Optimising spectrum for future mobile service needs

Abstract

The paper looks at the benefits of spectrum harmonisation, and how this has led to the reduction in costs of GSM handsets, which spurred extra take-up. This in turn has created a virtuous circle, making GSM the most popular worldwide mobile technology, with over 1.7 billion users today. In 1995 GSM had some 13 million users worldwide, with around 10 million users in Western Europe (nearly 80%)[1]. The paper argues that there is a need similar support for 3GSM in the nascent start up phase today, as was shown for GSM in the early 1990's. This allows the benefits of economies of scale, particularly for handsets to be realised. The GSMA believes that users of mobile services in developing countries are particularly sensitive to higher handset prices. The fragmentation of harmonised mobile bands could have the largest impact on the uptake of mobile services in such developing counties. This is of particular concern as studies have shown a strong link in developing countries between mobile phone penetration and economic growth (GDP).

Introduction

Economic growth, the pace of technical change, and the element of mobility in modern lifestyles, will continue to drive demand for mobile services and spectrum. Mobile services will grow in number and variety, and will come to include much that is mainly available from fixed access only today, such as music downloads and podcasting. Spectrum demand will also grow fuelled by innovative mobile services, such as picture and video messaging. We can also expect to see the increase in mobile camera resolutions drive this spectrum demand even further.

Founded in 1987, the GSM Association has played a pivotal role in the development of the GSM platform and of the global wireless industry.

Since its introduction GSM Association's members and staff have created the landscape of success for global mobile communications via GSM.

The GSM Association (GSMA) is the global trade association that exists to promote, protect and enhance the interests of GSM mobile operators throughout the world. At the end of April 2006, it consisted of 699 second and third generation mobile operators and more than 150 manufacturers and suppliers. The Association's members provide mobile services to more than 1.7 billion customers across more than 213 countries and territories around the world.

The GSMA aims to accelerate the implementation of collectively identified, commercially prioritised operator requirements and to take leadership in representing the global GSM mobile operator community with one voice on a wide variety of issues nationally, regionally and globally.

www.gsmworld.com

The GSM Association (GSMA) also believes that there will be future demand for the spectrum for Mobile TV services. Technologies such as Multimedia Broadcast and Multimedia Services (MBMS), which is available in both FDD and TDD carrier

[1] Source: Informa WCIS

[4] Frequency Division Duplex and Time Division Duplex.

formats can offer Mobile TV to 3GSM users, by taking advantage of the 2.5/2.6 GHz extension bands[2] that have been identified for IMT-2000 by the ITU.

A further advantage of using the extension bands for Mobile TV is that they are fully harmonised across Europe and the greater part of the rest of the world. The value of a harmonised approach for Mobile TV spectrum is recognised by Commissioner Reding in her speeches and the extension bands deliver this requirement without any need to further regulate or re-allocate existing bands. This will ensure that the Mobile TV growth is allowed to flourish unhindered by capacity constraints within the existing core bands.

Such growth is also dependent on the availability of low cost mobile terminals that have the capabilities to exploit the added value that data services can offer. This means mobile terminals with good screen resolution, sufficient memory, and processing power. It also means user interfaces that allow easy and intuitive use of mobile devices. Offering such mobile devices involves the industry investing in major upfront costs, such as R&D, silicon development, new software, and testing, etc. Large volumes of terminals are required to spread these upfront costs. If only low volumes of terminals are produced the recovery of upfront (fixed costs) will drive up the costs of terminals significantly. This will translate into less consumer up-take of these new and innovative mobile services, which can have a negative impact on employment, the economy and competition.

