UMTS Report

An Investment Perspective

[RESEARCHING THE FUTURE // INVESTING TODAY]

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1 INTRODUCTION

1.1 HIGHLIGHTS

- **M-commerce is dead, long live m-commerce.** We believe that m-commerce in the closed sense will not survive as a stand-alone business model. Instead, we expect to see the rise of multi-channel commerce (i.e. MC-Commerce), which will include a significant proportion of revenues from mobile commerce. Consumers will become increasingly exposed to digital media irrespective of the device (whether PC, mobile or iTV etc.) Portals and most applications will have to incorporate a multi-access approach.
- **Mobile internet services in Europe will be worth over €76 billion by the year 2005.** We forecast that the European market for mobile internet services (including mobile data traffic) will be worth €76 billion by the year 2005 if UMTS networks, handsets and services are available on time by early 2003. The value for those services represents about 45% of all mobile communications revenues, which will top €170 billion. The entire non-voice services market will continue growing at an annual rate of 72%. These forecasts depend largely on the ability of operators to adopt a new partnership model (with virtual operators, application and content providers), to offer attractive and comprehensible pricing schemes, and to improve their marketing capabilities.
- **UMTS license costs will not hinder mobile market development.** We believe that UMTS license costs in Europe will total €120 billion, but that this will not hinder development of the overall market, despite the fact that winners of licenses in the higher priced countries (Germany, UK, Italy) have recently been punished by credit rating agencies and by the stock market over fears that they have over-paid. We expect that by 2005, license costs will have been built into business models and will be largely forgotten by the markets. Only a few smaller carriers that have obtained expensive licenses but are unable to achieve a market share of over 25% will eventually become victims if they are not cross-subsidised by activities in other markets.
- **We will see a re-emergence of the service provider concept and an explosion in mobile services and applications.** Together UMTS network and license costs across Europe will reach a level of about €260 billion. To recoup their investments operators will be pressured to generate revenues by

1. *Pushing more advanced, revenue-generating services to the market.* We believe that there will be an explosion in mobile applications and services, with over 3000 running over mobile networks within the next five years. Many of these services will be created by companies that have not yet been established.
2. *Allowing the rebirth of the service provider concept.* We believe that operators need to act as wholesalers to Virtual Operators (VOs) in order to penetrate the market quickly. Successful VOs will be built around existing strong brands from the telecom as well as retail, media, financial and automotive industries.

- **GPRS is key enabling technology.** Applications, which were developed for WAP over GSM will start to generate revenues only when GPRS is widely available in the mass market (by mid 2002). The top revenue-generating services will include mobile multimedia messaging, mobile games and mobile brokerage. Packet-switched GPRS is the key technology enabler for mobile IP and provides a significantly more compelling user experience than existing GSM. The subsequent migration to UMTS will initially add only more spectrum to allow a greater number of users and will later provide more capacity.
- **WAP will be successful after all.** We believe that WAP will eventually emerge successful in Europe despite initial difficulties in generating active users. However, WAP 's success will lie primarily in the GPRS presentation layer for more phone-centric devices. By contrast, PDAs will be connected to the internet not via WAP but via a conventional HTML-browser.

- **We will begin to see the first casualties among WAP mobile start-ups. SMS will make money now, GPRS/UMTS will make money in the future.** The delay in uptake of WAP is beginning to create early casualties among mobile service and technology start-ups. We expect there are more casualties to come. Successful firms will refocus on revenue-generation using available technology, such as SMS. The most interesting investment opportunities will arise around next generation applications that are enabled by GPRS/UMTS and are thus more interactive, rich and appealing to the customer.
- **UMTS will not enable mobile multimedia for many years.** UMTS will not enable the mobile multimedia world heralded by operators and equipment vendors within the time frame predicted. The European consumer will have to wait for at least another four to five years to experience mobile audio streaming of songs or video streaming of short movies to be available conveniently at somewhat affordable prices. The main reason for this is that the network will reach a realistic data rate of only around 40 kbps towards the beginning of 2003, rather than the promised transmission speeds of 2 mbps with UMTS. Bandwidth limitations will be alleviated largely only by the introduction of 4G after 2008/2010.
- **Wireless LAN (WLAN) will become a public network technology.** Alternative technologies will challenge UMTS for dominance in the wireless market, such as WLANs (Wireless Local Area Networks) used in the public network. Large, densely populated cities are already being covered by these networks. However, the mobility features of UMTS will provide a strong differentiator as the WLAN market has still not developed a single standard. DAB (Digital Audio Broadcasting) will provide a compelling supplementary technology to UMTS.
- **Hardware availability will be key to applications availability.** Hardware availability will become a critical driver and/or inhibitor for mobile applications. Batteries with high life expectancy and powerful colour displays will be necessary to enable advanced applications. Handset vendors have become a bottleneck for the industry as they continue to delay introductions of new generations of terminals. Japanese and Korean vendors will enter the European marketplace for mobile devices successfully, and will challenge the current leaders. We expect UMTS equipment vendors to have difficulties rolling out 70 networks over the next three to four years almost simultaneously across Europe.

1.2 INVESTMENT HYPOTHESIS

The overall investment climate for TMT companies has changed considerably over the past year. Significant corrections in the market since Spring 2000 have impacted internet, technology and communications stocks and thus, also the mobile communications segment of the market. Multiples (in terms of EV/Revenues 2001) of European mobile operators have come down from a level of 19.5 in June 2000 to around 2.7 today. However, those operators that are highly mobile-focussed, such as Vodafone Group and Telecom Italia Mobile, are still performing better than the telco incumbents (who also have other lines of business), e.g. France Telecom and Deutsche Telekom.

Some of the reduction in Enterprise Value of mobile operators in Europe (a reduction averaging -28%) can be attributed to the UMTS licensing process, which has created financial bottlenecks for many established players. We expect to see three key developments occurring first in the markets with very high license costs: opening of the market to new players, better applications and services, as well as increased effectiveness of operations. Operators, who have spent more are under more pressure to recoup their investments in UMTS licenses and networks.

So far, the mobile telecom market has been characterised by land-grabbing for new customers, in a similar way to the fight for market share which we saw earlier in the internet market. Activities such as acquisition of customers at nearly any price through M&A activity (Deutsche Telekom was offering to pay over €20,000 for a VoiceStream customer) or the provision of heavily subsidised handsets for prepaid customers were key to achieving preferable valuations. It was all about getting new phone customers, who would supposedly become valuable m-commerce customers (similar to free internet access or portal customers, who were supposed to become valuable e-commerce consumers).

As penetration rates have topped 63% across Europe and market saturation is getting closer (typically experienced at about 87%), operators' strategy must shift towards maximising revenues and profitability in order to beef up investor confidence (and their multiples) during 2001. Once more, this trend is occurring in parallel with developments in the internet world, where only a few top internet access provider and portals are likely to survive the shakeout in each market. However, in contrast to many internet access providers and portals, mobile operators generate significant revenues and have real paying customers.

We believe that in order to generate additional revenues in the near future operators must use multiple distribution channels to market and push services to customers directly as well as via VOs. Additionally, we believe that during the next five years, a plethora of innovative services and applications will appear. These must be sufficiently compelling to benefit from widespread user adoption, and must be priced attractively. Supply and demand will determine fair prices for these services – we believe that the usage driver will dictate that these cannot be too expensive for mass market adoption.

Pushing advanced mobile data services and content will be the only way forward for operators to recoup their investments. This, in turn will generate significant start-up activity and investment opportunities.

Mobile operators will need to act quickly and turn themselves around from a network development, voice-centric and customer acquisition-focussed organisation to one which is essentially a portal business managing numerous partner relationships next to an almost independent infrastructure-operations business.

We see the focus of investment activity in the market shifting towards mobile internet enabling technologies and revenue-generating mobile services for SMS, GPRS and UMTS. Tremendous opportunities also exist for technologies around the public use of WLAN technology, and in advanced billing platforms.

Advanced equipment and device manufacturers, such as Nokia, are shifting their strategic orientation towards becoming Wireless Application Service Providers (WASPs) for the mobile industry in light of eroding margins in the handset business and slower growth unit sales as markets get closer to saturation.

1.3 METHODOLOGY

Research for this report commenced in June 2000, and in the interceding months the mobile communications market has experienced many changes. Indeed, there are few areas where the words written on one day have not been superseded within days by further market developments. As will become evident through the report, there are numerous additional notes that illustrate these markets changes, and explain how we believe they will affect its future.

Notwithstanding this pace of market development, we have published this report with the intention of providing the mobile commerce community, e.g. application providers, operators, equipment vendors, ventures capitalists and others, with pragmatic views and analysis of the upcoming developments with respect to UMTS (Universal Mobile Telecommunications System) in Europe. In this new report we are building on the research and results from the Durlacher Mobile Commerce Report of 1999, but we have developed the views further. We have again made our best effort to come up with forecasts on market growth and outline the applications that will drive adoption of new technologies.

The report does not aim to provide an exhaustive overview of the UMTS market place. Instead it analyses the enabling technologies and the implications of the introduction of next generation mobile technologies to Europe. In this report, we attempt to discuss important technology trends and mobile data applications that will be enabled through the 3G environment. In particular it should be noted that we explicitly exclude in-depth analysis of any of the equipment vendors or operators.

Many of these observations are not unique to Europe and we believe that trends from other areas of the world (especially Japan) are significant and important for the future of UMTS in Europe as well.

Primary Research

Over the past the nine months, Durlacher Research Ltd., Eqvitec Partners Oy and the Helsinki University of Technology have joined forces to conducted original research and numerous interviews and discussions across Europe, the US and Asia. We have exchanged ideas with industry leaders from all sides of the mobile industry, such as mobile network operators, virtual operators, application providers, portal companies, equipment vendors etc.

However, the market for advanced mobile applications is still in the early days of its creation and UMTS infrastructure has nowhere been installed. In such a young marketplace, it is almost impossible to extrapolate long-term trends from an early developmental snapshot.

1.4 SCOPE

Although this report is titled UMTS, it is focused on investment opportunities in the applications and services as well as the enabling technologies arena of the mobile telecommunications industry. While UMTS is only one technology of many, discussions about the licensing processes across Europe have centered the public attention around this single standard.

In this report, we avoid consciously to refer to UMTS applications as it does not seem to be a sustainable category in itself and to m-commerce as it has been used with too many interpretations over the past 18 months. For this report, we assume that attractiveness of applications and services will drive consumer uptake rather than availability of one particular technology, such as UMTS. On the other hand, we use the more classical, operator-oriented definition of data transmission and content & services since m-commerce has been used with varying definitions, so that currently there does not seem to be a common clear understanding of the concept in the market. This is providing also valuable input to validate the business case for 3G operators overall.

This report intends to provide the European view of global developments in the mobile industry with an analysis of how applications and services will emerge over the next 5 years.

2 CURRENT MOBILE MARKET OVERVIEW

- As the mobile market moves towards saturation, and capacity bottlenecks become a foreseeable reality, UMTS networks will become a solution for these two problems. UMTS will provide additional spectrum capacity and will enable revenue-generating services.
- Investments in UMTS licences and UMTS infrastructure will total €260 billion in Europe alone, and this will create significant pressures on Mobile Network Operators (MNOs) to aggressively push UMTS technology and advanced services.
- The time span for UMTS hegemony will be limited due to introduction of complementary 4G (Fourth Generation) technologies by 2008-2010
- The emergence of global operators and global operator alliances such as KPN-TIM-NTT DoCoMo will bring increased market complexity.
- i-Mode will try to position itself as an alternative to WAP in Europe. We doubt whether i-Mode will be as successful in Europe as in Japan. We expect i-Mode to face an uphill struggle as it requires the adoption of new types of handsets, new system infrastructure, robust pan-European partnerships, and services and applications that will differentiate it distinctly from those that will already be available in the European market.
- We expect to see a rapid growth of the mobile data market and up to 350 million connections until 2005.
- We believe that as many as 3000 new mobile applications are expected to emerge over the next few years.
- Durlacher projects the ARPU to bottom out during 2003 at a level of €35.6 per month and then pick up, growing to €40.9 per month by 2005.
- Japan is the world 's mobile data leader and is two years ahead of Europe. We believe they will maintain this position over the next five years.
- The US has assumed a waiting position in terms of introduction of UMTS. The FCC is planning to begin auctions in 2002.

2.1 THE UMTS DREAM

Today 's mobile data user has a poor experience. Devices are poorly designed and have a difficult user interface. WAP gateways suffer from high downtimes, and assuming that end-users do get through, calls are dropped easily. More importantly, the experience is not immediate: end-users still need to dial-up for a connection, and set-up times are long, which further frustrates end-users. Speeds are low, and transactions are not secure enough. Application design is poor as well: navigation is cumbersome because menu structures are complex and endless click-throughs are the name of the game. In short, today 's value propositions, for most services, fall well short on end-users' expectations.

UMTS is one of the key building blocks that will drastically improve the value proposition. GPRS is a significant step in the right direction as it is the first digital packet switching technology to become a mass market proposition, enabling mass market IP-based services for mobile end-users. GPRS also provides the always-on experience which means that end-users can choose to be in 'receive-mode' and/or 'send-mode' all the time, wherever they are. GPRS has shortcomings, however, which are mainly driven by the fact that the technology still operates in the GSM frequency bands. This means that data traffic will compete with voice traffic on the GSM network. UMTS network operators can solve this problem because they will have access to new frequency bands and significantly more capacity to carry both voice and data traffic. Congestion issues will no longer be significant.

UMTS is a digital packet switching technology and offers similar benefits as GPRS (always-on, and optimised for IP). UMTS speeds will be higher than on GPRS and more consistent too, because competition between traffic streams will be less intense. The quality of the transmission will be higher as well. As most MNOs are obliged to meet UMTS network

coverage criteria, end-users can look forward to a ubiquitous network, although we do not expect that MNOs will have completed the roll-out of their UMTS networks by 2005, or that the coverage will ever be as good as that of current GSM networks.

The increased capabilities of the UMTS network versus other type of mobile data networks will also allow for a much richer service environment. By 2005, always on connectivity to dynamically changing data will enable users to be proactively updated on events (what's on), their location, and optimal routes for reaching their destination. End-users will be able to receive rich and relevant information that is time sensitive and will be able to act on this information quickly in a convenient and effective way. End-users will use their devices to read their local newspaper abroad, to make purchases or simply use it to figure out more about a particular product they are interested in. Widespread adoption will foster the concept of communities on the move - with dynamic communication occurring between family members, friends or people that share an interest, and this will drive advanced forms of messaging. After 2005, video, TV and rich images will start to appear on mobile devices too.

As mentioned, UMTS is an important building block because it has the potential to provide a high quality network infrastructure for advanced forms of mobile communications. But UMTS is not the only communications technology that will emerge in this period. Other types of high-speed data communications technologies will become important as well, and will probably work in conjunction with UMTS, which raises the importance of middleware technologies to glue the different communications networks together. These networks include Bluetooth technology (for very short ranges), WLAN technologies (for short ranges), the existing GSM network infrastructure and also satellite networks (for global communications). Technologies that will optimise performance of this entire infrastructure will gain in importance including, for example, compression technology, spectrum management technology and frequency hopping technology.

Technologies that allow providers of services to refine their service portfolio will be critically important as well: security (to increase the quality of payment and transaction services), analytical tools (to increase the effectiveness of marketing and advertising), personalisation (to personalise the end-user experience), and location technologies (to enable location based services).

2.2 MARKET DRIVERS

2.2.1 Mobility in Europe is booming

Since the introduction of GSM technology in Europe, the market for mobile services has grown extremely fast. By the end of 2000, 252 million people in Europe used a mobile phone (63% of the population). This is eleven times the number of mobile end-users at the end of 1995. These numbers clearly show that Europeans enjoy 'mobility' and embrace the fundamental benefits that GSM has to offer:

- **Mobility** – instead of people going to phones to communicate, it has become common practice for phones to follow people. The development has dramatically altered the way in which people communicate.
- **Immediacy** – because GSM-based devices are small and portable, most people take them with them most of the time, which means that is has become much easier to communicate with people directly;
- **Ubiquity** – good national and international coverage of GSM-based networks means that communication devices can follow people anywhere they go and people can use them at anytime.

2.2.2 2001: Crossroads in the European Market

Despite the rapid growth of the mobile market to date, the market climate is changing, which is leading many industry participants to a crossroads in the market. Two key factors are driving this:

- **The mobile voice market is reaching saturation.** By the end of this year, 76% of Europeans (or 306 million people) will use a mobile phone, up from 63% at the end of 2000. We expect this market to saturate at around 87% of the population, which means that the market is already approaching saturation.
- **The mobile data market is largely untapped.** Investments in a new wave of wireless technologies, including UMTS, are lowering costs and speeding access to new value added services at a network level. However, because of handset and service delays, end-users do not have access to these new wireless technologies yet, which means that, with the exception of SMS (Short Message Service), the market for advanced value added services is still largely untapped.

On the one hand, MNOs applaud themselves for having successfully developed a mass market for mobile services in record time. On the other hand they, and providers of capital in particular, are in the dark as to how they will recoup the high investments they must make in their future. As the bulk of these investments will be allocated to UMTS-related areas, we understand that the industry may look towards UMTS as the scapegoat for the financial misery of mobile industry players. However, UMTS is just one of many technologies that will be introduced over the next five years: they command investments too. Some of these will compete outright with UMTS, but most will work in a complimentary fashion.

What has added to market difficulties, besides the unexpectedly high UMTS license fees in some countries, is the delay in the introduction of key 'interim' technologies. The non-availability of GPRS-handsets, for example, is a setback for MNOs, because it is denying them the opportunity to launch real commercial services well before the uptake of UMTS. Unfortunately, it is not the first time that the industry has experienced such a delay in the availability of end-user equipment: the same was true when GSM networks went on air for the first time, and the story repeated itself when MNOs started to deploy dual-band GSM networks. At both times the lack of handsets resulted in network resources lying idle. The same problem applied to the availability of WAP-enabled handsets, and when they finally arrived, WAP's positioning as the key-enabler for the mobile internet and its failure to deliver on inflated end-user expectations severely affected the credibility of the mobile industry.

SMS has increased the confusion. Despite the fact that SMS is very difficult to use, it has become very popular very quickly over the last three years. Some are cynical about the significance of SMS to the market and argue that it is 'just' kids using the medium, but we do not support this notion. Looking at revenues alone, SMS services are already significant. In Europe, SMS person-to-person messages generated €4.3 billion in 2000. More importantly, the margins on SMS traffic are very high and contribute significantly to profits of MNOs.

It should be recognized that SMS has been around from the moment the first GSM network went live in Europe. It only became popular, however, when the overall market reached mass market status, creating a critical mass of potential SMS end-users, which untapped and triggered huge demand for person-to-person messaging. This development took the market by surprise, without MNOs actively promoting SMS. MNOs were in a position to benefit immediately because most end-users already used SMS-enabled devices. We draw a few important conclusions from this:

- Critical mass increases reach and usefulness of a medium.
- SMS may seem difficult to use, but people do value SMS and they pay for it. The benefits of SMS outweigh inconvenience, and this creates value.
- Users need capable terminals to propel demand. The success of SMS shows how Trojan horse strategies can be highly effective.

Because new wide area network technologies such as GPRS and UMTS are optimised for IP traffic, integration of mobile networks with internet services will create ubiquity from the day GRPS-enabled devices are launched. Initially, the internet will provide the scale that requires IP-enabled mobile devices to be successful. As the installed base of IP-enabled devices starts growing, the internet will increasingly benefit from the effects of this increase.

In short, the features and benefits that end-users appreciate in SMS are here to stay and will only become richer once new technologies come to market. The incubation time of key technologies such as GPRS and UMTS will be shorter than in the case of SMS, because these technologies are much better suited to work with IP-enabled technologies and will be able to draw upon the broad end-user acceptance of the internet. The same criteria triggered and stimulated the success of SMS.

2.2.3 Will the mobile data market fly?

We believe that the mobile data market has strong potential and that key commercial and technology drivers are aligned for growth:

Commercial drivers. The benefits of anywhere, anytime commerce apply to all segments in the market, but different value propositions exist in different segments. Businesses have already recognised that mobile voice services enhance the productivity and efficiency of their operations, and are now looking at ways in which they can integrate mobile data technologies in their business processes, with an eye to unleashing new productivity gains. Mobile data technologies will apply to all processes in an organisation, including those that determine relationships with clients, suppliers and employees (see chapter 5). We believe that most businesses recognise these benefits from a conceptual point of view, but most are struggling to figure out the actual return they will derive from an investment in mobile data technologies. This is likely to delay their investment decisions. Consumers like mobility as well, but look for value in different ways. Value propositions need to be developed accordingly: soft factors such as fun (games), convenience (your milk is running out, shall I order a new bottle?), and security (people tracking) will become much more important. It will not be possible to quantify the benefits. However, the price of services will continue to be important.

Technology drivers. We have already seen the arrival of a number of new technologies over the last year (WAP, location sensing technologies, mobile payment systems, WLAN in public areas), but this is just a start and the introduction of new mobility-enabling technologies will continue to accelerate throughout 2005 and beyond. These technologies will touch every aspect of people's lives and range from 'things' that people use (mobile access devices, but also vending machines, parking meters, cars and applications), the networks that connect 'things' (GSM, GPRS, UMTS, Bluetooth, WLAN, satellite networks, etc.), and the systems that will make 'things' more useful (application servers, e-commerce platforms, middleware technologies or more accurate location sensing capabilities). The challenge clearly lies in the seamless integration of these different technologies to present end-users with a seamless end to end experience.

Wireless technologies are not only about people. Inherent in the absence of wires is a flexibility that allows machines to communicate more freely with one another. Wireless Machine-to-Machine (M2M) communications, for example, can drastically reduce the cost of connecting machines in remote areas. This advantage would apply to the installed base of remote machines, but will also boost the growth in the installed base of remote machines because they can be deployed more cost-effectively. In addition, freeing machines from their fixed locations by cutting their wires (which includes wires for communications, but also for power) make them more flexible to deploy and this will reduce their cost of ownership and/or increase efficiency and effectiveness of processes. This concept applies to a wide range of machines, ranging from standard products, such as wirelessly enabled laptops, to very specialised machines and/or devices.

2.2.4 The mobile data crunch

Technology glitches will always occur, and these may affect markets, but we do not believe that these glitches will fundamentally alter the long-term trend towards ubiquitous connectivity and computing. In the short-to-medium term, however, technology glitches are important and need to be recognised. Technological changes will continue to happen quickly and this will have a tremendous impact on the lifecycle of products. We believe that lifecycles for

products and services targeted directly at end-users will become shorter all the time. Devices and applications will quickly become obsolete, which means that a company's survival in the mobile market will largely depend on how well and quickly a business embraces new technologies. All parts of the organisation (strategy, sales and marketing, R&D, support) must feel this need to embrace change quickly and without hesitation.

The fact that WAP has not delivered against end-user expectations does not prevent the evolution of the mobile data market and will not hinder the commercialisation of other technologies such as GPRS, EDGE, and UMTS. WAP will get a second chance – it is bearer independent and will be available on GPRS handsets too. The combination of WAP with GPRS will deliver end-users a much better experience than they would receive today with WAP over GSM circuit switched networks. In contrast to SMS, WAP has not built up goodwill because its benefits currently do not outweigh its inconvenience (the latter driven by long connection times and hence lack of immediacy). WAP has experienced gateway connectivity problems, and the introduction of devices were delayed, connection inefficiency and high priced WAP services. With the arrival of GPRS and UMTS, many of these constraints will diminish and will open the door for the introduction of IP-based services in all segments of the market.

A similar notion affects the lifecycle of network technologies, although these lifecycles are much longer. GSM network technology, if properly maintained and invested in, will remain with us for the next 10 years, and has already been around for at least eight years. The lifecycles of GPRS and UMTS will be much shorter. GPRS, for example, will be commercially introduced this year and will reach its peak, we expect, in 2007, by which time it will have been overtaken by UMTS. The same will apply to UMTS as the industry starts working on 4G technologies.

2.3 UMTS INVESTMENT

2.3.1 Investment Drivers for UMTS

The vast growth in the number of mobile customers, and increased voice usage per customer, has led to a serious increase in demand for voice traffic, which has created significant capacity bottlenecks, especially in dense traffic areas. This has affected network performance, with decreasing levels of quality of service. With the introduction of packet-based technologies, small data packets can be sent more easily and efficiently in the GSM frequency bands, but we doubt that increased efficiencies will be sufficient to cope with the increase in data traffic that we expect to occur over the next five years. In short, capacity constraints on current networks are an important reason for MNOs to invest heavily in UMTS licenses.

Hedging against uncertain market conditions is another important reason why MNOs paid lots of money for UMTS licences in some countries. In situations such as auctions, bidders know two things for sure. Firstly, bidders know that they need to make a decision, and secondly bidders know that the outcome of that decision will have serious implications. The decision making process is complicated by the fact that bids must be made in the context of direct competitors bidding as well.

A bad decision for an MNO would have been to withdraw from a UMTS auction and to later see UMTS become successful. This was a scenario any operator had to avoid as it could have marginalised their business, particularly if direct competitors had bid successfully for a license. Not participating in the bidding process would have been a good decision only if UMTS network operators failed to deliver the revenues necessary to pay back their UMTS investment. To withhold from bidding, an operator would have had to believe strongly that UMTS would not generate the value required to make the desired return on investment. As part of this decision, bidders would have evaluated the value of alternatives. Alternatives would have included the option to deploy other high-speed data technologies (such as EDGE) using existing GSM frequency bands, and this would have introduced another series of uncertainties including availability of EDGE-enabled handsets and capacity shortage issues. In short, we believe that for operators, the perceived risks of not bidding for a UMTS license were far greater then the risks associated with bidding.

2.3.2 UMTS License Fees Will Total €120 billion in Europe

We expect governments in Europe to award 70 UMTS licenses in Europe and the vast majority of these licenses will be allocated to incumbent MNOs. Many new potential entrants lost interest in the European UMTS market after prices for UMTS licences, unexpectedly, skyrocketed in the UK. The government in the UK raised €39.3 billion in fees from five MNOs, which is €31.2 per head of the population per year. All of a sudden, many national governments realised that UMTS fees could be extremely valuable and this set the scene for a feeding frenzy among governments trying to maximise the proceeds of access rights to UMTS frequency bands. The outcome was disappointing for many governments and only the German auction resulted in a per capita fee (€30.9 per head of the population per year) that was similar to the per capita fee in the UK market. All other countries raised fees well under UK and German levels. Our current estimate (February 2001) is that governments in Europe will raise a maximum of €120 billion in fees.

Our analysis shows that MNOs in Germany, the UK and Italy will account for 85% of the license costs across Europe (see figure 1). This percentage holds no relation to the market share these countries provide. According to Gartner Dataquest, mobile services revenues in these countries accounted for 51% of total service revenues in the European market, while their share in the total number of connections in Europe accounted for 45%. This means that MNOs in Germany, the UK and Italy bear an excessively high percentage of total UMTS license costs. Besides these three countries, MNOs in other European countries do not suffer from excessively high UMTS license fees. UMTS license fees will thus not hinder the development of UMTS in these countries.

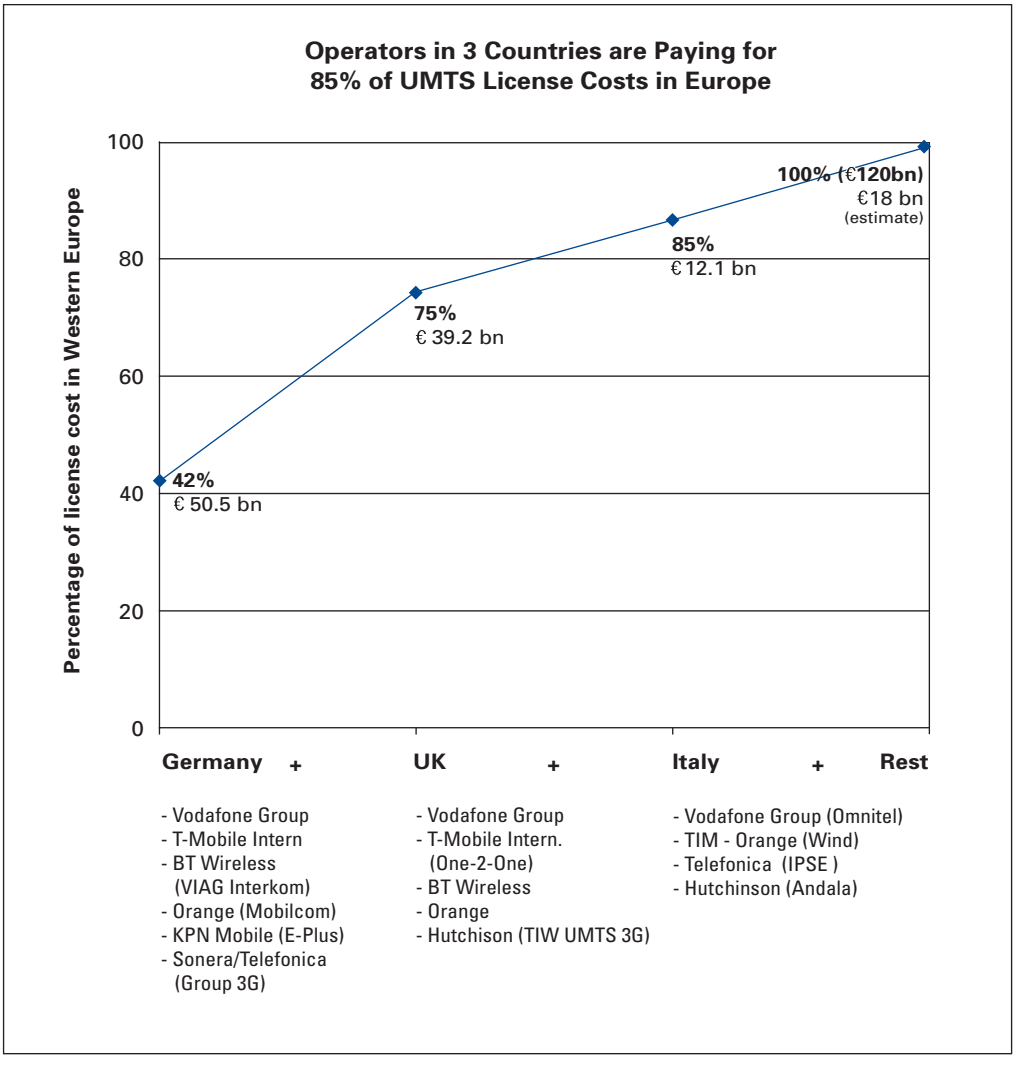


Figure 1: Distribution of licence cost burden Source: Durlacher Research Ltd., EQVITEC Partners Oy

Furthermore, in the high-risk countries it is mostly the large European MNOs that have exposed themselves to the high UMTS license fees. Casualties may occur among smaller UMTS network operators in high-risk markets if they fail to build up sufficient market revenue share over the next five years.

In the Asia Pacific region, local players have received the majority of licenses granted, mostly because local regulation does not allow for fully foreign-owned companies to run networks in those countries.

In the United States, frequency blocks required for the next generation systems have to be released first from their current holders, which mostly consist of cable television companies and other authorities. The Federal Communications Commission (FCC), the U.S. radio frequency authority, has postponed its planned auctions to 2002, which has further delayed the development of the UMTS market in the U.S.

2.3.3 Infrastructure Costs Will Top €140 billion

3G operators will make heavy investments in UMTS infrastructure. Our analysis shows that the costs of building 3G networks in Europe will be in excess of €140 billion. The German UMTS network operator Group 3G, a joint venture between Telefonica and Sonera, estimate that they will spend €8 billion to deploy a UMTS network that covers 90% of the German territory. With relatively few manufacturers of UMTS equipment, we expect that some MNOs will run into difficulties with the delivery and deployment of their UMTS network equipment.

Established mobile network equipment players such as Ericsson, Nokia, Lucent, and Nortel will be challenged by companies with stronger IP skills such as Cisco and some of the smaller Japanese players such as Fujitsu, Hitachi, NEC and Mitsubishi. Infrastructure vendors that are actively involved in the Japanese market will gain a competitive advantage by having the benefit of deploying the first commercial 3G networks.

2.3.4 Handset Subsidies Are Here to Stay

To date, we estimate that the global installed base of terminals amounts to 600 million voice centric terminals, and 'only' 30 million internet-enabled mobile phones and PDAs, including those enabled through WAP or i-Mode micro browsers.

Widespread adoption of mobile data services requires the replacement of the current installed base of mobile phones. This should have a positive impact on the volume of terminal devices, especially because the life cycle of a mobile phone is dropping to 15 to 18 months. However, considering that the growth of the mobile customer base has grown very quickly over the last 12 to 18 months, there are many people with relatively new mobile phones and it will be a challenge to convince these people that they need to upgrade their handsets to the latest technology. It will also be costly, because end-users (and MNOs for that matter) are 'addicted' to heavily subsidised terminal equipment. As competition intensifies over the next five years, driven by the entrance of new UMTS network operators and a larger number of VOs, we do not believe that the market can afford to break with this tradition. We note that MNOs in different countries have different strategies in this respect (MNOs in Finland do not use handset subsidies for example), but the vast majority do rely on this practice. This means that customer acquisition and/or retention costs will remain a major line item in the profit and loss account of the vast majority of MNOs and VOs.

Currently, buyers of mobile phones are encouraged by marketers to purchase WAP-enabled GSM devices. Later this year, the market will need to change this strategy and start to promote growth in the installed base of GPRS-enabled devices. As UMTS-enabled terminal devices come to market in 2003, the story will repeat itself again. Throw in other variations into the equation (choice of micro-browsers, Bluetooth chips, WLAN cards etc) and the picture will become more complicated. NTT DoCoMo's entry in the European market, for example, will increase complexity by the need to cater for mobile phones that are at least cHTML-compliant.

2.3.5 UMTS Will Accelerate Market Consolidation

The money that MNOs have paid for UMTS licences has been much higher than anticipated and, in many markets, spectrum now demands the lion's share of investments in the next generation of mobile networks. The high fees obviously have a negative impact on the economics of running a UMTS network, and we believe this will accelerate further consolidation among Europe's MNOs.

In countries where MNOs paid medium to high UMTS licence fees, we assume that MNOs with a high share of revenues will be able to run their UMTS networks profitably. MNOs with low market shares will run into financial problems. They have a number of options to resolve these problems:

- A large pan-European MNO may own a stake in the local loss-making MNO and they may decide to cross-subsidize the loss-making subsidiary. This scenario would assume that the large MNO takes full control of the local MNO as other shareholders in that MNO will not be prepared to fund a loss-making MNO;
- The loss-making MNO may merge or be acquired by another MNO. This scenario would only pass if regulators decide that the merged entity would not significantly increase its market power in the local market;
- Failing the above, the small MNO would go bankrupt and we would see the emergence of 'ghost' UMTS networks.

Differing UMTS license fees and procedures have led to fears that there will be significant differences between national markets. The fear is that in countries where MNOs have paid high UMTS license fees (the UK, Germany, and Italy, for example), operators will set high price levels for UMTS services, while countries with low or no license fees will experience lower service prices. In the latter case, applicable to countries such as Sweden, Finland and Norway, low retail prices would reign. We do not believe in the concept of a split Europe however: potential end-user demand will set prices, and this is dependent on a whole range of market conditions, such as the level of competition and prevailing price levels in a given market. UMTS license fees will have no influence on optimal prices because costs of additional UMTS customers and traffic are independent of the fixed cost of acquiring a license.

Lastly, most large pan-European MNOs have participated in most of the UMTS auctions. For this reason, on a European level at least, differences in UMTS licenses will not create gaps in the competitive positioning between the large European MNOs themselves. Of the major European players, Telecom Italia Mobile will prove the exception. The Italian MNO has not appeared in any of the high-license-fee UMTS auction countries (with the exception of Italy itself) and this does create a gap between them and the other large players.

i-Mode Will Not Succeed in the European Market

In a joint venture with KPN Mobile and Telecom Italia Mobile, NTT DoCoMo is planning to bring its i-Mode service to key European markets, claiming a potential customer base of 30 million end-users. We doubt whether i-Mode will be successful, and its introduction will be a complex exercise to orchestrate. To make it happen, the joint venture needs to build up a significant installed base of i-Mode enabled handsets. The company is planning to give end-users the capability to switch between WAP, the dominant browser technology in Europe, and i-Mode by offering handsets that are compliant with GPRS and both WAP and i-Mode. The big question is "when will these handsets will be available?". We assume that it will not happen until at least Q2 2002 or thereafter. Killer applications offered in the Japanese market currently are already similar to the killer applications that European MNOs offer to their end-users via GSM, including instant messaging, ringing tones and icon downloads. As WAP over GPRS is rolled out across Europe, it will offer the same features and benefits as i-Mode (always-on, speeds and presentation). To differentiate, the joint venture must focus on advanced services. We believe it is unlikely that European MNOs will adopt a walled garden approach, the route taken by NTT DoCoMo in Japan. This means the joint venture will need to adopt an approach

that is fundamentally different to that of NTT DoCoMo. What will bring the joint venture a significant advantage is the fact that by the time UMTS comes to the European market, NTT DoCoMo will be one of few players with commercial experience of 3G network services.

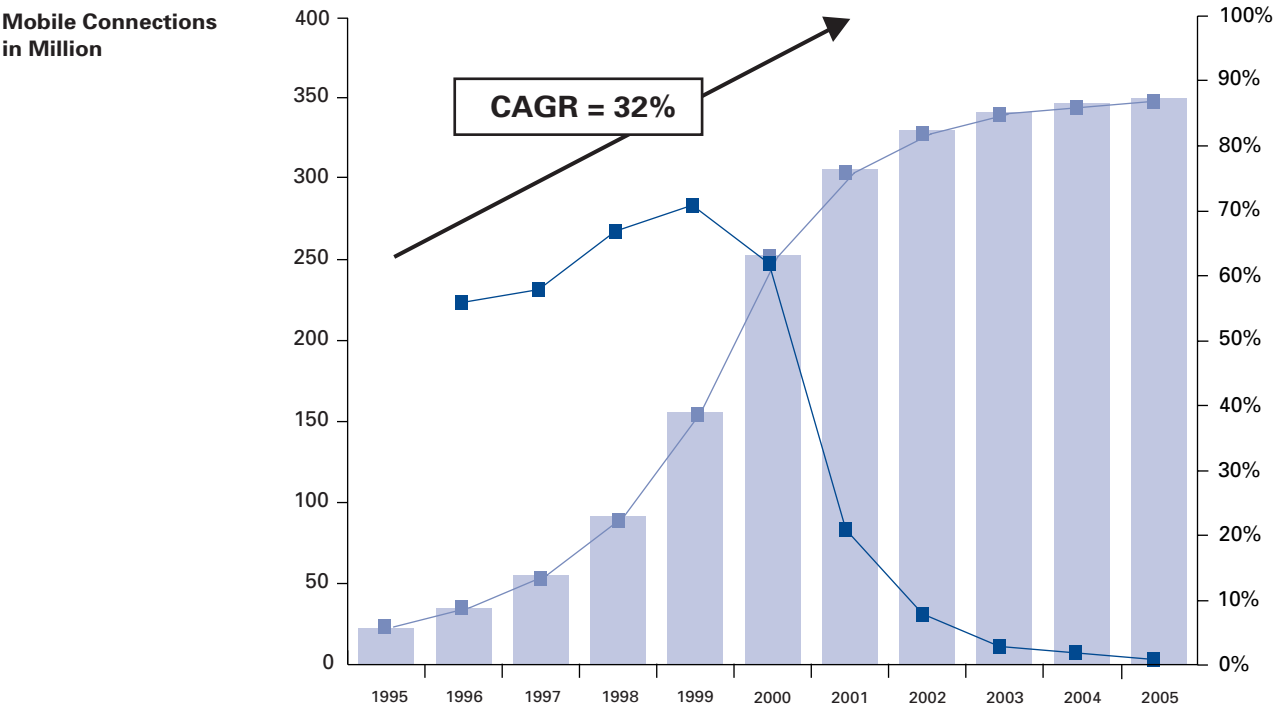
We doubt whether i-Mode will be as successful in Europe as in Japan. The company has done well in the way it has brought new services and applications to market, but the market environment in Europe is quite different and we would expect them to face an uphill struggle: from the adoption of new types of handsets, to making more robust pan-European partnerships and offering the right application mix.

Stock Market Considerations

By the end of 2000 operators have borrowed approximately €150 billion from the capital markets to finance their 3G investments. Standard & Poor's downgraded a number of major European operators in October 2000, including France Telecom, Vodafone Group, and Deutsche Telekom because of the cost and risk of acquiring licenses and deploying infrastructure well before market demand. Subsequently, the operators are finding it increasingly difficult to borrow money for financing actual rollout of the technology. The stock prices of these major operators have therefore declined. The main concern in the stock markets is that the operators have overpaid for the licenses and that break-even points for the operators in those markets where high license costs have been paid are unlikely to be reached for 10 years.

Figure 2:
Mobile connections in Europe
Source: Durlacher Research Ltd./EQVITEC Partners Oy

Mobile Connections in Europe



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Number of Mobile Connection (in million)	22.3	34.8	55.0	91.6	156.2	253.0	306.2	329.9	341.0	346.7	349.6
Annual Growth Rate	0	56%	58%	67%	71%	62%	21%	8%	3%	2%	1%
Penetration	6%	9%	14%	23%	39%	63%	76%	82%	85%	86%	87%

2.4 MARKET FORECASTS

Please refer to Appendix A for a description of the model that we use to predict the size of the European mobile services market. This section discusses the key findings and discusses some of its assumptions.

The number of mobile connections will increase from 253 million at the end of 2000 to nearly 350 million at the end of 2005. Connection growth rates during the period will decline dramatically as the market for mobile connections saturates towards the end of this year.

During the period, we expect the number of mobile data end-users to increase quickly. Over the next two years, we believe that SMS will continue to drive the market in terms of end-users. SMS-only users (i.e. end-users who only use SMS to transmit and receive data) will reach a peak of 128 million end-users in 2002, up from 63 million at the end of 2000. From 2002 onwards, the number of SMS-only users will start to fall quickly as other data technologies take over.

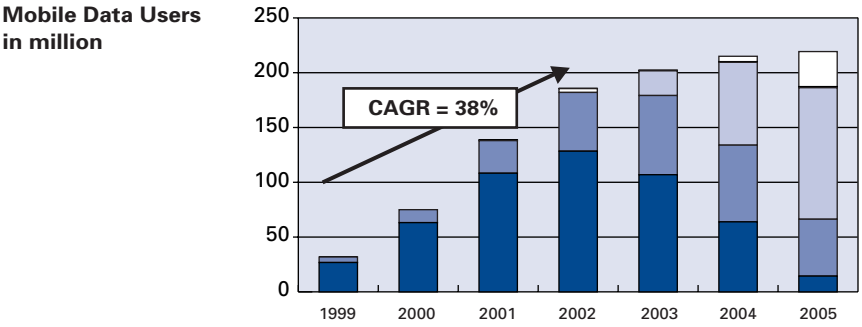
In the absence of GPRS-enabled handsets, WAP over circuit switched technologies will continue to be the main driver behind the number of mobile data users. We estimate that the number of WAP users stood at around 11.8 million at the end of 2000. This number will peak at 72 million at the end of 2003, and then start to fall towards 52 million end-users at the end of 2005. Whilst most of these end-users will use their WAP browsers, we do not expect that their usage will be high. We do assume that the vast majority of these end-users will be active SMS users, and that SMS will drive most of the data and content revenues that these customers generate.

While the first GPRS terminals are shipping this year, it will not be until 2003 when GPRS starts to make a real impact on the number of mobile data users, by which time we expect to reach a GPRS customer base of around 23 million end-users. The net increase in the number of GPRS users will reach its peak in 2004, but then start to decline as UMTS shipments start to gather pace. By the end of 2005, the number of GPRS customers will stand at around 120 million end-users, and this number will peak in 2007, before its starts to decline.

We expect the first UMTS terminals to arrive in the market in 2003, but shipments will be low and it will take at least until 2005 before UMTS shipments will have gathered steam to make an impact on the end-user base. We expect the number of UMTS users to reach 32 million end-users at the end of this forecast period, and that they will exceed the number of GPRS users in early 2007.

Figure 3: Mobile data users in Europe split by technology Source: Durlacher Research Ltd./EQVITEC Partners Oy

Mobile Data Users by Technology in Europe



	1999	2000	2001	2002	2003	2004	2005
UMTS Users in million	0.0	0.0	0.0	0.0	0.3	4.9	32.0
EDGE Users in million	0.0	0.0	0.0	0.1	0.3	0.6	1.0
GPRS Users in million	0.0	0.0	0.8	3.5	22.5	75.6	120.0
GSM Users in million	5.0	11.8	29.7	53.6	72.3	70.0	51.9
SMS Only Users	26.8	63.2	108.3	128.4	106.9	63.9	14.4
Total Mobile Data Users in Million	**31.8**	**75.0**	**138.8**	**185.6**	**202.3**	**215.1**	**219.3**

We do not believe that EDGE will receive support from many MNOs. All the large MNOs in Europe have a vested interest for UMTS to become a success and they will provide their full support behind this technology. This will crowd out interest for EDGE.

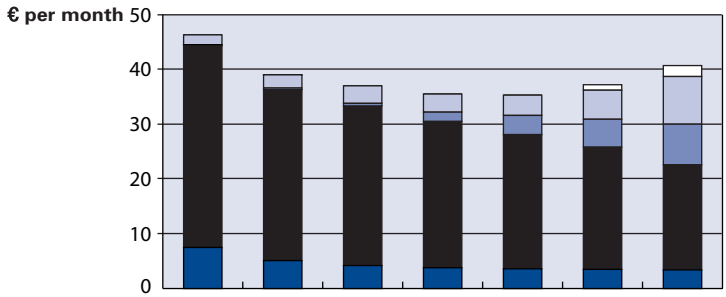
We define the Average Revenue Per User (ARPU) as the average revenue that a mobile customer generates. The ARPU is therefore an important indicator of how mobile services revenues may develop in the future.

Over the last few years, the market experienced a significant decline in ARPUs. We believe this trend will continue in the short-to-medium term, but ARPUs will bottom out in 2003 at a level of €36 per month, down from €39 per month during 2000. From 2004 onwards, we assume ARPUs will go up again and reach a level of €41 per month during 2005, slightly above the 2000 level.

We base this assumption on trends that we have already witnessed in countries such as Finland and Norway. As penetration rates progressed in these markets, MNOs experienced a decline in their ARPUs. This trend reversed once their markets reached high penetration levels. This upward trend was supported by two factors. Firstly, usage of SMS-based services supported revenues and, secondly, increased usage of mobile voice services contributed to the reversal. This reversal also took place at a time when end-users did not use sophisticated technologies such as GPRS or UMTS.

However, value may be derived in various ways. ARPUs are just one of many health indicators of the industry and we strongly believe that mobile communication services can create value in other ways. Productivity and efficiency gains are good examples. These benefits will create tremendous value, but are also areas that are not understood in the market today. In general, mobile internet companies must demonstrate how their customers can generate an ROI on investing in mobile technology. Those who can't will fail.

ARPU Development in Europe
Split by Revenue Source



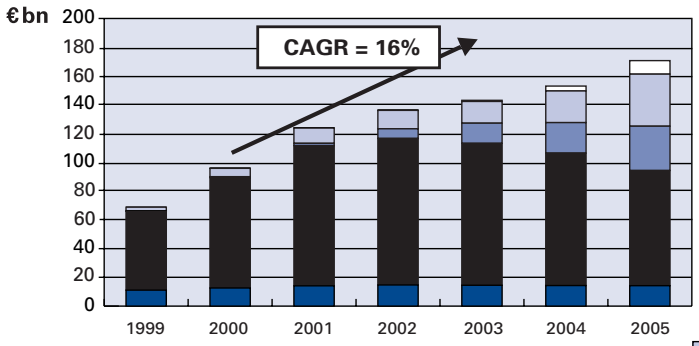
	1999	2000	2001	2002	2003	2004	2005
Indirect ARPU	0.0	0.0	0.0	0.0	0.0	1.0	2.0
Content & Service ARPU	1.8	2.4	3.2	3.3	3.7	5.3	8.7
Data Traffic ARPU	0.2	0.3	0.5	1.7	3.5	5.1	7.4
Voice Traffic ARPU	36.8	31.2	29.1	26.7	24.5	22.3	19.2
Access/ Subscription ARPU	7.5	5.1	4.2	3.8	3.6	3.5	3.4
Total in € per month	**46.3**	**39.0**	**36.9**	**35.7**	**35.6**	**37.1**	**40.9**

Figure 4: ARPU development in Europe Source: Durlacher Research Ltd./EQVITEC Partners Oy

Taking our assumptions on the development of the number of mobile connections and ARPU, we predict that the market for mobile services in Europe will increase from €96 billion in 2000 to €171 billion in the year 2005. Driven by the increase in the number of new mobile connections this year, revenue growth for mobile services will still be relatively strong during 2001, and lie around 29% for the year, down from 39% in 2000. During 2002 and 2003, the

slow down in the number of new connections will drive revenue growth rates down to 10% and 5% respectively. This is driven by three factors. The first point is that SMS will continue to show healthy revenue growth this year, but we are doubtful that the high margins on SMS traffic can be sustained beyond this year. We expect severe pressure on SMS retail prices next year, and that will hamper revenue growth. The trend will continue in 2003, and even result in declining SMS revenues that year. Secondly, WAP over circuit switched will not generate significant ARPUs during these years, and, thirdly, because GPRS will only start to gather momentum during 2003, we foresee severe pressure on revenues during 2002/2003. The situation will improve as GPRS steams ahead in 2004, while the uptake of UMTS will also contribute to higher revenue growth rates in 2004 and 2005.

Mobile Service Revenues in Europe
Split by Revenue Source



								CAGR*
Content & Service Revenues (indirect)	0.0	0.003	0.02	0.1	0.8	3.4	9.4	400%
Content & Service Revenue (direct)	2.6	5.8	10.6	12.8	15.1	22	36.2	55%
Data Traffic Revenues	0.3	0.7	1.6	6.7	14	21.2	30.8	116%
Voice Traffic Revenues	54.8	76.7	97.5	101.9	98.7	92.1	80.1	7%
Access Subscription Revenues	11.1	12.6	14.1	14.7	14.5	14.3	14.2	4%
Total in €bn	**68.8**	**95.8**	**123.8**	**136.2**	**143.1**	**153.0**	**170.7**	

*** Based on different base years**

Figure 5: Mobile service revenues in Europe split by revenue source
Source: Durlacher Research Ltd./EQVITEC Partners Oy

According to Gartner Dataquest, prepaid customers accounted for 60% of the European mobile customer base at the end of June 2000, and they expect this percentage to increase to 65% by the end of 2004. Because prepaid customers do not pay any subscription fees for voice and data services, subscription revenues will continue to loose importance over the next five years, and we expect its share of overall revenues to go down from 13% in the year 2000 to 8% in the year 2005.

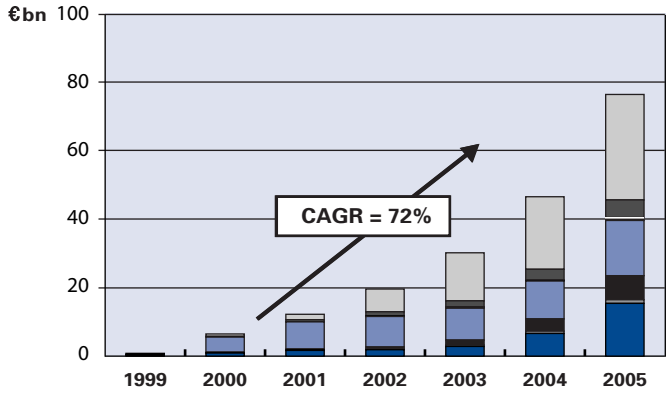
We also believe that voice traffic revenues will lose significance, although they will remain the largest revenue generators in the market. We estimate that their share of total revenues will decline from 80% in 2000 to 47% in 2005. Saturation of the mobile voice services market is the main factor driving this decline, causing pressure on retail prices resulting from intense competition between MNOs (including new UMTS network operators) and Virtual Operators (VOs). While we believe usage per customer will increase, we do not expect the increase in usage to compensate for pricing pressures, leading to an absolute decline in voice revenues from 2003 onwards.

In this scenario, we assume that absolute price levels for mobile services will have come down dramatically, but that prices will continue to be charged at a premium over prices for fixed-line voice services. If MNOs and VOs decide to aggressively attack the market for fixed-line traffic, we foresee a less rapid decline for voice revenues. The market for

roaming traffic is another possibility to increase overall traffic and revenues. This market is still a high-price and low-volume market, and has significant untapped potential. However, we see little activity in this segment of the market and we therefore remain cautious on how quickly this opportunity will be untapped. The market for mobile-based enterprise solutions presents another big opportunity. While technology solutions are available to address this market today, most parties lack the organisational focus (marketing & sales, deployment, pre -and post sales support) to develop this segment.

The decline in voice traffic revenues as shown in figure 5 will be offset by the opportunity to generate revenues from mobile data traffic as well as content and services. The market is witnessing a healthy demand for messaging services, and while most of this demand is driven by person-to-person messaging, demand for downloading ringing tones and icons is growing rapidly as well. As mentioned previously, we believe this is a good indication of things to come. In revenue terms, as shown in figure 6, we expect revenues for data traffic, content and services to increase from €6.5 billion in 2000 to €76.4 billion in 2005.

