RECOMMENDATION ITU-R M.1308

EVOLUTION OF LAND MOBILE SYSTEMS TOWARDS IMT-2000

(Question ITU-R 208/8)

(1997)

Summary

This Recommendation provides information on the existing set of requirements and objectives specified in other ITU Recommendations for International Mobile Telecommunications-2000 (IMT-2000). This Recommendation provides guidelines for developers of pre-IMT-2000 systems who intend to evolve their systems towards IMT-2000.

The ITU Radiocommunication Assembly,

considering

a) that Recommendations ITU-R M.1033 and ITU-R M.1073 summarize the characteristics of existing land mobile systems, hereafter referred to as second generation systems, which potentially could evolve to IMT-2000;

b) that the ITU-R is studying International Mobile Telecommunications-2000 (IMT-2000) (see Question ITU-R 39/8);

c) that various ITU Recommendations are being elaborated to describe the services and capabilities to be offered by, and specify the standards to be used in IMT-2000;

d) that it could be advantageous for existing land mobile systems to evolve in the near future to include, anticipated or advanced services, facilities, or technologies identified in the Recommendations referred to in *considering* c);

e) that enormous investment in pre-IMT-2000 networks will have taken place by the year 2000, and there is a need for as much commonality as possible between IMT-2000 and earlier systems in order to facilitate the evolution of pre-IMT-2000 systems;

f) that there is a need to support terminal roaming between pre-IMT-2000 and IMT-2000 systems;

g) that pre-IMT-2000 systems must address the primary customer demands of voice quality, coverage, and cost, while also offering a whole new range of services and capabilities;

h) that evolution and migration may occur in discrete steps and these steps may occur at different times in different regions and at different times for different operators;

j) that the evolution of systems and services can be independent of each other;

k) that a universal user identity module (UIM) functionality should be used within all IMT-2000 systems;

l) that some of the major objectives of IMT-2000 may be achieved by evolutions of existing mobile communication systems;

m) that mass market needs may be supported by cellular-based pre-IMT-2000 systems for quite some time, even after the introduction of IMT-2000,

recommends

1 that the key features and global vision for IMT-2000 included in Annex 1, should be considered by developers of pre-IMT-2000 systems;

2 that the requirements and objectives summarized in Annex 2 and specified in the ITU Recommendations listed in Annex 3 should be incorporated into existing and emerging land mobile systems that intend to evolve towards IMT-2000;

3 that the standards for IMT-2000 be adopted as soon as possible to support the timely evolution of existing systems to IMT-2000;

4 that high bit-rate services should be provided in such a way that the cost of providing the speech service and other widely used teleservices are not increased;

5 that pre-IMT-2000 systems intending to evolve towards IMT-2000 should:

– maximize commonality with IMT-2000;

– utilize the radio bearer adaptation functionality as discussed in Recommendation ITU-R M.1311;

– support universal UIM functionality.

ANNEX 1

Key features and global vision for IMT-2000

1 Introduction

IMT-2000 are third generation systems which aim to advance and unify the diverse systems we see in the mid-1990s into a radio infrastructure capable of offering a wide range of services around the year 2000 in many different environments, including the wireless aspects of personal communications services. IMT-2000 will provide access, by means of one or more radio links, to a wide range of telecommunication services supported by the fixed telecommunications networks (e.g. public switched telephone network/integrated services digital network (PSTN/ISDN), and to other services which are specific to mobile users. A range of mobile terminal types is encompassed, linking to terrestrial or satellite-based networks, and the terminals may be designed for mobile or fixed use.

Key features of IMT-2000 are:

– high degree of commonality of design worldwide,

– compatibility of services within IMT-2000 and with the fixed networks,

– high service quality,

– worldwide seamless roaming,

– use of a small pocket terminal worldwide.

In order to maximize benefit from investment in mobile systems that are currently in service or will be introduced prior to IMT-2000 (these systems are referred to as «pre-IMT-2000»), it would be desirable to identify ways in which these systems can evolve towards IMT-2000. This would also ease the introduction of IMT-2000 itself and may enable a higher degree of reuse in the network infrastructure, system concepts, and/or technologies than would be possible otherwise. This issue is being considered on the basis that pre-IMT-2000 systems may already possess some features and may undergo further development to enable an evolution path towards IMT-2000. It is also recognized that this approach may be most appropriate for those systems that operate in frequency bands close to the bands identified for IMT-2000.

2 Terminology and definitions

The following terminology and definitions are provided for the purposes of this Recommendation. See Recommendation ITU-R M.1224 on Vocabulary of Terms for IMT-2000 for definition of IMT-2000 terminology in general.

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 (based on ITU-T Recommendation Q.300).

Evolution

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

Evolution towards IMT-2000

A process of change and development of a mobile radio system towards the capabilities and functionalities of IMT-2000.

IMT-2000

Those systems that conform to the corresponding series of ITU Recommendations and Radio Regulations.

IMT-2000 radio interface (based on Recommendations ITU-R M.1034 and ITU-R M.1224)

The means of realizing the wireless electromagnetic interconnection between an IMT-2000 mobile station (or mobile earth station) and an IMT-2000 base station (or space station).

Integration

The act or process, or an instance, of forming, coordinating or blending into a functioning or unified whole.

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.

Interworking functions (ITU-T Recommendation I.113)

Mechanisms which mask the differences in physical, link, and network technologies by converting or mapping states and protocols into consistent network and user services.