Figure 5 on page 8 shows the impact such economies of scale can have on handset prices. In 1997 the average sale price of low-end GSM handsets was $250 USD. By 2004 this had fallen to around $50 USD, and has continued to fall. Part of this is due to handset subsidies, but these existed in 1997. Figure 5 also shows that the cost of silicon components (which are not subsidised) has also fallen at around the same rate. The period (1997-2004) saw GSM subscribers go from around 70 million worldwide (@40 million in western Europe)[3] to just over one billion worldwide (with only a third in Western Europe)[4]. This might indicate that economies of scale have delivered a reduction in terminal prices of up to 500%. However some of this reduction will have come from reductions in elements common to all mobile phones[5]. As Commissioner Reding noted in her CeBIT speech, "--the choice of a widely accepted standard – such as GSM for mobile telephony – is of paramount importance to get economies of scale"

The GSMA believes that the uptake in the early years of 3GSM is critical to its long-term success, as it was to the success of GSM. We are in that early phase for 3GSM, with some 74 million UMTS terminals worldwide (June 2006)[6]. Over 90% of this is in Western Europe and Japan. As we have seen with GSM, Europe can serve as the initial "breeding ground" to allow sufficient production scale to emerge, then allowing the service to flourish globally. We need to ensure that a virtuous circle is set up where more handset sales lead to cheaper handsets (because of the spreading of upfront costs). This will allow the 3GSM/UMTS market to grow the same way GSM did. Fragmenting 3G spectrum by allowing fixed wireless technologies to be the primary users[7] of such bands undermines this model. It sends a signal to other markets and regulators that might be interpreted as a lack of confidence.

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[2] 2500 – 2690 MHz.
[3] Source: Informa WCIS
[4] Source www.wirelessintelligence.com
[5] ie batteries, memory, screens, chargers etc.
[6] Source www.wirelessintelligence.com
[7] Technologies such as WiMax might be useful for cellular backhaul, or rural wireless local loop.

The GSMA also fears that developing nations will be the hardest hit by the fragmentation of spectrum usage, as people in these countries are the most price-sensitive, especially for handsets. The net effect might be less mobile broadband internet penetration. This could deny these economies the full benefits that internet might bring to increasing their economic productivity. In fact in a study by Professor Waverman of the London Business School, suggests that in a typical developing country, an increase of ten mobile phones per 100 people boosts GDP growth by 0.6 percentage points[8].

Why not let the market decide this?

The GSMA has studied various the outputs on this issue, that recommend leaving how bands are used to the market place. Some make the point that there is already sufficient spectrum for 3GSM reserved in other bands such as at 2.1 GHz, and likely 900 MHz and 1800 MHz bands. It could be argued that, in the absence of a market failure, the spectrum should be awarded on a technology neutral basis. This would allow bidders to decide what technology to use, as long as the technology causes no more interference than an IMT-2000 technology would have done. The GSMA believes that this is an over simplified view.

This "leave it to the market" view fails to appreciate where we currently are in terms of spectrum regulation. We are moving from the old "command and control" spectrum regime (where use and technology are mandated) to a more market-based regime. We have not yet arrived at a point where the market is able to work efficiently in assigning and allocating spectrum. This is due to the lack of "liquidity" of the current spectrum market. For such a market to work there needs to be clearly defined (and technology neutral) spectrum property rights. This would allow for market failures such as such as the unintended consequences of interference.

There seems to be no common agreement on what a technologically neutral spectrum property right is. Such rights are essential to allow change of use, which is needed to allow spectrum to flow from low to high value uses. There is also no common understanding of what constitutes harmful interference. In such circumstances, we do not have a properly functioning market for spectrum; one that is liquid enough to arrive at market clearing prices for various spectrum bands. Even if the spectrum market were sufficiently liquid, it might be that in some circumstances the benefits afforded by harmonisation in general, and frequency harmonisation in particular, may not be properly accounted for sufficiently in the market place. For example in helping new strategic technologies such as GSM in the early days, and 3GSM now, and Mobile TV in the near future.

In Europe and elsewhere, we are in a transition phase from a "command and control" system of spectrum management, to a more liberalised spectrum market. During such a transition, special care needs to be taken with key strategic spectrum industries such as 3GSM. We have seen the vital role GSM has played in increasing the economic welfare of countries, this economic welfare relates directly into providing jobs and tax revenues for governments. According to a study by Ovum, commissioned by the GSMA, some €106 billion was generated by the supply of mobile services in the EU15 alone in the year 2004. Some 1.7 million jobs are directly employed by the mobile industry, or depend on the mobile industry. This is some 1.1% of GDP (2004 figures). Mobile technology

[8] Reported on in The Economist, 10th March 2005, "Calling across the Digital Divide". Full report available from: http://www.gsmworld.com/documents/external/vodafone_africa_report05.pdf .

is an area where Europe has maintained a competitive advantage in terms of its technology.

