**AI 1.16**
**NGSO ESIM in Ka-band**

**AI 1.17**
**Inter-satellite links in Ka-band**

**Outstanding issues**

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***IAFI- 6th National Preparatory Workshop for WRC-23***

# WRC-23 Agenda Item 1.16

Enabling the use of the frequency bands

- 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth)

and

- 27.5-29.1 GHz and 29.5-30.0 GHz (Earth-to-space)

by Earth Stations In Motion (ESIMs) communicating with NGSO satellites in the FSS

# The need for NGSO ESIM operations in the Ka-Band

- Significant demand for broadband connectivity on the move (maritime and aeronautical)
- NGSO constellations in Ka-band enable the provision of global broadband connectivity with ***low*** latency
- In CEPT, NGSO ESIMs have been operating in the Ka-band since 2015 in compliance with ECC/Decision(15)04
- Other countries outside Europe are developing domestic frameworks for the operation of NGSO ESIMs
- **A global framework is needed to bring clarity for all administrations and benefits to consumers worldwide**

# Overview of the methods

## Method A

No change to the Radio Regulations and suppression of Resolution **173 (WRC-19)**

## Method B

Add a new footnote in RR Article **5** that refers to a Resolution containing technical, operational & regulatory conditions for the operation of NGSO ESIMs while ensuring protection of allocated services & consequential suppression of Resolution **173 (WRC-19)**

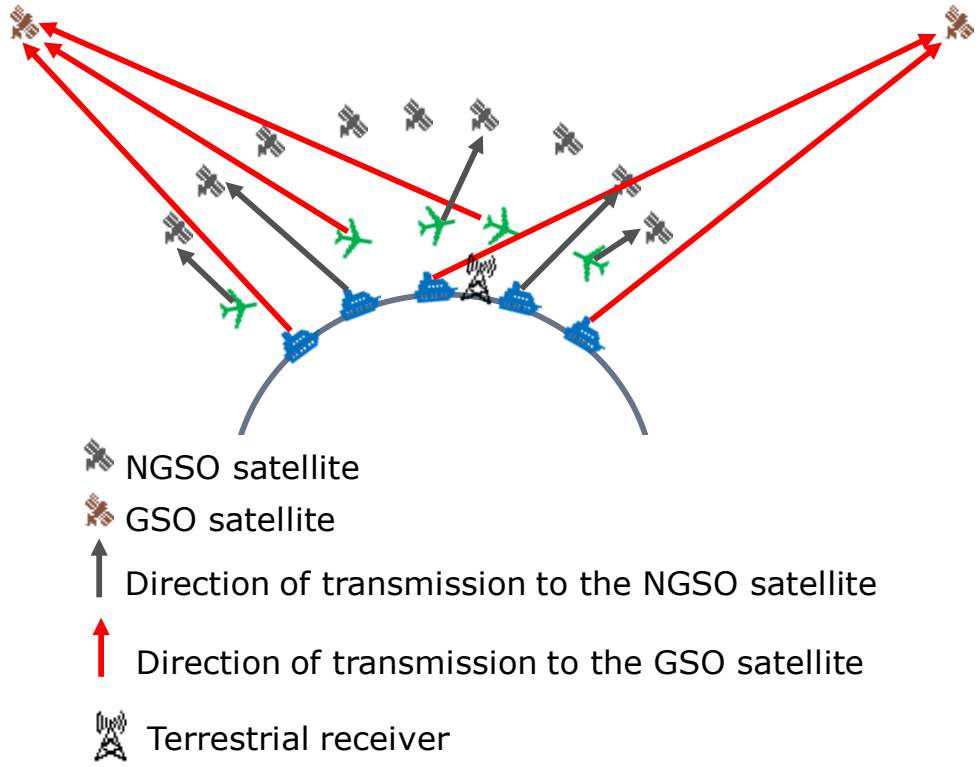
- NGSO ESIMs shall not claim protection from terrestrial services
- The sharing conditions with terrestrial services in 27.5-29.1 GHz will be consistent with those developed for GSO ESIM (see Resolution **169(WRC-19)**) and will provide protection of terrestrial services, where allocated, also in 29.5-30 GHz (secondary allocation **No. 5.542**)
- For protection of space services, NGSO ESIM characteristics shall remain within the envelope characteristics of the typical earth stations of the relevant NGSO system
- For the protection of GSO FSS networks, the relevant EPFD limits in Article 22 shall apply

