

# Telecom Scenarios 2010

- a wireless infrastructure perspective



Maxime Flament  
Fredrik Lagergren  
Rickard Stridh  
Olav Queseth  
Matthias Unbehaun  
Jiang Wu  
Jens Zander

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# 1. Introduction

## 1.1. *Background*

The consumer of telecommunication services of tomorrow will expect to receive the same services in a wireless fashion as he receives from a fixed network. These services require (at least instantaneously) high bandwidths. It is not expected that future telecommunication users are willing neither willing to sacrifice functionality for the added value of mobility nor to pay more for it - mainly because he will hardly be using any other stationary telecommunication devices. The successors of current digital mobile telephony systems, the so called "Third generation" mobile systems (UMTS and IMT-2000) aim at only partially solving these problems. By mainly extending second generation technologies higher data-rates, up to 2 Mbit/s are offered but only to a limited number of users at the time and only in certain areas. In rural areas only marginally higher bandwidth will be provided. In order to enable the use of truly new and innovative multimedia services, even higher bandwidths need to be provided at a lower cost that can be provided by second and third generation systems.

Studying alternative technologies and architectures for such wireless access infrastructures is the aim of this project. Key limiting factors have been identified as spectrum shortage, power consumption and infrastructure costs. Spectrum shortage is mainly due to interference from other users but also due to the slow process of international regulation & co-ordination with existing services. Device power supply technology is also a key problem are since it is not expected to make substantial progress (i.e., only 1-2 orders of magnitude) in the next decade putting severe restrictions on power consumption. High bandwidths seem to demand massive infrastructure investments with towering (and possibly prohibitive costs).

These problems are the focus of the 4<sup>th</sup> Generation Wireless Infrastructure (4GW) project within Personal Computing and Communication (PCC), a national strategic research program financed by the Foundation for Strategic Research (Strategiska forskningsstiftelsen). PCC aims at strengthening Swedish industry in the area of telecommunication. The program initiates research, relevant to industry, at the highest international level and runs graduate education preparing for international careers. Another aim is to keep interdisciplinary research and to promote co-operation between research groups both within academia and between academia and industry. The PCC Vision, guiding all activities, is "*Personal multimedia communication to all at the same cost as fixed telephony today.*" The 4GW project in turn aims at investigating and proposing overall infrastructure architecture solutions for the successor of these 3<sup>rd</sup> generation systems, what is here conceptually denoted as 4<sup>th</sup> generation "system", with respect to technical, economical and regulatory perspectives. This involves truly interdisciplinary efforts, spanning from services & user behavior, infrastructure economics, telecommunication analysis, down to implementation issues and device technology. The approximate time frame for the deployment considered by the project is 2010-2015.

## 1.2. *Personal Computing and Communication*

Today, the development in telecommunication and computing areas may be perceived as extremely fast. Keeping up to date with the latest developments in the research community may be a challenge in it self. However, in retrospect, the massive deployment of infrastructure has been, and still is, a slow process. This is mainly due to the large investments that are required, which in our time of deregulation and market uncertainty often are hard to motivate even for the largest actors on the telecommunication scene. The time spent from the first

research results to a fully deployed infrastructure may be of the order decades. One of the great challenges of this situation is to ensure that research performed today will be relevant in the future when results are to be applied in the design and deployment of a system.

To enable a systematic analysis of such future systems, the project has adopted a process model as illustrated in fig 1. The project work is focused around the *Working Assumptions* (WA:s) which as a collection form a conceptual description of a 4<sup>th</sup> generation wireless access system. The WA:s provide the common platform for interrelating comparing and selecting research problems in the different Work Packages(WP:s). The task of the work packages is to derive and analyse key (bottleneck) problems in the current set of working assumptions. The focus is on studying the feasibility of solving these problems as well as determining performance limits and potential bottlenecks. The result will be used to modify the working assumptions by changing the trade-offs between various bottleneck areas. An important first step in this process is to get a picture of the possible futures such a system will work in. Thus the first activity in the project has been a scenario analysis of the future telecommunication environment in which a 4<sup>th</sup> generation wireless access system is to be deployed. This environmental description has to encompass several different perspectives such as technical, political, social and economical. The working assumptions have to be consistent with a set of background assumptions describing relevant parts of the techno-/socio-/economical scenario for telecommunications which in our case will be set in the time period 2010-2020.

The objective of the work described in this report may be divided into three parts:

- Envision the possible future and thus define the area for the 4GW future research.
- To give the participants in the 4GW project a broad knowledge of Personal Computing and Communication systems and their environment and to supply a framework for future co-operation
- Support the rest of the PCC projects with thoughts and facts of interesting research areas.

### **1.3. 4GW Process Model**

The project process model is illustrated in fig 1. The project work is focused around the working assumptions that provide the common platform for interrelating comparing and selecting research problems in the different Work Packages. The task of the work packages is to derive and analyse key (bottleneck) problems in the current set of working assumptions. The focus is on studying the feasibility of solving these problems as well as determining performance limits and potential bottlenecks. The result will be used to modify the working assumptions by changing the trade-offs between various bottleneck areas. The working assumptions have to be consistent with a set of background assumptions describing relevant parts of a techno-/socio-/economical scenario for telecommunications in the time period 2010-2020.

### **1.4. Scenario Analysis**

As seen in the process model above the scenarios are intended as input to the basic assumptions. In most research or development project there exist some basic assumptions that form the questions asked and hence limits the range of answers one can get. Unfortunately, the basic assumptions are not always expressed in a more formal way. The problem of formulating and expressing the basic assumptions made is important to clarify the where the project is heading. How can this be done?

There are various techniques on how to make "predictions" about the future. Many economists are working with computer models on the economy and make "predictions" out of

running large batches of data assumptions through the models. These models are built around a few basic assumptions like "Humans are profit-maximising" etc. One model widely used to find strategic research issues is the Delphi-survey. A Delphi Survey is typically done by asking a number of experts on their opinion about the occurrence and timing of a certain event. The expertise's opinions are then merged through continuous iterations until one united opinion forms.

Scenario techniques provide a different approach. First they are based on more qualitative trends. That means that they are not easily described with a single number or value. This in turn rules out the usage of the econometric models described above. Secondly, the forming of one single opinion about the future, as in the Delphi, disqualifies any development that is perceived to be of "either/or" type. The scenarios may include such developments since, in general, one uses several scenarios.

The second perspective on scenario work is the formation of groups out of a number of individuals. Team building can be a matter of creating understanding among individuals about each other. It seems important to perform such a process within the professional context. It is therefore not enough to use a "weekend adventure happening" to achieve a team at a professional level. The professional level in this case demands working with the research problem.

The third facet of scenario work is the process of knowledge formation. Many researchers in technology use a scientific approach similar to what is used in studies of nature. An important part of the problem formation within such studies is to search problems that others have not been working on. This is, of course, important in technical research as well, but equally important is to understand the conditions that society places on a certain technical development. One tool to enhance such understanding is through scenario work.

## **1.5. Report Outline**

Chapter 2 introduces the reader to the methodology used. In Chapter 3 the background work outlining future trends is shown. The resulting scenarios are presented in chapter 4 and Chapter 5 contains the impact of the scenario on the 4 GW project. Chapter 6 concludes the results. Work documents follow in Appendices.

## 2. Methodology

### Knowledge formation

When bringing together a number of people that later will work together in a project with a common goal, some difficulties arise. Difficulties that sometimes are described as group dynamics or as a normal part of a group-forming process. Of course psychological and sociological factors have a deep influence on the performance of a group. But it can be beneficial to leave this perspective for a while and apply another perspective to the matter. The perspective of knowledge formation within different traditions. The way knowledge is formed and hence the way the world is studied and described differs from one scientific discipline to another. This is partly due to the fact that it is different objects that are under study, partly due to the history and the different developments of the different scientific disciplines.

One major problem is to define what the problem is; what the object of study is? What is considered to be a problem within one discipline is a self-explaining fact in another discipline. To be able to avoid problems due to this confusion one has to have a deep understanding of each other's traditions. In today's academic environment this is often not the case when specialisation and a more refined institutional environment is common. To actively investigate what is considered to be a problem and what is not is difficult and time-consuming but necessary. One way to help this process is by scenario work through which the matters are made visible.

Another problem is communication. Due to the different backgrounds of the participants, different uses of common expressions are common. The meaning of words differ, perhaps not entirely but a little. The slight difference in meaning can cause problems in communication since the connotation of the words is not the same.

In every tradition of science there exists a tradition of how good study is performed. When working together different ideals might collide which can cause doubts internally or externally whether an interdisciplinary study is in all "scientific" (a truly contestable term!)

The problem of integration of different disciplines is difficult. It is an open question whether full integration can be reached without completely adapting the two or more disciplines. The process towards an understanding of the basic problems of integration can be helped by different activities. One such activity can be through scenario work.

### **2.1. A history of scenarios**

After World War II, a number of research initiatives started investigating different aspects of the war. One conclusion was the importance of the technical development. The arms race during the war, which resulted in technologies as the atomic bomb, jet-planes and radar. After the war the arms race continued, now between the two superpowers, USA and the Soviet Union.

To be able to keep up with the increasing pace of development, priorities had to be set. The problem was to get information on what to prioritise. One way of getting information was to spy on the other and see what they gave priority. Another method was to try to predict the development and thereby be able to make the right predictions.

One research organisation involved in the work was the RAND Corporation. At RAND several researchers with different backgrounds as economists, sociologists and engineers

developed different methods. One was the Delphi-survey (described below) and another was to extrapolate trends.

In the book "The year 2000-A Framework for speculation on the next thirty-three years" a standard world is developed. The standard world is a description of a surprise-free development of the world as it was. It includes a broad screening of the situation of the world in categories as economics, technology and culture. As a contrast to this standard world, several alternative standard worlds are developed with various variations in the development.

The ideas and methods used came through with Kahn & Wiener's work although others have been doing similar things before. Kahn & Wiener generated a "standard world" which was essentially surprise-free. This was done by using statistics and extrapolating several visible trends. The "standard world" was a baseline for further discussion. In addition they developed a number of alternating futures that consisted of a chain of hypothetical events that were both important but also interesting and perhaps unexpected. They stress that the usage of several futures is intended to be a tool for further discussions.

## Scenarios

The word scenario means "outline or description of scenes" according to Wordsworth dictionary of difficult words. Scenarios have been used to outline the future for many years. The idea is to create a more vivid and creative background for thinking of how to act in the future.

Scenarios have two essential purposes, to **change the way people think** and to **envision the future**. People are "stuck" in a traditional thinking, which is a natural consequence of the specialisation of education and functions within organisations. To start changing the way people think it is necessary to connect different factors into something of holistic character. Scenarios are then used as a tool to reach this goal.

On the other hand, scenarios themselves are interesting as envisions of thinkable futures. Within them there are possibilities to test ideas and draw conclusions of many different developments. By nature such activities are speculations although they are based on what is known today. By identifying trends and extrapolate them into the future a basis for speculation can be made.

The final scenario stories can be viewed upon as stories that express assumptions about the future. These assumptions are made up of the groups' individual and common beliefs about the future. Many of these aspects or views are difficult to pinpoint and express directly. It seems to be easier to express them through writing a story about their impact. One can see this as an expression of the present. But if one believes that the present affects the future then it is also a prediction.

Another way of viewing the scenario stories is as a tool for unifying a standpoint within a group of people. The stories become a common reference point. Viewing it this way the scenario work becomes a strategic tool for anyone interested in defining a common ground within for example a firm or a research project.

Yet another reason for writing these stories is to widen the span of attention of the participants. By letting a group of people with different backgrounds working with it, new perspectives arise.

## From Shell to Global business network

The "modern" kind of scenarios stems from the developments at the strategic department of Royal Dutch Shell in the mid-seventies. A creative group of analysts worked with strategic planning and created scenario writing as a reaction against the more common quantitative methods that were used at that time. Instead of trying to perfect the methods used to forecast they accepted the uncertainty and tried to use it.

The idea behind the earlier scenarios was to examine influence factors and see what was predetermined. One of the group's first scenarios was about the world market for oil. Having sorted out what was predetermined and what was uncertain they could analyze what factors that had the greatest influence on the oil market. By doing so they identified the potential of an oil crisis. This caused the management at Shell to start asking "What if?" while using these scenarios as starting points. When the oil crisis of the mid-seventies later appeared they were of course better prepared.

One crucial idea that developed within the scenario creating group of Shell was that the scenarios had to be presented in a way that made it visible to management the general ideas behind the scenarios. This forced them to consider what preconceived ideas for each manager before presenting them. Many of the scenarios changed the basis of the worldview that different managers had. The scenarios therefore left them without impact if the group wasn't careful. (Wack, 1985)

The people behind the Shell scenarios moved on and formed the Global Business Network, GBN. GBN is a "think-tank" and a centre for scenario development. Through networking and consulting they spread the usage of scenarios and the "new way of thinking".

## Scenarios today

Scenarios are now in use at many places and in many different organisations. The purposes of each scenario are different but the two essential ideas, changing the ways people think and creating basis for discussions, are still the goal.

## **Ericsson**

The telecommunication corporation Ericsson has an ongoing project named "Vision 2005" which has been working since 1995. The background to this initiative was primarily that the markets that Ericsson operated in changes rapidly, secondly that the board wanted a new vision of where Ericsson is heading. In a first step the focus was on the merging markets of telecom, computer and media. Over 500 people internally and externally were interviewed. The first results are partly presented in the annual report for 1996. It consists of three scenarios and the identification of ten critical areas within Ericsson. One conclusion of their work is the essentiality of deeply rooting the scenario idea within the organisation. On the other hand it is important to get input from external sources. The scenarios are used within Ericsson to create business cases used in the internal management education and as a tool in the communication with the most important customers. (Ericsson, 1997)

## **Siemens-Nixdorf**

At Siemens-Nixdorf a small interdisciplinary group has been created to "identify long-term megatrends and discontinuities that will influence information and communication technology". The project has the name FutureScape. Their methodology consists of four steps:

- Determine driving forces



- Identifying megatrends
- Discover discontinuities
- Create scenarios

Four scenarios have been published on the internet and are used in their internal work. (Siemens-Nixdorf, 1997)

### **IVA-NUTEK**

Teknisk Framsyn (Technological Foresight) is the name of a project initiated by the Academy of Engineering Science in Sweden. It aims to produce a similar technological foresight as many other countries have done. The project covers all areas that are relevant to Swedish industry. Also people from other parts of the society will be involved.

### **Next generation Information infrastructure, NII**

"The unpredictable certainty-Information infrastructure through 2000" is the resulting document from a project by the Computer Science and Telecommunications Board of the National Research Council of United States. The project started in 1994 and had a three-fold task. First to examine the industry and see what their expectations and motivations for technology deployment in a 5 to 7 year perspective. Secondly to investigate to what extent a common shared vision of the development in different areas within the field exist. Third to conclude with suggestions to the U.S. government. (National Academy press, 1996)

### **Characteristics**

All the scenarios above are presented as short stories or descriptions of the future world they envisage, together with graphs explaining the trends their reasoning is based upon. Most scenarios describe a situation using different perspectives to stage the setting for a corporation. Typical perspectives are economic development, technical development and political-cultural development. To leave an impression on the reader, most scenarios are provided with eccentric names that both try to encompass the essence of the scenario and attract the reader. This is seen as an important part of the scenario. Many sets of scenarios contain one scenario that really differs from the expected. This type of radical should to stretch the mind and "span the room". In creating a vivid and internally consistent scenario it is easier for the reader to understand the idea and start thinking of the consequences that the scenario causes.

### **How to use scenarios?**

Kahn & Wiener, present in their book some uses for scenarios:

1. Scenarios draw attention to a wider range of possibilities that has to be considered in an analysis of the future.
2. They bring forward an analysis of details and events that are easily forgotten in abstract discussions.
3. They help in clarifying the connection between different areas of study, for instance technology and the humanities.

They used their book, as a tool for bringing up a discussion about the present world that they thought would be interesting and important.

Within Ericsson scenarios are used to fuse debates and discussions within the organisation. They use the scenarios to see both what kind of products and services customers in the future might want and also how to provide these. Another use is to adopt the company-internal staff development and human resource planning appropriately. (Ericsson, 1997)

Within Siemens-Nixdorf the scenarios are used to (Siemens-Nixdorf, 1997):

- challenge executive management's view of conventional business strategy development and implementation
- identify long-term social, business, economic & technological trends and discontinuities that will give rise to opportunities
- create a forum for exploration and exchange for the above trends, discontinuities and opportunities with the outside world and within the company
- build organisational and individual commitment to taking the actions required to capitalise on the identified opportunities.

### Comments on scenario creation

First, one cannot predict what really will happen, only interpret the present and speculate.

Second, one cannot see or understand all the factors that have an influence on the object. One cannot even see if there are other more important factors that are left out. This is of course directed by our preconceived ideas about the scenario work and what factors that have an influence on that.

Third the scenarios are not a map of the future, rather a collection of stories about interpretations about the future. Thereby new ideas and factors that are discovered underway can be included and used to change the scenarios as work progress.

## **2.2. Steps in creating scenarios**

Study the environment to the project.

Initially we tried to study the environment to the project. The participants of the group have graduated in Electrical- or Computer Engineering from different universities in the world. The different backgrounds and languages serve as a broad basis for different perspectives on the matter.

The surroundings to the project were interpreted as current trends and evolvments in the telecommunicationbusiness, business in general and at a more political level.

### Brainstorm

To initiate the discussion a brainstorming session was performed. During the session each participant was encouraged to think freely on the matter and write down observations, statements or questions on a note. Every string of text on these notes represented an area of thought that was of interest. If the text was a question, the question-answer pair was of interest. If it was a statement, the questions and reasons for the statement was of interest. Thereby everything represented a fragment of an interesting area that could be further examined.

During this session one rule was enforced. It was forbidden to put forward any form of critique on the others notes. It was even forbidden to place critique on one's own notes. The idea was to, as free as possible, generate interesting thoughts that could be further examined.

At the end there were around 100 notes in eight areas (Business and industry, Infrastructure, Market issues, Politics, Regulation, Social life, Technology and Usage). The division into areas was done by collecting and clustering the notes, trying to find the reasons behind the facts or questions on the notes.

### Formulate fragments of the observations

The different areas that appeared to be interesting were further examined and eventually developments in these areas could be seen. These developments later formed the basis for the "trends" that we identified to comprehend the development.

Together with this work, some additional research about some important areas, that were not yet covered, was performed. These areas were: "Who might the actors be in telecommunication and related areas in 2010?", "What will peoples life be like in 2010?" and "Neighbouring technologies that might affect our area of interest".

### Driving Forces

Bringing the fragments and the ideas from the additional research together we were able to form "driving forces" behind the development. Driving forces are more fundamental trends that together change the society. All driving forces could have strong influence on the development. These are the core directions of development in different areas and they may be perceived only via the influence they have on more visible developments. However, the underlying Driving Forces must be identified to understand the development.

Rather than providing an exact definition for these driving forces, we have decided to pursue a more pragmatic approach, which is adopted from quality improvement programs. We start with an observable change and ask "Why?" repeatedly. Where to stop asking "Why?" is also a pragmatic matter to be decided by common sense. For example:

Statement: "Brandnames will be more important!"

More precisely: The brand name of the content, e.g. CNN, Bonniers

Why? It is necessary to identify the sender of the information.

Why? The brand name will provide a guarantee of a certain quality.

Why? There will be many senders of information. It is necessary to quickly identify the information that is correct, and has relevance for the receiver.

Basic trend: "The amount of information available will increase dramatically."

It would be naive to expect clear chains of causality. Instead what will emerge is a "web" of interrelated driving forces. This web will also not be static, but rather evolve. Over time new forces will be added, existing ones combined and/or replaced, etc.

### Megatrends

Combining driving forces into Megatrends was the final step of abstraction. This is the clear and simplified output that could describe possible futures. The Megatrends are the basic parts in creating the scenarios. By changing the direction and strength of the different Megatrends we got several different scenarios.

Again, we are not concerned about trying to give an exact definition of a megatrend. The main characteristic of a megatrend is that it is not a "primitive" of analysis, but rather the result of several forces, which might change in their relative importance or even direction.

Identifying megatrends is therefore an interactive process. Some megatrends are already observable today. Uncovering and analysing them is the basis for identifying new megatrends. Identifying such new megatrends early on or even prior to their emergence is of course of greatest value.

The megatrends serve several purposes. First, by relating megatrends to observable changes, they help to gauge the relevance of them. Second, they can be used more readily in communicating our work. They can thus more readily inspire product ideas and in general help managers in discovering new business opportunities. Each Megatrend will be described using a number of attributes. The idea to structure these attributes is from the Siemens Scenarios, (Siemens-Nixdorf, 1997)

- What? A short description of the Megatrend.
- Why? Reasons for changes or movement in the Megatrend.
- Enablers? Factors which strengthen this Megatrend
- Inhibitors? Factors which weaken this Megatrend.
- Paradigms? Changes in ways of thinking due to the Megatrend.
- Predictability? Degree to which development can be foreseen for this Megatrend.
- Influence? Ways for companies to affect the Megatrend.
- Experts? Sources for additional information about this Megatrend.
- Timing? Dates for key milestones in the development of the Megatrend.

This is a clear and easily understandable output that could describe possible futures.

## Survey

We use a survey as a tool for verifying that our own choice of trends is. Therefore two questions that are asked during each round.

- Is this trend important to 4GW?
- Is its impact foreseeable?

After this survey we get a ranking of trends in two dimensions. Trends that are both important and have foreseeable impact are the common basic trends for the developments of scenarios. Trends that are important but without foreseeable impact are the trends that are used to develop different scenarios depending on the impact and direction that trend might play out.

## Scenario creation

The different Megatrends are ranked according to importance and uncertainty relative to the 4GW project. This is a rather difficult matter since some of the Megatrends seem to be both more important and more certain because of their nature. The trends that are more certain become the skeleton of all the scenarios while the ones more uncertain to us are used to create the variety of the scenarios. These "uncertain" megatrends then span a space of possible futures with the certain megatrends as a common basis.

One example is the combination of a strong "Communicating appliances" and weak "Standardisation" trend, which forms the input to the "Anything goes" scenario. ("Communicating appliances" and "Standardisation" refers to the different trends that will be further explained below.)

Many possible outcomes are defined and finally the most interesting ones in this scenario space are chosen to be the key Scenarios and the final outcome of the analysis.

To go from the Megatrend into a scenario, more "life" has to be added to the megatrend. This is done by extrapolating the megatrend and presenting the results in the form of newspaper headlines explaining important steps in the development. Some of the headlines for the megatrend "Communicating appliances" are shown below:

- 1999 Microsoft releases "Windows for Appliances".
- 2001 Sony, Matsushita and Phillips define a standard for inter-appliance communication over the power lines. (Standard mainly intended for home audio-video equipment).
- 2001 50 MHz released for unlicensed wireless LAN operation.
- 2002 More than 50% of the VCRs sold in Sweden are configurable via a web interface.
- 2004 95% of computers sold have built-in Wireless LAN connection.
- 2007 A Vattenfall study shows substantial savings in power consumption in houses with smart appliances, boosting sales.
- 2010 The largest manufacturer of white goods drops production of all non-web-enabled products.