This economic success is built on GSM, but future economic welfare will depend upon the growth of new technologies such as 3GSM. Any regulatory changes or uncertainty that jeopardises that needs to be considered very carefully. As the Commission Communication on radio spectrum policy[9] notes, "The EU's timely provision of harmonised frequencies "triggered" the development of new pan-European digital cellular system (GSM)". It further states that "this coherent approach was instrumental in the emergence of an industry which generated in 2004 a GDP contribution of €105.6 bn for the EU 15 alone."

The GSMA would argue that one of the dangers of this transition phase in spectrum management is in realising the benefits of frequency harmonisation, particularly economies of scale. The danger is that the competitive success of 3GSM is diminished because regulators allow the market for such services to fragment into a myriad of competing technologies. The private incentives of actors in the market are driven by issues such as IPR. The market for spectrum is not sufficiently liquid to allow such fragmentation to be reversed easily. Even if it were this would take time[10]. In the early start-up period time is a commodity that can be in short supply.

The market based approach to spectrum management advocated by some[11] notes that net gain from spectrum trading and flexible spectrum property rights would amount to €8-9 billion per year in Europe. The GSMA is not in a position to say if this is accurate or not. This figure might be used as an argument to allow flexibility in the 3G extension bands. Trading within use could still be allowed without any impact on the benefits of spectrum harmonisation if mobile is the highest value user of the band. It is clear from previous economic studies that mobile (GSM and in the future 3GSM) will be the highest value users of spectrum[12]. So the action of reserving this spectrum for 3GSM is not likely to have any significant negative impact on the benefits of trading and liberalisation.

What is required

In order to ensure the growth of 3GSM, a stable development phase is required within at least Europe. This can be achieved by reserving the 3G extension band for current IMT-2000 technologies, with an understanding that future enhancements of IMT-2000 will be allowed to ensure operators have access to the most advanced technologies. Allowing the extension bands to be used by quasi-fixed services[13] fragments this market. There are a number of technologies that are part of the IMT-2000 family, and inter-standard competition is ensured by the choice operators have between these five. It does not appear to the GSMA that this would in any way be counter to the letter or spirit of WTO rules. These rules state that international standards should be used where they apply. Any new technology that feels excluded is free to enter into the IMT-2000 family; if it can demonstrate it meets certain objective and proportionate qualification criteria. If a technology cannot meet such a basic hurdle, then it should not qualify as the primary use of IMT-2000 extension spectrum.

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[9] Brussels, 6.2005 COM(2005) 411 final.
[10] Due to problems such as hold-out issues. Ie sellers and buyers can't agree a price.
[11] For example Brussels, 14.9.2005 COM(2005) 400 final.
[12] Based on consumer and producer surplus figures.
[13] Services that describe themselves as "mobile" but do not offer standardised roaming, or seamless handover, or authentication etc.

Strong growth in mobile penetration and usage indicates a need for the 3G core and 3G extension bands

The year 2002 was a turning point in the world of telephony. For the first time, the global number of mobile subscribers overtook the number of fixed-line subscribers. Various factors point towards continued rapid growth in penetration and usage for mobile:

- Demand for 3G mobile services is growing rapidly
- Demand for general mobile services is growing, especially in markets with underdeveloped fixed line infrastructure
- Communication services are migrating from fixed to mobile networks
- The need for location-independent broadband access is forecast to grow

Growing traffic will drive the need for spectrum

Long-term forecasts for service demand are never certain since parts of them necessarily are based on forecasts of economic growth and how consumers will react to new services. Such forecasts have inbuilt assumptions, and the final demand can be very sensitive to the exact figures chosen. However, current trends and historical experience from the development of the internet both indicate an increased service demand and a substantial growth in traffic.

