The Path towards UMTS -

- Technologies for the Information Society

0. PREFACE

This report is produced by the **UMTS Forum**, an association of telecommunications operators, manufacturers and regulators active in Europe and other parts of the world that share the vision of UMTS as a system which will move mobile communications forward from where we are today into the Information Society. UMTS will deliver pictures, graphics, video communications and other wide-band information as well as voice and data, direct to people who can be on the move.

The report is a major input towards the decision making process in Europe, representing as it does, the consensus view on UMTS of the Forum members. This understanding of UMTS has been carefully developed and expanded over the past two year's life of the Forum.

The report covers the wide breadth of UMTS technology rather than dealing in detail, covering aspects of how the technology benefits the user, the community, the providers and the industry. It covers the steps and time-scales for introducing the UMTS technology. It also identifies the technologies which will be essential for UMTS at its introduction and those which are likely to be required for its continuing evolution.

This report follows on from the first report of the UMTS Forum which dealt with a Regulatory Framework for UMTS. Associated reports from the UMTS Forum will cover areas of frequency spectrum, market predictions, economic conditions, licensing issues and material for the Information Society intended to assist the successful implementation of UMTS.

The report is aimed at being of interest to all parties world-wide, involved in the future development of the mobile telecommunications industry.

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1. SCOPE

Part of the UMTS Forum's task is to set out and communicate a common vision of UMTS. This report is part of that vision, to crystallise what the critical technologies

required for the Universal Mobile Telecommunications System (UMTS) are and how they will be integrated to achieve the goals set out for UMTS.

UMTS technologies offer a major step forward in terms of services and capabilities to mobile end users in the early part of the 21st century, as well as being applicable for competitive low mobility services. The actual realisation is likely to be phased in accordance with the market needs of different countries. UMTS achieves the initial step forward by combining today's proven and emerging technologies with innovative new technologies.

This report seeks to position UMTS not only against today's mobile and fixed systems but also against the backdrop of future developments in communications, Information Technology (IT) and media which together will combine to deliver the Information Society, of which UMTS will be the mobile component. In this report a clear focus is maintained on UMTS during its introductory years from 2002, but its longer term potential beyond 2005 is also addressed to embrace new technologies and concepts in response to as-yet undreamed of applications and market demands.

2. INTRODUCTION

2.1 WHY DO WE NEED UMTS?

As the Information Society burgeons in the early years of the new millennium, users of data and multimedia telecommunications services will expect and demand that these same services will continue to be available to them when they move away from their desks, offices or homes. Multimedia services allow the delivery of a rich variety of audio, visual and text-based information in addition to „basic voice".

Current wireless or mobile systems, despite their evolution, are still constrained in terms of the data rate they can offer and their flexibility to manipulate complex, yet user friendly multimedia services. This need presents the opportunity to the mobile radio, Information Technology and consumer electronics communities to offer to users something new – a mobile system capable of managing and delivering a much wider range of information services to the mass market.

Elements of this opportunity include:

- an industry-wide and government commitment across the world
- a co-ordinated programme encompassing spectrum, standards, and technology
- initial terrestrial and satellite services available in 2002 in major markets, with wide scale roll-out and adoption by 2005
- large amounts of spectrum already designated
- synergy of communications, IT and media working to bring about global opportunities for businesses and consumers, while creating new ways of doing business, entertaining and informing
- a substantial mass market, potentially worth ECU 45 bn in Europe alone by 2005 [source: A Regulatory Framework for UMTS – UMTS Forum Report 1]

2.2 WHAT IS UMTS?

UMTS is one of the major new Third Generation mobile systems being developed within the framework which has been defined by the International Telecommunications Union (ITU) and known as IMT-2000. It has been the subject of intense world-wide efforts on research and development throughout the past decade. UMTS has the support of many major telecommunications operators and manufacturers because it represents a unique opportunity to create a mass market for highly personalised and user friendly mobile access to the Information Society.

UMTS seeks to build on and extend the capability of today's mobile, cordless and satellite technologies by providing increased capacity, data capability and a far greater range of services using an innovative radio access scheme and an enhanced, evolving core network.

Part of the ITU IMT-2000 family, an essential component of the Information Society

IMT-2000 has been defined by the ITU as an open international standard for a high capacity, high data rate mobile telecommunications system incorporating both terrestrial radio and satellite components. UMTS is being standardised by the European Telecommunications Standards Institute (ETSI) in the IMT-2000 framework, in co-operation with other regional and national standardisation bodies around the world to produce the detailed standards to satisfy growing market needs for global roaming and service availability.

UMTS is an important part of wider initiatives to satisfy the needs of corporate users and the mass market. Complementary work is under way throughout ETSI and other fora on every aspect of the emerging Information Society, multimedia, information and content.

Standardisation in ETSI

Technical studies have been progressing within ETSI since 1991, and early in 1998 ETSI selected a new radio interface for UMTS (called UMTS Terrestrial Radio Access or UTRA) as the basis for a global terrestrial radio access network.

The wide scale support for UMTS from the telecommunications industry has been an extremely important element in the work of ETSI and in the underlying collaborative research programmes such as RACE I and II, and ACTS. The support of the existing world-wide GSM community has been expressed by the GSM MoU Association.

Spectrum for UMTS

In 1992, the World Radio Conference identified the frequency bands 1885 - 2025 MHz and 2110-2200 MHz for future IMT-2000 systems. Of this the bands 1980 - 2010 MHz and 2170 - 2200 MHz were intended for the satellite part of these future systems.

