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| **Document Title:** Sharing between the fixed service and IMT operating in the frequency band 7 125-8 400 MHz |
| **Author(s)/Contributors(s):**Kathryn Martin, DoD CIOThu Luu, DAFDominic Nguyen, eSimplicity for DAFKellen Gibson, USARMYJennifer Seiler, RKF Engineering for DoD CIOTed Kaplan, RKF Engineering for DoD CIOTaylor King, ACES for DON CIOChristine DiLapi, HII for DoD CIO | kathryn.a.martin23.civ@mail.milthu.luu@us.af.mildominic.nguyen@esimplicity.comkellen.k.gibson.civ@army.miljseiler@rkf-eng.com tkaplan@rkf-eng.comtaylor.king@aces-inc.omchristine.dilapi@hii.com  |
| **Purpose/Objective:** This contribution proposes a new IMT and Fixed service compatibility study in the frequency band 7125-8400 MHz under WRC-27 agenda item 1.7.  |
| **Abstract:** This study examines the compatibility of IMT with Fixed Service (FS), focusing on the impact of new IMT deployments on existing FS systems. The influence of existing FS services on IMT deployments, commonly referred to as reverse studies, is not considered. Attachment 1 contains sharing studies between the fixed service and IMT operating in the frequency band 7 125-8 400 MHz. [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.] |

Sharing Between the Fixed Service and IMT operating in the frequency band 7 125-8 400 MHz

# Introduction

This document contains sharing studies and an approach between IMT in the frequency band 7 125-8 400 MHz and the fixed service to which the frequency band is allocated on a primary basis. The studies are found in the attachments. It should be noted that these studies are preliminary in status, subject to change and do not represent a final U.S. position on these studies or on this agenda item. The U.S. may update the studies at future Working Party (WP) 5D meetings, as appropriate.

# 2 Proposal

To facilitate the preparatory work for WRC-27 agenda item 1.7 within Working Party (WP) 5D, the United States of America proposes that the study found in Attachment A, “Sharing between the fixed service and IMT operating in the frequency band 7 125-8 400 MHz” be discussed. This study supersedes the one the United States submitted at the last WP 5D ([5D/757](https://www.itu.int/md/R23-WP5D-C-0497/en)), which was carried forward. It should be noted that this study implements the relevant technical and operational characteristics and propagation modelling information provided by the ITU-R expert working parties.

This document considers and justifies the use of assumptions involving modelling of random terrain, and the application of P.2108. The document considers both the long-term interference criteria and the Fractional Degradation of Performance (FDP).

attachment A

**Annex 2 – 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**

attachment 1

**Sharing between the fixed service and IMT operating
in the frequency band 7 125-8 400** **MHz**

## A1.1 Technical operational characteristics of fixed service operating in the frequency band 7 125-8 400 MHz

The table below shows the Fixed Service technical parameters that are found in Recommendation ITU-R F.758-8 Table-9 “System parameters for PP FS systems in allocated bands between 7.1 and 14 GHz”.

