proposed acquisition. Before concluding his plea for the proposal, Axel Schotte asserted that the procedure to finance the acquisition with a loan was in accord with a well established principle where the State had provided loans to the Telegraph Administration for promoting the uniform development of the telephone venture.

Concurrent with the preparation of the proposal within the government and Parliament, the Telegraph Administration issued a small leaflet briefly presenting the advantages of the deal and answering some of the objections to the acquisition.<sup>92</sup> As in

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<sup>89</sup> Ibid., pp. 35-36.

<sup>90</sup> Ibid., p. 38.

<sup>91</sup> Original sentences (in Swedish): "Allteftersom telefonen trängt in i vidare kretsar hos den stora allmänheten, har nämligen mera tydligt framträdit den stora olikheten i behovet af dess användande. Det kan då icke längre anses rättvist, att t.ex. en privatperson för sina jämförelsevis få samtal får vidkännas samma årsavgift som affärsmanen, hvars kontorstelefon upprepade gånger dagligen tager expeditionen i anspråk. Att uppgöra en för alla växlande förhållanden fullt exakt abonnemangsskala är dock icke möjligt. Emellertid hafva de af telefonbolagen under en lång tid tillämpade olika avgifterna visat sig synnerligen väl träffa allmänhetens olika behof i detta afseende, såsom beredande en hvar tillfälle att mellan flera välja det slags telefonabonnemang, som bäst motsvarar hans förhållanden." Ibid., p. 42.

<sup>92</sup> Arvid Lindman, 1906, *Hvarför bör staten inköpa de enskilda telefontäten?*, TALb; F I A:25.

other affirmations of the proposal's advantages, it was stressed in the leaflet that the proposed acquisition was advantageous to the public, to the nation, and to the Telegraph Administration.

Those opposing the proposed deal were not silent either. On 25 April another article critical to the proposed acquisition was published in *Aftonbladet*.<sup>93</sup> In the article it was asserted that the presentation made by the minister of public administration had not invalidated the objections raised against the acquisition. The article agreed with the minister on the presence of inconveniences to the public caused by the broken interconnection and the problems to the Telegraph Administration caused by the prohibition to run cables under the city streets. Nevertheless, the article continued, the minister of public administration had been unable to show that any attempts had been made to resolve these problems in any other way. Maybe, the article suggested, there was another wind now blowing in the City Council. But, it was added, "it seems like one is so keen on aiming for a State acquisition, that one has not wanted to consider any other arrangement."<sup>94</sup>

If the leaflet and the articles in the press were public expressions of the debate following on the proposal for an acquisition, there were also more direct attempts to enrol the support of the final decision-makers, that is, the members of Parliament. At the end of April the Telegraph Administration distributed a memorandum on the proposal to certain members of Parliament.<sup>95</sup> The memorandum was structured in question-and-answer form. The first question asked whether it was a matter for the State to purchase the Stockholm network from SAT. The answer to this question alluded to other State monopolies, an allusion not present in the official letter of 8 March:

The State presently owns almost all telephone networks in the country except the one now under consideration. The acquisition of private telephone networks has been going on continuously since the beginning of the 1890s. As we know, the postal and telegraph ventures are completely, and the railroads are largely, in the hands of the State. The acquisition of private railroads is not that rare.<sup>96</sup>

<sup>93</sup> "Det föreslagna telefonköpet," *Aftonbladet* (Stockholm), 25 April 1906.

<sup>94</sup> Full sentences (in Swedish): "Man hade väl åtminstone kunnat göra ett försök att träffa aftal med bolaget om samtrafik, liksom också att få förbudet om kablers nedläggande i gatorna upphävd. Hvem vet, om det ej nu blåser en annan vind bland stadsfullmäktige än förr. Men man synes så lifligt eftersträfvat statsköp, att man ej velat ta befattning med några andra arrangemang." Ibid.

<sup>95</sup> n.a., end of April 1906, "Frågor till opartiska riksdagsmän angående det föreslagna telefonköpet. & Bemötande af 'opartisk observators' frågor," (Questions to impartial members of parliament regarding the proposed telephone acquisition and answers to the questions raised by the 'impartial observer'), TAAAb; F I A:229.

<sup>96</sup> Original sentences (in Swedish): "Staten äger f.n. i stort sedt alla telefontät i hela landet utom de nu till inköp föreslagna. Sedan början af 1890 talet har inköp af enskilda telefontät

The memorandum contained 17 questions and answers in all, all pointing to the advantages of the deal and rejecting objections raised. The Telegraph Administration also won the first round when the parliamentary working committee approved the proposition, but the fact that 11 of its 24 members made a reservation against it indicated that the proposition was still not in the clear. Unfortunately for the Telegraph Administration, this indication turned out to be right.

The scenario as painted did not succeed in mobilising enough support in Parliament: On 23 May, Parliament voted against the proposition by a large majority.<sup>97</sup> Again a scenario aimed at resolving the ‘telephone issue’ had failed to pass Parliament despite the absence of unanimous opposition. Some members of Parliament had voiced an objection to the proposal on the grounds that the negotiated price was too high and had found support to this effect in the fact SAT’s share price had risen since the agreement had become public.<sup>98</sup> Others objected to the agreement on the grounds that competition was beneficial while still others found the issue of little national concern, but rather an issue of interest to the Stockholm region. Thus, the objections voiced in Parliament corresponded to objections voiced earlier and had, as such, been subject to attempts at refutation by those already enrolled in support of the scenario. However, taken together the objections proved stronger than the scenario.

The case was closed, but not in the way Arvid Lindman and the others at the Telegraph Administration headquarters had hoped for. At the end of May Arvid Lindman left it to others to continue working on a resolution of the ‘telephone issue’, as he became Prime Minister in a Conservative ministry. There he had to deal with the predominant political issue of the time – the issue whether and how voting rights should be reformed for general and local government elections.<sup>99</sup> The Liberal ministry headed by Karl Staaff (1860-1915) which had been in power during Spring, had resigned when it had failed to win Parliament’s support for a reform of voting rights and now Arvid Lindman as succeeding prime minister had to handle this fiercely disputed issue.<sup>100</sup>

### **What now? – Inventing other arrangements, 1906-1909**

It did not take many days after the defeat in Parliament before other ways to alter the telephone situation in Stockholm were actively discussed. The scenario’s failure to win

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oafbrutet pågått. Post- och telegrafväsendet befinna sig ju också helt och hållet och järnvägarna till stor del i Statens hand. Inköp af enskilda järnvägar äro icke så sällsynta.” Ibid.

<sup>97</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, pp. 177-178.

<sup>98</sup> Beckman, *Telefondebatten i riksdagen*, pp. 43-44.

<sup>99</sup> Lars-Arne Norborg, *Sveriges Historia under 1800- och 1900-talen: Svensk samhällsutveckling 1809-1986* (Stockholm: Esselte Studium AB, 1988), pp. 90-94.

<sup>100</sup> The Ministry headed by Arvid Lindman subsequently introduced a Bill in 1907 for ‘moderate’ reform of voting rights which gained the Parliament’s approval. Ibid., pp. 93-94.

enough support in Parliament had aroused a growing sense of the impossibility of reaching a solution along the lines of the scenario for many years to come. What had been the only solution until a few days earlier had become, through its failure in Parliament, a non-starter. The defeat therefore fuelled an exploration of alternative arrangements, a course actively suppressed previous to the defeat.

In an internal memorandum dated two days after the defeat, the head of the Telegraph Administration's telephone operations in Stockholm, Axel Hultman, argued that neither the situation as it was nor a return to the old interconnection agreement represented very satisfactory arrangements.<sup>101</sup> Instead of these alternatives, he suggested a new arrangement with free interconnection in combination with an extensive co-ordination between SAT and the Telegraph Administration on a few important issues. According to his suggestion, the 70 km-zone was to be divided into two halves. The western territory thus created should be given to SAT while the eastern territory should be given to the Telegraph Administration. Within its own territory each operator should be allowed to take on new subscribers, and within the other's territory the operators should only be allowed to continue to operate without increasing their numbers of subscribers. The subscription fees levied by the two operators should furthermore be identical, and Hultman also held open the option that under such an agreement the two operators could share some facilities such as pole lines to reduce costs.

Axel Hultman finally proposed that SAT under this arrangement should be given a concession limited to 15 years, after which it had to sell its network to the Telegraph Administration. In all, the arrangement suggested by Hultman contained some of the features of the barter agreement from 1904, such as the idea of a territorial division in combination with like subscription fees and free interconnection. However, unlike the 1904 agreement, the arrangement did not require any immediate barter and acquisition of network facilities. For obvious reasons, Hultman wanted to avoid any arrangement that required substantial funding and hence an approval from Parliament for the provision of such funds.

A few weeks after Axel Hultman had made his suggestions, a marginally altered arrangement was discussed within the headquarters of the Telegraph Administration. According to this suggested new arrangement, the subscribers should be enticed into changing operator in such a way that each of the two territories would gradually

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<sup>101</sup> Axel Hultman, 25 May 1906, "Till Kungl. Telegrafstyrelsen," (Memo to the headquarters of the Telegraph Administration), TALb; F I A:26.

become completely dominated by one operator.<sup>102</sup> This should be achieved by using a 0.10 krona interconnection fee for subscribers subscribing to the 'wrong' service for their location, whereas subscribers subscribing to the 'right' service for their location would be given free interconnection. In combination with releasing the duration of their contracts to enable the subscribers to change service easily, this arrangement was meant to gradually achieve a situation like the one sought in the 1904 agreement. The difference was that in this suggested arrangement, the market division would emerge gradually spreading the necessary payments between the operators over many years. It is unclear whether these two suggested arrangements were ever discussed with people at SAT. In the event, they were short-lived as the discussions soon moved in another direction.

The new suggestion to emerge was that the Telegraph Administration should rent SAT's network outside the 30 km-zone defined in 1904 until 1941 after which the rented network would become the property of the Telegraph Administration.<sup>103</sup> The year 1941 was chosen as it was the last year of SAT's 50 year long right to operate a telephone network within the 70 km-zone. It was also suggested that SAT's subscribers within the 30 km-zone should have toll free connection with the subscribers in the outer area until 1911, after which they would have to pay the same inter-urban fee as the Administration's subscribers when making calls to subscribers in the outer parts of the 70 km-zone.<sup>104</sup> This suggested arrangement finally came to contain also an interconnection agreement similar to the one proposed by the Telegraph Administration in March 1903.<sup>105</sup> One obvious target of this suggested arrangement was the practice that had prevailed since 1891 of not charging fees for inter-urban calls within the 70 km-zone. As with the previously suggested arrangements, it is unclear whether this suggested arrangement was ever discussed with people at SAT. What is clear, however, is that the suggested arrangements did not produce any extensive negotiations between the two parties.

The operations became somewhat easier for the two operators in Spring 1907 when the Stockholm City Council withdrew its insistence on an interconnection agreement as a condition for the two operators to run cables under the streets. This removed the major obstacle the Telegraph Administration had referred to in the

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<sup>102</sup> n.a., 13 June 1906, "P.M. angående telefonnätet i Stockholm," (Memo regarding the telephone network in Stockholm), TALb; F I A:27.

<sup>103</sup> n.a., 8 June 1906, "P.M. angående det yttre landsnätet," (Memo regarding the outer toll network), TALb; F I A:27.

<sup>104</sup> Ibid., and n.a., 21 September 1906, "P.M. angående yttre landsnätet," (Memo regarding the outer toll network), TALb; F I A:26.

proposed acquisition in 1906, when stressing why the telephone situation in Stockholm was problematic for the Telegraph Administration. There were no intense discussions about altered arrangements for the telephone system in Stockholm during 1907, perhaps as a consequence of this relief.

The City Council's decision must have given only transient or partial relief because in 1908 the discussions between the two operators resumed. This time the conditions had slightly changed, because the private network since 1 January 1908 was operated by a newly founded subsidiary of SAT, Stockholm Telephone. The stated reason behind the foundation of this subsidiary was to separate SAT's telephone operations in Stockholm from its previously mentioned telephone operations abroad as well as its substantial ownership in LM Ericsson. In this new situation, Henrik Cedergren at SAT offered the Telegraph Administration the opportunity of acquiring a majority in the newly founded Stockholm Telephone and an option of acquiring the remaining shares within three years.<sup>106</sup>

At the Administration the negotiations were conducted by the head of the technical department, Axel Rydin (1865-1935). He found the offer inappropriate for several reasons which he documented in an internal memo.<sup>107</sup> Firstly he noted that the press was not given to writing about the inconveniences caused by the broken interconnection, which he interpreted as indicating that the inconvenience had turned out to be less daunting than had previously been feared. These inconveniences, he argued, seemed to reduce with the continuous expansion of the Administration's telephone network in Stockholm. During the two previous years the number of subscribers in the Administration's network had increased by 27% whereas SAT's network had increased by 13%. This meant, he continued, that the Telegraph Administration was gaining strength, and would gain even more strength when the new lower subscription fees were introduced. It was only a matter of time, he boldly stated, before the Telegraph Administration was the superior operator.

SAT was in 1902 a dangerous competitor to the Telegraph Administration, it was less dangerous already in 1906, and in 1908 it is almost harmless!<sup>108</sup>

An acquisition would have been of a high value to the Telegraph Administration in 1902, Axel Rydin continued, it being impossible at that time to estimate the direction of

<sup>105</sup> n.a., 22 September 1906, "P.M. angående samtrafikens ordnande," (Memo regarding the arrangement of interconnection), TALb; F I A:26.

<sup>106</sup> Johansson, *Telefonaktiebolaget LM Ericsson*, p. 429.

<sup>107</sup> Axel Rydin, n.d. (1908), "P.M. ang. 1908 års köpeanbud fr. Allm. Bol.," (Memo regarding the acquisition offer from SAT 1908), TALb; F I A:26.

<sup>108</sup> Original sentence (in Swedish): "År 1902 var Allm. en farlig konkurrent till Riks., 1906 var det redan mindre farligt och 1908 är det nästan ofarligt!" *Ibid.*, p. 4.

the subsequent development. He argued that the value of an acquisition had decreased since 1902, which implied that the Telegraph Administration now should only pay the material value for the private network in the event of an acquisition. He also suggested that SAT's willingness to sell the subsidiary was partly caused by unexpected difficulties in converting the network to the CB-system.

The message given to Henrik Cedergren at the end of 1908 was that the Telegraph Administration found the offer unacceptable. The reasons given stressed that it was unlikely that the acquisition would be approved by Parliament, that the price was considered too high, that the Telegraph Administration would find it obnoxious not to have full ownership of the company, and finally that the Administration's current position made the advantages of an acquisition dubious.<sup>109</sup> Instead the Telegraph Administration produced a proposal along the lines suggested by Axel Hultman in 1906.

The core of this proposal was thus free interconnection in combination with a division of the 70 km-zone into two halves, where each operator had the right to expand only within its designated territory. Tariffs and fees were to be co-ordinated and inter-urban call fees were to be introduced within the 70 km-zone. The Telegraph Administration furthermore wanted the agreement to last until 1925 after which either party should be able to cancel it. The Administration finally wanted to have the option to acquire the private network from 1919 until 1925.

The proposal was received with some interest at SAT, but Henrik Cedergren firmly rejected the clause giving both parties the possibility to cancel the arrangement.<sup>110</sup> He furthermore wanted to alter the terms under which the Telegraph Administration could acquire the private network. In discussion, the different positions taken on the issue of cancellation of the agreement turned out to be especially difficult to bridge. Axel Rydin persisted that the Telegraph Administration could not tie itself to an unlimited contract, and Henrik Cedergren was as persistent in requesting that it should be impossible to cancel the agreement with less than an outright acquisition of the private network.<sup>111</sup> Henrik Cedergren was especially explicit in pursuing his

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<sup>109</sup> n.a. (Axel Rydin), 9 December 1908, "P.M." (Draft of memo handed to Cedergren 20 December 1908), TALb; F I A:26.

<sup>110</sup> n.a. (Stockholm Telephone), 4 January 1909, 'Memorandum,' TALb; F I A:26.

<sup>111</sup> Henrik Cedergren wanted the Telegraph Administration to have the option of acquiring the network for ten year periods from 1919. Ibid. The continued negotiation is documented in several letters: Axel Rydin, 10 January 1909, 'Letter to Henrik Cedergren;' Axel Rydin, 19 January 1909, 'Draft of letter to Henrik Cedergren;' Henrik Cedergren, 25 January 1909, 'Letter to Axel Rydin;' Axel Rydin, 9 February 1909, 'Letter to Henrik Cedergren;' Henrik Cedergren, 15 February 1909, 'Letter to Axel Rydin.' All at TALb; F I A:26.

position in one of the letters to Axel Rydin, in which he referred to past experiences with making agreements with the Telegraph Administration:

The experience from an earlier period in the company's existence is likely to explain why the company cannot limit its operations in the way presupposed in the proposed contract, without a corresponding assurance that the company will retain the advantages gained.<sup>112</sup>

It seemed impossible to bridge this gap in positions, in spite of earnest attempts on both sides. No agreement had been reached when Henrik Cedergren died a few months later, and all efforts made since the defeat in Parliament 1906 had come to nothing. The fact that negotiations were also taking place after Stockholm City Council had abandoned its demand for interconnection in 1907 indicates that there were reasons not stressed in the acquisition proposal of 1906 that still made efforts to alter the situation worthwhile.

### **The power of the 'telephone issue'**

The so called 'telephone issue' gained new strength, as we have seen, after interconnection was cut in 1903. On repeated occasions, fervent activity was spent on trying to reach an agreement on how to alter the telephone arrangements in the Stockholm region. People at SAT and the Telegraph Administration searched, negotiated and tried out several different arrangements. On the two occasions SAT and the Telegraph Administration succeeded in reaching an agreement, Parliament failed to give its approval. Taken together, these efforts point to the diversity of arrangements considered.

After the defeat in Parliament in 1906 the diversity of arrangements actually seems to have increased, which is ironic given the confident assertions made by the Telegraph Administration to Parliament stating that an outright acquisition was the only viable solution. After this defeat, people at the Telegraph Administration were reluctant to discuss arrangements which would require Parliament to approve of substantial funding. When Parliament could not be enticed to align, it had to be circumvented. However, in these later negotiations SAT and the Telegraph Administration themselves could not come to an agreement.

At one level these efforts show that many different arrangements proved to have been viable enough to produce vigorous efforts. Yet, at another level none of these arrangements proved to be viable enough, since none were actually strong enough to align all necessary parties and close the issue. The 'telephone issue' lived on, spurring new discussions on new arrangements.

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<sup>112</sup> Original sentence (in Swedish): "Erfarenheten från ett tidigare skede i bolagets tillvaro lärer förklara, att bolaget ej kan på sätt aftalet förutsätter inskränka sin verksamhet utan

The repeated efforts to reach an agreement not only reveal that a diversity of arrangements were seriously considered as possible ways to organise the telephone system in Stockholm. They also reveal the range of issues and actors that were connected to the 'telephone issue'. For instance, the vital role of the government in supplying funds to the Telegraph Administration is clear, as is the role played by Stockholm City Council in influencing the expansion of the networks of trunk and local lines. The negotiations prior to the acquisition proposal of 1906 also reveal the importance Henrik Cedergren put on SAT's relationship with LM Ericsson, where SAT's telephone network in Stockholm provided a field site for trying out new telephone technologies.

The story of these efforts reveals, furthermore, how intimately connected any alteration of the arrangement was with the physical outlines of the telephone networks. The investigations as to how the main exchanges had to be altered to conform to the agreement of 1904 are but one illustration of such connections. The set of arrangements discussed also reveals what kind of issues the actors considered to be particularly problematic with the prevailing situation, i.e., what they considered as constituting the 'telephone issue.' The lack of interconnection was evidently a central part of the 'telephone issue,' but the 'telephone issue' was more than the lack of interconnection.

Apart from allowing interconnection, all arrangements discussed also had other elements in common. Elements controlling prices and the recruitment of new subscribers were a recurrent feature in the arrangements in terms of which the private operator continued its operations. In the 1904 agreement, the 70 km-zone was to be divided into geographically defined monopolies and prices were moreover to be co-ordinated. In Axel Hultman's suggestion of 1906 new subscribers were to be recruited to one of the operators depending on the subscriber's location, and again prices were to be co-ordinated. To conclude, pricing and recruitment of new subscribers, together with interconnection, were central parts of the 'telephone issue.'

It is hardly surprising that the recruitment of new subscribers and growth were of vital concern to both operators, as the number of subscribers defined the extent of the operator's local service. The two networks also grew at a remarkable pace. The Telegraph Administration's network more than doubled the number of subscribers within the 70 km-zone between 1903 and 1909 and in the private network the number of subscribers increased by more than 60% during the same period. Figure IV-3 depicts the annual net increase in number of telephone sets in the two networks.<sup>113</sup>

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motsvarande försäkran att få behålla däremot vunna fördelar." Henrik Cedergren, 25 January 1909, 'Letter to Axel Rydin,' TALb; F I A:26.

<sup>113</sup> Compare with Figure IV-1 on page 58 which displays the same figures for 1892-1902.

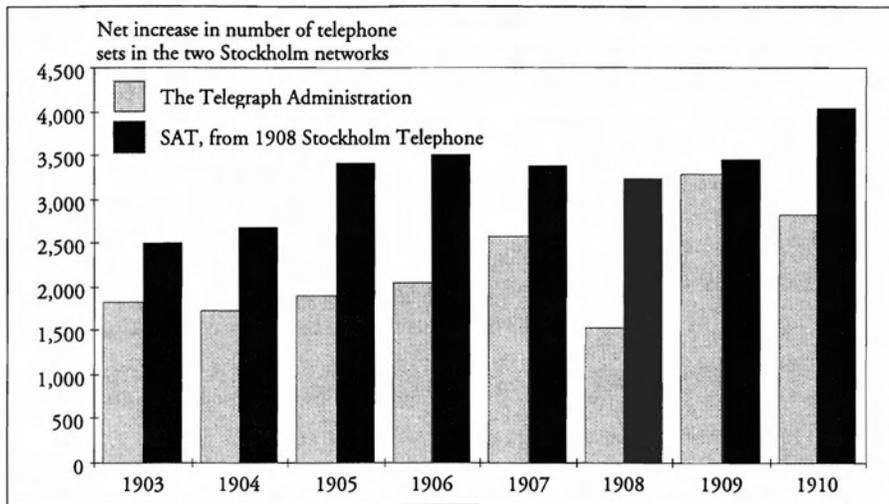


Figure IV-3 The growth of the two large networks within the 70 km-zone, 1903-1910.<sup>114</sup>

The source of this substantial growth after 1903 was not only new groups taking on the telephone. The lack of interconnection made more and more telephone users subscribe to both services as the only way to reach both the substantial number of subscribers SAT had in Stockholm and the subscribers the Telegraph Administration had in the rest of the country. The number of subscribers having both services gradually increased as the years after interconnection progressed. Between 1906 and 1910 almost 40% of the new subscriptions taken out were signed by subscribers adding a second telephone service to the one already subscribed to.<sup>115</sup> Before interconnection was cut almost 8% of the subscribers within the 70 km-zone subscribed to both services, and by 1910 this percentage had more than doubled, see Table IV-1.

Table IV-1 Approximate numbers of subscribers within and outside the 70 km-zone.

Area	Service	Number of subscribers (end of year)		
		1901	1905	1910
Stockholm, 70 km-zone	Only SAT / Stockholm Telephone	26,900	34,600	46,000
	Only the Telegraph Administration	8,100	11,000	18,000
	Both services	2,900	6,300	12,000
Outside the 70 km-zone	The Telegraph Administration	45,200	64,700	98,000

<sup>114</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 196.

<sup>115</sup> The total net increase in subscriptions within the 70 km-zone was 29,800 approximately during these years. Of this increase 11,400 were new 'secondary' subscriptions ((12,000-

Hence the growth of the two networks was both something the two operators wanted to regulate and something partly fuelled by the broken interconnection. The rapid expansion of the two Stockholm networks was furthermore reflected in the demands put on the main exchanges, and it is now time to return to the controversy on the appropriate design of a large exchange as viewed from within the Telegraph Administration.

## **On the Appropriate Design of a Large Exchange**

### **Discussing the usefulness of automatic switching devices**

The controversy within the Telegraph Administration between Axel Hultman and Anton Avén on the call-distributing system was hence concurrent with repeated failures to solve the 'telephone issue' and a rapid growth in the Telegraph Administration's telephone network in Stockholm. While Hultman and Avén were fighting out their differences, switching systems of another kind were gradually surfacing in discussions among European telephone engineers.

Early in October 1908 Axel Rydin and Axel Hultman of the Telegraph Administration returned after visiting Budapest to participate in the first European telephone-engineering congress for state-employed telephone engineers. In an interview with a Swedish newspaper recounting his impressions from the conference, Axel Rydin reported that the discussions concerning automatic switching systems had been the most interesting part of the conference.<sup>116</sup> In Budapest Axel Rydin and Axel Hultman heard two presentations on automatic switching devices as well as participated in the ensuing debate.

A paper presented by the engineer Charles Barth de Wehrenalp from Vienna focused entirely on the possible advantages with using automatic switches for large exchanges.<sup>117</sup> Since there was no automatic exchange in operation in Europe, he drew upon experiences made from studying American automatic switching systems and from experiments carried out at a small test-exchange in Vienna. He structured his discussion around four principal questions, moving from the possibilities and limitations of mechanical devices, over the attitudes of subscribers, to the issue of costs:

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6,300)\*2). This makes the net increase of 'secondary' subscriptions 38% of the total net increase (11,400 / 29,800).

<sup>116</sup> "Första internationella telegraf- och telefonkonferensen i Budapest: Byråchefen Axel Rydin relaterar sina intryck," *Stockholms Dagblad*, 13 October 1908.

<sup>117</sup> Charles Barth de Wehrenalp, "Discussion de la Question du Service Téléphonique Automatique ou Manuel," in *Compte Rendus de la Première Conférence Internationale des Techniciens des Télégraphes et Téléphones à Budapest 1908* (Budapest: Victor Hornyánsky Imprimeur de la cour Imp. et Roy., 1908).

1. Which manipulations in the telephone service can one entrust to mechanisms and which cannot do without human intelligence?
2. Is it possible to design, at the current technical state, devices for mechanical manipulation which promise at least the same security as the best manual switches?
3. Can one entrust these devices to the public without fearing that the operation of such a network will give reason for more complaints than a manual service organised in the best way?
4. And – last but not least – what is the expenditure for installation and traffic within telephone networks with automatic and manual switches respectively?<sup>118</sup>

When considering his first question, Charles Barth stressed that only inventors ignorant of the particularities of telephony would want to replace all personnel with machines. He asserted that machines could only perform uniform work. This meant that all inter-urban traffic, together with other services such as information services, should be completely excluded from automation.<sup>119</sup> Local traffic, according to Charles Barth, was on the other hand well suited for automation as the operations needed to make a local connection were repeated thousands of times a day. Machines, he maintained, would undoubtedly perform these operations with higher precision and more rapidly than operators. The higher precision, he asserted, was due to the faulty connections inevitably made by operators fatigued after working some hours:

With higher precision, because a machine, properly managed by the subscriber and working well cannot make a mistake. The operator, on the other hand, is charged with work requiring intelligence over and above the mechanical operations and will at the end of a couple of hours become fatigued which will result in misunderstandings and incorrect operations which in turn makes faulty connections inevitable.<sup>120</sup>

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<sup>118</sup> Original sentences (in French): “1. quelles manipulations du service téléphonique peut-on confier à des mécanismes et lesquelles ne peuvent se dispenser de l’intelligence humaine? 2. Est-il possible de construire, à l’état actuel de la technique, des appareils pour les manipulations mécaniques, qui promettent au moins la pareille sécurité que les meilleurs commutateurs manuels? 3. Peut-on confier ces appareils au public sans craindre que l’exploitation d’un tel réseau ne donne lieu à plus de plaintes que le service manuel le mieux organisé? 4. Et – last not least – quel seront les frais d’installation, et les dépenses du trafic dans les réseaux téléphoniques avec autocommutateur et avec commutateur manuel?” *Ibid.*, p. 3.

<sup>119</sup> *Ibid.*, p.4.

<sup>120</sup> Original sentence (in French): “Plus précisément, parce qu’une machine, bien dirigée par l’abonné et fonctionnent bien ne peut se tromper tandis que les opératrices, étant chargées en dehors des opérations mécaniques encore du travail d’intelligence sont au bout de quelques heures si énervées que des mal-entendus, des fausses manipulations et à la suite de cela des fausses communications sont inévitables.” *Ibid.*

The higher speed, he continued, was given by the “known fact that a consciously reflected performance of a mechanical activity takes more time than liberated mechanisms propelled by electrical currents.”<sup>121</sup>

Was it then possible at the time to design automatic devices that promised ‘at least the same security as the best manual switches?’ Turning to this his second question, Charles Barth described the test-exchange erected in Vienna. It was a Strowger<sup>122</sup> system and had 200 subscribers’ lines connected to it and there was intense traffic not only between these lines but also with the manual network comprising 24,000 subscribers. Charles Barth asserted that the switch worked well and did not require additional mechanics, but nevertheless expressed dissatisfaction with its American design and in particular its inferior manufacture.<sup>123</sup>

Despite the dissatisfaction with the design of their Strowger switch, Barth affirmed that automatic systems allowed for designs superior to those of the multiple switchboard used in many large manual exchanges. In the latter system all subscribers’ lines had to be within reachable distance of every operator, which meant that the jacks in the switchboard had to be small to fit into a given area. Experience had proved, he affirmed, that these delicate and concealed constructions constituted a rich source of disorder especially under the brusque and agile treatment of swift operations.<sup>124</sup> Furthermore, he continued, the requirement on size causing these problems was outside the command of the designer of the system since it was dependent on the minimum size and arm length of the operators. Such problems, he stressed, disappeared altogether with an automatic system:

All these adversities disappear with the automatic switch: in this case the designer has full command to design and dimension each section as its function requires.<sup>125</sup>

But could the subscribers be entrusted to operate the devices of an automatic switch without more complaints being raised? Moving on to his third question, Charles Barth

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<sup>121</sup> Full sentence (in French): “Il nous reste à dire pourquoi le service est plus rapide; d’abord il est connu qu’une transaction de réflexion spirituelle en activité mécanique exige plus de temps que de le dégagement de mécanismes occasionné par des courants électriques.” Ibid., p. 4.

<sup>122</sup> Robert J. Chapuis, who has written one of the major works on the history of telephone switching, noted that US Strowger was not the first automatic telephone switching system envisioned, but that it was the first system to be installed on a commercial basis. On the infancy of automatic switching in the US, see Robert J. Chapuis, *100 Years of Telephone Switching (1878-1978), Part 1: Manual and Electromechanical Switching (1878-1960's)* (Amsterdam: North-Holland Publishing Company, 1982), pp. 58-72.

<sup>123</sup> Barth de Wehrenalp, p. 5.

<sup>124</sup> Ibid.

began by agreeing with all that opponents of the automatic system had said against the Strowger dial.<sup>126</sup> Nevertheless, his experiences from Vienna had showed that the Strowger dial did not produce more faults and misunderstandings than did the manual system. Notwithstanding, they had replaced the Strowger dials with devices of their own design which enabled subscribers to view the entire number before setting the switch in motion. This particular feature constituted a considerable advantage, according to him, since it enabled the subscriber to correct a wrong number in time and furthermore in case of a faulty connection the subscriber could learn that “the fault should be attributed to him and not to the machine.”<sup>127</sup> The dialling device, according to him, was so easy that any child could handle it and in his view the public had quickly become accustomed to this invention and preferred it to all the inevitable adversities of the manual service.<sup>128</sup> He further disputed the notion that the manual system had a tranquillising effect on the subscribers, a claim he ascribed to ‘partisans’ of the manual CB-system. It was, he countered, impossible in a manual switch to answer and dispose of all calls instantaneously during rush hours and this unavoidable wait, he asserted, enervated the subscribers. The automatic switch, he continued, was completely different in this respect:

The automatic switch is on the contrary calming on the nerves: to make a connection the subscriber first must be attentive that he is indicating the correct digits in the desired number; as he alone is responsible for all errors. After this he turns the dial a few times and after only a few seconds he hears either the signal sounding at the other exchange or that the line is busy. There is neither opportunity nor time to get enervated.<sup>129</sup>

How did manual and automatic switches then compare in terms of investment and operation costs? Turning to this his fourth and last question, Charles Barth began by laying out the broad differences between the systems in terms of costs. The devices of

<sup>125</sup> Original sentence (in French): “Tous ces désagréments disparaissent par l’auto-commutateur: dans ce cas le constructeur a plein pouvoir de former et dimensionner les seules parties comme leur fonction l’exige.” *Ibid.*, p. 5.

<sup>126</sup> *Ibid.*, p. 6.

<sup>127</sup> Full sentence (in French): “S’il est nécessaire, il peut corriger à temps un erreur et en cas d’une fausse connexion constater que c’était lui et non la machine à qui il faut attribuer le défaut.” *Ibid.*, p. 6.

<sup>128</sup> In support of this point he furthermore referred to a US study presented at a congress in St-Louis in 1904, according to which subscribers who had tried both systems unanimously preferred the automatic system. *Ibid.*, p. 7.

<sup>129</sup> Original sentences (in French): “L’autocommutateur est au contraire vraiment calmant pour les nerfs: pour établir sa connexion, l’abonné doit d’abord faire attention qu’il marque juste les chiffres du nombre désiré; puisque lui seul et responsable de toute erreur. Après ce passe temps il tourne sa manivelle quelque fois et au bout de quelques secondes il entend déjà, soit le signal qui retentit dans l’autre station ou bien il constate que la ligne n’est pas libre. Il y a ni l’occasion ni le temps pour s’enervé.” *Ibid.*, p. 7.

the automatic system was naturally much more expensive and required a larger staff of mechanics, but the automatic system meant on the other hand that a majority of the operators could be 'liberated.' According to his calculations, the difference in cost was rapidly augmented in favour of the automatic system in networks of more than 10,000 subscribers or where the manual system already exceeded one exchange and the enormous expenses attached to installation and personnel for trunking. The figure presenting the results from his calculations is reproduced in Figure IV-4, and in it he also included results from similar calculations presented by the American Lee Campbell earlier in 1908.

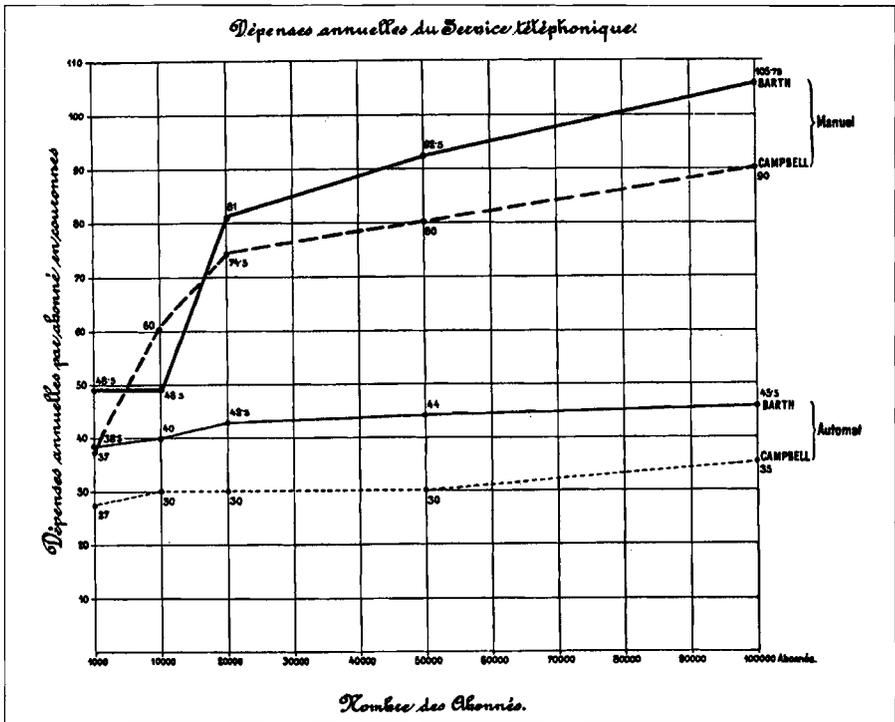


Figure IV-4 Diagram presented by Charles Barth de Wehrenalp on how annual expenditure per subscriber varies with size of network when using automatic and manual switches.<sup>130</sup>

These calculations however included only costs for erecting the devices, their maintenance and their operation, and Charles Barth stressed that there were other costs to consider as well. The costs for managing the operations were not included for instance and he affirmed that these were naturally much higher with the manual system,

<sup>130</sup> Ibid., p. 9.

since the thousands of operators demanded an elaborate administration and their retirement furthermore burdened the budget enormously.<sup>131</sup> To this point he further added that the obligations towards the operators constituted an appreciable difference between the European telephone administrations and the private American telephone corporations. One knows, he asserted, “that the latter have no such obligations towards their personnel; the operators are fired without a remuneration as soon as age or illness impede them from ensuing their occupation.”<sup>132</sup> The state administrations, on the contrary, had to provide for them ‘until the end of their days,’ and, he added, these obligations could become a major problem for any administration as their operators became older:

Think of an administration which has employed 10-20,000 more operators, women slowly but surely reaching comfortable old age; what can be done every year with this large number of such persons who are no longer capable of performing their service in a timely manner?<sup>133</sup>

This issue was in his view an issue for state administrations to seriously consider when choosing the system to come. Charles Barth finally added that the automatic system allowed savings through shorter subscriber's lines. In Europe, he noted, large exchanges were established solely to avoid the effect trunking had in incurring large increases in operating costs. He affirmed that these difficulties entirely disappeared with the automatic system which allowed for grouping of the subscribers as desired without increasing operating costs:

With this system every large local network may be exactly divided according to local circumstances; the subscriber's lines of every division will not have to be run to the centre of the district; they will in this way be shorter and cheaper.<sup>134</sup>

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<sup>131</sup> Ibid., p. 9.

<sup>132</sup> Full sentences (in French): “A propos de cela je suis à même de parler de la grande différence qui existe à ce point de vue entre les administrations d'état européennes et les compagnies privées américaines. On sait que ces dernières n'ont point de tels devoirs envers leur personnel; les opératrices sont congédiées sans indemnité aussitôt que l'âge ou maladie les empêchent de suivre leur occupation; les administrations d'état au contraire ont stabilisé presque tout leur personnel et doivent songer à son entretien jusqu'à la fin de ses jours.” Ibid., p. 9-10.

<sup>133</sup> Full sentence (in French): “Pensez donc qu'une administration ait engagé 10-20.000 opératrices au davantage, atteignant lentement mais sûrement à l'âge commode de vieilles filles; que fer-a-telle chaque année avec ce grand nombre de telles personnes qui ne sont plus capables de faire leur service ponctuellement?” Ibid., p. 10.

<sup>134</sup> Full sentence (in French): “Toutes ces difficultés disparaissent par l'autocommutateur qui permet de grouper les abonnés comme on veut sans renchérir l'exploitation; avec ce système chaque réseau aussi grand qu'il soit peut être précisément divisé d'après les circonstances locales; les lignes d'abonné de chaque division ne sont à conduire qu'au centre du district; elles seront de cette façon plus courtes et meilleur marché.” Ibid., p. 10.

Charles Barth de Wehrenalp concluded his presentation by summarising his view on the suitability of the automatic system: Firstly it gave a more rapid and reliable service. Secondly, it provided considerable economic advantages for local networks larger than 10,000 lines or where all subscribers could not be connected to a single exchange. Thirdly, in local networks of 500 to 10,000 lines the automatic system should primarily be chosen on its technical advantages and because it allowed the network to be enlarged without sudden escalations in costs. Fourthly, in local networks with fewer than 500 lines the automatic system should only be chosen where reliability and speed were of primary importance.

In short, Charles de Barth, claimed that most things – such as the bodily dimensions of the operators, the state administrations' pension obligations, the liberty to lay out the urban network without expensive manual trunking constraints, and the mental health of the subscribers – pointed in favour of automatic switches for all larger urban networks. The appropriateness of automatic switches increased furthermore with the size of the urban network. Indeed, what he presented to the delegates was no less than a scenario according to which the introduction of automatic telephone switches lay in the interest of both the state telephone administrations and their subscribers.

The paper on semi-automatic telephone operations presented by the engineer Hans Karl Steidle, of the Bavarian Post Administration, contained a quite different scenario.<sup>135</sup> His paper concerned the use of small automatic selectors to which 15-20 adjacent subscribers were connected and where these devices in turn were connected with a fewer set of lines to the manual main exchange. Such a device, according to this scenario, enabled savings in copper as well as allowing for increasing the capacity of the (manual) main exchange and hence reducing the need for trunking.

Steidle stressed that statistical investigations had shown that about 60% of subscribers made no more than three calls a day, which meant their subscriber's lines were only utilised about 15 minutes per day. He further noted that recent developments in switching technology still did not reduce the consequences of these load conditions, and that a technically and economically generally endorsed solution still had to be found. The reason for this, Steidle asserted, was that a quantitative formulation of the technical and economic task was lacking. The technology, he affirmed, was still too

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<sup>135</sup> H. K. Steidle, "Technische Grundlagen und Wirtschaftliche Bedeutung des Halbautomatischen Betriebes in Stadt- und Landfernsprechen," in *Compte Rendus de la Première Conférence Internationale des Techniciens des Télégraphes et Téléphones à Budapest 1908* (Budapest: Victor Hornyánsky Imprimeur de la cour Imp. et Roy., 1908).

much under the influence of emotional values, which reflected in the swing “from one extreme to the other.”<sup>136</sup>

Steidle emphasised the need of enhanced formalised knowledge on the effects of letting a number of subscribers share a reduced set of lines to the main exchange. The main question he wanted to be able to answer was the minimal number of lines sufficient for a given group of subscribers with a given average number of calls per day without producing a considerable waiting time for the individual subscriber attempting to make a telephone call. For this purpose, he had designed a chronograph for recording the traffic of different subscriber groups. This chronograph counted the number of calls made by each subscriber, the duration of each and the number of calls taking place simultaneously.

The results from his investigation using this chronograph showed, for instance, that a group of subscribers making in total up to 100 calls per day could be served with two lines and still 99% of all attempted calls would immediately receive a connection with the main exchange.<sup>137</sup> The maximum waiting time for the one call attempt that would have to wait would be 30 seconds. This meant that a group of 15-20 subscribers could be connected to an adjacent automatic selector<sup>138</sup> – an automatic satellite switch or *Selbstanschlussuntercentrale* to use his concept – which in turn would be connected to the main manual exchange with two exchange lines. Hence, for a group consisting of 20 subscribers and having a traffic of 100 calls per day, this arrangement could save 18 lines from the satellite switch down to the main exchange. Steidle further maintained that for the individual subscriber the need to wait would occur only infrequently and in proportion to the number of calls placed. The telephones were moreover to be furnished with a device indicating the current traffic.<sup>139</sup>

The use of automatic satellite switches, according to Steidle, would enable large savings in the use of copper in the local network as well as increase the capacity of the

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<sup>136</sup> Full sentence (in German): “Die Technik steht hier zweifellos noch zu sehr unter dem Eindruck der Gefühlswerte; man ist so, wie dies sich öfters zuträgt, von dem einen Extrem ins andere gelangt.” Ibid., p. 3.

<sup>137</sup> Steidle had made about 100 readings with the chronograph in different districts of Munich and including subscribers with varying traffic intensity. From the data thus collected he had formulated a table representing the relationships between the total number of calls per day made by a group of subscribers, the number of lines serving them, the percentage of attempted calls that could be served immediately, and the maximum waiting time. This percentage was labelled accessibility. The prevailing arrangement, where the subscribers were connected to the main exchange by individual subscriber’s lines had thus per definition an accessibility of 100%. Ibid., p. 8-10.

<sup>138</sup> When a subscriber within the group wanted to make a call, the selector would automatically connect the subscriber to an available line at the manual main exchange. In the case of incoming calls to a subscriber within the group, the selector would be directed from the manual exchange with the use of a dial managed by the operator. Ibid., p. 16-17.

main manual exchanges. On the basis of his investigation, he therefore made two propositions. Firstly, in urban networks subscribers with low or moderate traffic should be connected in groups with two lines to the main exchange.<sup>140</sup> Secondly, in rural areas the number of manual exchanges could be reduced with the establishment of semi-automatic sub-exchanges connected to a larger manual exchange with one or two trunk lines depending on the size of the region it should support. Steidle ended his paper by recounting the good results the Bavarian administration had had with its first automatic satellite switch which had been in operation in a town 20 km from Munich since July 1906.<sup>141</sup>

Thus, both papers on automatic switching devices presented at the conference expounded on the practice of using one or a few large manual exchanges in urban areas as a backdrop. The cost of trunking and the cost of subscriber's lines were central in both papers, but the scenarios proposed to reduce them differed and the weight given to the two costs differed. Charles Barth emphasised the cost of trunking incurred by using operators and argued for the use of automatic exchanges within urban networks. Steidle, on the other hand, put greater emphasis on the cost of subscriber's lines and argued for a preservation of the practice of using large manual exchanges. He emphasised, however, that the practice of connecting each individual subscriber directly to the main exchange caused an unnecessary waste of copper.

At the ensuing discussion the two authors had the opportunity to debate their diverging scenarios, and then Steidle noted that the use of automatic satellite switches moved the costs for a manual system to the right in de Barth's diagram (cf. Figure IV-4, p. 95):<sup>142</sup>

With the statistics gained from the chronograph it is only possible by the arrangement of group-switches to increase the capacity in the multiple fields from 10,000 plugs to about 60,000 lines, thereby limiting the introduction of

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<sup>139</sup> Ibid., p. 12.

<sup>140</sup> Subscribers were considered to have low or moderate traffic when they made and received no more than 5 calls per day on average. The size of the groups was adjusted so that the total traffic of the group reached 120-150 connections per day. Steidle motivated the choice of two lines to the main exchange on the grounds that two lines provided independent traffic conditions and a five times higher efficiency compared with a single line. More lines, and hence larger groups, on the other hand would not provide equally large savings and would furthermore entail what he called substantially a 'new technical effect,' in other words, it would require more complicated automatic selectors. Ibid., pp. 12-13.

<sup>141</sup> Ibid., p. 17-18.

<sup>142</sup> A transcription of the debate oscillating between French and German, is reproduced in: *Compte Rendus de la Première Conférence Internationale des Techniciens des Télégraphes et Téléphones à Budapest 1908* (Budapest: Victor Hornyánsky Imprimeur de la cour Imp. et Roy., 1908), pp. 19-23.

automatic exchanges to the really large networks also under the conditions given in the present comparative diagram.<sup>143</sup>

In his reply Charles Barth admitted that the main economic difference between automatic and manual service occurred at that point where the manual service needed a second exchange when, as a consequence, a part of the local traffic had to be trunked between the exchanges.<sup>144</sup> He also admitted that the capacity limit for one manual exchange might be increased with Steidle's system, but maintained that in the very large networks automatic switching was still the only remedy against the vast increases in cost incurred by trunking local traffic. Another delegate, F. Stegman from Bavaria, argued that the basis behind any cost calculations had to be adapted to local conditions, and maintained that the number of operators needed for an exchange with 10,000 subscriber's lines was lower than those used in the calculations by Charles Barth in his experience.<sup>145</sup> He added that he found the greatest advantages of the automatic system lay in the savings of wire in the local network, and that he was thoroughly convinced that automatic systems would be a part of the future in large cities.

Other delegates at the conference expressed concern as to how subscriber's would react and behave when confronted with automatic devices. Georges Radacovitch, head of the engineering department at the Romanian Administration, aired the fear that many subscribers in an automatic system might overuse any possibility to get manual service if that were to be made available to them. In that case, he asked, whether or not the Administration became obliged to have as many mechanics as were required in an automatic system and as many operators as were required in a manual system.<sup>146</sup> He therefore suggested that no such possibility should be given to the subscribers, forcing them to use the automatic service. Stegman noted that the undeniable advantages of the elaborate dial designed at the Austrian Administration seemed to him to come at too high a cost. He stated that in America the broadest section of the public comprehended how to select the desired number with the use of the simple dial.<sup>147</sup> The only misgiving with the ordinary dial, it was jokingly claimed, was that it could not be used in cases where the fingers were too thick to set the dial in motion.

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<sup>143</sup> "Nach den mit dem Chronographen gewonnenen statistischen Aufzeichnungen ist es nun durch Einrichtung von Gruppenferschalten möglich die Kapazität des Vielfachfeldes mit ca. 10.000 klinken leicht auf etwa 60.000 Anschlüsse zu steigern, und damit die Einführung des automatischen Betriebes auch unter den Verhältnissen des vorliegenden Vergleichsdiagrammes auf ganz grosse Netze zu beschränken." HK Steidle, *ibid.*, p. 22.

<sup>144</sup> Charles Barth de Wehrenalp, *ibid.*, p. 22.

<sup>145</sup> F. Stegman, *ibid.*, pp. 20-21.

<sup>146</sup> Radacovitch, *ibid.*

<sup>147</sup> Stegman, *ibid.*, p. 20.

Axel Hultman, from the Swedish Telegraph Administration, expressed scepticism as to how subscribers would react and behave when confronted with automatic devices. He described how the Administration had used small automatic selectors at several sites in rural areas over a number of years and that generally the subscribers were pleased with this arrangement. The subscribers nevertheless gradually became tired of performing the switching.<sup>148</sup> They complained for instance that it was difficult to dial without light when it was getting dark. Hultman agreed that some tasks such as the distribution of incoming calls could favourably be automated, but maintained that it should be left to operators to operate the automatic devices. The subscribers “shall have nothing more to do, to them belongs to take off and further to restore [the handset],” he affirmed.<sup>149</sup>

The largest drawback of all automatic systems is that one gives switching work to the public, and the danger lies in that the public after some time will demand a manual system.<sup>150</sup>

The Swedish Telegraph Administration, Hultman reported, would therefore not use an automatic system for its new main exchange in Stockholm.

To the comment raised by the Romanian delegate Georges Radacovitch, Charles Barth replied that the subscribers should naturally only have the possibility to receive manual service in cases of real disorder. To Stegman he replied that the dial used in America had indeed not given rise to any complaints but nevertheless the design used in Vienna was more reliable and convenient. He further asserted that the cost of the telephone sets would come down once production was started.<sup>151</sup> To the comments made by Axel Hultman, Charles Barth replied firstly that he did not believe that many subscribers were in the habit of using the telephone in gloomy rooms. And when that nevertheless was the case, the problem could easily be resolved by employing a small electric lighting device. Finally Charles Barth affirmed that if one chose to follow Hultman's suggestion and only automate some operations at the exchange, the step to full automation was neither expensive nor hazardous.

Lagging behind the United States in the availability of telephone engineering forums, the conference in Budapest was perhaps the first larger such forum at which

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<sup>148</sup> Hultman, *ibid.*, p. 19.

<sup>149</sup> Original sentence (in German): “Die Teilnehmer sollen nicht mehr zu tun haben, als ihre Hörer abzuheben und wieder anzuhängen.” Hultman, *ibid.*, p. 20.

<sup>150</sup> Original sentence (in German): “Der grösste Nachteil aller automatischen Systeme ist, dass man dem publikum die Vermittlungsarbeit gibt, und die Gefahr liegt vor, dass das Publikum ohne weiteres nach einer gewissen Zeit ein manuelles System verlangt.” Hultman, *ibid.*, p. 19.

<sup>151</sup> *Ibid.*, p. 21.

automatic switching systems had been discussed in a European context.<sup>152</sup> Nevertheless, as the contributions indicate, work was already being done in such directions. The conference in Budapest gives one a useful picture of prominent themes in the early discourse among European telephone engineers on the use of automatic switching devices. The discussion on switching displayed a shared concern about the cost of trunking and the cost of subscriber's lines, both using as a backdrop the practice of using one or a few large manual exchanges in urban areas. However, the two proposals on how to reduce them differed as already noted. The ensuing debate moreover added to this divergence and in particular the issue as to whether it was necessary and legitimate to induce or force the subscribers to use dialling devices. Thus, although there was a general agreement on the contours of the major problems with large urban telephone networks, there was no clear-cut consensus on the contours of a viable remedy. In short, there appears to have been a larger unity on what the central problems were than on what constituted viable solutions to these problems.

Despite this disunity, Axel Rydin expressed satisfaction with the conference upon his and Axel Hultman's return to Sweden. He affirmed in a Swedish newspaper interview that the discussion introduced by Charles Barth de Wehrenalp had been the most interesting at the conference.<sup>153</sup> He further stated that he considered automatic switching devices to have the future before them but that he was afraid that the existing automatic systems would prove hardly satisfactory to the Swedish subscribers. According to Axel Rydin, Swedish businessmen in particular would be unlikely to submit to manipulating a dial for every call. Therefore he could not for the present foresee any imminent introduction of automatic switches in the Administration's telephone network. It would hardly do to set up an expensive system only to find that the broad public found it unsatisfactory. Axel Rydin further claimed that, apart from the interesting foreign experiences with automatic switching devices, the general impression from the conference was that the Swedish Administration still had little to learn from foreign countries regarding telephony.

The article also reported that Axel Rydin and Axel Hultman had made several side visits on their trip to and from Budapest. Among other places, they had visited SAT's new telephone exchange in Warsaw, as well as a new very large switch in Hamburg designed for 80,000 subscribers. The Warsaw exchange used a variant of

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<sup>152</sup> Chapuis emphasises this lack of telephone engineering conferences as compared to the ones available in the United States. He also recounts that an initiative for such a conference had been raised as early as 1903 at a telegraph conference in London of the International Telegraph Union of Bern, only to be refused. Chapuis, pp. 74-75.

<sup>153</sup> "Första internationella telegraf- och telefonkonferensen i Budapest: Byråchefen Axel Rydin relaterar sina intryck," *Stockholms Dagblad*, 13 October 1908.

Anton Avéns call-distributing system<sup>154</sup>, and the system at the exchange in Hamburg had been designed by Anton Avén himself, who for this occasion had spent a long period there and only returned to Sweden and the Telegraph Administration earlier in May 1908.

### **The end of the controversy on the call-distributing system**

The conference in Budapest thus took place at a time when the 'switching system issue' was topical within the Telegraph Administration. The debate over the call-distributing system had become heated in the year before the conference in Budapest and continued in 1909 as was earlier reported. Axel Hultman had obviously not been impressed with what he had seen in Warsaw and Hamburg, as he also maintained his position that the cord pair system was superior to the call-distributing system after his trip in 1908.<sup>155</sup> For some time the controversy had been driven by Anton Avén and Axel Hultman, but in 1910 Erik Ekeberg (1868-1949) joined the deadlocked debate when he and a telephone inspector submitted a travel report with experiences from visits to telephone exchanges in Rotterdam, London and Nottingham. Before relating to what they said in their report, it may be useful to ponder on what happened within the organisation of the Telegraph Administration in 1909 as that may have a bearing on why Erik Ekeberg undertook a study tour in January 1910.

Erik Ekeberg had only become telephone director in Gothenburg in September 1909, and with that taking charge of the large exchange with the call-distributing system in operation there. He had taken the place of Karl Erik Landström (1866-1930) who replaced Axel Rydin as head of the technical department when Axel Rydin left the Telegraph Administration to become a member of the Swedish Supreme Administrative Court. Axel Rydin's departure resulted in a person with short but intimate experience of the call-distributing system becoming the head of the technical department. It is only speculation, but it might not seem too far-fetched to surmise that these organisational changes may have contributed to the decision to send Erik Ekeberg and telephone inspector Mauritz Agrell to study large manual exchanges of various designs, including a newly erected exchange with the call-distributing system.

The exchange they visited in Rotterdam in January 1910 had been taken into operation only two years earlier. It was a manual exchange with a call-distributing system and, like SAT's telephone exchanges in Warsaw and Moscow, had been

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<sup>154</sup> Johansson, *Telefonaktiebolaget LM Ericsson*, p. 302.

<sup>155</sup> Confer. pp. 63-66 above and Axel Hultman, 3 June 1909, "Telefondirektör Hultmans föredrag den 3 juni 1909 till Kungl. Telegrafstyrelsen," (telephone director Hultman's talk to the Telegraph Administration's headquarters 3 June 1909), TALb; FI A:30.

produced by LM Ericsson.<sup>156</sup> Erik Ekeberg and Mauritz Agrell noted that the call-distributing system used in Rotterdam was similar to that used in Sweden, but that some essential modifications to the better had been made.<sup>157</sup> They also noted that there was a strong 'English style' emphasis on monitoring the operators and the traffic to ensure high efficiency and reliability in the operations. Where it concerned London the first thing they noted was that it was inappropriate, or actually impossible, to bring all business telephones, let alone others, together into one exchange in such a large city as London. Both the 'Post Office', the state-owned operator, and the National Telephone Company had chosen to build several small exchanges instead.<sup>158</sup> This arrangement, Erik Ekeberg and Mauritz Agrell commented, produced gains both in terms of shorter subscribers' lines as well as a higher efficiency in switching due to the smaller switchboards.

To handle the large amount of trunked traffic, the Post Office had erected separate switchboards for incoming and outgoing calls at all its exchanges. In this way all incoming calls were handled by operators who connected the calling subscriber to a switchboard at the desired exchange where another operator made the connection to the desired subscriber. With this system the Post Office in effect also treated traffic within an exchange as trunked traffic. National, on the other hand, handled only trunked traffic with separate switchboards, whereas calls within an exchange were handled by one operator at an ordinary multiple switchboard. The exchange in Nottingham, to round off the list of exchanges visited, was a central battery cord pair system with 3,800 subscribers and was given little space in the report.

Ekeberg and Agrell had gathered and calculated a number of statistics for evaluating the labour efficiency of the various exchanges visited. Three particular statistics were regarded as best for comparing the exchanges: 1) number of calls per day divided by the number of operator and supervisor hours expended, 2) average answering time, and 3) percentage of calls answered within 10 seconds. Table IV-2 presents some statistics from the report.

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<sup>156</sup> Johansson, *Telefonaktiebolaget LM Ericsson*, pp. 300-302. This had caused a conflict between LM Ericsson and Anton Avén concerning an alleged infringement on his patents, a conflict to which I will briefly return in the next chapter.

<sup>157</sup> n.a. (Mauritz Agrell and Erik Ekeberg), January 1910, "Redogörelse för studieresa till Rotterdam, London och Nottingham," (Account of study tour to Rotterdam, London and Nottingham), TALb; F I A:132.

<sup>158</sup> The competition between the two prevailed in London until the end of 1911, when the state acquired the private operator upon the expiration of its license. For a brief overview of British Telephony up until the monopoly, see Eli Noam, *Telecommunications in Europe* (New York: Oxford University Press, 1992), pp. 19-22.

Table IV-2 Comparative statistics covering labour efficiency from the travel report by Erik Ekeberg and Mauritz Agrell.<sup>159</sup>

Calls per hour and operator...	Nottingham	Rotterdam	Gothenburg	Stockholm	
	(cord pair)	(call distr.)	(call distr.)	(cord pair)	(call distr.)
	Oct 1909	Dec 1909	Feb 1910	Feb 1910	Feb 1910
..., all day	164	186	163	151	134
..., busy hour	202	206	183	225	155
... + supervisor, all day	145	163	157	151	128
... + superv., busy hour	179	188	179	225	151
Answering times:					
Average answ. time	3.6 seconds	6.1 seconds	4.5 seconds	4.4 s	4.1 s
calls answ. within 10 s	98.2 %	91 %	94.7 %	94.3 %	95.8 %

When comparing operating statistics from the exchanges visited with similar statistics for the exchanges in Stockholm and Gothenburg, they asserted that the exchange in Gothenburg had quite comparable labour efficiency to a large exchange with the cord pair system.<sup>160</sup> The exchange in Gothenburg did not have as a high number of calls per operator at the busiest hour or as low average answering times as did the exchange in Nottingham. The high performance of the Nottingham exchange was explained by its small size, the extraordinary team work that prevailed between the operators, and the successful adjustment of the number of operators to the variation in the traffic-load over the day.

Ekeberg and Agrell were somewhat disappointed with the statistics from the Rotterdam exchange with the call-distributing system, and especially the long answering times, but asserted nevertheless that some improvements made to this switch should also be introduced at the exchanges in Sweden. When it came to the good figures for the cord pair switchboards in Stockholm, they asserted that these were only comparable to loaded switchboards at a large exchange, and hence not comparable with statistics for a large exchange taken as a whole.

Agrell and Ekeberg also emphasised that other contingencies, apart from the statistics, should be taken into consideration when choosing a new system for the new exchanges in Stockholm and Gothenburg. In this respect, they firstly claimed that the

<sup>159</sup> Selected statistics from appendix 1 of the travel report. In the appendix there are also statistics for additional months, for the exchanges in London as well as other measured statistics for the different exchanges. It is worth noting that some of the statistics for traffic for the exchanges in London were adjusted to become comparable with similar statistics for the other exchanges. n.a. (Mauritz Agrell and Erik Ekeberg), January 1910, "Redogörelse för studieresa till Rotterdam, London och Nottingham," (Account of study tour to Rotterdam, London and Nottingham), TALb; F I A:132, pp. 10-14 & appendix 1.

<sup>160</sup> Ibid., p. 14.

maximum size of the multiple, and hence the maximum size of the exchange, would be higher with the call-distributing system:

If one considers it desirable to keep all heavy callers within one exchange as long as possible, this is to a greater extent achieved with the call-distributing system, as with this one can make the multiple larger.<sup>161</sup>

Moreover, they argued, the call-distributing system was also better when the number of trunked calls increased, as that system was better the longer the time it took to put through a call. They noted that maintenance was easier on an exchange equipped with the cord pair system due to its simpler design. However, they continued, the present reliability of relays most certainly made a modern CB-switch of the call-distributing system not very far behind in this respect. They challenged claims made that exchanges with the cord pair system required less close surveillance of operators than exchanges with the call-distributing system. The personnel at a pair cord system had “to be as closely supervised in order to achieve good results.”<sup>162</sup> When discussing the personnel they also briefly discussed the matter of subscribers becoming divorced from designated operators, a feature of the call-distributing system. They saw this effect not simply as a drawback to the call-distributing system:

There is no doubt that it in many cases is very advantageous for a subscriber to [always] come to the same operator as in the cord pair system, but other cases probably also occur where it can be as advantageous to be unknown to the operator as is the case in the call-distributing system.<sup>163</sup>

They also asserted that the need for fewer switchboards in an exchange with the call-distributing system made such switches somewhat less expensive than switches of the cord pair system. According to them, the ‘modern’ switching technology seemed to go in the direction of semi-automatic systems, which were designed along similar lines as the call-distributing system. Therefore it was easier, they argued, to gradually transform exchanges with the call-distributing system into semi-automatic systems that automatically distributed the calls.

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<sup>161</sup> Original sentence (in Swedish): “Om man anser det önskvärdt, att så länge som möjligt bibehålla på en enda station alla mera ringande abonnenter, vinns detta i högre grad med fördelningssystemet, då man med detta kan göra multiplen större.” Ibid., p. 16.

<sup>162</sup> Full sentence (in Swedish): “Man har påstått att vid fördelningssystemet skulle fordras en så ytterligt sträng kontroll öfver personalen, men det torde vara tydligt, att personalen vid ett parsnöresystem behöfver öfvervakas fullt ut lika strängt för att goda resultat skola kunna vinnas.” Ibid.

<sup>163</sup> Original sentence (in Swedish): “Utan tvifvel torde det i många fall vara af stor fördel för en abonnent att komma till samma telefonist som i parsnöresystemet, men andra fall förekomma nog också då det kan vara lika stor fördel att såsom i fördelningssystemet, vara okänd av telefonisten.” Ibid.

Agrell and Ekeberg concluded by noting that their experiences from the trip and recent statistics from the exchanges in Stockholm and Gothenburg showed that it was impossible to say that one manual system was distinctly better than the other for large exchanges. They wanted nevertheless to recommend the preservation of the call-distributing system in Stockholm and Gothenburg. Firstly, since the system at these exchanges could be improved. Secondly, because its cheaper investment costs compensated for the possible savings in personnel with the cord pair system. And, finally, because the call-distributing system allowed for the construction of a multiple with a larger capacity than did the cord pair system.

Axel Hultman was outraged at the report by Erik Ekeberg and Mauritz Agrell. In an internal memo to the new general director of the Telegraph Administration, Herman Rydin (1861-1930)<sup>164</sup>, he gave full vent to his feelings.<sup>165</sup> He asserted right at the start that in his view the conclusions drawn in the report had to be based “on a certainly unconscious but nevertheless existing prejudiced opinion about the superiority of the call-distributing system.”<sup>166</sup> He then went on in minute detail to deal with the arguments in the report, discrediting the short account of the exchange in Nottingham as well as the calculations that showed that an exchange with the call-distributing system would be somewhat cheaper. He furthermore attacked the choice of statistics for comparing the efficiency of the different exchanges. Axel Hultman disliked the inclusion of the supervisors in the labour efficiency calculations, and asserted that the statistic had been chosen in the hope of making the call-distributing system appear better. This statistic, he asserted, was not comparable among exchanges and on this point he noted that the Telegraph Administration in Stockholm and Gothenburg had a bonus-system for the operators, which corresponded to several supervisors. Turning to the final conclusions in the report, he asserted that there he could find no trace of the power and joy that characterised firm confidence. Instead, he continued, the conclusion was more of an emotional prayer for the call-distributing system.

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<sup>164</sup> Herman Rydin had first been appointed acting general director in 1905 when Arvid Lindman had left the Administration for a brief period to become a minister in the government. When Arvid Lindman left the Administration once again in 1906 to become Prime Minister Rydin again replaced him, first as acting general director, and then in 1907 as appointed general director.

<sup>165</sup> Axel Hultman, 11 April 1910, “Generaldirektören VPM,” (Memo to the general director), TALb; F I A:30.

<sup>166</sup> Full sentence (in Swedish): “Härmed får jag vördsamt framhålla mina betänkligheter emot de slutledningar som Herrar Ekeberg och Agrell gjort i sin berättelse öfver resan till Rotterdam m.fl. platser, slutledningar som enligt min mening måste hafva sin grund i en helt visst omedveten men dock befintlig förutfattad mening om fördelningens öfverlägsenhet.” Ibid., p. 1.

One could almost say that the final declaration is a cry of agony. The anguish of the lover standing before the prospect of loosing an adored object.<sup>167</sup>

He concluded his examination of the report by affirming that he was now even more convinced that his earlier assertions were correct. Nevertheless the rapid development, he continued, forced changes that made the preservation of old systems impossible. Along this line he affirmed that it was impractical and inappropriate to keep the multiple switchboard for exchanges with more than 20,000 subscribers. And, according to Axel Hultman, this statement of fact terminated the controversy between the call-distributing system and the cord pair system.

The fight about the cord pair and the call-distributing system have in this way disappeared, since devices without multiples requires neither cords nor jacks.<sup>168</sup>

The system forced forward by this fact was the semi-automatic system, which Hultman deemed as "probably the only appropriate [system] for large exchanges."<sup>169</sup> Semi-automatic systems were, he argued, superior to all manual systems when the exchange was large. In a semi-automatic system, the operators did not have to do the engaged tests before making a connection nor disconnect the subscribers after a call. Instead, the operators set up the connections with manoeuvres identical to those done while typewriting on an ordinary typewriter. Hultman reported that some claimed that the switching in such a system was so swift that one could achieve 1,000-1,200 calls per hour and operator. As he wanted to be more conservative he stated that one could surely expect 400 calls per hour and operator, which would halve the number of operators needed, which translated into perhaps as many as 400 subscribers per operator. He admitted that such a reduction in the number of operators called for automatic call distribution to counteract the otherwise high probability of two subscribers concurrently requesting the attention of the same operator. Axel Hultman concluded that such a semi-automatic system was highly desirable since it would give direct service without expensive trunking, provide large savings on personnel as well as on subscriber's lines, and eliminate the need of multiples, cords and jacks. Since this was something highly

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<sup>167</sup> Original sentences (in Swedish): "Man skulle nästan kunna säga att slutanförendet är ett ångestrop. Den förälskades ångest inför utsikten att förlora ett dyrkadt föremål." Ibid., p. 5.

<sup>168</sup> Original sentence (in Swedish): "Härigenom har också striden om parsnöre contra fördelning försvunnit, då anordningar utan multiplar icke fordra hvarken snören eller proppar." Ibid.

<sup>169</sup> Full sentence (in Swedish): "Vid det system, som sålunda tvunget sig fram, och som för stora stationer torde vara det ända lämpliga, det s.k. semi automatiska systemet, behövas inga lystringar och inga nedtagningar, utan genom samma manipulationer som på en vanlig skrifmaskin kopplas abonnenterna tillsammans." Ibid.

desirable, all difficulties could be and had to be overcome with the help of good will, co-operation and the experience at the Telegraph Administration.

I therefore do not hesitate to suggest such a system for the new exchanges in Stockholm and Gothenburg, and may I respectfully suggest that preparatory investigations and work are immediately made in this direction.<sup>170</sup>

In sum and substance, what Hultman proposed was a scenario where the semi-automatic system was indispensable for the future operation of the Administration's network in Stockholm and thus it was in the Administration's interest to participate in realising this scenario.

### **Facts and Controversies on International Scenes**

From its starting point in the two main telephone exchanges in Stockholm, this chapter has depicted parts of controversies concerning the 'telephone issue' and the 'switching system issue'. Several actors have been encountered and they have spoken of even more actors. Several facts have been uttered, undisputed claims on the characteristics of the actors' realm of reality. More importantly, however, several contended claims have been made on how things are, how they ought to be, and what needs to be done.

Before returning to the continued efforts and controversies pertaining to the organisation of the exchanges in Stockholm, I will take a brief look at the contemporary world outside Swedish telephony. The reason for taking this primarily international look is to dispel any suspicion that undisputed solutions to the issues discussed in Sweden prevailed elsewhere. Thus, I want to sketch out parts of a primarily international space to illustrate the 'cocoon' of issues, opinions and alleged facts in which Swedish telephone engineers travelled from time to time.

First, I will return to Herbert Laws Webb's contemporary overview of how the telephone systems were organised in various European countries, together with his account of how they *ought to be* organised. Second, I will turn to the concept of natural monopoly as it emerged in the late 1800's and early 1900's in discussion on how large-scale businesses and public utilities ought to be organised and regulated. This involves a visit to the US and economists there discussing such issues in the context of competing public utilities, including competing telephone operations. An excursion which also warrants a brief outline of what contemporary Swedish economists discussed on these issues. Then I will follow Axel Hultman and Herman Olson as they travelled to North America in Spring 1910 to investigate the usefulness of semi-automatic switching

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<sup>170</sup> Original sentence (in Swedish): "Jag tvekar därför icke, att för de nya stationerna i Stockholm och Göteborg föreslå just ett sådant system, och får jag vördsamt föreslå, att förberedande undersökningar och arbeten i denna riktning genast vidtagas." *Ibid.*, p. 6.

systems. Finally, I will see what happened on the issue of switching systems by joining the European telephone engineers as they reconvened in Paris in September 1910.

### **The ‘curse’ which lies over the telephone business throughout Europe**

*The Development of the Telephone in Europe* by Herbert Laws Webb published in 1910 had a marked pitch against the approaching nationalisation of the private National Telephone Company in Britain and the consequent creation of a state monopoly in telephony.<sup>171</sup> His basic argument was that countries with a state monopoly had generally exploited the telephone less than well. The main target of his reproach were the state controlled post and telegraph administrations that in his view were fuelled by jealousy on the possibilities of the telephone to compete with the telegraph.<sup>172</sup> This political control was in his words ‘the curse’ which, with few exceptions, lay over the telephone business in Europe, including countries such as Austria-Hungary, Belgium, Bulgaria, France, Germany, Greece and Italy.

Concerning France, for instance, Webb noted that 20 years after the creation of the state monopoly in telephony in France, even most Frenchmen described it as a national disgrace. The plant according to him was largely antiquated and where it had been renewed its efficiency was destroyed by bad organisation, and the ‘commercial practice’ was “the rigid and cumbersome routine of the most bureaucratic of bureaucracies.”<sup>173</sup> On Germany he remarked that the German Government, which had always had a monopoly in telephony, had encouraged the development of telephony along purely German lines. He further asserted that “this tenacious adherence to purely domestic ideas and methods has resulted in seriously restricting the technical progress of telephony in Germany, and consequently in restricting the efficiency of the service.”<sup>174</sup> He further noted, somewhat condescendingly, that the commercial policy of the German Post Office had not been superior to its technical practice. The Austrian Administration was equally criticised for lagging several steps behind in technical practice, exemplified by the fact that “when the Vienna system was rebuilt a little over ten years ago, the common battery system was available, but was not adopted.”<sup>175</sup>

In other countries the rate and kind of government involvement was more diverse. In Holland the government had begun to operate the long distance service itself, while

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<sup>171</sup> Herbert Laws Webb, *The Development of the Telephone in Europe* (London: Electrical Press Limited, 1910).

<sup>172</sup> *Ibid.*, p. 19.

<sup>173</sup> *Ibid.*, p. 63.

<sup>174</sup> *Ibid.*, p. 64.

<sup>175</sup> *Ibid.*, p. 69. Webb did mention that the Austrian Administration had been experimenting with an automatic telephone system in recent years, but he was not very favourably inclined towards fully automatic systems, as will be reported later on.

granting “concessions for operating the local service to companies or to the municipalities.”<sup>176</sup> A similar approach was used in Russia, Webb noted, and that rapid progress had recently been made in St. Petersburg, Moscow and Warsaw.<sup>177</sup> Webb labelled Portugal and Spain, together with Greece and the Balkan States, as ‘relatively backward’ countries and that one should not expect them to have done much to the telephone. In Spain and Portugal, however, the state had no monopoly in telephony. Nevertheless, he noted, the few foreign companies that operated small telephone systems in some major Spanish cities worked “under rigorous restrictions and excessive royalties.”<sup>178</sup>

Webb’s verdict was more favourable, however, when it came to the development in the Scandinavian countries where the telephone had had the freest development in Europe.<sup>179</sup> Nevertheless, he noted with regret the tendency towards increased state involvement in all countries. In Sweden the state now had a monopoly outside Stockholm, and in Norway the state had acquired the company systems in the major towns and was acquiring others. In Denmark the state had left the active management to the companies but still dictated the rates and regulations to such an extent that, in his view, the companies had to adapt to Government’s exaction rather than to the requirements of the telephone business and of the public. Webb attributed the rapid development of the telephone in these countries in part to what he characterised as the comparative freedom from political control enjoyed by the telephone in Scandinavia in the beginning. The primary credit for the development in Scandinavia was given to the development in Stockholm and the late Henrik Cedergrén of SAT, however.

To a very large extent, however, Stockholm has set the pace in matters telephonic for the whole of Scandinavia; and Stockholm owes its conspicuous place in the world of telephony to the unbounded enthusiasm and the organising genius of the late Henry Cedergrén.<sup>180</sup>

Webb argued that SAT’s ‘enlightened’ policies and thorough organisation had set a high standard which had been reflected throughout Scandinavian telephony and had even, had its effect on the telephone work of the various state telegraph administrations.

In his overview of the practices in different countries, Webb often referred to what he called an ‘enlightened technical policy’ and an ‘enlightened commercial

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<sup>176</sup> *Ibid.*, p. 60.

<sup>177</sup> *Ibid.*, p. 70.

<sup>178</sup> *Ibid.*, p. 56.

<sup>179</sup> *Ibid.*, p. 73-74.

<sup>180</sup> *Ibid.*, pp. 74-75.

policy.’<sup>181</sup> The former included ‘all engineering matters,’ of which he specifically pointed out matters concerning telephone transmission and switching systems. On switching Webb on several occasions identified the manual CB-system as the state of the art at that time. He conceded that fruitful work was being done on using automatic switching devices, but asserted that the fully automatic exchange did not meet the conditions under which a telephone service had to be operated. He affirmed that those who had closely studied the subject were convinced that the operator was “a necessary feature to cope with the great range of selection required in the telephone service.”<sup>182</sup> These requirements, he stressed, were moreover best satisfied with young women, since the young woman had been “found to possess the best combination [of human brain and fingers] for the purpose.”<sup>183</sup> According to him it was hence not appropriate to transfer “the working of the service from the expert operator, who can be trained and supervised, to the inexpert member of the public who cannot be trained or supervised.”<sup>184</sup> The proper education of the public, according to Webb, was nevertheless a part of an ‘enlightened commercial policy’ so as to ensure correct use of the telephone service.

The commercial policy was almost as technical in its way as the engineering branch of the industry, according to Webb. It influenced moreover the engineering work, since the engineering work was necessarily affected by the rate of development of the system and by the efficient or inefficient use of the service by the public. He was furthermore careful to note that a good commercial policy contained reasonable rates, rather than low rates. Reasonable rates yielded returns which, he stressed, were necessary to supply funds for investing in the seemingly unbounded development.<sup>185</sup>

Webb asserted that government monopolies could not employ these principles, since they worked against fundamental characteristics of government management. A government department, according to him, was neither as effective as a well-organised private concern, nor as approving of individual initiatives.

[I]t seems hopeless ever to expect Government administrations really to learn the telephone business, because efficiency and enterprise are the two essential features of telephone work.<sup>186</sup>

Webb reckoned that if private enterprise was a necessary condition for unleashing efficiency and initiative, competition was not. He noted that in Stockholm the

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<sup>181</sup> Ibid., p. 49.

<sup>182</sup> Ibid., p. 54.

<sup>183</sup> Ibid., p. 54.

<sup>184</sup> Ibid., p. 55.

<sup>185</sup> Ibid., p. 49.

<sup>186</sup> Ibid., p. 45.

competition had produced an artificial development to a certain extent.<sup>187</sup> Competition implied a duplication of facilities and a division of the inhabitants into ‘two isolated telephonic camps’; in the end only the competitor with the largest system would survive:

In a telephone competition the two competitors engage in a life and death struggle to obtain, or retain, the larger share of the public patronage, and so obtain the more valuable system of the two and that which in the long run must attract all important customers and become the survivor.<sup>188</sup>

In London, on the other hand, Webb saw a case better than that of competition. There the Post Office and the National Telephone Company in 1901 had succeeded in agreeing to “share the telephoning of London, to charge the same rates, and to give an intercommunicating service.”<sup>189</sup> Experience had proved, Webb concluded, that this had been a sound and practical measure giving a great increase in telephones. However, Webb was quick to add, the results would have been still better had the company been allowed to extend the system on its own along uniform lines.

Webb hence did not argue for the virtues of competition, but rather for the virtues of private enterprise like that of the American Bell Companies; a company which, according to him, developed the telephone system along uniform lines employing ‘enlightened’ technical and commercial policies. Webb concluded his book by reiterating his argument that the government monopolies had restrained the development of telephony in Europe. Government management, with its vested interest and inappropriate policies, had in his view been allowed to check the natural advance of the telephone. Taking this thesis one step further, he ended his prayer in support of the private telephone company in the UK by praising the idea of private enterprise:

Financial soundness in the end governs the whole thing – organisation, efficiency, commercial and technical policy – and the difference between the government official and the business man is that the former need only produce accounts while the latter must produce the money. In the world of affairs, ... , it is not love that makes the world go round, but money.<sup>190</sup>

Hence Webb did not conceal the agenda behind his overview. As such, the book posed very few questions but gave an abundance of answers as to why things were as they were and how they ought to be instead. Webb conveyed a tendency towards increased government involvement in telephone matters in Europe and as one who professed to having studied telephony for over twenty years, he spoke against this tendency with

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<sup>187</sup> Ibid., p. 76.

<sup>188</sup> Ibid., p. 35.

<sup>189</sup> Ibid., p. 33.

<sup>190</sup> Ibid., p. 78.

lucid explicitness. The approaching creation of a state monopoly in telephony in the UK is but one example that the assertions put forward by Webb were not shared by everyone. The interest given to automatic switching devices at the second telephone engineering conference in Paris in 1910 is another illustration that there were engineers who did not submit to his view on the usefulness of such devices.

However, before turning to this conference I will attend to the telephone country so admired by Webb, namely, the United States. First, to examine the origins of the concept of natural monopoly as it was devised by US economists to characterise businesses that should be exempted from anti-monopoly regulations. Second, to follow Axel Hultman and Herman Olson as they travelled in North America to examine the development and use of automatic telephone switching devices.

### **The emergence of the concept of natural monopoly and its relation to telephony**

By 1910 the concept of natural monopoly had received its main contours and had begun to receive wide acceptance within the US.<sup>191</sup> The story of the emergence of the concept is heavily entwined with the emergence of large-scale business and public utilities in the latter part of the 19<sup>th</sup> century.<sup>192</sup> The concept had sprung up amidst the associated discussion among and between lawyers and economists on how the law should respond to these businesses. This discussion had, among other things, spawned the antitrust legislation of 1890 known as the Sherman Act that aimed at prohibiting monopolisations.<sup>193</sup> The emergence of the concept of natural monopoly had in particular been interrelated to the concurrent practice where many US local

<sup>191</sup> William Shepherd affirms in a footnote in the first edition of his textbook on *Industrial Organization* that the concept was widely accepted after 1910. William G. Shepherd, *The Economics of Industrial Organization* (Englewood-Cliffs: Prentice-Hall, 1979), p.9, note 2.

<sup>192</sup> The story of the early conceptions of the concept of natural monopoly has been retold several times for different purposes. See, for instance, Edward D. Lowry, "Justification for Regulation: The Case for Natural Monopoly," *Public Utilities Fortnightly* 18, no. 8 November (1973): 17-23; William W. Sharkey, *The Theory of Natural Monopoly* (Cambridge: Cambridge University Press, 1982), pp. 12-28; Thomas Hazlett, "The Curious Evolution of Natural Monopoly Theory," in *Unnatural Monopolies: The Case for Deregulating Public Utilities*, ed. Robert W. Poole, Jr. (Lexington: Lexington Books, 1985), 1-25; Benny Carlson, "Eli Heckscher and Natural Monopoly: The Nightmare that Never Came True," *Scandinavian Economic History Review* 40, no. 3 (1992): 53-79, pp. 55-62; and Milton Mueller, *Universal Service: Competition, Interconnection and Monopoly in the Making of the American Telephone System* (Cambridge: MIT Press, 1997), pp. 12-14. The *Principles of Political Economy* by the British philosopher and economist John Stuart Mill is often pointed out as containing an early observation that sometimes there are problems with providing public utilities with competition (see, for instance, Sharkey, 1982, *Theory of Natural Monopoly*, p. 14 and Alan Stone, *Public Service Liberalism: Telecommunications and Transitions in Public Policy* (Princeton: Princeton University Press, 1991), p. 144). In this section I will focus on the writings of two American economists who have been regularly identified as having been central in the emergence of the concept of natural monopoly.

governmental authorities franchised several public utility firms for each service and the experiences derived from these practices.<sup>194</sup>

One statement prominent in founding the concept had been provided by the American economist Henry Carter Adams (1851-1921) in the essay titled *Relation of the State to Industrial Action* published in 1887. In the essay's formal discussion of the issues of economies of production and economic organisation Adams had differed from the then general doctrine of *laissez-faire* and had noted that this doctrine did not "permit society to realize in any adequate degree the benefits of organization in the form of monopoly."<sup>195</sup> He had to this effect centred his discussion on the tension between the possibilities of achieving the benefits from concentrated organisation of production and the problems that could come with monopolies. The practical conclusion of his analysis had been that "society should be guaranteed against the oppression of exclusive privileges administered for personal profit, while at the same time it should be secured such advantages as flow from concentrated organization."<sup>196</sup>

Adams' treatment of the matter had been focused on the cost structure and the core of his analysis had been performed by dividing all industries into three classes according to "the relation that exists between the increment of product which results from a given increment of capital or labor," that is, according to their cost structure.<sup>197</sup> The first and second classes thus devised contained industries that conformed to the 'laws' of constant and decreasing returns respectively. On these Adams had concluded that no regulation was called for other than those necessary to determine the conditions under which competition should take place. Competition would secure, according to Adams, 'careful management' of industries belonging to these two classes.

The third and final class contained industries which were subject to the 'law of increasing returns,' that is, economies of scale. In these industries increased production was linked with a less than proportional increase in cost, and Adams had cited the

<sup>193</sup> For an overview of the intertwined development of law and economics as regards large businesses and trusts, see Herbert Hovenkamp, *Enterprise and American Law, 1836-1937* (Cambridge: Harvard University Press, 1991), chapters 20-22.

<sup>194</sup> In the fourth edition of Richard T. Ely et al's *Outlines of Economics* it was noted, in relation to the discussion of natural monopolies, that many cities twenty or thirty years ago had adopted the mistaken policy of trying to force competition into the field local public services. Richard T. Ely et al., *Outlines of Economics*, 4th ed. (New York: Macmillan, 1923), p. 189. A more recent observation of the link between this practice by local authorities in the US and the emergence of the concept of natural monopoly is made in Stone, *Public Service Liberalism*, p. 144.

<sup>195</sup> Henry Carter Adams, "Relation of the State to Industrial Action," in *Relation of the State to Industrial Action and Economics and Jurisprudence: Two Essays by Henry Carter Adams*, ed. Joseph Dorfman (New York: Columbia University Press, 1954), p. 103.

<sup>196</sup> *Ibid.*, p. 104.

<sup>197</sup> *Ibid.*, p. 105.

railroad business as a good illustration of this class of industries. In such industries, Adams had stressed, the relevance of the arguments in favour of individual management and competition lost much of its force. He had simply found it deceitful to believe that competition in these industries could secure a fair treatment of the public or to even believe that it was possible in these industries to enforce laws compelling competition.

For all industries...which conform to the principle of increasing returns, the only question at issue is, whether society shall support an irresponsible, extra-legal monopoly, or a monopoly established by law and managed in the interest of the public. In this latter way may the benefits of organization in the form of monopoly be secured to the people, and in no other.<sup>198</sup>

His analysis, as the quote above indicates, had an explicit leaning towards the prescriptive. This had become fully outspoken when he had concluded that “the control of the state over industries should be co-extensive with the application of the law of increasing returns in industries.”<sup>199</sup>

The influential American economist who coined the label of natural monopoly, Richard T. Ely (1854-1943), had a little more than a decade later added to the list of factors constituting such socially desirable monopolies. Ely had also added a more explanatory stance to the discussion in addition to, but not supplanting, the prescriptive stance Adams had taken. In his *Monopolies and Trusts* from 1900 Ely had argued that natural monopolies were businesses where monopolies were not only desirable, but also inevitable and thus should be controlled through public regulation or public ownership.<sup>200</sup> Ely had distinguished between two kinds of monopolies based on the source of monopoly power. Businesses organised as monopolies were according to this distinction either social or natural monopolies:

A *Social monopoly* is a monopoly which arises out of social arrangements and is an expression of the will of society as a whole, through government, or of a section of society strong enough to impose its will on society. A *Natural Monopoly*, on the other hand, is a monopoly which rests back on natural arrangements as distinguished from social arrangements.<sup>201</sup>

Ely had provided several examples of social monopolies. These included monopolies based on patents, fiscal monopolies and monopolies based on public or private favouritism. Ely had stressed that he preferred the term social monopolies rather than

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<sup>198</sup> Ibid., p. 114.

<sup>199</sup> Ibid., p. 110.

<sup>200</sup> See Almarin Phillips and Rodney E. Stevenson, “The Historical Development of Industrial Organization,” *History of Political Economy* 6 (1974): 324-342, p. 330.

<sup>201</sup> All italicised in original. Emphasis added. Richard T. Ely, *Monopolies and Trusts* (New York: Macmillan, 1900), pp. 42-43.

artificial monopolies, since the latter term carried with it a certain criticism, a criticism which was not necessarily well founded.<sup>202</sup> Natural monopolies were, on the other hand, not the creation of social arrangements and grew up independent of the will of society:

The term natural here is used in its well-understood and customary sense, to indicate something external to man's mind. A natural monopoly is one which, so far from giving expression to the will of society, grows up apart from man's will and desire, as expressed socially, and frequently in direct opposition to his will and desire thus expressed.<sup>203</sup>

These monopolies, Ely later stated, were not an expression of social will but "natural in the sense that they are outside of social arrangements and the social will."<sup>204</sup>

Ely identified three classes of natural monopolies, classified according to their source of monopoly power. One class was those monopolies arising from a limited supply of raw material, and another class was those monopolies arising from secrecy. A final class of natural monopolies was "those arising from *properties inherent in the business*."<sup>205</sup> Ely had affirmed that this third group of monopolies was the chief class of natural monopolies, and he had mentioned the highways, the railways, canals, the telegraph lines and the telephones among the businesses belonging to this class of natural monopolies.<sup>206</sup> With reference to Adams, Ely had affirmed that economies of scale was one inherent property which produced an inevitable tendency to monopoly. However, Ely had extended this class to include all businesses whose inherent properties gave a decided gain from a consolidated organisation:

We can say that we have monopolies arising from the inherent characteristics of the business, whenever there is a decided gain resulting from the combination of all those engaged in it. Whenever there is a decided and continuous increment in gain resulting from combination, we have a tendency to monopoly which will overcome all obstacles. It is this increment in gain which *is the cause of monopoly*.<sup>207</sup>

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<sup>202</sup> Social monopolies, Ely would later affirm in a co-authored textbook, were not inherently undesirable but should only be permitted in so far as they were "deemed to be advantageous means of achieving socially desirable ends." The first edition of his textbook *Outlines of Economics* was published in 1893 with subsequent editions published in 1908 and 1916. It has been difficult to retrieve any of these three first editions, and this quote comes from the fourth co-authored edition. Richard T. Ely et al., *Outlines of Economics*, 4th ed. (New York: Macmillan, 1923), p. 185.

<sup>203</sup> Ely, *Monopolies and Trusts*, p. 43.

<sup>204</sup> *Ibid.*, p. 56.

<sup>205</sup> Emphasis added. Ely, *Monopolies and Trusts*, p. 43.

<sup>206</sup> *Ibid.*, p. 59.

<sup>207</sup> *Italic in original. Ibid.*, p. 63.

Ely had further stressed that such gains resulting from a consolidated organisation only occurred under certain circumstances. Here he had explicitly dissociated himself from what he labelled the socialist point of view which according to him claimed that there was always an increment in gain resulting from combination.<sup>208</sup>

Richard T. Ely had further used telephony to illustrate that the causes behind the advantages of monopolies were diverse, and not only limited to cases of businesses with economies of scale.<sup>209</sup> Telephony, according to Ely, was not characterised by economies of scale after a given point. Nevertheless, he had stressed, in the case of telephony the advantages from monopoly would still continue with increasing size since the importance of unity in the service:

Let us take the case of the telephone. The importance of unity must sooner or later overcome all obstacles standing in the way of combination of the various telephone interests, inasmuch as the gains to be secured operate unceasingly like a law of nature, and ultimately must prevail. And why? it may be asked. It is because men are rational beings and prefer to do things in a superior way rather than in an inferior one. Two telephone companies cannot perform the same service which one can perform, inasmuch as complete unity is lacking. The object of the telephone is to bring people together, and the more completely it does this, the better it performs its functions. Two or more competing telephone plants, however, separate people, and thus operate antagonistically to the purpose for which the telephone was established.<sup>210</sup>

Thus, to Ely, telephony represented a business characterised by inherent properties other than economies of scale but which nevertheless made it a natural monopoly. Ely had stressed that it was gains from unity rather than economies of scale that made telephony a natural monopoly. At the time Ely wrote this in 1900, the Bell System was yet to totally dominate US telephony, and he had specifically noted that “many small cities now exhibit the disadvantages of competition in the telephone business.”<sup>211</sup> The statement that a ‘combination of the various telephone interests ... ultimately must prevail’ should be seen in this light. By 1910 the Bell System had achieved a more

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<sup>208</sup> Ibid., pp. 66-67. Later, in the co-authored textbook, he would de-emphasise the gain argument and instead emphasise that this class of monopoly often was rooted in “*conditions that made competition self-destructive*.” Emphasis in original. Ely et. al. *Outlines of Economics*, p. 187.