After that, several different lines of thoughts presented in the headlines are collected and discussed and three different scenarios are created. They are named "Anything goes", "Integrity-Big brother protects you from little brother" and "Pocket computing".

The scenarios are written in three different parts each. This gives a threefold perspective on each scenario. The three perspectives used are:

- A general description of the society in the scenario
- A scene from inside the telecommunication business
- A day in a normal persons life.

This creates a more vital picture for the reader and stimulate to further developments of each scenario.

### Scenario usage

The 4GW project is divided into five workpackages, represented by one Ph.D. The impact the scenariowork had on the different work packages, the way the working assumptions and problem definitions were altered, is outlined in detail in chapter 6 of this report. Worth mentioning here is, that the process of evaluating assumptions and problems against the scenarios is not a static procedure. It has to be carried out continuously and results need to be challenged as they appear in the research process.

### **3. Future trends**

#### **3.1. *Megatrends***

The Megatrends form the basis of the further scenario work. Below is a summary of the Megatrends. A more extensive version can be found in Appendix C. The final Megatrends that we identified are:

##### **Globalisation of products, services and companies**

Globalisation is an on-going phenomenon that has influenced the society ever since mankind started to cross the oceans. However after the World War II trade, travel and television has enabled more people to adapt to a global perspective on many issues.

One example is the global broadcast of news from CNN, providing people from many different countries with the same coverage of news. Another example is global brand names like Coca-Cola and Sony. Products are marketed worldwide with small or no differences between countries. A third example is the global companies that enables people from many different cultures to work together. A fourth example is the television soaps that are broadcast in almost all countries. This gives a natural insight in other cultures.

All of this is just examples of globalisation, examples that show that there is a global dimension to many issues that has to be taken into account.

##### **Communicating appliances**

This Megatrend is more related to the work of the 4GW project, but is still too fundamental to be considered as a short-term phenomenon.

Consumer devices, such as stereo, video, freezers, microwave ovens and similar equipment is said to be more "intelligent". This is because of the increasing use of microprocessors in all kinds of appliances to equip them with more functions. The latest Volvo Model, S 80, is said to be non-working, after it is assembled, but before its computer is programmed.

We believe that a natural continuation of this would be to equip all consumer devices with communicating capabilities.

##### **Services become more independent of the underlying infrastructure**

This Megatrend also relates more to the work of the 4GW group, compared to the Globalisation trend. Services, such as phonecalls, are being more separated from the infrastructure they use. A phonecall today typically crosses many different types of infrastructure e.g. from a mobile terminal through a wireless connection into a digital network, perhaps via satellite link over to an analogue network to another connected phone.

Continuing this trend would enable other services, such as television, internet services and others to use many different types of infrastructure.

##### **Information trading (Information overflow)**

The global access to information will enable people to receive a lot more input than they might be able to handle. This will increase the need for refining and quality control the information. This in turn increases the market for publishers, news agencies and different consultants.

## Education increasingly important

The change of focus from manual to more intellectual oriented work increases the need of education. Education is an ongoing process that will influence the whole working life. The methods and forms of education in the future are not yet clear, but it seems like self learning through use of computers could be one way.

## Standardising diversification

Standards are, in the world of telecom, important as starting points for technical developments. The standardisation process within the standardising organisations is becoming more and more a political matter. This slows down the process and forces companies to search for alternatives. One way is to "de-facto" standardise by taking control of the market. An example in software development is the Microsoft Windows. Another way is to ignore the standardisation process and license the technology to others.

### **3.2. Survey results:**

This section contains the results from the questionnaire. The effects on the trends are deduced based on the answers from the questions. In general the survey results confirm the Megatrends. (Qx refers to question number x in the questionnaire which is enclosed in the appendix.)

## Globalisation of companies

The telecommunicationmarket of the future will be dominated by worldcoms that provides communication services worldwide. Local companies provide part of the communication service mix, possibly for some specific niche or localised services.

The size of companies cannot be judged.

- Worldcoms increase their market share. Q5
- Users are capable of purchasing communication services from anywhere in the world. Q1
- Local sources provide some of the communication services. Q2

## Globalisation of products and services

Services will be purchased from anywhere in the world, but many services will be produced fairly close to the consumer. The kinds of services that will be important in the future may be both the kinds of services we have now and new ones. However in order for a new service to be purchased it must make improvements that the user can see.

Products are most likely to be manufactured close to the consumer since manufacturing competence is not the most important factor for production.

- The demand will be for local as well as global services. Q3
- We don't know if the requirements will be for new or the same type of service. Q8
- Most improvements to services will be visible to users Q6, Q13
- Manufacturing competence will not be very important Q4
- Stationary or mobile. No opinion. Q7

## Communicating appliances

The conclusion is that appliances will have built in communication capabilities more often. They will communicate using wireless technology probably using unlicensed frequencies.

- Wireless communication standard for appliances by 2007. Q9

- 2014, Most cars communicate with their environment. Q10
- More unlicensed bands will probably be available for communication. Q11

### Services become independent of infrastructure

We can expect a multitude of infrastructures that provides the same services. The terminal is multimode and adapts to various infrastructures.

Terminals are bought in retail stores. This indicates that companies will focus on a small part of the chain between service and user. Thus we can expect to see specific service providers and specific infrastructure providers.

- Technology that improves services will be the main thing. Q13
- One service - one terminal, we don't know Q14
- Service providers will not provide terminals. Q15, Q18
- Services will be available over many different infrastructures. Q16, Q17
- Multimode is the thing Q17.

### Standardisation diversification

Computer standardisation will be carried out by de-facto procedures. Telecommunication standards that are connected to the computation will also most probably be set by de-facto procedures.

Wireless standardisation has strong support both for de-facto standards and other standardisation methods. More unlicensed spectrum may indicate a shift toward de-facto procedures.

- Computer standardisation - De facto. Q21
- Wireless standardisation - Yes and No Q20
- Telecommunication standardisation - possibly de facto Q19
- More unlicensed bands will probably be available for communication. Q11

### Education increasingly important & social life

Education becomes an important factor for surviving in the future. Companies employ hire and fire strategy. This indicates that there will be an abundance of skilled workers that will compete for the available jobs. Employees also accept lower raises in exchange for education.

One question that needs to be answered is what the unemployed do?

Companies will gather a large amount of wealth, which will benefit the company owners. Depending on what the political bodies do there is a possibility of widening social gap.

- Possibilities for education during work valued slightly more than salary Q22
- Education in order to survive Q24
- Companies will mostly employ a hire&fire strategy. Q25

### Information trading

- Paper diminishes in importance Q23

### General conclusions

The survey makes it possible to see some effects for the various actors.

The infrastructure provider will have problems. An increasing amount of communication needs may be satisfied by using ad-hoc techniques in unlicensed bands. The end user is



purchasing increasingly efficient equipment, which takes care of his communication needs. Service providers are taking care of services. The parts left are mainly long distance communication where it is impossible for end users to utilise their own equipment. Since it is difficult to predict what services will be demanded, the long distance networks must be able to cope with diverse requirements from different services.

Equipment manufacturers will need to build multimode devices which easily can adapt to various standards. In order to sell new products, the customer should feel that there is an improvement in the service he receives. This, in conjunction with the decreasing importance of manufacturing competence, indicates that the battles will be in design, look and feel of products.

Services will be provided by large and small, global and local companies. These companies do probably not own infrastructure. A successful service is something that gives the end user improvements. Possibly improvements can mean better education.

### **3.3. Additional Research**

After defining the trends and Megatrends, there are still some white spots that have not been covered. In order to cover those white spots additional research areas were defined. Within three main areas additional information was required.

- What technologies will influence the development?
- What Actors/Firms are in the telecommunication business today and how will the structure change in the future?
- How will people's life in general change in the future?

The main purpose with the additional research was to gain knowledge to be able to create vivid scenarios, with relevant knowledge.

#### **Technologies in 2010**

In the Technology section, the purpose is to investigate what the competitive technologies are for the infrastructure, as well as the major technique challenges in the wireless part.

What do we know of neighbouring technologies? What do we know of underlying technologies? What are the other research initiatives in similar and related areas? To get a grip on the technological environment that the 4 GW will meet we need to find what is predictable about this.

The convergence of three major information areas is obvious to see. These areas are telecommunication, computing, and multimedia services. So far there have been a lot of new technologies emerging, among them, some technologies are of the most importance. This study points out some interesting technologies for the future.

The wired infrastructure will consist of the Plain Old Telephony network, cable TV networks and the powerlines. There are currently a number of prototype testing projects and investigations on how to use powerlines for personal communication and other purposes.

Telecommunications moves from voice to data, from circuit switched to packet switched. Wireless communication uses packet switched. Bandwidth will be scarce. Therefore efficient source coding and other measures to reduce bandwidth usage will be needed. Several different types of wireless communicating systems will evolve. This calls for abilities for inter system communication. Major obstacles here are the various standards and technologies that will form the radio environment.

Terminals are getting smaller and smarter. Although the physical properties of humans does not change it makes it possible to compress more and more features into a terminal of the same size as current terminals. One major obstacle for this development is of course battery size and load capability.

Software development is also important. Perhaps is the terminal of the future a bare device which can download different software modules from various producers that will adapt its function to the current usage.

## Global Actors in 2010

In the study, "Global Actors in 2010", the purpose is primarily to find what actors are in the business today and as well which actors might be in the business in the future. Secondly, the purpose to find out information on their strategic work. What do they believe about the future?

By actor or firm should be understood both traditional telecommunication firms like Ericsson and Nokia, but also information packaging and producing firms like CNN and BBC. Other firms related to this area might be computer firms and game producing firms like IBM and Nintendo. Other actors can be regulating bodies and governments.

The strategic work that we are looking for is the published work like the Ericsson scenarios or Siemens scenarios or similar published products. Other interesting things can be statements made in the yearly report or information on special investments made like Ericsson cyberlabs in New York and Japan.

The firms directly involved in the telecommunication business, such as equipment manufacturers, system developers and operators, seem to form larger alliances or fusion with one another. Hence the actors are growing larger and more powerful. This increases the ability to dictate new standards and to establish de-facto standards on the market.

Another trend is that actors from different parts of the telecommunications industry are engaging in the content of the communication. One example is Telias involvement in TV, another example is Sonys engagement in Hollywood productions through Warner.

On the technical side of the industry the merging of the telecom industry and the computer industry is a hot topic.

## Peoples life in 2015

In the people's life section-- "People's life in 2015", the purpose is to find out what are the possible major changes in the people's life in 10 to 15 years. This will hopefully yield conclusions for the requirement for the future wireless infrastructure.

What do we know about the life of ordinary people of tomorrow? A lot.

We know approximately where they will live and with what they will work. Still there are big changes going on in a global context. Underdeveloped countries will rapidly get industrialised and so on.

The focus of this research area is to draw conclusions about the environment and thereby the infrastructure the 4 GW.

Research should be aimed at finding what conditions of people's life of tomorrow that we can predict fairly well and what we can not predict. Fairly predictable facts are for example the demography of the world. The urbanisation and the like.

The goal of this additional research is to find out what are the possible major changes in the people's life ten to 15 years from now. This should yield simple conclusions on the

requirement for the future wireless infrastructure. Some everyday applications are described (See appendix).

Entertainment seem to be of ever increasing demand. The ability to choose and personalise the entertainment is increasing. Examples of this trend are video-on-demand, netgames and so on. The wireless technology will also change existing forms of entertainment. It will be safer and easier to sail across oceans when you always can reach help through satellite communications.

Other security issues that can be solved through the use of wireless technology are child surveillance and various home security services.

The basic assumption is that people won't change very much although they are getting new tools for enhancing life.

## 4. Scenarios

### 4.1. Introduction

The purpose of this scenario set is to initiate and justify the project "Overall design of the 4th generation wireless infrastructure" and to offer input to the PCC program. Thus the goal of the scenarios was to describe the possible environments to the computing and communication systems at the time the research outcome may come to market, in this case 2010.

The people that would perform the research created the scenarios and thus, not only the results, but also the whole process will contribute to the research results. Each step in the process of building the scenarios is built on the step before and some extra information. Thus the resulting scenarios are built with the basic brainstormed questions as a broad foundation.

The input to the scenario part of the work is the Megatrends, defined above and the additional research. The main thought is to picture the world if those trends will come true or not come true, thus spanning a space with possible outcomes. Points in this space will be the scenarios. By creating "newspaper headlines" that may come up at certain milestones or logical steps in a certain trend and combining these, a Scenario Embryo was created and this was in turn expanded into a full scenario

The process to create these scenarios has thus been:

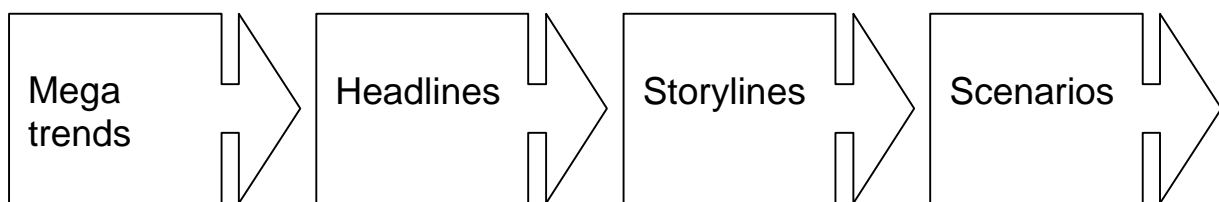


Figure 2, Scenario creating process.

To define and influence a research project from a scenario, it has to describe different views. Thus the 4GW scenarios are developed with three different perspectives:

First, an overview of the whole technological, political and economical system in 2010 is given. This offers a bird's eye view of technological systems, regulations and general development.

Second, a scene in telecommunication business is depicted. Here the aim is to show what kind of issues that are relevant to the business actors.

Third, the life of an ordinary citizen is described.

By using different perspectives, the idea of the scenario is showed in a natural way. This will allow different readers to interpret the scenario in relation to their interests and needs. Please observe that all parts of the scenario are presented as though 2010 had already arrived.

### 4.2. Scenario I - Anything Goes!

Essence of Scenario:

- Producers have a strong market power,
- Generic Hardware, Function and services in software,

- Intelligent individual adaptation of services,
- High development pace,
- Large amount of standards that are "de-facto standardised",
- Transparent access to the network.

## Overview of Society and Technological development

Over the last decade, there has been a strong development in software solutions for wireless communication equipment.<sup>1</sup> Due to this, the hardware used in transceivers is almost generic and the differences between different networks and systems lie mainly in the software. This has led to a technological system where most problems are resolved through software adaptations instead of tailored hardware.<sup>2</sup> Terminals, or access tools as they are generally called, are normally capable of using several different types of wireless networks to access the demanded services.

There has been an explosive increase in the number of wireless systems in operation. The number of large (regional/national) operators is approximately the same as at the turn of the century, but new actors have turned up.<sup>3</sup> First of all, small niche operators offering fairly local wireless networks, aiming at, for example groups of small firms or housing estates, have turned up. Secondly, most large corporations have their own wireless LANs at their facilities.<sup>4</sup> Thirdly, many consumers decided to use miniature wireless LANs to cover their homes or their workplaces at home. This development has increased the demand for transparent access to services regardless of what access system is used.<sup>5</sup> Several solutions have appeared such as terminals capable of operating with many network infrastructures, services that adapt the man machine interface (MMI) based on what type of access node is being used, etc.

As the use of information and communication services has increased, personal adaptation of services using personal statistics and usage history has become more and more frequent. The idea is to make individual applications adapted to each specific user.

Another user friendly development is the increase in using intelligent machines and agents to monitor and control systems used in everyday life. Such applications are currently used for everything from control of domestic appliances to automated management of communications networks.

One background to the multitude of wireless access systems that have appeared over the last years is a change in the way standardisation work is conducted.<sup>6</sup> Today almost all standards are of a de facto character. They are often developed through voluntary co-operation between a number of firms, rather than in a more organised form. The importance of ITU, ETSI and other similar organisations has diminished. This has also meant that the major issues in standardisation work are being first out with a solution, documenting it well enough and making it well known in industry.<sup>7</sup>

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<sup>1</sup> Beginning of the 21th century: 2000-2010.

<sup>2</sup> Refers to software radio research.

<sup>3</sup> Trend from additional research about Global Players.

<sup>4</sup> Refers to many WLAN research program like MEDIAN, part of ACTS European program

<sup>5</sup> Trend from "Services gets more independent of infrastructures"

<sup>6</sup> Trend of Standardization

<sup>7</sup> Refers to a recent example: Bluetooth ([www.bluetooth.com](http://www.bluetooth.com))

Almost everybody in the industrialised countries regularly uses information and communication services either through fixed network access or wireless access. The wireless access methods are still not quite as widespread as fixed network solutions, but the tables are starting to turn. The net has become a very important forum for marketing, education, entertainment, etc. since people of all ages and from all social classes use it.

### Inside telecommunication business

The scene is a meeting room in the Stockholm office of a large telecommunication equipment manufacturer. Mr. Optenberg is the representative of one of the small telecommunication operators that was started at the turn of the century in Sweden. Recent technological progress has made it possible to develop a new modulation technique that allows an increased capacity in multimedia cellular networks by approximately 20%. Mr. Optenberg is of course interested in this new technology, but he needs to know more before deciding to implement it.

The representatives from the telecommunication supplier are Mr. Ma, the manager for the new technologies division, Ms. Exner the technology expert and Mr. Salomon, the sales manager. They are of course anxious to find a customer for the new technology.

Ms. Exner begins the session by presenting the new technology, how it works and under which conditions. It turns out that improvements are only possible when many users are teleconferencing using both audio and video.

The discussion moves into questions regarding how Mr. Optenberg can implement the new solution in the network. It turns out that most of the base stations in the network can already handle the new software required. There are only a few base stations in the most rural areas that need to be replaced, and they have already been scheduled for replacement anyway. With only three different versions of the software (different processors) to install in the base stations, an implementation of the new technology should take about two weeks.

"But what about interoperability?", Mr. Optenberg asks. Ms. Exner looks a little bit uncomfortable, but Mr. Ma comes to her rescue. "We have tested the new solution with thousands of different software interfaces on dozens of different platforms and we have not experienced any problems. Besides, the software designers working on this new product are the best ones we have. They are quite competent in radio technology and software engineering". With that explanation Mr. Optenberg settles down. "How many of my customers will be able to use this new technology?" Mr. Optenberg asks. "According to our studies most of the terminals that are in use today have enough capacity to handle the new technology", Mr. Salomon says. "Also, the solution is already in use in many wireless LANs, mainly in offices. So many users may already have the required software installed in their VV glasses.<sup>8</sup> We have already licensed the technology to ten different equipment manufacturers and they are likely to offer cheap upgrades for their terminals shortly."

Mr. Optenberg's thoughts start to wander while Mr. Salomon continues on with an endless row of facts and figures. He thinks that back to the turn of the century, when most standards were set by large organisations, but when the increasing pace of technological development made more and more companies want to put a product on the market before a standard was set. In the beginning there had been a large number of inoperable systems, but eventually manufacturers learnt to implement support for other suppliers' devices as well. The result was

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<sup>8</sup> VV is acronym for Virtual Vision. Similar idea is being developed by Microvision ([www.mvis.com](http://www.mvis.com))

a patchwork of systems and devices that seemed to be able to communicate and internet-work most of the time.

As Mr. Optenberg returns his concentration to the meeting in question, Mr. Salomon is describing the results of a marketing study they have made. "...saw that over 90% of the users in our target group responded to the personal letter that we sent them. These are people who often use teleconferencing in their daily work. We spent some extra effort on those that use the service during peak hours and actually managed to get 95% of them to install the new software."

"But what about the other users?", Mr. Optenberg demands. "There are a lot of people that rarely teleconference, and absolutely not at peak hours". "Don't worry about that", Mr. Ma answers, "this is mainly useful if you want to increase capacity in downtown areas. But on the other hand, that is probably where you need more capacity and the solution is virtually for free. We will make sure that we can make you a reasonable offer." The discussion continues for some time. Finally they manage to negotiate a mutually satisfactory deal, and Mr. Optenberg leaves with a broad smile on his lips.

### The everyday-life and private sphere

Anders, 54 years old, lives in a comfortable 3 room-apartment in the Stockholm area. A few years ago, he installed his own wireless LAN kit, a very useful and easy-to-use tool. The technology for this came after a breakthrough in using the domestic electric wiring for communication.<sup>9</sup>

The date is Wednesday 28th of July. It is 7.00 am and Anders is just waking up to some nice music which seems to come from some very small speakers placed everywhere in his apartment. Anders is slightly upset since he would have preferred to sleep longer after working late in his home office last night. As usual he forgot to tell the computer this.<sup>10</sup> "Computers are still as stupid as when I was 20", he says, "I should buy that interactive sleeping device that I saw a few month ago, then this stupid machine would know when to wake me up. Now then, where are my glasses".

Anders finally finds his glasses. They have nothing to do with any vision problem; he never had one. Using VV glasses is just the easiest way to know what's up today. "Oh no, it's 7 o'clock! RADIO shut up!", he shouts. Instantaneously the music stops. Anders is awake by now and decides to check his mail while still in bed. "CHECK MY MAIL now that I am awake", he says. Anders raw morning voice has always been a problem for the speech recognition module. Anders was getting ready to move his hands using the virtual mouse that he could see in front of him through the glasses, when at last his list of e-mails, voice mails and letters appeared in front of him.<sup>11</sup>

Anders received his first glasses almost eight years ago from the company he was working for at the time. He can barely remember its name, the small company has been taken over by some larger corporation since then. The use of those devices was really limited at that time. They just had a transparent screen that used a mirror effect. In no way could they compare to today's glasses: an opaque and transparent virtual image, a virtual desk and keyboard, integrated microphone and earphones using speech recognition.

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<sup>9</sup> Home networks are very likely to use the electric wire. other ideas from Hometoys ([www.hometoys.com](http://www.hometoys.com))

<sup>10</sup> Refers to voice recognition software which already exists now.

<sup>11</sup> Refers to Virtual gesture recognition like research at medialab - MIT ([www.media.mit.edu](http://www.media.mit.edu))

In his mailbox there is a message from the company that produces his glasses. It informs him that there has been a change in the specifications for the wireless LAN at his workplace. He will have to upgrade the software module that is responsible for LAN communication. "Not again", he thinks, "that is the second time this month". The mail contains the upgrade that is to be installed and he is asked if he wants to install it now. He grumbles "Yes, go ahead" and lays back.

Suddenly, everything goes black. Something in the upgrade was incompatible with the rest of the software. It's not the first time it happens, and Anders swears loudly. He takes off his glasses, gets out of bed and walks to the computer in the corner of the bedroom. After fiddling around a little, he manages to get his glasses back to a fairly stable state.

Muttering, he returns to bed and continues reading the e-mails.

Anders pulls himself together and glances through all the advertisements that constantly seem to find a way around his mail filter.<sup>12</sup> He sighs and throws all the messages away. "At least I don't get any more washing detergent offers anymore since they found that I don't use my washing machine", he thinks to himself, and gets out of bed.

