World Radiocommunication Seminar 2016

Coordination between GSO Networks: ΔT/T examination exercise using GIBC Appendix 8 software

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Objectives:

- To learn about the latest Updates to Coordination Criteria between GSO networks in services and bands Not subject to a Plan

- To understand the different scenarios where AP8-△T/T Methodology is applicable.

- To get used to the GIBC-AP8 software by participating in a hands-on exercise, setting up the interface, running a case study and understanding the results.

Coordination Criteria after WRC-15:

Trigger Arc

Networks in the FSS, BSS, Space Research, Meteorological-Satellite and associated SO inside 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
± **12** degrees :	BSS → BSS	Ka band (21.4-22 GHz Reg. 1&3)
± **16** degrees :	FSS→ BSS, BSS→ FSS, BSS→BSS	Ka band

△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

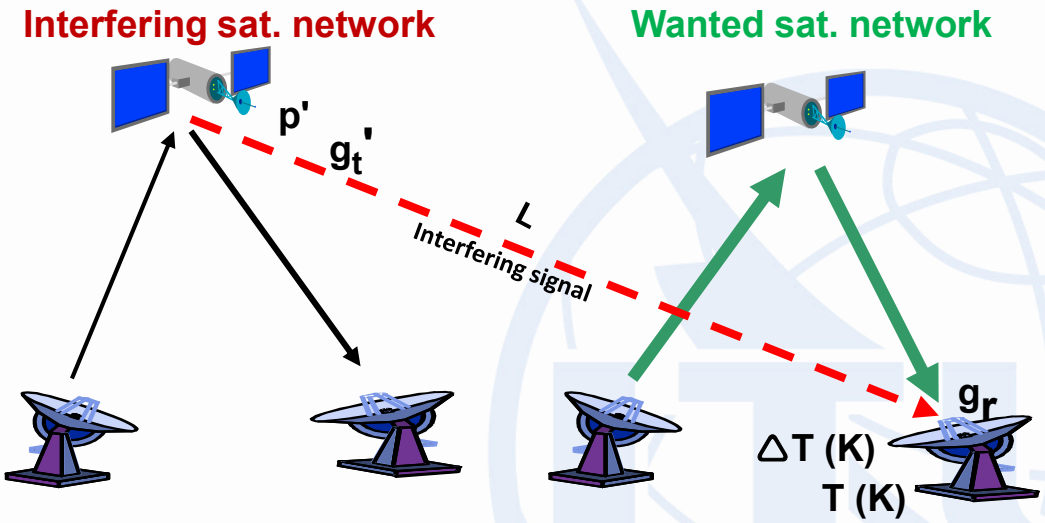
- For Notification purposes only, when 11.32A is requested.
- Based on methodology and criteria defined in REC. ITU-R S.741 and Rules of Procedure of RRB associated to 11.32A.

PFD

RESOLUTION 762 (WRC-15)

- Application of 11.32A to satellite networks in the 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 band) or 7 deg. (C band)
- PFD within potentially affected Service Area in case of downlink between networks separated by more than 6 deg.(Ku band)

AP8-ΔT/T Method: General Concept

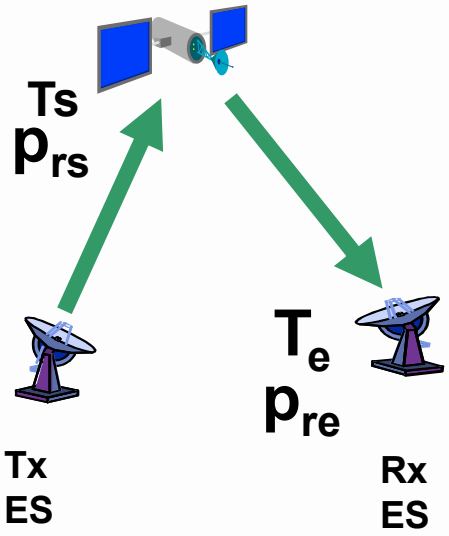


AP8 describes the method including definitions

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

↓

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.