Migration to IMT-2000

Movement of users and/or service delivery from existing telecommunication network to IMT-2000.

Network

A set of nodes and links that provides connections between two or more defined points to facilitate telecommunication between them (ITU-T Recommendations I.112, Q.9).

Network integration

Integration as applied to networks.

Path

The continuous series of positions or configurations of a mobile radio system that can be assumed in the process of change when moving towards an IMT-2000 system.

Personal communications service

A set of capabilities that allows some combination of terminal mobility, personal mobility, and service profile management.

Pre-IMT-2000

Mobile systems that are currently in service or will be introduced prior to IMT-2000.

Radio interface protocol

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

Service

A set of functions offered to a user by an organization (ITU-T Recommendations E.800, M.60).

System

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

System integration

Integration as applied to systems.

Technology

A scientific method of achieving a practical purpose.

User identity module (UIM)

In IMT-2000, a logical entity which could be removable from a unit (mobile or fixed) or provided by functionality contained in a unit. It contains information elements needed by the system to identify, authenticate and permit the users registration. The UIM can also be used to store user specific data.

3 Global IMT-2000 vision

The following high-level global «vision» of IMT-2000 contains a list of some of the key goals and objectives for IMT-2000, based upon the market demands from a global perspective. It is expected that this vision may be expanded to include additional goals and objectives as the work on IMT-2000 is progressed.

3.1 Quality of service

3.1.1 Voice quality, coverage, and cost

Market studies have consistently shown that when customers are asked what things are important to them in their current wireless service, three issues arise:

1) voice quality,

2) coverage,

3) cost.

Therefore, third generation systems must first address these primary customer demands, i.e. enable improved voice quality, support more ubiquitous and seamless coverage capabilities, and allow operators to offer services at a competitive price.

3.1.2 Quality of service aspects – Transmission and delay

With the range of services expected, both the transmission quality and delay need to be adapted over a very wide range, together with the bandwidth and data rates. For mobile speech and video services, the maximum bit error ratio is usually specified at 1×10^{-3}, while for data services, 1×10^{-6} is required from the Radio Access system (RAS). These error rates for radio are significantly worse than those provided by fixed networks and so the speech coders or data adapters must provide the necessary user service quality. The delay requirement attributed to the Radio Access part of today's second generation systems is about 50 ms. Other parts of the system take the overall figure up to 90 ms (one way). In itself, for speech applications, this delay is unobtrusive, but compounded by other delays (tandem systems, satellite links, etc.) it can become a problem and so improvements are always desirable. For multimedia data services, there is likely to

be a huge variation in demanded delay, and this will be an important aspect of service adaptation provided by operators in conjunction with adaptive terminals. Varying degrees of channel asymmetry may also be required. In order to allow much greater scope for mobile network operators to improve the perceived quality of their networks, this aspect will be one of the main applications for the adaptive, software downloadable capability of IMT-2000 terminals.

3.1.3 Increased efficiency and capacity

The clear trend is toward significant growth in the worldwide wireless subscriber base. Each wireless operator must prepare to meet this growth. Third generation systems must, therefore, provide operators with economical and efficient means for providing service to their growing customer base. Any new systems must provide increases in network efficiencies as well as new services so that operators are motivated to deploy them. The challenge for third generation systems is to achieve better spectrum usage than any second generation system for voice communication and also to maintain optimum spectrum usage for all services at all times, despite their differing demands for data rates, symmetry, channel quality and delay.

3.2 New services and capabilities

3.2.1 Raising the bar

Providing improvements in the three areas of voice quality, coverage and cost, while mandatory for third generation, will not be enough for the customers of the future. A rich range of services accessible in a variety of means will be needed to address the needs of the customers after the year 2000. In effect, the services available from the next generation of systems must «Raise The Bar» in capabilities in every way, enabling new voice and data service that are not currently available with first and second generation technologies.

3.2.2 Increasing demand for high bandwidth services (data, image, multimedia, etc.)

The mobile office concept utilizing wireless notebooks on a wireless Wide Area Network will likely be a reality by the year 2000 and as such will require much more bandwidth than is possible today. Similarly, other wireless image transmissions services are likely to be available, e.g. medical images for doctors, real-time road maps for vehicles, etc. Some administrations have already made considerable spectrum allocations in other bands to address the growing interest in high bandwidth packetized wireless data communications in the office or classroom environments. Systems are envisioned which offer the possibility of very high bandwidths, at least for small area coverage systems, such as indoor or other high density applications such as sports stadiums, shopping malls etc. Important challenges are to provide means for integrating and interworking between networks in other bands and IMT-2000, and to provide the technology at low cost.

3.2.3 Bandwidth on demand

Third generation concepts impose the requirement to provide broadband services, interworking with broadband ISDN. This has been clarified to mean wireless access to the information highway for multimedia applications. Multimedia can address a huge range of data rates, from simple low rate paging messages, through voice to high rates associated with video or file transfer. Therefore the RAS should be capable of providing bandwidth on demand. Some applications, such as software download, will require a highly asymmetrical data capability, requiring high rates in one direction, but much lower rates on the return path. Furthermore, some of these services require continuous transmission (such as desktop videoconferencing), some are bursty by nature, others require low delay and others require absolute integrity. The variable nature of the radio channel has already been mentioned; therefore the maximum throughput will be equally dynamic, requiring adaptive bandwidth from the RAS.