Europe and Japan have decided to implement the terrestrial part of UMTS (the UTRA air interface) in the paired bands 1920 - 1980 MHz and 2110 - 2170 MHz. Europe has also decided to implement UTRA in the unpaired bands 1900 - 1920 MHz and 2010 - 2025 MHz. In early 1998, the European Commission published the „EC Proposal for a European Parliament and Council decision on the Co-ordinated Introduction of UMTS" to ensure that EU member states undertake the appropriate steps to implement the European Radio Committee's (ERC) Decision on spectrum. This, in combination with the existing Licensing Directive, will ensure UMTS services can commence in 2002.

In the USA, In principle any licensee is free to implement any technology it chooses. Potential candidate bands for third generation technologies are the PCS bands, the WCS bands and parts of the UHF TV bands.

2.3 HOW AND WHEN?

The UMTS community has chosen aggressive timescales for the introduction of UMTS in order to meet the demands of customers in the early 21st century. The target date for its introduction has been set as the year 2002. The introduction of UMTS relies on many elements being in place including, for example, technology development, standardisation, an Applications Programming Interface (API) to a service creation environment, regulation, licensing and spectrum allocation.

To meet this 2002 deadline, UMTS is following a phased approach allowing its capabilities to be improved over time following its introduction. At launch, terrestrial UMTS will have the capability for data rates up to 2 Mbit/s, but it is designed as an open system which can evolve later on to incorporate new technologies as they become available. This will allow UMTS to eventually increase its capability above that currently being standardised, much in the same way that GSM will evolve from the original capability of 9.6Kb/s for data to GPRS (up to 115Kb/s) and then to EDGE technology (384Kb/s).

3. UMTS DEFINED

UMTS is a substantial advance over existing mobile communications systems. It is being designed with flexibility in mind above all else – for users, network operators and service developers and embodies many new and different concepts and technologies. Figure 1 attempts to summarise some of the key elements and features which, all combined, seek to define the scope of UMTS

Far more than second generation	• basic and advanced services • ever-increasing range of services built around virtual home environment • attractive multi-mode terminals for access to second and third generation services • future proof for the 21st century
UMTS	• a full third generation global mobile and wireless system • 2 Mbit/s capability in diverse radio environments • highly personalised mass market • new and innovative interactive and multimedia services
UMTS access via..	• a full member of the IMT2000 family • ITU identified spectrum for both terrestrial and satellite radio • UTRA, a revolutionary air interface optimised for both FDD and TDD spectrum
UMTS networks and services	• build on the footprint of the evolving GSM core network • are compatible with Internet Protocols • support convergence of fixed and mobile services • access via mobile or fixed, public or private networks

Figure 1: What is UMTS?

3.1 WHAT UMTS OFFERS

Ease of use and low costs

Customers above all else want useful services, easy-to-use terminals and good value for money. This means that UMTS will offer:

- Services that are easy to use, and customisable in order to address individual users' needs and preferences.
- Terminals and other "customer facing" equipment which allows easy access to these services.
- The user's costs for his or her UMTS service which are low enough to ensure a mass market - prices which are competitive.
- Similarly, a wide range of available terminals, with prices low enough to be affordable to the mass market, while supporting the advanced capabilities of UMTS.

New and better services

Market studies show that speech will remain the dominant service up to the year 2005 for existing fixed and mobile telephone networks, including GSM. Users will demand low cost high quality speech from UMTS, however the opportunity for increased revenue

over today's systems will come from offering advanced data and information services. Long term, industry forecasts for UMTS show a strongly growing multimedia subscriber base by the year 2010.

Fast access

One factor which sets UMTS clearly above second generation mobile systems is its potential to support 2Mbit/s data rates for users from the outset. This capability, together with the inherent Internet Protocol (IP) support of UMTS, is a powerful combination to deliver interactive multimedia services as well as other new wideband applications such as video telephony and video conferencing.

As the demand for user data rates increases in the long term, UMTS will be developed to support even higher data rates, perhaps one or two orders of magnitude greater (provided appropriate spectrum is allocated).

In later phases of UMTS development there will be a convergence with even higher data rate systems using mobile wireless Local Area Network (LAN) technologies (microwave or infrared) providing data rates of for example 155 Mbit/s in indoor environments.

Packet transmission and data rate on demand

Most cellular systems in use today use circuit switched technology for wireless data transmission, however, UMTS integrates packet and circuit data transmission. Packet data over-the-air gives several benefits to users:

- virtual connectivity to the network at all times
- alternative ways of billing – for example pay-per-bit, per session or flat rate per month
- asymmetric bandwidth in the uplink and downlink – as demanded by many emerging data services where one link direction carries simple commands and the other carries the content rich, bandwidth intensive traffic (for example Web browsing or video transmission)

UMTS is also being designed to offer data rate on demand, where the network reacts flexibly to the user's demands, his or her profile and the current status of the network. The use of packet-oriented transport protocols such as Internet Protocol (IP) are being studied for UMTS to enhance these abilities. Together, the combination of packet data and data rate on demand will remove technical barriers for the user and make operation of the system much cheaper – there will be no worries about how and when to connect to the network. *Friendly and consistent service environment*

UMTS services are based on standardised service capabilities which are common throughout all UMTS user and radio environments. This means that a personal user will experience a consistent set of services even when he roams from his home network to other UMTS operators – a „Virtual Home Environment“ (VHE). Users will always „feel“ that they on their home network, even when roaming. VHE will ensure the delivery of the service provider’s *total environment*, including for example a corporate user’s virtual work environment, independent of the user’s location or mode of access (satellite or terrestrial).

