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WRC-23 Briefings on Key Satellite Issues

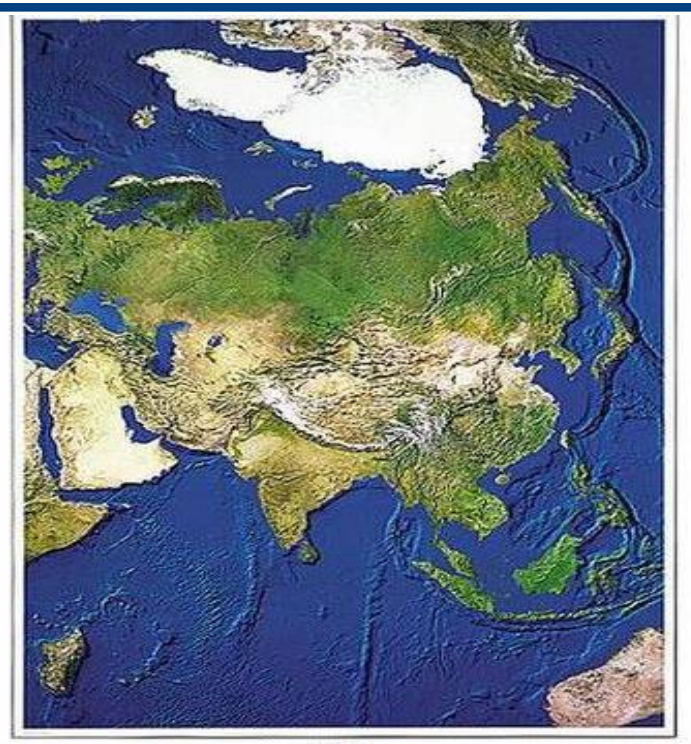
ITU - APT WORKSHOP
23 JUNE 2021

Bashir Patel
GSC /ESOA Coordinator

Global Satellite Coalition Partners

Region 2

Region 1



Region 3

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Key WRC-23 Agenda Items

- **Critical utilisation of C-Band in Region 3**

- **WRC-23 Key Satellite Issues**
  - Agenda Item 1.2: IMT in 3/6/7/10 GHz - Res. 245 (WRC-19)
  - Agenda Item 1.3: Mobile Service in 3600-3800 MHz in Region 1 - Res. 246 (WRC-19)
  - Issue 9.1 c): IMT in bands of the Fixed Service (FS) - Res. 175 (WRC-19)
  - Article-RR21.5: Applicability of RR21.5 to IMT stations (WRC-19 doc. 550)

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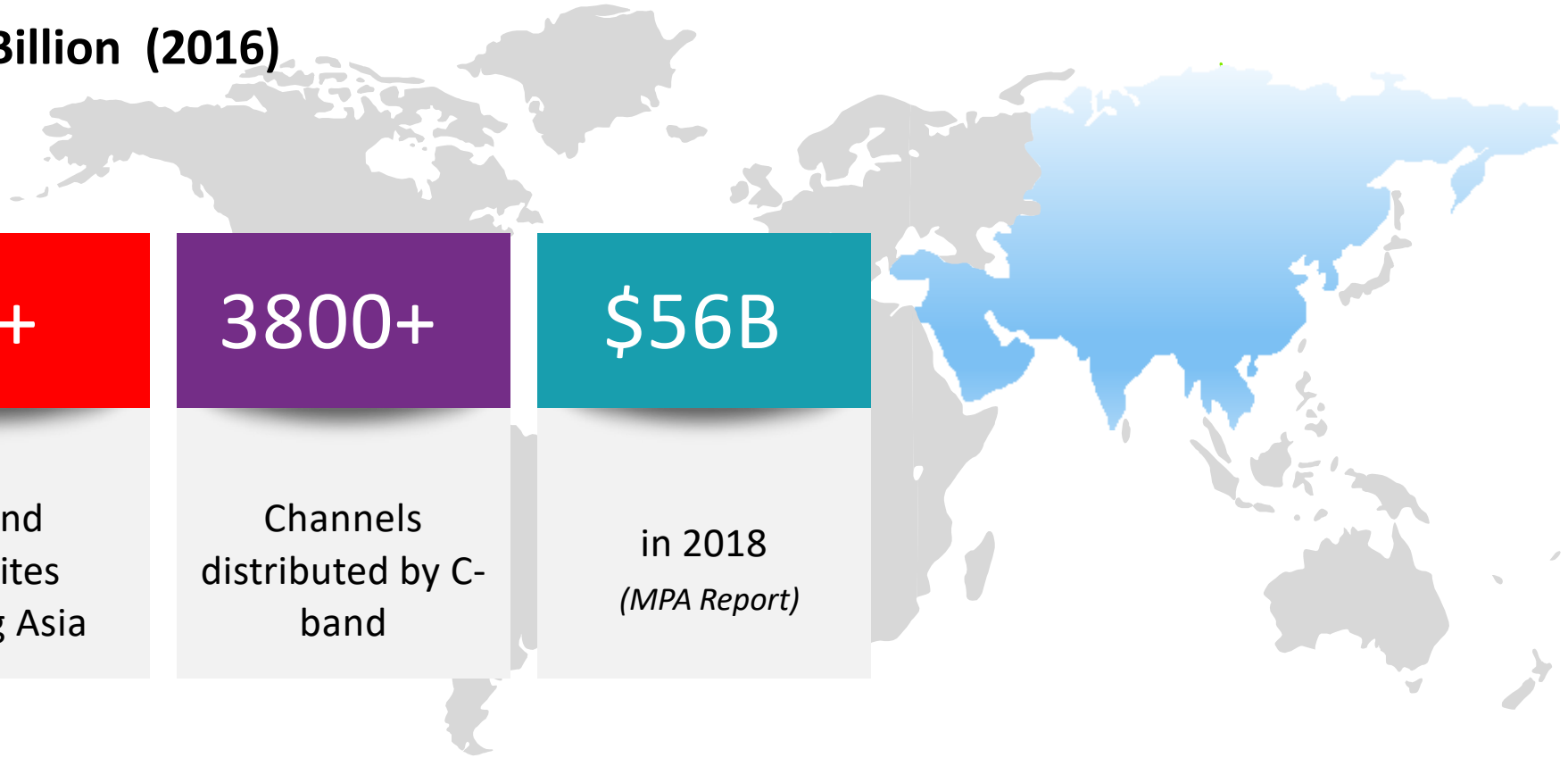
C-band facts & figures for Asia

Asia Population: 4.46 Billion (2016)



16+	80+	3800+	$56B
indigenous C-band Satellite Systems	C-band Satellites Serving Asia	Channels distributed by C-band	in 2018 *(MPA Report)*

There is no substitute for C-band Satellite Services in Asia

Billions Invested in Satellites to Meet Broadband Demand

- Over 80+ C-Band satellites in orbit covering India and Asia-Pacific and more underway
- These satellite networks will provide connectivity to existing and new markets (new products and services), enhance existing terrestrial markets (new geographies), and create competition v. existing terrestrial markets (particularly, legacy wireline and satellite networks). **Morgan Stanley, October 2017**

- Satellite broadband is changing lives by providing never-before available connectivity, and by offering choice and competition
- Increasing broadband connectivity grows economies and stabilizes communities
- C, Ku and Ka are the satellite spectrum bands that makes this all possible
- All countries deserve choices of broadband technologies

