



COORDINATION OF EARTH STATIONS

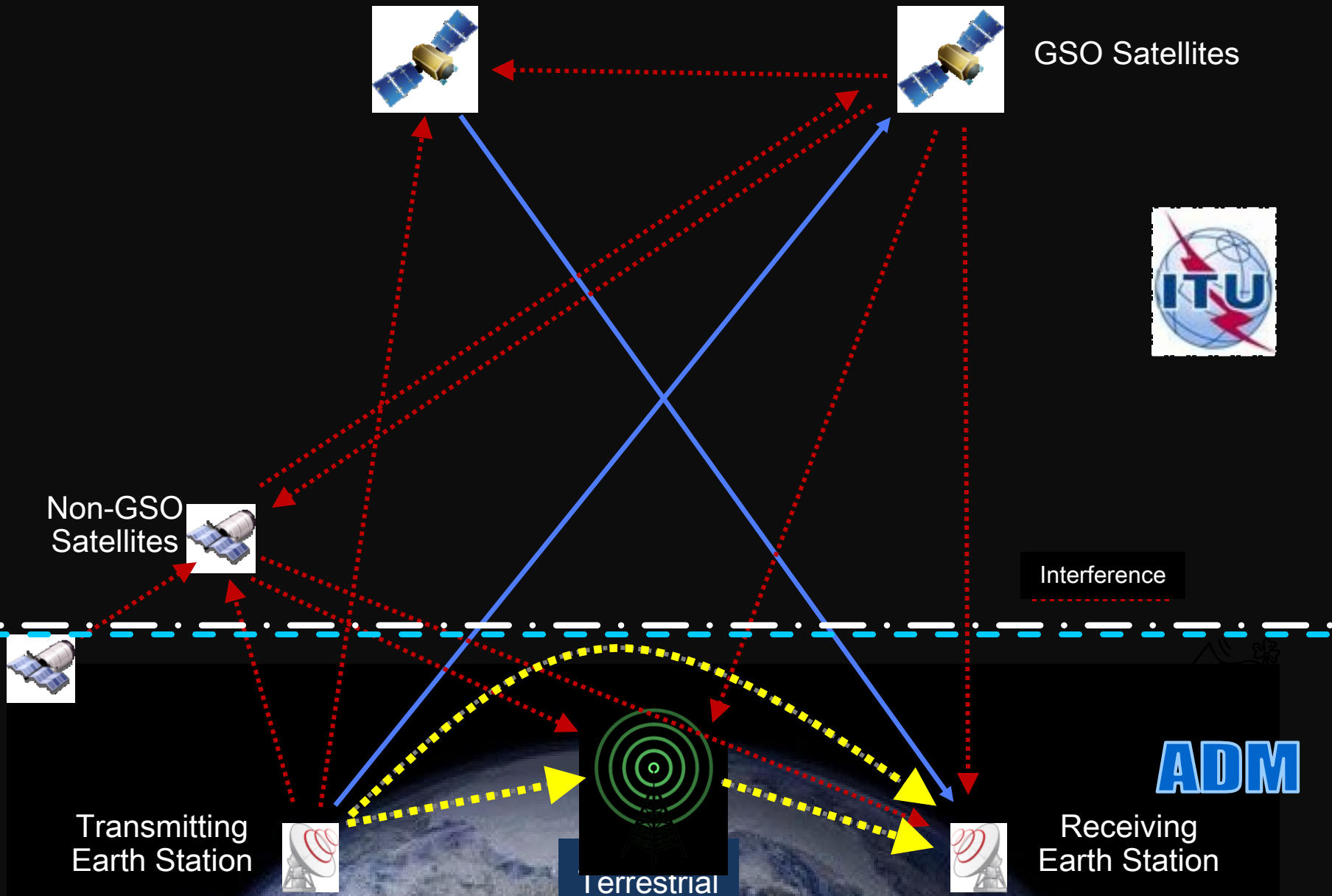
*WITH RESPECT TO TERRESTRIAL STATIONS /
OTHER EARTH STATIONS*

DongSik KIM

(dong-sik.kim@itu.int)

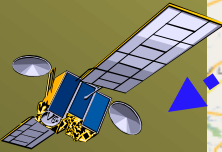
Space Services Department

Coordination requirements



Why ?

Propagation do not care for Borders.



COORDINATION OF EARTH STATIONS



Volume No.1
Article 5



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

Region 1

5850 - 5925 MHz

FIXED

FIXED-SATELLITE

(Earth-to-space) ↑

MOBILE

All Regions

6700 - 7075 MHz

FIXED

FIXED-SATELLITE

(Earth-to-space) ↑

(space-to-Earth) ↓

MOBILE

When ?

