Spectrum Policy Considerations for WRC-23 (AIs 1.16, 1.17, and 9.1 Topic D) and WRC-27 (AIs 2.2 and 2.3)

Potential Impact on Passive Bands Between 18 and 50 GHz

Presented By:

Mike Evans, Senior Spectrum Analyst

NASA Glenn Research Center

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WRC-23 Agenda Item 1.16:

Earth Stations in Motion (ESIMs) Communicating with Fixed-Satellite Service (FSS) NGSOs in 17.7-18.6 / 18.8-19.3 / 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 / 29.5-30 GHz (Earth-to-space)

Concerning Interference Scenarios:

- Out-of-band emissions from FSS downlinks into the 18.6-18.8 GHz EESS/SRS (passive) band.

Background Info:

- Please don't ask why ESIMs are FSS and not Mobile-Satellite Service (MSS)…because I honestly have no idea and have been asking that for years.
- WRC-19 AI 1.5 dealt with ESIMs communicating with FSS GSOs (including 18.6-18.8 GHz), and no regulatory actions were taken to protect passive sensors from FSS downlinks, but this AI has significantly different geometries.
- ITU-R Working Party (WP) 3J developed a bistatic scattering model that will be used to evaluate sea surface reflections in the studies conducted under this AI.
- The FCC released an R&O (FCC 20-66) in May 2020 that allows use of ESIMs with NGSOs in these bands, which completely dismisses out-of-band concerns. See updated Part 25 Rules and US NG527A.

Current Status:

- Arguments about scope – some say that the space station, which is providing the interfering downlink, should not be considered under the AI. However, the Resolution clearly says that adjacent/passive bands require protection under this AI, and any changes in the number of interferers, antenna dynamics, TDMA physical layer parameters, etc. as a result of allowing ESIM operation can greatly impact the overall interference environment.
- At its September 2020 meeting, WP 7C sent system characteristics (Rec. ITU-R RS.1861 + revisions and updates) and protection criteria (Rec. ITU-R RS.2017) to WP 4A for use in technical studies.

WRC-23 Agenda Item 1.17:

Inter-Satellite Service (ISS) Allocations in 11.7-12.7, 18.1-18.6, 18.8-20.2, and 27.5-30 GHz

Concerning Interference Scenarios:

- Out-of-band emissions from space-to-space links into the 18.6-18.8 GHz EESS/SRS (passive) band.

Background Info:

- This AI has multiple interests and objectives for NASA:
  - Ensuring that the interference environment for passive sensing operations in 18.6-18.8 GHz does not receive any further degradation.
  - Obtaining an ISS allocation for use with commercial services to replace TDRSS as a means of getting science data to/from the ground.
- ITU-R Working Party (WP) 3J developed a bistatic scattering model that will be used to evaluate sea surface reflections in the studies conducted under this AI.
- The frequency ranges for this agenda item do not include the FSS allocation in 18.6-18.8 GHz, which is limited to apogees greater than 20000 km (RR 5.522A) and non-Federal space stations are limited to GSOs (US NG164). However, frequency assignments outside of this range (and the corresponding out-of-band emissions) are not similarly limited.
- NGSO user space stations are expected to look like an FSS Earth station in terms of characteristics/functionality (same PFD at service provider, free-space path loss compensation, same off-axis e.i.r.p. restrictions, etc.).
- The effects of ISS links on the FSS service provider space station is unclear and will be determined in the sharing studies. Changes in the number of interferers, antenna dynamics, TDMA physical layer parameters, etc. can greatly impact the overall interference environment.
- ISS links are intended to operate in the "direction" of the existing FSS allocation (see Figures on next slide):
  - Earth-to-space = lower-altitude (d_2) user spacecraft to higher-altitude (d_1) service provider.
  - Space-to-Earth = higher-altitude (d_1) service provider to lower-altitude (d_2) user spacecraft.
  - As $d_1 - d_2 \rightarrow 0$, the interference geometries change significantly and may be more problematic.

