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| U.S. Radiocommunications Sector Fact Sheet  |
| Working Party:  ITU-R WP 5D  | Document No:  USWP5D-50/24  |
| Ref: Resolution 256 (WRC-23), Annex 4.xx to Document 5D/TEMP/337 | Date:   July 17, 2025  |
| Document Title: Sharing between the non-GSO fixed satellite service (Earth-to-space) in the frequency band 7 900-8 400 MHz and IMT operating in the frequency band 7 125-8 400 MHz  |
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| Purpose/Objective: This contribution proposes a new IMT and non-GSO fixed satellite service (Earth-to-space) compatibility study in the frequency band 7125-8400 MHz under WRC-27 agenda item 1.7.  |
| Abstract: This study is focused on IMT compatibility with non-GSO fixed satellite service (Earth-to-space). Sharing from existing services, in this case transmitting Fixed Satellite Service (FSS) into IMT, otherwise known as reverse studies, is not considered. Attachment 5 contains sharing between the FSS and IMT operating in the frequency band 7 125-8 400 MHz for Earth-to-space service. [DoD notes that these studies are technical in nature, consistent with ITU practices, and are being submitted solely for purposes of consideration in the U.S. preparatory process for the ITU-R WRC-27 WP5D meetings.  The results of these studies do not reflect policy positions of DoD and shall not be used for or have any bearing upon separate studies being performed by DoD or any other entity on the 7/8GHz band, including U.S./domestic studies that will be performed later this year.]  |

United States of America |
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| Sharing between the Non-GSO fixed-satellite service (earth-to-space) in 7 900-8 400 MHz And NON-GSO Mobile-satellite services (EARTh-to-SPACE) in the frequency band 7 900-8 025 MHz and IMT operating in the frequency band 7 125-8 400 MHz  |
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# 1 Introduction

This document contains a sharing study between IMT in the frequency band 7 125-8 400 MHz and the fixed and mobile satellite services (Earth-to-space) to which the frequency band 7 900-8 400 MHz is allocated on a primary basis. The study is found in the Attachment.

2 Proposal

The USA proposes that the study found in the Attachment be added to other studies that will go in the update to Annex 4.11 to Document 5D/792, “Sharing and compatibility studies between services to which the band is currently allocated and IMT systems in the frequency band 7 125-8 400 MHz under WRC-27 agenda item 1.7”. The document presents a methodology, as the USA expects to submit a full analysis to the next meeting of Working Party (WP) 5D.

**Attachment:** 1

attachment

Sharing between the non-GSO fixed-satellite service (Earth-to-space) in 7 900-8 400 MHz and non-GSO mobile-satellite services (Earth-to-space) in the frequency band 7 900-8 025 MHz and IMT operating in the frequency band 7 125-8 400 MHz

This Attachment contains a sharing study of the non-GSO fixed and mobile satellite service (Earth-to-space) in their allocated bands within 7 900-8 400 MHz and IMT operating in the frequency band 7 125-8 400 MHz. This document explicitly examines sharing compatibility between IMT and non-GSO satellite systems. The technical characteristics of IMT are provided in [Annex 4.15](https://www.itu.int/dms_ties/itu-r/md/23/wp5d/c/R23-WP5D-C-0793%21H4-N4.15%21MSW-E.docx) to Document 5D/792. The satellite service (Earth-to-space) characteristics are provided in [Annex 40](https://www.itu.int/dms_ties/itu-r/md/23/wp4a/c/R23-WP4A-C-0343%21N40%21MSW-E.docx) of, Document 4A/343, Draft reply liaison statement to WP 5D, Relevant technical information to support studies under WRC-27 agenda item 1.7.

[Note: The MSS characteristics reference will be updated based on the outcome of the WP 4C LS.]

# A1 Technical/operational characteristics of IMT and FSS/MSS systems modeled for the frequency band 7 125-8 400 MHz

## A1.1 IMT deployment scenarios modeled

The IMT characteristics are found in Document 5D/TEMP/361. This document focuses solely on modeling interference from macro-cell base stations (BS), as it is anticipated to be the primary contributor to overall interference. Future studies may include additional interference contributions from small cells and UEs.