<sup>209</sup> Ely, *Monopolies and Trusts*, pp. 64-65.

<sup>210</sup> Ibid., p. 64.

<sup>211</sup> Ibid., p. 65. According to the 1902 Telephone Census in the US, in 1902 there were about 969 thousand telephones in independent telephone networks not connected to the Bell System and 1.4 million telephones in the Bell System and independent networks connected to the Bell System. In all, there were at that time 449 communities with a population 5,000 or more that had dual service. See, Mueller, *Universal Service*, p. 61.

dominant position having somewhat more than half of the country's telephones in their networks, but telephony was yet to become exempted from the antitrust legislation.<sup>212</sup>

The discussion put forward by Ely thus differed somewhat in emphasis from Adams' earlier discussion. Ely's treatment of the issue had given the notion of natural monopoly some explanatory power, where certain sources of monopoly power both explained and justified the existence of monopolies that depended on these sources. The explanatory side of the concept is especially clear in Ely's discussion on the term natural and his emphasis of them growing independently of any social will. Adams' emphasis on economies of scale had moreover become included as only one type of the broader concept of inherent properties which could cause certain business to be natural monopolies. Their positions had been practically identical, however, on the prescriptive side and the issue of regulation. Ely had affirmed that there were only two alternatives to remedy or eliminate excessive profits that may stem from natural monopolies caused by properties inherent in the business: either public control over private property or public property with public management.<sup>213</sup> He had remained somewhat undecided on which of these two were preferable, but had nevertheless affirmed that public control over private monopolies complicated government more than did public ownership.<sup>214</sup>

The economists elaborating the notion of natural monopolies had found the notion applicable to telephony, and hence shared the conviction with Herbert Laws Webb that competition was detrimental in the telephone business. However, the arguments put forward by the American economists Ely and Adams were clearly not fully congruent with Webb's determined judgement against government involvement and public management of telephony. Indeed, Webb appears to have found the distinction between public and private management to be the principal distinction in determining the performance of telephone operations. These American economists, on the other hand, had affirmed that the distinction between competition and monopoly was principal for determining the performance of industries which were natural monopolies.

The differing emphasis and views of these two distinctions are worth keeping in mind when it comes to the positions of some influential Swedish economists' on issues

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<sup>212</sup> In 1910 the Bell System had around 3.9 million telephones in their networks and the independent operators had together around 3.7 million telephones (including those connecting with the Bell System), see Stone, *Public Service Liberalism*, table 5-1 on p. 131. However, an increasing part of the independent operators were at this time connecting with the Bell System, see Mueller, *Universal Service*, ch. 9 and especially table 9-1 on p. 110.

In the US, telephony became between 1913 and 1921 gradually exempted from the antitrust legislation and the Bell system grew subsequently to entirely dominate US telephony. Mueller, *Universal Service*, pp. 129-145.

<sup>213</sup> Ely, *Monopolies and Trusts*, p. 258.

<sup>214</sup> *Ibid.*, p. 263.

close to the concept of natural monopoly.<sup>215</sup> The concept of natural monopoly had not been as explicitly stated by 1910 nor had it been as extensively discussed in Sweden as it had been in the United States. When present, it had appeared in general discussions on monopolies, trusts and the role of the state which also had emerged in Sweden. But, unlike the US, the Swedish discussions were not held with an antitrust legislation similar to the Sherman Act as a backdrop.<sup>216</sup>

The economist David Davidson (1854-1942) had been influenced by German economists, just as the American economists discussed above had been.<sup>217</sup> In a lecture in 1890 Davidson had noted that competition ceased in the fields of transport and communication, and it was according to Davidson impracticable to prevent the emergence of such monopolies.<sup>218</sup> Instead he had found that state ownership or regulation was called for to prevent these emerging monopolies from abusing their position. In a later paper on cartels and trusts more generally, he had argued that legislation reducing the harm they could have was preferable to the prohibitive stance taken in the US.<sup>219</sup> To this, he had especially added that it would be preferable to have domestic cartels and trusts rather than foreign ones.

The term 'natural monopoly' had appeared in an article from 1901 by Gustav Cassel (1866-1945) on cartels and trusts. In the article Cassel had noted that the creation of trusts and cartels in recent years was caused by competition engulfing itself:

The ideas of free competition have barely been realised through transformations in legislation and technology, before signs of a reaction appear which apparently have the force to replace the age of economic »freedom» with an age of austere regulation.<sup>220</sup>

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<sup>215</sup> Two works by Benny Carlson has been of great help in gaining knowledge of the positions taken by Swedish economists during this period. See Benny Carlson, "Eli Heckscher and Natural Monopoly: The Nightmare that Never Came True," *Scandinavian Economic History Review* 40, no. 3 (1992): 53-79 and Benny Carlson, *The State as a Monster: Gustav Cassel and Eli Heckscher on the Role and Growth of the State* (Lanham: University Press of America, 1994).

<sup>216</sup> For a comparison of Swedish and US law on matters of monopolies and competition at this time, see Ulf Bernitz, *Marknadsrätt: En komparativ studie av marknadslagstiftningens utveckling och huvudlinjer* (Stockholm: Jurist- och samhällsvetareförbundets Förlags AB, 1969), esp. pp. 252-256, 411-413.

<sup>217</sup> Carlson, "Eli Heckscher," p. 61.

<sup>218</sup> *Ibid.*, pp. 60-61.

<sup>219</sup> David Davidson, "Koncentrerings-tendenser i det moderna näringslivet," *Ekonomisk Tidskrift* 7 (1905): 241-262, pp. 256-259, 261.

<sup>220</sup> Original sentence (in Swedish): "Knappt har den fria konkurrensens idé börjat förverkligas genom omhjälpningar på lagstiftningens och teknikens område, förr än tydliga tecken börja visa sig till en reaktion, som uppenbarligen har krafter nog för att ersätta den ekonomiska »frihetens» æra med det stränga reglerandets." Gustav Cassel, "Kartell- och trustväsendet från socialekonomisk synpunkt," *Ekonomisk Tidskrift* 3 (1901): 475-502, p. 475.

On the basis of recent developments in Sweden, Denmark, Germany and USA, Cassel had discussed the causes behind the creation of cartels, trusts and monopolies as well as the advantages and disadvantages which come with such organisations. He had noted, just as Adams had, that socially relevant advantages in many cases could be gained through a more concentrated organisation of industries. But he had also noted that trusts and cartels could gain too much power, especially in relation to workers and consumers. Cassel had specifically argued against concentrations based on the control of natural monopolies. He had on this point emphasised that companies and trusts could sometimes attain a too privileged position through gaining support from natural monopolies such as railways, and gas, water and tram-companies in the cities.<sup>221</sup> Cassel's conclusion on the issue of natural monopolies had therefore been that the state and municipalities should own and run natural monopolies, or at least exert a tight control over them.<sup>222</sup> Later, however, Cassel would reconsider his position and by 1920 he would scarcely find a single reason supporting the state running enterprises.<sup>223</sup>

The economist and economic historian Eli F. Heckscher (1879-1952) emphasised the role of potential competition in his discussions on large businesses and economies of scale. In the article *The state as entrepreneur* from 1911, he noted that state-owned firms were usually larger than private firms and could thus often exploit economies of large scale.<sup>224</sup> However, the crucial difference between a state-owned and a private monopoly, according to Heckscher, was that the latter always faced potential competitors. Therefore, he asserted, a state-owned firm could all too easily adopt an inefficient approach to its operations.

To conclude: The concept of natural monopoly emerged in the US and by 1910 had acquired a place within American economics. It had sprung out of discussions on how the law should respond to large-scale business, public utilities, and monopolies and against the backdrop of an antitrust legislation and local governmental attempts to foster competition among franchised utilities. Similar discussions concerning monopolies and trusts had surfaced in Sweden around the turn of the century, but the concept of natural monopoly had at best had a marginal place in these discussions. Swedish economists exhibited a more general accepting stance towards large scale businesses and monopolies as a means to exploit economies of scale. The concept of natural

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<sup>221</sup> Here Cassel had exemplified this behaviour by referring to Rockefeller and Standard Oil. He noted that Standard Oil pursued a policy of controlling the railway lines, thus both decreasing the production costs and making the transportation more difficult for competitors. *Ibid.*, p. 492.

<sup>222</sup> *Ibid.*, p. 501.

<sup>223</sup> Carlson, *The State as a Monster*, p. 245.

monopolies was seldom used to discern one particular kind of monopoly as distinctly different from other monopolies. Some of them, contrary to Ely and Adams, expressed furthermore an outspoken negative stance against public ownership of such businesses. Swedish economists were thus by 1910, perhaps even increasingly, more engaged in discussing the distinction between public and private management than the characteristics of different industries and what that might imply in terms of competition and monopoly.

### Going west: Meeting with parts of the independent telephone movement

Automatic telephone apparatus, eliminating the need of employing human operators, is a development of the art which has been made entirely by the genius of the independent forces.<sup>225</sup>

Herman Rydin, the general director of the Telegraph Administration responded almost immediately to the memo of 11 April 1910 in which Hultman had pleaded that preparatory investigations should be made in the direction of semi-automatic systems. Only three days later, on 14 April, Herman Rydin sent four letters to US and Canadian telephone companies asking them to receive Axel Hultman and Herman Olson from the Administration's engineering department on their impending trip to the US and Canada.<sup>226</sup> But it was not the Bell System so admired by Herbert Laws Webb that was to be the destination of the study trip.

The four recipients represented external parts of the US and Canadian telephone enterprise outside the Bell System, or parts of *the Independent telephone movement* as these enterprises called themselves at the time.<sup>227</sup> One letter was to Edward Clement who had invented a semi-automatic system, or automanual as he and the manufacturing company called it. Another letter was to the manufacturer of Clement's system, North Electric Telephone Company, which manufactured and sold telephone equipment to non-Bell telephone companies.<sup>228</sup> The third letter was to the manufacturer of the Strowger system, Automatic Electric Company, which sold automatic switching equipment of the Strowger system to independents. The fourth and final letter was to

<sup>224</sup> Eli F. Heckscher, "Staten som företagare," *Svensk Tidskrift* (1911), cited in Carlson, "Eli Heckscher," p. 63.

<sup>225</sup> n.a., 1909, "Automatic Telephone System San Francisco, California; Progress Report," Home Telephone Company of San Francisco. Copy available in; TALb; F I A:136.

<sup>226</sup> Herman Rydin, 14 April 1910, 'Draft of letters to Mr Edward E Clement (Washington DC), Mr Francis Dagger at the Canadian Independent Telephone Association (Toronto), the Automatic Electric Company (Chicago), and CH North at the North Electric Company (Cleveland),' TALb; F I A:134.

<sup>227</sup> On the independent movement, see e.g. Charles A. Pleasance, *The Spirit of Independent Telephony* (Johnson City, Tennessee: Independent Telephone Books, 1989).

<sup>228</sup> The Bell System had its own manufacturing branch, Western Electric.

the Canadian Independent Telephone Association. This neglect of the Bell System was hardly coincidental, since it was outside the Bell System where the US experimentation with automatic switching systems flourished.<sup>229</sup> In the letter Herman Rydin explicitly stated that the purpose of the trip was to investigate whether the semi-automatic system would suit the Administration's networks in Stockholm and Gothenburg, and asked that Axel Hultman and Herman Olson be given "such information of a technical and economic nature as could be of use for the fulfilment of the mission entrusted to them."<sup>230</sup>

The response was quick and welcoming in all four cases. Joseph Harris, the president of the Chicago based Automatic Electric Company probably saw the visit as a selling opportunity and suggested that Hultman and Olson came directly to Chicago and there determined in what manner they wanted to pursue their investigations.<sup>231</sup> He even offered to have a company representative meeting Axel Hultman and Herman Olson upon their arrival in New York. CH North, President of The North Electric Company in Cleveland was as polite, and affirmed that they would be "more than pleased to entertain Mr Hultman and Mr Olsson upon their arrival in Cleveland and give them every opportunity to inspect, under practical working conditions, the operation of our Automannual Telephone System."<sup>232</sup>

Late in April, even before the replies had been received, Axel Hultman and Herman Olson embarked on their journey. On their way out they visited Copenhagen, Hamburg, Paris and London to meet telephone engineers and discuss automatic switching. Before embarking on the ship that would take them over the Atlantic, Hultman made a quick report to the head of the Administration's technical department, Karl Erik Landström.<sup>233</sup> To Landström he reported that an engineer in Copenhagen was the only one they had met that had been doubtful of automatic switching systems. He further reported that some of those they had met, such as Major O'Meara at the British Post Office, had themselves made similar trips to the US to investigate automatic

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<sup>229</sup> In an article in *Industrial and Corporate Change* Kenneth Lipartito describes and analyses with a noted evolutionary framework the use of automatic switching in the Bell System, as opposed to its earlier use within the independent telephone companies. On the use of automatic switching devices within independent telephone companies, see Kenneth Lipartito, "Component Innovation: The Case of Automatic Telephone Switching, 1891-1920," *Industrial and Corporate Change* 3, no. 2 (1994): 325-357, pp. 338-339.

<sup>230</sup> Herman Rydin, 14 April 1910, 'Draft of letters to Edward Clement, Francis Dagger, The Automatic Electric Company, and CH North,' TALb; F I A:134.

<sup>231</sup> J. Harris (President of Automatic Electric Company), 27 April 1910, 'Letter to Herman Rydin,' TALb; F I A:134.

<sup>232</sup> CH North (President of The North Electric Company), 27 April 1910, Letter to Herman Rydin, TALb; F I A:134.

<sup>233</sup> Axel Hultman, 26 April 1910, 'Letter to Karl Erik Landström,' TAAb; F IV B:23.

systems, and he also reported that they had been able to see a test switch in Paris with the Lorimer system in operation.<sup>234</sup>

We do not know much about their doings in the US, since they did not deliver any extensive travel report upon their return to Sweden. All that has been found is a compilation of printed material and circuit drawings gathered on the trip together with a draft of a letter to Joseph Harris of the Automatic Electric Company, thanking him for the hospitality he had showed Hultman and Olson.<sup>235</sup> The circuit drawings included several schematic drawings of the Strowger system including its Keith line switch and a few drawings of the Lorimer system. From the scarce material it is nevertheless possible to infer a few things about their doings in the US. It is clear, for instance, that Hultman and Olson went to Chicago and met Joseph Harris and saw the plant of the Automatic Electric Company. From the draft letter we can also conclude that Joseph Harris of the Automatic Electric Company had invited Hultman and Olson to visit San Francisco, where the company presumably had been delivering switching equipment to the independent Home Telephone Company of San Francisco. They probably also visited Ashtabula (in Ohio approximately 90 km from Cleveland) and its semi-automatic exchange with approximately 450 subscribers.<sup>236</sup> It was there the first full-feature semi-automatic exchange of the North Electric system had been put into operation in 1908.<sup>237</sup> We also know that Axel Hultman asserted after the trip that the Strowger's fully automatic switching system worked. In 1911 he asserted that the exchanges with the Strowger system together comprised more than 100,000 Strowger 100-line selectors, and all these selectors worked "day and night without difficulty."<sup>238</sup> He further reported that in the US there were in total approximately 250,000 telephone

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<sup>234</sup> Chapuis reported that a few test prototypes of the Lorimer system were set up in England, France and Italy at about this time. See Robert J. Chapuis, *100 Years of Telephone Switching (1878-1978), Part I: Manual and Electromechanical Switching (1878-1960's)* (Amsterdam: North-Holland Publishing Company, 1982), pp. 162-163.

<sup>235</sup> Collection of material from the trip is available at TALb; F I A:136, and draft letter see, n.a. (in the absence of the general director), 13 July 1910, 'Draft of letter to Joseph Harris, President of Automatic Electric Company,' TALb; F I A:134.

<sup>236</sup> See Axel Hultman, 2 September 1911, "Förslag till anordnandet af den lokala telefonstationen i Stockholm," (Proposal for arranging the local telephone exchange in Stockholm), TALb; F I A:30, p. 4.

<sup>237</sup> Charles A. Pleasance, *The Spirit of Independent Telephony* (Johnson City, Tennessee: Independent Telephone Books, 1989), p. 129.

<sup>238</sup> Axel Hultman, 2 September 1911, "Förslag till anordnandet af den lokala telefonstationen i Stockholm," (Proposal for arranging the local telephone exchange in Stockholm), TALb; F I A:30, p. 7.

sets connected to automatic switches, and that “the American public which utilises these devices declare themselves fully satisfied with the fully automatic system.”<sup>239</sup>

**‘Première question: Service manuel ou automatique?’**

On 5 September 1910 engineers from European telegraph and telephone administrations reconvened in Paris. Of the circa 100 assembled delegates, 6 came from the Swedish Telegraph Administration led by Karl Erik Landström.<sup>240</sup> Axel Hultman and Herman Olson was not among the Swedish delegates, although earlier in the year Hultman had taken Axel Rydin's place on the committee preparing for the conference.<sup>241</sup> The Swedish delegates that did go nevertheless had the opportunity of discussing the pros and cons of automatic and manual switching devices, as the subject was as central as it had been two years earlier in Budapest and was the first of seven issues in all to be discussed at the conference.

This time five papers on the issue had been compiled by Hans Karl Steidle at the Bavarian Post Administration, who at the previous conference had been assigned to be the rapporteur on this issue together with Charles Barth de Wehrenalp. Hans Karl Steidle, who himself had written three of the papers, summarised the papers in a special report. He began his summary by affirming that the manual multiple switchboard was still the perfect switching system in both a technical and economic sense, as long as state managed telephony remained within moderate limits, that is, where the number of subscribers even in the largest networks were not counted in thousands.<sup>242</sup> But, he continued, considerable changes had manifested themselves in the course of time: The great popularity telephony had gained had made the manual switching system lose its economic value. After reviewing each of the five papers, Steidle therefore concluded the summary by stating that the tendency was towards automatic switching and that it now was economic considerations that had precedence:

From the papers presented on the first question, it is judged indisputable that the modern telephone technology tends towards the rapid realisation of

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<sup>239</sup> Original sentence (in Swedish): “Den amerikanska publiken, som använder dessa apparater förklarar sig fullt nöjd med det fullständigt automatiska systemet.” Ibid., p. 8.

<sup>240</sup> The other five were the head of the Administration's test and research division (Pleijel), the chief engineer of telegraphy (Carl Egner), the chief engineer at the training centre (Gunnar Holmström), and two engineers from the Administration's factory (Kinmanson and Gotthilf Ansgarius Betulander).

<sup>241</sup> Herman Rydin, 6 May 1910, ‘Draft of letter to the French Post- and Telegraph Administration,’ TAAb; F IV B:23.

<sup>242</sup> Hans Karl Steidle, “Rapport généraux sur les questions soumises à la conférence: Première question: Service téléphonique manuel ou automatique,” in *Comptes Rendus de la IIe Conférence Internationale des Techniciens des Administrations des Télégraphes et des Téléphones de l'Europe* (Paris: Ministère des Travaux Publics et des Postes et Télégraphes, 1910), 3-9, p. 3.

automatic service in its diverse appearances. In this tendency, the economic question recently has taken precedence, considering the significant importance the telephone has taken everywhere as a means of communication. It is this importance that has been the driving force behind the realised rapid developments.<sup>243</sup>

This argument was actually close to the core argument in the last of his own papers. In this paper, entitled *Tarif und Technik des Staatlichen Fernsprechwesens*<sup>244</sup>, Steidle argued that there was a mutual dependence between tariffs and technology within state telephony. This paper began by reporting that a commission set up by a German federation of trade and industry had produced a resolution against the planned increase in telephone tariffs in Germany. The commission had stressed in its resolution that the telephone must be a tool that was used daily, but that the telephone in Germany by far had not found its proper widespread use and popularity as it had in other countries and most notably Sweden.<sup>245</sup> The commission had emphasised that the telephone had become far too dear for small enterprises and households. To achieve the necessary popularisation, the commission had argued for a low subscription fee together with a reasonable traffic fee set on the basis of volume.

The commission had claimed, Steidle reasoned, “that the aimed at financial effect of the new tariff arrangement would be achieved with a reduction of tariffs rather than with their increase.”<sup>246</sup> Steidle objected that this way of thinking that applies to other business activities could not be defended when applied to the peculiarities of telephone operations. An urban telephone network after it had reached a given size would become more expensive to operate, Steidle emphasised. With several diagrams Steidle analysed and gave a breakdown of the different costs for erecting and maintaining a subscriber's line as well as for making connections. From this breakdown he concluded that the cost of switching calls was predominant among the costs that were

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<sup>243</sup> Original quote (in French): “Des travaux présentés sur la première question, il ressort incontestablement que la technique téléphonique moderne tend à la réalisation rapide du service automatique sous ses formes diverses. Dans cette tendance, c'est la question économique qui a récemment passé au premier rang, en raison de l'importance considérable qu'a prise partout le téléphone comme moyen de communication; c'est elle qui a donné la force impulsive dans les rapides développements réalisés.” Ibid., p. 9.

<sup>244</sup> Hans Karl Steidle, “Tarif und Technik des Staatlichen Fernsprechwesens,” in *Service Téléphonique Manuel ou Automatique; IIe Conférence Internationale des Techniciens des Administrations des Télégraphes et des Téléphones de l'Europe* (Paris: Ministère des Travaux Publics et des Postes et Télégraphes, 1910).

<sup>245</sup> The entire resolution is quoted in Ibid., p. 3 fn. 1.

<sup>246</sup> Full sentence (in German): “Die in der Resolution des Hansabundes vertretene, als Analogie zu Anderen Betriebserscheinungen wohl gerechtfertigte Anschauung, dass die mit der neuen Gebührenordnung anzustrebende finanzielle Wirkung eher durch eine Herabsetzung der Gebühren erzielt werden könnte, als durch deren Erhöhung, lässt sich bei näherer Prüfung der Eigentümlichkeiten des Fernsprechbetriebes also leider gleichfalls nicht vertreten.” Ibid., p. 6-7.

directly influenced by technology. It was therefore natural, Steidle maintained, that the ‘modern movement in telephone technology’ was making efforts on this side.

In his conclusions Steidle sketched out that modern technology opened itself along two paths to financially assist in the wider shaping of telephone operations. One path was to introduce businesslike principles of operation to promote the consolidation of state managed telephone operations. The other path, according to Steidle, was to support the societal economic directed efforts to diffuse telephony as much as possible. But, Steidle concluded, with the help of new switching technologies it was possible to strive to solve both these large tasks simultaneously:

To resolve both of the two large *complementary* tasks the new forms of operations – the *semi-automatic* or *fully automatic switches* and the small automatic selectors with independent interconnection or other equivalent systems – appears appropriate.<sup>247</sup>

These arguments provide an interesting contrast to the arguments put forward by Herbert Laws Webb above. Here was someone working at the Bavarian Post Administration, who claimed that automatic switching devices were appropriate if a state telephone operator desired both to pursue business goals and to fulfil tasks tied to the national economy. Webb, on the other hand, characterised state managed telephone networks as ‘a curse’ and furthermore did not include fully automatic switching systems in his notion of enlightened policies. It was not only their views on automatic switching that set their arguments apart. Of more interest is the fact that their starting points differed. To Steidle the state managed operator was a given starting point from which he put forward his arguments on tariffs, costs, goals and technologies. To Webb his notion of what constituted enlightened policies and the goal of diffusing telephony served as starting points from which he argued against state management and government intervention. There were, however, other positions also represented at the conference.

It appears that Hans Karl Steidle may have been a little precipitate when drawing his conclusions in the summary of the five papers. Two had not been written by him and at the session one of the other two authors made his voice heard. It was MC Hersen, a telegraph engineer from Berlin, who pointed out that one could still not decide to completely suppress manual telephone switching by substituting automatic switching

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<sup>247</sup> Original quote (in German): “Zur Lösung der beiden grossen sich *ergänzenden* Aufgaben erscheint die neuen Betriebsformen – der *halbautomatische* oder *vollautomatische Umschaltebetrieb* und der *Kleingruppenbetrieb mit selbststättigen Zwischenumschaltern* oder gleichwertigen anderen Apparatsystem – geeignet.” Ibid.

systems for manual ditto.<sup>248</sup> At the session he affirmed that it was still valuable to examine whether it was possible to improve the manual system by replacing some manoeuvres with mechanical movements.

Furthermore, this position was close to the views expressed by John Carty from the US who together with Charles Scribner were prominent guests at the conference, representing the Bell System.<sup>249</sup> At the conference John Carty gave a paper with remarks on the issue of manual or automatic switching. The paper, which had not been among the five papers summarised by Steidle, contained an argument against fully automatic switches. In his paper Carty criticised the way the labels automatic and manual were used routinely. He stressed that they were used misleadingly, since many manoeuvres were performed automatically in a so-called manual system and since many operations in a so-called automatic system were performed manually:

Indeed, the so-called *manual system* is in reality partly manual and partly automatic, and the automatic part even represents a large portion of the total.<sup>250</sup>

To illustrate this point, John Carty mentioned several operations which were now done automatically in a so-called manual system. A subscriber indeed lifted the receiver manually when wanting to make a call, but this act put a series of automatic devices in motion, among others the calling relay which automatically illuminated a lamp above the operator. According to Carty, the so-called manual system was in reality a semi-automatic system because of its mixture of manually and automatically performed operations.<sup>251</sup>

Turning to the system labelled automatic, John Carty stressed that it was not ‘properly speaking’ an automatic system, “but a system partly automatic and it would not be possible to make it to work in practice, without having recourse to human

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<sup>248</sup> Statement made by MC Hersen in Ministère des Travaux Publics et des Postes et Télégraphes, “Procès-Verbaux des Séances de la Conférence; Séance D’Inaguration (5 Septembre 1910),” in *Comptes Rendus de la IIe Conférence Internationale des Techniciens des Administrations des Télégraphes et des Téléphones de l’Europe* (Paris: Ministère des Travaux Publics et des Postes et Télégraphes, 1910), 59-69, p. 68.

<sup>249</sup> John Carty was the chief engineer at the long-distance branch of the Bell System, AT&T, and Charles Scribner held the same position at the Bell System’s manufacturing branch, Western Electric.

<sup>250</sup> Original quote (in French): “En vérité, ce soi-disant *système manuel* est en réalité partiellement manuel et partiellement automatique, et, même la partie automatique y représente, par rapport au tout, une proportion très grande.” John Carty, “Annexe No 1., Le Service Automatique ou Manuel, Remarques de M. J.J. Carty,” in *Comptes Rendus de la IIe Conférence Internationale des Techniciens des Administrations des Télégraphes et des Téléphones de l’Europe* (Paris: Ministère des Travaux Publics et des Postes et Télégraphes, 1910), 115-126, p. 116.

<sup>251</sup> *Ibid.*, p. 117.

intelligence at the exchange and without using operators there.”<sup>252</sup> When wanting to make a call, the subscriber had to perform several manual operations including lifting the receiver and dialling the desired number. Moreover, Carty continued, the automatic machinery at the exchange did not provide a proper service without the aid of mechanics continuously present, mechanics that according to him in reality were male operators. Plus, he added, in a so-called automatic system there was still a need for operators to handle chargeable calls, long-distance calls, calls to numbers which had been changed, and to fulfil the numerous special services that required the intervention of human intelligence. Visiting an exchange with a so-called automatic system was enough, he concluded, to see how deceiving the term *automatic* system actually was.

It was necessary according to John Carty to view the telephone system as a whole, and allowing for all particular circumstances one could envisage. The English word *plant* was in his view very suggestive. It comprehended the “ensemble of structures which constituted the material property of the network”<sup>253</sup>, but reminded also of the idea of continuous growth and its implications on the present issue. To achieve useful results it was necessary, Carty continued, to envisage the network as it grew. It was impossible to perfect the network, since it grew every day, month and year, but at the Bell System they were always trying to attain the maximum of efficiency in every period when arranging and expanding the network. He emphasised that to them this above all translated into the obligation to get the fundamental principles right.

This in turn implied, John Carty continued, that one could not limit oneself to consider only the main exchange. In his view, the question had to be studied from the point of view of canalisation of cables, of buildings, of telephone sets, of traffic, and of the growth in the population and in the number of subscribers. Finally it had to be studied from the point of view of appropriately uniting and co-ordinating all these diverse conditions to establish the fundamental plans.<sup>254</sup> The anticipated growth of such a network as that of the Bell System in New York, Carty exemplified, put them immediately on guard against presuming that the automatic system would be usable. In New York, or any other city where they anticipated a normal growth, the so-called automatic system was unusable despite the fact that it might work for a small number of subscribers. In addition, he added, the so-called automatic system was unsuitable given

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<sup>252</sup> Full sentence (in French): “ Nous trouvons, à proprement parler, que ce n'est pas un système automatique, mais un système partiellement automatique et qu'il n'est pas possible de le faire fonctionner en pratique, sans avoir recours au bureau central à l'intelligence humaine et sans y utiliser des téléphonistes.” Ibid., p. 117.

<sup>253</sup> Full sentence (in French): “ Ce mot anglais *Plant*, qui comporte l'ensemble des structures constituant la propriété matérielle du réseau, est très suggestif par rapport au point que je veux mettre en évidence.” Ibid., p. 118.

<sup>254</sup> Ibid.

the Bell System's vision of universal service, that is, the vision as that of an interconnected network where it was possible for a subscriber to call any other subscriber within a reasonable time. Returning to his metaphor, he asserted that they at Bell had to envisage their plant like the architect who designs a park and pictures the landscape as it will become later on:

We cannot choose a switch on the basis of its immediate obvious enchantment, if, when looking into the future, one realises that its development will forcefully stop and that it cannot survive in the severe winter of practice.<sup>255</sup>

He admitted that partisans of automatic systems had produced financial calculations pointing in favour of such systems, but he stressed that they at AT&T had taken great pains in making calculations on comparable systems and he reported that in all cases they had found the so-called manual system cheaper.<sup>256</sup> Referring to his earlier discussion on the incorrect use of the labels automatic and manual, Carty reformulated the topical question as being which was the best type of 'semi-automatic' system to employ. To this he concluded that the so-called manual switch answered to all the real needs, but added quickly that they at Bell of course strove to improve the so-called manual system.

Carty further refuted allegations to the effect that AT&T refrained from adopting the automatic system because they were frightened by the high investment costs. To these allegations he asserted that the company could not be fairly criticised if it refused to be absorbed by the enthusiasm of manufacturers and inventors. If it would be thus absorbed, the consequences would probably be to the detriment of the important service the company delivered to the public, he contended. He ended his paper affirming that they had nothing to fear, since they were searching but for the truth.<sup>257</sup>

In his paper and his presentation John Carty had opened up several issues that Hans Karl Steidle had left closed. John Carty had even contended for the labels automatic, semi-automatic and manual and had given them new meanings. But he did not completely succeed. In the comments after his talk, the delegates continued to talk about the automatic system rather than the *so-called* automatic system. An engineer representing the Austrian Administration told the other delegates that they were

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<sup>255</sup> Original quote (in French): "Nous ne devons pas choisir un commutateur à cause de son apparente séduction immédiate, si, en regardant dans l'avenir, on s'aperçoit que son développement sera forcément arrêté et qu'il ne pourra pas survivre aux rigoureux hivers de la pratique." Ibid., p. 121.

<sup>256</sup> Ibid., pp. 122-126.

<sup>257</sup> Full sentence (in French): " Nous ne cherchons que la vérité et c'est pourquoi nous n'avons rien à craindre." Ibid., p. 126.

installing an automatic switch in Graz for 1,500 subscribers.<sup>258</sup> He also reported that the experiences already gained had persuaded the Austrian Administration that such a system could be used in the projected new exchange in Vienna. Major O'Meara, the engineer-in-chief at the British Post Office, told the delegates that he had been in the US the previous year to study automatic systems and their possible suitability in England. He concluded that under the conditions where he had seen exchanges with an automatic system, it "certainly gave as a good service as the manual."<sup>259</sup> He nevertheless affirmed that it was preferable if the subscriber had only to lift the receiver, and then focus the efforts on limiting the number of operators needed to maintain the service. The presence of the operator "seemed to him indispensable for maintaining a human intelligence in the series of operations."<sup>260</sup> An engineer at the French Administration had similar thoughts. He reported that he too had visited automatic exchanges in America, and had as Major O'Meara the impression that they provided satisfactory service. He stated that the largest question was no longer technical but was instead whether the subscribers would accept having to dial the desired number themselves.<sup>261</sup>

How were the diverse positions taken at the conference summarised? The chairman concluded the discussion and stated that it seemed difficult to determine it by a vote, but added that the primary objective of the conference was to exchange views and information. This said, he nevertheless drew a conclusion in line with the one proposed by Steidle and stated that "the satisfactory application of the automatic system is no longer doubtful, but that the aptness of this application depends on local conditions."<sup>262</sup> No objections were raised.

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<sup>258</sup> Account of statement made by Arthur Linninger in Ministère des Travaux Publics et des Postes et Télégraphes, "Procès-Verbaux des Séances de la Conférence; Deuxième Séance (6 Septembre 1910)," in *Comptes Rendus de la IIe Conférence Internationale des Techniciens des Administrations des Télégraphes et des Téléphones de l'Europe* (Paris: Ministère des Travaux Publics et des Postes et Télégraphes, 1910), 70-72, p. 71.

<sup>259</sup> Full sentences (in French): " Dans les conditions où il a vu faire l'usage, l'automatique ~~donne certainement un aussi bon service que le système manuel~~, mais seulement dans le service urbain. Dans les relations entre villes, l'application de l'automatique n'a pas été considérée." Account of statement made by Major O'Meara in *ibid.*, p. 71.

<sup>260</sup> Full sentence (in French): " La présence de cette téléphoniste ~~lui paraît indispensable pour maintenir une intelligence humaine dans la série des opérations.~~" Account of statement made by Major O'Meara in *ibid.*, p. 71.

<sup>261</sup> Account of statement made by Mr Milon in *ibid.*, p. 72.

<sup>262</sup> Full account of statement (in French): " M. Le Président résume alors la discussion et dit qu'il paraît difficile de la terminer par un vote, le but étant principalement d'échanger les vues et les renseignements des membres de la Conférence sur les systèmes en présence. Aussi la conclusion à tirer lui paraît être celle de M. Steidle lui-même, à savoir que ~~l'application satisfaisante du système automatique n'est plus douteuse, mais que l'opportunité de cette~~

The Swedish engineers expressed satisfaction with the conference upon their arrival in Stockholm. In mid September a Swedish newspaper reported what Karl-Erik Landström and one of his colleagues had to say about the conference.<sup>263</sup> They reported among other things the discussion on automatic switches and also that they had seen an exhibition of six different automatic switches, the largest interest being shown in the Strowger system one as it was already used by a large American operator. The delegates were nevertheless not very hopeful regarding the use of an automatic system, Landström reported. To this effect he specifically mentioned the opposition to the automatic system presented by John Carty of AT&T. His conclusion was that the general opinion among the delegates was that the present telephone technology was not mature enough to allow for dispensing with the operators.

The discussions in Paris nevertheless did not quench the thirst among the Administration's engineers for gaining first hand contact with foreign automatic switching devices, nor had the trip to the US quenched it. In May 1911 Axel Hultman visited Vienna and Graz in Austria, and at the same time Erik Ekeberg, the Administration's telephone director in Gothenburg, went to Munich.<sup>264</sup> In the Autumn 1911 Herman Olson was planning a trip to Germany and the Netherlands, where he would visit Munich and Rotterdam among other places.

### **The state of knowledge on international scenes**

The above brief outlook towards the contemporary world of telephony outside Sweden has revealed a space full of issues, opinions, and alleged facts with bearing on both the issues debated concerning the telephone exchanges in Stockholm. If I was to attempt to reconcile the diverse positions taken, I would only be able to conclude that little was indisputably known internationally regarding the appropriateness of automatic telephone switching-systems, the appropriateness of state managed monopolies and so on. However, what this outlook has been looking into is not a homogenous international space, but rather an agglomeration of different localities. What the outlook does reveal is that different things were known in different places. Their degradation to *alleged* facts is only an effect of bringing them together, as was done in Paris, when Webb argued against an imminent nationalisation, or indeed as I have done here by bringing them together in this outlook.

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application dépendra des conditions locales. Aucune objection n'étant soulevée." Account of statement made by the chairman (M Eustanié) in *ibid.*, p. 72.

<sup>263</sup> "Telegraf- och telefonkongressen i Paris, De svenska deltagarna om förhandlingarna: Automatiska växelapparater och långdistanstelefon under debatt," *Dagens Nyheter* (Stockholm), 15 September 1910.

<sup>264</sup> Letters connected to these and other study tours are collected in; TALb; F I A:134.

From this I want to conclude, firstly that there did not prevail universally accepted solutions to the 'telephone issue' or the 'switching system issue' as depicted above. There were simply no 'universal' ready-made solutions for the actors involved in these controversies to simply import. Secondly, even given the many positions that in some sense were available to the Swedish actors as they travelled between different localities, bringing any of such positions home would involve both local choices and local work to settle them in the locality of Sweden and Stockholm.

Appreciating the economists' concept of natural monopolies or Webb's position against state managed telephone monopolies was one thing. Working out how the 'telephone issue' in Stockholm was to be resolved was quite another. Discussing the general applicability of automatic switching devices was one thing, resolving the 'switching system issue' as applied to the exchanges in Stockholm was another. Seeing foreign switching devices in experimental set-ups or at work in some foreign town was one thing, working out how the Telegraph Administration's new exchanges in Stockholm and Gothenburg should look like was another. Having circuit drawings of foreign switching devices was one thing, making your own designs was quite another. It is to the local conditions and the laborious domestic efforts I will now return.



# V

## Network Trials & Tribulations

### **Further attempts to alter the techno-economic order**

In the previous chapter I moved from the two main exchanges in Stockholm to the less solid controversies regarding the ‘telephone issue’ and the ‘switching system issue’. The chapter left the story of these controversies around 1910, a time at which they were still unresolved. The present chapter will tell the story of these controversies as they progressed from 1910, how more actors gradually became involved and how at times they became increasingly interrelated. In this chapter I recount what happened with Axel Hultman's claim made in April 1910 to the effect that a system using semi-automatic switches was probably the only appropriate system for large exchanges. The chapter further contains the story of what happened concerning the efforts to resolve the ‘telephone issue’ in Stockholm. At the end of this chapter the story is at a point where the networks in Stockholm, and in particular the Telegraph Administration’s network, were facing serious problems, in part due to further increases in telephone traffic and the number of subscribers connected to networks.

### **Changing the telephone networks in Stockholm**

#### **Stockholm Telephone**

When the City Council in Spring 1907 permitted the use of the city streets for running cables, notwithstanding the still unresolved matter of the broken interconnection, Stockholm Telephone immediately began to convert its Stockholm network to the CB-system, as was reported in the previous chapter. Large quantities of cement blocks with pipes for running cables were laid in the streets, houses and apartments were wired or re-wired, local-battery telephone sets were replaced with battery and magneto inductor-free telephones. The amount of insulated wire needed had been underestimated at first. It had been assumed initially that open-wire lines could still be used for parts of the subscribers’ lines since this had proved possible within SAT's CB-system networks in

Moscow and Warsaw. In the first report to the shareholders of the new subsidiary Stockholm Telephone, it stated that the conditions in Stockholm and notably the close proximity of the Telegraph Administration's wiring had made usage of open-wire lines for CB-system switches impossible.<sup>1</sup>

The efforts put into transforming the network were well quantified in the annual reports. In the annual report for 1912, when the work had been nearly completed, it states that in the years 1908 through 1912 more than sixty thousand apartments had been furnished with new wiring and more than 12 km of new cement blocks for running cables had been put down in the streets over the same period.<sup>2</sup> Table V-1 provides some figures abstracted from annual reports covering that period.

*Table V-1 Some figures from the conversion of the network of Stockholm Telephone to the central battery system.<sup>3</sup>*

Year	Efforts to convert the Stockholm network to central battery				Growth
	Length of cement blocks put down, meters	Length of cable pipes in new cement blocks, meters	Number of central battery telephone sets put up	Temporarily employed at end of year	Net increase in number of subscribers (total 70 km-zone)
1907	4,377	54,201	2,075	28	3,376
1908	2,139	37,140	3,621	40 + 12 admin.	3,246
1909	5,695	108,637	5,237	74 + 12 admin.	3,452
1910	7,667	63,549	3,192	84 + 7 admin.	4,030
1911	1,322	9,232	9,988	95 + 6 admin.	4,289
1912	4,362	15,513	13,304	99 + 8 admin.	5,404
1913	5,925	26,896	2,644	—	5,414
1914	2,836	10,935	1,245	—	4,047

But there was more to converting the network to the CB-system than running wires and installing the new-type telephone sets. The switchboards at the exchanges had to be converted or replaced. In 1906, the company had the main exchange at Malmkillnadsgatan, two more main exchanges as well as 9 sub-exchanges within the

<sup>1</sup> "Till Aktiebolaget Stockholmstelefon. Berättelse afgifven vid 1:sta ordinarie bolagsstämman, den 9 maj 1908," (*Report to first shareholders' meeting of Stockholm Telephone 9 May 1908*).

<sup>2</sup> Aktiebolaget Stockholmstelefon, *Aktiebolaget Stockholmstelefons styrelse- och revisionsberättelser för år 1912* (Stockholm: 1913), (*Stockholm Telephone Annual Report*).

<sup>3</sup> The following annual reports were used to prepare this table: Stockholms Allmänna Telefonaktiebolag, *Stockholm Allmännas Telefonaktiebolags styrelse- och revisionsberättelser för år 1907* (Stockholm: 1908) and Aktiebolaget Stockholmstelefon, *Aktiebolaget Stockholmstelefons styrelse- och revisionsberättelser för år 1908-1914* (Stockholm: 1909-1915).

city in total attaching 36,969 subscribers by the end of the year.<sup>4</sup> The sub-exchanges had been installed in leased premises. When it came to planning the large investment in putting down more cement blocks, continued use of leased premises was considered to be financially too risky.<sup>5</sup> In 1906 and 1907 four properties were acquired to house the new main exchange in the district of Södermalm and the three new sub-exchanges in the districts of Vasastaden, Kungsholmen and Östermalm. In 1910 the subscribers at Södermalm were transferred to the new exchange, and by the end of 1912 the new sub-exchanges had also been put in operation. Hence, by then, all of the network within the city except the main exchange at Malmskillnadsgatan had been converted to the CB-system. Before moving on to this main exchange, we should take a look at what the company did with its tariffs once the sub-exchanges had been converted.

SAT had operated with several forms of subscriptions for subscribers in Stockholm since the 1890s. The potential subscriber could choose from subscriptions with or without limitations on how many free-of-charge calls could be made within the 70 km-zone. There was also a special so-called 'star subscription' targeted on businesses, to which incoming calls did not reduce the number of free-of-charge calls for those calling. The 'star' subscribers were designated with an asterisk (\*) in the company's telephone directory. When the company had taken the new exchange at Södermalm into operation, it decided to profit from the new capacity and the many new spare circuits run in the streets by introducing on trial in that district a new cheap subscription where all calls other than to star subscribers cost 0.05 krona.<sup>6</sup> Though not marketed, the company had acquired 129 such subscriptions by the end of 1910. As the new sub-exchanges were put into operation, this cheap subscription became applicable in other districts of Stockholm. However, the company did not have full autonomy over its own fees and tariffs. As a quid pro quo for the use of the city streets the company had had to agree not to raise any fees without the consent of the City Council in Stockholm.<sup>7</sup> Table V-2 depicts the forms of subscriptions offered by Stockholm Telephone for subscribers in Stockholm from 1903 through 1917.

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<sup>4</sup> One of the sub-exchanges was situated in the same block as the main exchange. The structure and extent of SAT's physical network was very well spelled out, not surprisingly, in the 1906 acquisition agreement. See, Contract, 8 March 1906, TALb; F I A:27, and "Stockholms Allmänna Telefonaktiebolags Styrelse- och Revisionsberättelser för år 1906" (*SAT Annual Report 1906*).

<sup>5</sup> "Stockholms Allmänna Telefonaktiebolags Styrelse- och Revisionsberättelser för år 1907," (*SAT Annual Report 1907*), p. 2.

<sup>6</sup> "Aktiebolaget Stockholmstelefon's Styrelse- och Revisionsberättelser för år 1910," (*Stockholm Telephone Annual Report 1910*), p. 2.

<sup>7</sup> Hans Heimbürger, *Svenska Telegrafverket: Telefon, Telegraf och Radio, 1903-1920*, vol. 4 (Göteborg: Kungliga Telegrafstyrelsen, 1953), p. 191.

Table V-2 Subscriptions offered by Stockholm Telephone (before 1908, SAT) in the city of Stockholm, 1903-1914.<sup>8</sup>

Year	Yearly fee (kronor)	Name	Regulations of subscription (changes italicised)
1903 All Offers	100 kr.	Star	Unlimited number of calls free of charge within the 70 km-zone. Incoming calls were free and not included in the limited number of free calls for callers having such limited subscriptions.
	80 kr.	–	Direct pair wire connection, unlimited number of calls free of charge.
	60 kr.	–	As 80 kronor subscription but line shared with one other subscriber.
	45 kr.	Business	100 calls free of charge quarterly. Excess calls 0.1 krona each. All calls to star subscribers free and not included in limitation.
	36 kr.	Residence	Same regulations as the 45 kronor business subscription, with the exception that the subscriber must be a household.
1908 Changes	45 kr.	Business	100 calls free of charge quarterly. <i>Excess calls 0.05 krona each.</i> All calls to star subscribers free and not included in limitation.
	36 kr.	Residence	
1909 Changes	45 kr.	Business	<i>150 calls free of charge quarterly, calls not answered now included.</i> Excess calls 0.05 krona each. All calls to star subscribers free and not included in limitation.
	36 kr.	Residence	
1911 New	20 kr.	–	<i>New Subscription:</i> Calls to star subscribers free of charge, calls to all others 0.05 krona.

The exchange to which a subscriber's lines were connected depended not just on where in the city the subscriber was situated, but also on the kind of subscription the subscriber had. It had been the company's long-established practice to gather all subscribers with the right to an unlimited number of free-of-charge calls to one or a few exchanges. In fact, the label *main exchange* signified that subscribers with unlimited subscriptions were directly wired to that exchange. On the other hand, subscribers with lower yearly fees were connected to the closest *sub-exchange*, whose name similarly signified that it gathered such subscribers. The idea behind this practice was to

<sup>8</sup> The subscriptions in the table do not include subscriptions in other parts of the 70 km-zone. Moreover, the company had some other special forms of subscriptions apart from these subscriptions. For instance, for a while it offered people moving into a ready wired apartment a subscription of 0 krona yearly fee/0.10 krona per call. Hotels were also offered special subscriptions for wiring into every hotel room. The information re. subscriptions is taken from several sources: SAT, leaflet issued 1905, "Taxa för Stockholm," TAAb; F I A:229. "Aktiebolaget Stockholmstelefonens Styrelse- och Revisionsberättelser för år 1908," (*Stockholm Telephone Annual Report 1908*); "Aktiebolaget Stockholmstelefonens Styrelse- och Revisionsberättelser för år 1910," (*Stockholm Telephone Annual Report 1910*); "Aktiebolaget Stockholmstelefonens Styrelse- och Revisionsberättelser för år 1911," (*Stockholm Telephone Annual Report 1911*). Hemming Johansson, *Telefonaktiebolaget LM Ericsson, del 1 Från 1876 till 1918* (Stockholm: LM Ericsson, 1953), pp. 370-379.

concentrate the subscribers making most calls to the main exchange at Malmskillnadsgatan, in order to provide them with especially good service as well as to maximise the number of calls that could be switched within the main exchange.<sup>9</sup> Hence the subscriber's lines of a "star" subscriber situated in the Kungsholmen district were not connected to the Kungsholmen sub-exchange but to the switchboards at the main exchange at Malmskillnadsgatan.<sup>10</sup> Thus the whole arrangement of subscriber's lines, cement blocks, exchanges, subscribers and fees of Stockholm Telephone were elaborately held together, where the arrangement of one was not insulated from the arrangement of the others. To borrow the concepts used by Herbert Laws Webb, the commercial and technical practices were intimately intertwined. And, at the centre of this intricate arrangement was the large main exchange at Malmskillnadsgatan.

As the new sub-exchanges were put into operation, the efforts became concentrated on arranging the large main exchange at Malmskillnadsgatan according to a central battery system. A part of this exchange had already been equipped with a CB-switch with a manual call-distributing system, but in the Winter of 1912/13 new premises were arranged for housing switching equipment for the main exchange. According to the company's annual report for 1912, the work of installing this equipment began in Spring 1913, but was estimated to take at least until the end of 1914 before completion.<sup>11</sup> It was also reported that the company wanted the swiftest system possible for this exchange since it served primarily business telephones. The board had therefore "... for the main office decided to introduce an automatic call-distributing system according to designs developed within the company."<sup>12</sup> In 1913 equipment was erected for 2,000 lines with this system and later more equipment of this system as well as CB cord pair switchboards were installed at the main exchange.

The automatic call-distributing system employed has a somewhat interesting background. The exchanges put into operation around 1903 in SAT's networks in

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<sup>9</sup> Johansson, *Telefonaktiebolaget LM Ericsson*, p. 435.

<sup>10</sup> The only exception was the exchange at Södermalm which gathered all kinds of subscribers, hence the label main exchange rather than sub-exchange. It is somewhat unclear, however, whether this exception was already in force when the new exchange at Södermalm was put into operation, or whether it was introduced in the years that followed. Confer: Hugo Lindberg, *Med Fingerskiva: Minnesskrift med anledning av Stockholms telefontäts automatisering* (Stockholm: Telegrafstyrelsen, 1938), p. 13 and Johansson, *Telefonaktiebolaget LM Ericsson*, p. 434.

<sup>11</sup> "Aktiebolaget Stockholmstelefontöns Styrelse- och Revisionsberättelser för år 1912" (*Stockholm Telephone Annual Report 1912*).

<sup>12</sup> Full sentences (in Swedish): "Å denna station expedieras hufvudsakligen affärstelefoner, hvarför styrelsen varit särskildt angelägen tillse, att den största möjliga snabbhet i expeditionen kan garanteras. Styrelsen har därför beslutat för hufvudstationen införa ett automatiskt fördelningssystem i enlighet med vid bolaget utarbetade konstruktioner." "Aktiebolaget

Moscow and Warsaw had used the manual call-distributing system. This had caused Anton Avén to take a case for an infringement of his patent for a signalling device to be used between the distribution and multiple switchboards.<sup>13</sup> As Avén had no patents for this in Russia, it was LM Ericsson who became the defendant since the parts to be used in the Russian exchanges had been manufactured by it in Sweden. The legal proceedings were lengthy, with Anton Avén losing in the lower courts but finally winning his case in the high court. But Avén's patent was not applicable when automatic call distribution was used, and in 1911 SAT acquired a patent on an automatic call-distributing system.<sup>14</sup> This system used a kind of automatic radial selector and hence it was this call-distributing system that was referred to in the annual report.

By the end of 1914, Stockholm Telephone had literally dug itself in less than 10 years into an even firmer position in Stockholm. The company then had about 59 km of cement blocks in the streets giving almost 700 km of cable pipes.<sup>15</sup> Several properties had been acquired to house exchanges. The city network had been converted to the CB-system where two main exchanges together with 6 sub-exchanges served 62,724 subscribers in the city at the end of 1914.<sup>16</sup> At the same time the company had a total of 77,624 subscribers within the 70 km-zone, which indicates that company had its primary operations within the city. In the eight years from end 1906 to end 1914, the number of subscribers within Stockholm had increased by almost 70%.<sup>17</sup> The all female staff of operators working within the company's network in Stockholm had similarly increased in number and represented more than half the company's total number of employees. At the end of 1906 they numbered 530 and eight years later their number had increased to 916, an increase of about 73%. The company had made laborious effort to transform its Stockholm network and more operations had been automated in

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Stockholmstelefont Styrelse- och Revisionsberättelser för år 1912," (*Stockholm Telephone Annual Report 1912*), p. 2.

<sup>13</sup> A short account of this dispute is given in Johansson, *Telefonaktiebolaget LM Ericsson*, p. 302.

<sup>14</sup> "Själfkopplare för telefonledning och dylikt (Self-connector for telephone lines and the like," Swedish patent # 34423 (patent-class 11:a3) granted to SAT (inventor: Gunnar Agrell at SAT) on 10 February 1911, copy in LA; Samling G. Collberg #1.

<sup>15</sup> "Aktiebolaget Stockholmstelefont Styrelse- och Revisionsberättelser för år 1914," (*Stockholm Telephone Annual Report 1914*).

<sup>16</sup> This is from a draft of a contract concerning an acquisition of the network of Stockholm Telephone 'Draft of Contract', October 1915, TALb; F I A:26; and "Aktiebolaget Stockholmstelefont Styrelse- och Revisionsberättelser för år 1914," (*Stockholm Telephone Annual Report 1914*).

<sup>17</sup> "Stockholms Allmänna Telefonaktiebolags Styrelse- och Revisionsberättelser för år 1906," (*SAT Annual Report 1906*) and "Aktiebolaget Stockholmstelefont Styrelse- och Revisionsberättelser för år 1914," (*Stockholm Telephone Annual Report 1914*).

the switching of calls. Nevertheless, the company still relied on an increasing number of operators to participate in making the connections.

### **The Telegraph Administration**

The Telegraph Administration did not publish a similar volume of official reports and statistics on work towards enlarging its Stockholm network. For a long time the Administration had only the main exchange at Skeppsbron for its city network in Stockholm. This exchange, as mentioned in the previous chapter, had a local battery switch with the call-distributing system, erected in 1901. In 1908 another small switch of the cord pair system had been added to the main exchange, as a result of the then ongoing dispute between Anton Avén and Axel Hultman over the appropriateness of the call-distributing system.

For a long time the Telegraph Administration had only offered one kind of subscription in Stockholm, having charged 50 kronor per year since 1896 for a subscription allowing an unlimited number of local calls within the city. The Telegraph Administration had the same annual fee in some other of its city networks<sup>18</sup>, but nowhere else could a telephone subscriber make local calls within such an extensive region as the one defined by the 70 km-zone. Moreover, since the 1890s the Telegraph Administration had gradually reduced the areas within which subscribers could make free local calls outside the 70 km-zone, which in effect increased the number of chargeable inter-urban calls.<sup>19</sup> New changes reducing the several free-traffic areas in different parts of Sweden were made in 1905 and 1908. The free-traffic area within the 70 km-zone nevertheless remained intact and in 1909 the Administration introduced a new cheaper subscription unique to its operations in Stockholm.<sup>20</sup> The yearly fee was set at 30 kronor and it gave entitlement to 150 calls free of charge quarterly within the Administration's 70 km-zone network.<sup>21</sup> The free-of-charge calls included calls not answered, and it was after the introduction of this subscription that Stockholm Telephone also changed the conditions for its cheap subscriptions accordingly. It was in connection with this introduction that the Telegraph Administration erected its first sub-exchanges within the city, exchanges with the modified LB-system designed by

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<sup>18</sup> The annual fees varied greatly between regions, but were generally either 50, 60 or 80 kronor. See, Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 42.

<sup>19</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, pp. 47-48

<sup>20</sup> In connection with the attempt to acquire the SAT network in 1906, the Telegraph Administration had promised to maintain the multiple forms of subscriptions offered by SAT. But when this acquisition had failed, the yearly fee for a subscription remained unaltered. Cf. p. 81.

<sup>21</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 194.

Herman Olson.<sup>22</sup> The three new sub-exchanges in the districts Vasastaden, Östermalm and 'the City Between the Bridges'<sup>23</sup> were taken into operation in April 1909, and would primarily gather subscribers having the new cheap subscription.<sup>24</sup> Hence when introducing a subscription with conditions similar to Stockholm Telephone's cheaper subscriptions and using sub-exchanges for such subscribers, the Administration was following that company's example.

Discussions had been going on within the Administration since at least 1907 concerning the erection of a new main exchange. Indeed, it was in this context that the heated debate between Axel Hultman and Anton Avén on switching systems had taken place. However, the protracted and still unresolved debate had not entirely obstructed preliminary steps being taken towards the erection of a new main exchange, because in 1909 the Administration initiated work on that project.<sup>25</sup> The building, subsequently named Jeriko after the name of the block it was in, was situated in Jakobsbergsgatan, not very far from Stockholm Telephone's main exchange.<sup>26</sup> When Hultman put forward his arguments in April 1910 proposing a semi-automatic system, the building was still unfinished. His proposal was not only made in the context of an unresolved international debate on the appropriateness of different switching systems but also at a time when there was fierce debate within the Administration regarding the call-distributing system, leading to the fact that the carpenters and bricklayers were working on a large new building whose interior had not yet been determined.

These ongoing efforts to build and decide on the lay-out of the new main exchange also had certain repercussions upon the international forum for discussing telephone engineering matters. The Swedish delegation to the Paris conference in 1910 had been approached to see whether the Telegraph Administration could host the ensuing conference in 1913. Karl Erik Landström wrote to the chairman of the Paris conference in December 1910 to let him know that the Administration regrettably could not do so, due to the reconstruction of the exchange in Stockholm that would be under

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<sup>22</sup> See chapter IV, p. 62.

<sup>23</sup> This is a translation of the Swedish contemporary name of the district: *Staden mellan broarna*. This district is now known as 'Gamla Stan' or the Old Town.

<sup>24</sup> Lindberg, *Med fingerskiva*, p. 14.

<sup>25</sup> Lindberg, *Med fingerskiva*, p. 22.

<sup>26</sup> The building was designed by the architect Aron Johansson (1860-1936) who is probably best known for having designed the Riksdag (Parliament) and Bank of Sweden buildings only a few years earlier. Johansson came later also to design several other buildings to house telephone exchanges. Eva Eriksson, *Den moderna stadens födelse: Svensk arkitektur, 1890-1920* (Stockholm: Ordfront, 1990), pp. 137-141, 445. The design reproduced on the cover of this book is of the front of the Jeriko building designed by Aron Johansson.

way during 1913. The walls of ‘Jeriko’ would certainly have been erected by then, but their inner side would not yet be presentable:

Therefore, by that date, neither the old nor the new exchange lends itself to a demonstration that is of value to such experts as those who would be summoned to arrive inside our walls.<sup>27</sup>

As mentioned, the Telegraph Administration did not publish a large volume of official accounts and statistics on the work to enlarge its Stockholm network. The Administration was nevertheless an important compiler of statistics on telephony and telegraphy in Sweden, since it was responsible for publishing the official Swedish statistics for these areas. These volumes published annually contained a vast amount of information. In the 1913 edition, for instance, we learn that the Administration had a total of 159,252 telephones within its various local networks, more than the double the figure for 1903.<sup>28</sup> The same edition contains the information that by the end of 1913 there were 76,121 telephones in public networks operated by telephone companies, co-operatives, municipalities and railway companies.<sup>29</sup> Of these, 73,577 telephones belonged to the network of Stockholm Telephone. The Administration at the same time had 26,034 telephones within the city of Stockholm, which reportedly translated into 73.4 telephones per 1,000 inhabitants.<sup>30</sup> And the adjacent page reports that this figure was 241.4 telephones per 1,000 inhabitants when telephones in ‘other’ networks in Stockholm are included.

In another official Administration publication such figures were compared with those of other cities, presumably not without a certain measure of pride. In 1911 it was noted in the Administration’s Technical journal that Stockholm in 1909 boasted the largest concentration of telephones of cities in Europe.<sup>31</sup> Stockholm had reportedly then had 17.1 subscribers per 100 inhabitants whereas Copenhagen, the second city on this list, had had 6.9 subscribers per 100 inhabitants. It was further reported that Stockholm was only surpassed in the world league by Los Angeles in the US which then reportedly had 25.4 subscribers per 100 inhabitants.

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<sup>27</sup> Full sentence (in French): “Cette décision a été motivée en partie par le fait suivant – et que je vous ai d’ailleurs exposé déjà à Paris – savoir que notre station de Stockholm se trouvera en 1913 en voie de reconstruction; c’est pourquoi, à cette date, ni l’ancienne ni la nouvelle station ne se prêteraient à une démonstration devant des spécialistes de la valeur de ceux qui seraient appelés à venir dans nos murs.” K.E. Landström, 13 December 1910, ‘Letter to M Estaunié,’ TAAab; F IV B:23.

<sup>28</sup> Telegrafstyrelsen, *Telefon och telegraf, 1913, Sveriges officiella statistik* (Stockholm, 1914), p. 10.

<sup>29</sup> Telegrafstyrelsen, *Telefon och telegraf, 1913*, p. 37.

<sup>30</sup> Telegrafstyrelsen, *Telefon och telegraf, 1913*, p. 44–45.

<sup>31</sup> “Internationell telefonstatistik,” *Teknisk Bilaga Till Kungl. Telegrafstyrelsens Månads-Kirkulär för år 1911*, August 1911, pp. 63–64.

The official statistics also provided brief accounts on what was going on within the Administration. For instance, the 1913 edition reports that in same year the Administration's factory had moved from Stockholm to Nynäshamn south of Stockholm and that the factory had an average of 437 workers employed in that same year.<sup>32</sup> From the previous year's edition, we learn that the building at Jeriko had been finished, approved and partly been put into use.<sup>33</sup> But to what use the building was put was not revealed. Brief references to work in developing switches of a new kind for the main exchanges in Stockholm and Gothenburg were consistently appearing in the official statistics under the heading *Technical devices and investigations, etc.*, which summarised work done within the technical department. It was reported under this heading in 1911 that preparatory work had been done in developing designs that would reduce the work done by operators. The mechanical automatic devices envisaged could reportedly both save money and provide more reliable switching:

Continuous work has been undertaken at this department on preparatory constructions and trials to obtain a suitable telephone system for the main exchanges in Stockholm and Gothenburg. These attempts largely aim to reduce as far as possible the work which the operators perform when switching by introducing mechanical automatic devices. Among other things, a considerable financial saving would be achieved through this and at the same time the switching at the exchange could become more reliable.<sup>34</sup>

The following year, in the official statistics for 1912, it was briefly reported on the same issue:

The preparatory experiments and trials to extract the most suitable telephone system for the main exchanges in Stockholm and Gothenburg have gone on uninterrupted and been carried out with all possible swiftness.<sup>35</sup>

In the statistics for 1911, the aim of the work had been *to obtain a suitable telephone system for...*, but in 1912 the account had slightly changed and now the aim was to

<sup>32</sup> Telegrafstyrelsen, *Telefon och telegraf, 1913*, p. 50-52.

<sup>33</sup> Telegrafstyrelsen, *Telefon och telegraf, 1912*, *Sveriges officiella statistik* (Stockholm, 1913), p. 34.

<sup>34</sup> Original sentences (in Swedish): "För övrigt har å denna afdelning ett oafbrutet arbete nedlagt på förberedande konstruktioner och försök för erhållande af ett lämpligt telefonsystem för centralstationerna i Stockholm och Göteborg. I stort sedt syfta dessa försök att så långt som möjligt nedbringa det arbete, som telefonisterna vid kopplingen utföra, genom införande af mekaniska, automatiskt verkande anordningar. Härigenom skulle bland annat vinnas en väsentligt ekonomisk besparing på samma gång samtalsuppkopplingen å stationen kunde blifva säkrare." Telegrafstyrelsen, *Telefon och telegraf, 1911*, *Sveriges officiella statistik* (Stockholm, 1912), p. 52.

<sup>35</sup> Original sentence (in Swedish): "De förberedande experimenten och försöken till utvinnande av lämpligaste telefonsystem för centralstationerna i Stockholm och Göteborg hava oavbrutet fortgått och bedrivits med all möjlig skyndsamhet." Telegrafstyrelsen, *Telefon och telegraf, 1912*, p. 58

*extract the most suitable telephone system* for the main exchanges in Stockholm and Gothenburg. These brief official accounts would continue to be slightly altered as work progressed. For 1913, for instance, the words *automatic telephone system* were found for the first time.<sup>36</sup> However, unveiling the further changes encountered in the official records here at this stage would take us too far ahead of my narrative. It is time pause and to take a somewhat closer look on some of the Swedish efforts to discuss, experiment, and design automatic switching devices. But before doing so, it is worth mentioning the attempt made by two members of parliament in 1913 to resolve the 'telephone issue'.

### **A brief return to the 'telephone issue'**

The 'telephone issue' had been rather unattended since the inconclusive discussions between the two operators had ended in 1909.<sup>37</sup> The two operators, and Stockholm Telephone in particular, seem subsequently to have focused on enlarging and refurbishing their networks rather than in trying to resolve the 'telephone issue' through reaching an agreement of some sort with one another. Nevertheless, the impasse was not without its critics.

In 1913, two members of parliament introduced a motion stressing that the present dualism caused lower revenues for the State as well as increased expenses for the public.<sup>38</sup> They therefore demanded that the government investigate possible improvements to the telephone situation in Stockholm, and determine whether an acquisition of the private network was possible. The parliamentary working committee preparing the motion identified several disadvantages to the current regime. It argued that it was bad for the country to have two isolated networks lacking interconnection with one another, and that the duplication of lines to many subscribers was a waste of material and labour from a national point of view. These losses, moreover, were considered greater than the gains which competition brought by inducing improvements and reducing operating costs.

These considerations notwithstanding, the majority of the committee concluded that the difficulty in raising money for an acquisition made it necessary to recommend a dismissal of the motion.<sup>39</sup> It further stressed that the issue of financing an acquisition could be resolved if the Telegraph Administration could show that an acquisition would

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<sup>36</sup> Telegrafstyrelsen, *Telefon och telegraf, 1913*, p. 66

<sup>37</sup> Confer pp. 83ff in chapter IV above.

<sup>38</sup> Eric Beckman, "Telefondebatten i riksdagen: En studie i argumentering om statligt engagemang under perioden 1884-1918," (Department of History of Science and Technology, Royal Institute of Technology in Stockholm, 1994), pp. 44-45.

<sup>39</sup> Beckman, *Telefondebatten i riksdagen*, p. 44 and Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 208-209.

generate the yield necessary to pay off the purchase sum by instalments. The committee's recommendation to dismiss the motion was subsequently endorsed by Parliament. However, it is worth noting that some members of parliament supported the dismissal because they found it disadvantageous that an initiative towards an acquisition was taken by the government. This, they argued, would only encourage the company to demand too high a price for its Stockholm network.

Hence, this political initiative in attempting a redefinition of the telephone networks in Stockholm was as ineffective as the previous attempts where the two operators had agreed on an arrangement prior to involving the government. The arguments this time were similar to those put forward in relation to the attempted acquisition in 1906, perhaps with the difference that heavier emphasis was placed on the possibility of increasing the profitability of the Administration's network after an acquisition. This theme would later become even more prominent in the discussion on tariff reform which emerged in late 1914. However, it is time to return to the concurrent attempts to redefine the 'inner' workings of a telephone exchange by use of automatic switching devices.

### **Neither cords nor jacks: The beginning of three Swedish projects**

By 1911, as was noted above, there were preparatory constructions and trials going on at the technical department of the Telegraph Administration "...to obtain a suitable telephone system for the main exchanges in Stockholm and Gothenburg."<sup>40</sup> Secondary sources later reported that upon their return from the US in 1910 Herman Olson at the technical department and Axel Hultman began to work on developing automatic selectors.<sup>41</sup> It has also later been stated that they worked individually, but nevertheless discussed solutions with one another. However, no records of these early activities have been found in the archives of the Administration. In fact, little archival material has been found on Herman Olson's work altogether. Nevertheless, it might reasonably be assumed that the preparatory constructions mentioned in the official report for 1911 primarily referred to the work being undertaken by Herman Olson, since he worked at the department in question whereas Hultman did not.

What follows below is stories of early Swedish efforts to discuss, experiment, and design automatic switching devices. Stories which were concurrent with Stockholm Telephone's final refurbishment of its network in Stockholm and their employment of a switch with automatic call distribution. Axel Hultman's verbose efforts will be at the centre of these stories, but the stories will also cover the work by Herman Olson and a

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<sup>40</sup> See note 34 on p. 144.

<sup>41</sup> See, for instance, Lindberg, *Med fingerskiva*, p. 23.

third engineer who took a leave of absence from the Administration's factory around 1910.

**'There are strictly speaking no alternatives...'**

After Axel Hultman's trip to the US together with Herman Olson, Hultman continued to investigate how the main exchange in Stockholm should be arranged. He continued to make calculations on how many telephone calls an operator could switch per hour with different systems, and he also had experiments carried out to assess what these figures might be for semi-automatic switches. In September 1911, he presented a proposal to the headquarters of the Telegraph Administration on how the Administration should proceed in arranging the local exchange in Stockholm.<sup>42</sup>

In this proposal Hultman affirmed that although there was a general agreement on the superiority of CB-systems, there was still disagreement on what kind of CB-system to select. He stressed, nevertheless, that the investigations and measurements made over the last several years had produced absolutely reliable standards for comparing the amount of operator work needed with different switching systems. He further underlined how such comparisons should be made: Firstly, all operator work should be measured in number of switched calls per operator per hour. This measure should not include trunked calls and should refer to a given average answering time. Secondly, the load on the operators should be just enough, since "...the operator is a human and not an automatic device or machine which can be rushed to the extreme."<sup>43</sup> Thirdly, the more switched calls one tried to squeeze out per operator per hour, the worse the service and the answering times became. With an implicit address to his earlier debate with Anton Avén, Hultman stressed that the task of the telephone engineer was to increase the number of switched calls per operator per hour under given fixed answering times and without increasing the workload put on the operators.

With these principle made clear, Hultman went on to present figures on calls per operator per hour for different switching systems during busy hour. According to Hultman, the ordinary cord pair system could make 200 calls per operator per hour, whereas a manual multiple switchboard with automatic call distribution could deliver 250 calls per operator per hour, and a further improved system of the latter kind could deliver 310 calls per operator per hour. Next in turn was semi-automatic switches, that is, switches where the operators completed calls by pushing push buttons instead of

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<sup>42</sup> Axel Hultman, 2 September 1911, "Förslag till anordnandet af den lokala telefonstationen i Stockholm," (Proposal for arranging the local telephone exchange in Stockholm), TALb; F I A:30.

<sup>43</sup> Full sentence (Swedish): "Telefonisten är en människa och icke en automat eller maskin som kan jäktas ända till ytterlighet." *Ibid.*, p. 2.

using jacks and cords. He stressed that the figures for manual switchboard switches were completely accurate and comparable.

Where it concerned semi-automatic switches, however, Hultman admitted that the figures were not as precise. In Ashtabula (Ohio, USA), he advised that as many as 1,500 calls were switched per operator per hour for 3-digit telephone numbers but that this high figures was achieved by overloading the operators. Hultman contended that a more just workload would give approximately 700 calls per operator per hour for 3-digit numbers and perhaps 500 to 600 calls per operator per hour for 5-digit numbers. In Germany, he added, they had achieved 450 calls per operator per hour at their semi-automatic switches. In addition, Hultman reported on experiments he himself had commissioned. In these an untrained operator had worked at an experimental console performing 1,000 "connections" each for three different designs. This had given average switching times from 5 seconds to 4.1 seconds per call depending on the design. This, he calculated, would represent 360 - 440 calls per operator per hour.<sup>44</sup> These results, he concluded, confirmed that the figure of 450 calls per operator per hour was a reliable measure for semi-automatic switches.

What kind of switching system should then be chosen in different cases? Axel Hultman maintained that a switch with a 'modern' cord pair system should be used for smaller local networks of up to about 5,000 or 8,000 subscribers. In cases where there were 8,000 to about 12,000 subscribers and where the subscribers were geographically concentrated, a multiple switchboard with automatic call distribution should be used. In larger local networks of more than 12,000 subscribers where trunking could not be avoided, Hultman stressed that one should choose switches with an automatic or semi-automatic system.

To confirm these assertions, Hultman presented calculations based on a fictitious network of 30,000 subscribers, each making 10 calls per day of which 30% had to be trunked. Using his standard figures and adjusting the figure for manual system for the trunked traffic, he calculated that such a network would require approximately 232 operators if switches with manual multiple switchboards and automatic call distribution were to be used.<sup>45</sup> If, on the other hand, a semi-automatic system were to be used, only about 142 operators were needed. However, this difference had to be adjusted since the semi-automatic system required more repairmen for its daily maintenance. Hultman

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<sup>44</sup> He set a reasonable workload to be equivalent with an operator actually switching calls during 50% of an hour. Hence the number of calls per operator per hour was calculated as  $(3,600/\text{seconds per call}) * 0.5$ . Ibid. p. 5.

<sup>45</sup> For the manual multiple switchboards with automatic call distribution he calculated that each operator could switch 258 calls per hour as opposed to the ordinary 310, due to the trunked traffic. Ibid., p. 6.

estimated that that the semi-automatic switches in all required 9 additional repairmen, which he equalled with the wages of 23 operators. In this example, he reckoned that the yearly net saving in operating cost would be 67 operators.<sup>46</sup>

With a fully automatic system the savings in terms of operators was naturally even larger. When it came to discussing the investment cost of the different switching systems, Hultman contended that the limited space of the proposal did not admit a thorough account of this elaborate issue. He nevertheless claimed, and referred to calculations made by the American W. Lee Campbell, that the investment costs for automatic and semi-automatic switches were lower than those for manual switchboards, with or without automatic call distribution, when the local network contained more than 20,000-30,000 subscribers.

Axel Hultman asserted that the experiences of automatic systems in the US and other countries indicated that they provided satisfactory service. In Europe, Hultman reported, there were fully automatic exchanges in operation in Graz, Krakow, and Munich among other places. He further asserted that representatives of the Telegraph Administration had been to see that they worked well. He was, however, somewhat concerned with the trend in the design of automatic which strove to lower the investment cost, since a lower investment cost was rarely achieved without sacrificing the reliability of the system. Reliability, Hultman emphasised, was a primary concern to those who operated the service. He predicted that this trend would nevertheless develop since it was a field of great opportunities and that entrepreneurial engineers would try to take advantage by introducing cheaper switching systems:

Entrepreneurial engineers will to be able to throw themselves into this field with new devices and inventions to try to introduce new systems which are cheaper than those already on the market.<sup>47</sup>

Axel Hultman maintained that the automatic systems then in operation had proved to be reliable, but that a buyer of new switching equipment had to watch out for all new and cheaper designs that were introduced. Axel Hultman further maintained that since the Telegraph Administration should if possible produce its own larger constructions as it had the ability through its factory and with its experienced personnel.<sup>48</sup> This was also in line with what he had stressed already in the beginning of the proposal. There he had

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<sup>46</sup> The calculation he did was:  $232 - (142 + 23) = 67$ . By equalling 9 repairmen with 23 operators, he thus calculated that the wages of an operator were approximately 40% of the wages of a repairman. *Ibid.*, p. 6.

<sup>47</sup> Original sentence (Swedish): "För att kunna kasta sig in på detta område försöka därför företagsamma konstruktörer att genom nya anordningar, uppfinningar, få in nya system, som äro billigare än förut i marknaden varande." *Ibid.*, p. 9.

<sup>48</sup> *Ibid.*, p. 10-11.

stated that he himself in part had proposed a modified semi-automatic system with the view of enabling the Telegraph Administration, "...through a certain degree of independently developed devices, [to] be capable of defending its place among the forerunners in telephony."<sup>49</sup>

Hultman took the Strowger system as a starting point for discussing his modifications. He suggested, for instance, alterations to the 100-line selector that would make its cleaning easier. He also stressed that it was essential first to get the principles right, before discussing the details of a system. He emphasised that it was the designers' task to strive for the most reliable and uncomplicated design, but that it was "...not the designer, but the instrument-maker that should perfect the details."<sup>50</sup>

Hultman concluded his proposal by suggesting that the new local telephone exchange in Stockholm in the coming few years should be furnished with a semi-automatic system, and so designed that it could be converted to become a fully automatic exchange in the future. In fact, as he stressed, the Telegraph Administration had no real choice:

As automatic switches are cheaper in both investment and operation than multiple switches when the number of subscribers are above 20,000, and as they do not require trunking and decrease the cost of subscribers' lines, there are strictly speaking no alternatives since the use of any other system is simply a waste of money.<sup>51</sup>

Therefore, he requested the authority to immediately develop and test his designs with the help of engineers at the Administration's factory. He furthermore asked to be allowed to consult with an experienced patent agent, at the Administration's expense to find out whether the planned design would interfere with any existing patents. Thus, Hultman was now intending to take an active part in the development of such a semi or fully automatic switching system.

### **The founding of Autotelephone Betulander**

Axel Hultman and Herman Olson were not the only engineers from the Telegraph Administration who wanted to explore the possibilities of automatic switching devices.

<sup>49</sup> Full sentence (in Swedish): "Som bekant har jag föreslagit ett något modifierat half-automatiskt system, dels ..., dels äfven med tanke på att den svenska Rikstelefonen fortfarande genom i viss grad själfständigt utarbetade anordningar skulle vara i stånd att försvara sin plats bland föregångarna på telefonområdet." *Ibid.*, p. 4.

<sup>50</sup> Full sentence (in Swedish): "Det är ej konstruktören utan instrumentmakaren som skall fullända detaljerna." *Ibid.*, p. 11.

<sup>51</sup> Original sentence (in Swedish): "Då de automatiska stationerna för abonnenter öfver 20 000 äro billigare i anläggning och billigare i drift, än multipelstationerna, då de dessutom icke fordra någon trunking och nedbringa ledningskostnaderna till abonnenterna, så finnes egentligen icke något val, då anordnandet af andra system helt enkelt blir ett onödigt bortkastande af penningar." *Ibid.*, p. 14.

Gotthilf Ansgarius Betulander (1872-1941), a long time engineer at the Administration's factory, had already participated in the construction of tiny automatic switches in the late 1890s and a few of such switches had been installed in rural areas.<sup>52</sup> He had also given a few such step-by-step selectors to LM Ericsson for testing<sup>53</sup>, perhaps with the view of starting a collaboration with the company. In 1910, however, he chose a path of his own, taking leave of absence from his position at the Administration<sup>54</sup>, to seek alliances outside the Administration and LM Ericsson. When participating at the conference in Paris in September the same year he was officially part of the delegation from the Swedish Telegraph Administration, but it seems he was not only representing the Administration at the conference. At the conference he exhibited an automatic system and by then he had already forged a consortium with a Swedish banker active in Paris and a few French companies.<sup>55</sup> The consortium had acquired options on some of his patents.<sup>56</sup> In December 1910 he founded a company, Autotelephone Betulander, with the help of a few financiers and most notably a pioneer in the Swedish chemical industry, Oscar Carlson (1844-1916).<sup>57</sup> The French partners owned the majority in the company and when some of the French parties left the consortium in 1912, allegedly when they learned that no production was planned in France, the company was liquidated. Instead a new company, New Autotelephone Betulander, was founded with only Swedish financiers. Oscar Carlson remained the prominent financial partner in the new company as well and was a board member.<sup>58</sup>

Together with his younger engineering partner, Nils Palmgren (1888-1975), Betulander made several designs for automatic switching devices and they acquired

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<sup>52</sup> Lindberg, *Med fingerskiva*, pp. 21-22.

<sup>53</sup> Johansson, *Telefonaktiebolaget LM Ericsson*, p. 306.

<sup>54</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 70.

<sup>55</sup> "Telegraf- och telefonkongressen i Paris, De svenska deltagarna om förhandlingarna: Automatiska växelapparater och långdistanstelefon under debatt," *Dagens Nyheter* (Stockholm), 15 September 1910. A visiting card from the time had the headline – *Société des Téléphones Automatiques: Système "Betulander" Suède* – and indicated a banker named Wessling in Paris as President. The visiting card was found in the same folder in the archives of the Telegraph Administration as correspondence concerning the Paris conference. Visiting-card in TAAb; FIV B:23. See also Walter Broberg, "Nya AB Autotelefon Betulander: Ett pionjärföretag inom automattelefonin," *Tele: Televerkets tekniska tidskrift* 76, no. 4 (1971): 64-70, p. 65.

<sup>56</sup> A later contract discusses the options on patents earlier handed over to the Swedish banker in Paris, Wessling. Contract, 9 May 1912, "Kontrakt," (Contract between Oscar Carlson GA Betulander and New Autotelephone Betulander, Transcribed 20 October 1927), TALb; F I A:351.

<sup>57</sup> Broberg, *Nya AB Autotelefon Betulander*, p. 65-66.

<sup>58</sup> Contract, 9 May 1912, "Kontrakt," (Contract between Oscar Carlson GA Betulander and New Autotelephone Betulander, Transcribed 20 October 1927), TALb; F I A:351; and n.a. 22 October 1927, *Internal Memo*, TALb; F I A:351.

several new patents.<sup>59</sup> Early in 1913, the company entered into negotiations with the English Marconi company regarding the Betulander company's patents for automatic switching devices.<sup>60</sup> In May a deal was closed where the Marconi Wireless Telegraph Co acquired all the company's patents outside Sweden and a new Marconi company was founded to exploit the patents, The Betulander Automatic Telephone Company Ltd.<sup>61</sup>

The Swedish company New Autotelefon Betulander expanded in 1913 and some skilled workers were recruited from among those at the Administration's factory not wanting to move with the factory to Nynäshamn.<sup>62</sup> The company also manufactured and in 1914 delivered an automatic private branch exchange using relays to the Marconi house in London.<sup>63</sup> It seems that the Betulander company in the beginning sought to design automatic systems using mechanical selectors making the selection by steps, much along similar lines as those pursued by Herman Olson at the Telegraph Administration.<sup>64</sup> However, Betulander and his colleagues soon strove towards designing systems where the selection was made by relay-based selectors and the small private branch exchange delivered to the Marconi House had selectors consisting of link-connecting relays.<sup>65</sup>

GA Betulander's efforts to develop automatic switching devices had become differently organised in 1910 to those made by Herman Olson and Axel Hultman. Instead of continuing his work from his position at the Telegraph Administration, on several occasions Betulander had recruited external parties to provide support for his endeavours. Where Herman Olson and Axel Hultman, and most notably the latter, from 1910 onwards had striven for support by arguing their case in internal memos, GA Betulander had negotiated contracts with partners outside the sphere of Swedish telecommunications. It is fair to say that these liaisons altered the character played by Betulander. From having performed the role of the state employed engineer, from 1910 he became endowed with the character of being the inventor-entrepreneur, and what is more in a company bearing his own name. Furthermore, recruiting associates was not a one-time effort for Betulander. When some ties were not strong enough, such as his

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<sup>59</sup> A letter from Paul Hallgren (head of the technical department at the Administration 1920-1931) to Betulander lists several patents from this period. Paul Hallgren, 6 February 1925, "Till Verkstadsingenjören G.A. Betulander," TALb; F I A:351.

<sup>60</sup> Broberg, *Nya AB Autotelefon Betulander*, p. 66.

<sup>61</sup> Broberg, *Nya AB Autotelefon Betulander*, pp. 66-67 and Johansson, *Telefonaktiebolaget LM Ericsson*, p. 309.

<sup>62</sup> Broberg, *Nya AB Autotelefon Betulander*, p. 66.

<sup>63</sup> Broberg, *Nya AB Autotelefon Betulander*, p. 67.

<sup>64</sup> Broberg, *Nya AB Autotelefon Betulander*, p. 67.

early ties with French interests, new ones were forged. In the next chapter we will see that teaming up with the Marconi concern by no means put an end to the efforts to recruit allies to the Betulander company. But now it's time to return to Axel Hultman, to see how he also took his efforts elsewhere in allying himself with LM Ericsson in 1913 with a view to developing an automatic switching system.

### **Axel Hultman's efforts take a new turn**

After the conference in Paris, some European Administrations put more effort into experimenting with and introducing automatic switching devices. For instance, in June 1912 the Engineering Journal of the Telegraph Administration carried a small notice reporting that the first automatic switch in England had recently been put into operation in Epsom using the Strowger system.<sup>66</sup> The switch had been erected by the British Post Office with second-hand equipment from an exchange in Chicago and was designed for 500 subscribers.<sup>67</sup> This triggered, as similar events had on several earlier occasions, a desire to see it. Consequently, in November 1912 Axel Hultman and Herman Olson went to visit the new automatic switch in Epsom.<sup>68</sup>

In spite of his apparent enthusiasm for independent development within the Telegraph Administration<sup>69</sup>, in April of the year following their return Axel Hultman took a step which significantly altered his efforts to develop an automatic system. On 16 April 1913 he signed a contract together with the managing director and chairman of LM Ericsson, Hemming Johansson (1869-1955) and Wilhelm Montelius (1852-1918) respectively.<sup>70</sup> The basic premise of the contract was that Axel Hultman and LM Ericsson would collaborate on the further development of his ideas on an automatic switching system.

We cannot know the motives behind the signing of the contract, in the sense that we lack insight into what discussions preceded it. Yet there are several possibly interrelated interpretations as to why the contract was signed. Perhaps it was, as Hemming Johansson later recalled, Axel Hultman who had taken the initiative and

<sup>65</sup> Broberg, *Nya AB Autotelefon Betulander*, p. 68.

<sup>66</sup> "Den första automatiska telefonstationen i England," *Teknisk Bilaga Till Kungl. Telegrafstyrelsens Månads-Cirkulär för år 1912*, June 1912, p. 63.

<sup>67</sup> "Automatiska telefonstationer," *Teknisk Bilaga Till Kungl. Telegrafstyrelsens Månads-Cirkulär för år 1912*, November 1912, p. 102; and Epsom - the first automatic telephone exchange. <http://www.epsom.townpage.co.uk/telephon.htm>. Internetworks Ltd. Accessed 1999.

<sup>68</sup> Herman Rydin, 8 November 1912, 'Letter to 'le Secrétaire Général des Postes de la Grande-Bretagne', TALb; F I A:134.

<sup>69</sup> See excerpts from his memo 2 September 1911 cited on p. 149, especially those referring to notes 48 and 49.

<sup>70</sup> Contract, 16 April 1913, "Kontrakt Mellan Aktiebolaget L.M. Ericsson & Co, Stockholm och Telefondirektören C A Hultman (Avskrift)," (transcript of contract between LM Ericsson and Axel Hultman), TALb; F VIII E:2.

interested LM Ericsson in exploiting his ideas<sup>71</sup>, and maybe in this Hultman was motivated by a dissatisfaction at the lack of support he had received from his employer, the Telegraph Administration. On the other hand, he may have taken the step because he was spurred by the efforts to introduce automatic switching systems he had seen on his travels, or simply because he felt pressed to expedite a solution to the Administration's exchange in Stockholm. Perhaps he was motivated by something learned from Anton Avén's dispute with LM Ericsson concerning his patents for the call-distributing system. Or maybe it was LM Ericsson's representatives who sought to have an automatic switching system, after their failure two years earlier to finalise a contract with the German company Siemens & Halske on gaining rights to exploit their automatic system.<sup>72</sup> Or maybe the representatives of LM Ericsson simply wanted a closer contact with an influential engineer within the Telegraph Administration.

Thus several non-exclusive interpretations are possible. Fortunately, the most interesting thing about this contract is not the possible motivation behind it, but rather what it stated and how it affected the respective roles of LM Ericsson and Axel Hultman.

The main point of the contract was that Axel Hultman entitled LM Ericsson to use all future patents on "...an automatic telephone system invented by him."<sup>73</sup> However, this right was limited in one important respect:

The right to use the Swedish patents are solely valid for manufacturing made by Ericsson & Co for the Swedish State or for exports.<sup>74</sup>

In exchange for these rights, engineers at LM Ericsson would produce a model of this system under Axel Hultman's supervision. The company would furthermore fund the application for a German patent on the principles of the system. According to § IV of the contract, LM Ericsson had the possibility to renounce the contract within 10 months of the application being made, failing which LM Ericsson was obliged to apply for a similar patent in several other countries as well as applying for patents on four named

<sup>71</sup> Hemming Johansson, *Telefonminnen* (Stockholm: LM Ericsson, 1949), p. 87.

<sup>72</sup> Artur Attman, Jan Kuuse, and Ulf Olsson, *LM Ericsson 100 år: Pionjärtid, Kamp om koncessioner, Kris, 1876-1932* (Stockholm: LM Ericsson, 1977), pp. 147-148.

<sup>73</sup> Full § 1 (in Swedish): "Hultman överläter till Ericsson & Co på i detta kontrakt angivna villkor och med det i andra stycket av denna punkt angivna underlag ensam och uteslutande nyttjanderätt till alla de patent, som av Hultman kunna förvärfvas på ett af honom uppfunnet automatiskt telefonsystem med alla de förbättringar eller modifikationer af detta system, som framdeles kunna göras och patenteras av Hultman. Nyttjanderätten till de Svenska patenten gäller blott för sådan tillverkning, som Ericsson & Co utför för Svenska statens räkning eller för export till utlandet." Contract, 16 April 1913, "Kontrakt Mellan Aktiebolaget L.M. Ericsson & Co, Stockholm och Telefondirektören C A Hultman (Avskrift)," (transcript of contract between LM Ericsson and Axel Hultman), TALb; F VIII E:2.

<sup>74</sup> For original sentence, see last sentence of previous note.

designs invented by Hultman. LM Ericsson was moreover obliged to pay a royalty to Hultman whenever they sold switching equipment based on his patents:

For the rights which Ericsson & Co has been given in this contract, Ericsson & Co shall every six months make payment a royalty to Axel Hultman of ten /10/ per cent of the payment received by Ericsson & Co for exchange equipment whose design uses one or some of Hultman's patents in force, and if no other agreement is made between Ericsson & Co and Hultman in special cases.<sup>75</sup>

However, this royalty depended on the patents being granted. In the event they were not, LM Ericsson was nevertheless obliged to make a payment to Hultman.<sup>76</sup> This payment was set as 1 per cent on the investment cost for switching equipment based on his designs for the first five years after the contract and 1/2 per cent for the following five years. The contract also contained a special clause defining the conditions under which the system should be considered to be working in practice, an outcome which would grant Hultman an advance on future royalties on top of the royalties paid for the specific telephone exchange involved. The primary condition for this advance was that one exchange with at least 5,000 subscribers should have been in operation in at least one year and the purchaser should be satisfied with it. Moreover, for the advance to be paid, the exchange in question should show that "...Hultman's system was more reliable and not more expensive than other manufacturer's automatic telephone systems then in operation"<sup>77</sup> Finally, LM Ericsson had the option at all times to withdraw from the contract by giving one year's notice, in which case it lost all associated rights and obligations.

The contract stipulated, as business agreements often do, how the two parties should act in certain defined circumstances. For instance, according to § XIV, Hultman was obliged to prosecute any infringements of the future patents included in the contract and according to § I LM Ericsson was obliged not to sell equipment based on

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<sup>75</sup> § VII, Original paragraph (in Swedish): "För den rätt, Ericsson & Co tillförsäkrats genom detta kontrakt, skall Ericsson & Co till Hultman erlägga en halfårsvis utgående royalty af tio /10/ procent å af Ericsson & Co erhållen betalning för stationsanläggningar, för vilkas utförande något eller några af Hultmans i kraft varande patent tagits i anspråk, så framt ej för särskilda fall annat aftal träffats mellan Ericsson & Co och Hultman."

<sup>76</sup> Ibid., § XII.

