30TH WORLD RADIOCOMMUNICATION SEMINAR

24 – 28 October 2022
Geneva, Switzerland

Coordination between Geostationary Satellite Networks

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www.itu.int/go/wrs-22

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Objectives:

- To learn about Coordination Methodologies between GSO networks in services and bands Not subject to a Plan
- To understand the different scenarios where AP8-△T/T Methodology is applicable.
- What to expect from WRC-23 concerning compatibility between Geostationary Satellite Networks

Note: WRS-22 Document "GSO Compatibility Analysis" complements this presentation and provides further in-depth analysis of coordination between Geostationary satellite networks.

Coordination Methodologies :

Trigger Arc

Networks in the FSS, BSS, MSS, Space Research, Meteorological-Satellite and associated SO within a Window from the nominal orbital position with Frequency Overlap in the same direction of Transmission. Frequency bands detailed in Appendix 5.

± **6** degrees :	FSS/BSS → BSS/FSS or FSS/SRS → SRS/FSS	Ku band
± **7** degrees :	FSS→FSS	C band
± **8** degrees :	FSS→FSS	Ka bands and above
	FSS /Meteo. Sat. → Meteo. Sat./FSS	Ka band (18 GHz)
	FSS/BSS → BSS/FSS	Ka band
	MSS/FSS → MSS/FSS	Ka band
± **12** degrees :	BSS → BSS	Ka band (21.4-22 GHz Reg. 1&3)
± **16** degrees :	FSS→ BSS, BSS→ FSS, BSS→BSS	Ka band

New WRC-19

△T/T

- Any other service or sharing scenario where Trigger Arc is not applicable.
- Request to include/exclude a Network/Administration in/from Coordination under 9.41.

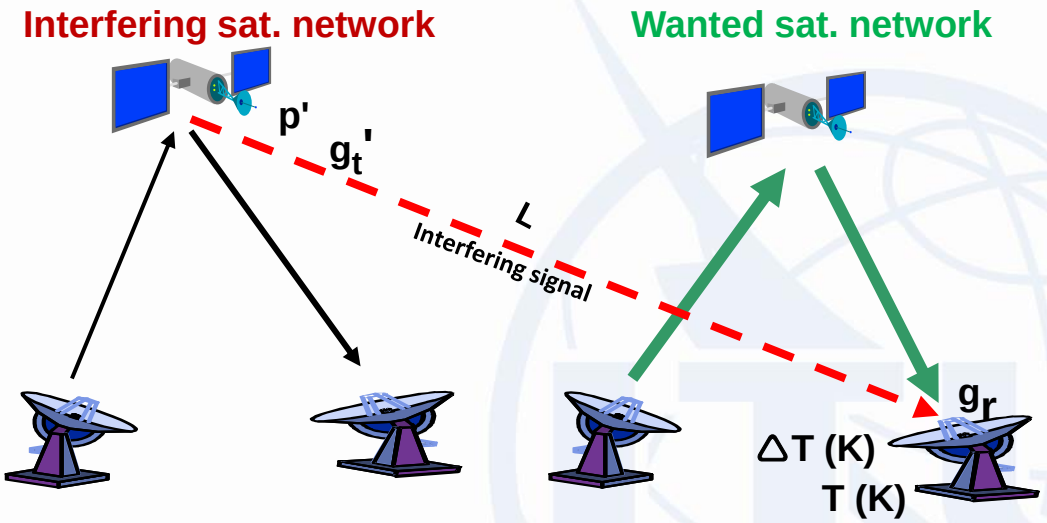
C/I

- For Notification purposes only, when 11.32A is requested.
- Based on methodology and criteria defined in REC. ITU-R S.741 and Rules of Procedure of RRB associated to 11.32A.

