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

(Question ITU-R 39/8)

(1994)

1. Preface

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. Purpose

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 minimising the impact on other systems and services in the bands and facilitating IMT-2000 growth as countries require it.

The ITU Radiocommunication Assembly,

considering

a) that the WARC-92 identified the bands 1 885-2 025 MHz and 2 110-2 200 MHz as being available on a worldwide basis for use by the terrestrial component of IMT-2000;

b) that the WARC-92 also identified within these bands the portions 1 980-2 010 MHz and 2 170-2 200 MHz as being available on a worldwide basis for use by the satellite component of IMT-2000 from the year 2005;

c) that the initial implementation of the terrestrial component of IMT-2000 is expected to commence by the year 2000 subject to market considerations;

d) that the simultaneous availability of both the terrestrial and satellite components of IMT-2000 would improve the overall implementation and attractiveness of IMT-2000 to both developed and developing countries;

e) that the bands identified in § a) above are shared with other systems of the mobile, fixed and mobile-satellite services and a portion with the space research service, many of which are in use now;

f) that these bands are used differently in various countries;

g) that the traffic and service mix carried by IMT-2000 networks may vary from country to country, and within countries, and that in many locations or parts of the world a bandwidth of less than 230 MHz could be adequate to meet IMT-2000 service demands;

h) the need to support the operation of IMT-2000 terminals in different regulatory environments including unregulated (residential and business cordless telephone) applications and regulated (public access) applications;

j) that the various radio access technologies that may be appropriate for IMT-2000 have not yet been selected, and that such technologies may have different channel bandwidth requirements, and hence varying impact on the basic frequency usage possibilities;

k) that traffic handled by mobile systems as well as the number and diversity of services will continue to grow;

l) that worldwide compatibility, possibly including a partial common frequency sub-band, would facilitate international roaming and therefore have a major positive impact on the personal station component of IMT-2000;

m) that future systems may include the use of a range of cell types from indoor cells to satellite cells, which must be able to coexist in a given location,

noting

a) that Administrations are seeking guidance as to proposed use of the 230 MHz spectrum identified for IMT-2000 at the WARC-92, which in its Resolution No. 212 of the WARC-92 reflected the ex-CCIR estimates of minimum requirements for IMT-2000 spectrum of approximately 170 MHz for mobile stations and 60 MHz for personal stations;

b) that many of the technical characteristics of IMT-2000 have still to be developed and defined by the ITU;

c) that early information on the principles covering the use of the relevant bands by IMT-2000 can assist Administrations to plan their future use of these bands;

d) that to make the best possible use of the available spectrum and to facilitate sharing with other services, IMT-2000 could employ advanced dynamic frequency assignment techniques to avoid harmful interference to co-frequency services;

e) that the two 30 MHz-wide bands available globally for the satellite component of IMT-2000 are together suited to frequency division duplex with a 190 MHz duplex spacing;

f) that potential duplex techniques considered for use by IMT-2000 include time division duplex (TDD) which uses a single band and frequency division duplex (FDD) which can use paired bands with sufficient frequency separation (the total amount of spectrum is the same for either technique). Allocations of spectrum segments appropriate to FDD implementations are generally also satisfactory for TDD implementations but the converse is not necessarily true; TDD offers the opportunity to exploit unpaired segments of spectrum;

g) that there are many possible forms of FDD implementation and that if, for example, the 190 MHz duplex spacing of the satellite component is used for terrestrial FDD systems, the sub-bands 1 920-2 010 MHz and 2 110-2 200 MHz together could provide up to twice 90 MHz for FDD operation. In this case the remaining sub-bands 1 885-1 920 MHz (35 MHz wide) and 2 010-2 025 MHz (15 MHz wide) would be less well suited to FDD operation but could be well suited to TDD operation (see *noting* b)),

recommends

1. that Administrations, in planning the implementation of IMT-2000, in the bands as identified, do so on the basis of the following objectives:

1.1 to facilitate introduction of IMT-2000 around the year 2000 subject to market considerations;

1.2 to facilitate growth of IMT-2000 as countries require it;

1.3 to minimise impact on other systems and services using the IMT-2000 bands;

1.4 to preserve flexibility of system implementation, including choice of multiple access, duplex, and modulation techniques until standards for IMT-2000 radio interface(s) have been established and Recommendations have been adopted by the ITU;

1.5 to facilitate worldwide roaming of terminals;

1.6 to integrate efficiently the terrestrial and satellite components of IMT-2000;

1.7 to optimise the efficiency of spectrum utilisation within the IMT-2000 bands;

