

MAGIC MOBILE FUTURE 2010-2020

April 2005

Presentation of the Report

UMTS Forum

The UMTS Forum is an open, international body that promotes the global success of UMTS third generation (3G) mobile systems and services and their evolution.

Aim of this Report

The main purpose of this Report is to assist the ITU process for the preparatory work of WRC-07 under agenda item 1.4, concerning long term market forecasts needed to determine spectrum requirements for future development of IMT-2000 and systems beyond IMT-2000. ITU-R WP8F monitors worldwide activities in that area by dedicated regional coordinators. This UMTS Forum Report will provide valuable and objective input for these activities. The objectives of these activities are to provide views and forecasts for the next decade (period 2010-2020) on evolution of penetration rate (including the development of machine-to-machine applications) on the services that are expected to be used and their characteristics and finally on the evolution of usage of these services.

The Report builds on the work already carried out previously by the UMTS Forum and covers:

- A definition of expected services, their main characteristics and their structure, building on the service categorisation already presented in previous UMTS Forum reports e.g. Report #33.
- A comparison of existing UMTS Forum study results and the ITU-R current documentation for the identification of the data that is needed.
- The development of a market model for the evolution of 3G services and possible future mobile services & applications to help in creating the vision on 3G evolution and creating data for the CEPT/ITU-R spectrum requirements calculation process.
- Detailed traffic forecasts, including one typical representative European country.

Sources

To underpin this activity the UMTS Forum has commissioned a study of the likely characteristics of the traffic that might be offered to 3G/UMTS networks. Telecompetition Inc, who had previously supported the UMTS Forum's work on the traffic offered in 2012 in Report #33, undertook the study for 2020 under the active guidance of UMTS Forum Market Team. Telecompetition documents have been partly integrated in the Response to the ITU Questionnaire, submitted to ITU at end January 2005, and in this report. Additional inputs from other appropriate sources, including studies by Gartner Group, and materials provided by the UMTS Forum's membership have also been integrated.

This study follows on from other UMTS Forum reports which have previously included: the regulatory framework for UMTS; spectrum and technical aspects; the impact of licence cost levels, licensing conditions; minimum spectrum requirements, an extended vision and market forecasts. Reports on these and other topics are listed in the Bibliography and can be found on the UMTS Forum web site, www.umts-forum.org/reports.html.

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EXECUTIVE SUMMARY

By the year 2020, the global communications marketplace – and mobile communications within that – could be unrecognisable when compared with today. By reference, we need only to look back 15 years to observe that most of the dynamics that dominate communications today – like the Internet, search engines and mobile telephony – did not exist at that time and were not commonly foreseen. New sources of growth and forces of change will make up a larger universe of public communications including telecommunications, broadcasting, media and content, aspects of computing, and of course the Internet. These changes will not only affect private consumers but also companies and governments, which will have the opportunity to use new services in order to improve their efficiency thanks to their new communication tools.

Building on the work already carried out previously by the UMTS Forum, this report provides predictions and forecasts for the next decade 2010-2020 on the evolution of penetration rate (including the development of machine to machine applications), on the services that are expected to be used and their characteristics and finally on the evolution of usage of these services. The objective is to give as many accurate trends as possible in order to have a realistic shape of the future world.

Methodology

Providing realistic forecasts can only be achieved by following a reliable methodology:

- **Step 1: Trends.** Having first explored the broadest drivers that will shape the world of 2010-2020, this report discusses some key technology trends that will impact on future devices and on future mobile networks. Some major emerging services that might be available by the 2010-2020 decade are reviewed in line with the technology improvements and with existing facts and possible trends in terms of consumer adoption.
- **Step 2: Scenarios.** Predicting the level and nature of wireless service demand – in the face of such fundamental uncertainty – calls for the use of scenarios. Some important global variables have been identified in the realms of geopolitics, socioeconomics, technology and industry dynamics. According to these keys parameters, a modelling framework was used to ensure a unique positioning of three different but possible scenarios that could be presented as the possible outcomes of the future of mobile communications.
- **Step 3: Forecasts.** Among these three scenarios one has been appeared to be the most plausible. A market model for the evolution of 3G services and possible future mobile services & applications in line with this scenario has been developed to help in creating the vision on 3G evolution and creating data for the CEPT/ITU-R spectrum requirements calculation process. This approach has led to detailed traffic forecasts for the next decade, including one typical representative European country.

Key drivers that will shape the world of 2010-2020

This report first explores the broadest context in which the communications industry will operate in the next decade. Major drivers and trends that will shape the world of 2010-2020 have been identified in terms of demography, economy, social climate and information technology trends such as:

- **More urban and more aged population.** In the next 15 years, the population of the world will increase by 1.5 billion. The population of more developed regions is anticipated to change little, whereas developing countries' population will rise steadily. On a worldwide scale, population in 2020 is expected to be more urban, with 55% of the population living in a city and more aged with 31 years old median age in 2020 (+5 years compared with 2000). In Europe, the evolution for the next 20 years will be characterised by a slow growth and a more ageing population with 44 years old median age in 2020 (+6 years compared with 2000).
- **Labour force evolution will lead to new needs of communication.** In Europe, labour force evolution will lead to new opportunities for mobile industry: An increasing number of women are going to have a professional activity, while assuring their maternal role. These women are thus going to feel an increasing need for communications tools which will allow them to keep contact with their children during working time, business trips, etc. The number of economically active seniors will increase from 33 million in 1995 to 52 million in 2025 (+ 60%) leading to a higher penetration rate in communication tools. Along these 2 evolutions, part-time workers population is going to grow dramatically (from 4 to 8 percentage points according to the regions). This population will combine purchasing power and spare time to dedicate to leisure activities, including multimedia and digital services.
- **Privacy and Education identified as major social trends:** Social trends and attitudes are difficult to predict. However, it is possible to identify current but strong key social topics like privacy and education that will be increasingly important in the future. On one hand, Privacy and consumer perceptions of privacy (the threat of 'Big Brother') will be a major social and corporate concern for many years and will have a major impact on the take-up of certain communication services. On the other hand, improved education will favour access to culture and digital contents: Adult literacy and school life expectancy will increase in almost all countries and – despite important educational inequalities among regions – education in the world is expected to improve significantly. Consequently, the access to culture and to digital contents will be favoured in the next 15 years.
- **ICT environment booming everywhere, dramatic growth rates in Asia:** The overriding trend for the coming years is that information technology will make major inroads in several areas around the globe. In Western countries, ICT equipment, broadband Internet access and mobile services will be accessible to a larger part of the population. The dramatic change will come from developing countries where ICT is now allowing an increasing number of people access to the digital world. For example, Asia will be the main contributor to the explosion of the global base of Internet users, which is expected to hit more than a billion people by 2007. While North American and Western European Internet users will see their representation dropping from 53% in 2003 to 41% in 2007, Asia will double in the same period its Internet users population to represent 41% of global base users in 2007 (33% in 2003).

Key technology trends

As the technological aspect will undoubtedly impact on future devices and on future mobile networks, some key technology trends have been identified. The goal is not to pretend to tell the true story of the next 15 years, but aims at looking ahead by identifying some key facts for the consumer and by evaluating how they will affect the future mobile usage.

Mobile devices will benefit from major breakthroughs expected to occur in the next decade:

- **Powerful, Infinitesimal devices everywhere:** Technology developments for the next 15 years are expected to enable the emergence of devices, which are increasingly complex and intelligent. Improvements in semiconductor and nanotechnology will make available chips with billions of transistors (versus 500 millions today) and will allow the emergence of new generation devices with MEMS (Micro Electro Mechanical Systems), RFID tags and sensors. Processing power and storage capacity will be accordingly increased, and user interfaces improved with speech recognition, flexible screen bracelet, etc.
- **But some battery concerns:** Power supply presents an impediment to the vision of ubiquitous wireless communications. While all building blocks have seen generational performance improvements, power supply has not significantly changed in the past 30 years and will only improve its power to weight ratio.

Many networking technologies will be available to enable true ubiquitous mobile access:

- **Profusion of technologies for interoperable networks?** In the next 15 years, many mature technologies will be available and will provide different wireless network architectures and solutions: Wireless Sensor Networks (WSN) will connect objects (sensors, controls...) to each other and to data collection environment, short and medium range wireless technologies will proliferate and many devices will support multiple technologies. “Enhanced 3G” will provide an all-IP connection at multiple-megabit data rates. Seamless domain roaming may allow users to move seamlessly between physical networks with a single session. New networking protocols will connect user to the best network available.
- **2 challenges: Interoperability and Security.** The key requirement for successful ubiquitous wireless communications is the interoperability between different networks. Another challenge will be to provide a high level of security, despite the increasing complexity of networks using many technologies and many network architectures.

Emerging mobile services

In line with the technology improvements, most likely trends for some key emerging services that might be available by the 2010-2020 decade were identified. Some of the services are in continuity with the services currently available in some advanced regions markets. Customers from South Korea for instance are already experimenting such services but the future of the technologies and the education of the consumer base will widen their usage worldwide.

Object Identification, Sensor Networks and M2M : Miniaturisation made possible through nanotechnology and new materials will enable every living and inanimate object to be tagged. This will add a new set of capabilities to detection, alert or online commerce through a set of technical and commercial "bridges" between the physical and online worlds. Wireless tags and beacons (e.g., using active RFID) will be associated with specific objects and locations, which will alert handsets in the vicinity to their location or availability. Sensor nodes are closely related to RFID tags, but have more intelligence and persistent power. Thanks to them at some point in the future the number of connected points, products or machines might exceed the number of connected people (billions of units a year) and will exert a major influence on daily life over the next 10 years. For instance, Homes will be "sensorised" with remote monitoring and control of refrigerator inventory, environmental controls and parental control of content. However, sensor networks cannot make progress in the market until location sensing becomes more reliable.

Health Monitoring: Technology for monitoring a person's vital signs (i.e., "physiological monitoring") will form part of a personal area network, with the mobile device as the hub. The local device will perform a first level of analysis, with more sophisticated analysis and long term data capture available through wireless transmission of the health information to a server maintained by individuals or their healthcare providers. From a niche market with basic applications - like blood pressure measurement - in 2010, adoption will expand to routine monitoring for proactive healthcare by healthy individuals, driven by a personal desire to stay healthy with sophisticated analysis techniques by 2020.

Location Discovery: Future technologies such as wireless beacons are likely to provide both location and context information (e.g. "this is the door of a shop, this is what we sell"). By 2020 systems such as GPS and Galileo are expected to provide precision of around 1 metre, near field wireless or RFID tags a few centimetres, beacons a few metres, 2.5G or 3G network based systems such as triangulation tens to hundreds of metres. Inhibitors to location discovery will be technology and consumer attitude. The main obstacle to location accuracy is indeed location or coverage. Consumer attitude and reluctance to be located may impede some development in location-based services.

M-Payment & Micro-commerce¹: The ability to complete the retail value chain – from inquiry, to information, selection, and financial payment – is an extremely powerful mechanism that can radically change the nature of personal and business commerce and the use of traditional transaction media such as cash and credit cards. By next decade, the technologies required for initiating the interaction, the mobile transaction authentication and payment reconciliation will have matured. The major issue is who will be the beneficiaries of micro-commerce from the various stakeholders in the emerging m-payment models... Consumer attitudes should not be a major inhibitor to the development of micro-commerce but it could slow down its development.

Digital content: Mobile devices and networks will be in place to meet the consumer demand for rich digital content anytime, anywhere and over any channel. As the telecom industry evolves to become a major provider of content services, the value of such a trusted environment becomes paramount. The provision of content services carries obligations and responsibilities, particularly in the area of consumer protection. Price-sensitive consumers will endure advertising-rich or pirated content. But many will be prepared to pay for the

¹ small transactions of less than 5 €, likely even much less e.g. into the cent-arenas

improved experience of advertising-free content, wrapped in services such as personalization, recommendation engines, community, ease-of-use and one-click buying.

Mobile entertainment: The user will have the ability to view, hear, or interact with entertainment media wherever or whenever desired. In addition, the user will increasingly have the ability to adapt and use media elements to create their own personalised entertainment experience.

Corporate services: Companies will benefit from improved communication tools in order to share more efficiently information and knowledge among workers. mobile technologies like VPNs or M2M services will enable the increased blurring of home and work life. The “office” becomes the mobile technology one carries to any physical location. Working hours are likely to become more flexible as a result.

M-Government: Government will encourage adoption of technology by proactively using networks and technology to disseminate information, provide services and mandate and encourage citizen participation in government.

M-Education would represent a second step in the digitalisation of education that was decided by many governments.

Customer usage in 2010-2020

Subscribers broadly do not care about technology but are motivated by human emotions such as sex, fear and greed. Because the usage of mobile services has traditionally been driven by social habits rather than technology availability, it was necessary to adopt a human-centric design perspective that considers many factors as age, social group and more.

From this point of view, several observations can be made for the future of telecommunications services:

- **New opportunities will arise from social behaviour which is unpredicted.** One of the key abilities of any network operator in the next decade will be agility, and it will be necessary to have a process to recognise and respond to such unexpected opportunities quickly enough to profit from them.
- **Niche demographics and applications will emerge.** It is likely that, like the internet, there will be no killer markets but instead thousands of micro-markets. Flexibility and agility will be again essential.
- **Consumer attitude versus technology will segment the market.** Several markets are expected to emerge depending on consumer attitude versus technology. For example, fashion oriented consumers will be more interested in devices and peer esteem applications like media, while “technology refusers” will demand “invisible” technology and easy to use devices/applications.

*Some scenarios illustrate how consumers will use and “interact” with the various technologies and functionalities described in the two previous sections and will help linking consumer behaviours with new technologies. **Five representative typical consumers profiles** different in term of age and available income were selected to illustrate how the needs and issues of those future consumers might be addressed by future services.*

Mobile scenarios for 2010-2020

Variables impacting on the future mobile world

A market framework for the evolution of 3G services and possible future mobile services & applications has been developed to help in creating the vision on 3G evolution and creating data for the CEPT/ITU-R spectrum requirements calculation process. Geopolitical, socio-economic and technology key variables were organised in four overarching planes were used to ensure the unique positioning of three different but possible scenarios that could be presented as the outcomes for the future of mobile communications.

- **Scenario 1 “Low price, Voice-dominated Growth”** is a pessimistic scenario that describes a mobile industry evolving to bigger volumes rather than enhanced capabilities. Consumer and business voice increase in volumes but revenue flows diminish, and are not replenished with robust adoption of new applications. Overall communication industry revenue could decline as all pricing levels continue to fall, and consumers spend their discretionary money on alternative activities. Preservation of wireless access may require the intervention of government authorities.
- **Scenario 2 “Balanced, Broad-based Growth”** describes an environment where mobile networks deliver compelling new services such as anytime, anywhere streaming video customised to the needs of users, stationary or otherwise. Businesses integrate mobile deeply into their operational practices as quality and interoperability concerns no longer prevail. Other communications industry service providers are effectively converged into mobile-led companies, while content and application providers find a healthy, growing marketplace.
- **Scenario 3 “Pervasive Data-driven Growth”** is a disruptive and risky scenario where ad-hoc broadband wireless networks start to take significant part of the traffic. On these ad-hoc networks, in highly populated areas costs are low and many services are close to, if not, free. Traffic volumes increase as the cost of enabling or subsidising access falls dramatically. The user has multiple options to connect, although seamless experiences are not guaranteed and consumers must cope with a patchwork of options. The larger mobile networks ensure complementary coverage to these ad-hoc networks, on a national level.

Among the three distinct scenarios have been presented on the future of mobile communications, Scenario 2 is the main scenario envisaged and Scenario 1 and scenario 3 are disruptive scenarios and are considered to provide a full picture of opportunities and risks.

Why is Scenario 2 considered the most likely?

The UMTS Forum believes that scenario 2 represents the most plausible development of mobile communications for years 2010-2020. Scenario 2 allows the steady migration of both voice and data traffic, from wireline and broadcast means to mobile and the steady evolution of the mobile services towards sophisticated and complex services requiring efficient solutions. Consumers readily adopt mobile access opportunities as mobile terminals get bigger screens, higher quality audio and video, as laptops replace desktops, as wireless voice availability becomes truly ubiquitous and high quality, and as personal video devices

complement televisions. The steady progression of consumer demand and the emergence of global consumer expectations, enable the mobile industry to retain and confidently expand their positions. A stable environment, with the helpful guidance of government policy makers, open standards, enhanced roaming capabilities, helps investment. Innovation creates growth-oriented pressure. Competitors differentiate propositions on the basis of applications, content and quality.

Traffic forecast for a representative western European country

Since Scenario Two is considered by the Forum as a plausible one, it was used to develop specific traffic forecasts for a representative Western European country in 2020 provided by the “Draft response to the ITU Questionnaire on the services and market for the future development of IMT-2000 and systems beyond IMT-2000”. Detailed traffic forecasts for 2012 are provided by the “UMTS Forum Report #33”. In comparing the results of these two studies, key findings have been detected.

Traffic forecast 2012-2020: Key findings

- **Traffic will increase by a factor of 23:** From 2012 to 2020, total daily traffic in the Representative Western European country will grow from 250 Tbytes to approx. 5 750 Tbytes. This large growth is due to the increasing number of available services using photos, videos... which will lead to exchange higher data volumes.
- **Internet access will be the driver:** Mobile Internet access (consumer segment) and mobile Intranet/Extranet access (business segment) will benefit from higher frequency of use and larger file sizes. Mobile Internet access subscriber base will grow significantly. In 2020, voice is overtaken in terms of volume (Tbytes) by Mobile Intranet/Extranet access which generates the highest traffic volumes
- **Voice will stay the predominant service:** In 2012, voice (simple and rich) is still the first service category in terms of daily traffic volumes. Simple voice duration will remain flat in both consumer and business segments. However, total call duration will be higher in 2020 than in 2012 thanks to the increase of rich voice and VoIP calls
- **Relations between people will expand:** P2P communications (such as MMS) traffic volumes will grow from 2012 to 2020 thanks to the migration from text based MMS to photo/video based MMS and thanks to the increasing number of M2M file transfers.
- **More personalised services – from entertainment to life coaching:** In 2020, customised infotainment subscriptions base will be slightly higher than in 2012 but traffic volumes will increase steadily thanks to a higher use of services.
- **A world under individuals' own control via sensors and location based services:** Location-based services daily traffic will grow thanks to both subscriber growth and frequency of use growth.

Introduction

By the year 2020, the global communications marketplace – and mobile communications within that – may well be unrecognisable when compared with today. By reference, we need only to look back 15 years to observe that most of the dynamics that dominate communications today did not yet exist and were not commonly foreseen.

The first step of this report is to explore the broadest context in which the communications industry will operate in the next decade. A possible shape of the world of 2010-2020 is presented in terms of demographic, economic and social trends. Major trends of the development of the Information Society for the next decade are also assessed.

Secondly, the major trends in terms of technological developments and their impact on future devices and networks are explained.

Finally, the report offers forecasts for expected mobile traffic in the period 2010-2020. Predicting the level and nature of wireless service demand – in the face of such fundamental uncertainty – calls for the use of scenarios. Three descriptions of what could exist in the decade 2010–2020 have been defined. To do so, some important global variables have been identified in the realms of geopolitics, socioeconomics, technology and industry dynamics; these and through the potential impact of these variables on service availability and demand.

The three scenarios are not static descriptions of a point in time, but more a general set of descriptions about the conditions and dynamics that could result from these variables. Each scenario has a theme that is the result of a few key drivers playing out in a particular direction. Within each scenario will likely be cycles of action and reaction as countries, regulators and companies pursue their objectives, and as technology innovation occurs. Similarly, consumer response to what is on offer will vary as a result of pricing, availability, trust, ease of use, inertia and the normal panoply of other demand determinants.

This study is about the future, the future of mobile communications, and the possible face of mobile networks and services in the decade from 2010-2020. It is about sources of growth and forces of change that are under the control of the people and industries that make up the large universe of public communications. This universe includes telecommunications, broadcasting, media and content, aspects of computing, and of course the Internet.

These results are presented to provide guidance on future mobile traffic loads in worldwide and European spectrum discussions, and to provoke meaningful discussion within companies and industries about the future of the mobile industry.

1 Shaping the world of 2010-2020

The following section proposes to identify major drivers and trends that will shape the world of 2010-2020. Existing trends and projections are exposed for several areas: demography, economy, social climate and information technology development.

1.1 Demographic trends

1.1.1 World population growth

World demographics:

Despite lower projected fertility levels and the increased mortality risks to which some populations will be subjected, the global population is expected to increase by 1.5 billion during the next 20 years, from 6.1 billion in 2000 to 7.6 billion in 2020.

World population is currently growing at a rate of 1.2 per cent annually, implying a net addition of 77 million new inhabitants per year. Six countries account for half of that annual increment: India for 21%, China for 12%, Pakistan for 5%, Bangladesh, Nigeria and USA for 4 per cent each.

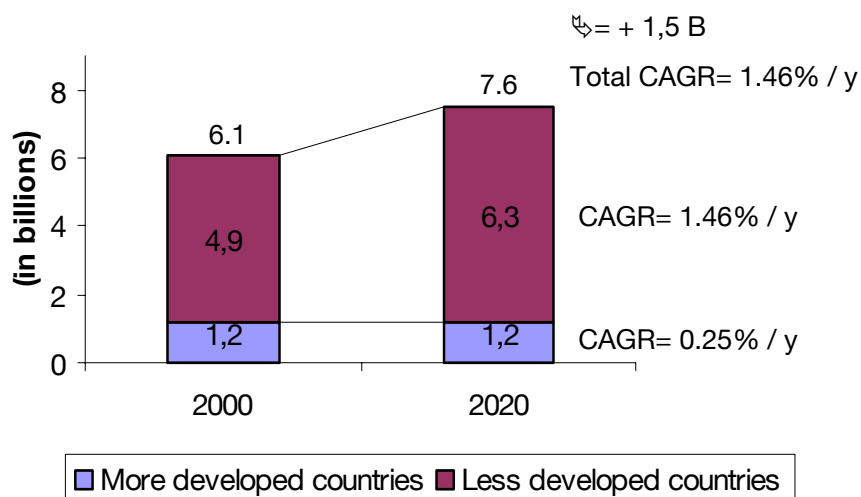


Diversity of population dynamics among the countries and regions of the world is increasing. While the population of the more developed regions is rising at an annual rate of 0.25 per cent, the population of the less developed regions is increasing nearly six times faster, at 1.46 per cent.

As a result of these trends, the population of more developed regions, currently at 1.2 billion, is anticipated to stay flat in the years to come. In addition, the population of some developed countries will decrease because of fertility levels that are below replacement level.

The population of the less developed regions is projected to rise steadily from 4.9 billion in 2000 to 6.3 billion in 2020. Particularly rapid growth is expected among the least developed countries, with current fertility rates of 5.1 children per woman.

Figure 1.1. World population

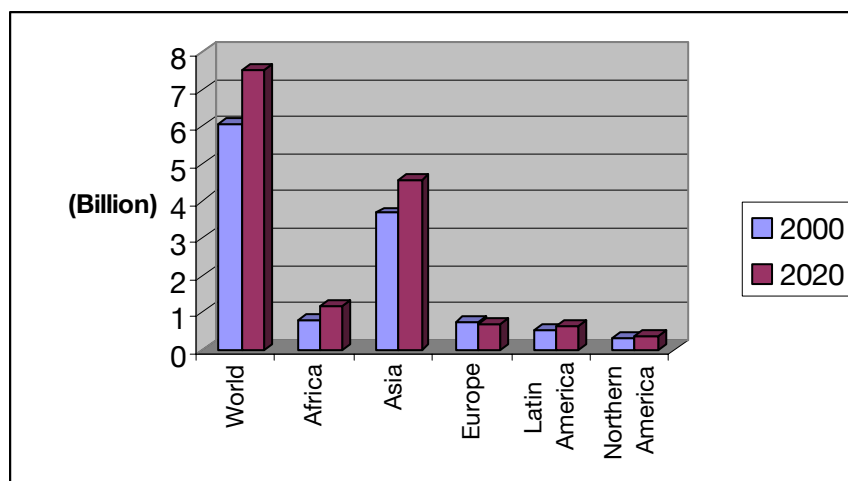


Source: UN, 2003.

(CAGR = Cumulative Annual Growth Rate)

Developed countries will represent 15% of total population in 2020, against 20% today.

Figure 1.2. World population forecast by region

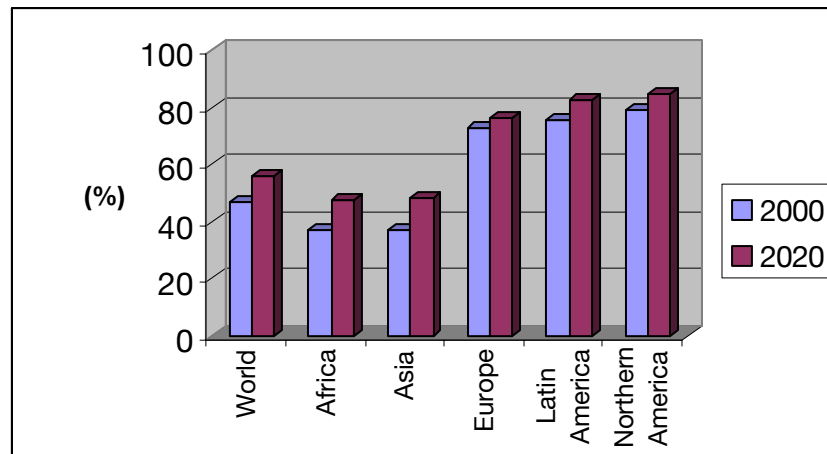


Source: UN, 2003.

Urbanisation:

Another trend that will characterise the next 15 years is increasing urbanisation. By 2020, more than half of the world's population will be living in cities, towns and metropolitan areas.

Figure 1.3. World urban population forecast by region

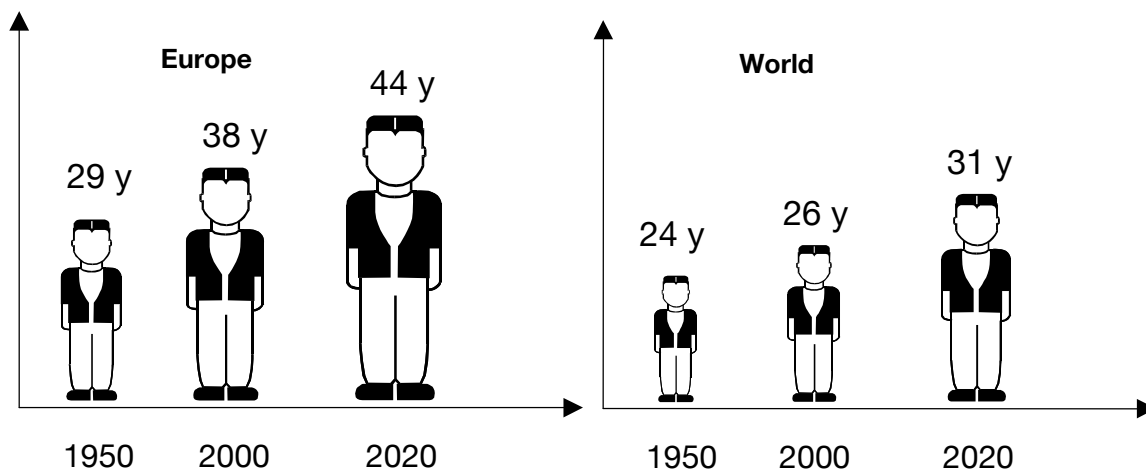


Source: UN, 2003.

An older population:

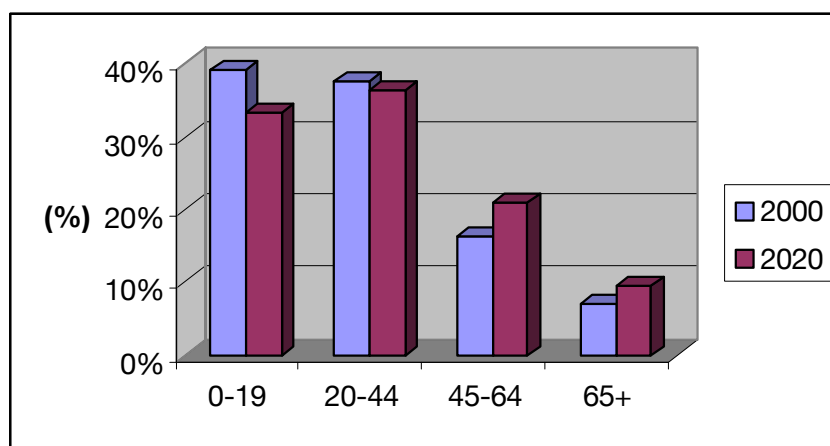
As world fertility continues to decline and life expectancy rises, the population of the world will age faster in the next 20 years than during the past half century. Over the past half century, the median age for the world increased by 2.8 years, from 23.6 years in 1950 to 26.4 years in 2000. Over the next 20 years, the median age is expected to rise by 4.3 years, reaching 30.7 years in 2020.

Figure 1.4. European and World median ages



Source: UN, 2003.

Figure 1.5. World population ageing



Source: UN, 2003.

In the next 15 years, the population of the world will increase by 1.5 billion. The population of more developed regions is anticipated to change little, whereas developing countries' population will rise steadily. On a worldwide scale, population in 2020 is expected to be more urban and more aged than today.

1.1.2 European population growth

Total European population:

The National Statistical Office reports a total population (15 European countries) of currently 375 millions persons. The National Statistical office also report 387 millions and 395 millions of persons respectively for 2010 and 2020, making the assumption of a slow growth for several years followed by a shrinkage. Western Europe will account for only 5% of the global population in 2020.

Split by age, EU 15 – year 2020:

The National Statistical Office provides the following forecasts:

Table 1.6. Split by age EU 15 in 2020

Range	0-14	15-44	45-64	65+
% of pop	16%	34%	28%	22%

Source: National Statistical Office, 2004.

