INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

Document 8-1/INFO/1-E
19 November 1997
Original: English only

Received: 17 November 1997

United Kingdom*

UMTS FORUM REPORT ON UMTS/IMT-2000 SPECTRUM REQUIREMENTS

At the last meeting of ITU-R Task Group 8/1 in Toronto the UK undertook to make available to members the UMTS Forum Report on UMTS/IMT-2000 Spectrum Requirements as soon as it was available. Please find attached this report as a contribution to the next meeting of ITU-R Task Group 8/1.

* This contribution has been agreed and developed within the UMTS Forum and is submitted by the UK on behalf of the UMTS Forum.

Report on UMTS/IMT-2000 Spectrum Requirements

UMTS is the proposed European member of the IMT 2000 family.

For World Radio Conference 1997

Source : UMTS Forum

October 1997

UMTS: Universal Mobile Telecommunications System

This report is produced by the Spectrum Aspects Group of the UMTS Forum, an association of telecommunications operators, manufacturers and regulators active both in Europe and other parts of the World that share the vision of UMTS (the proposed European member of the IMT-2000 set of standards) 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 main conclusions and recommendations in the report are supported by 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 Administrations cannot be bound by the detailed recommendations contained in the report.

The report is a major input towards the CEPT/ERC and ITU preparations on further spectrum for UMTS. The report considers the Spectrum Demand and shows the basic assumptions made in the calculations as well as the procedures to get the results. This document is the first report from the Spectrum Aspects Group of the UMTS Forum.

The Forum has identified a requirement in Europe for an extra 185 MHz of spectrum for terrestrial UMTS, and an extra 30 MHz of spectrum of satellite UMTS. This is in addition to the spectrum identified in the ERC Decision on UMTS, which is the CEPT implementation of the WRC 92 FPLMTS allocation. The terms IMT-2000 and UMTS are assumed to be synonymous in this document as UMTS is the proposed European member of the ITU IMT-2000 family concept. It is envisaged that the UMTS standard developed by ETSI will be submitted to the ITU-R as such at a future date. ETSI is the European standards making body charged with developing the UMTS standard, which will be an open standard supported by a large number of manufacturers.

The spectrum estimations in this document are based on the best available market and technical data at this time and are indicative that the question of extra spectrum for IMT-2000 should be placed on the agenda for the WRC following WRC ‘97.

It is hoped that this report will be of interest to all parties interested in the future development of the mobile telecommunications industry, not only in Europe but world-wide.

TABLE OF CONTENTS

1 Introduction

1.1 Background

The UMTS Forum is a non-profit making organisation that was set up in December 1996 to promote a common vision for the development of UMTS and to ensure its success as a world wide radio system. The Forum comprises of over 70 members and includes manufacturers, operators, regulators, the Commission, ETSI, and the CEPT-ERO.

The vision that the Forum shares is of total mobility, total flexibility, just one handset and a single phone number that reaches you whether you are in the office or at home or on the move. In the new information age, beyond the year 2000, mobile telecommunication will be able to deliver more than just voice calls, and low to medium data. They will become multimedia communications devices, that will change the way we live and work, for the benefit of business and individuals alike. To make all this possible however sufficient spectrum will need to be made available globally. We have tried to address the question , "is the WARC '92 allocation is enough?". This report suggests that the requirement for extra IMT-2000 spectrum be placed on the agenda for the next WRC after WRC 97.

This report is intended to help clarify the issues regarding spectrum as perceived by the UMTS Forum Spectrum Aspects Group, which is the sub-group of the UMTS Forum dealing with spectrum issues. The Regulatory Framework report [Ref. 2] made a number of recommendations regarding how much spectrum was required for UMTS and when it should be made available and via what mechanisms. The purpose of this report is to give a more detailed analysis of the spectrum issues. This relates also to earlier studies done in 1996 by the European Radiocommunications Office [Ref. 6]

In the Regulatory Framework report the Forum recommended that the full 155 MHz identified for terrestrial UMTS in the ERC Decision should be made available for UMTS services by the year 2005. It further recommended that an additional 185 MHz be made available to terrestrial UMTS by the year 2010. These recommendations were arrived at by analysing the possible demand for such services and translating this demand into a spectrum requirement. It should be noted that the demand analysis includes services provided by current second generation European services such as GSM 900 & 1800 and DECT, and takes into account the spectrum currently identified to them. The 185 MHz being the difference between the spectrum required for all mobile services and that currently designated. It should also be noted that the number of subscribers after 2010 is assumed to have a penetration of around 70%, rising to 80% by 2015. Although these market projections were based on Europe, it is the Forum's view that these projections are indicative of the world-wide demand for UMTS services.

