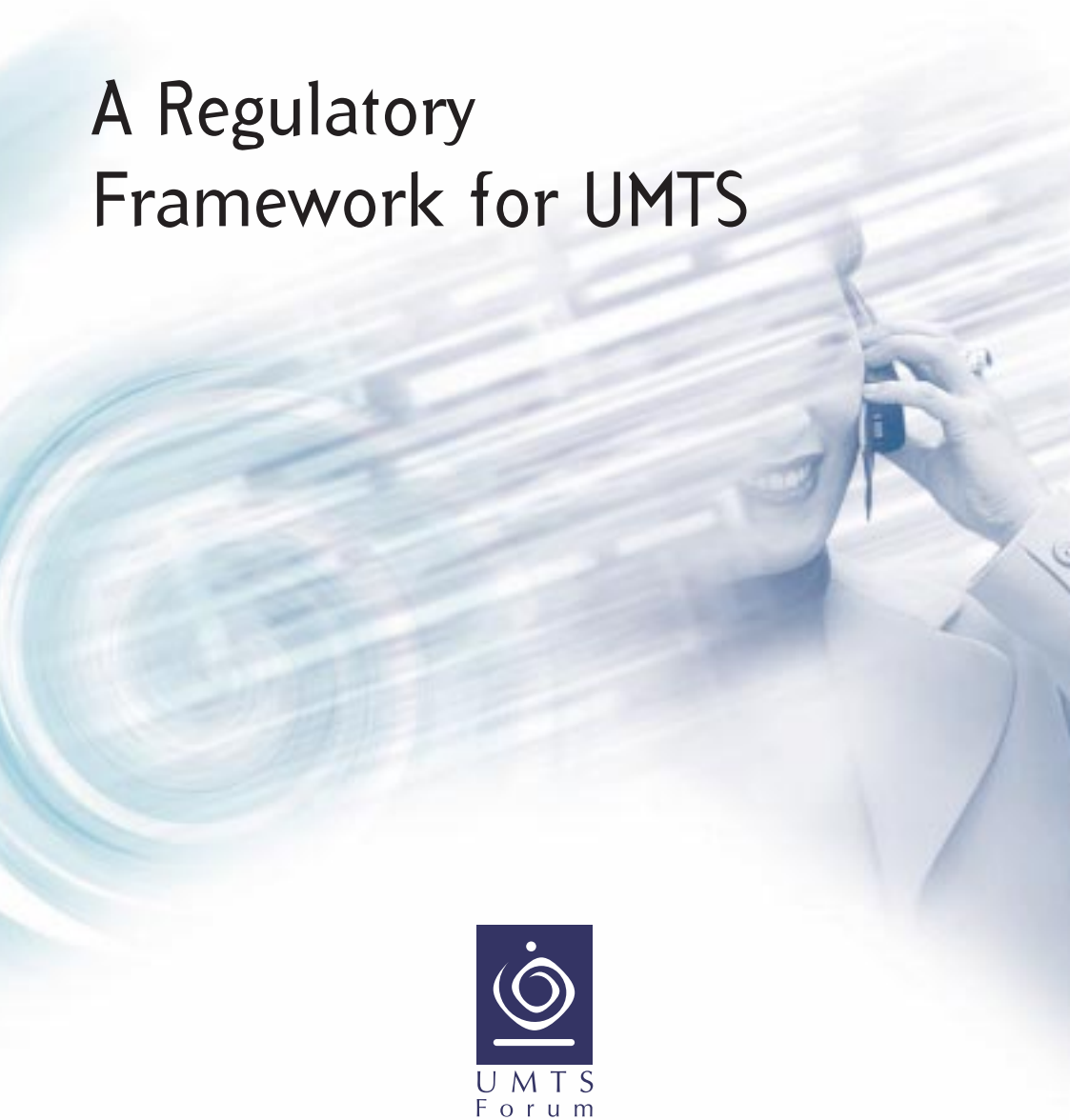
No 1

Report from the UMTS Forum

A Regulatory Framework for UMTS



UMTS Forum

This report is produced by the UMTS Forum, an association of telecommunica-tions operators, manufacturers and regulators active both in Europe and other parts of the World that share the vision of UMTS as a concept which will move mobile communications forward from second generation systems into the Information Society and deliver voice, data, pictures, graphics and other wideband information direct to people. The conclusions and recommendations in the report are supported by all operators and manufacturers in the Forum. The National Administrations that are members of the Forum have actively supported the development of the report. However, the views expressed do not necessarily represent the views of the National Administrations. Therefore the Administrations cannot be bound by the detailed recommendations contained in the report.

The report is a major input towards the decision making process in Europe when considering the regulatory framework for UMTS. The report considers several aspects and focuses the conclusions of each aspect on regulatory consequences. The recommendations in the report will be supplemented by additional inputs to reflect other ongoing UMTS studies specifically in the areas of frequency spectrum, technology standardisation, market predictions, service definitions, economic conditions and the competitive environment. This document is the first report from the UMTS forum. The Forum intends to further develop its view on how UMTS can be implemented

The report may be of interest to all parties interested in the future development of the mobile telecommunications industry, not only in Europe but all over the world.

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0. EXECUTIVE SUMMARY

0.1 UMTS for the user

The world of communications is evolving at an exciting pace, driven by European successes such as GSM, and global phenomena such as the Internet. Leading-edge technologies and pro-competitive policies are empowering citizens to an extent hitherto reserved to the realm of science-fiction.

Meeting complex and growing user demands as we enter into the 21st century is the major - and urgent - challenge for the European telecommunications industry. By harnessing excellence in cellular, terrestrial and satellite wideband technology, the Universal Mobile Telecommunications System (UMTS) will guarantee access, from simple voice telephony to high speed, high-quality multimedia services, regardless of physical location of the user.

UMTS will be a mobile communications system that can offer significant user benefits including high-quality wireless multimedia services to a convergent network of fixed, cellular and satellite components. It will deliver information directly to users and provide them with access to new and innovative services and applications. It will offer mobile personalised communications to the mass market regardless of location, network or terminal used.

The markets for mobility and for fixed multimedia are already large and growing rapidly. Customers will want to combine mobility with multimedia, resulting in higher demand for bandwidth and creating a significant shift towards new data services. For Europe alone, this new market is estimated to be as large in 2005 as the whole mobile market is today, given appropriate political and regulatory environment.

From a physical point of view, UMTS will comprise a new air interface and new radio components. The aim is to combine these in a modular way with new network components and components from pre-UMTS fixed and mobile networks, provided these have undergone the necessary evolutionary preparation. This approach will allow new entrants to establish UMTS networks and enable existing operators a smooth migration by re-using parts of their existing infrastructure to the maximum possible extent.

For the user UMTS will provide adaptive multi-mode/multi-band terminals or terminals with a flexible air interface to enable world-wide roaming across locations and with second generation systems. Software download to terminals may offer additional flexibility.

It is also a key enabler for convergence, and is considered an important building block in the construction of the Information Society. UMTS will play a key role by providing citizens with mobile access to advanced, higher quality, higher speed information and communication services than is possible from today's mobile systems. The true innovation of UMTS is that it will provide a federation of services, both those existing and their extension, to meet the ever-increasing demands and needs of users. Consequently, the business of UMTS represents a major investment opportunity for the telecommunications industry.

0.2 The UMTS Forum and the Forum report

The UMTS Forum was created in 1996 in order to accelerate the process of defining necessary standards, policy actions and industrial co-operation that are central to ensuring that UMTS will be ready for implementation and operation by the opening years of the 21st century.

The key purpose of this first report of the Forum is to encourage policy makers to act decisively and in timely fashion - i.e. from 1997 onwards - in order to secure frequency spectrum and provide an enabling regulatory environment for UMTS.

Governments and regulators have important roles with respect to UMTS. They must establish a regulatory framework and allocate frequencies, which will encourage innovation, liberalisation and competition in the provision of telecommunication and information technology services. They must also provide the leadership to make UMTS happen. Without political support it is a real risk that the European market will become fragmented and weak.

0.3 An enabling policy and regulatory environment

The Report examines those political and regulatory initiatives which the industry considers essential to the successful development of the UMTS market. Market and business studies show the need for an order of magnitude improvement in capacity and services, with service provision costs maintained similar to GSM today. Plans for the licensing of UMTS and for the provision of adequate frequency spectrum must be clear by the end of 1997 in order to reduce the risks and uncertainties for the telecommunications industry and thereby stimulate the required investment by manufacturers and potential operators. Common frequency bands

and standards in Europe and beyond will also benefit the user, due to economies of scale and a common basis for roaming across national borders.

Major milestones for UMTS

1 October 1997	ERC Decision on UMTS Core band.
31 December 1997	Regulatory framework for UMTS defined, including spectrum licences for Phase 1.
First quarter 1998	Operators identified: drafting of licences.
31 December 1999	ETSI UMTS Phase 1 standard.
Year 2002	Commercial UMTS operation.

A table of milestones for UMTS is shown in Annex 1.

Licensing

The Forum Report examines the regulatory framework that will be required to allow UMTS to meet the necessary and demanding time-scales. The key recommendations are:

- that spectrum identified in the CEPT ERC Decision on UMTS shall be reserved for systems using UMTS as defined in ETSI standards;
- that existing European regulations, for example the Licensing Directive, the Interconnection Directive and existing EU competition law, provide the necessary framework for licensing UMTS;
- that the process for licensing of operators should begin in 1998, so as to enable the start of commercial UMTS services by early 2002.

The Forum believes that in light of the nature of telecommunications service provision and the huge investment required to build networks and interconnect with third-party infrastructure, there is no apparent justification for excluding specific categories of entities from licensing procedures. A healthy and competitive telecommunications market depends upon getting the right mix between the experience of the existing industry players and competition from new entrants.

Spectrum allocation

The spectrum requirements for UMTS, within the context of the frequency spectrum identified by the ITU for IMT-2000 (FPLMTS) purposes, are clearly presented in the Forum report. The Forum has concluded that the full 155 MHz for terrestrial UMTS should be made available by the year 2005, on the basis of underlying market forecasts of the Forum. It has further concluded that an extra 185 MHz is required for terrestrial services by the year 2010. It is

recognised that careful consideration should be given to the possible transition from second generation systems to UMTS.

For the satellite component of IMT-2000, the ITU has identified 60 MHz. To meet the forecast market demand for satellite applications in UMTS an additional 30 MHz is required by the year 2010.

The Forum recommends that national administrations urgently release a minimum of 2x40 MHz of spectrum so as to ensure the launch of competing UMTS services by the year 2002, since each operator is expected to require in the order of a 2x20 MHz initial allocation. At the same time a band of 20 MHz will be needed for non-public in-building low mobility systems.

The Forum recognises the importance of CEPT countries adopting the draft ERC decision on UMTS in making spectrum available to UMTS in a fair and transparent manner. The Forum calls upon all the relevant authorities in Europe for a timely and co-ordinated approach to identifying, liberating and allocating UMTS spectrum in the EU Member States, through a fair, proportionate, non-discriminatory and transparent mechanism.

Standardisation

Standardisation is, and will remain, a key factor in providing quality services at an affordable cost and enable roaming between systems, and its success depends upon the flexibility of interfaces and the capacity to evolve in parallel with technology. Continued close co-operation between operators, manufacturers and regulators in the standardisation of UMTS is crucial for UMTS to be as successful as GSM.

ETSI, the European Telecommunications Standards Institute, should also in the future be entrusted with the task of UMTS standardisation, to ensure efficient use of the UMTS frequency bands. Only UMTS standards approved by ETSI should be used in those bands. A close co-operation between ITU, ETSI, and other regional standardisation bodies is essential to establish a framework for global compatibility. The Forum also places a great deal of importance in identifying UMTS as a part of the IMT-2000 family

Competition policy

The process of liberalisation and de-regulation in Europe has resulted in a solid basis for fair competition on every level, which is in the interest of consumers and the market in general. By encouraging competition in local and national markets the right conditions has been brought about for innovation in services and networks to flourish.

The Forum considers that, given the scarcity of frequency spectrum, there are likely to be constraints placed on the number of operators who can implement UMTS systems in a given country. However, these UMTS providers will for a large part of their service be competing with operators of technologically enhanced existing systems. Increased competition will also come from the commercial development of the market roles in various organisations, such as value added service provision and content brokering.

The Forum therefore considers that the application of the existing regulatory framework, together with the existing competition law, is sufficient to create an open and dynamic market for UMTS. The Forum believes that creating this dynamic home market in the early years of UMTS will create an important opportunity to promote the competitiveness of European industry on the world market.

0.4 Conclusions

This report highlights the enabling factors - political leadership, spectrum availability, fair licensing arrangements, availability of standards - that will make UMTS possible. The UMTS Forum considers these factors crucial to the success of the next generation mobile mass market services which will provide value for customers, industry players and governments alike. The Forum is convinced that the total commitments required will not be forthcoming unless the issues in this report are addressed by European governments.

In chapter 9 Recommendations, the UMTS Forum proposes its conclusions formulated into 27 recommendations, each of which are drawn from the conclusions of the foregoing chapters.

The Forum confirms its commitment to UMTS, and its willingness to work closely with EU Member States and the European Commission in order to achieve this worthy goal upon which depends the future of the Information Society in Europe. It is also willing to support the globalisation or extension of this initiative to other regions of the World on the basis of reciprocal commitment.

It is the responsibility of governments and regulators to provide the optimal regulatory and political conditions for UMTS, to bring users within reach of those services which will lie at the heart of Europe's social and economic progress in the next century. It is up to industry to show that the technology is well within the reach of innovative enterprises.

1. THE UMTS VISION

"Any sufficiently advanced technology is indistinguishable from magic."
Arthur C. Clarke: The lost world of 2001

We are moving into a new era of communications and information technology. Personal competitiveness in business relies more and more on increased personal productivity and responsiveness. Globalisation of organisations and trade produces the need for multi-company virtual teams - a kind of "bonding" which was previously restricted to the physical proximity of the people involved. At the same time, the desire for freedom and leisure time in our personal lives is being invaded from many angles, not the least of which is the blending of one's work and private life. The newest ingredient of the telecommunications systems - mobility - holds a high potential for bringing a happy balance to these seemingly conflicting business and personal lifestyle trends.

The mobile networks now in place globally can deliver a part of this promise. However they cannot transmit video pictures and high speed data, which is a necessary condition for many of the foreseen services. The next five years of innovation in the telecommunication industry will play an important part to enable a change in lifestyle and business which has many personal and economic benefits. Convergence of communications, information and entertainment content, consumer electronics and computing, as a result of advances in technology in areas such as multimedia computing, digital and interactive TV and the Internet, will lay the foundation for the development of an Information Society, in Europe as well as elsewhere. UMTS networks will provide enhanced easy access for everyone to public service databases and to other people, thus facilitating the trend towards flexible working practices, which could make a significant contribution to employment in the EU and globally.

The Universal Mobile Telecommunications System, UMTS, will take the personal communications user into the Information Society of the 21st century. It will deliver advanced information directly to people and provide them with access to new and innovative services. It will offer mobile personalised communications to the mass market regardless of location, network or terminal used.

1.1 UNIVERSAL aspects of UMTS

The goal of UMTS is to reach the mass market in order to satisfy consumer demands for personal mobile communications. This is highly dependent on the prices subscribers have to pay for the equipment and service usage.

Hence it is necessary to provide common standards to build a widely accepted framework where: a) low cost mass production for the manufacturers is made possible and b) open interfaces for the network operators, service and content providers are clearly defined. These standards should be globally established, in the context of ITU's IMT-2000 standards, in order to allow the user easy service access all over the world, in particular to advanced wideband services, and in both public and private networks. UMTS will therefore offer ubiquitous services, i.e. service provision anywhere.

1.2 MOBILE aspects of UMTS

UMTS will cater for different kinds of mobility. Terminal mobility means that a user will be served while on the move, regardless of network boundaries. Personal mobility allows a user not to be restricted to a special terminal when wanting to access his or her services. Roaming based on a common smart card technology and the provision of the Virtual Home Environment (VHE) are major aspects in this context. VHE means that the user will have the same interface and service environment regardless of location. Another issue here is the capability for a user to register for different services on different terminals. Service mobility means that a user can access his or her personalised services independently of the terminal and serving network.

1.3 TELECOMMUNICATIONS aspects of UMTS

Transparent services, i.e. the possibility to access the same services in different networks (e.g. fixed, mobile or satellite networks), are mainly seen from the user's point of view. Transparency must be secured also in the pre-UMTS networks that are interconnected to UMTS.

The universal accessibility of fixed and mobile networks as well as satellite and terrestrial networks will be an important feature. It will be made possible by multi-mode and multi-band terminals.

Additionally convergence of telecommuni-cations, computer technology and content provision will be the springboard for the UMTS enhanced services. Seamless service provision means that service provision should not be interrupted by the user's movements between different networks.

A key driver for UMTS is the increasing demand for multimedia services. Demand is also increasing for access to multiple types of media, often used in various combinations. Thus UMTS will need to provide both narrow and wideband services (e.g. voice, data, graphics, pictures and video), in combination, on demand and on the move. This flexibility needs to be economically delivered, with costs understood by the user.

1.4 SYSTEM aspects of UMTS

The **system** provides the means by which:

- connections are made for users anywhere to obtain service;
- service providers can interconnect;
- billing and accounting functions are performed for all of the various interests;
- security is maintained;
- the network is managed

all in a cost-efficient and spectrum-efficient manner.

Service choice and flexibility should be offered to the UMTS user through a large variety of different service providers and network operators. The system shall offer users a **simple and user-friendly access**.

UMTS will offer the user the opportunity to design his or her own user profile (supported by service providers). The user profile, in connection with personalised user interfaces independent from the current serving network (e.g. VHE), should be the tool for his **personalised service offerings**.

UMTS will provide mobile users with access to an exploding market of **innovative and interactive services**. Multimedia in terms of today's and tomorrow's Internet services, plus the independent use of different media components within the same session, are key features for UMTS. The integration of fixed and mobile networks, the convergence of some fixed and mobile services and of telecommunications and information technology will hence find its place in the rollout of UMTS.

1.5 The UMTS services and applications

Services on demand will be common in UMTS. High quality entertainment services, downloading of large files or on-line surfing are possible services in this context. In addition to the provision of multimedia, the user's needs for the present telecommunication services will also be satisfied inside UMTS.

Below are examples of new or enhanced services and applications which should be supported by UMTS. Some of these mass market services have already been applied in the fixed network or in GSM and will be improved with the advent of GSM based General Packet Radio Service (GPRS) and High Speed Circuit Switched Data (HSCSD), but UMTS will offer significant improvements both in service provision and delivery performance.

