IAFI National Workshop on the planning of the 6GHz Band in India

Analysis of the ITU 6GHz Sharing Studies

IAFI
ITU-APT Foundation of India
ITU's Association in India

Meta

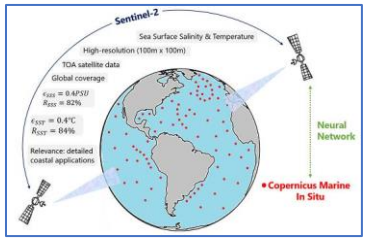
Agenda

- ITU sharing and compatibility studies for the 6 GHz band
  - Science and Space Services (RAS/EESS/SRS/SOS)
  - Fixed Service (FS)
  - Fixed Satellite Service (FSS uplink and downlink)
- Main assumptions impacting the results
  - IMT deployment parameters
  - Propagation models
  - FSS parameters
- Possible usage restrictions for IMT
- Conclusions

Science and Space Services

Radio Astronomy Service (in-band)

- The 6 GHz band is not allocated to RAS but is referred to in RR No. **5.149** (“*administrations are urged to take all practicable steps to protect the radio astronomy service*“). Studies show **separation distances between IMT stations and a Radio Telescope between 60km and several hundreds of km**.



Earth Exploration Satellite Service (in-band)

- The 6 GHz band is not allocated to the EESS but is referred to in RR No. **5.458** (“*administrations should bear in mind the needs of EESS (passive) and SRS (passive) in their future planning of the band*“). Studies show that **IMT stations on land would interfere with sea surface temperature measurements over oceans**.

Space Research Service (adjacent band)

- Studies showed no interference from IMT into SRS in the 7145-7190 MHz band but did show interference from SRS unwanted emissions into **IMT requiring coordination distances between tens of km up to 400 km**.

Space Operations Service (mostly adjacent band)

- Most studies showed that coexistence is feasible under certain assumptions, but one study showed that the SOS protection criterion would be exceeded in certain cases.

See Annexes 4.16 and 4.17 of document 5D/1555

Fixed Service

- Statistical studies with typical IMT parameters show main-lobe separation **distances up to 68 km**
- Sensitivity analyses with varying assumptions show **distances up to 58 km**
- A minimum coupling loss analysis for IMT and FS parameters shows **distances up to 200 km**

Countries with Fixed Links in urban and sub-urban areas would **need to clear the Fixed Links** out of the band to enable IMT deployments

- Assume **15 km** semi-circle area around each Fixed Link would not be available for IMT deployment
- Very few areas left to deploy IMT unless the Fixed Links are removed from the 6 GHz band

Region	Area (km^2)	# FS links	Area left for IMT
Colombia	1.14M	1753	46%
Netherlands	41540	73	38%
France	549087	3693	0%
Germany	357590	2463	0%

See Annex 4.18 of document 5D/1555

Fixed Satellite Service

Uplink

- 20 studies in WP5D have assessed aggregate interference from IMT stations into FSS space stations at various positions in a geostationary orbit for global, hemi, zone and spot beams
- Studies come to different conclusions whether sharing is feasible or not based on largely varying assumptions, e.g.:
  - Number of IMT base stations
  - Modelling of clutter loss and propagation
  - FSS antenna/parameter modifications
- In general, studies from IMT industry show sharing is feasible, studies from FSS industry show sharing is not feasible, and studies from administrations are divided depending on parameters and assumptions used (see next slides)

Downlink

- Studies show separation distances up to tens of km are required in order to protect the operation of non-GSO FSS earth stations

See Annexes 4.19 and 4.20 of document 5D/1555

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Smart Spectrum Solutions

The following is a subset of the input parameters affecting the study results:

Model Characteristics

- Single vs aggregate
- Deterministic vs statistical
  - Monte Carlo
- Propagation models
  - FSPL
  - Beam Spreading losses
  - Atmospheric Gas losses
- Clutter model
- Apportionment of interference to FS

IMT Deployment Scenario

- Deployment scenario
  - Urban vs suburban vs rural
  - Macro vs micro
  - BS only, or BS and UE
  - Number of BS (Ra, Rb, removal of unpopulated areas)
  - Number of UEs
- BS EIRP
- Network loading factor
- TDD activity factor

