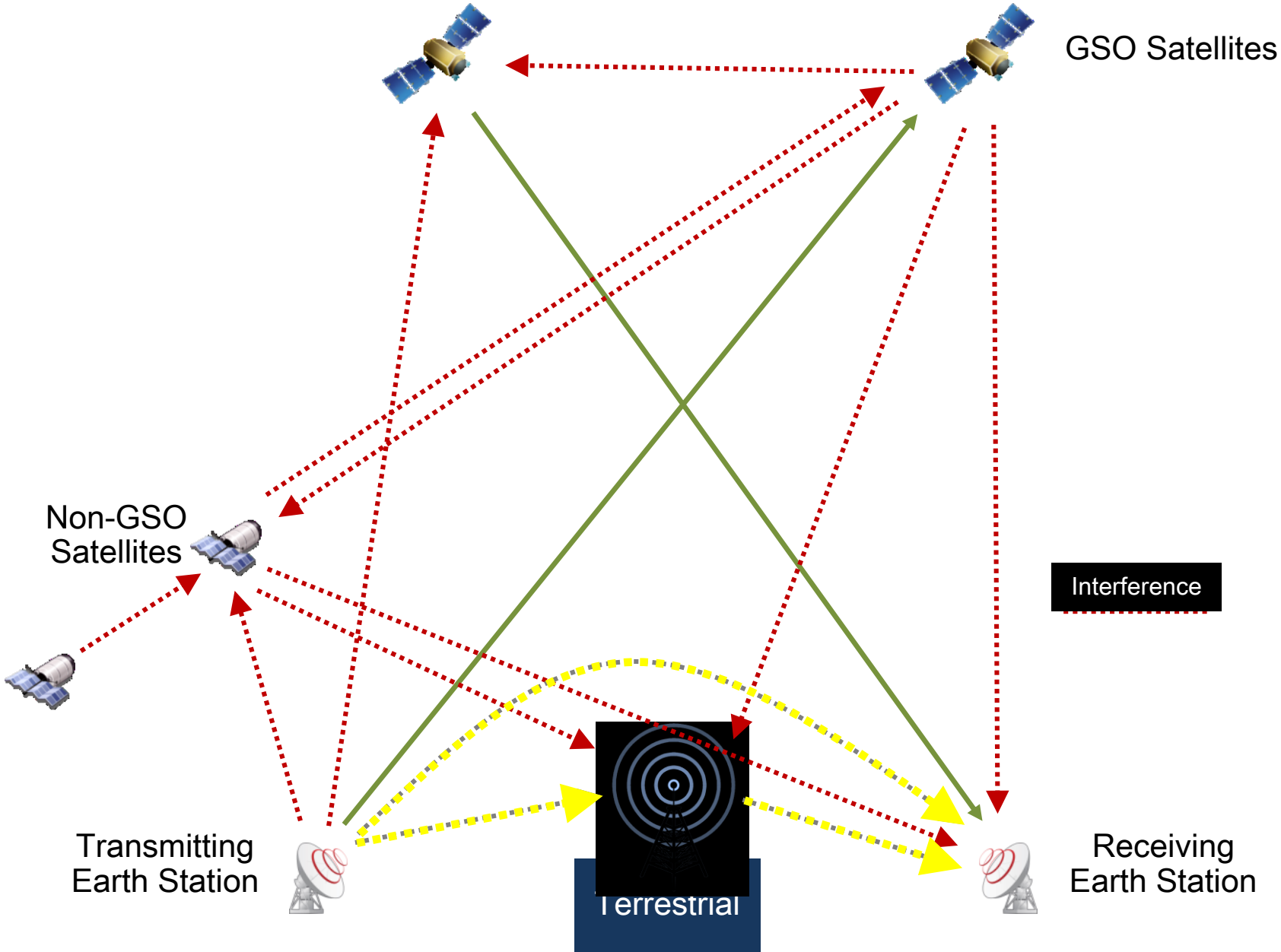
Earth Station Coordination and Tools

Cessy Karina

Contents

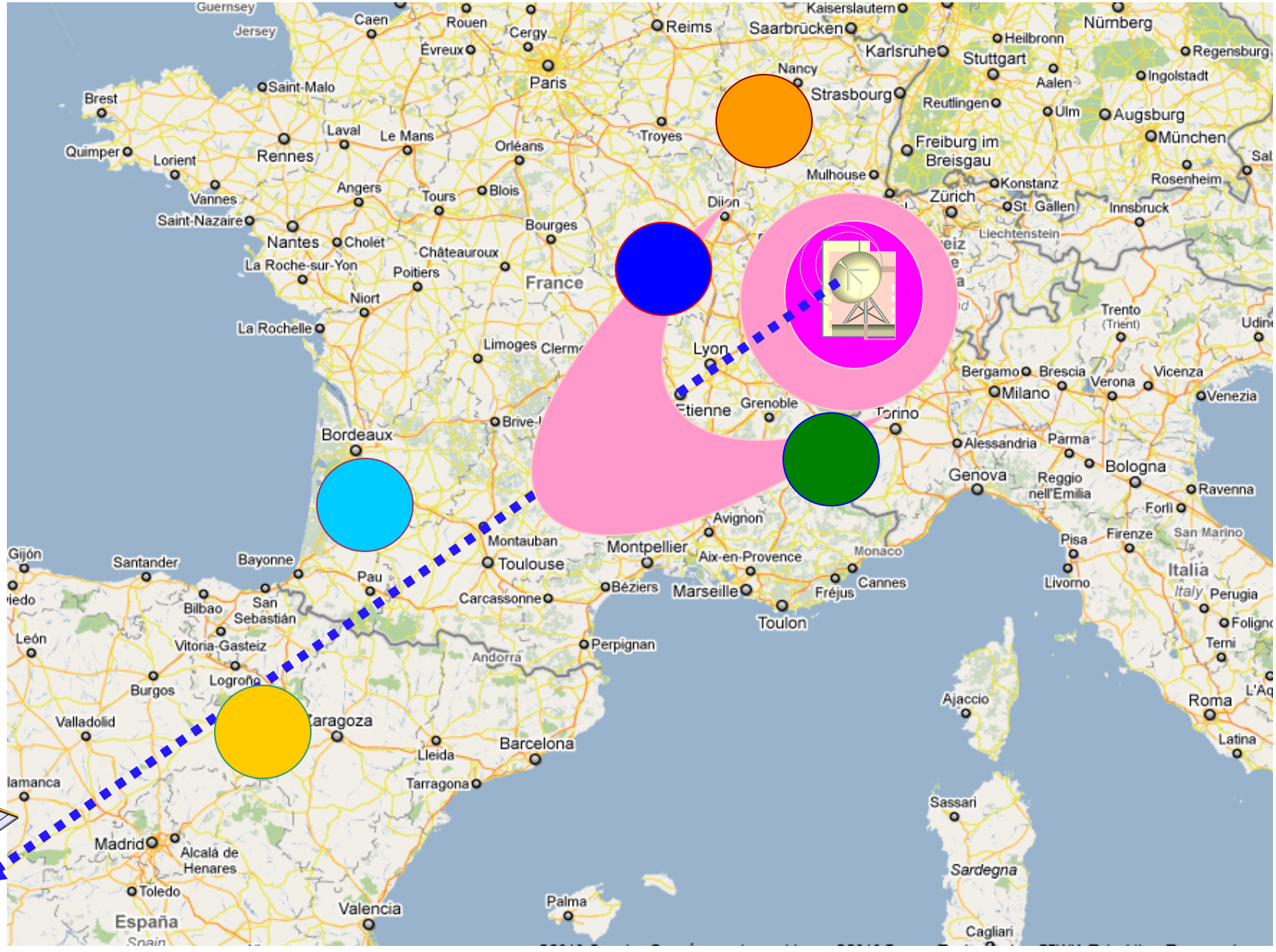
- Coordination Requirements
- Provisions for Effecting Coordination
- Tools

Coordination requirements

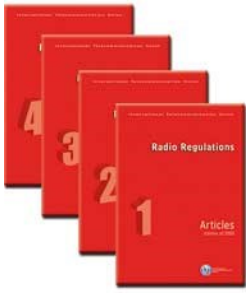


Why ?

Propagation do not care for Borders.



COORDINATION OF EARTH STATIONS



Volume No.1

Article 5

Region 1	All Regions
5850 - 5925 MHz	6700 - 7075 MHz
FIXED	**FIXED**
FIXED-SATELLITE	**FIXED-SATELLITE**
(Earth-to-space) ↑	*(Earth-to-space)* ↑
MOBILE	*(space-to-Earth)* ↓
	MOBILE

Article 9 ⇨ **Provisions : 9.6, 9.15, 9.17, 9.17A, 9.21**

Volume No.2

Appendix 5 ⇨ **Coordination area : Appendix 7**

Appendix 4 ⇨ **Coordination data to neighboring countries**

(Vol. 1) Article 11 ⇨ ***Notification in Master Register***

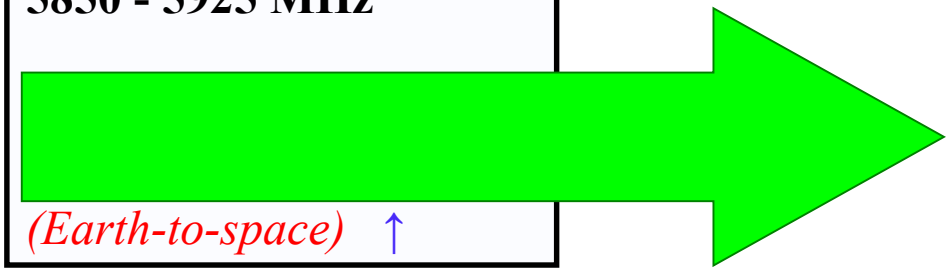
When ?