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

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

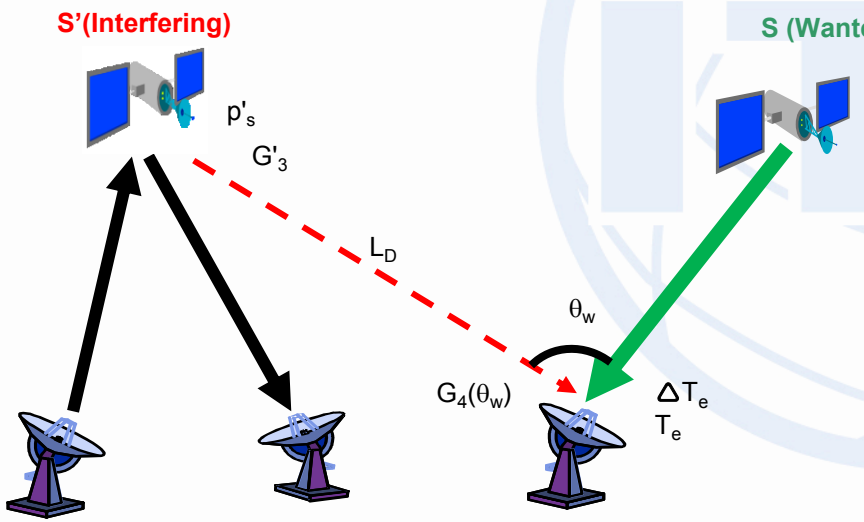
Equivalent Satellite Link Noise Temperature:

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

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

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

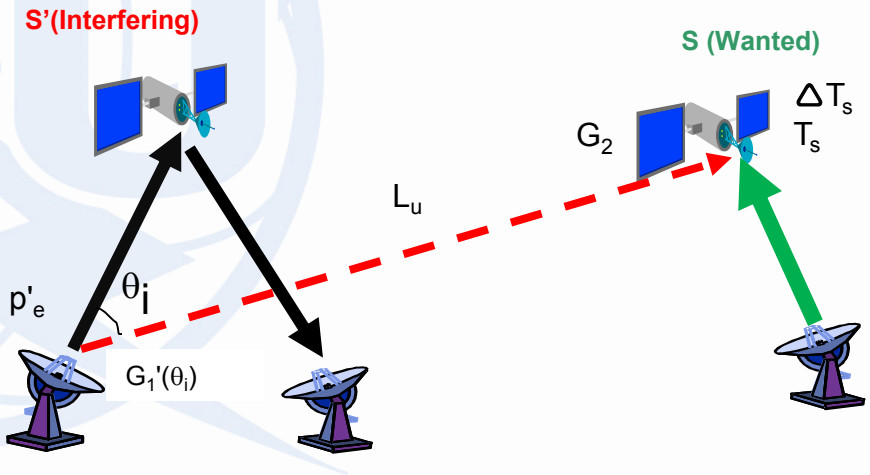
Freq.Overlap in Downlink only



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

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

Freq.Overlap in Uplink only



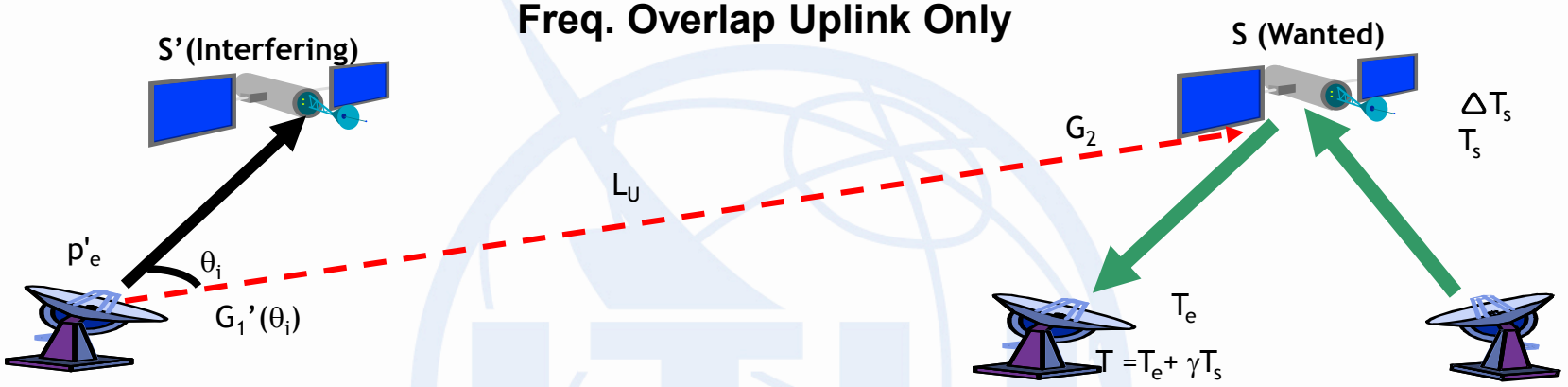
$$\Delta T / T = \Delta T_S / T_S$$

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

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

Simple Freq.Changing Transponder (Bent Pipe)

