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LAURA PAIJA (ed.)

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FINNISH ICT CLUSTER IN THE DIGITAL ECONOMY

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ABSTRACT: The last decade of the past millennium marked a fundamental change in the industrial structure and international position of Finland. It became one of the world's most high-technology intensive economies, and gained a position in the forefront of the global digital economy. This book provides three complementary perspectives on the development of the information and communications technology (ICT) cluster in Finland.

First, the book digs into the factors behind the competitive advantage of the cluster, and analyses the dynamic interaction between the factors, which has given rise to a self-nourishing system. Indeed, despite the seemingly rapid boom of the Finnish ICT sector, there is a long evolutionary process behind it. However, many coincidental factors beyond the control of the cluster play also a role in the phenomenon, which ultimately raises the question, can we actually explain it? There are several fundamental questions on the horizon, which will test, once again, the Finnish ICT cluster's ability to rise to the challenge.

Second, the book describes the birth of the private venture capital market in Finland in the 1990s. Greatly improved access of technology start-ups to risk funding explains much of the increased scale and scope of the ICT cluster. The book examines the growth and internationalisation of technology-based new companies through eight cases, with a focus on the impacts of venture capital on their value creation processes. It is concluded that the entrance of venture capitalists in the case companies has fuelled their growth not only through fortified capital base, but also through managerial support and improved credibility in the eyes of interest groups.

Thirdly, the book analyses strategic differences between the two 'digital superpowers', the U.S. and Europe, which have taken different paths on their way to the digital economy. To date, U.S. companies have enjoyed a leadership in the wired digital economy, while European, and most particularly, Nordic companies have pioneered in the wireless market. The two pioneers, however, cannot rest on their laurels. There are perceivable signs of the erosion of their leaderships. The transition to the third generation communications, which represents a disruptive technology, will vitiate some of their first-mover advantages gained in the previous phases of competition, and will thus challenge the pioneers' capability to find ways to renew the sources of their strategic advantages.

Key words: Finnish ICT cluster, competitive advantage, venture capital market, technology-based new companies, digital economy

CONTENTS

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Laura Paija

Introduction to the Volume

1. BACKGROUND

In 1992, an extensive cluster programme was initiated in ETLA – The Research Institute of the Finnish Economy. It was based on Michael E. Porter's book *The Competitive Advantage of Nations*,[1] in which an concept of industrial complexes, or clusters, was introduced and implemented in a captivating way. The message of ETLA's study to policymakers was that they should target cross-sectoral networks instead of isolated industry sectors in policy design. The study also emphasised the government's role as the creator of favourable framework conditions rather than as planner or controller.

In 1993, the White Paper (*National Industrial Policy*[2]) was outlined on the basis of ETLA's research. The cluster framework was adopted by national governments in many other countries, as well.

One of the clusters identified in ETLA's project was the telecommunications cluster.[3] It was found still incomplete in structure, but it was considered to possess great potential to develop into a competitive industrial system. The bottlenecks were found in inadequate external funding of firms, underdeveloped supplier infrastructure, and insufficient supply of skilled human resources. In the light of the current study, the two first weaknesses have greatly diminished, owing largely to the surge in private venture capital, the development of the stock market, and the purposeful public expenditure on R&D, which have been reflected in the strengthening of the supplier base. The third bottleneck, the exhaustion of labour resources, however, remains. Despite the recent global wave of dismissals in the ICT sector as a result of a hiccup in demand, the expected explosion of the market in view of next generation communications will uphold the need for skilled people in the years to come.

All in all, since the first study, Finland has undergone a major industrial metamorphosis. The share of ICT cluster value added in GDP has more than doubled, to 7-8 per cent by the end of the millennium, catching up with the forest cluster that has dominated Finnish industrial activity over the history. The share of ICT equipment of total exports has doubled as well, to 30 per cent in 2000. During the last decade of the century, Finland became the most specialised country in communications equipment exports in the world, outrunning Japan and Sweden. In essence, the exceptional expansion of the sector largely reflects the phenomenal growth of one sole company, *Nokia*, that now dominates the global market for mobile communications equipment.

At the time of the initial cluster study, the telecommunications sector looked somewhat different, too. In 1994, as remarked in the report, 'the telecommunications cluster [could] be broken down into two parts. It [consisted] of the telecommunications equipment industry and telecommunications services'.

This time the research environment was not as clear-cut. The convergence of information and communications networks, terminals, services, and the ensuing industrial restructuring has made the scene very complex. Firms are penetrating each other's traditional domains shaking the age-old industrial structures; content providing companies in their many forms are forcefully entering the scene; production value chains are being remodelled; access to the end-user, which used to be the sole right of the telephone operator, has now come under a battle between a number of actors.

Finland's leap to the international forefront of the industry, which used to be dominated by large 'national champions', and which is today perhaps the most dynamic field of technology, is in the focus of international curiosity. What is behind this quite unique phenomenon, and can we even explain it?

In this context, it had become evident that ETLA's telecommunications cluster study was to be updated. The name of the telecommunications cluster had also become obsolete, and needed to be revitalised to account for the whole ICT setting. Our idea to re-conduct the ICT study coincided with a research project initiated in the OECD as part of the National innovation Systems (NIS) programme, in which various focus groups have been set up to work on specific topics. Clusters, generally interpreted as reduced-scale NIS, were in the centre of attention of one of these groups. In the Cluster Focus Group clusters in selected industrial sectors in different countries were put into comparison. The objective was to compare the structure and central factors of competitiveness across national clusters, with specific focus on national innovation patterns and cluster-relevant policy.

The first chapter in this book, *The ICT Cluster in Finland – Can We Explain It?* draws on our contribution to the OECD teamwork in the ICT Focus Group. The final report of the OECD Cluster Focus Group is forthcoming in summer 2001.

However, we found that it was necessary, on the one hand, to look deeper into the change in one of the factors behind the ICT cluster development. That was the recent but influential emergence of private

venture capital, and the rapid change in the funding of young technology firms. The task was accepted by Eficor Group Oyj, one of the earliest companies in the young venture capital business. Mr. Perttu Rönkkö provides in his chapter *Growth and Internationalization of Technology-based New Companies: Case Study of 8 Finnish Companies* an overview of the development of the Finnish private capital market. He conducted a case study in eight Finnish start-up companies in the ICT cluster to analyse the structural change in the evolution process of technology-based new companies.

On the other hand, it was also important to put the Finnish, or more generally, the European 'mobile competitiveness' into global perspective. The development of the other 'digital superpower', i.e., the U.S., has taken somewhat different path. It was to be a challenging but rewarding task to put these two pioneers into comparison. This task was taken on by Professor Dan Steinbock, who has an impressive track record in studies in the ICT field. He draws the analysis in his chapter *Two Kinds of ICT Pioneers: The Mobilization of the Digital Economy* from his thorough conversance of the economies and the ICT industries of the both continents.

We wish to thank the Ministry of Trade and Industry for funding this study, which provided the authors an opportunity for a captivating experience in digging into one of the most exiting phenomena of our time.

2. OUTLINE OF THE VOLUME

The ICT Cluster in Finland – Can We Explain It?

Laura Paija analyses the development of the competitive advantage of the Finnish ICT cluster. The chapter begins by mapping the cluster's position in the domestic and international markets. Then, after on overview on the ICT cluster's history, the issue is approached with an account of the four internal determinants of competitive advantage (i.e., firm strategy, structure, and rivalry; demand conditions; factor conditions; and related and supporting industries), and the two external determinants (i.e., the government, and chance) outlined by Porter. The analysis of the dynamics of the ICT cluster system identifies numerous interactions between the factors, which have enforced the favourable development of the Finnish ICT cluster. The government as

the creator of framework conditions has had many important roles over time. For example, by conceding a multi-actor market, which induced buyer-supplier co-operation, it gave rise to the most distinctive feature that differentiated the Finnish market from other markets. However, behind surprisingly many beneficial circumstances there have been coincidental factors, or good chance. To conclude, the chapter picks up major issues that will influence the future prospects of the cluster. There are several fundamental questions relating to both internal and external factors of the cluster system, which challenge the Finnish ICT cluster's ability to sustain its competitive advantage in the future.

Growth and Internationalization of Technology-based New Companies: Case Study of 8 Finnish Companies

Perttu Rönkkö describes the changes in the Finnish capital market with a focus on the birth of the private venture capital industry in the mid-1990s. Behind the surfacing of private risk funding there was the structural change in the capital market induced by liberalisation and firms' changed attitudes towards private venture capitalists. In addition, the chapter introduces an analytical tool to examine the value creation process of a technology-based new company. This model challenges the traditional view of a technology-based firm's development, which allows for a piecemeal evolution of business processes. As the time-to-market of technology-based products has shortened, firms need to grow fast, and thus, develop all processes simultaneously. The new model on the evolution of technology-based start-ups is applied in eight case studies, by which the growth and internationalisation of the ICT-oriented firms are illustrated. The focus of the analysis is on the effects of venture capitalists on a firm's development. It is found that venture capital has accelerated the case firms' value creation processes, not only through the firms' improved financial positions, but also through their strengthened managerial resources and credibility. To conclude, the chapter contemplates the internationalisation model that would be most successful for Finnish companies.

Two Kinds of ICT Pioneers: The Mobilization of the Digital Economy

Dan Steinbock provides a comparative analysis of the U.S. and Europe, the two pioneers in the global ICT sector. The U.S. and Europe, both approaching the mobile digital economy, have advanced

somewhat different development paths. To date, U.S. companies have enjoyed a leadership in the wired digital economy, while European, and especially Nordic companies have benefited from a leadership in the wireless digital economy. A analytical comparison between the two continents is made by contrasting four Nordic and four U.S. pioneering companies, which are positioned in different horizontal layers of the digital economy. The companies on both sides of the Atlantic represent very different backgrounds and growth strategies. The analysis focuses on the reconfiguration of the intra- and inter-firm chains of these firms. Special attention is paid to the impact of horizontal and vertical layering of areas of ICT business on the firms. The cases are investigated within an industry transformation matrix, which allows for a comparative analysis of the Nordic and the U.S. sources of strengths and weaknesses in the mobilisation of the digital economy. Finally, the distinguishing qualities and also the pace of erosion of leadership of the two ICT pioneers will be considered. It is suggested that while Nordic companies have led the way in mobile communications, they lack certain complementarities that may hinder the full exploitation of this leadership. The U.S. pioneers, in turn, have the required complementarities in the wired digital communications, but are now forced to play a catch-up game in wireless communications. The transition to the third generation communications, which represents a disruptive change, will vitiate some of the early-mover advantages of the European and the U.S. pioneers. This gives the Asian consumer-electronics companies a new chance to enter the battle for the leadership of the market.

ENDNOTES

[1] Porter M.E. (1990), *The Competitive Advantage of Nations.* New York: The Free Press.

[2] Ministry of Trade and Industry (1993), *National Industrial Strategy for Finland.* Publication 3/1993. Industry Department. Helsinki.

[3] Mäenpää K. & Luukkainen S. (1994), *Teletekniikasta monimuotoiseen viestintään – teleklusterin kilpailukyky. (From Telecommunications Technology to Multimedia Communication – The Competitiveness of the Telecommunications Cluster.* With English summary.) ETLA – The Research Institute of the Finnish Economy, Series B96. Helsinki: Taloustieto.

Laura Paija

The ICT Cluster in Finland – Can We Explain It?

CONTENTS

The author is indebted to many of her colleagues in ETLA, most particularly to Petri Rouvinen for his invaluable support and assistance, Pekka Ylä-Anttila for his constructive comments, and Anthony de Carvalho for the revision of the manuscript. She is also grateful to David R. Charles in the CURD, the University of Newcastle and Pim den Hertog in Dialogic for their useful remarks on the earlier drafts of the report.

1. INTRODUCTION

This chapter can be regarded as an update of the initial telecommunications cluster study published in 1994 as a part of the cluster research programme co-ordinated by ETLA between 1992-1995.[1] Since then, the telecommunications environment has undergone fundamental structural changes owing to the convergence of information and communications technologies and services. These changes have made it necessary to rename the cluster to the information and communications technology (ICT) cluster.

This study has profited from numerous interviews made over the past year in all segments of the cluster. As the dynamics and 'spirit' in industrial networks, giving rise to innovations and upgrading, are not manifest in statistics, dialogues with cluster insiders provide the primary source of information for cluster studies.

The ongoing convergence of information and communications technologies coupled with its implications for market structure indicates that the portrait of the Finnish ICT cluster provided in this chapter will soon serve as a writing of history. The purpose of this study is, however, primarily to serve as an attempt to unveil some of the functioning of the mechanism behind the evolution of the cluster. Hence, the underlying question is, can we explain it. Our intention is, thus, not to add to the vast stock of future scenarios, yet we will conclude the chapter with a discussion on the future prospects and threats on the cluster's horizon.

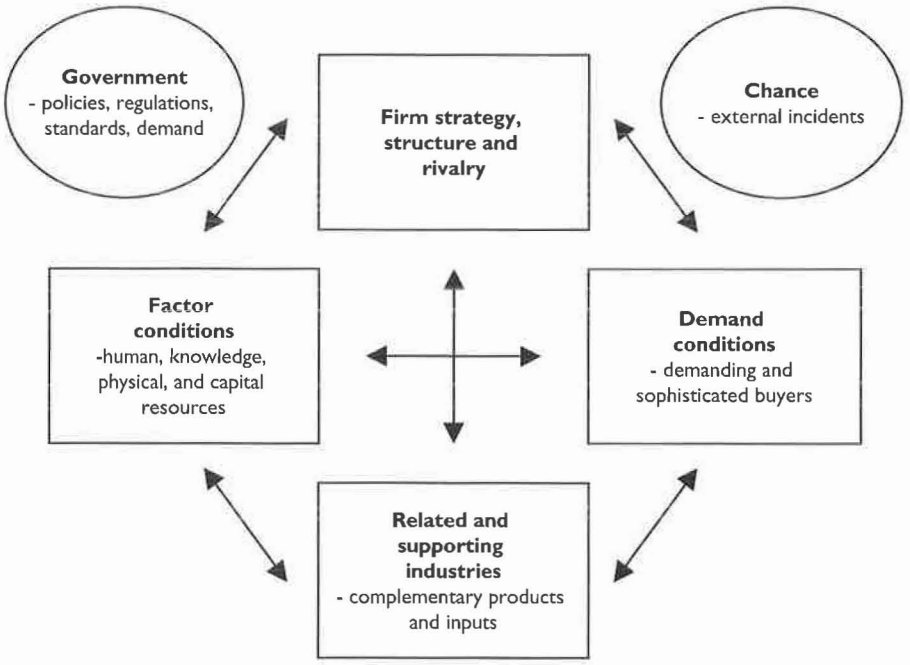
2. ICT CLUSTER IDENTIFICATION

2.1. What is a cluster?

Clusters are used to describe networks of organisations, in which competitive advantage grows from dynamic interaction between actors. Cluster relations cross sectoral boundaries, and spur innovation and upgrading through spill-overs and knowledge transfers.

According to Porter (1990), there are different home-based determinants influencing the competitiveness of a cluster (Figure 2.1). Paradoxically, he points out, globalisation of competition has not removed the importance of favourable domestic conditions, owing to several

Figure 2.1 The dynamic system of factors of competitive advantage



Source: Porter (1990).

factors related to proximity and common culture. Favourable home-based conditions provide advantages that can rarely be imitated by foreign competitors. This influence is decisive particularly for firms getting established and initially creating competitive advantage.

Porter divides the core factors of competitive advantage into four categories. First, the *factors of production* most important to the competitiveness are created through processes that are largely unique across nations and among industries. The rate at which critical factors are created and upgraded outweighs the importance of their absolute amount. Second, the pressure from *local buyers* provides an advantage through an impulse for product development. Third, the presence of competent suppliers in the *supporting industries* provides preconditions for a mechanism spurring innovation and upgrading in the industry. The exchange of R&D and joint problem solving accelerate development, and lead to more efficient solutions. Intensive interaction between actors in different phases of the value chain induces suppliers' specialisation in the specific needs of the industry. Fourth, the *goals, strategies and organisation of firms* and the *rivalry* between

them vary among nations. These aspects determine, e.g., the extent to which firms interact with other firms and are able to take advantage of the other factors of competitive advantage.

There are numerous cases, as pointed out by Porter, in economic history indicating that the importance of domestic rivalry as a stimulus for enhanced competitiveness has not been replaced by global competition. Firms that do not have to compete at home rarely succeed abroad. Economies of scale are best reaped through global sales, not through dominating the market.

Clusters are exposed to external forces. All *government policies* have influence on national competitiveness through their effects on the four determinants. By making successful decisions, the government can create favourable framework conditions to raise the probability of gaining competitive advantage, but it cannot create advantage itself. *Chance events* are incidents that are outside the control of firms. Technological discontinuities, political decisions in international contexts, and surges in demand create shifts in competitive positions, and can nullify old or create new advantages for firms.

Dynamic interaction between these factors of competitive advantage gives rise to a self-enforcing system – either virtuous or vicious, depending on the state of the factors.

Porter's model has been criticised for, e.g., its weak ability to explain the rationale for multinational corporations. According to critics, Porter overemphasises the importance of local conditions, because for globally operating companies national culture and the quality of home-based factors of competitive advantage lose their importance as a source of innovation and upgrading. Multinationals operate in clusters that cross national borders, and in which geographic proximity does not play a role. In addition, since it was originally made for the US market, the model puts an emphasis on the role of the home market that is not pertinent for a small open economy. Critics point to the necessity of a small country to look for resources and new markets abroad. Thus, competitive clusters in a small country are necessarily multinational.[2]

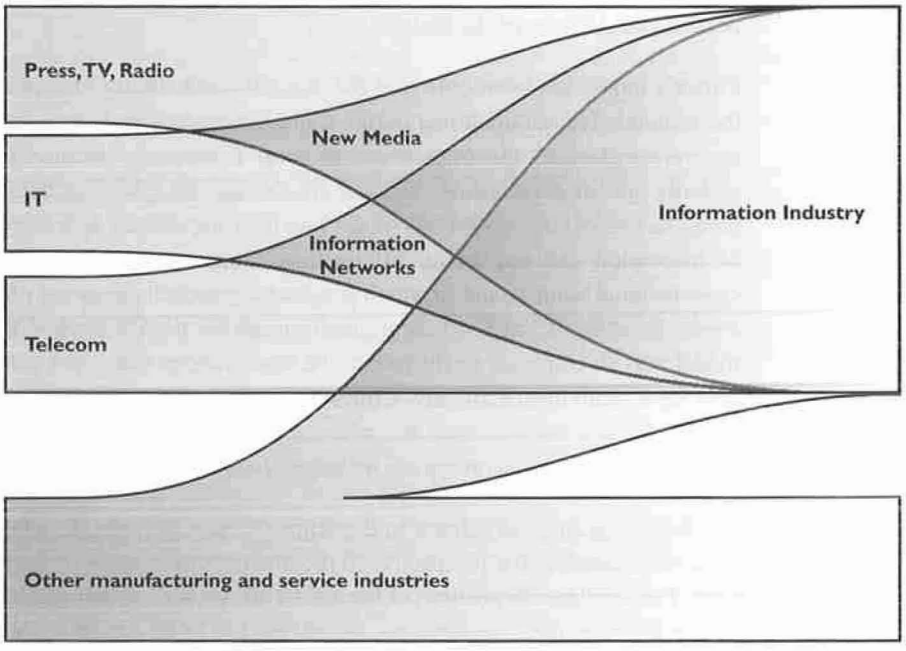
The following analysis adheres to the original Porter framework, while, however, extending the perspective to the international stage when relevant. The flexible composition of the model allows for a redefinition of the geographical area. Nevertheless, the perspective of this study is intentionally local despite the risk of being restrictive. Owing to its recent phenomenal growth and global success, there is a need to provide an over-

view of the development, composition, and dynamics of the ICT cluster in Finland, for which the Porter framework provides a workable tool.

2.2. ICT cluster under transformation

There are three trends, namely *convergence* of networks, terminals, services and industries, *digitisation*, as well as *deregulation* that are drastically stirring the clear-cut cluster chart we still had a few years ago.[3] Convergence is having an effect on different stages of ICT activities. First, it refers to the ability of different network platforms to carry similar kinds of services. Similarly, different consumer devices (telephone, TV, personal computer, record player, camera, game consoles, radio, and fax) converge towards multi-functioning terminals. Further, interlocking technologies induce convergence in the underlying industries as the established actors (equipment manufacturers, network operators, media, or more generally content providers) merge or form strategic alliances across sectoral boundaries. To some extent, the industrial restructuring takes paradoxical forms: on the one hand firms

Figure 2.2 Convergence of media, information and communications technology sectors over time

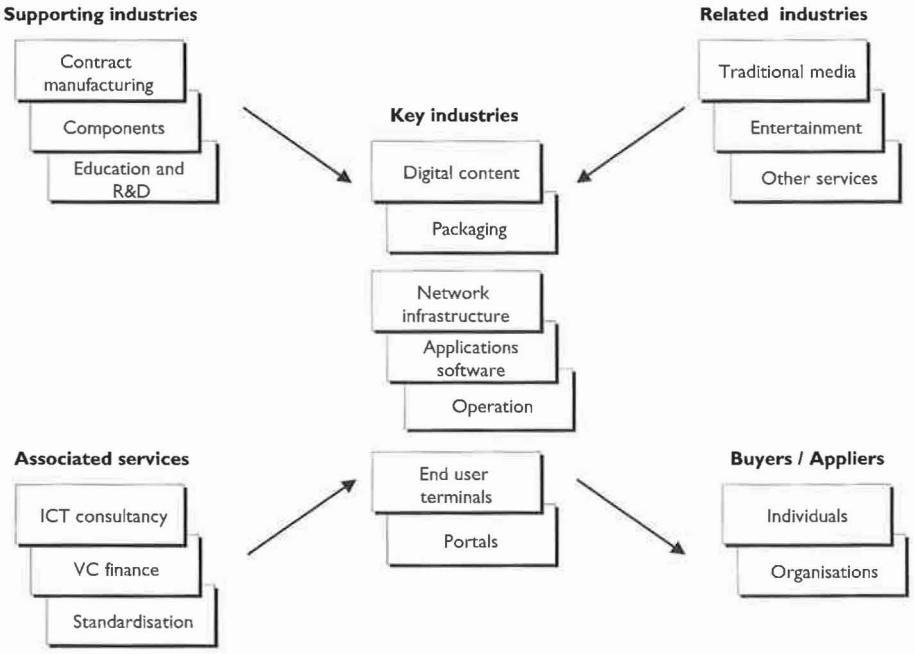


Source: Modified from Mäenpää & Luukkainen (1994) by Palja & Rouvinen (ETLA).

seek to take hold of a larger share – horizontal or vertical – of the value chain, and on the other hand, they strive at specialisation and networking. Finally, convergence gives rise to new services stemming from cross-sectoral fertilisation.[4]

The ICT cluster is depicted in Figure 2.3. In Finland the cluster centres upon communications equipment manufacturing and service provision. Around the key industries are those industries that are considered to harbour special potential in enhancing the competitive advantage of the system through innovative applications of ICT, or though improving its functional preconditions.

Figure 2.3 ICT cluster framework



Source: Paija & Rouvinen, ETLA.

Universities and research institutes have been successful in producing competent human resources and world-class R&D to support the cluster's development. The supplier industries, most particularly the electronics industry, in turn, have become highly specialised to meet the needs of the key activities over the last decade. The venture capital market, as an example of associated services, has emerged as a new

and important source of funding that has greatly enhanced the preconditions for growth in the cluster.

Many of the related industries have a dual role: first, as providers of value-added content to the infrastructure, and second, as buyers/appliers of ICT. Owing to the generic nature of ICT, the cluster has innumerable interfaces with other industrial clusters. Representative crossing points are found in the industries, in which new sector-specific applications of ICT are being developed.

Indeed, the overall economic impact of ICT is likely to be even more powerful on the demand-side of the technology than on the supply-side, since innovative applications of the technology are about to revolutionise traditional business models and increase productivity. From the point of view of economic analysis, the key concept is network externalities arising from scale economies on the demand side. Thus far, in Finland, economies of scale have benefited mainly the production side of the ICT. The critical question of the future, then, relates to Finland's capability to exploit the advanced technology on the user side to enhance productivity in the rest of the economy.[5]

3. ICT CLUSTER MAPPING

3.1. Domestic market position

Table 3.1 presents the key Figures of the Finnish ICT cluster for 1999.[6] The gross value of cluster production was EUR 21.4 billion. Manufacturing of equipment and electronic components dominated the cluster, representing 70 per cent of the value. The significance of software supply and other IT services is underestimated in the Table since ICT equipment includes a large amount of software, and the construction of telecommunications networks involves IT services that are included in the sales of equipment manufactures.

The value added generated in the cluster was 40 per cent of the gross value of production. Figure 3.1 reveals the breakthrough made by the communications industry in domestic production. Since reaching a turning point in its trend rate of growth in 1992, the cluster has grown at the average annual rate of 20 per cent (manufacturing 32 per cent and services 12 per cent). In 1999, the cluster's share of GDP was 6.9 per cent.[7]

Table 3.1 Key economic indicators of the ICT cluster in 1999

	ICT manufacturing		ICT Services				Cluster (total)	
			Telecom		Software, IT services			
	Euros (mill.)	Share of production	Euros (mill.)	Share of production	Euros (mill.)	Share of production	Euros (mill.)	Share of production
Production	14805	100 %	3678	100 %	2947	100 %	21431	100 %
Value added	4692	32 %	2254	61 %	1594	54 %	8542	40 %
Labour cost	1139	8 %	529	14 %	876	30 %	2544	12 %
Exports	12125	82 %	118	3 %	1009	34 %	13252	62 %
Imports	4185	28 %	151	4 %	605	21 %	4941	23 %
No. of firms	414		216		3463		4093	
No. of employees	38385		19294		25284		82963	

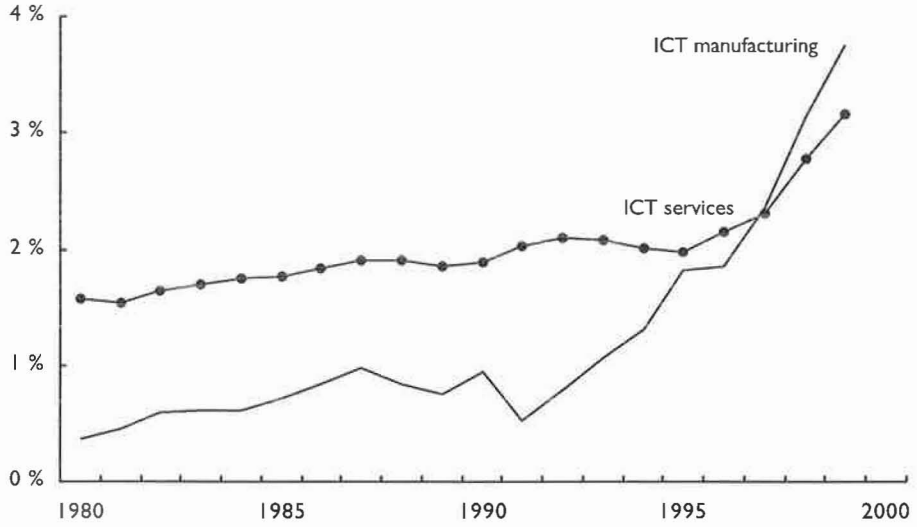
Source: Statistics Finland.

Note: ICT manufacturing exports and imports include associated services.

With 83 000 employees, the ICT cluster accounted for 3.6 per cent of total employment in 1999. *Nokia* alone employed around 23 000 persons in Finland and, thus, accounted directly for almost 30 per cent of the cluster's employment. According to our estimations, Nokia employed indirectly an additional 14 000 persons through its first-tier subcontractor firms.[8] As production networks expand further to sequential tiers, the employment effect of the major firm is significant, but cannot be readily quantified. However, without the chronic shortage of skilled labour the employment potential of the cluster would allow much higher recruitment.

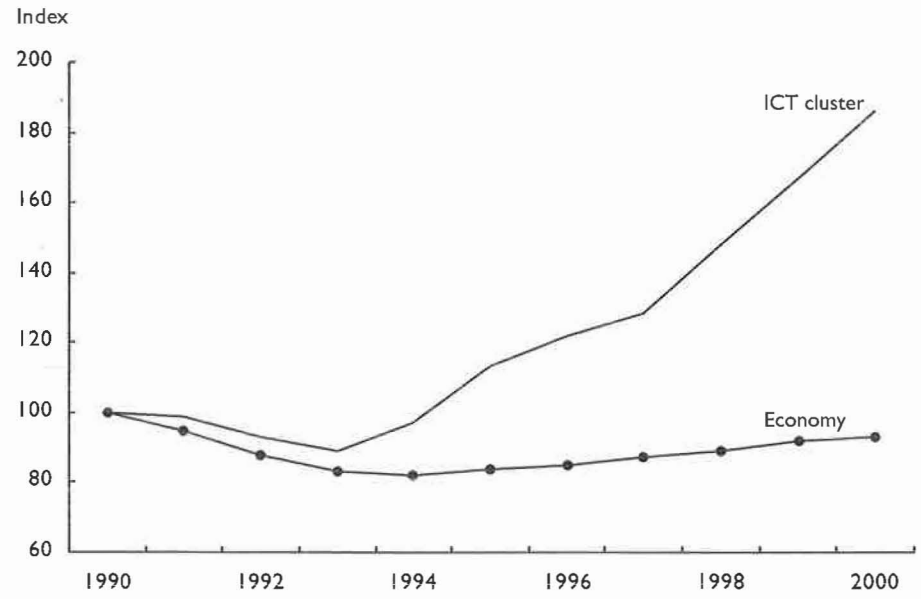
Since the economic slump of the first half of the 1990s, the ICT cluster has been able to maintain much higher employment rates than the economy as a whole (Figure 3.2).[9] The deterioration in total cluster employment in the early 1990s was aggravated by the coinciding full liberalisation of the telecommunications market. Highly automated and digitised systems underlay the necessity to reduce and restructure personnel in view of opening competition. During 1990-94, *Telecom Finland* (later *Sonera*) cut its human resources by over 40 per cent, while reductions in the private sector were more moderate. In 1998, however, the operator's employment rose back to its 1990 level – yet with marked changes in the educational structure.

Figure 3.1 The share of ICT value added in GDP



Source: Statistics Finland.

Figure 3.2 Employment growth indices in the ICT cluster and in the economy as a whole



Source: Statistics Finland.

At the same time, Nokia started to focus increasingly on telecommunications. Against the overall trend in the economy, the company started heavy recruitment of skilled people. The timing of Nokia's expansion was ideal for both the economy and the company: Nokia did not need to compete for skilled people, unlike today.

Despite the relative importance of the ICT cluster in the economy, the share of ICT firms is only 1.4 per cent (4 000) of the total. To note though, an important number of firms operating outside the 'statistical boundaries' of the ICT cluster (say, in metals, plastics, engineering, and certain service industries) are not included in this Figure.[10]

Finnish cluster firms are also relatively small from a global perspective. In terms of sales, Nokia is a leader in its own class in Finland, though in the global market it is still behind many of its peers. Also Sonera, despite its rapid growth and aggressive penetration in new markets, is still a minor company in the international arena (Table 4.1 on page 29).

3.2. International market position

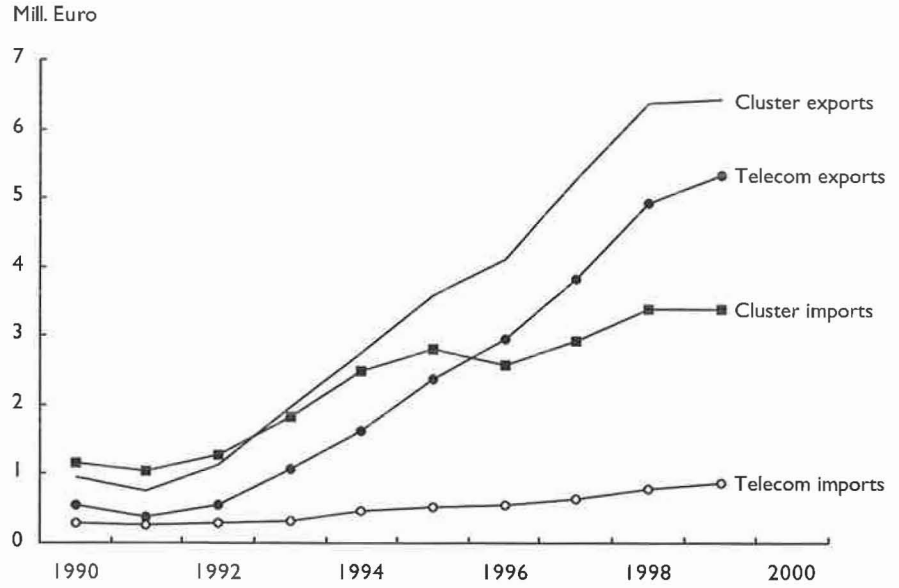
In 1999, the ICT cluster exported 62 per cent of its goods and services production, yet with marked variations between cluster sectors (Table 3.1). ICT exports accounted for a third of Finnish total exports.

Figure 3.3, depicting the trade balance in cluster products, illustrates the dominance of telecommunications equipment in Finnish ICT cluster trade. Despite the continuous growth in ICT cluster exports, the value of *non*-telecommunications exports (e.g. computers, office machinery, and electronic components) has remained almost constant over time. In 1999, it represented 17 per cent of total cluster exports. The growth in imports, in turn, depicts the dependence of the electronics industry on standard components (semi-conductors), while imports of foreign-made telecommunications equipment are relatively modest, and have hardly increased over the period.

The pace of growth in the Finnish electronics industry has been extraordinary over the 1990s. It has lead to an industrial restructuring in the former forest and metal based economy, in which knowledge has replaced capital, raw materials and energy as the dominant factors of production. During the past decade, Finland recorded the world's highest high-tech trade surplus (high-tech exports/imports ratio) among indigenous high-tech producers. The share of electronics and electrotechnical goods exports has almost tripled at the expense of pulp

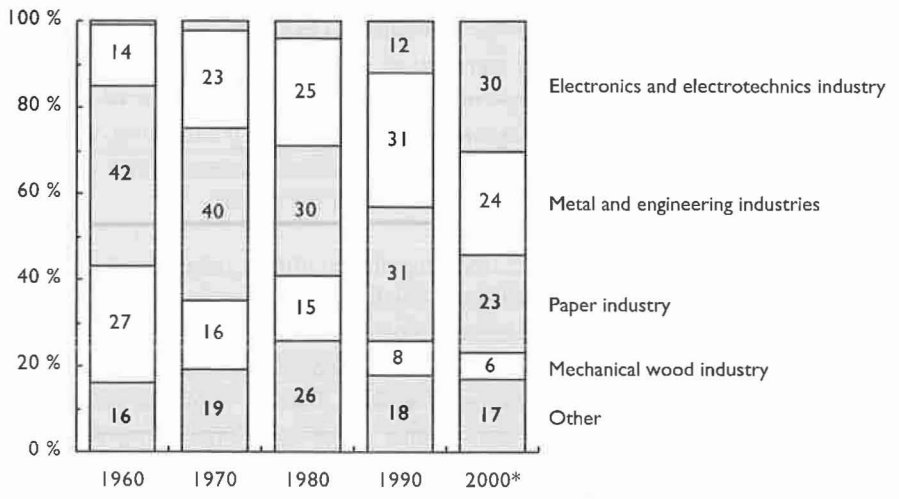
and paper and metals, representing 30 per cent of total merchandise exports in 2000 (Figure 3.4).

Figure 3.3 Foreign trade in ICT and telecommunications products (millions of Euros, in 1995 prices)



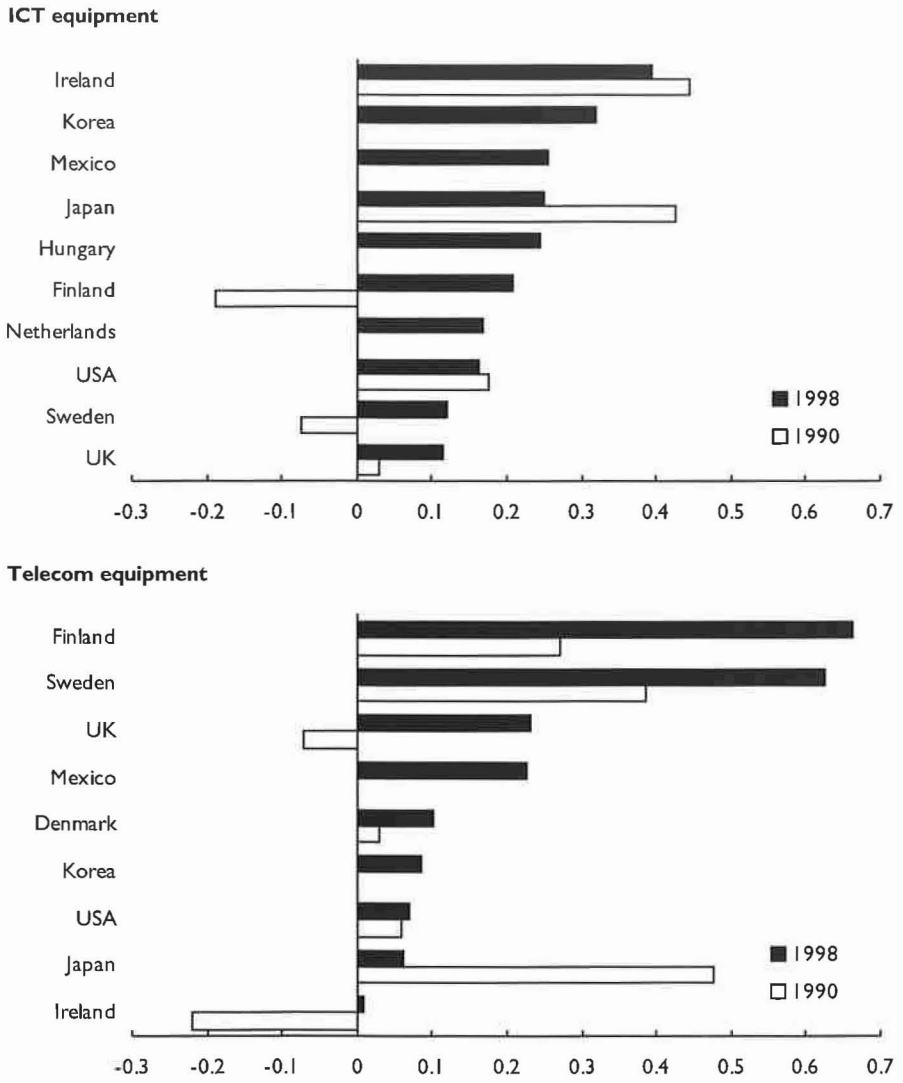
Source: National Board of Customs.

