KIWANJA.NET
MINDFUL SOCIAL CHANGE

MOBILE DATABASE · REPORT

BRIGHT FUTURE

Author / organisation	Deutsche Bank
Year recorded	2004
Region	Global
Category	Other
Original source	gsmworld.com
Archive page	kiwanja.net/mobile-database/bright-future/

This document is part of the kiwanja.net Mobile Database, an archive of more than 700 articles, reports and projects on mobile technology for development, collected between 2003 and 2010. It is reproduced here for reference; the original author's rights are retained.

Explore more. Browse the full archive at kiwanja.net/mobile-database.
Looking for support with your own social change work? See kiwanja.net/work-with-me.
Ken Banks offers coaching, mentoring and strategy support.

Global
Telecommunications

18 February 2004

Deutsche Bank

GSM White Paper

Brilliant past, bright future

Gareth Jenkins
(+44) 20 7547 5849
gareth.jenkins@db.com

GSM customers worldwide are nearing the one billion mark as of 16 February 2004, creating a tremendous impact on both economic and social scales globally. Deutsche Bank has created this white paper to explore the far-reaching changes that have occurred in the social and financial landscape as a direct result of the explosion of the family of GSM technologies -- GSM, GPRS, EDGE and UMTS/WCDMA. The paper addresses key areas such as: how GSM became the dominant mobile standard; the economic contributions made by the GSM community; and key success factors for the GSM industry going forward to the next billion customers.

GSM has had a significant economic impact

We estimate that global subscribers will exceed 1.5bn in 2004 and reach 2.3bn by 2010. We expect at least 85% of the world's next-generation wireless customers to utilise the GSM family of technologies for both voice and data services. Mobile network operator revenues alone totalled $426bn in 2003 (based on current exchange rates), an increase of 19% versus 2002. We believe GSM accounted for circa 65% of this total. Our returns analysis suggests that the sector is highly profitable but that this is split between the large haves (notably Nokia and Vodafone) and the have-nots. In addition, we estimate that mobile telephony has created 4.1m jobs worldwide and within this we believe GSM itself accounts for circa 75%. Following a couple of weaker years, we believe job creation will recommence and expect the industry to reach 10m employees by 2010.

GSM's social impact

Probably no single telecommunications system in recent history has had as profound an impact on global society than the GSM mobile phone. Its unprecedented growth in the world has paved the way for increased mobile telephone usage and brought badly needed modern telecommunications services to undeserved communities in the developing world. We have chosen two case studies to highlight how quickly and completely GSM has enabled economic and social development.

Why GSM?

Without GSM we believe the pace of development of mobile telephony would have pared dramatically and that additional revenue streams, such as roaming (estimated globally at $1.78bn in 2003), would not have been as successful.

Primer

GSM mobile communications is, without a doubt, one of the most explosive developments ever to have taken place in the telecommunications industry. Marrying the convenience of mobility with the rich multimedia content of the Internet, i.e. 3G, will be equally disruptive. In addition, the integration of the mobile phone, palm-sized computers, cameras and content related information makes it almost inevitable that the ubiquitous access point to the telecom network and Internet for that matter will not be the PC but some form of mobile appliance.

GSM's future key success factors (KSFs)

Over the next five years, several KSFs for the mobile industry will influence the market as we transition to the new 3G environment. These include:

- Enabling convergence with other wireless technologies
- Developing mobile centric applications
- Evolving the mobile business model
- Introducing mobile terminal enhancements and variety
- Fostering industry partnerships and co-operations
- Interoperability and inter-generational roaming between various platforms

In addition, we believe companies will increasingly have to prove their ability to brand both regionally and globally and offer services to clients in an easy-to-use mobile data environment.

Deutsche Bank AG

Deutsche Bank does and seeks to do business with companies covered in its research reports. Thus, investors should be aware that the firm may have a conflict of interest that could affect the objectivity of this report.

Investors should consider this report as only a single factor in making their investment decision.

DISCLOSURES AND ANALYST CERTIFICATIONS ARE LOCATED AT THE END OF THE BODY OF THIS RESEARCH

Table of Contents

Executive summary 1
GSM success story 6
Why has GSM been so successful? 8
The economic impact of GSM 13
The social impact of GSM 26
Key factors to GSM's continued success 31
Conclusion 36
Appendix 1: GSM around the world 38
Appendix 2: case study 1 41
Appendix 3: case study 2 43

Executive summary

Introduction – the success of GSM to date

In 1982, the Global System of Mobile communication (GSM) was established to initiate European telecommunication standards. Since 1992, it has been swiftly adopted by nations around the globe and now incorporates over 616 operators and 200 countries worldwide. We estimate that the number of GSM subscribers totalled 970m at the end of 2003, which we expect to increase to 2.3bn by 2010.

Why has GSM been successful?

The success of GSM is that its development was founded on the delivery of a specific user benefit - international roaming. The demands of international roaming had profound changes on GSM's architecture and mandated an open future-proof standard that ensured interoperability, without stifling competition, and innovation among suppliers. This lowered barriers to entry, promoted compatibility between systems which, in turn, lowered development costs and set the stage for better choice and innovation. The unparalleled economies of scale and competition that resulted brought convenience and falling prices to manufacturers, network operators and consumers.

The adoption of a digital system offered improved mobility, spectrum efficiency, better quality transmission and new services over the first generation systems. The use of Very Large Scale Integration (VLSI) microprocessor technology and other low cost IC architectures paved the way for more efficient and affordable pocket-sized mobile phones. This resulted in a profound change in users' mobile communication style from vehicular-based to personal, opportunity-based communications.

Although GSM is only one of the pieces in the cluster of current and future telecommunications networks, its ability to provide anytime, and almost anywhere, communications has resulted in tremendous economic and social consequences.

The economic and social impact of GSM

Mobile telecommunications is becoming one of the most important industries in the world. We estimate that in 2003, mobile telecom services directly generated over $426bn in revenues. Further, the global revenues attributable to GSM totalled circa $277bn in 2003, a 19% increase over 2002. We forecast this to increase to $500bn by 2005.

The catalytic presence of GSM and its derivatives, DCS-1800 and PCS-1900, has spurred significant research and development into wireless communications and pushed the frontiers of knowledge. The technological challenges of introducing a new 2nd Generation digital technology such as GSM, have wrought significant economic changes on the value chain of the mobile industry that directly embraces mobile operators, equipment providers, component suppliers, retailers and a large segment of the software market. Meeting these challenges involved the interplay of various clusters of technologies and competencies, the adaptation of new and existing technologies, and the appearance of specialist manufacturers. Each of these industries has created employment opportunities, many of which have directly resulted from the global emergence of GSM.

We estimate that mobile telephony has created 4.1m jobs worldwide and within this we believe GSM itself accounts for circa 75%. Following a couple of recent weaker years, we believe job creation will recommence and expect the industry to reach 10m employees by 2010.

In human terms, having access to a pocket sized mobile terminal has had a profound impact on society; empowering users with the freedom and convenience to conduct their affairs without being tethered to a wall, a terminal, or even a specific geographic location. The popularity and growth of mobile phones in society is changing the way we work and engage in our social interactions. The GSM mobile handset has also become more than just a phone; it is a very personal item and valued form of self-expression. Almost no other item is carried everywhere by users in quite the same way. But apart from the value of self-expression, the GSM handset has made its presence felt by changing the nature of social communications, allowing not only voice, but also creating textual modes as new, creative forms of dialogue.

But perhaps the most far-reaching social consequences of GSM telephony have been felt in low income economies. The deployment of GSM has helped to bridge the digital divide and bring modern telecommunications services to chronically underserved communities in Africa, Asia and Latin America. In the developing world, many countries are effectively starting "from scratch" when it comes to telecommunications; therefore, very large sums of money are needed. For the world's poorest countries, GSM mobile wireless represents the best chance of bringing the power of telecommunications to their economically disadvantaged or isolated communities. We have presented two case studies – in Nigeria and Afghanistan - to highlight how quickly and how completely GSM can be deployed; and substituted for fixed line telephones.

Undoubtedly, 3G will have a disruptive effect on the telecommunications industry, but its realisation will occur not through revolution, but rather graceful evolution from today's existing 2G infrastructure. The massive global deployment of GSM technology across 200 countries, and its global reach, necessitates the coexistence and reuse of GSM infrastructure. More importantly, backward compatibility with existing networks is vital to ensure that users enjoy the benefits of new 3G features and services, while continuing to enjoy the global coverage and roaming capabilities that they have come to expect from GSM. In that context, *3GSM represents the evolution of GSM to 3G that should culminate in a new W-CDMA air interface that will allow for coexistence of the current and new architecture and facilitate the reuse of the global GSM footprint.

After a few turbulent years for the industry, we highlight some of the key factors we view as critical for the continued success of GSM. These include:

- Enabling convergence with other wireless technologies
- Developing Mobile Centric Applications
- Evolving the mobile business model
- Mobile terminal enhancements and variety
- Fostering industry partnerships and co-operations
- Interoperability and Inter-generational roaming between various platforms.

Conclusion

We sought to identify how mobile telephony, and to a large extent GSM, is fostering the emergence of a mobile paradigm; whereby the mobile phone has become the first choice of personal phone. Its ready acceptance as the de facto global standard has been a key driver for socio-economic growth throughout the world. As we rapidly evolve towards a mobile wireless information society, that will bring about convergence of mobility and the Internet, GSM is continuing to play a crucial role in facilitating the smooth transition to the next-generation (3G) of mobile telecommunications services.

GSM success story

In the past decade, mobile communication has evolved from a niche business to one of the largest and most important industries in the world. To appreciate the growth in mobile communication, it is worth noting that in 1990 there were only 10m mobile subscribers worldwide. By the end of 2003, mobile subscribers comfortably exceeded fixed lines, and we estimate that the number of subscriber lines will reach 2.3bn by the end of the decade.

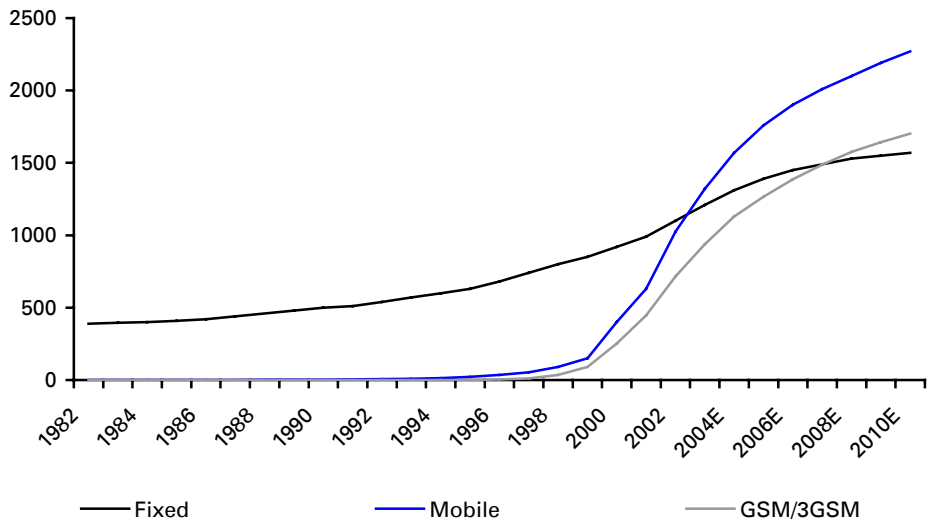
GSM is expected to reach the 1billion subscriber mark in early 2004.

In 2003, the number of global mobile subscribers exceeded the number of fixed lines for the first time.

There are 123 economies where mobile phones now exceed fixed telephone lines.

Much of mobile's success can be attributed to the pioneering design of the Global System for Mobile Communications (GSM) standard, which now leads today's global wireless market and continues to grow unabated. During early 2004, it is predicted that global GSM subscribers will surpass the one billion mark. GSM's success was founded on the decision by the original GSM committee to choose a digital technology that could be developed into an inexpensive, reliable means of communication, satisfying the specific user requirement of international roaming. GSM forced (and forged) a partnership between academia, governments and the telecommunications industry, the likes of which had never been seen, in order to make the results usable by all. GSM offered improved mobility, spectrum efficiency, better quality transmission and new services over the first-generation, analogue systems. The impact that the GSM mobile system has made over the past decade cannot be understated. In 1995, there were roughly 91m mobile subscribers globally and 689m fixed lines. By 2001, the number of mobiles had risen to 946m - a ten-fold increase. Sometime during the same year, the world reached one billion mobile subscribers; a feat that took fixed lines some 120 years to achieve. Astonishingly, in 2003, the number of mobile subscribers worldwide exceeded the number of fixed lines for the first time and now totals 1.3 billion globally. The ITU estimates that there are 123 economies where mobile phones now exceed fixed lines. We estimate that the number of mobile subscribers, globally, will reach 2.3bn by 2010.

Figure 1: World telephone subscribers (millions)



Source: ITU, EMC, Deutsche Bank estimates

GSM will hit its own important milestone by the first quarter of 2004: We forecast that it will reach one billion total subscribers worldwide – more than the number of television sets globally. GSM is, today, the most widely used digital wireless technology in the world: deployed on 616 networks; available in 200 countries; and

representing 76% of all digital mobile wireless subscribers. We believe that GSM/3G standards will surpass the number of fixed lines by 2007.

GSM around the world

GSM's growth continues unabated and, as it rapidly approaches one billion subscribers worldwide, we estimate that *one in six people on the planet will have a GSM phone in 2004*.

One in six people on the planet will have a GSM phone by 2004.

In the past 12 months alone, 180m new subscribers chose GSM; more customers than the total of any other wireless technology, and nearly 80% of all new wireless customers in the world. In 2003, an estimated 118 networks were planned to go on air, bringing the total number of GSM networks around the world to 616. A further 40-50 new GSM networks are planned to go on air in 2004 as mobile network operators, including those in the TDMA fraternity, as they select the GSM evolution to 3G next-generation mobile services. In our opinion, this is clear evidence of GSM's broad market acceptance and performance in the highly competitive mobile services market.

Much of the uptake in GSM in the past few years has shifted away from the developed economies towards the developing world (particularly Asia, Eastern Europe, Africa and Latin America). This has paved the way for increased mobile telephone usage and the introduction of badly needed modern telecommunications services to underserved communities in the developing world. The introduction of GSM has not only boosted the teledensity of these countries, but also resulted in positive economic and social consequences.