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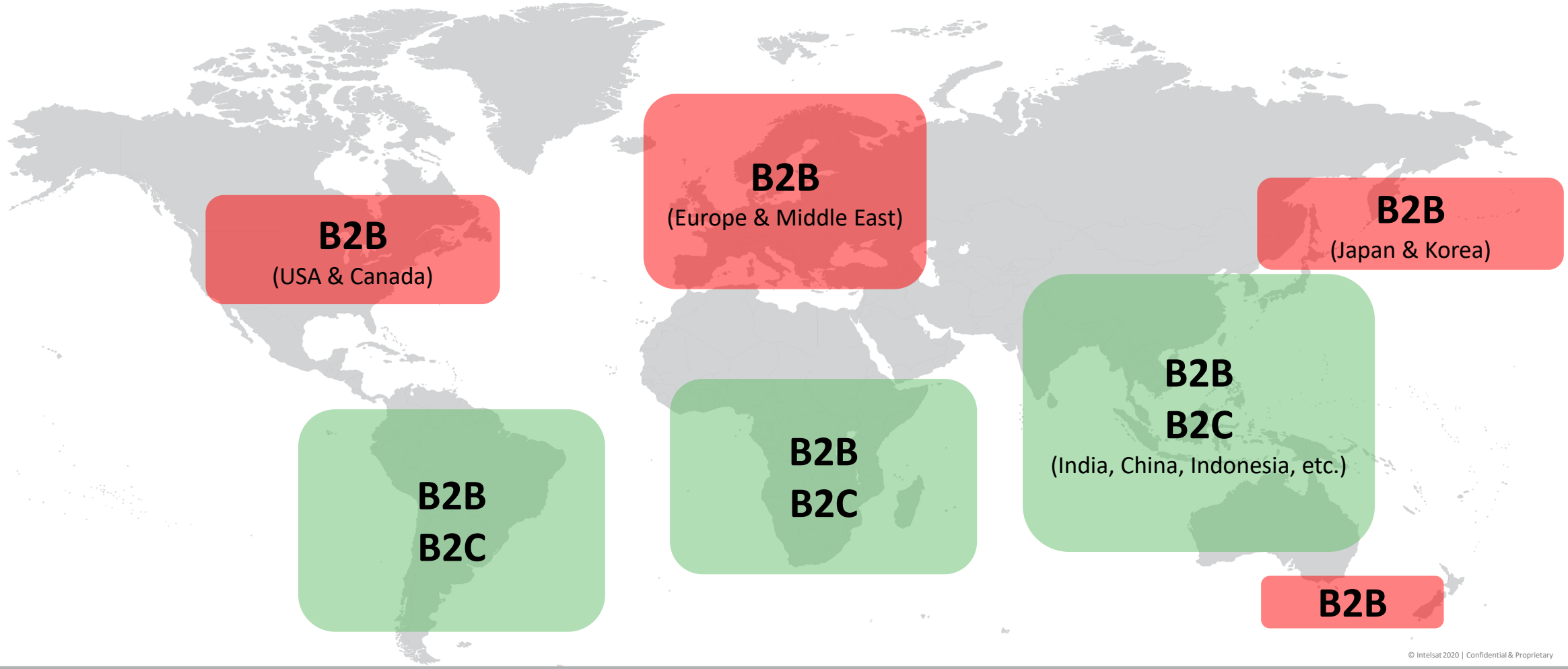
How FSS C-band is used around the world



B2C has thousands of earth stations hence re-farming is not possible as it is for B2B

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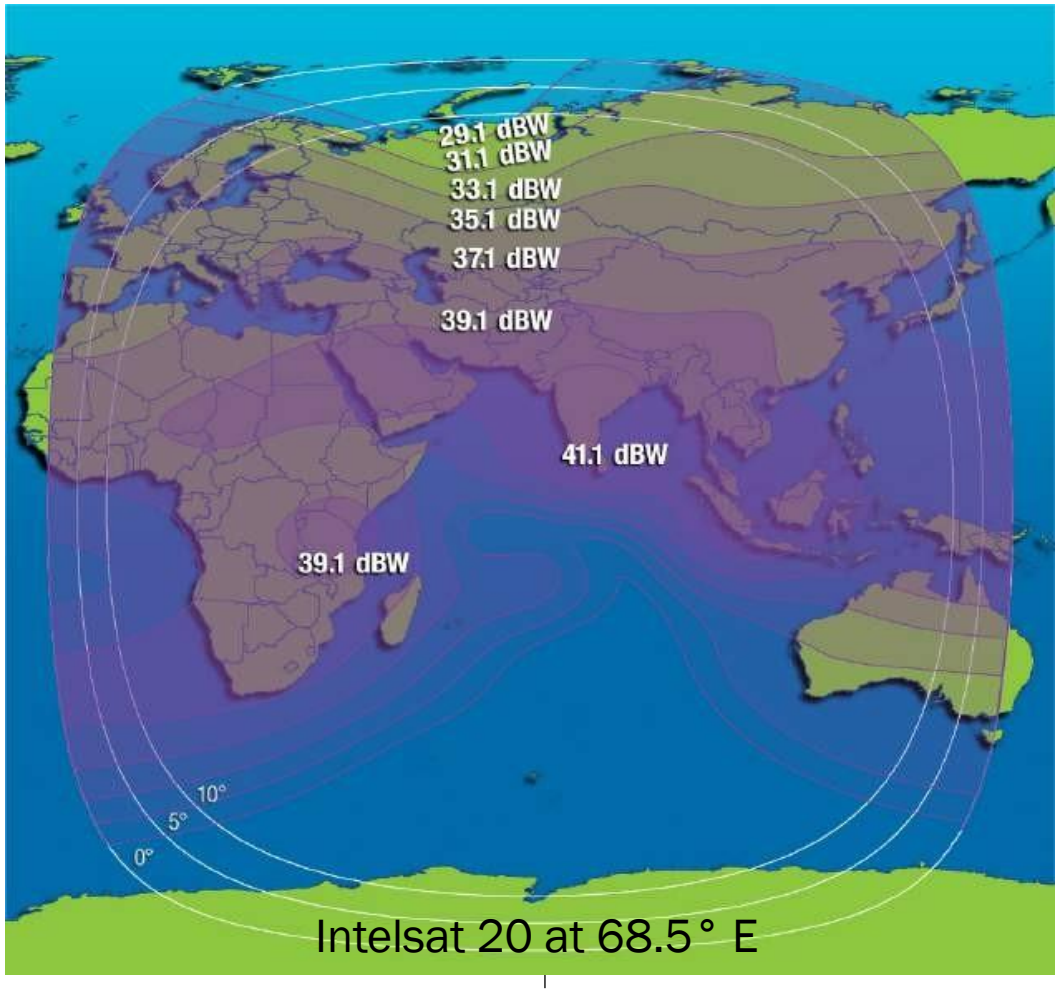
Why C-Band remains the distribution platform of choice

The most efficient, reliable, and economical medium for distribution of Media distribution