Figure 3.4 Export shares by industry group



Source: National Board of Customs, *ETLA's estimate.

Figure 3.5 Export specialisation in 1998 (RSCA index)



Source: OECD.

Note: ICT branches of the SITC Rev.3 classification. Countries with missing data for 1990 have become OECD members later. See Appendix 2 for the definition of the RSCA index.

Figure 3.5 depicts countries specialised in ICT exports in the OECD area. In total ICT exports (Figure 3.5 *upper*), Finland falls behind some more IT-oriented countries. However, many of the low-cost countries are not indigenous producers of ICT, and their high share of ICT exports owes mainly to foreign firms' exports. In telecommuni-

cations exports, in turn, Finland has become the most specialised country during the 1990s (Figure 3.5 *lower*). During the past decade, Japan lost its lead to the two Nordic countries, which have been since racing for the leading position.

In absolute terms, Finland accounted for 5.4 per cent of total OECD telecommunications equipment exports, enjoying the seventh position in a 1998 cross-country comparison.[11]

4. ICT CLUSTER SYSTEM

4.1. Evolution

Unlike in most other European countries, in Finland **telephone network operation** was never monopolised by the state. Initially, the fragmented market structure was the outcome of a political decision. At the time the first cables were being laid, in the 1800s, Finland was a Russian Grand Duchy. In order to complicate the potential seizure of the national telephony by the Tsar, the Finnish Senate granted many licences in telephony operation. In the 1930s, there were no less than 815 private local telephone companies.[12]

Once Finland became independent, the national public telecommunications operator (PTO) was established to operate the network left behind by the Tsar. There were several attempts throughout the decades to nationalise the private operation in view of harmonising the infrastructure, but they were frustrated by political incoherence and scarcity in public funds.[13] Nevertheless, the threat of nationalisation worked as an effective means of technical upgrading.

In 1921, the private companies founded the *Association of Telephone Companies* aiming at administrative cooperation and joining forces in face of the PTO, who acted as the regulatory body authorised to redeem poorly performing operators. The Association dominated local operation in growth centres while the PTO had monopoly over long distance and international calls. Over the years, the Association grew to become a powerful opponent to the PTO, giving rise to a duopolist market structure.

In the 1970s, the *Nordic Telecom Conference*, consisting of the national Post and Telegraph Administrations, engaged the industry in a

research project on an automatic cross-border Nordic mobile telephone (NMT) network, which was going to set the foundation for consumer-oriented mobile communications. Based on their experience, the Conference played an active role in initiating the *Groupe Spécial Mobile* (GSM) in 1982, and in the design of the pan-European digital mobile network.

The introduction of the NMT in 1981-82 made the Nordic countries (Denmark, Finland, Norway and Sweden) the world's largest mobile market in the early 1980s. The market, expanding at an unanticipated rate, started to attract private operators. Private licence applications were, however, rejected by the regulator-PTO, whose decisions pleaded to the notion of economies of scale of a natural monopoly. As a countermove, the Association founded in 1988 a joint venture, *Radiolinja,* to operate a private GSM network.

In fact, the dispute over the PTO's monopoly rights had its roots in the 1960s. The operative Imperial Telephone Decree of 1886 could not provide an unambiguous interpretation of the statutory rights to provide novel network services, such as data transfer, telefax and teletex. The new Telecommunications Services Act was enacted in 1987, separating the administrative and operational functions of the PTO, transferring the regulatory authority to an independent body under the Ministry of Transport and Communications. The private GSM licence application can be still regarded as the decisive stimulus to swift deregulation and full liberalisation of the telecommunications market, finalised in 1994.

As the winner of the regulatory battle, in 1991, Radiolinja was the first operator in the world to launch commercial GSM services. The liberalisation meant fundamental organisational and regulatory changes for the PTO, which was turned into a public corporation. It started to improve actively its service and price efficiency and launched its GSM service soon after Radiolinja, thus becoming among the very first to do so in Europe. In 1994, the post and telecommunications functions were demerged. The government started reducing its ownership and indicated further privatisation in due course. In 1998, the name of the company was changed to Sonera to pinpoint the change in the strategic focus, redirected to mobile and media services

The Finnish **telecommunications equipment market** also differed from many foreign markets by allowing competition. Up until the 1980s, the market was dominated by leading foreign manufacturers, like *Siemens, Ericsson*, and *ITT*. Attracted by the multi-operator market, they had set up production facilities in Finland. The leading re-

source-intensive foreign companies put a pressure on the emerging domestic industry. To illustrate, in 1970 the turnover of the Siemens Group was EUR 2 billion – almost equalling the total Finnish State budget of EUR 2,5 billion.[14]

The seeds of the Finnish radiophone industry were planted in three companies, *Salora, Suomen Kaapelitehdas*, and *Valtion Sähköpaja* in the 1920s. New radio technology was typically developed on the sidelines of the main activities of fervent engineers, often under suspicion and opposition of conservative colleagues. During a complex organisational evolution process, finalised in 1987, the three companies merged under Nokia's roof.

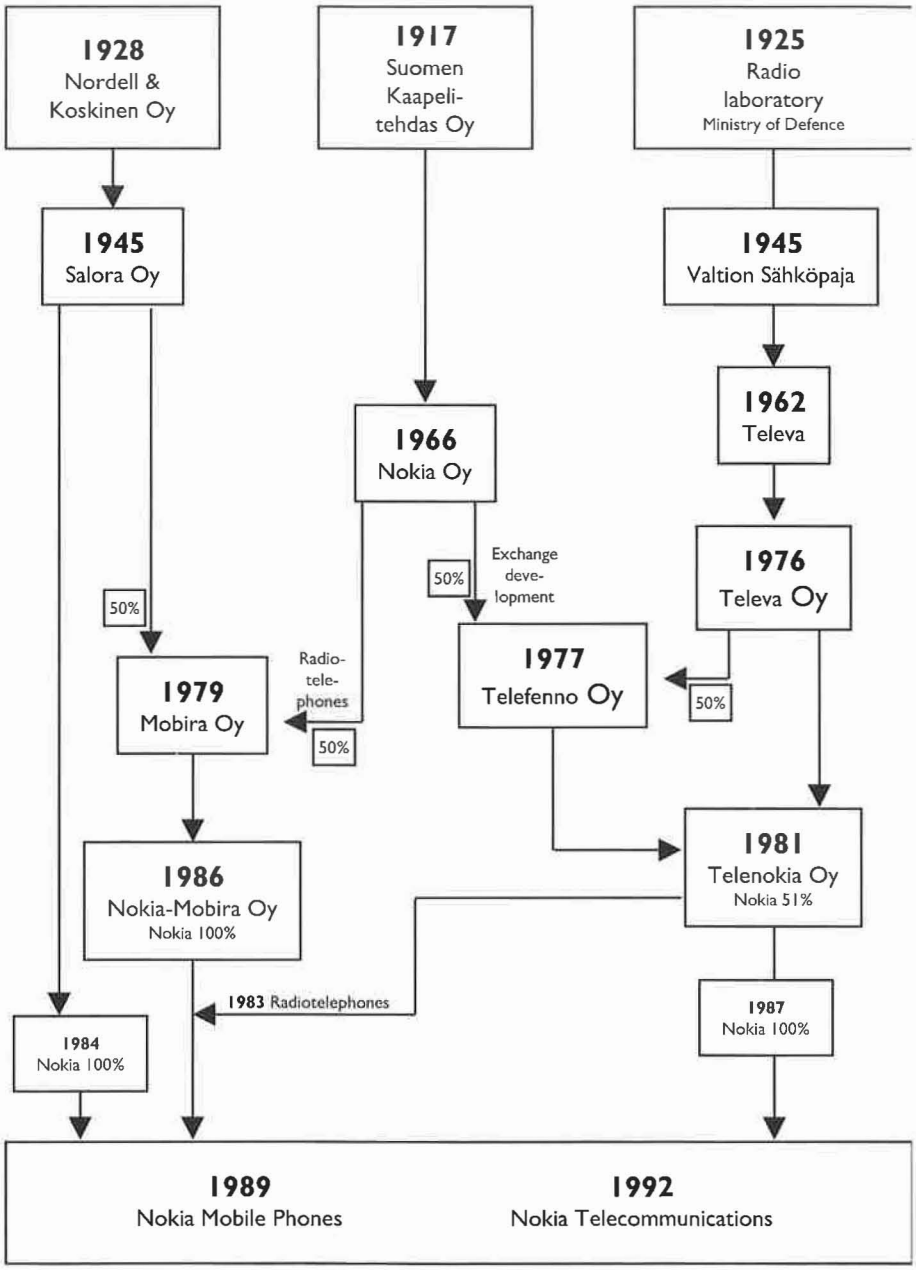
Salora (first established in 1928) was a manufacturer of TV and radio sets, who had a strong brand name beyond national borders and had accumulated experience in serial production and marketing, which proved valuable in the later mobile phone business development. The development of radiophones, initiated in 1964, was based on pioneering experiments conducted alongside core activities.

Suomen Kaapelitehdas (lit. Finnish Cable Works; founded in 1917), in turn, was a producer of telecommunications cables. Trade with the Soviet Union, originated during the deliveries of war indemnities, was decisive to the development of the company's technical skills.

Valtion Sähköpaja (lit. State Electric Works; first established in 1925 as the radio laboratory of the Ministry of Defence) was founded to strengthen national development and production of the strategic radio technology. After the wars, the activities were industrialised and merged with the R&D unit of the PTO. The company was renamed *Televa,* and in 1976, it became a state-owned limited company serving mostly public establishments for which it was the prime, but not exclusive, provider.

In 1963, the Army gave a decisive stimulus to the domestic industry by putting out an invitation for tenders for a radiophone. This was the first in a series of orders by which the government provoked companies to exceed their capacity to meet demanding requirements in the development of radio technology. Rather than a business opportunity, firms regarded the order as a chance to give a physical form to the know-how accumulated 'backstage'. Ultimately, the Army did not have the funds to redeem the phone, but the prototypes served the bidding firms in developing new portable phones, some of which became new export articles.

Figure 4.1 The evolution of the mobile communications industry



Souce: Modified from Häikiö (1998).

In 1966, Suomen Kaapelitehdas was merged with *Suomen Gummitehdas* (lit. Finnish Rubber Works) and Nokia, a 100-year-old wood

grinding mill that gave its name to the new corporation. The merger secured R&D investments in telecommunications, which was now regarded as one of the strategic business areas of the company.

In the 1970s, it became apparent that the market was too small and resources too scarce for parallel development of digital exchanges in both Televa and Nokia. Consequently, the companies combined their R&D and marketing efforts in digital transfer technology to form a joint venture, *Telefenno,* who finally, in 1982, introduced the first domestic digital exchange – only shortly after Ericsson, *AlcateI*, ITT and Siemens. It was the first fully digital exchange installed in the whole Europe, and thus, served in convincing the market of the domestic competence vis-à-vis the foreign manufacturers. For years the exchange was the most successful export article of Nokia.

In 1979, Nokia and Salora, in turn, joined their complementary resources. The fifty-fifty owned *Mobira* was set up to market and develop radio technology, especially the NMT terminal. The design of the NMT standard brought the Nordic telecommunications administrators and companies into close cooperation. While active in terminal development, the Finnish industry was not yet able to contribute to network specifications. Fierce pressure from the Finnish PTO's side to engage the domestic industry in cellular exchange development finally materialised in 1981 in the base station supplied by Mobira. In retrospect, it turned out to be crucial in maintaining the company's position in the emerging market.

The introduction of the NMT in 1981-82 marked the start of a fast-expanding new industry. The specifications were open to promote competition in equipment provision. No less than ten manufacturers entered the Nordic market.

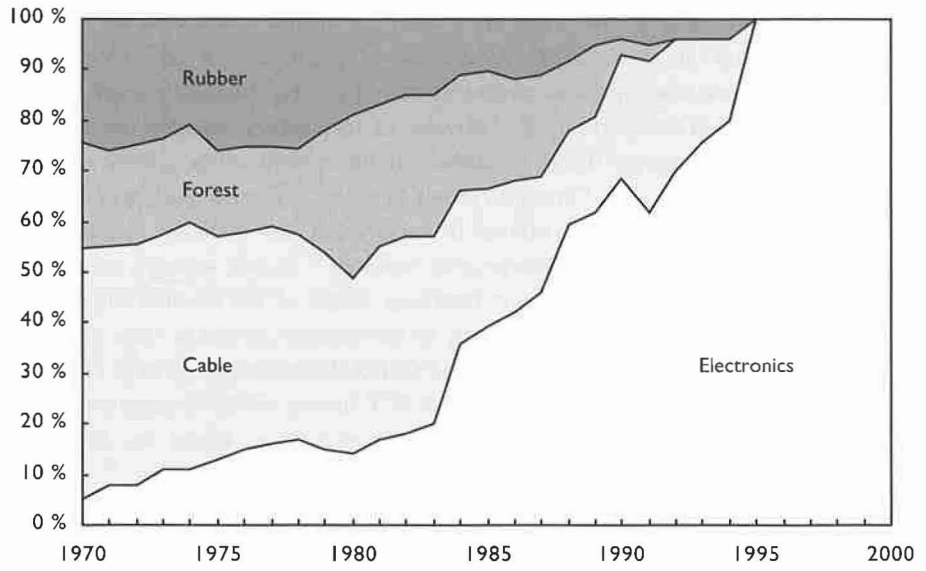
Following its vision of global mobile communications, Mobira took substantial risks in technology development and market expansion.[15] By 1985, it had a leading position in a number of foreign markets, and an average annual growth rate of sales at 50 per cent. Mobira allied with established foreign actors who taught the company, among other things, the importance of the brand - which was later going to distinguish a Nokia from other mobile phones in the challenging consumer market.[16]

Finally in 1986-87, Finnish telecommunications know-how was organised under one management when Nokia got full ownership of both Mobira and Telefenno. In the search of rapid growth and global

presence, Nokia ran into a crisis that almost destroyed the company. The downturn was aggravated by severe external shocks, i.e., the collapse of bilateral trade with Russia and the abrupt economic recession. However, the crisis gave a stimulus to a drastic dismantling of business sectors - varying from tissue paper and rubber boots to cable machines and consumer electronics – preserving exclusively the telecommunications activities (Figure 4.2). The structural changes were coupled with an important redesign of the company's management.

At the same time, the world witnessed a wave of telecommunications liberalisation. The boost in global demand for digital mobile equipment, coupled with Nokia's global position built in the 1980s, saved the company from a dive that would have probably destroyed the company.

Figure 4.2 The structure of Nokia's sales



Source: Lemola & Lovio (1996), updated by ETLA.

Owing to the recession hitting hard on consumer demand, it was crucial to dismantle the luxurious image of the portable phone. With softer aesthetic design and user-friendlier customer interface, Nokia invented the key to the consumer market. Since the first consumer-targeted model in 1994, Nokia has highlighted the life-style feature of communications in its brand building - a strategy that explains an important share of its breakthrough. In 2000, Nokia was the fifth most valuable global brand.[17]

4.2. The facets of the competitive advantage

Firm strategy, structure and rivalry

Nokia dominates the ICT cluster both in size and effect. The company's domestic production accounted for approximately 45 per cent of the total cluster production value, while Nokia's share of cluster exports amounted to 70 per cent in 1999. Nokia is not alone, though. There are several Finnish firms that have important shares in global niche markets, especially in wireless and Internet technology. Many companies with roots deep in the Finnish cluster have attracted foreign acquisitions (Table 4.1).

For example, *Comptel* has attained the world's leading position in mediation device solutions (subscriber data management solutions for operators). *Tecnomen* was the first to develop a unified messaging system and now leads the market for enhanced network service systems. In spring 2000, *Iobox,* one of the myriad of new technology-based start-ups, was named as one of the 100 most important companies in the world by *Red Herring* (a technology business magazine).[18] The company offers localised mobile content services over different platforms. *SSH Communications Security, F-Secure* and *Softstone* have established their positions in narrow but fast growing niches in the highly fragmented data security industry.[19] In fact, network security solutions are becoming the backbone sector of the Finnish software industry. *Benefon* – founded by an ex-manager of Nokia - has attacked a global niche with analogue and GSM/GPS navigator phones. *Linux* is a particular chapter in the Finnish ICT history. With its reputation as an efficient, fast-performing and low-cost system, Linux has been suggested as a possible alternative to *Microsoft's* predominance.[20]

Despite the global business environment the core activities of companies, namely the headquarters and R&D, are still predominantly located in Finland.[21] An established tradition in cooperation in the local innovation system and advanced R&D activities anchor companies to their home base.

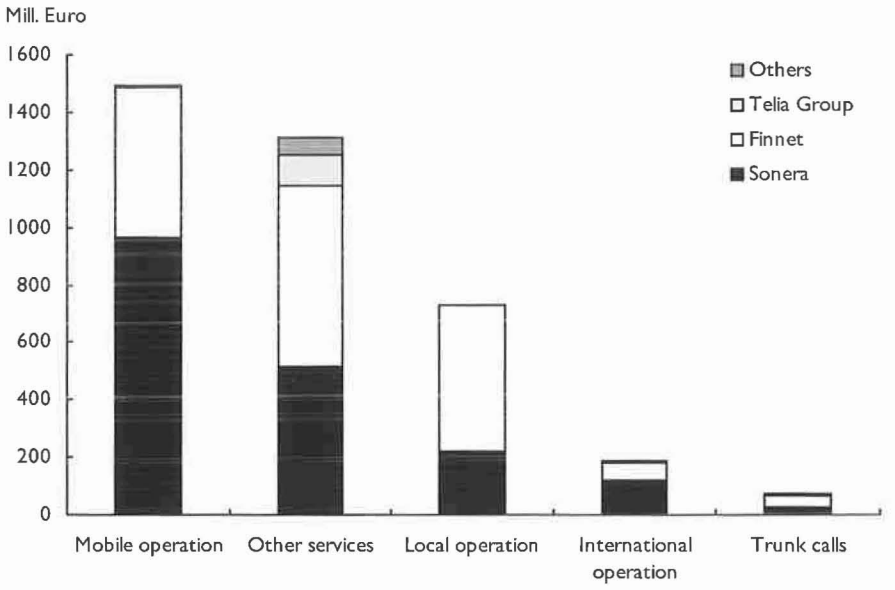
Even though the Finnish market provides a valuable development and test bed for Finnish firms, their actual business environment and reference groups are global from the early outset. For many, domestic competition has practically lost its effect on firm strategy.

Table 4.1 Some Finnish ICT cluster firms in 2000

FIRM	Line of business	Sales, mEUR	Person-nel
DIGITAL CONTENT/PACKAGING			
Sanoma-WSOY Oyj*	media house	1 448	10 350
eQ Online Oyj*	mobile brokerage services	17	173
Iobox Group* (acquirer: Terra Mobile, SPA)	mobile portal	na	200
WOW-Verkkobrandit Oy	digital newspaper	*0,20*	70
Springtoys Oy	mobile entertainment/platforms	*0,17*	40
INFRASTRUCTURE AND TERMINALS			
Nokia Oyj*	mobile phones and network systems	30 376	58 708
Tellabs Inc.* (ex. Martis Oy) (USA)	network access and transfer systems	3 640	8 643
Teleste Oyj*	access networks	92	562
Benefon Oyj	mobile phones	59	377
Electrobit Oy*	network equipment	*37*	*550*
Nemo Technologies Oy	network measurement tools	na	40
APPLICATIONS SOFTWARE			
TietoEnator Oyj*	enabling solutions	1 120	9 934
Tecnomen Oyj*	unified messaging solutions	66	484
Comptel Oyj	mediation device solutions	60	426
Samlink Oy*	electronic banking systems	45	243
F-Secure Oyj*	secure network solutions	41	399
CCC Oy	3D software	*34*	*400*
SSH Communications Security Oyj*	secure network solutions	16	130
Wapit Oy	enabling mobile entertainm.solutions	na	100
First Hop Oy	mobile access applications	na	na
OPERATION			
Sonera Oyj*	telecom and mobile operator	2 057	10 305
Elisa Communications Oyj*	telecom operator	1 244	6 161
Radiolinja Oyj	mobile operator	614	1 058
Jippii Group Oy	Internet service provider	35	387
COMPONENTS/CONTRACT MANUF.			
Elcoteq Network Oyj*	electronic manufacturing services	2 214	9 630
Perlos Oyj*	mobile phone enclosures	452	3 503
NK Cables Oy (acquirer: Draka Holding, NL)	communications cables	286	800
Flextronics Finland (ex. Kyrel EMS Oy)(USA)	electronic manufacturing services	*253*	*532*
Aspocomp Oyj*	printed circuit boards	240	2 007
JOT Automation Group Oyj *	industry automation	140	746
PKC Group Oyj*	data transfer systems	129	730
Filtronic LK Oy (ex. LK-Products Oy)(UK)	RF filters, access products, antennas	90	883
Salcomp Oy	power supplies and battery charges	na	650
Wecan Electronics Oyj*	telecom network electronics	47	457
Savcor Coatings Oy	enclosure coatings	*3*	90
ICT CONSULTANCY			
Satama Interactive Oyj*	Internet consultancy	30	414
TJ Group Oyj*	Internet consultancy	29	404

Note: *Consolidate Figures. Figures in *italics* are 1998 or 1999 data.

Figure 4.3 Operator market shares in 1999 (in million Euros)



Source: Ministry of Transport and Communications.
Note: 'Other services' include data transmission incl. ISP, cable-TV, business solutions, equipment sales, international calls of the 'others' (RSL Com Finland, Globetel, Global One, Telenordia) and Telia's advertising and equipment sales units.

In 2000, there were over a hundred **telecommunications operators** in Finland, many of which operated on leased network capacity. Despite the high number of participants and fully liberal competition, the market was dominated, with equal shares, by Sonera (formerly PTO) and the *Finnet Group* (the renamed Association of Telephone Companies, established in 1921). Together they generated 95 per cent of the telecommunications service turnover. Owing to the lack of technically and economically viable solutions, competition in the local loop has not taken place as anticipated.

In mobile services, Sonera's main competitor Radiolinja is owned by the largest private operator *Elisa Communications*. Swedish *Telia* has not succeeded in eroding any significant share of the GSM market since its entrance in 1997.[22] The third national mobile service, *DNA Finland,* was launched in early 2001 by a group of private operators.

Increased heterogeneity between operators and tightening competition in the local market has aroused friction within the Finnet Group,

which, after the eighty-year old history, has been breaking up into competing camps.

Finland granted UMTS licences to all four GSM operators in early 1999, being the first country to do so in the world. In the same year, licences in digital-TV operation were granted. It is expected that the analogue TV network could be waived by the end of 2006.

The past years have witnessed important changes in the strategies of telephone companies. *First*, as the revenue from basic telephony services is declining, operators are specifying their strengths and refocusing their operations. Some companies have enlarged their service base by mergers, acquisitions, and joint ventures over traditional sectoral boundaries. *Second*, as network capacity is accessible to any service provider, network services and infrastructure provision are separating as operator business areas. In view of declining return on investment some operators are planning on withdrawing from network ownership. *Third*, liberalisation and new business opportunities in the global arena have motivated the largest operators to make investments in international markets.[23] They are also looking for global partners with whom to share the uncertain future. However, for most local operators knowledge of and credibility in the local market remain their core strengths on which they are going to build their customer relationship management strategies also in the future.

Factor conditions

Capital resources. Liberalisation of capital markets in the 1980s has remodelled the institutional environment of corporate finance. Firms have access to international resources, and especially the emergence of venture capitalists during the 1990s has opened unparalleled opportunities for innovative technology-based start-ups to enter the market in a very early phase of product development. Successful investment cases at the turn of the 2000s have boosted the amount of available venture capital, which has actually become the most common source of capital for start-ups. The share of the ICT cluster of total venture capital investments has been around 30 per cent during the last few years (see Rönkkö in this volume).

The improved accessibility of capital has drawn more professional and growth-oriented entrepreneurs into the field. Respectively, investors are more field-specialised due to the increased number of funds and investment companies. As a result, start-up enterprises have become

more ambitious with greatly improved potential for a successful international launch.

The availability of venture capital has reshaped the role of public risk funding, traditionally the prime resource for risky enterprises. There have become new kinds of investment syndicates where the public sector carries part of the technology risk and a venture capitalist shares the commercial risk of an enterprise.

The strong growth in the capital market has been one of the most noteworthy contributors to the ICT cluster's growth and increased versatility. In fact, a phenomenon like Nokia would not have been possible for a small country like Finland without foreign capital investments. Foreign ownership (around 90% in Nokia) shares risk in a country that is increasingly dependent on the unsettled ICT sector.

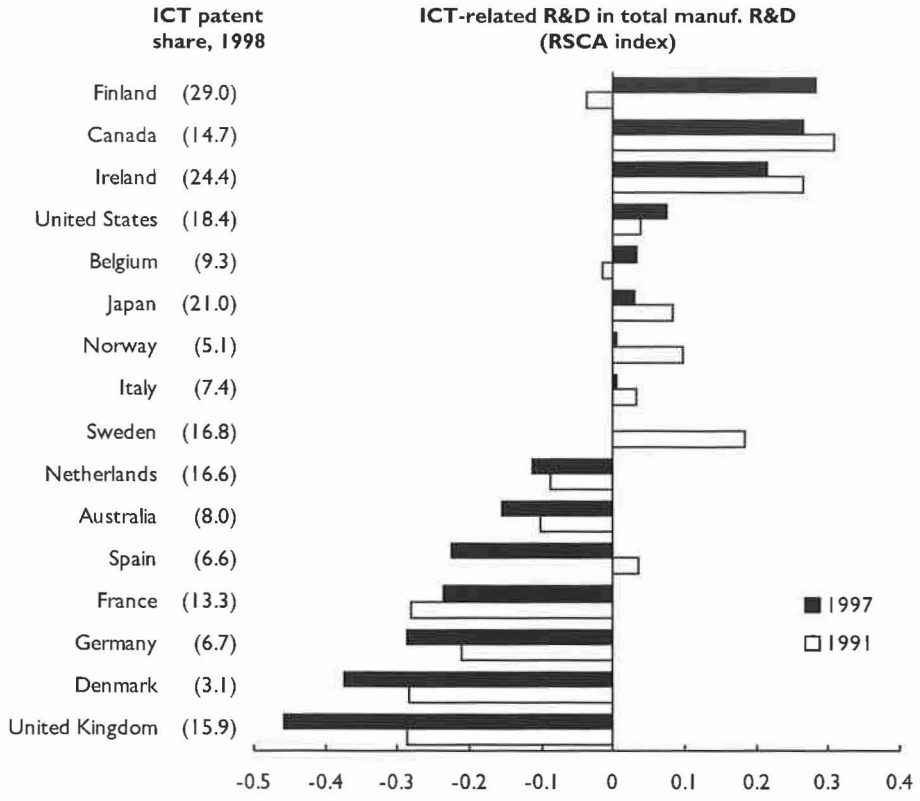
R&D intensity and organisation. In contrast to the OECD average, R&D expenditure as a share of GDP has been rising continuously in Finland since the early 1980s (Figure 4.6 on page 40). Increasing investment in R&D has reflected the purposeful orientation in technology policy adopted in the 1980s, and which was accentuated in 1996 by the government's additional appropriations for research (see the sub-section *Government* on page 38). Nevertheless, the share of public sector investments has fallen from 40 to 30 per cent over the 1990s owing to intensive growth in private input.

In 1997, Finland had the highest share of private ICT-related R&D in total manufacturing R&D in the OECD (Figure 4.4). In fact, between 1991 and 1997, Finland turned from a below-average investor into the leader. The share of the electronics industry is two-thirds of total private R&D expenditure, of which Nokia alone accounts for an estimated 40-50 per cent.

Intensified investment in ICT-related R&D generated an average annual growth rate of 42 per cent in ICT patents between 1992 and 1998.[24] Almost 30 per cent of the patents granted to Finland in the USA were in ICT, which was the highest ICT patent share in the OECD in 1998.

During the 1990s, a number of multinational ICT manufacturers (e.g. *ICL, IBM,* Siemens, *Hewlett Packard* and Ericsson*)* have extended their R&D activities in Finland. Some are also seeking intensified cooperation with local firms by establishing development forums.[25] Finnish-based R&D units have become strategic knowledge centres, which

Figure 4.4 ICT-related R&D input and output measures



Source: OECD ANBERD 2000, OECD (1999).

supply the multinationals with information on new communications technologies.[26] The share of foreign affiliates in ICT-related R&D, however, is not significant as compared to domestic expenditure.[27] Finland has remained the main R&D base also for Nokia despite its network of 52 research centres in 14 countries. An estimated 60 per cent of the company's R&D input are spent in Finland.[28]

Education. The critical factor in the development of the cluster is the scarce supply of skilled labour. There is a structural mismatch in available skills not only on the macro level but also *within* the cluster, notably in the software industry, owing to the fast pace of technological development.

There are 12 postgraduate schools providing education in information technology, in which enrolment has been on an extensive rise (see the sub-section *Government*). It has proved, however, difficult to increase

intake without lowering the level of standard. In the lower-level schools, natural sciences fail to inspire the new generation to a sufficient extent. Indeed, industry representatives are campaigning in schools for the image of the industry to contribute to a better match in the future demand for and supply of skilled employees.

As it seems that the demand for skilled labour will be increasingly difficult to satisfy with domestic supply, certain universities providing education in ICT have started to offer programmes tailored for foreign students. Moreover, the universities together with the industry have taken the initiative to establish an ICT-oriented university exclusively for foreign students to attract new employees to Finland. Nevertheless, there are little means to commit foreign graduates to work for the benefit of Finnish companies.

Demand conditions

Since 1996, Finland has been the leader in mobile penetration. In 1998, mobile subscribers outnumbered wired subscribers. Sixty per cent of households have both terminals, while 20 per cent of them rely solely on mobile communications. Furthermore, mobile phone replacements have exceeded the number of new subscriptions.

Consequently, the share of fixed communications of operator turnover is declining at the expense of mobile communications – from 99,7 per cent to 40 per cent between 1991 and 1999.[29] However, the rapid increase of ISDN subscriptions, due to growing Internet penetration, has supported the demand for fixed line services. Finland ranked number one in Internet host penetration rate, by 121 per 1000 inhabitants in 1999.[30]

Since the liberalisation in 1994, the general telecommunications price level has declined about 25 per cent in real terms.[31] Even though Finland has lost ground in its relative price efficiency in OECD comparison – at its highest in the mid-1990s – it was still leading in lowest pricing in data (including Internet) and digital mobile services in 1998.[32] Low pricing – together with the introduction of cheaper portable phones replacing auto phones – were major factors behind the breakthrough of consumer mobile communications in the mid-1990s.

The enthusiasm of the Finns in adopting the mobile phone has been explained by the technology-oriented nature of the people. After the global breakthrough of Nokia and Sonera, Finns seem to have adopted mobile phones as a national symbol. All the same, the home market

has provided technology developers a fruitful ground to experiment future products and services.

For example, in the early 1990s, Nokia took advantage of the advanced home market to develop consumer-oriented terminals. New models were designed to reflect individual life-styles, and consumer aspirations were investigated in polls – an innovation soon imitated by competitors. Today, the Finnish market (less than two per cent of Nokia's total revenue) has lost its importance in terms of revenue, but the market still serves as an important laboratory anticipating future trends in foreign markets.

In the early days' business-to-business market, domestic operators provided home base advantage for the emerging equipment industry in the form of sophisticated customers. Creative co-operation with the PTO climaxed in the NMT project. The co-operation with Radiolinja, in turn, produced the first GSM network in the world, which served as an important promotional case for Nokia in the eve of market explosion. Today, despite firms' global networks, this home base advantage has lost little of its importance. Finnish operators, among the most advanced in technology development, engage actively in R&D co-operation with equipment manufacturers.

Supporting and related industries

Since the mid-1990s, the structure of the ICT cluster has reached sufficient scale and scope to support competitive global operation. The domestic **supporting sector** has evolved to become very specialised for the needs of the original ICT equipment manufacturers (OEM). The growth in production volume *and* in the share of outsourcing, together with increasingly sophisticated needs of customers have generated an ever growing number of new suppliers. By the same token, established firms have refined their products to meet the specific needs of telecommunications growth companies.

The Finnish supplier sector has focused on highly customised inputs while in standard components - requiring large scale and effective distribution channels - Finnish OEMs rely on imports.[33] Special competence lies in contract manufacturing of parts and components (e.g. ASIC, rf-filters, printed circuit board production and surface mounting technology, hybrid circuits, silicon wafers), electronic manufacturing services (EMS), automation and precision mouldings.

Increased oursourcing has been coupled with intensified co-operation and long-term commitment. Increased technological complexity and pace of change together with shortening product life cycles have compelled firms to closer interaction and shared risk-taking. Strategic partnering aims at increasing value added from vertical relationships, which is attainable by taking advantage of supplier expertise in product design and development. Indeed, close vertical co-operation is a major factor contributing to innovation and firm upgrading. Not surprisingly, these kinds of relationships are more common in the proximity of the OEM than in the lower tiers of the production network, where supplier relationships still have more traditional features of standard outsourcing.

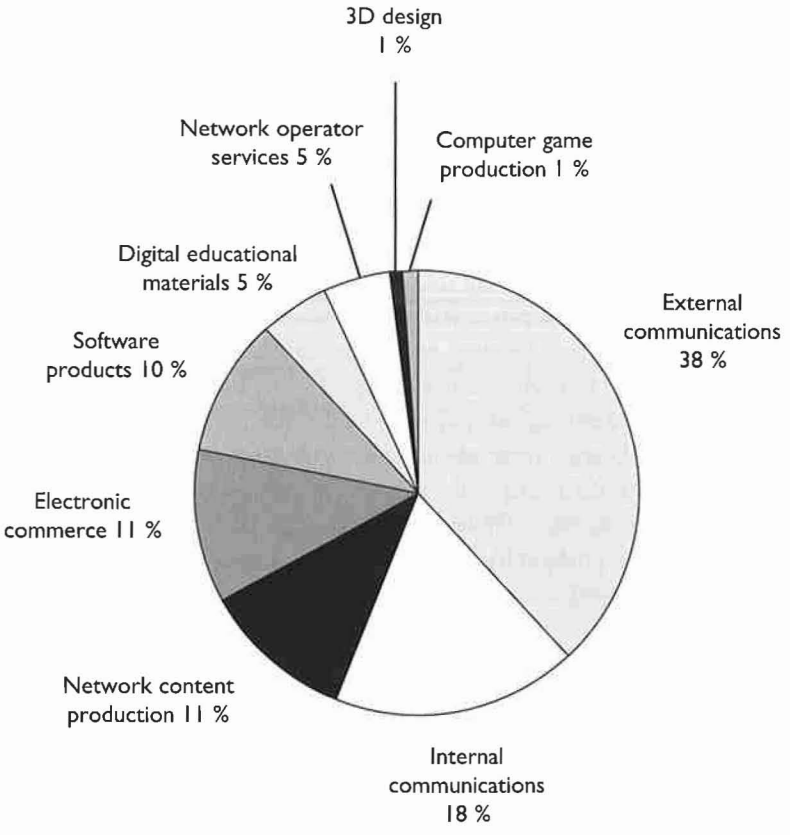
An exemplary case illustrating the change in the production paradigm – from hierarchies to networks of specialised companies – is the rapidly increased role of EMS companies between the OEM and component suppliers.[34] Their service may include complete production process, from component sourcing and production design to production, testing and delivery to the customer's distribution channels. The OEM does not necessarily need to take in the end product at all. Companies have expanded not only organically but also by acquiring manufacturing works of their customers.

Many supplier relationships have been stretched to OEMs' foreign markets. Suppliers' global presence has become increasingly important for efficient outsourcing. This has created not only great growth opportunities but also challenges for relatively small Finnish firms since foreign investments can not rely solely on one customer relationship.

Owing to the generic nature of ICT the key industries have a variety of **related industries** producing complementary products for the infrastructure. The industries with the most promising prospects are those able to convert their service products into digital form (Figure 2.3 above). Companies utilising ICT infrastructure as a distribution channel can be loosely referred to as 'content providers'. Digital content provision includes not only content creation but also 'packaging', i.e., combining and tailoring contents and services for various target groups and digital channels.

According to an estimate, there were over 300 companies engaged in the provision of digital content in 1999.[35] Figure 4.5 exhibits the range of related activities and their respective weights in the total turnover. The Figure provides, however, a limited perspective on the full scale and scope of content provision.

Figure 4.5 The scope of digital media activities in Finland in 1998 (EUR 120 million)



Source: Kuokkanen et al. (1999).

Note: External communications include e.g. organisational/marketing communication, while internal communications refer to, e.g., intranet and extranet solutions. 'Network operator services' are included only when part of new media companies' total sales; i.e., pure-play ISPs are excluded.