FSS Characteristics

- Beam
  - Global
  - Hemi
  - Spot
- Beamwidth
  - Full beam
  - 3dB footprint
- System Noise Temperature
- Peak Rx Antenna Gain
- Elevation angle from BS
- FSS Antenna Normalisation

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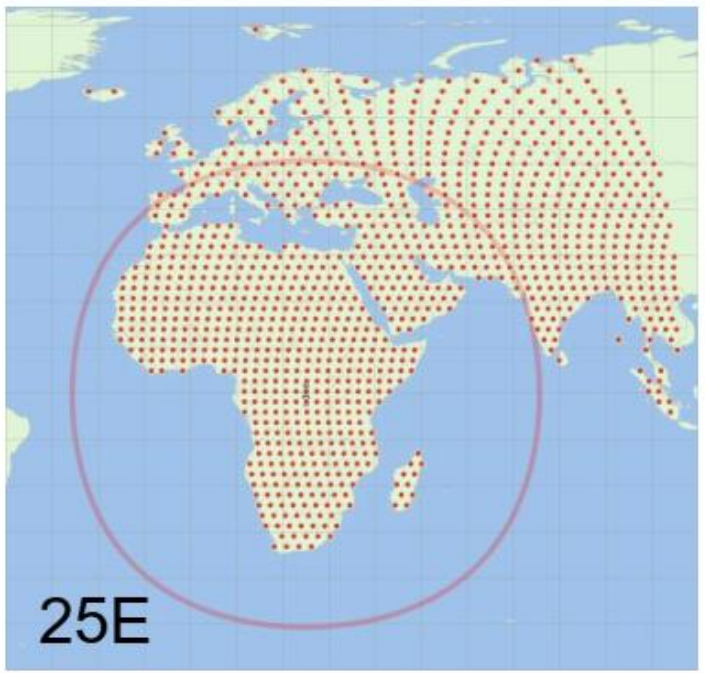
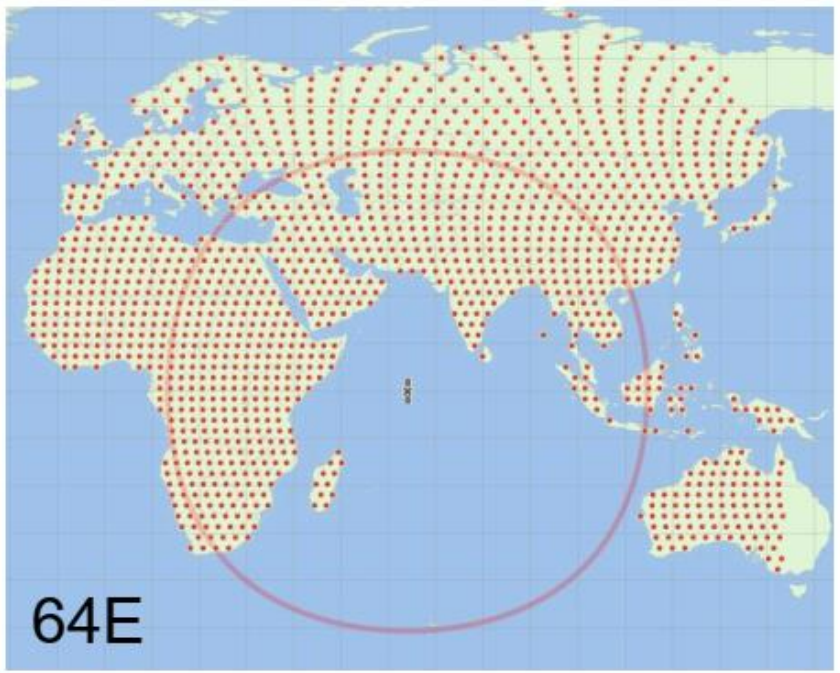
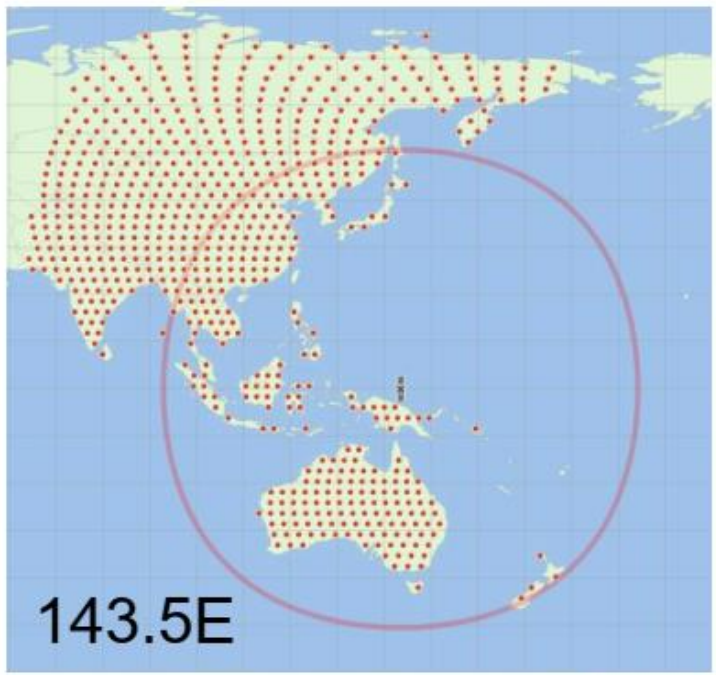
Orbital Slot Choice