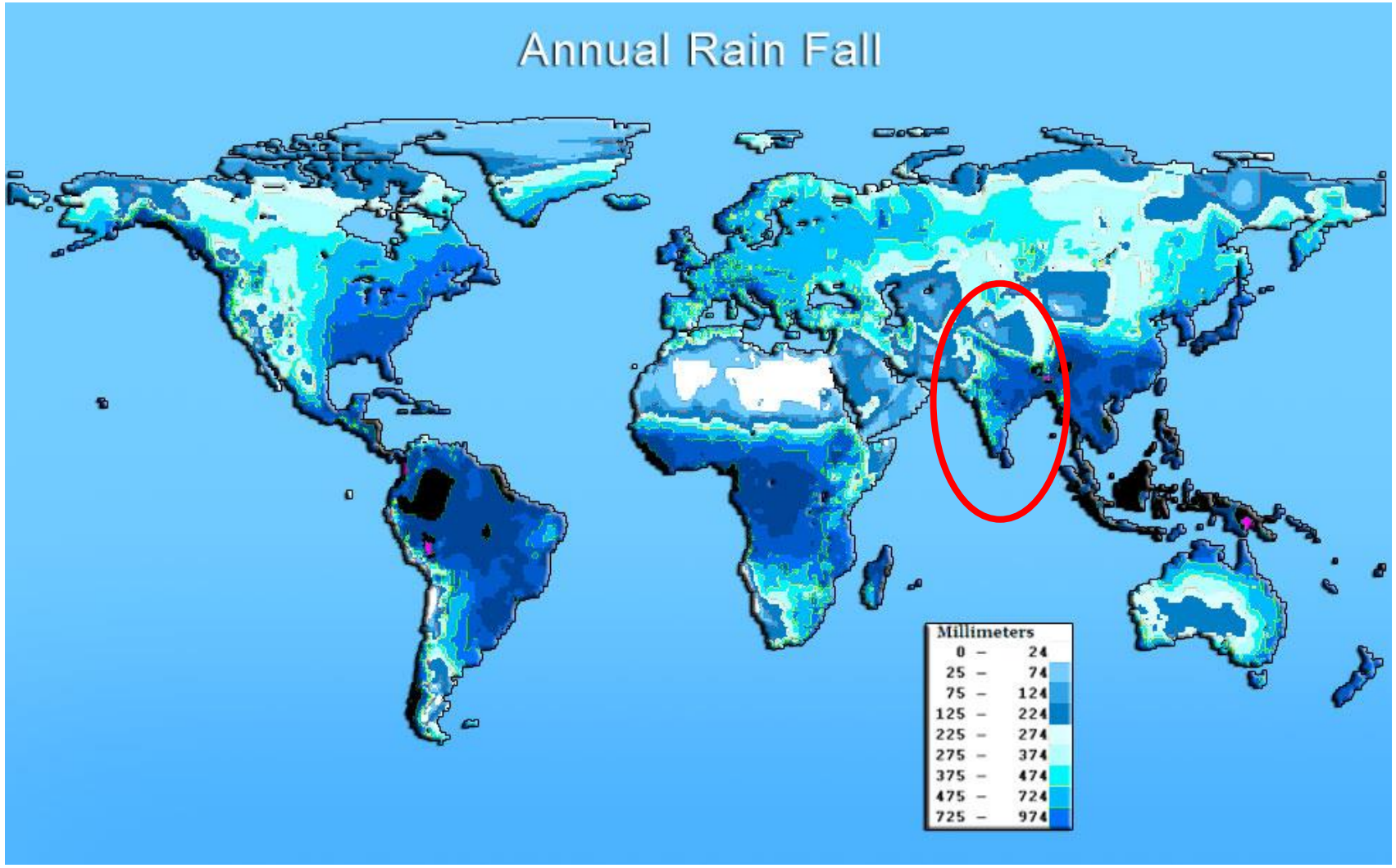


Intelsat 20 at 68.5° E

- **REACH**: C-band beams cover large geographic areas, facilitate intercontinental and global communications.
- **ECONOMICS**: 100s of thousands of installed earth stations around the world; over a hundred satellites in orbit, global reach and distribution efficiency;
- **RESILIENCE:** C-band has unique propagation and coverage characteristics that cannot be replicated in other frequency bands

C-band is irreplaceable and not substitutable

C- Band Resilience to Severe Weather Conditions



The properties of C Band make it uniquely robust for providing services in sub-equatorial regions, including much of India, which often suffer from very heavy rainfall.

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C – Band Utilization in India

- Last 25 Years C-Band (3.6-4.2 GHz) has been deployment and use by the Satellite Industry for Media Broadcast services within India and the region
  - ~900 TV Channels
  - Distributed to 200M+ Households in India, via MSOs, Cable Operators, DTH and HITS platforms
  - Indian content beamed from India and distributed to more than 140+ countries across Asia, Pacific, Middle East, Europe and Africa.
- Government Agencies
  - Defense agencies, borders, telemedicine
- Public Sector Organizations for their enterprise applications, Educational, Meteorology, Aviation
- Disaster Management Operations - feeder links to enable applications on hand-held and suitcase-based satellite devices

There is no substitute for C-band Satellite Services in India

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WRC-23 Agenda Item 1.2

Agenda Item 1.2: *to consider identification of the frequency bands 3 300-3 400 MHz, 3 600-3 800 MHz, 6 425-7 025 MHz, 7 025-7 125 MHz and 10.0-10.5 GHz for International Mobile Telecommunications (IMT), including possible additional allocations to the mobile service on a primary basis, in accordance with Resolution 245 (WRC-19);*

Responsible Group: **Working Party 5D**

Contributing Group for FSS: **Working Party 4A**

Resolution 245 (WRC-19) calls for studies for the terrestrial component of IMT in the bands:

- 3 300-3 400 MHz and 3 600-3 800 MHz (Region 2);
- 3 300-3 400 MHz (amend footnote in Region 1);
- 6 425-7 025 MHz (Region 1);
- 7 025-7 125 MHz (globally);
- 10 000-10 500 MHz (Region 2).

ESOA position on the band 6425-7125 MHz:

Considering that **many countries rely heavily on C-band satellite services offering vital services** which in many cases cannot be reliably provided or provided at all by other means, and that **existing studies between FSS and IMT have demonstrated that sharing is not feasible: in the bands 6 425-7 025 MHz in Region 1** and 7 025-7 075 MHz globally.

WRC-23 Agenda Item 1.2

Background:

C-band uplink - Existing studies between IMT and FSS in the band 5 925 – 6 425 MHz is to be done under AI1.2:

	IMT-Advanced (4G)	IMT-2020 (5G)	WIFI in 6 GHz
ITU	Report ITU-R S.2367	To be done under AI1.2	No studies
CEPT	No studies	No studies	ECC Report 302

In the range 6425-7125 MHz, one should differentiate the following sub-bands:

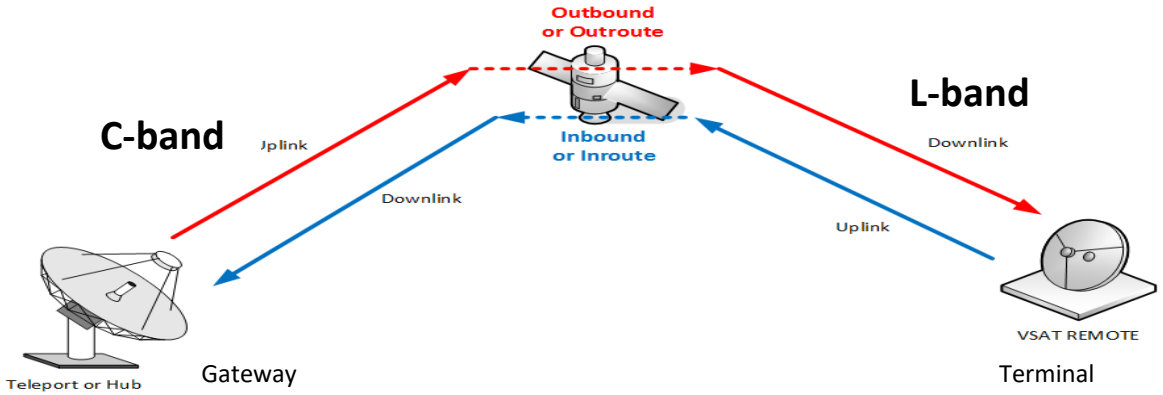
Sub Bands	Existing Utilisation
6425-6725 MHz:	Unplanned band, allocated to the FSS globally (earth-to-space). **Used for uplinks by large numbers of GSO FSS networks covering all Regions.** **Uses includes feeder links for MSS systems including safety services**.
6725-7025 MHz:	**Planned FSS band – subject AP30B**, there are no existing studies with IMT/5G
6 700-7 025 MHz	Allocated to the FSS globally (space-to-earth), Limited to feeder links for NGSO – MSS and is subject to coordination under No. **9.11A.**
7025-7075 MHz:	Allocated to the FSS globally (earth-to-space) and is not subject to a Plan
7075-7125 MHz:	there is no FSS allocation, so no direct impact

Existing studies related to IMT-Advanced (Report ITU-R S.2367) show very little potential for IMT operations while protecting FSS uplinks (indoor use only, EIRP limit necessary).

Studies conducted so far at CEPT level have demonstrated that sharing with unlicensed WiFi indoor could be more feasible than IMT.

