Mobile market dynamics

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Although mature, the global mobile market is still foreseen to grow due to the potential of new markets, fixed-to-mobile substitution, and emerging technologies such as EDGE, 3G – WCDMA, CDMA. Predicting the evolution of such a market with respect to the number of subscribers, the way they will use the services, the amount of money they will spend on telecom services, their choice of technology and terminals development are some of the pivotal ingredients for designing robust business models and reacting effectively on the changes in the market. The forecasts presented in this article show the market dynamics with respect to some of the above topics. The focal market is the mobile market in Western Europe, and the development of the number of users and number of handsets in use related to different access technologies is forecast. The development of the mobile subscriptions per technology is described as well. The results presented in this article are achieved in the CELTIC Eureka project – ECOSYS [18], and are also using the forecasting techniques and models developed in the IST TONIC [14] and AC 364 TERA [15] projects.

1 Introduction

In recent years, the global mobile market has seen unprecedented growth in its subscriber base. Globally, the mobile subscribers overtook fixed-line subscribers in 2002 and now stand at around 1.5 billion. This growth is expected to continue in the future due to the new emerging mobile technologies and services in mature markets, and the potential of the emerging markets.

But the mobile market is also rather complex and dynamic due to several reasons – various technologies implemented in the network infrastructure, strong regulation, migrations towards 3G, new roles and actors playing in the market, hard competition between the actors, the myriad of services they offer to the users, who are requiring more and becoming steadily more aware of technological advances that can improve their everyday life. Predicting the evolution of such market with respect to the number of subscribers, the way they will use the services, the amount of money they will spend on (tele)com services in the future, their choice of technology and terminals development are some of the pivotal ingredients for designing robust business models and reacting effectively on the changes in the market. Forecasts on the above listed topics are very important for anyone dealing with economic and strategic issues, for example designing business models, planning a strategy or running a techno-economic analysis. More information on the relevance of forecasts for techno-economic evaluation of the rollout of different technologies can be found in [13]. Examples of techno-economic evaluations of mobile rollouts of new technologies and business cases can be found in ([2–4], [6], [8–9], [11]).

This article presents long-term forecasts for the mobile markets in Western Europe covering the period 2004 – 2012. In particular, the development of the number of users and number of handsets in use with respect to different access technologies, and the development of the mobile subscriptions per technology are focused on. Four major technologies were considered – 2G/GSM, 2.5G/GPRS, 2.75G/EDGE, 3G/WCDMA. When arguing for the trends in the forecasts of the market development, different issues were taken into account – technologies available in both core and access portions of the network, services foreseen to be offered and their expected usage, terminals evolution and their capabilities, and the natural development of society – population, consumers' buying power and average spending on telecom and content industries, etc. The 3G-rollout plans for different operators were discussed as well. Though the monthly subscription fee would remain the same independent of technology, the functionality and capacity ability increases along with new technology generations. This opens for offering new services and new ways of distributing the content, which in turn generate more traffic and require higher traffic capacity. These factors are consequently the key for higher revenue and higher ARPU.

The results presented in this article are achieved in the CELTIC Eureka project – ECOSYS [18], in the activity dealing with the market dynamics/forecasts for both fixed broadband and mobile industries. The EU projects IST 2000-25172 TONIC [14] and AC 364 TERA [15] were predecessors to ECOSYS, where the pillars of the forecasting model used to get the results presented in this article were developed. Another project, IST TONIC, has also used a similar approach and made long-term forecasts ([7], [12]).

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The article is organised as follows: Before presenting the forecast results in Chapter 5, we first give a brief overview of the technologies considered for the forecast studies in the next chapter. Services for the 3G market, convergence issues and the fixed-mobile substitution are described in short in Chapter 3, followed by the reflections on the 3G rollout plans of the operators playing in the Western European markets in Chapter 4. Chapter 5 discusses the mobile handset issues. Finally, concluding remarks are presented in Chapter 7.

2 Technologies considered

Cellular, nomadic, broadcasting and proximity technologies were studied for the forecasts planning, but in this article we focus on the cellular technologies. Cellular technologies initially considered included the complete spectra – from the GSM and HSCSD, via GPRS and EDGE, towards UMTS/WCDMA, and further to the 4G. The four most significant of these technologies were considered forecasts. The other investigated technologies were not further focused on

Label	Technology	Description
2G	GSM	Global System for mobile communications (GSM) is a circuit-switched digital cellular technology standard primarily suitable for voice services. However, GSM also supports narrowband data service. GSM utilizes the FDMA/TDMA transmission technique and operates at 900, 1800 and 1900 MHz frequency bands. The 200 KHz frequency spectrum is divided into 124 frequencies, each of which is then divided into 8 time slots. GSM systems offer data rates ranging from 9.6 to 14.4 kb/s per slot. GSM introduced the concept of global roaming and short messaging services (SMS).
2.5G	GPRS	General Packet Radio Service (GPRS) is a packet-switched technology implemented over the existing GSM network; it operates in the same frequency bands and utilizes the same transmission techniques. Packet switching over multiple time slots makes GPRS spectrally efficient and enhanced data rates of up to 171 kb/s (theoretical) can be achieved. In practice, these rates may vary depending on the number of slots made available by the operators. GPRS is better than HSCSD in handling the bursty behaviour of data services. Voice services are still handled by the circuit-switched GSM part.
2.75G	EDGE	Enhanced data rates for GSM evolution (EDGE) is considered as an intermediate step in the evolution of the GSM family of technologies from GPRS to UMTS. EDGE differs from GPRS only in the access network, while the core network remains unchanged. Hence, an operator can easily upgrade its GPRS network to EDGE. It uses the 8-PSK modulation instead of the GMSK modulation used in GSM, thus achieving 48 kb/s per GSM time slot. EDGE provides better spectral efficiency than GPRS but it also requires higher radio signal quality (higher signal to noise ratio). This asks for more base stations to be added compared to those in the GSM networks. EDGE supports the four QoS classes adopted by 3GPP and promises data rates of up to 384 kb/s (for pedestrian) and 144 kb/s (for vehicles). EDGE and WCDMA are complementary technologies. Since EDGE and WCDMA share the same packet core network, many GSM operators tend to exploit the flexibility of both radio access solutions. Therefore, it is feasible to expect that most GSM operators will offer 3G services on a combined WCDMA/EDGE network, because EDGE can be seen as a business decision ensuring that operators can compete and defend existing investments and assets due to: · EDGE-enabled services can deliver new revenue streams, · No separate roaming agreements are required as EDGE is covered under GPRS roaming agreements, · EDGE stimulates growth of mobile multimedia services.
3G	WCDMA aka UMTS-FDD as defined by ITU-T in the IMT2000	Universal Mobile Telecommunications System-Frequency Division Duplex (UMTS-FDD) also called Wideband CDMA (WCDMA) is a packet-switched mobile technology standard specified by 3GPP (Release 99). Due to the lack of backward compatibility with 2G, 2.5G, and 2.75G technologies 3G networks and related services have suffered a slow deployment. WCDMA requires minimum 2x5 MHz channel bandwidth for a duplex transmission and provides a maximum data rate of up to 2 Mb/s. WCDMA supports approximately 98 to 196 voice calls over 2x5 MHz bandwidth and also supports the four QoS classes specified by 3GPP. WCDMA enables the provisioning of multimedia services over mobile networks.

