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ABSTRACT

Telecommunication infrastructure deployment, in contrast to the rest of the communication area, is a slow and costly process, demanding a long-range strategic perspective in decision making. Determining key issues for strategic research in this area is thus very important. This paper describes detailed work to that aim, within the PCC project. The aim was to find possible scenarios for the 4th Generation Wireless Infrastructures (4GW) around year 2010 and to determine their implications on the direction of research in wireless communications.

In this scenario work, a number of trends were created based on the current state of technology, economy and politics. These trends are verified by using Delphi methods. Based on these trends and additional research, three vivid scenarios are built, which picture different ways the trends may develop, The scenarios are called: "Big Brother Scenario", "Anything-Goes Scenario" and "Pocket Computing Scenario". At the end, the paper discusses the implications of the scenarios on the wireless communication research areas. In particular, the working assumptions and key research problems in each work package in the 4th Generation Wireless Infrastructure project are verified and prioritized according to the scenarios.

INTRODUCTION

Background

Today the development in telecom and computing areas may be perceived as extremely fast and keeping up to date with the latest developments in the research community may be a challenge. However, the deployment of infrastructure is still slow and the time it takes from the first research results to a fully deployed infrastructure may be of the order decades. One of the great challenges in this situation is to ensure that research performed today will be relevant in the future when results are to be applied in design and deployment of a system.

Methodology

During the last decade, scenarios have been widely spread as a managerial tool for promoting strategic thought within organizations. The methodology used here was originally developed at Royal Dutch Shell during the seventies. This methodology has since been spread by the inventors through the "Global Business Network" which is a "Think Tank" and consulting firm based in California [1].

Scenarios have two essential purposes. The first is to change the way people think and to envision the future. People are often locked in a traditional thinking pattern, which is a natural consequence of the specialization of education and functions within organizations. To start changing the way people think it is necessary to connect different factors into something of holistic character. Scenarios can be then used as a tool to reach this goal. The second purpose is that 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 strategic decisions can be formed.

An important issue when forming scenarios, is the purpose for which the scenario will be used. Several actors in telecommunication have used this technique and the purposes and results are different. Siemens' scenario work is called FutureScape [2] and the main objective is to create visions and identify business opportunities for the future. For this, four scenarios covering social, political, economical and technical issues were built. Ericsson has created another scenario set called "2005 - Ericsson Entering the 21st Century"

[3] The purpose of this set is also to identify profitable areas for Ericsson's future work. This set, though, concentrates on the telecom, computer and media market and focuses on the relation between content providers, services providers and users.

4GW View

The "4th Generation Wireless Infrastructures" (4GW) project within PCC aims at studying issues relevant to systems that are to be deployed 15 years in the future. In order to find the relevant areas of research it is necessary to form a picture of what the world could look like in 2010. For this objective the scenario tools are used to picture the future and to justify the proposed research area. The total 4GW scenario work is presented in a report [4] and the methodology used is presented in [5].

4GW SCENARIOS

The process of creating the scenarios started with collecting a wide range of information. This information was merged, and megatrends were identified. The seven megatrends described below were found to be the most important and also underlying many of the events in the telecommunication world today. These trends have been verified using Delphi methods.

Trends

Globalisation of products, services and companies

Companies establish presence in many countries. The same brand names may be used around the world but products and services are adapted to fit the local culture and requirements. This megatrend is enabled by increasing world trade and by efficient means of communication that makes it possible to manage companies spread around the globe.

Communicating appliances

An increasing amount of consumer devices will have built in communication capabilities. Thus more tasks can be automated and device management becomes easier.

Services become independent of infrastructures

The infrastructures and the services provided over them are becoming more and more separated into different layers. This makes it possible to use the same service via several different infrastructures. Due to standardized interfaces it becomes possible to have different companies providing the infrastructure and the service.

Information trading

More and more information becomes available which paradoxically increases the value of refined i.e. meaningful information since it is harder to find. This opens up a market for information brokers that are specialized in finding information that is useful to their clients.

Globalisation of cultures

The influence of different cultures on each other increases. The increasing information flow around the world as well as increasing travel is driving this megatrend.

Education increasingly important

Education increases as a success factor both for the individual and for companies that require highly educated employees in order to be competitive.

Standardization diversification

As more and more products are sold globally and more and more devices are expected to interact standardized interfaces become increasingly important. In some areas the leading manufacturer sets de-facto standards. In other areas there is no single company dominating the market forcing companies to cooperate.