VHE will also enable terminals to negotiate functionality with the visited network, possibly even downloading software so that it will provide „home-like“ service, with full security, transparently across a mix of access and core networks. The ultimate goal is that all

networks, signalling, connection, registration and any other technology should be invisible to the user, so that mobile multimedia services are simple, user-friendly and effective.

Mobility and Coverage

UMTS has been designed from the outset as a global system, comprising both terrestrial and global satellite components. Multi-mode terminals that are able to also operate via second generation systems such as GSM 900 and 1800 will further extend the reach of many UMTS services. In the future, there are likely to be even more networks using these and other standards: the goal is to achieve truly personal communications, with terminals able to roam between these different networks. This means that a subscriber will be able to roam from a private network, into a picocellular/microcellular public network, then into a wide area macrocellular network (which may actually be a second generation network) and then to a satellite mobile network with minimal break in communication.

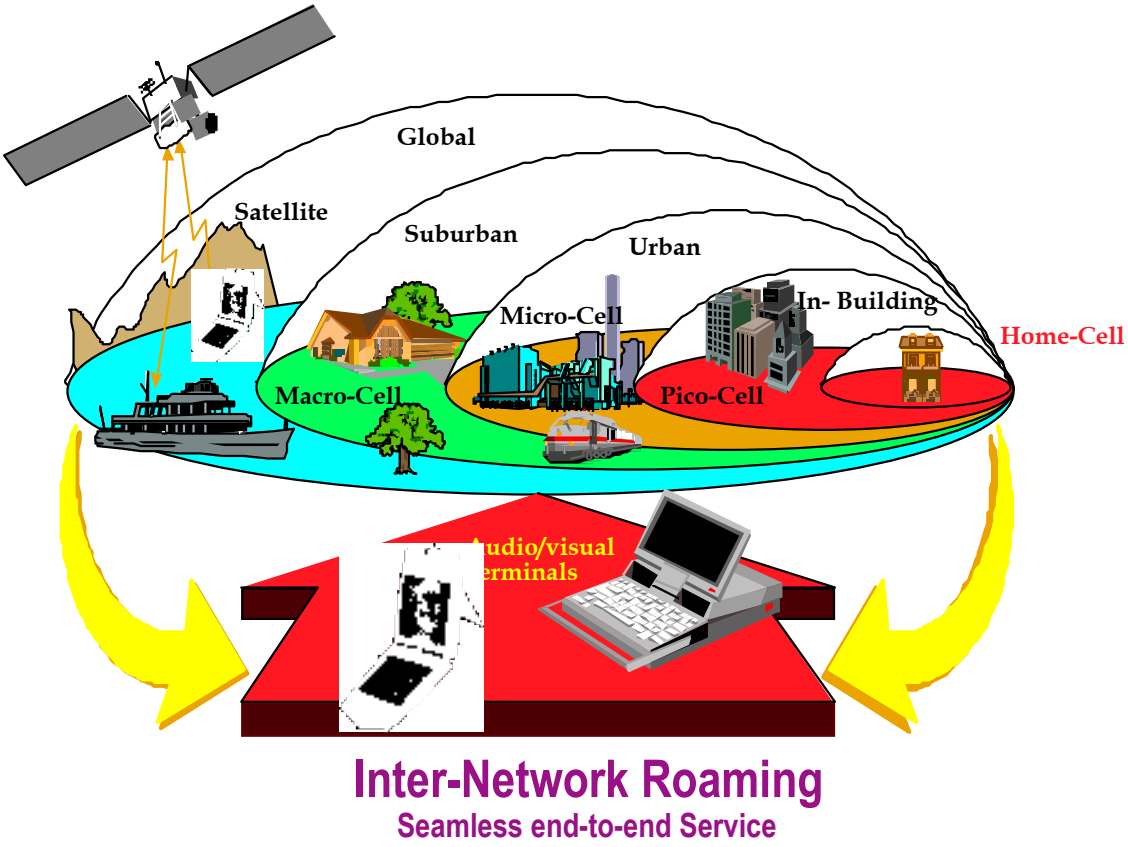

Figure 2: UMTS coverage is universal

Radio technology for all environments

The UMTS radio access system UTRA will support operation with high spectral efficiency and service quality in all the physical environments in which wireless and mobile communication take place. Today's user lives in a multi-dimensional world, moving between indoor, outdoor congested (urban), and outdoor rural environments with mobility ranging from essentially stationary through pedestrian up to very high speeds. There are also different user density environments, including three dimensional situations in high rise buildings. UTRA is being specified for all these environments.

In practical implementations of UMTS some users may be unable to access the highest data rates at all times. For example, the physical constraints of radio propagation and the economics of operating a network will mean that the system services might only support lower data rates in remote or heavily congested areas. Therefore in order to ensure that the subscriber is always able to use their terminal, services will be adaptive to different data rate availability and other Quality of Service (QoS) parameters.

In the early stages of UMTS deployment, traffic will probably be generated predominantly in locations such as airports and railway stations which operators will cover immediately following network launch. However users will want full coverage so that they can access their services wherever they are. To offer this, UMTS technology is being defined to enable roaming with other networks, for example a GSM system operated by the same operator or alternatively by roaming agreements with other networks such as other GSM based systems or other third generation systems including UMTS compatible satellite networks which will effectively be able to offer global coverage.