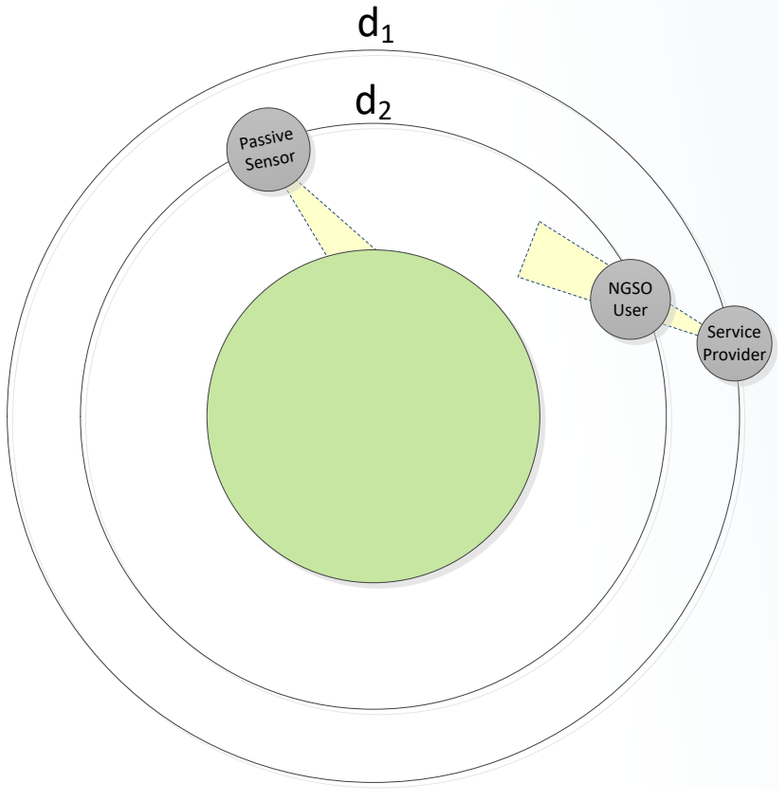
Current Status:

- At its September 2020 meeting, WP 7C sent system characteristics (Rec. ITU-R RS.1861 + revisions and updates) and protection criteria (Rec. ITU-R RS.2017) to WP 4A for use in technical studies.

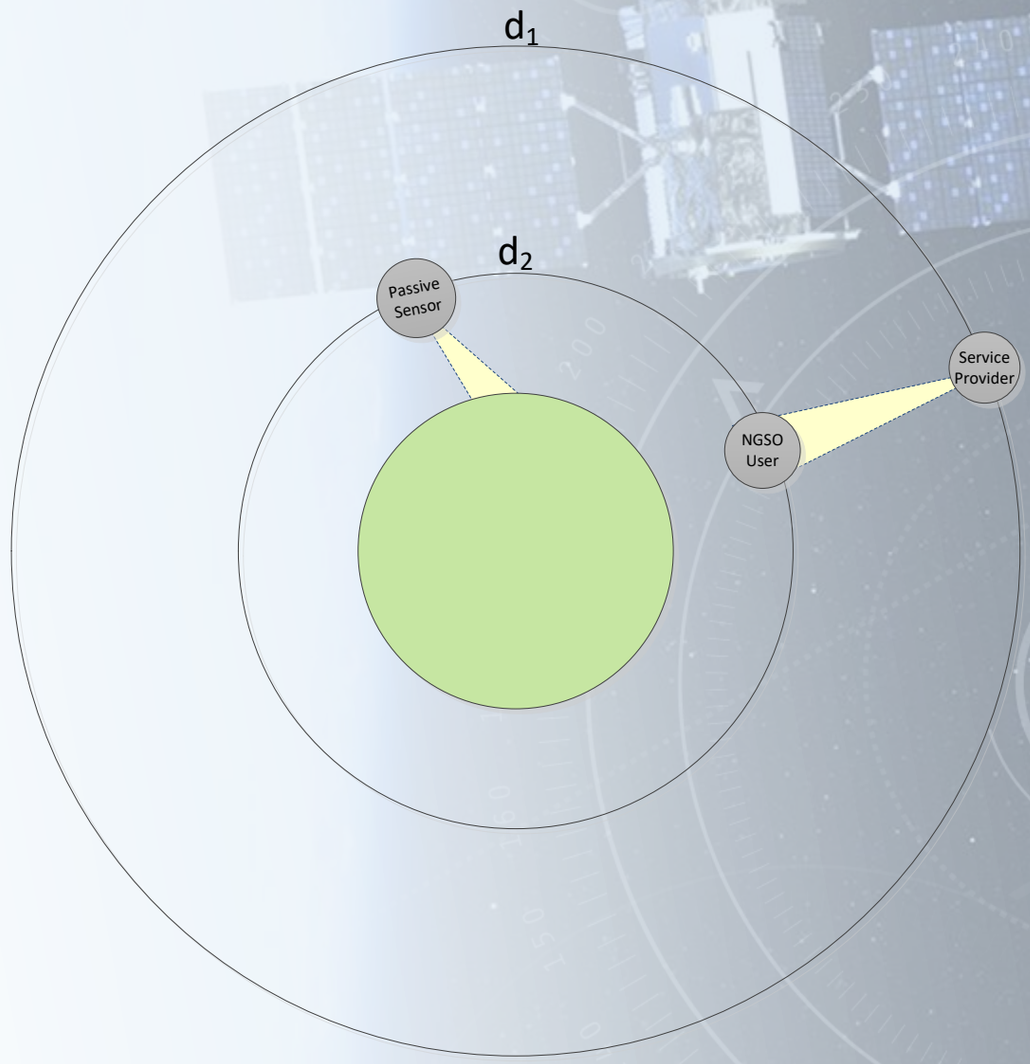
WRC-23 Agenda Item 1.17:

Inter-Satellite Service Allocations in 11.7-12.7, 18.1-18.6, 18.8-20.2, and 27.5-30 GHz, cont.

Scenario 1: d1 – d2 is Small



Scenario 2: d1 – d2 is Large



WRC-23 Agenda Item 9.1, Topic D:

Protection of EESS (passive) in 36-37 GHz from NGSO FSS Downlinks in 37.5-38 GHz

Concerning Interference Scenarios (see Figures on next slide):

1. Out-of-band emissions from low-altitude FSS downlinks into passive sensing measurements.
2. Out-of-band emissions from high-altitude FSS downlinks into cold-sky calibration measurements.

Background Info:

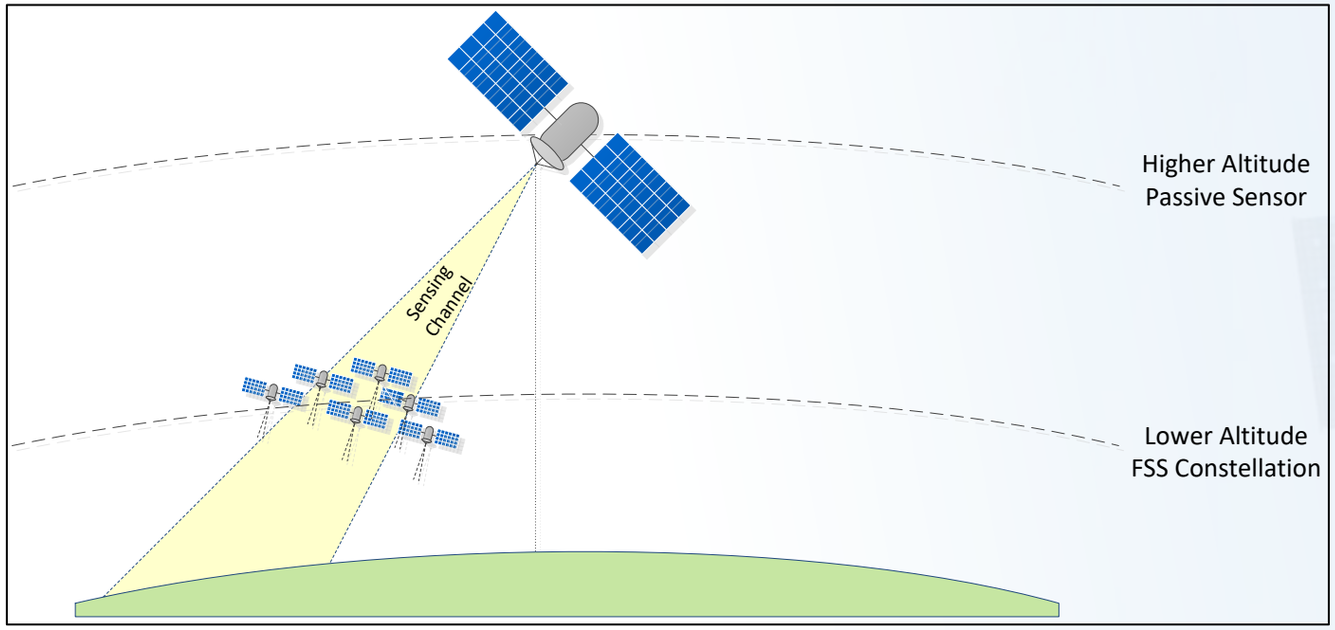
- This Topic continues study of a number of items that were not fully considered under WRC-19 AI 1.6.
- No changes to the Radio Regulations can occur under AI 9.1 Topics; these are strictly studies for inclusion in the BR Director's Report. Therefore, if deemed necessary, regulatory changes could not be imposed without a follow-on AI.
- The push to continue studying this topic came up at CPM23-1 and does not have an underlying Resolution.