1.8 to allow the possibility for competition;

1.9 to facilitate the use of IMT-2000 for fixed and other special applications such as those of developing countries;

1.10 to accommodate various types of traffic and traffic mixes;

1.11 to facilitate worldwide equipment standards;

1.12 to minimise terminal costs, size and power consumption, where appropriate and consistent with other requirements;

2. that Administrations, in planning the implementation of IMT-2000, in the bands as identified, do so on the basis of the following principles:

2.1 in order to maintain flexibility, the bands identified for IMT-2000 should not, ideally, be segmented for different types of IMT-2000 radio interfaces or services except where necessary for technical reasons. For example, it may be necessary to separate the terrestrial and satellite components of IMT-2000 in this way (see § 2.5);

2.2 the bands identified for IMT-2000 should be utilised to facilitate the achievement of optimum spectrum utilisation efficiency. Indeed IMT-2000 may need to have the flexibility/capability to support multiple service providers or networks within the same spectrum (see *noting* d) and also Appendix 1);

2.3 appropriate spectrum provision should be made to meet the needs of worldwide roaming;

2.4 common worldwide traffic or, at least, signalling sub-bands should be adopted;

2.5 any band segmentation between the satellite and terrestrial components of IMT-2000 should be flexible in order to accommodate the varying needs of different countries;

2.6 pre-implementation trials and testing may require the availability of the bands identified for IMT-2000 prior to the year 2000, at least in part; this could promote investment confidence;

3. that Administrations, in planning the implementation of IMT-2000, in the bands as identified, do so on the basis of the following criteria to be applied in evaluating the spectrum aspects of implementation strategies:

3.1 ability to share spectrum with existing spectrum users;

3.2 ability to efficiently support use of spectrum by more than one network operator or service provider;

3.3 ability to support use of the technology for fixed applications, including those of developing countries;

4. that Administrations, in planning the implementation of IMT-2000, in the bands as identified, do so on the basis of the following sharing constraints which need to be taken into account.

Constraints on spectrum use include sharing with other land mobile, satellite and fixed service systems, and implementation methods (see Recommendation ITU-R M.687, Annex 2).

4.1 Sharing aspects of duplexing method

A common frequency division duplex spacing between the terrestrial and satellite components of IMT-2000 would facilitate inter-operability between these components and result in reduced cost and complexity for inter-operable terminals, however, consideration of compatibility with other services utilising the band may necessitate the choice of other duplex spacings or duplex methods.

4.2 Sharing with other land mobile systems

The bands identified for IMT-2000 (1 885-2 025 MHz and 2 110-2 200 MHz) are in many countries presently being used or planned to be used for other applications of the land mobile service.

4.3 Sharing constraints with mobile satellite

The bands 1 980-2 010 MHz (1 970-2 010 MHz in Region 2) and 2 170-2 200 MHz (2 160-2 200 MHz in Region 2) are also allocated to the mobile-satellite service on a primary basis which includes the satellite component of IMT-2000. The IMT-2000 satellite and terrestrial components may have to share this band and the degree of sharing may vary in different regions. In parts of Europe, portions of the band may be used largely for terrestrial IMT-2000 (see also § 2.5). It should be noted that flexible band segmentation between the terrestrial and satellite services may introduce complexities in the satellite receivers e.g. the necessity of having variable width filters.

Studies have indicated that the high density of personal stations of the IMT-2000 terrestrial component could cause unacceptable interference to geostationary-satellite orbit (GSO) mobile-satellite reception in shared up link bands viz. 1 980-2 010 MHz (1 970-2 010 MHz in Region 2). The power flux-density from a single large metropolitan area would be sufficient to cause such unacceptable interference – even a 1° satellite beam would intercept multiple metropolitan areas. These studies were confirmed by similar studies on potential sharing with the scientific space services at 2 GHz. Note that, although these studies refer to the GSO, this issue also applies in principle to all orbits. Given the potential difficulties, it is preferable that the terrestrial component of IMT-2000 should not use the MSS bands until the traffic requirements of the terrestrial and satellite components are better defined.

4.4 Sharing constraints with fixed terrestrial services

In many parts of the world portions of the bands 1 885-2 025 MHz and 2 110-2 200 MHz are used by existing terrestrial fixed services.

Note 1 – Ongoing studies within the Radiocommunication Study Groups are addressing this issue.

4.5 Sharing issues between satellite systems

The selection of a particular satellite orbit configuration may have an impact on the optimum methods of using the IMT-2000 spectrum.