3.3 Evolution and migration capabilities

3.3.1 Ability to evolve/migrate

Support for the evolution and/or migration of pre-IMT-2000 systems is critical for the success of IMT-2000 systems. Enormous investments in second generation technologies are underway around the world. In addition, a huge base of existing customers already exists and will continue to exist into the 21st century. Pre-IMT-2000 operators do not want to have to discard all their existing infrastructure, rather they would prefer that the new system should coexist and interwork with the present one and act as an adjunct to it. An orderly evolution path from second generation to third generation is required.

3.3.2 Coexistence issues and compatibility with 2nd generation technologies

In the case of many regions, by the time of the introduction of IMT-2000 there will have been a very substantial penetration of second generation radio systems. These will have been evolved to provide significantly better quality and more diverse services than they do today. It is proposed that many second generation systems will provide an essential platform upon which IMT-2000 can build. In some administrations, IMT-2000 may provide the opportunity to offer high bandwidth multimedia applications as a first release (i.e. a high-tier service for early adopters), with second generation systems initially providing the bulk of the capacity for basic telephony and lower rate data services, thus maximizing the usage efficiency of the pool of available mobile spectrum. In later phases of IMT-2000 development, the technology (adaptive downloadable terminals) may also be used to achieve even higher quality, more efficient basic speech services which would then gradually replace the second generation systems. With the requirement for worldwide incoming roaming it is likely that the IMT-2000 infrastructure will have to be adaptive in order to support roamers from regions with differing terminal characteristics. This places a requirement on the adaptive terminals that they should be capable of multiband operation.

3.4 Flexibility: Multi-environment, multimode, multiband capabilities

3.4.1 Greater flexibility

There is a growing need to accommodate a maximum level of interworking between networks of different types to provide customers with greater coverage and consistency of services. This includes cellular, Personal Communication Systems (PCS), paging and data networks and services. What is needed in support of this interworking is a system that provides much greater flexibility. Such flexibility would enable operators to configure and manage their networks in accordance with the service demands of the market. Ideal flexibility includes the following characteristics: multi-functionality, multi-environment capabilities, multimode operation, and multiband flexibility. There is a recognition that pre-IMT-2000 systems will continue to add new features and functionality as dictated by the needs of the market and that some of these advancements might facilitate some of the needed flexibility.

3.4.2 Modulation and multiple access selection

Third generation Wireless Multimedia terminals will have to exist in a world of multiple standards. A single third generation air interface standard would ease the requirement for worldwide roaming. However, the different regional interests and different rates of progress will have to be taken into account. Furthermore, mobile network operators want backward compatibility so that the new terminals will still be able to interwork with the old infrastructure. The current thinking is that adaptive technology and over-the-air software download will make multimode/multiband, multimedia terminals feasible which can interwork with different standards, old and new. Intelligent cell sites will be needed as well as a flexible switching and transport infrastructure. At the same time, low cost is essential in order to assure a mass market.

3.4.3 Flexible control

There is a need to evaluate the feasibility of more flexible control techniques for the radio interface. Flexible control is needed not only to adapt a mobile terminal to a number of different interfaces and environments, but also to enable real-time control and dynamic tuning of basic parameters (modulation, channel coding, etc.) to optimize performance and spectrum efficiency.

3.4.4 Service adaptation

A goal for third generation mobile systems is to provide universal coverage and to enable terminals to be capable of seamless roaming between networks, which may be of differing types. The current thinking is that the services will negotiate with the radio bearer via an adaptation layer to secure channels in each direction, having the required characteristics of bandwidth, delay and quality, also recognizing that many multimedia communications will be highly asymmetric. The need to provide for future non-standardized services, which can be created independently in a competitive, multi-operator environment places radically new requirements on the radio interface concept. No longer will the various elements of the radio interface (e.g. channel coder, modulator, transcoder, etc.) have fixed parameters, rather, they would be in the form of a «toolbox» whereby the key parameters of bandwidth, transmission quality and delay can be selected, negotiated, mixed and matched by the requirements of the teleservice, according to the instantaneous capability of the radio channel. This is one aspect of the requirement for adaptive terminals for IMT-2000.

3.4.5 Multiple environments

A good RAS, particularly an adaptive one, should be capable of supporting operation with good spectrum efficiency, coverage efficiency and service quality in all the physical environments in which wireless and mobile communication will take place. Third generation systems should be more flexible than second generation systems which are something of a compromise. It is a multidimensional situation, involving physical environments such as in-building, outdoor congested (urban), and outdoor rural. There are different mobility environments such as stationary, pedestrian, vehicular mobility, and high speed applications. Finally there are different user density environments, including three dimensional situations. The RAS needs to optimally adapt to all propagation environments (terrestrial and satellite) and all traffic environments which result, including mixed environments, where, for example, fast moving vehicles may be moving on a roadway which is physically close to a pedestrian precinct.

3.4.6 Mobility management

In the future, there are likely to be even more networks than there are today, together with the possibility of a vast number of wireless Customer Premises Networks (CPNs). However a goal is to achieve truly personal communications, implying a single number (or name) service with the aim also to achieve seamless roaming across dissimilar networks. Roaming across dissimilar networks could mean that a subscriber terminal can roam from a CPN 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. Ubiquitous roaming impacts the RAS by requiring that it supports handover between different networks, as well as subscriber location techniques (location updating) in order that service delivery is not discontinued. The new network architecture design will require considerable innovation, in order to devise means of realizing distributed mobility management across networks, so that calls are routed with the optimum efficiency and minimum delay and so that independent subnetworks can maintain service to their subscribers. The self routing capability of asynchronous transfer mode (ATM) is being seriously studied as a possible new method. It is likely, therefore that there will be considerable advantages in structuring parts of the radio interface as wireless ATM.