<sup>77</sup> Full paragraph (in Swedish): "Sedan en station på minst femtusen /5000/ abonnenter blifvit utförd och varit i bruk under ett år till beställarens belåtenhet samt det härvid visat sig att Hultmans system är säkrare och icke dyrare än då i bruk varande, av andra telefonfirmor utförda automatiska telefonsystem, skall Ericsson & Co till Hultman förutom royalty för ifrågavarande anläggning erlägga ett förskott å kommande royalty med samma belopp, som den för ifrågavarande anläggning utgående royaltyn, dock högst femtiotusen kronor. Återbetalning af detta förskott sker på sådant sätt att Ericsson & Co af därefter förfallen, Hultman tillkommande royalty innehåller hälften, tills det erlagda förskottet är betalat. Någon ränta å nämnda förskott må ej beräknas av Ericsson & Co, ej heller kan Ericsson & Co fordra återbetalning däraf i annan ordning än här är nämnd." Ibid., § X.

these future patents to anyone in Sweden except the Swedish State. The contract actually provided a basis for profoundly redefining the roles of LM Ericsson and Axel Hultman. Axel Hultman to my knowledge had no previous private contractual relationship of this kind with the company as a private person. Later Hemming Johansson would recall how he and Axel Hultman contended for the same position as engineer at LM Ericsson in 1898, a position that Hemming Johansson succeeded in getting.<sup>78</sup> Hemming Johansson later also recalled that after visiting the Ashtabula plant in 1909 he had advised Hultman to do likewise. This was before Axel Hultman and Herman Olson had gone to see the plant in 1910.<sup>79</sup> But this kind of contract was something new, and even something peculiar given the situation within and between Swedish telecommunications organisations.

The Telegraph Administration's largest supplier of telephone equipment was at the time not LM Ericsson, but the Administration's own factory.<sup>80</sup> In fact, LM Ericsson was, as mentioned in the previous chapter, closely related to the Administration's competitor in Stockholm, Stockholm Telephone. The parent company of Stockholm Telephone, SAT, owned approximately a quarter of LM Ericsson and SAT, together with its telephone operating subsidiaries, was a much larger customer of LM Ericsson than the Telegraph Administration.<sup>81</sup> Moreover, SAT and LM Ericsson had operated a telephone network in Mexico in a joint venture since 1907.<sup>82</sup> Both Axel Hultman and the representatives of LM Ericsson signing the contract must have had full cognisance of the intricacies of the situation. Those signing the contract on behalf of LM Ericsson were even personally involved with SAT's operations. Wilhelm Montelius, the chairman of LM Ericsson since 1901, had been a member of SAT's board since 1883, a member of the board of Stockholm Telephone since its creation in 1908, and both he

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<sup>78</sup> Johansson, *Telefonminnen*, pp. 38-41.

<sup>79</sup> Johansson, *Telefonminnen*, p. 86.

<sup>80</sup> The total value of equipment delivered to the Telegraph Administration from its own factory was in 1913 about 2.2 million kronor. See Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 403.

<sup>81</sup> In 1913 SAT for its Stockholm, Warsaw and Moscow operations purchased equipment from LM Ericsson's Stockholm factory for 943 thousand kronor. On top of this SAT purchased equipment for its Moscow operations directly from LM Ericsson's factory in St Petersburg. The Telegraph Administration in the same year purchased equipment for 443 thousand kronor, which is almost the same amount as what SAT purchased from LM Ericsson for its Stockholm network. See, Attman, Kuuse, and Olsson, pp. 153-157.

<sup>82</sup> The planning for this operation had begun in 1904, and in 1905 a syndicate had been established where LM Ericsson had put in 60%, SAT 20% and Marcus Wallenberg the last 20%. The network had begun to operate in 1907, and in 1909 the network and the concession had been transferred to a new company, Mexeric, which was owned by the participants of the syndicate in similar proportions to their proportions in the syndicate. See, Attman, Kuuse, and Olsson, pp. 183-190.

and Hemming Johansson were members of the board of Mexeric, the joint venture in Mexico.<sup>83</sup>

The contract is in itself high profile from the point of Hultman's professional position and his earlier work on automatic switching devices within the Administration. With this contract his efforts to develop an automatic switching system acquired private financial stakes. The clause restricting LM Ericsson's use of the Swedish patents is in itself perhaps not surprising given Axel Hultman's professional position, but is the more high-profile given the salient relationships between LM Ericsson and SAT.

Thus, in making efforts, the contract had to consider and reflect the prevailing organisation of telephone services provision in Stockholm. The characteristics of Axel Hultman and LM Ericsson were by the same token somewhat redefined. Indeed, the contract gave Axel Hultman the character of being an actor with private financial interests. This new character was moreover somewhat apart from his character of being the Telegraph Administration's telephone director in Stockholm. This dual-type character of Axel Hultman would later serve the efforts to produce a new automatic switching system rather well, as will be seen in what follows.

The contract also enabled a profound transformation of the system Hultman had been working on. Years later Hemming Johansson stated that when a collaboration was first proposed early in 1913, Axel Hultman's inventions had not yet acquired any visible shape, not even on paper, although Hultman had claimed that they were already finished in his head.<sup>84</sup> The contract had to endow the system with a character apart. The system was referred to as having principles possible to patent as well as containing named devices also possible to patent. The system had acquired, by virtue of the contract, the possibility of translating itself into money for both LM Ericsson and Axel Hultman, and the contract regulated how these potential streams of money should be divided between them. Paragraph X, where the payment of an advance was regulated, even bestowed the system with a regulatory role: if a telephone exchange with a switch of that system under specified conditions produced specified results, Axel Hultman would get an advance on future royalties. We cannot know whether it was the specific ideas of a system that caused the high-profile contract to be written, but we can see that through the contract these ideas were given the potential of becoming much more than just ideas. This was an extraordinary feat. In June the next step was taken when a patent on the principle of using a bare wire multiple in the selector was applied for in Germany.<sup>85</sup>

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<sup>83</sup> Johansson, *Telefonaktiebolaget LM Ericsson*, pp. 188, 332.

<sup>84</sup> Johansson, *Telefonminnen*, p. 87.

<sup>85</sup> Johansson, *Telefonaktiebolaget LM Ericsson*, p. 311.

### Uninterrupted efforts within the Telegraph Administration

Designs, tests and investigations for extracting an appropriate automatic telephone system for the exchanges in Stockholm and Gothenburg have gone on uninterrupted during the year.<sup>86</sup>

Official account for 1913.

The investigative efforts and discussions as to how the future exchanges in Stockholm and Gothenburg should look continued within the Telegraph Administration. The technical department also continued to work towards developing an automatic switching system during 1913, in spite of Axel Hultman's new alliance with LM Ericsson. The book of official statistics for 1913 described the work within the technical department as going on uninterrupted. The brief account of this work for 1913 also contained a significant change in the format for describing the efforts to extract a new system for the exchanges in Stockholm and Gothenburg. Whereas the work in the account for 1912 had been classified as aiming at extracting *the most suitable telephone system*, the efforts for 1913 restated the aim as extracting *an appropriate automatic telephone system*.<sup>87</sup> Thus recommendations stressing the appropriateness of automatic systems for large local networks undoubtedly seem to have won sympathy within the Telegraph Administration. In other words, at this time the notion of the most suitable switching system for Stockholm and Gothenburg was translated into an automatic system.

Interestingly enough, the use of the classification *main* exchange disappeared at the same time as the concept of an automatic telephone system entered into the official account. The arrangement of a main exchange and sub-exchanges all using manual switchboards was evidently subtracted from the argument on future systems. This was more or less what Axel Hultman had argued in his 1911 memo, but now these arguments began to imprint themselves on the brief official accounts of work being done within the Telegraph Administration.

One event towards this restatement was a meeting held late in May 1913. First on the agenda was the question of manual multiple switches or automatic switches.<sup>88</sup> Among the summoned were the head of the technical department Karl Erik Landström, the telephone director in Gothenburg Erik Ekeberg, the head of the Administration's factory Klas Weman (1872-1966), the telephone director in Stockholm Axel Hultman

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<sup>86</sup> Original sentence (in Swedish): "Konstruktioner, prov och undersökningar för utvinnande av lämpligt automatiskt telefonsystem för stationerna i Stockholm och Göteborg hava under året oavlåtliga fortgått." Telegrafstyrelsen, *Telefon och telegraf, 1913*, p. 66.

<sup>87</sup> Confer the quote from the official statistics for 1912 on page 144 above.

<sup>88</sup> n.a., n.d., "P.M.," (Memo, Several names and the date: 1913 May 26 hand-written on it), TALb; F I A:351.

and Herman Olson from the technical department. Herman Olson had prepared a memo for this meeting entitled ‘a few words about semi-automatic telephone systems.’<sup>89</sup> In it he approved of the view that automatic systems became necessary when the local network became large:

[Manual] multiple systems are forced out by automatic systems as soon as it concerns larger main-office areas (about 25,000 and above) since the former first and foremost requires a single exchange. If several exchanges are needed a large share of the calls have to be handled by two operators and the switching costs become high.<sup>90</sup>

He thus affirmed, as others had before him, that it was the issue of trunking within the large local network that translated into the necessity to go automatic. However, the figure of 25,000 subscribers quoted by Herman Olson was a little higher than the number Axel Hultman had given in 1911 as the size above which one should choose automatic or semi-automatic switches. Herman Olson briefly justified his number as the limit of a ‘practical multiple,’ but it is difficult to discern what had provoked the rise of this number. Perhaps he simply wanted to produce a more conservative estimate of limits of the manual system. Anyhow, the rise in this number mattered little when it came to discussing the Administration's network in Stockholm. The number of 25,000 coincided rather well with the number of subscribers within the Administration's Stockholm network, and it was only a few years earlier the Administration had erected its second exchange within the city. Herman Olson was hardly ignorant of these circumstances, and he consequently argued a move towards an automatic system for Stockholm and Gothenburg.

Strangely enough, he made no reference to Stockholm Telephone where another system had recently been chosen for its much larger network. The manual system with automatic call distribution only figured in an outline he had prepared over different possible systems to further the discussion. Of these diverse systems, he argued that the best system for Stockholm and Gothenburg was probably a semi-automatic system that could be converted later to become fully automatic, cf. Table on next page.

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<sup>89</sup> n.a., n.d., “Några ord om halvautomatiska telefonsystem,” (This memo is referred to as Olson's memo on the agenda for the meeting 26 May 1913, see previous note), TALb; F I A:351.

<sup>90</sup> Original quote (in Swedish): “Multipelsystem utträngas av de automatiska systemen så snart det är fråga om större centraler (cirka 25.000 och däröver) därför att de förra helst fordra en enda central. Behövas flere centraler måste en stor del samtal handläggas av två telefonister och expeditionskostnaden blir hög.” Ibid.

Table V-3 Herman Olson's outline of different contemporary telephone systems.<sup>91</sup>

Multiple switches		
<b>A. Fully manual switching with cords and jacks</b> 1) Cord pair system  2) Single cord system 3) Manual call-distributing system	<b>B. Manual switching with cords and jacks and to that electromechanical supporting devices.</b> 1) Cord pair system with automatic call on desired subscriber's line. 2) Automatic call-distributing system. 3) Automatic call-distributing system with automatic call on desired subscriber's line. 4) Automatic call-distributing system with electromagnetically marked engaged test and automatic call.	
Automatic switches		
<b>A. Fully automatic systems, that is, systems where the subscriber makes his or her own provision for making the desired connection with devices of one kind or another by the telephone. The subscriber has moreover to listen for engaged test and ringing. The disconnection of the call depends on the subscriber.</b>	<b>B. Semi-automatic systems are systems where an operator manages electromagnetic switching devices on request from the subscriber.</b> a) Semi-automatic systems intentionally designed to remain semi-automatic and therefore hardly convertible to fully automatic operation. b) Convertible systems which can entirely or partly become fully automatic.	<b>C. Mixed fully and semi-automatic system. Such a system can at start up be arranged as semi-automatic and the subscribers' lines can be transferred in groups from semi- to fully automatic operation when deemed appropriate.</b>

Automatic switches were a necessity for large local networks. This was increasingly becoming a certainty that needed only a brief justification. But the concept of automatic switches was, as Herman Olson's outline already depicts, far from being as stable and self-evident as was for instance the cord pair system. The discussion in his memo further underlines how indefinite the concept still was. Automatic switches was the solution for large local networks, but what characteristics did this solution have? What demands should such a system be able to fulfil, and what were the choices?

Among the demands, Herman Olson firstly stressed that the convertible semi-automatic system should allow for continued use of telephone sets with local batteries during the transition period.<sup>92</sup> The system had moreover to be able to "...accommodate larger and smaller sub-exchanges (manual and automatic) situated within the city."<sup>93</sup> For incoming calls to subscribers having several subscriber's lines and using nominal call, the system should be able to automatically find and select an available line.

<sup>91</sup> Ibid. pp. I-II. Original table in Swedish.

<sup>92</sup> Ibid. p. 2.

<sup>93</sup> Full sentence (in Swedish): "Systemet måste kunna upptaga större och mindre växelstationer (manuella och automatiska) belägna inom staden." Ibid.

Herman Olson not only fixed the requirements. He also defined a manifold of choices he affirmed had to be made. One such issue concerned what part the subscriber should play in restoring the connected selectors after having finished a call in a semi-automatic system. When making a call it was inevitable with such a system, Olson declared, that the subscriber had to observe a signal to him or herself when the desired number was busy and another signal when the number was called. This, he noted, necessarily had to differ from the usual practice in manual multiple systems where the operator made the busy test. But should one or both subscribers disengage the selectors and their lines after a call? If one subscriber could do this by restoring the handset, calls could be prematurely terminated by accident. Another solution was to restore the selectors and disengage the subscribers' lines only when both subscribers had hung up. But according to Herman Olson this solution was not without its specific problems:

In that way there is no risk of involuntary disconnection, but one of the subscribers could by that [arrangement] shut the other out from the main exchange. It is hard to say whether the subscribers will make use of this possibility or not.<sup>94</sup>

A third possibility was to involve the operator. In this arrangement the operator had to observe the clearing signal for each conversing party, a procedure which according to Olson was completely analogous to the procedure in a manual CB-system. Each of the conversing parties taking part in a call was represented by a lamp arranged in pairs, one pair for each ongoing call. The operator then disengaged the selectors upon observing both lamps giving the clearing signal, that is, when both parties in a call hung up. Whereas an operator in a manual CB-system checked up to 17 ongoing calls, in a semi-automatic system he estimated that this figure would rise to at least 30 ongoing calls, since each operator in a semi-automatic system on average switched 400 calls per hour.<sup>95</sup> This meant that each operator's position had to be furnished with at least 30 pairs of lamps and corresponding push-buttons for disengaging the selectors.

Another problem concerning the operators' positions was whether each should contain one or several sets of keys as well as how the operator should start the selectors after having typed the desired number. Herman Olson maintained that special automatic help devices were needed if a single set of keys was preferred.<sup>96</sup> These devices would then set up the selectors and hence rapidly release the key set for disposing another call.

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<sup>94</sup> Original sentence (in Swedish): "Därigenom blir risken av ofrivillig nerkoppling ingen, men den ene abonnenten kan därigenom utestänga den andra från centralstationen. Huruvida denna möjlighet skall av abonnenterna användas eller ej är svårt att säga." *Ibid.* p. 9.

<sup>95</sup> *Ibid.* pp. 9-10. Herman Olson did not provide the calculations behind this statement, if indeed there were any.

<sup>96</sup> *Ibid.* p. 10.

If, on the other hand, two or three key sets were used, each key set could be engaged during the six to eight seconds it took for the selectors to connect the call. A related issue was whether it was desirable to have a special push-button for starting the work of the selectors or if the selectors should begin their work directly when the last digit had been chosen.<sup>97</sup> He did not settle if this possibility was desirable or not. He was just slightly more certain when turning to the control over the operator, call metering, and other such matters. These, he argued, could be arranged "...analogous with what already exists at multiple systems with central battery if this is considered sufficient."<sup>98</sup>

Another important issue advanced by Olson was the issue of how the calling subscribers should be distributed among the operators. Each operator's position could either be given a designated group of subscribers or the incoming calls could be distributed to them using a principle of call distribution. This was, he noted, an issue where the viewpoints were rather similar to those considered when choosing between the cord pair system and the call-distributing system. He did not propose which solution one should opt for, but noted that they probably implied different needs when it came to grouping the subscribers to balance the load of incoming calls. A wired distribution frame was perhaps not needed when using call distribution, but according to him one could not do without such a frame if call distribution was not used.<sup>99</sup> The distribution frame was simply needed for wiring together groups of subscribers, with the view of obtaining groups containing a mixture of subscribers making many calls and subscribers making only a few calls.

Herman Olson finally discussed a whole range of issues concerning how a semi-automatic system should work together with inter-urban exchanges. Without dwelling too much on these rather complex matters, a few things are worthwhile noting. Most long-distance calls were first ordered, to be established later when the desired inter-urban line was available for that call. With a semi-automatic system, the ordering of calls could be arranged rather similarly to how it was arranged with manual exchanges.<sup>100</sup> The major part of the problems discussed concerned how one should establish the inter-urban calls. Should the subscribers' lines be available in a special multiple or should designated automatic selectors be used?<sup>101</sup> Since the establishment of an inter-urban call should be able to interrupt any ongoing local calls, any selectors

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<sup>97</sup> Ibid. p. 11.

<sup>98</sup> Full sentence (in Swedish): "Kontrollen över telefonisterna, samtalsräkning o.d. kan ordnas analogt med den som redan finnes vid multipelsystem med centralbatteri om detta anses tillräckligt." Ibid. p. 12.

<sup>99</sup> Ibid. p. 12.

<sup>100</sup> Ibid. pp. 3-4.

<sup>101</sup> Ibid. p. 5.

had to fulfil a task somewhat different to selectors establishing local calls. Olson stressed that these designated selectors at the semi-automatic exchange had to establish a connection regardless as to whether a call was going on or not. Secondly, who should operate the selectors if this arrangement were to be used? He stated that the inter-urban operators could be given key sets to operate the selectors, but on the other hand this would clutter their positions. It was perhaps better, he concluded, that specific connection operators were used to aid the inter-urban operators to establish calls.<sup>102</sup>

To conclude, several characteristics of the desired semi-automatic exchange were handled as problems. There were still several unsettled issues on who should do what; what the switch should do, what the operator should do, and what the subscriber should do. However, the final two issues on the agenda for the meeting in late May 1913, indicate that there prevailed a sense of urgency to determine these things:

- 11) If a test-exchange first needs to be set up: how large, where, and so on?
- 12) In the meantime, what measure should immediately be taken at the exchanges in Stockholm and Gothenburg?<sup>103</sup>

Less than two weeks after this meeting, Axel Hultman and Herman Olson were in Antwerp to negotiate the purchase of a semi-automatic switch from Bell Telephone Manufacturing Co. The system in question had been developed within Bell's Western Electric in the US, but the work had soon been moved to its Belgian subsidiary, allegedly since the US Bell companies showed little interest in the system.<sup>104</sup> The rotary system, as it was labelled, used electrical motors for driving the selectors and was in this respect close to the Lorimer system. In fact, Western Electric had acquired the patents for the Lorimer system in exchange for a substantial amount of money, according to a story in *Telephone Engineer* in 1912.<sup>105</sup>

Anyhow, there had been contacts between the company and the Administration before the May meeting. But after the meeting in late May, things progressed rapidly. In early June Axel Hultman and Herman Olson were in Antwerp, staying at the Weber Grand Hotel. On 7 June 1913 a telegram was sent to the Administration's general director, Herman Rydin, asking for permission to immediately order the test-

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<sup>102</sup> Ibid. p. 6.

<sup>103</sup> Original quote (in Swedish): "11) Om en försöksstation först bör anordnas huru stor, varest m.m.? 12) Vilka åtgärder böra under tiden genast vidtagas å Stockholms och Göteborgs stationer?" n.a., n.d., P.M. (Several names and the date: 1913 May 26 handwritten on it), TALb; F I A:351.

<sup>104</sup> Charles A. Pleasance, *The Spirit of Independent Telephony* (Johnson City, Tennessee: Independent Telephone Books, 1989), pp. 134-135 and Christian Jacobæus, *LM Ericsson 100 år: Teletekniskt Skapande, 1876-1976* (Stockholm: LM Ericsson, 1977), p. 82.

<sup>105</sup> Pleasance, pp. 135.

exchange.<sup>106</sup> According to the telegram, the manufacturer agreed to have the exchange erected within 9 months, but requested on the other hand a guarantee that the Administration did not later manufacture switches of that system without the specific agreement of Bell Telephone Manufacturing Co. In a letter to the general director, Axel Hultman the same day reported that they had obtained what seemed to him to be good terms, and that "...Olson had got all his demands on the system fulfilled."<sup>107</sup>

Two days later Axel Hultman and Herman Olson signed a contract where the Swedish Telegraph Administration purchased a Western Electric semi-automatic telephone switch.<sup>108</sup> According to the contract, the exchange should initially be furnished with equipment for 800 lines, but should have the capacity to be extended to 2,000 lines. The exchange was to be erected in Landskrona in the south of Sweden, far from the large local networks in Stockholm and Gothenburg, and indeed of a size far from the size of 25,000 subscribers Herman Olson had stated as the upper practical limit for the manual multiple system. It was agreed that the exchange should be readily convertible to fully automatic operation. The exchange was to be in operation after 9 months and the manufacturer guaranteed "...the installation to give satisfactory and efficient service." Among the items included were '93 first line finders', '64 final switches of 200-line capacity' and '2 operator's positions including keys, registers, lamps, etc.' The number of switches was determined according to the contract as to handle a defined volume of traffic per subscriber line. However, all equipment was not to be delivered by the manufacturer. The Telegraph Administration agreed to deliver such items as the main and intermediate distribution frames as well as equipment for the power plant. The price for the switch was set to 100,000 BEF, and were to be paid 60 days after the completion of installation. The contract ended with a guarantee regulating the Administration's future manufacture and use of this system.

In consideration of the price quoted the Swedish Telephone & Telegraph Administration engages itself not to use nor manufacture the Western Electric machine switching system without first making an agreement satisfactory to the Bell Telephone Manufacturing Company.<sup>109</sup>

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<sup>106</sup> Wallin, 7 June 1913, 'Telegram to the general director of the Telegraph Administration,' TALb; F I A:351.

<sup>107</sup> Full sentence (in Swedish): "Olsson [sic] har fått alla sina fordringar å systemet uppfyllda och skall under Måndagen ytterligare gå igenom alla detaljer." Axel Hultman, 7 June 1913, 'letter to the general director of the Telegraph Administration (Written on stationary from Weber Grand Hotel in Antwerp),' TALb; F I A:351.

<sup>108</sup> Contract, 9 June 1913, 'transcript of contract signed by Herman Olson & Axel Hultman of the Swedish Telegraph Administration together with I.B. Christoffel representing Bell Telephone Manufacturing Co.' TALb; F IV A:19.

<sup>109</sup> Ibid.

Perhaps Axel Hultman and Herman Olson had sent out feelers to investigate whether the Administration's own factory could be allowed to produce equipment for switches of that system. Feelers or no feelers, the contract made clear that the company did not allow production given the price quoted.

Swedish efforts to develop automatic switching systems were at the same time underway, but none of these projects at that time were apparently deemed fit to deliver a switch for a test-exchange. The Administration had in the beginning of 1913 acquired a small 10-line automatic switch from the Betulander Company on which the technical department performed tests during the year.<sup>110</sup> Yet that seems not to have been enough. The purchase of the switch for a test-exchange in Landskrona displays a sense of impatience for gaining first hand long time experience of an automatic switch in operation.

The order of a switch of the Western Electric rotary system did not put an end to the efforts within the Administration's technical department to develop an automatic switching system of its own. Nor did it end Axel Hultman's or GA Betulander's efforts. In October 1913 Herman Olson asked to be allowed to equip an experimental workshop in the Jeriko premises, and to employ an instrument-maker named David Lienzén (1877-1938).<sup>111</sup> David Lienzén had previously worked at the Administration's factory, but had left for a position at the experimental department at LM Ericsson when the Administration's factory had moved to Nynäshamn earlier in the year. Karl Erik Landström gave his consent, and David Lienzén started at the new workshop in December.<sup>112</sup>

Unlike GA Betulander and Axel Hultman, Herman Olson continued to make efforts to develop an automatic system within the Administration. Unlike Axel Hultman, he was employed to work on such things at the technical department and he stayed on.<sup>113</sup> No traces of the work at the workshop have been retrieved, but the official report for 1914 affirmed that work was 'eagerly' carried out:

The ongoing investigations, tests and design-work to extract an appropriate automatic telephone system for the exchanges in Stockholm and

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<sup>110</sup> Telegrafstyrelsen, *Telefon och telegraf, 1913*, p. 67.

<sup>111</sup> Herman Olson, 6 October 1913, "Till Chefen för Kungl. Telegrafstyrelsens Linjebyrå," (To the head of the technical department of the Telegraph Administration), TALb; F I A:341.

<sup>112</sup> Karl Erik Landström, 7 October 1913, "Till linjeingenjören H Olson," (to the lines engineer H Olson) an excerpt from minutes 15 January 1914. Both, TALb; F I A:341.

<sup>113</sup> Even if he had desired to emulate Axel Hultman and had sought external allies, he would probably have been hindered by conditions of his employment as an engineer at the technical department of the Administration.

Gothenburg have been carried out with all eagerness during the year.<sup>114</sup>  
The Telegraph Administration, official account for 1914.

**Neither cords nor jacks, but still operators, subscribers, and other necessary allies**

By 1914, a semi-automatic system was the appropriate kind of switching system for the Administration's large local networks in Stockholm and Gothenburg, since automatic systems did not make trunking as expensive as manual systems did. The fight between the call-distributing system and the cord pair system had, in line with Hultman's arguments of 1910, been succeeded by a confidence in the appropriateness of the semi-automatic system. Three Swedish projects to develop such systems were also underway, and all three had some sort of connection to the Telegraph Administration. The credibility of these projects rested in part on the confidence in the appropriateness of semi-automatic systems, and the support accorded these projects manifested the credibility of these projects. By 1914 Herman Olson had appealed for and received support from the Telegraph Administration. Axel Hultman had associated with LM Ericsson. GA Betulander had had his share of difficulties in securing support for his venture, but by 1914 finally had the support of Swedish financiers as well as the English Marconi Company.

The new confidence in semi-automatic systems within the Administration did not imply that the characteristics of such a system were determined. When the fight concerning the two manual systems had ceased around 1910, one set of issues had been displaced. But the strife towards a semi-automatic system introduced several new ones into the discussion within the Telegraph Administration. How many calls would an operator be able to switch in one hour without being overloaded? Axel Hultman had carried out tests with an operator at an experimental console to get one answer to this question. How should the incoming calls be distributed, to balance the load between the operators? Herman Olson stated that this required either the use the principle of call distribution or the employment of intermediate distribution frames distributing the subscribers. How many additional repairmen would be needed, and how would that number compare to the number of operators saved? Axel Hultman produced estimates and calculations to answer these questions. What control over the exchange should be entrusted to the subscribers, and what control should the operators have? Herman Olson maintained that the subscribers would now have to make the 'engaged test' themselves, that is, they had to determine whether the desired number was busy or not. But, he was

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<sup>114</sup> Original sentence (in Swedish): "De pågående undersökningarna, prov och konstruktionsarbetena för utvinande av lämpligt automatiskt telefonsystem för stationerna i Stockholm i Stockholm och Göteborg hava under året bedrivits med all iver." *Telegrafstyrelsen, Telefon och telegraf, 1914, Sveriges officiella statistik* (Stockholm, 1915), p. 65.

at a loss when it came to the question whether the subscribers should be entrusted with disengaging the selectors without the mediation of an operator. He asserted that the setting up of the selectors ought to be controlled by the operators for now. However, he stressed at the same time that a system should allow for full automatic operation, where the control over the selectors had to be entrusted to the subscribers. How should the operators be controlled as long as the system was semi-automatic? Herman Olson stated that perhaps this could be arranged in a manner similarly to the way it was arranged in manual CB-systems.

Returning to the three lines of efforts to develop systems, it is also clear that gaining credibility and support for developing a new switching system was not the same as having a credible system that could be erected to switch telephone calls. The ordering of a semi-automatic switch from Bell Telephone Manufacturing is in this respect interesting. This act must be understood as growing out of a sense of impatience for gaining more experience of such systems in practice. Previously, Axel Hultman, Herman Olson, and other engineers within the Administration had travelled far and near to discuss and visit automatic switching systems. With this purchase, semi-automatic switching equipment was to be domesticated and put into operation in Sweden. It is clear that the order of this switch was not viewed as a move in opposition to the progression of the Swedish projects to develop automatic switching systems. Axel Hultman and Herman Olson had both taken an active part in the purchase but it did not terminate support for the three projects.

By 1914 there was a network of actors participating in three projects to develop automatic switching systems. The projects were neither insulated from one another, nor were they insulated from the telephone situation in Stockholm. The latter point being made most explicit in the contract between Axel Hultman and LM Ericsson, where the latter's right to sell a future system was explicitly regulated. The efforts were moreover not insulated from international efforts, but were on the other hand not passive parts of undertakings abroad. The escalating efforts to have contact with foreign experiences, went parallel with an escalation of domestic efforts. Domesticating ideas on automatic switching were not made without effort, and the undertaking to purchase the rotary switch was but one such endeavour intended to bring the product of foreign efforts closer into the web.

In 1914, the state of these projects were characterised by two important things. Firstly, actors providing resources to the projects were coming into place. Moreover, these supporting relations were not identical for the three projects. In other words, the projects did not mobilise identical actors and were hence not uniformly situated in the techno-economic network of Swedish telephony. Secondly, there prevailed a whole set of unsettled issues regarding automatic switches, and the three projects were moreover

attempting settle these with somewhat different means. These projects were thus slowly taking shape, comprising such things as designers, instrument-makers, and workshops. Other pieces, such as stable design features, were still missing, however. What the projects represent is thus primarily the establishment of local distinctions between project 'contexts', and project 'contents'.<sup>115</sup> Yet, neither 'content' nor 'context' or the very distinction between them were fully stable for any of the projects as will be seen further on in this and the next chapter.

At about the same time as the projects had come into place, one possible international forum for having further discussions on automatic switching systems was closed. The third conference for state employed telegraph and telephone engineers had originally been scheduled for the Autumn 1913. When the Swedish Administration had declined to host it, apparently no other candidate was immediately elected. Later the conference was rescheduled to be held in Bern in the Autumn of 1914. But it seems that the outbreak of the war that Summer came between the engineers and the forum, a war which presumably also reduced the efforts in some places to develop and introduce automatic switches.<sup>116</sup> On this note, it is time to return to the local telephone networks in Stockholm and among other things to see how this war entered into the operations of the Telegraph Administration and Stockholm Telephone Company.

### **Translating the Great War into issues of Tariffs and Monopoly**

What follows in this and the subsequent section is an account of years marked by commotion and turmoil. Sweden was officially neutral in the war, but the war nevertheless penetrated well within the Swedish border in many ways. The unfolding war was gradually brought into the discussions and practices of Swedish telephony. The war was repeatedly referred to as a cause for such things as increasing prices and shortages of certain materials, increased telephone usage, higher wages and salaries as well as why the state budget needed to be increased. In this section the focus is on a tariff reform and its many transformations. In the next section the focus is on development projects as well as the simultaneous efforts to maintain a satisfactory service within the telephone networks in Stockholm.

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<sup>115</sup> On this notion of locally generated content/context distinctions, see Michel Callon and John Law, "On the Construction of Sociotechnical Networks: Content and Context Revisited," *Knowledge and Society* 8 (1989): 57-83, especially pp. 77-78.

<sup>116</sup> Chapuis claims in his history of telephone switching that "the 1910s were marked by an almost complete absence of any progress in telephone switching." Robert J. Chapuis, *100 Years of Telephone Switching (1878-1978), Part 1: Manual and Electromechanical Switching (1878-1960's)* (Amsterdam: North-Holland Publishing Company, 1982), p. 249. This claim appears too categorical, but nevertheless a sense of declining efforts.

### The making of a needy State budget

The telephone networks were not just something that engaged engineers, subscribers, accountants, mechanics and operators. In the Autumn of 1914 the Minister of Finance, Axel Vennersten (1863-1948), raised the issue as to whether the Telegraph Administration could deliver more money to a needy State budget. This question invoked an intense discussion full of nuances and was soon extended to include issues related to the national economy, fairness of tariffs as well as the telephone situation in Stockholm. But before delving into this discussion, a brief account of the major contemporary political controversies is warranted.

In the years preceding the war, Swedish politics had been dominated by a set of issues related to voting rights, social reform and defence appropriations.<sup>117</sup> The Conservative government headed by Arvid Lindman, the former general director of the Telegraph Administration, had been succeeded by a Liberal government headed by Karl Staaff after the elections in 1911. The latter government had begun to overview the armed forces with the view to weigh defence appropriations against needs for social political achievements.<sup>118</sup> The Staaff government had also postponed the construction of an armoured naval vessel ordered by the previous Conservative government. These actions had fuelled a strong pro-defence agitation, where among others many Conservatives demanded increased defence appropriations. 'Sweden needs a strong military defence to counter the Russian threat,' it had been argued in a pamphlet that had attracted much attention.<sup>119</sup> Pro-defence groups had also raised public subscriptions to build the naval vessel, and SAT had been among the many companies contributing.<sup>120</sup> The fierce controversy regarding the appropriate magnitude of defence appropriations had also become connected with the issues of social reform and further reform of voting rights. Social Democrats, together with many Liberals, regarded the armed forces as the protector of the prevailing social order, and they argued against a 'fortified poorhouse.'<sup>121</sup>

In February 1914 this political controversy had translated itself into a parliamentary crisis, after the King had argued in favour of a strong defence in a public

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<sup>117</sup> Lars-Arne Norborg, *Sveriges Historia under 1800- och 1900-talen: Svensk samhällsutveckling 1809-1986* (Stockholm: Esselte Studium AB, 1988), pp. 90-94, 178-180.

<sup>118</sup> Norborg, p. 179.

<sup>119</sup> The pamphlet 'A Word of Warning' (in Swedish: *Ett Varningsord*) by the Swedish explorer Sven Hedin was published in 1912. Stig Hadenius, *Swedish Politics During the 20th Century*, rev. ed. (Borås: The Swedish Institute, 1990), p. 17.

<sup>120</sup> According to Hemming Johansson, SAT had contributed 218.000 kronor in 1912 to a subscription for the building of the armoured naval vessel, Johansson, *Telefonaktiebolaget LM Ericsson*, p. 422.

<sup>121</sup> Hadenius, p. 18.

speech and repudiated the policy of the government in office.<sup>122</sup> This action went against the established constitutional practice where the King should show unity with the government in place. The Staaff government had subsequently resigned, and had been replaced by a ‘non-political’ government which nevertheless was clearly conservative. It was within this government that Axel Vennersten had become Minister of Finance and by the Spring he had already introduced several new Bills for new taxes as well as a State monopoly on tobacco. The outbreak of the war on the continent brought a somewhat larger political unity for increased defence appropriations, and it was in this setting the question was raised whether the Telegraph Administration could deliver more money to the state budget.

### **Rydin’s attempt to translate the tariff reform into a monopoly**

In November, the general director Herman Rydin discussed the issue of increasing the revenues at length in a confidential memo, presumably directed to those government officials working on the issue.<sup>123</sup> In this memo Rydin stressed that any increase in tariffs or indeed a telephone tax had to be proportional since a fixed increase would affect the small users too much. But, he affirmed, any increase in tariffs could not be made without a reconstruction of the tariffs, since the current tariffs were so “...dissimilar and unfairly distributed that a proportional increase of them would only further accentuate the already intolerable conditions.”<sup>124</sup> The regulation of the Administration’s tariffs had been on the agenda for several years. According to the Administration, the harmonisation of the Administration’s tariffs in different regions for a long time had been obstructed by the organisation of its bookkeeping as well as guarantees on maximum tariffs that it had given to subscribers when acquiring private networks.<sup>125</sup>

The government had already commissioned the Telegraph Administration in November 1911 to prepare a proposal on how the Administration’s tariffs might be regulated.<sup>126</sup> With a new organisation of the bookkeeping in place by 1911, Karl Erik Landström, Herman Rydin and others within the Administration had begun to

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<sup>122</sup> The address was made to a demonstration where farmers from all over the country marched to the Royal Palace. Hadenius, p. 18.

<sup>123</sup> Herman Rydin, 4 November 1914, “VPM: angående eventuell telefonskatt (Ytterst förtroligt),” (confidential memo regarding a possible telephone tax), TALb; F I A:26.

<sup>124</sup> Full sentence (in Swedish): “Dessa äro nämligen så olikformiga och orättvist fördelade, att en proportionell förhöjning av dem skulle endast ytterligare skärpa det redan nu olidliga förhållandet.” Ibid. p. 2.

<sup>125</sup> The bookkeeping had been considered inappropriate since it had not been organised to provide profitability measures and statistics for different parts of its operations, measures on which the preparation of a reform would have to depend.

<sup>126</sup> Telegrafstyrelsen, *Telefon och telegraf, 1911*, p. 50.

investigate how its tariffs could be reformed.<sup>127</sup> In the memo of November 1914, Herman Rydin stressed that the commissioned proposal was now reaching completion and should be used as a starting-point when discussing the possibility to increase the revenues of the Telegraph Administration.<sup>128</sup>

The original proposal was being prepared on the premise of creating a fair and uniform regulation of tariffs without increasing the overall revenue, but could easily be adjusted to generate a larger overall revenue, according to Herman Rydin. He also stressed that it would be wise to divide the now proposed increase between the yearly fees and the call fees. It was, in his opinion, important that "...through comparably low yearly fees afford the public the possibility to obtain a means of communication, which turns itself out to become a daily necessity."<sup>129</sup>

The preliminary proposal contained several components. The first component of the proposed reform was to divide the country into more uniformly sized charging zones, each having a rate-zone centre.<sup>130</sup> At present the maximum distance within which a subscriber could make a local call free of charge now varied greatly in different regions, from 5 km at some places up to 110 km in others. This was unfair to the subscribers, Rydin affirmed, and had also caused discontent. The present yearly fees were as diverse, and varied from 8 kronor to 100 kronor. The second component of the preliminary proposal was consequently to harmonise the yearly fees and conditions of the subscriptions. Herman Rydin contended that the only entirely rational basis for calculating the yearly tariffs would be to have a single very low yearly fee and call fees on every call.<sup>131</sup> Since this, according to him, was not appropriate from many points of view, the proposal was instead to introduce a scale of yearly fees where each kind of subscription allowed for a certain maximum number of calls free of charge within the subscriber's charging zone. This scale should be the same all over the country – rural and urban areas alike – and the adjusted proposal contained seven different yearly fees ranging from 40 kronor to 160 kronor.<sup>132</sup>

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<sup>127</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, pp. 95-96.

<sup>128</sup> Herman Rydin, 4 November 1914, "VPM: angående eventuell telefonskatt (Ytterst förtroligt)," (confidential memo regarding a possible telephone tax), TALb; F I A:26.

<sup>129</sup> Full sentence (in Swedish): "Att lägga den enbart på abonnemangen är icke tillrådligt, då man enligt min mening aldrig bör släppa ur sikte målet att genom jämförelsevis låg abonnemangavgift kunna i största möjliga utsträckning bereda allmänheten tillfälle att förskaffa sig ett kommunikationsmedel, som artar sig att bli ett dagligt behov." Ibid. p. 3.

<sup>130</sup> Ibid. pp. 5-6.

<sup>131</sup> Ibid. p. 7.

<sup>132</sup> In the original proposal being worked out, where the overall revenue was kept constant, the fees ranged from 40 kronor to 140 kronor. The number of local calls allowed free of charge was also decreased for every subscription in the adjusted preliminary proposal presented. Ibid. pp. 7-8.

The third component of the preliminary proposal concerned the inter-urban tariffs. The commission suggested that inter-urban fees should be set according to the distance as the crow flies rather than as now on the basis of the actual length of the lines.<sup>133</sup> Eleven distance-depending tariffs on inter-urban calls were now suggested.<sup>134</sup> In all, the adjusted preliminary proposal was estimated to generate an increase in income of about 2.3 million kronor.<sup>135</sup> This increase notwithstanding, Herman Rydin stressed that the adjusted tariffs would nevertheless still be lower than corresponding tariffs in other countries.<sup>136</sup>

There were obstacles to be overcome before fair and harmonised tariffs as well as increased revenues to the State could be achieved, however.<sup>137</sup> The major obstacle discussed in the memo was the existence of Stockholm Telephone. The other non-State networks could be omitted from the discussion, according to Rydin, but the large operators in Stockholm had to be considered. Herman Rydin affirmed that the proposed tariff reformation assumed an acquisition of the company's network in Stockholm. He further supposed that the company would be willing to agree on a reasonable compensation upon the prospect of a tax. He stressed that such an acquisition also was a desirable end in itself, since it would further increase revenues and eliminate losses incurred by duplicate investments:

This measure is moreover desirable in itself, since it would lead to a considerable gain for the State, partly through a substantial and increasing addition in income, partly indirectly through avoiding the loss to the national economy which now yearly strikes the resources of the country

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<sup>133</sup> The reason given for this change was firstly that the inter-urban network now had direct lines between most areas, and secondly because it would deem changes in tariffs unnecessary as new shorter lines were erected between different charging zones. *Ibid.* p. 10.

<sup>134</sup> The cheapest tariff would in this proposal be 0.20 krona for a three minute call over a distance of more than 15 but less than 45 km. This proposed scale contained an increase in tariffs for inter-urban calls over shorter distances than 540 km compared to the original proposal being worked out. However, the five tariffs for calls over greater distances were not altered. *Ibid.* pp. 12-13.

<sup>135</sup> *Ibid.* p. 10, 14.

<sup>136</sup> Comparative tables over yearly and inter-urban fees in a few other European countries were appended to substantiate this claim. The proposed yearly fees were compared with those in Denmark, which allegedly had lower yearly fees than other countries, see *Ibid.* 9. The proposed inter-urban fees for calls over different distances were compared with those of Denmark, England, France, Italy, Norway, Spain, Germany, Austria, Japan and US, see *Ibid.* pp. 13-14.

<sup>137</sup> One obstacle mentioned was regions where the Administration's telephone operations were made more costly through what Herman Rydin labelled as excessive claims to compensation for the use of land. Before a new legislation on expropriation had come into force, he stressed, this behaviour required the possibility to increase the usual yearly fees in such regions to compensate for the additional costs. *Ibid.* pp. 14-15.

through investments on the same place into two parallel telephone operations, of which one is utterly unnecessary.<sup>138</sup>

Further on in his memo he returned to the issue of an acquisition, and stressed that the acquired network probably would produce enough revenues already at the outset to pay a reasonable return on the purchase sum, given that the price was reasonable. In these calculations he considered among other things the elimination of the business tax that the company now paid and which State operated businesses were exempted from paying.<sup>139</sup> He furthermore stressed that the company had recently completed substantial investments into its local network where it had run wires into every apartment in Stockholm. This work, he continued, "...remained to be done within the Administration's network for an estimated cost of 400,000 kronor, a sum which could be saved if the State acquired the private network."<sup>140</sup> The properties where the company housed its sub-exchanges would also be useful, according to Herman Rydin, since the Administration would soon have need of such properties.

It was out of the question, Herman Rydin emphasised, to introduce a more fair and uniform tariff regulation, while "...retaining the, for all other subscribers, justly detestable exceptional conditions with no call fees within the Stockholm area or the so-called 70 km-zone."<sup>141</sup> He further stressed that it was also impossible to abolish the exceptional conditions within the Administration's Stockholm network, if Stockholm Telephone would be allowed to continue with its current tariffs and its practice of not charging inter-urban calls within the area. Otherwise the Administration would lose the expensively acquired circle of subscribers, and "...the millions invested in erecting the Stockholm network would eternally lie buried bearing no interest."<sup>142</sup>

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<sup>138</sup> Original sentence (in Swedish): "Denna åtgärd är för övrigt i sig själv eftersträvansvärd, enär densamma skulle medföra en betydlig vinst för staten, dels direkt genom ett inkomsttillskott, som, redan från början rätt avsevärt, skulle snart stiga, dels indirekt genom undvikande av den nationalekonomiska förlust, som nu årligen drabbar landets tillgångar genom nedläggande av kapital på samma plats i två parallella telefonaffärer, av vilken den ena är fullkomligt onödig." Ibid. p. 4.

<sup>139</sup> Ibid. p. 15-16.

<sup>140</sup> Full sentence (in Swedish): "För rikstelefonnätet återstår ännu sådant arbete för en kostnad av omkring 400.000 kronor, vilket belopp skulle inbesparas, om staten övertog det privata nätet." Ibid. p. 16.

<sup>141</sup> Full sentence (in Swedish): "Det är nämligen givet, att en reglering av telefonavgifterna inom rikstelefonnätet efter rättvisare och fullt likformiga principer icke kan genomföras med bibehållande av det för alla andra abonnenter med rätta förhatliga undantagsförhållandet med frihet från samtalsavgifter inom Stockholm och dess omnejd eller det så kallade 70-kilometers-området." Ibid. p. 17.

<sup>142</sup> Full sentence (in Swedish): "Telegrafverket skulle därigenom till stor del förlora en med stora kostnader så småningom förvärvat abonnentkrets, och de i anläggningen av Stockholmsnätet nedlagda miljonerna skulle ligga räntelöst begravda för eviga tider." Ibid. p. 17.

Although arguing forcefully in favour of such an acquisition, Herman Rydin also discussed a tax arrangement that involved the continued existence of Stockholm Telephone. The tax on the Administration should be issued as increased tariffs, according to Rydin, whereas a pure tax should be imposed on the company's yearly fees and call fees. This tax had to be adjusted, in the eventuality the company did not agree on a reasonable price for its network, "... in such a way so that the State's telephone operations within the shared area did not occupy a more disadvantageous position than the private company."<sup>143</sup> The now proposed increases in the Administration's yearly fees, implied according to Herman Rydin an increase in its average yearly fee by 17.15%. Hence the tax on the company's yearly fees should amount to at least the same percentage on the company's average yearly fee multiplied by its total number of subscribers. According to Herman Rydin, the distribution of this calculated aggregate tax among the different kinds of subscriptions then became an affair internal to the company.

The introduction of a tax on inter-urban calls within the network of Stockholm Telephone was somewhat more problematic.<sup>144</sup> The problem lay in the difficulty to obtain a check on the number of inter-urban calls made. He therefore suggested it to be more appropriate to convert the inter-urban tax to an additional tax on the yearly fees. This implied according to his estimates another 20.6% on the company's average yearly fee. Together with the tax on the yearly fee he estimated that the company should pay in total about 20 kronor per subscriber in telephone tax. Based on the number of subscribers within the company's network at the beginning of the year, this would render the State an income of about 1.3 million kronor.<sup>145</sup>

This confidential memo by Herman Rydin was drafted to show the Administration's position on raising the revenues. But as such, it was also contrived as a probe for testing the possibility of achieving government support for changing the telephone situation in Stockholm. In the memo, rather firm arguments on the necessity and benefits of an acquisition were juxtaposed with just as firm arguments on the

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<sup>143</sup> Full sentence (in Swedish): "Skulle mot förmodan Aktiebolaget Stockholmstelefon inför utsikten av en skatt icke låta nöja sig med den lösensumma, som kan anses vara skälig, så bör den skatt, som då måste påläggas dess rörelse, avvägas så, att statens telefonrörelse inom det gemensamma området icke intager en oförmånligare ställning än det privata bolagets." Ibid. p. 4.

<sup>144</sup> Herman Rydin maintained that the tax on each inter-urban call ought to be calculated using the Administration's new inter-urban tariffs. The tax payable on an inter-urban call would then be the difference between the Administration's tariff for this call and the corresponding calculated operating costs for this inter-urban traffic. This was, he stressed, not only the correct and fair way to do it, but also a main condition for introducing a general regulation of the telephone tariffs within Sweden. Ibid., p. 18.

<sup>145</sup> Ibid. p. 19.

necessity of putting a tax on the company's tariffs. However, the overall scenario contained in the memo was clear:

The Administration has nothing against generating more revenues to the State. But this requires the implementation of a tariff reform, which is also desirable out of fairness. The tariff reform, in its turn, requires the government to support the acquisition of the network of Stockholm Telephone or at the very least to impose a new tax on the company. The prospect of a new tax might actually facilitate an acquisition, which is also in the interest of the national economy.

The memo thus related the issue of a needy state budget to the issue of acquiring the network of Stockholm Telephone. Some arguments on the benefits of an acquisition are recognisable from arguments put forward by Administration officials on previous attempts to acquire the network. The most obvious reiteration was the argument that an acquisition would present national savings through eliminating the 'redundant duplication' of cables and lines.<sup>146</sup> However, the earlier often used argument that an acquisition would restore interconnection in Stockholm is absent in the memo. Indeed the so-called 'telephone issue' is replaced in the memo with an association between tariffs, the situation in Stockholm, and state revenues; an association that had been made previously in the motion by two members of parliament in 1913.<sup>147</sup>

In the acquisition attempts of 1901 and 1906 as well as in the barter agreement of 1904, the private company (then SAT) and the Telegraph Administration had previously agreed to efforts to interest the government and Parliament. This time the order was reversed. In this scenario it was attempted to make the company interested in agreeing to an acquisition through prior action by the government. In previous attempts the government had primarily been imputed as having the interest to resolve the so-called 'telephone issue' in Stockholm as well as having the interest to economise on national resources. This time, however, the government and its newly stated interest in acquiring more money was pivotal in the chain of translations attempted. It appears as it was no longer deemed necessary or even beneficial to impute the government as having the interest to restore interconnection.<sup>148</sup> This time, the attempted chain of translations focused on making the government act in its own interest in increasing revenue, in the

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<sup>146</sup> See especially the résumé of the official letter on the attempted acquisition of 1906 in the previous chapter, pp. 72ff.

<sup>147</sup> On the discussion in 1913, see pp. 145f above.

<sup>148</sup> Perhaps this line of translations was abolished, since it had not been strong enough in previous attempts. Or perhaps it was abolished since it might have evoked questions on the volume of revenues lost if subscribers with double subscriptions annulled one of them after a merger of the two Stockholm networks. The financial calculations presented in the attempted acquisition of 1906 were criticised on exactly this latter point.

interest of introducing fair and uniform tariffs all over Sweden, and in the interest of saving on national resources.

The memo thus did not introduce the question of revenues into an unaltered issue of acquisition with its arguments and actors. The attempted chain of translations in this scenario made the acquisition as a means to somewhat other ends. The actors involved in previous attempts at an acquisition may appear to be largely the same. However, the attempt to translate the needy state budget into an acquisition also meant somewhat altered definitions of the interests of involved actors.

### **Wincrantz' resistance to the scenario and Rydin's reply**

For a scenario to succeed, the attempted chain of means to ends translations must hold. Other challenging definitions of actors' interests must be weakened, and the affirmed relationship tying the ends to the proposed means must be consolidated. As it turned out, the scenario became challenged from several different positions. In early December the managing director of Stockholm Telephone Karl Fredrik Wincrantz (1874-1932) presented a memo on the question of putting a tax on telephony.<sup>149</sup> In the memo he forcefully challenged large parts of Herman Rydin's proposal, and made it clear that the company would not silently accept the role given to it in Rydin's memo. He firstly asserted it was the State's business to manage a possible future tax on telephones:

If the State considers that the state finances give reason to employ a specific tax on the right to use telephones, it is naturally the State's business to debit and collect such a tax. The company cannot assume costs and responsibility for a levy of that sort.<sup>150</sup>

He stressed that the company had subscriber's contracts with a duration of five years. This made it impossible for the company to legally impose any additional charge on subscribers within the duration of their contracts. Most of the subscriber's contracts moreover contained a guarantee for making calls within the company's network without paying any call fees. An introduction of a tax on inter-urban calls amounted according to him to state interference into legally binding contracts and was absolutely against the general judicial conscience.<sup>151</sup>

But according to Karl Fredrik Wincrantz it was not only judicial conscience that spoke against the proposed construction of a tax. The physical network and the design

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<sup>149</sup> Karl Fredrik Wincrantz, 7 December 1914, "PM: angående ifrågasatt beskattning av telefoner," (memo regarding the considered telephone tax) TALb; F I A:26.

<sup>150</sup> Original sentences (in Swedish): "Om Staten anser att statsfinansiella skäl föreligga, att för rätten att begagna telefoner utgöres någon särskild skatt till Staten, är det naturligtvis Statens sak att debitera och inkassera sådan skatt. Bolaget kan ej åtaga sig kostnader och ansvarighet för dylik uppbörd." Ibid. p. 1.

<sup>151</sup> Ibid. p. 2.

of the company's exchanges made it difficult to impose a tax on inter-urban calls, since they were not geared to counting inter-urban calls:

At the construction of the new central battery exchanges in Stockholm the 2-conductor system has been used, which puts severe technical obstacles in the way of introducing efficient devices for counting inter-urban calls. The company therefore cannot at present perform any counting and debiting of those calls which are transmitted over its inter-urban lines.<sup>152</sup>

But, Wincrantz continued, there was even more to the question of a tax than a judicial conscience and technical problems: To the inhabitants in Stockholm a tax could also bring about a damage greater than the taxes collected.<sup>153</sup> He stressed that the company had been founded on the principle of providing cheap telephone subscriptions and this, together with limited state intervention, had led to the great extension of the network. And, he continued, it was in this way the network had "...obtained its real value not only to the company but above all to the subscribers."<sup>154</sup> According to Wincrantz, a tax making the cheap subscriptions dearer would undoubtedly reduce the number of subscribers and hence the value of the network for both the company and all subscribers. Following on this, he further stressed that the company employed about 2,000 people and that it already paid substantial local and state taxes. He thought it likely that the "...now proposed tax would inflict serious damage not only on the telephone company, but also on the Swedish telephone industry."<sup>155</sup> This, he continued, might have repercussions on both the company's ability to fulfil its financial obligations and on its large staff.

Karl Fredrik Wincrantz did not confine himself to raising objections against the tax as such, however. He also made two additional comments on how a tax should be arranged if a tax was to be introduced nevertheless. He firstly emphasised that it would be unacceptable to have a proportional tax on the yearly fees, since a tax set as a percentage would disadvantage the company. The tax should instead be set as a specific

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<sup>152</sup> Original sentences (in Swedish): "Vid byggandet af de nya centralbatteristationerna i Stockholm har 2-ledaresystemet tillämpats, hvilket lägger allvarliga tekniska hinder i vägen för införande af effektiva anordningar för räkning av inter-urbansamtal. Bolaget har därför för närvarande icke möjlighet att utföra någon räkning och debitering af de samtal, som föras öfver dess landsledning." Ibid. p. 3.

<sup>153</sup> Ibid. p. 4.

<sup>154</sup> Full sentence (in Swedish): "Genom denna stora spridning har telefonnätet också erhållit sitt egentliga värde icke enbart för bolaget utan framför allt för abonnenterna." Ibid. p. 3.

<sup>155</sup> Full sentence (in Swedish): "Det är alltför troligt att det nu framkastade skatteprojektet skulle komma att tillfoga icke blott Telefonbolaget utan äfven den svenska telefonindustrin en allvarlig skada, som i sin ordning skulle återverka såväl på bolagets möjlighet att uppfylla åtagna ekonomiska förbindelser som på dess stora personal." Ibid. p. 5.

amount for each kind of subscription.<sup>156</sup> He secondly emphasised that ‘fairness demanded’ the tax being arranged in the same way for both groups of subscribers: The increase in the Administration’s fees should also appear as a tax.

Yet all these objections did not stop Herman Rydin and his colleagues at the Telegraph Administration. In mid December officials at the Administration presented a somewhat modified proposal to representatives of Swedish commerce, industry and the media, apparently to test the ideas being worked out.<sup>157</sup> In a confidential memo of 31 December 1914, Rydin discussed how the taxes should be constructed for the private telephone operations.<sup>158</sup> The most important modification considered in December was to impose the tax on the yearly fees directly on the subscribers rather than on the company. By collecting this tax as a stamp duty, the proposal now avoided certain issues concerning the ‘legally binding’ contracts the company had with its subscribers. With a stamp duty, the company would only be obliged to verify that their subscribers had paid the necessary tax.<sup>159</sup> According to Rydin, this arrangement would not do when it came to the tax on inter-urban calls, however. Here, he affirmed, the only possibility was to impose a tax directly on the company.<sup>160</sup> The ideal was in his view to have a direct tax on each inter-urban call, but he affirmed that such an arrangement in practice would encounter too large difficulties and would moreover require detailed and costly control. He further suggested this tax to be gradually introduced over a period of five years.<sup>161</sup> In this way the arrangement would allow the company time to renegotiate all its contracts and allow the company to recoup the tax by introducing inter-urban fees.

However, the modifications stopped short when it came to discuss the issue of putting a tax on the Telegraph Administration. Herman Rydin insisted that it was unnecessary to complicate things, and brushed such demands aside by labelling them as

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<sup>156</sup> The reason given for this demand was that according to him the Administration applied too low yearly fees on the unlimited subscriptions. A proportional tax would further increase the difference between Administration’s and the company’s yearly fees for such subscriptions. *Ibid.* p. 4.

<sup>157</sup> According to an article by Karl Fredrik Winkrantz, the people gathered to discuss the Administration’s proposal belonged to the Royal Board of Commerce, the chambers of commerce, the Publishers’ Club (Publicistklubben), the Federation of Swedish Industry, the Swedish Bankers’ Association, and a Swedish federation of trade (Sveriges allmänna handelsförening). See Karl Fredrik Winkrantz, “I hvad mån innebär Telegrafstyrelsens nya taxeförslag en beskattning?,” *Ekonomisk Tidskrift* 17 (1915): 85-92, p. 85.

<sup>158</sup> Herman Rydin, 31 December 1914, “VPM: ang. skatt å de privata telefonnäten eller deras abonnenter (Förtroligt),” (confidential memo concerning a tax on the private telephone networks or their subscribers), TALb; F I A:26.

<sup>159</sup> *Ibid.* p. 8.

<sup>160</sup> *Ibid.* p. 12.

<sup>161</sup> *Ibid.* p. 13.

'psychological' and grounded on 'tax theoretical emotions.'<sup>162</sup> He further rejected the argument that a separation of tariff increase from tax was the only way to positively judge the profitability of the Telegraph Administration. If a tax was to be imposed on the Administration, according to him it should also be imposed on the inter-urban calls which in turn only would result in the painstaking task of accounting millions of minimal tax amounts. In the memo he also adhered to the earlier idea evinced that a tax imposed on Stockholm Telephone would make the company more prone to sell its operations in Stockholm, and thereby accomplish an arrangement which was in the interest of the national economy.

It should not be difficult to make the company more inclined to reach a reasonable agreement, upon the prospect of an especial tax imposed on the private network or its subscribers. Such an agreement would put an end to the present situation with parallel telephone networks which is so reprehensible from the point of view of the national economy.<sup>163</sup>

### Resistance on behalf of the national economy

This and previous references to the interests of the national economy makes the apparent scarcity of economists engaged in discussions regarding Swedish telephony conspicuous.<sup>164</sup> However, the proposed tariff reform and telephone tax made a graduate in law and member of The Swedish Economic Society step forward and speak on behalf

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<sup>162</sup> Ibid. pp. 9-11.

<sup>163</sup> Full sentence (in Swedish): "Förutom att detta vore oerhört oekonomiskt, skulle det just nu vara synnerligen oklokt, då det väl ej skulle vara så svårt att med utsikten av en skatt, speciellt lagd endast på privatnätet eller dess abonnenter, göra bolaget villigare att på hyggliga villkor träffa en överenskommelse, som gjorde slut på det nuvarande nationalekonomiskt förkastliga tillståndet med två jämsides gående telefonnät." Ibid. p. 3.

<sup>164</sup> The two major sources investigated are *Ekonomisk Tidskrift* (Economic Journal) and the proceedings from *Nationalekonomiska föreningen* (the Swedish Economic Society). The first issue of *Ekonomisk Tidskrift* was published in 1899. To get an overview over the issues discussed, I have used the index prepared in 1949 of articles published between 1899 and 1949. From 1899 up until and including 1914, the journal contained 446 signed articles (excluding reviews, and brief articles lacking indication of author). Of these, four articles had concerned telephone matters and especially matters on tariffs and profitability. All four had moreover been published in 1899 and 1900, and hence before the broken interconnection in Stockholm and the many subsequent attempts to resolve the 'telephone issue'. By comparison another emerging large communications system, the railway, appears in the title of five articles between 1899 and 1914. A count of words frequently used in the titles of articles indicates that matters related to agriculture, banks, currency, taxes, value, and work were more important in the discourse within economics. In fact, the morpheme "snaps" (Sw. brännvin) in words as snaps, snaps-monopoly, snaps-manufacturing, etc. occurs eight times between 1899 and 1914, whereas the morpheme "tele" occurred only in four words during the same period. A survey of the table of contents of the proceedings from the Swedish Economic Society provides an even greater absence of telephony. Of the 70 published talks and discussions published for the years 1900 through 1914, none concern telephony, whereas other fields of activity such as water, power and railroads appear on some occasions. See, *Ekonomisk Tidskrift, Ekonomisk tidskrift, register 1899-1949* (Stockholm: Almqvist & Wiksell, 1949) and *Nationalekonomiska Föreningen, Nationalekonomiska föreningens förhandlingar, 1900-1914* (Stockholm: 1901-1915).

of the national economy. Early in 1915 Malkolm Hamilton (1872-1918), published an article in *Ekonomisk Tidskrift* (Economic Journal) regarding the debated tax and tariff reform.<sup>165</sup> Interestingly enough, Hamilton stated already at the outset of his article that he abstained from considering the problems connected to the existence of the large non-state network in Stockholm. Instead he focused his discussion on the appropriateness of the proposed tariff reform and the subsequently proposed increase in the Administration's tariffs. Hamilton considered the tariff reform on the whole to be attractive, but he had nevertheless some important objections against the tariff levels proposed. On the proposed charges for inter-urban calls, he noted that the present profitability on the Administration's inter-urban traffic already surpassed the profitability on local traffic by far.<sup>166</sup> Indeed, he contended, the difference in profitability indicated in the Administration's statistics was understated due to a biased distribution of general costs upon the inter-urban and local operations.<sup>167</sup> This, he concluded, indicated that the charges for inter-urban calls ought to be decreased.

Hamilton's discussion became more extended when it came to the proposed yearly fees. He affirmed the indisputable soundness of the principle of having different yearly fees depending on how many local calls the subscriber was allowed to make free of charge. He even found it surprising that the Administration had not earlier introduced such a scheme outside Stockholm. The big question was what yearly fees one ought to have for different subscriptions. To resolve this question he assigned, as economists often do, monetary values on utility; in this case on the utility for making a call. He contended that it was against the interests of the national economy if subscribers abstained from making calls they valued more than the Administration's cost for completing the call only because it was priced above the subscriber's utility for that call. To illustrate this reasoning he gave the following example:

The Telegraph Administration's working expenses per call certainly do not exceed 0.01krona. If a subscriber, who for example pays 0.07 krona per call

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<sup>165</sup> Malkolm Hamilton, "Telefontariffreformen och Telefonbeskattningen," *Ekonomisk Tidskrift* 17 (1915): 49-73.

<sup>166</sup> According to the Administration's statistics for 1913 the inter-urban traffic gave interest of 14.19% on capital whereas the local traffic at the same time gave interest of 5.88% on capital. Ibid. 53.

<sup>167</sup> Several general costs were distributed upon the receipts for inter-urban and local operations on the basis of their level of revenue, according to Hamilton. From this followed, he contended, "... that the inter-urban network with its comparatively large level of revenue will carry a far too large proportion of these mentioned costs compared with the other lines of business." Original sentence (in Swedish): "Häraf följer, att inter-urbannätet med sin jämförelsevis höga inkomstsiffra kommer bära en alltför stor andel af nämnda kostnader jämfördt med de öfriga rörelsegrenarna." Ibid. p. 53. n. 1.

in yearly fees, abstains from making a call which for him has a value of 0.05 krona, there is apparently a loss to the national economy of 0.04 krona.<sup>168</sup>

Hamilton continued and calculated the price per local call by dividing the different proposed yearly fees with various numbers of calls.<sup>169</sup> From this, he concluded that subscribers paying low yearly fees after the tariff reform in effect had nevertheless to pay a substantially higher price per call than those paying a higher yearly fee. He further noted that the cost to the high volume subscribers of a single local call was increasingly below the postage for various kinds of mail. From this he concluded that the yearly fees for the low volume subscriptions ought to be even lower, whereas the yearly fees for the high volume subscriptions ought to be substantially increased. Moreover, the Administration's cheap 30 kronor subscription in Stockholm should be preserved.<sup>170</sup> He recognised that the proposed tariff reform was based on the Administration's fixed and variable costs for different kinds of subscriptions. But, he continued, it could not be regarded as 'rational' to not consider the subscribers' varying capability to pay the tariffs.

There are on the contrary strong grounds to lower the subscription fees for the smaller subscribers below the Telegraph Administration's calculated direct costs for them. This should on the other hand naturally not be done

<sup>168</sup> Original sentences (in Swedish): "Telegrafverkets driftkostnad per samtal öfverstiger säkerligen icke 1 öre. Om nu en abonnent, som exempelvis i abonnemang betalar 7 öre per samtal, afhåller sig från ett samtal, som för honom har 5 öres värde, göres tydligen en nationalekonomisk förlust om 4 öre." Ibid. p. 54.

<sup>169</sup> The table calculated by Hamilton on the basis of the proposed tariff reform (lacking the adjusted increase in overall revenues).

Subscription, yearly fee	Subscriber with	Subscription fee per call	
50 kronor	400 calls	0.125	krona
	500 calls	0.10	krona
	600 calls	0.083	krona
	700 calls	0.071	krona
	800 calls	0.063	krona
60 kronor	900 calls	0.056	krona
	1,000 calls	0.06	krona
	1,200 calls	0.05	krona
	1,500 calls	0.04	krona
	2,000 calls	0.03	krona
80 kronor	3,000 calls	0.02	krona
	4,000 calls	0.02	krona
	5,000 calls	0.016	krona
100 kronor	7,000 calls	0.014	krona
120 kronor	9,000 calls	0.013	krona
140 kronor	11,000 calls	0.013	krona

<sup>170</sup> He thought it to be the wrong way round, to first have introduced the low subscriptions without a corresponding increase of the fees for high volume subscriptions and to now consider a drop of the cheap subscription while raising the fees for high volume subscriptions. Ibid. p. 67. See also p. 141 above on the introduction of the 30 kronor subscription.

without a corresponding increase in the subscription fees for the larger subscribers above the Administration's costs for these subscribers.<sup>171</sup>

But why was the calculated direct cost of a particular kind of subscriptions not a good basis for pricing? By taking the subscribers' varying capability to pay into consideration, according to Hamilton more people would be enticed into subscribing to the telephone service. Hence, it would increase the size of the network. And, he continued, the addition of new subscribers was of value to all those who subscribed to the service.<sup>172</sup> It could not be ignored, he affirmed, that many subscribers, and in particular certain businessmen, valued it highly that as many subscribers as possible could call them.<sup>173</sup>

To illustrate this point, Hamilton presented a set of calculations where he estimated the economic consequences of a reduction of the lowest yearly fee.<sup>174</sup> The outcome of this exercise was a total gain for both new and old subscribers of 883,440 kronor, which was far above the calculated net loss of 450,830 kronor to the Telegraph Administration. The difference between the two, he concluded, was the considerable

<sup>171</sup> Original sentence (in Swedish): "Tvärt om föreligga starka skäl att sänka abonnemangen för de mindre abonnenterna under telegrafverkets beräknade direkta kostnader för dem, hvilket å andra sidan naturligtvis icke bör ske utan att i motsvarande mån höja abonnemangen för de större abonnenterna utöfver verkets kostnader för dem." Ibid. p. 58.

<sup>172</sup> Ibid. p. 59.

<sup>173</sup> This valuation was clearly demonstrated according to Hamilton by the additional charge many businessmen paid to receive a 'star subscription' (cf. p. 137 above) in the network of Stockholm Telephone. A 'star subscription' was 20 kronor more expensive than a subscription which was similar in other aspects, and Hamilton estimated that the company had receipts of about 200,000 kronor from this additional charge. Ibid. pp. 60-61.

<sup>174</sup> He estimated that a reduction of the lowest subscription fee by 14 kronor would result in about 12,200 new subscribers, and that each of them would receive as well as make 600 calls. By assigning a monetary net value to each of these calls, he then calculated that these would represent a gain for the old subscribers of 424,560 kronor. He further assumed that the old subscribers would value each incoming call from the new subscribers at 0.02 krona, and each call made to the new subscribers at 0.038 krona. He summarised his calculations in a table which is displayed below. Ibid. p. 62.

<i>Gain for the subscribers</i>	<i>Kronor</i>	<i>Loss for the state</i>	<i>Kronor</i>
Gain for <i>old</i> subscribers from increased possibility to make calls.		Loss at 16 kronor for 9,760 new subscribers	156,160
600 calls at 0.038 krona to 12,200 new subscribers	278,160	Loss at 14 kronor for 27,000 old with formerly a maximum of 600 calls + 1,420 old with more than 600 calls.	397,880
600 calls at 0.02 krona from the same subscribers	146,400	Gross loss	554,040
Lowered subscription fees at 14 kronor for <i>old</i> subscribers	397,880	Gain from 600 calls to new subscribers at 0.0141 krona per call	103,210
Total gain for <i>old</i> subscribers	822,440	Net loss	450,830
Gain from connection for <i>new</i> subscribers at 5 kronor	61,000	<b>Gain to the national economy</b>	<b>432,610</b>
	Total 883,440		Total 883,440

gain to the national economy that could be created with a reduction of the lowest subscription fees. The question was, of course, whether the Administration could compensate for the losses incurred from such a reduction by increasing the yearly fees for the high volume subscriptions. Hamilton was not altogether hopeful that the loss could be fully recovered, but maintained that the Administration nevertheless should set up 'star subscriptions' as well as consider having separate tariffs for business and household subscriptions.<sup>175</sup> He further added that telephony could, from an altogether economic viewpoint, be seen as such a publicly useful establishment that the State ought to contribute to its cost with funds from the state budget.<sup>176</sup> The development of telephony, he stressed, was promoted through "...keeping the technical and organisational arrangements for serving the public on a high level..." and "...through appropriate tariffs."<sup>177</sup> A tax on telephony would according to him undoubtedly hamper its development:

The proper exploitation of the telephone operations requires a management who are neither sparing with useful expenditures nor rushes to squeeze out the highest possible receipts from the traffic. From this also follows that a tax on telephony is highly disquieting, since it necessarily will put a drag on the development.<sup>178</sup>

Malkolm Hamilton had thus spoke on behalf of the national economy. As such, Hamilton had relayed a message rather different to the one Herman Rydin had conveyed when referring to the waste with having parallel telephone networks. Hamilton's message from the national economy did not strengthen the chain of translations attempted by the Administration. Indeed, without even considering the situation in Stockholm his message was that a tariff reform that strengthened the State budget would be against the interests of the national economy. To serve the interests of the national economy, the proposed tariff reform ought to be significantly altered and the idea to put a tax on telephony ought be abandoned.

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<sup>175</sup> Ibid. pp. 65-66.

<sup>176</sup> Ibid. p. 72.

<sup>177</sup> Ibid. p. 70.

<sup>178</sup> Full sentences (in Swedish): "Af ovanstående torde vara klart, att telefonväsendets behöriga utnyttjande kräfver en ledning, som icke knusslar med nyttiga utgifter eller brådstörtadt söker ur trafiken frampressa största möjliga inkomster. Därpå följer också, att telefonrörelsens beskattning är en mycket betänklig sak, då den med nödvändighet blir en hämsko på utvecklingen." Ibid.

### Resistance on behalf of sound business bookkeeping and profitability

Karl Fredrik Wincrantz from Stockholm Telephone put another perspective on the proposed tariff reform in another article in *Ekonomisk Tidskrift*.<sup>179</sup> Where Hamilton had spoken on behalf of the national economy, Wincrantz this time spoke with the voice of sound business bookkeeping and profitability.

In the article Wincrantz stressed that the proposed increase in the Administration's tariffs should not be considered as a tax, but rather as a necessary increase to cover the Administration's costs. He stressed that the Telegraph Administration employed accounting methods where it did not enter costs for regular depreciation of its investments into its books.<sup>180</sup> Instead, he informed, depreciations were only made when the Administration replaced old equipment and then these costs were accounted as ordinary maintenance costs. Together with the way the Administration calculated the profitability on its real estate, this heavily understated the Telegraph Administration's costs. He estimated that the proposed increase in the subscription fees actually only covered the present deficit in operations of the Administration's local telephone networks.<sup>181</sup> To this he added that the Telegraph Administration faced large investments in the approaching refurbishment of its local networks in Stockholm and Gothenburg to the CB-system, with or without automatic exchanges. The interest and instalments on these investments, he emphasised, would lay large claims on the Administration's profits.<sup>182</sup>

Where was the line distinguishing between the receipts the Administration had to make to be profitable and the tax? The Telegraph Administration, he answered, could "... not at present even distinguish in its bookkeeping between what is a depreciation and what is a maintenance cost."<sup>183</sup> He added that in the bookkeeping of the State Railways this distinction was already in place with a sinking-fund<sup>184</sup>, and that it was

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<sup>179</sup> Karl Fredrik Wincrantz, "I hvad mån innebär Telegrafstyrelsens nya taxeförslag en beskattning?," *Ekonomisk Tidskrift* 17 (1915): 85-92.

<sup>180</sup> Ibid. p. 87.

<sup>181</sup> Ibid. p. 89.

<sup>182</sup> Ibid. p. 91.

<sup>183</sup> Full sentence (in Swedish): "Telegrafverket kan för närvarande i sin bokföring icke ens skilja mellan hvad som är afskrifning och hvad som är driftkostnad." Ibid. p. 92.

<sup>184</sup> Ibid. p. 87. This practice had been introduced under the former general director of the State Railways, Fredrik Pegelow (1852-1925), who was the president of SAT since 1904 and of Stockholm Telephone since its creation in 1908. Pegelow had been the general director of the State Railways between 1907 and 1913, and had reportedly resigned partly due to a conflict with the Minister of Public Administration Axel Schotte, where Pegelow held a businesslike view on the operations of the State Railways and Schotte wanted to take social considerations into account.

necessary to introduce this distinction in the bookkeeping of the Telegraph Administration to uncover where the necessary receipts ended and the tax began.

### **The demise of Rydin's monopoly scenario and the rise and fall of new ones**

By Spring 1915 the scenario presented the previous Autumn was turning into a muddle. The attempt to forge a nice chain of translations between a needy state budget and the acquisition of the Stockholm Telephone's network was failing. While officials at the Telegraph Administration and government continued to prepare the proposed tax and tariff reform<sup>185</sup>, opposition to it mounted. Wincrantz of Stockholm Telephone continued to make it clear that the company did not accept the role given to it.<sup>186</sup> Wincrantz and Hamilton in journal articles had moreover torn apart the idea of connecting the tariff reform with a tax, albeit from two distinctly different points of view. Yet, this was not all. Subscribers, municipalities and business associations opposed the proposal and in particular the proposed new, and in many cases smaller, charging zones.<sup>187</sup>

The sad truth of an attempted chain of translations is that it does not require a coherent force of resistance to unmake it. All those necessary actors do not have to resist as one, and in this case they did not: Hamilton spoke on behalf of the national economy; Wincrantz interchangeably spoke on behalf of Stockholm Telephone, Swedish telephone industry, and sound business practices; still others spoke on behalf of municipalities and regions. It is impossible to say what broke the association between the needy state budget and the acquisition, but broken it was. Later that Spring the government decided instead to raise money by imposing a new excess profits tax.<sup>188</sup> Moreover, in June the government returned the issue to the Telegraph Administration, instructing it to revise a proposal for a tariff reform. People at the Telegraph Administration had to modify the tariff reform, and had to take into consideration over a hundred letters from different interests.<sup>189</sup>

The failure to impose a telephone tax on Stockholm Telephone also opened other possibilities for discussion. In the Summer 1915, Karl Fredrik Wincrantz approached officials at the Telegraph Administration and proposed a temporary arrangement to reduce competition which otherwise could harm both Stockholm Telephone and the

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<sup>185</sup> See, for instance, Otto Landén, 6 March 1915, "Förslag till förordning om telefonskatt," (proposed regulation of a telephone tax), TALb; F I A:26.

<sup>186</sup> Karl Fredrik Wincrantz, 19 March 1915, "Anteckningar rörande ifrågasatt beskattning af de enskilda telefonerna," (notes regarding the concerned telephone tax on the non-State telephones), TALb; F I A:26.

<sup>187</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, pp. 107-111.

<sup>188</sup> Ibid.

<sup>189</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, pp. 107-115.

Telegraph Administration.<sup>190</sup> His suggestion was that both should introduce the approaching tariff reform within the 70 km-zone, including fees on inter-urban calls. He further proposed the reintroduction of interconnection between the two networks at a 0.05 krona interconnection fee.<sup>191</sup> Wincrantz was of the opinion that such an arrangement would have advantages to the Telegraph Administration, to the company, and to the public.

It would make it possible for the Telegraph Administration to introduce the new tariff reform also within the 70 km-zone, and hence increase the revenues from the region and, in Wincrantz's view, the interconnection could also help to make the new tariffs more acceptable to the Administration's subscribers in Stockholm. For Stockholm Telephone, the proposed arrangement would imply higher revenues from its inter-urban lines as well as a reduced pressure to invest in additional inter-urban lines. Wincrantz finally stressed that the re-introduction of interconnection between the two networks would apply to all subscribers regardless of which service they subscribed to. There was a problem in that it would take five years before Stockholm Telephone could adhere to the proposed co-ordination of tariffs, but Wincrantz maintained that this should not stop the Telegraph Administration from introducing them within the 70 km-zone straight away.<sup>192</sup> He further affirmed that the opposition would be greater if they both introduced the new tariffs simultaneously.

Wincrantz' suggestions were greeted with interest at the Telegraph Administration, and a memo containing the suggestions and comments was sent to the Minister of Public Administration, Oscar von Sydow (1873-1936). It was nevertheless noted that it would be difficult to agree to introduce the new tariffs long before Stockholm Telephone. The memo concluded that it seemed that Wincrantz was pressed to increase the revenues of the company and secondly that he considered interconnection to be important.<sup>193</sup> The discussions subsequently continued. In the beginning of August, Wincrantz sent a letter to the head of the Administration's technical department, Karl Erik Landström, where Wincrantz reiterated and clarified his suggestions.<sup>194</sup> He had, for instance, explicit suggestions on how the interconnected traffic should be directed in different cases. He further suggested that the agreement

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<sup>190</sup> Notes from this meeting are reproduced in an unsigned memo from 6 July 1915. On the memo, it is noted that a copy of it had been handed to Oscar von Sydow, who had become the minister of public administration in February 1914. n.a., 6 July 1915, n.t. (concerning meeting with Wincrantz) TALb; F I A:26.

<sup>191</sup> *Ibid.* p. 1.

<sup>192</sup> *Ibid.* p. 2.

<sup>193</sup> *Ibid.*

<sup>194</sup> Karl Fredrik Wincrantz, 12 August 1915, 'Letter to Karl Erik Landström,' TALb; F I A:26.

should be in force for 30 years, after which it would be renewed for five years at the time. However, he emphasised that the essential prerequisite for reaching an agreement was that the Administration introduced 'financially sound' tariffs within the 70 km-zone, and tariffs which were the same as those it was preparing to introduce outside the zone.<sup>195</sup> At this point Axel Hultman became part of the discussion and a few days later he presented his views on the suggestions in a letter to Landström.<sup>196</sup> Hultman's stance towards the suggested agreement was one of suspicion:

It should be completely clear that an agreement between the Telegraph Administration and Stockholm Telephone will bring greater advantages to the latter than to the former Administration, in addition Stockholm Telephone will attempt, after the agreement, to invent all conceivable means to exploit the advantages gained by the agreement. The object is consequently to work out all the means from the agreement Stockholm Telephone will attempt to exploit, before this agreement is concluded.<sup>197</sup>

He accordingly urged that the agreement included a thorough harmonisation of all tariffs, fees and conditions so that each kind of subscription in the two networks should be entirely equivalent. On this theme he went so far as to demand that Stockholm Telephone was forbidden in the agreement to pay the interconnection fee for its subscribers.<sup>198</sup> He further urged that the charging zones were defined exactly the same in the two networks. He noted that it would take some time before the two networks could be interconnected, since new multiples had to be erected and the planned move of the inter-urban exchange to Jeriko had to be completed. On the arrangement of interconnection, he also stressed that calls should be interconnected to the receiving network as close as possible to the subscriber receiving the call.<sup>199</sup>

A few days later Karl Erik Landström sent his reply to Wincrantz.<sup>200</sup> There he followed Hultman's line, and urged that an agreement should include a complete harmonisation of all tariffs and conditions, and appended in confidence the latest edition of the revised scale of subscription fees being worked out within the

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<sup>195</sup> Ibid. p. 2.

<sup>196</sup> Axel Hultman, 16 August 1915, 'Letter to Karl Erik Landström,' TALb; FI A:26.

<sup>197</sup> Original sentences (in Swedish): "Det torde vara alldeles klart, att en uppgörelse mellan Riks och Stockholms telefon torde medföra större fördelar för den senare än för den förra förvaltningen, ävensom att Stockholmstelefon efter uppgörelsen kommer att söka uppfinna alla möjligt tänkbara utvägar för att utnyttja sina i följd av uppgörelsen vunna fördelar. Det gäller således, att innan denna uppgörelse avslutas försöka tänka ut alla de medel, som Sthlmtelefon på grund härav kan komma att söka använda sig utav." Ibid. p. 1.

<sup>198</sup> Ibid. Hand-written and signed addition on the back of the second page.

<sup>199</sup> Hence, Stockholm Telephone should not be allowed to use the Administration's inter-urban lines within the 70 km-zone for transmitting calls from its subscribers to subscribers in the Administration's network within the 70 km-zone. Ibid. p. 2.

<sup>200</sup> Karl Erik Landström, 21 August 1915, 'Letter to Karl Fredrik Wincrantz,' TALb; FI A:26.

Administration. Landström finally emphasised that an agreement rested upon Stockholm Telephone abolishing its five year subscription contracts.

This meant the end of this Summer's negotiations towards reducing competition through an agreement on interconnection and co-ordination of tariffs. Wincrantz affirmed that the company could not accept a complete harmonisation of tariffs, neither could he see any reason why the company should eliminate the five year subscription contracts.<sup>201</sup> He further noted that an increase in tariffs could not be made without the consent of the City Council in Stockholm, due to the contract on the use of city streets for running telephone cables. His idea, he concluded, had not been to achieve a complete end of competition, but rather to bring the two closer through making the Administration stop supplying cheap telephone subscriptions at a loss.

A month after this failure to reach an agreement on reducing competition, discussions on an acquisition of Stockholm Telephone's network re-emerged. In a letter to the president of both SAT and Stockholm Telephone, Fredrik Pegelow (1852-1925), Herman Rydin asked Pegelow to make investigations in preparation for discussions on an acquisition.<sup>202</sup> He had reason to believe, he added, that the government was not unwilling to submit such a proposal to Parliament, given that the price was right. The discussions on an acquisition continued during October and an acquisition contract was drafted, but it came to nothing.<sup>203</sup> It turned out the government was not as willing to consider an acquisition as Herman Rydin had maintained. The government declined to take the proposed contract to a Parliamentary working committee, as it did not dare to put forward a proposal that would further increase the state indebtedness.<sup>204</sup>

### **The realisation of a more limited tariff reform**

Notwithstanding the discussions between the management of the Telegraph Administration and Stockholm Telephone, people within the Administration concurrently continued to prepare a revised proposal for a tariff reform and in September their proposal was presented to the government.<sup>205</sup> This proposed reform was further altered during the Autumn and was accepted by the government late in November to come into force 1 January 1916. The new regulation contained fewer sets of subscriptions than the original proposal, and certain alterations had also been made to

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<sup>201</sup> Karl Fredrik Wincrantz, 21 August 1915, 'Letter to Karl Erik Landström,' TALb; F I A:26.

<sup>202</sup> Herman Rydin, 27 September 1915, 'Letter to Fredrik Pegelow,' TALb; F I A:26.

<sup>203</sup> n.a. (Stockholm Telephone), October 1915, 'Confidential draft of contract,' TALb; F I A:26.

<sup>204</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 214.

<sup>205</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, pp. 113-115.

definitions of the charging zones as well as the inter-urban fees.<sup>206</sup> Most importantly, however, was the fact that the Administration's operations within the 70 km-zone were exempted from the regulations.<sup>207</sup>

The tariff reform was not free of criticism after it came into force.<sup>208</sup> Much of the criticism from subscribers turned on how their yearly fees were set. The Telegraph Administration had opted for a different solution for the whole of the country, apart from Stockholm, to that practised in Stockholm by both the Administration itself and Stockholm Telephone. In Stockholm the subscribers chose what kind of subscription they desired, but outside Stockholm the tariff reform meant that the Administration decided what yearly fee each subscriber should pay depending on the number of local calls made. In practice this was done by intermittently measuring the number of local calls each subscriber made. The number of calls measured at such an instance was then extrapolated to the number of local calls the particular subscriber would make in a year, which provided the basis for deciding what yearly fee the subscribers should pay. This way of deciding the yearly fees was often contended by subscribers, who frequently maintained that the measurements were taken at a bad time while Administration officials maintained that they employed generous margins when establishing the yearly fees.<sup>209</sup>

As far as the Telegraph Administration was concerned, the debate on tariff reform, telephone tax, and defence appropriations had thus ended in a change much more modest than the one attempted. It had come down to an order in the shape of harmonised tariffs applied only outside the 70 km-zone, whose maintenance at times lay open and contended. The creation of one order depends upon the successful stabilisation of others. In this case all attempted chains of translation did not hold, and the ambitions for order were hence modified and reduced. The organisation of the Administration's bookkeeping had been stabilised enough, as had the procedure for the measurement of distances. The way the yearly fees were established was, it seems, just

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<sup>206</sup> The new tariff reform also included a new kind of star subscription that was to be supplied after a means test. This subscription implied that, subject to a special fee, subscribers in other charging zones could make calls free of charge to the holder of the star subscription. *Ibid.*

<sup>207</sup> Telegrafstyrelsen, *Telefon och telegraf, 1915, Sveriges officiella statistik* (Stockholm, 1916), p. 64.

<sup>208</sup> The tariff reform, for instance, was debated in Parliament. See, for instance, "Nya telefonfaxan önskas reviderad," *Svenska Dagbladet* (Stockholm), 25 May 1916.

<sup>209</sup> "Hur det nya telefonreglementet verkat," *Aftontidningen* (Stockholm), 5 January 1916, and Hans Heimbürger, *Svenska Telegrafverket: Telefon, Telegraf och Radio, 1921-1945* (Karlskrona: Televerkets Centralförvaltning, 1974), pp. 239-242. Stockholm Telephone, which had continuous automatic call metering for subscribers with limited subscriptions was not fully exempted from critique on call metering, however. See "Hur markeras öfversamtalen?," *Svenska Dagbladet* (Stockholm), 1 October 1916.

stable enough to hold. The attempts at altering the situation in Stockholm had on the other hand failed, despite the fact that, according to Herman Rydin, such alteration was in the interests of both the State and the national economy. Stockholm Telephone had not agreed to act as prescribed, and neither had its exchanges agreed to accommodate parts of the proposed telephone tax. The government had furthermore not conformed to the assigned role of enforcing the desired order in Stockholm.

### **Trials & Tribulations in the Stockholm Networks**

The war in Europe continued to rage and one would have thought that people might use their telephones less frequently, but not so! On the contrary, the rise in the number of calls put the telephone exchanges under considerable pressure. What is more the number of people wanting to subscribe increased.<sup>210</sup> For a long time, growth had been a mixed blessing to the two operators. The addition of new subscribers was deemed necessary, especially since interconnection had been broken in 1903, but at the same time it caused problems since it increased switching costs.

Since the Autumn of 1914 demand for telephony had surged, pushing the workings of the exchanges in Stockholm to new extremes. The temporary arrangement to reduce competition proposed by Karl Fredrik Wincrantz in the Summer of 1915 had been one attempt to ease the pressure. But it had failed, and the failure had pointed at some severe obstacles to such an agreement ever being reached. Moreover, the subsequent negotiations on an acquisition had pointed at the difficulties in interesting the government in funding an acquisition. As it turned out, the difficulties would escalate further, especially for the Telegraph Administration's operations in Stockholm.

### **Automatic test-exchanges: Foreign delivery and domestic order**

While the tariff reform issues were being discussed, the development projects had become well enough established to allow for the exhibition of selection devices intended for use in automatic telephone switches. For instance, Axel Hultman had been working on a selector project together with people at LM Ericsson, most notably Martin Löfgren (1880-1926) and Sigurd Johanson (1883-1940), where the former had worked for several employers in Germany, acquiring experience with automatic telephone switches before coming to LM Ericsson in 1912. During 1914 the group's work had resulted in a large selector capable of selecting across 10,000 lines being demonstrated

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<sup>210</sup> In the newspapers it was reported that both networks in Stockholm were putting through more calls than ever. It was further reported that this sometimes made it difficult for subscribers to make calls. See e.g. "Oerhörd stegring av telefontrafiken," *Stockholms Dagblad*, 18 November 1915.

to Herman Rydin and others at the Administration early in 1915.<sup>211</sup> Later, in April 1915, New Autotelephone Betulander exhibited to the public a switch with selectors consisting of link-connecting relays of a kind similar to the small private branch exchange it had delivered to the Marconi House in 1914.<sup>212</sup>

These displays seem to have been instrumental in persuading officials at the Telegraph Administration to consider testing the switching systems being developed because in June 1915 it ordered a semi-automatic switch of 1,000 lines for a test-exchange from LM Ericsson.<sup>213</sup> In August the Telegraph Administration ordered a switch of similar size from the New Autotelephone Betulander and later that fall the Administration's factory was commissioned to deliver a switch of the system worked out by Herman Olson and David Lienzén.<sup>214</sup> The latter order was also recorded in the volume of official statistics for 1915:

The eagerly performed work to try out an appropriate automatic telephone system for the local exchanges in Stockholm and Gothenburg has proceeded so well during the year that an order for a new test-exchange for 1,000 lines has been made.<sup>215</sup>

The time had come to put the three Swedish systems to the test: were the systems able to transform into test-exchanges that switched telephone calls? But while the Swedish projects were displaying models and contracts were being signed, the semi-automatic switch ordered from Bell in Antwerp had been put into operation in Landskrona. From the end of March 1915, calls between subscribers were switched by the new exchange.<sup>216</sup> Early statistics emerging from the exchange, recounted the following for 3-9 May 1915: At the exchange 5 operators served 748 subscribers, switching on

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<sup>211</sup> Sigurd Johanson, "Svenska automattelefonen och dess pionjärer (Hultman-Ericssons system)," in *Telefon och Telegraf i Sverige, del 1*, ed. Ivar Lignell (Stockholm: Natur och Kultur, 1935), 66-68, p. 68.

<sup>212</sup> Broberg, *Nya AB Autotelefon Betulander*, p. 67-68. See also, for instance, "När telefonisterna bli överflödiga: den Betulanderska autotelefonen demonstreras," *Aftonbladet* (Stockholm), 26 April 1915; "Betulanders telefonväxel nu fulländad," *Nya Dagligt Allehanda* (Stockholm), 27 April 1915; and "Telefon utan telefonfröken: Betulanders autotelefonväxel i nytt skick," *Stockholms Dagblad*, 27 April 1915.