Terrestrial private networks have traditionally included PABX and Centrex systems for voice communication within organisations. With the rise of the corporate intranet (virtual private networks based on Web technology) these systems are becoming complete working environments for staff, where not only reports and data can be exchanged but service manuals, training presentations, financial and sales data etc. can also be created, stored and accessed on-line through familiar, easy-to-use graphical interfaces. Today's users of corporate intranets are likely to be early customers for mobile multimedia as delivered by UMTS. Seamless operation and roaming between private and public UMTS networks as well as access to service via fixed and mobile will be possible to support these users.

UMTS services available globally by satellite

Satellite technology can readily provide global coverage and service and so it is expected to play an important role in the extension of UMTS coverage world-wide. The same services will be supported on both terrestrial and satellite systems and UMTS is being standardised to ensure that roaming and handover between satellite and terrestrial networks will be efficient and effective.

3.2 SERVICE CREATION

UMTS marks a major step forward in mobile telecoms as it contains a service creation environment (part of the VHE) which allows UMTS operators and other entities to create rapidly entirely new services. The VHE will include high level tools for service design and testing, so that both operators and other service entities can introduce new services with speed, confidence, and know that they will function independent of network, access, or terminal.

Traditional methods of service definition, for example through standards fora, are slow and can hinder operators working in today's fiercely competitive environment. VHE avoids this problem by allowing easy provision of new services.

VHE and its associated tools provide an ideal platform for use by independent entities (such as private networks and Intranets) who seek to deliver telecommunications-based services to their subscribers. The technology also enables the creation of totally new content and value added services. Service Providers, including also the network operators, will have for the first time a real tool and opportunity to contribute to the

development of the Information Society by delivering, optimising and packaging services available from a huge variety of sources– thus becoming in effect „Service Brokers“.

The flexibility introduced by VHE not only increases the range of services that can be offered to subscribers and users but also allows them to be tailored to different user types and market sectors, even down to an individual user. The personal profiles can be extended beyond *„any one, any time, any place“* so that the services are consistent but also able to adapt to the users' circumstances as well as the capabilities of their terminals and access networks.

VHE and the Content Provider

In order to bring this era of rich service and content provision to reality, new technology is required to give flexible access to the network. For greatly improved efficiency compared to today's cellular data systems, the radio access system must be instantaneously matched to each individual service. Therefore a content provider's service or application will be able to set up the preferred QoS from the network in terms of preferred bandwidth, maximum error rate and delay or latency. New charging and billing mechanisms will be developed in order to dynamically price the new services in relation to the QoS requested and that actually delivered.

Individual users need new ways to manage and control vast amounts of information from many diverse sources in order to fulfil their own objectives and interests. This will represent a very large and new personalised market that cannot be satisfied using existing concepts of service provision. This will lead to the development of a number of new roles or business entities, for example new types of service provider, not necessarily associated with a single network operator, content providers who are able to optimise existing content for UMTS and others who will develop new services and content specifically for mobile users.

A new entity, the Content Provider, will emerge as a means of delivering additional information to either the mass-market or niche markets. Content Provision is likely to emerge from today's Internet but will be able to cover subscription as well as non-subscription services. Content Provision services will also extend to cover corporate intranets where information is managed and delivered to closed user groups on an organisational or interest basis.