Table 1 Cellular technologies considered for the forecasts

	Data rate typical [kb/s]	Data rate maximum [kb/s]	Connection type	Generation label
TDMA	9.6	9.6	Circuit	2G
GSM	9.6	43,2	Circuit	2G
HSCSD (GSMf)	9.6-14.4	117	Circuit	2G
CDMAone	14.4	14.4	Circuit	2G
GPRS (GSMf)	20–40	117	Packet	2.5G
1xRTT (CDMA)	50–80	153	Packet	2.75G
EDGE(GSMf)	144	384	Packet	2.75G
WCDMA (FDD/TDD)	144	2000	Packet	3G
1xEV(CDMA-2000)	144	2000	Packet	3G
1xEV-DO ph1 (CDMA-2000)	600–1200	2500	Packet	3G

GSMf = GSM family

Table 2 Overview of the cellular technologies

in the forecasts due to either an insignificant market presence (e.g. HSCSD), or immaturity / early stage of development (e.g. 4G, MBWA), or non-predominant presence in Western Europe. For example, the 4G systems are not analysed here, since we anticipate that they will have a limited impact during the period 2004 – 2012, for which the forecasts have been made. One argument includes the fact that the allocation of 4G frequencies is not scheduled before 2007, and technological solutions for networks and terminals, as well as services are under research. It is a possibility that 4G systems will be introduced in 2010, but there are significant uncertainties connected to the introduction. Another example includes HSDPA air interface technology and MIMO systems that are rather interesting, but not considered in the forecasts due to the fact that they are still under development and many uncertainties are related to the potential technological solution. The third example includes an important technology omitted from our forecasts due to its negligible presence in Western Europe – the cdmaOne family of technologies (cdmaOne, CDMA2000 1xRTT, CDMA2000 1xEV-DO, CDMA2000 1xEV-DV) that have recently made inroads into the Eastern European markets. In addition, nomadic (WLAN, WiMax, etc.), broadcasting (DVB-H, DAB, etc.) and proximity (Bluetooth, Ultra-wideband) technologies were not considered in the forecasts presented here.

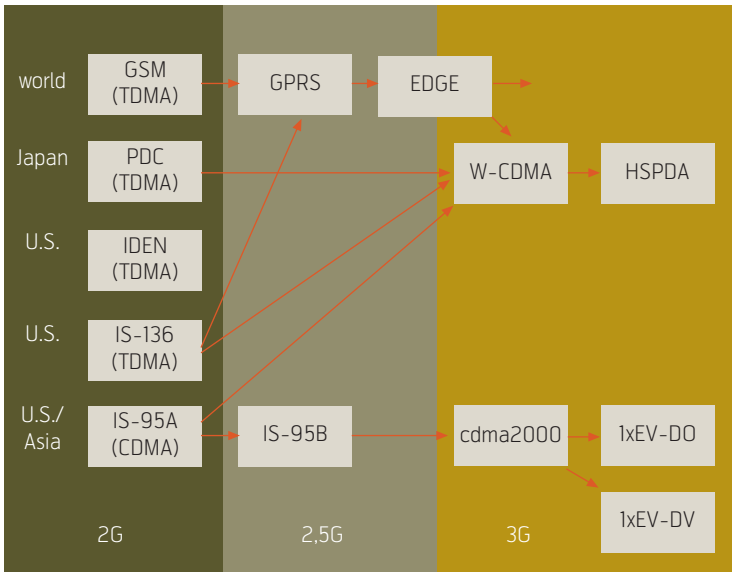

Figure 1 Evolution of 3G standards, from [17]

Four key mobile and wireless access technologies were considered for the forecast studies – 2G/GSM, 2.5G/GPRS, 2.75G/EDGE, 3G/WCDMA. These are briefly described in Table 1, along with a reflection on their evolution in the Western European markets. These markets are playing an important role in the development and presence of different mobile access technologies and services. More details on the other technologies mentioned above, which are not considered in these forecasts can be found in [1].

An overview of the major cellular technologies including the generation labelling, capacity and maximum data rate, as well as the switching paradigm is given in Table 2.

The evolution of different mobile technology standards is shown in Figure 1.

3 Market considerations

Our assumptions on the future mobile market are briefly presented in this chapter. The services described are drivers for the demand for new system generations and may potentially create additional revenue. When making forecasts we did not develop forecasts on different market segments such as: Consumers, SME and Corporate. Some considerations about the ARPU are presented in this chapter, since the combination of the mobile forecasts and the ARPU helps get a revenue picture. Finally, a brief outline of fixed-to-mobile substitution topics is addressed as well.

3.1 Services

The advent of packet-switched mobile technologies has provided operators with new opportunities in offering new value-added services that in turn generate more revenue. For the revenue estimation it is essential to try to quantify and describe the character of the traffic generated by these services. Though several service classifications are feasible, e.g. with respect to the pricing schemes, QoS requirements, communication type (person-to-person, person-to-machine, etc.), requirements on the terminal capabilities (screen size, resolution, OS, etc.) and the classification, we focused on the 3GPP proposal [16]. The services are organised in nine groups (Information, Communication, Entertainment, Business, Finance, Education, Community, Telematics and Special services) based on several parameters including QoS requirements, business area, etc. Traffic generated by these services can be described for example using four QoS service classes (Conversational, Streaming, Interactive and Background) adopted by 3GPP [16].

