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The Televerket ISDN project: an examination of the rationale to invest

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Abstract: The purpose of this thesis is to evaluate the Swedish Televerket's ISDN infrastructure project which ran from the mid-1980s to the end of the 1990s as an example of firm technological decision making. By drawing upon the analytical models of the behavioral and the managerial theory of firm decision making this thesis comprehensively examines the available primary and secondary sources to identify the grounds for the decision to invest. This allows for an evaluation of the sufficiency of either theory in explaining why economically inefficient projects are enacted. The findings suggest that either theory in isolation does not sufficiently explain the underlying mechanisms of technological decision making in this case.

Keywords: Technological decision making, ISDN, Televerket, Agency theory, Technological cycles, Infrastructure, Communications Technology

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Introduction

Among the questions we ask of firms are the reasons for the heterogeneous technologies chosen and the different outcomes they experience. Why do some firms thrive over time while others wither? Why do some firms make shrewd choices and reap the associated benefits whereas others do not? Why can one investment planning process, applied mechanically to all technological choices, return such different results in different times? In short, why do some decisions and investments of company capital in new technology fail to elicit a corresponding increase in profitability?

Technology investment has many of the standard characteristics of the typical strategic choices made by firms, in that there are degrees of uncertainty regarding both growth potential and profitability. However, they do differ from other types of projects that consume company resources. This is especially true when the goal is to be an industry leader in pushing the technological boundary. Betting on a certain technology will lay down deeper linkages within the company that should give the company a competitive edge, but this may become a handicap if it turns out that the firm has geared itself towards the wrong technology. The competitive forces of the market economy ruthlessly rationalize the available technologies by rewarding the ascendant choice of technology with further resources to cement its lead. It is therefore paramount to the survival of a firm that decisions regarding technology be given strong and serious consideration.

This thesis will explore the workings of a technological project during a time of rapid technological change. Primarily the aim is to evaluate the sufficiency of two institutionalized models in isolation in explaining the technological decision making process. In order to accomplish this, it evaluates primary and secondary source material from Swedish Televerket regarding the decision to invest in the ISDN technology in Sweden. Descriptively a project can be said to be initiated to either benefit owners or managers, but the process by which such a project becomes enacted is less well known in a state-owned enterprise. Using case study methodology, this thesis sheds light on the decision to invest by viewing the information available through the lenses of two seminal theories of firm decision making, the behavioral theory and the managerial theory. It operationalizes the two broader theories as testable a-priori expectations by drawing upon the free cash flow agency hypothesis and the technological revolutions cycles of financial malinvestment. By analyzing the project through this

method it elucidates on what basis the decision was made and the shortcomings of either theory in comprehensively describing the process.

Literature Review

Any technology decision made will be made within and affected by a greater network of elements than simply those directly responsible for the decision-making process. The greater scope of the firm's constituent parts and their associated power to influence decisions taken within the firm form one such environment and explanation. The stakeholders of the firm, dichotomized as owners and managers, may have disparate goals that do not always jointly align; this managerial view of goal misalignment will lead to a history of decisions which when viewed solely through the lens of one stakeholder's interests will seem erratic. The managerial theory of firm decision making allows for the two factions to work together in mutually beneficial ways, but only up to a point. Once a level of certainty of survival for the firm has been reached, their interests begin to misalign and managers will maximize their own benefit through their influence in the firm to the detriment of the owners.^{1 2 3}

The larger and more diffuse macro-environment is that of the surrounding economy and the competitive, technological and social forces that affect the firm. The long cyclical turn of growth, Kondratiev waves, has had many explanations, the most conventional being technological development and diffusion.⁴ As a major technological event develops and diffuses itself through the economy, it spawns new industries and transforms others. As these forces develop and change through the actions of innumerable sub-elements beyond the scope of the individual firm, they nonetheless come to exercise a powerful coordinating role in forcing each firm to inexorably develop itself. Depending on where in the cycle a certain decision has to be taken, the same behavior will have very different outcomes. Though disparate over time, the direction of development will on some occasions be more predictable than on others, such that developed learning and built-up knowhow will be more beneficial in choosing the best future path. The watershed technological moments are not immediately visible to those living through them, but are instead labeled post-fact. When such a technological watershed is about to be crossed, deep-grooved thinking may hinder the

¹ Baumol, W. J. (1962). On the Theory of Expansion of the Firm. *The American Economic Review*, 52(5), 1078-1087.

² Marris, R., & Mueller, D. C. (1980). The Corporation, Competition, and the Invisible Hand. *Journal of Economic Literature*, 18(1), 32-63.

³ Marris, R. (1998). *Managerial capitalism in retrospect*. London: MacMillan. Ch. 5

⁴ Perez, C. (2014). *Technological revolutions and financial capital: The dynamics of bubbles and golden ages*. Cheltenham: Edward Elgar.

realization of the new paradigm, instead defaulting to what worked previously under very different circumstances. In this way of thinking there are parallels to the behavioral theory of the firm wherein decisions are not considered to be taken under circumstances of perfect information.^{5 6} Instead, the elements of the firm act within the constraints of a bounded rationality, where the most optimal choices of profit maximization are not taken, not due to conflicting interest but rather through lack of foresight.^{7 8} The bounds of what can be conceived of and how certain the assumed outcome for a given technological project is will shift according to the phase of a technological era.⁹ As the boundaries become more constraining and the options within less assured, the decision-making agent will be even more likely to rely on cautionary heuristics at precisely the wrong moment.^{10 11}

The problem at hand is not necessarily which project a firm should invest in, but rather which kind of attitude or regime would enable the firm to take the best available path when faced with uncertainty. However decisions are not always taken with the top down-rationale of solely benefiting the owner, other stakeholders in the firm will likewise try to maximize their dividend from employment. There is a vein of research into the effects of free cash flows (FCF) on firm behavior.¹² ^{13 14} There is also thorough theorization on the agency aspect of general investment within private firms, of which technology is a part, with not least the analytical tool of free cash flows helping to elucidate the problem of overinvestment and suggesting debt financing as a solution.¹⁵ The agency aspect then has been thoroughly explored in listed companies, by examining the two main ways of creating shareholder value and the way they interact to form the playing field for the different agents. State-owned enterprises or monopolies have access to the same avenues of shareholder value creation but with an added permeability through the diffuse influence of the government and the

⁵ Cyert, R. M., Dill, W. R., & March, J. G. (1958). The Role of Expectations in Business Decision Making. *Administrative Science Quarterly*, 3(3), 307-340.

⁶ Cyert, R. M., & March, J. G. (1992). *A behavioral theory of the firm*. Cambridge, Mass: Blackwell.

⁷ Miner, J. B. (2006). *Organizational Behavior 2*. Armonk: M.E Sharpe.ch.4

⁸ March, J. G. (1990). *Decisions and organizations*. Cambridge, Mass.: Blackwell.

⁹ Perez, C. (2014). *Technological revolutions and financial capital: The dynamics of bubbles and golden ages*. Cheltenham: Edward Elgar.

¹⁰ Cyert, R. M., Simon, H. A., & Trow, D. B. (1956). Observation of a Business Decision. *The Journal of Business*, 29(4), 237.

¹¹ Perez, C. (2014). *Technological revolutions and financial capital: The dynamics of bubbles and golden ages*. Cheltenham: Edward Elgar.

¹² Schleifer, A. (1997). A survey of Corporate Governance. *The Journal of Finance*, 52(2), 737-783.

¹³ Shleifer, A., & Vishny, R. W. (1989). Management Entrenchment The Case of Manager-Specific Investments. *Journal of Financial Economics*, 25(1), 123-139.

¹⁴ Richardson, S. (2006). Over-investment of free cash flow. *Review of Accounting Studies*, 11(2-3), 159-189.

¹⁵ Jensen, M. C., & Meckling, W. H. (1976). Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure. *Journal of Financial Economics*, 3(4) 305-360.

people it is beholden to. This removal of insulation has been noted in resource rich economies where inefficiencies appear among state owned monopolies as their stakeholders can affect them in a way that would not be possible were it a privately-owned company¹⁶.

The agency aspects of state ownership are then often presumed, rather than known. There is a case for examining a technology investment using the available analytical tools of the managerial and behavioral theory of firm decision making and identifying the purported drivers of inefficiencies in both. Should it turn out that the case is too heterogeneous to be of general relevance it can nevertheless add to theory, by extending the scope of current theories or suggesting the need to develop them further. Should it turn out that many of the purported drivers of inefficiencies exist in a predictable way, it is an addition to empirics about agency and technological bewilderment.

Background

For most of the 20th century the Swedish utilities monopoly Televerket/Telia (Tvt) was state owned and run as a semi-private company with the dual mission of both earning money for the state budget as well as developing information infrastructure in Sweden, making it available and affordable to businesses and the greater public. This dual mission created a multitude of impulses for the direction of the firm, serving different purposes, often in competition with one another. As digitalization comprehensively began affecting the core business model many different technological projects opened up. Tvt was in the last quarter century profitable, creating large cash flows which could enable future investments or which could be appropriated by the Swedish state for other purposes.

¹⁷Some of these investments were to be great successes, such as the AXE project of early digitalization of exchanges, others were not. This then is an auspicious time to ask the aforementioned questions. ¹⁸

The ISDN-net was conceived of in the 1980s as a way to digitalize the last-mile transmission of voice traffic while also providing a data transfer capability. It was after some delays finally implemented in 1993, after which it quickly matured as a product and new investments discontinued. When the decision was made to invest there were ambitious plans for adoption rates

¹⁶ Shafer, M. (1983). Capturing the mineral multinationals: Advantage or disadvantage? *International Organization*, 37(01), 93-119. doi:10.1017/s0020818300004215

¹⁷ Carlsson, R. H., & Hallberg, M. (1997). *Ägarstyrning: Om Corporate Governance från Wallenbergsfär till offentlig sektor*. Stockholm: Ekerlid. Ch.5

¹⁸ Carleheden, S. (1999). *Telemonopolens strategier: En studie av telekommunikationsmonopolens strategiska beteende vid liberalisering av teleoperatörsbranschen*. Lund: Lund University Press. Ch. 4 & 5

and profitability, with the ISDN-net offering significant benefits over then current systems at the cost of a substantial investment. Its commercial deployment was much delayed and more importantly was soon surpassed by the ADSL data transfer network, which allowed for much faster rates at a substantially lower cost to the consumer. With the benefit of hindsight, the ISDN-net in fact looks certain to have been a technological dead-end that required large investments to get off the ground.

Research question

I will in this thesis examine in depth the rationale for taking the decision to invest in an ISDN network. I will examine the project through the lens of the different theories of firm behavior as they relate to technological investment decisions. Using the frameworks provided by Jensen and Perez as a basis to operationalize the scope and ask a-priori questions to the source material. Why was this decision taken and by which logic did the internal processes of the firm conceive of it? Was the decision taken to benefit the owner or management? Was it simply a natural process of path dependency, as a firm exhausts the technologies at the end of an expansion cycle? What do the different perspectives show and what do they obscure?

Theory

To answer these questions, the available sources relating to the ISDN project will be evaluated through the lens of two major theories of firm behavior, behavioral and managerial. The behavioral theory will be reduced in scope to fashion a useful analytical tool, the cyclical malinvestment and crisis models as conceptualized by Schön¹⁹ and Perez²⁰. The managerial theory is also reduced to allow for analysis, by conceptualizing the dilemma around the free cash flow model as described by Jensen.²¹ However, by looking not at the cash flows per se but rather the available information and drivers of the decision to carry out and continue the project, we can identify the suggested agency channels as purported. If a coherent narrative can be formed for either or both views it will help shed light on the rather empirically unexplored area of technological decision making in times of rapid change within state owned enterprises (SOEs).

¹⁹ Schön, L. (2012). *En modern svensk ekonomisk historia*. Stockholm: SNS förlag.

²⁰ Perez, C. (2014). *Technological revolutions and financial capital: The dynamics of bubbles and golden ages*. Cheltenham: Edward Elgar.

²¹ Jensen, M. C. (1986). Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. *The American Economic Review*, 76(2), 323-329.

In the cyclical view, sectors and economies at large go through cycles of expansion, change, stability and crisis; these cycles are built around a technology which during the economic cycle itself goes through rapid development and expansion in use. As the cycle comes to an end, the crises that spawned are due to accumulated capital seeking investment opportunities where there are none. The growth potential of that particular family of technologies has been exhausted. As the crisis dies down and capital has to go further afar to find returns, a new family of technologies appears to take the lead in a new cycle. At the end of the 1980s the conventional telephone network in Sweden was fully expanded, telephones per capita was among the highest in the world and the characteristics of the Swedish market had in many ways more in common with the mature North American markets (Canada, USA) than with continental European markets that still had a backlog of demand. Tvt was at a watershed technological moment in its history.

It is also possible that the decision to invest was taken at the behest of, or rather under the cover of, the sometimes nebulous and contradictory purposes of the owner. Benefiting the greater society at cost to the firm while placating the Swedish state through a project with a political impetus, such as maintaining a digital lead, would have been likely to conflict. The managerial theory of firm behaviors', an agency problem-centric view, is encapsulated by the financial theory of free cash flow capture. This theory is grounded in the conviction that the windfalls from a successful business will experience competition between the different stakeholders for their use. In this case the stakeholders are the Swedish state as the owner and the management of Televerket/Telia. The position of management is dependent on the quantity of the resources that belong to the owner—equity—and that are present in the company, these implicitly are the tools through which they earn their keep. There is thus a misalignment of goals; with the owner looking to payout the optimal amount and management only paying out the bare minimum to placate owners. The owner theoretically holds all of the power in the relationship, yet the manager has a much better insight into the firm. They will both use the tools at their disposal to further their sometimes at-odds goals. Large uninvested profits therefore run counter to the wishes of management. Their liquidity make them easy to disburse and their mere existence implies that there are not enough net positive value investments available to tie up capital. If that is indeed the case, management in this model of agency will then try to pass off projects that have a negative present value as beneficial to the owner.

These two views of the ISDN project, the cynical and the fatalistic, together form an exhaustive set of possibilities for why it was enacted. In either case it is important to deduce why it was put into

action. In the case of a well-meaning but ineffective and untimely investment, the rationale should be given careful consideration as the decision-making process was not rigorous enough in this time of uncertainty. In the case of management capture, the agency problem is laid bare and may point to ways in which to mitigate this, not least in SOE's and utility monopolies.

Decisions and outcomes

Any investment, be it of time or money, is an exertion of resources and as such has to have a purpose for the acting agent. The firm exerts resources in order to strengthen its position and secure its future. The actions it takes can be most clearly seen through the lens of that perspective; the teleological purpose of the firm is not however to just survive, rather paying some form of dividend to the physical owner takes precedence. The survival of the firm thus becomes, reliant on providing just that, or at the very least a probable future in which it will. The sets of actions that benefit the owner and those that benefit the firm overlap but are not proper subsets. As such the actors whose fortunes are tied more closely to that of survival of the firm, such as a salaried employee with no ownership, than with those of the shareholders will in some cases benefit from acting in a way that furthers their own interests while hindering those of the owners. The outcomes that a manager will see as beneficial will also extend outside of that which is either beneficial for the firm or the owner. If the firm's primary purpose is to amass as much resources as possible, the managers' impetus is to either control these resources within the context of the firm or expend them in such a way as to benefit themselves. This could take the shape of either pursuing a project which brings benefit to the employee but not to the profit goal of the company or by frittering away resources on pure frivolities, corner offices and private jets. In other words there exists an agency problem for firms' owners and a large academic literature has been devoted to identifying and suggesting policies which would help mitigate or eliminate these problems.