For Satellite UMTS the Forum has identified a requirement for 50 MHz of Spectrum by 2005 and 90 MHz by 2010. Presently 2x30 MHz is allocated to MSS at 2GHz.

The CEPT is seen as the best route for making the required spectrum available throughout Europe, which is a vital pre-requisite for the success of UMTS. For the global success of IMT-2000 (of which UMTS is the proposed European member) spectrum will be required world-wide, and the best mechanism for that is the ITU.

1.2 UMTS/ IMT-2000 for the User

The world of communications is evolving at an exciting pace, driven by 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/IMT-2000 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 the year 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/IMT-2000 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. IMT-2000 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, IMT-2000 represents a major investment opportunity for the telecommunications industry.

1.3 An Enabling Policy and Regulatory Environment

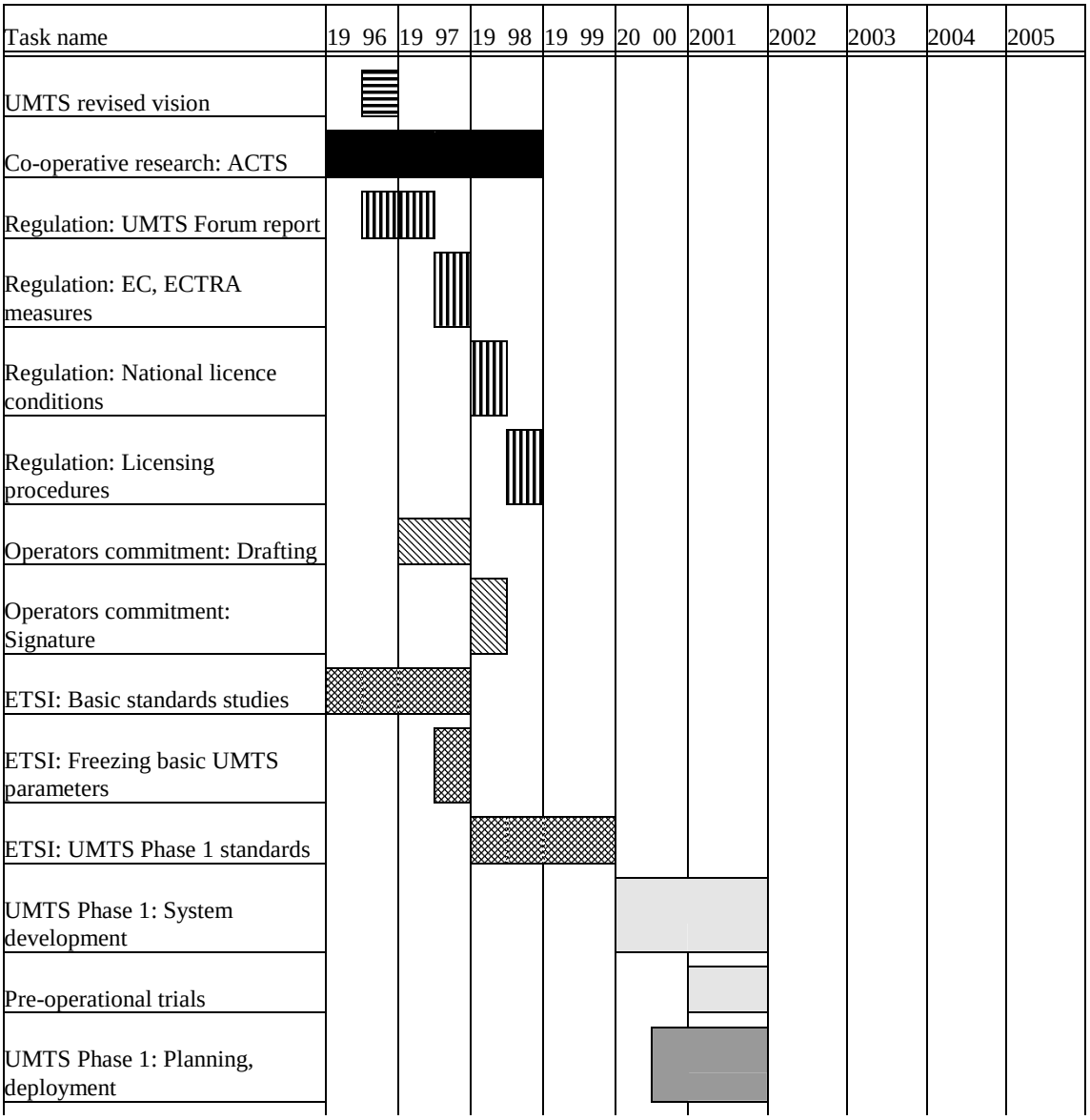
Plans for the licensing (in Europe) of UMTS and for the provision of adequate frequency spectrum should be clear by the end of 1997 in order to reduce the risks and uncertainties for the telecommunications industry and thereby stimulate the required investment by manufacturers and potential operators. Common frequency bands and standards in Europe and globally will also benefit the user, due to economies of scale and a common basis for roaming across national borders.