3.2 Market segments and the ARPU

Most typical market segments are Consumer and Business, where business subscribers are usually defined as those who do not personally pay for the subscription. Since different segments have different usage and spending patterns in the mobile market, more coarse segmentations within these groups may ease a process of ARPU prediction. For example, the differentiators could be a company size (SME, corporate), type of business (e.g. transportation, industry, public services), age of consumers (youth, established, older people). Both subscription types and the set of services used may vary between segments. For example, many consumer segment customers may use pre-paid subscription types (may to some extent lead to the restriction of a subscribers' consumption), while this could be considered as an unusual situation for business subscribers. Another interesting aspect within the 3G-market could be the issue of "mixed" subscriptions. "Mixed" subscriptions imply that the user may use the services for both private and professional purposes, but his company pays the subscription. Special rules and policies could determine his usage, e.g. the permission to use a certain (specified) set of services, pre-programmed set of phone numbers, refund via a tax system, etc. Therefore, the proportion of different segments could vary between countries.

The statistics of ARPU figures for certain markets are usually based on country statistics, where the total mobile telecom revenues are divided by the total number of subscriptions. As the future ARPU estimations are extrapolations of the historic data, this leads to ARPU forecasts that are not necessarily the right basis for the ARPU prediction for the 3G case.

Firstly, as we are modelling the usage amounts and thus spending per person, the subscription base is not the right reference, since one should look at the real average revenue per user, including both monthly subscription fee and usage tariff. In many Western European countries people tend to have more than one subscription, making ARPU per subscriber clearly higher than ARPU per subscription. For example in Finland, the subscriber penetration is near the 75 % level of subscriptions [21].

Secondly, ARPU levels differ substantially between different types of operators. Levels differ in different market areas (Eastern Europe and Western Europe), but also from country to country. Even within one country one operator might have twofold ARPU compared to another. A high percentage of business customers and high data revenue proportions are correlating with a high ARPU level of the operator. Mobile Virtual Network Operators (MVNO) in many cases focus on the low-end consumer segment competing with low costs and low tariffs. For 3G operators, it is highly important to consider their profile relating to market segment and new data related services.

3.3 Fixed-to-mobile substitution

Another phenomenon that influences mobile revenues and demand is the so-called fixed-to-mobile substitution. The migration from fixed to mobile has an effect on the mobile user and on subscription evolution. In addition, the migration implies that the services (and the traffic generated by these services) traditionally present in the fixed network are actually being moved to the mobile networks. Explanations could be that the living pattern of the Western European population has changed significantly (available always and anywhere), the mobile market is positively regulated, stable and mature, and the prices have fallen dramatically from the first days of the mobile industries, terminals' capabilities got highly improved. In Western

Europe around 20 % of all voice calls originate from mobile networks. A 50 % increase in mobile originated voice calls could increase the network traffic by 150 % according to Nokia [19].

At the moment, the voice service is predominantly affected by this phenomenon – according to Analysys [10] around 65 billion minutes of voice traffic worldwide could migrate to mobile networks from landline by 2007. Frost & Sullivan [5] report a 5 % drop in landline minutes in Europe in 2003 only. Such a substitution is a cause for the major concern among the landline operators considering the fact that voice services constitute the majority share of revenue earned and will continue to be so in the near future.

4 Status and rollout plans for EDGE and WCDMA in Western Europe

In 2000, UMTS/WCDMA was introduced as "the next big thing" of the IT and telecom world. In Europe alone, a total of EURO 120 billions were invested in license costs and about the same amount in the network deployment. This makes 3G the technology with the biggest investment in the history of telecom industry. But today's picture is slightly more moderate – WCDMA deployment has not been so fast and successful as it was believed in 2000. There are severe uncertainties related to the 3G market dynamics. In order to make forecasts for the market development of EDGE and WCDMA, we surveyed the status of the EDGE and WCDMA deployment today, and also investigated the rollout plans that operators in Western Europe either have announced or are obliged to fulfil due to the regulatory pressure.

In Finland, TeliaSonera is the first operator offering EDGE/WCDMA packet data handover in a commercial network. It means that the customers can enjoy seamless continuation of 3G services while roaming between EDGE and WCDMA networks. The handover between WCDMA and GSM/GPRS/ EDGE is crucial for better end-user experience, and the key to success of the smooth introduction of WCDMA.

In Norway, the "beauty contest" took place in November 2000 and four licences have been awarded (Broadband Mobile ASA, NetCom GSM AS, Telenor AS and Tele 2 Norge AS). The minimum conditions were WCDMA coverage for 12 defined urban areas (approximately 40 % of the population) within five years from granting the licenses. Broadband Mobile and Tele 2 have withdrawn their licences. Tele 2 has plans to become MVNO using Telenor's WCDMA network. In September 2003 Hi3G Access Norway AS (Hutchison), has been awarded a licence to offer 3G services in Norway. However, the company has not yet started network deployment in Norway.

At the moment, Telenor is running both EDGE and UMTS commercially. These were launched in 2004. NetCom experienced some delays, and plans to launch EDGE in the first place in 1Q2005, followed by WCDMA at the same time. More details on the Norwegian case can be found in Box 1.

In Germany, the regulatory requirement has imposed the licensees to realise the coverage of 50 % of the population by the end of 2005. T-Mobile has announced that it will boost its coverage to 50 % of Germany's population by end of the 2004.

In UK the coverage obligation set by the regulator is 80 % of the population by the end of 2007. O2 announced the least ambitious 3G rollout plan, a coverage map showing that its 3G service would reach 80 % of the population by 2007, just fulfilling the regulatory requirement. Other UK WCDMA operators promised to provide a wider 3G coverage than O2. For example, in July 2004, Orange announced that its 3G network already covers 66 % of the population.