Volume No.1 → **Article 5**

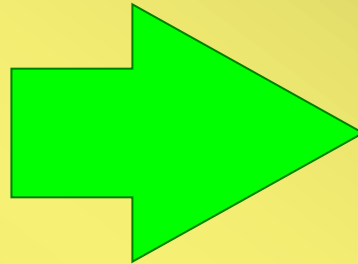
Region 1

5850 - 5925 MHz

FIXED

FIXED-SATELLITE

(Earth-to-space) ↑



equal rights

Space = Terrestrial

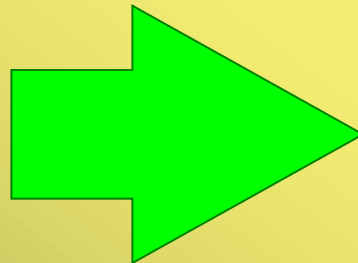
All Regions

6700 - 7075 MHz

FIXED-SATELLITE

(Earth-to-space) ↑

(space-to-Earth) ↓



opposite direction

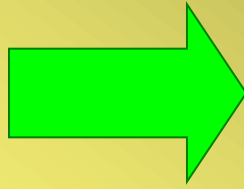
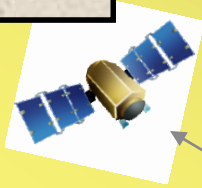
Uplink = Downlink

