

RECOMMENDATION ITU-R M.1035

FRAMEWORK FOR THE RADIO INTERFACE(S) AND RADIO SUB-SYSTEM FUNCTIONALITY
FOR INTERNATIONAL MOBILE TELECOMMUNICATIONS-2000 (IMT-2000)

(Question ITU-R 39/8)

(1994)

The ITU Radiocommunication Assembly,

recommends

that the elements addressed in this Recommendation be considered as the initial framework of concepts and principles regarding the International Mobile Telecommunications-2000 (IMT-2000) radio interface(s) and radio sub-system functionality.

In particular the Recommendation addresses three key factors:

- the concept of radio interface(s) based on core elements common to all interfaces and extensions to these elements;
- the establishment of transmission independent and transmission dependent aspects of the interface(s);
- the adoption of a flexible layered cell structure.

The Recommendation refines the concept of IMT-2000 and will be used to guide future Recommendations that will specify IMT-2000 in more detail.

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1. Introduction

International Mobile Telecommunications-2000 (IMT-2000) are third generation mobile systems (TGMS) which are scheduled to start service around the year 2000 subject to market considerations. They will provide access, by means of one or more radio links, to a wide range of telecommunication services supported by the fixed telecommunication networks (e.g. PSTN/ISDN), and to other services which are specific to mobile users.

A range of mobile terminal types is encompassed, linking to terrestrial and/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 quality,
- use of a small pocket-terminal with worldwide roaming capability.

IMT-2000 are defined by a set of interdependent ITU Recommendations of which this one is a member.

This Recommendation forms part of the process of specifying the radio interface(s) of IMT-2000. IMT-2000 will operate in the worldwide bands identified by the World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992) (WARC-92) (1 885-2 025 and 2 110-2 200 MHz, with the satellite component limited to 1 980-2 010 and 2 170-2 200 MHz).

The subject matter of IMT-2000 is complex and its representation in the form of Recommendations is evolving. To maintain the pace of progress on the subject it is necessary to produce a sequence of Recommendations on a variety of aspects. The Recommendations strive to avoid apparent conflicts between themselves. Future Recommendations, or revisions, will be used to resolve any discrepancies.

2. Scope

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 sub-system. The radio sub-system 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 on Requirements for the radio interface(s) for International Mobile Telecommunications-2000 (IMT-2000).

The Recommendation provides a high-level definition of logical elements and functionalities within the radio sub-system, 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.

3. Structure of the Recommendation

In § 4 issues relating to other Recommendations are discussed. Section 5 addresses definitions. Section 6 states the considerations that have been taken into account in the production of this Recommendation. In § 7 the radio interface(s) is defined and characterised. Section 8 outlines the protocol structure. Section 9 outlines the channel structure and multiplexing. Section 10 outlines the cellular structure and related issues. Section 11 outlines the link control and system management functions, which include link quality measurement, channel selection/assignment, handover and mobility supporting functions. Finally, Section 12 is a collection of specific issues that need to be addressed as a part of the radio sub-system specification in order to meet the system performance requirements.

4. Related documents

- Recommendation ITU-R M.687: International Mobile Telecommunications-2000 (IMT-2000)
- Recommendation ITU-R M.816: Framework for services supported on International Mobile Telecommunications-2000 (IMT-2000)
- Recommendation ITU-R M.817: International Mobile Telecommunications-2000 (IMT-2000). *Network architectures*
- Recommendation ITU-R M.818: Satellite operation within International Mobile Telecommunications-2000 (IMT-2000)
- Recommendation ITU-R M.819: International Mobile Telecommunications-2000 (IMT-2000) for developing countries
- Recommendation ITU-R M.1034: Requirements for the radio interface(s) for International Mobile Telecommunications-2000 (IMT-2000)
- 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
- Recommendation ITU-R M.1079: Speech and voice band data performance requirements for International Mobile Telecommunications-2000 (IMT-2000)
- Recommendation ITU-R M.1225: Guidelines for evaluation of radio transmission technologies for IMT-2000

5. Definitions

The terms used in this Recommendation are consistent with definitions used in other ITU-R Recommendations regarding IMT-2000.

6. Considerations

In the development of this Recommendation the following considerations, *inter alia*, have been taken into account:

- a) the relevant ITU-R and ITU-T Recommendations and ongoing studies;
- b) that system compatibility is necessary for international operation, and that commonality is desirable in any event to ensure that the overall cost per mobile user is significantly less than it is with present systems;
- c) the need for a flexible system structure able to match network investment to the revenue growth, to adapt readily to environmental factors and to respond to new developments without restricting innovation;
- d) the need for mobile stations (including those with satellite capability) to roam between mobile telecommunication networks in different countries;
- e) that standardised radio interface(s) would facilitate the roaming of mobile stations between networks;
- f) that satellite operation within IMT-2000 holds the possibility of significantly enhancing the overall coverage and attractiveness of the services;
- g) the increasing importance of spectrum efficiency and the need for ease of spectrum management, both within and between countries/regions;
- h) the radio interface(s) should be designed with scope for innovation, for example the later inclusion of services and features not envisaged yet.