Some of fastest growth in GSM has come from the Asia-Pacific region, particularly China, which is now the largest mobile phone market (by subscriber) in the world. Equally as impressive, although perhaps not as well known, are the countries in Indo-China where mobile subscribers are doubling each year. However, in terms of sheer pace of deployment, GSM growth in Latin America has been outstanding. GSM deployments now blanket the region, where only five years ago it was only available in four countries. As testament to GSM's global appeal, growth in the traditional CDMA stronghold of the US has been astonishing since its introduction a few years ago. GSM grew by 66% between September 2002 and September 2003 and just recently T-Mobile alone reported that it had acquired 13.1m subscribers in the US. In western Europe, GSM's traditional stronghold, the total number of mobile subscribers is now circa 400m. However, the GSM baton has been now been passed to eastern and central Europe, where total mobile subscriptions have topped 100m. Astonishingly, in Africa, where access to low-tech necessities like clean water and basic health care remain an urgent priority, GSM is proving to be one of the most successful drivers of economic development ever deployed and we expect it to grow at a rate of 60% CAGR by the end of 2010. (See more in Appendix1 - GSM around the world.)

Why has GSM been so successful?

The global voice market is worth around $784bn pa, and is expected to continue to grow to almost $1,000bn by 2007

GSM has been the catalyst in a tremendous shift in traffic volume from fixed networks to mobile networks. In just over a decade there are more mobile users (1.3bn) than fixed-line users (1.2bn) and the number of mobile users is growing. Across the world, users are substituting fixed lines in preference for a mobile phone (in terms of both usage and disconnections). We are witnessing an emerging mobile paradigm where the mobile phone is becoming our personal phone.

The ITU estimates that there are 123 economies where mobile phones now exceed fixed lines. The mobile phenomenon has taken place across geographic criteria such as countries, regions and continents; across socio-demographic criteria such as gender, income, or age and across economic criteria such as price premium for mobile or GDP per capita. *Mobile telephony has become the standard model for voice communications.*

Voice has always been an essential part of communications. Both fixed and mobile operators owe their existence to the carriage of voice communications from which they derive, even today, over 80% of their total revenues. Despite the popularity of data and text messaging, the majority of people's primary use of their mobile phone is for making voice calls. The voice market is worth around $784bn pa, and is expected to continue to grow to almost $1,000bn by 2007.

GSM has unquestionably become the predominant world standard for 2nd generation digital mobile communications. We attribute this success to the three key factors detailed below:

- **Standardisation**
- **Economies of scale**
- **Global roaming**

Standardisation

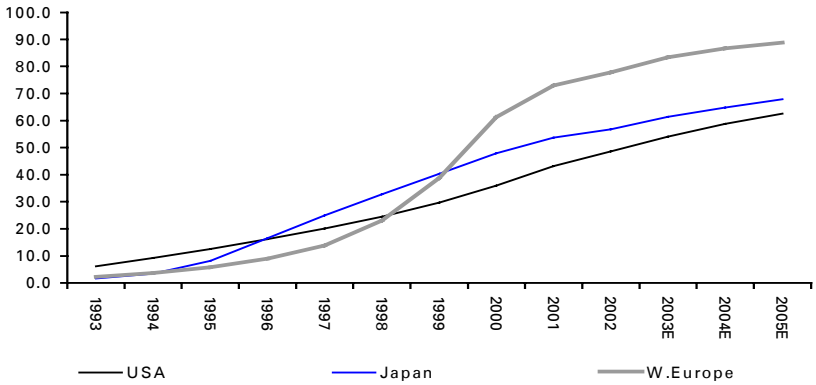
Standards such as GSM are essential not just for the efficient working of the world's vast communications networks, but also as a key driver for socio-economic growth. They bring economies of scale by focusing R&D to one large market, lowering development costs and setting the stage for better choice and innovation. They reduce technical barriers and promote compatibility between systems that, in turn, bring benefits to manufacturers, network operators and consumers.

From the outset, GSM's commitment to openness and interoperability, coupled with its compatibility with ISDN and Intelligent Networking concepts, fostered innovation and competition. This resulted in a single infrastructure based on common industry standards, which was equally accessible to all market participants. More importantly, it enabled operators to procure key network elements that give a high degree of flexibility, lower terminal and infrastructure costs and independence in their implementation, which eventually lead to lower costs for consumers. Before GSM, operators were tied to the proprietary interfaces within their networks, which were inherent in the original equipment, with no real ability to adapt them without the vendor's concurrence, or even to substitute vendors at a later stage.

Conversely in Japan and the US - where GSM was not initially adopted - it was common to have the network operator produce handsets and network equipment, provide mobile services and sign contracts with content providers. In such an environment, consumers could not easily switch from one network operator to another, which stifled competition and technological innovation. Moreover, the proliferation of multiple networks of varying conflicting standards in the US resulted in sparse national coverage, lacking interoperability and thwarting potential subscribers from roaming outside their regular service area.

Figure 2 shows that, prior to the emergence of GSM as a digital standard subscriber, penetration in western Europe lagged both Japan and the US. As soon as GSM operators developed services in earnest however, the situation reversed.

Figure 2: Penetration levels in western Europe vs. the US and Japan



Source: Deutsche Bank estimates and company data

Economies of scale

By focusing R&D to one large market, the advent of the GSM standard reduced development costs and provided suppliers with huge economies of scale in both network elements and handsets. Today, GSM's maturity and widespread production makes it far more price competitive than any other mobile technology.

While GSM is identified as a European standard, it is actually the *de facto* global standard that entitles any manufacturer around the world - even those who did not contribute to the Intellectual Property of GSM - to manufacture products. Consequently, North American (Lucent, Motorola and Nortel, etc) and Asian manufacturers (NEC, Sony, Mitsubishi, Ningbo Bird, and TCL) have manufactured GSM equipment and handsets, which has led to further economies of scale.

The unparalleled economies of scale created by GSM as a unified system that provided affordable mobile communications services by a single identity number, through a pocket sized mobile terminal, regardless of the characteristics of the country of residence, are enough to justify its implementation. It also provides a significant convenience to people, while having an impact on private lifestyles and business practices, through carrying just one communications terminal anywhere they go, regardless of national boundaries.

Technology, competition and innovation

There were those who argued that GSM as a single standard, mandated by government, adhering to a consensus approach, would limit freedom and flexibility in product design. It was also argued that competition would be stifled and consumers would be left with fewer choices. Further, multiple standards were

advocated that allowed service providers to meet the needs of different market segments and offer a range of distinct mobile wireless applications.

On the contrary, defining that the interfaces to the GSM subsystems remain open allowed the choice of the internal component technologies to be left to the equipment suppliers. This invited the formation of constellations of R&D alliances around competing component technologies, which in turn provided more choice for network operators, lowered costs and enabled third party applications, services and product variety. These products have provided additional benefits to consumers, while at the same time have spawned new industries. Three such innovations that resulted, which have not only dramatically led to the increased uptake of mobile communications but have been key drivers for socio-economic growth are: SMS, SIM and pre-paid.

For instance, the Short Message Service (SMS) or text messaging, a uniquely GSM service, was originally conceived as a paging mechanism for notifying users of voicemail messages. The soaring success and unwavering climb to ubiquity of SMS has largely taken the mobile industry by surprise. The phenomenal growth of SMS traffic is strongly aligned to the worldwide shift to the adoption of GSM, or GSM-like technologies, and now represents a substantial part of overall GSM traffic. This simple and accessible service is growing almost exponentially, with 25bn messages sent globally each month, and has become a dominant contributor to mobile operators' service revenues (estimated 15% at the end of 2003). SMS has become the surprise "killer app" as a growing number of users worldwide realise that GSM has more to offer than crystal clear voice calls.

While basic person-to-person messaging or voicemail notification currently make up the bulk of SMS messages, new innovative mobile information services such as news, stock prices, sport, weather, horoscopes, jokes and downloading of ring-tones are evolving rapidly. Downloadable ring-tones, using a combination of SMS and the Wireless Access Protocol (WAP), are worth a special mention. What started out as a novelty, now accounts for 10% of all music sold in the world. It, too, is becoming a significant contributor to mobile operator revenues. Vodafone, for instance, derived $1.3bn of revenue last year from ring-tones.

The pre-paid market is the largest growth segment of the mobile phone industry

The technology innovation of a simple, inserted, small smart card called the Subscriber Identity Module (SIM), with its ability for a single subscription to be moved between different handsets has encouraged more handset sales worldwide than any other second generation technology platform. Since then it has achieved a place in global telecommunications that, perhaps, not even the original architects had anticipated. The simple SIM today has become the most widely deployed application of smart cards worldwide.

Estimates suggest that 70-90% of new mobile phone subscriptions are pre-paid

One of the most important innovations behind the rapid spread of mobile telephony around the world has been the pre-paid subscription. The Portuguese operator, TMN, first introduced it in 1995, where it became an instant success. In most countries the number of pre-paid subscribers already exceeds post-paid customers. Some estimates suggest that 70-90% of new mobile phone subscriptions are pre-paid.

Today, network operators can use a number of Intelligent Networking (IN) platforms to implement mobile pre-paid services. These platforms have varying degrees of roaming, scalability, fraud and service features and real time rating. IN decouples the service logic from the network elements allowing mobile network operators to offer new, differentiated, revenue-generating services. GSM was developed from the

outset on an open-services-based architecture, with a close alignment to the principles of IN, that has facilitated the introduction of a range of SIM and other IN based services, of which pre-paid is just one.

The handset-based, pre-paid approach, using the SIM and SIM tool kit specification to perform the credit deduction, is unique to GSM. Credit and pre-paid tariffs schemes, as well as the ability to execute applications, are coded in the SIM, allowing the mobile network operator to quickly qualify the status of the customer's account balance. In the event that credit or cash has run out, or that the SIM has been declared as lost or stolen, the mobile network operator can rapidly restrict, or disable, that SIM from the network.

The ability and flexibility to use a mobile phone without the encumbrance of contracts and rate plans have simplified the service and served to boost competition. They have also opened access to mobile services for those who would not otherwise qualify for contract-based subscription plans. Although pre-paid is not unique to GSM, its authentication procedures, openness and alignment to the principles of IN have facilitated its rapid introduction. As pre-paid services have matured they have attracted a wider following beyond the initial target market of the "credit-challenged". Over the past eight years, the pre-paid mobile subscriber market has grown to become the primary form of payment for wireless services outside the US. Asia has been one of the main reservoirs in the mobile market, with growth higher than the worldwide average, principally through an increase in its total population of pre-paid subscribers.

What if GSM had not been developed?

We estimate that if GSM had not been developed, the western European market would be almost 90m subscribers (30%) smaller than it is today

It is doubtful that mobile communications would be where it is today without the advent of the GSM standard. Having a multitude of incompatible and competing systems throughout the world would only have moved us farther away from the goal of global mobile communications. However, isolating GSM's impact is extremely difficult. Comparing western Europe to the more parochial environments of both the US and Japan is a starting point. We estimate that, in subscriber terms, if GSM had not been developed, the western European market would be almost 90m subscribers (30%) smaller than it is today. Clearly, without the emergence of GSM in Europe, subscriber numbers in other regions would also be lower. It should be noted however, that this refers simply to subscriber numbers. Given that the average revenue per user (ARPU) is higher in both the US and Japan than it is in western Europe, we do not believe the mobile operators in Europe have been the significant beneficiaries of GSM. The primary beneficiaries have been the consumers in western Europe: as competition persuaded operators to provide extra services, in order to entice new, low–spending, pre-paid users; and with product "bundles" sometimes incorporating, where local regulations allowed, "free" or operator-subsidised handsets.

Global roaming

At the end of 2003, the roaming market in Europe accounted for over $1bn of operators' revenues and is expected to increase to over $1.2bn by 2005.

At the core of the GSM philosophy was the concept that a single standard would provide subscribers seamless and standardised contactability, regardless of national boundaries. The ability to roam, or use one's mobile on any other GSM network globally, IS the *raison d'être* of GSM.

The GSM system enhances personal mobility by allowing the user to have access to all subscribed services, irrespective of a specific mobile phone handset, through the property of a removable SIM. By decoupling the subscriber's identity from the mobile handset, roaming on GSM networks is simplified, thus allowing GSM phones

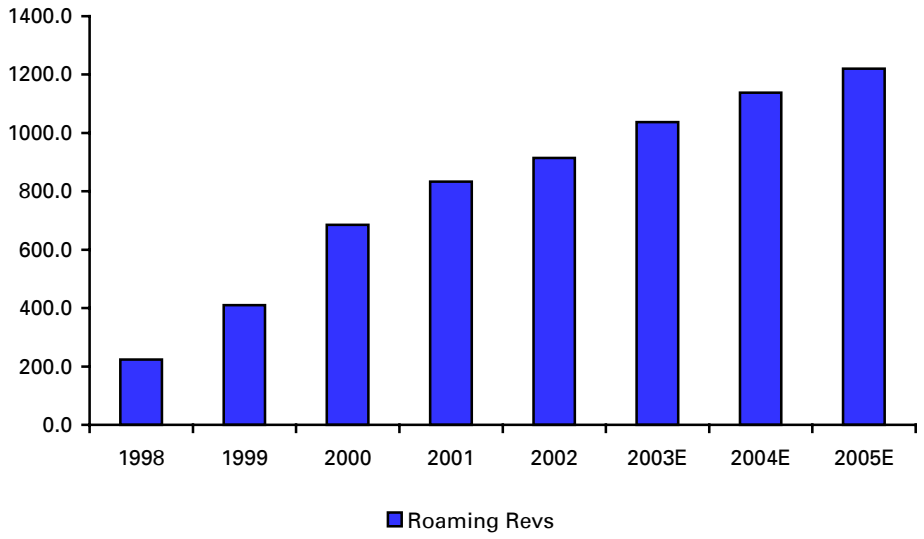
to be easily rented or borrowed. Even using GSM networks operating on different bands is as simple as moving the SIM from one handset to another. In the era prior to multi-band phones, travellers were able to avoid carrying multiple phone handsets, only needing to carry their personal SIM.

Global roaming, facilitated via the unique authentication feature of the SIM, has contributed greatly to the success of GSM, allowing the delivery of services to users across continents, which has boosted mobile operator revenues and resulted in a growing subscriber base. Even the SMS service or text messaging, mentioned earlier, supports international roaming with very low latency, enabling users to exchange alphanumeric messages (up to 160 characters) with other users of GSM, almost anywhere in the world within seconds of submission. SMS has become particularly suitable for applications such as paging, email and voice mail notification, and messaging services for roaming users.

Calls from mobile subscribers travelling abroad have given a significant impetus to traffic growth; generating calls that might otherwise not have been made. The rapid rise in GSM with its huge footprint worldwide has made it easy, although not necessarily cheap, to use a mobile phone when roaming from one country to another.

According to research conducted by Tele-Geography, which maps the pattern of telephone traffic, more than one in four international phone calls is being made from a mobile phone. Europe, where GSM is prominent, accounts for the largest volume of mobile originating and terminating traffic of any region, with a 56% share of the world's total. Deutsche Bank estimates that at the end of 2003, the roaming market in Europe accounted for over $1bn of operators' revenues and forecast this to increase to over $1.2bn by 2005.

