Document 5D/XXX-E
23 January 2025
English only

Spectrum ASPECTS

IAFI[1]

FURTHER UPDATES TO THE WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R M. [FS-IMT COORDINATION]

Coordination of stations in the fixed service with IMT stations in the frequency band 6 425-7 125 MHz

1 Introduction

ITU-R Working Party (WP) 5D is working towards a preliminary draft new Report ITU-R ITU-R M. [FS-IMT COORDINATION] on "**Coordination of stations in the fixed service with IMT stations in the frequency band 6 425-7 125 MHz**". This report is expected to facilitate the introduction of IMT in this band while ensuring the continued operation of existing fixed services through effective coordination mechanisms.

2 Proposal

IAFI has proposed updates to this working document as shown in the attachment.

[1] IAFI is a sector Member of ITU-R. For more details, please see https://iafi.in

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R M.[FS-IMT COORDINATION]

Coordination of stations in the fixed service with IMT stations in the frequency band 6 425-7 125 MHz

[Editor's note (WP 5D, June-July 2024): This report is to provide the methodology for calculating coordination distance and provide example of coexistence and mitigation techniques. Duplication of sharing studies undertaken under WRC-23 agenda item 1.2 should be avoided.]

[Editor's note (WP 5D, October 2024): Examples of calculating coordination distance based on the methodology will be provided in the Annexes of this report as appropriate.]

(20xx)

TABLE OF CONTENTS

Page

1 Introduction

The studies undertaken under WRC-23 agenda item 1.2 showed that co-channel coexistence between IMT and the fixed service in the frequency band 6 425-7 125 MHz can be achieved but would require site-by-site coordination if IMT and FS are deployed in the same or in adjacent geographical areas.

WRC-23 agenda item 1.2 resulted in a Conference decision to identify the frequency band 6 425-7 125 MHz for IMT via Resolution **220 (WRC-23)**, which invites ITU-R "to update existing ITU-R Recommendations/Reports or develop new ITU-R Recommendations/Reports, as appropriate, to provide information and assistance to the administrations concerned on possible coordination of stations in the fixed service with IMT stations in the frequency band 6 425-7 125 MHz".

This report is intended to provide the methodology for calculating coordination distance and possible approaches for the coordination between IMT and FS in the frequency band 6 425-7 125 MHz. This Report is not meant to repeat the sharing and compatibility studies undertaken during the WRC-23 cycle.

2 Methodology for calculating coordination distance

[Editor's note (WP 5D, October 2024): Further to check whether similar ITU-R Recommendations or Reports on methodology exist.]

2.1 Characteristics of systems

2.1.1 Fixed Service system parameters and deployment scenarios

The FS in the frequency band 6 425-7 125 MHz is deployed in rural and urban (including sub-urban) areas. The exact deployment scenarios vary country by country.

The FS parameters to be used in the calculation of coordination distances include:

– Antenna pattern
– Antenna height
– Antenna gain
– Link length
– TX output power
– Feeder/multiplexer loss
– Receiver noise figure

The values of these parameters in rural and urban deployments will normally be different, e.g. FS height and FS link length. Examples of typical values are provided in the table below. However, for coordination of actual sites, the site specific values for these parameters should be used in calculating the coordination distance.

TABLE 1

Simulation parameters of fixed service

System parameters	Rural area		Urban area	
Modulation	64-QAM		64-QAM	
	Example 1	Example 2	Example 3	Example 4
Channel spacing and receiver noise bandwidth (MHz)	40	40	40	40
TX output power (dBW)	3	3	3	3
Feeder/multiplexer loss (dB)	1.8	1.8	1	1.8
Antenna gain (dBi)	38	39.5	36	38
Antenna pattern	Recommendation ITU-R F.1245 for the aggregated case			
Antenna height(m)	60	60	20	60
Link length (km)	38	38	10	35

2.1.2 Protection criteria

2.1.2.1 Protection criterion for FS systems

***I/N* protection criteria**

The following long-term interference-to-noise protection criterion for FS systems is to be used in studies (Recommendation ITU-R F.758-7):

$$I/N = -10 \text{ dB to not be exceeded over 20\% of time}$$

***C/I* protection criteria (for sensitivity analysis)**

For coordination of actual specific sites, the following carrier-to-interference protection criterion, which accounts for possible margins in the FS systems link budget, can also be used:

C/I = 33 dB and 29 dB for 1 dB and 3 dB degradation respectively

2.1.2.2 Protection criterion for IMT systems

Typically, IMT employs protection criterion (irrespective of the number of cells and independent of the number of interferers) which is based on the interference-to-noise ratio. This criterion has been developed without considering any percentage of time related to it. When interfered by the other primary service the protection criterion $I/N = -6$ dB.

[Editor's note (WP 5D, October 2024): References on the 5% value are requested to be provided.]

Additionally for sensitivity analysis it is possible to use the protection criterion based on the throughput loss, the threshold throughput loss for IMT is typically equals 5%.