7. Radio interface(s) definition and characteristics

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

The IMT-2000 radio interface specification consists of a statement of the form and content of the signals transmitted from stations. The specification contains the definition of functional characteristics, common radio (physical) interconnection characteristics, signal characteristics, and other characteristics, as appropriate.

It should be noted that the satellite operating characteristics have many differences to the terrestrial operating characteristics. See § 10.1 for details on the satellite operating characteristics.

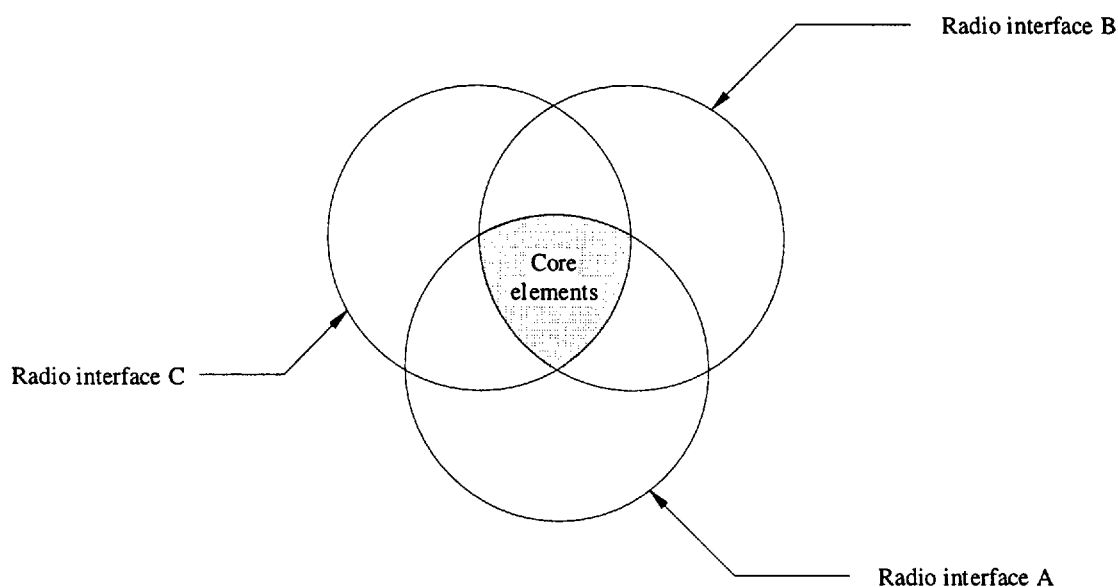
7.1 Commonality of the radio interface(s)

IMT-2000 may need to use more than one radio interface in order to meet various operating environment or application needs. However, IMT-2000 users may want the ability to use one terminal to access a given set of services in more than one operating environment.

It is desirable to minimise the number of radio interfaces. If multiple interfaces are needed, the degree of commonality between these interfaces should be maximised. Minimising the number of radio interfaces and maximising commonality between different radio interfaces would facilitate inter-operability while minimising cost. Maximising commonality would also facilitate the incorporation of different radio interfaces into a single portable terminal at a reasonable cost.

Commonality is defined as a common group of core elements that may or may not comprise a complete radio interface (see Fig. 1).

FIGURE 1
Core elements concept



The core elements concept should facilitate the definition of a universal platform that can be easily adapted to the various environment and service usage requirements. Manufacturers would benefit from such design if, due to the algorithmic flexibility inherent in digital systems of modular design, the adaptation capabilities are implemented as “software” reconfigurations of various modules in the transmission chain.

It is important that IMT-2000 support terminal mobility where the same terminal can be used in all environments if desired. This means that it must be possible to move between the different environments with the same terminal. It is impractical to provide terminal mobility for all possible services in all environments; therefore, a set of basic service functions must be defined for which full terminal mobility in all radio operating environments is desired.

A target for the IMT-2000 radio interface(s) is to support the possibility of using one low cost hand-portable terminal in a large number of operating environments with access to at least a minimum set of all services.

Restrictions in terms of bandwidth, range, and complexity imply that it may not be feasible for a single radio interface to support the use of an IMT-2000 terminal in all operating environments with access to all services. In this case the number of different radio interfaces should be made as small as possible with the restriction of not imposing too high complexity.