The UMTS Forum forecasts a typical Western European country will generate 250 Tbytes of traffic per day in 2012 and as much as 5750 Tbytes per day in 2020. The massive growth in traffic will be driven by image transfer, video transfer and internet access provisioning, the Forum predicts.[14]

When trying to meet increasing demand, there will be a choice between using additional spectrum and investing more in infrastructure, ie deploying additional base station sites. In deciding between these two options one needs to judge the difference in costs. This will depend on the difference between the savings in the cost of building new sites and the extra site rental costs, and extra cost of transceivers to use the extra spectrum (as well as the cost of acquiring more spectrum). Using typical values today, the cheaper option is to acquire more spectrum.

We are also dealing with new mobile services in their early start-up phase, so the exact dates, when consumer demand requires network capacity expansion, could be significantly sooner than the year 2020. Certain high-volume scenarios for 3G uptake predict the capacity of a typical 3G network will be exceeded in a few years.

[14] Magic Mobile Future, UMTS forum, April 2005

Strong growth expected for mobile data services

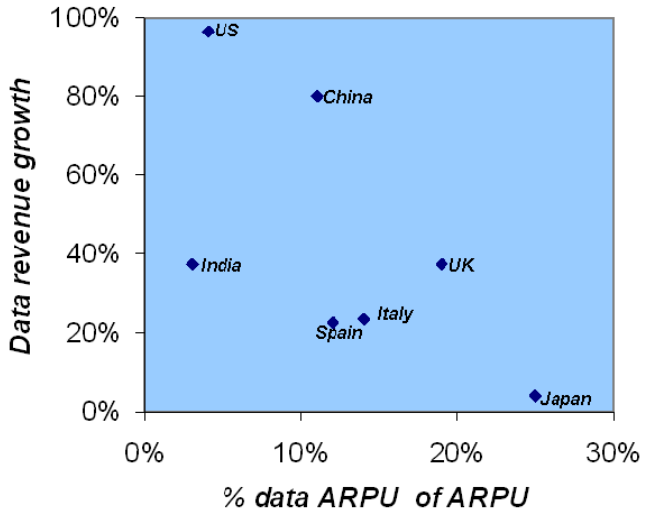

Figure 1 Mobile data ARPU YoY growth in selected markets Q1 2005 (Merrill Lynch, 2005)

Operators' revenue from data services shows strong growth (Figure 1). In 2005, a number of operators generated 20-25% of their revenues with non-voice applications. Advanced data services show particular growth. These are beginning to break the dominance of text messaging as major data revenue source.

As usage grows, end users' expectations on usability and performance will grow as well. An abundance of services and service developers are entering the

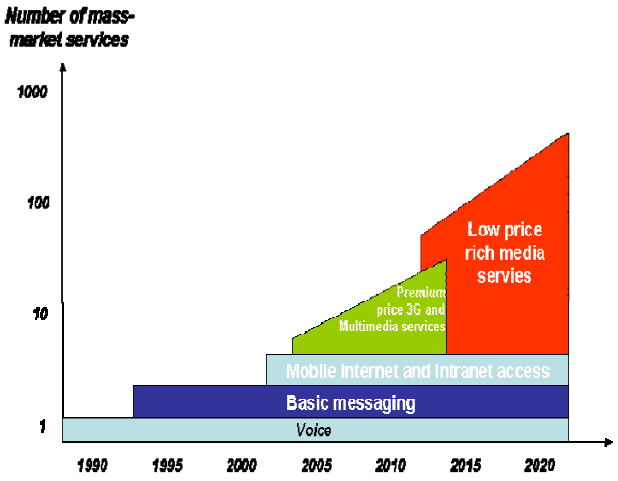

Figure 2 Mobile service availability outline 1990-2020 (Northstream)