The home appliance agent reminds Anders that his coffee has been ready in the kitchen for a while.<sup>13</sup> Anders decides to go to work today. He is bored with the virtual home office, and would like to meet some friends. "Well, if I want to go to work today I should perhaps tell this stupid agent", he remembers. A few virtual clicks later, Anders heads to the kitchen. On the way, in the corridor, his home network agent appears automatically to advise him of the corridor antenna malfunction, which it has done every other day lately.<sup>14</sup> "I know, I have to buy a new one. These antennas are worse than light bulbs. When will they build something cheap and reliable?", he demands. His shopping search agent appears a few seconds later. Anders reads "Best price at the moment: HOMETEL 155Mb/s V2002 compliant. 10 Euro.<sup>15</sup> Available in stock. Delivery: 1 day. Buy?". "OK, buy it and take the money from my Central Europe bank account." The simple everyday words were understood perfectly and he is asked for one more confirmation.

After taking a shower, Anders leaves home, bringing no keys, no ID, only his VV glasses. The apartment door locks itself behind him and the car is waiting for him in the basement. Total security is what poses most of the problems with the V2002 wireless technology, but things are definitely better nowadays. The car tells him what route to take, even though he knows the way.<sup>16</sup> It is school holidays, so there is really no need for the traffic advisor.<sup>17</sup> On the highway to the centre of Stockholm, the car drives itself assisted by the car radar detector and the visual road interpreter.<sup>18</sup> Like most people, Anders doesn't like to be driven by his own car and therefore stays alert. "We never know with the new technologies", he thinks.

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<sup>12</sup> Mail filters are already widely used in most popular internet mail software.

<sup>13</sup> Refers to a Vattenfall/Electrolux research project

<sup>14</sup> Even at home, intelligent systems will be able to diagnose systems malfunction.

<sup>15</sup> Euro will be the only European currency in 2010. Network parts like antennas will be cheap and simple to replace like light bulbs.

<sup>16</sup> GPS car systems are already optional equipment in many big car manufacturers.

<sup>17</sup> EUREKA 147, a standardisation program for DAB radio, has proposed the concept (<http://www.fedele.com/website/dab/ebu-147.htm>)

<sup>18</sup> Refers to research performed by some car manufacturers.



Anders has always been in love with new technologies, but has learned not to trust them too much.

Once in the office, Anders sits down and takes care of the days tasks. Right now there isn't too much to do. So after having lunch with his colleagues he spends some time taking a class from the local university. He leaves the office at 5 pm and drives back home. He joins his girlfriend virtually for dinner. They met on a virtual fair for abstract art, when looking at the same painting. Right now she is working in New York and while she is eating lunch Anders is having dinner. A virtual date is no replacement for the real thing, but it is a nice way to keep in touch when she is away.

Later that evening his mother calls him. Even though she knows how to send e-mail, she still prefers using the phone. In the last few years of the 20th century, when Internet was just beginning to become available to the general public, nobody could guess that ten years later it would be as natural to use the net as it was to use a phone or watch TV. Today, however, there are very few people in Sweden who don't use it for sending e-mail, shopping or entertainment.

### **4.3. Scenario II - Big brother protects you from little brothers!**

Essence of Scenario:

- Market is limited and controlled by political authorities
- Personal Integrity is no.1 priority in all systems,
- Global security control performed by international governmental organisations.
- Limited markets.
- Low development rate.
- Very few operators.

#### Overview of Society and Technological development

The development towards open information society looked great,<sup>19</sup> but suddenly a couple of years after the millennium turn, it suddenly went to far and the security of the individual was threatened.<sup>20</sup> By this time it was easy to find almost any information about a person or a company either directly via the WWW, but easier and more efficient by buying the information from one or a couple of the information traders. These were companies specialized in collecting information and selling it. Keeping files with personal information like this was of course illegal in many countries,<sup>21</sup> but as almost all information was published at the WWW so it was hard to limit the activity.

During 2004 the IT-trend had gone to far and people were fed up and demanded some measures from the government. It was now usual that people were contacted by firms, knowing a little bit to much about them and their behavior. In 1998 student unions sold the addresses of their members to possible employers, who used the addresses for mailing job offerings to students soon to graduate with the correct competence. Information were found by scanning email,<sup>22</sup> checking surfing habits and even by mapping behavior when playing the

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<sup>19</sup> Today there is a general trend of making more and more information available on the Internet.

<sup>20</sup> See the trend "Information trading"

<sup>21</sup> For example "Datalagen" SFS 1973:289

<sup>22</sup> <http://home.clear.net.nz/pages/research/casenotes.html#SigInt>

popular net games. There had also been some major cracker break-ins proving that "safe" systems were not that safe.<sup>23</sup>

For these different reasons authorities had to act. One reason was political, i.e. to revive the old times when governments actually had some power in this matter, another that the voters actually demanded a change. Legislation had been slower than the technological development, e.g. none had control over the Internet for several years. However now there was a strong support for the legislative bodies to regain control. Companies active in this giant info trading area were, of course, negative to the change and tried to move to more open countries.<sup>24</sup> Companies in general were very negative to legislation that restricted their activities. As the problem was global though, most developed countries co-operated.

As almost everything was built on general accessible information some major changes had to be done. Major companies were already aware of the problem and the spread of company information was strictly limited which meant that the activity was concentrated and e.g. outsourcing and telecommuting was limited. Computer security techniques were generally not perceived to be safe. Obviously these actions led to decreased growth in the company and country. Now the individual users got aware of the value of the information they had and this led to a reaction towards all electronic media that was so easy to tap for information.

By 2009 the governments had strong legislative control over the communications resources such as the available frequency bands and encryption. The new society were built on a new Information Constitution connected to the new Security and Integrity standard ISO 99000, built on previous quality standards. The new system was synchronised with most developed countries. Since the new laws conflicted with the constitution in many countries, e.g. "freedom of speech" the constitution had to be changed. The Information Constitution included rules in different areas:

- A new national electronic identification system, allowing authorization without giving the identity away if not necessary.<sup>25</sup> This systems work in most developed countries, but the passports remain as an international identification document, especially in underdeveloped countries.
- All companies and private persons, who want to handle or publish information of any kind, must be certified in ISO 99001. This standard only allows information to be gathered for a certain (government-approved) purpose and when used for that purpose it must be destroyed.<sup>26</sup> Also all information must have an owner who decides where and how it may be published.<sup>27</sup> •Producers of technical systems handling information must be certified in ISO 99002, stating rules for secure information management and transmission.<sup>28</sup>
- A new controlled Internet level, on which only certified users and equipment are allowed to operate. This Internet level is controlled by global governmental organisations. Proper identification and ISO 99000 certifications is demanded for access.

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<sup>23</sup> There are many reports of break-ins at <http://www.cert.org/>

<sup>24</sup> See the trend "Globalisation"

<sup>25</sup> Cash cards

<sup>26</sup> See for example laws governing the use of data gathered for scientific purpose.

<sup>27</sup> Recent law proposals on internet information publishing

<sup>28</sup> Today certification is necessary to produce and prescribe drugs.

- A new very large police branch, usually called InfoCop, with international contacts, enforces the rules. This authority has access to all available information (included in the ISO standard) and are of course authorised to gather all needed information.

Most of the developed countries had had the same problem and now went through the same process. To avoid being exposed to international firms in the information trading area,<sup>29</sup> the connections over borders were limited and the connections to countries not ratifying the new standard were scanned and filtered. By keeping information within the country law enforcement was simplified and integrity was improved i.e. the number of people having access to a specific piece of personal information was reduced. The decreased possibility for international communications made it hard for companies to be global and thus they split into decentralised divisions working with the authorities in each particular country. The authorities, though have extended globalised contacts.

These changes have affected the society in different ways. The fast technological growth of the 90s and beginning of the 00s is now much smaller and as the demand for services is roughly constant, the money allocated for R&D is decreasing and thus the life cycle of the existing systems is prolonged. Due to large costs for the security demand decreased. One positive issue is that the copyright laws has been adopted to the technology and actually enforced. Another claim is that the change is very good as the world again is able to develop in different cultural directions and the "culture equalisation" (popular culture spread over large geographical areas via the net) has been stopped.

As the information available off the internet decreased "websurfing" also decreased, though it was still used for a lot of official information. Also the "security overhead" in control and encryption protocols increased, giving less space for the actual information and especially links with low capacity experienced some bad years.

[Impact on wireless: Still important, Needed efficient use of bandwidth, prevent monitoring, possibility to pick up info anonymous]

### Inside telecommunication business

It is nice and sunny day in the middle of May 2010. In one meeting room on the third floor in one large building a meeting between the largest telecommunication operator in Sweden and one of the large telecommunication manufacturers is held. In order for the government to be able to be able to control the telecommunication operators very few were certified.

Mr. Optenberg is the operator representative. In the northern parts of Stockholm construction is going on. A new suburb is planned and there will be new offices, apartment buildings and shopping centres there. Since 2007 the demand for mobile telecommunication has been stable, but in this case there is a need to expand the network capacity in that particular area.<sup>30</sup> Mr. Optenberg is here to buy new base stations for his network.

Mr. Optenberg starts by quickly reviewing the details of the planned expansion of Stockholm and then he turns to the issue at hand. "I think it was two years ago that we bought base stations from you the last time. If I remember correctly it was the UB42X model that we bought. It has performed well over the last two years. I believe that you still produce it?". Mr. Salomon, the sales manager replies that they indeed still make it and that it is really popular among customers.

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<sup>29</sup> See the trend "Globalisation"

<sup>30</sup> Protocol overhead increased, but the demand had decreased.

"Are they exactly as those we bought the last time", Mr. Optenberg asks. Ms. Exner, the technical expert answers him. "Well, we have found a few errors in the software that we have corrected and we have three additional colours on the case, but apart from that they should be exactly like the ones you bought two years ago. Of course the errors were not connected to the security part of the base station, by the way. The UMTS standard has not changed the last two years, so we see no reason for changing our base stations."<sup>31</sup>

"It seems like the need for mobile data communication is fairly stable. Especially since the companies have become more restrictive with having people in the field communicating with the main office. Right now it seems like UMTS is able to handle most of the requirements so there is no obvious reason for changing the standard" she continues.

"Well that sounds good", says Mr. Optenberg. "But how about programming interfaces? We have made some special adaptations to fit the requirements of our business users. I'm sorry, but the base stations you sell are not very good at handling the Swedish security requirements. Actually we have spent several man years on that adaptation and we hope we will not have to rewrite a lot of it. But actually our software development division is quite good now. Most people stay on their job and there is nothing that increases quality as experienced programmers".

Mr. Ma, the manager, looks a little bit uneasy, but then he answers. "You can be sure that the programming interfaces are identical. We know that many operators make their own adaptations and we spend lots of effort on maintaining backwards compatibility". then he asks "I know it is not really my business, but how is that computer network operation going?".

"Well" Optenberg answers. "Ten years ago it was very popular to outsource maintenance of the computer networks and our business was fairly good. But since the government passed all the information security and protection laws companies have been more and more reluctant to outsource. Now our only customers are those that signed contracts for ten or fifteen years. But I guess that is something that we'll learn to live with".

## The everyday-life and private sphere

It is a normal Wednesday morning in May 2010. Anders is woken up by the alarm clock that turns on usually at 7.00 am. Slowly he gets out of bed, grabs a few pieces of clothing and heads for the shower. After the shower he is almost fully awake and he heads for the kitchen. He grabs what look like a calculator, and type in some number... 'OK, 146539 is my ID-card PIN today' (Used to activate the ID-card) After a while a free copy of the big national newspaper is printed on his printer. He only prints the parts that he is interested in, but he receives everything in order to not reveal his personal interests. He flips through it while eating his breakfast.

One of his favourite page on Wednesdays is the list of new domains which have been granted the new ISO 99000 certificate. For years, entire domains were restricted because they were not complying to the Security and Confidentiality Standards. Since 2007, after the information security revolution, the internet gets better. Confidentiality and security are the most important criteria when talking about telecommunications. A lot of free services which had a great success at the beginning of the century was forbidden by the newly created 'Information Police'. However, some services like shopping and private home page servers are coming back on the web with the new ISO 99000 certification. Strong control and integrity rules have to be applied to avoid the loss of the license.

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<sup>31</sup> UMTS well deployed by 2003. Standard changed 2005 and 2007 to improve security.

It is time to head for work and Anders walks to the subway station. At the entrance, he takes out his ID-card and the gate recognises the period ticket stored in the card and lets him through. During the last years it has been popular to store different functions in the ID-card since they are able to provide secure transactions without revealing the identity of the user. In the subway, there is the usual crowd. 'Transportation problem will never been solved.', thinks Anders when he crushes into the subway car. 'However, the security has been improved'. Anders has been commuting to work at the same time for several years, he recognises many of the other faces but everybody keeps quiet. Thirty minutes later, he finally gets to his office. Once again he sweeps his ID-card and enter his pin code to get in the building. Inside, a guard salutes him. He takes the elevator to the sixth floor and sits down at his desk. Security checks are everywhere, Just to get from the front of the building to his office, he needs to sweep his card five times. A new government technology was announced a few weeks ago: Smart badges will be available soon.<sup>32</sup>

When he logs onto the network he is notified that there are a few new email messages waiting for him. There is one message continuing a proposal for a new product plan and he is asked to contribute with comments. He spends a couple of hours to write down the reply. When he is finished he pushes the "send" button and a large box shows up on the screen. It informs him that he should not pass any personal information in an email. It also informs him that he should be aware that sensitive company information should not be sent in emails and that all external email will be screened for sensitive data. He knows that the email will be checked by the internal information control branch, which co-operate with the government.

Anders thinks back on the events of the previous ten years. It had started in the late twentieth century when computer networks became more and more popular among the general population. People had enjoyed the time saving possibilities of network shopping and email and they had also found the thrill of interacting with other people in various games and chats. The advertising and marketing business started to realise the potential and value of the information about each individual that seemed to be available on the net. Infotradors specialising in personal information boomed and became very skilled at analysing in individuals personality. Soon the advertising became too personal. Offers of marriage counselling a few hours after a quarrel, weapons offers to the most violent Quake players and sects that sold personal improvement courses to depressed individuals. When car insurance became more expensive for aggressive individuals (based on the language in their email) the government realised that somehow the flow of information had to be controlled.

The government realised that computers and networks are still too unsafe and error prone. The problems around year 2000 and numerous break-ins by hackers had proved that with more than desirable clarity. Thus heavy regulations on information trading and copyright was passed. In campaigns people were cautioned about using the network in such a way that it would give out any personal information. People stopped using the network for shopping and games and lots of businesses had to close down. In 2007, government resolution ordered to split the net and create a new level of security, information firewalls filtered all information between the two levels, especially for the private web pages. Companies had exactly one year to comply to the ISO99000 certificate unless they would be disconnected from the network. Most of the companies could make it with a strong financial support from governments. Island international companies like in India and Russia requested the special ISO99000-B that allows access to the security level from a non-secure country.

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<sup>32</sup> Smart Badge is a research at the department of teleinformatics, KTH. [www.it.kth.se](http://www.it.kth.se)

Anders is pulled back to reality by one of his colleagues that asks if he wants to have lunch. After lunch Anders leaves the office to go to the local authorities. Once a year, he has to renew his ID-Card. After waiting for some time, he finally comes to the desk. He gives his old ID-Card and his passport to the civil servant, he cannot see what he is typing. He moves a bit on the side to see the screen, there appears at once his picture and a lot of information on himself: his jobs, his ex-wife, his bank accounts, etc... These information come from the central nerve of the secure network, but the good thing is that it cannot be read without using his ID-card. In United States, it was the FBI who extended and re-formatted their intelligence data to give the necessary information about every single person. The database is now daily used by all the information police everywhere in the securely developed countries, they update their database to allow accessing in buildings, logging in, withdrawing cash, etc... only with one single card.

In the afternoon he sits in his office doing updates on base station software. It is mainly a matter of fixing bugs. The standard has not changed for a few years so he has mainly been doing bugfixes the last few years. "There are no challenges anymore he thinks, I should try to get another job. but these days it may be difficult. But if I could find something in an encryption hardware company it would give me more challenges". On his way home he passes by the theatre to see if there are any tickets available for the show on Friday night. There are some seats available and he buys two tickets and pays with his ID/cash card. He passes the grocery store and picks up some groceries and then heads home.

When he gets home he checks his mailbox. Of course there is no junkmail in it but there are a few bills and a letter from his mother. He reads his mail and then sits down in front of the TV and flips through the 20 available channels in the government digital network. Since pay-per view was outlawed in 2007 because they could get too much information about personal habits, some of the pay-channels got converted to total broadcast channels and found other ways to finance their program, others went bankrupted. Later on he goes to bed, turns out the light and falls asleep.

#### **4.4. Scenario III - Pocket computing or Smart devices that fit into your pocket**

Essence of scenario:

- Market is developed and controlled by operators
- Social and political differences
- Bandwidth still expensive
- Highly differentiated service and pricing levels
- Specialised service providers also provide equipment for specialised purpose
- Global multi-purpose services compete with local specialised services

## Overview of Society and Technological development

### **The telecommunication background**

Third generation systems are mature<sup>33</sup>, IMT-2000 has been reviewed several times since its commercial start in 2002, still delivering wireless up to 10 Mbps in offices, 2 Mbps in cities, and 384 kbps in the country side. However, the universal mobile idea has never reached the expectations<sup>34</sup>. A large variety of different mobile solutions are available<sup>35</sup>. GSM is still widely used with some new features but serious lack of bandwidth. Hence, it remains inappropriate for mobile multimedia needs. Usually, mobiles integrate DECT, GSM, IS-95, and some other indoor systems. More exclusive mobiles give also access to other services such as fast data connections allowing video, and Internet browsing.

The different wireless networks compliment each other<sup>36</sup>, but multi-mode solution is relatively expensive. Common people prefer to pay for reduced services at minimum price.

Having a smaller capacity, broadband mobile networks are fully loaded. Because the cost of antenna sites has risen enormously, telecommunication operators invest more in services than in infrastructure. Therefore, to match to the offer, the price of the broadband access has been risen. Only businesses want to afford all-in-one devices and pending services.

New exceptional frequency bands have been traded, as there is still a bandwidth demand.

Most of the people prefer to have light and small terminals to carry everywhere. Ad-hoc networking capabilities make it easy to wirelessly connect camera, display, keyboard or other computers within a short range<sup>37</sup>.

There is also a growth of hidden communication, i.e. cars communicate with each other and to beacons, household appliances etc. Those communications are very helpful; they increase the security and are often partly financed by authorities<sup>38</sup>. These devices are often wireless. They use relatively low bit-rate communication and simple protocols.

### **The economical background**

Most companies are present in every country with marketing service and studies<sup>39</sup>. Products are marketed worldwide. New services and gadgets are launched by professional Hypers (people stimulating a hype) and Trend Scouts. The same brand name is used worldwide but with strong adaptation to local markets. Some brands became so global that they don't have any origin identity. Imported influences (Coca-Cola and McDonalds) have less impact on populations than adapted products<sup>40</sup>.

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<sup>33</sup> Time scale is 10-15 years from now. (2010-2015)

<sup>34</sup> All-in-one devices offering all services are hardly affordable. In consequence, this gives longer lifetime to older systems.

<sup>35</sup> The service given is adapted to the user's need. See Megatrend Services become independent of infrastructure

<sup>36</sup> i.e. The different networks cover the whole 'Range vs. Bandwidth' space.

<sup>37</sup> See for example [www.bluetooth.com](http://www.bluetooth.com)

<sup>38</sup> for example stand-alone device could be used for identification purpose.

<sup>39</sup> See Megatrend Globalization of markets

<sup>40</sup> Adaptation is part of the service offered to the local customers. However, there is still a limited number of global products which coexist the locally adapted ones.

Some countries choose to have high trade barriers (also for information) due to political reasons and large cultural differences. They impose strong regulations (or even inhibit) on any trade of goods which has not been locally adapted. The importance of culture in economical issues increases<sup>41</sup>.

Global corporations have invested in worldwide corporate networks to coordinate the information and limit information leakage<sup>42</sup>. Communication expenses counts for one of the biggest part of WorldWide companies budget, together with salaries and R&D. Major incomes is coming from services and patents<sup>43</sup>. New companies made a big business from the network management buyout of big companies to sub contractors.

### **The social background**

Cultural and educational differences between countries lead to political instabilities and social unrest, mainly within countries. International investment is limited in some countries.

Part of the population lives and works everywhere, whereas the other part of society is stuck to region and cultural background<sup>44</sup>.

### **Inside telecommunication business**

During the past few years, most of the big corporation tried to grow by acquiring little businesses around the world to gain locality. The locality factor is one of the qualities that the big companies have difficulties to keep close to the different customers around the world. Competition is extremely intensive in the computer and telecommunication industry. The number of big companies in this sector is limited. Small companies are competing locally and end up by being bought.

Two big companies are discussing about an eventual merging. This is a rare and very difficult transaction but they need it because the top one gained market shares last year by introducing some new popular products. The goals are to grow both horizontally, and vertically. This should increase market and customer base and increase the scale of products and services, respectively. The two companies are NITIMAGOSHI, and Smith and Smile. The first is a huge Asian computer/router/etc. company; the second is a European, formerly British, data warehousing company.

They want to compete with the telecommunication establishment by increasing the WLAN network use and extend the idea to a non-cellular mobile phone/data network. The advantage is that the WLAN technology is adaptive and therefore needs very little network management. The capacity increase of the fully loaded networks could be done within a few weeks and kept relatively secret to surprise the other operators. However, this needs a huge financial investment.

Another reason for the merging is that the two corporate communication networks are complementary. The lack of fixed lines in Asia could be provided by merging the networks and vice versa. The development of the network has been limited those two last years and effort has been put on the middle class adapted terminals. Now that the broadband

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<sup>41</sup> In this scenario, the Megatrend Globalization of culture has less influence, as the national identity for the "middle class" is an important factor.

<sup>42</sup> Strong competition in R&D and in Strategy increase importance of corporation secrecy

<sup>43</sup> A lot of patents are shared with other companies by creating joint ventures.

<sup>44</sup> Consequence of Megatrend Education become more important



communication network becomes overloaded, it is vital to make a joint attack on the higher-class customer due to the recent rise of the bit rate price; business customers are ready to pay premium rates for reliable and fast access.

By merging, their economical global power would also provide them the political influence that they need in Asian developing countries.

Other consequences are expected, among them<sup>45</sup>:

- Devices talk without problems to each other, the next step is to extend it to a world-wide phone/data net. Ad-hoc networking will give a good coverage solution combined with the available joint infrastructure.
- Operators compete on low-price or high quality. The low-price battle becomes limited with no real winner. The new battlefield is the bitrate price, the mergers expect to come up with one tenth of the usual price for the customer.
- Utilize the global stock and financial market for increasing the value of their shares and lower taxes etc.
- 24h around-the-world software development.

The data warehouse company wants to go at very fast pace as they were used to expand their business on annual 2-3 digit increase in percentage. Their goal is to have the latest software, the fastest computer, catch most customers, get them attracted and charge them a premium fee for number crunching.

The computer manufacturer tries to slow down since they are used to long-lasting standardisation procedures, which caused them to make frequent, expensive router software updates at their customers sites. "All needs to be compatible, so we have to chose the market entry point carefully", they say. Actually, NITIMAGOSHI 's policy is that the first one on the market might be too fast and wiped away by some last minute change in standardisation, which then costs millions in software updates. So - "be second and beat the others in lower prices". This had impact on the telecommunication world. Competitors are mostly watching each other and move only if the other moves. This is why they have to prepare good and act fast.