SCENARIOS

To be able to define and influence a research project from a scenario set, 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 kinds of issues are relevant to the business actors. Third, the life of an ordinary citizen is described to capture the user perspective.

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. The following are summaries of three scenarios. The complete scenarios are found in [4].

Scenario I - Anything Goes!

The Anything Goes scenario pictures the world where just everything goes. The main megatrends building up

the scenario are Globalization of products, services and markets, Standardization diversification and Communicating appliances.

The development is very fast and new products and services are introduced in a very high pace. It is possible to start new networks and it is also possible for users to connect to these networks on an ad-hoc basis; access is more or less free. The requirement for access is possession of a (generic) broadband access tool and the right software, necessary to connect to the one or more of the networks. The networks are mostly wireless LANs that belongs to companies, residences or niche operators that cover certain "Hot Spots". Outside the WLANs coverage, there are several layers of cellular and satellite systems available.

As software is used to control all functions all products are easily adaptable to the type of network used, the service used and national and cultural requirements. This makes it possible for companies to sell a product worldwide, without any hardware adaptation.

Central regulation and standardization is minimal and many systems will have to coexist in the same frequency domain. As the central control has decreased, new ways of de facto standardizing is built up, combined with flexible multi-standard equipment. The major issues in standardization work are to be first out with a solution, document it well enough and make it well known in industry.

The impact on the private sphere is that the comfort offered by almost unlimited personal computing and communication is fully exploited e.g. for telecommuting from home offices and for controlling household appliances.

In this scenario each individual is responsible for buying the various components for communication. For example in order to communicate a person needs to purchase communication devices, software, connections, subscriptions and content separately. Users pay for services and content on a per use basis using electronic payment methods.

Scenario II - Big brother protects you from little brothers!

The Big brother scenario is based on the Information trading megatrend, where all information has a value and thus can be bought or sold. The little brothers symbolize all the people legally, or illegally, collecting information and the big brother symbolizes the government or international organization setting the rules for information handling.

The background is that the Information trading megatrend was dominant on the market and almost any information was available. The information available could be collected with custom methods, like company data bases, but also by combining different data bases with each other and with other information on the internet. For example email was scanned and behavior when playing the increasingly popular netgames, was mapped. As integrity and copyright was threatened, governmental organization had to intervene to protect and save the information society.

By 2010 the security and integrity are put first in every step of handling information. The governments in most developed countries cooperate to create a secure network level. This means that all citizens and companies who wants to perform computing and communication have to be certified for this, just like the systems with which it will be done. For this, a new secure Internet level is created and the rules are enforced by a specialized Information Police Branch.

Large operators that are closely controlled by the government provide communication services to individuals. Users pay for the services much in the same way as today via a monthly bill. Governments have retained and regained a lot of power. In addition to ensuring communications safety, they have a lot of influence on the standards set.

In the private sphere the change is seen since not as much information is available anymore and services adapted to a certain person are limited. Also, people are aware of the risks and they are careful in revealing personal data.

Another impact of this scenario is that the complexity of products and services increases and thus the cost. This, in turn decreases the development rate and the number of wireless systems and operators.

Scenario III - Pocket computing or Smart devices that fit into your pocket

Pocket computing pictures the world where the technological development is fast, but due to economical and educational differences, the society is divided between those who could follow the development and those who could not. Thus some parts of the population have access to a global service, and other parts are using more basic services.

Important trends are Services become independent of infrastructure, Education increasingly important, Communicating appliances and Globalization of products, services and companies.

The companies providing services and content are powerful enough to set the political agenda and to set standards. Users buy services and the company providing the service ensures that required infrastructure is in place and provides the proper device. Payment is done using a normal monthly bill.

The wireless development has continued, but the system that existed at the turn of the century are still working and are inexpensive, while new systems have been introduced. The new systems offering full mobile multimedia in certain areas and high security has not penetrated the wide market and thus the pricing rates are high. This means that the range of services available on the market is very extensive and the pricing level is highly differentiated.

A consequence of the differentiated services, combined with the importance of education and knowledge is that the society has become highly differentiated. Governments have lost a lot of their power to the service providers, which has resulted in a breakdown in the welfare systems.

The differentiated society makes the lives of people quite different. People that are well off can afford to pay for high quality and secure services and their terminals are multi purpose. The poor people can only afford low quality services and have to have many low-cost terminals to use their services.