Figure 3: Western European roaming spend ($m)



Source: Deutsche Bank estimates, company data and Tele-Geography

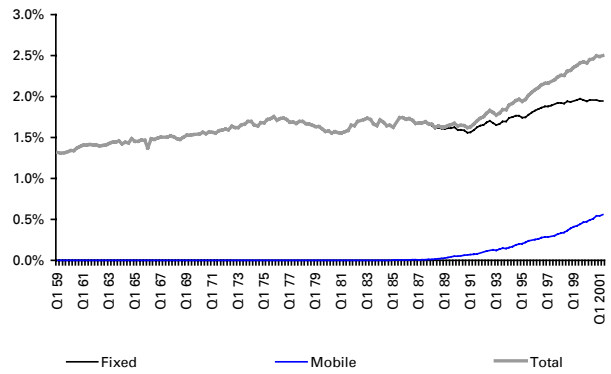
The economic impact of GSM

Global mobile telecom services generated an estimated $425bn in revenues in 2003. In Europe, aggregated telecom services accounted for 3% of GDP.

Mobile telecommunications is becoming one of the most important industries in the world. We estimate that in 2003, mobile telecom services directly generated circa $425bn in revenues. The phenomenal growth in mobile communications has driven price decreases which, in turn, has increased end-user spend on telecommunications services that were previously being spent on other things. As shown in Figures 4 and 5, mobile services have increased their share of GDP globally and have accounted for almost 1% of total GDP for the past decade. In Europe, telecoms in aggregate accounted for 3% of GDP. This is still a low proportion of overall GDP when considering that Utilities and Recreation & Culture combined account for some 14% and 11%, respectively, of European GDP. There is therefore a clear opportunity for mobile telephony to increase its share of the pie.

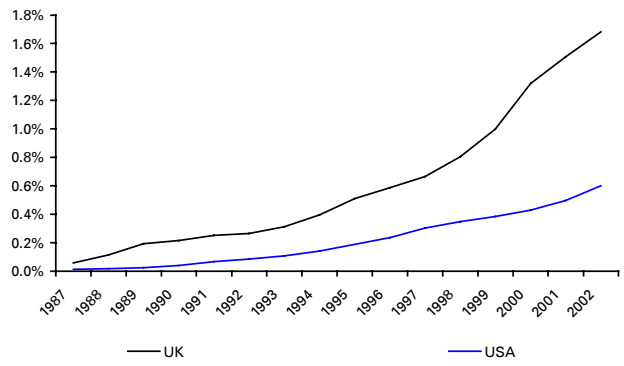
GSM has become the digital cellular technology of choice, enjoying the fastest growth rate and representing the largest segment within mobile telecommunications. The catalytic presence of GSM (and its derivatives, DCS-1800 and PCS-1900) facilitated the introduction of smaller, lightweight and less expensive mobile phones, that added value in terms of mobility, global roaming and convenience. In the process, this has led to tremendous economic and social consequences. Interestingly, from the diagram shown in Figure 5, it appears that in a country where GSM has been fully embraced (the UK), the economic impact has been more significant than in a country where multiple standards have emerged.

Figure 4: US telecom spending/disposable incomes



Source: Company information and Tele-Geography

Figure 5: Comparison of UK and US mobile spending/GDP



Source: Company information and Tele-Geography

In order to understand the significance of the economic changes that GSM has wrought, we need to be aware of the value chain of the industry. Mobile telecommunications is a reasonably new phenomenon and, as such, it is extremely difficult to value its economic impact. It is even more difficult to isolate the impact of a given technology. How, for example, should one account for the employees of AT&T Wireless, a company transitioning from TDMA to GSM? Moreover, since the very fabric of telecommunications is undergoing a change from the circuit-switched design to one of packet switching, it is to be expected that new developments and markets will ensue. We have identified four key elements to the mobile communications value chain and apologise to the myriad of companies that have been excluded by this simplification including, for example, the numerous businesses that have flourished around Newbury in the UK (home to Vodafone) or Espoo in Finland (Nokia's HQ).

Figure 6: The mobile communications value chain

Source: Deutsche Bank estimates and company data

If we simplify the mobile industry as a series of segments, it is easier to discern how each part links to, and creates value for, the others. For instance, consider the delivery of telecommunications services at the end of the value chain. The mobile operator exists to provide mobile telecommunications services to their customers either directly, or through a chain of service providers and retailers. It therefore requires the equipment providers to supply the hardware and software infrastructure needed to support the operator in that endeavour. The equipment providers, in turn, require the support of component and specialist contract manufacturers of the hardware and software elements.

The equipment providers can, in turn, be broken into subsystems that constitute the mobile network which we review below.

The radio access subsystem itself has forced innovative development of not only the handset, but base station equipment as well. The same ingenuity that has been applied to the development and production of semiconductors for handsets has been replicated in base stations. These radio interfaces of old, now support almost fully digital processors with dynamic activities which can be re-programmed on-the-fly. Further, the humble antenna has become "intelligent" in order to realise greater efficiencies and meet the greater demands of the technology.

GSM recognises the market expectation of offering a new generation of services, which combine the convenience of mobility with the rich multimedia content of the Internet. Accordingly, the GSM standard is evolving to 3G to enable the smooth transition from current circuit-switched networks to open, packet-based networks that support new IP based services with attendant higher data rates. General Packet Radio Service (GPRS) is a packet-switched extension of GSM and is the first step towards facilitating the transition from GSM to 3G. In brief, GPRS can be described as a service providing optimised access to the Internet, while reusing, to a large degree, existing GSM infrastructure. GPRS presents users and operators with a cost-effective and fast route to the functionality required to run a new generation of mobile services. In recognition of the importance of GPRS, the total number of commercial GPRS networks reached 200 by the end of 2003. Since the new equipment is predominantly made up of embedded software, it has necessitated the creation of multi-tiered sets of systems, control and applications software. In short, a whole industry of in-house and third party software providers are creating the intelligence for this infrastructure.

Moreover, the business of the mobile network operator will become more complex as GSM migrates towards 3G, and the concomitant need for information technology

will again, increase. This will, in turn, stimulate the development of new software to cater for the need to manage their network, customer base and revenues.

If we move away from the mere telecommunications network itself, it becomes clear that GSM forms the underlay to a whole new world of applications and business opportunities. For example, mobile commerce or "M-Commerce" (the ability to pay for goods and services using mobile technology) is a new industry on the verge of anticipated growth as the penetration of GSM handsets, in many countries, exceeds fixed telephones. It is fair to say that there are completely new applications and business opportunities that have not yet been envisaged! All of these will, in time, contribute to the economy centred on GSM mobile communications.

The value chain – components and contract manufacturing

Mobile phone component revenues have increased at a CAGR of 18%, from approximately $17bn in 1999 and are expected to double to $38bn by 2004

The advent of GSM has been one of the major driving forces behind the innovation and advances in the semiconductor industry. The desire for more efficient, cheaper, smaller and more battery efficient mobile phones led to the use of large scale VLSI technology. This space-efficient, surface-mount technology has enabled major radio modules to be housed in diminutive, microchip-scale packages.

Today there is a whole range of low cost component architectures used in mobile phones. ASICS (Application Specific Integrated Circuits) are specific-use component devices that offer the highest performance potential, low power consumption and lowest unit costs in high volume. Field Programmable Gate Array (FPGA) are a configurable microprocessor alternative to the ASIC based designs that offer excellent efficiency. The most configurable of all are the Digital Signal Processors (DSP), where the mathematics, algorithms and the techniques used to manipulate signals after they have been converted into a digital form, are implemented in software. All have been inspired by 2nd generation mobile phones and revolutionised the mobile industry.

Components for mobile phones now account for one of the largest portions of the market. According to IDC worldwide, mobile phone component revenues have increased at a compound annual growth rate (CAGR) of 18%, from approximately $17bn in 1999 and are expected to double to $38bn by 2004.

Figure 7: Wireless semis revenues ($m)

	2002	2003E	2004E
Voice only phones	13,404	10,633	3,420
Feature phones	3,506	7,579	14,416
Smarter phones	192	1,694	4,415
Total	17,102	19,906	22,251

Source: Deutsche Bank estimates, IDC worldwide and company data

GSM currently accounts for more than half of all chip revenues, due to its large installed base of users, particularly in Europe and Asia, securing 80% of new additions in 2003 and giving a cumulative share of 73%. This suggests GSM chipsets are significantly cheaper and offers further evidence of GSM's economies of scale.

Despite the recent slowdown, the opportunities for component vendors in the mobile market continue to look attractive. The forthcoming years, and the migration to the next-generation, are likely to be regarded as a time of major transition in the mobile market, particularly as more and more functionality is squeezed into the current scale of the mobile handset.

Spawning new segments within the mobile value chain

In the late 1990s, GSM mobile equipment manufacturers turned their hands to new venture economics, creating a number of start-ups and spawning new segments in the mobile value chain. Nokia, Ericsson and Motorola have all established venture funds to kick-start start-up markets in Europe and Asia. The start-ups range from mobile handset technologies to infrastructure and applications that help create new markets, improve the competitive positioning for manufacturers and their network operator customers.

In recent years the development and manufacture of mobile handsets has changed to the situation where, an increasing number of mobiles are now developed by Original Design Manufacturers (ODMs). ODM is a growing phenomenon that has rapidly impacted the mobile handset industry. Mobile Network Operators are also intensely involved in mobile handset requirements, design and branding, thereby fuelling the growth. Established GSM manufacturers such as Nokia, Sony Ericsson, Motorola and Siemens, increasingly turn to sub-suppliers to minimise their risks and efforts in the process of maintaining and expanding their product portfolios. Sub-suppliers such as Arima, BenQ, Compal, GVC, HTC and Microcell, to name but a few, owe much of their existence to mobile phones.

It is estimated that in 2002, the global workforce directly employed by mobile operators, equipment vendors and semiconductor companies totalled 1.2m and that GSM accounted for more than 75% of this

Taiwan is by far the most dominant country with regard to the number of mobile terminal ODM companies and mobile handset shipments. Korea holds second place, but other regions have started to challenge Asian domination. Deutsche Bank estimates that the ODM mobile handset market shipped 30m handsets in 2002 and we expect it to account for more than 40% of total mobile handset sales by 2005.

The value chain – equipment providers

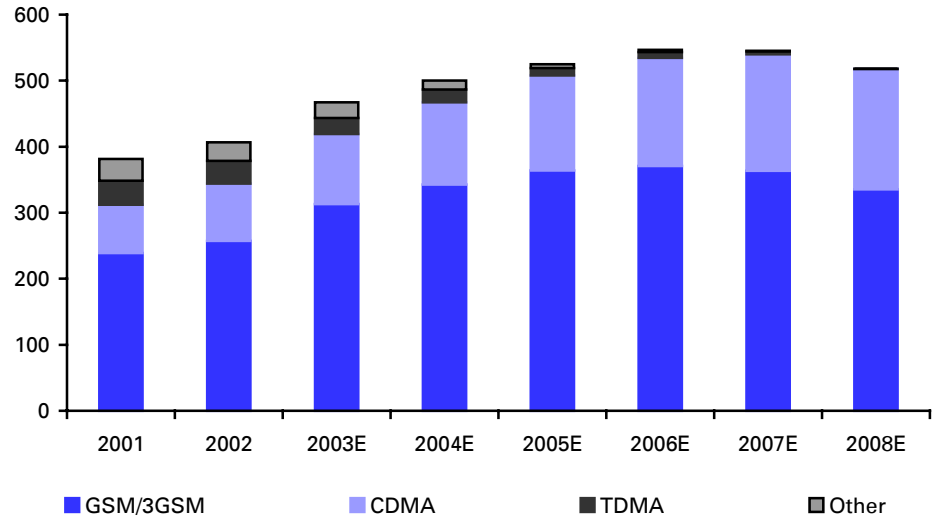
Handsets

The mobile phone handset market is dominated by GSM vendors accounting for almost 70% of shipments in 2003, estimated to be close to $300m

The first subsystem, within the Equipment Providers segment, is the mobile handset instrument itself. It is the most visible element and the source of inspiration for what is now a global, multi-billion dollar industry. It has spurred significant research and development into mobile communication techniques and pushed the frontier of technology. The demands of this research, in turn, have caused a seismic shift in the semiconductor industry insofar as those fundamental physical boundaries have been challenged, simply in order to meet the demands of next generation 3G mobile phone handsets.

Mobile phones have evolved from a luxury item of the rich and famous to an indispensable instrument of business and social communications. There are now an estimated 1.3bn mobile handsets in use; almost 1bn of which employ GSM – more than the total number of TVs and PCs combined.

Figure 8: Deutsche Bank global handset forecasts per year (m units)



Source: Deutsche Bank estimates and company data

Global mobile handset shipments have averaged 400m units per year since the peak in 2000, growing at a rate of +15% YoY and in 2003 reached 471m. GSM/3G vendors, who accounted for almost 70% of shipments in 2003, dominate the mobile phone market.

Mobile phones have become more than simply communication devices: they are status symbols and fashion statements. The main growth driver will be existing subscribers acquiring replacement handsets to gain new features and services, such as colour screens and data capability. One of the most compelling reasons for replacing one's handset is the emergence of a new type of "smart-phone" that combines mobile phone capabilities with a PDA, built-in camera, MP3 music playing and multimedia messaging capabilities, colour displays and multimode operation over GSM networks.

Even developing countries, that previously could not afford to build infrastructure for wireline telephony services, have joined the telecommunications world and ventured into this mobile wireless realm at significantly less cost. In 2002, despite the slowdown in telecom in developed countries, we estimate that more than half the shipments of mobile phones were to emerging markets.

Infrastructure

Factory shipments for GSM mobile telecommunications equipment (BTS, BSC, MSC) worldwide has averaged $25bn YoY pa. If we were to look at it simply in terms of the direct impact of GSM, where there are currently 616 networks on air worldwide, each would require a large number of Base Transceiver Sites (BTS) and Base Station Controllers (BSC). Typical costs for a fully equipped 3-sector BTS site range between Euro 100-300K, while a BSC ($4m each) handles around 50-100 BTS sites depending on the manufacturer.