Information
Public information services such as
- Browsing the WWW
- Interactive shopping
- On–line equivalents of printed media
- On-line translations
- Location based broadcasting services
- Intelligent search and filtering facilities

Education
- Virtual school
- On-line science labs
- On-line library
- On-line language labs
- Training

Entertainment
- Audio on demand (as an alternative to CDs, tapes or radio)
- Games on demand
- Video clips
- Virtual sightseeing

Community services
- Emergency services
- Government procedures

Business information
- Mobile office
- Narrowcast business TV
- Virtual work-groups

Communication services
Person-to-person services such as
- Video telephony
- Videoconferencing
- Voice response and recognition
- Personal location

Business and financial services
- Virtual banking
- Online billing
- Universal SIM-card and Creditcard

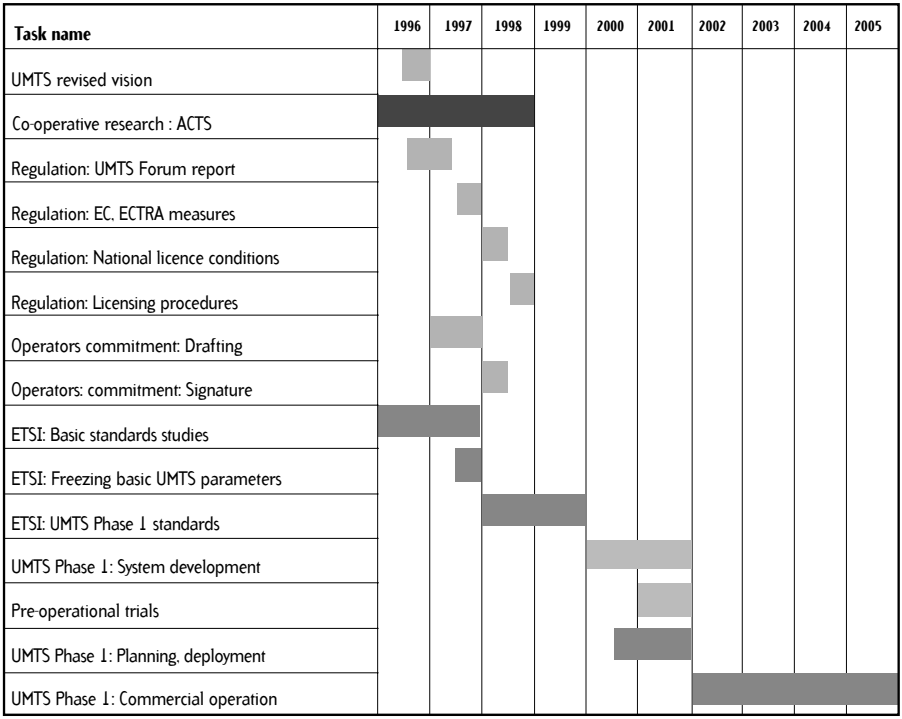
Road transport telematics
Special services
- Telemedecine
- Security monitoring services
- Instant help line
- Expertise on tap
- Personal administration

1.6 UMTS timetable

The UMTS Phase 1 standards, presently developed by ETSI, are the basis for development of wideband functionality by 2002. Phase 1 services include wideband (up to 2 Mb/s) multimedia, high quality speech at high spectrum efficiency, advanced addressing mechanisms, Virtual Home Environment (VHE) and a service creation environment.

Table 1.1 represents the currently emerging consensus for the timetable of Phase 1. A second phase of UMTS, extending its wideband capabilities, is being considered for the 2010 time frame. The further evolution of UMTS is the basis for mass commercial use in the later years.

Table 1.1: UMTS Phase 1 development schedule



2. UMTS MARKET TRENDS

2.1 Introduction

As illustrated in chapter 1, UMTS and other systems of the same type (third generation mobile systems) will take communications users into the Information Society by delivering narrow and wideband information, whether voice, data or video, direct to the user regardless of location, network or terminal used. Key requirements include: bandwidth on demand; quality in all environments comparable to a fixed network of today but allowing users to trade off price with quality of service if they wish; both symmetric and asymmetric services, perhaps on the same "call" or "session"; and identical services in all environments, including environments that change during the "call".

This demanding and exciting future is based in part on the continuing rapid growth of mobile. In Europe, mobile penetration is forecast to reach over 50% in the next ten years, and UMTS services, even though they will still be in their infancy, will play an important role in developing and enhancing that market. Sometimes described as "mobile interactive multimedia services" (although they are wider than that), UMTS services are a step-change from the mobility services of today, more limited in scope, which only focus on voice, messaging and narrow bandwidth data services.

However, to achieve a dynamic UMTS market requires the right regulatory environment, adequate spectrum, new radio access standards and the integration of services.

Successful service integration will allow an end user access to his personalised service profile through any network from any terminal, and enable "his" services to be presented to him with the "look and feel" he chooses. Appropriate and familiar service navigation tools will be immediately available to the user and the costs of the services will be known to him in advance. Development of these capabilities is continuing, is not currently regulated and the UMTS Forum sees no reason at this stage to doubt that the requisite capabilities will be in place by the time UMTS is intended to be available. This aspect of UMTS is not therefore considered to be a factor in determining the size of the market and is not discussed further.

The other aspects require management within and between countries and require co-operation at regulatory, technical and commercial levels in order to achieve efficient deployment of UMTS. These aspects are considered further in later chapters, but a critical factor underpinning the need for spectrum, standards and regulation is the forecast market which is explored in this chapter.

2.2 The European market

In the following sections, the European market forecast concentrates on the EU15 countries, as demand for mobile and mobile multimedia services in Europe will mainly be determined by these. It is assumed that other CEPT countries will be in line with the demands of the EU15, and in any case it is required that spectrum assignment and regulatory conditions shall be aligned throughout all CEPT member countries.

2.2.1 Terrestrial mobile users

The Forum has based its market forecast to a large extent on a report by the consultancy companies Analysys and Intercai (UMTS Market Forecast Study), dealing with the expected market drivers and size of the UMTS market in 2005, by which time full-scale deployment of UMTS is expected. The findings of that report has been compared and amended on the basis of market figures from other sources.

The Analysys/Intercai report focused on the potential for mobile multimedia services under various conditions. It forecast the European mobile multimedia market to grow to 20 million users by 2005, providing annual revenues (services and terminals) of 27 billion ECU. Impressive as these figures are for a market in its early stages, the UMTS Forum believes that the figures are understated. Other studies have come to higher figures. Growth in the use of computer-based communications, commerce and entertainment services; increasing demand for rapid and remote access to information; growing demand for seamless and personalised services across fixed and mobile networks; and explosive demand for bandwidth-hungry services, comparable to the ever increasing storage and processing capacities of computers, are all factors which UMTS is designed to meet.

Particular areas which the UMTS Forum believes will further accelerate demand include

- **higher forecasts of mobile users**

In the light of continuing strong market growth in 1996, manufacturers have recently increased their forecasts for western Europe to 130 million by 2001. The UMTS Forum projected these forecasts to 200 million by 2005.

- **greater reductions in mobile tariff premiums**

Recent initiatives by mobile operators in several countries suggest more rapid reductions are possible which would lead to a greater substitution of fixed by mobile calls.

In many countries, a 1% extra substitution could increase mobile traffic forecasts by more than 10%.

● **greater reductions in terminal costs**
Moves towards multi-purpose appliances could make multimedia functionality a marginal additional cost, thereby increasing affordability.

The UMTS Forum therefore believes that the annual market revenues in Europe for mobile multimedia will be at least 34 billion ECU (services and terminals) by 2005 with at least 32 million users using mobile multimedia services. In this figures the users of the GSM services GPRS and HSCSD are included. Figures for users, revenues and traffic are shown below. Traffic could even increase further if a "network centric" as opposed to "terminal centric" view of the future was taken (whereby greater intelligence was in the network rather than in the terminal, requiring greater traffic flows between terminals and intelligent networks). However, the UMTS Forum feel that the case for a network centric future is not yet proven and wishes to be cautious. If such a future did occur, the Forum believes that even more spectrum must be made available quickly to meet users demands and not artificially constrain the market.

Table 2.1: European mobile market

Market in 2005	Total Mobile Market	Mobile Multimedia Segment[1]	Mobile Multimedia (as % of total)
Users (millions)	200	32	16
Service revenues (billion ECU)	104	24[2]	23
Traffic (million Mbytes/month)	6320	3800	60
Traffic (Mbytes/user/month)	32	119	

Notes : 1 A definition of multimedia services is found in Annex 3. In this study also future data services delivered via GSM (GPRS or HSCSD) are considered as multimedia services. Present circuit switched data services in GSM (~ 10 kb/s) or short message services are not part of multimedia services.

2 Plus a further 10 billion ECU from terminal revenues.

In 2005 mobile multimedia will be noticeably emerging and already representing 16% of the users and 23% of the revenues. Traffic requirements of that sector will represent 60% of the total, despite many users being restricted to medium multimedia systems derived from present GSM technology. Every multimedia user will generate significantly more traffic than today's mobile user, but cannot be expected to pay a multiple of current tariffs, which implies

that UMTS tariffs will not be proportional to the traffic volume or to the used spectrum. This highlights the need for an order of magnitude capacity improvement with infrastructure costs maintained similar to GSM's today. This will be a major challenge for the communications and computing industries, but one which seems feasible to meet in the given time frame.

2.2.2 Additional market areas

The demand for mobile multimedia services and cellular type mobile services is not the whole market for UMTS services and spectrum. In particular, there are three other areas where UMTS services are likely to be used.

1. Systems with limited mobility, primarily used as replacement for wired access. This will be the case especially in areas with low population density or difficult topography, or where low mobility is required.

2. Private markets, ranging from wireless PBXs, to emergency wide area systems and even cordless systems with local mobility. The overlap between these services and more traditional wide area mobile services may increase over the next five years with, for instance, dual-mode and multi-mode handsets, pico-cells and changes to tariffing systems. The impact of these changes will need further study.

3. Satellite-based services, both narrowband and wideband. These will have a place in the market in their own right, and in providing both early and temporary coverage before and as terrestrial networks are rolled out. Additionally, satellite UMTS is likely to have an enhancing impact on the early years of terrestrial UMTS forecasts, since the former provides global coverage from launch, thereby enabling users full roaming and access capabilities from the start of UMTS.

Table 2.2: European satellite market

	Users (millions)		Traffic (million Mbytes/year)	
Type	2005	2010	2005	2010
Non-multimedia	0.4	1	100	200
Multimedia	0.1	0.2	200	300
Total	0.5	1.2	300	500

Forecast users do not include potential terrestrial replacement situations, i.e. where satellites are used to create a hub or base station to provide localised terrestrial coverage. It also excludes provision of temporary service prior to terrestrial infrastructure roll-out. (See Annex 2 for the role of satellites in UMTS).

2.2.3 Long term forecasts

Forecasts for mobile users beyond 2005 may be derived from assuming an ultimate penetration rate, an "S-Curve" rate of take-up and a best polynomial fit. Assuming saturation at the equivalent of 80% of the population (a view shared by many market players, and which allows for machine applications using mobile access), the following forecast for users in the EU is reached:

Table 2.3: Long term European mobile market

Year End	1995	2000	2005	2010	2015
Users (millions)	22	113	200	260	300

Note : Saturation will be reached around 2017.

These figures do not take into account major changes in technology costs, or in political, economical or societal conditions which could affect growth in the number of mobile users. However, even if the market develops slower than predicted,

- forecast numbers would be delayed a few years;
- in the later years, as saturation approached, the absolute difference in user numbers would be small; consequently the implications for when spectrum is needed to support UMTS services and users would be marginal. Spectrum is furthermore required early in order not to be a barrier to market growth.

Using the forecast mobile numbers as a base, the UMTS Forum estimates the following growth in mobile users and revenues, assuming flat revenues per mobile user and an annual 10% reduction in mobile multimedia revenues per user.

Table 2.4: European mobile users and revenues

Year End	1995	2000	2005	2010	2015
Users (millions) for					
- all mobile services	22	113	200	260	300
- mobile multimedia services alone	0	- 1	32	90	180
Revenues (billion ECU) from					
- all mobile services	17.5	72	104	140	162
- mobile multimedia services alone	-	- 1	24	46	54

Note: 1 GPRS and HSCSD services will be available in 2000 but have not been forecast.

The above assumes a favourable environment, in particular that:

- sufficient spectrum is made available in order not to constrain operators and providers of services (see chapter 6);
- competition is encouraged within economic parameters (see chapter 5);
- there are only a few (preferably less than three) globally recognised wideband air interfaces with roaming between them (see chapter 7);
- service personalisation and easy-to-use interfaces will continue to be developed within terminals.

2.3 Beyond Europe

The European market for UMTS is a small part of the potential global market. This has two major implications for UMTS, firstly that it is even more necessary to set regulatory and technological frameworks which will provide the greatest impetus to UMTS in Europe (including enabling roaming outside Europe), and secondly that UMTS developments need to take into account trends in other parts of the world. Such trends include greater use of wireless (including satellite) for all telecommunications services, particularly in emerging nations. The UMTS Forum has not felt able at this stage to forecast the full market for UMTS services outside Europe, but has forecast, as starting points, both the world-wide satellite UMTS market (to 2010) and the world-wide mobile market (to 2015).

2.3.1 Satellite users

Current expectations are that less than 20% of the world's land area will be covered by terrestrial cellular networks. Satellite systems are therefore important to UMTS to complete coverage. In turn, this is expected to spur further demand for terrestrially based UMTS services. World-wide forecasts for UMTS satellite services are:

Table 2.5: World-wide satellite market

	Users (millions)		Traffic (billion Mbytes/year)	
Type	2005	2010	2005	2010
Non-multimedia	3	7.5	1	1.5
Multimedia	1.5	3	3.5	5.5
Total	4.5	10.5	4.5	7

Note: Business users form approximately two thirds of total forecast users.

Forecast users do not include potential terrestrial replacement situations, i.e. where satellites are used to create a hub or base station to provide localised terrestrial coverage. It also excludes provision of temporary service prior to terrestrial infrastructure roll-out. Users from these environments will account for a sizeable addition to the forecasts shown. (A fuller discussion of the place and implications of satellites can be found in Annex 2).

2.3.2 Mobile users

In order to forecast mobile subscribers for the other world regions, the same approach and the same assumptions as for Europe have been taken, resulting in the following numbers:

Table 2.6: Long term world-wide mobile market

Users in millionsat year end	1995	2000	2005	2010	2015
EU 15	22	113	200	260	300
North America	36	127	190	220	230
Asia Pacific	22	149	400	850	1400
Rest of World	7	37	150	400	800
Total	87	426	940	1730	2730

North America is a region that will most likely face market saturation in terms of subscribers earlier than Europe. However, there is likely to be additional market potential by double subscriptions of individuals (one paid for by the employing company, the other one by the user himself) in order to separate business and private usage; this potential has not been taken into account.

In 2015, most countries in Asia, Africa and South America are expected still to be far from reaching saturation in terms of mobile users. Nevertheless the number of users in these regions will be many times higher than in Europe or North America, even without taking population growth into account.

2.4 Conclusions

The essence of UMTS is to enable a new end-user proposition which provides ubiquity and universality of services, and which cost effectively accommodates the shift over the coming decade from real-time voice to data and multimedia services, requiring higher bandwidth. Third generation systems, regulation and spectrum licensing economics must accommodate and enable a new cost profile to meet the emerging user demand.

The social, economic and personal user benefits of UMTS are significant and worthwhile. These benefits will be enabled over the next few years by early regulatory and spectrum licensing action in order to open the door to investment in, and implementation of, systems at the start of the next century. By 2005, there will be a substantial market for UMTS services in Europe, and this could spread globally in the following 10 years. If there are no regulatory constraints, UMTS will be well placed to build another success story, potentially rivalling GSM, and meet the growing mobility needs of users into the 21st century.

3. TECHNOLOGY ASPECTS

3.1 Introduction

UMTS development will be strongly driven by the market and enabled by technology. Technology relevant for third generation systems such as UMTS will feature a significant step forward compared to second generation technologies, mainly in terms of advanced multimedia wideband capabilities. This technology aims at the integration of mobile and fixed networks providing global coverage and mobility in terms of terminals and services.

New technology will have an impact on, inter alia, competition, cost vs. performance issues, terrestrial and satellite network integration aspects and the interfaces to be standardised. The new technology will also play a central role in the convergence of telecommunications and IT, encompassing multimedia and entertainment. The transition from second to third generation systems requires a careful phased approach. The UMTS technology is now under standardisation within the European Telecommunications Standards Institute (ETSI).

Among enabling technologies, some of the most challenging are: software radio , multi-media and components. Advanced R&D projects within the EU research program ACTS and other co-operative research programs in these fields, carried out by industry and supported by public funding, are a key success factor for third generation systems.

3.2 Cost and flexibility

Technology must enable flexible solutions allowing all of the UMTS market players to compete and offer customised solutions in an open, liberalised market. UMTS should meet the users' expectations of advanced services, with a better service quality, wider coverage and seamless operation at low cost. The users should be able to chose between price and quality of service. The technology will stimulate and enable the offer of UMTS services at attractive prices.

3.3 Integration

Integration of fixed and mobile network standards and technology is a key attribute of UMTS which will enable truly personal communications to be delivered. It will ensure lower

costs as well as providing wideband services which appear truly seamless to the user. Integration at a service level across different independent public and private operating environments is feasible, offering consistent business and personal customer services to the user wherever he roams.

It may prove neither economic nor feasible to extend terrestrial telecommunications infrastructure into sparsely populated areas. Today, significant areas are still not covered by terrestrial cellular systems, and terrestrial UMTS is not likely to provide truly global coverage either.

Satellite technology has the potential of providing global coverage and service from the first day and so it can play an important role as an extension of UMTS terrestrial coverage. Integration of the terrestrial and satellite components of UMTS is highly desirable to provide actual global coverage at least for a subset of UMTS services. Maximum commonalties between the terrestrial and satellite components of UMTS would also reduce the costs of the satcom terminals, thus making them more attractive.

3.4 A phased approach

UMTS is planned to become operational with its basic Phase 1 services by about 2002 (see section 1.6). Although UMTS foundations were laid through basic R&D effort (e.g. RACE and ACTS co-operative research programs) starting when GSM deployment was at its outset, the relevant standardisation activities are still intensifying. This will be further described in chapter 7. These activities overlap with the implementation of enhancements of existing pre-UMTS systems.

Transition from second to third generation systems can be devised according to various possible development scenarios supported by different, if not conflicting, commercial and industrial policies and interests. Considering the tight time schedule for UMTS development, an evolutionary approach with a number of innovative steps corresponding to significant milestones in the specification process might be a solution, with the advantage of enabling:

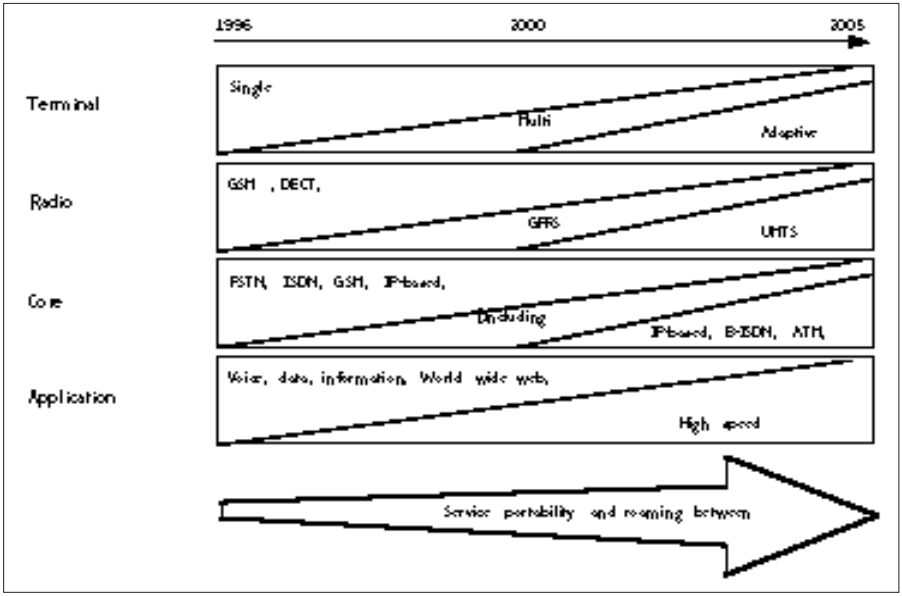
- full exploitation of the success and diffusion of pre-UMTS systems in the short to medium term,
- an integrated telecommunications network architecture in the medium to long term.