The purpose of a project, as used here, would best be described as that underlying motive which given the best possible available information most actors would understand to be the rationale behind the project. Most, because it is possible that actors will have differing ideas of how a specific project would come to benefit them, even when privy to the exact same information. Additionally, the actual truest likely outcome of a project may be obscured to anyone involved by lack of information and so their decision, and the project's commencement, is grounded on their best guess.

With this conceptualization, at the nascent side of an investment decision process three different options exist regarding its purpose. The purpose could be to solely serve the owners' interests, such

as a liquidation of a loss-making firm or any investment that strengthens the owners position at the cost of the agents. It could serve the interest of managers and owners mutually, any decision which will increase earnings at or above the cost of capital for the firm fall within this field. Lastly it could solely serve the interests of managers (used here as a non-owner entity involved in the running of the firm), examples include empire building and prestige projects or investments which do not justify the cost of capital. Optimally, only investments which benefit the owner would be allowed to be carried out; the owner would not assent to employing their capital in a way that was not beneficial to them. In practice however, through poor monitoring or managerial subterfuge, managers with superior access to information could well know that the decision will primarily serve their interests.

When looking at the results from chosen strategies the set of outcomes overlaps that of the reasons for enacting an action. That is, the outcome of a decision, if successful, can benefit the owner, the managers or both. The actual outcome, when teleologically viewing the firm, is only successful if it falls within the scope of benefiting the principal (see fig.1). But the set of outcomes stretches further than the initial rationale for taking a decision. There is also the possibility of the outcome being to the benefit of neither, such as with a poorly conceived ex-ante investment decision or a risk that does not pay off, even though the ex-ante reasoning may have been sound. Regardless of whether it benefited the agents or not, any investment outcome that ended up not producing the anticipated gains would be up for review. It is immaterial whether managers benefited as only those decisions which benefit the owner's interest lie in line with the purpose of the firm.

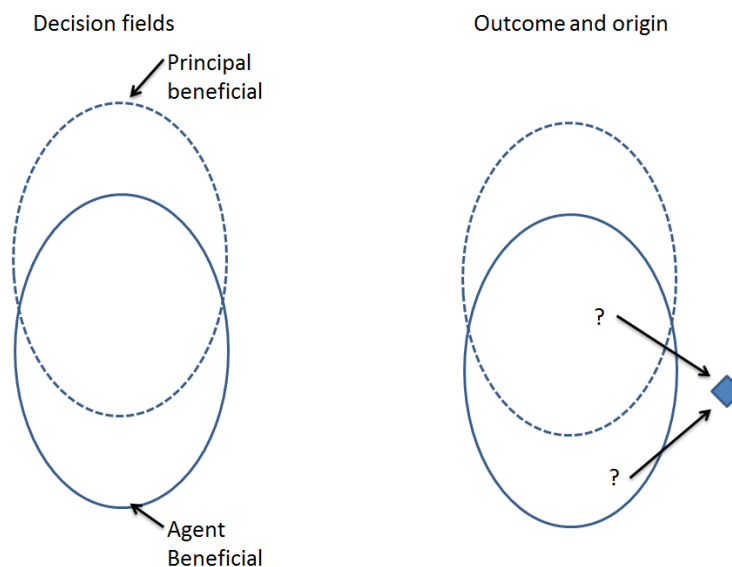


Fig.1 A visualized explanation of investment decisions and their outcomes

Even an actor with nigh on perfect information will not be able to properly anticipate how the exact outcome will come to serve their interests. While the decision may have been taken in the interest of serving the owners it may in the end serve managers and vice versa. There is a great deal of uncertainty ex-ante which results a decision will deliver. For an ex-post monitor, whether firm associated or impassioned observer, a mirror problem exists. It is less fraught with difficulty to determine the actual outcome of the decision to invest, but is again substantially more difficult to ascertain whence the original impetus came. The crossing of the investment event-frontier inverts the point of inquisition; once the outcome is known with some certainty the question becomes which prior behaviors to encourage and which to curtail. Answering this question is important, without adequate historical and empirical knowledge any pure ex-ante theorizing on how to better run firms will be mired in endless dead-ends and exhausting inquiries. This difficulty is well recognized within firms which therefore require substantial resources be spent on activities which add no benefit to immediate projects but which will inform future ones. This creates a wealth of primary and secondary sources in the form of internal strategy documents, correspondence, board minutes, financial statements, and multi-year plans. By studying these sources and applying a source critical method a researcher can hope to deduce the underlying motives of an investment decision.

Agency Theory and Free Cash Flows

The agency theory of free cash flow contends that though increasing the wealth of the shareholders is the stated purpose of a firm, the relationship between managers and owners is one of competing interests. The managers of the firm are loath to part with resources over which they can exercise control. Instead of paying out the profits which to an external monitor will appear as free cash flow a manager interested only in furthering his own interests will aim to keep the resources in the firm through reinvestment. Often this occurs in projects which would not meet the normal profitability criteria for a profitable investment. Jensen²² suggests that one way of sidestepping the monitoring costs of proper investments is to increase the leverage of a firm, paying out the principal of the debt and using the interest payments to offset any free cash flow. Effectively this outsources the monitoring to the market through the demands of regular interest payments.

²² Jensen, M. C. (1986). Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. *The American Economic Review*, 76(2), 323-329.

This model relies on the conventional and somewhat myopic, though reliable, view of evaluating success for a private firm. Though there are other analytical frameworks to evaluate the success of a company, this is by far the most commonly used. A firm's taken course will rarely be questioned so long as it delivers returns for shareholders. For an SOE, public utility or other monopoly in which the state is a substantial or majority shareholder there is a broader range of ways in which shareholder value can be created. As such, it would be remiss not to evaluate decisions taken by an SOE differently. The expanded ways in which an SOE can benefit the state are fourfold, the characteristics of which are decided and shaped by the market composition as well as the nature of the company. First, it can simply deliver profits which help the state pay for its budget, completely analogous to paying profits to shareholders. Second, profits can be reinvested in projects with a positive present value and so increase the potential future dividends. Third, a firm can lower its prices or tariffs in order to benefit the customers, which in turn exercise influence on the state. This decrease in monopoly power, resulting from the tariff decrease, is in effect a dispersed dividend as the benefit flows from the firm straight to its customers bypassing the state which could conceivably pay out the profits in the form of a tax credit or similar instrument to the taxpayer. Fourth, a firm can serve political purposes by investing in projects which have positive externalities for the society as a whole beyond the scope of the firm. By investing in untried technologies or products the SOE's alternate motivating principles, as expressed through the all-encompassing stake of the state in the economy, should allow it to conceive of and execute projects which primarily or partly enrich others, a public good. Note that this project need not make economic sense for the firm in question. In fact, what signifies it as a public good project outside of the scope of profit-maximizing investments is that it will negatively affect the bottom line of the company, but should benefit the country at large. An example of this would be the uneconomical coverage requirements for telecom companies. These projects need not even be in line with the main activity of the SOE, instead it's resources or expertise can be marshaled for projects which benefit the owner or some influencer of the owner. The important distinction in the latter case is that some nominal control of the project, though sometimes imposed, still lies with the SOE.

As their created values are not easily measured the last two forms of owner beneficial firm actions are more nebulous in terms of evaluation and monitoring. Jensen suggests that free cash flows and their use is likely to enable the managers of firms who will invest not to the benefit the shareholder but rather themselves, whether through prestige projects or by not inviting the monitoring of the

market on their actions. If investments for ostensible economic gain are subject to managerial corruption then the SOE unique strategy is also open to such. Deducing whether a public good has been created and what its magnitude is harder to evaluate than what wealth has been gained through shrewd investing or dividends.

Instead of investing in net positive public goods projects, the alternate ways stated above for creating shareholder value opens up more opportunities for management capture of the available resources. In the above specified decision model these types of projects have a hard to monitor outcome as well as a difficult to deduce ex-ante rationale. For management the additional channels through which to influence owners ought to allow for a wider variety of projects to convincingly frame as owner beneficial, regardless of whether or not they actually are. In fact, it is possible to view the differing investment strategies as beneficial to the different actors, owners and managers, in inverse proportion. This agency problem centric view naturally discards the situation in which there is no conflict between management and owners. Management of a firm will evaluate the negatives of an action from two different aspects, whether or not control of resources is lost and whether or not monitoring increases. They have the same basic outcome in terms of constraining managers but differ in the obvious sense of resources staying inside the firm. Dependent on whether or not they value this quality of control of resources over their magnitude, they will prefer one set of strategies over the other.

Of the two strategies available to both firms the least uncertain strategy to owners, with uncertainty here defined as the degree to which negative outcomes from pursuing a strategy will occur, will be dividends followed by firm profit maximizing investments. With a sure dividend based on the free cash flows there is less risk to the owner, not all investments will in the end turn out to increase future profits. From the managers point of view the only action which retains control of the resources is the re-investment strategy and will so be partial to that. For the SOE owner, of the two subsequent strategies, tariff reduction and public good investment, the latter is analogously more uncertain. Here the SOE strategies invite the least monitoring of actions. It is quite likely that the firm's management will have a large degree of say in the specification of tariff reduction as well as the implementation of any public good project.

There then exists problems of alignment of preferences between owners and managers, with the preferences of one not serving the other. Beyond the scope of listed firms and other privately owned companies, there is a dearth of insight into SOE agency issues, which are broader in scope for the

above stated reasons. What does this struggle of interest look like? What is the decision making process of an SOE and in what material ways does it differ from a listed company?

The ideal situation to examine this question would involve a subject firm which could, and was expected to, create value through all four shareholder value avenues. A public telecoms monopoly such as was common for most of the 20th century will allow an in depth examination of these questions. The core business model was vastly profitable, as opposed to a loss making SOEs, and creates the required free cash flows which the agency struggle focuses on. This, combined with the rapid cost-cutting technological development in the sector, creates pressure from both owners and customers to pay out, in the form of dividends or lower tariffs. They had an important coordinating function in the economy by setting standards and being responsible for an expansion of information infrastructure, thus allowing a thorough examination of the public goods avenue.

In order to disprove or prove the hypothesis of management capture of the free cash flows, the source material would have to yield evidence of managerial collusion, that is, acting against the interests of the owners in a way which would not be immediately obvious to the owner. Finding evidence in the rationale for the project suggesting it would either keep resources within the company or decrease monitoring would fit this bill; especially if this information was only apparent in “lower level documents” such as internal strategy documents and PMs to which the owner would not be easily privy to. Not only what is readily evident about the ISDN project is of importance, what is lacking from the investment planning can actually yield important insights too. The absence of well thought out business plans, timelines and follow-ups would indicate that the firm is not too concerned with it being a success. The firm faces a similar problem to the owner in that it can spend resources to monitor a project’s progress; if it was never intended to be, or was not highly prioritized to be successful too much monitoring could reveal that too. Generally speaking, the more concrete the goals for the project the more likely it would be that it was actually enacted in the spirit of creating some return for the owner, whether through financial resources or public gain.

Cyclical malinvestment

The cyclical malinvestment explanation of a failed investment strategy is a macro-economic explanatory model; the ebb and flow of technological innovation is taken out of the hands of individual firms and decision takers. Instead, the great technology clusters of the modern world, mechanization, steam power, electrification, combustion engine, and information technology are the foci of the transformative forces that then spread through the economy.

In Perez's work the large era-like developments are conceived of as a repetitive cycle of irruption, frenzy, crisis, synergetic expansion, and finally maturity. The characteristics of this cycle of diffusion of the potential of the technology can be described as logistic, the middle period characterized by exponential growth whereas the initial and final stages have a much slower expansion. As these two end-stages overlap from one technological era to another, they form a transitional period. From usually quite limited beginnings the technology reaches a point of technical sophistication where it becomes clear that it will be the wave of the future. What comes next is a period of frenzied expansion and financial exuberance where growth in uses and adoption exhibit a convex pattern of increasingly rapid adoption. What follows is a crisis, the unrealistic expectations of an economy based on the new technology which will grow beyond all bounds face up to a harsh reality. However, in the embers of the crisis lies the future of implementation, a take-off point where the initial questions of which configuration of production, regulation and product design will be preeminent have been answered. After this, a period of synergetic expansion follows in which the technology is adopted in more and more modes of production. This period is characterized by more realistic expectations on the technology by investors and a prudent use of their resources by producers. As the technology reaches more and more areas they are transformed by it and a hybrid mode of production appears; we still plow fields, but we do it with tractors, not oxen. As the technology reaches the end of the synergy phase maturity sets in. Instead of rapid factor expansion in the sense of more fields of production taking up the new technology and growth being exponential it instead becomes reliant on incremental improvements in the underlying technology, which benefit the fields that have adopted the technology already. The end of the technological cluster is near and what follows is a crisis; the large financial gains from the period of expansion are still seeking investment opportunities which the underlying technology is not able to provide. As the projected gains fail to materialize growth flounders and the financial exuberance cultivated in the expansion phase has to be reined in. The realization that the current technology cluster cannot provide the foundations for future growth lead financiers further afield, which enables and nurtures the next technology cluster.

In the case of Televerket/Telia the basic underlying technology at our time of inquiry is one of electrification, which Perez sees as the third epoch; the technology choice of investing in the ISDN project appears as a mature or even stagnant technological field is transformed by the intersection with a new one. The analog technology of replicating the human voice over large distances had at

this time reached its maturity, both technologically and adoption-wise; the widespread adoption of land-lines in Sweden left few avenues for future growth through conventional avenues. Since then the land-lines have been supplanted by technology from the fifth epoch, information technology, and in fact the most important markets for the carriers now are wireless technology and data-transfer in the form of the internet, with vocal information transfer being just one part of a plethora of choices available. Given that there has been such a paradigm shift in the way information is transmitted and that telecoms companies were at the center of this transformation there was a transition from one technology cluster to another. As the information technology cluster reached its frenzied phase the emphasis shifted from large scale central processing units with terminals to personal computers with their own processing power. This change then necessitated a way to connect these disparate machines through the transfer of data. The transformative power of the information technology cluster had reached the telecoms industry. The fact that the telecoms firms could not just weather but even thrive from this transformation would imply that they were not completely unprepared for this change. Digitalization had reached the telecoms market in ways that mirror the development of the information technology cluster of going from central improvements to more peripheral ones, the telephone exchanges, the central hubs of the network had already been digitalized through the joint development of the AXE-system with Swedish telecoms manufacturer Ericson.

