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## Introduction

### **The Wireless Industry at a Crossroads**

Telecommunications is a global business of enormous proportions. It is a \$1000 billion market, making it one of the biggest business opportunities in the world, second only to sex, drugs, and arms. The wireless communications sector is also huge and growing. The global number of mobile telephone users is now well over 1 billion. In 2001 the number of wireless subscriptions passed fixed-line subscriptions. Currently about 20 billion SMS messages are sent every day, even though this service has not really taken off in one of the largest and most important markets, the US. Over 400 million mobile phones were sold in 2002. Add to this 15–20 million PDAs (personal digital assistants) and 25–30 million laptop computers, many of which have wireless communication capabilities (Morgan Stanley 2001). The first (analog) cellular systems were introduced on the mass market only about 20 years ago, in the early and mid 1980s and the dominating second-generation digital standard, GSM, was introduced in 1992. Still, as late as 1997 the global number of mobile phone subscriptions was less than 150 million (Lindmark 2002; Economist 2001). The mobile phone is becoming an extension of our body. The development during the last decade has been truly amazing.

The telecommunications market can be divided into end users, equipment and terminal vendors, operators, service providers, service and application developers, and subsuppliers. The annual turnover of the industry supplying wireless equipment and terminals can be estimated at well over \$100 billion worldwide, of which about \$40 billion is revenue from sales of mobile infrastructure. Wireless telecommunications is indeed a very important sector and a truly global business, with markets spanning the world and large multinationals as well as small companies competing fiercely. For individual nations, such as Sweden, the telecom sector is even more important, currently accounting for about 8% of the country's total exports.

At the same time, the telecommunications industry is facing severe difficulties. For the first time, growth rates for mobile telephone subscriptions have slowed down in many important markets. Blinded by the hype in the late 1990s and early 2000s, operators have spent enormous amounts on licenses for third-generation cellular systems (3G systems); in Western Europe alone they come to around \$120 billion. The investments for building these systems are expected to be at least of the same size. Add to that possible subsidy of terminals, as in GSM, of the same magnitude. In most countries, especially in Europe, 3G is delayed compared to the original plans. 3G services will probably not be launched on a broad scale until 2004 at the earliest.

Despite the tremendous growth during the 1990s and the current problems, the long-term prospects are promising. In 2003 half the world has yet to make a phone call and global penetration of cellular phones is still only around 20% (Deutsche Bank 2001). Even though many operators are burdened by huge debt from the astronomical fees paid for 3G licenses and low profitability on wire-line operations, the cellular operations continue to grow while still very profitable.

With the introduction of the packet-switched 2.5G and 3G cellular systems, a whole new range of mobile data services are possible, for example MMS (multimedia messaging), streaming video, teleconferencing, various types of location-based services, downloading of customized software, and speech recognition. Other types of systems for example WLANs (wireless local area networks) providing advanced services in specific locations, sometimes called hotspots, will complement the cellular systems. This has already started. The global WLAN equipment market grew by about 70% in 2002 with revenues reaching \$2.1 billion (Northstream 2002). Many companies use WLANs as an integrated part of their office IT infrastructure. WLAN services in hotspots are becoming increasingly common in public locations as well, for example at airports, train stations, hotels, university

campuses, and cafes (Lind 2002). Already several operators exploiting the WLAN business have entered the scene, both new and specialized so-called WISPs (wireless internet service providers) and incumbent cellular operators. According to Gartner Dataquest, a continued increase in revenues from WLAN equipment of about 20% is expected for 2003, while prices will drop by 25%. Although dwarfed by the volumes in the market for cellular products, the development is very fast, with the US as the leading market.

The introduction of wireless data services and new types of network will no doubt lead to the emergence of new players on the wireless scene and probably a restructuring of the whole industry as a result. Service and content providers, application developers, virtual operators, and wireless portals are a few examples of players who will try to capture the market using new business models to compete with incumbent operators. The merging of telecommunication, data communication, and media into an integrated industry will mean business opportunities for existing actors but also for new competitors. The competition between traditional telcos and datacom companies, on both the terminal and equipment markets, is becoming fiercer every day. Telecom standards and protocols fight for dominance with datacom standards and protocols. Alliances are being formed between companies from these two different worlds.

