Nordic ICT Foresight:

Futures of the ICT environments and applications on the Nordic level

Summary Report

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Participant organisations in the project

Research / core partners

1. DTI, Danish Technological Institute (Denmark)
2. FOI, Swedish Defence Research Agency (Sweden)
3. SINTEF, Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology (Norway)
4. VTT Technical Research Centre of Finland (Finland)

Cooperation partners

5. Confederation of Danish Industries (Denmark)
6. The Danish Society of Engineers (IDA) (Denmark)
7. Ericsson Microwave Systems (Sweden)
8. Vinnova (Swedish Innovation System Agency) (Sweden)
9. Göteborg Pediatric Growth Research Center at Göteborg University (Sweden)
10. Abelia (Norway)
11. LO (Landsorganisasjonen) (Norway)
12. The Research Council of Norway (Norway)
13. SIVA - The Industrial Development Corporation of Norway (Norway)
14. Oslo Innovation Center (Norway)
15. Nokia Corporation (Finland)
16. Sitra (Finland)
17. Stakes (Finland)
18. Technology Industries of Finland (Finland)
19. TEK, Finnish Association of Graduate Engineers (Finland)

Title: Nordic ICT Foresight: Futures of the ICT environments and applications on the Nordic level
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Abstract: The Nordic ICT Foresight project was launched in May 2005 with research partners VTT (Finland), FOI (Sweden), SINTEF (Norway) and DTI (Denmark). The aim of the project was to contribute to the strategic intelligence of the Nordic knowledge region so that the full potential of information and communication technology can be exploited to increase the welfare in the Nordic countries. The focal areas of the ICT applications in this study were experience economy, health, production economy and security. In the research process there were five research phases: 1) desktop survey, 2) SWOT analysis, 3) scenario and vision workshop, 4) roadmapping workshop and 5) action workshop. The research phases were carried out as focused workshops that applied different methods. Some policy recommendations were formulated on the basis of the research process. Policy recommendations were divided into implementation strategies, i.e. actions that should be proactively pushed through on the Nordic level, and adaptive strategies, i.e. actions that are more reactive in the face of global developments. The implementation strategies were the following: 1) the creation of Nordic SME-based competence clusters and/or platforms in converging technological niches, 2) enhancing the utilisation of mobile ICT infrastructures to include remote monitoring, 3) an initiative for the creation and integration of Nordic test markets for ICT applications and ICT policies in the health sector, 4) a Nordic level research and policy initiative to develop new ICT-based concepts for information and general security, 5) the ideation and creation of new business models for the user-driven application developments, and 6) a Nordic initiative to enhance electronic business transactions and applications. The formulated adaptive strategies were: 1) deeper understanding of the cultural contexts of new services and solutions, 2) learning to utilise and productise innovations in the second or third wave, 3) widening the scope of innovation and learning to “recycle” the ideas into new niches, and 4) creating strategies for the utilisation of a “long tail” in the Nordic sphere.
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Executive summary

The purpose of this project was:

The aim of the project was to contribute to the strategic intelligence of the Nordic knowledge region so that the full potential of information and communication technology can be exploited to increase the welfare in the Nordic countries. The focal areas of the ICT applications in this study were experience economy, health, production economy and security. The more specific research and process aims were the following:

- To explore appropriate ways of implementing the innovative ICT applications and systems (prioritise the research, development and commercialisation of ICT, consider the required infrastructure technologies);
- To estimate and compare the implications of the ICT applications in the Nordic countries (Denmark, Finland, Norway, Sweden);
- To create scenarios illustrating the prospects for possible future applications for IC technologies with regard to technology, application and market issues;
- To build roadmaps of the developments in ICT applications in a ten-year timeframe;
- To provide solutions whereby ICT can make positive contributions to societal wellbeing;
- To evaluate the Nordic opportunities in ICT with longer-term growth potential;
- To assist in developing appropriate framework policies that facilitate the developments in the desired directions;
- To evaluate and reflect on the elements that are unique in applying the ICT applications in Nordic culture.

The study has achieved these aims by:

- Defining the boundaries of the technological field in the desktop study.
- Mapping trends in the national ICT business and research environment in research, industry, finance and government policy in the Nordic countries.
- Analyzing and elaborating emerging Nordic technologies in the workshop
- Depicting trends in the national ICT business and research environment in the four Nordic countries: Finland, Sweden, Norway and Denmark.
- Identifying the strategies that Nordic countries are currently following and by analyzing their key capabilities, strengths, key limitations and weaknesses in the future.
- Creating a scenario set of the future adoption of ICT applications in the Nordic region and testing potential sociotechnical ICT visions against this scenario set.
- Studying linkages between small and large sociotechnical visions and characterising the required developments in science and education, technologies, businesses and industries, markets and government level via roadmaps.
- Identifying a set of actions to be taken by the key players in the Nordic countries in order to support the desirable developments and successful implementation of the new innovative ICT solutions.

- Identifying and producing robust implementation strategies and adaptive strategies for the Nordic level developments in ICT applications.

Method:

The study was based on a combination of different methods.

In the desktop study, some 60 reports and documents were analyzed in order to form a picture of the most important development trends and to find key similarities, differences and complementarities in the four Nordic countries' (Denmark, Finland, Norway, Sweden) ICT environments.

In the SWOT phase, the ICT environments of these countries were further analyzed by workshop methods, questionnaires and interviews.

The two-day scenario workshop attracted 19 experts and a variety of methods were applied: the Shell scenario method, facilitated visionary brainstorming, clustering and scenario evaluations.

The two-day roadmapping workshop comprised 24 experts. Again, a variety of methods were utilised: facilitated visionary brainstorming, visionary sociotechnical roadmapping and scenario-based roadmapping.

The action workshop attracted 21 experts. The methods were facilitated workshops utilising delta analysis, scenario-based matrices and action path matrices.

Main results:

The Nordic ICT Foresight project was launched in May 2005 with research partners VTT (Finland), FOI (Sweden), SINTEF (Norway) and DTI (Denmark). The aim of the project was to contribute to the strategic intelligence of the Nordic knowledge region so that the full potential of information and communication technology can be exploited to increase the welfare in the Nordic countries. The focal areas of the ICT applications in this study were experience economy, health, production economy and security. There were five research phases in the research process. In the first phase, **the desktop survey,** the boundaries of the technological field were defined. The second phase, **the SWOT analysis**, identified trends in the national ICT business and research environment in four Nordic countries: Finland, Sweden, Norway and Denmark. The third research phase, **the scenario and vision workshop**, had two purposes: to create a set of external scenarios in Nordic ICT applications and to produce a set of sociotechnical ICT application visions. The fourth phase, **the roadmapping workshop**, created roadmaps on sociotechnical visions on the levels of science and education, technologies, businesses and industries, markets and government. In the final research phase, **the action workshop**, a set of actions to be taken by the key players in the Nordic countries were depicted.

The key results of the **desktop survey** illustrates that there are significant differences in scope, scale and goals for foresight activities in the four Nordic ICT Foresight countries (Denmark, Finland, Norway, Sweden). In a generalised fashion, it can be stated that the Swedish ICT material had strong descriptive sociotechnical emphases, the Danish material combined descriptive technological emphases with societally flavoured policy

recommendations and the Norwegian material mainly combined descriptive technological and policy foci with some societal emphases. The Finnish material mainly combined descriptive technological foci with quite technologically oriented policy initiatives.

Some Nordic level conclusions that cut across the Nordic ICT Foresight themes can be drawn from the national **SWOT analyses**. The Nordic countries have a lot of similarities in strengths, which emphasise the ICT infrastructure, education levels and literacy. In addition, advanced markets are an important Nordic strength. The common weaknesses are the generally weak capacities for building commercial solutions from technological developments. Risk funding is another common weakness. Opportunities are to be found in user-centred open innovation processes, in the creation of Nordic SME-based competence clusters in niche areas, the formation of a common Nordic test market for health applications and complementarities in the Nordic industrial structures. Common Nordic threats are the development of Asian R&D competences, lack of new business models and concepts, and lack global and visionary views in the development of ICT applications.

In the **scenario workshop**, four external sociotechnical scenarios were created for the Nordic level. Scenario 1, *ICT for Security's Sake*, describes a very security-driven development of ICTs. Scenario 2, *Nordic Mystique*, emphasises a harmonic open source and SME-based development in a Nordic welfare-driven society. Scenario 3, *Elite User's Paradise*, portrays a globally fragmented and class divided society of elite users, common users and ICT dropouts. Scenario 4, *Big Business Lock-In*, depicts an ICT future dominated by big players.

In the **roadmapping workshop**, visionary socio-technical roadmaps were constructed on the Nordic ICT Foresight themes. In experience economy, the roadmap topics were automatic language translation and intelligent fabrics and paper. In health, the roadmap topic was intelligent systems for self care, diagnosis and monitoring. In production economy, the roadmap topic was a control system for environmentally sustainable and efficient energy usage. In security, the roadmap topics were a secure management system for energy and a personal traffic agent for security. In addition to these thematic and application-oriented roadmaps, Nordic level summary roadmaps were also formed.

In the **action workshop**, the scenarios were further elaborated in the delta analysis. The analysis clarified the outcomes of the scenarios for the Nordic ICT Foresight themes. The action workshop also drafted Nordic level action proposals for each of them, which were utilised in the creation of the policy recommendations.

Some **policy recommendations** were formulated on the basis of the research process. The policy recommendations were divided into implementation strategies, i.e. actions that should be proactively pushed through on the Nordic level, and adaptive strategies, i.e. actions that are more reactive in the face of global developments. The *implementation strategies* were the following: 1) creation of Nordic SME-based competence clusters and/or platforms in converging technological niches, 2) enhancing the utilisation of mobile ICT infrastructures in remote monitoring, 3) an initiative for the creation and integration of Nordic test markets for ICT applications and ICT policies in the health sector, 4) a Nordic level research and policy initiative to develop new ICT-based concepts for information and general security, 5) the ideation and creation of new business models for the user-driven application developments, and 6) a Nordic initiative

to enhance electronic business transactions and applications. The formulated *adaptive strategies* were: 1) deeper understanding of the cultural contexts of new services and solutions, 2) learning to utilise and productise innovations in the second or third wave, 3) widening the scope of innovation and learning to "recycle" the ideas into new niches, and 4) creating strategies for the utilisation of a "long tail" in the Nordic sphere.

Policy recommendations:

Implementation strategies

- Creation of Nordic SME-based competence clusters and/or platforms in converging technological niches. Focal niches in these clusters could be the following. (1) *Sensor-based enhanced reality systems*. This niche could be directed to both professional applications requiring multi-sensory experiences and applications with more entertainment value. The second potential Nordic niche could be linked to (2) *Intelligent buildings and home automation*. In this case the direction would lead to technologies embedded in the everyday environments. One of the directions could be to focus on energy saving systems and home security systems. The third potential niche could be (3) *Development of mobile digital management applications especially for the production systems*. The core of this proposal is to foster development of mobile digital management applications in production systems, e.g. production lines and logistic chains. The key to this proposal is to concentrate on flexible interfaces (via mobile phone or laptop) and dynamic peer-to-peer networks.
- **Enhancing the utilisation of mobile ICT infrastructures in remote monitoring**. One of the potential policy proposals in this context could be a research initiative to create context-aware systems and applications for the surveillance of the environment, e.g. "Baltic Sea and Barents on the screen". The developed applications could be applied in the monitoring of peripheral geographical areas, in monitoring the general changes in the environment, in traffic and infrastructure surveillance or integrated production systems, "factory on the screen".
- Initiative for the creation and integration of Nordic test markets for ICT applications and ICT policies in the health sector. The ICT-wise starting point for *the creation of a Nordic test market concept* would be to formulate a somewhat common Nordic health record on how to store, handle and distribute the patient data. The second step would be to establish a common platform for search and suppliers/providers of services. The second proposed angle is to make a platform for *the applications of distance medicine*. This would be a core function in Nordic level home medicine and distance monitoring concepts and technologies. Some applications developed on this platform could include systems that monitor and assist elderly people living at home: applications for monitoring day-to-day activities (if, e.g., blood pressure is too low, a signal is sent to the hospital) and, in addition, ICT-based diet and nutrition systems. The third proposed application in this context is *the formation of a common Nordic health card*. The formation of a health card requires the creation of an integrated health record system. The construction of the actual card could be based on mobile technologies.
- **Nordic level research and policy initiative to develop new ICT-based concepts for information and general security**. The core of this strategy would basically be to present an initiative that aims at building a common Nordic agenda for the research, development and policy activities in the field of ICT security. The idea

should be quite wide and, therefore, it should be based on the general notion of security that combines information security with social security and with environmental and network security. Reflecting on these discussions, the key questions are: identity management, dynamic privilege management, long-term preservation of the data and non-reproducing technologies. The question of biometric identification is the core of the issue. Biometric identification combines a lot of technologies and practices, e.g. biometric tags, the questions of security of biometric information and the prevention of malpractices with the biometric information.

- **The ideation and creation of new business models for the user-driven application developments**. The quite egalitarian Nordic welfare society combined with relatively low societal hierarchies could be fertile ground on which to form business concepts on the "longtail" of niche applications, on the basis of user and "amateur-driven" applications and ideas. The key question for the business concept lies in the system of payment. In this case the key questions are the following: is the payment system closed, meaning that you pay for the key and the access, or open, meaning that you browse through a mass of advertisements to see the content? A potential Nordic niche could be to create ***advanced micro-payment systems and business concepts linked to user-generated products and business models***. These concepts should be future-oriented and seriously consider the already crucial issues of file sharing, IPR and digital rights management (DRM).
- **The Nordic initiative to enhance electronic business transactions and applications**. The Nordic area is well developed in its information infrastructures, but there are some gaps in the utilisation of ICTs as a business platform. In a recent Finnish Technology Barometer (Lehtoranta et al. 2007) it was acknowledged that there is still a lot to do in the development of e-commerce and digital communications in the consumer markets and in the business-to-business models. Besides, e-business functions are focused on large firms.

Adaptive strategies

- **Towards deeper understanding of the cultural contexts of new services and solutions**. The leading mobile firms have for some time experienced some "cultural frictions" because of the enhanced encounters with new cultures, locations and rapidly evolving market segments. This cultural and geographical market change can be called horizontal. However, there are also vertical market changes. The market segmentation also happens in the low-end and high-end continuum.
- **Learning to utilise and productise innovations in the second or third wave**. All the basic technology need not be developed by the firms themselves – the additional strategy might be to find new niches and areas for the old innovations or by bettering and smoothing the older innovations so that they could be utilised in older market areas.
- **Widening the scope of innovation and learning to "recycle" the ideas into new niches**. In ICT and industry in general there is a need to identify the innovation as a wider process than just developing a technology and making a product out of it. The innovations could be linked to the processes, to the brand, to the market segments or to the niches. Therefore, older technological solutions might be innovations in new areas.
- **Creating strategies for the utilisation of a "long tail" in the Nordic sphere**. The idea of the long tail is to make small niche products for minorities in a mass

production fashion. The advanced Nordic ICT production technologies and energetic cultural industries - e.g. in music and multimedia - and flat “user-driven” societal models could enable application of this idea of “segmented mass customisation” in a variety of fields.