Despite the huge reorganisation effort, they trust the chosen consulting company who is working on this for 9 months. Another danger is the company culture differences, which is a longer-term problem. However they expect high gains in synergy. Both companies have to release a lot of employees, which doesn't hurt since they are only on 1-2 year contracts<sup>46</sup>. They decide to staff the new dept. (500) with new entries. They are going to hire the top of last year graduate students via a huge advertisement program on the new Hyper-Engineering universities. Hundreds of consultants from MEM (Masters of Engineering and Marketing) programs are responsible to keep it secret.

### The everyday-life and private sphere

The following two stories show a one day snapshot of both the life of an educated and well paid consultant in investment banking and an engineer with academic background but working as an employee for a telephone operator.

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<sup>45</sup> Extrapolation of Megatrends in general

<sup>46</sup> Hire and fire policy from survey results

### **The business man<sup>47</sup>**

Stanislaw is an investment banker currently working for the Banco Santander in Madrid, a typical European. Born in Poland, he studied in the UK for 4 years, got a MBA in the US in 2 years and lived in Germany, Australia, Singapore, etc. never for more than 2 years<sup>48</sup>. Stanislaw is one of the 1000 specialists for hook-futures (options for buying/merging with a competitor to increase the companies size) worldwide. He's very well paid and can choose the best contract from a variety of offers.

Stanislaw is 45 years old, single, and resident in Luxembourg at the moment. He speaks a few languages but mainly communicates in English. He has World-wide clients. He is moving from project to project and country to country.

Paper work, math analysis of trends and markets is done by sub-contractors at one of the headquarters. The corporate network consists of a few central servers and mirrors. They are the hearts of the company, where all data is stored, and where all the information is available.

The thin notebook is his desk always virtually connected to the network. He uses a multi-mode phone/modem that allows him to phone from every place and connect most of the time with a correct data bit rate to the Internet and to the central server (or its mirror).

His company pays for the services. He needs fast access to information. Global communication and traveling are vital for his business. He can afford secure and reliable communication for premium rates.

He expects that global products can be found everywhere he goes without local adaptation.

### **The "new middle class"<sup>49</sup>**

Aldous is electrical engineer and works for a telephone operator in the US. He belongs to the so-called "new middle class", accounting for approx. 50% of the average US-European population. Aldous has a reasonably high income to afford vacation travelling, hobbies and the little nice things in life, such as a car, a cell phone, cinema, theatre, and lots of friends.

He has a wife and one young 10 years old son (Thomas). For him, the family is important. He tries to spend a lot of times with his son who is growing up too fast. He married his wife 15 years ago when she was 25; the tax situation at this time was enormous for the single workers.

Thomas is of the new communication generation. He is young and therefore a good target for the network game industry. Thomas couldn't imagine any game that cannot interact with his friends. It is not funny to play alone... Aldous still thinks that this generation has trouble to communicate the old way, they play together,

OK, but not enough on the play ground. He is so happy when he goes on Sundays to the park and spends a good afternoon without communication. The devices Thomas and his friends are playing with are using direct LOS connections and have to be played in a room to avoid interference with other eventual players.

Connection to some other services are possible but it is expensive. A SIMM-Card slot is under the Battery, sometimes Aldous uses his card to try the new games from the games

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<sup>47</sup> The High-end customer, service is the priority

<sup>48</sup> Mobility, flexibility of people

<sup>49</sup> The low-end customer, price is the priority

service provider. But he is always afraid of running out of credits before the monthly card recharging at his work.

Those last years, more and more new terminals are available. Each offering different service and quality level, some of them has software update capabilities and give the possibility to extend the original service. They are expensive as the same terminal competes with different services, but it is handy to have only one device in the pocket. Aldous has a basic Mobile Phone (GSM and DECT compliant) and could access high bit rate WCDMA services but he avoids it because it is expensive. He has a fixed network connection at home and at work and he thinks it is enough.

There is one thing Aldous has difficulties to support: whenever he accesses the network, he is traced by hyper-companies, it is part of the cheap service contract. He knows that if he buys something he will receive mail or post the next days advertising for accessories, or better deals from concurrent. If he could afford his secure personal connection, he would go for it at once.

His computer is the same as most of the people and configured for the network connection service that he subscribes to. It is not his computer; he just uses it and spends his money on the services!<sup>50</sup> Every now and then, he receives new patches by email to update the OS or the software.

His wife, Kate, is not that much interested in the entertainment that the network provides. She thinks it is really nice to communicate with her friends and to receive her favorite magazine newsletter every day. She likes the practical advantages that the service provider offers and profit of the web offers

At a little extra price, Aldous connected a daily kitchen forum directly to the shopping agent. The food is delivered twice a week. Since then, Aldous is proud to make the food as good as his mother used to make, but Kate tell him he cheats because he uses the interactive kitchen show on TV to prepare the dinners.

#### **4.5. Analysis**

Trend development to obtain scenarios

The scenarios are built as a combination of different trends, developing in certain directions. Here we describe what will happen to the trends building up the three scenarios.

##### **Anything Goes**

**Globalisation** is increased as most people can easily communicate world wide and as the main product is software, it is easy to sell products globally. **Standardisation** as today is really decreasing and de-facto standardisation takes over. All kinds of **appliances communicate** increasingly among each other.

##### **Big Brother**

The Integrity scenario was created basically from the trend **Information Trading** and the potential risks it might create. According to the trend, Information Trading will continue to increase, but at a certain breakpoint it will degenerate and sensitive information will be available. As access to sensitive information becomes too easy, the trend suddenly reverses.

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<sup>50</sup> Services become more independent of infrastructure

This is called a discontinuity of a trend. **Globalisation** is decreased, as authorities have to limit cross-border communication. **Standardisation** is increased as international organisations and governments enforce a new integrity and encryption policy.

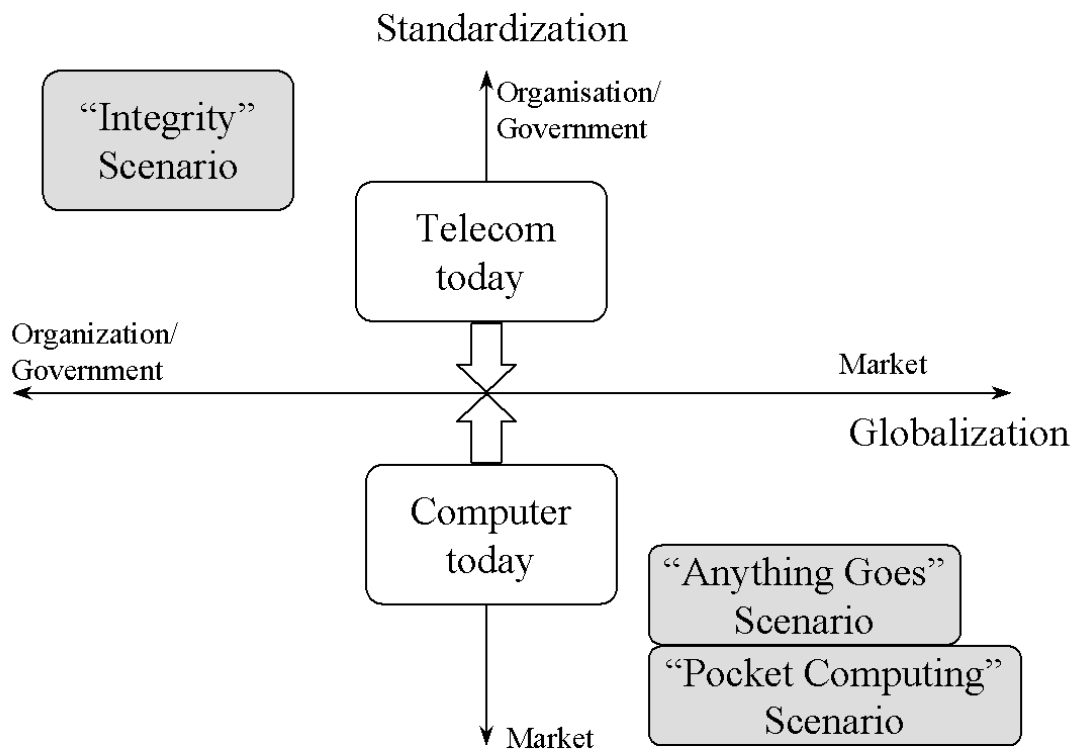
### **Pocket Computing**

The Pocket Computing shares most of the trend development with the Anything Goes scenario, with the difference that the development does not reach all people. **Standardisation** is ruled by big operators and the development of Communicating Appliances is slower.

### **Scenario Space**

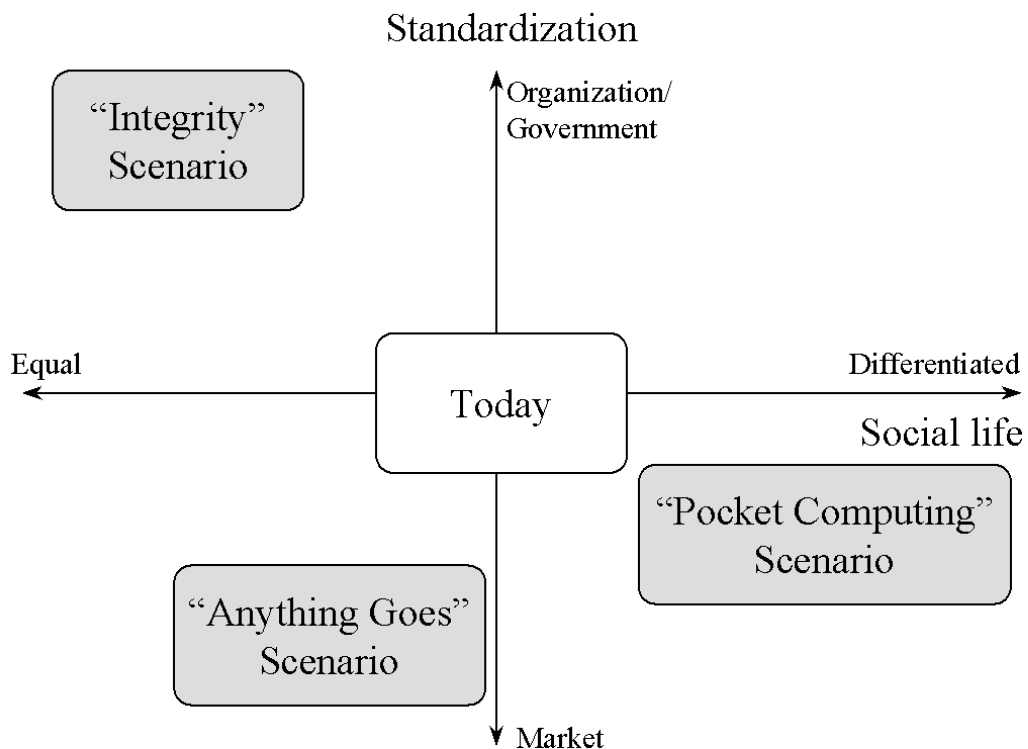
The process of creating the scenarios from the trends via the headlines provides scenarios based on the trends, but not necessarily covering all the possible outcomes of different trends. If each trend is looked upon as having two states: plays out - does not play out, and there are six trends, there are obviously 64 combinations at start. To evaluate the coverage of the existing scenarios, a Scenario Space may be constructed. The axes are the trends or any other interesting value or way of development. The purpose is to find a framework for comparing the scenarios within the set to scenarios already published by others.

In the example below, the two trends claimed to be most important span a 2D Scenario Space and the scenarios are positioned in that space. As a reference, the today's merging trend between the telecommunication world and the datacom world is shown. Apparently the Pocket Computing and the Anything Goes scenario are fairly close to each other whereas the Integrity scenario is in an opposite quadrant. If the social aspect would be one of the axes, the distance between Anything Goes and Pocket Computing would be significantly greater. On the other hand, two of the quadrants are not covered by scenarios since these are not of such a relevance for the project.



**Figure 3, Scenario dimensions**

A structure that separates the Anything goes and the Pocket computing scenarios may look like is shown in figure 4. Here only one quadrant is empty. This quadrant may be filled with a new scenario (maybe Elite Scenario), described with central and governmental standardisation and a differentiated society.



**Figure 4, Alternative scenario dimensions**

### Comparison to other scenarios

As mentioned above, a lot of organisations are creating scenarios and it would be desirable to compare these scenarios to the 4GW scenarios, as they are all trying to sketch, how the world may look like in the future. However, there are factors complicating such a comparison, since all these scenarios have different backgrounds, different environments and different purposes.

The first issue that differs between different scenario sets is the purpose for which the set is created. The 4GW set is created to envision the future and to make the participants think in a common way and thus work towards a common goal. In addition to the mentioned purposes companies such as Ericsson and Siemens often have a business aim with the analysis. It is most probable a tool for identifying new business areas and new market segments.

In each 4GW scenario there are some typical issues that span the scenario. For this simplified comparison we will focus on some of those issues to see if they appear in scenarios created by other organisations.

### 4GW

Purpose: To refine and verify research problems and assumptions

Covers: Telecommunication market and its environment

Scenarios and their essences:

- Anything Goes! - Fast development, Defacto standardisation, Multimode terminals, Almost free access

- Integrity - Security is prioritised, Slower development pace
- Pocket Computing - Socially differentiated. Markets are fragmented, Technology is highly differentiated. Pay for service – not equipment.

### **Ericsson**

Purpose: To define a company strategy and organisational structure, influence personnel.

Covers: Infotech Market.

Scenarios:

- "Service Mania" - Broker Service and Content Providers win. This may be found in Pocket Computing, that stands for the development towards strong operators.
- "Gran Tradizione" Strong operators, A conservative slow market. The slow market may be found in Big Brother, and the strong operator may also be found there, but strong operators are also found in Pocket Computing.
- "Up and away - Full speed ahead" – This scenario means a world with free access, where the terminal producers are the winners. This development has some parts in common with Anything Goes. Here it also means differentiated services, which are found in Pocket Computing.

Impact: Prepare the company for the convergence of communication and computing and its impact on end-user device.

### **Siemens**

Purpose: Create visions and opportunities for future business.

Covers: World society

Scenario Space axes:

- Value - Perception and influence of social values.
- Flow -. How easy it is to move people, products and information across the borders.

Scenarios:

- Civic Island – Local Competition, Regulations. Barriers, Strong government.
- Money Island – Local competition, Culture important, Barriers to flow, Equality, Security, Regulations
- Blade Runner Differentiated Global market, Technical advances Social differences-insecurity, Deregulation. Profit-maximising companies and selfish individuals.
- Cyber-Woodstock Scenario – Totally globalized information. Shared values like family and environments are important.

As Siemens has chosen a much broader perspective it is hard to compare more technical/economical scenarios to Siemens' more general scenarios. It is, though clear that most of the issues in the 4GW scenarios has corresponding parts in the Siemens scenario.

## **5. Impact on 4 GW**

### **5.1. Scenario implications**

After developing the set of scenarios, the main interest for the 4GW project is to investigate what impact the results have on the research work of the individual Work Packages in the 4GW project. For this analysis the following questions are to be answered:

- Are the working assumptions valid within the different scenarios?
- Are the problem definitions relevant within each of the scenarios?

As an example take a scenario which is populated by countless devices, each talking to another and moving around with its owner. Highly centralised and advanced resource allocation schemes are perhaps not applicable in this type of environment. This world would rather need smart, simple and distributed resource allocation schemes, which can be performed by each individual device with little computation and fast while attempting to talk to another device.

If necessary, the existing working assumptions and problem definitions need to be:

- modified, if the scenarios suggest a slightly different perspective on the problem;
- discarded, if they are irrelevant within the scenarios;
- complemented, if gaps are detected due to new, unexpected trends and consequences.

Further, the priority given to each problem should be carefully checked, so that results from the Work Packages are available at the right time in the overall research process of the PCC and when they are applicable within the anticipated scenarios.

Besides the immediate impact on the Work Packages there are some more indirect implications. The scenarios also point out trends and tendencies, which the project can't influence, but which have significant impact on the research work. These trends need to be observed while the research work is going on, to detect paradigm shifts early and, if necessary, modify the focus of the research work. One example are activities on the financial markets, which might have a massive impact on the deployment of the research results.

### **5.2. The analysis process**

The direct implications for the different Work Packages are obtained by individually cross-checking the initial Work Package descriptions against each Scenario in the following five steps:

1. Extracting the problems definitions and working assumptions from the initial Work Package descriptions;
2. Reviewing the assumptions by questioning their relevance within the scenarios and regarding the underlying trends with respect to:
  - Pace of technology change and required flexibility;
  - Mobility of people and companies/business;
  - Markets, competition, individual purchasing power;
  - Control of communication (centralised vs. decentralised);



3. Adjust the research focus and re-formulate the problem definition or, if applicable, add new sub-problems;
4. Re-formulate or add new working assumptions according the modified problem definitions;
5. Rank the research problems according their relevance and allocate priorities;

Some economic aspects are considered in the scenario analysis as well. Relevant questions with respect to the outcome of the research work and future communication markets are for example:

- Can the outcome survive in the markets anticipated in the scenarios?
- Is it possible to tailor proposed solutions to specific needs of individual scenarios?
- Can the outcome create new markets?
- Could different scenarios encourage or provoke competitive solutions?

### **5.3. 4GW Working assumptions**

#### Services

- Telepresence virtual meetings is a driving application
- 100 Mbit/s realtime data connection is required by telepresence meetings
- Multicast technology is a key enabling technology for telepresence meetings

The services provide 2010 range from mobile/ untheatered "tele-presence" in office/dense urban environments to wide area interactive information services requiring large bandwidth, but not necessarily in real time. "Tele-presence" is used to create virtual meetings between individuals and provides full stimulation of all sense required to provide the illusion of actually being somewhere else - an illusion that cannot be distinguished from the "real thing". The bandwidth required for tele-presence is, with efficient data compression and fast sensory feedback, less than 100 Mbit/s. The data stream is mostly dominated by 180-degree stereo, hi-resolution, and full motion video). Meeting processes will be mainly real-time. One possible killer application might be tele-presence. Real-time communication is essential for the meeting processes and multicast is required for group communication. Multiple party meeting processes is one of the major communication patterns foreseen for this application.

- Services are seamlessly available anytime, anywhere
- Information retrieval in non-realtime is one important share of the communication
- Non-realtime data retrieval is mainly due to infotainment

Virtually seamless connection to a wide range of information services, anywhere, anytime is a key feature of the information infrastructure. Information access of large volumes of data, pictures, video etc is nearly instantaneous in small portable terminals. Compared to real-time meeting process, this application is less delay sensitive. Users can tolerate longer delay for the information that is not real time critical. Possibly high data rate are required for high volume data transfer applications such as video retrieval. Bulk data transmission requires a very high data rate. The traffic pattern is highly asymmetric with 50/1 ratios or more favouring the system-to-terminal links. Seamless virtual connections (creating the feeling of always being connected) is important for the users. Information provisioning is dominated by educational/recreational material.

- Intermachine communication is an important cause of communication

- Cheap communication devices can be built (<\$1)

Inter-machine communication is an important application/service, ranging from simple maintenance routines (e.g. refrigerator telling repair shop that it's broken) to sophisticated massive data exchange (e.g. camera and PC/TV exchanging video/picture information). All cars, household and office equipment down to less than 20 US\$ have wireless interface as standard feature.

- Security services are an important part of all communication devices

Security is an indispensable feature of the infrastructure. Data integrity and protection against unauthorized access are key features providing reliable services for banking, electronic payment and handling of personal information. Schemes that reliably prevent unauthorized tracking of users and other intrusions in the private sphere are in operation.

- Services are provided in a one-stop fashion

Services are provided in a one-stop fashion ("turn-key") directly to the consumer at the point of sales. Services are immediately available when leaving the store. The store (information provider) takes full responsibility for the service (as well as for the hardware/software provided, if any).

### System architectural characteristics

- Multiple air interfaces in the infrastructure
- Non homogenous infrastructure
- The fixed network is packet switched
- Packet switched air interface provide 100 Mbit/s

The infrastructure architecture is non-homogeneous, consisting of several switching fabrics and a multitude of physical media. All elements of significance are digital. The fixed backbone structure is dominated by connection-less packet switching (IP-style). Also the new air interfaces in wireless systems use packet switching technology. The wireless infrastructure consists uses a multitude of air interfaces, inherited from the wireless systems of the late 90's and early year of the new millennium. Among the newer, packet oriented wireless systems for the high data rates in the 5 and 60 GHz system have emerged with data rates up to 100 Mbit/s for hand-portable use. An overlaid architecture will provide seamless, transparent internetworking using all kinds of air interfaces.

- Public Wireless access quality bandwidth varies

Public Wireless access quality and bandwidth varies, where higher data rates >20 Mbit/s are confined to dense urban areas, office environments (private/public systems) and homes (private systems). Operators/service providers provide partial coverage for non-real-time wideband (>10 Mbit/s) information access in most public places ("info-kiosk", infostations), in public transportation. Rural area information access bandwidth is limited to >1 Mbit/s but provides reasonable coverage along all main highways and villages of more than 100 inhabitants. Seamless transitions from private networks to public operated systems is possible.

- Multiple operators provide the infrastructure
- Ad hoc networks is an important part of the NW structure

Many actors will provide parts of the infrastructure. Ad-hoc networking (spontaneous deployment, self-planning) in unlicensed bands (the 5 and 60 GHz bands) will play an important role (the dominant role in the "pocket computing" and the "anything goes" scenarios) and compete fiercely with the existing traditional public operator which experience dwindling market shares. Techniques for efficient multi-operator (private/public) sharing of unlicensed spectrum have been developed. Ad-hoc structures, where the equipment of the users (companies or even individuals) provide part of the infrastructure, are adaptive to

possible new communication patterns. Control of the new emerging ad-hoc networks (incl. routing, mobility etc.) is fully distributed and highly reliable.

- Access ports (base station) are cheap/ low cost
- Access ports are self configuring
- Access ports use adaptive antennas to increase capacity

Access ports (base stations) in public systems are multi-mode with multiple access air interfaces to accommodate a wide range of terminals. Large operator systems use advanced access ports with adaptive antennas that self-configure with non-critical installation procedures(self-configuration) to reduce cost. The cost of base station equipment is neglectable in comparison with the cost of planning, and physical installation. Access ports (wireless gateways) in ad-hoc access systems are simple single mode/single air interface devices. 60GHz systems use adaptive antennas. The cost of access port hardware in these systems is neglectable.

- Terminals have a wide range of bandwidth requirements
- Terminals have at least one week of battery life

The terminal population exhibits large range of bandwidths, from less than 10kbit/s (e.g. simple appliances) to 100 Mbit/s (tele-presence terminals). Battery life for personal terminals will last at least for one week. Battery capacity/weight/volume ratios are up one order of magnitude compared with today's. Terminals in the 5 and 60 GHz range use advanced adaptive antennas.

- Terminals have a wide range of capabilities

Terminals are either multi-mode, multi-function terminals as in the "anything goes" scenario, or single-purpose, cheap terminals designed solely for a specific service ("pocket computing"). or function specific (e.g. receive only).

- Efficient air interface protocols provide one magnitude better resource utilisation

Efficient protocol design, tailored to the wireless environment to conserve frequency spectrum and computing power in mobile terminals is used. Seamless mobile multicasting is an integral part of the network architecture.