Indeed, non-fixed definitions and backward statistical classifications severely complicate economic valuation of digital content production, which ranges from transaction and information services to education and entertainment. Companies in the field vary from established content producers (e.g. media houses) and service businesses (e.g. banks and travel agencies) to Internet pure plays (e.g. portals). The expanding number of services provided via the network by different occupational groups (e.g. in health care and education) is expanding and further complicating the definition of the content industry.

Industrial digital content provision is in its early phase of evolution in Finland. To date, the development has been largely technology-driven. On the one hand, it takes time for dominant content producers, i.e. media houses, to redirect their production processes to fully exploit the possibilities provided by new digital distribution channels. On the other hand, small producers lack the resources to create potential 'killer applications'.[36] All the same, digital media production technologies and user-friendly media terminals are still in their infancy. Moreover, management of copyrights in the digital environment still lack workable solutions.

To be sure, there are numerous signs of an emerging industry, but innovative enterprises still often lack the skills crucial in professional business development and large-scale market penetration. For example, in 1999, there was a group of some fifty firms involved in games and entertainment software production, generating EUR 10-12 million. Despite their advanced technological skills, this group still operates on the fringe of the software sector, lacking sectoral concentration and volume.[37] However, technology leadership and new business models enabled by the Internet (digital mass distribution) provide new opportunities for the Finnish digital entertainment industry.

Rapid change in age-old operational models is causing friction between actors in different phases of the value chain. The tension stems largely from the uncertainty about the roles and power relations of the traditional players (e.g. media, operators, and equipment providers) in new value chain processes, in which valuable access to the end-user is at stake.[38] In spite of – or rather – because of the restructuring of the operational models, actors in different sectors are busy networking across borders.

For example, Nokia offers tools and support for entertainment service providers – totalling thousands registered world wide – in an open virtual forum to develop mobile content applications compatible with Nokia's equipment. Equivalently, operators ally with content providers, most notably with media houses, who lack their own digital distribution channel.

Government

After an era of interventionist policy-orientation in the 1960s -70s, the 1980s marked a change in the Finnish government's approach in economic and industrial policy. Public ownership and the regulatory framework were seen in new, more liberal light. The intertwining of

technology, science and the economy was regarded as the prime driver of societal change necessary in opening international markets. The idea was communicated by the adoption of the concept of the national innovation system in the policy outline.

The cluster approach was introduced in Finland by the cluster study co-ordinated by ETLA in the early 1990s.[39] The approach dominated the design of the policy guidelines outlined in 1993 in the White Paper (*National Industrial Strategy*) by the Ministry of Trade and Industry. The central message for policy makers was that all government actions have implications for national competitiveness. Therefore, economic and industrial policy design needs to be considered from an extended perspective, beyond sectoral ministries' administrative borderlines. Indeed, the cluster model gave a stimulus for constructing novel forums for interaction and co-ordination between the parties concerned: ministries, public and private research units, companies, and relevant users.

However, rather than providing a new radical method in industrial policy, the study served to convince policymakers of the relevance of the policy direction adopted in the 1980s in Finland. It served in clarifying the new role of the government as the creator of favourable framework conditions.

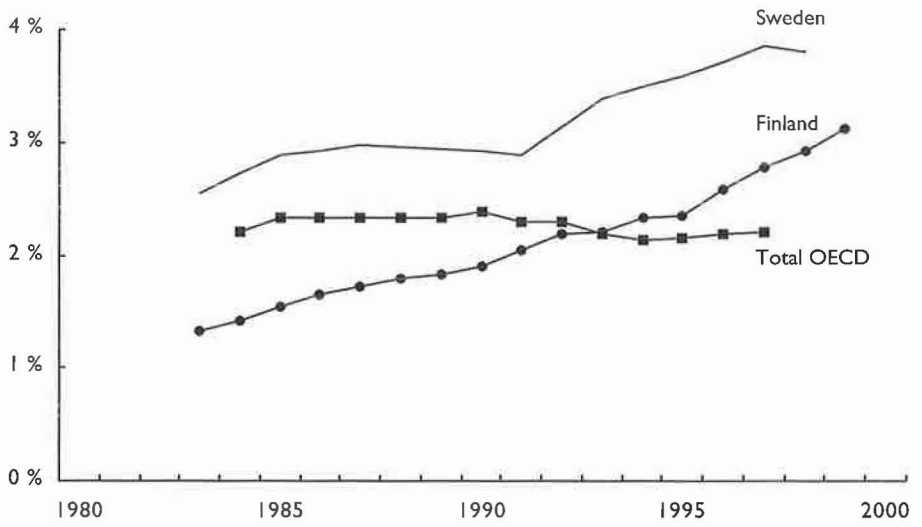
The cluster approach has been clearly reflected in subsequent government actions emphasising inter-organisational co-operation as well as accumulation and transfer of know-how. Implementation of government policies is now considered through policies concerning *technology, education* and *competition policies,* the core of the new Finnish industrial policy.

Technology policy. Dating back to the 1970s, the statutory separation between science and industry was terminated by the change in industrial policy orientation in the 1980s. The crucial role of science in technological development was recognised and, consequently, science policy was intertwined with technology policy in the newly established *Council of Science and Technology*, which co-ordinated the co-operation between the Ministries of Education, and of Trade and Industry. The new orientation in technology policy was also witnessed by the foundation of the *National Technology Agency (Tekes)* in 1983, which became the main executor of technology policy.

The new industrial policy was expressed in, e.g., continuous growth in R&D as a share of GDP. Between 1985 and 1999, the share doubled reaching EUR 3.75 billion at the end of the period, and representing

over 3 per cent of GDP. With this share, Finland ranks second in the world in R&D input.

Figure 4.6 R&D expenditure in some OECD countries (% of GDP)

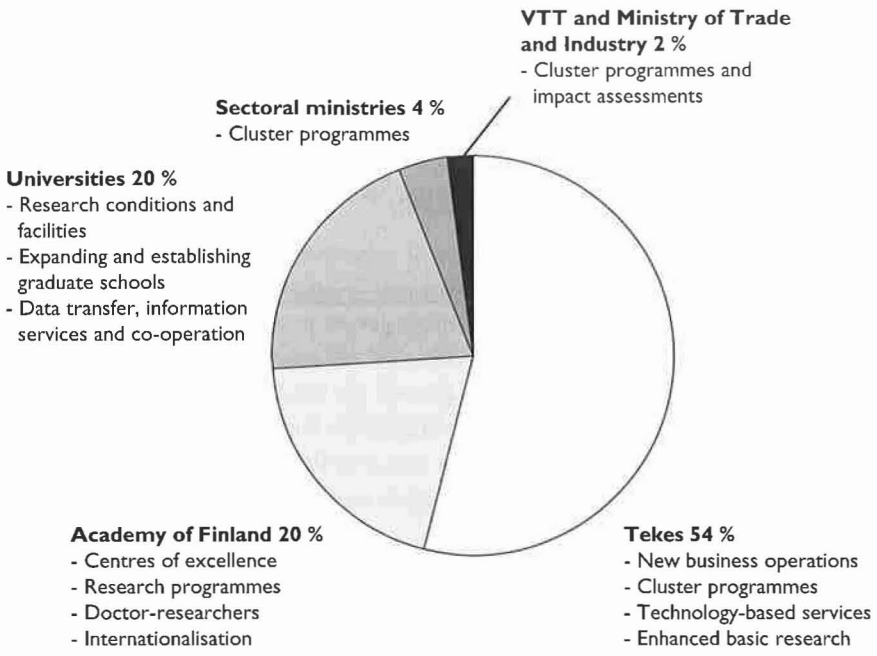


Source: OECD, Main Science and Technology Indicators 1999.

The turning point in R&D intensity in 1996 reflects the government's decision to increase systematically R&D funding in line with the White Paper (Figure 4.6). The target for the years 2001-2004 is to increase the funding in line with the GDP growth rate. The share of public R&D funding was stipulated at 40 per cent, but due to intense growth in the private share, it has remained at 30 per cent. The first additional appropriation for research, totalling EUR 540 million between 1997 and 1999, went contrary to the trend towards significant downsizing of general public expenditure which accompanied the severe depression.

The allocation of additional funds was made with specific attention being paid to cross-sectoral diffusion of knowledge. Thus, a share of these funds was directed to sectoral ministries' cluster programmes. Despite the fact that the ICT industry was not among the selected sectors for cluster-specific programmes, due to the good coverage of contemporary ICT-related programmes, the injection of additional R&D resources was allocated to the cluster through the other channels (Figure 4.7).[40]

Figure 4.7 Breakdown of allotment of additional appropriations for research, 1997-1999 EUR 540 million, by source of funds



Source: Sitra – Finnish National Fund for Research and Development (2000).
Note: VTT refers to the Technical Research Centre and Tekes denotes the National Technology Agency.

The convergence of ICT technologies and global competition has meant that public funding has had to be redirected away from a technology orientation (beginning of the innovation chain) towards a market orientation (end of the chain). The new approach has given rise, for example, to a series of digital media technology programmes, which, contrary to established technology-oriented practice, have allocated R&D funding also to *service* development. This has supported the creation of export-oriented digital content service production.[41]

Indeed, as the co-ordinator and part-financier of technology programmes, Tekes has assumed the role of a facilitator in digital media business development. It has created networks between firms, venture capitalists, universities, and research institutes that have been important in the infant industry development and internationalisation.[42]

Competition policy. The regulatory approach in telecommunications policy is based on pro-competitive policies, light handed regulation and technology-neutral competition. The market is subject to general competition and consumer protection legislation. The telecommunications authorities pursue minimum interference policy, intervening mainly in cases of insufficient competition. The approach is less interventionist than in many other OECD countries. Some mandatory EU requirements have been enforced in Finland rather reluctantly, as they are considered to go against the liberal functioning of markets.[43]

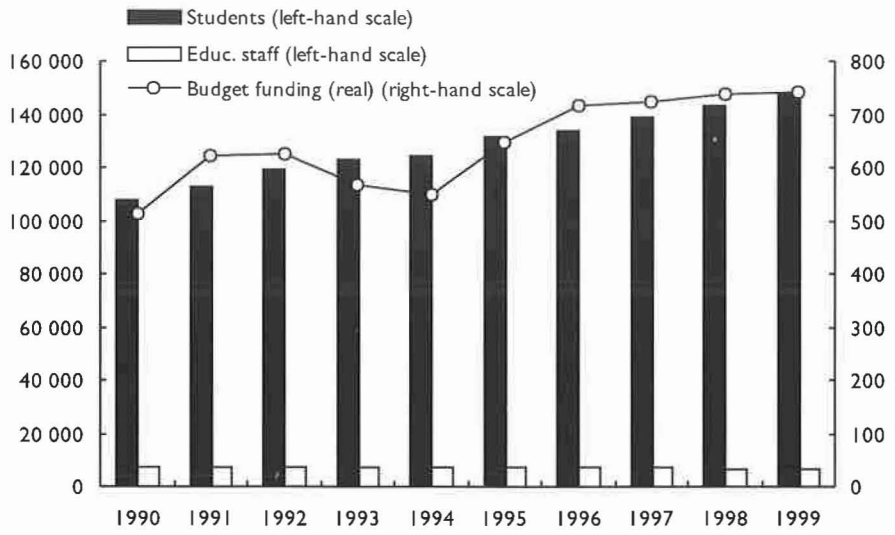
Despite the policy objective of enhancing high speed transmission capacity in Finland, the government decided in 2000 – unlike in Sweden - not to engage in direct infrastructure provision, to insure technology neutrality and free functioning of the market. In line with the liberal policy principles, Finland granted the third-generation mobile network licences free of charge in comparative tendering, being among the few countries to date to support free distribution of new technology. The licence does not restrict the choice of the third generation technology standard.

By mandate from Parliament, the government intends to withdraw from the telecommunications business. However, there has been some political debate as to the share the state should ideally retain in this nationally important sector.

Education policy. The rapid growth of the electronics industry has exhausted the resources of available skilled labour. The government has reacted by increasing openings in higher education institutions. Between 1993-98, the total intake in universities nearly doubled, and in polytechnics it nearly tripled. In early 1998, the government adopted a programme aimed at increasing further education in the information industry fields between 1998-2002.

Despite the sizeable growth in enrolment, growth in educational resources in science universities has been stagnant over the period (Figure 4.8). In fact, Finland ranked 14th – well below the OECD average – in the comparison on expenditure per student at the tertiary level in 1997.[44]

Figure 4.8 Number of educational staff and students (left) and real budget funding (MEUR, right) in science universities 1990-1999



Source: Ministry of Education (KOTA database).
Note: Budget funding excludes investments in buildings. The deflator is a weighted average of public sector wage index and wholesale price index; indices for 1998-99 are estimates.

Coincidental factors

The turn of the 1990s contained several external incidents with significant repercussions on the Finnish ICT cluster without which, it is fair to say, the average 30 per cent annual growth rate of the electronics industry would not have materialised.

Following the agreements within the EU and the WTO, the traditionally monopolistic telecommunications equipment and service markets were gradually liberalised. The opening of the East European market gave an additional boost to demand for mobile equipment. The effects of liberalisation were momentous. Between 1990-98, the value of OECD exports of telecommunications equipment grew by a multiple of some 2.5, reaching USD 110 billion at the end of the period.[45] Correspondingly, 96 per cent of the OECD market, as measured by telecommunications revenue, was open to competition by the beginning of 1999.[46]

In contrast, the collapse of the Soviet Union, together with the severe recession in Finland, severely hit ICT cluster demand in the early 1990s. Without the counterbalancing effects of market liberalisation, Finland's path to economic recovery would have been somewhat different.

5. ICT CLUSTER DYNAMICS

The Finnish ICT cluster has been evolving for over hundred years. The cluster as we see it today looks like a product of a master plan in industrial policy: a vigorous innovation system with high national competitive advantage. It is, however, an outcome of a dynamic self-reinforcing process in which coincidental factors have not played the least consequential role.

In order to get a grasp on the factors behind the ICT cluster development, the most influential dynamic linkages between the factors of competitive advantage will be analysed within the framework suggested in Section 2.1. It is obvious that the effects of single factors on the system are ambiguous and arguable, but the framework provides some systematics in the analysis.

5.1. Government as a catalyst for industry development

In retrospect, it can be argued that among the most influential factors affecting cluster development relate to those government decisions that have promoted a competitive market structure. This is naturally not to downplay the effects of the reoriented technology policy adopted in the 1980s (described in Section 4.2). However, the regulatory view on the ICT cluster evolution provides an illustrative perspective on the functioning of the cluster mechanism.

The foundation of the developed telephony infrastructure was laid already in the 19th century (see Section 4.1). The dispersed telephony market structure originated from the Finnish Senate's objective to defend sovereignty in telecommunications under the Tsar's reign. Moreover, the division of ownership between public and private companies promoted technical improvement of the infrastructure and created preconditions for equitable competition in the later (1994) liberalised market.

Furthermore, the multi-operator market, coupled with another local peculiarity, i.e., free equipment supply, provided a multidimensional upgrading mechanism for the emerging equipment industry. Vis-à-vis foreign supply, domestic firms had to catch up with foreign competitors on leading technology. In addition, the variety of competing technologies available developed operators' skills in interface technology, and thus, made them sophisticated customers for manufacturers in technology development.

On the local level, in turn, the existence of independent local actors (i.e. Suomen Kaapelitehdas, Salora and Valtion Sähköpaja) generated complementary skills that, combined in alliances, joint ventures, and mergers, gave a boost to the technological development that would not probably have taken place in a more monopolistic market structure. For example, without the joint venture of Televa and Nokia, the creation of the vital digital exchange would hardly have succeeded. By the same token, Mobira, the joint venture of Nokia and Salora, contributed critically to the timely launch of the first NMT terminal, and to its swift and successful export market penetration.

Government bodies played the role of a demanding customer. First, domestic firms with incubating know-how on radio technology got the required motive to come out with physical products, which ultimately served as prototypes of exportables.

Later, the public sector in the role of the Telecommunications Administrator initiated, together with the other Nordic administrators, the creation of a competitive cross-border mobile market. The industry, engaged in the standard development, got a valuable first-mover advantage in the new market. The Nordic standard spread widely in Europe and Asia in the 1980s-90s. To contrast, the national champions in Italy, France, and Germany developed their own technologies with local administrations with meagre results: the delayed and poorly functioning services failed to attract users in their home markets, neither was there any success in export markets.

In the 1980s, among the first in the world, the gradual dismantling of regulatory restraints of telecommunications service provision was started. The decisive stimulus for liberalisation came from the private sector, who required a stake of the state monopoly business.

Competition stimulated rapid penetration of mobile services. For the Finnish equipment industry, the delivery of the network for Radiolinja, the first GSM operator in the world, was a reference that lifted it

to the international stage. In the subsequent international wave of liberalisation, Nokia was well equipped to take off.

Had there been no competitive pressure, the PTO would have postponed the introduction of a new digital mobile network, since there were still important profits to be reaped from the analogue NMT network investments. Similarly, had the second NMT licence for the private sector been granted in the 1980s, it would have severely postponed Finland's transition to digital technology.[47]

Apparently, there was a pinch of good luck, rather than well-thought-out policies behind the perfect timing of liberalisation, the implications of which were momentous. The Finnish telecommunications sector got a head start in the exploding GSM market, and its stimulus was substantial in supporting the revival and restructuring of the economy.

5.2. Government as a facilitator of clustering

The emergence of the Finnish ICT cluster is an outcome of multidimensional dynamic interaction within the innovation system. The role of the government in the system has varied over time according to the emphasis prevailing in industrial policy. The focus has fluctuated from the post-war foundation of the basic structure for scientific, educational and technological activities, to interventionism in the 1960s hindering interaction between science and industry, and finally in the 1980s, to gradual integration of science and technology in policy design to improve total productivity and national competitiveness. Along with globalisation, though, national policy started to lose its effectiveness, and the appropriate role of government had to be redefined.[48]

The Government White Paper of 1993 was shaped on the basis of the cluster approach, which served in clarifying the role of the government as the creator of favourable framework conditions. Following the modern doctrine of industrial policy the government has assumed the role of a facilitator and co-ordinator. The setting for industrial policy design is characterised by intensive and informal communication between the government, the industry, academia and the labour market. The system is based on a shared view of the policy objectives and tools – excluding subsidies or other direct supports.

This interaction has been institutionalised in the Council of Science and Technology. Chaired by the Prime Minister and represented by

the key participants it has high status in the industrial policy system, and as such it is uncommon in the international stage. Industrial associations acting as influential intermediates between the industry and the public sector, are another institution with a salient role in the Finnish policy arena.

Through continuous communication the government sensitises itself to the changes in economic and technological environments. In a globalising society, as suggested by Castells (1996), instead of planning and controlling, modern industrial policy needs to adapt to the shift in decision making from public institutions to the networks of actors.[49] This shift is best dealt with by creating favourable conditions for straightforward interaction between the parties concerned.

The major tool in cluster-policy implementation was the government's additional appropriation for research, totalling EUR 540 million (see Section 4.2). The evaluation report of Sitra (2000) of the effects of the additional appropriation concluded that the cluster-oriented research funding had been "highly successful".[50] The policy tool, as noted in the report, has had perceivable positive impacts on private research investments and on growth in both productivity and employment, arising from intensified R&D activity.

Further, the report underlines the increase in networking – between the industry and the science, and between large firms and SMEs – which is "internationally recognised as one of Finland's strong points and has shown marked improvement over the past two decades" (Sitra 2000, p. 47). Indeed, the share of all Finnish firms with co-operation arrangements with universities or the government was 40 per cent, the second highest in the OECD, in 1996-1996.[51] Yet, as the report emphasised, the full effect of the funding will be manifested over the years to come.

5.3. Exceptional home base demand

The high penetration rate as well as swift adoption of new products and services have provided both the manufacturing industry and service providers a home-based advantage through trend-anticipating demand. To note, however, the demand conditions have been largely shaped by favourable impacts from the public sector.

Initially, the public decision to allow for a number of operators set the basis for exceptional demand conditions for equipment manufacturing.

Operators developed into sophisticated customers through the variety of competing technologies, and as such contributed to the industry development over time. The PTO's pressure on the 'reluctant' industry to develop the first cellular exchange, critical in the later conquest of international market shares, was one indication of the advanced customer sector.

Another vital customer segment was the public institutions using closed networks. The public authorities (notably the Army and the national railways) put out invitations for tenders for advanced equipment spurring companies for innovation. Public demand for germinating radio technology know-how was crucial in bringing forth physical products, with which export markets were later penetrated. Private users of closed networks (taxis, shipping and transport companies, industrial plants) played also a role in testing and developing new applications of radio technology.

The turning point in the mobile history was the introduction of the NMT that made the Nordic market the largest in the world (60-70 per cent of worldwide subscriptions) in 1982-83.[52] The home market advantage spurred Mobira to achieve an average 50 per cent annual growth rate between 1982 and 1987, during which time the share of exports in company sales rose from 50 to 75 per cent.[53]

The breakthrough of mobile telecommunications in the consumer market was fuelled by price cuts induced by competition, as well as by consumer-friendlier and cheaper handportables.[54] An additional boost was given by the increasing supply of value-added services that were swiftly adopted by consumers as a natural extension of digital communications.

5.4. Firm upgrading through interaction

Finnish ICT activities center heavily upon one core company, Nokia, which accounts for almost a half of the cluster's sales. A great majority of firms in the electrotechnic sector and many firms in other supporting industries are part of Nokia's multi-layered network.

The origins of the 'networked Nokia' are in the 1980s, when the company had to look for outsourcing to manage growth. Over the 1990s, interaction with suppliers has moved toward increased joint development of products and processes, simultaneously with Nokia's intensified concentration on its core competence areas. At present, Nokia is

extending its supplier co-operation to R&D activities, which is a sign of its moving to the next generation in supplier relationships. Compared to other leading manufacturers, Nokia has led the way in developing supplier relationships, which has contributed to its superior performance.

Not only has the company been able to assign an important amount of new business to the supporting industries, it has also importantly contributed to general industry upgrading through collaboration. General improvement has materialised in, e.g., firms' product development and streamlined operative processes. However, despite the two-digit growth rates of supplier firms, their relative size is still small as contrasted to the demand volumes of the head company, which results in many cases in high dependency rates.

As a global player, Nokia has acted as a transmitter of market information to its suppliers, and as such, it has been effective as a reference for a number of companies in extending their customer base abroad. [55] Firms have also extended to an increasing extent their operations to foreign markets in the footsteps of Nokia. Despite the many challenges firms are likely to encounter in global markets, internationalisation with the key customer has provided some security over the initial phase.

The stream of beneficial effects in network relationships has by no means been unilateral. Despite Nokia's global manufacturing networks, the advanced know-how and established supplier relationships in the country of origin have not lost their importance; they have nailed an important share of the company's product development activities in Finland. The supporting industry has been able to respond quickly to the increasing demands of the global customer, especially regarding the variety of advanced customised products.

The advanced digital communications infrastructure together with the dynamic cluster environment has nurtured the swift emergence of companies operating in the motley industry of applications software and content production. As these services are necessary in boosting demand for infrastructure, the actors concerned – Nokia and Sonera most obviously – are actively co-operating with service developers, for whom, in turn, venturing with established actors enhances the odds of successful innovations and their global distribution.

5.5. Abundant capital, scarce human resources

The central factor behind the Finnish ICT cluster development, highly qualified employees, started to show signals of exhaustion in the latter half of the 1990s. The sustained lack of employees has compelled firms to look for overseas labour markets, and to locate R&D activities abroad. While the government is struggling to improve the supply of labour, there are doubts whether the resources directed to this goal are sufficient and efficiently distributed.

The liberalisation and the consequent growth of the capital market have been among the most noteworthy contributors to the ICT cluster's growth. Rapid growth in private venture capital supply has increased the scale and scope of the cluster's firm base. For growth companies open capital markets have provided market-based risk funding non-existent only a decade ago. Cases like Nokia, with 90 per cent of shares held abroad, would not have been possible without foreign capital. Foreign ownership has shared the risk of a small economy dependent on an unsettled and funds-consuming industry.

Further, the development of the capital market has enabled, in the form of stock options, the creation of new tools for employee compensation and motivation, which have served especially start-up companies with limited liquidity.

Moreover, the newly emerged venture capitalists represent 'intellectual capital' for small technology-based companies with limited managerial skills, which has greatly improved the potential of successful international launches at an early phase of business development. The availability of private venture capital has reshaped the role of the public sector in risk funding, traditionally the prime resource for risky enterprises.

5.6. Worldwide liberalisation – perfectly timed for Finland

The 1990s witnessed intensifying liberalisation of world trade with powerful implications on the telecommunications sector. First, the entrance of new operators generated new demand for infrastructure, and second, the increased number of operators induced growth in mobile service demand stimulating the demand of terminals and additional network capacity.[56]

In Finland, the 1990s began with severe economic shocks brought about by the recession and the collapse of trade with the Soviet Union. In Nokia, the previous decade had been a period of expansion and internationalisation of the new business sector in the telecommunications industry. However, towards the end of the 1980s the company ran into an organisational crisis, which, coupled with the external economic shocks, nearly destroyed the business.

Yet, the preconditions for a take-off, developed over several decades, were in place in Nokia. With redefined strategies and proficient management, the company was able to grasp the opportunity opened up by the liberalised global market place. The European GSM standard met unanticipated success in third countries, providing the Nordic players a first-mover advantage. The successful take-off not only saved the company, but it also set off a fundamental restructuring of the economy.

Radiolinja's licence application was perfectly, but not calculatedly, timed in the eve of the opening of the global market. The first GSM network in the world, operated by Radiolinja and supplied by Nokia, put Finnish telecommunications on the global stage in 1991. The incident promoted the image of Nokia among new mobile operators appearing around the world in opening markets.

In retrospect, it is astonishing that the political dispute stirred up by Radiolinja's licence application in 1988 did not arouse any industrial policy considerations. Instead of foreseeing the stimulating effect competition was going to have on the market, the focus of politicians was primarily on ideological issues and on the economic justification of parallel networks in a small economy.[57] Admittedly, anticipation of the dynamic restructuring process (both within Nokia and between other actors of the cluster system) required for the take-off would have called for a sixth sense.

6. ICT CLUSTER PROSPECTS

6.1. Competition – the next generation

The future of the Finnish ICT cluster is linked to the development of the global market. Its present market position is at stake as the world moves over to the third generation of mobile communications tech-

nology. In the eve of the opening of the global mass market of mobile multimedia services, the global ICT sector is perplexed by many issues that, at the end of the day, may have important implications on the global market development and structure.

High-speed data transfer together with increased user volumes, envisaged in third generation mobile markets, require sizeable investments in new capacity. Operators wishing to keep track of the market development and grasp new cash flows have little choices but to invest in next generation technology. UMTS is one of the major third generation mobile communications systems being developed within the framework, defined by the ITU (*International Telecommunication Union*).

The challenge of this major undertaking has been scaled up by spectrum licence fees collected by some national governments. Licence charges reached unexpectedly high levels in auctions in some European countries, most notably in Germany (EUR 50 billion), the UK (EUR 39 billion), and Italy (EUR 12 billion), while in Asia-Pacific markets licences have been charged moderate, if any fees at all. The US authorities, in turn, have only recently initiated the process of freeing the spectrum occupied by a number of organisations. The spectrum auction is scheduled for 2002.

Total licence costs paid in Europe have risen to EUR 130 billion. The major share of the charges has been carried by the major European operators (*British Telecom, Deutsche Telecom, France Telecom, Telefónica* of Spain and *Vodafone* of the UK). Sonera is taking part in the European UMTS construction project through participation in UMTS licences granted in Germany, Italy, Spain, and Norway. The price paid for the licences totals almost EUR 12 billion, of which the share of the German licence accounts for over 70 per cent. In Finland the licence was gained free of charge.

Estimates of the funds required in the construction of the UMTS network in the European region vary around EUR 140 billion. These estimates exclude, e.g., other operator investments in infrastructure and service development as well as terminal subsidies, which represent an important but resource-consuming part of operator marketing strategies in many countries.

There have been serious concerns about the possible debilitating repercussions of the tax-like charges on the competitiveness of the European telecommunications sector. The price and variety of serv-

ices, user rates, and the economic health of licensees are at stake according to many observers. Recently, the European Commission stepped forward to question the conditions under which operators are expected to construct the infrastructure.

There is speculation on the possible final payers of the tax levied on UMTS technology. They may include content and application providers who will be charged by operators for the right to deliver services in the network, or consumers of the end services, or finally, users of services in other market segments (cross-subsidisation). In these circumstances, there is a risk that licence fees will hold back the supply of and/or demand for UTMS services, and consequently, slow down the development of the European market – with repercussions to the manufacturing industry.

But, there is no unanimity between analysts on the possibility of operators to pass on licence costs to service prices. According to some observers,[58] there will not be a 'split Europe', in which a service price disparity between high-fee and low-fee markets would prevail. End-user demand, as maintained by the view, will set prices, which are a function of a whole set of market determinants (such as the level of competition and prevailing price levels in a market) rather than of the sunk cost of a licence fee.

There is also a chance that alternative technologies, free of the tax burden, will gain superior popularity in transferring next generation services. WLAN (Wireless Local Area Network) and boosted GSM networks (GPRS) will be also able to provide third generation services at lighter total investment costs.

Indeed, some critics have questioned the value added of heavy UMTS infrastructure investments altogether. Not all third generation licences require investments in telecommunications-based UMTS technology. In these cases, operators may choose among two approaches to provide wireless Internet services. The Internet-based solution connects wireless terminals to the network via Internet Protocol (IP) ('the US approach'), while stepwise upgrading of the GSM network leads ultimately to UMTS ('the European approach'). In practice, however, the two solutions will be mostly complementary in providing user access to services. Finally, however, competing technologies will serve as an impediment to full scale reimbursing of licence costs in UMTS-based services. For all these reasons, to note, many operators do not confine themselves to one technology only.

Concerns about the economic justification of heavy UMTS investments have not been raised only in the context of competing technologies. The development of the fourth generation technology is already under way, too. Indeed, Japanese *NTT DoCoMo* has announced its intention to launch fourth generation services no later than in 2006.

Problems related to UMTS have provided an opportunity for information technology (IT) companies, such as *Cisco* and *3Com* supplying IP based network solutions, to extend their client base to traditional operators. Irrespective of third generation network standard, however, IT companies will, at any rate, penetrate the market that has been, up until recently, exclusive to mobile equipment manufacturers.

Having been considered primarily as a European solution, UMTS strengthened its status in the global standard race when, in late 2000, two large North American mobile operators, *AT&T* and *Rogers Wireless Communications*, chose to change standard to advance the third generation communications system through investments in the GSM standard. It was followed suite by operators in the three largest South American markets (Brazil, Mexico and Argentina). This turn of events marks significant future prospects for UMTS network and terminal vendors in the Americas.

Deteriorated financial positions coupled with uncertain future revenues of licence-winning operators have had a negative impact on their credit ratings. Operators with their market valuations plummeting may have difficulties in finding financiers for their investments, the payback period of which will be subject to uncertain market conditions. Consequently, equipment vendors may have to carry part of the risk in the form of customer credits. In fact, favourable customer credit arrangements, including acceptance of future operator revenues and shares of equity, are likely to play an increasingly important competitive weapon in the tightening competition for UMTS network deals.

Hence, the future of manufacturers reminds of a two-edged sword. On the one side, there are tremendous sales opportunities: there will be over 100 UMTS licences allocated by the end of 2001. But on the other side, there are leveraged customers whose risky future they may have to share to get stakes in the business. By early 2001, many vendors had already reported deteriorated profitability and decelerated sales growth, and some had seen their credit ratings reviewed or downgraded. Nokia, on the contrary, has succeeded in maintaining strong financial performance and grasping larger market shares.

All things considered, demanding operator business conditions are likely to promote further the consolidation of the market, initiated in the late 1990s. Analysts are anticipating consolidation in the manufacturing sector, too, as decreasing market valuations are making companies increasingly disposed to acquisitions.

The launch of the third generation mobile technology will erase many of the early-mover advantages the Nordic companies got in the second generation (GSM) technology. Japan, who issued the spectrums free of charge, will have a second chance to take over the mobile market dominance, once unintentionally conceded to the Nordic countries. Indeed, the Nordic equipment manufacturers were able to create their competencies without any pressure from the Japanese manufacturers who lost interest in the GSM standard in the absence of home market demand. However, since the third generation communications will build largely on GSM technology, competence gained in the second generation competition will be valid in the third round, too.

Yet, this time, Japan has an early-mover advantage gained with its mobile Internet application (i-Mode), launched in February 1999, that attracted over 20 million subscribers in only two years time. The mobile Internet application launched in Europe (WAP), with disappointing consumer experience coupled with high service price, has not proved nearly as successful. i-Mode is penetrating some Western markets. In Europe, however, the service is not expected to gain important success, nor seriously threaten local actors' positions.[59] Japan will, anyhow, be the first country in the world to launch third generation services, in May 2001, while Europe is not expected to follow before the summer of 2002.

While the U.S. disabled itself in the second-generation mobile market by the fragmented domestic infrastructure and discouraging pricing principles, in the next round, it will have a competitive advantage in the Internet technology (see Steinbock in this volume). However, it remains to be seen how critical the delay in the launch of third generation services will be for the global competitive positioning of the U.S. and how the US market will succeed this time in providing ubiquitous service with four competing future standards.

6.2. Globalisation

Finnish firms are in a historical situation by possessing advanced know-how in a rapidly growing market, in which new entrants have a

chance to grab large market shares in some of the myriad of opening segments. Electronic market places and distribution channels will abolish many of the business obstacles previously encountered by small firms. The knowledge-intensity and digital form of many ICT products makes them most suitable for global electronic trading. Finally, the market is not likely to show signs of levelling down in the foreseeable future.

According to an ETLA estimate, Finnish ICT cluster value added will continue to grow at an 8 per cent annual rate over the period 2001-2015, with variations between cluster sectors. The growth potential depends naturally largely on global demand. Over the same period, the share of ICT equipment of total OECD manufacturing is estimated to almost double, to over 10 per cent, from its 1997 level. The Finnish share of the global market is anticipated to increase sharply, from 0.9 per cent in 1997 to 3-4 per cent towards 2010.[60]

Despite these promising growth prospects, concern about the dependence of Finnish firms of the telecommunications industry, or more specifically, on one client firm, has been persistent in public debates. Obviously, the future of the global ICT market, notably in Europe, has many wild cards. However, on the global level, investments in communications infrastructure will continue growing strongly. The industry will be less sensitive to fluctuations in economic conditions than total industry on average.[61] Relative variations between different market areas and market segments will appear, though. Especially in business and consumer markets, ICT manufacturers deal with very different demand sensitivities.

Finland's ICT-related competence lies in a wide range of capabilities, most of which are widely applicable. Demand for electronics and software is in robust rise also in a number of non-ICT industries. Indeed, many of the Finnish supplier firms operating in the ICT cluster have diversified their client portfolios to other industries. In addition, the demand for ICT-related skills is global, and therefore, not tied to one market or one client company. The business opportunities of Finnish software suppliers in over-seas markets are considered especially good.

Globalisation has revealed deficiencies in managerial skills in Finnish technology-oriented firms. Some of the cluster sectors, such as software production, with great export potential lack a history in international operations management. Technological innovativeness does not

compensate for management and marketing skills required in rapid business growth and early international market penetration.

Venture capitalists and the increasingly market-oriented Tekes have offered important support to technology-oriented firms in their business creation process. Improved co-ordination between public and private sectors is still necessary to overcome business-related problems in exploiting the technological lead of Finnish firms. To support a sustainable future development of the sector, though, the requirements of the globalizing industry need to be better reflected in education strategies.[62]

6.3. Small size – limited opportunities

Despite two-digit business growth rates, the average size of Finnish firms is still small. Small size pertains not only to the production capacity of a firm, but also to its ability to bear risk, characteristic to the industry. Product development typically involves R&D investments with uncertain future revenues. The smaller the firm, the riskier the investment.

Partnerships serve as a means of distributing risk among several players, and therefore, suppliers, too, are expected to assume increasing risk related to the technological and commercial success of new products. Scarce financial resources limit the scale to which a firm can engage in collaborative development projects with a customer, and thus, the extent to which it can take risk in seeking higher future revenues. Small firms also typically lack some of the managerial skills required to qualify as a full-blown partner of global customers.

Thus, firms with insufficient resources risk falling in the category of second-tier subcontractors serving as a capacity-buffer for manufacturers. In such a case, vertical relationships do not offer an equal upgrading stimulus inherent in collaborative partnerships.

Limited resources of a supplier risk being occupied by one large customer's needs. In order to cater for the key client, the small firm may have to give up other business opportunities, which further increases dependence on the key customer.

However, Finnish ICT firms are increasingly aware of customer and industry risks, which has induced purposeful extension of the client base. Firms engage also in independent product development to in-

crease their own product variety and technological distinctiveness.[63] Yet, the ideal balance between customised and own products may be hard to find, since the scattering of limited resources is likely to hamper their efficient use.

Firms have, nevertheless, indicated their willingness to increase R&D collaboration, and to share more responsibility in sub-system deliveries. [64] Despite the growth in outsourcing, there is still plenty of potential to enhance competitiveness through increased specialisation. For example, the share of electronic manufacturing services (EMS) is still, at most, 20 per cent of the Finnish original manufacturers' production volume.[65] Extended R&D outsourcing requires, however, focus on the design of balanced agreements on intellectual property rights.

6.4. Electronic business – reform in firm interaction

Information networks offer firms of different size an opportunity to access electronic market places. According to the *Confederation of Finnish Industry and Employers* (2000), already about 95 per cent of all Finnish industrial companies have adopted some degree of electronic business, and 80 per cent sells products through information networks.