Preface

In May 2005, representatives of VTT (Finland), FOI (Sweden), SINTEF (Norway) and DTI (Denmark) proposed a project on ICT applications in the Nordic context. In its generality, the topic was intriguing and yet it seemed crucial to generate some wide-ranging views on the field of economic activity that had created wealth through unique competences in the Nordic area. The generality, however, posed the challenge of targets for the project: Where to aim in the vast field of ICTs? What are the key foci of this exercise?

The starting point was that the exercise should be future-oriented, scanning the horizons and probing the depths, but in a grounded fashion. This means that the limits of the exercise were defined from the Nordic perspectives – the search for future-oriented knowledge of ICT applications and infrastructures was primarily understood through a somewhat regional view by emphasising those branches of ICT that had some intrinsic value on the Nordic level. Of course, there was the advantage that the Nordic countries have such a rich dynamism in the field of ICTs – global players, dynamic SMEs, state-of-the-art research and development, advanced governmental cultures willing to adopt new ICT solutions and demanding customers – that the story to be told in this study was not to be just a regional one. It was, and undeniably is, a global story about the futures of ICTs in one northern corner of the old continent that has, due to some unique societal features, technological developments, business innovations and historical-geographical paths, become an interesting territory on the map of ICT development.

After this kind of optimistic sketching of the Nordic regional dynamics, the unwritten law of literature on competitiveness and foresight states that one should also be reminded about the uncertainties looming on the horizon. The future is, of course, full of unstable factors, but one should also remember that on the horizon, amidst sinister signs, there are unseen possibilities and potential that are yet to emerge. And that is why the Nordic region is such an interesting field in which to study the futures of ICTs. The Nordic countries have tasted long-term success because of their unique branches of the welfare societies. Because of their R&D innovations and business dynamics, these countries have played a key role in the development of the global information society. And because of their advanced education systems and SMEs, these countries still have potential to be at the cutting edge, despite the global challenges and changes in the balance of economic growth. The future is a landscape filled with peaks of possibilities for the one who understands the rifts and pitfalls.

In the spring-like countryside between Salo and Karjaa, 29.5.2007

Toni Ahlqvist

Introduction

In May 2005, representatives of VTT (Finland), FOI (Sweden), SINTEF (Norway) and DTI (Denmark) proposed a project on ICT applications in the Nordic context. The project was named "ICT Foresight and Roadmap towards Innovative Applications in the Nordic Countries", but it soon got the acronym "Nordic ICT Foresight". According to the original plan, the project aims were to identify, select and present scenarios illustrating the prospects for possible future applications for IC technologies with regard to technology, application and market issues. The specific aims of the project were to contribute to the strategic intelligence of the Nordic knowledge region. The main project core – a vision that has formed the bedrock of the workshop – was the general statement that the project should "increase the welfare in the Nordic countries and also in other parts of the world".

There were five research phases in the actual research process. In the first phase, the desktop survey, the boundaries of the technological field were defined. The second phase, the SWOT analysis, identified trends in the national ICT business and research environment in the four Nordic countries: Finland, Sweden, Norway and Denmark. The third research phase, the scenario and vision workshop, had two purposes: to create a set of external scenarios in Nordic ICT applications and to produce a set of socio-technical ICT application visions. The fourth phase, the roadmapping workshop, created roadmaps on socio-technical visions on the levels of science and education, technologies, businesses and industries, markets and government. In the final research phase, the action workshop, a set of actions to be taken by the key players in the Nordic countries was depicted. In addition to these research-intensive phases, dissemination and evaluation activities were also included in the project.

There were four core partners in the project: DTI Danish Technological Institute, FOI Swedish Defence Research Agency, SINTEF Norwegian Institute of Technology and VTT Technical Research Centre of Finland (project coordinator). The core partners were responsible for project execution and the actual research process. In addition to the core partners there were some 15 cooperation partners that contributed to the Nordic ICT Foresight process by participating in the workshops and giving expert viewpoints in the different phases of the project.

This report is a summary report that is complementary to the larger systemic research report (Ahlqvist et al. 2007). This report presents the main findings and recommendations and is divided into eight chapters. Chapter 1 is an introductory chapter. Chapter 2 presents the Nordic ICT Foresight project structure and takes a quick glance at the most important theoretical frames of the project. Chapter 3 presents a summary of the desktop study and depicts the most important similarities and differences of the Nordic ICT trajectories. Chapter 4 reviews the SWOT analyses made by the four Nordic ICT Foresight countries and presents a Nordic level summary SWOT. This chapter also includes a summary of the emerging ICT applications and generic technologies collected by the workshop process. Chapter 5 describes the scenario building process, which formed four external scenarios for the subsequent research phases. Chapter 6 depicts the process and results of the roadmapping workshop that created the application and system-oriented roadmaps in the four Nordic ICT

Foresight themes. Chapter 7 illustrates the action workshop that constructed the Nordic level action proposals for the creation of policy recommendations. Chapter 8 presents the policy recommendations formed after the research phases. The recommendations are divided into implementation strategies and adaptive strategies.

Project structure and aims of the Nordic ICT Foresight

The Nordic ICT Foresight project (full name: ICT Foresight and Roadmap towards Innovative Applications in the Nordic Countries) was launched in May 2005 with the research partners VTT (Finland), FOI (Sweden), SINTEF (Norway) and DTI (Denmark). The aim of the project was to contribute to the strategic intelligence of the Nordic knowledge region so that the full potential of information and communication technology can be exploited to increase the welfare in the Nordic countries. The focal areas of the ICT applications in this study were experience economy, health, production economy and security. The more specific research and process aims were the following:

- To explore appropriate ways of implementing the innovative ICT applications and systems (prioritise research, development and commercialisation of ICT, consider the required infrastructure technologies);
- To estimate and compare the implications of the ICT applications in the Nordic countries (Denmark, Finland, Norway, Sweden);
- To create scenarios illustrating the prospects for possible future applications for IC technologies with regard to technology, application and market issues;
- To build roadmaps of the developments in ICT applications in a ten-year timeframe;
- To provide solutions whereby ICT can provide positive contributions to societal wellbeing;
- To evaluate the Nordic opportunities in ICT with longer-term growth potential;
- To assist in developing appropriate framework policies that facilitate the developments in the desired directions;
- To evaluate and reflect on the elements that are unique in the Nordic culture in applying the ICTs. The special question is the following: What is the special value and meaning of "Nordicness" in the context of ICT applications?

The Nordic ICT Foresight "project space" is depicted in Figure 1. There were four core partners in the project: DTI Danish Technological Institute, FOI Swedish Defence Research Agency, SINTEF Norwegian Institute of Technology and VTT Technical Research Centre of Finland (project coordinator). The core partners were responsible for project execution and the actual research process. In addition to the core partners there were some 15 cooperation partners that contributed to the Nordic ICT Foresight process by participating in the workshops and giving expert viewpoints in the different phases of the project.

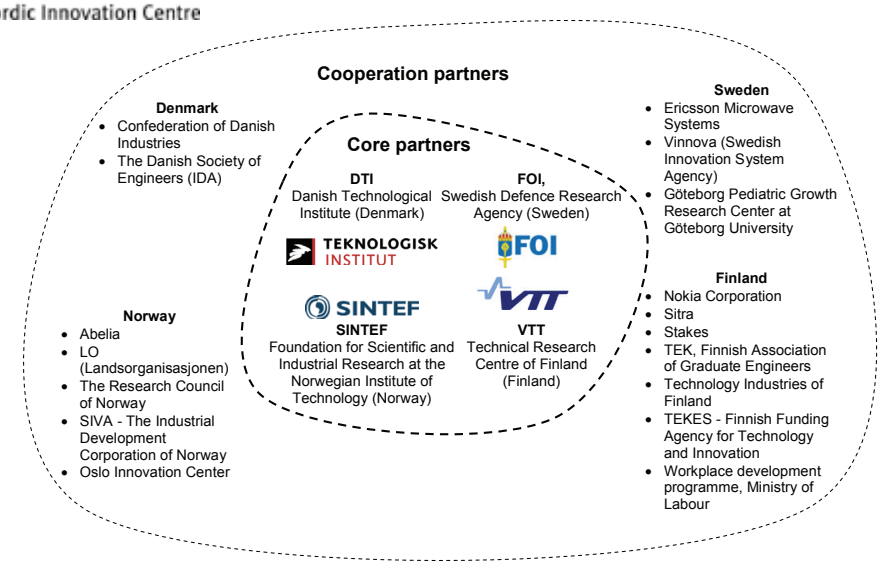


Figure 1. Nordic ICT Foresight partners and the project space.

The research process in Nordic ICT Foresight advanced through the following phases (see Figure 2):

Desktop study (leader: DTI). The first phase aimed at defining the boundaries of the technological field. It aimed at making the most of the existing knowledge and expectations in the ICT roadmaps in order to qualify the subsequent work packages. In this phase the major Nordic activities on ICT were mapped and related issues within research, industry, finance, and government policy in the Nordic countries.

SWOT workshops and questionnaires (DTI). The second phase aimed at depicting the trends in the national ICT business and research environment in the four Nordic countries: Finland, Sweden, Norway and Denmark. The key ideas in this phase were to identify the strategies that these Nordic countries are currently following, to identify their key capabilities, strengths, key limitations and weaknesses in the future.

Scenario and vision workshop (FOI). The third phase had two purposes: to create a set of external scenarios in Nordic ICT applications and to produce a set of socio-technical ICT application visions. In the scenario building the aim was to outline a set of external scenarios for the socio-technical environment around ICT in the Nordic countries from roughly 2007 to 2017. The focus was set on drivers for the future socio-technical environment that may act as substantial barriers or carriers for the adoption of selected ICT solutions. The aim of vision production was to brainstorm potential socio-technical visions for ICT applications in the Nordic countries and test them against the scenario set. The idea was to identify *robust implementation strategies*, strategies likely to help achieve ICT adoption under a wide range of external conditions. Where robust strategies are hard to find, *adaptive strategies* need to be defined. This means that alternative options are developed - subsequently to be exercised or otherwise based on external socio-technical developments. The two-day workshop was held in February 2006 in Bålsta, Sweden. There were 19 experts in the workshop.

Roadmapping workshop (VTT). The aim of the fourth phase was to create linkages between small and large socio-technical visions on the one hand and to characterise the required developments in science and education, technologies, businesses and industries, markets and government level on the other. An important element of the roadmaps was the identification of possible service and business opportunities and the

most important technologies enabling these opportunities. The two-day workshop was held in May 2006 in Espoo, Finland, and attracted 24 experts.

Action workshop (SINTEF). The aim of the fifth and final research phase was to identify a set of actions to be taken by the key players in the Nordic countries in order to support the developments and successful implementation of the new innovative ICT solutions. After the workshop the core team clustered and categorised the various actions into larger action fields, investigated how these actions fields cope with existing policies, and identified key issues to take into consideration when realising actions. The one-day workshop was held in November 2006 in Oslo, Norway. 21 experts participated in the workshop.

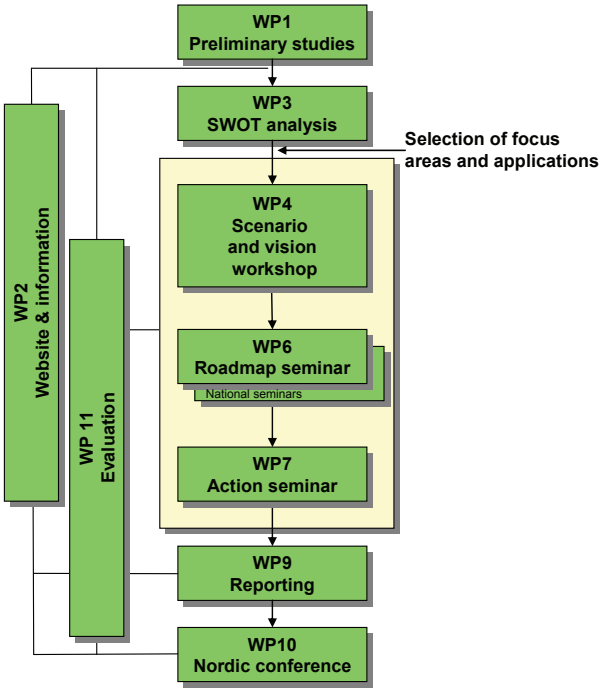


Figure 2. Nordic ICT Foresight project structure.

In order to facilitate the project management and circulation of information on the workshops, a project website was launched (http://nordic-ictfore.vtt.fi/). The final step in the Nordic ICT Foresight process is the project evaluation. In the evaluation phase, the knowledge obtained during the process will be analyzed from two perspectives: the perspective of technology foresight and the perspective of decision making. Special attention is to be paid to the lessons learned, i.e. positive and negative experiences concerning facilitation of useful knowledge creation for decision support, Nordic TF co-operation, comparison of the outcomes and experiences with those of corresponding TF exercises (in other countries/regions, in other technological fields) and the contribution of the results and experiences to the scientific and professional knowledge base. By comparing the dynamics of shared knowledge creation in a number of foresight processes, valuable knowledge can be gained for the further development of Nordic foresight practices.

Summary of the desktop study

Idea of the desktop study

The aim of the desktop study (Iversen et al. 2006) was to give a comprehensive overview of the Nordic countries on the present and future opportunities related to the use of ICT within healthcare, security, the experience economy and traditional industry. More specifically, the aim was to identify visions, strategic rationales and reflections on future challenges within the four Nordic ICT Foresight themes. The study utilised publicly available material on the four themes. The material was mainly technological foresights, scenarios, and reports on visions and research for development strategies for the Nordic countries. This means that the material does not necessarily represent the actual policies or the political priorities of the four studied countries. Instead, the material gives some Nordic research perspectives on the policy issues and views on the challenges and opportunities in the four Nordic ICT Foresight themes.

The reports in this desktop study summary are mostly made by researchers in governmental and non-governmental institutions. Thus the content of this report does not represent the political will and strategies of the governments of the Nordic countries but rather an overview of how the Nordic countries approach and analyze the four areas, and what the opportunities for action national governments may have in relation to the four themes of Nordic ICT Foresight. The material available in the four countries also differed a great deal in scope and scale, reflecting the differences in policy priorities and industrial structure as well as the differences in administrative structures and processes.

Key results

The studied reports from the four Nordic ICT Foresight countries quite clearly illustrate that there are significant differences in the scope, scale and goals of foresight activities in these countries. Since foresights are the primary source of information for descriptions of the Nordic countries' positions on ICT in the four themes, this means that clear comparisons between the different countries may be difficult. More specifically, the differences in approach may be described using the following parameters; in Figure 3 these differences are characterised on the basis of four focal areas:

Society focus: A focus on the socio-economic drivers of changes and challenges that are directly or indirectly linked to the opportunities of new technology.

Technology focus: Descriptions of key technologies and how these may develop in the future.

Descriptive: A focus on well-defined descriptions of dilemmas and opportunities.

Ideas for initiatives: A report structure that leads to recommendations for political action in the innovation system.

Naturally, these four focus areas are not mutually exclusive, and indeed many of the publications entail all four elements. On the basis of the desktop study it was possible to identify the differences in the approaches of the Nordic countries and illustrate them as in Figure 3.