This report considers interference into satellite uplink beams that cover wide areas. As such, the Ra/Rb deployment recommendations in section 5 of Annex 4.15 to Document 5D/792 are used in deploying IMT base stations, where:

 *Ra* (%) = ratio of coverage areas to areas of cities/built areas/districts;

 *Rb* (%) = ratio of built areas to total area of region in study.

The Ra for 7.125-8.4 GHz band assumes that IMT base stations in this band will not be deployed across the entire area of a city. Rb is independent from frequency band and deployment environment and only depends on the selected location for study. For this study in the frequency band 7.125-8.4 GHz, the Ra and Rb values in Table A-1 from Table 22 of Annex 4.15 to Document 5D/792 are used:

[Note: Area to be developed based on the representative non-GSO MSS system studied.]

Table A-2 shows the IMT deployment parameters, to be used in this study, from Table 13 in5D/TEMP/361. This sharing study does not consider rural IMT deployments.

Table A-2

Deployment-related parameters

|  | Large area scenario |
| --- | --- |
| Antenna height | 18 m urban / 20 m suburban |
| Sectorization | 3 |
| Frequency reuse | 1 |
| Below rooftop base station antenna deployment  | 65% Urban, 15% Suburban |
| Typical channel bandwidth  | 100 MHz |
| Network loading factor | 20% |
| TDD / FDD | TDD |
| BS TDD activity factor | 75% |

Given that UE transmission is generally omnidirectional, it has low transmit power, significantly lower elevation angles, and additional attenuation from clutter, the interference contributions from UE emissions are expected to be significantly lower than those from IMT base stations and are not included in this study.

## A1.2 IMT BS model

The IMT BSs are assumed to use advanced antenna systems (AAS) capable of beamforming. The antenna characteristics from Document 5D/TEMP/361 for the AAS BS antenna are shown in Table A-3.

Table A-3

Beamforming antenna characteristics for IMT macro-cell BS antenna characteristics, Document 5D/TEMP/361 (Table 19)

|  |  |
| --- | --- |
| Antenna pattern model  | Document 5D/563 Table 17 (Extended AAS Model) |
| Element gain (dBi) (Note 2) | 6.4 |
| Horizontal/vertical 3 dB beam width of single element (degree)  | 90º for H65º for V |
| Horizontal/vertical front-to-back ratio (dB) | 30 for both H/V |
| Antenna polarization  | Linear ±45º polarized sub-array |
| Antenna array configuration (Row × Column) (Note 4) | 8 × 16 |
| Horizontal/Vertical radiating sub-array or element spacing (Note 5) | 0.5 of wavelength for H, 2.1 of wavelength for V |
| Number of element rows in sub-array | 3 |
| Vertical element separation in sub-array () | 0.7 of wavelength for V |
| Pre-set sub-array down-tilt (degrees) (Note 6) | 3 |
| Array Ohmic loss (dB) (Note 2) | 2 |
| Conducted power (before Ohmic loss) per sub-array or element (dBm) (Note 3) | 22 |
| Base station horizontal coverage range (degrees) | ±60 |
| Base station vertical coverage range (degrees) (Note 1) | 90-100 |
| Mechanical down-tilt (degrees) | 6 |
| Base station output power/sector (e.i.r.p.) (dBm) (Note 7) | 78.3 |

Simulations will follow Recommendation ITU-R M.2101 assuming AAS BS antennas point toward the UE as shown in Figure A-1. At each iteration of the simulation 3 UEs are selected in each sector and the BS forms a beam in the UE direction. The use of this dynamic beamforming toward each UE reduces the likelihood of unwanted emissions toward satellites.

Figure A-1

BS dynamic beamforming



Network loading factors will be employed to determine the percentage of base station antennas that are active for a given snapshot. A typical loading factor of 20% will be assumed according to Annex 4.15 to Document 5D/792. The TDD activity factor will be set to 75% for the BSs.