#### **5.4. *The impact of the scenarios on the individual Work Packages***

##### **WP1 - Air interface**

The objective of WP1 is to propose and investigate possible radio interfaces for future broadband communication systems that is capable of transmitting much higher data rates than current systems do. This involves also considering much higher frequencies for potential air interfaces. Large bandwidth and high data rates are the key in all of the scenarios, but especially with respect to "Anything Goes" and "Pocket Computing" where it determines whether or not these two scenarios might become reality. Further, the high degree of mobility, mainly in these two scenarios, requires flexible and fully automated dynamic resource allocation schemes.

The key issues for WP1 are to define which multiple access schemes should be used and what types of signal processing techniques are appropriate in terms of complexity and feasibility. Underlying research topics are modulation, channel estimation, synchronisation, multi-user detection, channel coding, diversity and interference suppression through adaptive antennas.

To find a proper distribution of signal processing load between fixed infrastructure and portable devices is another research challenge.

From the first version of the working assumptions, the targeted bit rate is 100Mb/s in an outdoors-mobile environment using the 5 to 60 GHz frequency bands. Unlicensed frequency bands are of most interest for future systems. Fast mobility should be possible but at lower bit rate. The system should be able to adapt to a given traffic pattern and therefore the air interface must have a large flexibility. Packet switching is considered in order to provide a virtually seamless communication system. To extend the coverage in a range-limited communication system, ad-hoc networking and relaying techniques should be considered. Possible air interface should be investigated in co-ordination with the assumptions and work of the other WPs.

From another point of view, an ideal radio interface would comprise a spectrum efficient modulation and provide flexible multiple access schemes for different services at different bit rates. It should be resistant to frequency selective fading channels, require little equalisation and should cope with non-linear amplifier. Perfect synchronisation or low sensitivity to carrier frequency offset and drift are further desired properties. Low complexity algorithms are considered in other WP. The first points above make OFDM the most likely candidate for the broadband communication. The other points are OFDM's drawbacks. Other possible modulation scheme could give better results but OFDM is, so far, the only solution that has shown good behaviour in frequency selective channels (the multi-carrier modulation spreads many parallel signals over a larger period ending up with many parallel flat fading channels).

## WP2 - Smart antennas

The main topic of WP2 is to examine the use of antenna arrays in a complete cellular radio system, how this affects the system infrastructure and how the system solution affects the antenna strategies. Smart Antennas offer substantially improved bandwidth utilisation, by exploiting the spatial and temporal dimension of the radio channel, and thus increasing the antenna range, suppressing the interference and decrease the power needed for certain functionality. Smart antennas improve battery life as well.

The Scenario analysis implies that future wireless systems will require much higher bandwidth, ability to handle varying traffic situations and flexible system structures. Key research issues in the WP, are to find how Antenna Arrays should be used to offer increased system capacity and quality of service, as well as to identify critical infrastructure design parameters to meet the new requirements. This includes efficient ways to exploit the spatial dimension, both with array signal processing means and radio resource allocation means. It also means providing structures for analysis and performance assessment of mobile communication systems using Smart Antennas. Providing high system capacity is critical and a much more challenging task than supplying a high peak link capacity.

In the Working Assumption it is foreseen that the air interfaces will be packet switched and carry a much higher bandwidth than today. This requires use of new schemes for packet access and resource management, adopted to utilise of the antenna arrays. One major issue of this WP is to investigate such schemes. It is also assumed that antenna arrays will be used on the terminal side. A question for future investigation is how this will influence on the system capacity and quality of service. Antenna arrays also make it possible to move processing complexity from the terminal to the access point, and thus permitting the terminal to use lower power or offer increased functionality.

### WP3-A - Infrastructure architecture

The main objective for the WP is to investigate infrastructure architectures for low cost and low power systems as well as strategies for system planning and wireless resource management. This involves several aspects, ranging from the scalability of systems to different network sizes, gradual evolution of networks to preserve the operators investments to standardisation and planning problems.

The key requirement for future wireless networks is clearly flexibility, which allows operators to extend their cellular systems quickly and inexpensively to deploy new network capacity as soon as the market demand increases. One way to achieve this is to provide multi-hop capabilities, so that networks can adapt and change in shape and size as number of mobiles fluctuates. The difficult and from the research perspective most challenging part here is the resource management for these wireless networks. Algorithms need to be dynamic, distributed and flexible to cope with mobility.

Further, traffic is likely to be highly asymmetric due to the increasing importance and amount of data traffic, i.e. audio, video, web surfing etc. Possible alternatives to conventional approach will be studied, such as complementing cellular networks by uni-directional broadcast systems or Infostations.

Common to all solutions is that they have to be low-power and low-cost systems to decrease initial investments and running costs. This point proved to be very important in all scenarios, since strong competition requires both operators and manufacturers to provide services and equipment cheaply. The low-power problem is specifically crucial for the Anything Goes scenario because of the large amount of communication devices.

## WP3-B - Resource management and operators

In the working assumptions we assume that a multitude of operators will provide the infrastructure. A large number of operators will make the traditional way of sharing the frequency spectrum obsolete for a number of reasons. The traditional way is to give one operator the exclusive use of a certain frequency spectrum in a specific geographical region. When the number of operators is large this approach has these drawbacks:

- When splitting a resource into many small parts the total maximum utilisation is significantly lower than if the resource had not been split. This is known as trunking losses.
- The administrative overhead will be extremely high.

It is necessary that the sharing of frequency spectrum is in some sense fair. If that is not the case it will be difficult to attract investors.

The working assumptions also outline a very dynamic network environment. This points to automatic frequency planning algorithms as a key problem. Without this type of algorithms it will not be possible to design systems with the required degree of flexibility.

This work package will try to find algorithms that make automatic frequency planning possible in an environment with a multitude of operators that share the same radio spectrum. The work package will also study the fairness aspect of these algorithms.

## WP5 - Multicast

The research of this Work Package is focused on how to seamlessly extend multicast to the wireless networks. A first particular issue to study is the real-time application multicast support in the wireless networks, since one of the most important services that the Internet aims to provide is multicast. The key problem to study here is that mobility requires an adaptation of protocols. This requires to add packet switch and multicast capabilities to the existing and planned wireless networks and the integration with the backbone networks.

The impact of asymmetric traffic on the network architecture needs to be evaluated as well as the consequence of shrinking cell sizes and ad-hoc network solution. One of the main problems is that the current Internet consists of mainly fixed networks and most of the existing protocols were tailored for this specific situation, where mobility is not required. Wireless networks impose much different problems on the communication channel, so that protocols designed for fixed networks are likely not to work efficiently in a wireless environment.

The packet switching is optimised for Internet traffic, while most existing wireless WANs are using circuit switching, since they were mainly designed to support voice traffic. The importance of packet switching in the future becomes more and more obvious and one of the questions is, how long it will take to adapt the majority of wireless WANs to support packet switching.

### **5.5. Impact on the 4GW project work in general**

Besides the main impact on the research work there are also some secondary effects for the 4GW project, which concern more a social level and the work attitude. The following few items of self reflection should just point this out:

- The Work Packages within the 4GW project have built a consensus, i.e. the different scenarios, about what the future might look like with respect to wireless communication and infrastructures.
- The 4GW project developed a common language for discussing the future and its problems.
- The positions of and interfaces between the different Work Packages were established and reinforced for both the research fields and responsibilities as well as for the technical and scientific information flow.
- The PhD's involved in the scenario activities feel now more confident that they work on the *right* problems and research issues, which raised the motivation and team spirit in the group.
- The Scenario work increased the sensitivity to trend indicators and each Ph.D. student gained a better understanding of how the environment influences his individual research work.

## **6. To conclude...**

### **6.1. *Impact on the work of PCC and the other projects***

The following questions emerged during the scenario work, but are not directly within the scope of the 4GW project. Instead, they should be put forward for general discussions within the PCC and as an input for the other Work Packages.

About bit rate, delay, mobility, coverage, services in 2010:

- What and for who is there any need for very high bit rate?
- What would be the desired bit rate for home appliances? Does it need high bit rate access?
- Where do we need very high bit rate?
- In what extend do we want to move when we access the network at very high bit rate?
- Which services need real time symmetric data rates?
- Are the people ready to make a asymmetric bit rate trade off? Do we also need flexibility for down- and up-link bit rate?

About the terminal capabilities in 2010:

- How do we expect the batteries to evolve? What is the available energy per bit?
- Are people ready to share their battery consumption in case of hopping network?
- About the infrastructure in 2010:
- Where will it be possible to back up 155Mb/s in 2010?
- Is it possible to design a fully auto configurable system? Will we just have to place the antennas to build a wireless network?

### **6.2. *On the method used***

To understand the situation today

In every process of development exist preconceived ideas on what the end result may be. Clarifying some of these ideas gives deeper understanding of the problems and a firm base for further work.

People with different educational and cultural backgrounds have different ways of approaching a problem and even different perspectives on what is considered to be a problem. The group process gives a common experiences that will help group members to understand their different approaches. The process of developing scenarios is a good example of this.

To understand the situation tomorrow

Most technology is developed to be used. That is easy when one is enhancing existing technology to better suit the existing needs. What about future needs and future technology? To be able to start thinking of the future needs it is necessary to examine what the future needs might be. To be able to do that it is necessary to examine the needs today and in what directions the development might go. What is needed is a much broader approach than what is normally considered. Factors outside science and technology has to be included as well as developments that might take place within science.



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## Appendix A. Core Questions

### Group areas

B= Business and industry

I= Infrastructure

M=Market issues

P=Politics

R= Regulation

S=Social life

T=Technology

U=Usage

### Statements and questions

- B Global corporations get more important.
- B High cost of physical deployment and physical manufacturing.
- B Cost of labour increases.
- B,I Devices like satellites and base stations will be cheap, while radiofrequencies will be expensive.
- B,I Global personal satellitesystems will emerge.
- B,M Less people in manufacturing, more in information gathering/provisioning/ refining.
- I Most communication will start and end with wireless connection.
- M Globalisation of markets.
- M What is the total number of subscribers in the world at time of market intro?
- M How is the value of the "object" perceived?
- M How can 4 GW cope with shifting (geographical) markets?
- M Brandnames will be more important.
- M Are there other developments coming along that competes with 4 GW?
- M What type of functionality will they be able to offer? At what level and price?
- M,B Fragmentation of telecommunication and information industry.
- M,I What competing systems will already be operational when the 4 GW is launched?
- M,U How to filter information will be more important than how to provide more.
- M,U De-centralised media and distribution.
- P National governments loose power.
- P Governments will seek to control informationcontent.
- P Centralised control is needed for internet.
- P Will bandwidth be private or public?

- P Military spendings down even more resulting in little or no importance as driving force of te
- R Standards will be driven by the market. De-facto standards will be important.
- R International frequency regulation remains.
- S How can we understand the resistance that society makes against new technological solution
- S Will there be an "all global" society or "local islands"?
- S Electronic social life, is it possible?
- S Telecommunication can decrease social connectivity.
- S People prefer electronic communication instead of meeting face to face.
- S Personal security is of increasing importance.
- S Lower mobility due to increasing security awareness.
- S Time is limited for people with money.
- S Changes in life-style due to new technology is slow.
- S People will become citizens of virtual communities.
- S People will have multiple entities.
- S What will be the share of a persons income spent on information?
- S All individuals will get personal identifiers.
- S Group communication will grow popular.
- S Interactions with humans will be regarded as more valuable than interactions with machines.
- S How much of their total budget are people willing to spend on 4 GW?
- S Internet will introduce its own culture.
- S New cultures affects the content.
- S,P How will income/wealth be distributed?
- S,P Education gets more critical.
- S,U More electronic communication increases travel.
- S,U People like getting information by "push" rather than "pull".
- S,U Language gets more important.
- S,U Information overload will occur to people.
- S,U Language barriers will be more important.
- S,U Elderly and retired people will consume more of services. Adaption to these groups required.
- S,U Translation services will be more important.
- S,U What types of functions are we willing to pay for?
- S,U How fast will/can people adopt habits?
- S,U Technology adaptation is limited by human acceptance ability.
- T Physical infrastructure deployment gets more expensive which generates reuse of older infra:
- T All devices will be wireless.

- T The research in the wireless area will focus towards getting as high frequency as possible.
- T Underlying technologies-What does the map look like?
- T Does higher datarate mean more power consumption?
- T Will the role of the computer be more central or disappear?
- T Computing/communication artefacts disappear (i. E. Are not obvious.)
- T Can other development affect 4 GW?
- T,M What are the technical limitations of earlier systems?
- U Will the 4 Gw be a passive information access tool?
- U What is the object to be sold? (service/communicator)
- U Information will be important for different levels of use, local use and global, cultural us.
- U How will information be used as a status symbols?-Differentiation of information?
- U Mobility not just nomadicity.
- U Can 4 GW change other allocation? ( travel, entertainment)
- U Porn as driving force.
- U Most communication will be local.
- U Systems for e-cash will emerge making it possible to pay over the net.
- U Most communication will be non-local as users need not be physically correlated.
- U Wireless will be widely used for local loop connection with fixed network as backbone.
- U Customer needs vary substantially.
- U Edutainment will be a driving force of technology.
- U,B,I The content will be more profitable than the infrastructure.
- U,M Information packaging gets more important.
- U,M Will people pay more for information or will advertisement increase or both?
- U,M Consumers pay for services, not for the physical transportation.
- U,M Trust in information, in virtual entities.
- U,M How is the value of info perceived and labelled?
- U,R Will identities be single or multiple?
- U,R Many identities per user.
- U,S 4 GW mobile computer will increase nomadicity or reduce travel?
- U,T Will we be aware or unaware of contact? ( things in the background?)
- U,T Finite bandwidth of human senses as upper bound at need?
- U,T Can 4 GW offer new types of functionality and/or the same functionality more efficient?

## **Appendix B. Survey Questions**

Questionnaire for the 4<sup>th</sup> Generation Wireless project.

This questionnaire contains 25 questions about the development and future of wireless communication. Since the form is intended for a large number of people with different professions and backgrounds some of the questions might seem trivial to some and difficult to others. We apologize for that inconvenience and wish that you answer the questions anyway.

Each question is divided in two parts. First is the actual question followed by a possibility for you to mark your own degree of expertise in that particular area.

In the end of the questionnaire there is an opportunity for you to fill in a question that you believe should have been included. We would appreciate if you would help us refining this questionnaire by adding a question.

1. Due to the fact that communications services are used locally, in 2010 end users will purchase the services primarily from local sources.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

2. Globalization of communications services will allow end users in 2010 to purchase services from service providers located anywhere in the world.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

3. The globalization of communications services will in 2010 lead to similar demand of services from users all over the world. (i.e. The same news and entertainment services are requested in Malaysia and Sweden.)

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

4. Today the competence in design is said to be a dominant factor in the production of mobile phones. Will the manufacturing competence be the dominant factor in 2010?

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

5. Today Swedish national operators dominates the market for communication in Sweden. When will international "WorldComms" have more than 30% of the communications market?

2005 <input type="checkbox"/>	2010 <input type="checkbox"/>	2015 <input type="checkbox"/>	2020 <input type="checkbox"/>	2025+ <input type="checkbox"/>
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How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

6. A major part of research and development in communications technology until 2010 will improve the communications systems in a way not directly noticeable to the end user.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>



7. Wireless communications systems will in 2010 normally be designed for applications where the user equipment is portable/stationary rather than mobile.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

8. The market share for such telecommunications services that are familiar to most people today (1998) will not increase in comparison with the market share of new communications services.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

9. When will standard household appliances (for example Tv, video, microwave oven, etc.) have built-in wireless communication capabilities?

2005 <input type="checkbox"/>	2010 <input type="checkbox"/>	2015 <input type="checkbox"/>	2020 <input type="checkbox"/>	2025+ <input type="checkbox"/>
-------------------------------	-------------------------------	-------------------------------	-------------------------------	--------------------------------

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

10. When will the majority of cars communicate autonomously / independently with their environment? (For example with traffic signs, other cars, road systems etc.)

2005 <input type="checkbox"/>	2010 <input type="checkbox"/>	2015 <input type="checkbox"/>	2020 <input type="checkbox"/>	2025+ <input type="checkbox"/>
-------------------------------	-------------------------------	-------------------------------	-------------------------------	--------------------------------

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

11. In wireless communications an increasing amount of frequency bands will be made available for "unlicensed" operations where several operators/users share the same frequency spectrum.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

12. How will research and development of wireless communication strive to maximize the utilization of the frequency spectrum. By using few, expensive, "smart" base stations or many small, cheap but "dumb" base stations.

Mostly smart base stations	More towards smart base stations	More towards "dumb" base stations	Mostly "dumb" base stations
1. <input type="checkbox"/>	2. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

13. Development of new communications technology will focus mainly on such issues that end users perceive as enhancing the services they receive.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

14. In 2010 terminals [Terminal = mobile phone, lap-top computer, note-pad computer, etc.] are designed specifically for specific service and people in general will have several different terminals for their different needs.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

15. In 2010, service providers will generally provide the end-user with a terminal designed for the service being purchased.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

16. In 2010 communications services are becoming independent of the infrastructure they employ (i.e. Services are available on different wireless interfaces (= NMT, GSM, Satellite) but terminals are predestined for one wireless interface.).

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

17. In 2010, terminals [Terminal = mobile phone, lap-top computer, note-pad computer, etc.] will be able to offer the same services using several different types of infrastructure.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

18. Will terminals [Terminal = mobile phone, lap-top computer, note-pad computer, etc.] be mostly provided by service provider at 2010, or do people buy it in the retailer shops?

Almost only by service-providers/ operators	Mostly by service-providers/ operators	Mostly bought in retail store	Almost only bought in retail store
1. <input type="checkbox"/>	2. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

19. Future standardization (from 1998 and onward ) in telecommunications will be carried out mainly in "de facto procedures". ("De-facto procedure" = a standard is reached through market penetration instead of through negotiation and evaluating procedures.)

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

20. Future standardization in wireless communications will be carried out mainly in "de facto procedures".

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

21. Future standardization in computer technology will be carried out mainly in "de facto procedures".

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

22. In 2010 personal education will be an integrated part of working life, e.g. education and work will be carried out in parallel and will be valued higher than raised salary by most employed.

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

23. Electronic information services will in 2010 be more attractive to customers than other information services?

Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>	5. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

24. Education is obviously increasingly important. Are people motivated for education in 2010 more because of the ability to survive in a competitive society or for other values (such as art, etc.)?

Competitive reasons only	Mostly competitive	Mostly other reasons	Other reasons only
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

25. Do companies in 2010 follow more the "hire and fire" strategy or more "lifetime employment and education of specialists"?

"Hire and fire" only	"Hire and fire" mostly	Mostly lifetime employment	Lifetime employment
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

How do you judge your own expertise in this area?

Never thought about this	Have thought about this	Working daily with this	Have done research on this
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>	4. <input type="checkbox"/>

**Comments**

In a questionnaire as this there are always some important question that should have been asked. Please fill in the question you believe should have been asked.

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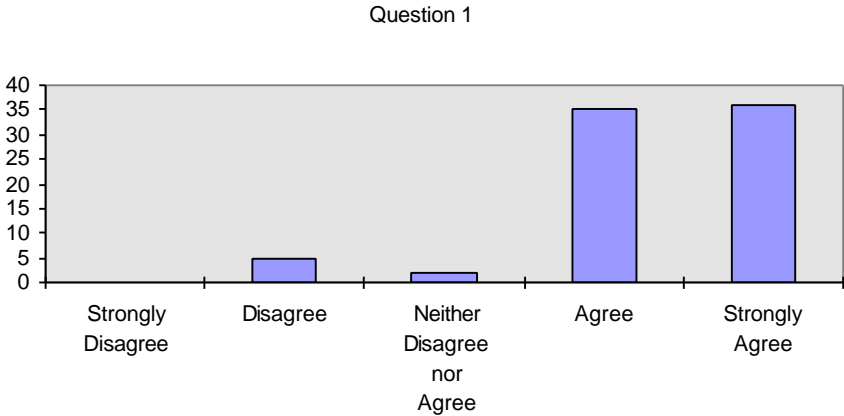
### Appendix C. Survey results

The questionnaire was sent out to approximately 50 people with a professional interest in the area. The panel was chosen by the 4<sup>th</sup> GW group in co-operation with professor Jens Zander. A total of 25 people responded.

The evaluation of the results takes into account the knowledge of the participant by rating their answers from 1 to 5 points, i.e. if a participant claims that he has very good knowledge about the field the question is about, his answer will be given a weight of 5 points. On the other extreme case, if the participant is uncertain of his answer, he will be given a weight of only 1 point.

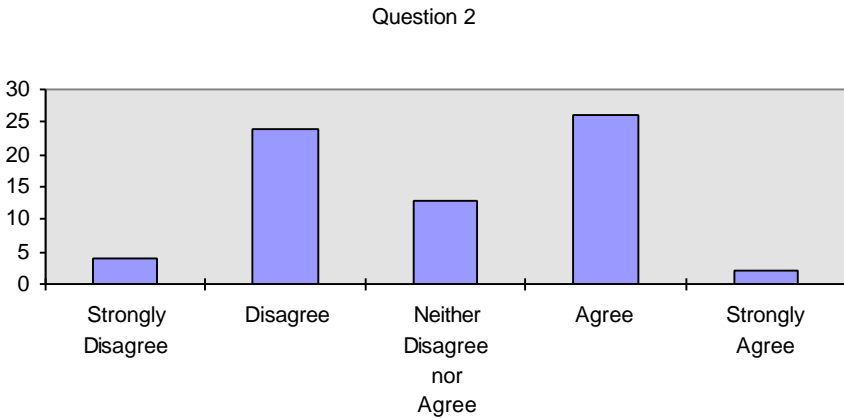
#### Question 1

In 2010 the typical household is capable of purchasing communication services (such as for example internet access provisioning, long distance telephony, etc.) from service providers located anywhere in the world.



#### Question 2

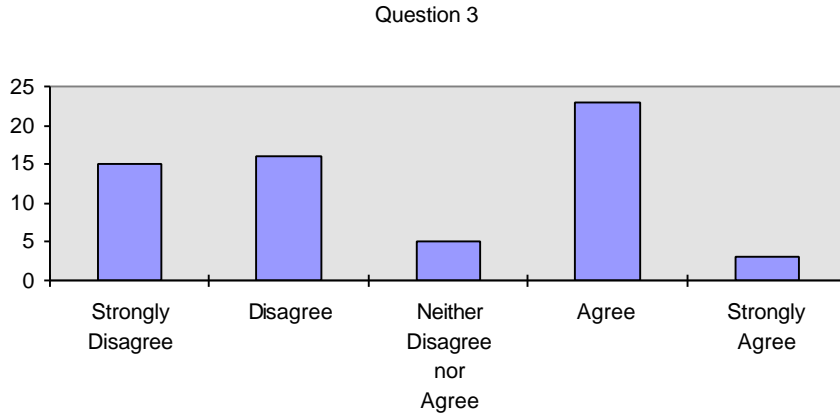
In 2010 end users will purchase communication services (such as for example internet access provisioning, long distance telephony, etc.) primarily from local sources.