TABLE A1.1-1

System parameters for PP FS systems in allocated bands between 7.1 and 7.725 GHz

| Frequency range (GHz) | 7.110-7.900  | 7.725-8.500  |
| --- | --- | --- |
| Reference ITU‑R Recommendation | F.385 | F.386 |
| Modulation | 16-QAM | 128-QAM | 16-QAM | 128-QAM |
| Channel spacing and receiver noise bandwidth (MHz) | 3.5, 5, 7, **10**, 14, **20**, **28**, **30**(3), **40**(3), **60**(3), **80**(3) | 3.5, 5, 7, **10**, 14, **20**, **28**, **30**(3), **40**(3), **60**(3), **80**(3) | 1.25, 2.5, 5, 7, **10**, 11.662, 14, **20**, **28**, 29.65, **30**, **40**, **60**(3), **80**(3) | 1.25, 2.5, 5, 7, **10**, 11.662, 14, **20**, **28**, 29.65, **30**, **40**, **60**(3), **80**(3) |
| Tx output power range (dBW) | −6.5… 13 | −6.5…13 | −6.5… 13 | −6.5… 13 |
| Tx output power density range (dBW/MHz)(1) | −25.5…3 | −25.5…3 | −25.5…3 | −25.5…3 |
| Feeder/multiplexer loss range (dB) | 0…3.0 | 0…3.0 | 0…3.0 | 0…3.0 |
| Antenna gain range (dBi) | 12…48.6 | 12…48.6 | 12…48.6 | 12…48.6 |
| e.i.r.p. range (dBW) | 5.5…55 | 5.5…55 | 5.5…55  | 5.5…55 |
| e.i.r.p. density range (dBW/MHz)(1) | −13.5…45 | −13.5…45 | −13.5…45 | −13.5…45 |
| Receiver noise figure typical (dB)  | 2.5…6 | 2.5…6 | 2.5…6 | 2.5…8 |
| Receiver noise power density typical (=*NRX*) (dBW/MHz) | −141.5…−138.0 | −141.5…−138.0 | −141.5…−138.0 | −141.5…−136 |
| Normalized Rx input level for 1 × 10−6 BER (dBW/MHz)  | −121.0…−117.5 | −112.5…−115.0 | −121.0…−117.5 | −111.3…−106.5 |
| Nominal long-term interference power density (dBW/MHz)(2) | −141.5…−138.0 + *I*/*N* | -138.0 + *I*/*N* | −141.5…−138.0 + *I*/*N* | −141.5…−136+ *I*/*N* |
| NOTE – The intended set of parameters for two reference systems for sharing/compatibility studies currently are partially or completely unavailable; On a provisional basis, the parameters reported in Annex 3 for the same bands may be used.(1) To calculate the values for the Tx/e.i.r.p. densities, channel spacing/bandwidth needs to be identified. In these tables, the channel spacing indicated in the **bold text** is used. Where a modal value (Mode) is provided, it is to be taken as indicative within the range specified and further sensitivity analysis may be required on a case-by-case basis to assess a given interference potential due to the variations within the range specified.(2) Nominal long-term interference power density is defined by “Receiver noise power density + (required *I*/*N*)” as described in § 4.13 in Annex 2 (see also § 4.1 in Annex 1).(3) This channel spacing value is not specified in the reference Recommendation.The FS sy |

## A1.2 Interference criteria of fixed service operating in the frequency band 7 125-8 400 MHz

**Long-Term Protection Criteria Consideration**

For this section, the fixed service parameters used in this study of the fixed service and IMT operating in the frequency band 7 125-8 400 MHz can be found in Documents [5D/129](https://www.itu.int/md/R23-WP5D-C-0129/en) and [5D/583](https://www.itu.int/md/R23-WP5D-C-0583/en) (WRC-23) and are shown in Table A1.2.1.1.2-1 below. In this study, the long-term protection criteria of *I/N* = ‒10 dB not to be exceeded for 20% of time, as provided in Table A1.1-2, is used. The protection criteria can be found in Recommendation ITU-R F.758-8 Table 5 for bands above 3 GHz.

**Fractional Degradation of Performance (FDP)**

FS links are designed to meet very high availability targets between 99.9% and 99.999%. In the 7/8 GHz band, in the US, links are designed for 99.999% availability targets at the design reference modulation. To meet these very high availabilities link fade margins are very high (e.g., > 20 dB). Thus, a long-term degradation of I/N = -10 dB representing a 0.4 dB degradation of this very high fade margin is less of a concern then the overall degradation in service availability, which is affected by both long-term and short-term interference effects.

Document 5D/129 references use of ITU-R Recommendation F.758-8, which defines error performance and availability objectives for FS links. For interference from co-primary sources, the total degradation in these objectives — considering both short-term and long-term interference — should be limited to 10% of the performance and availability criteria of the FS system. For interference from **non-co-primary** sources, while F.758-8 does not specify a quantitative limit, ITU-R studies (e.g., Recommendations SF.1006 and F.1191) and common regulatory practice often apply a more conservative criterion, typically limiting the degradation to **no more than 1%** of the FS system’s performance objectives, to ensure adequate protection of the primary service1.