Even though it can be argued that communication lies at the core of being human and that we have an insatiable need to communicate with each other, it is not at all clear what lies ahead for the communications industry. Will there really be a demand for all those services that are possible with the introduction of third-generation cellular systems and WLANs in hotspots? How much are we willing to pay for these services and at what price can they be offered? The difficulties of providing a broad range of data services over a variety of networks should not be underestimated. Going from the relatively simple world of providing voice and simple messaging services to the far more complex wireless world of the future is certainly not simple. Can the engineering challenges facing infrastructure vendors be solved so that user demands can be met? Will new terminal technology be developed so that the current problems with cumbersome human/machine interfaces (input/output units, small screens, etc.) are solved? Will new value chains and business models emerge so that all players necessary to create this new wireless world find it worthwhile to participate?

It seems the telecommunications industry in general and the wireless sector in particular are at a crossroads. The coming few years will indeed be very exciting.

## **Be Prepared for 2015**

This book, however, tries to look further ahead, into the wireless world beyond 3G into 2015. Which are the most important trends in the wireless industry and what are the long-term fundamental drivers of development? What services will be used in 2015? Who will be the users and what demands will they make? Which regions and nations will lead the development? What technological and other problems have to be addressed in order to realize a positive wireless future? Which are the most important areas of research? All these questions are addressed by this book.

The book's purpose can be stated in two words: *be prepared*. Our ambition is to provide a different way of thinking when preparing for the future. As we all know, there are numerous examples of forecasts completely missing the target. Just remember the predictions made on usage of wireless services, Wap, industry growth, etc., when the telecommunication hype was at its peak in 2000. As has been stated by several people before, the only thing we can say with certainty about the future is that we don't know what will happen. But we are not arguing that traditional forecasts and predictions are bad and that they should be abolished. What we suggest is that this way of preparing for the future is not enough. Our path is different. By devising scenarios that are broad and represent reasonably holistic images of the future, a different basis for reflection and discussion is created, enabling us to better prepare for what the future might hold.

## **Scenarios of the Wireless World in 2015**

The core of this book consists of four scenarios that describe possible wireless worlds in 2015. They are focused on the development of the wireless industry in a broad context. The scenarios are concrete images, including descriptions of the development of the telecommunications industry, the wireless systems of 2015, how these systems are used, and who are the most important users.

In "Wireless Explosion—Creative Destruction" wireless services and technology develop very rapidly, transforming industry so that the old market leaders, the traditional telcos and their equipment vendors, lose their dominant positions. The old world with closed and vertically integrated systems gives way to layered and open architectures based on the Internet Protocol (IP). Even though the previous market leaders don't vanish, it is the datacom industry that wins the market battle.

In “Slow Motion” the world moves into an economic recession following the bursting of the great telecom bubble in the middle of the 2000s. On top of that, research shows that electromagnetic radiation from mobile devices is harmful, forcing industry to retreat but finally to refocus on new and more harmless technologies. The problems with guaranteeing security and integrity in transmissions prove very difficult to solve. Users are reluctant to use wireless technology, severely affecting the industry. In 2015 the wireless industry has only just started to get back on track. We have seen a positive development in several of the big NICs (newly industrialized countries) and they are gradually catching up with the industrialized world.

“Rediscovering Harmony” involves a significant lifestyle shift in the industrialized world. Balance in life and human and environmental needs are in focus, affecting all sectors of society and industry. The migration flow into the large polluted cities ended in favor of quality of life and less stress in smaller local communities. There is large diversity in lifestyle between different groups, or tribes, in society. People live locally but think globally. There are fewer wireless services than expected around the turn of the century, but still a substantial market. Communication between people is a success but appetite for new cool and funky applications is lower than expected. The big difficulty for the wireless industry has been to rethink business models and services in relation to these changed market conditions.

Through consolidation and mergers, a few large companies have come to dominate the wireless world in “Big Moguls and Snoopy Governments.” These moguls have expanded outside their original business segments. Together with the world’s governments, they exert substantial control over information flow and the communication and media industries. The purpose of the governments is to protect society and individuals from cybercrime and terrorism, and to protect content owners from illegal copying. Most problems concerning security on the internet have been solved, but at the price of slow industry development. Some services are not introduced since they are illegal.

The scenarios are not predictions but possible and, hopefully, plausible descriptions of the future. They are intended as a source of inspiration when thinking about the future of wireless technology and industry. It is no coincidence that the title for the book is *Wireless Foresight*, not *Wireless Forecast*.

The scenarios are qualitative in nature. You will find no statistics, graphs, or growth figures in them. Since they are not intended as predictions, the choice was made early on to take a descriptive approach. This does not mean

that we have avoided statistical material or are unaware of it. There is a lot out there, most of it compiled by authors more competent statisticians than us. The scenarios are implicitly based on various predictions, trends, and forecasts of a more quantitative nature.