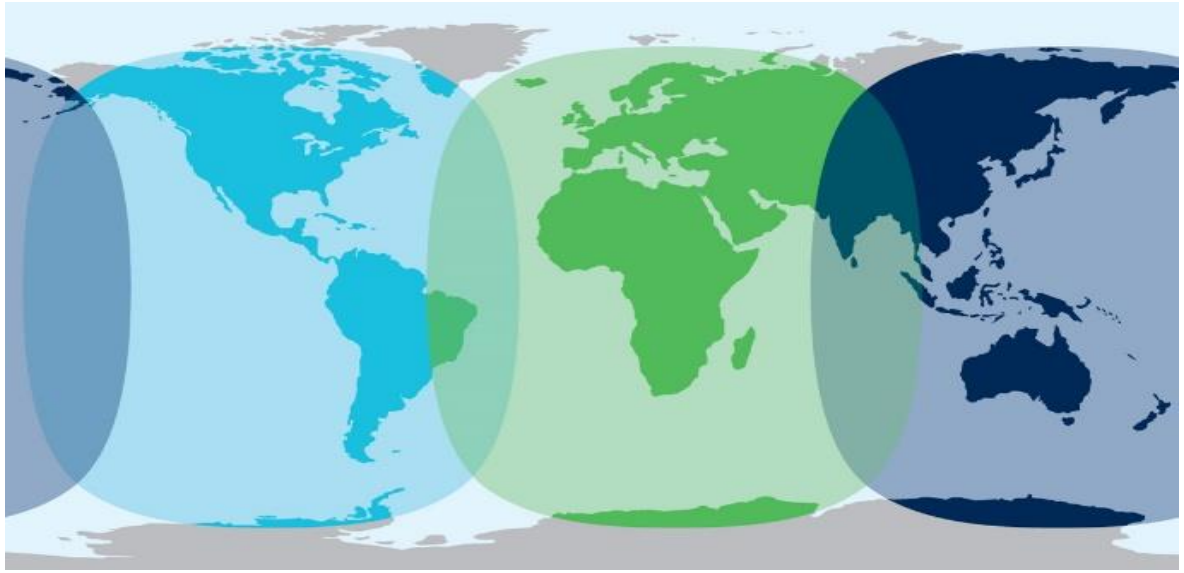
Use of C – Band - Frequency plan

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

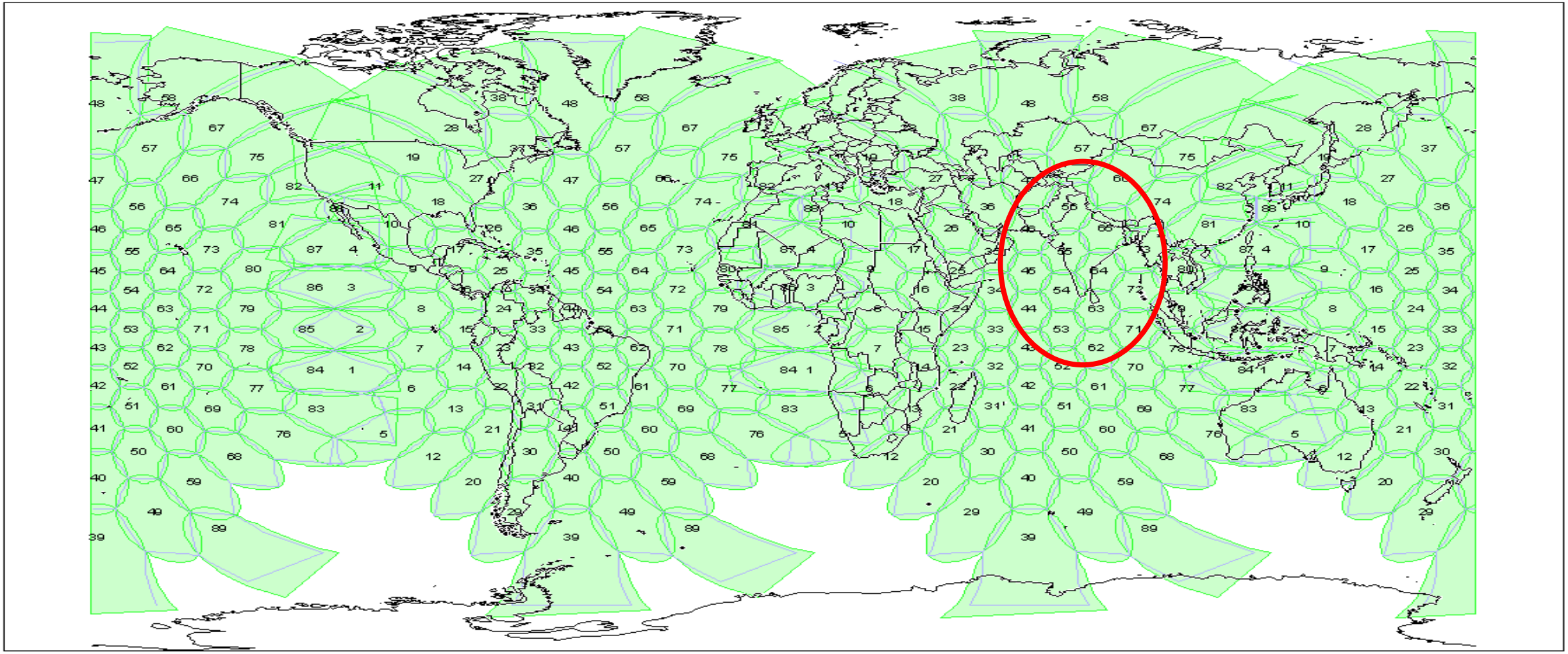


Feeder links used in L/C payload operating in the 'extended C-band' operating through more than 20+ Land Earth Stations carrying safety services traffic (L2C, C2L)

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



L & C Band Payload coverage over India Sub-Continent



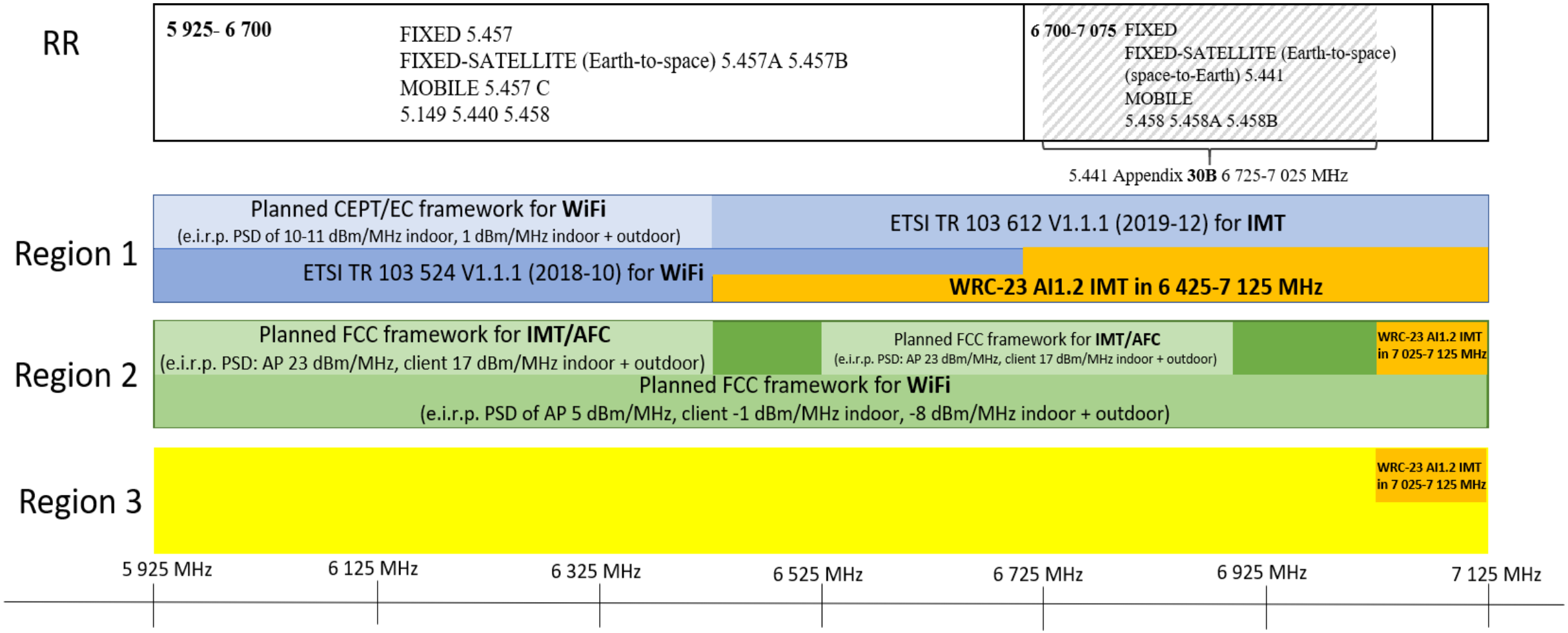
Highest Performing Mobility Service

AI 1.2 - 6GHz R1 -Other services/applications

- What are the long-term uses of 5925-6425 GHz? FS, FSS earth stations, IMT, WiFi?

ITU Region 1/2/3 allocations and footnotes	INDIA Allocation (NFAP 2018)
5 925-6 700 MHz **FIXED 5.457** **FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B** **MOBILE 5.457C** **5.149 5.440 5.458**	**5 925-6 700 MHz** **FIXED** **FIXED-SATELLITE (Earth-to-space)** 5.457A MOBILE 5.457C **5.149 5.440 5.458**
6 700-7 075 MHz **FIXED** **FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 5.441** **MOBILE** **5.458 5.458A 5.458B**	**6 700-7 075 MHz** **FIXED** FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 5.441 MOBILE **5.458 5.458A 5.458B**
7 075-7 145 MHz **FIXED** **MOBILE** **5.458 5.459**	**7 075-7 145 MHz** **FIXED** MOBILE **5.458**

WRC-23 Agenda Item 1.2



Ai 1.2 Studies requested by Resolution 245 (WRC-19)

C-band uplink (6426-7075 MHz)

Existing studies between IMT and FSS in the band 5925-6425 MHz and studies to be done under AI1.2.