- **If** coordination area includes the territory of another country

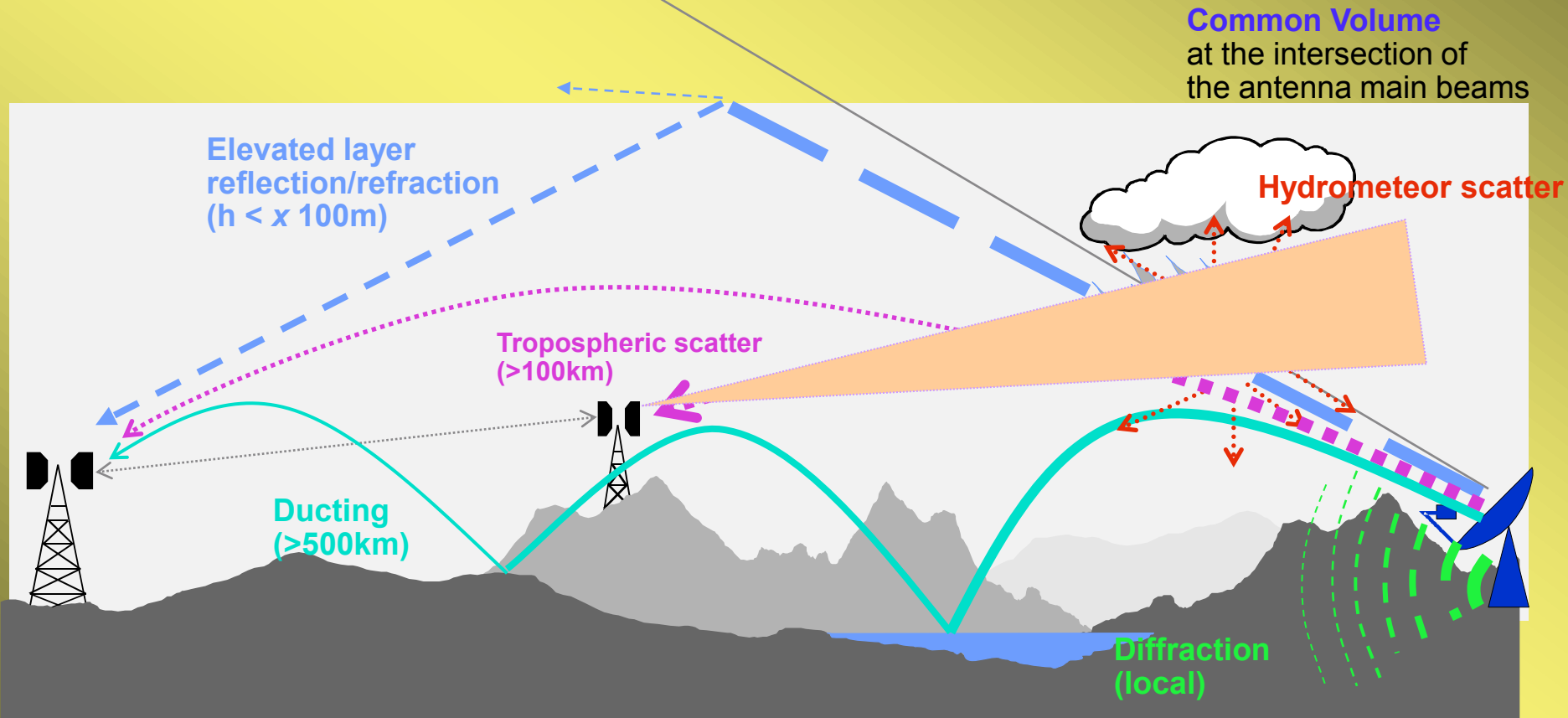
PROVISIONS for effecting COORDINATION

<u>Article 9</u>	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 , <i>with the exception of the coordination under 9.15</i>
	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) <u><i>*Rx E/S – No methodology in AP7</i></u>
	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



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

+

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

→ Coordination Distance

Simple button?

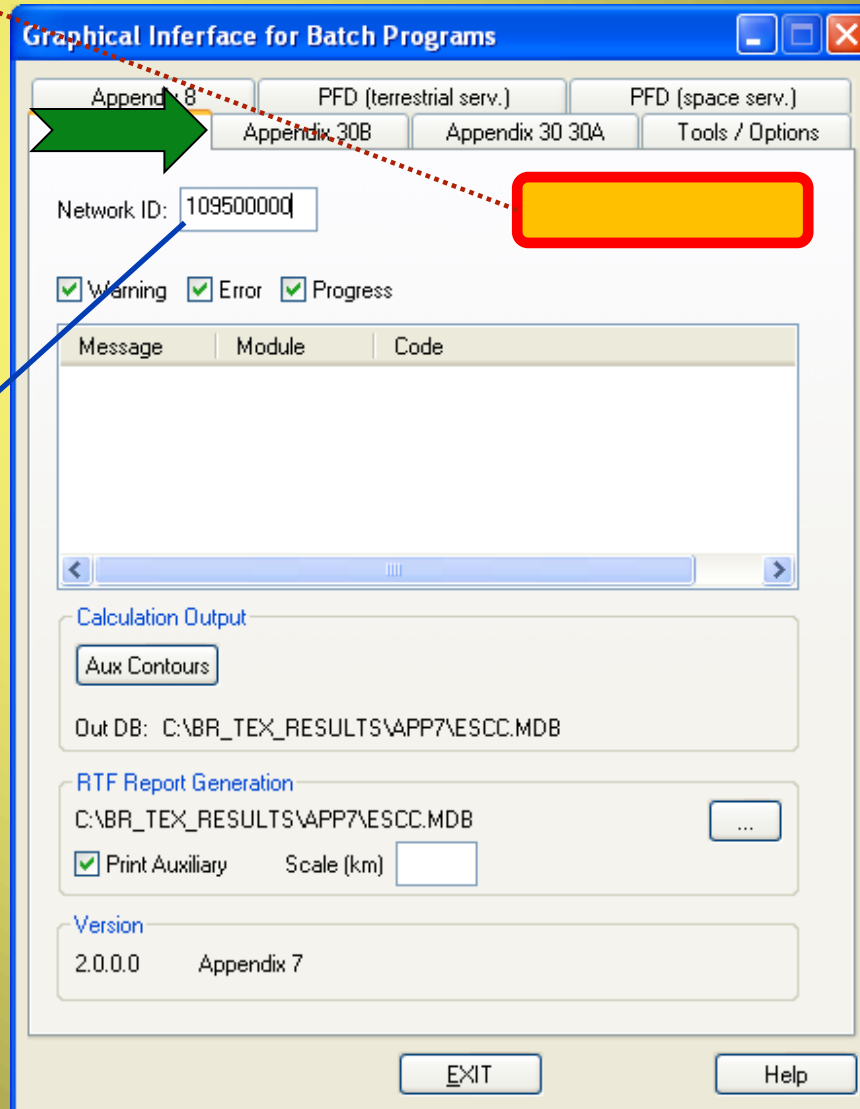
Computer Program for Determination of Coordination Area

AP7 embedded in GIBC



C:\BR_SOFT\BATCH

Create your Input File



Appendix 8 PFD (terrestrial serv.) PFD (space serv.)
Appendix 30B Appendix 30 30A Tools / Options