This approach has previously been described by the ETSI GMM Report where a picture similar to Figure 3.1 can be found.

According to the above approach, GSM2+/GPRS, DECT, ISDN, IN and other pre-UMTS systems could provide advanced services approaching those of UMTS. Obviously, UMTS will then have the potential to offer such services in a cost-competitive manner and still continue to evolve from that point on to more advanced services. Although technology can develop independently, there is a need to align the different areas to provide efficiently inter-domain services, e.g. virtual home environment, location management, hand-over.

UMTS cannot be developed as a completely isolated network with minimal interface and service interconnection to existing networks. Both UMTS and existing networks will need to develop along parallel, even convergent, paths if service transparency is to be achieved to any degree. This would then in the end allow UMTS services to be supported, although at different levels of functionality, across all networks.

Figure 3.1: Evolution towards UMTS and multimedia



It should be noted that this approach will enable a full exploitation of current systems. Moreover, due to the significant investments made, pre-UMTS operators do not want to discard their existing infrastructure and will prefer some type of coexistence and interworking between existing and new infrastructure. The balance between use of the current systems and UMTS systems will be decided by market forces.

3.5 Convergence

In our context, convergence can be defined as the trend towards the logical merger in a broad sense of the computer and telecommunications sectors, made possible by their common technological base, electronics. Convergence can impact several business areas at industry level (e.g. alliance of IT and telecommunication industries) and at technology level (same core technologies for IT and telecommunication equipment/infrastructures).

A result of convergence which can impact service provision structures and organisations is the concept of Full Service Networking. This encompasses the offering of telecommunication services over CATV infrastructures, "quasi" telecommunication services (voice/fax) over Internet and broadcast services on telecommunication networks (e.g. through ADSL techniques).

3.6 EMC framework

To lower the current hurdles in market development of mobile communications, increased generic immunity of electronic devices and systems are required.

It is essential that UMTS standards find a reasonable balance between design that minimises the risk of interference with other electronic devices and the demand for regulation to ensure increased interference immunity of other electronic devices and systems. Without such a balance, the usage of UMTS terminals may disturb such devices even if they conform to standards. This will have negative impacts on the acceptance and the economic success of UMTS.

3.7 Security and privacy

The UMTS Forum considers that security and privacy are important aspects of the use of mobile services, and that they will become even more important in the wider scope of the UMTS services. These aspects must be studied further in parallel with the development of the UMTS system.

Without the legal security of a Union-wide approach, lack of consumer confidence will certainly undermine the rapid development of the information society. The UMTS Market Forecast Study identifies as one of the key barriers for the UMTS market the "failure to resolve security issues and convince consumers that electronic commerce is secure". Therefore the regulation providing general rules for adequate provision of security on and about individual data must also be applicable to UMTS.

Furthermore, binding rules for network access required for lawful interception must be known well in advance so that the standard includes, for optional use, the necessary equipment specification. The same question had to be settled after the implementation of many of the GSM networks.

3.8 Conclusions

UMTS has been the subject of research and standardisation for almost a decade. While it would be premature at this stage to draw lasting conclusions concerning the technology aspect of UMTS, especially in the light of the ETSI mandate due for completion of its first phase at the end of 1999, the UMTS Forum believes the following:

- UMTS technology will play a major role in realising the convergence of the telecom, IT and broadcasting domains;

- Within the telecommunications field, UMTS will support the integration of existing and new, fixed, mobile, public and private services. It will represent a federation of telecommunications networks and technologies rather than the creation of a separate, isolated system;

- In implementing UMTS, proper consideration should be given to ensure a careful and phased approach to the transition from current second generation systems, building on the

recognised strengths of such systems (such as GSM and DECT), with the objective of providing a homogenous telecommunications environment to the user;

● Existing concerns such as EMC, the environment and the encryption of information will take on increased importance in the context of UMTS technologies and the emergence of the Information Society, and should therefore receive careful consideration by public policy makers.

● Given the major advances foreseen in technology, there would not appear to be any significant technical obstacle to the rapid development and deployment of fully-fledged UMTS services (in particular at the network and terminal levels)

4. UMTS ROLES AND ENTERPRISE MODEL

4.1 Introduction

This chapter introduces possible roles and relationships for the overall provision of UMTS services as a prelude to exploring the business case. Scenarios and options are identified to provide a basic understanding of some of the commercial relationships that are likely to exist between the various enterprises involved in realising UMTS services. These enterprises will most likely include

- network operators handling either a part of, or the whole of a complete telecommunications network;
- service providers as a point of contact to the subscriber or user;
- value added service providers (including content providers), offering additional information based services to the user.

4.2 Enterprise model

UMTS is assumed to support a range of services to users irrespective of their geographical location (within the area covered by UMTS). These services are expected to be available via different access technologies (fixed, radio, satellite, etc.) and will be provided as a result of co-operative as well as competitive relationships between different enterprises in an overall UMTS business environment. The format of the service may at times be limited by circumstance when, for example, data rates are constrained by radio propagation.

The objective of this chapter is to describe a flexible UMTS enterprise model that can be used in analysis to:

- identify the various roles that may need to be performed within the UMTS environment;
- establish a framework with which to explore the UMTS commercial environment;
- identify technical relationships that may be required for interworking and interconnect between UMTS roles;
- provide a basis for the further development of economic studies and the development of business cases;

An analysis of the existing GSM enterprise structure within Europe can be used as the basis for developing a reference enterprise model for UMTS. The functions performed by existing roles and the additional functions that will be required for UMTS are summarised in Table 4.1.

Table 4.1: UMTS functions from a user perspective

UMTS functions	Description
1 User	The person or machine using the UMTS Service
2 Subscriber	The entity that has a contractual relationship with the provider of UMTS services.
3 Service provider/manager	Single interface for the subscriber.
Subscriber billing	Bills the subscriber
Service profile management	Manages the profile of services and related data for subscribers.
4 Network service	
Service control and integration	The real time control of user services, execution of service logic and access to service data
Service management	Call management, security management
5 Access provision	
Fixed access	The provision of fixed access to services
Radio access	The provision and management of the radio segments, access management and handover
Spectrum management	Clearance, allocation, tariffing, planning and optimisation
6 Mobility management	Management of performance and service delivery, location, authentication and fraud
7 Transport provision	These functions will be provided by fixed infrastructure (including long distance)
Fixed transport	Voice, data, leased circuits, PSTN and ISDN interconnect
Non-circuit related signalling	The support of non-circuit related messages (required for Mobility Management and Service Control).
UMTS transport	The transport requirements required for UMTS users - specifically any UMTS specific transport between UMTS users.
8 Intelligent network functions	Services like freephone, number translation and premium rate services, not specific to UMTS.
9 Value added service provision	
10 Content provision	
Provision of content	E.g. feature films, information, etc.
Content tailoring	Tailoring the content to make it suitable for the UMTS environment.
Content brokering	The means by which a user selects an appropriate content provider

These functions have been grouped into related categories, i.e. functions that are closely associated with one another and could logically co-exist within a single business. The table is not exhaustive and the functions listed only represent the core UMTS functions.

These listed UMTS functions can be used in the development of one or more overall UMTS enterprise models which can be used to determine necessary commercial and technical relationships and interfaces. These individual functions can be grouped together to provide individual roles within the model. A single role will represent the minimum building block within the model (i.e. functions that cannot be separated further) and an enterprise will represent a grouping of individual roles.

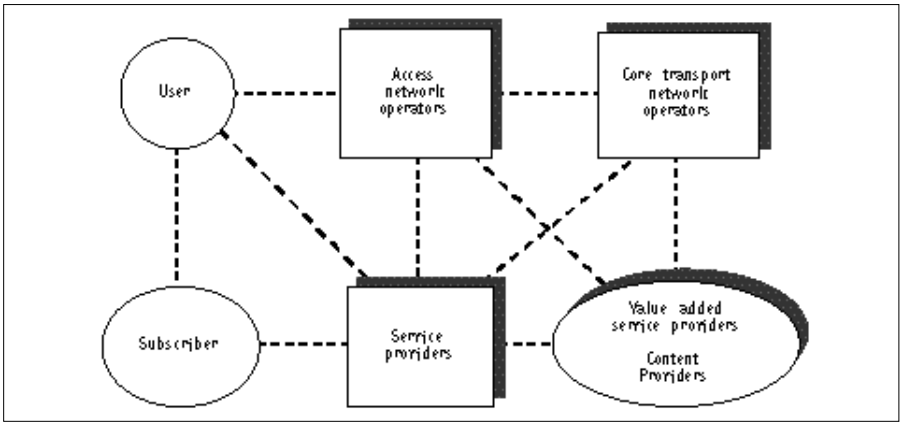
The model can be used to highlight the relationships that need to be established between the various roles within the UMTS enterprise structure. When these roles are performed by separate enterprises within the structure, the relationship between roles can be described as :

- **commercial** - where one role is performing a function (i.e. providing a service) to another role as a result of a commercial agreement;
- **technical** - where one role has a technical relationship with another role in order to pass information or provide control. Technical relationships will generally be either real time signalling relationships (e.g. call control) or management interfaces (e.g. billing data).

Practical relationships between any two roles are likely to be a combination of the above types.

4.3 A sample UMTS value chain

Figure. 4.1: Illustration of UMTS market roles



The basic role model in Figure 4.1 shows the various roles that may exist, but it should not be assumed that each of these can exist as independent commercial entities. However, it does suggest the opportunities for new types of commercial enterprise that may develop within UMTS. One of the many possible mapping of UMTS functions to individual roles is shown in table 4.2. This value chain could also be applicable to present pre-UMTS voice-oriented systems, but these are unlikely to provide sufficient emphasis on the value added and content provider functions.

Table 4.2: Roles

Roles	Functions
Access network operator	Access provision Network service Mobility management (alt.)
Core transport network operator	Transport provision Intelligent network functions Mobility management (alt.)
Service provider	Service profile management Mobility management (alt.)
Value added service provider	Value added service control Content provision

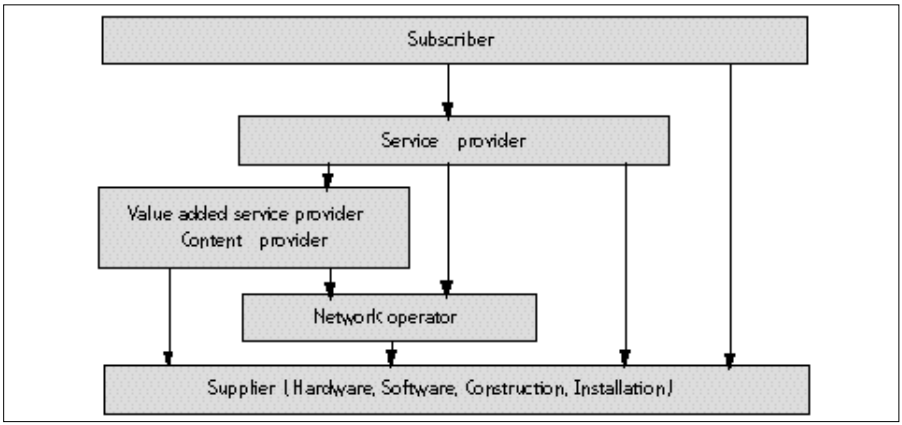
Each of the roles identified in Table 4.2 differ by background, by the regulatory conditions they have to comply with, and by investment cycles.

In order to model a complete value chain and a complete UMTS operator business case, additional types of market players have to be taken into account:

- suppliers of hardware and software to the subscribers (i.e. in today's terminology handhelds, fax machines, laptops, etc.);
- suppliers to operators and service providers, e.g. manufacturers, software houses, and companies dealing with the construction of these networks.

Figure 4.2 is one example of the many possible models for revenue flow between the various entities, i.e. the arrows indicate how the money paid by the subscriber for accessing and using the services can flow to the other market entities. The functions of service provider and network operator can be held by the same entity.

Figure 4.2: UMTS Revenue Flows



4.4 Conclusions

The key points to note from this brief introduction are that UMTS will:

- evolve from the existing traditional telecommunications function structure as a result of existing commercial criteria;
- result in the creation and establishment of new roles and functions. The function structure should evolve according to market and commercial criteria where there is currently some uncertainty. The integration of roles into an enterprise will differ depending on the market environment and may vary over time. This should therefore not be a matter for sector specific regulation but be regulated by general competition law;
- form an important part of an overall future telecommunications environment and will represent a subset of overall mobility needs in a growing and dynamic market.

Increased competition will come from the commercial development of the market roles in various organisations. Any proposed licensing regime should not preclude the integration of different roles within a specific organisation, provided that this does not prevent any competitive opportunities.

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5. ECONOMIC CONSIDERATIONS

5.1 The scope of the UMTS business case

The business model that has been analysed by the UMTS Forum is a traditional vertical structure as indicated in the previous chapter. A range of options has been explored and compared to a base case, in order to show relative, but not absolute, differences under different conditions. The business is limited to UMTS delivery via a cellular type architecture. No economic model has been created for UMTS service delivery through low mobility systems or satellite systems. This must however not be taken to imply that such systems will not prove to be important market sectors.

Market size and revenue were based on analysis in chapter 2. External sources of revenue such as multimedia content or advertising have been ignored. The model reflects a simplified approach compared to figure 4.2, since it takes into account the revenue stream from the subscriber to the service provider, and then further down to the network operator and the supplier, but it ignores the revenue streams from the subscriber to the suppliers and from the service providers to value added service providers and content providers. No attempt has been made to justify how the revenue could be broken down into separate business units, because each market player will have different strategies and competencies resulting in subtle splits of revenue. The physical and contractual interfaces will affect the business model when it comes to issues like infrastructure sharing, and these matters are dealt with later in this chapter.

Capital expenditure costs were largely drawn from today's GSM experience. In order to mitigate these assumptions a sensitivity test was carried out on total capital investment. It is important to note that the economic model does not address the significant investment that will be required in existing carrier networks to support UMTS transport and signalling capabilities.

The results from the calculations cannot be interpreted to show the absolute level of profitability for the UMTS business case. The results given below indicate that certain factors have a great effect on the profitability. The UMTS Forum will continue to investigate the profitability of UMTS and will be pleased to discuss these questions with any regulatory body on a national or European level.

5.2 Economic simulation

Two different economic models have been tried using a common set of assumptions for correlation purposes. These are proprietary models provided by an operator and a manufacturer. The conclusions in this chapter have been drawn when close agreement has been found between the two

models. Due to the uncertainties of the assumptions used it is not possible to draw absolute figures from these models.

The models are based on a 10 year business plan which does not take into account the remaining value of the business after 10 years. No parameter elasticity has been assumed when performing sensitivity tests on the model, i.e. there is no assumption that if call prices drop then subscribers usage goes up. The models analyse the project viability of the different scenarios and does not take into account financial impacts due to equity/debt ratios.

The model indicates that the economics of UMTS are not as attractive as those traditionally associated with establishment of second generation mobile networks. This has to do with the traditionally lower margins of data communication services and the different market situation for UMTS. The economics are also highly sensitive to the regulatory and licensing environment. Simulation shows a considerable impact of increasing or decreasing the total UMTS operator investment. Increased investment could result from increased prices for infrastructure hardware and software, high costs for spectrum and other licensing costs, and coverage demands above what is economically justifiable. A 30 % increase in investments would lower the internal rate of return (IRR) with about 40 %. Delayed licence or spectrum payments would not affect the cumulative 10 year cash flow but would reduce the operators risk during the build out phase.

Decreased investments can be a result of sharing of infrastructure resources, either when an incumbent operator re-uses sites and masts already built for a second generation system, or when two operators share the same infrastructure. In one of the calculated cases reusing old infrastructure did double the IRR.

Simulation also shows the very high sensitivity of the business model to subscriber revenue and hence to the accuracy of industry predictions for UMTS revenue. An increase in subscriber revenue of 20 % would double the IRR, while a reduction of 20 % would reduce IRR to less than half the initial value.

5.3 Economic regulatory drivers

5.3.1 Introduction of new operators

Existing mobile operators wishing to operate third generation networks may find some advantages compared to new operators. However, these advantages can be offset by active

marketing measures and co-operation between market players. Unlike the current second generation operators, the new third generation operators will face a much more competitive market place in which great progress is likely to have been made in improving aspects such as subscriber service, marketing and competitive distribution channels.

Whilst acknowledging the need for ongoing competitive infrastructure investment to encourage innovation and choice for users, it should also be noted that this choice may be extended by new distribution channels, and by content and value added service providers.

5.3.2 Effect of number of operators and subscriber revenue

The model indicates the sensitivity of the business case to the number of operators and to the number of subscribers, and consequently revenues. The positive effect of sharing the same number of subscribers between two operators instead of four is shown in almost three times the IRR for two operators compared to four. Only incremental investments are needed to cater for the extra numbers of subscribers per operator.

Overall, given reasonable assumptions, the model suggests that if the market is less than predicted, more than two national operators would face severe challenges in achieving acceptable rates of return.

5.3.3 Investment costs

The economic model has indicated that the UMTS business case is sensitive to the investment level. Increased investment levels seriously reduces the internal rate of return, while reduced investments and the possibility to use already existing sites increases it.

One of the possibilities mentioned to reduce investments, at least in the early years, is to share infrastructure with other operators. However, this poses many technical and operational difficulties. These are further discussed in chapters 6 and 8.

It is further mentioned that actions from regulators may increase investment levels. Such actions are coverage obligations and costs for licensing, in particular spectrum pricing. UMTS is more sensitive to spectrum pricing than
GSM due to its bandwidth requirements, mentioned in chapter 2. Auctions are further discussed in chapter 8. From an economic point of view, such costs that occur before the business has achieved a positive cash flow are more serious than later costs. Means should be

found to spread out regulatory costs over the lifetime of a system instead of taking money out of the business in the beginning when the costs for equipment are most heavy. Such means will in the long term lead to a higher revenue gain for the government.

5.3.4 Length of licence period

All the scenarios considered in the economic simulations show payback times of 7 years or longer. The actual slope of the cash flow curves are also quite flat so that a licence of less than 10 years would not be at all attractive to investors. Offering licences for a period of time less than 10 years would not encourage any serious deployment of infrastructure. The operator would be encouraged to take very short term views resulting in limited mobility and heavy competition for the simple voice market.

5.4 Conclusions

The economic model has demonstrated the high sensitivity of the UMTS business to regulatory decisions, investment levels and market uncertainty. It has also indicated that the economics of UMTS are not as attractive as those traditionally associated with second generation mobile networks.

The model has emphasised the following key points:

- The business case is sensitive to the number of operators, so increasing the number of competing operators significantly reduces the return on investment;
- Infrastructure sharing between operators, or with existing second generation operators, could facilitate an overall reduction in the cost base and a consequential increase in return on investment;
- Any significant increase in investment costs has a disproportionate impact upon the return on investment. Such costs also include those associated with regulatory factors;
- The business case is highly sensitivity to changes in customer revenue, where a small change in revenue has a large impact upon the return on investment;
- The payback periods from the model suggest that licence periods of less than 10 years are likely to be unacceptable to the business case.

The results of the economic modelling work to date have demonstrated the requirement for a stable regulatory environment that recognises the above sensitivities during the establishment of a competitive UMTS market.

6. FREQUENCY SPECTRUM ISSUES

6.1 General remarks and assumptions

This chapter reflects the work done within the UMTS Forum concerning frequency spectrum for UMTS up to May 1997. The UMTS Forum will later in 1997 produce a more detailed report concerning spectrum issues for UMTS.

The calculations of frequency spectrum requirements for UMTS cannot be limited to multimedia services and high speed data services. A number of the foreseen UMTS services, such as voice and low speed data services, are today delivered by second generation systems, and this will be the case also when UMTS has been introduced, at least for a transitional period. In the satellite field, UMTS satellites and narrow-band satellites will to a certain extent share the same market.