Non-geostationary satellites on an orbit inclined to the equatorial plane and with a period which is not synchronized with the Earth's rotation may roam anywhere above any point of the Earth's surface between the North and South latitudes corresponding to the inclination angle. That means that a frequency band for such a non-geostationary satellite system should be assigned considering the interference with other satellite systems as well as terrestrial systems within the relevant area.

Sharing and coordination between non-geostationary and geostationary satellites is currently under study in the ITU;

5. that Administrations in planning the implementation of IMT-2000, should use as a framework the following development paths for IMT-2000:

5.1 within the bands identified for IMT-2000 by WARC-92, designate some sub-bands for implementing the terrestrial and satellite components of IMT-2000, including sub-bands for experimental purposes;

5.2 if possible, choose sub-bands which could be available worldwide;

5.3 expand these sub-bands as required within the IMT-2000 identified bands according to local needs;

5.4 preferably refrain from using the MSS bands for the terrestrial component of IMT-2000 until the traffic requirements of the terrestrial and satellite components are better defined.

Note 1 – Information on common sub-band aspects and dynamic spectrum management issues is given in Appendix 1.

APPENDIX 1

Common sub-band aspects and dynamic spectrum management issues

The following text is supplementary information on the issues of common sub-bands and dynamic spectrum management.

1. Common sub-band aspects

International roaming could be facilitated by globally available common sub-bands. These should be available in both the terrestrial and satellite frequency bands, to an extent depending on the traffic requirements.

1.1 Common traffic sub-bands

Worldwide common traffic sub-bands simplify the ability of roamers to access automatically the IMT-2000 traffic bands to receive service. Roaming terminals would normally operate in these commonly agreed traffic sub-bands, but would not be precluded from operation in other parts of the IMT-2000 bands, providing that this was permitted by the respective Administration and supported by a network operator.

Common traffic sub-bands would have to be sufficiently wide to support acquisition, signalling, registration and subsequent call traffic of a roaming terminal. These sub-bands could also carry signalling information identifying alternative (additional) traffic sub-bands which may exist in a given country or operator's network and which a given country may additionally wish to make available for roaming use. In addition to providing service-offering flexibility, this facility could be one method of providing scope for growth of the common roaming sub-bands as traffic grows, if desirable.

1.2 Common signalling sub-bands

Roaming terminals may have to operate in a number of different traffic sub-bands if not all Administrations are able to agree on common traffic sub-bands. In this case international roaming could still be achieved, provided that roaming terminals are able to operate across the complete IMT-2000 bands.

One or more common worldwide signalling sub-bands would then facilitate the implementation of international roaming. These could be a series of broadcast identification channels to be designated, spaced, for example, at 5 MHz intervals throughout the identified IMT-2000 bands, with one or more of these implemented as appropriate and necessary by each IMT-2000 system. A newly activated terminal would scan each of the designated channels until it found an active identification transmission.

2. Dynamic spectrum management issues

It is possible that IMT-2000 may use some form of dynamic partitioning or intelligent spectrum sharing.

A dynamic allocation mechanism is generally preferable to fixed partitioning of the bands into classes such as indoor, outdoor, large cell, satellite, etc. The feasibility of this approach for IMT-2000 requires further study.

A key to this dynamic allocation is the ability of radio equipment to operate throughout the IMT-2000 bands. This flexibility would also aid worldwide operation when different parts of the IMT-2000 bands become available at different times in the various countries or regions.

Another important approach would be for the mobile terminal to be essentially a slave to the local base station as far as control of which parts of the IMT-2000 spectrum are available for use in any given location. This would also facilitate sharing with existing users such as fixed microwave links. In such a case there would need to be an agreed procedure for the mobile terminal to find the local "broadcast" channel and adapt to the requirements of the local base station.

In the case of say three or more operators drawing spectrum, (e.g. in "basic" channels, as required, on a real time basis) from a common pool, there needs to be an agreed procedure which all obey. It is of course possible and perhaps desirable to have only some of the "basic" channels dynamically assigned to a given use or operator.

There are many advantages to such a scheme for network operators, service providers and regulators. Such a procedure could be standardised and used by the network operators and service providers to manage their spectrum use. It should be noted that since in this case mobile terminals use spectrum identified by the system this dynamic spectrum management is transparent and so a global system could provide mobile coverage in areas using fixed spectrum assignments.

Separate frequency assignments for public (licensed) networks and private (licence-exempt) networks is desirable unless a dynamic allocation method can be found which guarantees that use of common spectrum does not result in degradation of operating conditions for either type of network.