Major milestones for UMTS in Europe	
1 October 1997	ERC Decision on UMTS Core band.
First quarter 1998	Drafting of licences.
31 December 1999	ETSI UMTS Phase 1 standard.
Year 2002	Commercial UMTS operation.

A more detailed table of milestones for UMTS is shown in Annex 1 and the development schedule in table 1.1.

TABLE 1.1

UMTS Development Schedule for Europe



UMTS Phase 1: Commercial operation							

1.4 Licensing in Europe

The Forum has examined 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.

1.5 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 this report. The Forum has concluded that the full 155 MHz for terrestrial UMTS (Phase 1) 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 UMTS (Phase 2) by the year 2010. It is recognised that careful consideration should be given to the possible transition from second generation systems to UMTS.

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.

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.

1.6 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, and envisages the ETSI UMTS standard being submitted to the ITU selection process for IMT-2000 system.

1.7 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/IMT-2000 systems in a given country. However, these UMTS/IMT-2000 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.

2 UMTS/IMT-2000 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 ITU countries will be in line with the demands of the EU15.

Beyond Europe market prediction by the UMTS Forum has shown a variation in UMTS market demand between different regions of the world. Nevertheless, commonality in spectrum assignments and regulatory conditions is desirable also outside Europe to facilitate global implementation of IMT-2000.

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[Ref. 3]*), 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 Forum 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 these figures the uses of the General Packet Radio System (GPRS) and High Speed Circuit Switched Data (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	

NOTE 1 - A definition of multimedia services are found in Annex 2. In this study also future data services delivered via GSM (GPRS or HSCSD) are counted as multimedia services. Present circuit switched data services in GSM (< 10 kb/s) or short message services are not part of multimedia services.

NOTE 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 in many countries being restricted to low data rate services derived from present GSM technology, offering restricted multimedia services. 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 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 at current 2nd generation levels. 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 Additional Market Areas

The demand for mobile multimedia services and cellular type mobile services is not the whole market for services and spectrum. In particular, there are three other areas where IMT-2000 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 IMT-2000 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.

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.

3 Frequency Spectrum

3.1 General Remarks and Assumptions

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:

3.1.1 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.

3.1.2 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.

3.1.3 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.

3.2 Terrestrial UMTS Spectrum Demand

3.2.1 Introduction

Considering the progress in Europe from year 2000 to 2010 the required spectrum needs for both evolved second generation systems (such as GSM 900, GSM 1800 and DECT) and the third generation system (UMTS) is estimated for the years 2005 and 2010. The estimation comprise both public and private users. The available spectrum for that type of services today consist of 2*35 MHz for GSM 900, 2*75 MHz for GSM1800, 20 MHz for DECT and finally 155 MHz for 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

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.

The estimation model is based on six service characteristics and six operational environments.

The first two parts of this section describe the applied assumptions in the model regarding the penetration of these services and the potential user density. Succeeding parts handle the assumed characteristics of the services and the traffic. The spectrum efficiency and the cell size presumptions are then outlined before the estimation results and additional conclusions are treated in the last part.

3.2.2 Market Forecasts and Penetration

The spectrum estimation is aligned with the predicted growth of mobile subscribers within the 15 EU countries as described by the UMTS market aspects group (MAG). Table 1 shows the market forecasts for the physical mobile subscribers and, out of them, the number of mobile multimedia users (MM) and their assumed penetration rates.