Network ID: 109500000

Warning Error Progress

Message	Module	Code
---------	--------	------

Calculation Output

Aux Contours

Out DB: C:\BR_TEX_RESULTS\APP7\ESCC.MDB

RTF Report Generation

C:\BR_TEX_RESULTS\APP7\ESCC.MDB

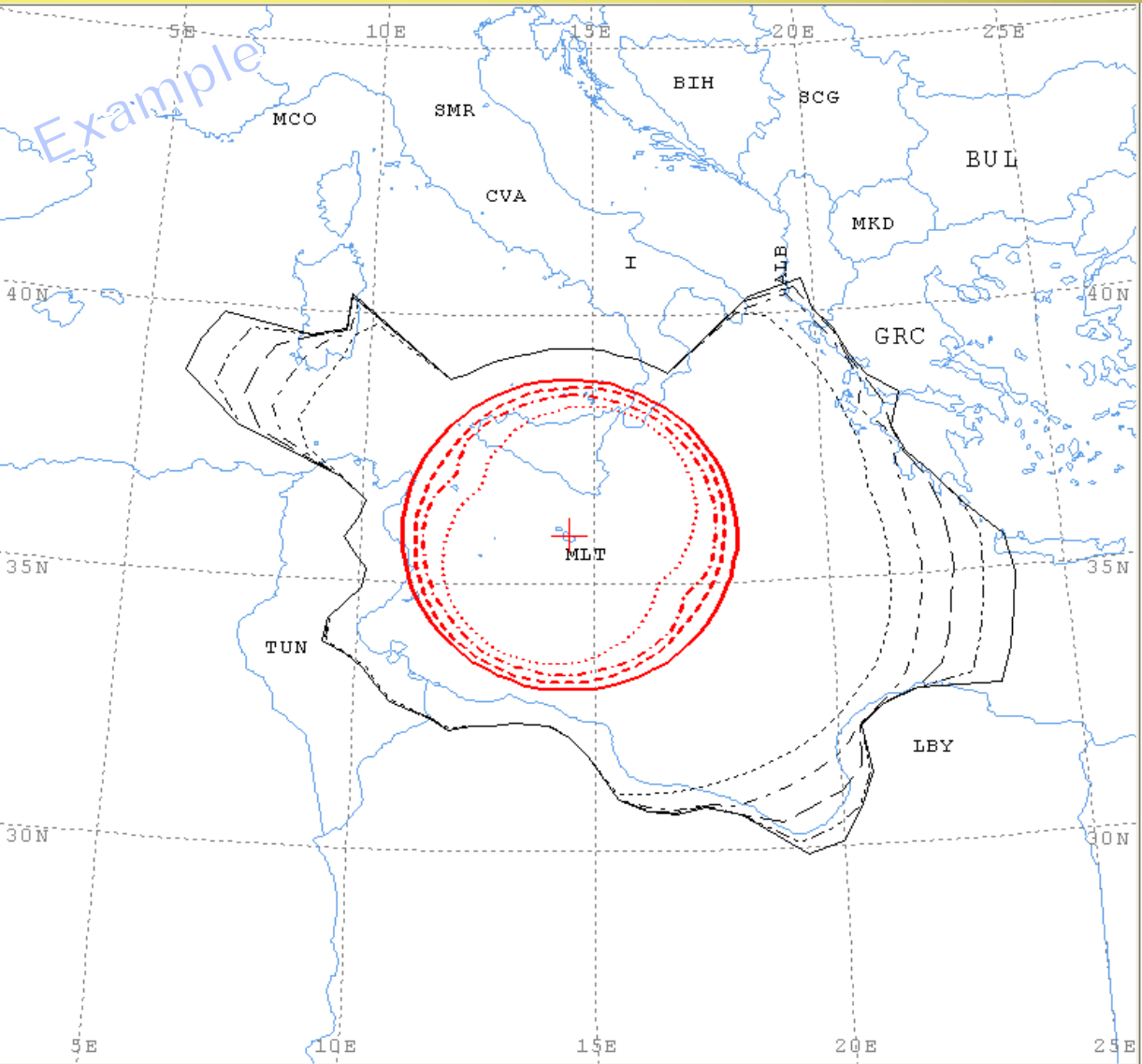
Print Auxiliary Scale (km)

Version

2.0.0.0 Appendix 7

EXIT Help

Report (p1) of AP7 (GIBC) program



Example

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:
Countries included in Coordination Distance/Area



Automatic indication in AP7 report

	ES position		Aux. Model -5.0db		Aux. Mode2 2.0deg
	Main Model 0.0db		Aux. Model -10.0db		Aux. Mode2 3.0deg
	Main Mode2 0.0deg		Aux. Model -15.0db		Aux. Mode2 4.0deg
			Aux. Model -20.0db		Aux. Mode2 5.0deg