Mobile Data Revenues in Europe
Split by Revenue Source



								CAGR*
Data Traffic Revenues	0.31	0.69	1.58	6.65	14.03	21.18	30.80	115%
M-Workforce Revenues	0.07	0.23	0.63	1.25	1.78	3.08	5.10	104%
M-CRM Revenues	0.0	0.0	0.01	0.02	0.07	0.22	0.55	172%
M-SCM Revenues	0.0	0.0	0.0	0.01	0.03	0.12	0.35	227%
M-Communications Revenues	2.15	4.38	7.90	8.91	9.30	11.05	16.12	40%
M-Transaction Revenues	0.03	0.21	0.31	0.54	1.45	3.58	7.03	148%
M-Information	0.03	0.06	0.12	0.27	0.42	0.68	1.06	81%
M-Entertainment Revenues	0.37	0.91	1.67	1.87	2.83	6.62	15.41	86%
Total in €bn	**2.96**	**6.48**	**12.22**	**19.52**	**29.92**	**46.52**	**76.38**	

*** Based on different base years**

Figure 6: Mobile data service revenues in Europe
Source: Durlacher Research Ltd./EQVITEC Partners Oy

In chapter 5 we provide detailed breakdowns of the services that will drive these revenues.

The European market is showing that the countries with the largest customer numbers of mobile services will also generate the largest revenues from the mobile internet by the year 2005. Germany will be by far the biggest market accounting for 23% of Europe, while the UK (18%) and France (17%) follow with some distance. Italy follows with 13% of the total European market for mobile internet services of €76.4 billion. The advanced Scandinavian countries will not be able to generate too much revenues on a European scale, simply because of their low population figures.

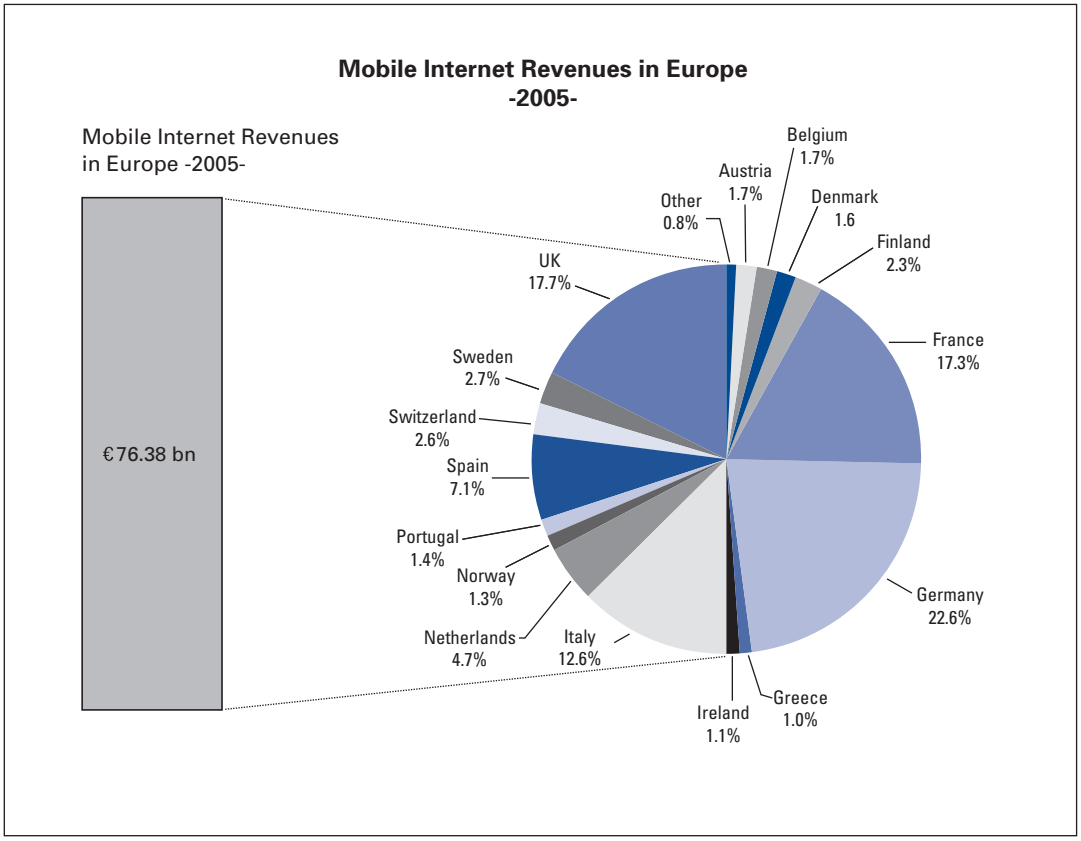
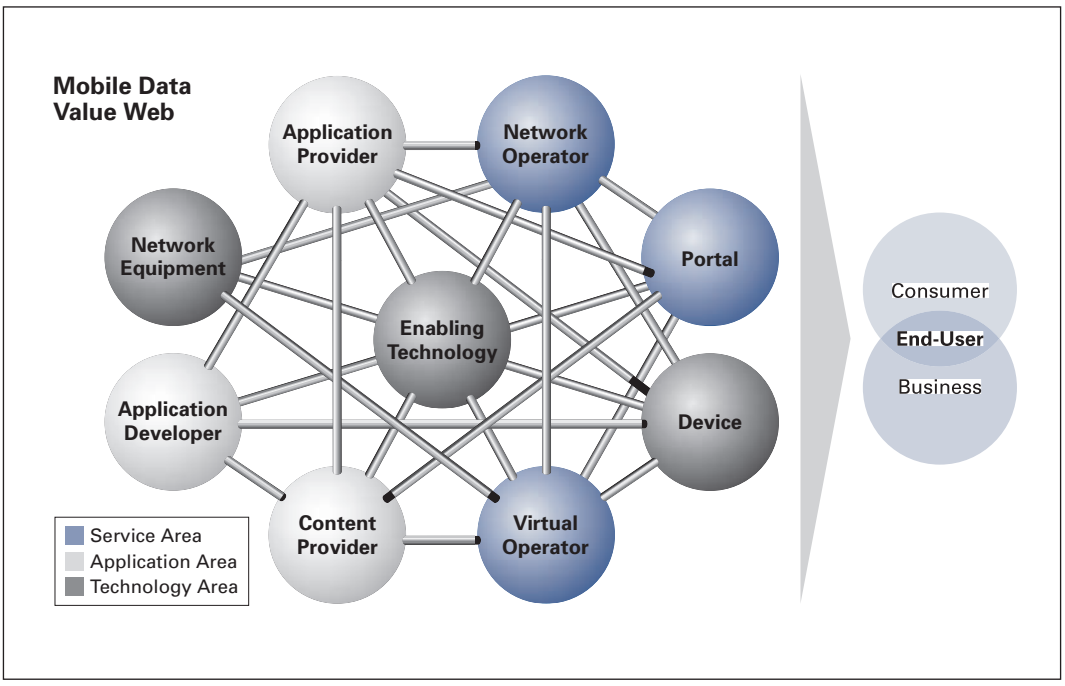


Figure 7: Mobile internet revenues in Europe Source: Durlacher Research Ltd./EQVITEC Partners Oy

2.5 DYNAMICS OF THE MOBILE DATA VALUE WEB

The structure of the mobile data market has become very complex indeed. Because market conditions are changing rapidly, players in the value chain are constantly repositioning themselves in their market areas and/or moving to or between different market areas. It is difficult for a single company to offer end-to-end solutions on its own to customers, which means that partnerships are crucial to their survival. Companies are tangled in a complex network of interrelationships, which we call the mobile data value web.

Figure 8: Mobile data value web Source: Durlacher Research Ltd./ EQVITEC Partners Oy



As shown in figure 8, we identify a number of different players in each of the market areas:

Services – this area includes MNOs, VOs and portals.

Technology – this area includes network equipment vendors, enabling technology companies, and handset manufacturers

Applications – this area includes application providers, content providers and application developers.

2.5.1 Network Equipment

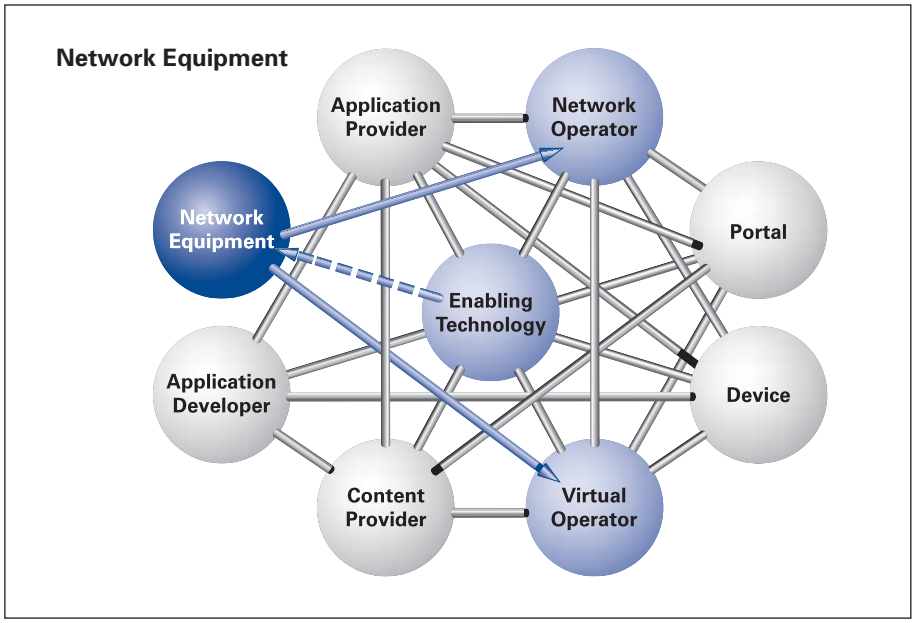


Figure 9: Mobile data value web: network equipment
Source: Durlacher Research Ltd./EQVITEC Partners Oy

This part of the value web consists of network equipment providers, which includes infrastructure manufacturers and component providers. Manufacturers of infrastructure provide mobile air interface and service infrastructure, routers and switches (e.g. Nortel, Lucent, Ericsson, Siemens, Nokia, Cisco) to mobile network operators. These companies will be among the first to benefit from the industry's drive to deploy the infrastructure for third-generation mobile services.

2.5.2 Devices

This segment is composed of manufacturers that market mobile-enabled devices, ranging from smartphones (e.g. Nokia, Ericsson, Siemens, Fujitsu, Samsung etc.) to PDAs (e.g. Compaq, IBM, Palm, Psion, Cyberbank etc.), mobile laptop access solutions in the form of PCMCIA cards (e.g. 3Com, Lucent, Option International etc.) and pager-based devices (RIM, Motorola). They offer the hardware front-ends that defines the end-user's wireless experience.

Component manufacturers are also included in this segment and include manufacturers of mobile-specific microchips, display technologies, battery technologies and storage technologies.

Challenges in this market place include:

- Backward compatibility issues: As the European market moves from circuit switched to packet switched technologies, end-users will need multi-mode devices;
- New functionalities: Besides voice, devices will need to integrate new functionalities such as GPS (to increase the accuracy of location sensing systems), music and video.

- Sales channels: MNOs and VOs are the primary sales channels through which devices reach the end customer - usually they are offered as a part of the service bundle. We believe that sales of devices without a service bundle or directly from manufacturer to end customers will represent a minor share of market revenues.

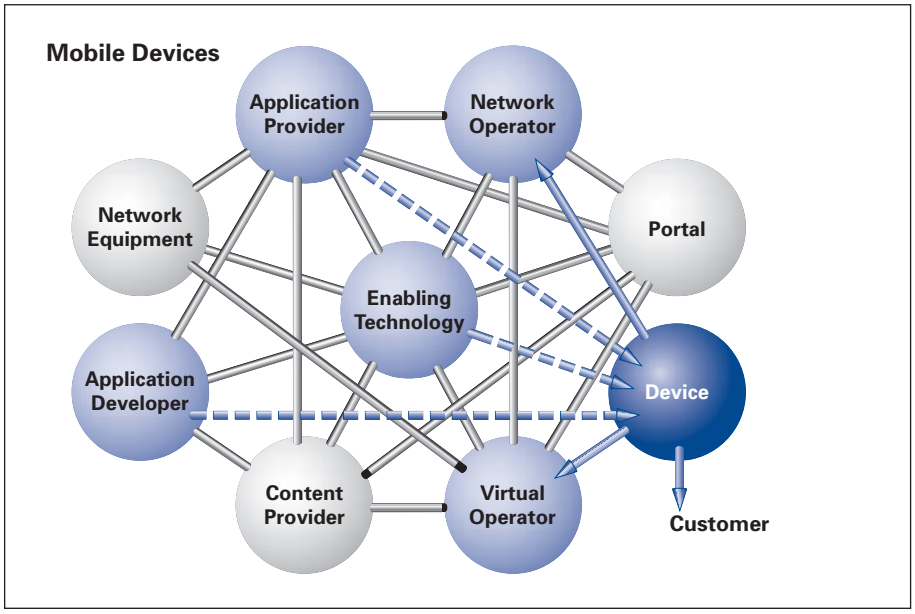


Figure 10: Mobile data value web: mobile devices Source: Durlacher Research Ltd./EQVITEC Partners Oy

2.5.3 Enabling Technology

Providers of enabling technologies deliver the basic operating environments on which application platforms and applications are based: operating systems for mobile terminals (e.g. Microsoft Pocket PC/Windows CE, EPOC, PalmOS, Linux etc.) and execution environments, which provide a framework for application programming, such as MexE and 1K Java.

Another set of technology enablers provides components such as transceivers, integrated circuits, signal processors, antennas and positioning technologies (Qualcomm, Cambridge Positioning Systems, Cellpoint).

The third are companies building application platforms, such as location-based platforms, billing and security platforms (e.g. SignalSoft and Sepro).

Enabling technologies are a crucial element for all market functions, providing for example:

- Operating environments and OS software to device manufacturers and application developers
- IP billing platforms to MNOs and VOs
- Multi-access interfaces and personalisation platforms to portals
- Hosting infrastructure to applications and content providers.

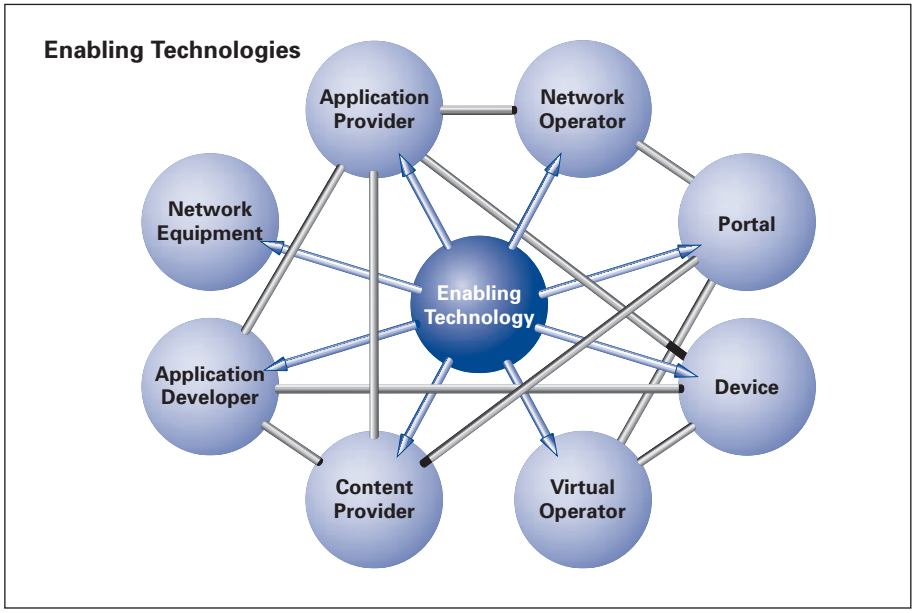


Figure 11: Mobile data value web: enabling technologies Source: Durlacher Research Ltd./EQVITEC Partners Oy

2.5.4 Application Developers

Application developers comprise two principal categories: those that provide platform middleware and those that purely provide applications. The first category includes developers of commerce, payment, media, location and presentation platforms – these include, for example, Wireless Commerce WCL, Wapit, network365, 12Snap, Categoric, and Argo Group. The second category, pure application developers, includes companies such as Spyglass, Springtoys, and LPG Innovations.

Such companies provide their products to application providers and device manufacturers (mostly embedded software). Some application developers are trying to integrate the application provision function to be able to distribute services directly too.

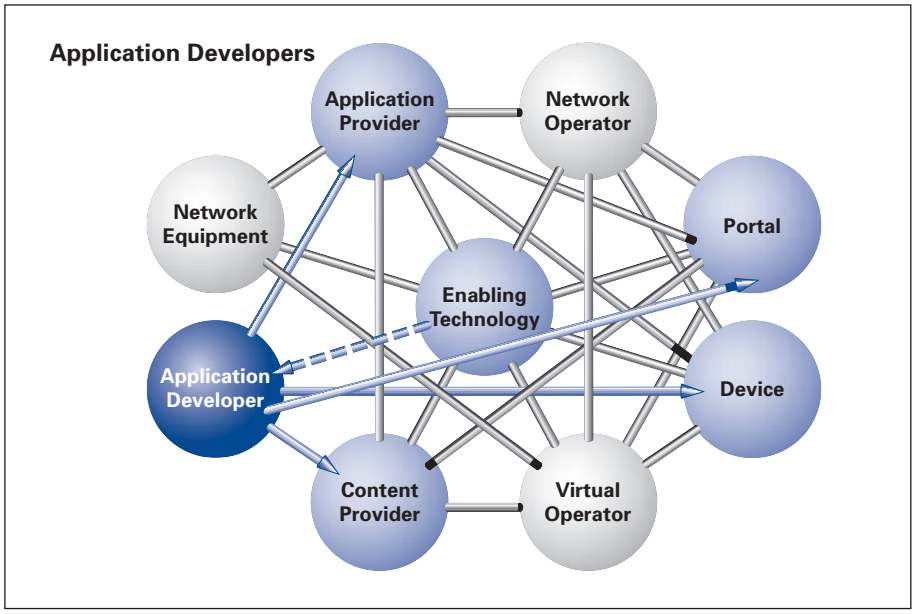


Figure 12: Mobile data value web: application developers Source: Durlacher Research Ltd./EQVITEC Partners Oy

2.5.5 Application Providers

The majority of companies are choosing to distribute their applications using the Wireless Application Service Provider (WASP) model. WASPs enable businesses to use the mobile channel to contact their employees or customers by providing remote hosting, services, maintenance and upgrades of wireless applications. WASPs, especially in the technologically and geographically fragmented North-American market, have arisen to provide services on any network on any device directly through portals. WASPs include companies such as Geoworks, Aspective, and Dataroam. There are also an increasing number of WASPs that deliver applications to MNOs and VOs such as Wanova for games. It is much easier for operators to integrate applications into their business processes if they have been developed from the start with the operator in mind.

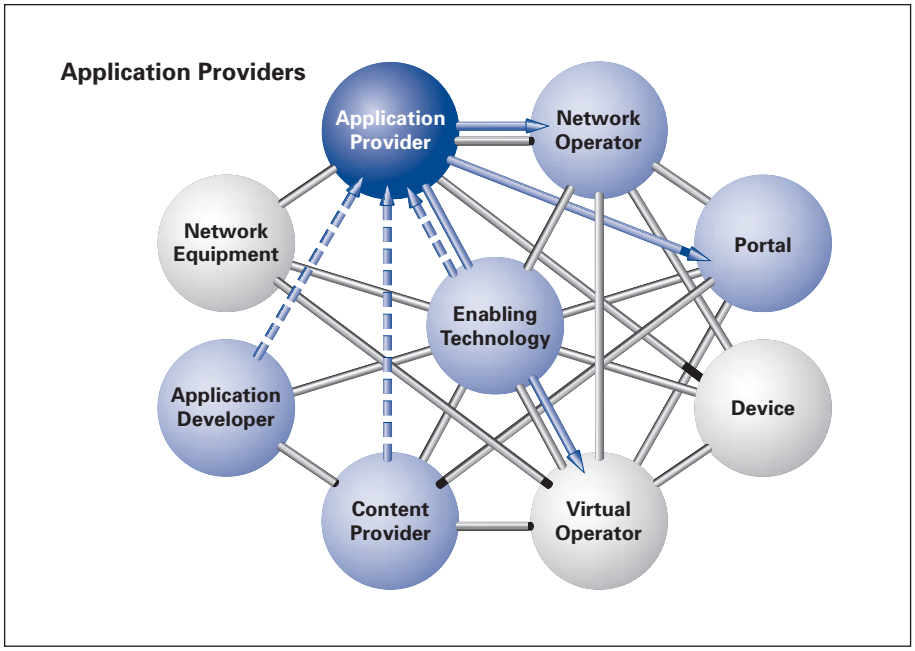


Figure 13: Mobile data value web: application providers Source: Durlacher Research Ltd./EQVITEC Partners Oy

2.5.6 Content Providers

Content providers are represented by several distinctive types of companies. The first consists of pure content aggregators, such as iSyndicate, that package and structure content from different sources for delivery over mobile networks.

Another type of company develops original content for various distribution channels. Companies such as Bandai, the Japanese mobile entertainment provider, have the capability to offer their content either directly or through a content aggregator. Such companies may choose to deliver their content to application providers and portals, or directly to MNOs and VOs.

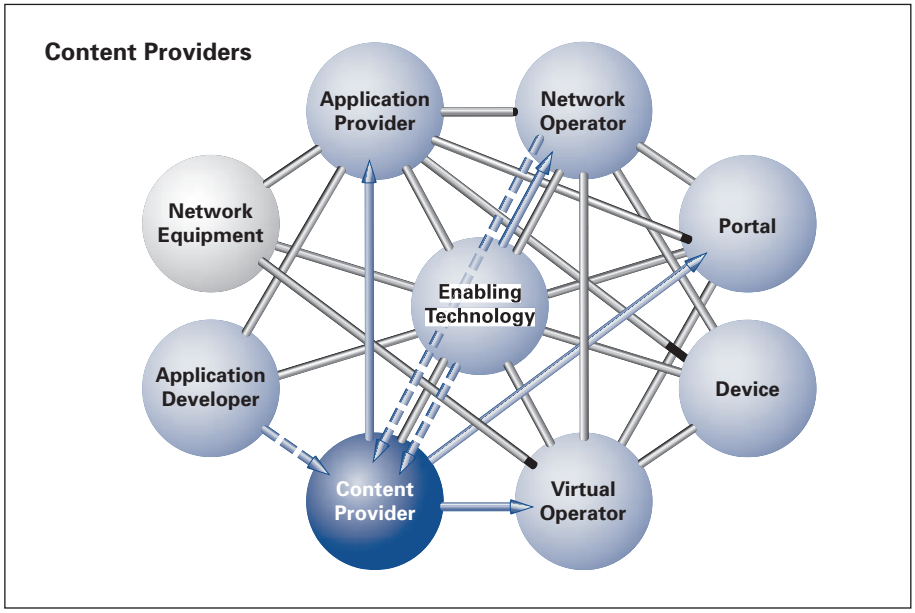


Figure 14: Mobile data value web: content providers Source: Durlacher Research Ltd./EQVITEC Partners Oy

2.5.7 Mobile network operators

The MNO's core competence is to build and manage mobile networks. Network operators provide mobile voice and mobile internet access services to end consumers. Until 2005, voice will be the dominant service they provide, initially paired with a few value-added services such as voice mail and SMS.

As the revenue sources shift increasingly towards mobile data services, operators will become reliant on portals, application and content providers to compete. Vodafone Group, T-Mobile International, TIM or Sonera are examples for leading European network operators. There is a trend in Europe for operators to open up their networks to VOs.

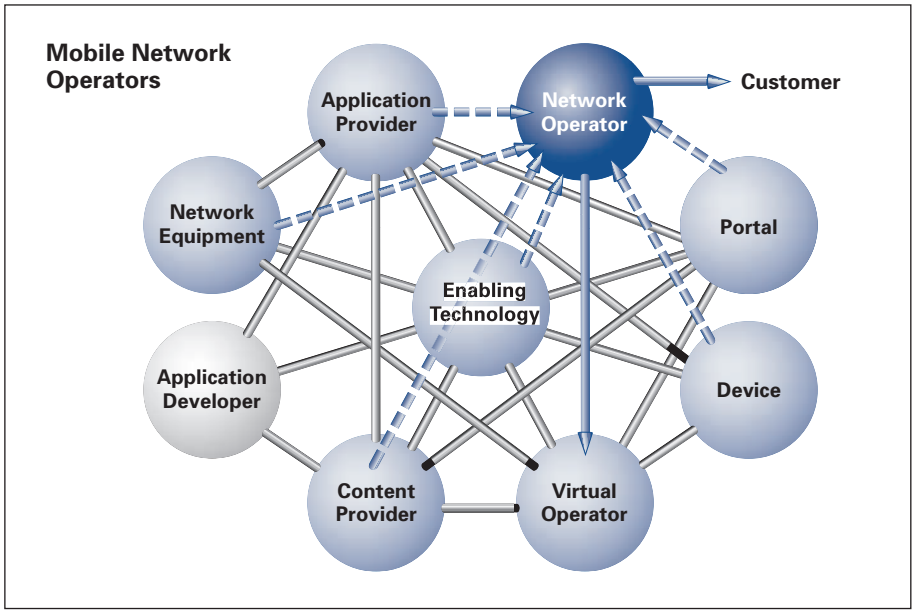


Figure 15: Mobile data value web: mobile network operators Source: Durlacher Research Ltd./EQVITEC Partners Oy

2.5.8 Virtual Operators

VOs have access to networks of one or more MNOs and offer services to customers using that network. We see different types of VOs emerging, but what they have in common is the fact that they do not directly own rights to use radio spectrum in GSM and/or UMTS designated frequency bands. This means that they are always dependent upon the radio access network elements of MNOs. Network capacity and operation services are usually bought at wholesale rates and resold under the brand name of the VO.

Common types of VOs are mobile service providers such as Debitel or Mobilcom. They are intermediaries that provide end customers with mobile access services and, in some markets, offer bundled services such as cable, fixed line and mobile access. These entities typically maintain the contract and billing relationships with customers.

Although they have been able to increase their customer numbers significantly, the overall share of the market of service providers has decreased gradually over the years, as many MNOs strengthened their own distribution channels either organically or through the acquisition of independent VOs. Over the next five years, however, we expect a new type of VO to emerge in the mobile market: the Mobile Virtual Network Operator (MVNO). These companies will provide a full service to their customers and will take full control of their operations, something that many VOs lacked in the past.

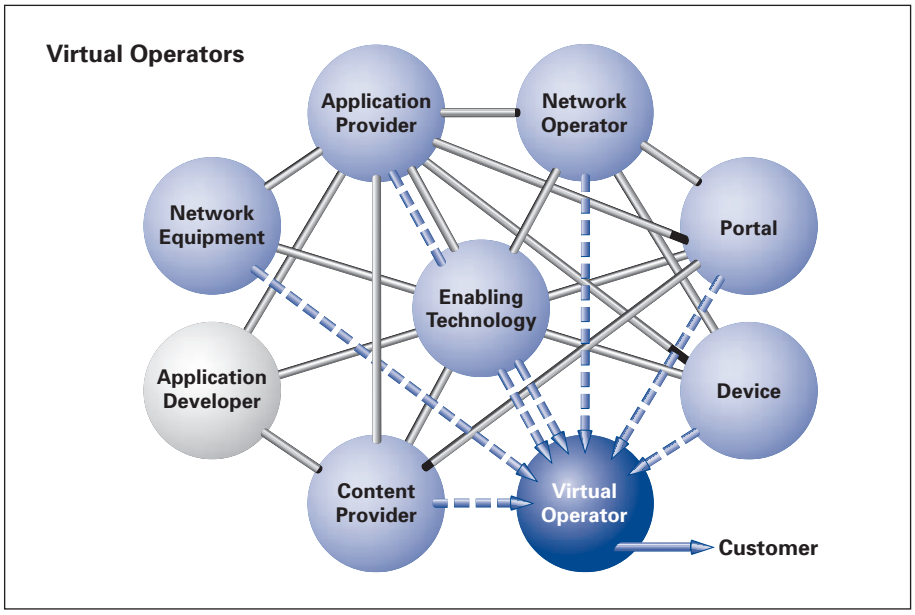


Figure 16: Mobile data value web: virtual operators
Source: Durlacher Research Ltd./EQVITEC Partners Oy

2.5.9 Mobile Portals

Portals provide end consumers with relevant and personalised content, commerce and community functions in one single place. Mobile portals include Sonera Zed, AOL Anywhere, Djuice.com, Vizzavi, Genie, and T-Motion. Mobile portals are emerging both from the operators as well as from traditional internet portals who have started to mobile-enable their offerings. New start-up portals are competing to become the "Yahoos" of the mobile market, but we do not believe that they will succeed as stand-alone businesses. The recent failures of breathe.com and Go.com are good examples in the internet world. This has become more apparent in a mobile environment: WAP is not sufficiently developed to allow a highly functional portal. We believe that successful mobile portals will be pushed largely by existing brands.

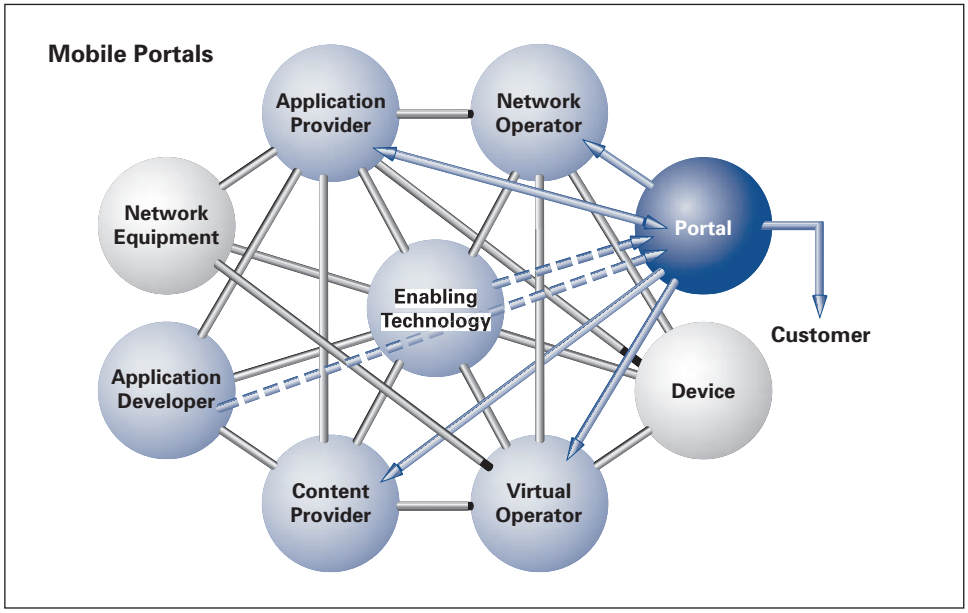


Figure 17: Mobile data value web: portals
Source: Durlacher Research Ltd./EQVITEC Partners Oy

- The domination of the MNO as a unique interface to the customer is over.
- New players such as VOs (e.g. Virgin Mobile), portals (e.g. Iobox) and WASPs (e.g. Akumiitti Oy) are competing for customer access.
- Additionally, device manufacturers such as Nokia are trying to acquire portal functions to access the customer directly.
- There is also a general drive by portal owners to move into the application space, since it will generate most of the future mobile data UMTS revenues.
- Any player that has the intention to directly realise future mobile data revenues will have to set up a mobile value web of service, content and portal functions. These functions may be acquired by a direct acquisition or by striking partnerships and building a virtual value chain to the customer.

2.6 BENCHMARKING EUROPE WITH JAPAN AND THE US

Globally, we identify three distinctive types of markets:

- Mobile operator driven;
- Internet driven;
- Technology driven.

Mobile operator-driven markets are characterised by countries with low internet penetration and high penetration of mobile services (e.g. Japan). Due to the dynamics of the economies in these countries, network operators can influence content, and employ a closed portal strategy. The operators extend their market power across the entire sector, which includes influencing specifications (ranging from handsets to applications to infrastructure equipment). NTT DoCoMo is a good example.

Internet-driven markets are composed of markets with high penetration of internet and relatively low penetration of mobile services. ISPs, portals, application developers and content providers, who have matured in the internet world, are dominant players in this market. Large portals such as Yahoo, MSN and Excite regard mobile communications as another channel to their customers. The U.S. is a good example of this type of market.

Technology driven markets are sophisticated markets where both internet and mobile penetration is high. Players who foster this environment to spur further innovation and development largely dominate the market. Finland is an example of a technology-focused country with Nokia contributing significantly to the country's growth.

Global Market Summary

	Europe	US	Japan
Data Market Orientation/ Identity	Technology (Ericsson, Nokia)	Internet (Yahoo, AOL)	Operators (NTT DoCoMo)
Key Drivers	Network and Handset Technology	Internet Applications	Mobile Services
Primary Data Mode	Desktop and Mobile Phone	Desktop and Pager/ PDA	Mobile Phone
Technology Standards	Unified (GSM)	Mixed (GSM, TDMA, CDMA, AMPS, Analog)	Mixed (PDC, PHS, CDMA)
Future Standards	GSM, W-CDMA	GSM, TDMA, CDMA(2000), W-CDMA	W-CDMA, CDMA2000
Mobile ARPU	Below €45	Above €45	Above €75
% Data Revenue	5%-7%	Below 1%	10%-15%
Competition	Moderate (4-6 players per country)	Low (Fragmented Market)	Low (3 players)
Terminal subsidies	Diverse From full cost to 0	Plan dependant	Allowed moderately
Pop density	Moderate	Moderate	High
UMTS Introduction	Q4 2002-2004	After 2004	Q2 2001

Table 1: Global market summary
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

2.6.1 Europe

In Europe, the mobile and internet markets are diverse. Scandinavia occupies a leading position in the European mobile industry, but it has lost its absolute lead to Japan. Northern Europe is a heavy user of both mobile communications and fixed internet access. Finland, for example, has a mobile penetration rate of 75% and fixed line internet penetration rate of 50%. Other countries such as Germany, the Netherlands and the UK are catching up fast. Germany, for example, has grown its mobile penetration from 29% in December 1999 to over 60% at the end of December 2000. Southern European countries have high mobile penetration, but a low fixed access penetration. Italy, for example, had 12% penetration of fixed line internet and 65% penetration of mobile phones in late 2000.

2.6.2 Japan

Japan is already on the cutting edge of the commercialisation of wireless data technologies. Japanese MNOs are to introduce 3G networks, based on W-CDMA technology (NTT DoCoMo and J-Sky) and CDMA2000 (KDDI Group) later this year, and we believe that they will be able to maintain their leading global position for mobile internet services over the next five years.

NTT DoCoMo's i-Mode service is very successful and had 18.5 million customers in early 2001 (see figure 19). It has become the global benchmark for the mobile internet. However, it is not only NTT DoCoMo that has been successful. KDDI and J-Phone, two other large mobile operators in Japan, have advanced quickly in the mobile internet space.

NTT DoCoMo's position in Japan is unique. They are the dominant operator in the mobile market and are well protected from the entry of newcomers. Its dominant position has enabled the company to dictate the development of the technology enablers for the i-Mode concept. This includes networks, terminals and applications.

Congestion on NTT DoCoMo's network was a key factor that made NTT DoCoMo decide to develop a proprietary packet-switched overlay (the PDCP standard) on its circuit switched PDC network, which also carries the traffic for the i-Mode service. NTT DoCoMo further set the terminal specifications that handset manufacturers had to comply with, including specifications on screen size and even a specific i-Mode button. Application developers must

follow guidelines on the type of content that they can produce and on how they must do it. When NTT DoCoMo launched its i-Mode service, more than 70 different services were already available. NTT DoCoMo's i-Mode services were modelled on AOL's early closed portal approach, with the operator controlling the content providers and customer billing.

In November 2000, the au Group emerged as a strong player in the market. The group represents the merged operations of DDI, KDD and IDO corporations and 'au' is the unified brand for seven of the group's eight regional cellular operations.

J-Phone, Japan's third largest MNO, plans to become a big player in the Japanese 3G market. They sell their mobile data services under the J-Sky brand. J-Phone is leading edge on the technology front, offering the most advanced handsets (e.g. with built-in camera), and is used as a platform to 'test-drive' many sophisticated services. The company operates a top-of-the range location-based service called J-Navi, which they launched in May 2000. The service lists over 17 million businesses in a spatial database and covers all of Japan's residential areas. In its first 48 hours of operation, the service processed more than 2.2 million positioning queries from more than 600,000 customers. In June 2000, J-Phone added billing capabilities to its service platform, and since that time the company reports that the service is in use by approximately 350,000 people on a daily basis. The service broke even within six months of commercial launch. J-sky developed the service in partnership with Xmarc, a US-based company that develops location based service platforms.

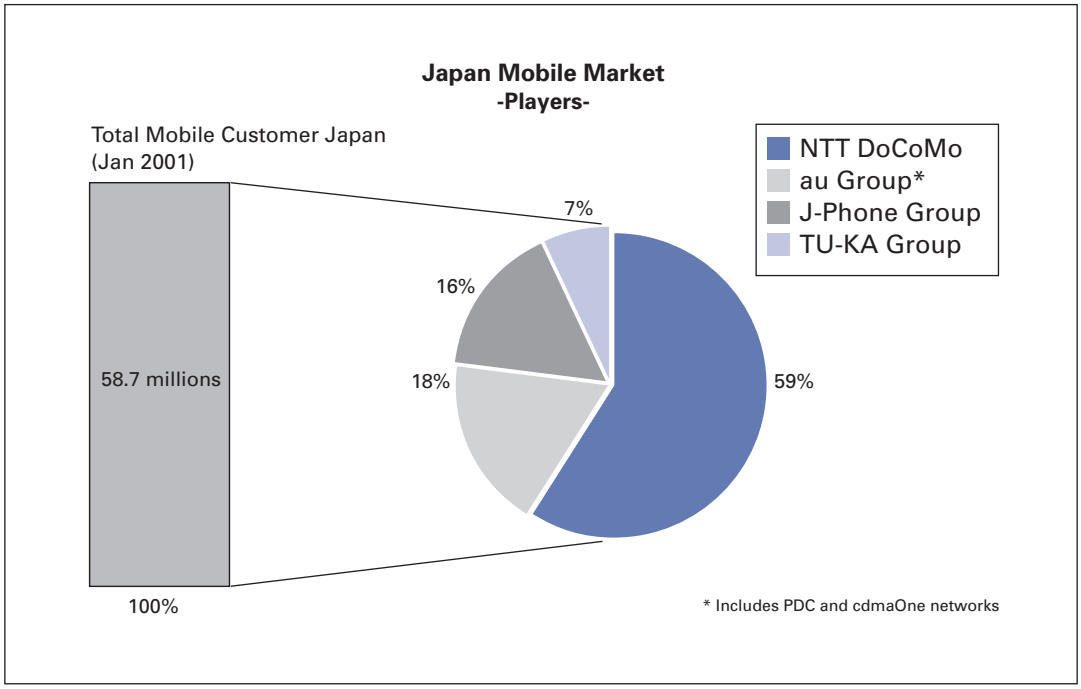


Figure 18:
Japan mobile market – players
Source: Japanese Telecoms Carrier Association

Key-success factors of Japan's mobile internet services:

1. Packet-based networks provide always-on connectivity: this provides customers with the benefit of immediacy;
2. Speeds are low (i-Mode only offers 9.6 kbps), but applications are useful;
3. The prices for services are relatively low. i-Mode customers may pay up to €3 per month for a service channel (although many service channels are available at no cost to the end-user). The price of traffic itself is low as well. NTT DoCoMo have charging capabilities that allows it to bill per byte, and the price per byte is low;
4. Low-usage of fixed-line internet access;

5. The youth segment shows significant interest in mobile internet services. Killer applications include messaging, ringing tones and wallpaper downloads. Killer applications in Japan are actually very similar to the applications and services that are very popular in Europe today including SMS messaging, ringing tones and icon downloads.

Comparison of Japan's Mobile Data Services

	i-Mode	EZweb	J-Sky
Company	NTT DoCoMo	KDDI/au-Group	J-Phone
Markup Language	cHTML	HDML (WAP)	MML
Microbrowser	Compact Netfront	EZ Browser	Proprietary
Image Formats	GIF	BMP/PNG	PNG/JPEG
Handset display colour capability	256	256	256
E-mail length for sending (bytes)	500	510	6000
E-mail length for receiving (bytes)	500	4000	6000
E-mail attachments	None	Images & Melodies	Images & Melodies
Current Network	Packet-Switched	Circuit & Packet-Switched*	Circuit-Switched
Speed (Bps)	9600 (28000 on DoPa)	9600 (6400 on cdmaOne)	9600
3G Standard	W-CDMA	CDMA2000	W-CDMA
3G Launch	May 2001	Second half of 2002	Q4 2001

Table 2: Comparison of Japan's mobile data services
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

* EZweb operates both on circuit and on packet-switched networks across different operators

All Japanese operators regard the development of handset technology as a key success factor in the uptake of their mobile data services. Their focus is primarily on multimedia and processing capabilities. Java-based phones are expected by early 2001. Already, NTT DoCoMo offers a multimedia phone under *ai shiteru* brand while J-Phone offers similar devices under their *FeelH* brand. The advanced multimedia devices should be able to distribute over-the-air music. *Keitai de Music* is an early test-version of how music can be distributed to mobile devices. The service uses a proprietary technology that allows users to download songs and spoken-word comedy to 32-megabyte memory cards. The technology is in use by large music labels such as Sony, but also by independent music distributors such as SoundMarket.

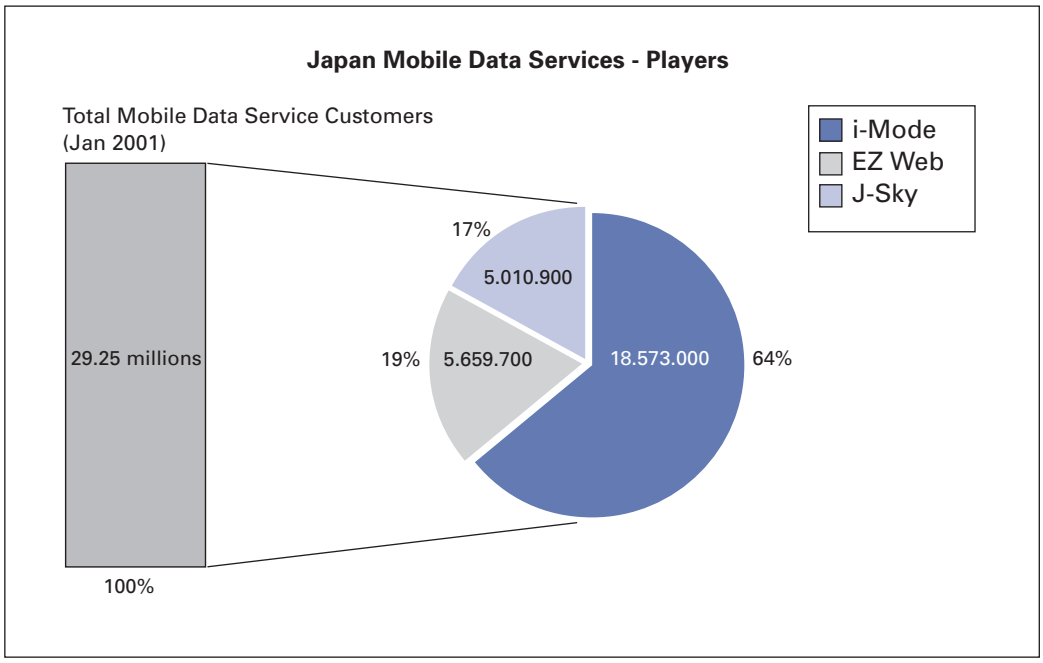


Figure 19: Japan mobile data market – players Source: Japanese Telecoms Carrier Association

2.6.3 United States

The North American market leads the world in internet adoption and e-commerce, but lags behind in the mobile sector. The US still wrestles with multiple standards (e.g. AMPS, PCS) and coverage issues, and this has held back quality and service levels in comparison with leading regions of Europe.

3G license auctions have been postponed to 2002, and this will further delay the commencement of next generation mobile services in the US. The fact that television channels occupy some of the frequencies intended for 3G will hinder the introduction of next generation mobile services further. Another factor that will hinder the adoption of mobile services is the fact that the "Calling Party Pays" principle does not apply in the US market. Customers in the US pay for incoming call traffic, which means that many people generally switch off their mobile phone to reduce cost. In fact, they may use pagers to receive messages indicating that people have tried to call them.

Until recently, two-way text messaging services have been limited to paging networks (Motorola, RIM). However, US carriers have started to launch SMS services. A major shortcoming of these services is that end-users will not be able to send messages to end-users on other networks. It will therefore be difficult to create the ubiquity that made SMS so popular in Europe.

High internet usage, however, does make the North American market for mobile data an interesting one. This is partially reflected by recent interest from foreign MNOs in North American carriers. Recently, NTT DoCoMo acquired a 16% stake in AT&T Wireless Group to drive the development of next-generation networks and portal platforms. The agreement leverages AT&T's existing network infrastructure and NTT DoCoMo's i-Mode experience. The deal will also serve to promote W-CDMA technology in the North American market.

3 NEW MOBILE BUSINESS MODELS

- New business models are gaining ground in the mobile communications industry, namely the VO and the multi-access portal business models. While we believe that these are crucial developments that have to be considered, they are not in themselves providing a feasible investment opportunity for start-up companies. The third new business model, the WASP concept, however, provides tremendous opportunities for start-ups either as a consumer WASP or as a business WASP.
- We strongly believe that MNOs will increasingly facilitate access to their networks for VOs, a trend that will be driven by strong market conditions rather than regulatory forces. This will allow many UMTS network operators, but not all, to successfully exploit the market opportunity. However, it will require MNOs to shift their business focus away from dealing directly with end-users towards a focus that will allow them to service wholesale clients as well. MNOs that fail to implement such strategies will not survive in the long-term.
- MNOs and VOs are expected each to occupy their own space in the market. They will differentiate themselves towards customers through their range of services and brand rather than through deployment of their own infrastructure. In order to economically offer valuable services, white-label portals and WASPs will provide content and applications on tap. These services will be viable opportunities for start-ups to enter, at least for the next two to three years.
- Customers want to be able to transact and do business from anywhere at any time and they want to do so in a consistent manner with the best available device. Many enterprises are starting to execute upon a multi-channel strategy as they increasingly regard mobile as an extension of their online strategy. In the long term, therefore, we do not believe that pure-play mobile portals will succeed. They will need to strike partnerships with larger players and become multi-access portals. Alternatively, they will be acquired, or go bankrupt.

3.1 MOBILE NETWORKS WILL OPEN UP

MNOs in Europe face significant challenges over the next five years. Many of them are investing heavily in UMTS licences and, at the same time, in the rollout of a wide range of new technologies (GPRS, HSCSD, UMTS, WLAN, Bluetooth etc.) that will enable a completely new 'spectrum' of data-oriented services and applications. MNOs' challenges may be summed up as follows:

- Finding the finance required to pay for spectrum, technology, and development.
- Choosing and implementing the right technologies.
- Commercialisation of the technologies and business development.

Traditionally, MNOs have mainly concentrated on the first two issues. Revenues from voice services have driven the vast majority of their existing business in the past, and, lured by healthy revenue growth, MNOs lacked the need and/or incentives to look beyond current activities. However, existing revenue streams are not sufficient to generate a good return on the investments they will make over the next five years as customer growth flattens out and ARPUs come down. Developing new services and applications, and the capabilities to steer such an effort, will therefore become a critical success factor in the emerging UMTS market.

A key question MNOs have to answer is how they are going to develop the capabilities to exploit the UMTS market successfully with partners such as portal players. As in any other industry, MNOs face 'buy or build' decisions. As time-to-market will be an important factor that drives such decisions, we assume many operators will tilt towards a buy decision: building an organisation from scratch will simply cost too much time. In fact, we strongly believe that an MNO's survival chances are minimal if it decides to build new organisation structures from the ground up.

Partnerships are an appealing option for MNOs, not least because experienced 'internet' partners are eager to gain a foothold in the fast growing mobile market. MNOs should develop a mindset that enables them to cater well for the needs of these potential partners. Going a step further, MNOs should start to build organisations in which they treat partners as potential clients. This would require a significant refocus of an MNO's core business: business partners will have completely different needs than their retail customers, a segment MNOs have traditionally focused on. This means that MNOs must develop wholesale capabilities, in addition to their existing retail business.

But the lack of business development capabilities and resources is not the only driver for the shift in the MNO's business focus. Other reasons for MNOs to move towards (more) open access to their networks include:

Uncertainty about the killer application – We believe that new technologies potentially enable thousands of new services and applications. Organisations will find it impossible to develop such a wide variety of applications, and it is hard to imagine that they will find it attractive to do so from a commercial point of view. Even if MNOs manage to develop a number of successful services and applications, it is highly unlikely that they will pick all potential winners. In short, MNOs needs to work with 3rd party service providers to hedge against the risk of not developing successful applications themselves.

Huge Investments – MNOs across Europe will spend at least an estimated sum of €260 billion on licenses and network infrastructure for 3G alone. This amount needs to be financed with increasingly high interest payments as credit ratings are going down and valuations of potential spin-offs are becoming more and more disappointing

The desire to maximise capacity utilisation – An MNO's network capacity must accommodate the traffic that its customers generate during their peak-hours. Outside these hours, MNOs have a lot of spare capacity, which is one of the main reasons why more and more operators work with 3rd party service providers to fill-up some of this capacity. This trend will continue over the next five years and the migration towards UMTS networks will reinforce this because UMTS networks have far greater capacity then their 2G counterparts. Given the high investments in UMTS businesses, it is hard to see why MNOs should not adopt an open model for network access.

No experience in service creation – Apart from lacking the business development capabilities and resources to develop new markets, MNOs do not have the right skillset to develop new services such as appealing portals and applications.

Lack of brand equity – Traditionally, MNOs have heavily relied on a single brand strategy. In a market where homogeneous goods and services prevail, this strategy has worked for most MNOs. As the market moves towards a heterogeneous service environment, MNOs must develop new brand values that reflect and radiate the features and attributes of a broad and deep product portfolio. It is unlikely that MNOs' existing brands carry the equity to support this transformation. Even if an MNO successfully develops one or even more brands on their own (as some MNOs are doing), it remains unlikely that they will fill up the 'entire' space, which means that opportunities will emerge to work with companies that have developed their own brand propositions.

Regulatory pressure – The basic principle is that regulators favour market conditions in which market participants strike agreements between themselves on a voluntary basis. Regulators will only intervene when parties cannot reach such agreements. If MNOs and 3rd party service providers (VOs), for example, cannot agree on terms and conditions for access, regulators will argue that market entry is not efficient and will then push for regulation that stipulates the economic and legal conditions under which new entrants would have to be given access to an MNO's network. In current market conditions, where many MNOs carry the tag of having Significant Market Power (SMP), large MNOs in particular will find it hard to refuse access to those that demand access.

Differences promote competition – The intensity of competition is not only determined by the number of players that compete in a given market, but also, and probably more

importantly, by the way in which competitors differ. Small MNOs, for example, will have more spare capacity than larger MNOs and will be keen to sell spare capacity on their networks. The UK market illustrates this example well: One 2 One, the smallest UK-based MNO, set-up Virgin Mobile, a joint venture virtual operator with Virgin, to sell Virgin branded mobile services. Larger MNOs in the UK market are following the example. Another important difference between players is that new UMTS network operators, such as Hutchison 3G in the UK or the 3G Group in Germany, are in a position to build state-of-the art organisations and do not have any legacy they need to consider. This goes much further than the physical infrastructure they will build, but it also applies to the way they build their business and go to market (sales channels and focus, marketing, customer care and billing operations etc.). With regard to the latter, we strongly believe that good opportunities exist for those MNOs that focus on selling enterprise solutions.

Wholesale Clients – an emerging market – The migration towards UMTS will require mobile operators to spread and reduce risks and will force them to work with newly emerging players in this market. These include VOs (see section 3.3), WASPs (see section 3.2) and portal companies (see section 3.4). This will cause new forms of competition.

3.2 WASP

Application service providers (ASPs) are third party companies that help deploy, manage and remotely host a wide range of applications and services for enterprises and operators. WASPs extend the functionality of applications and services to mobile devices over mobile networks.

The mobile market represents an additional channel for businesses offering their products and services and WASPs serve the role of a "buffer zone" between mobile customers and companies that either do not have the expertise to develop mobile functionality or the desire to bear the associated financial risks.

3.2.1 Drivers

Key reasons why businesses choose to outsource their applications and services to WASPs include time-to-market, risk reduction, lower costs and increased focus.

Time-to-market – Businesses realise that mobility offers potential opportunities, but lack the resources to extend their products and services to mobile customers in a timely manner. Through ongoing relationships, enterprises have access to skilled labour and resources.

Risk Reduction – Enterprises that outsource applications reduce and/or transfer the ownership risk of an application and will gain access to best-of-breed applications built on the latest technologies.

Lower and Predictable Costs – Adopting the ASP model means that customers can lower the upfront cost normally associated with the adoption of new applications, which therefore reduces total cost of ownership. The pay-as-you go model provides enterprises the benefit to predict their costs better.

Focus on the Core Business – The WASP model enables enterprises to focus on their core business and let specialist providers deliver particular services.

3.2.2 Players

Many companies are entering this market and they come from many different angles including MNOs, VOs, wireline ASPs and pureplay. Potential target customers vary widely but will include demand from MNOs, VOs and enterprise customers. A rough segmentation of the WASP market results in two types of WASP players: those that are focused on enterprises/business users and those that are on consumers.