The following equations approximate the throughput over a channel with a given SINR (dB), when using link adaptation:

$$Throughput\ (SINR),\ bps/Hz\ =\ \{0\ \ \alpha\cdot S(SINR)\ \alpha\cdot S\left(SINR_{MAX}\right)\ \ for\ SINR\ <\ SINR_{MIN}\ for\ SINR_{MIN} \le SI$$

where:

$S(SINR)$:	Shannon bound, $S(SINR) = \log_2 (1 + 10^{SINR/10})$ (bps/Hz);
α:	Attenuation factor, representing implementation losses;
$SINR_{MIN}$:	Minimum SINR of the code set, dB;
$SINR_{MAX}$:	Maximum SINR of the code set, dB.

The parameters α, $SINR_{MIN}$ and $SINR_{MAX}$ can be chosen to represent different modem implementations and link conditions. The parameters proposed in Table 2 represent a baseline case, which assumes:

– 1:1 antenna configurations;

– AWGN channel model;

– Link adaptation (see Table 2 for details of the highest and lowest rate codes);

– No HARQ.

TABLE 2

Parameters describing baseline link level performance for IMT

Parameter	DL	UL	Notes
α	0.6	0.4	Represents implementation losses
$SINR_{MIN}$, dB	−10	−10	Based on QPSK, 1/8 rate (DL) & 1/5 rate (UL)
$SINR_{MAX}$, dB	30	22	Based on 256-QAM, 0.93 rate (DL) & 64-QAM, 0.93 rate (UL)

2.1.3 IMT system parameters and deployment scenarios

Technical characteristics of IMT-2020 for the 6 425-7 125 MHz frequency band developed in ITU-R in the WRC-23 study cycle are summarized in Table 3.

TABLE 3

Simulation parameters of IMT-2020

System parameters	Macro suburban	Macro urban
Common parameters		
Frequency band	6 425-7 125 MHz	6 425-7 125 MHz
TDD/FDD	TDD	TDD
Network loading factor	50%	50%
TDD activity factor	75%	75%
User equipment density for terminals that are transmitting simultaneously	3 UEs per sector	3 UEs per sector
UE distribution	Uniform distribution in the hexagon area	Uniform distribution in the hexagon area
Typical channel bandwidth	100 MHz	100 MHz
Deployment related parameters		
BS Antenna height (m)	20	18
UE Antenna height (m)	1.5	1.5
Cell radius (m)	600	300
Sectorization	3 sectors	3 sectors
Base station maximum coverage angle in the horizontal plane (degrees)	±60	±60
Base station vertical coverage range (degrees)	90-100	90-120
Mechanical downtilt (degrees)	6	10
Base station antenna characteristics		
Antenna pattern	Refer to Recommendation ITU-R M.2101 Annex 1, section 5	
Element gain (dBi)	6.4	5.5
Horizontal/vertical 3 dB beamwidth of single element (degree)	90º for H 65º for V	90º for H 90º for V
Horizontal/vertical front-to-back ratio (dB)	30 for both H/V	30 for both H/V
Antenna polarization	Linear ±45º	Linear ±45º
Antenna array configuration (Row × Column)	16 × 8 elements	16 × 8 elements
Horizontal/Vertical radiating element spacing	0.5 of wavelength for H 0.7 of wavelength for V	0.5 of wavelength for H 0.5 of wavelength for V
Array Ohmic loss (dB)	2	2

System parameters	Macro suburban	Macro urban
Conducted power (before Ohmic loss) per antenna element (dBm)	22	22
Noise figure (dB)	6	6
ACS	42	42
Blocking response level	In-band blocking level: −43 dBm Out-of-band blocking level: −15 dBm	In-band blocking level: −43 dBm Out-of-band blocking level: −15 dBm
User equipment characteristics		
Antenna pattern	Omnidirectional	
Typical antenna gain for user terminals (dBi)	−4	−4
Body loss (dB)	4	4
Maximum user terminal output power (dBm)	23	23
Power control model	Recommendation ITU-R P.2101	Recommendation ITU-R P.2101

2.2 Propagation and clutter loss models

The signal propagating from the IMT base stations to FS station is subject to the following propagation losses/attenuations:

– Free space loss;

– Diffraction loss due to the surrounding terrain;

– Clutter loss;

– Polarization loss.

2.2.1 Basic propagation loss for terrestrial paths

[Editor's Note (WP 5D, October 2024): Use of propagation models to be checked against the guidance from SG3 WPs.]

The recommended method to determine the path propagation loss between the IMT equipment and the FS station is provided in Recommendation ITU-R P.452 or Recommendation ITU-R P.2001. Topographic information, i.e., terrain height data, should be incorporated as it has a significant effect on the diffraction loss.