Volumn No.1 → **Article 5**

Region 1

5850 - 5925 MHz

(Earth-to-space) ↑



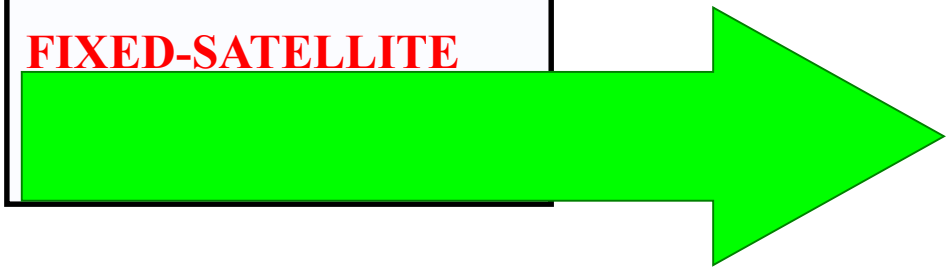
equal rights

Space = Terrestrial

All Regions

6700 - 7075 MHz

FIXED-SATELLITE



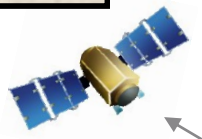
opposite direction

Uplink = Downlink

Provisions for Effecting Coordination

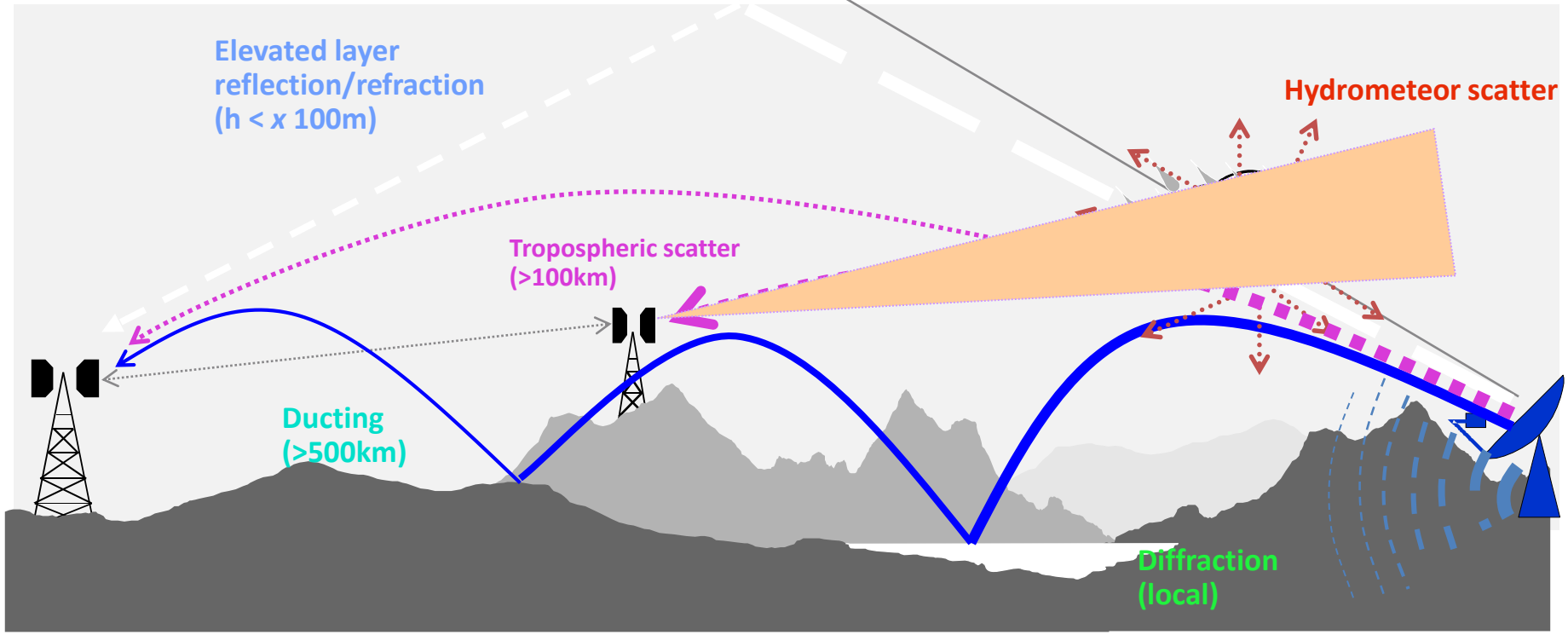
Article 9	**9.6**	Administrations **shall effect coordination before** notifying to the BR or brings into use any frequency assignment.
	9.11A/ 9.15	Coordination of a **Specific or Typical** Earth Station of **non-GSO** in respect of **Terrestrial Stations** (associated with Footnote - 9.11A)
	9.17	Coordination of any **Specific Earth Station** or **Typical Mobile** Earth Station in frequency bands above 100 MHz, in respect of **Terrestrial Stations**, *with the exception of the coordination under 9.15*
	9.17A	Coordination of any **Specific Earth Station** in respect of other Earth Stations operating in the **opposite direction** of transmission **(ODT)**, or any **Typical Mobile** Earth Station in respect of **Specific Earth Station (ODT)** ***Rx E/S – No methodology in AP7***
	9.21	**Specific Earth Station** of a service required to seek agreement of other administrations (under Footnotes)

Why AP7?



Anomalous (short-term) Interference
Propagation mechanisms

Common Volume
at the intersection of
the antenna main beams



Great-circle propagation
(Mode 1) ***– 4 Radio-Clim. zone***

+

Hydrometeor scatter
(Mode 2) ***– 15 Rain zone A-Q***

⇨ **Coordination Distance**

Tools

AP7

GIBC

Coordination Contour

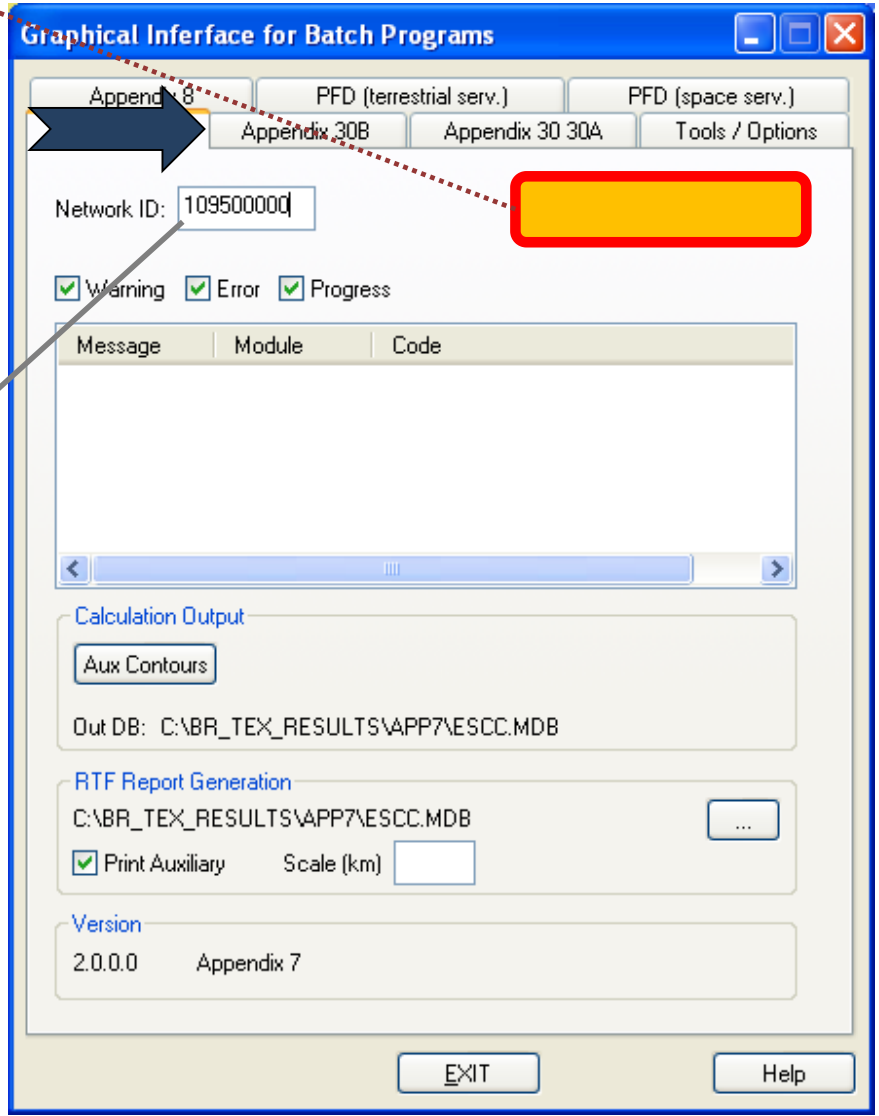
Simple button?

Computer Program for Determination of Coordination Area

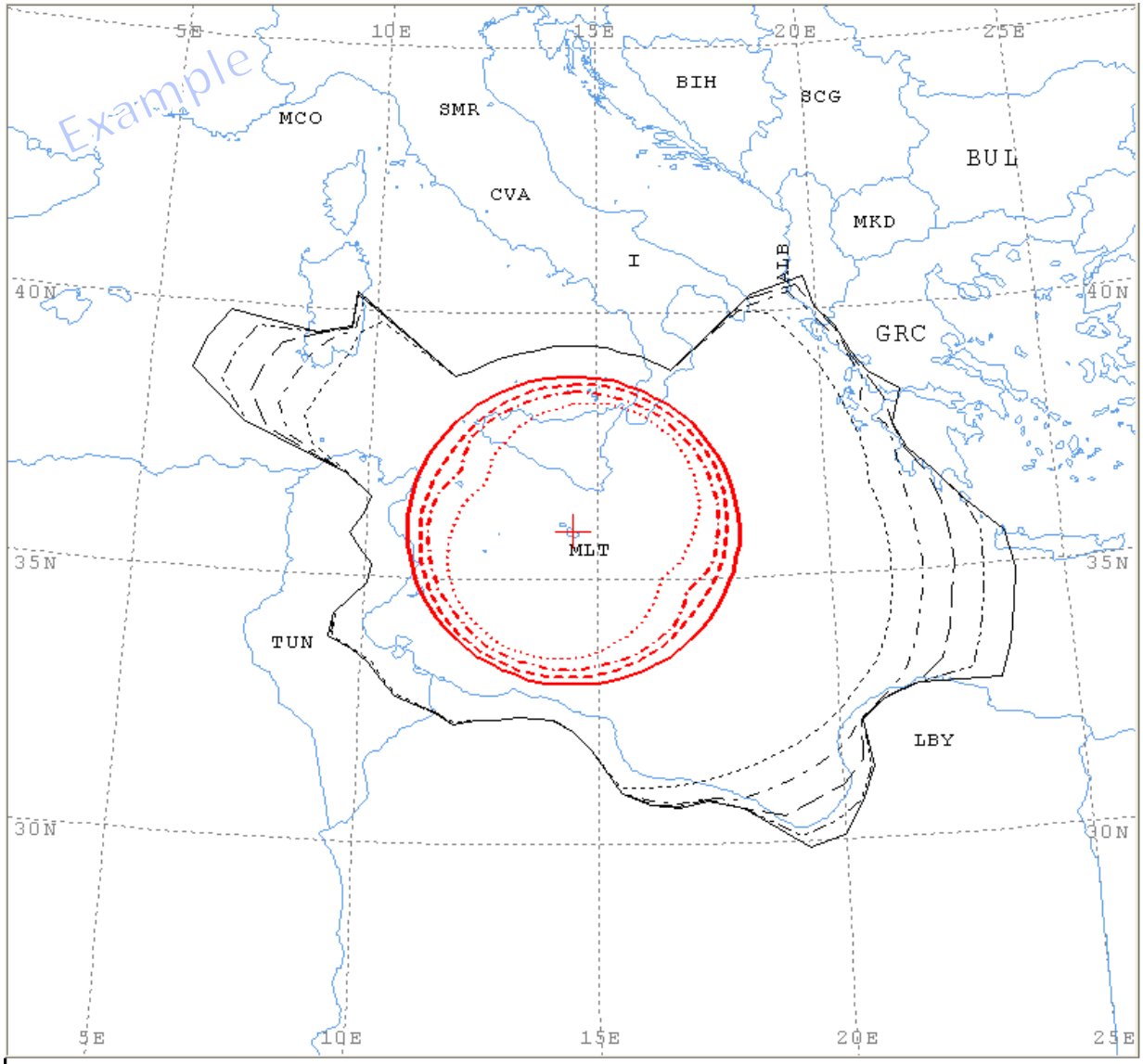
AP7 embedded in GIBC

C:\BR_SOFT\BATCH

Create your Input File



Report (p1) of AP7 (GIBC) program



Rcv GSO ES (FSS) w.r.t. Terrestrial St (TS, FS, MS)

Freq: 3850-4200 GHz
Sat longitude : 18 W
Horizon Ele. Anagle : 0

Affected countries:

Automatic indication in AP7 report

Report (p2) of AP7 (GIBC) program

Example

Diagram 4: 2.1_TABLE8. RECEIVING GSO ES in FIXED-SATELLITE SERVICE W.R.T. TRANSMITTING TERRESTRIAL STATIONS. TS in FS or MS

NOTICE ID: 108500000 EARTH STATION NAME: BR SEMINAR ES1 EARTH STATION POSITION: 014E264035N5556 PHASE: N
ADM/GEO_AREA: BEL/MLT RAIN CLIMATICAL ZONE: K
SATELLITE NAME: ITU BR TEST SAT SATELLITE ORBITAL POSITION: -18.00 DEG
ANTENNA AZIMUTH: 227.5 DEG ANTENNA ELEVATION: 36.09 DEG
FREQUENCY BAND: 3850.000 - 4200.000 MHZ BEAM EFFICIENCY: 95.0 PERCENTAGE OF TIME: 0.0017 %
MAXIMUM ANTENNA GAIN: 59.3 DBI MAXIMUM POWER DENSITY: - DBW/HZ NOISE TEMPERATURE: 100.0 K
ANTENNA PATTERN: APEREC015V01
2.1_TABLE8 Model: PLM_DUCTING

TRANSMISSION LOSS MODE 1: 204.9 DB (DOES NOT INCLUDE HOR. CORR. AND ANT. GAIN)
TRANSMISSION LOSS MODE 2: 162.9 DB

Tech. parameters of the planning E/S

Calculated parameters by 5° Azimuth

AZIMUTH	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115
OFF-AXIS	123.1	126.7	130.0	133.1	135.9	138.4	140.5	142.1	143.3	143.8	143.8	143.2	142.0	140.3	138.2	135.7	132.8	129.7	126.4	122.9	119.3	115.6	111.7	107.8
HOR.ELEV.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HOR.CORR.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANT.GAIN	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0
COORDINATION DISTANCE (KM)																								
MODE 1																								
0.0 DB	391	391	391	391	394	394	391	685	696	669	668	688	688	704	665	674	719	769	841	855	850	850	847	748
MODE 2																								
0.0 DEG	321	321	321	321	321	321	321	321	321	321	321	321	321	321	321	321	321	321	321	322	322	322	322	322

Coordination distance by 5° Azimuth

AZIMUTH	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235
OFF-AXIS	103.9	99.9	95.9	91.8	87.8	83.8	79.8	75.8	71.8	67.9	64.1	60.4	56.8	53.3	50.0	46.9	44.1	41.6	39.5	37.9	36.7	36.2	36.2	36.8
HOR.ELEV.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HOR.CORR.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANT.GAIN	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-9.8	-9.1	-8.5	-7.9	-7.5	-7.1	-7.0	-7.0	-7.1
COORDINATION DISTANCE (KM)																								
MODE 1																								
0.0 DB	703	691	765	801	820	808	674	626	618	595	561	465	425	40	402	408	427	444	470	470	477	491	488	485
MODE 2																								
0.0 DEG	322	322	323	323	323	323	323	323	324	324	324	324	324	324	325	325	325	325	325	325	325	325	325	325