# Lessons from WRC-15 and WRC-19

- Regulatory framework already in place for GSO ESIM in Ka-band
  - Resolution **156 (WRC-15) -** 19.7-20.2 GHz and 29.5-30.0 GHz
  - Resolution **169 (WRC-19) -** 17.7-19.7 GHz and 27.5-29.5 GHz
- Technical and operational characteristics of NGSO ESIMs are practically identical to those of GSO ESIMs
  - Some manufacturers are already producing ESIM terminals that can switch seamlessly between GSO to NGSO space stations (e.g. https://www.thinkom.com/ka-band-comms-on-the-move-antenna/)
- Interference management practices and the functioning of the Network Control and Monitoring Centre (NCMC) do not present significant differences from the case of GSO ESIM

# Sharing environment between NGSO ESIM and terrestrial services in 27.5-29.1 GHz and 29.5-30 GHz is the same as for GSO ESIM

- The number of satellites in the NGSO system is irrelevant, because **ESIMs**, and not the space stations, **are transmitting**
- The number of aero/maritime ESIMs depends on the number of aircraft/vessels wishing to have connectivity and not on the introduction of NGSO ESIM
- The elevation angle for NGSO ESIMs can be higher than that for GSO ESIMs (because of more choice of satellites in the sky) and the power transmitted can be potentially lower (because of the shorter distance from the Earth). This can make the interference risk lower than for GSO ESIMs
- **The same sharing conditions developed to protect terrestrial services from GSO ESIMs also appropriate for NGSO ESIMs**
  - –Maritime ESIMs: max EIRP spectral density limit towards the horizon of 24.44 dB(W/14 MHz) and minimum distance from low water mark of 70 km
  - –Aero ESIMs: same PFD masks for aircraft altitudes above and below 3 km developed for GSO ESIMs at WRC-19
- **There is no technical or operational justification for change**
- In relation to the aeronautical PFD, while the development of a methodology regarding examination of compliance by the Bureau is supported, adequate transitional measures should be put in place in case WRC-23 could not finalize the methodology



# Publication of the list of countries authorizing NGSO systems (1/2)

- ESIMs should be operated under the responsibility of the notifying administration of the NGSO system with which ESIMs communicate
- ESIM have been operating in various frequency bands without significant interference issues since 2003. In the unlikely case that interference occurs to terrestrial services, while complying with the sharing conditions in the draft resolution, existing practices familiar to administrations can be used. For example the notifying administration could be identified with the help of the administration where the aircraft/vessel is registered (flag nation) or by contacting the aircraft or vessel directly
- There is nothing "new/peculiar" about NGSO ESIM in Ka-band to justify additional concerns or a different regulatory treatment from the one used for other similar earth stations

From the current CPM text:
*"instructs the Director of the Radiocommunication Bureau*

Option 1

5. **to publish the list of NGSO satellite systems** with which ESIM communicate brought into use with information about its service area **and countries authorize such use if any;** this information shall be updated regularly**"**

This is intended to help the administration potentially affected by interference to identify the notifying administration through NGSO ESIM authorized in neighboring countries

While it is clear that ESIMs needs to be authorized, as any other earth station, based also on RR Article 18 and Resolution **22 (WRC-19),** there are difficulties with this option

# Publication of the list of countries authorizing NGSO systems (2/2)

Telesat and other NGSO satellite operators do not support this option because:

- **it is not effective in resolving potential cases of interference**
- **it creates a discriminatory framework with respect to ESIM communicating with GSO/NGSO space stations in the same or other bands**
- **it imposes an additional burden on authorizing administrations**
- **it is difficult to implement**

1) Applying this requirement **ONLY** in the case of NGSO ESIM in the Ka-band would lead to discrimination with respect to the operation of other similar terminals, including GSO ESIM in Ka band, GSO Aeronautical Earth Stations in Ku-band, Earth Stations on Vessels on C and Ku band and NGSO ESIM in Ku band

2) Publication of a list of countries authorizing NGSO ESIM would be problematic, as:

- authorizations vary greatly from country to country and can cover multiple licenses/authorizations provided to different entities
- administrations do not typically make such licenses/authorizations public

Furthermore, publication of the list of countries authorizing NGSO systems **would not solve** the issue of identifying the notifying administration responsible for resolving the interference and/or the specific ESIM potentially causing interference

- there can be multiple NGSO systems authorized in the same country
- the interference could be caused from a different type of Earth Station, with no "authorization list"
- essentially useless in relation to vessels
- the interference could be coming from an ESIM in international waters/airspace

# Network Control and Monitoring Centre (NCMC)

- An ESIM has the capability – by design – to enable, adjust or cease, as appropriate, transmission depending on location and applicable authorizations
- This is based on information relating to geographical areas where ESIMs are allowed in compliance with location-specific regulatory requirements
- The NCMC monitors and manages the operation of each ESIM to ensure it remains within the prescribed operational parameters
- In case of interference by an ESIM to any other service, the designated permanent point of contact for the ESIM operation will ensure that NCMC sends command to the ESIM to cease/adjust transmissions
- **NCMC and interference management are not new invention**
  - ESIM operation have been subject to permanent monitoring & control by NCMC or equivalent facility for many years

# Conclusions (1/2)

Telesat supports:

- The sharing environment with terrestrial services does not change between NGSO and GSO ESIM in the Ka-band
- Technical studies have shown that the sharing conditions with terrestrial services can be exactly the same as for GSO ESIM
  - No need for additional restrictions or complications
- ESIM have been operating in various frequency bands since 2003 with no major/relevant cases of harmful interference issues
- In the unlikely case a harmful interference event occurs, existing practices familiar to administrations can be applied
- Publication of list of countries authorizing the NGSO satellite systems should be opposed as it would be:
  - ineffective and unprecedented;
  - discriminatory in relation to other similar networks/systems operating in Ka and Ku band.

**There is nothing peculiar about the operation of NGSO ESIM in Ka band to justify additional concerns or any regulatory treatment different from other ESIM operating in the same or different frequency bands**

# Conclusions (2/2)

**Telesat proposals for addressing options in the CPM text/draft new Resolution [AI116]:**

1) **Resolves 1.3.1 Option 1** Only the notifying admin is responsible for resolving cases interference, ***Option 2*** *(without the "only") The notifying administration is responsible to resolve cases interference (e.g. the flag administration or the authorizing administration could help, should they agree to do so*)

2) **Resolves 8** The implementation of this Resolution remains in abeyance pending: **Option 1** Universal agreement on a number of issues (e.g. description of interference management procedure, NCMC facilities, etc), **Option 2** Provision to the administrations of descriptions of system functionality (e.g. interference management and NCMC procedure). *Delete both options as these cannot be part of a resolution- in any case if these issues are not addressed resolution will not be approved*)

3) ***Resolves further 9:*** ***Option 1*** No need for Annex 4 as such hardware and software requirements are not appropriate in a resolution and would be better kept in a report or recommendation, **Option 2** The system shall employ the minimum software and hardware capabilities listed in Annex 4)

4) **Instructs the Director of the BR 5**: **Option 1** To publish the list of non-GSO satellite systems with which ESIM communicate brought into use with information about its service area and countries authorize such use if any, **Option2** To publish the list of non-GSO satellite systems with which ESIM communicate brought into use with information about its service area; *delete Option 1 as this will a) not help identifying the notifying administration responsible to resolve the interference, b) create additional complications. Support Option 2*