3.4.7 Mobile-satellite services

The integration of terrestrial and satellite services is a key attribute of IMT-2000. Together they cover the wide range of user densities, service types, and available service sets which comprise IMT-2000.

3.4.8 Fixed wireless access

The capability of IMT-2000 to support fixed wireless access services is an essential need in developing countries and will be utilized for providing competition and/or supplement capacity to the fixed wired network in many developed countries.

4 Key features and objectives

Some of the key features and objectives of IMT-2000 as compared to pre-IMT-2000 (which refer to mobile services that are currently in service or will be introduced prior to IMT-2000), are as follows:

4.1 Global system

– A global standard promoting a high degree of commonality of design worldwide while incorporating a variety of systems,

– use of a small pocket terminal worldwide, but also the accommodation of a variety of other terminal types,

– bigger marketplace leading to lower costs,

– worldwide common frequency band,

– worldwide roaming based on terminal mobility,

– worldwide, off-the-shelf compatible equipment.

4.2 New services and capabilities

– Provision of capability which enables new voice and data services which are significantly more advanced than pre-IMT-2000 technologies,

– availability to mobile users of a range of voice and non-voice services, including packet data and multimedia services,

– higher service quality, in particular voice,

– high quality and integrity, comparable to the fixed network,

– significantly higher user bit rate capability,

– flexible radio bearer, leading to improved spectrum efficiency and lower cost per Erlang,

– the capability to provide bandwidth on demand supporting a wide range of data rates, from simple low rate paging messages through voice to high rates associated with video or file transfer,

– support for asymmetrical data capabilities which require high rates in one direction but much lower rates in the other,

– improved security,

– improved ease of operation,

– intelligent network (IN) based service creation and service profile management based on ITU-T Q.1200-series of Recommendations,

– coherent systems management based on ITU-T M.3000-series of Recommendations.

4.3 Evolution and migration

– Flexibility for evolution of systems, and migration of users, both from pre-IMT-2000 and evolution within IMT-2000,

– compatibility of services within IMT-2000 and with the fixed telecommunications network (e.g. PSTN/ISDN),

– provision of a framework for the continuing expansion of mobile network services and access to services and facilities of the fixed network,

– an open architecture which will permit easy introduction of advances in technology and of different applications,

– ability to co-exist and interwork with pre-IMT-2000.

4.4 Flexibility: multi-environment capabilities

– Accommodation of a maximum level of interworking between networks of different types to provide customers with greater coverage, seamless roaming and consistency of services,

– integrated satellite/terrestrial networks,

– provision of services by more than one network in any coverage area,

– provision of these services over a wide range of user densities and coverage areas,

– provision of services to both mobile and fixed users in urban, rural and remote regions,

– wider range of operating environments, including aeronautical and maritime,

– a modular structure which will allow the system to start from as small and simple a configuration as possible and grow as needed, in size and complexity,

– caters to needs of developing countries,

– flexibility to utilize adaptive software downloadable terminals to support multiband and multi-environment capabilities,

– key parameters of bandwidth, transmission quality and delay can be selected, negotiated, mixed and matched by the requirements of the service according to the instantaneous capability of the radio channel,

– better use of the radio spectrum than pre-IMT-2000 consistent with providing services at acceptable costs, taking into account their differing demands for data rates, symmetry, channel quality, and delay.

ANNEX 2

Requirements and objectives template for describing attributes of transmission technologies for IMT-2000

The following tables 1 to 3 divide the summary of the requirements and objectives for IMT-2000 that describes attributes of radio transmission technologies for IMT-2000 into three categories. Table 1 provides technical requirements and objectives for which a performance metric has been quantified. Table 2 provides generic requirements and objectives which specify functionality or a qualitative performance attribute. Requirements and objectives which require a subjective assessment or for which additional specificity is required to determine conformance are provided in Table 3.

The template is provided as a tool for developers or operators of existing systems in assessing the status of that system's evolution towards IMT-2000.

Any of these requirements and objectives may apply to either the terrestrial or satellite component of IMT-2000, or both. The tables indicate whether each item is an objective or a requirement, as well as the source ITU Recommendations which should be used for assessing whether the stated requirements and objectives are met. The last column is provided as a checklist for convenience.

List of acronyms used in the tables

DTMF: Dual Tone Multi Frequency

EMC: Electromagnetic Compatibility

IMT-2000: International Mobile Telecommunications-2000

ISDN: Integrated Services Digital Network

PSTN: Public Switched Telephone Network

UPT: Universal Personal Telecommunications

WARC: World Administrative Radio Conference

TABLE 1

Summary

Requirements and objectives template for describing attributes of transmission technologies for IMT-2000