The heart of the European mobile market will be older on average:

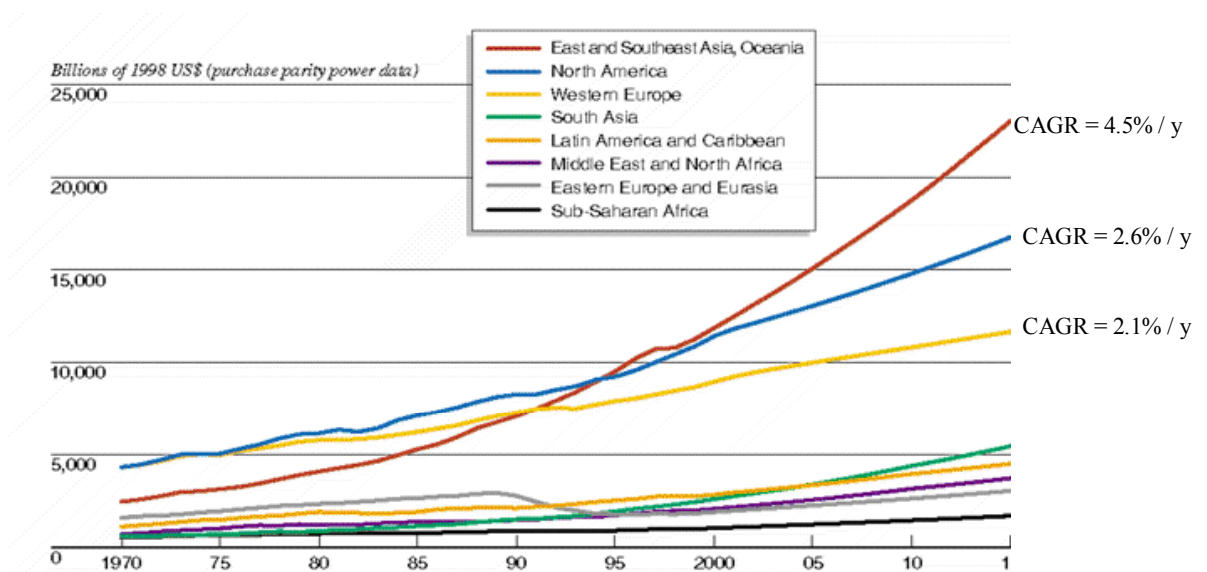
In Europe, the evolution for the next 20 years will be characterised by a slow growth and an ageing population.

1.2 Economic trends

1.2.1 Global trends

The global economy is expected to return to high levels of growth. Dynamism will be strongest in emerging markets, especially in China and India, but it will be shared by other countries, including both developed and many developing countries. However, regional differences will remain important. Countries facing internal conflicts or failing to diversify their economies will be left behind. Some countries in Sub-Saharan Africa, in the Middle East and in Latin America might not reach high growth rates for political reasons.

Figure 1.7. Regional GDP: 1970-2015



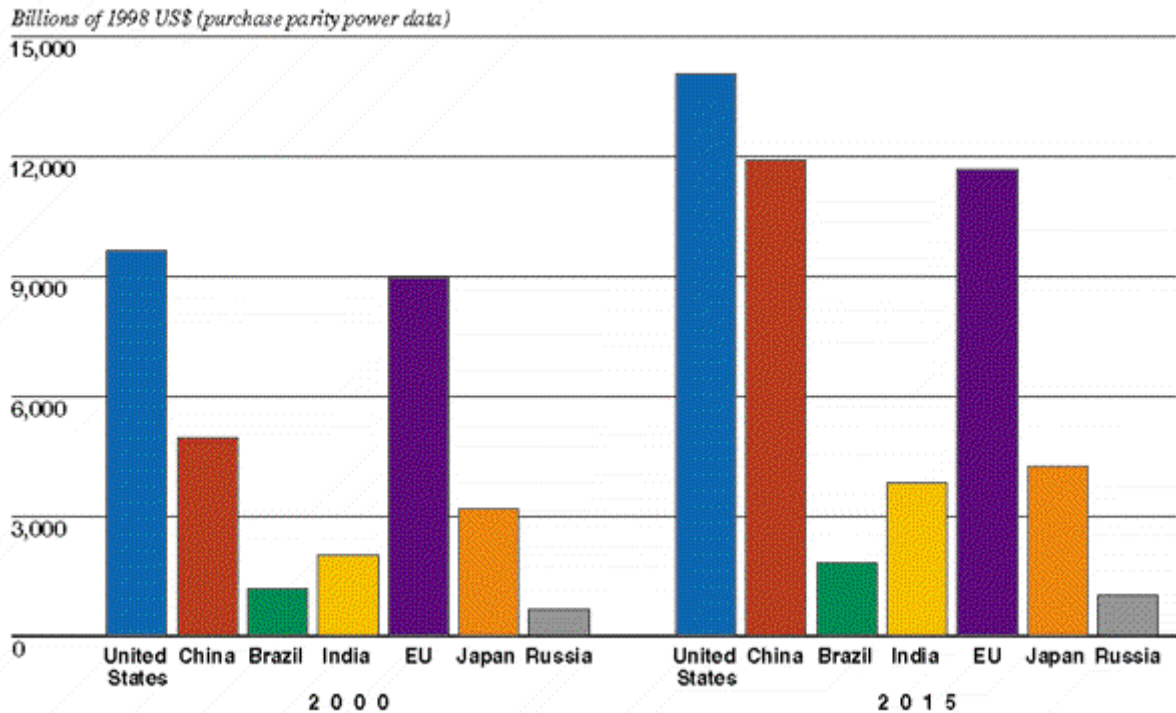
Source: NIC, December 2000.

Major global economic trends expected for the next 15 years are listed below:

- Asia will be the fastest growing region. China will have to implement reforms in order to have a more efficient economy and to enable rapid growth to continue. India will benefit from its relatively strong educational system, democracy and English-language skills. However, it will have to narrow the gap between poor and rich states.
- USA will continue to be the preponderant power of the global economy, but Western Europe is likely to improve its economic performances.
- Eastern European countries will adopt reform policies thanks to EU membership. South-Eastern Europe will have to improve regional security in order to experience better economic prospects.
- Japan's economic performance will be stronger than that of the 90's but its relative importance in the global economy will decrease.
- Latin America's growth will be high but it will vary from one country to another. Some regions will struggle with a poorly educated labour force and unstable governance.

- In Middle East and North Africa, internal differentiation will increase: some countries will benefit from globalisation whereas others will lag. In Sub-Saharan Africa, many countries will be prevented from experiencing economic growth because of persistent conflicts, low levels of education and widespread diseases.

Figure 1.8. GDP by major countries



Source: NIC, December 2000.

As shown in the graph above, China could reach the 2nd place in term of GDP, after USA and before Europe. Indeed, China is expected to be increasingly integrated into the world economy through foreign direct investment, trade, and international capital markets. India's economy, long repressed by the heavy hand of regulation, is likely to achieve sustained growth to the degree reforms are implemented. But more than half a billion Indians will remain in dire poverty.

1.2.2 European GDP evolution

Gartner has forecasted an average growth of 2.1% per annum (real) for Gross Domestic Product (GDP) in Europe by 2020. It is thus assumed that European economy will continue to grow progressively and, on the economic level, no crisis or boom will appear.

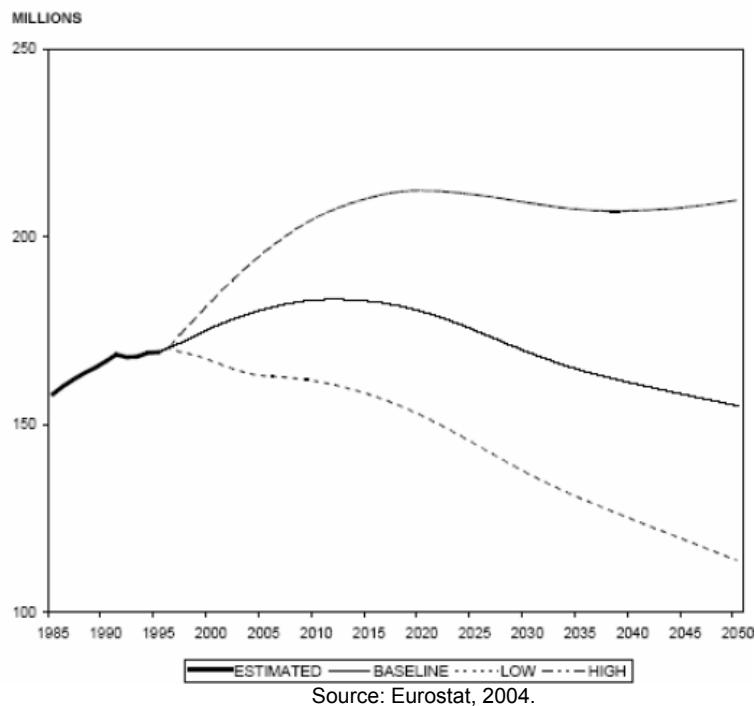
1.2.3 Labour force evolution in Europe

The number of regions within the European Union experiencing labour force decline will probably increase in the next 2-3 decades:

During recent years only Eastern Germany, and some parts of Northern Italy, Spain and Sweden have been confronted with a shrinking labour supply. If current demographic and labour market trends persist, by the year 2025 almost all European regions will face decreasing numbers of (economically) active people.

In the period 1985-1995 the EU's labour supply grew from 154 to 169 million people. If current demographic and labour force participation trends persist (baseline scenario), this labour force will first continue to grow. Around 2010, a maximum of 183 million people is expected. Thereafter the labour force will decline, and by 2050 the number of active people observed in 1985 could be reached. If fertility levels remain low, net migration drops significantly and female labour force participation stagnates (low scenario), labour supply will continue its decline that started in 1999, and fall to a level of 114 million persons by 2050. Only if fertility recovers strongly, net migration remains high and activity rates reverse or increase (high scenario), a constant level of about 210 million active people from 2015 onwards will occur.

Figure 1.9. Scenarios of labour force evolution in Europe

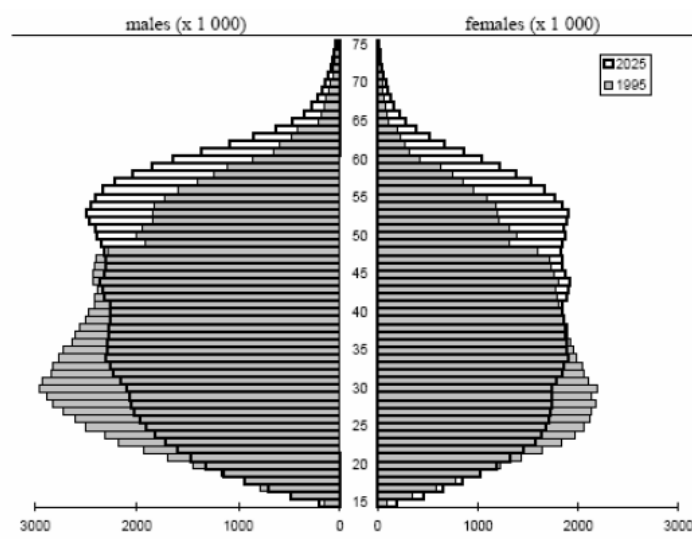


According to the baseline scenario, the number of regions with a declining labour force is expected to grow. Between 1995 and 2005 several regions in southern and northern Europe and in eastern Germany will again be confronted with a shrinking labour supply. Around 2015 half of EU's labour force is located in regions with a declining labour force, while by 2025 almost all regions might be hit. The strongest labour force decline during the next 25 years is foreseen for the eastern German regions and some regions in northern Italy and northern Spain.

All regions will experience a strong increase of elderly (50+) in the labour force:

All countries of the EU will see the share of older workers (aged 50 to 75) in the total labour force increase significantly, from around 20% in 1995 to around 30% in 2025. The major reason, however, is the ageing of the numerous post-war generations. In the European Union as a whole, the number of economically active seniors will increase from 33 million in 1995 to 52 million in 2025, which is an increase of almost 60%. However, there are big differences between countries. By 2025, Sweden might have around 20% more seniors in the labour force than observed in 1995, whereas it could almost double for the Netherlands. The comparison of the age-pyramid of 1995 with that of 2025 according to the baseline scenario shows that the shape will change drastically. While the 1995 pyramid has a large base and is getting smaller at middle age, the 2025 pyramid has a narrow basis and is getting larger at higher ages, reaching its widest part around the age of 55. This bottom-up ageing of the labour force is predominantly due to population changes, as the post-war baby-boom generation will grow older and be replaced by less numerous generations born in the 1970s, 1980s and 1990s.

Figure 1.10. Age pyramid of the labour force, EU-15

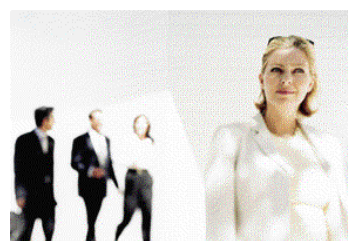


Source: Eurostat, 2004.

Regions that currently have a relatively high percentage of older workers in the labour force are mainly found in Sweden, Germany, Greece, Portugal and the United Kingdom. Low percentages are found in central and southern Europe, as well as in Ireland and Finland. By 2025, this picture will have changed considerably leading to substantial higher values. Highest values are expected in a belt going from Sweden to Greece, as well as in the United Kingdom and the Iberian Peninsula. Perhaps even more interesting to know is the speed with which regions are confronted with an ageing of the labour force. Over the period 1995-2025 several regions will probably see the share of seniors almost double.

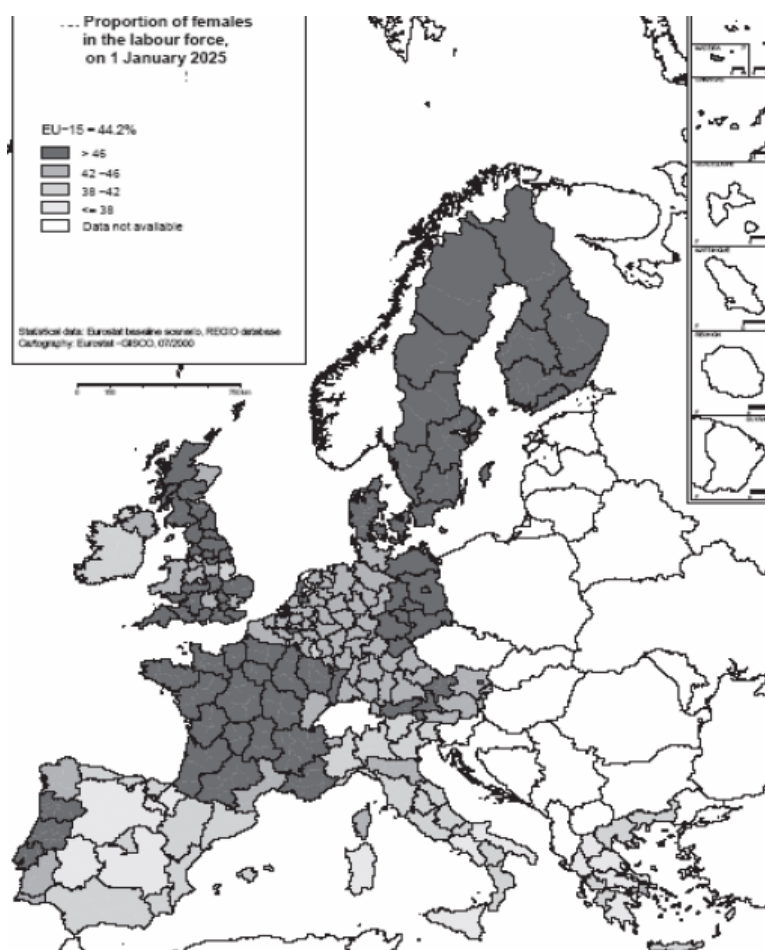
The vast majority of regions will see the proportion of women continue to rise:

Activity rates among females have shown a marked growth over the last decades. This has been facilitated by their increasing acquisition of educational qualifications and is reinforced by drastic changes in the social and cultural environment.



In all countries (except Sweden), the participation of females is expected to show a further increase. Due to (future) shortages in labour supply and further growth of the services sector, employers are, on average, more inclined to make working hours more flexible and expand parental leave arrangements. Lowest percentages were observed in Greece, southern Italy, Spain, Luxembourg and Ireland. By 2025, the picture still shows similarities with the one of 1995. High percentages are by then also found in France. Low values are to be found in Greece, southern Italy and central Spain. Only six regions show within the period 1995-2025 a decrease in the share of females in the labour force. Of those regions, five are located in the Scandinavian region where the percentages were already relatively high in 1995. Relatively high growth rates are mainly found in southern Italy, southern Spain, Austria and large parts of the Benelux region.

Figure 1.11. Proportion of females in the labour force, year 2025



Source: Eurostat, 2004.

Part-time working will continue to gain importance:

Over the last decade there has been a general tendency throughout the European Union for a growing popularity to work part-time (less than 32 hours per week). Especially for women, working in large part-time jobs (20-31 hours per week) has gained importance in the EU. In the Nordic countries most mothers take up large part-time jobs or continue to work full-time in order to combine having children with professional labour. In the Netherlands and the United Kingdom, the majority of women change from a full-time job towards either a large or a small part-time job (1-19 hours per week) after childbirth. In the southern countries both

males and females hardly participate in small part-time jobs. The recent rise in female participation in the labour force is expected to continue in the future. Therefore also part-time work will increase. All countries will see their share of part-time workers increase with between 4 and 8 percentage points. By 2025, the Netherlands will continue to have the highest share (over 39%) whereas Greece, Portugal and Spain will remain at the lowest level (around 16%).

In Europe, labour force evolution will lead to new opportunities for mobile industry:

An increasing number of women will be professionally active while retaining their maternal role. These women are thus going to feel an increasing need for communications tools which will allow them to keep contact with their children during working time, business trips, etc.

In the next 15 years, the population of part-time workers will increase. This population will combine purchasing power and spare time. On one hand, these workers will have a real purchasing power, thanks to their professional activity. On the other hand, they will have enough spare time to dedicate to leisure activities, including multimedia and digital services.

1.3 Social trends and education

Social trends and attitudes are difficult to predict. However, it is possible to identify current but strong key social topics (like concerns about threats to individual privacy) that will be increasingly important in the future.

1.3.1 General trends

From other sections of the report, we can picture the main characteristics of consumers of tomorrow.

Generally speaking, the heart of the market will be older on average, but more familiar with with mobile services.

The average customer will benefit from a higher purchasing power. He or she will be willing to spend more money in telecommunications in order to have communication tools for both professional and personal use.

Thanks to a better education, he or she is likely to buy an increasing number of cultural products, like e-books, music and movies. E-commerce will become usual and consumers will not be reluctant to buy products globally through the Internet.

1.3.2 Privacy climate

Privacy is a very emotional topic and consumer perceptions of privacy will have a major impact on the take-up of certain services, for example those exploiting personal location, spending pattern and identity. According to Gartner's analysis ("New Trends & Technologies in Communications 2010-2020 Scenarios" pub. November 2004), society is part way through a long term redefinition of "privacy". In the past privacy was defined as "control over the collection of information". The massive proliferation of sensors and monitoring using cameras, mobile devices, network sniffers and so on, means that controlling data collection is becoming impossible. As a consequence privacy will be redefined as "control over data

exploitation”. Privacy will be a major social and corporate concern for many years. Corporations will have to decide whether they use personal information with extreme care, and retain customer trust, or exploit it and operate a low trust customer relationship model.

Long term trends are difficult to predict but the current evolution of information and trust is expected to lead us in a world of controlled privacy: customers have the right to control how personal information is used but controls are established informally without government intervention. Consumers may allow access to personal information without explicit permission but they also control the access rules.

Potential evolutions that are plausible but not considered here include:

- ‘Big Brother’: Consumers are monitored continuously by governments and private industry and information is exploited mercilessly and without permission.
- Privacy Backlash: Corporate indifference to customer privacy has resulted in a political and consumer backlash which has established many regulations and expectations controlling privacy. This requires complex privacy management and monitoring systems and makes it impossible to exploit personal or location information without complex audits and controls and explicit permission in each instance if the customer demands it.

1.3.3 Other social trends

Other social trends that may impact on the consumer behaviour and its consumption of products and services are listed below:

- **Single living** demands products for lone lifestyles, such as smaller packs of commodities and security products, because for most of the day, no-one is at home.
- **Attitudes to time and money:** High-income individuals tend to have money but not time and won’t wait for anything. Forty-five seconds is too long to wait to download a web page.
- **New working trends**, such as the blurring of work and leisure, can be supported by wireless “always on” technology and collaboration tools.
- **Globalisation** demands multilingual and multicultural products.
- **Personalisation** demands products that match users’ values and attitudes.
- **Technology refusers** may become a new demographic demanding invisible, not overt, technology.
- **The ageing population** often can’t access technology. They may dislike it or be unable to read small screens or press small buttons, but provide a huge opportunity for connected products and services, such as healthcare.



1.3.4 Global education

An improvement in education level:



The period from 1990-2001 witnessed substantial growth in participation in education. A comparison of school life expectancy levels in 1990 and 2001 reveals increased participation in primary and secondary education in every region of the world.

Countries in Africa and South America had the greatest increase in participation. In both regions the median school life expectancy rose by about 1.5 years within that period. In Africa and Asia, it appears that countries lagging behind made the greatest progress over the decade. In South America, the overall increase in the years of schooling since 1990 was accompanied by greater variation among countries. This difference between countries can reach more than one year. In Asia and North America, a more even distribution among countries is observed, with a reduction of the gap between countries with low school life expectancy and high school life expectancy.

Figure 1.12. Distribution of countries by average school life expectancy, by region, 1990 and 2001

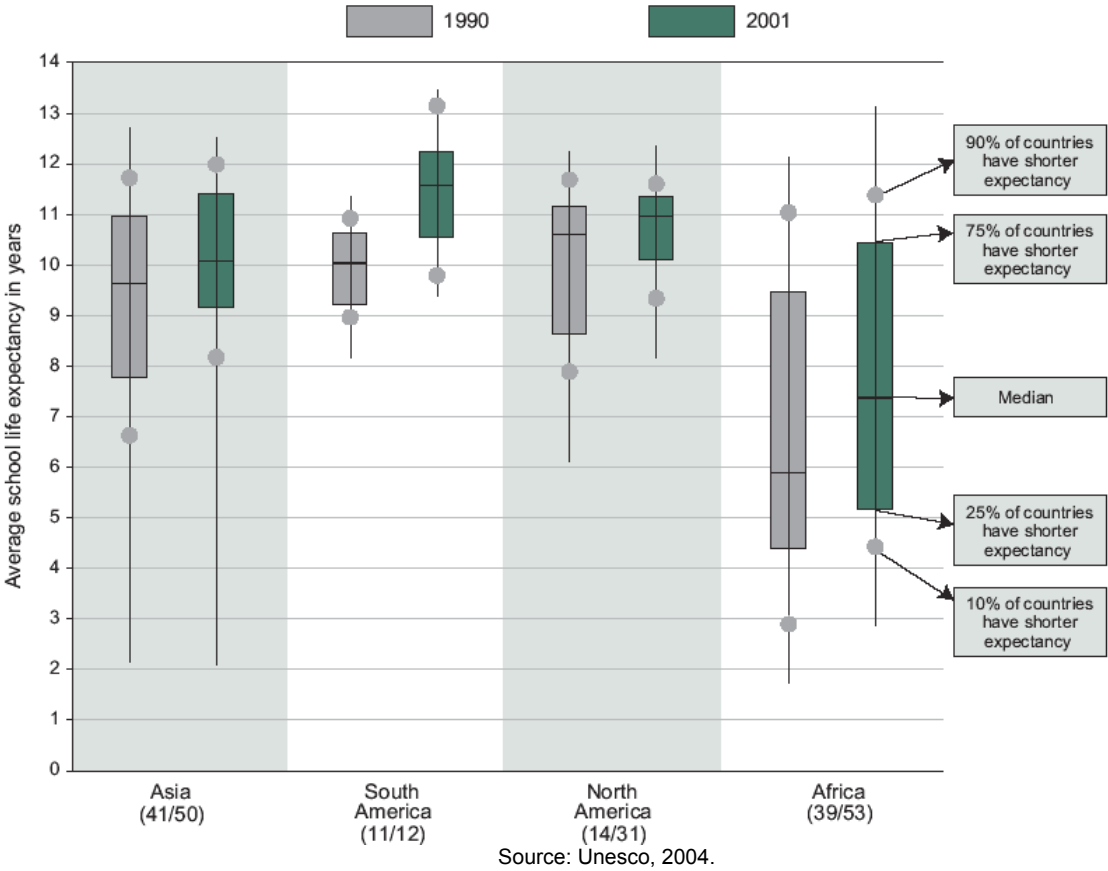
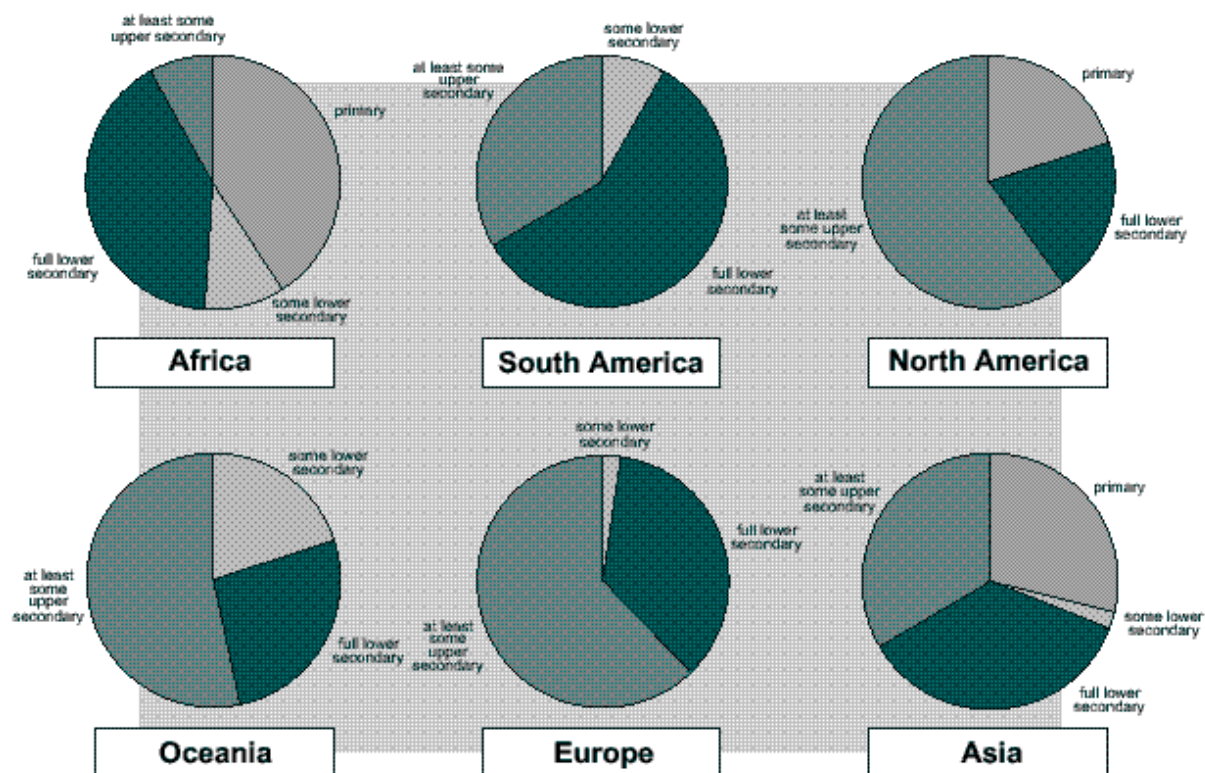


Figure 1.13. Levels of compulsory education by region in 2001

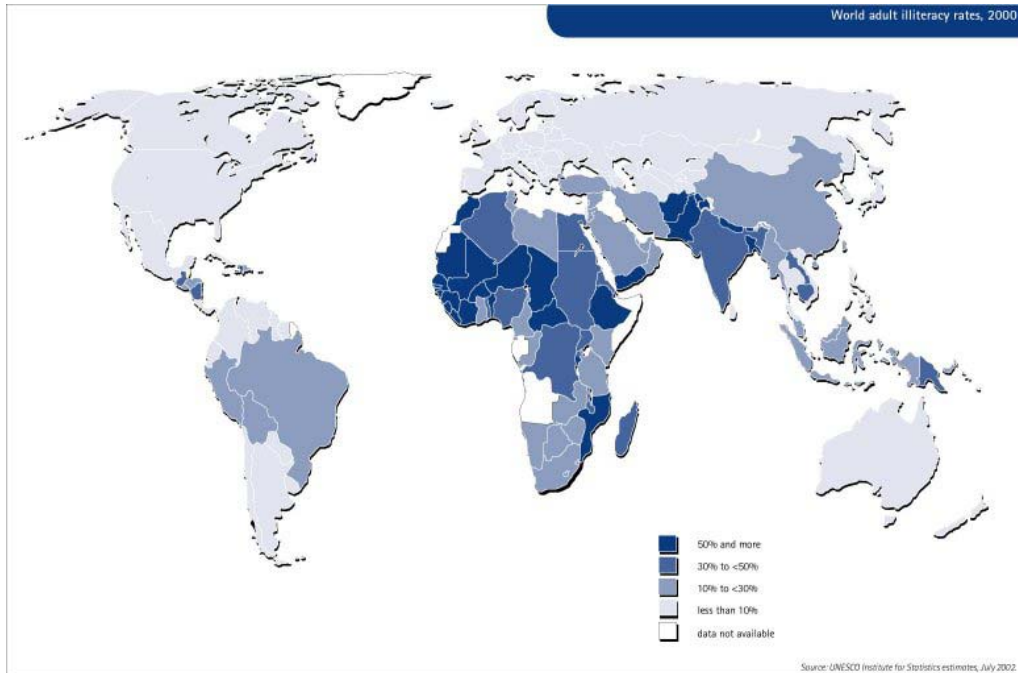


Source: Unesco, 2004.

The figure above presents the distribution of countries by region in terms of the intended coverage of compulsory education. Four in five countries worldwide have regulations that define compulsory education as extending beyond primary school. Typically, lower secondary education is part of compulsory education (in three-quarters of the countries), and in others, compulsory education includes some or all of upper secondary education. Compulsory education in all countries of South America, Europe and Oceania includes some secondary education. In a minority of countries in Africa (20 out of 49), North America (6 out of 30) and Asia (13 out of 45), compulsory education is represented by the primary cycle. In other words, the majority of countries within each region include some secondary education as part of compulsory schooling.