There are, however, notable differences in networking across firms of different size. Small companies are lagging behind the industry average. The lack of users' know-how and the high price of technical solutions are the prime obstacles to small firms entering the electronic business.[66] There is a threat that firms unable to enter the digital market will not only miss the new business opportunities offered by the technology, but they may lose their current market positions gained in 'tangible' markets.

Electronic business will have powerful implications on the functioning of production networks. They will gain in improved transparency of information, which will level down fluctuations in production volumes. Electronic market places will also increase price bidding through increased market information.

On the other hand, increased price bidding induced by electronic market places has roused concerns about its implications on supplier innovation. In other words, can firms investing in product development compete with their non-innovative, and thus, lower-cost rivals?[67] Or, to what extent does the electronic operating environment support inter-firm knowledge transfer and innovation inherent in face-to-face

teamwork? This question relates to intellectual property rights issues, which are at the heart of the digital economy.

6.5. Educational system challenged

The gradual exhaustion of skilled labour resources is already limiting the full growth of ICT firms and efficient exploitation of opportunities opening in the market. The higher education system has not been able to rise to the challenge despite the significant increase in openings over the 1990s (Figure 4.8). There have been concerns that the education system is being watered down by excessive intakes coupled with inefficient allocation of educational resources. Increased workload and static development in the income level of higher education personnel, compared to the private sector, have eroded the attractiveness of an academic career. Consequently, the industry draws both students and personnel from higher education institutions, which erodes severely the generation of future labour resources. There have been calls for a cultural change in the education sector, from a technology to a business orientation, which would require fundamental changes in established structures.

The global success of the Finnish ICT industry has made it attractive for talented individuals. The public sector is in a decisive role in supporting required institutional changes, and in guaranteeing efficient reallocation of educational resources to assure optimal conditions for skilled labour development. In order to keep pace with the fast-developing technology, the industry, in turn, has a crucial role in communicating its needs, and catalysing knowledge transfer to the education system.

6.6. Content production - the third base of the ICT cluster?

The Japanese case of the mobile Internet (i-Mode) implies that a successful commercial launch of the third generation services will depend on the content displayed on terminals. Certainly, the focus of the telecommunications business is moving fast from technology to content provision, which will be the next growth sector in the global ICT market.

The favourable development and global competence of the Finnish content industry have high rankings on the national agenda. In 1999, the government initiated the *Content Finland Programme*, an inter-

ministerial agenda for the period 2000-2003 to improve Finland's preconditions to develop into a leading country in the provision of – in addition to telecommunications technology – content industrial products. The programme contains eight ministries under which new content products for a wide range of application areas will be developed in co-operation with businesses and other financiers.[68]

The history of the Finnish ICT cluster has a chance to repeat itself upon building the Information Society. Interaction between the industry and the public sector, as a demanding customer and content provider, has every opportunity to generate content innovations reproducible in foreign markets.

Moreover, recent breakthroughs of the Finnish entertainment industry indicate a sudden positive change in the tradition of domestic content provision. It is likely to strengthen the new ambitious and enthusiastic attitude that has developed in the Finnish ICT cluster over the 1990s.

APPENDIX 1: DEFINITION OF THE ICT CLUSTER

The branches of the SIC-95 classification used in the calculation of economic indicators for the ICT cluster

ICT Manufacturing

30010	Manufacture of office machinery
30020	Manufacture of computers etc
31300	Manufacture of insulated wire and cable
32100	Manufacture of electronic components
32200	Manufacture of radio transmitters etc
32300	Manufacture of radio receivers etc

ICT Services

Telecom services

642	Telecommunications

Software and IT services

72	Computer and related services

Note: The branches used in this report for describing the production of goods and services as part of the ICT cluster differ from those recommended by the OECD (see: Statistics Finland (1999), On the Road to the Finnish Information Society II. Helsinki: University Press). This report excludes manufacturing of equipment and appliances used in the production process of goods (branches 33200 and 33300), and goods-related services (branches 51432, 51641, 51652, and 71330).

APPENDIX 2: MEASURING THE EXPORT SPECIALISATION OF A COUNTRY

The degree of a country's specialisation in product exports can be measured by the RCA (Revealed Comparative Advantage) index, which is calculated as follows:

$$RCA_{ij} = \frac{X_{ij} \Big/ \sum_{i} X_{ij}}{\sum_{j} X_{ij} \Big/ \sum_{i}\sum_{j} X_{ij}},$$

where X_{ij} is the exports of cluster *i* from country *j*, and $\sum_{i} X_{ij}$ is total exports from country *j*. The denominator shows the share of the OECD cluster *i* (the sum of cluster *i* exports from all the OECD countries) of total OECD exports. The RCA can be scaled between -1 and 1, which yields the RSCA (Revealed Symmetric Comparative Advantage) index. If the RSCA index equals zero, the country in question is as specialised in cluster *i* exports as the OECD in average. If the RSCA index value is positive, the country is specialised in the exports of this cluster.

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ENDNOTES

[1] Mäenpää & Luukkainen (1994); Hernesniemi et al. (1995).

[2] Penttinen (1994), cf. Jääskeläinen (2001).

[3] Cf. Mäenpää & Luukkainen (1994).

[4] See European Commission (1997).

[5] See Jalava & Pohjola (2001) on the effects of ICT on productivity in advanced economies.

[6] According to the definition, clusters do not follow sectoral boundaries. Sectoral data inevitably includes firms not active in the cluster, and respectively, excludes many important actors. For example, national statistics do not yet enable quantification of digital content production, which is however largely included in the data on telecom operation and software production sectors. Further, it has been necessary to combine the data for electronic components (inputs) and ICT equipment (outputs), since many of the input suppliers are classified under the branch of their main clients. Despite these problems, the national data applied here covers the crucial business sectors of the cluster. See Appendix 1for the SIC-95 branches included.

[7] To contrast, the share of the largest cluster, i.e. the forest cluster was about 9 per cent of the GDP (Lammi, 2000). Owing to higher growth rates in the telecommunications sector, the ICT cluster is about to overtake the position as the largest industrial cluster in Finland.

[8] Ali-Yrkkö, Paija, Reilly & Ylä-Anttila (2000).

[9] Paija & Ylä-Anttila (1996).

[10] See Hernesniemi et al. (2001) for an input-output analysis of the economic effects of the ICT cluster on other industries in Finland.

[11] Shares of OECD telecommunications exports in 1998 (total USD 115 billion):

Shares of OECD exports	
USA	19.7
Japan	11.0
UK	11.0
Germany	9.1
Sweden	9.0
France	7.2
Finland	5.4
Mexico	4.7
Canada	4.1
Korea	4.0

Source: OECD.

[12] Between 1950-65, the number of operators declined dramatically as structural regulations, aiming at general network improvement, forced minor companies to merge with either a bigger company or the PTO.

[13] State redemption of the long distance operation in 1934 was an exception to the rule. There were also occasional acquisitions of operators by the state, motivated by national defence and technical concerns.

[14] Mäkinen (1995).

[15] Mobira manufactured equipment for five standards adopted in different countries. Only Motorola supported an equal amount of standards.

[16] Mobira came ashore the US under an OEM agreement with *Tandy Corporation*, which offered an extensive distribution channel. The alliance with *Alcatel* and *AEG* for marketing and system development opened the doors of the French and German PTOs, and gave credibility to the emerging mobile

manufacturer. Cooperation was gradually terminated after the company was capable of supplying independently a GSM system in 1991.

[17] Interbrand.

[18] The company was acquired by a subsidiary of the Spanish operator *Telefónica* for EUR 230 million.

[19] For example, SSH Communications Security was awarded in 1998 the European IT Prize by Esprit programme of the European Commission as being 'a representative of Europe's strengthening position in information technology and telecommunications'. The cryptography and authentication technology (SSH Secure Shell) for Internet has become a de facto standard for logins.

[20] The kernel (the central part of the operating system) of a UNIX-like operating system was developed by Mr. Linus Tordvals at the University of Helsinki in Finland. As a publicly open and free system, extendible by any contributor, it soon gained supporters from all over the world. Linux comes in versions for all the major microprocessor platforms, and it is distributed commercially by a number of companies.

[21] Nokia, as an example, spends approximately 60 per cent of its R&D input in Finland (Ali-Yrkkö et al., 2000).

[22] Telia owns networks only in major cities, while for nation-wide services it has a leasing contract with Radiolinja. There are other mobile service providers in the market, as well.

[23] Sonera has five UMTS licences and 12 foreign mobile joint ventures. The newly established mobile technology units (*Sonera SmartTrust* and *SoneraZed*) are targeted to international markets. The largest private operator Elisa Communications, in turn, has advanced through acquisitions in the German city carrier market.

[24] ICT patents granted by United States Patents and Trademarks Office (OECD, 1999).

[25] For example, in 2000, Hewlett Packard set up the *Mobile E-Services Bazaar*, an innovation centre, in Finland to coordinate mobile service development in Europe. The objective is to gather together communications technology developers from different fields to cooperate in innovative e-services development. IBM and Ericsson have expressed their intentions to establish similar kinds of innovation centres in Finland.

[26] Pajarinen & Ylä-Anttila (2001).

[27] The share of foreign affiliates in total manufacturing R&D was around 10 per cent in 1997, compared to the most 'internationalised' country, Ireland, where the share was 68 per cent (in 1993) (OECD, 1999b).

[28] Ali-Yrkkö et. al (2000).

[29] Ministry of Transport and Communications.

[30] EITO 2000.

[31] Ministry of Transport and Communications.

[32] In digital mobile service prices, Finland ranked first in residential services but seventh in business services. Ministry of Transport and Communications (1999), OECD (1999a).

[33] No less than 92 per cent of the electronic component market value is composed of imports. (Hienonen, 2000).

[34] In 1999, there were some 240 companies in the field whose total value of gross production had grown at an average rate of 25 per cent over the latter half of the 1990s. (Ministry of Trade and Industry, 1999a).

[35] Kuokkanen et al. (1999). The study included companies engaged wholly (60%) or partly (40% of the population) in 'new media' activities (listed in Figure 4.5).

[36] Kurki (1999).

[37] Autere, Lamberg & Tarjanne (1999).

[38] Direct access to the end-user is regarded as a major strategic advantage in the value chain of digital content provision as it offers, according to the view, an opportunity to direct the development of the business. According to *Ericsson,* there are tree different scenarios in which either the content pro-

vider (media), the service provider (operator), or the terminal provider (equipment manufacturer) is the core actor with access. (http:/www.ericsson.com/SE/kon_con/tema_indepth/id1_97/scen3.html; printed in 15th Feb. 2001). This observation can be used to explain much of the strategic behaviour of the actors in the industries concerned.

[39] Hernesniemi et. al (1996).

[40] A small ICT cluster-based programme was established to promote the exploitation of information networks in SMEs.

[41] Digitaalisen Median Sisältötuotteet (Digital Media Content) Programme initiated in 1996. See: Tekes (1999).

[42] See e.g. Tekes (1999).

[43] Ministry of Transport and Communications.

[44] Finnish education input per graduate student was USD 7 145 as compared to the OECD average of USD 10 893 (OECD, 2000a).

[45] OECD (1999a) and OECD trade statistics.

[46] ITU (1999). The remaining six countries are committed to liberalisation in coming years.

[47] See Häikiö (1998).

[48] See Jääskeläinen (2001).

[49] Cf. Jääskeläinen (2001).

[50] Sitra (2000). The expert group for the evaluation was established by the Ministry of Trade and Industry and the Ministry of Education

[51] OECD (1999b).

[52] Pulkkinen (1996).

[53] Koivusalo (1995).

[54] As compared with some other markets, in Finland the relatively reasonable pricing is coupled with favourable charging practices, including the prohibition of terminal subsidies by operators and the 'caller pays' principle. They have contributed to low operator churn rates and credit losses, and have thus promoted the sound growth in demand (see: Ministry of Transport and Communications, 2000).

[55] Ali-Yrkkö (2001).

[56] According to the OECD, the number of operators correlates positively with market growth rate (OECD, 2000b).

[57] See Häikiö (1998).

[58] Durlacher Research Ltd and Eqvitec Partners Oy (2001).

[59] Ibid.

[60] The estimate includes the following NACE classes: 30 (Manufacturing of office machines, computers, etc.), 32 (Communications equipment etc.), and 641+641 (Postal and telecommunications services). (Hernesniemi et al. (2001).

[61] See e.g. ETLA (2001).

[62] See also Autere et al. (1999).

[63] Ali-Yrkkö (2001).

[64] Ibid.

[65] Ministry of Trade and Industry (1999a).

[66] Ibid.

[67] In the 1980s, the US automobile industry pursued improvement in competitiveness through supplier price bidding. This strategy damped suppliers' R&D activities, further deteriorating manufacturers' competitive edge vis-à-vis their Japanese rivals, who instead, put supplier innovation in active use (see e.g. Helper, 1993).

[68] The programme is concerned with the following content-related areas and issues: digital learning material, digital content, digital information services, cultural and nature tourism services in the network, digitisation of the cultural heritage, content production in sports, and copyrights. (Ministry of Trade and Industry (1999b), http://www.minedu.fi/opm/hankkeet/sisu/index.html. (Printed in Feb. 20, 2001.)

Perttu Rönkkö

Growth and Internationalization of Technology-based New Companies: Case study of 8 Finnish Companies

CONTENTS

The author wishes to express his gratitude to Mr. Erkko Autio (Institute of Strategy and International Business, Helsinki University of Technology) and Mr. Mikko Puhakka (Eficor Group Oyj) for their assistance and comments in developing the evolution model for a technology-based new company. In addition the author wishes to thank his colleagues Mr. Tom Henriksson and Mr. Mark Roth in Eficor Group of their support.

1. INTRODUCTION

1.1. Structural changes in the Finnish capital market[1]

The 1980's in Finland were characterized by rapid economic growth and deregulation of the capital market. Interest rate regulation ended during 1983-1986, and restrictions on the cross border movement of capital were gradually abolished during 1986-1990. Due to the liberalization, borrowing from banks more than quadrupled, and foreign credits grew almost ten-fold during the 1980's. Since 1993, there are no longer restrictions on foreigners purchasing shares of Finnish companies. Deregulation of capital markets was a global phenomenon at the time, partly due to technological development hampering official supervision, and partly induced by European integration.

The 1990's, in turn, were characterized by the economic downturn that swept over all of Europe. The economic recovery lasted until the late 1990's. The recession was most severe in Finland, owing to the overvalued Finnish currency in 1989, which was the result of the Finnish monetary policy of fixed exchange rates, and to the collapse of Finland's important trade partner, the Soviet Union. The recovery promoted strong growth in Finnish export industries. In 1998, exports accounted for 39 per cent of the gross domestic product, while in 1990, they accounted for 23 per cent. The increasing internationalization of Finnish industry, induced by growing foreign trade, had its effects on the capital market, as well.

During the past few years, the Finnish capital market has been characterized by rapid globalization, which has been further accelerated by the introduction of the Euro. As a result of restructuring, the banking and insurance sector has became more consolidated. In terms of their balance sheet total, the three largest banks hold over two thirds of the market. At the same time, the market share of foreign banks has also been on the rise, yet, in 1999, foreign banks accounted for only 3.3 per cent of all credit issuing.

Even though the role of the stock market has clearly increased in the 1990s in Finland, listed companies are still relatively few in number. It can be argued that the main reason for this is the relatively modest number of medium-sized companies, and the minor role private equity financing has traditionally played in company financing. One of the main barriers to the development of the capital market has been the

lack of a well-functioning secondary market. However, the establishment of the NM list on the Helsinki Exchanges (HEX), along with a number of successful listings during the last two years, has improved the situation. Currently, the public sector accounts for one-fifth of risk capital investments. Accounting for more than 60 per cent, insurance companies and pension funds hold a substantial part of all capital investments.

Owing to the low level of interest rates, in 1998, almost two thirds of all external finance granted to firms consisted of bank loans. The popularity of bank loans is, however, declining thanks to the widening variety of more competitive financial instruments.

1.2. Sources of financing to small and medium-sized companies

The most important forms of financing, both equity and debt, for small and medium-sized enterprises (SMEs) include:

- **Debt financing** by banks and other financial institutions.
- **Private venture capital** through venture capital funds and investment companies, normally in the form of equity, but also in the form of loans and convertible loans.
- **Public venture capital** through public and semi-public venture capital funds.
- **Business angel investments** by wealthy individuals, who invest their own funds professionally in a manner similar to venture capital funds.
- **'Petite angel' investments** by individuals providing relatively small amounts of equity either to start a company, or to fund a start-up phase company of a friend or relative. Petite angels do not operate professionally like business angels and are usually passive investors.
- **Government subsidies** in the form of soft loans, investment subsidies, collateral and tax breaks, mostly to support R&D development and internationalization. The most important providers include: *Tekes* (the National Technology Agency) and the Ministry of Trade and Industry, whose funds are delivered mainly through *FINPRO* (formerly the Finnish Foreign Trade Association), *Finnvera* (the Export Credit Agency) and the local Employment and Economic Development Centers.

Debt financing has traditionally been the most popular financing instrument used by SMEs in Finland. In 1995, more than 80 per cent of SMEs had debt financing. Because of the increased profitability of companies and the availability of alternative financing instruments, the popularity of debt financing has decreased significantly since 1995. In May 2000, over half of all SMEs had no bank debt, and only 17 per cent had resorted to bank loans during the last 12 months. As collateral is usually needed in debt financing, equity financing becomes more important when pre-seed and seed phase companies are concerned. In these companies, the most important sources of equity are 'petite angels', business angels, venture capitalists, and governmental bodies.[2]

During 1999, some 6000 new limited liability companies (Finnish legal form *osakeyhtiö*, abbreviated *Oy.)* were registered in Finland. The capital required for establishing these companies totaled over EUR 48 million in equity.[3] According to the population survey of the GEM Global Entrepreneurship project 2000, during 1999 at least EUR 170 million of equity was channeled from petite angels to starting and financing new ventures.[4] Therefore, petite angels represent an important source of pre-seed financing, and, thus, contribute to the renewal of the population of Finnish companies.

While petite angels are active in Finland, professional business angel activity has been relatively insignificant. According to our estimates, business angel investments totaled less than EUR 20 million in 1999. In the US, for example, business angels account for the largest share of all equity investing. However, business angel investing is finally taking off in Finland due to many recent entrepreneurial success stories.

Currently venture capital accounts for the largest share of all equity investing. In 1999, venture capital investments totaled EUR 285 million, of which EUR 77 million was invested in the information and communications technology (ICT) segment.[5] Considering the investments made by foreign investors on top of those made by domestic venture capitalists, it is fair to say that risk capital was readily available in Finland in the turn of 2000.

Of all venture capital investments, only EUR 19 million were invested in start-up stage companies and EUR 15 million in seed stage companies in 1999. Of all seed investments, 84 per cent was carried out by *Sitra* (Finnish National Fund for Research and Development). The evident lack of adequate seed financing is caused mostly by the immaturity of the business angel activity as well as the private equity

market, where just a few investors are actively investing into seed-stage companies.[6]

The public sector has traditionally been the most important financier of start-ups in the form of various subsidies, soft loans and other instruments. Government subsidies for, e.g., technology development and foreign trade have been readily available for years. As venture capital has become more popular, the role of government is changing. A new kind of syndication is emerging: the venture capitalist carries the market risk of a new company, while Tekes carries the technology risk. Through this type of syndication the public sector has a more focused role as a catalyst of technological development.

Box 1.1 Background: Venture Capital in brief

Private equity investors provide equity capital to enterprises not quoted on a stock exchange. The equity is usually used to develop new products and technologies, to expand working capital, to make acquisitions, or to strengthen the balance sheet. Buy-out or buy-in of a business by experienced managers may be achieved using private equity funding, as well.

Venture capital is, strictly speaking, a subset of private equity and refers to equity investments made for the launch, early development, or expansion of a business. Among different countries, there are variations in what is meant by venture capital and private equity. In Europe, these terms are generally used interchangeably, and venture capital thus includes management buy-outs and buy-ins (MBO/MBIs). This is in contrast to the US, where MBO/MBIs are not classified as venture capital. This report adopts the European usage, which views venture capital and private equity as the same.

Venture capital funding process. The actual venture capital investment made in a company is preceded by a thorough and selective assessment of potential investment targets made by the venture capital investor. At the first stage, the assessment of the investment request is based on a business plan made by the company. This is the stage where most projects (typically about 90 per cent) are rejected. The initial assessment is made relatively rapidly, and therefore, the company should pay attention to two aspects: the business plan should be carefully prepared, and the contact targeted to the correct investors. A well-prepared business plan summary is the best means of attracting and convincing the investor.

The central issues considered by the venture capital investor at this stage are:

- Is the company able to conduct profitable and growing business operations?
- Do the company executives have the necessary qualities to manage the business in various development stages?
- Will the investor be able to obtain the desired return through an increase in the company's net worth?

Besides the company's business plan, the venture capital investor will assess the compatibility of the investment request against its own investment strategy. The decisive investment strategy criteria may be company size, development stage, branch or geographical location. Contacts directed to appropriate investors at an early stage of the process will save time and diminish the probability of negative response. Should the investor decide that the investment request meets his criteria, the following step is a meeting arranged with the company management. Experience has shown that about half of the remaining companies are discarded at the negotiation stage.

The third stage, or the due diligence stage, involves a thorough study of the target company by the venture capital investor who assesses the company on the basis of his own, weighted investment criteria. The preparedness of the company's management to launch and develop the business in question is generally seen as the most important criterion. Other vital issues include the size and development of the company's target market, the competitiveness of the company's product and technology, as well as the capital required by the business at the actual investment stage, and the eventual additional investment needs.

During the second and third stage of the assessment process, the investor determines the value of the company. Once the entrepreneur and the investor have agreed on the value, the investor's future share of the company is determined. In the end, the investment is made in about 3 to 4 cases per hundred received investment requests. The parties finally make a shareholder agreement to establish practical operating rules.

After the investment is made, the investor and the entrepreneur start working on the common task, i.e., building the value of the company. Usually soon after the investment, the venture capital process is started all over again in order to acquire further funding for the company. In this process, the investor already onboard is a help to the entrepreneur in negotiating the next agreement.

As the company reaches profitability and/or meets the requirements for public listing, the venture capitalist gets a chance to exit the company. Other common types of exit for the venture capitalist are trade sales of the company, MBO/MBIs, and, potentially, a bankruptcy. The basic logic in the venture capital business is that successful exits make up for the losses from unsuccessful exits.

Excerpted with modifications from the Finnish Venture Capital Association FVCA (www.fvca.fi)

1.3. The rise of the Finnish venture capital market

Private equity investing increased considerably and began to show professional traits during the mid-1980s. During the 1990s, the sector matured and became an important investment class amongst institutional investors. Currently, there are 36 private equity firms as members of the Finnish Venture Capital Association.

Along with the maturation of the private equity industry, the role of the government has diminished. Today, public activities in company financing are limited mainly to seed financing, offering guarantees for private equity investments, and providing money through the fund-of-funds vehicle.

Table 1.1. demonstrates the rapid development of the venture capital industry in Finland. The amount of new funds doubled during 1995 and boosted the average investment size significantly in the following year. Starting in 1999, successful public listings of high-tech start-ups have added further the interest to private equity investments, which has been mirrored in the volume of new funds. The biggest venture capital deals closed during 2000 have hit national records. The deteriorating market situation during year 2000, however, made investors more cautious, and the amount of new funds decreased for the first time in years.

A kind of a snowball effect can be seen behind the growth of equity investments. First, success stories demonstrate business potential to investors. Thus, the amount of new funds increases, which is, in turn,

Table 1.1 Private equity investments and new funds in Finland in 1994-2000[7]

	Number of Cases	Growth %	Invest-ments M EUR	Growth %	Av. Inv. Size M EUR	Growth %	New funds M EUR	Growth %
1994	115		28,3		0,246		63,2	
1995	122	6 %	37,8	34 %	0,310	26 %	128,5	103 %
1996	137	12 %	83,8	122 %	0,612	97 %	193,9	51 %
1997	205	50 %	136,4	63 %	0,665	9 %	305,4	58 %
1998	265	29 %	192,4	41 %	0,726	9 %	328,3	7 %
1999	350	32 %	285,4	48 %	0,815	12 %	655,9	100 %
2000*	420	20 %	403,7	41 %	0,961	18 %	588,7	-10 %

Source: Finnish Venture Capital Association FVCA

Note: * preliminary data

mirrored in bigger investments, giving rise to new start-ups with better resources, which are then capable of showing promising results faster than their predecessors. As a result, the amount of new capital has grown every year, until 2000. By the end of 1999, the total capital committed in Finnish venture capital funds was EUR 2000 million, which still grew another EUR 589 million during year 2000.

Public listings and trade sales, continuing in 2000, demonstrated that remarkable capital gains were attainable through private equity investments in Finnish technology start-ups. *Iobox* serves as a good example of rapid value creation. The company was acquired by Spanish *Terra Mobile* in July 2000 with a cash payment of EUR 230 million, just some two years after the company was introduced to the public. In 2000, a number of record-breaking venture capital rounds were raised by Finnish technology companies, such as *Solid Information Technology* (EUR 55 million) and *Riot Entertainment* (EUR 17,3 million).

Despite the collapse of technology company valuations during the latter part of 2000, large amounts of venture capital were still flowing into Finnish technology companies at the turn of 2001. These included *Digia* (EUR 34,8 million), *AVS Technologies* (EUR 6,4 million), and *LPG Innovations* (EUR 10 million) to name a few of the largest. This indicates that the most promising companies were still able to acquire venture capital.

The deteriorating market situation struck the hardest on those companies whose success was less obvious. At the end of 1999, at the peak of the technology start-up hype, almost all companies were able to get funding. The role of venture capitalists in screening and selecting the best ideas was almost forgotten for a moment. Ultimately, the shake out in start-up valuations made the venture capital business healthier.

Close to one-third of all recent venture capital investments in Finland were made in the ICT industry. The share of ICT companies is even bigger with respect to seed and start-up stage investments. For the past few years, the institutional learning among Finnish investors has been very strong due to the rapid development of Finnish ICT companies. The simultaneous rapid growth of both the Finnish ICT cluster and the venture capital industry is not a coincidence. While new ICT start-ups have attracted more and more capital to venture capital funds, increasing venture capital money has boosted the growth of new ICT start-ups.

1.4. Landing of international venture capitalists in Finland

International venture capitalists have actively monitored the emergence of the ICT cluster in Finland since the early 1990's. Recent success stories have encouraged also international investors to start investing in early-stage Finnish technology companies. Rather than seed phase financing, most of the funds provided by foreign investors have been first, second, or third round venture capital investments. This is mainly due to the fact that internationalizing companies usually look for foreign investments in order to strengthen their international network. The majority of the capital raised in the recent large private placements (e.g., Solid, Digia, Riot, AVS and LPG) was supplied by international venture capitalists.

Thanks to mostly hard technology-oriented start-ups rather than pure Internet businesses, or 'dot.coms', Finnish ventures have been able to keep up the interest of international investors, despite the wave of bankruptcies in foreign markets.

While in 1999 foreign investors made just a few investments in Finnish technology start-ups, in 2000 foreign investors became a substantial part of the Finnish technology financing pool. 2001 is expected to be the year of rapid growth in foreign investors' market share. Foreign investors are also expected to participate in seed round investments as their knowledge of the Finnish market increases. Syndication of investments with local and international investors is becoming more popular as well. Local expertise combined with an international network of contacts makes a successful match in many cases.

1.5. A developing industry

In the early years of the Finnish venture capital market, investments were made by banker-type investors, who were minimally involved in developing portfolio companies. As the amount of investors and funds has increased, investors have become more active and focused on their special area of expertise. Today, venture capitalists are more like active industry specialists than passive portfolio investors. Naturally, the degree of contribution to business development varies between venture capitalists, and international investors are likely to have built even stronger skills in some areas of expertise than their Finnish colleagues because of their longer experience in venture capital investing.

The better financial status of start-ups, owing to increased professional venture capital funding, has attracted more qualified, experienced, and motivated entrepreneurs. This, in turn, has increased the amount of growth-oriented and rapidly internationalizing start-ups, and increased significantly the quality of new ventures. Due to venture capital financing the risk tolerance of entrepreneurs has also increased. While in the old days of bank debt financing, aggressive growth-oriented business plans were usually considered too risky, they are today viewed as challenges worth pursuing. The increased risk tolerance of entrepreneurs is critical for the existence of more and more ambitious new ventures with the potential of international take-off.

In addition to increased capital resources, more experienced people are shifting to the venture capital business as well. Experienced individuals, coming from both large telecom companies, and start-ups having reached initial public offering (IPO) or trade sale, have lately set up new venture capital companies and funds. They are often highly focused on specific technologies and/or development stages in order to differentiate and offer more value to their target companies. In this manner, investors have been able to enhance their expertise and, thus, to offer value adding business development assistance to their portfolio companies. The accumulated experience of venture capital companies form a base for the Finnish ICT cluster to flourish and produce new generations of start-up companies.

1.6. Changing attitudes and the high-tech roller coaster

Entrepreneur's attitudes towards venture capitalists have undergone a dramatic change during recent years. Until 1998, venture capitalists were not familiar to most Finnish entrepreneurs, who usually tried their best to avoid equity investments to protect their managerial independence. Businesses were kept running with sales revenues, often from resource-draining project work, which was done at the expense of the primary goals, such as product development. Only companies struggling to survive approached venture capitalists. Thus, venture capital-backed businesses did not represent first-class start-ups.

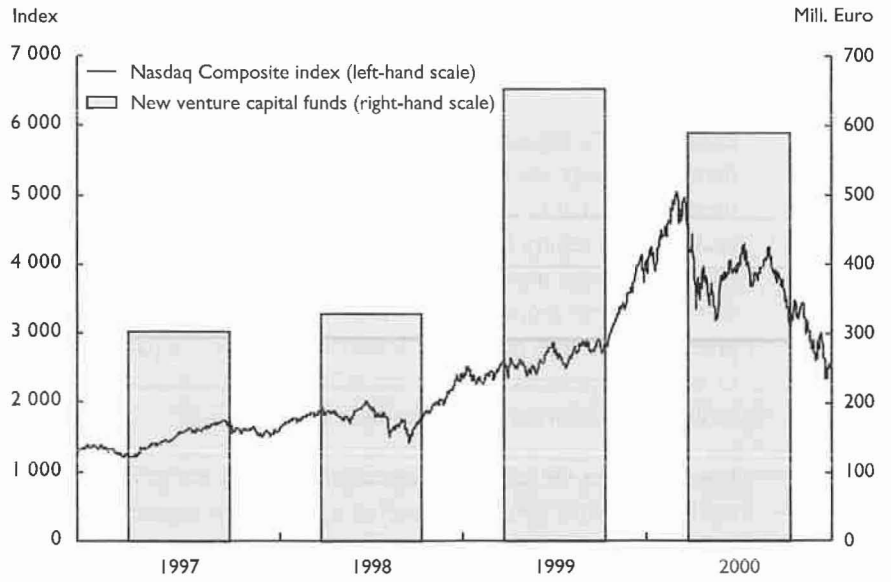
It appears that the change in attitudes started at the turn of 1999. Already successful companies started approaching venture capitalist in the hope of making their business even more successful. Although entrepreneurs realized the opportunity to gain extra resources for

growth through venture capital, they did not, however, see venture capitalists as potential business advisors.

Later in 1999, as equity investors started demanding more active roles in their portfolio companies, Finnish entrepreneurs realized that it was more than only financing that the best investors were able to offer. At the same time, equity investors increased in number and started focusing on specific technologies in order to develop themselves as business advisors.

Soon it became customary that entrepreneurs shopped around investors to see who was able to give the best value added, in addition to financing. The best venture capitalists took the role of a management consultant in their portfolio companies. Ultimately, the investor and the entrepreneur shared a common interest: to create a successful company with the ability to grow and internationalize rapidly. There are already a few cases demonstrating that working with venture capitalists has taught entrepreneurs to see their companies more objectively. For example, in some cases entrepreneurs have realized that stepping aside and recruiting a new CEO is in the best interest of the company to take it further in business development.

Figure 1.1 Nasdaq Composite Index (left-hand scale) and new venture capital funds (in million Euro) (right-hand scale), 1997-2000



Source: FVCA.

Companies that showed profit and were already on a growth track started seeking financing to accelerate growth and internationalization. The Finnish venture capital business was suddenly booming because the number of potential investment targets kept increasing, and more resources flowed into venture capital funds. Simultaneously, valuations of Internet and technology companies rocketed worldwide (Figure 1.1).

It appears that valuations of early stage technology companies have mirrored the Nasdaq index quite directly.[8] The technology boom reached its peak on the Nasdaq in early 2000, but it was soon followed by decreased valuations of start-ups, also in Finland. Many Internet ventures collapsed around the world as funding was almost entirely cut off. More technology-oriented companies were better sheltered by their more tangible core competence.

It seems that Finnish technology companies overcame the downturn better than, for example, their Swedish counterparts. This might be due to the fact that Sweden was a little ahead of Finland in starting aggressive Internet ventures, such as *boo.com* that later collapsed with major casualties. In Finland, new ventures were in most cases more technology-driven and, thus, less affected by the Internet hype. It was finally realized that a patented technological solution was usually worth more than a mere domain name.

Although equity investors became more cautious and started investing more selectively, many investments were still being made in Finland during the latter part of 2000. It was not the end of the high-tech and venture capital industries, but rather a play-off for start-ups as well as for investors. Yet, play-offs are not over. Many start-ups are still refocusing their business plans, and the Finnish private equity market is under intense consolidation. It is likely that during the next year some investment companies will strengthen their position through mergers, while some others will withdraw entirely from the business.

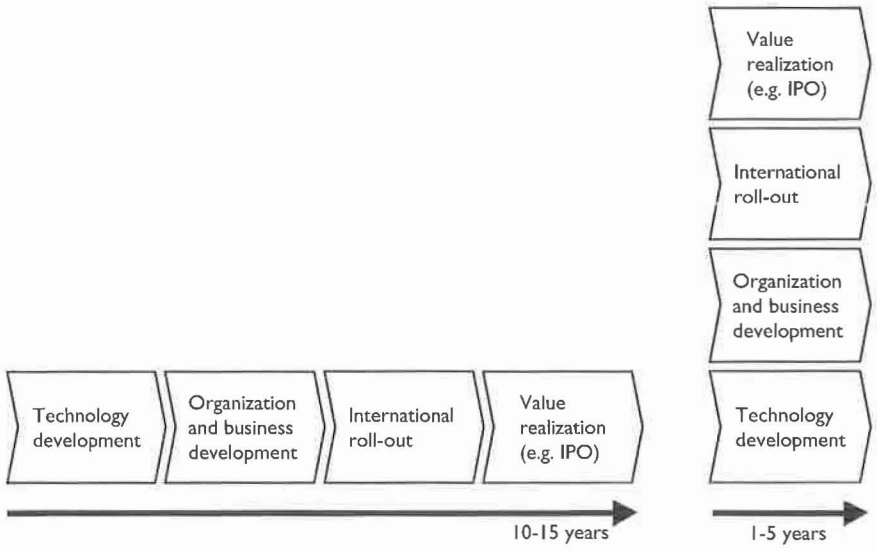
2. EVOLUTION MODEL FOR A TECHNOLOGY-BASED NEW COMPANY

In the traditional view, the evolution of a technology-based new company is seen through separate consecutive stages. First the technology is developed, which is followed by the setting up of the organization.

Once the organization has reached a sufficient scale, internationalization is started. Finally, the value of the company is estimated, usually at the point when preparation for realization, either through an IPO or trade sale, begins.

Since the time-to-market of a new product has shortened, and consequently, the growth of business needs to be accelerated, the traditional view is challenged (Figure 2.1). The step-by-step model no longer applies to high-tech firms. New companies have to be fast moving, and develop all business processes simultaneously to outrun competition.

Figure 2.1 Traditional vs. new model



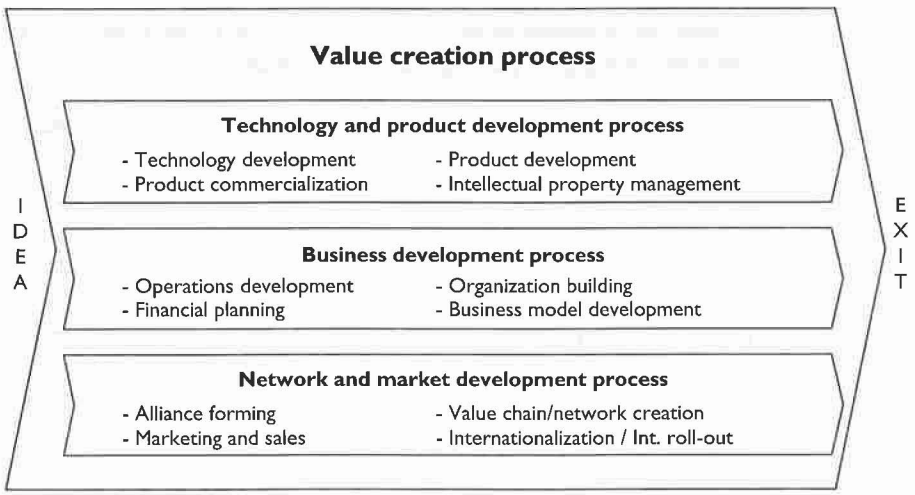
In order to better understand and assess the structural change in the development process, a generic evolution model is introduced. The model, illustrated in Figure 2.2, describes the development path from the initial business idea to exit, and demonstrates realization of the value of the company. Exit refers to investors' withdrawal of ownership, usually through an IPO or trade sale. In some cases, the entrepreneur has also a possibility of a partial or full withdrawal of ownership.

The backbone of the model is the value creation process, upon which three other core processes of a technology-based new company are installed. The value creation process is considered the main process

since it is, or at least should be, the ultimate target of any venture. The value of a company is also one of the only objectively measurable parameters useful in describing the development phase of a new venture.