(0 - 355º)

AZIMUTH	240	245	250	255	260	265	270	275	280	285	290	295	300	305	310	315	320	325	330	335	340	345	350	355
OFF-AXIS	38.0	39.7	41.8	44.3	47.2	50.3	53.6	57.1	60.7	64.4	68.3	72.2	76.1	80.1	84.1	88.1	92.2	96.2	100.2	104.2	108.2	112.1	115.9	119.6
HOR.ELEV.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HOR.CORR.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANT.GAIN	-7.5	-8.0	-8.5	-9.2	-9.8	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0
COORDINATION DISTANCE (KM)																								
MODE 1																								
0.0 DB	498	525	497	416	400	415	434	409	401	456	697	83											1	391
-10.0 DB	498	525	497	416	400	415	434	409	401	456	649	71											1	391
MODE 2																								
0.0 DEG	325	325	325	325	325	325	324	324	324	324	324	32											2	322

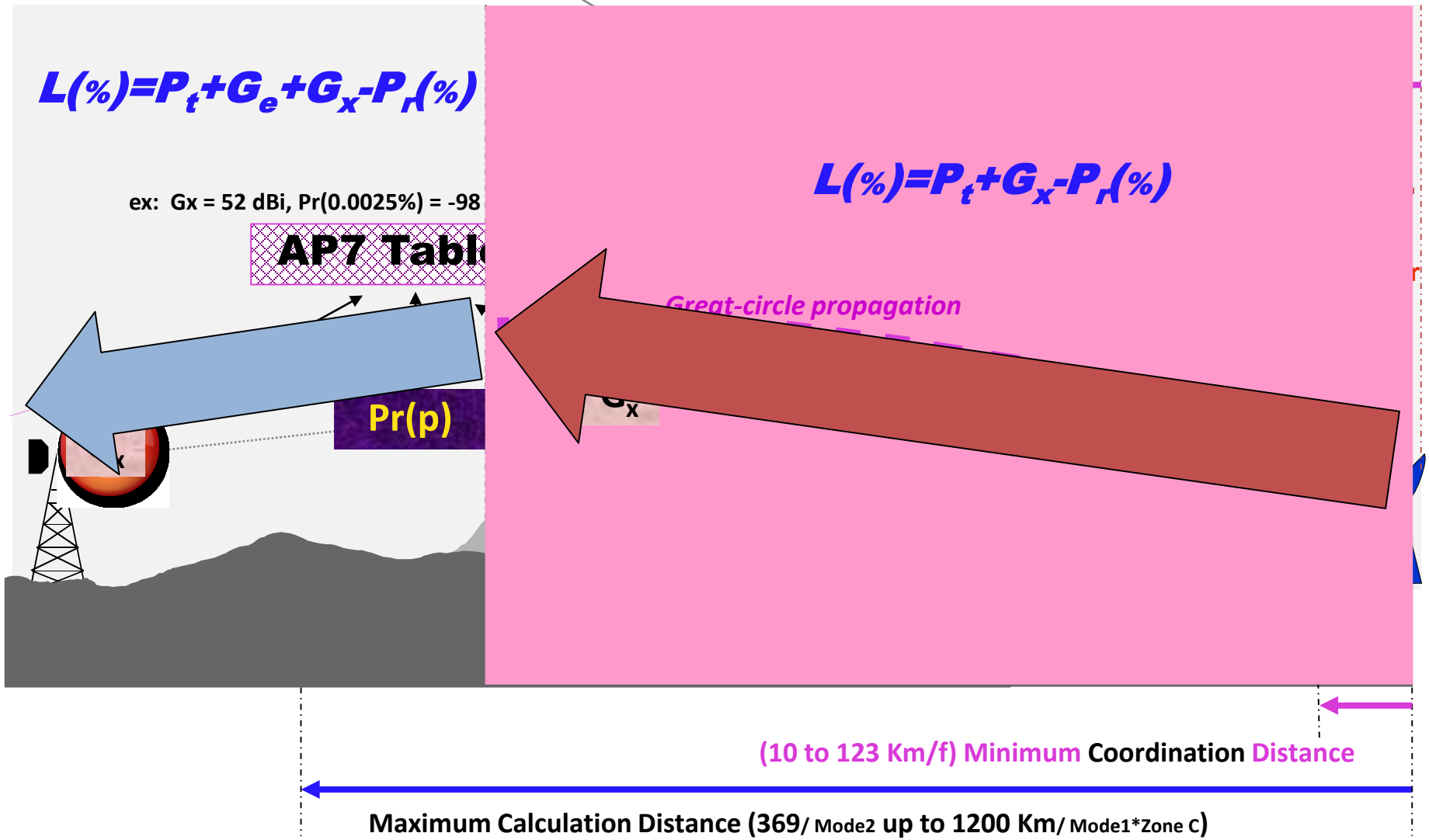
Probably Affected ADM in AP7 report

How (Tx E/S)?

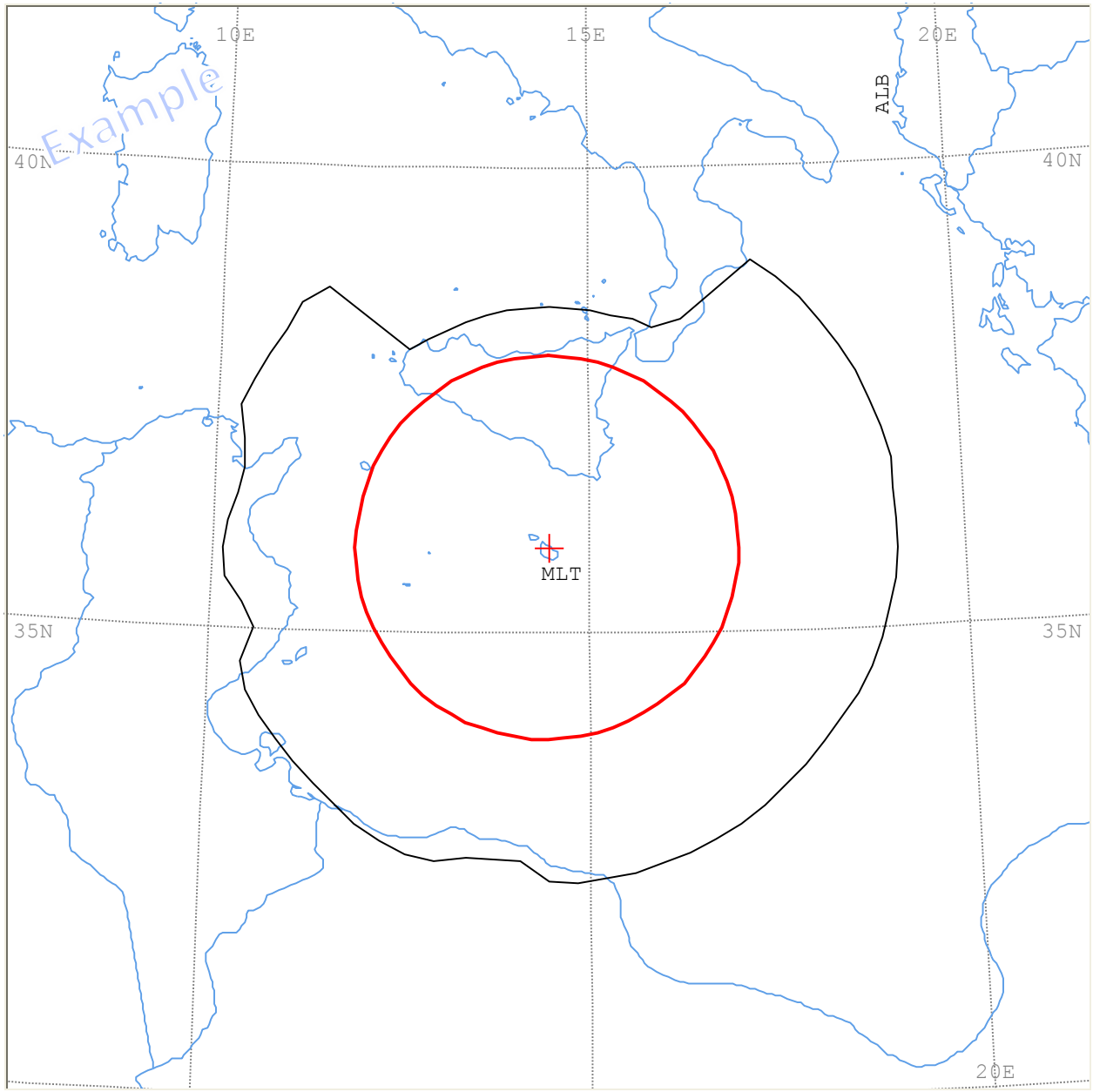
Azimuth x°

Coordination Distance

Max (Great-circle propagation (Mode 1) , Hydrometeor scatter (Mode 2))



Coordination area of Tx GSO E/S (FSS) with respect to Rcv Terrestrial stations (FS)



Freq: 5925 - 6425 GHz

Sat longitude : 1 W

Horizon Ele. Anagle : 0

Affected countries:

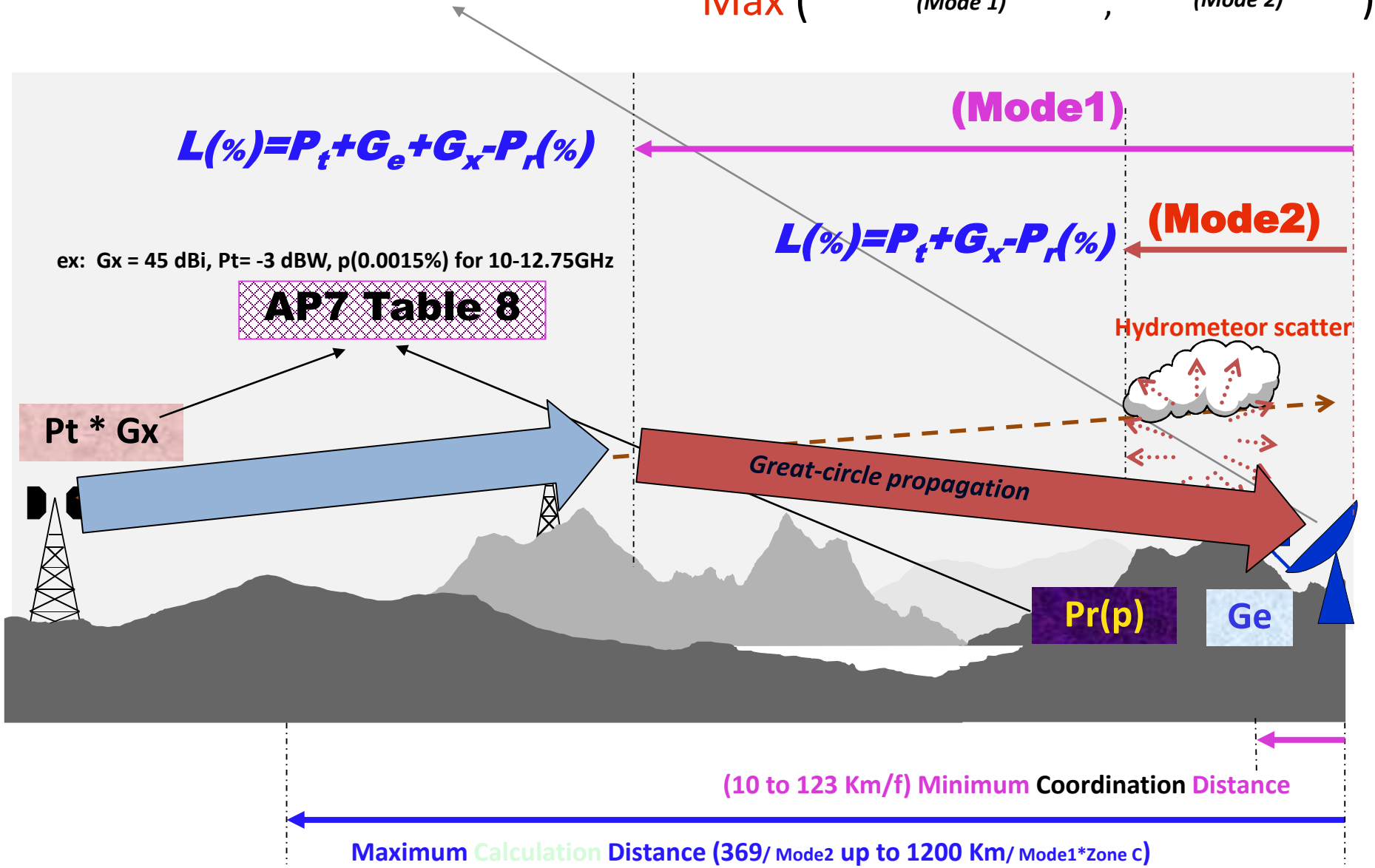
I LBY TUN

How (Rcv E/S)?