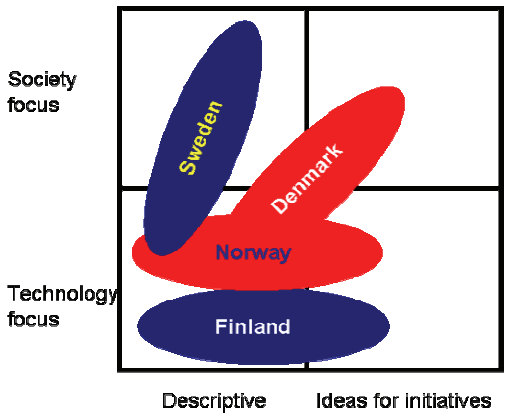


Figure 3. The basic emphases of the technology foresights in the Nordic ICT Foresight countries.

Experience economy

There is a common perception that the creative industries that belong to the experience economy are important. All Nordic countries identify strong positions in the experience economy and the underlying rationale is that these positions should be nourished since they deliver great value (economically and culturally) to society and are relatively hard to copy and/or off-shore. From a Nordic perspective then, the experience economy in itself is identified as a very important sector, but the role of ICT in relation to the sector is not analysed and discussed in the same thorough manner as the health care sector and traditional industry. One explanation for this could be due to the fact that the experience economy is not under the same kinds of pressure for change as health care and traditional industry. Another explanation may be that the potential benefits and new products form a lesser part of the total turnover and value in the experience economy as it does in traditional industry and the health care industry.

In Finland, the main focus on the experience economy is related to mobile technologies, where a range of new applications and location-based and context-aware services are expected to broaden the scope and scale for the use of mobile technologies. Marketing and entertainment are identified as the most important areas. In the Swedish and Danish material, it is argued that the countries are strong in areas such as design, games and TV and film production, and that significant synergies with ICT should be expected and pursued in these areas. On the other hand, there is a fear that much of the future development of ICT and the experience economy may be located in the US, so initiatives should be cautious and well thought through from a long-term perspective. The reports from Norway also recognise the importance of the experience economy from a cultural and economic perspective and identify it as an important sector in Norway. But in the material available there are no links made between ICT and the experience economy, except for the possibilities to use ICT in relation to tourism.

Health

The reports from all four countries identify trends such as the aging society, individualisation and "user orientation" and the need to increase efficiency as important drivers for implementation of ICT in the healthcare sector. The use of ICT is, therefore, closely tied to a vision of a service-oriented cost-efficient healthcare system that is able to put the user in the centre. All countries rank high in one or more areas of e-health and, generally speaking, both healthcare systems and ICT infrastructure are described as well developed in all four countries. This means that the structural conditions for a strong development in e-health are in place. In Finland there was little documented information available in English, but the available material indicates that Finland has a very strong focus on ICT in healthcare and that the future development of bioinformatics is a focal niche for Finland. In Denmark, the available material conveys a strong belief that the Danish healthcare sector and ICT industry are strong in the areas of ICT in medical equipment, the development of sensor technologies, and electronic health records. In Norway and Sweden, telemedicine and electronic health journals are identified as the major strengths and future focus areas. There are few concrete visions or suggestions for initiatives directly related to the suggested focus areas.

Production economy

All the studied countries share the same understanding of the pressure and opportunities that globalisation and developments in ICT create on the traditional production economy. All four countries lift ICTs as the centre of their strategies to keep traditional industries competitive. Historically, the Nordic countries are strong in different industrial areas and the industrial perspectives differ mildly in each country. But from an ICT and strategic perspective, many of the insights and visions for the future are basically the same. Basically, the ability to combine efficiency and flexibility for complex industrial products and production processes are at the heart of the visions for the use of ICT in traditional industry. In relation to this vision, Denmark identifies its most promising areas of ICT strengths as software for production planning and control, sensor technologies and wireless technologies. Finland's focus is on mobile and wireless infra structure and set-up in geographically disperse production units. Sweden has a strong focus on complex production systems while Norway has a strong focus on the special challenges related to SMEs.

Security

ICT and security may be defined and discussed in many ways. Based on the studied material, two definitions are ICT security predominant. The first definition, here named system security, understands it as a practice that thrives to prevent the misuse of ICTs, dealing with such issues as viruses, spam and phishing. The second definition, here named network security, sees ICT security as the secure use of ICT in security applications and systems ranging from home security and alarm systems to modern weapons and defence systems. These two definitions are different, and this is also reflected in the studied material.

Material from all four countries put the system security perspective high on their ICT agendas since the lack of security may become a severe barrier for development of new ICT applications and markets within consumer and business segments. System security

is not viewed as a strategic area for business development as such, but rather as a prerequisite for the future development of the information society. Consequently, few ICT-related strengths are identified in system security. Instead, a range of socio-cultural factors are identified as a means to strengthen citizens' and business focus and understanding of the importance of ICT security.

Network security is only explicitly addressed in the material from Sweden, where it is highlighted as a very important area in which Sweden has significant strengths and opportunities due to its strong tele-industry and security and defence industry. Given the nature of the subject, the fact that no material is available publicly does not necessarily mean that none of the other three Nordic countries are interested in the subject and/or has companies and research communities focusing on the area.

Synergies and complementary areas

Seen from an ICT perspective, mobile/wireless technologies are central in all four countries when strengths and opportunities are identified. Furthermore, the wireless technologies (and sensor technologies) are deemed important in relation to the four Nordic ICT Foresight themes. The mobile/wireless technology would therefore seem an obvious choice for enhanced focus and strengthening of Nordic ambitions for development. Of the four themes, it seems as if there are significant synergies between the four countries' initiatives within e-health and production systems. In relation to the experience economy, the area as such is identified as important in all four countries. The role of ICT and opportunities related to ICT are predominantly positively reviewed in the material from Denmark and Finland. ICT system security is identified as important in all four countries but not described as an area of strength or opportunity from an R&D or business perspective. Networked defence is only described in the Swedish material. Wireless/mobile and sensor technologies are central in this application area. It would seem advisable to further investigate the opportunities for the creation of Nordic focus in this application area.

National SWOT analyses

Background to the SWOTs

National-level SWOT analyses were carried out for Denmark, Finland, Norway and Sweden in the autumn of 2005. The aim was to depict national characteristics of the four project countries in the context of the international business and research environment in ICT. The SWOT process was carried out in a slightly differing fashion in each country (for further detail see Ahlqvist et al. 2007). A Nordic level summary SWOT for each focus area was constructed on the basis of the national SWOT analyses and is presented in the following.

Nordic level summary SWOTs

In the area of *experience economy*, the combined Nordic strengths are similarities in ICT infrastructures, the existence of globally competitive ICT players and clusters in the region and utilisation of mobile technologies and applications (see Table 1). In the Nordic region there are advanced markets and users, and the new products are easy to pilot. People and regional communes in the Nordic countries are, in general, quite willing to adopt new things. The Nordic countries have strong national R&D systems and strong national investments in certain ICT fields. Thus the IPR and patent base is also robust, considering the relative size of the Nordic population on the global level. The key weakness in the experience economy on the Nordic level emphasises the weak capacity to build commercial solutions from technological developments. It can be stated that Nordic actors are quite small and there is a need to build networks for the creation of critical mass. There is also a shortage of risk funding, although the recent Finnish Technology Barometer (Lehtoranta et al. 2007) states that in Finland the number of business angels is on a slight relative rise. One Nordic element might be the unclear division of labour between governmental organisations. In addition, if the Nordic cooperation is to be intensified, there is a strong need for evidence of the benefits of the Nordic cooperation. The last combined weaknesses describe the common technologically oriented development culture in the Nordic countries. Albeit development is too technology driven, there are still development gaps in some technologies, such as fuel cells.

Table 1. Nordic level summary SWOT on experience economy.

Strengths	Weaknesses
• Similarities in ICT infrastructures • Advanced globally competitive players and clusters in production ICTs • Advanced mobile technologies and applications • Advanced markets and users: new products are easy to pilot • IPR and patent base • Strong national R&D systems • People and regional communes are willing to adopt new things • Strong national investments in certain ICT fields	• The capacity to build commercial concepts from technological developments • Too many small players > need for Nordic networking to build critical mass • Lack of private risk funding • Deficiencies in the division of labour between different governmental organisations • In some areas there is a lack of evidence-based information about the benefits of Nordic cooperation • Development culture is technologically oriented • Gaps in some technological niches, e.g. screen technologies, fuel cells
Opportunities	**Threats**
• Developing user-centred open innovation processes • Creation of Nordic SME-based competence clusters in niche areas • Integration of education and information technology competences, e.g. navigation, control of health information • Advanced knowledge in the cost-effective data transmission > Nordic countries sparsely populated • Utilisation of knowledge of ICT infrastructures and remote sensing systems for remote environmental monitoring in peripheral areas, e.g. Barents Sea • Hybrid knowledge > combinations of different sciences and businesses • Combination of technology and design competences	• International competition • Large segment of Nordic ICT firms are not growth-oriented • Strengthening R&D competences in Asia • Rigidities in the cooperation of different sectors: sciences, governments and businesses • No clear Nordic vision of the cooperation benefits for different actors • Lack of global perspective • Lack of new business models and concepts

The Nordic opportunities and development potential the in experience economy are many (see Table 1). The most promising potential is in the development of user-centred open innovation processes. This could include the utilisation and targeting of the "long tail" aptly coined by Anderson (2004 & 2006). The long tail refers to the number of small and varied niches that exist in, for example, the music industry's fragmented consumer markets. There is also potential in the creation of Nordic SME-based competence clusters in some niche areas, e.g. in mobile applications. There are opportunities in the integration of education and information technology competences, e.g. in the fields of navigation and control of health information. This might open up possibilities for the formation of "hybrid knowledge" at the cross-sections of different sciences, businesses and design branches. Moreover, the fact that the Nordic countries are quite sparsely populated and all of the Nordic countries, maybe excluding Denmark, contain large peripheral national regions creates opportunities in ICTs. The vast territories could be utilised as an advantage to develop cost-effective data transmission formats and solutions. This idea could also be utilised to create unique knowledge of ICT-driven remote sensing systems to monitor peripheral areas, e.g. the Barents Sea. The threats to the Nordic experience economy mainly come from the international competition landscape, especially the development of Asian R&D competences. The notion that a large segment of Nordic ICT firms – and also firms in other sectors – are not growth-oriented brings hindrances to the formation of new jobs. There is also a lack of Nordic level and global perspectives among the SMEs in the region. In addition, rigidities exist in the cooperation between different societal spheres, e.g. sciences, governments and businesses. Furthermore, lack of new business models and concepts is a threat that could have considerable effects in the longer term.

In the *health* area, Nordic strengths are advanced basic research and R&D in biotechnology and medical sciences (see Table 2). The Nordic health infrastructures are

advanced and rather alike. The Nordic strengths in health are advanced basic research and R&D in biotechnology and medical sciences. There are strong niches in ICT health applications, e.g. biotechnology and sensors, besides the traditional cooperation between public and private actors in the Nordic countries. The Nordic countries have advanced national innovation systems in health ICT applications. The Nordic weaknesses in health are mainly in the capacities to build commercial concepts from technological developments. Although the innovation system is working in a quite effective way, there are some critical limitations in resources, especially in adapting new eHealth solutions in practice and education. This also reflects another "hole" in funding, namely the lack of private risk funding. Two kinds of risk funding are required: 1) long-term "slow" funds and 2) more short-term experimental funds. The Nordic level opportunities in health are coiled around the idea of the formation of a common Nordic test market for health applications. It is also important to develop user-friendly interfaces, especially for the needs of the aging population. However, it should be remembered that some elderly people have ICT abilities to act as advanced early adopters. The Nordic countries have huge potential in developing advanced mobile applications in health.

Table 2. Nordic level summary SWOT on health.

Strengths	Weaknesses
• Advanced basic research and R&D in biotechnology and medical sciences • Advanced and quite similar health infrastructures • Strong niches in ICT health applications, e.g. biotechnology and sensors • Strong national innovation systems in health ICT applications > Nordic governments advanced in the financing of health applications • Good cooperation between public and private actors	• Capacity to build commercial concepts from technological developments • Non-compatibility of European, national and local regulations • Limited resources > the capacity to adapt new eHealth solutions in practice and education • Lack of risk private risk funding. Need for two kinds of funding; 1) long-term "slow" funds and 2) more short-term experimental funds. • Some critical fragmentations in health system on national and Nordic levels
Opportunities	**Threats**
• Common Nordic test market for health applications > to adopt Nordic view on health applications • Creation of user-friendly interfaces for the aging population > some elderly people could be early adopters • Adapting advanced mobile applications in health • Creating strong competences in some eHealth niches and exporting the applications globally • Hybrid knowledge > combining different branches, e.g. sciences and businesses	• Seeing the benefits of health developments in a too narrow sense and in a too short time span • Unclear division of labour and responsibilities in health sector > many actors and interest groups • Regulation runs behind the potential applications • Rigidities in the cooperation of different sectors: universities, governmental organisations and firms • Considerable proportion of aging population cannot cope with new technological solutions • Lack of global perspective

Focusing might also be a key opportunity – the Nordic countries could focus, for example, on some eHealth niches and aim at global markets in these niches. The threats in the health sector can be wrapped up in the following way: the key threat is the lack of a visionary view, i.e. the benefits of health developments are usually seen through a narrow local perspective and in a too short time span. The health sector is fragmented; there are many actors and interest groups. This creates an unclear view of the division of labour in the health sector. There are also crucial rigidities in the cooperation between universities, governmental organisations and firms. It is also important to realise that a considerable proportion of the aging population cannot cope with the new technological solutions. The final Nordic level threat lies in the regulation that runs way behind the fast-running health applications.

In the area of *production economy* the strengths on the Nordic level are advanced markets and advanced users (see Table 3). The ICT competences in production economy are strong, especially in simulation, telecommunications, IP and mobile applications. General ICT literacy on the industrial level is strong. Besides, there are complementarities to be found in the diversity of the production economy in the Nordic countries. The crucial weakness in the production economy application is the weak capacity to build commercial concepts from technological designs. Standardisation and a lack of private risk funding are also seen as crucial weaknesses. Utilisation of ICTs in the production economy is too focused on actual production functions. ICT application could be used more widely in the ideation and commercialisation phases. Furthermore, there is one clearly stated Nordic weakness: the difficulty in attracting new students to grass root production areas.

The Nordic opportunities in the production economy are in the search for complementarities in the diverse Nordic production base and, therefore, in the creation of cross-cutting applications. Another opportunity is to utilise Nordic ICT competences in the creation of user-friendly and adaptable interfaces for different production systems. Opportunities are also to be found in the development of ICT applications for the production chain as a whole: ICTs could be more widely utilised in ideation, concept formation, production, logistics and marketing. Other niche opportunities are to be found in the development of simulation software and applications, and in adopting advanced mobile applications in the production economy. In addition, the adoption of ICT applications in SMEs could be more broadly supported. The Nordic level threats in the production economy culminate in the lack of Nordic level visions on the theme that is shared with key stakeholders. International competition, especially from Asia, forms a critical threat. The effects of international competition are also seen in the globalising ownership structure of Nordic firms. In the long term this could affect the direction of foreign direct investments.