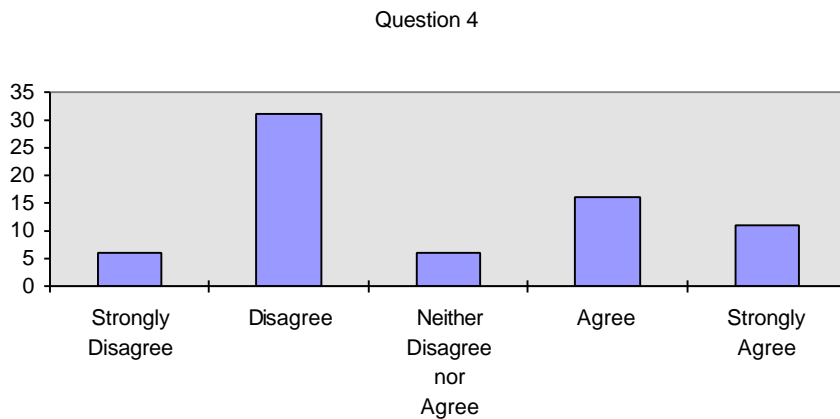
### Question 3

In 2010, we will see very similar demands for communication services from users all over the world, (e.g. the same news and entertainment services are requested in Malaysia and Sweden.) despite of national & cultural differences.



### Question 4

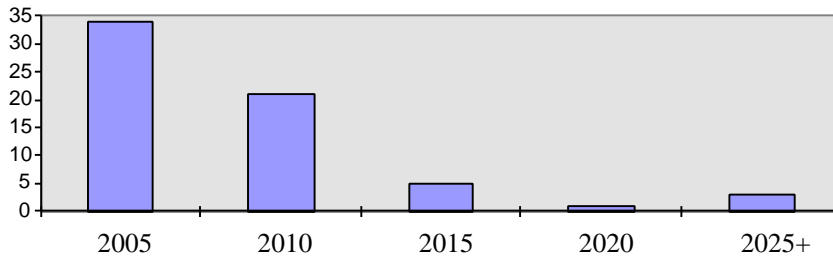
Today the competence in design is said to be a dominant factor in the production of mobile phones. Will the manufacturing competence be the dominant factor in 2010?



### Question 5

Today Swedish national operators dominates the market for communications in Sweden. When will international "WorldComms" have more than 30% of the communications market?

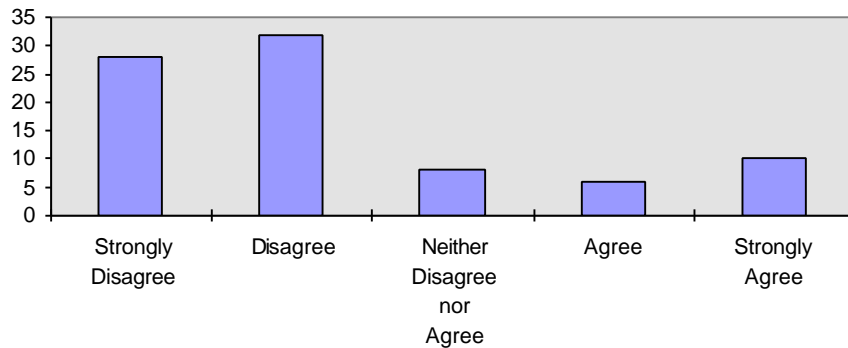
Question 5



### Question 6

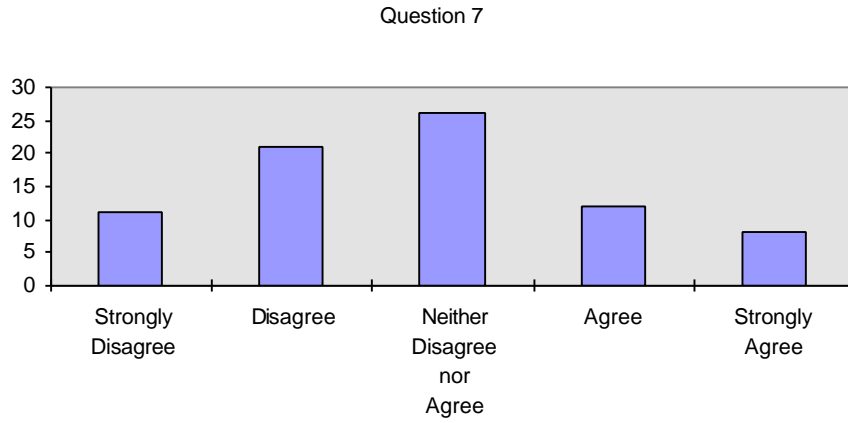
A major part of research and development in communications technology until 2010 will improve the communications systems in a way not directly noticeable to the end user.

Question 6



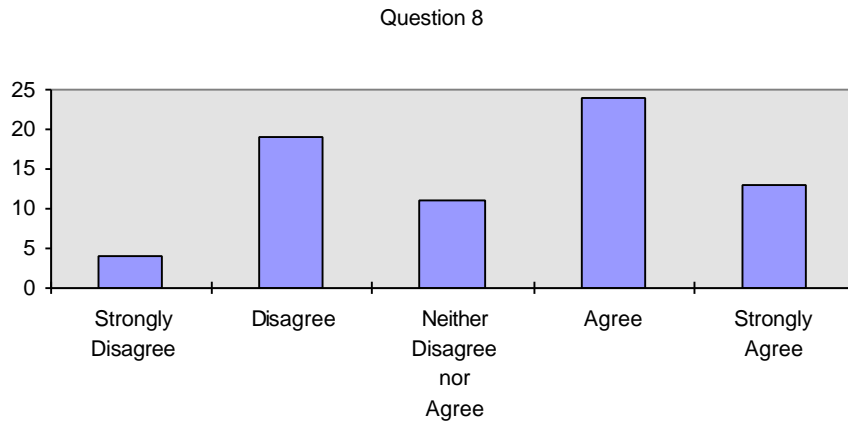
### Question 7

Wireless communications systems will in 2010 normally be designed for applications where the user equipment is portable/stationary rather than mobile.



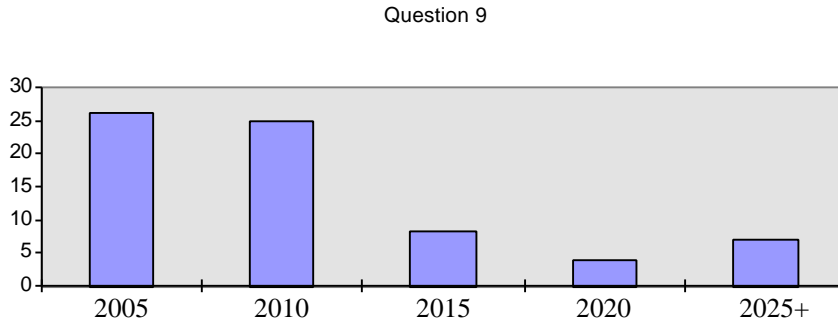
### Question 8

The market share for such telecommunications services that are familiar to most people today will not increase in comparison with the market share of new communications services.



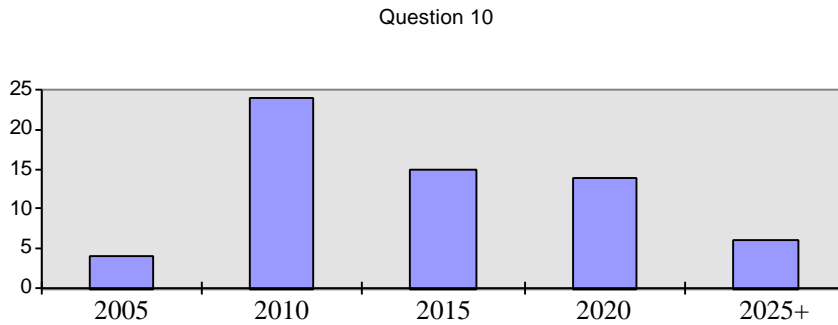
### Question 9

When will standard household appliances (for example Tv, video, microwave oven, etc.) have built-in wireless communication capabilities?



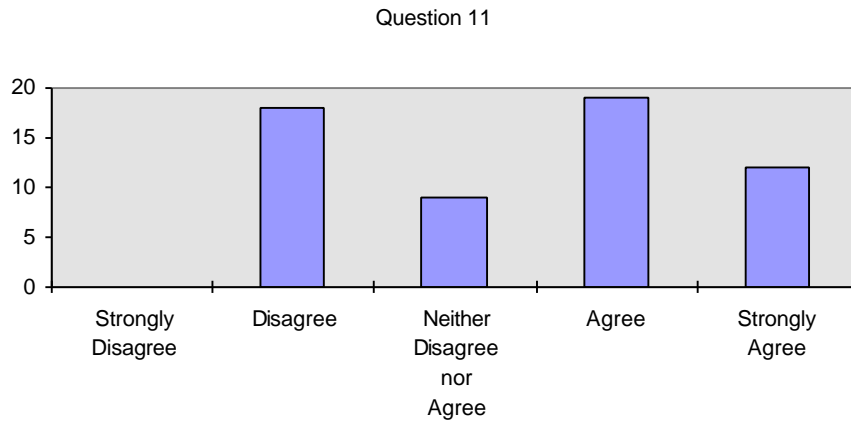
### Question 10

When will the majority of cars communicate autonomously/independent with their environment? (For example with traffic signs, other cars, road systems etc.)



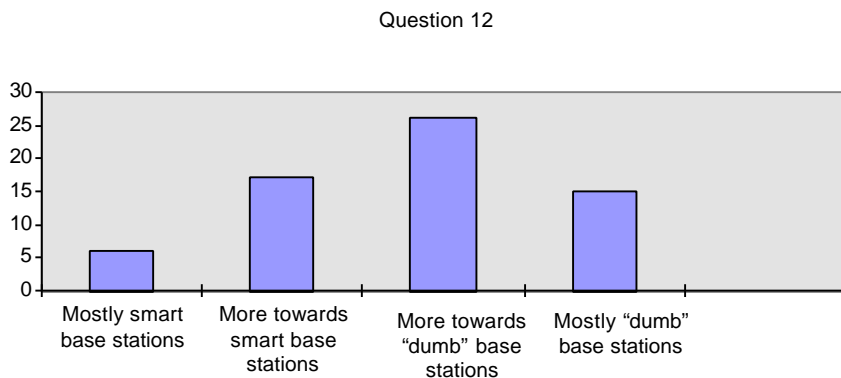
### Question 11

In wireless communications an increasing amount of frequency bands will be made available for "unlicensed" operations where several operators/users share the same frequency spectrum.



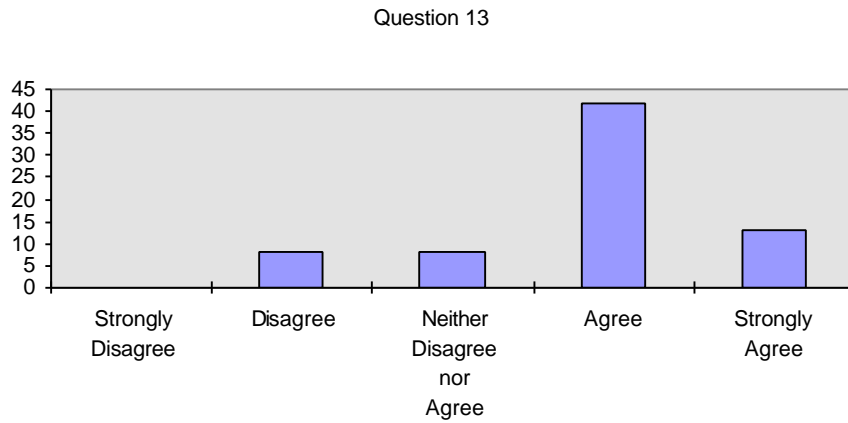
### Question 12

How will research and development of wireless communication strive to maximize the utilization of the frequency spectrum. By using few, expensive, "smart" base stations or many small, cheap but dumb base stations.



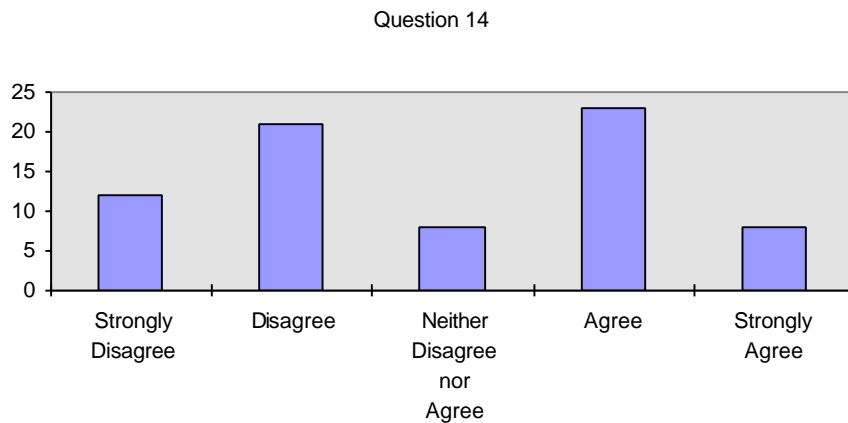
### Question 13

Development of new communications technology will focus mainly on such issues that end users perceive as enhancing the services they receive.



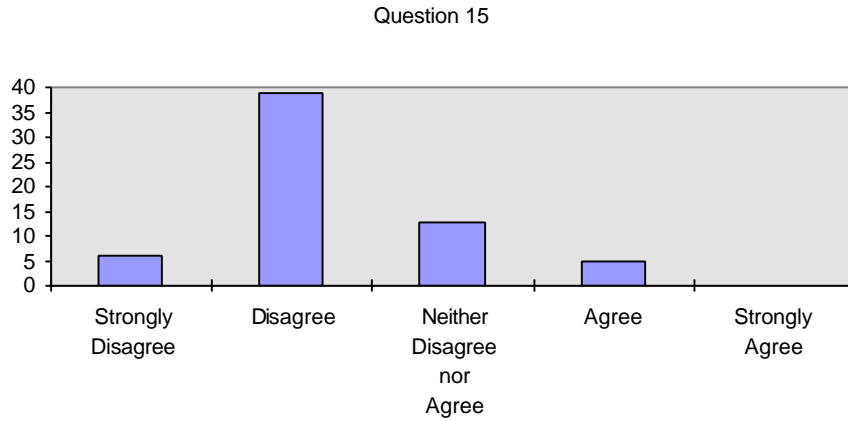
### Question 14

In 2010 terminals [Terminal=mobile phone, lap-top computer, note-pad computer, etc.] are designed specifically for specific service and people in general will have several different terminals for their different needs.



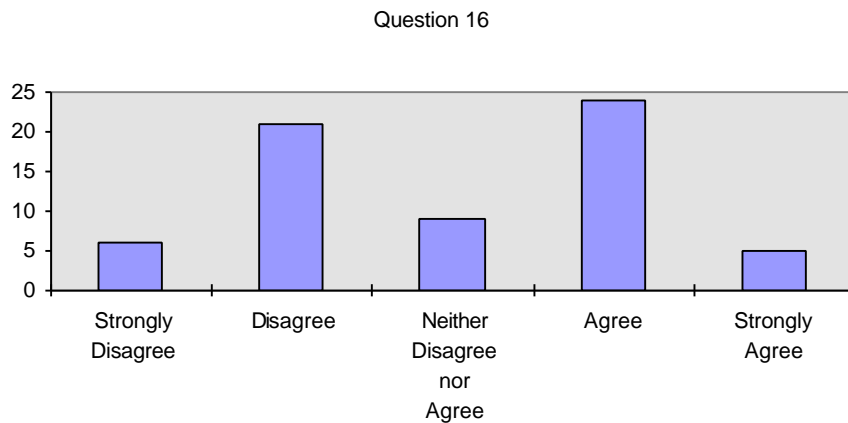
### Question 15

In 2010, service providers will generally provide the end-user with a terminal designed for the service being purchased.



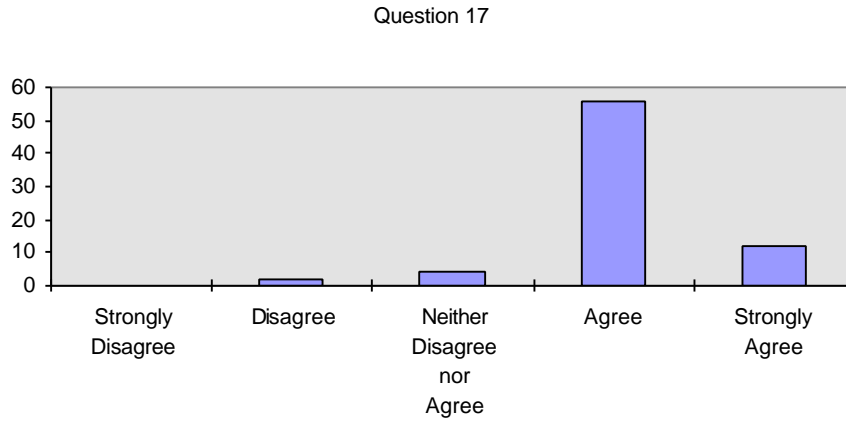
### Question 16

In 2010 communications services are becoming independent of the infrastructure they employ (i.e. Services are available on different wireless interfaces (=NMT, GSM, Satellite) but terminals are predestined for one wireless interface.)



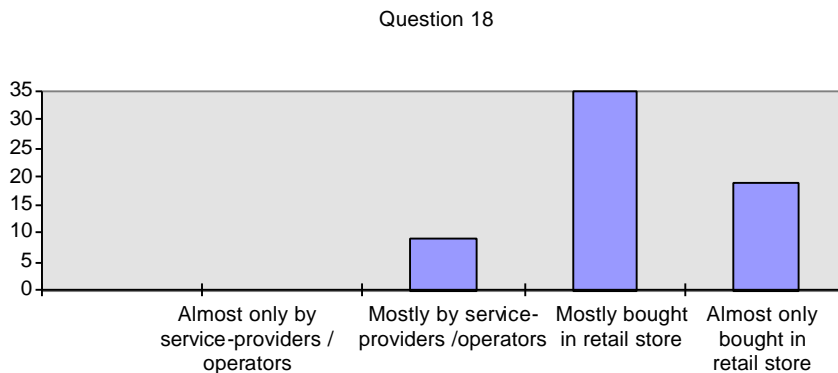
### Question 17

In 2010, terminals [Terminal=mobile phone, lap-top computer, note-pad computer, etc.] will be able to offer the same services using several different types of infrastructure.



### Question 18

Will terminals [Terminal=mobile phone, lap-top computer, note-pad computer, etc.] be

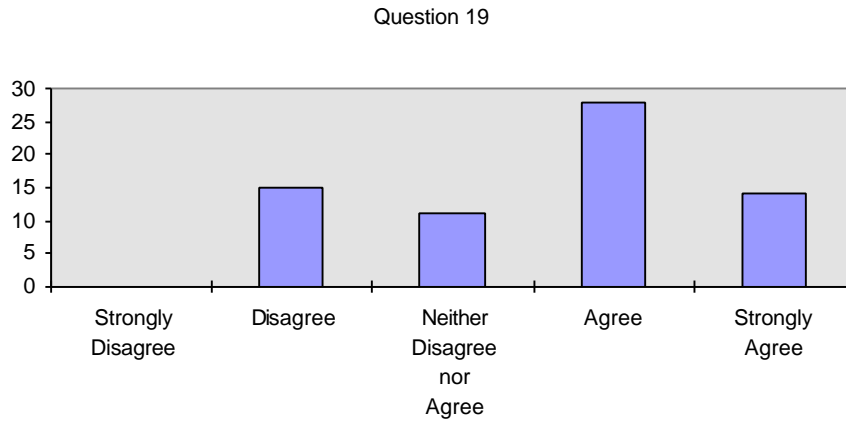


mostly provided by service provider at 2010, or do people buy it in the retailer shops?



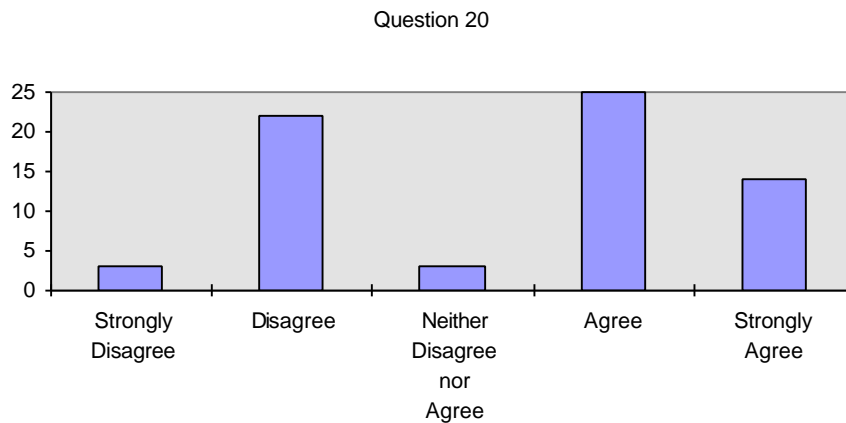
### Question 19

Future standardization (from 1998 and onward) in telecommunications will be carried out mainly in "de facto procedures". ("De-facto procedure" = a standard is reached through market penetration instead of through negotiation and evaluating procedures.)



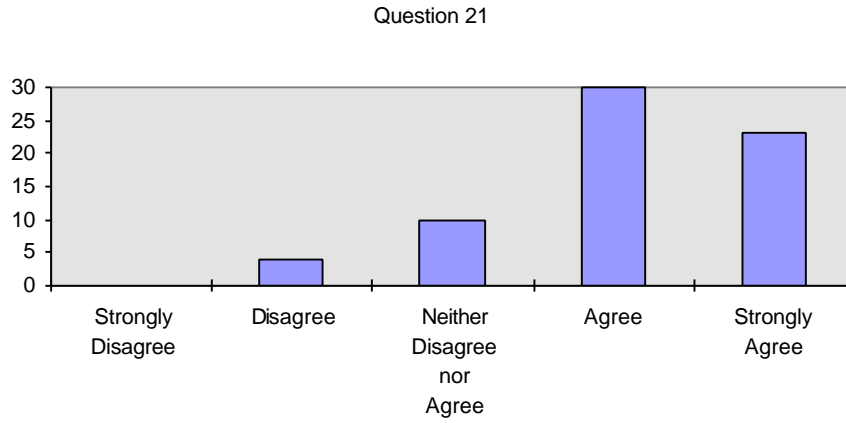
### Question 20

Future standardization in wireless communications will be carried out mainly in "de-facto procedures".



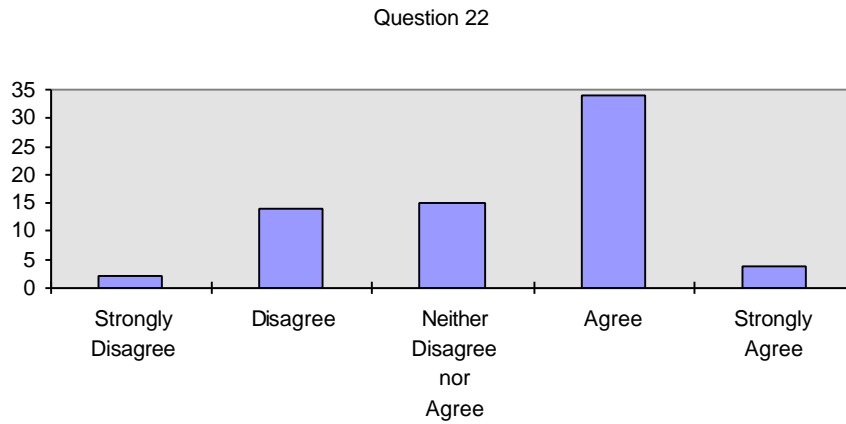
### Question 21

Future standardization in computer technology will be carried out mainly in "de-facto procedures".