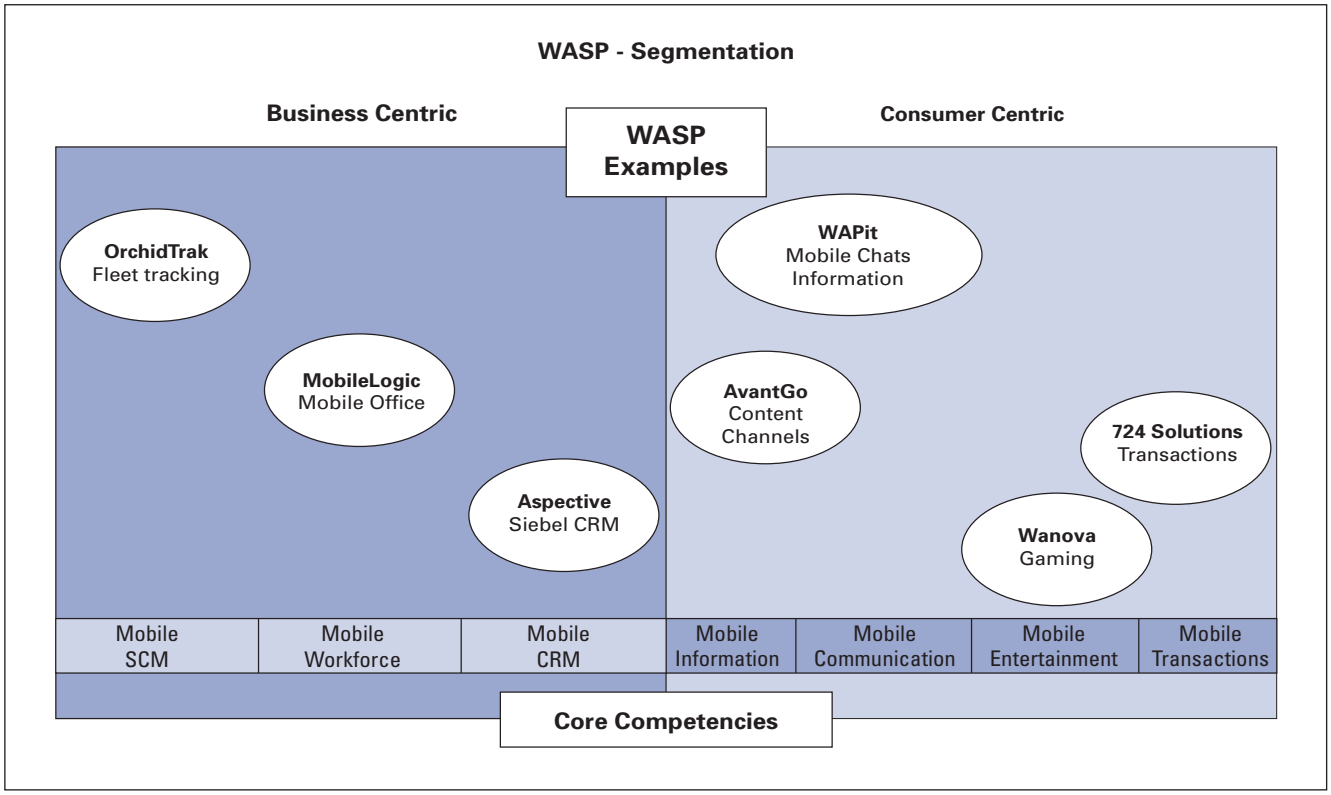


Figure 20: WASP – segmentation
Source: Durlacher Research Ltd., EQVITEC Partners Oy

Consumer-Centric

Consumer-centric WASPs provide applications and services across four key application types: information, communications, entertainment and transactions (see figure 20). Within the consumer-centric segment we see two groups emerging. The first group consists of players who focus on providing platform solutions to MNOs, VOs, and ISPs. For example, Sweden-based Aspiro, offers a full suite of services for the creation of consumer-centric portals. A more specialized approach is exemplified by Wanova, that focuses exclusively on providing an independent platform for mobile gaming to mobile operators and portal providers, which integrates easily with existing legacy systems.

Business-Centric

Business centric WASPs consist of companies that are focused on enterprise customers. Companies such as Aspective and Orchid bring the functionality of e-CRM and e-SCM solutions to mobile devices. Companies such as Mobile Logic and AvantGo extend the functionality of existing office software suites to the mobile workforce.

3.2.3 Revenue Models

WASPs have a number of revenue streams:

- Licensing
- Resource Usage
- Share of Traffic Revenues

Licensing – This is the most common revenue model. Revenues include upfront payment for the integration of the wireless solution itself, and revolving license payments over the lifetime of the contract depending on number of users or number of applications. This revenue model is similar to that of a traditional WASP for outsourcing applications and services.

Resource usage – Resource usage models vary and can be based on how long a specific application and/or service is used, the amount of data transmitted, a per user price, or by how many transactions a client conducts.

Traffic revenue share – WASPs also frequently negotiate percentages of traffic revenues that their particular applications and services generate.

We expect that revenue models for many WASPs will evolve into a combination of the above revenue streams.

3.2.4 WASPs: Success Factors

We have identified a number of critical success factors for WASPs including:

- Billing
- Integration
- Partnerships

Billing – As revenue models grow more complex, WASPs need sophisticated billing systems to succeed. This is a good opportunity for vendors of billing systems. For example, Copernicus GBS, a WASP itself for Sepro Vivaldi's core billing platform, offers a flexible and scalable unified billing platform for ASPs and mobile data service providers.

Integration & Partnerships – The WASP market is becoming more and more fragmented. Many WASPs are emerging offering single applications and services solely for a few MNOs. However, VOs and large enterprises, which present a much bigger potential target market, require more unified partnerships and JVs to be established between WASPs. Large system integrators might also function increasingly as an aggregator of applications.

3.2.5 Market Outlook

WASP Explosion

We believe that over 3000 applications and services will be offered on mobile networks by 2005. Because of the different focus in interests, operators will not be as heavily involved in the hands-on development of these. Instead, the number of WASPs will continue to grow quickly as the business model make it easier to get a foot in the door with customers who would normally refrain from buying from small software companies. Selling software products alone will become even more difficult as integration issues become more complex.

We believe that most software vendors have to offer WASP solutions, either by themselves or through partners. This will provide significant investment opportunities for WASPs turning new innovative application and technologies into carrier optimised solutions. We believe that WASPs need strong technical competence and understanding of their customers' business processes to really provide added value.

Consolidation

WASPs that provide best of breed applications and services will present interesting acquisition opportunities to several constituents including MNOs, software vendors and larger ASPs over the next 24 months. They will acquire WASPs mainly to ensure their own competitive advantage.

Integration

Based on the multi-channel nature of future digital commerce, consolidation will occur between WASPs and wireline ASPs to offer integrated ASP applications and services. WASPs offering horizontal functionality will align themselves with traditional ASPs offering functional oriented applications such as ERP and CRM applications.

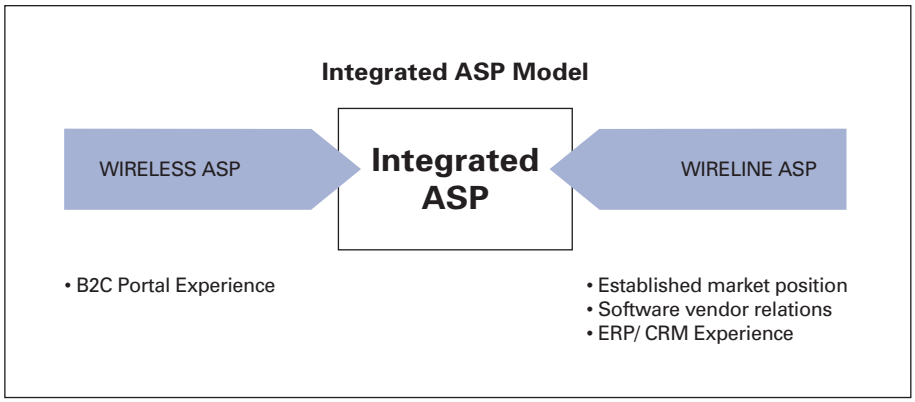


Figure 21: Integrated ASP model
Source: Durlacher Research Ltd., EQVITEC Partners Oy

We believe that within the next three to four years corporate customers and SMEs will be able to outsource all applications and services across platforms in an integrated e-business and m-business solution.

3.3 VIRTUAL OPERATORS

3.3.1 Definition

VOs have access to networks of one or more MNOs and offer services to customers using that network. Different types of VOs exist. VOs do not have the rights to use radio spectrum in the GSM and/or UMTS designated frequency bands, which means that they are always dependent upon the radio access network elements of MNOs (we refer to them as non-substitutable network elements). MNOs also use network elements that are substitutable: this offers VOs the opportunity to differentiate themselves if they decide to deploy their own infrastructure instead of the substitutable network elements of MNOs. Figure 22 provides a schematic overview of the different types of VOs and shows to what extent they rely on facilities provided by the MNO.

Non-substitutable network elements include all the radio elements of the mobile network such as basestations, basestation controllers, radio transmission links, control functions, mobile management functions and transmission and switching facilities required to link radio facilities to the points of interconnection with other parties (such as VOs). Within the radio network, the bulk of the money is spent on basestations and basesation controllers. Suppliers such as Ericsson, Nokia, Motorola, Nortel, and Lucent dominate this market. All these players have strong and established relationships with MNOs and it will be difficult for small players to take away business from this group of players. However, some opportunities for small companies exist but mostly as potential suppliers to the big infrastructure manufacturers. Companies with a strong technological expertise and vision will have opportunities in this market and will focus on a wide range of areas including Software Defined Radio (SDR).

To differentiate, VOs have the opportunity to take control of the network elements that are substitutable. This is where differences between VOs and MNOs kick-in. Some VOs will decide to rely fully on the MNO and will hardly invest in their own infrastructure, while others will aim to control as much as possible and will invest in their own network elements where they can. The more a VO relies on the MNO, the more the VO will pay for access and the less flexible the VO will be in creating its own services.

As service creation and low-cost access becomes increasingly important over the next five years, successful VOs will invest in their own infrastructure. This will include investments in mobile devices, SIM cards, switching centres (for both circuit and packet networks), home location registers (HLRs), authentication centres, equipment and identity registers, operation and maintenance centres (OMC centres, which includes billing systems), service control points (SCP) and intelligent networks (IN). All of these areas provide additional opportunities for suppliers, and thus increase the market potential for areas in which start-ups are active, such as mobile devices, authentication servers and IP billing systems.

Note that most elements relate more to communications and the management thereof, and less to the creation of new services (IN Systems are an exception as are the SCPs associated with them). For the creation of new services, VOs need other service and application platforms too, such as commerce and portal platforms, which will open up opportunities for suppliers in this space. We predict that most current suppliers of operators will attempt to supply to the VOs as well, but additional consulting and integration skills will be required.

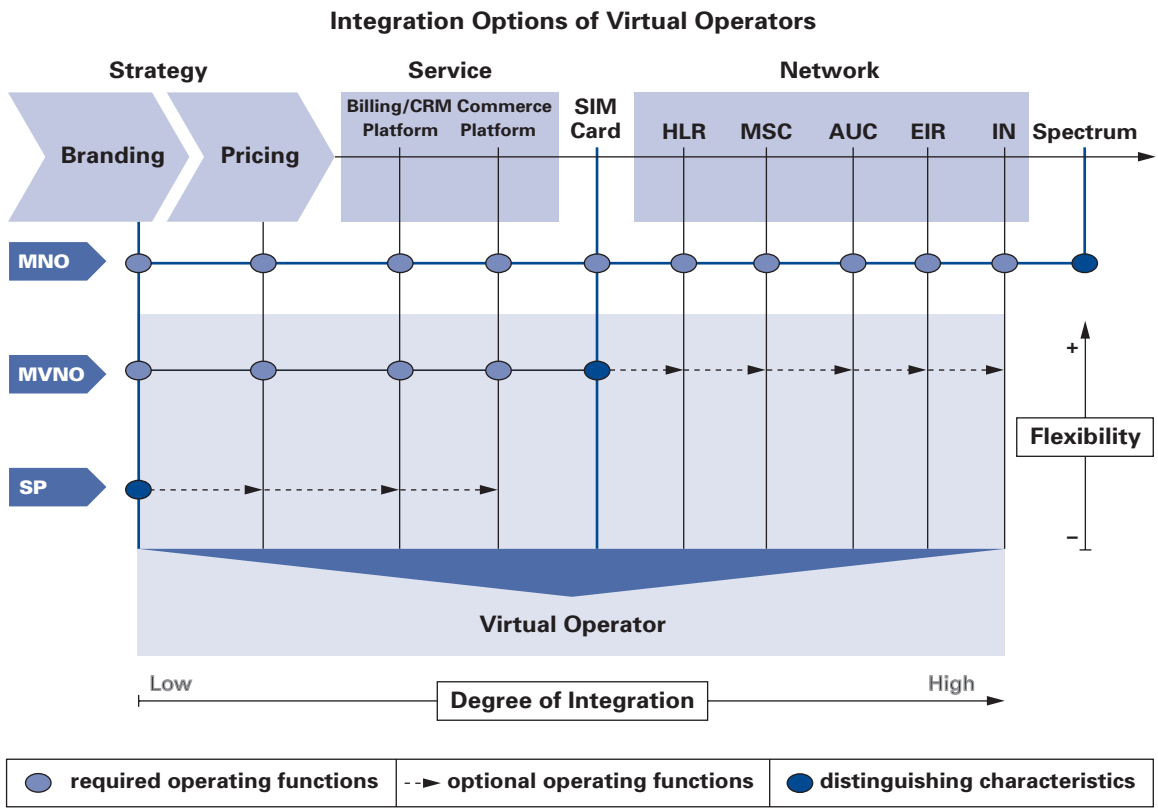


Figure 22:
VO integration options
Source: Durlacher Research Ltd., EQVITEC Partners Oy

3.3.2 VOs: A Varied Breed

As stated earlier, the extent to which VOs invest in their own infrastructure determines the level in which they are able to offer their different packages of services and tariffs from those available today. Based upon this notion we distinguish a number of different layers in the VO market:

Tied Service Providers – These service providers (SPs) sell subscriptions and airtime branded by their parent MNO. The tied SP buys an end-to-end service from the MNO who will charge wholesale rates for both subscriptions and airtime. They have limited freedom in terms of the service they offer as they rely heavily on the parent MNO for network services and marketing support. MNOs that have adopted this model include companies such as BT Wireless, Vodafone Group and KPN Mobile, and many others.

Independent Service Providers – Independent SPs also buy wholesale subscriptions and airtime from MNOs. However, they are not limited to doing business with a particular MNO and have the opportunity to brand their services independently from the MNO that provides the underlying network service. They usually rely to a large extent on the network capabilities of the MNOs they deal with, but may differentiate by running their own billing systems. These independent SPs are active in many European countries including Germany (Debitel, Mobilcom, Talkline), Netherlands (Debitel), Norway, Sweden and the UK.

Indirect Access providers – IA providers are a slowly emerging tier in the European VO market. They provide mobile customers with call services only (a customer would have to dial an access number to be connected over the code of the IA operator). They do not sell subscriptions. They do not buy the end-to-end service from the MNO and will invest in their own infrastructure (switches, for example). This allows them to make decisions about the routing of calls themselves, rather then rely on the call routing facilities of MNOs. This gives them greater flexibility in providing services and provides potential cost savings. To add further value to their service offering, IA operators must invest in infrastructure that will enable them to offer value added services. We do not believe that a significant market for IA operators will emerge. Their main value proposition is low prices for end-users, which they can only sustain by negotiating low cost routing agreements with operators. Low cost routing mostly applies to international calls and not so much to domestic traffic. This means that IA operators will find it hard to compete for national traffic on mobile networks, where the bulk of the traffic is local. Regulatory issues will also hinder IA operators coming to market: the conditions under which they will be able to gain access to existing mobile networks are ill defined and there seems to be no strong push to improve this situation. Assuming that regulatory issues will be resolved, IA operators need to carve out a better value proposition if they are going to succeed in the market.

Mobile Virtual Network Operators – Mobile Virtual Network Operators (MVNOs) would contract directly with end-users and would pay MNOs for use of their networks for access services and traffic. They would have much larger control of the customer and they are therefore in a position to offer a much wider range of service to the end-user. As is the case with VOs in general, MVNOs come in different shapes and sizes as well. Again, some rely heavily on the network facilities of the MNO, while others rely mainly on their own infrastructure. We would expect most of them to have their own billing platforms. All MVNOs provide and own the customer's SIM card. In all other VO cases, the MNO would own the SIM card: this provides them with important branding benefits over other types of VOs.

3.3.3 Drivers

There are several key drivers affecting the VO market.

Competition – Players from diverse industries such as automotive and retailing will want to capitalise on future mobile voice and data services revenues. Various companies will position themselves as VOs to benefit from mobile commerce in the coming years.

Distribution Channel – The VO business model enables non-telecommunications companies to enter the mobile market and gain access to an additional distribution channel for their products and services. They will also gain a 2-way communication channel with the customers if they do not already have one.

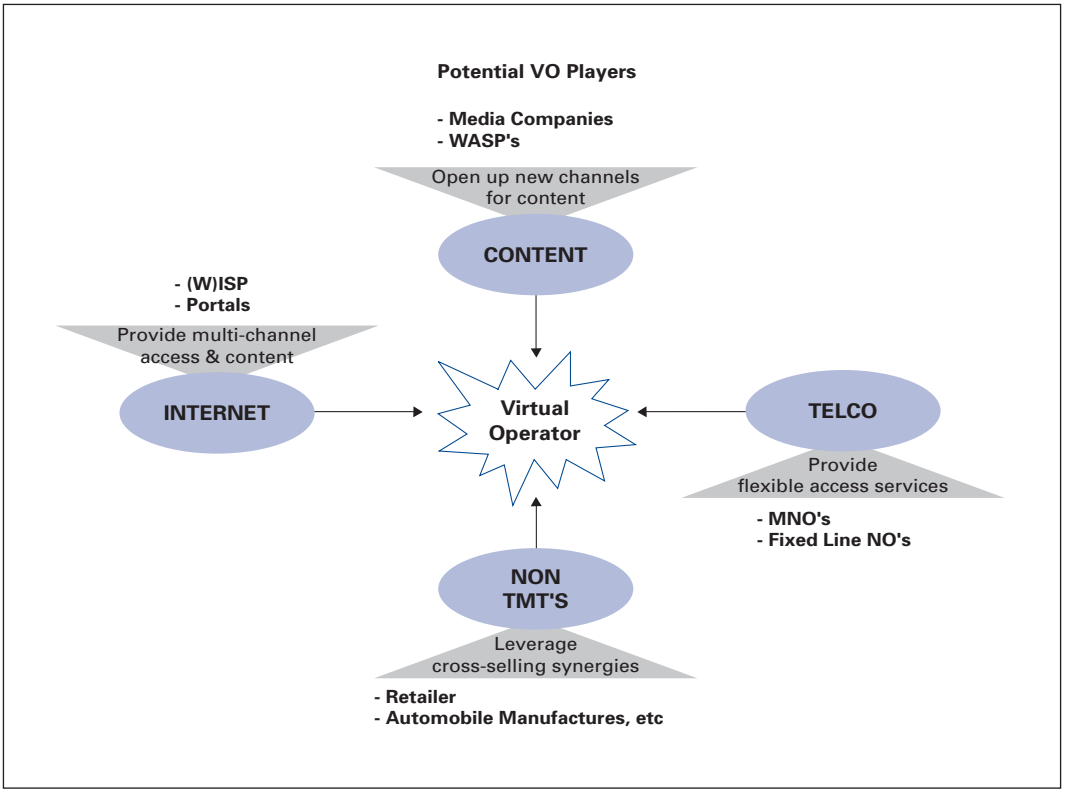


Figure 23: Potential VO players Source: Durlacher Research Ltd., EQVITEC Partners Oy

3.3.4 New VOs

We have identified four principal types of new VO players including content providers, network operators, internet service providers and non-TMT companies. Each of these groups has different motives to enter this market:

Content providers – This group includes media and entertainment companies. They see mobile devices as an additional distribution channel for their services. Many of them recognise the concept that people need access to relevant information, but not many content providers understand what makes content relevant. Personalisation is only one aspect of relevancy, but once the 'personal' information is delivered to a mobile customer, the user quickly needs to understand what the relevance is of that information. The relevance of the information thus becomes more important and that is where we believe new real value propositions can be found. This requires intelligent software applications and tools that are able to analyse a wide variety of content sources creating personalised content into value added content. Another driver for content providers to enter the mobile space is the fact that they have been burning large amounts of money with setting up online ventures while not generating revenues.

ISPs and WISPs – Internet service providers and wireless internet service providers will implement VO strategies to generate revenues from mobile internet access traffic as it is unlikely that they will be generating revenues from kick-back revenues. Kick-back revenue models are well established in the fixed market, but are not prevalent in the mobile world. ISPs and/or WISPs must consider establishing themselves as a VO to generate traffic revenues. This would allow them to create revenues on the margin between retail and wholesales rates.

Non-TMT companies – Non-TMT companies will be attracted to the mobile services market for a number of reasons: to leverage existing brands and customer bases, to generate cross-selling opportunities, to avail of a high-volume market, to extend their existing product and/or service range. Large retailers such as Tesco and Sainsbury's, for example, are attracted by the high revenues in the mobile services market and are well set-up to make money on low margin goods and services. They also see opportunities to sell their existing products through mobile devices. Automotive manufacturers such as General Motors and BMW are experts in the mobility market already, and mobile communication

services seem a logical extension to their existing product range. They are also able to deploy wireless technologies in the core product itself (i.e. the car) not only to improve communications in the car, but also to enhance the communication flow between the car and, for example, its owner, the garage (for maintenance) and traffic control systems.

Network operators – This group includes MNOs, fixed line network operators and other players. Again, motivations vary. MNOs will unfold VO strategies to expand their operations abroad. T-Mobile International, for example, has indicated interest in becoming an MVNO in Italy, a market in which it does own a UMTS license. Fixed line operators are interested because it will complement their domestic service offerings. Fixed line operators in this space are likely to comprise will new entrants rather than incumbent fixed line operators. The latter are usually active as an MNO in their domestic market anyway, while companies such as Energis, a fixed line operator in the UK, is working with Vodafone in the UK to offer mobile services.

3.3.5 Revenue Models

Voice

Voice revenues consist of incoming and outgoing call revenues. VOs should recognise that margins for mobile voice services are already under severe pressure, and the entrance of new VOs will reinforce this trend. As mentioned before, the more a VO relies on its own network infrastructure, the lower the price for wholesale access and traffic, and the higher the cost of the infrastructure needed. However, VOs do need to bear the cost of the infrastructure. Many argue that companies such as Tesco and Sainsbury's, two large retailing chains that recently entered the UK market as VOs, will position themselves as price leaders. This would cause further pressure on retail prices, and will bite into the margins of all their direct competitors including MNOs and other VOs. However, it is unlikely that they will force wholesale prices down. We expect that MNOs will be able to hold a strong hand over wholesale prices for network services, and that this will become an increasingly important revenue source for MNOs.

Mobile Data & Applications

Mobile data revenues will grow quickly over the next five years, but tapping these revenue streams requires significant investment in applications infrastructure for communications, entertainment, information, and transactions. Many parties will compete for revenues in this segment including VOs, MNOs, WASPs and content providers.

Cross-Selling

Cross-selling revenue opportunities are strategically important for VOs, especially for those that are non-telco companies. We do not expect that transactions conducted directly over mobile devices will lead to a significant increase in incremental revenues, but do expect that the share of retail transactions conducted over mobile networks will go up significantly. We also expect mobile devices to become an important communication channel between retailers and their customers. This would include their use for provision of information on delivery status of goods, special promotions and advertising. Virgin in the UK is a prime example of a company that has started selling communication services through its existing distribution channel. The firm is also using SIM toolkit technology to develop commerce services through which its customers can buy CDs and travel related services from other Virgin businesses.

3.3.6 Key Success Factors

New entrants in the VO market will only succeed if they meet the following criteria:

Branding and Customer Base – We believe VOs need to have strong brands and an established affinity with particular market segments to compete in this market.

Access To Distribution Channels – A VO must have access to a complex and well-integrated physical distribution network in order to market, sell and service products. Most MNOs already have these capabilities, and are continuously expanding their retail and high-street presence. This kind of expansion in the channel will be a key contributor to success. We believe that the vast majority of mobile phones will continue to be sold in the high street.

CRM Capabilities – A VO must be able to manage and retain its 'mobile' customer base. Good CRM requires strong organisational capabilities. Apart from a distribution network, this includes a retail service capability; call centres and WAP/web-based customer self-care facilities such as online billing information and basic account management functionality on websites.

Billing and Payment – Having best-of-breed customer billing and invoicing/collection is vital to the VOs' success. VOs can outsource this function to MNOs, but many of the latter face billing challenges of their own. It is therefore more likely that VOs will turn to state-of-the-art billing platform vendors, from whom they can either license or buy services. Some WASPs provide billing functionality too, including Copernicus GBS.

Roaming – A VO can choose to set up its own roaming agreements, but may also piggyback on the roaming agreements of existing MNOs. Other options are to turn to roaming providers such as Mint Telecom and Dialaway. These companies provide fixed roaming plans to mobile telephony providers. Mint and Dialaway purchase a significant number of prepaid roaming minutes that can be resold to network operators and VOs.

Portal and M-Commerce Strategy – We expect most VOs not to rely on mobile voice revenues alone, which mean that VOs need to execute upon a (mobile) portal and commerce strategy. Again, a number of different technology companies are offering services to build mobile portals, including Openwave, Materna, Wapit and Oracle. These generally cater for for multi-access portals. Portals would need to offer payment and transaction capabilities via the mobile channel. AOL is a good example of a multi-access portal as it currently offers access to e-mail through a variety of channels such as TV set top boxes, pagers, telephone (voice), smartphones (data) and PC's.

Time to Market – To generate revenues, VOs will need to achieve rapid time-to-market and provide compelling applications and services to end consumers. VOs will need flexible and scalable platforms, particularly for UMTS applications and services. MNOs will be faced with similar time constraints. WASPs will be vital to providing a wide range of outsourced applications and platforms for VOs and MNOs.

3.3.7 Implementation Strategies

To set-up their operations, VOs will adopt a number of different strategies ranging from setting up the entire operation themselves to outsourcing the complete solution. MNOs will obviously play an important role, but a wide range of other players will emerge in this space too.

MNOs own network infrastructure, billing and payment systems, and have roaming agreements with foreign MNOs. MNOs can leverage their technical network expertise and experience with billing and payment systems to provide quick and cost effective solutions to potential VOs.

White label VOs are also emerging. Talkcast in the UK, for example, provides a complete m-commerce environment including content and gateways for SMS and WAP. They are also capable of customizing 3rd party network technology and services, such as CRM and billing. We believe that system integrators will become increasingly active in this space.

3.4 MULTI-ACCESS PORTALS

Players focused on maximizing revenues from different distribution channels will implement multi-access portals to reach end-customers at all potential access points. We believe that multi-access portals are viable as a complimentary business.

3.4.1 Definition

Multi-access portals enable customers to access a wide variety of personalized services through a variety of communication channels. These may include content, commerce and communication services. The most important driver for a multi-access portal strategy is the fact that customers need access to their services and applications from any device, at any time, from any location. The challenge is to optimise the user experience (determined by device, access channel and the type of service and/or application). Additionally, portal owners need to understand how their users move across different access channels and devices. When new type of access devices, channels and methods emerge, portal owners need to be able to quickly integrate them into their portal platform. Obviously, such developments offer many new opportunities to interact with customers, but they also give rise to a whole range of new complexities.

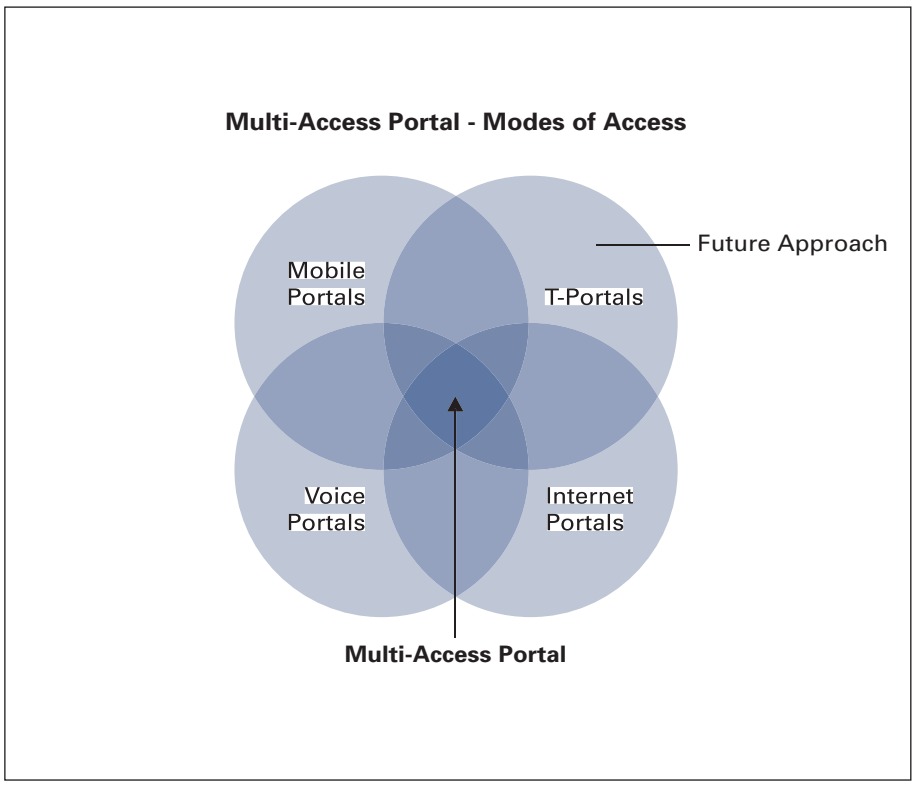


Figure 24: Multi-access portal – modes of access
Source: Durlacher Research Ltd., EQVITEC Partners Oy

3.4.2 Point Solutions Dominate Today's Market

The portal market today can be characterised by portals that provide specific functionality for specific devices. This seems to apply in both the internet and mobile domains. Many applications and services are device specific. Portals may also deploy a gateway solution that caters for a wider set of devices, but they usually only cater for specific types of device. For example, a portal specifically caters for the needs of PDA users, but it may not be suited for access by a WAP device, while the vast majority of WAP sites do not optimise the experience for a PDA user.

Today, we distinguish between different types of portals using different access methods:

- Mobile phones
- Speech recognition
- PCs and laptops
- Set-top boxes

Mobile portals such as T-Motion, Iobox, and M-Info allow end-customers access to data services through a mobile device, and present content in a customized format that is easy to navigate.

Voice portals provide users access to services through voice recognition technologies. Companies such as Tellme.com or 365 Corporation use speech recognition, text-to-speech technology and voice-activated navigation for a wide variety of services such as news, weather, stock quotes, sports scores, e-mail, voice mail, document management, access to personal schedules, and travel arrangements. Users can access these services through any voice-enabled device.

PCs provide the principal form of access for the traditional internet portals. These portals are the pioneers behind content and communication aggregation platforms.

As television evolves from scheduled broadcast to the interactive on-demand model, TV channels will evolve to include portal functions as well. Broadband interactive TV portals will move traditional advertising models one step forward, introducing an additional channel for interactive commerce.

Portals are slowly moving away from using point solutions to cross-device platforms, but it will take time before true multi-channel architectures will be mainstream. Today, multi-access portals consist of a mix and match of different point-solutions and usually involve the combination of a traditional internet site and a mobile portal site. The site may include voice recognition capabilities, but it usually stops there. Another major shortcoming is the fact that wireless internet architectures mostly focus on the delivery of the data, and not on the data itself. Neither has there been a strong focus on the integration of wireless components of a multi-access platform with application and commerce platforms used in enterprises. This is changing as vendors such as IBM (Websphere), Microsoft, Volantis Systems, and Brience are closing this gap. They develop solutions that address the integration of systems with legacy systems, but also with a whole range of emerging content & application platforms.

3.4.3 Players

There are different types of companies positioned to enter the multi-access portal space. The key players that we have identified include:

- MNOs
- VOs
- Internet portals
- Destination sites
- Intranet portals
- Start-ups

All have different motivations to pursue this strategy. MNOs face declining ARPUs and must generate more revenues to justify the sums paid for 3G licenses. Revenues must be generated by new content, services and applications, offered across different access channels. Service differentiation is also becoming crucial as new players such as VOs and internet portals enter the market. Experience proves that a successful portal offering may help address these challenges. BT Cellnet, for instance, claims that with the introduction of its multi-access portal, Genie, its churn rates fell to 24%, ARPUs went up and SMS traffic increased dramatically.

Top brand owners such as Coca-Cola or Virgin have the opportunity to convert their product users into portal customers through the strength of their respective brands. A customer base of this kind bound to a portal will unlock lucrative opportunities for product bundling and cross-selling.

Internet portals will establish multi-access portal services to add additional distribution channels for content. Internet stalwarts such as MSN can leverage their brand names and their existing customers base. Yahoo in October 2000 registered 61,942,000 Unique Users, translating into a reach of 70% of all internet users in the US, which means there is tremendous potential overlap with mobile phone users.

Multi-access portal startups that do not have any ties to an established brand or to significant technology experience will have little chance of succeeding on their own. Startups, though, may offer a white-label portal solution if their technology is advanced enough to compete. In addition, they may seek partnerships with established players, as Jamba did through its alliance with Debitel and the Metro Group in Germany.

3.4.4 Key Success Factors

Content Aggregation – Delivering content in a personalised, relevant and location-aware manner will be vital to attracting and retaining end customers. Among the players that we have identified, internet portals have a strong lead in understanding content aggregation and many have developed strong ties with content providers.

Customer/Brand Ownership – A large existing customer base will be important for introducing a sustainable multi-access portal. Another way to build a customer base is through converting existing users of the brand to mobile portal usage.

CRM Capabilities – All constituents will need to implement adequate CRM systems to collect and analyse customer interactions at various touch points. Amassing customer information and delivering personalised and relevant content will be vital to providing value added services.

Flexible Platforms – Multi-access portals will need to support numerous different standards, protocols and devices. Building flexible and scalable platforms will enable multi-access portals to integrate with commerce and application platforms and new access and device technologies.

Integration of Digital Commerce with Real Commerce – Multi-access portals are always looking to increase the number of touch points with their customer base. A shortcoming is the fact that most portals focus purely on 'digital' touch points, whereas the vast majority of customers will continue to rely heavily on their physical world of goods. This is particularly relevant for pure internet portals that sell goods and services. These portals will need to implement strategies that integrate on-line buying behaviour with off-line buying behaviour.

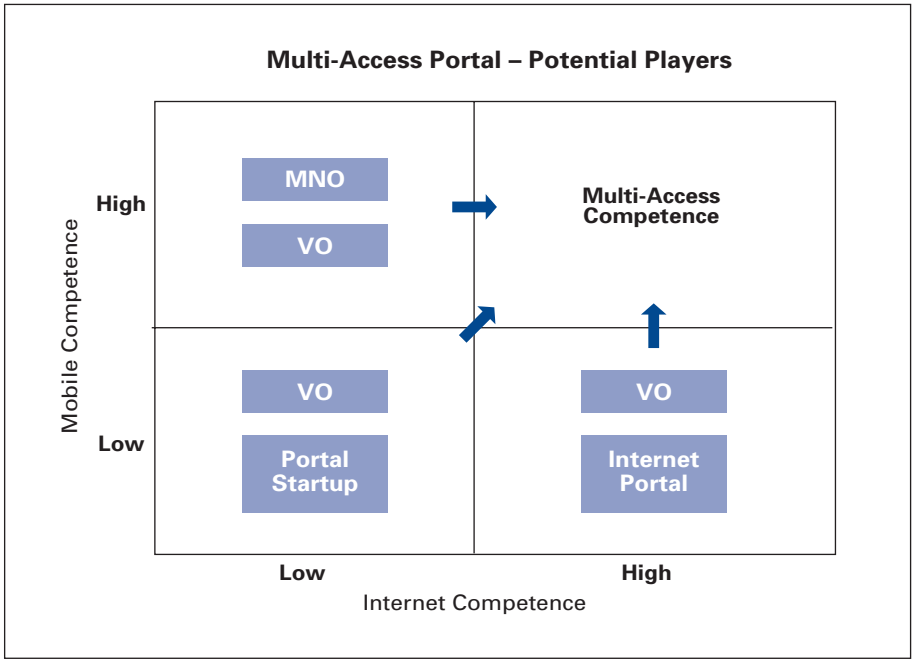


Figure 25: Multi-access portal – potential players Source: Durlacher Research Ltd., EQVITEC Partners Oy

3.4.5 Market Entry Strategies

There are several ways to acquire the channel competency required for a multi-access portal. A portal platform may be purchased from an existing portal. For example, Sonera ZED and Room33 sell their portal platforms to third parties.

A partnership with an existing start-up portal player is also a valid alternative. Jamba.de, a mobile portal start-up partnered with Debitel of Germany to deliver multi-access portal functionality. However, this was only possible because Debitel also became a major shareholder. Other mobile portals, such as Breathe.com, have failed, as they did not generate revenues over WAP.

WASPs such as Digital Mobility provide portal players with applications and content, or in some cases, with a complete portal platform. Platform vendors such as Openwave offer "out-of-the-box" mobile solutions to traditional portals.

MNOs are well positioned to create multi-access portals. They usually possess a large customer base and extensive user profiles enabling personalised service. MNOs also have long experience of offering mobile services. For instance, location-based services require positioning data that can be provided only through the operator's core system and the operator might use this dominance, at least temporarily, to gain a competitive advantage. Another important strength of the operator is its ability to maintain a billing relationship with the customer that ensures that services provided are paid for.

3.4.6 Revenue Models

Multi-access portal players possess several revenue streams, including: access, advertising, transactions and content and/or application provisioning.

Advertising

Advertising is already profitable for top internet sites, and will be a valid model when extended to the mobile space. Top portal players such as Yahoo and Lycos are primarily interested in delivering location-based, personalised advertising campaigns when becoming mobile portals. High-reach portal properties can generate revenue streams with content placement services.

Transactions

We believe that access providers with billing and charging capabilities are in a good position to benefit from this revenue stream, but we do not believe significant revenues will be generated in the short term. From 2003 onwards, when issues around key-inhibitors are resolved (the most important of which is non user-friendly applications), the market for transaction revenues will take off. Having recognised the increasing importance of transaction revenues, Mobilcom in Germany recently moved into financial service provisioning, through M-Bank, which it recently established with Landesbank Baden-Württemberg.

Direct Content Revenues

Content and services revenues are typically received from end-customers through either subscriptions or through an ad hoc payment model. There are different ways to quantify content usage based on data volume, time or value. IP billing capability and compelling value-based pricing schemes are key enablers for the realisation of this revenue stream.

Direct Access Revenues

Other revenue sources include charges for mobile or fixed-line access services. AOL receives significant revenues from selling access to the fixed line internet as well as mobile RIM services on Bellsouth networks, which actually designates AOL as a VO in both wired and mobile access modes.

We believe that there will be opportunities for technology enablers of multi-access platforms, who do provide strong competencies in particular areas. It is important to design the solutions to work across networks from the beginning to ensure full versatility.

4 IMPACT OF TECHNOLOGY

- GPRS will be the first revolutionary step for mobile data, because of its packet-based always-on nature and increased bandwidth. Europe will predominantly adopt GPRS. Although UMTS will be introduced commercially towards the beginning of 2003, we believe that GPRS will remain a key technology for nation-wide coverage over the next 10 years. In terms of the consumer experience, the transition from GSM to GPRS will be a far greater leap than the subsequent less evident migration to UMTS.
- Japan has gained a significant market lead in the adoption of mobile data services over the past 18-24 months. Now, the first Japanese operators are expected to roll out their 3G networks by end of Q2 2001. On the other side, UMTS rollouts in Europe will be significantly delayed by the shortage of network equipment and deployment resources. First rollouts are expected by end of 2002-2003. With the early introduction of UMTS and the convergence of mobile devices with consumer electronics, Japanese technology providers are likely to expand their lead in the market. European players will find it increasingly hard to compete.
- We expect that 4G will be the real next round of innovation after GPRS, allowing theoretical speeds of up to 54 mbps and being introduced by 2008. Wireless LAN will be a key technology in public use for "hot spots", such as hotels, airports and supermarkets.
- Bluetooth will be an important enabler of device modularity, replacing currently commonplace infrared and wired connections. It will also be successful as a peer-to-peer and small hotspot technology for WLANs. Thus, we believe that Bluetooth will increase significantly the usability and the success of all future mobile technology. It provides a significant investment opportunity especially on the applications-side for the next two years.
- We expect that multi-network environments will emerge over the next five years, triggering the demand for multi mode devices. Processing power, storage, power supply and the interface of the mobile device will become the principal restricting factors in development of the mobile data space.
- We believe that there will be space for two major existing operating system standards in the foreseeable future; each will start rolling into the market from one end - EPOC is likely to become the OS of choice for smartphones, while Microsoft Pocket PC will dominate the PDAs. Palm OS with its current capabilities is unlikely to achieve success in the long run if it is not replaced quickly with a new more advanced version.
- WAP will finally be successful with the introduction of GPRS as a bearer technology. Different presentation languages and standards (HDML, WML, cHTML) will converge around xHTML – a single, XML-based multi-channel presentation language. Channels of communication will be converging around IPv6, shifting the focus from purely mobile to MC-commerce (Multi-Channel commerce). JAVA will emerge as a key standard for allowing mobile devices a previously unseen degree of interactivity and interoperability.

4.1 NETWORK AND COVERAGE EVOLUTION

The emergence of broadband services and applications drive the demand for more network capacity, higher transmission speeds and better service quality on mobile networks. 3G has been developed to eventually provide a unified mobile technology platform across the globe, but the path to it from the current differing 2G standards is not as clearly defined. The major evolutionary options, which will leverage the particular available frequencies, are outlined below:

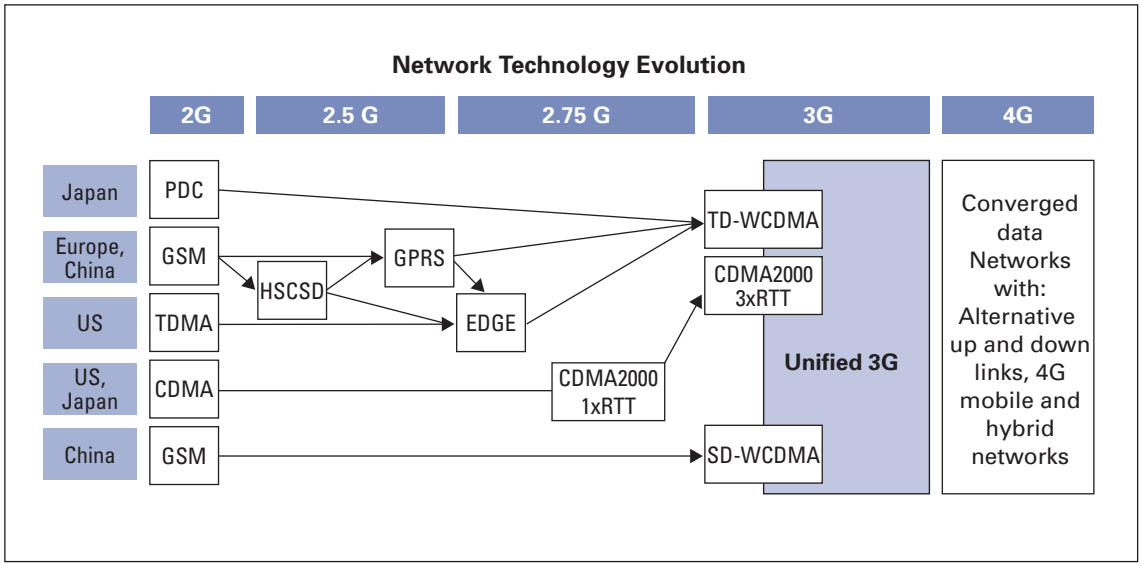


Figure 26: Network technology evolution Source: Durlacher Research Ltd./ EQVITEC Partners Oy

However, we believe that a number of wireless technologies will emerge and co-exist because of their particular strengths. The table below illustrates the different wireless data transfer technologies according to the coverage area they are designed for.

Wireless Coverage Areas

Coverage	Scale Example	Technology Example
Personal Area	Cubicle, Room	Bluetooth, IR, FM, etc
Home Area Public Hotspot	Building, Apartment Office	Home RF, WDSL, WLAN, UWB, etc
National & International	City, Country	GSM, GPRS/EDGE, UMTS
Global	Worldwide	Satellite

Table 3: Wireless technology coverage area Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Furthermore, the technologies are each designed for different types of applications. Bluetooth, for example, could offer connectivity between devices in a home office environment and eventually within a building, but would not be used as a national coverage technology. Some technologies work better indoors (WLAN) while others provide connectivity both indoors and outdoors, or only outdoors as is the case with satellite systems. Finally, a key difference among the technologies is their support for mobility. Many short-range technologies lag behind in this area, while national coverage technologies (such as GSM) are the most suitable solutions for widespread mobility.

UMTS as a 3G technology, is a solution providing access to new frequency bands as well as increased speed, quality and spectral efficiency. Technologies such as WLAN will, however, continue to evolve and provide cost-efficient wireless IP access that will both complement and substitute 3G.

Once 4G emerges in the future (not before 2008-2010), the focus will shift away from bandwidth constraints to interoperability and integration of different existing technologies.

4.1.1 2G Technologies

In Europe, current GSM networks offer only circuit switched traffic and are theoretically capable of transmitting data up to 14,4 kbps (single slot HSCSD). The standard rate reaches a maximum of only 9.6 kbps (basic GSM). The actual speeds that end-user experience are much lower depending on network implementation and traffic density – these are typically at around 25-30% of the optimum level. This implies that it takes approximately one hour to download a one megabyte file using today's 2G networks.

Operators employing systems based on other major cellular technologies such as CDMA, PHS and PDC are advertising maximum speeds of 64 kbps, about a six-fold advantage compared to GSM. However, all of the present 2G systems have capacity constraints both on the number of users they are able to support simultaneously and on data transfer speeds, mainly due to terminal capacity constraints. Thus, there is a clear need for 3G infrastructure.

We believe that SMS over GSM networks will continue to grow significantly at least until 2004. Together with the emergence of 2.5G technologies, this provides an early framework for any future mobile application providers.

4.1.2 2.5G Network Technologies

GSM networks are being upgraded with HSCSD, GPRS or EDGE/E-GPRS technologies, which can be rolled out at limited additional costs above that of current network equipment.

In HSCSD, connections are circuit-switched as in basic GSM. Higher bit rates are achieved by higher modulation per time slot and by enabling multi-slot connections. This technology increases the capacity problems in the network and is expensive for operators with scarce frequency resources. Thus, it is only offered by a few operators who also have spectrum in the 1800 MHz band. It has not been proven to make any impact in the market due to the lack of terminal equipment (modem cards, phones) and high prices. Current solutions also lack international roaming or a compelling mass-market proposition. De facto, HSCSD is only useful for the domestic business traveller, who is equipped with a laptop and who needs to connect to the internet or intranet.

GPRS offers packet-based connections, achieving high efficiency for burst data traffic. The change from circuit switched to packet-based connections alleviates network capacity problems by increasing capacity per time-slot and by improving efficiency by multiplexing connections, resulting in an increase in the number of connections per carrier. GSM operators will be able to offer IP-based services and applications.

EDGE technology is a further development of current GSM networks, enabling hypothetical maximum speeds of 384 kbps.

Most mobile operators will upgrade current GSM networks to GPRS. Beyond GPRS, several options exist; Enhanced Data rate for GSM Evolution (EDGE), UMTS or other development steps. The decision is largely defined by operators' specific strategies and market visions. Independent of their current choice of 2G or 2.5G, operators have a free choice in selecting their UMTS (Universal Mobile Telecommunication System) technology on top of their existing system. W-CDMA and CDMA2000 are being harmonised and could be implemented on top of GSM, IS-95 CDMA or IS-136 TDMA.

Implementing HSCSD and GPRS will require relatively few changes to network hardware and software. HSCSD is mainly a software update for terminals and base station transceivers. In GPRS networks packet based technology will be implemented in parallel to circuit-switched technology, requiring only marginal changes to base stations and base station controllers. For EDGE, more changes are needed in both hardware and software. Projected capital expenditures for an EDGE upgrade are less than 1/5th the cost of a full UMTS roll out for GSM operators and 1/4th the cost for TDMA operators such as AT&T. Groups from the two camps have been working on ways to align their 3G plans. This will assist operators using either standard to roll out GPRS packet-based high-speed networks, together with EDGE as a radio interface.

GPRS networks are expected to overcome most of the technical obstacles for data transmission with WAP over normal GSM. GPRS provides improved data rates, an instantaneous "always-on" connectivity and more flexible billing capability. The network upgrade is likely to change charging principles and will ultimately drive the market towards value-based pricing strategies in certain services. Charging for traffic is, however, a strategic choice for operators who are starting to offer GPRS services either with volume-based or flat rate pricing to attract more traffic and to ease pressure on their billing systems. The flat rate pricing model eliminates much of the customer confusion that may be associated with volume-based billing.

We believe that virtually all GSM operators will introduce GPRS, regardless of whether they provide UMTS services. GPRS will become in the short-term the common mobile data service standard with the widest geographical distribution and it will provide the first real platform for developers of advanced mobile data applications. Thus, considerable investment opportunities are emerging for GPRS mass market services, an area which has not been served very much as many developers still focus on WAP.

4.1.3 3G Network Technologies

UMTS has been developed as a complex network technology that incorporates several different solutions. There are two main carrier technologies capable of offering high mobility that meet the criteria set by ITU for UMTS: wideband CDMA (W-CDMA) and CDMA2000. The systems have different operating technologies and initially will not be interoperable/compatible. Additionally, China has developed a third generation standard of its own together with Siemens called SD-WCDMA that the ITU is trying to accommodate and harmonize.

All UMTS technologies offer significant increases to traffic capacity per carrier when compared to GPRS. For example, in W-CDMA, a carrier with 50% uplink loading offers more than 10 times the capacity of a basic GSM carrier. Cell ranges are also different due to technology and frequency levels and the number of base stations needed is about six times that for a GSM900 network.

The world's first third generation system will be built in Japan by NTT DoCoMo with a commercial launch planned for May 2001, shortly followed by Manx Telecom on the Isle of Man. The rest of Europe and Asia will follow with commercial introduction at the end of 2002 or early 2003.

The roll-out of new networks and the upgrading of existing 2G to 3G networks provides significant investment opportunities for vendors of hardware such as RF, IP access, base station module and antenna technologies. Additionally, IP billing and network management solutions will be in high demand.

4.1.4 Bandwidth – Hype vs. Reality

Although GPRS promises to deliver up to 115 kbps of gross bandwidth, in reality it will only allow end-users to use speeds less than 60 kbps. The networks will have a light rollout, but GPRS mobile devices will not be able to take advantage of the enhanced capacity. In addition, operators will not allocate the whole capacity of the network to a single user. Our estimate is that the initial data rate will be in the vicinity of 20 kbps.

Nortel Networks has introduced a bandwidth manager to provide varying degrees of bandwidth based on user profiles, which enables users prioritisation. Users who pay a premium will receive better bandwidth connections, enabling higher-priced services for business users.

UMTS, which has promised to deliver up to 2 mbps, will initially provide an average bandwidth range of 40 kbps, which might increase to 200 kbps by 2006. As the technology develops and various enhancements for UMTS are made (resulting in what we call "Enhanced UMTS"), we expect the average data rate to grow further.

Bandwidth is an important enabler for multimedia applications. However, simple information services often do not require significant bandwidth. For many applications the instant availability and reliability of an "always-on" network are more important. Such features are already delivered by GPRS.

Due to limitations in available bandwidth, we believe that opportunities for streaming audio and video media will not become realistic before 2006 and 2008 respectively.

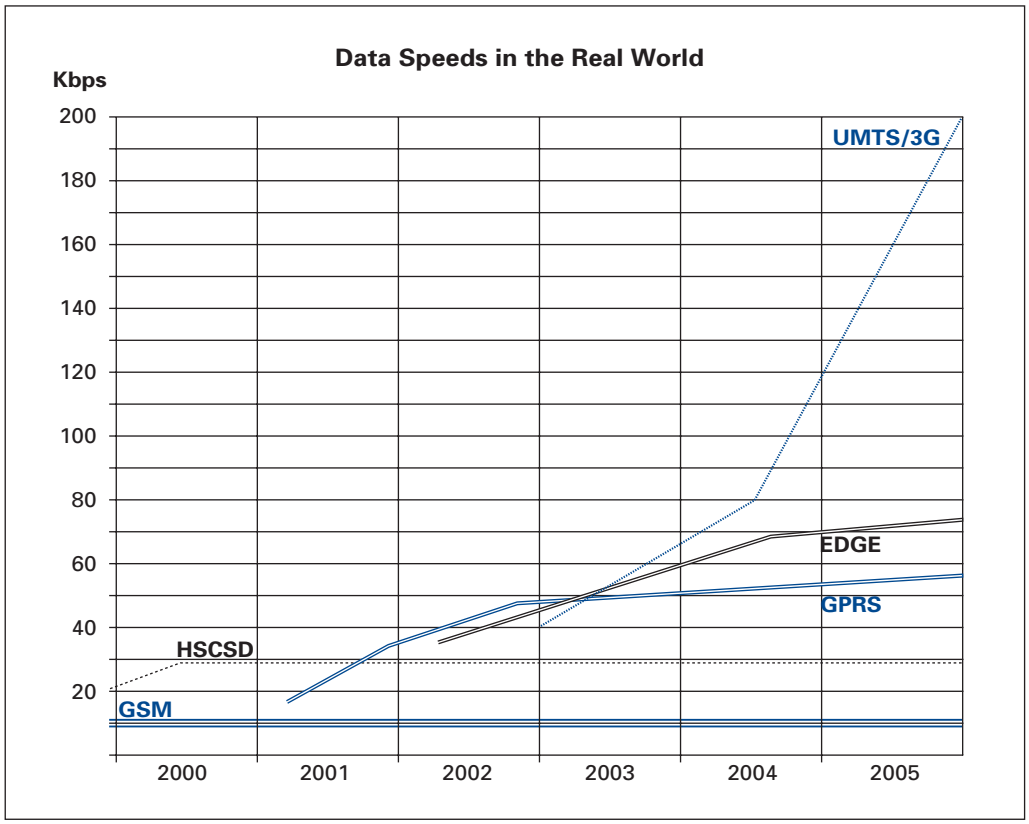


Figure 27: Real world data speeds Source: Durlacher Research Ltd./ EQVITEC Partners Oy

4.1.5 Network Roll-Out Schedules and Cost Implications

Commercial GPRS services will be launched during the first half of 2001 in most European countries. However, we do not believe that handsets will hit the retail market in sufficient numbers until Q4 2001.