Current Status:

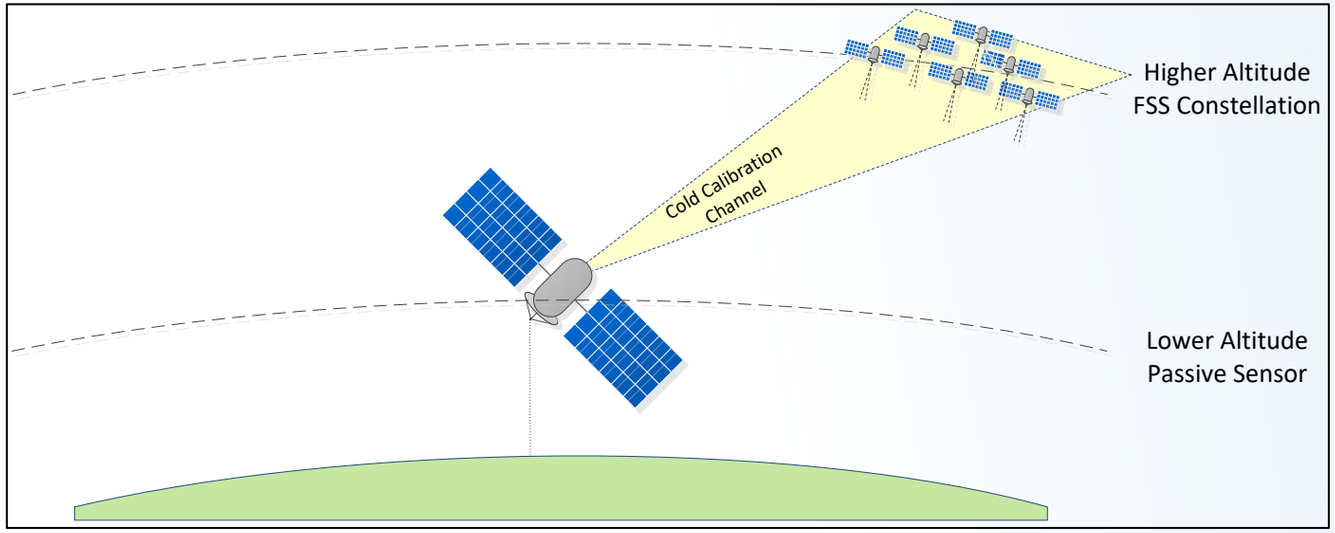
- Sensor data for GPM Microwave Imager (GMI) was added to the revised version of Rec. ITU-R RS.1861 for use in these studies.
- ESA began studies last cycle on Scenario 1 in WP 4A, and these studies will be continued in WP 7C. Previous studies considered FSS constellations comprised of 2000 to 7518 satellites.
- At its September 2020 meeting, WP 7C asked WP 4A for updated information on V-band FSS constellations and out-of-band emissions for usage in the studies conducted under this topic.
- Topic for Further Discussion: Rec. ITU-R RS.2017 specifies a protection criteria of -166 dBW per 100 MHz for measurements in the 36-37 GHz band, which may be exceeded 0.1% of time. Is this a sufficient protection level for cold-sky calibration measurements?