- Alongside the choice of beam, the satellite location is also an important consideration. Beams chosen to point at, for example, largely sea areas will see fewer base stations than those with visibility of parts of Europe, Asia and Africa.
  - For example, **the land (and number of IMT base stations) visible to a number of GSO satellites (figures below) varies considerably** (up to 2x between 64E and 143.5E, noting that the current Agenda Item for 6425 - 7025 MHz only covers Region 1, while Agenda Item for 7025-7125 MHz covers Region 1, 2 and 3).







Source: 5D/1489

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Number of IMT base stations

- # of IMT base stations is modelled via parameters **Ra** (*ratio of coverage areas to areas of cities/built areas/districts*) and **Rb** (*ratio of built areas to total area of region in study*) with different options available for study
- Studies with low Ra/Rb values mostly show **sharing is feasible**. Studies with high Ra/Rb values mostly show **sharing is not feasible**.

Values for Ra and Rb to be used in studies involving IMT deployments for frequency bands between 6 and 8 GHz

	Options *	Macro	Micro
Ra	1	30% Urban (area < 200 000 km²) 10% Urban (area > 200 000 km²) 10% Suburban (area < 200 000 km²) 5% Suburban (area > 200 000 km²)	10% Urban (area < 200 000 km²) 5% Urban (area > 200 000 km²)
	2	45% Urban, 20% Suburban	10% Urban
Rb (depending on the area under study)	1	5% (area < 200 000 km²) 2% (200 000 - 1 000 000 km²) 1% (area > 1 000 000 km²)	5% (area < 200 000 km²) 2% (200 000 - 1 000 000 km²) 1% (area > 1 000 000 km²)
	2	5% (area < 3 500 000 km²) 3% (area > 3 500 000 km²)	5% (area < 3 500 000 km²) 3% (area > 3 500 000 km²)
	3	2.5% (area < 200 000 km²) ** 2% (200 000 - 1 000 000 km²) 1% (area > 1 000 000 km²)	2.5% (area < 200 000 km²) ** 2% (200 000 - 1 000 000 km²) 1% (area > 1 000 000 km²)

* The Ra and Rb values used in the sharing and compatibility studies should be provided together with the results of studies, for the purpose of comparison, as well as information on which specific geographical location the analysis is applicable to.