Obviously then, the at the time rapidly developing information technology cluster had begun having an effect on the settled technologies of Televerket/Telia. Succeeding is however not simply a climb onto the next rung of a technological ladder, the activity of evaluating technological investment opportunities has to be viewed as coming up against the dual difficulties of path-dependency and watershed-uncertainty. The planning, control and decision making processes were formed during very different times in the technological cycle, in fact Perez would suggest that they were formed by it²³. As the technological frontier is closed the structures and rung-thinking which have sustained the business model until now are as ill-suited to take the next step as the previous technology path. Viewing the different paths open for the firm through the lens of the cyclical malinvestment theory then becomes a choice between the current path of land-line-centric technologies with a data component or to radically retool the operation to focus on large scale data transfer for consumers, of which voice would just be one component. The decision to invest into the ISDN project looks

²³ Perez, C. (2014). Technological revolutions and financial capital: The dynamics of bubbles and golden ages. Cheltenham: Edward Elgar. p.73

more rational if it can be conceived of as a safer stepping stone from the analog now to the digital future, instead of as the dead-end it turned out to be.

The malinvestment is then not a result of conflicts of interest in how a company's resources should be used but rather a natural effect of encountering the mental barrier of a commencing technological shift. Rather than a conspiracy to enrich the managers at the cost of the owners the setback is due to a lack of imagination in a time of change; the right imagination rather, because what for the previous generation of managers was successful prudence would in such a time be costly inertia. There will always have been seeds indicating the future outcomes, but they are only clearly visible to us now that they have sprouted. But in crossing the event-frontier and consulting the primary and secondary sources available at the time of the decision indications of what the rationale was at the time will come to light.

Data supporting the case that the malinvestment was a natural outgrowth of the changing times would include indications in the planning stage that there existed a low level of awareness. The more formulaic the process of deciding the investment is and the more it seems to be springing from heuristics developed during a previous period the more likely it is a phase misalignment of the decision and the control functions. Likewise if the rationale is mired in an iterative conception of technological change rather than a paradigmatic. Conversely, the positive indicators (which indicate something by their presence rather than absence) of a firm's management facing the kind of dilemma that appears at the end of a technological phase would be the realization of uncertainty and a stated conviction that due to this ever more binding rationality the safest bet is the best bet.

If most any management rationale beyond the self-aggrandizing would point to support the cyclical malinvestment hypothesis it is not easily falsifiable; however, by being more stringent with the stated rationale in the sources a falsification strategy can be formed. If the project is conceived of and presented as a risky bet which is necessary in a turbulent time then it can be said that there are at least inklings of awareness, it is thus possible to reconstrue the investment project not as a dead-end inertia-driven choice but as the kind of adventurous seeking of new possibilities that is necessary at a crossroads. There is otherwise the risk of falsifying the managerial collusion hypothesis only to iteratively be left with the cyclical malinvestment theory as a catch-all. As stated above there is an important distinction between a project which never made economic sense and one which, though risky, might pay off. Therefore it is important that leeway is given to evaluate even a failed project

outcome as successful in the planning phase lest the danger of consequential ethics obscure the actual important question of what projects make economic sense.

Unlike the FCF explanation any type of indicator would be just as likely found in top-level board minutes as well as lower-level internal documents. There is no need to hide your rationale if what is being pursued is the best educated guess at the time. In fact, the more information left on the paper trail the more justification it can provide later, should the investment fail in its implementation. But there is also the competing motivating factor of wanting to implement the project and not just form a strong rationale of why it might fail why there may be dichotomous statements surrounding the project, or even contradictory statements in different forums. By evaluating for whom the information some information can be gleaned as to what message it is trying to impart vis-à-vis the project: go, caution, or stop.

The overlapping theories

Though the different pitfalls of firm behavior are distinct in their assumed driver of inefficiency, they are not mutually exclusive. On the theoretical level, both leave space for the other and differ primarily in their favored driver of inefficiency; there are areas where both theories enter the area of the other.

The cyclical malinvestment model contains elements to explain events not encapsulated by the unpredictable development of technology. A distinction must be made, stakeholders are analogously to the above decision model divided into financial and productive capital owners.²⁴ The financial capital owners own resources which are liquid or semi-liquid and not locked in plant or technology. They are seeking returns for their capital by placing it in the hands of the right productive capital and are generally more able to divest themselves from a technological field than productive capital. Productive capital borrows wealth from financiers in order to create more wealth, however they are intimately tied with a particular field of industry and cannot easily disengage themselves, they have a vested interest in increasing the resources under their control so as to enable them to keep exercising their skill. This distinction is necessary for Perez so as to explain the, on the one hand, different pressures exerted by financial capital on industries during different phases but also to give an

²⁴ Perez, C. (2014). Technological revolutions and financial capital: The dynamics of bubbles and golden ages. Cheltenham: Edward Elgar. p.71

explanation why the lessons of previous eras may be so hard to learn. The vested interest of production capital stand to influence the financiers in their addictive search for returns. In the penultimate phase of an era the two forces work closely together to rationally expand and improve the domain of the technology. These close relationships formed during this phase would then linger and hinder a more arm's-length contact that would be necessary to truthfully evaluate the different investment possibilities outside the previous drivers of growth. While Perez's model's base case would seem to be that of an entrepreneur looking for finance in the marketplace, most contacts that have these characteristics would occur within a firm. In amalgamation, the choice for an owner which has a free cash flow is whether he believes the future potential of the underlying business is worth re-investing in. The fact that most of these relationships are more familial than that of the open market would in a sense explain the problems of disengagement when an era is coming to its end.

The FCF model of inefficiency allows for projects that are not strictly meant as appropriation of resources by managers but which contain such a great deal of uncertainty that it would be best for the firm not to invest in them at all. The proposed remedy, loading up the company with debt to recreate the survival impetus of a company barely avoiding insolvency, through which more prudent decisions are taken would be recognized within the malinvestment model as an attempt to impose artificially the careful mutuality of the synergetic expansion and to align the forces of financial and productive capital. As the policy to ameliorate the agent-principal problem in the FCF would also affect the misalignment of productive and financial capital it can be said that they are different way to describe the same thing.

As both models allow for the inefficiency driver of the other there is no fundamental conflict in an answer that yields aspects of both, even to the degree that neither can be falsified. As described in the decision model, the true purpose or motive of a decision could well be different for each actor with a stake in it. An answer that yields evidence of both would be believable as regardless of the preferences of the individual actor there may be something they find palatable in the investment decision. The actual project may contain the potential to serve both the interest of owners and managers but only realize one. Borrowing from the field of medicine, Hickam's dictum argues against an overly parsimonious diagnosis and states: "Patients can have as many diseases as they damn well please."

Short summary of ISDN project

The meandering aspect of the ISDN project naturally lends itself to division into three different phases, conception, inception and reception. The first period is primarily concerned with planning and waiting; it stretches from the early 1980s to the end of 1989. While the digitalization of the trunk lines is underway the natural progression in the modernization of the telephone network becomes some sort of digitalization of the end-user transmission technology. ISDN appears then as a natural way to refine the base product of telephony. The work of standardizing the protocol progresses slowly and delays both deployment from an infrastructure point of view but also the development of applications that will use it.

In 1990 the second phase begins, testing has started and the technology is approaching real world implementation. With the CCITT standard finalized, a decision to build a limited ISDN network is taken in 1990^{25 26} and the testing is carried out under the aegis of there at least being some limited implementation. However during this period no real dependency has been built outside of the political promises to other European telecoms companies and the credibility invested towards equipment manufacturers, which have been encouraged to produce terminals. This phase has a limited deployment and is primarily characterized by the search for a way to actually turn deployed technology into customer services. It terminates in 1993 with the actual commercial launch of the ISDN network. This is the last phase for which there are available primary sources and beyond this point only secondary are publicly available.

The third phase commences when ISDN is a product available to end-consumers and terminates when the adoption has completely stalled at the turn of the millennium. After a slow launch adoption rates increase and the project experiences satisfactory growth caused by the sudden appearance of the internet and its associated demand for connectivity. After 2000 ISDN is rapidly overtaken by the explosive growth of the ADSL protocol and can be said to be legacy technology comparable to that which it once was slated to replace.

²⁵ KCL 2/6/1990 Board minutes

²⁶ PM Nis 90 005

Methodology

Case study methodology

In order to test the sufficiency of the two models of inefficiency in the case of Televerket this thesis will be employing a case study methodology as elaborated by Yin and Eisenhardt.^{27 28} The case study methodology is suitable for contemporary events and helps form testable hypotheses for qualitative data such as archival sources. It is a method suited for elaborating on theory rather than empirically or statistically evaluating outcomes. The two theories help form a-priori narrative expectations of processes that should be evident within the source material, which in summation forms a testable hypothesis of whether the presumed driver of inefficiency is present. The prevalence of a supporting narrative for both theories will indicate that a more general theory of technological inefficiency is necessary to properly encapsulate the decision making processes in a project such as this.

Narrative expectations

Using the three phases as natural distinct segments of the project with different associated activities, the different theories of firm behavior will ascribe certain motives do be evident. Using the available primary and secondary source material from Tvt we can evaluate what has been said against what the different theories would prescribe, so supporting or disproving one or the other of the theories.

In phase 1 the behavioral theory of firm behavior would expect there to be a large degree of uncertainty in how a future telephone network will look. But not only that, there would also be a certain degree of awareness of this uncertainty. This contraction of the bounds of rationality would be felt and acted upon. This forms the basis of a heuristical decision making which defaults to a known choice, helping to build path dependency. In this knowledge of uncertainty and attempts at reduction there may be inklings of prescience about the future. This would support the case that the project's goal was still to better the company's position. The managerial position instead suggests that the project would be characterized not by uncertainty and awareness, but by a lack of care and certainty. The project is primarily being instituted to serve other interests which to the implementers are well known and certain (i.e. the spending of investment resources), with the success being

²⁷ Eisenhardt, K. (1989). Building Theories from Case Study Research. *The Academy of Management Review*, 14(4), 532-550

²⁸ Yin, R. (2014). *Case Study Research: Design and Methods*. Sage publications Inc. Thousand Oaks, CA.

secondary. This carelessness would take the form of glossing over, or mentioning in passing, flaws with the project as well as primarily exposing the strong aspects.

In phase 2 the limited tests carried out in conjunction with potential customers and equipment manufacturers starts to yield results which indicate the final outcome. Of primary interest are those problems which are inherent with the technology and not changeable through Tvt-action, such as organizational issues and marketing. These will primarily exhibit themselves in terms of the market for technology reliant products and in the end the market of end-users that these terminals create. The behavioral theory will expect there to be a rigorous discussion of the available information as uncertainty recedes. There will be attempts at amelioration of the identified problems as the underlying motivating principle of the project is still to create a profit, however hindered by future uncertainty. The managerial theory will expect the sources to treat problems appearing not as valuable information ahead of a full commitment but as hindering the project from continuing, with the associated benefits to management that it provides. To the extent that it is possible, the project should also be evaluated against other large scale investments; while it is natural that more important or certain projects should take precedence, the waxing and waning of a project can also indicate the wish to maintain a certain level of investment, regardless of the profitability.

As the primary sources that relate to phase 3 beginning in 1993 are still classified it will be harder to support one narrative over another in the same manner as the previous two. The secondary sources available through financial reports and the like will give clues however. The behavioral theory will expect the earlier exuberance to have been thoroughly curtailed and that the rollout is done within the confines of the realized difficulties. The managerial theory will instead expect the rollout to be performed not within the confines but as pushing against the confines. The difference between the two lies in the original motivating principle, adapting the project to reach the goal of a profitable project taking precedence in the behavioral narrative. The managerial narrative will instead expect the actual implementation of the project to be the primary goal, with the actual viability being a means to an end.

Database

To help answer these questions Ratio an independent Swedish enterprise institute and in collaboration with EHFF (The Institute for Economic and Business History Research) have granted access to their extensive digital Swedish Telecoms database based on the publicly available

information in Riksarkivet Arninge as well as the personal archives of former management. The database contains over 7000 entries, containing a wealth of information in the form of board minutes, literature, correspondence, strategy documents, financial statements, business plans, magazines and industry journals from Televerket/Telia as well as associated firms such as Teleinvest and Ellemtel. The entries range in length from one page to over 500 in the case of some of the books. Please refer to appendix A for a complete list of contents.

The material in the database has been extensively documented, categorized and catalogued. All documents have been made machine readable allowing for this extensive source material to be searched. Furthermore, each document contains a range of metadata such as original source location, technological projects mentioned, people, and organizations involved and date of creation. This grants the prospective researcher a lever on time invested, with complex interconnections and context setting becoming much easier to establish and browse. Much of the time that would normally be spent doing administrative work, such as documenting the source-series and archive box is taken care of for the researcher. While the optical character recognition technology is not infallible, neither is the human eye, it thus comparably vastly cuts down on time wasted following dead-leads. Not only can it search for relevant documents through metadata, it can also search within them, allowing the researcher to quickly decide if the document is relevant or only tangentially associated. Compare this to the classical process of spending time in the archives, choosing relevant archive boxes to explore, with most time spent not adding value to the project. What this improved process has allowed for is to take in a greater breadth of material than the scope of this thesis would normally have warranted. This breadth allows for a more certain evaluation of the ISDN project as it provides a degree of exhaustion that time-wise would otherwise not have been possible. The completeness of many of the records also lends credence to, or removes an avenue of reproach to, any conclusions reached as criticisms leveled will have to contend with the actual interpretation of the underlying source material rather than the problem of missing documents.

To answer the above questions and clarify the rationale behind the decision to invest in the ISDN network, access to communication between and within stakeholders is required. With this data, differences in insight and information between different stakeholders can be gleaned. Therefore it is important to contrast what is said horizontally, between sections of management in the company, with what is said vertically, to the owner. Horizontal communication would involve lower-level

correspondence, strategy meetings and internal memoranda. Vertical communication would involve higher-level material, such as board minutes, business plans and outside communication (press releases, newspapers, etc.).

As the needs of the thesis have developed, in addition to the digital EHFF/Ratio database, time has had to be devoted to delving into the actual physical archives in Arninge, of which part of the digitalized database forms a subset. The reason for this is that while the digitalized database focuses on complete series of higher level documents, much of the horizontal/intra-firm communication on the ISDN project occurred inside the telecom networks division (Nätavdelningen) where the digitalized database only contains the directorial minutes and not the materials on which decisions are based. The technical aspects aside, the later work to introduce the ISDN technology was primarily from a technical level and not from business side development. As such the rationale for continuing the project beyond the initial point can be found in the collected opinions of the networks division. Naturally this re-introduces some of the problems that the digital archive remedies. However, since this is a limited search with a very specific goal a level of in-depth knowledge on par with the rest of the database can be achieved, complementing depth to the database's width.