	IMT-Advanced (4G)	IMT-2020 (5G)	WIFI in 6 GHz
ITU	Report ITU-R S.2367	To be done under AI1.2	No studies
CEPT	No studies	No studies	ECC Report 302

In the range 6 425-7 125 MHz, one should differentiate the following sub-bands:

- 6 425-6 725 MHz: this band is unplanned FSS (e-s) globally.
- 6 725-7 025 MHz: this band is subject to the FSS plan (AP30B, e-s).
- 6 700-7 075 MHz: this band is unplanned FSS (s-e) globally, limited to feeder links for NGSO MSS.
- 7 025-7 075 MHz: this band is unplanned FSS (e-s) globally.
- 7 075-7 125 MHz: there is no FSS allocation.

Leading to:

1. **Studies from IMT to FSS satellite receivers (GSO, non-GSO, including App 30B planned systems) – *most critical due international aspect***
2. **Studies from FSS transmitting earth stations to IMT receivers**
3. **Studies from IMT to receiving earth stations (non-GSO MSS feeder downlinks)**

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WRC-23 Agenda Item 1.3

Agenda Item 1.3 *to consider primary allocation of the band 3 600-3 800 MHz to mobile service within Region 1 and take appropriate regulatory actions, in accordance with Resolution **246 (WRC-19)**;*

Responsible Group: Working Party 5A

Resolution 246 (WRC-19)

Resolves to invite ITU-R
"to conduct sharing and compatibility studies in time for WRC-23 between the mobile service and other services allocated on a primary basis within the frequency band 3 600-3 800 MHz and adjacent bands in Region 1, as appropriate, to ensure protection of those services to which the frequency band is allocated on a primary basis, and not impose undue constraints on the existing services and their future development,"

Resolves to invite WRC-23
"based on the results of studies in resolves to invite ITU-R, to consider possible upgrade of the allocation of the frequency band 3 600-3 800 MHz to the mobile, except aeronautical mobile, service on a primary basis within Region 1, and to take appropriate regulatory actions,"

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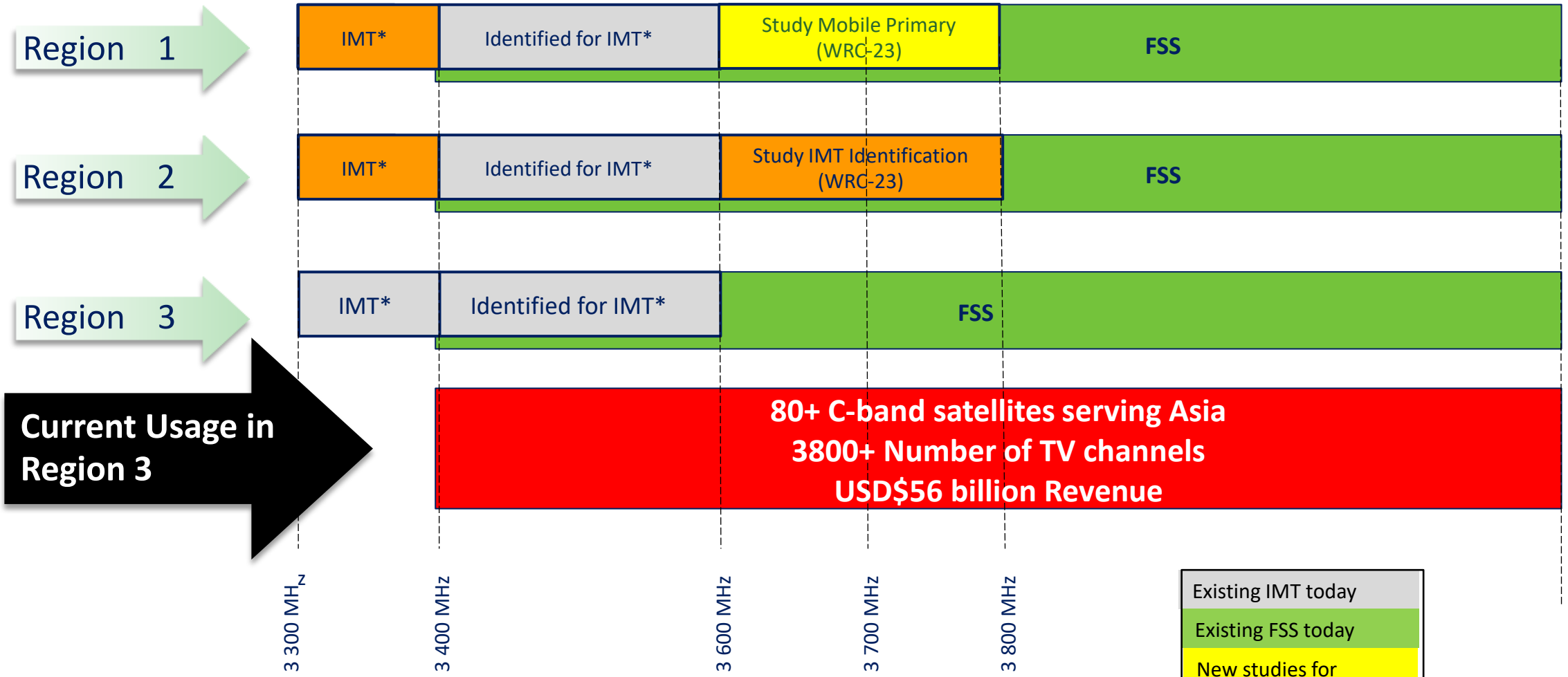
C-Band Status Post WRC-19



*Footnotes 5.429B , 5.429D, 5.429F, 5.430A, 5.431B, 5.432B, 5.433A

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Current status and responsible WPs in ITU-R

Services	Responsible ITU-R group	Studies to be conducted
Mobile service	ITU-R WP 5A (responsible for studies)	-
IMT	ITU-R WP 5D	Adjacent band sharing
Fixed satellite service	ITU-R WP 4A	In-band and adjacent band sharing
Fixed service	ITU-R WP 5C	In-band sharing
Aeronautical mobile	ITU-R WP 5B	Possible removal of aeronautical mobile as a consequence

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>3 400-3 600 MHz
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile 5.430A
Radiolocation

5.431</td><td>3 500-3 600 MHz
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile 5.431B
Radiolocation 5.433</td><td>3 500-3 600 MHz
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile 5.433A
Radiolocation 5.433</td></tr>
<tr><td rowspan="2">3 600-4 200 MHz
FIXED
FIXED-SATELLITE (space-to-Earth)
Mobile

Possible elevation of mobile service to primary in the 3 600-3 800 MHz range in Region 1</td><td>3 600-3 700 MHz
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile 5.434
Radiolocation 5.433</td><td>3 600-3 700 MHz
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile
Radiolocation 5.435</td></tr>
<tr><td>3 700-4 200 MHz
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile</td><td>3 700-4 200 MHz
FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE except aeronautical mobile</td></tr>
</table>

FSS and mobile co-frequency sharing is not feasible

FSS operators & mobile operators agree that co-frequency sharing is not practical

Numerous ITU studies showed that co-frequency sharing between 5G and FSS is not feasible