Therefore, the calculations of frequency spectrum demand have been made taking account of all mobile services, excluding only services from fixed or quasi-fixed systems.

The spectrum calculations concentrate on the European scenario, although scenarios in other continents also need investigation. It was discussed that similar investigations could be undertaken together with the GSM MoU 3GIG and its interest groups for other continents.

The following main assumptions were made:

6.1.1 UMTS spectrum for a coherent set of standards

UMTS will integrate all present and future services into one system of interworking network modules. Therefore, it is of considerable importance that ETSI is entrusted with the task to define a coherent set of standards to be used in the UMTS frequency spectrum bands identified by ERC.

A coherent set of standards means that the standards shall be developed as a basic set of specifications for the main applications. Like a platform or tool-set, the standards should be usable for other applications not burdening the main applications with high complexity and costs. As a result, a modular radio solution could be developed.

6.1.2 UMTS spectrum designation

In order to adopt multimedia applications sufficiently and to save spectrum resources, both circuit and packet switched radio access are assumed. The traffic calculations consider both transmission principles.

Further, it is assumed that asymmetric traffic distributions may influence the spectrum demand on the uplink and downlink side by designating different bandwidths.

6.1.3 UMTS spectrum development

For a number of reasons, UMTS should be structured into phases. The reasons are of a technology as well as a spectrum development nature. The phases of spectrum development are the following:

Phase 1: Core band, where UMTS is tested and mass market begins;
Phase 2: Extension band(s) + Refarming, for the full mass market needs.

6.2 UMTS spectrum demand

6.2.1 Estimation of spectrum requirements for terrestrial UMTS

The spectrum requirements for terrestrial UMTS are based on several factors:

- Market forecast and penetration;
- Potential user density;
- Service and traffic characteristics;
- Infrastructure and technical characteristics.

The estimation is built on the assumption that all mobile traffic, both from wideband and multimedia services as well as from narrowband services similar to the present second generation services, are carried by UMTS. The forecast numbers (users, traffic volumes, etc.) from chapter 2 constituted the bases for the spectrum estimates. The estimation includes public as well as business and private users. It builds on calculations made for the years 2005 and 2010.

For the year 2002, when UMTS introduction is planned, market conditions of their own will not determine the necessary amount of spectrum. To enable the provision of multimedia services in UMTS with a continuous coverage, a minimum frequency band in the order of 2x20 MHz will be needed for public licensed use by each operator. This result can be derived from the RACE II projects ATDMA and CODIT. Systems presented as candidates for UMTS within ETSI (i.e. the FRAMES project) verify these estimates.

Recognising that in the initial phase limited spectrum may be provided for public systems, an additional band of 20 MHz would need to be designated as start-up band from the year 2002 for non-public non-licensed in-building low mobility systems. Such systems are seen as playing a key role in establishing a strong market for multimedia terminals and, more importantly, in stimulating a requirement for public access "away from base". In addition, more capacity will be freed for public systems.

The spectrum requirements for such non-public non-licensed in-building low mobility systems are included in the total spectrum requirement estimates for 2005 and 2010. However, such systems will require separate frequency allocations of 20 - 40 MHz out of the estimated required spectrum in order to avoid interference to public systems.

Table 6.1: Result of terrestrial spectrum requirement calculations

Year	2005	2010
High interactive MM 1	22 MHz	82 MHz
Medium & high MM 2	113 MHz	241 MHz
Switched data	12 MHz	9 MHz
Simple messaging	2 MHz	2 MHz
Voice	220 MHz	220 MHz
Total	369 MHz 3	554 MHz 3
Total (allowing for spectrum division) 4	406 MHz	582 MHz

Notes:		
	1	Characterised by high speed data rates, symmetric and reasonably continuous transmission and minimum of delays.
	2	Characterised by moderate data rates, medium to large size of files, asymmetric and bursty transmission and tolerance to a range of delays. GPRS and HSCSD come into this category.
	3	Already identified spectrum is 395 MHz (70 MHz GSM/E-GSM · 150 MHz GSM 1800 · 20 MHz DECT · 155 MHz terrestrial UMTS).
	4	Trunking inefficiency and guardbands must be allowed for, due to multiple operators, and public/private and service category segmentation. This is assumed to improve from 10 % in 2005 to 5 % in 2010.

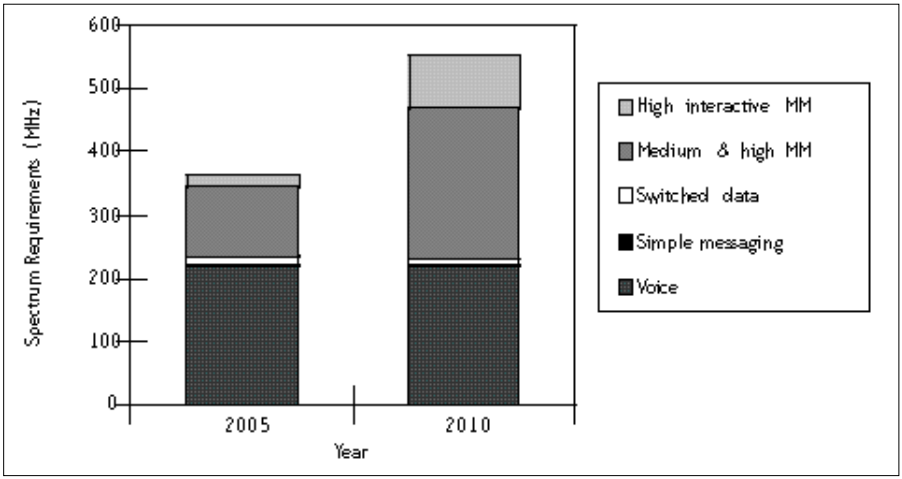
Table 6.1 and Figure 6.1 below show the required frequencies per service in the busy hour for the years 2005 and 2010.

The conclusion is that about 580 MHz will be required in the year 2010. The requirement includes the bands currently designated for second generation systems , and the bands designated as Core band for UMTS, plus new spectrum resources fully and flexibly exploited. It

should be noted that non-public non-licensed in-building low mobility systems represent some 20 MHz in 2005 and 40 MHz in 2010 of this spectrum.

For the more distant future, i.e. after 2010, the increase in penetration will not be significant. However, the use of services requiring wider bandwidth is expected to increase. This will lead to increasing spectrum demand. Further designation of frequency bands to cover such spectrum demand should be considered as early as possible when experience has been obtained from the implementation of UMTS.

Figure 6.1: Required spectrum for terrestrial UMTS services (incl. second generation services)



It should be noted that the forecast number of persons using mobile services is roughly equal with the voice service users, i.e. all other services are considered as supplementary to the basic voice service. One person will thus be using several services. The forecasts in chapter 2 show that the use of the higher bandwidth multimedia services will increase over time, leading to a proportional decrease in the share of the voice services. However, it is not foreseen that the absolute volume of voice services will be diminishing. Due to the undefined nature of future services, particularly the multimedia services, a certain degree of care is needed in interpreting the estimated figures in table 6.1. The estimates of spectrum requirements are for the network busy hour, but the profile of traffic for each service type varies through the day. The future mix of services should result in spectrum

being utilised more evenly than the present, particularly through the use of delay in high volume data applications.

Factors that are not treated in the calculations and which may further increase the required spectrum include higher traffic rates, higher penetration and user density variations. Nor are factors that might reduce the spectrum requirements, such as half rate speech codecs, low rate video codecs, adaptive and/or distributed antennas, efficient statistical multiplexing and overall improved C/I performance, considered in the performed calculations.

Improvements in technology will lead to improvements in spectrum efficiency. However, this potential may be partially reduced if improved quality is chosen, which is expected to be a market requirement. In addition, cellular radio has a practical difficulty in the problem of finding cell sites in optimal locations. The cellular grid will become more irregular as the nominal cell size is reduced with a consequential degradation in frequency re-use.

6.2.2 Estimation of spectrum requirements for satellite UMTS

Calculations have been made for the years 2005 and 2010. Two types of terminals are expected to provide satellite UMTS services: hand-held terminals providing voice and low-rate data services and somewhat bulkier terminals providing multimedia services. The predicted market demand for these UMTS satellite services are given in chapter 2. In order to estimate the demand in the 15 EU states, it is assumed that EU generates 12.5 % of total world demand for UMTS satellite non-multimedia services and 6% of demand for satellite multimedia services. That gives the following demand in the EU:

Table 6.2: UMTS satellite use within EU

	Users (millions)		Traffic (million Mbytes/year)	
Year	2005	2010	2005	2010
Non-multimedia	0.4	1	100	200
Multimedia	0.1	0.2	200	300
Total	0.5	1.2	300	500

These figures for mobile users are the initial estimates (based on limited information) of the market for satellite UMTS services. Such services will be provided as part of the wider S-PCS requirements. Recent market studies by ICO on S-PCS traffic demand for voice and low rate data indicated a total subscriber base of 6 million subscribers in EU in 2005. A part of this demand will be for UMTS services.

The amount of traffic generated by satellite UMTS users was estimated based on market research which considered 12 operating environments and 4 different services (see also Annex 2). Based on typical frequency reuse and modulation techniques of planned MSS systems, the following spectrum requirements can be calculated. The additional demand could be fulfilled in frequency bands higher than the UMTS Core band.

Table 6.3: Spectrum requirements for satellite UMTS services in Europe

Year	2005	2010
Non-multimedia	2x6 MHz	2x15 MHz
Multimedia	2x18 MHz	2x28 MHz
Total	48 MHz	86 MHz

Note: The peak world-wide spectrum requirement for multimedia services has been predicted to be 2x30 MHz in 2005 and 2x46 MHz in 2010. For handheld terminals, ICO has predicted a spectrum requirement of 2x85 MHz in 2005 and 2x100 MHz in 2010.

6.2.3 Conclusions

The UMTS Forum has calculated the following total spectrum demands, both up- and downlink, for terrestrial and satellite UMTS services:

Table 6.4: Mobile spectrum demand for 2005 and 2010

Year	2005	2010
Terrestrial UMTS and evolved second generation	410 MHz	580 MHz
Satellite UMTS	50 MHz	90 MHz

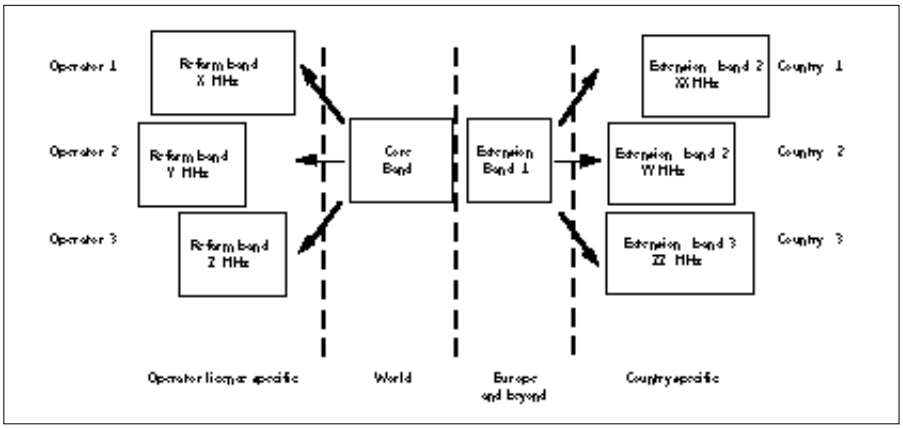
For terrestrial services in Europe, 240 MHz are defined for second generation standards. The Forum has earlier concluded that the full 155 MHz for terrestrial UMTS designated by the ITU should be made available by the year 2005. To meet the UMTS market forecast for 2010 an additional 185 MHz is required.

For the start-up in the year 2002, each licensed UMTS public terrestrial operator will need in the order of 2 x 20 MHz to enable the provision of multimedia services. For non-public non-licensed in-building low mobility systems, an additional 20 MHz will be required.

6.3 Spectrum vision

Spectrum is a limited resource. The considerations for UMTS spectrum have up to now been focused on Europe, and the spectrum situation in other regions may differ considerably. Also spectrum demand may differ from country to country depending on population density and economic development. The concept in Figure 6.2 could provide a possible solution for a flexible spectrum designation for UMTS.

Figure 6.2: Spectrum Vision



6.3.1 Core band

The Core band is given in the Draft ERC Decision on UMTS spectrum, which is based on the IMT-2000 band. Since UMTS is understood as one of the third generation systems within the IMT-2000 family, the UMTS Forum decided to start the discussion defining a Core band which will be available in parts or in total in most parts of the world.

The Core band will be required for full implementation of UMTS and therefore technology development can be based upon this frequency range. The Core band should be designated mainly for full mobility applications.

6.3.2 Extension band 1

Extension band 1 should be harmonised at least throughout Europe. The size is not known yet. It depends among other things on the feasibility in Europe to make frequencies available in the 2 GHz band. Candidates are under investigation.

It would be desirable that the expansion of traffic up to the year 2010 could be taken in this band. The Extension band 1 should be used mainly for full mobility applications.

6.3.3 Extension band 2

Extension band 2 may differ in frequency range and size from country to country. Harmonisation throughout Europe should not be the main requirement. It is recommended to be used as:

- an overflow band for regions where higher capacity is needed, because of high population density and high penetration rate regarding mobile communications,
- a preferred band for business and private in-building limited mobility applications characterised by low mobility and cordless applications (perhaps combined with fixed radio),
- separate bands for fixed radio services using the same radio standard outside the regions mentioned in the first bullet and where a higher capacity is needed.

The Extension band 2 can lie between 2 GHz and 3 GHz, above or below Extension band 1. It could also lie below 2 GHz, if long distance requirements have to be fulfilled. This is for further discussion in rural applications.

The frequency band for non-public low mobility systems should be chosen within the Extension band 2.

6.3.4 Refarming bands

Refarming bands are frequency bands currently allocated for second generation mobile systems (e.g. GSM) or for other purposes (e.g. existing land mobile services and TV-broadcasting bands). Such bands are mainly between 300 MHz and 2 GHz.

Refarming bands should be used for full mobility applications as a first priority.

6.3.5 Conclusions

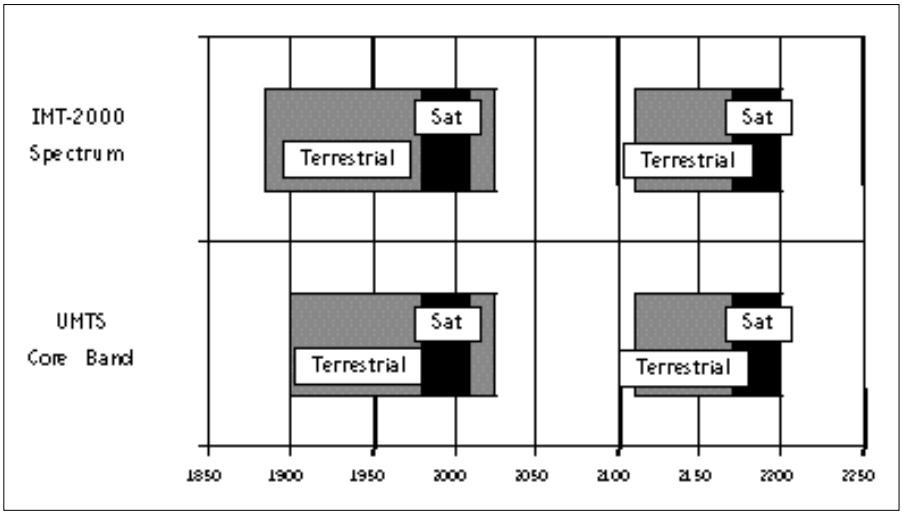
The UMTS Core band, as identified in the ERC Decision, Extension band 1 and Refarming bands shall be used mainly for full mobility applications. Extension band 2 may be used also for low mobility applications, and for fixed applications outside regions with high traffic density.

6.4 Spectrum plan

6.4.1 Core band

The structure of the Core band is shown in Figure 6.3. It includes the satellite part with 60 MHz in total. For terrestrial applications, 155 MHz will be available in total.

Figure 6.3: UMTS Core band



The designation of the Core band is presently under consideration by ERC. A Draft ERC Decision was released for comments in March 1997 and is foreseen to enter into force by 1 October 1997. The main points in the Decision are:

- UMTS is defined as equipment complying with ETSI standards for UMTS;
- 9 The frequency bands 1900-1980 MHz, 2010-2025 MHz and 2110-2170 MHz are designated for terrestrial UMTS applications;
- The UMTS satellite component applications are accommodated within the bands 1980-2010 MHz and 2170-2200 MHz;
- At least 2x30 MHz in the bands 1900-1980 MHz and 2110-2170 MHz are made available for UMTS by 1 January 2002;
- Further spectrum could be made available for UMTS from the above-mentioned bands subject to market demand.

The UMTS Forum has requested that the full 155 MHz for terrestrial services in the UMTS Core band shall be available by 2005. The Forum has furthermore pointed out that at least 2x40 MHz will be needed in 2002 if infrastructure competition shall be possible.

6.4.2 Extension and refarming bands

The locations of the extension bands for UMTS require further studies. Such studies have started within ERO and have to be pursued vigorously. The demand for new spectrum in 2010 is, according to the calculations, 165 MHz for full mobility applications in Extension band 1, and 20 MHz for low mobility applications in Extension band 2, when all refarming possibilities are used.

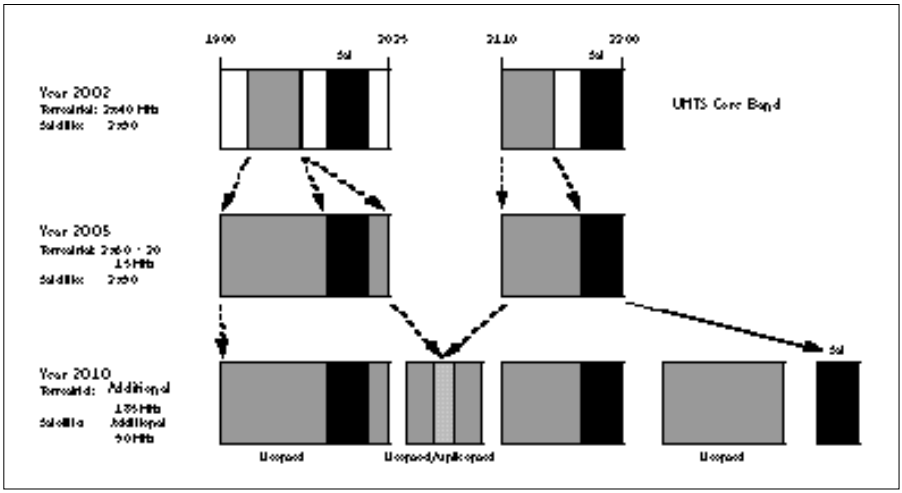
The existing spectrum designated for the second generation mobile services (such as GSM 900 and GSM 1800) may be refarmed and integrated into the allocations for UMTS, if both the licensed operator and the national regulator agree. It is the expectation that refarming of the existing mobile bands will occur as a result of market forces rather than being enforced by regulation. The attractiveness of UMTS services to the users and the advantages of improved spectrum efficiency for the existing operators should naturally stimulate the changes when the market is ready.

6.4.3 Timely availability of spectrum

Figure 6.4 shows as an example the possible spectrum allocation for the years 2002, 2005 and 2010. The figure shall not be taken as a suggestion for where the extension bands can be found. The Core band designation is based upon the draft ERC Decision on UMTS. The UMTS Forum has requested that the full 155 MHz for terrestrial services in the Core band shall be available in
2005, and has further calculated a need for new spectrum of 185 MHz in 2010. For satellite services, the Forum requests that the full 60 MHz in the Core band shall be available in 2005. It is estimated that in the order of 30 MHz more will be needed in 2010.