The actual investment numbers for the ISDN project are not easily gleaned from the financial statements that are available in the digitalized database either. This is in part due to it not being easily separated from the network investments required to implement the technology. Actual follow up is also complicated by a major reorganization of Tvt during the crucial time around 1992, whereby comparability in costs between different departments disappears. Instead the resources invested during the first two phases can be estimated conservatively to run up to 120m Swedish crowns based on scattered mentions of a year's or future years spending. The initial testing up to the commercial launch are estimated to be 20m crowns at 1985 valuation, the limited commercial evaluation costs 95m crowns at 1989 valuation. Costs associated with the full commercial rollout are not available beyond the large investment in 1997 of 400m crowns mentioned in the yearly report, and an estimate in the 1997 business plan of up to 900m crowns²⁹. Neither are resources spent through Ellemtel, in their work with CCITT available. High inflation during the studied period further complicate a numerical analysis of the sources which range from outcomes, forecasts (often over several years) and decisions. The actual outcome of the technology project can and should be

²⁹ SWT 3341 "Affärsplan Teliakoncernen 1997-99"

compared to the initial expectations in terms of uptake and transformation of the business rather than simply the financial forecasts of which there are only very anemic ones available.

Analysis

The ISDN technology in context

The origins of the ISDN technology lies in reconciling existing legacy infrastructure with emerging needs. The predominant technology for voice transmission as supplied by telephone companies was at the time analog transmission over copper loops between the end user and the switching exchange; these would then be aggregated into larger regional stations and so on to connect separate areas. The modernization of the original 19th century technology started with its innermost components, with human switchboard operators being replaced by electromechanical switches which were later digitalized. The cables connecting the switching stations, the trunk lines, were also upgraded to allow for modern digital transmission protocols. What is important however is that this process largely left the last leg of transmission, from local switching station to end-consumer, the so called last-mile , untouched. The home-based telephony equipment, be it a fax machine, dial-up modem or telephone still communicated with the local switching station by the same twisted copper wires, a century old solution. This part of the infrastructure had been laid at great expense and would not easily lend themselves to replacement, especially as the last-mile was the most expensive in terms of installation. There was a rationale then for building any future information transfer solution around the backbone infrastructure, allowing the legacy copper-wiring to remain in place³⁰. It should be mentioned however that ISDN can work on digital lines as well, and some of the early business users were expected to use this.

The growth of information technology and need for generalized data transfers between geographically separate locations spurred the growth of dial-up modems (MODulator/DEMODulator). These communicated acoustically on the old telephone wires, with certain amplitude, frequency and phase shifting translating into bits of information on the receiving end. Though flexible in terms of the data it could transfer, the drawback was low speed (by today's standard), occupying the telephone line and so not allowing incoming calls and the connection being broken if an attempt was made to use the standard telephone for outgoing calls. The speed was especially limited by having to send information the last mile within the boundaries of analog telephone frequencies. In other words, the full spectrum of frequencies available on an electric current was not used by the telephone system and so could not be used by a modem.

³⁰ SWT 9108 "New Lines for old"

The limitations were recognized as modems were pushing the limits of what was possible within the confines of the analog telephone system. In 1984³¹ the International Telegraph and Telephone Consultative Committee (CCITT now ITU) called for standardization of a hybrid network protocol that was to become ISDN. The Integrated Services Digital Network would go some way towards integrating data transfer into the telephone network. It would digitalize voice traffic and at the same time allow for data transfer on the same wires, thus solving the occupancy problem. The ISDN connection required a dial-up process and was not readily available in the way internet is today. The speeds would not be markedly different compared to a modem. The Basic Rate Interface (BRI) variant available from converting a copper loop had 3 channels, 2 for data or voice transfer and 1 control channel. If both communication channels were used for data transfer it could reach speeds of 128 kb/s, or 64 kb/s if speech were happening concurrently. The most common ISDN connection for businesses was the PRI or Primary Rate Interface which had 30 channels and 1 control channel.³² This more powerful line gave speeds of up to 1.5 mb/s and was envisioned to integrate with intra-business telephone exchanges to allow for many outgoing calls and data transfers. So the PRI should not be viewed as a potential communication speed for the individual end-user whether an office worker or private consumer, rather the PRI implementation of the technology was to allow for a downstream switching station to aggregate demand at the very least at the start. The channels, 2 for BRI and 30 for PRI, are important to remember because adoption rates are later presented in terms of installed channels. Modems could usually reach speeds of around 56 kb/s (the protocols used differed slightly between countries and over time). While the speed of ISDN compared to modems is a substantial increase, it is best to think of speed comparisons logarithmically, as more complicated media (browsing, voice, video) requires significantly more data than simple text transfer. As such, it is possible to view the data transfer products as exhibiting quite steeply concave curves of utility. Once speeds allow for one product but not the next one, incremental speeds are not substantially useful; once you can stream one video and send one email being able to do two of the same is not immensely useful.

The protocol that was to dominate the early 2000's was xDSL (Digital Subscriber Line), the x signifying different variations of the protocol. The xDSL protocol worked in a similar vein to ISDN in that it could work on the twisted wire copper loop. It however allowed for greater flexibility in speeds, dependent on the distance from the end-user to the local switch. The xDSL system ran its

³¹ NAT SE/RA/420509/420509.101/B 2 c/21 "Förutsättningar för 1985 års strategiska planering vid teleområdena"

³² Internetmarknaden i Sverige (Rep.). (n.d.). Stockholm: Öhrlings Coopers & Lybrand AB.

signal concurrent with the underlying analog voice channel on frequencies not used by the old voice network. With this frequency range dedicated to data transfer the normal POTS (Plain Old Telephone Service) could still be used at the same time at no cost to download speeds. Whereas in the ISDN protocol one of the two dedicated channels would have to be changed into voice mode, with associated speed costs. The ADSL (Asymmetric) protocol, which would become predominant in Sweden, recognized that most end users would primarily be downloading data and traded upload speed for download speed thus allowing download speeds of up to 8 mbit/s. Finally, the internet was always-connected, requiring no time-consuming dial-up process. The primary difference is that the xDSL technology allowed for a great deal of variance for the end-user, with distance being a primary driver of signal loss and thus slower speed. The ISDN protocol was more conservative in its potential channels, whereas xDSL varied according to the best available service. The benefit then was that ISDN could be deployed where xDSL could not, almost exclusively over great distances where signal loss was substantial, and would perform to maximum specification.

The differences between the two protocols is substantial in terms of when they became available, as xDSL is a successor technology to ISDN. With ISDN Digital Subscriber Line (IDSL) as a bridging technology which offered the benefit of minutely higher speed and always online connection over normal ISDN. Roughly a decade divides the two technology groups in terms of conception. However the standardization of the ISDN protocol would be slow and seriously delay the development of applications and implementation³³. The ISDN protocol is first discussed in published minutes by the CCITT in 1984 and in spite of publishing to the effect that it is a complete technology in 1986, the final standard was laid down in 1988. Televerket was aware of this developing technology and discuss the nascent protocol as early as 1982³⁴.

The ADSL protocol's first technical standard is laid down in a release by the American National Standards Institute in 1995³⁵, but as with ISDN there is a long preceding period of testing and discussion. Televerket mentions ADSL technology as early as May 1993³⁶ and in 1994 mention it as a future technology competing with cable-TV for information transfer³⁷; the question as posed in the document is not whether the technology will deliver on its promises but rather if the television or

³³ SWT 6101 "Treårsplan 1990-1992"

³⁴ SWT 9116 Bilaga 3, "Sweden: National Presentation ICCP Committee"

³⁵ ANSI T1.413

³⁶ SWT 4618 "Trender I den tekniska utvecklingen"

³⁷ SWT 4332 "Koncernstrategi v.2.2"

the computer will be the primary terminal through which consumers retrieve information. So even though the two technologies are conceived of at different times, the implementation of the ISDN protocol overlaps with the ADSL technology as a viable competitor for investment resources. The investments required for both technologies were mostly on the receiving end at the local switching stations in addition to socket replacement at the user-end for ISDN, whereas ADSL could run from normal telephone sockets.

In summation the ADSL protocol had clear benefits over the ISDN technology, which is natural as it is a successor technology. Even so, why then were resources spent on developing the ISDN network when a clearly superior technology was close to commercial deployment? The delayed implementation of ISDN with the original commercial deployment planned for 1987³⁸ later pushed back to 1993³⁹ should have made it a hard sell. Even if ADSL had not appeared at the time the decision was made the incremental improvements of ISDN should not have warranted a large scale deployment of the technology on top of existing infrastructure, it rather made sense in a context in which the basic telephone network was not fully developed. The ISDN technology, even though it contains some crucial innovations, in terms of product improvement is better understood as an incremental technology such as can be leap-frogged to by being a late adopter. Thus it is easier to see why the ISDN protocol was more successful in terms of adoption in continental European countries such as Germany (with its new Bundesländer) and France than in Sweden where the satisfactory capabilities of the old analog net had already been fully rolled out.⁴⁰

Project within Televerket/Telia

Phase 1: Conception 1984 to 1989

The ISDN project, as opposed to the ISDN technology, appears as part of a greater follow-up to the AXE implementation called Digitalen 87⁴¹. This project built on the success of the AXE system, by upgrading the connecting trunk lines. When it was completed in 1987 ⁴²it was the world's first digital network with country-wide coverage. Country-wide coverage is a somewhat nebulous term as only 1.7 million subscribers out of 5.2 million were served by its trunk lines, but it did stretch across the geographic majority of the country in that all Televerket regions were connected. The process of

³⁸ SWT 6452 "Videotex"

³⁹ SWT 4346 "Årsredovisning 1992"

⁴⁰ Carlsson, R. H., & Hallberg, M. (1997). Ägarstyrning: Om Corporate Governance från Wallenbergsfär till offentlig sektor. Stockholm: Ekerlid p.181

⁴¹ SWT 11578 "Teldok Nr.3 Jan 1986"

⁴² SWT 2032 "Årsredovisning 1987"

replacing the last of the electromechanical exchanges and trunk lines would continue concurrently with ISDN implementation and was finished in 1995. The new digital network was well poised to enable Sweden to quickly adopt the new telecommunications technologies of 1990s mobile telephony and data transfer (internet).

While Televerket is in the planning stages for the future after the digitalization of the trunk lines the ISDN technology is still in its infancy. The standards are being laid down in CCITT talks in which Tvt, partly through the joint venture with Ericson Ellemtel, is taking part. There is a fitful aspect to the ISDN standardization process with the CCITT declaring in 1986 that ISDN is “coming of age”⁴³ in a published editorial, but there still remained lots of work to be done as evidenced by the fact that the final standard is not laid down until the end of the 1980s. Behind these stops and spurts of activity is work and disagreement in the commission by different partaking telephone companies. The actual ebb and flow of commission activity is beyond the scope of this thesis but Televerket/Ellemtel takes an active part in shaping the standard and affecting the outcome of the commission’s work⁴⁴⁴⁵.

While ISDN exists as a known technology family prior to Digitalen’s completion in 1987 it becomes a real viable option to invest in once the digitalization of the trunk lines is completed. Given Sweden’s lead in the digitalization of the telecommunications area Televerket is in the position of being able to implement ISDN faster and more comprehensively than other corresponding telecoms companies. Progress in CCITT is slow however and while the sources do not give a sense of urgency in wanting to deploy ISDN there is a sense of impatience⁴⁶.

⁴³ Dècina Et al (1986)

⁴⁴ SWT 2392 “Treårsplan Televerkskoncernen 1985/86 - 1987/88”

⁴⁵ SWT 6643 “Svenska televerket Del VII: Från myndighet till bolag: Kapitel 6. Nätutveckling. 6.3 Nya Nättjänster

⁴⁶ SWT 6101” Treårsplan 1990-1992”

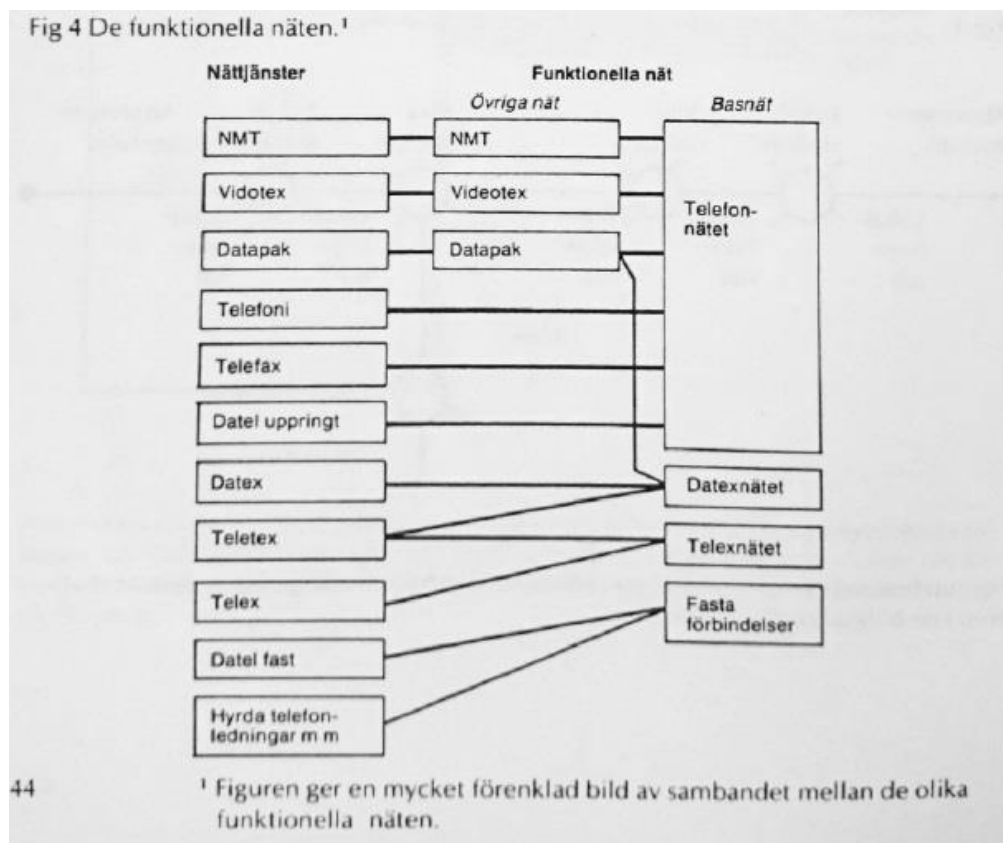


Fig. 2 Products and their associated networks before ISDN.