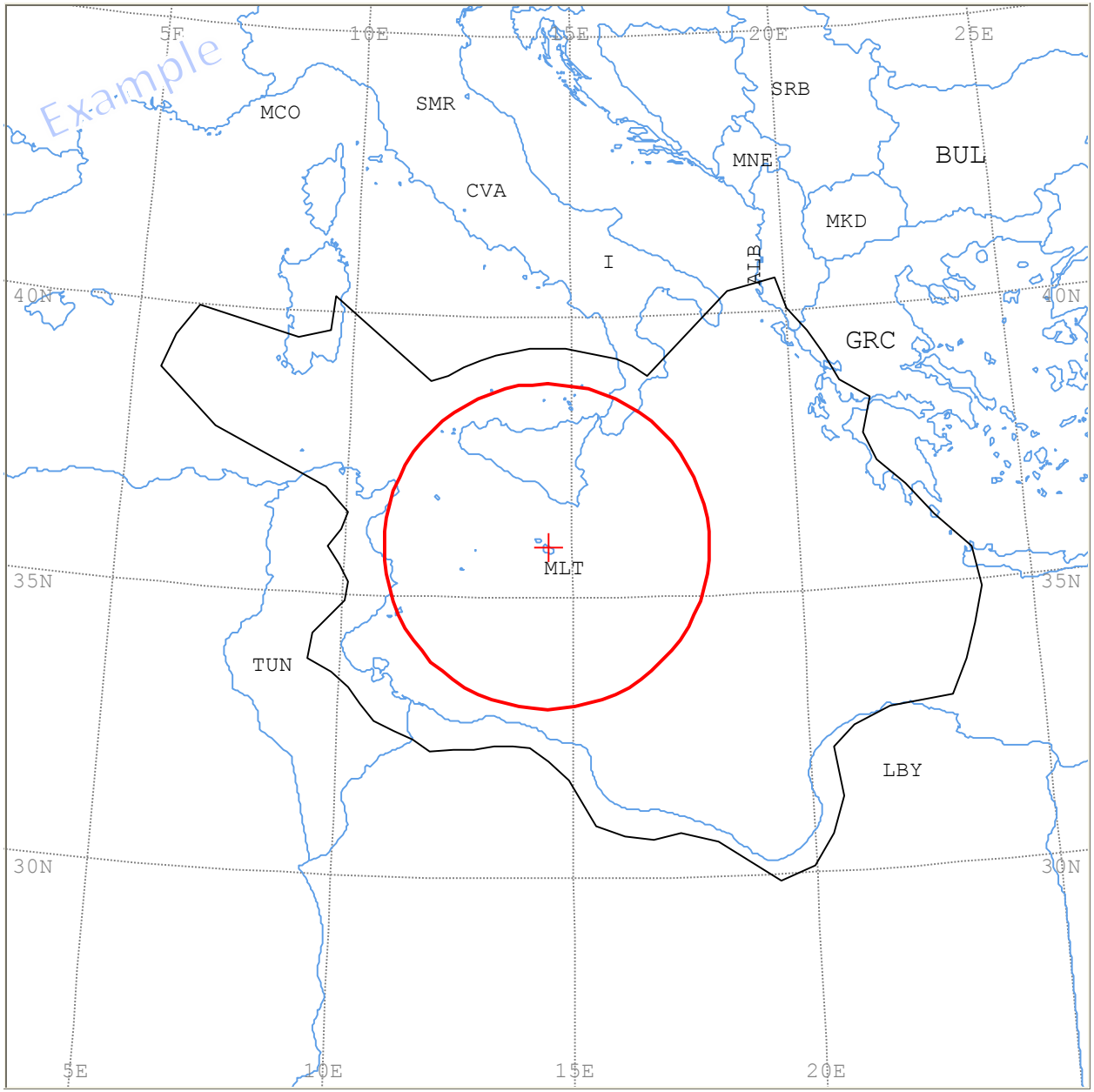
Azimuth x°

Coordination Distance

Max (Great-circle propagation (Mode 1) , Hydrometeor scatter (Mode 2))



Coordination area of Rcv GSO ES (FSS) with respect to Tx Terrestrial stations (FS)



Freq: 3700 - 4200 GHz

Sat longitude : 1 W

Horizon Ele. Anagle : 0

Affected countries:

ALB GRC I LBY TUN

Contour of Opposite direction 1

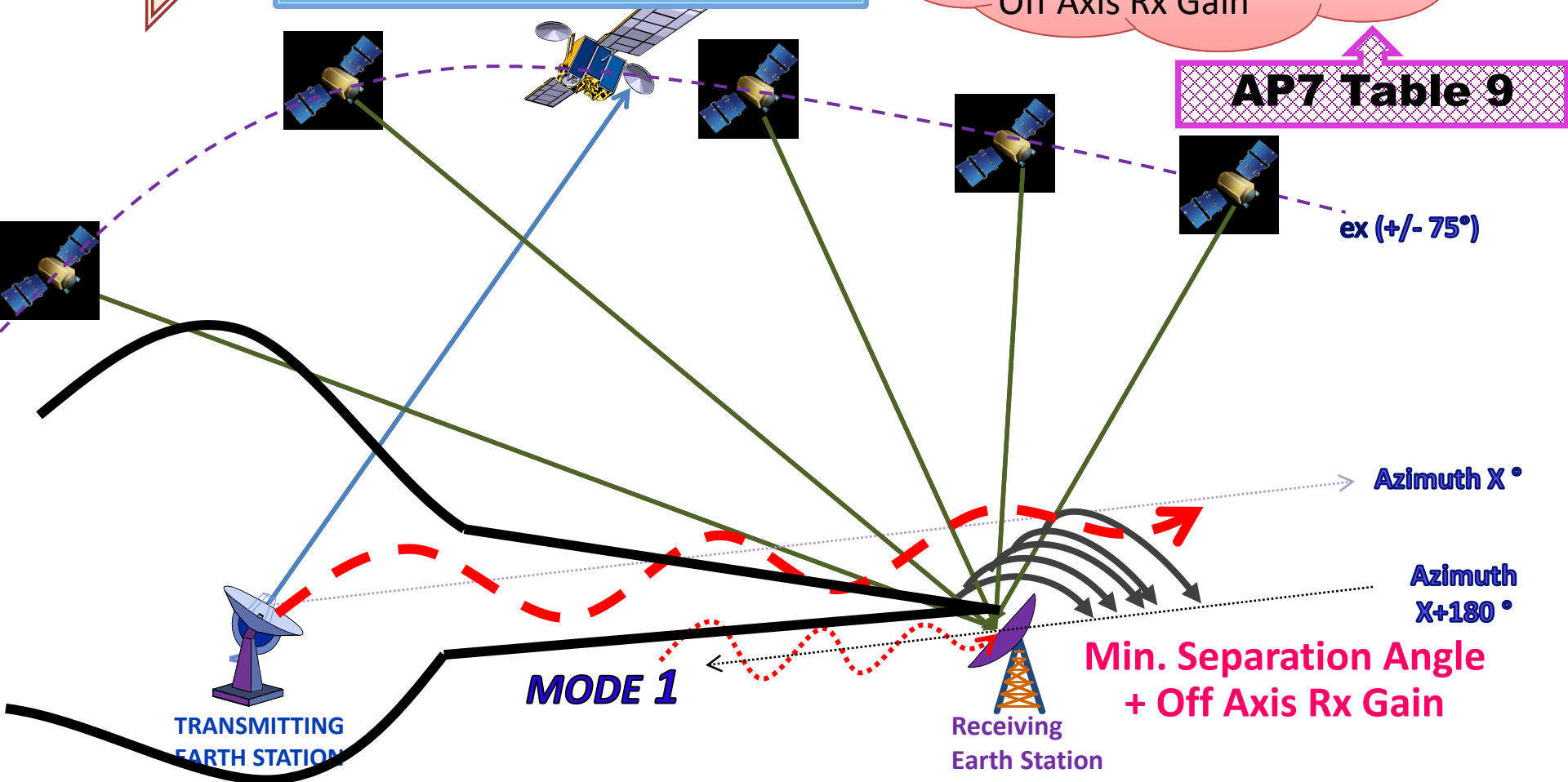
MODE 1 Appendix 7 - Annex 3 & 5 + Table 9

Worst Case Scenario (for Rx E/S)

- Horizon ele. angle (Rx E/S) = 0 °
- Orbit inclination = 0 °
- Anywhere in GSO orbit (> ε_{min})
- Same latitude with Tx E/S

- Find Min. separation Angle of Rx E/S (for Azimuths)
- Calculate Distance with Off Axis Rx Gain

AP7 Table 9



Contour of Opposite direction 2

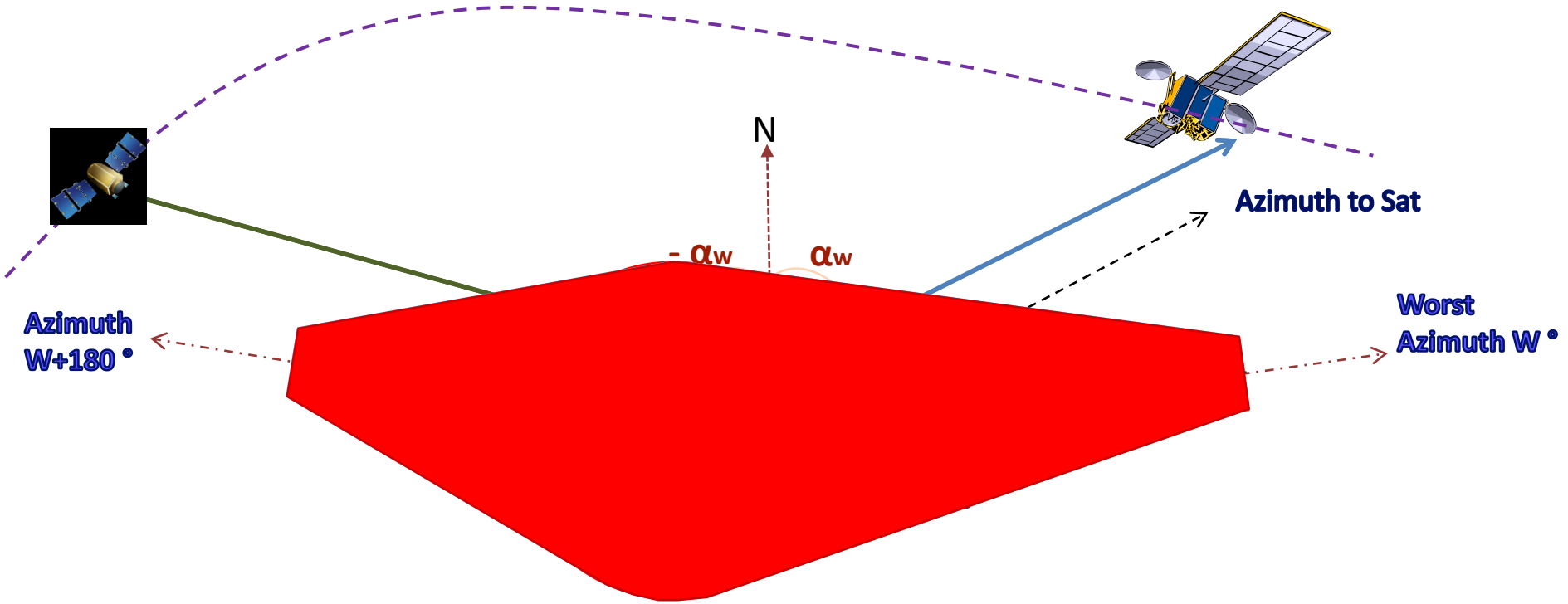
MODE 2 Appendix 7 - Annex 5 + Table 9

Worst Case Scenario + (as Mode1)

- Plane geometry approximation
- Rx E/S operates at Min. Ele. angle
- Beam intersection under Rain height