The National Regulatory Authority (NRA) in France revised the 3G network rollout obligations for Orange and SFR in 2004. The deadline for commercial service launch has been set for December 31, 2004. By this date, each operator must provide 3G services in at least 12 of the largest urban areas. By December 31, 2005 both operators are required to cover 58 % of the population. In addition, ART considers that the medium-term objective of providing 3G coverage to a majority of users must be upheld. The rollout obligations for the third French WCDMA licence holder, Bouygues Telecom have been relaxed, thus giving it more time to meet its license obligations.

In Italy the original rollout requirement was to cover regional capitals within 30 months and provincial cities within 60 months. Telecom Italia Mobile has adopted the same approach for its EDGE rollout as specified by the operator's WCDMA-license population coverage obligations in an attempt to overcome the shortage of 3G spectrums.

Sweden had the strictest coverage requirements (99.98 % of the population by the end of 2003). This requirement was alleviated and the infrastructure-sharing model was allowed. According to current regulation, the operators need to offer coverage for at least seven million people by December 31, 2004, eight million by the end of 2005 and eight and a half million by the end of 2006, while the whole popula-

Box 1 – 3G in Norway

		2005	2006	2007
Telenor	Total number of inhabitants	2,820,000	3,250,000	3,750,000
	Total geographical area [km^2]	15,100	35,000	75,500
NetCom	Total number of inhabitants	1,697,635	3,365,610	3,401,600
	Total geographical area [km^2]	1,996	45,749	50,046

Table 3 WCDMA rollout for Norway

Due to slow development in WCDMA deployment the Norwegian Government suggested in February 2003 that the minimum conditions for coverage and rollout frequency encompasses WCDMA coverage to 30 % of the population within six years in order to obtain the necessary interest for the available WCDMA licenses. The Government decided to tender the two free WCDMA licenses as soon as possible, and for the licenses to be distributed by auction. At the same time the Government suggested that the two remaining WCDMA licensees, Telenor Mobil AS and NetCom AS are given a 15 month postponement regarding the licenses' obligation on rollout requirements.

In order to facilitate the development of competition in the mobile market the Government also considers the possibility of mandatory national roaming between WCDMA networks. Roaming implies that mobile network operators agree to using each other's networks. As stated in the White Paper, demanding national roaming between different WCDMA networks will be considered when the rollout of WCDMA is accomplished according to the license conditions. A possible decree regarding national roaming will be issued in accordance with regulations in the forthcoming regulatory framework for electronic communications.

Both Telenor and NetCom consider EDGE as an important step to the WCDMA deployment. Telenor launched EDGE in September 2004, and by October eleven of the largest cities in Norway were covered. The plans are to cover the 35 biggest cities before the end of 2004. NetCom have not yet launched EDGE. NetCom is upgrading its network starting in Northern Norway. The final launch for EDGE in Oslo is expected March 2005. NetCom tried in August 2004 to reduce its concession requirements by offering EDGE to a broader population and to further reduce its initial WCDMA population coverage of 76.5 %. NetCom has announced commercial WCDMA launch in March 2005, but will start some trials for business customers in 4Q2004.

tion, 8.8 million people, must be covered by December 31, 2007.

According to Global mobile Suppliers Association (GSA) [20], EDGE is commercially launched in thirty-eight networks worldwide as of October 2004. A total of 114 EDGE network operators in 67 countries have committed to deploy EDGE. In Western Europe, EDGE is launched in Finland, Norway, Italy and (a trial) in the Netherlands.

When it comes to 3G, GSA defines a commercial WCDMA network as a network that meets all of the following criteria:

- Anyone can subscribe to a service (not a limited trial or selected customers only)
- WCDMA phones or terminals are available to users
- WCDMA phones are sold to subscribers (not only rented)
- The operator has made a public announcement
- The operator charges for the service

Some operators deploy only WCDMA. After a slow start of WCDMA deployments, a significant number of new networks have been launched in Europe and Asia offering services in 2003, and several launched in early 2004. In total 120 WCDMA licenses have been awarded in more than 40 countries.

As of October 2004 GSA reports of the 50 commercial WCDMA networks in 24 countries world-wide,

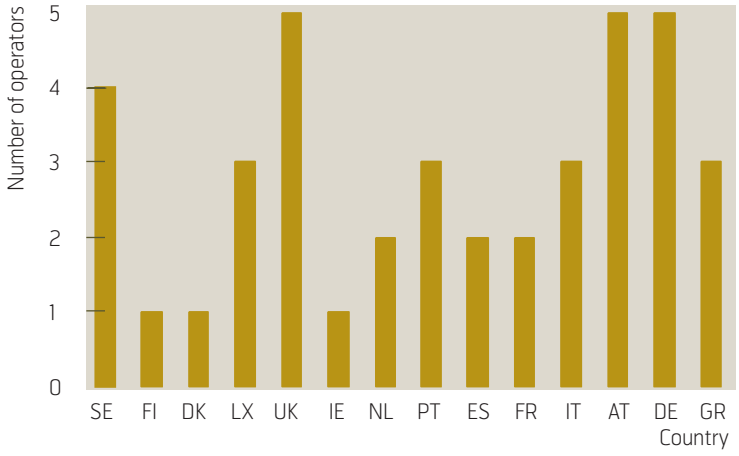

Figure 2 Overview of commercially launched WCDMA networks in Western Europe (October 2004)

Handset (by access technology)	Description
GSM	This is a GSM-only handset
GPRS	This handset may support GPRS as well as GSM
EDGE	This handset may support GSM, GPRS and EDGE
WCDMA	This handset may support GSM, GPRS, EDGE and WCDMA

Table 4 Handset classification (by access technologies)

with 40 of these in 14 West European countries (Figure 2).

As already mentioned, the analysis of rollout plans is important for argumentation built in the predictions for EDGE and UMTS subscriber penetration. For example, the UMTS subscriber penetration is highly dependent on the coverage development.

The rollout analysis in Western Europe shows that all incumbent operators with a high market share are involved in providing or deploying UMTS services. Some of them will also deploy EDGE providing data services to a broader customer base.

5 Mobile handsets

The development and the presence of mobile handsets have played a central role in the rollout of services in the past. They assured not only success but contributed to the failures, latest experienced within the 3G market.

New and advanced mobile data services require numerous functionalities to be included into handsets. Their usage depends on the capabilities of the handsets. These issues imply that the evolution of the handsets is an important factor to be considered when predicting the success of future mobile services.

