RECOMMENDATION ITU-R M.1036-3

Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications-2000 (IMT-2000) in the bands* 806-960 MHz**, 1 710-2 025 MHz, 2 110-2 200 MHz and 2 500-2 690 MHz

(Question ITU-R 229/8)

(1994-1999-2003-2007)

1 Introduction

International Mobile Telecommunications-2000 (IMT-2000) are third generation mobile systems which provide access to a wide range of telecommunications services, supported by the fixed telecommunications networks (e.g. PSTN/ISDN/IP), and to other services that are specific to mobile users.

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;

– small terminal suitable for worldwide use;

– worldwide roaming capability;

– capability of multimedia applications and a wide range of services and terminals.

The capabilities of IMT-2000 systems are being continuously enhanced in line with user needs and technology trends.

IMT-2000 will operate in the frequency bands identified in the Radio Regulations (RR) as intended for use on a worldwide basis by administrations wishing to implement IMT-2000, as follows:

WARC-92 identified the bands:

– 1 885-2 025 MHz

– 2 110-2 200 MHz

and WRC-2000 identified the bands:

– 806-960 MHz**

– 1 710-1 885 MHz

– 2 500-2 690 MHz (for the terrestrial component and parts of it for the satellite component of IMT-2000,

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* Some administrations may deploy IMT-2000 systems in bands other than those identified here.

** The whole band 806-960 MHz is not identified on a global basis for IMT-2000 due to variation in the primary mobile service allocations and uses across the three ITU Regions.

for possible use by IMT-2000 systems, noting (in accordance with RR No. 5.388) that identification of these bands does not establish priority in the RR and does not preclude use of the bands for any other services to which these bands are allocated. Also, some administrations may deploy IMT-2000 systems in bands other than those identified in the RR.

2 Scope[1]

The scope of this Recommendation is to provide guidance on the selection of transmitting and receiving frequency arrangements for the terrestrial component of IMT-2000 systems as well as the arrangements themselves, with a view to assisting administrations on spectrum-related technical issues relevant to the implementation and use of the terrestrial component of IMT-2000 in the bands identified in the RR. The frequency arrangements are recommended from the point of view of enabling the most effective and efficient use of the spectrum to deliver IMT-2000 services – while minimizing the impact on other systems or services in these bands – and facilitating the growth of IMT-2000 systems.

3 Objectives

In planning the implementation of IMT-2000, in accordance with Resolution 223 (WRC-2000), the following objectives are desirable:

– to ensure that frequency arrangements for the implementation of IMT-2000 have longevity, yet allow for the evolution of technology;

– to facilitate the deployment of IMT-2000, subject to market considerations and to facilitate the development and growth of IMT-2000;

– to minimize the impact on other systems and services within, and adjacent to, the bands identified for IMT-2000;

– to facilitate worldwide roaming of IMT-2000 terminals;

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

– to optimize the efficiency of spectrum utilization within the bands identified for IMT-2000;

– to enable the possibility of competition;

– to facilitate the deployment and use of IMT-2000, including fixed and other special applications in developing countries and in sparsely populated areas;

– to accommodate various types of traffic and traffic mixes;

– to facilitate the continuing worldwide development of equipment standards;

– to facilitate access to services globally within the framework of IMT-2000;

– to minimize terminal costs, size and power consumption, where appropriate and consistent with other requirements;

– to facilitate the evolution of pre-IMT-2000 systems to any of the IMT-2000 terrestrial radio interfaces as specified in Recommendation ITU-R M.1457.

Flexibility is afforded to administrations:

– to determine, at a national level, how much spectrum to make available for IMT-2000 from within the identified bands;

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[1] This Recommendation should in no way prejudge or impact the decision to be taken by WRC-07 under Agenda item 1.4 with respect to the frequency band below those currently identified in RR No. 5.317A for IMT-2000 and systems beyond IMT-2000.

– to develop their own transition plans, if necessary, tailored to meet their specific deployment of existing systems;
– to have the ability for the identified bands to be used by all services having allocations in those bands;
– to determine the timing of availability and use of the bands identified for IMT-2000, in order to meet particular market demand and other national considerations.

The following guiding principles have been applied in determining frequency arrangements:

– harmonization;
– technical aspects;
– spectrum efficiency.