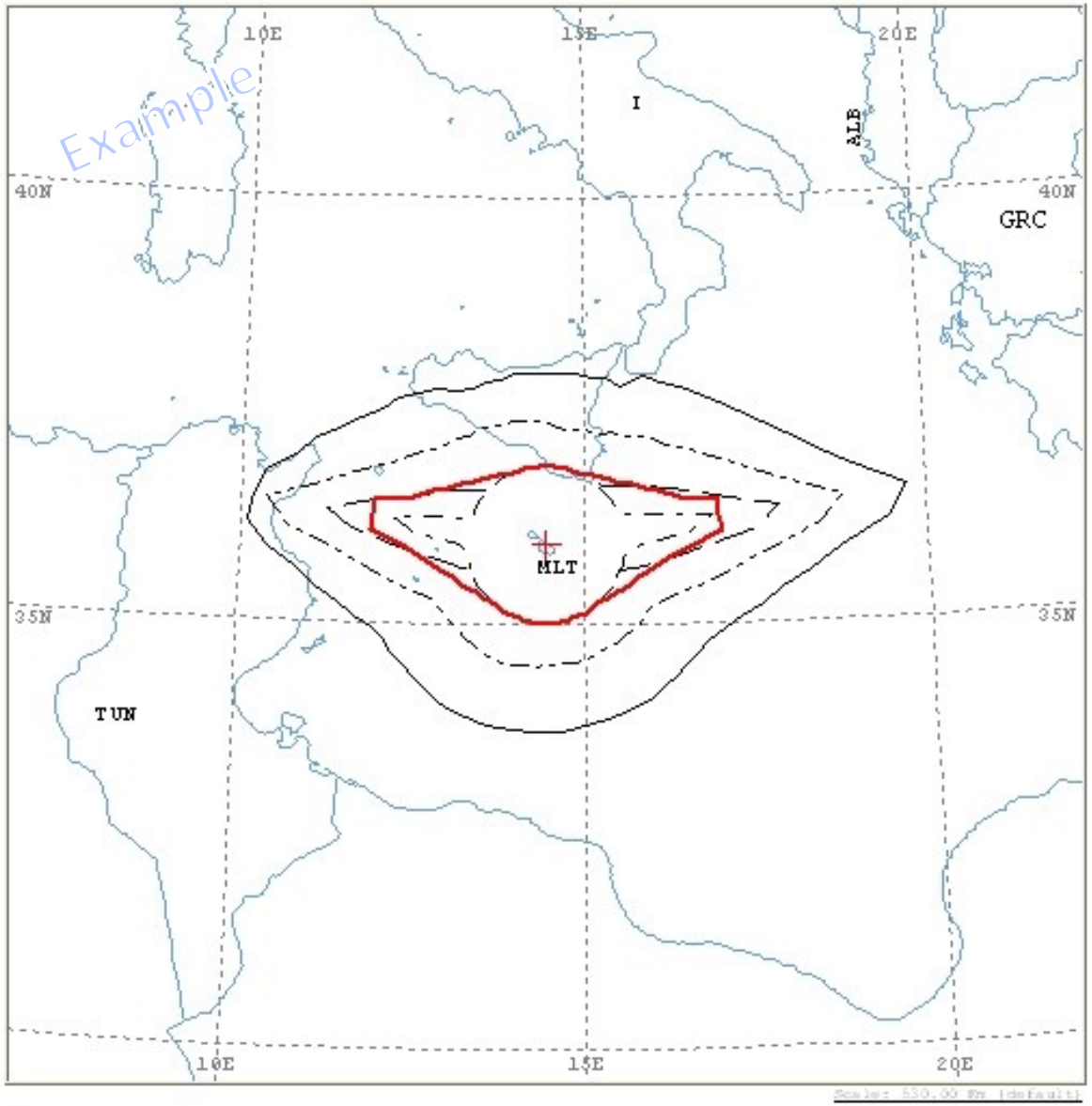
Apply Geometrical construction
- Min. Coor. Distance (for some Azimuths)
- two 6° sectors => worst-case distance

No auxiliary contours (No calculation)



- h_R : rain height
- d_s : horizontal distance
- α_w : Azimuth to possible Rx E/S (by Latitudes, ε_{min})
- d_{emax} : Max calculation distance by h_R

Coordination area of Tx GSO ES (FSS) with respect to Rcv GSO ES (EESS)



Freq: 8025-8350 GHz

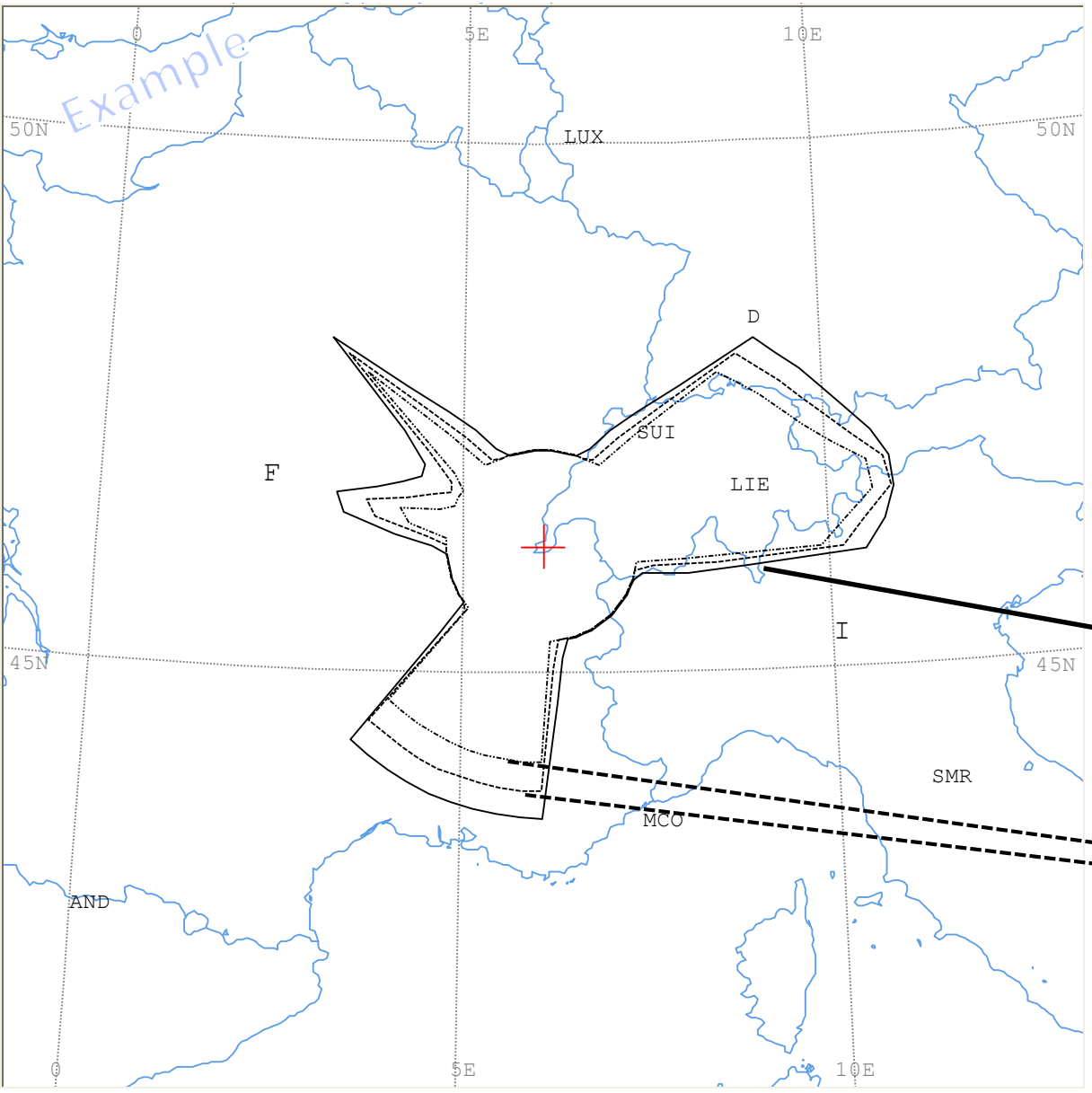
Sat longitude : 1 W

Horizon Ele. Anagle : 0

Affected countries:

I TUN

Coordination area of Tx NGSO ES (FSS) with respect to Rcv GSO ES (EESS)



Earth station (NGSO)

No Mode2 contours

Tracking Antenna reduce the probability of Mode2.

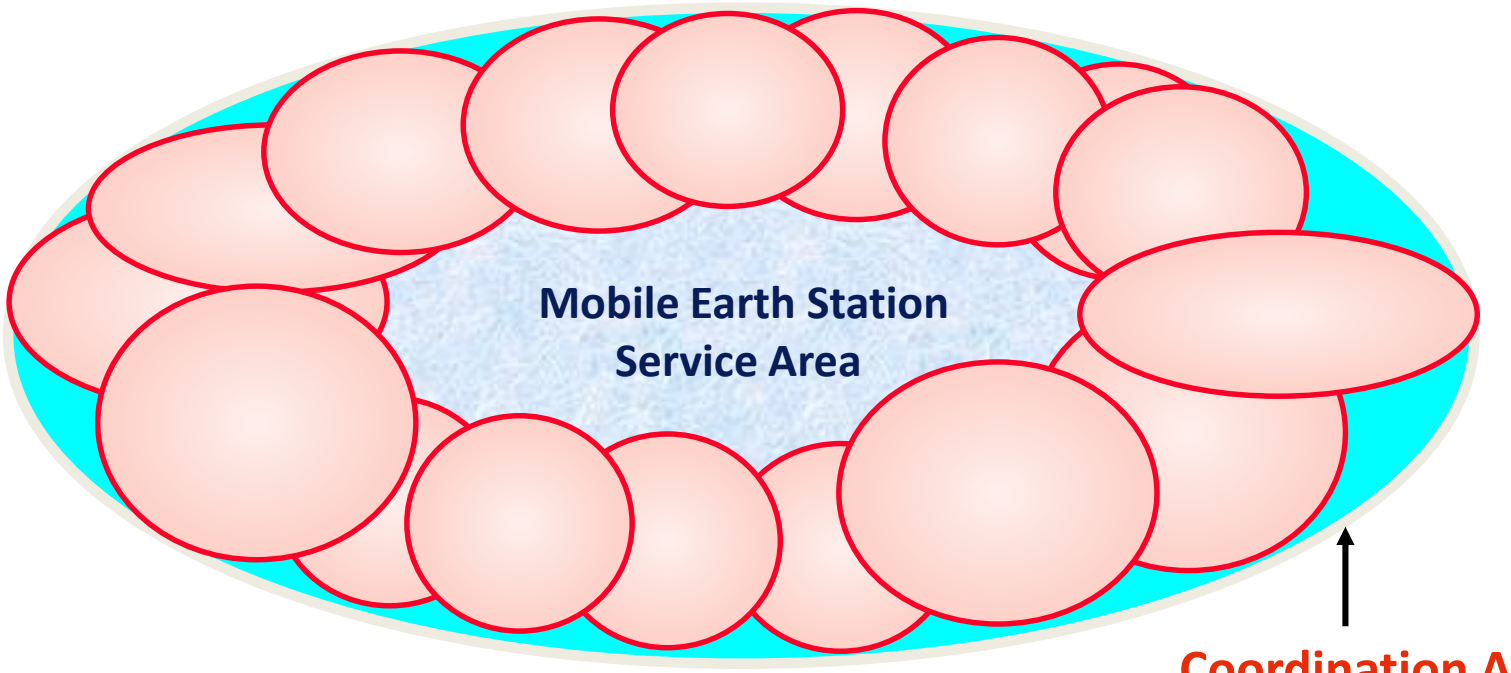
Main Mode 1

Aux. Mode 1

Coordination Area of Mobile Earth Stations

For a mobile earth station,
the periphery of the service area is extended by the coordination distance (calculated or predetermined).

Calculated



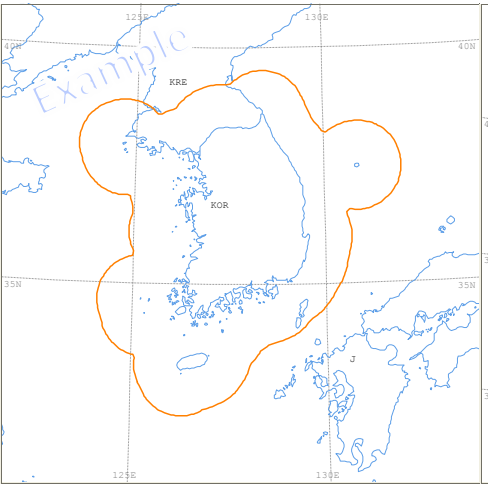
Predetermined Coordination distance

(Table 10 of Appendix 7)

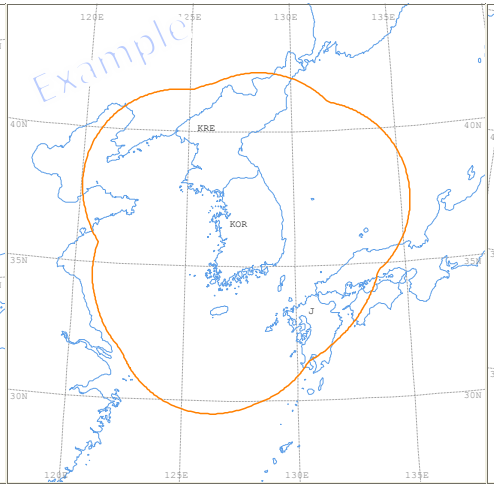
Predetermined → **AP7 Table 10**

(Example Adm: **KOR**)