The three other core processes, i.e., the technology and product development process, the business development process, and the network and market development process, each have distinctive measurable milestones. Some of these milestones are fully or partially dependent on each other. Milestone achievement in any of the core processes has a direct or indirect effect on the main process, i.e., value development. For example, before completing the first version of a business plan, i.e., meeting one of the early milestones of the business development process, it is almost impossible to get seed funding, which is, in turn, one of the milestones of the value creation process.

Figure 2.2 The evolution model for a technology-based new company



The overall goal in introducing the model is to concretize the interdependence of all actions performed in a technology-based new company, and underline the fact that all actions have either direct or indirect effects on the valuation of the company. The model also allows us to compare companies in terms of mode of operation. The order of milestone achievement tells us whether the company is technology, business, or market-driven. The purpose of the model is also to draw the attention of, for example, a technology-driven company to other processes. All four core processes of a technology-based new company are further discussed in the following. The model is also used to analyze the case companies presented in this study.

2.1. Value creation process

The value of a new venture is derived by discounting predicted future cash flows to the present. The discounting factor depends on the probability of returns. Even if a company has significant potential future cash flows, the risk of failure decreases its net present value. As the company proceeds towards profitability the likelihood of success increases, and the value of the company grows. Thus, it can be argued that every step a company takes towards its goals increases its value.

Since new ventures are not publicly quoted, the value of a venture cannot be exactly determined at every point in time. Instead, it is determined at each transaction where shares of the company are exchanged for money or other financial instruments. Most common transactions are equity injections by private equity investors, but mergers and acquisitions conducted through exchange of shares are also typical points of venture valuation. However, in case of share exchange the monetary price is not absolute, but rather relative to the valuation of the other party involved in the transaction.

Due to the increased complexity of products and services, time-to-market tends to lengthen. In order to maintain sufficient resources until the company reaches profitability, external financing is needed. The time needed in turning a company's cash flow positive varies considerably. A long product development phase and slow market penetration prolong the period of negative cash flow. Simultaneous internationalization drains resources at an even higher rate. Since start-ups do not usually have collateral to secure bank loans, equity financing is the most evident form of financing. Venture capital funding is usually sought in order to get business development support in addition to plain financing.

Financing is usually raised in several different financing rounds. Table 2.1 represents the most common rounds with indicative valuations and investment sizes. Typically, companies utilize only a part of the acquired financing. For example, after a large business angel investment, many companies aim directly at the first venture capital round. The number of venture capital rounds depends on the capital need of a particular company.

Exit valuations of technology companies are dependent on the prevailing market situation. Because the presumed exit valuation is the most important measure when considering the value of a company at

Table 2.1 Typical financing rounds of a technology-based new venture

Milestone	Indicative valuation range, million euros	Indicative investment range, million euros
Founding, establishing legal form		0,008 – 0,1
Business angel investment	0,02 – 1,5	0,01 – 0,2
Seed investment	1 – 5	0,1 – 1,5
1st VC investment	3 – 15	1 – 4
2nd VC investment	8 – 40	3 – 15
3rd VC investment	15 – 200	10 – 50
Exit	20 – 500	

the last venture capital round before an IPO, it is obvious that exit valuations have significant effects on valuations at all investment rounds, although the effect diminishes towards the founding stage. Due to recent dramatic changes in exit valuations, there has been wide variation in valuations at various venture capital rounds, as well.

In what follows, the selected key milestones[9] used in case analyses are introduced and specified. The milestones are presented in indicative order. A more detailed list of the most common milestones is provided in Appendix I. The key word for later reference to the milestones is presented in parenthesis after the milestone title.

2.2. Technology and product development process

The technology and product development process consists of functions aiming at creation, development, and commercialization of products and services. It also includes intellectual property rights management as this is, or at least should be, an integral part of a company's R&D functions. The starting point of the technology and product development process is in the emergence of an idea, and its formulation to the initial product concept.

Box 2.1 Key milestones in the technology and product development process

Technology / product patented (PATENT). The company is granted its first patent, or the company has been able to exclusively license an existing patent.

Prototype / demo publicly announced, so-called alpha-phase (PROTO). Giving the first public demonstration of a product, service, or functioning prototype. This development stage is commonly noted as the alpha-development phase.

Trial / pilot with customers, so-called beta-phase (PILOT). Piloting the product or service launch to a selected or limited group of trial users. This development stage is commonly noted as the beta-testing phase.

Product ready for shipping (PRODUCT). The product includes at least the minimum functionality that the customer demands. The ready-to-ship product needs to also have the appropriate manuals, packaging, and installation or deploying instructions. The product is considered ready-to-ship, when it can be released to distribution channels without major difficulties.

Income from products (INCOME). Company receives payments from customers in exchange for products or service products. Payments for project work or (highly) customized services are not considered as milestone achievement. Venture capitalists often refer to this milestone as the 'proof of concept'.

2.3. Business development process

The business development process includes the following functions: operations development, organization building, financial planning, and business model development. In other words, the process includes both planning and execution of a company's internal functions, excluding only the technology and product development related functions. As the business development process is initiated at the emergence of a business idea, the process starts with a business-planning phase. Latter milestones focus more on execution and organizational development issues. Mergers and acquisitions are left out from the model due to their occasional nature.

Some of the milestones refer directly to the internationalization of the company, or to gathering resources for internationalization, such as hiring a foreign manager. It seems that companies with vast international resources in the early phases of the process are more likely to succeed in internationalization. In the Finnish case, internationalization is vital for the growth of a company due to the small size of the home market.

Box 2.2 Key milestones in the business development process

Initial business plan (PLAN). The first written documentation, describing the business idea on a rough scale, is completed.

Founding (FOUNDING). Establishing the legal form of the company. The milestone refers to the contractual establishment of the company rather than the filing date of register authorities.

Own premises (OFFICE). Moving into own premises.

Management team hired (MANAGEMENT). This milestone is considered achieved when four out of the following six positions are fulfilled: General manager, Financial manager, Sales and Marketing manager, Technology manager, Human resource manager, and Business development manager. Naturally, the management team can always be strengthened, and thus, is never 'complete'.

First foreign member of the management team (INT. MANAGER). The first foreign is manager appointed.

Team size of 10 employees (TEAM OF 10). The number of the personnel reaches ten.

First foreign member of the board of directors (INT. BOARD). The first foreign member is appointed to the board of directors.

Team size of 30 employees (TEAM OF 30). The number of the personnel reaches 30.

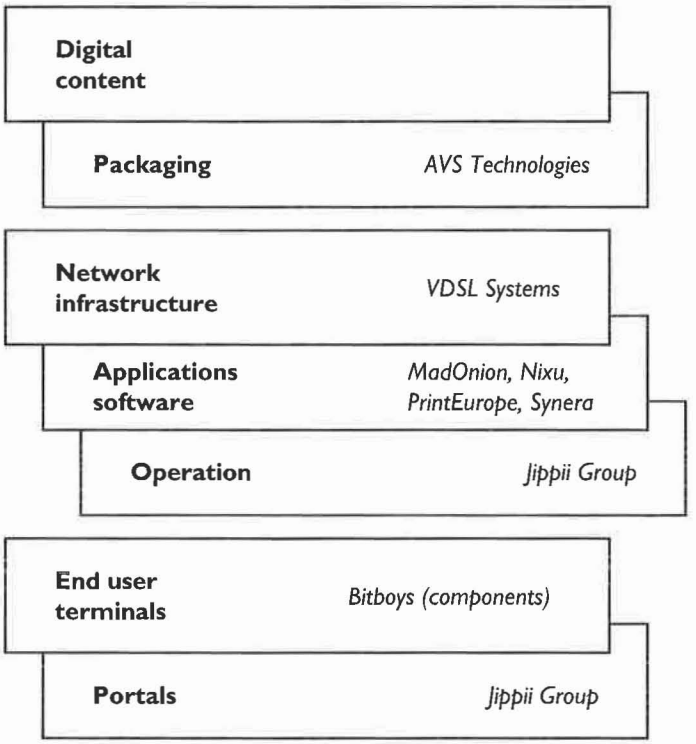
Operations in multiple countries (INT. ORGANIZATION). The company extends its operations to one or several other countries. Operations include, at minimum, hired personnel and own premises.

3. CASE DESCRIPTIONS

3.1. Positioning of the case companies

The case companies for this study were selected from the Finnish ICT cluster. Our goal was to have a sample representing different areas of the cluster, while at the same time, representing companies with different backgrounds. All case companies were relatively young, and apart from *Jippii Group*, privately owned. The age of the case companies varied from less than two to twelve years, while the average age was slightly above four years. All case companies were funded by venture capital, since they all were growth-oriented start-ups with a goal to develop international operations. Companies following a path of organic growth, and funded entirely by revenues were left out. The case companies are mapped on the ICT cluster chart provided in Figure 3.1 (compare with Figure 2.3 in Paija).

Figure 3.1 Mapping of the case companies on the ICT cluster chart



Because application software companies are the largest group in number in the Finnish ICT cluster, half of the sample represents this group. The selected application software companies function in different fields of software development: *Synera* is a pure software house, while *Nixu*'s offering is a mix of software products and services. *Printeurope* represents business-to-business Internet companies, whereas *Madonion* provides a more consumer focused Internet service.

3.2. AVS Technologies Oy

AVS Technologies develops next generation video distribution technology for both the wireless and fixed Internet. AVS's Java-based solutions work with standard Internet browsers without specific plug-ins. AVS is powered by its proprietary MVQ video codec, enabling fast decompression at the receiving end even with limited processing power.

Key Facts of AVS Technologies Oy

Website:	www.avstechnologies.com
Headquarters:	Helsinki, Finland
Founded:	11/1996
CEO:	Anttoni Vesterinen
Industry segment:	Video compression software
Employees (2/2001):	21
Owners:	Management team and investors
Investors	
Business angel rounds:	1996-1998 € 0,17 M Private individuals
Seed round:	11/1999 € 0,25 M Holtron
1st VC round:	5/2000 € 1,5 M Nokia Ventures
2nd VC round:	1/2001 € 6,4 M Zouk Ventures (UK) and Nokia Ventures
Subsidies:	-

Past

Mr. Antero Alvesalo, previously the head of Nokia's DECT-group, founded AVS Technologies in 1996 to pursue the opportunity in transferring still images over GSM data connections. The initial idea was to develop solutions for security services. Various surveillance applica-

Credits

The business case of AVS is founded on solid patented technology. The development of MVQ started in VTT as early as in 1991, and today, AVS has exclusive licenses for the technology. First AVS failed in introducing surveillance applications, but after restructuring and a complete turnaround in the business strategy, the company has now solid investors and resources for the product rollout.

Presently, AVS has a strong management team and all the ingredients for successful growth. AVS's MVQ technology is very competitive compared to its rivals, but large organizations, such as Microsoft, Apple and RealNetworks should not be overlooked. There are also a number of other video streaming solutions trying to make their way to Internet and mobile devices. AVS recently acquired its first pilot customers, but it has not yet generated any revenue.

3.3. Bitboys Oy

Bitboys is about to launch a revolutionary 3D graphics solution, based on unique processor architecture. Bitboys is a chip design company, using subcontractors for chip manufacturing. PC-card manufacturers, who distribute the commercial boards to consumers, are the targeted customers of Bitboys.

Key Facts of Bitboys Oy

Website:	www.bitboys.com
Headquarters:	Espoo, Finland
Founded:	1997
CEO:	Shane Long
Industry segment:	Semiconductors
Employees (2/2001):	25
Owners:	Management team and investors
Investors	
Seed round:	7/1999 € 3,0 M Infineon Technologies AG (Germany) and other industrial partners
1st VC round, step 1:	8/2000 € 3,7 M Conventum
Step 2:	11/2000 € 1,6 M Aboa Ventures II, Karhu Pääomarahasto II, and others
Subsidies:	€ 1,7 M Tekes, 1999-2000

Past

The original development team, the first 'bitboys', has its roots in a 3D processor and software development project started in 1994. The project was funded by industrial partners involved in the development work. Among other innovations the team developed an algorithm, which was later licensed to Microsoft to be a part of the DirectX standard. Bitboys Oy, in its current form, was founded in 1997, as the idea of launching a revolutionary 3D processor emerged. The unique processor design is based on an architecture that combines a compact and powerful 3D core with an embedded DRAM memory on the same microchip. This architecture, Bitboys Xtreme Bandwidth Architecture, enables the use of wide memory bandwidth between the core and the embedded memory, enabling a dramatic improvement in performance over the traditional 3D graphics technologies.

Until seed financing was received in July 1999, the company had been funded by the management team, and revenues were generated from project work for clients. As the company focused increasingly on developing a new 3D processor for OEM markets, the project business was run down during 1999. Bitboys received seed financing from its manufacturing partner *Infineon Technologies* and some other industrial investors. Professional venture capitalists were taken aboard rather late, in fall 2000.

Present

Bitboys is well on track to provide a functioning chip for the first pilot users at the end of 2001. With a dual chip configuration a capacity of 3 gigapixels per second will be reached and, with the increased memory bandwidth, a notable improvement in performance over traditional 3D graphics technologies will be achieved. To date, no competitor has announced any intentions of developing a product that would match Bitboys' processor in performance in the near future. Presently, Bitboys holds two patents and has applied for several more, which are related to solutions for managing the embedded memory and the 3D core.

Ultimately, the products will be also used in OEM markets, once the technology has been proven in the high-end gaming market. The total market for display adapters is in the range of 150 million units per year, of which the performance board market is roughly 5 million units. At the initial product launch, Bitboys aims at acquiring a 10-20 per cent market share of the performance board market, and later, extending to the whole display adapter market, and strengthening its po-

merger. The name of the company was changed to *Saunalahden Serveri* soon after. Acquisitions continued during the same year, totaling seven other ISPs. The transactions were funded by *Auratum*.

During 1999, Saunalahden Serveri extended its operations to other complementary business areas: telecommunications, wireless Internet, mobile and Internet portals. At the end of 1999, the company searched for a strategic partner for internationalization. As a suitable partner with complementary knowledge was not found, the management decided to seek public listing of the company.

Setting up of international activities started in March 2000, when a subsidiary was opened in Norway. Saunalahden Serveri was listed on the NM List of the Helsinki Exchanges in April with a market capitalization of EUR 280 million. Aggressive acquisitions continued after the IPO as operations were started in major European markets: the Netherlands in May, Switzerland in June, the UK in August and Germany in October. In October, the company changed its name to Jippii Group to better fit the internationalization of the company. The name Jippii had already been used as a brand name for the mobile portal.

Present

Today, Jippii is a fast growing European multiservice provider with a wide range of products and operations in 14 countries. After the IPO the company has acquired either the majority of the capital stock or purchased the business operations of the following operators: *Gigabell AG*, *MagicNet* and *Cross Telecom AG* in Germany, *Gigabell Ltd* and *Webleicester* in UK, *Mopos Sro* in the Czech Republic, *Gigabell Ibérica SL* in Spain, and *Supertel* with operations in Finland, Sweden, Denmark and UK. Major acquisitions in Finland include *NIC Tietoverkot* and *Cabinet Group*, which included the major domain name business *THK.net*.

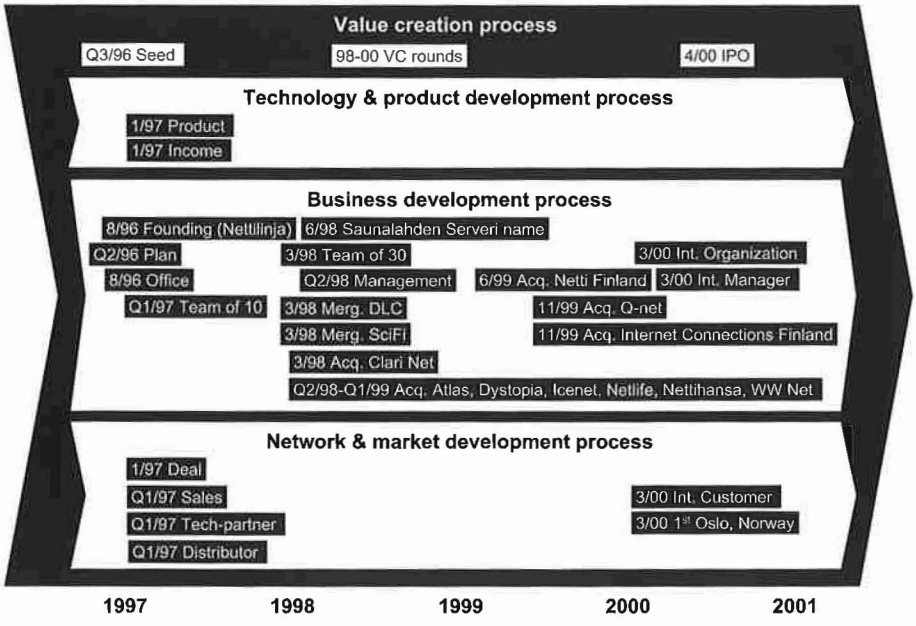
In 2000, the turnover of the Group was EUR 34,6 million with an operating profit of EUR 0,7 million. Since international operations were set up only recently, the majority (71 per cent) of the turnover still comes from Finland. At the end of the year 2000, Jippii was the second largest ISP in Finland with its 230 000 private and 35 000 corporate customers. In addition, by the end of February 2001, Jippii had already 35 000 GSM subscribers to its service opened just few months earlier. Jippii's Internet portal came (in early 2001) second in average page impressions, already ahead of *MTV3*, and just after *SoneraPlaza*.[10]

Credits

Today, Jippii is a very interesting mix of different communications businesses. Since the beginning, the company has been on a very fast growth track. Successful acquisitions have followed each other at a fast pace, first in Finland, and then in Europe. The Group plans to make half of its turnover abroad already in 2002. Jippii might be able to reach this goal, since its internationalization model seems to work well: a new market is entered by first setting up portal services for Internet and mobile users, and later, the business is extended to Internet service provision and GSM services over leased network capacity. More capital-intensive telecom and access services are offered once the brand is recognized in the market.

Although Jippii's share price fell soon after the IPO below the listing price, it has survived better than technology companies in general, thanks to the many growing business areas Jippii is involved in. The critique towards the company usually focuses on its "octopus like" organization: there appears to be no clear focus, and almost all new businesses are entered seemingly without hesitation. One of the recent projects, setting up an access network based on WLAN technology, was however spun off from other operations in February 2001. Ac-

Figure 3.4 Jippii Group

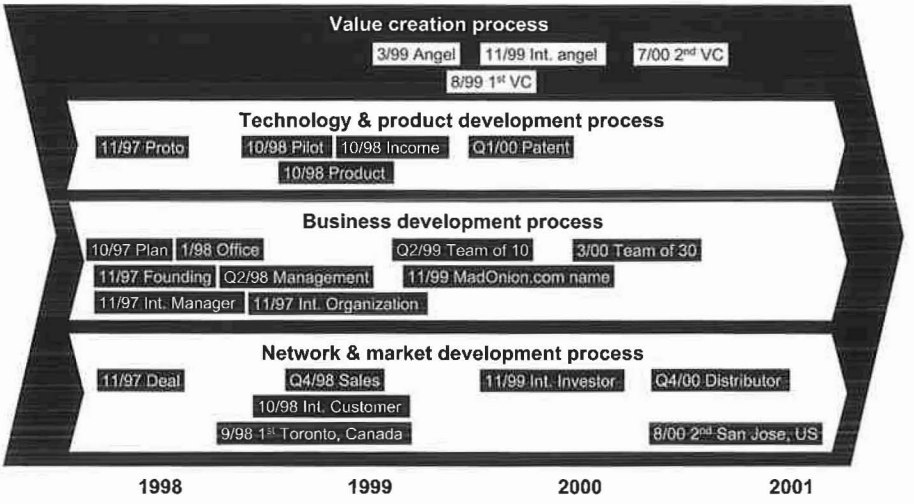


billion to USD 150 billion by the year 2005. The company plans to reach profitability during 2001. Madonion has offices in Toronto, Canada and San Jose, California in addition to its headquarters in Espoo.

Credits

Due to easy redistribution and illicit copying of the benchmark software, Madonion has not yet had a chance to fully capitalize the great success that its software products have received. Madonion has been constantly forced, but also able to refocus its distribution strategy and revenue model. The current model includes multiple revenue streams and is focused on business-to-business markets. As Madonion has been able to form strong partnerships with hardware manufacturers through its own beta development program, it is likely that Madonion will continue to dominate the 3D benchmarking software market with its US-based ally BAPCo. It will be interesting to see if Madonion will be able to capitalize the success of its products with its current revenue model.

Figure 3.5 Madonion.com



Madonion has been growing rapidly since its flying start as a spin-off of Remedy Entertainment. The internationalization of Madonion has been notably fast. Operations were started simultaneously in Finland and the UK upon founding the company, although the UK operations were later transferred to Canada. The successful early international rollout has clearly benefited from the international team of three foun-

ders with valuable industry connections. The fast internationalization has, however, been cash consuming, while revenues have remained modest. Success of the new business model in generating revenue will be critical for the future of Madonion.

3.6. Nixu

Nixu has solid technology know-how in network platforms and network security. Nixu focuses on products and solutions for the management of global mobile Internet infrastructure. Currently, Nixu is reshaping its offering to a more product-oriented direction with its flagship product NameSurfer, used to manage DNS data in large system along the new Content Billing Gateway products.

Key Facts of Nixu Oy

Website:	www.nixu.fi
Headquarters:	Helsinki, Finland
Founded:	11/1988
CEO:	Oiva Karppinen
Industry segment:	Internet / mobile Internet and data security services and software
Employees (1/2001):	85
Owners:	Personnel and investors
Investors	
Early emissions:	1988-1996 € 0,02 M Employees
Business angel rounds:	1997-1999 € 0,4 M Arto Karila, Peter Gylfe, and other private individuals and employees
1st VC round:	10/2000 € 1,2 M Stratos Ventures
Subsidies:	€ 0,14 M Tekes for NameSurfer since 1996

Past

Mr. Pekka Nikander, a student at the Helsinki University of Technology, founded Nixu in 1988. Operations were started by offering antivirus training. TCP/IP based Internet technologies were adopted as early as in 1990-91 as the first customer projects started. Although the company has been profitable since the beginning, its growth was relatively slow during the early years. The turnover of the company increased from EUR 0,2 million in 1993 to EUR 1 million in 1997. Mr. Oiva Karppinen was appointed CEO in March 1996.

During the 1990's, Nixu acted as a technology-consulting agency, offering custom-made solutions. The company has been closely monitoring the research and development activities and participating in the Internet standardization process. For example, Nixu has been involved in the Internet transport level cryptography development and standardization process (IPSEC). In 1996, Nixu founded *NameSurfer*, as a joint venture with *Akumiitti* and *Araneus,* and and was planning to spin off its first product innovation, used to automate the DNS data management. *F-Secure* (then *Data Fellows*) took on the marketing of the new product.

In the early years, sales to *Sonera*, then Telecom Finland, generated most of the revenues, but towards the mid-1990's, the number of customers increased steadily. A breakthrough was finally made in 1998, when Nixu closed a deal of EUR 7.2 million to set up a nationwide firewall for Saudi-Arabia to allow religiously and politically correct access to the Internet. Important deals with Nokia and *Ericsson* were made in the same year. The turnover of the company grew to EUR 2,3 million already in 1998, and to EUR 3,8 million in 1999.

Present

Nixu, by applying open source software, offers its customers reliable, low-cost, free-of-license software solutions that are independent of proprietary systems. However, Nixu is now stepping aside from the service business: in 2000, Nixu bought back the shares of NameSurfer from the other owners. The current plan is to merge NameSurfer to the parent company, and refocus the offering towards a more product-oriented direction. The share of product sales, 15 per cent in 2000, is targeted at 60 per cent in 2002.

Nixu offers infrastructure projects to customers in the Middle Eastern and European markets until the product-based business takes off. Nixu plans to utilize partners in distribution of its products. Office in Hong Kong was opened in the fall of 2000 to develop partnerships in Far East. Currently there are a few R&D projects in progress to complement the product offering. New service deals are signed selectively with key customers in order to maintain profitability also during the product development period.

Credits

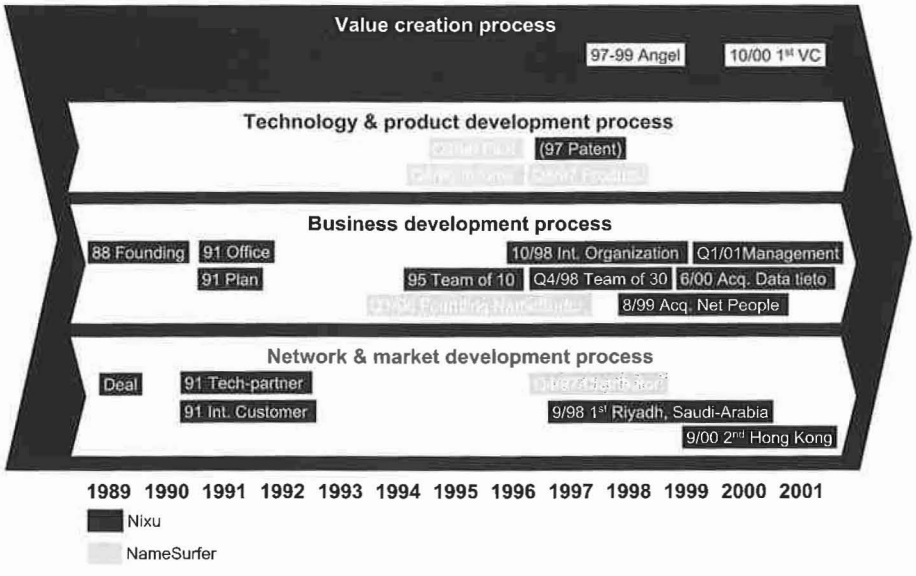
Apart from the leap in 1998, Nixu's growth has been organic and stable since the beginning. The acquisition of *Net People*, made in late-

1999, was followed by those of *Datatieto* and *Magic Cookie* in summer 2000. The growing number of staff, along with intensifying internationalization has had implications for Nixu's informal and democratic corporate policy, characteristic to the company's culture in its early years. The growth together with the undergoing change in the business strategy has called for restructuring of the organization. As the company is simultaneously aiming at a product-based business model, restructuring has been needed. A management team with dedicated responsibilities was appointed rather late, at the end of 2000.

Nixu's first product, NameSurfer, is very competitive in dealing with DNS management data. Thus, the future success of Nixu's product-based strategy depends rather on the organization's capability to reshape itself. Challenges lie in setting up an effective sales and marketing team as well as other functions supporting product sales.

In general, the evolution of Nixu differs from that of the other case companies. In the past, Nixu was a pure service company, while today, it is strengthening its product-based operations. However, the small size of the recent financing round, in comparison to Nixu's turnover, indicates that a turnaround in the business focus is likely to be slow.

Figure 3.6 Nixu



3.7. Printeurope.com (Printing Network of Europe Oy)

Printeurope acts as an intermediary between print buyers and printing houses. Solutions of Printeurope enhance communication between the two parties and simplify the traditionally complicated printing processes. By streamlining the process, the products of Printeurope save time and money, as well as increase accuracy by storing all print job information in a centralized location.

Key Facts of Printing Network of Europe Oy

Website:	www.printeurope.com
Headquarters:	Espoo, Finland
Founded:	12/1999
CEO:	Teppo Paavola
Industry segment:	Business-to-business Internet intermediary
Employees (2/2001):	21
Owners:	Management team and investors
Investors	
Seed round:	1/2000 € 0,4 M Holtron, Portal Equity and private individuals
1st VC round:	3/2000 € 1,4 M TransConnect (Germany), Innovations Capital (Sweden) and Conventum
2nd VC round:	1/2001 € 3,0 M Digital Mountain (Germany), BureEquity (Sweden) and existing investors
Subsidies:	€ 0,3 M Tekes 4/2000

Past

Printeurope.com was founded by an experienced management team in December 1999 in response to the growing need for a centralized co-operation network for the European printing industry. Printeurope aimed at offering a complete set of services for print buyers and printing houses, including collaboration applications and a market place for print jobs. Printeurope was set up to pursue fast and aggressive internationalization. The seed round and the first venture capital round were raised in the early stage to support rapid growth. In May 2000, Printeurope was chosen as the best European non-listed Internet intermediary out of 700 applicants in the e-challenge competition, the world's largest competition for Internet and wireless companies. In May 2000, Printeurope launched its service offering simultaneously in four countries (Finland,

the Netherlands, Sweden and the UK), and opened offices in Stockholm and Amsterdam.

The next financing round, considerably bigger than the previous, was planned to be completed during the summer 2000. Despite the flying start of their business activities, Printeurope faced major difficulties in negotiating the second venture capital round. The valuations of Internet start-ups had plummeted from their early-year levels. At the same time, attitudes had changed: what was considered a viable service launch in the beginning of the year was now, a few months later, considered a draining of resources. Thus, Printeurope, unable to gather additional financing at the end of 2000, was forced to reformulate its business model and delay its rollout plans. The planned opening of new offices in European cities was postponed, respectively. While the previously more Internet-centric business approach was redirected to a more software-centric model, the market place service was laid aside.

To date, Printeurope has entered into strategic alliances or co-operation with F-Secure, *Enfocus*, a PDF-software solution provider, and VTT (Technical Research Centre of Finland) in order to gain proprietary technology in addition to building its own technology team. So far, two patent applications have been filed.

Present

Currently, Printeurope focuses on capitalizing on an end-to-end solution for the printing industry, aiming at enhancing effectiveness and productiveness at both ends of the printing process. Rather than providing a market place, or acting as an intermediary, as previously, the focus of the company is now on the existing customer-vendor relationships between print buyers and printing houses.

Although customers are sometimes slow in adopting new services, Printeurope has succeeded in attracting a relatively a large number of customers. The challenge, however, is to convert the transactions into profitable business as the revenues so far have been very modest. At the moment, Printeurope enjoys at least a slight first-mover advantage over most of its competitors in Europe that still offer a market place-based solution. The US based rivals have been faster in moving towards collaboration with the software business. Depending on the definition of the business, there are tens of competitors in the electronic printing business, in which competition is fierce owing to the large size (EUR 160 billion in Europe), and traditionally inefficient functioning of the printing market.

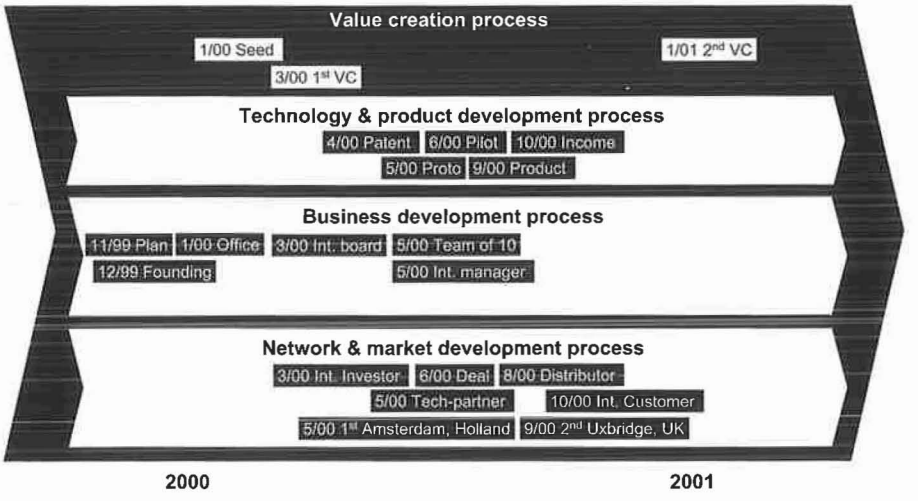
Credits

Printeurope.com is a perfect example of the sudden collapse of booming Internet businesses in late-2000. The prospects for the Internet-business were first overvalued and, soon after, devalued as the reality fell short of expectations. Printeurope was abandoned by investors when seeking additional financing in the summer of 2000. The importance of timing in acquiring financing could not be demonstrated more clearly. For example, a bigger first round financing in March 2000, when it was readily available, could have helped the company over the summer.

Because of the strong, skilled management team Printeurope was however, able to restructure the business and acquire further financing in the beginning of year 2001. On this context it is easy to see why investors put such a high value on the management team's talents. In a changing environment, the management team is one of the most important success factors for a new venture.

At the moment, Printeurope's future is heavily dependent on customer adoption. If the services are welcomed by customers, the company may be able to make profits in the near future. If the adoption is slow, Printeurope might again be in a tough situation. It should be noted that the current situation is already imminent, since milestone achievement has been extremely slow in the past few months.

Figure 3.7 Printeurope.com



3.8. Synera Oy

Synera is a software company that helps business service providers to expand their business with easy-to-use online applications directed to small businesses. By using Synera's products, business service providers, such as ISPs (Internet Service Providers), accounting agencies, insurance companies, banks, and business portals can provide their small business customers with applications that can be easily and safely used via Internet terminals and smart phones.

Key Facts of Synera Oy

Website:	www.synera.com
Headquarters:	Helsinki, Finland
Founded:	1990
CEO:	Markus Tarkiainen
Industry segment:	business application software
Employees (2/2001):	14
Owners:	Management team, board members and Holtron
Investors	
Seed round:	4/2000 € 0,25 M Holtron
Subsidies:	€ 0,22 M Tekes 5/2000

Past

Mr. Markus Tarkiainen, the founder of Synera has been working on business process modeling since 1997. Although the company was registered already in 1990, the business idea of Synera clarified in late 1999. In May 2000, Synera received seed financing from Holtron to fund product development and starting of operations.

Since May 2000, Synera has been focusing on providing small companies with business applications delivered via ASPs (Application Service Providers), which host the service logic in their servers. The end customers use the services via Internet terminals and smart phones. In order to provide a complete offering, Synera started simultaneous development of its service platform and the first set of applications. The first applications include time tracking, invoicing, and catalogue software. At a later stage, ledger, e-payment, workforce management, and eCRM (electronic Customer Relationships Management) applications will be added into the service palette in cooperation with third party application providers.

In addition to Synera's own applications, third party application providers are encouraged to use Synera's platform. Synera has already attracted a few application developers to use its platform in offering their solutions through the ASP business model. In the future, Synera's goal is to focus entirely on the development of the platform, and let third party developers take care of application development.

Present

To distribute its services Synera needs to partner with ASPs (e.g., ISPs, accounting agencies, and business portals), which are needed in providing servers for application hosting. Consequently, right kind of ASP partners are essential in attracting end customers. With the advent of the Web browser as the universal client interface, the ASP market is expected to grow rapidly during the next few years. In spite of high expectations, the ASP business has taken off slowly.

However, once customers become familiar with the ASP concept the market is expected to pick up fast, especially in the small business segment. It is far more cost-efficient for a small company to pay per use or per month for application software, rather than acquire costly licenses.

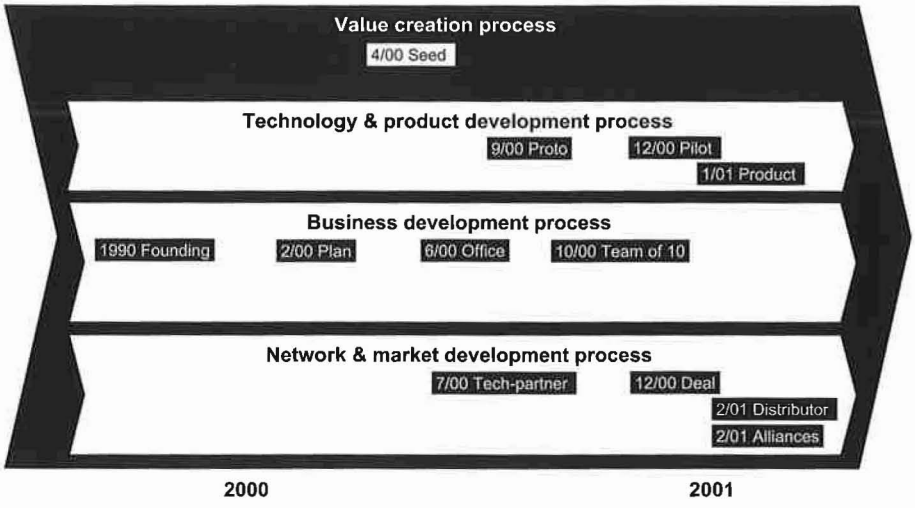
At the moment, Synera is piloting its first applications. As negotiations for distribution agreements are in progress, the first payments for products are in view. Synera is also moving to the wireless space: Synera's first application, the time tracker, is already able to combine the use of the Internet and mobile devices. For example, after a client-meeting working hours are input to the time tracker via a mobile phone. The data can be then viewed and processed by browser-based tools.

Credits

Synera has been able to come out with the proposed services on schedule. Synera's know-how in its field of technology is strong. A few third party applications developers are working on services utilizing Synera's platform. These are for example *Rex Partners* working on workforce management, *Fivetec Solutions* developing an Internet based Customer Relationship Management (eCRM) software, and *Done Logistics*, working on a financial administration application.

The main challenge for Synera is to justify using ASPs to distribute its service product. Potential service providers, end customers, and even future investors have to be convinced of the business model since it has not yet been widely adopted. If/when the ASP business takes off, it is most likely that Synera will be well positioned in the market.

Figure 3.8 Synera



3.9. VDSL Systems

VDSL Systems specializes in developing VDSL products for IP networks. The product range includes VDSL office routers and modem interface cards. These products allow fast (up to 29 Mbps) Internet and other IP-based connections over ordinary (copper pair) telephone lines. VDSL Systems' products and solutions are flexible, easy-to-manage and based on the industry standard VDSL technologies.