F.758-8 references F.1108-4 for the calculation of FDP, which defines the change in unavailability (limited to 10% for co-primary operation). The derivation of FDP can be found in Attachment B.

**A1.3 Technical Analysis**

[USA Note: This preliminary study may be update at future WP 5D meetings.]

**A1.3.1 Technical characteristics**

To address the questions posed in 5D/TEMP/347R1:

* Which P-series Recommendations have been used and for which purposes? Has terrain data been considered?
	+ M.2101 with beamforming AAS antenna, P.2001-4, P.2108-1, F.758-8 and 5D/583 WRC-2023 Fixed Service parameters are used.
	+ Terrain data is considered, as well as smooth Earth.
* Which technical characteristics, operational parameters have been applied for the services/systems and, which of them deviate from the parameters agreed by the contributing groups and why?
	+ All IMT parameters are as prescribed in the 5D chairman’s report.
* Which methods have been used for interference calculations and simulation methodologies and are these baseline studies or sensitivity analysis?
	+ Monte-Carlo analysis is used with P.2101 and P.2001.

**A1.3.1.1 Technical and operational characteristics of IMT systems operating in the frequency band 7 125-8 400** **MHz**

The IMT system characteristics are provided in Annex 4.15 to Document [5D//TEMP/361](https://www.itu.int/md/R23-WP5D-C-0563/en). The list of IMT modelling assumptions are provided in Attachment C. Utilizing Recommendation ITU-R M.2101, an IMT network was created with base station (BS) sectors arranged in a hexagonal grid of 19 tri-sectorized sites. Each hexagon represents a sector with 120-degree azimuth coverage. In each iteration of the simulation, the BS forms three beams simultaneously serving 3 User Equipment (UEs).

Figure A1.3.1.1.-1

19 sites with 3 Sectors (M.2101-0)



**A1.3.1.2 Technical and operational characteristics of Fixed Service systems operating in the frequency band 7 125-8 400** **MHz**

As this is the first study to consider both the long-term and short-term criteria, only a single FS link will be considered. Future studies may consider additional FS links. The link characteristics are provided in Table A1.3.1.2-1

Table A1.3.1.2-1

Assumed FS point-point system parameters that are used in the study (from 5D/583 WRC-2023)

|  |  |
| --- | --- |
| System parameters | VAl |
| **Modulation** | 256-QAM |
| **Channel spacing and receiver noise bandwidth (MHz)** | 40 |
| **Feeder/multiplexer loss (dB)** | 1.8 |
| **Antenna gain (dBi)**  | 38 |
| **Receiver noise figure (dB) (assumed in the study)** | 4.6 |
| **Antenna height above local terrain (m)**  | 60 |
| **FS link distance** | 30 Km |
| **Link Availability** | 99.999% |
| **Link fade margin (P.530)** | 54 dB[TBD] |

FS link separation distances were tabulated using the UNII-8 (6 875 MHz to 7 125 MHz) band as a proxy. Link characteristics and deployment information is publicly available in the FCC Universal Licensing System (ULS) for this band. This band is also close enough to the 7/8 GHz band under study that the link characteristics are similar. Approximately 4 300 FS locations in the UNII-8 band were examined. Figure A1.3.1.2-1 shows the CDF of the FS link lengths. The median distance is approximately 30 Km. This was selected as a representative link to analyse in this study.



Figure A1.3.1.2-1: FS Link Lengths Reported in FCC Universal Licensing System (ULS) (6875-7125 MHz)

FS links typically require very high availability (E.g., 99.9% to 99.999%). NTIA[[1]](#footnote-1) indicates that in the 7/8 GHz band, in the US, the target availability is 99.999%. This is assumed in this study. P.530 was used to calculate the corresponding fade margin, where both the receive and transmit FS antenna heights are assumed to be at 60 m.

Recommendation ITU-R F.1245-3 is used for the fixed service (FS) antenna pattern. For each snapshot, the FS antenna points to 0 degrees in elevation and toward the centre of the IMT stations in azimuth.