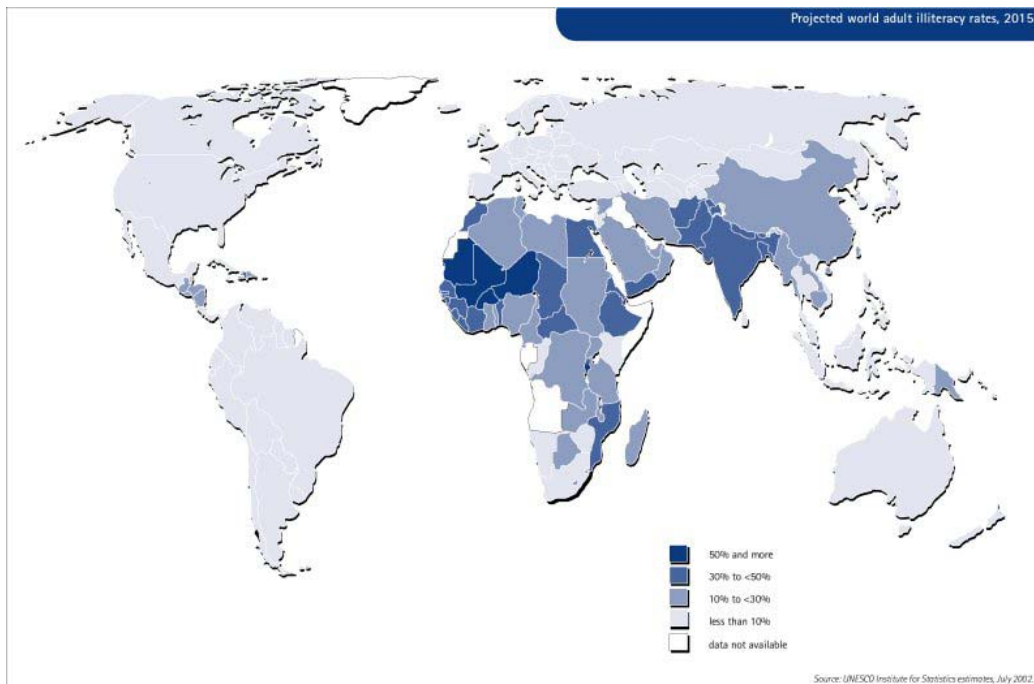
As a consequence of higher school life expectancy, illiteracy is expected to diminish in several regions of the world (Figures 1.14 and 1.15.). Two notable exceptions are China and India, which are expected to face challenges dealing with their population growth.

Figure 1.14. World adult illiteracy rates in 2000



Source: Unesco, 2004.

Figure 1.15. Projected world adult illiteracy rates in 2015



Source: Unesco, 2004.

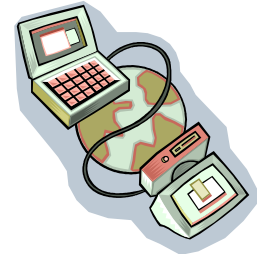
An improving education will favour access to culture and digital contents:

Adult literacy and school life expectancy will increase in almost all countries and, despite important educational inequalities among regions, education in the world is expected to improve thoroughly. Consequently, the access to culture and to digital content will be favoured in the next 15 years.

1.4 ICT environment

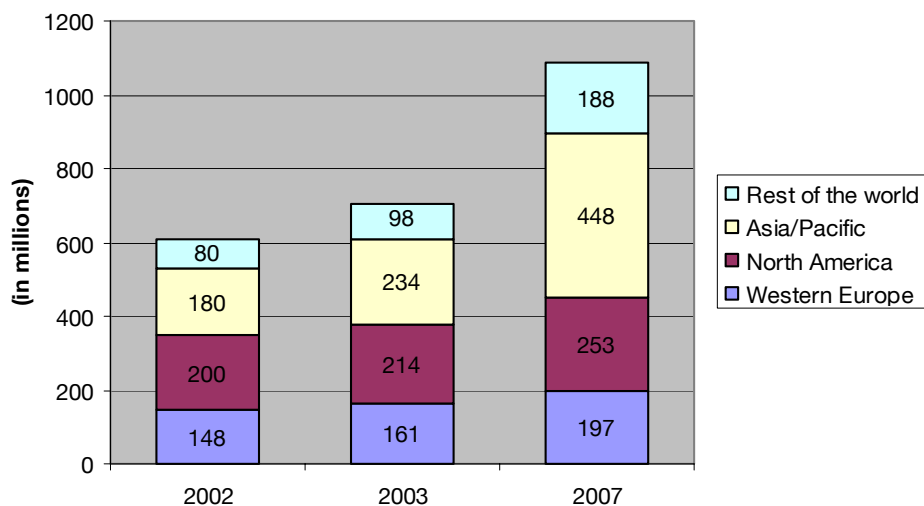
1.4.1 Internet user base

The world's Internet user population is going to grow considerably during the next few years. In regions such as Western Europe and North America, the number of Internet users will grow moderately, because high penetration rates have already been realised in these regions. But many other countries are going to widen significantly their base of Internet users.



Asia especially is the region which is going to see the highest growth rates and will be the main contributor to the explosion of the global base of Internet users. This region benefits from high population concentrations, enabling easy deployment of telecom infrastructure. Asian households have also a relatively high preponderance of computer equipment. English is not expected to be the most common Internet language in the near future.

Figure 1.16. Trends in worldwide Internet user base



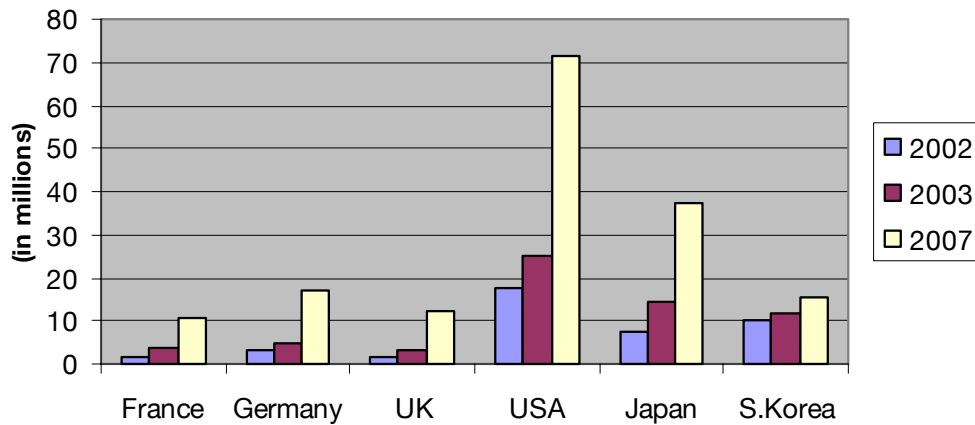
Source: Idate, March 2004.

1.4.2 Broadband subscribers

After the steady rise of the number of broadband connections in 2003-2004, the growth is expected to be still high for the next few years. Dial-up users' migration to broadband will continue and allow a large majority of Web users to access the Internet in a comfortable way and thus to take advantage of on-line content without limitations.

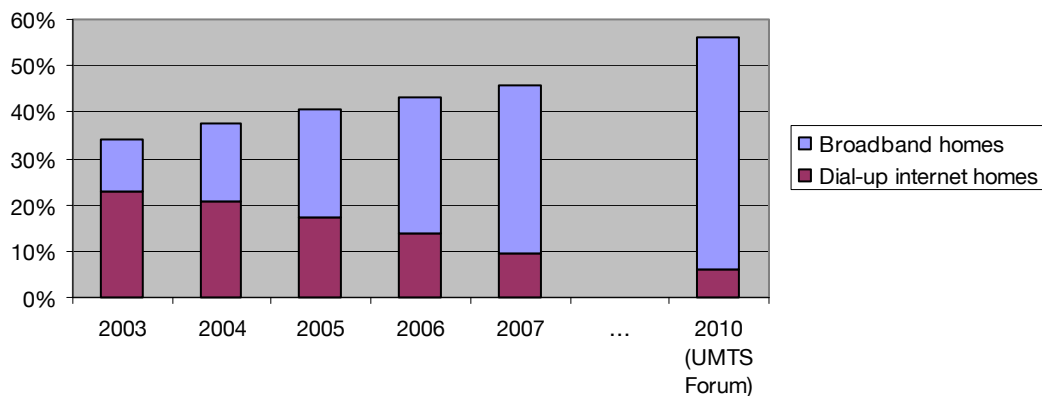
DSL and cable modem are the two main technologies for broadband connections but other access modes such as Fibre To The Home are appearing and are providing higher bandwidths.

Figure 1.17. Broadband Internet subscribers by country



Source: Idate, March 2004.

Figure 1.18. Broadband vs. Dial-up Internet connections in Western Europe



Source: Idate, March 2004.

1.4.3 Mobile subscribers

In most industrialised countries, mobile markets are nearing saturation. Thus, growth rates will be moderate in these regions. On the contrary, developing countries will boast considerable subscriber growth. Once again, Asia/Pacific will see impressive growth rates and will contribute half of the growth to the worldwide base of mobile subscribers. In the Chinese market, the number of mobile users rose from 145 million at the end of 2001 to over 320 million at the end of 2004, which means that 4 to 5 million new subscribers were gained each month. With a still low penetration rate, several other countries or regions like India, Indonesia and Latin America will see significant growth.

Figure 1.19. Trends in mobile subscribers base

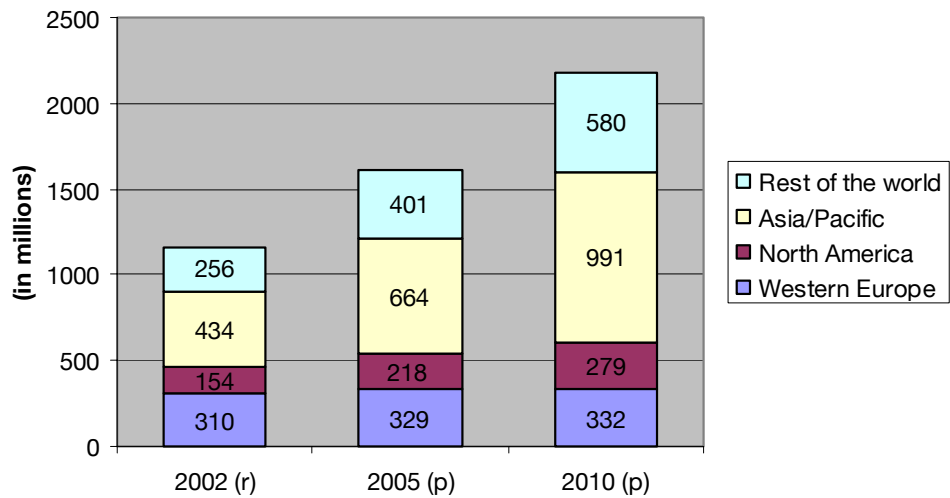
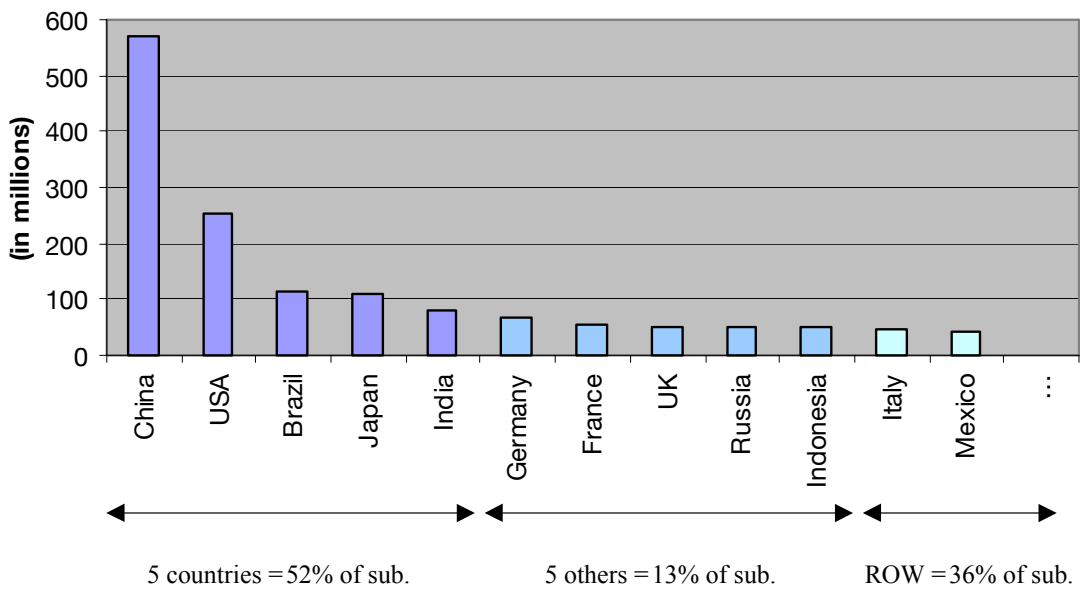


Figure 1.20. Share of the 5 largest markets in subscribers base in 2010



Another trend is that in Western Europe and in North America, there is an increase in devices per single user and an increase of multiple data subscriptions per device.

For instance, more and more people have two mobile phones, one personal and one professional. In the future, the number of connected devices per person is expected to grow steadily. As a consequence, it is necessary to separate “subscribers” and “subscriptions”. Whereas the number of subscribers will remain flat, the number of subscriptions will increase significantly.

The development of the Information Society:

The overriding trend for the coming years is that information technology will make major inroads in several areas around the globe. In western countries, ICT equipment, broadband Internet access and mobile services will be adopted by a larger part of the population. In developing countries, ICT is now allowing an increasing number of people access to the digital world.

2 Key technology trends

In the following, we will discuss some key technology trends that will impact on future devices and on future mobile networks.

Undoubtedly, forecasting 15 years into the future is always a challenge, representing more of an art than a science. To give an example of how challenging a meaningful look at the year 2020 is, let's look at some of the things we didn't know about seventeen years ago in 1988:

- The Worldwide Web – developed 1989
- Digital cellular phones - developed 1989
- High Definition TV - developed 1989
- Java – developed 1995
- DVD – developed 1995
- Search engines – first widely appeared in 1995

The PC was only invented 23 years ago. If you think of the revolution started by these inventions, it makes the potential for 2020 exciting. Today we have a range of new, potentially disruptive technologies that we know about.

But if we look to the research labs, things like ad-hoc networks are knocking on the door and some others are not yet envisioned.

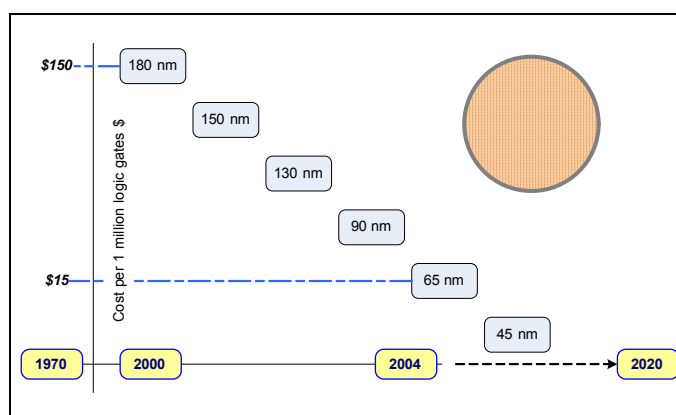
Consequently, the following part does not pretend to tell the true story of the next 15 years. It aims instead to look ahead with an open mind, by identifying some key consumer trends and evaluating how they will affect future mobile usage.

2.1 Technologies for future devices

2.1.1 Semiconductor and Nanotechnology

Much of the personal computing industry is built around the microprocessor, and performance is expected to follow Moore's law with a doubling in the number of transistors every 18 months or so. The semiconductor industry is currently tackling design and manufacturing challenges at the 90 nm and 65 nm line width scale.

Figure 2.1. Trend in nanoelectronics



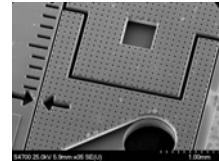
Source: Xilinx, 2004.

As can be seen in Figure 2.1. in just four years from 2000 to 2004, the average cost of one million gates for high-end products has dropped by 10 times, while the line width of integrated circuits has fallen by a factor of three from 180 to 65 nm.

The current trend of transistor miniaturisation cannot continue forever: this is because at 65 nm scale, a transistor feature such as a logic gate contains about 100 silicon atoms. At this scale, minor defects and material fluctuations can affect transistor performance and wafer yield and thus increase production costs.

By 2020, the wafer foundries will have met the biggest challenge in manufacturing history and mastered the science and technology for building chips with billions of transistors.

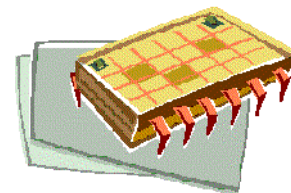
Moreover, the future developments of MEMS (Micro Electro Mechanical Systems) will allow the emergence of a broad range of new generation devices:



- “Network cameras” that can transmit images from anywhere at any time will be the result of incorporating MEMS sensors (which will make possible even smaller, highly functional parts) and network devices into digital cameras.
- Optical MEMS network devices will help lead the way to the next-generation network, with optical switches that quickly and selectively direct light into multiple optical fibres.
- Basic “sensors” with genuine functions (e.g. providing basic binary information to a central data collecting point) will be widely available at a low price.

2.1.2 Processing power and Storage capacity

This trend is easier to predict based on the past since multiple chips can be packaged into a single microprocessor module and even if a single processor reaches its performance limit the multi-chip module can still have ever faster speed. Microprocessors have come a long way – from Intel-8088 at 4.77 MHz clock and 0.33 MIPS (Million Instructions Per Second) processing power in 1979, to Pentium 4 at 3.6 GHz and 11,356 MIPS in 2003. This represents an increase of 34,412 times in 23 years in MIPS performance.



By 2010, we may expect to see a pocket sized low power personal mobile device with a processing power equivalent to a 4 GHz Pentium with storage of the order of several hundred Gb. In 2010 a basic wide area device with battery could be manufactured in a volume of less than 4cm³.

Between 2010 and 2020, it may be possible to build a pocket sized low power personal mobile device with a processing power equivalent to a 10 GHz Pentium with storage of the order of 1 Tbyte, assuming the evolution of new storage technologies such as Millipede.

2.1.3 Batteries / Power supply

Power supply has always been a critical component in all computing and networking devices. It can be observed that all building blocks, except the power supply, have benefited from the nanoelectronics industry and have seen generational performance improvements. The power

supply, however, has not significantly changed in the past 30 years. This presents an impediment to the vision of ubiquitous wireless communications.

By 2010, batteries will not become significantly smaller but technologies such as fuel cells will improve the power to weight ratio enough to deliver tens of hours of active device life on complex personal devices. We already have 5 years-battery life on simple sensor nodes.

► To be expected: hundreds of hours of life on simple or special purpose devices, 5 to 15 years of life on dedicated, very simple, occasionally used devices such as sensor nodes.

In addition, by 2010 some mobile devices will use low power consumption screens, such as E-Ink screens, which only draw power when contents of the display change. This, coupled with ongoing advances in low power processors, will further boost battery life of some models up to weeks of continuous use.

Between 2010 and 2020, power supply advances (e.g. fuel cells, thermo generators, micro turbines, power harvesting) and widespread use of low power screens and low power processors might make battery life no longer an issue. Devices will have an effectively infinite battery life as they will be charged at a rate exceeding their consumption. Any necessary supporting infrastructure (e.g. to supply methanol, hydrogen etc) will be deployed.

► Inhibitors: Slow progress in commercialisation of fuels cells, and slow uptake of e-ink and other low power screens by device vendors, for example due to inferior performance for colour and video display capabilities.

2.1.4 User interfaces

By 2010, one of the challenges to mobility that will still remain will be the user interface. During the next decade the traditional user input techniques of keypad, touch screens and pen are expected to be augmented by additional use of speech recognition and other emerging techniques such as movement and gesture recognition. These techniques will be combined to complement each other to be more efficient. Screens will also continue to evolve, particularly in terms of higher resolution delivered with less weight and less power consumption.

Speech Recognition Input

Unconstrained speech recognition will not be achieved even within the next 15 years. However, there will be ongoing improvements in speech recognition that will enable it to be used for a larger number of mobile applications by 2010. Speech recognition on servers already performs well in selecting from lists of thousands of items and similar capabilities will be achievable on the classes of mobile device available in 2010. Examples will include controlling common functions on the mobile device (e.g., connecting to a named individual) or accessing stored digital content (e.g., retrieving a favourite piece of music).

Text entry for dictating emails, SMS or other notes will also start to be available by 2010. However, it is not likely to be widely adopted until it is augmented by a redesigned user interface that makes speech a primary input mode with seamless access to all or most of the mobile device's functionality. This will start to be achieved during the 2010 to 2020 timeframe through a dialogue-based interface. A key feature of the dialogue interface will be that the system will not assume that the user makes a complete and unambiguous request of the system, but can engage the user in a dialogue to get the additional information needed to

complete the request. These “mixed initiative” dialogues will become available first in server-based contact centre applications and then will move to the broader set of functions required to interact with a mobile device.

► Inhibitors: Progress in speech recognition performance is slow but steady, so that every few years a level of performance is reached that allows speech to be applied to a new set of functionality. This slow pace will continue for the foreseeable future. Also, the lack of privacy of voice interaction may be an inhibitor to adopting speech as a primary input modality in public places.

Other input technologies

By 2010, other input capabilities to supplement speech and traditional keypads will include:

- Pen: extensions of today’s techniques for menu selection and character and handwriting recognition.
- Touch: touch screens and controls (e.g., Apple iPod system “ClickWheel”) and other mechanical controls for scrolling and selecting.

Between 2010 and 2020 the following techniques may possibly be added as input techniques, but are low probability:

- Movement: inbuilt sensors to detect movement can be used as an input technique, for example indicating a direction by pointing a device, or tilting a device forward and backward to scroll up and down a list.
- Gesture: recognition of a range of hand gestures or facial expressions through a camera mounted on the device or on the user.
- Gaze tracking: determining the angle or position of a human's visual attention, usually by use of a camera.
- Direct brain interface: through a technique similar to biofeedback, users can create distinct though patterns that a computer can distinguish and use as a control technique. Simple two to four state devices exist today using external sensors. More sophisticated control requires implanting electrodes, which is only used experimentally today in paralysed patients.

► Inhibitors: User interface technologies face challenges in terms of accuracy and user acceptance that tend to leave them languishing in research labs for a decade or more prior to commercialisation.

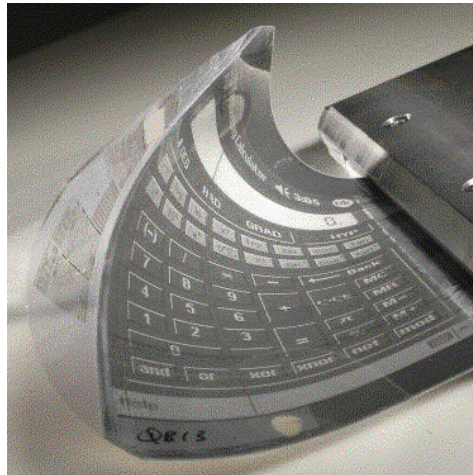
Screens

Screens will be a primary area of focus for mobile devices because the small displays are a constraint on the functionality that can be offered, and screens are a major consumer of battery power.

By 2010, several new display options will be commercialised that are physically flexible, and so could be carried separately from the device or delivered in a way that provides more screen space (e.g., rolled up and ready to be pulled out when needed). These techniques also require no backlight, unlike liquid crystal displays, so power consumption is low.

- Electronic ink/digital paper: resembles a sheet of plastic-laminated paper. Beneath the plastic are tiny microscopic beads that change colour to form text and images. The result is a nearly paper-thin, rewritable display.
- Light-emitting polymers (LEPs) are based on long-chain polymers that fluoresce when a current is passed through them. Using inkjet technologies they can be "printed" onto practically any substrate to form a display of light-emitting pixels
- Organic light-emitting diodes (OLEDs) are similar to LEPs but use short chain molecules, vacuum deposited onto a transparent substrate. Applying a low voltage across the matrix stimulates each pixel to transmit light.

Figure 2.2. Philips' flexible active-matrix display



Source: Philips, 2004.

Figure 2.3. Vodafone's flexible bracelet



Source: Vodafone, 2004.

Other types of display will start to be commercially available in 2010 and will gain a critical mass of adoption between 2010 and 2020:

- Retinal displays: a type of head-up display that "paints" a picture directly on the sensitive part of the user's retina. The image appears to be on a screen at the user's ideal viewing distance. There is no actual screen in front of the user, just some simple optics (for example, modified eyeglasses) that reflects the image back into the eye.
- Projected displays: similar to retinal display technology, but with the projection system built into the mobile device so that the user holds the device up to their eye to see the screen.

► Inhibitors: Screen technologies face fundamental engineering problems in creating and manufacturing the new approaches to a high enough quality at a low enough cost.

Non-visual output: audio, haptics

By 2010, a likely addition to output techniques in the mobile world will be text to speech (speech synthesis). Text to speech can be used to convert any text string into a spoken output, and is already virtually indistinguishable from human voices. It is more flexible than pre-recorded speech, where the vocabulary items must be identified and recorded ahead of time. It is used today for call centre applications and telephone access to e-mail, and by 2010 will be used for a much broader range of information access and interaction. However it will not be suitable for all types of interaction because of the linear nature of speech compared to text or graphics. For example, a user accessing a list of available flight would probably prefer to see the options on a screen than hear them read one after the other, as the user would not be able to easily "scroll back" in the speech stream to find an earlier option. But for basic SMS or e-mail it can apply extensively.

By 2020, mobile technologies may take advantage of haptics - the user's sense of touch - to provide information. Haptics is used experimentally in military settings as an alert to dangerous conditions; for example, by wearing a special haptic vest, fighter pilots can feel vibration to indicate the direction from where an enemy is approaching. In the mobile world phones can already be set to vibrate when a call is received, and other more subtle types of haptic feedback may be used to indicate a broader range of information. In Finland, MyOrigo has developed vibration feedback for touch screens and a means of assuring the user that their input has been received; in the United States, Immersion has licensed programmable vibration technology to Samsung to provide functions such as a distinctive pulse sensation that signals when a call has been dropped.

- **Inhibitors:** User acceptance of novel interface techniques is extremely hard to predict.

Powerful and Infinitesimal devices everywhere:

Technology developments for the next 15 years are expected to enable the emergence of devices, which are increasingly complex and intelligent.

Unlimited power will be almost reached and infinitesimal devices will be spread everywhere. Many current obstacles will be removed by the technology improvements such as power supply, processing power, screens and multi-equipment at low cost will be available.

2.2 Network evolution

2.2.1 Future Network Architectures



Several different network architectures will co-exist. These include networks with controlled and managed access points (e.g. the cellular or 802.11 models) and ad-hoc or mesh networks.

In an ad-hoc (or "spontaneous") network, devices are part of the network only while in some close proximity to the rest of the network. In Latin, *ad hoc* literally means "for this," further meaning "for this purpose only," and thus usually temporary. The term has been applied to future office or home networks in which new devices can be quickly added.

Ad hoc networks are attractive because of their lack of central control and low cost barriers to installation. They can also grow on an as-needed basis, making them more economic than any other network design.

Mesh wireless networking is a candidate topology for wireless communication systems in the future. A mesh network employs one of two connection arrangements, full mesh topology or partial mesh topology. In the full mesh topology, each node is connected directly to each of the others. In the partial mesh topology, some nodes are connected to all the others, but some of the nodes are connected only to those other nodes with which they exchange the most data. Consequently, mesh networking is able to provide many alternative paths for a given communication.

Mesh architectures will be used in several ways including city-wide broadband deployments, special purpose ad-hoc networks (e.g. between moving vehicles) and person to person peer to peer (P2P) networks, e.g. between consumer devices.

Wireless Sensor Networks (WSN) will also become a major component of the telecommunications industry in 2020. They will provide distributed network and Internet access to sensors, controls, and processors that are embedded in equipment, facilities, and environments. Especially, RFID tags are expected to proliferate and to connect objects to each other and to data collection environments.

► Inhibitors: The major variable will be the human reactions such as privacy concern, “big brother” fear and viruses.

2.2.2 Mobile and wireless networking technologies

Wide Area mobile Networks (WAN): the pace and characteristics of network evolution will vary on a regional basis, and be influenced by market conditions, legislation and technology. The major trend is the evolution from second generation (2G) via 2.5G to third generation (3G) and then to higher-data-rate 3.5G technology. In most regions, two or three generations of networks will coexist, and applications must be designed to perform adequately on poor connections and previous-generation networks.

Personal Area Networks (PAN) and Metropolitan Area Networks (MAN) technologies: The number of PAN and MAN technologies will continue to grow. No single technology will be suitable for all applications because each provides different trade-offs in terms of bandwidth, range and cost. Many types of PAN and MAN technologies will coexist in most organisations. Moreover, the growth of domestic wireless networking will continue. Initially, this was predominantly intended for distributing broadband throughout the home, but in the next few years, a variety of consumer devices will acquire short-range wireless networking. Examples include televisions, high-fidelity systems, set-top boxes, cars, game consoles and remote-control light switches.

By 2020: Many types of wireless networking technology will be available. Ranges will span everything from near field, through personal area to national. The average consumer by 2020 may regularly use at least 7 separate bidirectional networking technologies. Many devices will support multiple personal or home area wireless networking technologies. The incremental cost of adding wireless networking to electronics will be very low (under €1 per device) as wireless will be integrated onto chips performing other functions. Wireless will be cheaper than wires for low to medium data rate communications.

As a consequence many information devices (i.e. devices capable of consuming or creating information) will have access to several networking technologies. This will challenge business models based on supplying information such as music over a single channel controlled by one vendor. This trend also illustrates the need for digital products and services to be generally independent of the bearer technology.

2.2.3 Broadcast technology

Consumers will have access to several unidirectional (broadcast) technologies capable of delivering data as well as media content, examples include digital radio, different broadcast systems and terrestrial digital TV. Many devices will support multiple broadcast technologies (e.g. some phone handsets might be capable of receiving digital radio, DVB-H and public digital TV).

2.2.4 Seamless domain roaming

By 2010, devices such as mobile handsets will support many different short and medium range wireless technologies including RFID, near field, PAN, WAN, WLAN and metro broadband. This will be achieved through either SDR (Software-defined radio) or multimode chips combined with smart antenna technology. This seamless domain roaming will allow users to move seamlessly between physical networks with a single logical session, unaware of which technology they are using.

