International Telecommunication Union

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Radiocommunication Sector of ITU

Recommendation ITU-R M.1799

(03/2007)

Sharing between the mobile service and the mobile-satellite service in the band 1 668.4-1 675 MHz

M Series

Mobile, radiodetermination, amateur and related satellite services

International Telecommunication Union

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***Note**: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R M.1799

Sharing between the mobile service and the mobile-satellite service in the band 1 668.4-1 675 MHz

(2007)

Scope

This Recommendation addresses sharing between the mobile service and mobile-satellite service (MSS) in the band 1 668.4-1 675 MHz and recommends using the information contained herein in planning the use of this band.

The ITU Radiocommunication Assembly,

considering

a) that the band 1 668.4-1 675 MHz is allocated to the mobile service and mobile-satellite service (MSS) (Earth-to-space) on a primary basis;

b) that Resolution 744 (WRC-03) invites ITU-R to study, as a matter of urgency and in time for WRC-07, the use of the band 1 668.4-1 675 MHz by the mobile service, and to complete any relevant sharing studies between the mobile service and the MSS in this band, taking care to avoid undue constraints on either service;

c) that Appendix 7 of the Radio Regulations (RR) gives the methodology and parameter values to determine the coordination area for mobile earth stations with respect to potential interference from mobile earth stations to mobile stations;

d) that RR Article 21 contains no e.i.r.p. limits on mobile stations applicable in the band 1 668.4-1 675 MHz;

e) that studies regarding interference from mobile stations to MSS space stations are contained in Annex 1,

noting

a) that the studies in Annex 1 have shown that the unconstrained operation of some mobile systems and MSS networks would not be compatible in the band 1 668.4-1 675 MHz;

b) that the use of the band 1 668-1 675 MHz by MSS uplinks is likely to be in conjunction with the corresponding downlink band, 1 518-1 525 MHz,

recognizing

a) that RR Article 21 contains pfd limits applicable to MSS systems in the band 1 518-1 525 MHz and applicable to a certain defined geographical area between 71º W and 125º W, and that these limits prevent the operation of MSS systems in that geographical area and also preclude use of some orbital locations by MSS networks in the same band;

b) the *resolves* of Resolution 744 (WRC-03);

c) that RR No. 5.380 identifies the band 1 670-1 675 MHz for aeronautical public correspondence systems;

d) that, as shown in Annex 1, some types of mobile system would cause interference to MSS satellites above the acceptable level,

recommends

1 that, when planning use of the band 1 668.4-1 675 MHz, account should be taken of the following:

– to adequately protect MSS networks, the e.i.r.p. of transportable radio-relay stations should not exceed −27 dBW in a reference bandwidth of 4 kHz in the direction of the geostationary orbit;

– the operation of some types of mobile system which could be envisaged for this band, as detailed in Annex 1, would not be compatible with the use of this band by the MSS.

Annex 1

Interference calculations to assess sharing between the mobile service and the MSS in the band 1 668.4-1 675 MHz

1 Introduction

This Annex provides interference calculations based on the mobile system and mobile-satellite system characteristics currently available.

2 Characteristics of MSS satellite receivers

The band 1 668-1 675 MHz is allocated for MSS (Earth-to-space) but is unlikely to be useable in the United States of America, where alternative terrestrial uses are planned. This and other restrictions which are likely in other parts of the world mean that this band is unlikely to be used by non-GSO MSS systems. Where the band is used for MSS, it is likely to be paired with the band 1 518-1 525 MHz, which is allocated to MSS (space-to-Earth) and which is subject to coordination requirements with a number of countries which operate terrestrial systems. This situation probably prevents the downlink band being used by MSS systems operating “global” beams but will limit systems to those which make use of high-gain satellite antennas and small spot beams.

Hence the band 1 668-1 675 MHz is most likely to be used by GSO MSS systems employing multiple spot beams, of which representative characteristics are shown in Table 1.

TABLE 1

Representative space station parameters

Orbit	Geostationary
Peak antenna gain (dBi)	41
Polarization	Circular
Satellite receiver noise temperature (K)	501

Regarding the interference criterion for studies relating to sharing between the mobile service and MSS space stations, it is expected that any interference received at the satellite will be almost constant in power level and therefore a “long-term” sharing criterion of 6% $\Delta T/T$ or $I/N = -12$ dB has been used. This value is used as the threshold for coordination between GSO MSS systems, and has been used in previous sharing studies, for example those relating to sharing between mobile and MSS services in the band 2 500-2 690 MHz (see Report ITU-R M.2041).

3 Calculations of interference from mobile systems to an MSS satellite receiver

3.1 Interference from transportable radio-relay stations

Transportable radio-relay stations are used to provide temporary point-point links. They operate as part of the mobile service.