TABLE 3.1

Population of EU 15 and the Penetration of Future Mobile Services

Year	Population in mio	Physical mobile service users in mio	Penetration	Thereof MM service users in mio	Penetration
2005	385	200	0.52	32 (from which 20 use High MM)	0.08 (0.05 for High MM)
2010	387	260	0.67	90	0.23

Corresponding penetration values for mobile subscribers used in the spectrum estimation is 0.6 for the year 2005 and finally 0.75 for the year 2010. The slightly higher penetration values used in the spectrum estimation for mobile subscribers, compared to the figures in table 3.1, are motivated due to the fact that the figures in table 3.1 are average values and some countries (e.g. in Scandinavia) have higher penetration figures. The same penetration values have been used in all operational environments.

Due to the uncertainty regarding multimedia (MM) services the penetration values used in the spectrum estimation are equal to the figures in table 3.1.

3.2.3 Potential user density

The potential user density per operational environment is based on[Ref. 5] and could be seen in Table 3.2.

TABLE 3.2

Potential user density

Operational environments	**Density of potential users/km^2**
1) CBD/Urban (in building)	**180 000**
2) Suburban (in building or on street)	7 200
3) Home (in building)	380
4) Urban pedestrian	**108 000**
5) Urban vehicular	**2 780**
6) Rural in- & out-door	36

Only three of the operational environments (marked in bold in table 3.2) contribute to the required amount of spectrum as they coexist in the same geographical area. In areas with high UMTS spectrum demands fixed and quasi fixed including Wireless Local Loop (WLL) applications would preferably utilise other bands. The spectrum requirements for these applications are therefore not included in the estimates of this report.

3.2.4 Service Characteristics

The definitions of the services are based on same definitions as in the market report from Analysys. Table 3.3 shows the service characteristics.

The speech service corresponds to a 16 kb/s speech codec. The channel coding gives rise to an overhead of 1.75 times the user net bit rate of the codec. The speech service is a typical symmetric service with the same amount of information in the up link (UL) as in the down link (DL). The effective call duration is based on an average call duration equal to 120 seconds multiplied with an occupancy factor of 0.5. This finally ends up with an effective call duration of 60 seconds as shown in table 3.3. The usage of the occupancy factor implies that the system should handle the discontinuous transmission mode.

The simple messaging service corresponds to a SMS look alike service. The user net bit rate of the simple messaging service is based on the assumption that the typical size of a simple message is 40 Kbytes and an "acceptable" delay for this service is assumed to 30 seconds. The final user net bit rate is derived by dividing the obtained relation between the file size and the acceptable delay to get an equivalent continuos user net bit rate. Further on a division is made with a packet efficiency factor of 0.75. The packet efficiency factor is based on consideration of practical packet networks and includes the effects of re-transmission of unsuccessful packets.

The same type of calculations are made in order to find out the user net bit rate for the medium and high MM services. The services are similar to evolved WWW types of services. The typical amount of data that needs to be transmitted for the medium MM service is 0.5 Mbytes during the duration of 14 seconds while the same figures for the high MM service are 10 Mbytes and 53 seconds. Further on the MM services are assumed to be asymmetrical.

The interactive MM service is assumed to be based on a 128 kb/s symmetrical connection. The duration of this service is 180 seconds with an assumed occupancy factor of 0.8 resulting in an effective call duration of 144 seconds.

The switched data is a 14 kb/s circuit connected service type similar to existing data services within GSM.

The signalling overhead, training sequences etc., used for all type of services is 20%.

TABLE 3.3

Service Characteristics

Services	**User net bit rate [kb/s] (1)**	**Coding factor (2)**	**Asymmetry factors (3)**	**Effective call duration [s]**	**Service bandwidth* [kb/s]**
High interactive MM	128	2	1/1	144	256/256
High MM	2000	2	0.005/1	53	20/4000
Medium MM	384	2	0.026/1	14	20/768
Switched data	14	3	1/1	156	43/43
Simple messaging	14	2	1/1	30	28/28
Speech	16	1,75	1/1	60	28/28

* The service bandwidth is the product of columns 1,2,& 3.

