

## 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  $1 \times 10^{-3}$ , while for data services,  $1 \times 10^{-6}$  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.