<sup>213</sup> Lindberg, *Med fingerskiva*, p. 26 and Johansson, *Telefonaktiebolaget LM Ericsson*, p. 311.

<sup>214</sup> Lindberg, *Med fingerskiva*, p. 26.

<sup>215</sup> Original sentence (in Swedish): "De ivrigt bedrivna arbetena på utprovandet av ett passande automatiskt telefonsystem för lokalstationerna i Stockholm och Göteborg hava under året fortskridit så långt att en ny provstation för 1 000 ledningar kunnat beställas." Telegrafstyrelsen, *Telefon och telegraf, 1915*, p. 67.

<sup>216</sup> Charts describing the operations from 21 March 1915 and the following month were drawn depicting number of calls requested each day, number of faulty calls, and percentage of faulty calls. See TALb; F IV A:19.

average 405 calls per operator per hour during the busy morning hours (10 a.m. to 1 p.m.).<sup>217</sup>

The test-exchange in Landskrona was undoubtedly a source of experience to people at the Administration, and in particular Axel Hultman and Herman Olson. At the same time, though, its existence put pressure on the three Swedish projects as being the major contenders for producing automatic switches for the local exchanges in Stockholm and Gothenburg. This pressure became especially critical when the telephone operations in Stockholm, and in particular the Administration's network, were beginning to crack under the pressure.

### **'Obstacles of the most daunting kind'**

At the Telegraph Administration, it had already been decided in Autumn 1914 that the inter-urban exchanges should be moved from the main exchange to the new building at Jeriko to make room for additional switchboards for local traffic. The move had taken time to effectuate. Switchboards and wires had been ordered in several batches from the Administration's factory, but delivery had been seriously delayed. The adversities behind the delays had been manifold.<sup>218</sup> Firstly, it had been decided that the inter-urban switchboards had to be of a new design which could accommodate local exchanges using both the present LB-system and the future CB-system. This work at the technical department had taken time, where the last wiring diagram had been sent to the Administration's factory in December 1915. Secondly, the factory had had trouble in procuring components for the exchanges. In certain cases the deliveries had been delayed and in others it had simply been impossible to procure the desired components. In the latter cases substitutes had had to be designed, tested and manufactured.

At the beginning of 1916, the work in installing the new inter-urban switch at Jeriko was far from completed and the construction of the additional switchboards at the main exchange were not yet initiated. At the same time dissatisfaction with the telephone services in Stockholm was in the increase and it was mostly the Administration's service that was subject to criticism:

It is nowadays – in the opinion of those complaining – only a stroke of luck if you receive an answer and the correct number when calling up 'Riks' [the service of the Telegraph Administration], and when you at one time after

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<sup>217</sup> Telegrafstyrelsen, *Telefon och telegraf, 1915*, p. 131.

<sup>218</sup> The plans and the adversities encountered was recounted in an unsigned memo from the Autumn 1916, see n.a., n.d. (December 1916), "Trafiken ökades vid krigets början, hösten 1914 med..." (the traffic increased at the outbreak of the war with...), TALb; F I A:68.

several difficulties finally have a conversation going with the requested number you are disconnected as sure as eggs are eggs.<sup>219</sup>

To counter the many complaints the Telegraph Administration even provided the Stockholm newspapers with explanations for what was seen as a less than satisfactory service. Administration officials admitted to its service being unsatisfactory, and explained the problems by referring to the unanticipated tremendous increase in traffic in conjunction with a lack of equipment, lack of personnel, and lack of space for setting up additional switchboards. The continuous increases in traffic in Stockholm were ascribed in one article to the non-introduction of the tariff reform within 70 km-zone due to the competition with Stockholm Telephone.<sup>220</sup> The necessary enlargements of the network, it was further explained, could only be made gradually, especially since the Administration was encountering 'obstacles of the most daunting kind.'<sup>221</sup> These obstacles were reportedly first and foremost difficulties in procuring material such as the 'indispensable' ebonite which hitherto had been acquired from abroad.

However, enlarged facilities to improve the Administration's service were reported, starting with the opening of a new inter-urban exchange at Jakobsbergsgatan the coming Summer. It was also reported that occasional disconnection and long answering times were caused by switchboards crowded with cords, worn plugs, and rushed operators.<sup>222</sup> A subscriber experiencing disconnection frequently, it was added, should not complain to the operator but rather ask the fault complaint service to examine the relevant plug at the switchboard. One journalist even suggested that perhaps the subscribers would be less prone to complain about the operators if they could see how hard the operators at the exchange worked.<sup>223</sup>

Other explanations which surfaced were those pointing out the misuses to which subscribers put their telephones. In an interview with a telephone inspector at the

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<sup>219</sup> Original sentence (in Swedish): "Numera är det – enligt de klagandes åsikt – endast en lyckträff, om man råkar få svar och rätt nummer vid en påringning i Riks, och när man en gång efter mångahanda besvärigheter äntligen fått konversationen i gång med det begärda numret, blir man avbruten så säkert som amen i kyrkan." "Riks och allmänheten: Ett bemötande av klagomålen," *Aftonbladet* (Stockholm), 14 April 1916. This newspaper published several letters to the editor with complaints over the Administration's service. See: "Fria ord i dagens frågor: Missförhållandena vid rikstelefon," *Aftonbladet* (Stockholm), 12 April 1916; "Fria ord i dagens frågor: Svårigheten att komma fram i rikstelefon," *Aftonbladet* (Stockholm), 13 April 1916; "Fria ord i dagens frågor: Rikstelefonens skötsel," *Aftonbladet* (Stockholm), 20 April 1916.

<sup>220</sup> "Den oerhörda frekvensökningen på 'Riks' i Stockholm," *Nya Dagligt Allehanda – Vårt land* (Stockholm), 24 March 1916.

<sup>221</sup> Ibid. and "Den stora frekvensökningen på 'Riks'," *Svenska Dagbladet* (Stockholm), 25 March 1916.

<sup>222</sup> "Den oerhörda frekvensökningen på 'Riks' i Stockholm," *Nya Dagligt Allehanda – Vårt land* (Stockholm), 24 March 1916.

<sup>223</sup> "Riks och allmänheten: Ett bemötande av klagomålen," *Aftonbladet* (Stockholm), 14 April 1916.

Administration's main exchange in Stockholm it was affirmed that "the public's love of chatting is to a large degree to blame for the unendurable state of things."<sup>224</sup> People could according to the article talk for hours on trivial matters, much to the annoyance of others trying to reach them. The telephone inspector maintained that the tariff reform introduced outside Stockholm actually was a kind of tax on unnecessary chatter, since the yearly fee was associated with the number of calls made. He considered such a tax appropriate in Stockholm as well. Complaints about difficulties in reaching the directory enquiry service of Stockholm Telephone were also met by laying a measure of the blame on those calling. Karl Fredrik Wincrantz acknowledged that there were problems but maintained that many of the enquiries were unnecessary since about 90% of them could have been answered with the use of the telephone directory.<sup>225</sup> It seemed a hopeless task, he added, to create a directory enquiry service that sufficed.

The public arguments voiced that Spring about the telephone services in Stockholm bore all the signs of impending breakdown. The Administration's telephone network in Stockholm, in particular, was showing signs of sinking under a multitude of problems such as worn plugs, crowded switchboards, rushed operators and dissatisfied subscribers. In this emerging multitude of problems, other elements such as ebonite, space, tariff reform, and personnel were apparently missing. Even the telephone traffic became discussed as more heterogeneous than the concept of telephone traffic usually implied. That traffic was increasing was undisputed, but traffic was no longer only a number of calls at busy hour. It was no longer only a quantity which could change over time. Traffic was attributed as having varying qualities, where certain traffic had a questionable right to exist. In short, the telephone service was disintegrating, for all to see, into an array of problematic elements and issues, all clamouring to receive more attention.

#### **'Additional manual switchboards should be used to enlarge the network'**

Surely something had to be done if the Telegraph Administration's telephone service in Stockholm was not to continue in a state of decline. Efforts were called for to improve the service. In a Stockholm newspaper there was a report concerning the three test-exchanges.<sup>226</sup> Perhaps automatic switches were the solution? The article stated that the testing of these, together with the test in Landskrona, would not be concluded for another few months, but that the intention then was for a speedy introduction of the

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<sup>224</sup> Original sentence (in Swedish): "Allmänhetens pratsjuka har en stor skuld i de olidliga förhållandena – folk kan stå och slamra i timtal om riktiga struntsaker, och under tiden explodera andra av ilska över att numret är upptaget." Ibid.

<sup>225</sup> "Nummerbyrå–upptagen!" *Stockholms Tidning*, 16 January 1916, and "Allmänna telefon och allmänheten," *Dagens Nyheter* (Stockholm), 10 February 1916.

system finally selected. Axel Hultman, as the Administration's telephone director in Stockholm and participant in one of the three Swedish projects, expressed another opinion.

In a report sent to the Telegraph Administration's headquarters in April 1916, Hultman argued that there was no immediate hurry to order a full-scale automatic switch, and described in some detail what was planned to be done during the year to improve operations.<sup>227</sup> He reported that in the middle of October about 2,000 of the most sensitive subscribers would be connected to six new local multiple switchboards arranged in a new auxiliary exchange as an annexe to the main exchange. However, he stressed, this required the space now occupied by the inter-urban exchange to be cleared by 1 August and that no additional problems to procure material arose as a consequence of the war.<sup>228</sup> The six new local switchboards, he affirmed, could directly connect to a large proportion of the subscribers at the main exchange which in turn ought to give good answering times. A certain amount of trunking was introduced within the main exchange, but so far it was not necessary in the majority of calls between subscribers at the new auxiliary exchange and subscribers at the main exchange. According to Hultman, this measure alone should also improve the service at the old switchboards of the main exchange. The six new switchboards comprised altogether 16 operator's positions and Hultman estimated that 10 of these were required to improve the operations of the present traffic load whereas the remaining six positions could be used to serve approximately 900 new subscribers.<sup>229</sup> He further reported that an additional order for another four multiple switchboards had recently been made. These, he added, should be in operation at the auxiliary exchange by Christmas and would allow for an additional 700 new subscribers. Hultman estimated that this additional capacity would cover new subscribers until approximately October 1917.

According to Hultman, this and future orders for additional switchboards made it unnecessary to have a full scale automatic exchange in operation until late 1920. Until then, he reassured, the network could be extended using manual switchboards. This implied, he added, that the Administration "...without danger could postpone the order for an automatic system until 1 January 1918."<sup>230</sup> Hultman added that the order could

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<sup>226</sup> "Riks prövar automatiska system," *Dagens Nyheter* (Stockholm), 5 March 1916.

<sup>227</sup> Axel Hultman, 17 April 1916, "Till Kungl. Telegrafstyrelsen," (To the Telegraph Administration's headquarters), TALb; F I A:68.

<sup>228</sup> *Ibid.*, pp. 1-2.

<sup>229</sup> *Ibid.*, p. 2.

<sup>230</sup> Full Sentence (in Swedish): "Om nu, såsom synes av bifogade uppgifter, man i allmänhet kan beräkna en leveranstid av 1 1/2 år för stationer för 5000 à 10000 abonnenter, så kan man ju uppskjuta beställningen av ett automatiskt system utan fara till den 1 januari 1918, men vill man räkna med mycket stor säkerhet, så kunde ju beställningen ske redan den 1 juli 1917, då ingen

be made on 1 July 1917 if one wanted to be really safe, and affirmed that the operations in the meantime would be rather good and considerably better than at the present. This would also provide time to work out a complete programme for Stockholm's new automatic network, a task which he estimated to have finished by the end of the year. Ordering an automatic system earlier would according to Hultman jeopardise the possibility of acquiring a domestically produced system:

I consider it unnecessary to place the order as early as 1 January 1917, unless the headquarters has completely given up the wish to obtain a Swedish system.<sup>231</sup>

The signs of a telephone service in decline were not just problems in their own right. They also endangered the three development projects. Axel Hultman had for a long time argued that there was 'strictly speaking' no alternative to automatic switches as the network grew. Now he reassured that additional manual switchboards should be used to enlarge the network, switchboards that moreover would generate costly trunking to some extent, even within the main exchange. It seems time was running faster in the telephone network than it was in the development projects. From his position as telephone director he argued for confidence in the measures taken and patience with the three projects. His attempted chain of translations was simple:

In the headquarters' interest in acquiring a Swedish automatic system, the troubled situation in the Administration's network in Stockholm translates into the employment of additional manual switchboards.

The three projects would produce Swedish automatic switching systems, but they needed, according to Hultman, more time. Nevertheless, soon after his memo had been presented, an inquiry was sent from the Administration's technical department to Western Electric and Siemens-Schuckert in preparation for a future offer of an automatic switch.<sup>232</sup> It is impossible to conjecture whether the inquiry was primarily sent because Karl Erik Landström and others at the technical department were on the verge of renouncing any wish to obtain a Swedish system, or if it was primarily sent to obtain

som helst fara bör föreligga, och expeditionen bör under hela denna tid vara ganska god, betydligt bättre än nu." *Ibid.* p. 3.

<sup>231</sup> Original quote (in Swedish): "Att göra beställningen så tidigt som den 1 januari 1917, anser jag vara onödigt, för så vida Styrelsen icke alldeles uppgivet önskan att få ett inländskt system." *Ibid.* p. 3.

<sup>232</sup> Representatives of the two companies answered the inquiry in the middle of May. They both expressed great interest in a future offer and to both letters were appended a large set of questions regarding the telephone network, answers to which they needed for further preparing an offer for an automatic switch. See Einar Brofos (Western Electric Company Limited, London), 16 May 1916, 'Letter to the Telegraph Administration's headquarters,' and Wallin (Elektriska Aktiebolaget Siemens-Schuckert, Stockholm), 17 May 1916. 'Letter to the Telegraph Administration's technical department,' both in TALb; FI A:68.

more information about these foreign systems. In any case, the problems in the network in Stockholm did not result in the immediate cancellation of any of the orders concerning the three envisioned test-exchanges. The projects were not compelled to produce just yet. Nevertheless, pressure was definitely mounting. In May 1916, an automatic private branch exchange designed at Siemens was put into operation at a company near Stockholm<sup>233</sup>, and the semi-automatic switch in Landskrona of WE descent continued to put through calls in what seemed a satisfactory manner.<sup>234</sup>

### 'The record year of 1916'

Not only did the Administration receive more complaints than did Stockholm Telephone, the Administration's Stockholm network was also increasingly making a loss. The increasing traffic and the temporary measures taken to keeping the network together increased operating expenses. Wincrantz, at the Stockholm Telephone, maintained that the company had had its difficulties in the past but these had largely disappeared since the transformation to the new system.<sup>235</sup> The previously finished reconstruction was also quoted as a major reason for the company's ability to remain in profit, in spite of the increased prices.<sup>236</sup>

Could this advantage enjoyed by Stockholm Telephone be translated into something that would relieve the Administration's troubled operations in Stockholm? In May 1916, people within the Administration calculated the value of the company's

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<sup>233</sup> See "Vår första moderna helautomatiska telefonstation," *Svenska Dagbladet* (Stockholm), 31 May 1915.

<sup>234</sup> A letter to the Administration headquarters from an Administration official in Landskrona reported: "Concerning my own exchange, things are going on just as usual. Western Electric are plodding on with the installation of the fully automatic, but they have the usual problem of attaining what they should have. The complaints are in my opinion few. It is gratifying to notice that most subscribers are pleased when consulted about the system and consider it to generally work well. There are as we know always some loud-mouthed persons, but those are as a rule equally displeased with every system." Original sentences (in Swedish): "Vad min egen station angår, så går allt sin gilla gång. Western Electric knogar på med installationen av helautomaterna, men som vanligt ha de svårt att få hit vad de skola ha. Klagomålen äro i mitt tycke få, och det är glädjande att kunna konstatera att de flesta av de abonnenter, som man tillfrågar huru de tycka om systemet, säga sig vara nöjda och anse att det i allmänhet går bra. Några bråkstakar finns ju alltid, men sådana äro i regel lika missbelättna med alla system." HJ. Sturzen-Becker, 25 May 1916, 'letter to Nils Johansson (head of the traffic department at the Telegraph Administration),' TALb; F I A:134.

<sup>235</sup> "Vi och våra telefoner," *Stockholms Tidningen*, 9 May 1916.

<sup>236</sup> In the annual report for 1916 the following was written on operating costs and the previously performed reconstruction: "The reconstruction of the company's telephone network performed during the last few years, has made it easier to restrain the increase in operating expenses which has followed with the period of high prices." Original sentence (in Swedish): "Den ombyggnad av bolagets telefontät, som under senare åren företagits, har underlättat möjligheten att tillbakahålla stegringen i driftutgifterna, som blivit en följd av dyrtiden." "Aktiebolaget Stockholmstelefoners Styrelse- och Revisionsberättelser för år 1916" (*Stockholm Telephone Annual Report 1916*), p. 1.

network if acquired.<sup>237</sup> The value of an acquisition included firstly the investments saved, and secondly the yield of the acquired network given a preservation of the present tariffs. In this valuation, it was affirmed that an acquisition of the network could postpone the erection of the planned new local exchange at Jeriko for three years, which translated into a saving of about 900,000 kronor. It was further noted that an acquisition could postpone the running of new wires, since it would render the Administration reserve circuits to a value of at least 2 million kronor and these wires would gradually produce yield as they were put into use upon the arrival of new subscribers.<sup>238</sup> Together with the real estate and the yield from the subscribers' fees, the value to the Administration of the company's network was estimated to be between 25.9 and 28.9 million kronor.

In the previous discussion concerning the tariff reform and a telephone tax, an acquisition had been primarily discussed as a means towards increasing the tariffs within the 70 km-zone. In these new calculations an acquisition became a means for relieving the Administration's troubled operations in Stockholm. But, these preparations for yet another attempt at an acquisition were halted, presumably since it was deemed impossible to interest the government sufficiently to persuade it to provide the necessary funding. How could the Telegraph Administration acquire the network of Stockholm Telephone without having to interest the government in making an outlay of capital?

As Summer 1916 turned to Autumn, the adversities for the Telegraph Administration in moving the inter-urban exchange and installing the new local switchboards continued. In addition to problems in attaining certain materials, a reported lack of skilled workers further delayed the installation of the new inter-urban exchange.<sup>239</sup> The new inter-urban exchange at Jeriko was opened for traffic late in October<sup>240</sup>, nine months behind the original plan and three months behind the schedule Hultman had hoped for in April 1916. This in turn delayed the work in installing the additional switchboards in the new auxiliary exchange next to the main exchange, work which was subsequently carried out night and day to put the new switchboards into

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<sup>237</sup> n.a., 18 May 1916, "V.P.M.: angående beräkning av inkomsterna från A.B. Stockholms-telefons nät om detsamma övertages av staten, och de nuvarande abonnemangsvillkoren bibehållas," (memo regarding an estimation of receipts from Stockholm Telephone's network if it is acquired by the State and the present subscription conditions are retained), TALb; F I A:26.

<sup>238</sup> *Ibid.* pp. 1-2.

<sup>239</sup> Among the delays reported was that the charging and signalling equipment for the new inter-urban exchange had not been delivered until September, and that 4,000 signalling bulbs had been also missing until 3,500 of them could be acquired from the stock of LM Ericsson. See; n.a., n.d. (December 1916), "Trafiken ökades vid krigets början, hösten 1914 med....," (the traffic increased at the outbreak of the war with...), TALb; F I A:68, pp. 3-4.

<sup>240</sup> *Ibid.* p. 4.

operation. By the end of the year, 14 operator's positions were in operation and another 14 were scheduled to be in operation in February 1917.<sup>241</sup> Switchboards with an additional 28 operator's positions had also been ordered for the auxiliary exchange, and these were scheduled to be put into operation in April. There was also work being done that Winter to expand the Administration's sub-exchanges with additional switchboards.

Why did the Administration's operations in Stockholm seemingly have greater difficulties than the operations of Stockholm Telephone? We have already heard the explanation given by Stockholm Telephone in its annual report: 'We have fared well thanks to the recently completed reconstruction of our telephone network.' In December Axel Hultman gave quite another explanation. In a hand-written note, presumably to the technical department, he reported on the situation at the main exchange and the probable reason behind the degenerating service:

The traffic increase is probably normal within Stockholm Telephone [Co.], since we presumably receive all profiteers not the least since they can cancel the instrument after 3 months and they need to speak inter-urbanly. The number of operators on the morning duty is at present 106 local and 21 trunk operators.<sup>242</sup>

A similar argument was later made in a memo from Herman Rydin, the general director of the Telegraph Administration, to the minister of public affairs.<sup>243</sup> There it was noted that the two services in Stockholm operated under conditions that were only seemingly similar. If comparing the two services, it was argued, note should be taken of the fact that the Administration probably had experienced a far greater increase of traffic. A specific group of persons was invoked as generating the 'abnormal' increase in traffic which degenerated the service, namely the profiteers or the large numbers of shady

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<sup>241</sup> Ibid. p. 5.

<sup>242</sup> Original sentences (in Swedish): "Trafikökningen inom Sthlm telefon är antagligen normal, ty vi få antagligen alla Gulaschbaroner, icke minst därför, att de kunna säga upp apparaten efter 3 månader och behöfva tala interurbant. Telefonistantalet vid f.m. vakt f.n. 106 st lokala & 21 st trunktelefonister." Axel Hultman, 21 December 1916, 'Hand-written note, presumably sent to the technical department,' TALb; F I A:68.

<sup>243</sup> The content of the memo was extensively reported in several Stockholm newspaper 4 January 1917. See; "Svårigheterna vid rikstelefon: Telegrafstyrelsen om orsakerna till den försämrade expedieringen," *Aftonbladet* (Stockholm), 4 January 1917; "Rikstelefonens försämrade expediering," *Aftontidningen* (Stockholm), 4 January 1917; "Klagomålen mot rikstelefon: Ett bemötande av chefen för telegrafstyrelsen," *Dagens Nyheter* (Stockholm), 4 January 1917; "Rikstelefontrafiken växer för fort: Telegrafgeneralen bemöter klagomålen i en skrifvelse till civilministern," *Nya Dagligt Allehanda* (Stockholm), 4 January 1917; "Missförhållandena vid Rikstelefon: Orsakas av de många nya gulaschabonmenterna," *Social-Demokraten* (Stockholm), 4 January 1917; "Abbonentträngseln på Riks: Telegrafstyrelsens åtgärder för att möta den ständiga stegringen," *Stockholms Dagblad*, 4 January 1917; "Rikstelefonens svårigheter: Orsakerna till den försämrade expedieringen," *Stockholms Tidningen*, 4 January 1917; "Rikstelefonens svårigheter: Skrifvelse från telegrafchefen till civilministern," *Svenska Dagbladet* (Stockholm), 4 January 1917.

businessmen who made a living on the wartime state of the markets.<sup>244</sup> In April, Hultman had invoked another group of subscribers, 'the most sensitive subscribers,' when referring to subscribers who needed particular attention when the main exchange was enlarged. On this occasion, he and later Rydin invoked an already outlined and generally disliked group which had emerged in a Stockholm marked by food shortages and increasing food prices.<sup>245</sup>

However, the argument that the two services operated under different conditions was soon disputed. In an interview with Karl Fredrik Wincrantz published only a few days later in January 1917, Wincrantz triumphantly noted that Stockholm Telephone experienced a far greater net increase in subscribers in 1916 than the Telegraph Administration's network in Stockholm. The network had increased by 9,128 subscribers, whereas that of the Telegraph Administration had increased by around 2,700 subscribers.<sup>246</sup> It was further reported that the Stockholm Telephone's exchanges had switched some 226 million calls during the previous year and that it had had 91,765 subscribers at the end of last year.

Keeping the Telegraph Administration's telephone service in Stockholm from further decline had translated into a multitude of different efforts in 1916. Great efforts had been made to install additional switchboards in the network, with all that implied in terms of redistributing subscribers among switchboards, hiring and training additional operators, etc. Efforts were made to explain to the public the problems connected with this work towards enlarging the network. Certain elements of the network, such as worn plugs, not only needed attention from the engineers, the needed attention from the public in the form of prompt fault reporting. Efforts had finally been made to attribute qualities to the traffic served, in particular the alleged fact that the increase was caused by profiteers. All these efforts notwithstanding, the Administration's operations in Stockholm were far from being in the clear.

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<sup>244</sup> The exact wording differed only slightly among the majority of the newspapers. Perhaps the strongest phrasing was in the article in the socialist newspaper *Social-Demokraten*, which in its headline already concluded that the bad condition of the Administration's service was caused by the many new profiteers. Only two newspapers, *Dagens Nyheter* and *Nya Dagligt Allehanda*, refrained from reporting the argument concerning shady businessmen as causing the increase in traffic. For references, see the previous note.

<sup>245</sup> Newspapers wrote on the subject of profiteers in December. See, for instance, "Invasionen österifrån," *Aftonbladet* (Stockholm), 10 December 1916.

<sup>246</sup> "Rekordår vid Stockholmstel.," *Svenska Dagbladet* (Stockholm), 9 January 1917. Articles on Stockholm Telephone's 'record year' were also reported in several other Stockholm newspapers: "Oerhörd utveckling av Stockholmstelefon," *Aftonbladet* (Stockholm), 8 January 1917 and "1916 ett rekordår vid 'allmänna' telefon," *Stockholms Tidningen*, 9 January 1917.

### **The unrealised plans for acquiring automatic switches for ordinary operation**

Was it possible to discipline the subscribers to avoid using the telephone service for long conversations of frivolous chatter? The Administration's tariff reform introduced outside the 70 km-zone had been suggested as one such disciplinary measure. Another measure discussed in a newspaper in January 1917 was the possibility of introducing restrictions on the duration of calls. Axel Hultman was reported to be sceptical to the suggestion and referred to technical problems and to the many calls on business matters which at times had to be of long duration.<sup>247</sup> According to a subsequent article Wincrantz was more positive to such measures. Wincrantz affirmed that it was necessary to introduce time limits on calls from slot telephones and on all inter-urban calls, but ruled out the possibility to have operators listening in on calls to determine whether the matters discussed were sufficiently trivial to warrant immediate disconnection.<sup>248</sup>

However, the Stockholm newspapers primarily pinned their hopes on another kind of device. In December 1916 and January 1917 a few newspaper articles reported on the ongoing installation of semi-automatic test-exchanges within the Administration's network.<sup>249</sup> In a previous newspaper report on the projects published in March 1916, it had been said that the tests should have been finished and a system selected after a few months. However, in the beginning of 1917 the tests were still in a 'state of progress.' None of the three test-exchanges was yet switching telephone calls on anything like a regular basis. One of the articles nevertheless hopefully asked if the forthcoming results from these tests meant that the Administration's telephone service would be better ordered at last.<sup>250</sup>

The hope for automatic switches improving the order of things was partially answered in January 1917 when Axel Hultman presented a preliminary program for introducing semi-automatic switches in Stockholm to the Administration's headquarters. The program was accompanied by a mass of figures and calculations representing both the future size of the network and characteristics of different switching systems. The basic outline of the plan was to have three semi-automatic exchanges in operation in January 1919, which implied an introduction of semi-automatic exchanges more than one year earlier than envisioned by Hultman in April 1916. Of the three first semi-

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<sup>247</sup> "Tidsbegränsning för telefonsamtal?," *Dagens Nyheter* (Stockholm), 8 January 1917.

<sup>248</sup> "Tre minuter eller en timme?," *Dagens Nyheter* (Stockholm), 9 January 1917.

<sup>249</sup> See "Auto-telefon för sitt intåg på Stockholms-'Riks'," *Nya Dagligt Allehanda* (Stockholm), 14 December 1916; "Telefonnyheter. Skall det äntligen bli bättre ordning?" *Aftonbladet* (Stockholm), 15 December 1916; and "Tidsbegränsning för telefonsamtal?," *Dagens Nyheter* (Stockholm), 8 January 1917.

automatic exchanges, the new main exchange for 7,000 subscriber's lines at Jeriko would be the largest.<sup>251</sup> According to the program, these would subsequently be enlarged and in January 1922 another three semi-automatic exchanges should be in operation. At that time, six semi-automatic exchanges would be in operation serving in total 37,000 subscriber's lines, which meant that the Administration's entire network within Stockholm would have been converted into a semi-automatic system for switching local calls.

This program, Hultman stressed, implied that the order for the new automatic system had to be placed within five months. The big question was now to choose a system, or rather to determine the standards the Telegraph Administration should stipulate when inviting tenders. In a draft of the invitation to tender and two internal memos, Axel Hultman suggested an abundance of figures and terms to be employed of which only a few key points can be mentioned here. Firstly, the system should be semi-automatic at the outset, but be readily convertible to fully automatic operation.<sup>252</sup> Secondly, the system should allow for a local network of 200,000 subscribers, which was a number that by far exceeded the present number of subscribers in the two networks in Stockholm taken together. Thirdly, the Telegraph Administration should provide the numbers of selectors it deemed appropriate for each switch, and the supplier should calculate the price for the switches by using these figures rather than using own estimates.

The last point is interesting, since Hultman affirmed that such a procedure was necessary to ensure that fully comparable offers were obtained. The importance accorded to these figures is also evident by the large number of calculations made to establish what these figures should be for every exchange in Stockholm with each of five different semi-automatic switching systems. To produce these figures, Hultman invoked a whole range of other figures. First there were estimated figures representing the traffic within each exchange, which included the number of subscribers that would be connected to the exchange, the number of calls they would make during busy hour, the recipient exchanges of these calls, the number of calls they would receive from subscribers at other exchanges, and the duration of all calls. All these figures were specifically forecast for each future exchange, but were the same across the different switching systems.

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<sup>250</sup> "Telefonnyheter. Skall det äntligen bli bättre ordning?" *Aftonbladet* (Stockholm), 15 December 1916.

<sup>251</sup> Axel Hultman, 31 January 1917, 'To the Telegraph Administration's headquarters,' TALb; F I A:69, p. 3.

<sup>252</sup> Axel Hultman (no signature), January 1917, "Förslag till kostnadserbjudande för automatiska telefonanläggningar i Stockholm," TALb; F I A:69, p. 1.

However, figures representing subscribers' future use of their telephones were not in themselves sufficient to calculate the numbers of selectors needed. Figures representing various characteristics of the different automatic systems were also needed. Selector size was perhaps the most important among these characteristics, that is, the number of lines each selector selected over. This figure varied greatly among automatic systems. All systems were built around groups of selectors arranged in several levels, where first group selectors selected among groups of second group selectors and so on until a group of final selectors could select a particular subscriber's line. Since the size of the selectors varied among systems, so would the numbers of selectors required to manage a given amount of telephone calls. In principle, the more lines each selector selected over, the fewer selectors would be needed.

Yet, the question was how many selectors a given exchange of each system would need. How many final selectors, for instance, would be needed if they each selected over 200 subscriber's lines? The number of selectors for each group of 200 subscribers would put a limit on the number of incoming calls that simultaneously could take place to that group. To calculate the numbers of selectors needed required more than having figures representing a particular system and figures representing subscribers' future use of their telephones. Some sort of further transformation was called for, which could translate the figures representing the system and the subscribers into something more like an exchange, that is, into numbers of selectors needed.

Luckily, there were graphs available for making such transformations. Hultman referred to both the calculated graphs made by 'Magister Erland and Christensen' at the telephone company in Copenhagen<sup>253</sup>, and the empirically induced 'experience curves' from Siemens in Berlin and Western Electric in Chicago. According to Hultman all these were very similar, but yet different enough to warrant the use of precisely the same graph for establishing the number of selectors needed for the different systems: "All these graphs are slightly different, but the same graph should be applied to all systems to ensure a completely impartial basis for calculation."<sup>254</sup> Indeed, this

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<sup>253</sup> The 'Magister Erland' referred to was the Danish mathematician Agner Krarup Erlang (1878-1929) who had taken a position as scientific collaborator at the Copenhagen Telephone Company in 1908. Later 1917, Erlang published an article in Danish where he presented some formulas based on probability theory developed for calculating blocking characteristics in automatic exchanges. The article was translated in the subsequent years and published in German, French and English Journals. The latter (Agner Krarup Erlang, "Solution of some Problems in the Theory of Probabilities of Significance in Automatic Telephone Exchanges," *The Post Office Electrical Engineers Journal* 10 (1918): 189ff.) is reproduced in E. Brockmeyer, H.L. Halstrøm, and Arne Jensen, eds., *The Life and Works of A.K. Erlang, Transactions of the Danish Academy of Technical Sciences #2* (Copenhagen: Copenhagen Telephone Company, 1948), pp. 138-155.

<sup>254</sup> Original sentences (in Swedish): "Dessa beräkningar, för vidlyftiga att här närmare ingå på, stämna numera mycket väl överens med de empiriska kurvor (erfarenhetskurvor), som

difference was the reason why Hultman found that the Telegraph Administration should transform the figures representing the systems and the subscribers into figures representing the exchanges.

Calculations of the numbers of selectors needed were performed for each of the six planned exchanges for each of five different systems: the WE system, the Siemens system, the Hultman-Löfgren system, the Betulander-Palmgren system, and the Olson system.<sup>255</sup> The three Swedish switching systems were thus transformable into 'exchanges', although none had yet transformed into an operating test-exchange. Altogether, these calculations resulted in 30 sets of numbers of selectors, each set representing an exchange. The 'Siemens exchange at Jeriko' serving 16,000 subscribers had, for instance, 1,810 final selectors and 871 first group selectors, whereas the 'Hultman-Löfgren exchange at Jeriko' had 879 final selectors and 979 first group selectors.<sup>256</sup> All these numbers were calculated with a graph for 1% blocking. This meant that the graph provided the number of selectors needed for a given traffic with 1% probability that an attempted employment of these selectors would be blocked due to all selectors already being occupied. According to Hultman the specific graph used was close to Siemens' experience curve, somewhat "higher than Erlands [sic.] latest theoretical curve," and somewhat lower than WE's experience curve.<sup>257</sup>

However, Hultman's calculations were not completely subservient to the graph. Hultman maintained it was necessary to balance for unevenness in the load arising in different groups of subscribers.<sup>258</sup> Certain groups would simply receive many more calls than other groups, and in his view this unevenness had to be accounted for if the selectors selected among 200 lines or less. Hultman therefore increased the traffic when calculating the number of final selectors needed for systems with final selectors which

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uppsatts av Siemens i Berlin och Western Electric i Chicago. Alla dessa kurvor skilja sig något åt inbördes; men för att få en fullt rättvis beräkningsgrund böra alla system räknas efter samma kurva." Axel Hultman, 31 January 1917, "Till Kungl. Telegrafstyrelsen," (To the Telegraph Administration's headquarters), TALb; F I A:69, pp. 9-10.

<sup>255</sup> In Hultman's papers, the Hultman-Löfgren system was actually labelled the Hultman system, and the Betulander-Palmgren system was labelled the Betulander system. I have chosen to add a second name to these labels in recognition of the contributions of Martin Löfgren and Nils Palmgren to the two systems respectively. This said, it is interesting to note that the three systems from the Swedish projects actually were identified by the name of an engineer rather than any other characteristic. One possible reason for this is actually that the characteristics of these systems were changeable for quite some time.

<sup>256</sup> Axel Hultman (no signature), January 1917, "Förslag till kostnadserbjudande för automatiska telefonanläggningar i Stockholm," (proposal for invitation for offers for automatic exchanges in Stockholm), TALb; F I A:69, appendix.

<sup>257</sup> Axel Hultman, 31 January 1917, "Till Kungl. Telegrafstyrelsen," (To the Telegraph Administration's headquarters), TALb; F I A:69, appendix D.

selected across 100 or 200 subscribers. In this way the exchanges with the WE system acquired a number of its 200-line final selectors which according to the graph corresponded to a traffic 10% higher than the traffic originally estimated. The Siemens, the Betulander, and the Olson systems all had 100-line final selectors, and their exchanges acquired a number of final selectors which corresponded to a 14% increase in traffic. The only exchanges not receiving any 'balancing' increase in traffic on their final selectors were those of the Hultman-Löfgren system, which had 10,000-line final selectors.

It was not that difficult for Hultman to construct local exchanges for Stockholm with good service, as long as neither he nor the resultant exchanges had to leave his desk. Besides paper and pencil, all that was needed were subscribers in the form of predicted figures, a system in the shape of another set of figures, and finally a set of graphs and calculations which transformed these into an exchange in the shape of yet another set of figures. However, bringing any of the thus constructed exchanges from the desk and into real operation switching calls between subscribers would be quite another matter. To do this, a massive set of activities had to be performed, including taking in bids, choosing an offer (system), erecting and wiring selectors of the chosen system, training operators, the selectors setting up and disconnecting calls in a desired manner, the forecast number of subscribers making calls at forecast levels, and so on.

Apart from anything else, these activities depended on Hultman's calculations not being disputed: That the representations of the systems and subscribers were undisputed, and that the transformation of these figures into exchanges was accepted. The problem was that the predicted number of future subscribers was far from stable, since new discussions on an agreement with the Stockholm Telephone had been initiated at about the same time as Hultman had performed his calculations. The question that consequently arose was whether the procurement of semi-automatic switches should be adjusted to include the incorporation of Stockholm Telephone's network. The undecided state of this matter appears to have postponed all further activities towards proceeding with the procurement. Hultman's preparations for the procurement were put on hold since it was deemed uncertain whether in 1922 there would be far more than the predicted 37,000 subscribers in the Telegraph Administration's network in Stockholm.

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<sup>258</sup> Axel Hultman (no signature), January 1917, "Förslag till kostnadserbjudande för automatiska telefonanläggningar i Stockholm," (proposal for invitation for offers for automatic exchanges in Stockholm), TALb; F I A:69, appendix.

### **The rise and fall of a new monopoly scenario**

The discussions postponing going out to tender concerned a new scheme for the Telegraph Administration to acquire control of Stockholm Telephone's network. Involved in the discussions were Herman Rydin, Karl Erik Landström, Karl Fredrik Wincrantz, Fredrik Pegelow and the banker Joseph Nachmanson (Stockholms Enskilda Bank). Several previous attempts had failed due to the difficulty in interesting the government in putting up the necessary funds. An acquisition under this new scheme was intended to be free of government funding, the idea being that Stockholms Enskilda Bank should provide the necessary funds. The key feature of the new scheme was the creation of a holding company which should acquire the network of Stockholm Telephone. This holding company should in turn lease the network to the Telegraph Administration which in return should pay a rent as well as pay off the network by instalments. After 30 years the network would become the property of the Administration following which the holding company would be dissolved.

In the ensuing negotiations the question of the price for the network took on new dimensions. Herman Rydin emphasised in a letter to Nachmanson that the Administration's calculated net income from the leased network put an upper limit on the price.<sup>259</sup> Hence, the leased network should provide a calculated yield which was larger than the rent and lease payable to the holding company. In a subsequent memo Wincrantz argued for a higher price by pointing out several sources of income which should be considered in the Administration's calculations.<sup>260</sup> Among the things mentioned were the lower maintenance costs which would result from a merger of the two networks, the increased income from the introduction of the tariff reform within the 70 km-zone, and the increased income from inter-urban traffic generated by subscribers stemming from the company's network. He finally pointed out that many of the about 20,000 subscribers who subscribed to both networks would leave one of their subscriptions upon a merger, which meant that several expensive enlargements of the merged network could be postponed.

In March the negotiations had advanced to a point where government needed to be approached to give the Telegraph Administration the authority to execute the agreement devised. Landström presented the framework of the agreement in a long memo. He stressed that the need for an early decision on what the future exchanges in

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<sup>259</sup> In the letter Herman Rydin stated that there was no point in even talking about a price higher than 27 million kronor, since the calculated net income of 1,975 thousand kronor capitalised to that amount given an interest rate of 7.25%. Herman Rydin, 13 January 1917, "Herr Bankdirektör" (Letter to Joseph Nachmanson), TALb; F I A:26.

<sup>260</sup> Karl Fredrik Wincrantz, 22 January 1917, "P.M. angående Stockholmstelefoners nät," (memo regarding the network of Stockholm Telephone), TALb; F I A:26.

Stockholm should look like made the execution of the negotiated agreement particularly timely, indeed urgent:

The network of the Telegraph Administration in Stockholm has now reached such an extension, that a decision concerning the final arrangement of the yet provisional exchanges has to be made in the immediate future. This involves, apart from planning the new main exchange for a certain size, also the construction of sub-exchanges and acquisition of house properties for these. In all attempts to establish the figures for calculated number of subscribers and other things, the question arises whether one is required to allow for the incorporation of the company's network.<sup>261</sup>

Landström further stressed that this was a 'now or never' situation since the decision on the exchanges could not be further postponed. He went on to say that if decisions on the exchanges were made and carried through in the spirit that the two operators should continue to operate independently from one another, in such circumstances the Telegraph Administration would no longer be interested in acquiring the company's network.

However, the government was neither engaged by the scenario nor entirely disinterested. The reply from the minister of public administration was neither one thing or the other but an inquiry as to whether the parties would stand by the preliminary agreement until 1 April 1918.<sup>262</sup> The present government was retiring. Perhaps, the minister implied, the agreement could not be put forward to the present Parliament. The negotiations on the agreement continued. As they were dragging on, however, decisions were taken for additional provisional enlargements within the Administration's network in Stockholm.<sup>263</sup>

In a long memo drafted in the Summer 1917, Landström put forward several arguments against proceeding with the agreement at that moment. Landström maintained that the motives favouring an agreement in the Spring had already played out their role and in his view all that remained were the original and well known motives. The work of constructing two new sub-exchanges, for instance, could not be

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<sup>261</sup> Original sentences (in Swedish): "Rikstelefonnätet i Stockholm har nu nått den omfattning, att ett avgörande inom den närmaste framtiden måste träffas angående slutgiltigt ordnande av de ännu provisoriska stationsanordningarna. Detta medför förutom planerande av den nya huvudstationen för en viss storlek, även anläggning av understationer och anskaffande av fastigheter för dessa. Vid alla försök att bestämma siffrorna för beräknad abonnenttillgång m.m. uppställer sig den frågan huruvida man skall behöva räkna med inkorporering av bolagets nät." Lm [Landström], 23 March 1917, n.t. (memo concerning the arrangement of a holding company), TALb; F I A:25, p. 4.

<sup>262</sup> The inquiry from the minister of public administration was forwarded from Landström to Wincrantz in a letter of 31 March, Karl Erik Landström, 31 March 1917, 'Letter to managing director K F Wincrantz,' TALb; F I A:26.

<sup>263</sup> Karl Erik Landström, 21 July 1917, "P.M." (draft of memo concerning a possible agreement with Stockholm Telephone), TALb; F I A:26, p. 27.

postponed "...while awaiting an uncertain agreement with the company."<sup>264</sup> Landström further maintained that, in the event of the Administration acquiring the other network, it was impossible to establish an interconnection at the moment between the two networks in Stockholm.<sup>265</sup> He also noted that the approaching gradual introduction of semi-automatic switches would require many special arrangements for switching traffic between new semi-automatic exchanges and old manual exchanges. These arrangements, he maintained, would become even more complex and costly if interconnection was to be established with the acquired network of Stockholm Telephone. Landström therefore concluded that, in the event of an acquisition, the most economical procedure was therefore to establish interconnection only after the Administration had automated its network.<sup>266</sup> In this way some of the switching arrangements used during the automation could be re-used when merging the two networks. Hence, Landström now argued, if the network was to be acquired soon, it was nevertheless best to operate it in isolation from the Administration's network while semi-automatic exchanges were introduced into the latter network.

#### **Continued trials and the belated delivery of the projects**

The discussion on an acquisition of the network of Stockholm Telephone was cooling down.<sup>267</sup> Moreover, even if an acquisition was carried through, according to Landström it should not impede the introduction of semi-automatic switches into the Administration's network. This must have rendered greater stability to the program for automation which Hultman had presented in January. Then, the predicted number of future subscribers had been rendered uncertain by the discussions on acquiring the network of Stockholm Telephone. Thus, with this issue settled actions towards procuring automatic switches ought to have taken place in the Summer 1917. The first three switches ought to have been ordered by 1 July according to Hultman's program from January. But they were not ordered. Not in June, not in July nor in August.

I do not know why the ordering program for semi-automatic switches was postponed this time. With the predicted number of future subscribers in place, something else must have suspended the move of three of the exchanges off Hultman's desk and into a contract. Something that failed to turn the 30 exchanges into a contract, turning them instead into a heap of papers filled with figures only suitable for filing in

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<sup>264</sup> Ibid.

<sup>265</sup> Ibid. p. 19.

<sup>266</sup> Ibid. p. 22.

<sup>267</sup> The message that the time was wrong, due to a high price, was presented in a letter from Herman Rydin to the new Minister of Public Administration, Walter Murray. Herman Rydin, 8 September 1917, 'Letter to Murray,' TALb; F I A:26.

the archives. Perhaps the suspension was related to the substantial increase in the tariff for urgent inter-urban calls which was introduced within the Administration's network throughout Sweden.<sup>268</sup> But if so, the suspension was probably also related to the continued efforts to enlarge the Administration's network in Stockholm with the employment of additional manual Switchboards. There was, for instance, work being done with the view of opening a new manual sub-exchange at Jeriko in January 1918.<sup>269</sup> Finally, perhaps the suspended order was related to the continued problems facing at least two of the three projects in putting their test-exchanges into operation.

In June the test-exchange of the Betulander-Palmgren system from New Autotelephone Betulander was put into operation in a spare space within the Jeriko premises.<sup>270</sup> The so-called B exchange had three operator's positions and around 400 subscribers were connected to this test-exchange. At about the same time the test-exchange ordered from the Administration's factory was also put into operation within the Jeriko premises.<sup>271</sup> This so-called O exchange of the Olson system had a capacity of 200 subscribers, but for some reason only a few, primarily official, telephones were connected to it.

At the end of July David Lienzén, who had been employed to work on the Olson system, left his position at the Telegraph Administration and began to work with LM Ericsson and the Hultman-Löfgren project. However, the project within LM Ericsson was the one having the biggest problems. While the B exchange was switching around fifty thousand calls per month and the O exchange was putting through at least some calls, the Hultman-Löfgren system test-exchange was not yet doing any switching, i.e. this project had not yet delivered. There appear to have been disagreements between Axel Hultman, and the two LM Ericsson engineers Martin Löfgren and Sigurd Johansson.<sup>272</sup> Löfgren temporarily left the project for a brief period in 1917, and at end July Sigurd Johanson left the project and LM Ericsson and became employed at the Telegraph Administration. At that time there were still no H exchange switching calls.

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<sup>268</sup> Urgent calls were inter-urban calls where the subscriber paid an extra fee to gain priority over ordinary inter-urban calls, that is, they were calls that went before ordinary calls in the queue of calls being set up on the inter-urban lines. On the price increase of these calls which was initiated by the minister of finance. See Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 126.

<sup>269</sup> n.a., 11 September 1917, 'report to the general director,' TALb; F I A:68.

<sup>270</sup> Lindberg, *Med fingerskiva*, p. 29.

<sup>271</sup> *Ibid.*, pp. 27-29.

<sup>272</sup> Several notes and papers on the development of the 'Hultman' system and in particular Martin Löfgren's role were written and collected by another engineer employed at LM Ericsson, G. Collberg. According to one such note Sigurd Johansson was taking the credit for much of the design work being made by Martin Löfgren. See note G Collberg, 3 January 1917 (with later additions), 'LME & Co.,' LA; Samling G. Collberg #3.

According to the intermittent reports on the state of telephony in the Stockholm newspapers, any hopes for an improved service had now been dashed. Besides complaints, the Administration's network continued to show signs of decline. Readers of the newspapers were informed of the importance manganese and copper played in the Telegraph Administration's network. Manganese, used in the local batteries, was in short supply which reportedly meant that poor batteries had to be kept in service with poor sound quality as a result.<sup>273</sup> Likewise, a shortage of copper made it impossible for the Administration to run any new inter-urban cables to shorten long waiting times for making an inter-urban call.<sup>274</sup> Another theme increasingly brought up was a reported lack of politeness in the interaction between operators and subscribers.<sup>275</sup> Subscribers complained about rude operators and conversely operators complained about impatient and impolite subscribers. When the secret talks on an acquisition were on the wane in the Summer 1917, the many complaints about the Administration's service prompted Karl Fredrik Wincrantz to publicly, and somewhat impertinently, suggest that if certain public bodies were permitted to subscribe to Stockholm Telephone's service without seeking the government's consent, it might relieve the Administration's network of some of the traffic.<sup>276</sup>

There were also signs of weariness over the Administration's reports on the causes behind the problems and its seemingly empty promises of impending improvement.<sup>277</sup> Industrial associations also started to express their tiredness at the telephone situation. According to one newspaper article there was a growing dissatisfaction within industrial circles with the Administration's reply to a letter issued by the Federation of

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<sup>273</sup> "Fnruror på telefonråden: Svårigheter på riks, särskilt till följd av brunstensbrist," *Stockholms Tidningen*, 4 April 1917. There were also criticism of how the Telegraph Administration managed the shortage of manganese by charging its subscribers extra for refreshing their batteries, see "Riks [Letter to the editor]," *Dagens Nyheter* (Stockholm), 4 June 1917 and "Underliga metoder på Riks," *Svenska Dagbladet* (Stockholm), 5 June 1917.

<sup>274</sup> "Överbelastningen på interurbanlinjerna," *Nya Dagligt Allehanda* (Stockholm), 26 September 1917 and "Oefterrättlighetsstillståndet på rikstelefon," *Stockholms-Tidningen*, 27 September 1917.

<sup>275</sup> "En som är nöjd med sin rikstelefon," *Svenska Dagbladet* (Stockholm), 18 January 1917; "Är klandret mot 'rikstelefoneländet' berättigat?," *Aftontidningen* (Stockholm), 18 January 1917; "Hövligheten i telefon," *Stockholms-Tidningen*, 4 October 1917; and "Telefonhövligheten [Letter to the editor]," *Stockholms-Tidningen*, 5 October 1917.

<sup>276</sup> This suggestion was made with special reference to the heavy traffic generated by organisations set up in the time of crisis by the City and the State, see "Stockholmstelefon och riks," *Svenska Dagbladet* (Stockholm), 5 June 1917.

<sup>277</sup> One article maintained that it would no longer do to blame the problems only on the growth in the number of subscriber and shortages of certain materials, see "Vår Rikstelefon: Expeditionen blir allt sämre och sämre," *Nya Dagligt Allehanda – Vårt land* (Stockholm), 19 February 1917. Another article that one finally had become used to issued promises of improvement not being effectuated, see "Tålmod," *Stockholms Dagblad*, 5 May 1917.

Swedish Industries concerning the telephone service.<sup>278</sup> It was further reported that the unsatisfactory service had began to nurture a suspicion in these circles that the Administration's network was far from technically perfected. A few weeks later, in the middle of August, other industrial associations came forward and complained about the recently increased charge on urgent calls.<sup>279</sup>

In September 1917, the Telegraph Administration's service was reportedly worse than ever, particularly in respect of inter-urban calls.<sup>280</sup> Within the Administration, measures were suggested to manage the situation. An increasing number of operators were recruited and trained, and additional switchboards were under construction at several exchanges.<sup>281</sup> There were suggestions of moving 2,000 subscribers from the switchboards at the main exchange to the two new manual sub-exchanges whose construction had been initiated in the Spring. There were also suggestions to temporarily not accept any new subscribers until the two new sub-exchanges were in operation. The remedial measures taken evidently did not have the desired effect and it appears that both the Administration and Stockholm Telephone were facing a somewhat new problem in the Autumn. The operators in Stockholm were reportedly organising themselves into unions, with a view to achieving increased wages as well as improved working conditions.<sup>282</sup>

Would a better order prevail at last in the Administration's telephone service? In January 1918, the test-exchange designed by Hultman and Löfgren was finally ready to be put into operation. The so-called H exchange contained equipment for 1,000 lines and was erected at the Administration's premises on Norrtullsgatan in Stockholm. In early January, Hultman demonstrated the exchange to Karl Erik Landström, Erik Ekeberg, Klas Weman and Herman Olson from the Telegraph Administration and Knut

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<sup>278</sup> "Klagomålen över rikstelefonen," *Aftonbladet* (Stockholm), 16 July 1917. The initiative of the Federation of Swedish Industries was also reported in "Klandret mot rikstelefonen," *Svenska Dagbladet* (Stockholm), 16 July 1917 and "Rikstelefons usla skötsel i Stockholm," *Social-Demokraten* (Stockholm), 16 July 1917.

<sup>279</sup> "Telefonfördyringen och affärlivet," *Aftonbladet* (Stockholm), 2 August 1917; "Åter en protest mot Riks," *Nya Dagligt Allehanda – Vårt land* (Stockholm), 17 August 1917; "Affärsmännen mot de höjda telegramportona," *Svenska Dagbladet* (Stockholm), 18 August 1917; and "Protest mot telefonafgifternas höjning," *Stockholms Dagblad*, 18 August 1917.

<sup>280</sup> "Överbelastningen på interurbanlinjerna," *Nya Dagligt Allehanda* (Stockholm), 26 September 1917 and "Oefterrättighetstillståndet på rikstelefonen," *Stockholms-Tidningen*, 27 September 1917.

<sup>281</sup> n.a., 11 September 1917, 'report to the general director,' TALb; F I A:68.

<sup>282</sup> Reports of meetings held to constitute these organisations were published in several Stockholm newspapers: "Telefonisternas organisation," *Dagens Nyheter* (Stockholm), 17 October 1917; "Telefonisternas organisation," *Nya Dagligt Allehanda* (Stockholm), 17 October 1917; "Telefonisterna organisera sig," *Svenska Dagbladet* (Stockholm), 17 October 1917; "Telefonisternas löner och tjänstgöring," *Dagens Nyheter* (Stockholm), 18 October 1917; and "Telefonisternas organisation," *Social-Demokraten* (Stockholm), 19 October 1917.

Kåell (1887-1962) from LM Ericsson. From the recorded minutes, this demonstration carried out during a few days in the beginning of January appears to have been a rather peculiar one.<sup>283</sup>

Axel Hultman expressed dissatisfaction with the design of several devices included in the exchange bearing his initial, the H exchange. He reported, for instance, that the design of the register used at the H exchange should not be used in a full scale exchange of the system. He further commented that the present design of the final selectors was inappropriate and needed to be replaced and that the selector size should be decreased from the present 10,000 lines to 2,000 lines. In fact, Hultman is described in the minutes as reporting in effect that "all main parts are either to be replaced with other components or to be significantly redesigned."<sup>284</sup> This made the demonstration move from Norrtullsgatan to the premises of LM Ericsson, where untested models were exhibited. The demonstration, if appropriate to call it that, later continued with discussions on the intended redesign of other components as well as alterations to the circuit diagram of the system.

The H exchange, installed in a room at Norrtullsgatan, hence only remotely resembled the system envisaged by Hultman. In many respects the system was better represented by models of redesigned devices as well as by drawings on paper. A committee consisting of Landström, Ekeberg, Olson and Weman reported that it nevertheless found the system simple and ingenious and that the experiments should be continued.<sup>285</sup> But, the committee added, it would take at least another nine months before the system could be subjected to any detailed scrutiny, which also meant that any production of switches was at least nine months away.

Later in the following Spring, the H exchange would nevertheless begin switching calls for about 300 subscribers. However, at the beginning of 1918 it was clear that none of the test-exchanges would deliver any of the significant improvements to the Administration's service attributed to them only 12 months earlier. Again, neither the three development projects nor any agreement on an acquisition of the other network had come to the rescue. Indeed, for a while it seems as if the two kinds of solutions had inhibited one another, and Landström's efforts to insulate the issue of automation from

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<sup>283</sup> Alfred Lundgren, 7 January 1918, "Protokoll, hållet vid sammanträden den 2-4 januari 1918 för bedömning av telefondirektör A. Hultmans telefonsystem," (minutes from meetings 2-4 January 1918 to evaluate Hultman's system), TALb; F I A:68.

<sup>284</sup> Full sentence (in Swedish): "Sedan av direktör Hultmans meddelanden sålunda framgått, att systemets samtliga huvudbeståndsdelar antingen skulle helt ersättas med andra eller till väsentliga delar omkonstrueras, besöktes Akteibolaget LM Ericssons & C:o fabriker, där modell till ny ledningsväljare och ny sequence-switch förevisades." Ibid. p. 2.

<sup>285</sup> Karl Erik Landström, Erik Ekeberg, Klas Weman, and Herman Olson, 7 January 1917, "V.P.M.," (memo), TALb; F I A:68.

the issue of an acquisition had not succeeded in moving any of them forward. It is true that the other two test-exchanges, and in particular the B exchange, had been ticking over in switching calls since Summer. But, for some reason, the planned procurement of automatic switches was suspended even after Landström had stabilised the forecast number of subscribers.

### The technical details of the telephone services became increasingly apparent

In 1908, Hultman had maintained that the subscribers should have nothing more to do than to remove and restore the handset. This he had maintained contra to automatic systems where subscribers had to use a dial to make their calls. However, his affirmation also conveys a more general ambition of rendering a telephone service without subscribers being burdened with the technical details. Apart from choosing the kind of subscription desired and ordering calls by speaking to an operator, the objective was that subscribers in Stockholm would need to see little of the workings of the telephone network.

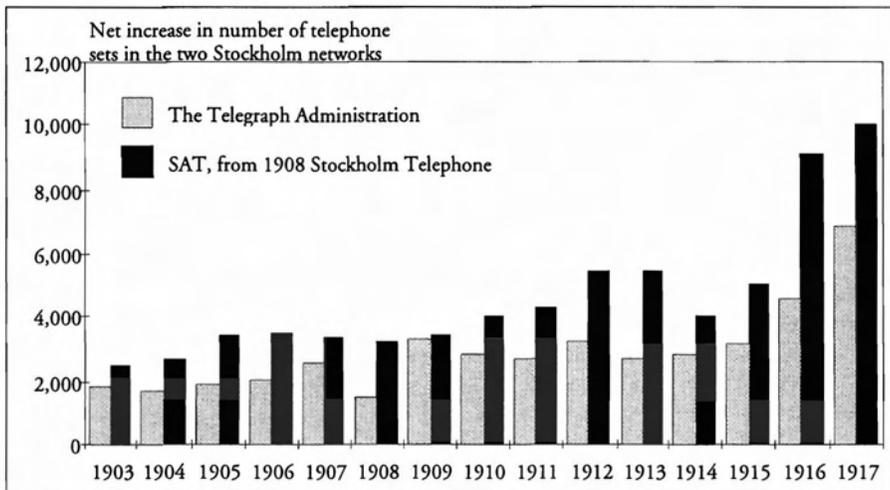


Figure V-1 The growth of the two networks within the 70 km-zone, 1903-1917.<sup>286</sup>

However, the increasing turmoil surrounding tariffs, attempted acquisitions, and deficient services had brought the inner workings of the telephone networks increasingly into the public domain. Moreover, the numbers of subscribers increased in both networks (see Figure V-1). This in itself made it increasingly difficult for the engineers and other managers of the two networks to achieve the objective of screening the growing numbers of subscribers from the intricacies of their networks. This chapter

<sup>286</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 196.

has depicted some of the work being done, but has also displayed difficulties with establishing what the appropriate measures ought to be as well as difficulties in carrying them through. The next chapter follows some of the many further efforts performed to alter the workings of the telephone networks in Stockholm.

## VI

# Automation for the Nation

### Patching the Networks Together

The previous chapter depicted the two telephone services in Stockholm as beset with difficulties during the war years and up to January 1918. The Telegraph Administration network in particular seemed on the verge of succumbing to diverse forces, made up of people wanting to make (too many) calls, (too many) people wanting to have a subscription, the increased trunking of local calls, a shortage of operators and the lack of such things as copper, manganese and space to house additional switchboards. This chapter recounts some of the further work that went into patching together the networks in Stockholm. The chapter will end at a point where the techno-economic organisation of Swedish telecommunications had been utterly transformed.

### Towards the Transformation of Swedish Telephony

#### Could an acquisition be achieved with so little money about?

The two telephone services were becoming increasingly less black-boxed (and non-functioning) in the view of subscribers. What is more, their operating costs seemed to outstrip their revenues. This was partially attributed to rising costs due to the ever augmented number of trunked calls caused by network growth, but it was also – in the jargon of economists – a period of high prices.<sup>1</sup> Among other things, this had translated into cost-of-living allowances, which had been added to wages at the Telegraph Administration as well as Stockholm Telephone since at least 1916.<sup>2</sup>

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<sup>1</sup> The phenomenon of *dyrtid* (the Swedish term for a period of high prices) was reflected in *Ekonomisk Tidskrift* (Economic Journal). According to an index prepared in 1949 of articles published between 1899 and 1949, the word 'dyrtid' appeared in the title of 3 signed articles (excluding reviews, and brief articles lacking indication of author) in 1914, in the title of 3 signed articles in 1916 and in the title of 4 articles in 1917. See *Ekonomisk Tidskrift, Ekonomisk tidskrift, register 1899-1949* (Stockholm: Almqvist & Wiksell, 1949).

<sup>2</sup> The cost-of-living allowances were in particular, but not exclusively, directed to those with breadwinners with low wages. See *Aktiebolaget Stockholmstelefon, Aktiebolaget Stockholmstelefon, Styrelse- och Revisionsberättelser för år 1915* (Stockholm, 1916), p. 2; *Aktiebolaget Stockholmstelefon, Aktiebolaget Stockholmstelefon, Styrelse- och Revisionsberättelser för år 1916* (Stockholm, 1917), p. 2; and *Aktiebolaget Stockholmstelefon,*

The Telegraph Administration's local telephone service within the 70 km-zone had been operating at a loss, according to its records, since 1913. From a meagre surplus of 1.70 kronor per telephone in 1912, the surplus had turned into an swelling deficit of 8.77 kronor per telephone in 1916 and almost 15 kronor per telephone in 1917.<sup>3</sup> Stockholm Telephone's service had fared better in this respect, having showed a surplus even for 1917. At the same time, there were signs of increasing complaints regarding the company's service.<sup>4</sup> Moreover, the company had increased some of its tariffs outside of the city of Stockholm in December 1917 and had also applied to the Stockholm city council in November 1917 for permission to increase its tariffs within the city itself.<sup>5</sup>

The troubled state of Stockholm Telephone's telephone network, however, was just one of the considerations facing SAT, its parent company. SAT's previously profitable operations in Moscow and Warsaw had been incurring losses since 1916.<sup>6</sup> The telephone network in Warsaw had been commandeered by the Germans. The network in Moscow had been handed over to the Russian authorities in January 1917, but no compensation had been paid to SAT by January 1918.<sup>7</sup> Moreover, a Swedish newspaper had reported in November 1917 that a building related to Swedish telephone interests had been destroyed during disturbances in Moscow.<sup>8</sup>

Politics seemed to intervene in the field of telephony in Sweden as well. In October 1917 a new Swedish government came to power, based on a coalition between Social Democrats and Liberals. Towards the end of that year, the recently appointed

*Aktiebolaget Stockholmstelefon's Styrelse- och Revisionsberättelser för år 1917* (Stockholm, 1918), p. 2; and Hans Heimbürger, *Svenska Telegrafverket: Telefon, Telegraf och Radio, 1903-1920*, vol. 4 (Göteborg: Kungliga Telegrafstyrelsen, 1953), pp. 509-520.

<sup>3</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 199.

<sup>4</sup> See, for instance, "Olidliga förhållanden: Personalen vid Stockholmstelefon måste hållas efter," *Aftonbladet* (Stockholm), 6 November 1917; "10 000 nya telefonabbonnenter: ett rekordår för Stockholmstelefon: den ökande samtalsfrekvensen nödvändiggör en del restriktioner," *Svenska Dagbladet* (Stockholm), 30 December 1917; and "'Det är som att väcka döda': En mängd klagomål mot Stockholmstelefon," *Svenska Dagbladet* (Stockholm), 25 March 1918.

<sup>5</sup> *Aktiebolaget Stockholmstelefon, Aktiebolaget Stockholmstelefon's Styrelse- och Revisionsberättelser för år 1917* (Stockholm, 1918), pp. 1-2; "Stockholmstelefon vill höja årsavgifterna," *Nya Dagligt Allehanda* (Stockholm), 6 November 1917; and "Stockholmstelefon blir dyrare," *Stockholms Dagblad*, 6 November 1917.

<sup>6</sup> Artur Attman, Jan Kuuse, and Ulf Olsson, *LM Ericsson 100 år: Pionjärtid, Kamp om koncessioner, Kris, 1876-1932* (Stockholm: LM Ericsson, 1977), p. 183.

<sup>7</sup> Hemming Johansson, *Telefonaktiebolaget LM Ericsson, del 1 Från 1876 till 1918* (Stockholm: LM Ericsson, 1953), p. 407.

<sup>8</sup> "Svenska telefonbyggnaden i Moskva förstörd," *Göteborgs Aftonblad*, 22 November 1917. It is unclear from the article whether it was a building belonging to SAT's telephone network in Moscow or a building belonging to the joint-venture between the Russian LM Ericsson and SAT started in 1916. On these two businesses in Russia, see Attman, Kuuse, and Olsson, pp. 173-183, 191-197.

Minister of Public Administration, Axel Schotte, had commissioned the Telegraph Administration to investigate whether its telephone tariffs could be raised.<sup>9</sup> When the proposal was later discussed within the parliamentary working committee, the issue of including the 70 km-zone in future tariff increases was raised (again). This set the scene for new negotiations between the heads of the Telegraph Administration and Stockholm Telephone.

Negotiations towards an acquisition of Stockholm Telephone's network began sometime in March 1918. They began at a time when money was universally in short supply. The State had budget needs; the Telegraph Administration was allegedly making a loss on its local telephone service in Stockholm; employees faced increasing food prices; and so on. Moreover, it became clear in March 1918 that LM Ericsson's subsidiary in Russia, which included a large factory in Petrograd (now known as St. Petersburg), and its joint venture there with SAT, had both been nationalised without compensation.<sup>10</sup> With money so universally scarce, what could be done to make it possible for the Telegraph Administration to acquire Stockholm Telephone's network?

#### **Negotiating a new scenario**

Calculations were made within the Telegraph Administration with Karl Fredrik Wincrantz of Stockholm Telephone supplying figures giving the estimated value of the company's network.<sup>11</sup> Initial negotiations went quickly, since the two parties proceeded from drafts made during the negotiations in 1917. By 4 April a preliminary agreement had been reached and the Administration's general director Herman Rydin sent a long confidential memo discussing the issue to Axel Schotte and the party leaders in Parliament.<sup>12</sup> At the same time, rumours of an acquisition reached some newspapers. On the very same day as Rydin sent his confidential memo, a Stockholm newspaper ran an article on these rumours, reporting that Stockholm Telephone's share price had recently risen on the Exchange.<sup>13</sup> In the same article Fredrik Pegelow, chairman of the board of Stockholm Telephone, denied the rumours. Pegelow affirmed the self-evidence

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<sup>9</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 215.

<sup>10</sup> The loss to LM Ericsson from these nationalisations was later estimated to around 20 million kronor. Attman, Kuuse, and Olsson, p. 197.

<sup>11</sup> N.a., 20 March 1918, "Ekonomisk kalkyl över bärigheten av rikstelefonnätet inom 70 km området, under förutsättning att taxereformen genomföres," and K. F. Wincrantz, 16 March 1918, 'Letter to K.E. Landström,' both at TALb; F I A:26.

<sup>12</sup> On the first page it is noted in handwriting that the memo had been handed to Schotte and the 'party leaders.' Herman Rydin, 4 April 1918, "VPM ang. telegrafverkets övertagande av det enskilda telefontätet i Stockholm och dess omnejd (Förtroligt)," TALb; F I A:26.

<sup>13</sup> "Rykten om statsinköp af Stockholmstelefon: Frågan nu icke alls aktuell," *Nya Dagligt Allehanda* (Stockholm), 4 April 1918.

of the fact that present conditions, and specifically the predicament of the state finances, were hardly conducive to such a transaction.

Yet it was exactly to such a transaction that Rydin's memo invited a positive response from Schotte and the party leaders. As set out in the memo, there was a lot that pointed in favour of taking over Stockholm Telephone's network as soon as possible. One thing was the sense of unfairness to the rest of the country that the capital was exempted from the tariff reform introduced in 1916. An acquisition was almost necessary, Rydin emphasised, since it gave the possibility to introduce the tariff reform within the 70 km-zone. This, in turn, made the proposed transaction a good bargain for the State. He summarised the three principal reasons why the transaction was both good and almost necessary as follows:

[1] The carrying through of uniform telephone conditions in the whole country can be achieved. The Stockholm region will thus be subjected to the same terms as the rest of the country. [2] The finances of the Stockholm network can be ordered in a manner that makes this part of the telephone administration produce a reasonable yield on invested capital. [3] The purchase sum represents a reasonable price and the State will receive a good return on the transaction.<sup>14</sup>

Rydin further noted that those subscribing to both services had been seen as a disadvantage in earlier proposed acquisitions. Now, he emphasised, the number of dual-subscribers was an advantage at a time of shortages since an acquisition would release valuable equipment when these subscribers cancelled one of their subscriptions.<sup>15</sup> Thus, all told, Rydin's memo spoke in favour of an acquisition on the grounds of finances and fairness and it specifically aimed at invalidating any objection on the grounds that the state finances would not allow such a transaction. An objection on those grounds would be meaningless, it was stressed, since the preliminary discussions with representatives of Stockholm Telephone indicated that they could accept payment by instalments of some sort.<sup>16</sup> Several such alternative terms of payment was further outlined in the memo, including a consortia alternative where the Administration would lease and pay off the network by instalments over a longer period of time.

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<sup>14</sup> Original sentences (in Swedish): "Genomförandet av enhetliga telefonförhållanden över hela landet kan ernås och således även Stockholmsrayonen underkastas samma villkor som övriga landet. Ekonomin inom Stockholmsnätet kan ordnas, så att även denna del av telefonförvaltningen lämnar skälig avkastning på det där nedlagda kapitalet. Köpesummans storlek motsvarar ett skäligt pris för affären och staten erhåller en god vinst på densamma." Herman Rydin, 4 April 1918, "VPM ang. telegrafverkets övertagande av det enskilda telefonnätet i Stockholm och dess omnejd (Förtroligt)," TALb; F I A:26, p. 27.

<sup>15</sup> Ibid., p. 9.

<sup>16</sup> Ibid.

On 20 April Rydin informed Karl Fredrik Wincrantz that it seemed as though both the government and a majority in Parliament were favourable towards an acquisition as such.<sup>17</sup> Rydin informed that they had the feeling that it was perhaps the last time the prospects were favourable for a resolution through an acquisition. However, he added, the government had specifically expressed that payments in 1918 and 1919 would be difficult. He therefore asked Wincrantz to outline a scheme on terms of payment that involved payment by instalments and that furthermore avoided a consortia solution. In his reply three days later, Wincrantz outlined a scheme incorporating promissory notes at 6% interest, with 5 million kronor payable on 1 July 1918 and 1919 respectively, 10 million kronor payable on 1 July 1920 through 1922, and the remainder payable on 1 July 1923.<sup>18</sup>

The day after Wincrantz replied, Rydin sent five copies of a new memo to Axel Schotte, presumably to allow the latter to inform the party leaders.<sup>19</sup> There Rydin reiterated the basic arguments for the acquisition as well as the suggested terms of payment. Rydin further stressed that the two first instalments could be made by using a part of the funds already budgeted to the Telegraph Administration.<sup>20</sup> If the Telegraph Administration was allowed to finance the first two instalments by using these funds, no extra burden would be put on the state finances for 1918 and 1919. Moreover, given the present shortages of material, the purpose of the budgeted funds – to develop the Administration's telegraph and telephone services – was even better served this way, he argued. Rydin concluded the memo by briefly presenting calculations that showed that the network in the Stockholm area would render a 6.11% yield on invested capital after an acquisition and after the introduction of the tariff reform.

The agreement may have seemed to be in the clear, but apparently it was not. Only a few days after Rydin's second memo, Rydin had to inform Wincrantz that the government considered delaying the issue until the Autumn.<sup>21</sup> Apparently there were those that doubted whether this was the right time to present a government proposition on an acquisition. He therefore asked Wincrantz whether Stockholm Telephone could stand by the agreement until the Autumn. In that way, he added, "there would be time

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<sup>17</sup> Herman Rydin, 20 April 1918, 'Letter to K. F. Wincrantz,' TALb; F I A:26.

<sup>18</sup> Karl Fredrik Wincrantz, 23 April 1918, 'Letter to Herman Rydin,' TALb; F I A:26.

<sup>19</sup> On the first page it is noted in handwriting that 5 copies of the memo had been handed to Schotte. Herman Rydin, 24 April 1918, "VPM ang. telegrafverkets övertagande av det enskilda telefonnätet i Stockholm och dess omnejd," TALb; F I A:26.

<sup>20</sup> *Ibid.*, pp. 4-5.

<sup>21</sup> Herman Rydin, 29 April 1918, 'Letter to K. F. Wincrantz,' TALb; F I A:26.

to more thoroughly influence and steady the sentiment.”<sup>22</sup> In a reply the same day, Wincrantz informed that the board could not agree to stand by the agreement until the Autumn, given the present fluctuations in money value.<sup>23</sup>

What had happened with the memo sent to Axel Schotte on 24 April?<sup>24</sup> It seems that Schotte had wanted to be assured that the agreed upon acquisition had widespread support among the parties before presenting the government proposition. His probing had indicated that most party representatives he had talked to were positive to the acquisition. However, one important group appeared to have had objections to the agreement, the Conservatives in the second chamber. Their leader was Arvid Lindman, the former general director of the Telegraph Administration and since 1916 the chairman of the board of LM Ericsson. He had presented himself as favourable to the acquisition, as such, but had raised objections against the timing, given the situation on the money market.

New discussions quickly ensued, given the situation in Parliament and given Stockholm Telephone’s refusal to stand by the agreement until the Autumn. The bargain struck a few days later was to move the third and later instalments forward by 2 years, and in compensation the price was increased by 2 million kronor. This scheme was allegedly also approved by Arvid Lindman.<sup>25</sup> On 7 May, the contract between the Telegraph Administration and Stockholm Telephone was signed, and 3 days later the government proposition was presented. Before this proposition was presented another salient contract was signed by representatives of SAT and LM Ericsson. On 8 May they agreed to merge the two companies, *provided* that Parliament approved the Administration’s acquisition of the Stockholm Telephone network and provided that the relevant shareholders’ meetings approved the acquisition and the merger. Thus, to the scenario of acquisition another scenario attached. The professed motive behind the merger was that the two companies had a strong community of interest, and that the merger better prepared for the reality that would come after the anticipated end to the war.<sup>26</sup>

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<sup>22</sup> Full sentence (in Swedish): “Propositionen skulle i så fall framläggas vid riksdagens början och man finno tid att grundligare än nu kunnat ske bearbeta och stadga stämningen.” Ibid.

<sup>23</sup> Karl Fredrik Wincrantz, 29 April 1918, ‘Letter to Herman Rydin,’ TALb; F I A:26.

<sup>24</sup> This paragraph is based on a hand-written résumé of the political negotiations found at the archives of the Telegraph Administration among the correspondence between Rydin and Wincrantz quoted above: n.a., n.d., “Ang. inköp av Stockholmstelefon våren 1918,” TALb; F I A:26. Since the note is undated and unsigned the merits of its account are somewhat limited. However, the story in this note corresponds with the briefer account given in Heimbürger, *Svenska Telegrafverket, 1903-1920*, pp. 215-217.

<sup>25</sup> Ibid.

<sup>26</sup> Johansson, *Telefonaktiebolaget LM Ericsson*, p. 229.

The government proposition presenting the acquisition began by briefly offering the primary arguments and an account of the previous attempts where an acquisition (or barter) agreement had been submitted to Parliament.<sup>27</sup> It was specifically noted in relation to these failed attempts that the large number of dual-subscribers (now 20,000) was an advantage in the present time of shortages, a point that Rydin had already made in his memo of 4 April.<sup>28</sup> About half of these, it was estimated, would terminate one of their subscriptions releasing much needed supplies of certain equipment. Another professed financial advantage to the Administration was the possibility to profit from the newly refurbished network of Stockholm Telephone. It was further stressed that the proposed acquisition was also profitable to the government, since it enabled the Administration to produce a reasonable yield. The possibility of also applying uniform conditions in the Stockholm region was also stressed as a desirable end in itself.<sup>29</sup> The transaction had to be undertaken sooner or later, it was finally stressed in the introduction. If postponed, it would only become more expensive to carry it out.

The above arguments were later reiterated in Schotte's narration towards the end of the proposition. There he stressed that this was indeed a government matter; a point apparently directed at those who found the issue to be a regional, rather than a national, matter. The people in Stockholm, he added, had more or less become accustomed to the dual service. It was not primarily a matter concerning them but the government. The government, he stressed, "which holds the rest of the large national telephone network in its hands, has to sooner or later incorporate the private business which operates a similar enterprise in the capital of significant extent."<sup>30</sup> He further reiterated an argument stated on previous occasions where an acquisition had been attempted: The present arrangement was detrimental from the point of the view of the national economy. This point, he asserted, had gained in importance since the previous acquisition proposals were presented to Parliament:

The extension of the State's and the company's networks ramifying side by side has increasingly proved to be reprehensible from the point of view of the national economy. This dual exploitation of two telephone networks within the same area involves unnecessary expenditures in terms of needless duplication of junction and subscriber's lines, exchanges, and other things.<sup>31</sup>

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<sup>27</sup> Kungl. Maj:ts Nåd. Proposition Nr 431, 10 May 1918.

<sup>28</sup> *Ibid.*, p. 4.

<sup>29</sup> *Ibid.*, p. 6.

<sup>30</sup> Full sentence (in Swedish): "Staten, som har det stora rikstelefonnätet i övrigt i sin hand, måste för eller senare införliva med sig det enskilda företag, som i huvudstaden bedriver en liknande verksamhet av betydlig omfattning." *Ibid.*, p. 20.

<sup>31</sup> Full sentence (in Swedish) "Sålunda har med utbredningen av statens och bolagens jämsides förgrenande telefontät den anordning visat sig allt mera nationalekonomiskt

The day after, on 11 May, the board of Stockholm Telephone presented the agreement to the company's shareholders.<sup>32</sup> At that meeting it was maintained that it had become increasingly obvious that the public would be better served if the two operations were merged into one. A merger, it was asserted, would make it possible to utilise the network more efficiently and it would make it possible to avoid expensive new constructions in the present time of crisis. The shareholders were further informed that the agreement gave the Administration the right to utilise the company's patents all over Sweden. The agreed price was too low it was admitted, but the board confirmed that it nevertheless endorsed the agreement reached. An agreement, it was affirmed, was inevitable anyway:

The company board considers that it ought to approve the agreement regardless of [the low price], and in this position the board has especially taken into consideration the impossibility of putting an end to the issue of an agreement between the two telephone networks. The issue is certain to reappear and will always be disturbing to the company's business. Sooner or later an agreement has to be brought about.<sup>33</sup>

Thus by 11 May there was a new scenario on the Administration's acquisition of Stockholm Telephone's network. This scenario of inevitable necessity had already been negotiated, enrolling such entities as the board of Stockholm Telephone, the Telegraph Administration's headquarters, the minister of public administration, and some party leaders. Yet, it remained to be seen if other necessary actors could be persuaded to support the scenario:

The acquisition is inevitable and it is desirable to carry it through as soon as possible. This acquisition is in the interest of the public, the State, the national economy, the Telegraph Administration, Stockholm Telephone, and the shareholders of Stockholm Telephone.

#### **Further trials of strength: Would the scenario hold?**

In an address to the annual meeting of the *Federation of Swedish Industry* on 23 April 1918, the economist Eli F. Heckscher spoke on *the State and private initiative after the war*.<sup>34</sup> The lecture had been a defence of free trade and industry, in the course of which

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förkastlig, som innebär onödiga utgifter, då två telefonnät exploateras inom samma område med därav föranledda obehövliga dubbla förbindelse- och abonnentledningar, dubbla stationer m.m." Ibid., p. 14.

<sup>32</sup> Aktiebolaget Stockholmstelefon, *Kallelse till extra stämma...* (Stockholm: 1918).

<sup>33</sup> Original sentences (in Swedish): "Då styrelsen det oaktat anser sig nu böra tillstyrka en försäljning, har styrelsen särskilt tagit hänsyn till, att frågan om en uppgörelse mellan de olika telefonnäten icke kan bringas ur världen utan med säkerhet återkommer och alltid inverkar störande på bolagets verksamhet. Förr eller senare måste en uppgörelse komma till stånd." Ibid., p. 2.

<sup>34</sup> Eli F. Heckscher, *Staten och det enskilda initiativet efter kriget* (Stockholm: Sveriges Industriförbund, 1918), p. 3.

he had reiterated a central argument from his article published in 1911: Monopolies owned or guaranteed by the State lacked potential competition to enforce adaptation to the demands of the market.<sup>35</sup> Potential competition for the private monopoly, he had stressed, would see to it that the “trees would not grow to the sky.”<sup>36</sup> Private monopolies arising from the play of the free forces could also disappear by the play of these forces, he contended.

Since Pegelow had given his reassurance in the beginning of April that no take-over agreement was under consideration the press had been void of reports on ongoing negotiations. The potential creation of a state monopoly in telephony had not been mentioned in Heckscher's lecture, however. Instead Heckscher's lecture had opened by referring to a recent government proposition to create a state monopoly in sulphite spirit and a recent proposal by the State Railways to investigate the nationalisation of the complete railway network. Given the general argument that had followed, his position was apparent on these tendencies towards nationalisation that accompanied the war: “We should have as little as possible of state enterprise by the time the war is over.”<sup>37</sup>

Only a matter of days later several newspapers had run articles about the ongoing negotiations concerning a new acquisition agreement.<sup>38</sup> Incidentally, these reports had coincided with articles reporting that two regional chambers of commerce were associating the Telegraph Administration's operating loss in 1916 with the situation in Stockholm.<sup>39</sup> The two chambers of commerce, it had been reported, were complaining to the government that the unprofitable state of the Telegraph Administration was caused by the low tariffs in Stockholm; tariffs that enabled subscribers there to telephone at the expense of those living in other parts of the country. An argument it appears that would strengthen the scenario as it was presented in the beginning of May.

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<sup>35</sup> Ibid., p. 21.

<sup>36</sup> Original full sentence (in Swedish and German): “Det gäller därför även om privatmonopolet: es ist dafür gesorgt, dass die Bäume nicht in den Himmel wachsen.” Ibid., p. 17.

<sup>37</sup> Full sentence (in Swedish): “För att nu till sist komma fram till frågan om staten och det enskilda initiativet efter kriget, kan den slutsatsen utan vidare dragas, att vi böra ha minsta möjliga statsdrift, då kriget är över.” Ibid., p. 33

<sup>38</sup> See, for instance, “Skall staten övertaga Stockholmstelefon? En bankruttförklaring för rikstelefonpolitiken,” *Aftonbladet* (Stockholm), 26 April 1918; “Statsinköp av Stockholmstelefon? Förhandlingar sägas pågå, och det uppges, att riksdagsmajoritet värfats för transaktionen,” *Nya Dagligt Allehanda* (Stockholm), 26 April 1918; and “Stockholmstelefon till staten? Underhandlingar om försäljning pågå,” *Svenska Dagbladet* (Stockholm), 26 April 1918.

<sup>39</sup> See, for instance, “Stockholm telefonerar på vår bekostnad: 450 000 kronor i förlust för Riks på Stockholm som landsorten betalar,” *Göteborgs-Posten*, 24 April 1918; “En miljonförlust för staten: En följd av konkurrensen mellan Riks och Allmänna,” *Svenska Dagbladet* (Stockholm), 24 April 1918; and “Rikstelefon går med förlust: Därför att abonnenterna i Stockholm gynnas för mycket,” *Östgöta Korrespondenten* (Linköping), 24 April 1918.

Yet Heckscher's address had expressed a general position against state enterprise and state monopolies. Although he would appear to have remained silent, there were other voices raised against the negotiated agreement as it became public. A Conservative member of parliament presented a proposition on 18 May against the proposed acquisition.<sup>40</sup> He objected to the Administration's assertion that competition was no longer either prevalent or needed in Stockholm. It was because of competition, this member of parliament asserted, that the telephone *had been* financially and otherwise well-managed. It was better in the present situation, he continued, to have two telephones, knowing that one could get through within a reasonable time, than to have only one network where one would have to wait for hours. He furthermore objected to the notion of uniformity and fairness stressed in the proposal. The interest on the payment for the acquisition, according to him, would in the end be taken out of the pockets of the public in the name of fairness. If instead the Administration took the argument about its unprofitable operations in Stockholm seriously, the Administration should learn from the profitable operations of Stockholm Telephone, he contended.

A few days later a letter to the editor of *Svenska Dagbladet* expressed support for the proposition against the acquisition.<sup>41</sup> This subscriber complained about the Administration's service in Stockholm and ironically remarked that perhaps the personnel at the exchange had taken time off while awaiting Parliament's decision. If the service was this miserable now, what might it not be when the useful competition has ceased, the subscriber asked. There were articles more favourable to the proposed acquisition, but it appears that at the end of May and the beginning of June those against were in majority.<sup>42</sup> The government proposition was scheduled to be presented to Parliament on 5 June, but as this date came closer it was far from apparent that the acquisition was in the clear. The shareholders meeting of Stockholm Telephone had approved the agreement on 27 May, but would Parliament perform its role proposed in the scenario?

In an article published 4 June, Gustav Cassel presented a forceful argument against the acquisition.<sup>43</sup> This article merits special attention not only because Cassel

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<sup>40</sup> Proposition presented by Ernst Lindblad with the consent of Alexander Hamilton and Fr. Fant. Motioner i Första Kammaren, Nr 208, 18 May 1918.

<sup>41</sup> "Rikstelefoneländet" (letter to the editor), *Svenska Dagbladet* (Stockholm), 23 May 1918.

<sup>42</sup> For one article favourable to the acquisition, stressing among other things its benefits from the point of view of the national economy, see "Telefonköpet," *Aftontidningen* (Stockholm), 25 May 1918; for additional articles against the acquisition, see, for instance, "Statsinköpet av Stockholmstelefon (letter to the editor)," *Stockholms Dagblad*, 3 June 1918 and "Innan telefonköpet genomtrufas," *Aftonbladet* (Stockholm), 4 June 1918.

<sup>43</sup> "Telefonköpet (by Gustav Cassel)," *Svenska Dagbladet* (Stockholm), 4 June 1918.

was a prominent economist, but also because it represents perhaps the most systematic attack on the scenario. Cassel labelled the striving to align the telephone conditions in Stockholm to those prevailing elsewhere as bureaucratic and found it furthermore designed to nourish sentiments of envy between regions by emphasising the present differences. The State, according to Cassel, was “the true representative of the societal interest and national community.”<sup>44</sup> It was therefore unworthy of a government administration to glorify separatist sentiments by signifying this striving for uniformity as something being in the interest of the country. Thus, to Cassel the ambition for uniformity in this case had the adverse opposite effect of disunity.

Cassel further disqualified the argument that the acquisition was desirable since the Administration’s Stockholm network was unprofitable. No proof, he contended, had been presented to substantiate the claim that the Administration’s operations there actually were unprofitable. His contention was that it was impossible at present to decipher if, and in that case to what extent, the local operations were credited with any of the large revenues from the inter-urban traffic. The bookkeeping and the calculations presented were inferior and should carry no weight in the decision, he asserted. On the other hand, it was obvious that Stockholm Telephone would profit from the agreement, whereas it was hardly evident that the acquisition was profitable to the government and to the Telegraph Administration. The merger would not produce the same kind of real savings as those realised in mergers within trade and industry, he asserted.

When discussing the calculations, Cassel estimated that to obtain a profit of 1.16 million kronor, the Administration would have to demand payments many times greater than that figure from the public. This represented nothing but a miserable financial policy, he opined. Cassel furthermore objected to the acquisition on the grounds that the competition was beneficial to the public. The public in the Stockholm area would be worse off after the merger, he contended, and pointed to the raised tariffs and the fact that it would nevertheless take time before the two networks were interconnected.

In his conclusion he finally attacked the notion that sooner or later an agreement was inevitable anyway. This notion, he affirmed, was simply an unfounded belief that the proponents sought to persuade both themselves and others to believe in. According to Cassel, the acquisition was neither inevitable nor desirable, especially not now given the dire state of the Government’s finances. He suggested instead that the acquisition

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<sup>44</sup> The full quote on his view on the argument of uniformity (in Swedish). “När chefen för civildepartementet i den nu avlämnade propositionen om telefonköpet betecknar Stockholms-områdets likställighet med det övriga landet som ett ‘landsintresse’, så är detta ett mycket olämpligt förhållande av separatistiska stämningar, som icke ens ha den förtjänsten att representera positiva separatintressen, utan endast äro ett uttryck för en rent negativ avundsjuka. Staten som ~~det verkliga samhällsintressets och den nationella samkänslans företrädare~~ är sådant icke värdigt.” Ibid.

had been proposed because of the Administration's interest in filling in the remaining gap in its sphere of power. Thus, all told, Cassel attacked every translation of interests in the scenario designed to make the public and Parliament ally with it. In Cassel's view the acquisition was against the interest of the public, the State, and the national economy.

Yet, by the time of Cassel's elaborate attack, the parliamentary working committee had approved of the government proposition.<sup>45</sup> The committee's approval had not been unanimous, however. When the committee presented its statement six of the 23 members of parliament present had begged to differ. There were also signs that the Conservatives in the second chamber were far from unanimously in favour of the acquisition. In an unsigned draft of a letter to Schotte, presumably by Rydin, Schotte was informed that discussions with Arvid Lindman had revealed that some Conservatives in the second chamber were against the acquisition on the grounds of a fear for state socialism.<sup>46</sup> The draft concluded that it was difficult to anticipate how such an objection could and ought to be answered, since it was unknown in what form such objections might arise.

The debates the following evening in the two chambers of Parliament were lengthy. In both chambers Axel Schotte elaborated and reiterated the reasons as to why the acquisition ought to be approved. The first reason was on grounds of principle: The government ought to hold the whole of a means of communication like telephony in its hand. He further stressed that this principle had previously been sanctioned by Parliament when approving the acquisition of other local telephone networks. This, he contended, had undoubtedly led the Parliament to assume the position that "the telephone service by its nature ought to be a state monopoly."<sup>47</sup>

Schotte secondly reiterated that the acquisition ended a waste to the national economy produced through unnecessary duplication of junction lines, exchanges, and so on. There were, he continued, additional practical reasons why an acquisition was called for at this particular moment. These reasons included the introduction of the tariff reform also in Stockholm, the possibility to render the Administration's operations there

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<sup>45</sup> Statsutskottets utlåtande Nr 196, 31 May 1918.

<sup>46</sup> N.a., 4 June 1918, "Herr Statsrådet m.m. Schotte," TALb; F I A:26. The draft letter mentions an appended memo of 3 June which was signed by Herman Rydin and upon which it was noted that it had been handed to Schotte on 4 June (Herman Rydin, 3 June 1918, "VPM (sent to Schotte)," TALb; F I A:26). The memo as the letter of the day after provided answers on some of the criticism issued in the newspapers against the acquisition.