Similar to services, handsets can also be classified by different criteria – by functionality, by the access technology they support, etc. We focused on the functionalities and the supported access technology, and recognised four main groups of handsets (Table 4). Note however that the subscribers who own these handsets may not necessarily be using all the technologies embedded in them. Therefore, it is not straightforward to devise a clear picture of the actual subscriber numbers for each access technology.

More details on the functionality of these four groups of handsets along with the popular names for the handsets are given in Table 5.

As we see from Table 5 the handsets have evolved from the basic voice phones to the advanced phones supporting various access technologies and functionalities necessary for new mobile data service provisioning. Major analysts anticipate for example that smart phones will be the leading handset type in Western Europe, and that the USIM will be much more significant in the next 3–5 years. For example, Yankee Group predicts that smart phones will have the majority share of sales in Western Europe by 2008 owing to lower costs and supply-side migration to WCDMA. It also predicts that all handsets sold in 2007 will have Java and colour displays while Bluetooth- and camera-enabled handsets will be close to 70 % and 80 % respectively in 2008. Push over Cel-

Access Technologies	Functionalities				
	Voice Phone	WAP Phone	Feature phone	Smart phone	Convergence Phone
	Voice & SMS	WAP browser, polyphonic ringtones, color	Speaker phone, MMS, camera, Java, MP3, email client, IM Client, M-wallet, PTT, Presence, PIM	OS-based, touch screen, QWERTY keyboard, video player, memory card, video conferencing	PDA, WLAN interface, DVB-H
2G/GSM	x				
2.5G/GPRS	x	x	x	x	x
2.75G/EDGE	x	x	x	x	x
3G/WCDMA	x	x	x	x	x

Table 5 Handset classification as considered in the ECOSYS

lular (PoC) handsets are expected to constitute 90 % of the total by 2008.

In Western Europe, the use of multi-SIM devices will decrease according to Strategy Analytics, while the multi-device segment will show an increase with nearly 10 % of users having a second handset by the end of 2008. The number of users by access technology would follow the natural evolution of the GSM family of technologies, i.e. an increase in the user numbers for GPRS-enabled handsets followed by an increase in EDGE-enabled handsets and ultimately leading to WCDMA-enabled handsets. Strategy Analytics expect approximately 45 % of all users in Western Europe to have WCDMA-enabled handsets by the end of 2008.

6 Mobile forecast modelling

Before going into the details of particular forecasts and results, we discuss the presumptions of the long-term modelling. The forecasts presented here are made for the main technologies described in Chapter 2 – 2G/GSM, 2.5G/GPRS, 2.75G/EDGE, 3G/WCDMA. Recall that the other technologies were not taken into account due to their negligible presence in Western Europe in the period considered, or their immaturity. Usually long-term forecasts are developed based on rather long time series. However, most of the mobile technologies are rather new and no historical data are available. Sufficient data are available on GSM, but we lack the historical data for the technologies introduced just recently.

Furthermore, the market considered is the whole of Western Europe. Though the picture of each particular market may reveal some peculiarities – and the picture would differ for the large country market (e.g. France, Germany) and for the small country market (Scandinavian countries) – we made a homogeneous picture that reflects the Western European market as a total. This view has been used as a basis for the forecasts. Mobile market information has been gathered from a lot of different sources. Project partners in the CELTIC project ECOSYS have collected up-to-date data of the mobile evolution. Other important sources have been consultant reports from OVUM, Jupiter, Forrester and Strategy Analytics. However, their forecasts have not been used, but ECOSYS has developed its own forecasts. Finally, the services, market segmentation, the fixed-to-mobile substitution phenomenon, and rollout plans of various operators have been taken care of when modelling the forecasts. The handset evolution, as described in Chapter 5, has been an important element when modelling the forecasts presented in this chapter. Recall that we distinguish between four types of handsets:

- GSM handset has no possibility using technologies other than GSM;
- GPRS handset supports GPRS as well as GSM;
- EDGE handset supports GSM, GPRS, and EDGE;
- WCDMA handset supports GSM, GPRS, EDGE and WCDMA.

The handset forecasts for the different technologies are called technology forecasts. This means that the market share for the GPRS technology is equal to the market share for the GPRS handsets, and the same is valid for the penetration.

So far, it is observed that the number of handsets in use is very close to the number of mobile subscribers. Very few subscribers have two handsets. In other words, the technology forecasts based on the handsets are very close to the mobile subscriber forecasts. However, the concept subscriber related to a technology/handset is not precise when he has more than one handset.

On the other hand, many subscribers have more than one subscription. It may be a combination of post- and prepaid subscriptions, and the subscriber may very well have one handset but different SIM cards (different subscriptions). Some of the subscribers also have an active subscription and in addition a subscription which mainly is not used.

Also, the issues of WLAN hot spots, and the strategic question whether the mobile or fixed network operators will go for such a solution is highly dependent on many factors, such as the focal market, company organisation and vision, competition picture, etc. In the ECOSYS project, we have plans to investigate the so-called convergence case, where we assume that fixed and mobile networks support the traffic coming from either fixed or mobile terminals, and the services are provided independently of the underlying network infrastructure, but depending on the context (location, terminal capabilities, personal preferences, etc.). In such cases the WLAN needs to be considered along with the cellular technologies, which is not the case for the forecasts presented in the following.

6.1 Forecasting methodology

As already mentioned, the analysis is mainly based on mean values from the Western European market. The models can be improved by making forecasts for particular (homogeneous) groups of European countries or by making forecasts for each Western European country. Then more dedicated information such as rollout speed, coverage of various technologies, demographics, prices etc. appropriate for the different countries will be used.