The BS transmit power of 46.1 dBm/100 MHz and the BS peak antenna gain of 32.2 dBi will be used. The BS output power per sector of 78.3 dBm/100 MHz is in agreement with Table A-3. Frequency Dependent Rejection (FDR) will be included in each snapshot when the transmitter bandwidth is greater than the receiver channel bandwidth. The IMT BSs heights will be set to 18 m for urban and 20 m for suburban with all BSs.

## A1.3 Propagation

Based on the recommendations from WP 3M in Document [5D/160](https://www.itu.int/md/R23-WP5D-C-0160/en), for the earth to space path propagation loss between IMT and satellite services, Recommendation ITU-R P.619 will be applied above clutter height. Path Loss for the Earth-space slant path will be considered for this analysis (using Recommendation ITU-R P.525-4). Accurate modeling of environmental clutter is essential for demonstrating the coexistence of systems. Clutter models are key in validating spectrum sharing scenarios, as environmental features can provide the necessary isolation between systems.

Clutter modeling is based on the updated version of ITU-R P.2108, Section 3.3, as outlined in document 5D/629. The model is applied using directional base station antennas, as specified in the attachment to document 5D/629. The Recommendation supports time percentage exceedance from 1-99%, which will be varied as a random variable in the Monte Carlo trials.

## A1.4 Modeling of non-GSO FSS and MSS space receivers operating in the allocations within the frequency band 7 900-8 400 MHz

## A1.5 FSS non-GSO satellites

This study focused exclusively on non-GSO satellite systems. Their relatively smaller coverage areas, compared to GSO systems, enabled an analysis of the sensitivity of results to variations in beam elevation pointing direction.

Non-GSO satellite system characteristics are defined in Table 4-7 of Annex 35 of Document 4A/128. Table A-5 lists the non-GSO systems. The FSS channel bandwidth considered is 125 MHz. This study is based on the Ra/Rb method, and is focused on analysis of Systems 2 and 3 (see Table A-5).

[Note: To be updated based on the LS from WP 4A/4C.]

Table A-5

Non-GSO system orbital characteristics (from ITU Document 4A/128 (Annex 35)-E)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **System 1** | **System 2** | **System 3** | **System 4** |
| Apogee (km) | 500 | 1 200 | 500 | 40000 |
| Perigee (km) | 500 | 1 200 | 500 | 1000 |
| Inclination angle (°) | 50 | 50 | 85 | 63 |
| Number of planes | 36 | 22 | 36 | 4 |
| Number of satellites per plane | 36 | 24 | 36 | 2 |

The required parameters to carry out compatibility studies are shown in the table below for non-geostationary space stations.

[Note: To be updated based on the LS from WP 4C.]

Table A-7

Non-GSO FSS space stations characteristics (following Rec. ITU-R S.1328)

| Non-GSO | Units | System 1 | System 2 | System 3 | System 4 |
| --- | --- | --- | --- | --- | --- |
| Receiving tuning frequency range  | MHz | 7 900-8 400 |
| Receiving antenna gain patterns | MHz | Rec. ITU-R S.1528, Ln = −15 dB, 3 dB beamwidth = 1.7 deg |
| Receiving antenna gain | dBi | 40 | 40 | 40 | 30 |
| Receiver noise temperature | K | 600 | 600 | 600 | 500 |
| Uplink polarization (RHC, LHC, VL, HL or offset linear) |  | Circular | Circular | Circular | Circular |
| Downlink tuning frequency range  | MHz | 7 250-7 750 |
| Downlink polarization  |  | Circular | Circular | Circular | Circular |
| Peak transmit antenna gain | dBi | 40 | 40 | 40 | 30 |
| Transmit antenna gain pattern |  | Rec. ITU-R S.1528  |
| Maximum transmit e.i.r.p. spectral density | dBW/Hz | Complies with Table 21-4 of RR Art. **21**(\*) |

## A1.6 FSS and MSS interference criteria

Considering that receivers in the FSS and MSS operate with low margin and require protection from interference from other radiocommunication services, the protection criteria to be used for their protection in the sharing and compatibility studies with respect to IMT under WRC-27 agenda item 1.7 are summarized in Table A-6 below.