Televerket had several data transfer networks which predate Digitalen -87. The networks differed in degree of speed, availability and sophistication. One of the rationales for implementing a comprehensive ISDN network is that it would consolidate and improve the product portfolio, see figure 2 for a stylized representation of the different networks on offer and how they relate to the main telephony network⁴⁷. There thus was a rationale for streamlining the networks from the infrastructure point of view where the different protocols could communicate more easily with one another. But also from the point of view of the customer who instead of having to order a purpose-built data transfer network such as Datex would be able to use capacity already built into the main telephony lines⁴⁸. Though there is mention of the rapid growth in data service⁴⁹ the idea is not to build the new network primarily to serve a rapid growth but rather to rationalize the available

⁴⁷ SWT 2394 "Treårsplan Televerkskoncernen 1988-1990" p.44

⁴⁸ SWT 2394 "Treårsplan Televerkskoncernen 1988-1990" p. 46

⁴⁹ NAT SE/RA/420509/420509.101/B 2 c/21 "Förutsättningar för 1985 års strategiska planering vid teleområdena" - Nis 85 005

product offering by integrating a data transfer network into the standard telephone network⁵⁰. The planned expansion of the data networks (datex, datapak) is to seamlessly transition into the ISDN network without the customers service experiencing major interruption.⁵¹

The project in this phase is to an extent inertia driven; the big investment in Digitalen 87 spawn spin-off projects such as Integralen 90 within which ISDN plays a major role. The sense of impatience is heightened by foreign developments. While Televerket waits for final standardization of the ISDN protocol to complete the telecoms companies in Germany and France forge ahead and start their own ISDN networks ahead of time using domestic standards.^{52 53} It is natural that Tvt does not embark on this kind of venture of their own as the Swedish market and standard would carry small weight in any CCITT deliberations. Televerket clearly states in a board memo⁵⁴ that the basis for their development of the ISDN technology are the accepted recommendations of the CCITT. But it does much to add to the sense of losing the lead that had been achieved with Digitalen. The impetus to remain ahead plays a large part in the early phase of the project.

Contrary to what the behavioral theory would assume, there is no large sense of uncertainty in the beginning, in addition there is no awareness of the crossroads. While ISDN will be a shift in transmission technology, it is not one in transmission philosophy. ISDN is seen as the natural culmination of a wave of innovation affecting the telecoms market⁵⁵. The ISDN technology is discussed primarily in terms of as the next logical step. After the modernization of the exchanges and the trunk lines, the last element of the standard network that still runs on the old standard is the last mile technology from exchange to end-user. In the three-year plan written immediately after the completion of Digitalen 87 the ISDN technology is described as a long term conclusion of the previous modernization work not as one of many options of how to better offer digital products to customers.⁵⁶

⁵⁰ NAT SE/RA/420509/420509.101/B 2 c/21 "Vad är ISDN? (Tjänsteintegrerade digitala nätet)"

⁵¹ SWT 4645 "Digital Telecommunication Services in Sweden"

⁵² DNT SE/RA/420509/420509.088/B2/8 "IN och ISDN i accessnätet 92-04-08"

⁵³ SWT 11585 "Teldok 76" p.51

⁵⁴ NAT SE/RA/420509/420509.101/B 2 c/21 "Förutsättningar för 1985 års strategiska planering vid teleområdena" Nis 85 005

⁵⁵ SWT 9766 "Från dagens Telenät till Bredbandsnät" – Bilaga 1 1985-01-11

⁵⁶ SWT 2394 "Treårsplan Televerkskoncernen 1988-1990" p.46

For a network that is supposed to upgrade and replace the entire telephone network⁵⁷ there is a real lack of a comprehensive idea of what it is to be⁵⁸. It is supposed to offer new lines of data communication for consumers and business, without affecting sales of current custom-built lines. In addition, it is going to safeguard the future of the data transfer networks and in the long-term integrate them. It will improve the basic telephony services and service quality, while at the same time integrating data transfer capabilities to allow new (in comparison to telephony) services such as the telefax improved service⁵⁹ ⁶⁰. The end result is that the ISDN technology is supposed to mean many things to many different departments and stakeholders.

From the managerial theory this seems quite reasonable. The main objective is to build support for and present the future project as serving the interests of whomever can help its acceptance. The unresolved questions of the ISDN technology as it relates to the Tvt-market are not discussed to a great deal in the early prospects. The lack of a market of products that goes beyond improvements in performance of already existing ones is a clear example of this. As mentioned above the focus lies squarely on the positive aspects, with sometimes contradictory communication as to what it will accomplish, especially as relates to existing data networks. Since the ISDN project is not formalized and these discussions are based around the potential of the technology rather than a proposition, which goes some way towards resolving the inconsistencies of the discussion. Since this is the period in time wherein the different stakeholders can affect the design of a future ISDN-net and its interaction with the current makeup of Tvt there is a reason to present it in a manner which forms expectations of the end result in their favor. The political aspect of work in the CCITT commission is not readily evident as it is performed partly through Ellemtel and does not appear in the primary sources. But sources written after the fact indicate that much work and company prestige went into the work performed in the commission. Apart from standardization for equipment manufacturers, the goal is also to create an interconnected European ISDN network, the work laid down in setting the standard also builds a strong impetus to actually commit to building the network. The decision to build a Swedish ISDN network and begin commercial testing is made partly within the context of

⁵⁷ TDA SE/RA/420509/420509.103/F3 bs/1 "Systemstudie "Datavision"" p.9

⁵⁸ SWT 7098 "Tele Nr.3 1987"

⁵⁹ MAR SE/RA/420509/420509.097/A 1 a/1 "Strategisk inriktning för företagssystem" PM 85-12-13

⁶⁰ SWT 5625 Teldok Rapport 40

fulfilling an implied commitment to the CCITT by signing a memorandum of understanding (MOU)⁶¹.

In addition to work towards developing the ISDN standard the first phase is also characterized by a search for applications of the technology. The ISDN protocol is a standard for incorporating data transfer and telephony in the same network, its adoption and implementation created the potential for, but did not automatically create new products for the end-users. Equipment manufacturers could not and naturally would not develop customer facing terminals until a well-established standard was laid down⁶². The product offerings that the ISDN availability will result in are at this point not known. The extent to which the Integralen 90 project could see a use for ISDN is in providing simultaneous telephone and data-transfers from multi-functional terminals, co-traffic between the data-networks Datex, Teletex and Datapak and fast file transfers from personal computers, and telefax.⁶³ In other documents which focus more on the telephony aspect the improved voice quality and simultaneous capacity to transfer simple images is mentioned.⁶⁴ Compared to the estimations in 1985⁶⁵ of integrated service products being available as early as 1987 not just for businesses but even for consumers, the delays are of such magnitude even as late as 88 there is no clear timeline for commercialization or introduction which is instead pushed into the future pending commission work⁶⁶. In the end, the decision to build the first commercial test network with later expansion is taken in a board meeting in early 1990.⁶⁷ ⁶⁸ The memorandum that is the basis for the decision to build the basic ISDN network is in line with an MOU signed between 25 operators in 20 European countries about a standardized ISDN network within Europe. At this point the original idea of a comprehensive national network has been seriously reduced, while there is not apprehension the original assured optimism has been replaced with a degree of caution. There are inklings in outward communications that the ISDN technology may not be as important in Sweden compared to other European countries⁶⁹ ⁷⁰

⁶¹ KCL SE/RA/420509/420509.086/F 4 b/12 "Väsentliga tendenser i den teletekniska utvecklingen" p.1

⁶² SWT 11583 "Teldok Nov 1986 Rapport 25" .p6

⁶³ NAT SE/RA/420509/420509.101/B 2 c/21 "Förutsättningar för 1985 års strategiska planering vid teleområdena" Nis 85 005

⁶⁴ NAT SE/RA/420509/420509.101/B 2 c/21 "Vad är ISDN? (Tjänsteintegrerade digitala nätet)"

⁶⁵ SWT 2392 "Treårsplan Televerkskoncernen 1985/86 - 1987/88"

⁶⁶ SWT 6452 "Videotex"

⁶⁷ KCL SE/RA/420509/420509.086/A 1 a/19 "2/6/1990 board minutes"

⁶⁸ NAT SE/RA/420509/420509.101/B 2 c/ PM Nis 90 005

⁶⁹ SWT 9429 Communications Engineering International 10/89 – "Moving from strength to strength in the future"

While there has been a technical testing group operating for some years, this is the founding date for an influential group in the future of ISDN: Teknikgrupp ISDN (TG-ISDN), later Projektgrupp ISDN (PG-ISDN) and after a 1992 reorganization “Ledningsgruppen för vidareutveckling av ISDN” (LG-vidar). This was to be a crucial group reporting to the networks and business divisions. Later after the reorganization the group was to report to the Networks division only, for which complete series exist for 1992. The protocols and discussions of this group form a natural basis for the next phase.

Phase 2: Inception 1990 to 1992

The second phase stretches from the creation of the ISDN-task force in early 1990 until the decision in late 1992 to commercially deploy the ISDN project outside of the commercial test areas in 1993. The process involves taking the prototype, insofar as one existed, and developing a product offering for customers. At the point of decision, the ISDN project is ill-defined and lacks a clear focus beyond needing to be implemented. The needs of the project are to fulfill obligations towards other companies, with the details of commercial viability and product positioning being secondary. That is not to say they were ignored in the planning phase, but as opposed to the need to fulfill the commitment, they were anemic in their completion. The problems can best be encapsulated by the technicians running the early technical tests.

“Farhågor inför kommersiell drift:

Efter direktionens beslut om grundnätet sprids en massa information om ISDN. I allt som skrivs används nu formuleringar som hävdar/antyder att Televerket nu fältprovar nätet som skall tas i kommersiell drift 1992. Det är därför nödvändigt att påpeka att fältprovet inte har något samband med det nät som sedan skall tas i drift.

Eftersom Televerket ännu inte ställts några krav på sitt ISDN kan fältprovet inte heller prova efter dessa. Nödvändigtvis måste därför fältprovet formulera sina egna krav, som kan vara helt skilda från de krav Televerket så småningom kommer att ställa på ISDN. [...]

Om inte Televerket omgående börjar utreda och formulera krav på hur ISDN skall fungera som nät, i samarbete med andra och i samarbete med kunderna och deras terminaler så kommer det

⁷⁰ SWT 11516 “Televerket Scenarios”

aldrig att finnas tid att fältprova detta före en kommersiell start.” –Rapport från Teknikgruppen till TG-ISDN 1990⁷¹

Author’s translation: Apprehensions before commercial launch:

After the board’s decision to implement a basic network there is a lot of information being disseminated about ISDN. In everything written wording is now used which indicates/claims that Televerket is currently testing the network which will be put into commercial use in 1992. It is therefore important to point out that the field-tests in no way have any connection to the net which will later be put into use.

Since Televerket still have not specified its demands on its ISDN, the field test cannot test for these. Out of necessity then, the field-test has had to formulate their own demands, which may be completely different from those which Televerket which will later require from ISDN. [...]

If Televerket does not immediately commence research and formulates the demands on how their ISDN will work as a network, in cooperation with others and in cooperation with the customers and their terminals, there will never be time to test this in the field before a commercial start.

Though the actual quote primarily concerns itself with the technical specifications and the tests that will delay the launch, the quite frank note reveals many issues by working as a photographic negative. Beyond any actual delay to the project that the raised issue concerns, the fact that the early gateway of specifications for the network has not been laid down raises the question: if the network cannot be tested to specifications because there are none, then how can there be any market or product plan? It mirrors the sentiment of the previous section in that if the ISDN project is to be everything to everyone it is not anything. The decision has been taken without a clear plan in place. That is what the work of the project group will try to remedy during this phase. The project group is aware of the difficulties facing them and their mandate is primarily to create plans for further development of ISDN, finding products which use the protocol that can be marketed as services. Their mandate is not however to develop a market or business plan for them but their results will be the basis of on which such can be created.⁷² The most immediate issues are those of lack of

⁷¹ DNT SE/RA/420509/420509.088/F 5/50 “Rapport från teknikgruppen till PG-ISDN”

⁷² DNT SE/RA/420509/420509.088/F 5/51 “Lägesrapport Oktober 1991” LG vidar PM 1991-08-19

positioning and products, both for the immediate commercial test and in the long run. The idea that ISDN will grow to encompass the entire telephony net has at this point been quietly dropped in favor of a limited deployment. However among the limited contributions from the market subgroup in the ISDN-group there is a suggestion that ISDN be marketed as the new telephone network and not a new data-transfer network, as late as a week before the decision to implement a limited network.⁷³

The most pressing concern then is finding a way to deploy a technology which due to delays has already lost some relevance. From the beginning ISDN's early adopters were supposed to be businesses and public administration which did not see the need to invest in proprietary lines and needed a better communications solution than just the telephone network can provide.⁷⁴ Due to an already wide product offering, with different dedicated networks, the hybrid solution that ISDN can offer is only afforded a rather narrow niche^{75 76} wherein it is recommended for heterogeneous demands (picture, data, voice), but not pure data transfer. There are contradictions on this as within the same period ISDN is also slated to connect Local Area Networks (LAN) over large distances wherein file transfers are the primary source of traffic.⁷⁷

For businesses another important potential use was the upgrading of private branch exchanges (PBX). These were localized exchanges within a geographic location such as an office or factory. The PRI interface with its many potential voice channels was well suited to this task.⁷⁸ However as late as 1992 there were no such products available.⁷⁹ Beyond this limited but important use, the issue of terminals which were ISDN compatible is a large problem. Throughout the years of the commercial tests (1990-1992) the group mentions that there is a real lack of interest and products from suppliers as well as for equipment with which to build the networks.^{80 81}

In addition to low levels of interest from suppliers of ISDN-compatible equipment the search for a market for what products did exist did not go well. The demands from businesses were primarily for faster speeds of data-transfer, anticipating the explosive growth in the later 1990s, which ISDN by

⁷³ DNT SE/RA/420509/420509.088/F 5/50 "Möte nr.27" PG-ISDN 1990-01-30

⁷⁴ NAT SE/RA/420509/420509.101/B 2 c/21 "Tema integralen 90"

⁷⁵ DNT SE/RA/420509/420509.088/F 5/51 "Positionering av Televerkets Datakommunikationstjänster" 1991 02 07

⁷⁶ Appendix B1 & B2

⁷⁷ DNT SE/RA/420509/420509.088/F 5/51 "Ansats – Marknadsscenario år 2000"

⁷⁸ SWT 11585 "Teldok 76" p.51

⁷⁹ DNT SE/RA/420509/420509.088/F 5/51 "PM 92-03-23" NUL 92009

⁸⁰ DNT SE/RA/420509/420509.088/F 5/51 "Protokoll TG-ISDN-009"

⁸¹ DNT SE/RA/420509/420509.088/F 5/51 "Projektinfo ISDN 1-91"

the groups own admission was poorly suited for.⁸² Instead the search for a market lead back to the idea of ISDN as an incorporating network in the long term. Where the overlay network that would be rolled out in 1993 would later grow to incorporate most current data networks. This would be accomplished through organic growth in the ISDN user base, the products would hopefully come, which makes the overlay costs unbearable. The most prominent aspect of the market group in the protocols is not their input but their conspicuous absence.⁸³ All meeting protocols contain briefs from the major roles in the project, with most of the time going to technical aspects, the market group has most often nothing to say. Since there is a real dearth of products for the market group to work with, this may be a problem upstream. However, considering later developments, it could also be a case of simply not wanting to report that there is little or no market for ISDN. This was at the very least readily evident to outside observers who describe it as a general technology looking for applications and customers.⁸⁴

From the behavioral point of view the problems inherent in the technology as it relates to the Swedish telecoms network are becoming plainer. While attempts are made to solve the problems within the ISDN project they are still made within the confines of a project that must be run to completion. The ISDN-group is given a great deal of discretion on what shape the project will take within the Swedish telecoms market, except on the major point of whether to implement or disinvest. As some of the problems are unsolvable and identified during this time, most pressingly the lack of an associated product market and the lack of interest from customers this causes, there is a lack of upwardly directed warnings in this regard extant in the material. However, the final commercial launch of ISDN is as a to-cost investment model. Where if the customers want ISDN, they will have to pay the entire installation cost. When working within the confines of the demands meted on the projects implementation, this is quite a good way of limiting the economic damage that a full-scale roll-out on par with Digitalen 87 would have caused. This is a substantial change in conception of the scope of the project, comparable to the limited expectations when the ISDN-decision was taken in 1990. Instead of a comprehensive digitalization of the telephone network to ISDN being the next generation of telecoms infrastructure, to a limited commercial network, to an invest if customer pays. It should be noted that this is quite uncommon in Tvt's market model wherein large costs concentrated to the networks division (which is primarily a cost center) from

⁸² DNT SE/RA/420509/420509.088/F 5/51 "Lägesrapport Oktober 1991" LG vidar PM 1991-08-19

⁸³ SE/RA/420509/420509.088/F 5/50-51

⁸⁴ SWT 7842 "Swedish Telecommunication Series" Capgemini Consulting 1 June 1992

infrastructure building have to be internally budgeted against incomes from teleservices (which are business and customer facing). The shift in attitude within the company towards the ISDN project which this signifies is quite stark, not least since the networks division is not generally a revenue generating department. While the discussions show insight into the inherent problems, the major external event of a serious financial crisis in Sweden during this time is a more probable reason for prudence. It is not possible to deduce to what extent this would come to affect the Networks division of Tvt, but there are substantial cuts to investment spending evident in the 1993 budget⁸⁵. There is no mention that the to-cost rollout of ISDN is due to the ongoing financial crisis, but it is not unreasonable to assume that a project which was already facing an uncertain future would not be spared cuts.