IMT-2000 item description	Objectives/ Requirements	Source (Recommenda-tion)	Meets
Voice and data performance requirements			
One-way end to end delay less than 40 ms	Requirement	ITU-T G.174, § 7.5	☐ Yes ☐ No
For mobile videotelephony services, the IMT-2000 terrestrial component should operate so that the maximum overall delay (as defined in ITU-T Recommenda-tion F.720) should not exceed 400 ms, with the one way delay of the transmission path not exceeding 150 ms	Requirement	Supplement ITU-T F.720, ITU-T F.723, ITU-T G.114	☐ Yes ☐ No
Speech quality should be maintained during ≤ 3% frame erasures over any 10 second period. The speech quality criterion is a reduction of ≤ 0.5 mean opinion score unit (5 point scale) relative to the error-free condition (ITU-T Recommendation G.726 at 32 kbit/s)	Requirement	ITU-T G.174, § 7.11 et UIT-R M.1079 § 7.3.1	☐ Yes ☐ No
DTMF signal reliable transport (for PSTN is typically less than one DTMF error signal in 1×10^4)	Requirement		☐ Yes ☐ No
Voiceband data support including G3 facsimile	Requirement	ITU-R M.1079, § 7.2.2	☐ Yes ☐ No
Support packet switched data services as well as circuit switched data; requirements for data performance given in ITU-T Recommendation G.174	Requirement	ITU-R M.1034, § 10.8, 10.9	☐ Yes ☐ No
Radio interfaces and subsystems, network related performance requirements			
Network interworking with PSTN and ISDN in accordance with ITU-T Recommendations Q.1031 and Q.1032	Requirement	ITU-R M.687, § 5.4	☐ Yes ☐ No
Meet spectral efficiency and radio channel performance requirements of Recommendation ITU-R M.1079	Requirement	ITU-R M.1034, § 12.3.3/4	☐ Yes ☐ No
Provide phased approach with data rates up to 2 Mbit/s in phase 1	Objective	ITU-R M.687, § 1.1.14	☐ Yes ☐ No
Maintain bearer channel bit-count integrity (e.g. synchronous data services and many encryption techniques)	Objective	ITU-R M.1034, § 10.12	☐ Yes ☐ No
Support for different cell sizes, for example: Mega cell Radius ~ 100-500 km Macro cell Radius ≤ 35 km, Speed ≤ 500 km/h Micro cell Radius ≤ 1 km, Speed ≤ 100 km/h Pico cell Radius ≤ 50 m, Speed ≤ 10 km/h	Objective	ITU-R M.1035, § 10.1	☐ Yes ☐ No
Application of IMT-2000 for fixed services and developing countries			
Circuit noise – idle noise levels in Recommendation 99% of the time about 100 pWp	Objective	ITU-R M.819, § 10.3	☐ Yes ☐ No
Error performance – as specified in Recommendation ITU-R F.697	Objective	ITU-R M.819, § 10.4	☐ Yes ☐ No
Grade of service better than 1%	Objective	ITU-R M.819, § 10.5	☐ Yes ☐ No

TABLE 2

Summary

Generic requirements and objectives describing the attributes of radio transmission technologies for IMT-2000

IMT-2000 item description	Objectives/ Requirements	Source (ITU-R Recommenda-tion)	Meets
Radio Interfaces and subsystems, network related performance requirements			
Security comparable to that of PSTN/ISDN	Objective	M.687, § 4.4	☐ Yes ☐ No
Support mobility, interactive and distribution services	Requirement	M.816, § 6	☐ Yes ☐ No
Support UPT and maintain common presentation to users	Objective	M.816, § 4	☐ Yes ☐ No
Voice quality comparable to the fixed network (applies to both mobile and fixed service)	Requirement	M.819, Table 1, M.1079, § 7.1	☐ Yes ☐ No
Support encryption and maintain encryption when roaming and during handover	Requirement	M.1034, § 11.3	☐ Yes ☐ No
Network access indication similar to PSTN (e.g. dialtone)	Requirement	M.1034, § 11.5	☐ Yes ☐ No
Meet safety requirements and legislation	Requirement	M.1034, § 11.6	☐ Yes ☐ No
Meet appropriate EMC regulations	Requirement	M.1034, § 11.7	☐ Yes ☐ No
Support multiple public/private/residential IMT-2000 operators in the same locality	Requirement	M.1034, § 12.1.2	☐ Yes ☐ No
Support multiple mobile station types	Requirement	M.1034, § 12.1.4	☐ Yes ☐ No
Support roaming between IMT-2000 operators and between different IMT-2000 radio interfaces/environments	Requirement	M.1034, § 12.2.2	☐ Yes ☐ No
Support seamless handover between different IMT-2000 environments such that service quality is maintained and signalling is minimized	Requirement	M.1034, § 12.2.3	☐ Yes ☐ No
Simultaneously support multiple cell sizes with flexible base location, support use of repeaters and umbrella cells as well as deployment in low capacity areas	Requirement	M.1034, § 12.2.5	☐ Yes ☐ No
Support multiple operator coexistence in a geographic area	Requirement		☐ Yes ☐ No
Support different spectrum and flexible band sharing in different countries including flexible spectrum sharing between different IMT-2000 operators (see Recommendation ITU-R M.1036)	Requirement	M.1034, § 12.2.8	☐ Yes ☐ No
Support mechanisms for minimizing power and interference between mobile and base stations	Requirement	M.1034, § 12.2.8.3	☐ Yes ☐ No
Support various cell types dependent on environment (Recommenda-tion ITU-R M.1035 § 10.1)	Requirement	M.1034, § 12.2.9	☐ Yes ☐ No
High resistance to multipath effects	Requirement	M.1034, § 12.3.1	☐ Yes ☐ No
Support appropriate vehicle speeds (as per § 7) NOTE 1 – Applicable to both terrestrial and satellite proposals.	Requirement	M.1034, § 12.3.2	☐ Yes ☐ No
Support possibility of equipment from different vendors	Requirement	M.1034, § 12.1.3	☐ Yes ☐ No
Offer operational reliability as least as good as second generation mobile systems	Requirement	M.1034, § 12.3.5	☐ Yes ☐ No
Ability to use terminal to access services in more than one environment, desirable to access services from one terminal in all environments	Objective	M.1035, § 7.1	☐ Yes ☐ No
End-to-end quality during handover comparable to fixed services	Objective		☐ Yes ☐ No
Support multiple operator networks in a geographic area without requiring time synchronization	Objective		☐ Yes ☐ No

