GSOA Contribution to the 4TH EACO MEETING IN PREPARATION FOR WRC-23

Monday, 28th February 2022

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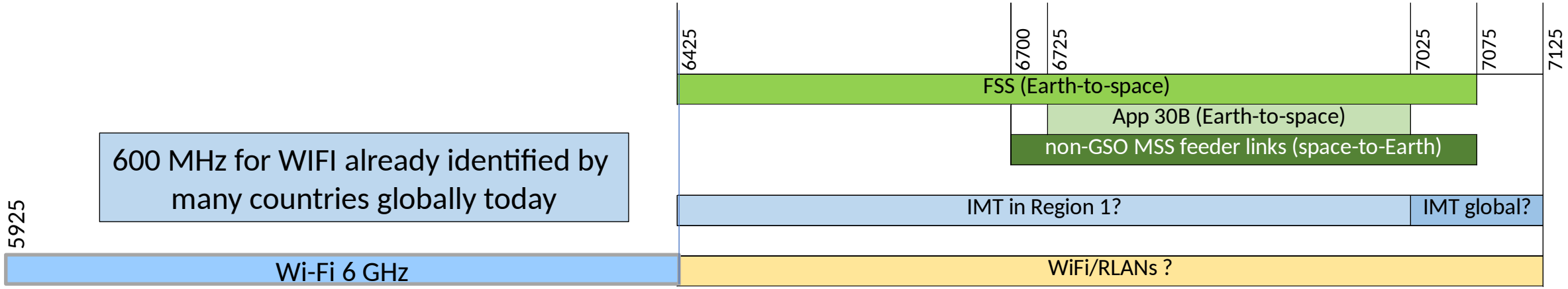
Review of FSS earth station characteristics & description of different mechanisms which can create interference into C band FSS earth stations and satellites under

Agenda Item 1.2
Bashir Patel (Inmarsat)

Agenda Item 1.3
Kevin/ Mohaned (Intelsat)

What are the long-term uses of 5 925 - 6 425 - 7 125 MHz? FS, FSS e/s, IMT, WiFi-6/7?



6425-7075 MHz – FSS E-S

⇒ For geostationary uplinks used by large numbers of GSO FSS networks covering all regions, includes Inmarsat use

⇒ Studies required on

1. Interference from IMT to satellite receivers
2. Interference from FSS earth stations to IMT stations

6725-7025 MHz - Appendix 30B

⇒ This frequency band is allocated to the FSS globally and used for FSS as per the provisions of Appendix 30B.

⇒ Objective: to "…guarantee in practice, for all countries, equitable access to the geostationary-satellite orbit…"

⇒ Provides every administration with a preserved orbital slot and frequency allotments.

⇒ Studies required on interference from IMT to planned national allotments

6700-7075 MHz - NGSO MSS downlinks

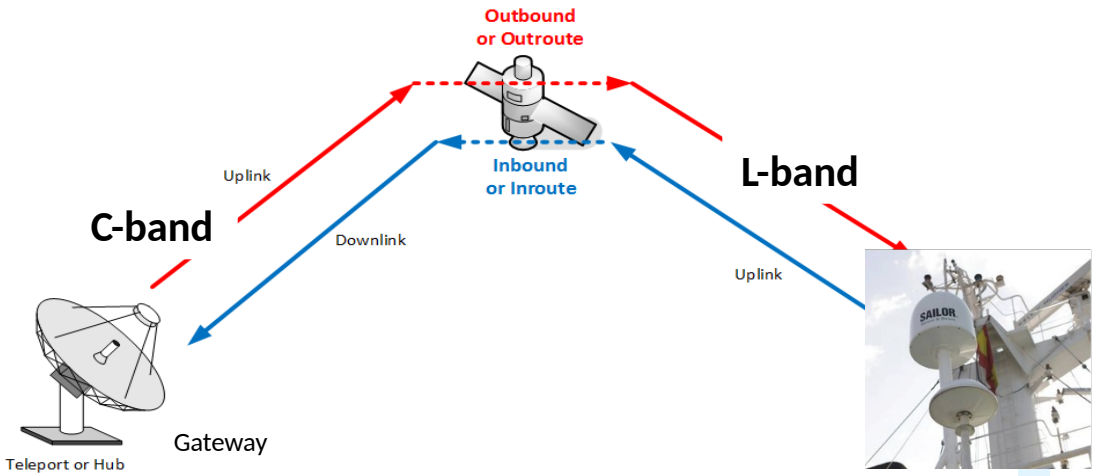
⇒ Gateway earth stations deployed around the world for NGSO MSS systems (e.g. GlobalStar, OmniSpace, EchoStar Helios)