Upgrading GSM networks to GPRS will cost approximately €10 per customer; significantly less than implementing UMTS networks. EDGE is expected to cost between three to five times as much as GPRS (€30-50 per customer). UMTS will cost 20 times as much as GPRS, i.e. €200 per customer.

The first Japanese UMTS launch has been planned for May 2001. All major Japanese network operators will be offering 3G services by 2002. NTT DoCoMo and J-Phone opted for W-CDMA technology, while the KDDI/AU group decided on CDMA2000. The Japanese launch of next generation systems will initially provide coverage only in traffic hotspots in major cities to alleviate the congestion of present networks.

In 2003, UMTS networks will be commercially available in most European countries. There are three major factors driving UMTS infrastructure rollouts:

- License terms,
- License & installation costs and
- Network implementation.

Some European countries granted licenses to operators based on their ability to provide adequate network coverage rapidly throughout the nation. In Sweden, operators must

eventually ensure coverage of 99.8% of the population. In Spain, the government mandated MNOs to launch their UMTS services commercially in the fall of 2001. All MNOs appealed since equipment will not be available.

Over the next three years more than 70 networks will have to be deployed in Europe alone. This massive demand for network equipment and services is likely to create supply bottlenecks, due to the lack of vendor production capacity and trained staff.

Significant investment opportunities exist for companies that provide streamlining of processes (such as Crowncastle in the UK for base station site acquisition) or advanced network planning tools.

4.1.6 Road to 4G

Blueprints for technologies beyond 3G have already been proposed, even though an established standard has yet to emerge. There are several technologies currently under discussion that aim to bring higher data rates to users and lower costs to operators by using the available radio spectrum more efficiently.

Enhanced 3G

Upgrades for W-CDMA systems that might support a theoretical speed of up to 8 mbps downstream, called enhanced 3G, are the first step. Vendors who plan such upgrades have not disclosed technical details of how they plan to boost the data rate, but it is expected that these solutions will focus on more efficient packet coding.

We expect a number of interesting investment opportunities to arise in the field of sophisticated technology solutions for enhanced 3G, as each of these will need to utilize the existing bandwidth more efficiently.

4G

There are several different interpretations in the market of what 4G technologies actually are. We present here the different developments that will all compete with UMTS.

The next step in the development towards 4G technologies will be separation of the up and down link technologies. AT&T have already conducted feasibility tests, for a system with an EDGE up link and wideband OFDM (Orthogonal Frequency Division Multiplexing) down link. Other possible configurations combine GPRS or UMTS for the up-link and WLAN technology for the downlink. Digital broadcasting systems such as DAB & DBV are also becoming more relevant as downlink alternatives.

Among the modulation technologies that hold the most potential for 4G applications is OFDM, initially developed by Flarion technologies. Its potential bandwidth was estimated to be as high as 100 mbps for the aggregated capacity of one cell. Nortel Networks is aiming to provide 20 mbps per user peak rates on multi-carrier OFDM. Some companies go as far as to quote theoretical peak rates of 54 mbps (Wi-LAN Ltd. and HiperLAN Standards). Other modulation technologies such as UWB are also sometimes referred to as 4G.

Only recently have 4G technology developments commenced. Many of these set out to achieve the performance that 3G originally intended to provide. Several large telecom companies including Ericsson, NTT DoCoMo and Lucent have committed extensive resources to develop 4G systems. They are focussing on creating a convergent network that offers seamless IP connectivity over several radio interfaces (WLAN, OFDM, W-CDMA) and wireline networks with very high data rates.

We believe that fourth generation systems will be the source of the next round of innovation in terms of a major improvement in bandwidth speeds and mobile broadband applications. Applications such as mobile video streaming will only be realised in a 4G environment. We believe that implementation of 4G networks will not occur before 2008.

Clearly, opportunities exist for technology companies involved in the research of 4G technologies that will lead to higher data rates and more efficient use of the spectrum.

4.1.7 Alternative Wireless Network Technologies

In addition to the above network technologies, there are several alternative mobile access technologies that will provide business opportunities in addition to or instead of UMTS for particular applications.

These are listed in the table below.

Table 4: Alternative wireless network technologies Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Technology	Usage	Standard	Operating frequency	Data rate	Max Cell Radius	Key Constraints	Multi-Network Environment Impact	Examples Companies
Personal Area								
Bluetooth	Peer-to-peer, Home	IEEE 802.15	Unlicensed 2,4Ghz	721Kbps max	5-10m, 100m with amplifier	Near line of sight required	Allows data exchange, synchronization and M-Commerce in PAN	Ericsson, Several Others, see: www.bluetooth.com
Infrared	Peer-to-peer, Home	IrDA	Infrared light	up to 11Mbps	~10m	Full line of sight required		
Indoors Short range								
WLAN		802.11 (FHSS)	Unlicensed 2,4Ghz	1 or 2 Mb	10-500m			
WLAN		802.11 (DSSS)	Unlicensed 2,4Ghz	1 or 2 Mb	10-500m			
WLAN		P802.11B (DSSS)	Unlicensed 2,4Ghz	2,4Mb-11Mb	10-500m	Interoperability between different suppliers, Near line of sight requirements	Possibility to avoid costs related to public networks, Possible integration to 4G	Microsoft, Lucent, Nokia, Cisco, Ericsson, 3Com etc. see: www.wlana.org
(PLANNED) WLAN with OFDM	Low mobility and mainly indoor solutions	P802.11A (FHSS)	Unlicensed 5Ghz	54Mbps	5km			Wi-Lan, see: http://www.ieee.org/
Home RF	Home Solutions	Home RF (FHSS)	Unlicensed 2,4Ghz	1 or 2 Mb	Under 100m			Microsoft, Intel, Motorola, Siemens
Hiper LAN (PLANNED)	Low mobility & mainly indoor solutions	7.2 HIPERLAN	Unlicensed 5Ghz	23,5Mbps	10-200m	Interoperability between different suppliers, Near line of sight requirements		Proxim
UWB	WDSL and other indoor solutions	FCC Support in US	Spread spectrum	20Mbps	10-200m			TimeDomain
Residential Area Fixed Wireless								
WLL	Residential network connectivity		3,4-3,6Ghz	4 to 25 Mbps, depending on channelization	2.8 km to 26.6 km	Line of sight required for two way systems and high power required for long distance	Backhoul or residental area fixed wirelss data distribution	
LMDS	Broadcast TV, Residential network connectivity		27,5Ghz-31,3Ghz	1,5Gbps-2Gps downstream 200Mb upstream	3-12km			
MMDS	Broadcast TV, Residential network connectivity		2,5Ghz-2,7Ghz	T1 down-stream, 512K upstream possible	Up to 65km			
Full Mobile Networks								
TETRA	Mobile Networks		450MHz	26,4Kbps	30km-60km	Low data rates	Fully mobile networks for rural areas	Dolphin Telecom, Nokia, Motorola,
GSM 400 (INITIATIVE)	Mobile Networks		450MHz	N/A		System not available yet	Fully mobile networks for rural areas	Nokia, Lucent, Ericsson
CDMA 400 (INITIATIVE)	Mobile Networks		450MHz	N/A		System not available yet	Fully mobile networks for rural areas	Qualcomm

Bluetooth

Bluetooth will allow synchronisation of mobile devices with PC applications, data exchange and m-commerce applications (e.g. payment, ticketing) within a radius of up to 10 meters. Bluetooth is a widely accepted and supported technology and we believe that it will become the standard for short range, peer-to-peer and home networking of devices and appliances because of its low expected unit price of €5 in the near future. Bluetooth eliminates the need for cables and wire extensions. The first Bluetooth devices were available from TDK technologies, but many other companies, including Ericsson, Alcatel, Nokia, Motorola, Intel and IBM plan on introducing their equipment in early 2001. Some companies such as Red-M are looking at an option to increase Bluetooth range up to 100 meters, thus making it a viable hot-spot service technology. One of the major advantages of Bluetooth over competing technologies is the fact that it is widely accepted as a standard and adopted both by component and device manufacturers.

We believe Bluetooth will emerge as a dominant standard for short-range peer-to-peer and personal area networking. Eventually, it might play a more significant role in covering hot spots too, since we expect to see wide distribution of the chipsets. While investment opportunities in Bluetooth to date have been focussed on the technology side, they are now shifting to the applications side.

UWB

UWB (Ultra-Wide-Band) is an innovative low-power, spread spectrum technology that relies on coded pulse modulation for data transmission. Among the advantages of this technology is the fact that it does not require an assigned frequency or a power amplifier and is so random and low powered that it is almost indistinguishable from noise. It is being commercialised by a company called Time Domain that offers a PulsON chipset solution. The technology has a lot of potential uses including data communication and location technologies. In some respects it may be viewed as a competitor to Bluetooth for short range, peer-to-peer and home networking, but it also has broadcast capabilities. Time Domain now faces several standardization issues with the technology, as there might be problems of interference with other technologies on different frequency bands. We do not believe in the short-term mass market success of this technology as a common standard, as the required interfaces are still missing.

WLAN

Wireless Local Area Networks (WLAN) are substituting cable based LAN's. The wireless LAN infrastructure is similar to cellular systems where the terminal communicates with the base station over an air interface at a certain frequency band. The WLAN infrastructure is currently used mainly in laptop equipment indoors. For example, Lucent and 3Com supply data cards for laptops and base stations, which can be installed in offices and homes. The network interface from the base station is established in most cases through a broadband wireline connection such as xDSL or leased line.

Once WLANs provide increased mobility between cells and applications that support connectivity to these systems, they will compete with UMTS mobile networks. Finnish start-up Micsom has been developing a technology that actually provides mobility and roaming between WLAN cells, irrespective of the manufacturer.

Public WLAN systems are less expensive than the UMTS systems, easy to install and they are likely to emerge as hot spot technologies in densely populated areas. Typical locations where this service will be offered initially include hotels, airports, supermarkets and similar places where demand for mobile broadband data services is increasing. For example, a public WLAN environment may be offered by an airline company at their lounge as a value added service, making the airline company a VO. They only need to build the connection between the existing data network and the base station and configure the system so that anyone with a WLAN card can access the high speed network.

Finnish company Jippii, has been offering a WLAN service in Helsinki since 2000, and is planning to expand its offering to provide wireless internet services for multi-mode devices.

A software enabler called *Dynamics IP* allows the company to efficiently (with little latency and packet loss) hand-over mobile clients with a fixed IP address. This enables the company to emerge as an alternative full-coverage network operator in urban environments at a fraction of UMTS investment costs.

WLAN has suffered so far from a lack of standardisation. However, we foresee that these problems will be resolved over the next 12-18 months. Interoperability is pushed by existing solutions such as the one presented by Micsom. WLAN will become the technology of choice for indoor coverage in corporate and private home environments, but it will increasingly also enter the public space with its attractive proposition of high bandwidth.

We expect significant investment activities in the WLAN technology space, especially in Scandinavian countries, which seem to have a clear lead in the market.

Interference & Interoperability of Bluetooth and WLAN

Wireless LANs cause interference with low power Bluetooth technology because the systems operate on the same frequency band of 2,4Ghz. Due to the expected penetration of Bluetooth enabled devices, interference will be inevitable in offices, airports, and train stations, schools and shops, all locations where WLAN technology is gaining acceptance.

Both industry forums, the Wireless LAN Association and the Bluetooth Forum are working on resolving interoperability issues. Both technologies suffer from a lack of interoperability between devices from different manufacturers. Even though the standard has been agreed upon, there are slight differences in the technical execution of the systems. According to Ericsson, their initial Bluetooth products can only recognise and operate with other Ericsson devices. As more infrastructure providers and the respective forums focus on incompatibility issues, adequate solutions will be developed.

TETRA

There are already alternative networks in operation such as Dolphin Telecom. Dolphin Telecom offers a nation-wide TETRA (Terrestrial Trunked Radio) solution for companies that need fleet management and dispatch applications in several European countries. They charge only a flat monthly fee. The system offers data rates of up to 26.2 kbps. The latter is adequate for most business solutions. Additionally, the system is capable of ad hoc connectivity between two terminals in areas without network coverage.

We believe that use of TETRA will be reserved to niche applications such as police, fire service and taxi companies, where communication occurs generally between the people within their particular community. TETRA as a form of private mobile radio technology has been around for years, but it does not have very high chances of becoming a mainstream technology with the decrease in GSM prices and the rise of GPRS and UMTS.

Mesh Networks

Mesh networks are another form of an emerging ad hoc solution. They are a potential alternative to traditional mobile networks and will attempt to alleviate many of the problems facing mobile broadband operators today. Currently, base stations must be deployed that transmit signals to numerous local receiver units. Mesh technology incorporates receiver units into its networks and enables them to transmit signals as well. End-users effectively pass signals to each other and form a network of low-power transmitters that can cover large population centres. Some start-ups such as Radiant Networks believe mesh technology may be the most cost-effective high-bandwidth alternative to running fibre-to-the-home. We believe the technology has high potential for creating low-cost wireless local loop (WLL) networks. However, the technology is still immature and currently cannot be viewed as viable competition to major mobile data network standards.

However, mesh network technology should be monitored for upcoming start-up activity, as its promises to be highly rewarding.

4.1.8 Multi-Network Environment

In the future we expect that there will be more than one network technology to provide the customer with mobile data services:

- GPRS based on GSM technology will provide extensive coverage for packet based mobile data services by late 2001, but is limited in terms of bandwidth.
- UMTS will offer more spectrum and efficiency, particularly with respect to capacity. However, UMTS will initially be available only in urban areas due to the high costs of implementation and rollout time required, as over 70 networks need to be set up over the next three years in Europe.
- Public WLANs will provide users with broadband access in specific hot spots such as railway stations or airports. For example, Telenor Mobile is planning to offer its customers up to 11 mbps access to corporate intranet and internet services via WLAN.
- Bluetooth is providing a private area network (PAN) technology for peer-to-peer applications such as m-payment, data exchange and cordless synchronisation.

Initially, we believe there will be a lack of multi-mode devices integrating GSM, GPRS, UMTS, WLAN and Bluetooth interfaces. Device manufacturers will have to design powerful chipsets that can seamlessly move between different modes. Symbol Technologies made a step in this direction by integrating Bluetooth and WLAN technology on Palm based PDAs for professional users.

We believe that mobile commerce in Europe will be conducted in a multi-network environment where applications will autonomously choose the best way to communicate and transfer the information according to the user's needs, payment preferences and availability of different technologies.

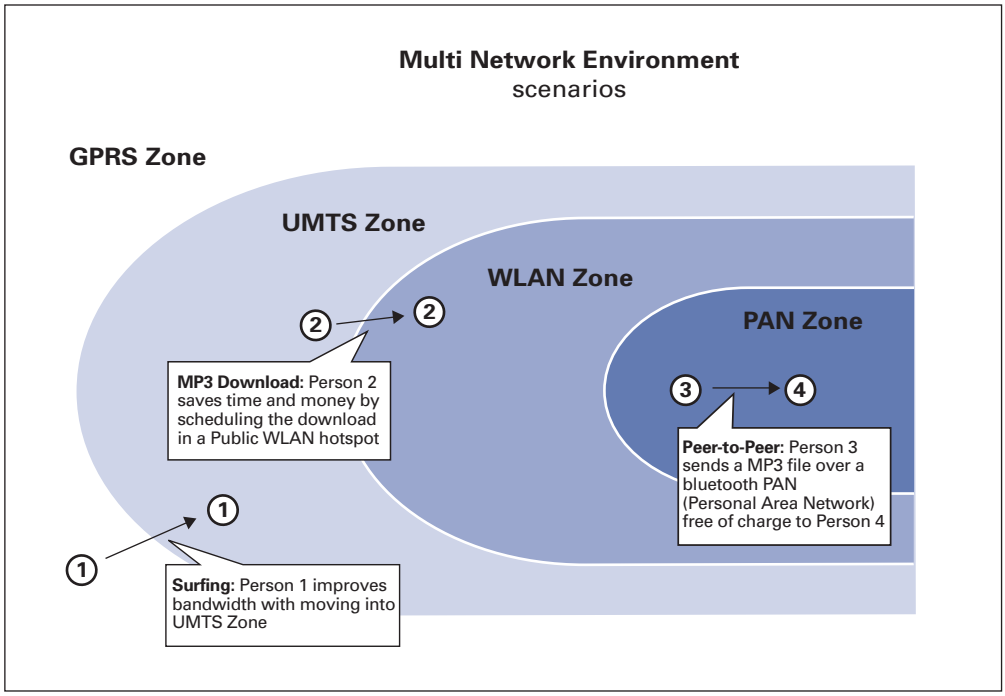


Figure 28: Multi-network environment usage scenarios Source: Durlacher Research Limited/ Eqvitec Partners Oy

The above chart indicates three different scenarios for use of applications in various zones:

Scenario 1 ("surfing"): The user initiates a web-surfing session while on the train from a GPRS-enabled suburb to a UMTS-enabled metropolitan area in the early stages of UMTS rollout. It would be ideal that when the available bandwidth becomes higher, the terminals will automatically switch to the new technology and frequency band to take advantage of higher data rates. However, technologically it still remains a challenge to establish transparent hand-overs between different types of networks. The management of the

hand-overs and different access charges associated with different network environments will require a reconnection when reaching the higher bandwidth network, or a harmonisation of prices. The likely approach is that a given connection will be retained for the duration of the session, since GPRS will also be available in the UMTS zone. A download started in one standard will be completed in the same standard if the network continues to be available. In case the network is not there (for example in a high mobility scenario) a download resume function might be used for convenience.

Scenario 2 ("MP3 Download"): As UMTS is likely to be more expensive than the public WLAN, the user may want to switch the download carrier from UMTS to WLAN when downloading a large low value file, such as an MP3 track. Take for example a teenager wishing to download a song to the terminal while on the way to the mall. The session is initiated on the UMTS network but since the mall offers public WLAN service for free to attract potential consumers, the youngster will change the download network to use the WLAN.

Scenario 3 ("ad hoc"): A user has uploaded a family photograph onto his smartphone at home and wants to share it with a friend. The file is transferred over Bluetooth (available in both users' terminals) rather than UMTS, therefore bypassing public network charges.

In Japan, for example there are two different network technologies currently deployed: the nationwide Personal Digital Cellular (PDC) mobile network and a PHS (Personal Handyphone System) network. PHS offers higher speed data transfer rates (64 kbps or 32 kbps), but has limited coverage. With the recent introduction of multi-mode DoCiMo (roughly translated as "whichever way you like it") phones of NTT DoCoMo, several new services were introduced to leverage the advantages of both networks. In December 2000, streaming video on demand was made available to customers via PHS. Very short (a few seconds only) sports, news, music and movies may be accessed via a special device called "eggy" that attaches to the phone and works in PHS coverage zones. In zones where only PDC and no PHS coverage is available, the user can still access the usual i-Mode services.

The scenarios indicate the variety of networks to be likely in place by 2005 and how they will be used. It is clear that UMTS alone will not deliver the all singing, all dancing multimedia world commonly associated with it. Rather, there will be differentiated use of the available resources. We believe that the higher number of different network technologies deployed will provide space for providers of specific hardware and software components as well as for cross-network solutions and enablers.

4.2 POSITIONING TECHNOLOGIES

Location-based services are regarded as a key enabler for future value-added mobile services. Presented in figure 29 is the positioning technology value chain with the roles of the players discussed below.

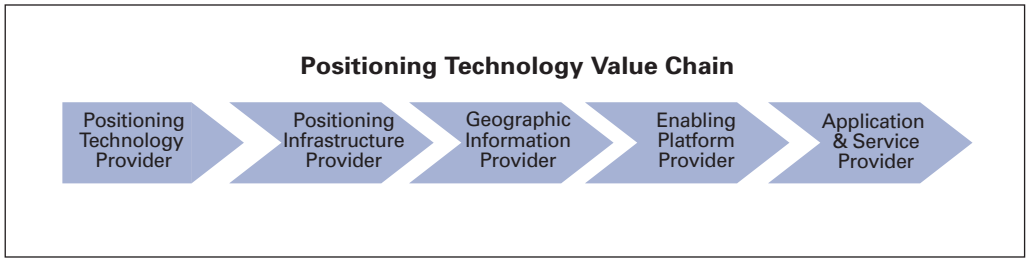


Figure 29: Location-based value chain
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Positioning technology providers are represented by vendors such as Cellpoint and CPS. They provide the core technology that locates the position of a dedicated mobile device. These players offer their solutions to positioning infrastructure providers.

Positioning Technologies Overview

Location determining	Companies	Positioning Calculation	Technology	Accuracy meters	Upgrades needed	Magnitude of upgrade (dimension)	Cost of upgrade to user	Time of Introduction
Cell ID		Terrestrial Network	Cell proximity	100-20000	Device	Small	Low (SIM)	2001
Enhance Cell ID	Cellpoint	Terrestrial Network	Cell proximity	Up to 50 in the city	Device	Small	Low (SIM)	2001
Angle of Arrival		Terrestrial Network or Device	Triangulation	up to 200	Device and Network	Significant	Moderate (chip)	
Time of Arrival		Terrestrial Network or Device	Triangulation	up to 100	Device and Network	Significant	Moderate (chip)	
Time Difference of Arrival	Cell-loc, TruePosition	Terrestrial Network or Device	Triangulation	up to 15	Device and Network	Significant	Moderate (chip)	2001
Observed Time Difference		Terrestrial Network or Device	Triangulation	up to 50	Device and Network	Significant	Moderate (chip)	
Enhanced Observed Time Difference	CPS	Terrestrial Network + Satellite	Triangulation	up to 20	Device and Network	Significant	Moderate (new device) in handset	2002
GPS	Airbiquity, Benefon	Device from Satellite data	Triangulation	10	Device and Network	Very Significant	High (chip integration)	2000
AGPS	SnapTrack	Satellite + Terrestrial	Triangulation	5-50	Device and Network	Very Significant	High (chip integration)	2001

Table 5: Positioning technologies overview Source: Durlacher Research Ltd./ EQVITEC Partners Oy

With respect to accuracy, we believe that satellite-based technologies such as assisted GPS will play an important role in the long term. The GPS based positioning infrastructure is to be provided free of charge by the US Department of Defence (Navstar) to all customers at least until 2006.

The accuracy dependence of device-specific positioning technologies, mainly on the cell size, does not make it very appropriate for mobile commerce applications. Thus, network based technologies, such E-OTD, are more likely to succeed and seem to be gaining momentum.

We believe that this market has been divided up largely already, and that there will not be space for many new start-ups.

Providers of location-based infrastructure will work with device manufacturers to eventually incorporate the necessary client software. Operators need to offer location-based services for opening up new services and revenue streams.

Geographic location information, i.e. geo-coded data, is an important component to put positioning information in geographical context. Several companies including NavTech (Navigation Technologies), Tele Atlas, Geodata, and ESRI provide detailed digital map information.

Enabling platforms are complex relational databases that take geo-coded data from location positioning systems. Players include Webraska, Yeoman Group, Xmarc, Tomtom and Signalsoft. Tomtom, for example, provides a platform that has been developed especially for use on smartphones and connected PDAs. It therefore provides advanced personal navigation and dynamic map creation technology. Other examples are UK-based Whereonearth.com and French ISMAP, which have developed an intelligent mapping platform that helps to locate venues such as local cinemas or restaurants.

Location-sensitive services and applications are divided into business and consumer applications. Business applications comprise vehicle management information systems and cargo tracking services. Consumer location based services will be composed of personal navigation, location-sensitive advertising, location- specific billing, location-based information, telematic, traffic & commerce services and emergency services.

Once the positioning technology and the enabling platform technologies are in place we expect ASPs to provide a multitude of location-based services. Enabling technologies and location sensitive services will take off at the earliest by 2003 as GPS-enabled handsets become cheap enough for the mass market and more accurate network-based positioned methods come into operation.

The market will undoubtedly provide interesting investment opportunities but technological realities and their timing have to be considered if early failures from companies such as Citikey or Starwap are to be avoided.

4.3 DEVICES

As the only tangible element connecting the user to their mobile data, the device is central to a customer's experience of mobile services. The market for devices is growing rapidly as cellular telephony substitutes landlines and manufacturers are pressed to deliver terminals capable of using increased functionalities to deliver next generation services.

4.3.1 Device Functions

The need to integrate additional functionality into the mobile device has put pressure on the form factor of a device.

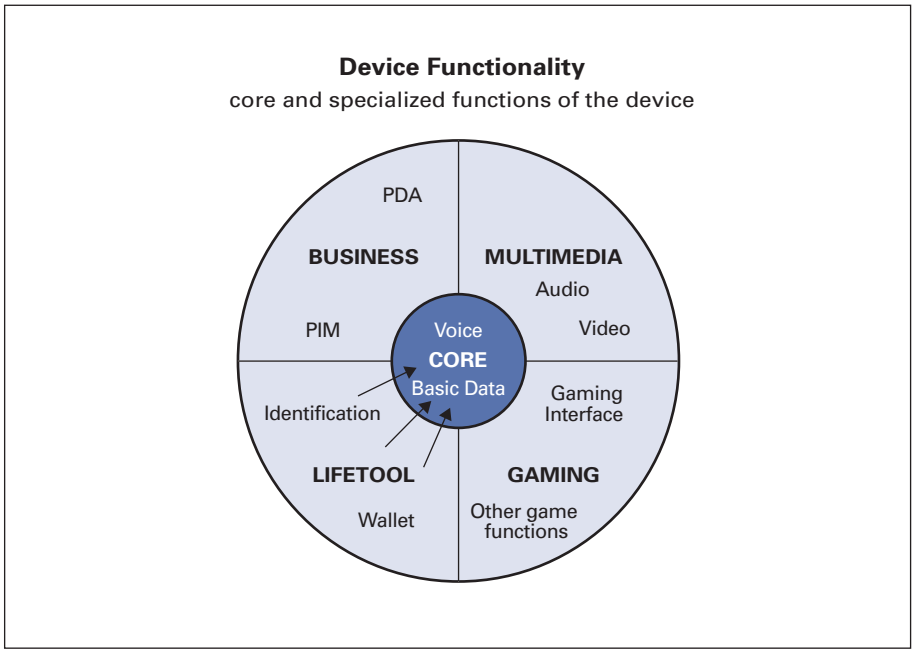


Figure 30: Device functionality
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

- Business device functionality is usually oriented at the professional user. Devices of this type have sophisticated data input and display capabilities such as full-blown keyboards or Palm-like handwriting recognition to enable more convenient messaging, scheduling and document editing.
- Multimedia devices are equipped with additional media rendering functionality, incorporating a larger screen, a better audio output tract and a more advanced set of codecs for different media types. For example, Japanese operator J-Phone has introduced a picture phone and Korean Samsung has already launched a videophone.

- Lifetool functionality is built around the concept of the mobile phone as a personal trusted device that substitutes some important, security-intensive everyday functions. A lifetool feature could be a personal wallet and payment functionality via a Bluetooth chip within a phone. The mobile device could serve as a form of personal identification, a user ID or as access keys for the home. We believe that this function will be integrated into mobile devices within the next two to three years, but it will require a sophisticated security infrastructure such as PKI.
- Gaming devices usually have a games-specific user interface, aimed at achieving maximum playability. This is accomplished using a joystick and/or joypad and/or easy-to-use buttons, supported by games-specific hardware including graphics and audio processors. The network capabilities of such devices will need to support gameplay-related functions such as playing a multi-player game over a personal area or mobile network. Cyberbank of Korea is developing this kind of gamephone based on its successful Cybird PDA phone platform. Wanova of the UK recently partnered with Cyberbank to provide its mobile games platform and the relevant content for GPRS and UMTS to operators with the purpose of delivering an advanced gaming experience incorporating the specifics of mobile network, handset and multi-player games content.

4.3.2 Device Types

Two major development trends dominate the device market, both of which are critical for satisfying the needs of customers. On the one hand, devices will need to become integrated for convenience, so that users need only one device to receive the functionality they desire. On the other hand, devices will become increasingly specialised and focused on offering a given functionality to the fullest extent. There are several strategies the device manufacturers will pursue to solve this problem:

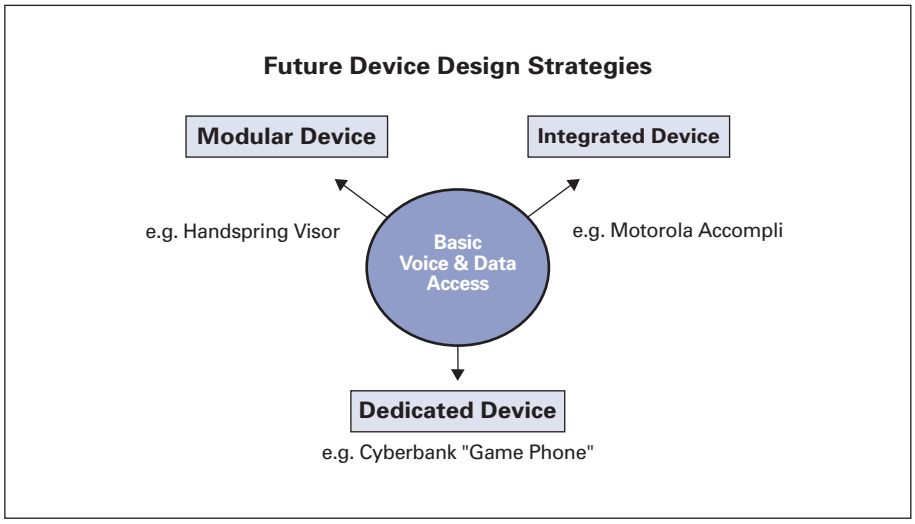


Figure 31:
Future device design strategies
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Integrated Devices

The first strategy is to accumulate many functions onto a single device. This approach has not proven too successful, as it leads to increased costs. Devices lack a convenient form factor, which is also affected by the need to accommodate a more elaborate interface such as a keyboard or a touch screen.

An example of this type of device is the Ericsson R380 smartphone that integrates phone, browser and organizer functionality. Despite its high-end price point the device has received a warm welcome from the market, largely because it eliminates the need for carrying two separate devices for communication and organization. Nokia had originally defined that market through its communicator known as Nokia 9110. Motorola has also unveiled their PDA phone combination in the form of the new Accompli 009 GPRS

terminal. However, the success of the communicator type equipment has been limited due to high prices, large size and complex functionality. There are a few new small focussed hardware manufacturers (actually more software and hardware design houses) entering this market, such as Cyberbank or Sendo, but they will face tough competition from both established consumer electronics and mobile phone companies.

Modular Devices

A more flexible way to create devices is to make them modular. Larger user bases are required for such devices to be successful. This can be achieved either through establishing common standards or through imposing a vendor-specific module standard if the vendor is powerful enough, as in the case of the Handspring *Visor*.

Based on the successful design and architecture of Palm's line of organizers, the *Visor* includes an extension port called *Springboard*. Through this port its functionality can be expanded to include, for example, a GSM phone snap-on module, a GPS positioning device, a snap-on modem or a snap-on MP3 player. Modularity is also making its way into mass market mobile multimedia devices launched by KDDI in Japan under the brand name of *FeelH*. Terminals manufactured by Sanyo and Matsushita include a port for a portable digital camera that can be purchased separately.

Datacards for conventional notebooks, another type of modular device, represent a minor portion of the overall market for mobile devices. They are slowly being replaced by a combination of a soft modem and a data communication capable device. Using a standard PCMCIA card, such devices may constitute either a cellular modem with a phone (no external phone needed) or a connectivity device without phone functionality (external phone required).

Most available datacards have either one or two supported network types, for example, ethernet and GSM data or single mode WLAN, GSM data, or Bluetooth, ethernet connection. Nokia, for instance, offers a Bluetooth kit including a data card and a Bluetooth battery pack for laptop-phone interaction. In the near future, as the different networking technologies go online, we will see datacards designed for multi-network environments. Key players in this market are the major PCMCIA card vendors, such as Xircom, 3Com, TDK and FastLink.

The modular approach to building a device does not necessarily have to conform to the physical "snap-on" or "connect" paradigm. Enabling technology such as Bluetooth allows a user to experience device modularity from a PAN (personal area network) point of view. In Europe this approach was pioneered by Ericsson introducing a wireless hands-free set for its Bluetooth-enabled phones. While Ericsson claims to have taken the lead in developing Bluetooth applications, some Asian companies are producing much more advanced designs within the bounds of the same paradigm. GPRS modules for PDA are also starting to emerge and shall be available on the market by mid 2001. Belgian company Option International, for example, has developed a leading position in developing and producing these kinds of GPRS modules.

Developing specialised modules for modular devices is a growing area of opportunity for smaller companies since volumes are not yet up for mass production and, therefore, larger companies are not yet interested. We expect that focussed specialists may occupy many of the niches over the coming three to four years.

Dedicated Devices

For very specific target segments dedicated devices with particular functionality will be developed.

Videophones are oriented at high-end consumers and are available, for example, from Samsung (based on Emblaze technology) to Orange Videophones, which were scheduled to hit the market in Spring 2000. However, these have been delayed considerably and are still not on the market.

To address the mobile games market, several hardware providers have decided to push dedicated devices into the market, such as Nintendo, Cybiko and Cyberbank. Nintendo Game Boy Advance is a pure-play next generation handheld gaming device oriented towards games enthusiasts that can, via hardware expansions, connect via mobile networks to other Game Boy Advances for multi-player purposes but has no voice functionality. This feature is currently planned on NTT DoCoMo's i-Mode service only, but agreements with other operators are expected to be unveiled.

The success of US-based Cybiko, with its wireless games/chat device, and the early stage interest in Cyberbank, with its specifically developed gamephone, suggests that there will be demand for purpose-built devices. Key to this, though, is not the technology but the applications that can be run on the devices.

4.3.3 Device Technology Limitations

The key limiting factors of a mobile device's functionality are:

- Memory,
- Battery life/power output,
- CPU

Memory – both RAM and ROM – is key for retaining complex data on the device. It enables storage of programs, audio and video files and provides users with more efficient data compression methods. Sufficient memory also allows devices to run Java, a programming language that requires substantial memory to implement. According to memory chip manufacturers AMD and ST Microelectronics, an average new mobile phone carries approximately 21 megabytes of flash memory today. They foresee that this will double every 24 months. This will inevitably increase the cost of high-end terminals, as the storage technology's price degradation hasn't been as fast as increase in memory requirements.

Hard drive storage for PCs is inexpensive on a per-megabyte basis. However, mobile devices possess only a limited power supply. Hard disk-based storage consumes significant power, which hinders its applicability in mobile devices. For this reason, manufacturers currently tend to use solid-state storage for mobile devices, whose price is not declining as fast. For example, consumer prices for 64 megabytes flash memory cards are higher than €300 per unit, which is similar to Sony's *MemoryStick*. IBM's miniature gigabyte harddrive still costs only €500.

Today, a mainstream mobile device has around two megabytes of memory to accommodate the operating system code. Storage of a single MP3 file would require twice that amount plus additional space in which to perform the decompression. Memory requirements are even higher for video applications. We believe that storage is, and will continue to be, a major device constraint for the next three to five years.

Battery Technologies are becoming a current bottleneck for the development of devices. Mobile devices require more power with the implementation of more memory, better screens and better audio capabilities. Devices of the future will be largely multi-mode and support GSM, GPRS and UMTS. This is also likely to increase their power consumption. A future multimedia concept device with current battery technology would have an operation time of minutes rather than hours.

Battery technologies such as Lithium Polymer appear set to dominate the next generation device market for the next five years until new technologies emerge. Fuel Cell technology has the potential to create a breakthrough in the battery market in the long run. It substitutes the need to recharge batteries with the process of supplying fuel. Motorola leads the market producing Direct Methanol Fuel Cells (DMFC) technology, for mobile and portable device applications. Aluminium Power Inc., another player, has worked with an aluminium-air fuel cell technology that has shown promising results during field trials with Nokia mobile phones.

CPU designs are developing quite quickly, but modern processors consume considerable power. Mobile-specific processor designs from companies such as ARM and Japanese manufacturers such as Toshiba seem to be taking the lead.

Mobile device processors will be able to service most multimedia applications. They provide more efficient compression methods for audio and video, which improve storage and bandwidth. Faster processors offer smarter user interfaces that can adapt to user's behaviour. Processing power is also very important for positioning applications.

The above constraints of the device lead to the conclusion that pure bandwidth is not enough to offer a compelling service. A device that could take advantage of the bandwidth and associated technology is required, and this will still be a bottleneck for the overall development of the technology.

Current and future device limitations will curtail several much-vaunted applications and is likely to delay their introduction. This is an important consideration when making investment decisions, since many of the largest industry players have attempted to address the these issues for quite some time. We cannot recommend any investments in applications that are based on the assumption that performance of memory, battery or CPU will improve very fast.

4.3.4 Device Operating Systems

The principal operating systems for smartphones and PDAs are:

- EPOC
- Microsoft Pocket PC
- Palm OS
- Linux

EPOC is one of the longest coordinated efforts to develop an operating system for a mobile device, driven by the Symbian consortium. The system now has released its 6th version and appears to be the strongest player in the phone-specific arena with the world's three top mobile phone manufacturers supporting it. For example, EPOC is powering Nokia's newest communicator offering, the Communicator 9210. The Ericsson R380 smartphone still incorporates the older version of the same operating system. The light construction of this operating system and support from mobile phone manufacturers is likely to assist in building EPOC's further dominance of the smartphone market.

Microsoft Pocket PC is a platform that has evolved from Microsoft's Windows CE product as the company fine-tuned its mobile strategy. The new offering features a better mobile-specific interface. Microsoft has publicly disclosed the importance of its mobile strategy and will back the system with sufficient resources. This operating system will tend to be used in the more powerful mobile devices of the PDA market, with manufacturers coming from the handheld computer side. EPOC is likely to assume a dominant position in the future of this segment. Additionally, it will be complemented by its sister product, *Stinger*, which is geared more at the smartphone segment.

PalmOS is a proprietary platform developed by Palm for its line of organisers, and is licensed to other companies such as Handspring, Sony and Qualcomm. It is very device-specific and is not truly developed to suit the mobile environment. Furthermore, the platform is not designed for multitasking, which means that it can only run one application at a time. Most of the offerings from Palm in the mobile arena are based on proprietary standards. Ironically, the OS that revolutionized the market by bringing Palm's form factor and interface to the consumer and gained the lion's share of the market seems to hold the least potential in the long run now. However, Palm has recently unveiled the next generation operating system Palm OS 4 using 32bit processor technology in an attempt to retain its share of the market. The new system has built-in support for Bluetooth, Java and wireless communication applications.

Linux is an extremely efficient open operating system platform that has been developed by independent software professionals for many years, following the open source model. Many modifications of Linux are actually suited for embedded systems. Tynux is an

implementation offered by a Korean company PalmPalm that has recently introduced a Linux-powered mobile phone. However, Linux is unlikely to succeed in the long run, unless it gains commercial acceptance from a major handset vendor, similar to Linux's gain in acceptance from the commitment of IBM on the server side.

In an environment with many operating systems, a standardised cross-platform application development standard becomes very important. Integrated development across platforms increases the potential user-base and thus the market for applications developers.

One of the technologies that could solve this problem is JAVA, a language for platform-independent development that has existed for some time already. The problem with implementing JAVA across mobile devices is that it requires a significant amount of processor speed, storage and power. However, the promise of interactivity and richness of content possible with Java seems compelling enough for market players to push the standards. NTT DoCoMo has recently launched a series of JAVA-enabled i-Mode handsets that support a new set of services called *i-Appli*. These JAVA-based products are a major step forward in terms of interactivity and visual quality of the services, ranging from games to business information. Despite early technical difficulties, the example of *i-Appli* clearly outlines the potential for similar technologies outside Japan. Mobile technologies such as MeXe and 1K-JAVA will evolve to become compelling application development platforms. The services currently offered range from simple multi-player games to interactive financial news and stock quotes. However, JAVA is not yet seen to be the technology of choice for real-time applications.

We believe strongly that application developers must stay independent of the underlying operating system as much as possible. The growing community of 6 million Microsoft developers shall shift the power in the market more towards the Windows CE world as they can always attract more content. However, selected, fast-moving companies such as Digia of Finland with significant EPOC competence are likely to succeed by moving close to the large Symbian supporters, which will enable them to stay at the forefront of innovation.

4.3.5 Microbrowser

An important element, largely defining a user's experience with mobile data is the microbrowser. There is a plethora of products available in this space, supporting most of the existing mark-up standards – cHTML (standard currently used by i-Mode), HDML (mainly in US) and WML (current WAP markup language).

Microbrowsers come in embedded and non-embedded format. Embedded microbrowsers offered by companies such as Pixo, Espial and Microsoft are characterized by a small footprint. A lot of the currently available mobile devices also support the older UP-browser from Openwave, since there is a lot of content available for this specification.

Non-embedded browsers are mostly oriented towards PDA operating systems and include offerings for most major standards such as ProxiWeb for PalmOS, Opera for EPOC (a standard browser for Psion *Revo Plus*). Browsers of this type usually make use of HTML as a standard, since the devices are usually powerful enough to support it.

XHTML-compatible browsers are the base of the new WAP specification and may be expected to dominate the future market. The new overall trend is towards the convergence of different mark-up standards, as exemplified in the new Openwave browser that supports both, WML and cHTML. These standards deliver roughly the same results in terms of content presentation. The winning standard will be the one that provides consistent presentation quality across different mobile access devices.

The question for application developers is whether cHTML (as used by i-Mode) or WML (i.e. WAP) will be more successful in Europe in providing the presentation layer. We believe that cHTML will not reach any major success in Europe while WAP should succeed over GPRS. Companies betting on WAP as becoming a widely used standard have so far been disappointed, but we predict a revival when a proper bearer network is in place and when the early technology problems have been overcome. This process might take up to the beginning of 2003.

4.3.6 Data Compression

Data compression is one of the key enabling technologies for mobile devices as it enables richer content to be transferred over limited bandwidth. Although the promises for increased bandwidth on mobile networks will take some of the pressures away, we believe compression technologies will play an important role.

Decompression of data requires significant memory capacity and processing power of the mobile device. Until recently mobile telephones did not use compressed formats for pictures, but only PNG or GIF bitmaps. J-Phone's picture phone, which was launched in Japan, allows users to send and receive pictures in a compressed JPEG format.

Existing compression technologies developed for the PC are now being implemented in the mobile world. PacketVideo supplies end-to-end MPEG4 protocol implementation for the mobile environment. It boasts implementations for key PDA platforms such as *Palm* and *CE* and efficient server software. Many algorithms on the client side are suited to compensate for the problems of the mobile environment. *Emblaze* is a similar technology developed by Geo Interactive Media. AVS – a multimedia platform company – offers a very scalable and device independent MPEG4 player that only needs a 15 kilobyte footprint on the client-side. The player is capable of running multimedia content on a PDA over a GSM network.

New compression technologies are also being created especially for the mobile world. Wavelet compression is a new principle for compressing images and video by utilizing special mathematical functions. It will be the basis for the new JPEG image encoding standard as well as a base for some proprietary compression standards.

Important players in the wavelet compression space include companies such as ActiveSky, which offers proprietary mobile video compression architecture for all operating systems. The technology also features clever use of XML-based data mark-up to create interactivity in the delivered content.

LightSurf is another U.S.-based start-up offering a wavelet-compression based end-to-end architecture for image delivery and printing. The company uses Motorola *accompli* devices for image-capture and transmission and is partnering with Kodak for image printing and distribution.

The key benefit of compression is that it enables data to occupy less space. There are other ways of achieving the same result with for example vector graphics.

Technologies such as *Quicktime* and *Shockwave* have revolutionised the internet by bringing quality interactive graphics and animations in small files. Low amount of data needed to produce complex graphics on the screen makes this technology important for mobile devices. This kind of technology could enable applications such as mobile postcards or better user interfaces.

Data compression will continue to provide a very interesting investment area as bandwidth limitations are not disappearing. It is particularly well suited for any start-up as a critical enabler for generating advanced applications revenues and, thus, directly impact the ROI figures in the operators' business cases.

4.4 MIDDLEWARE

As mobile data services continue to develop, there is a growing need for bridging proprietary network infrastructures with the IP world. Middleware is a conceptual layer that connects the mobile terminal and the server. Such solutions enable data access and render the data so that it can be properly displayed or stored on a mobile device. Gateways for circuit switched mobile networks were the crucial link between the radio access networks and IP world of the internet. Some of the current gateways are responsible for rendering the contents according to the specifications of the WAP terminal requesting access, while others only act as communication ports with no conversion features. Packet-based GPRS and UMTS infrastructure has an integrated gateway linking the systems to IP networks.

The gateways for mobile data serve as interfaces to different bearer and presentation technologies:

- WAP gateways
- SMS gateways
- Proprietary gateways (e.g. i-Mode)

WAP gateways connect mobile devices to servers by using a standard protocol. The first company to provide such a product was Openwave. The market for basic gateways is becoming commoditised to some extent. A good example would be the emergence of free open source WAP/SMS gateways such as Kannel, led by Wapit. This project has resulted in packaged gateways, such as Alligata from 3G labs and Ophelia from Singapore-based 3ui.com Pte Ltd. Today there are several companies offering free gateways for wireless services. In the U.S., YadaYada Inc. offers a solution for mobile HTML-based access for handheld devices. Microsoft will offer a middleware server solution for converting data stored in *Outlook* or *Exchange* into WML or HTML and displaying the information in a micro-browser on a mobile phone, PDA or other handheld device. The *Mobile Server* will include a WAP gateway and will be marketed to carriers and enterprises.

SMS gateways have been developed by the large mobile network equipment vendors, such as Nokia and Ericsson, and mobile specialist developers such as CMG. Melody of Sweden has developed a Wireless Access Gateway (WAG), which translates WML content into text format and can transmit it through SMS messages.

The i-Mode enabled *Portal-to-Go R1.0.2* gateway package from Oracle can reconstruct selected data from HTML texts into a language for mobile phones, including c-HTML. The middleware first converts HTML-formatted information on web pages into Extensible Markup Language (XML). It then performs a second conversion into specific mobile languages such as HDML (for EZweb), MML (for J-Sky), WML and VoxML.

The role of the gateways is changing as a result of the introduction of packet-based networks as GPRS and UMTS packet networks inherently provide connectivity to IP networks with the network gateway nodes. The gateways are becoming more application-specific, emerging as platforms for supporting certain functions. The key platform areas include:

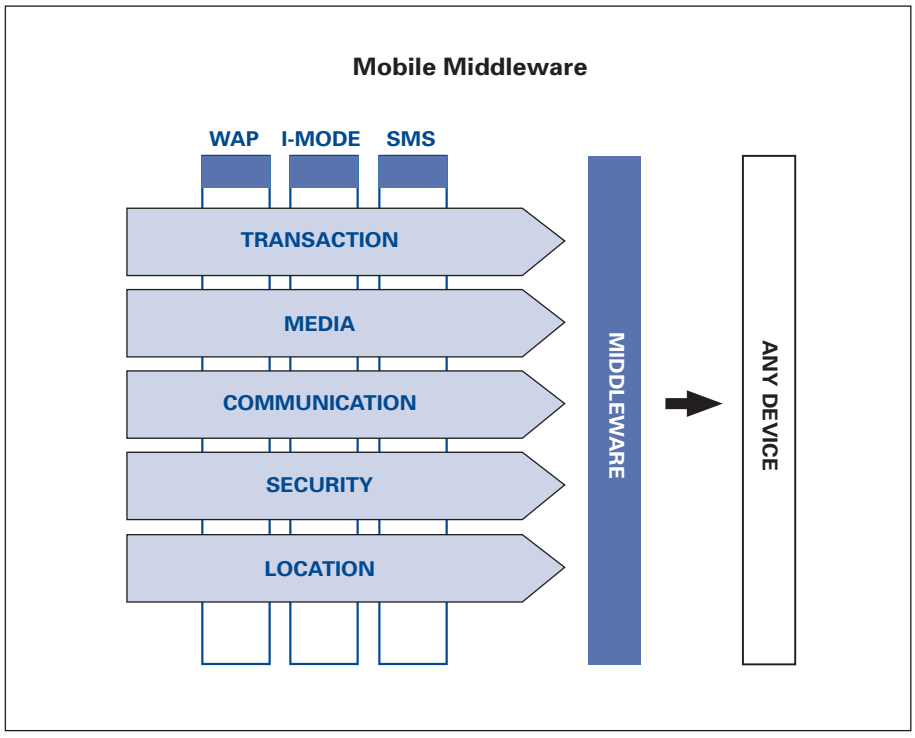


Figure 32:
Mobile middleware
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

- Transactional middleware vendors include companies such as Capslock, network365 and Iconverse that provide products with secure commerce functionality.
- Media middleware may be exemplified by IBM's *Websphere Transcoding Publisher*, a product that renders content to different mobile devices.
- Communication middleware suppliers include vendors such as Peramon (for email) and Convisual (for multimedia messaging).
- Security is an inherent component of all transaction middleware offerings and includes products such as authentication servers which are supplied by Wapit of Finland or ISR of Japan.
- Location-based service platforms are a very attractive middleware concept, exemplified by GeoJava, a conceptual framework for using location information in Java-based services, implemented in Oracle's spatial database offerings.

There are several ways to operate gateway services. A company might choose to own the technology in-house due to security reasons for example. Deutsche Bank has decided to host its own mobile brokerage solution behind its corporate firewall to protect it from the outside world.

Another way to operate a gateway is to outsource it to a WASP, or companies that often provide additional hosted applications with the basic wireless functionality. An example of such a company would be Materna of Germany that offers a hosted SMS gateway and hosted unified messaging applications. Mobile network operators have a strong position with the control of the network gateways between the mobile networks and the internet.

In the future, as the multi-access model develops, middleware will be one of the key success factors of multi-channel service. The focus will shift from network to IP traffic translation to a higher-level multi-channel translation of single source content for different device types. One of the key drivers of this evolution will be the widespread adoption of XML as the common data mark-up language and rendering standard.

There will be a significant opportunity for WASPs in Europe who are adopting the role of an intermediary to operate middleware platforms and to provide unique content platforms to businesses, which cannot develop the entire infrastructure themselves. Additionally, there will be an opportunity to offer platform-specific functionality, e.g. delivering application server functionality. Another investment opportunity exists in the area of creating advanced, high-end middleware technology such as authentication servers, location servers or database connectors for companies with a clear-cut approach to the market.

4.5 PRICING AND BILLING

Providing flexible and scalable billing systems will be essential for offering successful mobile data services and applications to end-customers.

4.5.1 Pricing

So far, service provider pricing schemes have been primarily designed for voice calls, i.e. on an airtime, subscription and connection fee basis, and not for mobile data services. Although there is no single best billing scheme for all services, we believe that the key to unlock the full market potential will be value-based and, thus, differentiated pricing based on the perceived value of a service or application.

While mobile telephony services began by being paid for after the actual service was used (post-paid), pre-paid services became increasingly popular. Pre-paid plans have a lower entry barrier in terms of cost and provide customers with almost immediate service provisioning. Prepaid calling plans were critical in capturing the lower segments of the mobile market and boosting the strong demand for cellular services. T-Mobil in Germany, for example, is expecting 60% of their customers to be pre-paid customers by the end of 2001. Customers in the youth segment and lower income individuals prefer prepaid calling plans.

Introducing new services in the prepaid market requires considerable effort to encourage usage and adoption. Postpaid plans are decreasing as a percentage of all accounts, which

is leading almost to a loss of customer ownership. It is very hard to maintain a customer relationship with a prepaid customer for voice and also for other services.

Pricing for mobile data services and applications can be classified in two main categories, unmetered (flat-rate) and metered pricing. Flat-rate pricing usually benefits a small percentage of very active users (20%) that are subsidised by a larger group of less active users (80%). Metered pricing more accurately reflects the individual value of usage.

Pricing Schemes

Pricing Types

Applications	Metered				Unmetered
	Time based pricing	Data Volume based pricing	Value based pricing	Location based pricing	Flat-Rate pricing
Access	X	X	X	X	X
Voice	X		X	X	X
E-Mail		X	X		X
Instant Messaging		X	X		X
Content			X	X	X

Table 6: Pricing schemes Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Unmetered Pricing

Flat-rate pricing does possess some important advantages. For example, it promotes greater usage of services. AOL has indicated that once it switched to offering flat rate pricing, they experienced rapid customer growth. Implementing flat-rate pricing plans and billing for the services is much less costly than metered billing. A number of mobile operators have indicated they will offer GPRS services based on flat rate pricing schemes – initially at least. Sonera in Finland commercially launched their GPRS network in December 2000 at a flat-rate of €17 per month for basic data access. Europhone, the first live European GPRS network introduced flat-rate pricing as one of its monthly offers in 2000. BT Cellnet markets unlimited mobile internet access, through unlimited SMS and WAP for €31 a month (€15.5 each) in order to encourage use of the service.

However, we expect that operators will continue to review their pricing strategy and take corrective measures if the network load becomes to heavy.

Metered Pricing

Metered pricing allows MNOs to bill for services based on increments of usage. Billing for voice services based on time is the natural established mode for quantifying the value of the call. However, time-based pricing for data services contributed to the failure of European WAP services. The disappointment for WAP has been caused by slow connections to servers with long waiting times, which in turn resulted in unpredictable prices for particular information, as well as by the lack of reliable service availability.

For GPRS services, many mobile operators have now moved on to volume-based pricing which is leading to even higher prices as the price of a 10 kilobyte packet is set to be between €0.04 and €0.25. Thus, prices can vary dramatically for a fixed amount of data from operator to operator. Nevertheless, this pricing model is considered a better representation of value than the traditional time-based one when looking at it from the network engineering and dimensioning angle.