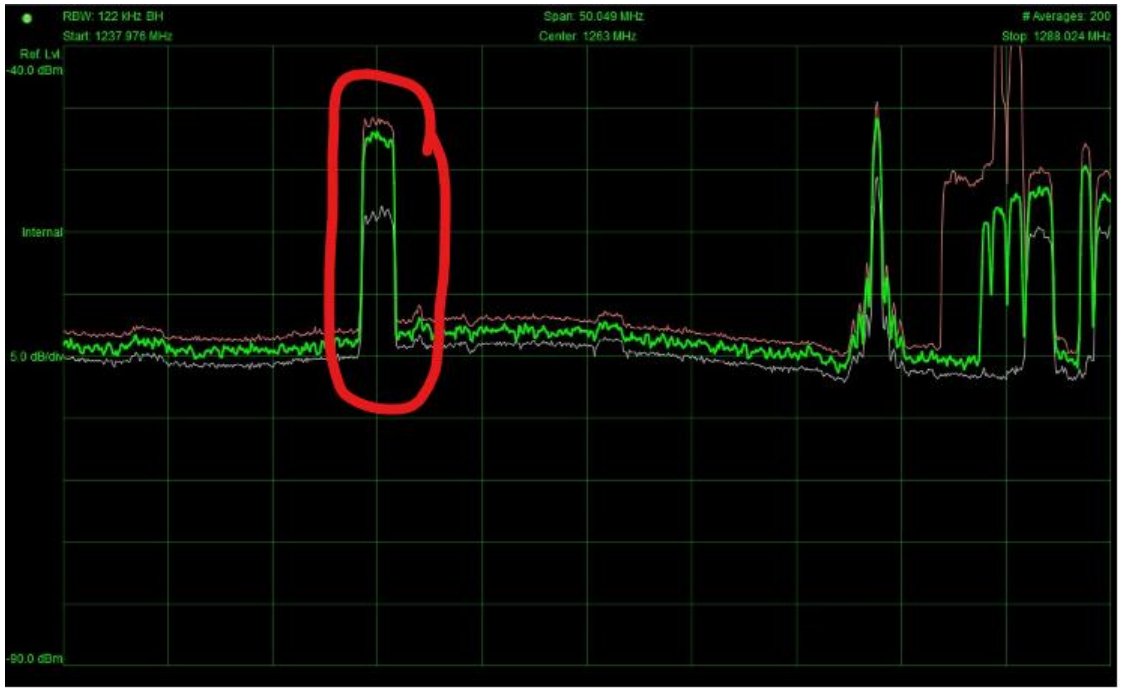
Statements made by Ericsson and Nokia to the FCC confirmed that sharing was not feasible due to large exclusion zones around earth stations

5G signals are considerably more powerful than satellite signals; this complicates coexistence between mobile and FSS

Even when 5G and FSS operate in adjacent bands, interference into FSS will occur, unless carefully managed

Field Test Measurement Possible OOBE of 5G to FSS (C-Band)

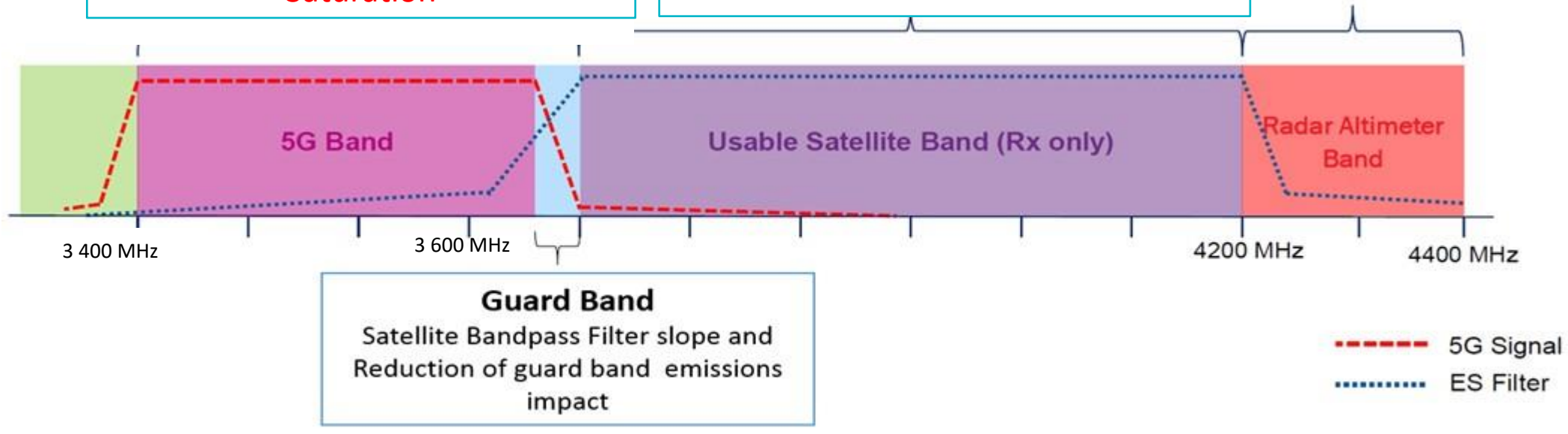
- **Even when 5G and FSS operate in adjacent bands, interference into FSS will occur**



FSS & 5G in Adjacent Frequency Bands

5G In-Band Emissions (IBE)
Impact: Earth Station LNB Saturation

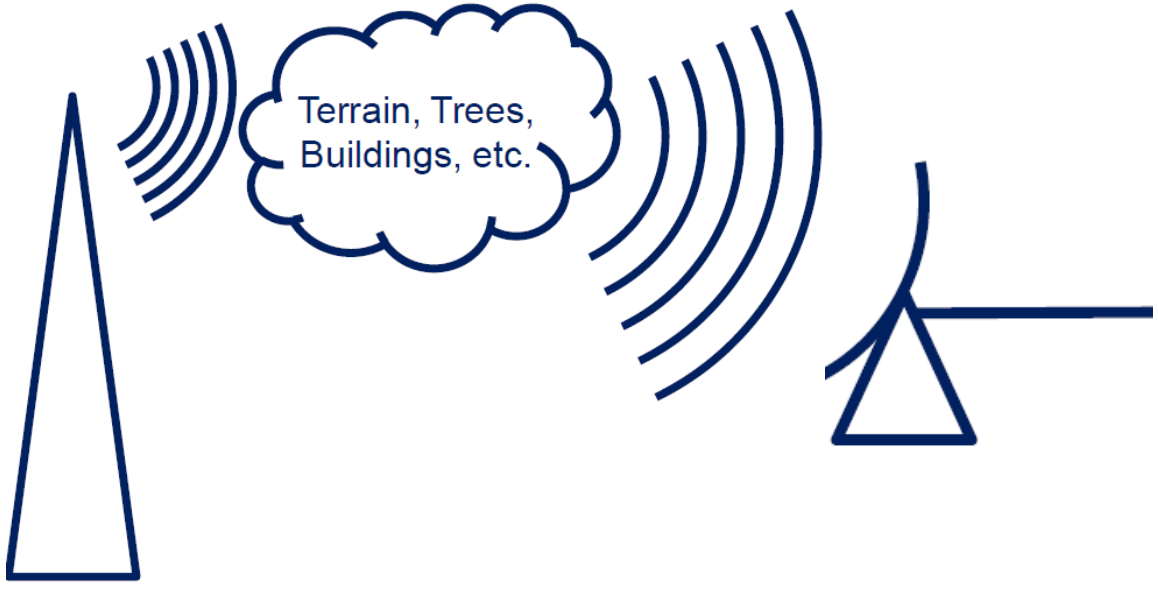
5G Out of Band Emissions (OOBE)
Impact: Satellite Signal Degradation



5G Interference mechanisms into FSS:

1. **Saturate the LNB of the earth station – even when the 5G signal is adjacent to the satellite signal**
2. **Out-of-Band-Emissions (OOBE) of the 5G signal can cause in-band interference to FSS signal**

Measures to protect FSS operations



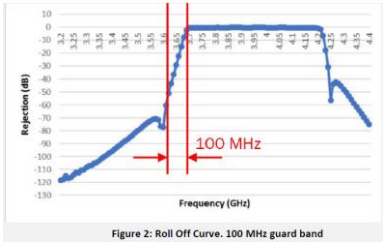


Figure 2: Roll Off Curve. 100 MHz guard band

LNB

Filter (BPF)