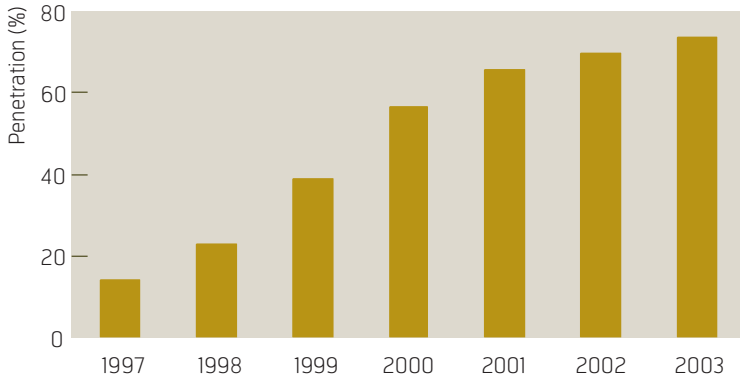

Figure 3 Penetration of mobile handsets in Western Europe 1997 – 2003

The first step is to develop a forecasting model for the total number of mobile handsets in use. As commented earlier, the number of handsets in use is very close to the number of subscribers. The model does not differentiate between the customers' segments (i.e. who is paying for the subscription), or usage of services, or ARPU, but only the terminal capabilities.

Predictions of the evolution of market shares between different mobile technologies are then developed based on a set of Logistic forecasting models. Migrations between the GSM, GPRS, EDGE and WCDMA technologies are handled.

Finally, the mobile penetration forecasts for the technologies are found by multiplying the total forecasts with the market share forecasts for the technologies.

6.2 Mobile forecasts

6.2.1 Handset penetration

The mobile handset penetration, which is very close to the subscriber penetration, in the period, 1997 – 2003, is shown in Figure 3.

Since GSM was introduced in Europe and common standards and roaming were in place early, it has witnessed a remarkable increase in the number of mobile subscribers. The Nordic countries had a significant demand even before 1997, because of early deployment of the Nordic Mobile Telephone System (NMT) at the beginning of the 1980s. However, the Western European market got a significant push only after GSM was introduced in 1992.

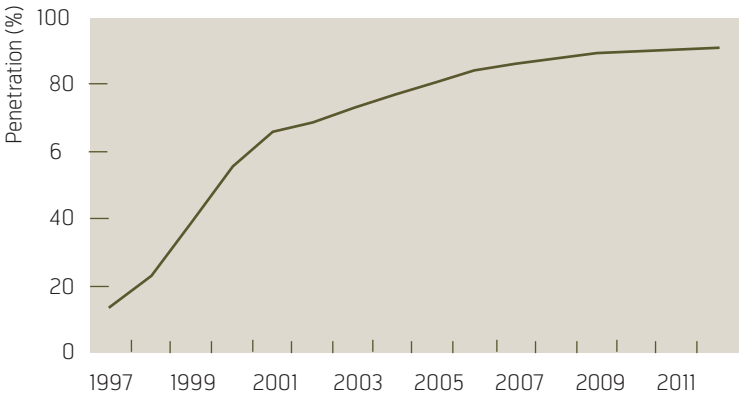

Figure 4 Mobile handset penetration forecasts for Western Europe

After the prepaid cards were introduced the penetration got even deeper. The penetration shown in Figure 4 considers all customers without differentiating between business and consumer market segments. The shape of the mobile subscriber evolution follows an S-shaped curve, pointing at diffusion models as the right alternative for modeling the forecasts. A four parameter Logistic model has been used. The long-term saturation is set to 93 %. The question is of course at what time young boys and girls will get their own mobile handsets, and how many persons will never have a mobile handset. Some arguments advocating for the 93 % saturation level are:

- Young children (younger than 5 – 6 years) will seldom have a mobile handset;
- Some people will always hesitate to buy a mobile handset;
- Very old people (older than 80 – 85 years) will not be able/willing to use the handset.

One could naturally argue that the saturation level can be either lower (on the mean Western Europe basis) or higher. For example, the saturation level could be lower if the starting age of having a mobile handset moves to 8 – 10 years. We can point it out in a Norwegian case. In 1999, eight year old children were not included in statistics since only few of them had a mobile, but by 2004 every fourth eight year old child in Oslo has a mobile handset. In addition, the fact that as much as 90 % of all 12 year olds and 100 % of youngsters aged 16 – 21 have mobiles nowadays, contributes to the expectation of 93 % saturation level for the Western Europe on average. Another argument supporting the saturation level being higher than 93 % is that the youngsters who are already accustomed to the mobile usage and handsets, in 10 years will be in the working segment of the population with their own income, and the people with mobile handsets who are now older than 70 – 75 years will be in the group of very old people. In addition, the question is how long will the last sceptics reject mobile technology given for instance new services and values that the mobile can bring to them (e.g. *e*Bank, *e*Learning, *e*Wallet).

Though the multi-device penetration is important to consider, we assume that subscriber penetration is very close to the mobile handset penetration. Figure 4 shows the mobile handset penetration forecasts for the Western European market in the period 2004 – 2012.

The next step is to make market share predictions for each technology: *Plain GSM, GPRS, EDGE* and *WCDMA*.

As already pointed out, historical data are rather important for making forecasts, and we use them here as a starting point. Figure 5 shows the evolution of plain GSM penetration in Western Europe.

The figure shows that the number of users of plain GSM has started to fall, e.g. comparing 2002 and 2003 results. In the modeling approach, it is more interesting to investigate the market share evolution where we study the relative share that a certain technology has on the market. The market share for GSM is reduced from nearly 100 % in 2001 to about 55 % in 2002. The GPRS is now capturing significant market shares from GSM. The question is how long will the GSM handsets be on the market. In addition, the EDGE system is now introduced in many Western European countries, while it is expected that also the WCDMA will be introduced in many of the countries by the end of 2004. Therefore, plain GSM will in the next years lose its market share significantly. One important factor is the lifetime of the handsets, which is currently about three years but is expected to decrease further. When a customer needs a new handset there is a high probability that the customer chooses a handset with the new technology if the subscription fee remains the same.

Based on historical evolution and knowledge, a Logistic four parameter model is applied to model the forecasts for the sum of GPRS + EDGE + WCDMA. The plain GSM forecasts are found by taking the difference between 100 % and the accumulated penetration for the new technologies. The forecasts are shown in Figure 6.

The market share for plain GSM is anticipated to decrease significantly in the coming years. Different countries will phase out the system at different times. It is therefore difficult to predict at what point the system will be eliminated from the Western European market. However, the current development indicates that there is reason to believe that after 2007 the number of plain GSM subscribers will be very limited (less than 2 %). As pointed out, one important reason is the short lifespan of the handsets.