From 2010 through 2020, new networking protocols will continue to be added as required to connect with the “best” (e.g. most appropriate price/performance for the user) wireless network available in any given location.

► Inhibitors: Even when seamless domain roaming becomes technologically feasible, the business models to support consolidated billing across the networks may delay widespread usage. Regulators and the general public may be concerned by “too many” networks and that may influence the future.

2.2.5 Wide Area Networks bandwidth

Even in 15 years it will not be cost effective to build wireless networks to achieve 100% connectivity everywhere in a country. Also effects such as local overloads will saturate connectivity sometimes we therefore cannot assume either consistent connectivity parameters (speed, latency etc) or even connectivity 100% of the time.

The major trend for 2020 is that we will benefit from 100 Mb/s 95% of the time and 1Mb/s 98% of time (due to lack of network coverage). The average citizen will have 100 Mb/s into his pocket 95% of the time. Many subscriptions will be flat rate so data volume consumed is not an issue for citizens.

These characteristics could be less important in a case of a pessimistic scenario. The pessimistic assumption is that there are no real advances beyond HSDPA (High Speed Downlink Packet Access) because of economic or social reasons. However, this pessimism is not confirmed by current facts: 3GPP is working on “beyond HSDPA” and is aiming at improving UMTS/W-CDMA in a significant manner.

2.2.6 Wireless Security

Although wireless poses new security challenges it is expected that the evolution in personal devices will provide sufficient processing power for security to be achievable. In this content security can be defined broadly as “anything that would cause the user to worry about”, this includes data interception, loss of data when devices are stolen or fail, authentication, impersonation etc. Fairly good security can be obtained today, although it requires device owners to integrate products from several sources.

The demand for security and the evolution of both client and server side features may mean that acceptable security will be achievable for a wide range of applications by 2006 and that security implementation will continue to get simpler. Devices will not offer equivalent security, some will be more secure than others. However it will be possible to obtain a combination of device, network services, and supporting security products for both the client and server to achieve adequate security for 95% of consumer and corporate applications.

A profusion of technologies for interoperable networks?

- In the next 15 years, many mature technologies will be available and will provide different wireless network architectures and solutions.
- The key requirement for successful ubiquitous wireless communications is interoperability between different networks.
- Another challenge will be to provide a high level of security, despite the increasing complexity of networks using many technologies and many network architectures.

3 Emerging mobile services

In this section we review some key emerging services that might be available in line with the technology improvements by the decade 2010-2020. Most likely trends for year 2010 and probable evolution are presented.

Some of the services quoted in this report are in continuity with the services currently available in some markets. While customers from advanced regions (e.g. South Korea) are already experimenting such services, the future of these technologies and the education of the consumer base will widen their usage worldwide.

The services are therefore linked with existing facts and trends, reducing the scope of the prediction for future traffic assumptions, even if consumer trends and service adoptions are difficult to forecast. Because realistic forecasts cannot uniquely be based on prospective trends on each service, these services have been organised and gathered in service categories, which are one of the basic parameters taken in account in the model.

3.1 Service category

Section 3 analyses all the service categories shown in the table above. This table provides the specific definitions and examples of each service category as defined in earlier UMTS Forum studies.

Table 3.1. Service classification

Service Category	Description	Example of emerging mobile services	In the report
Mobile Intranet/extranet Access	A business 3G service that provides secure mobile access to corporate Local Area Networks (LANs), Virtual Private Networks (VPNs), and the Internet.	Intranet Access, VPN, Access to Corporate Databases	Corporate services
Customised Infotainment Services	A consumer 3G service that provides device-independent access to personalised content anywhere, anytime via structured-access mechanisms based on mobile portals.	M-commerce: E-commerce sites, Online banking and finance, Advertising	M-payment, Micro-commerce
		Others: Mobile Customised Portal, Blogs, Games (download, online), lotteries, bets, Personalisation of devices (ring tones, logo...)	Object Identification, Health Management, Entertainment, M-government
Multimedia Messaging Services	A consumer or business 3G service that offers non-real-time, multimedia messaging with always-on capabilities allowing the provision of instant messaging. Targeted at closed user groups or business communities that are services provider- or user-defined. MMS includes messaging between people and also between machines (telemetry).	SMS, Simple Email, Instant Messaging, Chat, Forum, MMS, Photo, Video messages, Telemetry	M2M and Sensor Networks, Digital Content
Mobile Internet Access	A 3G service that offers mobile access to full fixed ISP services with near-wireline transmission quality and functionality. It includes full Web access to the Internet as well as file transfer, email, and streaming video/audio capability.	Email, File transfer, Streaming and Downloading of Video/audio clips, Internet-style websites, Internet Browsing	Digital Content
Location-Based	A business and consumer 3G service that enables users to find other people, vehicles, resources,	Downloading of geo-localised maps, GPS,	Location discovery,

Services	services or machines. It also enables others to find users, as well as enabling users to identify their own location via terminal or vehicle identification.	Advertising, People Finder, Product and Service Finder, M2M	Object Identification
Simple Voice and Rich Voice Services	A 3G service that is real-time and two-way. Simple Voice provides traditional voice services including mobile voice features (such as operator services, directory assistance and roaming). Rich Voice provides advanced voice capabilities (such as voice over IP (VoIP), voice-activated net access, and Web-initiated voice calls, and mobile videophone and voice enriched with multimedia communications.	Voice telephony, Voice messages (recording and reading messages), Video-telephony, VoIP, Video-conference, collaborative work	

3.2 *Some mobile services available during the 2010-2020 time frame*

3.2.1 Object Identification

While the power and functionality of end user devices continues to improve, other capabilities are being developed to increase their range of applications. Sensing and actuating technologies such as micro-electromechanical systems (MEMS) will be embedded in a growing number of real-world objects and places, opening a range of new solutions that will quickly impact in activities such as logistic or supply chain (device, car, wagon, truck).

Wireless communication technologies, with radio frequency identification (RFID) leading the charge, will connect first objects directly to data collection environments; further down the line they will connect objects to each other with data collection environments. This will add a new set of capabilities for detection, alerts or online commerce through a set of technical and commercial "bridges" between the physical and online worlds.

By 2010, capabilities will include:

- Some handsets that will be equipped with specialised readers to identify items tagged with barcodes, RFID or other identifiers
- Handsets that will be also able to read several types of printed tag using just a camera, such as QR codes, Semacodes, Spot Codes and Bango spots. Multiple formats of printed handset readable information will co-exist on products.

These capabilities will be used for accessing Web information about products and locations, and for comparison shopping between various real-world and online outlets. They will be used in conjunction with geo-coding (GeoURLs), which add location information to Web information (e.g., overlaying selected points of interest onto a map, as at maps.yahoo.com). For example, these capabilities will have simple and direct applications such as mapping disease or pollution propagation, harvest problem, temperature measurement etc.

Between 2010 and 2020, wireless tags and beacons (e.g., using active RFID) will be associated with specific objects and locations, which will alert handsets in the vicinity to their location or availability. This will be used to drive more flexible mobile and micro-commerce, as users can be alerted of interesting and relevant business propositions in their vicinity, or searched one out based on their current needs.

We can imagine in that future each individual will manage him- or herself a series of personal wireless tags (in his house and personal tags). Remote control of his or her personal life will then be possible.

► **Inhibitors:** The main inhibitors to ubiquitous identification of items and locations will be coverage of the tags in the real world. GPS and geo-coding allow much of the infrastructure to be built up without each location having its own tag, but more fine-grained information access will require item tagging. This is more straightforward with products, particularly for printed codes, as the tags are also required for supply chain management. Grass roots initiatives may drive some coverage of location tagging (e.g., www.yellowarrow.org, where users affix a yellow spot with a unique ID to a real world location, and associated comments with the location via text messaging), as will the desire for merchants and others to broadcast relevant information about their goods and services.

3.2.2 Sensor Networks and M2M

At some point in the future (2020 or later) the number of connected points, products or machines might exceed the number of connected people. Even though machine traffic and revenue may not be as large as people-derived revenue, they will be considered as an opportunity. High wireless bandwidth opens up new machine possibilities such as streaming security cameras. Also, there is a basic business principle that you can take a product, add networking, and turn it into a service or a relationship. So M2M will enable some transformational applications.

One major contributor to the growth of connected machines will be sensor nodes. Sensor nodes will exert a major influence on daily life over the next 10 years. So much so that, like PCs and cellular phones, shipments of sensor networks will be measured in billions of units per year.

Miniaturisation made possible through nanotechnology and new materials will enable every living and inanimate object to be tagged. Tiny passive chips can be implanted in buildings, on buildings, in machines, in jet engines, in wallets, carpets, fields, deserts, battle zones, road signs, pets and people, for everything from enhanced security to exchange of contact information.

Homes will be “sensorised” with remote monitoring and control of refrigerator inventory, environmental controls and parental control of content. Highways will have sensors that will dramatically reduce accidents by linking to vehicle controls and maintaining safe minimal distances. Contextual information linked to location data will be pervasive. Wide availability of translation devices will enable real-time direct communications in between any of the earth’s languages – in speech or written communications.

Sensor nodes are closely related to radio frequency identification (RFID) tags, but have more intelligence and persistent power. The two technologies will eventually converge, although there will be technical issues to solve first. Sensor technologies in power, radios and networking, for example, are well under way.

However, sensor networks cannot make progress in the market until location sensing becomes more reliable. It's no good deploying billions of sensors if you have to record the location of every node. At the moment, the technologies around location sensing are still somewhat in the early stages of research. There will be tactical deployments, where the number of sensor nodes is small enough that location does not have to be automatic, but the true potential of sensor networks will have to wait.

3.2.3 Health Monitoring

Technology for monitoring an individual's vital signs (i.e., "physiological monitoring") will form part of a personal area network, with the mobile device as the hub. The local device will perform a first level of analysis, with more sophisticated analysis and long term data capture available through wireless transmission of the health information to a server maintained by individuals or their healthcare providers.

Through 2010, health monitoring linked to wireless capture and analysis will develop but still be primarily a specialist or niche application. The main uses will be during exercise (e.g., advances on today's watches with heart monitors), for patients with chronic conditions and for military applications. Some consumers will use basic health monitoring applications like blood pressure measurement or weight control.

Between 2010 and 2020, adoption will expand to routine monitoring for proactive healthcare by healthy individuals, driven by a personal desire to stay healthy as well as by incentive programs from healthcare and insurance providers and employers. In addition to device-oriented capture, biometric monitoring may also be performed through smart fabrics built into clothing, such as Sensatex's SmartShirt vest. In addition, implanted devices (e.g. similar to today's pacemakers) may become a platform of choice. The biometric information could also be used for other purposes, such as identification or determination of emotional state. As well, sophisticated analysis techniques like "lab on a chip" may exist by 2020, with mobile phones being used to 'sniff' an individual's breath for chemicals that indicate illness. Personal health information on a chip or easily transferable (under privacy control) will be offered.

Inhibitors: Adoption of monitoring technology by healthy individuals will be driven largely by fashion and social norms, which are extremely difficult to predict. Non-implanted devices may not become adopted by 2020 for two reasons: they would not deliver enough accurate data, and they would not be convenient to wear; also "Smart Clothing" may be very expensive even in year 2020, if aiming at providing the same data accuracy as implanted devices.

3.2.4 Location Discovery

Every wireless technology can provide some location information as a side effect of its operation. Technologies like GPS and Galileo exist solely to provide location information. Accuracy will be improving in that area for the next coming years.

By 2010 future technologies such as wireless beacons are likely to provide both location and context information (e.g. "this is the door of a shop, this is what we sell"). In the case of mobile transmission technologies such as 3G some location information can be deduced either directly (e.g. by knowing which cell or access point is nearby) or by using additional network equipment measuring signal direction or timing.

By 2020 systems such as GPS and Galileo are expected to provide precision of around 1 metre in real-world conditions, near field wireless or RFID tags a few centimetres, beacons a few metres, 2.5G or 3G network based systems such as triangulation tens to hundreds of metres.

Multiple implementations...

Equipment such as MEMS accelerometers which may be installed in electronic devices for purposes such as user interaction or detecting if the user has fallen over, also have a role to

play. These aid location deduction because they might be used for approximate dead reckoning calculations based on the acceleration of the user. Researchers have also demonstrated systems, which can deduce their location by comparing an image of the surroundings with an image database. However even by 2020 this is unlikely to provide mass coverage because of the difficulty of maintaining a sufficiently comprehensive and up to date database.

...through multiple networks

Also by 2020, not only systems dedicated to location discovery but also various other devices will enable location based applications. Many mobile devices will support multiple wireless technologies and multiple ways to deduce location. For example, a future mobile handset might incorporate 3G, GPS, accelerometers and one or more short range wireless technologies. Such a device will therefore have several ways to deduce its location.

In practice not all technologies will be available all the time, e.g. GPS or Galileo will require that the handset can "see" several satellites: fewer satellites provide less precision, and in some situations such as when operating indoors, no satellites may be visible. In the targeted period, a wireless device is likely to maintain a continuous estimate of its location by integrating several estimates from different technologies (e.g. Mitsubishi's PAS (Positioning Augmentation Services) solution combining GPS with a network of electronic reference points on the ground), preferring the most precise source of information at any time.

In the 2010-2020 period, it is assumed that location will always be available, but its precision may vary from around 1 metre in the best case to several tens of metres in poor situations.

► Inhibitors: Inhibitors to location discovery will be technology and consumer attitude. The main obstacle to location accuracy is indeed location or coverage. Consumer attitudes and reluctance to be located may impede some development in location-based services.

3.2.5 M-Payment

By 2010 the technologies required for initiating the interaction, the mobile transaction authentication and payment reconciliation will have matured. There will be likely several complementary systems in place.

The interaction between a user's device and a merchant's system can be dealt with by 2010 using any type of networks.

For the mobile transaction authentication several alternatives exist. Mobile operators are likely to use the existing authentication to make phone calls. Internet e-payment providers or the European Click&Buy Alliance could leverage the same technologies as in the desktop-Internet world (e.g. cookies) and potentially a third alternative could be another token that interacts with the mobile handset (e.g. a Bluetooth dongle).

Three to four alternatives may exist when it comes to payment reconciliation. There are several models of user, merchant, and payment provider interaction. From the end-user perspective mobile payments could be billed via telephone bill (in that scenario the mobile operators are payment processors), via credit card bill (in that scenario the credit card processors are payment processors), via checking account transfer (in that scenario the retail

banks are payment processors), or via the Internet e-payment provider such as PayPal (eBay) or the European Click&Buy Alliance.

The major variable sits in how dominant the different alternatives of the m-payment steps will become, which will also determine the size of the cake mobile operators can potentially own. How will the incumbent banks react? Two main issues will impact future m-payment models: Who will consumers trust most when it comes to payment settling? Who will be most successful in relationship management with the major merchants?

3.2.6 Micro-commerce

Mobile communications provide an alternative channel to access information about desired goods and services and complete the transaction within a secure environment. This ability to complete the retail value chain – from enquiry, to information, selection, and financial payment – is an extremely powerful mechanism that can radically change the nature of personal and business commerce and the use of traditional transaction media such as cash and credit cards.

The logic of micro-purchases (small transactions of less than €5, or even much less e.g. into the cent-arenas) is the increasing penetration and consequentially decreasing transaction cost of electronic payments. This will enable new things to be sold largely centred around (mobile) paid content and location-based-services initially.

By 2010 micro-payments using some form of active device (e.g. smart card with near field wireless, RFID identifier, mobile handset, Internet PC) will be an almost pervasive capability available to anyone with bank account. By 2020 it will be essentially pervasive.

Three largely intersecting major trends are driving micro-commerce:

- Widespread access to physical and social infrastructures providing a marketplace for buyers and sellers to locate each other (today mostly through PC-based e-commerce, increasingly through m-commerce on wireless networks)
- Low cost and trusted models for completing transactions
- Discovery mechanisms (e.g. electronic publishing) of targeted content and services.

The seeds of the possibilities are already seen in Korea and Japan. In other areas of the world, security concerns and high cost have so far made mobile commerce less popular. It has also been discussed that consumers may not adopt micro-payments because of "mental transaction costs", or lack of trust. These are misguided objections and the best example is the existing business model of the telecommunications industry, which in fact since many decades is a \$700 billion business based on micro-purchases (i.e. telephone calls to a large part of less value than €5).

We can observe already today new forms of micro-commerce evolving:

- Apple's iTunes music store has been extremely successful - originally conceived of as a driver of iPod sales - is now becoming a revenue driver for the whole of Apple Inc.
- In the mobile application domain, European users spent €2 billion on ring tones, logos and screen savers in 2004.
- In the B2B space, online-advertisement got significant traction as evidenced by Amazon's referral program with more than 50K partners and Google's AdSense service.
- The Zingo taxi-hailing service in London uses location tracking and payment through a mobile phone.

Moreover, we can anticipate many more usage of micro-purchases, such as new business opportunities driven by significantly lower direct and hidden transaction costs and that will initially cluster around:

- Paid digital content at new levels or granularity (e.g. ring-tones, music, video, government or transportation information).
- Location-based Services (e.g. dispatching, routing services, parking space reservations, Pre-booking of fast food, shopping for event tickets, en-route delivery services.)

Consumer's attitudes should not be a major inhibitor to the development of micro-commerce but could slow down its development. By 2010, micro-commerce could grow to at least 10 micro purchases per month for 25% of the adults in OECD nations (e.g. about 1 billion adults). At an average transaction revenue of €1, this will generate €30 billion in new product and service revenue per year.

By 2015 the commercial world will have changed significantly as a result of micro-purchases and we suppose that Micro-commerce opportunities for new products and services below €5 will generate €60 billion in revenue per year by 2015. The assumption behind this trend is that 25% of adult consumers in OECD nations make at least 20 new micro-purchases per month at an average of €1 per transaction.

Some other possible trends are:

- Micro-commerce opportunities for new products and services below €5 will generate €300 billion in revenue per year by 2015. This is assuming that 50% of adult consumers in OECD nations make at least 50 new micro-purchases per month at an average of €1 per transaction.
- Micro-commerce opportunities for new products and services below €5 will generate €780 billion in revenue per year by 2015, based on the assumption that 65% of adult consumers in OECD nations make at least 100 new micro-purchases per month at an average of €1 per transaction.

Micro-commerce will present a significant redirection of cash flow. The major issue of course, is who will be the beneficiaries of micro-commerce from the various stakeholders in the emerging m-payment models.

3.2.7 Digital content

One of the areas that will experience greatest change in the next decade will be the way we deal with information or content, whether as individuals, teams, enterprises or societies. The changes, driven by many technologies, will affect all areas of life. We are now moving into a world where the consumer is demanding rich digital content anytime, anywhere and over any channel.

Within the 2010-2020 timeframe, mobile devices and networks will be in place to meet this demand. The demand for digital content will strengthen the demand for connectivity, but the opportunity for operators to extract value from content will not be unlimited because people will have the possibility to load pirated or cheap content onto personal gadgets via the Internet. This is generally true for stable, non-time-critical content such as e-books and music. However, operators may have a range of opportunities to charge a premium for content which

is time-urgent, or location-specific, or where consumers are prepared to pay for the convenience and/or immediacy of instant gratification (impulse buying).

Telecom companies will take advantage of the fact that they are the primary point of contact for customers. Moreover, their historic relationship with the end user has been more one of trust (e.g., confidentiality of communications) than in other newer industries. As the telecom industry evolves to become a major provider of content services, the value of such a trusted environment becomes paramount. The provision of content services carries obligations and responsibilities, particularly in the area of consumer protection.

The old slogan of “Content is King” is expected to be replaced with the new slogan of “Customer Experience is King”. Price-sensitive consumers will endure advertising-rich or pirated content. But many will be prepared to pay for the improved experience of advertising-free content, wrapped in services such as personalisation, recommendation engines, community, ease-of-use and one-click buying.

3.2.8 Mobile entertainment

Mobile technology can also change the nature of entertainment. Whereas entertainment today is externally focused – i.e., an external event one attends or purchases for use in the home, entertainment will become increasingly internal and personalised, an expression of one’s personal interests and needs. The user will have the ability to view, hear, or interact with entertainment media wherever or whenever desired. In addition, the user will increasingly have the ability to adapt and use media elements to create their own personalised entertainment experience.

Users will expect to be able to choose entertainment from a highly diverse selection and control the timing and place of entertainment delivery.

Mobile interactive technology will enable a mobile gaming experience with remote players that emulates “being there”. Gamers will be able to join in group games with people all over the world, either peer-to-peer or through a server. Players will be able to interact with each other through voice, video, and or graphic/text in real time, creating an interactive, responsive gaming experience.

Gaming events could be created spontaneously via messaging for virtual or physical games. Mobile video technology will also enable a wider audience.

Being able to watch movies or television only in a fixed time or place will become a thing of the past. Users might order, select and pay a movie on one device (on mobile for instance) and watch it on another one (TV or PC). The media industry will expand the use of portable messaging to allow viewers an increasingly interactive experience. The integration of television shows with mobile data technology can already be seen with viewers voting via SMS. The accessibility and personalisation of mobile devices will enable a level of interactivity between the media and audience not possible before. The new “reality shows” will likely include the audience experience as well.

3.2.9 Corporate services

Companies will benefit from improved communication tools in order to share more efficiently information and knowledge among workers. Especially, professional experiences will be shared through corporate blogs. Mobile instant messaging will also be a tool enabling workers to better communicate. Moreover, corporations will have the opportunity to manage supply

chains and inventories more efficiently: the access to corporate data bases as inventory state will enable companies to have a advantage in cost, efficiently and flexibility.

Actually, mobile technologies like VPNs or M2M services will enable the increased blurring of home and work life. Not only is one always accessible for work-related responsibilities, technology provides the increased ability to manage one's personal life from a remote work location. The questions of where one is located physically when earning income become irrelevant as everyone balances work hours between home and a number of business sites. The "office" becomes the mobile technology one carries to any physical location. Working hours are likely to become more flexible as a result.

3.2.10 M-Government

Government will encourage adoption of technology by proactively using networks and technology to disseminate information, provide services and mandate and encourage citizen participation in government.

Government mandates to foster use of networks could take the form of required electronic filing of all government forms. Thanks to mobile technologies, these forms would be available anywhere and any time. Electronic voting is also expected to take advantage from mobility, by enabling each citizen to proceed to a vote, whatever his or her location is on polling day.

3.2.11 M-Education

M-Education would represent a second step in the digitalisation of education that was decided by many governments.

New devices such as the Tablet PC would represent a complementary way to improve a student's knowledge, although they are not expected to replace current teachers. They would provide tools, anywhere and anytime, to check his or her knowledge. For instance, university and school students will carry with them an always-on screen to manage their work.

Great changes expected for consumers, companies and governments:

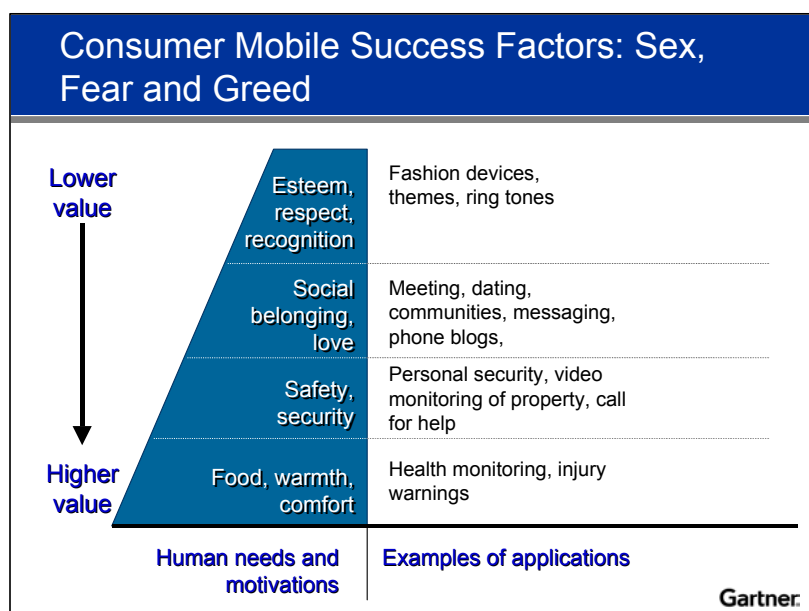
Expected dramatic technology advances outlined in Section 2 will enable a wide range of mobile solutions and options. While it is difficult to predict exactly which services and applications will develop a decade from now, it is however possible to foresee that potential services could dramatically impact on how people live, work and play. Undoubtedly, the way we deal with information and content will experience a great change. These changes will not only affect private consumers but also companies and governments, which will have the opportunity to use new services in order to improve their efficiency thanks to their new communication tools.

4 Customer usage in 2010-2020

4.1 Consumer mobile needs

The usage of mobile services has traditionally been driven by social habits rather than technology availability. Subscribers broadly do not care about technology but are motivated by human emotions such as sex, fear and greed. A Maslowian perspective is often a good starting point to assess the potential of new mobile services. Needs are organised as a hierarchy ranging from a basic physiological need (e.g., food) through higher levels, including safety and social belonging, up to abstract needs such as self esteem. Lower level needs are satisfied before higher ones. While such views are not strictly correct under all circumstances, they provide a useful model to evaluate mobile applications and understand why applications are successful or not.

Figure 4.1. Consumer Mobile Success Factors



Source: the Maslowian diagram adapted by Gartner, November 2004.

As an example the huge teenage use of SMS is strongly motivated by sex and greed; sex because it's an integral part of the teenage dating process, and greed because SMS is easier to budget for users of "pay as you go" mobiles.

Future mobile data services will be successful if they are able to provide enough human value, because failures are often due to a lack of human value, not a lack of technology.

Several observations can be made for the future of telecommunications services:

- New opportunities will arise from social behaviour which is unpredicted: For example trends such as blogging may evolve into "life blogs" where some individuals collect audio and video continuously. This could drive massive wireless data usage. Some other social trends can be identified: the need to stay in touch through small signs, the wish to have a private virtual space that can be shared with other people. It will be important for an operator to watch social trends closely and be prepared to exploit them quickly. One of the key abilities of any network operator in the next decade will be agility, and it will be

necessary to have a process to recognise and respond to such unexpected opportunities quickly enough to profit from them.

- **Niche demographics and applications will emerge:**

Asking which technologies and applications will generate revenue for telecom operators in 2020 is rather like asking in 1990 which content would be popular on the Internet in 2004. Some areas are predictable such as shopping and “adult content” but many were not identified at the time. Few observers predicted the success of “Friends Reunited” for example. It is likely that, like the Internet, there will be no killer markets but instead thousands of micro-markets. Flexibility and agility will be essential.

- **Consumer attitude versus technology will segment the market:**

Several markets are expected to emerge depending on consumer attitude versus technology. For example “technophiles” will just want cheap bits and buy devices separately; fashion oriented consumers will be more interested in devices and peer esteem applications like media. On this other side “technology refusers” will demand “invisible” technology, easy to use devices/ applications.

Delivering high human value services:

Social factors will become increasingly important and one of the most important factors for a successful mobile service is that it satisfies a human need.

It will be necessary to adopt a human-centric design perspective that considers many factors such as age and social grouping.

4.2 New way of life in 2010-2020

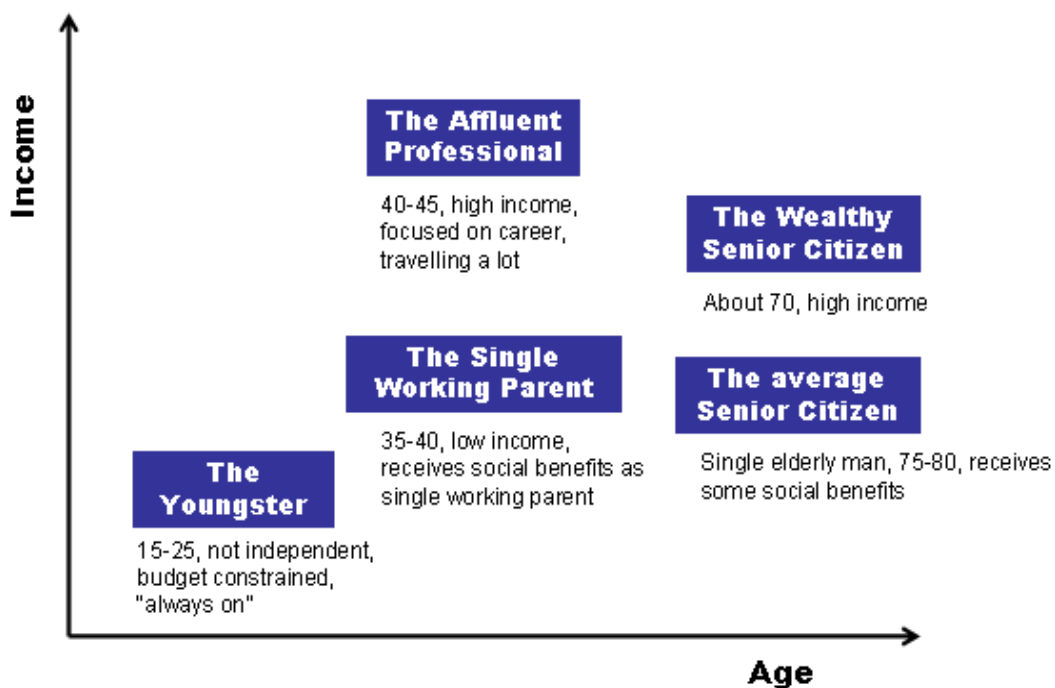
The following scenarios illustrate how consumers will use and “interact” with the various technologies and functionalities described in the two previous sections and will help linking consumers behaviours with new technologies.

These scenarios may target the 2010-2020 timeframe, while the various inhibitors described in the previous two sections, to better assess the level of confidence / uncertainty, have to be kept in mind.

Consumers are not a homogenous group, as many demographics and profiles exist, with different needs and issues. In this section, 5 typical consumer profiles were selected that illustrate how the needs and issues of those future consumers might be addressed by future technologies.

The following diagram illustrates these 5 typical consumers, in term of age and available income.

Figure 4.2. Five typical consumers



4.2.1 The Youngster

Group socialising: communication with friends, dating, meeting new people

Constantly on, constantly “in touch” generation

Fashion driven purchasing

Music, watching videos, listening to the latest fashion news

Price constrained

Juan is not really very interested in the geology field trip that is unfolding on the tablet in front of him. The sandstone formation being explored by fellow students in the university’s partner institution does not look very unusual. And the old professor has still not yet got the knack of dealing with scattered class participants.