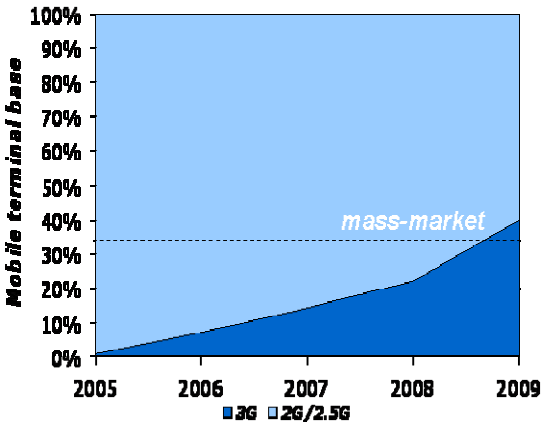

Figure 3 Penetration of 3G handsets 2005-2009 (Northstream)

market to meet these expectations. This occurs not least with 3G services. Already, operators offer a variety of interesting 2.5G data services. The 3G service market will offer an even richer set of services by all accounts (Figure 2).

Penetration remains the key indicator for 3G traffic levels. Mass-market mobile data usage and subsequent massive traffic growth assumes 3G penetration will reach mass-market levels (Figure 3).

Growing demand for mobile broadband

The penetration of broadband internet access is increasing globally. In 2005 in the US, close to 45% of households access the internet using a broadband connection. By 2010, penetration is expected to reach 80%.[15] Broadband access today is mainly offered over fixed networks. Penetration development is heavily dependent on the availability and quality of last-mile fixed-line infrastructure.

In regions with poor last-mile fixed-line infrastructure, 3G networks may provide a cost-efficient alternative. Compared with single-application access solutions, 3G provides a compelling alternative as the infrastructure cost can be spread over multiple services, including mobile voice. Internet penetration, the availability of fixed-line infrastructure, user density and affordability will determine demand for broadband over 3G.

3G can also serve as an attractive mobile alternative or complement to fixed-line broadband in markets where fixed-broadband penetration is already high. Early 3G operator experience shows that users are likely to use 3G to access the internet, especially when on the move. Ubiquitous 3G coverage, increased customer awareness and attractive price packages will drive users' willingness to access the internet via a 3G device.

Migration of basic fixed line voice services to rich mobile communication services

Fixed-line voice traffic is rapidly migrating to mobile networks. The fixed-to-mobile substitution trend indicates that 70-80% of all voice traffic in Europe will be carried over mobile networks by 2015 (Figure 4). The substitution trend in Europe correlates with increasingly mobile lifestyles and an ever-increasing focus on individual values and needs. A similar development is expected in other urban markets with well-developed fixed-line infrastructure.

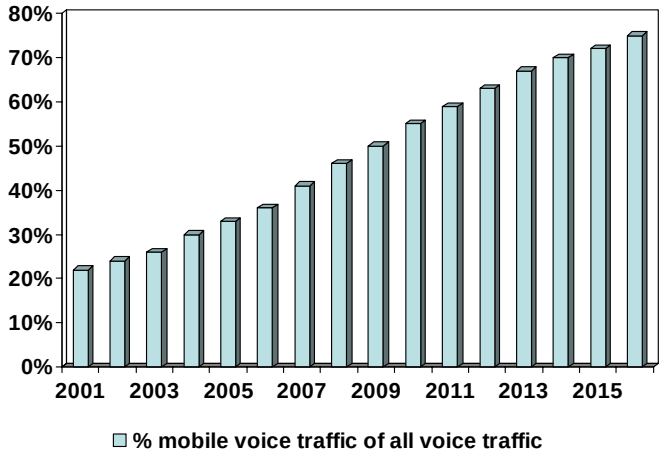

Figure 4 Assessment of fixed mobile substitution in EU-15 market (Northstream)

In addition to the fixed-to-mobile substitution trend, there is an ongoing trend where basic person-to-person voice communication is substituted for richer person-to-person communication. The addition of multimedia components to basic communication services will intensify the demand for network capacity.

In countries where fixed-line infrastructure is less developed, mobile service is the natural choice for person-to-person communication. In these cases, mobile

[15]US Online Population Forecast, 2005 to 2010 Jupiter Research, May 2005

connections are the principal means of communication rather than a substitute for fixed lines. The cost and speed of rolling out fixed-line infrastructure in such markets is unattractive compared with mobile alternatives.