<sup>47</sup> Full sentence (in Swedish): "Det är otvivelaktigt, och riksdagen genom att alltjämt medverka till, att de små lokalnät, som funnits, finge uppslukas av statsnätet principiellt ställt sig på den ståndpunkten, att telefonväsendet till sin natur bör vara statsmonopol." Schotte in the parliamentary records from first chamber, Riksdagens Protokoll, Första kammaren Nr 45, 5 June 1918, p. 4.

profitable, the supplies of materials released, and so on. He further gave an account of why the Administration's network had been in such a difficult state in the last few years.<sup>48</sup> On this he noted the work for preparing a new exchange, work which was not finished when the war broke out. The consequent shortages of material and the onrush of traffic and new subscribers had thus hit the network at a vulnerable time, he affirmed. The resulting temporary solutions with new auxiliary exchanges placed as an annexe to the main exchange had, in turn, increased the number of trunked calls and thus operating costs. This, together with the rise in prices, was an important reasons for the bad financial situation as well as for the many complaints about the service, he contended.

When discussing the profitability of the acquisition and the future Telegraph Administration, Schotte stressed that the merger would also produce savings in costs. In this argument, he explicitly rejected the views of those representing industrial interests who had questioned the possibility of achieving savings in cost in this case:

It is also evident that the merger will deliver savings in many areas. Men of industry are as we know generally prone to mergers in different fields of industry to reduce administrative cost. In this case, however, the representatives of the very same interests appears to argue in an opposite direction when they claim that a merger in this case will not produce any significant savings in administrative costs. I believe this to be incorrect.<sup>49</sup>

There were several divergent objections raised against the government proposition. One objection, for instance, was that the funds used for an acquisition could be put to better use in extending the telephone operations all over Sweden.<sup>50</sup> Another objection was the present state of the government's finances.<sup>51</sup> Another objection was that the proposition was written in haste, lacking a foundation in a proper investigation.<sup>52</sup> The member of parliament who had presented a proposition against the acquisition expressly cited Cassel's attack on the calculations showing the Administration's alleged unprofitability

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<sup>48</sup> Ibid., p. 9.

<sup>49</sup> Original sentences (in Swedish): "Givet är också, att besparingar på många områden komma att uppstå genom sammanslagningen. Man är ju annars bland industriens män angelägen om sammanslagningar på olika områden av industri och näringar för att förbilliga administrationskostnaderna. Här tycks däremot representanterna för samma intressen vilja gå en motsatt väg och påstå, att här skulle en sammanslagning icke medföra någon avsevärd minskning i administrationskostnaderna. Jag tror, att detta är felaktigt." Schotte in Riksdagens Protokoll, Andra kammaren Nr 69, 5 June 1918, p. 8.

<sup>50</sup> See, for instance, Strömberg in Riksdagens Protokoll, Första kammaren Nr 45, 5 June 1918, pp. 24-25; Magnusson (i Skövde) in Riksdagens Protokoll, Andra kammaren Nr 69, 5 June 1918, pp. 32-33.

<sup>51</sup> See, for instance, Hildebrand in Riksdagens Protokoll, Andra kammaren Nr 69, 5 June 1918, pp. 28-32.

<sup>52</sup> See, for instance, Andersson (i Skivarp) and Nylander in Riksdagens Protokoll, Andra kammaren Nr 69, 5 June 1918, pp. 2-3, 21-23.

in Stockholm.<sup>53</sup> One opponent found the information about the Administration's planned new main exchange to be deficient, and asserted furthermore that it was unclear when interconnection could be established.<sup>54</sup>

Yet, a central theme in the debate concerned the issues of monopoly versus competition and State versus private enterprise. In the first chamber the Conservative leader Ernst Trygger affirmed that he held the opinion that private enterprise was preferable to state enterprise in principle.<sup>55</sup> However, he continued, here the State already controlled most of the country's telephone network. Therefore, in this case, he argued that the conditions favoured an acquisition. Other Conservative members of parliament, and especially some in the second chamber, begged to differ in this case. In the second chamber several Conservative members spoke in favour of competition. One stated, for instance, that the competition had positively spurred the development of the Administration's operations all over the country. This made the issue of the proposed acquisition, this member of parliament continued, an issue of importance to the whole country. We have, he emphasised, "no guarantee whatsoever ... against that the elimination of this competition not will significantly worsen the whole of our telephone service."<sup>56</sup>

Another member of parliament objected to the positions taken by the Conservatives, and assured that Parliament was indeed capable of ensuring that a state monopoly of this kind did not overcharge the public.<sup>57</sup> Yet another member of parliament objected to the speeches that talked about "blessed effects that came with free competition."<sup>58</sup> Referring to their posture in an earlier issue regarding the nationalisation of the private sugar monopoly, he charged these opponents as not being pro competition but rather pro private monopolies:

I'm therefore ... compelled to draw the conclusion ... that it is not the free competition that these gentlemen cherish, but certainly the monopoly with

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<sup>53</sup> Ernst Linblad in Riksdagens Protokoll, Första kammaren Nr 45, 5 June 1918, pp. 21, 32.

<sup>54</sup> Lübeck in Riksdagens Protokoll, Andra kammaren Nr 69, 5 June 1918, p. 12.

<sup>55</sup> Ernst Trygger in Riksdagens Protokoll, Första kammaren Nr 45, 5 June 1918, pp. 17-19.

<sup>56</sup> Full sentences (in Swedish): "Och vi ha icke någon som helst garanti för – det tror jag man måste säga – att icke bortfallandet av denna konkurrens kommer att försämra hela vårt telefonväsende ganska betydligt." Lübeck in Riksdagens Protokoll, Andra kammaren Nr 69, 5 June 1918, pp. 14-15.

<sup>57</sup> Jönsson (i Revinge) in Riksdagens Protokoll, Andra kammaren Nr 69, 5 June 1918, p. 26.

<sup>58</sup> Full sentence (in Swedish): "Här har en rad av talare som ett av de väsentligaste skälen för avslag talat om de välsignelsebringande verkningarna utav den fria konkurrensen." Ingvarsson in Riksdagens Protokoll, Andra kammaren Nr 69, 5 June 1918, p. 27.

the little addition that it should be private monopolies excluding state monopolies.<sup>59</sup>

Given the political attributions of this issue, it is worth noting that Conservative leader in the second chamber, Arvid Lindman, remained silent (at least on record). Lindman, who had assisted in the negotiation of the government proposition, spoke neither in favour or against the acquisition and on his views on the virtues of competition and monopoly he said nothing. The one who was chairman of the board of LM Ericsson at the time and who had been the Telegraph Administration's general director when the issue of an acquisition had been discussed in Parliament in 1906, said nothing whatsoever on an issue of importance to Swedish telephony. Maybe his position rendered him disqualified to speak, or perhaps he remained silent to avoid such an issue being raised. Moreover, his involvement in the negotiations prior to the agreement indicate that he had presumably already done his share in attracting support for the scenario.

When all was said and done, the voting was largely in favour in the first chamber and 137 for and 37 against in the second chamber. The scenario had held, even in the face of the seemingly omnipresent lack of money. The Telegraph Administration was to acquire Stockholm Telephone's network on 1 July 1918 for about 47 million kronor. Parliament had decided, albeit by majority vote, to support the scenario. Thus in a sense it had agreed that telephony by its 'nature' ought to be a state monopoly and that the creation of this monopoly was in the interest of the State, the public, and the national economy.

Later in the Summer the shareholders' meetings of LM Ericsson and SAT agreed to merge the two companies into one new company, General Telephone LM Ericsson. Leaving the further work of merging LM Ericsson and SAT aside, it should nevertheless be noted that it meant that the substantial purchase sum for the Stockholm network was subsequently used in part to cover the losses both companies were experiencing in Russia.<sup>60</sup>

Thus, by the Summer 1918, the organisation of Swedish telecommunications had been utterly altered. A few signatures on two contracts from May 1918 and the abundance of documents which followed had summoned up support. Yet, as with all decisions put down on paper, a lot of work remained to materialise them. The remainder

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<sup>59</sup> Full sentence (in Swedish): "Jag nödgas sålunda därur draga den slutsatsen, min herrar, att det är inte den fria konkurrensen, som i grunden är herrarnas hjärtebarn, utan det är nog monopolet, med det lilla tillägget bara, att det skall vara privatmonopol men icke statsmonopol." Ibid.

of this chapter accounts for some of the work done to further realise the merger of the two networks in Stockholm, making the monopoly more than a parliament-approved 'paper' scenario.

### Managing the Merger

Realising the merger was apparently considered no small challenge. In a memo on the need to alter the organisation of the Administration it was asserted that the difficulties grew more rapidly than did size:

As the multiple at an exchange grows by the square of the number of subscribers, one can say that the technical difficulties on the whole grow quadratic with the development of the telephone network. ...

It would therefore be more than remarkable if an organisation, appropriate and appointed under the relatively modest conditions that prevailed 1902, would be satisfactory for a technical state enterprise of the size the Telegraph Administration has now attained.<sup>61</sup>

Given its implications in increased size, there were indeed difficulties facing the 'merger on paper.' In mid 1918, there were around 4,000 people put on hold for a new subscription.<sup>62</sup> There were several complaints in the newspapers regarding the new order and about the allegedly bad service.<sup>63</sup> As if the existing adversities were not enough, an epidemic of Spanish flu began to spread among the telephone operators. Professedly the disease was carried from operator to operator by the mouthpieces at the switchboards, and by the end of July it was reported that more than 400 operators were sick.<sup>64</sup> The large numbers of sick operators even had the Telegraph Administration begging the public in Stockholm to keep their calls to a minimum.

<sup>60</sup> In the early 1920s roughly 22 million kronor was used to pay debts that largely were related to the two company's losses in Russia. A detailed account of how the purchase sum was utilised is given in Attman, Kuuse, and Olsson, pp. 250-251.

<sup>61</sup> Original sentences (in Swedish): "Man kan påstå, att liksom multipelfältet å en telefonstation växer kvadratisk med antalet abonnenter, så växa också de tekniska svårigheterna överhuvud taget kvadratisk med telefonnätets utveckling. ... Det skulle därför vara mer än märkvärdigt om en organisation, lämpad för och fastställd att gälla under så relativt små förhållanden som voro rådande år 1902, skulle vara tillfredsställande för ett tekniskt affärsverk med de mått som telegrafverket numera uppnått." Herman Rydin, 4 October 1918, "Till Kommunikationsverkens Lönekommitté," (To the communication administrations salary committee), pp. 2-3, TALb; F I A:31.

<sup>62</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 135.

<sup>63</sup> See, for instance, "Telefonsorger," *Svenska Dagbladet* (Stockholm), 28 June 1918; "Efter telefonsammansslagningen," *Aftonbladet* (Stockholm), 6 July 1918; and "Fria uttalanden: Missnöje med de nya telefonavgifterna," *Svenska Dagbladet* (Stockholm), 7 July 1918.

<sup>64</sup> See, for instance, "Spanska sjukans börjar bli allvarlig," *Svenska Dagbladet* (Stockholm), 30 July 1918; "Spanska sjukans härjningar: Allmänna telefon värst utsatt på torsdagen," *Nya Dagligt Allehanda* (Stockholm), 1 August 1918; and "Telefonerna och influensan: Taltrattarna äro smittospridare, som ej får förbises," *Dagens Nyheter* (Stockholm), 20 August 1918.

### **Interconnecting exchanges, tariffs, and bookkeeping**

In the Summer of 1918 Axel Hultman was appointed to the special position of chief engineer for the Administration's two telephone networks in Stockholm, with the mission to oversee their merger.<sup>65</sup> As chief engineer his main responsibility was to supervise the take over of Stockholm Telephone's exchanges and the technical aspects of merging them with the Administration's network. There had been no interconnection between the two networks since 1903, and it proved to take quite some time to re-establish interconnection between the two networks in Stockholm. Interconnection was hastily introduced in other parts of the 70 km-zone and by 1920 all exchanges except those in Uppsala had been interconnected.

In Stockholm, the obstacles were more considerable and the re-establishment of interconnection was put on hold. In Stockholm the exchanges in both networks were crowded with no reserve space to accommodate switchboards for switching calls between the two networks. What is more a substantial number of connecting cables had to be run between the exchanges.<sup>66</sup> Equipment for a new interconnection exchange had already been ordered in Autumn 1918, but until Summer 1919 subscribers had to continue to rely on the manual messaging service to transfer short messages to subscribers belonging to the other network. In June 1919 a small interconnection exchange was put into operation, located at the premises of Stockholm Telephone's main exchange where, for a special interconnection fee, subscribers could have calls switched to the other network. The service was limited, however. The new interconnection exchange was restricted to local calls, which meant that placing inter-urban calls to and from the Stockholm Telephone network was still impossible. It took until 1923 before full interconnection was established between the two networks.

Anders Lignell (1866-1943), a superintendent from the Administration's operations in the province of Hälsingland, was appointed acting telephone director to take over Hultman's position, which meant heading the Administration's original telephone network in Stockholm. Apart from anything else, this involved supervising the introduction of a new tariff structure. The decision had been taken on 28 June 1918 that the 1916 telephone regulations and tariffs applicable outside the 70 km-zone should when possible be made applicable for the two networks inside the 70 km-zone.<sup>67</sup> Stockholm Telephone had entered into five year contracts with its subscribers which implied that the new tariff structure could only be introduced gradually as running subscriber contracts expired. Before the tariff reform had been introduced in

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<sup>65</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, p. 485.

<sup>66</sup> Heimbürger, *Svenska Telegrafverket, 1903-1920*, pp. 226-228.

<sup>67</sup> *Ibid.*, p. 130.

Stockholm, subscribers had not only chosen between the two services but also among several different subscriptions. With the tariff reform, the categorisation of subscribers was to be reversed. Now the new yearly fee for each subscriber was to be determined according to a tariff scale based of how many local calls the subscriber made, in practice estimated by taking measurements a few weeks per year.

Not surprisingly, the new tariff structure and practices attracted complaints similar to those attracted by the 1916 revision affecting other parts of Sweden.<sup>68</sup> In June 1919, the Telegraph Administration took measures towards an integration of the administration of the two networks, in part explicitly motivated by a desire to coordinate the practices of determining tariffs. A memo to the government from the Administration's central administrative department stressed the importance of having Lignell supervise the incorporation of subscriptions in both networks into the structure of the tariff reform.<sup>69</sup>

The setting of the subscription tariffs for both networks, often raising issues dependent on subjective judgement, should be placed under the supervision of one single person as quickly as possible. On the one hand, the public must find it inappropriate that different grounds for tariffs are maintained within the two networks. On the other hand, it is of the utmost importance right from the beginning for the Telegraph Administration to incorporate expiring subscriptions in the acquired network into proper subscription categories.<sup>70</sup>

The memo also recommended tighter integration of the administration and bookkeeping of the two networks and described Anders Lignell as having worked for some time on arranging the bookkeeping at the Administration's Stockholm network to accommodate the new tariff structure. This work was reportedly also increasingly needed within the Stockholm Telephone network and it was stressed that this should be done by applying the same principles as the Telegraph Administration. This would facilitate the achievement of great savings by the bringing together of the administrative departments to make one single department "when the time was right and necessary premises were

<sup>68</sup> See, for instance, "Till vederbörande styrelser i Riks och Allmänna (letter to the editor)," *Aftonbladet* (Stockholm), 7 April 1919.

<sup>69</sup> Adolf Hamilton (sign. AH), 29 July 1919, "Till Konungen," (Draft of letter to the government), TAAb; F I A:259.

<sup>70</sup> Original full sentences (in Swedish): "Särskilt böra de på subjektivt bedömande ofta beroende frågorna angående abonnemangens taxering snarast möjligt för båda nätens vidkommande förläggas under en och samma person. Å ena sidan måste det nämligen för allmänheten te sig olämpligt att olika taxeringsgrunder göras gällande vid de skilda näten. Å andra sidan är det för telegrafverket av synnerlig vikt, att redan från början få in abonnemangen vid det övertagna nätet, i den mån kontrakten upphöra, under riktiga abonnemangsklasser, och att därvid anläggas sådana ekonomiska synpunkter, att det kan bli möjligt att med nu rådande dyra priser å arbetskraft och materiel göra det inköpta telenätet inkomstbringande." *Ibid.* pp. 2-3.

put into order.”<sup>71</sup> This necessitated Anders Lignell also being put in charge of transforming the administrative routines and bookkeeping within the network formerly belonging to Stockholm Telephone.

### **Automatic switches and the merger of the two networks**

Prior to the actual acquisition, the idea of introducing semi-automatic switches had appeared in several different guises in relation to a potential merger of the two networks. Early in 1917, for instance, the program for a swift automation of the Administration's network prepared by Hultman had been halted due to discussions regarding an acquisition of Stockholm Telephone. Later that Spring the head of the technical department Karl Erik Landström had pressed for a swift settlement of these negotiations to be able to move forward with deciding on the size of the future main exchange of the Telegraph Administration. Finally, in the Summer 1917, Landström had argued that, in the event of an acquisition, the most economical procedure was to carry through a merger of the two networks only after the Administration had automated its network.<sup>72</sup>

When the preparations for procuring automatic switches recommenced in the Autumn 1919, the Telegraph Administration approached the government demanding funding for erecting buildings to house automatic exchanges.<sup>73</sup> This request provided an account of what the problems were and how they might be satisfied with the introduction of automatic switches. It was asserted that a growing urban network equipped with manual switchboards would at some point reach a size where, for purely technical reasons, it would be impossible to connect all subscribers to a single exchange. With more than one exchange, arrangements with special transfer switchboards were needed but as growth continued there would come a point where this system would no longer suffice. The growing sub-exchanges and the multiplied numbers of transfers between the exchanges would increase the work of operators more and more. This meant either a deterioration in service or a constant increase in personnel.

The operating costs would rapidly increase without being matched by increased service and large sums would hence be wasted. A continuation on this road cannot be characterised as anything else than the opposite of businesslike conduct.<sup>74</sup>

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<sup>71</sup> Ibid. pp. 1-2.

<sup>72</sup> Confer chapter V, pp. 206-208 passim.

<sup>73</sup> Document extensively quoted in Hugo Lindberg, *Med Fingerskiva: Minnesskrift med anledning av Stockholms telefonnätets automatisering* (Stockholm: Telegrafstyrelsen, 1938), pp. 38-40.

<sup>74</sup> Original sentences (in Swedish): “Driftskostnaderna skulle således snabbt stiga i höjden

It was then affirmed that the telephone network in Stockholm had come dangerously close to this critical turning point over the last few years. To substantiate this point the request depicted the telephone exchanges which constituted the two networks in Stockholm and the number of subscribers' lines connected to each, see Table VI-1.

*Table VI-1 The exchanges in the two telephone networks in Stockholm 1919.<sup>75</sup>*

<i>The Telegraph Administration</i>		
A main office at Skeppsbron 2, containing:		
a main exchange with.....	16,110	subscriber's lines
an auxiliary exchange with .....	3,780	»
a sub-exchange for 4 districts with in total .....	2,490	»
the nominal call exchange with .....	850	»
A sub-exchange at Jakobsbergsgatan 24 (Jeriko) with .....	1,380	»
A sub-exchange at Upplandsgatan 48.....	2,080	»
A sub-exchange at Sibyllegatan 39.....	2,250	»
Total	28,940	subscriber's lines
<i>formerly Stockholm Telephone</i>		
A main office at Malmkillnadsgatan 26-30, containing:		
a main exchange with.....	22,380	subscriber's lines
a sub-exchange with.....	4,840	»
A sub-exchange at Högbergsgatan 33 and 35 with .....	17,000	»
A sub-exchange at Vegagatan 10 with.....	13,570	»
A sub-exchange at Sibyllegatan 24 with .....	6,630	»
A sub-exchange at Polhemsgatan 32 with.....	5,430	»
Total	69,850	subscriber's lines

It was asserted that given the increased tariffs, the subscribers had legitimate claims to be offered the ability to reach all other subscribers swiftly and safely and furthermore the public eagerly awaited an amalgamation of the two networks. The request stressed that the Telegraph Administration had an obligation to arrange the telephone operations in such a way in the future that it could satisfy these legitimate claims. This obligation, it continued, translated into a national obligation now that the State had a virtual monopoly in telephony through the Telegraph Administration:

The headquarters of the Telegraph Administration cannot help reflecting that since the State now has a virtual monopoly in telephony and telegraphy, the State should pursue these operations in a manner which will convince the users that they would not have been better off exposed to the exploitation of private enterprises.<sup>76</sup>

utan att dock motsvaras av det vunna resultatet, och stora summor vara så gott som bortkastade. En fortsättning på denna väg kan ej karakteriseras annorlunda än som den rena motsatsen till affärsmässig drift." Quoted in Lindberg, *Med fingerskiva*, p. 38.

<sup>75</sup> Adapted from request, quoted in Lindberg, *Med fingerskiva*, p. 39.

<sup>76</sup> Original sentences (in Swedish): "Telegrafstyrelsen kan ej undertrycka den reflexionen,

This called for placing all subscribers into a single systematically ordered telephone network and it was stressed that this was financially the only possible way to satisfy the interests displayed above. It was once again affirmed that a network systematically ordered in this manner using manual exchanges could not be arranged without financial wastefulness. Automatic exchanges were essential for the realisation of a network of this nature. It was in addition affirmed that the perfection that automatic switches now had acquired made them not only less expensive to install but also less costly to operate. The telephone network envisaged had a total capacity of more than 200,000 subscribers' lines which was estimated to satisfy the demand for 20 years to come. The network as envisaged would have eight exchanges in all, each serving a specific district in Stockholm, see Table VI-2.

*Table VI-2 The exchanges in the network envisaged in the request for funding 2 September 1919.<sup>77</sup>*

An exchange at Jakobsbergsgatan 24 (Jeriko) for.....	25,000	subscriber's lines
An exchange at Malmskillnadsgatan 26-30 for.....	25,000	»
An exchange in the western part of the upper district of Norrmalm for.....	35,000	»
An exchange in the north part of the upper district of Norrmalm for.....	10,000	»
An exchange in the district of Östermalm for.....	40,000	»
An exchange in the district of Kungsholmen for.....	25,000	»
Two exchanges in the district of Södermalm, each for 25 000 subscribers' lines.....	50,000	»
Total	210,000	subscriber's lines

A possible future was set out. Indeed, what was presented was a scenario depicting the interests of the Telegraph Administration and the State as well as the subscribers and the public. Two networks with 13 exchanges altogether, connecting slightly less than 100,000 subscribers' lines in all, were to be amalgamated into one giant network with eight exchanges and a total capacity of more than 200,000 subscribers' lines. As with the new tariff structure, gone was the old principle of connecting up subscribers on low yearly rates to sub-exchanges and heavy callers on high yearly rates to the main exchanges. Unlike this vision of the future, the present 'order' was characterised as the cluttered result of exchanges added over the course of time. Now was the time to take action, it was stressed. The telephone operations were at a critical turning point where a

att då staten numera lyckats intaga den ställningen, att staten praktiskt sett utövar telefon- och telegrafverksamheten såsom ett monopol, staten bör i denna förvaltningsgren även se de därav beroende till godo på ett sätt, som ej giver anledning ens till en förmodan, att dessa skulle blivit bättre betjänta, om de utlämnats till exploatering av enskild företagsamhet." Quoted in Lindberg, *Med fingerskiva*, pp. 39-40.

<sup>77</sup> Adapted from request, quoted in Lindberg, *Med fingerskiva*, p. 40.

sustained use of exclusively manual switchboards was unjustifiable. This made automatic exchanges an essential part of the proposal.

It was asserted that a realisation of the outlined systematically ordered network with automatic exchanges was not only in the interest of the Telegraph Administration. Those subscribers complaining about the increased tariffs and at the delayed merger of the two networks were turned into a group having an interest in seeing this brought about and an interest in seeing that the State supported the scenario. The plan was presented to the State as the only way it could legitimise its acquisition of the monopoly in telephony and telegraphy in the previous year. In short, the systematically ordered network with automatic exchanges was presented as the only means through which the Telegraph Administration, the State, and the subscribers could attain their desired ends. In the process, the automatic switch had taken on the role of being perfected and aligned to the operation of the merged telephone network in a businesslike manner, an instrument for satisfying dissatisfied subscribers and providing legitimacy to the monopoly. In short, a new scenario had been presented:

It is necessary to immediately begin to fund and arrange for the introduction of automatic exchanges. This is in the interest of the public, the subscribers, the State, and the Telegraph Administration.

The Telegraph Administration received the requested funding, and began erecting buildings for housing the new exchanges. But, as was the case when the house at Jeriko was erected 10 years earlier, it was still not decided what kind of switch would go into these houses. The scenario had passed an initial trial of strength, but many further trials of strength remained. The automatic exchange had been given a new role, but how that role should be performed was still contested.

## **What Kind of (Semi-)Automatic Switching System?**

### **Inviting changeable switching systems**

It had been decided provisionally that the premises at Jeriko and Norrtullsgatan would be the first to be provided with automatic switches. Axel Hultman prepared an invitation to tender for two semi-automatic switches during the Autumn 1919 and sent it to New Autotelephone Betulander, General Telephone LM Ericsson, North Electric, Siemens and Western Electric. The so-called Olson system was not included in the invitation. The Olson system had been included when Axel Hultman had prepared the invitations to tender in 1917, but in 1919 the system was apparently excluded from the set of possible systems.<sup>78</sup> On the other hand a Strowger system represented by North

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<sup>78</sup> No material has been obtained depicting why the Olson system was no longer considered in an invitation to tender. Perhaps the executive 'decision' was already made in 1916-1917

Electric in the US was included on this occasion. The Swedish switching systems now invited had furthermore been altered significantly since the end of 1917 and were still under constant modification.

The work within LM Ericsson and later General Telephone LM Ericsson had been divided into two different projects since 1917. In one project Martin Löfgren had continued to work out different designs in interaction with Axel Hultman. The work on the H exchange at Norrtullsgatan had proceeded and selectors selecting over 1,000 and 2,000 lines had been tried as replacements for the selector selecting over 10,000 lines.<sup>79</sup> In 1918 another project within LM Ericsson had been initiated under direction of Knut Kåell. David Lienzén, who had been working on the Hultman-Löfgren system since mid 1917, had been recruited in 1918 to the project headed by Kåell. This project soon started to work on smaller selectors selecting over 500 lines. These selectors shared some characteristics with the Hultman-Löfgren selectors such as the bare wire multiple and the machine-driven selector contact arms. But the movement of the selector contact arms was altered.

The selectors in the Hultman-Löfgren system selected a line by first making a lateral movement for selecting a group of lines and then the contact arm selected the desired line within the chosen group by moving perpendicularly to the first movement. In the Kåell-Lienzén system being elaborated, the selectors selected a line by first making a circular movement for selecting a group of lines and then the contact arm selected the desired line by making a radial movement. Martin Löfgren had considered and tried this latter kind of design before 1918, but had apparently abandoned it since it would have encroached on the patent on selectors for an automatic call-distributing system held by SAT.<sup>80</sup> He had simply concluded that it was impossible to combine patents held by Hultman with patents belonging to SAT. It would not have produced a working system for use in Sweden, in the sense that neither of the two telephone operators in Stockholm would have allowed the other to use it.<sup>81</sup>

The situation had changed by the time Kåell and Lienzén took up this design theme for the selectors. Since the merger of SAT and LM Ericsson into General

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when the test exchange of that system, the O exchange, was given much less traffic than the other two test-exchanges.

<sup>79</sup> Lindberg, *Med fingerskiva*, p. 31.

<sup>80</sup> Note by Gustaf Collberg, 2 September 1919, "LME," LA; Samling G. Collberg #3.

<sup>81</sup> Confer the clause in Hultman's contract with LM Ericsson from 1913 which restricted LM Ericsson from selling switches based on Hultman's patents to any other operator in Sweden than the Telegraph Administration. See chapter V pp. 153ff.

Telephone LM Ericsson there was no longer any risk of infringing on the SAT patent since that was now within the same company.<sup>82</sup>

The system developed within New Autotelephone Betulander had also been altered since the end of 1917. Nils Palmgren and GA Betulander had worked on a new kind of relay-based selector, and in 1919 a new so-called crossbar selector selecting over 100 lines was fitted into the B exchange at Jakobsbergsgatan.<sup>83</sup> The work on the system had been presented in letters to the Telegraph Administration, where Betulander had presented what was being done and stressed the advantageous characteristics of the system. The scalability of the switches and the high reliability of the relays had been especially emphasised.

In December 1918, Betulander had informed the Telegraph Administration about the new designs being worked on for the circuit scheme related to the link-connecting principle. At that time he had stressed that the new design meant that a switch would only take up about half of the space taken up by the current B exchange without altering any characteristics of the system:

The mentioned new construction for the distribution does not bring any new unknown factors into the function or reliability of the automatic switch. We can therefore without any further experimentation build an automatic switch of any desired size and moreover guarantee that it will operate with the same precision and as faultlessly as the automatic test-exchange now set up.<sup>84</sup>

In January 1917, when preparing the procurement later abandoned, Hultman had expressed scepticism towards systems employing so-called graded schemes. He had then stressed that a supplier of systems of that kind should declare “what drawbacks in operation and maintenance such a reduction in the number of selectors will bring about.”<sup>85</sup> In his letter of December 1918, Betulander had nevertheless confidently exclaimed that the new scheme endowed the relay system with such perfection that one

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<sup>82</sup> Note by Gustaf Collberg, 2 September 1919, “LME,” LA; Samling G. Collberg #3, p. 2.

<sup>83</sup> Lindberg, *Med fingerskiva*, p. 29.

<sup>84</sup> Original sentence (in Swedish): “Den omnämnda nya konstruktionen för fördelningen inför icke några nya okända moment i automatvexelns funktion eller arbets säkerhet, hvarföre vi utan vidare experiment skulle kunna bygga en automatstation enligt den nya fördelningen af hvilken storlek som önskas och dessutom garantera för att den skulle komma att arbeta med samma precision och lika felfritt som den nu uppsatta automatvexeln.” G.A. Betulander, 2 December 1918, “Till Kungl. Telegrafstyrelsen” (To the Telegraph Administration headquarters), p. 2, TALb; F I A:351.

<sup>85</sup> Full sentence (in Swedish): “Dock måste härvid uppgivas, vad en sådan reduktion i väljareantalet kommer att medföra för olägenheter i avseende på driften och skötseln av ett sådant system.” Axel Hultman, 31 January 1917, “Till Kungl. Telegrafstyrelsen,” unsigned appendix titled: “Förslag till kostnadserbjudande för automatiska telefonanläggningar i Stockholm,” TALb; F I A:69, p. 2.

no longer could hesitate when choosing between a relay system and driven systems.<sup>86</sup> On the matter of graded systems and internal congestion, however, Betulander had apparently conceived it insufficient to rely entirely on such statements. In 1919 Betulander interested a Swedish physicist, Ragnar Holm (1879-1970), in making calculations on congestion in automatic switches.<sup>87</sup> Holm, who recently had returned to Sweden from employment at Siemens in Germany, had acquired a position at the testing and research office at the Telegraph Administration's technical department. In the latter part of 1919 Holm published calculations and experimental results about congestion in automatic telephone switches in several articles in technical journals.<sup>88</sup> In two of these, Holm specifically presented calculations about internal blocking characteristics of Betulander's and Olson's systems.<sup>89</sup> He noted there that a formula presented by A.K. Erlang gave far too high a probability of blocking for situations with high calling frequencies.<sup>90</sup>

Betulander had further reported in his December letter on the few errors which had occurred at the B exchange during the 17 months of operation. There had occurred 1.7 errors per 100,000 calls on average, which according to Betulander was less than the 28 errors per 100,000 calls generated by a WE exchange of similar size.<sup>91</sup> According to an appended fault report, the exchange had completed more than 1 million calls. At the same time only 19 faults had emerged, but it was stressed that only 12 of these were related to parts belonging to the automatic parts of the exchange such as soot in a relay.<sup>92</sup> During 1919, Betulander continued to send excerpts from the fault reports of the B exchange to the Telegraph Administration.<sup>93</sup> In August 1919, for instance, he

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<sup>86</sup> G.A. Betulander, 2 December 1918, "Till Kungl. Telegrafstyrelsen" (To the Telegraph Administration headquarters), p. 2, TALb; F I A:351.

<sup>87</sup> Walter Broberg, "Nya AB Autotelefon Betulander: Ett pionjärföretag inom automattelefonin," *Tele: Televerkets tekniska tidskrift* 76, no. 4 (1971): 64-70, p. 68.

<sup>88</sup> Ragnar Holm, "Beräkning av spärningstal för automatiska centraler," *Teknisk bilaga till Kungl. Telegrafstyrelsens cirkulär*, no. 8-9 (1919): 57-72, Ragnar Holm, "Om sannoliketskalkylens tillämpning på telefontrafikproblem," *Teknisk Tidskrift (Veckoupplagan)* 49, no. 48 (1919): 485-488 and Ragnar Holm, "Beräkning av spärningstalet hos vissa viktiga kopplingsanordningar för automatiska telefoncentraler," *Teknisk Tidskrift (Veckoupplagan)* 49, no. 49 (1919): 503-505.

<sup>89</sup> Holm, "Beräkning av spärningstal för automatiska centraler," and Holm, "Beräkning av spärningstalet hos vissa viktiga kopplingsanordningar för automatiska telefoncentraler."

<sup>90</sup> Holm, "Beräkning av spärningstal för automatiska centraler," p. 69.

<sup>91</sup> G.A. Betulander, 2 December 1918, "Till Kungl. Telegrafstyrelsen," (To the Telegraph Administration headquarters), p. 2, TALb; F I A:351.

<sup>92</sup> G.A. Betulander, 2 December 1918, "Till Kungl. Telegrafstyrelsen," (To the Telegraph Administration headquarters), appendix B, TALb; F I A:351.

<sup>93</sup> GA Betulander, 27 January 1919, "Till Kungliga Telegrafstyrelsen," GA Betulander, 12 March 1919, "Kungliga Telegrafstyrelsen," GA Betulander, 26 May 1919, "Till Kungliga Telegrafstyrelsen," GA Betulander, 21 August 1919, "Kungliga Telegrafstyrelsen," (four letters to the Telegraph Administration headquarters), TALb; F I A:351.

reported that the number of accumulated relay faults had increased from 12 to 17 during the now 26 months of operation. The experience seemed to indicate, he affirmed, "that there are less and less faults within the automatic switch the longer it is used."<sup>94</sup> The results would become even more dazzling if more subscribers were connected to the exchange, he contended. According to the measurements, the number of faults increased at a lower rate than did the number of connections made.

However, there seems to have been another doubt concerning the Betulander-Palmgren system. The company was undoubtedly much smaller than its contenders in furnishing Stockholm with automatic switches, and this made it apparently vulnerable to doubt as to whether the company had the ability to produce switches on a greater scale. In February 1919, the UK based Relay Automatic Telephone Company, in other words the Marconi owned company having the international rights to the system, stepped in. In a letter to New Autotelephone Betulander, the managing director of Relay Automatic gave reassurance that it had the capacity in a recently purchased large factory and that the Marconi Company would guarantee a manufacturing contract.<sup>95</sup> A copy of the letter was sent to the Telegraph Administration within three weeks, evidently to reassure people there that the Betulander company had the ability to deliver.

Hence, the Betulander-Palmgren system was increasingly accompanied with paperwork as 1919 progressed, paperwork embodying alliances which supported that the system was reliable and scalable and that the company could deliver. Any scepticism felt that the system's heavy use of relays produced an unreliable system was countered with massive figures from fault reports. Any scepticism felt that the system's use of graded distributions made it incalculable and thus less useful for large exchanges was similarly contested with calculations performed by Ragnar Holm. Finally, the Marconi company was teaming up to invalidate any suspicion that the company could not deliver.

Still, were these alliances strong enough for the Betulander company's offer to win? An order to deliver automatic switches to the Telegraph Administration would undoubtedly be of vital importance to the company, and perhaps the company was

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<sup>94</sup> Original sentence (in Swedish): "Erfarenheten synes gifva vid handen att det blir mindre och mindre fel i automatvexeln ju längre den användes." GA Betulander, 21 August 1919, "Kungliga Telegrafstyrelsen," (to the Telegraph Administration headquarters), TALb; F I A:351.

<sup>95</sup> C.B. Clay (Managing Director of the Relay Automatic Telephone Company), 26 February 1919, "Nya Aktiebolaget Autotelefon Betulander," (Letter to New Autotelephone Betulander, transcript of which arrived at the Telegraph Administration 13 March 1919), TALb; F I A:351.

financially weak since the company's largest owner had passed away in 1916.<sup>96</sup> An order would also be important to General Telephone LM Ericsson as it would be a first order for automatic switches for the company which, contrary to its major international competitors, still relied completely on selling manual switchboards and telephone sets. In December 1919 the difference between winning and losing the order to the other Swedish contender was significantly reduced. Less than a month before the offers were to be handed to the Telegraph Administration, a contract was signed between General Telephone LM Ericsson and a syndicate comprised of those owning the majority of the shares in New Autotelephone Betulander, including G.A. Betulander himself.<sup>97</sup>

According to the intricate contract, the LM Ericsson company acquired the stock of New Autotelephone Betulander under the condition that the Telegraph Administration ordered an automatic switch of either any LM Ericsson system or the Betulander-Palmgren system within three years.<sup>98</sup> A deposit of 50,000 kronor was immediately handed to the syndicate, but the final price for the shares was made dependent on whether the Administration chose the Betulander-Palmgren system or any of the LM Ericsson systems. The price of the Betulander company was simply made higher in the event of the Betulander-Palmgren system being chosen, but the syndicate would not be left without any share in the event an LM Ericsson system was chosen. Indeed, the syndicate was even allowed to keep half of the deposit if the acquisition was not realised, that is, in the event the Telegraph Administration did not place an order for any of the systems controlled by the two parties.<sup>99</sup>

But General Telephone LM Ericsson had more to do under the contract. Firstly, General Telephone LM Ericsson should assist the Betulander company in managing the offer for the Betulander-Palmgren system. Secondly, the LM Ericsson company should offer positions for all salaried employees at the Betulander company.<sup>100</sup> Thirdly, if the LM Ericsson company sold switches based on the Betulander-Palmgren system, it should pay a royalty of 3% to the syndicate on all such sales in Sweden during 10 years

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<sup>96</sup> It was the important backer Oscar Carlson who passed away in 1916. According to one source, during the final years of the war New Autotelephone Betulander had also had problems in filling its small production capacity in producing telephone equipment and that it had begun producing locks, see Broberg, *Nya AB Autotelefon Betulander*, p. 69.

<sup>97</sup> Contract, 30 December 1919, (Contract signed by Hemming Johansson & Gottlieb Piltz of General Telephone LM Ericsson and G.A. Betulander, Ivar Carlson, & Wolter Ljunggren, transcript), TALb; F VIII E:2.

<sup>98</sup> *Ibid.*, § 1 and § 10.

<sup>99</sup> *Ibid.*, § 10.

<sup>100</sup> *Ibid.*, § 6.

from the first sale to the Telegraph Administration.<sup>101</sup> If on the other hand the Telegraph Administration chose any of LM Ericsson's own systems, the company should pay a 1% royalty on sales to the Telegraph Administration:

LME shall pay a royalty of one percent /1%/ of the order sum to the syndicate for all orders of telephone switches of any LME-system that LME obtains from the Telegraph Administration within 10 years from the first such order obtained from the Telegraph Administration.<sup>102</sup>

Thus, as the deadline for submitting offers approached, the invited Swedish systems were continuously elaborated and the networks of parties supporting them had become more intertwined. With the Kåell-Lienzén system a new switching system was elaborated within General Telephone LM Ericsson, and the Betulander-Palmgren system was now associated with General Telephone LM Ericsson. By the end of 1919, there were finally six systems contending for furnishing the Stockholm telephone network with automatic switches, with General Telephone LM Ericsson producing the switches if either of the Hultman-Löfgren, the Kåell-Lienzén or the Betulander-Palmgren system should be chosen.

### **Aligning the incoming offers**

Western Electric's offer of two semi-automatic switches had already been received in the Autumn 1919, and the offers from the other tenderers were received during January 1920. There then remained a mass of specifications and figures to be gone through. Moreover, not all tenders accepted Axel Hultman's estimates concerning the number of selectors needed for their switches, given the estimated amount of traffic. Western Electric's offer, which concerned a switch similar to the one in operation in Landskrona, had also contained an alternative offer based on their own calculations. Referring to "Poissons formula derived from his 'Theory of small numbers'," the alternative offer showed that the number of selectors could be decreased compared to the numbers calculated by Hultman.<sup>103</sup> Similarly Siemens & Halske submitted an alternative offer based on the company's own calculations. These systems were, however, not graded in the same sense as the Betulander-Palmgren system. The offer

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<sup>101</sup> *Ibid.*, § 3b. The contract also stated that the syndicate should assist General Telephone LM Ericsson in negotiations with Relay Automatic with the view to enabling the LM Ericsson company to acquire exclusive licences for a series of other countries. *Ibid.*, § 7.

<sup>102</sup> Original sentence (in Swedish): "För beställningar av telefonstationer enligt något LME-system, som LME erhåller av Telegrafverket inom 10 år, räknat från den dag, avtal träffats med Telegrafverket angående den första beställningen, erlägger LME till konsortiet en royalty av en procent /1%/ av beställningssumman." *Ibid.*, § 3c, p. 3.

<sup>103</sup> Western Electric Automatic Department in Antwerp, n.d., "Proposal for semi-automatic equipment (alternative) for Stockholm Sweden," quote from p.1. The proposal was appended to letter: Einar Brofos (WE Kristiania), 30 September 1919, "Till Kungl. Telegrafstyrelsen," (To the Telegraph Administration headquarters), TALB; F I A:69.

from the Betulander company simply disregarded the estimated number of selectors provided by Hultman. Instead the company submitted a single offer where the numbers of some of the different selectors were calculated referring to the formulas presented by Ragnar Holm.<sup>104</sup> However, the prices for the Betulander switches were calculated by the same person who calculated the prices for the two other systems controlled by LM Ericsson, Knut Kåell. One LM Ericsson engineer and friend of Martin Löfgren noted in a somewhat dismal note that Kåell had found the Hultman-Löfgren system 40% more expensive, and the Betulander-Palmgren system about 15% more expensive than the Kåell-Lienzén system.<sup>105</sup> In all, there were eight different offers to consider for each of the two exchanges. Table VI-3 provides some of the figures from the large table summarising the offers.

*Table VI-3 Excerpt from table of the incoming offers in January 1920.<sup>106</sup>*

<i>Tenderer and specification of offer</i>	<i>Semi-automatic switch, 10,000 lines (US \$ / kronor)</i>	<i>Semi-automatic switch, 5,000 lines (US \$ / kronor)</i>	<i>Delivery time (months)</i>
North Electric	\$ 650,000		12
		\$ 284,000	10
Western Electric	\$ 819,350	\$ 381,980	18
Alternative	\$ 721,050	\$ 361,080	18
Siemens & Halske			
Based on calculations provided by the chief engineer	2,800,244 kr.	1,248,594 kr.	18
According to the company's own calculations	2,159,669 kr.	993,427 kr.	18
Storage batteries	79,341 kr.	45,786 kr.	
New Autotelephone Betulander	1,828,000 kr.	829,000 kr.	18
General Telephone LM Ericsson			
System with 500-line selectors	1,600,000 kr.	711,700 kr.	18
System with 1,000-line selectors	2,252,000 kr.	1,011,000 kr.	18
Power plant	111,000 kr.	55,200 kr.	

How were Axel Hultman, Karl Erik Landström and others within the Telegraph Administration to go about comparing and ultimately choosing one of these eight

<sup>104</sup> Wolter Ljunggren (New Autotelephone Betulander), 23 January 1920, "Anbud å automatiska telefonstationer för Stockholm enligt Betulanders system," (Offer of automatic telephone switches for Stockholm according to the Betulander-Palmgren system), appendixes, p. 2. TALb; F I A:69.

<sup>105</sup> Note by Gustaf Collberg, 30 January 1920, "LME," LA; Samling G. Collberg #3.

<sup>106</sup> The large table summarising the offers was drawn up by a clerk when the incoming offers were opened on 26 January 1920 in the presence of Karl Erik Landström and Axel Hultman. Karl Karlsson, 26 January 1920, "Protokoll över inkomna anbud å automatiska telefonanläggningar för Stockholm," (Minuted received offers for automatic exchanges for Stockholm), TALb; F I A:69.

different offers? Apparently the offers were not deemed sufficiently aligned to allow them to make a choice. In March Axel Hultman sent a letter to each of the contenders, asking them to resubmit their offers. This time he emphasised that to enable a fair comparison, all offers were to use a more uniform specified disposition and all quoted prices were to be specified for a large number of items.<sup>107</sup> Furthermore, this time he wanted prices for fully automatic switches as well. To Siemens he specifically emphasised that the company should employ a specific curve when estimating the number of selectors needed.<sup>108</sup> However, Western Electric did not receive a similar objection to the calculations they had presented.<sup>109</sup> In an additional letter to LM Ericsson, Hultman specifically addressed the possibility of internal blocking in the graded Betulander-Palmgren system and asserted that the company had to assume the responsibility for resolving any blocking problems if that system was chosen:

The following should be appended to § 1 of the contract in case the relay system will be used: If more blocking than calculated will arise within the system, it is the duty of the supplier to – at no additional cost to the Telegraph Administration – remedy this by adding new necessary group and line selectors etc. together with necessary increases in the number of circuits between the groups.<sup>110</sup>

In the same letter Axel Hultman added that the price for the switches of the 1,000-line selector system (i.e., the Hultman-Löfgren system) had to be recalculated on the basis of new drawings for the system that he would send to the company in a few days.

#### **What system should be chosen and according to what criteria?**

As the revised offers were coming in, Axel Hultman drafted a memo to the Administration's headquarters on what system to choose.<sup>111</sup> He suggested at the very outset that fully automatic switches should be used in Stockholm. He reported that

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<sup>107</sup> See, e.g., Hultman's letters to Siemens' representative in Stockholm and General Telephone LM Ericsson: Axel Hultman, 17 March 1920, "Elektriska Aktiebolaget Siemens-Schuckert," (To Siemens-Schuckert) and Axel Hultman, 26 March 1920, "Allmänna Telefonaktiebolaget LM Ericsson," (to General Telephone LM Ericsson), both TALb; F I A:70.

<sup>108</sup> Ibid. p. 2. This curve was according to the letter calculated by Prof. Henning Pleijel (1873-1962), who earlier had worked at the testing and research office at the Telegraph Administration's technical department.

<sup>109</sup> Axel Hultman, 29 March 1920, "Herr ingenjör Einar Brofos," (to Einar Brofos WE), TALb; F I A:70.

<sup>110</sup> Original sentence (in Swedish): "För den händelse reläsystemet kommer till användning, skall i kontraktets § 1 därjämte införas följande: Om 'spärningar' inom systemet uppkomma utöver de beräknade, åligger det leverantören att utan kostnad för Telegrafstyrelsen avhjälpa detta genom tillsättande av nya behövliga grupp- och ledningsväljare mm jämte nödig ökning i antalet förbindelseledningar mellan grupperna." Axel Hultman, 31 March 1920, "Allmänna Telefonaktiebolaget LM Ericsson," (to General Telephone LM Ericsson), TALb; F I A:70.

<sup>111</sup> Axel Hultman, 28 May 1920, "Till Kungl. Telegrafstyrelsen: Angående de automatiska telefonanläggningarna i Stockholm," (to the Telegraph Administration headquarters regarding the automatic exchanges in Stockholm), TALb; F I A:70.

during a recent trip to USA and Germany he had found that fully automatic telephone systems were now favoured over semi-automatic systems in both countries. In the US, he affirmed, AT&T had for a long time opposed the Automatic Electric company and automatic telephone exchanges, and instead had tried to preserve its manual systems as long as possible. Now, he stressed, this development had turned for the whole US since AT&T which practically had a monopoly on telephone operations now “acknowledged the fully automatic system and adopted it at first for New York and Chicago.”<sup>112</sup> In Germany, he continued, both semi- and fully automatic systems had been tried but now the latter was favoured. Apart from this international ‘evidence’, Hultman gave another reason which according to him favoured fully automatic systems over semi-automatic. When the number of employees grew to several hundreds in manual or semi-automatic systems their demand for space became difficult to meet. It was simply a case of being difficult to provide space for all the “cloakrooms, bathrooms, lavatories, meeting places, bedrooms and canteens with associated kitchens” which came with manual or semi-automatic systems.<sup>113</sup> In Hultman’s view, the advantages of the fully automatic systems, devoid of all these difficulties along with what he called “the increasingly complicated personnel conditions”, became all the greater.

But what specific system should be chosen? The alignment of the offers had progressed somewhat, although not all tenderers had managed to submit revised offers for fully automatic switches. Axel Hultman chose to characterise the offers at hand on the basis of how the selectors were driven and cost per subscriber, see Table VI-4. From the quoted prices he drew the conclusion that American systems, that is, those offered by North Electric and Western Electric, could not be used since both were too expensive. Hultman noted that the Western Electric system, as such, had worked satisfactorily in Landskrona in both semi-automatic and fully automatic operation and he especially emphasised that this machine driven system was somewhat superior to the older step-by-step systems.<sup>114</sup> On the Siemens system Hultman informed that the switches of the system had proved to work rather well in Germany. He reported that Siemens had had problems with the relays on some locations, which had forced the company to introduce twin contacts on every relay. There had, on the other hand, been less problems with the selectors themselves, and to Hultman this gave the general

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<sup>112</sup> Full sentence (in Swedish): “Nu har utvecklingen dock helt och hållet vänt sig till fördel för det helautomatiska systemet, som slagit igenom över hela Amerika i och med att AT&T. Co. erkänt det helautomatiska systemet och antagit det till en början för New York och Chicago.” Ibid., p. 1.

<sup>113</sup> Full sentence (in Swedish): “Kapprum, bad- och toaletterum, samlingsrum, sovrum och matsalar med tillhörande kökslokaler fordra stora utrymmen och svårigheterna att bereda plats för alla dylika lokaler bli avsevärda.” Ibid., p. 2.

<sup>114</sup> Ibid., pp. 5-6.

indication that “the relays are not as absolutely reliable parts in an automatic system as it is asserted.”<sup>115</sup> His overall conclusion concerning the Siemens offer was that there was nothing against it except the price which was considerably higher than the Swedish offers especially taking into consideration the additional freight, packing, and customs.

*Table VI-4 The considered offers according to table made by Hultman in May 1920.<sup>116</sup>*

<i>Tenderer and specification of offer</i>	<i>Selectors</i>	<i>Fully automatic switch, 10,000 lines (kronor/subscriber)</i>	<i>Note</i>
North Electric	Step-by-step	288.00 kr. / sub.	
Western Electric	Machine driven	346.00 kr. / sub.	semi-automatic
Siemens & Halske	Step-by-step	213.54 kr. / sub.	semi-automatic
New Autotelephone Betulander	Relay based	207.06 kr. / sub.	
General Telephone LM Ericsson			
System with 500-line selectors	Machine driven	188.53 kr. / sub.	
System with 1,000-line selectors	Machine driven	259.27 kr. / sub.	

The Swedish offers received the most attention in Hultman’s memo. They were far cheaper than the American offers and Hultman considered that they warranted the most thorough examination although all were partially untried. On the system with 1,000-line selectors (i.e., the Hultman-Löfgren system) Hultman informed of his efforts to construct selectors selecting over more lines than the usual 100 or 200 lines. He further stressed that in the present situation the advantages with large selectors had increased. The acquisition of the network of Stockholm Telephone meant that the exchanges had to operate within a larger network than previously envisioned, which according to Hultman made it advantageous to select over as large groups as possible.<sup>117</sup> The selector selecting over 10,000-lines had been tested for about three years, but Hultman affirmed that the now considered 1,000-line selector was mechanically easier to

<sup>115</sup> Full sentence (in Swedish): “Samma erfarenhet har gjorts här i Sverige och även i Köpenhamn på Siemens anläggning därstädes, vilket tydligen visar, att reläerna icke äro så absolut pålitliga delar i ett automatsystem, som man vill låta påskina.” *Ibid.*, p. 5.

<sup>116</sup> Excerpt compiled from two tables in *Ibid.* See *Ibid.*, p. 4 and appendix A. The price comparison in the appendix is presented in a large table covering both semi-automatic and fully automatic switches for the two sites considered.

<sup>117</sup> The advantages with large selectors lie, according to Hultman, in the possibility to save on the number of lines within and between the exchanges: “It has, since the acquisition of the network from Stockholm Telephone, become necessary to prepare for larger constructions than previously planned. To reduce the number of lines as much as possible, it is advantageous to select over as large groups as possible, preferably over 20,000 lines.”

Original sentences (in Swedish): “Sedan Stockholmstelefoners nät förvärvats har det blivit nödvändigt, att bereda sig på betydligt större anläggningar än som förut planerats. För att därvid minska förbindelseledningarnas antal så mycket som möjligt, är det fördelaktigt att välja över så stora grupper som möjligt, helst över 20,000 ledningar.” *Ibid.*, p. 7.

manoeuvre. However, Hultman did express outright dissatisfaction with the 1,000-line selectors now erected at the H exchange. These were of a design which did not allow the selectors to operate at the desired speed and Hultman reported that he regretted having given way to the LM Ericsson engineers in his earlier criticism of this design. He advised that he had now proposed a new design, which in this respect was similar to the one used in the selectors by Western Electric. More generally, as far as possible he had now purposely avoided new arrangements and he subsequently informed that the new design relied on 'Lorimer's well-tried electrical arrangements' and that the design of the engaged test devices was the same as the one used in Siemens' system. The registers, however, contained devices which differed from other systems, but according to Hultman their design was fully tested at the H exchange. The message was thus that this system was an amalgamation of devices whose design had been tested elsewhere and devices whose design was simple and partially tested at the H exchange. He therefore concluded that this system was thus so tested that it would not offer any difficulties to employ it in real operation even for the largest of networks.

The system with selectors selecting over 500 lines (i.e., the Kåell-Lienzén system) was the next system to be considered in Hultman's memo. Hultman began the discussion on this system by noting that General Telephone LM Ericsson apparently was of the opinion that it was cheaper to manufacture switches of this system than switches of the 1,000-line selector system. He stressed that he himself held this as rather unlikely to be the case. An "altogether clear, thorough and completely enlightening estimate of costs for both systems" was called for according to him to see if this system really was cheaper.<sup>118</sup> From this Axel Hultman went on to discuss the advantages and disadvantages of the Kåell-Lienzén system as compared to the Hultman-Löfgren system. On this, he first concluded that the time it would take for the systems to find a calling subscriber was equal, provided the 500-line selectors worked on a higher speed in terms of steps per second than the 1,000-line selectors.<sup>119</sup> The same was true when it came to comparing the time it took for each system to switch a call. Both systems had the same operating time, but only provided that the selectors in the Kåell-Lienzén system worked faster than the selectors in the Hultman-Löfgren system. He considered the ability to operate the selectors at low speed to be a tremendous advantage since a high speed meant more wear and unreliability. He further added that the Kåell-Lienzén

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<sup>118</sup> Full sentence (in Swedish): "Det är därför först och främst nödvändigt, att få en fullständigt klar, noggrann och fullt belysande kostnadsberäkning för de bägge systemen, så att man verkligen kan se, att 500-väljaren blir avsevärt billigare än 1000-väljaren." *Ibid.*, p. 9.

<sup>119</sup> *Ibid.*, pp. 9-13.

system required about 30% more selectors than the Hultman-Löfgren system, which translated into a larger number of devices to look after and adjust.<sup>120</sup>

The last system covered in Axel Hultman's memo was the Betulander-Palmgren system. There Hultman continued to express doubts against the work being done to calculate the blocking within the Betulander-Palmgren system:

The examinations of the relay system have caused considerable work since its accessibility have been extremely difficult to calculate, and this issue is presumably not yet fully illuminated.<sup>121</sup>

He further reported of the recent design changes made to the selectors and concluded that the system now offered with crossbar selectors was far from the system which had been tested. No one had any experience, he maintained, on how selectors of this kind would operate in a situation with heavy traffic. This also meant, he continued, that the fault reports repeatedly sent to the Telegraph Administration probably were misleading on the maintenance characteristics of the offered system. These fault reports, he stressed, considered a system which only remotely resembled the system now offered. Hultman therefore made his own estimates on the basis of fault reports concerning relay problems at the WE exchange in Landskrona and he furthermore stressed that twin contacts ought to be introduced on every relay on the basis of the experiences with the Siemens system. In spite of this rather harsh treatment of the Betulander-Palmgren system, nevertheless in his final summary Axel Hultman affirmed that one could assume that this system was fully usable in practice.

Hultman affirmed again in his concluding summary that the choice stood between the three systems offered by General Telephone LM Ericsson, since the foreign systems were already disqualified due to their high prices. Of the three LM Ericsson systems, he characterised the Hultman-Löfgren system as the most tested system, but that the two other systems could nevertheless both probably be used in real operation. The circumstance that was decisive, according to Hultman, was instead the fact that the company seemed to prefer the Kåell-Lienzén system:

Judging from the quotations sent in it seems as General Telephone LM Ericsson supports the 500-line selector system above all, and one should not force a manufacturer into fields in which he, for one reason or another, is

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<sup>120</sup> Hultman also raised other objections against the present offer for the Kåell-Lienzén system. General Telephone LM Ericsson had suggested an altogether new design of the register, and Hultman asserted that much work would have to be done before it could be asserted that this new design worked. Hultman displayed similar distrust in a suggested new design of the dial plates which the company had suggested for the Kåell-Lienzén system. *Ibid.*, pp. 15-16.

<sup>121</sup> Original sentence (in Swedish): "Undersökningarna av reläsystemet ha vållat ett betydande arbete, då dess framkomstmöjligheter varit särdeles svåra att beräkna, och denna fråga är nog ännu icke fullt upplärerad." *Ibid.*, p. 16.

not interested, but should rather let him work on the project he himself recommends.<sup>122</sup>

Here he thus displayed a somewhat more lenient posture, and suggested that the revealed disposition of General Telephone LM Ericsson should carry a decisive weight in the choice of system. All his previous comments on the Kåell-Lienzén system were not forgotten, however. He emphasised that this system should be chosen only provided the company assumed all responsibility if the system did not work satisfactorily, and that the new proposed dials were not used.<sup>123</sup>

In a hand-written letter to the general director Herman Rydin later in the Summer 1920, Axel Hultman maintained his views. He assured Rydin that it was not any desire to order from General Telephone LM Ericsson that was decisive, but rather that it was important that a Swedish system was chosen:

I am no admirer of LME, but wanted the [Telegraph Administration's] factory to manufacture the future system, no matter which one, as long as it was good. The idea of throwing oneself, like a poor wretch, into foreign arms, goes against the grain.<sup>124</sup>

In reply to a letter from Rydin, Hultman further reassured Rydin that he no longer had any 'inventor's interest' in the matter due to the turn the issue now had taken.<sup>125</sup> Hultman furthermore informed Rydin that he had made new wiring schemes for the Kåell-Lienzén system along tried lines. He notified Rydin that he regrettably needed more time to examine a new offer from Siemens for fully automatic switches which had been received in June. He finally suggested that perhaps a commission should be set up to make the final decision, but that there regrettably were no experts in the field within the Telegraph Administration except himself, Olson and their assistants.

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<sup>122</sup> Original sentence (in Swedish): "Att döma av de insända kostnadsförslagen synes Allmänna Telefonaktiebolaget LM Ericsson framför allt hålla på 500-väljarsystemet, och man bör icke tvinga in en tillverkare på områden, som han av en eller annan anledning icke känner sig intresserad för, utan helst låta honom arbeta på det förslag, han själv förordar." *Ibid.*, p. 22.

<sup>123</sup> *Ibid.*, p.23.

<sup>124</sup> Original sentences (in Swedish): "Jag är ingen beundrare av LME, utan såge hellre om Verkstaden ville tillverka det blivande systemet, sak samma vilket, bara systemet blir bra. Att som en stackare kasta sig i utlandets armar bär för mig emot." Axel Hultman, 31 July 1920, "Generaldirektören," (hand-written letter to the general director of the Telegraph Administration), p. 2, TALb; F I A:70.

<sup>125</sup> *Ibid.*, p. 1. The letter from Rydin to Hultman has not been retrieved and it is thus difficult to decipher what Hultman referred to when he stated that he no longer had any 'inventor's interest' in the matter. A reasonable interpretation is nevertheless that Hultman reassured Rydin that he had no private financial stakes in the matter when recommending the Kåell-Lienzén system.

### Arguments favouring a swift automation

Axel Hultman had recommended the Kåell-Lienzén system because that offer had the lowest quoted price, because it was preferred by General Telephone LM Ericsson, and because it was Swedish. Other engineers within the Telegraph Administration begged to differ. Anders Lignell, the acting telephone director in Stockholm, and Paul Hallgren (1886-1949) who recently had been appointed as the new head of the technical department, argued in an internal memo for a rapid automation which to them meant that the Siemens system should be chosen.<sup>126</sup> The Siemens system was according to them the cheapest of the fully tested systems considered, and a fully tested system was in turn necessary for a rapid automation.

In the memo they centred their discussion on the Siemens system and the Kåell-Lienzén system, since the latter was the system recommended by Hultman. The Kåell-Lienzén system, they affirmed, was not yet tested and they stressed that it furthermore contained many newly designed and untested devices. These devices, they continued, might look good on paper but there was no guarantee that they would be suitable in practice. Therefore, they concluded, more work was necessary before any decision about the system's suitability could be made:

[I]t must be considered necessary to transfer the system from paper to reality before any decision about the system's suitability can be made. All details are not even shown and these have to be examined before the [Telegraph Administration's] headquarters can even consider, out of consideration for this system, further postponement of the automation of the network in Stockholm.<sup>127</sup>

A new test-exchange for 5,000 subscribers would also be called for, they argued. All this work implied more time, however, and more time translated into costs. The Siemens system, they emphasised, was fully tested which meant that switches of that system could rapidly be introduced into the network. The new quoted price from Siemens was 200 kronor per subscriber for a fully automatic switch of 10,000 lines. This was still somewhat higher than the price quoted for the Kåell-Lienzén system, but in the memo they affirmed that this difference would be more than offset by savings made in reduced operating costs through faster automation of the network in

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<sup>126</sup> Paul Hallgren, Anders Lignell and Alfred Lundgren, 20 August 1920, "VPM," (memo), TALb; F I A:70.

<sup>127</sup> Full sentences (in Swedish): "Med den erfarenhet, som Telegrafstyrelsen hittills haft av automatsystem, som icke varit prövade i praktisk drift, måste det därför anses nödvändigt att systemet överflyttas från papperet till verkligheten innan något avgörande om systemets lämplighet kan fattas. Alla detaljer äro icke en gång visade, och dessa måste dock granskas innan Styrelsen ens skall kunna tänka på att, av hänsyn till detta system, ytterligare uppskjuta automatiseringen av Stockholmsnätet." Ibid., p. 3.

Stockholm. A more rapid automation simply meant savings in wages to operators. Time was money.

In the memo, they presented calculations to substantiate this argument.<sup>128</sup> To do this they presented two automation scenarios, one for each of the two systems and given a forecast growth in the number of subscribers. In the Siemens scenario, the first large automatic exchange for 15,000 subscribers would be in operation in 1923 and the automation would continue with 15,000 subscribers yearly until 1932 when the erection of automatic exchanges would be completed. In the 'Kåell-Lienzén scenario', on the other hand, the first large automatic exchange would be in operation three years later and the automation would be completed in 1937. For each of these scenarios, they then estimated the yearly operating costs for the remaining manual exchanges and the costs of construction for the automatic exchanges. The accumulated difference between the two scenarios was 31.9 million kronor by 1937 including interest. This, they concluded, showed what could be saved by choosing the Siemens system:

From a financial point of view, the examination made thus shows that by choosing a system which is ready for an immediate start to the automation will save no less than some 32 million kronor by 1937.<sup>129</sup>

In April 1916, Axel Hultman had pleaded with the Administration's headquarters to postpone ordering semi-automatic switches until July 1917 to ensure that the system was Swedish.<sup>130</sup> That time no semi-automatic switches had been procured and the situation changed several times due to the discussions to acquire Stockholm Telephone's network. Now, four years later, the new head of the technical department and the acting telephone director in Stockholm argued for a swift automation. To them the 32 million kronor saving carried more weight than keeping the future system Swedish.

A month later Anders Lignell received more material in support of his and Paul Hallgren's argument that the Swedish systems were not fully tested. A report from the fault complaint service commissioned by Lignell showed problems with both the H and the B exchanges.<sup>131</sup> Both test-exchanges were too sensitive to problems with the

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<sup>128</sup> The calculations are presented in *Ibid.*, pp. 4-6 with tables presenting the yearly figures in appendices 2-4.

<sup>129</sup> Original sentence (in Swedish): "Den granskning, som ur ekonomisk synpunkt gjorts, visar således att man genom att välja ett system, som redan är färdigt, så att automatiseringen omedelbart kan påbörjas, till år 1937 inbesparat icke mindre än omkring 32,000,000 kronor." *Ibid.*, p. 6.

<sup>130</sup> Confer quote in chapter V, p. 196.

<sup>131</sup> Einar Ström, 21 September 1920, "Till Telefondirektören," (letter to the telephone director with 5 appended written communications from one lines overseer and three lines foremen), TALb; F I A:71.

subscribers' lines, according to a report from two lines foremen, and in particular too susceptible to weak leakage caused by incomplete insulation.<sup>132</sup> They noted that the designers probably maintained that the lines should be kept absolutely flawless, but countered that the designers did not take into necessary consideration what that would imply for a network as large as the one in Stockholm. The H exchange, according to the lines foremen, incessantly ruined the microphone of the telephone sets, probably due to too high currents. They also reported that the H exchange received more complaints about switch faults than the B exchange and that it also seemed as if the switch faults at the H exchange were more difficult to locate and remedy. The two lines foremen concluded that although there were more problems with the H exchange, neither of these two systems worked satisfactorily both from the point of view of maintenance costs and public service.

### Arguments pointing in another direction

Anders Lignell and Paul Hallgren had argued that there was a big difference between a system on paper and its translation into reality. The subsequent fault report revealed that the performance of the test-exchanges was less than satisfactory which further strengthened their case. Axel Hultman disagreed because the examination on which their conclusion was based seemed to him to have been executed with little respect to reality. The results were therefore of little value, Hultman dryly noted in his internal memo to the headquarters that Autumn.<sup>133</sup> His conclusions, he contended, were founded on reality, the present state of things which had to be taken into account and not on any undue bias on his part:

The conclusions which I will present below depend only on what I *presently* consider to be the *purely practical* state of things, and which have to be taken into account when taking the decision. Thus the conclusions do not depend on my favouring one system over another.<sup>134</sup>

There were numerous conclusions which Axel Hultman described in the memo as important when taking the decision. Firstly, in his view, Siemens was not a good alternative for several important reasons.<sup>135</sup> Choosing Siemens would require large advances of cash. Hultman also argued that the problematic situation in Germany made

<sup>132</sup> Report by two lines foremen appended to Ibid.

<sup>133</sup> Axel Hultman, 1 October 1920, "Till Kungliga Telegrafstyrelsen: Angående automatiseringen av Stockholms telefontät," (to the Telegraph Administration headquarters regarding the automation of Stockholm's telephone network), TALb; F I A:70.

<sup>134</sup> Original sentence (in Swedish): "De slutsatser, vartill jag sålunda här nedan kommer till, bero således på de *rent praktiska* förhållanden, som jag *för närvarande anser råda*, och som måste tagas i betraktande vid beslutets fattande och bero sålunda icke på, att jag föredrager det ena systemet framför det andra." Hultman's emphasis. Ibid., p.1.

<sup>135</sup> Ibid., pp. 2-3.

any promises regarding price or delivery time ambiguous and that, in the event of conflict, it would be much more difficult to put pressure on a foreign enterprise than on LM Ericsson. He further stressed that if Siemens was chosen, the Telegraph Administration might become completely bound to Siemens and the Siemens system. General Telephone LM Ericsson on the other hand had already offered to allow the Administration's own factory to produce switches of the Kåell-Lienzén system if the Administration later desired to do so. Hultman emphasised that he had not managed to extract any suggestions along such lines from Siemens.

Secondly, Hultman maintained that the Kåell-Lienzén system could be chosen without any further examinations or trials.<sup>136</sup> He stressed that parts of the system had been tested at the H exchange for about three years, and he characterised the workings of the test-exchange as excellent considering that not all parts had been appropriately designed. With the changes in the design of the selector that General Telephone LM Ericsson was now willing to make, there was no reason to doubt that the system would work satisfactory, he affirmed. Furthermore, he added, the company carried the risk and responsibility in case of problems and not the Administration. It was thus incorrect to assume that it would take several years before the first exchange of the Kåell-Lienzén system could be delivered and put into operation, he concluded.

Thirdly, Axel Hultman agreed that rapid automation would save on operating costs, but pointed out that in reality one probably had to accept a much slower transition to the automatic system.<sup>137</sup> He argued that it was easy to demonstrate that a very swift automation would be profitable even when using the expensive Western Electric system. However, he affirmed, such a scheme would probably be impossible to realise. Western Electric, in spite of its large resources, would probably be unable to deliver equipment so quickly, and other problems would hinder an expeditious automation even if the company could deliver. Rapid automation meant that two new buildings for the exchanges had to be finished in 1922 and another two in 1924. All this, he emphasised, demanded yearly sums of money which he deemed unobtainable from the Swedish Parliament.

Fourthly, Axel Hultman had another objection to the automation program contained in the memo by Lignell and Hallgren. They had argued in their report that the automation should contribute to as rapid a merger of the networks as possible.<sup>138</sup> They had also suggested that the first automatic exchanges replace the manual exchange with

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<sup>136</sup> *Ibid.*, pp. 1-2, 6.

<sup>137</sup> *Ibid.*, pp. 3-4.

<sup>138</sup> Paul Hallgren, Anders Lignell and Alfred Lundgren, 20 August 1920, *op. cit.*, p. 2 and appendix 1.

the worst quality and operating costs, i.e., the main exchange at Skeppsbron with its main exchange and auxiliary exchange. Their recommendation was that the first automatic exchange should be placed at Jeriko to take over subscribers connected to Skeppsbron and some of the sub-exchanges nearby. They emphasised that there was no immediate need to place an automatic exchange at Norrtullsgatan. Hultman objected to this exclusion of Norrtullsgatan, stressing that the premises housing the Administration's existing sub-exchange in the district had to be vacated in October 1923 and that Stockholm Telephone's sub-exchange in the district was overfull. Norrtullsgatan, which incidentally already housed the H exchange, had therefore to be supplied with the first automatic switch regardless.

Fifthly and finally, Axel Hultman objected that Lignell and Hallgren had given little consideration to what it meant for a state administration to place such a large order with a foreign firm.<sup>139</sup> It was difficult, he emphasised, for a state administration to deprive Swedish industry of considerable working opportunities:

By handing the automation over to a domestic company, one has also supported the Swedish industry and afforded considerable employment to the country's own workers.<sup>140</sup>

The previous Summer, in a letter to the general director, he had expressed repugnance at the idea of procuring from a foreign company. Now he evoked the notion that it was desirable to support Swedish industry and Swedish workers, a notion that readily tied in with the emergent crisis in Swedish industry that was connected to falling prices and the rising international competition facing many Swedish companies after the war.<sup>141</sup> Hultman thus argued that the issue of choosing switching systems ought to be related to the concurrent difficulties of Swedish industry as well as the rising unemployment.

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<sup>139</sup> Axel Hultman, 1 October 1920, op. cit., p. 6-7.

<sup>140</sup> Original sentence (in Swedish): "Genom att överlämna automatiseringen åt en inhemsk firma, har man ju också understött den svenska industrien och berett betydande arbeten åt det egna landets arbetare." Ibid., p. 7.

<sup>141</sup> The acute stage of what later has been identified as the crisis of deflation began in Autumn 1920 and is generally seen as having lasted until 1922. Some surrogate and munitions industries had faced a crisis already upon the end of the war. However, the crisis of 1920-21 was more sweeping with a decrease in industrial production of 25% and a rise in unemployment to 25%. On this crisis in Swedish industry, see Erik Dahmén, *Svensk industriell företagarverksamhet: Kausalanalys av den industriella utvecklingen, 1919-1939* (Stockholm: Industriens Utredningsinstitut, 1950), pp. 30-31, Jan Glete, *Nätverk i Näringslivet: Ägande och industriell omvandling i det mogna industrisamhället, 1920-1990* (Stockholm: SNS, 1994), pp. 84-85, and Lars Magnusson, *Sveriges ekonomiska historia* (Stockholm: Tiden Athena, 1996), pp. 367-369. An overview of the crisis from the viewpoint of unemployment and exchange rates is provided in Stephen N. Broadberry, "The North European Depression of the 1920s," *Scandinavian Economic History Review* 32 (1984): 159-167.

### Elaborating the arguments

Did Axel Hultman, as opposed to Anders Lignell and Paul Hallgren, have the decisive arguments? To Axel Hultman the 32 million kronor calculated by Lignell and Hallgren carried no weight and was irrelevant. The things that were relevant pointed to an altogether different conclusion. According to Hultman, the offer from General Telephone LM Ericsson ought to be accepted. Nevertheless, within the Administration headquarters, the argument advanced by Lignell and Hallgren apparently carried some weight. At about the same time as Hultman presented his memo, Anders Lignell, Erik Ekeberg and Herman Olson were commissioned to travel to Germany to investigate exchanges of the Siemens system in operation.<sup>142</sup>

However, Axel Hultman did more than just oppose the conclusion drawn by Anders Lignell and Paul Hallgren. Indeed, some of the work Hultman performed that Autumn in fact supported his conclusion. He actively tinkered with both the characteristics of the Kåell-Lienzén system and the criteria according to which the decision should be made.

Firstly, Hultman demanded changes in the design of several parts of the Kåell-Lienzén system, demands which General Telephone LM Ericsson for the most part accepted.<sup>143</sup> Hultman desired, for instance, that the switch should operate with a voltage of 48 V. The reply indicated that the company preferred 24 V, but assured that 48 V would be used if that was his wish.

Secondly, and more importantly, Axel Hultman took an active part in preparing a new invitation for tenders for the supply of two automatic switches. A month after his memo discarding the argument by Lignell and Hallgren, Axel Hultman presented a new draft contract. This draft contract, which was sent along the invitation for tenders, stipulated longer delivery times than had previously been discussed.<sup>144</sup> According to § 4, the exchange at Norrtullsgatan should be in operation 21 months after the contract had been signed, and the exchange at Jeriko should be in operation another 9 months

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<sup>142</sup> According to their subsequent travel report they left Sweden for Germany on 6 November 1920. Anders Lignell, Erik Ekeberg, and Herman Olson, 29 December 1920, "Reseberättelse," (Travel report), TALb; F I A:132.

<sup>143</sup> Axel Hultman, 25 August 1920, "Till Direktören Herr Hemming Johansson," (to Hemming Johansson) and reply by Gottlieb Piltz (LME), n.d., "Överingenjören för Stockholms telefonanläggningar," (to Axel Hultman), both TALb; F I A:70. Axel Hultman drafted another list of the same and some additional changes he desired to have made and sent to Paul Hallgren, see no signature (Axel Hultman's stationary), 24 September 1920, 'Letter to head of technical department,' TALb; F I A:71.

<sup>144</sup> Suggested contract written on Axel Hultman's stationary and appended to letter from Axel Hultman to the Administration headquarters, see Axel Hultman, 4 November 1920, "Till Kungl. Telegrafstyrelsen," (to the Telegraph Administration headquarters), TALb; F I A:70.

later. The suggested contract also included a paragraph allowing the Administration to later manufacture switches of the system, if it desired to do so:

§ 17. If the question in the future will arise about delivery of automatic telephone switches of the system which have been used for the exchanges in question here, and T. [the Telegraph Administration] will find the prices S. [the supplier] then may demand too high, or that the work would be more speedily performed if it was completely or partially performed at the Administration's factory, T. is free to manufacture the whole or parts of the switches at its factory. S. shall in this case receive a reasonable compensation if patents, granted, applied or in any other way acquired by S. after the signing of this contract are utilised.<sup>145</sup>

When drafting the suggested contract Hultman, according to his earlier memo, had already a conformation from General Telephone LM Ericsson that it would accept this kind of arrangement. By adding such a paragraph to the contract the other manufacturers would have to reveal if they also accepted this kind of concession. The new invitation for tenders was sent out in November 1920, requesting new offers and reactions on the suggested contract before 1 January 1921. North Electric and LM Ericsson's Hultman-Löfgren system were excluded this time, probably because of the high quoted prices on previous offers.

### Aligning the arguments

When the new offers came in, it became apparent that neither Western Electric nor Siemens accepted the paragraph which would allow the Telegraph Administration to later manufacture switches of their system.<sup>146</sup> Another significant change compared to previous offers was that the price quoted in the Siemens offer had come down substantially. However, Siemens' offer was quoted in an invented 'gold krona' to reduce problems with fluctuations in the value of the Swedish krona.<sup>147</sup> At the current

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<sup>145</sup> Original paragraph (in Swedish): "§ 17. Om då i framtiden fråga uppstår om leverans av automatiska telefonstationer enligt det system, som kommit till användning vid ifrågavarande stationer, S. [Telegrafstyrelsen] skulle finna de priser, L. [leverantören] då kan komma att fordra, för höga, eller att arbetet skulle kunna bedrivas med större skyndsamhet genom att helt eller delvis utföras å telegrafverkets egna verkstäder, är det S. obetaget att låta helt eller delvis utföra tillverkningen å sina verkstäder. För tillverkning med användande av patent, meddelade, sökta eller på annat sätt förvärvade av L. efter detta kontrakts underskrivande, skall L. erhålla skälig ersättning av S." *Ibid.*, p. 6.

<sup>146</sup> In the Western Electric offer it was stated that the company considered this such an important question that it suggested making this a subject for separate negotiations. In the Siemens offer it was stated that the company could not make this kind of concession, but that it was willing to discuss other arrangements which would allow the Administration some control over future prices. Einar Brofos (Western Electric), 29 December 1920, "Till Kungl. Telegrafstyrelsen," (to the Telegraph Administration headquarters), p. 3, and Wallin (Siemens-Schuckert), 31 December 1920, "Till Kungl. Telegrafstyrelsen," (to the Telegraph Administration headquarters), p. 8, both at TALb; F I A:77.

<sup>147</sup> Wallin (Siemens-Schuckert), 31 December 1920, "Till Kungl. Telegrafstyrelsen," (to the Telegraph Administration headquarters), TALb; F I A:77.

exchange rate, the offer was nevertheless slightly lower than LM Ericsson's offer regarding the Kåell-Lienzén system. Together these two offers had the lowest quoted prices, see Table VI-5.

*Table VI-5 Excerpt from table showing the incoming offers in December 1920.<sup>148</sup>*

<i>Tenderer</i>	<i>Fully automatic switch with 10,000 lines</i>		<i>Fully automatic switch with 5,000 lines</i>	
Western Electric	3,009,991	kronor	1,346,020	kronor
Siemens & Halske [exchange rate 1.3]	1,336,448 [1,737,382]	'gold krona' kronor]	619,426 [805,253]	'gold krona' kronor]
New Autotelephone Betulander	2,017,600	kronor	892,300	kronor
General Telephone LM Ericsson	1,845,000	kronor	804,000	kronor

A few days after the offers had been opened a meeting was held at Axel Hultman's office to discuss the new offers. Gathered there were Axel Hultman together with Paul Hallgren, Herman Olson and Helge Ericson (1890-1953) from the technical department, and the head of the Administration's factory, Klas Weman. The minutes of the meeting focused entirely on the offers from General Telephone LM Ericsson and Siemens.<sup>149</sup> The two offers were discussed in three dimensions; the contract, the technical devices, and the prices.

Regarding the contract, it was noted that General Telephone LM Ericsson had submitted some changes to the suggested contract, but that all those changes were of little or no relevance for judging the offer. Siemens, on the other hand, had submitted several changes which according to the minutes were considered important. Siemens had wished for shortened delivery times as compared to the suggested contract. In the Siemens' offer it had been stated that it was surprising that the prescribed delivery time had now been prolonged.<sup>150</sup> Echoing the earlier argument by Lignell and Hallgren, Siemens stressed that the judgement of the offer should benefit from the offered reduction in delivery time since it meant savings in operators' wages. In the minutes, however, it was only briefly noted that this was an advantage of the offer. Other submitted changes in the Siemens offer were considered disadvantageous, however.

<sup>148</sup> Exchange rate conversion for the Siemens & Halske made by the author on the basis of an approximate exchange rate. The table summarising the offers was drawn up by a clerk when the incoming offers were opened on 3 January 1921 in the presence of Paul Hallgren and Alfred Lundgren. Karl Karlsson, 5 January 1921, "Protokoll hållet vid öppnandet..." (minutes from the opening of incoming offers), TALb; F I A:70.

<sup>149</sup> Helge Ericson, n.d. (13 January 1921), "Protokoll över sammanträde hos Överingenjör Hultman den 13 januari 1921 angående anbud på automatiska telefonstationer i Stockholm," (minutes of meeting at chief engineer Hultman 13 January 1921 regarding offers for automatic telephone exchanges for Stockholm), TALb; F I A:71.

<sup>150</sup> Wallin (Siemens-Schuckert), 31 December 1920, "Till Kungl. Telegrafstyrelsen," (to the Telegraph Administration headquarters), pp. 2-3, TALb; F I A:77.

The quotation in 'gold krona' and the suggested payment procedure with one third in advance, for instance, were considered disadvantages. Most notably however, Siemens stressed in the offer that it could not accept the paragraph which would later allow the Telegraph Administration to produce switches of the system. It was simply impossible, it had been stressed in the offer, to put the company's patents and production experience at the Administration's free disposal in exchange for an order of only two rather small switches.<sup>151</sup> However, the minutes affirmed, Siemens was willing to discuss other arrangements which would allow the Administration to have some control on the prices for future switches.<sup>152</sup> In all, the minutes concluded, the changes to the contract submitted by Siemens made its offer not fully comparable with the other offers.

Regarding the technical devices of the system offered by General Telephone LM Ericsson, it was briefly noted in the minutes that they had been seen during a visit to the offices of LM Ericsson and that Sigurd Johansson and a colleague were to examine the devices in detail.<sup>153</sup> When it came to the system offered by Siemens, it was specifically noted that examinations carried out by Erik Ekeberg, Anders Lignell and Herman Olson on exchanges in operation in Germany had uncovered a disturbingly high number of faults. The minutes noted that Siemens explained these results by affirming that the switches had not received the due maintenance during the years of war. It was further stressed in the minutes that the number of selectors included in the offer was based on Siemens estimates and lower than the estimates made within the Telegraph Administration.

This last point was adjusted in the ensuing comparison in prices. While the prices quoted in the offer from LM Ericsson were accepted as they were, the prices quoted in the Siemens offer were adjusted.<sup>154</sup> Firstly, the prices were increased to cover the number of selectors as estimated within the Telegraph Administration, which meant an increase with 65 and 13 thousand 'gold krona' for the two exchanges respectively. After another addition for insuring the transport to Sweden, it was concluded in the minutes that the two Siemens switches would cost 1,840 thousand kronor and 832 thousand kronor respectively if the exchange rate from 'gold krona' was 1.3.<sup>155</sup> If the exchange rate went down to 1.2, it was added, the prices would be 1,699 thousand kronor and 768 thousand kronor respectively.

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<sup>151</sup> *Ibid.*, p. 8.

<sup>152</sup> Helge Ericson, n.d. (13 January 1921), *op. cit.*, p. 3.

<sup>153</sup> *Ibid.*, pp. 1, 3.

<sup>154</sup> Helge Ericson, n.d. (13 January 1921), *op. cit.*, pp. 1, 3-4.

<sup>155</sup> This made the Siemens offer thus somewhat more expensive than the offer from General Telephone LM Ericsson, see Table VI-5 on p. 257.

According to the minutes, the participants finally agreed that the offer from Siemens had six principal disadvantages.<sup>156</sup> Firstly, the rather large advance. Secondly, the quotation in ‘gold krona,’ which could increase the price. Thirdly, the difficulty to control the prices on future orders, since Siemens would not allow the Administration to manufacture. Fourthly, the way Siemens wanted to calculate fines in case of delayed delivery. Fifthly, weaknesses in the system. Sixthly and finally, problems in Germany which might affect Siemens’ ability to deliver:

The risk under Germany’s present industrial conditions to acquire makeshift material, which could further increase the weakness of the system, and the risk that difficulties to deliver may arise due to industrial and political conditions.<sup>157</sup>

The meeting had spoken. Gone was the 32 million kronor which Anders Lignell and Paul Hallgren had estimated to weigh in favour of the Siemens system. Gone was also Axel Hultman’s emphasis on supporting Swedish industry and affording employment to Swedish workers. Gone, at least for the moment, was also the discussion regarding how tested the system offered by LM Ericsson actually was and consequently whether much work remained to transfer the system from paper to reality. In their place were instead six matters of fact which weighed against choosing the Siemens offer, some of which echoed Hultman’s previous arguments against the Siemens system. Most notably, § 17 in the suggested contract drafted by Hultman had succeeded in weighing against the Siemens system.

### **Drawing to a close**

As the diverse arguments were becoming aligned to form the preferences of the Administration, the issue of choosing was slowly drawing to a close. The offer from Western Electric had little support within the Telegraph Administration, and had thus gradually become weeded out from the discussion. The offer from New Autotelephone Betulander had similarly become excluded from the discussion. Neither Axel Hultman, nor the people at General Telephone LM Ericsson, afforded much weight to the blocking calculations performed by Ragnar Holm. Moreover, there had been discussions within the Administration since the Autumn 1920 whether one could employ the Betulander-Palmgren system, excluding the link-connecting principle, for

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<sup>156</sup> Helge Ericson, n.d. (13 January 1921), op. cit., pp. 4-5.

<sup>157</sup> Original sentence (in Swedish): “Risken att under Tysklands nuvarande industriella förhållanden erhålla kristidsmaterial, som än mer kunna öka svagheten i systemet, samt risken att leveranssvårigheter kunna uppstå på grund av industriella och politiska förhållanden.” *Ibid.*, p. 5.

small exchanges in two towns.<sup>158</sup> In fact, Herman Olson had been put to work on the matter. Thus, gradually the Betulander-Palmgren system was literally constructed as a system functional for small exchanges, but unsuitable for large exchanges.

The conclusion from the internal meeting pointed towards finally weeding out the offer from Siemens, making the offer from General Telephone LM Ericsson the only remaining offer to consider. The Siemens offer, however, did not accept a withdrawal without further argument. In the beginning of February the Administration received a letter from Siemens advising that the exchange rate had come down to 1.213, which made the Siemens offer cheaper.<sup>159</sup> In addition, only a few days later the Administration received a long report refuting the examinations presented in the travel report by Anders Lignell, Erik Ekeberg, and Herman Olson.<sup>160</sup> The report from Siemens stressed that of the 17 or 18 million telephones in the world, about one million were connected to automatic exchanges. For these, the Strowger system dominated, which proved that it was a system 'capable of living.' Since the Siemens system was an extension of this system, it was stressed, this meant that the 'Strowger-Autelco-Siemens-system' had to be held as "hitherto unsurpassed especially for automation of telephone networks in larger cities."<sup>161</sup> It was then stressed that the fault rates from the semi- and fully automatic exchanges visited in Germany were not comparable in the way presented in the travel report with fault rates from a manual exchange in Stockholm since certain items were simply missing in the statistics for Stockholm.

The report from Siemens then turned to the examinations performed in Germany. Firstly, it was stressed, the travel report had wrongly characterised the switches as representative for Siemens' present system. The exchanges visited, it was emphasised, were all of what was referred to within Siemens as their 'pre-war' system. The system offered for Stockholm contained several improvements made on the basis of accumulated experience. Secondly, it was asserted that most of the faults observed by the group during their examinations were not attributable to the system but to factors

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<sup>158</sup> A decision had been taken in October 1920 to investigate whether the Betulander-Palmgren system could be used for exchanges in Halmstad and Sundsvall. See: The Telegraph Administration Headquarters, 23 October 1920, "Utdrag av protokoll..." (Excerpt of minutes from the headquarters of the Telegraph Administration), and Herman Olson, 19 January 1921, "Till chefen för Linjebyrån," (letter regarding choice of exchange for Sundsvall to head of technical department), both at TALb; F I V A:5.

<sup>159</sup> Wiklund (Siemens-Schuckert), 4 February 1921, "Till Kungl. Telegrafstyrelsen," (to the Telegraph Administration headquarters), TALb; F I A:70.

<sup>160</sup> Wallin (Siemens-Schuckert), 12 February 1921, "Till Kungl. Telegrafstyrelsen," (to the Telegraph Administration headquarters), TALb; F I A:70.

<sup>161</sup> Full sentence (in Swedish): "Det ena med det andra gör att vi trots allt vågar påstå att Strowger-Autelco-Siemens-systemet hittills måste anses vara ööverträffat särskilt då det gäller automatisering av telefonnäten i större städer." Ibid., p. 2.

outside the switches examined. It was stressed, for instance, that the relatively large number of wrong connections observed were mainly due to factors outside the system. Dresden, Halle, and Leipzig all lay in an area where the Saxon dialect was spoken, and this dialect it was emphasised was “widely known to be particularly inarticulate and often difficult to understand, especially over the telephone.”<sup>162</sup> Thus the large number of wrong connections observed at the semi-automatic exchanges there surely depended on the operator hearing the wrong number. At the fully automatic exchange in Munich, the fourth and last exchange visited, the many wrong connections observed, according to the Siemens report, probably lay in the subscribers making the wrong connections. The report concluded by stressing that the largest lesson from the travel report was that only a long-standing practical experience could determine if an automatic system was capable for use on a large scale.

The report from Siemens caused no immediate reaction within the headquarters of the Telegraph Administration. However, a few days later several Stockholm newspapers published some figures from the travel report, taking them as perhaps the plans to halt the introduction of automatic switches in Stockholm.<sup>163</sup> This publicity made the Administration come under pressure from Siemens, leading to the Administration subsequently informing the press that the published numbers were misleading and not comparable to figures from manual exchanges in Sweden.<sup>164</sup> Nevertheless the report from Siemens did not significantly alter things within the Administration. The offer from Siemens was being weeded out.

Thus remaining was the offer for two switches of the Kåell-Lienzén system from General Telephone LM Ericsson. A system which never had been put into operation anywhere. Now the Administration engineer Sigurd Johanson wrote to Axel Hultman reporting on what he had found taking a closer look at the Kåell-Lienzén system.<sup>165</sup> Johanson reported that he had found no unsafe combinations if 48 V was used, and that

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<sup>162</sup> Full sentence (in Swedish): “Vad Halle, Leipzig och Dresden angår vilja vi erinra om att dessa ligga inom ett område där sachsisk dialekt talas och är det ett allmänt erkänt förhållande att denna är synnerligen otvetyg och ofta svårförståelig, särskilt i telefon.” Ibid., p. 6.

<sup>163</sup> See, for instance, “Telefonväsendets automatisering blir skrinlagd?,” *Stockholms-Tidningen*, 17 February 1921 and “Automattelefon torde komma att skrinläggas t.v.,” *Svenska Dagbladet* (Stockholm), 17 February 1921.

<sup>164</sup> The examinations in Germany had been carried out on condition that the results were not made available to outsiders. Soon after the information from the travel report had appeared in the newspapers, the Administration received a letter from Siemens in Germany which stressed the confidential nature of the travel report and demanded the Administration to inform the newspapers that the earlier published information was misleading. Siemens & Halske, 7 March 1921, “An die Königliche Generaldirektion der Telegraphen,” (to the general director of the Telegraph Administration), TALb; F I A:70.