There are pricing models that reflect the value of the service perceived by the user even more accurately. A good example of such a model applied to a service is the current pricing for SMS, which is priced on various levels depending on the perceived value of the information. For example, a simple person-to-person SMS may have a standard price of €0.20 while a share price sent via SMS might cost €1.00.

A user's location can also affect pricing. Calls made from different locations can be priced according to the value derived from them. Many carriers offer lower rates for users who make calls to and from their home city designated in their contract. Viag Interkom also offers a service called Genion for home users of mobile phones. Pricing for these calls is similar to that of wireline calls if the end-user remains within his home cell.

An important differentiator will be the pricing associated with accessing data in different modes of mobile devices. In the next couple of years, a user of a multi-mode device will be able to choose between downloading a file in a more expensive public UMTS cell, or utilising a cheaper local WLAN connection. Another example would be differentiated pricing for voice and data calls.

In summary, we believe that the way forward to successful services uptake must be value-based pricing. Although the underlying infrastructure will remain a key parameter in determining the number of customers and the particular services they may use simultaneously, to optimise revenues at all times for operators, the perceived value of the service must be the determining factor. The pricing model must be so flexible that each service might have a different means of calculating the cost of usage. For example, high quality mobile games services may require lots of bandwidth but the target market is likely to prove particularly sensitive to over-charging. There is also a question as to who will be able to understand a price based on 10 kilobyte packets. The mass market will have difficulties following this. We strongly promote the idea that in order to generate revenues, marketing experts should drive pricing, not the network engineers.

4.5.2 Billing

Differential pricing models require sophisticated IP billing solutions with smart rating engines in order to put a price tag on everything greater than a single IP packet. Billing mediation is focusing on collecting and filtering network usage data for valuable information on router records and end-user interactions at other network levels, which will be used to form billable events.

Next generation billing companies such as Sepro, Geneva, Portal Software and XACCT offer flexible, scalable and real-time platforms for operators to introduce new billing and pricing services that are for more flexible than those inherited with circuit-switched networks. The challenge is to integrate the billing platform with legacy systems and provide flexibility to support the rapid deployment of new services and pricing plans. Billing systems are at the core of operator processes and, therefore, must be stable, carrier-grade and operate in heterogeneous environments too.

A number of players have emerged offering compelling services and platforms. More Magic Software in Finland is offering an architecture that provides a single point of entry for usage, authentication and billing information aggregation. Sepro Billing in Ireland offers an integrated software suite that ties together billing, marketing, customer/account management and customer care. The company provides an advanced rating engine that combines flexibility of event rating with an ability to interface with legacy systems. This product enables operators to do e-commerce billing using their legacy voice-centric billing infrastructure. Geneva Billing Systems offers a complete billing solution and mediation services with an architecture similar to More Magic's. XACCT offers one of the most comprehensive billing mediation platforms for general IP networks.

There are several players positioned to offer billing services such as network operators who bring billing functionality to the market as a one-stop shop for VOs. These operators include Deutsche Telekom, SONOFON, and Orange.

Billing ASPs such as Copernicus, which have built on Sepro's products, are well positioned to offer their services to telco operators and content providers alike. Pure play billing mediators are unlikely to succeed on their own, as they will need to secure significant market power by striking partnerships with some bigger integrator. Operators will integrate mediation into their core operating system.

We believe that more than 3000 mobile internet services and applications will emerge over the next over the next five years. Value propositions will differ widely, and value will be measured in lots of different ways. This means that billing systems must be able to cater for a wide variety of value propositions and be able to translate them into prices that make sense to the end-user. Ultimately, billing systems should be able to come up with prices for things such as (source: Geneva Technologies):

- Per minute (voice, videoconferencing)
- Per megabyte (wireless LAN access, disk storage)
- Per message (SMS)
- Per view (video-on-demand)
- Per transaction (ring tones, music downloads, commission on purchase)
- Per ticker symbol (WAP stock quotes)
- Per click (click-through advertising)
- Per response (location based advertising)
- Per seat (software rental)
- Per page (fax)
- Per mile (direction-finding services)
- Per bullet (games)
- Per goal (sport update video clip)

We restate our strong support for IP billing solutions. The need for operators, VOs, portals and content providers to provide a highly flexible pricing mechanism is only becoming stronger. The space provides huge returns potentially for the providers of IP billing technology as well as for the services side around it. An ASP solution provides an easy way for a billing company to provide a real live customer demo.

4.6 ROAMING

Establishing seamless roaming is crucial to achieving critical mass of network users and enabling the widely advertised international data services. Previously, the most important roaming issue was receiving service when travelling to other countries and logging on to different operators' networks.

However, mobile data roaming issues have become more complicated as the roaming will be required to support different types of networks such as UMTS, Bluetooth, GPRS and WLAN. These networks would all carry standardised IP data, but would offer different quality of service, affecting pricing models. Additionally, the issue of how to bill for services, applications and content across networks becomes central for generating revenues from international roamers.

Basically, there is little difference between voice-centric and data-centric roaming. The exchange of usage detail records or billable events is composed of the TAP protocol for Call Detail Records (CDR) exchange in old networks and IP usage Detail Records (IPDR) exchange for the new networks. However, products over IP on one network might have different prices on the other.

There are several governing bodies such as the GSM Association and the International Roaming Expert Group (IREG), that have considerable experience and should be able to resolve current and future roaming issues.

Technically, IP usage is a more complex phenomenon than voice, and exchanging records is quite intricate. IPDR is an XML-based standard for usage detail recording and an important roaming enabler. Another standard recently developed is Global Roaming Exchange (GRX) that connects networks with different backbones. GRX provides a packet clearing house and backbones that connect several different networks. There are several GRX providers who are typically backbone operators or telecom operator subsidiaries. They include Star*Home, Comfone, Sonera and Deutsche Telekom.

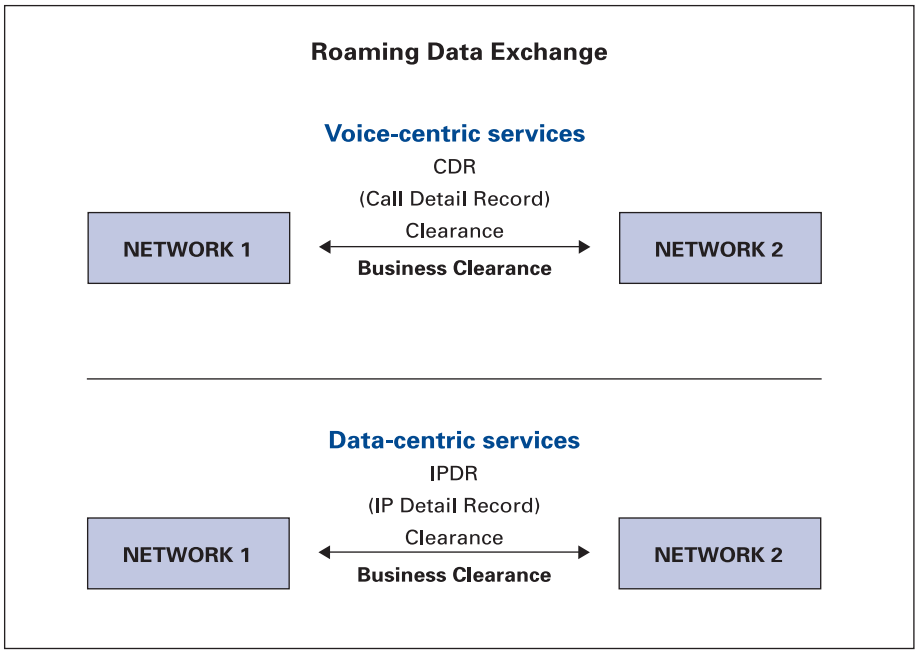


Figure 33: Roaming data exchange
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

We expect that roaming contracts will emerge, using IPDR for service usage detail records. Since European operators are already experienced in coordinating complex roaming agreements, and administrative bodies (IREG and GSM Association) are already in place, truly international data coverage should not be a problem within three to four years. The roaming space provides opportunities for software companies with innovative solutions that help to tackle the issue faster and support the solutions being put forward by administrative bodies.

4.7 SECURITY

Security is an important enabler for the development of the mobile data market. Consumer and business applications will not be able to realise their fullest potential unless a sufficient level of trust is established in the underlying security of mobile networks.

To address current concerns the market will have to provide end-to-end security. As mobile networks converge with the IP world to unified data architectures, security concerns of both areas should be viewed from an integrated perspective rather than as separate issues. The following key elements should be considered:

- Device
- Mobile Network
- Gateway
- IP
- Server

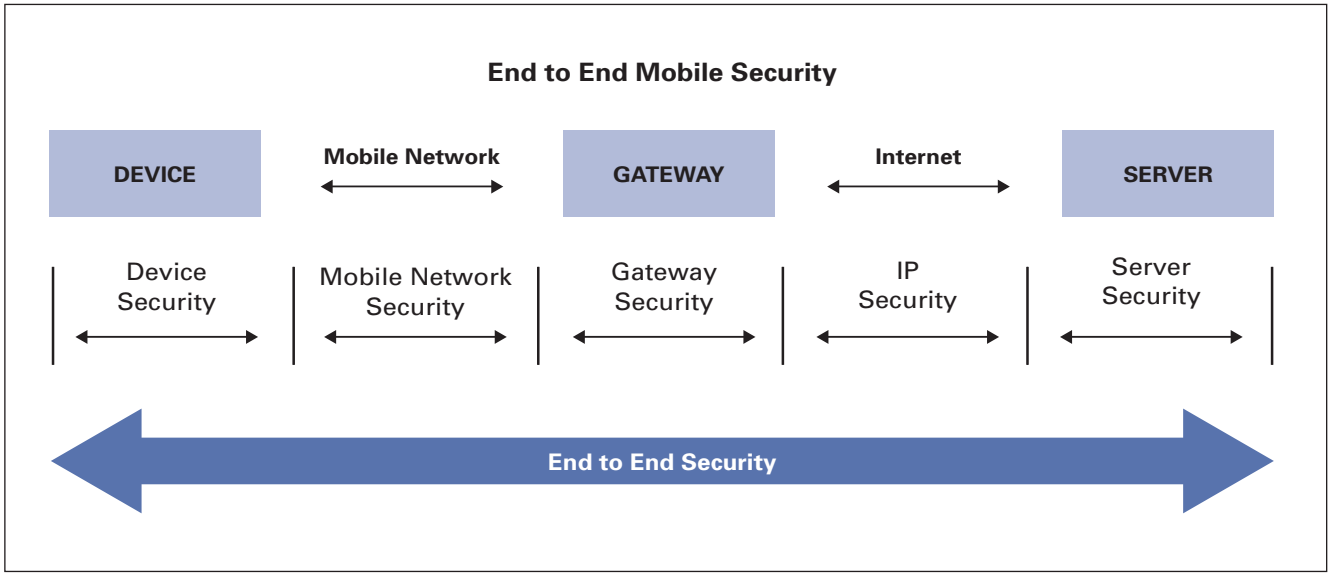


Figure 34: End-to-end mobile security
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

4.7.1 Device Security

Mobile devices are becoming the weak link within the converged data world. The diversity of standards available and their relative immaturity makes it very difficult to impose sufficient security standards on mobile device access. This is even more aggravated in a corporate environment, where a robust and expensive security infrastructure may be easily penetrated through a mobile device security hole.

Current devices are largely based on closed standards. However, as open standards for PDAs and smartphones together with new programming environments start to emerge, security problems will be aggravated. Always-on connectivity, push capabilities of packet-based networks and the emergence of multi-platform languages, will open unlimited possibilities for the propagation of malicious code, both within the mobile network and across IP networks. For example, with the introduction of NTT DoCoMo's JAVA service for mobile phones, increasing concerns for the emergence of harmful viruses such as Trojans have been raised.

There are currently offerings of anti-virus software for portable devices such as Palm and Pocket PC provided by companies such as AVP, Mcaffee and F-Secure, but their penetration remains low. We expect problems associated with mobile device security to fully emerge over the period of the next two years.

4.7.2 Mobile Network Security

The air interface of the mobile communication networks has some inherent security mechanisms.

For example, GSM communication is encoded with a 128k algorithm to ensure secure wireless transport. Each of the users is assigned a temporary code that enables them to receive only the digital signal sent to them. In an eavesdropping scenario the time required to crack the code is usually longer than the life of the temporary key. The security offering capability of the upcoming UMTS system is going to be higher due to the higher data rates and more complex modulation schemes.

Alternative network technologies are to a larger extent subject to security issues. Radio waves from wireless local area networks (WLAN) can extend to areas outside the organisation's physical premises. This is basically equivalent to leaving an open network connection for everybody to peruse without the need to physically plug in a cable. To a certain degree, this issue is addressed by a standard security function called Wired Equivalent Privacy (WEP). In many cases this technology alone is not sufficient, so additional security options are being developed for WLANs to enhance the protection provided by WEP.

4.7.3 Gateway Security

On a higher level, communication between the device and the gateway is also subject to being protected by data security protocols.

The model of WAP Security, for instance, is reliant on WTLS (Wireless Transport Layer Security) and SSL (Secure Socket Layer) protocols. Communication of the wireless device with the gateway is protected by WTLS. WTLS is a version of the internet protocol (Transport Layer Security) tailored to the limitations of mobile devices by minimizing overhead, using more efficient compression, and employing more efficient cryptography.

There are certain security problems with the port of TLS specification to the wireless space. Independent testing showed that WTLS is potentially vulnerable to a larger extent than TLS.

4.7.4 IP and Server Security

The security of a public or private IP network and of its servers is a problem that is not directly related to the mobile space. Still, they are very important components of an end-to-end mobile data security infrastructure.

At the moment, sensitive data communication is being protected by various encryption technologies. One of the basic widespread standards is SSL. Other standards using more sophisticated encryption schemes are also available.

In the future, mobile traffic on the internet may be protected by a protocol called IPsec. It will be used to create highly secure "tunnels" for mobile data in the underlying IPv6 network as all traffic moves to IP.

The proliferation of mobile devices also imposes additional requirements on corporate network management. Large companies are starting to incorporate mobile device security features into their enterprise security products. Tivoli, for example, has upgraded its SecureWay Policy Director software to centralise the security management of cell phones, PDAs and other handheld devices.

4.7.5 Security Summary

End-to-end security platforms will be a major area of development. Many services require secure transactions such as mobile retailing and mobile payment. Several organisations promoting standards for secure transactions have emerged, including Radicchio, mSign and Mo-Sign. The first two organisations, Radicchio and mSign, include many leading innovations in the platform-level security market – they joined forces in February 2001. Among the most important companies currently are Sonera SmartTrust, Brokat and Baltimore Technologies, each offering end-to-end security technologies.

PKI (Public Key Infrastructure) encoding methods are the future of the mobile security solutions market. PKI requires a key mechanism consisting of a public key and a private key used for encoding and decoding any piece of data. The mobile industry is currently aiming to store private keys on subscriber Wireless Identification Modules (WIM) cards of mobile devices. Valimo Wireless is offering open PKI-based authentication system software for mobile and wireless networks.

We believe that PKI will become the security solution of choice for many operators but it requires heavy investments and new SIM Cards for all customers, which would presents a challenge in itself. It is needed to make m-commerce happen. Investment opportunities will arise only with solutions that are compatible with the standards developed by Radicchio/mSign and Mo-Sign.

4.8 CHANNEL CONVERGENCE

Many of the current data services are already available through different access channels such as the web and the mobile network. In future digital content and applications will also be available through alternative access modes such as digital TV. For example, the BBC is offering a WAP solution from Peramon to deliver thousands of content sites as well as chat to digital end-users.

Customers will take advantage of the most efficient and convenient access method to content or services. Time-sensitive information such as sports news or SMS-chat might be accessed, for example, through a mobile device. Broadband intensive MPG (multi-player game) adventures could be played by simply turning on the TV set. Finally, the user may prefer to use the PC and DSL-access for surfing and researching information on the internet, because performance and presentation are so much better.

Initially, multi-channel access platform providers will be the result of the convergence trend. In the long term, we believe unified content platform providers, intelligent multi-channel enabled smart bots and databases will succeed in the market. Unified messaging is one attempt to address the channel convergence that has been available for some time, but has still not delivered on its promises.

An example of a development environment for the multi-channel world is MAXML. It is an XML-based language for content development and delivery across channels that was developed by Curious Networks. Curious currently supports traditional wireline, a plethora of wireless devices protocols (WAP, WML, HDML, WAP, Palm PQA), VoiceXML and Interactive TV.

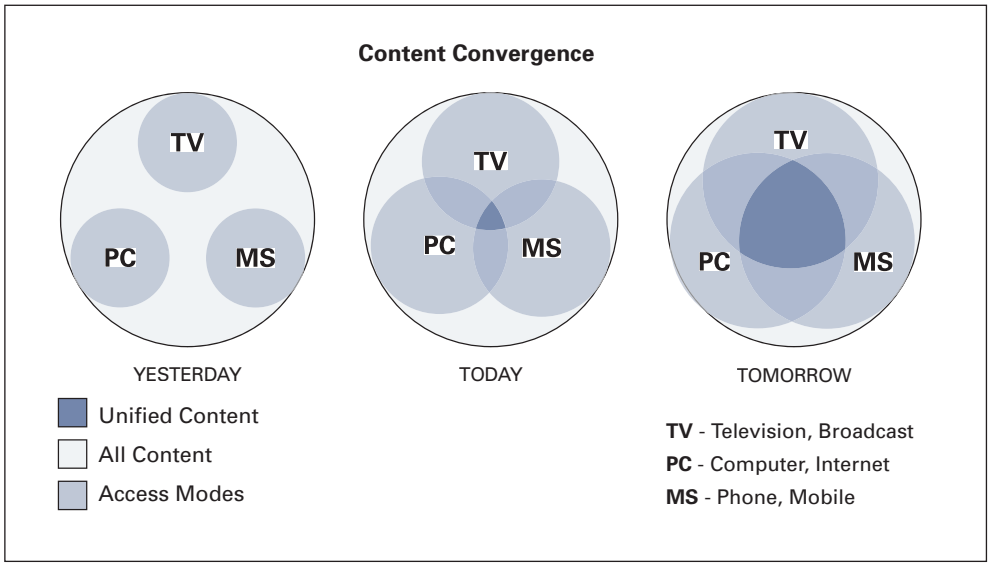


Figure 35: Content covergence
Source: Digiscope/ Phillips Global Media

We believe that on the transport and addressing layers of the network, convergence will most likely occur around the next generation IP protocol – IPv6. The new IP will integrate all connected devices in the same address space, within a unified end-to-end architecture. The integration will be furthered on the application level by platform-independent programming languages such as JAVA and device-agnostic mark-up languages such as MAXML and XHTML. They will become the "glue" for the converged content world of tomorrow.

For the user, mobile data services are just another complementary channel of access. We believe there will not be a very large market for "pure play" m-commerce in future, but rather a converged world shifting towards mc-commerce (multi-channel commerce).

The convergence space provides investment opportunities for players that can adapt quickly to the multi-channel environment and can create middleware that is network independent.

5 MOBILE APPLICATIONS AND SERVICES

Many industry players have been instrumental in promoting 2.5G and 3G and the various applications associated with them. Increasing transmission speeds enable new types of value-added services, which, in turn, may require new enabling technologies to function. In this section, we examine such services and enablers from a practical viewpoint. We also assess the different services with respect to their possible success and revenue potential.

The market for business services is significantly different from the market for consumer services. Factors driving these differences are numerous and include:

Value drivers and propositions – Generally, consumers base value more on a qualitative decision process, whereas enterprises base value depends more on a quantitative decision process. To determine the value of a mobile data application, enterprises will justify their spending on mobile applications by trying to quantify a Return on Investment (ROI), whereas consumers are much more likely to qualify their decisions to use mobile applications to generate fun and convenience. Enterprises think in terms of opportunities, threats and efficiencies and they will spend their money accordingly.

Complexity – Consumers will use simple applications, whereas business applications will vary in their degree of complexity ranging from simple to complex applications. 'Simple' applications will be built around people and are personal in nature, regardless of whether that person is a consumer or a business-user, whereas enterprise applications are generally far more complex (the degree depends on the business process they support).

Focus – Generic (or horizontal) applications will dominate the consumer market. Applications in the business market will be a mixture between generic and vertical applications. Generic applications are out-of-the-box and targeted at a broad base of users (e-mail and instant messaging, for example) whereas specialised applications are developed for particular markets against very specific requirements such as mobile fleet management systems.

Role of Mobile Access – Multi-channel access will be important in all segments of the market, but the relative importance of mobile access will be higher in the consumer market than in the business market. For example, it is highly unlikely that a large share of business transactions will be carried out on a mobile device alone. In the consumer market, we expect that the share of exclusively mobile transactions will be much higher. However, mobile devices will play an important supporting role in a business environment, including capabilities to deliver alerts, either to people or machines.

Table 7: Application charateristics
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Application Characteristics	
Business Applications	**Consumer Applications**
Lower Volume (One To Few)	High Volume (One To Many)
Greater Complexity	Lower Complexity
Higher Customisation	Lower Customisation
Higher Margins	Lower Margins
Slower Sales Cycle	Faster Sales Cycle
Strategic	Convenience (Consumer) Productivity (B2B)
Higher Criticality	Lower Criticality
High Need to Integrate	Lower Need to Integrate
Higher Service Requirements	Lower Service Requirements
Need for IT support	Need to be self configurable

Device Usage – In the business segment of the market, users are more likely to use high-end and/or specialised devices (such as PDAs or laptops equipped with a mobile modem). Most users in the consumer segment will continue to use voice-centric devices for another five years at least, of which the vast majority will be microbrowser-enabled mobile phones sometimes with niche mobile data devices such as mobile gaming consoles and MP3 music players.

Geographical Focus – business applications will need to cater for increased business user mobility. Additionally, enterprise applications need to follow the geographical scope of the business activities they support. Supporting application solutions on an international level is more challenging than supporting such solutions on a domestic level alone.

Support for legacy systems – System integration relies on the existing interfaces of legacy IT systems. Most of the former generation systems are very limited in input and output interfaces open for the user, which clearly hinders the introdution of mobile applications as extensions to the system. More recently developed ERP systems (for example SAP) usually have a modular approach to interfaces that eases the integration process significantly.

Table 5 gives a short overview of the main characteristics in each segment of the market and highlights the differences between them.

5.1 SERVICES OVERVIEW

Overall, the space for 3G applications will not differ substantially from that already established for 2.5G applications. In 3G, as in 2.5G, business services and applications will remain distinct

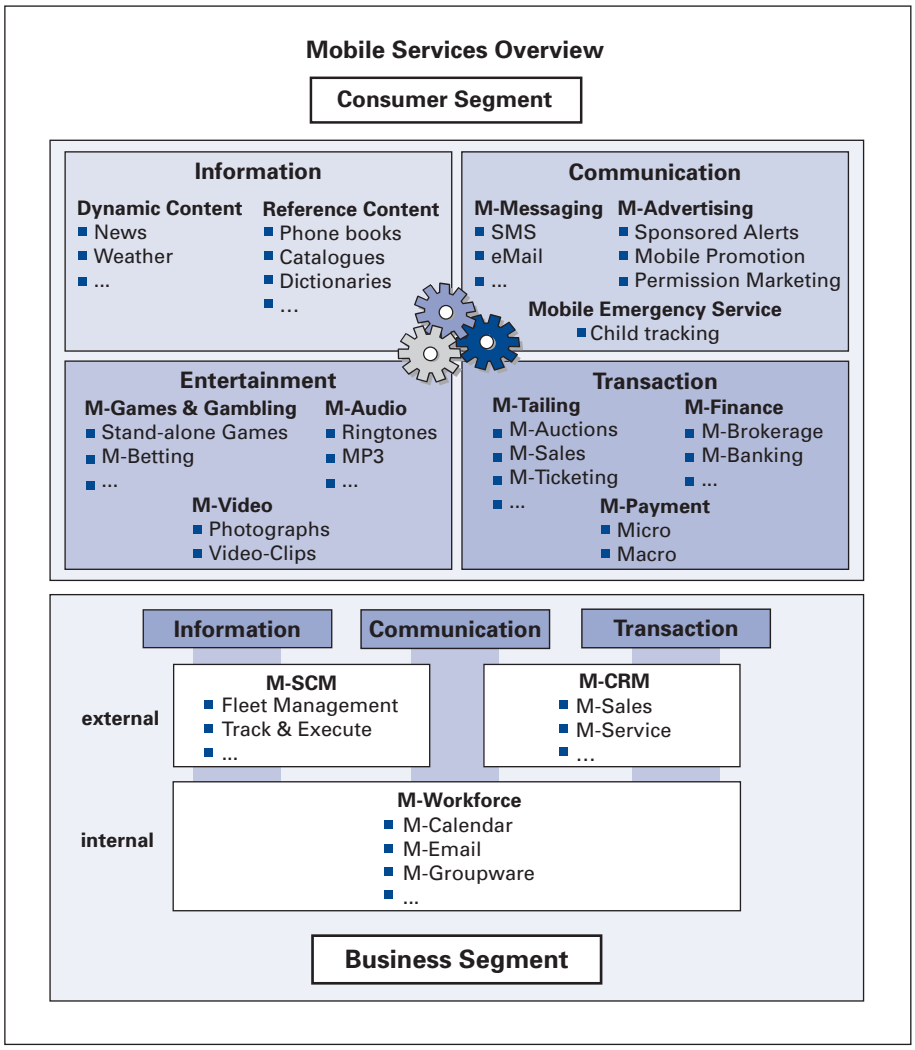


Figure 36:
Mobile services overview
Source: Durlacher Research Ltd., EQVITEC Partners Oy

from consumer applications. Basic application categories are not likely to change. In essence, the progression from 2G towards 2.5G and 3G will manifest itself in gradually richer information content, greater interactivity, and in some new (or greatly enhanced) application features such as location dependence, personalisation, and immediacy. These will enhance the usability of many applications and services. The 3G application and service space is mapped in figure 36 on the previous page.

5.2 KEY IMPROVEMENTS

In the following we will highlight the major improvements we expect to see arriving with 2.5G and 3G networks and discuss their significance for the mobile service and application space.

Location-specific information

One of the distinguishing features of mobile devices is their ability to provide location-specific information to users. More exact positioning data will enable businesses to push locally tailored information to users, thus increasing the potential value to the user. New positioning technologies are being developed to further enhance the provision of location-specific data in 2.5G and 3G networks. Such data will open the door for enhancing existing services (e.g. location-specific advertising and price-comparison) as well as entirely new ones (e.g. personal navigation). The potential impact of location-specificity is substantial, with the killer applications likely to emerge first being in the advertising and travel service segments.

A number of start-ups, such as Citikey or Starwap with their mobile cityguides, were betting on location-based information being available during 2000. However, network operators have been slow in implementing the necessary positioning systems. Only with the position automatically identified by the network can location-based services become a commercial reality. It is just too cumbersome to enter a street address with current mobile devices. We estimate that positioning technology will be in place within 18 months across Europe, which coincides with the arrival of GPRS to the market on a larger scale. However, until then companies who intend to offer location-based services will be too early to market and will not survive the next 24 months without revenues.

Personalisation

The online industry has demonstrated the importance of creating personalised end-user interfaces that are tailored according to the individual's personal needs and preferences. The success of many online portals, such as Yahoo and AOL, has been partly based on their ability to personalise the user's service experience. 3G will allow new ways of personalising the mobile service according to individual user needs. In particular, we expect to see the emergence of intelligent personalisation solutions that will be able to record and learn from the user's behaviour patterns. When compared with the wireline internet, the need for intelligent personalisation will be of greater importance for mobile services and applications because of the inherent constraints of the user interface that mobile terminals can offer. The traditional 'tick-the-box' personalisation, that dominates wireline internet applications, is not likely to be sufficient. Instead we believe in advanced personalisation engines provided by the likes of Autonomy and BT's Rocking Frog.

Immediacy

Immediate access to information is also a key distinguishing factor of mobile applications and services because users generally always carry their terminals with them. The immediacy of information access will be enhanced in 2.5G and 3G networks by the 'always-on' functionality. 2G systems already incorporated a 'push' feature in the form of SMS messages. This feature will become even more relevant in the 2.5G and 3G systems as the technology allows continuous streaming of new information without becoming too intrusive. The 'push' and 'always-on' features support the provision of time-critical information for conducting high value

transactions, such as participating in (mobile) auctions and executing mobile stock-trading deals. These type of transactions will without doubt become some of the most interesting, revenue-generating services simply because of the economic value attached to them.

On the other hand, providing localised and relevant information in a timely manner will be increasingly critical to attracting and retaining mobile data users in future, but these services will not generate huge revenue-streams by themselves.

Service Availability

Availability of services, servers and sites with WAP has not been up to a level that is expected by both, operators and end-customers. Disappointment over long connection times as well as the lack of service quality have led to a negative image of the mobile internet as promoted in the media. Application developers, portal operators and gateway vendors have gone through a steep learning curve. Although there are still major difficulties in the operation of GPRS networks and linking them to the internet, we expect that they will be overcome during the following 18 months. The lack of developer resources that understand both mobile network and IP has led to the current bottleneck.

In summary, we believe that the following are four key differentiators for mobile applications that will provide significant value for the end-customer.

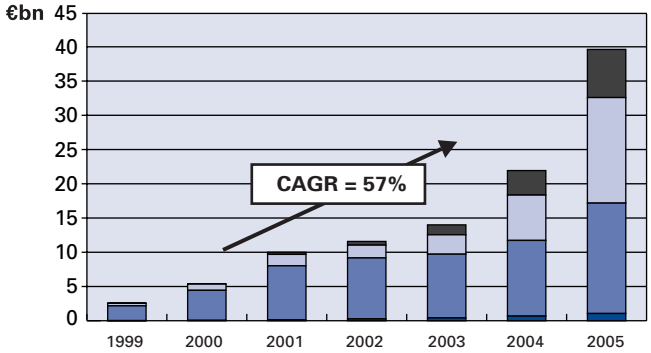
- Location-based
- Personalised
- Immediate
- Available

5.3 CONSUMER SERVICES

The market for consumer applications has developed significantly since Durlacher's Mobile Commerce report of 11/1999. The market is under pressure to introduce applications quickly, but there is still uncertainty as to which applications will be successful. There are several key success factors for mobile data applications as identified above. There are also some obvious limitations consumer applications will face, such as a lack of bandwidth, limited device capabilities and availability of software enablers.

Figure 37: Mobile consumer services revenues in Europe
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Mobile Consumer Services Revenues in Europe



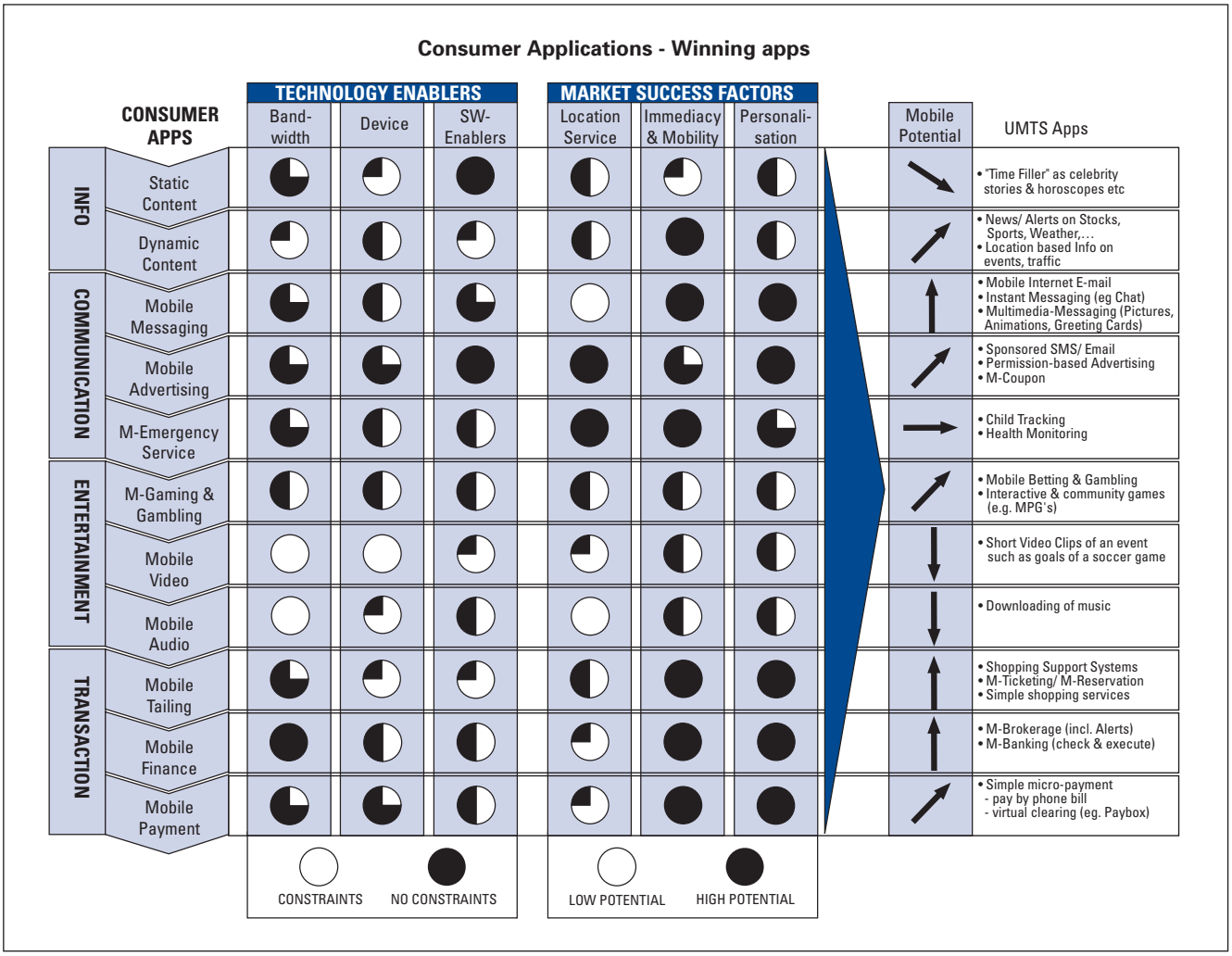
	1999	2000	2001	2002	2003	2004	2005	CAGR*
M - Transaction Revenues	0.03	0.21	0.31	0.54	1.45	3.58	7.03	148%
M - Entertainment Revenues	0.37	0.91	1.67	1.87	2.83	6.62	15.41	86%
M - Communication Revenues	2.15	4.38	7.9	8.9	9.3	11.05	16.12	40%
M - Information Revenues	0.025	0.06	0.12	0.27	0.42	0.68	1.06	87%
Total in €bn	**2.6**	**5.6**	**10.0**	**11.6**	**14.0**	**21.9**	**39.6**	

* Based on different base years

Despite these limitations, the opportunities in the mobile consumer services market in Europe are healthy with an overall CAGR of 57% until 2005. We forecast the market to reach total revenues of €39.6 billion. This market is already growing quickly and generated annual revenues of €5.6 billion during 2000, up from €2.6 billion during 1999, representing a growth rate of 115%. Today, communication services dominate this market (person-to-person messaging and other SMS-based services such as mobile chat), but other types of revenue sources, mainly entertainment and to a lesser extent information services, will start to add to the revenues. Entertainment services in particular will gain momentum from the end of 2002 onwards, reaching a 37% share of total revenues in the consumer services market in 2005, up from hardly 0.1% in 2000. Content services will remain relatively small in comparison with communication and entertainment services, but will generate revenues in excess of €1 billion in 2005. Transaction services will not generate significant direct end-user revenues throughout the forecast period; most of the revenues in this segment will be indirect.

Below we have compiled a list of the different consumer applications that we believe will succeed based on the key success factors of mobile services. Application providers as well as technology and middleware enablers that will deliver the majority of application development will be viably positioned to profit from the rush to offer applications and services to mobile consumers. The market for consumer services is large and fragmented with numerous start-ups focusing their activities on specific consumer segments. Mobile messaging, mobile advertising, mobile finance, and mobile payment consumer services have already been introduced and experienced some success with end consumers. However, other more bandwidth intensive applications will require faster connection speeds, new devices and better microbrowsing capabilities.

Figure 38: Assessment of consumer services Source: Durlacher Research Ltd., EQVITEC Partners OY



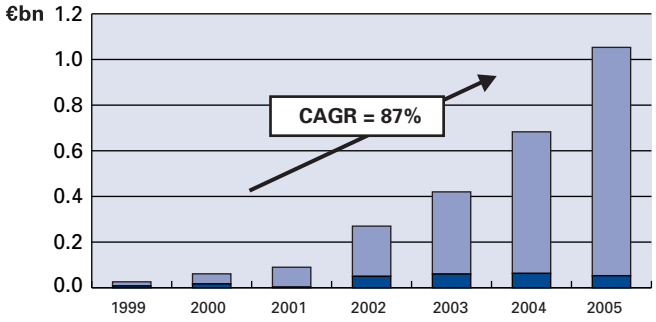
5.3.1 Mobile Information

Digital distribution of content and information is growing rapidly. A great variety of information with a varying attached value can be delivered via a mobile device to the end-user. Examples of such services include sports news, weather information, share prices, and traffic updates. This content can be accompanied by various forms of sponsored advertisements. We believe that mobile information will not be a great revenue-generator, even if it is highly personalised. Even then, end-users will not be willing to pay themselves for the vast majority of the content as they do not currently pay for it on the internet. A few exceptions to this are the Wall Street Journal, TheStreet.com or the451.com, who actually generate revenues from their high perceived-value content, but these are currently exceptions. Thus, sponsoring and advertisements by third parties provides the only real feasible business model to operate profitably in this market.

Mobile information can be segmented by content types and value chain constituents. Content can be differentiated in terms of static (e.g. reference catalogues) and dynamic or transactional content (e.g. news feeds or broker info). According to our analysis, static content will not generate strong value propositions and therefore no significant revenues. Another important demarcation line is provided by location-specificity. Location-based information provides a particular value-add for the mobile user and thus also, significantly more revenue-potential. Different types of mobile information content are discussed in more detail below.

Dynamic content services will generate 95% of revenues in this segment of the market with overall mobile information revenues reaching €1 billion in 2005, up from around €44 million in 2000. The overall market is growing fast with a CAGR of 87%. As mentioned, in addition to the opportunity to generate direct revenues from end-users of information, we believe opportunities exist for indirect revenues too, for advertising in particular.

Mobile Information Revenues in Europe



	1999	2000	2001	2002	2003	2004	2005
Dynamic information Revenue	0.018	0.044	0.087	0.22	0.36	0.62	1.0
Static Information Revenues	0.007	0.017	0.029	0.05	0.06	0.063	0.053
Total in €bn	**0.025**	**0.061**	**0.12**	**0.27**	**0.42**	**0.68**	**1.06**

Figure 39: Mobile information revenues in Europe Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Key players of the mobile information value chain include content providers such as CNN, content aggregators such as iSyndicate, and content distributors such as mobile portal Yahoo Everywhere. The roles and distinguishing characteristics of these entities have been discussed in more detail in chapter 2.

We expect that the mobile information space will be dominated by existing large media companies and portals, which do have the branding and therefore, the credibility for delivering quality content. This is based on the fact that mobile users will rely on smaller quantities of more exact information because of the limitations of the mobile device and medium, possibly putting brand at a premium.

Content Types

The inherent constraints of mobile terminals will create new demands for mobile information delivery to the end consumer. Almost by definition, the mobile information channel cannot compete in terms of information richness, volume, or multimedia characteristics. Distinguishing elements need to be sought in characteristics specific to the mobile delivery channel, such as location-specificity, personalization, and immediacy.

As shown in figure 39 above, the mobile information space can be mapped along the dimensions of location-specificity and content dynamics. Static content comprises dictionaries, Yellow Pages, map directories, city guides, search engines, phone books, and other forms of reference data that are seldom updated. The element of immediacy is incorporated in the dynamic content categories that include traffic information, event notifications, sports news, general news, stock quotes, transportation schedules, and other time-critical and frequently updated information.

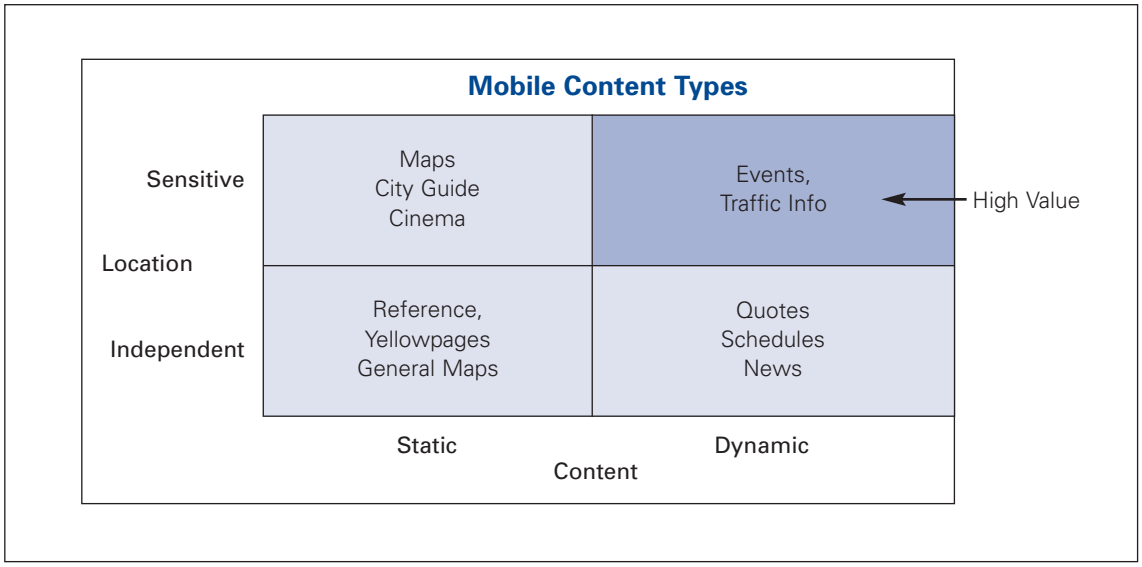


Figure 40: Mobile content types
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Mobile content can be either "time-filling" or "time-critical" information. Examples of "time-filling" information include soap opera updates, television picks, celebrity stories and horoscopes. "Time-critical" content includes information on favoured sports results, events, financial market alerts, and classified notifications.

Currently mobile information is enabled mostly through SMS because of the current poor connection times and because of the restricted user interface offered by today's WAP terminals running on the GSM network. . Most types of mobile-eligible information can be easily transferred in alphanumeric format, a format that is fairly easily handled by today's 2G mobile phones. Examples of 'push' information services include horoscopes, weather information, stock quotes and news feeds offered, for example, by Saraide or quios.com. The Finnish television company MTV3 mobile-enabled their popular internet portal early on, by sending news titles via SMS. All UK television channels have discovered SMS by the beginning of 2001 as a way to interact with consumers and generate additional revenues. SMS provides an ideal bearer service for short information transmitted to mass market mobile devices.

In contrast to push services, information pull is more difficult to achieve with SMS due to the constrained user interface. The "clickability" of links on WAP devices constitutes a significant usability improvement, enhancing interactivity between the user and the content management system. However, WAP servers have not been very stable to date, and they are often difficult and slow to access. This has resulted in increased dissatisfaction with the technology among end-users.

The arrival of GPRS-enabled devices will not precipitate a fundamental shift in consumer preferences. Information that is suitable for the mobile delivery channel will still have to be location-based, personalised, and time-critical. However, advances in technology will give users more control over the process of information retrieval, prompting a shift from pure SMS-based intrusive 'push' services and applications towards more dynamic, continuously updated services and applications.

Mobile Information Value Chain Constituents

Content Providers

Many providers have now discovered that the mobile channel for distribution allows them to charge for content, unlike in the wireline internet where they failed to generate revenues. In addition, content providers view the mobile space as a means to maintain and expand their existing customer base. Content provision is therefore likely to become one of the more popular services among 2.5G and 3G services, and relatively low entry barriers will make this an intensely competitive sector. Currently, SMS messaging remains the dominant medium, and mobile internet services (via WAP, HTML on PDAs, etc.) are not expected to really take off in the mass market until mid-2002, when GPRS is available on a larger scale.

Content providers have different options to enter the mobile market space: as an unbranded syndicated content provider, as a branded syndicated content provider or as a branded consumer service, i.e. portal. The main differences between these three groups are illustrated in Table 8 below.

Mobile Information Content Providers			
	Unbranded Syndicated Content Provider	**Branded Syndicated Content Provider**	**Branded Consumer Service (M-Portal)**
Description	• White-labelled	• Branded	• Branded/ own Portal
Pros	• More revenue sources	• Low risk	• Complete control
Cons	• Less Revenue than branded content • No contact to end-customer	• Indirect relationship with end-customer • No significant source of revenues	• Market dominated by operators and Internet-portals • Very competitive
Costs	• Lowest costs, no marketing costs	• Low entry costs as only raw content is being provided	• High marketing costs
Challenges	• No control over end-customer • Identify winning Portals	• Brand Building • Partnerships need to be established with mobile portals	• Marketing effort to communicate the portal address to many people
Revenues	• Provision of content	• Revenue Sharing	• Ads, cross-marketing & share of e-commerce

Table 8:
Mobile Information Content Providers
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Examples for the above categories are iSyndicate as a company offering unbranded syndicated content across a variety of channels. News agencies such as Reuters use their strong brand to follow the model of a branded syndicated content provider. Players such as Vizzavi exemplify the branded consumer service – a multi-access portal using its own content base.

We believe that, initially, all of the business models described above have a right to exist and might generate some revenues. Start-ups with content specifically created for mobile

use might be under more pressure: they do not have the same brand equity as stronger and established media players that are moving into this market.

Content Aggregators

Content aggregators repackage content and information for distribution to mobile devices. They also add value by delivering content in a format appropriate for mobile distribution. Content aggregators such as InfoSpace or AvantGo typically source content from a number of channels that they bundle and resell to mobile portals. A content aggregator can also position itself as a WASP by offering aggregation and hosting to portals and network operators.

We believe that the content aggregator opportunity has passed, from an investment perspective, as the market does not seem to offer space for more players and most content owners have already developed a mobile channel which they market independently.

Content Distributors and Mobile Portals

We believe that portals such as Yahoo will provide the focal interface for internet and mobile users alike. To attract customers, portals have to offer "sticky applications" through cross-channel marketing and through the provision of both wireline and mobile content. Fixed-line internet access can be used as the main channel for providing complex content and services, whereas the mobile channel can be used for delivery of targeted, time-critical, and location-specific content and services.

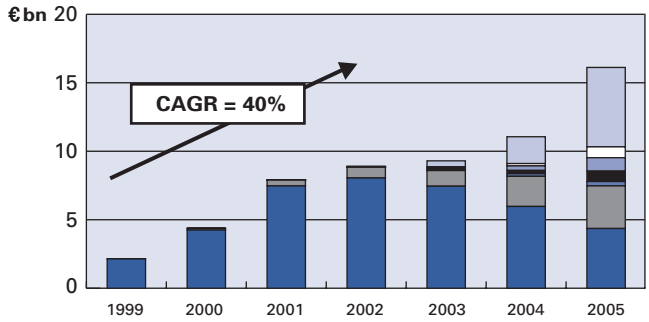
Mobile portals do not provide any significant investment opportunity except for technology or white-label platforms. The business models are still not compelling as users of mobile internet are missing in volume and therefore, no revenues are generated. We believe that mobile portals will largely be delivered by the MNOs or service providers or some of the top global portal brands.

5.3.2 Mobile Communication

The communication services segment provides a number of revenue opportunities. These opportunities will materialize at different times, and that will result in attractive, but not

Figure 41: Mobile communication revenues in Europe split by revenue source Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Mobile Communication Revenues in Europe Split by Revenue Source



	1999	2000	2001	2002	2003	2004	2005
Advertising revenues (in € billion) in direct	0.0	0.001	0.01	0.04	0.43	1.96	5.80
Healthcare (in € billion)	0.0	0.0	0.0	0.001	0.03	0.17	0.79
Emergency (in € billion)	0.0	0.0	0.01	0.02	0.1	0.33	0.98
Instant Messaging (in € billion)	0.0	0.0	0.001	0.005	0.06	0.24	0.76
Mobile E-Mail (in € billion)	0.0	0.0	0.003	0.01	0.09	0.19	0.32
Multimedia Messaging (in € billion)	0.08	0.12	0.42	0.78	1.14	2.20	3.11
SMS Messaging (in € billion)	2.14	4.25	7.47	8.05	7.45	5.97	4.36
Total in €bn	**2.15**	**4.38**	**7.90**	**8.90**	**9.30**	**11.10**	**16.12**

steady, revenue growth of 40% overall in this segment of the market. Until 2002 at least, the bulk of revenues will be driven by mobile messaging services.

While SMS will continue to be the largest single source of revenues by far until 2004, advertising is expected to start generating some revenues too, since availability of GPRS and location-based services will enable the growth of the market. Towards the end of the forecast period, limited opportunities will arise for offering subscription-based services for instant messaging and e-mail services. From 2004 onwards, we believe that revenue opportunities will emerge for mobile emergency applications such as personal security and health monitoring.

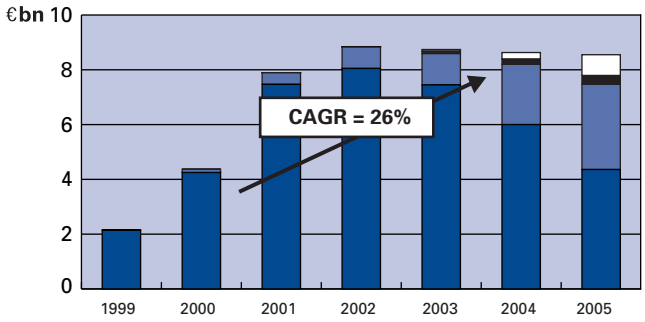
Mobile Messaging

Mobile messaging applications, including all person-to-person communication excluding voice telephony are generally regarded as the "killer applications" in the upcoming UMTS environment. This is supported by the huge success of SMS in the GSM world and by the success of internet messaging services such as e-mail and instant messaging.

The wireline internet instant messaging market is dominated by two large players, AOL Messenger and ICQ. In late 2000, there were approximately 40 million AOL Messenger users and 84 million ICQ users globally. At that time, ICQ transmitted approximately 22-23 billion messages per month. This is equivalent to eight messages per user per day. If this number is compared to the number of SMS messages, where the average user in the UK, for example, sends 0.5 messages per day, and with UK teenagers, who send about 2.5 messages a day, the potential of messaging applications becomes clear.

E-mail remains the most established messaging system available on the internet, far ahead of instant messaging. According to IDC, there were 263 million electronic mailboxes with over 300 billion e-mail messages sent each month by the end of 2000.

Mobile Messaging Revenues in Europe
Split by Revenue Source



	1999	2000	2001	2002	2003	2004	2005
Instant Messaging (in € bn)	0.0	0.0	0.001	0.005	0.06	0.24	0.76
Mobile E-Mail (in € bn)	0.0	0.0	0.003	0.01	0.09	0.19	0.32
Multimedia Messaging(in € bn)	0.01	0.12	0.42	0.78	1.14	2.20	3.11
SMS Messaging (in € bn)	2.14	4.25	7.47	8.05	7.45	6.0	4.36
Total in €bn	**2.15**	**4.37**	**7.89**	**8.85**	**8.74**	**8.63**	**8.55**

Figure 42:
Mobile messaging revenues in Europe split by revenue source
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Within the mobile messaging segment, a number of revenue opportunities can be identified. These opportunities will materialise at different times, and that will result in discontinuous revenue growth in this segment of the market. Until 2005 at least, the bulk of revenues will be driven by SMS messaging services. While the number of SMS users, and their usage, will continue to increase over the next three years, severe pricing pressures

will manifest themselves within the next 24 months. This development will start to erode SMS service revenues significantly from 2003 onwards.

Other mobile messaging applications and services will not have matured sufficiently at this time to counteract the pressure on SMS messaging services. Thus, revenues will not grow further after 2002. From 2003 onwards, rich multimedia messaging services will start to grow more quickly, with the mass availability of GPRS devices and the arrival of a more appropriate pricing structure. This will really lift mobile messaging off the ground. Towards the end of the forecast period, limited opportunities will arise for offering subscription-based services for instant messaging and e-mail.

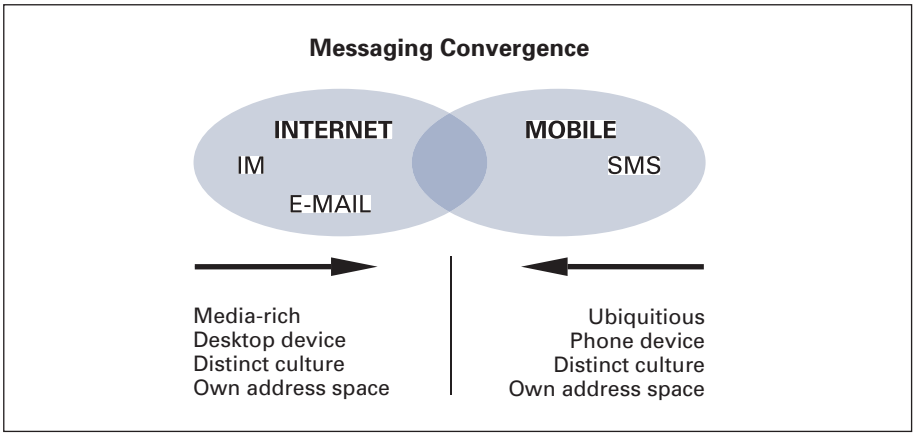


Figure 43: Messaging convergence
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

There are also signs that the internet and mobile messaging worlds are converging with the introduction of packet-based mobile IP networks. The expected growth has prompted response among a great number of different players, including messaging software developers, device manufacturers, middleware developers, ASPs, system integrators, and internet portals:

– Messaging software developers such as Microsoft and Lotus are creating the possibility for mobile access to legacy corporate systems that run their e-mail platforms, Microsoft *Outlook* and *Lotus Notes*. However, they have not been rolled out to the market on a large scale yet as the solutions are still in the trial stage at operators. We do not expect this to happen until year-end 2001. Materna, based in Germany, offers their own independent alternative unified messaging platform for companies.