The calculation of propagation loss according to the models in these Recommendations requires a specific terrain profile but may be suitable for Monte Carlo simulations by running the model repeatedly on real (but random) paths of a fixed length. Such paths should be chosen by using a terrain database for a region representative of the environment of interest (for example, by choosing a specific city to represent an urban area or choosing a specific mountain range to represent a mountainous area). Within this region, for each path a random starting point is generated, and the end point is calculated at a random azimuth, using the path length of interest. The propagation analysis is then performed on each path, and the Monte Carlo approach is used to derive the statistics of the loss for this path length. This can then be repeated for other path lengths.

It is noted that Recommendation ITU-R P.452 or ITU-R P.2001 refers to Recommendation ITU-R P.676 for calculation of atmospheric losses. If available, atmospheric/weather data may be taken into account for more precise estimates of the atmospheric attenuation.

2.2.2 Clutter loss

Recommendation ITU-R P.2108 section 3.2 (terrestrial paths) provides a statistical clutter loss model. In an aggregation calculation (Monte Carlo simulation) for each IMT BS station, a randomly chosen p_L value (uniformly distributed between 0 and 100%) should be used.

2.2.3 Polarization loss

The polarization loss will be specific to the loss caused by the polarization mismatch. A polarization loss of 3 dB should be considered.

2.3 Method for calculation of coordination zone around FS station

[Editor's Note (WP 5D, October 2024): MCL methodology could be added for the site-specific scenario under this method.]

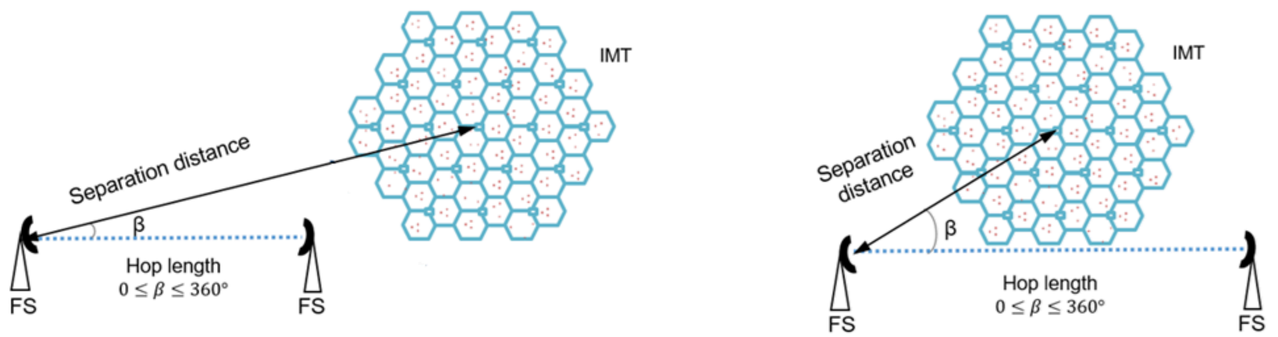
The generic methodology for calculating a coordination zone using Monte-Carlo simulation is set out in the following steps. The methodology calculates the aggregate interference from IMT base stations at a FS station receiver and then derive the separation distance. This is repeated at different azimuth angles around the FS receiver.

Step 1:

Determine the parameters and generate FS station, IMT base stations and user equipment. As an example, all active IMT base stations are generated in Hexagon grid with 57 sectors (see Figure 1 below). The FS station receiver is located at a distance from IMT network.

FIGURE 1

Illustration of possible locations of FS stations and IMT base stations



Step 2:

Locate the IMT network at an initial distance d of the FS receiver. This initial distance could be 1 km for co-channel calculation and 250 m for adjacent channel calculation. Run a Monte Carlo simulation to calculate a Cumulative Distribution Function of the aggregated interference, I, from IMT base stations using the procedure in 2.3.1 below. Compare the aggregated interference with the protection criterion of the FS station receiver. If the criterion is not exceeded, then the separation distance is found. Otherwise repeat with the IMT network separated further away, until the criterion is not exceeded.

Step 3:

Repeat the process at a different azimuth angle β (between the FS pointing direction and the IMT network) until the 360 degrees arc is completed.

2.3.1 Co-channel calculation

Modelling of the IMT network is performed according to Recommendation ITU-R M.2101. The interference power from one BS is calculated as:

$$I_{BS} = PSD_{TX} + G(\theta)_{TX} - L(\theta)_{clutter} - L_{prop} - L_{pol} + G(\psi)_{Fs} \quad (dBm/MHz) \qquad [1]$$

where:

I_{BS} = single entry interference power from a BS (dBm/MHz);

PSD_{TX} = power spectral density of the i^{th} BS (dBm/MHz);

$G(\theta)_{TX}$ = antenna gain of the i^{th} BS in the direction of fixed service (dBi);

$L(\theta)_{clutter}$ = clutter loss from the BS location to fixed service (dB);

L_{prop} = propagation loss according to Recommendation ITU-R P.2001 or P.452 (dB);

L_{pol} = polarisation loss (3 dB);

$G(\psi)_{FS}$ = FS antenna receiving gain towards the direction of the i^{th} BS (dBi).