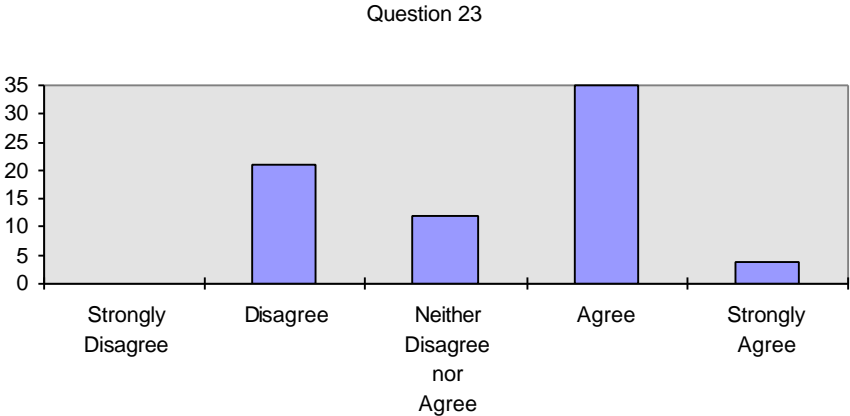
### Question 22

In 2010 personal education will be an integrated part of working life, e.g. education and work will be carried out in parallel and will be valued higher than raised salary by most employed.



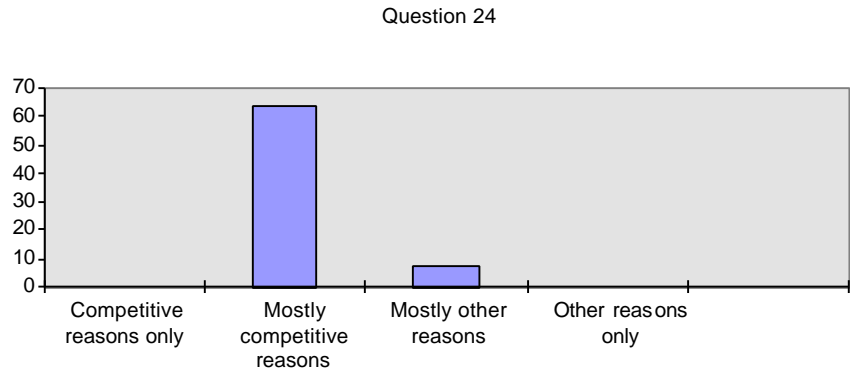
Question 23

In 2010, typical consumers/households will mainly derive information from electronic information services, i.e. printed information will play a diminishing role.



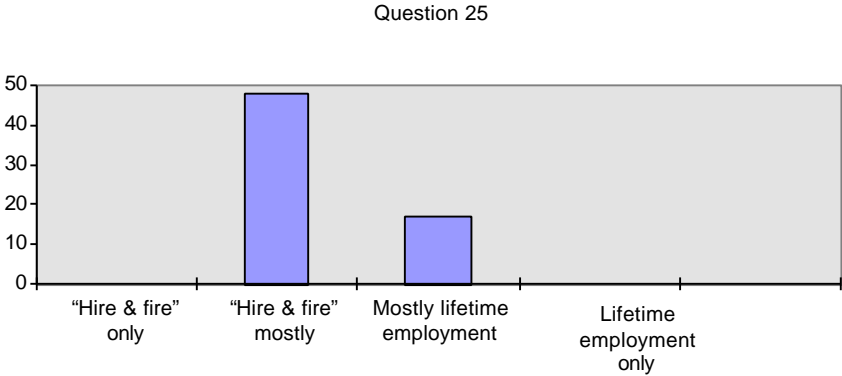
Question 24

Education is obviously increasingly important. Are people motivated for education in 2010 more because of the ability to survive in a competitive society or for other values (such as art, etc.)?



Question 25

Do companies in 2010 follow more the "hire and fire" strategy or more "lifetime employment and education of specialists"?



## Appendix D. Megatrends

This document is a summary of the identification of the trends presented earlier. The effort is concentrated on several selected MegaTrends that we identified to be the most important within the next 10 years period.

Each trend will be described using a number of attributes:

- What? A short description of the driving force.
- Why? Reasons for changes or movement in the driving force.
- Enablers. Factors that strengthen this driving force.
- Inhibitors. Factors that weaken this driving force.
- Paradigms. Changes in ways of thinking about the world due to the driving force.  
Predictability. Degree to which development can be foreseen for this driving force.  
Influence. Ways for companies to affect the driving force.
- Experts. Sources for additional information about this driving force.
- Timing. Dates for key milestones in the development of the driving force.

Globalisation of products, services and companies.

### What?

- Companies will be more global
- Top Management is centralized
- Management layers become more global
- Products are marketed world-wide with adaptation to local markets
- Marketing services and local behavior studies in every country
- Products are produced at several places in the world
- The same brand name is used world-wide
- Large corporations tend to increase their research efforts
- Development is centralized to a few research centers

### Why?

The need to increase efficiency continuously to be competitive forces companies to press more on the economy of scale.

Necessary to find competent personnel. One location cannot support a large research organisation. Knowledge management becomes more efficient.

Number of competence centres appear world-wide, i.e. Silicon Valley, Route 128, Research Triangle Park, Ideon, Mjärdevi Science Park. This creates a creative environment where firms and people learn from each other.

By marketing products globally, economies of scale can be achieved. Products require more and more research and development. Also in order to achieve economies of scale the same

product is manufactured (long production runs) and adapted to local demands. Media is becoming more and more global and thus advertisements reach global audiences. This makes it convenient to use the same brand name all over the world.

R&D activities has to be concentrated to perform efficient research and product development. The main research topics are the same for all countries and can be done at only one place where the company has his R&D centre. This location is a secure and stable area where the knowledge and level of education is high. The R&D centres have to perform local research for each local market to achieve local adaptation.

Production is close to the customer in order to achieve short transportation, fast customer response and to get through trade barriers. Production is done where labour is cheap. But this can lower the quality level required by 'educated' countries.

### **Enablers**

- World-wide (and affordable) travel, i.e. people expect to have certain products available everywhere
- World inter connectivity, allowing information to propagate through an organisation although it is not geographically concentrated
- World trade
- Globalization of culture
- Powerful global companies and their political influence
- Spread of company branches according to the optimum conditions (e.g. for production, taxation, identity), i.e. different conditions in different geographical regions
- International financial markets and money flow
- Possibility to adapt products to local conditions (color, shape, language)
- Increasing research efforts in large corporations, i.e. R&D budgets increasing fraction of product budget.
- The ratio between the development cost and manufacturing / transportation costs shifts towards development.
- Political and economical stability

### **Inhibitors**

- Local identity and market (to maintain a specific local taste of a region)
- Problems in communicating research results and experiences in a geographically distributed organisation.
- Larger research projects, requiring large concentration of personnel at one location.
- Trade barriers
- Some products are demanded only in a limited region.
- Political and economical instabilities
- Education differences, between countries

### **Paradigms**

- Global corporations.
- Global communication and traffic networks.
- Global stock and financial market.
- USA and (the yet to come) EU.
- Efficient project management is dependent of geographical proximity, distributed organisations are difficult to manage...

- Design once adapt anywhere.
- Produce where it is cheapest.

### **Predictability**

The trend is natural. The globalisation of their products is a final goal for a mega-corporation. the world market is the potential limit for their geographical expansion. But this will happen if there is a better international trade and long run stability.

### **Influence**

We will be buying the same brands all over the world. The product is designed centrally but it is adapted, manufactured and sold locally.

Firms tend to locate research centres close to important markets and creative environments.

### **Experts**

Daily newspapers

Gunnar Eliasson, et al... Handelshögskolan, Ekonomisk geografi, Uppsala Universitet.

### **Communicating appliances**

#### **What?**

An increasing number of consumer devices will be "communications enabled". This creates a number of new applications that automate processes at home or elsewhere.

#### **Why?**

People generally do not want to do spend time on repetitive tasks. They want to focus more on creative activities (or no activity at all). By communicating, machines will become easier to handle and we will have to spend less time taking care of them. i.e. there is a need for process automation.

New seamless I/O devices will be released to interact with the machine without cable nor the interaction of human; always smaller and faster e.g. Voice, writing, eyes and body movement, etc. Possibly a "universal controller" will control all appliances.

This trend is driven by decreasing costs of communication devices. Cheaper communication devices make new applications possible. Since these applications are more and more demanding, communication devices are produced in sufficient such that it further decreases the cost of the devices and its related development.

### **Enablers**

- Smart (more intelligent, but also complex) technology.
- Cheap communication systems/devices (and microprocessors).
- Universal standards for inter machine communication.
- Product developments in other areas that creates a need for wireless communications for monitoring, control, etc. of products. Successful examples will create a need.
- A communication protocol that has a large enough address space to accommodate all devices.

- Simple installation and configuration of devices. So simple that communication is taken for granted.

### **Inhibitors**

- Limited demand increases production cost
- Bad influence on health from electronic devices
- Cost of infrastructure installation

### **Paradigms**

- Communication devices as natural as microprocessors are today
- One-chip communication systems

### **Influence**

We may expect that technology handles more for us automatically.

Develop applications in co-operation with firms from other industries to show what is possible.

Services become more independent of infrastructure.

### **What?**

- Infrastructure and services are more and more separated into two different layers.
- The infrastructure is becoming more intelligent to accommodate various terminals. Terminals will be able to use many different infrastructures.

### **Why?**

There are many services that users find useful. The user's focus tend to move from the actual terminal he is using towards the service that the operator is offering. Users want to use a service independent of which terminal that they use.

People don't care about how the service is done. This is already the case for the fixed phone: people complain when they cannot call Kathmandu but they don't care about the enormous amount of infrastructure parameters which make it work or not.

Equipment manufacturers put more and more features into their product in order to be competitive.

The terminal is getting so complex that the user cannot both handle the terminal and the application.

### **Enablers**

- Increasing capabilities of the terminal gives the terminal possibility to handle more services and to adapt to various infrastructures
- Standardised interfaces between service entities and infrastructures
- Operators strive to supply complete service. Operators expanding their market segment Established standards, so that applications can be adapted to different communications environments
- Open systems



## **Inhibitors**

- Too many standards make inter working between services, infrastructures and terminals too complex
- Increasing complexity increases cost. This cost may be too high compared to the customer perceived value
- Hardware suppliers strive to keep their market segment
- Different capabilities in different infrastructures, e.g. bandwidth
- Habits of old generation. People will not utilize new services from new terminals
- Proprietary systems

## **Paradigms**

Buy the service (including the terminal), not a computer/telephone.

The underlying technology is not important anymore, the information/communication and the quality of this services counts.

Multi-mode terminals and infrastructures. Software-radio technology.

## **Predictability**

This trend is ongoing and growing. For example facsimile, e-mail, telephony is already available from many infrastructures using different terminals.

## **Influence on society**

Being able to access many services from the same terminal makes peoples life easier and more comfortable. As the offer creates the demand, this may change users behaviour.

Hardware companies have to adopt to the ruling (de-facto) standards.

## **Experts**

Operators future plans. Already examples within mobile communication.

Information Trading (Information Overflow).

## **What?**

The value of refined information will increase and it will be an issue of trading due to the enormous increase in available data representing information that are refine to some limited extent.

Info brokers will offer specific packages of information. In the extreme case, the brokers will provide end user equipment with the service.

The information that a company or a person buys or sells will be tailored for the needs and interests.

Companies and individuals pays for tailored information according to their specific need.

## **Why?**

With the possibility to publish information on the web the amount of published information has increased much faster than before (e.g. Web pages). This has also increased the amount of data representing raw or bad quality (even wrong) information published, that would not have

been published in traditional media. This leads to information overflow and, at a certain point, creates major problem finding refined information as many suppliers claim to have it.

There is an increasing demand for customer information for focused marketing

### **Enablers**

- Global access to information.
- Global data networks.
- Technology development, Data storage, Data communication
- More detailed customer lists.
- Large parts of the population have access to data networks.
- Efficient copyright laws and enforcement methods.

### **Inhibitors**

- Personal and national integrity aspects.
- Regulation

### **Paradigms**

Don't give away information for free/at all.

### **Predictability**

The phenomenon is already present, and may expand further, e.g. it's already possible to get selected parts of the newspaper via Internet

### **Influence**

General companies can adopt to this by collecting info about their customers. Personal Marketing

### **Experts**

Source: HBR Compare to Ericsson and Siemens scenarios.

Education increasingly important.

### **What?**

As society evolves, we move now into an information era. Education becomes increasingly important for the individual in order to be competitive.

Educated people will be highly requested both in technology research and manufacturing, as well as information packaging.

Company's assets will be softer and educated people is a key success factor.

The generation of wealth depends more and more on know-how.

Intellect and high education is the key qualification and key to success in educated world. But it is not the easiest way to achieve success.

Broad Education becomes more and more difficult to find while narrow education will be more and more common. This is not a good long term solution as it decrease the potential

understanding and collaboration of people which are not from the same working (or research) areas.

The "survival knowledge" level increases, i.e. the amount of knowledge required to survive and participate in the society increases.

### **Why?**

Individuals want to be wealthy, Knowledge results in wealth, Education increases knowledge.

One of the driving forces in the human nature is greed. People want money for their own sake or for what they represent.

Money gives power, makes it possible to lead a comfortable life without having to worry about how to get food for the day, buy time that can be used for recreation (buy housecleaning) or buying things.

Education can give a more rewarding and intellectually challenging job.

Knowledge base of mankind is growing steadily and effort to manage and improve this knowledge base (find and access information) increases.

More and more complex products with longer development time requires more people with lots of knowledge. In addition more complex products are more difficult to use/support and that requires more knowledge.

Development is faster than the supply of knowledgeable individuals. This will make it possible for individuals to demand higher salaries.

Technology is getting much more complex and demand more educated personnel.

### **Enablers**

- Social help for education
- Local political stability
- Increasing complexity of life (technology, economy,...)
- Increasing size of networks (markets, communication, travel, trade, ...)
- Increasing complexity of products
- University research activities involved in commercial R&D activities

### **Inhibitors**

- Companies does not reward education
- Political islands (denying progress in science and technology)
- Companies treating employees as "work robots"
- Difficulties in managing the increasing creativity
- Evolution of machine intelligence that reduces the need for thinking
- Decrease of the research activities due to major financial instabilities.
- Show business world.

### **Paradigms**

The World may be divided in educated and not educated. Today's educated people may become independent consultants offering their know-how to their old company. Internet, increasing importance of IT and opening the door to knowledge. Countries with high education level are wealthier.

## **Predictability**

The trend is there, but when it will peak is difficult to predict - if there is any maximum. Will the third world catch up and get into the education market? How long will it take? The trends will come with relative long delay in developing countries.

## **Influence**

High Influence on society. This will change the way that people perceive education and also how the knowledge asset is controlled. Increasing revenues and salaries for know-how and experience. Motivation for continuous learning and education of employees

## **Timing**

Already ongoing trend, but difficult to predict the angle of the slope or even to quantify knowledge.

Global knowledge and education is a very long term trend. One or two generations are needed to change a civilisation level of education.

This trend is not at the same state in every part of the world, e.g. it is not valid in violent countries but could become a very long term trend.

Globalisation of cultures.

## **What?**

Different cultures around the world have always influenced each other. The booming of information makes this trend even bigger.

Sometimes mixing of cultures results in conflicts.

## **Why?**

Increasing global communication and global trade also results in a mixing of cultures around the world.

## **Enablers**

- Fast development of information technology
- Fast deploying of the world-wide information networks
- The globalizing economy
- International traveling
- People are eager to know other cultures
- Common language

## **Inhibitors**

- Strong boundaries among the different cultures
- Government control over information flow
- Too rapid mixing of cultures can make governments try to reduce influence of a new culture

## **Paradigms**

Hollywood films, Coca-Cola, English...

## Timing

Need at least one generation to make changes.

## Standardisation diversification

### What?

Standards are created by companies and co-ordinated by international standardization organizations with the aim to manage, control and influence the pace of technological development (post-harmonisation).

Three separate areas need to be considered when talking about standardization with regards to communication and

technology:

Standardization is essential for the success and even survival of a system

- Global markets requiring inter operability
- Standards are derived by co-operation of competitors and co-ordinated by official institutions (GSM: Ericsson, Nokia, Siemens, ETSI)

Standards for limited application or geographical area

- Regional limited markets
- Driven by governments / lobby organizations
- De-regulation of telecommunication - governments try to re-gain or maintain some level of control by establishing offices "for equal competition and convenient liberalization"

De-facto standards

- Technology evolves faster than legislation (politics)
- Completely open and competitive markets - parts of the market are dominated by one big company (Microsoft)
- Markets are too small (niches) or have no public impact - agreements between different parties (specific gateways, customer ICs)

### Why?

Standardisation is becoming a more and more political issue and is therefore complex and slow. Open licensing policies become increasingly important to establish de-facto standards and conquer markets. Companies have to co-ordinate their development due to increasing development costs. This forces even competitors to take place on the round-table. The compatibility issue (and connected to this: standardisation) is carefully evaluated upon launching a product, since it defines the positioning in an existing or opening of a new market

### Enablers

- Fast prototyping / production (e.g. for software)
- Big, powerful companies, dominating complete market segments
- Joint research projects
- Global market
- High technology development pace.

### Inhibitors

- Lots of small companies, none dominates the market

- Too many de-facto standards or different products (none winning) and increasing incompatibility
- Global unified research without research competition
- Local market with their own standards

### **Paradigms**

Microsoft, Cisco, Intel, Nestle, Coca-Cola, McDonalds, Sony, Kirch

### **Predictability**

Global markets requiring inter operability. Regional limited markets heavily depends on how much industry and politics are connected De-facto standards

Difficult to estimate how the current trend continues

### **Influence**

Co-operation and agreements within one market Great influence on the telecommunication market and wireless systems.

Governments may loose some of their power to companies. Standards are created by companies instead of by standard organisations.

### **Experts**

ITU, ETSI,

## Appendix E. Additional Research

### Technology

#### **Wired infrastructure**

Telephone lines are the most widespread infrastructure for communication. It consists of fibre optics and the wires. Fibre optics is mainly used for the backbone, while wires are for the local loop. The challenges are to lay the fibre optics as close as possible to the users, and to digitise the local wired line in a most efficient way.

Cable TV is considered a broadcast medium. It has got high penetration rate to the households. Lack of capacity may happen when the number of users that are sharing the same cable get large.

Power lines are powerful in the sense of penetration rate, but yet not tamed enough to be used for communication. Household appliances are the candidates for the initial market.

#### **Wireless infrastructure:**

Satellite is the backbone infrastructure to reduce the backbone cost. It can as well cover the places where it is impossible to be connected by wires (Ocean, desert). The main problem seems to be the latency due to the fact that the round trip distance is fairly long even for the LEOs.

Cellular is a good alternative for the wired local loop, the challenges are described in detail below

#### **Switching technology**

- From Voice to Data: From Circuit switched to Packet switched
- Wireless communication using Packet switched communication.

Traditionally, wireless communication systems were designed with circuit switch technology, which was tailored for the voice traffic. While with the development of the computer communication, it is highly desirable to support the new packet traffic pattern in the wireless communication systems. So instead of offering pure circuit switch, wireless communication systems should also offer the packet switch capability, it is very important for wireless communication systems' future. Particularly, it is widely agreed that "multimedia services in the same network" can be fulfilled more efficiently by packet switch networking technology.

The leading companies in wireless communication arena have already made efforts to adjust themselves to deploy the packet switch technology. Nokia has acquired a company -- IPsilon, which has been very successful with the packet switch technology "IP Switch". And one of the latest press releases by Ericsson announced their intention to target IP - based services (not only in wireless).

Satellite communication is another example. The most ambitious project in this area is Teledesic, which aims to offer the packet switch infrastructure in the sky.

In order to support packet switch, a large portion of the systems should be modified or changed, it is not a minor task. To make a smooth handover, the coexistence of both packet switch and circuit switch will be a good choice. They share the bandwidth and share the topology.

## **Frequency efficiency**

- Bandwidth is precious
- Use High frequency band despite technological challenges
- Efficient Frequency reuse
- Importance of Source coding
- Multicast

Bandwidth is certainly one of the most precious communication resources in the world. How to use the bandwidth as efficiently as possible is a huge task in wireless communication. One approach is to use the higher frequency span, now about 60GHz. It is attractive but with quite a few technical difficulties.

Another way is to reuse the bandwidth geographically as many times as possible, which lead to the micro cell and picocell concept. But when the cell size is reduced, the processing among the cells becomes another burden to the wired part. A method of reusing bandwidth without decreasing the cell size is to use adaptive array antennas and Space Division multiple Access (SDMA).

Coding is a way to achieve frequency efficiency by compressing the original input to occupy minimum bandwidth. Combination of different multiplexing technology is a good idea as well.

A quite different solution, "multicast" is based on the observation that "group communication will become very popular in the future". Instead of trying to accommodate more information into the fixed bandwidth, "multicast" is going to eliminate the unnecessary usage of the bandwidth from the network layer and link layer.

## **Inter-System Communication**

Integrate every existing wireless communication systems

Different communication systems have different properties, and it is highly desirable to integrated all the systems. Satellite system, Cellular system, Cordless system, Wireless LAN are successful in their own arena, but different standards and different technology specifications makes it a difficult task to smoothly integrate all these systems.

Another problem rises when the fixed network and wireless network merges, especially in packet based network. For the high layer of the protocol stack, i.e. TCP, due to the large difference of the channel characteristics, what has been very successful technology in the fixed network was found very inefficient in the wireless area. In such a overlapped wireless structure, how to exploit the technology in the most intelligent way is still an unsolved problem

## **Mobile terminals**

- Smaller terminals reach goal in size
- Body area network
- Power supply is still a problem. temporary solutions.
- Flexibility with Platform independent programming

We are quite confident with the IC technology, it makes the chip smaller and smaller. Consequently, the mobile terminals have reached its ultimate goal in size, "because the distance between the ear and month of human beings has not shorten so much as the size of the mobile terminals", wearable devices are emerging now to build up a "body area network". On the contrary, the power supply and display technology have not developed as fast as the IC



technology. How to make long life battery will be a extreme hot point. A alternative (temporary) solution for power supply problem might be that to build a infrastructure of power supply for the terminals, e.g. battery recharge slot anywhere, or shops are available everywhere for changing the exhausted batteries. As for the display, limited by the size of the mobile terminals, high resolution and smart browse technology are needed.

The traditional terminals are dedicated to voice. But the difference between a powerful personal computer and mobile terminal is getting less. The terminals will become more powerful and with more fantastic functions (it is not necessary to turn a mobile terminal to a PC, although it is technically possible). Trans-platform programming language like JAVA will make the mobile terminals more flexible, software control will play a important role the terminals.