It is very important that all the CEPT countries, and especially the 15 EU countries, make frequency spectrum for UMTS available according to the decision of the ERC.

Figure 6.4: Possible UMTS frequency spectrum allocation



There will be no decision upon candidates for Extension band 1 before WRC '99, and it remains open if Extension bands 2 could be regionally designated to UMTS at an early date, shortly after start of commercial operations.

6.4.4 Conclusions

The UMTS Forum has calculated the total demand for terrestrial spectrum in 2010 to be 580 MHz. For terrestrial services in Europe, 240 MHz are defined for second generation standards. The Forum has earlier concluded that the full 155 MHz for terrestrial UMTS designated by the ITU should be made available. To meet the UMTS market forecast an additional 185 MHz is required.
The calculated spectrum demand for the satellite component of UMTS is 50 MHz by 2005 and 90 MHz by 2010.
The UMTS Forum calls upon the relevant authorities to take timely action to make sufficient spectrum available for UMTS to satisfy market demand.

For the start-up in the year 2002, each terrestrial operator will need in the order of 2x20 MHz to enable the provision of multimedia services. It is therefore recommended that at least 2x40 MHz then will be made available to provide competitive services.

There is a need to designate an additional 20 MHz as start-up band for non-public non-licensed in-building low mobility systems. This spectrum will be required from the year 2002 to help build the market for multimedia terminals and to stimulate a demand for public UMTS access.

6.5 Segmentation of the UMTS spectrum

6.5.1 Transmission modes

The current view of the segmentation of the UMTS environment stems from the UMTS Task Force, which essentially portrays UMTS as having cellular, cordless, satellite, Wireless Local Loop (WLL) and Radio Fixed Access (RFA) components. From the UMTS Forum's point of view, the two last environments are characterised by low or no mobility requirements.

It is expected that for technical reasons the wide area cellular UMTS environments will need to use Frequency Division Duplex (FDD) transmission. The same is true for the UMTS satellite environment. However, the question of whether some or all of the other UMTS terrestrial environments could use Time Division Duplex (TDD) transmission does have significant implications for spectrum usage.

FDD requires exclusive paired bands and spectrum for such systems is therefore hard to find. The FDD spectrum will remain a scarce resource. On the other hand, TDD can make use of individual small sub-bands that do not need to be mirrored for the return path, and hence spectrum is more easily identified. Furthermore, TDD readily satisfies the requirement for asymmetric transmission, by allocating more transmission time in one direction than in the other. The release of TDD spectrum can be done more individually between various countries than FDD spectrum, which would ease the problem of finding enough UMTS spectrum. Perhaps most short-range UMTS should be TDD, even that used by the traditional cellular operators for high-capacity microcells. Ideally, the entire terrestrial UMTS spectrum should be useable in either mode, and the modes should be able to coexist. Therefore, the hand-over capabilities between FDD and TDD components might be central to the success of UMTS.

It can be argued that TDD low mobility, indoor and microcell applications all form parts of a generic cordless applications group which would offer bit-rates up to 2 Mbit/s. Similar technology could be used for all cordless applications areas, thus these UMTS environments can, for spectrum purposes, be considered together.

6.5.2 Conclusions

It is accepted that the terrestrial wide-area and the satellite environments will need to use FDD transmission in paired sub-bands. There are however ways that this type of transmission might be combined with short range TDD transmission, or with other forms of transmission, in order to prevent traffic asymmetry decreasing the efficiency of spectrum use. It is therefore important that there are no regulatory barriers to such combinations.

In order to ensure excellent levels of spectrum efficiency, and indeed to facilitate the task of finding more UMTS spectrum, the regulatory and standards environments for UMTS should encourage new and innovative combinations of different transmission modes.

6.6 Increased spectrum efficiency

6.6.1 Introduction

A significant element of the UMTS vision is the need to achieve a major improvement in spectrum efficiency compared to that already being achieved for second generation mobile systems. The increases in spectrum efficiency will need to be found from four major sources:

- radio transceiver technology, including access technology, modulation and coding, adaptive interference management, diversity techniques, and smart antenna technology;
- applications and services technology, including the use of packet transmission, asymmetry management, compression techniques and agent technology;
- traffic management, especially via the use of delay management and tariffs to manage peak-to-mean traffic ratios;
- radio channel access management, i.e. the management of instantaneous access to the spectrum, to reduce the probability of idle channels during peak traffic hours.

The two first points are entirely dependent on the choice of technology which is done by ETSI, and these are therefore not in the regulatory field. The third point is in the commercial field and should not be regulated either.
In the context of the last point, it has been suggested that the sharing of a common pool of spectrum by operators might be a method of significantly improving spectrum efficiency, thereby minimising the overall demands for spectrum for UMTS. In this scenario, a pool of spectrum would be available that could be accessible to the various operators according to their current traffic demands. The idea of operator spectrum sharing was formally raised by ERO . The UMTS Forum has examined the topic from technical, regulatory and commercial viewpoints.

6.6.2 Technical considerations

Sharing the same frequency spectrum between several operators could result in a higher trunking efficiency and savings in guard bands. However, these savings do not take into account the airtime overheads which arise during call set-up, clear-down, handover, etc. These overheads will not diminish due to spectrum sharing; on the contrary, the additional complexity of operating with shared spectrum may significantly increase the overheads. This could negate much of the perceived advantage of operator spectrum sharing.

The technical problems associated with operator spectrum sharing are likely to be significant. It would be especially difficult to control the quality and interference environments of a particular network, which are important factors in competitive differentiation. Dynamic channel allocation, with radios that seek interference-free channels in completely independent networks, is probably not the solution to this problem.

These technical problems lead to thoughts about synchronisation of networks or shared radio infrastructure. A logical further step is the single spectrum access operator which would provide radio access across the entire spectrum using one set of base stations, and which would then sell air-time to the mobile network operators. From the spectrum efficiency point of view, this may be seen to offer some benefits, but the need to ensure fair and equal spectrum access by all mobile operators means regulatory and contractual restraints on individual operators. This might negate many of the sharing benefits.

The sharing of spectrum between terrestrial and satellite UMTS networks will not generally be feasible, due to the expected wide differences in received power flux density and transmitted power levels between the terminals operating in these systems. Therefore, it will be necessary to make separate spectrum allocations for terrestrial and satellite UMTS networks. However, feasibility of spectrum sharing between the UMTS satellite down-link component and indoor, unlicensed use should continue to be studied.

6.6.3 Commercial considerations

An operator's revenue is approximately proportional to the spectrum available. Therefore, the access to a larger pool of spectrum would certainly be attractive to operators. To build a business case, UMTS operators must however be certain about the spectrum to which they have uninhibited access. One possibility is to give each operator a guaranteed minimum number of channels. This will reduce the spectrum efficiency advantage.

For the remaining free pool of spectrum, the operators will try various methods to attract users to their own networks. Operators may be reluctant to invest in radio hardware for this spectrum if there is no real certainty that the additional channels would be available when needed. Should they improve quality or services, or increase the number of base stations, then this is consistent with higher spectrum efficiency, but the cheapest way is to increase transmitter power levels. The commercial drivers may therefore lead to network developments that lower spectrum efficiency. This is in contrast with the situation in their own spectrum assignments, where the commercial drivers make them increase the capacity of the network and as a consequence also the spectrum efficiency.

One method of spectrum sharing is to allow users access to several or all of the operators in the same region. In this way, the users share the spectrum instead of the operators. While this method avoids some of the commercial problems of other sharing methods, technical and commercial problems remain. The user terminals have to ensure that the spectrum is efficiently utilised, which might increase the airtime overheads, and operators have to compete for users on a call-by-call basis. It is not yet clear if a stable market situation with investment incentives can be achieved in this situation.

6.6.4 Regulatory considerations

Access by many operators to a common pool of spectrum will necessitate detailed regulation to prevent domination of the pooled resources by any single operator. Regulation will also be necessary to prevent operators from investments in technology that will diminish other operators' possibilities to use the spectrum. It is probable that the regulatory constraints will reduce the potential for spectrum efficiency gains.

6.6.5 Conclusions

The sharing of spectrum raises many questions from technical, commercial and regulatory points of view. While the present system of exclusive spectrum allocation encourages the operators to invest in infrastructure that improves system coverage and spectrum efficiency, the UMTS Forum believes that sharing a common pool of spectrum could be a significant disincentive for operators to maximise their spectrum efficiency. No definite conclusion can yet be drawn and this question has to be studied further in order to find the most commercially viable means of maximising spectrum efficiency.

The UMTS Forum considers that the licensing of UMTS spectrum cannot for the present be based on the concept of imposed spectrum sharing. However, licences should allow operators to agree on spectrum sharing on economical grounds and on their capability to guarantee quality of service to subscribers.

The feasibility of sharing spectrum between satellite down-link bands and indoor unlicensed applications should be studied, provided that the satellite services are not constrained in the satellite bands. Such studies should not delay the initial release of spectrum for UMTS.

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7. STANDARDISATION OF UMTS

7.1 GSM success factors

The experience of the GSM success factors should be taken as a guide in the standardisation of UMTS, but recognising that the regulatory situation is different. The main GSM policy embraced the following:

Standardisation activities comprising
- open system standardisation to allow world market volumes for terminals and networks,
- harmonisation of services, charging, accounting principles and operational procedures to allow world-wide roaming,
- co-ordinated type approval of mobile stations, one specification, one conformance test and mutual recognition.

The early setting of strategic targets (in 1982) for
- voice and non-voice services including international roaming,
- quality,
- authentication and encryption,
- cost of terminals and infrastructure,
- viability of hand portables.

Close co-operation between operators, regulators and manufacturers in defining requirements, priorities, resolving conflicts and preparing standards, including
- early spectrum designation,
- early implicit licensing of operators,
- commitment of operators to procurement,
- commitment of operators to open service at an agreed date.

Efficient documentation production process:
- definition of requirements through ETSI and the GSM-MoU,
- efficient production of technical standards by ETSI and the Project Team,
- operational and commercial procedures elaborated by the GSM-MoU.

7.2 The standards path : Technical, operational and commercial

Communication systems like UMTS which are designed for large numbers of terminals and widely deployed infrastructure, and which allow roaming between all networks, require a considerable number of standards in two areas:

- technical standards to be elaborated and agreed in ETSI,
- operational and commercial standards agreements to be elaborated by a forum of interested operators.

These standards must provide the necessary degree of core detail but must also allow flexibility in their application to different business scenarios and to the technical and network planning requirements of different operators.

These standards must be developed in phases, to allow a rapid specification of the necessary elements, see also figure 1.1. The most obvious short-to-medium phases are

- freezing the basic parameters of UMTS by end of 1997,
- UMTS Phase I standards by end of 1999 (including the global system definition),
- evolution of UMTS in annual steps after Phase I.

UMTS must be defined as a unified set of standards. It must provide a substantial contribution to global standards, such as the ITU Recommendations for IMT-2000 (FPLMTS), and possess a strong global market potential.

A unified set of standards with open interfaces for all external interconnections and for key internal network functionality will provide a stable framework for UMTS development and quick implementation. The set of standards must have a modular structure to enable long-term evolution of services and systems.

This will limit development risk, be responsive to emerging market requirements and maximise returns to manufacturers from development expenditure. It will create a competitive environment where users can change operators and allow both choice and purchase confidence.

The decisions on key items of the UMTS should be made in ETSI. Only in this way can the necessary spectrum efficiency and systems interworking be guaranteed. The big market success of single standards like AMPS, TACS and NMT for analogue systems and GSM and PDC for digital systems show that this is also in the interest of the users.

7.3 Interfaces to other networks

UMTS will co-exist and will need to interwork with a number of existing networks supporting numerous subscribers, and which may be operated by other licensed operators, as well

as with private networks. All of these interfaces need to be considered when defining the UMTS standards and regulatory framework.

Beside the prime task to standardise the UMTS Radio Interface, ETSI is standardising the interfaces between the Generic Radio Access Network and other networks, both for existing networks such as GSM and ISDN/IN, and for emerging networks such as B-ISDN/IN and other UMTS/IMT-2000 networks. The definition of these interfaces should include mobility management functions, in order to enable roaming.

One network of special importance for UMTS is the Internet. Internet will provide UMTS with a mass market user base for various data and multimedia applications. Mobile access to the Internet will be one of the early volume applications that will support the growth of UMTS use. Therefore the interface towards Internet and other networks using the Internet Protocol (IP) will be of crucial importance for UMTS.

UMTS will not be a limited number of detailed standardised telecommunication services, but will have a toolkit for assembling in a flexible way bearer capabilities and service logic for forming services which suit the specific requirements of different users. In order to provide a rich variety of multimedia content based services, UMTS networks must provide access for a new class of independent service providers, innovative content providers and service brokers.

7.4 Global compatibility

The Forum recognises that third generation systems have a global dimension and it is essential that the European perspectives are recognised in the formulation of international standards. Likewise, the needs of the global community must be incorporated into UMTS.

The process of standardising third generation mobile systems has gone furthest in Japan. The Japanese standards body ARIB has started such a standardisation project, strongly supported by the biggest Japanese operator NTT DoCoMo. This operator has in parallel ordered prototypes for a test system, based on wideband CDMA technologies, from a number of companies, Japanese as well as European and American companies. The prototype equipment for the test shall be delivered already in the spring of 1998, and tests will be performed till the end of 1999. The test results will be fed into not only the Japanese standardisation process but also the ITU process. Commercial operation of such a system is planned for the year 2000.
The USA standardisation process has just started, but is driven with the highest speed. The res-

ponsible body for mobile standardisation, TIA, has within its committee TR 45.5 established a working Group IV dealing with wideband CDMA technology based on IS-95. Also European companies take part in the WG IV. A strong US lobbying activity is going on within the Pan-American organisation CITEL to get support for an American wideband CDMA solution to IMT-2000. Also Japanese authorities are lobbied.

UMTS is standardised by ETSI as a true third generation service/system with evolution paths from GSM, ISDN and DECT. UMTS will be a member of the IMT-2000 family. It is intended to specify roaming with other members of the IMT-2000 family based on market needs and business viability. Also commonalties between the different systems should be furthered. The objectives for UMTS shall be the implementation of real third generation mobile services and systems that must be a substantial step forward from existing second-generation capabilities, be receptive to new mobile system techniques and have a capability to meet new and evolving market requirements.

The facilitation of global terminal mobility and global services interworking can be seen as the primary objectives for IMT-2000 Recommendations. The Forum encourages regional and national standards bodies to co-operate towards the establishment of interworking between second-generation (digital) mobile systems world-wide.

It is understood that European national delegations to the ITU are normally headed by representatives from CEPT Member Administrations. Accordingly the Forum believes it is essential that national positions in the ITU should reflect and support the views of ETSI. The technical standardisation work in ETSI on UMTS is key in supporting the European activities in relation to ITU's IMT-2000. The advice of ETSI and its members should also be sought in preparing Europe for the ITU World Radio Conferences.

7.5 Conclusions

As has been mentioned in section 6.1.1 and in section 7.3, it is of considerable importance that ETSI is entrusted with the task to define all the standards to be used in the UMTS frequency bands identified by ERC. Only equipment that conforms to the ETSI standards for UMTS shall be allowed in the UMTS terrestrial frequency bands. The terrestrial service licences should explicitly mention UMTS as standardised by ETSI.

The UMTS frequency spectrum, as identified by ERC, shall be reserved for systems using UMTS as defined in standards adopted by ETSI.

8. REGULATORY ASPECTS

The future regulatory regime for UMTS should establish a stable environment for the telecommunications sector where the user gets access to new and innovative services and where the market actors are given the incentives to invest and develop new services.

The telecomms industry as a whole believes that telecommunications-specific regulation will only be necessary in the short term, in order to accommodate market changes in passing from a monopoly environment to a totally competitive market. However, in particular due to the expected convergence of telecommunications and broadcasting services towards UMTS, this view is not shared by all National Regulatory Authorities.

It can be assumed that the regulatory framework under which UMTS will operate will increasingly rely upon competition law, both competition law specific to the various countries inside or outside Europe, and competition law founded on the relevant articles in the Treaty on European Union.

However, in the short term sector specific regulation will be in place and has in certain cases to be adapted to the characteristics of wideband mobile systems such as UMTS. This section of the report covers some of the key policy and regulatory points affecting the implementation of UMTS.

8.1 Current regulatory environment in the European Union

8.1.1 Licensing rules

for telecommunication services are found in the

- 97/13/EC European Parliament and Council Directive on a common Framework for General Authorisations and Individual Licences in the field of Telecommunications Services (Licensing Directive).

The rules in this directive are of relevance also for the licensing of UMTS services.

8.1.2 Interconnection policy

of relevance to UMTS is addressed in the following EU directives:

- European Parliament and Council Directive on the application of open network provision (ONP) to voice telephony and on universal service for telecommunications in a competitive environment (Voice Telephony Directive),
- European Parliament and Council Directive on Interconnection in Telecommunication with regard to ensuring Universal Service and Interoperability through application of the principles of Open Network Provision (ONP) (Interconnection Directive).
- Draft Notice on Application of telecom rules to telecom access agreements.

The main legal basis for the conclusion of commercial network interconnection agreements between UMTS operators is assumed to be the Interconnection Directive. The fundamental principle of this directive is to allow any-to any communication within the EU, i.e. to ensure that any user is able to communicate with any other user on a public network or to access any publicly available telecommunications service, at the appropriate level of interoperability.

The key concepts of the directive are:

- the right to interconnect,
- the obligation to interconnect,
- the possibility to impose and harmonise technical conditions and the use of standards.

In order to stimulate the transition from the past monopoly situation (in particular in the voice telephony market) to full and effective competition, the directive defines "significant market power" and imposes specific additional obligations on operators with such a power. The obligations include non-discrimination, transparency, proportionality and cost-orientation in their interconnection agreements. In this respect, the Interconnection Directive is complementary to general competition law.

The Draft Notice mentioned above supports the same basic principles as the Interconnection Directive. It will cover not only the public networks and services but all types of networks providing telecom and multimedia services.

8.1.3 Infrastructure sharing

is treated in the 90/388/EEC Service Directive as amended by the 96/2/EC Directive on mobile and personal communications, the 96/19/EC Full Competition Directive, and in the Interconnection Directive.

The Mobile Directive calls for the abolition of restrictions on the provision and use of the self-provision of infrastructure and/or the use of third party infrastructure. The Directive provides for Member States to lift restrictions on operators of mobile and personal communications systems with regard to sharing of infrastructure. It affirms that "such restrictions on the provision and use of infrastructures constrain the provision of mobile and personal communications services by operators from other Member States and are thus incompatible with art. 90 in conjunction with art. 59 of the Treaty".
The Interconnection Directive recognises that an "agreement for collocation or facility sharing shall normally be a matter for commercial and technical agreement between the parties concerned." Certain infrastructure sharing arrangements, particularly those involving shared ownership, may require notification to the European Commission under Article 85 procedures.

8.1.4 Conformance assessment and the free circulation of equipment

have been dealt with by the European Union in a number of actions, starting with the 91/263/EEC Directive on mutual recognition of the total type approval process, including placing on the market and putting into service of telecommunication terminals, and extending to satellite equipment with Directive 93/97/EEC, followed by the co-operation agreement between the EC and CEPT in 1993.