While there are a number of different systems in operation, they have generally similar characteristics which allow for a single set of representative characteristics. It may be noted that the systems all have wide tuning ranges, for example 1 350-1 850 MHz or 1 350-2 690 MHz. With respect to the transportable radio-relay antenna, the diameter can be taken as about 1.2 m, which gives a peak gain of about 24 dBi at 1 670 MHz. Using the reference antenna pattern for Recommendation ITU-R F.699, the side-lobe gain beyond 48º is 1.8 dBi. With respect to the transmitter power, the value of 7 dBW is taken as a representative maximum. To determine the power spectral-density of the transmitter, it is assumed that the maximum power would be used with the high bit-rate/wide bandwidth carriers and that the corresponding bandwidth is about 2 MHz.

The representative transportable radio-relay parameters are shown in Table 2.

Three scenarios are considered:

Scenario 1: Interference from the side-lobe of a transmitting antenna into a satellite at high elevation.

Scenario 2: Interference from the side-lobe of a transmitting antenna into a satellite at low elevation.

Scenario 3: Interference from the main-lobe of a transmitting antenna into a satellite at low elevation.

Results are shown in Table 2.

TABLE 2

Interference from transportable radio-relay systems to MSS space stations

Parameter	Unit	Scenario 1	Scenario 2	Scenario 3
Frequency	MHz	1 670	1 670	1 670
Elevation to satellite	degrees	90	5	5
Distance	km	35 786	41 127	41 127
Free space loss	dB	188.0	189.2	189.2
Satellite receiver temperature	K	501	501	501
Reference bandwidth	kHz	4	4	4

TABLE 2 (*end*)

Parameter	Unit	Scenario 1	Scenario 2	Scenario 3
Noise in reference bandwidth	dBW	–165.6	–165.6	–165.6
Criterion (*I*/*N*)	dB	–12	–12	–12
I maximum in reference bandwidth	dBW	–177.6	–177.6	–177.6
Satellite antenna gain	dBi	41	41	41
Polarization discrimination	dB	3	3	3
e.i.r.p. maximum in reference bandwidth	dBW	–27.6	–26.4	–26.4
Mobile station				
Transmitter power	dBW	7	7	7
Feeder loss	dB	0	0	0
Antenna gain towards satellite	dBi	1.8	1.8	24.0
Bandwidth	kHz	2 000	2 000	2 000
e.i.r.p. in reference bandwidth	dBW	–18.2	–18.2	4.0
Interference excess	**dB**	**9.4**	**8.2**	**30.4**

Each scenario considers only a single interferer within the satellite antenna beam.

In all cases interference exceeds the criterion and in the case of Scenario 3, where the transmitting antenna is directed towards the satellite, the excess is about 30 dB. These results suggest that power and/or pointing restrictions may be necessary to adequately protect the satellite receiver.

To protect the MSS satellite receiver from harmful interference, it would be necessary to limit the e.i.r.p. in the direction of the satellite to about –27 dBW in a reference bandwidth of 4 kHz. This figure assumes only a single interferer but considering the relatively low density of transportable radio-relay system, this is probably a reasonable assumption.

3.2 Interference from aeronautical public correspondence systems

Through RR No. 5.380, the bands 1 670-1 675 MHz and 1 800-1 805 MHz are intended for use, on a worldwide basis, by administrations wishing to implement aeronautical public correspondence. Such systems are no longer envisaged and it appears that there is no longer any interest in aeronautical public correspondence systems.

However RR No. 5.380 was retained by WRC-03 and hence the possibility exists for such systems to be implemented. Characteristics of the terrestrial flight telecommunication system (TFTS) are contained in Recommendation ITU-R M.1040. The system was designed to use the 1 670-1 675 MHz band for the ground-to-aircraft link and for the ground stations to use omnidirectional (in the horizontal plane) antennas. Therefore, only two scenarios need to be considered:

Scenario 1: Interference from a TFTS ground station to a satellite at a high elevation.

Scenario 2: Interference from a TFTS ground station to a satellite at a low elevation.

Results are shown in Table 3.

TABLE 3

Interference from TFTS ground stations to MSS space stations

Parameter	Unit	Scenario 1	Scenario 2
Frequency	MHz	1 670	1 670
Elevation to satellite	degrees	90	5
Distance	km	35 786	41 127
Free space loss	dB	188.0	189.2
Satellite receiver temperature	K	501	501
Reference bandwidth	kHz	4	4
Noise in reference bandwidth	dBW	–165.6	–165.6
Criterion (*I*/*N*)	dB	–12	–12
I maximum in reference bandwidth	dBW	–177.6	–177.6
Satellite antenna gain	dBi	41	41
Polarization discrimination	dB	3	3
e.i.r.p. maximum in reference bandwidth	dBW	–27.6	–26.4
Ground station			
Transmitter power	dBW	11	11
Feeder loss	dB	0	0
Antenna gain towards satellite	dBi	0	8
Bandwidth	kHz	22	22
e.i.r.p. in reference bandwidth	dBW	3.6	11.6
Interference excess	**dB**	**31.2**	**38.0**

The value of transmitter power is the maximum value given for an "en route" ground station. Other categories of ground station have a maximum value 10 dB lower but this still results in a significant excess of interference. These results suggest that any aeronautical public correspondence ground station would exceed the interference criterion at any visible satellite.