Analysis and Comparison

To be able to compare created scenarios to other scenarios and to find missing scenarios in the set, the Scenario Space used in [2] is a useful tool. The scenario space is made up of one or more axes, spanning a space, in which the created scenarios are positioned. The dimensions may be any useful parameter, e.g. the
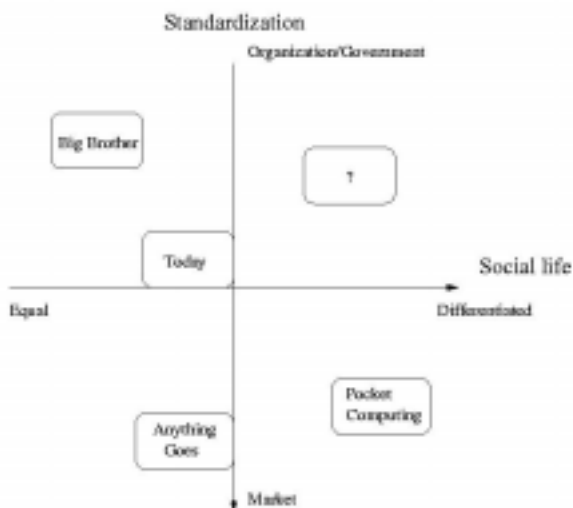

Figure 1. Scenario Space for the 4GW scenarios

megatrends. In Figure 1 the megatrend Standardization and the parameter Social life are spanning the Space. The Standardization axis pictures if the standardizing in the scenario is made centrally, by governmental organizations or decentralized by the Market. The Social Life parameter depicts the equality in society. Figure 1

show that it is possible to put the scenarios in different quadrants of the Space and the direction of development from the current state is showed. It is also possible to identify a new scenario in the upper right quadrant. This possible scenario is however not considered in the scenario set.

As mentioned previously a lot of organizations are creating scenarios and it would be desirable to compare these scenarios to the 4GW scenarios, as they all are trying to sketch how the world may look like in the future. However, there are factors complicating such a comparison as all these scenarios have different backgrounds. They are made in different environments and have different purposes. Anyway, it can been seen that several parts in 4GW scenarios have corresponding parts in other scenarios, such as the Ericsson and the Siemens scenarios, but the combinations of the parts differ.

IMPLICATIONS

The scenarios point to a number of areas that are relevant for future infrastructure research. In some of the scenarios the requirements on security are very high. This indicates a need to look into security and copyright issues. There are areas of how to securely use the radio broadcast medium and still avoid interception. Another problem that arises is how to avoid disclosing someone's position, especially in dense infrastructures. Another relevant issue is to look into how the control structure around security should be organized.

The mobility and automatic adaptation to various standards and infrastructures that provide different bandwidths at different delays opens up an area of research within protocol issues. There are questions on how to most efficiently adapt to new conditions, when to switch between systems and which layer that should be responsible for different functions. This also puts a requirement on applications and user interfaces that must be usable even though the underlying bandwidth/delay may change.

The increased amount of communicating devices calls for more flexible structures. This indicates that areas such as adaptive antennas and ad-hoc networks are important to study. There is a need for both new models and performance measures.

In the "Anything goes" and the "Pocket computing", scenarios there are many different users of the radio spectrum, more than can possibly be handled, configured and managed. This calls for techniques that automate configuration, detection of other devices, creation of ad-hoc networks and management of the radio spectrum.

In all scenarios, there seems to be an increased demand of bandwidth, either for carrying more services or for use by security protocols. This means that

important research areas are those that makes the most efficient use of the scarce resources. Typical issues may be efficient protocols, adaptive antennas and efficient modulation techniques.

The actors on the telecom market differ in all scenarios. For example in the "Anything goes" scenario the user pays for services, communication and equipment individually whereas in the "Pocket computing" scenario the users pays for the service and the service provider provides everything. The impact is that infrastructure research must develop solutions that are viable in all these business environments.

CONCLUSION

Scenarios have been used to envision the environment of telecommunication infrastructures and to identify research areas of importance. Three vivid scenarios have been developed from megetrends that can be identified in the world today. The scenarios show that infrastructure research is influenced not only by technical issues but also by political and economical factors.

In addition the scenario work has given the 4GW project a common language and a broad background for future research. It has also put the infrastructure issues into the context of the whole PCC project.

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