⇒ Providing voice, data and Internet of Things globally

⇒ Studies required on Interference from IMT to receiving earth stations

Usage in Unplanned band 6425-6725 MHz

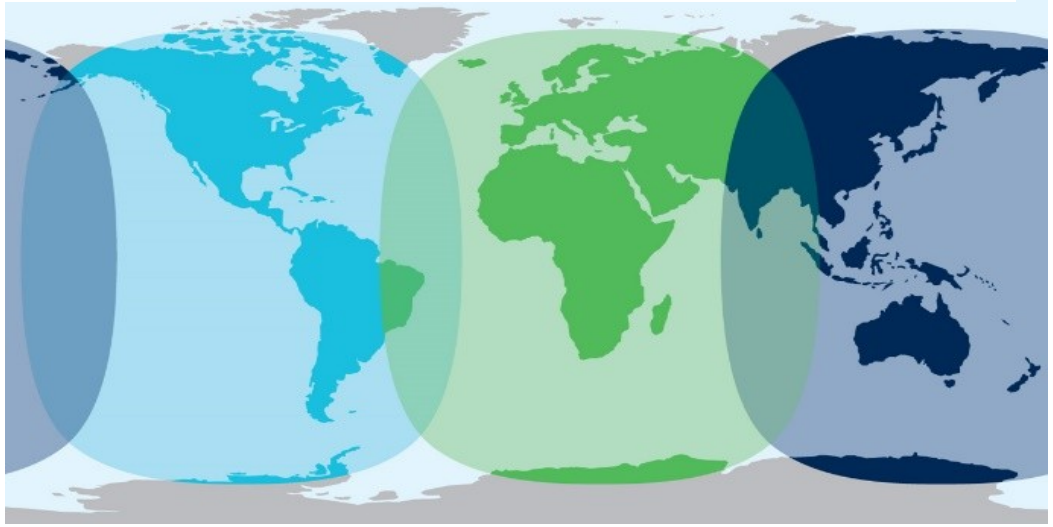
- **Used by “global beam” antennas, to allow use by gateway stations in almost any country**
- **Used for feeder links for GNSS augmentation (SBAS) on some satellites**
- **Used to support the L-band service uplinks and downlinks**
- **Feeder links used to carry maritime and aeronautical safety traffic**



<u>C band (standard and extended)</u>
Downlink: 3 400 - 4 200 MHz , Uplink: 5 850 - 6 725 MHz

Feeder links used in L/C payload operating in the ‘extended C-band’ operating through more than 20+ Land Earth Stations carrying safety services traffic (C2L, L2C,)

Down link: 3550 – 3700 MHz,
Uplink : 6425 – 6575 MHz



Need to protect critical safety services

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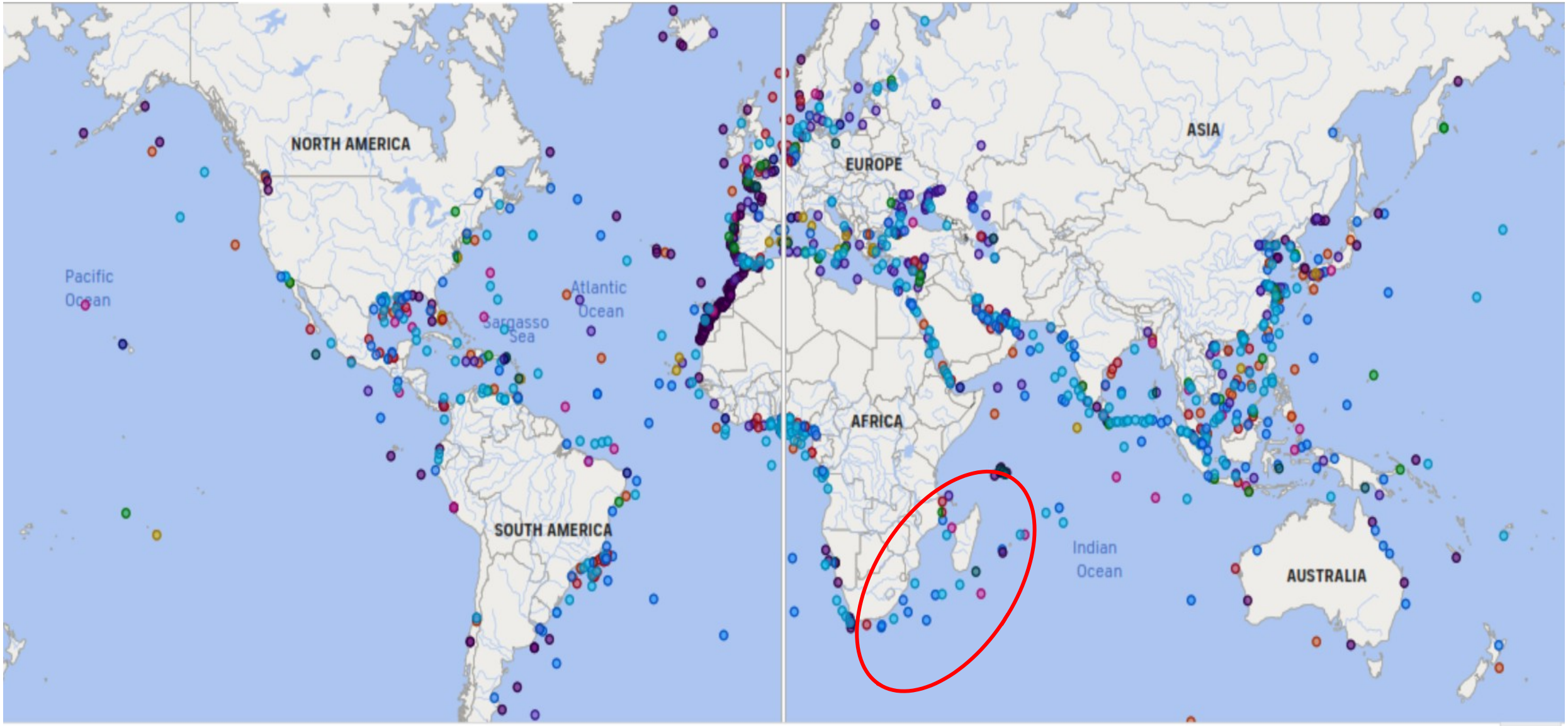
GMDSS Distress Calls Map