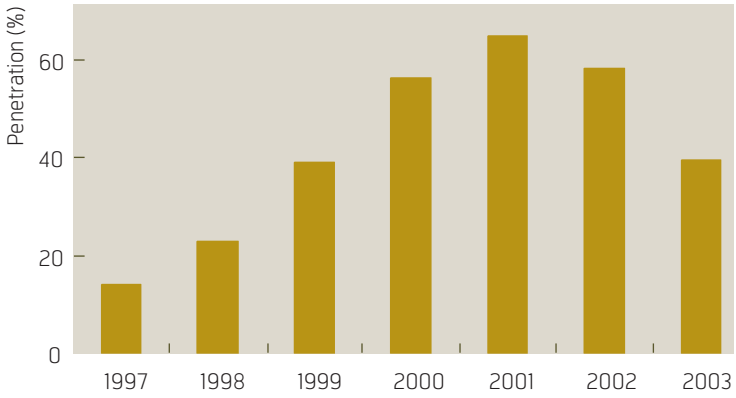

Figure 5 GSM handset penetration in Western Europe 1997 – 2003

The most important mobile system in the coming years will be WCDMA or UMTS. After a slow start, caused by high license fees in many European countries, the lack of handsets with adequate capabilities and other problems, WCDMA is now deployed in some of the Western European countries.

The presentation of the status and rollout plans for the EDGE and WCDMA for a selection of Western European countries (ref. Chapter 4) indicated rather aggressive rollout plans that may support the expectations for the UMTS launch in 2004/2005.

The WCDMA system is superior to the preceding mobile systems, especially because of its functionality and capacity. The investments in the 3G (licenses and systems) are rather heavy, and the operators want to get a significant return on their investment as fast as possible. A set of different factors such as the market, the functionality, new and enhanced services, content possibilities, the tariffs, and competition between the other mobile systems – will influence future penetration. We used a four parameter Logistic model to forecast the future market share for WCDMA.

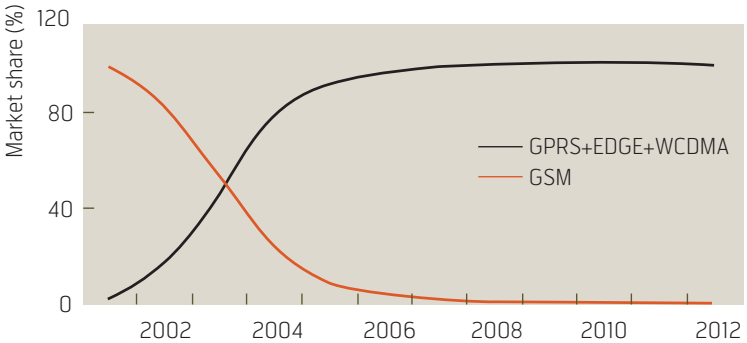

Figure 6 Market share forecasts for GSM handset and the sum of GPRS, EDGE and WCDMA handset for Western Europe

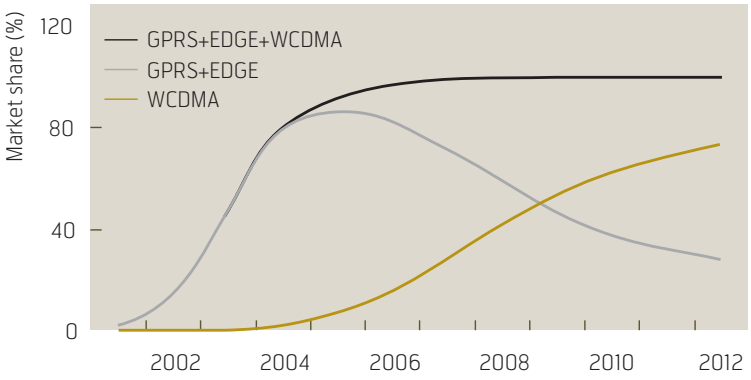

Figure 7 Market share handset forecasts for WCDMA, GPRS + EDGE, GPRS + EDGE + WCDMA for Western Europe

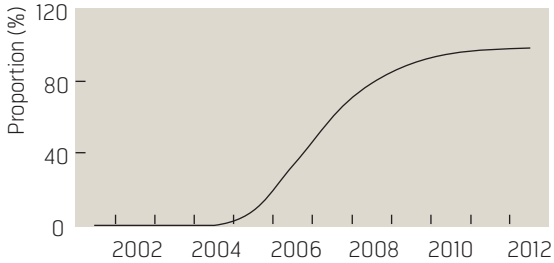

Figure 8 Forecasts of EDGE handset proportion of EDGE + GPRS handsets

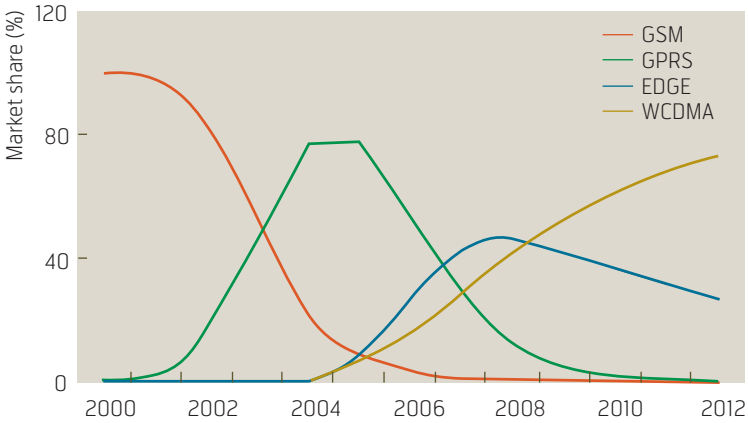

Figure 9 Market share forecasts for GSM, GPRS, EDGE and WCDMA handsets for Western Europe

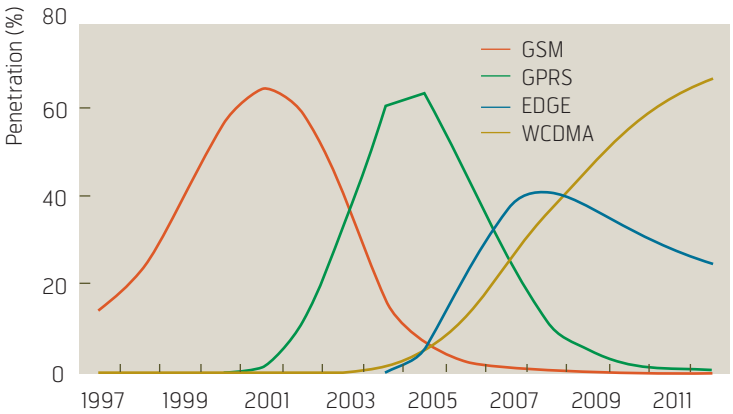

Figure 10 Handset (technology) penetration forecasts for GSM, GPRS, EDGE and WDCMA for Western Europe

The market share forecasts for WCDMA, GPRS + EDGE, GPRS + EDGE + WCDMA are shown in Figure 7.