<sup>165</sup> Sigurd Johanson, 8 March 1921, “Till Överingenjören,” (to the chief engineer), TALb; F I A:70.

it was probably safe to run the system on 24 V. He further reported of several items which had yet been redesigned to operate at 48 V. Johanson concluded his report suggesting that 32 V might be better for the lines, the contacts, and the microphones. The report from Johanson gave a promising view of the Kåell-Lienzén system, but indicated nevertheless that it was still a system very much under construction.

A few days later the issue of automation and the situation in the networks in Stockholm were being discussed in an internal memo.<sup>166</sup> According to this memo it would be possible to postpone the erection of the first automatic exchange until 1925, in spite the worsening condition of some of the manual exchanges and the forecast growth in the number of subscribers. However, the memo noted, something still had to be done at Norrtullsgatan before that time since the premises nearby housing the current exchange had to vacated in October 1923, and that the Stockholm Telephone sub-exchange in the district was overfull. Moreover, the memo continued, further postponement of the choice of automatic system implied that one would still have no experience of a Swedish system. Therefore, it was recommended that one switch was ordered from General Telephone LM Ericsson:

To acquire sufficient knowledge about the LM Ericsson system until 1925 and to have it satisfactorily tested, it is suggested that the exchange at Norra Vasa [Norrtullsgatan] be in built and put in operation on 1 April 1923.<sup>167</sup>

A little more than a week later, on Sunday 20 March, the board of the Telegraph Administration confirmed the outcome of the preceding process. An automatic switch of the Betulander-Palmgren system for 3,000 subscriber's should be constructed and manufactured within the Telegraph Administration and be put into operation in the town of Sundsvall.<sup>168</sup> It was further decided that all offers for two automatic exchanges for Stockholm should be declined thus abolishing the formal procurement process. Letters were sent to all tenderers informing them that the procurement had been cancelled because the Telegraph Administration had found all offers disadvantageous, and since the extent of automation originally planned no longer applied due to lack of funds.<sup>169</sup>

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<sup>166</sup> n.a., 11 March 1921, "VPM anående automatisering av Stockholms telefonstationer," (memo regarding the automation of Stockholm's telephone exchanges), TALb; F I A:71.

<sup>167</sup> Original sentence (in Swedish): "För att till år 1925 kunna erhålla tillräcklig kännedom om det LM. Ericssonska systemet och få detsamma nöjaktigt utprovat, föreslås byggandet av stationen Norra Vasa att vara färdig 1 april 1923." *Ibid.*, p. 3.

<sup>168</sup> The Telegraph Administration headquarters, 20 March 1921, "Utdrag ur protokoll...", (excerpt from minutes), TALb; F I A:71 and F IV A:5.

<sup>169</sup> Paul Hallgren (signed P.Hn.), 31 March 1921, 'no title,' (draft of letters to General Telephone LM Ericsson, Western Electric, Siemens, and New Autotelephone Betulander), TALb; F I A:70.

After these formal decisions, negotiations were initiated a few days later with General Telephone LM Ericsson concerning the purchase of one automatic switch for 5,000 subscribers to be put in operation at Norrtullsgatan. The negotiations moved on expeditiously. In the midst of them, the Telegraph Administration headquarters received instructions from the recently established ministry of communications urging it to make as many of its procurements as possible within Sweden, to help Swedish industry and reduce unemployment.<sup>170</sup> This certainly echoed an argument advanced by Hultman the previous Autumn and if anything supported the posture that the Administration should procure from LM Ericsson rather than Siemens. Yet the order now negotiated was smaller and hence less immediately supportive of Swedish industry than the one envisaged earlier on in the process.

On 1 April, the managing director of General Telephone LM Ericsson wrote to Axel Hultman confirming that the company was willing to reduce the price by 7.5 % and that the requested 5% royalty to Hultman was included in the price.<sup>171</sup> After a few more weeks a contract had been approved and signed by representatives of the Telegraph Administration and General Telephone LM Ericsson.<sup>172</sup> According to the contract, the exchange should be in operation in 21 months, and the paragraph allowing the Administration's own factory to later produce exchanges of the system was intact from the draft contract used in the previous invitation of offers. To General Telephone LM Ericsson this contract was most certainly important. It had managed to sell a switch of a system that still was untried. Nonetheless, this contract with the Telegraph Administration was not the only such achievement. At about the same time as the contract was signed, the company succeeded in signing contracts on delivering three switches of similar and smaller sizes to two foreign operators.<sup>173</sup>

To the Telegraph Administration the contract implied the settlement of a lengthy procurement process, albeit with the outcome of procuring only one switch. Soon after

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<sup>170</sup> Walter Murray, 29 March 1921, "Till Telegrafstyrelsen," (To the Telegraph Administration's headquarters), TAAb; E I:48.

<sup>171</sup> Hemming Johansson, 1 April 1921, "Herr Överingeniören mm," (To the chief engineer etc., Axel Hultman), TALb; F VIII E:2.

<sup>172</sup> Contract, 23 April 1921, (Contract between the Telegraph Administration and General Telephone LM Ericsson), TALb; F I A:77.

<sup>173</sup> One was sold to be put in operation in Rotterdam (Holland), the other two in Hamar and Kristiansund ((Norway). The first of these was put in operation in May 1923, that is, about a half a year before the one at Norrtullsgatan. Christian Jacobæus, *LM Ericsson 100 år: Teletekniskt Skapande, 1876-1976* (Stockholm: LM Ericsson, 1977), p. 87. However, all three of these were small compared to the large exchange envisaged in the Swedish procurement process. In 1926 the Rotterdam switch was equipped for 5,000 subscriber's lines and the two in Norway were equipped for 1,200 and 1,500 subscriber's lines respectively. LM Ericsson, "Tabell över i drift och under byggnad varande automatiska telefonstationer enligt LM Ericssons system," *LM Ericsson Review* 3, no. 5-6 (1926): 73.

the contract had been signed, Gotthilf Ansgarius Betulander began to work for the Telegraph Administration again. This time to assist in designing the switch for Sundsvall. Others, including Hultman and Lignell, still had much work and many arguments ahead of them before the telephone networks in Stockholm were merged and equipped with automatic telephone switches. Indeed, it was still not formally decided what kind of switch should be used for the planned local exchange at Jeriko. But, before giving attention to some of that work and their related controversies, some additional threads relating to the controversy just covered will be attended to.

### **Interlude Involving a Few Loose Threads**

#### **Axel Hultman, the royalty and the story of Martin Löfgren**

In the Summer 1920 Axel Hultman had reassured Rydin that he no longer had any 'inventor's interest' when recommending an automatic switching system for Stockholm. A few months later he had stressed in a memo that his conclusions did not depend on him favouring one system over any other. Yet, in the final event the contract from 1913 between him and the LM Ericsson had been enacted. During the final negotiations with General Telephone LM Ericsson, Hultman had asked for and been promised a personal royalty of 5%. It was half the 10% royalty set down in the 1913 contract, but still more than the non-existent 'inventor's interest' which he had implied half a year earlier. However, these events do not necessarily mean that Hultman had been misleading when he affirmed in 1920 that he no longer had any 'inventor's interest' and it has proved impossible to retrieve any material to indicate that this subsequently became an issue. It has only been possible to establish that the 1913 contract was applied in the end in Spring 1921.

There is, however, another story related to this contract which begs to be told. That is the story of a suppressed controversy concerning who invented what. According to established history Axel Hultman was the inventor and Knut Kåell the important designer of the so-called 500-point system, i.e., what I have labelled the Kåell-Lienzén system above.<sup>174</sup> This story was contended at the time within LM Ericsson, however. According to the alternative version, from 1913 and onwards Martin Löfgren made the vital contributions to the work of designing devices for the switching system.<sup>175</sup> In

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<sup>174</sup> For but two of the many reiterations of this story, see e.g. Jacobæus, pp. 83-85 and Robert J. Chapuis, *100 Years of Telephone Switching (1878-1978), Part 1: Manual and Electromechanical Switching (1878-1960's)* (Amsterdam: North-Holland Publishing Company, 1982), pp. 186-187.

<sup>175</sup> The notes were collected by Gustaf Collberg who was an engineer at LM Ericsson and friend of Martin Löfgren. Many of the notes are in Collberg's own hand, but he gathered also notes, sketches, and memos by Martin Löfgren and others. This material was retrieved more or

1914, he sent a memo, with drawings of a pre-selector he had designed, to the managing director of LM Ericsson Hemming Johansson, but received no reply.<sup>176</sup> In 1917 it was reported that Löfgren had constructed the 'whole machinery of Hultman's system', but that Sigurd Johanson (who then worked in the project) seemed to want to take all the credit.<sup>177</sup> Several years later David Lienzén said that he could 'put his life' on the fact that Löfgren was the inventor/designer of the bare wire multiple used for the selectors.<sup>178</sup> It was this design which Hultman later patented and earned his royalty on. From at least 1918, Löfgren himself made several compilations of what he had designed in relation to the automatic switches, and he submitted critical remarks on design suggestions presented by Axel Hultman to a senior executive within LM Ericsson.<sup>179</sup> In short, this story claims that Löfgren's contributions were not recognised by the company.<sup>180</sup>

Judging exactly who invented what is an impossible task. What makes this story interesting is the evidently suppressed conflict concerning the attribution over who had done what in designing the automatic switches. Particularly interesting are the indications that Löfgren's claims did not interest Hemming Johansson and other executives within LM Ericsson, even though these might just have had the potential to release the company from paying any royalties to Hultman. This stance could have been taken for a number of reasons, including: in fear of staging a potentially harmful conflict over rights to patents, to avoid estranging Hultman as an important

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less by accident in the rather unorganised archives, at least in 1996, of LM Ericsson. LA; Samling G. Collberg #3.

<sup>176</sup> On the back of the memo, Collberg has noted that the memo was found about 6 years later in a heap of papers thrown out from the office of Hemming Johansson. Martin Löfgren, 15 October 1914, "Anropsfördelare (förväljare)," (call distributor & preselector), LA; Samling G. Collberg #3.

<sup>177</sup> Gustaf Collberg, 3 January 1917, "LME & Co," (hand-written note), LA; Samling G. Collberg #3.

<sup>178</sup> Lienzén's statement is reported in a note by Gustaf Collberg where it is noted that this was what Lienzén had said the very same day and several times before, see Gustaf Collberg, 19 September 1925, "Betr. autom. väljare," (hand-written note concerning automatic selectors), LA; Samling G. Collberg #3.

<sup>179</sup> See e.g. Martin Löfgren, 30 August 1918, "Ing. Martin Löfgrens konstruktioner 1913-1918," (enumeration of designs made by Martin Löfgren 1913-1918), and Martin Löfgren, 28 October 1919, 'no title' (memo to Gottlieb Piltz who at the time was managing director of General Telephone LM Ericsson together with Hemming Johansson), both at LA; Samling G. Collberg #3.

<sup>180</sup> No evidence has been retrieved which indicates that Hultman was involved in suppressing this story. However, he was at times, as has been depicted above, openly critical about design decisions made within LM Ericsson. It might also be worth noting that, in a memo in 1911 concerning automatic switching, he made a strong and clear distinction between the designer drawing up the principles of the system and "the instrument maker who should perfect the details." See Axel Hultman, 2 September 1911, "Förslag till anordnandet af den lokala telefonstationen i Stockholm," (proposal for arranging the local telephone exchange in Stockholm), p. 11, TALb; F I A:30.

representative of the Telegraph Administration, or because Löfgren's claims were considered unwarranted or too weak. Yet, whichever of these interpretations one chooses, the suppression of Löfgren's claims and the fact that Hultman was to receive a royalty (albeit at a reduced rate) point to the significance given to the contract signed in 1913.

The signing of this contract in 1913 manifested that Axel Hultman and LM Ericsson had succeeded in interesting one another in assuming certain roles. These inscribed roles apparently also held at least some grip over them in the ensuing years, and in 1921 it was apparently in their interest to enact the paragraph related to the purchase of a switch for 5,000 numbers. These roles were enacted regardless of what Hultman had uttered within the Telegraph Administration and regardless of what Löfgren might have done to the switching system between 1913 and 1921.

The outcome is clear. It is indisputable from the account provided above and in the previous chapter that Axel Hultman was simultaneously involved in attempts to modify both the switching system developed within LM Ericsson and the Administration network into which it should fit. One Administration historian wrote, without mentioning the 'Löfgren story', that Hultman undoubtedly should be credited with the arrival of a Swedish switching system appropriate for Stockholm, regardless of how the actual designer's honour was distributed among different parties.

One thing was mainly Hultman's merit regardless of how the designer's honour is distributed among different parties: a Swedish automatic switching system appropriate for Stockholm arrived at a convenient time, something which both Swedish telephone operations [i.e., the Telegraph Administration] and Swedish telephone industry [i.e., LM Ericsson] have reason to thank [him] for.<sup>181</sup>

This is largely consistent with my own account. One should remember, however, that there had been arguments raised at times before 1921 to the effect that the right time for beginning the automation was then and not later.<sup>182</sup> Indeed, without doubt Hultman should be credited with having been involved in efforts to displace earlier 'convenient points in time,' points in time which otherwise could have ended the Administration's support for a future switching system from LM Ericsson. Similarly, without doubt he should be credited with having been involved in the efforts to establish what constituted a switching system appropriate for Stockholm. Thus, for the quote's veracity to be

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<sup>181</sup> Original sentence (in Swedish): "Oberoende av konstruktörsärens fördelning mellan olika parter, en sak var huvudsakligen Hultmans förtjänst – ett för Stockholm lämpligt svenskt automatsystem kom fram vid en lämplig tidpunkt, något som svensk telefondrift och svensk telefonindustri båda ha anledning att tacka för." Lindberg, *Med fingerskiva*, p. 33.

consistent with my story, it should be stressed that the notions of ‘convenient time’ and ‘appropriate’ were as much negotiated as the ‘selected’ switching system.

**Why did paragraph 17 in the draft contract achieve the desired ends?**

Paragraph 17 of the contract drafted by Hultman in the Autumn 1920 was important in the account above. In requiring contending suppliers to concede that the Administration’s own factory should be allowed to eventually produce switches of the system without payment for the use of existing patents was asking for a substantial concession.<sup>183</sup> Clause 17’s existence was motivated by Hultman as a way of ensuring reasonable prices later on. However, the paragraph also became an important device for debarring from consideration offers from foreign tenderers, and in particular Siemens. Hultman was already aware, even before the paragraph was drafted, that General Telephone LM Ericsson would accept such an agreement while Siemens probably would not. When the offers came in with only the one from LM Ericsson accepting the paragraph, the disassociating principle of § 17 was clear. Subsequently, it was endorsed when becoming accepted within the Administration as an important criteria for selecting LM Ericsson’s offer.

One pertinent question is why the executives at General Telephone LM Ericsson accepted this paragraph while their counterparts at Siemens and Western did not. One ‘conspiracy inclined’ guess is that they were aware of the paragraph’s potential for disassociating the competition from the procurement process. The argument proposed here is that the paragraph was accepted since it represented less of a loss to LM Ericsson than it did to its competitors.

In 1915, at the time when the Telegraph Administration procured the switch for the H exchange from LM Ericsson, Axel Hultman entered into an agreement with the Telegraph Administration, putting the use of his future Swedish patents for automatic switching devices at the Administration’s disposal.<sup>184</sup> Furthermore, Hultman was to be remunerated if the Administration exploited the patents. In this contract it was affirmed that this grant of use did not entail any limitation on the rights granted to LM Ericsson in 1913. Nevertheless, from 1915 and onwards both the Administration and LM Ericsson had the right, in Sweden, to employ Hultman’s future patents for manufacturing automatic switches to the Administration’s telephone network.

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<sup>182</sup> See the argument for a swift automation by Anders Lignell and Paul Hallgren in 1920 (pp. 250ff above), or indeed Karl Erik Landström’s demand for a swift automation in 1917 (chapter V, pp. 206ff).

<sup>183</sup> The complete paragraph is quoted on page 256.

<sup>184</sup> Contract, 25 June 1915, (agreement between Axel Hultman and the Telegraph Administration headquarters), TALb; F VIII E:2.

Thus in 1920 and for Sweden, both the Telegraph Administration and General Telephone LM Ericsson had a 'grant of enjoyment' of Hultman's patent for a selector with bare wire multiple.<sup>185</sup> It is not known what communication passed prior to the Autumn 1920 when Hultman advised that the company was willing to allow the manufacturing concession. However, it is plausible to assume that the pre-existing contract between Hultman and the Telegraph Administration had something to do with it, since it made such a concession less of a loss to General Telephone LM Ericsson. Thus, paragraph 17 in the draft gained its disassociating potential from an earlier indirect association between the Telegraph Administration and LM Ericsson woven through two contracts and one subsequent patent. In all this, Hultman appeared as an important engineer involved in both creating § 17 and in making it work.

### **The Betulander-Palmgren system and the Telegraph Administration**

When the Telegraph Administration ordered the switch from LM Ericsson, New Autotelephone Betulander became fully owned by General Telephone LM Ericsson under the terms of the agreement between the syndicate of owners and LM Ericsson.<sup>186</sup> GA Betulander returned to work at the construction section of the Administration's technical department. There, he entered into an inventor's agreement with the Telegraph Administration which was standard for engineers working in a position such as his. According to this agreement, the Telegraph Administration was allowed to freely use within Sweden all things related to automatic switching which Betulander might invent during his employment.<sup>187</sup> However, many of the details of the Betulander-Palmgren system were patented while Betulander worked within New Autotelephone Betulander. Therefore the question is how the Administration could decide to manufacture a switch of the system for Sundsvall when the company, with its Swedish patent rights, was acquired by General Telephone LM Ericsson.

The standing of the Swedish rights to Betulander's patents was less clear-cut than might appear at first sight, however. In 1912 G.A. Betulander entered into an agreement with the Telegraph Administration in connection with his leave of absence from the Administration. According to this agreement, Betulander granted the Administration the right, in Sweden, to freely utilise inventions which Betulander might make during his

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<sup>185</sup> This was the only patent concerning automatic switching devices granted to Hultman at the time. The application was sent in 23 February 1915, and the patent was issued 15 March 1917 (Patent # 42258). A list of Hultman's patents is available in TALb; F VIII E:2.

<sup>186</sup> On this contract, see pp. 240f.

<sup>187</sup> Contract, 11 May 1921, (contract between the Telegraph Administration headquarters and GA Betulander), TALb; F VIII D:1.

leave of absence.<sup>188</sup> When his patents were later transferred to New Autotelephone Betulander, it was noted that this transfer should not imply any limitation on the Administration's rights. Therefore, when General Telephone LM Ericsson later acquired the company, the Swedish rights regarding the patents issued to Betulander between 1912 and 1919 became shared between the Telegraph Administration and General Telephone LM Ericsson. This was at least the view within the Telegraph Administration. It is unclear, however, whether this picture of the situation was shared with LM Ericsson at the time of the agreement to acquire New Autotelephone Betulander.<sup>189</sup>

To conclude, the issue of the Swedish rights to the patents related to the Betulander-Palmgren system was and continues to be confusing. There was little conflict about the situation, however, presumably since LM Ericsson at the time had little interest in the system. Betulander worked together with Herman Olson and others at the Administration's factory to design a switch using the crossbar selector but without the link-connecting principle.<sup>190</sup> The initial capacity was to be 3,000 subscribers' lines, and the maximum capacity 8,000 subscribers' lines. Several problems arose during the work and the exchange was subsequently put into operation later than planned, in October 1926.<sup>191</sup>

### **Further Stabilising of the Workings of the Exchanges in Stockholm**

In Spring 1923 full interconnection was re-established between the two formerly separated services, and the special interconnection fee was abolished.<sup>192</sup> The subscribers of the former Stockholm Telephone network had then been included in the Telegraph Administration's Stockholm directory, some subscriber's had also been

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<sup>188</sup> Karl Erik Landström, 19 January 1912, "Till Verkstadsdirektören," (letter to the head of the Administration's factory), TALb; F I A:351.

<sup>189</sup> In 1927 there was an attempt within the Administration to map out the standing of the Swedish rights to Betulander's patents. This investigation indicated that there prevailed differing views between LM Ericsson and the Telegraph Administration regarding their respective rights. See n.a., 22 October 1927, 'no title,' (untitled memo regarding Betulander's patents and the relation with LM Ericsson), TALb; F I A:351.

<sup>190</sup> See e.g. Herman Olson, 10 December 1921, "Till Linjedirektören, Sundsvall: Betr. Sundsvalls automatiska telefonstation," (letter to the lines director in Sundsvall regarding the automatic exchange in Sundsvall), GA Betulander, 29 December 1921, "Till Verkstadsdirektören: Betr. Sundsvalls nya automatstation," (letter to the head of the Telegraph Administration's factory regarding the new automatic exchange for Sundsvall), and GA Betulander, 26 October 1922, "Till Verkstadsdirektören: Betr. Stativ för Sundsvall och reläer av ny typ," (letter to the head of Administration's factory regarding racks for Sundsvall and relays of a new type), all at TALb; F IV A:5.

<sup>191</sup> Hans Heimbürger, *Svenska Telegrafverket: Telefon, Telegraf och Radio, 1921-1945* (Karlskrona: Televerkets Centralförvaltning, 1974), p. 33.

<sup>192</sup> Heimbürger, *Svenska Telegrafverket, 1921-1945*, pp. 6-9, 114.

connected to other exchanges, two sub-exchanges had been closed, a new intermediate exchange had been opened, and many subscriber's had received new telephone numbers since many numbers had been used in both networks. In August, the automatic exchange at Norrtullsgatan was put into operation.<sup>193</sup> First, 100 of the Administration's own service telephones were connected to the exchange, and in January 1924 a couple of hundred subscribers were connected. By the beginning of February in all 2,200 subscribers were connected to the exchange, using a dial attached to their telephone sets to make their calls.

The procurement of an automatic switch, and the subsequent work of erecting it and making it into an exchange capable of switching telephone calls, marked the successful settlement of a substantial number of issues. Yet, there still remained a lot of work to be done, and this section will deal with some of the work related to the installation of automatic telephone switches into the telephone network in Stockholm. The first topic concerns discussions on how the early automatic exchanges should be domesticated to fit into a network with manual exchanges. The second topic concerns the further fate of some of the engineers who had been involved in the three original projects. Specifically it covers the controversy about Axel Hultman's royalties which arose when the second automatic switch was to be ordered, that is, the one to become the local exchange at Jeriko. The third topic concerns some discussions related to the issue of subscribers and automatic switching and in particular the availability of a semi-automatic service for heavy users. The fourth and final topic concerns the operators in the wake of the automation, and in particular a demand raised to halt the introduction of the automatic service so as not to deprive the operators of their livelihood.

### **Integrating the automatic switch into a network of manual exchanges**

In what manner were calls to be switched between manual and automatic exchanges, and what scheme was to be used for the telephone numbers? Issues like these had repeatedly been debated during the procurement of the first automatic exchange, but continued to be disputed during the ensuing years.

It had been decided in 1921 in connection with the order for the equipment that traffic from the manual exchanges to the new automatic exchange at Norrtullsgatan should be handled by operators at key set switchboards situated at the latter exchange.<sup>194</sup> There, the operators would complete the call by operating the selectors by using a key set, that is, in a way resembling that of a semi-automatic exchange.

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<sup>193</sup> Lindberg, *Med fingerskiva*, pp. 43-44.

<sup>194</sup> n.a., 13 April 1921, "Bilaga C: Plan för expeditionen av trafiken mellan automatstationer och manuella stationer," (appendix C to the contract containing plan for switching traffic between automatic and manual exchanges), TALb ; F I A:71.

Incoming inter-urban traffic, on the other hand, was to be routed past the selectors of the automatic switch. This implied that trunk lines from the inter-urban exchange were to be wired to special manual multiple switchboards with one jack for each subscriber's line.<sup>195</sup> Local calls from the automatic exchange to the manual exchanges were finally to be dialled by the subscribers and the selectors would then connect to the desired manual exchange. There the desired telephone number was to be displayed on a visual display panel above manual multiple switchboards where operators made the final part of the connection. For these latter kinds of calls the calling subscriber would not talk to any operator, despite their participation in establishing the connection. Thus, to the subscribers the above described arrangements would make the whole telephone network in Stockholm assume the characteristics of the exchange to which they were connected. Those connected to a manual exchange were to order all their calls as before, that is, from an operator. Those connected to the automatic exchange, on the other hand, were to order all their local calls using their dial, and they were only to order inter-urban and other special calls by talking to an operator.

According to the established numbering principle, each subscriber had a telephone number consisting of an exchange prefix indicating the city district followed by a number, such as «NORTH 2959».<sup>196</sup> The decision having been taken that all local calls from the automatic exchange should be dialled, the question arose as to how to adapt the numbering to the use of dials. The idea which dominated during the planning was to put letters alongside the digits on the dials signifying the districts. That is, to have the automatic exchange acquire an adapted version of the numbering used at the manual exchanges. In the end, however, a dial with no letters was chosen. This, in turn, required that all local telephone numbers be translated into all digit numbers, replacing the exchange prefix with two digits.

This caused a problem, however. Presumably to not (further) interfere with the interaction between operators and subscribers by further changes in numbering, it was considered undesirable to simultaneously change the way the subscribers still connected to manual exchanges ordered their calls. The solution chosen, beginning in 1923, was to print two separate editions of the telephone directory.<sup>197</sup> In the edition for those

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<sup>195</sup> One reason given for this special arrangement for incoming inter-urban traffic was that this allowed for the long established principle of breaking any ongoing local call to make way for an inter-urban call. *Ibid.* p. 1.

<sup>196</sup> There were two exceptions to this. First, those subscribers connected to the main exchange had no prefix but only a number. Second, there were subscribers who subscribed to a nominal call service, which meant that subscribers could call on them by using their *Name* instead of their number.

<sup>197</sup> However, the 'automatic' edition of the directory included a key which enabled those subscribers to themselves translate any all digit number to the established district prefix number

connected to a manual exchange the district prefix prevailed, in the edition for those having a dial the new all digit numbers were used. This solution was not uncontested, however. In 1925 Axel Hultman, for one, suggested the introduction of all digit numbers for all subscribers, making the printing of two editions of the telephone directory redundant.<sup>198</sup> However, the decision to print the directory in two editions prevailed.

The issue of numbering arose again within the Administration in 1928 when the second and third automatic exchange in Stockholm were close to being put into operation. The question this time was whether these new exchanges (as well as the one at Norrtullsgatan) should acquire exchange prefix numbering, so that the number mentioned above could be dialled as «N\* 2959».<sup>199</sup> To this effect, the 6,500 or so subscribers at the recently enlarged exchange at Norrtullsgatan were asked whether they preferred this suggested numbering principle or the all digit numbering they presently used.<sup>200</sup> A large majority of those answering preferred the exchange prefix. Nevertheless, the outcome was considered indecisive since the subscribers not answering were regarded as probably being satisfied with the present practice. Accordingly, the suggested change was refused. Hence there was to be a gradual movement to all digit numbers, at the expense of either an expeditious movement to all digit numbers or a sustained preservation of the exchange prefix. As a consequence, the Administration continued to issue two editions of the Stockholm telephone directory up to 1932 by which time most of the exchanges in Stockholm had been automated.

The employment of visual display panels for traffic from the automatic exchanges was as sustained as the use of dials without letters. The arrangement used for traffic to the automatic exchange was more disputed, however. During the planning for enlarging the exchange at Norrtullsgatan there were different opinions regarding whether key set switchboards or manual multiple switchboards should be used for the enlargement. Lignell, who argued that more key set switchboards should be added, stressed the savings in operating costs and wanted also the possibility to offer semi-automatic

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used by the subscribers connected to a manual exchange. See Heimbürger, *Svenska Telegrafverket, 1921-1945*, p. 25.

<sup>198</sup> Axel Hultman, April 1925, "VPM angående automatiseringen i Stockholms telefontät," (memo regarding the automation of Stockholm's telephone network), p. 17. TALb; F I A:77.

<sup>199</sup> The letter N was to be put next to the 2 on the dial and the \* next to 0, and so on for the other district letters. It was thus not a question of changing the registers at the automatic exchange, but rather a question of how the subscribers should interact with the telephone directory and the dial.

<sup>200</sup> The telephone director in Stockholm (Anders Lignell), June 1928, "Cirkulär," (questionnaire), TALb; F I A:68. 2,711 replied to the questionnaire and of these 2,004 preferred the exchange prefix, see Lindberg, *Med fingerskiva*, p. 46.

service to be considered.<sup>201</sup> Hultman, on the other hand, stressed that the present arrangement worked unsatisfactorily and that more key set switchboards, through an increased number of selectors, would intrude on the premises utilised by the H exchange.<sup>202</sup> The dispute was settled during a meeting in November 1924, when it was decided that multiple switchboards should be used for the enlargement at Norrtullsgatan.<sup>203</sup> However, it was also decided that the future automatic exchanges should have key set switchboards for switching calls originating from manual exchanges.

Another, perhaps more subtle, issue of integration concerned the voltage used at the automatic exchange at Norrtullsgatan and by the former Stockholm Telephone network. Apparently the combination of 48V and the lines built for 24V caused a large number of line faults. According to an early fault report this was particularly common for lines originating from the Stockholm Telephone network, since they were insulated with cotton together with a lacquered cable.<sup>204</sup> However, the faults were gradually remedied as they emerged and boxes of a new design were fitted in place of the faulty ones. However, the fault report concluded, this weakness of the line network ought to be amended before the subsequent automatic exchange was put into operation. Thus, integrating the automatic switch in effect also demanded a reintegration of the lines to accommodate this new kind of switch. The weakness was professedly not in the switch, but in the lines network and in particular in the lines network formerly operated by Stockholm Telephone.

### **A switch for Jeriko and the destinies of some of the engineers**

The destinies of the engineers who had been involved in the three development projects differed significantly as the further efforts to elaborate and integrate the automatic switching devices progressed. Two of them, Axel Hultman and Martin Löfgren, were disassociated from this work, whereas the others continued to participate in this further work. What follows below is primarily the story of the disassociation of Axel Hultman,

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<sup>201</sup> Anders Lignell, 26 August 1924, "Till Kungl. Telegrafstyrelsen L.B.," (to the Telegraph Administration's technical department), TALb; F I A:68.

<sup>202</sup> Axel Hultman, 28 July 1924, "Till Kungl. Telegrafstyrelsen," (to the Telegraph Administration headquarters), TALb; F I A:77 and Axel Hultman, 1 September 1924, "Till Kungl. Telegrafstyrelsen," (to the Telegraph Administration headquarters), TALb ; F I A:71.

<sup>203</sup> Mauritz Agrell (Telegraph Administration, Stockholm), 12 November 1924, "Protokoll hållet vid sammanträde hos Överingenjören den 11 november 1924," (minutes from meeting at the office of Axel Hultman attended by Hultman, Hallgren, Lignell, Olson, Lennman, Ohrling and Agrell), p. 2, TALb; F I A:68.

<sup>204</sup> Gustaf Ohrling, 3 January 1925, "PM beträffande underhåll, driftsäkerhet och felstatistik för automatstationen Norra Vasa," (Memo regarding maintenance, reliability of service, and fault statistics for the automatic exchange 'Norra Vasa'), TALb; F I A:71, p. 5.

which to some extent tied in with the order for the switch to be used at the Jeriko exchange. This is followed by a brief account of the destinies of the other engineers.

As the first automatic exchange was beginning to switch calls, new programs regarding the continued introduction of automatic exchanges were drawn up and the savings possible through continued introduction of automatic exchanges were estimated.<sup>205</sup> An order for enlarging the exchange at Norrtullsgatan was placed with General Telephone LM Ericsson in September 1924, and in November it was decided that the planned local exchange in Jeriko should also be of the so-called 500-point system (the Kåell-Lienzén system).<sup>206</sup> Axel Hultman did not fully agree with this decision and continued to experiment with a machine driven system with one small motor for each selector which furthermore was to select over 1,000 lines. As late as in April 1925 he argued that the Administration should use such a system, that is, a system which more resembled the previous Hultman-Löfgren system than the 500-point system. He further voiced his dissatisfaction with LM Ericsson's disinterest in a 1,000-point selector system and therefore affirmed that the Administration's factory should manufacture it:

In spite of all the above described experiments and investigations and in spite of repeated reminders to LM Ericsson of the desirability to converge to a 1,000-point selector system, as late as 2 October 1924 in a written communication to the Administration's headquarters the company reveals that it has not realised the great advantages which could be obtained with such selectors and has therefore not taken the necessary interest in it.<sup>207</sup>

The procurement of the switch for Jeriko and two other exchanges was nevertheless being prepared, with the view of procuring switches of the 500-point system from LM Ericsson. Hultman failed in persuading others within the Administration to take sufficient interest in a 1,000-point selector system. A defeat which is somewhat ironic

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<sup>205</sup> See, for instance, Anders Lignell, 5 September 1924, "Förslag till automatiseringsplan för Stockholms telefonstationer." (Proposal for automation program of the telephone exchanges in Stockholm), TALb; F I A:71.

<sup>206</sup> The exchange was to be enlarged from a maximum capacity of 5,000 subscribers' lines to 10,000. Contract, 17 September 1924, (Contract between General Telephone LM Ericsson and the Telegraph Administration), TALb; F I A:77.

Mauritz Agrell (Telegraph Administration, Stockholm), 12 November 1924, "Protokoll hållet vid sammanträde hos Överingenjören den 11 november 1924," (minutes from meeting at the office of Axel Hultman, attended by Hultman, Hallgren, Lignell, Olson, Lenman, Ohrling and Agrell), p. 2, TALb; F I A:68.

<sup>207</sup> Original sentence (in Swedish): "Trots alla här ovan gjorda experiment och utredningar och trots upprepade påminnelser till firman LM Ericsson angående önskvärdheten att för Stockholm övergå till ett 1,000-väljaresystem, så skriver firman så sent som 2 oktober 1924 till Telegrafstyrelsen en skrivelse, som tydligen visar, att firman icke insett de stora fördelar som kunna ernås med ifrågakvarande väljare och därför icke tillräckligt intresserat sig för detsamma." Axel Hultman, April 1925, "VPM angående automatiseringen i Stockholms telefonnät," (memo regarding the automation of Stockholm's telephone network), p. 5, TALb; F I A:77.

given that it was during the heated controversy on the appropriate switching system for the Jeriko exchange where he first, some 15 years earlier, had affirmed that it ought to be an automatic switch.

Hultman nevertheless came to be an important part of the subsequent procurement discussion since the Administration's general director expressed dissatisfaction with Axel Hultman's royalty. Herman Rydin stressed that now there were several large switches to be ordered before the patents expired, he considered Hultman's royalty of 5% too high.<sup>208</sup> He therefore commissioned the head of the technical department, Paul Hallgren, to seek to negotiate a reduction in Hultman's royalties. At that time, Hultman had already received a promise of a 5% royalty if the three switches in question were ordered.<sup>209</sup>

Negotiations ensued, negotiations which Hemming Johansson, LM Ericsson's managing director, would later label as strange since the company representative had to act as mediator between two Administration officials, Hallgren and Hultman.<sup>210</sup> The royalty percentage was subsequently decreased for orders from the Telegraph Administration in a new agreement between Hultman and LM Ericsson.<sup>211</sup> But, apparently the reduced royalty was not considered good enough. Rydin wanted the question settled once and for all. A few weeks later, in mid April 1925, an agreement acceptable to all parties was reached, according to which Axel Hultman was to sell his inventions, Swedish patents, and Swedish patent applications for automatic switches to LM Ericsson.<sup>212</sup> For this he would receive 150,000 kronor, a fortune considering that Rydin as general director at the time had an annual salary of 25,000 kronor. The company, however, was allowed to waive the agreement in case it did not receive the order for the Jeriko exchange before June 1925. Indeed, the Jeriko order was intimately linked to the agreement, since the first instalment was to be paid to Hultman as soon as LM Ericsson received the advance payment for the Jeriko exchange. The agreement

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<sup>208</sup> Herman Rydin also noted that for the exchange to Norrtullsgatan Axel Hultman had received royalty on the sale of equipment such as the power plant which according to Rydin should have been excluded from the calculation of royalty. Herman Rydin (signature Rdn.), 23 March 1925, "PM," (memo), TALb; F VIII E:2.

<sup>209</sup> Hemming Johansson, 5 March 1925, "Herr Överingeniör Axel Hultman," (to Axel Hultman), TALb; F VIII E:2.

<sup>210</sup> Hemming Johansson, *Telefonaktiebolaget LM Ericsson, del 1 Från 1876 till 1918* (Stockholm: LM Ericsson, 1953), p. 318.

<sup>211</sup> Contract, 24 March 1925, "Herr Överingeniören mm," (agreement between General Telephone LM Ericsson represented by Hemming Johansson and Axel Hultman), transcript at TALb; F VIII E.

<sup>212</sup> Hence this annulled both the agreements made earlier in 1925 and the part of the contract from 1913 which concerned Sweden. For sales to other countries the earlier royalty agreement was still valid. Contract, 17 April 1925, (contract between General Telephone LM Ericsson and Axel Hultman), transcript at TALb; F VIII E.

was effectuated about a month later, when the Telegraph Administration ordered an automatic switch for 20,000 subscribers' lines for Jeriko from LM Ericsson.<sup>213</sup> Hultman retired on a pension later in 1925. He earned a fortune from this agreement and the many switches LM Ericsson subsequently sold abroad.<sup>214</sup>

Turning to Martin Löfgren, it is apparent that he had not completely given up his fight for recognition for his contributions to the system. From around 1920 he had spent less and less time at work because of a heart-disease, and later his right arm became paralysed due to cerebral haemorrhage. Nevertheless, around 1925 he had a friend at the Telegraph Administration to document the 'true story' of how the system was developed, and in 1926 he also dictated to his wife an account of what he had done and what Hultman had done.<sup>215</sup> But he continued to fail in attracting sufficient attention to his story. Martin Löfgren died in November 1926, only 45 years old.<sup>216</sup> A final episode to this story is worth mentioning. A few months after the funeral, Axel Hultman visited Löfgren's widow and informed himself about her financial situation with the view that she would be able to keep the house for herself and her daughter. Before he left, he gave her a cheque for 5,000 kronor.<sup>217</sup>

Thus by 1926 neither Axel Hultman nor Martin Löfgren was associated with the on-going work of developing and introducing automatic switches. Not only were their stories similar in that they both departed this work, they both left the scene lacking the attention of one sort or another they craved. Hultman for his part was unsuccessful in his attempts to convince that larger selectors should be used, Löfgren on his part was unsuccessful in his attempts to gain recognition for his contributions. Yet, this similarity is not without its ironic twist, given that Hultman lived on to earn a fortune and a place in the annals of telephone switching whereas Löfgren died young and his story ended

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<sup>213</sup> The order was signed on 13 May 1925. Johansson, *Telefonaktiebolaget LM Ericsson*, p. 318.

<sup>214</sup> One indication of the significance of these royalties is that there were preprinted forms used within the LM Ericsson to calculate Hultman's royalties. Furthermore, when the company experienced financial difficulties in 1932, it was granted a respite for payment of a remaining royalty debt of 1.6 million kronor to Axel Hultman. See Artur Attman and Ulf Olsson, *LM Ericsson 100 år: Räddning, Återuppbyggnad, Världsföretag, 1932-1976* (Stockholm: LM Ericsson, 1977), p. 24.

<sup>215</sup> Bertil Brander, n.d. (around 1925), "Hur LM Ericssons automatiska telefonsystem uppstått," (how LM Ericsson's automatic telephone system came into existence), Collberg noted on the manuscript that Löfgren apparently was not pleased with the story as told by Brander. Ida Löfgren, July 1926, 'no title.' All at LA; Samling G. Collberg #3.

<sup>216</sup> Gustaf Collberg, 8 November 1926, (untitled hand-written note), LA; Samling G. Collberg #3.

<sup>217</sup> In 1927, this amount of money represented more than six months pay to Martin Löfgren's former colleague, Sigurd Johanson. This visit of Axel Hultman is said to have happened in February 1927, see: Ida Löfgren, 14 July 1927, "Herr ingenjör Collberg," (letter to Gustaf Collberg), pp. 2-3, LA; Samling G. Collberg #3.

up buried in LM Ericsson's archives. Martin Löfgren has become an unsung engineer, perhaps for reasons beyond what he did or did not do when working with automatic switching devices within LM Ericsson. Axel Hultman, on the other hand, shared the same epitaph as those heroic engineers who are depicted as inventors, whose great virtue was their ability to argue and promote.

Turning to Betulander, it has already been mentioned that he had joined the Administration's technical department to work on the crossbar switch that was to be erected in Sundsvall. There were also reports that smaller switches of his system (with the link-connecting principle) were erected abroad by the UK based Relay Automatic Telephone Company.<sup>218</sup> It is unclear, however, what Betulander's role in these ventures was. Herman Olson also at the technical department had, as also has been mentioned, participated with Betulander and others at the Administration's factory in the work of designing a crossbar switch. Sigurd Johanson, finally, remained within the Telegraph Administration as a lines engineer.

Nils Palmgren, Betulander's former colleague and usual co-inventor, joined General Telephone LM Ericsson in 1920 upon the agreement that in effect resulted in the company acquiring New Autotelephone Betulander. There he participated in the development of the 500-point selector system<sup>219</sup>, and in the process became a colleague of Knut Kåell and David Lienzén.

Thus, many of the other engineers who participated in the three pioneering projects continued to participate in the work of introducing automatic switches, although some of the systems they actually worked on had changed to some extent. Finally, the financial remuneration from their work varied to a significant extent with (the disconnected) Hultman at one extreme.<sup>220</sup>

<sup>218</sup> "Betulanders automattelefon vinner terräng," *Nya Dagligt Allehanda* (Stockholm), 10 Februari 1923.

<sup>219</sup> Attman and Olsson, p. 395.

<sup>220</sup> The below table depicts the income between 1921 and 1930 for seven of the engineers involved in the original development efforts adjusted for additional capital tax (kronor).

Year	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
Betulander	20 410	19 740	14 700	16 440	17 850	18 480	21 750	19 980	46 190	25 230
Hultman	47 590	43 430	45 090	47 440	81 740	145 330	148 540	154 500	165 800	165 440
Johanson	11 150	11 510	9 810	9 150	13 580	9 390	9 200	9 900	9 330	11 190
Lienzén	<8 000	9 250	8 470	7 960	8 230	11 230	11 230	9 060	10 830	15 130
Löfgren	8 350	<8 000	7 550	7 050	6 540	<6 000	†	†	†	†
Olson	19 370	19 200	17 030	15 050	15 610	16 980	17 690	30 040	21 510	21 930
Palmgren	10 830	11 870	12 190	11 710	12 650	13 220	14 170	14 710	11 010	17 700

Taxeringskalender, "Stockholms stads, villastäders och läns taxeringskalender, 1921-1928," (Stockholm: Fahlcrantz' boktryckeri, 1922-1929) and Taxeringskalender, "Stockholms stads, villastäders och läns taxeringskalender, 1929-1930," (Stockholm: Åhlén & Åkerlunds tryckeri, 1930-1931). This information was retrieved with the help of advice provided by Ulf Larsson.

### Integrating the subscribers – semi-automatic service for heavy users?

Certain subscribers were dissatisfied with the service rendered by the automatic exchange at Norrtullsgatan. They complained that often they were connected to the wrong number, that it was difficult to operate the dial and so on.<sup>221</sup> Some reports in newspapers, stemming from the Telegraph Administration, held that the service was working satisfactorily.<sup>222</sup> Yet, unpublished measurements of fault rates were discouraging with a high rate of faults attributed to the subscribers, see Table VI-6.

*Table VI-6 Reliability measurements from the automatic exchange at Norrtullsgatan compared with a manual exchange, 1924.*<sup>223</sup>

Faults caused by...	From automatic exchange		Manual exchange
	to automatic	to manual	–
... the technical devices	1.32 %	0.70 %	1.03 %
... the subscriber	7.87 %	5.19 %	1.43 %
... by operator & miscellaneous	–	0.25 %	1.67 %
<b>Total</b>	<b>9.19 %</b>	<b>6.14 %</b>	<b>4.13 %</b>
Number of calls measured	1,284 calls	14,716 calls	3,000 calls
Measurement period	(15 May–18 Sept. 1924)		(19 Sept.–25 Oct. 1924)

When the switch for the Jeriko exchange had been ordered, the issue arose as to whether or not a semi-automatic service should be offered and the one promoting this was Anders Lignell who had become full telephone director in Stockholm after Hultman's retirement. Lignell noted that there were only a few heavy users connected to the exchange at Norrtullsgatan.<sup>224</sup> With Jeriko it would be different. Indeed, of the 3,400 subscribers connected to the exchange at Norrtullsgatan, only 152 subscribers made more than 2,500 calls annually. It was this minority, he stressed, which had expressed most of the complaints. Apparently one businessman had cancelled his subscription, and another had demanded that he was given a telephone connected to a manual exchange. Lignell reported moreover that call metering had revealed that some

<sup>221</sup> See, for instance, "Damens fingrar voro för tjocka för telefonen," *Dagens Nyheter* (Stockholm), 4 February 1924 and "Automattelefonens fördelar vägda mot nackdelarna," *Stockholms-Tidningen*, 1 April 1924. Lindberg also later reported that some subscribers even cancelled their subscription or were given a telephone connected to a manual exchange, see Lindberg, *Med fingerskiva*, p. 46.

<sup>222</sup> See, for instance, "Automattelefonen får gott betyg," *Nya Dagligt Allehanda* (Stockholm), 20 February 1924; "Automattelefonen har motsvarat förväntningarna," *Stockholms Dagblad*, 23 April 1924; and "3,000 nya automat-telefoner," *Aftonbladet* (Stockholm), 6 October 1924.

<sup>223</sup> Adapted from Gustaf Ohrling, 3 January 1925, "PM beträffande underhåll, driftsäkerhet och felstatistik för automatstationen Norra Vasa," (memo regarding maintenance, reliability of service, and fault statistics for the automatic exchange 'Norra Vasa'), p. 4, TALb; F I A:71.

<sup>224</sup> Anders Lignell, 27 October 1925, "Några spörsmål i samband med automatiseringen av Skeppsbrocentralen," (memo: some questions in relation to the automation of the exchange at Skeppsbron), pp. 3-4, TALb; F I A:68.

businessmen with several telephone subscriptions had adopted the practice of using their manually connected phones for outgoing calls, leaving their dial telephone for incoming calls. Thus their dial remained untouched.

Now it was the turn of the Jeriko exchange. Jeriko was to take over the substantial number of subscribers connected to the exchange at Skeppsbron, among whom there were many heavy users on account of the exchange's former position as main exchange in the days prior to the tax reform. This constituted an important trial of the strength to the earlier assertion that automatic exchanges in a systematically ordered network were the only means through which the Telegraph Administration, the State, and the subscribers could attain their desired ends. What if lots of these subscribers were unwilling to be enrolled by refusing to use their dials? Earlier in 1925 it had been suggested within the Administration that perhaps some of the present manual exchanges should be kept in operation for the purpose of offering heavy users a service where they would not have to use a dial.<sup>225</sup> However, that would not make the automatic exchanges obligatory. The reliability measurements and the reactions from heavy users connected to the exchange at Norrtullsgatan was nevertheless discouraging. Lignell suggested therefore that semi-automatic service should be offered to heavy users:

Probably the automation in Sweden, with our high demand for convenient use of the telephone, should therefore necessarily call for an introduction of the possibility of semi-automatic service for the heavy user. In this way he can escape the, for him, especially burdensome and distracting work with the dial.<sup>226</sup>

He furthermore contended that this had to be done in conjunction with the approaching introduction of the automatic service.<sup>227</sup> Otherwise the certain later retreat to semi-automatic service for these subscribers would only discredit the automatic system as a whole, he emphasised. The realisation of this measure, according to Lignell, required that different tariffs were introduced and not just to recover the extra expenditure for equipment and operators. A considerable difference in tariffs was in his view also

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<sup>225</sup> No signature (The Telegraph Administration's technical department), 14 March 1925, "P.M. beträffande frågan om införande av hel- eller halvautomatisk drift i Stockholm för abonnenter i de högsta abonnemangsklasserna," (memo regarding the question of introducing fully or semi-automatic service in Stockholm for subscribers in the higher subscription classes), p. 3. TALb; F I A:68.

<sup>226</sup> Full sentence (in Swedish): "Automatiseringen torde därför här i Sverige, med våra höga pretentioner på bekvämlighet vid telefoneringen, med nödvändighet kräva införande av möjlighet till halvautomatisk drift för stortrafikanten, så att denne kan undgå det för honom särskilt betungande, och vid tankearbete distraherande, arbetet med fingrskivan, detta givetvis mot en avgiftskompensation, som kan betingas av de härför ökade driftkostnaderna." Anders Lignell, 27 October 1925, "Några spörsmål i samband med automatiseringen av Skeppsbrocentralen," (some questions in relation to the automation of the exchange at Skeppsbron), p. 4, TALb; F I A:68.

<sup>227</sup> Ibid. p. 2-4.

necessary to prevent practically all subscribers from choosing semi-automatic service. He further claimed that it was impossible to raise the tariffs for semi-automatic service above present tariff levels, since that certainly would produce “a storm of aversion towards the automatic system.”<sup>228</sup> The savings which would be generated from the automation, according to Lignell, fortunately allowed for a reduction in tariffs for subscribers choosing the fully automatic service.

A confidential investigation was subsequently commissioned within the Administration’s headquarters in response to Lignell’s suggestions.<sup>229</sup> Three questions were to be answered: I) Was it possible to reduce the tariffs for fully automatic subscribers when the automation of the Stockholm network was completed? II) Was it, considering the finances, possible to apply this reduction at the time when the exchange at Jeriko was put into operation? III) Would the possible reduction create a sufficient difference between the tariffs for automatic and semi-automatic service?

Anders Lignell was disturbed when he learned the preliminary result of the investigation. The preliminary answer to the first question was ‘no.’ As the one who had originally made so many of the financial calculations on the automation, he stated in a comment on the result that the automation *had* to translate into lower tariffs.

The decision to automate the Stockholm network was an appropriate and justifiable measure *provided that it will be possible to lower the tariffs below present levels*, with the exception of the tariff for a residential subscription which already is too low. *One has to be able to state this reason to defend the automation.*<sup>230</sup>

Lignell emphasised that the automation implied no gain to the average subscriber from the viewpoint of reliability of service, and from the viewpoint of convenience it was a deterioration. To Lignell, the promise of lower tariffs was therefore essential to succeed in enrolling the subscribers. However, the conclusion was only slightly altered when the final report of the investigation was presented in April 1926.<sup>231</sup> The report was full of

<sup>228</sup> Full sentence (in Swedish): “En höjning av nuvarande taxor för att erhålla halvautomatisk drift skulle med säkerhet emottagas med en storm av ovilja mot automatsystemet och är ej heller behörlig.” Ibid.

<sup>229</sup> The Telegraph Administration headquarters, 25 November 1925, “Utdrag av protokoll...,” (excerpt of minutes from the headquarters of the Telegraph Administration), TALb; F I A:71.

<sup>230</sup> Emphasis added. Original sentences (in Swedish): “Förutsättningen för att den beslutade automatiseringen av Stockholmsnätet varit en lämplig och försvarlig åtgärd är, att taxenivån vid fullbordad automatisering skall kunna sättas lägre än den nuvarande med undantag för bostadsabonnemangen, som redan nu äro för lågt taxerade. Detta skäl måste man kunna anföra för att motivera automatiseringen.” Anders Lignell, 17 March 1926, ‘no title,’ p. 2, TALb; F I A:71.

<sup>231</sup> Alfred Lundgren, Gustaf Ohrling, Mauritz Agrell, 24 April 1926, “Konfidentiellt: VPM angående taxorna vid automatiseringen av Stockholms telefontät,” (confidential memo regarding the tariffs during the automation of the telephone network in Stockholm), TALb; F I A:71.

financial calculations showing that the network was presently yielding a bad return. It concluded by saying that the automation would therefore make it possible to refrain from the increases in tariffs that otherwise would have been necessary. The answer to all three questions was 'no.' The possibility of increasing the tariff for semi-automatic service was finally ruled out since that would imply an unintended increase in the tariffs for manual service as well. The report ended by stating that Lignell had expressed that he had no objections to the report. The suggestion to introduce semi-automatic service for heavy users was shelved.

The enrolment of the subscribers had to be achieved by other means, means which had to make them use the dial. The subscribers were to be educated and supervised. As the subscribers were to be rewired to the automatic exchange they were visited by instructors, and the supervision at the exchange was facilitated by the introduction of supervisor's positions where operators could follow the subscribers' attempts to make a connection and assist if necessary.<sup>232</sup> Subscribers were connected to the automatic exchange in small doses of 1,000 subscribers at a time, to allow for the operators at the supervisor's positions to follow the subscriber's first days of use of the dial.<sup>233</sup>

The continued availability of special services introduced before the acquisition of the private network was a heated matter however. Business subscribers could, for instance, subscribe to nominal call and subscribers could call a special services exchange to learn the time, and so on. These services were initially maintained with several special arrangements after the introduction of automatic exchanges, against the stated plans for automation drawn out in the early 1920s.<sup>234</sup> During the subsequent automation other special services were slowly weeded out or automated.<sup>235</sup>

### **Disassociating the operators**

In 1928 the second automatic exchange was opened, in Kungsholmen. Finally in Spring 1929 the automatic exchange in Jeriko was opened, some 20 years after Avén's and

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<sup>232</sup> Heimbürger, *Svenska Telegrafverket, 1921-1945*, p. 76.

<sup>233</sup> Lindberg, *Med fingrskiva*, p. 53.

<sup>234</sup> Axel Hultman on several occasions argued that the nominal call service should be cancelled as automatic exchanges were introduced. See, for instance, Axel Hultman, 28 May 1920, "Till Kungl. Telegrafstyrelsen: Angående de automatiska telefonanläggningarna i Stockholm," (to the Telegraph Administration headquarters regarding the automatic exchanges in Stockholm), TALb; F I A:70, p. 3.

<sup>235</sup> The service giving the time was transformed into the automated Speaking Clock beginning in 1934. The nominal call service was maintained as a manual service for quite some time and became gradually weeded from the 1940s and onwards. On the fate of these special services from the 'manual era', see Claes-Fredrik Helgesson, "När ny teknik blir gammal: Den manuella telefonväxeltekniken efter 1924," in *Teknikens landskap: En teknikhistorisk antologi*

Hultman's fierce debate concerning the appropriate design of the future main exchange. However, the opening of the second and third automatic exchange in Stockholm caused a debate in Parliament about the merits of automatic telephone switching. A debate which centred on the automatic exchanges from the point of view of the operators.

A plan had been outlined within the Administration as early as July 1926 that implied that all operators in Stockholm and Gothenburg who had been employed more than 10 years were to be gradually discharged.<sup>236</sup> To mitigate the effects of this plan, those discharged were offered further temporary employment with lower wages. Furthermore, more recently employed operators were made subject to the revived so-called 5 year rule, a rule which had lain dormant since the difficult years preceding the acquisition of the Stockholm Telephone's network.<sup>237</sup> According to this rule, originally introduced in 1897, newly employed operators had to leave their employment if they had not become permanently employed inter-urban operators within 5 years after their employment.<sup>238</sup> Originally this rule had served as a means to weed out operators coming of age and those who were deemed unfit for employment as inter-urban operators, a job which was accorded the highest ranking. During the introduction of automatic exchanges, however, the rule was used for regulating the oversupply of operators.

This treatment of the operators caused a member of parliament, Carl Lindhagen (1860-1946), to present a proposition in January 1929 demanding a stop to the further introduction of automatic exchanges.<sup>239</sup> In the proposition, he generally objected to the way the shop assistants, clerks, and operators were being treated. In the introduction, he somewhat poetically noted that while they were living at the high summer of civilisation characterised by a high technical standard, "the loci of power compete to domesticate our passions to their advantage along with the fight between interests raging untamed in the depths."<sup>240</sup> As regards the operators, he specifically objected

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tillägnad Svante Lindqvist, ed. Marika Hedin and Ulf Larsson (Stockholm: Atlantis, 1998), 61-81, pp. 74-76.

<sup>236</sup> Heimbürger, *Svenska Telegrafverket, 1921-1945*, p. 1017-1019.

<sup>237</sup> Ylwa Waldemarson, "Kön, klass och statens finanser: en historia om statligt arbetsgivarskap och statsanställda kvinnor, 1870-1925," in *I statens tjänst: Statlig arbetsgivarpolitik och fackliga strategier, 1870-1930*, ed. Lasse Kvarnström, Ylwa Waldemarson, and Klas Åmark (Lund: Arkiv, 1996), 111-243, p. 196.

<sup>238</sup> Gunilla Thorstenson, "Telefonist vid Televerket, 1864-1990," (Farsta: Televerket, 1990), p. 15.

<sup>239</sup> Proposition presented by Carl Lindhagen. *Motioner i Första Kammaren*, Nr 205, 30 January 1929.

<sup>240</sup> Full introduction in Swedish: "Vi dväljas som sagt i civilisationens högsommar. Den utmärker sig genom hög teknik, medan samtidigt maktställena tävla att till sin fördel tämja våra lidelser samt intressekampen rasar otämd på djupen." *Ibid.*, p. 5.

against the introduction of automatic exchanges on the grounds that they deprived the operators of their employment.

One forgotten suffering among others is the *discard of operators* through a new technical invention, the automatic telephone. It is economic speculation, without compensation, to put the trouble on the public instead, to manoeuvre its telephone calls itself. Where the living workforce, who through this "great invention" is thrown away, shall go is of little concern to us who occupy safe positions. A momentary apologetic sum of money can not replace the lost source of livelihood.<sup>241</sup>

In all, it was an gesture of empathy for those who lost their livelihood through the automatic exchange. In other words, he objected to the notion that automatic exchanges were in the interest of the public and the government. The further automation, he requested, ought to be postponed at least until the operators thus loosing employment were ensured a sufficient livelihood in some other way.

The parliamentary working committee discussed the issue primarily from the point of view of the 5 year rule and the compensation given to the operators discharged.<sup>242</sup> Citing an official letter from the telephone director in Stockholm from 1924, among other things the longstanding existence of this rule was noted. The rationale, the cited official letter emphasised, was that the work at a local exchange was of such a taxing nature that it was unfitted for operators above the age of 40.<sup>243</sup> It was hence necessary, it was continued, to ensure that operators at this age at the latest either were transferred to the less taxing work at the inter-urban exchanges or to other work within the Administration. However, since these positions were less numerous, some operators had to be discharged and that was where the 5 year rule came in. On this point it was stressed that it was deemed impossible to provide a pension to all operators becoming superfluous. The letter stressed that the rule had been unused for a period of time, but that the improved conditions on the labour market now had made it necessary to discharge over aged operators. Thus, the 5 year rule referred to in this letter was not associated with the issue of automatic exchanges.

When it came to Lindhagen's request to postpone the further introduction of automatic exchanges, the committee had a clear position. This, it stressed, was

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<sup>241</sup> Original sentences (in Swedish): "Ett bortglömt lidande är bl.a. *telefonisternas utmönstring* genom en ny teknisk uppfinning, automattelefonen. Det är en ekonomisk spekulation att man lägger i stället gratis på allmänheten besväret att själv få manövrera in sina telefonsamtal till bestämmelseorterna. Var den levande arbetskraften, som följd av denna 'stora uppfinning' kastas bort, sedan skall taga vägen, det väcker föga bekymmer hos oss, som sitta på våra säkra platser. En tillkastad samvetspenning för tillfället är icke någon ersättning för ett förlorat livsupphålle." Ibid., p. 7.

<sup>242</sup> Första kammarens andra tillfälliga utskotts utlåtande Nr 3, 19 Mars 1929.

<sup>243</sup> Ibid., p. 6.

untenable given the lengthy preparations made to modernise this state-owned public enterprise:

[I]t appears to the committee as impossible to demand a discontinuation of a modernisation within a state-owned public enterprise that has been initiated after lengthy, careful, and costly preparations.<sup>244</sup>

Hence, the automation had to continue because of all the efforts already put into it. Lindhagen further raised objections in Parliament, stressing the brutality and the contempt held for the human beings that lay behind the discharging of operators without what he considered a reasonable compensation.<sup>245</sup> Yet, when it came to the vote, his proposition was discharged as recommended by the committee. The introduction of automatic exchanges should continue and the unavoidable discharge of operators also had to continue.<sup>246</sup>

## Epilogue

In 1929 a report comparing private and public enterprise commissioned by the international chamber of commerce was published.<sup>247</sup> Arriving in the wake of the nationalisation debate which had flourished in Sweden since the mid 1920s, this report affirmed that the operations of the Telegraph Administration were satisfactory. It was affirmed to this effect that the tariffs used by the Telegraph Administration were so adjusted that the Administration neither provided an instrument for taxation (unlike the post) nor did it have to rely on government subsidy.<sup>248</sup>

By 1930 the introduction of automatic telephone switches was well underway in Stockholm and had begun in Gothenburg and Malmö, Sweden's second and third largest cities respectively. Automatic switching had become the future of Swedish

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<sup>244</sup> Full sentence (in Swedish): "Vad härefter angår inställandet av automatiseringen vid telefonväsendet synes det utskottet omöjligt att kräva ett avbrytande av en efter långvariga, noggranna och dyrbara förberedelser igångsatt modernisering inom ett affärsdrivande verk." *Ibid.*, p. 7.

<sup>245</sup> Riksdagens protokoll, Första Kammaren nr 19, 10 April 1929, pp. 96-102.

<sup>246</sup> In 1920 the Telegraph Administration's exchanges within the city of Stockholm had employed 2,122 operators of which 80% were local operators. By 1940 the then much larger network employed 986 operators of which about 20% were local operators (primarily for special services). Although this decline in employment of operators was noticeable in the cities, in the country as a whole the number of operators employed at the Administration continued to increase until 1950, primarily in association in the increase of inter-urban traffic which for a long time continued to be manually switched. See Helgesson, "När ny teknik blir gammal," pp. 69-70.

<sup>247</sup> Erik Linder, "Jämförande undersökning rörande allmän och enskild affärsverksamhet i Sverige: på begäran av Internationella Handelskammaren verkställd genom försorg av Svenska Nationalkommissionen," (Stockholm: Svenska Nationalkommissionen för internationella näringsfrågor, 1929)

<sup>248</sup> *Ibid.*, p. 101.

telephony, just as some kind of automatic switching had become a part of telephony in many other countries during the 1920s.<sup>249</sup>

In April 1930 Telephone LM Ericsson arranged an information and propaganda course held at the premises of Stockholm School of Economics.<sup>250</sup> There the telephone director in Stockholm, Anders Lignell, was introduced by the managing director and chief engineer of LM Ericsson, Karl Fredrik Wincrantz. In his speech, Lignell stated that automatic switches were reaching perfection and that in Stockholm at present about 32,000 of the total 106,000 subscribers were connected to an automatic exchange. He further informed that the fault rate was considerable lower at these exchanges as compared to the manual ones. Lignell ended his speech by affirming that the future development with certainty would continue in the direction of automation.

This event served not only as a manifestation that automatic exchanges had come to be an inseparable part of Swedish telecommunications, it also manifested the association between Telephone LM Ericsson and the Telegraph Administration forged by these switches. Here, the former managing director of Stockholm Telephone, Wincrantz, together with Lignell, provided one of the many appearances associating the two organisations LM Ericsson and the Telegraph Administration. An association that has later been identified as a vital relationship in Swedish telecommunications, or even the association constituting a development pair.<sup>251</sup>

For Telephone LM Ericsson the 1920s had implied an increasing transition towards manufacturing automatic switches. From the selling of 4 switches of a still unsettled system in the early 1920s, of which one had been that at Norrtullsgatan, international sales of automatic switches had increased. By mid 1926 the company had delivered and put into operation some 17 exchanges of the 500-point selector system, albeit most of them of a size significantly below 5,000 subscriber's lines.<sup>252</sup> By the end

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<sup>249</sup> Chapuis notes, for instance, that most European capitals received their first automatic exchange during the 1920s. See Chapuis, p. 250.

<sup>250</sup> The course and Lignell's speech were reported in "Automattelefon är framtidens, säger dir. Lignell," *Nya Dagligt Allehanda* (Stockholm), 24 April 1930.

<sup>251</sup> On the exchange relationship and automatic and manual switching, see Claes-Fredrik Helgesson, "Networks of Actors and Changes of Technological Regimes: Development and Divestment in the Swedish Telecommunications Network," in *Coordination and Change in Telecommunications* (Stockholm: EFI, 1994), 27-59; on the two as a development pair, see Mats Fridlund, "Switching Relations: The Government Development Procurement of a Swedish Computerized Electronic Telephone Switching Technology" (Tema-T Working Paper, Department of Technology and Social Change, Linköping University, 1998).

<sup>252</sup> LM Ericsson, "Tabell över i drift...." Some of these 17 exchanges were very small in Spain, for instance, there were 5 exchanges of the system. However, apart from an exchange in San Sebastian for 5,100 subscriber's lines the four other exchanges in operation in Spain were at that time not larger than 250 subscriber's lines each. In all of these 17 exchanges, only four were of a size of 5,000 subscriber's lines with the enlarged one at Norrtullsgatan being the largest one equipped for 10,000 subscriber's lines. *Ibid.*

of 1931 LM Ericsson had delivered and put into operation 102 automatic exchanges of the 500-point selector system, 7 of which were in Sweden.<sup>253</sup> In all, these served 354,000 lines, a number which maybe appears modest given that there world-wide at that time were 10 million telephones served by various automatic systems.<sup>254</sup> Nevertheless, that year automatic switches represented 69% of the company's revenues and only 4% came from manual switches.<sup>255</sup>

Telephone LM Ericsson's increasing international sales of automatic switches notwithstanding, the company's association with the Telegraph Administration must be considered to have been of significant importance to the company. When the contract for the Jeriko exchange for 20,000 subscriber's lines had been signed in 1925 this size was four times larger than any such switch in operation and twice the size of any other switch ordered from the company at least up until mid 1926.<sup>256</sup> Moreover, in 1926 the recently enlarged switch at Norrtullsgatan still surpassed by far in size the 16 switches then exported. Although impossible to asses and weigh the importance of the company's international sales of switches as compared to the sales to the Administration, this nevertheless indicates the Administration's continued participation in shaping (if not determining) the company's venture into automatic switching. In addition, the Administration's continued need for manual switchboards was met by its own factory, a fact which must have contributed to the transition of Telephone LM Ericsson to automatic switching.<sup>257</sup>

It was not only the introduction of automatic telephone switches that was underway in Stockholm. There were at this time also changes made to the practices of counting the number of calls made. The practices behind establishing what yearly fee a subscriber should pay had long been criticised, particularly the intermittent counting of calls made to estimate the yearly number of calls, and those cases where uncompleted calls were counted.<sup>258</sup> During the 1920s electric call meters had begun to be used and

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<sup>253</sup> Attman, Kuuse, and Olsson, pp. 310.

<sup>254</sup> 6 of these 10 million telephones were in the United States. *Ibid.* and Chapuis, p. 285.

<sup>255</sup> Attman, Kuuse, and Olsson, pp. 311-312.

<sup>256</sup> LM Ericsson, "Tabell över i drift...."

<sup>257</sup> In 1940 more than 50% of the Administration's factory sales of switches was still for manual switches. Helgesson, "Network of Actors," pp. 44-46.

<sup>258</sup> Criticism had been levelled since the introduction of the tariff reform. In 1924, a newspaper ran several articles concerning these complaints from subscribers, see "Kritik och protester mot samtalskontrollen vid vårt telefonverk," *Stockholms Dagblad*, 8 November 1924; "Flera missnöjda med telefonens samtalskontroll," *Stockholms Dagblad*, 9 November 1924; "Hyresgästernas telefonkommitté går till strids," *Stockholms Dagblad*, 11 November 1924; "Tryck ej på klykan, då blir det samtal! Nytt om kontrollen," *Stockholms Dagblad*, 14 November 1924.

moved between the subscribers to count calls.<sup>259</sup> In the second half of 1920s, Herman Olson presented a new smaller call meter which was to permanently count calls for each subscriber. This call meter was subsequently manufactured by both Telephone LM Ericsson and the Telegraph Administration's factory.

In a newspaper article from 1930, it was reported that Olson had received a reward for his design of an inexpensive and small call meter and that 63,000 such call meters already had been installed in Sweden.<sup>260</sup> The plan, it was continued, was to provide each of the 400,000 or so subscribers in Sweden with such call meters. The introduction of this call meter, the article further stressed, would reduce the incidence of complaints about the call metering and the establishment of one's yearly fee.

During the 1930s, efforts escalated towards introducing automatic exchanges in smaller towns and whole rural districts<sup>261</sup>, efforts where the crossbar switches manufactured by the Telegraph Administration's factory were used.<sup>262</sup> All larger exchanges erected were manufactured by LM Ericsson, however, and of the same kind as the one ordered in 1921. The distinction forged in the early 1920s between what was appropriate for large and small exchanges held, at least until the 1940s when it became more widely accepted that one could calculate blocking in systems employing the link-connecting principle.<sup>263</sup> This meant that the issue of scalability of such switching systems had been altered as compared to the winning view in the procurement of the first switch in Stockholm. From the 1950s onwards crossbar switches employing the link-connecting principle became almost the only kind of switches used for automating small as well as large exchanges.

The gradual introduction of automatic exchanges was also brought to bear on the system of tariffs during the 1930s. In 1937, a committee within the Telegraph Administration presented an official report on the Administration's telephone tariffs

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<sup>259</sup> Heimbürger, *Svenska Telegrafverket, 1921-1945*, pp. 240-241.

<sup>260</sup> "Fin apparat som räknar alla samtal," *Svenska Dagbladet* (Stockholm), 18 February 1930.

<sup>261</sup> See, for instance, the official report from 1933 concerning the introduction of automatic telephony in rural districts, Kommunikationsdepartementet, SOU 1933:16, "Automatisering av telefonnätet på Sveriges landsbygd," (Göteborg: Elanders, 1933).

<sup>262</sup> On the further introduction of automatic exchanges see, for instance, Helgesson, "Network of Actors," pp. 40-41, 52-53; and Artur Finström, "Boråsområdets automatisering: En milstolpe mellan Barkarö och Arjeplog," *Tele: Televerkets tekniska tidskrift* 83, no. 4 (1977): 8-22.

<sup>263</sup> This change was in part due to work in USA where the Bell Laboratories in the 1930s had developed crossbar switches with the link-connecting principle inspired by the work of Betulander, Palmgren and the Telegraph Administration. The first such switch was put in operation in Brooklyn in 1938. This work, in turn, inspired the Administration to venture into such lines of efforts. Chapuis, pp. 378-381. Bertil Bjurel, "Några svenska och amerikanska insatser vid utvecklingen av koordinatväljare och koordinatväljarsystem för telefonstationer," *Tele* 54 (1949): 49-62, esp. p. 55, and Nils Rönnblom, "Moderna Koordinatväljarsystem för telefonstationer: telegrafverkets markörsystem," *Tele* 54 (1949): 149-153, esp. p. 153.

where a future tariff reform was discussed in light of the past and continuous introduction of automatic switching:

The development within telephone technology has as we know progressed rapidly during the last 15 years. Inter-urban lines ... have to a large extent been converted to cable. The largest local telephone exchanges – in Stockholm, Gothenburg, and Malmö – have been automated, and a number of medium sized and small main and minor exchanges have also been converted to automatic operation. ... The influence this technological development might have on the telephone tariffs shall be included in the present investigation.<sup>264</sup>

To conclude. By 1930 the some of the significant controversies that had characterised Swedish telephony during the previous decades had been settled although their outcomes continued to put their mark on further efforts and controversies to alter the workings of the field.

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<sup>264</sup> Full sentences (in Swedish): “Under de senaste 15 åren har som bekant utvecklingen inom telefontekniken gått mycket raskt framåt. Mellanortsledningarna – såväl riks- som landsledningarna – ha i stor utsträckning kablificerats. De största lokala telefonstationerna – i Stockholm, Göteborg och Malmö – ha automatiserats, och även ett antal medelstora stationer och mindre centralstationer samt växelstationer ha överförts till automatisk drift. Såsom framgår av telegrafstyrelsens inledningsvis omnämnda framställning till Kungl. Maj:t skall i nu förevarande utredningsarbete ingå en undersökning av den inverkan, som denna tekniska utveckling kan utöva på våra telefontaxor.” Telegrafverket, “Telegrafverkets telefontaxor” (Telegrafverkets författningssamling, serie A:11, Elanders, 1937), p. 10.

# VII

## Making a New Order

### **Dynamics and Reconfiguration**

The previous three chapters are immersed with accounts of efforts, of which some contributed to the making of a discernible new order in Swedish telecommunications. The method used when putting together this account allowed for a detailed story to unfold. More importantly, it allowed for more than just a plot where, for instance, autonomous technological change reordered the economic organisation into a monopoly. Indeed, it allowed for an account that did not presuppose any fixed and stable boundary between what constituted the economic organisation and what constituted technology.

The main plot in the resulting account has been one of increasing instability followed by a renewed stabilisation. The point of entry was the ‘telephone issue’ and the ‘switching system issue’, two controversies with distinctly different focuses that nevertheless had linkages to one another. My further account of the progression of these controversies shows that, as they continued to remain unsettled, they became at times more closely linked. Then, gradually, they were resolved. The emergence and subsequent gradual realisation of a monopoly scenario in 1918, and the gradual stabilisation of what constituted the appropriate telephone switching system for the exchanges in Stockholm, all contributed to the making of a discernible new order in Swedish telecommunications.

The question then is, what does this resulting account provide in terms of answers to how efforts to alter technology were interrelated to efforts to alter the economic organisation in the making of this new monopolistic order. In this chapter, I dwell on this question in two sections, setting the focus first on the dynamics of the controversies and their settlement and secondly on the resulting changes in Swedish telecommunications. Throughout this discussion, comments are presented that condense and summarise the topics discussed. The purpose is to gradually outline notable contours relevant in response to the above question. The way these remarks are phrased explicitly displays their dependence upon the methodology employed in this study.

However, they are further phrased with plain reference to the specifics of the field under inquiry.

In the first section the focus is on the variable extent of the controversies as well as their subsequent settlement. The variable degree of separation between the 'telephone issue' and the 'switching system issue' constitutes the first topic. The focus is here on the changeable boundaries and links between these two issues. Building on this discussion, the second topic concerns the settlement of controversies. This discussion focuses on the realisation of the monopoly scenario in 1918, as well as the sequence of contended efforts that made the automatic switching system a part of this emergent new monopoly order. This, in turn, leads to a third topic that focuses on the appearance of action and agency, which consequently thus concerns how to understand the sources of actions that brought on the dynamics and stabilisation of the controversies.

In the second section, the focus is on some facets of the resulting transformation of Swedish telecommunications. First, the transformation of some significant elements within Swedish telecommunications is depicted and in particular how certain elements were transformed in association with one another. This discourse provides the basis for the subsequent discussion about the discernible new order as a altered configuration of the techno-economic network that constituted Swedish telecommunications.

The chapter is concluded with a brief discussion on what this study may contribute to the research on order and change in fields of economic activity.

## **The Dynamics of Techno-Economic Controversies**

### **The variable extent of controversies**

The many efforts and controversies depicted in the previous chapters represent more or less successful attempts of enrolment, involving attempts to establish translations between various means and ends. To describe the dynamics of such efforts I will depict the 'telephone issue' and the 'switching system issue' here as variable sets of what counted as solutions, problems, and elements.<sup>1</sup> This depiction provides for a discussion on the variable boundaries separating, and links associating, the issues and indeed how efforts to resolve them were interrelated.

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<sup>1</sup> The problem/solution dichotomy is here used in the sense of the actor-network approach, that is, with no implication that problems necessarily arrive before solutions or that there are solutions that in the order of things are the appropriate solution to a problem. This view on the problem/solution dichotomy is further close to the one explored in some research on decision-making. See, for instance, Michael D. Cohen, James G. March, and Johan P. Olsen, "A Garbage Can Model of Organizational Choice," *Administrative Science Quarterly* 17 (1972): 1-25.

A general theme present in the discussions concerning both issues was network size and growth as regards the number of subscribers connected. Both issues repeatedly included problems such as increased trunking and thus increasing switching costs occasioned by the increased number of subscribers and the competition for new subscribers with its consequent low tariffs.<sup>2</sup> Indeed, the solutions achieved in both issues were in some way associated with mastering network growth or, as an economist would say, with mastering network growth in the face of diseconomies of scale.

Steps to regulate the rate of network growth, in the shape of a monopoly or in the shape of an arrangement regulating recruitment of new subscribers by the two operators, was a recurrent theme in the solutions discussed in the 'telephone issue'. At the same time, whenever the 'switching system issue' was discussed within the Telegraph Administration the repeated question was what kind of switching system and exchange arrangement was appropriate for a large and growing urban network, and in particular the network in Stockholm. However, in spite of their affinity, the 'telephone issue' and the 'switching system issue' were regularly more or less well delineated into two distinct sets of problems, solutions, and elements.

*'What is Feasible and Appropriate?'*

The distinctly different focuses of the 'telephone issue' and the 'switching system issue' as accounted for in chapter 4 (up until around 1910) can first and foremost be attributed to their involving distinctly different sets of solutions. The arrangements offered as possible solutions in the 'telephone issue' included an acquisition and monopoly or some sort of other agreement between SAT/Stockholm Telephone and the Telegraph Administration. The corresponding solutions concurrently contended in the 'switching system issue' were various (manual) switching systems such as the cord pair system, the single cord system and the call-distributing system.

Furthermore, the specific problems that these above arrangements were intended to solve differed to a great extent between the two disputes. The absence of interconnection, for instance, was regularly brought up before 1910 as a central problem

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<sup>2</sup> Indeed, these can be seen as 'reverse salients' to the system's further development to use the concept coined by historian of technology Thomas P. Hughes. See, for instance, Thomas P. Hughes, "The Evolution of Large Technological Systems," in *The Social Construction of Technological Systems*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (Cambridge: MIT Press, 1987), 51-82, especially pp. 73-76. The concept of reverse salient acknowledges that agreement on what constitute a reverse salient to a system is subject to socio-technical negotiation, see Donald MacKenzie, "Missile Accuracy: A Case Study in the Social Processes of Technological Change," in *The Social Construction of Technological Systems*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (Cambridge: MIT Press, 1987), 195-222, p. 197. The concept is not used here, however, since a main theme here is the very repeated renegotiations on what constitute the relevant problems and what constitute the relevant solutions and elements to take into consideration.

in discussions concerning how to resolve the 'telephone issue'. Interconnection, on the other hand, was largely absent in the concurrent discussions concerning what constituted an appropriate switching system for the Telegraph Administration's main exchange in Stockholm.

The matters under dispute was a third distinct difference between the 'telephone issue' and the 'switching system issue' as accounted for in chapter 4. In the negotiations January 1906 - February 1909 aiming at resolving the 'telephone issue' several matters were under dispute, including: whether competition was beneficial or not, the value and price of the private network, whether profitability calculations were prudently made or not, whether the absence of interconnection was a problem or not, and whether the two networks were technically compatible. In the controversy June 1907-April 1910 on the 'switching system issue' the matters under dispute included: what constituted the appropriate design for the Administration's new main exchange, how to measure the efficiency of different switching systems, measurement routines, whether different statistics were comparable or not, the role of operator supervision and bonus-system, whether or not judgements were influenced by prejudiced opinions, and so on.

However, these two specific sets of concurrent efforts were nevertheless linked by certain elements in common. Some persons, such as the Telegraph Administration's telephone director in Stockholm (Axel Hultman), were significantly involved in both efforts as were certain officials at the Telegraph Administration's headquarters. Moreover, the future of telephone switching in Stockholm was not only a topic in the 'switching system issue'. The development of telephone switching was also one of the subjects in the negotiations prior to the acquisition agreement between the Telegraph Administration and SAT in 1906. The subject had been brought into the 'telephone issue' by representatives of SAT who wanted to ensure LM Ericsson's access to telephone exchanges in Stockholm for development purposes. Telephone switching was also somewhat later brought into the subsequent monopoly scenario of 1906 through the argument that the acquisition would favour the introduction of new telephone technologies, including CB-system exchanges. In this case, it was argued, the proposed solution to the 'telephone issue' would also resolve some problems with the present exchanges.

In these instances telephone switching appeared quite differently as compared to how it appeared only slightly later in the controversy over the merits of different switching systems. In the above instances much of the apparently intricate (and possibly disputable) elements of telephone switching were black-boxed. No one countered the monopoly scenario presented in 1906 by affirming, for instance, that the introduction of new telephone technologies and specifically CB-system switches were undesirable (although some opponents actually asserted that competition favoured technological

progress more than did a monopoly). In the efforts to resolve the 'telephone issue' the merits of different telephone switching systems were not disputed.

The discussion centred on the efforts up to around 1910 to resolve the 'telephone issue' and the 'switching system issue' may be condensed up to this point into two remarks. The first remark concerns the contours of the two issues, in terms of solutions, problems, and elements related to the efforts involved towards their resolution. The second concerns the links between the two issues.

**Remark 1:** Efforts to resolve the 'telephone issue' and the 'switching system issue' involved a heterogeneous set of solutions, problems, and elements. Both issues implied a specific framing, that is, a specific demarcation of what interdependencies in the techno-economic network were taken into account and what were ignored.

**Remark 2:** Elements or problems that were taken into account in both the 'telephone issue' and the 'switching system issue' did not necessarily appear similar in both. What in one issue appeared as a whole set of disputed solutions, problems and elements, could at the same time appear as a black-boxed element in the other.<sup>3</sup>

Remark 1 largely echoes the delineation of these two issues as the point of entry for this study (done in chapter 3). In addition it acknowledges that these issues indeed involved heterogeneous concerns. Remark 2, on the other hand, emphasises that links between two issues were not necessarily constituted of shared elements of similar appearance. The dissimilar appearance of telephone switching, for instance, accentuates the fact that there was a certain 'ontological distance' between the two issues at this point, in the sense that the issues were set apart to such an extent, allowing for such a dual character of an element. Thus, there was a difference in the framing performed by the efforts to resolve the 'telephone issue' on the one hand and the 'switching system issue' on the other.

#### *'Network Trials & Tribulations'*

In chapter 5 (covering the period from around 1910 until January 1918) the dispute within the Telegraph Administration on the 'switching system issue' was replaced by three projects all aiming at developing semi-automatic and automatic switching systems. Furthermore, as these efforts gradually expanded there were again intermittent discussions on altering the relationship between the Telegraph Administration and Stockholm Telephone and resolving the 'telephone issue'. Despite these apparent

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<sup>3</sup> Confer Donald MacKenzie's notion of a "certainty trough" which suggests that a certain uncertainty about the facticity of an element's qualities is greater to those situated closer to the heart of its production than it is to those somewhat more distanced from it. See, Donald MacKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge: MIT Press, 1990), pp. 370-372.

continuities, there were changes in what counted as solutions, problems, and elements in all these sets of efforts. Furthermore, the links between them became more intricate.

Let me first illustrate this change by referring to the efforts from Autumn 1914 until Spring 1915 concerning an acquisition of the network of Stockholm Telephone. These efforts turned on an attempt by the Telegraph Administration to translate a combination of a tariff reform within the Administration's telephone network and a state budget in short supply into an acquisition of the competing network. Contrary to most previous attempts, this attempt aimed at interesting the government and Parliament to act before attempting to make Stockholm Telephone agree to sell its network. In these efforts not only were a sparsely provisioned state budget and a tariff lacking in nationwide co-ordination presented as more central problems than in previous ones, but the vexed problem of interconnection was not even raised. Thus, although this 'monopoly solution' closely resembled the solution in previous monopoly scenarios, the problems it represented as offering a solution to were significantly altered and re-graded in this instance. This change as regards the problems was furthermore interrelated to the altered order in which the government and Stockholm Telephone were to be enrolled and by what means.

Remark 3: A 'monopoly solution' was linked to quite different problems at different instances. Efforts to resolve the 'telephone issue' involved a changing set of problems, solutions and elements. Changes that were related to specific attempts of enrolment.<sup>4</sup>

Similar changes occurred to the development projects, and what counted as solutions, problems, and elements were furthermore not identical among them. Leaving the issue of the projects' progression to the next section, I will here indicate how the projects differed by noting how they were differently situated.

The contract between Axel Hultman (the Telegraph Administration's telephone director in Stockholm) and LM Ericsson signed in 1913 concerned the development of an automatic switching system. In codifying this association between Hultman and LM Ericsson, this contract contained a clause denying LM Ericsson the right to sell future switches of that system to Stockholm Telephone despite the established ownership links between the two companies. Thus, the contract created a space for a development project (the Hultman-Löfgren project), but regulated this space in relation to the then still unsettled 'telephone issue' that included the relationship between Stockholm

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<sup>4</sup> This conforms well with the notion of problematisation within the actor-network approach which indicates a translation that links a problem to a proposed solution. See glossary and Michel Callon, "Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St-Brieuc Bay," in *Power, Action and Belief: a New Sociology of Knowledge?*, ed. John Law (London: Sociological Review Monograph: Routledge & Kegan Paul, 1986), 196-233, pp. 203-206.

Telephone and the Telegraph Administration. The Olson project, on the other hand, was performed within the Telegraph Administration and hence did not involve any such specific regulation. Finally, the Betulander-Palmgren project was performed within a separate company and apparently involved efforts to raise financial support for the project from outside the field of Swedish telecommunications.

**Remark 4:** The three different projects aiming to develop automatic switching systems to some extent involved different problems, solutions and elements. Indeed, the difference in elements enrolled to support them implicated differences in their demarcation of what interdependencies in the techno-economic network were taken into account.

The mounting difficulties from around 1915 carried with them efforts with more inclusive and complex sets of what counted as problems, solutions, and elements. The overall problem that more or less undisputedly came to the fore was the less than satisfactory workings of the telephone networks in Stockholm. Furthermore, this problem transcended the previous separation between the efforts focusing on the workings of the present and future switches on one side and the efforts focusing on altering the relation between the Telegraph Administration and Stockholm Telephone on the other.

Indeed, the suggested potential solutions oscillated between the realms of altering the exchanges and the realms of altering the organisation of the telephone operations in Stockholm. Several solutions were mooted within the Telegraph Administration: an acquisition of Stockholm Telephone's network and a subsequent tariff reform, a quick introduction of semi-automatic telephone switches, an enforced enlargement of the network using manual switchboards. This oscillation between such distinctly different solutions even appears to have been detrimental to the making of any sustainable scenario. At one time an order for semi-automatic switches was postponed by the Telegraph Administration. This was professedly due in part to uncertainty as to whether the Stockholm Telephone network was to be acquired (Spring 1917). Somewhat later that Spring the head of the Administration's technical department argued for a swift settlement of the negotiations concerning an acquisition to be able to move forward with planning for introducing semi-automatic telephone switches. Inversely, at a later date (Summer 1917) he voiced opposition within the Telegraph Administration to an acquisition agreement on the grounds that such an agreement could disturb the introduction of semi-automatic switches. At the same time, though, there were others such as Axel Hultman who sought to postpone such an introduction, since a swift introduction would be detrimental to the Swedish projects.

What this illustrates, therefore, is the emergence of a more inclusive framing, accounting for an increasing set of interdependencies of a techno-economic network in decay. What had been two distinguishably separate sets of efforts became efforts

involved in an increasingly interlaced set of problems, solutions, and elements. Furthermore, this rendered a less stable basis for establishing means ends translations and hence a less stable basis for achieving enrolment, action and stabilisation. Moreover, precisely as there was much work done to literally patch the telephone network together into a black-boxed whole from the viewpoint of the subscribers, there was work done to re-separate problems, solutions and elements from one another so that the work of developing and introducing semi-automatic switches did not interfere with the attempts to acquire the Stockholm Telephone network and vice versa.

**Remark 5:** The tendency of disintegration of some elements in the techno-economic network contributed to a more inclusive framing that took more of the interdependencies in the techno-economic network into account. The associated integration of several problems, solutions, and elements was countered, in turn, by efforts to re-separate them.<sup>5</sup>

From this it follows that the previously depicted reasonably separated efforts to resolve the 'switching system issue' and 'telephone issue' depended on the possibility of leaving many interdependencies unaccounted for. This provides for an additional remark.

**Remark 6:** The selective framing performed by the (previously) rather separated efforts to resolve the 'switching system issue' and the 'telephone issue' depended on a stable subordination of the many interdependencies in the techno-economic network that were not taken into account.

Taken together these two remarks points back to remark 2 and the possibility for an element to simultaneously appear as a black-boxed element in one issue and as a whole set of disputed solutions, problems and elements in another. Such an 'ontological distance' indicating the separation of two issues, depended on the extent different efforts could leave many interdependencies in the techno-economic network unaccounted for. The increased difficulties in the telephone networks in effect made more interdependencies soliciting to be taken into account, which in turn could be seen as a reduced 'ontological distance' between efforts focused on solutions in terms of telephone switches and efforts focused on solutions in terms of altering the relation between Stockholm Telephone and the Telegraph Administration. Furthermore, these two remarks underscore the dependence of enrolment on the possibility of leaving (many) interdependencies out.

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<sup>5</sup> The notion of a variation between selective and inclusive framing bears affinity with the notions of variation between open and closed periods in a decision-process as discussed in Bengt Jacobsson, *Kraftsamlingen: Politik och Företagande i Parallella Processer* (Lund: Doxa, 1987), esp. pp. 28-34.

*'Automation for the Nation'*

Chapter 6 (covering from 1918 up until around 1930) begins by recounting an intricate situation with interrelated problems acknowledged: that the working of the telephone networks in Stockholm was less than satisfactory, that the Telegraph Administration's local service in Stockholm was operating at a loss, that the state budget was in need of replenishment, and that none of the Swedish development projects were yet capable of delivering a full scale working telephone switch. Nevertheless, it was from this intricate situation that several issues began to stabilise. The framing performed by these efforts provides a last picture of the variable extent of controversies.

Renewed efforts to acquire the Stockholm Telephone network emerged early in 1918 subsequent to a government request to the Telegraph Administration to increase its tariffs. The negotiations resulting in a preliminary agreement between Stockholm Telephone and the Administration subsequently became a monopoly scenario that put little emphasis on the less than satisfactory service of the networks in Stockholm. The monopoly scenario emphasised several other problems instead: the state budget in need of support, the sense of unfairness caused by the lack of tariff reform in Stockholm, the unprofitable operations of the Administration's network in Stockholm, the waste to the national economy caused by present duplication, and the pressing need for supplies of certain equipment. According to this scenario, it was these problems that would be solved by realising the acquisition and the monopoly. In other words, the scenario attempted to enrol support by translating the creation of a monopoly into a number of stated ends.

Several points in the attempted chain of translations in the scenario were contested, including: the merits of monopoly and competition, the veracity of the Administration's stated losses in its telephone operations in Stockholm, whether the present situation represented a waste to the national economy, the veracity of the profitability calculations quoted in the acquisition feasibility study, and whether an acquisition really was inevitable. However, the diverse problems with services in Stockholm were not brought into the controversy, nor were the efforts focusing on the workings of the present and future exchanges in Stockholm. The more inclusive framing of the previous year had been supplanted with a framing performed by a scenario focusing completely on the acquisition as the solution to all problems brought up.

As this scenario gained the support necessary for realising the monopoly, a new scenario appeared the following year (Autumn 1919) when the Telegraph Administration requested funding for the introduction of automatic switches. This scenario promoted problems with the services in Stockholm and in particular the future escalation of these problems if manual switches were to continue to be used in the

merged network. Here automatic switches were presented as the solution that would allow for the complete merger and provide for businesslike operation of the enlarged network in face of increased trunking. Furthermore, in this scenario the automatic switches would provide legitimacy to the recently inaugurated state monopoly in telephone services, since automatic switches would enable the Telegraph Administration to operate the network in a manner that would discourage criticism of the monopoly.