However, large-scale migration of fixed-line traffic to mobile networks will challenge network performance. The current strict standards for service availability and quality will need to be maintained. It will also further increase the demand for spectrum and for a 3G extension band.

Spectrum harmonisation will boost the development of mobile services

Historically, spectrum harmonisation has positively impacted mobile service markets. The three major reasons are:

- Better economies of scale
- Lower financial risk for vendors of infrastructure and handsets
- Improved conditions for roaming

Harmonisation expands the market for equipment and services

Spectrum harmonisation enables globalization of markets for mobile network infrastructure and handsets. Globalization means better use of economies of scale, reduced manufacturer risks, shorter time-to-market and lower costs. Globalization also benefits buyers as it drives global competition and brings lower prices on infrastructure and handsets.

Economies of scale and competition improve efficiency in handset manufacture and distribution

GSM and WCDMA are the most dominant network technologies in the world, serving 74% of all mobile subscribers in 2005.

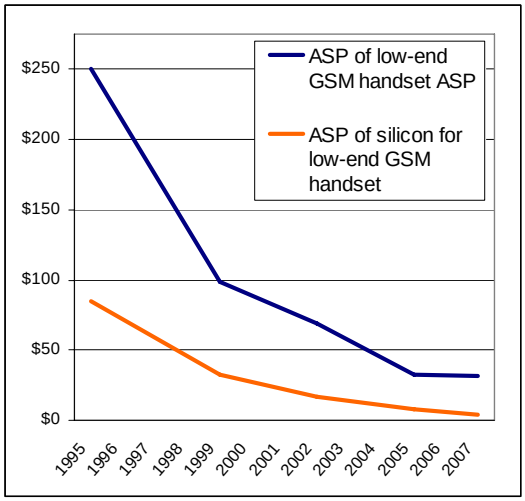

Figure 5 Average sales price (ASP) of low-end GSM handsets and their silicon chip components 1995-2007 (Arete)

GSM and WCDMA handset suppliers have benefited from better economies of scale in development, manufacture and distribution than, say, their CDMA counterparts. Economies of scale combined with intense competition among GSM and WCDMA suppliers at several levels (handset, chipset etc.; see Figure 5) have resulted in a rapid handset price decline. Ultra-low-cost GSM handsets, at $20 USD or less, will reach the market in 2H 2006[16]. WCDMA handsets are expected to follow a similar development path.

Handsets supporting cellular technologies such as CDMA, TDMA and iDEN address a substantially smaller community than GSM and WCDMA.

[16] Arete September 2005

Global competition between handset suppliers has intensified price pressure and terminal feature development, bringing market growth. The availability and variety of entry-level handsets is an important component of growth. In January 2003, less than 5% of all CDMA handsets were priced below $180 USD. The corresponding proportion of GSM handsets was greater than 40%.[17]

Fragmentation delays feature development and service interoperability

The development of GSM and WCDMA handsets has benefited from global demand for features and performance – and continues to do so. It is fair to say that GSM handset features historically have had shorter time-to-market than CDMA counterparts. Standardisation and spectrum harmonisation represent the most time- and cost-efficient path towards interoperability of networks.

Harmonised spectrum lowers the threshold for establishing roaming

When a mobile radio technology and a spectrum plan have an international base of users, it is easier for operators to make an attractive service to customers when roaming overseas.

The most obvious incompatibilities between different technologies and between different spectrum plans can be overcome technologically with multi-band, multi-mode terminals. However, the multiple radio interfaces needed in such terminals drive up the costs of development and manufacture.