The figure shows that GPRS and EDGE are losing their position to WCDMA in the long run. WCDMA is predicted to have about the same market share as GPRS + EDGE at the end of 2009. Here, the proportion of the GPRS and EDGE includes the uncertainty regarding the lack of historical information and the exact facts on the strategic decisions operators will make. In case many decide to go for the EDGE as the natural step towards UMTS, the EDGE share could be somewhat stronger than what is shown in the current forecasts.

When discussing the proportion of the market presence between the EDGE and GPRS, it is useful to recall that both of them are the members of the GSM family – 2.5G and 2.75G, respectively. EDGE uses the same platform as GPRS, but offers higher capacity and supports customers' demands for services that need higher bandwidth and QoS. The EDGE system is more effective than GPRS and the investments in upgrade are not very high. Some European countries are now installing EDGE, e.g. in Norway it has been commercially available since 3Q2004. The question is how fast the system will be implemented in the other Western European countries. Handsets with EDGE and GPRS functionality are already available on the market, but due to the stronger capabilities of the EDGE system one can expect the GPRS handsets to be phased out after some years.

Figure 8 shows how the proportion of EDGE handsets increasees compared to the EDGE and GPRS total (GPRS+EDGE). It defines the market share evolution for EDGE and GPRS.

An overview of the market share forecasts for all four technological solutions, i.e. GSM, GPRS, EDGE and WCDMA is shown in Figure 9.

The figure shows that GSM will lose significant market shares in the coming years. GPRS will reach its maximum level at the end of 2006. The WCDMA technology is predicted to be the dominating technology in Western Europe from the end of 2008.

As a result of the market share forecasts and the total mobile handset forecasts, the penetration forecasts for each technology are found by multiplying the mobile handset forecasts by each market share forecast. The technology penetration forecasts are shown in Figure 10. The figure reflects the penetration forecasts for all of the considered technologies. GPRS will in a year or two reach the same penetration level as GSM had

in 2001, and it is interesting to note that an "early" introduction of WCDMA compared to EDGE seems to reduce the maximum penetration of EDGE.

6.2.2 Subscription forecasts

A rather simple forecast model has been developed for the mobile subscription forecasts. It is assumed that the long-term saturation for the subscriptions is 115 %. The saturation level for the subscribers was 93 %. It is assumed that the number of additional subscriptions is proportional to the penetration of each technology. The subscriptions are divided into three classes:

- GSM
- GPRS+EGDE
- WCDMA

Since GPRS and EDGE are quite similar and use the same network platform, it is expected that these technologies will constitute a common subscription class.

The resulting penetration development is shown in Figure 11. The figure shows that the subscription penetration reaches nearly 110 % in 2012. Since the subscription penetration is evolving continuously in the period 2001–2012, the WCDMA subscription penetration is expected to reach the peak level of GPRS + EDGE in 2012/2013.

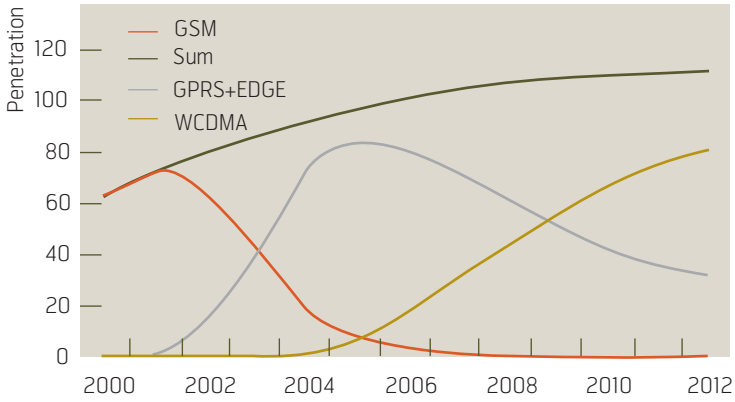

Figure 11 Mobile subscription forecasts for GSM, GPRS, EDGE and WCDMA for Western Europe

7 Conclusions

Long-term mobile forecasts have been developed for the Western Europe as a whole. The forecasts are made for handsets and subscriptions and segmented in Plain GMS, GPRS, EDGE and WCDMA (UMTS) technologies. While historical data for GSM are available, only limited demand data exist for the new technologies – GPRS, EDGE and WCDMA. A reason for this is simple – these technologies were not present in the market long enough – GPRS has been on the market for about two years, while EDGE and WCDMA are being introduced now. Important elements in the forecasting input are techno-economic evaluations of the technologies, rollout plans to the operators, handset technologies and handset lifetime. Additional uncertainties bring the variation in EDGE and WCDMA rollout plans in the different Western European countries.

The long-term forecasts show that GMS handset penetration will be quite low in 2007. The GPRS technology is taking over followed by EDGE, which uses the same platform. The WCDMA technology enters the market based on significant rollout and launch in 2004. The handset (in use) penetration as a mean for Western Europe is about 70 % in 2002 and is expected to reach 90 % in 2010.

The Western European long-term forecasts show the future evolution of the new mobile technologies EDGE and WCDMA. The results are used as input to techno-economic evaluation of mobile business cases and rollout strategies. New forecasts, limited to specific country groups or countries, will be developed as input to the different techno-economic analysis. These forecasts will reduce the uncertainty to some extent, because of the possibility to include more precise information like rollout plans and other type country specific information.

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For a presentation of Kjell Stordahl, please turn to page 2.

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