Report (p2) of AP7 (GIBC) program

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

```

SITE ID: 108500000 EARTH STATION NAME: BR SEMINAR ES1 EARTH STATION POSITION: 014E264035N5555E PHASE: N
A.GEO_AREA: BEL/MLT RAIN CLIMATICAL_ZONE: K
SATELLITE_NAME: ITU BR TEST SAT SATELLITE_ORBITAL_POSITION: -18.00 DEG
ANTENNA_AZIMUT: 227.39 DEG ANTENNA_ELEVATION: 26.08 DEG
FREQUENCY_BAND: 1290.0 MHz FREQUENCY_BAND_WIDTH: 40.0 MHz 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
    
```

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	123.6	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)																								

Calculated parameters by 5° Azimuth

MODE 1	0.0 DB	391	391	391	391	394	394	391	515	696	669	667	505	304	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

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)																								

(0 - 355°)

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	831	711	525	498	498	498	498	498	498	498	498	498	391
MODE 2	0.0 DEG	325	325	325	325	325	325	324	324	324	324	324	324	324	325	325	325	325	325	325	325	325	325	325	325

Probably Affected ADM
in AP7 report



How (Tx E/S)?

Azimuth x°

Coordination Distance

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

$$L(\%) = P_t + G_e + G_x - P_r(\%)$$

ex: $G_x = 52 \text{ dBi}$, $P_r(0.0025\%) = -98 \text{ dBW/Hz}$ for 12-14GHz

AP7 Table 7

$$L(\%) = P_t + G_x - P_r(\%)$$

(Mode2)

(Mode1)