The aggregate interference towards the FS station is calculated by summing up contributions from 57 BSs deployed within the simulation area as shown in equation [2]:

$$I_{total} = 10\left(Pr_{BS\_TDD} \sum_i 10^{\frac{I_{BS}(i)}{10}}\right), \text{dBm/MHz} \qquad [2]$$

where:

$I_{BS(i)}$: interference from i^{th} IMT base stations, dBm/MHz;

I_{total}: aggregate interference power density from IMT base stations, dBm/MHz;

Pr_{BS_TDD}: TDD factor.

The TDD factor in the equation [2] is equal to the fraction of IMT sub-frames that are used for downlink transmissions in the IMT system (see Table 3).

Then aggregate IMT BSs interference over the noise of FS receiver is calculated and compared with the protection criteria specified in section 2.1.2.

2.3.1.1 Sensitivity analysis using *C/I* protection criteria

Modelling of the IMT network is performed according to Recommendation ITU-R M.2101. The signal level at the FS link receiver is calculated according to the equation below:

$$C_{FS} = P_{FS\,Tx} + G_{FS\,Tx} + G_{FS\,Rx} - L_{prop(Link\ Length)}\ dBW \qquad [3]$$

where:

$P_{FS\,Tx}$: transmit power of fixed service transmitter;

$G_{FS\,Tx}$: antenna gain of fixed service transmitter;

$G_{FS\,Rx}$: receiver antenna gain of fixed service of receiver;

$L_{prop(Link\ Length)}$: propagation losses between two FS link transceivers, free space path loss can be assumed.

The *C/I* is calculated using the following equation:

$$\frac{C}{I} = C_{FS} - I_{total},\ \text{dB} \qquad [4]$$

where:

C_{FS}: wanted signal at an FS receiver;

I_{total}: Interference of IMT stations calculated in equation [2].

The resulting *C/I* is compared with the criteria specified in section 2.1.2.

2.3.2 Adjacent channel calculation

The generic methodology for calculating the adjacent channel case using Monte-Carlo simulation is the same as for the co-channel case, but the power spectral density of the individual IMT BS must be corrected to the out-of-block power for the frequency offset range. The out-of-block power spectral density can be derived from the spectral mask.

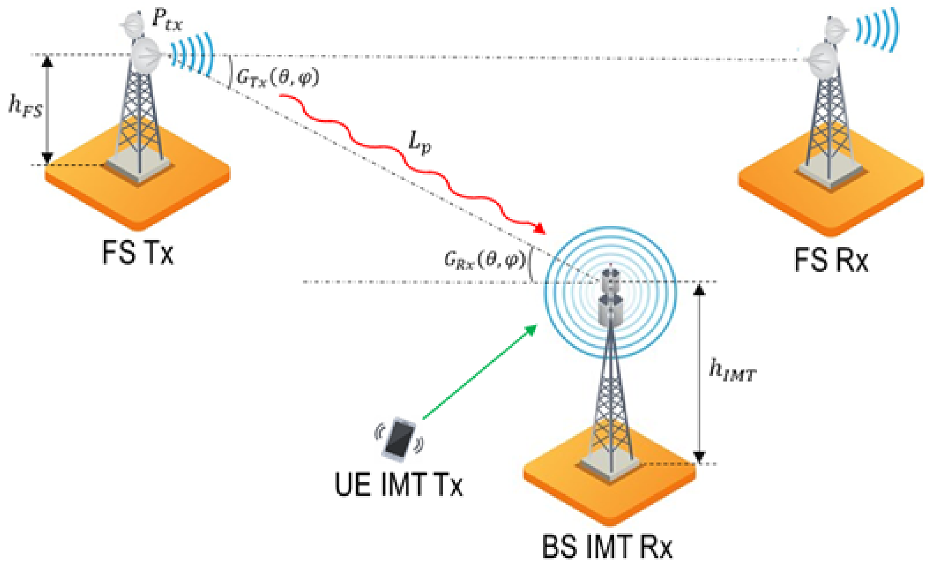
2.4 Method for calculation of coordination zone around IMT stations

2.4.1 Minimum coupling loss analysis

MCL analysis normally assesses the worst-case scenario by determining the minimum possible path loss between a transmitter and a receiver, thereby estimating the highest level of interference that could occur. This method is particularly useful in spectrum management, where it is essential to ensure that different systems can coexist without causing harmful interference to each other.
Figure 2 shows typical example scenario of the interference from FS to IMT in the 6 425-7 125 MHz and required components to conduct MCL calculations.