**A1.3.1.3 Models used in the study**

**A1.3.1.3.1 IMT simulation method**

This analysis employed Recommendation ITU-R M.2101, which is leads to a Monte Carlo analysis. Monte-Carlo analysis enables the assessment of the likelihood of interference by simultaneously simulating the inter-system interference from multiple interfering sources. In addition, GeoTiff bare earth 1/3 Arc-Second terrain data was selected, based on the guidance from WP 3M.

**A1.3.1.3.2 Path loss model**

Based on guidance from WP 3M in Document 5D/160, for the terrestrial path propagation loss between IMT and the fixed service, Recommendation ITU-R P.2001-4, Section 3.2 was applied. This Recommendation has the benefit of providing a full-time percentage range of 0 to 100% and is useful where Monte Carlo analysis is needed.

**A1.3.1.3.3 Clutter model**

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.

For macro-cell base stations, which are typically designed to operate above the rooftops within their service area, the situation becomes more complex when considering areas beyond their immediate coverage. While the base station may be above local clutter within its service area, it may be below clutter when viewed from outside that area. This variability must be accounted for in clutter modeling to ensure realistic and reliable analysis of potential interference and isolation.

Therefore, an appropriate clutter model is essential for accurately assessing the potential for IMT systems to share the 7/8 GHz band with incumbent users. In 5D/160, Study Group 3 referenced Recommendation ITU-R P.2108 for clutter modeling but did not specify the conditions under which its use is appropriate. Within WP5D, two approaches have been commonly used when applying P.2108. It is either applied to all IMT base stations or only to base stations below rooftop.

Section 3.2 of P.2108 assumes a terminal located deep within clutter, resulting in a very low probability of clutter free paths. This can be seen in Figure A1.3.1.3.3 which shows the clutter loss CDF at 8 GHz from P.2108, section 3.2. The probability of a clutter free path is 1e-16 and the probability of a clutter path less than 20 dB is less than 1e-3. Therefore if P.2108 is applied to all base stations there won’t be any clutter free paths. On the other hand, if P.2108 isn’t applied to base stations above rooftop the probability of clutter free paths in urban areas is 35% and 85% in suburban areas.



Figure A1.3.1.3.3: Clutter Loss CDF at 8 GHz (P.2108, Section 3.2)

Considering that IMT macro-cell base stations are generally designed to operate above rooftop within the area that they cover and until we receive more guidance from SG3, this report has selected to apply P.2108 only to base stations below rooftop.

**A1.3.1.3.4 Terrain**

At the previous meeting of 5D, concerns were raised, and a request was made to ensure that all modeling assumptions are clearly justified. At the same time, the group advised that random terrain be incorporated into the modeling of interference paths. However, the random terrain needs to be selected appropriately given that we are modelling IMT deployments. This section justifies the terrain modelling approach used in this report.

An interim study was carried out to determine the height where FS were typically located in the local terrain. This study was carried out using the UNII-8 (6 875 MHz to 7 125 MHz) band as a proxy. Link characteristics and deployment information is publicly available in the FCC Universal Licensing System (ULS) for this band. This band is also close enough to the 7/8 GHz band under study that the link characteristics are similar. Approximately 4 300 FS locations in the UNII-8 band were examined. At each location, we computed the distribution of terrain heights within a 4 km × 4 km grid centered at the FS location and the determined the CDF value (or percentile) of the FS terrain height within the region. Figure B5 shows the distribution (CDF) of the FS terrain height percentile across all stations in the UNII-8 band (black line). It is important to note that if the FS locations were randomly placed within terrain, or random terrain paths were used, these FS would have a uniform distribution of terrain percentile as shown in the red line. However, the data suggests that FS placements are highly weighted towards being high in the local terrain (i.e. on top of hills) with >30% being located in the 99th percentile, and ~55% being in the 80th percentile.