PFD

- **RES 762 (WRC-15)** Application of **11.32A** to FSS and BSS in 6 GHz and 10/11/12/14 GHz ranges.
- PFD at the GSO in case of uplink between networks separated by more than 6 deg. (Ku) or 7 deg. (C)
- PFD within potentially affected Service Area in downlink for networks separated by more than 6 deg.(Ku)
- **RES 554 (WRC-12)** PFD Masks to identify **coordination requirements under 9.7** for BSS in 21.4-22 GHz Regions 1 and 3.

AP8-ΔT/T Method: General Concept

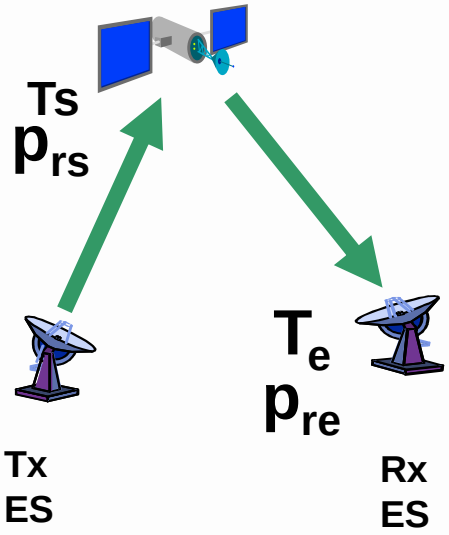


AP8 describes the method including definitions

$$\Delta T / T = (p'\, g_t'\, g_r) / KLT$$

↓

Interfering power density level



Transmission gain γ :

- Valid for Simple Freq. Changing Transponders (Bent Pipe) only.
- Not applicable when satellite has on-board signal processing (digital regenerating transponders, change of modulation, etc). This case requires separate treatment of up and downlinks.

$$\gamma = p_{re} / p_{rs}$$

$$\frac{\text{Power received at the earth stn.}}{\text{Power received at the satellite}}$$

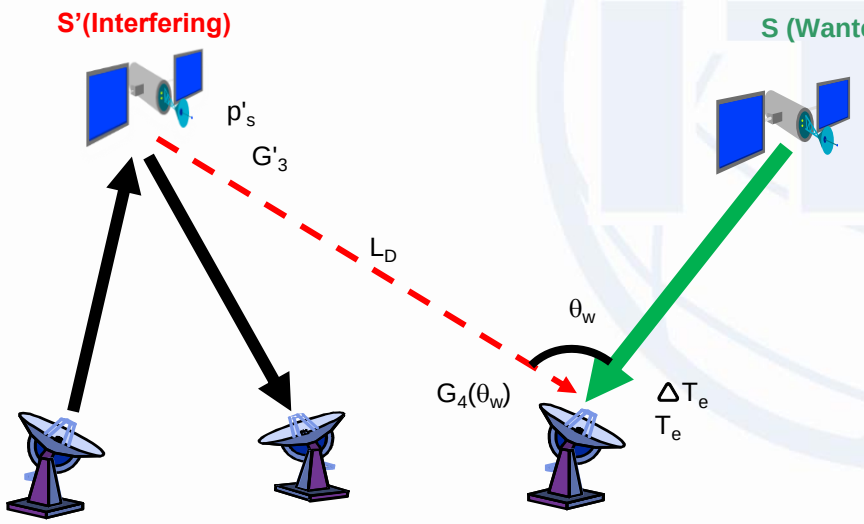
Equivalent Satellite Link Noise Temperature:

$$T = Te + \gamma\, Ts \quad (K)$$

ΔT/T Case I : Freq. Overlap Co-Directional

Separate treatment of Up- and Downlink
(Wanted Satellite has on-board signal processing)