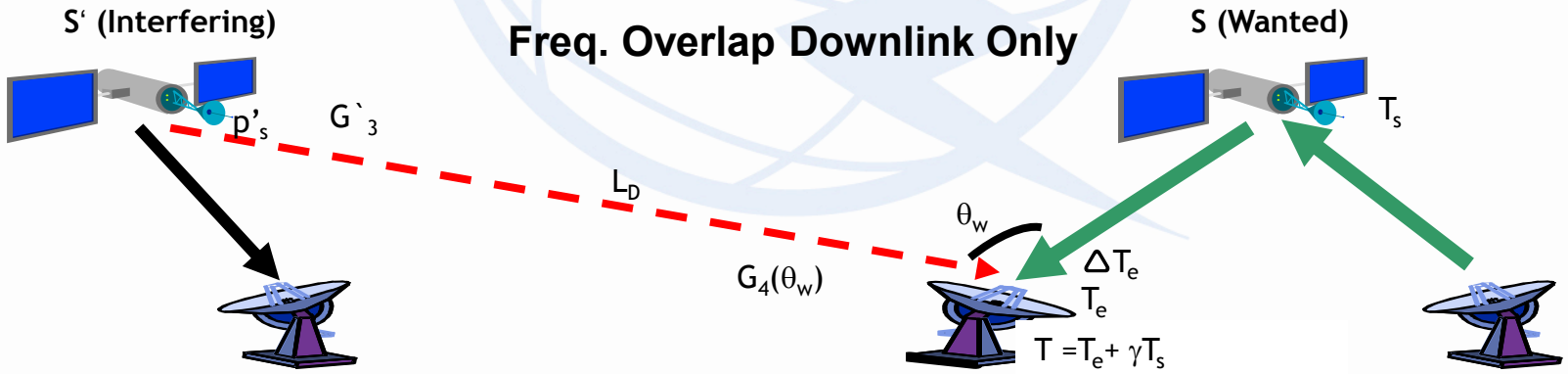
Freq. Overlap Uplink Only



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

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

Freq. Overlap Downlink Only



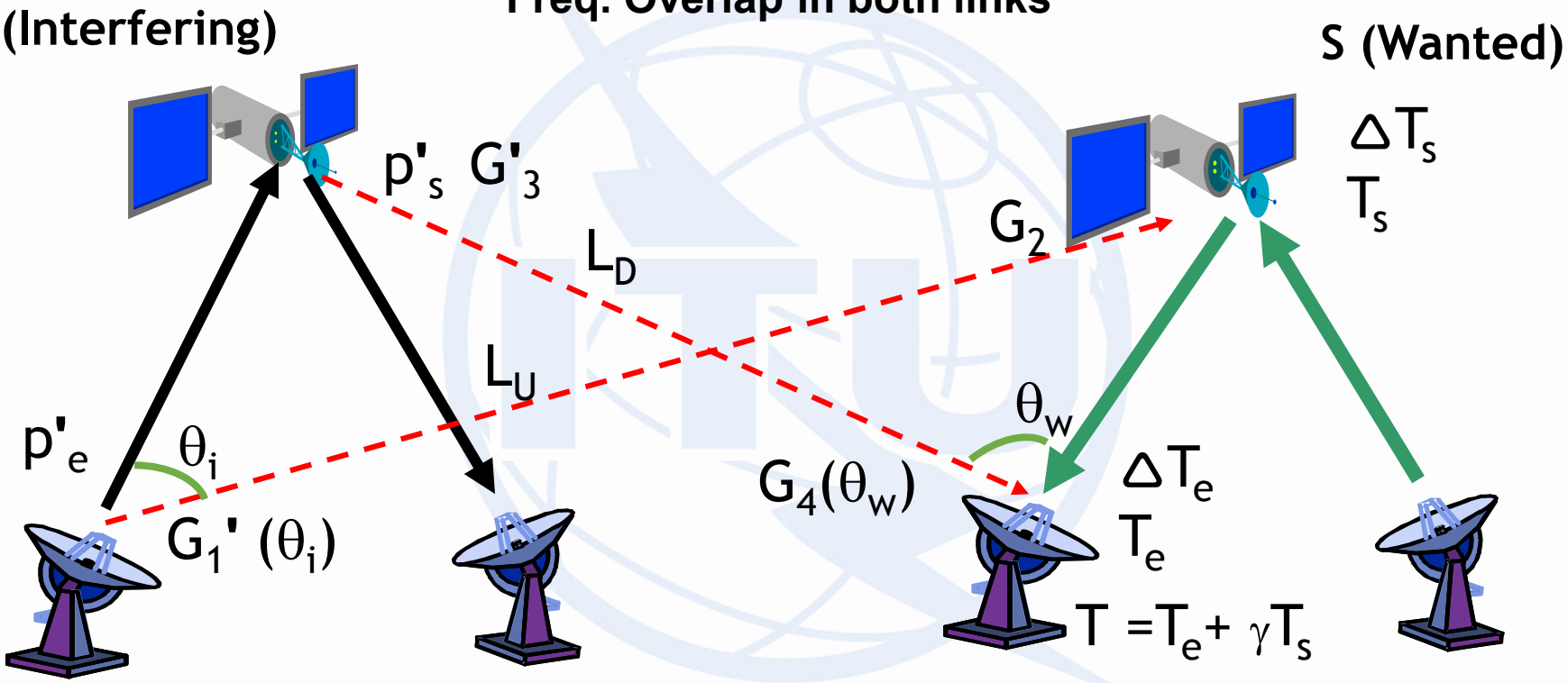
$$\Delta T / T = \Delta TE / T$$

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