TABLE 2 (*continued*)

IMT-2000 item description	Objectives/ Requirements	Source (ITU-R Recommenda-tion)	Meets
Radio Interfaces and subsystems, network related performance requirements (continued)			
Layer 3 contains functions such as call control, mobility management and radio resource management some of which are radio dependent. It is desirable to maintain layer 3 radio transmission independent as far as possible	Objective	M.1035, § 8	☐ Yes ☐ No
Desirable that transmission quality requirements from the upper layer to physical layers be common for all services	Objective	M.1035, § 8.1	☐ Yes ☐ No
The link access control layer should as far as possible not contain radio transmission dependent functions	Objective	M.1035, § 8.3	☐ Yes ☐ No
Traffic channels should offer a functionally equivalent capability to the ISDN B-channels	Objective	M.1035, § 9.3.2	☐ Yes ☐ No
Continually measure the radio link quality on forward and reverse channels	Objective	M.1035, § 11.1	☐ Yes ☐ No
Facilitate the implementation and use of terminal battery saving techniques	Objective	M.1035, § 12.5	☐ Yes ☐ No
Accommodate various types of traffic and traffic mixes	Objective	M.1036, § 1.10	☐ Yes ☐ No
Application of IMT-2000 for fixed services and developing countries			
Repeaters for covering long distances between terminals and base stations, small rural exchanges with wireless trunks, etc.	Requirement	M.819, Table 1	☐ Yes ☐ No
Withstand rugged outdoor environment with wide temperature and humidity variations	Requirement	M.819, Table 1	☐ Yes ☐ No
Provision of service to fixed users in either rural or urban areas	Objective	M.819, § 4.1	☐ Yes ☐ No
Coverage for large cells (terrestrial)	Objective	M.819, § 7.2	☐ Yes ☐ No
Support for higher encoding bit rates for remote areas	Objective	M.819, § 10.1	☐ Yes ☐ No
Additional satellite specific requirements and objectives			
Links between the terrestrial and satellite control elements for handover and exchange of other information	Requirement	M.818, § 3	☐ Yes ☐ No
Take account for constraints for sharing frequency bands with other services (WARC-92)	Objective	M.818, § 4	☐ Yes ☐ No
Compatible multiple access schemes for terrestrial and satellite components	Objective	M.818, § 6	☐ Yes ☐ No
Service should be comparable quality to terrestrial component as far as possible	Objective	M.818, § 10	☐ Yes ☐ No
Use of satellites to serve large cells for fixed users	Objective	M.819, § 7.1	☐ Yes ☐ No
Key features (e.g. coverage, optimization, number of systems)	Objective	M.1167, § 6.1	☐ Yes ☐ No
Radio interface general considerations	Requirement	M.1167, § 8.1.1	☐ Yes ☐ No
Doppler effects	Requirement	M.1167, § 8.1.2	☐ Yes ☐ No

TABLE 3

Summary

Subjective requirements and objectives describing of radio transmission technologies for IMT-2000

IMT-2000 item description	Objective/ Requirement	Source (ITU-R Recom-mendation)
Fixed Service – Power consumption as low as possible for solar and other sources	Requirement	M.819, Table 1
Minimize number of radio interfaces and radio subsystem complexity, maximize commonality (Recommendation ITU-R M.1035, § 7.1)	Requirement	M.1034, § 12.2.1
Minimize need for special interworking functions	Requirement	M.1034, § 12.2.4
Minimum of frequency planning and internetwork coordination and simple resource management under time-varying traffic	Requirement	M.1034, § 12.2.6
Support for traffic growth, phased functionality, new services or technology evolution	Requirement	M.1034, § 12.2.7
Facilitate the use of appropriate diversity techniques avoiding significant complexity if possible	Requirement	M.1034, § 12.2.10
Maximize operational flexibility	Requirement	M.1034, § 12.2.11
Designed for acceptable technological risk and minimal impact from faults	Requirement	M.1034, § 12.2.12
When several cell types are available, select the cell that is the most cost and capacity efficient	Objective	M.1034, § 10.3.3
Minimize terminal costs, size and power consumption, where appropriate and consistent with other requirements	Objective	M.1036, § 1.12

ANNEX 3

ITU Recommendations for IMT-2000

Recommendation ITU-R M.687 – International Mobile Telecommunications-2000 (IMT-2000)

This Recommendation defines the objectives to be met by IMT-2000 and provides the overall IMT-2000 concepts with particular consideration to achieving worldwide roaming and compatibility.

This Recommendation provides a high level statement on the topics of: services, architecture, network aspects, implementation, sharing, and operational characteristics. Guidance is provided, for a limited number of possible scenarios, on spectrum bandwidth and band of operation based on critical technical parameters and traffic estimates.