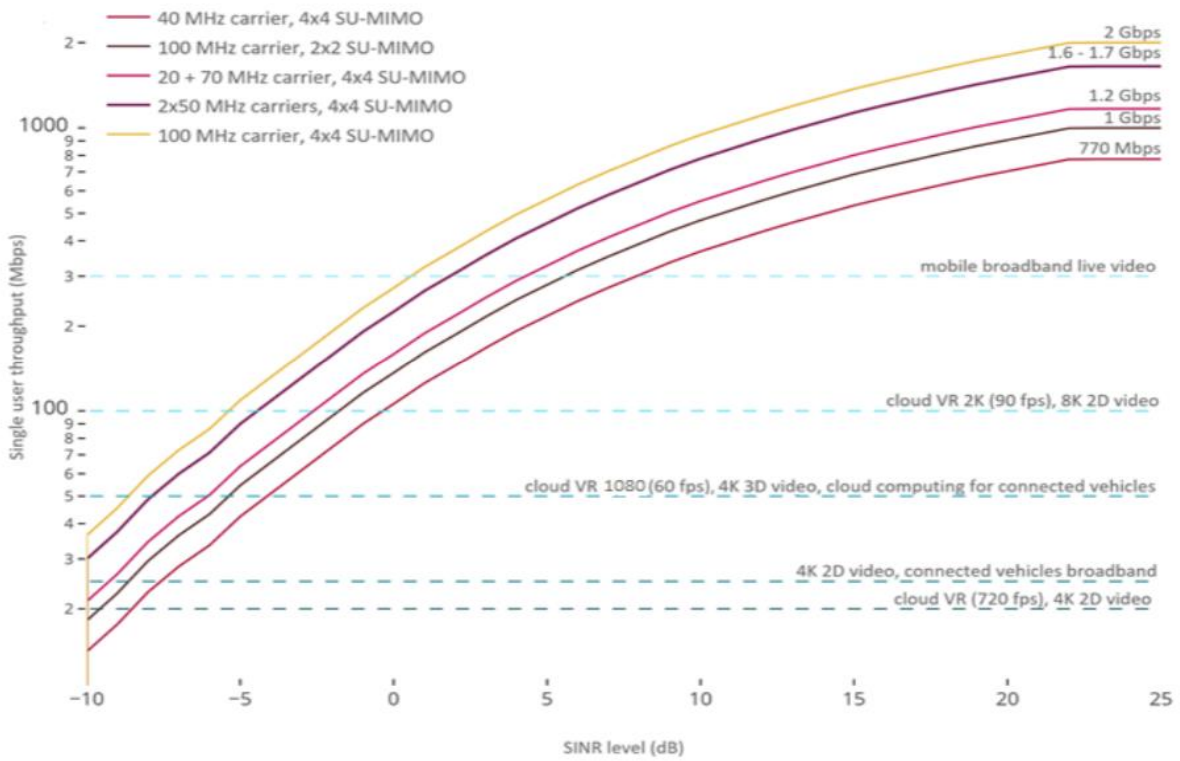
Out of Band Emission Limits (OOBE) + **Earth Station Registration** + **Guard Band**

Country	Guard band
Hong Kong	100 MHz
Singapore	50 MHz
Taiwan	44 MHz

Is more spectrum needed in Mid Bands?

- Most countries have typically 3 to 4 national MNOs so making 200 to 300 MHz available should allow every MNO to have 60 to 100 MHz
- Majority of benefits to the economy and consumers will be realized through MNOs each deploying the first 40 MHz of C-band spectrum
- In response to claims by some MNOs that they needed access to at least 80 MHz of contiguous spectrum, Ofcom researched the ability of mobile operators to launch 5G services with 40 MHz of spectrum. It found that:

"(…) there was no evidence that 5G could not be delivered with smaller [e.g. 40 MHz blocks] or non-contiguous carriers in other frequency bands [i.e. spectrum other than C-band]."



80 to 100 MHz per MNO is a MYTH

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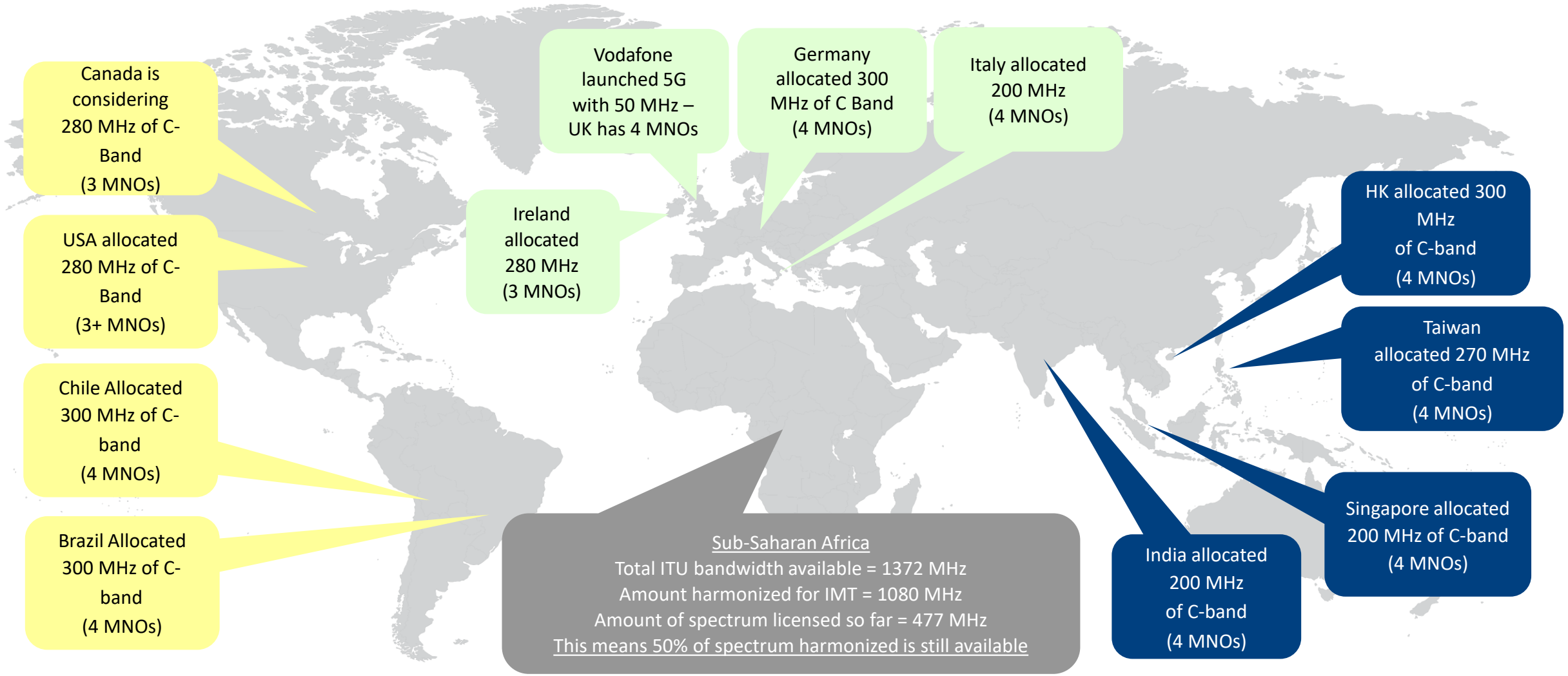
The Myth of 100 MHz-per-MNO



Ofcom study de-bunks the 5G “80-100 MHz per operator” myth – This is supported by real-world cases

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Overview of technical studies to be conducted

	Interference scenarios	Technical studies and outputs
3600-3800 MHz Downlink (s-e)	In-band: interference from MS BS/UE into receiving FSS earth station (short-term and long-term criteria).	In-band: separation distances (range of) required between MS BS/UE and receiving FSS earth stations to ensure in-band co-existence.
	Adjacent band: interference from MS BS/UE into receiving FSS earth station (short-term and long-term criteria).	Adjacent band: out-of-band emission limits for MS and minimum frequency separation required to protect receiving FSS earth stations in adjacent band.
	Assessment of the potential saturation of LNA/LNB of receiving FSS earth stations.	Assessment of potential saturation of LNA/LNB of receiving FSS earth stations and what mitigation measures are needed (e.g. BPF).
	Interference between MS BS/UE in country A into receiving FSS earth stations in a neighbouring or nearby country B.	For example, a PFD limit at the border of countries to protect FSS operations in neighbouring or nearby countries.