3.2.5 Traffic Characteristics

The “busy hour call attempt” (BHCA) in Table 3.4 defines an important part of the traffic characteristics in the spectrum estimation model. The BHCA is here defined as the ratio between the total number of connected calls and the total number of subscribers in the considered area, measured during the busy hour. This traffic characteristic is hard to predict especially for the MM type of services. New services will have different temporal characteristics so that the relative spectrum balance between speech and other services varies through the day. Further on, differentiated tarifs during the day would change the traffic characteristics entirely.

TABLE 3.4

Busy Hour Call Attempt

	2005			2010		
Services	**CBD urban**	**Urban in building**	**Urban on street**	**CBD urban**	**Urban in building**	**Urban on street**
High interactive MM	0.12	0.06	0.004	0.24	0.12	0.008
High MM	0.12	0.06	0.004	0.12	0.06	0.004
Medium MM	0.12	0.06	0.004	0.12	0.06	0.004
Switched data	0.06	0.03	0.002	0.06	0.03	0.002
Simple messaging	0.06	0.03	0.002	0.06	0.03	0.002
Speech	1	0.6	0.6	1	0.85	0.85

Further more the assumed BHCA values for the MM services lack of good comparison material due to the fact that similar charged services do not exist in public use today.

The required spectrum is very sensitive to changes of the BHCA for the MM services in the ”Urban in building” environment. As an example, if the BHCA for the high MM service for year 2010 is doubled in the urban in building environment, *the required spectrum will increase by 200 MHz !*

The interactive MM service, the switched data and the speech services are all circuit connected services with an assumed blocking rate of 0.02. Apart from the 20 % signalling overhead and the packet efficiency factor of 0.75, no extra resources are added to the packet based services (e.g. according to the Erlang B formula) in order to handle situations similar to the blocking.

3.2.6 Cell Sizes and Spectrum Efficiency

The averaged cell radius for the central business district (CBD) is assumed to be 100 m during the whole period. The averaged cell radius for the other two operational environments of significance, (the urban pedestrian and vehicular on street) is around 1 km for the year 2005 and decreased to around 750 m for the year 2010. An average cell radius of 1 km describes an environment where the cell sizes vary from 500 m to 1.5 km. Similarly an average cell radius of 750 m correspond to cell radius between 500 m to 1 km.

As a reference system the spectrum estimation model utilises the GSM spectrum efficiency figures (measured in kb/s/cell/MHz) that correspond to the cluster size 12. The model is based on the use of a spectrum efficiency figure independent of the access technology. Although the calculations are done for a GSM like system, CDMA systems achieve similar efficiency figures. For years 2005 and 2010 the spectrum efficiency corresponds to the GSM system with the cluster size nine. A sectorization of three is assumed for all cell types.

3.2.7 Results

Table 3.5 and Figure 3.6 below show the required frequencies per service in the busy hour for the years 2005 and 2010. Detailed calculation will be described in future reports.

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.

TABLE 3.5

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

NOTE 1- Characterised by high speed data rates, symmetric and reasonably continuous transmission and minimum of delays.

NOTE 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.

NOTE 3 - Already identified spectrum is 395 MHz (70 MHz GSM/E-GSM + 150 MHz GSM 1800 + 20 MHz DECT + 155 MHz terrestrial UMTS).

NOTE 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.