So Juan is busily exchanging messages with his friends and discussing where to meet. His friend Lorenzo has just seen Gabriella in the ice skating rink. He knows Juan is interested and he taunts him by sending a clip of her falling down on the ice.

After class, Juan, Lorenzo and their friends all gather in the live chat space and agree to join the game being run by their favourite music store. The promotion offers an electronic discount on the new set by an American band.

They check out the music and like it. Juan has won the discount so he downloads the set onto his mobile. Once they are all well clear of the store’s detection system, he passes it on to his friends.

Lorenzo, meanwhile, is suffering from teenage boredom. He asks his virtual friend for suggestions. The virtual friend has been tracking his movements for the last three months and knows what films he has seen, what he likes and what’s on. It makes a couple of suggestions and one appeals to him.

The friend then asks if he wants to go alone or maybe try a blind date. It knows someone else with his tastes and nothing particular on. It sets up a call in which their avatars can talk. As the camera analyses their expressions and gestures, the virtual friend offers to switch to a live video call. They agree and seem to get on. So they arrange to meet in a bar near the movie house. Lorenzo does not know the bar, so gets turn-by-turn directions from his mobile.

The bar is big and crowded but Juanita can use the short-range wireless to guide her to where Lorenzo has found a table. Later, the virtual friend guides them to the seats next to each other that earlier it booked separately. The blind date is going well.

4.2.2 The Single Working Parent

Neither time nor money

Parent that needs to stay in touch with children

Using public transportation and taking advantage of what is publicly available

Receives social benefits from the state

Greta is a waitress in a large company in a large city. She has both a mobile phone and a wireless information tablet device (at home) funded by the local government to ensure that as a low-income parent she has adequate access to e-government services.

Greta's son complained of not feeling very well but insisted on going to school. She placed a video call to him during the mid-morning break. The call showed his face and displayed his heart rate and temperature. Greta was reassured that he had no fever and reckoned that it was something like a minor stomach upset.

During her lunch break, Greta went to the white goods store in the central mall to look for a microwave oven. The store is funded by the manufacturers who provide samples of their appliances with tags providing detailed information about the specification and price. Transferring the data to a handheld allows the shopper to make comparisons. Greta's selection is based on price. She is hesitating as she would like to buy this oven but also needs a new washing machine (hers has broken down and she currently has to wash outside).

Greta wonders about a new washing machine. With a low income and no credit card, she has no credit rating. But the local administration has a program to provide small loans to people like Greta. So she sends a message asking for a loan. The loan association broadcasts a message to people it has lent money to and who might know and vouch for Greta. Some people do so and the loan association agrees the loan. It sends the credit token with the conditions that it be used within six hours to buy a washing machine from a particular shop.

Greta is a member of a support group for other low income, single mothers. One she hasn't met before broadcasts a plea for help as she has to take her daughter to the doctor and will be unable to collect her son from school. Fortunately, Greta's son goes to the same school so she agrees to collect him. The mothers exchange photo messages so that Greta and the boy can recognise each other while Greta will have received an identity token which can be read by the boy's mobile to confirm that she is who she says she is.

Greta is always on the lookout for extra work to help support her children, she is a member of a catering workers union. When a restaurant is very busy and needs an extra waiter for a few hours they contact the union. Greta allows the union's systems access to personal information such as her location and calendar which she maintains online. When they receive a request the union systems check the available staff and find that Greta is in the vicinity of the restaurant, and is about to finish her shift in half an hour. They contact her and ask if she wants a few hours more work. Greta agrees and uses her mobile handset to sign a 3-hour contract on screen, the device then directs her to the restaurant that needs help. When she finishes her extra work she completes a simple form on her handset, which allows the union to send a bill to the restaurant on her behalf.

Once having picked up the kids, Greta is on the bus home, and she can connect to the subsidised information services run by the city for people like her. She reviews the financial implications of her new purchases and sends an e-mail to the mother of the boy she has collected from school to reassure her that all is well.

4.2.3 The Affluent Professional²

Focused on career

Travelling a lot for business

Use of mobile devices for business and extended use at home

Looking for information

A tendency to outsource because of time constraints

Fitness, health

Worries about not spending enough time with his or her family because of work commitments, likely to see technology as a way to compensate

Spends money instead of time

On his way to a meeting in Spain, Peter's mobile handset alerts him to a good spot in one of the airport car parks. He accepts that the parking fee should be added to his mobile phone bill³. Arriving in the terminal, he walks straight to the departure gate. He knows that the airport has recognised him as a frequent flyer, booked for the first flight to Madrid. He will have been checked in by the time he reaches the gate⁴.

Unfortunately another passenger collides with him and splashes coffee onto his tie. He has no time to check the shops so he adds the chore to the list of things to do in the lounge. He places a call to the virtual mall, which displays the likeliest store and shows him their range of ties. He sends his order and arranges for delivery in the lounge.⁵

In the lounge, he clears his e-mails and collects from the corporate systems the designs and proposal he needs for the meeting⁶. He also receives a message from his son asking for money to pay for repairing his scooter. This he can do easily enough. More worrying is that the health monitoring service he subscribes to has sent a message about his elderly mother. She has had a fall and not got up within 30 seconds, so help has been summoned and is on its way. He will have to keep in touch and see her on his return.

For his own health, Peter has a similar system. He wears a camera in his lapel to recognise and analyse all the items on any plate of food in front of him. Its calorie count will trigger a warning on his mobile phone unless the sensors he wears have calculated that his recent energy consumption would make the meal acceptable.

² On this scenario, we inserted footnotes to specifically provide examples of link to technologies – Those technologies are not necessarily different for the various scenarios

³ Driven by microcommerce and location-based discovery

⁴ Enabled by contact-less smart cards in possible combination with his mobile handset.

⁵ This either requires a larger screen to allow for this complex interaction OR can be dealt with via concierge services offered by intermediaries call centre.

⁶ Largely driven by larger screen technologies

The camera will also take photographs of people he meets and adds time and place details to the entry in his daily work files. When he meets the same person again, the system recognises the person and retrieves relevant data from the work files. If Peter is wearing his earpiece, it can remind him of the person's name and background.

The last thing Peter does in the airport lounge is to transfer the drawings to his rolled-up display so that he can study them in usable detail on the plane.

4.2.4 The Wealthy Senior Citizen

Not an aggressive technology adopter (more familiar with technology from the 1970s-2000 era when they were younger): technology is a tool more than a fashion statement and probably prefers technology to be invisible rather than aggressive

Still living in own property, possibly with a partner. Wants to be independent but starting to get less able, for example, inclined to forget things, maybe not as able to carry heavy shopping, more susceptible to illness like colds and flu.

Health is a concern but more healthy than a 70 year old in 2004

Travels quite a lot — several holidays outside the country in a year (has money and time).

Wants to stay in touch with his/her family (children and grand children)

Personal security, safety are major worries

Communication with peers, social communication is important

Jaana woke early this morning knowing that she had a busy day ahead of her: there's the third round of the chess tournament, a date for bowls in the afternoon and friends coming round for dinner in the evening.

She is determined that today, at least, she will be organised. She gets chicken pieces out of the refrigerator and hunts for the issue of a magazine which had a recipe that looked ideal. Failing to find the magazine, she connects to its Web site and gets the recipe displayed on the kitchen display screen.

The recipe calls for a spicy marinade so she calls her local store to deliver the paprika and onions. The store suggests that she should also re-stock with a couple of other items which it thinks she may be running low on. Half an hour later, the ingredients arrive and Jana has put the chicken in the marinade.

Now running a bit late, Jaana sets off in a hurry for the chess club. On the way, the car tells her the back door is unlocked and asks whether she wants it locked. That is a simple "yes."

Meanwhile, however, the medicine cabinet has noted that her supply of medication has not gone down by the right amount for the day. Since Jana is now more than half a kilometre away from home, the cabinet sends an alert to her daughter. Jaana's daughter instructs her phone to place a call to her mother. Knowing which number to call, the phone makes the connection for voice only. A quick chat lets the daughter remind her mother to take the pills.

After getting through to the next round in the chess competition, Jana is in a good mood for bowls. That mood soon evaporates after the game when the car refuses to start. But 30 seconds after the failure, the car has contacted the BMW support system and submitted some diagnostic data. The system contacts the nearest dealer to check availability of parts and repair time. Having had Jaana accept the quotation, the support centre orders the parts. It then tells

the dealer where the car is and sends an electronic token, which will let it, open the car for 48 hours.

Jana chooses to get a taxi to take her home, knowing that the charge will be automatically deducted from her bank account.

Arriving by the front door rather than through the garage, Jaana notices that the guttering seems to be blocked. A quick call to the Web site of her regular home maintenance service arranges for a repair man to call.

As her guests arrive for the evening, Jaana relaxes with the knowledge of how truly stressful the day would have been just 15 years ago.

4.2.5 The Average Senior Citizen⁷

Not an aggressive technology adopter, technology is a tool more than a fashion statement and probably prefers technology to be invisible rather than aggressive
Lives alone in an apartment, has married children and grandchildren
Communication with peers, social communication is important.
Wants to stay in touch with his/her family (children and grand children)
Health is a concern, has some aches and pains
Personal security, safety are major worries
Can't read small screens and use small keyboards, prefers voice interactions.
Wants to be independent but starting to get less able
Doesn't travel much, can't afford many holidays; most journeys are in the local town
Receives some social benefits and is a user of public health services

Jim has both an enhanced mobile phone and a wireless information tablet device (at home) funded by the local government to ensure that as senior he has adequate access to government services. In addition Jim has various pieces of wireless biometric monitoring equipment that communicate by wireless via his broadband link (at home) or his mobile handset (outside the home). A key goal of the government services is keep Jim as healthy as possible for as long as possible.

Jim was woken by his wireless tablet, which reminds him that he has a dental check-up later. As he gets up the apartment systems gently remind him if he has forgotten anything such as cleaning his teeth. Key biometrics such as blood pressure, heart rhythm, and body temperature are monitored by systems in both his clothes and the apartment. Many items in the apartment are monitored with cheap sensor nodes, e.g. cupboards, doors etc. Systems in the apartment analyse this information to detect patterns or changes which suggest that Jim may be having difficulties.

Part of the condition of the government supplying Jim with a free handset and wireless tablet device is that healthcare workers can monitor his location and biometrics. They use this information to maintain an overview of Jim's life and general well being, e.g. is he visiting friends, going to the cinema, going to the café etc. This is used to generate early warnings if Jim appears to be slowing down and becoming less self-reliant.

⁷ This scenario is a bit more futuristic than the previous one, targeting more year 2020, instead of year 2015.

At 10, the dental technician calls Jim who opens his mouth and points a camera in his phone at his teeth for the technician to take a quick look at their health. The phone images his teeth in visible light, ultra violet and infra red and the technician is a bit concerned by one, so they make an appointment for Jim to see a dentist in person the next week. The appointment is transmitted to Jim's personal diary on the tablet. While looking at his teeth the dental technician also checks the records from Jim's wireless electric toothbrush and his purchase records of toothpaste to check that he's remembering to clean his teeth regularly.

Jim checks some of his food supplies and decides to buy more. He starts using the wireless tablet to contact the supermarket, but the device gently suggests that as it's a nice day Jim might like to walk down to the supermarket in person. So Jim gets dressed and sets out. When he gets to the supermarket he walks around zapping things he needs with a mobile device, which reads the RFID or barcode and builds a list. When the list is complete he OK's it and the shopping will be delivered later that day by the normal supermarket home delivery system. Once the order is accepted Jim gets a message from the supermarket saying he's eligible for a free coffee and cake in the café. So Jim goes to the supermarket café, as he gets to the front of the queue with his coffee and cake the POS system recognises him from the wireless identity broadcast by his phone, checks what's on his tray using the RFID tags on the food and cups and says "hello Jim, nice to see you again, there's no charge, just walk through".

Jim decides to buy a book, so he asks his mobile phone where he can get the latest novel, the phone finds a shop with a good price and downloads a discount coupon then gives him turn by turn directions to the shop. As he is following these and starts to cross a road the phone says "Stop Jim, the traffic light is about to change, you won't get across in time". After finding the shop Jim buys the book (using the discount token), and starts for home. As he's walking along the phone sometimes says "careful here Jim, the pavement is slippery" (it has picked up this information from a temporary wireless beacon set up by the road maintenance crew who created the mud that made the pavement slippery).

However despite the warning Jim slips and falls, fortunately not seriously. As soon as his handset detects he's fallen it starts a timer, if he doesn't get up within 30 seconds it will call for help. Fortunately he does get up, so instead it contacts his daughter who calls him on her video phone just to take a quick look to see that he's OK. All is well, so after a quick chat he continues his walk.

Jim feels like lunch, so he sends an "anyone want lunch?" message to his friends, which the systems automatically route to those who are within 1 Km and who haven't already had lunch. The friends systems forward the message to their friends as well and Jim gets a reply saying there are two friends plus one "friend of a friend" who'd like to join him for lunch. The handset systems also suggest restaurants in the vicinity, which serve food they all like and are reasonably priced. They have a quick voice conference call to agree on a restaurant, and use a handset to book a table.

While Jim is out, a remote controlled wireless vacuum cleans his apartment, it is operated by a lady working from home in Poland who sees streaming video from the cleaner and can direct it around to collect dirt and pick up small objects. As she cleans she also takes a quick look around the apartment and will warn Jim's health visitor if she sees anything untoward, e.g. damage, anything dangerous, signs that Jim isn't looking after himself properly.

Finally, as Jim is heading home he feels a little faint, he presses a “feel ill” button on his handset, which sends a message to his medical practice. The systems there do a quick check on his biometrics (which seem generally good) and pass the information on to a nurse who calls Jim. She decides that he’s just getting tired and recommends doesn’t walk all the way home so he decides to take the subway. The nurse sends him a free subway ticket, which is loaded onto his handset, which then directs him to the station, opens the barrier, tells him which train to get on etc. Jim is finally safe at home and rests on the sofa.

5 Variables impacting on the future mobile world

Geopolitical, socioeconomic and technology variables have been identified as important factors in determining the future communications marketplace. These variables were analysed and sorted into a range of classes including predetermined forces and key variables. Key variables were then prioritised and the two most important selected in each of four Planes.

5.1 *Predetermined Forces*

This study excludes several very real variables from consideration. These operate at a macro level, on an infrequent basis, or with region-specific affect. Excluded were:

- Whether demographic trends will diverge significantly from current projections
- Whether global and regional economic cycles will become more or less pronounced or prolonged
- Whether global capital markets will artificially constrain, or over-stimulate, communications investment
- Whether consumers' total discretionary wallet of spending for communications will be consumed by expenditures other than communications
- Whether disease, famine, disaster, war and strife, migration and immigration, terrorism, fundamentalism or imperialism will play a material role

5.2 *Notes on Scenarios*

An important caveat is that there is substantial variety in the starting point for each country and region in today's communications marketplace. Regulation, consumer use and attitudes, deployment and availability, and market structures can and do vary in significant ways across the globe.

This study outlines three scenarios about the future of mobile communications. Scenario Two - Balanced, Broad-based Growth - is the main scenario envisaged as a plausible forecast. However, to provide a full picture of opportunities and risks, disruptive scenarios (Scenario One and Scenario Three) are also studied even though considered to be less plausible.

It is important to acknowledge that the consumer and business populace will have aged by 15 years in 2020. Readers must guard against assuming that concerns in today's market – spam, privacy, ease of use – will be as important to the experienced and emerging consumers of tomorrow.

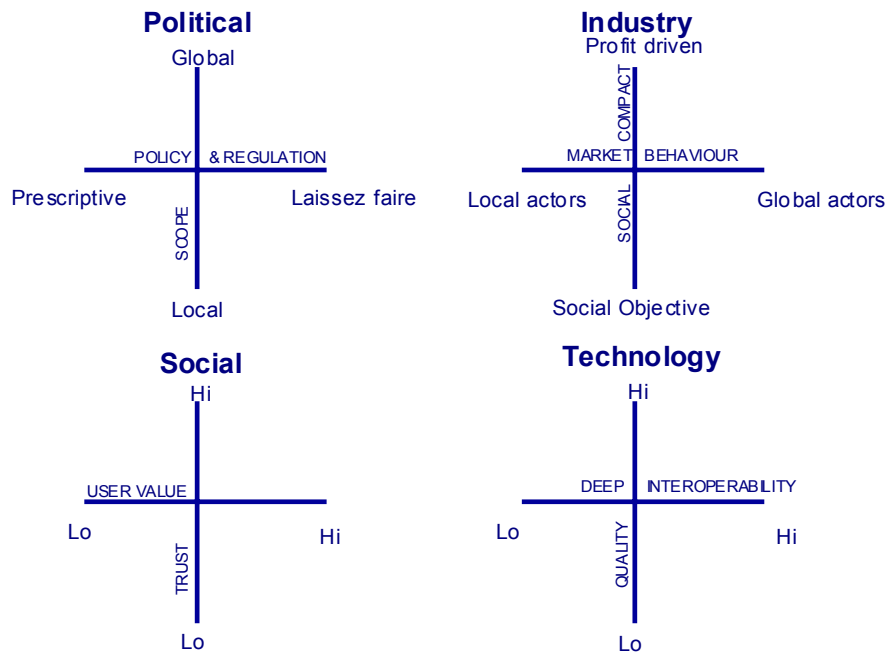
5.3 *Key Variables*

This study concludes that the most important variables are in four overarching Planes. Within each Plane, two particular variables are described as the most important.

Each of these variables consists of many specific issues and complexities. Three or four of these issues are listed below each variable. To make the task manageable, an attempt has not been made to assess or describe all the possible outcomes for each variable. Rather, a few different but plausible outcomes for each variable are identified, and effort was taken to make sure that the three scenarios are populated with minimally overlapping outcomes.

The unique positioning of each scenario can be represented, at a high level, by employing perpendicular axes for each of the two variables within each Plane, as shown in Figure 5.1.

Figure 5.1. Variable Planes for the scenario definitions



5.3.1 Political Plane – Key Variables

The scope and objective of **Industrial Policy**:

- Will it typically be more regionally and internally focused, or globally and expansively focused?
- Will the effort by regional regulatory authorities to normalise policies within a multi-country region consume a great deal of attention?
- Will countries pursue domestic communications technology export objectives with tariff, tax or investment policies, or other forms of “technology mercantilism?”
- Will countries and regions seek to converge with global frameworks in their own legal frameworks around patents, intellectual property rights and digital rights management?

The degree to which **Governmental Policy** is prescriptive or laissez-faire:

- Will issues around mobile access to content (cultural sensitivities, inappropriate content, content labelling) become a regulatory nightmare and an inhibitor to market adoption?
- Will the inevitable issues of a “level playing field” between the various uses of spectrum, and associated users and providers, create policy gridlock?
- Will policy bodies succeed in pursuing an agenda of harmonisation of spectrum policy?

5.3.2 Social Plane – Key Variables

The degree of **User Value**, beyond existing services (voice, messaging, data, video), for mobile access to information, entertainment, applications and richness of choice:

- Will global consumer expectations continue to rise related to mobile use?

- Will consumer engagement with mobile solutions intensify or not?
- To what extent will mobile access replace fixed access methods?

The degree of user concern, **Trust** and protection regarding health effects, fraud, inappropriate access, privacy and identity protection, spam, viruses and security:

- Will solutions emerge to deal with these potential inhibitors of demand?
- Will consumers readily adjust their expectations as they gain experience, also keeping in mind that today's youth will become the "middle" of tomorrow's market?
- Will brands successfully position themselves to increase user trust?

5.3.3 Technology Plane – Key Variables

The degree of **Deep Interoperability** achieved between access methodologies, operating systems, applications, roaming capabilities, billing and user experience:

- Will users be able to use an application seamlessly as they change access methods and place (roaming)?
- Will the pace of change and the attitude of industry participants help or hinder the work necessary to achieve robust interoperability, including such key enablers as micro-billing?
- Will "smart" radios, antennas and devices, and other technology advances such as neural networks, overcome rigid or proprietary solutions and overcome interference potential?

The degree of **Quality** related to availability, reliability, quality of service, and ease of use that mobile solutions assure:

- Will necessary but complementary applications, such as user authentication, support or subtract from the user experience?
- Will contending uses impede the reliability of new forms of wireless access?
- Will business users be assured of the quality of service they want for their critical applications?
- Will users accept low quality and interference if the price is low?

5.3.4 Industry Plane – Key Variables

The degree to which **Market Behaviour** is composed of a few global actors or of many local actors:

- Will the current industry value chain remain, or be upset by disruptive forces?
- Will open standards or proprietary solutions be more influential?
- Will industry profitability permit appropriate capital investment and adequate paybacks?
- Will benefits of global economies of scale override (by other benefits) other factors?

Whether the **Social Compact** has strong social dimensions or is overwhelmingly profit driven:

- Will market solutions satisfy social objectives around ubiquitous access, affordability, the environment, e-government?
- Will social objectives be achievable in the context of industry profitability and the cost of attainment?
- Will governments seek to maintain leverage over competitive entry, pricing and services availability in order to pursue social objectives?

5.4 Impacts and Implications

It is useful to distinguish between independent and dependent variables versus outcomes. As a scenario becomes more long term, independent variables inevitably interact with each other, and therefore become somewhat dependent on each other. However, the above four Planes tend to be relatively independent, when compared to the relatively more dependent outcomes introduced below.

Below are six significant mobile communications industry constituencies. Each constituency faces a set of dependent outcomes, described as Impacts and Implications in each scenario. These outcomes are such things as financial health, user experience, investment returns, and application adoption. As with the variables, these also are unique to each scenario, and are discussed in the following six categories:

- Users – Consumers
- Users – Business
- Government
- Service Providers
- Manufacturers
- Content and Applications Providers

6 Mobile scenarios for 2010-2020

6.1 Scenario One: Low price, Voice-dominated Growth

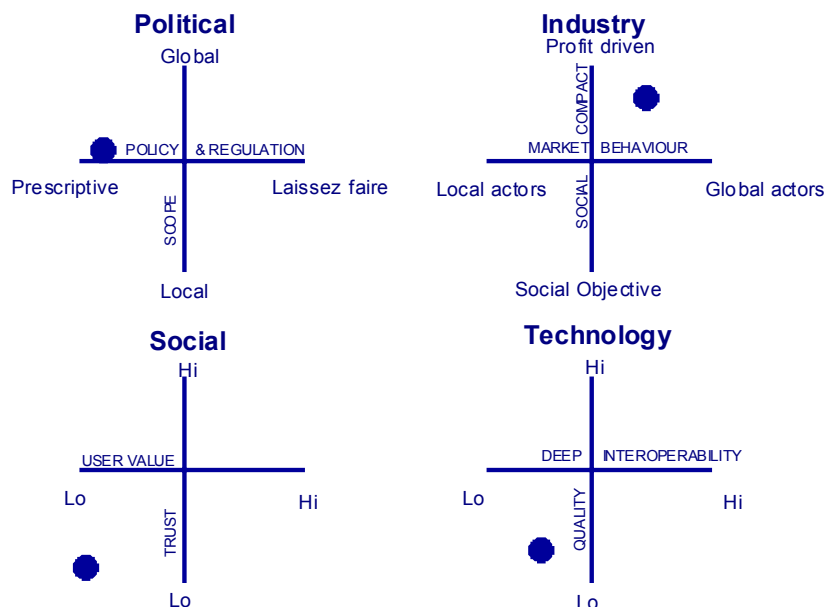
6.1.1 Key Drivers

The central feature of this scenario is the rapid decrease of price of existing services (in particular voice), leading to an increase of usage of these services but with no large development of new services. Such scenario could result from the transition to all-IP networks and the proliferation of IP compatible technologies traffic to very low price wireless VoIP-based solutions, without compensatory growth in new mobile data service revenues. Regulation is slow to react or support incumbents in creating a fair competitive landscape. Significant tensions with policy makers, and between competing industry camps, result in a struggle, damage to brands, and prescriptive regulatory reactions. These tensions hinder the harmonisation of spectrum policy across regions, and make it more difficult for manufacturers to plan for or achieve significant scale economies.

While consumers benefit from very inexpensive voice service, they do not see a compelling reason to adopt new services or migrate their surfing and video activity to more sophisticated and expensive systems. This is not helped by the absence of solutions to issues of privacy, trust, and ease of use.

6.1.2 Discussion of Variables

Figure 6.1. Scenario One variables



- Political Plane:

The rise of regional regulatory and policy authorities causes the regulatory agenda to be primarily consumed with normalising intra-regional policies. As a result, policy does not keep pace with technology change or the dynamics created by increasingly global competition, such as the requirement for harmonised global spectrum allocations. Unregulated alternatives

gain strength as incumbents are disadvantaged by rigid prescriptions on issues such as terminating call pricing, quality of service, coverage requirements, and consumers' "bill of rights." Content regulation for wireless operators remains unresolved. Frustration rises and defensive or self-interested attempts by firms to "play the system" only result in policy backlash, hindering investment, innovation and expansion into regulated broadcast markets. Such scenario could be favoured by a stagnation in the general economy.

- **Social Plane:**

Widespread consumer adoption of wireless data applications does not happen, although a steady stream of "hot hits" (games, music, clips) keeps some consumer segments engaged. But the appetite for paid content emerges only in pockets. Mass adoption is hindered by the market's sufficient satisfaction with entrenched alternatives for Internet access and video entertainment. No killer application emerges, other than VoIP, to stimulate broad growth in wireless volumes. Further hindering demand is consumer mistrust resulting from the ongoing industry struggles with regulators, and the fragmentation of offerings that exist. Because the industry is on the defensive, it is slow with a comprehensive response to consumer concerns about spam, health and privacy, and business concerns about security and interoperability.

- **Technology Plane:**

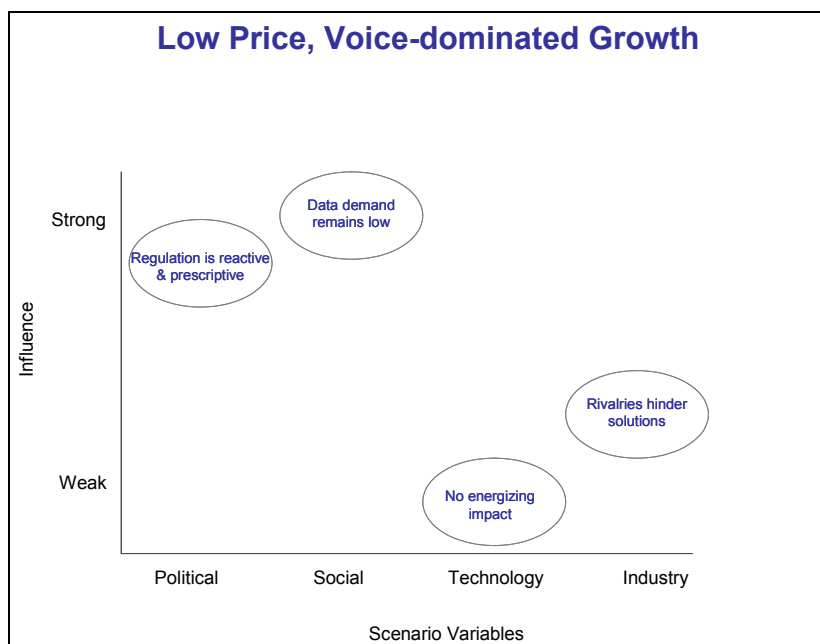
Robust adoption of VoIP makes it difficult and eventually impossible to detect voice communication since voice samples carried in IP packets look no different from data. A simple interleaving or scrambling will be all that's needed to confuse the network operator who does not own the end device and has no knowledge of its design. This drives the market to uniformly low pricing for all mobile access services.

Incumbents resist new standards as a defensive reaction to their constrained position. Patents and Intellectual Property Rights become a battleground. New entrants who do emerge and use innovative technologies actively avoid depending on incumbents to complement their service offerings, for fear of being drawn into a legal and regulatory morass. Interoperability between offerings suffers as a result, and no offering is able to meet the most robust market requirements for availability and quality.

- **Industry Plane:**

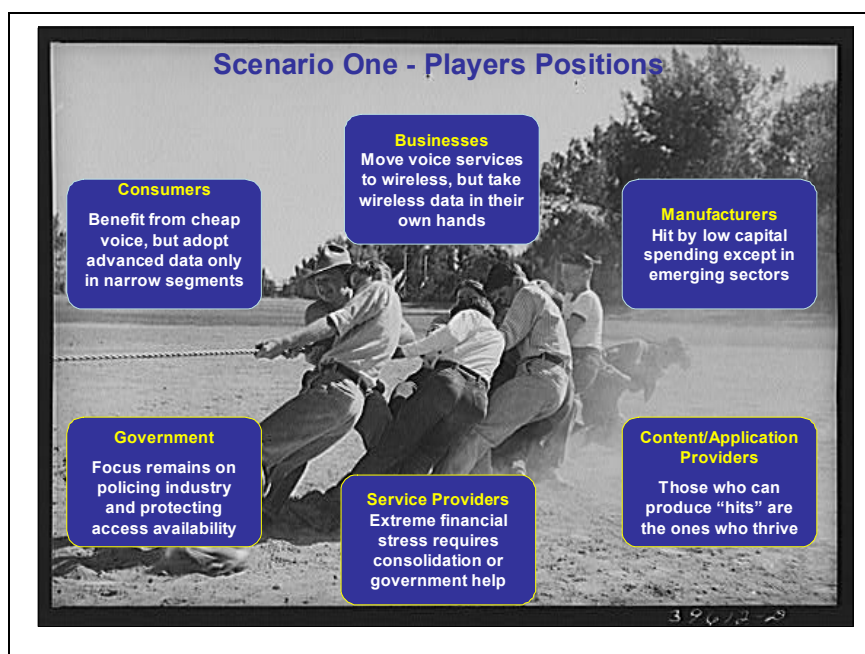
The industry becomes increasingly balkanised but concentrated, as slow growth triggers consolidations, and competing camps emerge depending on their support for new technologies and standards. Intense rivalries manifest themselves in price wars and an inability to solve difficult problems around such as digital rights management, user-defined preferences, spectrum reuse and resale, and VoIP quality of service. Without the likelihood of adequate returns, capital investment withers. Providers cannot afford to pursue "socially motivated" objectives.