Figure A1.3.1.3.4-1

Distribution of FS terrain height percentiles around local terrain heights



The interference paths from IMT deployments all start either in urban or suburban areas. Thus, the interference paths used should be selected starting in either urban or suburban centers. In this report, population is used to identify urban and suburban centers near borders in North America. To do this population tiles from the WorldPop and LandScan databases[[2]](#footnote-2) were sorted from highest density to lowest density. Urban centers and suburban centers were thresholded using definitions in ITU-R P.1238-10 for urban/suburban context in propagation models.. Thus Urban centers are defined as those having population densities greater than 500 people/km² (as used in UN/World Bank classifications), while suburban centers are defined as those have population densities greater than 250 people per square Km but less than 500 people per square Km (OECD (2020), “Cities in the World,”).

In order to examine geometries indicative of border areas, population tiles within 100 Km on either side of the US/Canadian and US/Mexico borders are examined. Random paths are drawn from the population tiles classified as either urban or suburban, based on the specific IMT deployment being modelled. Each path is assigned a random azimuth within a range that is within 100 Km of a border crossing. The following procedure is then used to place FS stations along the interference path. As shown above the FS are normally place close to the local maximum. To model this, the distribution of terrain heights are sorted every 4 Km. FS stations are then selected in each 4 Km section according to the FS height distribution shown in Figure A1.3.1.4-1.

A total of 10,000 [TBD] urban and 10,000 [TBD] suburban random paths were selected, with FS stations placed at 4 km intervals along each path, extending up to 100 km. Using P.2001, the path loss was calculated assuming an IMT BS station at 18 m for urban and 20 suburban and an FS station height of 60 m. Figure A1.3.1.4-2 and Figure A1.3.1.4-3 shows the path loss as a function of distance for urban and suburban paths respectively. Also shown in the figure is a curve reflecting the median path loss and path loss assuming smooth earth. As a result of this analysis, it is clear that a smooth earth approximation provides a conservative yet acceptable estimate of median path loss for interference scenarios considered.

Figure A1.3.1.4-2 [TBD]

Figure A1.3.1.4-3 [TBD]

**A1.3.1.3.5**  **IMT base station antenna pattern**

To speed up the simulations the 3D CDFs for IMT base station antenna gains were precomputed. Figure A1.3.1.3.5-1 and Figure A1.3.1.3.5-2 show the antenna gain CDFs for urban and suburban environments, respectively. Each vertical line in the figure is a CDF of the antenna gains for a particular elevation angle.



Figure A1.3.1.3.5-1: 3D CDF for IMT base station antenna gains for an urban environment



Figure A1.3.1.3.5-2: 3D CDF for IMT base station antenna gains for an suburban environment

**A1.4 Methodology**

The IMT characteristics are found in Annex 4.15 to Document 5D/792. For this study, an IMT network was modelled with base stations in a hexagonal grid that included 3 base stations at each hexagonal site with 120 degrees azimuth coverage each. The grid encompassed 19 sites, or 57 base stations (BS) sectors. Three UEs per base station sector were distributed uniformly in the sector coverage area with UEs that had a maximum transmit power of 23 dBm, ‒4 dBi antenna gain and assumed a 4 dB body loss that was applied on the transmit and receive sides of the UEs. The IMT grid inter-site distances (ISD) were set to 600 m for urban with a 400 m cell size and 1200 m for sub-urban with a cell size of 800 m. The UEs had a minimum distance to the BS of 35 m. In this simulation, for any given snapshot, when a base station was active, it could serve 3 UEs simultaneously. A network loading factor was employed to determine the percentage of base stations that were active for a given snapshot. A loading factor of 20% as baseline and 50% as a sensitivity case were assumed. The TDD activity factor was set to 75% for the BSs and 25% for the UEs with all base station synchronized. The BS transmit power was 46.1 dBm/100 MHz and the BS peak antenna gain was 32.2 dBi. The BS output power per sector was 78.3 dBm. Frequency Dependent Rejection (FDR) and a 3 dB polarization mismatch were included in each snapshot. The IMT BSs heights were set to 18 m for urban and 20 m for suburban with all BSs. In this study, the clutter losses for terrestrial paths were applied only on the IMT side, and only to base stations below rooftop, based on Recommendation ITU-R P.2108-1 with a uniformly distributed random percentage of locations.