Table 3. Nordic level summary SWOT on the production economy.

Strengths	**W**eaknesses
• Advanced markets and users: new products are easy to pilot • ICT competences in production economy are strong: simulation, telecom, IP, mobile • ICT literacy in industries is generally strong • Diversity > Nordic countries have different specialities in production economy	• Capacity to build commercial concepts from technological developments • The utilisation of ICTs in the production economy is too focused on actual production functions • Standardisation • Lack of private risk funding • Difficulties in attracting new students to grass root production
Opportunities	**T**hreats
• Search for complementarities in diverse Nordic production base and creation of cross-cutting applications • Creation of user-friendly and adaptable interfaces for different production systems • Developing ICT applications for the whole production chain > ICTs could be utilised in ideation, concept formation, production, logistics and marketing • To support SMEs in ICT applications • Development of simulation software and applications • Adopting advanced mobile applications in the production economy • Hybrid knowledge > combinations of different sciences and businesses	• No clear Nordic vision • Globalising ownership structure in firms and its effect on the national investments • International competition • Strengthening R&D competences in Asia • Rigidities in the cooperation of different sectors: sciences, governments and businesses

In the area of *security,* the Nordic level strengths are well developed research networks, competences in cryptography, many advanced business players in ICT security and advanced competences in security technologies, e.g. in surveillance (see Table 4). The crucial weakness, as in all the previous SWOTs, is also focused on the capacity to build commercial concepts from developed technologies. In addition, the Nordic players are quite small and in need of private risk funding. In short, industry is still somewhat underdeveloped. Security is also dependent on global software producers. Moreover, the user perspective, e.g. in interfaces, could be developed further. The Nordic region has much potential in the field of security. For example, R&D on ID management and biometrics could be important opportunities. ICT security applied in health forms an important opportunity. There is also potential in the creation of tools for secure financial transactions, mobile applications in security and engaging in standardisation of software solutions. The large number of players with complementary competences in the field provides a good starting point. Furthermore, there are possibilities in the different larger topics, such as ICT applications in environmental security, i.e. in the Baltic Sea, North Sea, Barents Sea and in the applications built on networked defence concepts. Interesting opportunities might also rise from the fact that the images of threat are somewhat dissimilar between the Nordic countries and provide a quite wide understanding of security. However, there are some threats in the field. One key threat is that there is not enough public discussion on the consequences of ICT security. There is also a need for further knowledge about the benefits ICT security, especially for the SMEs. Lack of standards creates a threat, as well as regulation, which is lagging way behind the potential applications and potential needs of the customers. A wider threat might be the fact that security is usually approached as an obligatory need rather than a business opportunity.

Table 4. Nordic level summary SWOT on security.

Strengths	Weaknesses
• Research networks well developed • Cryptography • Advanced business in ICT security • Security technologies advanced, e.g. surveillance • Many players	• The capacity to build commercial concepts from technological developments • Lack of private risk funding • Players are quite small • Industry is still underdeveloped • Dependence on global software producers • User perspective underdeveloped
Opportunities	**Threats**
• R&D on ID management (e.g. DRM, biometrics) • ICT security in health • R&D on tools to secure financial transactions • Standardisation of software solutions • Adapting advanced mobile applications in security • ICT and environmental security (Baltic Sea, North Sea, Barents Sea) • Competences in networked defence concepts • Potential complementarities of many players • The images of threat quite dissimilar between the countries > large understanding of security	• Not enough public discussion on the consequences of ICT security • Lack of studies on the benefits of ICT security • Organised crime • Lack of standards • Technological development way ahead of regulation and legislation • Security is approached as an obligatory need, not as a business opportunity

Emerging ICT applications

Nordic ICT Foresight emphasises four themes in ICT adoption: experience economy, health, production economy and security. *Experience economy* widely covers the media, communication and entertainment applications of ICT. It touches upon such themes as mobility, content digitalisation, new terminals, user interface development and user-

generated content. *Health* emphases the consequences of ICTs in the health sector and discusses such issues as health information systems, document distribution, storing and management, data organisation, health consultation, self-medication, home care and support for elderly. *Production economy* considers the ICT applications in the production industries. In the production economy theme, such topics as Internet-based information systems, logistics, industrial sensor systems, automation and energy infrastructure are of importance. In the fourth theme, *security*, the focus is on security in general and in information security. Security in general covers issues such as general crisis management, natural catastrophes, prediction and prevention of external and internal infrastructural crises. In information security the important issues are confidentiality, management of user identities and secure electronic transactions. Such issues as intelligent traffic systems are also covered in this theme. The main results of the discussion concerning the emerging technologies in the context of the Finnish SWOT workshop are reported in the following (see Ahlqvist 2006a for further information).

Experience economy

The most important ICT applications can be categorised into nine categories: tailored service applications, network applications, voice and language-oriented applications and ubiquitous technologies (Table 4). In *tailored service applications* the questions of personally tailored information control and digital identity were heavily debated. Another set of issues was personally tailored media chains, where the user can make personified "value chains". The second category of the experience economy applications was *network technologies*. The workshop discussion wandered around the questions of ad hoc and heterogeneous networks. The question of content delivery through open networks and the different solutions enabling different content services was also a focal issue. *Voice and language-oriented applications* was the third category under discussion. Different simultaneous translation applications were estimated to be especially crucial in the future. The fourth category in the experience economy was *ubiquitous technologies*. The notions of virtual presence and ambient design were seen as potential particular sources of applications in the future. In the fifth category, *hybrid media*, the application examples could be intelligent paper and intelligent packaging. Another application could be "talking paper", which combines sounds with still images. The sixth category was *communication services*. Based on the workshop discussions, the development is going towards a global media network. The third category was *voice and language oriented applications*. In this category the simultaneous translation services became a hotspot of discussion. Simultaneous translation was estimated to be a plausible emerging application on the Nordic level. The seventh category for discussion was *technical solutions*. The most plausible applications discussed were printable electronics, RFID tags, silent computer and digital technology (without background noise or humming) and home robots. The eighth category is *virtual environments*. In this category the most important applications were home virtual environments, multi-sensory environments and virtual learning platforms. The ninth category is *entertainment*. The discussion centred on "edutainment" concepts (games that combine education and entertainment) and games based on mobile positioning.

Table 4. Emerging experience economy applications. The number in brackets presents the weighted value of the discussion topic.

Applications in *experience economy*	
Tailored service applications • ***Personal information control***: communication and identity independent of the device • ***Digital identity*** • ***Personal media production***: personal value chain, real-time production • ***Community-based information solutions*** • ***Bi-directional media services***: informing, teaching, "users as innovators"	**Communication services** • ***Global media network***: you can see your favourite show anywhere • ***Digital me*** • ***Mobile ID-TV*** • ***Group phone calls*** • ***Free services with different devices*** **(2)** • ***Expression and performance of civil rights via networks*****:** voting, taxes **(2)**
Network applications • ***Content delivery through networks***: peer to peer • ***Compatibility of networks*** • ***Intelligent information search and organisation techniques***: e.g. based on neural networks	**Technical solutions** • ***Printable electronics*** • ***Silent computer and digital technology***: without background noise or humming • ***Home robots*** • ***RFID tags***
Voice and language-oriented applications • ***Applications of language technologies*** • ***Multilingual solutions*** (travelling, informing, speech recognition) • ***Simultaneous translation services (4)***	**Virtual environments** • ***Home virtual environments*** • ***Enhanced reality*** **(1)** • ***Multi-sensory environments and virtual learning platforms***
Ubiquitous technologies • ***Ubi-intelligence***: techniques of virtual presence • ***Ambient Design***: multiple senses, marketing	**Entertainment (2)** • ***Games*** • ***"Edutainment"*** • ***Games based on mobile positioning***
Hybrid media (1) • ***Combinations of printed and electronic media***: e.g. 2D code that is readable via a mobile camera phone that connects the mobile phone to a database • ***Intelligent paper and intelligent packaging*** • ***"Talking paper"***: sound + still image • ***Tailored news***: printed either to communication device or local printing service (communal printing) **(2)**	

Health

The first and central category of the ICT applications in health is the *personal healthcare* or *"home medicine"* (Table 5). The key applications in home medicine are systems that monitor, gather and analyse personal health information. Another set of home medicine applications is systems that monitor and enable the living of the disabled or the elderly people. The nature of interfaces is a crucial issue in monitoring systems. Interfaces could be executed in several ways: by sensors, by implantation, or by wearing (e.g. alarm bracelets). The second class was *diagnostic and treatment applications*. These applications included pattern recognition, dosing and mobile solutions. ICT applications could also serve as an infrastructure for treatment, in dosing, nutrition and routine checks. The third class that was discussed could be labelled *medical information processing*. The discussion emphasised a coherent and convergent database that could be utilised by data mining and data drilling techniques. On the national scale, a database could serve as data warehouse where one could load personal histories of the patients and make comparisons and analyses between larger numbers of cases. Fourthly, there are *socially activating and assisting applications* that help the patient in everyday living. There were also ideas about intelligent homes that could adapt to the inhabitants' health conditions. The fifth application category estimated to be very plausible was the *applications for the control of allergies*. In this category the most efficient solutions would be linked to the prevention, diagnosis and self-treatment

of allergies. The sixth category in the discussions was the advanced *documentation applications*.

Table 5. Emerging health applications – Group 1. The number in brackets presents the weighted value of the discussion topic.

Applications in *health*	
Personal healthcare, "home medicine" (8) • ***Gathering and analysis of information***: diaries, training calendar, prevention **(6)** • ***ICT home treatment***: free self-service systems, health centre and pharmacy systems, additional services, "mobile service and competition" automata **(5)** • ***Systems that monitor and assist elderly people living at home***: controlling the changes in health, monitoring day-to-day activities **(2)** • ***Technology-assisted training***: modular technologies • ***Vital sign data capture / collection*** • ***Adaptive, intelligent home***: conditions adapt to inhabitants' health conditions • ***"Every home" service robots*** • ***Systems that monitor patient's condition in real time***: especially in the case of emergency (elderly people, etc.), real-time diagnostics **Diagnostic and treatment applications** • ***General ICT applications in health***: pattern recognition, ubicomputing, mobility, hybrid media, dosing... • ***Nano / picosensors*** • ***ICT-based diet and nutrition systems*** • ***Chip laboratories*** • ***Virtual diagnostics, distance diagnostics*** **(2)**	**Medical information processing** • ***eHealth & ePrevention****:* knowledge-based, data warehouses, data mining / drilling • ***National health databases*** **Socially activating and assisting applications (5)** • **Brain interface**: for the seriously disabled • ***Basic technology, tailored interfaces*** • ***Intelligent user-centred services for the senior housing***: technologies that activate everyday social contacts **Applications for the control of allergies (4)** • ***Prevention*** • ***Diagnosis*** • ***Self-treatment*** **Documentation applications** • ***Documentation in the doctor's reception***: records of the doctor's instructions on the net, crisp instructions on the net and as a print **(1)**

Production economy

In the production economy, the key discussion topics in the emerging technology workshop can be clustered into five categories: industrial production applications, industrial information processing, management of the logistic chain, convergence of the information systems and simulation applications (Table 6). In *industrial production applications*, the most important technologies in the future shorter term are the RFID applications and Internet-based production applications. The central applications consist of mass-tailored production lines, which could intensify and rationalise the production by minimising storages. An important application is also new kinds of interfaces, which could come in multiple shapes and functions. Automatic reasoning systems, aiming at error seeking and production optimisation, were also seen as key applications in the production economy. The second category in the production economy is *industrial information processing*. The most important transformations will focus on the modes of information transfer. These are also related to new kinds of production control methods, e.g. sensor technologies and IP-based production solutions. The third theme discussed was *management of the logistic chain*, which emphasised information synthesis. Production processes will be more and more based on tailored and customised solutions between client and producer. This brings challenges to ICT applications on two levels. Firstly, one should be able to dynamically model the total production process from the very starting inputs (ideation and planning) to the final output (marketing and customer interface). Secondly, in order to be flexible, one should also be able to modify, alter and

customise the bits and pieces of the process. Production processes should, therefore, be as modular as possible. The fourth category is the *convergence of information systems*. Convergence turns the production process into a smoothly fluctuating network of active modules. The vision is that the performing, controlling and packing of information is combined via sensors. Lifecycle systems are connected to this process. The fifth category is *simulation applications*. These applications consist of simulation of micro-level phenomena in different fields, e.g. electronics, nanotechnology, fabrication of medicines, and material technologies. Another application would be to combine 3D visualisation and simulation to the actual production process.

Table 6. Emerging production economy applications.

Applications in *production economy*	
Industrial production applications • ***Sensor technologies***: especially passive sensors • ***Applications of RFID*** (radio frequency identification) • ***IP-based (Internet Protocol) systems*** • ***Learning devices***: self-monitoring of machines • ***Fully automatic factories*** • ***Minimisation of production-related environmental hazards*** • ***Mass-tailored production lines***: on-demand systems, no storages **(2)** • ***New interfaces***: tangible, wearable, embedded **(4)** • ***Multi-sensory process control and robotics*:** input / output **(1)** • ***Applications enabling telework and mobile work*** **(1)** • ***Mobile maintenance systems*** **(1)** • ***Automatic reasoning systems***: error seeking, production optimisation • ***Environmental measuring systems and services*:** security, "emission trading" and emission control **(2)**	**Industrial information processing** • ***Information and data transfer in production systems***: man2man, man2machine, machine2man • ***General information gathering***: technology, markets, financing... **Management of the logistic chain** • ***Gathering and analysing the process data in real time*** • ***Quality control*** • ***Mobile and automatic maintenance and repair*** **Convergence of information systems** • ***Convergence of information***: the performing, controlling and packing of information is combined via sensors, then the combined information moves to be compared with planned information **(1)** • ***Convergence of all of the lifecycle systems*** **(3)** **Simulation applications** • ***Simulation of micro level phenomena in different fields*** : electronics, nanotechnology, fabrication of medicines, material technologies **(2)** • ***Combination of 3D visualisation and simulation***

Security

The workshop discussion on the emphasis of information security can be grouped into three categories (Table 7). First category is called *confidentiality in general*. The key to this dilemma is to consider the different meanings of information. Information in ICTs will be understood more and more as contextual phenomena, not just as an abstract particle based on a principle of 1/0. The most important applications identified in the workshop were those of identity management and dynamic privilege management. Identity and privilege management is pivotal in mobile and device independent heterogeneous and ad hoc networks. In dynamic identity and privilege management the question is also about data integrity and the general trustworthiness of the actors providing security services. In the discussion, the *confidentiality* issue centred on the IPR issues, particularly in the industrial information processes. There were also ideas about a virus-free "Internet". This "Internet" will probably not be the same global network it is today. Instead, it will be a network built on secure modules where you should prove your identity. The second category discussed in the workshop was *security in environments and networks*. Two applications were considered to be important. Firstly, new kinds of control models for open spaces. These could, for example, be

based on sensor networks. Secondly, "invisible" information security. As was discussed, the general aim of the information security developments should be the creation of "invisible" systems, i.e. systems that secure the information channels without the specific attention of the user. The third, and highly important, category is the security applications based on *biometrics*. Biometric security refers to the applications utilising biological characteristics as the basis of identity and privilege management systems (for example DNA, molecular fingerprints).