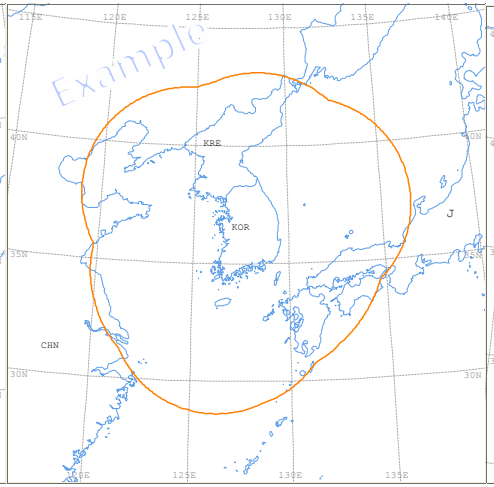
Typical, 100Km



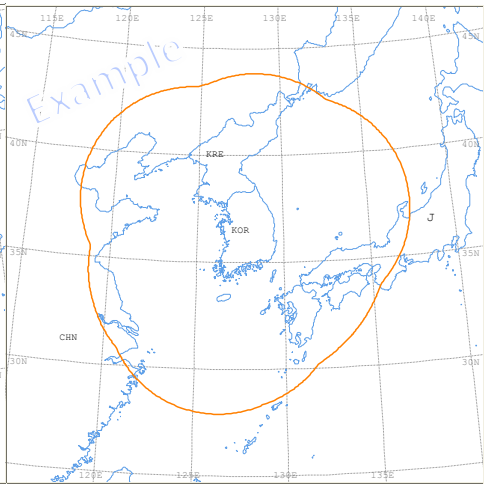
Typical, 400Km



Typical, 500Km

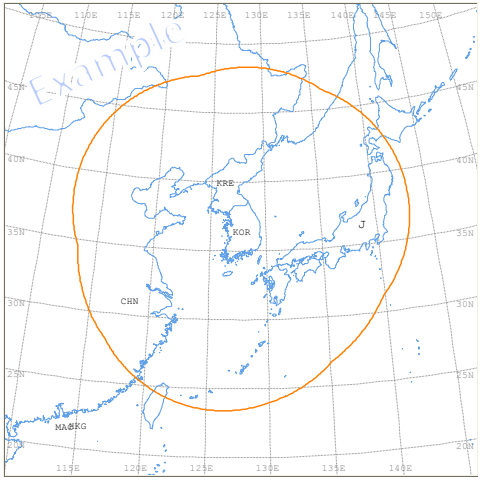


Typical, 580Km

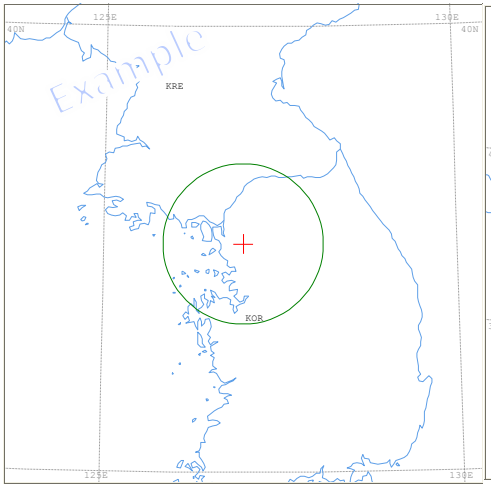


Typical, 1000Km

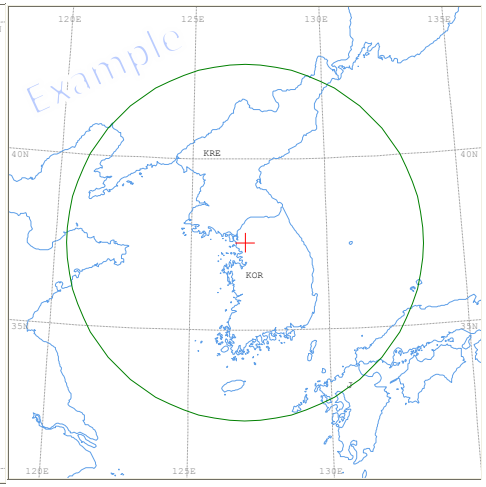
Typical, 1080Km



Specific, 100Km

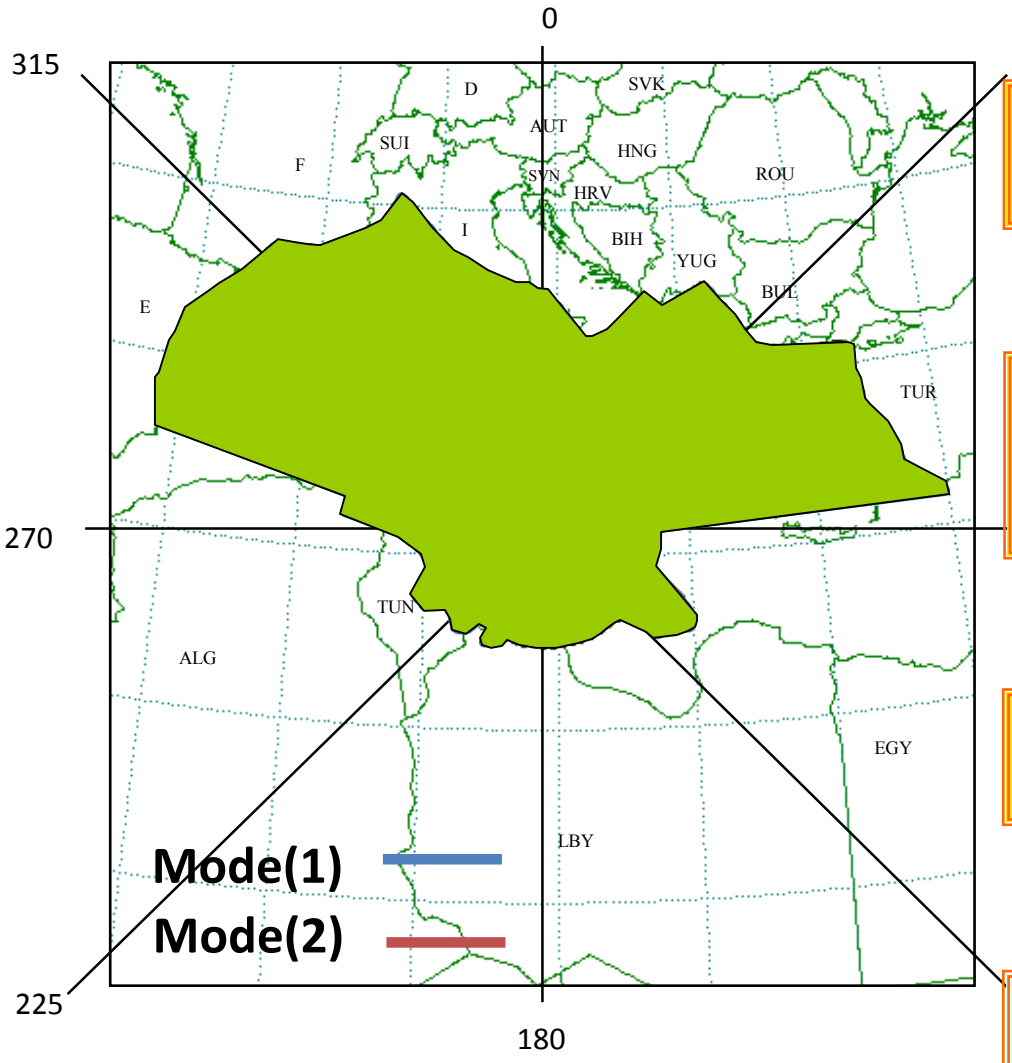


Specific, 580Km



APPENDIX 7

Definition of the Coordination Area



Coordination contours with the greatest coordination distance

However

It represents a regulatory concept based on Worst Cases & Conservative Assumptions.

i.e.

It's not a exclusion zone.

means

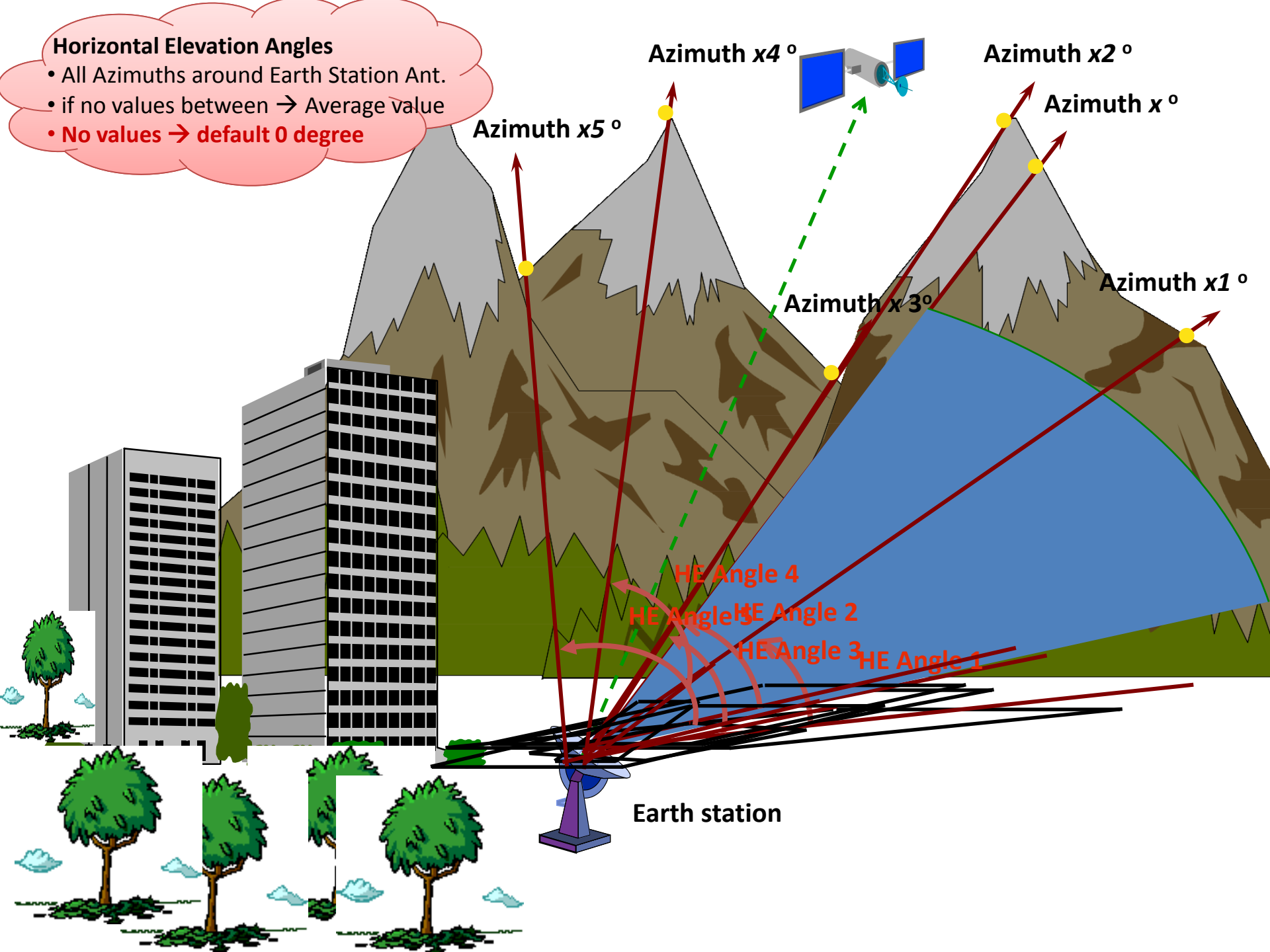
More detailed calculations and discussions need to be performed.