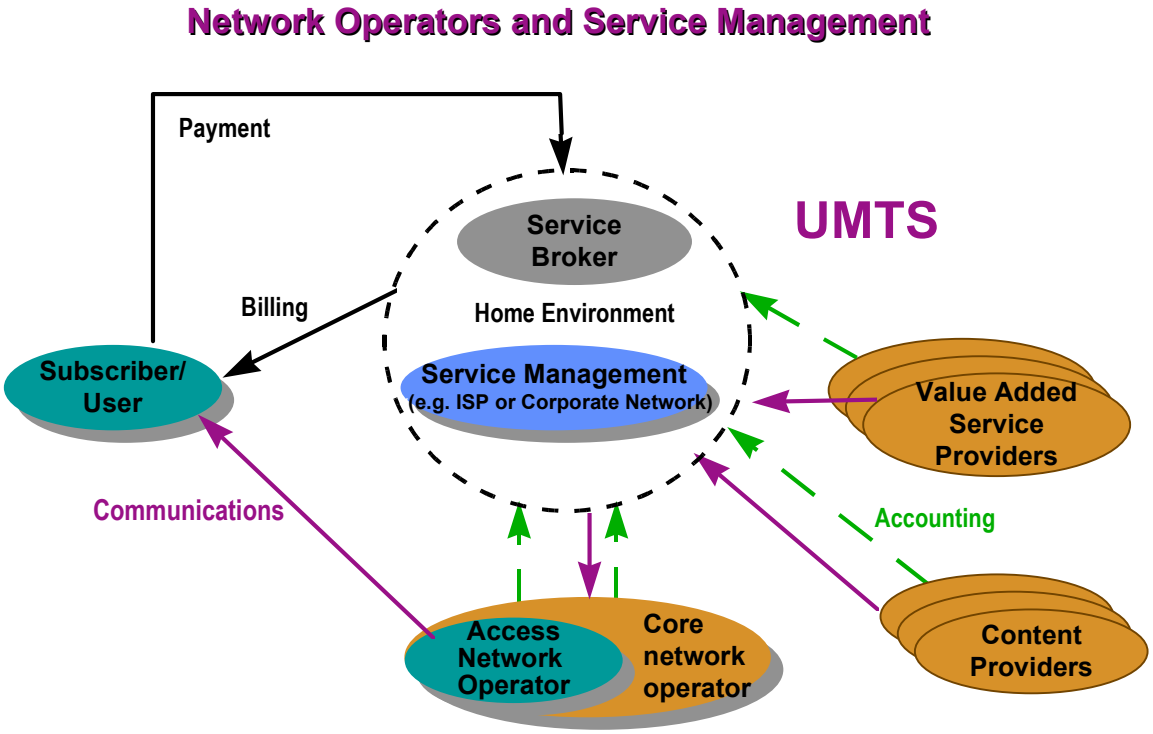

Figure 3: Example Functions in UMTS service delivery

The above diagram illustrates an example of the roles and interfaces that may be built upon the technology and standards solutions for UMTS. It must be stressed that this is only one example of the arrangements which the highly flexible UMTS architecture and interfaces will enable. In particular, the network operators will also be an important class of both service provider and content provider, as well as the independents. Services will be created and managed from functionality and information available throughout the elements of the UMTS system and linked systems, and for which definition of the enabling interfaces will be key.

4. HOW AND WHEN?

UMTS is planned for deployment by terrestrial and satellite operators from year 2002. This requires the completion of a number of key steps relating to spectrum allocation, regulation, service and technology design to be completed.

4.1 THE KEY STEPS FOR UMTS

In order for UMTS to be a commercial as well as technical success, and to meet its 2002 launch deadline, a number of key steps are being undertaken by manufacturers, standards bodies, operators and regulators in key markets across Europe and around the world. These steps include:

- *Creating an adequate regulatory framework*, incorporating for example, issues as roaming between networks and access mechanisms (terrestrial and satellite), security of transactions, new service offerings over and above voice and data, use and distribution of terminals and the evolution of the value chain to include new players such as content providers

- *Ensuring timely availability of licenses*, giving operators time to implement hardware and services ready for 2002, and giving them sufficient freedom to operate innovative services and form new relationships
- *Allocating adequate spectrum to operators* to launch a realistic level of service in a cost effective manner
- *Producing UMTS standards in a timely fashion* to allow manufacturers to develop competitive products for UMTS' launch
- *Encouraging simultaneous uptake of UMTS in a number of countries* to ensure a world-wide market and stimulate uptake of services.

4.2 A PHASED APPROACH

The introduction of UMTS will proceed through a number of pre-operational and operational phases taking place over the years 2002 – 2005. The aim of this phased approach is to reduce risk and cost for operators and ensure early adoption of services by end users. A UMTS Phase 1 development schedule as envisaged in Report #1 (June 1997) of the Forum is reproduced below. It represents the consensus on the timetable at that time and although there are some backlogs already visible today, there is a widespread confidence that the basic schedule will be maintained though and may require adjustment of the detailed schedule.

The current situation, however, is less than optimal, particularly with regard to licensing certainty. The EC Proposal envisages licenses being granted in all EU countries by 1st January 2000. This represents a delay of one year on the schedule originally proposed by the UMTS Forum in its Report #1, while maintaining the commercial deployment phase beginning in 2002. The primary phases towards the development of UMTS are:

- *Extension of GSM's capability* to include packet (GPRS) and high speed data operation (EDGE)
- *Pre-UMTS Trial Phase*, during which prototype UMTS base stations will be trialled either in subsets of real GSM networks, or in isolated trial packet-based networks
- *Basic deployment phase* beginning in 2002, which includes the first incorporation of UTRA base stations into „live" networks and the launch of satellite-based UMTS services; new services based exclusively on UTRA's capabilities; and support of both narrowband and broadband services over the same UTRA interfaces
- *Full commercial phase*, beginning shortly after 2002 and approaching fruition in 2005 incorporating enhancements to its performance and capability, and involving the introduction of new, sophisticated UMTS based services.