Despite the fact that a significant multi-system handset base exists, inter-standard roaming remains a niche business opportunity. Inter-standard, multi-band mobile roaming is well behind mainstream GSM and WCDMA in commercial and technological development. Consider the following examples of challenges faced:

- Sprint PCS introduced international roaming in 2000, four years after GSM was launched in the 1900 MHz band

- The first GSM-CDMA inter-standard global roaming agreement was announced in 2002 at the FIFA World Cup in Korea, a full decade after the first GSM roaming agreement had been established between Telecom Finland and Vodafone UK

The GSMA also strongly believes in the benefits of harmonisation in driving down the cost of network equipment and particularly handsets. These cost efficiencies can only be achieved by producing large volumes of handsets and equipment. This is because the large upfront costs associated with developing equipment (R&D, setting up or modifying factories for production, testing etc) can then be spread over as large a number of users as possible. A one million dollar upfront cost spread over 10, 000 terminals is $100 per terminal. Thus the cost of a terminal is the cost of the materials and assembling and shipping them, plus $100. If this upfront cost is spread over one million terminals, this extra cost drops to $1 per terminal. This makes a significant difference to the affordability of mobile services, particularly in developing markets.

[17] EMC, Terminals statistics from Chinese market, total volume from February 2002 to January 2003.

Case study: Harmonisation in Europe vs. fragmentation in the United States

During the 1980s, Europe and the United States saw a similar development in their respective markets for mobile communications. In different regions, mobile operators deployed diverse mobile communication systems in a range of frequency bands, creating many cases of incompatibility. In the latter part of the decade, however, the situation started changing in Europe as international mobility was prioritized as part of unification processes. Spectrum harmonisation thereby became an important part of ongoing technology standardization efforts.

The US approach was different. International roaming was deemed of little importance, and in 1987 the FCC declared it would not mandate what technologies should be used to transmit in the 800 MHz band.

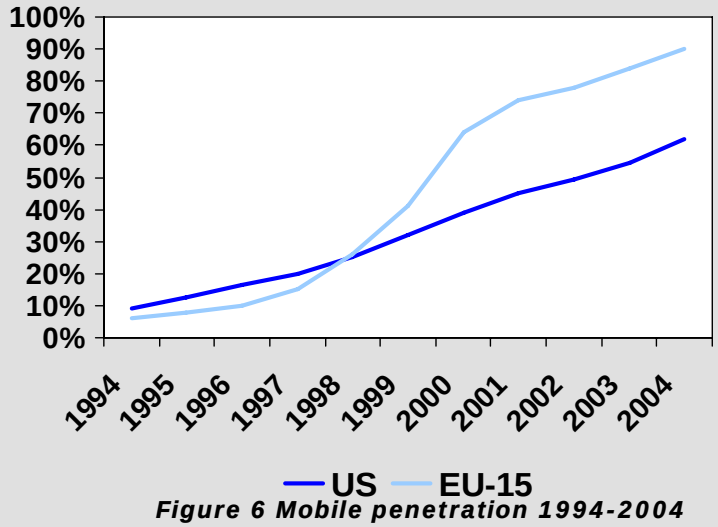

Figure 6 Mobile penetration 1994-2004 (FCC, Merrill Lynch, www.europa.eu.int)

The US approach resulted in a fragmented technology situation. The US was pushed towards continued focus on regional markets and limited interest for global spectrum harmonisation. The decision to license the 1900 MHz band as opposed to the 1800 MHz band to meet growing demand for mobile services was another step in this inward direction. Major GSM vendors rapidly developed a GSM variant customized for the 1900 MHz band but international roaming was not widely offered until the advent of handsets supporting multiple frequency bands. GSM and GSM/CDMA roaming across the 800, 1800 and 1900 MHz bands was offered. GSM/CDMA roaming in particular added substantial complexity and cost to the handset.

The fragmentation of the US market has impaired its ability to quickly make handsets available and affordable. US handsets have continuously lagged behind mainstream European GSM handsets in terms of features, performance, size and weight. Handset manufacturers have been forced to focus on basic mobility performance for the US market, at the expense of feature development.

The decision not to join the global band plan made the US handset market a local one, set apart from global mainstream competition. Market fragmentation limited the number of handset manufacturers that were able to reach economies of scale, which in turn reduced the level of competition. Differences between US and European handsets were particularly notable during the late 90's. Average US handsets, irrespective of technology were out-performed by mainstream European GSM handsets on availability, features, size, and weight.

The mass-market European service penetration in 1998-2001 (Figure 6) was catalysed by the availability of cheap mass-market handsets. GSM had been introduced to support the growing demand for mobile services as well as to satisfy the emerging demand for international roaming. Comparable US penetration was not reached for another four years. Higher handset prices and less attractive business models (receiving party pays) negatively affected take-up in mass-market segments.