Usage in Planned Band 6725-7025 MHz - AP30B Considerations

- In ITU Region 1, **the band 6725-7025 MHz is subject to Appendix 30B of the ITU Radio Regulations**
- This appendix is intended to **guarantee, for all countries, equitable access to the geostationary-satellite orbit in the 6725-7025 MHz band**.
- Therefore, Many **Developing countries Administrations have rights to operate this band over their territory without time limits.**
- **Any deployment of wireless technologies in the 6725-7025 MHz band will need to protect the Appendix 30B national allotments** of all Developing countries.

EXAMPLE:

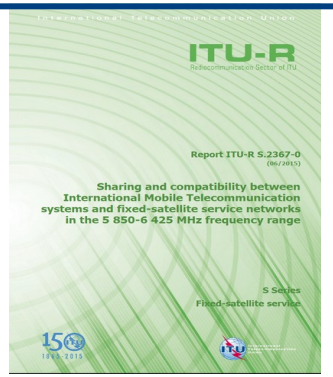
Country	Allotment code	Nominal orbital position (deg)
Burundi	BDI00000	-3.5
Kenya	KEN00000	78.2
Rwanda	RRW00000	17.6
South Sudan	-	-
Tanzania	TZA00000	67.5
Uganda	UGA00000	31.5

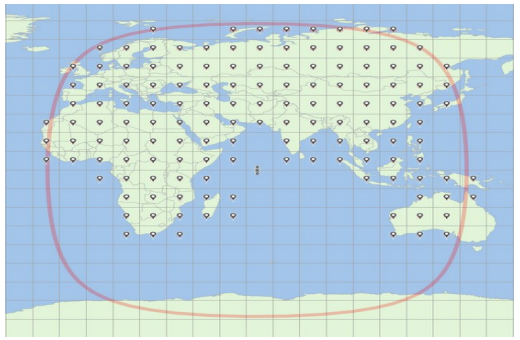
Significantly important for Developing Countries to protect their interest

Uplink Studies (5925- 6425- 7125 MHz)

Previous ITU-R Studies (5850-6425 MHz)

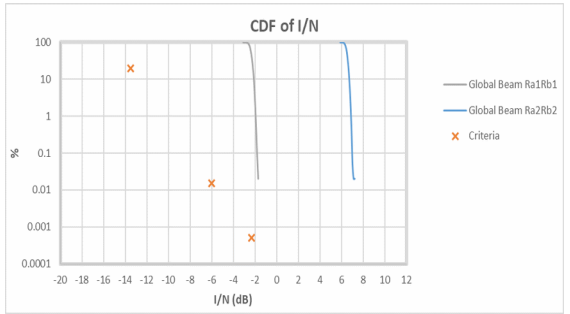
- Studies have been carried out for **IMT-Advanced in the band 5850-6425 MHz** in **ITU-R Report S.2367**
- **FSS characteristics used in S.2367 are similar to those in the band 6425-6575 MHz**
- Interference from Uplink Ground Earth Stations to IMT-Advanced BSs:
  - Example separation: "10-78 km to protect outdoor macrocell in a suburban environment"
- Interference from IMT-Advanced stations to FSS satellite receivers:
  - ITU-R Report S.2367 conclusion:
    - *that **FSS space receivers would be subjected to excessive levels of interference from the aggregate operation of IMT (small cell) base stations**, irrespective of whether they are deployed outdoors or indoors. It was stated that necessary conditions for deployment of IMT systems would include limitation to indoor only and establishment of strict limits on maximum allowable e.i.r.p. for IMT stations.*
    - **These conclusions are also relevant for the frequency band 6 425-7 025 MHz**