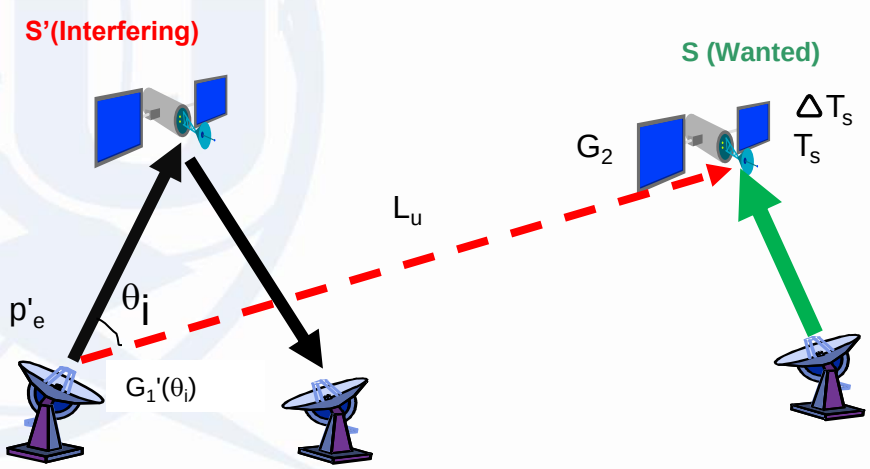
Freq.Overlap in Downlink only



$$\Delta T / T = \Delta T_E / T_E$$

$$\Delta T / T = 10\log(p'_s) + G'_3 - L_D + G_4(\theta_w) - K - T_E \quad (dB)$$

Freq.Overlap in Uplink only



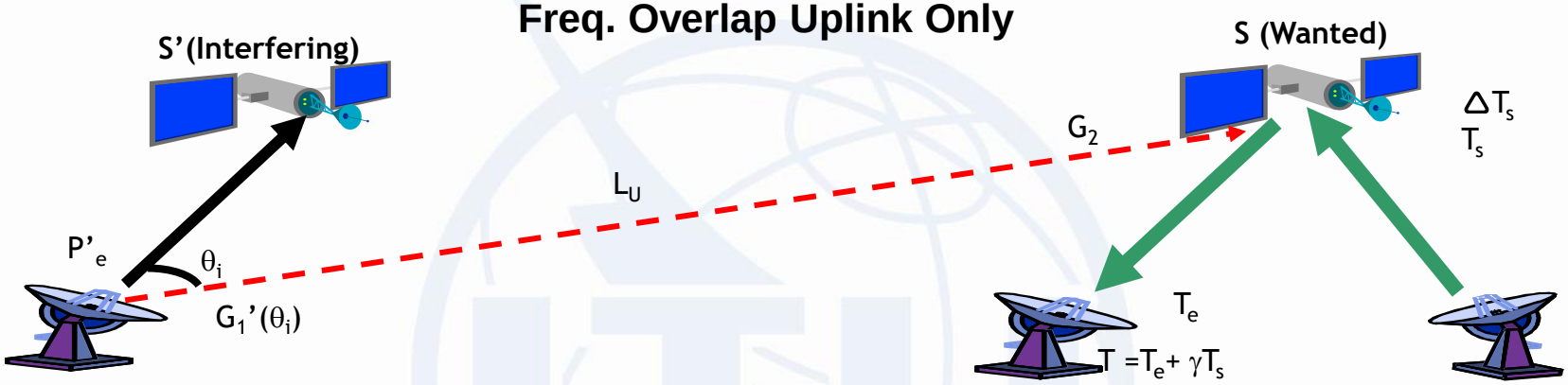
$$\Delta T / T = \Delta T_S / T_S$$

$$\Delta T / T = 10\log(p'e) + G'_1(\theta_i) - L_U + G_2 - K - T_S \quad (dB)$$

ΔT/T Case I : Freq. Overlap Co-Directional

Simple Freq.Changing Transponder (Bent Pipe)