It forms a foundation for the subject of IMT-2000 and for the subsequent work activities and recommendations.

Recommendation ITU-R M.816 – Framework for Services Supported on International Mobile Telecommunications-2000 (IMT-2000)

This Recommendation forms a framework for continued development towards detailed IMT-2000 service descriptions as defined in ITU-T Recommendation F.115.

A phased approach is adopted for the definition of IMT-2000. In this Recommendation the services required for Phase 1 are described, and an outline of the services for Phase 2 is also given. Phase 1 includes those services supported by user bit rates up to approximately 2 Mbit/s. Phase 2 is envisaged as augmenting Phase 1 with new services, some of which may require higher bit rates.

Recommendation ITU-R M.817 – International Mobile Telecommunications-2000 (IMT-2000) ***Network Architectures***

This Recommendation presents the functional network architectures and some of the resulting network configurations which are possible for IMT-2000. It should form the basis for defining the information flows within IMT-2000.

Recommendation ITU-R M.818 – Satellite Operation within International Mobile Telecommunications-2000 (IMT-2000)

The Recommendation provides high level guidance on the integration of the satellite component into IMT-2000. In particular, it comments on the critical technical factors for selection of band of operation and identifies subsequent work to be carried out.

Recommendation ITU-R M.819 – International Mobile Telecommunications-2000 (IMT-2000) for Developing Countries

Recognizing the disparity that exists in the telecommunication infrastructure in the world, this recommendation points out the potential of cellular technology (and its evolution into the IMT-2000 technologies) to help developing countries bridge the gap. IMT-2000 have been conceived primarily for mobile telecommunications which of course is of interest to developing as well as developed countries. The objective of this Recommendation is to emphasize the needs and interests of developing countries by promoting the application of IMT-2000 for fixed services. It should furthermore be stressed that the use of IMT-2000 for such applications is also attractive to developed countries.

Recommendation ITU-R M.1034 – Requirements for the Radio Interface(s) for International Mobile Telecommunications-2000 (IMT-2000)

The purpose of this Recommendation is to build on the IMT-2000 concepts contained in Recommendation ITU-R M.687 and to provide a high-level view of the constraints placed on the radio interface(s) particularly in terms of the system requirements, user requirements, and operational requirements. It takes account of other IMT-2000 Recommendations to produce recommendations on the requirements for the IMT-2000 radio subsystem from an overall system perspective.

Recommendation ITU-R M.1035 – Framework for the Radio Interface(s) and Radio Subsystem Functionality for International Mobile Telecommunications-2000 (IMT-2000)

The purpose of this Recommendation is to present an overview of the radio subsystem for IMT-2000 and give guidelines for the development of the structure of the radio subsystem. The radio subsystem includes the functionalities needed to provide IMT-2000 services over (a) radio interface(s) to mobile terminals in all IMT-2000 operating environments, as defined in Recommendation ITU-R M.1034. The Recommendation provides a high-level definition of logical elements and functionalities within the radio subsystem, including the radio interface, channel structure, link control and radio system management functions. In addition, this Recommendation identifies areas which are to be specified in detail in subsequent Recommendations.

Recommendation ITU-R M.1036 – Spectrum Considerations for Implementation of International Mobile Telecommunications-2000 (IMT-2000) in the Bands 1 885-2 025 MHz and 2 110-2 200 MHz

At this stage of IMT-2000 development it is neither appropriate nor possible to produce a definitive Recommendation on IMT-2000 operation in the bands 1 885-2 025 MHz and 2 110-2 200 MHz. However a more general Recommendation on the relevant principles covering the exploitation of these bands by IMT-2000 can provide valuable early advice to Administrations to enable them to plan use of the relevant bands. Thus the purpose of this Recommendation is to give principles to guide Administrations on spectrum technical issues relevant to the implementation of IMT-2000 in the bands identified by WARC-92, while minimizing the impact on other systems and services in the bands and facilitating IMT-2000 growth as countries require it.

Recommendation ITU-R M.1079 – Speech and Voiceband Data Performance Requirements for International Mobile Telecommunications-2000 (IMT-2000)

This Recommendation defines the speech quality and voiceband data performance requirements for the IMT-2000, including the satellite aspects. It lists the basic recommendations essential for achieving speech and voiceband data quality comparable to the fixed network by specifying natural speech, free, for example from excessive delay and echoes, that will enable users to converse easily using the IMT-2000 network, taking account of the full range of impairments like transcoding and environmental noise that are to be expected. Acceptable bit error ratios are also defined.

This Recommendation also defines the connection performance, concerning issues like call set up time and handover probability, to be achieved in the IMT-2000 network that the user will expect in a network of comparable performance to the fixed network.

Recommendation ITU-R M.1167 – Framework for the Satellite Component of International Mobile Telecommunications-2000 (IMT-2000)

Recommendation ITU-R M.818 sets the overall requirements of the satellite component of IMT-2000. Recommendation ITU-R M.1035 describes the framework of the radio interfaces of IMT-2000 taking particular account of the terrestrial component.

This Recommendation together with Recommendation ITU-R M.1035 describes the technical and operational capabilities and features of the satellite component, particularly where they are distinct from those of the terrestrial component. It forms the framework for further development of the satellite component of the integrated overall systems of IMT-2000.