Current Studies (6425-7125 MHz)

- WP5D & WP4A provided the necessary parameters to undertake sharing and compatibility studies. July 2021
- Initial Studies conducted takes into consideration parameters and assumptions provided by WP5D & 4A. [**type of study (Monte Carlo as per M.2102), clutter loss (application of P.2108, specific percentage, etc.), Ra/Rb options, polarization discrimination, UE power control, elevation angles used in the study, network loading factor (20% or 50%), 3dB contour, Apportionment (Yes), Rural scenario (Yes), Aggregate interference calculation, etc**.]
- The initial results (I/N) show that **aggregate interference from IMT base stations exceeds both the long-term and short-term criteria of FSS receivers for all cases**, i.e. for both the highest and lowest IMT deployment densities and for all three satellite beams considered. The CDFs are near vertical, indicating an almost constant level of aggregate interference.



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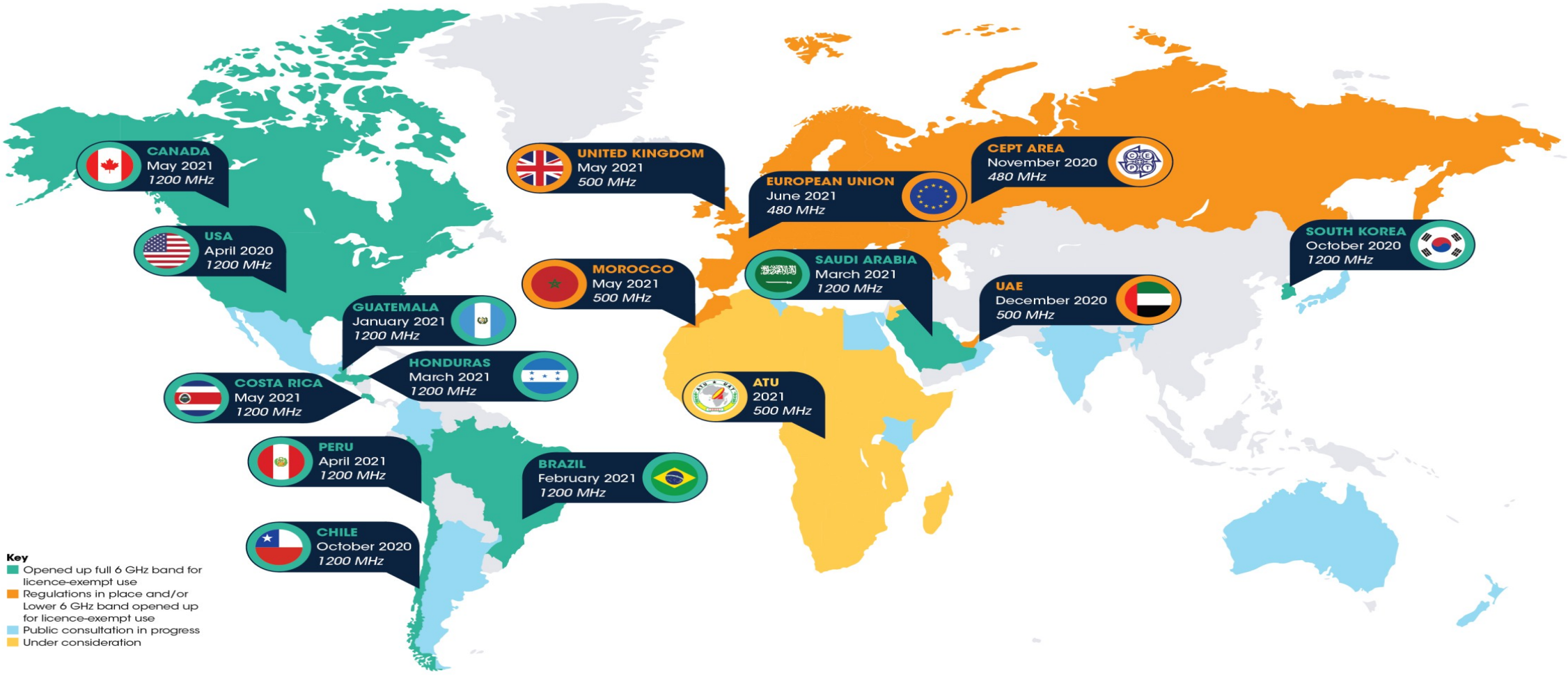
Growth of Wi-Fi / RLANs Considerations