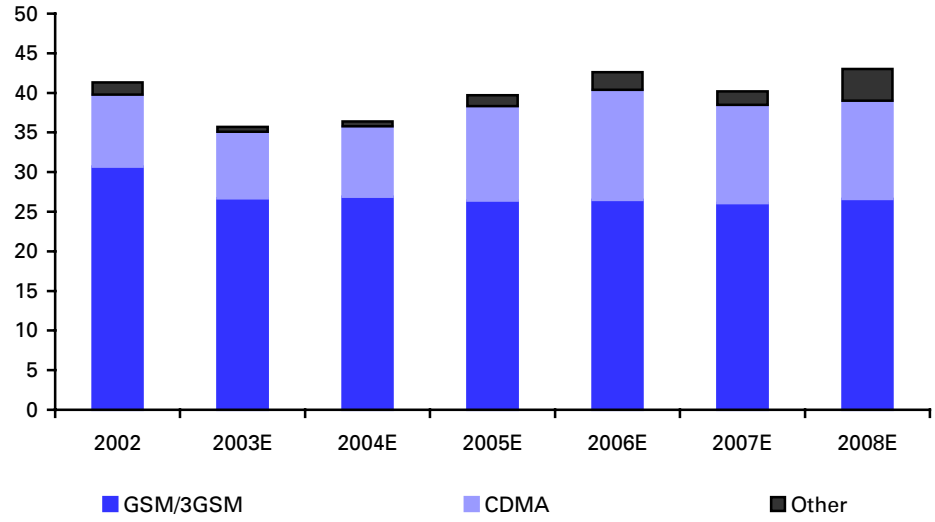
To get an idea of the scale, consider Vodafone in the UK, which has a GSM network of 6,000 BTS sites, or perhaps O2, which also has around 6,000 BTS. This is in contrast to T-Mobile and Orange (who operate at higher frequency bands) in the UK who have 12,000 BTS sites each. All this is, simply, to provide national coverage throughout an island (the UK) the size of the state of Victoria in Australia. Multiply

that by the 616 GSM networks throughout the world and one is looking at an installed first cost of approximately $300bn since the inception of GSM.

The installed first cost of GSM mobile telephony networks throughout the world is approximately $300bn since the inception of GSM

The extraordinary growth in GSM mobile networks throughout the world has fuelled the need for more mobile switching centre (MSC) capacity. MSC's are essentially CLASS 5 type telecommunications switching nodes and are the centre point of interconnection with all the other entities that make up a mobile network. They also provide the necessary inter-working between the mobile network and the Public Switched Telephone Network (PSTN).

Figure 9: Mobile telecom equipment spending by technology ($bn)



Source: Deutsche Bank estimates and company data

A further example here may help to illustrate. As we have stated, there are 616 GSM networks deployed in 200 countries. Depending on the coverage area, each network would require between two and 10 MSCs. If we assume that, on average, three MSCs are required per network, at a cost of circa $3m each, a tidy $6bn of revenue has been generated by GSM alone for one fully amortised piece of telecom switching equipment. It is estimated that the combined global market opportunity for traditional MSC switches, and their more contemporary younger brothers, the "soft switches", will increase from $10.8bn in 2002 to $22.5bn by 2008. Deutsche Bank estimates that, although traditional MSC switches will represent the greatest share of equipment revenues through 2008, mobile soft switches will also have an immediate and significant impact.

The basic need for switching and connectivity, and ever-growing demand for bandwidth, has opened the door to the next networking growth phase – Intelligent Networking platforms. Intelligent networks are an area of great technological growth that has been significantly driven by mobile technology. These transport-independent architectures enable mobile network operators to offer new revenue generating services (including instant provisioning, calling and pre-paid services and number portability) and will lead to new transaction and location-based services.

The evolution of these services into next-generation network technology has now started and should address the convergence of fixed, GSM, 3G and IP networks. What is particularly significant in the next-generation is its emphasis on enhanced services, improved technical capabilities and functionality, coupled with the concept that these services should be delivered over any type of access network.

Mobile infrastructure consulting, integration and management services alone were estimated to be worth $21.4bn in 2002 and could increase to $37.4bn by 2006E

Operational support systems/business support systems

The rapid growth of GSM has given significant impetus to the development of the crucial IT and software systems known as Operational Support Systems (OSS) and Business Support Systems (BSS) that run the mobile network operator's business. OSS is big business, with the telecommunications the single-largest customer for the software industry. The emergence of the large number of mobile network operators has spawned a surge in the number of independent software and integration companies, who produce a range of OSS/BSS systems, including Service Assurance, Subscriber and Service Provisioning, Customer Care to Mediation and Collection, Billing and Revenue Assurance. Once again, the 616 GSM networks around the world will all require an OSS/BSS system each. This demand base, coupled with the inherent characteristics of GSM (global roaming, SIM cards, new SIM-based products & services), has formed a solid market foundation for past and future OSS/BSS product development.

OSS systems are not shrink-wrapped software that can be installed by the operator. On the contrary, OSS systems have to be mapped to, and integrated with, the business processes of the mobile network operator. A large component of the figures for OSS/BSS include the hardware sales, systems integration, consulting, and outsourcing by OSS/BSS vendors, in addition to the software licence. We estimate that the mobile infrastructure consulting, integration and management services alone was worth $21.4bn in 2002 and could rise to a market size of $37.4bn by 2006E.

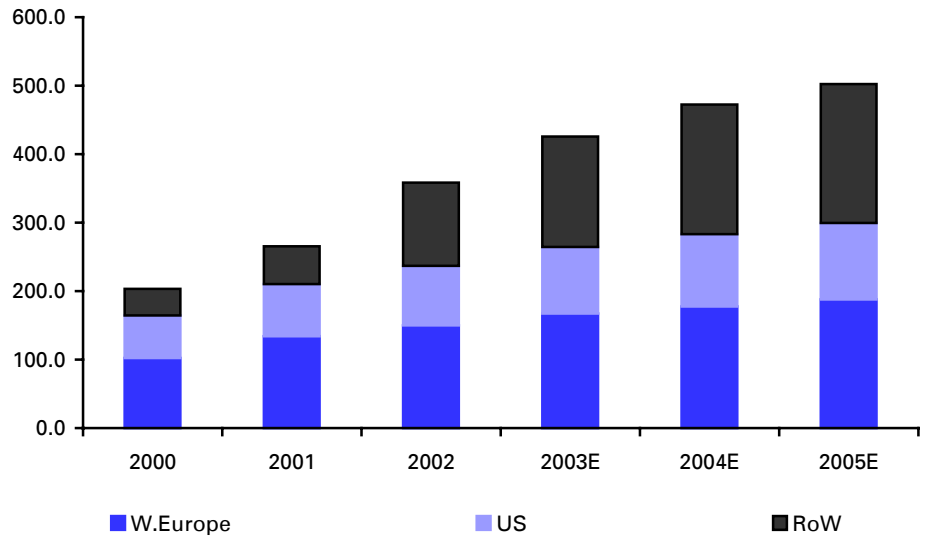
The value chain – mobile network operators

Mobile Network Operators (MNOs) occupy a unique position in the value chain. Mobile operators can deliver person-specific rather than location-specific services. As a result, they control the most personalised and value-added form of distribution of telecommunication services.

Deploying a mobile network is a capital-intense exercise. Today, almost 80% of the world's mobile network operators have chosen to employ GSM as their means of delivering 2nd generation mobile telecommunication services. GSM has enabled Mobile Network operators to procure key network elements that give a high degree of flexibility, lower terminal and infrastructure cost and independence in their implementation.

Nevertheless, the huge task of staging a mobile network has fostered partnerships, co-operative agreements and some fairly surprising bedfellows, in order to share the costs of physical rollout of mobile networks and speed up time to market. The deployment of 616 GSM networks, and more than a million BTS sites throughout the world, has brought about a form of convergence between the owners of appropriate industrial real-estate assets and the Mobile Network Operator. Network operators often share buildings, transmission sites, base station equipment, radio masts and antennae. These commercial arrangements improve the economics of deployment and have prompted some interesting revenue-sharing and cost reduction arrangements, including build operate transfer, shared wireless infrastructure, outsourcing capital expenses (Capex) and capex-transfer-to-opex. We estimate that mobile network operator revenues totalled $426bn in 2003 (based on current exchange rates), an increase of 19% vs. 2002. We believe GSM accounted for circa 65% of this total. Going forward, Deutsche Bank expects much of the growth to be attributable to the Rest of World category, primarily driven by China.

Figure 10: Mobile network operator revenues ($bn)



Source: Deutsche Bank estimates and company data

MVNO's could account for 195m of the world's 1.9bn mobile subscribers by the end of 2006, representing just over 10% of all mobile customers

Spawning the MVNO

The concept of a Mobile Virtual Network Operator (MVNO), a service provider that does not own its own spectrum and usually does not have its own network infrastructure, was largely a European GSM phenomenon. Today, the concept of MVNO had caught on in many parts of the world, including the US. The MVNO concept was loosely based on attempts by new mobile network operators to reduce costs while increasing their national coverage. MVNOs have commercial arrangements with traditional mobile operators to buy minutes of use (MOU) for sale to their own customers. MVNOs typically add value such as brand appeal, distribution channels, and other embellishments to the resale of mobile services. Perhaps the most famous example of an MVNO is Virgin Mobile, who has successfully used its strong brand and customer relationships to sign up millions of customers throughout the world. Although, MVNOs typically do not have their own infrastructure, some leading providers have actually established their own Mobile Switching Centres (MSC), and even Service Control Points (SCP), which plug into the Intelligent Network. In this way, MNVOs can treat the Mobile Network Operator's Radio Access Network as a mere commodity, while the MVNO offers its own advanced intelligent and differentiated services.

MVNOs have full control over the SIM card, branding, marketing, billing and customer care operations. While sometimes offering operational support systems (OSS) and business support systems (BSS), to support the MVNO, most incumbent mobile operators prefer to keep their own OSS/BSS processes and procedures separate and distinct from those of the MVNO.

The advent of the MVNO is often seen as a double-edged sword. On the one hand, the mobile network operator has invented a new competitor that may capture returns. On the other hand, the MVNO attracts and stimulates more traffic on to the network, resulting in a better return on investment for the mobile network owner.

Subscribers to MVNOs are likely to increase dramatically over the next five years (according to Deutsche Bank estimates), accounting for 195m of the world's 1.9bn mobile subscribers by the end of 2006, which represents just over 10% of all mobile subscribers. Deutsche Bank predicts an Annual Average Growth Rate (AAGR) of

127% in subscribers to virtual operators between 2001 and 2006, compared to a 17% AAGR for mobile subscribers as a whole. In our view, it is likely that incumbent mobile operators will continue to embrace MVNOs as a means of deriving revenue to offset the enormous cost of building next-generation networks.

The value chain - retailers

Retailers are the final segment in the mobile telecommunications industry. They offer mobile services to end-users on behalf of the mobile operators and service providers. Customers can purchase mobile telecommunications hardware and services from two types of retail outlets: specialty outlets that may be branded by a Mobile Operator, or outlets that sell mobile telecommunications as part of a broad range of products.

The retail outlets play an active and important role in the sale and set-up of, and education about, value-added services. They help to reduce the complexity of purchasing decisions for mobile phones, help to understand the various advantages and capabilities of the service, and may even help to stimulate increased traffic on the network.

Mobile operators in many western economies are reaching saturation point in terms of market penetration. This has meant that GSM mobile operators have needed to create new channels to market. This has resulted in a range of partnering between mobile operators and a host of retail organisations (both specialty and consumer electronic), as well as the development of new self-service retail formats such as multimedia mobile portals to reach the mass market consumer.

Mobile portals represent an increasingly popular business strategy and an important retail development area, influencing many of the applications and services that could help the successful take-up of 3G in the future. As a result, mobile operators are developing value-added services (VAS) to generate new revenue streams, reduce churn and differentiate their businesses from their competitors. By pre-packaging mobile service and products both on-line (via Portals) and through their own and third-party retail outlets shops, the operators have become very successful in driving additional services that have relevance and add value to different mobile subscriber groups. In our view, some of the most interesting examples of this bold retail portal strategy are Vodafone's Vizzavi, O2's Genie, T-Mobile Wireless, and even Mviva.com from Carphone Warehouse, to name but a few.

We believe that mobile portals as branded content aggregators will account for over 40m users in western Europe in 2007, with an estimated market value of over $1bn. Mobile portals are also likely to see impressive growth opportunities in emerging markets such as Asia-Pacific where Sohu, Sina, and NetEase have already seen incomes soar from increasing mobile data (and SMS) usage, especially amongst younger mobile users.

In a few keystrokes of their mobile phone, GSM mobile phone users can access any portal service or mobile Internet site they want. The ability to locate people through their handheld device, the availability of services regardless of time and space, the immediacy of receiving information and service at hand, in our view makes mobile e-commerce a natural evolution of e-business. By the end of 2004, we believe 130m mobile customers will have engaged in mobile e-commerce. We estimate that these users could generate circa 14bn transactions, yielding $200bn in annual revenue. By the end of 2004, half of all Europeans will be able to access the Internet

via GSM based mobile devices, moving the mobile e-commerce market from information-provisioning services to industry-specific and transaction-based services.

Employment opportunities

Although perhaps not the intent of introducing a new technology, the implementation of the GSM standard has directly, and indirectly, contributed to economic growth, led to the creation of new employment opportunities and contributed significantly to the GDP of many countries.

Determining the exact employment contribution is as equally difficult as calculating global mobile revenues: it is extremely difficult to know where to draw the lines. Typically, economists use a "multiplier" for a given industry to work out the total employment level of all of its offshoots. We estimate that in 2002, the global workforce directly employed by mobile operators, equipment vendors and semiconductor companies totalled 1.2m, of which we believe GSM accounted for over 75%. Assuming a fairly conservative multiplier, we estimate that approximately 4.1m staff were employed by the overall mobile industry in 2002. We do not believe this rose dramatically in 2003 as many companies, particularly in western Europe, tightened their belts in order to produce strong free cashflow.

Although it can be argued that mandating a particular standard does not automatically lead to employment opportunities, it is doubtful that a competing, diffuse set of standards, lacking the openness and huge economies of scale of GSM, would have had the same impact. The introduction of GSM enhanced competition by defining that the interfaces to the subsystems remain open, but allowing the choice of the internal component technologies to be left to the equipment suppliers. This invited the formation of constellations of R&D alliances around competing component technologies.

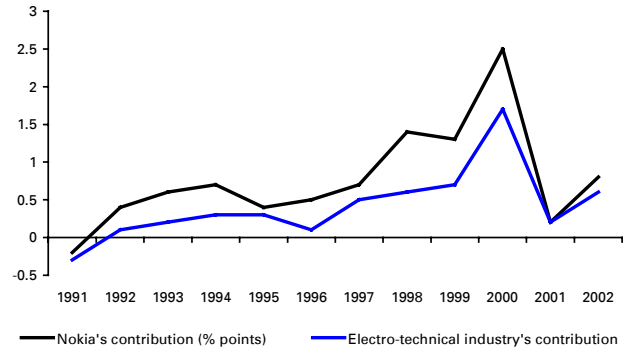
Moreover, the technological challenges of introducing a new digital technology were immense, with exponential increases in the complexity of the radio, signalling and control software. Meeting these challenges involved the interplay of various clusters of technologies and competencies. Thus, the EU standardisation of GSM permitted a number of European telecommunications equipment companies (e.g. Ericsson, Nokia, Siemens, Alcatel and Philips) to enjoy the benefits of technological learning and economies of scale in component manufacture, enabled by the early adoption and growth in world markets for mobile communications.