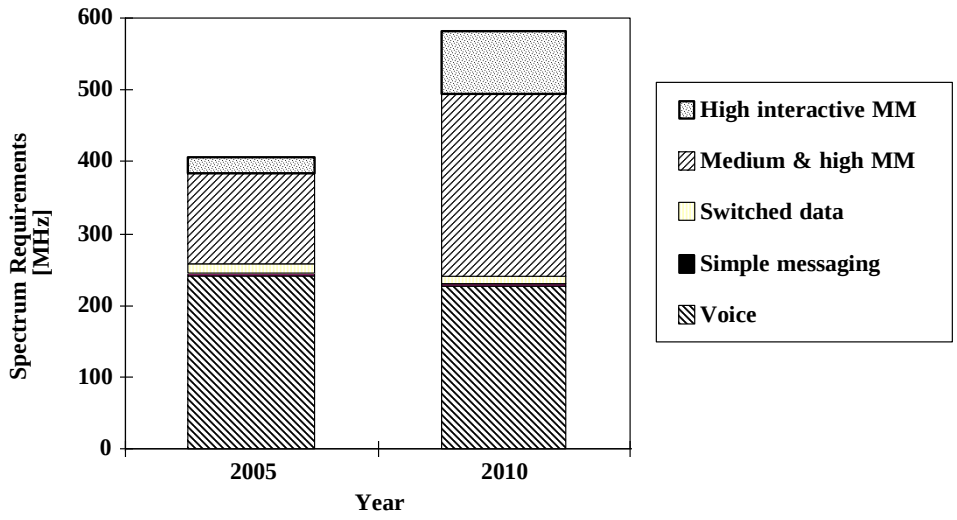


FIGURE 3.6

Required spectrum for terrestrial UMTS services (incl. second generation services) including trunking and guard band overheads.

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 figure 3.6. 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.

The approach adopted in the calculation of spectrum has been to describe the cellular radio network by a nominal cell radius and re-user factor. These parameters have the most impact as their charges have an approximately square law effect on the spectrum estimate. In comparison, reductions in

occupied bandwidth, occupancy factor etc. are essential pro rata. Hence changing the cell radius from 1 km to 750 m and the re-use from 12 to 9 represents an improvement factor of approximately 3, The way in which the future technology improvement factor will build up is difficult to predict but this figure seems to be of the correct order for a spectrum estimation purposes.

3.3 Satellite 3rd Generation Spectrum Demand

Calculations have been made for the years 2005 and 2010. More details will be contained in future Reports. 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 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 the total world demand for UMTS satellite non-multimedia services and 6% of demand for satellite multimedia services. This gives the following traffic demand in the EU:

TABLE 3.7

UMTS Satellite traffic demand 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 non-multimedia users are the initial estimates (based on limited information) of the market for satellite UMTS/IMT-2000 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. The portion of this demand that applies to UMTS services has been used to calculate the spectrum demand in Table 3.8.

The amount of traffic generated by satellite users was estimated based on market research which considered 12 operating environments and 4 different services. 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 above the WRC'92 FPLMTS allocation.

TABLE 3.8

Satellite UMTS/IMT-2000 Spectrum Demand 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 handhold terminals, ICO has predicted a spectrum requirement of 2x85 MHz in 2005 and 2x100 MHz in 2010.

3.4 Spectrum Vision

Spectrum is a limited resource. The considerations for IMT-2000 spectrum have up to now been focused on Europe, and the spectrum situation in other regions may differ, affecting spectrum demand from country to country. Such factors as population density and economic development will be important considerations. The concept in Figure 3.9 could provide a possible solution for a flexible spectrum designation for IMT-2000.

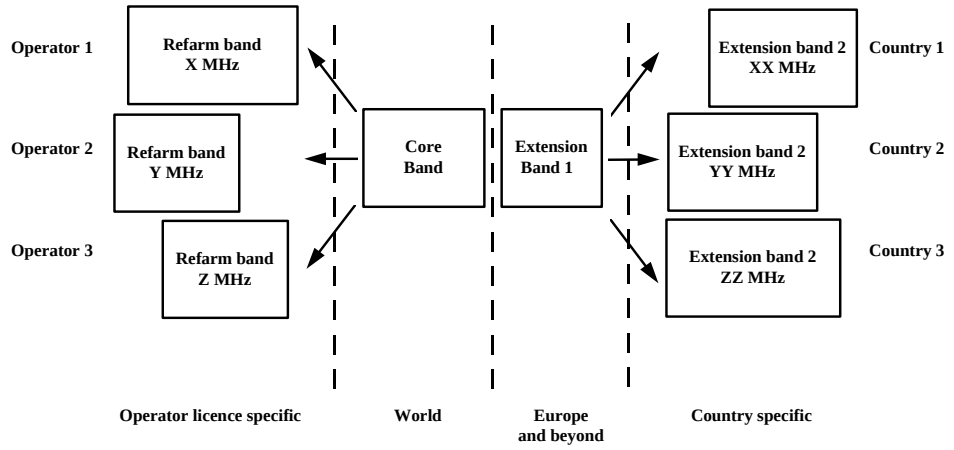


FIGURE 3.9

Spectrum Vision

3.4.1 Core Band

Within the CEPT the core band is given in the 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 considers that no is the time to start the discussion of defining a core band for IMT-2000 which will be available globally.