Key Facts of VDSL Systems Oy

Website:	www.vdslsystems.com
Headquarters:	Espoo, Finland
Founded:	1/1999
CEO:	Jussi Autere
Industry segment:	Access network hardware
Employees (2/2001):	48
Owners:	Management team, Applied Computing Research ACR Oy and investors
Investors	
Seed round:	2/2000 € 1,1 M 3i Finland (former SFK finance)
1st VC round:	6/2000 € 1,5 M Kennet Capital (UK), 3i Finland
Subsidies:	€ 0,45 M Tekes 2/1999

Past

Clinet, one of the small Finnish Internet operators, pioneered Internet connections, based on the ADSL (Asynchronous Digital Subscriber Line) technology in the early 1990s. Soon after the initial ADSL project, Mr. Heikki Suonsivu, chairman of the board and Chief Technology Officer of Clinet, was working on new fast-access technologies. Because developing communications equipment was not a part of Clinet's core business, Mr. Suonsivu decided to start a separate company to pursue the opportunity in developing products based on VDSL (Very high speed Digital Subscriber Line) technology.

Together with the main software architect of the VDSL products, Mr. Tatu Ylönen (owner of *Applied Computing Research*), and Mr. Juri Sipilä (current manager for hardware design in VDSL Systems), and Mr. Suonsivu founded VDSL Systems in January 1999. During the

next fall, VDSL Systems introduced prototypes of VDSL modems and routers for the new product line, named as Ivalo Rapid. VDSL Systems was the first company to offer pure IP-based VDSL hardware that supports traditional phone lines and integrates into IP, ATM, Ethernet and Optical networks. The VDSL technology offers the fastest possible data transmission speeds (3 – 29 Mbps) over existing copper telephone lines without the need for rewiring. With an effective range of 4 kilometers, VDSL Systems' products offer the most flexible approach to new network design and existing network upgrading. Using pure IP traffic simplifies both the hardware and software architectures, and lowers overall costs.

Present

VDSL Systems was ready to pilot its products in the summer of 2000, and shortly after, it received further financing. Since then, the company has been growing rapidly; and has acquired its first customers. The current product line is targeted to business customers, while a low-cost version is under development to penetrate the consumer market later on. VDSL Systems aims at serving telecom, Internet, and cable service providers in Europe, Asia and the US.

The company also expanded its operations to Korea in order to manage more effectively its contract manufacturers. Sales offices have been opened in Denmark and the US. The company plans to reach profitability during year 2002, and is currently looking for further financing to support its international rollout.

Credits

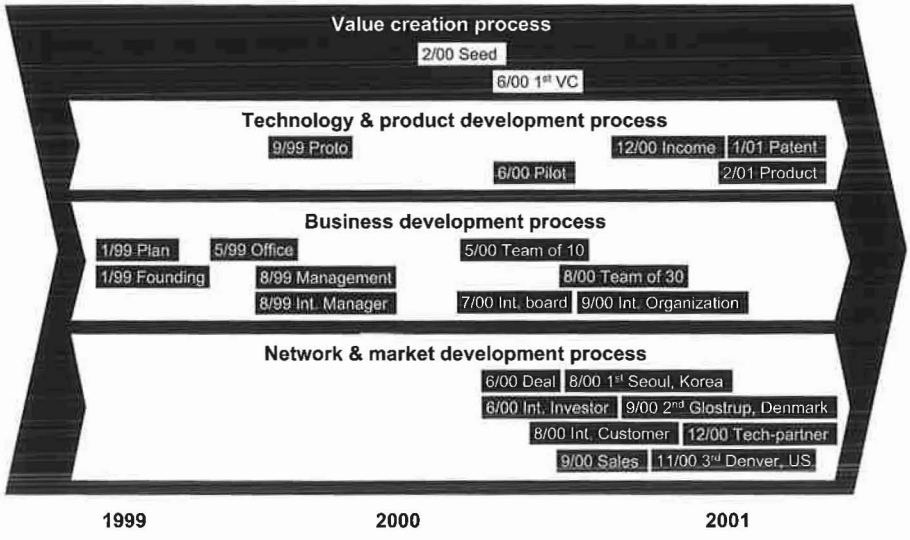
Use of the ADSL technology has already proven the business concept for using other DSL technologies. Although the VDSL data business is expected to grow rapidly during the following years, the market (estimated to grow to EUR 10 billion by 2003) is not very attractive. Margins of fairly standard hardware are relatively low, and existing producers of ADSL solutions are eventually extending to VDSL and other DSL technologies.

Yet, there is a good chance for VDSL Systems to achieve significant revenues: the company is one of the pioneers in VDSL solutions with solid know-how and several patented innovations. However, gaining and maintaining a share of the rapidly growing market demands effort. To date, VDSL Systems has shown that it is well-managed, can

achieve fast growth, and it has been able to make agreements for co-operation with major industry players, such as *Flextronics*, for manufacturing.

The ability to acquire customers and extend operations to several foreign countries during its second year of operation is a remarkable achievement for any start-up company. The future of VDSL Systems is, however, strongly dependent on the prevalence of the VDSL technology. VDSL is the fastest DSL-based technology, but not yet widely adopted.

Figure 3.9 VDSL Systems



4. SUMMARY OF CASES

4.1. Patterns of evolution

Each of the case companies has followed a unique development path. However, rough generalizations of the patterns of evolution can be made. Rather than comparing the achievement of specific milestones, different evolution patterns can be detected by focusing on the overall development speed of the companies and their main processes, i.e., milestone density, over a given time period. Two groups can be distinguished: a group of more technology-driven companies, and that of more market or business concept-driven companies.

The group of technology-driven companies consists of AVS Technologies, Bitboys, Synera, and VDSL Systems, while the companies regarded as more market or business concept-oriented are Jippii Group, Madonion and Printeurope. It is hard to categorize Nixu in either of these groups due to its long history in the service business, and the recent turn towards a product-based business.

Looking at the evolution patterns of the technology-driven companies (see the figures in the case descriptions), similarities can be found: the milestone achievement density in the technology and product development process is relatively low, and milestones are achieved during a short period in the late stages of the process. This is a sign of the long time required in the development of technology. Another notable characteristic is delayed progress in the network and market development process, accompanied by gradual progress in the business development process. This, in turn, is explained by the need to develop the organization piecemeal, along with the product development process. Network and market development is delayed in order to minimize overhead costs. In the case of AVS Technologies and VDSL, the eve of a full-scale product launch is distinguished by intensifying the market development process by extending operations to foreign markets.

The case of Synera is clear. Since the company is rather young, most of the milestones loom in the future. However, the company is approaching the expansion stage as indicated by the constantly rising density of milestone achievement. Bitboys, in turn, due to its exceptionally long product development cycle, is not yet close to its product launch. However, Bitboys has already started network and organization building with the help of venture capital backing.

The principal characteristic of the market and business driven companies is the fast introduction of their products, combined with simultaneous, quick progress in other processes. In short, all processes are aggressively pushed on with strong venture capital backing. Business concept-centric companies benefit usually from being the first in the market. For example, Madonion and Printeurope both raced against time, yet, their speed slowed down considerably with the cooling off of the Internet boom. Jippii Group had a similar flying start for its business. In this case, the development of the business took place first in the domestic market. Internationalization was scheduled for the time of the IPO of the company. Despite its courageous acquisition strategy, the speed of internationalization was modest until the IPO, after which, the pace of acquisitions of European operators, and starting of operations in foreign markets has been fast.

4.2. Venture capital accelerates milestone achievement

In all of the cases milestone achievement has intensified after the initial external funding, and, similarly, additional financing has further accelerated the pace of development in the majority of the cases. Obviously, the enhanced financial situation of the externally funded companies has aided the milestone achievement, but according to the case evidence, there is more to venture capital than just money. Some of the central aspects concerning the development of a venture capital-backed company will be discussed next.

Venture capitalist as an agent of change

Growth companies are every once in a while faced with situations where radical changes are needed. The most common changes are: 1) moving from an R&D-driven mode of operation to a business and marketing driven mode, 2) moving from a project-based service business to a scalable product-based business, and 3) moving from domestic sales to international sales and operations. Most of the time, these changes are hard to implement since they demand changes in the whole organization, including the top management.

In order to implement radical changes, a change agent is needed. A venture capitalist with a fresh outside view and proper authority in the company, usually through a board seat, often makes a good agent of change. The primary interest of venture capitalists is to increase the value of the company by developing it further. Thus, to arrive at this

goal, it is sometimes necessary to change the top management, rather than risk the future development of the target company.

AVS Technologies is a perfect example of using venture capitalists as a change agent. At first a seed investor was brought in to turn the company from an R&D-focused organization into a product-based business. Soon after, further financing was raised from an international investor, Nokia Ventures, to help the company in internationalization. The case of Nixu, in turn, is an example of a turnaround from a project business to a product business. A venture capitalist was taken aboard after a long track record without a need for external financing. Similar strategic changes taking place shortly after a new investor has entered the company can be identified in most of the cases.

Credibility through venture backing

Most start-up ventures carry high risk, and have a relatively short track record as an individual company. From this perspective, it is obvious that there are potential customers hesitating to count on start-ups as critical suppliers of products or services. Similarly, potential employees may also doubt applying for a job in a young company operating in a volatile market. Trustworthy, globally acknowledged investors backing a start-up can, in many cases, improve the situation.

For example, after receiving financing from Nokia Ventures, AVS Technologies started attracting new jobseekers in an entirely new manner. The increased credibility of AVS Technologies was noted by investors, as well: many international investors started showing considerable interest towards AVS Technologies right after Nokia Ventures' investment. In short, a well-known venture capitalist backing a start-up improves the company's credibility when it approaches partners of any kind.

Venture capitalist as a business consultant

New ideas and creativity are necessary in setting up a new business, but once the business idea is to be sold to various interest groups, including investors, partners, employees, etc., consistency and clarity in the formulation of the business plan is important. Moreover, clear focus is crucial for target-oriented business development. Based on their experience, venture capitalists can often offer entrepreneurs the needed outside view in screening their ideas, and helping the company to focus on the right issues.

Venture capitalist mindset

As indicated earlier, the sole underlying objective of a venture capitalist is to earn return on an investment. In other words, venture capitalists look for businesses with high potential for value creation. The key issues contributing to the value creation potential of a firm include:

1) The company operates in, or plans to move into fast growing markets.
2) The company has a sustainable competitive advantage over its rivals, for example, unique technology, a patented solution, and/or proprietary knowledge.
3) The business model of the company is scalable and the company has a clear growth path.
4) The management of the company is capable of making results.

When considering the case companies, it is rather easy to pinpoint the factors that have attracted venture capitalists. For example, in the case of Bitboys, the company had unique technological solutions that could be applied in building products for a fast growing market. In the case of Jippii, it was the vision and growth objectives of the management team that assured the investor.

Many businesses do not have the characteristics venture capitalists are looking for. On the other hand, businesses generating revenues may be able to grow organically, and thus, do not necessarily need external funding. Nixu, for example, had been able to operate with its sales revenues for seven years. It could have continued the same way, but the strategic decision to move to a product-based business was coupled with venture capital financing.

Pitfalls of venture capital

Sometimes venture capital can work against the timely realization of sales revenues of an R&D-intensive product. When a company focuses on product or service development under venture capital funding, the pressure to close deals and generate revenues may be actually decreased. If the entrepreneur decides to extend the product development phase to fine tune the product, rather than aggressively go after sales with the already functioning product, the company is on a dangerous track. Although external financing can be of great help for a company in funding product development, it is the sales revenue, not external financing, that fuels the company in the long run.

4.3. ICT cluster supports new ventures

The ICT industry enjoys a very dynamic business environment due to several factors:

- early deregulation of the telecommunications market
- fast development of technology, led by Nokia
- fast growth of the wireless subscriber base
- high level of technological education
- favourable government policies.

The conditions have been beneficial to numerous small technology-based companies that have been able to develop in an environment of advanced technology, and a market able to quickly adopt new technologically advanced services and products. Despite the small size of the Finnish economy, the wireless service market has reached a comparatively large scale, enabling pilots of new wireless services ahead of the rest of Europe and the U.S. The market has also attracted numerous foreign companies to test their new services and products.

Despite the prevailing favorable conditions, the Finnish ICT cluster is young. There is a relatively large number of start-ups compared to publicly listed technology companies. Moreover, there are only a few internationally recognized technology companies. Nokia, Sonera, *Instrumentarium* and *Bionx* are the only Nasdaq-listed companies originating from Finland, while Israel, for example, has produced more than one hundred companies quoted on Nasdaq.

However, there are many Finnish companies about to make their debut in international markets in the near future. F-Secure, *Comptel* and *Stonesoft* are examples of companies with a fast growing share of foreign sales. According to American venture capitalists, it takes USD 30-50 million to build a globally operating software company. Keeping in mind the recent investments in Finnish start-ups, i.e., Solid, Riot and Digia, it is fair to say that a new generation of Finnish companies is well on the way towards international rollout.

Apart from Jippii Group, all of the case companies presented in this report represent an even younger generation of internationalizing Finnish technology companies. A notable fact is that this generation is by far the largest in number. According to the cases, there are several cluster-related reasons for the successful development of these new start-up ventures:

Support for technology development

Tekes, the National Technology Agency, is the major contributor to technology development projects. Most of the case companies had received subsidies from Tekes for their technology development projects. A few companies found Tekes funding critical to their entire existence: without subsidies the technology development process would have been too risky to enter.

International network

More than half of the case companies stated that an international support network had or would have helped their initial steps in the internationalization process. Some case companies had found FINPRO very useful in assisting with legal formalities, such as work permits and licenses, as well as in providing basic information on a foreign location. Some of the companies would have needed similar assistance, but were unable to find it.

Cluster synergies

Almost all of the case companies had directly benefited from other companies within the Finnish ICT cluster. Forms of synergy are listed in the following:

- Finland has an advanced infrastructure for testing and piloting new products and services. For example, Finland's wireless network infrastructure is one of the most advanced in the world.
- Pilot customers for advanced business-to-business services and products exist in the home market.
- Competitive subcontractors and suppliers are readily available in the home market providing favorable preconditions for strategic partnering. The complete offering can be delivered to customers in co-operation with domestic partners.
- Some of the Finnish technology companies are already well networked internationally, and are thus able to provide important connections to their domestic partners.

Other indirect benefits of the Finnish ICT cluster experienced by the case companies include:

- Finland is internationally recognized as a producer of high-technology products and services. This helps Finnish technology start-ups to get in negotiations with international parties.

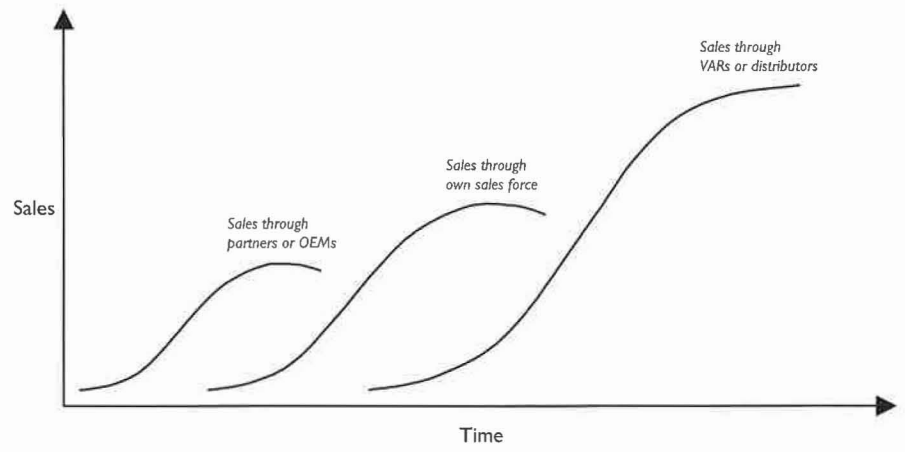
- Finland has proven itself as an interesting market for foreign venture capitalists.
- The existing success stories attract talented people to the cluster.
- The available workforce with advanced know-how in technology meets start-up companies' special needs.
- Services and support programs tailored to the needs of technology-based new companies are already widely available in Finland.

A few of the case companies have participated in business development and networking programs organized by *SPINNO Business Development Center*, a partly publicly funded institution. All participants found the program useful in terms of networking with other companies and financiers.

Sales and marketing support

In the case of a technology-based new company, credibility plays an important role in new client acquisition. Although a new company might be able to attract customers in its home market, it is much more difficult to assure foreign customers. Sales partners and "door openers" with local connections have helped some of the case companies in acquiring the first foreign customers. For many, OEMs (original equipment manufacturers) have proven workable marketers of their products with yet non-established brands.

Figure 4.1 Conceptual model of developing sales channels



Once companies have international references, their own sales efforts start to generate results. As illustrated in Figure 4.1, the use of Value Added Resellers (VARs) and distributors usually follows success in the company's own sales efforts. When the company's offering is well known, markets start to demand or "pull" the products. Resellers and distributors can then be utilized to enhance distribution.

Box 4.1. Key lessons learned

Building a start-up company is a complex and demanding task, the critical concerns of which are mostly case specific. However, a few general pieces of advice for future entrepreneurs can be given. The rest is learning by doing.

Keep a tight focus
A start-up always has limited resources. Keeping the focus on the most critical issues increases the probability of attaining the set goals.

Stick to your plans and visions
Business prospects in a technology market can fluctuate widely. Do not always believe the hype. Things that are hot today may freeze almost the day after. It is worthwhile to stay alert, but it is important to let your own plans and visions, rather than the latest trends, guide you.

Revisit your revenue model
As your target markets change, the business and revenue models should be thought out again. The ability to change the business model along with changing markets is vital.

Push the sales
Venture capital funding is not the only source of cash for a start-up company. Being able to generate sales in the early stage of development provides extra revenues, but more importantly, gives a signal of future success. It is far easier to attract further financing once your business concept has been proven by paying customers.

Build the network
Try to network with as many other companies as possible. According to the case entrepreneurs, the benefits do not necessarily always show up immediately. But wait for the day when you realize that your classmate from start-up crammer is your best customer. When building your network, remember that individuals are more important than organizations.

Prepare for failures and delays
Everything will not go as planned. Always be prepared for failures and delays. It is important to be able to fail in the best possible way, once the failure is inevitable. All agreements are possible failures. Make contingency plans once the primary plan is ready.

Timing is crucial
As markets for new technology are prone to sudden changes, it is important to be in the right place at the right time. For example, fund raising during the Internet hype was a lot easier than just a few months later. Taking advantage of the situation makes huge differences.

Make an exit plan for the investors
When seeking investors, it is important to have a ready exit plan for them. The companies that are able to convince investors of realistic exit plans are at the top of the their deal-flow lists.

Be persistent
Regardless of the situation, it always pays to be persistent. If you keep your faith in a better future, it is easier for others to believe in the company as well.

4.4. Discussion

Finland, as one of the smallest industrialized economies, has been able to produce an international market leader, Nokia, in the demanding mobile telecommunications business. What are the chances that the Finnish economy can create another such company with global recognition?

Traditionally, most of the large global ICT companies have been US-based, enjoying a large home market advantage that enables them to grow large before entering international competition. Industry analysts have suggested that, since the US market is the world's biggest market, the leader in the US will most likely be the leader in the global market, as well. Software companies, such as Microsoft and *Oracle*, are good examples of this view. Similarly, Japanese and German companies have utilized their large home markets to become global companies.

Among smaller economies, Israel has been very successful in producing internationally recognized companies. The Israeli model can be summed up as follows: 1) First technology is developed and piloted in the small home market. 2) At the rollout phase a sales office is opened in the US market. 3) Once international sales have taken off, the headquarters are moved to the US. 4) By the time of public listing, the company is entirely US-based, possibly with some R&D activities remaining in Israel. So far, there are more than one hundred Nasdaq-listed companies with Israeli origins.

In the light of the US and Israeli models, the history of Nokia is very special. Although the company is operating globally in dozens of locations, and more than 90 per cent of the shares are in foreign ownership, it is still in essence a Finnish company. The headquarters are in Finland, the top management is mostly Finnish, and 40 per cent of the employees are working in Finland. According to the case companies, Finland's small, but adaptive home market, along with the advanced ICT cluster, forms close to an ideal launch pad for new technology start-ups. Due to the small size of the home market, it is impossible for Finnish companies to grow to world-class measures without expansion to foreign markets. Any universal model for successful internationalization has still not been discovered for Finnish start-ups. Would it be possible to follow the path of Nokia, or should a company go abroad pursuing the Israeli model?

As national economies globalize gradually, it might be possible to Nokia's model in internationalization, i.e., to build an international organization gradually extending to new markets, but with headquarters and key activities remaining in the country of origin. However, the Israeli model might also be a viable alternative because of its impressive track record. Looking at the currently internationalizing Finnish-based companies it will be interesting to see, which model will be more successful. *Ztango*, providing wireless applications, is one of the few Finnish-based companies following the Israeli-model. F-Secure, a security software supplier, and Comptel, a telecommunications software company, are examples of the use of Nokia's model. Following the development of these companies might give some early signs of a successful internationalization model for Finnish start-ups.

APPENDIX 1: DETAILED LIST OF COMMON MILESTONES IN INDICATIVE ORDER

Technology and product development process

Product concept / idea
Product specification / demo
Technology / product patented
Platform / technology selection
Prototype / demo publicly announced, Alpha-phase
Starting of commercialization
Dedicated CTO appointed/freed (with solid project management skills)
Trial / pilot with customers, Beta-phase
Product ready for shipping
Income from products, 'proof of concept'
Versioning of products
Optimized production / design for manufacturing (ready for mass production)
Dedicated resources for technical support / help-desk
IPR portfolio analysis
Product profitability (R&D costs covered by sales)
Localized products to a foreign market
Separate R&D and further product development teams
2nd product generation (based on new technologies)
Multiple distinctive products based on distinctive technologies

Business development process

Business idea
Initial business plan
Founding (establishing legal form of a company)
Own premises
Business model (including revenue model) – including pricing
Value proposition and positioning of offering
Business plan ready (including detailed action plan)
First foreign employee
First outside-company member of board of directors
Management team hired
First foreign member of management team
Business concept publicly announced
Team size of 10 employees
Clear separate roles of operational management and board of directors

First foreign member of board of directors
Option plan for employees
Team size of 30 employees
Operations in multiple countries
Team size of 100 employees
Operations on three or more continents
Profitability (positive monthly cash flow excluding funding and subsidies)

Acquisitions
Mergers

Network and market development process

First market research
Initial customer segment identified
First appearance to investors and local press coverage
Marketing plan ready
Registered trade marks
Pilot / first customers signed
Platform decisions made / technology partnerships signed
First appearance to international investors and international press coverage
Sales organization ready and launch of marketing campaign
First foreign investor on board
Agreements with distributors / resellers (operators in case of network services)
First foreign customer signed
All crucial business model specific alliances signed in initial market
Deliveries to first foreign customer
1st country manager appointed
2nd country manager appointed
3rd country manager appointed
4th country manager appointed
All crucial business model specific alliances signed in first foreign market
International sales organization ready
Local / regional market leader position
Extension to other (distinctive) customer segments
Foreign sales more than 50 per cent of sales
Distributors / resellers share more than 50 per cent of sales
Deliveries to three or more continents
Global market leader position

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ENDNOTES

[1] Based on Kiander & Vartia (1998), and Ministry of Finance (1999, 2000).

[2] The Finnish Bankers' Association.

[3] The minimum equity amount upon registering a limited company in Finland is EUR 8 000.

[4] Arenius & Autio (2000).

[5] Finnish Venture Capital Association.

[6] Finnish Venture Capital Association.

[7] The euro became the official currency of Finland in 1.1.1999 at the conversion rate of 1 euro = 5.94573 markkas. For consistency, all figures originally in Finnish markkas have been converted to euros in this report.

[8] The Nasdaq Composite Index is used here as an indicator of valuations of global early-stage IT companies, as it consists mainly of technology companies in their early or expansion stage. Major European exchange indices (including the HEX index), in contrast, are strongly affected by non-technology industries.

[9] The selection criteria for the presented milestones are reasonable possibility to point out the specific time of reaching the milestone, and descriptiveness of a milestone in terms of process advancement.

[10] SoneraPlaza, the portal of the incumbent telecommunications company, and MTV3, the portal provided by a major television channel, have for long been the two most popular Internet portals in Finland.

Dan Steinbock

Two Kinds of ICT Pioneers: The Mobilization of the Digital Economy

CONTENTS

1. GROWTH, CATCH-UP, AND ICT PIONEERS

"In Finland, customers of Sonera Ltd. can pay for a car wash, a parking space or even a vending-machine soda by placing a call from their mobile phones. The charge appears later on their phone bill... This is the future of cellular phones in the U.S., already on display in Europe. The Continent has long maintained a lead in wireless technology largely because it has only one digital standard. So manufacturers can introduce new phone models and have a ready potential market of 300 million Europeans. The U.S., by contrast, has a hodgepodge of incompatible digital standards. And while fixed phone lines are expensive in Europe, digital wireless services are cheap, reliable and well-suited to Europeans frequently on the move."[1]

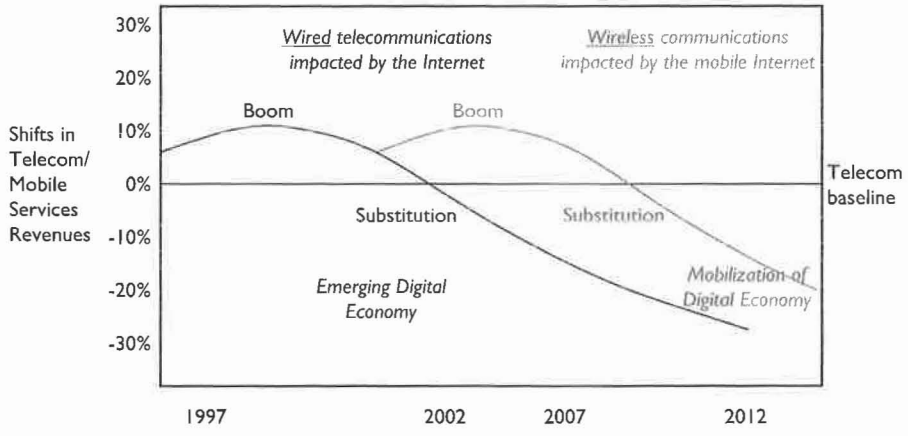
Wall Street Journal, June 3, 1999.

"... in Finland, arguably the most cell-phone-obsessed country in the world, consumers can use phones for such edge-of-the-envelope experiences as buying a soft drink from a vending machine. In the United States, instead of bemoaning the lack of such opportunities, a growing number of industry executives and analysts contend that consumers and communications companies can only benefit by letting someone else be the guinea pigs. So far, in Europe and Asia, there has been little evidence that many of the wireless services can actually make money for the companies that provide them, portending an industry shakeout comparable to America's dot-com meltdown of the last year."

New York Times, January 29, 2001

On both sides of the Atlantic, the drivers of the recent economic growth stem from a sequence of two digital tornadoes. In the first one, *the digital economy*, the U.S. has enjoyed an absolute and relative leadership. In the second, *the mobile digital economy*, several firms in Western Europe and, to some extent, Japan enjoy comparable leadership. Today, there are two kinds of pioneers in the information and communications technology (ICT) industries, i.e., the pioneers of the digital economy and the pioneers of mobile digital economy. The first dominate the wired and the second the wireless "new economy" (Figure 1.1).

Figure 1.1 Two substitutions



Starting in the late 1990s, the shift to Internet services in developed telecommunications and mobile markets has translated to a radical restructuring of the traditional telecommunications industry. New technologies have given rise to new business models as the Internet's open standards and rapid innovation have shattered vertical integration in the traditional industry. The new industry structure is horizontally layered and dominated by companies with horizontal business models. First, Internet access has pumped up demand for telecommunications bandwidth, which has caused a boom in the business. Thereafter, Internet services have resulted in functionalities that compete with traditional telecommunications services, which has translated to substitution. Finally, Internet technologies have displaced telecommunications as the primary platform for service innovation.[2]

The sequence of events described above illustrates the emergence of the digital economy in many, if not most developed markets. The mobilization of this digital economy, however, means still another sequence of boom, substitution, and displacement. First, the access to the mobile Internet increases the demand for mobile infrastructure, handsets and services, which, in turn, causes a boom in the mobile business. Thereafter, mobile Internet services offer functionalities that compete with mobile services, which translates to substitution. Finally, mobile Internet technologies displace traditional digital cellular as the primary platform for service innovation.

In the 1990s, digital convergence provided extraordinary first-mover advantages for the U.S. in the international ICT sector. However, the recent years – i.e., the early phases of the Internet revolution – should not be mistaken with the final outcomes of the digital convergence. After all, these developments have barely begun, as evidenced by the emergence of the digital economy in the U.S., the rise of mobile communications in Europe, and the early birth pains in both. Still, the rush toward Internet-enabled systems has already resulted in significant reshaping of various industries, vis-à-vis horizontal and vertical layering.

The emergence of the mobile Internet reflects the increasing complexity and novelty of the technology sector that no single nation can any longer hope to dominate.[3] However, the idea that American technological dominance is "gone for good" – a popular idea in the late 1980s and early 1990s - is only seemingly indisputable. Conversely, the more recent idea that the American economy is stronger today than ever before downplays the inherent weaknesses of U.S. technological leadership. This leadership is indisputable; however, its dominance is no longer the kind of across-the-board superiority that it held in the postwar era. It is, thus, increasingly vulnerable to strategic attacks and challenges in certain pockets of industry segments. U.S. leadership does continue in the critical convergence segments– with the exception of mobile communications.

Until the 1990s, U.S.-based companies dominated the first-generation mobile rivalry (analog cellular, or 1G), but this leadership was lost in the second-generation competition (digital cellular, or 2G) to Europe, particularly the Nordic ICT cluster (the Sweden-based *Ericsson* and the Finland-based *Nokia*). As the European companies began to pioneer the 3G rivalry and the mobile Internet in the late 1990s, the U.S. companies have often been one to two years behind the learning curve.[4]

Prior to the 1980s, the international competitiveness of nations was largely the subject of macroeconomic analysis. The rise of cluster research (Michael E. Porter) has augmented the classic research literature with microeconomic analysis. This shift is not only methodological; it is intertwined with the globalization of the industries. While a stable political context and sound macroeconomic policies remain necessary, they are not sufficient to ensure a prosperous economy. Perhaps even more important are the microeconomic foundations of economic development that are rooted in the firm's strategic conduct and operating practices, as well as in the business inputs, infrastructure, institutions, and policies that constitute the full environment in

which a nation's firms compete. This emphasis on the microeconomic factors builds upon the cluster research of locational advantage.[5] It can also shed light on the recent performance of the U.S. industry – whose strengths were ignored by macroeconomic analysis in the late 1980s:

... the general picture is one of stronger [U.S.] performance in the 1990s than in the early 1980s, attributable to a variety of factors including supportive public policies, competition and openness to innovation, and changes in supplier and customer relationships – factors that might not be as readily apparent if the analysis were of the macroeconomy or at the level of the firm. Vigorous foreign competition forced changes in manufacturing processes, organization, and strategy but then receded, making the performance of U.S. industries look even better.[6]

Although this form of analysis provides a methodological path for industry- or segment-level investigations, it may not go far enough, for several reasons. Instead of focusing on the internationalization of distinct business practices within the firm (including vertical and horizontal specialization), it examines national and regional clusters of these firms. Second, instead of anchoring strategic advantages on the dynamics of innovation, it stresses competitive advantages that are more prevalent in maturing industries and specific industry phases.[7] Third, due to accelerating international competition, neither intra- nor inter-firm practices can any longer be studied within the clusters of individual countries; rather, they must be understood in the context of the internationalization or even globalization of such clusters. As Mowery and Nelson (1999) have demonstrated, the sources of industrial leadership can be elusive, complex, and heterogeneous.[8]

The next chapter will examine these issues vis-à-vis eight brief company case studies, or "mini-cases".[9] All of the companies discussed are ICT pioneers in their respective industries. Four of them represent the central layers of the U.S. digital economy. The other four reflect the basic layers of European mobile communications. While most of these companies are relatively well known, the cases do not necessarily spotlight their most familiar aspects. Instead, they focus on the reorganization of the business practices inside and outside of these firms, or the reconfiguration of the intra- and inter-firm chains. The cases, thus, pay special attention to the impact of horizontal and vertical layering on these companies, as well as on how these companies shape this layering. Finally, each case will be illustrated with an industry transformation matrix, vis-à-vis business and geographic diversification and vertical chains. The matrix, though a highly qualitative instrument, permits the

investigation of the sources of strengths and weaknesses among the U.S. digital economy first movers and the European – or, more precisely, Nordic – mobile communications pioneers.

In the last chapter, the pace of erosion will be considered, along with the qualities that distinguish the U.S. digital economy pioneers from the Nordic mobile communications pioneers. While Nordic countries have pioneered mobile communications, they lack the complementarities that would enable the full exploitation of this leadership. Conversely, the U.S. industry leaders no longer enjoy strategic superiority in all critical industry segments. While they do possess the required complementarities in the digital economy, they are now engaged in a catch-up game in mobile communications.

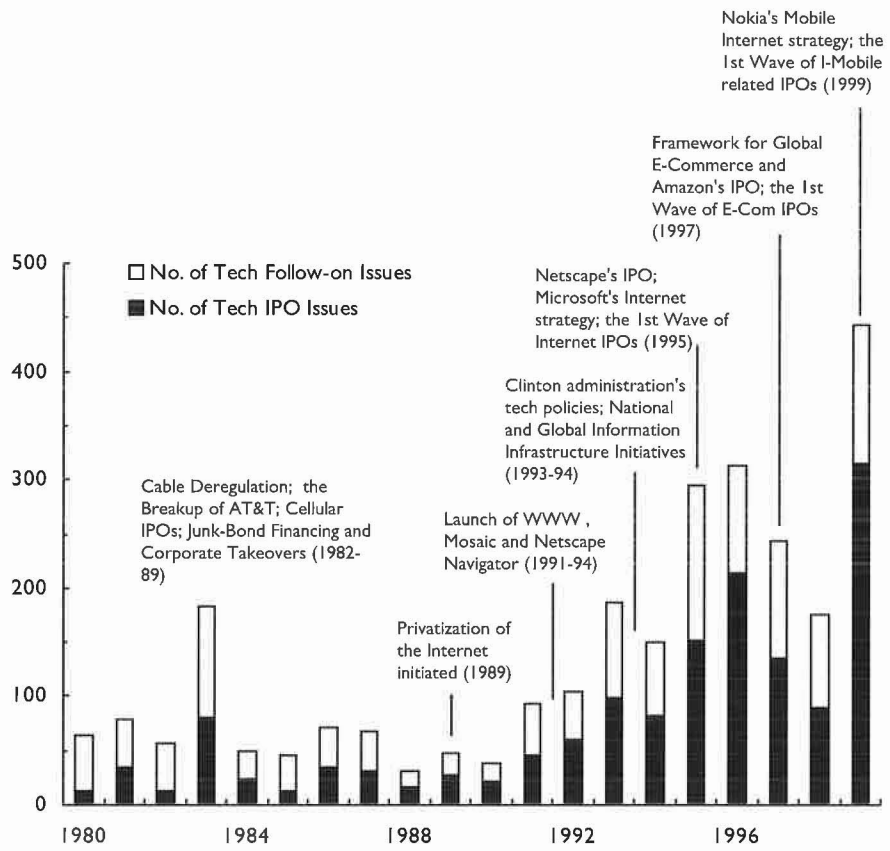
In the postwar era, the "American Century" endured only some 25 years. Today, a new catch-up game is in progress and is bound to erode U.S. strategic advantages in the long run. However, it may erode the advantages of European mobile communications pioneers even more quickly. Furthermore, Asian firms – whose potential impact into technology competition has recently been almost entirely ignored– will play a critical role in the mobilization of the digital economy.

The mobilization of the digital economy reflects the realities of accelerating international competition. Today, strategic advantages are increasingly difficult to achieve and sustain across-the-board. Weaknesses are quickly identified and exploited in entry strategies that reveal the vulnerabilities of the incumbent players, as well as in the repositioning strategies of these incumbents themselves. In this new world of increasingly global dynamic competition, ICT pioneers must create, cultivate, expand, retain, and renew their strategic advantages.

2. TWO KINDS OF ICT PIONEERS

After the privatization of the Internet backbone, and the commercialization of Internet-driven services triggered the online revolution, the first wave of pure Internet public initial offerings (IPO) ensued in 1995, the first e-commerce IPOs in 1997, and the first mobile Internet IPOs around 1999 (Figure 2.1). At the same time, the U.S. witnessed the emergence of the digital economy, which prompted the reorganization of the entire telecommunications sector (codified in the new Telecommunications Act of 1996).

Figure 2.1 Number of technology IPO issues and follow-on issues



Source: Steinbock (2000d).

By the mid-1990s, the growth prospects of the emerging digital economy were stunning. In aggregate terms, *Morgan Stanley Research*,[10] for instance, predicted that new businesses that were created by or for the Internet marketplace would grow rapidly, at an estimated compound annual growth rate (CAGR) of 38 per cent from 1995 until year 2000. Concurrently, growth in some existing markets, namely PCs, servers, semiconductors, and telecommunications service and equipment, would benefit indirectly. This segment was predicted to grow at a 30 per cent CAGR, thanks in part to its role in supporting the Internet's growth. The size of the Internet market space was estimated at USD 5 billion for new markets plus another USD 11 billion related indirectly to existing infrastructure companies. The "new businesses" market was expected to grow to USD 36 billion in the year 2000, and the indirectly related existing markets to USD 43 billion.[11]

By 1998, the convergence of computer and telecommunications industries had given rise to a digital economy, which was generating an estimated USD 301.4 billion revenue in the U.S., and was responsible for 1.2 million jobs, according to a study commissioned by *Cisco Systems*.[12] It portrayed the digital economy in four horizontal layers (Box 2.1). Indeed, e-commerce and the IT-producing industries in the U.S. were growing at a breathtaking speed. Yet, as a share of the retail portion of the economy, e-commerce remained small comprising less than 1 per cent of the total.