Note that only base station interference was considered in this study as it is expected to be the dominate contributor. The UE uplink was only used in considering whether the base station pointing directing is valid. The links between BS and UE used the 3GPP TR 38.901 UMa (Urban Macro) or SMa (Suburban Macro) propagation models.

Table A1.4-1 lists the cases to be studied assuming the long-term interference criteria. The short-term criteria will require a million simulations to assess links with an availability equal to 99.999%. Therefore, only the baseline loading factor is considered and only with sidelobe pointing toward the IMT deployment.

TABLE A1.4-1

Senarios modelled assuming the long-term interference criteria

|  |  |  |
| --- | --- | --- |
| Deployment Type | Network Loading Factor (%) | FS pointing discrimination |
| Urban Macro | 20 (Baseline) | Main-lobe, side-lobe, back-lobe |
| 50 (Sensitivity) | Main-lobe, side-lobe, back-lobe |
| Sub-Urban Macro (Sensitivity) | 20 (Sensitivity) | Main-lobe, side-lobe, back-lobe |
| 50 (Sensitivity) | Main-lobe, side-lobe, back-lobe |

**A1.5 Study results**

attachment B

Derivation of Fractional degradation in performance (FDP)

In this derivation no account is taken of Automatic Power Control (ATPC) or Adaptive Coding and Modulation (ACM). The FS link design is based on a reference modulation and the FDP is calculated relative to this reference modulation. ATPC isn’t accounted for as it can be turned off and there is no information as to whether IMT interference does or does not trigger the ATPC mechanism.

Figure B-1 shows a plot of the received signal-to-noise ratio (SNR) for an FS, without ATPC. The SNR\_RMC (reference measurement channel) is defined as the SNR which results in severely errored seconds (SES) at the target link modulation. This is the design modulation of the link and defines the availability objectives for that link. The fade margin (FM) is the clear sky margin required to achieve the target link availability.



Figure B-1: ATPC Threshold and ATPC Range

The full interference probability distribution shall be considered in the total degradation. The total apportionment of error performance objectives (EPOs) derived from the fractional degradation of performance (FDP) from long and short-term interference should not exceed 10%; (co-primary services).

The following derivations assume that fading and interference events are statistically independent. However, in a rain dominated environment (>10 GHz) the fading on the desired and interfering paths could be correlated. The correlation will depend on the lengths of interfering and desired paths.

As described in ITU-R Rec. F.1108 the FDP is given by

 = (1)

Where:

* Po,0= is the probability of outage due to fading only.
* =
* is the fade in dB
* = the fade probability density function calculated using ITU-R P.530, defined from to .
* FM is the Fading Margin in dB estimated based on Rec. P.530 according to the Performance Objectives (EPO) parameters.
* Po,i =The probability of outage from fading and interference and is given by the joint probability in equation 2. This is written in a format that was derived in F.1108.

 (2)

Where:

* , and is the numerical interference to noise ratio in linear scale,
* is the probability density function of the interference to noise ratio distribution and its support is from to
* FDP >0

The FDP equation can be divided into two components, a short-term and long-term:

*FDP= FDPLT +FDPST*  (3)

Where,

* FDPST = The short-term fractional degradation in performance occurs when the interference degradation exceeds the FM. This is referred to as short-term degradation because high levels of interference occur with low probability.
* FDPST = (4)
* FDPLT = The long-term fractional degradation in performance occurs when the interference degradation is less than the FM, but the combination of fading and interference exceed the FM. It is referred to as long-term because low levels of interference occur with higher probability.
* FDPLT = (5)
* is the joint probability of outage from fading and interference when the interference degradation is greater than or equal to the FM (or and  and is given by:

(6)

attachment c

# Technical/operational characteristics of IMT systems modelled for the frequency band 7 125-8 400 MHz

**A1.1 IMT deployment model**

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.

Table A-1 shows the IMT deployment parameters from Table 13 in Document 5D/TEMP/361.