Global 6GHz Wi-Fi Momentum

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Optimum Utilisation of 6 GHz

Key Considerations:

- **For 5G/IMT spectrum -** examine current utilisation, spectrum already available and possible future requirements, re-farm existing spectrum, use alternative bands, evolutionary development etc
- **Preserve provisioning of safety services -** National / Regional considerations, for national emergencies/disasters, maritime and aeronautical services in compliance with IMO & ICAO requirements. National and Regional Rescue Coordination operations (RCC).
- **Appendix 30 B- FSS protection** - National/Regional protection of band 6725-7025 MHz that is subject to Appendix 30B of the ITU Radio Regulations. Domestic development of satellite-based services includes bridging the digital divide, particularly among many developing countries.
- **On 6 GHz Wi-Fi –** Establish national policy for the growth of unlicensed band services,– consider adopting full-band 5925 GHz to 7025 GHz for expected demand and include development of Wi-Fi 6E and 7 for nationwide indoor implementation [growing need to utilise full 1200 MHz – 5925-7125 MHz – many countries are opting for this includes U.S., Saudi Arabia, Canada, South Korea, Brazil..]

Many countries rely heavily on C-band satellites offering vital services that in many cases cannot be reliably provided or provided at all by other means. Given the above factors together with existing ITU-R studies between FSS and IMT, it is evident that IMT sharing is not practical nor feasible in 6 GHz Bands with FSS BUT sharing with WiFi is feasible:

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Kevin/ Mohaned (Intelsat)

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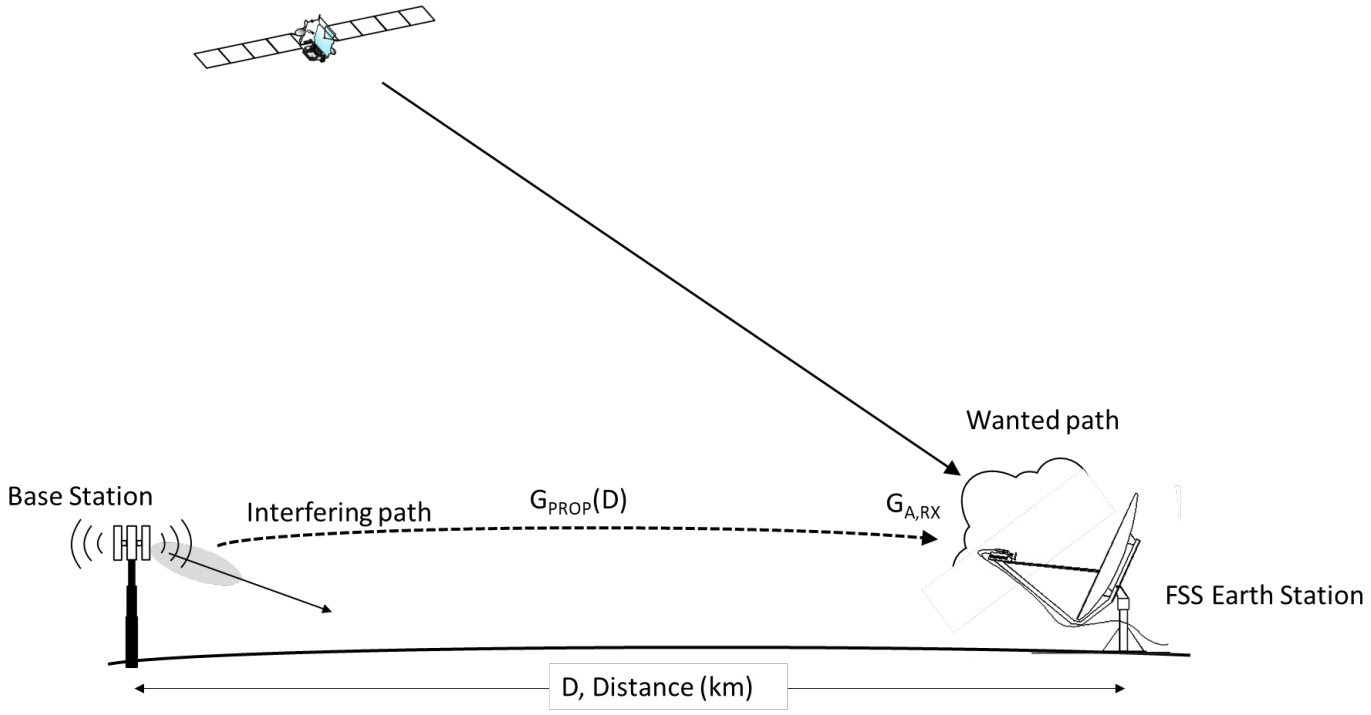
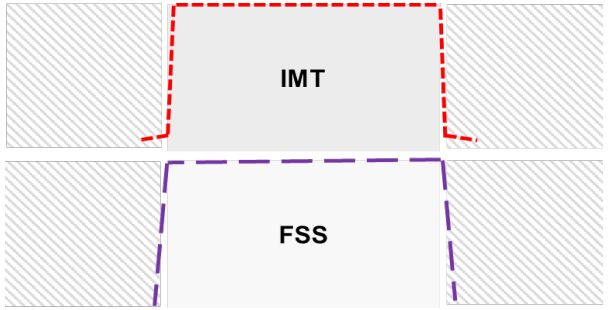
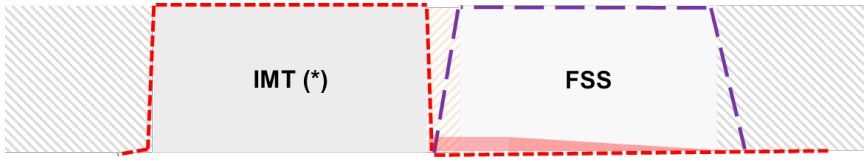
The Coexistence Scenarios