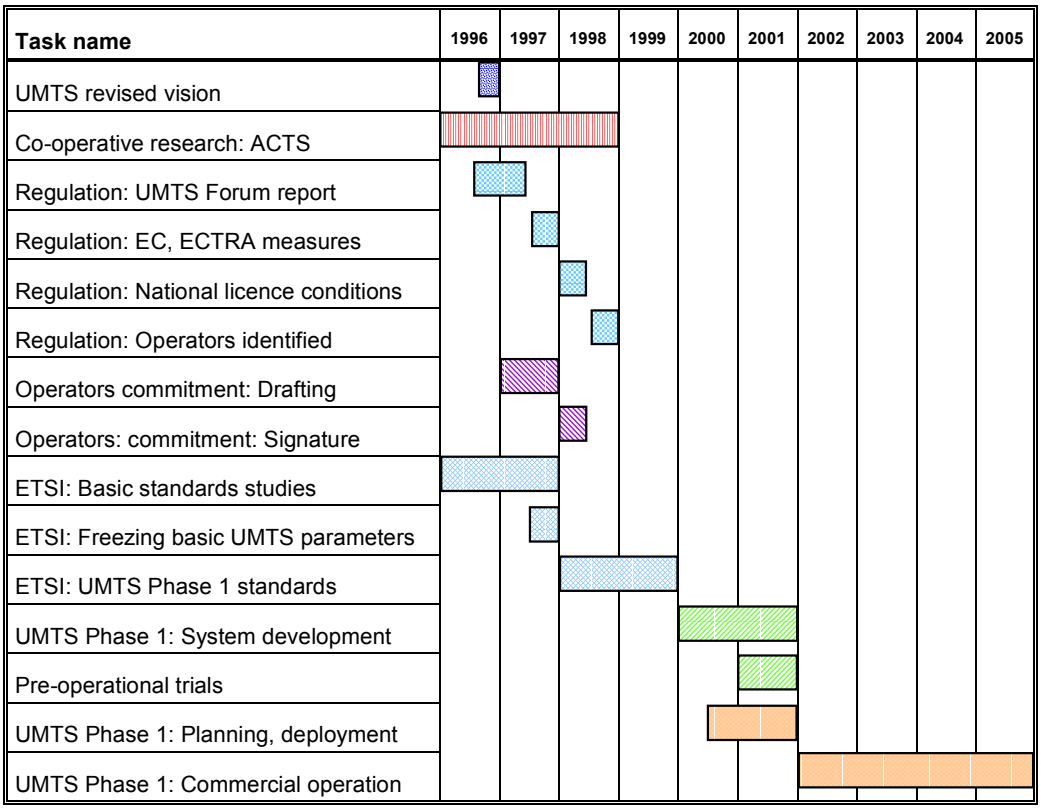

Figure 4: UMTS Timeline

Many within the industry believe that an important step along the way will be the widespread deployment of packet radio services being developed for second generation systems, such as GPRS (General Packet Radio Service) for GSM. These systems will give valuable experience with connectionless systems for the operators and could provide a platform for the development of service interworking functions and service provider interfaces as well as a core of mobile multimedia services. This can be done with less initial investment than is necessary for UMTS, where a completely new radio infrastructure and terminals will be needed. Customers can be attracted onto these intermediate networks by the provision of attractive services from new content and service providers. These customers will then be willing to invest in new UMTS terminals in the anticipation of better and more efficient delivery of these services and more. In turn, this provides the incentive for network operators to invest in UMTS infrastructure in order to satisfy the need for capacity demanded by a successful mobile multimedia mass market.

Network evolution

There are currently two views of how existing core networks will evolve towards UMTS:

- *Network centric,* through upgrades to the current switching infrastructure using GSM MAP and new IN features
- *Client-server,* based on the GSM SIM Toolkit which allows the SIM to run applications and manipulate data while placed within a GSM handset.

In the new era of deregulation and more flexible standards as well as the need for a very rapid response typified by the IT market, it should be possible to achieve the result

through a variety of methods to suit the skills of a particular supplier and the preferences of a particular customer. The standards must be open to different approaches, but with sufficiently defined interfaces to enable interworking to take place.

4.3 KEY TECHNOLOGIES

Some of the critical technologies essential for the successful introduction of UMTS include the following.

UTRA

The ETSI decision in January 1998 on the radio access technique for UMTS combined two technologies – W-CDMA for paired spectrum bands and TD-CDMA for unpaired bands – into one common standard. This powerful approach ensures an optimum solution for all the different operating environments and service needs.

The transmission rate capability of UTRA will provide at least 144 Kbit/s for full mobility applications in all environments; 384 Kbit/s for limited mobility applications in the macro and micro cellular environments and 2.048 Mbit/s for low mobility applications particularly in the micro and pico cellular environments. The 2.048 Mbit/s rate may also be available for short range or packet applications in the macro cellular environment, depending on deployment strategies, radio network planning and spectrum availability.

Multi-mode Second Generation/UMTS Terminals

UMTS terminals will exist in a world of multiple standards and this will enable operators to offer maximum capacity and coverage to their user base by combining UTRA with second and other third generation standards. Therefore, operators will need terminals that are able to interwork with legacy infrastructures such as GSM/DCS1800 and DECT as well as other second generation world-wide standards such as those based on the US AMPS standard, because they will initially have more complete coverage than UMTS. Many UMTS terminals will therefore be multi-band and multi-mode so that they can work with different standards, old and new. Achieving such terminals at a cost which is comparable with contemporary single mode second generation terminals will become possible because of technological advances in semiconductor integration, radio architectures and software radio.

Satellite Systems

At initial service launch in 2002, the satellite component of UMTS will be able to provide a global coverage capability, to a range of user terminals. These satellite systems are planned to be implemented using the S-band Mobile Satellite Service (MSS) frequency allocations identified for satellite IMT2000 and will provide services compatible with the terrestrial UMTS systems.

USIM Cards/smart cards

A major step forward which GSM introduced was the Subscriber Identity Module (SIM) or Smart Card. It introduced the possibility of high security and a degree of user customisation to the mobile terminal. SIM requirements, security algorithms, card and silicon IC technology will continue to evolve up to and during the period of UMTS deployment:

By 2002, the smart card industry will be able to offer cards with greater memory capacity, faster CPU performance, contactless operation and greater capability for encryption. These advances will allow the UMTS Subscriber Identity Module (USIM) to add to the UMTS service package by providing portable high security data storage and transmission for users. As well as configuration software for the operation of any UMTS terminal, images, signatures, personal files, fingerprint or other biometric data could be stored, down- or up-loaded to or from the card.