The lesson from Europe and the US (handset markets benefit from economies of scale brought by harmonisation) continues to be relevant as one studies mobile markets, not least in developing countries.

The Impact on Developing Markets

Experience from the GSM community proves that harmonised spectrum combined with standardized roaming processes lowers the threshold for successful roaming. Harmonisation of technology and of spectrum plans creates necessary momentum for roaming and distributes roaming establishment costs among a larger community.

The GSMA fears that those hardest hit by market fragmentation will be developing markets. In these markets consumers are very price sensitive. Thus if the overall increase in price is say $30, then this will have a much greater impact on users who pay say $60 for a basic terminal, as opposed to users who pay $100's of dollars for high end feature rich phones.

Studies have shown the benefit that increasing mobile phone penetration can have on developing markets. Studies have also shown the increased efficiency gains that developed economies have gained in productivity from internet usage. It seems likely that developing markets would also gain in productive efficiency from increased broadband internet penetration. Frequency harmonisation is likely to raise the costs, and or lower the performance, of mobile broadband terminals. If terminals have lower performance specifications, this will mean that to provide the same quality of service will require extra infrastructure investments.

The figure below (Figure 6) illustrates the importance that mobile services can play in helping to boost economic efficiency and overall growth in developing markets. Decisions made about the spectrum used for this sector have much wider implications that relate to overall international competitiveness and attractiveness for foreign investment.

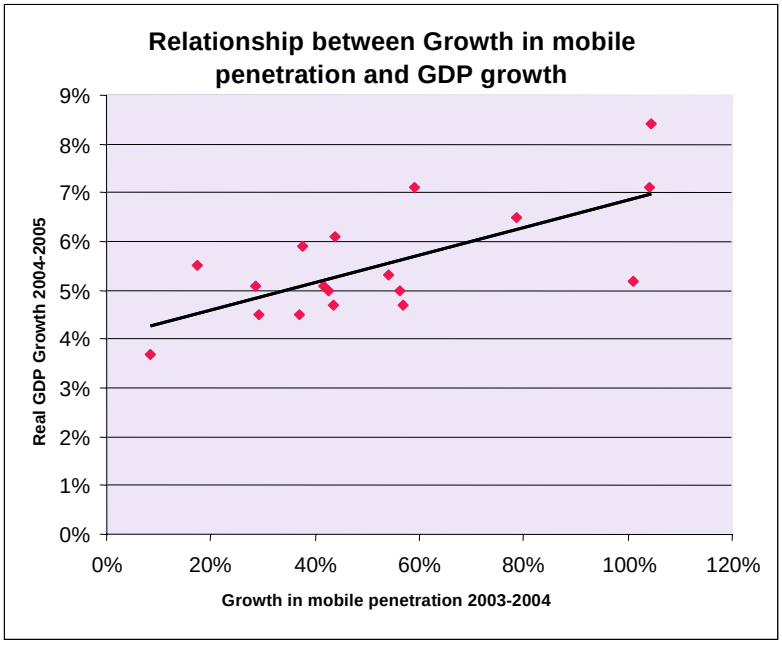

Figure 6 - Source: "The Economic and Social Benefits of Mobile Services in Bangladesh - A case study for the GSM Association" by Ovum, April 2006

The GSMA believes that the availability of broadband access promotes productivity and efficiency, and this can have a multiplier effect on investment, and economic wealth. Many studies have cited the positive impact that the

Internet has had on developed economies such as the US, in boosting productivity. Figure 6 shows the impact that predominantly voice services can have on developing economies. It seems likely that broadband Internet will have an even greater impact.

Neither of these outcomes (lower performance phones, or higher cost phones) is desirable, as they will limit mobile broadband penetration in these countries.

The case study of the US, shows the detrimental impact of fragmentation on handsets costs and performance. If this is the impact on a strong developed market economy, it is likely that the impact on developing markets will be even more profound, and negative.

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July 2006

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