** The value is applicable for Region 1, for bands considered globally the value of 5% should be used.

Region	Nb BS Sectors Low Ra/Rb	Nb BS Sectors High Ra/Rb	Nb 5G BSs	Number of IMT Sites
Colombia	1000	50000		13000 Sites
Netherlands	1100	9300	13000	16000 Sites
France	2000	28000	39000	54000 4G Antennas
Germany	1800	32000	79000	82000 4G BSs

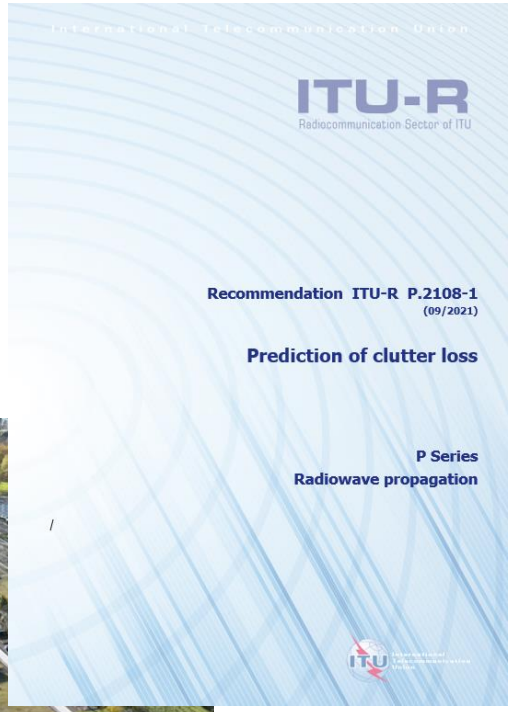
Based on current 4G base stations in urban areas in India, how many of those would eventually be upgraded with 6 GHz in the long term?

Clutter modelling

- ITU-R expert group on propagation advised WP5D to use clutter model in Recommendation ITU-R P.2108
- A draft new clutter model was also proposed in ITU but is still under discussion and review by the expert group
- New proposal was substantially modified various times to try and address concerns but still not approved
- Some WP5D studies used the newly proposed (but not approved by the expert group); most show **sharing is feasible**
- Other studies have used Rec. ITU-R P.2108 as adivsed by the ITU expert group; most show **sharing is not feasible**

- Assumption for studies that 65% of the IMT base stations are installed below rooftop in urban areas

Based on expected re-use of existing 4G base stations for 6 GHz, are 65% of all urban sites in India installed below rooftop?