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

Simple Freq. Changing Transponder (Bent Pipe)

Freq. Overlap in both links



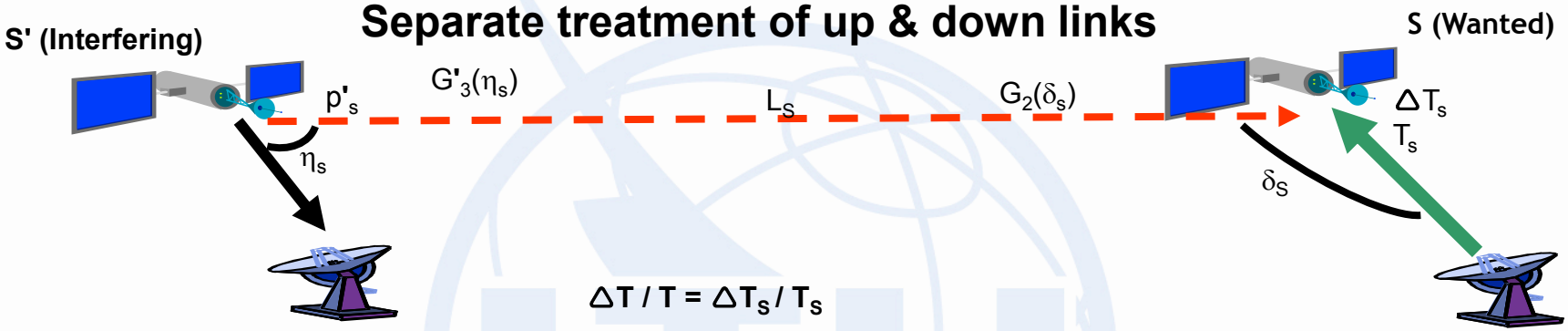
$$\Delta T/T = (\Delta T_e + \gamma \Delta T_s) / T$$

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

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

Downlink (interfering) overlaps Uplink(wanted)