Figure 6.2. Relative influence of variables on scenario outcomes (scenario 1)



6.1.3 Impacts and Implications

Figure 6.3. Players' positions in scenario one – Low price, voice-dominated growth



- **Users – Consumers:**

Users benefit from rapidly falling voice prices, and are able to consume as much wireless content and data services as they wish to. However, the quality of experience, especially in multi-network situations, or complex data applications, is poor. The primary basis for

differentiated propositions is the availability and quality of voice service, though consumers are primarily price driven.

▪ **Users – Business:**

Low voice pricing is a clear benefit to businesses, which actively replace embedded landlines with wireless solutions. However, business users find that service providers are often unwilling to tailor service offerings, invest in augmented network availability, assure quality of service, or develop security solutions. Interoperability with alternative wireless access methodologies is not provided, and causes most businesses to rely heavily on unlicensed wireless alternatives for their local data applications.

▪ **Government:**

Without wide adoption of data services, initiatives to take advantage of wireless e-government solutions are stymied. Since vendor costs are elevated due to the presence of many competing standards and solutions, there is little ability or will to subsidise penetration into marginal markets.

▪ **Service Providers:**

This is a world of extreme financial stress on service providers, where voice revenues evaporate as VoIP becomes “free.” Investment and innovation are not affordable. New entrants often face strong reactions from incumbents, who rely on brand loyalty and protect their position through aggressive price moves. To the extent that incumbent players cannot attain the cost structure necessary to avoid bankruptcies, political authorities may force cross-border and other managed consolidations as a survival tactic. In the most extreme cases, in order to preserve ubiquitous wireless access, some national governments choose to nationalise the “wireless pipe” and force a clear separation of content and application provision from underlying licensed wireless transport.

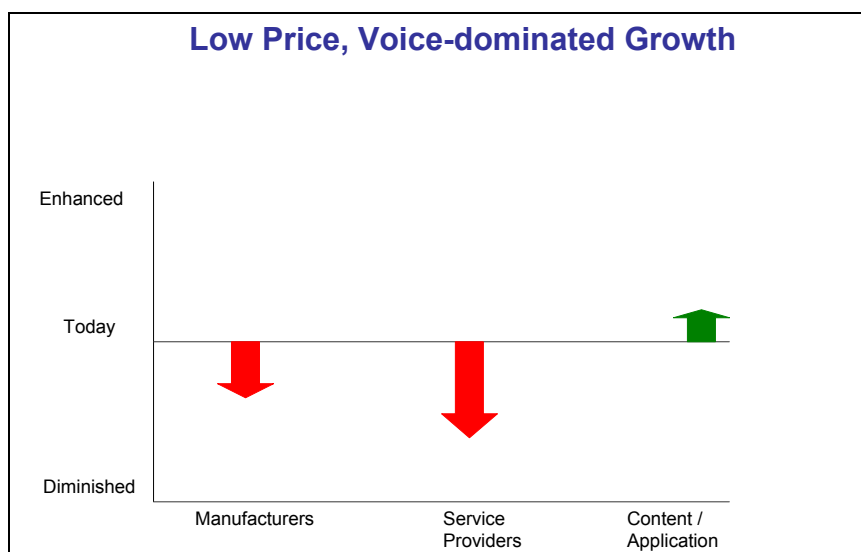
▪ **Manufacturers:**

Financial stress extends to this sector, as operator capital investment dries up, and device replacement cycles are not fuelled by new applications. Alternative access technologies create some new frontiers for growth. The large penetration opportunities in Asia are not spread broadly amongst potential suppliers, but captured primarily by domestic firms.

▪ **Content and Applications Providers:**

Although content is not broadly consumed, in those segments where content matters the market is “hit” driven. Content creators retain a relatively large share of revenue as a result, and because service providers cannot transform themselves (for reasons of affordability, regulation and skill) into “hit makers” or effective marketers.

Figure 6.4. Changing influence and role of industry participants 2020 (scenario 1)



6.1.4 “A Day in the Life”

It is useful to explore how a typical customer spends their day under each scenario. A representative residential (consumer) and business customer follows:

- **Consumer:**

Harry has been very frustrated with his mobile phone and its service. Whilst he likes the ability to call anyone anywhere for paying practically nothing, he always finds that his bill is wrong and he never gets to talk to a person if he calls to complain. It seems his service provider just doesn't care and is unwilling or unable to provide a reasonable level of customer support. Harry would just change service providers, but in the past 2 years he has already done so 3 times and the services providers are all like. He wanted to get some new cool services – video phone, gaming and the like, but he's now just given up. He gets most of his entertainment from his cable TV company who now has some interactive services or else he just spends time with his friends at the pub.



- **Business Customer:**

Alice just got a significant promotion, now she will manage the entire Western European market for her media company. She will need to be on the road much more than in the past. “How frustrating” she thinks. There not a single mobile solution that provides more than basic service and even at that her calls still get dropped. Complaints are useless. She will rely on her wired broadband connection at each hotel when she's on the road. Even those wireless hotspots that are advertised are useless. By the time you can figure out how to log on and how to pay, she is out of time and interest – she no longer bothers.

6.2 Scenario Two: Balanced, broad-based Growth

6.2.1 Key Drivers

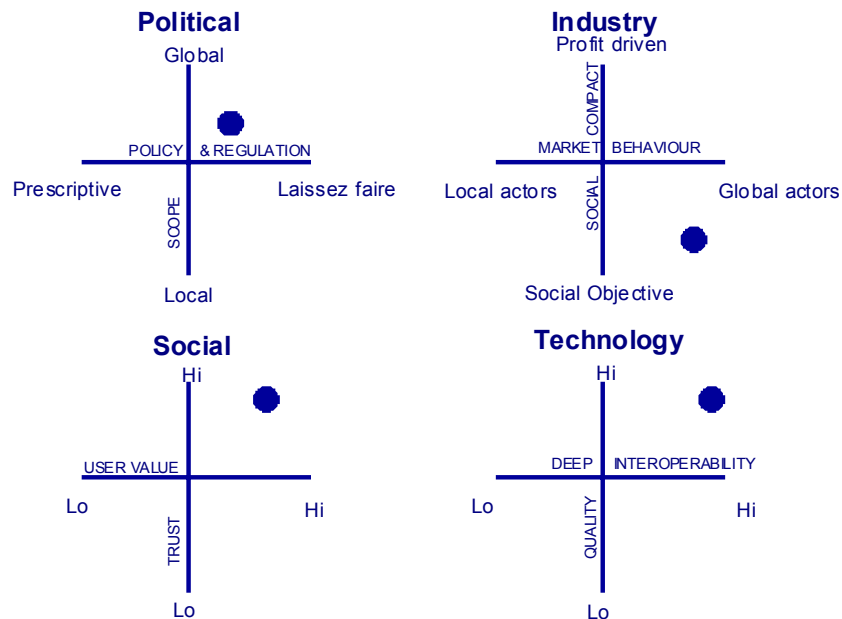
The central feature of this scenario is the steady migration of both voice and data traffic, from wireline and broadcast means, to mobile and the steady evolution of the mobile services towards sophisticated and complex services requiring efficient solutions... Consumers readily adopt mobile access opportunities as mobile terminals get bigger screens, higher quality audio and video, as laptops replace desktops, as wireless voice availability becomes truly ubiquitous and high quality, and as personal video devices complement televisions. The steady progression of consumer demand, and the emergence of global consumer expectations, enables firms that dominate different aspects of the value chain to retain and confidently expand their positions. With the helpful guidance of government policy makers, open standards, roaming capabilities are enhanced and managed competitive entry helps to maintain a stable environment for service provider investment. Innovation amongst firms and developers creates growth-oriented pressure. Competitors differentiate propositions on the basis of applications, content and quality.

Mobile industry succeeds in creating fundamental solutions to difficult communications industry issues around trusted multimedia environments, micro-billing, and inappropriate content. The industry also is able to invest in pan-industry solutions that enable a high degree of seamless application performance, user-defined quality, and personalisation. Mobile activities also drive the preponderance of profitability in the overall industry, helped by robust content revenue sharing, revenue-producing interconnection arrangements, and disciplined pricing.

As a result, mobile becomes the centre of an industry convergence at both the platform and service provider level. Mobile industry maintains a proactive stance with policy makers, including voluntary efforts at supporting affordability and adoption. Convergence between mobile and broadcasting is successful from technology point of view and traffic migrates accordingly.

6.2.2 Discussion of Variables

Figure 6.5. Scenario Two variables



▪ Political Plane:

Regulators and policy makers provide a proactive “guiding hand” in terms of achieving converged industry policy frameworks, including spectrum harmonisation, and uniform standards, to enable economies of scale for products. The pace of convergence-driven consolidation occupies the agenda, and increasingly authorities perceive that the available service choices, and innovation, are adequate to meet consumer needs. As a result policy-makers take a cautious stance to promoting new competitive alternatives, although new technology enables such entry. The dominant players navigate the policy arena well, find self-policing solutions to content regulation, and steadily erode barriers to entry into traditional broadcast services.

▪ Social Plane:

Users readily embrace the mobility benefit, and mobility premium, associated with migrating desktop and home entertainment activities into mobile laptops, PDAs, smart phones and other appliances and electronics. Adoption of wireless PANs and LANs at home and work explodes. Innovative mobile applications find an eager audience; a global consumer expectation emerges for continued innovation and choice. The industry is proactive in addressing many of the potential concerns that plagued the Internet’s early rise, and mobile access becomes seen by consumers as a trusted environment.

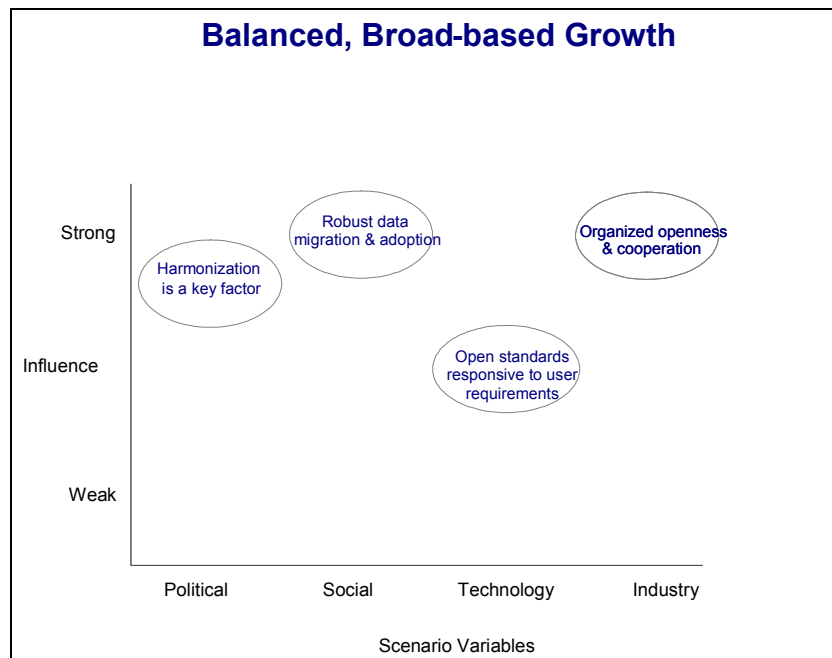
▪ Technology Plane:

Adherence to open standards increasingly marks the industry’s approach to new technology deployments, and the big players enforce that approach. This enables early and effective efforts to ensure interoperability at all levels. One critical achievement is the adoption of robust and standard micro-billing capability for usage-based mobile applications and internetworking between different access methods. The big players also force obsolescence in hardware and software platforms in order to assure their revenue models, and to migrate users into increasingly rich application suites.

▪ **Industry Plane:**

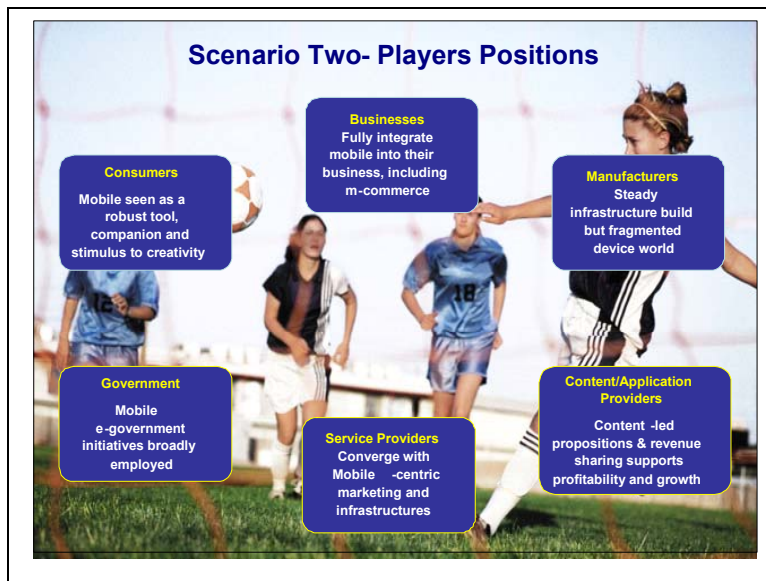
Cooperation and coordination mark the largest players' behaviour as they actively guide investment away from proprietary solutions. Intellectual property rights are not a battleground. The industry succeeds in establishing wireless-originated infrastructure platforms as the de facto converged standard across the entire communications industry. Where new technology and spectrum create a compelling alternative means of wireless access, existing providers typically co-opt the alternative by building it into a comprehensive proposition. An open approach toward intellectual property fosters a robust level of new investment and application innovation amongst smaller players and start-ups. Larger players continue to expand horizontally and globally, and significant consolidation occurs within the industry as the distinction between fixed and mobile disappears for operators and manufacturers of access devices, infrastructure and software. Long-term capital investments are made with relative confidence.

Figure 6.6. Relative influence on scenario outcomes (scenario 2)



6.2.3 Impacts and Implications

Figure 6.7. Players' positions in Scenario Two – Balanced, broad-based growth



▪ Users – Consumers:

The relative stability and profitability of the industry facilitates a robust developer tier and a flowering of consumer applications. Content increasingly is created to serve the mobile market. Consumers interact intensively with their mobile devices and services, coming to see them as a robust tool, companion, and stimulus to creativity. Mobile medical monitoring is one example of an application that consumers embrace.

▪ Users – Business:

Of great importance, the banking industry embraces mobile payment methods, including transaction micro-billing and as a result mobile commerce enjoys broad adoption. The stability, interoperability and quality of mobile communications encourage several industries to fully integrate mobile solutions into their way of doing business – supply chain management, information exchange, distribution, billing and customer management.

▪ Government:

The relative stability and cohesiveness of the market and its underlying standards mean that governments are able to plan and successfully implement e-government initiatives on a broad scale. Tax payments, voting, administrative automation and delivery of services are all facilitated by converged, interoperable and trusted communications infrastructures. Mobile is core to that.

▪ Service Providers:

Although VoIP puts continuing pressure on voice revenues and margins, service providers grow their way out via the robust adoption of data applications by consumers and business, and usage-based pricing. Service providers integrate alternative access means as part of complementary total solutions, but work with vendors to assure the continued dominance of traditional access methods. Mobile becomes the centrepiece of integrated propositions, including significant content packages.

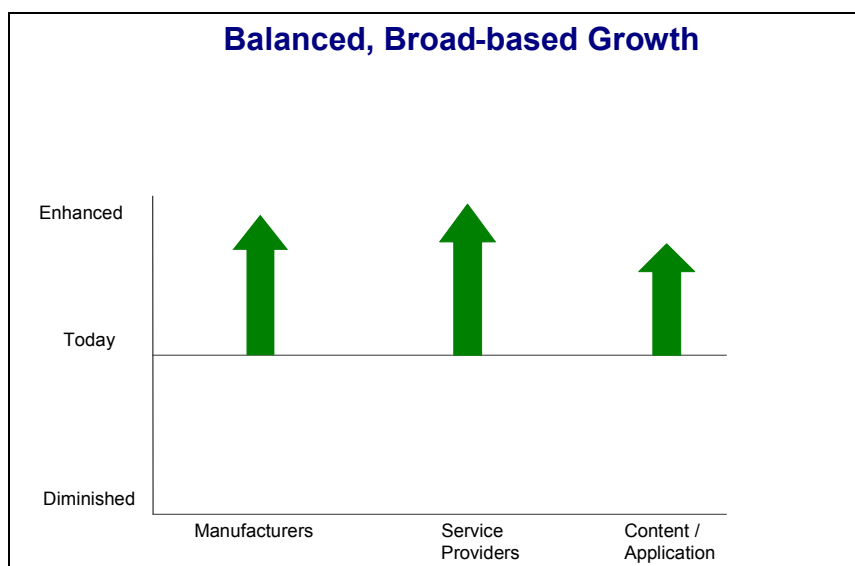
▪ **Manufacturers:**

Service providers pilot a measured rollout of new capabilities and infrastructures, but that is balanced by the healthy opportunities created by obsolescence and the convergence of platforms. Device manufacturers face competition from the entire consumer electronics industry as consumers segment their mobile device buying along application lines – be it music, video, voice, messaging, games, productivity, creativity, information retrieval – and as manufacturing costs tumble.

▪ **Content and Applications Providers:**

Many propositions become content-led, and robust micro-billing capability means that adequate revenue sharing supports the health of content providers. A similar dynamic exists for application creators.

Figure 6.8. Changing influence and role of industry in 2020 (scenario 2)



6.2.4 “A Day in the Life”

▪ **Consumer:**

Farad is excited; he is in second place for the global “Caves and Camelot” game that he has been playing for 9 days straight. He is so dedicated he barely takes time to sleep, although when he does, his buddy Jack sits in for him to assure he doesn’t lose ground. He can play from anywhere and frequently has strategy videoconferences with Jack whilst still engaged in the game. His archrival, Deepak, plays from India and has really been gaining ground recently. Hundreds of other players come and go, but few have the dedication of the real champions. Jack is Farad’s key competitive edge since Jack is the former grand master of the Dragons and Dinosaurs tournament.



Farad has reached high levels in the gaming community whilst still holding down his job as a junior editor for the local newspaper. He rarely goes in the office and sends most of his copy in at the local coffee shop. It’s simple and all his billing is handled automatically. Here’s his greatest frustration – those darn bills. He is looking forward to even better value pricing for all the wireless technology that he needs.

▪ **Business Customer:**

Kent is a manager for the global overnight delivery service – GemExpress. He is delighted with the company incentive plan, which provides him with the wireless tools and monetary incentives to track all of his customers’ shipment by the minute across the globe. He has direct contact through his mobile phone to his customers’ supplier chain partners. When orders change, he can immediately intercept the order processing and issue a changed directly with the suppliers. His customers are delighted with this value-added service. Every parcel is tracked with a RFID that he can access through his mobile. While the service is expensive, his company is so big that they have proven time and time again that the cost is well offset by the increased revenues generated through their highly valued service. Kent has daily videoconference calls with his manager. Whenever his customers call, he is able to provide simultaneous video feeds to his warehouse, his manager and the supplier at the far end. This has saved the day many times since a problem can be resolved quickly and in real-time. Language is not even a barrier since he has access to auto-translators for over 200 different languages.

6.3 Scenario Three: Pervasive Data-driven Growth

6.3.1 Key Drivers

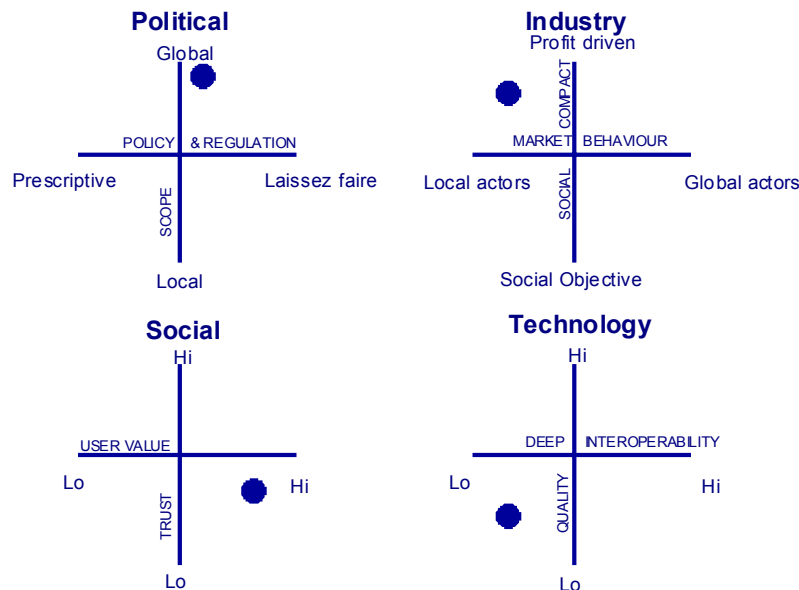
The central feature of this scenario is the relentless deployment of low cost platforms, speed to market, an extreme focus on developing specific local competencies and capturing targeted market opportunities. Wireless access options proliferate with ad-hoc networks in highly populated areas. Prices fall rapidly, with commodity-like pricing a constant risk. The rapid deployment of overlay networks, WANs beyond 3G, plus connected LANs and ubiquitous PANs means that the user has multiple options to connect, although seamless experiences are not guaranteed and consumers must cope with a patchwork of options. However there is a need to ensure complementary coverage to these ad-hoc networks with the larger mobile networks on a national basis.

Manufacturers adopt aggressive “leapfrog” strategies, using opportunistic partnerships and sourcing arrangements that employ proprietary end-to-end solutions. Many manufacturers, consumer/content brands and enterprises become virtual service providers in order to secure end-user markets for their core products. In the drive for quick scale economies, firms aggressively court – and deploy capability to – previously underserved markets around the globe, in highly populated areas. Service providers find this to be an attractive avenue of growth. Incumbent licensed network service providers are ultimately unable to compete with their existing cost structures. Regulatory influence is diminished.

The market (customer segments, propositions and providers) initially fragments to an extraordinary and chaotic degree – fed by a proliferation of access options, content propositions and device types. Use of wireless explodes, including in peer-to-peer content applications using ad hoc networks and pirated content. By 2020 service provision necessarily begins consolidating again, led by global consumer brands that have expertise in managing customers through repeated generations of technology and propositions.

6.3.2 Discussion of Variables

Figure 6.9. Scenario Three variables



▪ Political Plane:

Manufacturers seek to undercut dominant “embedded” standards, providers and price levels through an aggressive leapfrog strategy which promotes: much lower deployment costs, proprietary end-to-end solutions, and access to and re-purposing of virtually any content at significant savings compared to the original distribution source. Device technology and consumer behaviour (peer-to-peer creation and piracy of content) make the industry “ungovernable.” Initially, some policy officials’ response is to adopt an increasingly hands-off attitude, satisfied that competition will meet customer needs. However, over time many regulators find the market to be too unstable and not in the public interest, and push for more rationale market development. Some regions mandate an accelerated and standardised ubiquitous network rollout beyond 3G as a defensive industrial policy in response. Spectrum harmonisation suffers as a result of this uncoordinated and inconsistent approach and no economies of scale can be achieved for equipment production.

▪ Social Plane:

The ubiquitous availability of low-cost content increases peer-to-peer content applications and “co-production” on top of an already rich market for video entertainment. In highly populated areas, wireless becomes a great enabler of virtual work and social patterns however quality is very low. Consumer markets and propositions become segmented along new lines according to emerging preferences for cost, quality and features. Some providers offer content ratings and protection as an example.

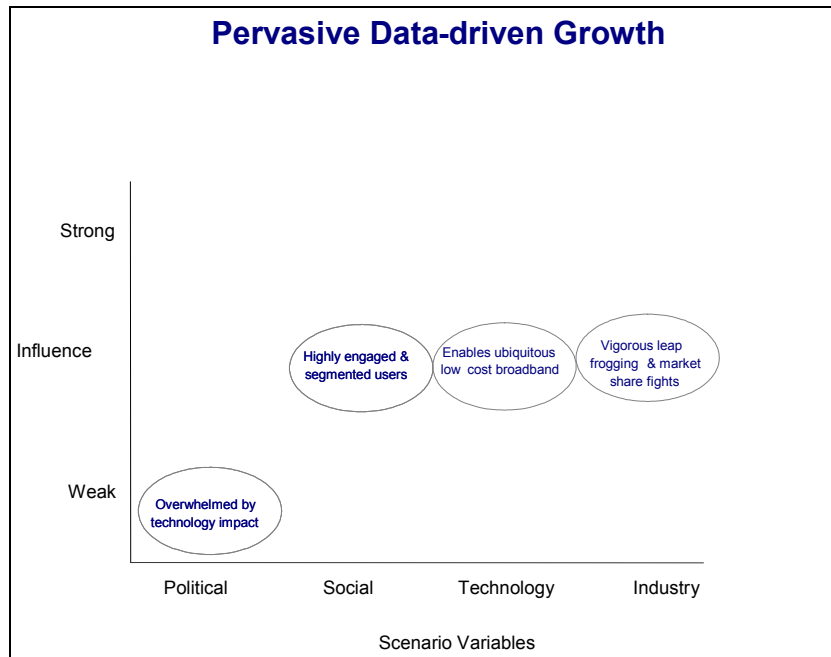
▪ Technology Plane:

The fracturing of dominant standards reintroduces interoperability challenges, and leads to emerging “virtual islands” of providers and users that adopt lower cost “leapfrog” end-to-end solutions. Since cost and speed to market are the dominant drivers, as a result quality and security often lags customer requirements significantly. Widespread ad hoc or mesh network deployments are one of the “leapfrog” tactics of low-cost manufacturers and service providers, and “bottoms-up” creation of such networks becomes widespread.

▪ **Industry Plane:**

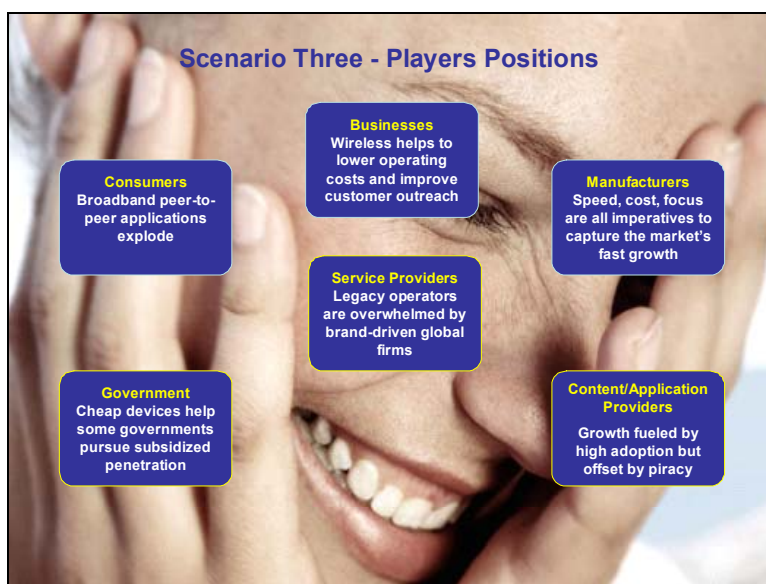
The drive for market share through low cost creates significant stress on many firms, and those that do not rapidly reduce costs are consolidated. As firms radically restructure and focus on their core strengths, networks of specialised low-cost providers emerge to defend markets and expand globally. Market shares shift rapidly and alliances form opportunistically. Utilities, cable television firms, municipalities, consumer lifestyle brands and automobile manufacturers all develop wireless propositions. Capital investment decisions face shorter payback requirements.

Figure 6.10. Relative Influence on scenario outcomes (scenario 3)



6.3.3 Impacts and Implications

Figure 6.11. Players' positions in Scenario Three – Pervasive data-driven growth.



- **Users – Consumers:**

An increase of peer-to-peer content, user-created content, and quickly changing propositions marks this scenario. Users are able to find offers that meet their essential needs, often at very low cost. Basic devices are very low cost, but capabilities can be limited and differ from device to device. Certain market segments churn aggressively to take advantage of the latest offers. Subscriptions grow rapidly as previously unserved markets become economic for service providers. Many of the subscriptions are for voice or simple messaging applications in highly populated areas of some currently under-served markets.

- **Users – Business:**

Businesses are able to find providers who could offer a tailored mix of applications and features to suit their needs however accepting a low quality. Machine-to-machine applications grow rapidly. The low cost of devices also encourages businesses to distribute application-specific wireless devices to customers as a way of locking them in, and lowering the cost of customer management, information exchange and distribution. The side benefit is increased wireless adoption.

- **Government:**

In some developing economies, the relatively low cost of deploying infrastructure and devices that are voice-only, messaging-only or otherwise applications specific allows modest subsidies. Governments, development authorities, foundations and micro-lending institutions may choose to subsidize the distribution of devices to encourage connectivity, and to provide incentives to deploy networks broadly. Some developed economies could undertake similar efforts such as e-government, but on a more localized or application-specific basis.

- **Service Providers:**

Vendors push low cost end-to-end solutions directly to consumers, business and communities of interest and virtual service providers. To preserve revenues existing network operators insistently pursue wholesale provision of backbone and core infrastructure services to emerging and virtual service providers. The proliferation of wireless networks, including coalitions of local unregulated access providers, and the incentive to switch providers created by low cost intelligent devices, means that existing service providers can't afford broad infrastructure upgrades or other long term investments and find it ultimately impossible to compete on the basis of their legacy networks, today's cost structures and profitability models.