FIGURE 2

Typical scenario of FS station interference to IMT BS station



The interference level from SRS station to the IMT station may be expressed with the following equation:

$$I = P_{tx} + G_{tx}(\theta, \varphi) + G_{rx}(\theta, \varphi) - L_{prop} - L_{clutter} - L_{pol} \qquad [5]$$

where:

P_{tx}: Output power of the FS in dBW;

$G_{tx}(\theta, \varphi)$: Antenna gain of the FS towards the IMT station in dBi;

$G_{rx}(\theta, \varphi)$: Antenna gain of the IMT station towards the FS station in dBi;

L_{prop}: Propagation losses based on Recommendation ITU-R P.2001 or Recommendation ITU-R P.452;

$L_{clutter}$: Clutter losses based on Recommendation ITU-R P.2108 in dB;

L_{pol}: Polarization difference losses in dB.

Adjacent band considerations

Taking into account that above-mentioned results for co-channel interference, it can be seen that we cannot place an FS receiver within the same areas as IMT networks, for the same deployment scenario where IMT and FS are located inside the same area frequency. Separation was used and the simulation was done based on *I/N* and *C/I* protection criteria. In order to calculate adjacent channel interference, adjacent channel selectivity (ACS) of FS stations and adjacent channel leakage ration (ACLR) of IMT need to be used. ACS of the FS station is provided in Table 1, whereas the ACLR of IMT can be obtained from spectrum emission masks. Here, the ratio of the total interference between adjacent channels is given by the adjacent channel interference ratio (ACIR), hence, the following:

$$ACIR = 10\log log\left(\frac{1}{\frac{1}{10^{\wedge}(ACR/10)} + \frac{1}{10^{\wedge}(ACLR/10)}}\right)$$

[6]

where:

– ACS is adjacent channel selectivity in dB;

– ACLR adjacent channel leakage ratio in dB.

Note that in this expression ACLR needs to be provided as a single value, however in many cases ACLR provided as a spectrum emission mask, in that case, the following expression should be used:

$$FDR(\Delta f) = \frac{\int_0^{\infty} P(f)df}{\int_0^{\infty} P(f)|H(f+\Delta f|^2 df}$$

[7]

where:

P(*f*) is the power spectral density of the interfering signal equivalent intermediate frequency in W/Hz;

H(*f*) is the frequency response of the receiver, depending on Δf = ft − fr (MHz), where ft interferer tuned frequency, fr receiver tuned frequency.

Thus, adjacent channel interference can be calculated using the following expression:

$$I = P_{tx} + G_{tx}(\theta, \varphi) + G_{rx}(\theta, \varphi) - L_{prop} - L_{clutter} - L_{pol} - FDR(\Delta f)$$

2.4.3 Site-specific studies

Site specific studies should include terrain around the protected IMT station, including its topographyor site-specific studies area analysis approach should be used to estimate the protection area around the particular IMT station. Area analysis typically involves a victim or interfering station being positioned at each of a set of points within an area and at each location undertaking a static analysis. Any of the values derived in the calculations at that point can then be shown graphically either through the use of colour-coded pixels (blocks) or by drawing coordination distance lines based on the *I/N* protection criterion.

[Editor's Note (WP 5D, October 2024): Due to limited time available the content below was not reviewed by WP 5D and further considerations are needed.]

3 Possible approaches for coordination between IMT and FS

This section provides some possible approaches for coordination between IMT and FS systems for the purpose to provide information and assistance to administrations concerned on possible coordination of stations in the fixed service with IMT stations in the frequency band 6 425-7 125 MHz. However, it does not present an exhaustive list. These possible approaches may not be applicable in all countries and it is subject to each country to decide which if any approach(es) to adopt. Consequently, the approaches outlined in this section should be regarded as informational only and do not oblige any country to adopt or implement any of them.

3.1 Possible separation approach between IMT and FS

The studies undertaken in ITU-R under WRC-23 agenda item 1.2 for the 6 GHz band showed that co-channel and / or adjacent channel coexistence between IMT and the FS can be achieved but would require site-by-site coordination if IMT and FS are deployed in the same or in adjacent geographical areas. The following approaches, or a combination of these approaches, could be considered to manage co-channel or adjacent channel coexistence between IMT and FS:

– Separation in geography/space.

– Separation in frequency

The feasibility of the different approaches depends on the different situations regarding, e.g. the location and density of FS links, the band fragmentation, and ownership of the deployed FS links (e.g. only mobile operators). Therefore, administrations should choose which approach or combination of approaches might be most suitable for the coordination between IMT and FS.

3.1.1 Separation in geography/space

Several sharing and compatibility studies between the FS and IMT in the frequency band 6 425-7 125 MHz were performed in ITU-R in preparation for WRC-23. Studies looked at the co-channel scenario and found that a separation distance is necessary for the coexistence between FS and IMT. Four studies used a Monte-Carlo approach. This considers the statistic nature of the radiation of IMT BS AAS (it is expected that AAS will be used in the band) and of other parameters such as clutter and propagation losses. The results from these studies range from 10 to 68 km when the IMT cluster is within the FS antenna main lobe, and from 1 to 10 km when the cluster is in the FS side lobe.