Automatic switches were thus not only presented here as the solution to problems of switching telephone calls in Stockholm, but also something that would further stabilise (and literally solidify) the monopoly. In this scenario the automatic switches appeared as perfected, but that was hardly how such switches appeared in the efforts to develop and assess automatic switching systems were still in process. In the latter efforts automatic switches were at the heart of controversies in terms of what they ought to look like, how they should interact with subscribers, operators and other parts of the telephone network (confer Remark 2).

The important point here, though, is that the monopoly scenario of 1918 and the automation scenario of 1919 in effect accomplished a sequential separation of some problems, solutions, and elements that in an earlier instance had been intertwined in a way that had made it difficult to achieve a sustainable scenario.

**Remark 7:** The monopoly scenario of 1918 involved an exclusion of certain problems, solutions and elements that only the year before had been included in efforts related to resolving the 'telephone issue'. The appearance of the automation scenario upon the subsequent successful realisation of the monopoly, in effect made the two scenarios perform a sequential separation of problems, solutions and elements.

Although this remark takes me prematurely into the issue of stabilisation, the sequential separation achieved is worth a note here in relation to links between efforts related to the 'telephone issue' and the issue of introducing (semi-)automatic switches. The sequential separation between such efforts was apparently not predetermined as is indicated by their previous further integration (see Remark 5). Thus, the monopoly scenario attempted (and subsequently achieved) the exclusion of certain problems, solutions and elements in its attempt to enrol support for the acquisition proposed.

*The variable extent of controversies and attempted translations*

In this section I have discussed the dynamics of the controversies by bringing up some features from the accounts of efforts of the three previous chapters. This discussion has produced a number of itemised remarks that have depicted different instances as well as different facets of boundaries and links between the two sets of efforts that began as the 'telephone issue' and the 'switching system issue'.

It should be noted that this depiction rests on the method used in constructing my account. However, although the method permitted such matters to be depicted, it neither prescribed the presence nor the character of such links and boundaries. In particular, the dynamics actually depicted illustrate the extent to which the 'issues' evolved in successions of attempted translations and enrolment. This, in turn, leads to the issue of stabilisation of controversies.

### **Stabilisation of controversies**

A central premise in this thesis is that the successful stabilisation of statements, arrangements or machines should not be explained as being caused by them being inherently true, appropriate, or efficient. According to this premise, such properties should be seen as the outcome and not the cause of the stabilisation. This premise shifts attention from any inherent properties to the processes of translation and enrolment where they (statements, arrangements, machines) acquire their properties. Given this, and informed by the previous discussion on the variable extent of controversies, it is time to discuss the stabilisation of the monopoly scenario of 1918 as well as the gradual stabilisation of the automatic switching system.

I have used the concept of scenario to outline how a proposed solution was presented in order to enrol further support. Such scenarios, therefore, are a good starting point for discussing successful and failed stabilisation. In the scenarios I have depicted such things as how problems and solutions have been defined, what elements are defined and the interests with which they are attributed. It should, however, be noted that the notion of scenarios (as used in this thesis) is no more than a convenient label put on a negotiated set of attempted translations requesting further support. The negotiations preceding what I have labelled a scenario are no different in kind than are those attempted to follow on the presentation of scenario. The only thing distinctive about what I have labelled a scenario is that a scenario signifies a negotiated outcome, as yet still far from being a *fait accompli*.

#### *The stabilisation of a monopoly scenario*

Thus, understanding stabilisation in line with the premises of this thesis implies an appreciation of how a negotiated scenario emerges, as well as how support is further enrolled. Before discussing the successful monopoly scenario of 1918 I will illustrate the implications of such a stance by discussing the monopoly scenario of 1906. This exercise is helpful since this scenario in some ways resembles the scenario of 12 years later, yet failed to enrol support to further realise the proposed monopoly.

The scenario of 1906 had it that the proposed acquisition was inevitable in the long run, and that the timing was right. It further held that the proposed acquisition was in the interest of the public, the subscribers in Stockholm, SAT, the Telegraph

Administration, the national economy, and the technical advancement of the telephone network in the Swedish capital. Among the ends translated to interest these parties were the reintroduction of interconnection which, it was asserted, was of national interest and difficult to attain by other means. Furthermore, the presence of two networks was labelled an unnecessary duplication that represented a waste to the national economy.

However, a glance into the negotiations preceding this scenario and the preliminary acquisition agreement between the Telegraph Administration and SAT provides another picture. Most noticeable are the negotiations where the managing director of SAT preferred a cartel agreement with a geographical division of the networks whereas Administration officials preferred a complete acquisition of SAT's network. In these negotiations the Administration's general director Arvid Lindman made some concessions to SAT regarding LM Ericsson's further access to the network and as a quid pro quo bound SAT to loyally support the acquisition agreement as the only possible solution. Thus, the notion of the acquisition being the only solution was not only sustained by the attempted translations expressed in the scenario, it was sustained by SAT being enrolled.

Yet the scenario failed in Parliament despite the absence of concerted resistance. Among the objections to the attempted translations of the scenario were that the price was too high, that competition was beneficial, and that the issue was not of national concern.

This failure spawned new negotiations between SAT and the Telegraph Administration with the view of finding other ways to restore interconnection between the two services. Thus, upon the failure of the scenario in 1906, the scenario was also abandoned by those who had participated in promoting it as the only solution. What the fate of this scenario illustrates is the frailness of proposed translations even when they are expressed in terms of the only solution. True, in subsequent negotiations efforts to establish interconnection again failed, and on the other hand its continued absence also gradually lost it its position as a prime problem in subsequent efforts to resolve the 'telephone issue'.

Turning now to the monopoly scenario of 1918, the prime question is naturally why it succeeded where so many other attempts to resolve the 'telephone issue' had failed. The scenario itself had it that the proposed acquisition creating the monopoly was inevitable and that it was a particularly desirable time to carry it through and included, furthermore, a merger of SAT and LM Ericsson. The scenario expressed that the creation of a monopoly was in the interest of the public, the State, the national economy, the Telegraph Administration, Stockholm Telephone, and the shareholders of Stockholm Telephone, providing a needed contribution to the state budget, a tariff

system fairer to the public, a turn-around in the Telephone Administration's finances and access to much needed supplies and generally less waste to the national economy.

A look at the negotiations preceding this scenario reveals first that a monopoly solution only the year before had been destabilised by being intertwined with the issue of resolving the less than satisfactory services in Stockholm and plans for procuring semi-automatic switches. Incidentally these two matters were addressed by the introduction of additional manual switchboards at least in part so as not to disfavour the Swedish projects but thereby increasing the costs to the Administration. Nevertheless, the separation from these matters was a major feat of the monopoly scenario (confer Remark 7). Furthermore, the fact that negotiations took place in Spring 1918 towards how the acquisition of Stockholm Telephone was to be executed at a time when money was in such short supply is telling. Here the involvement in the negotiations of Arvid Lindman, now a member of parliament and party leader of the Conservatives and additionally the chairman of the board of LM Ericsson, was central. In renegotiating the payments he enrolled some support for the scenario from those who were considered the less enthusiastic Conservative members of parliament. The scenario was eventually successful in enrolling enough support in parliament, a feat that verges on the obtrusive given that the purchase sum would end up in the merged SAT/LM Ericsson.

In the debate, several features of the scenario were challenged. The assertion that the acquisition was in the interest of the national economy, for instance, was countered by the influential economist Gustav Cassel. A respected spokesperson for the national economy and moreover familiar with the concept of natural monopoly, he spoke against the notion that the state monopoly was in the interest of the national economy. Yet the opposite translation was maintained by the minister of public administration when he presented the proposal to the members of parliament, and where he furthermore asserted that telephone service by its nature ought to be a state monopoly. Later, the proposed acquisition was approved and as a direct consequence LM Ericsson subsequently merged with SAT to become General Telephone LM Ericsson.

Juxtaposing the successful enrolment of support for this scenario in Parliament with the failure to gain support for a monopoly scenario in 1906 raises some interesting points. First, the fate of the scenario in 1906 clearly illustrates that the opposite to successful enrolment and support was not concerted resistance. Heterogeneous resistance did just as well in annulling it. Second, it is apparent from the debate in 1918 that unanimous support of the scenario was not a requisite to the scenario's success. This underscores the advantage of not explaining the achievement of the monopoly in 1918 as being an inherently appropriate and inevitable solution.

This step towards a thorough reorganisation of Swedish telecommunications was a negotiated achievement and not the outcome of any capacities inherent in the

scenario's solution. The efforts of enrolment had succeeded in translating a state budget in straitened circumstance into an acquisition that implied substantial government expenditure. Moreover, the Administration officials had succeeded in separating the scenario from the simultaneous discussions and efforts aiming at developing and introducing automatic switches.

**Remark 8:** The monopoly created in 1918, was a negotiated outcome where the notions of it being the appropriate and inevitable solution were as much a part of the negotiated outcome as was the monopoly itself.

Yet, the outcome of these decisions was fragile and far from a final stabilisation of the scenario. The scenario had only been made somewhat more real in the Parliament and at the shareholders' meetings. All the efforts (and controversies) that went into transforming 'the monopoly on paper' into becoming more real should also be included in the stabilisation. These included the burdensome efforts to introduce the tariff reform and to merge the two networks in terms of tariffs, lines, numbering, etc. It also included the further work of introducing automatic switches, which after the acquisition was presented as a necessary step to further stabilise the monopoly.

**Remark 9:** The successful monopoly scenario of 1918 created more or less fragile new interdependencies, and required many further efforts to reduce the reversibility of the achievement.

#### *The stabilisation of an automatic switching system for Stockholm*

The further stabilisation of the monopoly scenario of 1918 included, as noted above, the automation scenario of 1919 presenting automatic switches as the necessary solution to stabilise the monopoly. A scenario that completed the sequential separation discussed above (confer Remark 7). The work in introducing (semi-)automatic telephone switches dated from much further back, however. This work grew primarily out of the controversy centred on what constituted the appropriate switching system for the Administration's planned new large telephone exchange. The emerging projects to develop automatic telephone switching devices, as discussed above, were partially entangled with problems, solutions, and elements central in the 'telephone issue' controversies. In short, the work on developing automatic switches did not begin as work to provide a 'solution' to a 'problem' caused by the creation of a monopoly.

What, then, can be said about success and failure of these projects? First, it is all too easy to depict LM Ericsson's 'winning' Kâell-Lienzén system as the single successful outcome of these projects and the others as failures. On one account all three projects emerging after 1910 were successful, in that they all enrolled enough support to become discernible projects. Moreover, all three projects succeeded in acquiring an order for a test-exchange (1915), and during the preparations for inviting tenders in 1917 they were all (at least formally) considered as able to deliver a telephone switch in

due course, and they all succeeded in delivering a test-exchange that switched telephone calls.

Instead of discussing success and failure as a single outcome, settled at one point in time, it is more fruitful to describe the progression of the projects over time.<sup>6</sup> In doing this, the focus is put on their changing networks of enrolled elements. We may think of each of these networks in part as the network of support that generated the space, time and resources for these projects, and in part the local project network elaborated in the course of developing automatic switching devices.<sup>7</sup> Instead of discussing success and failure at a single point in time, then, the point here is to describe some facets of the projects' changing local project networks as well as their changing networks of support. All with the view of revealing some significant points on the stabilisation of what became the automatic switches used in Stockholm.

It is clear that each of the projects was established differently and that their respective networks of support furthermore continued to change so that they gradually became less similar in that respect. A picture from around 1911 depicts two of the projects (the Olson and Hultman projects) as primarily supported by, and performed within the premises of, the Telegraph Administration while the third (the Betulander-Palmgren project) was performed within the premises of the start-up company Autotelephone Betulander and was partially funded by French partners. A picture from 1914, on the other hand, depicts the Olson project in a newly furnished workshop within the Jeriko premises of the Telegraph Administration, the Hultman project as having become the Hultman-Löfgren project after Hultman allied with LM Ericsson, and the Betulander-Palmgren project as linked to New Autotelephone Betulander backed by Swedish funding independent of Swedish telecommunications interests. Hence, the projects were created and sustained by networks of enrolled elements, some more stable than others.

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<sup>6</sup> This is in line with Michel Callon and John Law's notion of 'translation trajectories' in, John Law and Michel Callon, "The Life and Death of an Aircraft: A Network Analysis of Technical Change," in *Shaping Technology/Building Society: Studies in Sociotechnical Change*, ed. Wiebe E. Bijker and John Law (Cambridge: MIT Press, 1992), 21-52, pp. 45-50. This notion of a trajectory is quite distinct from the one proposed by Giovanni Dosi, e.g., Giovanni Dosi, "Technological Paradigms and Technological Trajectories," *Research Policy* 11 (1982): 147-162. The notion of a translation trajectory emphasises the continual negotiations shaping the trajectory and refutes the idea of a trajectory intrinsically given by any project 'core' conceived in the origination of the project, confer Law and Callon, "The Life and Death of an Aircraft," note 11, p. 52.

<sup>7</sup> This is similar to the concepts of local and global networks, see *Ibid.*, pp. 21-22. Concepts such as these are purposefully contrived to avoid any a priori and fixed distinction between content and context.

Furthermore, the automatic switching devices that the projects undertook to deliver meant different things to different supporting parties.<sup>8</sup> To the French partners in Autotelephone Betulander, for instance, the Betulander-Palmgren project had meant potential for generating production in France, but they lost interest in 1912 when production undertakings were unfulfilled. To the Telegraph Administration, on the other hand, the Hultman and Olson projects warranted continued support as promising to provide an answer to what the planned new main exchange in the Jeriko premises should look like. Later, during preparations for procuring automatic switches, the three projects were also discussed in terms of their Swedish origin offering production to Swedish industry. After the creation of the 'monopoly on paper' the State was enrolled to support automation as a means towards solving the problems caused by the imminent merger of the two telephone networks.

On the basis of my narrative, one interpretation would be that all three projects were supported by a 'general' conception that automatic telephone switching devices were part of the future of urban telephone networks like those in Stockholm. This gains support from the few references in the narrative to controversies concerning the appropriateness (in general terms) of introducing automatic switching devices in the Stockholm networks. However, such an interpretation misses two vital points. First, the apparent initial interest by Telegraph Administration officials in supporting the projects on such grounds can hardly be taken as a 'general' conception that semi-automatic and fully automatic systems were perceived everywhere as the only kind of appropriate systems for large exchanges. The fact that some officials within the Telegraph Administration subscribed to this conception could be attributed, at least partially, to the words and actions of Axel Hultman, Herman Olson and others, and so their views were not independent of the projects. In other words, the projects participated in generating this 'general' translation of automatic switching as the appropriate switching system for a large urban network. At times this depiction of the projects was also reflected in newspaper articles setting hopes by (these) automatic switches as being the answer to the perceived problems with the Administration's service in Stockholm. However, the efforts within Stockholm Telephone at refurbishing its much larger network took another route (with less emphasis on automatic switching). There is also evidence that

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<sup>8</sup> This is a central point in the notion of interpretative flexibility of objects as presented in the SCOT-program (social construction of technology). See, e.g., Trevor J. Pinch and Wiebe E. Bijker, "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other," in *The Social Construction of Technological Systems*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (Cambridge: MIT Press, 1987), 17-50, pp. 40-44 and Wiebe E. Bijker, *Of Bicycles, Bakelites and Bulbs: Toward a Theory of Sociotechnical Change* (Cambridge: MIT Press, 1995), pp. 73-77.

the international community of telephone engineers was apparently far from united in its views on automatic switching.

Second, emphasis of the vital importance of a 'general' belief in automatic switching misses the significant ambiguity concerning what characterised an appropriate automatic telephone switch. Was it, for instance, a switch with fewer sets of large selectors or a switch with many small selectors? Was it a switch where the subscribers dialled the desired numbers themselves, or was it a switch where the selectors were operated by operators? When was the appropriate time to introduce (semi-)automatic switches into the telephone network? Such issues were, as the previous chapters reveal, heavily contested at times. To take one significant example, the appropriateness of using fully automatic telephone exchanges and hence dialled service for frequent callers was contested among engineers within the Telegraph Administration as late as the mid 1920s.

It is further clear that each project's local project networks were evolving and taking on different shapes at different times and they differed moreover from one another. One picture from their early years depicts the Betulander-Palmgren project involving selectors selecting over 10 lines, the Hultman project involving selectors selecting over 10,000 lines, and the Olson project involving selectors selecting over 10 and 30 lines. Pictures from later points in time reveal repeated transformations of the projects, including selectors of quite different sizes than those depicted above. The projects' test-exchanges put in operation in 1917 and 1918 were, for instance, part of project networks quite transformed from those tendered for a few years earlier.

I should emphasise at this point the interrelated character of each project's network of support on one side and its local project network on the other. The once discontinued efforts to develop selectors selecting with a radial movement illustrates this point clearly. Martin Löfgren, an LM Ericsson engineer working on the Hultman-Löfgren project, had reportedly worked on such selectors prior to the Administration's acquisition of Stockholm Telephone's network in June 1918. He had abandoned this line of effort, however, since it could have produced selectors that mixed patents held by Hultman and patents held by the parent company of Stockholm Telephone, SAT. The contract between Hultman and LM Ericsson precluded the latter from selling future switches using Hultman's patents to Stockholm Telephone, and apparently Löfgren deemed that SAT would act similarly if a system using its patent was intended for sale to the Telegraph Administration. In other words, he reportedly abstained from pursuing

this work since it would have produced a non-working switching system *given* the location of patents and the current roles of the two operators in Stockholm.<sup>9</sup>

The efforts of the Betulander-Palmgren project to enlist calculations on congestion in automatic switches in its support provides another example of the interrelated character of a project's network of support and its local project network. Axel Hultman, in the course of preparing a procurement for large exchanges in 1917, had once expressed doubts concerning the blocking characteristics of the way selectors were interconnected in that system. Betulander subsequently enrolled supportive calculations (and calculator) in attempting to dispel the possibility for such doubts to be raised. Thus these efforts to elaborate the local project network were made to interest the Telegraph Administration in what the Betulander-Palmgren project undertook to deliver. In this case, the response was not completely successful given the further course of efforts. The interesting point here, however, is the interplay between elements involved in the project. The questioning of the system's scalability characteristics was not only countered by delivering a test-exchange that switched calls satisfactorily (and numbers to substantiate that), it was countered by enlisting supporting calculations to accompany the test-exchange. For the project to succeed in attracting the Telegraph Administration (represented by Hultman in this instance), the system's scalability could not be in doubt.

At this point, it should therefore be noted first that all three projects were truly changing entities. In the progression of the projects their networks of support changed, their local project networks evolved, and finally there were intricate interrelations and interdependencies between the two networks for at least two of the three projects.<sup>10</sup>

Remark 10: The development projects differed among one another both in terms of their local project networks and in terms of their networks of support. These differences appear to have been sustained as they progressed.

Remark 11: The progression of the development projects depict (at least for the Betulander-Palmgren project and the Hultman-Löfgren project) that there were intricate interrelations between each project's local project network and its network of support.

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<sup>9</sup> I use the term non-working since switches of that design at that time would have been impossible to sell to either the Telegraph Administration or Stockholm Telephone. The account on the radial selectors was actually made in chapter 6 in relation to later efforts among some other LM Ericsson engineers to design selectors along similar lines. At that time the Telegraph Administration had acquired the network of Stockholm Telephone and SAT had merged with LM Ericsson. These changes had produced to these engineers a new *given* according to which such a line of design would not necessarily produce a non-working system.

<sup>10</sup> Here, again, is the problem that so little has been found from the development of the Olson project.

The account in the previous two chapters described all three projects as sustained at least up until 1918. Around 1916 and 1917 they all 'survived' the threat of the Administration placing a swift order for semi-automatic switches, which allegedly would have been of foreign manufacture since the projects could not deliver. All three were still considered as projects in 1917 and were (at least formally) included in the preparations for an invitation to tender. Thus, at that time, all still represented a promise to deliver automatic switches to the Administration's network in Stockholm later on.

The scenario changed, however, after the test-exchanges had begun switching telephone calls on something resembling a regular basis, after the Telegraph Administration had acquired the Stockholm Telephone network, and after SAT and LM Ericsson had merged. At that stage the Telegraph Administration presented a new scenario, having managed to persuade the government that not only was the introduction of automatic switches the solution to the problems of switching telephone calls in Stockholm, it would also further stabilise the monopoly. Thus, it was at this time that the Telegraph Administration renewed its efforts to procure two regular telephone switches. Thus in preparing their tenders, the projects should attempt to deliver this new solution.

The Olson project had lost support at this point. It was also at about this time that a new set of efforts within General Telephone LM Ericsson gave rise to the Kåell-Lienzén project, a project to an extent separated from the Hultman-Löfgren project. It was also about this time that the Betulander-Palmgren project enrolled supportive calculations concerning the blocking characteristics of the system. Finally, at a slightly later stage the owners of New Autotelephone Betulander entered into an agreement with General Telephone LM Ericsson in terms of which the latter would acquire the former in case any of the two switching systems offered by General Telephone LM Ericsson or the system offered by New Autotelephone Betulander was chosen by the Telegraph Administration. Thus, the projects were significantly altered during the period mid 1918 and end of 1919.

The projects had been transformed in preparation for attempting to enrol the support (and order) from the Telegraph Administration. At the ensuing procurement process the three tenders, all formally managed by General Telephone LM Ericsson, were set against tenders from foreign manufacturers. The account concerning this procurement process depicts a dense set of negotiations and changes. Not least, suppliers were asked to revise their tenders to cater for the supply of fully automatic switches, after Axel Hultman (at this point unchallenged) emphasised that the Administration ought to procure automatic switches for dialled service. He argued on the basis of the 'international evidence', the reduced space required by such switches, and the employment situation.

Not only were there discussions on what was the best offer, there were also discussions on the criteria according to which such a judgement should be based. These discussions covered a large set of issues, including; the desirable and possible rate of introduction of automatic switches, whether the large network made switches with large selectors more appropriate, how to calculate blocking characteristics; the manufacturers' ability to deliver, the reliability of relays, whether it was preferable to buy a Swedish system, the manufacturers' willingness to concede that the Administration's own factory should later be allowed to produce exchanges of the system, etc.

It would be too much to reiterate all the twists and turns of this procurement process. Suffice it say, during these months of negotiations three particularly notable points arose concerning the networks of the contending projects.

First, Axel Hultman appears to have held a strong position in the procurement process due to his position as chief engineer of the two merging networks. He had drafted the proposed contracts and had participated in negotiating the criteria according to which the offers were to be judged. Moreover, he participated in further shaping the two main offers from LM Ericsson, for instance by requesting changes in the design of the systems offered. Thus, to some extent he participated in renegotiating both the interests of the Telegraph Administration as regards the switches to be procured and the local project networks of the two LM Ericsson offers.

Second, there was opposition expressed by a few other leading Administration engineers, including the head of the technical department, against choosing any of the Swedish systems. These were of uncertain status, they contended, since they had never been tried on a larger scale. In other words, they considered these projects as still uncompleted. A swift automation, with switches from Siemens, was in their view preferable since it translated into considerable savings. The divergent positions among different Administration engineers produced a controversy to the effect that the interests of the Administration were renegotiated. Although issues such as the nationality of the manufacturer were discussed, the negotiated outcome relayed a longer delivery time and a paragraph requesting the supplier to concede that the Administration's own factory should later be allowed to produce exchanges of the system. The negotiated outcome translated the Administration's interests into procurement criteria that favoured the offers from General Telephone LM Ericsson.

Third, the Betulander-Palmgren system was diverted from the large exchanges scenario and adapted for small switches. The question of the system's scalability was preserved during this procurement process and Hultman put into the draft contract that the manufacturer should assume all responsibility for resolving potential blocking problems. General Telephone LM Ericsson, which handled the offer for a Betulander-

Palmgren system switch, apparently refrained from fighting on this issue, probably because the company had another system competing for the same order. In addition, neither Betulander or his financiers were to be left without any share even if another of Ericsson's systems were chosen. During the process of procurement, it was also decided within the Telegraph Administration to design small exchanges using elements from the Betulander-Palmgren system. Thus, both the network of support and the local project network of the Betulander-Palmgren project were utterly altered

When the Kåell-Lienzén system was finally chosen (albeit only for a larger test-exchange), it marked the end of a procurement process where neither the local project networks, nor the networks of support had been stable. It was not chosen, this is clear, because it was inherently the best system according to pre-set criteria upheld by a stable context. What instead comes into view is an iterative process of stabilisation where both the networks of support and their local project networks for all contending projects were negotiated. Indeed, the gradual and negotiated stabilisation of what criteria the Telegraph Administration should use – what the Administration's interests were – for choosing the system was as an important part in deciding the outcome as was the stabilisation of the offers.

Indeed, the story of the progression of the projects depicts the Kåell-Lienzén project as the project whose network of support and local project network had the most iterative and intertwined development. This interpretation thus presents the 'selection' of the Kåell-Lienzén system as the outcome of an iterative joint process of changes in both its 'content' (its local project network) as well as in its 'context' (its network of support).

**Remark 12:** The decision in 1921 to use the Kåell-Lienzén system for the first automatic exchange in Stockholm was an outcome of a long process where both the Kåell-Lienzén project's local project network and its network of support were the subject of more iterative and intertwined negotiations than were the other contending projects.

The fact that General Telephone LM Ericsson, at about the same time, succeeded in selling switches of a similar kind to a few foreign operators as well, is intriguing given the system's unsettled character. Although beyond the scope of this study, one cannot but wonder how the extensive procurement process involving the Telegraph Administration was influenced or interrelated to the offers to foreign potential clients that simultaneously had to be managed within the company. The fact that General Telephone LM Ericsson negotiated with other clients simultaneously indicates the less than full dependence of the company on the Telegraph Administration for such an order. It does not, however, diminish the degree to which the chosen system was the outcome of truly intertwined and iterative negotiations.

And again, the decision to chose this system stabilised only fragile new interdependencies, and required further efforts to reduce the reversibility of the achievement. Efforts beginning with a whole new set of negotiations domesticating the exchanges into the larger techno-economic network inhabited by subscribers, subscriber's lines, operators and so on.

#### **A note on agency and actors in techno-economic controversies**

Thus far in this chapter I have used the word actor sparingly. Instead I have relied on general nouns such as element and proper nouns like Hultman, the Telegraph Administration, and the Kåell-Lienzén system. For good reason, since there is the obvious possibility of interpreting the plot along the lines of dominant human agency. If such a reading is cultivated, the extraordinary human agent only replaces other unsatisfactory concepts such as extraordinary innovation as the autonomous force causing change. To their merit, stories of heroic engineers seldom carry confusing a priori distinctions between economic organisation and technology, but tend on the other hand to analytically privilege the extraordinary human agent. Too much power and ability is simply ascribed to the main characters of such stories.

Axel Hultman, to take one distinct 'actor' in the plot, often appeared close to the action. Positions expressed by him appear to have been repeatedly sustained, often in spite of vigorous opposition. Even if Axel Hultman is released from the credit of having designed the automatic switching system manufactured by LM Ericsson, it is difficult to push him into oblivion. He nevertheless appears as an extraordinary engineer, as a master of heterogeneous engineering<sup>11</sup>, arising both in instances when new translations of means to ends emerged as well as when such translations were broken. Hultman, for instance, participated in the action when a link between the problem of a disintegrating network in Stockholm and a swift procurement of semi-automatic switches was avoided in 1917. He also appeared close to the action when, during the procurement controversy, the issue of selecting an offer for automatic switches became connected with a demand that the supplier should concede manufacturing rights to the Administration's own factory. In short, time and again Axel Hultman appeared as one of those powerful human agents who got it his way.

Negotiations such as these were important in bringing on the stabilisation of efforts and hence contributed in shaping the outcome. Yet, it is no more than prudent to ponder in what ways the position to be a heterogeneous engineer itself, is "the outcome

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<sup>11</sup> On heterogeneous engineering and heterogeneous engineers, see John Law, "Technology and Heterogeneous Engineering: The Case of the Portugese Expansion," in *The Social Construction of Technological Systems*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (Cambridge: MIT Press, 1987), 111-134.

of a set of interactions among forces of different degrees of obduracy.”<sup>12</sup> Or, to put it more broadly, in what ways the attribution of agency in itself can be seen as a network effect in the face of the strategic action being a collective property.<sup>13</sup>

It is clear that at many times Hultman was in a position where he appeared close to the action. His position as telephone director and later chief engineer of the enlarged Stockholm network put him in a privileged position. The dispute between him and the Administration engineer Anton Avén concerning the appropriateness of different manual switching systems is telling in this respect (1907-1909). In this dispute the privileged position of Hultman became an issue when Anton Avén claimed that Hultman in his position as telephone director had allocated operators with a lower than average proficiency to the exchange of Avéns system and that the measurements ordered and compiled by Hultman were biased. At the same time, Avén furthered his point by presenting figures calculated from measurements he himself had secretly made at an exchange in Stockholm. Being telephone director, authorised to speak on behalf of the exchanges and the future of the telephone network. Yet this privileged position was far from an indisputable one. The position attributed agency to Hultman at the same time was not an unquestionable position as was illustrated by Avén or indeed when the number of voices speaking on behalf of the exchanges (or parts thereof) multiplied when the service became more decomposed and less satisfactory to those using it.

Another important theme regarding the position held by Hultman was that it brought him close, but not too close to the action. The job of a telephone director was not to design switches, or at least, there was no contract stating that inventions made by a telephone director automatically became the property of the Telegraph Administration. This made Hultman different from the two engineers pioneering the other two projects. In this respect Hultman as telephone director was a ‘free agent’ from the outset, able to sign a contract with LM Ericsson. This association, in its turn, made him in a position of buffer, and go-between. He became an element mediating between the work to develop a new exchange within LM Ericsson and the Administration's exchanges in Stockholm. It made him appear closer to more action, but at the price of becoming much less of a ‘free agent’.

The appearance of extraordinary actors, then, was as much an effect of attributing the source of collective actions to particular elements upholding extraordinary positions. Elements, such as Hultman, were not only performing heterogeneous

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<sup>12</sup> Ibid., p. 132.

<sup>13</sup> Michel Callon and John Law, “After the Individual in Society: Lessons on Collectivity from Science, Technology and Society,” *Canadian Journal of Sociology* 22 (1997): 165-182, p. 177.

engineering, but were themselves engineered by heterogeneous elements including contracts, crowded switchboards, complaining subscribers, and ministers of finance. In addition, this attribution is to some extent relayed by my point of entry, by which actors I have followed. The point here is that the dynamics of the controversies contain more than the acts of a few independent and extraordinary humans altering artefacts and the economic organisation to the best of their pre-given and fixed interests. The sequences of stabilisation were an achievement of heterogeneous collectives.

### **Techno-economic stabilisation**

In this section I have put the focus on some efforts and controversies and their gradual stabilisation. In this, I have displayed first how the interrelations between the efforts that began as related to the 'telephone issue' and the 'switching system issue' were concrete, diverse, and variable. Secondly I have displayed parts of the contingent and iterative stabilisation of the monopoly scenario of 1918 as well as parts of the gradual stabilisation of the automatic switching system that later became used in Stockholm.

The overall argument is that these were negotiated and interrelated outcomes. In brief, the stabilisation of the automatic switching system came to be a part of the stabilisation of the monopoly, since automatic switching rose to become a solution to problems related to the creation of the monopoly. Moreover, the stabilisation of the automatic switching system was in several ways shaped by the emergence of this monopoly, including the possibility to use radial selectors and the sense that switches with large selectors were more appropriate given the larger size of the network.

Yet this course was itself the outcome of an emergent and in part negotiated sequencing and was not the result of any inherent properties in either the monopoly or automatic switches. It is conceivable that the Administration could have ordered semi-automatic switches from (presumably) a foreign supplier in 1917, just as it is conceivable that the monopoly scenario of 1918 could have failed to receive the support in Parliament. Or indeed that the two parties had already managed to reach some sort of agreement in 1906 subsequent to the failure to enrol support for an acquisition.

True, the problems with mastering network scale and growth was a persistent theme in many of the controversies and efforts. This makes it perhaps inconceivable that nothing would have been achieved, in terms of introducing new switching devices and/or reaching some kind of agreement between the Telegraph Administration and Stockholm Telephone. Yet, this is far from understanding the course of stabilisation depicted above as intrinsically determined in the setting with which I began my account.

Thus, I am not evoking an understanding of the outcomes as being predetermined. The outcomes were negotiated and their stabilisation was characterised by the frail achievements whose reversibility was gradually reduced by further achievements.<sup>14</sup> This is what happened when the stabilisation of the automatic switching system came to be a part of, as well as shaped by, the stabilisation of the monopoly. Yet, there were other scenarios that at times had been just as likely to produce frail achievements subject to further efforts and subsequent stabilisation. With hindsight, the propensity to interpret these specific changes as inevitable and the resulting order as natural is in this view in itself an effect of the stabilisation.

Neither am I evoking an understanding of the outcomes as being determined by a few actors simply having it their way. First, the many failed scenarios and the presence of at times prolonged controversies testify to the absence of omnipotent actors. Second, where heterogeneous engineering has appeared it has still been a question of negotiation and enrolment rather than shaping the world at their will. Third, as discussed above, noticeable heterogeneous engineers as Axel Hultman were themselves heterogeneously engineered. With hindsight, the propensity to interpret these outcomes as determined by a few actors is in this view, in itself an effect of the stabilisation and its attribution of agency.

In the next section I focus on some facets of the resulting transformation of Swedish telecommunications, with the view of further exploring the heterogeneously interrelated character of the new emergent monopoly order.

### **The Interconnected Reconfiguration of Elements**

In the above, the focus was on some controversies and their stabilisation. To attain a somewhat more extensive picture of the resulting transformation, this section focuses on some of the outcomes. Retaining the appreciation of the variable extent of efforts and the negotiated character of outcomes, the focus here is on the transformation of

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<sup>14</sup> This notion of gradual reduction of reversibility is closely related to the idea of stabilisation. It can, furthermore, be seen as a constructivist reformulation of what Paul David have termed path-dependence, see Paul A. David, "Clio and the Economics of QWERTY," *American Economic Review* 75 (1985): 332-337. For the path-dependent argument used in a setting of economic sociology, see Mark Granovetter, "Problems of Explanation in Economic Sociology," in *Networks and Organizations: Structure, Form and Action*, ed. Nitin Nohria and Robert G. Eccles (Boston: Harvard Business School Press, 1992), 25-56, p. 50. On the shaping of the economic organisation of industry a sociological version has been outlined in Mark Granovetter and Patrick McGuire, "The Making of an Industry: Electricity in the United States," in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 147-173, pp. 149-150 and a socio-technical version have been used in Anders Lundgren, *Technological Innovation and Network Evolution* (London: Routledge, 1995), pp. 196-197. The notion of gradual reduction of reversibility used here attempts to capture a sense of stabilisation being neither fully irreversible and to emphasise the permanence of efforts required to sustain stabilisation.

Swedish telecommunications. In particular, the focus is on how the associations between elements within the techno-economic network were transformed as a result of processes of stabilisation such as those discussed in the previous section. This section makes use of the notion of configuration which is to provide a characterisation of an element's role and workings. The configuration of an element depicts how this element is defined, enabled and constrained.<sup>15</sup> The question, then, is to depict the making of the new order through the reconfiguration of certain elements.

**The 'economic organisation': The monopoly and the reorganisation of tariffs**

Consider first the two sets of tariffs, one set for each service, in Stockholm around 1910. Then there were a number of different subscriptions for prospective subscribers to choose from. There were subscriptions with low yearly fees that allowed the subscriber to make only a limited number of local calls free of charge, and there were other subscriptions allowing for an unlimited number of local calls to be made free of charge. A so-called star subscription enabled subscribers with limited subscriptions to call the holder of a star subscription without any reduction in the number of calls free of charge. The star subscription further included a specific indication (a star!) in the telephone directory to entice holders of limited subscriptions to give star subscribers a call.

The number of different subscriptions was further multiplied by the existence of two unconnected networks, since each network enabled different calls to the extent they gathered different subscribers. Indeed, the two networks arranged for different communication communities by way of their different extensions.<sup>16</sup> To a prospective subscriber the choice of service was therefore influenced by how the people and organisations s/he wanted to communicate with were distributed between the two services. This fact was also acknowledged by the two operators in their striving to recruit new subscribers. A striving which also fed and sustained the practice of offering many different subscriptions, each providing a somewhat different configuration of the subscriber. People could indeed choose which specific configuration they were to assume were they to subscribe to a telephone service. Yet, the framework for comparing and choosing among the subscriptions was provided by the operators, the

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<sup>15</sup> This is inspired by Woolgar's notion of configuring the user, Steve Woolgar, "Configuring The User: The case of Usability Trials," in *A Sociology of Monsters: Essays on Power, Technology and Domination*, ed. John Law (London: Routledge, 1991), 57-99, p. 69.

<sup>16</sup> Confer Milton Mueller's discussion on divided communication communities in relation to dual service and in particular his account of what service different groups subscribed to in Louisville, USA. Milton Mueller, *Universal Service: Competition, Interconnection and Monopoly in the Making of the American Telephone System* (Cambridge: MIT Press, 1997), pp. 81-86.

terms of their contracts, and the extent of the network in terms of the communication possibilities.

The different configurations of subscribers were at this time (around 1910) not only inscribed in their subscription contracts and their listing in the telephone directory. They were also inscribed in the records at the exchanges where the calls were conjointly supervised and switched. More interestingly, however, the different subscriptions were associated with the network arrangement of the exchanges, the subscriber's lines, and the trunk lines. Indeed, the very definition of a sub-exchange was that it gathered subscribers holding subscriptions with low fees and limitations on how many local calls the subscriber could make free of charge. The two main exchanges, on the other hand, gathered subscribers with subscriptions that allowed them to make many calls, as well as star subscribers who were to receive many calls.

The tariffs thus constituted a marked association between the configurations of the subscribers and the configuration of the exchanges: The sub-exchanges gathered subscribers configured to make few calls, while the main exchanges gathered subscribers configured to make (and receive) many calls. This can be interpreted as an arrangement to manage the load factor. The load factor represents in the words of Thomas P. Hughes "the ratio of average output to the maximum output during a specified period" and the focus to this factor is in his view a major explanation for the growth of technological systems.<sup>17</sup> However, the situation here does not comply with this interpretation, since growth apparently was not motivated to increase the load factor or any other economising on costs, but rather since growth extended the service. Instead, the matters of costs and growth were much more intimately interrelated with the issues of tariffs and the arrangement of the telephone exchanges.

The association between the subscribers, the tariffs, and the arrangement of the telephone exchanges brings us to the switchboards, the operators, and the engineers. We are brought right into the then acknowledged notion that it was desirable to delimit the number of trunked calls between the exchanges, in itself a translation of the notions of cost and efficiency captured in such metrics as number of calls per operator and answering times. In a sense then, the characteristics of the tariffs were not only interrelated to the subscribers and the operators' competition for recruiting new ones. First, the two operators had agreed to refrain from increasing the tariffs without the consent of the Stockholm City Council in exchange for using the streets for running cable. Second, and of greater significance, the tariffs were also interrelated to the work of arranging the exchanges to master network size and growth. In a sense then, the

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<sup>17</sup> Hughes, "The Evolution of Large Technological Systems," p. 72. The term of load factor is originally from the 19<sup>th</sup> century electrical utility industry.

tariffs constituted an association between the work of attracting and retaining subscribers and the work of arranging the switching of telephone calls. To each operator the tariffs constituted an association between the work of adding new subscribers and the work of managing the problems with switching telephone calls among an increasing number of subscribers, where the latter could translate into increased trunking and hence rising switching costs.

**Remark 13:** The tariffs was interrelated to the configurations of the subscribers, of the exchanges (and their arrangement), and the competitive relation between the two services. The characteristics of each element were negotiated in relation to the others.

The 'economic organisation' as viewed from the vantage point of tariffs thus reveals an interrelated set of heterogeneous elements. Indeed, it reveals parts of the techno-economic network. No wonder then, that the many attempts to resolve the 'telephone issue' had extended in many directions. Growing from the difficulty to establish a new interconnection fee it had been intimately related to the issues of tariffs and the recruitment of new subscribers. As the attempts to resolve the 'telephone issue' continued, the specific issue of interconnection appears to have lost in relevance. Yet, the tariffs and the recruitment of new subscribers continued to be at the fore of the repeated negotiations.

A particularly interesting attempt from the vantage point of tariffs in this respect was the Telegraph Administration's attempt to introduce the tariff reform within Stockholm at the same time as it was to be introduced elsewhere (1915-1916). The tariff reform implied not only higher and uniform tariffs throughout the country. It also implied a new categorisation of the subscribers: The yearly fee of each subscriber was to be specified according to a classification based on an estimate on the number of calls s/he was making. The subscriber would hence basically choose the yearly fee by making calls rather than choosing among different subscriptions. In effect this implied an altered configuration of the subscribers: The framework for choosing a subscription had become limited to the choice of having one or not, while the new tariffs simultaneously enabled the subscribers to 'decide' their yearly fee by regulating how many calls they made.

Anyhow, as regards Stockholm the attempt to introduce the tariff reform failed upon the failure to translate it into an acquisition of the network of Stockholm Telephone. This withheld the tariff reform as it was introduced elsewhere from the Stockholm area. With the Telegraph Administration's network subsequent and increasing difficulties in delivering a satisfactory service, the failed attempt to introduce the tariff reform was presented by Administration officials as one cause for the problems with the service. Indeed, a telephone inspector in Stockholm had presented

the tariff reform as a desirable tax on unnecessary chatter. In other words, it was maintained that the tariff reform would have enforced subscribers to make fewer calls and hence reduced the difficulties with worn plugs, crowded switchboards and so on.

The Telegraph Administration later gradually introduced the tariff reform in the Stockholm area in the wake of the acquisition in 1918. Then, the new configuration of the subscribers inscribed in the new tariffs became contested by some subscribers. Not the least contested were the practices employed within the exchanges of intermittently counting the number of calls to establish the yearly fee. Such complaints even made the Telegraph Administration assign Anders Lignell, the then acting telephone director in Stockholm, to handle such complaints with the assertion that the settlement of such complaints could only become more uniform if they all were handled by the same individual. Indeed, the settlement of this admittedly subjective matter was made more standardised by passing all complaints through one person. This illustrates the point that the creation of the reform's new uniformity was neither effortless nor uncontested.

When automatic switches were introduced, these became associated with the new tariff scheme. This alliance became particularly manifest in the controversy among some Administration officials concerning the possibility of introducing a semi-automatic service for frequent callers in conjunction with the automation of the main exchange. Here, the argument against differentiated tariffs (and hence differentiated service) won. No longer were subscribers to be connected to a particular exchange based upon the number of calls they made. The variation in how many calls different subscribers made was absorbed by each exchange so that, for instance, not too many frequent callers were wired to the same group of first selectors. No longer were subscribers to choose among different subscriptions. Later again, the automatic switches were endowed with call meters rendering it more difficult for subscribers to challenge the basis used for establishing their yearly fee. The new configuration of the subscriber inscribed in the tariffs had literally become further solidified by its inscription into the call meters as well.<sup>18</sup>

Thus by 1930 the reconfigurations of subscribers and exchanges were underway in association with the new tariff scheme. The subscribers had been endowed with a new calculative frame for choosing to have a subscription in the first place and then making calls. On the other hand, they had been deprived the capacity to choose among

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<sup>18</sup> The introduction of this automated quantification arrangement provided credibility to the call metering and hence made the grounds for establishing the yearly fees less contestable. This ties well with the observation that the generation of numbers ought to be perceived as impersonal as possible to gain credibility as being objective. See, Theodore M. Porter, "Information, Power and the View from Nowhere," in *Information Acumen: The Understanding and Use of Knowledge in Modern Business*, ed. Lisa Bud-Frierman (London: Routledge, 1994), 217-230, p. 225.

different subscriptions and their possibility to challenge their yearly fee had furthermore diminished. The exchanges, in their turn, had acquired precisely an enhanced capacity to count the number of calls each subscriber made and thus provided numbers for establishing their yearly fees. Moreover, no longer were subscriber's lines run across the city because a particular subscriber was a heavy caller. The issue of trunking had faded and had in turn been replaced with the issue of balancing the load of traffic put on the different groups of selectors within the automatic switch.

Thus, the reorganisation of the tariffs was far more than the outcome of the elimination of the competing service. In all, the reorganisation of tariffs with its interrelations with a reconfiguration of both the subscribers and the exchanges tells of the emergence of an altered calculative frame of the Telegraph Administration: the acknowledged relationships between revenues, costs and growth were being altered. With the new tariffs the revenues became more closely linked to the number of calls made at the same time as the automatic switches reduced, if not eliminated, the tendency for growth in subscribers and traffic to translate into increased switching costs per call. The full scale of this transformation is beyond what I have been able to account for in this study. However, what it points to is that the reorganisation of tariffs reveals facets of a reconfiguration of the Telegraph Administration: Changes in how it was defined, enabled, and constrained as an economic agent.

**Remark 14:** The new tariffs were interrelated to the configurations of the subscribers, the configuration of each exchange with wiring and call metering capacity, the configuration of the Telegraph Administration as economic agent, and the elimination of the competing service.

In conclusion, then, viewing the techno-economic network from the vantage point of the reorganisation of tariffs reveals an interrelated set of changes. Indeed, it reveals the interconnected reconfiguration of several elements, including the telephone exchanges, as well as the Telegraph Administration and the subscribers as economic agents.

### **The 'technology': The switching from operators to selectors**

Although the above discussion on the tariffs has revealed parts of the reconfiguration of the exchanges, more is disclosed when shifting the vantage point directly to the telephone exchanges.

Even a brief list of matters involved in the switching of telephone calls in Stockholm around 1910 would include a number of heterogeneous elements. First there were the telephone operators who furthermore were classified according to what kind of exchange they were working at. Hence, there were local operators, inter-urban operators, special services operators, etc., a classification which furthermore coincided with their terms of employment to a great extent. The operators were furthermore rated according some measure of proficiency, supervised by supervisors, and worked under

some sort of bonus-system; elements which hence should also be added to the list. Then there are the switchboards with their operator's positions equipped with cords, jacks in multiples, headsets, keys, lamp signals, etc. Switchboards of various designs which furthermore belonged to switches that were classified in a number of dimensions such as whether they were of the LB- or CB-system, or whether they were of the single cord, cord pair, or call-distributing system. And so the list would continue with the buildings housing the switches and operators, the telephone sets, the subscriber's lines, the trunk lines, the subscribers, the telephone directories, and so on.

It may seem banal to point out that these elements were in some way interconnected as far as each of the two networks were concerned. That is what we expect of a telephone network. It would nevertheless be fruitful to ponder on some of these interconnections as they appear in the chain of events that took place when a call was switched. A signalling lamp for a specific subscriber was turned on at an operator's position. A person (the subscriber) had wanted to make a call and had translated the person s/he wanted to call into a telephone number (exchange name + subscriber number) by using the telephone directory. The signalling lamp had been turned on when the calling person had lifted the handset (central battery, no crank) which caused an electric circuit to be made. The lamp received the attention of the operator at the operator's position and she (they were all female) connected to the line and listened for the desired number where speech were translated into electric currents (microphones) and retranslated into speech (loudspeakers) at the other end. It was a local number (within the same exchange) and the operator translated the number into a jack on the multiple. After having performed a busy test and finding the line free, the operator inserted a cord into the jack and produced a signalling current to the recipient's telephone. Upon the handset being lifted, the operator completed the circuit and the two persons made their conversation. When they hung up, the signalling lamp at the switchboard went out and when the operator observed this she disconnected the circuit by removing the cords from the jacks.

Chains of events like these can be varied almost infinitely depending on the kind of call, upon the type of switch, upon the level of detail (above I barely touched upon the wiring within the exchange). What this brief account nevertheless provides is a sense of the rich set of interactions that took place every time a call was made. It further tells something about how elements such as the switchboards, the operators, and the subscribers were configured to allow for these interactions. A first obvious arrangement is the use of telephone numbers. Except in cases where the recipient subscribed to a nominal call service, the prescribed use of telephone numbers was central in the communication between the calling subscriber and the operator(s) switching the call. This prescription put on the conduct of both operators and subscribers was not only

embodied in regulations. They were also embodied in the telephone directory as well as the numbering set next to the jacks at the multiple of the switchboard.

It is further interesting to note in relation to the interactions between subscribers and operators that the issue of them becoming known to one another was raised concerning the properties of the cord pair, single cord, and the call-distributing system. The two former systems provided a more recurrent interaction between a given subscriber and a given operator than did the latter.<sup>19</sup> The possibility for a subscriber and an operator to become known to one another was seen as having both upsides and downsides, and was hence apparently not a matter of indifference.

When it comes to the configuration of the operators the lay-out of the switchboard and the channelling of traffic should be mentioned, as well as the presence of supervisors and bonus-system. All of them participated in enabling and constraining the room of conduct available to the operators. At the same time though, these elements were configured in relation to the operators. The dispute on the switching systems, to take one example, discussed the different systems in relation to the appropriate workload put on the operators. An issue which furthermore was related to whether calls or subscribers were to be distributed among the operators to balance their workload.

The supervision and the bonus-system was furthermore related to the performance of the operators' work which in turn was quantified in metrics such as the number of calls switched per hour and operator, average answering time, and percentage faulty connections. The conduct of subscribers was also exposed to such metrics, including the notion of traffic and busy hour. However, the varying propensity of subscribers to make calls, as discussed above, was principally contained in the configuration of the tariffs, which in turn was interrelated to the arrangement of the exchanges.

Finally, it is perhaps worth noting other interdependencies such as the one between the powering of the switchboard and the subscriber's lines. This issue received attention not the least when SAT/Stockholm Telephone had wanted to refurbish its exchanges to the CB-system. These efforts had become associated with the posture of the City Council on the lack of interconnection and their control over the city streets, since it professedly was important to use cables to ensure the better insulation required by such CB-switches.

**Remark 15:** The configuration of the switchboards was interrelated to the configurations of a range of other elements, including the configurations of the subscribers and the operators. Through the arrangement of the

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<sup>19</sup> In the cord pair and single cord systems the calling subscriber always came to the same operator's position and hence requested the desired number from any of the few operators that occupied that particular position over the shifts. In the call-distributing system, on the other hand, the calling subscriber ended up at any operator's position available at the time.

exchanges, the configuration of switchboards were also related to such things as the configuration of the tariffs and the competitive relation between the two services.

No wonder then, that the many efforts aiming at developing and introducing automatic and semi-automatic switches had extended in many directions. These efforts raised among other things questions about the configuration of the operators and subscribers. In 1913, to take an early instance where such issues were aired, an Administration engineer discussed at some length the various possibilities for disconnecting the call and restoring the selectors. Were one or both of the subscribers to themselves disconnect the circuit and restore the selectors upon terminating a call or should an operator do it? Apparently, the different possibilities of what one or the other was to be authorised to do was an important question long before any of the projects had delivered a test-exchange.

The later efforts to introduce automatic switches is perhaps more telling about the configuration of the subscribers and operators, however. The automatic switch put into operation in 1924 had been equipped for dialled service. The subscribers themselves were hence to dial the number and the numbering of all subscribers in Stockholm had been translated into numbers to this effect without any exchange prefix. This had, in turn, been translated into the printing of two editions of the telephone directory to retain a directory containing numbers with exchange prefix to use for subscribers still connected to a manual exchange.

In this setting, the subscribers were thus reconfigured to operate the switch by using the dial and the cradle. Furthermore, a subscriber connected to the automatic exchange was to dial the number for all local calls regardless as to whether the recipient was connected to an automatic exchange or not. In case the recipient was wired to a manual exchange, an operator received the desired number on a display and made the connection without speaking to the calling subscriber. Conversely, subscribers connected to a manual exchange asked for the number as usual (with exchange prefix and all) even when the recipient was wired to the automatic exchange.

Hence, the subscribers were either configured as 'manual' subscribers or 'automatic' subscribers and their interaction with their exchange regulated accordingly. It was instead telephone directories, operators, and special switchboards who were configured to assume the mediating role between the two kinds of exchanges and indeed to bridge the two practices prescribed for the two groups of subscribers. Apparently, the aim was to render the status of all other exchanges except their own indiscernible to the subscriber. In addition, measurements were taken at the automatic exchange to assess the conduct of the subscribers as well as of the switching devices.

It was such unpublished measurements, as well as subscriber complaints, that made Anders Lignell, the telephone director in Stockholm, argue in 1925 for the use of a semi-automatic switch for the planned exchange at Jeriko. This exchange was to gather the subscribers then connected to the exchange that had previously been the main exchange. This group, Lignell argued, contained many frequent callers and he doubted that these could be enticed to use the dial. The introduction of a semi-automatic service according to him should be coupled with a decrease in the tariff for those connected to the dialled service. In the ensuing debate, the issue of semi-automatic service became linked to calculations on possible tariffs and costs. In the end a lowered tariff for dialled service was ruled out, as was an increased tariff for semi-automatic service. The imperative of tariffs and costs, and in particular the uniformity of the tariffs, had proved stronger than any aversion from frequent callers and the work required to entice or enforce them to assume the configuration of 'automatic' subscribers.

The subscribers were to be educated and furthermore some operators received the role of supervising subscribers connected to the automatic exchange to overlook and occasionally intervene when they used their dial. Despite this stress for uniformity, the subscribers would still differ in when and how many calls they made. To the issue of dimensioning the switching devices and balancing the load between different devices, the issue of traffic metrics and traffic calculations rose to greater primacy. Thus, without further entering into the myriad of dials, motors, relays, and selector arms that now participated in switching calls it is safe to say that the new automatic exchanges were part of a substantial reconfiguration of both subscribers and operators.

**Remark 16:** The new automatic exchanges were interrelated to the configurations of the subscribers, the configuration of tariffs, and the configuration of operators. The configuration of each of the elements was negotiated in relation to the others.

### **Making the new order**

By 1930, the introduction of automatic switches was well underway in Stockholm and had begun in other cities as well. In 1929 a request in Parliament to cancel their further introduction on the grounds that it released operators from their livelihood had been raised, but had failed to gain support. Too much time and resources had already been invested in this modernisation, the successful opposition had declared.

What 15 or 20 years earlier had been 'mere' efforts attempting to establish translations of means and ends, through much work and many controversies had created a monopoly as well as reconfigured the tariffs, the exchanges, the subscribers, and so on. Even the Telegraph Administration had been utterly reconfigured in the process and had furthermore become much more closely associated with the new General

Telephone LM Ericsson than the Administration had earlier been with LM Ericsson. Achievements once frail and reversible had become much less so.

In the previous section I displayed and argued that the automatic switches and the monopoly were the outcomes of interrelated efforts. In this section I expand this picture by looking on how certain elements were reconfigured. This contributes to the picture of the stabilisation of the monopoly and the automatic switches as being part of a reconfiguration of several elements of the techno-economic network. Indeed, it displays the new order in Swedish telecommunications as an interconnected reconfiguration. Thus, not only were the efforts heterogeneous, their outcomes was equally heterogeneous.

**Remark 17:** The interconnected reconfiguration of elements made achievements once frail and reversible less so. The new order was characterised by a new set of negotiated interdependencies.

Yet, the facets of the resulting new order depicted above do not primarily convey the picture of an altered though static techno-economic network. It conveys as much a picture of a new techno-economic pattern of change with the Telegraph Administration monopoly, and the introduction of automatic switches, and the refinement of tariffs as significant elements. A pattern of change which resembles what Donald McKenzie have called an institutionalised pattern of technological change, which implies a relatively stable organisational framework, a channelling of resources to support this framework, and finally a credibility in that the direction of change is possible and appropriate.<sup>20</sup> Indeed, the organisational framework with the Telegraph Administration as well as its collaboration with LM Ericsson appears to have been there, as were the resources stemming from the tariff reform and perhaps from savings when replacing operators with automatic switches, the latter of which professedly had acquired credibility as the appropriate switching technology.

However, any notion of patterned change must still recognise the continued interrelated and iterative negotiations on what arrangements were appropriate as well as which machines were efficient. True, once frail and reversible achievements had become much less so as the new order stabilised. Yet, none of them were irreversible as not the least the more recent transformations of Swedish telecommunications illustrate.

In the epilogue that follows I will conclude this thesis by discussing the retrospective characterisation of this new order as a natural monopoly. First, however, I want to make some concluding remarks on how this study thus far may contribute to

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<sup>20</sup> MacKenzie, *Inventing Accuracy*, pp. 386-388. His notion of an institutionalised pattern of technological change is furthermore affiliated to Thomas P. Hughes' notion of technological momentum, see Hughes, "The Evolution of Large Technological Systems," pp. 76-80.

fields of empirical research aiming to understand the character of order and change in the organisation of economic activity.

### **A Note on Contributions to an Emergent Sociology of Industry**

What I have ventured to explore in this study is how change as well as order in a field of economic activity were negotiated outcomes of contingent and iterative processes. More specifically, I have examined how efforts to alter technology were interrelated to efforts to alter the economic organisation in the making of a discernible new order in a field of economic activity.

This study has primarily drawn on a methodological approach from sociology of science and technology, while its interest in order and change in fields of economic activity has a great affinity with other fields of empirical research. Fields of research which I identified in chapter 3 as belonging to an emergent sociology of industry. There were two primary reasons for why this study was undertaken with such a ‘borrowed’ approach. First, since I found it to provide tools and insight on how to appreciate the positions and roles of technology in social orders. Second, since I found it to provide an attractive stance that allowed for an empirical inquiry into how statements, machines, and arrangements were made, while refraining from judging their characteristics as true, efficient, or appropriate as the cause for the stabilisation. I found this attractive not the least for enabling an inquiry into notions of the natural and inevitable that sometimes appear in discussions about order and change in fields of economic activity.

Yet, there is a reverse to the medal of this methodological stance. This drawback becomes readily apparent when an inquiry such as this one is confronted by demands for tangible theoretical contributions to research focused on order and change in fields of economic activity. The noted anti-essentialist stance of the actor-network approach<sup>21</sup>, renders it difficult to deduce general theoretical findings about order and change in fields of economic activity. Indeed, taken to its end, an anti-essentialist stance refutes generalisations on such a level and perhaps even the possibility of distinctly delineating such a phenomenon as order and change in fields of economic activity.

I want, nevertheless, to emphasise the relevance of such a phenomenon as an object for research, and the necessity of sustained empirical research into this phenomenon. It is a pertinent research topic if only because of the pertinent influence the order and change in industrial sectors exert on overall society. Thus, and despite the difficulty of the methodology mentioned, I want to endeavour to suggest three points

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<sup>21</sup> On the anti-essentialist stance of actor-network approach, see Bruno Latour, “On recalling ANT,” in *Actor Network Theory and After*, ed. John Law and John Hassard (Oxford: Blackwell, 1999), 15-25, pp. 19-22.

where this inquiry contributes to research within what I have called the emerging sociology of industry.

The first point concerns the interrelations between technology and economic organisation within a field of economic activity, and indeed the interrelations between technological change and changes in economic organisation. Research focusing on order and transformations in the economic organisation of industrial sectors sometimes employs the notion that some technological changes are subservient to as well as sustaining the prevailing order whereas others press for change by destabilising it. Sometimes this dual character of technological change is depicted in a dichotomy, such as the one of extraordinary and normal innovation.<sup>22</sup>

In my view such dichotomies rather obscure how efforts to develop technology may be a part of economic organising. A notion that innovations have an inherent property that may or may not be subservient to the prevailing order excludes most issues of how technology and technological change are related to the economic organisation in different industries and industrial sectors. This study's exploration into what ways efforts to alter technology were interrelated to efforts to alter the economic organisation is in this respect suggestive. With this focus on interrelations in between, this study has provided several remarks that weaken arguments for treating technological change as a phenomenon that is inherently apart from the economic organisation.

The sequence of the creation of the monopoly and the subsequent stabilisation of the automatic switching system is particularly telling. What this study has shown is that this sequence was hardly predetermined, but rather an outcome of a sequence of negotiations where the creation of the monopoly involved the suspension of certain issues (Remark 5 and Remark 7). Furthermore, the way the automatic switching system came to be a part of, as well as shaped by, the stabilisation of the monopoly was hardly due to any inherent properties of the technology. Indeed, the inquiry into the progression of the different development projects exposed intricate and changing interrelations between their 'contents' and 'contexts' (Remark 4, Remark 10, and Remark 11). Finally on the issue of technology and economic organisation, the depiction of how the reorganisation of tariffs became interrelated with the configuration of such things as the automatic exchanges, the subscribers and the Telegraph Administration is telling (Remark 13 and Remark 14). Such an analysis of the (techno-) economic organisation of an industry indeed suggests that there are good reasons for

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<sup>22</sup> See, for instance, John L. Campbell and Leon N. Lindberg, "The Evolution of Governance Regimes," in *Governance of the American Economy*, ed. John L. Campbell, J. Rogers

not treating technology, no less technological change, as phenomena inherently apart from the 'rest' of the economic organisation of an industry.

The second point concerns the relations between order and change in fields of economic activity. One major theme in research on industrial networks is that stability and change are not opposites, but rather complementary in the sense that change in one dimension necessitates stability in others or that change in one dimension may preserve stability in others.<sup>23</sup>

From the vantage point of its more pronounced focus on the dynamics of efforts to achieve change, this study contributes to this notion. The depiction of the automatic switching system and the monopoly as negotiated and interrelated outcomes provides several instances which conform with the view that stability and change are complementary. The apparent difficulty to achieve change in face of a disintegrating techno-economic network and the consequent inclusive framing is one such instance which could be interpreted as a situation where change was difficult to achieve precisely because of the instability of the situation (Remark 5). However, what the depiction of the dynamics of controversies further displays is how an element could appear as a stable black box in the controversy concerning one issue while at the same time appear as an array of contested elements in another (Remark 2). What this points to is how an attempt to realise what I have called a scenario in fact can be seen as an attempt to stabilise or exclude certain elements to the end of mobilising change (Remark 7). In short, negotiated change presupposes the negotiated stabilisation of the elements necessary to achieve change.

The third point is methodological and specifically the focus on following controversies before their settlement while employing a principle of symmetry. This stance, with its origin in sociology of science and technology, has in fact proved useful also when discussing issues of economic organisation. The recommendation to analytically discriminate between the stabilised outcome and the making of this outcome allows for avoiding retrospective determinism or indeed for avoiding a confusion outcome with causality.<sup>24</sup> What the principle of symmetry stresses is the necessity to investigate how outcomes are negotiated and indeed how the attributions of

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Hollingsworth, and Leon N. Lindberg, *Structural Analysis in the Social Sciences 5* (Cambridge: Cambridge University Press, 1991), 319-355, 336-340.

<sup>23</sup> See, for instance, Håkansson, "Introduction," p. 18; Anders Lundgren, "Coordination and Mobilisation Processes in Industrial Networks," in *Industrial Networks: A New View of Reality*, ed. Björn Axelsson and Geoffrey Easton (London: Routledge, 1992), 144-165, p. 162; Lars-Gunnar Mattsson, "Firms, 'Megaorganizations' and Markets: A Network View," *Journal of Institutional and Theoretical Economics* 151 (1995): 760-766, p. 761.

<sup>24</sup> For a critique of research on governance transformations that assumes outcomes as efficient, see Campbell and Lindberg, "The Evolution of Governance Regimes," p. 320.

the outcome being true, appropriate or efficient is itself a part of the outcome. Since I take research within what I have labelled sociology of industry to share a commitment to empirically investigate order and change, rather than to deduce regularities from outcomes alone, a methodological position employing the principle of symmetry is essential to such research.

For instance, without such a stance, the resulting monopoly could easily have been interpreted as having been inherently the best solution among the ones available and, moreover, that it was exactly for that reason it emerged. With the methodological stance employed here and the empirical work it warranted, such a retrospective determinist interpretation confusing the outcome with causality has been avoided (Remark 3, Remark 8, and Remark 9). Similarly, without such a stance the automatic switching system that emerged could easily have been interpreted as a case where the most efficient technology was selected in face of given predetermined conditions. What this study has offered instead is a much more intricate story about the development and introduction of a technology (see Remark 4, Remark 10, Remark 11, Remark 12, and Remark 16).

In relation to this last point, a final contribution of this study to research within what I have called the emerging sociology of industry is related to its pronounced ambition to inquire into the making of a natural order and inevitable change. Some instances where the inevitable has been referred to have indeed been depicted. However, it has not been possible to inquire into the making of the natural monopoly in Swedish telecommunications in direct proximity to the creation of the actual monopoly simply because the notion was not present at the time of the making of the monopoly. Therefore, I have had to leave this part of the inquiry to the ensuing epilogue where some consequences of the retrospective characterisation of a natural monopoly are discussed. In concluding the study, this discussion displays some ways in which concepts from economics participate in shaping fields of economic activity and thus presents us with a final contribution to a sociology of industry by providing for further discussions on how this highly relevant issue may be subject to further empirical research.



## VIII

# Epilogue: The Making of the Natural and Inevitable

What I shall have to say here is neither difficult nor contentious; the only merit I should like to claim for it is that of being true, at least in parts.

John Langshaw Austin, 1962.<sup>1</sup>

### **What About the Concept of Natural Monopoly?**

This study is drawing to a close. It set out by inquiring into the making of a natural order, my interest aroused by an affirmation in fairly recent Swedish official reports that the former monopoly in Swedish telecommunications was a natural monopoly. The subsequent narrative, and the ensuing discussion in the previous chapter, have centred on what went into the making of this alleged natural monopoly and in particular how technological change was interrelated to changes in the economic organisation in this process. In this, I have exposed the inconclusive character of order and change during the making of the monopoly. What I arrived at was a depiction of the emergent order as a reconfigured techno-economic network characterised by a fairly stabilised pattern of change. In isolation, this depiction may be interpreted as conforming with the notion that the former monopoly had indeed been a natural one. The presumable economies from introducing automatic switching, for instance, would appear to fit nicely in depicting the order as constituting a natural monopoly due to economies of scale, rendering competition unsustainable.

Yet my version of the emergence of this order differs in important respects from the one offered by the notion of it having been a natural monopoly. For instance, I have exposed in my narrative that the changes, while in the making, were hardly as inevitable

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<sup>1</sup> John Langshaw Austin, *How to do things with words* (London: Oxford University Press, 1962), p. 1.

or the resulting order hardly as natural as the concept of natural monopoly implies.<sup>2</sup> I have also specifically depicted that issues of technological change (including matters relating to economies of scale) could hardly be considered as independent from issues of changing the economic organisation. Thus my narrative shows that changes in the cost characteristics of the telephone system were not as autonomous from the prevailing economic organisation as a notion of natural monopoly implies.

Another intriguing aspect of the current characterisation of this former monopoly as a natural monopoly is the fact that while the monopoly was made, the concept of natural monopoly was evidently absent. The concept was known at the time, as I briefly outline in chapter 4. It had emerged in the US at the turn of the century and the concept had been used, albeit sparingly, by contemporary Swedish economists. Yet, what the narrative of the subsequent chapters clearly conveys is that the concept had no role in the creation of the Telegraph Administration's monopoly in telephone services. Indeed, when my narrative terminates in the early 1930s the notion that telephony was a natural monopoly had not yet occurred in Sweden.

This points to the fact that the ultimate occurrence of the notion of a natural order in Swedish telecommunications is of later date than the economic organisation it is said to describe. The question then remains as to how the natural monopoly in Swedish telecommunications was made and, in particular, how it has become known in retrospect that this was an inevitable natural monopoly. The aim of this epilogue is to deal with this question and the additional issues it raises.

I want to stress that the objective of this epilogue is not to invalidate either the concept of natural monopoly or the characterisation of the recent Swedish telecommunications monopoly as a natural one. Instead, what I want to do is to contribute to the understanding of the foundation of this characterisation, to explore some of the contrasts that arise when juxtaposing it with the account in the previous chapters of the emergence and configuration of the monopoly, and finally, to discuss some of the consequences of retrospectively characterising the recent monopoly as a natural one. All this with a view to contributing to our understanding of the making of inevitable changes and natural orders in fields of economic activity. An endeavour that

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<sup>2</sup> This has previously made me criticise the natural monopoly characterisation of the former monopoly in Swedish telecommunications, especially since interconnection in the recent deregulation (again) has become an important and controversial issue, see Claes-Fredrik Helgesson, "På jakt efter en naturlig ordning: Ansträngningar för att organisera telefonsystemet i Stockholm 1891-1918," in *Den konstruerade världen: Tekniska system i historiskt perspektiv*, ed. Pär Blomkvist and Arne Kaijser (Stockholm: Symposium, 1998), 231-257. Now, however, I find it more productive to accept the retrospective natural monopoly characterisation while simultaneously investigating the basis for this characterisation as well as its consequences. This makes me now argue that the notion that the monopoly was predetermined is an effect of the natural monopoly characterisation, rather than a basis for the characterisation.

in this case evidently includes economics, or at least, concepts stemming from economic theory.

The next section ventures to follow the concept of natural monopoly further and once again takes a look at the US to see what happened with the concept after 1910. This is primarily because the concept's further history, and in particular its prolonged association with US telephony, holds important keys to the foundation of the retrospective natural monopoly characterisation of Swedish telecommunications. Secondly, it provides means for discussing the consequences of this retrospective characterisation.

The subsequent section then returns to the recent Swedish official reports and their use of the concept of natural monopoly. Here I relate their retrospective characterisation both to the prolonged use of the concept in the US to characterise telecommunications as well as to my own narrative of previous chapters. This section ends by acknowledging instances where the Swedish official reports more directly relate to specific discussions within economics on issues of natural monopoly. This, in turn, provides the opening for the subsequent section that explores some of the more recent developments within economics related to the concept of natural monopoly. This exploration, into some wider debates within (predominantly US) economics depicts several interdependent efforts of revisionism, which include efforts to either invalidate the use of the concept in the context of US telecommunications or even the concept itself.

These efforts of revisionism provide an augmented position for discussing the consequences of retrospectively characterising the former monopoly as a natural one, which is the topic of the final section. This time, the discussion focuses on the retrospective characterisation in its context of the minimal story of change, which has it that the former natural monopoly of Swedish telecommunications has been unmade by technological change. This, in fact, exposes the making of the inevitability of the more recent changes in Swedish telecommunications. More precisely, the argument is that the retrospective natural monopoly characterisation of Swedish telecommunications as a consequence has made the recent so-called deregulation appear as an inescapable response to technological change.

### **The (US) History of the Notion of Natural Monopoly and Telephony**

The concept of natural monopoly had been used to a limited extent by Swedish economists before 1910. Moreover, it appears to have been of less continued importance to subsequent generations of Swedish economists than it has been to their contemporary US colleagues. Although it is difficult to truly substantiate the lesser importance historically attached to the concept in Sweden, a look at articles in leading

economic journals provides one indication.<sup>3</sup> Moreover, such a lesser importance would appear reasonable given the different and less prohibitive legislative stance taken in Sweden towards concentrated industries and monopolies.<sup>4</sup> To Swedish economists

<sup>3</sup> One crude measure of the notion's historically minor importance in Swedish economics can be obtained by looking for its presence in titles of articles in the Swedish journal *Ekonomisk Tidskrift* (Economic Journal) and its predecessors. I have found no article containing 'natural monopoly/monopolies' (or its Swedish equivalent 'naturligt/naturliga monopol') in the title of signed articles of *Ekonomisk Tidskrift* throughout its time of publication, vol. 1 (1899) – vol. 66 (1964). Nor have I found it in the title of any signed article of its predecessors the *Swedish Journal of Economics*, vol. 67 (1965) – vol. 77 (1975) and the *Scandinavian Journal of Economics*, vol. 78 (1976) – vol. 100 (1998, still in publication). The same absence is conspicuous when searching the titles in the electronic database Periodicals Citation Index (PCI) that contains an index of the above journals. The Swedish journal *Ekonomisk Debatt* began publication in 1973 to complement the predecessors to *Ekonomisk Tidskrift* by being in Swedish and focusing on economic analysis of topical issues, that is, to be more like the earlier volumes of *Ekonomisk Tidskrift*. Searching an index of *Ekonomisk Debatt* covering vol. 1 (1973) – vol. 20 (1992) provides one signed article containing 'naturligt/a monopol' in its title: Stefan Lundgren, "Behövs offentlig kontroll av naturliga monopol?," *Ekonomisk Debatt* 18 (1990): 546-555.

As a comparison PCI gives two citations when searching for 'natural monopoly/ies' in the title of articles in *American Economic Review* (AER) from vol. 1 (1911) – vol. 79 (1989). PCI does, however, omit one article in AER from 1977 that I have found in my research on the concept (this missing article is indexed in PCI, although with another title than my copy). In all I have thus found citations of three articles for the period 1911 – 1989 in AER containing 'natural monopoly/ies' in the title. The citations obtained are: Dean A. Worcester, Jr., "Justifiable Price Discrimination under Conditions of Natural Monopoly: A Diagrammatic Representation," *American Economic Review* 38 (1948): 382ff; William J. Baumol, "On the Proper Cost Tests for Natural Monopoly in a Multiproduct Industry," *American Economic Review* 67 (1977): 43-57; William J. Baumol, Elizabeth E. Bailey, and Robert D. Willig, "Weak Invisible Hand Theorems on the Sustainability of Multiproduct Natural Monopoly," *American Economic Review* 67 (1977): 350-365.

Searching PCI in the older American journal *Quarterly Journal of Economics* provides two citations of articles containing 'natural monopoly/ies' in their titles when searching volume 1 (1886) through volume 105 (1990). One was published in 1892 and the other in 1930: John R. Commons, "Protection and Natural Monopolies," *Quarterly Journal of Economics* 6 (1892): 479ff; and Bruce W. Knight, "Control of Investment 'versus' Control of Return in the Regulation of Natural Monopolies," *Quarterly Journal of Economics* 44 (1930): 263ff. Given the early article by Commons (incidentally a student of Ely), it might be added that PCI contains citations for numerous journals from 1770 onwards and that the earliest citation provided containing 'natural monopoly/ies' in its title is an article by Richard T. Ely from 1889: Richard T. Ely, "Natural Monopolies and Local Taxation," *Lend a Hand* 4, no. 3 (1889): 178ff.

Sources: *Ekonomisk Tidskrift*, *Ekonomisk tidskrift, register 1899-1949* (Stockholm: Almqvist & Wiksell, 1949); table of contents of *Ekonomisk Tidskrift*, the *Swedish Journal of Economics* and the *Scandinavian Journal of Economics*; *Nationalekonomiska Föreningen, Ekonomisk debatt, 1973-1992* (Stockholm: Nationalekonomiska Föreningen, 1993), pp. 30-49; and Periodicals Contents Index (PCI), <http://pci.chadwyck.com>, (Cambridge, UK: Chadwyck-Healey, accessed 1999).

<sup>4</sup> Neither the Swedish competition law from 1925 nor the legislation in 1953, 1956 and 1966 prohibited monopolies in the same way as did the US anti-trust legislation. The focus in Sweden appears to consistently have been on limiting the effects of concentrated industries, not to prohibit them in conjunction with treating specific industries as exceptions from such general prohibitions. This makes notions such as that of natural monopoly less valuable since it has been of less value in Sweden to clearly specify exceptions given the less prohibitive stance towards industry concentration. For a comparison of Swedish and US law on matters of monopolies and competition, see Ulf Bernitz, *Marknadsrätt: En komparativ studie av marknadslagsstiftningens utveckling och huvudlinjer* (Stockholm: Jurist- och samhällsvetareförbundets Förlags AB, 1969), pp. 252-275, 411-428.

issues other than the issues of competition, monopoly and structural determinants of market structure appear to have dominated.<sup>5</sup>

In the US, however, the concept of natural monopoly continued to evolve and transform after its early conceptions and it continued to be linked to the provision of telephone services.<sup>6</sup> In fact, the two have repeatedly appeared together in economics textbooks where telephony has been advanced as a typical example of a natural monopoly. Furthermore, they have appeared together in research aimed at developing the theory of natural monopoly, and they have appeared together in research and policy discussions concerning the proper organisation and regulation of the provision of telephone services. This section highlights some of these appearances. The aim is to give some idea of the concept's evolution and manifold relations forged between this concept and telephony.

### **The early days: The 'inherent properties' definition**

In the US, the concept of natural monopoly had found its main contours by 1910, as was reported in chapter 4. In the beginning it had been a prescriptive concept, prescribing when it was inappropriate to foster competition. However, the notion of natural monopoly had soon acquired an explanatory property as well, where certain sources of monopoly power explained (and justified) the existence of such natural monopolies. The concept had also been applied early on to the telephone service industry, where Ely in 1900 had affirmed that telephony, despite its lack of economies of scale, was a case of natural monopoly since the advantages of monopoly would continue with increasing size because of the importance of unity in the service.<sup>7</sup>

Around 1900, when Richard T. Ely had first formulated the concept and applied it to telephony, the Bell System was far from being the single dominant operator in the US. A fact that provides meaning to his then uttered prescription that a consolidation ultimately must prevail in telephony. In 1923, at a time when the Bell System had become more dominant, Ely returned to telephony in the co-authored fourth edition of his textbook *Outlines of Economics*. In a discussion on public industries, telephony (together with such industries as railroads and lighting companies) was indicated as a

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<sup>5</sup> A Swedish textbook in Industrial Economics from 1990 noted that the subject of Industrial Organization has had a less prominent place in Sweden than in other countries. This, it was suggested, could perhaps be explained by the prominence of macroeconomics or that competition law has been deemed of less importance. Arne M. Anderson, Per-Olof Bjuggren, and Olle Ohlsson, *Industriell ekonomi* (Stockholm: SNS, 1990), p. 7.

The field of Industrial Organization is, as I maintain below, a sub-field of economics within which the concept of natural monopoly has had a given place for a long time.

<sup>6</sup> For a number of stories about the concept's evolution, see Chapter IV note 192 on page 114.

<sup>7</sup> Richard T. Ely, *Monopolies and Trusts* (New York: Macmillan, 1900), pp. 64-65.

natural monopoly enterprise that the State undertook “not for suppression, not for profit, but primarily for regulation...to prevent monopolistic extortion and corporate abuse.”<sup>8</sup> In the case of telephony, again it was gains from unity rather than economies of scale that was the inherent property both explaining and justifying the emergent monopoly in telephony. The specific properties giving rise to natural monopolies differed among businesses but in Ely’s view they all shared the general feature that they were predetermined to become precisely monopolies:

*Natural Monopolies.* – These depend for their existence on natural forces as distinguished from social arrangements. They grow up independently of man’s will and desire and sometimes even in direct opposition to it.<sup>9</sup>

At the same time, Ely’s emphasis on unity as the central inherent property in telephony was also emphasised by another economist, John Maurice Clark (1884-1963). While not using the concept of natural monopoly, Clark noted that it was not cost, but service which was the decisive element in favour of consolidation in telephony. On the issue of costs Clark specifically noted, however, that the introduction of automatic exchanges was an “interesting innovation, involving an enormous investment, a corresponding reduction of direct operating expense, and in investment in machines-to-make machines which looks a generation ahead.”<sup>10</sup>

### **The field of Industrial Organization: The ‘economies of scale’ definition**

In the decades that followed, the concept of natural monopoly was gradually purified in more formalised micro-economic terms, and incorporated into the emerging sub-field of economics known as Industrial Organisation. The field of Industrial Organization, as in any field of research, was established gradually and Adams, Ely and J.M. Clark are generally considered as being among the field’s forerunners. Industrial Organization was formally accepted by the American Economic Association as a subdivision of economics in 1941<sup>11</sup>, but its emergence can be traced back to a period of “ferment rethinking and rhetoric during the 1930s.”<sup>12</sup>

Many economists were involved in this formative period of the field, but the economist and Harvard professor Edward S. Mason (1899-1992) should be especially

<sup>8</sup> Richard T. Ely et al., *Outlines of Economics*, 4th ed. (New York: Macmillan, 1923), p. 650.

<sup>9</sup> Emphasis in original. *Ibid.*, p. 187.

<sup>10</sup> John Maurice Clark, *Studies in the Economics of Overhead Costs* (Chicago: University of Chicago Press, 1923), p. 322.

<sup>11</sup> Almarin Phillips and Rodney E. Stevenson, “The Historical Development of Industrial Organization,” *History of Political Economy* 6 (1974): 324-342, p. 324.

<sup>12</sup> William G. Shepherd, *The Economics of Industrial Organization* (Englewood-Cliffs: Prentice-Hall, 1979), p. 19.

singled out. At the meetings of the American Economic Association in 1938 Mason advocated a new approach which linked classifications of market structures to performance.<sup>13</sup> This approach meant a shift in focus from the firms to the industry and constituted also the beginning of what later has been referred to as the *Structure-Conduct-Performance* (or SCP) Paradigm.<sup>14</sup> Mason suggested that the elements constituting an industry's market structure (such as the relative size of sellers) should be treated as causes determining price policies and performance of the industry. To separate cause and effect, in Mason's view the industry's performance could not be allowed to affect the elements of the industry's market structure. Similarly, he did not want to treat market structure as completely exogenous and therefore affirmed that it was explained in turn by technological factors.<sup>15</sup> The one-line causality between market structure and performance was in other words maintained through technological determinism.<sup>16</sup> This stance of explaining structure had clear affinities with the notion of natural monopoly and its implied stance of explaining (and justifying) certain monopolies by reference to their inherent properties.

With the works of Mason, his contemporaries, and followers, and related to the emerging production of census data, industry emerged as an object of knowledge.<sup>17</sup> The SCP Paradigm was gradually refined. New statistical studies were performed and new factors were added to the conceptualisation of the industry as an object of knowledge.

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<sup>13</sup> The section on Mason is based on Phillips and Stevenson, p. 335-340.

<sup>14</sup> The 'Structure-Conduct-Performance Paradigm' is the label used by Phillips and Stevenson (p. 337). This label, or its abbreviated equivalent, also appears in some of the works in the field of Industrial Organization. For instance, Frederic M. Scherer talks about the "basic conditions-market structure-conduct-performance paradigm in the introduction to his textbook." Frederic M. Scherer, *Industrial Market Structure and Economic Performance*, 2nd ed. (Boston: Houghton Mifflin, 1980), p. 5. Here the capitalised abbreviated label SCP Paradigm is used to indicate the status of the label as a label sometimes used within and about the field of Industrial Organization. The notion of paradigm as used in these texts may very well entail an implicit reference to the notion of research paradigms developed by Kuhn (see, for instance, Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. (Chicago: University of Chicago Press, 1970)).

<sup>15</sup> In his own words: "The problem, as I see it, is to reduce the voluminous data concerning industrial organization to some sort of order through a classification of market structures. Differences in market structures are ultimately explained in terms of technological factors. The economic problem, however, is to explain, through an examination of the structure of markets and the organization of firms, differences in competitive practices including price, production, and investment policies." Edward S. Mason, "Price and Production Policies of Large Scale Enterprises," *American Economic Review* 29 (1939): 61-74, p. 66.

<sup>16</sup> Phillips and Stevenson, p. 339.

<sup>17</sup> William Shepherd noted that the shift in focus from individual firms to industry conditions and concentration was related to the availability of new census statistics on industries. He specifically mentions that the first concentration ratios for industries in the US were published in 1939 and that "data on prices, costs, output and other industry features also began to be issued". William G. Shepherd, *The Economics of Industrial Organization* (Englewood-Cliffs: Prentice-Hall, 1979), p. 19.

The field also got a foothold, influencing public policy in matters related to the structure, conduct and performance of industries.<sup>18</sup> Hence, the SCP Paradigm acquired a prescriptive stance in addition to its focus on explaining inter-industry differences in competitive practices and performance.

The concept of natural monopoly fitted well into the emerging SCP Paradigm. Both economies of scale or the broader conception of inherent properties fitted nicely into the notion of technological factors determining market structure. Joe S. Bain (1912-1991), a student of Mason's and a well known scholar within the early period of the field of Industrial Organization, in his *Price Theory* from 1952 wrote the following on economies of scale and natural monopoly:

In certain industries economies of increasing scale are realized for expansion of the firm up to such a point that the whole market would be fully supplied by a single firm before it had reached its lowest-cost or optimum size. Such an industry may be called a "natural monopoly," and the firm in question may never grow big enough to encounter the ultimate upturn in its long-run average cost curve.<sup>19</sup>

It should be noted, however, that Bain both in this and other works discussed the issue of natural monopoly not only from the point of economies of scale. There are instances where he specifically discussed natural monopoly in relation to telephony, and where he presented in addition to economies of scale an 'inherent properties'-explanation more in line with the one previously presented by Richard T. Ely. In Bain's *Industrial Organization* from 1959, for instance, telephony appeared when he discussed public utilities and the rationale for regulation:

Telephone communications. With respect both to local markets and to the nationwide long-distance market, the finding again is one of natural monopoly based on scale economies, and also on the inconvenience to consumers of parallel competing systems. The solution again has been monopoly franchises plus the regulation of monopolists' rates and service.<sup>20</sup>

Here economies of scale was identified as the primary property constituting the natural monopoly within telephony, with united service only appearing as an auxiliary property. Bain wrote this at a time when the Bell system had come to totally dominate US telephony, a fact that is reflected in his mixture of present and past tense. A present

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<sup>18</sup> Shepherd has noted that Henry C. Adams and Richard T. Ely already influenced the content of early regulations and that there had been repeated influence on policies towards market power from research since then. William G. Shepherd, "On the Core Concepts of Industrial Economics," in *Mainstreams in Industrial Organization – Book I: Theory and International Aspects*, ed. Henk W. de Jong and William G. Shepherd (Dordrecht: Kluwer Academic Publishers, 1986), 23-67, p. 54.

<sup>19</sup> Joe S. Bain, *Price Theory* (New York: Henry Holt & Co., 1952), pp. 113-114.

<sup>20</sup> Joe S. Bain, *Industrial Organization* (New York: John Wiley & Sons, 1959), pp. 591-592.

tense ('telephone communications *is* a natural monopoly') was used by Bain to explain and justify a past set of events ('that is why it *has been* regulated').<sup>21</sup> The present tense hence identifies something like a timeless essence that both justifies the prevailing order as well as explains its past creation. In fact, for a long time what Bain expressed was a set phrase when it came to the concept of natural monopoly and industries such as telephone and telecommunications services provision that were organised as monopolies.<sup>22</sup>

Later the practice of including various inherent properties in defining what constituted a natural monopoly gradually ceased, and natural monopoly became in effect defined as a matter of cost characteristics. In the 1980 edition of the Industrial Organization textbook by Frederic M. Scherer (1932-) natural monopoly was accordingly defined as when "economies of scale are so persistent that a single firm can serve the market at lower unit cost than two or more firms."<sup>23</sup> He further labelled the existence of natural monopoly "as the most traditional economic case for regulation," and further down the same page identified local telephone service together with electric power and gas distribution and certain railroads as reasonably clear examples of natural monopolies and thus traditional cases for regulation.

### **The subadditivity definition and the research efforts at Bell Labs**

This refined definition of the concept of natural monopoly as denoting industries with particularly persistent economies of scale has been gradually replaced since the 1960s by another definition, however.<sup>24</sup> This newer definition also covered the multi-product firm and was founded on a somewhat complicated argument where an industry is a natural monopoly if the cost function is strictly subadditive over the range of relevant outputs.<sup>25</sup> In effect, what it does is to define natural monopoly as a state where one firm can produce the whole output at less cost than two or more firms can. Thus, instead of

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<sup>21</sup> On the authoritative gnomic present as a style to attempt authority in economic writing, see D. N. McCloskey, *If You're So Smart: The Narrative of Economic Expertise* (Chicago: University of Chicago Press, 1990), pp. 61-62.

<sup>22</sup> For another variation of this set phrase, see the quote from Lennart Waara et. al. reproduced in the beginning of chapter 2 of this book.

<sup>23</sup> Scherer, *Industrial Market Structure and Economic Performance*, p. 482.

<sup>24</sup> The departure from the economies of scale definition can be traced back to the 1960s in the work of James C. Bonbright, where he argued that it was unwarranted to assume that a natural monopoly had to be founded on economies of scale. James C. Bonbright, *Principles of Public Utility Rates* (New York: Columbia University Press, 1961), pp. 14-15.

<sup>25</sup> A formal definition of cost subadditivity: "A cost function  $C(y)$  is strictly subadditive at  $y$  if for any and all output vectors  $y^1, y^2, \dots, y^k, y^i \neq y, i = 1, \dots, k$ , such that  $\sum y^i = y$ , it is the case that  $C(y) < \sum C(y^i)$ ." John C. Panzar, "Technological Determinants of Firm and Industry Structure," in *Handbook of Industrial Organization*, vol. 1, ed. Richard Schmalensee and Robert D. Willig (Amsterdam: North-Holland, 1989), 3-59, p. 23. For a formal treatment on natural monopoly and cost subadditivity, see *ibid.*, pp. 24-33.

focusing on decreasing marginal costs as output rises (economies of scale), this definition compares the costs of producing all output within one firm with the costs that would arise if the same total output were to be divided between several firms.

The major work in establishing this definition was done by William J. Baumol (1922-) and colleagues in the 1970s.<sup>26</sup> This work was largely done within the Bell System by a formal economics research group established in the Bell Laboratories in the 1960s.<sup>27</sup> According to an official history of the Bell System, this research group had been established “to cope with rapidly growing technical innovation and with its relations to legal and political questions of regulation, competition, and monopoly that confronted the Bell System in the 1960s.”<sup>28</sup> Their work on the subadditivity definition of natural monopoly cases and appended notions was disseminated in books and journal articles (including articles in the distinguished journal *American Economic Review* and in the ‘in-house’ journal *Bell Journal of Economics*).<sup>29</sup> Furthermore, according to the Bell System official history the work of Bell Lab’s economists in creating a ‘modern’ theory of natural monopoly was summarised in *The Theory of Natural Monopoly* by William W. Sharkey from 1982.<sup>30</sup>

The subadditivity definition has also made inroads in textbooks, replacing the economies of scale definition. In the 1998 edition of a (US) microeconomics textbook, to take one example, the presented general definition of a natural monopoly is

<sup>26</sup> See, for instance, Baumol, “On the Proper Cost Tests for Natural Monopoly in a Multiproduct Industry,” cited in William W. Sharkey, *The Theory of Natural Monopoly* (Cambridge: Cambridge University Press, 1982), p. 3.

<sup>27</sup> The official history of this research group claims in fact that it was chiefly this group that produced in the early 1970s a formal theory of natural monopoly: “While the term natural monopoly had been known and used by economists for a long time, a formal theory of natural monopoly was largely the work of Bell Laboratories economists in the early 1970s.” Edward E. Zajac, “Economics Research in the Communications Industry,” in *A History of Engineering and Science in the Bell System: Communications Sciences (1825-1980)*, ed. S. Millman (New York: AT&T Bell Laboratories, 1984), 473-486, p. 478.

<sup>28</sup> *Ibid.*, pp. 474-475. Industrial Organization economist William G. Shepherd has more critically remarked on this phenomena of economics research sponsored by firms facing an anti-trust action. He noted specifically that the Bell Systems defence team of economists for anti-trust cases after 1974 was said to include 27 professors from five leading departments. Shepherd contended that such corporate sponsored research could create a bias as well as “create or reinforce an interest in ideas which suit the sponsors.” Shepherd, “On the Core Concepts of Industrial Economics,” pp. 55-56.

<sup>29</sup> See, for instance, Baumol et. al., “Weak Invisible Hand Theorems,” and William W. Sharkey, “Suggestions for a Game-Theoretic Approach to Public Utility Pricing and Cost Allocation,” *Bell Journal of Economics* 13, no. Spring (1982): 57-68. Both cited in Zajac, “Economics Research,” p. 479.