This core band will be required for full implementation of IMT-2000 services globally. The availability of core band will be a major encouragement to manufacturers to invest the time and resources to develop these new IMT-2000 services, and ensure their global success.

3.4.2 Extension Band 1

Within Europe it is proposed that extension band 1 should be harmonised to cater for the projected demand for UMTS services. To enable IMT-2000 services to be offered globally the Forum believes that further spectrum should be identified by the ITU. The exact spectrum requirement is not yet known. It depends among other things on the feasibility of making frequencies available in the 2 GHz region. Candidates are under investigation within the CEPT.

It would be desirable if the projected increase in demand for 3rd generation services (up to the year 2010) be accommodated in this expansion band. The Extension band 1 should be used mainly for full mobility applications.

3.4.3 Extension Band 2

Extension band 2 may differ in frequency range and size from country to country. Harmonisation throughout Europe or the ITU 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[1]),
- 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.

Extension band 2 could lie between 2 GHz and 3 GHz, or above. It may also be below 2 GHz if extra range s required for some types of services. The band will vary based on the particular market requirements of each country.

The frequency band for non-public low mobility systems should be chosen within the Extension band 2, subject to the market requirements of each country.

3.5 Spectrum Plan

3.5.1 Core Band

The structure of the core band is shown in Figure 3.10. It includes the satellite part with 60 MHz in total. For terrestrial applications, 155 MHz has been identified by the CEPT.

---

[1] Distinction between limited mobility applications and fixed/quasi-fixed is deemed to be necessary

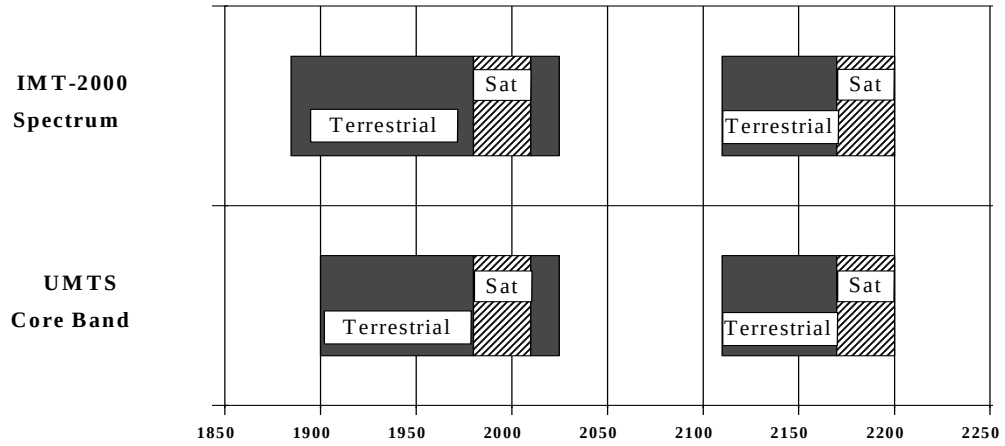


FIGURE 3.10

UMTS/IMT-2000 Core Band

The main points of the ERC Decision, ERC/DEC/(97)07 are:

- UMTS is defined as equipment complying with ETSI standards for UMTS;
- 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 2x40 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 by 1 January 2005 for UMTS subject to market demand.

The UMTS Forum has requested that the full 155 MHz for terrestrial services identified in the ERC Decision on UMTS be available by the year 2005.

3.5.2 Extension Bands

The locations of the possible extension bands for IMT-2000 will require further work. Such studies have started within CEPT-ERO. The demand for new spectrum in the year 2010 is, according to the calculations, 185 MHz for full mobility applications in Extension band 1, and 20 MHz for low mobility applications in Extension band 2.

3.5.3 Timely availability of Spectrum

The UMTS Forum has requested that the full 155 MHz for terrestrial services identified in the ERC Decision on UMTS band be available in the year 2005, and has further calculated a need for new spectrum of 185 MHz is required by the year 2010. For satellite services, the Forum requests that the full 60 MHz in the WRC '92 FPLMTS Recommendation be available in the year 2005. It is estimated that in the order of 30 MHz of more satellite spectrum will be needed by the year 2010.

3.6 Further Spectrum Issues

IMT-2000 is required to support a wide range of traffic types including mobile multimedia. The characteristics of mobile multimedia services differ from telephony in that the demand over time varies in its requests for speed of transfer, length of transmission streams and the symmetry of bi-directional transmissions.