The European Radiocommunications Committee (ERC) has adopted a Decision on the "free circulation of radio equipment in CEPT member countries", which covers free circulation and use of radio equipment fulfilling specified criteria. The ERC has also approved a Recommendation in June 1996, subsequently amended in September 1996, on the "Free Circulation and Use of Land Mobile Satellite Service Terminals in Europe".

8.1.5 Frequency planning and assignment

are tasks for the National Regulatory Authorities. They co-operate on the harmonisation of frequency assignment within the ERC, which decides on the designation of common frequency bands for European services.

8.2 Licensing

8.2.1 Elements of UMTS systems

UMTS systems may be composed of several elements for which authorisations are required:

- the fixed network, including fixed radio links,
- the terrestrial mobile network, including fixed radio links and low mobility applications,
- the satellite network and its earth stations,
- basic services such as bearer data services and voice telephony,
- value added services, complementary services and services not offered to the public,
- terminal equipment.

8.2.2 Provision of services

The Forum believes that the optimum benefits for the user will be created through a competitive UMTS environment where advanced and innovative
services are provided over competing infrastructure in a multiple operator and multi-player content and service provision marketplace. Europe's competi-tiveness depends upon getting **the right mix between the experience of the existing industry players and competition from new entrants.**

It is likely that UMTS will differ significantly from existing second generation systems in the area of services and content provision. In second generation systems, service provision normally relates to the resale of air-time with only limited value added services. However, in the case of UMTS, a more appropriate model is likely to be the Internet where the market has seen a proliferation of competing service providers offering a range of products over both fixed and mobile telecommunications networks. A similar scenario is envisaged for UMTS where multimedia services may be offered by a number of service providers with the added benefits of the higher data rate capabilities of the access networks.

UMTS will thus encourage a rich variety of competing content creators, content providers and service providers. Service and content players will benefit from fair commercial access to networks. In such a competitive environment, industry specific regulation of the structure of this value chain is likely to drive up costs and inhibit innovation. The Forum believes that fair

commercial access to networks and market forces will lead to the development of services by independent service providers in addition to any services offered by network operators. The regulatory framework should not seek to impose an artificial industry structure in this value chain. Examples of market-driven service creation are already evident in the Internet environment and it is envisaged that a similar solution within UMTS will offer cost benefits to subscribers and stimulate the development of innovative services.

The establishment of the networks which will carry UMTS services will encourage value chain players to invest in the development of products and services for the UMTS environment. The timely licensing of operators will therefore be key in order to encourage the development of the value chain.

8.2.3 Co-ordination of the licensing of UMTS systems

The elements of a UMTS system may be provided by different entities (operators and service providers) which must be authorised to provide the service or network. The Licensing Directive provides in its annex an exhaustive list of conditions for general authorisations and individual licences.

The basis for licensing UMTS services should be the Licensing Directive. No additional licensing regime at European level is considered necessary for licensing of UMTS.

There is a need for operators to be confident that they will receive a UMTS licence in order to invest in the development and specification activities for UMTS. Similarly manufacturers need to see a commitment to UMTS on the part of operators so that they are confident of a significant market for UMTS equipment.

Regulators therefore need to make known the licensing regime for UMTS and operators need to be identified before the end of 1998.

Wherever possible the National Regulatory Authorities should make the UMTS licensing regime known during 1998 and operators should be identified before the end of 1998.

If a UMTS system requires several authorisations at the same time, co-ordination should be organised. Co-ordination may be established either at national or European level.

- At the national level, harmonisation of licensing conditions and procedures will simplify co-ordination which will be restricted to the management of procedures between authorities in

charge of telecommunication affairs and those in charge of radio affairs. It will be more complicated if such a co-ordination also involves broadcasting authorities.

- At the European level, co-ordination procedures already exist for the licensing of some services such as the One-Stop-Shopping procedure (OSS). The OSS, mentioned in the Licensing Directive, has already been established by the European Telecommunications Office (ETO) on behalf of NRAs for a first group of services (bearer data services, value added services and services not provided to the public). OSS may progressively be extended to other telecommunication services including radiocommunications, and will commence with VSAT services.

The OSS type of licensing procedure should help expedite the licensing of UMTS where more than one country is concerned. However, licensing of scarce resources cannot be done this way.

8.2.4 Coverage

A coverage requirement is a very important licensing condition due to the significance of the issue when establishing business plans. The problems of UMTS coverage is touched upon in section 8.4. Coverage of a certain part of a territory or a population can be reached by several means for which quality of services and bandwidth can differ. If terrestrial coverage obligations are linked with service quality and bandwidth capacity, it may create heavy constraints.

Coverage conditions for terrestrial UMTS components, if imposed, should consider the constraints of technology. In areas where terrestrial coverage is not economically or technically viable, UMTS services may be provided over satellite components.

8.2.5 Selection process

Selection is justified only if all applicants cannot be authorised due to the limitation of scarce resources such as frequency spectrum. Therefore selection can only be made on certain parts of a UMTS system which use frequency spectrum or any other scarce resource. Any selection process must be fair and transparent.

The selection process may differ for each type of UMTS component. Two main types of selection procedures can be employed:

- auction or competitive bidding,
- comparative bidding.

In both types of selection process, the applicants may be required to satisfy certain minimum entrance requirements as to their ability to set up and run such a service.

The relative advantages and disadvantages need to be carefully considered before deciding on the procedure for a selection process. One aspect of such a process is its influence on spectrum pricing. Properly designed and applied spectrum pricing would encourage operators to maximise the spectrum efficiency of their systems to reduce spectrum cost overheads and encourage them not to hoard spectrum.

Too high spectrum pricing would add to the operators cost and lead to higher tariffs and reduce the number of users. Spectrum prices may also have implication for the market for UMTS equipment. If spectrum prices are higher for UMTS than for competing technologies, then the UMTS technology may become more expensive compared to what other competitors can offer. Therefore, the impacts on the competitiveness of UMTS standards when enforcing higher spectrum efficiency than other international standards have to be studied carefully.

Properly designed auctions provide certainty, stability and security of tenure for the winners. Auctions also have the advantage that they are transparent and the winning criterion is objective, which can prevent possible legal challenge. Comparative bidding can cause difficulties when there are more applicants for licences than the spectrum can support. Auctions are an effective means of determining the market value of the spectrum.
Among the negative aspects of auctions, if not properly designed, is that they more easily lead to excessive spectrum pricing. Another negative aspect is the possible fragmentation of the coverage and problems in roaming that may be the result of a spectrum auction. This is particularly serious for a satellite system. The access to spectrum for use by satellite is subject to international regulations in the ITU, in addition to any national regulation. If however a selection process for the satellite component of UMTS is to be considered, auctions may be inappropriate due to the pan-national nature of satellite coverage.

It is for the NRAs to determine which selection process to adopt, within the framework of the Licensing Directive. However, a decision to impose very high prices for UMTS spectrum usage, which may be motivated by fiscal reasons and the scarcity of spectrum, will have adverse effects on market success. This will mean higher tariffs and would be against the best interests of the end users.

If spectrum pricing is introduced for UMTS frequencies, it is important that this pricing does not hinder the uptake of UMTS services.

8.3 Interconnection

8.3.1 UMTS telecommunications industry structure

The spectrum demands of UMTS necessarily limits the number of infrastructure operators for any given geographic region. This has been shown in chapter 6. In chapter 5 it has been discussed how the costs of UMTS infrastructure set against the expected revenue streams will determine the number of economically viable operators in any given geographic region. In some regions the number of viable operators may, especially in the early phase, be very few. However, the need for extensive UMTS terrestrial coverage is recognised as a valid regulatory and consumer requirement.

The value chain associated with UMTS will be considerably different from that of both traditional fixed and cellular networks:

- Content providers will be of increased importance in the UMTS chain.
- UMTS offers the possibility for innovative added value services. New service providers will enter the market, and it is not unlikely that they too will gain importance.
- Broadcasters could be involved in some UMTS applications.
- Other new players, such as IT systems suppliers, will be key players in a UMTS environment.

As mentioned in chapter 4, this new value chain presents opportunities and will sometimes lead to vertical integration (one company operating the whole chain) and/or horizontal concentration (companies getting significant market power in specific parts of the chain). This complicates the notions of signi-ficant market power and dominant market position.

8.3.2 Increasing interconnection requirements

The complexity and multimedia character of UMTS increase the required service functionality of the interconnection. Obviously, this means higher service interoperability requirements. Downloading software to terminals can considerably reduce the problem in a terminal-server connection. The problem remains, however, in the case of terminal-terminal connections, although it should be possible to introduce "negotiated" protocols, as with faxes or modems.

As mentioned in chapter 7, UMTS will co-exist and will need to interwork with a number of existing public networks supporting numerous subscribers, and which may be operated by other licensed operators. Further, UMTS will have to interwork with private networks. Mobility

management will become an important part of the service interoperability functions. Such functions may include:

- subscriber location within UMTS and between UMTS and other mobile, fixed and private networks,
- roaming within UMTS and between UMTS and other mobile private networks,
- hand-over in a call within UMTS and even between UMTS and other mobile and private networks (such as GSM or DECT).

The regulatory regimes of existing networks must be taken into account when the regulation for UMTS is considered. This means that the specialised regulatory regime for satellite communication must also be taken into account, especially when viewed from a global perspective.

Clearly the more complex value chain associated with UMTS will result in many new relationships between players, beyond those covered by the Interconnection Directive. However the Forum considers that where competition law is well developed it will ensure appropriate relationships, and that in these circumstances it will not be necessary to create additional sector specific regulation.

8.3.3 Conclusions

The interconnection directive as a basis for future regulation

The basic principles laid down in the Interconnection Directive require interconnection between public networks to ensure any-to-any communication at the appropriate level of interoperability. These principles are also a valid basis for UMTS interconnection, i.e. interconnection between different public UMTS networks, as well as the interconnection between public UMTS networks and other public networks.

The UMTS Forum considers that no further regulation for UMTS interconnection is required.

Self-regulation of interconnection requirements

The UMTS Forum considers that the regulatory control of the UMTS interfaces and interconnection requirements should be minimised. Self-regulation, within the framework of the Interconnection Directive, (such as was observed for the GSM MoU) is deemed preferable, provided that workable competition is achieved.

This would apply in particular to the following domains:

- agreed service level (inclusive of mobility management) and service interoperability,
- support for roaming and handover,
- accounting principles,
- interconnect standards,
- the "grey area" in between or overlapping regulation and standardisation.

It may later be necessary to adapt the current regulation, both for interconnection within UMTS and for interconnection between UMTS and other networks, in order to reflect the UMTS standardisation.

8.4 Infrastructure provision

8.4.1 Introduction

It is important to ensure that, where possible, there is competition in infrastructure provision by establishing parallel networks. Such an environment encourages a rich variety of service innovations and user propositions. However, as was mentioned in chapter 5, the economic aspects of UMTS are likely to be different from earlier generations of networks with regard to the different business environment established by mobile infrastructure competition. In addition, there may be constraints with respect to the availability of spectrum resources. Therefore, it will be important for the success of UMTS that the regulatory environment should not present barriers to infrastructure sharing or national roaming between networks

8.4.2 The problem of coverage

Earlier in this report, in chapter 5, it has been shown that the business case for a UMTS system may be weak in areas of low population density. This is analogous to the comparison between GSM 900 and GSM 1800, where the cost of additional cell sites resulting from just the increase in frequency, results in a doubtful business case in some less densely populated areas. With UMTS, the situation will become even worse since in some areas the higher bit-rate will reduce the working range of a terminal.

In addition to the economic constraints relating to the numbers of cell sites, there will also be challenges regarding the capacity requirements of the associated transmission links. Some

existing cellular network operators rely heavily on microwave and millimetric radio systems but the high bit rates required by future UMTS services will place heavy demands on frequency resources. The limited spectrum resources will further add to infrastructure costs, particularly where more costly cable or leased line connectivity may be the only alternative.

The consequence will be problems with unprofitable areas which may result in poor coverage for the terrestrial network in general. It is however recognised that the satellite component of UMTS can provide service to areas which cannot be economically covered by the terrestrial component, albeit at a higher end user cost and a somewhat lower service level. Operators may also find difficulties in communicating the diverse levels of service to the users.

8.4.3 Consequences on regulation

UMTS high speed services will be provided by the terrestrial network in office environments and densely populated areas. There are also likely to be areas with medium population density with sufficient market potential to support one network, but insufficient to support several networks. In such areas the regulatory regime should give priority to the objective of supporting the maximum provision and roll-out of the service, in preference to the aim of maintaining competition in infrastructure provision. The NRA may even want to secure coverage in certain regions by imposing coverage obligations in the licence. Then it is important that the regulatory environment promotes realistic investment opportunities. Therefore non-competitive co-operation with regard to the provision and use of infrastruc-ture between otherwise competing operators will make it possible to have high-speed UMTS services in some areas with medium population density and UMTS coverage in rural areas.
There are several possibilities for cost sharing between operators. Infrastructure sharing is one possibility and this could involve not only the sharing of physical radio sites but also the radio resource itself. This has been elaborated in chapter 6. Other options include commonly owned rural networks or licences combined with national roaming arrangements.

There is a very strong business logic for the sharing of infrastructure. This logic applies to the radio part but may also apply to the wire component of UMTS. Sharing implies agreements between separate entities, either to jointly take responsibility for infrastructure in a given area or for one of them to take responsibility for the infrastructure in a given area, the use of which is then shared between the parties.

Agreements of this type may fall under Article 85 of the Treaty of Rome and require notification to the European Commission or other relevant competition authority, especially if the agree-

ments to share infrastructure are between parties that are dominant in the same or a related market. Further, it is conceivable that the Commission could impose conditions on the parties to the infrastructure sharing agreement. One such condition may be that membership of a network consortium should not be denied to any service provider meeting a minimum set of standards.

In view of the above economic scenario, it is essential that the network infrastructure already developed by the second generation (GSM) operators is taken into account. These operators are in a position to provide, particularly during the early development of UMTS, a GSM-based overlay offering voice and low data rates covering large geographic areas. This could complement higher tier services provided in areas of medium and dense population supported by multi-mode user terminals. In such a case, there would be significant benefits in choosing a technology offering backward compatibility and co-existence with GSM. It is therefore important that existing GSM 900 and GSM 1800 operators are allowed to participate in the deployment of UMTS in addition to any new players who may be able to develop viable UMTS services.

When defining the regulatory regime, a number of aspects should be taken into account:

- National differences will exist with respect to demography and maturity of the marketplace and this may justify different arrangements with respect to the provision of parallel infrastructures or sharing arrangements between operators.
- Any proposed cost sharing should preferably be arranged in such a way that it does not eliminate the possibilities for all of the involved operators to build up a market share in any part of the aggregated coverage area. The regulatory regime should not prevent such arrangements.
- The need for co-operation between competing parties is a function of time; as the market matures, the unprofitable areas will gradually decrease. The regulatory regime should therefore permit arrangements which allow for gradual reduction of the extent of co-operation between operators.
- The actors in the marketplace should be allowed to seek their own solutions for co-operation. The agreements between operators could be notified to the NRA, or the NRA could choose to intervene only when found necessary.
- Existing network infrastructure should be utilised as a back-up where possible, particularly in the more sparsely populated areas; this means that GSM 900 and GSM 1800 operators should not be excluded from the UMTS licensing process.

8.4.4 Satellite services

Mobile satellite services are likely to play an important role in the universal delivery of UMTS services, and the definition of UMTS clearly identifies a satellite component alongside the more widely recognised terrestrial component. It is highly unlikely that satellites will ever

match the hand-held performance of its terrestrial counterpart in terms of capacity or power consumption, and its limited in-building penetration will restrict its usefulness in the urban office and domestic environment. However, satellite services are likely to be fully integrated into the overall UMTS environment and their role will be to provide users with direct global access to UMTS services, even in remote land or ocean areas where terrestrial coverage is just not economic or possible.

Satellite UMTS will also enable UMTS technology to become global and expand well beyond Europe. It is therefore important that the regulatory environment will not present any barriers to the integration of UMTS satellite services.

8.4.5 Co-operation with broadcasting companies

Co-operation with broadcasting companies could to some extent change the technical prerequisites for wideband communications. Such co-operation could, for instance, include the use of high-power Digital Audio Broadcasting (DAB) transmitters as part of the overall UMTS service with the possibility of providing high-speed downlink data services in certain areas. This potential need for asymmetry in terms of high data rates on the down-link has already been identified in other UMTS studies. Another possibility would be Digital Video Broadcasting (DVB), also called digital TV, currently discussed in many countries.
A similar possible development is that mobile UMTS operators could adopt the DAB technology for broadcasting/narrowcasting type services, possibly even in the 800 MHz band. The realism of this development is difficult to assess at the present stage. However, in general there has been separation between the regulatory environments for broadcasting and mobile telecommunications and there is therefore a need for interactions between the regulatory regimes to be carefully considered. The regulation of broadcasting content should be kept separate from regulation of transmission in order to enable such an interaction.

8.4.6 Conclusions

In general, it is important to ensure that competition exists in the provision of infrastructure in the network components of UMTS in order to provide the associated benefits to users. In some cases, however, either infrastructure sharing or national roaming arrangements, or a combination of both, may be necessary.

With regard to infrastructure sharing, current European regulation does not prevent this from taking place, provided that the sharing is open to all interested participants. Conflicts with

competition law may occur if closed clubs of participants are formed. In addition, from 1997, community legislation prevents NRAs from putting additional restrictions on the sharing of infrastructure. However, based on the arguments discussed in this paper, especially the sensitive UMTS business case, the following issues should be taken into account in developing the future regulatory environment:

In general, the UMTS licensing processes should ensure that there is competition in infrastructure provision. For economic reasons there may be a need to consider infrastructure sharing or roaming between networks. The regulatory framework should not present barriers to such arrangements if they do not have negative impact on competition between operators.

Existing second generation networks can provide the terrestrial foundation infrastructure from which UMTS networks can evolve. Therefore, the existing mobile operators should not be excluded from the UMTS licensing process.

There should be no regulatory barriers to the integration of different technologies (terrestrial and satellite systems) and services (telecommunica-tion services and broadcasting services) from the telecommunication, satellite and broadcasting fields, subject to spectrum and network constraints.

8.5 Free circulation of equipment

8.5.1 Introduction

Current experience is based on the application of Directive 91/263/EEC to terminal equipment for systems such as GSM 900 and GSM 1800. This has revealed a need for improvements of the type approval regime for mobile terminal equipment. Some examples of this are:

● With complex systems some inaccuracies have been found with the TBRs concerned. These could be such that the test carried out is incorrect, does not test the core requirement or is meaningless .

In such cases it is essential that the type approval test be modified as quickly as possible. A rapid change procedure is required which has not so far been possible.

● It is not clear how the type approval of accessories to terminal equipment covered by the Directive should be handled. Presently, this is treated differently by different type approval authorities. It can be difficult to decide what is an accessory requiring type approval.

● New and innovative features are not always covered by the relevant TBR. As with complex systems, a rapid maintenance procedure for the type approval requirements is required.

● As mobile systems develop in parallel, the possibility of dual mode mobile stations becomes more apparent. Typical examples today could be GSM 900/GSM 1800 and GSM/MSS terminals. It is not clear how such stations should be tested.

Such deficiencies, together with the rate of change in telecommunication markets and technology, indicate that a flexible regulatory regime needs to be defined, to enable innovative technologies to penetrate the market, encourage industry to benefit from a mutual recognition agreement environment, and take into account the new elements of liberalisation, and the need for a flexible decision-making process. This is further encouraged by the fact that manufacturers are increasingly implementing quality assurance systems, and the fact that the standardisation process can be lengthy when new network types emerge and require quick development.