Coordination data (Appendix 4)

Annex 2		
	GEOGRAPHICAL DATA	(Earth station's) **Location, Altitude**
	SATELLITE	**Orbital Location, Identification (Geo, Non-Geo)**
	ANTENNA	**Maximum gain Radiation pattern**
	SIGNAL CHARACTERISTICS	**Power Maximum Power Density Frequencies Noise temperature Emission Type**
	Others	**Horizontal Elevation Angle**

Horizontal Elevation Angles

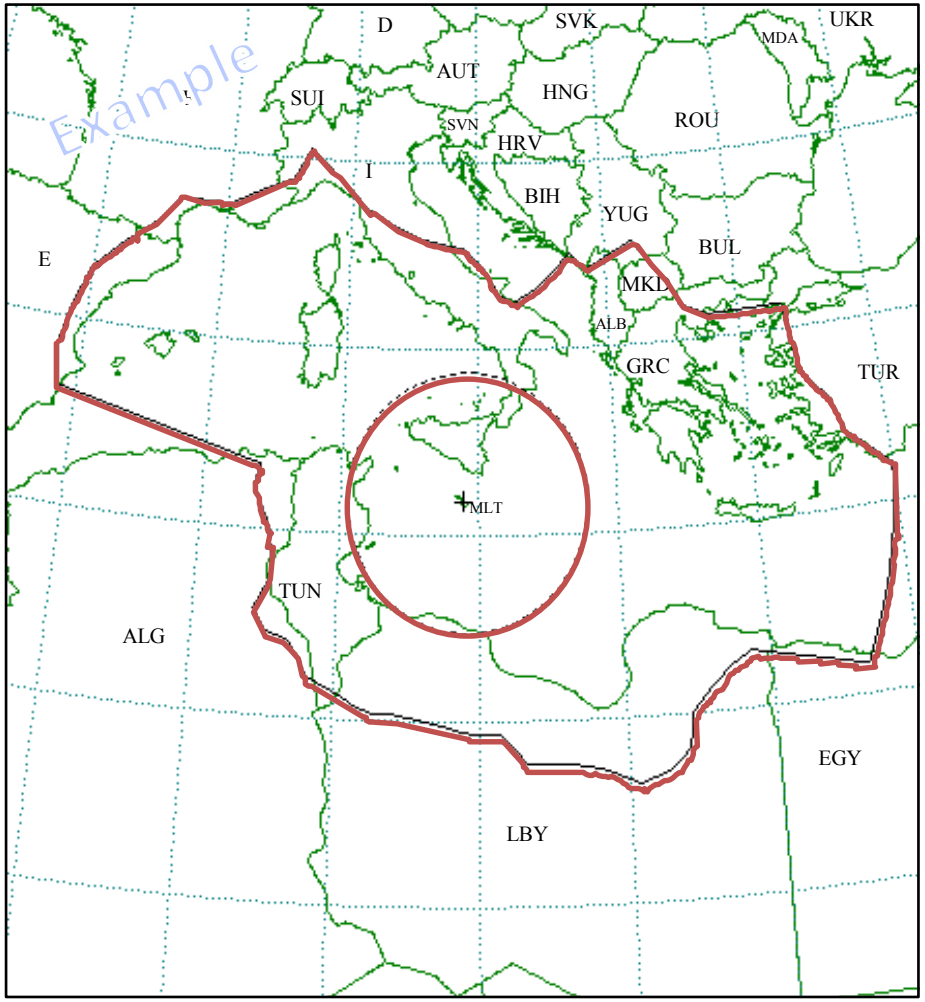
- All Azimuths around Earth Station Ant.
- if no values between → Average value
- **No values → default 0 degree**



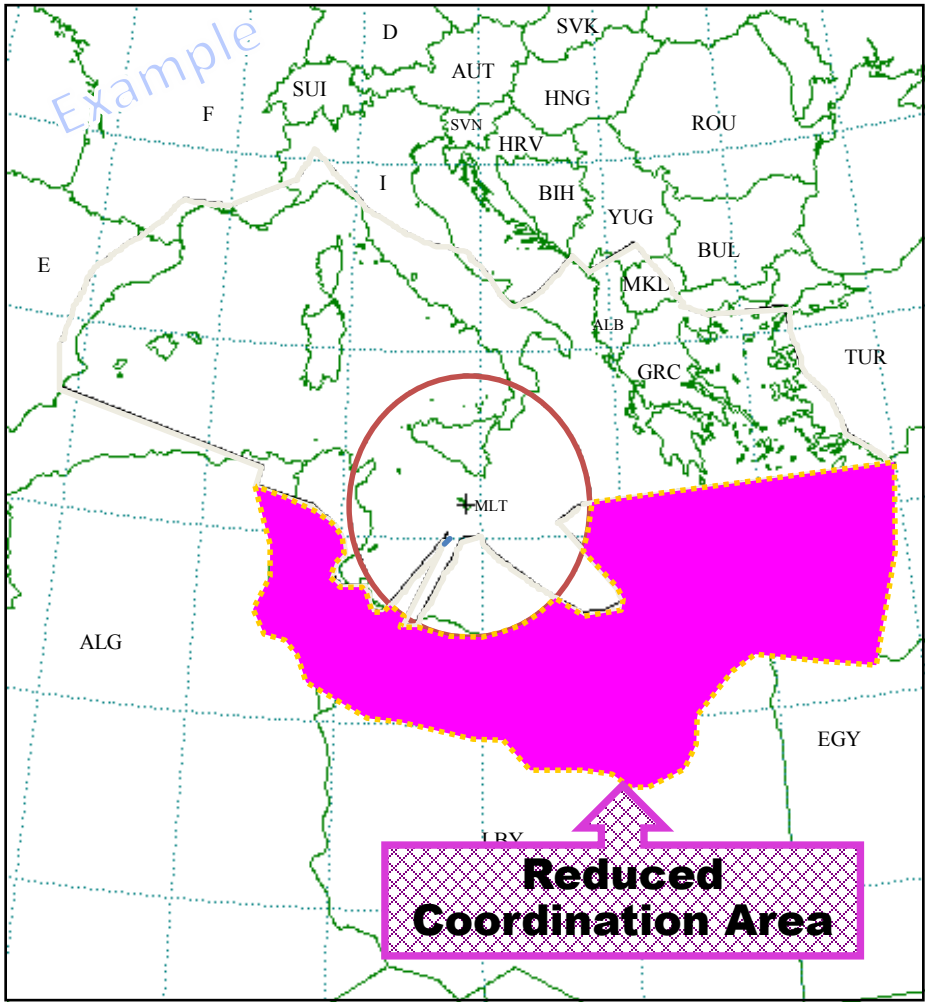
Effect of Horizon Elevation Angle

RECEIVING EARTH STATION COORDINATION AREAS

MAGHTAB MLT/MLT 014E2640 35N5556 4135.0 - 4135.0 MHZ



HORIZON ELEVATION ANGLE : 0 °

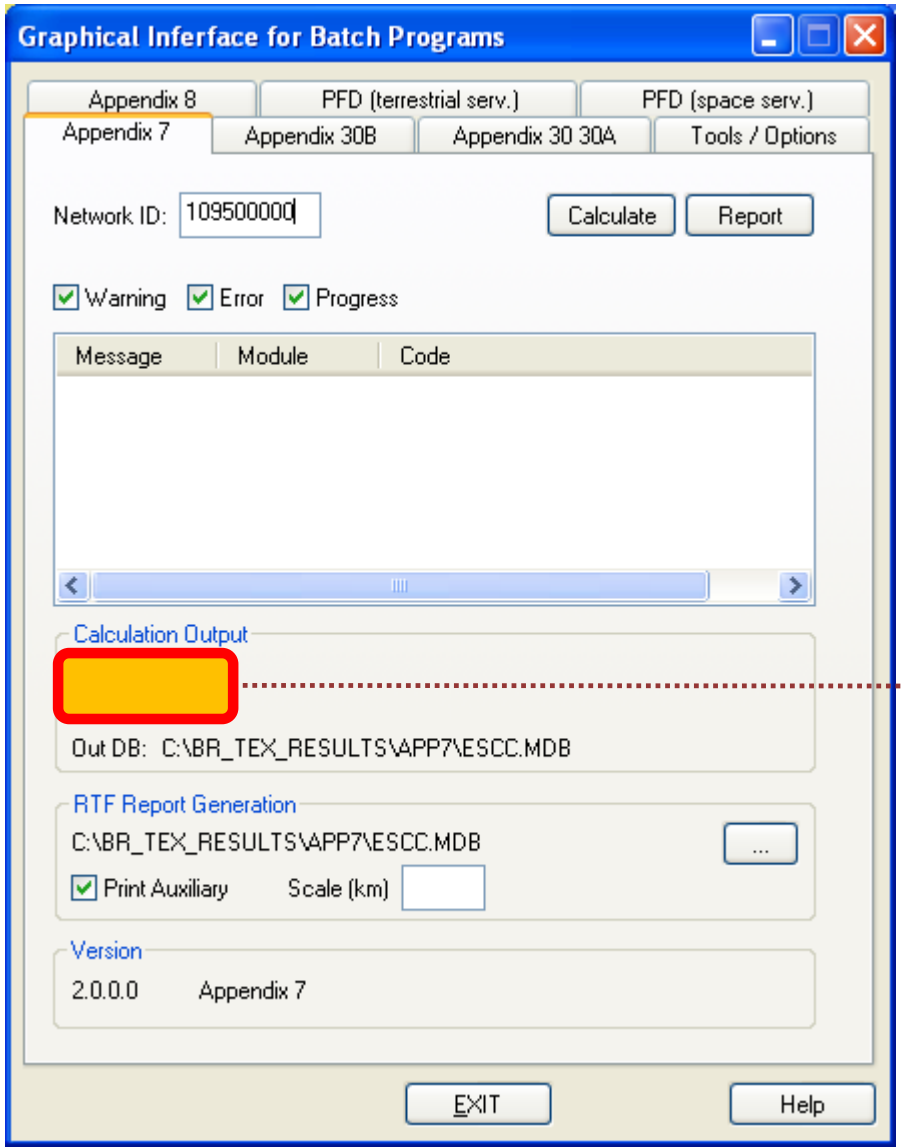


HORIZON ELEVATION ANGLE: Actual Value

Tips for Coordination ?

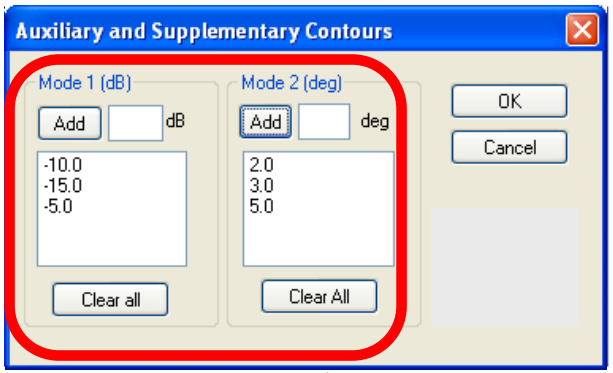
More practical consideration on the Coordination Area

AP7 embedded in GIBC



Auxiliary Contour

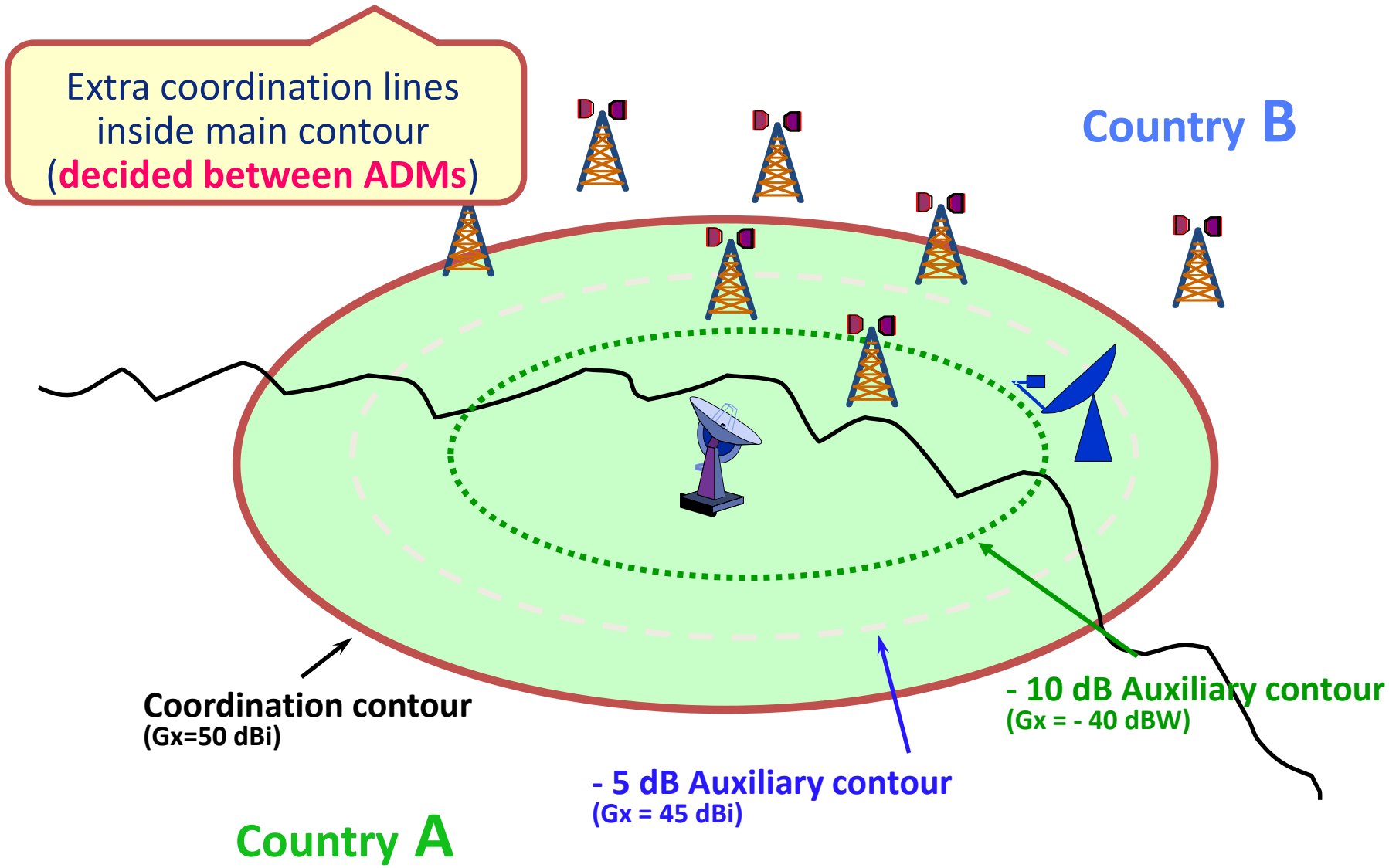
Extra coordination lines inside main contour