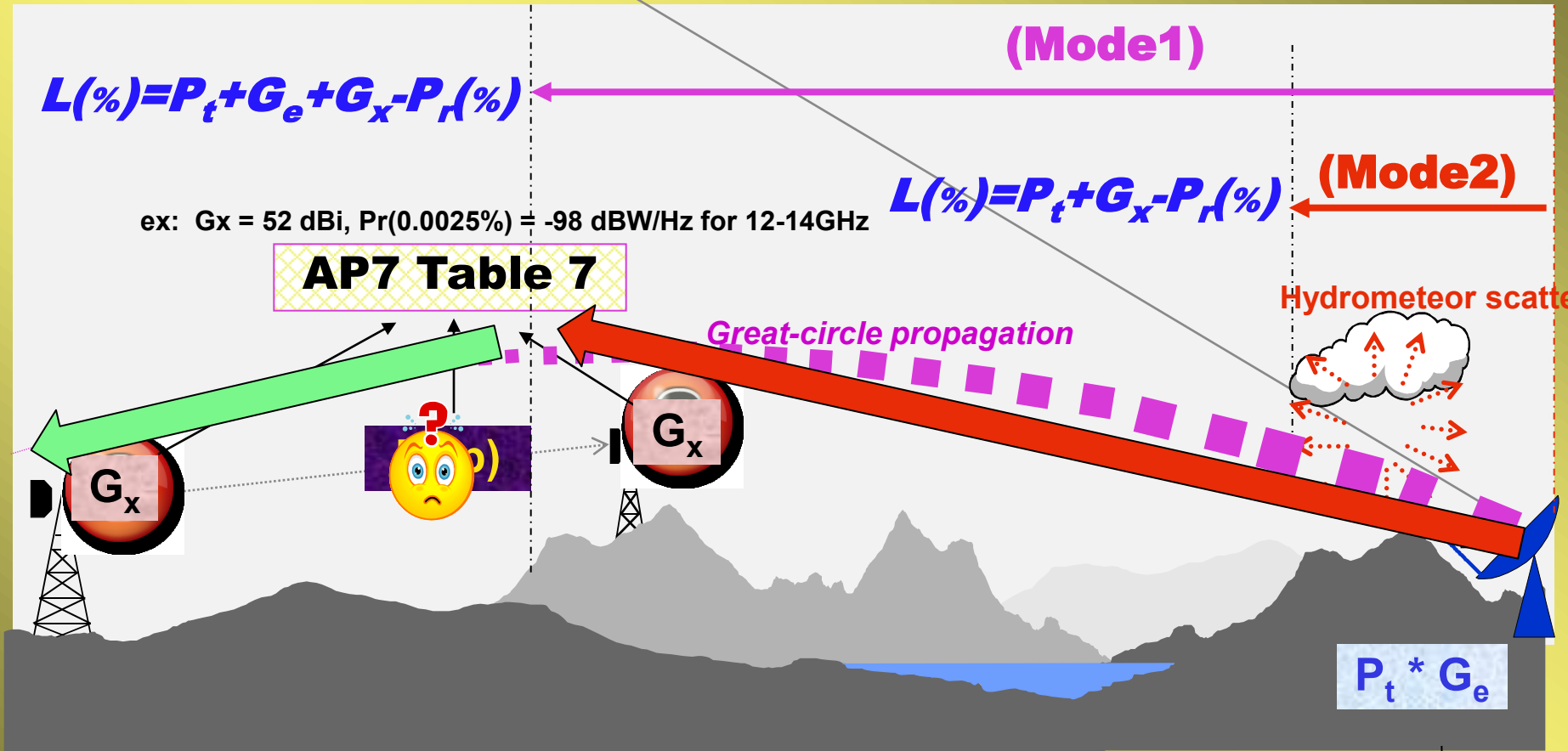
Hydrometeor scatter

Great-circle propagation

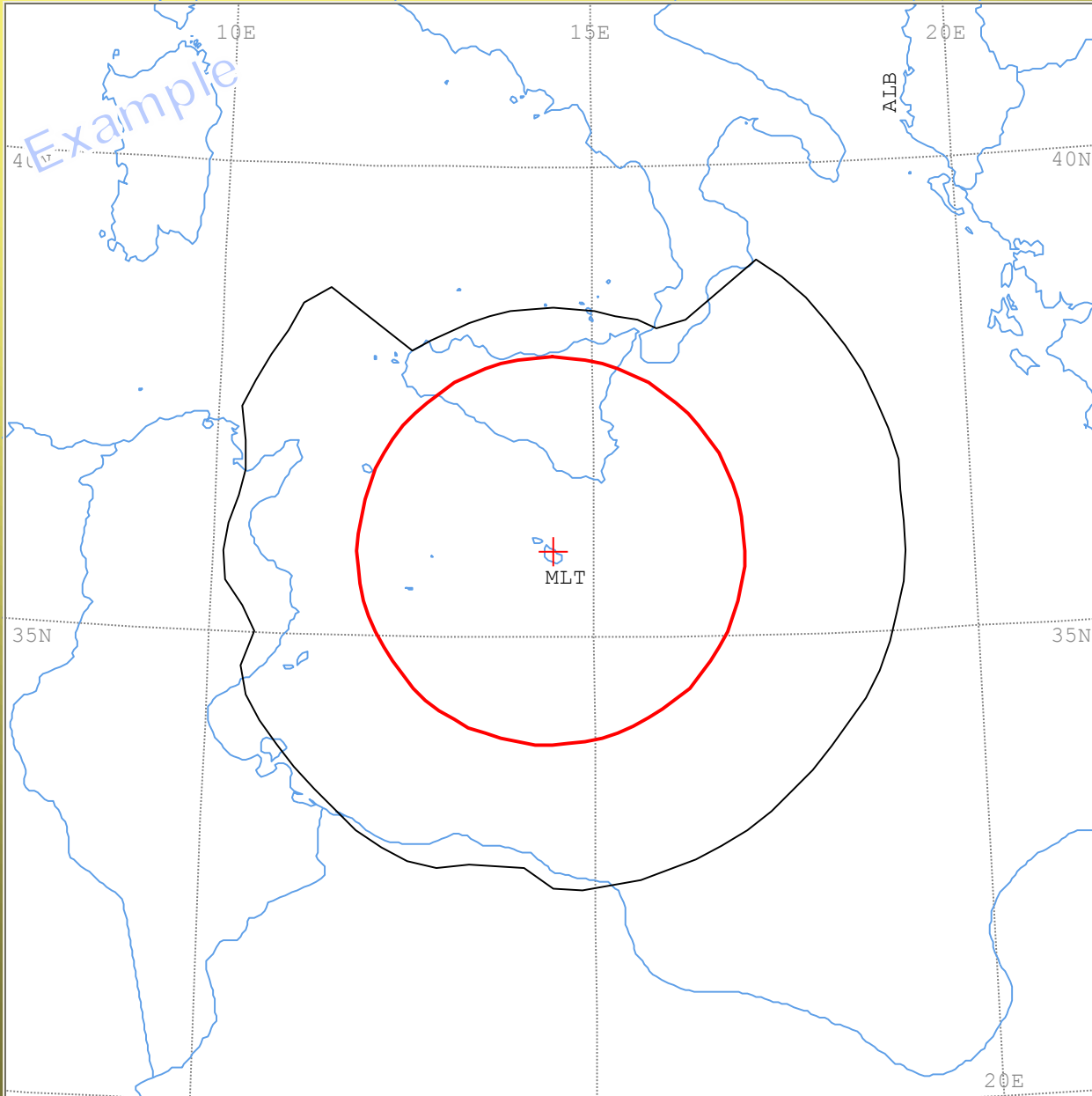
$P_t * G_e$

(10 to 123 Km/f) Minimum Coordination Distance

Maximum Calculation Distance (369/ Mode2 up to 1200 Km/ Mode1*Zone C)