FSS earth station receiver parameters

Parameter	Typical value	Remark
Range of operating frequencies	3 600-3 800 MHz	In-band sharing studies
	Below 3600 MHz. Above 3 800 MHz.	Adjacent band compatibility studies
Antenna diameters (m)	1.2, 1.8, 2.4, 3.0, 4.5, 8, 16, 32	From Report S.2368
Minimum elevation angles (deg.)	5	From Report S.2368
Antenna reference pattern	Recommendation ITU-R S.465	From Report S.2368
Range of emission bandwidths	40 kHz – 72 MHz	From Report S.2368
Receiving system noise temperature	100 K for small antennas (1.2-3 m) 70 K for large antennas (4.5 metres and above)	From Report S.2368
Sensitivity of LNA/LNB receivers	-60 dBm	From Report S.2368

WRC-23 Agenda Item 1.3

ESOA preliminary view:

- Considering that:
- Many countries rely heavily on C-band satellite services offering vital services which in many cases cannot be reliably provided, or provided at all, by other means
- Existing studies between FSS and IMT/MS have demonstrated that sharing is not feasible in the same geographical area
- **Based on the existing studies, which results remain valid, ESOA believes that a position of No Change is the preferred option.**
- Furthermore, an IMT identification for this band in Region 1 is not in the scope of the agenda item.

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“Agenda Item 9.1 (c) @ WRC-23 Agenda”

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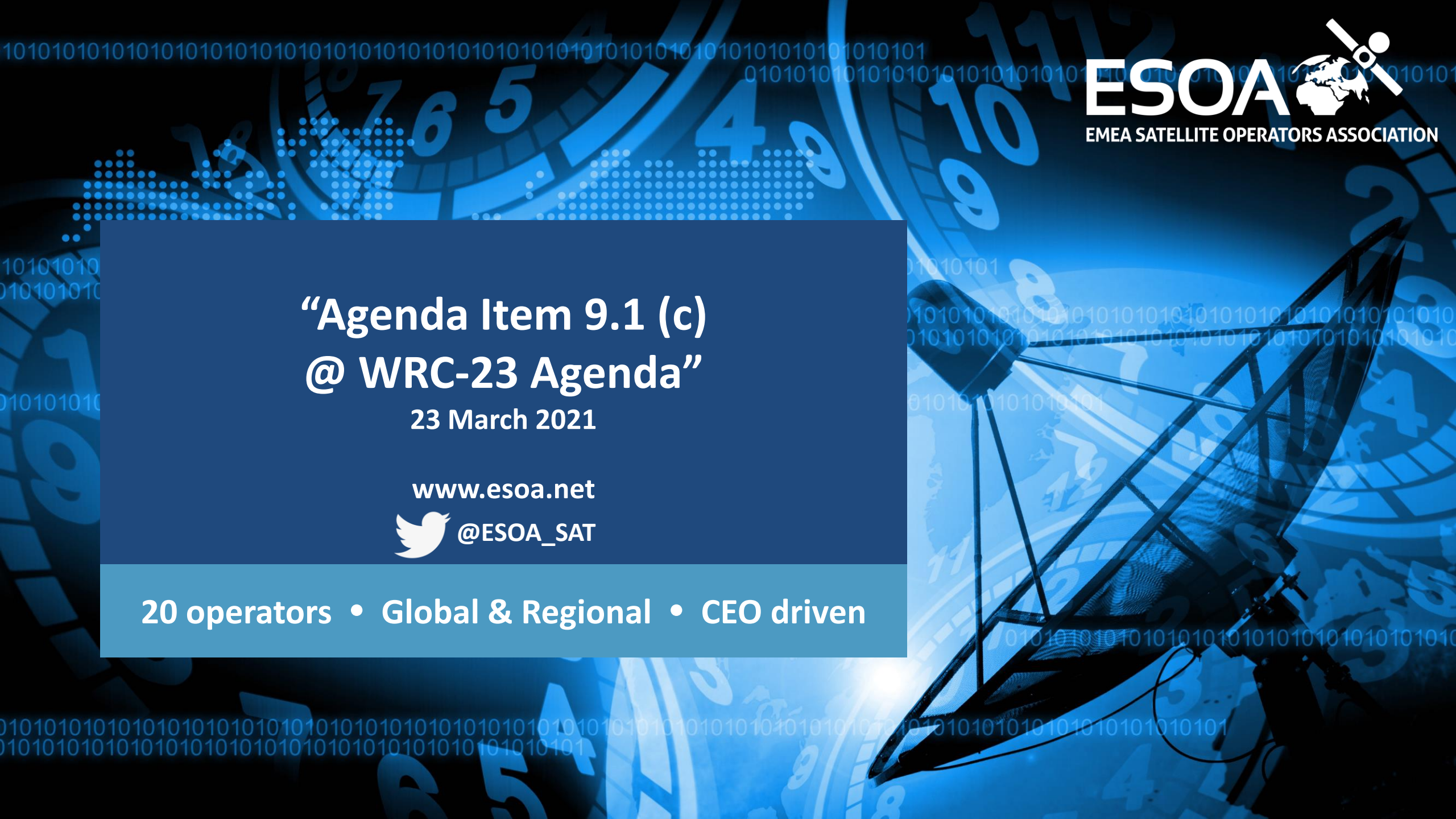

WRC-23 Topic 9.1 (c)

Topic 9.1 c) *Study the use of International Mobile Telecommunication system for fixed wireless broadband in the frequency bands allocated to the fixed services on primary basis, in accordance with Resolution **175 (WRC-19)**;*

Responsible Groups: Working Parties 5A and 5C

Resolution 175 (WRC-19)

"c) that the ITU-R Handbook on "Fixed Wireless Access" addressed the use of International Mobile Telecommunication (IMT) systems for Fixed Wireless Access, and **Recommendation ITU-R M.819** contains specific requirements pertaining to fixed wireless access,"

resolves to invite ITU-R

"to conduct any necessary studies on the use of International Mobile Telecommunication systems for fixed wireless broadband in the frequency bands allocated to the fixed service on primary basis, taking into account the relevant ITU-R studies, Handbooks, Recommendations and Reports,"

Background

This Topic arose at the last minute of WRC-19 and is part of a move by some parties in the Mobile industry to envisage "mobile/IMT like systems" in Fixed Service bands.

WRC-23 Topic 9.1 (c)

Preliminary position:

- Ensure that the **results of studies under this Topic will only be reflected in the Report of the Director of the Radiocommunication Bureau** and lead to possible updates of existing ITU-R publications, e.g. Handbook on Land Mobile, Volume 1: Fixed Wireless Access and relevant Recommendations of ITU-R F-Series.
- Note that in line with guidelines of CPM23-1 (CA/251), **only a short summary of the results for Chapter 5 of the CPM Report should be developed under this topic**, there should be no related Methods and Regulatory or Procedural considerations
- The **scope of the studies should be technologies used for FWA**, not the deployment of mobile systems, in the fixed service. Hence, the activity is within the usual activities of the ITU-R WPs 5A and 5C, not ITU-R WP 5D.

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Agenda Item 9 Article 21 @ WRC-23 Agenda”

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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

The matter which was raised in the context of WRC-19 AI1.13 is **whether RR21.5 applies to IMT stations and/or which power limits (e.g. Table 21-2) apply to IMT stations.** Some may interpret the application of these limits to array type IMT stations in such a way that it would allow a significant increase in the power radiated towards the GSO arc.

Power limits of Article 21 are intended to protect satellite receivers from interference from terrestrial stations, by limiting the aggregate interference from fixed/mobile stations (including IMT stations) in a satellite uplink beam. The power limit of RR 21.3 (+55 dBW) would not be an effective limit to protect satellite reception noting that 55 dBW is a typical EIRP for VSAT terminals. RR21.5 power limits should apply to all stations 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.

These limits use the parameter "power delivered by a transmitter to the antenna", which leads to some ambiguity when applying the limits to antennas that use an array of active antennas. One interpretation is that Article 21 limits assume that each radiating element is an "antenna", and hence would apply the limit of RR 21.5 (+10 dBW) to each radiating element. As an example of the impact of such an interpretation, the studies conducted before WRC-19 regarding IMT in the 40 GHz band assumed radiated power per antenna element of 5 dBm (-25 dBW). If the RR21.5 limit were to be applied to each radiating element, that would allow IMT base station operation with radiated power 35 dB higher than was assumed in the ITU-R studies, which would significantly exceed the satellite protection criteria.

It may be noted that AAS antennas are 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, for example in the band 27.5-29.5 GHz, which is also a satellite uplink band.

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 AAS antennas for stations in the fixed or mobile service including IMT stations.

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

ESOA position:

RR21.5 power limits should apply to all stations 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.

ESOA supports necessary modifications to Article **21** to enable the application of Article 21 to AAS antennas for stations in the fixed or mobile service including IMT stations, in frequency bands for reception by space stations where the frequency bands are shared with equal rights with the fixed or mobile services.

ESOA 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**.

ESOA
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Thank you
Questions

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