- **Manufacturers:**

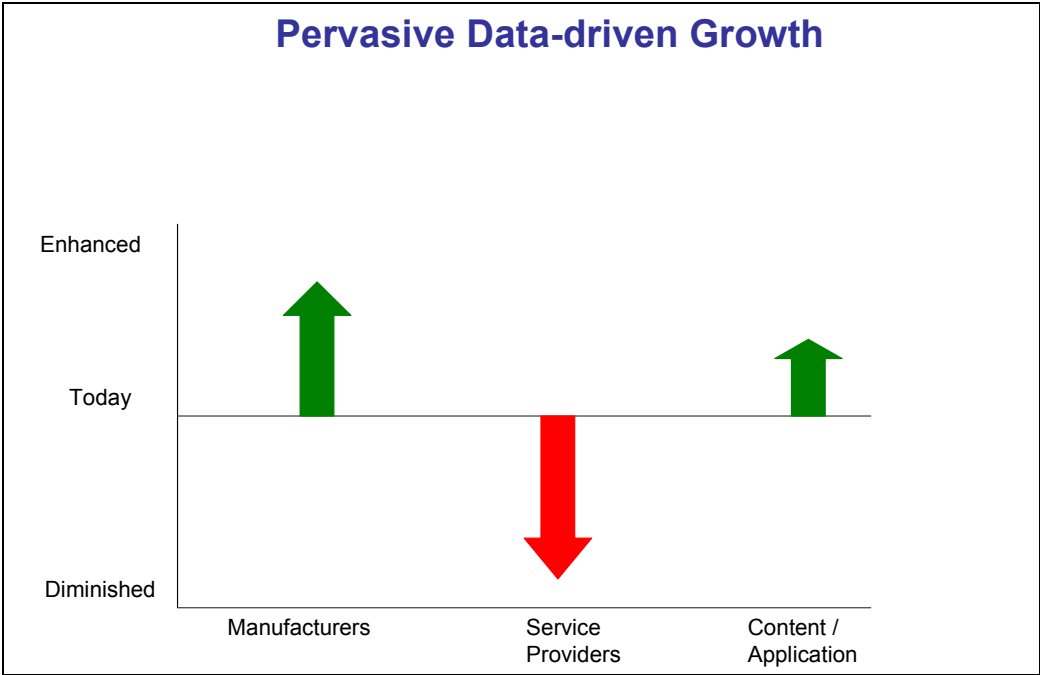


Manufacturers drive the overall market, but those who cannot operate at extreme speed, clear focus and low cost are left behind. Restructure is an imperative for existing players. Quickly assembled and disassembled global supply chains and distribution networks enable effective penetration of new application opportunities, vulnerable installed bases, and developing markets. Many manufacturers integrate forward into virtual service provision, or partner with global consumer brands to provide turnkey service offerings, including content sourcing.

- **Content and Applications Providers:**

Digital rights management is a battleground in this scenario. Immense volumes of high bandwidth content are consumed and shared in this scenario. However, some service providers avoid industry frameworks and provide compelling, pirated content at low price. Large content brands react by pursuing multi-pronged distribution, packaging and pricing strategies.

Figure 6.12. Changing influence and role of industry participants 2020 (scenario 3)



6.3.4 “A Day in the Life”

▪ **Consumer 1:**



Kou-Hui has made real progress in the past year in his village. He has expanded his customer base for his fertiliser business from just his local village to farmers three villages away – without even having to leave home. He is able to send a receive order and confirm deliver with his push-to-talk communicator that his village council gave to him. He pays the equivalent of 1 hour’s pay for a whole month of service. He can even use it to communicate with his wife, but no to his cousin in another region, as he has a different kind of system in use. The most exciting thing on the horizon is promised access from the village centre to the Internet. He could get cheaper materials by expanding his suppliers. The shared access has been promised within one year. Life is really changing

for Kou-Hui.

▪ **Consumer 2:**

Brian is connected! He spent one week’s pay to get his communicator – it fits in his pocket with a wireless headset, even a tiny wireless printer. He can use it on any network that is supported by his communicator and never has a problem with billing. Some of the networks are free – like the one the city set up. Others, like his games, he pre-pays for a month’s worth

of endless play for about 1 hour's pay from his factory job. He can chat with his friends, consult with his game coach and even order his groceries all at the same time using those networks that is supported by his communicator.

▪ **Business Customer:**



Rachael has been self-employed as a free-lance graphics designer for the past 5 years. She has built up a worldwide clientele using her always on wireless notebook – it has everything she needs to do her job and when she's in her home office she just docks it so she use her wall display and remote hand navigator. She heard there used to be wires that connected all the devices in a home – but she's never seen such a thing. She does have two different service providers and also her housing complexes free broadband service. She's happy to pay the affordable price for each, since each provides link to the network –based software that enables her to deliver amazingly complex 3-D real-time marketing collateral for her customers and through real-time connections, she customises each product within 15 minutes of being notified of an upcoming needs of her customer. When she's at the office, at home or sitting at the bench, the customer never knows. She just wished that her wireless notebook also worked while she is on the high speed train.

6.4 Scenario Comparison and Overarching Implications

Three distinct scenarios have been studied about the future of mobile communications:

- Scenario Two is the **main scenario envisaged** as it is believed to be the most plausible evolution of mobile communications for years 2010-2020.
- Scenario One and scenario Three are **disruptive scenarios** and are studied to provide a full picture of opportunities and risks.

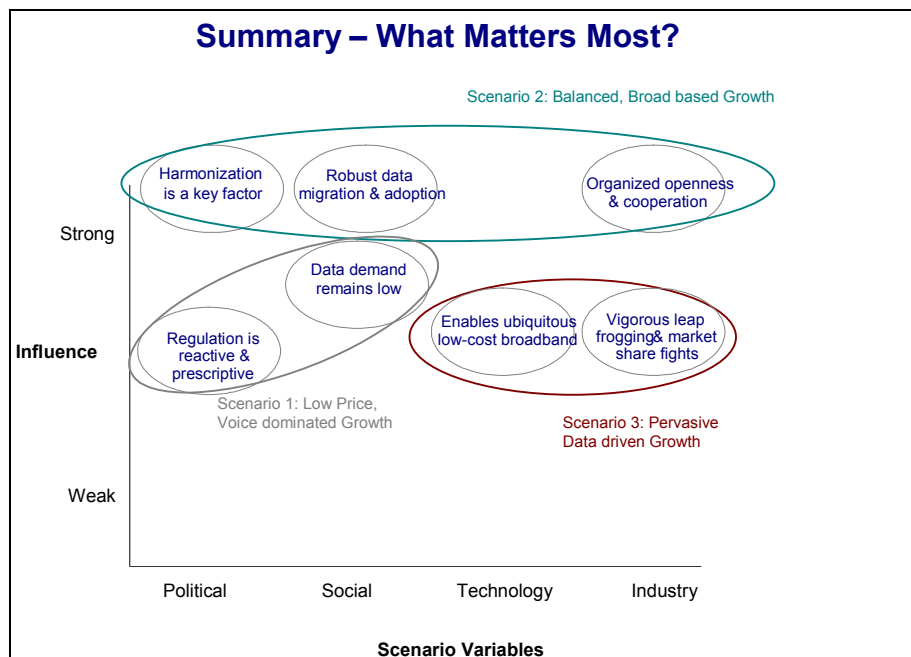
The investigation and analysis of the different scenarios have indeed identified scenario 2 as the most plausible. This conclusion could be summarised as follows:

- Lessons learned have particularly brought the awareness to the industry that interoperability is the key essential element for global communications.
- Despite turbulence and disruptive technologies in the Standards bodies, Industry and Regulatory regimes, users and consumers will still communicate the normal way utilising convergent wireless solutions regardless of how the services are delivered.
- Innovative technologies will lead to Network capacity and efficiency enhancements.

The scenarios presented here represent three case studies for global wireless subscriber numbers, traffic levels, industry health, and the future value chain. Variables have been highlighted that have wide ranges of possible outcomes, and they can be combined thematically to result in strikingly different scenarios. Are there any insights that can be gained by comparing these scenarios and their implications?

The first comparison in Figure 6.13. below demonstrates the most influential factors are for each scenario. Should the variable play out as highlighted, then the likelihood of the associated scenario is heightened.

Figure 6.13. Most influential factors for each scenario



For the first scenario “Low-price voice dominated growth,” the absence of broad consumer demand for wireless data – combined with virtually free voice services – starves the industry of necessary sources and incentives for new investment and innovation. Contentious with regulators put further constraints on growth, for service providers in particular. There is plenty of similar current precedent for this combination of variables and their impact on growth.

The mobile industry is evolving to bigger volumes that enhance capabilities. Consumer and business voice increase in volumes but revenues flows diminish, and are not replenished with robust adoption of new applications. VoIP is embraced as a competitive necessity across the global telecommunications industry. Quality of Service standards, terminating price regulation and interconnection arrangements, are all elements to be taken into account.

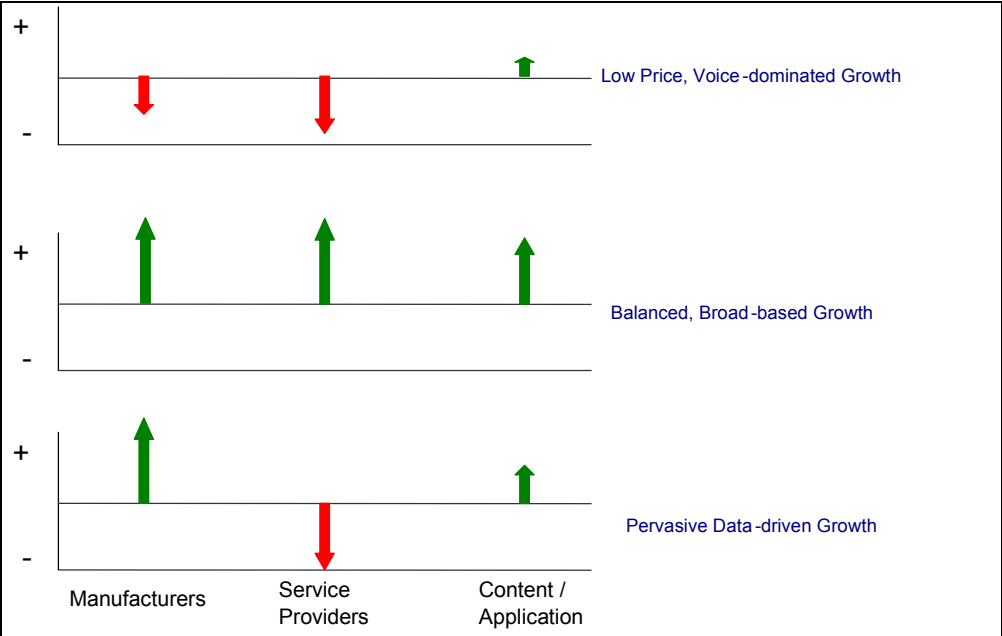
The second scenario “Balanced, broad-based growth,” offers the opportunity to create a stable growth environment allowing effective industry cooperation. A united front with regulators, an adoption of open standards, harmonisation efforts and an effective focus on encouraging migration of wired data traffic to wireless are the strong points of this scenario.

As new technology enables competitive entry, the industry’s response (including effective engagement with regulators) will determine the degree to which the market will fragment along lines of alternative access approaches, versus expand cohesively into an integrated set of service and access offerings. The key lesson of this scenario is that all types of participants in the mobile industry can succeed with advantages of cooperation and harmonisation. In this scenario investment can be made with confidence about long-term positive returns.

For the third scenario “Pervasive data-driven growth,” it is low cost proprietary technology and vigorous competitive entry that rule the day. The ad hoc broadband wireless networks start to take significant part of traffic. Those competitors who anticipate the necessity for a low cost structure, for quick adjustments to product and partnership arrangements, and for aggressive fights for market share, will be the ones who prevail. It is they who will most likely monetize the growth of data subscriber and traffic volumes, even as voice revenues decline. Larger mobile networks are needed to ensure complementary coverage, on a national basis, to these ad-hoc networks.

As shown in Figure 6.14., the summary of the potential value chain “winners and losers” in the three scenarios indicates how uncertain is the upcoming environment for all participants. To some extent this is a direct result of the degree of decline in voice revenues implied by the emergence of VoIP even with the resultant stimulation of traffic volumes.

Figure 6.14. Changing influence of players by scenario



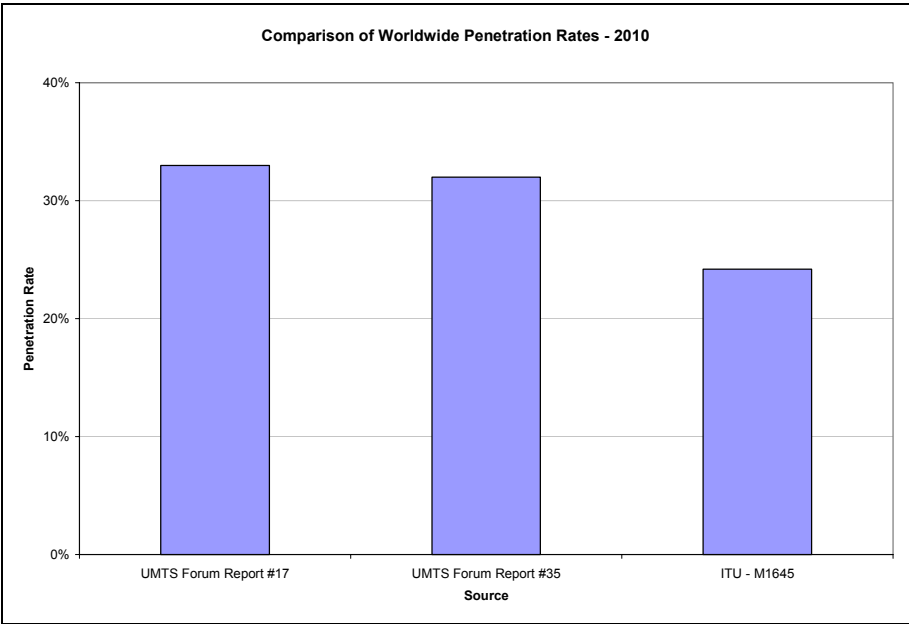
The number of subscribers and subscriptions can be projected in these three scenarios.

Global subscriber forecasts for the period 2010–2020 were developed with the following approach:

- Rational consistency with known worldwide voice and data forecasts for the year 2010
- Rational consistency with scenario descriptions used in this study for the year 2020 including a normalise rating of voice and data intensity
- Realistic worldwide penetration rates for voice and data services based on cost, pricing and technological constraints presented under each scenario
- Rational annual growth rates between 2010 and 2020 based on technical and business considerations presented in each scenario
- Consideration of country and region-specific economic and political forces that impact the adoption rates.

Figure below shows three of the worldwide forecasts of penetration rates for 2010 that were considered in setting the initial 2010 penetration rate for this forecast.

Figure 6.15. Key subscriber forecasts for 2010 considered in this study

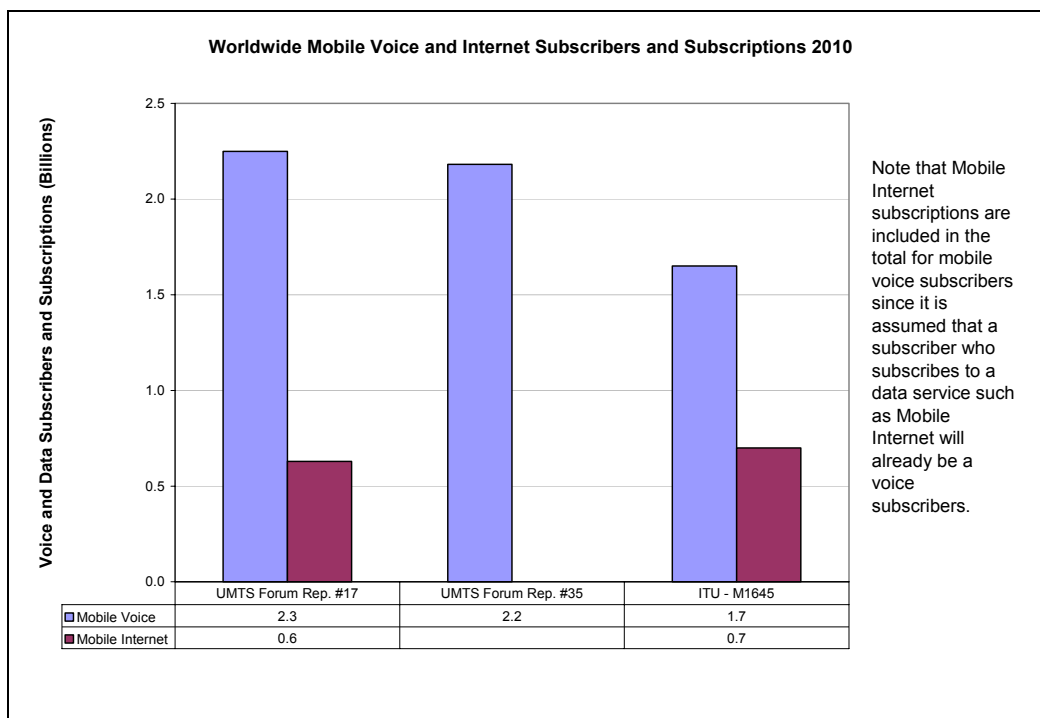


Source: Various as stated (2002-2004)

Based on worldwide populations of 6.8 billion in 2010⁸, these forecast rates correspond to mobile voice subscribers ranging from 1.7 to 2.6 billion as shown in figure 6.16. Mobile data subscriptions have been forecasted between 600 and 800 million subscriptions for the same year.

⁸ 6.2 Billion in 2002 up to 7.6 Billion in 2020

Figure 6.16. Forecast of mobile voice and mobile data subscribers worldwide in year 2010



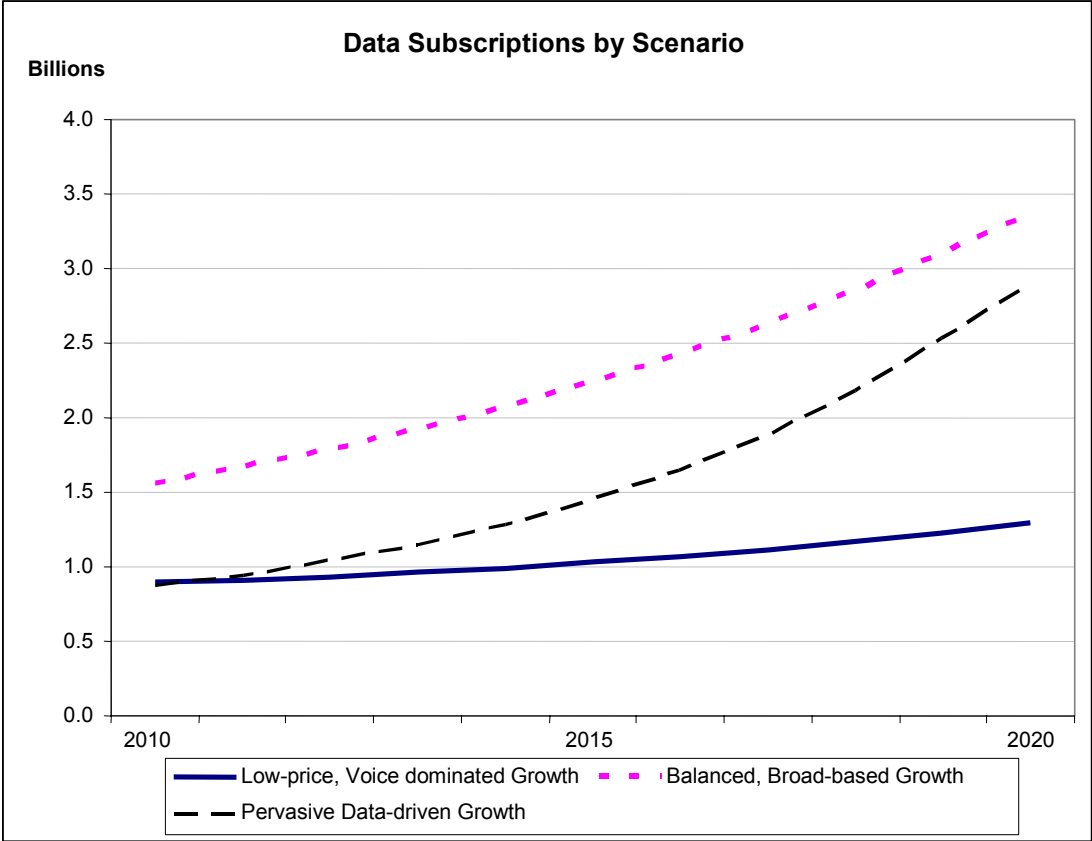
Source: Various as stated (2002 – 2004)

These forecasts were considered as the longer range forecasts for the period 2010-2020 were developed. All the variables and drivers of voice and data growth were next studied to determine what type of end state for each scenario might be predicted in 2020 based on the social, political, business and technological factors in play in each scenario.

However, the different results obtained for 2020 are presented to provide guidance on future mobile traffic loads and to provoke meaningful discussion about the future of the mobile industry. As they are forecasted fifteen years away from now, the figures are indicative and reflect different trends. Thus, it's more relevant to take into account the relative difference rather than the absolute figures resulting from the scenarios. For instance, Figure 6.17 helps to reduce the scope of uncertainty in giving upper and downer limits for data subscriptions. Figure 6.18 provides an overview in terms of global penetration rate for scenario 2, which is the most plausible.

Figure 6.17. compares the total global data subscriptions by scenario.

Figure 6.17. A comparison of data subscriptions by scenario



Source: Telecompetition, Inc., November 2004.

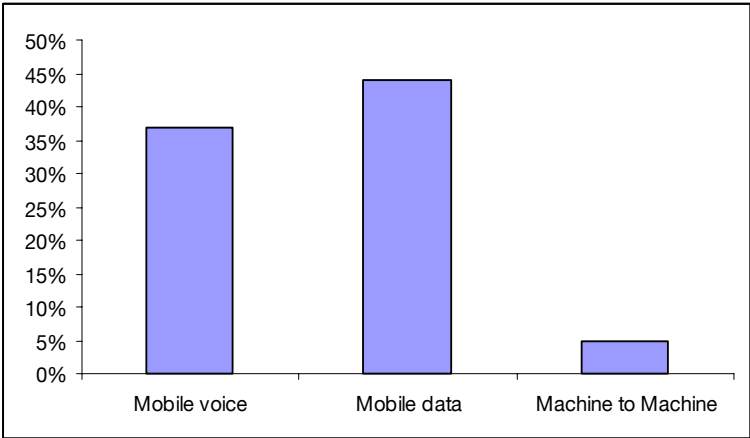
In Scenario One, the challenging industry dynamics due to the wide availability of “free” voice over IP in both wired and wireless networks and resultant low value of wireless data services lead to an environment where potential users never embrace the data market and take their discretionary spending elsewhere.

In Scenario Two, the investment by service providers in more compelling mobile data services results in steady subscriber growth. Emerging economies and large populations within the developing world take full benefit from harmonised approach and economies of scale. As a consequence the “Digital Divide” erodes substantially by 2020.

In Scenario Three, availability of low cost or free ad hoc networks leads to high growth rate in both voice and especially data service subscribers in highly populated areas. The market is highly fragmented. Here, machine to machine applications accelerate resulting in “access possibilities” that could be higher than the total human population.

The global penetration rates assumed in scenario 2 are detailed in Figure 6.18.:

Figure 6.18. Penetration rates in 2020 for scenario 2



Source: Telecompetition, November 2004.

The combination of these dynamics related to value chains, traffic and subscriber volumes, implicit requirements for investment, and likely overall financial returns can be expressed in a speculative chart about industry capital flows across the three scenarios.

Table 6.19. A comparison of investor perspective by scenario

Industry Capital Flows	Scenario One	Scenario Two	Scenario Three
Overall communications industry spending	Low	Moderate	Moderate
Wireless industry spending	Low	Moderate	High
Overall communications industry capital returns	Negative	Neutral	Negative
Mobile industry capital returns	Negative	Positive	Negative
Explanation:	Few sources of growth, margin pressure affects all, little new investment	Wireline suffers at mobiles' benefit; balanced overall capital returns	Chaotic growth requires capital for wireless, which dominates industry requirements

From an investor perspective, this chart highlights the need for individual firms to manage towards low cost structures, exhibit discipline about pricing, and effectively target opportunities. In particular, cooperation across the industry can help to avoid expensive battles around the competing standards inherent in Scenarios One, and to some extent, Three. Harmonisation of approaches towards new spectrum allocation would help investor confidence and returns.

Finally, from a user perspective, the value and trust they experience in each scenario varies markedly as shown in Figure 6.20. It is tempting to assert that the “High Trust / High Value” aspects of Scenario Two are ones that should be pursued no matter what course other variables take.

Table 6.20. Comparison of user views on trust and value for each scenario

User Needs		Scenario One – Low-price voice dominated growth	Scenario Two – Balanced, broad-based growth	Scenario Three – Pervasive data-driven growth
Value	Brand Affiliation / Self Esteem	Best value in terms of voice ubiquity and price	High trust in service providers and brands	Trust in peers and community values; provider choice based on lowest cost unless peer group has a preference
	Accessibility	Voice coverage most important	Interoperability, Ubiquity and quality of voice and data important	Ease of use, price and range of voice and data offering connecting to my community are most important. Best effort service is acceptable as long as it is low cost.
	Features and Functionality	Limited choices Some integration of voice with multimedia services	Broader choices with addition of multimedia and data elements on a global basis	Very broad and diverse choices mainly on a local basis
Trust	Source of Trust	Deteriorating trust in service provider	High trust in service providers	Moderate trust providers; users co-produce products and take responsibility for their security, privacy, etc.
	Safety / Security	Few universal solutions implemented	Generally High security global solutions implemented	Low; user willing to take on responsibility for safety and security issues

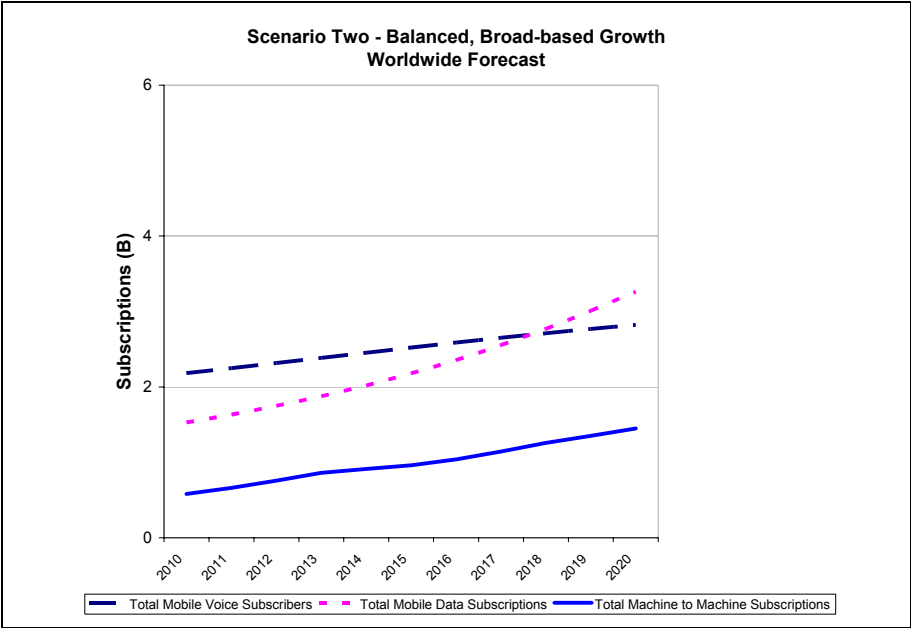
7 Traffic forecast for a representative Western European country

Since Scenario Two is considered by the UMTS Forum as the most plausible, it was used to develop specific traffic forecasts for a representative Western European country in 2020.

7.1 Traffic forecast for 2020

The figure below shows the global subscriber and subscription forecasts if the state of the key variables in the political, industrial, social and technology Planes were generally present throughout the world.

Figure 7.1. Global subscriptions for Scenario Two



Source: Telecompetition, Inc., November 2004.

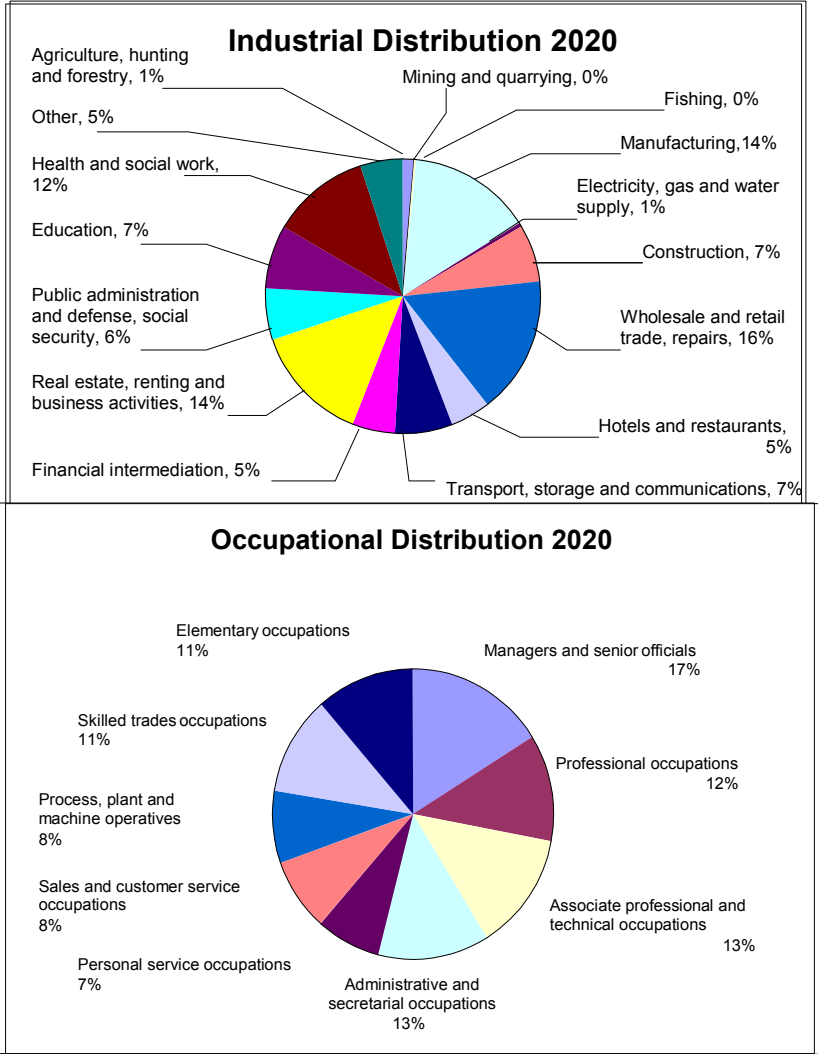
The central feature of this scenario is the steady migration of both voice and data traffic, from wireline and broadcast means, to mobile and the steady evolution of the mobile services towards sophisticated and complex services requiring efficient solutions. In a wirefree world, consumers readily adopt mobile access opportunities as mobile terminals get bigger screens, higher quality audio and video, as laptops replace desktops, as wireless voice availability becomes truly ubiquitous and high quality, and as personal video devices complement televisions. The steady progression of consumer demand, and the emergence of global consumer expectations, enables companies that dominate different aspects of the value chain to retain and confidently expand their positions.