Radio interface(s) should be developed using layered and building block approaches in order to maximise commonality and allow flexibility. Radio interface specifications should allow for the use of standardised extensions to a set of interface core elements to facilitate changes in service based on users' needs, radio environments, and other factors. The use of these extensions should also facilitate the development of new services and capabilities.

7.2 Layered approach to commonality

A layered approach is used to clearly define the interface structure and protocols required to support telecommunication services. Additional advantages are identified by employing a layered approach; examples include the inter-system availability of software packages developed for signalling/communication layers of specific systems. Another advantage identified in mobile radio communication is the ability to separate radio interface functions as transmission independent and transmission dependent. This separation may require a sub-layered structure. The set of transmission independent functions should be maximised to facilitate interoperability across different radio interfaces. For example:

a) *Transmission independent:*

- application protocol,
- call control,
- identity, validation and confidentiality,
- registration and location control,
- acknowledgement control and error recovery procedure in flow control,
- maintenance and configuration,
- logical channel structure and multiplexing.

b) *Transmission dependent:*

- RF functionalities,
- radio resource management,
- error detection/correction.

A common protocol can be applied to the transmission independent part for all radio interfaces. The building block approach and the choice of an appropriate set of interface core elements would be used to maximise commonality. Additional discussion of protocol layering is contained in § 8.

7.3 Building block approach to commonality

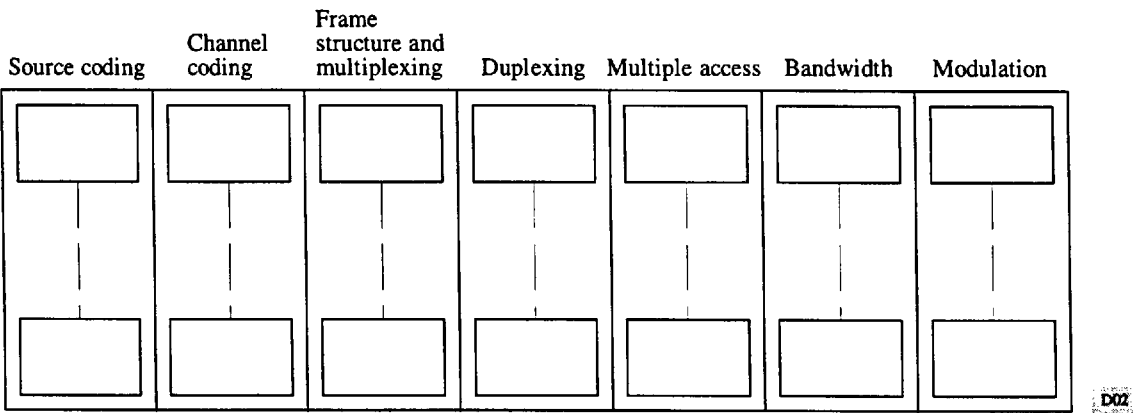
The set of the basic building blocks that may make up the transmission dependent portion of a low layer radio interface include the following:

- transmission multiplexing,
- transmission frame structure,
- duplexing method,
- RF channel bandwidth choice,

- source coder bit-rate and algorithm selection,
- channel coding and interleaving,
- multiple access method,
- modulation scheme.

A system comprised of these building blocks could be optimally designed for each operating environment or user application (see Fig. 2).

FIGURE 2
Building block approach to maximising commonality of multiple radio interfaces



The transmission dependent portion of a radio interface may be specified by combining choices made within each building block.

A set of core elements can be defined as common to all radio interfaces. This set may or may not define a complete radio interface with respect to some set of applications.

To define the concept of commonality and the procedures to maximise commonality the following model is helpful:

- specify a set of applications by identifying all possible combinations of services and operating environments. This set of applications shall, by its specification, be a complete list of all features offered to the IMT-2000 user;
- define a generic set of building blocks that constitute a radio interface;
- use these sets as axes in a matrix demonstrating the two approaches. The matrixes are shown in § 7.4.

7.4 Approaches to achieve commonality

Figures 3 and 4 conceptualise how the core elements of the radio interface can be used to maximise commonality. The process of defining the IMT-2000 interface(s) contains two steps:

- defining core elements. The core elements may or may not define a complete radio interface with respect to some set of applications;
- finding extensions to the core elements to support all applications.

Methods to achieve this can be:

Method 1 – Focusing the efforts to a best suited set of core elements that may not define a complete radio interface but with a number of suitable extensions gives a cost/complexity optimised solution for the entire set of applications. To specify a complete radio interface for a minimum set of applications, a number of non-core elements may need to be added to the core elements.