The introduction of GSM, and the associated liberalisation of mobile markets in the late 1980s, enabled companies like Ericsson and Nokia to quickly take their advantage and emerge as major global players in the mobile telecommunications market. We believe Nokia's breakthrough, and the Finnish experience, is a story worthy of special mention.

In 20 years, Nokia, has grown from being a manufacturer of wood-pulp and paper products to the world's leading producer of mobile phones. It has become the archetype of a company influenced by the GSM mobile phone. Nokia is now so large and powerful it dominates the economy in its home country of Finland. It accounts for almost a quarter of total Finnish exports and contributes significantly to the country's economic growth. Nokia employed approximately 52,000 people in 2003, which represents 5% of the manufacturing labour pool and 1% of the total employment figure for Finland. Nokia itself has increased GDP by more than 1.5% and represents an industrial economic pillar, in its own right, alongside Finland's traditional metal and engineering and forest based industries.

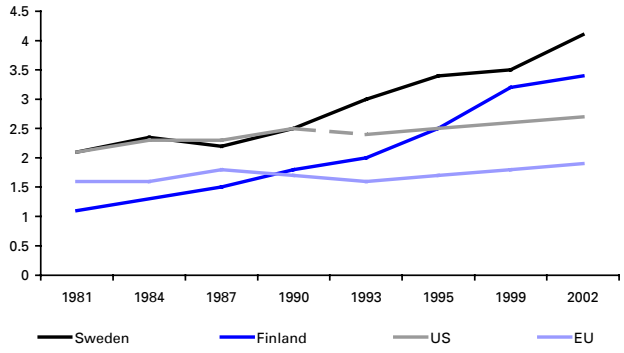
As Nokia has grown, a whole Information and Communications Technology sector of over 6,000 companies has sprung up around it. Some of these companies work directly for Nokia, others owe their existence to the company because of the huge sums it has spent on research, development and staff training. Finland's share of gross domestic research & development expenditure (GERD) is the second highest in the world - only neighbouring Sweden surpasses it.

Figure 11: Nokia's contribution to domestic GDP (%)



Source: ELTA Research Institute

Figure 12: Gross domestic spending on R&D



Source: ELTA Research Institute

Much of the structural change, and rising investments in R&D, is attributable to the Information Communications and Technology (ICT) sector; and within that sector mobile telecommunications equipment manufacturing and Nokia dominate. In order to meet the technological challenges of GSM, Nokia began co-operating with a large number of Finnish companies, which have been able to expand their operations and to grow internationally with Nokia. The foremost examples are:

- Elcoteq, which has become one of the world's largest electronic product contract manufacturers;
- Eimo and Perlos, whose products include precision and decorative plastic components and enclosures for mobile phones;
- Comptel, who develops mediation software linking OSS and BSS systems;
- Tecnomen, which develops messaging and intelligent network (IN) systems for mobile operators.
- At the other end of the value chain, we could also mention the large Finnish mobile network operators such as Sonera and Elisa, which are not only Nokia's customers, but have also been developing innovative new solutions with Nokia.

In many ways, the story of Nokia's success is the story of GSM, which helped create a unified European mobile market in the 1990s, although we recognise that Finland is not the world. The growth of the ICT sector, and in particular GSM mobile communications, has led to socio-economic impacts which are also unfolding in many other parts of the world.

Impact on financial markets

The telecommunications industry in the OECD invested nearly $230bn during the decade ending 2000

Given the hyper growth in subscriber numbers, it may come as no surprise that GSM mobile technology was one of the drivers of massive infrastructure spending in the telecom sector, into the mid to late-1990s. The emergence of new telecommunications technologies, demand for Internet and growth in mobile communications, resulted in high expectations for future revenues and earnings, boosting share prices and allowing unprecedented levels of investment.

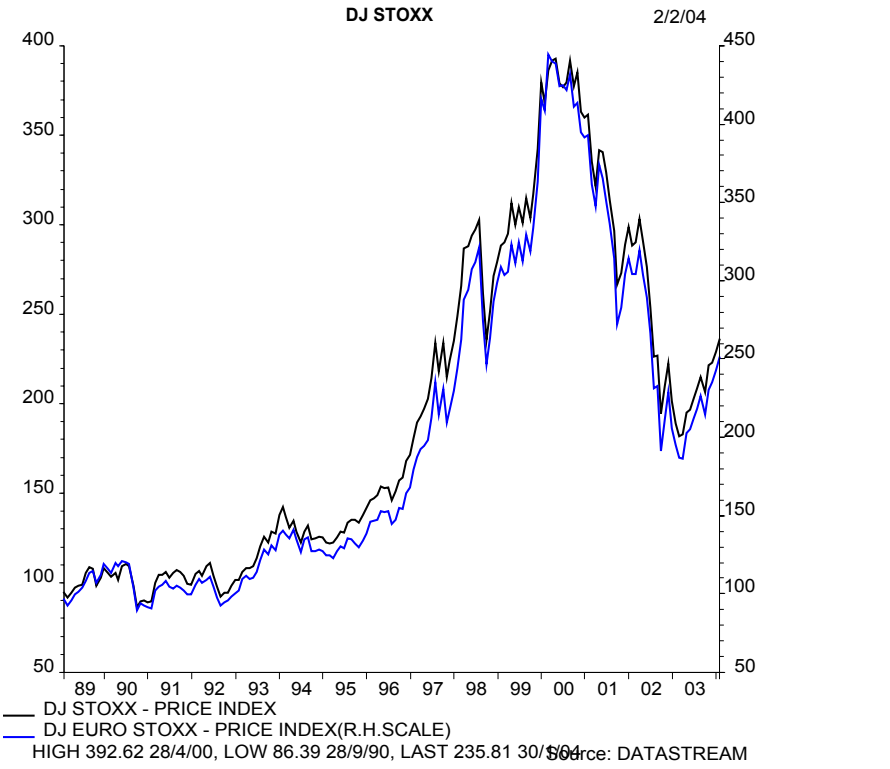
In the UK and Germany, the spending on GSM licenses was the equivalent of almost $600 per inhabitant

Deutsche Bank estimates that between 1990 and 2001, the total capitalisation of global equity markets more than doubled from $9.3trn to $26.5trn, to which the technology and telecom sectors were significant contributors. This was truly the golden age of telecommunications.

By the late 1990s Mobile Equipment manufacturers (Nokia, Ericsson) and Mobile Operators (Vodafone (VOD), Deutsche Telekom (DT) and France Telecom (FT)) had become the darlings of the stock markets, dominating the telecommunications roster, and in so doing became some of the largest capitalised companies on the planet. For a time, Nokia was Europe's highest valued company with a market capitalisation of over $210bn.

The Dow Jones Euro Stoxx Index tracks companies in countries that joined the single currency and includes the likes of Finland's Nokia, France's Alcatel, Sweden's Ericsson, Germany's Siemens and the top Telecom and Mobile Operators such as TIM, Telefonica, DT and FT. Figure 13 clearly depicts the rise and the impact these companies (which make up the largest weighting, ie 21%) had on the index over the period.

Figure 13: DJ Stoxx



Source: Datastream

The period of the late 1990s is probably best described as a market share land-grab. Awash with investors' cash, mobile companies were able to finance large-scale investment projects - customer as well as technology acquisition became paramount. Five of the 10 largest mergers or acquisitions in history involved telecoms companies during this boom period.

Of particular note was British mobile operator, Vodafone AirTouch, which had been transformed from a virtually unknown wireless start-up into the biggest mobile operator on the planet, sinking nearly $300bn into deals in 28 countries. When Vodafone AirTouch PLC (VOD) acquired Germany's Mannesmann in February 2000, it paid an astounding circa $12,400 for each of its rival's customers. Today, no other mobile operator in the world can replicate Vodafone's network with over 50,000 employees and critical mass of 130m customers worldwide.

The telecommunications industry invested heavily during the late 1990s until 2000, when spending on infrastructure reached nearly $230bn in the OECD. In addition to spending on assets, telecommunications operators spent considerable amounts, most notably in Europe, to purchase spectrum licenses for 3G/UMTS. Initially heralded as successful market-based sales of public goods, the allocation of licenses in Europe has come under increasing scrutiny and debate. Moreover, the period soured investors, with the entire telecom industry subsequently suffering from a crisis of trust.

Although mobile communications was only one of the components of the telecom bubble, the success of GSM and its phenomenal subscriber growth, in both voice and SMS services, had inspired the imagination of the industry. By 2000 there were already four times more mobile phones than PCs in the world. Technologies such as GSM fuelled the idea that the mobile phone would not only become the substitute for fixed lines, but would emerge as the preferred medium through which future Internet content and services would be accessed. The concept gained a life of its own and inspired visions of new value chains and models for commerce, with mobile operators at the nexus of this value chain and themselves acting as the new value added content aggregators, thereby emerging as the ultimate winners.

Time will tell whether this vision of the emerging mobile paradigm will materialise or not. But what we can say is that GSM has been the main driver in the shift of users from fixed lines to mobile wireless. The resulting transformational shift in communications from person-to-location to person-to-person has driven up traffic volumes, made telecommunications more accessible, spawned new industries and yielded profound economic and financial impact. Perhaps more importantly, it is the social implications of GSM in becoming the standard model for voice communications, for so many people in the world, that is its true gauge of its success.

The social impact of GSM

Social benefits of GSM

It terms of the social consequences, we believe the ready acceptance of the GSM standard is the true measure of its success. If we look at these consequences in human terms, they are not insignificant, even in what our modern world may take for granted. The biggest impact has been felt in the least developed countries, merely by GSM telephony providing a basic communications service to the remotest and poorest citizens of these nation states.

In general, the success of GSM telephony could also be weighed, in societal terms, in a number of facets:

GSM is now pervasive and cuts across societal boundaries. It can be applied to the full range of human activity from personal use to business and government. It can be tailored, personalised and localised to meet the diverse needs of the adopting community.

GSM communications is a key enabler in network creation, whether personal or business related. It can help retain family ties or encourage business relationships, in situations where fixed line telephony is either rare or absent.

The global reach of GSM allows communities to access markets that they previously had not realised existed, nor to which they had links. GSM has the potential to disintermediate, enabling producers to contact agents or customers, while reducing the need for "go-betweens".

GSM technology is the network of choice in developing countries. There are over 94 GSM networks in Africa alone

The architecture of GSM allows for rapid flow of information by voice or data messaging (SMS). Users now have access to more information, whether personal, technical, economic or political, more quickly than was possible before the global presence of GSM. Even remote communities are able to integrate into networks (sometimes global) thereby making information, knowledge and culture accessible, in theory, to anyone.

Through its global reach, GSM has allowed communities to transcend cultural and linguistic barriers by providing individuals and groups the ability to live and work anywhere. This allows local communities to retain their identities, maintain contact with expatriates and the Diaspora, while interacting with the greater mass of the world's peoples.

The standards suite of GSM encourages and allows for the rapid rollout of networks. This is particularly advantageous to telecom operators in developing countries where a mobile infrastructure does not exist. For those countries, so encompassing is the GSM architecture that, it has the feel of "telco-in-a-box" and has provided the solution for many potential implementation issues, as well as becoming the network technology of choice.

In some countries that have implemented GSM, it is a fact that the GSM standard offers technological enablers (and sometimes solutions) for overcoming the lack of a banking system (via the SIM card). This is a profound result for what was intended as a secure authorisation and authentication subsystem for telecommunications. It also demonstrates that a standardised system such as GSM can be a stabilising

influence, providing an environment for future investment and an open, flexible platform at the same time.

In many instances, particularly where telephone penetration was low or scarce, the establishment of a GSM network has enhanced a whole community's way of life. Even if individuals were unable to afford a handset themselves, they could often obtain access to one. Communities have become less isolated and more secure with the knowledge of being able to contact others.

Mobility factor – the need for humans to be mobile

One of the most appealing aspects of wireless communications is its mobility. Much of the success of GSM is due to its mobility management, offering users the freedom and convenience to conduct business from almost anywhere at any time. Hunters of the "killer app" in telecommunications perhaps fail to see that *mobility itself* is the killer app. Mobility makes it easier for people to communicate without being tethered to a wall or a terminal - or even a specific geographic location – serving the human need to communicate, and thus achieving its intended purpose.

The ability of people to originate and receive calls, and access subscribed telecommunications services on a pocket-sized, mobile terminal, in any location, has had a profound impact on society. The emergence of mobility has shifted voice from location-specific to person-specific communications. The unique consequence of which is that the network knows the context (location) you are in. This has led to the development of more precise location technology, ie callers in unfamiliar surroundings can be located and reached more speedily by the fire, police, and ambulance services; and thus relief efforts can be co-ordinated more easily.

Trials have recently started in Germany, Sweden, Spain, the Netherlands and Italy on a mobile phone-sized car safety device. It will automatically phone emergency services, telling operators in their home language if a vehicle has been involved in a severe accident and where to find it. Attached to the underside of the dashboard, is activated by the same sensor that triggers the airbag in a crash and then sends a text message, composed in the local language, which is automatically sent to the nearest emergency services operator.

Today, the mobile phone is even changing the way we work. By virtue of the mobile phone we are now (or expected to be) "contactable" 24 hours-a-day, seven days a week. Having a mobile phone removes the physical boundaries of today's static office structure and allows people to communicate and conduct business without restriction. It has granted us unprecedented flexibility and convenience while being more accessible. We can therefore complete more tasks and communicate at times, such as when travelling, which would previously have been unproductive "dead time".

Social impact of the mobile phone – personal communicator

In French the mobile phone is called "le portable", or "le G", which stands for GSM. In German it is "the handy". The Finns have adopted the term "kanny", which stemmed from a brand name, but also refers to an extension of the hand. In Spanish it is "el movil"; in Greek it is called "keeneeto" which means moveable or mobility; Americans still call it a "cell phone". In Thailand it is a "moto". In Japan it is "keitai denwa", a carried telephone, or simply "keitai", In China it is "sho ji", or "hand machine". Whatever it is called, and wherever it is used, this simple, accessible technology has changed the way in which individuals conduct their everyday lives. Many have formed a deep personal attachment to their handset; and

it has become a technology that people have become dependent on – perhaps obsessively so.

Almost no other item is carried everywhere by people in quite the same way as a mobile phone. It is far easier to make a fashion statement with a gadget that accompanies you on every social activity, than, say, with a flat screen television or hi-fi system which sits at home.