In particular, the Recommendation comments on the aspects of integration with the terrestrial component, operational considerations, network interfaces and radio interfaces.

Recommendation ITU-T F.720 – Videotelephony Services - General

This Recommendation defines and describes the general features and attributes of the videotelephony service regardless of the network environment where the service might be provided. The videotelephony service is classified in the following two main categories:

– videotelephony service for narrow-band networks,

– videotelephony service for broadband networks.

The higher quality videotelephony service will not necessarily employ any fixed information transfer rate as variable bit rate coding may be used.

Recommendation ITU-T F.723 – Videophone service in the Public Switched Telephone Network (PSTN)

This Recommendation contains the description and network specific service requirements for videophone services offered in the PSTN. The substance of the Recommendation complements the main body of draft Supplement to ITU-T Recommendation F.720, which deals with network independent service requirements for respective Low Bit-Rate (LBR) videophone services provided in networks such as PSTN and digital mobile telecommunication networks across LBR channels. The difference between the service requirements in these two network domains stems from variations in access rates, mobility, robustness of digital wireless transmission and different terminal environments. In addition to network specific requirements, the network independent requirements for LBR videophone services and general requirements for all videophone services, included in Recommendation ITU-T F.720, apply for the service as well.

Recommendation ITU-T G.114 – One-Way Transmission Time

This Recommendation provides specifications for transmission time, including delay due to equipment processing time as well as propagation delay, in connections with echo adequately controlled. Recognizing that the delay became a limited resource in modern networks, the Recommendation is intended to assist network operators as well as equipment manufacturers in controlling the detrimental effects of delay (without echo) on service quality. All services with overall performance which depend on user or terminal interactivity are considered.

Recommendation ITU-T G.174 – General Characteristics of International Telephone Connections and International Telephone Circuits; Transmission Performance Objectives for Terrestrial Digital Wireless Systems Using Portable Terminals to Access the PSTN

This Recommendation provides transmission performance objectives that, if realized, should facilitate widespread user acceptance of emerging wireless technologies. These objectives apply to terrestrial digital wireless systems that use portable terminals to access the PSTN. Additionally, this Recommendation reinforces the fact that comparable PSTN quality encompasses, among many other considerations, a broad set of transmission performance criteria, all of which need to be considered to achieve the robustness and interworking capabilities of the PSTN.

Additional approved Recommendations not previously included are listed below for reference.

Recommendation ITU-R M.1224 – Vocabulary of Terms for International Mobile Telecommunications-2000 (IMT-2000)

This Recommendation consists primarily of those terms and definitions that are considered essential to the understanding and application of the principles of IMT-2000. Included are terms that may already be defined in other ITU Recommendations. However, the definitions given here embrace only the essential concepts and on this basis it is considered that they are not inconsistent with the more specialized definitions that appear in those Recommendations.

The terms defined below are not exclusive to IMT-2000, and so far as they are relevant, may also apply to other radiocommunication systems and services where a truncated term is widely used.

Recommendation ITU-R M.1078 – Security Principles for International Mobile Telecommunications-2000 (IMT-2000)

The scope of this Recommendation is to provide the principles and framework for the security provided by IMT-2000. The Recommendation covers all aspects of security for IMT-2000 and is intended as a basis for more detailed aspects of IMT-2000 security to be integrated in various ITU-R or ITU-T Recommendations including IMT-2000 requirements at a later stage.

The Recommendation identifies the security requirements for IMT-2000 and defines security features for IMT-2000. An informative Annex to the Recommendation contains a threat and risk analysis including the justification for the various security features defined. The system requirements on security in this Recommendation does not imply any legal responsibility of involved parties concerning the security of the communication and associated information as this will be in accordance with a country's national law.

The management of security features is dealt with in Recommendation ITU-R M.1168.

Recommendation ITU-R M.1223 – Evaluation of Security Mechanisms for IMT-2000

The scope of this Recommendation is to identify classes of security mechanisms appropriate for implementing the IMT-2000 security features defined in Recommendation ITU-R M.1078 on security principles for IMT-2000, and thus for satisfying the IMT-2000 security requirements identified in the same Recommendation.

This Recommendation is intended to be a starting point for the development of more detailed IMT-2000 Recommendations relevant to security which will be developed by various ITU Study Groups.

Recommendation ITU-R M.1168 – Framework of International Mobile Telecommunications-2000 (IMT-2000) Management

The purpose of this Recommendation is to present the conceptual and methodological framework of the definition of the management of IMT-2000.

Recommendation ITU-R M.1225 – Guidelines for Evaluation of Radio Transmission Technologies (RTT) for IMT-2000

This Recommendation provides guidelines for both the procedure and the criteria to be used in evaluating RTTs for a number of test environments. These test environments, defined herein, are chosen to simulate closely the more stringent radio operating environments. The evaluation procedure is designed in such a way that the impact of the candidate RTTs

on the overall performance and economics of IMT-2000 may be fairly and equally assessed on a technical basis. It ensures that the overall IMT-2000 objectives are met.

The Recommendation provides, for proponents and developers of RTTs, the common bases for the submission and assessment of RTTs and system aspects impacting the radio performance.

This Recommendation allows a degree of freedom so as to encompass new technologies.

The actual selection of the RTTs for IMT-2000 is outside the scope of this Recommendation. It deals only with the methodology for the technical evaluations that should be performed. The results of the evaluation are to be documented in an evaluation report and submitted to the ITU-R.