These studies use parameters for FS and IMT developed in ITU-R. The studies are therefore for generic scenarios and not actual sites. The studies did not take terrain into account.

The separation distances calculated in preparation for WRC-23 mainly depended on the coexistence scenario, and on the different ways to account for clutter losses and propagation losses. In general, the ITU-R studies found that separation distances are:

– significantly larger when the IMT interferers are in the pointing direction (main beam) of the FS antenna;

– larger in suburban than in urban scenarios;

– dependent on the antenna heights, the higher the antenna the larger the distance;

– dependent on the clutter.

ITU-R studies did not consider adjacent channel scenarios, but it is expected that the separation distances would be significantly smaller.

Calculation of separation distances for specific actual FS sites should follow the procedure in section 2.3. The procedure provides a zone around the actual site where IMT BS should not be deployed, to avoid interference to the FS receiver. The figure below provides an example of what such a zone looks like for an actual FS station in South Africa.

Figure 3

Exclusion zone for a FS site in the suburbs of Durban, South Africa

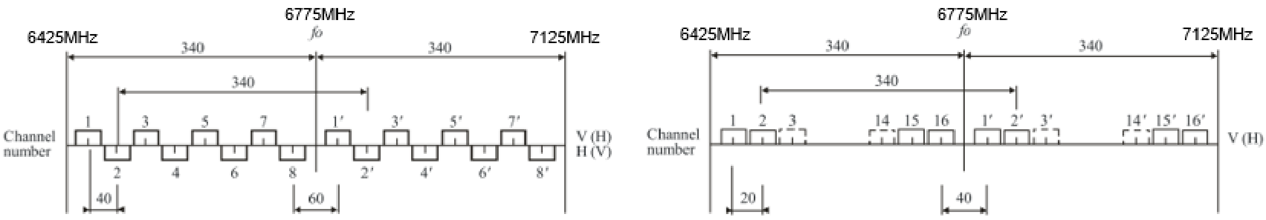
This approach can be time consuming if there are many FS stations in the areas where IMT will be deployed. However, IMT is expected to be deployed in urban and suburban areas, and administrations may decide that the FS in those areas get migrated to a different band. In that case, it may be possible to simplify the coordination procedure with the establishment of IMT areas, where IMT BS can be deployed and FS stations are migrated, and FS areas, where FS stations remain. The calculation would then be conducted only for those FS stations in the proximity of the IMT areas.

3.1.2 Separation in frequency

Recommendation [ITU-R F.384-11] contains channel plans for the FS in the 6 425-7 125 MHz frequency band. Typical plans use channelisation of 16 channels (8 forward and 8 return) of 40 MHz and 32 channels (16 forward and 16 return) of 20 MHz. This is shown in the figure below:

Figure 4

Typical channel arrangements in 6 425-7 125 MHz (Recommendation ITU-R F.384-11)



Typically not all channels are used in one of the directions of a fixed link. This is because a small number of channels may be enough for the traffic requirements at a particular site, because of the planning of a FS network to avoid inter site interference, and because of the self-interference between the transmitter and receiver at the site. This means that there may be opportunities for use of the unused spectrum by IMT.

FIGURE 5

Diagram of a bidirectional fixed link and the protection areas for each site

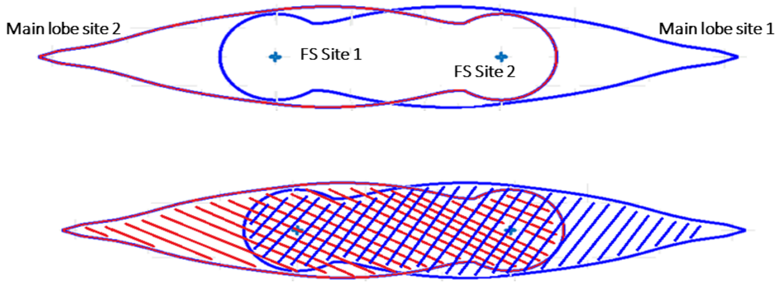


Figure 5 above shows a simple diagram of a fixed link with go and return directions, and the exclusion areas required to protect each of the receivers. With 4+0 or 8+0 configuration that are typical for long-haul transmission in the band, IMT could theoretically use part of the band as follows. This is an idealised scenario with one link only, in practice there may be other links using other channels at the same sites or in the same area and hence there will be other exclusion areas that overlap with these.

8+0 with 40 MHz Channel Spacing (CS) (worst case)

– Half of U6 GHz band (6 775-7 125 MHz) could be used by IMT in blue only area.

– Half of U6 GHz band (6 425-6 775 MHz) could be used by IMT in red only area.

– No U6 GHz band could be used by IMT in the red and blue overlapping area.

4+0 with 40 MHz CS

– 3/4 of U6 GHz band could be used by IMT in blue only area.

– 3/4 of U6 GHz band could be used by IMT in red only area.