Table 7. Emerging security applications – Group 1. The number in brackets presents the weighted value of the discussion topic.

Applications in *security*	
Confidentiality in general • **Virus-free "Internet"** (4) • ***IPR in the industrial information processes***: rights to use, billing, software licences as in entertainment (2) • ***Identity management*** • ***Dynamic privilege management*** • ***Integrity*** • ***Long-term preservation*** • ***Non-reproducing technologies*** • ***Animated agents that endorse the trust of the users***	**Security in environments and networks** • ***Distributed networks***: important information is directed to a different network • ***Automatic control in open spaces***: e.g. figure identification for cameras • ***Invisible information security***: ad hoc, availability, PMAC + PMF, mobility...
Biometrics • ***Bioidentifiers***: reliable electronic system, bioidentity **(7)** • ***Security of biometric information***: prevention of malpractices **(2)** • ***Biometric tags***	

Generic technologies

In the second phase of the emerging technologies workshop the experts identified the most important generic technologies in the ten-year time frame. The formal process was the same as in the identification of applications. The emphasis was laid on the generic ICTs and ICT concepts cross-cutting different branches. The central technologies in the workshop discussions can be categorised into seven categories (Table 9). The first is *evolving network concepts*. This theme emphasised solutions that steer towards heterogeneous and ad hoc networking. The second category is *network technologies*. The most important solutions were wireless applications, new terminals and gadgets. Pivotal applications are the networks based on semantics. The third category highlighted in the discussions was *new media solutions*. Cross-media via multiple channels and interoperability of devices was especially emphasised. Also, new kinds of hybrid media applications, such as intelligent paper, were seen as important future solutions. The fourth category discussed was *new technological solutions* and interfaces in the form of 3D avatars and wearable computing. The fifth category was *mobility,* where new kinds of terminals and devices are emerging, 3G, wireless wideband and, in the more short-term future, the permeating of positioning technologies. The sixth category was *intelligent systems*. In this category the most important generic ICTs were sensor technologies, RFIDs and systems measuring the reliability of information. New kinds of distributed and flexible architectures were also important. The seventh category was *new interfaces*. In this category the weight was laid on the flat and flexible screens and 3D systems. Besides, systems that would empower social interaction seemed to be

important. Voice-controlled systems were also seen as key emerging technologies in this sense.

Table 9. Generic ICTs.

Generic ICTs	
Evolving network concepts • Personal Area Network • Ad Hoc networks • Ambient Intelligence: urban environment as an experimental environment, security, entertainment, informing **Network technologies** • Wireless applications: last mile, terminals, gadgets • Semantic networks: distribution of contents **New media solutions** • Cross-media: multiple channels, interoperability • Printed codes: intelligent paper, matrix codes **New technological solutions** • 3D avatars • Wearable computing	**Mobility** • Systems • Terminals • Services • WIFI • 3G • Network technologies • Wireless wideband • Positioning technologies **Intelligent systems** • Sensors technologies and networks • RFID • Systems that measure the reliability and value of information • Flexible, distributed architectures • Visualisation techniques of information semantics • Semantic web • Multi-technical modelling design **Interfaces** • Flat • Flexible • 3D • Systems that endorse communality and social interactions • User modelling in real time • Voice-controlled systems > producing, understanding and interpretation

The discussion can be further characterised via the Nordic ICT Foresight emphases. Connected to the field of communication were discussions on the generic nature of agent-based solutions. The discussion was two-faceted: on the one hand, agent-based technologies could be highly utilisable in expert services and other production enhancing applications. On the other hand, agents allow the construction of superviruses that could be a real problem for the networks of the future. Other discussed technological advances were 3D screens and holographic keyboards. It was estimated, however, that it would take at least 10 years before a 3D screen could be a commercial innovation. An interesting topic was the discussion on tailored mobile phones for different trades. The general line of discussion was that mobile communication solutions could have high variance according to the needs of the users. This could bring crucial business opportunities, as is aptly stated in Anderson's (2004 & 2006) discussion of the "long tail". Furthermore, mobile devices need not resemble traditional phones. For example, people working in the field of security could find mobile phones imitating spectacles quite useful.

Generally, it was estimated that interfaces will become more important than the mere infrastructure. That is because the information infrastructure has become the most important pipeline of society: wideband mobile access could be available almost anywhere. There are, nonetheless, limits to the variations, at least in the short term. There were comments that, e.g., glasses would not be very successful general interfaces, except for certain special trades, because it was estimated that people are not too eager to use interfaces that have to be worn. It was estimated that "low tech" applications might therefore be important solutions of the future.

External socio-technical scenarios

Scenario building

The Nordic ICT Foresight study utilised the so-called Shell/GBN method for the construction of external scenarios. In this tradition a scenario is thought of as being a picture of the future external world for an organisation (or a "system"). This means that the set of scenarios primarily deals with factors not under control by the organisation. The idea is then to discuss issues under the control of the organisation with the different scenarios as different scenes of possible future environments. Of course, in a globalised and, in many respects, highly connected world it is hard to judge what factors are controlled by which actor; some of the factors in the scenarios presented below could very possibly be influenced by the actors in the organisation. For further information on the scenario building process see Ahlqvist et al. 2007.

The set of external scenarios

Four scenarios were constructed by the project team. They can be illustrated with the help of a so-called scenario cross. The dimensions spanning the space were User acceptance, with end-points "harmony" and "conflict", and Business paradigm, with end-points "open source" and "lock-in" (see Figure 4). The condensed scenario narratives are presented in Table 10. The scenario storylines are described in more detail in Ahlqvist et al. 2007.

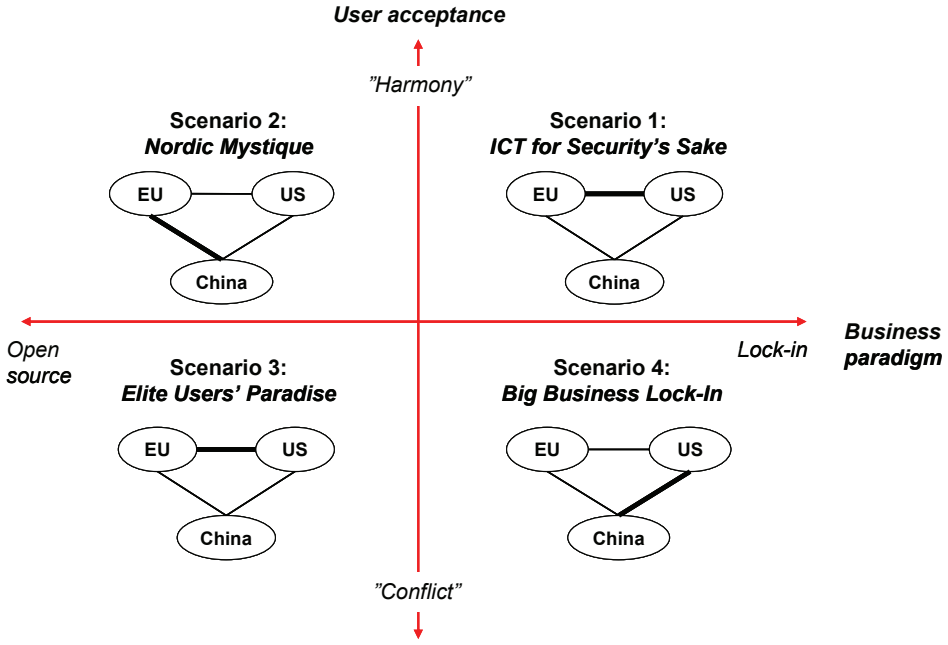


Figure 4. The Nordic ICT Foresight scenario dimensions and geopolitical emphases of the scenarios.

Table 10. Condensed scenario narratives (continues on the next pages).

	SCENARIO I: ICT FOR SECURITY'S SAKE	*SCENARIO II*: NORDIC MYSTIQUE	*SCENARIO III*: ELITE USER'S PARADISE	*SCENARIO IV*: BIG BUSINESS LOCK-IN
GLOBAL POLITICAL SCENE	• Global terrorism & energy on top of global agenda • Shared values (conservative) US-EU in GWOT • Pakistan and Saudi Arabia ruled by extreme Islamists; allied with China • Suspected Chinese coalition with radical Islamic movements • Russia part of the coalition in GWOT	• A more isolated and weaker US than 10 years ago • A stronger EU takes a more active role on the global scene • Strong links between EU and China, and positive environmental and HR development China • A positive attitude towards globalisation in the EU • Russia a strategic partner to US	• Top of the agenda: climate change & energy • Shared liberal values in US–EU • US and EU on the same track regarding energy and environment • EU/US concerns over HR and environmental rights in China and elsewhere • Russia and China close partners	• US oriented towards Asia • Terrorism mostly a concern for the US and China • Economically and politically marginalised Europe • Russia is important partner and supplier of energy to Europe
GLOBAL ECONOMIC SCENE	• Decline in economic development • Higher interest rates; falling real estate prices • Slow down in US home market • Slow down in China • The Nordic countries conform to the US/EU position	• Stable economic development • EU has a strong economy • China is still growing at a fast pace	• Small slow down in economic development • Big investments to handle the energy shortage and climate change	• Strong economies in Asia and US • EU is lagging behind
NORDIC COUNTRIES IN THE GLOBAL SCENE	• Back to traditional conservative values in the West • Social and religious tensions both in EU and between the West and the Muslim world • Mental closure around the West	• Nordic countries have a high profile internationally; attractive region for ST&I, mainly as a test market; institutional role model • Strong links between Nordic countries and certain leading regions in Asia	• Nordic region has important role in the EU-US link • International interest in Nordic environment and energy policy & technology	• Nordic countries try to reach out of the isolation of Europe • The Nordic region is an important area for the collaboration between EU and Russia
SOCIETAL DEVELOP-MENT	• The Nordic countries conform to the US/EU position	• "Balance in life" is influential line of thought, especially in the Nordic countries • Less American cultural dominance; more balanced welfare influences • Cultural and social influences from Asia into EU	• Fragmented opinions among people in the West; one group arguing for a tougher line against the rest of the world in the competition for energy, one group arguing for a more sustainable society	• Increased wealth concentration • Social tension in Europe (unemployed, immigrants) • Standardised entertainment global phenomena

Table 10. (continued)

	SCENARIO I: ICT FOR SECURITY'S SAKE	*SCENARIO II*: NORDIC MYSTIQUE	*SCENARIO III*: ELITE USER'S PARADISE	*SCENARIO IV*: BIG BUSINESS LOCK-IN
RELATION BETWEEN BUSINESS AND POLITICS	• Strong alliances between centralised political power (POTUS) and companies	• Politicians in EU more positive towards the new OS business climate than their colleagues in the US	• A sense of cooperation between the political sphere and the business world on energy and climate change. • Tension in the ICT industry; lack of consensus on issues related to innovation system and digital divide	• Strong alliances between and business and politics (US + China)
BUSINESS PARADIGM	• Very few big well-known companies are providers of products and services in accordance with the needs of GWOT • Big brands are symbols of security, security comes first • The market accepts monopoly as a price for (perceived) security • MS takes a dominate role in the whole ICT world; telecom companies one step behind • US government picks a few trusted partners as critical suppliers of ICT • What's good for MS is good for US	• Successful business models attached to the open source movement • Many new companies built around open source • "Application-centred development" • Established ICT companies strive to adopt the new business paradigm; some are successful, some are not • Nordic region is a hot spot for the new business paradigm	• The suppliers to the consumer markets are divided into two groups: smaller high-end players that can provide the best SW from the OS world and big retailers that control the low-end ICT markets by packaging OS code: IKEA, Wal Mart (and Nokia and MS) mobile phones, PC, etc. • In B2B critical applications are provided by big companies • Slow down of ICT innovation • Problems with interoperability; different competing platforms • The consumer market has ceased to be an important driving force in ICT development	• Influential big business; strong oligopolistic competition • US and China agree on business climate in general terms • Different companies linked to different political environments • ICT as an "ordinary 21st century industry" • Technical lock-ins; No ICT hegemony • Leading global Chinese-US companies
TECHNO-LOGICAL DRIVERS	• Everything dealing with "security" is of importance • Logically and even physically isolated ICT infrastructure	• ICT for health and care of the aged • ICT for environmental system solutions • Digital gaming	• Energy and climate have taken over the roles as the primary research area • The OS community is a key driver in many ICT areas • Interoperability and large-scale system engineering • Innovations in energy and environment are key drivers	• Gaming and entertainment services • Interoperability

Table 10. (continued)

	SCENARIO I: ICT FOR SECURITY'S SAKE	*SCENARIO II*: NORDIC MYSTIQUE	*SCENARIO III*: ELITE USER'S PARADISE	*SCENARIO IV*: BIG BUSINESS LOCK-IN
INNOVATION SYSTEMS AND R&D	• EU and the US invest heavily in R&D for security (not only ICT)	• The OS model and the main areas of applications induce "innovation in networks" – users are important part of the development • Technology and business integrated in the R&D process • Needs and business models push technological developments	• The creative, and in many senses chaotic, OS community is at the centre of the innovation system • Large governmental research funds towards energy and environment in EU and US	• Business-oriented private universities dominate the market for education and academic research • Few big players dominate the R&D activities and set the agenda for policy and academic research
IPR AND COMPETI-TION POLICIES	• IPR is subordinated to security; "what's good for MS is good for US".	• Clash of IPR between EU and US; EU has taken a radical position with regard to patent of SW; In the US, patent is the model	• Difficulties in getting patents for softwares • Big companies adapt to OS model, but have trouble keeping up with the development	• Patents for SW accepted; "in support of big business"
USER ACCEPTAN-CE	• Because ICT infrastructure is also part of the GWOT, there are repeating attacks on ICT systems that discourage many users • Security prevails over integrity • In the Nordic countries, people use the safe Internet platforms	• Optimistic attitude towards technologies; technomania • Strong focus on user friendly applications; almost no one left out in the West • Digital divide between rich and poor countries • Digital integrity has high priority	• Three groups of users • 1. Elite users: Take full advantage of the development in the OS community. In many cases users=developer. The group can be as large as up to 15%. • 2. Normal users: Low-end ICT users. Buyers of retail SW based on OS. • 3. Non-users: Do not take part in the digital sphere; not online; no possession of digital ID	• Majority of people use standard Internet and the services attached • Opposition to big business/big brother climate via number of "undernets", which take on many different forms and include e.g. criminals, political activists and OS enthusiasts.

ICT application visions reflected against the scenario set

The application visions collected during the first brainstorming were clustered and further developed as back-office work between the first and second day of the workshop. The elaborated visions were then grouped according to the four Nordic ICT Foresight themes and one general theme (experience economy, health, production economy, security & ICT in general). Furthermore, the visions were given a few short characterisations. The visions and the characterisations are presented in Table 11.

Table 11. Characterisations of the elaborated ICT vision for the Nordic region.