– Device manufacturers such as Nokia and Ericsson offer enhanced mobile messaging features. Nokia has developed an entertainment platform to send colour and graphic intensive messages on 3G mobile devices. Ericsson has created a touch screen text input scheme for several of its mobile devices (e.g. the *R380*). Research in Motion in the U.S. offers very successfully its *Blackberry* mobile devices for access to corporate e-mail.

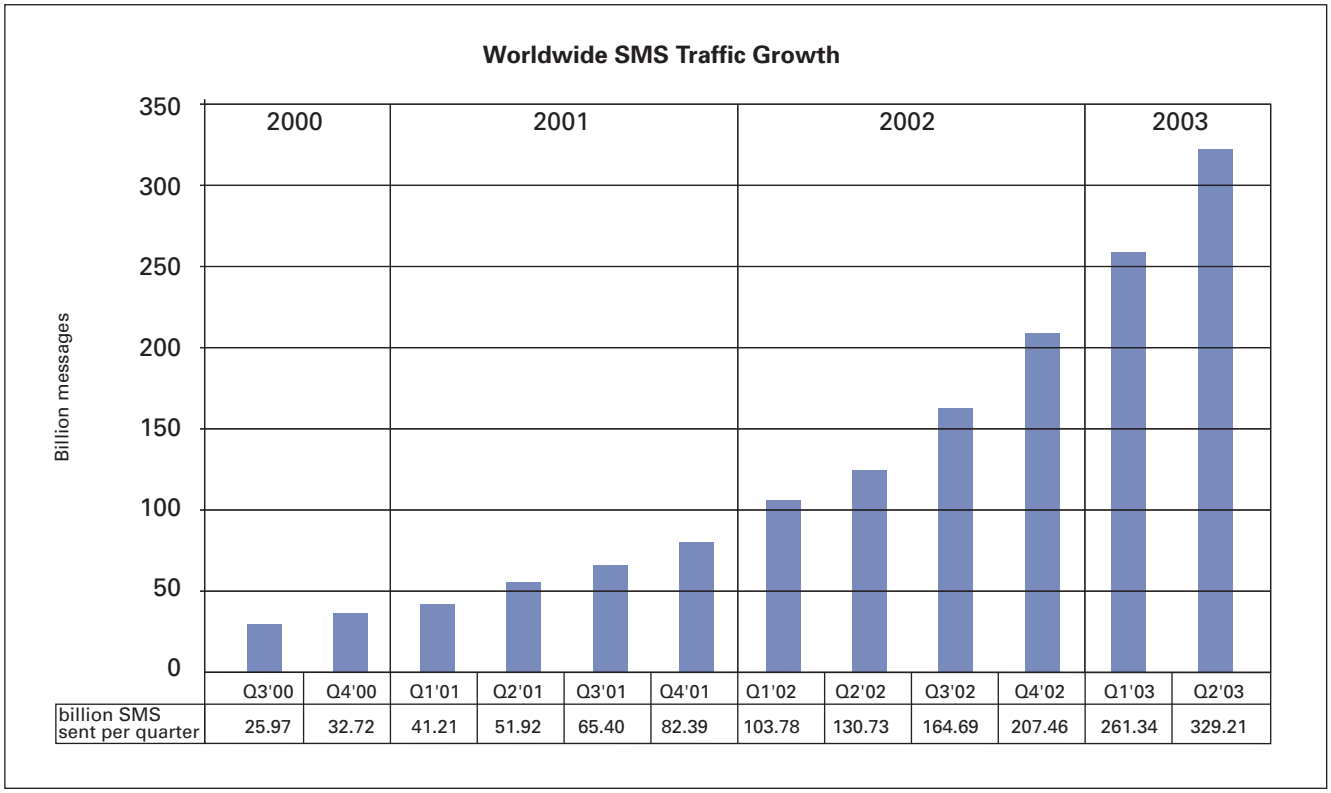
– Middleware developers are providing interfaces to legacy messaging systems such as Peramon's *Mobilizer* and Wapit's *Mobile Mailer*.

– Portals such as Yahoo or Web.de are implementing unified communication platforms and services to offer a comprehensive solution to better manage customer needs.

– As different communication channels converge on IP networks, we see an emerging need for managing a user's messaging services that are distributed across different device and address spaces. Technologies such as SIP (Session Initiation Protocol) enable users to manage their mode of communications around a unified address.

Short Message Service (SMS)

Currently, mobile messaging in Europe is dominated by SMS, the most popular data communication service available for mobile devices. We expect this market to continue to grow as mobile penetration increases and more customers learn how to use SMS text messaging as a means of communication.



	Q3'00	Q4'00	Q1'01	Q2'01	Q3'01	Q4'01	Q1'02	Q2'02	Q3'02	Q4'02	Q1'03	Q2'03
billion SMS sent per quarter	25.97	32.72	41.21	51.92	65.40	82.39	103.78	130.73	164.69	207.46	261.34	329.21

Figure 44: Worldwide SMS traffic
Source: GSM Association (7/00); Durlacher Research Ltd./ EQVITEC Partners Oy (estimates)

As shown in the figure above, we expect SMS to experience explosive growth and thus, to further strengthen its position as the mobile messaging killer application. In fact the service grows so quickly that existing networks frequently are facing a congestion crisis on their SMSCs caused by, for example, the number of greetings sent during Christmas, 2000, or Happy New Year messages on January 1, 2001.

We expect that through the implementation of GPRS and finally with UMTS, a wider range of messaging applications will become available. Prices for SMS will increasingly become a competitive weapon and are coming down in almost all European markets. As new, richer messaging applications are introduced, basic SMS revenues will decline further.

Multimedia Messaging

Mobile messaging currently exists in fairly basic forms and is still waiting for multimedia capabilities. Despite the accelerated uptake of the service, the long-term prospects of SMS's lead position in data services is threatened. The industry has realised that basic SMS is maturing (in certain markets), and extensions to messaging services are under development. The following section discusses three development stages of mobile multimedia messaging:

- Picture Messaging
- Enhanced Messaging
- Multimedia Messaging

We believe that the first step towards multimedia messaging is the picture messaging capability as supported in the newer Nokia and Philips phones. The phone can store messages that include small GIF-images that can be ordered using SMS, WAP or the internet. Once the images are stored on the phone they can be sent with inserted text to other phones that support this messaging format. The image consumes 39 characters of space, thus leaving 121 characters for the text message. The problem with the current terminals is that the images cannot be produced on the terminal and therefore the options for the user are limited at a given point of time. A more advanced form of picture messaging

service is offered by J-Phone in Japan. The network operator offers photographic quality JPEGs acquired from a digital camera embedded in the back of the device to be sent over a circuit-switched 9.6 kbps network.

The second generation of picture messaging includes small animations integrated with text. Enhanced Messaging will resemble the animated electronic postcards of the internet, available from, for example, bluemountain.com. Formats such as *Flash* or *Shockwave* seem likely to gain power on this segment because of the vast availability of content and relative ease of use. We believe that this type of messaging becomes possible with GPRS and will experience enormous uptake over the next three to four years, as the network matures and more people use the service. We foresee similar constraints for this type of messaging as we see for picture messaging, and, therefore we think that this application will take longer to take off than generally anticipated by the market.

True multimedia messaging, which offers video and audio on top of the previous capabilities will, in our opinion, not become mass market in the near future or even the mid-term. The hindrance in this market is not only the lack of bandwidth (which will eventually be resolved) but also varying behaviour patterns and the diversification of device form factors. As we see it, simple messaging based on text is relatively simple to provide as are the SMS and e-mail services of today, whereas multimedia messaging will require significantly more effort.

In addition to the inhibitors introduced above, we predict that there will be problems with interoperability of formats between vendors of mobile phones, which is likely to cause a temporary format war. For example, at present it is not possible to send icons from a Nokia to a Siemens phone. This problem is addressed by multimedia messaging providers such as ConVisual, a German start-up. This company is a WASP that offers a platform for creating messages and manages to distribute them to any type of mobile phone optimised to the particular model of the receiver. *M@gic4* is actually developing a format which might evolve as a standard for enhanced messaging. Providing solutions for mobile media messaging is an attractive investment area especially in light of the enormous potential of the market, which is widely untapped.

We believe that mobile multimedia messaging will take off in the form of services that offer customisable pre-made content, similar in nature to customisable postcards available on the internet. Multimedia messaging will also move the mobile world one step closer to internet messaging, serving as a base for better interoperability between the messaging systems such as e-mail and ICQ.

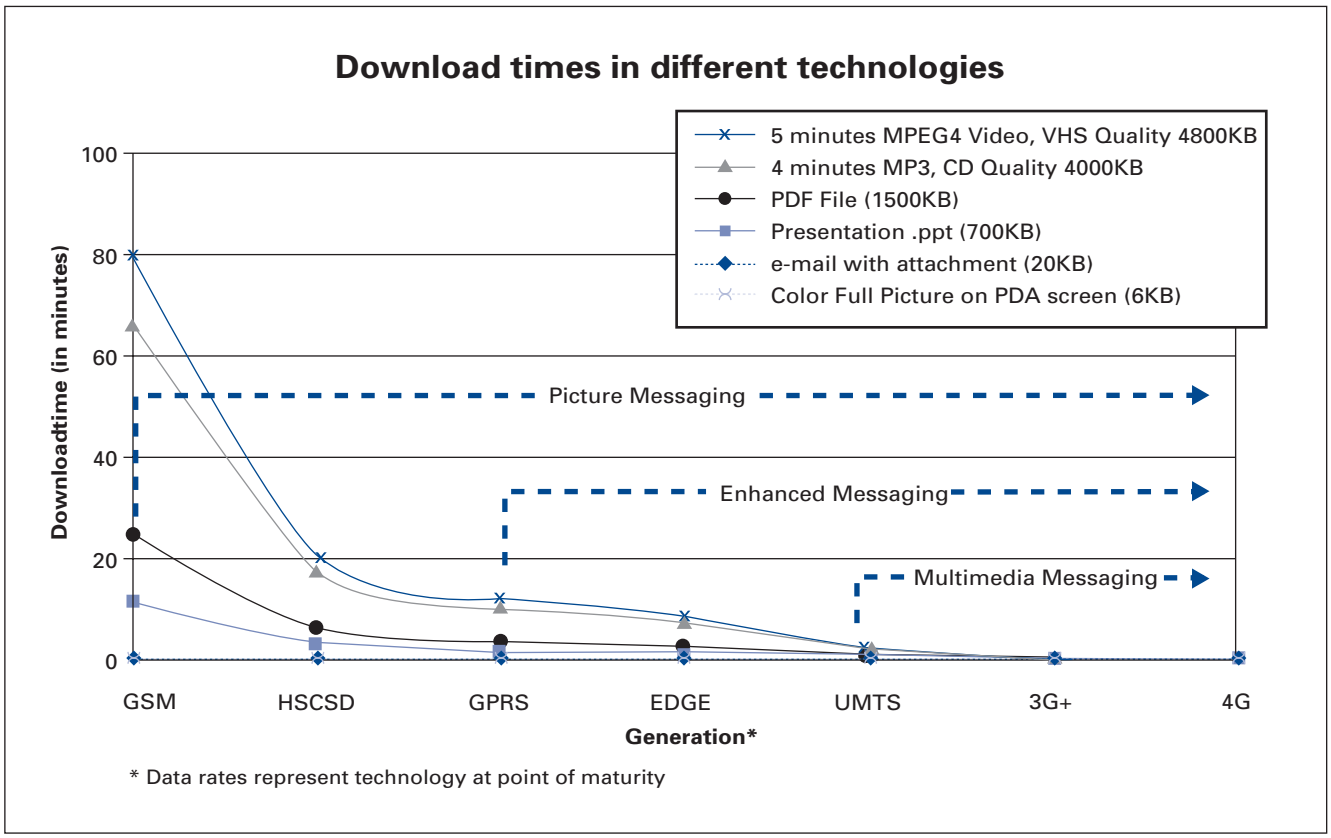


Figure 45: Download time in different technologies
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Very short video-clip transfer will be possible over an acceptable period of time with 3G network technology, but handset capabilities are another important constraint for next generation messaging. We believe that Japan has a clear lead in device technology, e.g. strong device design allowed J-Phone in Japan to offer a photographic quality picture messaging service over a circuit-switched 9.6 kbps mobile network already during the year 2000.

E-mail Applications

The second major focus area for messaging applications is access to internet e-mail. The majority of email applications available today are based on SMS and WAP. Once GPRS is deployed, instant messaging will be possible. Users will also be able to send moderate sized attachments with their e-mail through mobile devices. However, inputting information into mobile devices remains slow and is not convenient for frequent use. Solutions such as adaptive text input T9 from Tegic, which allows easier text input for some people, is implemented by most manufacturers in their new terminals, and Ericsson's plug-in keypad (*message board*) has been developed to speed up the typing process.

We believe that the majority of current solutions are targeted to business users. The consumer market will overtake the business market by number of users in 2004.

Peramon is an example of a company that offers basic solutions to provide access to standard messaging protocols. The company provides corporate e-mail access and standard facilities including reading, replying, composing and forwarding e-mails. Common e-mail servers such as POP3 and IMAP4 and remote access to corporate e-mail are supported.

Advanced solutions will provide access to more complex functions of corporate customers. Microsoft has introduced a middleware component called *Microsoft Mobility Server* that extends *Outlook* to mobile devices. Once this system is stable it will be pushed down the channel, but it will require lots of integration work with mobile networks and legacy systems. There are also other third party solutions, such as Wysdom and Smartner, that provide SMS and WAP to e-mail solutions.

Reliable and convenient mobile devices with special features will be successful among business customers. An example of such a device is the *RIM Blackberry* which is very popular in the US. The success of this solution lies in the fact that it is a complete service, including well-tuned middleware and an attractive flat-rate pricing scheme. RIM will introduce the *Blackberry* pager based on GPRS with BT Cellnet in the UK as a first attempt to enter the European market. However, although we believe that the concept is very good, we doubt that introducing a new device specifically for e-mail will be successful. Instead, we believe that all-purpose communicator-type phones, such as those provided by Nokia and Ericsson, will be more successful as clients for mobile mail.

The arrival of UMTS will not herald a new era for this type of application. The average size of an e-mail sent through current wireline networks is about 20 kilobytes. The bandwidth offered by GPRS allows transfer of such messages in 40 seconds or less. We believe that the mobile email market is very attractive for companies that are able to go to market before the end of 2001 (i.e. before Microsoft and Lotus enter it) as straight forward and easy-to-adopt solutions are still not commercially available. However, revenues will come mainly from mobile data traffic as it will be difficult to use other pricing schemes beyond the business market.

Mobile Instant Messaging

Mobile instant messaging applications will target mass market customers due to their wider appeal and the fact that mobile terminals enjoy higher penetration levels than PCs. Instant messages are also more immediate and ubiquitous. As a means of communication, instant messaging closely resembles SMS messaging. The important difference between the two is that SMS is a 'store-and-forward' technology; thus, it is less immediate than instant messaging. The delivery of SMS messages may sometimes take minutes, or even hours or days during peak times and in network roaming situations.

Instant messaging will continue to converge with SMS in the future. Mobile phones will become a valid extension of and complement to the current internet chat groups. As an example, ICQ has recently started to integrate its service with SMS, bridging the internet world with mobile communications. Messages can be sent from ICQ to SMS enabled mobile phones and from SMS enabled mobile phones to ICQ. Due to the short character of instant messaging postings, this integration is possible with existing technology and does not require UMTS.

Mobile chat will be successful as it promotes the formation of user communities. Chatting applications can encompass dating, affiliate communities and anonymous SMS-based services. Mobile chat is a service that starts generating revenues almost immediately. For example, Globe Telecom generated over 2.7 million SMS messages per month upon introduction of an SMS chat service in Summer 2000 with Wapit's middleware and chat application. It is possible to chat already via both SMS and WAP technologies, but neither one is suitable for a real cross-platform chatting service. Due to the restrictions of the terminal's interface, mobile chatters are still too slow for their counterparts in front of a PC.

Instant messaging is by nature shorter and more immediate than e-mail. This makes it ideally suited for low-latency applications such as chat and time-critical notifications. E-mail is better suited for "heavier" applications as correspondence with multimedia attachments. Currently, SMS substitutes both technologies in Europe. With the introduction of GPRS we expect mobile e-mail applications to fully emerge, with SMS serving more the lower segments of the market.

Mobile Advertising

We expect mobile advertising to become the second biggest mobile commerce service by 2005 with revenues of €5.8 billion in Europe.

As an advertising medium, the mobile phone complements other forms of advertising such as TV, direct mail, and web advertising. It also adds some unique characteristics that no other medium can effectively match. Existing advertising media are targeted at undifferentiated, mass audiences, and they rely predominantly on one-way mass communication. Because of its ability to efficiently identify the user, mobile advertising could be tailored to highly selective customer groups.

The ubiquitous mobile platform enables instant response from the recipient of advertisements e.g. SMS-based advertising services. It offers also the possibility to combine user information with location data, a unique differentiating characteristic among advertising media. Furthermore, the ability to offer a permission-based advertising option offers an effective way to increase the potential value of the advertising message to the consumer. These characteristics make the mobile phone a potentially lucrative advertising medium, and a number of players are already attempting to secure a position in this area.

As mobile advertising evolves towards mobile marketing, this channel will only increase in importance for traditional marketing functions such as brand building, promotion and direct-response marketing.

Mobile Advertising Players

Mobile advertising offers potential revenue-generating opportunities for a number of different players, but the industry is rather fragmented at the moment. Mobile network operators and virtual operators such as Vodafone and Virgin try to leverage their exclusive ownership of the end-customer by providing portal services such as WAP banner space and permission-based push services. Mobile portals such as Quios.com provide access to the end-customer, and try to lure these with, for example, free sponsored SMS messages and alerts. However, this service must be highly personalised in order to generate sufficient interest in the market, and must always be permission-based.

Mobile advertising companies, such as Advertising.com, Zagme and Windwire, conduct one-to-one advertising campaigns on behalf of traditional retailers and businesses. Initial campaigns have been very successful with response rates of up to 40% using mobile coupons for larger discounts with a short timeframe. WASPs such as 2Roam provide mobile advertising applications based on an ASP model. M-intelligence companies, such as Sonata, provide tracking of users as they move in mobile environments, thus providing for more effectively targeted advertising campaigns.

Platform or solution developers such as WCL, First Hop, Mediatude or Add2Phone develop advertising solutions for the use of the above listed players. Finland-based First Hop and Regisoft of Israel have developed a new mobile application that replaces physical coupons. The m-coupon uses public key cryptography to verify the authenticity of "digital coupons" which are sent to mobile devices via WAP, SMS or E-mail. Wireless Commerce Limited markets *Reach-U*, a 2-way SMS-based permission-based advertising application that enables the mobile consumer to immediately respond to a mobile SMS advertisement. Add2Phone has developed an advertisement server solution enabling operators and service providers to send advertisements, information, and sponsored content to mobile handsets.

We believe that the market for mobile advertising has been hindered by the lack of new intermediaries, i.e. advertising WASPs, who bring together the worlds of mobile operators, advertising agencies and advertisers.

Advertising models

While the advertising model has largely failed to generate sufficient revenues for the internet, except for the top 10 sites, mobile advertising does provide unique advantages which make it appealing.

Mobile advertising comprises several different forms of media applications including mobile banners, sponsored alerts, and one-to-one push advertisements. Mobile banners

are similar to online banners, but are limited by current device functionality and usability, which is basically black & white on small screens. Therefore, we do not expect mobile banners to become popular. Mobile banners will be possible at the earliest with GPRS, but without advanced personalisation systems in place, the value per banner message will be rather limited.

Sponsored services push individually tailored, time-sensitive content to a user's mobile terminal. For example, Quios sends free weather forecasts and horoscope alerts via SMS to users' mobile devices. The free alerts are accompanied by sponsored mobile advertisements. Sonera Zed offers free SMS services to users paid for by companies wishing to advertise on the website.

Push advertising allows tailored content to be sent to the user via SMS and soon via WAP. Wap-You-Up's *MindMatic* service claims to have click-through-rates of more than 40%. This level of click-through response rate is considered high, given that wireline internet rates are typically less than 1%. The success of mobile advertisements could be attributed to their novelty value. As the novelty effect vanishes, click-through rates are likely to fall. Nevertheless, due to the personalised, location-specific, and time-sensitive nature of mobile advertising, we expect click-through rates to flatten out at approximately the 5% level. This is a much higher level than that which can be reached by internet or other forms of media advertising. However, internet business models have moved away from artificial performance parameters, such as unique visitors, pageviews and click-through rates (which focussed on potential rather than real revenues).

Location-specific information further enhances the potential value of mobile advertising applications. As an example, Zagme initiated a location-specific advertising campaign in the Lakeside Shopping Mall in Essex, England. Customers can register an account with ZagMe in which they gather points applicable towards pre-paid mobile vouchers. Users receive ZagMe points each time they activate the service and each time they receive notifications from certain predetermined retailers.

Because of the highly personal and intimate nature of the mobile medium, any type of one-to-one marketing has to be very targeted but non-intrusive. Privacy concerns and the danger of mobile spamming will largely allow only permission-based mobile advertising schemes to be successful. In addition to permission-based advertising, loyalty programs will provide another key to success. Loyalty programs can reward the frequent user with coupons, promotions, pre-paid calling vouchers, cash refunds, and services such as premium-content alerts. As an example, Advertising.com's *AdBroadcast* network pays a fee of €0.05 - €0.5 for every accepted mobile advert.

We believe that mobile advertising will be successful, but only from 2003 onwards when location-specific information will be available for the customer. Creative concepts for advertising will emerge and a new breed of intermediaries will establish themselves in the market to seize the opportunity.

Mobile Emergency Service

Mobile emergency services have already existed on GSM networks in the form of free SOS calls that connect end-customers to a help-desk operator. The emergence of positioning technologies and services will drive this application to a new level. The distress call functionality is regarded as a natural extension to the services of location-based system vendors with high revenue potential. In some markets regulatory requirements were a significant driver for mobile emergency technologies.

Emergency services require distinct pricing models. While many introductory services today rely on traffic or transaction-based revenues, emergency services cannot be charged per accident or per amount of data traffic. A subscription-based model requiring the customer to pay a flat service fee over a longer period of time seems to be most appropriate.

In cars, telematic services are growing in importance, with emergency functions being one of their key components. For example, *OnStar*, one of the largest telematic services in the

US, automatically notifies the local service centre if anything unusual occurs, such as the triggering of an airbag, and relays specific event details and the location of the car.

Personal tracking services designed specifically for children are also promising. Siemens, in cooperation with GAP AG, is currently conducting a test project in the Munich area for a tracking and communication system embedded into a toy. A teddy bear, for example, holds a GPS device inside. Linked to a mobile phone, the teddy bear constantly delivers details about the child's whereabouts to the call centre and the parents. The child may activate a device by pushing a button that connects it to the call centre to seek help. However, although this service concept sounds interesting, it might become superfluous, because 50% of children have mobile phones already and location-based-services will be available in the next 24 months. Companies such as Digital Angel in the US are trying to pursue the same vision by placing a miniature tracking and communication device into a wristband. In the future, we may see such devices built into personal items such as watches or jewellery.

We believe that mobile emergency services provide interesting revenues and lucrative business models mainly operated in a WASP mode. It is a market that has been largely neglected so far, but the availability of positioning signals will make it attractive.

Mobile Health Monitoring is another service that is in trials now. Finnish companies Uniqmed, Nokia and Mehiläinen are currently testing a service for treating and monitoring patients at home. Specific portable equipment provided by Uniqmed measures a patient's vital signals including the pulse, blood pressure or electrocardiogram, and sends the information over the GSM network to a central location in a hospital. In many cases such services may improve a patient's quality of life and bring increased confidence for the elderly and critically ill at home. As the cost, size and power consumption of such devices decrease, they may also be used for disease prevention. For example men over forty who are at an increased risk of a cardiovascular disorder could be equipped with such devices to detect early symptoms. We see this area as potentially having some potential but it is unlikely to be significant before the years 2003/2004.

Mobile emergency services are not constrained by the capabilities of available networks as they do not generate significant data traffic. The main technical constraints are the accuracy of existing network-based positioning methodologies and the relatively high cost of device-based GPS positioning devices. However, companies, such as Parthus Technologies, are starting to come up with cheaper and more portable versions of GPS positioning devices that will eventually become mainstream over the next three to five years.

The market will be reliant on GPS-based solutions until network-based positioning solutions can resolve current constraints. Network-based positioning services will be practical only in fairly populated urban areas where the cell size is relatively small and different methods yield high positioning accuracy. As the cell size increases the accuracy of network-based positioning methods is likely to fall. Ironically, mobile emergency services are mainly required beyond high-traffic areas where other means of calling help exist.

We believe that basic personal emergency services will become part of the essential network offering over the next three to five years. Premium services concentrating around health and personal location monitoring will materialise over the same period, enabled by advances in device and network location technologies. This category of services will also present the most opportunities for start-ups in the area. Telematic services will continue to develop, driven by automotive manufacturers and location-based services companies in the US and Germany. The development of this market will create a favourable environment for technology start-ups in these areas.

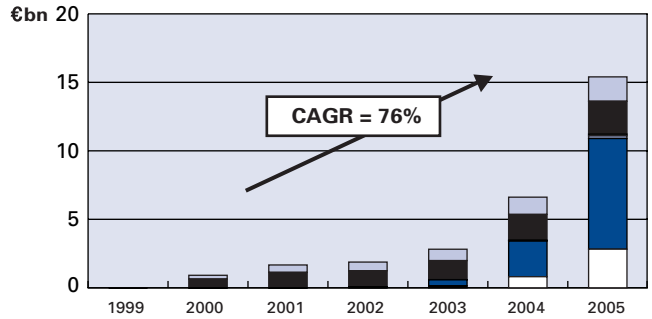
5.3.3 Mobile Entertainment

Entertainment services, i.e. mobile games, gambling, icons, ringing tones, audio and video, will be key to unlocking the revenue opportunity in the B2C market. To date, revenues from mobile entertainment services are very limited indeed. The transition towards an always-

on environment and higher speeds, in combination with the emergence of gaming-centric devices, will result in features that will particularly appeal to young people in the market.

We expect mobile games to become the number one service and generate annual revenues of around €8.1 billion by 2005. On-line mobile betting presents another big opportunity in this segment, with annual revenues of €2.8 billion at the end of this forecast period. Technical constraints will limit opportunities for audio and video based services.

Mobile Entertainment Revenues in Europe
Split by Revenue Source



	1999	2000	2001	2002	2003	2004	2005
Icons (in € bn)	0.0	0.27	0.54	0.63	0.83	1.26	1.78
Ringing Tones (in € bn)	0.0	0.64	1.12	1.18	1.39	1.88	2.4
Audio (in € bn)	0.0	0.0	0.0	0.002	0.006	0.027	0.12
Video (in € bn)	0.0	0.002	0.003	0.006	0.01	0.04	0.2
Games (in € bn)	0.0	0.001	0.004	0.04	0.43	2.60	8.08
Gambling (in € bn)	0.0	0.0	0.0	0.02	0.15	0.81	2.82
Total in €bn	**0.0**	**0.91**	**1.67**	**1.88**	**2.82**	**6.62**	**15.40**

Figure 46: Mobile entertainment revenues in Europe split by revenue sector Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Mobile Games and Gambling

We define mobile gaming as games that are played on mobile networks and on mobile communication devices. We exclude single and multiplayer handheld gaming devices such as Nintendo's Game Boy that do not generate network traffic.

The evolving mobile games value chain

The current mobile games market is characterised by the marked absence of established games companies and by the prevalence of mobile games start-ups. The mobile games value chain, as a result, currently comprises a plethora of intermediaries including platform providers and aggregators whose roles will increasingly become merged into those of mobile games service providers and mobile game publishers. The value chain is capped at both ends by mobile game developers (who create the content) and mobile network operators (who provide access to the users). As long as the operators retain control of the customer relationship (principally through their billing relationship), they will remain the most important element in the mobile games value chain. However, although operators will naturally seek 'best-of-breed' interactive entertainment services that increase the value of their offering to consumers and enhance customer loyalty, operators that adopt proprietary mobile gaming standards in pursuit of differentiation will suffer disproportionately. With hundreds of network operators all seeking content, games content owners will naturally gravitate towards the largest addressable markets and have historically ignored platforms with small installed bases. This is the principal reason why the major games publishers have shunned the mobile gaming market and why they will continue to do so if a fragmented market emerges.

With open standards adopted and the support of the major games publishers (and the games IPR that they bring) secured, the potential for mobile gaming would be very substantial. The installed base of mobile devices will be larger than that of any dedicated game consoles or PCs either historically or in the foreseeable future. Gaming services should provide operators with a core application revenue stream that could significantly offset the substantial UMTS license costs and allow them to tap into the €19.5 billion global games industry.

Much of the success of the mobile games market will depend upon the success of mobile game service providers (MGSPs), such as In-Fusio, Springtoys and Wanova, in establishing advanced, open games platforms that are supported widely enough by operators and handset manufacturers to allow cost-effective mobile games development and to attract the most valuable games IPR. MGSPs are critical not only for establishing common platforms for mobile games content development, billing and multiplayer coordination but also for providing operator integration and service deployment. We believe that success (i.e. the extent to which operators adopt the service) will be determined as much by the sophistication of the platform solutions as by the ease with which the solutions can be integrated.

At present, independent mobile games developers such as Picofun, nGame and Grip Studios Interactive, are the primary developers of new mobile games. As most of them are funded by external means, they have largely been able to retain the IPR on the games they have created. Whilst the cost of developing mobile games remains low, mobile games developers will continue to operate in this way. However this will begin to change with the arrival of the traditional games publishers and as the cost of developing mobile games starts to escalate. When they finally choose to enter the mobile games market, traditional game publishers will view the mobile games market as an additional distribution channel to help monetise their IPRs. They will bring with them considerable financial resource, marketing skills, IPR and relationships with traditional games developers that will force the mobile games industry to increasingly mimic the traditional games industry.

Mobile gaming

Mobile games can be played by either downloading single or multi-player games directly to the mobile device or by playing streamed network games which do not require a download but run on MGSPs' or operators' game servers. Alternatively, single or multi-player games could be pre-installed in the mobile device but would be restricted by the storage capacity of the mobile device.

Multi-player games are typically coordinated through a multi-player lobby server system although infrared, Bluetooth and other short-range personal area network technologies may permit direct, server-less multi-player interaction. Simple multi-player games currently available include Monster Mash from Digital Bridges, Alien Fish Exchange from nGame and Nokia game (Nokia, Bikker, Human-i). However, the severe restrictions imposed by platform, handset, mobile network and metered billing methods have prevented the development of more sophisticated products.

Streamed single and multi-player games represent an alternative approach to network gaming. Streamed games are run on the server with only the most important (visual, audio and control) data being relayed to the handset via a constant data stream. Since this data stream can be relayed via MPEG4, the handset hardware requirements do not need to feature advanced audio and graphics processing capabilities only video processing capabilities, whilst current mobile phone hardware will not be able to support the streaming of gaming applications, the more recent colour PDAs might. Some companies such as G-Cluster have already proven the technical feasibility of streamed mobile games. The biggest hurdle faced by the streamed content model, though, is the fact that it requires a constant stream of high-bandwidth data, something which mobile networks will not be able to support for many years and which could pose billing problems for operators looking to charge a metered data rate. Another games technology that will increasingly feature in games, and we believe will even spawn a new genre of game, is location-specific gaming. Location-specific games, which allow gamers' locales to feature in gameplay, will at first

be based on the model of currently existing GPS-based treasure hunt games but other, more creative location scenario games will doubtless emerge.

The target demographic for mobile games will initially be the mass-market with casual users more likely to take to simple mobile games than the sort of complex games found on games consoles and PCs. To appeal to the mass market, games will need to be user-friendly, possess intuitive controls, have low learning curves, be relatively short in gameplay duration and provide instant gratification. Revenue models for simple games can include advertising, sponsorship, download and usage commissions. Examples include parlour games, casino games, card games, puzzles, quizzes/brainteasers, basic platform games, and text-based games. As an example, the Finnish company Riot-E has proven particularly successful with interactive SMS games. SMS messages are sent to the user who responds to the messages via Riot-E's game server. The responses sent to the games server determine the outcome of the game.

Multi-platform mobile games are games that can be played in conjunction with online, PC and console versions. Examples include role-playing games, which allow the user to control their characters whether they are at home on a PC or on the move via their mobile devices. Pokemon card games permit users to apply skills they have acquired from PC and video games by visiting certain locales or electronically swapping information with other users.

As the market evolves and advanced platform, network and handset technologies become more mainstream, more sophisticated games will start to emerge that appeal to games aficionados and experts. These games will be less intuitive but more rewarding and more addictive in the long term. Where these games have sufficiently high production values (and thus be more differentiated from other products), publishers will be able to justify higher ongoing usage charges. Operators could support a subscription model based on different levels of payment; per minute, per byte, per level, and per component. The first examples of technologies enabling this level of sophistication have already been demonstrated by companies like Wanova who provide a Game Boy Advance-quality GPRS mobile games platform.

Gambling

Gambling represents another large category that will attract significant revenues but is a market characterised by potential pitfalls. Despite the fact that mobile gambling games are a natural fit with the convenient billing capabilities of mobile operators, difficult to attain gambling licenses may be required for some territories and the laws governing gambling are widely expected to undergo extensive changes that may impede the market's development.

Dai-Ichi Kangyo Bank in Japan will bring the Japanese National New-Year's Lottery ticket sales to i-Mode for the first time this year and in Europe, companies such as Bantry Technologies of Ireland, are offering complete betting platforms that address security and payment-related issues in one convenient package. Bantry Technologies currently offers scratch-card lottery and blackjack games, but plans to expand its offering to other traditional casino choices such as poker and baccarat. One of the key enablers of mobile gambling is the emergence of mobile Java technologies that will help address gambling experience, interactivity and security issues.

The mobile platform allows users to place bets anytime, anywhere, even as the event of interest unfolds. Players could place bets and receive information on changing odds as a football game advances, for example. The same scenario can be applied to most sporting events. However, real-time betting places great requirements for the ability of the mobile infrastructure to provide reliable and immediate service, and we expect it to take one to three years before real-time services become widely available. Many successful companies that have experience offering betting services on the internet are adding a mobile channel to their operations. For example, Eurobet, the online business division of Coral Eurobet plc has announced WAP betting capabilities on all of its sports betting offerings as early as May of this year. European companies such as Paddy Power of Ireland and Veikkaus Oy of Finland offer WAP access to most of their events.

Mobile Audio

Mobile devices provide another distribution channel for online music. We believe that mobile music will be subject to many of the current limitations of online music distribution, ranging from the cosy industry structure of five majors dominating 80% of the market, to unclear mobile digital rights management issues to additional technical constraints specific to mobile data. Some degree of distribution of music content will be inevitable in the mobile internet world due to a variety of reasons. Music is an information product and a natural entertainment product. Major music labels view mobile music as another distribution channel that they will seek to exploit as they face increasing competition in both the online and offline worlds.

Due to cost issues, unclear mobile music rights and capacity constraints, we do not expect digital mobile music distribution to be a reality until 2005. The inherent advantages of the mobile medium, location-specificity, personalisation, and immediacy will provide little additional value for music distribution, while the alternatives are numerous. Furthermore, the lack of available bandwidth will continue to remain a major problem affecting sound quality, particularly for streaming music content. Consumers will continue to use portable consumer electronics, such as MP3 players, Discman etc., for accessing and playing music content. Copyright issues and insufficient security solutions will further inhibit widespread adoption of mobile music.

There are three main possible delivery modes and thus, revenue sources for distribution of music via the mobile network, which theoretically could become available for the first time with GPRS:

- Downloading files (immediately in "trickle-and-store" mode)
- Streaming music (similar to wireline music streaming)
- Broadcasting music (live shows and programming)

The mobile music distribution market will be attractive to operators and major labels as future mobile devices will provide 'always-on' connectivity and device integration with other portable consumer electronics. Again, the lack of bandwidth will be more acute in the mobile world than in the wireline world for the next five years, and switching between networks is likely to remain problematic. Data storage continues to remain costly, and substantial battery usage will further impede the uptake of mobile music download services. The only mobile audio application to be widespread over the next few years will remain downloading of simple ringing tones and short (a few seconds) low quality sequences. Even background downloads would take too long and would be most likely be too expensive until 2006. We do, however, believe that we will see increasing convergence between MP3 players and mobile devices, with the mobile device being used as a local storage and playback device for music files. Files will be transferred to the device locally from a PC using Bluetooth, removable storage media (such as SmartMedia card or memory stick), via wireless LAN, or via wired connections. We do not expect to see widespread usage of the mobile network for transfer of music files.

We believe that mobile music streaming is unlikely to become a widespread service, as the properties of GPRS and 3G networks will not allow for reliable quality of service, and varying bandwidth will prevent constant connections required for streaming. Over-the-air music broadcasting might potentially succeed as a coordinated effort in a dense geographical market such as Japan. Only a powerful operator such as NTT DoCoMo would be able to dictate handset manufacturers and content players to produce music streaming capabilities. However, even in the case of Japan, significant technical constraints would remain. Mobile devices would require substantial CPU power to enable broadcasting or extremely high battery power in the case of Digital Audio Broadcasting (DAB). Network roaming for mobile broadcasting is likely to evoke difficult interconnectivity and billing issues.

Mobile Video

Mobile video shares similar characteristics with mobile music. We believe that there may be a market for mobile video distribution, but only in the rather distant future. The bandwidth

constraints limiting the introduction of mobile music services will be even more acute for the information-intensive video services. Currently, only the smallest forms of video entertainment, such as video clips, are routinely distributed over the wireline internet. Mobile video will be a viable extension of this market, but it faces pressing technical constraints. As is the case with mobile audio, the three main distribution modes are: downloads, video streaming, and video broadcast.

Digital video downloads will not reach the mass market until 2007. The lack of bandwidth, copyright issues and poor picture and sound quality will be the primary hurdles inhibiting the uptake of this service. DVD quality video, for example, requires an average stream of 4.7 mbps. Available substitutes to digital video also exist such as the TV, VCR, PVR and cinema. Viewing of smaller length digital video content, such as a few seconds long video clips, will begin to take off by 2005 as the underlying technology already exists today, and bandwidth will become available over time.

On top of the technology issues, the video and film industry is unclear about how mobile rights should be priced for events such as the Football World Cup or the Bundesliga. Worldzap has secured early on mobile video rights for those events, which puts the company in a powerful position. Their technology of choice will be focussed around multicasting.

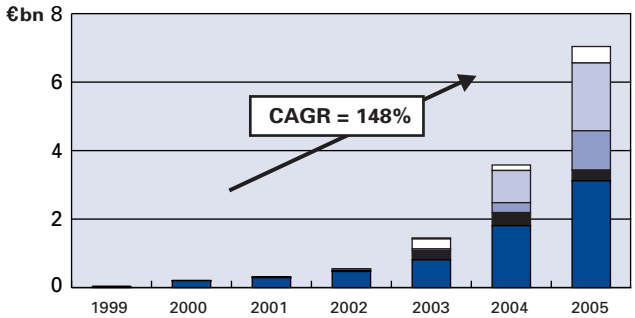
With regard to other mobile video distribution services, we do not believe that video streaming will materialise for 3G. The properties of 3G networks will not allow for reliable video streaming, whereas DAB could provide a viable alternative. Overall, mobile video will face too many obstacles, both technical and commercial, to become a mass market service on 3G.

5.3.4 Mobile Transactions

Mobile transactions will become a lucrative market. However, revenues will be derived from sources other than the end-user. Very limited opportunities exist for generating direct revenues. In the short-to-medium term some users will be prepared to pay for some services and applications that focus on enabling transactions, but in the long term we expect these direct revenue opportunities to sizzle out. The bulk of transaction-related revenues will therefore continue to be indirect.

Figure 47: Mobile transaction revenues split by revenue source
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Mobile Transaction Revenues in Europe
Split by Revenue Source



	1999	2000	2001	2002	2003	2004	2005
Referral Revenues Indirect (in €bn)	0.0	0.0	0.0	0.0002	0.03	0.16	0.48
Transaction Revenues Indirect (in €bn)	0.0	0.0002	0.016	0.048	0.29	0.94	1.98
Payment Revenues Indirect (in €bn)	0.0	0.0	0.0006	0.004	0.05	0.29	1.15
Payment Revenus Direct (in €bn)	0.0	0.0	0.007	0.02	0.27	0.38	0.31
Finance Revenues (in €bn)	0.0	0.2	0.129	0.47	0.81	1.81	3.12
Total in €bn	**0.03**	**0.20**	**0.31**	**0.54**	**1.45**	**3.58**	**7.04**

M-Tailing

M-Tailing refers to mobile transactions facilitated by or concluded with a mobile device. Mobile devices provide consumers with an additional channel for electronic ordering of products.

The killer applications in the mobile retail domain will be those that resonate most with the key advantages of the mobile channel: location-specificity, personalisation, and immediacy. Based on these factors, we predict that the most likely killer applications in the m-(re)tailing domain will include m-auctions, m-promotions, and other retail applications that are based on time-critical information and benefit from immediate response from the user.

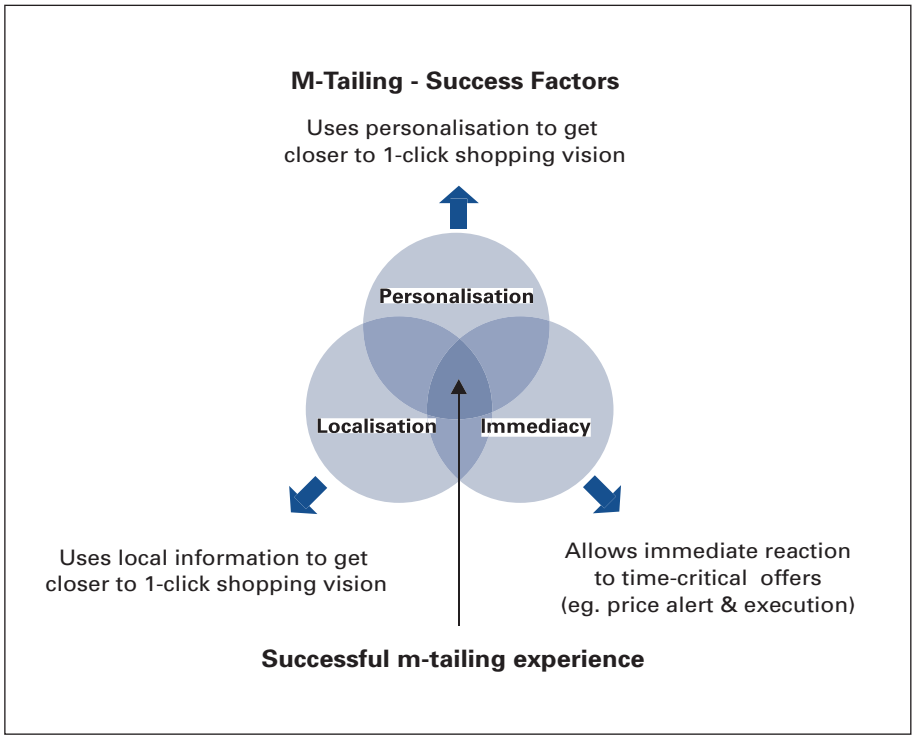


Figure 48: M-tailing success factors
Source: Durlacher Research Ltd./ EQVITEC Partners Oy

Mobile (re)tailing is best suited for impulse purchases and for situations in which instant product and price information is required. Examples of services amenable to the mobile platform include "in-store" price comparisons on CDs and appliances, movie ticket purchases, mobile auctions, and buying a CD after listening to a particular song. Shopping alerts and notifications of discounts and m-coupons complement such applications. WCL of Finland and network365 have developed independent m-tailing application bundles, which enable shopping across different technology platforms.

In the United Kingdom, Pricerunner.com offers an SMS service in which the user can request "best deal" information on home electronics, appliances, computers and phones or have price alerts delivered to him. This enables the consumer to carry out immediate "on-the-go" price comparisons while shopping. This information is provided at no additional charge over the price of the SMS sent. The service also includes WAP access to its product/price database. While the SMS service is an excellent idea, we believe that the WAP section of the service is not used very much.

Convenient mobile ticketing and reservation schemes will also enjoy significant success. Joe Network in the UK, for example, is offering an m-ticketing platform, which is based on SMS and uses the Categoric Xalerts engine to send tickets to user's mobile phones and to provide them with pushed event and pricing information according to their preferences. The company is planning to launch its service in the beginning of 2001, making it free to users and incurring a per-transaction fee from participating companies. Joe Network is targeting travel, film, music, sports and arts ticket vendors. In the future the company intends to expand its product offering to include Bluetooth technology for ticket validation.

A German company, Dynetics, is offering cineWAP, a complete cinema m-reservation solution, based on its proprietary *emoveo* platform, together with several convenient payment options, either through customers' monthly bill or through the services offered by Paybox.net AG. Platforms from Aspiro and Regisoft are emerging to offer tools for distribution, redemption and monitoring of electronic coupons and vouchers.

Airlines are starting to realize the potential of m-ticketing as well. Lufthansa, for example, developed a service concept called "Check-in evolution" that includes WAP-based check-in services for passengers. Users of this service have additional advantages such as booking a specific type of seat as early as 18 hours prior to departure and receiving updated information about flight times and boarding gates.

We believe that m-(re)tailing will become widely adopted in the market by over 130 million customers in Europe in 2005. However, it will not provide the most significant revenue source for the players with only €3.6 billion (payment fees, transaction fees, referral fees). This excludes the value of the goods and services purchased. We further believe that it is crucial that easy payment services are set-up up by either operators, or financial institutions or new intermediaries. Only applications that fully realise the value of immediacy and cater to time-critical or impulse needs will succeed.

Mobile Finance

Traditional and online banks view mobile data as an additional distribution channel for their traditional and online banking services. Many financial institutions are concerned that mobile operators will move into their territory by providing financial services to their end-users. Many financial institutions have therefore invested a considerable amount of money to prepare for the eventual growth of the mobile financial services market.

We believe that financial organisations are leading the industry in adopting a multi-channel commerce strategy. The financial institutions are dealing with more and more commoditised products that create more value as they are increasingly handled in a digital way, i.e. without the involvement of real human beings. Adding digital channels such as mobile will clearly help to shift further tasks towards the customer through self-provisioning and thus, will help cut operational costs.

Three main types of players have emerged in the mobile financial services market. The first and largest group consists of traditional North American and European banks and brokerages such as Bank of Montreal (Canada), Deutsche Bank (Germany), Merita-Nordbanken (Finland/Sweden) and the Woolwich Bank (UK). Pure online banks and brokerages such as Cahoot (UK), E*Trade (US), and Consors (Germany) comprise the second group. Technology enablers, such as 724 Solutions, Aether Systems, w-Technologies, Finansium and Brokat Systems, are the third group that have developed the majority of mobile financial services available today.

Capitalising on high mobile and internet penetration rates in the Nordic region, Scandinavian banks were the first to offer SMS and WAP based mobile banking services. Merita-Nordbanken introduced SMS mobile banking solutions in Finland back in 1996. Today, most major Nordic banks offer complete WAP services, including mobile transaction services, WAP equity trading, and mobile access to account information.

In other regions across the world, financial institutions have approached mobile banking with limited success. Most have only recently begun to offer mobile banking services to customers. However, there are few distinguishing features among the majority of current mobile banking services. The majority of mobile financial services offered today can be divided into three main areas:

Mobile Banking

- Account balance and transaction history
- Funds transfer
- Bill payment
- News and other information

Mobile Brokerage

- Stock trades and quotes
- Alerts and notifications
- Portfolio Management

Mobile Insurance

- Insurance on demand (e.g. ordering travel insurance at the airport via a mobile device)
- Customer care and related information

Financial institutions will have to distinguish themselves by offering value added applications and services and by implementing robust CRM systems. Recently, SAIC, Corillian and Compaq partnered to create E-Bank ASP, which will enable data mining, targeted marketing, and customer relationship management for financial institutions. In addition, E-Bank intends to incorporate a complete view of the end customer by integrating all customer touchpoints. Applications are also being developed that incorporate new technologies such as voice enabled content and intelligent agents. Artificial Life has developed applications that use intelligent bots to assist customers in making informed investment decisions. Future applications that permit micropayment options and mobile ATM access will be beneficial for users too.

There is significant competition within the mobile financial services industry. Players that focus on delivering user-friendly, and quick to execute value-added services will be auspiciously positioned. Services such as mobile stock trading and mobile access to account information are best suited for mobile use as they focus on the advantages of mobile data solutions, delivering time-critical, relevant and often high value services.

We believe that all financial institutions will have to implement a forward-looking strategy and provide multi-channel access or disappear within the next five to seven years. Customers will learn to raise their expectations of the minimum service set.

Mobile Payment

A mobile payment system is defined as a method of payment that requires or enables the use of a mobile device to conduct financial transactions. There are two main mobile payment solutions available for customers, 3rd party virtual clearing solutions and smartcard solutions.

3rd party virtual clearing is a flexible mobile payment solution that does not require any major changes such as middleware or device implementation when it is installed in the existing business infrastructure of the implementing company. This is because third parties are used to verify and carry out the transaction. There are several start-ups within the virtual clearing space that have struck partnerships with larger players to carry out this third-party function.

Paypal, for example, is a free person-to-person payment service by X.Com that enables the user to collect and send money instantly and securely to anyone with a WAP e-mail phone. Paybox.net AG has aligned itself with Deutsche Bank to provide a simple payment solution in which the user can pay an invoice with a simple 2G mobile phone (via SMS) and an existing bank account. Payitmobile AG partnered with Gesellschaft für Zahlungssysteme (GZS), a German credit card clearing house, to provide a similar mobile payment service by using the WAP technology. Sonera Mobile Pay provides a solution for the purchase of small

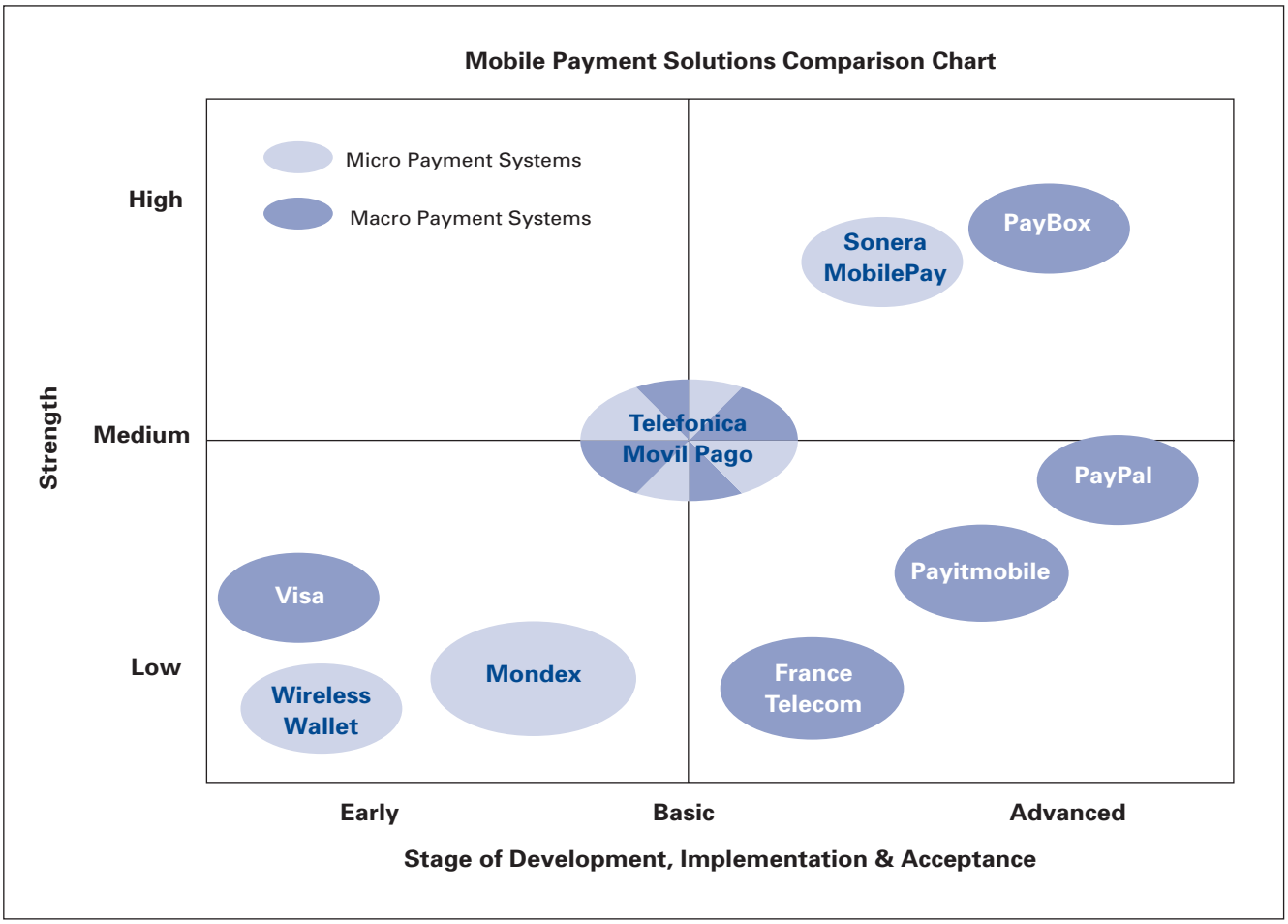
transaction quantities or micropayments. Customers can use a 2G mobile phone to dial premium rate numbers, displayed on vending machines for instance, to authorise payment for goods and services. These payments are then added to the monthly phone bills. In Japan, NTT DoCoMo has enabled similar micropayment options via its i-Mode service for conducting mobile commerce (only for officially registered sites) where customers can purchase smaller items that are added to their monthly mobile phone bills .