Table A-1: Deployment-related parameters

|  |  |
| --- | --- |
| Macro-cell deployment density | 600 m ISD Urban (400m cell size) 1200 m ISD Suburban (800m cell size) |
| Metropolitan area deployment density | 10 BSs/km2 urban 2.4 BSs/km2 suburban  |
| Antenna height | 18 m urban 20 m suburban |
| Sectorization | 3 |
| Frequency reuse | 1 |
| Below rooftop base station antenna deployment  | Urban: 65%Suburban: 15%  |
| Typical channel bandwidth  | 100 MHz |
| Network loading factor | 20%, 50% |
| TDD / FDD | TDD |
| BS TDD activity factor | 75% |
| Power Dynamic Range  | 56 dB |
| Maximum output power | 23 dBm |
| Noise figure | 13 dB |
|  |  |
|  |  |

The initial simulations will assume a dense deployment of macro-cells. The IMT network will be modeled using hexagonal grid configuration featuring three base stations at each hexagonal site, each providing 120 degrees of azimuth coverage. The grid consists of 19 cell sites, corresponding to a 57sector laydown of IMT base stations as shown in Figure A-1. Both urban and suburban geometries defined in Table A-1 will be simulated. The IMT grid inter-site distances (ISD) were set to 600 m for urban areas resulting in a cell radius of 400 m and an ISD of 1200 m for suburban areas resulting in a cell radius of 800 m. These cell radii are designed to meet the BS densities shown in Table A-1, which is taken from Table 13 of Document 5D/TEMP/361.

The simulations will be used to determine the separation distance between the IMT deployment and the FS station to meet both long-term and short-term interference criteria.



Figure A-1: IMT Interference scenario into an FS receiver from a deployment of 19 IMT cell sites

Additional simulations will also be performed. These will help identify scenarios that could be of concern and help in understanding if additional mitigation strategies are needed. These studies will consider base station design and propagation models.

In addition to scenarios based on Figure A-1 two metropolitan locations (San Diego and Pheonix) were studied to examine interference. These are locations that are known to have large numbers of deployed FS links.

**A1.2 IMT BS model**

The ITM 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 is shown in Table A-2

. Table A-2: Beamforming antenna characteristics for IMT Macro-cell BS Antenna Characteristics, Document 5D/TEMP/361 (Table 19)

|  |
| --- |
|  |
| Antenna pattern model  | Document 5D/TEMP/316 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 M.2101 assuming AAS BS antennas point toward the UE as shown in Figure A-2. At each iteration of the simulation 3 UEs are selected in each sector and the BS forms a beam in the UE direction.



Figure A-2: BS antenna coverage

Note that systems can also implement switched beamforming, where the beam downtilt remains fixed while only the beam azimuth varies. Switched beamforming systems may result in more interference as the beams may point closer to the horizon. Future studies should consider whether switched beamforming could increase the risk of interference.

Network loading factors were employed to determine the percentage of base station antenna beams that were active for a given snapshot. A typical loading factor of 20% was assumed according to Annex 4.15 to Document 5D/792. An additional study also considered simulations with a 50% loading factor consistent with Document 5D/792 for highly loaded base stations. The TDD activity factor was set to 75% for the BSs downlinks.

The BS transmit power was 46.1 dBm/100MHz and the BS peak antenna gain was 32.2 dBi. The BS output power per sector was 78.3 dBm in agreement with Table A-2. Frequency Dependent Rejection (FDR) was included in each snapshot when the transmitter bandwidth is greater than the receiver channel bandwidth. The IMT BSs heights were set to 18 m for urban and 20 m for suburban with all BSs.

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1. 7/8 GHz, Non-Federal Multi-Stakeholder Forum, January 15, 2025, Co-Led by The Federal Agencies and NTIA (UUI) [↑](#footnote-ref-1)
2. WorldPop ([www.worldpop.org](http://www.worldpop.org/)) or LandScan Global Population Database, Oak Ridge National Laboratory (<https://landscan.ornl.gov/>). [↑](#footnote-ref-2)