4 Related Recommendations

The existing IMT-2000 Recommendations that are considered to be of importance for this particular Recommendation are as follows:

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.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.1033:	Technical and operational characteristics of cordless telephones and cordless telecommunication systems
Recommendation ITU-R M.1034:	Requirements for the radio interface(s) for International Mobile Telecommunications-2000 (IMT-2000)
Recommendation ITU-R M.1035:	Framework for the radio interface(s) and radio sub-system functionality for International Mobile Telecommunications-2000 (IMT-2000)
Recommendation ITU-R M.1073:	Digital cellular land mobile telecommunication systems
Recommendation ITU-R M.1167:	Framework for the satellite component of International Mobile Telecommunications-2000 (IMT-2000)
Recommendation ITU-R M.1224:	Vocabulary of terms for International Mobile Telecommunications-2000 (IMT-2000)
Recommendation ITU-R M.1308:	Evolution of land mobile systems towards IMT-2000
Recommendation ITU-R M.1390:	Methodology for the calculation of IMT-2000 terrestrial spectrum requirements
Recommendation ITU-R M.1457:	Detailed specifications of the radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)
Recommendation ITU-R SM.329:	Unwanted emissions in the spurious domain.

5 Recognitions and considerations

In order to determine the principles and practical use of the spectrum for IMT-2000 systems it is recognized:

Regarding spectrum band/frequency usage

a) that the RR identify the bands 806-960 MHz**, 1 710-2 025 MHz, 2 110-2 200 MHz and 2 500-2 690 MHz as intended for use on a worldwide basis by administrations wishing to implement IMT-2000, as indicated in RR Nos. 5.388, 5.384A and 5.317A and in Resolutions 212 (Rev.WRC-97), 223 (WRC-2000), 224 (WRC-2000), 225 (WRC-2000) and 228 (WRC-03); by taking these provisions and Resolutions into account, flexibility should be afforded to administrations to decide on using these bands at the national level according to each administration's evolution/migration plan;

b) that in some countries, other services are in operation in the bands identified for IMT-2000 as indicated in Resolution 225 (WRC-2000), RR Nos. 5.389A, 5.389C, 5.389D, 5.389E and Recommendations ITU-R M.1073 and ITU-R M.1033;

In order to determine the principles and practical use of the spectrum for IMT-2000 systems, it is considered:

c) that a minimized number of globally harmonized frequency arrangements in the bands identified for IMT-2000 by one or more conferences willreduce the overall cost of IMT-2000 networks and terminals by providing economies of scale;

d) that when frequency arrangements cannot be harmonized globally, a common base and/or mobile transmit band would facilitate terminal equipment for global roaming. A common base transmit band, in particular, provides the possibility to broadcast to roaming users all information necessary to establish a call;

e) that when developing frequency arrangements possible technological constraints (e.g. cost efficiency, size and complexity of terminals, high speed/low power digital signal processing and the need for compact batteries) should be taken into account;

f) that guardbands for IMT-2000 systems should be minimized to avoid wasting spectrum;

g) that Report ITU-R M.2031 – Compatibility between WCDMA 1800 downlink and GSM 1900 uplink, addresses adjacent band compatibility at 1 850 MHz;

h) that when developing frequency arrangements, current and future technological advances (e.g. multimode/multiband terminals, enhanced filter technology, adaptive antennas, advanced signal processing techniques, variable duplex technology and wireless connectivity peripherals) should be taken into account;

j) that sufficient frequency separation between transmitter and receiver frequencies must exist in a frequency division duplex system;

k) that certain compatibility studies have been undertaken to consider coexistence between services and between systems in frequency bands identified for IMT-2000, for instance, on sharing and adjacent band compatibility with the satellite component of IMT-2000 in the 2 GHz and 2.2 GHz ranges as outlined in Annex 1;

Regarding traffic aspects

l) that individual subscriber traffic in IMT-2000 systems is expected to be dynamically asymmetric where the direction of asymmetry can vary rapidly within short (ms) time-frames;

m) that per cell level traffic for IMT-2000 systems is expected to be dynamically asymmetric where the direction of asymmetry will vary based on the aggregate subscriber traffic;

n) that IMT-2000 network traffic may change in asymmetry over the longer term;

Regarding technology aspects

o) that the IMT-2000 radio interfaces are detailed in Recommendation ITU-R M.1457;

p) that IMT-2000 has two modes of operation – frequency division duplex (FDD) and time division duplex (TDD);

q) that Report ITU-R M.2030 and Report ITU-R M.2045 address coexistence and mitigation techniques, respectively, between IMT-2000 TDD and FDD radio interface technologies within the frequency range 2 500-2 690 MHz operating in adjacent bands and in the same geographical area;

r) that selectable/variable duplex technology is considered to be one technique that can assist in the use of multiple frequency bands to facilitate global and convergent solutions. Such a technology could bring further flexibility that would enable IMT-2000 terminals to support multiple frequency arrangements;

s) that the Reports identified in consideration q) above can assist in determining means to ensure coexistence, e.g. guardband requirements, between the FDD and TDD systems;

Regarding other aspects

t) that there may be the need to support the operation of IMT-2000 terminals for self-provided applications[2].