<sup>30</sup> Zajac, “Economics Research,” p. 479. Sharkey’s position as an employee at the Bell Laboratories is readily stated in the preface of *The Theory of Natural Monopoly* and several Bell Lab colleagues are acknowledged in the preface as having contributed to his study. The Bell Laboratories is furthermore indicated as holding the copyright to the book. Sharkey, *The Theory of Natural Monopoly*, p. iv, vii-viii.

consistent with the 'modern' subadditivity definition. This particular textbook is further interesting since it sustains the longstanding tradition of linking the concept to telephony: The local telephone company 'Ding-a-Ling Lines' is literally used as the textbook example of a natural monopoly and serves as the basis for the textbook discussion on the design of regulations of natural monopolies.<sup>31</sup>

### **The recurrent transformations of knowledge about economic organisation**

When exploring parts of the vast intellectual history of the concept of natural monopoly, one undoubtedly enters into the domain of knowledge about economic organisation and the recurrent reformulation of such knowledge. Furthermore, this exploration of the intellectual history of the concept gives repeated encounters with US telephony, encounters which encompass more than just instances where US telephony has simply been characterised as a natural monopoly. Indeed, telephony, together with such industries as power distribution and railroads, has repeatedly been used to typify the notion of natural monopoly. Thus, despite the recurrent reformulation of the concept, the knowledge that a few industries including US telephony are natural monopolies has prevailed for a long time.

Science sociologist Harry M. Collins has likened knowledge to a model ship inserted in a bottle since "once it is in the bottle of truth it looks as though it must always have been there and it looks as though it could never get out again."<sup>32</sup> What the longstanding relation between the concept of natural monopoly and US telephony conveys, however, is a recurrent reformulation of both the abstract definition of the concept and what part of telephony (local, nation-wide, or telecommunications more broadly) is a natural monopoly. When expressed in the timeless present tense of textbooks, both the concept itself and its application to telephony appear as timeless textbook knowledge, or if you like, like ships trapped in bottles for all time.

Yet, the fact that such seemingly timeless knowledge changes over time is as close as we can get to timeless truths. It is furthermore clear that it is not only economists who have participated in establishing a particular version of the concept of natural monopoly. Changes in industries such as US telephony have also contributed to

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<sup>31</sup> Michael L. Katz and Harvey S. Rosen, *Microeconomics*, 3rd ed. (Boston, Mass.: McGraw-Hill, 1998), pp. 432-437. Although the general definition of a natural monopoly provided in the textbook is consistent with the 'modern' subadditivity definition, Ding-a-Ling Lines and its market is primarily represented in the form of cost and demand curves, curves whose shape clearly indicates that the textbook company operates with economies of scale at the level of demand. The two problems of regulation discussed are first the problem for the regulator to obtain information about the firm's average cost curve and secondly the unintended consequences that may arise from regulations and specifically the effect it may have on the firm's incentive to innovate.

<sup>32</sup> Harry M. Collins, *Changing Order: Replication and Induction in Scientific Practice*, 2nd ed. (Chicago: University of Chicago Press, 1992), p. ix.

such transformations of the knowledge about economic organisation. It would not seem too far-fetched, therefore, to suggest that the concept of natural monopoly accounts for a regularity progressively enforced by the joint movement of the industries it has been applied to and the economics contained in the concept.<sup>33</sup>

### **The Practice of Framing: the Official Reports Revisited**

A state-owned natural monopoly provided for the telecommunications services in Sweden, then came technological change, and then the provision of telecommunications services was no longer a natural monopoly and the monopoly was gradually divested.

The concept of natural monopoly entered into the Swedish official reports on matters related to the organisation of Swedish telecommunications from the mid-1980s and onwards. It was used partly to characterise a past now undone by technological change, as was depicted in chapter 2, and partly to dissect different parts of the telecommunication system for individual characterisations. This latter use of the concept was more precisely to characterise certain parts of the telecommunications network (such as the so-called access network) as a remaining natural monopoly that still had not been (but would become) undone by technological change. All of this, but particularly the retrospective use of the concept, persuaded me extract the above contemporary story of change from the official reports, a story whose beginning provided a first point of departure for my own inquiry into the making of the state-owned monopoly in telephony.

I have already stressed on more than one occasion that this characterisation was primarily retrospective and I can now add more forcefully that this provides a notable difference between the US and Sweden. Whereas telephony and the concept of natural monopoly have been tightly linked companions for a long time in the US, the concept appears to have risen in importance only recently when retrospectively characterising the former state monopoly on telephony in Sweden. The aim of this section is now to return to the official reports and their use of the concept, with the benefit of having my narrative of the making of the monopoly as well as parts of the concept's intellectual history as further points of reference.

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<sup>33</sup> This is analogous to what Michel Callon has formulated regarding market laws, see Michel Callon, "Introduction: The Embeddedness of Economic Markets in Economics," in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 1-57, p. 46. This view on knowledge about economic organisation is incidentally close to what William G. Shepherd captured in his *Industrial Organization* textbook when discussing the continuous research and rethinking process within the field *Industrial Organization*, see Shepherd, *The Economics of Industrial Organization*, pp. 8-10.

**The making of a past state: Forming analogy and enrolling the past**

The use of the concept of natural monopoly is one instance which indicates how the official reports depend on economic reasoning and concepts from economic theory. A dependence which is especially present, not surprisingly, in the official reports published by *The Expert Group for Studies in Public Economy* (ESO).<sup>34</sup> This dependence, however, is only accompanied to a varying degree by explicit references to and citations from works from the field of economic theory.

The fact that the use of the concept of natural monopoly in itself is rarely related to any specific references to economic literature is of particular interest here. An illustrative example of this is the statement that “a natural monopoly is characterised *as we know* by declining average costs or scale economies which makes it efficient with only one enterprise.”<sup>35</sup> Such a lack of reference to any source renders indiscernible the conditions of how such a statement was produced, as compared to a statement that, for instance, would have begun with the following: ‘economist Richard T. Ely claimed that a monopoly is natural when it is characterised by...’.<sup>36</sup> The above lack of reference indicates that the notion of natural monopoly is treated as generally recognised knowledge.

A similar effect of black-boxing is discernible in statements to the effect that Swedish telecommunications *is* (or *has been*) a natural monopoly. In such statements, the economics contained in the definition are also black-boxed, as are the conditions behind this specific assessment of Swedish telecommunications. Uncontested, such a statement makes the economics behind it indiscernible and thus a transparent transmitter of messages inherent in the nature of the field of economic activity considered.<sup>37</sup> With the benefit of the above brief intellectual history of the concept it is

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<sup>34</sup> On this group confer pp. 12f in chapter II.

<sup>35</sup> My emphasis, Finansdepartementet, Ds 1991:77, “SJ, Televerket och Posten - Bättre som bolag? Rapport till Expertgruppen för studier i offentlig ekonomi (ESO),” (Stockholm: Allmänna Förlaget, 1991), p. 25. See the full quote in chapter 2 above (p. 13 ).

<sup>36</sup> In rephrasing the statement, in effect I produced negative modalities of the original statement, i.e., modalities which lead the original statement back to its ‘conditions of production.’ A positive modality, on the other hand, is when a statement points away from the conditions of production of the original statement and makes some consequences necessary. Such modalities related to the concept of natural monopoly abound in the official reports. See for instance the statements where the access network, but not the long-distance network, is depicted as a remaining natural monopoly. On facts and their relation to negative and positive modalities of statements, see Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Cambridge: Harvard University Press, 1987), pp. 22-26.

<sup>37</sup> The notion of transparent instruments is comparable to a notion of black-boxed instruments. Yet, the notion of transparency as regards scientific instruments conveys the notion that the very presence of a translating instrument becomes invisible. On the notion of transparency and transparent instruments see Simon Schaffer’s study of the experimental controversy regarding Newton’s prisms and the refraction of light, Simon Schaffer, “Glass Works: Newton’s Prisms and the Uses of Experiment,” in *The Uses of Experiment: Studies in*

nevertheless possible to infer that we are in a domain of economic reasoning where there has been a long tradition of linking telephony to the concept of natural monopoly. Indeed, as I suggested above, we are in a field of a regularity progressively enforced by the joint movement of (changeable) industries such as US telecommunications and the (equally evolving) field of (primarily US) economics.

This makes it not too far-fetched to suggest that the Swedish official reports' retrospective characterisation of the monopoly as a natural one hinges in part on an analogy: An analogy with how telephony in a US context has been characterised as a natural monopoly for a long time. This analogous framing of the past of Swedish telecommunications has been both concealed and facilitated by the timeless and de-localised expressions disseminated in textbooks: Textbooks which have affirmed that industries such as telephony – regardless of time and locality – *are* natural monopolies. What I suggest is thus, that this logic of similarity has had a role when official reports began describing the past of Swedish telecommunications as natural monopoly.

Yet, it is impossible to turn the retrospective characterisation of Swedish telecommunications as having been a natural monopoly only into an analogy with how US telecommunications have been characterised. To their support the official reports have most probably also had the previous although scant instances where the concept prior to 1980 had been used to characterise the then present status of Swedish telecommunications.<sup>38</sup> This, in turn, points to the necessity that the past of Swedish telecommunications was susceptible to such a characterisation. In other words, the monopoly whose emergence has been at the heart of this study had to conform to the notion that it was a natural monopoly. The question then is how this past, as described in the Swedish official reports, was enrolled into having been a natural monopoly.

As noted above, there are no distinct references pointing towards the conditions behind the natural monopoly characterisation. For instance, had there been references to econometric assessments on the economies of scale in Swedish telecommunications from say 1900 and onwards, these assessments (with their calculative techniques) would have been the means by which the past was enrolled. Given the absence of such sources for the characterisation, the answer as to how the past was enrolled has to be more speculative on my part.

Judging from the accounts on the past in the Swedish official reports it appears that what has been central in making the characterisation has been precisely the actual

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*the Natural Sciences*, ed. David Gooding, Trevor J. Pinch, and Simon Schaffer (Cambridge: Cambridge University Press, 1989), 67-104, esp. pp. 70, 91-96.

<sup>38</sup> See, for instance, the quote from Lennart Waara et. al. reproduced in the beginning of chapter 2 of this book.

monopoly, the gradual introduction of automatic switching and billing, and the tariffs employed by the Telegraph Administration.<sup>39</sup> The actual creation and prolonged existence of the state monopoly does not contradict the natural monopoly characterisation. Indeed, the state monopoly is rendered a condensed explanation and justification by the notion of natural monopoly, a fact which doubtlessly renders credibility to the characterisation in return. The introduction of automatic switching and billing presumably represents the presence of economies of scale and therefore also conforms with the characterisation. Finally, the tariffs that had been set partly with social considerations in mind conform with the notions of regulation contained in the concept of natural monopoly.

In sum, the foundation behind the retrospective characterisation of Swedish telecommunications as having been a natural monopoly is largely black-boxed. Most likely, however, this characterisation rests both on an analogy with how US telephony had been characterised as a natural monopoly for a long time and on the fact that crucial parts of the Swedish past conform to the characterisation. The official reports surely do not represent the origin of this characterisation of Swedish telecommunications, but they reinforced it at the same time as it came to be a characterisation of a past rather than a present state. It is now time to explore some of the contrasts arising when juxtaposing this characterisation with the previous chapters' account of the emergence and configuration of the monopoly.

### **Exploring contrasting interpretations**

The characterisation of the former monopoly as a natural monopoly produces some contrasts when compared to the previous chapters' account of the emergence and configuration of the monopoly. For instance, there is a contrast between my narrative denying that the creation of the monopoly was a predetermined outcome and the one implied by the natural monopoly characterisation which exactly has it that the monopoly was a destined, even inevitable, outcome given that telephony was a natural monopoly.

The presence of such contrasts could be interpreted and handled in at least three ways. First, contrasts might be dismissed as curiosities on the basis that they are produced by juxtaposing interpretations founded in two inherently different perspectives. Second, contrasting interpretations might be taken as incompatible knowledge claims regarding the former 'nature' of Swedish telephony where it has to be determined somehow or other which one is true. Since I view neither of the above postures as very productive, I opt for a third one. This position indeed takes the

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<sup>39</sup> Confer my account from the official reports in chapter 2.

contrasts as the outcome of the juxtaposition of interpretations produced by two different perspectives. Yet, this position finds the resulting contrasts to fruitfully provide for an exploration into what it means to retrospectively characterise the monopoly as a natural one.

A first step into such an exploration of contrasts is to make the two bases of characterisation somewhat more reconcilable. Characterising a monopoly as being a natural monopoly does not primarily produce a story, it produces a static picture of that industry since the frame provided by the concept is synchronic.<sup>40</sup> The natural monopoly framing produces a still life of that industry, or a *nature morte* to use the even more suggestive French term. Characterising a monopoly, as I have done, is quite different in this respect. In my account of previous chapters the monopoly was part of an emergent order that was the outcome of heterogeneously contingent and iterative processes. Such a narrative is necessarily provided by a diachronic frame. Thus what we have is two interpretations produced by a diachronic and synchronic frame respectively.

It is self-evident that different perspectives, different frames, account for different things. No frame can simply capture the entirety of the inherently heterogeneous and changeable network of interdependencies that makes up a field of economic activity. Therefore, different frames depict different interdependencies of such a network. It is furthermore obvious that every frame will leave many interdependencies unaccounted for, interdependencies which either silently abide by or resist the framing imposed.<sup>41</sup> To ask what it means to retrospectively characterise the monopoly as a natural one can now be reformulated: What does this framing account for and what does it leave unaccounted for as compared to the diachronic framing contained in the narrative of this study?

The main thing depicted in the natural monopoly framing is obviously the special cost characteristics emphasised by a 'modern' definition of the concept. The cost characteristics emerge in this frame as the extracted essence, or the inherent property if you like, that made the former provision of telephone services in Sweden into a natural monopoly. With the extraction of an essence it follows that the natural monopoly framing neither can nor aspires to account for any changes in this essence. The outcome of any efforts that significantly altered the cost characteristics of the telephone services operations are necessarily left unaccounted for.

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<sup>40</sup> The concepts of diachronic and synchronic are taken from Deirdre McCloskey in her discussion on linguistics as a model for economics. She in turn cites the founder of modern linguistics Ferdinand de Saussure for these concepts, see D. N. McCloskey, *The Rhetoric of Economics*, 2nd ed. (Madison: University of Wisconsin Press, 1998), pp. 28-31.

The only change that the synchronic frame of natural monopoly can account for is the creation of the factual monopoly on the basis that the industry in essence had always been a natural monopoly if not a real one. This inevitable adjustment of reality to conform with the industry's inherent essence is the only element of story that can be accounted for in the frame. In short, it can provide a retrospective story of determinism. It is this retrospective determinism hinging on an essence that renders the creation of the actual monopoly inevitable. This provides a marked difference with the frame used in my narrative. There, no essence was extracted and the narrative consequently denied the actual order emerging as having been predetermined. Thus the notions of the natural and the inevitable implied in the natural monopoly framing hinges on the frame extracting a determining essence.

The natural monopoly framing furthermore leaves all technological changes unaccounted for. Technological changes are instead accommodated in the framing with no highlights, as silently abiding under the presumption that they did not significantly alter the essence, that is, the cost characteristics that constituted the natural monopoly. It cannot, for instance, account for the many efforts addressed to manage the rapid increase in operating costs in the merging Stockholm telephone network; an issue which in economics parlance implied a state of diseconomies of scale. In my framing the issue of monopoly was depicted as intertwined with the issues of switching and costs to such an extent that the creation of the monopoly was depicted as motivating further efforts to reduce switching costs. The natural monopoly framing, however, cannot account for anything that intertwines the extracted essence of cost characteristics with issues such as technological change or changes in the economic organisation.

Although not accounted for, changes can be accommodated within the framing as long as they do not interfere with the separated essence. This is why the official reports can refer to such changes as the gradual introduction of automatic switching and billing. As far as the natural monopoly framing is concerned, these changes did not reverse the natural monopoly essence of Swedish telecommunications. In my narrative frame these changes appear as part of the transformation of the economic organisation and specifically as contributing to the solidification of the new order. In the natural monopoly framing they appear as changes which are in line with the timeless essence of the field.

This points to an interesting alliance between timelessness and essence. The extracted timeless essence produced by the natural monopoly framing relies, on as well

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<sup>41</sup> On the issue of framing and overflowing see Michel Callon, "An Essay on Framing and Overflowing: Economic Externalities Revisited by Sociology," in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 244-269.

as reinforces, the overall timelessness of the characterisation. According to the natural monopoly framing, the monopoly of 1920 is essentially the same as the monopoly of 1940 or 1960. The natural monopoly framing is not synchronic in the sense that provides a characterisation of a specific moment, it is synchronic in the sense that provides a characterisation that transcends time. Changes, if not accounted for, are accommodated in the sense that they are seen as nonessential to the essence constituting the monopoly.

### **Providing glimpses into the knowledge about economic organisation**

The timeless quality of the natural monopoly characterisation is supported by the seeming timelessness of the concept itself. The definitions of the concept have changed over time, however, as I discussed in the previous section on the concept's history. Definitions relying on inherent properties have been supplanted by definitions relying on economies of scale and so on. Thus far I have discussed retrospective natural monopoly framing in some Swedish official reports without further exploring this aspect of the concept. The grounds for neglecting changes in knowledge were that the reports' use of the concept was generally treated as involving generally recognised knowledge not calling for any references to specific sources.

There are exceptions to this lack of references in the official reports, exceptions which convey instances of being beyond generally accepted knowledge. Indeed, these instances indicate the production of knowledge about economic organisation and the conditions for this production. An exploration of some such instances is warranted, not only for further understanding the retrospective characterisation of the past as a natural monopoly, but also for understanding the use of the concept in the contemporary story of change.

One such instance is displayed in a footnote in the official ESO report from 1991 on the possible advantages of incorporating certain state-owned public enterprises. In this footnote there is a discussion concerning the issue of whether the field of telecommunication services provision, together with the provision of postal and railroad services, is a natural monopoly.

There is an extensive empirical literature about the cost structure and economies of scale in the fields providing postal, telecommunication and railroad transport services. The main impression from these studies is that there are considerable economies of scale in the distribution of mail, in the production of telephone calls (without therefore implying that all parts of a given telecommunication network necessarily is a natural monopoly), and for railroad transportation on a given line. The complexity in the definition of services in this field is considerable and have contributed to a number of apparently contradictory results. For a few leading studies in their respective

fields refer to Estrin and Meza (1988) on the field of postal services and to Sharkey (1982) on the fields of railroads and telecommunications.<sup>42</sup>

Thus, here is one instance where issues of knowledge about economic organisation are seeping into issues of actual economic (re-)organisation.

This instance explicitly refers to a domain inhabited by a theory of natural monopoly and empirical studies of cost structures and economies of scale. Specifically, it displays some of the difficulties with producing a statement to the effect that the field providing telecommunications services in Sweden is (or is not) a natural monopoly. Problems of defining the services have produced apparently contradictory results, the report informs.

Another instance that bears witness to the importance of economic knowledge is displayed further on in the same ESO report from 1991. In a discussion on the implications of new technology in relation to the issue of considering an incorporation of the state-owned enterprises providing rail, postal and telecommunications services the following is stated:

The extension of the properties of the communications which imply natural monopolies have also changed. *The knowledge about these properties has at the same time changed.* The local telephone network is the primary natural monopoly while large parts of the traffic on the network as a whole are at least in principle subject to competition.<sup>43</sup>

It is unclear in the passage from which this quote is taken what this new knowledge referred to is or what its specific implications might be. Perhaps it is the theory of contestable markets that is intended, a theory which is referred to a few pages earlier as support for the idea that efficiency can be raised in natural monopolies through bidding competition.<sup>44</sup> However, this specific theory is brushed aside in the official ESO report from 1996 as an inconsistent belief on the 'next step in telecommunications policy'. This latter report affirms that this theory has influenced the debate regarding natural

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<sup>42</sup> Original sentences (in Swedish): "Det finns en omfattande empirisk litteratur om kostnadsstruktur och skalfördelar på PTJ-området. Huvudintrycket av dessa studier är att det finns betydande skalfördelar inom brevdistributionen, produktionen av telesamtal (utan att därför alla delar av ett givet telenät behöver utgöra ett naturligt monopol) samt för järnvägstransporter på en given linje. Komplexiteten i definitionen av tjänster på detta område är dock stor vilket bidragit till ett antal synbarligen motstridiga resultat. För några tongivande studier hänvisas till Estrin och Meza (1988) för postområdet samt Sharkey (1982) för tele- och järnvägsområdena." Finansdepartementet, Ds 1991:77, ESO, p. 24 footnote 5.

<sup>43</sup> Emphasis added. Full sentences (in Swedish): "Omfattningen av de egenskaper hos kommunikationerna som innebär naturliga monopol har också ändrats. Samtidigt har insikten om dessa egenskaper ändrats. Det lokala telefonnätet är det primära naturliga monopolet medan stora delar av trafiken på nätet som helhet är åtminstone i princip konkurrensutsatt." Finansdepartementet, Ds 1991:77, ESO, p. 33.

monopolies in the field of telecommunications, among other fields. The theory, it is asserted, is inconsistent and a footnote is provided citing a work that according to the report provides a detailed critique of the theory.<sup>45</sup>

In instances such as these, the reports tell us that there is indeed something mediating between the real domain of economic activity and our knowledge about this field. This does not invalidate my assertion of the significant presence in the official reports of a contemporary story of change which has it that Swedish telecommunications was a natural monopoly recently being unmade by technological change. What it does do, however, is to suggest a venture into more recent developments related to the concept of natural monopoly. A venture which takes us to a new period of 'ferment rethinking and rhetoric' that began in the US in the early 1980s.

### **Controversies and Recent Efforts of Revisionism in the United States**

Looking at some recent US debates involving the concept natural monopoly provides a cracked picture. In the following I will tell of three interdependent cracks which all convey arguments related to the concept itself as well as the natural monopoly status of US telecommunications. First is the debate concerning the contestability theory, a controversy which also made its marks in the official reports discussed above. Second are the conflicting statements as to whether US telephony and telecommunications are or at least have been a natural monopoly. Third is the increase in conflicting statements as to whether the concept of natural monopoly is a valid concept at all.

#### **The notion of contestability contested**

Apart from establishing the subadditivity cost function definition of natural monopoly, the group of economists associated with Bell Labs also presented a view on how natural monopolies (and other concentrated industries) ought to be regulated. One presentation of this regulatory side was published in 1977 in an article by William J. Baumol and two colleagues on 'weak invisible hand theorems'. There they argued that even for natural monopolies the threat of entry by other firms could impart some power to the invisible hand.<sup>46</sup> In other words, the threat of competition could induce a monopolist to set prices closer to the social optimum even in the absence of regulation. A few years later this analysis had been elaborated and extended under the label contestable

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<sup>44</sup> Ibid., p. 26-27. The work cited for this theory is William J. Baumol, John C. Panzar, and Robert D. Willig, *Contestable Markets and The Theory of Industry Structure* (New York: Harcourt Brace Jovanovich, 1982).

<sup>45</sup> Finansdepartementet, Ds 1996:29, "Nästa steg i telepolitiken: Rapport till Expertgruppen för studier i offentlig ekonomi (ESO)," (Stockholm: Fritzes, 1996), p. 6. The work cited as the source for the detailed critique is William G. Shepherd, "Contestability vs. Competition – Once More," *Land Economics* 71 (1995): 299-309.

markets.<sup>47</sup> In a presidential address delivered at the American Economic Association in December 1981, William J. Baumol characterised the theory as “An Uprising in the Theory of Industry Structure.”<sup>48</sup>

Not all economists engaged in these issues responded to Baumol’s call, however. The notion of contestability was soon criticised for being too laissez-faire oriented among other things. The well-known Industrial Organization economist William G. Shepherd (1936-) was a particularly insistent early critic of the theory, in which he was far from alone, and he declared that the prescriptive content of the contestability notion was no more than a mere *gedankenexperiment*.<sup>49</sup> He specifically argued that the analysis of the consequences of contestability in fact only held under conditions of ‘ultra-free entry’. This, Shepherd contended, made the analysis and prescriptions to hold only for conditions which he found extreme. The contestability notion has continued to be contested among economists, at the same time as it has had at least some influence on public policy in the regulation of concentrated industries.<sup>50</sup> Baumol

<sup>46</sup> Baumol et. al., “Weak Invisible Hand Theorems,” p. 360.

<sup>47</sup> Baumol et. al., *Contestable Markets*.

<sup>48</sup> The address was later published in William J. Baumol, “Contestable Markets: An Uprising in the Theory of Industry Structure,” *American Economic Review* 72 (1982): 1-15.

<sup>49</sup> William G. Shepherd, “‘Contestability’ vs. Competition,” *American Economic Review* 74 (1984): 572-587, p. 585. Early critical reviews from those other than Shepherd include Marius Schwartz and Robert J. Reynolds, “Contestable Markets: An Uprising in the Theory of Industry Structure: Comment,” *American Economic Review* 73 (1983): 488-490 and Martin L. Weitzman, “Contestable Markets: An Uprising in the Theory of Industry Structure: Comment,” *American Economic Review* 73 (1983): 486-487.

<sup>50</sup> In a follow-up article Baumol and Willig forcefully rejected that the theory lent support to a libertarian ideology. With reference to Shepherd’s review, they stated that it was simply “incorrect to associate our writings on contestability with an all-pervasive laissez-faire position on the role of regulation and anti-trust.” On the other hand, they continued, they equally rejected the position that a high industry concentration was “sufficient to justify governmental restrictions upon the structure or conduct of an industry.” William J. Baumol and Robert D. Willig, “Contestability: Developments Since the Book,” *Oxford Economic Papers* 38 Supplement, no. Nov. (1986): 9-36, p. 10.

Others continued to argue that the theory had little relation to reality. Frederic M. Scherer, for instance, asserted that he found it difficult to find ‘real-world cases’ that corresponded with critical assumptions and that he viewed “contestability theory as more circles within circles – an aesthetically pleasing creation whose conformity to reality is at best questionable.” Frederic M. Scherer, “On the Current State of Knowledge in Industrial Organization,” in *Mainstreams in Industrial Organization – Book I: Theory and International Aspects*, ed. Henk W. de Jong and William G. Shepherd (Dordrecht: Kluwer Academic Publishers, 1986), 5-22, p. 13.

A similarly harsh assessment can be found in an article published in the same issue as Baumol and Willig’s 1986 article. There Marius Schwartz asserted that the threat of entry was unlikely to check on monopolistic behaviour in most markets. He therefore concluded that “given its restricted empirical applicability, contestability theory should not significantly alter either our theoretical thinking about concentrated industries or our policy approach to such industries.” Marius Schwartz, “The Nature and Scope of Contestability Theory,” *Oxford Economic Papers* 38 Supplement, no. Nov. (1986): 37-57, p. 55.

Shepherd has also returned to criticise the notion of contestability and stressed in an article from 1995 the importance of the matter by remarking that the Baumol group had testified in a variety of settings in efforts to change anti-trust and regulatory policies. In this assessment

has furthermore later returned to the issues contestability and natural monopoly in the field of policy towards telecommunications.<sup>51</sup>

### **The natural monopoly status of US telecommunications contested**

The subadditivity definition of natural monopolies stemming from Bell Labs has been far less contested. It was put to use in the early 1980s in a controversy concerning whether the Bell System was and had been a natural monopoly. This controversy began as a part of the increasing regulatory pressures to reform the Bell System, a process which rose to a peak in 1982 with the out-of-court settlement to break up AT&T to take effect 1 January 1984.<sup>52</sup> In fact, one significant collection of studies within this controversy was performed by economists of the ‘Chicago School’ who were consultants to the US Justice Department during the trial and negotiations with AT&T preceding the 1982 settlement.

In an article published in 1984 in *American Economic Review* stemming from this work, David S. Evans and James J. Heckman proposed “a new test of necessary conditions for natural monopoly” that required less information on the cost function

Shepherd produced an even sharper critique than he had eleven years earlier. He affirmed that the assumptions regarding entry conditions were inconsistent and unrealistic. In conclusion he held the theory to be “internally inconsistent, difficult to relate to reality, and hazardous for policy treatment of market power.” Shepherd, “Contestability vs. Competition – Once More,” p. 300.

Criticism against the prescriptive side of the contestability notion has also been aired in Sweden when Stefan Lundgren in 1990 asserted that the theory contained strange behavioural assumptions as regards the pricing behaviour of the incumbent firm. This made him affirm that the notion of contestability had limited value as an argument for market forces replacing regulation of natural monopolies. Lundgren, “Behövs offentlig kontroll av naturliga monopol?,” p. 552.

<sup>51</sup> Baumol published together with Gregory J. Sidak a book addressing the status and appropriate regulation of local telephony in 1994. In this book they argued for deregulating entry in US local telephony largely on the basis of contestability theory. Instead of arguing for econometrics determining the natural monopoly status of local telephony they argued that employing certain rules would make the market “able to determine which activities in the local arena are truly natural monopolies and which are ‘naturally competitive.’” William J. Baumol and J. Gregory Sidak, *Toward Competition in Local Telephony* (Cambridge: MIT Press, 1994), p. 6.

<sup>52</sup> For an extensive case study on the process leading up to this settlement and some of its aftermath, see Peter Temin with Louis Galambos, *The Fall of the Bell System: A Study in Prices and Politics* (Cambridge: Cambridge University Press, 1987). For a brief discussion on the case from the perspective of Industrial Organization, see Frederic M. Scherer and David Ross, *Industrial Market Structure and Economic Performance*, 3rd ed. (Boston: Houghton Mifflin, 1990), pp. 460, 462-464. Temin’s study was in fact sponsored by AT&T, but under the condition that the company did not interfere with the views expressed by the author, see Temin, p. xii. A review of the book in *Technology and Culture* underscores that the book in many ways presented views differing from those expressed by the company, see George David Smith, review of *The Fall of the Bell System: A Study in Prices and Politics*, by Peter Temin with Louis Galambos, *Technology and Culture* 31 (1990): 133-137.

than did the test proposed by Baumol et. al.<sup>53</sup> This proposed test was then performed on a cost function estimated from data on the Bell System to test the hypothesis that the cost function was subadditive for the years 1958-1977. As it turned out, their econometric calculations rejected this hypothesis for all the years tested.<sup>54</sup> In other words, according to them the Bell System had not been a natural monopoly since at least 1958.

The test devised by Evans and Heckman as well as their results with regard to the Bell System were publicly questioned, however. Not so much by Baumol et. al., but rather by a few prominent researchers within the field of operations research. In an article in *Management Science*, Abraham Charnes et. al. employed another method of analysis on the same data as Evans and Heckman. The outcome was intriguing. The 'goal programming/constrained regression' used, reversed "the main findings of the econometric studies in every one of the 20 years covered."<sup>55</sup> Their analysis indicated that the Bell system had indeed been a natural monopoly. On the basis of this result, they therefore argued that it would generally be prudent to rely on more than one discipline when large issues of policy were to be guided by the results.<sup>56</sup> Another paper again using the same data, but estimating a different kind of cost-function, found again that the data on the Bell System was consistent with the natural monopoly hypothesis.<sup>57</sup>

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<sup>53</sup> David S. Evans and James J. Heckman, "A Test for Subadditivity of the Cost Function with an Application to the Bell System," *American Economic Review* 74 (1984): 615-623, p. 1. Evans and Heckman did not explicitly refer to Baumol et. al. as economists affiliated to AT&T, but referred and discussed extensively their book on contestable markets (Baumol, et. al., *Contestable Markets*).

<sup>54</sup> Evans and Heckman, "A Test for Subadditivity of the Cost Function," p. 621. In an erratum, published two years later, they were even more explicit: "These corrections have no substantive effect on our finding that the Bell System was not a natural monopoly." David S. Evans and James J. Heckman, "Erratum: A Test for Subadditivity of the Cost Function with an Application to the Bell System," *American Economic Review* 76 (1986): 856-858, p. 856.

<sup>55</sup> Abraham Charnes, William W. Cooper, and Toshiyuki Sueyoshi, "A Goal Programming/Constrained Regression Review of the Bell System Breakup," *Management Science* 34 (1988): 1-26, p. 1.

<sup>56</sup> Evans and Heckman gave a twelve-page reply in the same issue of *Management Science*, asserting that the claim for reversed results was false. According to Evans and Heckman, Charnes et. al. had in fact used different data, estimated a different cost function, and had falsely accused them of using erroneous cost share data. The method used by Charnes et. al. would, Evans and Heckman stressed, yield similar results when these were based on the same data and similar cost function specifications. A more fruitful line of inquiry, they concluded, was to find better data and not alternative estimation metrics. David S. Evans and James J. Heckman, "Rejoinder: Natural Monopoly and the Bell System: Response to Charnes, Cooper and Sueyoshi," *Management Science* 34 (1988): 27-38.

In an appended note, the Editor-in-Chief asserted that the controversy contained in the two articles was of general scientific importance, but that the review process of the journal could not resolve most of the additional concerns or questions raised from the two articles. Note printed on last page of the reply by Evans and Heckman, p. 38.

<sup>57</sup> This paper by Lars-Hendrik Röller published in 1990 proposed a new kind of cost function and provided new calculations on the same data on the Bell System as had been used

However, as this debate concerning the former status of the Bell System was being fought, the Bell System had been replaced by independent local monopolies and competing inter-urban operators. In this new situation the issue of whether local telephony indeed was a natural monopoly was brought to the fore by some economists and econometricians. An article published in 1992 by Richard T. Shin and John S. Ying addressed this issue from an econometric point of view and presented a test for a sub-additive cost function on data from 58 local (Bell) telephone subsidiaries for the period 1976 to 1983.<sup>58</sup> From their calculations they concluded that local telephony was not a natural monopoly, and that it furthermore was doubtful whether the Bell System as a whole had been a natural monopoly before its divestiture in 1984. Their conclusion spoke directly to the then continued monopoly status of local telephone operators in the US. Shin and Ying therefore argued for introducing competition in local telephony, since "local telephone companies are unnatural monopolies in undeservedly protected monopoly markets."<sup>59</sup>

Thus there have been several econometric studies which have had ambitions to retrospectively assess the natural monopoly status of the pre-1984 Bell System. Furthermore, since the Bell break-up attempts to retrospectively disassociate the concept of natural monopoly from telephony have also been presented in detailed historic case studies attempting to revise the natural monopoly interpretation of the emergence of the Bell system monopoly in the early 20<sup>th</sup> century.

In one such study, historian Kenneth Lipartito argued that there was reason to doubt the popular interpretation that the emergence of a single monopolistic telephone system was caused by natural monopoly conditions. He argued instead that "the modern telephone system of the United States came about not because of the workings of impersonal technological and economic forces, but through the conscious efforts of AT&T managers earlier in this century."<sup>60</sup> The large-scale monopoly system was thus

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in the previous papers. Röller took their diverging results as problems of robustness which in part were related to the translog cost function all of them had used. Röller therefore argued for a departure from the 'translog world,' and asserted that a quadratic cost function seemed better suited for multi-output models. When estimating his cost function for the Bell System and performing a subadditivity test analogous to the one used by Evans and Heckman, Röller found the gains from divestiture to be negative for all years. The evidence, he concluded, was 'consistent with the natural monopoly hypothesis.' Thus, in the 'quadratic world' of Röller, the pre 1980 Bell System had been a natural monopoly. Lars-Hendrik Röller, "Proper Quadratic Cost Functions with an Application to the Bell System," *Review of Economics and Statistics* 72 (1990): 202-210.

<sup>58</sup> Richard T. Shin and John S. Ying, "Unnatural Monopolies in Local Telephone," *Rand Journal of Economics* 23 (1992): 171-183.

<sup>59</sup> *Ibid.*, p. 182.

<sup>60</sup> Kenneth Lipartito, "System Building at the Margin: The Problem of Public Choice in the Telephone Industry," *Journal of Economic History* 49 (1989): 323-336, p. 323. Lipartito furthermore affirmed that the desire for universal service apparently was not strong enough to

according to Lipartito the consequence of the company's strategy and public officials who were convinced to support the emergence of the Bell System since "AT&T made its system seem like a natural culmination of the logic of telephone development."<sup>61</sup> Another study provided a similar critical revision of the natural monopoly interpretation of the emergence of the dominating Bell System. In this study, Milton Mueller examined the political and business activities which forged a unified telephone network out of an agglomeration of competing and unconnected telephone operators.<sup>62</sup> He argued that concept of natural monopoly (here defined in terms of cost characteristics) produce several anomalies when applied to telephony.<sup>63</sup> Somewhat in contrast to Lipartito, Mueller argued as the basis of his study that the emergence of the Bell System monopoly was more the product of political consensus than unilateral actions by Bell managers.

In all, there are many retrospective assessments of telephony and telecommunications. Many of these heterogeneous efforts attempt to retrospectively object to the natural monopoly characterisation of the Bell System, which in effect makes them efforts to invalidate past characterisations as expressed by Ely, Bain, Scherer and others. In this, they propose a minimal story on the theme of learning:

The Bell System was long believed to having been a natural monopoly, then came new knowledge (econometrics or detailed historical case studies), and then as a consequence it is now known that the Bell System was not really a natural monopoly.

### **The authority of the concept of natural monopoly contested**

The above minimal story is not the only crack in the picture depicted when looking at contemporary US debates involving the concept natural monopoly. In addition, there has emerged a crack which centres on the validity of the very concept of natural monopoly. A first indication of this wider weakening of the concept's authority can be found when comparing the third (co-authored) edition of the well-known Industrial

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force consolidation. He further suggested that the benefits of a large-scale system may have been outweighed by its costs, given the lack of scale economies and the way consumers used the service.

<sup>61</sup> Ibid., p. 336.

<sup>62</sup> Milton Mueller, *Universal Service: Competition, Interconnection and Monopoly in the Making of the American Telephone System* (Cambridge: MIT Press, 1997).

<sup>63</sup> Among these anomalies Mueller mentioned that contemporaries cited unified service and not economies of scale as the important reason why the monopoly emerged. To this point he further stressed the presence of diseconomies of scale: "Thus, the cost characteristics of the industry not only failed to conform to the expectations of natural monopoly theory, but actively violated them." (Ibid., p. 15). Mueller noted Richard T. Ely as the one coining the concept of natural monopoly, but Mueller did not note on the other hand that Ely in his *Monopolies and Trusts* had also used the case of telephony to point out that it was not only economies of scale that produced natural monopolies.

Organization textbook by Frederic M. Scherer from 1990 with the one published in 1980. In the 1990 edition the concept natural monopoly is used far more sparingly. The concept is completely absent in a discussion regarding regulation of so-called public utilities and it is furthermore affirmed that “few industries satisfy the criteria for classic public utility regulation unambiguously.”<sup>64</sup> In the 1980 edition, however, the concept of natural monopoly was present in the corresponding discussion.<sup>65</sup>

Outside the field of Industrial Organization proper, the plethora of efforts to diminish the concept's authority have been more marked. There have been journal articles and books containing phrases such as *Unnatural Monopolies*, *The Life and Death of Unnatural Monopolies*, and *The Natural Monopoly Myth* in their titles<sup>66</sup>, and many versions of the concept's intellectual history have been issued. One work that combines a review of the concept's history with efforts to diminish its authority was written by Thomas Hazlett. In this version of the concept's history Hazlett contended that the notion of natural monopoly had sprung more out of ideological agendas than from scholarly research programs:

The economists' analysis of the inefficiency of unregulated natural monopoly markets did not spring from a scientific or particularly scholarly research program but in response to “a growing clamor for more government.” Indeed many of the early natural monopoly writers had attacked the problem because of personal ideological agendas; their politics preceded their studies.<sup>67</sup>

What this text thus attempted was to diminish the concept's authority as a neutral concept of textbooks by retrospectively (re)politicising the work from which the concept emerged. Labels of ideology are not only something assigned to certain

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<sup>64</sup> Frederic M. Scherer and David Ross, *Industrial Market Structure and Economic Performance*, 3rd ed. (Boston: Houghton Mifflin, 1990), p. 8. The ‘so-called public utility industries’ included in the text are: “electric power and natural gas distribution, local telephone service, bulk commodity railroading, and the transportation of petroleum and natural gas in pipelines.” (ibid.)

At another place in this edition of the textbook, where the concept of natural monopoly was used the economies of scale condition was further conditioned by the addition that this, in turn, depended on the “relevant technology and the size of the market.” Ibid., p. 111.

<sup>65</sup> Scherer, *Industrial Market Structure and Economic Performance*, p. 482.

<sup>66</sup> Confer, for instance, Robert W. Poole, Jr., ed., *Unnatural Monopolies: The Case for Deregulating Public Utilities* (Lexington: Lexington Books, 1985); Walter J. Primeaux, *Direct Electric Utility Competition: The Natural Monopoly Myth* (New York: Praeger Scientific, 1985); Richard T. Shin and John S. Ying, “Unnatural Monopolies in Local Telephone,” *Rand Journal of Economics* 23 (1992): 171-183; John T. Wenders, “Unnatural Monopoly in Telecommunications,” *Telecommunications Policy* 16, no. 1 (1992): 13-15; Bruce W. Radford, “TechnoEconomics: The Life and Death of Unnatural Monopolies,” *Public Utilities Fortnightly* 131, no. 17 (1993): 45; Adam D. Thierer, “Unnatural Monopoly: Critical Moments in the Development of the Bell System Monopoly,” *Cato Journal* 14, no. 2 (1994): 267-285.

economists of the past, however. The very book containing this effort stemmed from work performed in association with *The Reason Foundation*, a US policy think tank which was part of what has been characterised as the first wave of libertarian think tanks founded in the late 1970s.<sup>68</sup>

The presence of such think tanks (or private non-profit research groups to use the less colloquial term) discussing such matters is far from surprising. Although not a new phenomena, think tanks rose to a new significance in the US during the 1980s and therefore also took a place in economic research related to public policy.<sup>69</sup> There are consequently plenty of cases in the 1980s and 1990s where such private non-profit research groups have appeared in some association with works posing a critique of some kind against the concept of natural monopoly and its place in public policy. Indeed, some of the works with such themes have appeared with think tanks like *Cato Institute*, *RAND Corporation*, and *American Enterprise Institute* as publishers.<sup>70</sup>

The wider weakening of the concept's authority can thus be linked to a concurrent period of 'ferment rethinking and rhetoric' as regards to public policy that characterised much of the 1980s and 1990s. However, the increasingly contested authority of the concept of natural monopoly is not only something to be depicted in publications associated with think tanks. In 1997, to take a noticeable example, the distinguished Chicago economist Gary S. Becker (1930-) declared in an issue of *Business Week* that there was nothing natural with natural monopolies.<sup>71</sup> The concept of natural monopoly had in his view an inherent defect in its failure to recognise technological change. This

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<sup>67</sup> Thomas Hazlett, "The Curious Evolution of Natural Monopoly Theory," in *Unnatural Monopolies: The Case for Deregulating Public Utilities*, ed. Robert W. Poole, Jr. (Lexington: Lexington Books, 1985), 1-25, p. 21. The phrase quoted is from Henry Carter Adams.

<sup>68</sup> The connection to previous work undertaken at the Reason Foundation is indicated in the preface. Poole, ed., *Unnatural Monopolies*, p. ix. The label libertarian is one of the descriptive nouns the foundation uses to describe its journal. The notion of a first wave of libertarian think tanks was made by James A. Smith, a wave into which he counted Reason, Cato and a few other policy research operations emerging in the late 1970s. See James A. Smith, *The Idea Brokers: Think Tanks and the Rise of the New Policy Elite* (New York: The Free Press, 1991), p. 221.

<sup>69</sup> For two works on the surge in the US in the 1980s of such organisations situated between academic social science on one side and politics on the other, see Smith, *The Idea Brokers*, and David M. Ricci, *The Transformation of American Politics: The New Washington and the Rise of Think Tanks* (New Haven: Yale University Press, 1993).

<sup>70</sup> Thierer, "Unnatural Monopoly," was published in *Cato Journal*; Shin and Ying, "Unnatural Monopolies," was published in *Rand Journal of Economics*; Mueller, *Universal Service*, and Baumol and Sidak, *Toward Competition*, were both published by MIT Press in collaboration with *American Enterprise Institute*.

<sup>71</sup> Gary S. Becker, "There's Nothing Natural About 'Natural' Monopolies," *Business Week* 6, no. 26 (1997).

kind of argument is not entirely new<sup>72</sup>, but nevertheless provides a nice recent contribution to the topic of natural monopoly.

What all these efforts questioning the validity of the very notion of natural monopoly amount to is another minimal story; a story which claims priority over the story of learning which has it that the Bell System was not really a natural monopoly. This alternative, and perhaps more radical, minimal story of learning has it that it is now known that the notion of natural monopoly was ideologically rather than scientifically grounded and carries with it inherently defective policy implications:

The concept of natural monopoly was an ideologically founded belief that for a long time influenced public policy on among other things the field of telecommunications, then came new knowledge, and hence it is now known that the concept of natural monopoly and its policy implications are inherently defect.

### **A multitude of somewheres replacing the view from nowhere**

It is sometimes said that when knowledge claims are stabilised as truths they appear as the view from nowhere. What the above reported arguments depict, however, is an apparent increase in contrariness on what is true and what is mere ideology or false belief. What the story of the concept of natural monopoly of recent decades thus depicts is a multitude of somewheres, each producing different knowledge claims about how to regulate natural monopolies, whether certain industries indeed are (or have been) natural monopolies (and how this ought to be established), and whether the concept of natural monopoly is valid at all. At a time where the concept still has a place in some economics textbooks, there are simultaneously plenty of claims raised challenging the concept's appearance as timeless truth.

The point that different knowledge claims and policy recommendations come from different places does not make any of them less true or wrong by default. Knowledge claims and policy recommendations always have to come from somewhere. The point here is simply that the number of somewheres, the number of diverging knowledge claims, and the number of diverging policy recommendations all seem to

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<sup>72</sup> See, for instance, the point made in 1971 by William Melody when addressing the American Economic Association meetings where he argued that "the theory of natural monopoly based on technological determinism has come to be used as a major weapon in attempting to prevent changing technology from altering the established structures." William H. Melody, "Technological Determination and Monopoly Power in Communications" (paper presented at the American Economic Association, Transport and Public Utility Session, New Orleans, 1971), p. 5. Quoted in Lowry, p. 18. A book stemming from a Brookings conference held in 1969 similarly contains the argument that many industries normally regarded as natural monopolies have only remained natural monopolies because of the way regulation has interacted with and shaped technological change. William M. Capron and Roger G. Noll, "Summary and Conclusion," in *Technological Change in Regulated Industries*, ed. William M. Capron (Washington D.C.: The Brookings Institution, 1971), 197-226, p. 222.

have increased since at least 1980.<sup>73</sup> Indeed, the seeming increase in histories of the concept of natural monopoly (including the one contained in this chapter) may in itself be taken as indicating that the concept is increasingly questioned in contemporary debates.

## **The Power of Framing**

### **The natural order and the inevitable change in the framing of change**

A state-owned natural monopoly provided for the telecommunications services in Sweden, then came technological change, and then the provision of telecommunications services was no longer a natural monopoly and the monopoly was gradually divested.

Above is (again) the minimal story of change extracted from the Swedish official reports. One important reason behind this study's inquiry into the making of the state-owned monopoly was the contemporary depiction of technological change as the autonomous force unmaking it. With the benefit of the above explorations it is now possible to conclude this study by discussing what the retrospective natural monopoly characterisation implies for our understanding of the changes of our own time and indeed our understanding of the making of natural orders and inevitable changes.

When discussing the retrospective characterisation of the past as a natural monopoly I asserted that the synchronic (static) framing left all technological changes unaccounted for. I argued that the framing indeed could not account for anything that intertwined with the extracted essence of cost characteristics produced by the natural monopoly framing. Technological changes (such as the introduction of automatic switches) were accommodated within the framing on the presumption that they did not interfere with this extracted essence.

When viewed in the minimal story of change the consequences of the natural monopoly characterisation are different. There it is an autonomous change in the extracted essence of the industry that necessarily has to account for the discontinuation of the state of natural monopoly. The story also tells of a forceful autonomous change that makes the once tenable natural monopoly characterisation untenable, namely technological change. The extraction of this particular force, however, is a direct consequence of the retrospective characterisation of the former monopoly as a natural monopoly. Nothing except autonomous technological change could have been depicted as the element causing change, *given* the framing that comes with the beginning and

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<sup>73</sup> I cautiously use the word *seem*, since it is difficult to determine whether this represents historically significant increases. Perhaps this seeming increase is simply an effect of the vantage point of a present which always appears ambiguous when looking for more than *one* point of view.

ending of this story. Technological change is simply the only force that can explain the discontinuity of the state depicted in the beginning of the story.

The plot of this minimal story is even more telling given the wider discussions with relation to the concept of natural monopoly that have emerged in the US more recently. Specifically, the two minimal stories extracted from these discussions resist in two different ways the notion of natural monopoly. Insisting on the importance of new knowledge, one minimal story has it that the Bell System had never been a natural monopoly and the other that the concept of natural monopoly in itself was invalid. What both these minimal stories of learning bring to the fore, however, is the work of economics. The very existence of such stories outside the realm of Swedish official reports indicates the black-boxing of economics that is carried out in the story of change in the reports. This black-boxing is understandable given the role of official reports, since they are conceived with the prime purpose of advising on matters of policy instead of devoting themselves to theoretical discussions. Yet this black-boxing contributes to the production of an ontology of technological determinism.<sup>74</sup> In other words, this black-boxing of economics participates in creating a powerful macro-actor, in this case technological change, in a story of change.<sup>75</sup>

True, there are many other changes that in principle can account for the discontinuation of the actual monopoly in Swedish telecommunications. The depiction of a political reorientation in policy towards so-called public utilities could, for instance, account for the discontinuation of the monopoly. There have also been studies about this so-called deregulation of Swedish telecommunications that have contributed to such richer accounts.<sup>76</sup> Yet, except for technological change, all conceivable changes that may have contributed to the so-called deregulation are suppressed when the discontinuation of the monopoly is told as a story of a natural monopoly unmade.

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<sup>74</sup> True, the minimal stories of learning convey instead a strange rationalist epistemology. Their epistemology is strange simply because the alleged falsification of past knowledge is only temporarily tenable because for a moment it has the last word. Confer the discussion by Michel Serres on the rationalist idea of epistemological ruptures in Michel Serres and Bruno Latour, *Conversations on Science, Culture, and Time*, trans. Roxanne Lapidus (Ann Arbor: University of Michigan Press, 1995), pp. 48-52.

<sup>75</sup> On the construction of macro-actors, see Michel Callon and Bruno Latour, "Unscrewing the Big Leviathan: How Actors Macro-Structure Reality and How Sociologists Help Them To Do So," in *Advances in Social Theory and Methodology: Toward an Integration of Micro- and Macro-Sociologies*, ed. Karin Knorr-Cetina and Aron V. Cicourel (London: Routledge & Kegan Paul, 1981), 277-303.

<sup>76</sup> Two studies on the process of so-called deregulation in Swedish telecommunications that do not use the framework of natural monopoly, provide quite different (and richer) accounts of this process. See Dimitrios Ioannidis, "I Nationens Tjänst? Strategisk Handling i Politisk Miljö" (Ph.D. diss., Stockholm School of Economics, 1998) and Magnus Karlsson, "The Liberalisation of Telecommunications in Sweden: Technology and Regime Change from the 1960s to 1993" (Ph.D. diss., Linköping University, 1998).

In conclusion, then, two significant consequences come with characterising the former monopoly of Swedish telecommunications as having been a natural monopoly. First, it implies that this order had been natural due to properties inherent in the industry and that its past creation had been the inevitable outcome given these inherent properties. Second, in a story of change the retrospective natural monopoly characterisation produces technological change as the autonomous force that unmakes this past state. As a consequence, all other conceivable changes are suppressed and the so-called deregulation appears as the inevitable consequence of technological change. In brief, the presence of a natural order and inevitable changes are not the basis for the retrospective natural monopoly characterisation. These notions are instead the consequences of this retrospective characterisation.

**'How to do things with words'<sup>77</sup>**

Good stories serve to render sense to situations characterised by high degrees of ambiguity and conflicting interests.<sup>78</sup> The above minimal story extracted from the Swedish official reports is in this respect no different and does undoubtedly render unambiguous sense to the transformation of Swedish telecommunications. Yet, the official reports were not producing 'mere' stories of change serving to render a sense to what was going on within Swedish telecommunications.

The official reports were themselves situated at the boundaries of the transformation of Swedish telecommunications. Their stories have to some extent been mediators in this transformation. In other words, they have participated in shaping this transformation by way of framing it. They have participated in framing what is going on, and what ought to be done in terms of public policy. In this sense, it is a simple exercise to depict a scenario embedded in the minimal story of change. A scenario that presents measures to divest the Swedish state-owned monopoly as inevitable, considering that the former natural monopoly is (inevitably) being unmade by technological change.

Viewing the minimal story in this way discloses that it carries with it a striking orientation towards particular actions. The characterisation of the past as having been a natural monopoly now unmade by technological change delivers an unambiguous message that action is called for. This gives the story a striking de-politicising effect, since it subtly suppresses rather than lays open different possible interpretations and

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<sup>77</sup> I am here, of course, alluding to the famous book by John Langshaw Austin and his notion of the performative use of language.

<sup>78</sup> See Karl Weick's discussion on stories and sensemaking in organisations. Karl E. Weick, *Sensemaking in Organizations* (Thousand Oaks: Sage, 1995), pp. 60-61. Quoted in Barbara Czarniawska, *A Narrative Approach to Organization Studies* (Thousand Oaks: Sage, 1998), p. 15.

courses of action. This, in turn, suggests that the black-boxed economics that participate in framing this story in effect contribute to the suppression of a discussion of alternative interpretations and alternative courses of action as regards the fate of Swedish telecommunications. It is beyond the scope of this study to assess the causes and effects of the contemporary transformation, but these matters were surely much more complex and the options more numerous than this story conveys.

The action mentality, or even action 'intelligence'<sup>79</sup>, manifest in the story of a natural monopoly unmade is understandable given the advisory role of official reports. Yet the de-politicising effect of this story may cause concern from a democratic and humanist point of view. Changes are never inherently inevitable nor are orders inherently natural. They are only made to become so.

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<sup>79</sup> I am here drawing on notions presented by Nils Brunsson. He argued that forceful action conflicts with decision rationality, in the sense that processes attempting to deliver a rational choice are likely to be at a loss in delivering action and vice versa. A certain 'narrow-mindedness' may in this respect be functionally effective in achieving action. Nils Brunsson, *The Irrational Organization: Irrationality as a Basis for Organizational Action and Change* (Chichester: John Wiley & Sons, 1985).

# Glossary

**Adams.** Henry Carter Adams (1851-1921). Adams, together with Richard T. →Ely, John Bates Clark (1847-1938) and a few other economists, belonged to the core group of predominantly German-trained American economists who founded the American Economic Association in 1885 for challenging the prevailing doctrine of *laissez-faire*.<sup>1</sup>

**AT&T.** The American Telephone and Telegraph Company was founded in 1885. With precursors in the previous Bell incorporations made less than 10 years earlier, AT&T became the US long-distance operator and parent company in the emerging →Bell System. In 1982, an out of court settlement was reached, following a lengthy antitrust case (filed in 1974), to the effect that the Bell local operating companies were to be divested from AT&T as of 1 January 1984, after which AT&T was to retain its long-distance services, its manufacturing branch (Western Electric), and its research branch (Bell Laboratories).<sup>2</sup>

**Autotelephone Betulander** (1910-1912, Swedish name: *AB Autotelefon Betulander*). Company founded by Gotthilf Ansgarius →Betulander together with Swedish and French financiers in 1910, only to be liquidated in 1912 and replaced by a new company: →New Autotelephone Betulander.

**Avén.** Anton Avén (1861-1914). Engineer at →SAT 1883-95, after which he worked at the technical department of the →Telegraph Administration. Intimately associated with the manual →call-distributing system.

**Bell System.** Name identifying the assembly of companies that in the late 19<sup>th</sup> and early 20<sup>th</sup> century were gradually co-ordinated and brought into the dominion of →AT&T. Headed by the long-distance operator and parent company AT&T, the Bell System contained the Bell operating companies, the manufacturing branch Western Electric and the research branch Bell Laboratories. The Bell System gradually came to totally dominate US telephony during the 1910s and 1920s and until its break-up in 1984 (see →AT&T).

**Betulander.** Gotthilf Ansgarius Betulander (1872-1941). Engineer at the →Telegraph Administration's technical department. Betulander was on leave of absence from this position from around 1910 to the beginning of 1920, during which time he ran the companies →Autotelephone Betulander until 1912 and then →New Autotelephone Betulander Company.

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<sup>1</sup> For more on these progressive economists and the founding of AEA see, for instance, Herbert Hovenkamp, *Enterprise and American Law, 1836-1937* (Cambridge: Harvard University Press, 1991), esp. pp. 105-106, 298-300.

<sup>2</sup> On the early days of the Bell incorporation and the founding of AT&T, see for instance, Herbert N. Casson, *The History of the Telephone* (Chicago: A. C. McClurg & Co., 1910), especially chapter 5. On the divestiture, see Peter Temin with Louis Galambos, *The Fall of the Bell System: A Study in Prices and Politics* (Cambridge: Cambridge University Press, 1987).

**black box.** The result of →stabilisation where a machine, fact or any other →element composed by a heterogeneous set of other elements is stabilised and counted as a single entity.<sup>3</sup>

**blocking.** The phenomena where some telephone calls are not put through due to the lack of a free trunk line or inter-urban line between exchanges or a lack of free equipment in any of the exchanges through which the call has to pass (→internal blocking). Blocking appears when there is no system to queue the calls and is usually counted as a percentage of all attempted calls that have been blocked in a given period of time.

**call-distributing system** (Swedish name: *fördelningssystem*). With the (manual) call-distributing system incoming calls were first connected to one of a set of telephone operators who, without speaking to the caller, allocated each call to a free operator at the multiple switchboard who talked to the caller and then set up the desired connection. This deviated from the usual →multiple switch where the incoming calls from a given subscriber always came to the same operator's position at the multiple (see the →single cord system and the →cord pair system). The idea with the call-distributing system was to smooth out the work-load between the operators at the multiple. The call-distributing system was first devised by Anton →Avén in the late 1890s. An automatic call-distributing system was later employed within →SAT, where the distribution operators were replaced by automatic selectors connecting the incoming calls to a free operator's position at manual multiple switchboards. Automatic call distribution was further used in →semi-automatic switching systems to distribute the incoming calls between different operators' positions.<sup>4</sup>

**Carlson.** Oscar Carlson (1844-1916). Industrialist. Founded a superphosphate company and built several of the first large-scale chemical factories in Sweden. Carlson was the primary investor in the →New Autotelephone Betulander.

**Cassel.** Gustav Cassel (1866-1945). Economist and professor at *Stockholms högskola* 1904-33. Cassel specialised in monetary issues and in the 1920s became an internationally acclaimed expert in this field.<sup>5</sup>

**Cedergren.** Henrik Cedergren (1853-1909). Received a Master of Engineering degree in 1875 and was the primary founder of →SAT in 1883. Cedergren was the managing director of SAT up until his death in 1909, and held the same position in SAT's

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<sup>3</sup> See, for instance, Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Cambridge: Harvard University Press, 1987), pp. 2-3 and Michel Callon, John Law, and Arie Rip, eds., *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World* (London: Macmillan Press, 1986), p. xvi.

<sup>4</sup> On the early call-distributing system and the work of Anton Avén, see Hans Heimbürger, *Det Statliga Telefonväsendet, 1881-1902*, vol. 1 (Göteborg: Kungliga Telegrafstyrelsen, 1931), pp. 251-252; on LM Ericsson and SAT and the call-distributing system, see Hemming Johansson, *Telefonaktiebolaget LM Ericsson, del 1 Från 1876 till 1918* (Stockholm: LM Ericsson, 1953), pp. 300-302.

<sup>5</sup> According to Lars Magnusson, Schumpeter characterised Cassel as probably the most influential leader of economics in the 1920s. Lars Magnusson, "Gustav Cassel, Popularizer and Enigmatic Walrasian," in *The History of Swedish Economic Thought*, ed. Bo Sandelin (London: Routledge, 1991), 122-140, p. 123.

subsidiary →Stockholm Telephone from its foundation in 1908 until 1909. He was furthermore a member of LM Ericsson's board from July 1902.

**central battery system (CB-system).** A system where the speaking circuit between the exchange and the telephones is powered from the switch, as opposed to a local battery system where the speaking circuit is powered by the batteries in each telephone set. In the early days of telephony the switches and the telephone sets had local batteries, but the CB-system came gradually to dominate in the first decade of the 20<sup>th</sup> century. Automatic switching systems generally also powered the speaking circuit from the switch.

**configuration.** Captures how the stabilised element is defined, enabled and constrained<sup>6</sup>, and provides a characterisation of the identity, role and workings of a stabilised network of heterogeneous element. A configuration is the precarious (and in principle reversible) outcome of a process of →stabilisation. The notion of configuration stresses that the characteristics of an element are relational first since the stabilised element in itself is constituted by a heterogeneous set of elements, and second since the element is configured in relation to other elements.

**cord pair system.** An arrangement employed at a (manual) →multiple switch, and often contrasted with two other arrangements of manual multiple switches; the →call-distributing system and the →single cord system. In the cord pair system one cord was used for answering calls at an operator's position whereas the other cord was used to connect the caller to the desired subscriber's jack in the multiple. The use of two cords enabled adjacent operators to assist in executing calls when many incoming calls came to a single operator's position.

**Davidson.** David Davidson (1854-1942). Professor of economics and finance at Uppsala University 1890-1919. Davidson together with Gustav →Cassel and Knut Wicksell are generally seen as the main figures in early modern Swedish economics. Davidson founded *Ekonomisk Tidskrift* (Economic Journal) in 1899 and was its editor for 40 years.<sup>7</sup>

**Ekeberg.** Erik Ekeberg (1868-1949). Engineer employed at the →Telegraph Administration from 1891. Acting telephone director at the Administration's network in Stockholm 1900-02, thereafter line director in Malmö 1902-09 and from 1909 the Administration's telephone director in Gothenburg (until 1935).

**element.** Anything having an identifiable identity, role and workings, be it a machine, a fact, an engineer, accountant, manager, contract, organisation, a legislation, etc. Being a part of a →techno-economic network, every element is itself the outcome of the

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<sup>6</sup> Refer to Woolgar's notion of configuring the user, Steve Woolgar, "Configuring The User: The case of Usability Trials," in *A Sociology of Monsters: Essays on Power, Technology and Domination*, ed. John Law (London: Routledge, 1991), 57-99, p. 69.

<sup>7</sup> On his career and major contributions see, Carl G. Uhr, "David Davidsson: The Transition to Neoclassical Economics," in *The History of Swedish Economic Thought*, ed. Bo Sandelin (London: Routledge, 1991), 44-75.

→stabilisation of other heterogeneous elements. The capacity of an element to appear as an actor is itself the outcome of the linkages to other heterogeneous elements.<sup>8</sup>

**Ely.** Richard T. Ely (1854-1943). American Economist trained in Germany. Co-founder, together with among others Henry Carter →Adams, of the American Economic Association for challenging the prevailing doctrine of *laissez-faire*. Ely has been characterised as a typical member of the policy elite that emerged in the US in the late 19<sup>th</sup> century, an elite whose members had made academic careers while seeking to apply their expertise in the realm of politics.<sup>9</sup>

**Ericson.** Helge Ericson (1890-1953). Employed at the →Telegraph Administration's technical department 1912-28. Then worked two years for →Telephone LM Ericsson, before becoming head of the Telegraph Administration's factory in 1930. In 1939 he became general director of the Telegraph Administration, a position he left in 1942 to become managing director of Telephone LM Ericsson.

**Erlang.** Agner Krarup Erlang (1878-1929). Danish mathematician employed at the Copenhagen Telephone Company from 1908 until his death in January 1929. After his death, Erlang has gradually become considered as one of the great forerunners in introducing theory of probabilities into the domain of telephone traffic. His publications include 'The Theory of Probabilities and Telephone Conversations' from 1908 and 'Solution of some Problems in the Theory of Probabilities of Significance in Automatic Telephone Exchanges' from 1917. In 1944 the name *erlang* was coined on the initiative of the Swedish researcher Conny Palm to identify a unit of telephone traffic. In 1946, a technical committee within the International Telecommunication Union (ITU) accepted erlang as the international unit of telephone traffic intensity after an initiative by the Swedish Telegraph Administration.<sup>10</sup>

**framing.** The work of demarcating which linkages in a →techno-economic network are taken into account and which are ignored. The inherent complexity of a techno-economic network implies that framing constitutes the necessary work of simplification

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<sup>8</sup> The notion of element is inspired by the notion of components in technological systems as developed in the works of Thomas P. Hughes (see, for instance, Thomas P. Hughes, "The Evolution of Large Technological Systems," in *The Social Construction of Technological Systems*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (Cambridge: MIT Press, 1987), 51-82, pp. 51-53). It is furthermore close to the broad notion of actor as used in the actor-network approach, see for instance, Michel Callon, "The Sociology of an Actor-Network: The Case of the Electric Vehicle," in *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World*, ed. Michel Callon, John Law, and Arie Rip (London: Macmillan Press, 1986), 19-34, esp. pp. 29-30.

<sup>9</sup> James A. Smith, *The Idea Brokers: Think Tanks and the Rise of the New Policy Elite* (New York: The Free Press, 1991), p. 28.

<sup>10</sup> On the Life and Works of Agner Krarup Erlang, see E. Brockmeyer, H.L. Halstrøm, and Arne Jensen, eds., *The Life and Works of A.K. Erlang, Transactions of the Danish Academy of Technical Sciences #2* (Copenhagen: Copenhagen Telephone Company, 1948). This volume also contains the English versions of several of Erlang's articles, including the two above mentioned titles from 1909 and 1917 respectively. The creation of the traffic unit *erlang* is recounted in *ibid.*, pp. 19-22.

that will always leave linkages unaccounted for.<sup>11</sup> Framing both provides a representation and a basis for intervention through →scenarios.

**General Industry HT Cedergren** (1918-1921, Swedish name: *Allmänna Industri AB HT Cedergren*). Company created subsequent to the →Telegraph Administration's acquisition of the network of →Stockholm Telephone to house the promissory notes issued by the Administration when acquiring the network as well as certain telephone related industrial production performed within Stockholm Telephone The company was liquidated in 1921 and merged with →General Telephone LM Ericsson.<sup>12</sup>

**General Telephone LM Ericsson** (1918-1926, Swedish name: *Allmänna Telefon AB LM Ericsson*). Company created at the merger of →LM Ericsson and →SAT in 1918. The company changed name in 1926 and became Telephone LM Ericsson, *Telefon AB LM Ericsson* (in Swedish).

**government.** The Swedish government was a rather changeable entity during the years which concern us. Prime Ministers came and went, as did the other Ministers in the Cabinet. The table below depicts the Prime Ministers, the Ministers of Public Administration and Ministers of Transport and Communications from September 1900 to June 1930.

*Table G-1 Prime ministers, Ministers of Public Administration and Ministers of Transport and Communications from September 1900 to June 1930.*<sup>13</sup>

Government	Prime Ministers	Ministers of Public Adm., from 1 July 1920 Ministers of Transport and Communications
Sept. 1900 – July 1902	Fredrik von Otter	J E von Krusenstjerna
July 1902 – Apr. 1905	Erik Gustaf Boström	Hj. Westring
Apr. 1905 – Aug. 1905	Johan Ramstedt	Hj. Westring
Aug. 1905 – Nov. 1905	Christian Lundeberg	J Widén
Nov. 1905 – May 1906, Liberal	→Karl Staaff	→Axel Schotte
May 1906 – Oct. 1911, Conservative	→Arvid Lindman	J. Juhlin (- Dec. 1907) H. Hamilton
Oct. 1911 – Feb. 1914, Liberal	→Karl Staaff	→Axel Schotte
Feb. 1914 – Mar. 1917, –	Hjalmar Hammarskjöld	→Oscar von Sydow
Mar. 1917 – Oct. 1917, Conservative	Carl Swartz	Walter Murray
Oct. 1917 – Mar. 1920, Liberal and Social Democratic coalition	Nils Edén	→Axel Schotte (- Nov. 1919) F Holmquist

<sup>11</sup> Confer Callon's discussion on framing and overflowing in Michel Callon, "Introduction: The Embeddedness of Economic Markets in Economics," in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 1-57, pp. 15-16, and Michel Callon, "An Essay on Framing and Overflowing: Economic Externalities Revisited by Sociology," in *The Laws of the Markets*, ed. Michel Callon (Oxford: Blackwell, 1998), 244-269, esp. p. 252-255.

<sup>12</sup> Artur Attman, Jan Kuuse, and Ulf Olsson, *LM Ericsson 100 år: Pionjärtid, Kamp om koncessioner, Kris, 1876-1932* (Stockholm: LM Ericsson, 1977), p. 247.

<sup>13</sup> Table based on tables on Swedish governments presented in Stig Hadenius, Björn Molin, and Hans Wieslander, *Sverige efter 1900: En modern politisk historia*, 13 ed. (Stockholm: Bonnier Alba, 1993), pp. 361-380.

Government	Prime Ministers	Ministers of Public Adm., from 1 July 1920 Ministers of Transport and Communications
Mar. 1920 – Oct. 1920, Social Democratic	Hjalmar Branting	Carl E. Svensson
Oct. 1920 – Oct. 1921, caretaker ministry	Louis De Geer d.y. (- Feb. 1921) →Oscar von Sydow	Walter Murray
Oct. 1921 – Apr. 1923, Social Democratic	Hjalmar Branting	Anders Örne
Apr. 1923 – Oct. 1924, Conservative	Ernst Trygger	S Lübeck
Oct. 1924 – June 1926, Social Democratic	Hjalmar Branting (-Jan. 1925) Rikard Sandler	V Larsson
June 1926 – Oct. 1928, Liberal coalition	Carl Gustaf Ekman	Carl Meurling
Oct. 1928 – June 1930, Conservative	→Arvid Lindman	T Borell

**Hallgren.** Paul Hallgren (1886-1949). Became head of the Telegraph Administration's technical department at the beginning of 1920, a position he held until the beginning of 1931 when he left the Administration to work for Standard Electric in Norway.<sup>14</sup> Administrative director at Standard Telefon & Kabelfabrik AS in Oslo from 1933, member of the board of Telephone LM Ericsson from 1934.

**Hamilton.** Malkolm Hamilton (1872-1918). Graduate in Law. Office manager at three different bank offices, 1900-08. Hamilton became secretary of the Chamber of Commerce in the city of Gävle in 1910. Malkolm's father, Gustaf Knut Hamilton (1831-1913), was a professor in law and economics.

**Heckscher.** Eli F. Heckscher (1879-1952). Professor in economics and statistics at Stockholm School of Economics 1909-29. Professor in economic history at the same school 1929-45. Heckscher was a prolific writer and apart from his scientific work produced many contributions to contemporary debates.<sup>15</sup>

**Holm.** Ragnar Holm (1879-1970). Became doctor in physics 1908. Employed at Siemens in Germany 1909-19. Employed at the testing and research office at the Telegraph Administration's technical department 1919-21. Lecturer at an engineering 'gymnasium' 1921-1927. Back at Siemens 1927-45, and finally employed at Stackpole Carbon Co in the US 1947-70.<sup>16</sup>

**Hultman.** Axel Hultman (1858-1932). Assistant at a department of the Royal Institute of Technology 1882-85. First Engineer at →Stockholm Bell Telephone 1885-88, and

<sup>14</sup> Hans Heimbürger, *Svenska Telegrafverket: Telefon, Telegraf och Radio, 1921-1945* (Karlskrona: Televerkets Centralförvaltning, 1974), p. 822.

<sup>15</sup> Rolf G.H. Henriksson, "Eli F. Heckscher: The Economic Historian as Economist," in *The History of Swedish Economic Thought*, ed. Bo Sandelin (London: Routledge, 1991), 141-167, pp. 141-142.

<sup>16</sup> Based on Thomas Kaiserfeld, *Vetenskap och karriär: Svenska fysiker som lektorer, akademiker och industriforskare under 1900-talets första hälft* (Lund: Arkiv, 1997).

managing director at the same company 1888-90. Telephone inspector at the →Telegraph Administration 1890-1903. Telephone director in Stockholm at the Telegraph Administration 1903-18. Chief engineer of the two merging Stockholm telephone networks run by the Telegraph Administration 1918-25.

**internal blocking.** The phenomena where some telephone calls are not put through an exchange due to the lack of free equipment within the exchange. Internal blocking appears when there is no system to queue the calls, in which case the congestion would appear as a waiting time for some callers. (see also →blocking).

**Johanson.** Sigurd Johanson (1883-1940). Engineer employed at →LM Ericsson from 1910 until 1917. Thereafter employed at the →Telegraph Administration.

**Johansson.** Hemming Johansson (1869-1955). Engineer at →SAT between 1893-98, thereafter employed at →LM Ericsson. Engineer-in-chief at LM Ericsson 1901-18, member of the company's board 1903-18, and the company's managing director 1909-18. Member of the board of →General Telephone LM Ericsson 1918-52, its managing director together with Gottlieb Piltz 1918-22 and with Karl Fredrik →Wincrantz 1922-25.

**Kåell.** Knut Kåell (1887-1962). Engineer with a Master of Engineering degree, who was employed at →LM Ericsson in 1911. He became engineer-in-chief at →Telephone LM Ericsson in 1946.

**Landström.** Karl Erik Landström (1866-1930). Engineer employed at the →Telegraph Administration. Landström had begun to work at the Telegraph Administration in the early 1890s. Line director in Norrköping 1903-07 thereafter the first telephone director in Gothenburg 1908-09. Head of the →Telegraph Administration's technical department 1909-20, thereafter head of the new fiscal department within the Telegraph Administration until 1928.

**Lienzén.** David Lienzén (1877-1938). Employed at the →Telegraph Administration's factory until its move to Nynäshamn in 1913. Thereafter employed at →LM Ericsson for a brief period, before being employed at the Administration's technical department. Left the Administration for LM Ericsson in 1917.

**Lignell.** Anders Lignell (1866-1943). Acting telephone director at the Telegraph Administration in Stockholm 1918-25. After the retirement of Axel →Hultman in 1925, Anders Lignell was appointed telephone director in Stockholm, a position he held until 1933.

**Lindhagen.** Carl Lindhagen (1860-1946). Member of Stockholm's city council 1903-09 and 1910-42. Member of Parliament, in the second chamber 1897-1917 and in the first chamber 1919-40. Lindhagen began his political career as a member of the Liberals but joined the Social Democratic party in 1909. Lindhagen presented numerous propositions in Parliament.

**Lindman.** Arvid Lindman (1862-1936). General director of the →Telegraph Administration 1904-07 (on leave from August 1905). Prime Minister 1906-11 and 1928-30, also Minister for Foreign Affairs during a brief period 1917. Party leader of the Conservative party 1912-35. Chairman of the board of →LM Ericsson 1916-18, and of →General Telephone LM Ericsson 1918-25.

**LM Ericsson** (1876-1918). Company founded in 1876 to produce telegraph equipment, but became soon oriented towards manufacturing telephone equipment. The company merged in 1918 with →SAT and became →General Telephone LM Ericsson.

**local battery system** (LB-system). A system where the speaking circuit between the exchange and the telephones was powered from local batteries in the telephone sets. A telephone set with a local battery was equipped with a crank used for signalling to the exchange that one desired to make a call or to signal to the operator that the call one had made was finished. See also →central battery system.

**local exchange**. A telephone switch where telephones are connected. A local exchange can either be a →main exchange or a →sub-exchange. See also →subscriber's line and →trunk exchange.

**local network**. A network of subscriber's lines. The local network is nowadays often referred to as the local loop. See also →subscriber's line.

**Löfgren**. Martin Löfgren (1880-1926). Engineer employed at →LM Ericsson in October 1912, after having worked in Austria and Germany for several employers including Siemens-Schuckert in Vienna (Oct. 1903 – July 1905) and Deutsche Telefonwerke in Berlin (Sept. 1911 – Sept. 1912).

**main exchange**. The main →local exchange within an urban centre.

**Montelius**. Wilhelm Montelius (1852-1918). Member of the board of →SAT 1883–1916, and Chairman of the board of →LM Ericsson 1901–16.

**multiple switch**. A manual switch with switchboards equipped with multiple connection jacks for each →subscriber's line.<sup>17</sup> This made it possible to switch calls to any of the subscribers connected to the exchange from each operator's position. A multiple switch was frequently (but far from exclusively) a →central battery system. If the multiple switch was not arranged with a →call-distributing system each operator's position served incoming calls from a designated subset of the exchange's subscribers, but could connect calls internal to the exchange by finding the desired subscriber on the multiple of connection jacks. In the absence of call distribution a multiple switch was arranged as either a →single cord or a →cord pair system.

**natural monopoly**. Concept within economics which has it that certain industries have such characteristics that competition is neither possible nor beneficial. The definition of the concept has changed several times since its emergence in the US at the end of the 19<sup>th</sup> century. Henry Carter →Adams and Richard T. →Ely are generally considered ranked among those central in forming the first notions contained in the concept of natural monopoly.

**New Autotelephone Betulander** (1913-1921, Swedish name: *Nya AB Autotelefon Betulander*). Company replacing the liquidated →Autotelephone Betulander. New Autotelephone Betulander was founded by Gotthilf Ansgarius →Betulander together with Swedish financiers in 1913. A consortia of the major shareholders entered into a

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<sup>17</sup> On multiple switches, see Erik Ekeberg, *Telefoni*, vol. 1 (Göteborg: Kungl. Telegrafverket, 1920), pp. 364-386, Robert J. Chapuis, *100 Years of Telephone Switching (1878-1978), Part 1: Manual and Electromechanical Switching (1878-1960's)* (Amsterdam: North-Holland Publishing Company, 1982), pp. 51-53.

major agreement with →General Telephone LM Ericsson at the end of 1919, and the company was subsequently acquired by General Telephone LM Ericsson. The company founded in 1913, together with Marconi Wireless Telegraph Co. in London, the Betulander Automatic Telephone Company Ltd.

**nominal call.** A call made by requesting the desired subscriber by providing its *name* instead of its number. In all but the smallest manual exchanges it was only possible to make nominal calls to subscribers who subscribed to a nominal call service, a service generally subscribed to by businesses and other establishments.

**Olson.** Herman Olson (1872-1934). Engineer at the technical department of the Telegraph Administration.

**open-wire line.** Telephone lines with no insulation, e.g., a →subscriber's line. Open-wire lines were cheaper, but were more open to influences from the environment and had to be run above ground.

**problematization.** A →translation that states an equivalence between two problems that requires those interested in solving one to accept a proposed solution for the other.<sup>18</sup>

**Palmgren.** Nils Palmgren (1888-1975). Employed at →Autotelefon Betulander and →New Autotelefon Betulander. When the latter was transferred to →General Telephone LM Ericsson in 1920, Palmgren transferred over as well and remained until his retirement.

**Pegelow.** Fredrik Pegelow (1852-1925). Master of Engineering. General director of the State Railway Administration 1907-13. Chairman of the board of →SAT 1904-18, and chairman of the board of →Stockholm Telephone 1908-18. Vice-chairman of the board of →General Telephone LM Ericsson 1918-25.

**Rydin, Axel.** Axel Rydin (1865-1935). Head of the →Telegraph Administration's technical department between 1902-09. Employed as a member of the Swedish Supreme Administrative Court from 1909 until his retirement in 1934.

**Rydin, Herman.** Herman Rydin (1861-1930). Education in law. Had several positions as clerk and auditor at such places as Parliament and the State Railway Administration, before coming to the →Telegraph Administration in 1897. He became first acting general director of the Telegraph Administration in 1905, after an interlude as office manager at the ministry of public administration. He became general director of the Telegraph Administration in 1907, a position he held until 1928.

**SAT, Stockholm General Telephone Co.** (1883-1918, Swedish name: *Stockholms Allmänna Telefonaktiebolag*). Company founded in 1883 by Henrik →Cedergren to operate a telephone network in Stockholm in competition with →Stockholm Bell, which it later acquired. The company subsequently expanded its telephone operating to

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<sup>18</sup> Adapted from glossary in Michel Callon, John Law, and Arie Rip, eds., *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World* (London: Macmillan Press, 1986), pp. xvi-xvii. On problematization see also Michel Callon, "Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St-Brieuc Bay," in *Power, Action and Belief: a New Sociology of Knowledge?*, ed. John Law (London: Sociological Review Monograph: Routledge & Kegan Paul, 1986), 196-233, pp. 203-206.

include ventures abroad. The company merged in 1918 with →LM Ericsson and became →General Telephone LM Ericsson.

**scenario.** A negotiated declaration of what constitutes an appropriate (or even inevitable) course of actions and events. A scenario is frequently embodied in texts and simultaneously defines the identities of the relevant elements and provides assertions of how these elements will benefit from the realisation of the scenario. A scenario thus involves attempted chains of →translation and in particular series of →problematisation, where the defined elements (or their representatives) are enticed (or even forced) to participate in realising the scenario.<sup>19</sup>

**Schotte.** Axel Schotte (1860-1923). Public official and Liberal politician. Minister of Public Administration 1905-06, 1911-14, 1917-19 (see →government). Member of Parliament 1909-21 (second chamber until 1919).

**semi-automatic switches.** There were many very different kinds of switching systems which were all labelled semi-automatic. In Sweden there gradually emerged the general idea that a semi-automatic switch referred to a switch where the operators completed calls by pushing buttons rather than using jacks and cords.

**single cord system.** An arrangement employed at a (manual) →multiple switch, and often contrasted with two other arrangements of manual multiple switches; the →call-distributing system and the →cord pair system. In the single cord system the operator receiving the call connected with a key to the caller's line to get the desired number before completing the connection by inserting a cord in the desired jack at the multiple.

**Staaff.** Karl Staaff (1860-1915). Worked as a lawyer in Stockholm between 1893 and 1905. Member of Parliament from 1897, member of the Liberal party from 1900, and its leader from 1905. Prime Minister 1905-06 and again 1911-14 (see →government).

**stabilisation.** The process by which a network of heterogeneous elements becomes strengthened and more stable, be it a fact, a machine, or a techno-economic network. Stabilisation signifies the gradual settlement of the negotiations (and often even controversies) concerning the identity, role and workings of the different elements constituting the stabilised network which as an outcome may appear as a →black box or a network of black boxes. The characteristics of the stabilised entity is denoted in its →configuration. The negotiations and controversies making up a process of stabilisation involve the precarious establishment of chains of →translation where →scenarios constitute one form of attempt of enrolment and thus stabilisation.

**Stockholm Bell Telephone** (1880-1907, Swedish name: *Stockholms Bell Telefon Aktiebolag*). A subsidiary of the American International Bell Telephone Company. The majority of the shares in Stockholm Bell Telephone were acquired by →SAT in 1888 and the Bell network in Stockholm was later merged with SAT's network. The company ceased as an operating company (if not as a legal entity) at the end of 1907 when the Stockholm telephone networks of SAT and Stockholm Bell Telephone was transferred to the new subsidiary of SAT, →Stockholm Telephone.

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<sup>19</sup> The notion of scenario is similar to the notion of an obligatory point of passage, with the difference that the scenario signifies an *attempt* to establish an obligatory point of passage. On obligatory point of passage, see Callon, "Some Elements of a Sociology of Translation," pp. 205-206.

**Stockholm Telephone** (1908-1918, Swedish name: *Aktiebolaget Stockholmstelefon*). Subsidiary of →SAT operating a telephone network in the Stockholm region until 1 July 1918 after which its network was gradually incorporated with that of the →Telegraph Administration.

**Storckenfeldt**. Erik Storckenfeldt (1847-1902). Erik Storckenfeldt had been the general director at the Telegraph Administration between 1890 and 1902. He has generally been closely associated with the large expansion of the state-owned telephone network during this period.<sup>20</sup>

**sub-exchange**. A →local exchange connected to a →main exchange, which is the main exchange within an urban centre.

**subscriber's line**. The line that connects a telephone to a local exchange. A network of subscriber's lines is referred to as the →local network.

**techno-economic network**. An understanding of a field of economic activity as an inter-linked set of heterogeneous elements which interact to develop, produce, distribute and diffuse methods for generating goods and services.<sup>21</sup>

**Telegraph Administration** (1853-1953, Swedish name: *Telegrafverket*). Founded in 1853 responsible for erecting and managing the national telegraph network. Ventured gradually into telephony as well.

**Telegraph Administration, headquarters**. *Telegrafstyrelsen* (Swedish name). The headquarters contained several bureaux, including the →technical department, the administrative department and the traffic department.

**Telegraph Administration, the factory**. *Telegrafverkets verkstad* (Swedish name). A branch of the Telegraph Administration founded in 1891 for performing repair and manufacturing of telecommunications equipment. When the factory was moved to Nynäshamn south of Stockholm in 1913, it employed more than 400 workers.

**Telegraph Administration, the technical department**. *Linjebyrån* (Swedish name). One of the bureaux making up the →Telegraph Administration's headquarters. Among its fields of activities were acquisition and maintenance of the Administration's house properties, design of equipment, and the technical equipment of exchanges.

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<sup>20</sup> On Storckenfeldt as general director see, for instance, the chapter entitled 'the obituary of general director Storckenfeldt' in Heimbürger, *Det Statliga Telefonväsendet, 1881-1902*, pp. 315-320.

<sup>21</sup> The definition is adapted from Michel Callon, "Techno-economic Networks and Irreversibility," in *A Sociology of Monsters: Essays on Power, Technology and Domination*, ed. John Law (London: Routledge, 1991), 132-164, p. 133. The notion of techno-economic network is close to what the 'market-as-networks' tradition has denoted industrial networks, but lacks the a priori distinction between network of relationships and technological system or actors and resources. Confer, for instance, Jan Johanson and Lars-Gunnar Mattsson, "Network Positions and Strategic Action: An Analytical Framework," in *Industrial Networks: A New View of Reality*, ed. Björn Axelsson and Geoffrey Easton (London: Routledge, 1992), 205-217 and Anders Lundgren, *Technological Innovation and Network Evolution* (London: Routledge, 1995), p. 94.

**Telephone exchanges in Stockholm.** Depicted below are the telephone exchanges of the two networks in the city of Stockholm as well as the locations of three automatic test-exchanges.

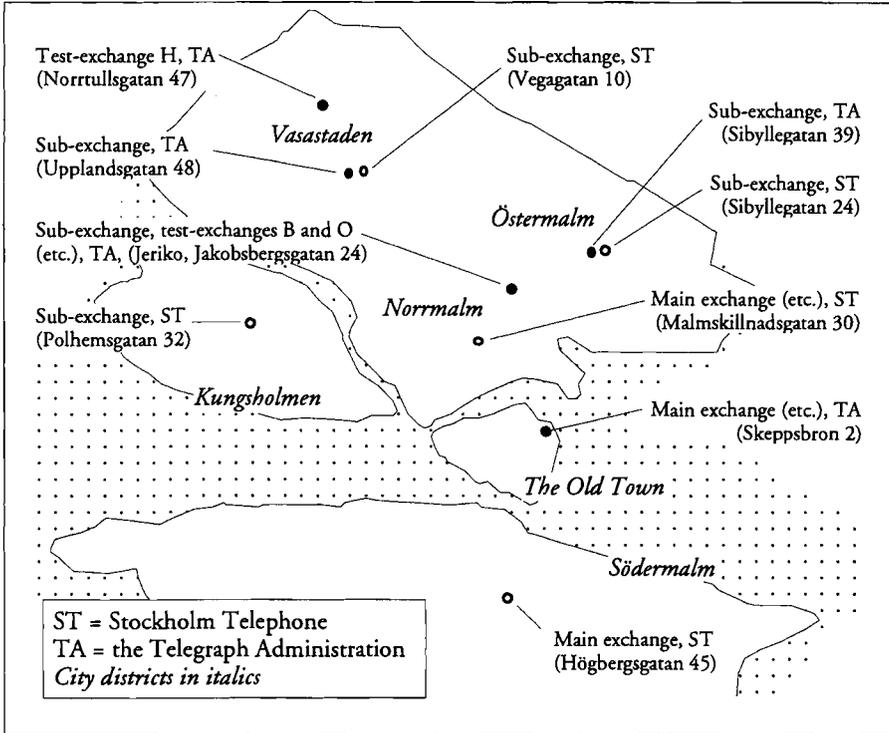


Figure G-1 Telephone exchanges in Stockholm, 1918.<sup>22</sup>

**Telephone LM Ericsson** (1926-, Swedish name: *Telefon AB LM Ericsson*). See →General Telephone LM Ericsson.

**translation.** The work of linking elements, of making dissimilar elements equivalent. Translation captures the work of enrolment during which the identity, role and workings of the elements are negotiated.<sup>23</sup>

**trunk exchange.** A telephone exchange where →trunk lines are connected. Often there are special trunk exchanges that handle inter-urban traffic and consequently have no →subscriber’s lines directly connected to them.

**trunk lines.** The telephone lines connecting different →telephone exchanges within an urban centre. There are, for instance, trunk lines between two local exchanges as well as between the local exchanges and an inter-urban exchange.

<sup>22</sup> Map based on Hugo Lindberg, *Med Fingerskiva: Minnesskrift med anledning av Stockholms telefonnätets automatisering* (Stockholm: Telegrafstyrelsen, 1938), p. 37v.

<sup>23</sup> On translation see, for instance, Callon, “Some Elements of a Sociology of Translation,” and Callon, “The Sociology of an Actor-Network,” pp. 24-28.

**trunking.** Connecting telephone traffic between exchanges. In manual switching trunking between exchanges within the same urban area was a particular consideration, since trunking always required more than one operator to deliver the call.

**Vennersten.** Axel Vennersten (1863-1948). Industrialist and conservative politician. Member of Parliament 1906-36, and Minister of Finance in the Hammarskjöld ministry 1914-17 (→ government).

**von Sydow.** Oscar von Sydow (1873-1936). Government official. Minister of Public Administration 1914-17, and Prime Minister in a caretaker ministry 1921 (→ government).

**Weman.** Klas Weman (1872-1966). Employed at →LM Ericsson in 1895 as one of the company's very first engineers who had a degree in engineering. Weman was for a time technical director of the company's factory in Russia, and from 1902 until 1909 he worked for the company in the United States. Head of the →Telegraph Administration's factory 1909-1917 and 1920-1930. He then worked for →Telephone LM Ericsson until 1933 when he became managing director of the Carbon company in Stockholm.

**Wincrantz.** Karl Fredrik Wincrantz (1874-1932). Engineer. Worked as an assistant at the →Telegraph Administration between 1893 and 1900. After working at the Swedish Patent Office for a brief period he became employed at SAT in 1900 and became managing director of Stockholm Telephone in 1910, a position he held until 1918. Between 1918 and 1921 managing director of →General Industry HT Cedergren, and between 1922 and 1925 managing director together with Hemming Johansson of →General Telephone LM Ericsson. Managing director of Telephone LM Ericsson between 1925 and 1930.



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### Archival sources, abbreviations used

- TA Telegrafverket Archives  
TALb: Telegrafverket Archives, Telegrafstyrelsen, linjebyrån, 1896-1941  
TAAb: Telegrafverket Archives, Telegrafstyrelsen, administrativa byrån / ekonomi och kanslybyrån, 1879-1941
- LA LM Ericsson & Co Archives  
Unpublished manuscript concerning the history of LM Ericsson from 1928.

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