Smartcard mobile payment solutions differ from 3rd party virtual clearing in that they require changes in the business infrastructure of the implementing company. For security purposes, smartcard solutions integrate a dual slot reader for external smartcards in mobile phones. These changes require extensive modifications for existing mobile devices. As an example, France Telecom has offered a smartcard solution through Paiement CB sur Mobile. Visa has partnered with Nokia and Merita-Nordbanken to develop an open platform that enables customers to pay securely via Secure Electronic Transaction using a second smartcard within the phone. However, it should be noted that no commercially relevant smartcard solution has been implemented to date.

There are a number of mobile payment platform enablers that provide integration to companies' enterprise systems, enabling them to offer mobile payment solutions to customers. Such companies include Netlife, Brokat Systems, Wirecard, Atos, and Trintech. Brokat of Germany provides a modular e-service platform called Twister, which provides secure online and mobile payments via web, WAP and SMS.

Primary constituents active in the mobile payment arena include; mobile network operators (e.g. T-Mobile International, Telefonica, Vodafone Group, etc.), device manufacturers (e.g. Nokia with Visa), banks (e.g. Deutsche Bank with Paybox.net AG), and credit card companies (e.g. Visa, Eurocard/ Mastercard) as well as a plethora of smaller start-ups, e.g. Wiredcard and Thyron (who are trying to create mobile payment standards).

Figure 49: Comparison of mobile payment solutions
Source: Durlacher Research Ltd., EQVITEC Partners OY



We believe that the potential size of the mobile payment market and revenues from transaction fees and airtime charges will be substantial, generating almost €1.5 billion by 2005. Mobile payment satisfies a number of key criteria necessary for the success of applications in the mobile internet world. Mobile payments enable immediate payment anytime and at any location. They provide direct access to personal accounts and profiles. Mobile payments are convenient in that they provide cashless capabilities and add functions similar to credit cards. Mobile brokerage and banking have already experienced reasonable success and will become an increasingly user-friendly option for consumers once current networks are upgraded to GPRS.

The long-term success of mobile payments depends on a variety of factors. Security concerns from consumers will need to be allayed by implementing adequate measures and building confidence and trust in mobile payment providers. International billing capabilities and acceptance issues will need to be resolved by network operators and credit institutions. User-friendly navigation and attractive pricing schemes will be crucial to ensure widespread consumer adoption.

The mobile payment industry will see significant competition from various large players within different industries. Mobile network operators, financial institutions, and device manufacturers will all attempt to provide the preferred mobile payment option for consumers. Current offline and e-payment business models are threatened by the mobile internet – as networks and payment methods improve, more consumers will conduct transactions from mobile phones. Many partnerships have been established and we will see more globally to support coverage and acceptance of different payment options. Smartcard solutions provide a high level of security, but universal acceptance still needs to be achieved.

Easy to use solutions such as that provided by Paybox.net AG have been successful in 2G environments, but will need to secure retailer acceptance and improve security. Network operators are moving aggressively into the mobile payment market. They will provide micro-payment options for their customers (e.g. pay-by-GSM) and collect charges for purchases made on their monthly mobile phone bill.

Due to the widespread acceptance of Visa and Eurocard/Mastercard across the globe, credit card companies are enviably positioned to extend their influence in the mobile payment world. They possess a worldwide network and a proven international billing and charging system. However, the mobile payment system that requires the least number of parties to be involved and the least hardware modifications is likely to win the race for dominance. We believe that we will see joint ventures and even M&A activities between mobile operators and established financial institutions. This development will speed up the acceptance of mobile payment services by offering integrated (mobile-, web-based-, offline-, micro- and macro-) payment services to their customers.

However, the issue of mobile payments for prepaid mobile phones has so far not been solved. The mobile payment market is still at a very early stage and no solution has yet clearly been proven beyond small trials. We believe that PKI infrastructure must be adopted and pushed by the operators as it provides the basis for the future m-commerce, and can be used to generate revenues from 3rd parties too. Although a large number of players are devoted to tackling the mobile payment market, a clear winner is yet to emerge. We believe that a winner must create a very flexible, easy to use solution for mobile payments.

5.4 BUSINESS SERVICES

- The mobile business services market, though getting less publicity than the consumer services market, will be significant by the year 2005, generating revenues of about €6.0 billion with by far the largest share of it coming from mobile office solutions.
- Larger software vendors such as Microsoft, Lotus, SAP, Siebel and Oracle that provide the majority of enterprise applications are best positioned to dominate the mobile business applications market with standard mobility kits for their existing software. However, it has taken them very long to develop marketable products. To gain a foothold

in the market, these larger players will need to partner with promising ASPs, established SIs and consultancies.

- On the CRM side, larger players such as Siebel and SAP will continue to focus on integrated, multi-channel solutions, but this will require more than just straight-forward adaptation of the standard software.
- Mobile SCM will not create a paradigm shift like the internet, but will be an important enabler of the evolution towards streamlined and optimized business processes.
- We believe that synchronization between different devices and technologies will enhance productivity and mobility of employees. Middleware providers that can link various devices to back office systems seamlessly will be well positioned to profit from the growth of the mobile business applications market.

Applications have always existed to assist businesses to achieve competitive advantages in terms of saving costs or realizing revenue opportunities. Mobile technologies have the potential to enhance an organisation's processes and interfaces by making them available anywhere at any time.

In a very fragmented business application market, we have identified three major segments positioned to gain significantly from mobile technology:

- customer relationship management (CRM), comprised of applications that deal with partners, businesses and end customers,
- supply chain management (SCM), primarily dealing with business suppliers,
- workforce applications (mobile office) targeting the employees within the organisation.

Below, we will examine how mobile functionality can be applied to these business processes and which emerging applications are positioned to be successful.

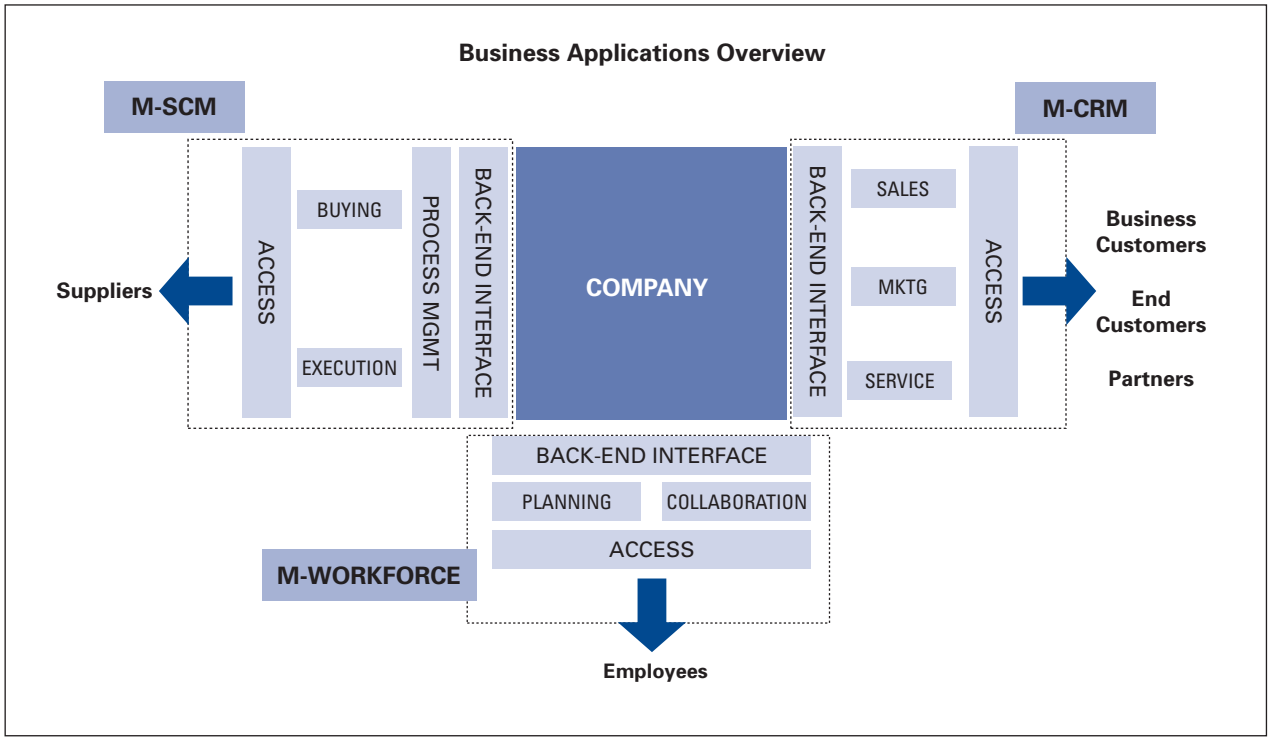


Figure 50: Business applications overview Source: Durlacher Research Ltd., EQVITEC Partners OY

5.4.1 Mobile Customer Relationship Management (M-CRM)

Customer relationship management (CRM) solutions are designed to enhance an organisation's customer-facing functions such as sales, service and marketing. They have the potential to increase revenues, customer satisfaction and profitability.

The impact and uptake of internet-enabled CRM applications has been impressive, and we believe the mobile internet will further enhance the viability of the internet as a customer-facing channel. Mobile CRM enables current systems to extend existing services and transactions through mobile devices. Such solutions open up opportunities for creating entirely new products and unique mobile customer services.

We believe that

- mobile CRM revenues are and will remain a small portion of the overall multi-channel CRM market.
- large established players will continue to focus on the full spectrum of CRM, delivering integrated multi-channel CRM solutions that are beyond the scope of start-up companies.
- the mobile CRM market will be pushed towards consolidation as larger vendors will seek strategic acquisitions to provide a more comprehensive product offering.
- e-CRM vendors such as E.piphany will succeed by pursuing partnerships to deliver an integrated CRM offering.
- start-ups will be able to succeed by offering highly specialised vertical applications.
- there will be opportunities for solution providers and integrators since CRM vendors cannot provide the link to mobile telecommunication infrastructure.

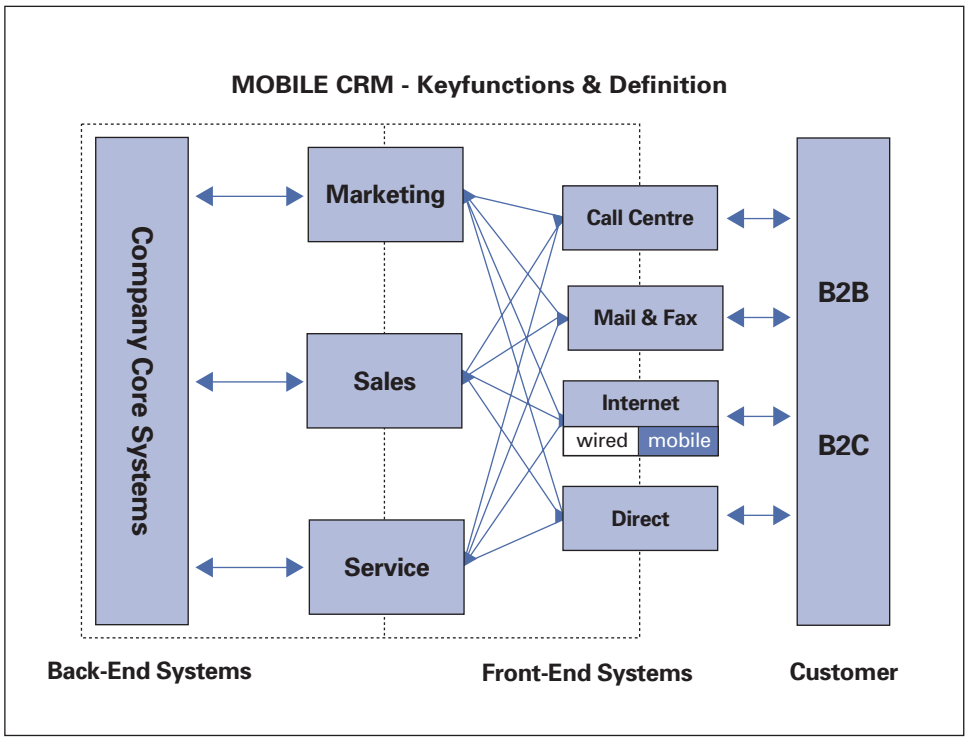


Figure 51: Mobile CRM – key functions and definitions
Source: Durlacher Research Ltd., EQVITEC Partners Oy

Figure 51 depicts the marketing, sales and service functions of CRM that gather end customer interactions from various end-customer touch points into a single database to market products and services based on end customers' preferences.

Marketing function

The marketing function of CRM involves aggregating all interactions conducted by the end-customer from different channels into an integrated data repository used to generate promotional and marketing campaigns based on end-customers' preferences.

Businesses will need to manage end customers' interactions conducted from mobile devices and incorporate the information into their customer profiles. Larger e-CRM vendors have

recently started to develop solutions for the mobile marketing function. But it will take them at least until early 2002 to put those successfully in operation.

E.piphany, a leading online CRM vendor, recently partnered with Brience, a company that provides a universal delivery platform, to extend E.piphany's CRM enterprise wide functionality to mobile devices. E.piphany's web-based CRM system provides intelligent customer interaction solutions driven by customer interactions, campaign management, and real-time personalisation to reach all customer touch-points and deliver a unified customer profile.

Companies such as Volantis Systems and Brience have developed flexible software platforms that enable businesses to easily and rapidly extend their enterprise applications to any internet-enabled device while preserving a rich and consistent user interface.

Another company operating in this space is Room33, a Swedish based start-up, which provides one-to-one permission-based mobile marketing capabilities to businesses. End customers can receive targeted products and services through customer loyalty programs or competitions.

Sales function

The sales function of CRM systems focuses on sales force automation (SFA) to coordinate sales efforts and provide easy to use tools for representatives in the field. A wide range of solutions has been developed for mobile access to enterprise systems as mobility plays an increasing role in streamlining business processes and increasing customer loyalty.

Popular applications include contact details, appointments, order history and confirmation, special pricing, real-time availability of goods and resources, and delivery confirmation. More advanced systems incorporate more detailed information on customers such as product and policy information. For example, Rissa Solutions enables mobile extensions to online ERP systems integration, catalog management and corporate business portal management with mobile clients (PalmOS, WAP, EPOC).

We believe that large players such as Siebel and SAP are best positioned to capitalise from this market segment. They have recently moved forward into the mobile solution market, have existing installations of systems, and have the resources to wirelessly enable thousands of employees on enterprise wide systems.

We also believe that investment opportunities will arise in niche players who will be able to develop highly specialised applications for vertical segments.

Service function

Service features available on mobile devices include accessing information regarding product problems, job details, and technical specifications. Significant value can be added to traditional service applications by mobilising these features.

Mobile service functions differ from mobile sales functions as they are not interactive and actionable, but rather provide static information and notifications to field sales operatives. An area where mobile service functions provide value is in the provision of self-service help features similar to the help sections of web sites. Self-help features are particularly useful for businesses that market products and services directly to end customers and could be established as a sub-set of online help features.

Customers, for instance, could access delivery information for products on their mobile devices. The majority of players in this market segment comprise larger players such as Oracle, who will continue to dominate the segment. There are several start-ups currently offering applications for this segment, such as AvantGo, based in the US, which provides a rapid deployment platform for extending CRM applications to the mobile world. AvantGo offers applications such as service dispatching to field service representatives, particularly for transport logistics solutions, in the U.S., but has made little impact so far in Europe.

5.4.2 Mobile Supply Chain Management (M-SCM)

The emergence of the internet and the development of e-marketplaces and e-business hubs has had a dramatic influence on the supply-side function of enterprises across all industries, in which the mobile channel will be of assistance. Markets have enabled companies to purchase, fulfil and ship orders more efficiently.

We have identified the following M-SCM connectivity and visibility-related applications that are most likely to benefit from mobile technology;

- mobile data collection applications
- mobile alert generation applications
- mobile-enabled integrated SCM applications

Areas where mobile technology could add significant value to existing SCM systems are limited to intelligent alert generation, primary data collection, and gateways to enterprise-grade messaging backbones. Positioning technologies are another important enabler for improving supply chain visibility.

Intelligent alert generation systems will be an important complement to workforce messaging applications and would be focused on developing flexible business rules and managing multi-channel user communication.

Mobile data collection applications will be developed, but not exclusively, for GPRS or UMTS. Enterprises will pragmatically use the most efficient technologies for a given task such as WLAN or other up and coming standards.

Data Collection Applications

Primary data collection is an important enterprise function that spans across the entire organisation. The quality and accuracy of primary information affects planning and forecast applications and inventory applications, and enables transactions to be conducted in a faster, more controlled way. There are several areas where mobile technologies could contribute to better results:

- Barcode Scanning
- RFID (Radio Frequency ID)
- Location-Stamping
- M2M Applications

The first mobile-driven innovation to emerge in this area of item coding was the handheld barcode scanner equipped with a radio interface. Such solutions primarily use WLAN technology as the radio interface. However, in a global context UMTS may be considered too. Some of the pioneers in the field of wireless barcode scanning are Symbol Technologies and Proxim. Symbol Technologies was one of the first to introduce a Palm device with an integrated barcode reader. This is used, for example, in the transportation logistics industry, where they provide scanning technology to collect real-time information from companies' distribution centres and consolidate this via a wide area network for tracking purposes. AirClic, a start-up funded by Ericsson, Motorola and Symbol, is currently developing a wireless barcode scanner that will connect to the internet and to corporate databases in real-time. AirClic will initially target small businesses: "In basic terms, we're like a large switch that'll route millions of requests every day for information driven off scans". Barcode scanning is popular for field-related processes such as order booking and tracking, where a standardised and flexible data standard is of benefit, although opportunities in the consumer market also exist.

RFID is a technology that is better suited for standardised enterprise processes. It attempts to further automate processes by offering the ability to collect data (equivalent to barcodes) without having to be in immediate contact with the item. Items to be tracked are equipped with special tags. The reader device then polls the tags in the area and receives replies over a proprietary radio interface. One of the leaders in this field is Intermec that uses RFID tags for its WLAN-based inventory management solutions. However, RFID lack unifying coding standards and this will need to be resolved before the technology can be used across, for example, different enterprise logistic systems.

Positioning technologies such as GPS are an important complement to different item coding technologies such as RFID or barcoding. They make the collected data richer and provide a location context. Automated location stamps are an important piece of information to collect, for instance, in logistics and fleet management applications to reliably track the position of the item in question. For example *OrchidTrack* – a service from Global Telematics, offers end-users a way to track their vehicles via a WWW-based interface. The vehicles will need to be equipped with a special device that consists of a GPS receiver and a GSM transceiver.

Another important set of applications comprises machine-to-machine (M2M) monitoring. Such systems routinely retrieve a set of parameters from a given device such as a vending machine, a car engine etc. and sends them to a data collection device. For example, a company called Vetronix in the US offers an automotive diagnostic solution. It collects information from a variety of analogue probes, encodes it and sends it over an air interface such as GSM, AMPS or ReFLEX.

Alert generation applications

Information collected from primary data sources has to be communicated to decision-makers and fed into respective enterprise systems. Alert generation applications can deliver timely and actionable alerts to corporate mobile employees. The key properties of such systems should include:

– connectivity to enterprise systems

– ability to create flexible business rules that trigger messaging events

– ability to deliver information intelligently through a variety of channels

– interactivity features that allow the user to react to specific alerts in a predefined way

The following scenario demonstrates the functionality of such a messaging system in an enterprise context. The barcodes of packages to be delivered for an organisation are scanned at a warehouse as they are loaded onto a truck. The data is wirelessly entered into the company's logistics monitoring system. This triggers an event that generates an alert for the manager. It sends a notification that the products will not be delivered on time. The alert arrives at the manager's e-mail address, and a headline is also sent to his mobile phone in the form of an SMS headline. The manager dials into his company's unified messaging server and has the alert read out to him. A typical system providing such functionality is *XALERT* from Categoric Software. It offers interfaces to most popular ERP systems and includes an intelligent routing platform that can forward messages over WAP, SMS, E-Mail, fax and voice.

We believe that alert generation can make employees less dependent on physical spaces when remote interaction is possible.

Mobile-enabled integrated SCM applications

To reap the maximum benefits of SCM technology, enterprises have to enable their suppliers to access the same SCM technology. For example, a solution such as Descartes *DeliveryNet* integrates all of an enterprise's suppliers on a single messaging backbone, with unified data interchange standards, increasing supply chain visibility and efficiency.

This integration is a very important enabler for the emergence of e-marketplaces and, ultimately, e-hubs as well. B2B hubs are centrally hosted applications that can integrate a multitude of supply chains in a hosted environment. An example of a centrally hosted SCM application is the Global Logistics Network also provided by Descartes. It offers supply chain visibility functions integrated with a fulfilment and delivery marketplace. A single point of connection to the network can be established through the internet, a VPN, a WAN or mobile devices using WAP and SMS alerts.

The integrated approach allows many organisations to reap the efficiency benefits of SCM on a single platform that includes all the key elements.

5.4.3 Mobile Workforce Applications

Mobile workforce applications facilitate communication of business processes to mobile employees through services such as planning, connectivity and collaboration. Among the pioneers of this segment were CCC Mobile, who were involved in the development of the first such applications for the Nokia Communicator platform. Continuous innovation on different levels has led to the emergence of many different devices and standards for retaining and exchanging planning and collaboration data.

As more and more mobile-enabled devices become available, integrating the data from different sources such as PCs, PDAs and smartphones is becoming of increasing importance. SyncML – a data synchronisation protocol that defines the communication flow for a data synchronisation session – is the key enabler for this process. We believe that the true importance of synchronisation will be realised in combination with bearer technologies such as Bluetooth and WLAN, that allow wireless device synchronisation at speeds of up to 721 kbps and 2 mbps respectively. We also believe that synchronisation will be a key area of development until the year 2004, when the issue will be resolved to a large extent.

Branded service providers deliver basic personal productivity functionality in the form of calendaring, scheduling and collaboration applications built around a messaging interface, usually e-mail, and some model of outsourced storage. Such solutions are ideal for managing small projects in the SoHo and to an extent in the SME environment.

We believe the majority of mobile office applications will not require intensive bandwidth speeds. GPRS will provide adequate bandwidth for these applications. The potential constraints lie in the poor device functionality and lack of integration with back office systems.

Large corporate organisations will rely on the strategies of top software players and links to their products, including *Lotus Anywhere* and Microsoft *Mobile Information Server*. These firms will experience fewer problems with devices as they can implement proprietary offerings.

On the other hand, we believe that SMEs will deploy the services of ASPs and outsource the majority of their applications. ASPs are also dependent on the offerings of top software players. However, due to the lack of proprietary systems, SMEs will be subject to the limitations of device functionality.

We believe that the mobile office space provides tremendous potential to increase the personal effectiveness of employees that are mobile. However, the offerings must provide a total solution to corporate customers as the concept is rather complex to implement and requires significant system integration.

6 INVESTMENT OPPORTUNITIES

In the following chapter we have composed our views on investment opportunities in the mobile data space. We have allocated specific time periods to potential investment areas which we believe will emerge either in the short term or mid term. Investments in the indicated areas should be made within the given time period to maximize benefits from the growth of specific markets. Determining potential winners in the long term is even more challenging as early indications of the growth of the mobile data market have been rather disappointing.

In general, the roll-out of new networks and the upgrading of existing 2G to 3G networks provides significant opportunities for investment in vendors of hardware such as RF, IP access, base station module and antenna technologies. Additionally, IP billing and network management solutions will be in high demand.

4G technologies: > 24 months

Opportunities exist for technology companies involved in the research of 4G technologies that will lead to higher data rates and more efficient use of the spectrum. We believe that 4G infrastructure will emerge before 2008, but from an investment perspective, will remain a high risk proposition. Until major industry players establish standards and determine how large the mobile data market will be, 4G will continue to be a long term investment objective.

Alternative wireless infrastructure technologies: 12 - 24 months

Alternative wireless infrastructure technologies such as public WLANs and Bluetooth implementations offer several opportunities such as flexible point of sale infrastructure integration, provision of payment solutions and indoor data transfer solutions. We predict that these technologies will emerge simultaneously with UMTS infrastructure and will create a substantial market for indoor applications.

Applications in ASP mode: < 12 months

We believe in the success of the ASP model as it addresses the needs of several important categories of market players. We believe that most software vendors will need to offer WASP solutions, either by themselves or through partners. This will provide significant investment opportunities in the creation of WASPs. WASPs will take new innovative applications and technologies and turn them into solutions that are optimized for MNOs, VOs and enterprise clients. WASPs need strong technical competence and understanding of their customers' business processes to provide added value.

Bluetooth applications: 12 - 24 months

Bluetooth will significantly increase the usability and success of all mobile technologies. It provides a good investment opportunity for the next two years, especially for those companies that develop appealing applications. Ad hoc networking solutions using Bluetooth or WLAN technologies for person-to-person file transfers, payment solutions and identification will be viable once enabling chip technology reaches the market and interoperability between different manufacturers' products is achieved. Application platforms are required for both the terminal and counterpart solutions.

Business application platforms: < 12 months

Business application platforms for operations enhancement and integration to legacy systems will be among the highest growth segments in the mobile data market. Application platforms for Intranet application extensions such as corporate white pages and e-mail will be popular.

Commerce platforms: < 12 months

Commerce platforms remain a compelling opportunity. They are required for transaction tracking and generation of billing information – without these systems m-commerce would not be possible. Therefore, any player willing to extend its reach to the mobile markets needs either its own platform or access to an external source. Therefore, the market size for these platforms will expand rapidly as technology becomes available. Solution providers still have time to fine-tune their offerings for next generation systems.

Compression and decompression technologies: 12 - 24 months

Efficient compression and decompression technologies to optimise storage and processor capacity consumption are key components in the future multimedia market. In the beginning (2003-2004), animation and slideshow type content are the most likely to succeed in the mobile multimedia space. We believe that MPEG4 will become the standard storage and delivery format for video applications. Technologies capable of efficiently offering this type of content, taking into account the limitations of the terminal and the requirement for high usage times, will be among the winners of the multimedia market. Packaging technologies for file transfers or even browsing applications have sufficient value as they ease traffic and utilise the transfer spectrum more efficiently.

Device Components: < 12 months

Device technology will remain the key constraining factor on the development of the mobile data market, as the technology is still largely under development. We do not expect performance of these components to improve beyond the pace that is set by the big vendors that dominate this space.

The inevitable growth of the terminal market provides opportunities for innovative companies who can improve different modules of the device. Particularly crucial are battery, display, processing and memory technologies for next generation systems. Additionally, companies that can offer improvements on the usability of terminals and services will be important for the development of the whole market. Developing specialised modules for devices is a growing area of opportunity for smaller companies and we expect that focussed specialists will occupy niches over the next three to four years.

GPRS optimized applications: < 12 months

Considerable investment opportunities will emerge for GPRS mass market applications, an area which has been neglected as many developers still focus on WAP.

Health hazard applications: 12 - 24 months

Health issues are an increasing concern of the public, which potentially offers investment opportunities in the form of lower emission devices and earpieces, more sector specific antenna technology and protective casings and covers.

High end middelware: < 12 months

There will be opportunities for platform-specific functionality, including opportunities in the area of creating advanced, high-end middleware technology such as authentication servers, location servers or database connectors.

IP billing solutions: < 12 months

IP-billing solutions and/or platforms already offer a significant value proposition in the data communication world. The increasing number of data customers pose a challenge to the capabilities of current solutions, which is likely to trigger a new round of investment in billing solutions. Advanced pricing models require sophisticated IP billing solutions with smart rating engines that can price or tag anything. The space provides significant potential returns for the providers of IP billing technology as well as for the services side surrounding it.

IPv6: 12 - 24 months

We believe that on the transport and addressing layers of the network, convergence will most likely occur around the next generation IP protocol – IPv6. The new IP will integrate all connected devices in the same address space, within a unified end-to-end architecture.

Location-based applications: < 12 months

We believe that location-based applications will be implemented by most operators, making the market finite but valuable.

M-Advertising platforms: 12 - 24 months

M-Advertising (downstream messaging) applications present one of the largest potential revenue sources within mobile technology as they can utilise key network capabilities that are not available in any other media. We believe that advertising platforms will become important once networks and terminal equipment can support richer applications and location detection, and user profiling becomes available. Furthermore, we see attractive opportunities in the mobile advertising concept as advanced downstream multimedia messaging develops in the more distant future.

Mesh technologies: 12 - 24 months

Mesh network technologies show considerable promise and should be monitored for upcoming start-up activity.

Mobile emergency services: 12 - 24 months

We believe that mobile emergency services provide interesting revenues and lucrative business models mainly operated in a WASP mode. It is a market which has been largely neglected so far but the availability of positioning signals will make it attractive. Individual tracking services like child tracking will be successful in the medium term. Mobile telemedicine and patient condition monitoring are lucrative but highly specialised vertical market opportunities.

Mobile gambling: 12 - 24 months

Mobile gambling is also an attractive market and many parallels can be drawn with gaming applications. However, since this market is heavily regulated, there will be less start-up activity from new players.

Mobile gaming services: < 12 months

Whilst investment in the mobile games IPR is potentially highly rewarding, it will also become highly risky as competition from mainstream games developers and publishers starts to emerge. The most attractive opportunities lie at present in the most advanced games platform providers and in mobile games publishers that have secured valuable mobile games rights.

Mobile multimedia messaging: < 12 months

Providing solutions for mobile multimedia messaging is an attractive investment area. This market is largely untapped, but has great potential. We believe that mobile multimedia messaging will take off in the form of applications that offer customisable pre-made content, similar in nature to customisable postcards available on the Internet. Multimedia messaging will also move the mobile world one step closer to internet messaging, serving as a base for better interoperability between messaging systems such as e-mail and ICQ.

Mobile workforce applications: < 12 months

We believe that mobile office applications have tremendous potential to increase personal effectiveness of the workforce. However, the offering must provide a total solution to corporate customers as the concept is rather complex to implement and requires significant system integration.

Multimode devices: 12 - 24 months

Multi-network environments will emerge over the next five years, triggering demand for multimode devices.

Profiling tools: < 12 months

Profiling tools and platforms beyond caller groups and situation profiles are required on both devices and at the service-end to increase the relevance of interactions between customers and content. In the near term, advanced bot and agent technologies are well worth observing.

Roaming solutions: < 12 months

The roaming market provides opportunities for software companies with innovative solutions that help to tackle GPRS and UMTS issues faster than solutions of administrative bodies, which currently set the pace.

Security technologies: 12 - 24 months

Security technology presents a clear value proposition in the network technology sector. Both tunnelling and encryption technology can be used to increase security which is essential for businesses with intranet solutions as well as customers who need to trust the technology to conduct transactions. We believe that PKI will become the security solution of choice for many. Solutions must be compliant with up and coming standards, including those developed by Radicchio, mSign and Mo-Sign.

Technology Enablers: < 12 months

We believe that there will be opportunities for technology enablers of multi-access platforms. It is important to design solutions that work across networks to ensure full versatility. Multi-access platforms will shift their focus from network and/or IP traffic translation to high-level multi-channel translation of single source content for different device types. One of the key drivers of this evolution will be the widespread adoption of XML as the common data mark-up language and rendering standard.

Vector graphics: < 12 months

Vector graphics have revolutionised image rendering and transfer because it allows high-quality, interactive graphics and animations to be stored in small files. This technology is therefore important for mobile devices and enables services like mobile postcards. They will also improve user interfaces.

Voice recognition technologies: 12 - 24 months

Improved voice recognition with enhanced performance allows multiple usage modes for hands free and earpiece use. More importantly, in the future of multimedia applications, sound is an inherent part of the experience and has to be available as high-end terminals are rolled out. The challenges lie in producing adequate sound quality, output capability and weight specifications.

White label MVNO: < 12 months

A number of players from different industries will explore the opportunities of an MVNO strategy to expand their business. This will create demand for the services of white-label MVNOs, because of their ability to offer "out-of-the-box" service to new entrants. This is the only niche in the SP and MVNO market where startups have a space to succeed. We see increasing demand for VO operation enabling platforms that act as billing solutions as well as roaming facilitators.

7 APPENDIX

7.1 COMPANY PROFILES

Company name: **12Snap**
Web site: www.12snap.com
Country: Germany
Company profile: Offers mobile auction platform using different technologies (SMS, voice and cell broadcast).
Private/Public: Private

Company name: **3G lab**
Web site: www.3glab.com
Country: UK
Company profile: Offers an open-source SMS and WAP gateway and services to support it.
Private/Public: Private

Company name: **3ui.com Pte Ltd**
Web site: www.3ui.com
Country: Singapore
Company profile: Offers advanced middleware solutions for simple WAP services, WAP-compliant push and e-mail access.
Private/Public: Private

Company name: **724 Solutions**
Web site: www.724.com
Country: Canada
Company profile: Offers a complete secure payment platform for wired and wireless, also through a WASP model. Strengthened its mobile data capabilities by acquiring Tantau.
Private/Public: Public

Company name: **ActiveSky**
Web site: www.activesky.com
Country: US
Company profile: Offers proprietary client and server software for delivering multimedia over wireless networks. Supports Pocket PC, Palm and EPOC platforms.
Private/Public: Private

Company name: **Advertising.com**
Web site: www.advertising.com
Country: US
Company profile: Offers solutions for conducting and evaluating targeted interactive e-marketing campaigns across a variety of channels including mobile.
Private/Public: Private

Company name: **Aether Systems**
Web site: www.aethersystems.com
Country: USA
Company profile: Offers services, software and hosted infrastructure for mobile commerce and messaging.
Private/Public: Public

Company name: **AirClic**
Web site: www.airclic.com
Country: US
Company profile: A technology that enables customer wireless devices to read barcodes and pull information and services basing on the code read. This technology is designed to speed up user data input for commerce-related applications.
Private/Public: Private

Company name: **AirLink Communications**
Web site: www.airlink.com
Country: US
Company profile: Offers wireless connectivity products, conducts research into high-bandwidth OFDM solutions.
Private/Public: Private

Company name: **Akumiitti**
Web site: www.akumiitti.com
Country: Finland
Company profile: Offers a range of mobile data solutions: Entertainment Service Centre - an easy to deploy integrated software suite for delivering icons, songs and melodies to mobile devices; software for building SMS services; telematics solutions.
Private/Public: Private

Company name: **Aluminium Power**
Web site: www.aluminiumpower.com
Country: Canada
Company profile: One of the leading providers of commercial fuel-cell technology. Fuel cell solutions are based on solid state fuel (aluminium). The company has developed solutions specifically for the mobile device market.
Private/Public: Private

Company name: **Argo Group**
Web site: www.argogroup.com
Country: UK
Company profile: Offers wireless middleware for device-independent content delivery and content conversion.
Private/Public: Private

Company name: **Artificial Life**
Web site: www.artificiallife.com
Country: US
Company profile: The company specializes in creating smart interactive bots, capable of carrying out intelligent tasks in electronic commerce and for mobile data environments.
Private/Public: Public

Company name: **Aspective**
Web site: www.aspective.com
Country: UK
Company profile: Delivers fully integrated multi-channel e-business solutions through an ASP model.
Private/Public: Private

Company name: **Aspiro AB**
Web site: www.aspiro.com
Country: Sweden
Company profile: Offers packaged solutions for enterprises – ranging from white-label portals to complete solutions.
Private/Public: Public

Company name: **AvantGo**
Web site: www.avantgo.com
Country: US
Company profile: Offers a platform and content for delivery to mobile devices. Provides solutions for mobilizing enterprise applications.
Private/Public: Public

Company name: **AVS**
Web site: www.avstechnologies.com
Country: Finland
Company profile: Offers java-based solution for multimedia broadcasting over IP with very low requirements for decoding on the receiving terminal.
Private/Public: Private

Company name: **Baltimore Technologies**
Web site: www.baltimore.com
Country: Ireland
Company profile: A security company that focuses on mobile data. Provides PKI systems, cryptographic toolkits, security applications and hardware.
Private/Public: Public

Company name: **Bantry Technologies**
Web site: www.bantry-technologies.ie
Country: Ireland
Company profile: Offers smart-card based platforms for banking and e-commerce and a WIM (Wireless Identification Module) platform. Developed a MobiGamble solution for secure mobile gambling.
Private/Public: Private

Company name: **Brience**
Web site: www.brience.com
Country: US
Company profile: Provides middleware/content transformation tools that link enterprise systems and data services to a variety of access channels such as fax, phone, internet and others.
Private/Public: Private

Company name: **Brokat Systems**
Web site: www.brokat.com
Country: Germany
Company profile: Provides a Twister platform for e-services and transactions that includes mobile signature functionality. Also offers consulting and system integration services in partnership with Sun Microsystems.
Private/Public: Public

Company name: **BskyB**
Web site: www.sky.com
Country: UK
Company profile: Provider of sports, movies, entertainment and news, who is now also expanding into the area of content delivery for mobile devices.
Private/Public: Private

Company name: **Cahoot**
Web site: www.cahoot.com
Country: UK
Company profile: Multi-channel e-banking provider. Service is currently available for WAP and wireline internet, planned to be expanded to digital TV in the next year.
Private/Public: Public

Company name: **Cambridge Positioning Systems**
Web site: www.cursor-system.com
Country: US
Company profile: Offers network-based positioning technology (E-OTD) called Cursor and a set of tools for location service-based application development called Coverge.
Private/Public: Private

Company name: **Capslock**
Web site: www.capslock.fi
Country: Finland
Company profile: Offers infrastructure for building secure services for a variety of mobile devices.
Private/Public: Private

Company name: **Categoric Software**
Web site: www.categoric.com
Country: USA; UK
Company profile: Offers a system for generating event-driven alerts for a variety of communication channels including mobile.
Private/Public: Private

Company name: **CCC Mobile**
Web site: www.ccc.fi
Country: Finland
Company profile: CCC software production is specialised in delivering customer-specific solutions to various sectors i.e. to industry, electronics, public authorities, health care, data transfer, media and space. CCC's products consist of software designed to meet the high requirements of the mobile smart communication equipment, CAD-planning, multimedia and the virtual templating in e-business.
Private/Public: Private

Company name: **Cellpoint**
Web site: www.cellpoint.com
Country: USA/Sweden
Company profile: Offers white-label applications built around an OSI-based platform for positioning technology.
Private/Public: Public

Company name: **Central Command Inc.**
Web site: www.avp.com
Country: US
Company profile: Provides virus protection services and software for handheld (Palm and Pocket PC) devices.
Private/Public: Private

Company name: **Comfone Ltd.**
Web site: www.comfone.com
Country: Switzerland
Company profile: Offers complete roaming solutions (backbone and data interchange facilities), aiming to become a one stop shop for operators.
Private/Public: Private

Company name: **Consors**
Web site: www.consors.de
Country: Germany
Company profile: Offers market data, brokerage and options trading services across a variety of channels including mobile (WAP, SMS information alerts).
Private/Public: Public

Company name: **ConVisual**
Web site: www.convisual.de
Country: Germany
Company profile: Offers a platform for smart visual messaging services. Interfaces between messaging systems. Partners with M@gic4.
Private/Public: Private

Company name: **Copernicus**
Web site: www.copernicusgbs.com
Country: UK
Company profile: Provides carrier-grade IP billing services through an ASP model. Uses software from Sepro Billing as a basis.
Private/Public: Private

Company name: **Curious Networks**
Web site: www.curiousnetworks.com
Country: US
Company profile: Provides a multi-platform content development and delivery solutions. Based on a proprietary multi-channel mark-up language.
Private/Public: Private

Company name: Cyberbank
Web site: www.cyberbank.co.kr
Country: South Korea
Company profile: Technologically advanced manufacturer of portable data access devices (PDAs, Smartphones and Gamephones).
Private/Public: Private

Company name: Cybiko
Web site: www.cybiko.com
Country: US
Company profile: Provides wireless gaming and chat devices for teens, based on proprietary RF interface.
Private/Public: Private

Company name: Dataroam
Web site: www.dataroam.com
Country: UK
Company profile: A WASP that offers mobile-enabled solutions for businesses.
Private/Public: Private

Company name: Descartes
Web site: www.descartes.com
Country: Canada
Company profile: Offers internet based logistics solutions and aggregation hubs for enterprises.
Private/Public: Public

Company name: Digia.fi
Web site: www.digia.fi
Country: Finland
Company profile: Offers software and value-added services for Symbian based devices.
Private/Public: Private

Company name: Digital Angel
Web site: www.digitalangel.net
Country: US
Company profile: Develops a personal single-chip based device to be worn on the body, measure key vital signs, provide tracking information and communication capability. It is currently positioned for applications such as identification, payment, medical monitoring and emergency tracking.
Private/Public: Public

Company name: Digital Bridges
Web site: www.digitalbridges.com
Country: UK
Company profile: Offers an interactive content service platform, capable of supporting multi-player gaming with pre-billing functions embedded.
Private/Public: Private

Company name: Dynetic
Web site: www.dynetic.de
Country: Germany
Company profile: Provides a complete m-commerce platform. Develops ticketing, media and location-based services over SMS and WAP. Developed a complete cinema m-ticketing solution.
Private/Public: Private

Company name: E*Trade
Web site: www.etrade.com
Country: US
Company profile: Offers market data, brokerage and options trading services across a variety of channels including mobile (Palm VII).
Private/Public: Public

Company name: E.piphany
Web site: www.epiphany.com
Country: US
Company profile: Provides multi-channel CRM software for personalized marketing, sales and service.
Private/Public: Private

Company name: Epcos
Web site: www.epcos.com
Country: Germany
Company profile: A joint venture between Siemens and Matsushita Electronics Corporation. Delivers a diverse range of electronic components.
Private/Public: Public

Company name: Espial
Web site: www.espial.com
Country: Canada
Company profile: Offers a diverse set of server, client and development tools for quick deployment of services to mobile devices.
Private/Public: Private

Company name: ESRI
Web site: www.esri.com
Country: US
Company profile: Provider of diverse GIS software solutions and source map data.
Private/Public: Private

Company name: First Hop
Web site: www.firsthop.com
Country: Finland
Company profile: Offers secure messaging gateway and portal software as well as value added services. Developed technology called Escio Tokens, that is positioned to replace passwords, tickets, coupons and certificates with secure messaging.
Private/Public: Private

Company name: Flarion
Web site: www.flarion.com
Country: US
Company profile: Developers of flash OFDM technology, offer chipsets and equipment for OFDM-based connectivity.
Private/Public: Private

Company name: F-Secure Corporation
Web site: www.f-secure.com
Country: Finland
Company profile: Offers security (antiviral) solutions for a wide range of devices including mobile.
Private/Public: Public

Company name: FusionOne
Web site: www.fusionone.com
Country: US
Company profile: Hosted synchronization service that updates data across all connected devices of a single user.
Private/Public: Private

Company name: G-Cluster
Web site: www.g-cluster.com
Country: Finland
Company profile: Offers streaming mobile games technologies to MGSPs and operators.
Private/Public: Private

Company name: Geo Interactive Media
Web site: www.emblaze.com
Country: Israel/US
Company profile: Develops an end-to-end solution for video streaming over mobile networks for carriers and handset manufacturers.
Private/Public: Public

Company name: Geoworks Corporation
Web site: www.geoworks.com
Country: USA
Company profile: Offers suites of mobilizing software for enterprises (e-mail and messaging, porting web sites to mobile) also using an ASP model.
Private/Public: Public

Company name: Global Telematics
Web site: www.global-telematics.com
Country: UK
Company profile: Provides hardware, software and service platform for fleet management, utilizing mobile networks and GPS-based location technology. Offers a hosted real-time fleet tracking solution called Orchid Trak.
Private/Public: Private

Company name: Iconverse
Web site: www.iconverse.com
Country: US
Company profile: Offers a platform for rapid development and deployment of wireless data services across different devices. Also provides integration services.
Private/Public: Private

Company name: In-Fusio
Web site: www.in-fusio.com
Country: France
Company profile: Provides games and a platform that allows users to execute downloaded games on a mobile phone. Also provides gaming community creation and support services.
Private/Public: Private

Company name: ISR
Web site: www.isr.co.jp
Country: Japan
Company profile: Offers middleware such as identification servers and database connectors. Also offers turnkey mobile-related projects.
Private/Public: Private

Company name: iSyndicate
Web site: www.isyndicate.com
Country: US
Company profile: A content aggregator that provides diverse content channels for data services on different devices.
Private/Public: Private

Company name: **Jamba AG**
Web site: www.jamba.de
Country: Germany
Company profile: Mobile portal WASP with shares held by Metro Group and Debitel.
Private/Public: Private

Company name: **Jippii**
Web site: www.jippii.com
Country: Finland
Company profile: Offers internet access services. Rolls out WLAN as public access technology for cities.
Private/Public: Private

Company name: **Joe Network**
Web site: www.mticket.co.uk
Country: UK
Company profile: Offers an SMS-based m-ticketing for customers in UK. Technology is based on intelligent alert engine provided by Categoric.
Private/Public: Private

Company name: **LightSurf**
Web site: www.lightsurf.com
Country: US
Company profile: Offers an end-to-end digital imaging infrastructure based on a proprietary wavelet compression algorithm. Partners with Motorola and Kodak to deliver mobile digital photography infrastructure.
Private/Public: Private

Company name: **LocatioNet**
Web site: www.locationet.com
Country: US
Company profile: Offers an integrated real-time platform for location-based services over the internet.
Private/Public: Private

Company name: **Logica**
Web site: www.logica.com
Country: UK
Company profile: Provides hosted gateway services, SMS software platforms for mobile phone operators. Was one of the first companies to offer cHTML functionality in its gateways.
Private/Public: Public

Company name: **M@gic4**
Web site: www.magic4.com
Country: UK
Company profile: Provides a thin client called g@te for creating multimedia messaging and OTA diagnostics.
Private/Public: Private

Company name: **Materna**
Web site: www.materna.de
Country: Germany
Company profile: Offers SMS and WAP infrastructure, custom business solutions. The company also provides unified messaging solutions.
Private/Public: Private

Company name: **Mcaffee**
Web site: www.mcaffee.com
Country: US
Company profile: Provides security software and virus protection services for handheld (Palm and Pocket PC) devices.
Private/Public: Public

Company name: **Mediatude**
Web site: www.mediatude.com
Country: Sweden, UK
Company profile: Develops mobile-based products for direct advertising, along with solutions for market research.
Private/Public: Private

Company name: **Melody**
Web site: www.melody.se
Country: Sweden
Company profile: Offers mobile middleware for data and e-mail access. Also includes a module for accessing WAP-based services over SMS. Provides software for controlling embedded software via WAP.
Private/Public: Private

Company name: **Micsom**
Web site: www.micsom.fi
Country: Finland
Company profile: Offers WLAN and Bluetooth application platform solutions for future alternative network operators.
Private/Public: Private

Company name: **m-Portal**
Web site: www.mportal.com
Country: Austria
Company profile: Offers solutions based on its proprietary Enterprise Anywhere platform that extend business applications to mobile devices.
Private/Public: Private

Company name: **NavTech**
Web site: www.navtech.com
Country: US
Company profile: Provider of diverse GIS software solutions and source map data.
Private/Public: Private

Company name: **Netcom**
Web site: www.netcom.se
Country: Sweden
Company profile: Group of companies offering telephony, data and internet services across Europe. Provides multi-channel portal services in the market it operates in. Has a subsidiary specializing in billing/transaction services.
Private/Public: Public

Company name: **Netlife**
Web site: www.netlife.de
Country: Germany
Company profile: Provides integrated software solutions for brokerage, banking and mobile commerce.
Private/Public: Public

Company name: **Network 365**
Web site: www.network365.com
Country: Ireland
Company profile: Provides infrastructure for building mobile network-based shopping malls. Key product is called m-Zone and is a transaction/commerce application server.
Private/Public: Private

Company name: **Openwave**
Web site: www.openwave.com
Country: US
Company profile: Develops total solutions for connecting a variety of devices to internet and portals. A result of a merger between software.com and phone.com.
Private/Public: Public

Company name: **Option International**
Web site: www.option.com
Country: Belgium
Company profile: Offers solutions for GSM and GPRS data connectivity.
Private/Public: Public

Company name: **Oracle Corporation**
Web site: www.oracle.com
Country: USA
Company profile: Among other products offers a platform for building and deploying mobile internet-enabled business applications.
Private/Public: Public

Company name: **PacketVideo**
Web site: www.packetvideo.com
Country: USA
Company profile: Develops small-footprint wireless multimedia solutions optimized for mobile environment (MPEG4 implementation for mobile devices).
Private/Public: Private

Company name: **Paddy Power**
Web site: www.paddypower.com
Country: Ireland
Company profile: One of Ireland's leading betting houses offering sports and other event bets over the internet. It was among the first to offer betting via WAP.
Private/Public: Private

Company name: **PalmPalm**
Web site: www.palmpalm.com
Country: South Korea
Company profile: Optimizes Linux OS for internet appliances and integrates software programs into the OS.
Private/Public: Private

Company name: **Parthus**
Web site: www.parthus.com
Country: Ireland
Company profile: Offers chip platforms for mobile internet including information, multimedia, Bluetooth and positioning hardware platforms.
Private/Public: Public

Company name: **Payitmobile**
Web site: www.payitmobile.de
Country: Germany
Company profile: Offers a secure and convenient platform for mobile device-based payments. Partners with GZS – a German credit-card payment-system operator.
Private/Public: Private

Company name: **Paybox.net**
Web site: www.paybox.net
Country: Germany
Company profile: Offers a secure and convenient service for mobile device-based payments. Partners with Deutsche Bank.
Private/Public: Private

Company name: **Peramon Technologies**
Web site: www.peramon.com
Country: UK
Company profile: Provides software and hardware for mobilizing existing internet and Intranet corporate services such as email and messaging.
Private/Public: Private

Company name: **PicoFun**
Web site: www.picofun.com
Country: Sweden
Company profile: Develops, aggregates and publishes games for mobile devices.
Private/Public: Private

Company name: **Pixo**
Web site: www.pixo.com
Country: US
Company profile: Develops software platforms and services for mobile phones, such as microbrowsers that are supporting multiple mark-up standards.
Private/Public: Private

Company name: **Proxim**
Web site: www.proxim.com
Country: US
Company profile: Offers broadband wireless access hardware for home, enterprise and public networks.
Private/Public: Public

Company name: **Puma Technology**
Web site: www.pumatech.com
Country: US
Company profile: Offers browsing (microbrowser for Palm), notification (smart alert generation) and synchronization technology for mobile devices.
Private/Public: Public

Company name: **Quios**
Web site: www.quios.com
Country: US
Company profile: Having created a user base with its free SMS portal, Quios also offers hosted community, messaging and advertisement products.
Private/Public: Private

Company name: **Radiant Networks**
Web site: www.radiantnetworks.com
Country: UK
Company profile: Offers hardware solutions, planning and management for mesh networks.
Private/Public: Private

Company name: **Regisoft**
Web site: www.regisoft.com
Country: Israel
Company profile: Provides a unified trade system for distributing e-coupons and e-vouchers.
Private/Public: Private

Company name: **Research In Motion**
Web site: www.rim.net
Country: Canada
Company profile: Delivers mobile data access devices (RIM Blackberry) and a complete custom solution for e-mail access. Recently added to its portfolio instant messaging services in cooperation with AOL.
Private/Public: Public

Company name: **Riot Entertainment**
Web site: www.riot-e.com
Country: Finland
Company profile: Creates, distributes and publishes interactive content for SMS and WAP. Developed several games as tie-ins for movie premieres in 2000.
Private/Public: Private

Company name: **Rissa Solutions**
Web site: www.rissasolutions.com
Country: Finland
Company profile: Offers multichannel ERP back office systems integration and professional mobile clients. Rissa's mZipper is a third generation mobile and Internet multichannel customer service system with strong back office systems integration interface.
Private/Public: Private

Company name: **Room33**
Web site: www.room33.com
Country: Sweden
Company profile: Provides complete portal and marketing solutions for the mobile world.
Private/Public: Private

Company name: **Saraide**
Web site: www.saraide.com
Country: US
Company profile: Offers a complete range of information, communication and commerce services to carriers. Enables e-mail/fax unified messaging on standard GSM devices.
Private/Public: Private

Company name: **Sendo**
Web site: www.sendo.com
Country: UK
Company profile: Innovative handset manufacturer, offers one of the world's lightest and smallest handsets.
Private/Public: Private

Company name: **Sepro**
Web site: www.seprobilling.com
Country: Ireland
Company profile: Offers advanced IP billing and rating solutions for next-generation packet-based data services.
Private/Public: Private

Company name: **Siebel Systems**
Web site: www.siebel.com
Country: USA
Company profile: Provides multi-channel customer-centric e-business applications with a focus on CRM.
Private/Public: Public

Company name: **Signalsoft**
Web site: www.signalsoftcorp.com
Country: US
Company profile: Offers a network-based wireless location platform and applications that enable local information delivery, location sensitive billing and other location-based services.
Private/Public: Public

Company name: **Skygo**
Web site: www.skygo.com
Country: US
Company profile: Provides an integrated platform for mobile marketing, including advertising campaigns, interfaces to sales and order processing systems and marketing research.
Private/Public: Private

Company name: **Smartner**
Web site: www.smartner.com
Country: Finland
Company profile: Offers a wide range of wireless applications such as e-mail and scheduling gateways. Targets ASPs and service providers.
Private/Public: Private

Company name: **Solid Information Technology**
Web site: www.solidtech.com
Country: US
Company profile: Offers an integrated platform for synchronization of distributed data across different devices called Synchronet.
Private/Public: Private

Company name: **Sonera SmartTrust**
Web site: www.smarttrust.com
Country: Finland
Company profile: Offers a complete platform for PKI-based security for existing mobile networks, internet and future converged IP infrastructure.
Private/Public: Private