6 Recommendations

6.1 Frequency arrangements

6.1.1 Paired frequency arrangements in the band 806-960 MHz

The recommended frequency arrangements in these bands, taking into consideration existing public mobile systems, should be used as summarized in Table 1 and in § 6.1.4.1.

[2] Self-provided applications are expected to develop to complement the services provided by operators and may be provided by businesses or private individuals to cover their own offices or residences, and may stand alone or connect to other networks. A key characteristic of self-provided services, apart from their short range, will be that their availability is not guaranteed because they will operate in spectrum shared with other similar users. An example could be a museum that installs a system to provide communications between staff, and to provide guided tours and souvenir shopping to visitors. Self-provided applications are expected to develop to operate at lower powers, in self-coordinating mode.

TABLE 1

Paired frequency arrangements in the band 806-960 MHz

Frequency arrangements	Mobile station transmitter (MHz)	Centre gap(1) (MHz)	Base station transmitter (MHz)	Duplex separation(2) (MHz)
A1	824-849	20	869-894	45
A2	880-915	10	925-960	45

NOTE 1 – Due to the overlap of base station transmitter and mobile station transmitter bands and the different usage of the bands 806-824 MHz, 849-869 MHz and 902-928 MHz between Regions, there is no common solution possible in the near- and medium-terms.

(1) *Centre gap* – the frequency separation between the upper edge of the lower band and the lower edge of the upper band in an FDD paired frequency arrangement.

(2) *Duplex band frequency separation* – the frequency separation between a reference point in the lower band and the corresponding point in the upper band of an FDD arrangement.

6.1.2 Frequency arrangements in the band 1 710-2 200 MHz[3]

The recommended frequency arrangements in these bands, taking into consideration existing public mobile systems, should be used as summarized in Table 2 and in § 6.1.4.2.

TABLE 2

Frequency arrangements in the band 1 710-2 200 MHz

Frequency arrangements	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	Un-paired spectrum (e.g. for TDD) (MHz)
B1	1 920-1 980	130	2 110-2 170	190	1 880-1 920; 2 010-2 025
B2	1 710-1 785	20	1 805-1 880	95	None
B3	1 850-1 910	20	1 930-1 990	80	1 910-1 930
B4 (harmonized with B1 and B2)	1 710-1 785 1 920-1 980	20 130	1 805-1 880 2 110-2 170	95 190	1 900-1 920; 2 010-2 025
B5 (harmonized with B3 and parts of B1 and B2)	1 850-1 910 1 710-1 770	20 340	1 930-1 990 2 110-2 170	80 400	1 910-1 930

3 The 2 025-2 110 MHz band is not part of this frequency arrangement.

Notes to Table 2:

NOTE 1 – Administrations can implement all or parts of these frequency arrangements.

NOTE 2 – In the band 1 710-2 025 and 2 110-2 200 MHz three basic frequency arrangements (B1, B2 and B3) are already in use by public mobile cellular systems including IMT-2000. Based on these three arrangements, different combinations of arrangements are recommended as described in B4 and B5. The B1 arrangement and the B2 arrangement are fully complementary, whereas the B3 arrangement partly overlaps with the B1 and B2 arrangements.

For countries having implemented the B1 arrangement, B4 enables optimization of the use of spectrum for paired IMT-2000 operation.

For countries having implemented the B3 arrangement, the B1 arrangement can be combined with the B2 arrangement. B5 is therefore recommended to optimize the use of the spectrum:

– B5 enables the use of spectrum to be maximized for IMT-2000 in countries where B3 is implemented and where the band 1 770-1 850 MHz is not available in the initial phase of deployment of IMT-2000 in this frequency band.

NOTE 3 – TDD may be introduced in unpaired bands and also under certain conditions in the uplink bands of paired frequency arrangements and/or in the centre gap between paired bands.

NOTE 4 – If selectable/variable duplex technology is implemented within terminals as the most efficient way to manage different frequency arrangements, the fact that neighbouring countries could select B5 will have no impact on the complexity of the terminal. Further studies are necessary.

6.1.3 Frequency arrangements in the band 2 500-2 690 MHz

The recommended frequency arrangements in this band, taking into consideration existing public mobile systems, should be used as summarized in Table 3 and in § 6.1.4.3.