Box 2.1 The horizontal layers of the digital economy

By the late 1990s, the emerging digital economy consisted of four basic horizontal layers: infrastructure, applications, content and aggregation, and retail.

Infrastructure. This layer consisted of the telecommunications companies, Internet service providers, Internet backbone carriers, "last mile" access companies, and manufacturers of end-user networking equipment, all of which was a prerequisite for the Web and the proliferation of Internet based e-commerce.

- Internet backbone providers (e.g., Qwest, MCI Worldcom)
- Internet service providers (e.g., Mindspring, AOL, Earthlink)
- Networking hardware and software companies (e.g., Cisco, Lucent, 3Com)
- PC and server manufacturers (e.g., Dell, Compaq, HP)
- Security vendors (e.g., Axent, Checkpoint, Network Associates)
- Fiber optics makers (e.g., Corning)
- Line acceleration hardware manufacturers (e.g., Ciena, Tellabs, Pairgain)

Applications Software. This layer involved software products and services necessary to facilitate Web transactions and transaction intermediaries. Also, the layer included the consultants and service companies that designed, built, and maintained all types of Web sites, from portals to full e-commerce sites.

- Internet consultants (e.g., USWeb/CKS, Scient)
- Internet commerce applications (e.g., Netscape, Microsoft, Sun, IBM)
- Multimedia applications (e.g., RealNetworks, Macromedia)
- Web development software (e.g., Adobe, NetObjects, Allaire, Vignette)
- Search engine software (e.g., Inktomi, Verity)
- Online training (e.g., Sylvan Prometric, Assymetrix)
- Web-enabled databases (e.g., Oracle, IBM DB2, Microsoft SQL Server; only Internet/intranet related revenues are counted)

Intermediary (Content/Aggregation). The third layer consisted of businesses, which were mainly Internet pure-plays. Their Web-based business generated revenues indirectly, through advertising, membership subscription fees, and commissions. Many were purely Web content providers while others were market makers or market intermediaries. These "infomediaries" were expected to have a significant impact over time on the efficiency and performance of electronic markets.

- Market makers in vertical industries (e.g., VerticalNet, PCOrder)
- Online travel agents (e.g., TravelWeb.com, 1Travel.com)
- Online brokerages (e.g., E*Trade, Schwab.com, DLJDirect)
- Content aggregators (e.g., Cnet, ZDnet, Broadcast.com)
- Portals/Content providers (e.g., Yahoo, Excite, Geocities)
- Internet ad brokers (e.g., Doubleclick, 24/7 Media)
- Online advertising (e.g., Yahoo, ESPNSportszone)

Retail. Conducting Web-based commerce transactions, these firms crossed a wide variety of vertical industries.

- E-tailers (e.g., Amazon.com, eToys.com)
- Manufacturers selling online (e.g., Cisco, Dell, IBM)
- Fee/Subscription-based companies (e.g., thestreet.com, WSJ.com)
- Airlines selling online tickets
- Online entertainment and professional services

Many companies were involved at multiple layers.

Source: University of Texas' Center for Research in Electronic Commerce (2000).

These developments, in turn, accelerated the arrival of digital cellular services in the U.S. around 1998, as well as the nascent mobilization of the digital economy. In both cases, certain companies served as the primary drivers of economic growth. Here, the case companies have been selected to represent the key layers of the emerging U.S. digital economy and the emerging European mobile communications (Box 2.2). The U.S.-based ICT pioneers are *AT&T* (operations), *Microsoft* (operating systems, software), *America Online* (aggregation/content/media), and *Amazon.com* (e-commerce). The European-based mobile communications pioneers are Ericsson (infrastructure), Nokia (handsets), *Sonera* (aggregation/content/media), and *Merita-Nordbanken* (e-commerce). Each of these companies represents its respective industry segment, both in the emerging digital economy and the mobile communications.

Box 2.2 First movers: Digital and mobile communications[13]

The Digital Economy First-Movers

AT&T. In 1999, AT&T was a major player in the operations layer. It had revenues of USD 62.4 billion and almost 150,000 employees (USD 422,000 per employee); its long-term debt amounted to USD 22 billion, and it had a market value of USD 162 billion (2.6 times revenues). Through its third breakup, AT&T has extended its vertical chain from the old cash cow (consumer long-distance) toward business data and local phone (local, wireless, and the Internet). This vertical diversification has extended geographically, as well, from majority and minority investments to subsidiaries, joint ventures and strategic alliances.

Microsoft. Through its operating systems and applications, Microsoft had a key role in software. In 1999, Microsoft, despite the ongoing and long-running antitrust trial, still dominated the application software and operating systems layer in the digital economy. It had revenues of USD 23 billion, and more than 39,100 employees (USD 587,000 per employee); its market value exceeded USD 422 billion (more than 18 times revenues). Through its "embrace and extend" strategy, Microsoft has extended its vertical chain into the Internet, in cable and, to some extent, into wireless (e.g., joint ventures, technology coalitions, instant messaging). Vertical diversification has been extended and leveraged worldwide.

America Online. America Online was a leading firm in the intermediary layer for content and aggregation (and, through Time Warner, in media). In January 2000, AOL became the world's largest entertainment and media firm through its USD 183 billion (the price at the time of the announcement) agreement to acquire the media behemoth Time Warner. It had revenues of USD 6.9 billion, almost 15,000 employees (USD 459,000 per employee), and its market value amounted to USD 122 billion (almost 18 times revenues). Through Time Warner, AOL has extended its vertical chains from the Internet to the local cable and telecom services, from aggregation to content production, and into the wireless. Vertical diversification in old and new media has been extended worldwide.

Amazon.com. Amazon.com was the pioneer of online retail. As one of the first pure e-commerce players, the Seattle-based Amazon.com initiated its operations in online book retail, but began diversification in 1998. In 1999, Amazon had revenues of USD 1,640 million and almost 7,600 employees (USD 216,000 per employee); in five years, its net income has soared from

USD 0.3 million to USD 720 million. With USD 1,466 million in debt, its debt ratio exceeded 84 per cent. Still, its market value amounted to USD 26.3 billion (16 times revenues).

European Mobile Communications First-Movers

Ericsson. In the emerging mobile digital economy, Ericsson is the dominant player in the infrastructure, Stockholm-based Ericsson dominated global sales in the wireless infrastructure market, while trailing Nokia and Motorola in handset sales. Ericsson's core products for telecom providers accounted for 70 per cent of sales. In 1999, Ericsson had revenues of USD 25.3 billion and some 103,000 employees (USD 245,000 per employee); a year before, its market value amounted to USD 46.7 billion (2.1 times revenues).

Nokia. In 1999, Nokia was the world's leading handset maker, and remained a significant player in infrastructure as well. Headed by CEO Jorma Ollila, the company's strategy was to "bring the Internet to everybody's pocket." In 1999, Nokia generated almost USD 20 billion in revenues with more than 51,000 employees (USD 390,000 per employee). Its market value amounted to more than USD 222 billion (11.1 times revenues).

Sonera. In 1999, Sonera was pioneering mobile software and services. Based in Helsinki, the former Telecom Finland remained the country's leading provider of telecom services. Sonera also provided telecom services in Russia and Northern Europe with a fiber-optic network stretching from Moscow to North America. Sonera's mobile pioneership, wireless unit, and global ambitions made the company unique worldwide. In 1999, Sonera had revenues of USD 1,866 million and 9,000 employees (USD 207,000 per employee); its debt ratio exceeded 38 per cent, and it had a market value of USD 50 billion (26.8 times revenues).

Merita-Nordbanken. In 1999, Merita-Nordbanken was the pioneer of mobile e-banking. When Finland's Merita and Sweden's Nordbanken merged to form a new parent company, the ensuing Nordic Baltic Holding became one of the first European cross-border bank mergers. Its main subsidiary, Merita-Nordbanken, provided retail and corporate banking, asset management, and insurance to more than 6.5 million individuals and about 400,000 companies in its home countries as well as Estonia, Latvia, Lithuania, and Poland. The Swedish government owned about 43 per cent of Merita-Nordbanken, which has bought Denmark's Unidanmark and is buying Christiania og Kreditkasse of Norway. In 1999, Merita-Nordbanken had revenues of USD 6 billion and almost 19,000 employees (USD 318,000 per employee).

2.1. U.S. digital economy

In the postwar era, the U.S. has enjoyed a distinct technological advantage in two broad areas of manufacturing: mass production (e.g., automobiles, steel, consumer durables) and high technology (e.g., electronics, aerospace, pharmaceuticals).[14] Technological dominance gave rise to industrial leadership. This, as Sylvia Ostry (1997) has argued, was the initial context of the post-Cold War trading system: "American technological leadership after World War I was across-the-board dominance – that is, the American lead was apparent in all industries and not simply in high tech." Unlike the industrial leadership, America's preeminence in the technology sector emerged only after World War II, most importantly by massive investment in R&D by industry, academic institutions, and government. Furthermore, a large fraction of government and industrial R&D flowed from the Department of Defense, including the first Internet-related R&D projects in the aftermath of the Soviet Sputnik in 1957.[15]

It was this post-war "technology gap" with the U.S., first enunciated by the Organization for European Economic Cooperation (OEEC), that prompted the idea of catch-up by the countries that are today known as developed nations.[16] As the master-architect and builder of the "convergence club" (the OECD countries), the United States contributed to the strengthening of its future economic rivals – through trade, foreign direct investment, intra- and inter- industry spillovers, technological capabilities of host-country firms, and an increasing numbers of scientific communities – until the international trade and technology conflicts in the 1970s and 1980s.[17]

The strong performance of the U.S. economy between 1995 and 2000 contrasted both with its performance from 1973 to 1995, and with that of the rest of the industrial world (compare Figures 2.2a and 2.2b). The advocates of the "new economy" have pointed to an amalgam of factors that contributed to this strength, including favorable monetary and fiscal policies, pro-competitive regulation, risk capital, and an entrepreneurial business culture.

As the era of the Clinton-Gore administration approached its end, the policy strategy of maintaining fiscal discipline, investing in people and technologies, and opening international markets, as the White House argued, had borne rich fruit, allowing the nation to exploit new opportunities, and reap the benefits of major scientific and technical advances. As the administration saw it (and quite a few observers concurred), the record was extraordinary: a 20-million-job increase in pay-

Figure 2.2 Economic growth, productivity, and U.S. resurgence: What happened to the catch-up game?

Figure 2.2a Growth of GDP per capita 1960-1999

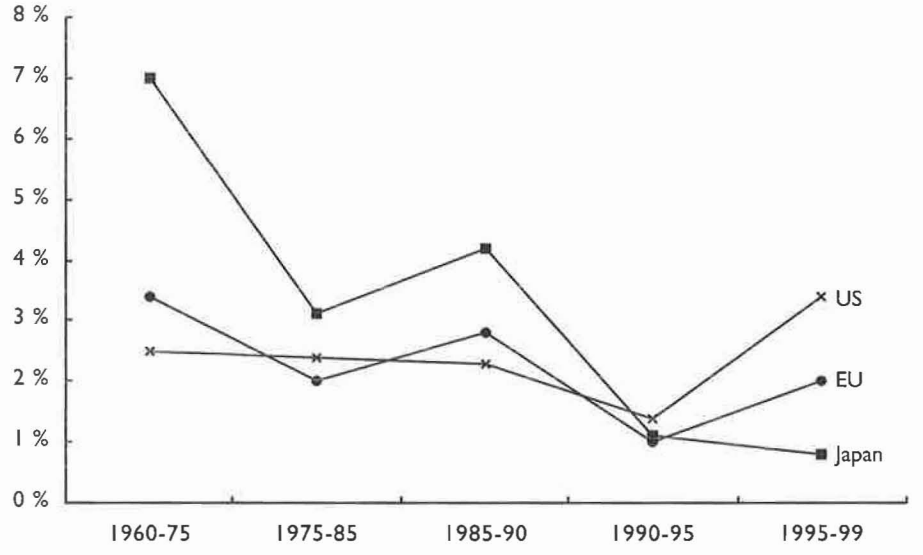
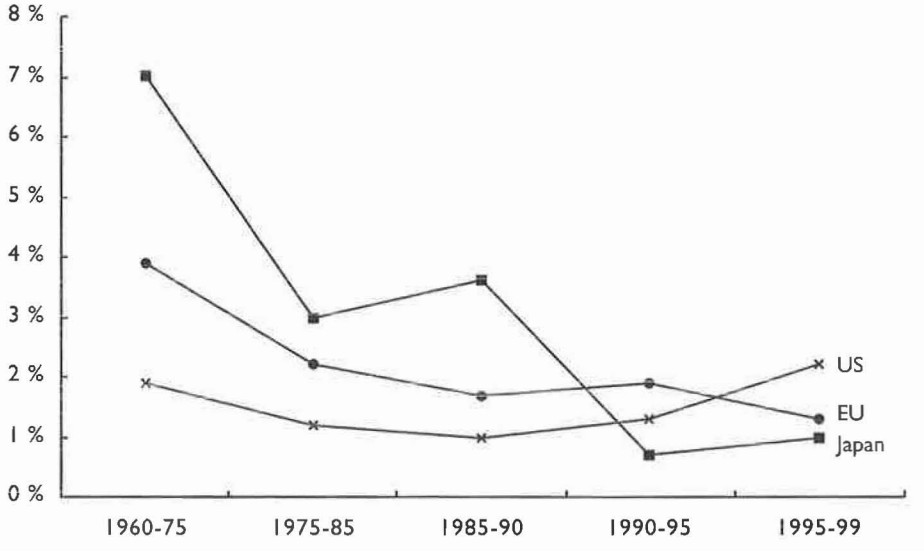


Figure 2.2b Growth rate of labor productivity per employee 1960-1999



Source: European Commission.

roll employment since January 1993; the lowest unemployment rate since 1969; the lowest core inflation rate since 1965; the lowest poverty rate since 1979; rising productivity; significant gains all across the income distribution; and a Federal budget in surplus for two years in a row after nearly three decades of deficits.[18] By the year 2000, the U.S. economic expansion was in its tenth year. The optimists believed sustained economic strength with low inflation evidenced that the U.S. economy "may well have crossed into a new era of greater economic prosperity and possibility, much as it did after the development and spread of the electric dynamo and the internal combustion engine."[19]

The advent of the "new economy" coincided with dramatic cost reductions in computers, computer components, and communications equipment. Declining IT prices and years of sustained economic growth spurred massive investments not only in computer and communications equipment but also in new software that harnessed and enhanced the productive capacity of that equipment. The new economy was also shaped by much cheaper and more rapidly increasing electronic connectivity. The Internet helped to level the playing field among large and small firms in business-to-business e-commerce. Firms were moving their supply networks and sales channels online, and participating in new online marketplaces. They were also expanding their use of networked systems to improve internal business processes.

The vitality of the digital economy was grounded in IT producing industries, i.e., the firms that supplied the goods and services that supported IT-enabled business practices across the economy, as well as the Internet and e-commerce. Over the 1990s, and especially since the mid-1990s, these industries have been a powerful factor in the economy's rapid and sustained growth, a significant restraint on inflation, and a focal point of prolific technological innovation. Although IT industries still account for a relatively small share of the economy's total output – an estimated 8.3 per cent in 2000 – they contributed nearly a third of real U.S. economic growth between 1995 and 1999.

In the U.S. digital economy, AT&T, Microsoft, America Online, and Amazon.com illustrate the horizontal layers. AT&T has been a dominant player in the operations layer. Microsoft, through its operating systems and applications, has had a key role in software. America Online is a leading firm in the intermediary layer for content and aggregation (and, through *Time Warner*, in media). And Amazon.com is the pioneer of online retail. The older the firms, the more extensive have been their international operations (AT&T, Microsoft); the

younger the firms, the more they have favored strategic partnerships rather than vertical integration (Amazon.com). Through mergers and acquisitions and consolidation, even the newer players have begun to seek increasing integration (e.g., AOL/Time-Warner).

2.2. European mobile communications

After World War II, Nordic countries found themselves between the socialist East and the capitalist West. They struggled for a "third way" that would do justice to their mixed economies. In 1945, the Nordic Social Democrats drafted a far-reaching declaration on Nordic cooperation. The explosion of the cellular business was the result of these initiatives. From the earliest introduction of dispatch radio services, the major Nordic countries – Sweden, Finland, Denmark and Norway – adopted an unusually progressive attitude towards all forms of mobile communications.[20]

The use of the mobile phone was heavily promoted, and use of the available spectrum was encouraged in the Nordic countries, unlike in most other European countries. The topography of the Nordic countries favored mobile communications, with its dispersion of much of the population in remote places. In June 1969, the Nordic telecommunications conference in the Lofoten Islands established *the Nordic Mobile Telephone Group* (*Nordiska Mobil Telefongruppen*, *NMT*). Led by market needs, the strategy for the introduction of mobile services was not geared at profitability, but at the public-service values of the Nordic PTTs, which integrated mobile operations with the rest of their activities. [21] The low price for fixed subscriptions posed a minimal barrier to potential users. By the same token, revenues would be highly dependent on adequate traffic levels and cost-leadership strategies.

While the cellular market growth took off rapidly in both Nordic Europe and the U.S., the emerging mobile players in the latter country faced far more obstacles. There were five major differences between Nordic and U.S. developments. The first four stemmed from Nordic initiatives, while the fifth originated from the European integration process.

Centralized decision daking: Market creation and new technology. While AT&T believed strongly in the market prospects of cellular services, it had to spend years convincing the *Federal Communications Commission* (*FCC*), and it took even longer to initiate the licensing process. In Nordic countries, the highly centralized decision

making, coupled with enlightened views of markets and technology, presented no such obstacles.

Roaming as a precondition of market creation. Nordic countries made roaming a precondition of market creation, whereas in the U.S., the fragmented licensing approach ignored the roaming needs. This resulted in problems that took years to resolve.

The selection of frequency bands. The use of 450 MHz in the Nordic countries encouraged a rapid start, whereas the choice of 800 MHz imposed by the FCC made the initial launch difficult and costly. Yet, even Nordic PTTs did not anticipate the explosive market growth, just as they had to learn marketing to achieve acceptance of the second-generation 900 MHz system. In the long term, these marketing capabilities, coupled with existing customer service levels, made Nordic systems highly efficient.

Differences in pricing practices. Pricing differences involved two additional determinants. The Nordic countries popularized the "caller pays" principle, which nurtured parity between fixed and mobile services. In the U.S., mobile phone users have paid for both outgoing and incoming calls, which has served as a hindrance for market expansion, freezing mobile services into a marginal niche rather than a true complement to fixed services. Also, the U.S. telecommunications services have had fixed fees, whereas the Nordic users have been accustomed to time-based pricing, which mobile pricing simply emulated.

GSM as an instrument of European integration. With the gradual unification of the European markets at the end of the 1980s, *the European Conference of Postal and Telecommunications Administrations* (*CEPT*) decided to develop a common standard for digital mobile telephony. Today, this standard is known as Global System for Mobile Communications (GSM). The early initiatives by the European Commission stimulated the introduction of GSM. In the late 1980s, the concept of GSM matched the European Commission's objectives of providing comprehensive pan-European services and standards, as well as the EC's willingness to transform European telecommunications, from domestic monopolies into a fully competitive environment. In the U.S., the fragmented markets failed to replicate the triumph of the GSM standard.

In the emerging mobile digital economy, Ericsson, Nokia, Sonera, and Merita-Nordbanken illustrate the horizontal layers. Through the 1990s, Ericsson has been the dominant player in the infrastructure, while

Nokia has dominated in handsets. In the late 1990s, Sonera was pioneering mobile software and services, whereas Merita-Nordbanken has long been the pioneer of mobile banking. Unlike their U.S. counterparts, these European companies have been relatively old.

Historically, Sonera emerged from Russian telecommunications operations in Finland, a Grand Duchy of the Tsarist empire in the mid- and late 19th century. Nokia, initially a forestry business, was launched in 1866, and Ericsson emerged only a decade later. Similarly, Merita and Nordbanken originated from banks that were established more than a century ago. In practice, these firms have been among the first movers of their industries, leading in one or more business segments, and benefiting from enlightened corporate leadership. Furthermore, Ericsson, Nokia, and Sonera participated in Nordic cooperation, which initiated the transition to digital cellular. Through its electronic services, Merita, an investor in and client of Nokia and Sonera, initiated its own experiments in text-based computer banking in the early 1980s.

Unlike other Nordic and European firms, these companies have been bold risk-takers, willing to bet for high long-term growth prospects. In addition to such pull motives, they have also been driven by push factors. Ericsson and Nokia rushed to the 2G markets amidst serious crisis situations in which they had a lot to gain but little to lose. Sonera opted for new markets amidst impending privatization. Merita intensified its efforts to explore new markets during Finland's severe recession and banking crisis in the early 1990s.

2.3. Industry transformation matrix

The dynamic impact of the emerging digital economy and mobile communications can be illustrated with an *industry transformation matrix*, emphasizing the concurrent interplay of horizontal and vertical systems (Figure 2.3a). One axis makes note of the horizontal layering of the emerging digital economy, while another depicts the new vertical layering of the telecommunications industry. In both cases, the matrix represents a dynamic reality. In the mid-1990s, it was still relatively easy to sort out the central players into the distinct categories of local, long-distance, wireless, and Internet players, in the U.S. telecommunications markets. Yet, these industry boundaries were, for most practical purposes, artificial.[22] In addition to the industry matrix, the companies can be sorted according to the degree of their geographic presence (significant/dominant, medium, low), as well as vertical chains within the matrix (Figure 2.3b).

Figure 2.3 Industry transformation matrix

Figure 2.3a Industry transformation matrix

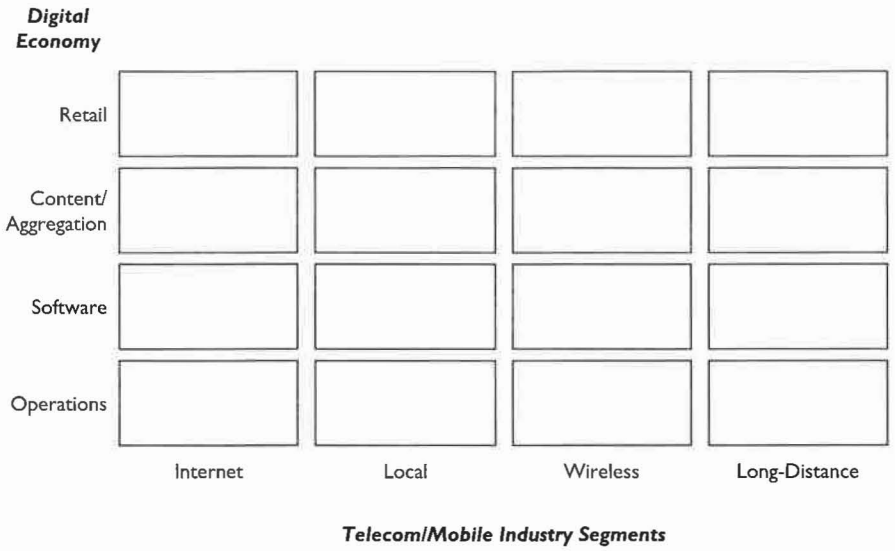
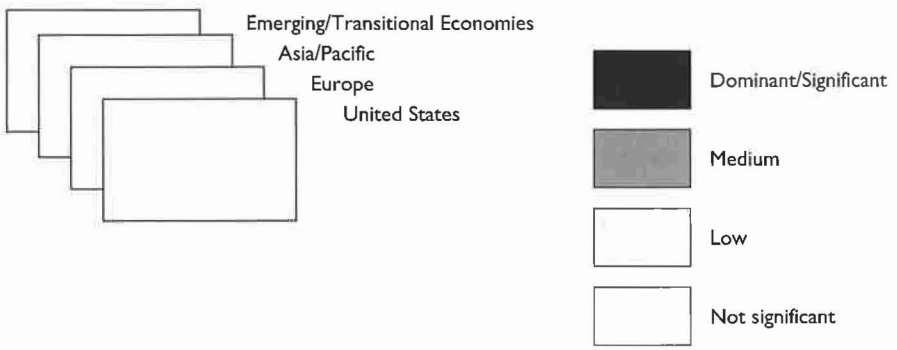


Figure 2.3b Georaphic precence



Simple statistical comparisons of the U.S. pioneers and the European first movers are useful for preliminary analysis, but they do not necessarily illustrate central *strategic* variables. Take, for example, cable, the growth business of the 1980s: No aggregate industry study could have predicted the rise of Turner's *CNN*. At the time, CNN's

major rival seemed to be *Satellite News Channels* (*SNC*), a joint venture by *ABC* and *Westinghouse*. The combined revenues of these two players amounted to USD 11.8 billion, whereas Turner's parent company generated only USD 1 million. In numbers and resources, it was the fly against the giants. Yet, only five years later, CNN was in the black, unlike its broadcast TV rivals; it had also become a global franchise.[23]

Statistical considerations, then, must be augmented with strategic ones, including:

- *strategic inflection points*: online migration from physical operations to Web-based activities, and the ensuing mobile migration from Web-based activities to mobile processes
- *business growth prospects*: the pace of evolution as well as potential scale
- *geographic presence and growth prospects*: the pace of evolution in the diversification of business and geographic segments, and the ensuing scope
- *ownership and control of the vertical chains*

2.4. U.S. and European ICT pioneers: Strategic comparisons

These ICT pioneers might also be sorted according to the basic characteristics of the markets (old/new) and the firms themselves (old/new). In both cases, the Internet revolution, whose beginnings are often associated with the IPO of *Netscape* in August 1994, is the relevant yardstick. The companies that were founded prior to the mid-1990s may be considered older, whereas those that emerged after the mid-1990s may be considered young. The U.S. pioneers are former monopolies (AT&T) that seek a foothold in new markets, dominant firms (Microsoft) that have embraced new markets, or relatively new Internet players (America Online, Amazon.com). Unlike their U.S. rivals, European mobile communications pioneers tend to be former monopolies (Sonera) and dominant firms (Ericsson, Nokia, Merita-Nordbanken) that originated in the late 19th century but have stayed abreast with new markets.

Figure 2.4 Industry transformation matrix: ICT pioneers

Figure 2.4a Geographic presence

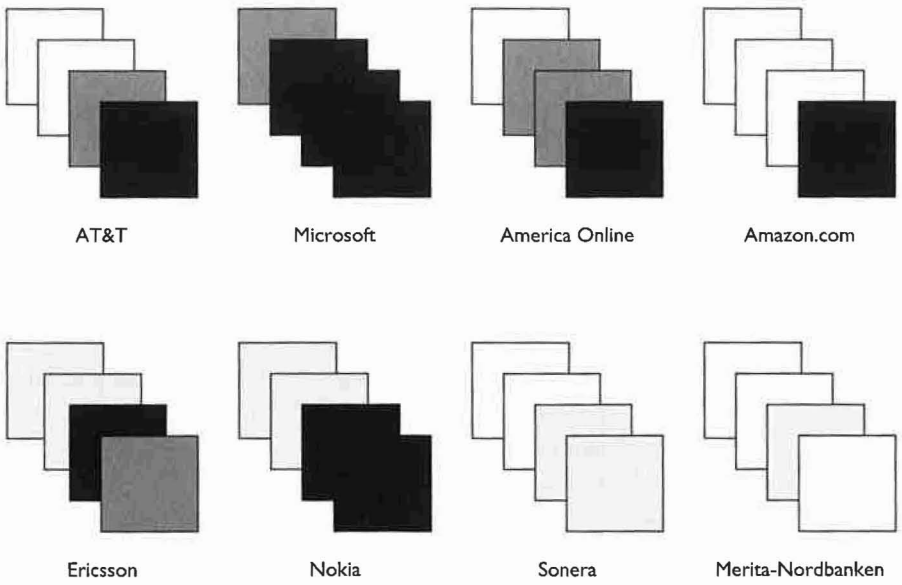
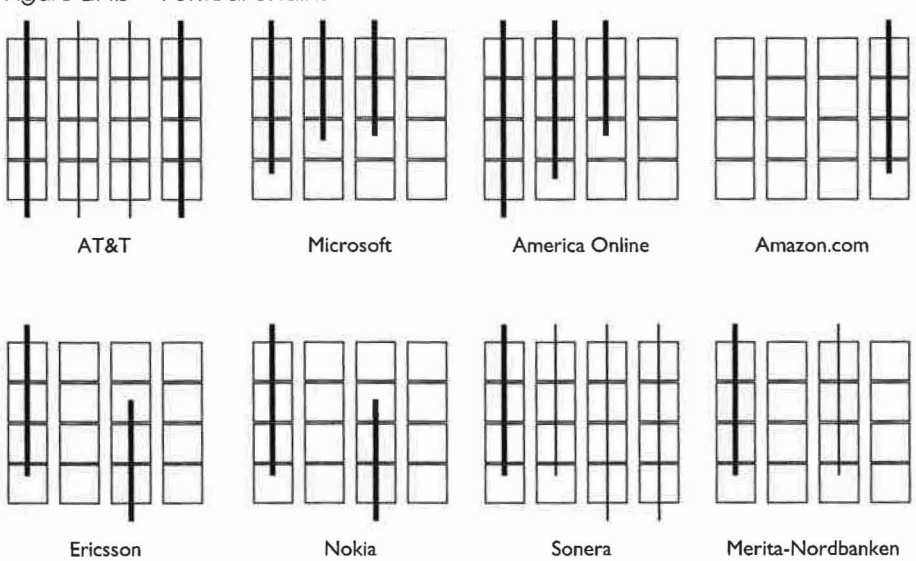


Figure 2.4b Vertical chains



The industry transformation matrix permits the investigation of the ICT pioneer companies against the context of both horizontal and vertical layering, while acknowledging the dynamics of the system. The companies can be illustrated in terms of their recent revenues, revenue/employee (proxy for productivity), and market value/revenue (proxy for valuation) (see Box 2.2 on page 143). Furthermore, they can be illustrated in terms of geographic presence and vertical chains (Figures 2.4a and 2.4b).

Strategic Inflection Points. Unlike many European players, the U.S. ICT pioneers have often engaged in risky, ambitious, and bold growth strategies. While these strategies have been most prominent among the more recent players (Amazon.com, America Online), the older firms have followed along since the 1980s, especially since the dawn of the Internet revolution. In the U.S., competition policy (the longstanding antitrust efforts against Microsoft) and certain regulatory decisions (the Telecommunications Act of 1996) have contributed to these developments. Driven by rapid investor reactions, U.S. ICT pioneers have had few options but to respond quickly to market reactions.

Unlike the U.S. players, the European ICT pioneers have moved more incrementally. In contrast to Sweden, the Finnish players, except for Nokia in the mobile business, have also been relatively isolated and sheltered from international competition until the early 1990s. In the past 20 to 30 years, the European first-movers have initially focused on innovative technology strategies rather than (shareholder) value strategies. Consequently, they have not always excelled in listening to the market, as evidenced by the initial failures of Nokia and Ericsson in the digital convergence. With the GSM standard, however, the European firms have been successful – the failure of the U.S. regulators and ICT pioneers to develop integrated 2G markets has contributed to this triumph.

Business Growth Prospects. The most remarkable aspect of the U.S. innovation system may well be the priority it accords to rapid and flexible entry and exit in dynamic markets. In 1990, America Online followed in the footsteps of *Prodigy* (the market leader that it would soon defeat) and *CompuServe* (a keen rival that it would ultimately acquire); it was a rapid follower, not a first mover. In 1999, its market value was estimated at USD 122 billion, and it was about to acquire Time Warner in a then USD 183 billion deal. All of the U.S. ICT pioneers – from AT&T since the late 1880s to Amazon.com in the late 1990s – have been quick to benefit from the massive scope of the U.S.

markets; none have engaged in local or regional strategies, even initially. With changing markets, these companies have also engaged in dramatic strategic turns. In December 1995, following Bill Gates's famous "Pearl Harbor" speech, Microsoft opted for an Internet-driven "embrace and extend" strategy, which, in just a few months, transformed the software giant.

Only Nokia's extraordinary growth strategy in the early 1990s compares with those of the U.S. ICT pioneers, not least because of the Finnish mobile vendor's dramatic crisis after a decade of expansion. Most European ICT pioneers simply have not been able to match the rapid growth pace or the potential scale of U.S. ICT pioneers. The success of the European ICT first-movers, as well as the massive scale of the greatest of them (Ericsson, Nokia), originates from the late 1960s; it has not been of recent nature. Furthermore, the climax of this success – the 2G dominance – has been relatively narrow historically, pertaining almost exclusively to a single phase of mobile evolution.

Geographic Presence and Growth Prospects. All U.S. ICT pioneers have sought to leverage domestic success with geographic diversification, especially as the growth markets have migrated to overseas locations, from AT&T in the early 1910s (when it already operated in the central worldwide locations) to America Online in the mid-1990s (when it, along with *Yahoo!*, first engaged in internationalization) and Amazon.com later in the decade. In effect, Microsoft built its success in the U.S. markets upon the foundation it had first created in the European markets in the 1980s, through its operating systems and application software.

The European ICT pioneers, especially the Finnish, have been far slower to enter overseas markets than the U.S. players. Nokia has engaged in world markets since the very beginning of the 20th century, but its entry into worldwide mobile markets evolved only in the 1980s. Due to the relative isolation and heavy regulation of the Finnish banking and telecommunications sectors, Merita (then *KOP*) and Sonera had little taste of international competition until the late 1980s and early 1990s. Unlike the Finnish players, Ericsson has been more driven internationally, from its very genesis; however, its role in the mobile markets grew only toward the late 1960s and 1970s.

Vertical Chains. In dynamic markets, particularly in the digital economy and mobile communications, no single company can any longer hope to control the entire chain of business practices, from suppliers

and manufacturing to service and end-customers. While all ICT pioneers have engaged in significant vertical disintegration since the 1980s, the U.S. and European pioneers differ drastically in terms of the roles and power they have in the new vertical chains. Overall, the U.S. ICT pioneers have fewer vertical chains, control more individual stages, engage in greater scale and scope of operations and, thus, hold greater bargaining power than the European ICT pioneers. Even the most recent entrant, Amazon.com, though narrow in its strategic focus, enjoys relatively thick vertical chains, and has leveraged its capabilities through related diversification as well as increasing presence in critical worldwide markets.

Both Nokia and Ericsson have thick vertical chains in the mobile business, as well as favorable positioning in the mobile wireless; however, because the 3G success is not directly dependent on the 2G capabilities, they will face tough competition in the future. Sonera remains primarily a Finnish player in traditional telecommunications segments, though it is a technology pioneer in the mobile Internet. Due to its thin scale and scope, however, it must engage in mergers and acquisitions of its own, or it will be acquired. Merita-Nordbanken is likely to expand into a regional player in Northern Europe, but the scale and scope of its operations will remain relatively thin, which translates to technology leadership rather than industry dominance.

Overall, then, the strategic comparisons between the U.S. and European ICT pioneers indicate that where the former enjoy industry dominance, the latter have excelled in technology leadership, except for the historically brief 2G rivalry in mobile communications.

3. PIONEERSHIP AND STRATEGIC ADVANTAGES

The focus of this chapter is the pace of erosion and the kind of pioneership that distinguishes the U.S. digital economy first-movers from the European mobile communications pioneers. While Nordic countries have pioneered mobile communications, they lack the very complementarities that would enable the full exploitation of this pioneership. Conversely, the U.S. industry leaders no longer enjoy strategic superiority in all critical industry segments. While they do possess the required complementarities in the digital economy, they are now engaged in a mobile communications catch-up game.

3.1. The pace of erosion

The idea that the EU countries would rush in the footsteps of the U.S. into the emerging digital economy was at best simplistic. It ignored the fundamental differences between the two trading blocks, vis-à-vis firms, industries, institutions, innovation and investment systems, and the far more fragmented technological and cultural infrastructures in Europe. Furthermore, European players, as followers rather than first-movers in many industries, have benefited from hindsight. They have had the opportunity to review what has succeeded and failed in the U.S. Finally, in some segments, the later entry of European companies into the digital economy, particularly e-commerce, may give them the advantage of applying technology that has advanced considerably in just two years.

For example, in the U.S., the first round of this layer of the digital economy went resoundingly to the pure Internet companies. In Europe, when incumbent businesses have moved quickly enough, they have had opportunities to beat out the competition – both the local Internet pure plays and the U.S. online subsidiaries. By 2000, the *McKinsey* consultants argued, on the basis of these differences, that "any thought that Europe will remain several steps behind the United States may well prove wrong."[24]

While the regional differences are indisputable, the benefit of hindsight – i.e., strategic followership – is often debatable in dynamic and technology-driven industries, where first-mover advantages, early critical mass, and network effects may result in enduring advantages. In the digital economy, no technologies, competencies, or capabilities can be built and accumulated in isolation; in an interdependent system, horizontal and vertical specialization is often based upon underlying similarities in standards and technologies. Consequently, the idea of hindsight, which is predicated on static sustainability, may be an afterthought in the digital economy. And as e-commerce in Europe – measured by the share of its population that is currently online, Web purchasers as a percentage of Web users, and average spending per buyer – has lagged behind e-commerce in the U.S. by one to two years (in 2000), today's hindsight may often serve as tomorrow's rationalization.

Take e-commerce. The resurgence of the European incumbents in the digital economy may have less to do with moving quickly than the absence of opportunities for startups and new entrants to grow even

more quickly. After the mid-1990s – since the European Union laid out a regulatory framework for the liberalization of member states' telecommunications industries, and billion-dollar private funds investments – for the countries that have led the way, such as the U.K. and Finland, the result has been an upgraded telecommunications infrastructure, a host of new entrants, better service, and lower prices.