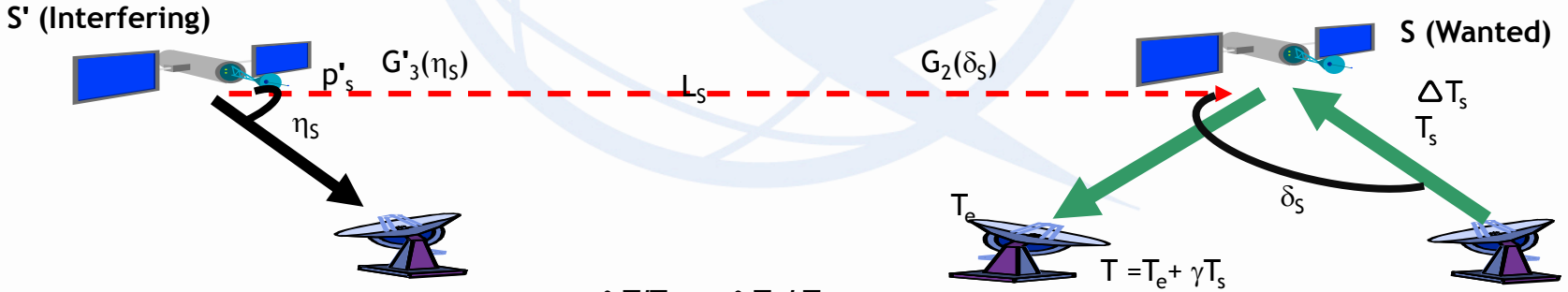
Separate treatment of up & down links



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

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

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 for determining the need for coordination between geostationary satellite networks.
- ΔT/T method described in Appendix 8 of RR.
- Criterion based on the calculation of the increase in noise temperature at the receiver due to interference.
- ΔT/T > 6% triggers coordination.

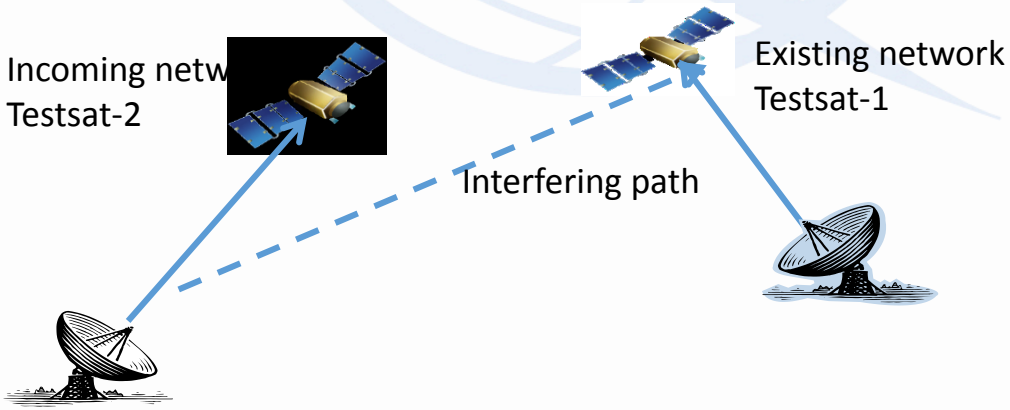
  Beyond the threshold value harmful interference may occur.
- If the limit value is not exceeded, the potential for interference does not exist and there is no need for further detailed calculations.
- Appendix 8 ΔT/T is utilized by the BR to establish coordination requirements and by Administrations 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).

GIBC/Appendix 8 Exercise

- Using Gibc/Appendix 8 software to assess the coordination requirements

- In a real case, different interfering scenarios will be considered. In this exercise we are focusing on the Appendix 8 case I Uplink, co-directional interference.

- The satellite includes on-board signal processing for separate treatment of the up- and downlinks.



GIBC/Appendix 8 Exercise - Files

Ap8_exercise_wrs16.mdb

SNS formatted database containing the information for one incoming and one existing network.

Ap8_exercise_wrs16_gims.mdb

GIMS graphical data: service areas and gain contours that were captured and stored in the GIMS-format database.

Ap8_exercise_results_wrs16

Directory containing the results of the Appendix 8 examination.

GIBC/Ap8 Exercise - Test case data

Existing network:

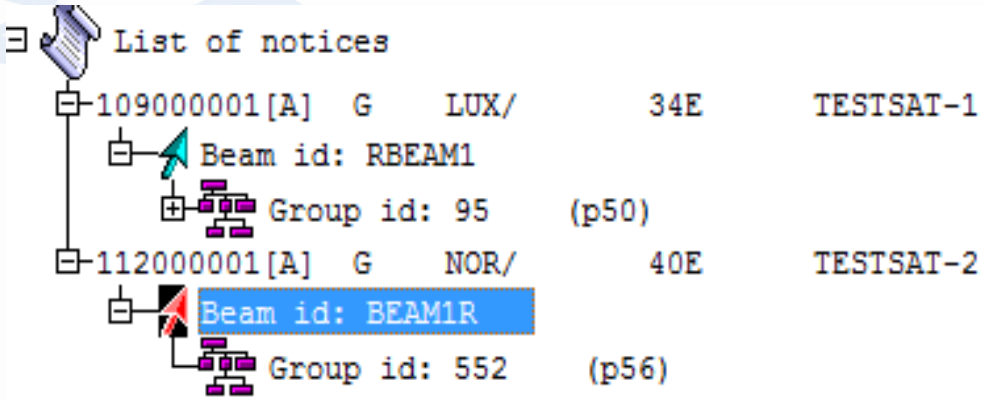
- TESTSAT-1 Id:109000001 at 34°E
- R/Beam: RBEAM1, Max Gain 42dB, Noise Temperature 550K
- Central frequency: 29.95GHz, BW 72MHz

Incoming network:

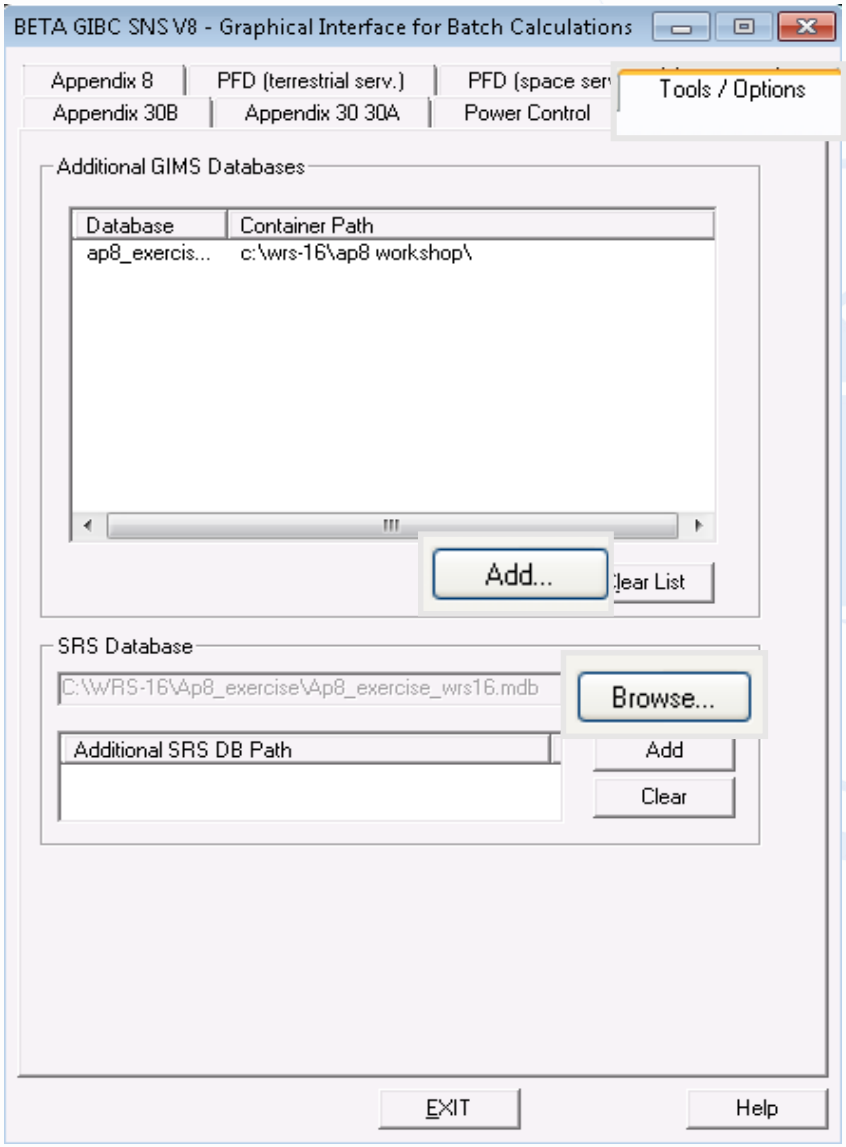
- TESTSAT-2 Id:112000001 at 40°E
- R/Beam: BEAM1R, -49.90dBW/Hz
- Central frequency: 29.96GHz, BW 72MHz

Associated ES:

- Name: TYPICAL ES1
- Type: Typical Earth Station
- Radiation pattern:REC-580-6
- Max Gain: 54.50dB



GIBC/Ap8 Exercise: Tools&Options



In the Tools&Options tab we specify the location of the databases involved in the analysis.