CO-FREQUENCY: Operations within the same frequency ranges



ADJACENT BAND: Operations in spectrum adjacent to each other



Impact on FSS earth station

- LNB Blocking -> Loss of service
- Increase in interference
- Reduction of C/(N+I)
- Increased BER and reduced link margin

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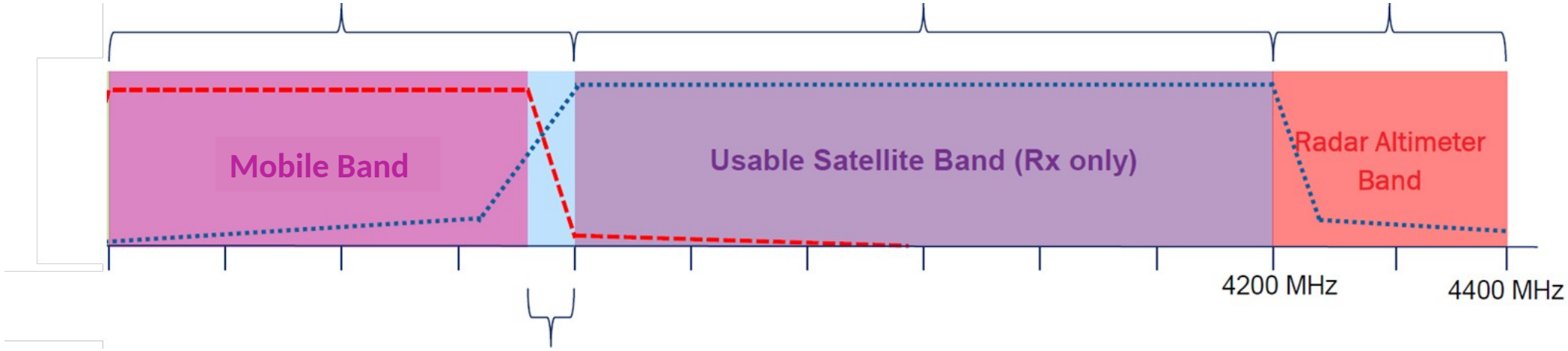
The adjacent band scenario

Example assumes mobile operations in 3.4-3.6 GHz and FSS in 3.6-4.2 GHz

Mobile In-band Emissions (IBE)
3400 – 3600 MHz
Impact: Earth Station LNB saturation

Mobile Out-of-Band Emissions (OOBE)
3600 – 4200 MHz
Impact: Satellite Signal Degradation
Increased BER and reduced link margin