The following issues have been identified as possibly affecting the spectrum requirements of UMTS and will be studied in more detail by the Forum.

3.6.1 Transmission Modes

Terrestrial wide-area systems and the satellite environments will require paired bands for FDD (Frequency Division Duplex) transmission, but short range systems can use an unpaired asymmetrical band and TDD (Time Division Duplex) transmission. There are however ways that FDD transmission might be combined with TDD transmission, or with other forms of transmission, in order to prevent traffic asymmetry decreasing the efficiency of spectrum use.

The spectrum identified will not all be paired and it is important that the bands are well matched to the user requirements. The exact split between paired and unpaired bands spectrum need to be considered carefully along with techniques to utilise capacity in a more flexible manner than current systems (e. g. re-assignment of FDD to TDD). It is therefore important that there are no regulatory barriers to such combinations.

3.6.2 Duplex Direction

There have been suggestions to reverse the duplex directions from conventional services due to compatibility considerations with other regions. The Forum's view is that the prime considerations should be spectrum efficiency and the effective engineering of IMT-2000 high bit rate, low power mobile terminals. Developments in technology should enable equipment to be adaptable in different regions. Reversing the duplex direction will have a very significant impact on reducing mobile battery life times, due to the extra path loss of moving to a higher frequency.

During some periods, traffic may be dominated by downloading data from a central source. However, at other times this traffic flow may be more balanced or even reversed by data gathering applications, e. g. picture transmissions from remote cameras. Unless flexible ways of assigning band width and direction are found, spectrum may be wasted.

For these reasons the Forum is of the view that the duplex direction for mobile services should not be changed from the conventional sense (mobile transmit low, base transmit high) without better justification than has been shown so far.

3.6.3 Spectrum efficiency

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.

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. 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 that arise during call set-up, clear-down, handover, etc. The problems associated with operator spectrum sharing are likely to be significant, and could reduce competition between operators.

Furthermore, to build a business case, UMTS operators must be certain about the spectrum to which they have uninhibited access. Operators may be reluctant to invest in radio hardware for the spectrum if there is no real certainty that the additional channels would be available when needed. The commercial drivers may instead lead to network developments, such as increasing transmitter power levels, which will lower spectrum efficiency.

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.

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.

4 Conclusions

Four major milestones for UMTS form the basis of the spectrum requirements in Europe:

Major milestones for UMTS	
1 October 1997	ERC Decision on UMTS Core band.
First quarter 1998	Drafting of licences.
31 December 1999	ETSI UMTS Phase 1 standard.
Year 2002	Commercial UMTS operation.

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 IMT-2000 is 50 MHz by the year 2005 and 90 MHz by the year 2010.

The UMTS Forum calls upon the relevant authorities to take timely action to make sufficient spectrum available for IMT-2000 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.

5 References

[1] ‘UMTS Task Force Report’
Brussels, 1st March 1996

[2] ‘A Regulatory Framework for UMTS’
Report no. 1 from the UMTS Forum
25 June 1997

[3] ‘UMTS Market Forecast Study’
Final Report for EC DG XIII
Analysis/Intercai Report Number 97043
12 February 1997

[4] Communication from the Commission to the European Parliament and the Council
'The World Radio Communications Conference 1997' (WRC-97)

Commission of the European Communities, Brussels 18.06.1997

Com (97) 304 final

[5] CEC deliverable R2066/SESA/GA2/DS/P/030/b1

'Results of traffic modelling for UMTS'

[6] 'ERO Report on UMTS'. Sep 1996

European Radio Communications Office Midtermolen 1, DK 21000 Copenhagen

ANNEX 1

Milestones for UMTS, Work plan from SAG

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	Preliminary identification of candidates for additional UMTS frequency spectrum (Extended band, approximately 185 MHz).
First quarter 1998	ETSI freezing of basic UMTS parameters.
	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

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. 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.

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.
ETSI	European Telecommunications Standards Institute. The body charged with developing the UMTS standard.
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.
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).

IMT- 2000 International Mobile Telecommunications-2000. A global standard for 3rd generation mobile telecommunications systems, promoting a high degree of commonality of design worldwide while incorporating a variety of systems. Previously known as FPLMTS.

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 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 environment, 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 is the planned European members of the ITU IMT-2000 family concept. 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.

_____