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)*)

$$L(\%) = P_t + G_e + G_x - P_r(\%)$$

ex: $G_x = 45$ dBi, $P_t = -3$ dBW, $p(0.0015\%)$ for 10-12.75GHz

AP7 Table 8

$P_t * G_x$

$$L(\%) = P_t + G_x - P_r(\%)$$

Hydrometeor scatter

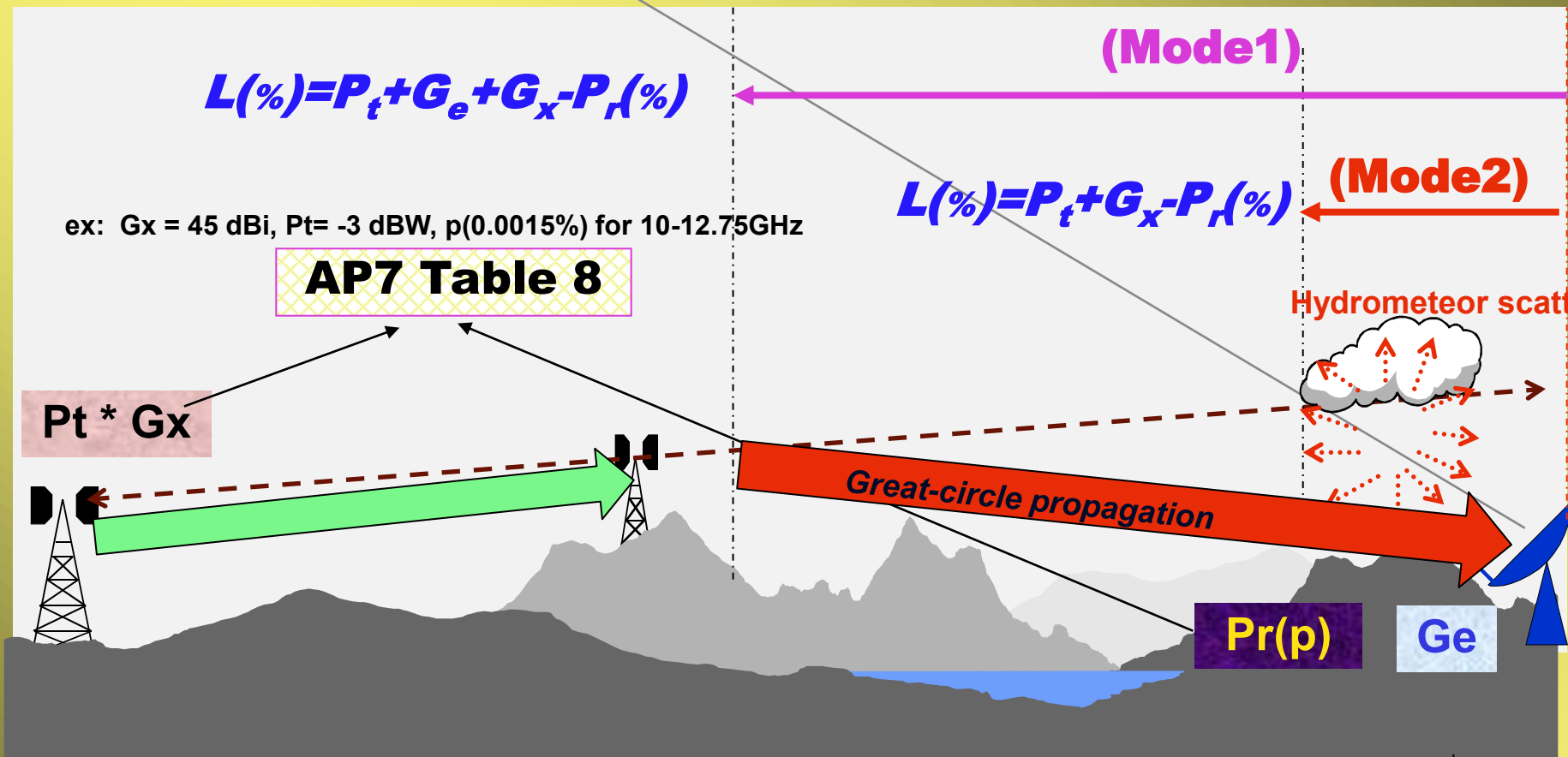