Experience economy
1. Smart training • Home exercise equipment • Virtual interface gives motivation via games • Virtual runner, runs in the landscape
2. Intelligent paper • Successful co-operation between ICT companies and paper industry • Instant transfer of data (text, images, sound, video) from PC or mobile phone to paper • Constantly updated newspaper
3. Enhanced reality games • Add virtual elements to a real physical environment • Mixed virtual/real world • WWII with all the equipment and a whole battalion of soldiers • Fight with a lion in the Coliseum
4. All-sensor sports events • A lot of sensors are placed at various strategic positions in sports events, e.g. football (the ball, the shoes, around the arena), Formula 1, hockey (cameras on the walls, the helmets, the goal) • Create innovative online games based on sensor information; betting markets • Create new visual services

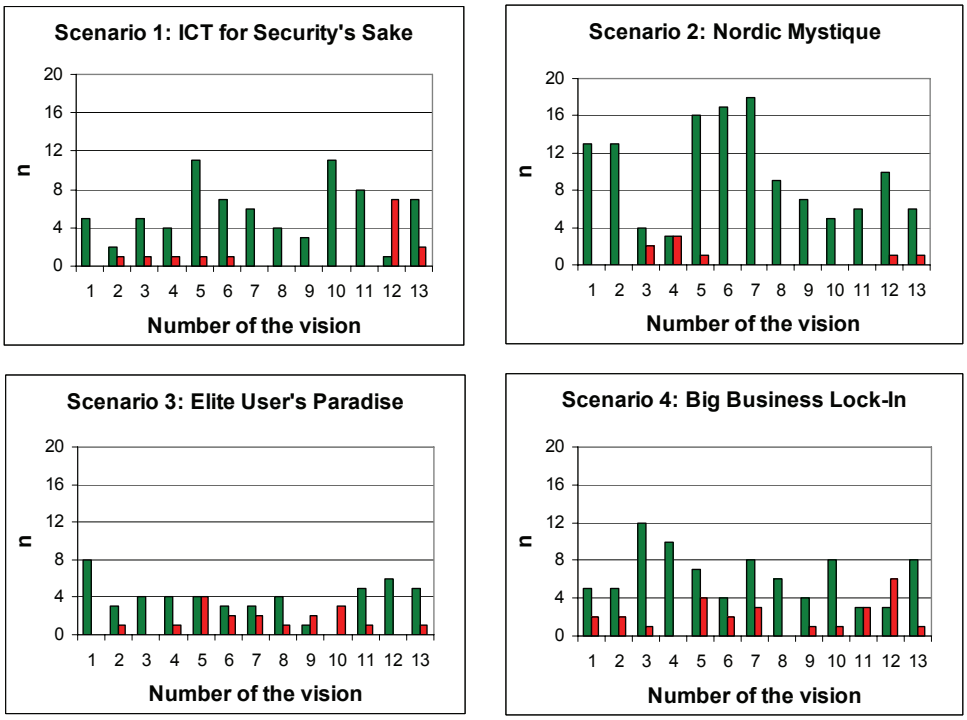
Health
5. The personal health card • Everybody has a smartcard in their wallet with all medical data • When in need of healthcare, individuals show their card in hospitals or in other health agencies • Activated via biometric identification • Valid throughout the whole Nordic Region • The card is only available to health institutions accredited by the State, not for insurance companies or other companies.
6. Early warning system for elderly at home • Wearables with sensors attached to an individual • If e.g. blood pressure is to low, a signal is sent to the hospital • Applicable at home and directly outside the home • Also other diseases can be measured, e.g. eye movement for the recognition of dementia and Alzheimer's disease
7. Nordic common market for ICT in the health sector • There are common standards for ICT systems in the Nordic health sector • A single market of critical size for being commercially interesting • Dynamic competition between companies • One system for electronic health records and electronic health card

Production economy
8. Self-monitoring and robust production lines • Modularity; if the system detects a fault, it warns the operator before breaking down and also reroutes the production line • Fault-tolerant production with mobile interface
9. Control system for efficient energy use • Control system for, e.g., efficient heating of buildings • Combination of sensors and optimisation algorithms radically reduces the energy need

Security
10. Closed and safe Internet • Only accredited modules are allowed to attach • Applications typically in health sector, e-banking, contacts with authorities
11. Security system for local neighbourhoods • Result of convergence between security services industry and ICT industry • Intelligent system for surveillance in local area • Alternative to gated communities • Sound balance between integrity and security

ICT in general
12. Dual online-offline spontaneous networks • Trustworthy system that permits people to be online everywhere, to log in and log out instantaneously • It is ensured that when you log out, you can't be traced or eavesdropped • When you're in, you're part of the global system
13. Intelligent distributed data storage • To be utilised in the ad hoc, device-independent mobile networks; accessible everywhere • Trustable e-Identity (via bioinformatics) is a key element in the system. • System makes a profile of the user and semi-automatically recognises the data that should be recorded, and records it in a safe storage space • The data could be files or spontaneous notes made by the user via speech recognition. • Makes continuous separations between important data in the user profile, not-so-important data and threats/viruses.

The participants were then asked to vote on how well these application visions support the general vision of the project, i.e. "…to increase the welfare in the Nordic countries and also in other parts of the world" in each of the four scenarios (green votes). If a vision is counterproductive for this aim in a scenario under question, red votes were given. The results of the voting are presented in the Figure 5.



1. Smart training
2. Intelligent paper
3. Enhanced reality games
4. All-sensor sports events
5. The personal health card
6. Early warning system for elderly at home
7. A common Nordic market for ICT in the health sector
8. Self-monitoring and robust production lines
9. Control system for efficient energy use
10. Closed and safe Internet
11. Security system for local neighbourhoods
12. Dual online-offline spontaneous networks
13. Intelligent distributed data storage

Figure 5. Prioritisation of the application visions in the four scenarios.

As can be seen from Figure 5, the prioritisation of the visions reflected the narrative of the scenario. In scenario 1, *ICT for Security's Sake*, visions of the personal health card (5), closed and safe Internet (10) and security system for local neighbourhoods (11) got the most green votes. Also intelligent distributed data storage (13), early warning system for the elderly home care (6) and common Nordic market for health ICT (7) got green votes. In scenario 1, the spontaneous ad-hoc networking (12) was seen as quite implausible.

In scenario 2, *Nordic Mystique*, all the application visions got high green rankings. This reflected the open source and Nordic welfare spirit of the scenario. According to the votes, the scenario seemed to particularly favour the health applications of ICT. The common Nordic health applications market (7), early warning system for the elderly at home (6) and the personal health card (5) were voted high. Also smart training (1) and intelligent paper (2) got a high number of green votes.

In scenario 3, *Elite User's Paradise*, the general number of votes was quite low. Since scenario 3 depicted a polarised user group world, the low number of votes could be interpreted as uncertainty towards the "application consequences" of the scenario. Many of the 13 application visions produced had the welfare society tone to them, meaning that, in order to be realised, most of the visions would require a quite balanced societal development and a critical mass of at least the Nordic level. Smart training (1) and dual online-offline spontaneous networks (12) got the most green votes in scenario 3. The personal health card (5) and closed and safe Internet (10) got the most red votes.

In scenario 4, *Big Business Lock-In*, the green and red votes were divided most uniformly in the Nordic ICT Foresight scenario set. The scenario described a kind of business-as-usual situation, where big players dominate the developments in ICT. This scenario seemed to favour ICT applications for entertainment and leisure. Enhanced reality games (3) and all-sensor sports events (4) got the most green votes. Also common Nordic health market (7), closed and safe Internet (10) and intelligent distributed data storage (13) got quite high green votes. Spontaneous networks (12), personal health card (5), common Nordic market for health applications (7) and security system for local neighbourhoods got the most red votes.

Visionary roadmaps

Roadmapping in Nordic ICT Foresight

This chapter presents the results of the roadmapping workshop held in May 2006 at Hanasaari, Espoo. The roadmapping workshop process was linked to the earlier phases of the Nordic ICT Foresight project. An especially important phase was the scenario workshop. The aim of the roadmapping workshop was to create and elaborate visionary socio-technical roadmaps for the Nordic ICT Foresight project emphases.

We propose our special brand, visionary socio-technical roadmaps, for the Nordic ICT Foresight (Figure 6). *Visionary socio-technical roadmaps* aim for the targets defined in the bullets below by (1) *emphasising application visions that are embedded in the roadmap structure* and (2) *by combining different layers of society and technology*. In this project, the roadmaps have five layers: education and science, technology, business and industry, markets and government. It is crucial to note that the roadmaps are application-oriented and visionary, i.e. they do not try to depict all the possible development trajectories relevant to the sector under scrutiny. Instead, the roadmaps produce partial glimpses of the elements and development paths surrounding a certain application. The applications roadmapped in this exercise can be labelled either visions of *development trajectories in the systemic level* (e.g. roadmaps of the intelligent systems in the self-are or the secure management system of the energy) or potentially *disruptive application visions* (e.g. roadmaps of the automatic language translation and personal traffic agent for security).

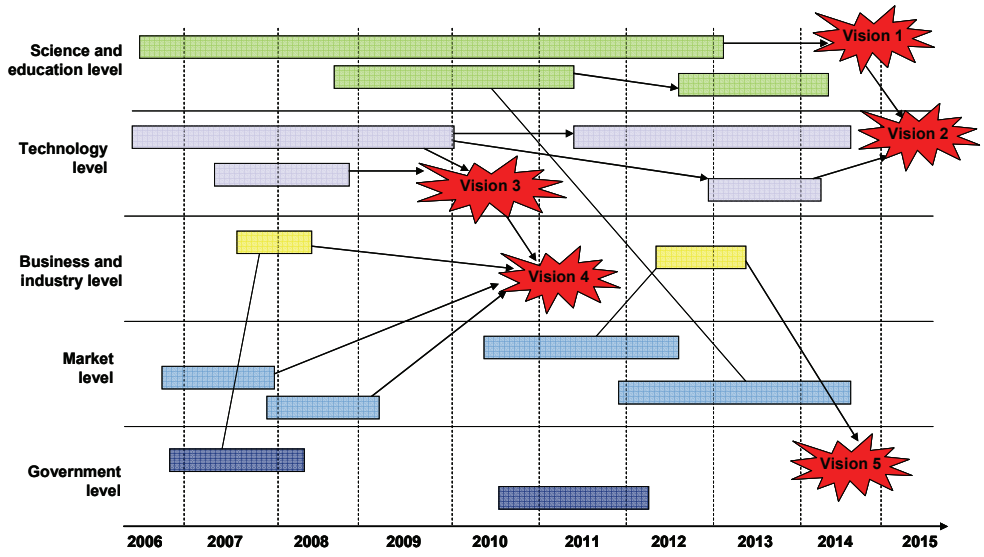


Figure 6. The ideal model of the visionary socio-technical roadmap.

The key idea in the construction of the roadmaps was to combine external scenarios and visionary development paths. Therefore, each roadmap was basically built within the context of one of the four Nordic ICT Foresight scenarios. Roadmaps were created on the project's four themes: experience economy, health, production economy and

information security. For each of the socio-technical visions – or groups of these – the workshop discusses the potential developments on the following five roadmap levels:

- Science and education (needs for scientific research, needs for competences)
- Technology level (networks, terminals, content delivery, quality of service, security among others)
- Business/industry level (business opportunities, business development in the match between technologies and markets, finance, industrial standards)
- Market level (market mechanisms and end use markets)
- Government level (industry policy, public R&D, early market stimulation, standardisation).

The connections between the scenario and roadmapping workshops were made by linking each thematic roadmap to a certain scenario. In this way the process produced scenario-based roadmaps on the four Nordic ICT Foresight themes. In the simplified form, the combination of a theme and a scenario was decided in advance in the core group of Nordic ICT Foresight. In the actual workshop, the scenarios were thoroughly described by emphasising three or four main characteristics of the scenarios. By advancing in this manner, the following combinations of themes and scenarios were formed: Experience economy–Big Business Lock-In, Health– The Nordic Mystique, Production Economy–Elite User's Paradise, and Security –ICT for Security's Sake (Figure 7).

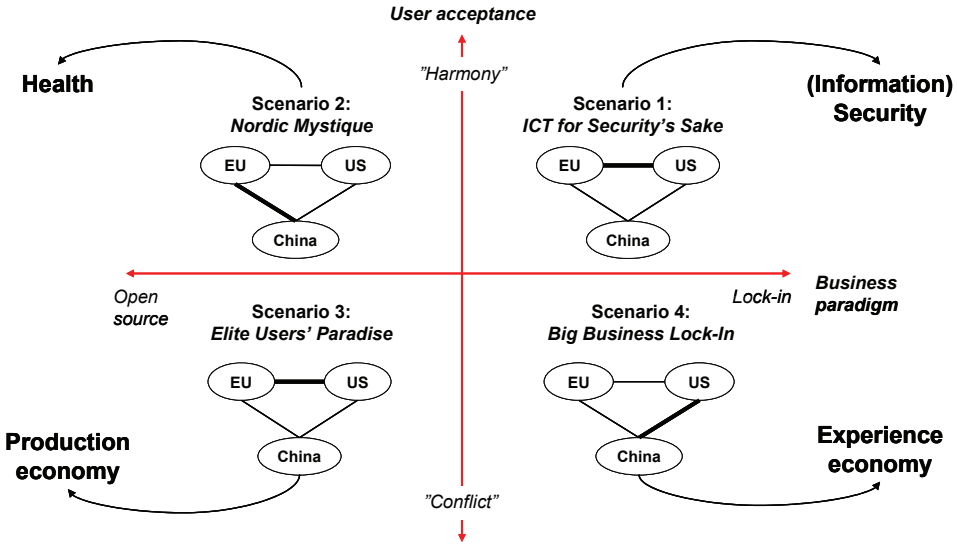


Figure 7. Linking scenarios and roadmaps.

Nordic ICT Foresight roadmap summaries

The key idea of the roadmapping process was to produce roadmaps within the context of the four Nordic ICT Foresight scenarios. Therefore, some of the elements in the roadmaps should be understood as consequences of this research decision. However, it should be emphasised that although the scenarios formed the basic context for the roadmaps, the roadmaps are meant to be read in a general sense as well. The roadmaps include elements and paths that are valid for the Nordic level despite the external

developments that may or may not be realised in the future. Therefore, the scenario context of the roadmaps should not be read as a too rigid or too deterministic framework. Hence, in the roadmap narratives the scenario context is deliberately faded from the front, but it should be seen as a background and a source for the described developments.

Tables 12, 13 and 14 present summaries of the roadmaps constructed on the Nordic ICT Foresight themes and scenarios. Table 12 presents the general Nordic level summary of roadmaps and emerging technology evaluations. On the basis of the roadmaps, the following synthetic conclusions can be made. In the short term (1–5 years) there is an overall trend towards convergence of ICT solutions and formation of modular solutions. ICT technologies and products are still quite disparate and without common frames. Separate technologies are applied to different platforms, e.g. mobile, entertainment and production. The key question is that solutions in the short term are tailored to different user contexts. However, there are considerable increases in the number of relationships between different ICTs. In addition, central technological platforms are being designed and constructed. In the medium term (5–10 years) there is an overall trend towards the actualisation of a mobile network society. This means that technological readiness for the realisation of the new level of network society will be somewhat reached. Technological readiness is based on compatible and multi-channelled devices and context-aware applications. There are developments towards the formation of heterogeneous networks. These new multi-channelled devices enable personally tailored communication and media services, e.g. ubi-services which utilise intelligent agents and distributed data storage in real time. There are waves of convergence within the ICT application groups. ICTs are becoming more embedded in materials and objects. This development intensifies the depths and dimensions of networking. Also, new technological solutions are about to emerge, such as 3D and flexible screens and fuel cell batteries. In the long term (over 10 years) the mobile network society more or less exists, which means that the everyday environment is “stuffed” with sensors and communication terminals that are constantly forming ad hoc links. ICT devices network spontaneously with other devices, platforms and everyday objects. This creates possibilities for different services, but also forms specific information threats. Overall, it is crucial to acknowledge that the social and ethical dimensions of the technologies should be important levels of societal discussion in the short and, especially, in the long term – networking technologies enable transparent utopian development trajectories as well as dark dystopian ones.