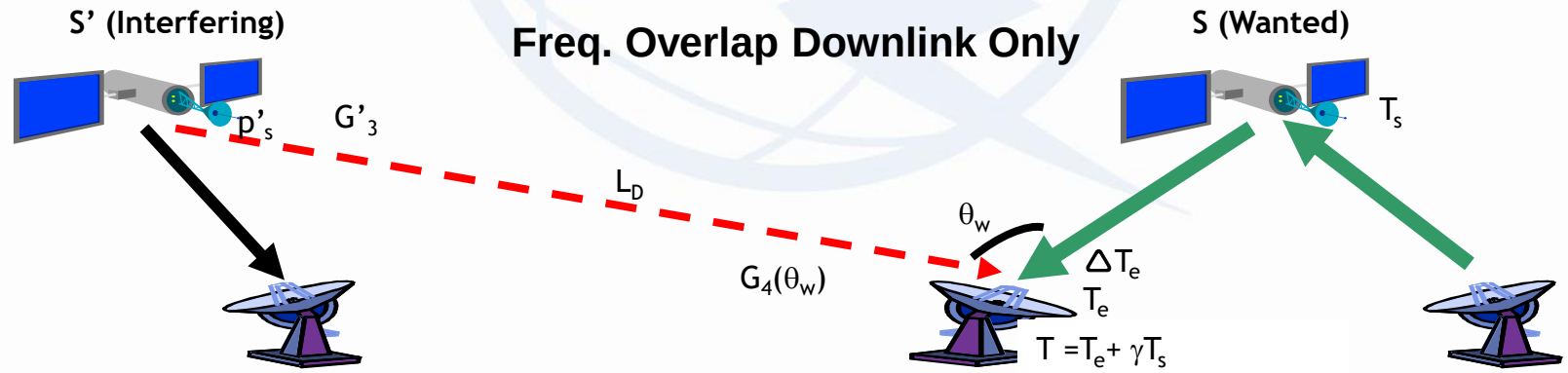
Freq. Overlap Uplink Only



$$\Delta T / T = \gamma \Delta T_s / T$$

$$\Delta T / T = 10\log \gamma + 10\log(p'_e) + G'_1(\theta_i) - L_U + G_2 - K - T \text{ (dB)}$$