Today, people can choose between various models to match changing usage needs, differing lifestyles and individual preferences. In this regard no other mobile platform can boast as wide a variety or more configurable range of mobile devices as GSM. So important is the aspect of personalisation that manufacturers are beginning to recognise that consumers often care a good deal more about the image or fascia of their mobile phone than they do about its functionality. A recent fad was to decorate the exteriors of the mobile phones with original designs such as zebra or leopard stripes, chrome or flag patterns, even lights that flashed, spawning a veritable industry in the process. Today, mobile phones are customised around popular fashion themes from jewel incrusted designs for women, to graffiti splattered faceplates for teenagers.

Owners are increasingly customising their phones' sounds, turning mobile phones into an avenue for self-expression. Programming of melodies of the latest hit songs, in place of a standard ring tone, has become very popular. In response to this trend, newer mobile phones, which were originally quite limited, are being equipped with an ever-blossoming multitude of functions and attention-grabbing sounds and designs.

While the public display and musical capabilities of mobile phones have become a valued means of self-expression, it is the functional aspects and ability to enhance social communications that has had the most profound impact. In a role we may choose to define as the personal communicator, GSM has made its presence felt in almost every region of the world. It has changed the nature of communications, allowing not only voice, but textual modes, opening new creative forms of expression.

GSM's rapid spread and vast reach has brought the mobile phone straight into the hands of unprecedented numbers and varieties of individuals throughout the world. It has also found its way into several regions and communities who have found themselves, more often than not, excluded from the world of telecommunications and is now helping to shape that emerging world.

Bridging the digital divide

"There are more phones in Manhattan than all of Africa south of the Sahara"

The potential of GSM cellular communications to connect chronically underserved communities in Africa, Asia and Latin America, was a scenario few of the principal development agencies anticipated when mobile uptake first began to soar in Europe and the US, in the mid-1990s.

Universal access to modern telecommunications remains a dream in much of the developing world. For instance, there are more phones in Manhattan than the whole of Africa south of the Sahara. Universal access is, however, not an unrealisable dream – we believe it can be achieved with sufficient political will and the use of appropriate technology.

The most far reaching social consequences of deploying GSM mobile networks are felt in low income economies. The deployment of GSM, with its economies of scale and associated cost reductions, has demonstrated that bridging the digital divide, and bringing modern telecommunication services within reach of the inhabitants, is indeed achievable.

The regulatory regime in the target country can be the greatest obstacle (or assistance) in implementing a GSM network. Oftentimes, in developing nations, the incumbent operator has only a wireline network and is government owned. The entry of a mobile operator is seen as a potential threat and pressure is put on the government to resist this change in the status quo. A benign regulatory regime is consistent with the recent findings of the ITU on digital access and applies to telephony, as well as to Internet communications. The regulatory framework needs to be transparent, inclusive and adaptable and not hinder the development of competition in the telecommunications sector. A recent case in point is India, where inappropriate regulation and licensing held back the technical and market development of GSM.

In many sub-Saharan countries, where mobile cellular services act as a substitute for the often unreliable fixed (wireline) service, competition would expand network coverage, and hence make mobile technology an even more attractive substitute to fixed telephony. Mobile telephony, having relatively low capital intensity compared to fixed telecommunications, is therefore ideally suited to new players entering the market. In this context, GSM has won out and progressively become the technology of choice in Africa. At the end of 2003, there were 102 cellular networks in Africa with 94 networks using GSM.

A similar story can be found in Asia. China's combined teledensity at the beginning of 2003 was just 33%, which is similar to the US in 1970 and Japan in 1980. At the end of 1995, China had a total of 44.3m telephone subscribers (40.7m fixed, 3.6m mobile). However, by the beginning of this year, China's market had grown nearly tenfold in the space of seven years to over 420m subscribers. It took the US, by comparison, the best part of half a century to reach 331m. What is extraordinary is that at the end of 1990 there were just 18,319 cellular subscribers in China – or one in every 65m people in the country. However, by the end of the decade, numbers were practically doubling year-on-year, with 43.3m mobile subscribers in China at the end of 1999, 85.3m by 2000, 145m by 2001 and 250m at the end of 2003.

We have chosen two unique case studies to further highlight how quickly and completely mobile phones can replace fixed lines telephones. These can be found at the end of this report and are titled: "*Stimulating the Economy - MTN initiatives in Nigeria*" and "*GSM – the answer to an emergency in Afghanistan*".

Enabling rapid infrastructure development in developing markets

Fixed versus mobile wireless development

China plans to have a combined teledensity of 40% (over half a billion) by end 2005, but this will probably be achieved in 2004

GSM mobile wireless systems are desirable because, by their very nature, they can be designed quickly, are much cheaper than fixed line (wire-line) technologies to install and operate, and can be up and running in a fraction of the time.

Civil works account for the major costs in rolling out a wire-line infrastructure and remain the major impediment to the delivery of basic telecommunication services to households in developing countries. Typically, civil works can account for up to 90% of the total capital outlay. For example, although labour rates and municipality requirements and conditions can vary in each country, the average cost of civil

works typically falls in the range $150-$350 per metre. In some municipalities, with stringent by-laws, it can be as much as $1,000 per metre.

In the developing world, many countries are effectively "starting from scratch" when it comes to telecommunications. The very large sums of money that are needed go well beyond the capacity of most local institutions, and therefore effectively rule out wire-line deployment. The high civil works costs, together with the slow process of burying copper or fibre cables, and the associated geographic challenges, are eliminated when a mobile wireless technology such as GSM is selected. Accordingly, for the world's poorest countries, mobile wireless represents the best, perhaps the only, chance of bringing the power of telecommunications to economically disadvantaged or isolated communities.

An important ancillary benefit of deploying mobile wireless is the mobility factor. Fixed wire-line telephony cannot compete with the mobility factor of mobile wireless telephony.

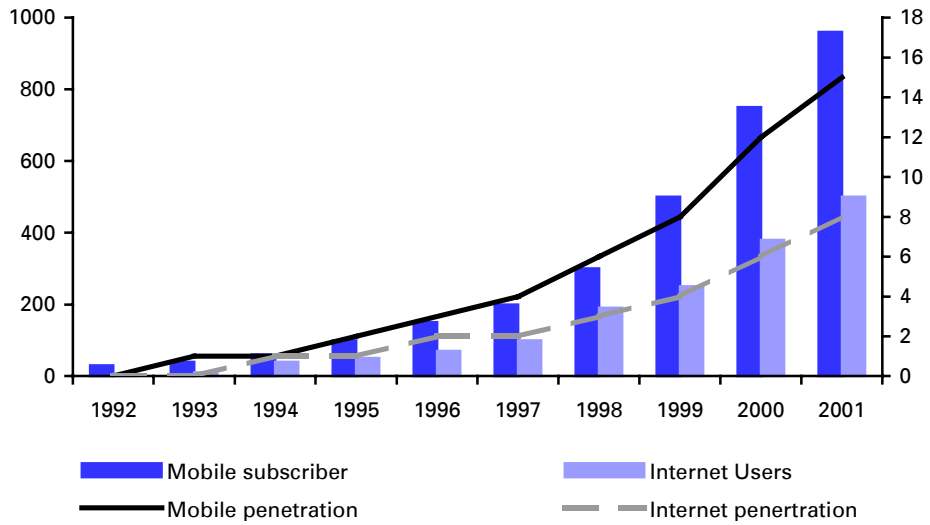
The advantages of mobile wireless include:

- lower entry and deployment costs;
- ease and speed of deployment (systems can be deployed rapidly with minimal disruption to the community and the environment);
- rapid realisation of revenue (due to rapid deployment);
- demand-based build out (scalable architecture employing open industry standards ensuring services and coverage areas can be easily expanded as customer demand warrants);
- cost shift from fixed to variable components;
- no "stranded" capital when customers churn; and
- cost-effective network maintenance, management, and operating costs.

Key factors to GSM's continued success

GSM mobile communications is one of the most explosive developments ever to have taken place in the telecommunications industry.

Figure 14: Growth of mobile and internet subscribers over past decade



Source: ITU

The Internet is also one of the technical and business success stories of the twentieth century - notwithstanding the financial losses experienced by investors - and it has emerged as a major driving force behind new developments in the area of telecommunications networks.

We expect convergence of mobility and the Internet to be the next wave in the communications and information revolution. We are evolving to a mobile wireless information society, one where a pervasive network infrastructure offering time and location independent wireless access to an abundance of value added applications and services promises to make our lives easier.

Beyond 2G -towards the mobile wireless information society

Following the great success of GSM mobile communications systems, the industry worldwide has started work on the next generation cellular system that can enhance the convenience and magnify the service quality of mobile cellular communications and provide higher speed data communications to a wider area of mobile users worldwide. 3G is the result and aims at providing a future mobile communications infrastructure combining personal communications with global, mobile, seamless and universal services, offering time and location independent access to an abundance of value-added applications that promise to make our lives easier.

As we move closer towards this mobile wireless information society, the key factors of critical importance to the continued success of GSM/3G are identified

below. The essence is: to enable data to be delivered in a global mobile environment, with the same efficiency as voice, and to ensure that the capabilities and features we have come to expect from GSM are maintained. 3G should not be preoccupied by the speed of the radio "pipe". It is far more important that services are always on, mobile centric, and enabled across continents, to deliver the expectations of the Internet – now, and wherever people want it.

Implementing 3G is really not about spectrum, technology, or data bits: it is about change. It is about service ubiquity and the freedom and convenience of conducting business from anywhere, at any time that enables the valuable extension of global person-to-person communications.

Key success factor 1 - enabling convergence with other wireless technologies

It is unlikely, even in the next generation, that there will be one unified mobile wireless access system providing pervasive connectivity to what we may proclaim as the Mobile Wireless Information Society. Realistically, future wireless access networks are likely to evolve as a network of networks, involving the integration of low-speed data services provided over large coverage areas. This will utilise the 2G/3G cellular mobile network infrastructure, with high-speed data services, provided over geographically small areas called "hotspots".

The deployment of Public Wireless LAN (PWLAN) "hotspots" has caught the public imagination. PWLANs are complementary and provide mobile cellular operators with a cheaper deployment alternative in some situations, and a viable option to supplement its infrastructure and service portfolio. A future, converged, loosely-integrated 3G-WLAN network would combine the strengths of each; resulting in a wide-area system capable of providing users with ubiquitous data service ranging from low (3G) to high speed (WLAN) in strategic locations.

To generate additional revenue in the PWLAN space with cellular mobile customers, we believe the industry will need to focus on providing a seamless user experience between the GSM/3G cellular and PWLAN access networks. The need to provide seamless coverage over heterogeneous networks and efficiently manage user mobility, as they move across different administrative domains, say from Starbucks' WLAN to T-Mobile's network, will be challenging.

As there is no existing formal standard for PWLANs, and as it lacks sufficient subscription, roaming and security facilities will be necessary to reuse existing GSM AAA mechanisms, in order to facilitate internetworking and to ensure wide adoption of a combined Cellular/PWLAN service offering. GSM systems have elaborate customer care, charging and billing systems and procedures that can be reused as the basis for the subscription management, roaming and charging facilities in a seamless, heterogeneous cellular/PWLAN services environment. This phenomenon, often referred to as wireless technologies convergence, will need the collaboration and co-operation of industry standardisation groups.

Key success factor 2 - mobile centric applications

It will be vitally important that new applications, attempting to overlay the expectations of the Internet, are mobile-centric rather than PC-centric and deliver on the promise of – "now" and "where" I want it.

The appeal of mobile "smartphones" lies in their potential to make our lives easier via the use of context-related information for facilitating and mediating communication between people. For instance, one of the unique features of cellular based wireless networks is that the context you are in (location) is known by the network; so that changing information about an individual's location, environment, and social situation can be used to deliver new context-aware communications services and applications.

Rather than simply list a sequence of potential killer 3G applications, we shall simply state what we believe are key attributes for successful mobile wireless applications.

- Easy to use and easy to buy
- Rich experience – sound, image
- Addictive – something new every time
- Impulsive – catch the user's mood
- Instant gratification – need is met immediately
- Task oriented – feel-good sensation.

Key success factor 3 – evolution of mobile business model

Simply providing access or connectivity will not be enough in a 3G world. There will be a clear separation of access and service. As network convergence continues, the method of access to a service will vary, while the service itself remains the same.

Adding 3G capabilities is more than just building a RAN network; it implies changing the core network from a network based on circuits to a network passed on packets. It is the changes to the core that will have a profound impact on all facets of the mobile operator's network and business processes and in our view will be the biggest challenge facing the mobile network operators. Although these changes have commenced, the mobile operators are finding it difficult to offer higher, data-rate, mobile IP-based services with the same quality, coverage and roaming capabilities that users have come to expect from GSM, while ensuring that existing 2G services are not compromised.

The new 3G world will shatter the old models of doing business. A new range of services is being developed that will require new business and revenue models. These services are typically real-time, on-demand and self-provisioned (initiated) by the customer, they cross physical and logical boundaries within the operator and rely on both old and new technologies from the telecommunications and computer environments in order to work. Quite simply, they operate within a whole new paradigm and need the business "re-think" to accompany that.

To be successful, the key players will have to effectively exploit this new environment, which will require a revolution in the mindset and the business model of the operator!

Changes to Operational Support Systems (OSS) and new Business Support Systems managing whole business processes and cost effectively managing the underlying network, will be required and will be critical to the success of 3G. For instance, billing and accounting are business processes that will be critical in the move towards 3G. The nature of the future services - always on, anytime, anywhere - implies ubiquitous connectivity, and therefore the ability to bill on the basis of data usage. The existing methodology of billing that uses call data records and "after the

event" processing is not sufficient in a 3G world. Billing systems will need to transition from today's transaction based systems to usage-based systems, with differing quality, based on the actual service used and contract price.

Mobile operators have a unique opportunity to take control of a gigantic mobile messaging market. Apart from talking, humans have developed a number of forms of communication that rely on technology: in their most primitive form text, or writing, as well as pictures or images. If we ignore the many touted human-to-machine interactions, then we believe that person-to-person communications will still be the single most critical factor driving the success of mobile telephony. All these products will be key to the future of the next generation of 3G mobile communications, by providing us with a more shared and inherently gratifying experience.

Key success factor 4 – mobile terminals variety

For the consumer, the mobile handset is crucial to the user experience; it is the medium through which the services are accessed and presented. The convergence of cellular mobile telephony, palm-sized computers, location-based information and other sensor data into a 3G mobile handset will involve considerable design challenges: including extra processing power, improved battery life and additional memory. All these requirements must be packaged into a form factor that is more aesthetically pleasing, more colourful, and with a lot more "grunt" than its best 2G/2.5G predecessors.

We expect pocket-sized PDAs, notebooks and mobile handhelds to be equipped with multiple air interfaces (i.e. dual mode and even tri-mode) to enable almost seamless integration over heterogeneous wireless networks. Practical limitations, as well as the reality that some subscribers will not require (or be willing to pay for) this ultimate flexibility, will dictate that 3G is allowed the time to settle the standard, and ensure commonality through various operators' solutions.