Company name: **Sonera Zed**
Web site: www.zed.com
Country: Finland
Company profile: A subsidiary of Sonera and one of the leading mobile portals in Europe. Also sells its portal platform to third-parties.
Private/Public: Private

Company name: **Space2Go**
Web site: www.space2go.com
Country: Germany
Company profile: Offers hosted mobile office functionality – access to e-mail, files, calendars and contacts from any device with which the user chooses to access the service.
Private/Public: Private

Company name: **Springtoys**
Web site: www.springtoys.com
Country: Finland
Company profile: Develops games and interactive content for mobile devices based on WAP, SMS, EPOC and Palm OS.
Private/Public: Private

Company name: **Star*Home**
Web site: www.starhome.com
Country: Switzerland
Company profile: Provides mobile network interconnectivity services and GRX-based data roaming. Operates its own backbone and offers roaming management services.
Private/Public: Private

Company name: **Starfish**
Web site: www.starfish.com
Country: US
Company profile: Provides SyncML based solutions for synchronization of diverse devices and applications. Is a fully owned subsidiary of Motorola.
Private/Public: Private

Company name: **Symbol Technologies**
Web site: www.symbol.com
Country: USA
Company profile: Offers specialized handheld computers & terminals on diverse hardware platforms (Palm, Pocket PC) for enterprise applications.
Private/Public: Public

Company name: **Talkcast**
Web site: www.talkcast.com
Country: UK
Company profile: Provides fixed and mobile telecommunication services focusing on content delivery and communication. Provides on of UK's first SMS chat services.
Private/Public: Private

Company name: **Tegic**
Web site: www.tegic.com
Country: US
Company profile: Provides small footprint software for speeding up text input on mobile phone keyboard, using a predictive algorithm.
Private/Public: Private

Company name: **The 451.com**
Web site: www.the451.com
Country: UK/US
Company profile: Subscription-based multi-channel news and analysis service.
Private/Public: Private

Company name: **TheStreet.com**
Web site: www.thestreet.com
Country: US
Company profile: Provides subscription based financial news and analysis over a variety of channels.
Private/Public: Public

Company name: **Thyron**
Web site: www.thyron.com
Country: UK
Company profile: Offers YES – an open multi-channel secure end-to-end payment platform.
Private/Public: Private

Company name: **Time Domain**
Web site: www.timedomain.com
Country: US
Company profile: Develops and sells chipsets based on Ultra Wide Band technology for tracking, radar and communication applications.
Private/Public: Public

Company name: **Tomtom**
Web site: www.tomtom.com
Country: UK/Netherlands
Company profile: Offers location-based applications. Services include route planning and information about places of interest delivered in a personalized format on smartphone/PDA. A subsidiary of Palmtop.
Private/Public: Private

Company name: **Trintech**
Web site: www.trintech.com
Country: UK
Company profile: Supplies infrastructure of secure end-to-end payment solutions. Its PayWare platform is designed across multiple access channels.
Private/Public: Private

Company name: **Uniqmed**
Web site: www.uniqmed.fi
Country: Finland
Company profile: Company specializing in telemedicine and remote signal measurement. Provides solutions for home telecare and telemedicine for emergency situations.
Private/Public: Private

Company name: **Vaultus**
Web site: www.vaultus.com
Country: US
Company profile: Provides secure middleware platform for mobilizing a company's applications, also via a WASP model.
Private/Public: Private

Company name: **Veikkaus**
Web site: www.veikkaus.fi
Country: Finland
Company profile: Finland's biggest betting house offering service through SMS.
Private/Public: Private

Company name: **VeriSign**
Web site: www.verisign.com
Country: USA
Company profile: Provides trusted infrastructure services to web sites, enterprises, electronic commerce service providers and individuals.
Private/Public: Public

Company name: **Vetronix**
Web site: www.vetronix.com
Country: US
Company profile: Provides telematic devices on Microsoft's Car PC platform, offers automotive service systems with over-the-air diagnostics capability.
Private/Public: Private

Company name: **Vizzavi**
Web site: www.vizzavi.com
Country: UK
Company profile: A joint venture between Vodafone group and Vivendi Universal to create a multi-access portal.
Private/Public: Private

Company name: **Volantis**
Web site: www.volantis.com
Country: UK
Company profile: Offers a platform for the future "Pervasive internet" – a complete solution for device-independent web presence and customer contacts.
Private/Public: Private

Company name: **Wanova**
Web site: www.wanova.com
Country: UK
Company profile: Provides complete end-to-end platform, integration and development solutions for operators to offer advanced gaming on GPRS and UMTS networks.
Private/Public: Private

Company name: **Wapamente**
Web site: www.wapamente.com
Country: Spain
Company profile: Offers a mobile portal delivering information and commerce (e.g. m-ticketing) functions. Provides personal and corporate WAP communication and collaboration services such as access to e-mail, contacts and schedules.
Private/Public: Private

Company name: **WapIT**
Web site: www.wapit.com
Country: Finland
Company profile: Offers turnkey mobile middleware solutions and applications for WAP and SMS. Provides a toolbox to operate and administer custom mobile solutions.
Private/Public: Private

Company name: **Wap-You-Up**
Web site: www.mindmatic.com
Country: Germany
Company profile: Leading provider of permission-based marketing solutions for wireline and mobile internet. Its SMS and WAP services offer cash incentives for ad exposure.
Private/Public: Private

Company name: **WCL**
Web site: www.wcl.com
Country: Finland
Company profile: Offers commerce and one-on-one permission-based marketing platforms. Developed a mobile auction platform.
Private/Public: Private

Company name: **Webraska**
Web site: www.webraska.com
Country: France
Company profile: Offers client and server software for personal navigation and for creating custom location-based services. Also offers real-time traffic information and map delivery system for automotive players.
Private/Public: Private

Company name: **Whereonearth.com**
Web site: www.whereonearth.com
Country: UK
Company profile: Provides location based service infrastructure and GIS for wired and mobile internet.
Private/Public: Private

Company name: **Windwire**
Web site: www.windwire.com
Country: US
Company profile: Provides one-to-one wireless marketing and advertising solutions targeting users of mobile devices.
Private/Public: Private

Company name: **Wirecard**
Web site: www.wirecard.com
Country: Germany
Company profile: Offers applications for full payment processing service. Offers products for payments via WAP (Independent Cell phone Payment) and Bluetooth.
Private/Public: Private

Company name: **Wizbang**
Web site: www.wizbang.fi
Country: Finland
Company profile: Develops digital entertainment for internet, mobile devices and other channels such as digital TV and future game console platforms.
Private/Public: Private

Company name: **w-Technologies**
Web site: www.w-technologies.com
Country: US
Company profile: Offers an integrated suite of mobile data applications ranging from financial and commerce solutions to content and communication.
Private/Public: Private

Company name: **Wysdom**
Web site: www.wysdom.com
Country: Canada/USA
Company profile: Provides an integrated platform for mobile business called MAP (Mobile Application Platform) and mobile gateway functionality.
Private/Public: Private

Company name: **XACCT**
Web site: www.xacct.com
Country: Israel
Company profile: Offers advanced data collection/pre-billing mechanisms for data services on heterogeneous networks.
Private/Public: Private

Company name: **YadaYada**
Web site: www.yadayada.com
Country: US
Company profile: Offers proprietary wireless data access, e-mail and alert services for Palm and Handspring devices.
Private/Public: Private

Company name: **Yeoman Group**
Web site: www.yeomangroup.plc.uk
Country: UK
Company profile: A group of companies delivering diverse geographical information solutions. The mobile arm of the company uses the GIS to provide a platform for delivering location-based services.
Private/Public: Public

Company name: **Zagme**
Web site: www.zagme.com
Country: UK
Company profile: Offers interactive advertising services, sending targeted messages to shoppers and serving as a delivery medium for redeemable points – a reward for reading the ads.
Private/Public: Private

7.2 MARKET FORECASTS

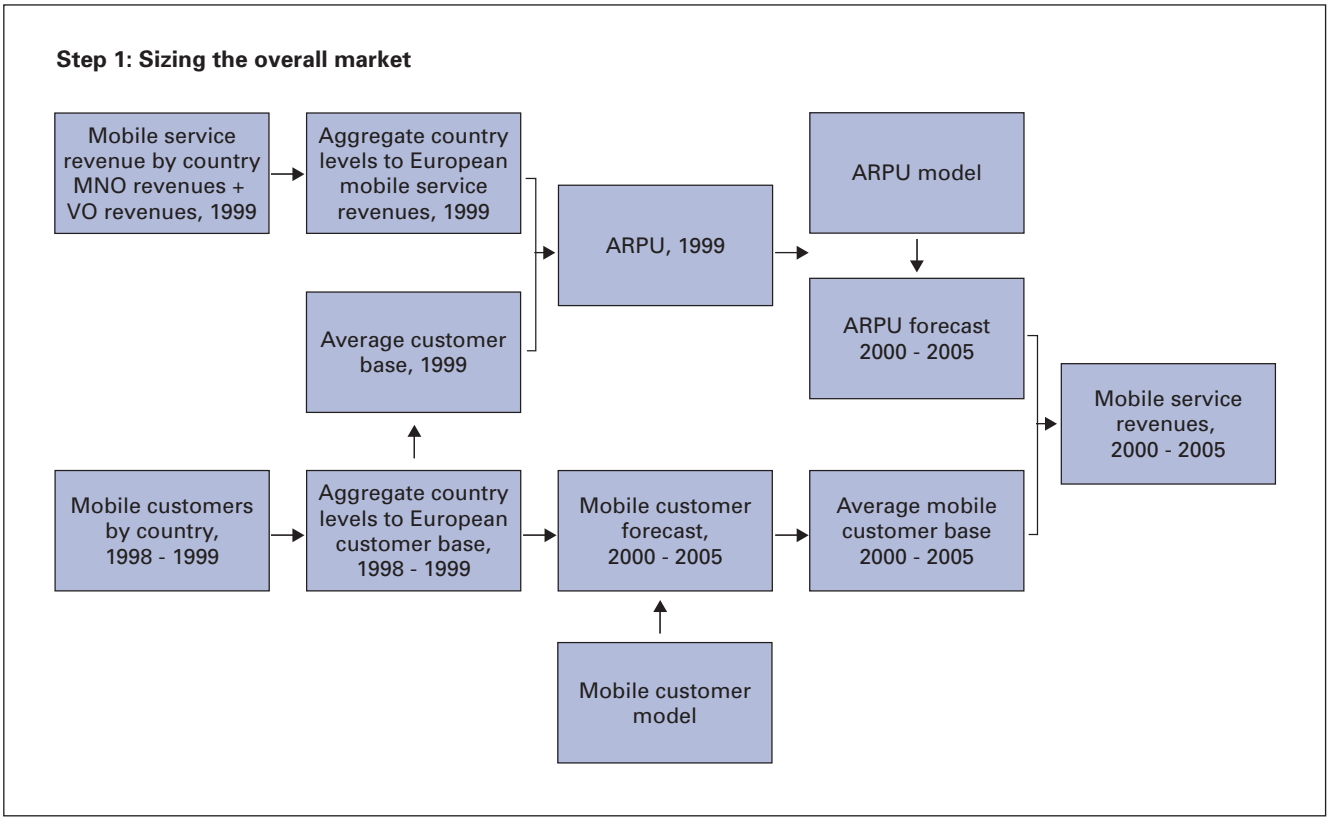


Figure 52: Explanation of the model

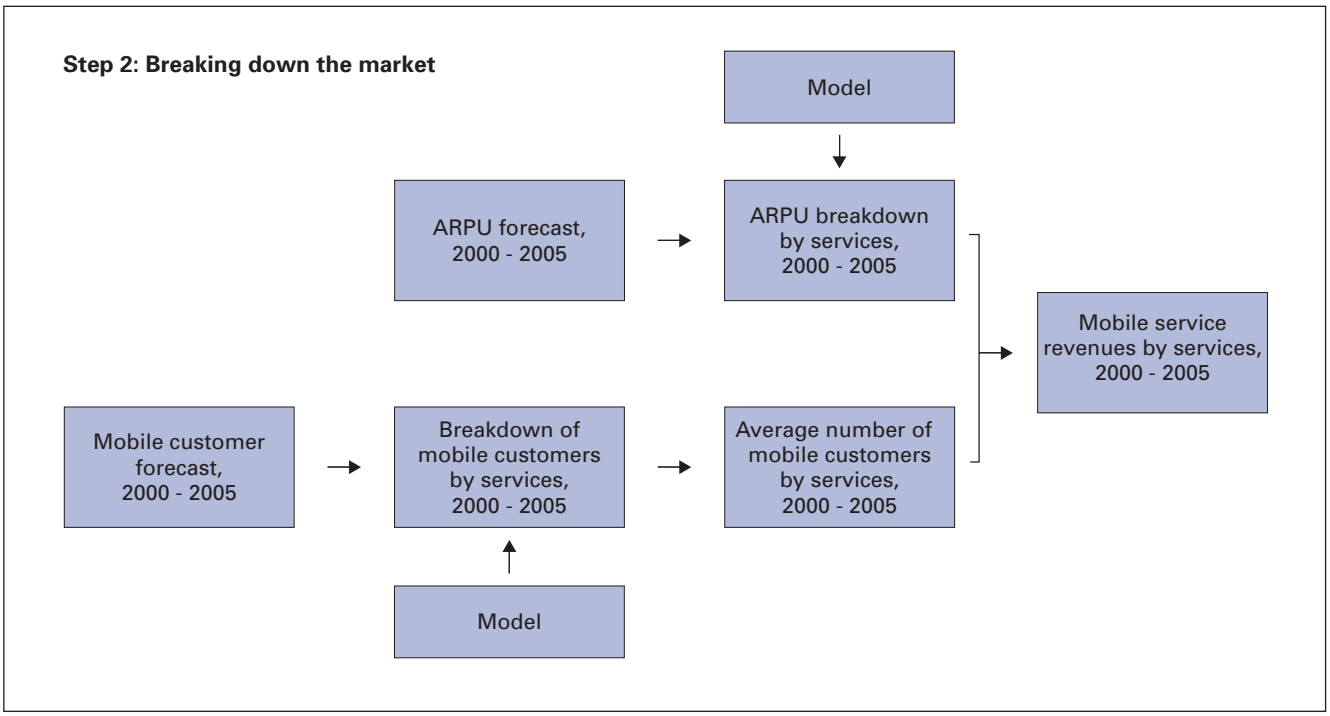


Figure 53: Explanation of the model continued

Geographical scope of the model			
Austria	Finland	Latvia	Slovenia
Belgium	France	Lithuania	Spain
Croatia	Germany	Netherlands	Sweden
Denmark	Greece	Norway	Switzerland
Estonia	Ireland	Portugal	United Kingdom

Figure 54: Geographical scope of the model

Table 9: Mobile Connections in Europe (in 000s)

	1999	2000	2001	2002	2003	2004	2005
Mobile Connections	156,217.1	252,976.0	306,224.0	329,884.0	341,028.0	346,697.0	349,588.1
Growth (in %)	71%	62%	21%	8%	3%	2%	1%
Average Number of Mobile Connections	123,883.4	204,596.5	279,600.0	318,054.0	335,456.0	343,862.5	348,142.5
Penetration rate	39%	63%	76%	82%	85%	86%	87%

Table 10: Mobile Data Users in Europe (in 000s)

Split by bearer technoloogy

	1999	2000	2001	2002	2003	2004	2005
SMS only	26,800.0	63,158.8	108,275.9	128,381.8	106,915.8	63,990.5	14,448.2
CS	5,000.0	11,800.0	29,679.5	53,606.3	72,266.7	70,032.4	51,879.8
GPRS	0.0	0.0	750.0	3,493.5	22,519.7	75,632.5	120,029.3
EDGE	0.0	0.0	0.0	84.6	253.9	550.2	994.5
UMTS	0.0	0.0	0.0	0.0	275.0	4,925.8	31,979.9
Total	31,800.0	74,958.8	138,705.4	185,566.2	202,231.1	215,131.4	219,331.6

Table 11: SMS Users (in 000s)

	1999	2000	2001	2002	2003	2004	2005
SMS only	26,800.0	63,158.8	108,275.9	128,381.8	106,915.8	63,990.5	14,448.2
Data + SMS	0.0	6,500.0	24,190.2	48,809.0	80,649.6	122,879.2	158,248.4
Total SMS	26,800.0	69,658.8	132,466.1	177,190.7	187,565.4	186,869.7	172,696.5

Table 12: Mobile Connections in Europe (in 000s)

Split by MNOs versus others

	1999	2000	2001	2002	2003	2004	2005
MNOs	124,973.7	200,272.7	234,771.7	241,914.9	235,877.7	225,353.1	209,752.8
Others	31,243.4	52,703.3	71,452.3	87,969.1	105,150.3	121,344.0	139,835.2
Total	156,217.1	252,976.0	306,224.0	329,884.0	341,028.0	346,697.0	349,588.1

Table 13: Mobile Service Revenues (in € million)							
Split by direct versus indirect revenues							
	1999	2000	2001	2002	2003	2004	2005
Direct Revenues	68,807.4	95,751.2	123,806.9	136,025.3	142,340.7	149,580.2	161,259.6
Indirect Revenues	0.0	2.6	21.9	96.2	799.5	3,352.2	9,402.6
Total Revenues	68,807.4	95,753.7	123,828.8	136,121.6	143,140.2	152,932.4	170,662.2

Table 14: Mobile Service Revenues (in € million)							
Split by revenue source							
	1999	2000	2001	2002	2003	2004	2005
Access/Subscription Revenues	11,078.0	12,583.3	14,072.7	14,656.7	14,495.0	14,347.2	14,223.1
Voice Traffic Revenues	54,770.7	76,693.8	97,535.4	101,946.9	98,720.8	92,068.3	80,054.1
Data Traffic Revenues	314.4	688.5	1,584.6	6,652.1	14,030.5	21,176.0	30,800.6
Content & Applications Revenues	2,644.3	5,785.6	10,614.2	12,769.7	15,094.4	21,988.6	36,181.8
Indirect Revenues	0.0	2.6	21.9	96.2	799.5	3,352.2	9,402.6
Total Revenues	68,807.4	95,753.7	123,828.8	136,121.6	143,140.2	152,932.4	170,662.2

Table 15: Mobile Service Revenues (in € million)							
Split by MNOs versus others							
	1999	2000	2001	2002	2003	2004	2005
MNO Revenues	58,385.5	80,333.6	101,659.2	107,302.4	107,926.0	106,250.6	104,492.2
Other Revenues	10,421.9	15,420.2	22,169.6	28,819.1	35,214.2	46,681.8	66,170.1
Total Revenues	68,807.4	95,753.7	123,828.8	136,121.6	143,140.2	152,932.4	170,662.2

Table 16: ARPU (in € per month)							
Split by direct versus indirect revenues							
	1999	2000	2001	2002	2003	2004	2005
Direct ARPU (in € per month)	46.3	39.0	36.9	35.6	35.4	36.3	38.6
Indirect ARPU (in € per month)	0.0	0.0	0.0	0.0	0.2	0.8	2.3
Total ARPU (in € per month)	46.3	39.0	36.9	35.7	35.6	37.1	40.9

Table 17: Total ARPU (in € per month)							
Split by revenue source							
	1999	2000	2001	2002	2003	2004	2005
Access/Subscription ARPU (in € per month)	7.5	5.1	4.2	3.8	3.6	3.5	3.4
Voice Traffic ARPU (in € per month)	36.8	31.2	29.1	26.7	24.5	22.3	19.2
Data Traffic ARPU (in € per month)	0.2	0.3	0.5	1.7	3.5	5.1	7.4
Content & Service ARPU (in € per month)	1.8	2.4	3.2	3.3	3.7	5.3	8.7
Indirect ARPU (in € per month)	0.0	0.0	0.0	0.0	0.2	0.8	2.3
Total ARPU (in € per month)	46.3	39.0	36.9	35.7	35.6	37.1	40.9

Table 18: Access/Subscription Revenues (in € million)							
Split by MNOs versus others							
	1999	2000	2001	2002	2003	2004	2005
MNO Revenues	9,416.3	10,590.9	11,610.0	11,603.2	10,992.1	10,162.6	9,245.0
Other Revenues	1,661.7	1,992.4	2,462.7	3,053.5	3,503.0	4,184.6	4,978.1
Total Revenues							

Table 19: Voice Traffic Revenues (in € million)							
Split by MNOs versus others							
	1999	2000	2001	2002	2003	2004	2005
MNO Revenues	46,555.1	64,550.6	80,466.7	80,707.9	74,863.3	65,215.0	52,035.2
Other Revenues	8,215.6	12,143.2	17,068.7	21,238.9	23,857.5	26,853.3	28,018.9
Total Revenues	54,770.7	76,693.8	97,535.4	101,946.9	98,720.8	92,068.3	80,054.1

Table 20: Data Traffic Revenues (in € million)							
Split by MNOs versus others							
	1999	2000	2001	2002	2003	2004	2005
MNO Revenues	298.7	648.3	1,472.3	5,903.7	11,750.5	16,323.2	21,560.4
Other Revenues	15.7	40.2	112.2	748.4	2,280.0	4,852.8	9,240.2
Total Revenues	314.4	688.5	1,584.6	6,652.1	14,030.5	21,176.0	30,800.6

Table 21: Content & Service Revenues (in € million)							
Split by MNOs versus others							
	1999	2000	2001	2002	2003	2004	2005
MNO Revenues	2,115.4	4,541.7	8,093.3	9,018.6	9,811.3	12,753.4	17,729.1
Other Revenues	528.9	1,243.9	2,520.9	3,751.1	5,283.0	9,235.2	18,452.7
Total Revenues	2,644.3	5,785.6	10,614.2	12,769.7	15,094.4	21,988.6	36,181.8

Table 22: Transaction revenues (in € million)							
Split by MNOs versus others							
	1999	2000	2001	2002	2003	2004	2005
MNO Revenues	0.0	1.5	12.8	33.8	182.1	466.1	693.2
Other Revenues	0.0	0.4	4.0	14.0	113.4	473.1	1,287.5
Total Revenues	0.0	1.9	16.8	47.8	295.4	939.2	1,980.7

Table 23: Referral revenues (in € million)							
Split by MNOs versus others							
	1999	2000	2001	2002	2003	2004	2005
MNO Revenues	0.0	0.0	0.2	1.3	18.2	77.6	166.7
Other Revenues	0.0	0.0	0.1	0.6	11.3	78.7	309.6
Total Revenues	0.0	0.0	0.2	1.9	29.5	156.3	476.3

Table 24: Advertising revenues (in € million)							
Split by MNOs versus others							
	1999	2000	2001	2002	2003	2004	2005
MNO Revenues	0.0	0.5	3.2	30.3	264.2	974.6	2,029.1
Other Revenues	0.0	0.1	1.0	12.6	164.5	989.4	3,768.2
Total Revenues	0.0	0.6	4.2	42.9	428.7	1,964.0	5,797.3

Table 25: Payment revenues (in € million)							
Split by MNOs versus others							
	1999	2000	2001	2002	2003	2004	2005
MNO Revenues	0.0	0.0	0.6	3.5	44.3	278.1	1,033.5
Other Revenues	0.0	0.0	0.0	0.1	1.5	14.6	114.8
Total Revenues	0.0	0.0	0.6	3.6	45.9	292.7	1,148.3

Table 26: Model summary split by country – Austria							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	4,215.6	5,848.0	6,777.0	7,242.0	7,462.0	7,563.0	7,690.9
Voice related revenues (in € million)	1,950.1	2,415.9	2,795.0	2,842.4	2,744.8	2,560.0	2,268.0
Mobile internet revenues (in € million)	62.2	109.4	195.5	314.5	496.6	794.4	1,304.5
Total revenues (in € million)	2,012.3	2,525.3	2,990.5	3,156.9	3,241.5	3,354.4	3,572.5
Voice ARPU (in € per month)		40.0	36.9	33.8	31.1	28.4	24.8
Mobile internet ARPU (in € per month)		1.8	2.6	3.7	5.6	8.8	14.3
Total ARPU (in € per month)		41.8	39.5	37.5	36.7	37.2	39.0

Table 27: Model summary split by country – Belgium							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	3,208.0	5,188.0	6,431.0	7,080.0	7,390.0	7,533.0	7,735.7
Voice related revenues (in € million)	1,544.2	2,273.1	3,050.8	3,346.7	3,377.5	3,258.3	2,886.6
Mobile internet revenues (in € million)	43.0	77.8	161.7	284.8	474.4	800.9	1,315.2
Total revenues (in € million)	1,587.1	2,350.9	3,212.5	3,631.5	3,851.9	4,059.2	4,201.8
Voice ARPU (in € per month)		45.1	43.8	41.3	38.9	36.4	31.5
Data ARPU (in € per month)		1.5	2.3	3.5	5.5	8.9	14.4
Total ARPU (in € per month)		46.7	46.1	44.8	44.4	45.3	45.9

Table 28: Model summary split by country – Denmark							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	2,647.0	3,398.0	3,943.0	4,309.0	4,544.0	4,689.0	4,763.1
Voice related revenues (in € million)	948.1	1,169.4	1,367.7	1,434.1	1,413.2	1,337.1	1,184.6
Mobile internet revenues (in € million)	66.8	98.1	183.1	300.5	473.7	747.3	1,222.2
Total revenues (in € million)	1,015.0	1,267.5	1,550.8	1,734.7	1,886.9	2,084.3	2,406.7
Voice ARPU (in € per month)		32.2	31.1	29.0	26.6	24.1	20.9
Data ARPU (in € per month)		2.7	4.2	6.1	8.9	13.5	21.6
Total ARPU (in € per month)		34.9	35.2	35.0	35.5	37.6	42.4

Table 29: Model summary split by country – Finland							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	3,329.2	3,876.0	4,227.0	4,440.0	4,567.0	4,640.0	4,713.7
Voice related revenues (in € million)	1,466.7	1,672.8	1,902.2	1,927.8	1,859.6	1,739.1	1,540.7
Mobile internet revenues (in € million)	161.9	257.0	383.9	537.7	751.2	1,089.4	1,756.9
Total revenues (in € million)	1,628.6	1,929.8	2,286.2	2,465.5	2,610.8	2,828.4	3,297.6
Voice ARPU (in € per month)		38.7	39.1	37.1	34.4	31.5	27.5
Data ARPU (in € per month)		5.9	7.9	10.3	13.9	19.7	31.3
Total ARPU (in € per month)		44.6	47.0	47.4	48.3	51.2	58.8

Table 30: Model summary split by country – France							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	20,305.0	30,380.0	38,478.0	44,197.0	47,938.0	50,277.0	51,039.9
Voice related revenues (in € million)	9,071.3	13,016.7	17,052.3	18,943.9	19,285.9	18,616.3	16,492.8
Mobile internet revenues (in € million)	350.4	885.4	1,830.7	3,221.5	5,087.1	8,047.4	13,214.6
Total revenues (in € million)	9,421.8	13,902.1	18,883.0	22,165.4	24,373.0	26,663.7	29,707.4
Voice ARPU (in € per month)		42.8	41.3	38.2	34.9	31.6	27.1
Data ARPU (in € per month)		2.9	4.4	6.5	9.2	13.7	21.7
Total ARPU (in € per month)		45.7	45.7	44.7	44.1	45.2	48.9

Table 31: Model summary split by country – Germany							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	23,495.0	53,079.0	67,833.0	73,030.0	74,670.0	75,171.0	75,098.7
Voice related revenues (in € million)	11,129.6	16,214.5	21,559.5	22,085.6	20,802.6	19,101.5	17,059.5
Mobile internet revenues (in € million)	744.0	1,760.7	3,344.6	5,032.5	7,218.4	10,646.4	17,263.0
Total revenues (in € million)	11,873.6	17,975.2	24,904.0	27,118.1	28,021.0	29,747.8	34,322.5
Voice ARPU (in € per month)		35.3	29.7	26.1	23.5	21.2	18.9
Data ARPU (in € per month)		3.8	4.6	6.0	8.1	11.8	19.1
Total ARPU (in € per month)		39.1	34.3	32.1	31.6	33.1	38.1

Table 32: Model summary split by country – Greece							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	3,894.1	5,589.0	6,747.0	7,443.0	7,833.0	8,044.0	8,181.0
Voice related revenues (in € million)	1,531.8	2,083.1	2,510.5	2,613.8	2,555.4	2,391.3	2,118.5
Mobile internet revenues (in € million)	29.9	45.8	90.2	157.3	267.6	453.3	781.0
Total revenues (in € million)	1,561.7	2,129.0	2,600.8	2,771.2	2,823.0	2,844.6	2,899.5
Voice ARPU (in € per month)		36.6	33.9	30.7	27.9	25.1	21.8
Data ARPU (in € per month)		0.8	1.2	1.8	2.9	4.8	8.0
Total ARPU (in € per month)		37.4	35.1	32.5	30.8	29.9	29.8

Table 33: Model summary split by country – Ireland							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	1,448.0	2,103.0	2,574.0	2,871.0	3,046.0	3,144.0	3,310.1
Voice related revenues (in € million)	660.1	861.1	1,038.5	1,109.6	1,130.1	1,090.9	966.4
Mobile internet revenues (in € million)	18.4	55.3	101.4	168.8	274.4	448.6	802.0
Total revenues (in € million)	678.6	916.4	1,139.9	1,78.4	1,404.5	1,539.5	1,768.5
Voice ARPU (in € per month)		40.4	37.0	34.0	31.8	29.4	25.0
Data ARPU (in € per month)		2.6	3.6	5.2	7.7	12.1	20.7
Total ARPU (in € per month)		43.0	40.6	39.1	39.6	41.5	45.7

Table 34: Model summary split by country – Italy							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	30,245.3	41,850.0	46,358.0	48,579.0	49,630.0	50,118.0	50,186.3
Voice related revenues (in € million)	11,282.6	14,061.9	16,568.1	16,985.7	16,556.0	15,583.9	13,900.6
Mobile internet revenues (in € million)	358.3	741.4	1,373.7	2,214.5	3,523.9	5,670.0	9,586.3
Total revenues (in € million)	11,641.0	14,803.3	17,941.8	19,200.3	20,080.0	21,253.9	23,486.9
Voice ARPU (in € per month)		32.5	31.3	29.8	28.1	26.0	23.1
Data ARPU (in € per month)		1.7	2.6	3.9	6.0	9.5	15.9
Total ARPU (in € per month)		34.2	33.9	33.7	34.1	35.5	39.0

Table 35: Mobile summary split by country – Netherlands							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	6,757.6	10,514.0	12,756.0	13,881.0	14,403.0	14,638.0	14,760.1
Voice related revenues (in € million)	2,553.7	3,288.5	4,024.6	4,270.1	4,233.8	4,026.4	3,567.1
Mobile internet revenues (in € million)	88.5	262.0	501.0	835.5	1,330.4	2,123.4	3,590.1
Total revenues (in € million)	2,642.2	3,550.6	4,525.6	5,105.6	5,564.2	6,149.8	7,157.2
Voice ARPU (in € per month)		31.7	28.8	26.7	24.9	23.1	20.2
Data ARPU (in € per month)		2.5	3.6	5.2	7.8	12.2	20.4
Total ARPU (in € per month)		34.3	32.4	31.9	32.8	35.3	40.6

Table 36: Model summary split by country – Norway							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	2,744.8	3,110.0	3,390.0	3,597.0	3,747.0	3,854.0	3,921.1
Voice related revenues (in € million)	1,088.2	1,143.7	1,214.5	1,207.8	1,169.0	1,103.5	977.7
Mobile internet revenues (in € million)	127.1	169.2	226.0	302.2	421.6	617.1	993.0
Total revenues (in € million)	1,215.2	1,312,9	1,440.5	1,510.0	1,590.5	1,720.7	1,970.7
Voice ARPU (in € per month)		32.6	31.1	28.8	26.5	24.2	21.0
Data ARPU (in € per month)		4.8	5.8	7.2	9.6	13.5	21.3
Total ARPU (in € per month)		37.4	36.9	36.0	36.1	37.7	42.2

Table 37: Model summary split by country – Portugal							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	4,680.5	5,969.0	6,891.0	7,501.0	7,886.0	8,123.0	8,260.7
Voice related revenues (in € million)	1,473.8	1,925.1	2,356.8	2,567.4	2,627.9	2,573.3	2,279.8
Mobile internet revenues (in € million)	47.2	72.5	128.0	217.4	364.8	616.7	1,031.2
Total revenues (in € million)	1,521.0	1,997.6	2,484.9	2,784.8	2,992.7	3,190.1	3,311.0
Voice ARPU (in € per month)		30.1	30.5	29.7	28.5	26.8	23.2
Data ARPU (in € per month)		1.1	1.7	2.5	4.0	6.4	10.5
Total ARPU (in € per month)		31.3	32.2	32.2	32.4	33.2	33.7

Table 38: Model summary split by country – Spain							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	15,005.0	26,740.0	34,017.0	35,470.0	35,728.0	35,773.0	35,721.7
Voice related revenues (in € million)	5,804.2	8,365.3	10,565.4	11,024.9	10,364.0	9,522.1	8,341.7
Mobile internet revenues (in € million)	153.3	380.6	785.2	1.340.0	2,105.7	3,338.4	5,385.1
Total revenues (in € million)	5,957.4	8,745.9	11,350.5	12,365.0	12,469.7	12,860.6	13,726.9
Voice ARPU (in € per month)		33.4	29.0	26.4	24.3	22.2	19.4
Data ARPU (in € per month)		1.5	2.2	3.2	4.9	7.8	12.6
Total ARPU (in € per month)		34.9	31.1	29.7	29.2	30.0	32.0

Table 39: Model summary split by country – Sweden							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	3,065.0	5,058.0	5,909.0	6,202.0	6,296.0	6,325.0	6,342.8
Voice related revenues (in € million)	2,060.4	2,255.6	2,479.1	2,526.2	2,471.1	2,349.6	2,081.6
Mobile internet revenues (in € million)	188.8	284.7	415.3	588.6	849.4	1,273.1	2,062.4
Total revenues (in € million)	2,249.1	2,40.3	2,894.4	3,114.9	3,320.5	3,622.7	4,144.0
Voice ARPU (in € per month)		46.3	37.7	34.8	33.0	31.0	27.4
Data ARPU (in € per month)		5.8	6.3	8.1	11.3	16.8	27.1
Total ARPU (in € per month)		52.1	44.0	42.9	44.3	47.8	54.5

Table 40: Model summary split by country – Switzerland							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	5,125.0	6,137.0	6,841.0	7,302.0	7,595.0	7,777.0	7,876.8
Voice related revenues (in € million)	1,894.5	2,820.1	3,592.8	3,669.8	3,470.1	3,186.9	2,823.4
Mobile internet revenues (in € million)	60.4	157.0	312.3	504.0	780.3	1,223.7	1,986.0
Total revenues (in € million)	1,954.9	2,977.0	3,905.1	4,173.9	4,250.4	4,410.6	4,809.4
Voice ARPU (in € per month)		41.7	46.1	43.2	38.8	34.6	30.1
Data ARPU (in € per month)		2.3	4.0	5.9	8.7	13.3	21.1
Total ARPU (in € per month)		44.1	50.2	49.2	47.6	47.8	51.2

Table 41: Model summary split by country – UK							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	23,947.0	41,097.0	49,205.0	52,249.0	53,305.0	53,662.0	54,459.3
Voice related revenues (in € million)	10,525.1	14,538.6	17,918.9	18,211.2	17,223.3	15,880.3	13,932.1
Mobile internet revenues (in € million)	436.4	1,093.8	2,129.9	3,390.6	5,317.6	8,266.3	13,499.5
Total revenues (in € million)	10,961.5	15,632.3	20,048.8	21,601.8	22,540.8	24,146.6	27,431.6
Voice ARPU (in € per month)		37.3	33.1	29.9	27.2	24.7	21.5
Data ARPU (in € per month)		2.8	3.9	5.6	8.4	12.9	20.8
Total ARPU (in € per month)		40.1	37.0	35.5	35.6	37.6	42.3

Table 42: Model summary split by country – other countries							
	1999	2000	2001	2002	2003	2004	2005
Mobile connections (in 000s)	2,104.8	3,040.0	3,847.0	4,491.0	4,988.0	5,366.0	5,526.4
Voice related revenues (in € million)	864.3	1,171.8	1,611.3	1,836.5	1,931.7	2,095.1	1,856.1
Mobile internet revenues (in € million)	22.2	25.9	58.0	107.3	187.0	360.5	592.0
Total revenues (in € million)	886.5	1,197.7	1,669.4	1,943.9	2,118.8	2,455.6	2,448.1
Voice ARPU (in € per month)		38.0	39.0	36.7	34.0	33.7	28.4
Data ARPU (in € per month)		0.8	1.4	2.1	3.3	5.8	9.1
Total ARPU (in € per month)		38.8	40.4	38.9	37.3	39.5	37.5

8 GLOSSARY

2G	2nd Generation. Currently available digital communication networks (GSM, CDMA, PDC).
2.5G	2.5th Generation. Upgrades to currently available communication networks, bringing more bandwidth and, where not available, packet-based network. In European context associated with GPRS.
2.75G	2.75th Generation. A set of upgrades for 2.5G networks allowing for greater bandwidth. In Europe usually associated with EDGE.
3G	3rd Generation. Mobile technology according to IMT-2000 standard (e.g. UMTS in Europe).
4G	Future mobile technologies, based on new modulation schemes (OFDM) and idea of a separate uplink/downlink channel in a multi-network environment.
AGPS	Assisted GPS – combined positioning technology where results of GPS reading are corrected by terrestrial-network based solution.
AMPS	Advanced Mobile Phone System.
AOA	Angle of Arrival – a positioning method.
ARPU	Average Revenue per User.
AuC	Authentication Center – element of cellular system architecture responsible for authentication of users.
B2B	Business to Business – relates to transactions between businesses.
B2C	Business to Consumer – relates to transactions between a business and a consumer.
Bluetooth	Chip technology enabling seamless voice and data connections between a wide range of devices through short-range digital two-way radio.
CAGR	Compounded Annual Growth Rate
CB	Cell Broadcast.
CDMA	Code Division Multiple Access. A 2G technology that allows reuse of scarce radio resource in adjacent areas.
CDMA2000	North American version of IMT-2000, a 3G technology.
CDR	Call Detail Record – a protocol for recording details of a circuit-switched telephone call.
Cell ID	Cell proximity location technology.
CHTML	Compact HTML – a HTML-compatible mark-up language for hand-held devices developed by NTT DoCoMo.
CPU	Central Processing Unit of a telephone, PDA or a PC.
CRM	Customer Relationship Management – includes the systems and infrastructure required to analyse, capture and share all parts of the customer's relationship with the enterprise.
DAB	Digital Audio Broadcasting.
D-AMPS	Digital Advanced Mobile Phone System.
DBV	Digitally Broadcasted Video.
DES	Data Encryption Standard: the most widely used method for "symmetric" encryption.
DSL	Digital Subscriber Line.
EDGE	Enhanced Data for GSM Evolution. Allows networks to meet many of the requirements for UMTS. Usually associated with 2.75G.
EIR	Equipment Identity Register – element of GSM architecture responsible for keeping information about legal and fraudulent mobile devices.
EOTD	Enhanced Observed Time Difference – a positioning method.
ERP	Enterprise Resource Planning – a business management system that integrates all facets of the business, including planning, manufacturing, sales and marketing.
FM	Frequency Modulation – currently dominant analogue standard for quality broadcast audio. In mobile context is used as a broadcast bearer technology for RDS and TMC.
GIF	Graphics Interchange Format.
GIS	Geographical Information System.
GPRS	General Packed Radio Service.
GPS	Global Positioning System – satellite-based navigation system originally developed by the US military.
GSM	Global System for Mobile communication – leading 2G communication standard.
HDML	Handheld Device Mark-up Language – XML-based mark-up language originally proposed by Phone.Com.
HDR	High Data Rate
HLR	Home Location Register – element of cellular network architecture responsible for keeping information about subscriber service provisioning.
HSCSD	High Speed Circuit-Switched Data

ICQ	Pronounced "I seek you", an instant messaging system from AOL (formerly from Mirabilis).
IMAP4	Intelligent Mail Access Protocol v4. A standard protocol for access to Internet e-mail.
i-Mode	Leading Japanese mobile data service provider, owned by NTT DoCoMo.
IMT-2000	International Mobile Telecommunications 2000. The IMT-2000 system will provide a seamless, global communications service through small, lightweight terminals.
IN	Intelligent Network – lower-level element of GSM architecture.
IP	Internet Protocol.
IPDR	IP usage Detail Record – an XML-based protocol for recording details of an IP service usage.
IREG	International Roaming Expert Group.
JAVA	A high-level object-oriented language, allowing applets (applications) to be written once, run anywhere (whatever the platform is). The aim is to help simplify application development.
JPEG	Joint Photography Expert Group. Compressed Image Format.
LAN	Local Area Network.
LBS	Location-Based Service.
LMDS	Local Multi-point Distribution Service.
M2M	Machine to machine communications.
MANO	Mobile Alternative Network Operator – companies who operate alternative mobile networks like for example public WLAN.
MAXML	Universal multi-device mark-up language developed by Curious Networks.
MExE	Mobile Execution Environment.
MMDS	Mobile Multi-point Distribution Service.
MMS	Multimedia messaging service.
MO-SIGN	Mobile Signature Consortium aimed at promoting smartcard usage.
MPG	Multi-Player Game.
MSC	Mobile Services Switching Center – element of GSM architecture responsible for switching and internetworking functions.
M-SIGN	Mobile Electronic Signature Consortium.
MVNO	Mobile Virtual Network Operator.
OFDM	Orthogonal Frequency Division Multiplex – a modulation scheme associated with 4G technologies.
OTA	Over The Air. The method used to manage applications on a subscriber handset remotely.
P2P	Peer-to-peer – mode of communication where devices in the network communicate with each other directly.
PAN	Personal Area Network.
PCMCIA	Personal Computer Memory Card International Association – also a hardware standard for add-on devices for notebooks and PDAs.
PDA	Personal Digital Assistant.
PDC	Personal Digital Cellular – dominant Japanese mobile telephony standard.
PGP	Pretty Good Privacy. A popular public key encryption algorithm.
PHS	Personal Handyphone System – complementary Japanese mobile phone standard with lower coverage, but higher bandwidth.
PIN	Personal Identification Number.
PKI	Public Key Infrastructure.
PNG	Portable Network Graphics.
POP3	Post Office Protocol v. 3A standard protocol for access to Internet e-mail.
QOS	Quality of service.
RAM	Random Access Memory.
RAN	Radio Area Network.
RDS	Radio Data System – embeds data packets into a conventional FM broadcast.
ROI	Return on Investment.
ROM	Read Only Memory.
SCM	Supply Chain Management. The process of optimising delivery of goods, services and information from supplier to customer. SCM is a set of business processes that incorporate a trading-partner community engaged in a common goal of satisfying the end customer.
SET	Secure Electronic Transactions: a standard for credit card payment across networks, which does not depend on the security of the network and does not allow the merchant access to the customer's card number.

SIM	Subscriber Identification Module. Smart card holding the user's identity and telephone directory; SMS-Applications may reside on the SIM.
SMS	Short Message Service. Facility for sending text messages on GSM handsets.
SMSC	Short Message Service Centre.
Spectrum	Part of the radio wave spectrum allocated to an operator for commercial exploitation of a given technology.
SSL	Secure Socket Layer. A form of data encryption used in computer based transactions.
SyncML	Synchronisation Mark-up Language – a specification for synchronising data across various devices.
TCP/IP	Transmission Control Protocol/ Internet Protocol.
TDMA	Time Division Multiple Access – older spectrum utilization technology, on which most dominant systems (GSM) are currently based.
TDOA	Time Difference of Arrival – a positioning method.
TD-SCDMA	Time-Division Synchronous Code Division Access. A separate version of 3G standard developed for the Chinese market.
TETRA	Terrestrial Trunked Radio.
TMC	Traffic Message Channel – FM overlay technology for transmitting traffic information.
TMT	Telecommunication/Media/Technology market.
TOA	Time Of Arrival – a positioning method.
UMS	Unified Messaging Service.
UMTS	Universal Mobile Telecommunication System; the third generation mobile standard.
UWB	Ultra Wide Band – a low power, spread-spectrum technology that relies on coded pulse modulation for data transmission.
VO	Virtual Operator.
VPN	Virtual Private Network.
VXML	Voice Extensible Mark-up Language.
WAP	Wireless Application Protocol – a set of protocols developed to deliver data services to mobile phones, developed by WAP Forum.
WASP	Wireless Application Service Provider.
W-CDMA	Wideband Code Division Multiple Access – a 3G mobile technology.
WEP	Wireline equivalent Privacy.
WISP	Wireless Internet Service Provider.
WLAN	Wireless LAN – LAN equipped with a wireless interface for use within corporations and for public hot-zone access to data services.
WLL	Wireless Local Loop.
WML	Wireless Mark-up Language.
XHTML	Extensible HTML – the new modular presentation mark-up standard designed to unify development for different devices.
XML	Extensible Mark-up Language. A meta language for describing other languages, which lets you design your own content mark-up.

About Durlacher

The name of Durlacher is well known within the City of London. The firm has stock-broking origins reaching back to the early 1930s. Over the past five years, Durlacher Corporation has successfully transformed itself from a traditional stockbroker to a specialised research-led investment house with expertise in media and emerging technologies. It is now a leading European organisation of its kind, with first-rate analysts and corporate financiers who provide a unique European perspective on the global technology and media sectors. Durlacher Research is an acknowledged leader in the provision of research services in the area of Internet and related technologies. In addition, Durlacher Research has provided expertise in analysing a variety of markets including enterprise software, knowledge management, e-commerce, digital television and convergence markets, computer and video games, and telecommunications. Durlacher Research undertakes consulting engagements on a limited basis where it complements our business model and where we can be confident of delivering maximum value to the client. In the past, Durlacher Research has worked on market analyses, benchmarking studies, acquisition strategies and other proprietary projects for large corporate clients, including Microsoft and BT, as well as for smaller players in the convergence industry.

About EQVITEC Partners

Eqvitec Partners Oy is a leading Finnish venture capital firm founded in 1997, and it currently manages three limited partnerships with a total committed capital of around €255 million from offices in Helsinki. Eqvitec focuses on technology-intensive venture capital investments in Finnish and Nordic companies. Eqvitec's portfolio is currently balanced across two dimensions of the investment horizon: across the investment stage, from seed to expansion, and across technology sub-sectors, from information technology to applied technologies. Eqvitec's success is based on a balanced approach across technology sectors emphasising companies developing mobility-enabling technologies and solutions. Eqvitec has a proven track record with top-quartile performance returns, and outstanding opportunities generated for step-ups and exits. Eqvitec has a continuous high quality deal flow and the leading position as a technology private equity brand in Finland. The first equity fund – the Eqvitec Technology Fund I LP – targeted the converging technologies of telecommunications, information technology and new media. This fund is now fully invested, and will only finance follow-on rounds in current portfolio. Eqvitec Technology Mezzanine Fund is a private equity fund exclusively targeting the mezzanine market for technology companies. Recently Eqvitec completed the first closing of the Eqvitec Technology Fund II in which we have commitments of €132,5 million. The final closing is expected in June 2001 at around €170 million. Eqvitec's mission is to continue it's successful strategy of concentrating on early-stage investments balanced across technology sectors in Finland. Eqvitec is actively pursuing new investments which will also emphasise opportunities in companies enabling the growth of communications, information technology and the multichannel Internet.

About Helsinki University of Technology

The Institute of Strategy and International Business at Helsinki University of Technology (HUT ISIB) is Finland's leading institute for research and education in technology-based venturing, strategy, and international business. The research projects of HUT ISIB focus on venturing, entrepreneurship, strategy, and mBusiness in Information and Communication (ICT) industries in particular. The Institute has helped spawn a number of high-profile, successful technology-based ventures, and it has played a leading role in the creation and development of the Otaniemi Science Park – Innopoli complex, a leading concentration of technology-based new ventures in Northern Europe. The Institute is particularly known for its expertise in the wireless and mobile business sectors.

About the author team (Durlacher):

FALK MÜLLER-VEERSE is responsible for Durlacher's European research activities, establishing and managing the German office as well as the wireless research activities. He is the author of the Durlacher report on m-commerce from an investment perspective and a frequent chairperson and speaker at industry events. He is a board member of several mobile internet companies. Before that, he has been working in the Mobile Strategy Group of Logica Consulting, heading the FMC competence center, for companies such as Mannesmann Mobilfunk, KPN, Teligent and Belgacom. Falk has been earlier a Senior Analyst at Dataquest/GartnerGroup and a Marketing Manager at Nokia/Finland. He has received an MBA from California State University, USA, and a bachelor's degree in Technology Management from the University of Kaiserslautern, Germany.

BODO KOHLENBACH is a Senior Analyst focusing on Mobile Commerce at Durlacher Research Limited. Prior to joining Durlacher Research, Bodo was a Senior Consultant with Detecon Marketing Consulting (DMC) in Frankfurt. DMC is fully owned by Deutsche Telekom with a focus on new media and technologies. Bodo specialised in advising organisations on e-business and m-business strategies, particularly in the telecommunications industry. He has also worked with a range of other organisations including internet service providers (e.g. T-Online) and financial institutions (e.g. Deutsche Bank). Bodo has a Masters Degree in Business Administration from the University of Dortmund (Germany). He also studied International Business Administration at Dublin City University (Ireland).

DIRK BOUT is Head of Wireless Research at Durlacher Research Limited. Dirk has worked with a variety of companies and start-ups in defining their long-term strategic objectives. Prior to joining Durlacher, Dirk worked for Gartner Dataquest, the worlds leading IT and telecommunications research house. Dirk worked with a variety of companies ranging from large corporations to start-ups. Activities included research, report writing, and consulting. Prior to Gartner, Dirk worked for two smaller research and analysis firms, and with Inmarsat, the leading operator of a satellite network for global mobile communications. Dirk graduated from the University of Amsterdam with an MBA in Economics and Finance.

SHUM SINGH is a Senior Analyst focusing on Mobile Commerce at Durlacher Corporation. Shum has worked with a variety of Fortune 500 companies and start-ups in defining their long-term strategic goals from an internet strategy and corporate finance perspective. Shum graduated from the University of Chicago with a bachelor's degree in Economics. Prior to joining Durlacher, Shum was employed at CommerceOne's (AppNet, Inc.) internet strategy consulting group, where he managed a variety of engagements for large corporations and start-ups. Activities included strategy consulting, business plan writing, creating new ventures, and coordinating global e-business initiatives. Prior to CommerceOne, Shum worked for CIBC Oppenheimer in New York in their investment banking group, focusing on executing a variety of transactions including mergers and acquisitions, private placements, initial public offerings, and general financial advisory assignments.

GENNADY GOLUB is a junior Technology Analyst at Durlacher Research. Prior to joining Durlacher he has held management positions with several ERP/technology companies in Russia. He has a Bachelor's degree from the Moscow State University School of Business, specialising in technology management and market research.

About the author team (EQVITEC Partners):

JUKKA HÄYRYNEN is a co-founder of EQVITEC Partners. Prior to EQVITEC he worked for two years as Director of Sitra Seed Finance. Before joining Sitra, Jukka Häyrynen worked with the Technical Research Center of Finland. He was responsible for various functions involving marketing, technology and expertise based business development, as well as software integration and R&D. Jukka Häyrynen has an M.Sc. degree in mechanical engineering and an MBA, both from Helsinki University of Technology. Jukka is specialized in applied technologies, optics and engineering as well as telecommunications

SASU LAITINEN is a Wireless Analyst at venture capital firm EQVITEC Partners Oy. He has a Master's degree from Helsinki School of Economics and Business Administration specialising in international business and electronic commerce. He has experienced two exchange semesters, one in Higher Learning Program Institute in Kuala Lumpur, Malaysia and one in New York, USA at Frank Zarb School of Business in Hofstra University. His previous work experience includes ERP system implementation at the global electronic group ABB.

About the author (HUT):

DR ERKKO AUTIO is Professor in Technology-Based Venturing at the Institute of Strategy and International Business of Helsinki University of Technology (HUT ISIB). Previously, he has held academic research and teaching positions at London Business School, University of Sussex, and the Asian Institute of Technology. He has published, advised, and consulted widely in the areas of venturing, innovation, mobile eCommerce, and technology and innovation policy, for private and public organizations alike. In all, he has authored or co-authored some 140 publications in his areas of research interest.

With the contribution of

Andy Bottomley, Director of Research at Durlacher Research Limited

David Herbada, Iberian Research Manager at Durlacher Research Limited

Jay Marathe, Head of Consulting at Durlacher Research Limited

Jouko Posti, Investment Manager at EQVITEC Partners

Kimmo Jyllilä, CFO at EQVITEC Partners

Manu Mäkelä, Senior Investment Manager at EQVITEC Partners

Nick Gibson, Senior Games and Internet Analyst at Durlacher Research Limited

Richard Wendland, Telecoms Analyst at Durlacher Research Limited

Sarah Skinner, European Internet Analyst at Durlacher Research Limited

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Durlacher
Durlacher Research Ltd

4 Chiswell Street, London EC1Y 4UP, United Kingdom.
Tel: +44 (0)20 7628 4306 Fax: +44 (0)20 7628 3225 e-mail: research@durlacher.com

Wilhelmstr. 28, 53111 Bonn, Germany.
Tel: +49 228 9696 170 Fax: +49 228 9696 1717 e-mail: bonn@durlacher.com

c/Serrano 63, Esc 3 - 6º Izda, 28006 - Madrid, Spain.
Tel: +34 91 576 9087 email: madrid@durlacher.com

EQVITEC
PARTNERS

Mannerheimintie 8, P.O.Box 148, 00100
Helsinki, Finland. email:info@eqvitec.com

HELSINKI UNIVERSITY OF TECHNOLOGY
Institute of Strategy and International Business

P.O.BOX 9500, 02015 HUT, Finland. email:erkko.autio@hut.fi