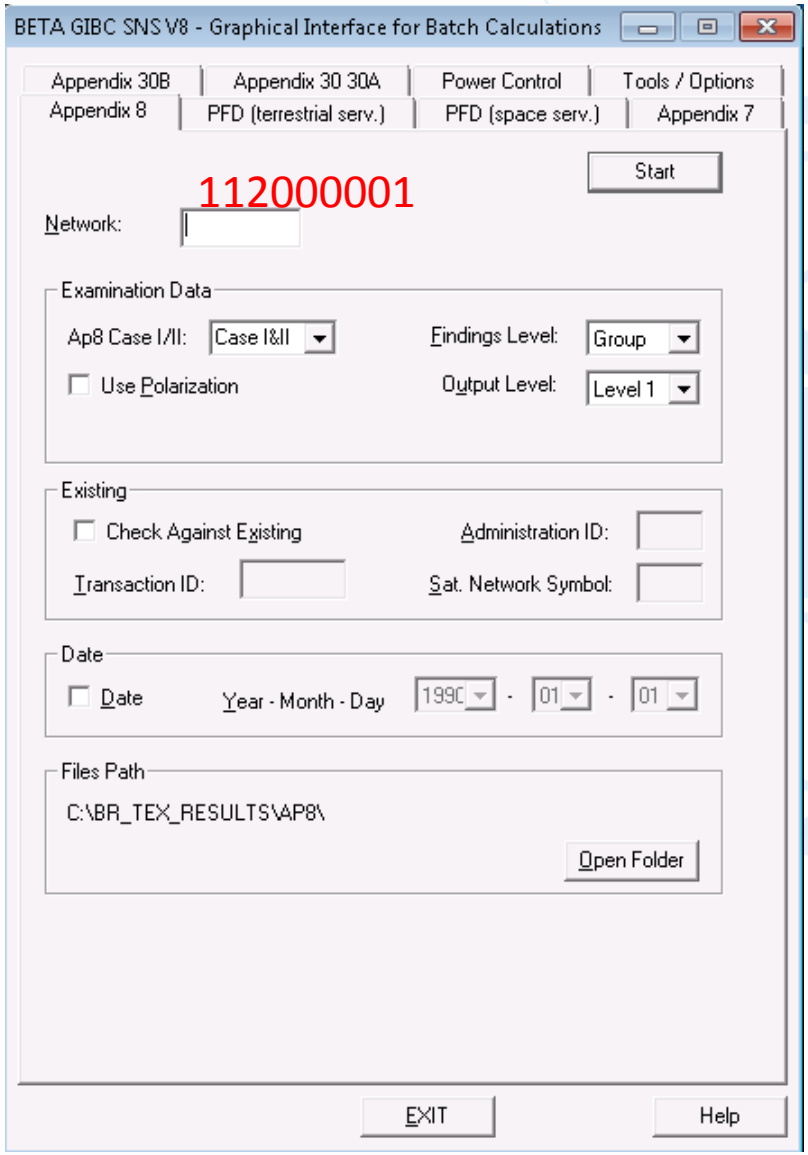
*Click **Browse** and select the file:*

Ap8_exercise_wrs16.mdb

*Click **Add** and select the additional GIMS database file:*

Ap8_exercise_wrs16_gims.mdb

GIBC/Appendix 8 Examination



In the Appendix 8 tab:

To introduce id of the incoming network: *112000001*

*Click **Start**.*

Wait for the program to finish:
"PROGRAM SNSBPAP8 TERMINATED OK"

*Then we click **Open Folder**.*

GIBC/Appendix 8 Results

The results are files located in an individual folder.

We will be looking in detail at the **APP8.LST** file.

APP8_OPT.LST with ΔT/T excess (for information).

If any GIMS diagram were missing it is listed in the **MSG.LST** file.