From the following classes of essential requirements, it should be identified which should apply to UMTS equipment:

● prevention of misuse of network resources causing a degradation of services to other than the user, his called or calling party,
● interworking via networks and portability between network termination points in cases where the Council has declared that there should be a Community-wide availability,
● effective use of spectrum allocated to terrestrial/space radio communication and used for radio services,
● features for the disabled,
● features for the emergency and security services,
● protection of individual privacy.

In this context it should be noted that CEPT/ERC is expected to adopt certain measures to facilitate the free circulation of UMTS terminals within the CEPT member countries

8.5.2 Impact of the future CTE Directive

Working toward a new regulatory regime, the Commission has issued a draft of a future Connected Telecommunication Equipment (CTE) Directive which will replace the Terminal and Satellite Directives. Considering the short time available to review the draft, the Forum's comments are of an initial nature and further input will be forthcoming during the development of this directive.

The main features of the Draft CTE Directive are:

- an enlargement of the scope of equipment covered by the inclusion of radio equipment,
- a difference between radio equipment and other terminal equipment in terms of requirements for placing on the market,
- a scope covering placing on the market, free circulation of equipment and right to use equipment,
- a set of new definitions making the directive future-proof by taking into account the liberalisation of infrastructures and competition between operators,
- a development of the concept of telecommunications-specific essential requirements to take into account technological trends,
- a flexible decision-making process whereby future network infrastructures and systems can readily be covered,
- a light conformity assessment regime based upon the principle of manufacturer's declarations.

It appears that the actual regulatory requirements for placing on the market will be significantly reduced. The actual requirements for UMTS equipment need to be clarified at an early stage.

The development of the CTE Directive will need to take into account all of the problems encountered with the current regime as detailed above and a number of other issues which arise from the global nature of UMTS. These are in particular

- the development on a global scale of mutual recognition of requirements for placing on the market, free circulation and use of UMTS equipment, the possible imbalance in trade resulting from a too liberalised market in Europe compared with other countries, where it is relatively easy for manufacturers outside Europe to access the European market while European manufacturers cannot easily access other markets.

8.5.3 Free circulation and use of satellite equipment

Users and potential users in some countries have encountered different types of restrictions on the use of mobile satellite terminals. Some of these barriers are as follows:

- **Prohibitions on use.** Some countries prohibit any use of mobile terminals. Some countries may permit use only in exceptional circumstances (such as for disaster relief or emergencies) or in particular geographic areas.
- **High licence fees.** In some countries the annual licence fee is several thousand dollars, in some cases three times the cost of the mobile terminal itself. Even among CEPT countries, there are cases where licence fees exceed the cost of the mobile earth stations.
- **High customs duties.** In some non-EU countries, customs duties may be 50 or 60 per cent of the cost of the equipment. One country charges customs duties of 108 per cent of the value of the equipment. Some countries demand customs duties even if the mobile terminal is in the country for only a few days.
- **High taxes.** Value added and other taxes may add up to 25 per cent or more to the cost of the equipment and use.
- **Regulatory difficulties.** Some countries have limited numbers of staff to deal with the needs of mobile terminal users or a lack of regulatory procedures which can cause delays in commissioning and/or licensing of equipment and/or service providers.
- **Additional type approval.** Some countries require equipment to be tested, certified or type approved domestically even though the equipment has received type approval in other countries or meets internationally recognised standards, such as those of the ITU or the European Telecommunications Standards Institute (ETSI).

Reasons for barriers

The reasons some countries restrict use of mobile satellite terminals will generally be one or more of the following:

- **Concerns about bypass.** The country is concerned that terminal users will bypass the national terrestrial network and thus result in a loss of revenues for the national operator.
- **Security.** The country fears that drug smugglers, car thieves or other criminals may use mobile terminals to avoid detection. However, if a criminal intends to break the law, he will do so anyway. On the other hand, security forces will be better equipped if they can use mobile terminals, especially in areas where there is no other means of communications.
- **Radio frequency interference.** The country may have some users, such as the military, who are using

the same or adjacent frequency bands as those used for the mobile satellite services. Sharing studies generally show that accommodation is possible between terrestrial and mobile terminal users.

- **Legislative requirements.** The country may need to draft and adopt new legislation in order to allow use of land mobile satellite services.
- **Protectionism.** A few countries seek to protect a domestic satellite operator from international competition.
- **Lack of regulatory policies and staff.** Some countries may not permit the use of land mobile satellite services because they have not yet developed a policy or regulatory framework covering such services or do not have the staff to implement such policies.

Consequences for UMTS

Without regulatory intervention, the above difficulties already encountered with satellite terminal equipment will also apply to the satellite components of UMTS. In addition, there will be free circulation issues concerning multi-band or multi-mode terminals where specific member states have not authorised terminals with particular technologies (or where mutual recognition agreements do not exist for all technology types). Therefore, the Commission should take appropriate action to ensure that these barriers are removed.

8.5.4 Conclusions

Manufacturers and operators need to assess the impact of the likely future change in essential requirements for UMTS terminal equipment compared to GSM.

It is highly desirable that UMTS terminal equipment type approval is recognised on a global scale as a basis for placing on the market, free circulation and use.

It is assumed that a new type approval regime will apply to UMTS terminal equipment. The likely extent of the essential requirements for UMTS terminal equipment will have to be discussed by all parties concerned as soon as possible.

The future regulatory regime should take into account the multi-band/multi-mode terminal development for interworking between second and third generation systems.

The Commission, the Council and the Parliament of the European Union should ensure that there is ample time for the Forum to put forward further comments during the elaboration of the CTE Directive.

8.6 Market access

The most important key success factor for UMTS and for European industry will be access to global markets. The provision of service in and to individual countries and the access that users have to UMTS services within those countries depend on national regulatory authorities adopting an appropriate policy and regulatory framework.

Currently, many countries restrict market access, especially to foreign suppliers. Some countries prohibit the supply of services by other than a single domestic telecom operator. The barriers to market access may be higher for some parts of UMTS than for others. Barriers to market access are particularly notable in the satellite services domain where some countries prohibit or restrict the use of foreign registered terminals. Barriers to market access may take the form of high licence fees for individual mobile terminals, high customs duties and taxes and/or long delays in the bureaucratic processing of licence applications. Still other barriers exist or may exist because, for example, the country has assigned the particular frequency band to other services or because the country has adopted standards for comparable services which are not those adopted by European industry.

However, a number of initiatives have been taken at the international level to improve market access and reduce or remove regulatory barriers.

In the context of the General Agreement on Trade in Services (GATS), the World Trade Organisation (WTO) established a **Group on Basic Telecommunications (GBT)**, which came to a successful conclusion on 15 February 1997. The results included commitments from 69 countries to liberalise markets in basic telecommunications including voice telephony, data transmission services, telex, telegraph, facsimile, private-leased circuit services, satellite services, cellular mobile telephony, personal communications systems, international switching and other international gateway facilities. Participants succeeded in elaborating a set of principles covering matters such as competition safeguards, interconnection guarantees, transparent licensing processes, and the independence of regulators in a common negotiated text called the Reference Paper. The results of the telecom negotiations will be extended to

all WTO Members through most favoured nation (MFN) treatment, which prohibits WTO Members from discriminating among themselves or from treating Members less favourably than any non-Members. Each country will have until the end of November 1997 to put their commitments into effect.

While the 15 February agreement was a big step forward, the level and extent of commitments to liberalise varied significantly from country to country. Furthermore, WTO membership includes only about 125 countries and excludes some important emerging markets such as China and Russia. At this moment, it is not clear to what extent UMTS, as a new technology and service, might be covered by the commitments reached last February.

The European Union could usefully assess to what extent UMTS might be covered by the commitments made within the Group on Basic Telecommunications and take steps in the World Trade Organisation to encourage other countries to permit market access for UMTS services.

While some countries charge customs duties of 50 to 70 per cent of the value of the equipment imported (or even higher; at least one country charges as much as 108 per cent), customs duties constitute a formidable barrier to market access. There are two international organisations concerned about customs duties. One is the WTO, the other is the World Customs Organisation (WCO).

At the WTO meeting in Singapore in December 1996, ministers from 28 countries produced a Ministerial Declaration on Trade in Information Technology Products (also known as the **Information Technology Agreement, ITA**), which covers telecom and information technology products. From July 1997, when the ITA is due to come into force, to the year 2000, customs duties are to be reduced to zero on these products. As of April 1997, 40 countries have signed the ITA and they represent more than 90 per cent of world trade in information technology.

The European Union could usefully take steps to ensure that UMTS products are explicitly covered by the Information Technology Agreement and to encourage more countries to sign the Agreement.

The WCO has developed two international agreements which might cover UMTS products. One is the Istanbul Convention, which binds countries to eliminating customs duties on personal effects and professional equipment carried by visitors. Some industry observers believe that

radio transceivers, including UMTS terminals, could be regarded as among personal effects and professional equipment and thus be excluded from customs duties by signatory countries. Unfortunately, only 12 countries as of April 1997 had signed the Istanbul Convention, although the EU is expected to do so in the near future.

Another agreement adopted by the WCO is the **Professional Equipment Convention**, which has so far been adopted by about 40 countries. That Convention exempts from customs duties equipment used by professionals, e.g., journalists, doctors, relief workers, businessmen, etc.

The European Union should take steps to increase its participation in the World Customs Organisation with a view to adopting the Istanbul Convention and/or the Professional Equipment Convention and to encourage other countries to do likewise and to ensure that UMTS products are covered by one or the other or both agreements.

UMTS will include a satellite component. The issues of type approval and free circulation of satellite terminals were addressed by ITU initiative in the first World Telecommunications Policy Forum in October 1996 which, inter alia, agreed a draft **Memorandum of Understanding on Global Mobile Personal Communications by Satellite (GMPCS-MoU)**, which was finalised in February 1997. The GMPCS MoU covers type approval and marking, licensing, customs duties and traffic data reporting.

It has been suggested that an arrangement similar to the GMPCS-MoU might be suitable for UMTS terminals. The arrangement within the GSM MoU offers another model, where operators from more than 100 countries have become members. This may offer a more flexible and suitable example than an MoU where government are members. This question merits further studies.

The European Commission is, rightly, not satisfied with the pace of progress in opening markets and enabling free circulation of mobile terminals. It has prepared an EU Action Plan on Satellite Communications in the Information Society, which was made public in March 1997. The EU Action Plan says the European Commission intends to take further measures aimed at overcoming regulatory barriers within the EU, CEPT countries and indeed around the world. The EC's actions promised in the EU Action Plan should also be helpful for deployment of and improving market access for the UMTS satellite component.

The European Union should take a proactive role in ensuring that barriers for free circulation of mobile terminals are removed, preferably well in advance of the deployment of the first UMTS systems, and that the scope of its actions concern the terrestrial component as well as the satellite component of UMTS.

The European Union should present to countries around the world a set of measures, agreed with operators, manufacturers and service providers, aiming at encouraging adoption of a policy and regulatory framework conducive to the availability of UMTS services and equipment.

8.7 Necessary prerequisites for UMTS

A number of scenarios can be formulated where UMTS will not be able to fulfil its intended role. Apart from competing technologies, UMTS can be threatened by shortcomings in the European regulatory environment:

- Frequency spectrum will not be available in sufficient quantity or in a too fragmented manner;
- Frequency spectrum will be too expensive to allow for the service market to develop;
- Standards will be established too late and incorrectly specified;
- The regulatory framework may be too uncertain to give incentives for the necessary significant investments in a UMTS technology;
- The harmonisation of rules between countries may be insufficient, giving too small possibilities for roaming and economies of scale;
- Regulatory barriers are set between narrowband and wideband systems, preventing effective interworking and roaming;
- With the expectation that mobile multimedia will be a major user requirement for UMTS, then a high degree of co-operation and co-existence must be established with the market growth for multimedia on fixed networks, where this demand is currently being established. UMTS will need to build on the market growth of this segment and on the user demands for mobility from the mobile segment.

9. RECOMMENDATIONS

In order to reach the described market opportunity, the following recommendations are intended to advise policy makers on the optimal way forward to ensuring the success of UMTS in Europe The success of UMTS will depend on many factors, of which the most important will be spectrum availability, cost, coverage and quality. Competition between various standards will be fierce and UMTS will have to prove itself in this competitive environment.

UMTS networks will support a host of new service providers and independent content creators, in a similar way to the Internet. Today's airtime resellers will be joined by a new breed of "value adding" service providers who will come from market environments as diverse as telecommunications, entertainment, utilities, publishing, retailing, banking. As a result, competition for subscribers, and their revenue, will be intense at these levels.

To achieve this will require the establishment of a "virtuous circle". Spectrum, standards and regulation are the key enabling factors. Getting the framework for these right will enable sustainable, high competition and lead to a wide range of attractive services. In turn, this may require more spectrum.

The essence of UMTS is to enable a new end-user proposition which provides ubiquity and universality of services, and which cost effectively accommodates the shift over the coming decade from real-time voice to data and multimedia services, requiring higher bandwidth. Third generation systems, regulation and spectrum licensing economics must accommodate and enable a new cost profile to meet the emerging user demand.

9.1 Spectrum

Spectrum for UMTS needs to be

- adequate, which means in the order of 2x20 MHz per licensee. With minimum two licensees in any given geographical area this means a total minimum of 2x40 MHz by the year 2002,
- available early to allow both technical and market trials,
- available for full use in time. At least the Core band as identified in the ERC Decision on UMTS needs to be fully available across Europe, even if extension bands may be specific to individual countries,
- available at a price that is fair and does not discriminate against UMTS services.

Recommendation 1

The UMTS Forum has calculated the total demand for terrestrial spectrum in 2010 to be 580 MHz. For terrestrial services in Europe, 240 MHz are defined for second generation standards. The Forum has earlier concluded that the full 155 MHz for terrestrial UMTS designated by the ITU should be made available. To meet the UMTS market forecast an additional 185 MHz is required.
The calculated spectrum demand for the satellite component of UMTS is 50 MHz by 2005 and 90 MHz by 2010.
The UMTS Forum calls upon the relevant authorities to take timely action to make sufficient spectrum available for UMTS to satisfy market demand.

Recommendation 2

For the start-up in the year 2002, each terrestrial operator will need in the order of 2x20 MHz to enable the provision of multimedia services. It is therefore recommended that at least 2x40 MHz then will be made available to provide competitive services.

Recommendation 3

There is a need to designate an additional 20 MHz as start-up band for non-public non-licensed in-building low mobility systems. This spectrum will be required from the year 2002 to help build the market for multimedia terminals and to stimulate a demand for public UMTS access.

Recommendation 4

The UMTS Core band, as identified in the ERC Decision, Extension band 1 and Refarming bands shall be used mainly for full mobility applications. Extension band 2 may be used also for low mobility applications, and for fixed applications outside regions with high traffic density.

Recommendation 5

In order to ensure excellent levels of spectrum efficiency, and indeed to facilitate the task of finding more UMTS spectrum, the regulatory and standards environments for UMTS should encourage new and innovative combinations of different transmission modes.

Recommendation 6

The UMTS Forum considers that the licensing of UMTS spectrum cannot for the present be based on the concept of imposed spectrum sharing. However, licences should allow operators to agree on spectrum sharing on economical grounds and on their capability to guarantee quality of service to subscribers.

Recommendation 7

The feasibility of sharing spectrum between satellite down-link bands and indoor unlicensed applications should be studied, provided that the satellite services are not constrained in the satellite bands. Such studies should not delay the initial release of spectrum for UMTS.

9.2 Standards

UMTS standards need to be

- established by ETSI according to a timetable that allows commercial deployment at the latest by 2002,
- established, if possible, in a co-operation with other standardisation organisations in order to avoid unnecessary technical differences,
- compatible with other major standards of the IMT-2000 family in order to enable roaming and interworking.
- established in harmonised frequency bands, starting with the UMTS Core band.
- defined to allow the possibility of use in existing mobile bands.

Recommendation 8

The UMTS frequency spectrum, as identified by ERC, shall be reserved for systems using UMTS as defined in standards adopted by ETSI.

9.3 Regulatory environment

The regulatory environment, including the licensing regime, should be stable and encourage competition. Some elements are therefore needed, already from the start:

- an obligation to interconnect UMTS networks with other telecommunication networks;
- an obligation to ensure interoperability of applications on a agreed minimum level;
- freedom to share sites, infrastructure and facilities, to combine services and operate throughout the value chain;
- harmonised licensing conditions in different countries;
- consistency with regulation in other related markets such as entertainment and broadcasting, so that services in these environments can converge;

Recommendation 9

The basis for licensing UMTS services should be the Licensing Directive. No additional licensing regime at European level is considered necessary for licensing of UMTS.

Recommendation 10

Wherever possible the National Regulatory Authorities should make the UMTS licensing regime known during 1998 and operators should be identified before the end of 1998.

Recommendation 11

Increased competition will come from the commercial development of the market roles in various organisations. Any proposed licensing regime should not preclude the integration of different roles within a specific organisation, provided that this does not prevent any competitive opportunities.

Recommendation 12

Coverage conditions for terrestrial UMTS components, if imposed, should consider the constraints of technology. In areas where terrestrial coverage is not economically or technically viable, UMTS services may be provided over satellite components.

Recommendation 13

If spectrum pricing is introduced for UMTS frequencies, it is important that this pricing does not hinder the uptake of UMTS services.

Recommendation 14

The UMTS Forum considers that no further regulation for UMTS interconnection is required.

Recommendation 15

The UMTS Forum considers that the regulatory control of the UMTS interfaces and interconnection requirements should be minimised. Self-regulation, within the framework of the Interconnection Directive, (such as was observed for the GSM MoU) is deemed preferable, provided that workable competition is achieved.

Recommendation 16

In general, the UMTS licensing processes should ensure that there is competition in infrastructure provision. For economic reasons there may be a need to consider infrastructure sharing or roaming between networks. The regulatory framework should not present barriers to such arrangements if they do not have negative impact on competition between operators.

Recommendation 17

Existing second generation networks can provide the terrestrial foundation infrastructure from which UMTS networks can evolve. Therefore, the existing mobile operators should not be excluded from the UMTS licensing process.

Recommendation 18

There should be no regulatory barriers to the integration of different technologies (terrestrial and satellite systems) and services (telecommunica-tion services and broadcasting services) from the telecommunication, satellite and broadcasting fields, subject to spectrum and network constraints.

Recommendation 19

It is highly desirable that UMTS terminal equipment type approval is recognised on a global scale as a basis for placing on the market, free circulation and use.

Recommendation 20

It is assumed that a new type approval regime will apply to UMTS terminal equipment. The likely extent of the essential requirements for UMTS terminal equipment will have to be discussed by all parties concerned as soon as possible.

Recommendation 21

The future regulatory regime should take into account the multi-band/multi-mode terminal development for interworking between second and third generation systems.

Recommendation 22

The Commission, the Council and the Parliament of the European Union should ensure that there is ample time for the Forum to put forward further comments during the elaboration of the CTE Directive.

9.4 Other government initiatives

Whilst this report shows there is a substantial and growing market for UMTS services, a further spur to its growth could also be provided by government initiatives making use of mobile multimedia. Such initiatives could include, for instance, making government databases available 'on-air' as well as 'on-line', and encouraging Intelligent Transport Services and Electronic Commerce to embrace the capability offered by UMTS.

Within the field of access to other markets, there are a number of actions the European Union can undertake to remove barriers to the use of UMTS beyond Europe.

Recommendation 23

The European Union could usefully assess to what extent UMTS might be covered by the commitments made within the Group on Basic Telecommunications and take steps in the World Trade Organisation to encourage other countries to permit market access for UMTS services.

Recommendation 24

The European Union could usefully take steps to ensure that UMTS products are explicitly covered by the Information Technology Agreement and to encourage more countries to sign the Agreement.