TABLE 3

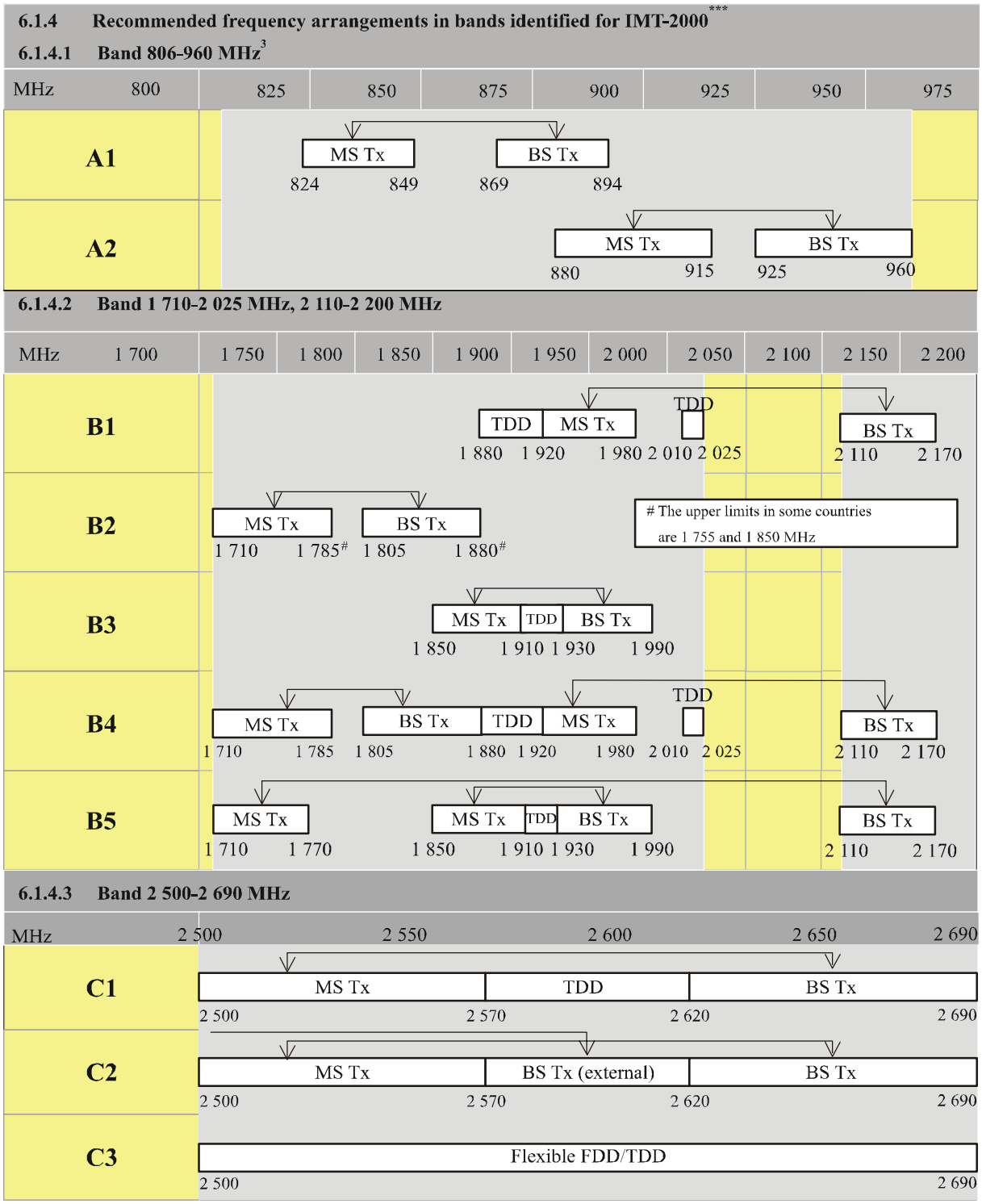
Frequency arrangements in the band 2 500-2 690 MHz (not including the satellite component)

Frequency arrangement	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	Centre gap usage
C1	2 500-2 570	50	2 620-2 690	120	TDD
C2	2 500-2 570	50	2 620-2 690	120	FDD DL (external)
C3	Flexible FDD/TDD				

NOTE 1 – Administrations can implement all or parts of these frequency arrangements, taking into account other services allocated in this band.