3.3 Interference from cellular or similar high-density mobile systems

Cellular or similar high-density mobile systems could be envisaged in the band 1 668.4-1 675 MHz. In one country, the band 1 670-1 675 MHz is used for a high-density mobile system and another country is planning to introduce such a system. Although such systems are currently limited to a specific geographical area, from the regulatory perspective there are no reasons why such systems could not be introduced more widely in the future and it is therefore necessary to consider the possible consequences of the introduction of such systems on MSS systems.

The mobile system characteristics used here are taken from those in Report ITU-R M.2039 which contains the characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analyses. For the base stations, the characteristics of a typical macro cell base station are used. Although actual system characteristics may vary from the ones used, the characteristics allow broad conclusions of the interference potential to be determined.

Four scenarios are considered:

Scenario 1: Interference from a mobile station into a satellite at high elevation (≈45º).

Scenario 2: Interference from a mobile station into a satellite at low elevation (≈0º).

Scenario 3: Interference from a base station into a satellite at high elevation (≈45º).

Scenario 4: Interference from a base station into a satellite at low elevation (≈0º).

Results are shown in Table 4.

TABLE 4

Interference from other mobile systems to MSS space stations

Parameter	Unit	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Frequency	MHz	1 670	1 670	1 670	1 670
Elevation to satellite	degrees	45	0	45	0
Distance	km	37 412	42 164	37 412	42 164
Free space loss	dB	188.4	189.3	188.4	189.3
Satellite receiver temperature	K	501	501	501	501
Reference bandwidth	kHz	4	4	4	4
Noise in reference bandwidth	dBW	–165.6	–165.6	–165.6	–165.6
Criterion *(I/N)*	dB	–12	–12	–12	–12
I maximum in reference bandwidth	dBW	–177.6	–177.6	–177.6	–177.6
Satellite antenna gain	dBi	41	41	41	41
Polarization discrimination	dB	3	3	3	3
e.i.r.p. maximum in reference bandwidth	dBW	–27.2	–26.3	–27.2	–26.3
Mobile/base station					
Transmitter power	dBW	–6	–6	13	13
Feeder loss	dB	0	0	1	1
Antenna gain towards satellite	dBi	0	0	–1(1)	14(1)
Bandwidth	kHz	5 000	5 000	5 000	5 000
e.i.r.p. in reference bandwidth (4 kHz)	dBW	–37.0	–37.0	–20.0	–5.0
Interference excess (single interferer)	**dB**	**–9.7**	**–10.7**	**7.3**	**21.3**
Interference excess (100 interferers)	**dB**	**10.3**	**9.3**	**27.3**	**41.3**

(1) Assumes 2.5º downtilt angle.

Each scenario considers interference from a single source. In practice there may be multiple co-frequency transmitters which increase the total interference received by the satellite and this is particularly the case for code division multiple access (CDMA) based networks, as envisaged here. As a rough estimate of the aggregate interference, the final row shows the interference excess assuming 100 simultaneous co-frequency interferers.

In the case of Scenarios 1, 2 and 3, it can be seen that a high level of interference can be expected from a mobile station or base station. Hence the use of such mobile networks would prevent the operation of MSS systems in the same geographic area. Considering the high levels of interference, particularly from MS base stations, excessive interference may also be caused to MSS systems providing service to adjacent or nearby geographic areas.

In the case of Scenario 4, interference significantly exceeds the criterion and even 20-25 dB of satellite antenna isolation will not be sufficient mitigation. This means that orbital locations where mobile service operations are visible from a low elevation angle may not be useable for MSS. Operation of these types of mobile systems in a particular country could therefore prevent MSS operations in other countries even with considerable geographic separation. The MSS satellite would therefore be likely to receive interference considerably in excess of the criterion from unpredictable locations.

4 Conclusions

All of the mobile systems considered have the potential to cause excessive interference to MSS satellites. To adequately protect MSS satellite receivers, the aggregate interference from mobile service stations within the satellite beam would need to be limited to –27 dBW in a reference bandwidth of 4 kHz.

In the case of transportable radio-relay systems, which are used in relatively low numbers, an e.i.r.p. of about –27 dBW in a 4 kHz reference bandwidth in the direction of the GSO would just meet the interference criterion for protection to the MSS (a lower value may be necessary if the risk of multiple interference is considered significant).

In the case of aeronautical public correspondence systems, it appears that excessive interference would be caused to any MSS satellite "visible" from an aeronautical ground station.

The study confirms Report ITU-R M.2041 (for bands around 2.5 GHz) that co-frequency sharing between MSS uplinks and mobile is not possible in the same geographic area. Furthermore, interference from such mobile service systems may cause harmful interference to any visible satellite operating in the same band. Hence if systems with characteristics similar to those assumed in § 3.3 were to be used, the impact on MSS could be significant – potentially preventing use of the band for MSS.