Freq. Overlap Downlink Only



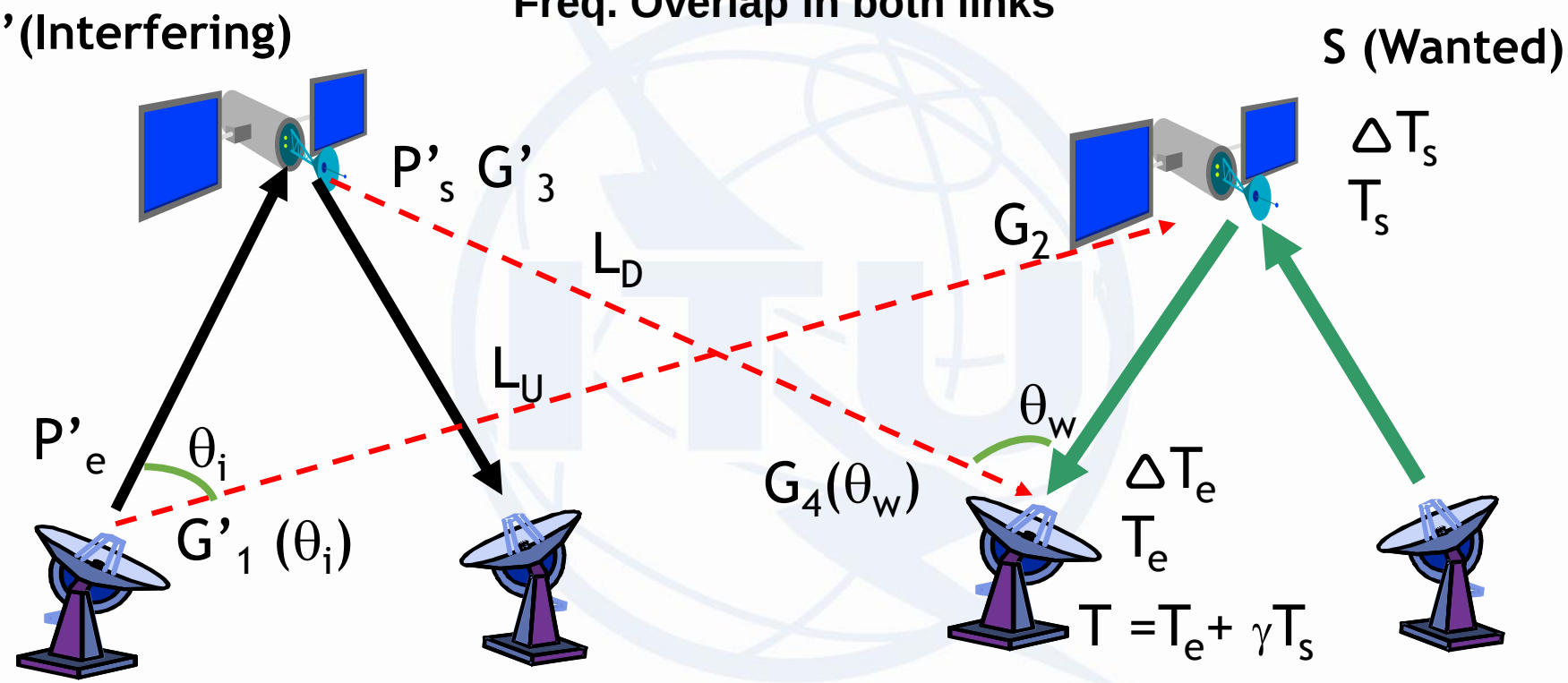
$$\Delta T / T = \Delta TE / T$$

$$\Delta T / T = 10\log(p'_s) + G'_3 - L_D + G_4(\theta_W) - K - T \text{ (dB)}$$

ΔT/T Case I : Freq. Overlap Co-Directional

Simple Freq. Changing Transponder (Bent Pipe)

Freq. Overlap in both links



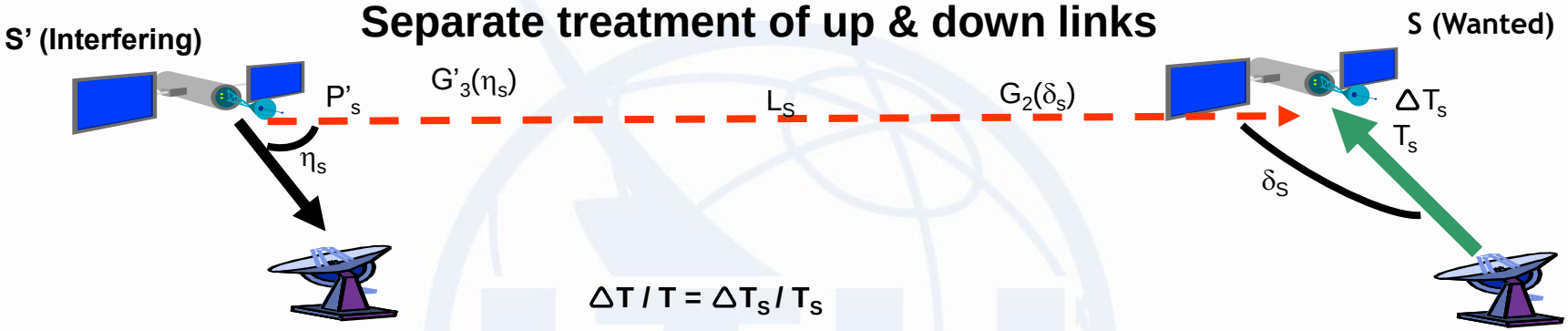
$$\Delta T/T = (\Delta T_e + \gamma \Delta T_s) / T$$

$$\Delta T / T = (p'_s \, g'_3 \, g_{4(\theta_w)}) / (k \, I_D \, T) + \gamma \, (p'_e \, g'_{1(\theta_i)} \, g_2) / (k \, I_U \, T)$$

ΔT/T Case II (Satellite-Satellite): Freq.Overlap in Opposite Direction of Tx.