Since Scenario Two is the basis for detailed traffic forecasts that are part of this study, further insights into the nature of future traffic load is also presented. Since the many applications and services that will be available in the future will have dramatically different traffic characteristics it is impossible to predict traffic volumes directly from subscribership.

To study the implication of these traffic forecasts in more detail, a more geographical specific assessment of the offered traffic is required. In order to do that, the demographic profile in 2020 of a representative Western European country has been used to determine by market

segment the type and volume of traffic that would be generated in Scenario Two. Figures below show the assumed demographic makeup of the representative country.

Figure 7.2. Assumed industrial and occupational distribution for 2020 traffic forecast

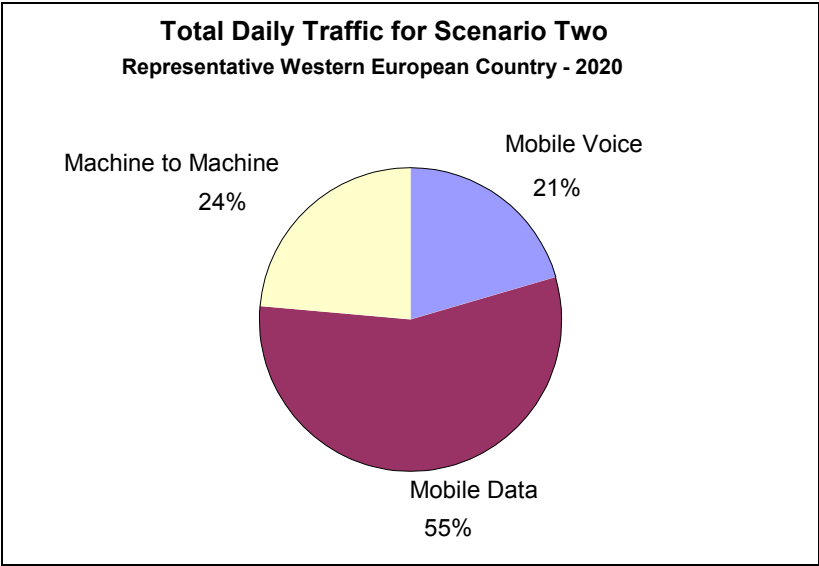


Source: Telecompetition, Inc., November 2004.

This traffic was analysed across a wide range of activity types used by both consumers and business customers as described in the UMTS Forum Report #33. These activities include gaming, web browsing and shopping, video conferencing, Intranet and extranet access, video and audio streaming, email and a range of other activities. These activities were then consolidated into the Service Categories shown in Figure 7.4. This Figure shows the percentage of the overall traffic that category represents.

Figure 7.3. Below shows the relative traffic volumes of mobile voice, data and machine to machine services.

Figure 7.3. Total daily traffic by service type

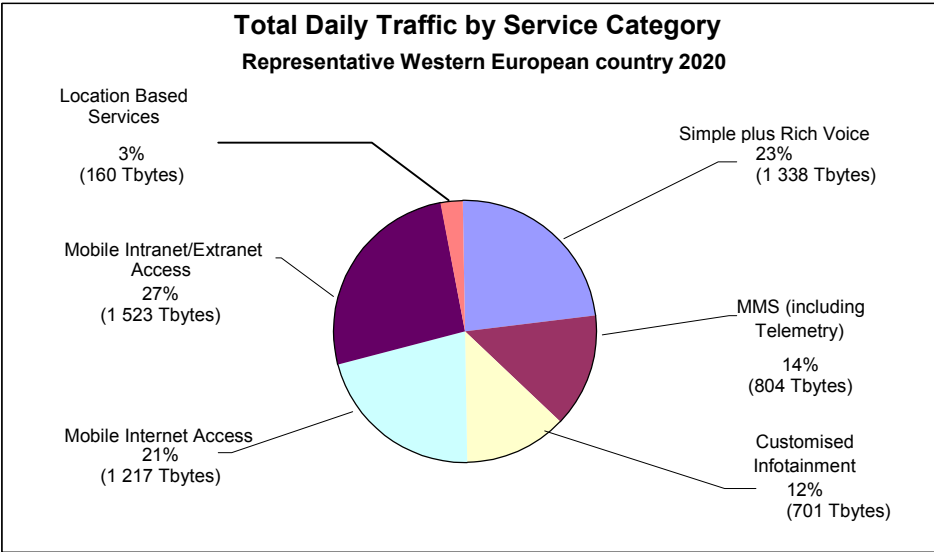


Source: Telecompetition, Inc., December 2004.

Scenario 2 is characterised by higher frequency of use, larger files sizes, higher bit rates and higher mobility (wirefree devices). The use of media enhanced messaging, voice, and data is widely available and very popular. Networks are transparent to the user – who can even use wireline and wireless facilities seamlessly.

Nomadic and machine to machine traffic is included, since there is no reason in 2020 that this traffic could not be carried over a mobile network if the users have trust in the network, perceive value from the service and the pricing is acceptable. Figure below shows the total traffic in a typical business day. This includes the full 24-hour period and all consumer traffic as well.

Figure 7.4. Daily Traffic Distribution by Service Category



The Figure below shows the traffic in a busy hour during a typical day. This busy hour varies by service and by market segment (consumer or business). Since these segments typically have their busiest hour of the day at a different time, the hour chosen for each service category will vary and represent the highest traffic for that service category during the 24 hours period.

Figure 7.5 a. Busy hour traffic by activity for the Business market

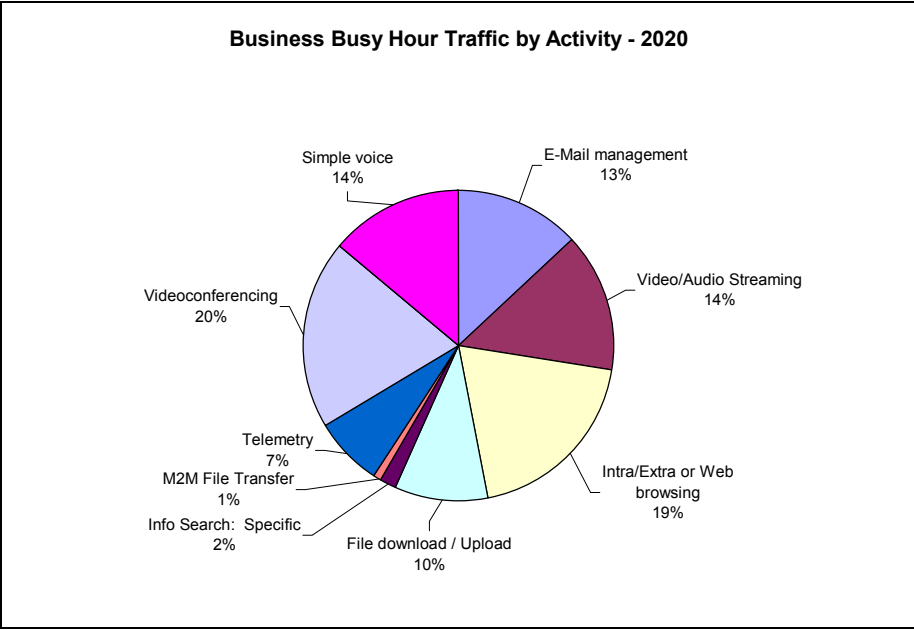
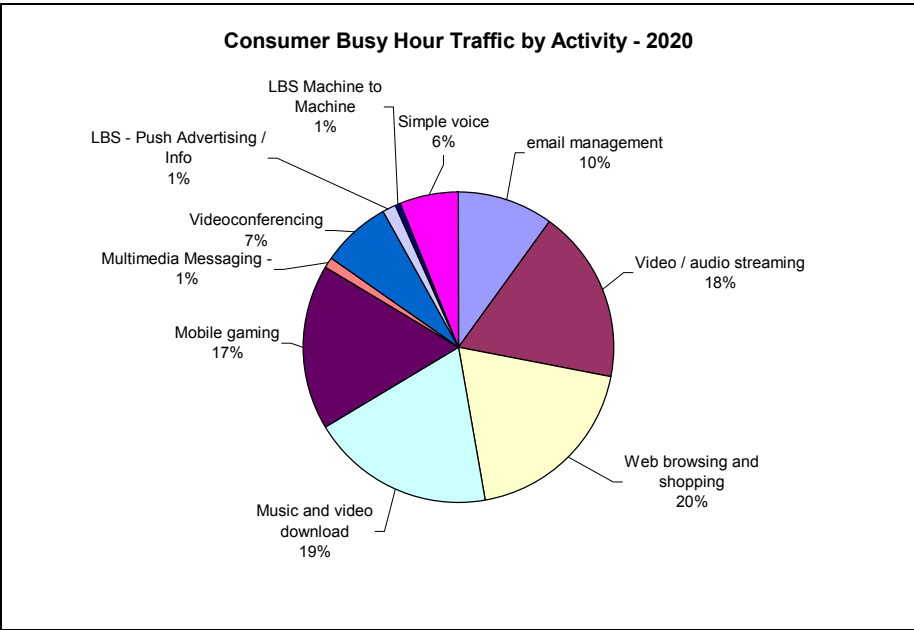


Figure 7.5 b. Busy hour traffic by activity for the Consumer market



Source: Telecompetition, November 2004.

7.2 Traffic forecast: a comparison between 2012 and 2020

In the following part are mentioned key points of comparison between 2012 (provided by Report #33) and 2020. Further details are available in Annex 1 and Annex 2.

- From 2012 to 2020, total daily traffic in the Representative Western European country will grow from 250 Tbytes to approx. 5750 Tbytes. This large growth is due to the increasing number of available services using photos, videos etc, leading to the exchange of higher data volumes.
- Mobile Internet access (consumer segment) and mobile Intranet/extranet access (business segment) will benefit from higher frequency of use and larger file sizes. Mobile Internet access subscriber base will grow significantly.
- In 2012, voice (simple and rich) is still the first service category in terms of daily traffic volumes. In 2020, voice is overtaken in terms of volume (Tbytes) by Mobile Intranet/extranet access which generates the highest traffic volumes.
- P2P communications (such as MMS) traffic volumes will grow from 2012 to 2020 thanks to the migration from text based MMS to photo/video based MMS and thanks to the increasing number of M2M file transfers.
- Simple voice duration will remain flat in both consumer and business segments. However, total call duration will be higher in 2020 than in 2012 thanks to the increase of rich voice and VoIP calls.
- In 2020, customised infotainment subscriptions base will be slightly higher than in 2012 but traffic volumes will increase steadily thanks to a higher use of services.
- Location-based services daily traffic will grow thanks to both subscriber growth and frequency of use growth.

8 Conclusions

This study provides several predictions and forecasts on the future of mobile communications and on the possibility of what mobile networks and services might be in the decade from 2010-2020. The objective is to give as many accurate trends as possible in order to be able to have a realistic shape of the future world.

Three distinct scenarios have been presented on the future of mobile communications:

Scenario 1 (Low price, voice-dominated growth) describes a mobile industry evolving to bigger volumes rather than enhanced capabilities. Consumer and business voice increase in volumes but revenue flows diminish, and are not replenished with robust adoption of new applications. Overall communication industry revenue could decline as all pricing levels continue to fall, and consumers spend their discretionary money on alternative activities. Preservation of wireless access may require the intervention of government authorities.

In Scenario 2 (Balanced, broad-based growth) mobile networks deliver compelling new services such as anytime, anywhere streaming video customised to the needs of users, stationary or otherwise. Businesses integrate mobile deeply into their operational practices as quality and interoperability concerns no longer prevail. Other communications industry service providers are effectively converged into mobile-led companies, while content and application providers find a healthy, growing marketplace.

In Scenario 3 (Pervasive, data-driven growth), the ad-hoc broadband wireless networks start to take significant part of the traffic. On these ad-hoc networks, in highly populated areas costs are low and many services are close to, if not, free. Traffic volumes increase as the cost of enabling or subsidising access falls dramatically. The user has multiple options to connect, although seamless experiences are not guaranteed and consumers must cope with a patchwork of options. The larger mobile networks ensure complementary coverage to these ad-hoc networks, on a national level.

The UMTS Forum believes that scenario 2 represents the most plausible development of mobile communications for the years 2010-2020.

Scenarios 1 and 3 are disruptive scenarios, and are considered to provide a full picture of opportunities and risks for the industry.

Scenario 2 allows the steady migration of both voice and data traffic, from wireline and broadcast means to mobile and the steady evolution of the mobile services towards sophisticated and complex services requiring efficient solutions. Consumers readily adopt mobile access opportunities as mobile terminals get bigger screens, higher quality audio and video, as laptops replace desktops, as wireless voice availability becomes truly ubiquitous and high quality, and as personal video devices complement televisions. The steady progression of consumer demand and the emergence of global consumer expectations, enable the mobile industry to retain and confidently expand their positions. A stable environment, with the helpful guidance of government policy makers, open standards, enhanced roaming capabilities, helps investment. Innovation creates growth-oriented pressure. Competitors differentiate propositions on the basis of applications, content and quality.

In Scenario 2, mobile industry succeeds in creating fundamental solutions to difficult communications industry issues including trusted multimedia environments, micro-billing, and inappropriate content. The industry is also able to invest in pan-industry solutions that enable a high degree of seamless application performance, user-defined quality, and personalisation. Mobile activities also drive the preponderance of profitability in the overall industry, helped by robust content revenue sharing, revenue-producing interconnection arrangements and disciplined pricing, plus increasing consumer awareness and demand for mobile multimedia services.

As a result, mobile becomes the centre of an industry convergence at both the platform and service provider level.

Based on the traffic forecast predicted in this study for the period 2012 to 2020, and with all the qualifications attached to such a long study timeframe, total daily traffic in the Representative Western European country will grow from 250 Tbytes to approx. 5750 Tbytes.

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9 Annexes

Annex 1: Traffic forecast for 2020 for a Representative Western European country

Tables 10.1. to 10.6. summarise the offered traffic and traffic characteristics of all 2020 traffic. This offered traffic is grouped by the market-based, UMTS Forum Service Categories.

Table 10.1. MMS - offered traffic in 2020.

Description	Per Country Traffic (Tbytes)		Per Subscription Traffic (Mbytes)	
	Busy Hour Traffic	Average Weekday Daily Traffic	Busy Hour Traffic	Average Weekday Daily Traffic
Multimedia Messaging				
Consumer	2.37	25.05	0.19	2.02
Business	34.93	778.96	1.42	31.64
Total	37.30	804.01	1.61	33.66
Asymmetry (DL/UL)	1.08	1.04	1.11	1.05

Source: Telecompetition, Inc., December 2004.

Table 10.2. Simple and Rich Voice – offered traffic in 2020.

Description	Per Country Traffic (Tbytes)		Per Subscription Traffic (Mbytes)	
	Busy Hour Traffic	Average Weekday Daily Traffic	Busy Hour Traffic	Average Weekday Daily Traffic
Simple and Rich Voice				
Consumer	52.95	795.00	2.53	32.51
Business	52.86	542.94	5.93	63.05
Total	105.81	1337.93	8.46	95.55
Asymmetry (DL/UL)	1.12	1.06	1.17	1.09

Source: Telecompetition, Inc., December 2004.

Table 10.3. Customised Infotainment – offered traffic in 2020.

Description	Per Country Traffic (Tbytes)		Per Subscription Traffic (Mbytes)	
	Busy Hour Traffic	Average Weekday Daily Traffic	Busy Hour Traffic	Average Weekday Daily Traffic
Customised Infotainment				
Consumer	49.14	701.32	4.98	71.07
Business	0.00	0.00	0.00	0.00
Total	49.14	701.32	4.98	71.07
Asymmetry (DL/UL)	7.60	7.60	9.36	9.36

Source: Telecompetition, Inc., December 2004.

Table 10.4. Mobile Internet Access – offered traffic in 2020.

Description	Per Country Traffic (Tbytes)		Per Subscription Traffic (Mbytes)	
	Busy Hour Traffic	Average Weekday Daily Traffic	Busy Hour Traffic	Average Weekday Daily Traffic
Mobile Internet Access				
Consumer	77.00	1217.15	10.71	169.23
Business	0.00	0.00	0.00	0.00
Total	77.00	1217.15	10.71	169.23
Asymmetry (DL/UL)	10.78	10.78	13.59	13.59

Source: Telecompetition, Inc., December 2004.

Table 10.5. Mobile Intranet Extranet Access – offered traffic in 2020.

Description	Per Country Traffic (Tbytes)		Per Subscription Traffic (Mbytes)	
	Busy Hour Traffic	Average Weekday Daily Traffic	Busy Hour Traffic	Average Weekday Daily Traffic
Mobile Intranet Extranet Access				
Consumer	0.00	0.00	0.00	0.00
Business	130.57	1523.41	10.29	120.04
Total	130.57	1523.41	10.29	120.04
Asymmetry (DL/UL)	4.40	4.40	4.53	4.53

Source: Telecompetition, Inc., December 2004.

Table 10.6. Location-Based Services – offered traffic in 2020.

Description	Per Country Traffic (Tbytes)		Per Subscription Traffic (Mbytes)	
	Busy Hour Traffic	Average Weekday Daily Traffic	Busy Hour Traffic	Average Weekday Daily Traffic
Location-Based Services				
Consumer	10.51	155.42	0.34	4.98
Business	0.19	4.62	0.01	0.16
Total	10.70	160.04	0.34	5.14
Asymmetry (DL/UL)	6.89	6.64	6.85	6.58

Source: Telecompetition, Inc., December 2004.

Table 10.7. Total offered traffic by service category in 2020

	Per Country Traffic (Tbytes)		Per Subscription Traffic (Mbytes)	
	Busy Hour Traffic	Average Weekday Daily Traffic	Busy Hour Traffic	Average Weekday Daily Traffic
Multimedia Messaging	37,30	804,01	1,61	33,66
Simple and Rich Voice	105,81	1337,93	8,46	95,55
Customised Infotainment	49,14	701,32	4,98	71,07
Mobile Internet Access	77,00	1217,15	10,71	169,23
Mobile Intranet Access	130,57	1523,41	10,29	120,04
Location-Based Services	10,70	160,04	0,34	5,14
Total	410,52	5743,86	36,39	494,69

Source: Telecompetition, Inc., December 2004.

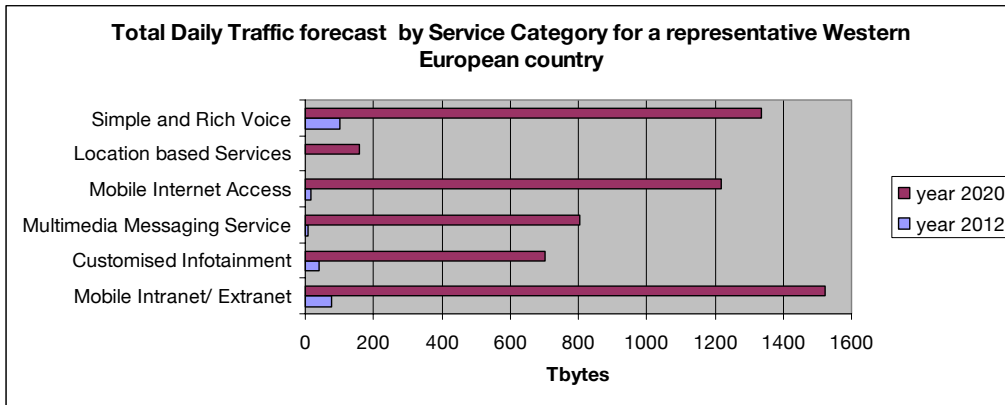
Annex 2: Traffic and service assumptions comparison between 2012 and 2020 for a Representative Western European country

Traffic

From 2012 to 2020, total daily traffic raises from 250 Tbytes to 5744 Tbytes (e.g. a + 2200% growth).

As shown in Figure 10.8. the highest traffic volumes are generated by simple and rich voice in 2012 and by mobile intranet/extranet access in 2020:

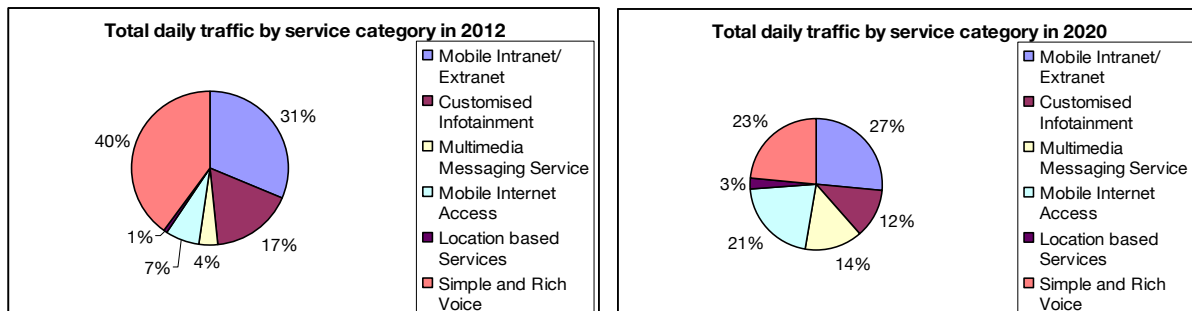
Figure 10.8. Total Daily Traffic forecast by Service Category: 2012 Vs 2020



From 2012 to 2020, we can notice the growing share of enriched P2P communications through MMS and Mobile Internet access in total daily traffic (Figure 10.9.). While MMS and Mobile Internet access represent respectively only 4% and 7% of total traffic in 2012, they raise to 14% and 21% of total traffic in 2020.

The highest growth rate from 2012 to 2020 is for location based services (+12 211%) which represent 3% of total daily traffic in 2020.

Figure 10.9. Allocation of Total Daily Traffic by Service Category: 2012 Vs 2020



Service assumptions

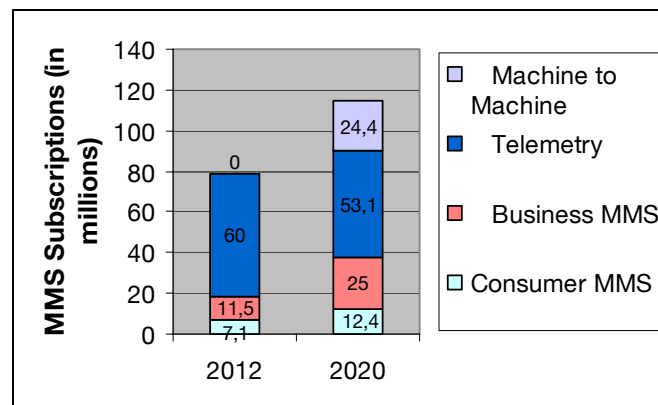
* MMS:

From 2012 to 2020, the total number of subscriptions will rise by 12 millions, which represents a 15% growth rate between 2012 and 2020.

Table 10.10. MMS usage assumptions in 2012 and 2020

Multimedia Messaging Service	Subscriptions in millions	
	2012	2020
Consumer MMS	7,1 (12% of pop)	12,4 (20% of pop)
Total Business	71,5	78,1
Business MMS	11,5 (19% of pop)	25 (40% of pop)
Telemetry	60	53,1
Machine to Machine	0	24,4
Total	78,6	90,5

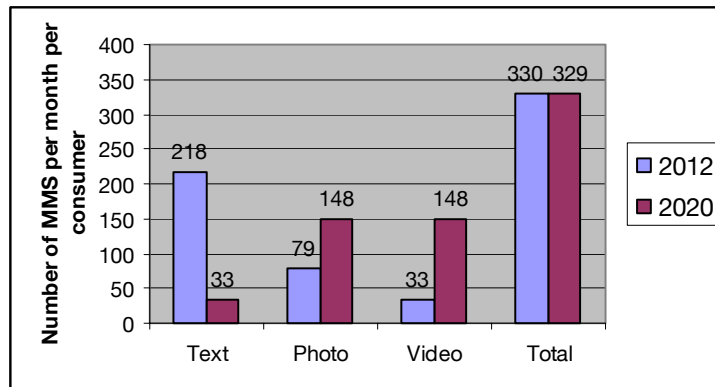
Figure 10.11. MMS subscriptions in 2012 and 2020



However, MMS traffic will grow significantly (from 10 Tbytes in 2012 to 804 Tbytes in 2020) thanks to two factors:

- While the average number of MMS sent per month and per user will remain flat (for consumer and business users), the migration from text based MMS to photo/video based MMS will increase the average MMS size. This phenomenon is shown for consumer subscribers in the figure 10.12.

Figure 10.12. MMS consumer use in 2012 and 2020



- The number of M2M volume traffic will know a high growth. M2M connections are divided into two parts. The first category is “telemetry”, which is composed of sensors, which are exchanging relatively small files (0.5 Kbytes). The total number of subscriptions for telemetry will decrease (from 60 to 53 millions) but the frequency of use will grow steadily (from 720 to 3600). The second category is “M2M file transfer”, which represents exchanges of large files (8 000 Kbytes).

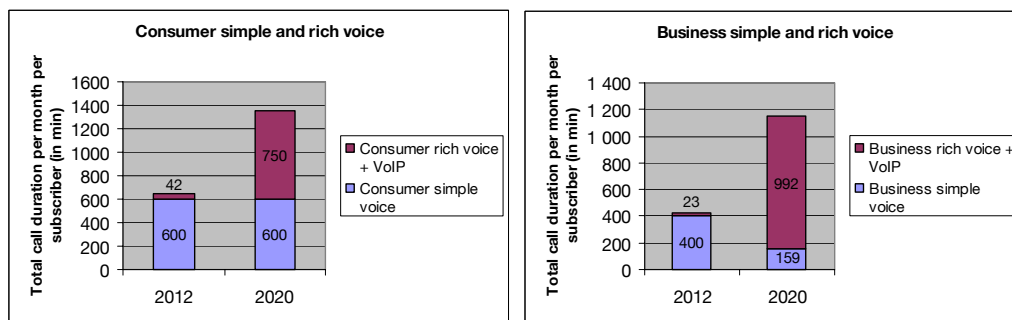
* Simple and rich voice:

Simple and rich voice daily traffic will grow from 100 Tbytes in 2012 to 1338 Tbytes in 2020. This steady growth of voice traffic is explained by the explosion of rich voice and VoIP in both consumer and business segments.

Table 10.13. Simple and rich voice usage assumptions in 2012 and 2020

Simple and Rich Voice	Total call duration per month (in min)	
	2012	2020
Consumer simple voice	600	600
Consumer rich voice	42	250
Consumer VoIP	inc in rich voice	500
Business simple voice	400	159
Business rich voice	23	872
Business VoIP	inc in rich voice	120

Figure 10.14. Consumer and business total call durations in 2012 and 2020



* Customised infotainment:

From 2012 to 2020, the number of customised infotainment subscriptions will increase slightly (18.5 millions in 2020 Vs 18.2 millions in 2012).

Table 10.15. Customised infotainment usage assumptions in 2012 and 2020

Customised Infotainment	Subscribers in millions	
	2012	2020
Youth	2,2	n/a
Adult	16	n/a
Total	18,2 (30% of pop)	18,5 (30% of pop)

Total daily traffic for customised infotainment will grow from 42 Tbytes in 2012 to 701 Tbytes in 2020 because the average use per consumer will intensify steadily (see table below) and file size will be larger.

Table 10.16. Customised infotainment sessions per month in 2012 and 2020

Customised infotainment	Sessions per month	
	2012	2020
Email	20	50
Video/audio streaming	3	78
Web browsing	25	52
Mobile gaming	13	52
Music/video download	6	78

* Mobile Internet access:

Mobile Internet access traffic will grow from 18 Tbytes in 2012 to 1217 Tbytes in 2020. This steady growth is due to three factors: growth of subscribers base, intensification of use and growth of file size.

The number of consumer subscribers for mobile Internet access will grow from 2.5 millions in 2012 to 14.9 millions in 2020:

Table 10.17. Mobile Internet access usage assumptions in 2012 and 2020

Mobile Internet Access	Subscribers in millions	
	2012	2020
Youth	0,3	n/a
Adult	2,2	n/a
Total	2,5 (4% of pop)	14,9 (24% of pop)

Table 10.18. Mobile Internet access sessions per month in 2012 and 2020

Mobile Internet Access	Sessions per month	
	2012	2020
<i>Email</i>	39	50
<i>Video/audio streaming</i>	5	78
<i>Web browsing</i>	49	52
<i>Mobile gaming</i>	26	52
<i>Music/video download</i>	12	78

* Mobile intranet/extranet access:

Mobile Internet access daily traffic will grow from 78 Tbytes in 2012 to 1523 Tbytes in 2020. While subscribers base will grow slowly (11.5 millions subscribers in 2012 Vs 13.4 millions subscribers in 2020), the frequency of use by subscribers will be much higher in 2020 than in 2012.

Table 10.19. Mobile intranet/extranet usage assumptions in 2012 and 2020

Mobile Intranet Extranet Access	Subscribers in millions	
	2012	2020
<i>"Typically mobile"</i>	9,3	n/a
<i>"Occasionally mobile"</i>	1,8	n/a
Total	11,5 (19% of pop)	13,4 (21% of pop)

Table 10.20. Mobile intranet/extranet access sessions per month in 2012 and 2020

Mobile Intranet Extranet Access	Sessions per month	
	2012	2020
<i>Email</i>	56	150
<i>Video/audio streaming</i>	7	75
<i>Intranet/Extranet and Web browsing</i>	16	52
<i>File transfer</i>	8	114
<i>Info search</i>	47	195

* Location-based services:

Location-based services daily traffic will grow from 1.3 Tbytes in 2012 to 160 Tbytes in 2020. This growth results from the combination of both subscriber's growth and frequency of use growth.

Table 10.21. Mobile LBS usage assumptions in 2012 and 2020

Location-based services	Subscribers in millions	
	2012	2020
<i>LBS Push advertising</i>	5,1	31,2
<i>Navigation/Travel info</i>	17,3	31,2
<i>Telematics</i>	1,8	31,2
<i>Personal tracking</i>	1,3	28,4
<i>Fleet/Asset tracking</i>	0,3	28,4

Table 10.22. Mobile LBS sessions per month in 2012 and 2020

Location-based services	Sessions per month	
	2012	2020
<i>LBS Push advertising</i>	30	120
<i>Navigation/Travel info</i>	8	64
<i>Telematics</i>	4	35
<i>Personal tracking</i>	5 040	43 200
<i>Fleet/Asset tracking</i>	5 040	43 200