The primary trends to contend with when applying the managerial theory of firm decision making to the second phase is that of the expectations leveraged against the potential of the technology meeting the twin issues of real applicability and a harsher financial environment. The ISDN project is substantially scaled down in the 1990 board decision but is at the same time cemented in what seems to be an irrevocable way. It is difficult to disengage the two drivers of rationalization from one another as the sources from the ISDN project group do not mention any change in mandate or scope of the project due to cutbacks. But as mentioned above there is evidence in the 1993 budget of precipitous cuts to investment for the networks division. While Tvt did not experience financial difficulties that threatened the firm's survival, it did experience a drop in demand for their services. The managerial theory suggests that once satisfactory profit has been achieved other considerations start affecting decision behavior at the managerial level and only if survivability is at stake does a symbiotic relationship reappear. It is likely that this dynamic plays out on a micro level within a firm as well, with borderline projects having to rationalize their goals and offerings first. While the scope of the final deployment was circumscribed there were no major issues raised by the ISDN project group. A group who by definition if not by admission were heavily invested in the success of ISDN, both in terms of its success for Tvt and in terms of its adoption overall. The lack of prescience in criticism could be assigned either to the obvious explanation of setting the project's success above the needs of Televerket, but also the possibility that it wasn't within the project group's remit to give any. The mandate of the working group was to suggest a proper way to implement the ISDN network, as had been decided in the board meeting, following commercial tests. It was not within

⁸⁵ SE/RA/420509/420509.088/G 2/3

their remit to decide or change the scope of the project. Therefore the lack of criticism of the internal project as a whole could either be assigned to the futility of the action or to the ulterior motive of wanting to reach deployment. The criticism that does exist is directed outside of the company and most crucially never directed at the technology. The commitment laid down in the MOU towards other companies forms a strong perpetuating influence in the project and can explain why there was such a reduced remit for the ISDN-group. The fact that the stratego-political decision had been taken outside of the networks division circumscribed their mandate in this matter.

Phase 3: Reception 1993 to 2001

From the commercial deployment in 1993 and onward the internal sources of Telia/Televerket are not publicly available. Therefore, this section will primarily concern itself with the launch of the publicly available ISDN network and its reception as can be gleaned from secondary sources. This phase can be said to terminate with the wide availability of the ADSL protocol in 2001.

In the budget for 1993, the expected uptake in the first year of ISDN is 4000 BRI interfaces and 800 PRI interfaces for a channel sum total of 32000 to 37000 channels (depending on if Tvt counts the non-data-bearing control channel).⁸⁶ Compare this to the actual outcome in figure 3, which measures channels installed, not subscribers. The actual launch of the ISDN network is a disappointment, even with the much-reduced expectations. Compare this with the rapid uptake of internet modems which measures actual subscriptions. It should be noted here that the actual uptake of internet is much greater in the market as Tvt was slow to realize its potential and never reached the market dominance it held in fixed telephony. In trying to compare the subscription numbers for ISDN versus internet it is important to keep in mind that the actual number of subscriptions could be anywhere from 50 to 97% lower than the number of channels, depending on the breakdown between the two ISDN types. Since the uptake is presented in such an incongruous way it seems likely that the true figure tends towards the conservative end. Outside of the yearly reports, in internal documents the ISDN-uptake is described as low⁸⁷ and in official histories is described as “[..] never a success in Sweden, in contrast to Germany and Norway.”⁸⁸

⁸⁶ DNT SE/RA/420509/420509.088/G 2/3 “Budgetunderlag för utbyggnad av ISDN-nätet 1993”

⁸⁷ SWT 3417 “VL-U 1/1994”

⁸⁸ SWT 7007 The History of Telia p.33

Telia-koncernen					
	1997	1996	1995	1994	1993 ¹
Fast och mobil telefoni, utlandssamtal, samtalsminuter (miljoner)	747	708	700	697	683
ISDN kanaler Sverige (1 000-tal)	198	104	40	18	10
Internet, abonnemang Sverige (1 000-tal)	232	105	9	—	—
Internet, abonnemang Danmark (1 000-tal)	10	—	—	—	—
Kabel-TV, abonnemang Sverige (1 000-tal)	1 308	1 291	1 275	1 259	1 250
Kabel-TV, abonnemang Danmark (1 000-tal)	145	137	135	—	—
Kabel-TV, abonnemang Estland (1 000-tal)	14	11	—	—	—
Kabel-TV, abonnemang Lettland (1 000-tal)	7	—	—	—	—

Fig.3 Cropped key figures relating to adoption of ISDN. See appendix B3 for original document.

After the disappointing years up to 1995, with the advent of the internet in the late 1990s ISDN will experience a short renaissance as it offers faster speeds than the prevailing modem infrastructure; finally the product had a use for customers. It should be noted that the benefits compared to the original vision for ISDN as a phone network with data transfer capabilities was reversed; instead it was primarily a data transfer network with a legacy voice transfer component. However, the upswing will be short-lived and penetration never approach the 100% coverage envisioned in the 1980s, the number of installed channels peaks at ~900,000 in the early 2000's⁸⁹ and 126.000 subscribers, less than 3% of the amount of POTS subscriptions.⁹⁰ Contrast this with the then conservative estimate shortly before the launch of 9.5% of the connections being ISDN by 2000.⁹¹ The 1997 yearly report contains the most positive post-launch evaluation of the project after the number of channels grow rapidly, from a low base. Of the original product line that the ISDN-group envision only the PBX-ISDN interface would see a limited realization and while this is mentioned, it is primarily the wish for higher internet speeds that drive demand, especially among consumers. Internet is described as the "Killer-app" for ISDN, one which was never anticipated even tangentially in the planning process.⁹²

Without the access to primary lower level sources it is hard to deduce what the fallout inside the company from the ISDN project was. What can be gleaned is that even with the much-reduced expectations for ISDN the results were worse than expected. There is a substantial amount of money invested as adoption rates increase. Since they are specified as planned for investments and not to-cost purchase from customers the view of the project must have changed after the initial years. With the available sources, it is impossible to tell why the project changed in character inside

⁸⁹ Telia AB Annual Report 2000, Telia AB Annual Report 2001, Telia AB Annual Report 2002, Telia AB Annual Report 2003

⁹⁰ SWT 5611 Liberalisering, regler och marknader SOU 2005:4

⁹¹ DNT SE/RA/420509/420509.088/B2/8 "IN och ISDN i accessnätet"

⁹² SWT – 6446 "Omvärldsanalys @ Omvärld & Strategiutveckling"

Tvt after a few years of disappointing growth. This phase will therefore, outside of the results of the project as a basis for the veracity of claims made earlier, not feature greatly into the analysis of decisions relating to the ISDN project.

The cyclical malinvestment case

The ISDN technology is originally conceived of as the culmination of the analogue telephone network, its primary component being to provide voice communication over long distances, but as an added benefit it allows for data transfer as well. However, the provision of these data transfer services is firmly rooted in the faster application of existing products. It is not so much a case of providing new products as it is one of ensuring that the next generation of an existing product will be compatible with existing networks rather than an original project wherein the primacy of generalized data transfer is anticipated and the future is provided for. The question is one of the phone network's nature, is it to be a classic (but digitalized) phone network with data transfer capabilities, or a data transfer network which can handle voice? From the planning documentation, the idea is stated much this way, a streamlining of existing data networks to both improve the quality offered as well as more easily allowing intercommunication between them, while at the same time future-proofing the telephone network by bringing it up to a higher standard and incorporating some data transfer capabilities. When the project is later scaled down it is still referred to as something that will keep expanding and into which the underlying data networks will coalesce.

On these levels then there is a strong case to suggest that it is a standard case of a cyclical malinvestment. There are no indicators that any money or resources spent developing, exploring and investing in the ISDN project would come to be beneficial later beyond the administrative benefit of option exhaustion in the discarding of the plans for a country-wide ISDN network. The country wide ISDN network should be seen as the original project, the reason behind all the commission work, the test networks and the anticipated developments stated in the strategy documents. The rollout of ISDN that would come to reap the most long-term success was not the anticipated urban businesses and households, rather it was through the more parsimonious distance losses compared to ADSL that made it a viable in rural locations.

On some level the failure to recognize the coming growth of data transfer and the stagnation of voice traffic in the terrestrial network is tantamount to accusing Tvt of not anticipating the internet, which would be a tall order for any organization. However, criticism can be levelled at the lack of foresight when comparing growth rates for communication products. Data transfer networks had

shown high and steady growth for many years by the mid 1980s with no signs of abating. POTS growth had been low and only marginally profitable for years, especially in local calls. With the digitalization of the trunk lines, the prior cost differential for local versus long-distance calling, and the earning potential therein, had been eliminated as the need for as cost of repeating a signal over long distance was much reduced.

The dependencies that appear seem to be partially connected to the technology path chosen, with the time and cost invested in making this technology available for deployment giving the project an inexorable component. However, there is also a dependency created by the work laid down in the CCITT commission. This politico-institutional dependency does not have a physical component. However, the commitment implied by the time and resources laid down in the commission work builds a similar kind of inertia inside the organization, one of a sunk cost. The delays on an international level associated with the ISDN project can be said to have been to Tvt's benefit. The long time that passed from the exuberance at finishing Digitalen 87, and so having the world's most modern telephony network, to a potential deployment of ISDN no doubt allowed for a more thorough examination of the technology, with many of the inherent flaws becoming obvious. It should be noted that even though the invested capital is quite extensive in arithmetic means, upwards to half a billion SEK, it pales in comparison to other projects at the same time. Putting the project into context and comparing the actual outcome in terms of adoption and deployment to what was originally planned, there is a case to say that while the pursuit of ISDN went far further than it should have, the potential loss from realizing the original plan would dwarf the real ones. The ISDN technology was the safer choice in terms of familiarity with the technology, but especially in the product offering that it could manage. Therefore it may be unfair to levy the charge of lack of foresight against Tvt when the actual reality of the project could be construed as due-diligence that went slightly too far rather than a complete boondoggle. There are however strong indicators that the original impetus and subsequent commitment to get involved in the standardization of the protocol were sprung out of a familiarity with the current technology and legacy infrastructure which obscured the future upheaval.

The managerial collusion case

Shifting the gaze somewhat, the ISDN-technology's very conception is indicative of a managerially driven project. The certainty in the mentions of an "imminent"⁹³ change of the telephone network into an ISDN network with integrated services is reminiscent of inertia infused hubris. The ISDN standard at this time was not laid down to a satisfactory degree such that much of anything could be said about what the future of the telephone network would look like, even if it was to be an ISDN-like solution. Though it was the most likely technological successor to the legacy POTS system at the time it was not the only possible one, nor was there only one way of implementing ISDN in Sweden.

The possible collusion that plays out is not between top management and owner, but rather between the networks division employees involved in the project and management. This need not falsify the hypothesis of higher level involvement since source availability is biased towards lower level sources such as the ISDN-group. Strong indicators of a managerially motivated project are in the incipient phase wherein the nebulous nature of the project seems to be worked to the benefit of making it more palatable to invest in. The idea was that the rationalization of the data networks and wide product line, which would surely come, would pave the way for wide and rapid adoption, which in turn would pay for the invested capital in short order. The project would at the same time streamline Tvt's infrastructure to cut costs. The certainty of the presented future scenario was plausibly to give the technology a sense of inevitability.

The certainty takes other malicious forms as well, beyond the inevitability aspect. The questions raised early on regarding possible product applications and market need were brushed aside for as long as was possible and would come to affect the project as though they were unforeseen external events rather than integral parts of the discussion at hand. Later, the constant lack of candor of the ISDN-group on these subjects as they became clearer also indicates that some level of occlusion of problems towards management was present. Their primary mandate was to test the basis for an ISDN network in Sweden and form the basis of an actionable decision to management. The fact that these problems were never satisfactorily rectified before commercial deployment indicates that there were other motives present than purely to improve Tvt's bottom line.

⁹³ SWT 9766 "Från dagens Telenät till Bredbandsnät" Bilaga 1 1985-01-11

The big unexplored question is what motivated Tvt to sign the MOU on ISDN and so actually give the project a strong enough commitment that some sort of deployment became inevitable. Due to the scope of this thesis this decision has had to be treated axiomatically as a strong influencing political factor towards ISDN's development. Since top management would have had to be involved in a decision that would consume company resources, it would help clarify both top management's stated reasons for entering into this deal as well as the complicated interplay of Ericson and Televerket through Ellemtel. However, top management would have been acting on information passed to them from agents more intimately involved with the technology, so it is likely that the extant sources with exuberant expectations form part of the decision basis for the MOU.

At the same time this analysis must be tempered by the shape that the ISDN project finally took. Some limitation of scope and economic rationalization happened from 1990 to 1993. The primary sources do not mention that the mandate for the project has changed due to owner or managerial intervention. Rather this seems to have been an internal process of due diligence towards the ISDN-technology after the ISDN groups completion of their report. So even though there are strong indications that there naturally were agents whose interest in the project went beyond what was optimal for the firm, the control structures of the company somewhat efficiently handled those within the confines of the deployment committed to.