WRC-23 Agenda Item 9.1, Topic D:

Protection of EESS (passive) in 36-37 GHz from NGSO FSS Downlinks in 37.5-38 GHz, cont.



Scenario 1



Scenario 2

WRC-27 Agenda Item 2.2:

ESIMs Communicating with Fixed-Satellite Service (FSS) GSOs in 37.5-39.5 / 40.5-42.5 GHz (space-to-Earth), and 47.2-50.2 / 50.4-51.4 GHz (Earth-to-space)

Concerning Interference Scenarios:

- **Out-of-band emissions from ESIM uplinks into the 50.2-50.4 GHz passive band.**
- **Out-of-band emissions from FSS downlinks into the 36-37 GHz passive band.**
- **Out-of-band emissions from FSS downlinks into the 42.5-43.5 GHz RAS band.**

Background Info:

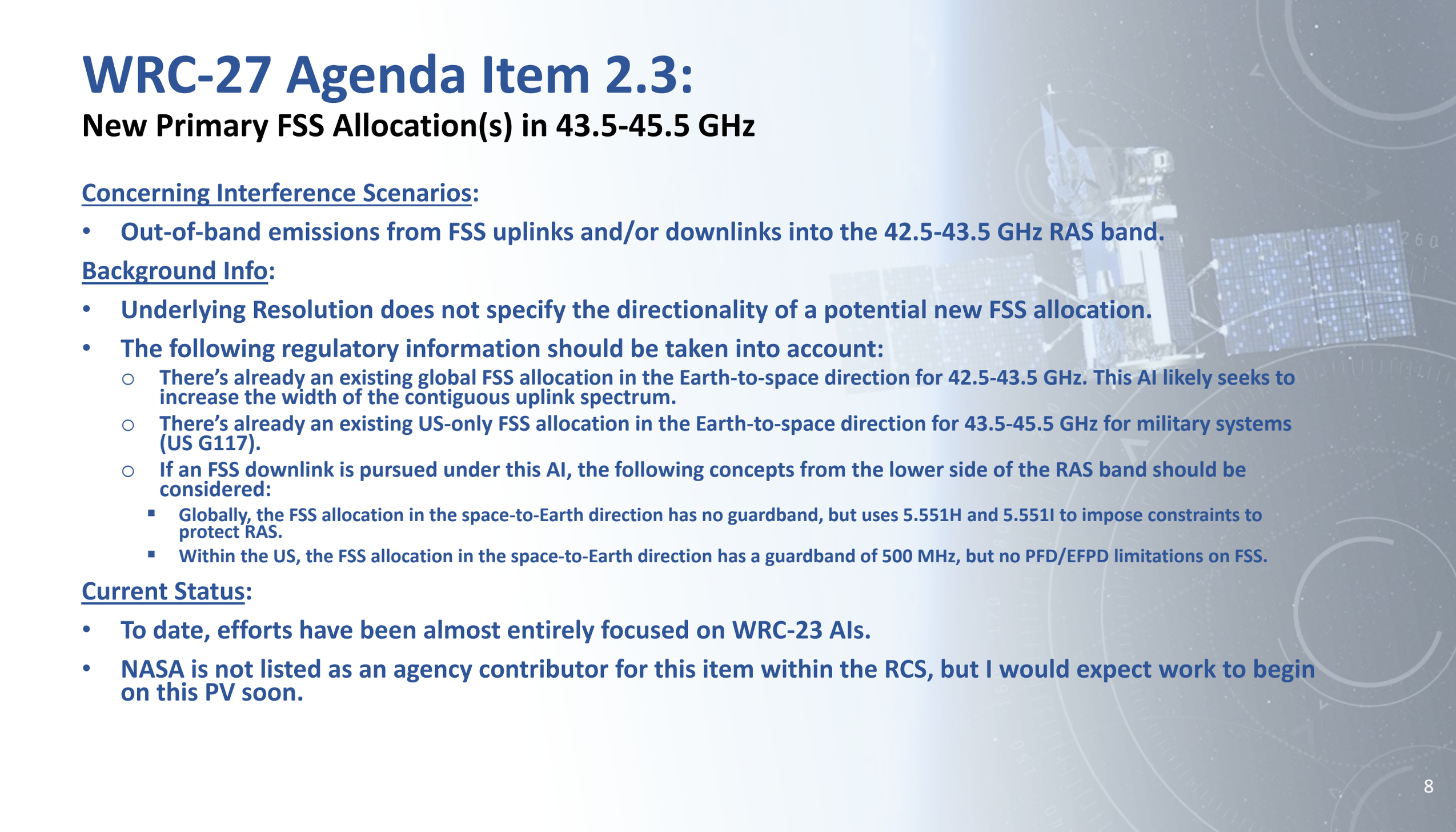
- **WRC-19, under AI 1.6, revised out-of-band emission limits (Res. 750) for fixed Earth stations that operate with GSOs in these frequency bands.**
  - **Technical studies indicate that the revised limits, while significantly better than what was previously in-force, only provide full protection to nadir-scanning sensors and not conical-scanning sensors.**
  - **ESIMs add significant complication to the overall sharing scenario because they will increase:**
    - **Total aggregate interference because technical studies did not account for the additional number of interferers that comes with allowing operation of ESIMs.**
    - **Received sidelobe interference if using electronically-steerable phased arrays.**
    - **The above two points indicate that far stricter limits may be necessary to protect passive sensors from ESIM uplinks.**