NOTE 2 – In C1, in order to facilitate deployment of FDD equipment any guardbands required to ensure adjacent band compatibility at the 2 570 MHz and 2 620 MHz boundaries will be decided on a national basis and taken within the band 2 570-2 620 MHz and should be kept to the minimum necessary, based on Report ITU-R M.2045.

NOTE 3 – In C3, administrations can use the band solely for TDD or some combination of TDD and FDD. Administrations can use any FDD duplex spacing or FDD duplex direction. However, when administrations choose to deploy mixed FDD/TDD channels with a fixed duplex separation for FDD, the duplex separation and duplex direction as shown in C1 are preferred.



*** Administrations can implement all or parts of these frequency arrangements.

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6.2 Traffic asymmetry implications

It is recommended that administrations and operators consider asymmetric traffic requirements when assigning spectrum or implementing systems.

In this context, asymmetry means that the basic amount of traffic may differ between the uplink and the downlink direction. As a possible consequence, the amount of resources needed for the downlink may differ from that of the uplink. Estimates for a mix of traffic are described in Report ITU-R M.2023. Suitable techniques to support asymmetric traffic are described in Report ITU-R M.2038.

It is noted that traffic asymmetry can be accommodated by a variety of techniques including flexible timeslot allocation, different modulation formats, and different coding schemes for the uplink and downlink. With equal FDD pairing for uplink and downlink, or TDD, a degree of traffic asymmetry can be accommodated. As there is not presently definite information on the nature of traffic asymmetry for future mobile traffic, care needs to be exercised in catering for traffic asymmetries by making hard spectrum decisions (e.g. unequal FDD uplink and downlink designations) as such actions may be irreversible.

6.3 Segmentation of the spectrum

It is recommended that the frequency arrangements not be segmented for different IMT-2000 radio interfaces or services except where necessary for technical and regulatory reasons.

It is recommended that the frequency arrangements should, to maintain flexibility of deployment, be available for use in either FDD mode, TDD mode, or both, and should not, ideally, be segmented between FDD and TDD modes in paired spectrum except where necessary for technical and regulatory reasons.

6.4 Duplex arrangement and separation

It is recommended that for all bands, IMT-2000 systems, when operating in FDD mode, should maintain the conventional duplex direction, with mobile terminal transmit within the lower band and base station transmit within the upper band. Studies have shown that this use is preferable when considering compatibility with MSS (see Annex 1) and with non-IMT-2000 terrestrial services, the development of dual mode satellite/terrestrial terminals, differences in propagation loss (resulting in changes in battery life and/or cell size), and the impact on global roaming.

In the conventional duplex direction for FDD terrestrial mobile systems, the mobile terminal transmits at the lower frequencies and the base station at the higher frequencies. This is because the system performance is generally constrained by the uplink link budget due to the limited transmit power of terminals. For the 2.6 GHz band, a reversal of the duplex direction would change the uplink link budget by about 1 dB, which would result in a coverage reduction of around 10%.

It is recommended that for administrations wishing to implement only part of an IMT-2000 frequency arrangement, the channel pairing[4] should be consistent with the duplex frequency separations of the full frequency arrangement.

6.5 Frequency availability

It is recommended that administrations make available the necessary frequencies for IMT-2000 system development in a timely manner.

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[4] Duplex channel frequency separation: the frequency separation between a specific channel carrier in the lower band and its paired channel carrier in the upper band of an FDD arrangement.

Annex 1

Satellite component sharing issues

The following conclusions are derived from studies undertaken for the bands identified for IMT-2000 at WARC-92 and for the frequency range 2 500-2 690 MHz (see Report ITU-R M.2041).

In the MSS uplink band, considering the e.i.r.p. of terrestrial IMT-2000 transmitters at high elevation angles and the number of terrestrial IMT-2000 stations, the aggregate interference from this large number of terrestrial IMT-2000 stations will be unacceptable to MSS satellite receivers.

In the MSS downlink band, sharing could lead to a decrease in cell size and/or capacity for the terrestrial IMT-2000 component.

In both the MSS uplink band and the MSS downlink band the interference between mobile earth stations and terrestrial IMT-2000 stations would impose significant limitations on satellite and/or terrestrial service areas and require complicated coordination.

For these reasons, it is clear that co-coverage, co-frequency sharing between the terrestrial and satellite components of IMT-2000 is not feasible unless techniques, such as the use of an appropriate guardband between the satellite component and the terrestrial component of IMT-2000 for the band 2 500-2 690 MHz, or other mitigation techniques are applied.

Further studies on implementation of the terrestrial component and complementary satellite component (hybrid systems) may be required.