Altimeter Radar Emissions
4200 – 4400 MHz
Impact: Earth Station LNB Saturation



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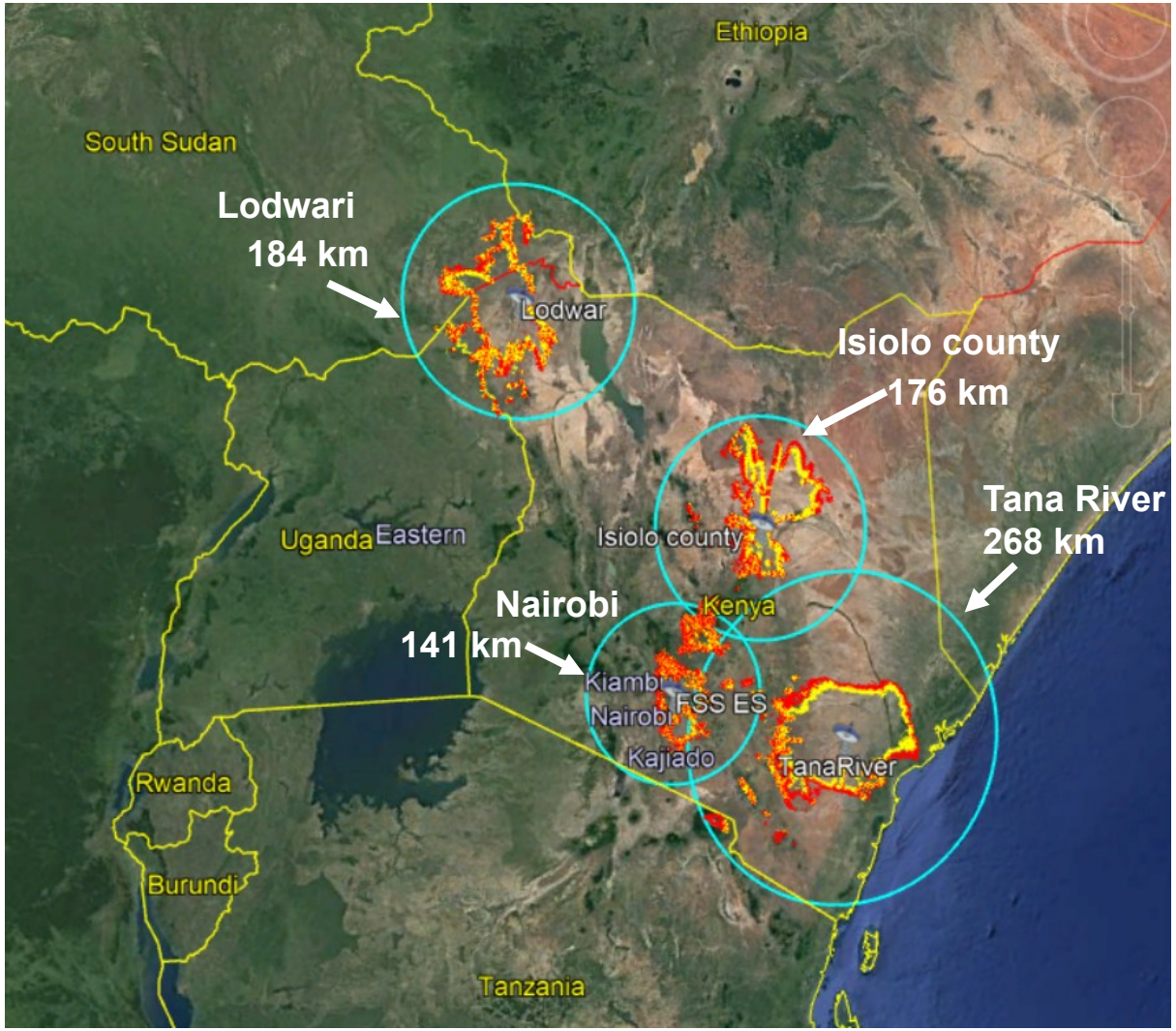
Results – Kenya

Case studied: In-band interference from potential Mobile stations in 3.6-3.8 GHz into FSS ES receivers.

- Separation distance for each ES site depends on a number of factors but mainly driven by
  - Terrain
  - ES pointing / Elevation
  - Antenna size

- Note that in all of these analysis, the actual FSS ES are taken not the worst case scenarios (5 ° elevation). For a worse case analysis, taking GSO arc extremes into account, the separation distances would be greater.



Separation distances range between 141 – 268 km

➔Potential cross border interference

➔Protection of national deployment should be ensured (keep MS secondary/introduce pfd limits)

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Overview of the status of discussion

- Contribution 5A/457 by Nigeria/RSA/Zimbabwe at the November 2021 meeting showed very small separation distances required to protect FSS Earth station receivers from Mobile service deployments in the 3.6-3.8 GHz
  - Long-term protection criteria (I/N = -10.5, 20% time) : 3.7 – 4.6 km
  - Short-term protection criteria (I/N = -1.3, 0.005% time): 4.0 – 5.5 km
- Results are inconsistent with existing knowledge of FSS and MS sharing:
  - These results are very different (10x or 50x shorter) from results presented in existing ITU-R reports (S.2368 & M.2109)
  - Results clash with contribution 5A/443 submitted by 7 African admins which present results aligned with existing study reports.
  - If results were accurate then there would be no issues between FSS and Mobile which is in fact one of the most difficult coexistence issue that exists today. Mobile identification to C-band spectrum means vacating the band by other services which conflicts with the conclusion obtained by the Nigeria/RSA/Zimbabwe contribution.
- Many comments raised at the WP 5A by various administrations as the study is lacunar in its explanation. Discussion helped to gather a bit more information on how the study was claimed to have been performed

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Next steps

Technical studies:

➔Recreate the Nigeria/Zimbabwe/South African study to check these results and to identify key issues on the assumptions taken.