The non-GSO FSS and MSS protection criteria in Table A-6 are from Annex 40, Doc. 4A/343, Table 7.

[Note: To be updated based on the latest LS from WP 4C.]

Table A-6

GSO FSS protection criteria (7 250-7 750 MHz (s-E))

|  |  |  |
| --- | --- | --- |
| Options | % exceedance time | *I/N* Criteria (dB)  |
| Option 2 (non-GSO) | 20%0.6%0.02% | -10.5-60 |

# A2 Simulation methodology

In this section, the methodology used to calculate the probability of interference to non-GSO Systems 2 and 3 (Table A-5) are described.

**A2.1 Number of IMT BSs**

According to Doc. 5D/563, Annex 4.15, section 5 the total number of IMT BSs is given by:

The Ra, Rb values are used to determine the total number of IMT BSs () km area, is given by (1), but not including the dense urban and suburban hexagonal areas.

 (1)

where:

 : is the surface of the considered area in km2;

 : is the ratio of coverage areas to areas of cities/built areas/districts;

 : is the ratio of built areas to total area of region;

 : is the BS density in suburban (2.4 / km2);

 : is the BS densities in urban (10 / km2).

Recommended values of and , from Doc. 5D/792, are given in Table A-1.

[Note: Further modelling of wide areas will be described based on the studied non-GSO MSS constellation.]

**A2.2 Satellite static analyses**

For satellite Systems 2 and 3 the interference to the individual satellite is calculated. The elevation angle pointing direction of the individual satellite beams are varied within the area where the IMT base stations are deployed. For each elevation pointing direction the aggregate interference is calculated at the satellite using Equation 2.

 (2)

where:

*I/N* = Aggregate interference to noise ratio at the MSS station (dB) calculated over all sectors in the simulation

*NBS = Number of base stations within the -20 dB down contour of the satellite beam*

*PTki* = Transmit power of the Kth BS and the ith beam (dBm)

 = Gain of the kth BS and the ith BS beam in the direction of the MSS station (dBi)

 = Gain of the FSS Receiver Antenna in the direction of the kth BS (dBi)

*PLk* = Path loss calculated over the full distribution (1 to 9%) using P.528(dB) for the kth BS

 = Clutter loss applied at base stations below rooftop (i.e., P.2108 section 3.3) for the kth BS

*LP* = Polarization loss = 3 dB

The IMT channel bandwidth (BWBS) in this study is 100 MHz (see Table A-1). Path loss from the IMT base station to the satellite is calculated per iteration according to applicable ITU recommendations (P.619, P.2108, Section 3.3).

Equation 2 is used to identify the minimum elevation angle above which the interference criteria in Table A-6 is just met. These thresholds are used in the simulations of the satellite constellations in determining the probability that the interference exceeds the thresholds.

**A2.3 Simulating the satellite constellations**

This section outlines the simulation of the satellite constellation and the calculation of interference probability. An Earth station service location is defined within the IMT deployment area. Satellite selection plays a critical role in determining the likelihood of interference. Two selection criteria are considered:

* Selection of the satellite with the highest elevation angle
* Selection that maximizes satellite hold time (minimizes jitter)

Both approaches are evaluated in this analysis. When a sufficient number of satellites are available, selecting the satellite with the highest elevation angle may avoid interference threshold violations. However, this strategy may still lead to a reduction in overall system capacity. Quantifying this impact is challenging, as it depends on traffic assumptions that are outside the scope of this study.

For the systems described in Table A-5 we run orbit models that track the satellite positions relative to the IMT locations we wish to model for a statistically significant number of orbits to gain the elevation and azimuth distributions for said systems and locations for each tracking method. These distributions are then used to select elevation angles for our modeling as describe in section A2.1.

# A.3 Study results

[To be developed and provided at the next WP 5D meeting.]

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