### **Operating Systems and Application Software**

- Operating system optimized for better bandwidth usage

Operating systems for wireless communication systems should be particularly designed for the efficient usage of the precious frequency resource. Real time operating system in the base stations in cellular system is crucial. When the mobile terminals get more and more complex, it might be true that a dedicate operating system is desirable. Good application software will change the mobile terminals from the voice only device to a versatile gadget. Maybe it is reasonable to regard mobile terminals as a bare device with different software modules available from somewhere else, e.g. by downloading from the network's servers.

### **Global Actors**

In the study, "Global Actors in 2010", the purpose is primarily to find what actors are in the business today and as well which actors might be in the business in the future. Secondly, the purpose to find out information on their strategic work. What do they believe in about the future?

By actor or firm should be understood both traditional telecommunication firms like Ericsson and Nokia, but also information packaging and producing firms like CNN and BBC. Other firms related to this area might be computer firms and game producing firms like IBM and Nintendo. Other actors can be regulating bodies and governments.

The strategic work that we are looking for is the published work like the Ericsson scenarios or Siemens scenarios or similar published products. Other interesting things can be statements made in the yearly report or information on special investments made like Ericsson cyberlabs in New York and Japan.

## Global Player (now)

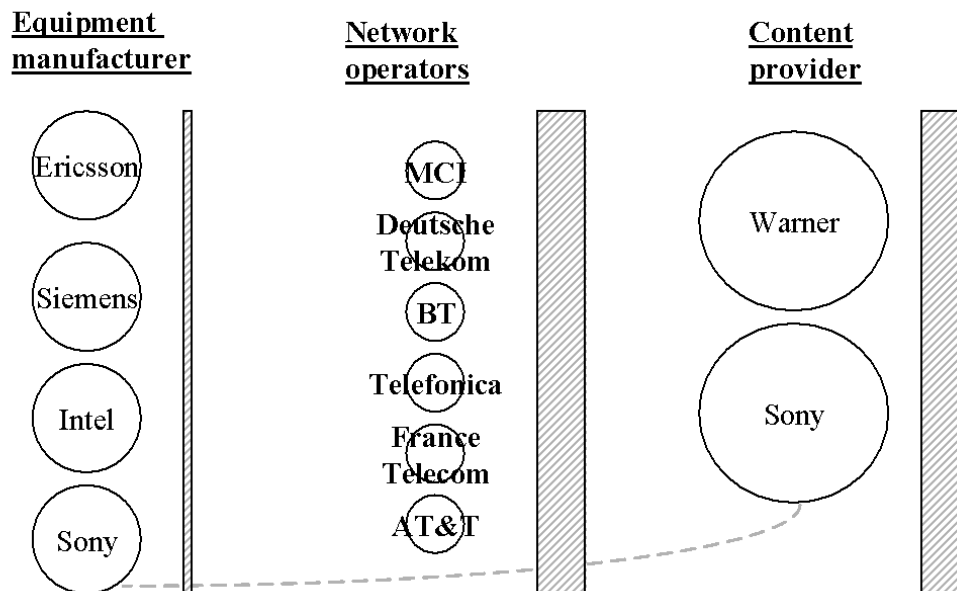


Figure 1, Current situation among global actors.

### Operators:

- Companies with major local influence have international ties and large turnover (German Telekom: 37 Bill. \$, MCI: 20 Bill. \$)
- Fully/partly controlled by government and well established lobbying
- They own strategic important resources (networks)
- New network operators, with or without their own networks, are coming up.
- Major local companies ally to acquire global influence.

### Three major alliances:

- Global One: German Telekom, France Telecom, Sprint (USA)
- Concert: BT, MCI (USA - now with WorldCom), Telefonica Spain, Telefonica Portugal
- Uni Source: AT&T, Swiss PTT, Telia, Netherlands Telecom

WorldCom controls approx. 60% of the Internet lines

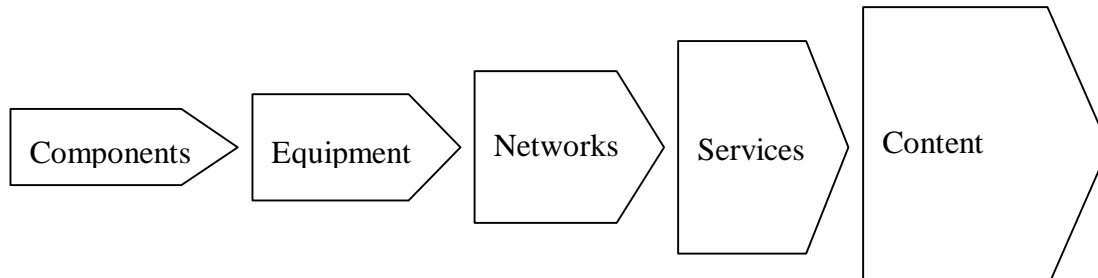
### Equipment manufacturers:

- Big international companies in main markets, Small companies survive in niche markets
- Hard competition and small margins
- Decreasing number of component manufacturers

### Media business & content provider:

- Big national companies in TV, Radio
- Big international companies in news, entertainment
- Local companies connected to major actor

This situation may be described as value chain, where the value grows from components to service and content.

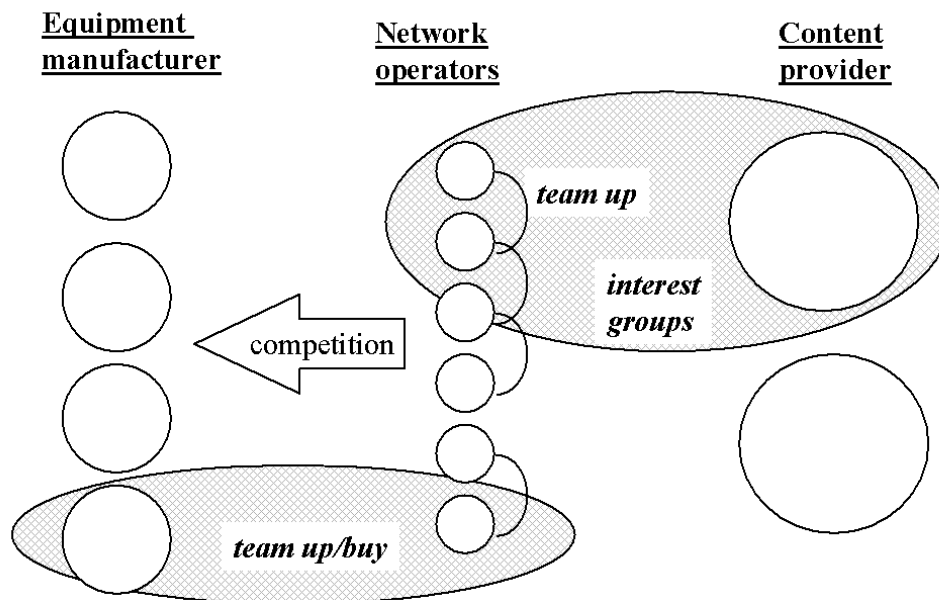


**Figure 2, Value chain of telecommunications technology.**

In this chain the value is increasing in every step and the margins are following the value. These thoughts are presented in Ericsson Annual Report 1997

**Identified Trends**

# Global Player (merging trend)



**Figure 3, Merging trend among actors.**

- Companies are expanding up the value chain to cover new market segments that offer higher margins

- Companies are expanding in the current field to increase their market shares.

## Global Player (moving trend)

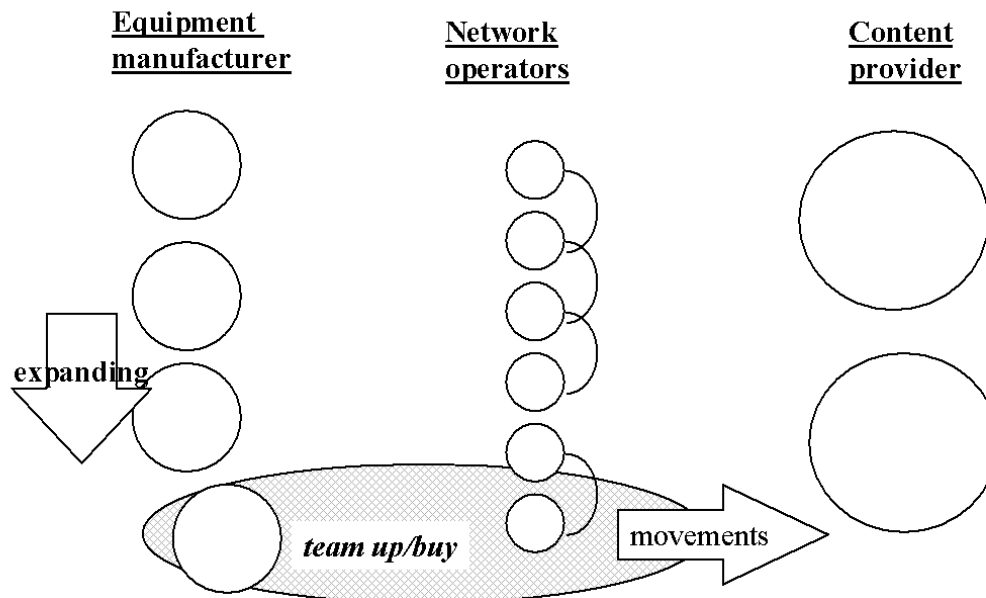


Figure 4, Movements in the value chain.

- Companies are retaining their size, but they are moving their products up the value chain. This may be happening due to their product automatically is developing towards a new field or that the other actors are threatening the current field.

### New markets

#### Geographical

There are still a lot of areas and countries where modern information technology hasn't got its breakthrough or is in a very early stadium of development. One example is China, that currently is opening their equipment market, but the market of information is still closed. Major media actors are waiting for this market to open up.

#### Technical

Following the technical development a lot of new market segments are created. These segments may be covered by current actors, but also by new companies.

#### Strategic views:

##### Overview

Most companies want to be the BIG in their market, otherwise they team up with partners to become part of the BIG, e.g. Ericsson. Telecommunication and Media (network operator plus

equipment manufacturer plus content provider) are merging. Companies in both fields want to expand on each other.

## **Components, Equipment and Systems**

### **Ericsson**

Markets for telecommunications and data communications are merging. The dominant trend is the convergence of three industries: telecommunications, data and media. Ericsson plans to supply the new Infocom industry with an entire solution for systems, products and services. They see new business opportunities in such areas as network design and the operation of telecommunications networks and administrative support systems. As more and more intelligence and "functionality" is being built into silicon chips, the companies that produce them will be able to offer more or less complete products. It will be possible, for example, to build a mobile telephone consisting of only one, or very few, microchips. Thus, there is a risk of losing business slice by slice in the lower level of the telecommunication suppliers segment.

### **Nokia**

Nokia plans to develop intelligent applications for fixed and wireless network infrastructures.

They believe that telecommunications, information technology and, media applications will increasingly merge in the future. More differentiation from the competition is required in these new markets.

An illustrative example of this is the semi-conductor industry. Although Nokia itself does not manufacture semi-conductors, it searches for future solutions together with the manufacturers. Research and development projects are carried out in collaboration with their business partners.

### **Motorola**

Motorola have focused on covering the equipment field and has covered all fields from components to systems. They focus on expanding into new geographical markets such as Asia and Latin America while US and European market will advance more slowly. Motorola also has activities in a number of fast-growing markets for electronic equipment. They expect that the demand for communication equipment will continue to be stimulated by: new technologies, new radio frequency spectrum licensed by governments around the world and increase in the number of service providers

## **Service/Network Operation**

### **Telia**

Telia focus their services on highly potential fields like information search, education, electronic trading, marketing and entertainment. They will help their clients to structure and package the information in the services using their network and system.

Telia will develop towards a new information media company, increasing transfer rates for movies and sound. However they do not want to take over the position of the current media actors.

Telia's goal is to provide wide range of services including networks, services, software and hardware. This will be possible by working together with partners. They are teaming up for the future within the UniSource group.

## **Media**

Media players have already started their expansion, by the means of using communications to distribute their products.

### **Sony**

Sony has come far in adopting its structure to the new convergence of the different areas. They started with in electronics and have now expanded to all kinds of media. Now they have activities in almost all fields from components and terminals, via networks to media, such as music and movie production. The only major area that they do not cover is network operator services.

### **News Corporation (Sky, Fox)**

News Corporation's main products are within global media and entertainment. They are now expanding into the area of distribution and current areas of focus include direct broadcast satellite television, terrestrial broadcast television and online/Internet activities.

Newscorp has expanded from information supply to broadcasting communication, Internet service and online games.

## **Surrounding business with potential impact on Telecom**

### **The banking sector**

- Concentration of "Service" (bank offices, insurance, etc.), "Communication" (financial transactions), and "Content" (generation and administration of money)
- Continuing concentration process, in the year 2000 the market leader could reach an annual balance of 1 Bill. \$ (twice the size of the biggest bank now in only 3 years)
- Increasing networking and merging with insurance companies
- Large insurance companies (Allianz - market leader, Gerling,?) make 50% of business in other countries
- Global and niche market companies will survive the merging

### **Reasons:**

- Liberalized capital and share markets
- Former blocking laws were knocked down
- Business with money is independent of location (unlike manufacturing and other products)
- The necessary huge investments in IT technology kick small companies out of the market

### **Top 3 listing of banks worldwide (1997 balance figures):**

- Bank of Tokyo:675 Bill. \$
- United Bank of Switzerland:647 Bill. \$
- Deutsche Bank: 594 Bill. \$

## **Surrounding Thoughts**

The "Government" companies - potential new players?

National governments loose power balanced by

- Local authorities: juridical and social politics, economy (e.g. the German "Länder")
- International bodies: infrastructure development, foreign affairs, military/defense (e.g. EBU, ITU, ETSI)

Both international and local bodies might transform and act as companies offering "political services". Therefore they would become a new business category (e.g. governments already seeking for support from big consulting companies). Weakened national governments are a bottleneck between these two entities and might use this to control development in some areas (e.g. use national votes in the WARC to block or accelerate liberalisation of telecommunication markets)

The new money or: "We might have to re-evaluate our way of thinking about business, players and being big or small."

Virtual money (Internet and Cyber cash):

- Internet trading in the year 2001 is estimated 300 Bill \$
- Could yield total de-regulation of cash- and stock market
- Destabilisation of established banks and national money policies

### **De-nationalised money**

Money could be privatised and therefore knock down the monopoly of banks and governments. Cyber cash would compete with "ordinary" money.

Problems:

- Trust (value and liquidity of a bank)
- Crime (manipulation - old fashioned money is well established and accredited, "cleaning" of criminal business money)
- Avalanche effects in financial markets and systems (Cyber cash is not balanced by gold etc.)

### **People's Life**

In the people's life section-- "People's life in 2015", the purpose is to find out what are the possible major changes in the people's life in 10 to 15 years. This will hopefully yield conclusions for the requirement for the future wireless infrastructure.

What do we know about the life of ordinary people of tomorrow? A lot.

We know approximately where they will live and with what they will work. Still there are big changes going on in a global context. Underdeveloped countries will rapidly get industrialised and so on.

The focus of this research area is to draw conclusions about the environment and thereby the infrastructure the 4 GW.

Research should be aimed at finding what conditions of people's life of tomorrow that we can predict fairly well and what we can not predict. Fairly predictable facts are for example the demography of the world. The urbanisation and the like.

The goal of this additional research is to find out what are the possible major changes in the people's life ten to 15 years from now. This should yield simple conclusions on the requirement for the future wireless infrastructure. Some everyday applications are described.

### **Basic assumptions**

People won't change very much

We assume a simple Social Model describing different type of people (class, values)

- For the social class, there is the mass workers and educated worker

- For the Values, there is the Money People (or working People) and the Family People.

Those classes won't change, only the proportions will.

As education is increasing, the educated social class will grow decreasing the importance of the mass worker social class.

The main Value will be more and more the Money. That is a pity but that seems to be the trend. People (educated people at least) always want to earn more money.

The mass worker will have time and no money to spend. Whereas, the educated people won't have time but has money to spend.

One good combination is to be Family People and educated worker. Those people will have some time and some money to spend.

They will have less time to do what they want.

- Why will people have less time, what do they do with it?
- Who will have less time? Is it only highly skilled professionals or will it be everybody?

The amount of different activities they want to do increases dramatically. Often the remaining activities are only the obligatory ones.

The reasons could be:

- They have too many things to do. (Bad Management)
- They don't organise themselves good enough. (No Parallel Formation)
- They are lazy. (Human nature)
- They have something else to care about. (Individualism)

### **What are important driving forces?**

- Save time
- Laziness
- Have time for more tasks
- Make more money
- Save money
- People are "greedy"
- Buy more time
- Buy Quality, and Reliability
- Comfort of life
- Need Quality
- Need Reliability

### **What do people do and how will they do it in the future**

#### *Food Preparation*

- Help shopping/delivery
- Help selecting dishes
- Intelligent kitchen machinery?
- (Restaurants)

#### *Food shopping:*

To have something to eat, we need to go shopping.



If there are habitations, there are little shops. Most of the people go to the little shop to buy last minute food or late when the other shops are closed. We see here that people want to have the possibility to go and buy whenever they want but as cheap as possible.

Range, time of the day, and money are related in the normal human buying behaviour:

### *Range*

There is a trade-off between range, and money. We are ready to go far to buy the cheaper.

### *Time*

Time of the day can be divided in three different slots:

From 0900 to 1800:

- Every shop is open.
- Wide choice of goods
- Cheaper shops
- Limited need

Large amount of buyer From 1800 to 2200:

- Local and night shops are open
- Limited choice of goods
- More expensive shops
- Need normally increased

Limited amount of customers From 2200 to 0800:

- Very few Open shops
- Very little choice
- Very expensive shops
- Big need
- Very few amount of buyer

### *Money*

Even if money is an important driving force, availability (or possibility to buy whenever we want % time of the day) and range (or more time to get to the shop) can take over if we have money.

### *Cooking*

One thing that has been improved is 'How fast is it possible to make something to eat?'

Last 10 years, the microwave oven became a centre tool in every kitchen, but quality puts limits to the fast food.

Medicine has improved and shown that some food is dangerous for the health. Does it influence our way of eating? Some people eat healthier, but in general people don't think long term and don't change their habits. New generations drive the changes.

Exceptional quality happenings: Good restaurants will always remain, but new type of specialised restaurant could appear. Eventually, machines in your kitchen could cook automatically. However, automated cooking in the kitchen is very unlikely compares to assisted cooking and shopping. Complete stand-alone installations are typically for mass production. It is likely that companies offer cooking services for you and deliver something almost ready to you. As the money is the major driving force in the future world, fast food delivery is not an issue. We can however consider this as the really short time and expensive meal solution.

Future cooking may use open shops, phones, and electronic money in order to save time and avoid waste of money. Intelligent agents will help us with cooking, and orders the food needed in on-line grocery store.

It will propose what to eat for dinner. Knowing your preferences, based on what you have eaten the previous weeks, what is available in the refrigerator, and your wish for the day (something with meat that tastes salty), the agent selects a suitable dish, finds the recipe in an online database. If needed it orders the missing ingredients at the local grocery store. The food can be delivered to your door or you can go and pick it up in five minutes.

Of course, someone will have cooking as an hobby and in that case time is not important neither is how much money it costs, but I mean that those people that have cooking as hobby will not influence things to a great extent.

Time factor is more important than the quality of the food for most of the people; Money is ruling the food situation. People want to have more time. If they can afford it, they will try to buy more time. Wasted time is Money in the shopping case. Future situation will try to minimise the Range-Time-Money function. Most likely the information will have a great role in this development.

### *Sleeping*

Hard to improve sleeping. Possible applications make sure sleep is undisturbed

There is no secret, we will always spend 30% of our life to sleep: this is a human need.

How can we improve the way we sleep? New technologies could arise and give a possibility to assist the sleeping period (for example electromagnetic waves to calm the sleeper, and so on?) Sleeping monitoring could be a good wireless application. We know that the human has sleeping period when it is not good to wake him up unless it is really important. The device could monitor those phases and wake him up between two of them before the alarm clock does. The same could be done in hospitals. We need to have the insurance that we will sleep good and be waken in the morning at the optimum time. We want to sleep less, but better.

### *Hobbies*

- Not being disturbed while doing a hobby
- The net creates new hobbies
- Enhancements of already existing hobbies
- Can take up much time/money

Main point

People have less time to spend for their hobbies. They would spend all their money for their hobby. They want to disconnect when they play. But not totally disconnected they prefer to have a cheap background agent such as answering machine. The problem in the answering machines case is that very few people leave messages. We need a passive connection: the caller does not decide whether he wants to leave a message.

### **Influence and benefit of communication**

Information and communication have created new hobbies for the new generations. Hobbies create applications that will create an increasing demand for the throughput, the mobility, etc. (ex: surfing the net for throughput, sailing for the mobility).

Wireless technologies can also add other features or improve our hobbies. For example sailors and skiers can increase their security.

Communication creates communities of people that would never have survived before.

#### Watching TV

- Possibility to choose how to pay
- Changing terminals functionalities
- Mobility is not really necessary
- Content might not change that much

TV has to adapt to the information. TV is a passive information media. It is not going to survive the information era. This device will be transformed such that the user can decide what he wants to see and when he wants to see it. We will have a wider choice of programs. Time and content are the important factors. However, the passive media's are of major importance for the commercial and financial business. The advertising are the main revenues of the non-pay TVs. The future will give us the choice whether or not we want to pay for what we watch. Let's say that somebody don't like commercial he could ask no commercial breaks and pay more than the other one who choose maximum rate of commercial breaks and pay almost nothing... However, the form of the content will survive. These will still be soaps, films, talk shows and education programs. The gadgets used for watching the TV shows will change also: Wrist watches heads up displays and home cinemas.

Do the people need mobility for the TV? I don't think so. People lie on their sofa when they watch TV and don't walk on the street. Of course, as Wireless communication is interesting for the video conferencing, it could be developed for the TV network.

The design will be more like a wireless local loop. On the other hand, in 15 years the local broadcast operator and satellite broadcast company will already have adapted themselves to the video-on-demand technology?

#### *Taking care of the kids*

- Child surveillance
- Security services

I think that raising kids is something that cannot be changed that much.

One thing that parents want to do though is to be able to keep an eye on their kids while not being there. If something happens to the kid they want to be alerted. We can think of a few examples of such devices/systems. The baby monitor. A small radio transmitter is places in the baby's cradle. It has a microphone and transmits to a receiver that the parents carry around. If the baby cries the parent can hear that and take action.

Parents give their kid a portable game that is also a pager so that they can come home and eat when it is dinner. In skiing school parents are given a pager. The ski instructor has a cellular phone and the parents can call in case something is wrong.

In the future I can imagine things like super-cradle (tm) that monitors 100s of body parameters (temperature, breathing, heartbeats etc.) and alerts you when something is wrong or when diapers need to be changed. Or clothes with built in position sensors that makes it possible to see where a person is.

If we extend the subject to the home, Some other safety device and agent are coming on the market: The Alert company that handles all kind of alarms in the house. The devices are connected to the phone and in case of fire or theft, alert the security company which diagnoses it and sends security guards etc? We can imagine that those house devices will evolve to all kind of services, like the locking of the doors, the detection of people in the room, the warming... Most of those applications are wireless and important to consider for the future

system. The common line of sight characteristics for those applications may introduce an IR air interface.