Recommendation 25

The European Union should take steps to increase its participation in the World Customs Organisation with a view to adopting the Istanbul Convention and/or the Professional Equipment Convention and to encourage other countries to do likewise and to ensure that UMTS products are covered by one or the other or both agreements.

Recommendation 26

The European Union should take a proactive role in ensuring that barriers for free circulation of mobile terminals are removed, preferably well in advance of the deployment of the first UMTS systems, and that the scope of its actions concern the terrestrial component as well as the satellite component of UMTS.

Recommendation 27

The European Union should present to countries around the world a set of measures, agreed with operators, manufacturers and service providers, aiming at encouraging adoption of a policy and regulatory framework conducive to the availability of UMTS services and equipment.

ANNEXES :

Annex 1

Milestones for UMTS

1 October 1997	ERC Decision on UMTS Core band.
30 November 1997	UMTS additional frequency spectrum demand put on the agenda of WRC '99.
	Suggestions for UMTS regulatory framework from the EC.
31 December 1997	Identification of candidates for additional UMTS frequency spectrum (Extended band, approximately 185 MHz).
	Regulatory framework for UMTS defined, including spectrum licences for Phase 1.
First quarter 1998	ETSI freezing of basic UMTS parameters.
	Operators identified; drafting of licences.
Second quarter 1998	Operators commitment.
31 December 1999	WRC '99 Recommendation on UMTS Extended band.
	ETSI UMTS Phase 1 standard.
1 October 2000	ERC Decision on additional UMTS frequency spectrum.
Year 2001	Pre-operational UMTS trials.
Year 2002	Partial availability of UMTS Core band.
	Commercial UMTS operation.
Year 2005	Availability of full UMTS Core band.
Years 2008 - 2010	Availability of UMTS Extended band

Annex 2

Satellite Market

One objective of the UMTS vision is to extend UMTS services universally to all environments in which users may be personally mobile. Studies have shown that users will demand services in all environments and all locations to which they travel or roam. As terrestrial UMTS infrastructure is not expected to be able to offer services in all environments or geographical locations, due to speed of roll-out and economics, then users, in such areas, will be able to be satisfied by UMTS via satellite. Satellite UMTS services will be offered in all geographical locations immediately from day one of UMTS introduction.

Demand for UMTS satellite services will be driven by the expectations created by terrestrial services (i.e. users of UMTS services will expect services to be available in all areas in which they are mobile). It is not expected that satellite UMTS users will constitute a mass market in themselves.

Environments in which satellite will need to provide UMTS services include:
- rural "vehicular" (e.g. trains, cars), pedestrian (mobile or portable) and fixed,
- remote "vehicular", pedestrian and fixed,
- maritime (e.g. ships, boats) and aeronautical (e.g. planes),
- localised "terrestrial" base station (e.g. on trains or buses)
- any other locations where terrestrial UMTS services are not yet available.

Studies have shown that multimedia services demanded by business users operating in these environments (and served by satellite) are mostly the asymmetric applications such as LAN access, file transfer and Internet WWW. These studies also showed:
i) that these users' requirements were for applications to be delivered at rates up to 144 kbits/s, which is consistent with the wide-area data rates of the UMTS vision, and
ii) that voice remained as a key service along side the multimedia services.

The trend in personal communications is towards ever smaller terminal size and portability. However, the inevitable mismatch between size and technical limitations leads to users being prepared to accept some trade-offs between size/portability and functiona-

lity/capability. It is likely that UMTS services delivered via satellite with fall into two differing terminal types. One will provide services limited to voice and low speed data but incorporating dual mode (terrestrial/satellite) into a handheld terminal. The other will provide full UMTS multimedia services to the minimum wide-area data rates but with a slightly less portable terminal than a handheld (which will also be capable of acting as a base station providing handheld services in a localised area). In the case of dual mode handsets, the UMTS network will search first for a terrestrial signal and if this is not available, then it will automatically switch to satellite.

Pricing of services will be a key factor in the growth of UMTS. Pricing of satellite UMTS services will be higher than for terrestrial UMTS due to the inherent cost base of satellite service provision. However, the difference in price would be relatively proportional to that between current terrestrial mobile and fixed line communications.

Forecasts for UMTS satellite services are summarised as follows:

The demand for UMTS satellites services will follow a similar "S-curve" take-up as in terrestrial UMTS forecasts.

World-wide users (millions)a

	2005			2010		
Type	Business	Non-business[b]	Total	Business	Non-business[b]	Total
Handheld voice &low speed data	2[c]	1	3	5[c]	2.5	7.5
Multimedia	1	0.5		1.5	2	13
Total	3	1.5	4.5	7	3.5	10.5

Notes: a Forecast users do not include potential terrestrial replacement situations, i.e. where satellite is used to create a hub/base station to provide localised terrestrial area. It also excludes provision of temporary service to terrestrial infrastructure. As demand will exist in both situations; then the number of forecast UMTS satellite users could be considerably more than indicated above.

b Satellite UMTS users will be primarily business users. As such, non-business users have been calculated at 50% of the forecast business users to allow for satellite price sensitivity impacts.

c Forecast of UMTS satellite handheld users assumes that UMTS becomes the de facto global standard and that handheld satellite terminals which are non-UMTS standard are excluded.

World-wide Traffic (Business only - no attempt has been made to quantify non-business related satellite UMTS traffic):

(Millions)	2005		2010	
Service Category	Mbytes/year	Minutes	Mbytes/year	Minutes
Voice	400	1.700	600	6.100
Low speed data (~9.6 kb/s)	500	800	700	3.800
Asymmetric applications e.g. LAN/Database access and Internet WWW (9.6 kb/s up to 144 kb/s)	1900	500	3000	1.900
Interactive Multimedia e.g. videoconference (144 kb/s)	200	50	300	200
Total	3000	3.050	4600	12.000

EU 15:

The demand for UMTS satellite services within the EU15 countries will be limited in the long term, as it is likely that most countries will complete terrestrial UMTS coverage on par with second generation digital cellular services, forecast at less than 5% of overall world-wide UMTS satellite services. However, as this forecast excludes potential terrestrial replacement situations and temporary service ahead of the roll-out of the terrestrial infrastructure, then the demand will likely be higher than is forecast here.

As UMTS will be introduced starting with the EU15 countries, then potential users in these countries will demand UMTS services to be available immediately in all geographic areas. In this case, satellite UMTS will be able to complement the terrestrial roll-out plans, offering UMTS services via satellite initially, then terrestrial as infrastructure is built.

Annex 3

Vocabulary of Terms

Accounting
A function which apportions the revenue obtained by the service providers to network operators in line with commercial arrangements.

Adaptive terminal
Terminal equipment with the capability of adapting to more than one type of network.

NOTE - Adapting to different networks could be accomplished by using a combination of techniques such as analogue-to-digital/digital-to-analogue conversion, multi-band antennas and/or software radio architectures.

Air interface
The common boundary between the mobile station and the radio equipment in the network, defined by functional characteristics, common radio (physical) interconnection characteristics, and other characteristics, as appropriate.

NOTE - An interface standard specifies the bi-directional interconnection between both sides of the interface at once. The specification includes the type, quantity and function of the interconnecting means and the type, form and sequencing order of the signals to be interchanged by those means.

Air interface protocol
The protocol used across the air interface (usually a collection of protocols supporting various layers of the protocol reference model).

Authentication
The process of verifying the identity of a user, terminal, or service provider.

Base station (BS)
The common name for all the radio equipment located at one and the same place used for serving one or several cells.

Base station area
The area covered by all the cells served by a base station.

Bearer service
A type of telecommunication service that provides the capability for the transmission of information between user-network interfaces.

Billing
A function whereby charging information generated by the charging function is transformed into bills requiring payment. Billing also includes collecting payments from the subscribers.

Broadcasting service
A service where the same message (voice, text, pictures, video or data) is transmitted simultaneously to all users within the radio coverage of the broadcasting transmitter(s) or to a group of several users via wire or cable.

Call
The use, or possible use, of one or more connections set-up between two or more users and/or services.

Capability
The ability of an item to meet a service demand of given quantitative characteristics under given internal conditions.

Cell
The radio coverage area of a satellite spot beam or a base station, or of a subsystem (e.g. sector antenna) of that base station corresponding to a specific logical identification on the radio path, whichever is smaller.

NOTE - Every mobile station in a cell may be reached by the corresponding radio equipment.

Charging
A function, whereby information is gathered, recorded or transferred in order to make it possible to determine and to collate usage for which the subscriber may be billed.

Circuit transfer mode
A transfer mode in which transmission and switching functions are achieved by permanent or quasi-permanent allocation of channels, bandwidth or codes between identified points of a connection. See also Packet transfer mode.

Compatibility
A degree of transparency sufficient to support an acceptable grade of service with respect to a connection between system entities. Full compatibility implies full transparency.

Connectionless service
A service which allows the transfer of information among users without the need for end-to-end call establishment procedures. Connectionless services may be used to support both interactive and distribution services.

Earth station
A station located on the Earth's surface intended for communication with a satellite system.

Emergency service
A telecommunication service, which is used to access a public emergency centre, characterised by a locally significant access number, high priority, and distinctive feature interactions.

Encryption
A function used to transform data so as to hide its information content to prevent its unauthorised use.

Evolution
A process of change and development of a mobile radio system towards enhanced capabilities.

Fixed network service
A service with a set of capabilities that allows service profile management but not any type of mobility.

Fixed-access
A terminal access to a network in which there is a set relationship between the terminal and the access interface. A single "identifier" serves for both the access interface and the terminal. If the terminal moves to another access interface, it assumes the identity of that interface.

FPLMTS / IMT-2000
Those systems that conform to the corresponding series of ITU Recommendations and Radio Regulations.

Freephone
A supplementary service which allows a subscriber to offer a call free of charge to a caller at the subscriber's expense for that call.

Handover
The action of switching a call in progress from one cell to another (intercell) or between radio channels in the same cell (intracell) without interruption of the call.

NOTE - Handover is used to allow established calls to continue when mobile stations move from one cell to another (or as a method to minimise co-channel interference).

Integration
The act or process or an instance of forming, co-ordinating, or blending into a functioning or unified whole.

Intelligent network (IN)
A telecommunication network based on an architecture that provides flexibility for facilitating the introduction of new capabilities and services, including those under customer control.

Interactive service
A service which provides the means for the bi-directional exchange of information between users or between users and hosts.

NOTE - Interactive services are subdivided into three classes of services: conversational services, messaging services and retrieval services.

Interoperability
The ability of multiple entities in different networks or systems to operate together without the need for additional conversion or mapping of states and protocols.

Interworking
The means of supporting communications and interactions between entities in different networks or systems.

Location service
A particular mobility service in which location information can be provided to authorised users or to relevant authorities in case of emergency calls or for vehicular traffic management.

Macro cells
Cells with a large cell radius, typically several tens of km.

NOTES: - The radius of a cell can be extended by the use of directional antennas.
- Macro cells are characterised by low-to-medium traffic density, support for moderate mobile station speeds and narrow band services.
- A typical macro cell may be situated in a rural or suburban environment, with moderate building blockage, and, depending on on terrain, significant foliage blockage.

Mega (satellite) cells
Cells which provide coverage to large areas and are particularly useful for remote areas with low traffic density. Due to their size, mega cells will provide coverage in many kinds of envi-

ronment, from remote to urban, in areas without access to terrestrial telecommunications networks and in developing countries (even in urban areas) where this may be the only cell type available.

NOTE - Currently, satellites can only practically provide mega cell coverage (the term "satellite cell" is sometimes used interchangeably with mega cell); however, it may be possible in the future for satellites to provide macro cell coverage.

Messaging service
An interactive service which offers user-to-user communication between individual users via storage units with store-and-forward, mailbox and/or message handling (e.g. information editing, processing and conversation) functions.

Micro cells
Cells with low antenna sites, predominantly in urban areas, with a typical cell radius of up to 1 km.

NOTES: - Micro cells are characterised by medium-to-high traffic density, low mobile station speeds and narrow band services.
- Blockage by man-made structures may be significant in a micro cell environment.

Migration
Movement of users and/or service delivery from existing telecommunication networks to new networks.

Mobile Satellite Service (MSS)
A radiocommunication service:
- between mobile earth stations and one or more satellites, or between satellites used by this service; or
- between mobile earth stations by means of one or more satellites.
This service may also include feeder links necessary for its operation.

Mobile service
A service with a set of capabilities that allows some combination of terminal mobility and service profile management.

Mobile station (MS)
A station in the mobile service intended to be used while in motion or during halts at unspecified points.

Mobility manager
A repository of information and its associated processes accessed by personal mobility management or terminal mobility management.

NOTE - A mobility manager is used for location management, terminal registration and personal registration. A mobility manager is a functional concept which may be implemented in different ways, for example, as a database or in a signalling transfer point.

Multi-band terminal
Terminal equipment with the capability of accessing services using different frequency bands.

Multimedia service
A service in which the interchanged information consists of more than one type (e.g. video, data, voice, graphics). Multimedia services have multivalued attributes which distinguish them from traditional telecommunication services such as voice or data. A multimedia service may involve multiple parties, multiple connections, the addition/deletion of resources and user's within a single communication session.

Multi-mode terminal
Terminal equipment with the capability of accessing services using different radio interfaces and/or techniques.

Network
A set of nodes and links that provides connections between two or more defined points to facilitate telecommunication between them.

Network architecture
A network configuration which identifies and defines physical entities and physical interfaces between these physical entities.

Network operators
A provider of network capabilities needed to support the services offered to subscribers.

Non-fixed access
A terminal access to a network in which there is no set relationship between the terminal and the access interface. The access interface and the terminal each have their own separate "identifiers". The terminal may be moved from one access interface to another while maintaining its unique identity.

Packet transfer mode
A transfer mode in which the transmission and switching functions are achieved by packet oriented techniques, so as to dynamically share network transmission and switching resources between a multiplicity of connections. See also Circuit transfer mode.

PCS system
A collection of facilities which provide some combination of terminal mobility, personal mobility, and service profile management.

NOTE - The term facilities should be understood to include hardware, software, and network components, such as transmission, switching and signalling facilities, databases, etc.

Personal communications service (PCS)
A service with a set of capabilities that allows some combination of terminal mobility, personal mobility, and service profile management.

NOTE - The acronym PCS should be taken to refer to personal communication services.

Personal mobility
The ability of a user to access telecommunication services at any terminal on the basis of a personal telecommunication identifier, and the capability of the network to provide those services according to the user's service profile.

NOTES: -Personal mobility involves the network capability to locate the terminal associated with the user for the purposes of addressing, routing, and charging of the user's calls.

-The word "access" is intended to convey the concepts of both originating and terminating services.

-Management of the service profile by the user is not part of personal mobility.

Pico cells
Small cells with a typical cell radius of less than 50 m that are predominantly situated indoors.

NOTE - Pico cells are characterised by medium to high traffic density support for mobile low speed stations and wide band services.

Privacy
The right of individuals to control or influence what information related to them may be collected and stored and by whom and to whom that information may be disclosed.

NOTE - National laws may apply in matters dealing with the protection of privacy.

Private service provider
A service provider which offers services to a closed group of subscribers, i.e. not to the general public.

Public
An attribute for services and networks accessible to everyone that wants to subscribe.

Public land mobile network (PLMN)
A network established and operated by an administration or Recognised Operating Agency (ROA) for the specific purpose of providing land mobile telecommunication services to the public. A PLMN may be regarded as an extension of a fixed network (e.g. PSTN) or as an integral part of the PSTN.

NOTE - PLMN may comprise terrestrial cells or a combination of terrestrial and satellite cells.

Public network operator
A provider of the network capabilities needed to support the services offered to the general public.

Public service provider
A service provider which offers services to the general public.

Quality of service (QoS)
The collective effect of service performances which determine the degree of satisfaction of a user of a service. It is characterised by the combined aspects of performance factors applicable to all services, such as:
- service operability performance;
- service accessibility performance;
- service retainability performance;
- service integrity performance; and
- other factors specific to each service.

Radio frequency (RF) channel
A specified portion of the RF spectrum with a defined bandwidth and a carrier frequency and is capable of carrying information over the radio interface.
Mission and reception of signals over the radio interface.

Radio resource
A radio resource is a portion of spectrum available in a limited geographical area (cell). This portion of spectrum can be further divided into radio frequency channels.

Robustness
The ability to withstand random errors, burst errors and high bit error ratios over the whole service area.

NOTES: - Robustness of a system is an important attribute.

- The ranking of potential speech/channel codec combinations may be different under good and marginal conditions.

Roaming
The ability of a user to access wireless telecommunication services in areas other than the one(s) where the user is subscribed.

Satellite network
A satellite system and its co-operating earth stations.

Satellite system
A space system using one or more artificial satellites.

Security
The protection of information availability, integrity and confidentiality.

Service
A set of functions offered to a user by an organisation.

Service profile
A record containing information related to a user in order to provide that user with a defined set of services.

Service provider
A person or another entity that has the overall responsibility for the provision of a service or a set of services to the users and for negotiating network capabilities associated with the service(s) he/she provides.

Subscriber
A person or other entity that has a contractual relationship with a service provider on behalf of one or more users. (A subscriber is responsible for the payment of charges due to that service provider.)

System
A regularly interacting or interdependent group of items forming a unified whole technology.

System integrity
The property (in the context of security) that data and the methods of handling the data cannot be altered or destroyed in an unauthorised manner.

Telephone service
A public telecommunication service primarily intended for the exchange of information in the form

of speech, whereby users can communicate directly and temporarily between themselves in conversational mode, and should be provided in accordance with the International Telecommunication Regulations, and the relevant ITU-T Recommendations. Sometimes referred to as POTS.

NOTE - The telephone service can also support a number of non-voice services such as facsimile and data transmission.

Terminal
The equipment which interfaces the end user with a network.

Terminal equipment
A device or functionality which provides the capabilities for user applications, e.g. telephony, including the user interface.

Terminal mobility
The ability of a terminal to access telecommunications services from different locations and while in motion, and the capability of the network to identify and locate that terminal or the associated user.

NOTE - This ability implies the availability of telecommunication services, ideally, in all areas and at all times. Terminal mobility may be provided according to the mobile terminal's or the user's service profile.

Terminal roaming
The movement of a terminal (associated with at least one user) from one cell, location area, area served by one visitor location database, exchange area, sub network or network to another, respectively, while the network keeps track of the terminal's location.

Universal mobile telecommunications system (UMTS)
Future multi-function mobile system with wideband multimedia capabilities as well as present narrowband capabilities. UMTS will probably consist of a family of interworking networks, delivering the same new and innovative personal communication services to users regardless of used networks.

UMTS Access network
Future multi-function mobile access network with wideband multimedia capabilities (presently under standardisation within ETSI) that will interface with several different core networks.

UMTS services
A set of services accessible through the UMTS access network. UMTS services will probably be limited to services that require transmission speeds less than 2 Mbit/s.

Universal personal telecommunications (UPT) service
A service which provides personal mobility and service profile management.

NOTE - This involves the network capability of uniquely identifying a UPT user by means of a UPT number.

User
A person or other entity authorised by a subscriber to use some or all of the services subscribed to by that subscriber.

Value added service provider
A service provider which offers services that add value to other (primitive) services. (A value added service cannot be used alone, i.e. with another primitive service.)

Wireless access
A terminal access to the network which uses wireless technology.

Wireless terminal
A general term used for any mobile station, mobile terminal, personal station or personal terminal, with which non-fixed access to the network is used.

Wireline access
A terminal access to the network which uses wireline technology.

NOTE - For example conventional telephone sets and subscriber lines are means of access to the wireline network.

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