– 1/2 of U6 GHz band could be used by IMT in the red and blue overlapping area.

4+0 with 20 MHz CS

– 7/8 of U6 GHz band could be used by IMT in blue only area.

– 7/8 of U6 GHz band could be used by IMT in red only area.

– 3/4 of U6 GHz band could be used by IMT in the red and blue overlapping area.

The assessment above is theoretical and would need to be adjusted to account for the fact that the IMT BS out of band emissions would also cause interference to the FS receiver in adjacent channels. However, the resulting exclusion zones for adjacent channel interference will be significantly smaller in comparison to the co-channel case.

3.1.3 Angular discrimination

3.1.4 Combination of the above …….

3.2 Possible mitigation measures/techniques on FS and IMT and other considerations

3.2.1 Examples of Fixed Service mitigation techniques

Adding an antenna shroud to the antenna of the FS receiver can improve isolation by:

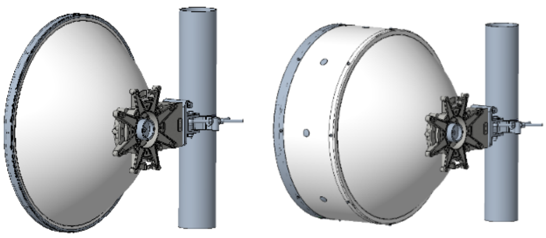
– around **15 dB** at azimuth angles from around 20 to 85 degrees;

– around **7 dB** in the Front to Back (F/B) ratio.

These gains could **further reduce the separation distance at side lobe and backside** of FS stations. Figure 6 shows an FS antenna with and without a shroud.

FIGURE 6

FS antenna without shroud and with shroud



3.2.2 Other considerations

Administrations may want to consider that, when considering protection of specific sites, some of the actual operational parameters may allow for improved coexistence conditions. Notably:

<u>Front to back ratio</u>

Actual FS antennas have better Front to Back (F/B) ratios than assumed in the studies in ITU-R. A more realistic modelling of this parameter in the calculations will reduce the separation distance at the backside of FS stations. The antenna pattern modelled according to Recommendation ITU-R F.1245 result in a F/B ratio of around 50 dB. However, measurement of this parameter in commercial antennas gives a value that can be several dBs better.

<u>Use of *I/N* = 0 dB protection rule</u>

In fixed network planning, it is generally accepted that the fixed system can tolerate interference equal to the noise floor, i.e., *I/N* = 0 dB. This condition is used in scenarios of dense deployment of fixed links when, despite a high risk of links interfering with each other, it is necessary to optimize spectrum use. The *I/N* = 0 dB criterion could be used for protection of FS (from IMT interference) in scenarios where FS deployment is not already dense.

3.2.3 Examples of IMT mitigation measures/techniques

A list of possible mitigation techniques that can be adopted by IMT systems to reduce the interference at the FS receiver includes:

– Careful choice of the IMT site locations;

– Reduction of antenna height;

– Reduction of transmitter power;

– Increased antenna tilt;

– Ensuring NLoS propagation IMT-FS.

The calculations conducted according to the methodology generally ensure interference protection for IMT stations from FS stations, even in worst-case scenarios. To further mitigate interference, several technical solutions may be considered:

– Designing FS links so that their azimuths do not align the main lobe of the FS antenna directly towards the IMT station;

– Implementing frequency offsets at specific sites by selecting portions of the 6 425-7 125 MHz frequency band that do not overlap with nearby IMT base stations;

– The use of information about real antenna radiation patterns and terrain in calculations.

3.3 Possible migration approach

Clearance of FS deployments where IMT systems will be deployed, with FS either migrated to other FS bands or replaced by fibre, is a possible measure depending on national situations and the locations and density of FS deployments in the band. It requires national administrations to identify FS migration policies (e.g. assignment of new spectrum in alternative bands).

Clearance requires that operators of FS networks replace FS equipment and re-plan their FS network. The FS migration will need time, mainly in countries with many fixed links (in the areas earmarked for IMT), and therefore administrations should give advance notice of the date of migration to FS operators. A phased migration might be advisable. The locations where IMT is most likely to be used first, such as busy urban centres, could be scheduled for earlier clearance. Other locations – such as suburban neighbourhoods – could be given a longer period for clearance. It must be noted that spectrum for IMT systems will not be available in a sufficient amount during the migration phase.

clearance should be considered together with the coexistence methodologies. In areas outside of urban and suburban centres, coexistence following the approach in section 3 may be possible, and hence clearance would not be necessary.

4

Conclusions

Annex A

Examples of calculating coordination distance based on the methodology in section 2.4

In this example protection areas around hypothetical IMT base station is calculated when interfered by the main lobe, side lobe and back lobe of the FS station.