Summary of analysis

The complex system of business areas, divisions, and political considerations, with the added layer of horizontal and vertical communication has yielded too much supporting evidence for either analytical framework to easily allow the project to be categorized as squarely supporting one or the other theory. Instead there is a shifting dual layer of first lower-level ISDN supporters building up political support for a commitment to ISDN. When this commitment comes, it comes from the top management decided MOU. This MOU forms a strong commitment dependency for the project, with later lower levels of management working to lay bare and curtail some of the issues of the project, but at the same time also occluding some of the inherent problems. This need not be an inherent contradiction, as both theories acknowledge the existence if not the importance of the other motivating principle of inefficiencies. Where they differ is in focus, with the behavioral theory taking a macro stance irrespective of the financial health of the firm and managerial theory suggesting its driver of inefficiency is an always underlying phenomenon, the self-interest of agents, which recedes only in times of firm financial stress. With the outcome of the project having been

not a success, nor an outright failure, the reason why a project which had strong warnings of two types of pitfalls did not result in failure needs explaining. The delays of the ISDN project would have allowed for awareness of issues inherent in the technology as well as other technological options to appear, therefore shifting outward the boundary of uncertainty that otherwise limited the conceived available options. The Swedish financial crisis that happens at a pivotal moment in the ISDN project's timeline would have reduced the scope of the project by constraining available resources, just as the managerial theory suggests. However, without comparisons to how other concurrent network projects were affected it is hard to say for certain if the ISDN project was singled out because it was known to be a troubled project.

Conclusion

The results of this thesis have, using the twin lenses of the behavioral and managerial theories of firm behavior, shed light on how a Swedish publicly owned utility discussed and treated a technological hurdle in a time of rapid change. It has shown that the same project can exhibit strong indications supporting both overarching decision models over the course of its life, and indeed at the same time. It adds to theory by showing that narrowly evaluating decisions with preference given to one theory to the exclusion of the other belies the complex factors that enter into a technological decision such as this. This is not unanticipated as both Carter⁹⁴ and Monsen⁹⁵ from their respective theoretical frameworks recognize the need for a broadening of the scope of analysis. This suggests that a more comprehensive framework of technological decision making is necessary to evaluate projects of this kind, one which allows for a more complicated process rationale beyond a one-sided commitment to either managerial collusion or a path-dependency induced technological myopia.

Further research

Further research is needed to broaden understanding of how SOEs make strategic technological decisions. Broadening the scope of this thesis and looking at the CCITT discussions, comparisons to the domestic tele market of each country of the MOU and later uptake would do much to put the technology's benefits and drawbacks vis-à-vis already existing infrastructure into perspective. Furthermore, rather than an axiomatic assumption that the commitment given by Tvt formed a

⁹⁴ Carter, E. E. (1971). The Behavioral Theory of the Firm and Top-Level Corporate Decisions. *Administrative Science Quarterly*, 16(4), 413.

⁹⁵ Monsen, R. J., & Downs, A. (1965). A Theory of Large Managerial Firms. *Journal of Political Economy*, 73(3), 221-236.

strong inertia driven force in the ISDN project, a greater understanding of exactly what Ellemtel and Televerket fought for in the commission would do much to broaden our understanding of the ISDN project. The access to primary sources stretching further than 1993 would also help shed light on the shift in attitude towards ISDN that happens after 1996. This is something which is not possible with the currently available sources.

In terms of the ISDN project's shrinking scope, comparing and contrasting its timeline to that of concurrent and comparable projects within the networks division would be helpful to better understand what external factors affected it and to better separate those that were inherent to the project and the technology. Examples of such projects could be Videotex, the already existing data networks (datex, datel, etc.) and GSM for mobile phones. Using the same analytical framework and archival material, looking at investments as a whole within networks during the limited time of the Swedish financial crisis in 1991-1992 would shed light on how project priorities are set during times of decreasing profitability within an SOE.

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Yin, R. (2014). *Case Study Research: Design and Methods*. Thousand Oaks, CA : Sage Publications Inc..

Archival collections

Riksarkivet Arninge (RA)

KCL	Televerket Koncernledningsstab G 1968-1993
NAT	Televerket Nätavdelningen 1983-1990
DNT	Televerket Division Nättjänster 1990-1993
MAR	Televerket Marknadsavdelningen 1975-1990
TDA	Televerket Data / Televerket ADB-Service / Televerket ADB-Avdelningen 1979-1991

Ratio/EHFF digital database

SWT	SWE Telecom
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Documents extant in Riksarkivet Arninge (RA):

Internal ID – EHFF/Ratio database Source ID-number (if any)

Archive: Televerket Koncernledningsstab G 1968-1993 - SE/RA/420509/420509.086 (KCL)

Series: SE/RA/420509/420509.086/A 1 a/19 – Direktionsledningsprotokoll – 1989-1990

RA-A1 - 1097 2/6/1990 *Board minutes*

Series: SE/RA/420509/420509.086/F 4 b/12 – Planeringskonferenser – 1989-1990

RA-A2 - 11479 *Väsentliga tendenser I den teletekniska utvecklingen*

RA-A3 - 11516 *Televerket Scenarios*

Archive: Televerket Nätavdelningen 1983-1990 - SE/RA/420509/420509.101 (NAT)

Series: SE/RA/420509/420509.101/B 2 c/

Volume: 21

RA-B1 *Förutsättningar för 1985 års strategiska planering vid teleområdena Nis 85 005*

RA-B2 *Strap 85, sammanfattning av Årets telefonmöten PM NIS 85 006*

RA-B3 *Vad är ISDN? (Tjänsteintegrerade digitala nätet)*

RA-B4 *Tema Integralen 90*

Volume: 50

RA-B5 *PM Nis 90 005*

Archive: Televerket Division Nättjänster 1990-1993 - SE/RA/420509/420509.088 (DNT)

Series: SE/RA/420509/420509.088/F 5/50 – Projektdokumentation ISDN 1988-1991

Volume: 50

RA-C1 *Rapport från teknikgruppen till PG-ISDN*

RA-C2 *Möte nr.27 PG-ISDN 1990-01-30*

Volume: 51 - Projektdokumentation ISDN 1989-1992

RA-C3 *LG vidar PM 1991-08-19 Lägesrapport Oktober 1991*

RA-C4 *Positionering av televerkets datakommunikationstjänster 1991 02 07*

RA-C5 *Ansats – Marknadsscenario år 2000*

RA-C6 *PM 92-03-23 NUL 92009*

RA-C7 *Protokoll 1991-09-02 TG-ISDN-009*

RA-C8 *Projektinfo ISDN 1-91*

Series: SE/RA/[420509](#)/[420509.088](#)/G 2/3 – Budget och budgetuppföljning

RA-C9 *Budgetunderlag för utbyggnad av ISDN-nätet 1993*

Series: SE/RA/420509/420509.088/B2/8 – PM och rapporter 1987-1992

RA-C10 *IN och ISDN I accessnätet 92-04-08*

Archive: Televerket Marknadsavdelningen 1975-1990 - SE/RA/420509/420509.097 (MAR)

Series: SE/RA/[420509](#)/[420509.097](#)/A 1 a/1 – Ledningsgruppsprotokoll -1985-1986

RA-D1 - 5346 *Strategisk inriktning för företagsystem PM 85-12-13*

Archive: Televerket Data / Televerket ADB-Service / Televerket ADB-Avdelningen 1979-1991 - SE/RA/420509/420509.103 (TDA)

Series: SE/RA/[420509](#)/420509.103/F3 bs/1 - Videotex systemstudie (1984) och slutrapport (1988)

RA-E1 - 6514 *Systemstudie "Datavision"*

Documents extant in EHFF/Ratio Swe Telecom database (SWT):

Internal ID – EHFF/Ratio database Source ID-number

Archive: Bertil Thorngren's Personal Archive Volume 1

SWT-A1 – 9108	<i>New Lines for Old - The Economist</i>
SWT-A2 – 6101	<i>Treårsplan 1990-1992</i>
SWT-A3 – 9116	<i>Bilaga 3, Sweden: National Presentation ICCP Committee</i>
SWT-A4 – 4618	<i>Trender i den tekniska utvecklingen</i>
SWT-A5 – 4332	<i>Koncernstrategi v.2.2</i>
SWT-A6 – 4645	<i>Digital Telecommunication Services in Sweden</i>
SWT-A7 – 7098	<i>Tele Nr. 3 1987</i>
SWT-A8 – 6446	<i>Omvärldsanalys @ Omvärld & Strategiutveckling</i>

Archive: Teldok- arkiv med Teldoks skrifter 1981-2006

SWT-B1 – 5625	<i>Teldok Rapport 40</i>
SWT-B2 – 11578	<i>Teldok Nr.3 Jan 1986</i>
SWT-B3 – 11585	<i>Teldok 76</i>
SWT-B4 – 11583	<i>Teldok Nov 1986 Rapport 25</i>

Archive: Centralt utgivna föreskrifter och tryck

SWT-C1 – 2032	<i>Årsredovisning 1987</i>
SWT-C2 – 2392	<i>Treårsplan Televerkskoncernen 1985/86 - 1987/88</i>
SWT-C3 – 2394	<i>Treårsplan Televerkskoncernen 1988 – 1990</i>
SWT-C4 – 4346	<i>Årsredovisning 1992</i>

Miscellaneous Archives within the Swe Telecom database:

SWT-D1 – 7842	<i>Swedish Telecommunication services</i> , Capgemini Consulting 1 June 1992 – Kommunikationsdepartementet: Regeringsakter, Kommunikationsdepartementet Diarienummer: K92/2071/5
SWT-D2 – 9766	<i>Från dagens Telenät till Bredbandsnät</i> Bilaga 1 1985-01-11 Näringsfrihetsombudsmannen: NO-Ärenden F1A:104

SWT-D3 – 5611	<i>Liberalisering, regler och marknader</i> SOU 2005:4
SWT-D4 – 6643	<i>Svenska Televerket Del VII: Från myndighet till bolag: Kapitel 6. Nätutveckling, 6.3 Nya nättjänster</i>
SWT-D5 – 3417	<i>VL-U 1/1994</i> Telia AB: Protokoll Koncernstab Ekonomi och Finans A4a:1
SWT-D6 – 9429	<i>Communications Engineering International 10/89 – “Moving from strength to strength in the future”</i> Tony Hagströms Arkiv F1: pressklipp 1977-1993
SWT-D7 – 7007	<i>The History of Telia</i>
SWT-D8 – 3341	<i>Affärsplan Teliakoncernen 1997-99</i> Handlingar till styr och ledningsgruppsmöten, volym A2b25, Telia AB
SWT-D9 – 6452	<i>Videotex</i> , Riksdataböndet ISBN 91-86656-09-0

Complete list of consulted archives and volumes

Televerket Division Nättjänster 1990-1993

SE/RA/420509/420509.088

Series: F 1 J Volumes: 1-4

Description: Diarieförda handlingar, nätaffärer (Na)

Series: F 5 Volumes: 50-51

Description: Projektdokumentation ISDN-projektet

Series: G 1 B Volumes:8

Description: Bokslutshandlingar Resurs och projektuppföljning

Series: G 2 Volumes: 1-3

Description: Budget och budgetuppföljning

Series: B 2 Volumes: 8

Description: PM och rapporter – Rapporter och PM om nätutveckling

Televerket Division TeleTjänster 1990-1993

SE/RA/420509/420509.096

Series: F 7 j Volumes: 17

Description: Marknadsanalysrapport 1980-1991

Series: E 3 Volumes: 1

Description: Inkomna Handlingar FC/TC 1990-1993

Series: F 1 d Volumes: 1-3

Description: Handlingar ordnade enligt dossiéplan Fd Affärsområde Datakommunikation 1990-1994

Series: A3 a Volumes: 1-2

Description: Protokoll, Fd, Affärsområde Datakommunikation, (TFD) 1990-1992

Televerket Nätavdelningen 1983-1990

SE/RA/420509/420509.101

Series: F 7 c Volumes: 1

Description: Nd, Datanätsektionen Tele-K AB, Delrapport m.m.

Series: A 2 Volumes: 2-3

Description: Föredragningslistor, B-Föredragningar 1985-1991

Series: B2c Volumes: 21 & 50

Description: Skrivelser, Ni 1985 & 1990

Appendix A: Abridged EHFF/RATIO Onedrive representation of database contents

Sweden Telecom
Coloured box indicates series or multiple document within one year
Documents collected, series complete, N of documents in FM
Documents collected, not complete series, n of documents in FM
Documents not collected/uncertain status (available according to Archive description, not researched)
no series found

INCUMBENT																
Televerket - Tella																
Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Minutes, board and management																
Televerket Management minutes, Direktionsprotokoll (Cd, Cf, Hk, TLG, TLG-minuteBoard minutes)																
Televerket Board minutes																
Tella board minutes																
Tella management minutes (KL-G, TLG, VL, VL-U, KL-minutes)																
Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Minutes/(Meeting notes), subsections, Televerket -1993																
Televerket Tekniska avd 1975-1983, SC-minutes																
Televerket, Avd. för grundteknik och provning 1983-84, Avd för grundteknik 1984-1991, SC-minutes																
Televerket Avd. för telenätsplanering 1975-1979, Avd. för nätsplanering 1979-1983, SC-minutes																
Televerket, Nätsavdelningen 1983-1990, NC(?) -minutes																
Televerket, Div Telenätk 1990-1991, Div Nätsplanering 1991-1993, LG-N-minutes																
Televerket, Marknadsavd för datakommunikation / Marknadsavdelningen för telefon 1975-1980, Marknadsavdelningen 1980-1990, SC-minutes																
Televerket, Div Telenätsplanering 1990-1993, FC/TC(?) minutes																
Televerket, Materieldivisionen 1975-81, Materieldivisionen 1981-91, Div. materiel & service 1991-93, SC/MC(?) -minutes (Meeting notes), Staff minutes, LG-minutes																
Televerket, Administrativa avd 1975-1991, Koncernstab Personal 1992-93 (Meeting notes)																
Televerket, Ekonomistab 1975-1991, Koncernstab Ekonomi & Finans 1992-1993																
Televerket, Rationaliseringsavd 1975-84, LG-O-minutes, (Meeting notes)																
Televerket ADB-avd 1979-84, Televerket ADB-service 1984-1990, Televerket Data 1990-91, SC/LG-minutes																
Televerket, Radiodivisionen 1975-84, Radio 1984-92, SC-minutes, LG-minutes, RHK-minutes																
Televerket, Frekvensförvaltningen 1975-1991																