Current Status:

- **To date, efforts have been almost entirely focused on WRC-23 AIs.**
- **However, this is a very concerning item for NASA, and we're planning to submit a Preliminary View (PV) to the Radio Conference Subcommittee (RCS) within the next few months.**

WRC-27 Agenda Item 2.3:

New Primary FSS Allocation(s) in 43.5-45.5 GHz



Concerning Interference Scenarios:

- Out-of-band emissions from FSS uplinks and/or downlinks into the 42.5-43.5 GHz RAS band.

Background Info:

- Underlying Resolution does not specify the directionality of a potential new FSS allocation.
- The following regulatory information should be taken into account:
  - There's already an existing global FSS allocation in the Earth-to-space direction for 42.5-43.5 GHz. This AI likely seeks to increase the width of the contiguous uplink spectrum.
  - There's already an existing US-only FSS allocation in the Earth-to-space direction for 43.5-45.5 GHz for military systems (US G117).
  - If an FSS downlink is pursued under this AI, the following concepts from the lower side of the RAS band should be considered:
    - Globally, the FSS allocation in the space-to-Earth direction has no guardband, but uses 5.551H and 5.551I to impose constraints to protect RAS.
    - Within the US, the FSS allocation in the space-to-Earth direction has a guardband of 500 MHz, but no PFD/EFPD limitations on FSS.

Current Status:

- To date, efforts have been almost entirely focused on WRC-23 AIs.
- NASA is not listed as an agency contributor for this item within the RCS, but I would expect work to begin on this PV soon.

Updated Contact Information for US Chairpersons

ITU-R Group	US Chairperson(s) Name	Contact Information
WP 1A	Amy Sanders	ASanders@ntia.gov
WP 4A	Clay DeCell	Clay.DeCell@fcc.gov
WP 5A	Dante Ibarra	Dante.Ibarra@fcc.gov
WP 5B	Louis Bell Eric Lee	louis.bell@fcc.gov elee@ntia.gov
WP 5C	Shelli Rose Haskins	shaskins@ntia.gov
WP 5D	Dante Ibarra	Dante.Ibarra@fcc.gov
WP 7B	Lisa Cacciatore	lisa.e.cacciatore@nasa.gov
WP 7C	Dave Franc	david.franc@noaa.gov
WP 7D	Ashley Zauderer	bezauder@nsf.gov

The US has an open process, and anyone is invited to participate!

Questions?

Feel free to contact me after today's presentation at michael.a.evans-1@nasa.gov if there are additional questions.