C:\BR_TEX_RESULTS\AP8\id\time_stamp

Gibc/Appendix8 Exercise: Report File

Details of the analysis

```
START OF JOB SNSBAP29     02.12.16      09.24.47        VERSION 8.0.0.7

AXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
ǂ
         112000001 2                       1GNN          NN
```

Details of the interfering case

```
ǂ
                    SNS  AP 8 EXAMINATION           REQUESTED BY :             DATE: 02/12/16      09:24:47                 PAGE:  0001

          EXI UP-LINK IS AFFECTED                       MANDATORY EXAMINATION                        DT/TS =          7.61 %

I S NOR     TESTSAT-2                         40.00E  0.10 0.10      29.960000 G   72000 K  23.10.12                C112.000001/000.000552/0001
    BEAM1R   EI EI       M          38.60 DB
      1M00G7W--     10.10 DBW  -49.90 DBW/HZ  -49.90 DBW/HZ (TOT. BW)  2D:23.10.12

E S LUX     TESTSAT-1                         34.00E  0.10 0.10      29.950000 G   72000 K  12.03.09              A C109.000001/000.000095/0001
    RBEAM1   EC EC       M          42.00 DB  42.00 DB             550 K                               DT/TS =          7.61 %
      3M00G7W--     11.90 DBW  -52.90 DBW/HZ  -52.87 DBW/HZ (TOT. BW)  2D:12.03.09
I E NOR     TYPICAL ES1                     030W5211  16N1544  REC-580-6              54.50 DB   9.50 DB

---------------------------------------------------------------------------------------------------------------------------------
ǂ
                    SNS  AP 8 EXAMINATION           REQUESTED BY :             DATE: 02/12/16      09:24:47                 PAGE:  0002


         SUMMARY FOR TRANSACTION :      C 112.000001         TESTSAT-2                        NOR
            9.7      TRIGGER ARC ADM: (NOT APPLICABLE)
ǂ
                    SNS  AP 8 EXAMINATION           REQUESTED BY :             DATE: 02/12/16      09:24:47                 PAGE:  0003

         SUMMARY FOR TRANSACTION :      C 112.000001         TESTSAT-2                        NOR
            9.7   AP 8 MANDATORY ADM:      LUX
BEAM1R   R G000.000552       29 GHZ    :    LUX
ǂ
```

Summary of the analysis

Report file Details (Case I Uplink)

Interfering scenario and DT/T value at the satellite

EXI UP-LINK IS AFFECTED MANDATORY EXAMINATION DT/TS = 7.61 %

Incoming satellite: adm, name, orbital position, tolerances, central frequency, bandwidth

Incoming id, group, assignment

I S NOR TESTSAT-2 40.00E 0.10 0.10 29.960000 G 72000 K 23.10.12 C112.000001/000.000552/0001

Beam name, class of station, max gain

BEAM1R EI EI M 38.60 DB

Designation of Emission, power characteristics

1M00G7W-- 10.10 DBW -49.90 DBW/HZ -49.90 DBW/HZ (TOT. BW) 2D:23.10.12

Existing sat: similar to the incoming plus the off-axis gain, noise temperature and DT/T value at the satellite

E S LUX TESTSAT-1 34.00E 0.10 0.10 29.950000 G 72000 K 12.03.09 C109.000001/000.000095/0001

RBEAM1 EC EC M 42.00 DB 42.00 DB 550 K DT/TS = 7.61 %

3M00G7W-- 11.90 DBW -52.90 DBW/HZ -52.87 DBW/HZ (TOT. BW) 2D:12.03.09

Associated ES: adm, name, coordinates, pattern name, max and off-axis gain

I E NOR TYPICAL ES1 030W5211 16N1544 REC-580-6 54.50 DB 9.50 DB

Appendix 8 Exercise Sum Up

In the USB Key (ITU WRS-16), the concerned files for the exercise are located under:

\\Space_Workshops_(14-16-Dec)\09-Coordination-of-satellite-networks-technical-excercise\AP8

Follow those steps to complete the exercise:

1. Open GIBC
2. Tools&Options page:
   a) Add the additional GIMS database file: Ap8_exercise_wrs16_gims.mdb
   b) Add the SRS Database file: Ap8_exercise_wrs16.mdb
3. Appendix 8 page:
   a) Enter notice Id: 112000001
   b) Press **Start**
   c) When the program finishes press **Open Folder**
4. Open the results subfolder.
5. Open **App8.Lst** file with Notepad editor for perusal.

More information:

brsas@itu.int

Thank you for your kind attention!

Please note that the all the technical data in this presentation and associated exercise files are only intended for demonstration purposes.