5) **Annex 1 Part 1 Maritime non-GSO ESIMs 1.2** Max EIRP density transmitted towards the territory of coastal state: **Option 1** 24.44dBW/14MHz (i.e. same as Res 169 (WRC-19)), **Option 2** 12.98dBW/1 MHz, **Option 3** TBD

6) **Annex 1 Part 2 Aeronautical non-GSO ESIMs 2.1** Above an altitude of 3 km, the maximum pfd produced at the surface of the Earth shall not exceed: ***Option 1*** *Reference bandwidth 14 MHz (same as for GSO ESIM In Res 169(WRC-19))* , **Option 2** Reference bandwidth 1 MHz

# WRC-23 AI 1.17 – Inter-Satellite Links (ISLs)

Resolution **773 (WRC-19)**

to determine and carry out, on the basis of the ITU-R studies, the appropriate regulatory actions for the provision of inter-satellite links in the ~~11.7-12.7 GHz~~, 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz bands or portions thereof, by adding an inter-satellite service allocation where appropriate

- There is now general agreement to remove 11.7-12.7GHz from consideration under this AI

# CPM methods to satisfy AI 1.17

The CPM text contains 2 methods:

- Method A: NOC
- Method B: regulatory solutions for inter-satellite links in the frequency bands 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz

Alternatives are included depending for example on the type of allocation for the space-to-space links (ISS/FSS) and the possible sharing mechanisms, terrestrial and NGSO and GSO FSS systems/networks

The Resolution includes five Annexes as follows:

- Annex 1 addresses the concept of operation
- Annex 2 addresses the protection of terrestrial services
- Annex 3 addresses the EESS (passive) protection
- Annex 4 addresses the NGSO systems protection
- Annex 5 addresses the GSO FSS networks protection

# Type of allocation & Concept of operation

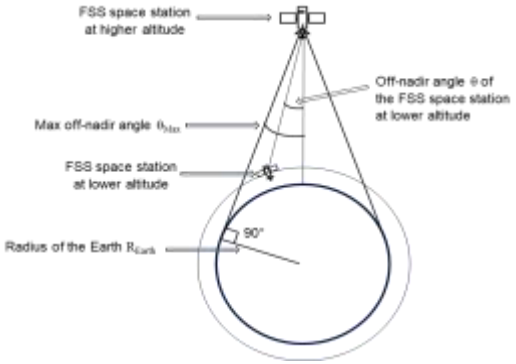
## Type of Allocation: FSS vs ISS

- The tendency is towards a new ISS allocation with a footnote that recognizes satellite-to-satellite operations as part of the intersatellite service in these bands
- **Telesat supports a new ISS allocation and the limitation to certain applications***

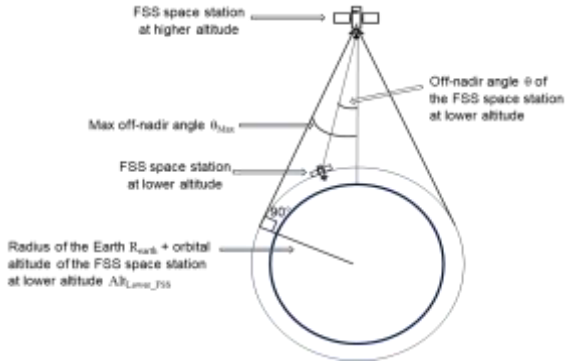
## Concept of Operation

- For both concepts, operations allowed only when "theta" is less than or equal to "theta max"

**"Within the cone" concept**




**"Alternative expanded cone" concept for GSO service providers**




*…**Such use is limited to space research, space operation and/or Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space** and is not subject to coordination under No. 9.11A. No. 4.10 does not apply. (WRC-23)