Key success factor 5 - industry partnerships and co-operations

The standardisation and industry partnership efforts being developed to evolve the GSM core, reuse its mobility and roaming facilities, and help define a complete set of specifications for the internetworking between cellular, other next generation and hotspot radio systems, will be crucial to the success of the industry going forward.

If the history of the development of GSM may serve as a model for the future, then the success of 3G must also lie in the ability of all interested parties to work together. It is no longer the domain of government regulatory bodies to determine how, when and for how much services will be offered. It is a fact of life in the complex world of telecommunications that there is a place for consultation between industry groups (comprised of vendors and operators), regulators, customer advocates and government.

The global regulatory environment is complex, wide and has far reaching implications on the ability to successfully launch and provide GSM and future 3G technologies. Government regulators have the considerable responsibility of ensuring that regulations are technology-neutral, transparent and non-discriminatory, while at the same time ensuring a "level playing field" for all participants. We believe government also has to ensure that the customer is not disadvantaged, particularly in markets where the GSM network is the default monopoly.

At the centre of this confluence is the extensive work of various industry groups, who are focussed on the 3G goal of a harmonised, if not unified, 3rd generation platform for mobiles. These groups include: the International Telecommunications Union; umbrella industry groups like the GSM Association and the UMTS forum; engineering collectives as diverse as IEEE, IEE and IETF. In fact, so broad is the reach of 3G, nearly all of C21st telecommunications is affected in some way. It is this effort which seeks to unify the international approach to spectrum management, interconnectivity, interoperability and technical standards ranging from the radio physical layer through to software applications interfaces. It is a mammoth task and has been in development for a number of years.

Of course partnerships have, and will, serve the industry well. Witness the case study of Afghanistan (see appendix 3: *GSM - the answer to an emergency in Afghanistan*) where the first mobile operator in the country was an equity partnership between government and private industry. In the commercial sector, partnerships and alliances between organisations are formed and dissolved, usually to the advantage of the members as well as the mobile telephony industry at large.

Key success factor 6 – interoperability and roaming between various platforms

Roaming has contributed enormously to the success of GSM in delivering services to users across the world. In 3G, we believe the guidelines for roaming will need to remain a central tenet. As the introduction of the 3G networks will be phased in over time, initially introduced in metropolitan areas as islands of increased capacity, within a continuous GSM sea, the ability to interoperate and roam between the islands of coverage will be critical to winning the hearts and minds of users.

New multi-mode and multi-band devices are likely to emerge that enable users to attach themselves to a range of wireless access systems. Accordingly, Inter-generational (2G-2.5G, 2G-3G, 3G-2G and GSM-CDMA, etc) roaming between the huge GSM install base and 3G, as well as other next generation mobile systems, will be key. Continuous coverage is likely to be maintained via handoff mechanisms between the technology generations and, perhaps, even other standards.

Some operators may simply choose, perhaps because of licensing or other reasons, not to deploy 3G network infrastructures, but rather become MVNOs entering into commercial roaming arrangements with the 3G infrastructure owner. Whatever business model transpires, we believe the need for backward compatibility and handover and roaming mechanisms between the technologies, will be of paramount importance.

Conclusion

This White Paper has attempted to highlight the economic and social successes of a 2nd Generation Digital Mobile Communications standard known as GSM. The economies of scale created by GSM as a unified system have provided affordable mobile communications services to all. Its ready acceptance as the de facto global standard has been a key driver for socio-economic growth in many regions throughout the world.

We also attempted to show that GSM represents more than just a radio air interface. It defines a total, functional network for a complete mobile, cellular, personal communications network. We highlighted how the success of GSM may be attributed to the fact that its development was founded on the delivery of a specific user benefit - international roaming. The demands of international roaming led to profound changes in GSM's architecture and mandated an open future-proof standard that ensured interoperability, without stifling competition and innovation among suppliers.

Moreover, we have looked at how GSM has been the catalyst in the tremendous shift in traffic volume from fixed networks to mobile networks. This has resulted in the emergence of a mobile paradigm, whereby the mobile phone has become the first choice of personal phone. How the emergence of a simple, alphanumeric text messaging system (SMS), a uniquely GSM phenomenon, has soared in an unwavering climb to almost ubiquitous acceptance. In doing so, it has significantly contributed to the mobile network operator's average revenue per user, while enriching person-to-person communications. Perhaps, most importantly of all, we highlighted how the advent of pre-paid subscriptions, and the ability and flexibility to use a mobile phone without the encumbrance of contracts, has become the single most important revenue-generating service for mobile network operators in the world. Pre-paid has simplified the service and opened access to mobile telecommunications for those who would not otherwise qualify for contract-based subscription plans. Although we accept that pre-paid is not unique to GSM, the standard's open architecture and unique design features facilitated its introduction and pervasiveness. Today, most new subscriptions globally are pre-paid rather than post-paid.

Although GSM is only one of the elements in the cluster of current, and future, telecommunications networks, it has had a profound effect on our lives. Although other forms of mobile technology may also be justified in staking a claim to the socio-economic contribution to mobile communications, it is GSM's pervasive nature that has made it almost synonymous with mobile telephony.

If we look at these aspects in human terms: GSM, merely by providing basic communications and connecting chronically underserved communities in Africa, Asia, and Latin America, has helped to bridge the digital divide and has demonstrated the most far reaching social consequences. Whereas it was once touted, "half the world hasn't made a phone call yet" (drawing attention to the digital divide between the developed and developing world), today we can say that half of the world is now within reach of a phone - and that phone is a GSM mobile phone.

Finally, we are rapidly moving towards a mobile wireless information society that will bring about the convergence of mobility and the Internet. This society promises

to provide a pervasive network infrastructure offering time and location independent wireless access to an abundance of value added applications and services, while at the same time promising to make our lives easier. However, the road to the mobile wireless information society will not be reached through revolution, but rather by evolution. But evolution does not mean it will be without challenges.

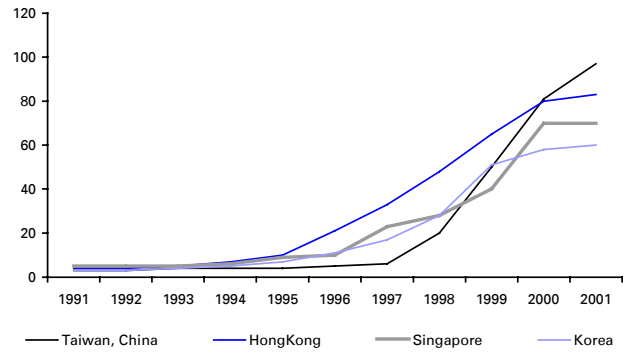
Accordingly, GSM is also evolving to enable the smooth transition to the next-generation mobile telecommunications system. Whatever disruption the next-generation systems might bring, voice and the freedom and convenience to communicate without being tethered, will remain an essential form of human communication.

Appendix 1: GSM around the world

Asia-Pacific

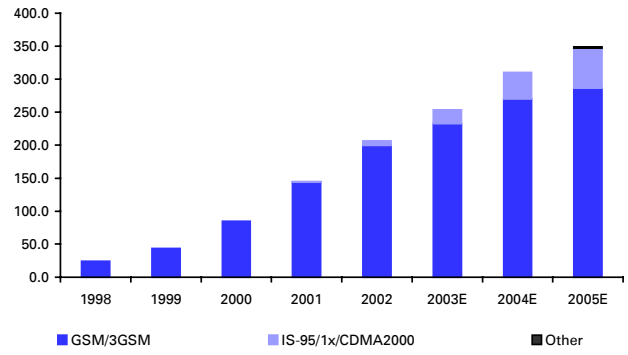
The Asia-Pacific region has been one of the only regions in the world to substantially increase its share of global teledensity since the telecom downturn began in early 2001. It is now the world's major telecommunications region, with around 36% of the world's circa two billion subscribers. To state it another way, more than one new subscriber is added every second! Surprisingly, some of the fastest growth has come in the past two years when the rest of the world has been in a telecommunications recession. We estimate that by 2006, Asia Pacific will represent 45% of the world's mobile subscribers.

Figure 15: Mobile penetration indeveloped Asia (%)



Source: ITU

Figure 16: China mobile subscribers (m)



Source: Deutsche Bank estimates and company data

China's is the largest mobile phone market (by subscribers) in the world, and currently accounts for the greatest absolute number of new subscriber additions - of any market. Mobile telephony has driven China's combined teledensity to 33% in just three years and this, together with its thriving manufacturing capability, has commanded the attention of the key global mobile handset, infrastructure and software players. It therefore comes as no surprise that most of GSM's recent growth has occurred in China; with its main GSM operator – China Mobile HK - now the largest in the world (by subscriber numbers), adding 4-5m per month. GSM's growth alone in the first quarter of 2003 was 14.1m subscribers, or 87% of new additions. The number of mobile phones has just overtaken the number of fixed telephone users (255m); and Deutsche Bank forecasts subscribers to reach 350m by 2005. The growth in the lesser known countries of Indo-China has been equally dramatic. In Cambodia, mobile communications has experienced hundred-fold growth in a decade with mobile subscribers, almost all being based on GSM, now exceeding fixed lines by more than eight to one. Vietnam's mobile growth rate has also been impressive, at over 50% annually. By the beginning of this year there were 2m subscribers, which we expect to increase to 7m by 2006, with GSM technology occupying 80% of the market. Thailand is the biggest telecoms market in Indo-China where the subscriber base currently totals over 20m, from 3m at the beginning of 2001.

India, as the second most populous country on the planet, has more inhabitants (1.04bn) than the next five most populous countries combined, and represents one of the most exciting growth opportunities for mobile. In 1995, when India opened up the telecoms sector to private companies, the country had only 8m phones- all fixed lines and no mobile connections - among the lowest in the world at 0.8% teledensity. Even today, India's teledensity at just over 6% is below the world average (14%). In 2003, it was reported that the mobile market had grown at a rate of 164%. India now, with its billion plus people, has just over 23m mobile subscribers and we expect this to grow to 120m subscribers by 2008. This makes India's mobile sector one of the fastest growing markets of this decade.

Asia contains the fastest and largest GSM markets in the world, with growth rates between 50% and 150% pa

But perhaps one of the best examples of how GSM can connect chronically underserved communities can be seen in Afghanistan. GSM mobile wireless has brought the power of telecommunications to this economically disadvantaged and isolated country. See Appendix 3: case study 2, *GSM – the answer to an emergency in Afghanistan*.

Europe

European subscribers have topped 400m with the fastest and largest market with over 32m

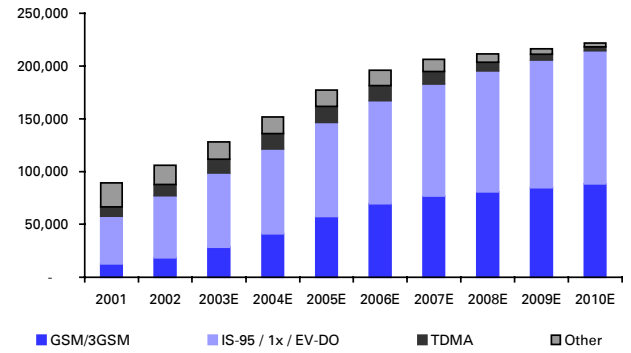
Until recently, Europe as a region had the highest total number of mobile subscribers in the world, with almost all being based on GSM. Today, the total number of mobile subscribers in Europe is approaching 400m. While western Europe previously enjoyed remarkable subscriber growth, the market – in terms of human subscribers at least – has reached saturation. It is now eastern Europe that has taken up the mobile gauntlet. In central and eastern Europe, the total number of mobile subscribers topped 100m during early October 2003, and we expect this to reach 139m by 2005. Much of this growth has been driven by Russia which is the largest, and by far the fastest, growing market in the region, with over 32m subscribers.

Americas

There are now 66 GSM networks in the Americas with a total of more than 4.5m GSM subscribers

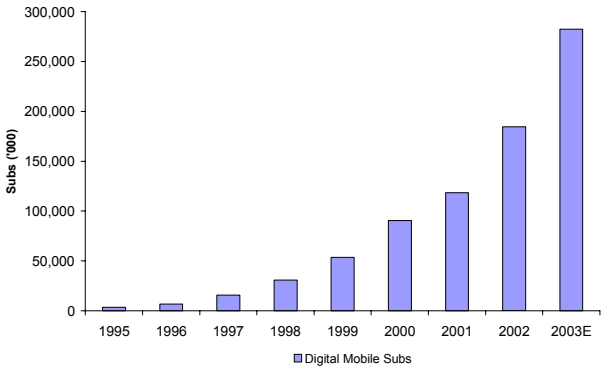
The success of GSM in the Americas has been outstanding. Brazil, the largest American market, added 1.5m new GSM customers since the beginning of 2003. This brought the total number of GSM subscribers to 4.5m. In Mexico, the second largest market, 2.16m new GSM subscribers were added over the past twelve months, making GSM the number one choice for all new mobile subscribers in the country. GSM deployments now blanket the Americas region (66 networks) with every country in Latin America and the Caribbean, with the exception of Haiti, having GSM-based mobile services. From June 2002 to June 2003, 18 operators launched GSM networks in 12 countries and that pace will only quicken as an additional 31 operators expect to launch GSM services in 20 countries in the region by the end of this year, making GSM the fastest growing technology. This is a remarkable feat, given that only five years ago GSM was operating in only four countries in the region. GSM has also outpaced other wireless technologies in the US and Canada. Based on Deutsche Bank estimates, GSM took approximately 59% of the share of net subscriber additions in 2003 in the US. In 2004, we forecast this to increase to 83% as AT&T Wireless and Cingular Wireless migrate their TDMA subscribers across to GSM. For the first time, the number of TDMA customers in North America declined by 1% in the second quarter of 2003, exemplifying the move of customers from TDMA to GSM.

Figure 17: US subscribers ('000)



Source: Deutsche Bank estimates

Figure 18: E. European digital subscribers ('000)



Source: ITU

Africa

Africa has a total of 34.3m subscribers with Vodacom, in South Africa, the largest network operator (13m subscribers). While this may seem puny relative to other markets, Africa is forecasted to grow at twice (60%) the forecasted annual world growth rate. GSM has become the technology of choice in Africa, with 94 of the 102 networks on air using GSM, and represents 96% of total mobile subscribers.