Table 12. General Nordic level summary of roadmaps and emerging technology evaluations.

SHORT TERM: 1–5 years	MEDIUM TERM: 5–10 years	LONG TERM: over 10 years
• Converging ICT solutions • Formation of modular ICT • Disparate groups of ICT technologies and products: technologies are without a common frame • Separate applications are utilised in different technological platforms: e.g. mobile, non-mobile, entertainment, work, production, and housing • Increase of relationships between different ICTs • Central technological platforms are being constructed	• Towards a mobile network society • Personally tailored communication and media services: ubi-services, intelligent agents, distributed data storage and information search... • Compatible, multi-channelled devices: convergence, forming heterogeneous networks, ad hoc, context awareness… • New technological solutions: 3D screens, flexible screens, fuel cell batteries, etc. • Embedded intelligence in materials and objects • Convergence and compatibility of ICT groups	• Existing mobile network society > ubiquitous solutions in everyday environments • Ad hoc heterogeneous networks • Spontaneously linking and communicating devices and platforms • Everyday environment is immersed in ubiquitous solutions and embedded systems • Ambient intelligence and ubiquitous computing • Sensor networks

Table 13 presents a general summary of the thematic roadmaps in the Nordic ICT Foresight. The first row summarises the roadmaps in the *experience economy*. In the *short term* (1–5 years) the technologies are based on different network technologies and solutions, e.g. peer-to-peer and parallel networks. In addition, communicating embedded solutions such as RFID are emerging. The potential business models emphasise the utilisation of user-generated content and the creation of integrated service concepts. In the theme of experience economy there was discussion about already springing "policy products", i.e. ICT solutions that enable new government practices in cyberspace. In the *medium term* (5–10 years) combinations of product platforms are forming. Applications are becoming more modular and devices communicate through different network platforms. There are strong development trajectories in mobile applications as well as in semantics and information ontologies. Another strong trajectory is materials and fabrics with embedded sensors, i.e. intelligent materials. In the medium term the business models are based on the concepts that emphasise user-generated content and models based on mobile and real-time integrated service concepts. Some disruptive potentials were identified and sketched in the scenario workshop. It was acknowledged that applications based on, e.g., automatic language translation bring potential for the Nordic ICT developers. In the *long term* (over 10 years) the roadmaps anticipate fluidly and spontaneously communicating product platforms. Sensors will be embedded in infrastructure, materials and moving objects, thus enabling spontaneous ad-hoc networks. In the long term there will be new business models based on service concepts utilising networked environments, semantic web and agents technologies. In addition, new and efficient battery formats and energy systems could be created for ICT terminals and devices.

The second row in Table 13 summarises the roadmap on the *health* theme. In the *short term* (1–5 years) the roadmap emphasises ICT-based support systems for healthcare, especially for treatment (e.g. diabetes) and measuring (e.g. blood pressure, targeting and dosing of medicines).The alarm systems and products for the aging population are also highlighted. ICT applications are focused on bioinformatics, bio-information systems and databanks, which are used as extensive biological datasets for data mining. In addition, these datasets and ICT applications for simulation and visualisation are utilised for modelling, e.g. biological interactions. In the *medium term* (5–10 years) the roadmap emphasises the potential of the Nordic platform for testing the customer markets of the developed health applications. The ICT applications are focused on advanced "home medicine" solutions, e.g. monitoring systems, virtual pharmacies,

alarm systems, virtual and distance medicine. ICT-based diet and nutrition systems are applied and utilised. New technological advances in chip laboratories and ePrevention will grow in importance. There is also a growing need for socio-technical innovations that enable the utilisation of ICTs in home medicine. These include, for example, innovations in service automation and customisable interfaces using combinations of senses. In the *long term* (over 10 years) it is anticipated that the Nordic test market will develop into a Nordic health support system endorsing ICT applications for research, self-care and monitoring. The health ICTs could, in the long run, be utilised in the ubiquitous health environments that adapt to personal health conditions.

Table 13. General summary of the visionary roadmaps in experience economy and health.

THEME	SHORT TERM: 1–5 years	MEDIUM TERM: 5–10 years	LONG TERM: over 10 years
EXPERIENCE ECONOMY	• Business models based on the utilisation of user-generated content • Business models based on integrated service concepts • "Policy products" > ICT solutions that enable new government practices in cyberspace • Network technologies and solutions: peer-to-peer, parallel networks • Communicating embedded solutions, e.g. RFID	• Product platforms and modular solutions > devices communicate through different networks • Business models based on the utilisation of user-generated content • Business models based on mobile and real-time integrated service concepts • Developments in mobile technologies, semantics and information ontologies • Intelligent materials and fabrics with embedded sensors • Automatic language translation as potentially disruptive technology > lock-in breaking possibilities for smaller language groups	• Sensors embedded in infrastructure, materials and moving objects • Fluidly and spontaneously communicating product platforms • Business models based on service concepts utilising networked environments • Semantic web • Agent technologies • New, efficient battery systems for the ICT terminals and devices
HEALTH	• Alarm systems and products for the aging population • Need for innovations combining social and technological aspects • Databases • ICT-based support systems for healthcare: e.g. diabetes, blood pressure, targeting and dosing of medicines • Bioinformatics, bio-information systems and databanks: extensive biological datasets, data mining, interactions • Simulation and visualisation: e.g. system biological interactions, protein research, virtual models	• Nordic platform to test the customer markets of the developed health applications • Applying advanced "home medicine" solutions > monitoring systems, virtual pharmacies, alarm systems, virtual and distance medicine • Socio-technical products: service automation, customisable interfaces using combinations of senses • ICT-based diet and nutrition systems • Chip laboratories • eHealth and ePrevention: data warehouses, data mining and drilling • User generated applications in healthcare?	• Adaptive ubiquitous environments > environments and buildings that adapt to personal health conditions • Nordic test market develops into Nordic health support system endorsing ICT applications for research, self-care and monitoring • Nano- and picosensors

The summary of the *production economy* roadmap is presented in the first row of Table 14. In the *short term* (1–5 years) ICT applications in production economy emphasise ICT-based distributed local energy solutions, mass-tailored production lines and on-demand systems. It is anticipated that knowledge management principles will permeate all levels of the production economy and bring lifecycle management, performance indicators, simulation and design tools to the core of industrial processes. Advanced control systems will be important for the ICT applications. Modularity, flexible architectures, advanced algorithms and unexpected situation management are expected to rise in the short term. Applications that are based on mobility will be accentuated in the form of mobile interfaces and mobile maintenance systems. In the short term the

sensor applications, especially RFID, and field devices, e.g. sensor fusion and sensor actuator smart devices, will be emphasised. In the *medium term* (5–10 years) the ICT applications will be integrated to form fluid and mobile data transfer. In the medium term the lifecycle management systems will be converging and real-time analyses of the production process and logistic data will be highlighted as well as new industrial applications stressing, e.g., automatic reasoning, error seeking and systemic optimisation. New analysis systems and user interfaces will also emerge. These include, for example, mobile terminals, fault navigation tools, abnormal situation management tools and different visualisation applications. In the *long term* (over 10 years) the roadmap emphasises the control systems for efficient energy use on the Nordic level. In the industrial sphere the developments will emphasise intelligent and adapting devices for the production systems. These will be based on the applications of agent technologies. The emerging fully automatic factories will be maintained and repaired by mobile and automatic maintenance systems.

The second row of Table 14 presents the summary roadmap for the *security* theme. The *short term* (1–5 years) sketched in the Nordic ICT Foresight accentuates simulation and scenario models for the prognoses of crises in the societal systems, i.e. platforms, plants and infrastructures. In addition, simulation models for the implementation of sensor systems, for example in the traffic system, are needed for the efficient planning and anticipation of security issues. The networked infrastructures, e.g. energy, roads, electricity, as well as the ICT infrastructure, require new kinds of security concepts. Furthermore, concepts for "invisible" security will be needed because mobile and networked solutions should have fluent security levels. Moreover, the key questions of information security will be strongly emphasised. These include identity management of the users, long-term and safe preservation of the data and utilisation of distributed networks to minimise the escalation of viruses and infiltrations. The questions of IPR management and software standardisation will be high on the agenda in the short term. In the *medium term* (5–10 years) the key issue raised in the workshops was biometric information security, which emphasises the preservation of biometric information in digital form gathered via biometric tags and bioidentifiers. Another key topic is the non-reproducing technologies that could be basis for the formation of robust security systems. All in all, security on the level of links and networks will be crucial. This means the creation of new information security protocols, ways to secure information flows and guaranteed authentication algorithms. The issue of network trust will be highlighted. Network trust covers the prevention of eavesdropping and scanning of private information, obstruction of unauthorised access, preparing checks for the "man-in-the-middle", blocking of "backdoors" and the entrance of Trojan horses and, on the whole, preventing the system malfunctions and breakdown caused by potential viral attacks. Considering these issues, it is anticipated the infrastructure and network security applications will be an important development trajectory in the medium term. In the *long term* (over 10 years) there should be large-scale security concepts for the ad hoc network solutions and general communication infrastructure. Moreover, infrastructural security applications rise in importance when sensor systems are embedded in the large static infrastructures, e.g. roads, electric wires and energy pipelines.

Table 14. General summary of the visionary roadmaps in production economy and security.

THEME	SHORT TERM: 1–5 years	MEDIUM TERM: 5–10 years	LONG TERM: over 10 years
PRODUCTION ECONOMY	• ICT-based distributed local energy solutions • Mass-tailored production lines and on-demand systems • New mobile interfaces to control the production processes • Mobile maintenance systems • Simulation and design tools • Field devices: e.g. sensor fusion, sensor actuator smart devices • Applications based on RFID • Knowledge management principles permeate all levels of the production economy: lifecycle management, performance indicators, simulation • Control systems: e.g. modularity, flexible architectures, advanced algorithms, unexpected situation management	• Testing the ICT-based energy control systems in the Nordic level • Fluid and mobile data transfer • Real-time analysis of the production process and logistic data • Automatic reasoning, error seeking and optimisation systems • Convergence of lifecycle management systems • New analysis systems and user interfaces: e.g. mobile terminals, fault navigation tools, abnormal situation management tools, visualisation	• Control systems for efficient energy use on the Nordic level • Intelligent and adapting devices in the production systems • Fully automatic factories • Mobile and automatic maintenance and repair • Agent technologies in the production systems
SECURITY	• Simulation and scenario models for the prognoses of crises in the systems > platforms, plants and infrastructures • Simulation models for the implementation of sensor systems, e.g. in the traffic system • Questions of standardisation • Development of network and infrastructure security concepts • Concepts for the “invisible” security > security should be as fluent and invisible as possible • Identity management • Long-term preservation • IPR management • Distributed networks	• Biometric information in digital form • Biometric tags and bioidentifiers • Non-reproducing technologies • Trustable and secure information systems: eavesdropping, scanning of private information, unauthorised access, “man-in-the-middle”, system breakdown, trojan horses, backdoors... • Security on the level of links and networks: information security protocols, secure information flows, authentication, security in the mobile and heterogeneous networks • Infrastructure security applications	• Information security for ad hoc network solutions • General security and filtering solutions embedded in the communication infrastructure: DRM, SPAM, virus • Security applications in the sensor systems over the large static infrastructures, e.g. roads, electric wires and energy pipelines

Actions on the Nordic level

Action workshop process

The aim of the action workshop was to identify and evaluate a set of actions and policy alternatives to be taken by the key players in the Nordic countries in order to support the desirable developments and successful implementation of the new ICT solutions. The Oslo workshop in November 2006 was built on the basis of the preceding phases of the project. It consisted of short project and thematic presentations and two group works. The focus was on possible future actions and actors of the Nordic policies around ICT applications and innovations. The participants first brainstormed the plausible socio-technical visions (see Ahlqvist et al. 2007), on the basis of which the action proposals were produced.

Elaborated action proposals

The elaborated action proposals are presented in the following tables – Table 15 presents the action proposals for experience economy theme, Table 16 for health and Table 17 for production economy.[1] The key issue to notice is that the action proposals were produced within the context of scenarios. This procedure aimed at gaining more depth to the scenarios. It also made the process quite hard and demanding for the experts – thinking in the scenario frame is not an easy task, even for an experienced facilitator.

Table 15 presents the results of the work on *experience economy*. In the workshop there was some discussion on whether the group should choose a different socio-technical vision for different scenarios or whether the group work should with the same vision in different scenarios. In the end the group worked with a kind of combination of the two. The generic idea of "electronic space" was chosen as the combining element between the scenarios, but in each scenario some unique characteristics of the "electronic spaces" were identified. In the frame of scenario I (ICT for Security's Sake) the elaborated actions were 1) applications for simulating threats (i.e. virtual spaces, games, simulators) and 2) the creation of an ICT-bio-identifier for the access to different eSpaces. It was further characterised that this application could be based on, e.g., scanning of the eye. In the context of scenario II (Nordic Mystique) the elaborated action proposals were 1) applications for user-driven innovation processes in industries and research areas, and 2) digitalisation of the cultural heritage of small languages. In the second proposal the idea was to form a loose network of Nordic actors to form a public-private style coalition to realise this issue. In the frame of scenario III (Elite User's Paradise) the action proposals were 1) the creation of extremely sophisticated smart e-spaces for the elite users, 2) the creation of moderately smart e-spaces for the different hobbyists and 3) closed e-spaces for the value-driven communities. The idea of these e-space proposals was inspired by the narrative of scenario III, which emphasised the polarised user groups. In the frame of scenario IV (Big Business Lock-In) the action proposals in the experience economy theme were 1) franchising the standard models of the big companies and 2) customisation of the standard products for the niche markets.

[1] A separate table for the security area is not included because of the incomplete information due to the time limitations in the workshop.

Action proposals on the *health* theme are presented in Table 16. The socio-technical visions discussed circled around the issues of a single Nordic health market, personal health card, home medicine applications and early warning systems for the elderly home care. In the context of scenario I (ICT for Security's Sake) one action proposal, a single Nordic market for healthcare ICTs, was discussed in two steps: 1) a broadly initiated design process on a Nordic level and 2) establishing a common platform for search and suppliers/providers of services. In scenario III (Elite User's Paradise) the elaborated action proposal covered the issues of preventive health care, health monitoring, and personal healthcare/preventive medicine for the elite users. It was stated that the idea was to provide advanced ICT-based systems of "ideal health care" for the elite and simpler systems for the general market. In the context of scenario IV (Big Business Lock-In) the discussion was targeted on the outsourced medical services – a kind of simplified version of the elite health systems provided by large private operators – to be sold to the general public.