Contactless cards will permit much easier use than with today's cards, for example allowing the smart card to be used for financial transactions and management such as electronic commerce or electronic ticketing without having to be removed from a wallet or phone.

It is expected that all fixed and mobile networks will adopt the same or compatible lower layer standards for their subscriber identity cards to enable USIM roaming on all networks and universal user access to all services. Electronic commerce and banking using smart cards will soon become widespread and users will expect and be able to use the same cards on any terminal over any network.

New memory technologies can be expected to increase card memory sizes making larger programmes and more data storage feasible. Several applications and service providers could be accommodated on one card. In theory, the user could decide which applications/services he wants on the card, much as he does for his computer's hard disk. This is the challenge and opportunity for service industries which evolving smart card technology presents.

Internet Protocol (IP) Compatibility

UMTS is a modular concept that takes full regard of the trend towards convergence of fixed and mobile networks and services, enabling a huge number of applications to be developed. As an example a laptop with an integrated UMTS communications module becomes a general-purpose communications and computing device for broadband Internet access, voice, video telephony and conferencing for either mobile or residential use.

The number of IP networks and applications are growing fast. Most obvious is the Internet, but private IP networks (intranets) show similar or even higher rates of growth and usage.

UMTS will become the most flexible broadband access technology as it allows for both mobile, office and residential use in a wide range of public and non-public networks. UMTS can support both IP and non-IP traffic in a variety of modes including packet, circuit switched and virtual circuit.

UMTS will be able to benefit from parallel work by the Internet Engineering Task Force (IETF) who are further extending their basic set of IP standards for mobile communication. New developments like IP version 6 allows parameters such as quality of service (QoS), bit rate and bit error rates (BER), vital for mobile operation, to be set by the operator or service provider. Developments on new domain name structures are also taking place. These new structures will increase the usability and flexibility of the system, providing unique addressing for each user, independent of terminal, application or location.

Cross platform interoperability

The ability to transport multimedia content over various types of network, such as broadcast, telecommunications, and internet, requires industry to develop cross platform interoperability because the properties of the networks may have an impact on the content. In many cases several different kind of networks will be cascaded such as Ethernet, ATM, X25 and UMTS.

API and Development toolbox

The UMTS market will be driven by the rapid development and deployment of new and innovative services.. The key enabler in this area will be the standardisation of the UMTS Application Programming Interface (API).

The API allows the abstraction of both the terminal and network, providing a generic way for applications to access terminals and networks. The API will allow the same application to be used on a wide variety of terminals and will also provide a common method of interfacing applications to UMTS networks.

The API will support security, billing, subscriber information, service management, call management, SIM management user interaction and content translation. It will build upon and extend today's technologies such as Java, Wireless Application Protocol (WAP), GSM SIM Toolkit and Internet technologies which are also exploiting convergence with other emerging technologies for consumer Information Society products such as digital TV set top boxes.

Client-server architecture

One of the primary drivers for UMTS is service differentiation, to allow network operators (and service providers) to market products based on more than just coverage and capacity issues. The key aspect is the ability to develop and offer new features in short timescales, without requiring modifications from infrastructure suppliers.

Many new developments in the IT industry are based on a client/server technology, which allows intelligence to be downloaded transparently (from a server) into the user's terminal (the client), providing direct and immediate high-performance user interaction, validation and interpretation. Tasks which must remain centralised, such as databases, are held on centrally administered servers and respond to queries from the clients rapidly and efficiently. Many examples of commercially successfully client/server solutions are to be found in the banking, travel and service industries, enabled by the growth in the use of desktop PC's and low cost networking links.

For the mobile industry, intelligent terminals and USIM cards will allow personalisation of the user interface and provision of features not possible with basic terminals in today's networks. With the increase in roaming traffic, the ability to provide such features independently of the serving network will become increasingly important. Existing and evolving GSM standards, such as SIM Toolkit and Mobile Execution Environment, together with other initiatives such as WAP, provide the framework for delivering this client/server approach. The use of an object-oriented language such as Java is attractive because it is platform and operating system independent, and optimises the download.

Customer Care and Billing systems)

UMTS will operate in a very different environment to today's mobile systems. The new roles and many new players must inter-operate in a fully integrated manner. *Customer care and billing systems* are critical to commercial success. Customer care and billing are inextricably linked and must be able to effectively operate across all the players and roles in a customer friendly manner. For UMTS the bill will no longer be just a piece of paper but a key part of a highly sophisticated approach to customer care across all services a provider could offer.

Convergence will not only require the interoperation of fixed, mobile, satellite, private and public systems but also the integration of players from non telecommunications fields such as Internet, finance, entertainment and the media. This will require a harmonised solution to *customer care and billing systems* despite very different legacy practices.

The competitive services market will demand multiple flexible interconnections, between players and roles. Global roaming and VHE will dramatically increase these demands. Seamless delivery will require a unification of management and a means to provide interworking without a prior relationship. Significantly higher levels of automation and timeliness will be required to support the billing and customer care operations and in addition, fraud management will need to be applied across the whole value chain. Charging and billing will need different concepts to those typically available today.

Corporate use of UMTS including global mobile access to intranets will be a key driver for UMTS. It will demand greater flexibility for customisation and more devolved service control to optimise productivity and operational efficiencies within such corporate networks. The UMTS subscriber and network management capabilities will be enhanced to meet these new and evolving requirements.

4.4 UMTS IN THE LONG TERM

In order to ensure that UMTS flourishes in the long term, its capabilities will be progressively increased by the addition of new technologies. The paragraphs below detail some of these technologies.