INCUMBENT																
Televerket - Tella																
Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997				
Minutes, board and management																
Televerket Management minutes, Direktionsprotokoll (Cd, Cf, Hk, Tlg, Tlg-minuteBoard minutes)																
Televerket Board minutes																
Tella board minutes																
Tella management minutes (KLG, TLG, VL, VL-U, KL-minutes)																
Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997				
Minutes/(Meeting notes), subsections, Televerket -1993																
Televerket, Tekniska avd 1975-1983, SC-minutes																
Televerket, Avd. för grundteknik och provning 1983-84, Avd för grundteknik 1984-1991, SC-minutes																
Televerket, Avd. för telenktsplanering 1975-1979, Avd. för nkplanering 1979-1983, SC-minutes																
Televerket, Nätavdelningen 1983-1990, NC(?) -minutes																
Televerket, Div Telenkt 1990-1991, Div Nätjänster 1991-1993, LG-N-minutes																
Televerket, Marknadsavd för datakommunikation / Marknadsavdelningen för telefon 1975-1980, Marknadsavdelningen 1980-1990, SC-minutes																
Televerket, Div Telenktjänster 1990-1993, FC/TC(?) minutes																
Televerket, Materieldivisionen 1975-81, Materieldivisionen 1981-91, Div. materiel & service 1991-93, SC/MC(?) -minutes (Meeting notes), Staff minutes, LG-minutes																
Televerket, Administrativa avd 1975-1991, Koncernstab Personal 1992-93 (Meeting notes)																
Televerket, Ekonomilavd 1975-1991, Koncernstab Ekonomi & Finans 1992-1993																
Televerket, Rationaliseringsavd 1975-84, LG-O-minutes, (Meeting notes)																
Televerket ADB-avd 1979-84, Televerket ADB-service 1984-1990, Televerket Data 1990-91, SC/LG-minutes																
Televerket, Radiodivisionen 1975-84, Radio 1984-92, SC-minutes, LG-minutes, RHK-minutes																
Televerket, Frekvensförvaltningen 1975-1991																

Appendix B: Selected copies of original documents

Fig B1&2: Positioning of ISDN networks towards businesses

Rekommenderade lösningar: Blandad datakom (trans+filer)				
1. Höga svarstidskrav				
Karaktär	Lokalkom Inom byggnad tomt	Tvärkom Många varierande punkter Olika företag	Företagskom Fasta punkter samma företag och nära partner Publikt Nät Privat Nät	
Volym				
Små	TKS STD.LAN	Dtp X.32 1) (via Dtx)	Datex ISDN 64000	Anatel Data
< 1 h/dag eller < 5 ggr/dag				
Stora	STD.LAN FDDI	Datapak 1) X.25	Datapak 1) X.25 Datex	FAM FAP Eripax FDDI Radiolänk
> 1 h/dag eller > 5 ggr/dag				
2. Måttliga = låga svarstidskrav				
Karaktär	Lokalkom Inom byggnad tomt	Tvärkom Många varierande punkter Olika företag	Företagskom Fasta punkter samma företag och nära partner Publikt Nät Privat Nät	
Volym				
Små	PABX TKS STD.LAN	Dtp X.28 1) (via Dtl upp- ringt) Datex (om stor säkerhet krävs)	Dtp X.32 1) (via Dtx) ISDN	PABX (nätgrupp) Anatel Dat
< 1 h/dag eller < 5 ggr/dag				
Stora	STD.LAN GEN.LAN	Datapak 1) X.25	Datapak 1) X.25 IDN 64000	FAM FAP Eripax
> 1 h/dag eller > 5 ggr/dag				
1) Vid internationell kommunikation (tvärkommunikation eller publik nät) är Datapak lämpligast p g a stor internationell acceptans. Datapak X.28/X.32 via Datex fungerar endast i den svenska änd- punkten.				

Rekommenderade lösningar: Integrerad kommunikation (ljud, data, bild)				
1. Höga svarstidskrav				
Karaktär	Lokalkom Inom byggnad tomt	Tvärkom Många varierande punkter Olika företag	Företagskom Fasta punkter samma företag och nära partner Publikt Nät Privat Nät	
Volym				
Små	TKS PABX	ISDN *)	IDN 64000	FAM PABX (nätgr)
< 1 h/dag eller < 5 ggr/dag				
Stora	PABX TKS	ISDN *)	IDN 64000	FAM Radiolänk
> 1 h/dag eller > 5 ggr/dag				
2. Måttliga = låga svarstidskrav				
Karaktär	Lokalkom Inom byggnad tomt	Tvärkom Många varierande punkter Olika företag	Företagskom Fasta punkter samma företag och nära partner Publikt Nät Privat Nät	
Volym				
Små	PABX TKS	ISDN *)	IDN 64000	FAM PABX (nätgr)
< 1 h/dag eller < 5 ggr/dag				
Stora	TKS PABX	ISDN *)	IDN 64000	FAM Fiber Radiolänk
> 1 h/dag eller > 5 ggr/dag				
Med bild avses även rörlig bild. ISDN vid tvärkommunikation får nu lösas med en kombination av olika tjänster. *) ISDN marknadsintroduceras succesivt i ett pilotnät som redan				

Fig B3: Annual report 1997 p.70 – Key figures, uncropped

<i>Teliaconcernen</i>	1997	1996	1995	1994	1993 ¹⁾
Resultaträkning (MSEK)					
Nettoomsättning	46 444	43 324	39 830	36 946	34 774
Rörelseresultat	4 844	4 796	4 504	4 576	5 494
Resultat efter finansiella poster	4 031	3 622	3 227	2 955	3 953
Årets resultat	2 735	2 304	2 234	2 237	3 148
Utdelning (för 1997 enligt styrelsens förslag)	1 210	1 152	1 000	900	799 ²⁾
Balansräkning (MSEK)					
Immateriella anläggningstillgångar	1 583	1 809	941	215	188
Materiella anläggningstillgångar	42 173	41 465	40 897	39 721	41 250
Finansiella anläggningstillgångar	5 088	3 775	2 372	1 939	1 564
Omsättningstillgångar	15 358	14 086	13 164	12 792	12 460
Summa tillgångar	64 202	61 136	57 374	54 667	55 462
Eget kapital	24 048	22 463	21 169	19 842	17 926
Minoritetskapital	306	218	13	6	0
Avsättningar	11 902	14 976	17 867	16 872	15 339
Räntebärande skulder	14 813	9 837	4 513	4 639	9 627
Ej räntebärande skulder	13 133	13 642	13 812	13 308	12 570
Summa skulder och eget kapital	64 202	61 136	57 374	54 667	55 462
Investeringar (MSEK)	11 803	11 949	11 832	8 348	7 171
Nyckeltal (definitioner se s. 65)					
Bruttomarginal (%)	28,4	29,8	32,1	35,7	38,7
Rörelsemarginal (%)	10,4	11,1	11,3	12,4	15,8
Vinstmarginal (%)	11,0	11,9	12,0	13,2	16,9
Nettomarginal (%)	8,7	8,2	7,9	7,8	11,2
Avskrivningar enligt plan	8 335	8 100	8 291	8 619	7 773
Avskrivningar i % av nettoomsättning	17,9	18,7	20,8	23,3	22,4
Avskrivningar i % av historiska anskaffningsvärden	10,4	10,5	11,9	15,6	15,2
Totalkapitalets omsättningshastighet (ggr)	0,74	0,74	0,73	0,69	0,62
Sysselsatt kapitals omsättningshastighet (ggr)	1,07	1,06	1,02	0,94	0,85
Räntabilitet på totalt kapital (%)	8,2	8,7	8,6	8,9	10,4
Räntabilitet på sysselsatt kapital (%)	11,9	12,6	12,3	12,3	14,1
Räntabilitet på justerat eget kapital efter full skatt (%)	12,4	11,0	11,4	12,3	19,2
Räntabilitet på justerat eget kapital efter schablon-skatt (%)	13,2	12,6	11,9	11,7	17,3
Balanslikviditet (ggr)	0,74	0,76	0,82	0,82	0,70
Soliditet (%)	35,6	34,9	35,2	34,7	31,5
Skuldsättningsgrad (ggr)	0,9	1,0	1,0	1,0	1,3
Räntetäckningsgrad (ggr)	4,6	3,4	3,1	2,5	3,2
Självfinansieringsgrad (ggr)	0,84	0,91	1,01	1,31	1,94
Förändring av totalproduktivitet (%)	-0,2	-2,8	0,3	0,8	5,0
Personal					
Antal anställda	32 549	34 192	33 065	32 593	34 080
Medelantal anställda	33 930	34 031	32 825	32 807	34 312
Löner och ersättningar (MSEK)	9 472	8 876	7 948	7 690	8 202
Arbetsgivaravgifter (MSEK)	2 807	2 719	2 606	2 427	2 496
Förändring av arbetsproduktivitet (%)	10,4	3,9	10,1	12,4	14,0
Rörelseresultat per medelantal anställda (kSEK)	143	140	137	139	160
Löner och arbetsgivaravgifter i % av rörelsekostnader	28,8	29,9	29,3	30,4	35,9
Bestånds- och trafikuppgifter					
Fast telefoni, abonnemang Sverige (1 000-tal)	6 010	6 032	6 013	5 967	5 910
dito per 1 000 invånare	679	682	680	677	676
Mobil telefoni, abonnemang Sverige (1 000-tal)	1 935	1 745	1 438	1 175	785
dito per 1 000 invånare	219	197	163	133	90
Fast telefoni, nationella samtal Sverige, antal (miljoner)	9 020	8 370	7 740	7 530	7 050
Fast telefoni, nationella samtal Sverige, samtalsminuter (miljoner)	34 500	32 100	31 000	—	—
Fast och mobil telefoni, utlandssamtal, samtalsminuter (miljoner)	747	708	700	697	683
ISDN, kanaler Sverige (1 000-tal)	198	104	40	18	10
Internet, abonnemang Sverige (1 000-tal)	232	105	9	—	—
Internet, abonnemang Danmark (1 000-tal)	10	—	—	—	—
Kabel-TV, abonnemang Sverige (1 000-tal)	1 308	1 291	1 275	1 259	1 250
Kabel-TV, abonnemang Danmark (1 000-tal)	145	137	135	—	—
Kabel-TV, abonnemang Estland (1 000-tal)	14	11	—	—	—
Kabel-TV, abonnemang Lettland (1 000-tal)	7	—	—	—	—

Fig B4: Annual report 2001 p.72 cropped. Compare rapid growth of ADSL subscriptions versus the maturation of ISDN channels.

Telia koncernen – operativ information	2001	2000	1999	1998	1997	1996	1995
Telia Mobile							
Mobil telefoni, abonnemang totalt Sverige (1000-tal)	3 439	3 257	2 638	2 206	1 935	1 745	1 438
varav privatkunder	2 356	2 042	1 557	1 203	985	927	791
varav företagskunder	1 083	1 215	1 081	1 003	950	818	647
Mobil telefoni, GSM totalt Sverige (1000-tal)	3 295	3 076	2 348	1 703	1 180	824	463
varav abonnemang	1 759	1 755	1 425	1 390	1 180	824	463
varav kontantkort	1 536	1 321	923	313	–	–	–
Mobil telefoni, NMT totalt Sverige	144	181	290	503	755	921	975
Mobil telefoni, avgående trafik Sverige (Mmin)	3 016	2 591	2 089	1 745	1 554	1 221	1 046
Mobil telefoni, inkommande trafik Sverige (Mmin)	2 067	1 766	1 416	1 091	885	677	612
Mobil telefoni, trafik per kund och månad Sverige (min)	127	123	121	114	111	99	106
Mobil telefoni, SMS-meddelanden Sverige (miljoner)	389	185	46	13	4	–	–
Mobil telefoni, churn Sverige (%)	8	8	9	14	12	n/a	n/a
Mobil telefoni, ARPU Sverige (SEK)	285	308	332	362	345	366	399
Mobil telefoni, abonnemang totalt Norge (1000-tal)	970	850	–	–	–	–	–
varav privatkunder	794	707	–	–	–	–	–
varav företagskunder	176	143	–	–	–	–	–
varav abonnemang	469	417	–	–	–	–	–
varav kontantkort	501	433	–	–	–	–	–
Mobil telefoni, trafik per kund och månad Norge (min)	136	139	–	–	–	–	–
Mobil telefoni, SMS-meddelanden Norge (miljoner)	501	302	–	–	–	–	–
Mobil telefoni, ARPU Norge (NOK)	310	308	–	–	–	–	–
Mobil telefoni, abonnemang Danmark (1000-tal)	288	263	170	112	–	–	–
Mobil telefoni, SMS-meddelanden Danmark (miljoner)	61	39	23	–	–	–	–
Mobil telefoni, abonnemang Finland (1000-tal)	239	149	33	8	–	–	–
Mobil telefoni, SMS-meddelanden Finland (miljoner)	57	28	4	1	–	–	–
Telia Internet Services							
Bredband ADSL/LAN, abonnemang Sverige (1000-tal)	194	27	2	–	–	–	–
Bredband fast access, abonnemang Sverige (1000-tal)	3	2	1	1	1	1	1
Internet, abonnemang uppringd access Sverige (1000-tal)	747	687	598	439	230	105	9
varav privatkunder	617	576	501	364	160	73	6
varav företagskunder	130	111	97	75	70	32	3
Internet, uppringd trafik Sverige (Mmin)	7 117	7 072	5 330	2 938	1 147	128	–
Internet, abonnemang uppringd access Danmark (1000-tal)	89	78	67	60	11	–	–
Kabel-tv, abonnemang Sverige (1000-tal)	1 378	1 358	1 348	1 330	1 308	1 291	1 275
varav digitala	124	21	–	–	–	–	–
utbyggda bredbandsanslutningar i kabel-tv-nätet (1000-tal)	420	193	36	–	–	–	–
varav Internetanvändare	48	22	3	–	–	–	–
Kabel-tv, abonnemang Danmark (1000-tal)	179	175	170	164	145	137	135
utbyggda bredbandsanslutningar i kabel-tv-nätet (1000-tal)	304	175	145	110	101	17	–
varav Internetanvändare	58	30	11	3	–	–	–
Telia Networks							
Fast telefoni, PSTN, abonnemang Sverige (1000-tal)	5 663	5 783	5 889	5 965	6 010	6 032	6 013
varav privatkunder	3 841	3 868	3 919	3 901	3 903	3 919	3 922
varav företagskunder	1 822	1 915	1 970	2 064	2 107	2 113	2 091
Fast telefoni, ISDN, kanaler Sverige (1000-tal)	922	838	630	424	244	129	49
varav privatkunder	121	99	53	23	–	–	–
varav företagskunder	801	739	577	401	244	129	49
Fast telefoni, nationella samtal Sverige (Mmin)	26 533	31 360	35 200	35 600	31 700	30 500	30 500
Fast telefoni, internationella samtal Sverige (Mmin)	503	520	560	600	660	670	680
Fast telefoni, samtal till mobiltelefon Sverige (Mmin)	1 744	1 590	1 490	1 270	1 110	890	750
Fast telefoni, prefix- och avtalskunder Danmark (1000-tal)	264	232	209	160	86	12	–

Appendix C: Mentions of ISDN in Televerket reports

A cursory glance gives an idea of the span of the project. Of special interest are the lack of mentions in 1988 and 1989 in the annual report pending committee decisions.