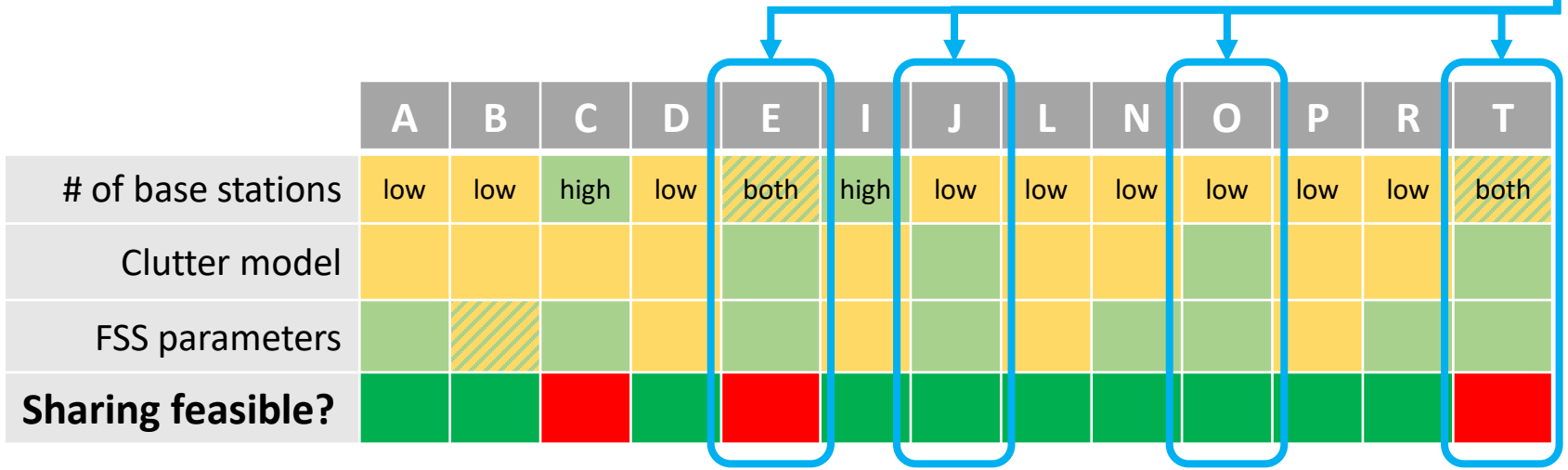


FSS parameters

- ITU expert group on satellites provided FSS antenna patterns
  - Some studies used the pattern as provided, some other studies modified the pattern to what the authors believed to be more realistic
  - Some studies considered the entire area visible by the satellite beam as provided by the ITU expert group, some other studies only considered the 3dB footprint area
- Some studies considered all elevation angles from the base station, some other only considered certain angles
- Some studies considered apportionment for IMT & FS interference into FSS, some other studies only considered IMT interference in isolation

Overview of studies from administrations

- Many variations in the study assumptions
- Study results driven by choice of assumptions
- Only some studies used assumptions fully in line with guidance from ITU expert groups
- For those studies, only those assuming low numbers of IMT base stations showed sharing is feasible



	A	B	C	D	E	I	J	L	N	O	P	R	T
# of base stations	low	low	high	low	both	high	low	low	low	low	low	low	both
Clutter model													
FSS parameters													
Sharing feasible?													

Updated sharing study provided to CPM

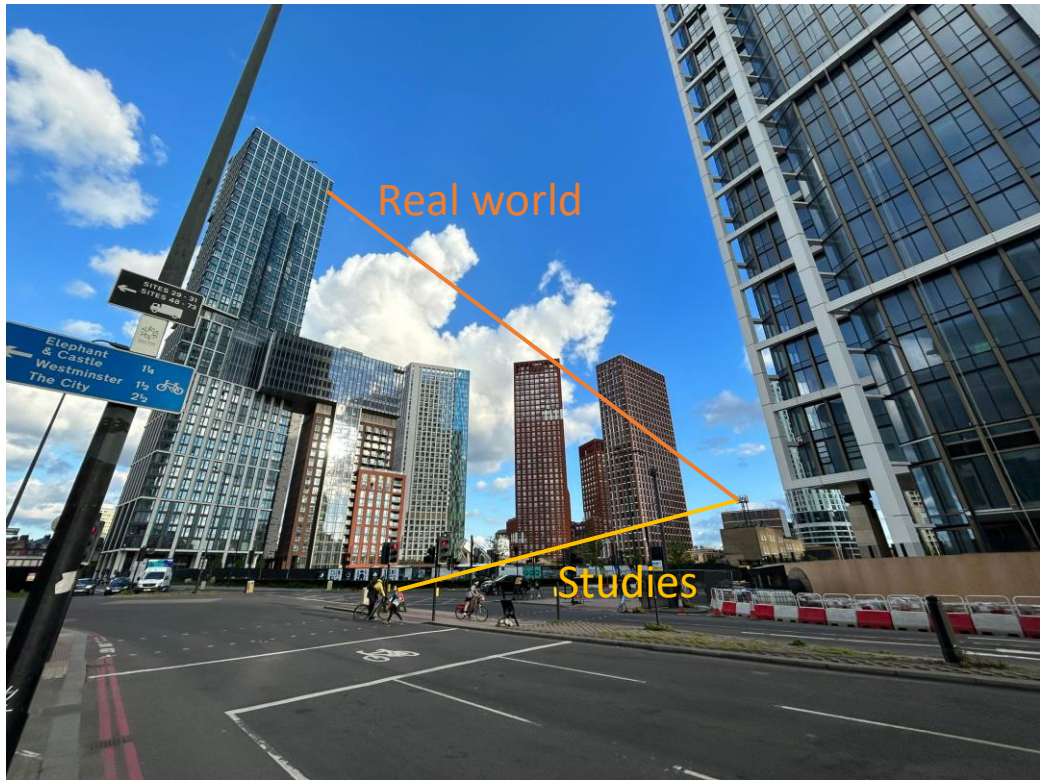
- Sharing studies submitted to WP5D have shown many variations in assumptions and modelling approaches which make it difficult to assess their applicability for real network deployments
- The UK submitted a new sharing study to CPM (document 215), based on real network deployments to overcome the difficulties experienced with the WP5D studies, with the following results:

High power IMT would exceed the protection criteria for FSS-UL in many of the carrier/slot scenarios. Additional mitigations would be needed if widespread IMT deployments were to be permitted in the 6 425-7 125 MHz band. Mitigations may not be needed to protect the global beams if IMT density remains low, however with a higher density assumption exceedance of up 7 dB is shown. Zonal (non-global) beams would be impacted the most, with exceedance up to 21 dB in some scenarios.

It would be possible for medium power (or low power indoor) IMT to share with FSS (any carrier, any orbital slot).

Terminal location and EIRP limits

- WP5D studies assume that all terminals are at 1.5m height
- WP5D assumes 70% terminals indoor
- 1.5m corresponds to outdoor terminals or terminals on ground floor.
- AAS IMT Base Stations would direct most of the energy downwards for terminals located at 1.5m
- However, for terminals located at BS level or higher, significantly more energy could be radiated towards satellites
- WP5D underestimates the interference to satellite.
- Fixing the maximum EIRP would solve this issue.
- The studies do not provide any valid indication of the interference generated if the regulation is based on mean/expected EIRP.



Can IMT stakeholders guarantee that the emissions above the horizon assumed in the studies will not be exceeded in real deployment?

Possible usage restrictions for IMT

- Various different transmit power restrictions for IMT base stations proposed
- Some defined as max. limits, some as mean limits, some as “expected average“ limits
- Ongoing discussions about implementability of such regulatory provisions

GSOA

Elevation angle	MAXIMUM e.i.r.p. dBW
[0 ≤ θ ≤ 1]	[20.7]
[1 < θ ≤ 10]	[20.7 − 1.777(θ − 1)]
[10 < θ ≤ 90]	[4.7 − 0.239(θ − 10)]

Russia

Elevation angle	MEAN e.i.r.p. dBm
0 ≤ θ ≤ 5	56,9
5 < θ ≤ 10	-2.346·θ + 68.63
10 < θ ≤ 30	-0.5904·θ + 50.94
30 < θ ≤ 60	33,36
60 < θ ≤ 80	29,13

Nokia

Elevation angle	EXPECTED e.i.r.p. dBW
0° ≤ ϑ < 5°	32
5° ≤ ϑ < 10°	28
10° ≤ ϑ < 15°	24
15° ≤ ϑ < 20°	24
20° ≤ ϑ < 30°	20
30° ≤ ϑ < 60°	18
60° ≤ ϑ ≤ 90°	17

Huawei

Elevation angle	EXPECTED e.i.r.p. dBW
0° ≤ ϑ < 5°	31,5
5° ≤ ϑ < 10°	26,5
10° ≤ ϑ < 15°	22,5
15° ≤ ϑ < 20°	21,5
20° ≤ ϑ < 30°	19,5
30° ≤ ϑ < 60°	18,5
60° ≤ ϑ ≤ 90°	18,5

- How can the low IMT base stations numbers (that lead to feasibility of sharing) be reflected in regulatory provisions?
- How can such regulation be implemented across various countries (aggregation)?
- Would such a restricted and constrained IMT deployment be economically feasible?

Conclusion

Fixed links in urban & sub-urban areas need to be cleared for IMT

WP5D studies have used various different assumptions

- Very low IMT BS numbers ⇒ Sharing mostly feasible
- Higher IMT BS numbers (based on 4G deployments) ⇒ Sharing mostly not feasible

- Studies deviating from ITU expert group guidance ⇒ Sharing mostly feasible
- Studies in line with ITU expert group guidance ⇒ Sharing mostly not feasible

New study modelling real-life networks shows sharing mostly not feasible

Conservative studies ⇒ IMT usage restrictions ⇒ Economically feasible?

Anticipated IMT deployments do not seem to match conditions required to protect incumbents