➔Preliminary results show separation distances greater than 45 km and 300 km for long term and short-term protection criteria respectively

➔Other studies:

- Adjacent band studies
- Study impact of AAS antennas

Upcoming meetings to contribute to the discussion:

➔ATU WG (May/June?)

➔ITU WP5A (23rd May – 3rd June; deadline 16th May)

➔APM23-3 (September/October?)

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Article 21.5

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Agenda Item 9 Article 21
(RR21.5 and IMT stations WRC-19 doc. 550)

RR21.5 and IMT stations *"ITU-R is invited to study, as a matter of urgency, the applicability of the limit specified in No. **21.5** of the Radio Regulations to IMT stations, that use an antenna that consists of an array of active elements, with a view to recommend ways for its possible replacement or revision for such stations, as well as any necessary updates to Table **21-2** related to terrestrial and space services sharing frequency bands. Furthermore, the ITU-R is invited to study, as a matter of urgency, verification of No. **21.5** regarding the notification of IMT stations that use an antenna that consists of an array of active elements, as appropriate." **(WRC-19 doc. 550)**;*

Responsible Group: Working Party 5D

Background

1. The matter which was raised in the context of WRC-19 AI1.13 is about **how RR21.5 would be applied to IMT stations with active antenna system (AAS).** Some may interpret the application of these limits to each element of an antenna array for IMT stations in such a way that it would allow a significant increase in the power radiated towards the GSO arc.
2. **Power limits of Article 21 are intended to protect satellite receivers from interference of terrestrial stations, particularly RR No.21.5 is intended to limit the aggregate interference from fixed/mobile stations (including IMT stations) in a space receivers**.
3. **RR No.21.5 uses the language "power delivered by a transmitter to the antenna", which leads to some ambiguity when applying the limits to IMT station that deploys an antenna system comprises an array of active elements.**
4. If the RR21.5 limit (+10 dBW) were to be applied to each radiating element, that would allow IMT base station radiated power 35 dB higher than was assumed in the ITU-R studies, which would significantly exceed the satellite protection criteria.
5. It may be noted that AAS are also being considered for use in mobile systems operating in bands which are not identified for IMT and are being considered for use in fixed service systems.
6. **This ambiguity in application of RR No. 21.5 should be addressed and consequently there is a need to clarify the application of Article 21 to fixed or mobile (including IMT) stations deployed with AAS.**

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RR21.5 and IMT stations (WRC-19 doc. 550)

GSOA position:

1. **RR21.5 power limits should apply to all stations (whether with passive or active antennas) in the fixed or mobile service including IMT stations** consistently with the intention of the provision to protect satellite reception, in frequency bands for reception by space stations where the frequency bands are shared with equal rights with the fixed or mobile services.

2. GSOA **supports the application of Article 21 to AAS antennas for stations in the fixed or mobile service including IMT stations through confirmation of the RR21.5 limit of 10dBW using the Total Radiated Power of the antenna, (with a reference bandwidth of 200MHz (as per WRC-19 studies).**

3. GSOA also **supports an update of Table 21-2 to include frequency bands for reception by space stations** (Earth-to-space) where the frequency bands are shared with equal rights with the fixed or mobile services (including for IMT stations) and not yet included in Table **21-2**.

4. GSOA has reviewed the RR 2020 edition and identified, at this stage, the following frequency bands that should be added to Table 21-2:
   - FSS allocations in 24.65-25.25 GHz (Region 1), 24.75-25.25 GHz (Region 2), 42.5-43.5 GHz, 47.2-50.2 GHz, 50.4-51.4 GHz and 81-86 GHz.
   - MSS allocations in 43.5-47 GHz, 66-71 GHz, and 81-84 GHz.
   - ISS allocations in [AA-BB, CC-DD] GHz

While there are bands above 86 GHz that may also need to be added to Table 21-2, it seems premature to add those bands at this time, without a more detailed evaluation. The following Note could be added to Table 21-2: *The frequency bands above 86 GHz are not currently addressed in Table 21-2, but may be considered for addition by a future competent World Radiocommunication Conference*".