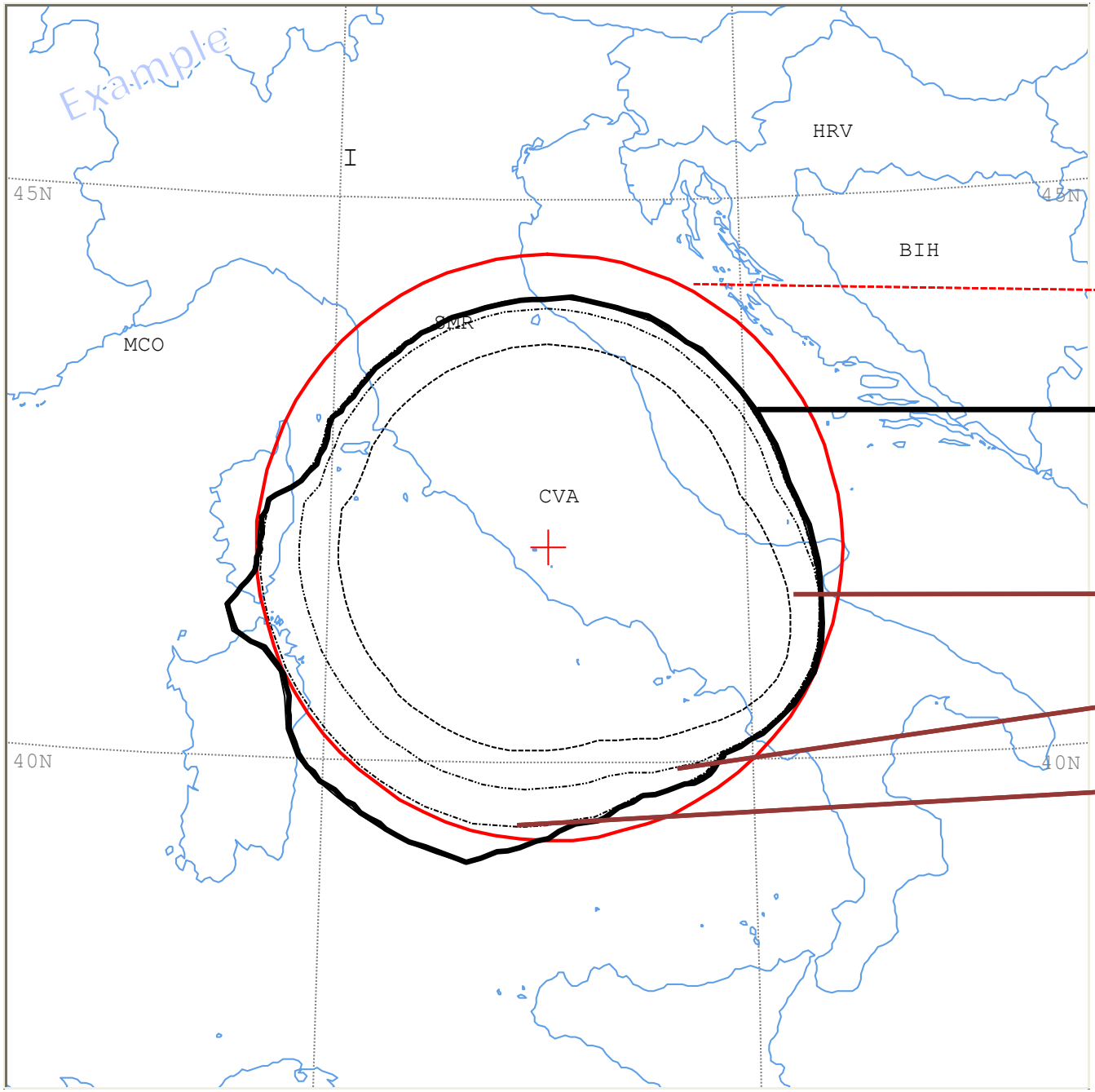
It's all **Complementary information**.

Auxiliary Contour - Mode 1 (& 2)

Appendix 7 - Annex 6



Auxiliary Contour - Mode 1



Auxiliary Contour
(ex. -5,-10,-15 dB)

MODE 2

Mode 1

Auxiliary Mode1

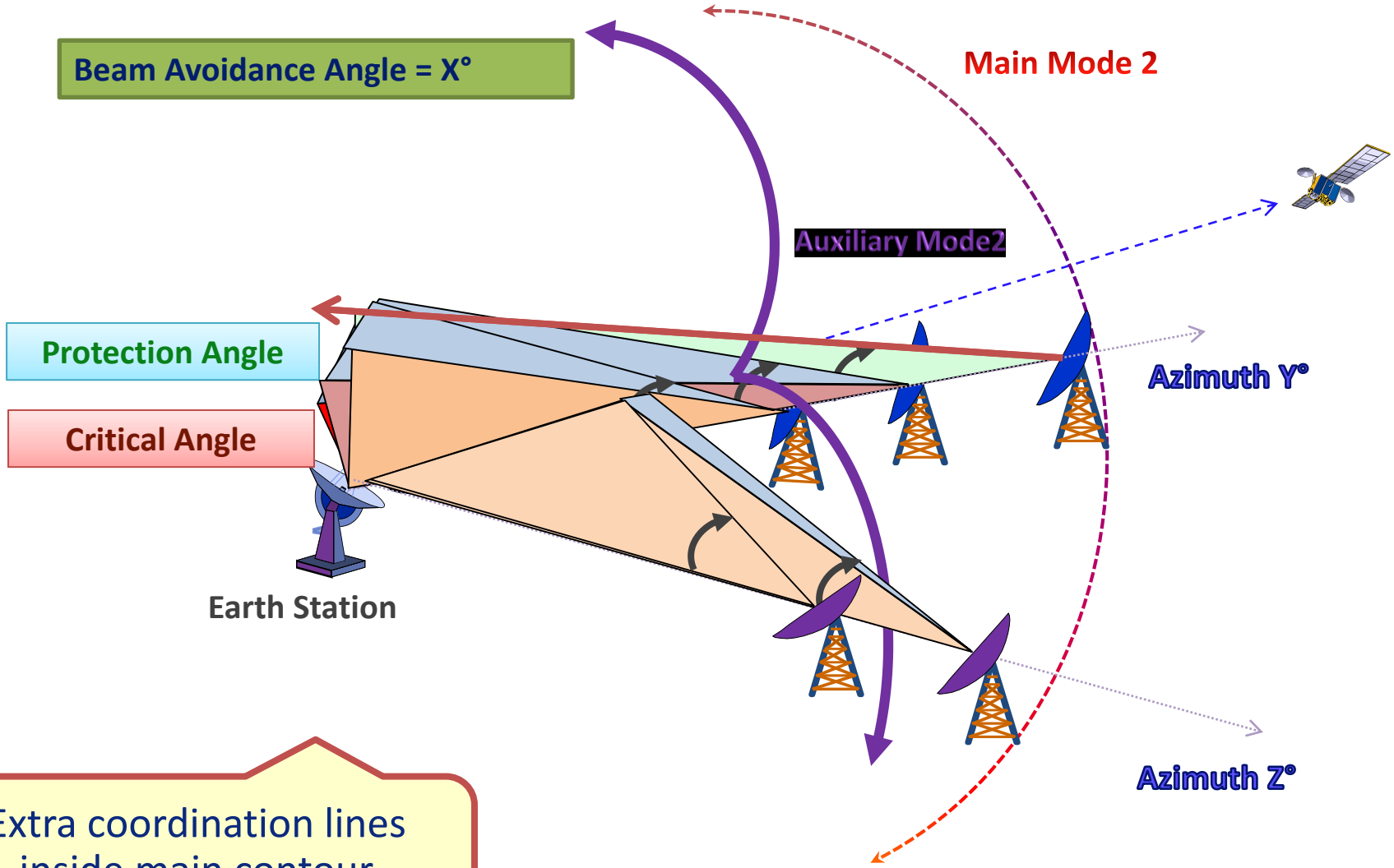
- 15.0 dB

- 10.0 dB

- 5.0 dB

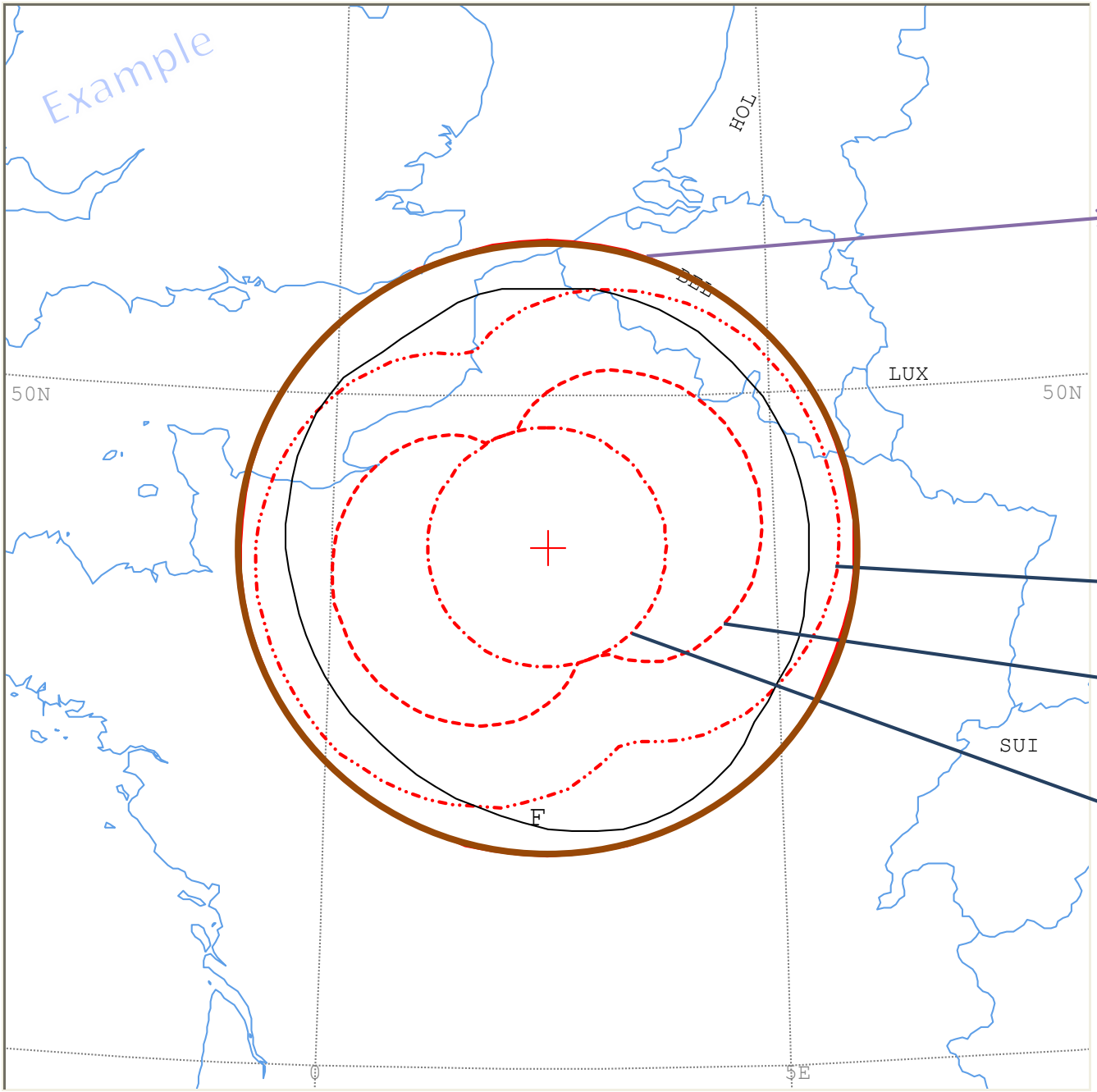
Auxiliary Contour - Mode 2

Appendix 7 - Annex 6 (from WRC-2000)



Extra coordination lines inside main contour (**decided between ADMs**)

Auxiliary Contour - Mode 2



Main Mode2

Auxiliary Mode2

Avoidance angle 2.0 °

Avoidance angle 3.0 °

Avoidance angle 5.0 °

Results of WRC-12

No major change in AP7

- **Some frequencies/services were deleted/added in Table 7 – 9.**
- **It's consequential arrangement with regards to Art 5 & footnotes.**