Since the objective is to develop plausible and consistent descriptions of possible wireless worlds in 2015, it is necessary to have a long-term perspective and a broad scope. The temporal perspective is until 2015 and the scope is broader than the industrialized world. The development in the leading regions of today—Western Europe, North America, and parts of Asia-Pacific—is very important. Also of interest are other countries with the potential to become not only large markets but also homes to important players in the wireless industry.

### **Challenges for the Future**

The futures described in the scenarios contain positive and negative aspects for industry as well as users, highlighting obstacles that need to be overcome and possible paths towards a positive wireless future. This makes the scenarios an excellent platform for discussing challenges facing various actors in the wireless arena, now and in the long run. The scenarios are therefore followed by a discussion of long- and short-term challenges for industry, for some especially important regions and nations, and for the research community. The images of the future described in the scenarios contain certain assumptions about the characteristics of wireless technology in 2015. These are further elaborated in the discussion on research challenges.

### **Creating Scenarios**

The scope of the scenarios is broad. They are based on several fundamental drivers or mega-trends in technology, society, business and industry, and among users. These are things that we feel certain will be valid in 2015 as well as today. We thus paint a broad picture of the development in the larger context of the wireless industry. From these fundamental drivers, a set of more concrete trends are identified; these are 14 trends whose direction and rate of change are uncertain. Each trend is assigned different values; for example, strong or weak, fast or slow, problem solved or problem unsolved. In this way a scenario space is created and the four scenarios are defined by combining the values of the trends in different ways. Input to the scenarios

comes from various sources; the most important sources are external experts from different fields in industry and academia, articles and literature on the development of the telecommunications industry, and other scenarios.

The scenarios were developed at Wireless@KTH, a center for industry-related research and education on wireless systems at the Royal Institute of Technology (KTH) in Stockholm, Sweden.

## **Guide to the Book**

Chapters 2 to 5 describe the four scenarios: Wireless Explosion—Creative Destruction, Slow Motion, Rediscovering Harmony, and Big Moguls and Snoopy Governments. Each chapter is divided into four parts, starting with a table of the 14 trends used as dimensions when creating the scenario. The table, with different weights assigned to the trends, gives a first hint of the scenario's flavor. The second part of each scenario is a storyline in which we meet real users of wireless technology in 2015. The third part is the actual scenario describing the future wireless world and how it has evolved. Each scenario ends with a short description of the wireless technology and services used in 2015.

Chapter 6 lays out the basis for the scenarios. It describes trends, fundamental drivers (mega-trends), and theories underlying the scenarios. It is divided into three parts. The first part describes the 14 trends used to define the scenarios and gives a listing of the fundamental drivers underlying each trend. The second part contains a table with all the fundamental drivers and a short description of each driver. The chapter concludes with an overview of theoretical models underlying and supporting some of the fundamental drivers. Chapter 7 describes a number of technical implications that can be derived from the scenarios. The technical implications are formulated as statements about the wireless technology in 2015. By assuming these will be true in 2015, we also assume that the underlying research and engineering problems have been solved.

Chapter 8 discusses the main engineering challenges for creating a positive wireless world. It presents several important areas for research in order to realize a positive wireless future for industry and users. The research areas are based on the technical implications discussed in Chapter 7. Chapter 9 uses the scenarios to discuss the most important challenges facing industry in the next 10–15 years. The discussion is focused on topics we believe are critical for a positive industrial development and on problems where industry can stumble if things go wrong or are left unresolved.

Chapter 10 shifts the focus from industry to some of the most important wireless markets now and in the coming decade: the US, Europe, China, Japan, and Korea. Not only will they be important in the future as markets for wireless products and services, but also as homes to the industry's important global players. Each region has its own section in the chapter and the descriptions are rather broad, focusing on the current state of affairs and the most important trends and challenges facing the wireless industry.

Chapter 11 deals with the methodology of devising scenarios and of our work. It begins by discussing logics of creating scenarios. Then it briefly describes our methods and working procedures. The chapter ends with a brief overview of other scenarios and future-oriented studies that have been important for us as input and inspiration. Chapter 12 is a conclusion. The first section contains a full recap of the scenarios and the most important issues discussed in the book. The final section is a brief reflection on the importance and the difficulties of taking a step back from the present when thinking about the future.