Re-configurable Terminals

UMTS terminals will have to exist in a world of multiple standards – both second generation standards and other members of the IMT-2000 family. Also, standards themselves are expected to evolve. In order to provide universal coverage, seamless roaming and non standardised services, some of the elements of the radio interface (e.g. channel coder, modulator, transcoder etc.) will no longer have fixed parameters, rather they will be in the form of a "toolbox" whereby the key parameters can be selected or negotiated to match the requirements of the local radio channel. In addition to the capability to adapt to different standards as described above, downloadable terminals will enable network operators to distribute new communications software over the air in order to improve the terminals' performance in the network or to fix minor problems. An example would might be the downloading of an improved handover algorithm. This aspect of software download will generally be invisible to the user.

Application and Service Download

When using today's multimedia terminals (for example PCs), users have accepted the idea that the capabilities of the terminal can be modified over time through software download. It is now commonplace for a user to download a new „plug in" (for example a

video or audio codec) to access new types of content. The introduction of multimedia services on UMTS will take this concept into the mobile domain.

UMTS „plug ins“ will come from a variety of sources, for example:

- Pre-installed on the user's terminal by the network operator or service provider.
- Downloaded over the air, at the user's request or automatically by the network, much as today, where many Internet service providers upgrade one's software or databases during a session.
- Supplied on media such as CD-ROM, for example free with magazines or direct mail.

This concept of software download will be closely linked with newly developed SIM capabilities discussed above. The terminal and the SIM will co-operate in requesting, storing and executing software plug ins – ideally the majority of new software should be stored on the SIM to allow the user to „SIM roam“ onto a new terminal while still keeping the optimum home environment.

Smart Antennas

Smart antennas react intelligently to the received radio signal, continually modifying their parameters to optimise the transmitted and received signal. This allows them to:

- Increase coverage and capacity by reducing interference between adjacent mobiles
- Offer space division multiple access, where frequencies are assigned on a per-mobile rather than a per-cell basis allowing vastly increased capacity
- Enable user location in space, allowing the introduction of advanced location-based services.

Smart antennas are a key way of enhancing the capability of UMTS in the long term.

Broadband Satellite Systems

Several broadband satellite systems are also planned for deployment in the post 2002 timeframe, to offer data rates beyond 2Mb/s and into the Gigabits domain. Some of these systems may offer compatibility with UMTS service concepts using satellite frequency allocations in the 20/30 GHz range. The requirements of the terminal equipment and higher power consumption will necessitate larger size transportable or fixed terminals.

5. CONCLUSIONS & RECOMMENDATIONS

UMTS is going to happen – the multimedia market exists and is growing while technologies are being put in place to bring it into the mobile community.

We expect to see a phased introduction of UMTS hardware and services with coverage, capability and number of operators growing over time. This phased introduction ensures the early availability of services to users while reducing risks for UMTS operators and manufacturers.

UMTS needs to be capable of co-existing and working with existing second generation mobile communications technologies so that operators can choose to re-use their existing infrastructure assets and expertise.

Global availability of UMTS services will be ensured by providing for roaming between members of the IMT-2000 family, and handover between GSM and UMTS.

A number of technologies are required, in addition to the radio interface on which so much focus has been placed recently. In addition, technologies from other fields, (for example IP) will be used to reduce costs and increase the performance of UMTS.

Though much attention is currently focused on the early years of deployment, UMTS is being defined with a view to the long term. In time we expect that its capabilities will extend far above those envisaged today.

A number of key requirements need to be met to ensure that UMTS deployment takes place on schedule:

- *Successful implementation* of data services on existing networks. Though UMTS will support voice services its future depends on the use of mobile data within the mass market. Operators considering UMTS are now looking towards take-up of existing GSM data, and anticipating the success of new data services like GPRS as models for UMTS' success.
- *Per-packet billing systems in place*. Billing and customer care are becoming ever more complex as a means to achieve competitive differentiation. UMTS will require complex interworking between many organisations, and the convergence of different industries will introduce new customer care and billing concepts. The UMTS subscriber and network management capabilities will need to be enhanced to meet these new and evolving requirements.
- *Implement the service creation environment and interfaces* so that the rich range of services can be offered to end users.
- *Maintain and progress the vision*.
- *Abide by the timescales*. UMTS timescales are tight. Implementation of networks in 2002 requires constant attention and adherence to the overall UMTS project plan
- *Support continuing research* to ensure UMTS' long term evolution, for example in the area of spectrum/resource sharing.

UMTS is a significant opportunity for manufacturers, operators, regulators and content providers, both as a communications system in itself and as part of the greater Information Society. The vision of UMTS is as a customer-focused system, where customers include both network operators and end users. The challenge to the communications industry is to integrate the technologies needed for UMTS in a way which supports this goal and thereby transforms the vision into reality.

6. GLOSSARY OF TERMS

API Applications Programming Interface

BER bit error rates

ERC	European Radio Committee
ETSI	European Telecommunications Standards Institute
GPRS	General Packet Radio Service
IETF	Internet Engineering Task Force
IN	Intelligent Network
IP	Internet Protocol
ITU	International Telecommunications Union
LAN	Local Area Network
MoU	Memorandum of Understanding
QoS	Quality of Service
SIM	Subscriber Identity Module
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
VHE	Virtual Home Environment
WAP	Wireless Application Protocol