The action proposals in the *production economy* are shown in Table 17. The group discussed different possible socio-technical visions and worked with the following visions: Barents on screen, new digital management, home automation and convergence of information systems. In the frame of scenario I (ICT for Security's Sake) the elaborated action proposal was context-aware systems/applications with surveillance of production and environment (Barents on screen). It was thought this would be realised in three steps: 1) improving logistics, 2) producing new regulation and 3) engaging in actor-oriented dialogue on the ethical and business consequences of these monitoring systems. The action proposal in the context of scenario II (Nordic Mystique) highlighted the new digital management. The new ways of digital management were seen as being realised in three steps: 1) implementation of "open innovation" in the production economy, 2) setting criteria to ensure quality digitally and 3) measuring output/performance. Finally, in the frame of scenario III (Elite User's Paradise) the action proposal discussed was home automation. In the action workshop this action was initiated in three steps: 1) implementation of energy saving systems, 2) formation of intelligent security systems and 3) activities to create innovative entertainment systems.

In the fourth theme, *security*, the group discussed five possible visions to work with: 1) co-nets (isolated internets) - the possibility to build secure nets for specific purposes; 2) a security and management system for energy; 3) a security and management system for water supply; 4) a personal traffic agent for security and 5) a digital version of the cultural content for small language areas. Some important generic technologies in the context of security were also discussed. These were cryptographic technology, biometrics, sensors, and system architectures for systems based on open source. The elaboration of the action proposals was not finalised on the security theme.

Table 15. Summary of the action proposals in the experience economy.

THEME	SCENARIO	ACTION	ACTORS	DRIVERS	BOTTLENECKS
EXP. ECONOMY	***I: ICT for Security's Sake***	**1. Applications for simulating threats** > virtual spaces, games, simulators **2. ICT-bio-identifier for the access to different e-Spaces** > sophisticated application- based on e.g. scanning of the eye	**1.** Business, government; Nordic joint venture combining public & private **2.** Co-operation between research and SMEs	**1.** Atmosphere of insecurity; Security is a central part of everyday life **2.** Because of the theft identities, organisations need identifiers; Market demand in US and more unstable developed countries; The instability in the outer world makes the Nordic countries more attractive	**1.** "Security" could be understood too widely > it is taken for granted; Too many initiatives under the broad concept of security > losing focus **2.** Theft of identities > you cannot use any identity because of the possible thefts
	II: Nordic Mystique	**1. Applications for user-driven innovation processes** in industries and research areas **2. Digitalisation of cultural heritage of small languages** > Pre-study and a Nordic demo to invite private companies to develop services	**1.** Nordic SMEs and larger firms, EU research programs **2.** A pan-Nordic actor for front figure; Government and State (university libraries and national libraries); Publishers; Business	**1.** ICT can be a general trend in all industries; Nordic countries are very developed in ICTs > coverage in ICT equipment; Nordic mindset is ripe for these kinds of solutions **2.** Need to conserve cultural data in digital form; A common platform; Development of services	**1.** Too specialised competences > need for cross-cutting and multidisciplinary competences; Cultural difficulties in changing production practices **2.** Political will; Funds; Conservatism in copyrights; Suitable business models; Bottlenecks of public–private partnerships
	III: Elite User's Paradise	**1.** Creation of extremely sophisticated **smart e-Spaces** for the elite users **2.** Creation of **moderately smart e-Spaces** for the different hobbyists (semi-Ikea products) **3. Closed e-Spaces** for the value-driven communities	**1.** Firms, researchers, exclusive networks (executive clubs) **2.** Enthusiasts of the different branches **3.** People who have a value-driven cause	**1.** Technological developments in ICTs; Elite users are driving the innovation processes in the smart training **2.** Technological developments in ICTs; Interests in the different branches (e.g. motorcycles, horses) **3.** Value differences in society; In a free society you are able to create value-driven networks; Value differences drive to use of ICTs (e.g. it is more environmentally sustainable to use ICTs)	**1.** If you are not part of the elite, you have no access > where's the critical mass? **2.** Exclusive clubs that are divided by the interests **3.** Some of the e-Spaces are not allowed for all of the users
	IV: Big Business Lock-In	**1. Franchising the standard models** of the big companies **2. Customisation of the standard products** for the niche markets	**1.** Nordic firms **2.** SMEs	**1.** Cost-efficiency of the standard models; Simple to use; Large export opportunities in developing regions; Big companies outsource non-core operations **2.** Volume's are too small for big companies	**1.** Lack of trust in the monopoly solutions and monopolies themselves; Standard models are not commercially exciting; Boring selection of goods **2.** Only to be done with the permission of big firms

Table 16. Summary of the action proposals in health.

THEME	SCENARIO	ACTION	ACTORS	DRIVERS	BOTTLENECKS
HEALTH	***I: ICT for Security's Sake***	**A single Nordic market for healthcare ICTs** **STEP 1.** Broadly initiated design process on a Nordic level **STEP 2.** Establishing a common platform to search for suppliers/providers of services	**STEP 1.** Collaboration between responsible parties: government, hospitals, representatives of patient groups, research institutes **STEP 2.** Government	**STEP 1.** Society interested in reducing total health costs and enabling better coordination **STEP 2.** EU regulations; Common data card for all EU inhabitants	**STEP 1.** Strong organisations, different issues, solutions, regional hospitals on their own agendas **STEP 2.** Too complex in structure and technologies
	III: Elite User's Paradise	**Preventive health care, Health monitoring, personal healthcare/preventive medicine for the elite users >** An exclusive private market offer of advanced ICT-based systems for "ideal healthcare"; "second rate" simpler systems for the general market	Privatised smaller clinics supplying "high-class" service for wealthy clients.	Lack of capacity in the public health service	General acceptance of private services
	IV: Big Business Lock-In	**1. Outsourced medical services** > Advanced systems too expensive to be applied in general. Simple versions of health systems provided by large private operators	**1.** Few large suppliers of systems and health services	**1.** Financial strength of the few companies having legal access to the health market	**1.** Lack of user acceptance for the complex system / or lack of facilities in the system

Table 17. Summary of the action proposals in the production economy.

THEME	SCENARIO	ACTION	ACTORS	DRIVERS	BOTTLENECKS
PROD. ECONOMY	***I: ICT for Security's Sake***	**Context-aware systems/applications with surveillance of production and environment (Barents on screen)** **STEP 1.** Improving logistics **STEP 2.** New regulation **STEP 3.** Dialogue on ethics and business	**STEP 1.** Oil companies **STEP 2.** Government (national, EU) **STEP 3.** NGOs, environmental groups, companies	**STEP 1.** Development of context-aware technology enablers **STEP 2.** Climate changing, rising awareness **STEP 3.** Big environmental accident (big oil spill)	**STEP 1.** Cost and availability; integration **STEP 2.** Cost, profit making large companies **STEP 3.** Complexity of the question, conflicting interests
	II: Nordic Mystique	**New digital management** **STEP 1.** Implementation of "open innovation" **STEP 2.** Setting criteria to ensure quality **STEP 3.** Measuring output/performance	**STEP 1.** Dynamic and ever-changing peer-to-peer/ business networks **STEP 2.** Project owner, participants **STEP 3.** Private and public employees/employers	**STEP 1.** Open ideas approach, open idea auctions **STEP 2.** Common idea of project **STEP 3.** Creative knowledge work	**STEP 1.** Need for new platforms for co-development **STEP 2.** Individual preferences **STEP 3.** Need for new definitions of performance, problem of existing systems
	III: Elite User's Paradise	**Home automation** **STEP 1.** Implementation of energy saving systems **STEP 2.** Intelligent security systems (home, health, etc.) **STEP 3.** Innovative entertainment systems	**STEP 1.** Energy industry, Construction companies, ICT players, EU policy makers **STEP 2.** SMEs providing technology, health sector (private/public) Convergence of film and virtual reality	**STEP 1.** Energy price, sensor technology, energy awareness **STEP 2.** Demand and desire for more security, health sector efficiency	**STEP 1.** Public attitudes, (choice hotel/private person), reconstruction/renovation of housing constructions **STEP 2.** Integration of technologies

Policy recommendations

In this chapter we form and crystallise the key policy recommendations on the basis of the research process. The angle of the formation of policy recommendation is on the Nordic level – the policy recommendations are, therefore, directed to a quite general transnational level. However, the policy recommendations are written in the form that thrives to make the recommendations applicable to other regional (European, national, sub-national) and even organisational levels.

The key idea in structuring the policy recommendations is to divide them into *implementation strategies*, i.e. strategies that could be implemented on the Nordic level in order to produce new innovation dynamics in ICT or to find a new, potentially prosperous, production niche from the Nordic viewpoint. Where robust strategies are implausible, one should seek *adaptive strategies*. These refer to strategic options that put the emphasis on the ways to cope and prosper in the overwhelming global "ICT streams".

Recommendations I: Implementation strategies

In this chapter we discuss possible implementation strategies that could be adapted on the Nordic level (for a wider depiction of the recommendations, see Ahlqvist et al. 2007).

- Creation of Nordic SME-based competence clusters and/or platforms in converging technological niches. Focal niches in these clusters could be (1) *sensor-based enhanced reality systems*. This niche could be directed both to the professional applications requiring multi-sensory experiences and applications with more entertainment value. The second potential Nordic niche could be linked to (2) *intelligent buildings and home automation*. In this case the direction would lead to technologies embedded in the everyday environments. One of the directions could be to focus on energy saving systems and home security systems. The third potential niche could be (3) *development of mobile digital management applications especially for the production systems*. The core of this proposal is to foster development of mobile digital management applications in production systems, e.g. production lines and logistic chains. The key to this proposal is to concentrate on flexible interfaces (via mobile phone or laptop) and dynamic peer-to-peer networks.
- **Enhancing the utilisation of mobile ICT infrastructures for remote monitoring**. One of the potential policy proposals in this context could be a research initiative to create context-aware systems and applications for the surveillance of environment, e.g. "Baltic Sea and Barents on the screen". The developed applications could be applied in the monitoring of peripheral geographical areas, in monitoring the general changes in the environment, in traffic and infrastructure surveillance, or it could be applied in integrated production systems, "factory on the screen".
- Initiative for the creation and integration of Nordic test markets for ICT applications and ICT policies in the health sector. The ICT-wise starting

point for the (1) *the creation of a Nordic test market concept* would be to formulate a somewhat common Nordic health record on how to store, handle and distribute the patient data. The second step would be to establish a common platform for searching for suppliers/providers of services. The second proposed angle is to make a platform for (2) *the applications of distance medicine*. This would be a core function in Nordic level home medicine and distance monitoring concepts and technologies. Some applications developed on this platform could include systems that monitor and assist elderly people living at home, applications for monitoring day-to-day activities (e.g. if blood pressure is too low, a signal is sent to the hospital) and, in addition, ICT-based diet and nutrition systems. The third proposed application in this context is (3) *the formation of a common Nordic health card*. The formation of a health card requires the creation of an integrated health record system. The construction of the actual card could be based on mobile technologies.

- **Nordic level research and policy initiative to develop new ICT-based concepts for information and general security**. The core of this strategy would basically be to present an initiative that aims at building a common Nordic agenda for the research, development and policy activities in the field of ICT security. The idea should be quite wide and, therefore, it should be based on the general notion of security that combines information security with social security and with environmental and network security. Reflecting on these discussions, the key questions are: identity management, dynamic privilege management, long-term preservation of the data and non-reproducing technologies. The question of biometric identification is the core of the issue. Biometric identification combines a lot of technologies and practices, e.g. biometric tags, the questions of security of biometric information and the prevention of malpractices with the biometric information.
- **The ideation and creation of new business models for the user-driven application developments**. The quite egalitarian Nordic welfare society combined with relatively low societal hierarchies could be fertile ground on which to form business concepts on the "long tail" of niche applications, on the basis of user and "amateur-driven" applications and ideas. The key question for the business concept lies in the system of payment. In this case the key questions are the following: is the payment system closed, meaning that you pay for the key and the access, or open, meaning that you browse through a mass of advertisements to see the content? A potential Nordic niche could be to create ***advanced micro-payment systems and business concepts linked to user-generated products and business models***. These concepts should be future-oriented and seriously consider the already crucial issues of file-sharing, IPR and digital rights management (DRM).
- **The Nordic initiative to enhance electronic business transactions and applications**. The Nordic area is well developed in its information infrastructures, but there are some gaps in the utilisation of ICTs as a business platform. In a recent Finnish Technology Barometer (Lehtoranta et al. 2007) it was acknowledged that there is still a lot to do in the

development of e-commerce and digital communications in the consumer markets and in the business-to-business models. Besides, e-business functions are focused on large firms.

Recommendations II: Adaptive strategies

In mobile ICT, the Nordic region has been the advanced developer of solutions for about 15 years. The field of mobile ICT is changing radically in the waves and tides of global competition and the global marketplace. In this context, the Nordic countries could initiate three kinds of adaptive strategies.

- **Towards a deeper understanding of the cultural contexts of new services and solutions**. The leading mobile firms have for some time experienced some "cultural frictions" because of the enhanced encounters with new cultures, locations and rapidly evolving market segments. In culture and geography the challenge is to adapt to different markets and find the key to success. Many firms have solved this dilemma by moving the production nearer the potential markets, in a process that has been notoriously known as the China phenomenon. This cultural and geographical market change can be called horizontal. However, there are also vertical market changes. The market segmentation also happens in the low-end and high-end continuum. In the low-end, cost-efficiency is the most important decisive factor. Low-end users buy the most cost-effective products with the basic technologies. In the newer markets, like China or India, the low-end might be an important gate to the more advanced products as the living standards of the population increase. In the high-end, the competition will be in the quality of services and usability of products. The high-end customers demand fluidity and coherence of services.
- **Learning to utilise and productise innovations in the second or the third wave**. In Nordic electronics and ICT production there has traditionally been a "settler" spirit: the core of the firms is based on the basic technological or business innovations. Some new aspects could be linked to this strategy: maybe some Nordic actor could be the top player in the bettering and moving of innovations. Not all the basic technology needs to be developed by the firms themselves – the additional strategy might be to find new niches and areas for the old innovations or by bettering and smoothing the older innovations so that they could be utilised in older market areas.
- **Widening the scope of innovation and learning to "recycle" the ideas into new niches**. In ICT and industry in general there is a need to identify the innovation as a more wide process than just developing a technology and making a product out of it. The innovations could be linked to the processes, to the brand, to the market segments or to the niches. Therefore, older technological solutions might be innovations in new areas.
- **Creating strategies for the utilisation of a "long tail" in the Nordic sphere**. The long tail – coined by Anderson (2004 & 2006) and referring

to the “right end of a right-skewed distribution” (ETEPS 2007) – refers to the production and distribution of vast varieties of low-demand tailored products that can collectively amount to equal shares of market successes or “blockbusters”. The idea of the long tail is to make small niche products for minorities in a mass production fashion. The advanced Nordic ICT production technologies, energetic cultural industries, e.g. in music and multimedia, and flat “user-driven” societal models could enable application of this idea of “segmented mass customisation” in a variety of fields.

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