Improbable though it may seem in an area where access to low-tech necessities such as clean water and basic health care remain an urgent priority, mobile technology is proving to be one of the most successful drivers of economic development ever deployed. Africa became the first region where mobile phones outnumbered fixed lines in 2001. By 2003, in countries such as Morocco, Cameroon and Uganda, mobile phones had outnumbered fixed lines by five to one. In the Congo, mobile phones outnumber fixed lines by a ratio of eight to one. But it is Nigeria that has embraced GSM with the greatest enthusiasm. Its introduction has boosted Nigeria's infrastructure capacity and jump-started its strangulated national economy. The socio-economic consequences of introducing GSM have been revolutionary - transcending telecommunications and encouraging a world of commerce. For more on how GSM has impacted Nigeria see Appendix 2: case study 1: *Stimulating the economy - MTN initiatives in Nigeria*.

Appendix 2: case study 1

Stimulating the economy - MTN initiatives in Nigeria

MTN Nigeria provides us with an example of powerful commercial results that can be achieved by a GSM network operator, even in trying circumstances.

MTN Nigeria (a division of M-Cell, owned by MTN Group, South Africa) secured its GSM licence in January 2001, for a fee of $285m. MTN estimates that the Nigerian Telecommunications market will grow to around 10m over the next 10 years (in a population of over 124m).

Faced with poor infrastructure, an unreliable electricity supply, a restrictive regulatory regime and the anti-competitive behaviour of Nitel (the incumbent state-run phone company), MTN built a 3,000km microwave backbone through a large portion of Nigeria. This investment totalled $120m, which is substantial for the Nigerian economy.

This injection of funds, as one of the largest telecommunications infrastructure projects in Nigeria in recent times, had many positive effects:

- Accelerated capital injection into the Nigerian economy.
- Repatriation of experienced telecommunications and service personnel back to Nigeria.
- Boost to local employment from the construction work undertaken by MTN by building 17 base station sites (*from zero*) in six months.
- Build out of the network to 173 radio sites, in seven months, covering most of Nigeria's major towns.
- The establishment of three service centres and three call centres as part of the business and the employment that accompanies such a development.

This highly competitive company has energised the Nigerian economy in recent times. The mere presence of MTN in some cities has stimulated businesses and economic growth. The effect has been both direct and indirect on businesses throughout the value chain, from suppliers to bankers, subscribers, and investors.

MTN purposely partnered with many companies, while acting as a catalyst in the formation of others. It has also generated taxation revenue for the government, created employment and improved the operational efficiency of some existing organisations.

Some measure of the social impact of MTN may be seen in the following:

- MTN has generated (directly or indirectly) over 4,500 new jobs.
- Nigerians can get a MTN GSM service instantly on a "cash and carry basis" using pre-paid SIM cards. MTN can provision the service immediately – compared to a wait of several months for a wireline connection from NITEL.
- A number of armed robbery attempts have been foiled because the target families were able to contact the police.

- During the January 2002 bomb explosion incidents in Lagos, MTN not only provided people with the means to establish contact with their families, it also materially helped many people to contact their loved ones.

The economic flow-on effect of MTN's establishment into other businesses may also be seen in the start-ups established in Nigeria.

- The aftermarket for GSM handset accessories has provided employment for many people who would otherwise be unemployed.
- MTN recently signed a partnering agreement with Valu card, Nigeria's foremost electronic payment system. Subscribers can now use their Valu Card to buy recharge cards without exchanging physical cash, allowing Valu card to bring its services to over 3,000 new outlets across the country.
- MTN also has agreements with several Nigerian banks, allowing: the MTN recharge cards to serve as a ready distribution channel for the banks' services; and providing access to new and existing customers. MTN customers can now engage in "GSM banking" without even visiting the bank's branch office, establishing the company as a defacto agent of those banks.
- The mere presence of a national GSM network has dramatically improved the operational efficiency of many companies in Nigeria. Further, it has reduced the operational costs of many businesses by improving transport and personnel availability and mobility.

It could be argued that "mobile communications provided by MTN, and other companies have become essential for effective socio-economic function". and this could be one of the strongest statements of support for any technology in the 20th century.

Appendix 3: case study 2

GSM – the answer to an emergency in Afghanistan

As an example of what can be achieved by a GSM network operator, Afghan Wireless must be the most outstanding!

In November 2001, just after the Taliban regime abandoned Kabul, Afghanistan had approximately 20,000 working telephone lines for a population of 27m. Few of these lines were connected to the outside world. Outside the capital, Kabul, very few telephones were capable of making international or long distance calls.

Figure 19: Afghan Wireless Communication Company

Source: Afghan Wireless Communication Company

Most Afghans could only make calls after waiting in line for hours to use limited public call centres. For years Afghans were faced with the choice of either travelling for some distance and taking their chances with an unreliable public phone system or travelling to a neighbouring country to place their call. The latter option was arduous and dangerous, but many Afghans opted for this, thereby taking their cash out of the local economy and draining what little money the average Afghan could spare. This resulted in a vicious circle whereby the small amount of capital locals may have repatriated from relatives and friends was spent on expensive internationals calls – the money simply leaving the country again.

On a broader scale, the aftermath of the war demanded the limited resources and attention of the interim government. It was simply unable to commence the development projects critical to the nation's future, since foreign aid was held up. Simultaneously, the lack of telecommunications was seriously hampering the government's ability to perform basic functions.

In response to this emergency, the owner of Telephone Systems International (TSI), formed a new subsidiary as a joint venture with the Afghan Ministry of

Communications: Afghan Wireless Communication Company (AWCC), with the aim of building a GSM mobile telephony network. The first function of the new network would be to allow the government and international delegations to function effectively, and without recourse to individual, expensive satellite telephones.

Afghan Wireless had considerable obstacles to overcome:

- The availability of electricity in Afghanistan was, and remains, intermittent and unreliable, or simply non-existent. Afghan Wireless had to provide its own power by generators, requiring fuel to be delivered regularly over uncertain roads and guarded 24 hours a day, seven days a week.
- Transport infrastructure was badly damaged by two decades of war, with no functional highways (then) between major cities.
- Raw materials for site construction were nearly impossible to obtain. Construction teams found that there was no usable gravel available in Afghanistan—an irony in such a rocky country. Building materials were hauled in from Pakistan to install cell site towers and base stations.
- There was almost a complete absence of long distance communications infrastructure in Afghanistan at that time. Therefore, Afghan Wireless inter-city and international services required the use of satellites to carry calls between domestic towns and international gateways.

The Afghan cellular service presently relies almost exclusively on pre-paid GSM SIMs, using "top-up" cards purchased at AWCC retail outlets and customer service centres. This was seen as the only viable option, since Afghanistan did not have a banking system or reliable postal service, and the pre-paid model had proven successful in many developing countries.

The combination of international connectivity and pre-paid billing has proved to be a winner. Within months the network had grown to seven cell sites in Kabul and work had begun in four other major cities: Herat, Mazar-i-Sharif, Kandahar, and Jalalabad.

Afghan Wireless began construction of the Kabul section of its network in late January 2002. Nine weeks later, a limited wireless communications service was available to the public, including direct dialled international telecommunications via satellite (and voice mail capability). Within nine months of the initial service launch in Kabul, the entire Afghan Wireless network was hosting more than 25,000 subscribers and handling upwards of 30,000 calls during peak hours—more than three times the expected growth rate for the first year.

The speed of AWCC's network build has been breathtaking! A few milestones serve to hint at the feat it has undertaken in a very short time. In the calendar year 2002 the significant events were:

- January - Construction began on wireless network in Kabul.
- April - GSM service was launched in Kabul with four base stations.
- June -Afghan Wireless provided the Afghan Governing Council with voice and data services.
- October - Fire and Police Services in Kabul received their first handsets.
- November - Implementation of the Customer Care & Billing System commenced.
- December – Network connected a total of more than 20,000 subscribers

The years 2003 and 2004 have seen, and will see, continuation of the aggressive AWCC network rollout. The network and subscriber targets are triple the figures achieved in 2002.

- The city of Jalalabad has been brought on line.
- 15 new base station (BTS) sites were constructed in 2003, with 15 more planned.
- The first terrestrial, microwave, international link will be established (with Pakistan) in 2004.
- AWCC plans the release of a number of new services to assist government and commercial infrastructure, including GSM switched circuits.
- In Q2 2004, international roaming will commence operation.

The benefits from this system continue to accumulate. AWCC now provides communications access to many people who have never had a phone; and a large portion of the money spent by Afghan Wireless customers is funnelled directly back into the local economy.

Moreover, the AWCC network itself has taken on a strategic significance; it has now enabled and facilitated the actions of government in ways not first anticipated. Few government offices had working internal phone systems and those that did were not interconnected to each other. The Afghan Wireless GSM network has now become the de facto office and inter-office phone in government buildings.

Figure 20: Afghan Wireless Communication Company

Source: Afghan Wireless Communication Company

Afghan Wireless is investing in the community by providing free, or low-cost, support for emergency services, government functions and community groups. In October 2002, the company donated 30 phones and service to the Ministry of the Interior, for use by Kabul police and fire services. This may be extended to provide similar services to emergency personnel in other cities.

Further, Afghan Wireless employs more than 300 local workers in jobs ranging from management, help desk and customer service support to security and maintenance. In doing so, the company has provided more than 6,000 man-days of training to Afghan staff. The company also provides housing and accommodation (in many cases built by the company) for its employees.

The company's $60m initial investment in the network is the largest private investment in the country's history. It is paying off as a significant factor in improving the lives of many Afghans, by taking a war-torn country, with a population desperate for news and contact with the outside world, to one where some people can now communicate within their own borders for the first time.

This transformation is due in part to the selection of GSM as the choice of standard for the network infrastructure. The ready international pool of talent, the number of potential suppliers/vendors, the availability of handsets and the readiness of expatriates with GSM know-how has allowed AWCC to make such a rapid build-out a success.

The support of the owners of AWCC goes beyond merely fast-tracking a GSM network under harsh conditions. These benefactors have also, independently, financed a medical clinic for the welfare of AWCC employees and citizens of the country. They have also established facilities for water treatment and sanitation and opened Kabul's first bank.

Disclosures

Additional Information Available upon Request

For disclosures pertaining to recommendations or estimates made on a security mentioned in this report, please visit our global disclosure look-up page on our website at http://equities.research.db.com.

The views expressed in this report accurately reflect the personal views of the undersigned lead analyst(s) about the subject issuers and the securities of those issuers. In addition, the undersigned lead analyst(s) has not and will not receive any compensation for providing a specific recommendation or view in this report.

Gareth Jenkins

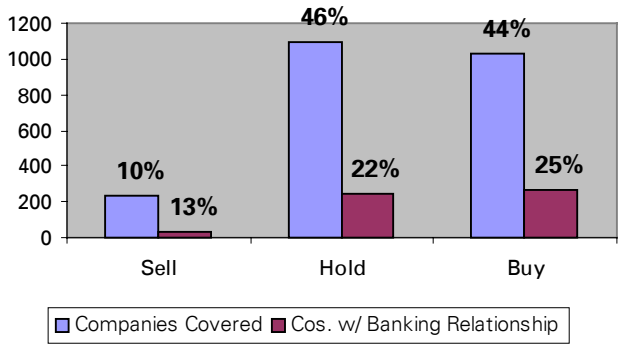
Rating key

Buy: Total return expected to appreciate 10% or more over a 12-month period

Hold: Total return expected to be between 10% to –10% over a 12-month period

Sell: Total return expected to depreciate 10% or more over a 12-month period

Rating dispersion and banking relationships



Global Universe

Deutsche Bank AG

International locations

Deutsche Bank Securities Inc.
60 Wall Street
New York, NY 10005
United States of America
(212) 250 2500

Deutsche Bank AG London
1 Great Winchester Street
London EC2N 2EQ

Tel : (44) 20 7545 8000
Fax : (44) 20 7545 6155

Deutsche Bank AG
Große Gallusstraße 10-14
60272 Frankfurt am Main
Germany
(49) 69 910 41339

Deutsche Bank AG
Level 19, Grosvenor Place
225 George Street
Sydney, NSW 2000
Australia
(61) 29258 1234

Deutsche Securities Limited
Tokyo Branch
2-11-1 Nagatacho, 20th Floor
Sanno Park Tower
Chiyoda-ku, Tokyo 100-6171
Japan
(81) 3 5156 6701

Deutsche Bank AG
Level 55
Cheung Kong Centre
2 Queen's Road Central
Hong Kong
(852) 2203 8888

Additional information available on request

The information and opinions in this report were prepared by Deutsche Bank AG or one of its affiliates (collectively "Deutsche Bank"). The information herein is believed by Deutsche Bank to be reliable and has been obtained from public sources believed to be reliable, but Deutsche Bank makes no representation as to the accuracy or completeness of such information.

Deutsche Bank may engage in securities transactions in a manner inconsistent with this research report and with respect to securities covered by this report, will sell to or buy from customers on a principal basis. Disclosures of conflicts of interest, if any, are discussed at the end of the text of this report or on the Deutsche Bank website at *http://equities.research.db.com*.

Opinions, estimates and projections in this report constitute the current judgement of the author as of the date of this report. They do not necessarily reflect the opinions of Deutsche Bank and are subject to change without notice. Deutsche Bank has no obligation to update, modify or amend this report or to otherwise notify a reader thereof in the event that any matter stated herein, or any opinion, projection, forecast or estimate set forth herein, changes or subsequently becomes inaccurate, or if research on the subject company is withdrawn. Prices and availability of financial instruments also are subject to change without notice. This report is provided for informational purposes only. It is not to be construed as an offer to buy or sell or a solicitation of an offer to buy or sell any financial instruments or to participate in any particular trading strategy in any jurisdiction. The financial instruments discussed in this report may not be suitable for all investors and investors must make their own investment decisions using their own independent advisors as they believe necessary and based upon their specific financial situations and investment objectives. If a financial instrument is denominated in a currency other than an investor's currency, a change in exchange rates may adversely affect the price or value of, or the income derived from, the financial instrument, and such investor effectively assumes currency risk. In addition, income from an investment may fluctuate and the price or value of financial instruments described in this report, either directly or indirectly, may rise or fall. Furthermore, past performance is not necessarily indicative of future results.

Unless governing law provides otherwise, all transactions should be executed through the Deutsche Bank entity in the investor's home jurisdiction. In the U.S. this report is approved and/or distributed by Deutsche Bank Securities Inc., a member of the NYSE, the NASD, NFA and SIPC. In the United Kingdom this report is approved and/or communicated by Deutsche Bank AG London, a member of the London Stock Exchange. This report is distributed in Hong Kong by Deutsche Bank AG, Hong Kong Branch, in Korea by Deutsche Securities Korea Co. and in Singapore by Deutsche Bank AG, Singapore Branch. In Japan this report is approved and/or distributed by Deutsche Securities Limited, Tokyo Branch. **Additional information relative to securities, other financial products or issuers discussed in this report is available upon request.** This report may not be reproduced, distributed or published by any person for any purpose without Deutsche Bank's prior written consent. Please cite source when quoting.

Copyright © 2004 Deutsche Bank AG