Downlink (interfering) overlaps Uplink(wanted)

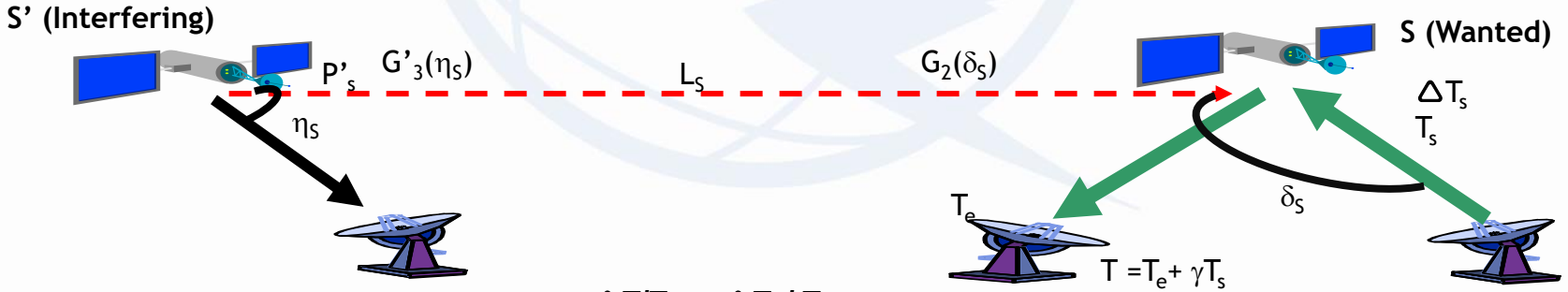
Separate treatment of up & down links



$$\Delta T / T = \Delta T_S / T_S$$

$$\Delta T / T = 10\log(p'_s) + G'_3(\eta_s) - L_s + G_2(\delta_s) - K - T_s \quad \text{(dB)}$$

Wanted Satellite has Simple Freq. Changing TXP (bent-pipe)



$$\Delta T/T = \gamma \Delta T_s / T$$

$$\Delta T/T = 10\log\gamma + 10\log(p'_s) + G'_3(\eta_s) - L_s + G_2(\delta_s) - K - T \text{(dB)}$$

η_s = Direction in the GSO Orbit, from Interfering Satellite S' to Wanted Satellite S

δ_s = Direction in the GSO Orbit, from Wanted Satellite S to Interfering Satellite S'

Appendix 8 ΔT/T in Brief:

- ΔT/T analysis is a method to assess the need for coordination between geostationary satellite networks.
- ΔT/T method is described in Appendix 8 of RR.
- Criteria is based on computing the increase in noise temperature at the receiver due to interference.
- ΔT/T > 6% triggers coordination.

  Harmful interference “may” occur when above this threshold level
- Below this threshold, it is considered that the interference level is negligible and there is no need for coordination.
- Appendix 8 ΔT/T is used by the BR to establish coordination requirements and by Administrations under 9.41 to be included or excluded from the coordination process.
- GIBC/Appendix 8 software for ΔT/T analysis and the coordination arc approach (see Appendix 5 of the RR).

WRC-23 AIs relating to compatibility between GSO satellite networks:

- AI 1.8 - to review and possible revise Res 155 (Rev.WRC-19) and No. 5.484B to accommodate the use of FSS networks by control and non-payload communications of unmanned aircraft systems
- AI 1.15 - to harmonize the use of the frequency band 12.75-13.25 GHz (Earth-to-space) by earth stations on aircraft and vessels communicating with GSO FSS globally
- AI 1.19 - new primary allocation to the FSS (space-to-Earth) 17.3-17.7 GHz in Region 2

Details and possible solutions may be found at the Draft CPM Report to be posted soon at: https://www.itu.int/md/R19-CPM23.2-C/en

Thank you!

ITU – Radiocommunication Bureau

Questions to brmail@itu.int

ITUWRS GENEVA2022