Yet, in terms of all EU nations, these first-mover countries have been bold exceptions rather than the general rule. Indeed, the low degree of dynamic competition is perhaps nowhere as apparent as in the very infrastructure of the emerging digital economy in Europe.[25] In addition to infrastructure problems, there are EU-wide transaction-related issues that keep suppressing even pioneers' first-mover strategies. Great variation also exists in the use of credit cards, the reliability and cost of package delivery, and the extent of catalog sales. Finally, in Europe, there has been no tax moratorium on e-commerce, as there has been in the U.S., and cross-border shipping charges remain high and complex.[26]

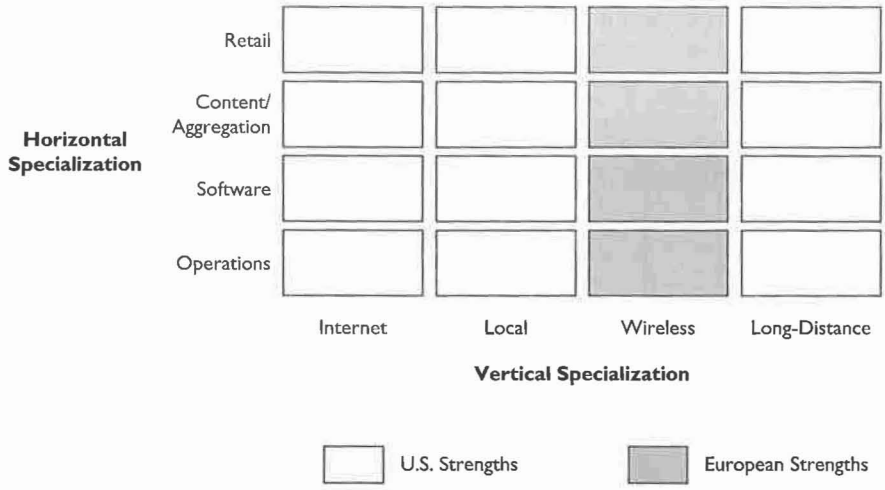
In year 2000, European mobile commerce – retailing through mobile phones – may have been in the same stage that U.S. e-commerce was in around 1997. However, it could emerge more quickly than it did in the U.S., due in part to the delay in PC and Internet penetration in Europe. Furthermore, in contrast to the U.S. incumbents, which missed important opportunities in the emerging digital economy (the classic case was the belated entry of *Barnes & Noble* in online book retailing, following the entry of Amazon.com), the European incumbents were expected to dominate e-commerce. Yet, these entrenched players have stumbled in periods of disruptive innovation.

By 2000, the United States had a strategic advantage in the emerging digital economy, whereas the European (particularly Nordic) countries had an advantage in mobile communications (Figure 3.1). In the long run, the absolute advantages of each would erode in relative terms. But this erosion proceeds differently among the ICT pioneers in the two continents.

U.S. digital economy: Absolute superiority, relative erosion

In 1957, the U.S. Department of Defense initiated the military R&D programs that gave rise to the Internet. Due to the extraordinary pace of change after the privatization and commercialization of the Internet

Figure 3.1 Industry transformation matrix: U.S. and European ICT strengths



in the 1990s, the membership composition of several leading stock indexes were soon chasing the history rather than making it. In December 1998, America Online Inc. replaced the established retailer *Venator Group Inc.* in the Standard & Poor's 500 index, underscoring the growing importance of Internet stocks in the economy. It took another year– until October 1999– for some of the "industrial"' to be taken out of the Dow Jones Industrial Average. Companies representing the old industrial economy were replaced with the building blocks of the global information age. Gone were *Chevron*, *Goodyear Tire & Rubber*, *Sears Roebuck*, and *Union Carbide*, companies that were synonymous with a bygone era. In came *Intel*, Microsoft, *SBC Communications*, and *Home Depot*, which joined *Hewlett-Packard*, *IBM*, and *Wal-Mart* on the list of 30 blue-chip companies.[27]

Through all of these developments, the U.S. companies have retained strategic first-mover advantages over new technologies, products, and processes. Despite the dramatic absolute expansion of the digital economy, the first signs of relative erosion were discernible quite early. In 1997, according to *IDC*, a worldwide population explosion on the Web was under way.

Figure 3.2 Web users and Internet commerce volume 1997 and 2001

Figure 3.2a Web users in the USA, Western Europe, and Asia/Pacific

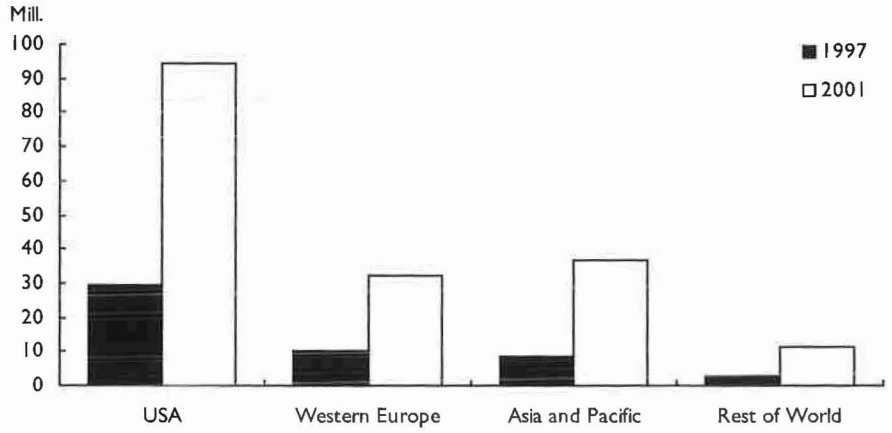
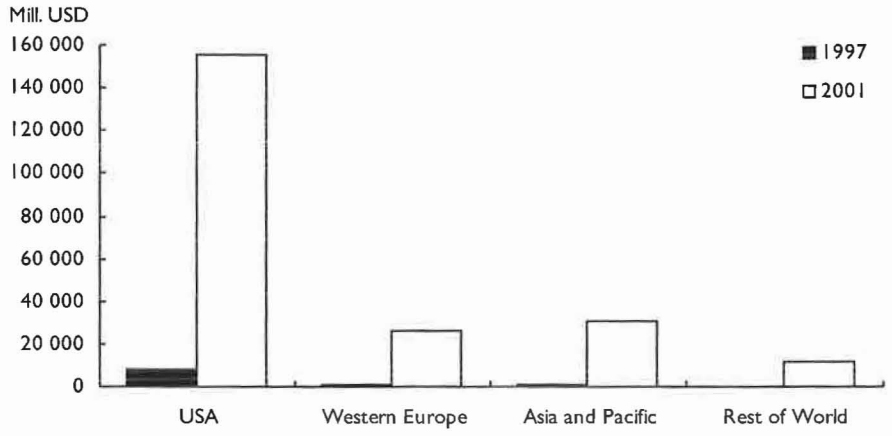


Figure 3.2b Internet commerce volume (in million USD)



Source: IDC (1997).

The number of Web users was expected to grow from 50.2 million in 1997 to 174.5 million in 2001 (Figure 3.2a). The U.S. dominated the Web population in 1997 (58 per cent), but this percentage was declining (54 per cent in 2001). IDC forecasted Asia/Pacific to "leap-

frog" Western Europe in Web population by 2001, replacing Europe as number two behind the U.S. The greatest payoff for corporations that invested in the Internet was expected to come from conducting business on the Internet (Figure 3.2b). Between 1997 and 2001, IDC estimated that online transactions would soar from USD 10 billion to USD 220 billion, that is, from less than 0.05 per cent to just under 1 per cent of the global economy. While the U.S. was expected to dominate Internet commerce through 2001, its market power was expected to slip from about 80 per cent of worldwide volume in 1997 to less than 70 per cent in 2001.[28]

European mobile communications: Absolute growth, relative erosion

There are critical differences between the U.S. digital economy pioneers and the European mobile communications pioneers. The first have enjoyed the benefits of efficient risk capital markets, which were crucial in the early years of the pure Internet players. They have also benefited from scale and scope, which has been important in the growth stages of these companies. In contrast, most European mobile communications players have found it difficult to gain access to risk capital. Even more importantly, most of them simply have not had comparable access to scale and scope, due to the far more fragmented European markets.[29]

At the very end of the 1990s, for example, the small Nordic countries had already achieved the highest penetration rates. Scale and scope were found primarily in major EU countries, which, except for Italy, still had low penetration rates (Figure 3.3a). Conversely, small Nordic countries had become largely saturated and had low market potential (Figure 3.3b). The high growth prospects, thus, were now in the major EU markets, not in northern Europe. In the handset shipments, for instance, the high volume was entirely in the major EU markets.

Figure 3.3 Nordic ICT pioneer countries: The erosion of leadership in late 1999

Figure 3.3a Western Europe: Cellular penetration

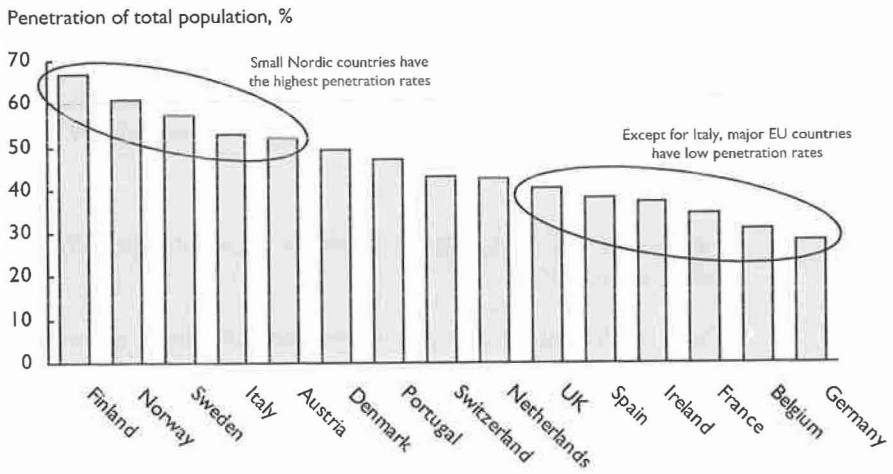
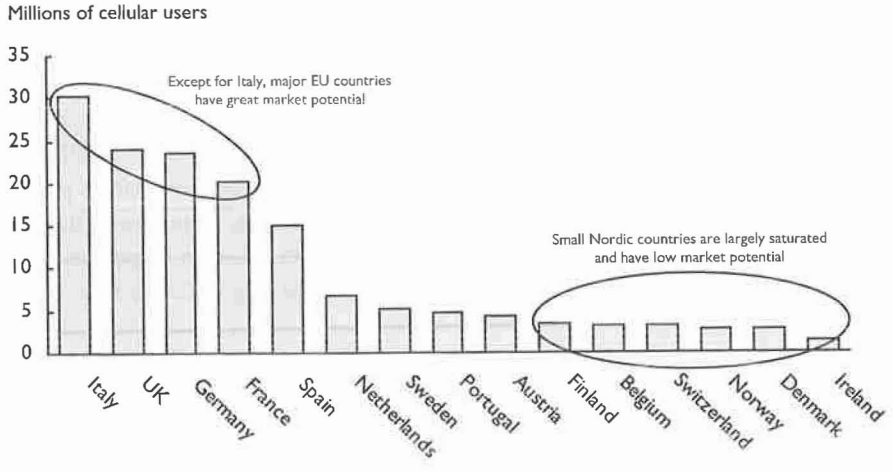


Figure 3.3b Total cellular market size



Source: Strategy Analytics (2000a).

Figure 3.4 Worldwide cellular/PCS markets 1997-2005

Figure 3.4a Worldwide cellular/PCS subscriber penetration

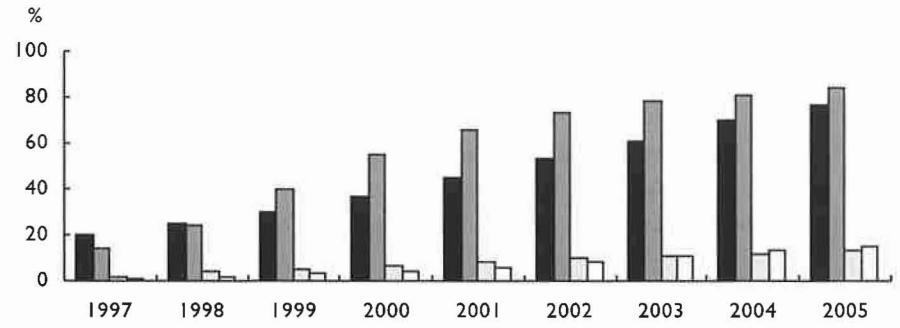


Figure 3.4b Worldwide cellular/PCS service revenue

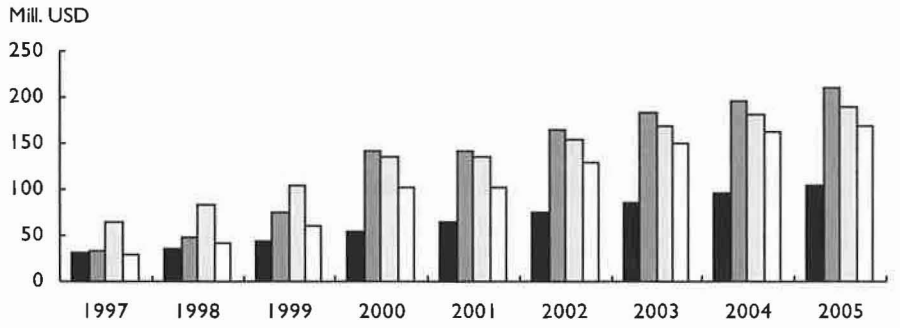
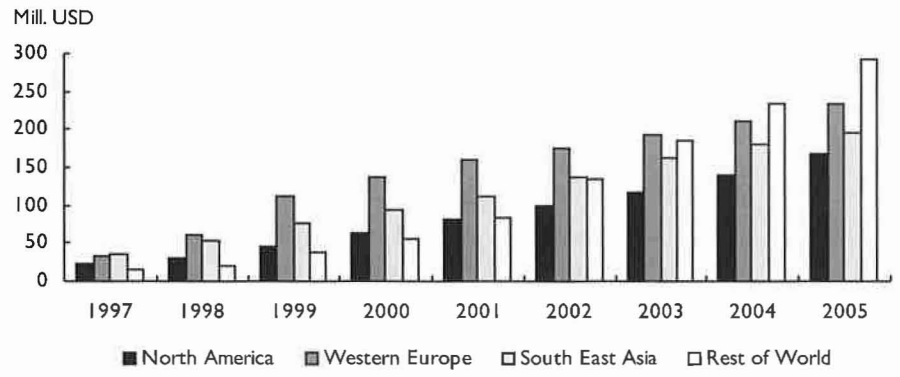


Figure 3.4c Worldwide cellular/PCS shipments



Source: Strategy Analytics (2000b).

In the past, pioneership made the difference, but by 2000, scale and scope – i.e., the total market size – was more important. U.S. digital economy first-movers were primarily industry pioneers; they benefited from efficient risk capital, and they had scale and scope. In European mobile communications, these first-movers were technology pioneers that managed to translate their competitive edge into industry leadership, but many had neither comparable access to early-stage risk capital nor scale and scope. The EU markets remained far more fragmented compared to those in the U.S. The strategies of the ICT pioneers reflected these facts – in terms of growth and risk orientation, investment allocations, and innovation policies.

The edge in mobile communications did provide a window of opportunity to ICT pioneers and startups at the turn of the millennium. Take worldwide cellular/PCS markets. In 1999, Western Europe surged past North America in terms of population penetration, with total penetration more than 40 per cent (Figure 3.4a). Between 2000 and 2002, the penetration rate in Western Europe was expected to exceed that of North America by some 20 per cent. The major and pioneering EU countries had a window of two or three years to exploit their dynamic advantage. Between 2003 and 2005, the catch-up game was expected to erode this difference to 7 per cent. Concurrently, South East Asia would trail far behind the two leading trading blocks (13 per cent in 2005).

In worldwide cellular/PCS service revenues, South East Asia was the leader with a 37 per cent share of the global annual service revenues in 1999 at USD 104 billion (Figure 3.4b). Between 2000 and 2005, Western Europe would reclaim its first place with USD 210 billion in service revenues in 2005, while South East Asia (USD 190 billion) and North America (USD 104 billion) would trail behind.

Powered by a 16-point jump in penetration, Western European handset shipments reached 113 million in 1999, representing 41 per cent of global unit volume (Figure 3.4c). South East Asia was the second largest demand center at 77 million units (28 per cent) followed by North America (17 per cent). With the explosion of the replacement market, Western Europe, by 2005, was expected to soar to 234 million units, followed by South East Asia (197 million) and North America (167 million).[30]

Despite their edge in mobile communications, then, it was debatable how well and for how long the European ICT firms could stay ahead.

After all, this strategic window necessitated the kind of dynamic strategies that the U.S. ICT pioneers were far more familiar with than their European counterparts.

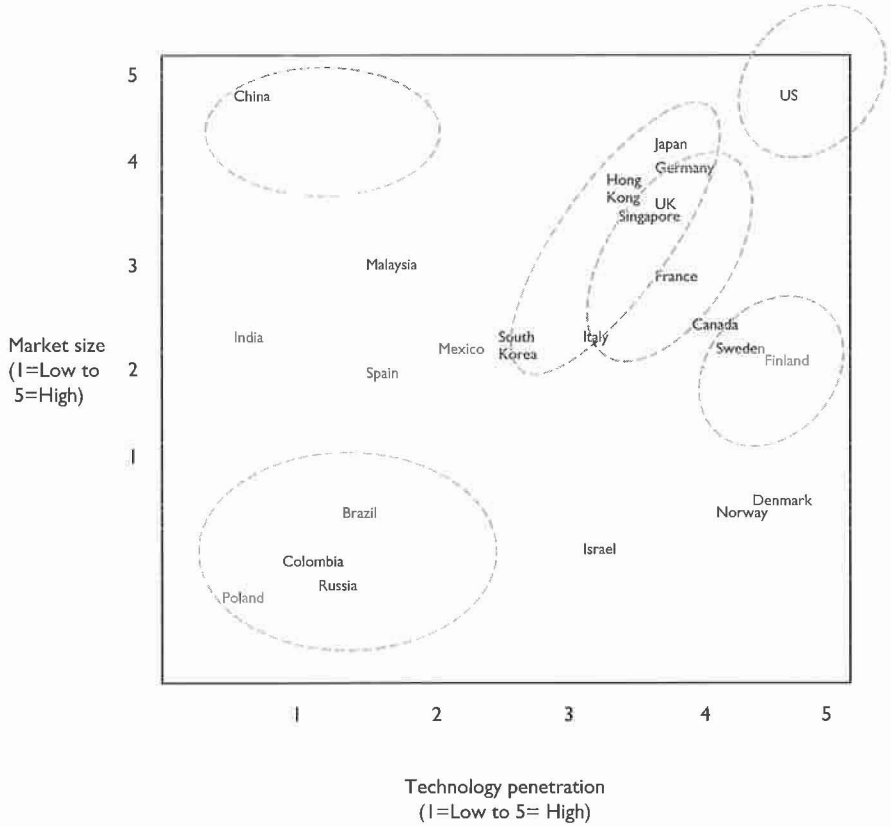
3.2. Two kinds of pioneership

With the IPO of Amazon.com and the first wave of pure e-commerce plays, the U.S. became the world's leading e-commerce superpower, with Germany, the U.K., Japan, and Canada its nearest challengers, reported *Forrester Research* in 1997. The market research firm ranked 45 of the world's largest economies – from Argentina to Turkey – based on market size, technology penetration, and cultural and political climate. Each country was then assigned a final grade that reflected its overall viability for e-commerce (see Appendix 1). While countries like the U.S. and Japan set the pace for deploying e-commerce, the market research firm found that other traditionally strong economies, including France, Italy, and Australia, risked falling behind. Conversely, the researchers urged international business and government leaders to look to wired smaller markets, such as Finland, Sweden, and New Zealand, for a glimpse of the future reach of e-commerce.[31]

In retrospect, the Forrester report may have underestimated the national technology capabilities of several emerging markets (e.g., China, Malaysia), as well as the significance of scale and scope in integrated markets (the U.S.) as opposed to fragmented markets (the EU). In effect, if strategic attention is focused only on market size (as proxy of scale and scope) and technology penetration (as proxy of Internet and mobile capabilities), the data demonstrate the potential success of global e-commerce in the first mover (the U.S.), the major EU nations (Germany, UK, France, Italy), and the leading Asia/ Pacific countries (Japan, Hong Kong, Singapore, South Korea).

Building upon Forrester's data, these results can be visualized (Figure 3.5). Due to its great potential scale and scope, China plays a critical role as a future market. Despite the pioneership of the Nordic countries, their volume potential is too insignificant to play a crucial role in the high-volume markets. Finally, potential instability, economic polarization, and low technology serve as barriers of economic and technology expansion in emerging and transitional economies, just as a military and political instability can serve as barriers even in countries with relatively high technological infrastructure (Israel).

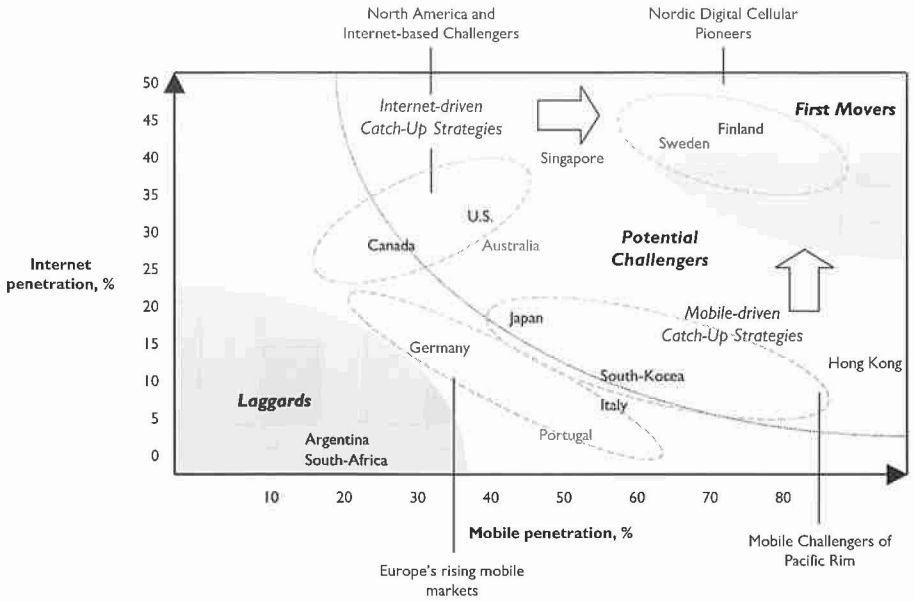
Figure 3.5 Global e-commerce potential in 1997: Market size and technology penetration



Source: Forrester Research (1997).

If strategic attention is focused on Internet capabilities (with online penetration as an approximate proxy) and mobile capabilities (with mobile penetration as a comparable proxy), the Nordic nations – not the U.S. – are the digital cellular pioneers (Figure 3.6). Potential challengers come from two directions. High Internet capabilities give rise to Internet-driven catch-up strategies (North American players), while high mobile capabilities prompt mobile driven catch-up strategies (key EU and Asia/Pacific players). Low Internet and mobile capabilities reflect laggard catch-up strategies (emerging and transitional economies). If, however, scale and scope were to be factored into these estimates, the roles of the U.S., Japan, and certain Asia/Pacific nations, as well as those of the leading EU countries, would prove far more critical. Additionally, if strategic attention were focused on the

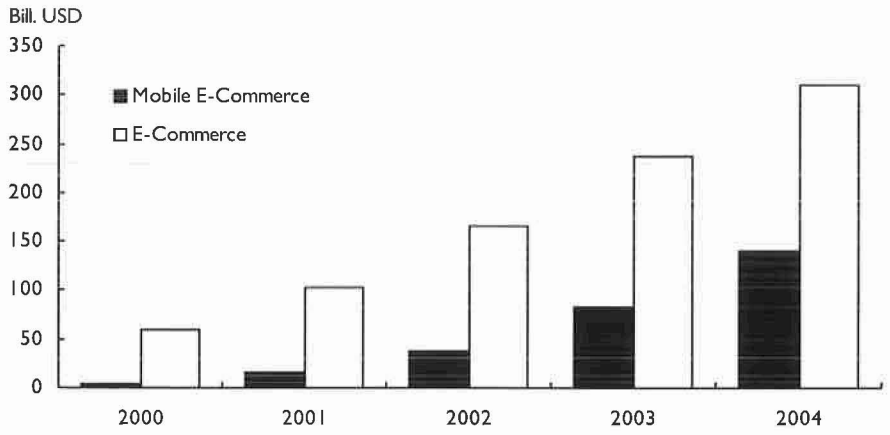
Figure 3.6 Internet and mobile capabilities: National strategies (1999)



high-volume markets, integrated markets would prove far more beneficial than fragmented markets, boosting the fortunes of great national markets, such as the U.S., Japan, Germany, the U.K, and China.

What kind of scale and scope are the ICT pioneers preparing to struggle for? In preliminary estimates between 2000 and 2004, market research firms expected worldwide mobile e-commerce revenues to soar 40-fold, from less than USD 3.6 billion to more than USD 140 billion (Figure 3.7). Of this amount, some 35 per cent (USD 48.9 billion) was expected to go to Western Europe and some 23 per cent (USD 32.4 billion) to North America. Concurrently, worldwide e-commerce was expected to grow more than fivefold, from USD 59 billion to USD 310 billion. Of this amount, 60-75 per cent originated from North America (USD 186-233 billion).[32] Due to uncertainty and different methodologies, the estimates varied significantly among different market research firms. By 2000, digital economy was growing quickly but not as quickly as mobile communications. While the U.S. enjoyed absolute superiority in the worldwide digital economy revenues, it also had a significant role in the mobile communications revenues. Mobile communications revenues were growing explosively, but, as previously noted, U.S. ICT firms have traditionally been more familiar with dynamic strategies than their European rivals.[33]

Figure 3.7 Worldwide Internet and mobile revenues 2000-2004



Source: Ovum Ltd. (2000), Strategy Analytics (1999).

Historians and researchers of mobile cellular have argued that a converging set of determinants caused the Nordic countries to take the lead in the nascent cellular services.[34] These factors – particularly dispersed populations, rapid technology adoption, relatively high-income levels, market-driven public policies, historical local competition and price parity (fixed, wireless), absence of handset subsidies, and "calling party pays" principle – have been relatively similar in all Nordic countries. They may explain the rapid penetration of the digital cellular in the Nordic countries as opposed to other developed cellular markets (until recently, that is).

The recent leadership of Finland vis-à-vis other Nordic countries stems from several additional factors. In politics, the end of the Cold War and the collapse of the Soviet trade allowed the Finns to catch up with market developments that the Scandinavian countries had enjoyed for decades. In the public sector, the Finnish authorities, since the 1980s, have consistently liberalized more quickly than their Swedish counterparts. In the marketplace, the Finnish telecom/mobile vendors and operators have also been faster than their Scandinavian competitors in first-mover strategies, not least because of Nokia's hyper growth. Consequently, the Finnish success drivers – geopolitics, public strategies, and firm-level first-mover advantages – have been unique vis-à-vis the other Nordic countries.

However, these drivers may not be sustainable in the ongoing transition from the digital cellular to third-generation rivalry and the mobile Internet. Until the very end of the 1990s, the Finnish ICT cluster enjoyed most typical first-mover advantages.[35] Signs of erosion did become discernible toward the very end of the 1990s. Take, for instance, WAP (wireless application protocol), which the mobile vendors oversold and the media over-hyped. As operators found WAP to be a "bug-infested transitional technology," as some put it less diplomatically, existing and potential buyers became more discriminating with other Finnish offerings as well.

Meanwhile, Asian consumer-electronics giants were mounting a low-cost challenge they had failed to accomplish in the course of the second-generation rivalry. Starting in the low-end segments, these attacks were felt among the "big three" (Nokia, Ericsson, and *Motorola*), which all suffered significant share price erosion in July 2000.[36] Severe attacks in low-end segments may translate to erosion in premium pricing in high-end segments. If these attacks are driven by disruptive rather than sustaining technologies and business models, even industry giants may find themselves in trouble.[37]

Through the 1970s, 1980s, and 1990s, the Nordic countries have played a pioneering role in the development, formulation, and implementation of mobile strategies in the first-generation and second-generation competition. Since the close of the 1990s, however, the strategic drivers that had made the Finnish telecom/mobile cluster a success were eroding. That, of course, did not mean that the Finnish companies were "losing" the competition. Instead, it meant that these firms, like other Nordic players, would have to find ways to renew the sources of strategic advantage, in order to thrive in the impending 3G rivalry. They had excellent strategic starting positions; the question was whether these could be translated to success in the new and dynamic markets. In terms of the second-generation environment, 3G represented a disruptive change.[38]

* * *

By year 2000, the mobile communications businesses in Europe were in a situation similar to that of the U.S. digital economy pioneers around 1991-1993, i.e., the years that witnessed an intense competition over the impending "information superhighways." "Over the next three or four years," reported *The Economist,* "European telecom and mobile giants would have to invest more than USD 300 billion in order to bring together the mobile telephone and the Internet... In Asia, Japanese and

South Korean firms have been given their new licenses free of charge, while in America, forever, it seems, the mobile laggard, the vital spectrum has still to be released. What makes this a leap in the dark of such titanic proportions is that nobody knows if consumers will want the new services – or even exactly what they will be."[39]

Meanwhile, the "mobile laggard" was about to wake up. On October 13, 2000, President Clinton announced a timeline for rearranging U.S. airwaves to make room for third-generation wireless technology. The government planned to free up space that was crowded by broadcasters, government agencies and others by hosting a mammoth auction in 2002. The bidders would decide who would buy a piece of the country's wireless future and who would be left out. Industry observers expected a complicated, highly political process and staggering bids. Clinton told federal government agencies and the private sector to work together to determine, by July 2001, which chunks of the radio spectrum could be offered to 3G systems in a September 2002 auction. The president said that "time is of the essence" because if the country did not move quickly, it "could lose market share in the industries of the 21st century."[40]

The Clinton announcement followed years of increasing frustration over the stumbling of the FCC amidst the mobile tornado. With its pro-technology policies, the administration paved way for the information infrastructure and e-commerce. By the spring of 2001, however, the Democrats had left the White House and the new Bush administration, while highly pro-deregulation, was not expected to develop and implement activist technology policies.

In the U.S., the digital economy pioneers had the requisite dynamism, scale and scope, but lacked the relevant capabilities in mobile communications. In Europe, many of the mobile communications pioneers lacked scale and scope but possessed the relevant capabilities. The former struggled to survive the ongoing consolidation in the technology sector. The latter struggle to survive the costs of the 3G birth pains.

The mobilization of the digital economy began with extraordinary risk and uncertainty, in which the pioneers might not have the complementary capabilities to survive as first-movers, and where the first-movers might not be those who pioneered the markets. In the stock exchanges, the convergence of mobility and the Internet was the "next big thing." It was far more difficult to determine which companies would be the "next big players" in the long run.

APPENDIX 1: GLOBAL E-COMMERCE POTENTIAL: MARKET SIZE, TECHNOLOGY PENETRATION, AND POLITICAL CLIMATE IN 1997

	Country	Market Size	Tech Penetration	Political Climate
Superpowers	United States	5	5	5
Contenders	Germany	4	4	5
	United Kingdom	3.75	4	5
	Japan	4.25	3.75	4.25
	Canada	2	4.25	5
Gateways	Singapore	4.75	3.75	4
	Netherlands	2.25	4.75	4.75
	Belgium/Lux.	3	3.75	4.75
	Hong Kong	4	3.75	3+
Sprinters	Finland	2	5	5
	Sweden	2	5	5
	Denmark	2	5-	5
	Norway	2	4.75	5
	New Zealand	1.25	4.75	5
Stragglers	France	3	4-	4.25
	Australia	2	4.25	4.25
	Italy	3	3.25	4.25
	South Korea	1.75	3.25	2+
	Spain	1.75	1.75	3.75
Wild Cards	Switzerland	2	4.75	4
	Austria	1.75	4.25	4.75
	Ireland	1.75	3	4.25
	Israel	1.25	3.25	2
	South Africa	1	3	2.75
Low Techs	Mexico	2-	2.25	3
	Malaysia	2-	3	3.75
	Greece	1	2.25	3
	Brazil	2	1.75	2
	Chile	0.75	2.25	2
	Indonesia	0.75	1.75	2
	Czech Republic	0.75	1.75	2
	Portugal	0.75	1.75	2
	Turkey	1	1	2.25
	Argentina	1	1	1.75
	Venezuela	1	1	1.75
	Colombia	1	1	1.75
	Poland	0.75	0.75	1.75
	Thailand	1	0.75	1.25
Resisters	China	5	0.75	0.75
	Saudi Arabia	0.75	2.25	1.25
	India	2.25	0.75	1
	Philippines	0.75	1	1.25
	Russia	1.25	0.75	1
	Pakistan	0.75	0.75	1.25
	Iran	0.75	0.75	0.75

Source: Forrester Research (1997).

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ENDNOTES

[1] Gautam Naik: *Europe's Cell Phones Reach Out, Offer Movable Feast of Services*, Wall Street Journal, June 3, 1999.

[2] Compare the reports by Forrester Research and Jupiter Communications toward the end of the 1990s, especially Mines et al. (1997) and Neufeld (1998).

[3] On these changes and shifts of the R&D regimes, and the increasing technological complexity and novelty, see Iansiti (1998) and Steinbock (2001c).

[4] On the role of Nordic firms in the digital cellular rivalry and the emerging 3G competition, see Steinbock (2001a, 2001b).

[5] On these microeconomic foundations and reforms, see Porter (1999b). On cluster research and locational advantage, see Porter (1990, 1998, 1999a, 1999b).

[6] See the conclusions of the Board of Science, Technology, and Economic Policy of National Research Council in Mowery (1999), especially Preface.

[7] On strategy and innovation, see Steinbock (2001b).

[8] See Mowery & Nelson (1999), especially Chapters 1 and 9.

[9] The analysis pertains to the situation as in October 2000. Since then, Merita-Nordbanken has merged with four other Nordic banking and insurance companies (i.e., *Christiania Bank og Kreditkasse*, *Tryg-Baltica, Unidanmark,* and *Vesta*) to form *Nordea*.

[10] Meeker & DePuy (1996).

[11] Meeker & DePuy (1996, p. 1-12); Steinbock (1997).

[12] In a study by the University of Texas' Center for Research in Electronic Commerce, revenues and jobs were measured using a four-layer structure developed by the researchers. The four-layer structure bears great resemblance to those developed by Morgan Stanley Research and Forrester Research, Inc. between 1995 and 1997.

[13] See endnote 9.

[14] Ostry and Nelson (1995), especially Chapter 1. See also Nelson and Wright (1992).

[15] On these early years of the Internet, see Hafner and Lyon (1996).

[16] See OEEC (1959), pp. 85-90.

[17] Compare Ostry (1997), especially Chapter 1.

[18] White House (2000, p.21).

[19] U.S. Department of Commerce (2000).

[20] This section draws from Steinbock (2001a).

[21] Historically, PTT denoted the Ministry of Post, Telecommunications and Telegraph. Now a term to describe the incumbent, dominant operator in a country, many of which are being or have been privatized.

[22] With the new Telecommunications Act (1996), regulatory obstacles were largely eliminated, in exchange for assurances for competition. Furthermore, with accelerating digitalization and online migration, local, long-distance, and Internet segments were rapidly converging. As AT&T entered local telecommunications through cable, *Verizon* (formerly *Bell Atlantic*) obtained permission to launch long-distance operations. Meanwhile, both companies were already competing in the Internet services and rushing toward the mobile Internet.

[23] Steinbock (1995), p. 85.

[24] See Cornet et al. (2000).

[25] This phenomenon has been described in another report by McKinsey consultants in 1998, alarmingly entitled "Full telecom competition in Europe is years away." See Beardsley (1998).

[26] See Cornet et al. (2000).

[27] Some of these new additions were barely 20 to 30 years old, including such as Microsoft and Intel, the world's biggest computer chip maker, which were traded on the Nasdaq stock market. These two were the first Nasdaq stocks to make the DJIA (Dow Jones Industrial Average), which had driven the 207-year-old New York Stock Exchange until 1999. The changes in the Dow were the first since 1997, the year Hewlett-Packard was added.

[28] See IDC (1997).

[29] These two factors play a critical role in Europe's alleged "small market syndrome." See Steinbock (2000d).

[30] Strategy Analytics (2000).

[31] Forrester Research (1997).

[32] See Ovum Ltd (2000), Strategy Analytics (1999).

[33] On the erosion argument, see Steinbock (2001a).

[34] On these determinants, compare Garrard (1999, pp. 51-52), Steinbock (2001a, 2001b), and ITU (1999).

[35] On first-mover advantages, see Steinbock (2001a). On first-mover advantages as drivers of industrial capitalism, see Chandler (1990); on these advantages and dynamic capabilities, see Teece (1993).

[36] In Europe as well, the second-tier industry players were emulating the success drivers of the "big three." Take, for instance, the impressive turnaround of Siemens in the mobile-phone business. Led by a slate of new products, it was on track to triple its sales of mobile phones in the year 2000, to 30 million, while passing Alcatel and Ericsson to take the third position behind Nokia and Motorola in Europe. Like Nokia and Ericsson, it was paying increasing attention to marketing, design, and costs.

[37] Compare Steinbock (2001a).

[38] Most new technologies foster improved product performance. These *sustaining* technologies can be discontinuous or radical in character. Occasionally, however, *disruptive* technologies emerge. They bring to a market a very different value proposition that had been available previously; they also provide great opportunities to new and agile startups, just as they often result in the demise of the old industry leaders. See Christensen (1997).

[39] See "The Wireless Gamble," *The Economist,* October 12, 2000.

[40] White House Press Release, October 13, 2000.