The following assumptions are made in the analysis:

TABLE A-1

Assumptions of the example analysis of determining coordination zone around IMT BS

Assumption	Value
IMT deployment type	Suburban/Rural
FS antenna height	60 m
IMT BS azimuth	The azimuth always aligns with location of the FS
Percentage of time for Recommendation ITU-R P.2001	50%
Clutter	No clutter applied
Polarization loss	3 dB
I/N protection criterion	−6 dB

Propagation losses can be calculated using Recommendation ITU-R P.2001. Given that the beam position of an IMT base station (BS) varies depending on the User Equipment (UE) location, a random percentage of time should be used for accurate modelling. However, this requires Monte-Carlo analysis. For more common static analyses, typically used in coordination, a 50%-time probability can be applied, as it yields results nearly equivalent to using a random percentage.

It is important to note that in some scenarios, clutter losses may also be included in the model. Clutter losses are generally not applied to the transmitting Fixed Service (FS) station, as FS links are designed to ensure an unobstructed Fresnel zone between transmitting and receiving stations. However, clutter losses may be relevant for the victim IMT station. In such cases, Recommendation ITU-R P.2108 can be used, with a 50% location probability applied to account for these losses.

Figure A-1 illustrates the *I/N* levels around the IMT base station for main lobe interference. Figure A-2 depicts the protection zones for main lobe interference (red coordination distance), side lobe interference (green coordination distance), and back lobe interference (pink coordination distance). As shown, the protection distance for main lobe interference varies significantly, ranging from 15 to 75 km in certain areas. For side lobe interference, the protection distance spans from 5 to 25 km, while for back lobe interference, the protection area is typically less than 3-4 km.

It is important to note that for cross-border interference, acceptable distances can extend up to 38 km, even in worst-case scenarios, given that this aligns with the typical link length of fixed service (FS) systems operating in the 6 425-7 125 MHz frequency band. Additionally, the likelihood of an FS station being directly aligned with the IMT base station is very low. Further mitigation could also occur if the IMT base station is shielded by environmental clutter.

FIGURE A-1

***I/N* levels around IMT station when interfered by the main lobe of the FS station**

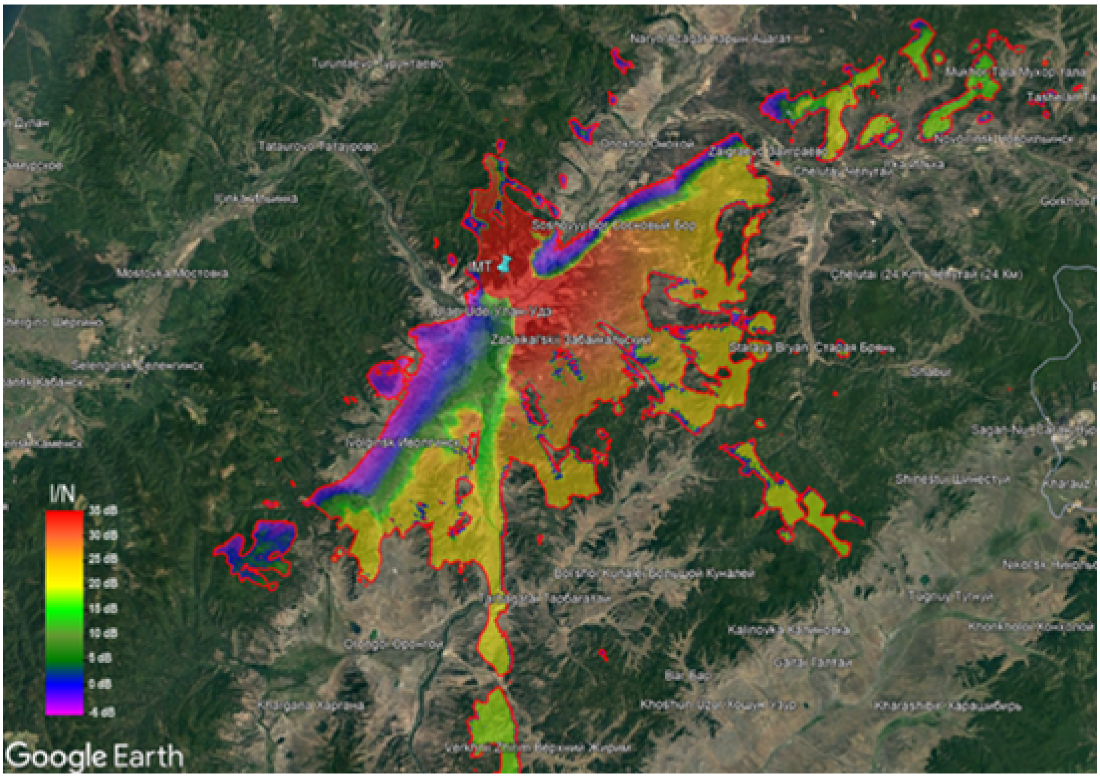


FIGURE A-2

Protection coordination distances around IMT BS when interfered by the FS main lobe (red coordination distance), side lobe (green coordination distance) and back lobe (pink coordination distance)