# Annex 2: Protection of terrestrial services in 27.5-29.5 GHz

Four options are being considered:

- Option 1: PFD mask based on RR Article **21** values in the 17.7-19.7GHz band

- Option 2: PFD mask of Aero ESIM operating up to an altitude of 3 km as defined in Annex 3 of Resolution **169 (WRC-19)**- Ref. Bandwidth 1MHz

- Option 3: PFD mask of Aero ESIM operating above an altitude of 3 km as defined in Annex 3 of Resolution **169 (WRC-19)** - **Ref. Bandwidth 14MHz**
  - **Telesat considers this a viable option** as a) coherent with the general concept of operation under the envelope of the typical Earth Station of the service provider system/network and b) the user space station will always be above 3km!

- Option 4: values TBD

# Annex 4: NGSO systems protection in 27.5-30.0 GHz

- Fixed power limits and a "no-fly zone" (i.e. orbital altitude range where the user space station should not transmit) are being proposed.
- While there is general agreement on some of the power limits, others are still under discussion
- In Telesat view, the proposed no-fly zone should be larger than currently proposed to guarantee adequate protection:
  - NGSO space stations transmitting in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz shall not operate at orbital altitudes **greater than or equal to 900 km and less than ~~1 290~~/1350** km
- The emissions from any NGSO space station transmitting in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz to communicate with a NGSO system with a minimum operational altitude lower than 2 000 km shall not exceed an on-axis e.i.r.p. spectral density of (~~−26~~/**−28**/~~−30~~) dBW/Hz
  - -28dBW/Hz is a compromise among the values under consideration and -30dBW/Hz is too strict to allow inter satellite link operation

# Annex 5: GSO network protection in 27.5-30.0 GHz

- *Option 1:* the emissions of this NGSO space station shall not produce a power flux density at any point in the GSO arc greater than the power flux-density produced by earth stations associated with satellite network/system with which they communicate – i.e. operation "under the envelope" of the typical earth station associated with the service provider network/system
- *Option 2:* the emissions of this NGSO space station shall comply with the provisions contained in Annex 5 to this Resolution for protection of GSO space stations
- Option 3: shall not produce a power flux-density at any point in the GSO arc greater than the power flux density produced by earth stations associated with the satellite network/system with which they communicate as determined in Annex 5 to this Resolution

**Annex 5**

a) GSO service provider in 27.5-30 GHz or NGSO service provider in 28.6-29.1 GHz:

– GSO protection done via coordination

- "Under the envelope approach" with checks performed by the BR - not a "blank check"

b) NGSO service provider in 27.5-28.6 GHz and 29.1-30 GHz:

–Current GSO protection is done via epfd limits with an additional single entry PFD limit at the GSO arc of [−163/~~−165]~~ dBW/m² in any 40 kHz band

**Telesat supports Option 1 above. However if either Option 2 or Option 3 are to be considered, Telesat support the single entry PFD limit of -163 dBW/m² in any 40 kHz band, as GSO protection is in any case already covered by compliance with Art. 22 epfd limits**

# Conclusions

- Telesat supports:
  - –a new ISS allocation and the limitation to certain applications
  - –for protection of terrestrial services, the PFD mask of Aero ESIM operating above 3 km as in Annex 3 of Resolution **169 (WRC-19)** - **Ref. Bandwidth 14MHz**
  - –for protection of NGSO systems, a no-fly zone of **900-1350 km** and a max on-axis e.i.r.p. spectral density for the NGSO user station transmitting to a NGSO space stations in a system with a minimum operational altitude lower than 2000 km of **−28 dBW/Hz**
  - –for protection of GSO networks, **operation of the user space station within the envelope of the typical earth station of the service provider network/system**, e.g. in 27.5-28.6 GHz and 29.1-30 GHz compliance with epfd limits in Article 22. If an additional single entry PFD limit at the GSO arc is considered: **−163 dBW/m² in any 40 kHz band**