Great-circle propagation

$P_r(p)$

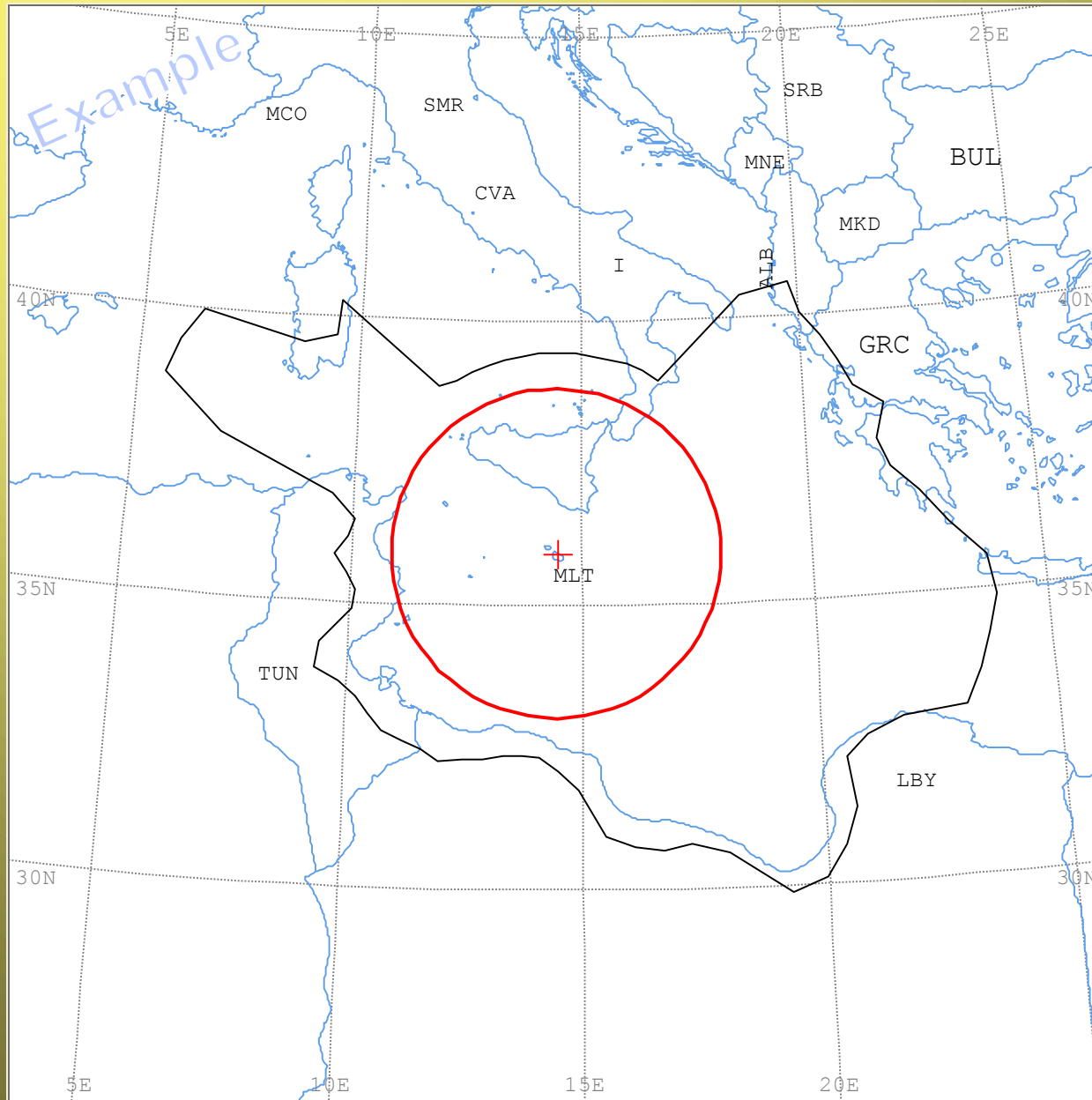
G_e

(10 to 123 Km/f) Minimum Coordination Distance

Maximum Calculation Distance (369/ Mode2 up to 1200 Km/ Mode1*Zone C)



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 | LBY TUN

Contour of Opposite direction 1

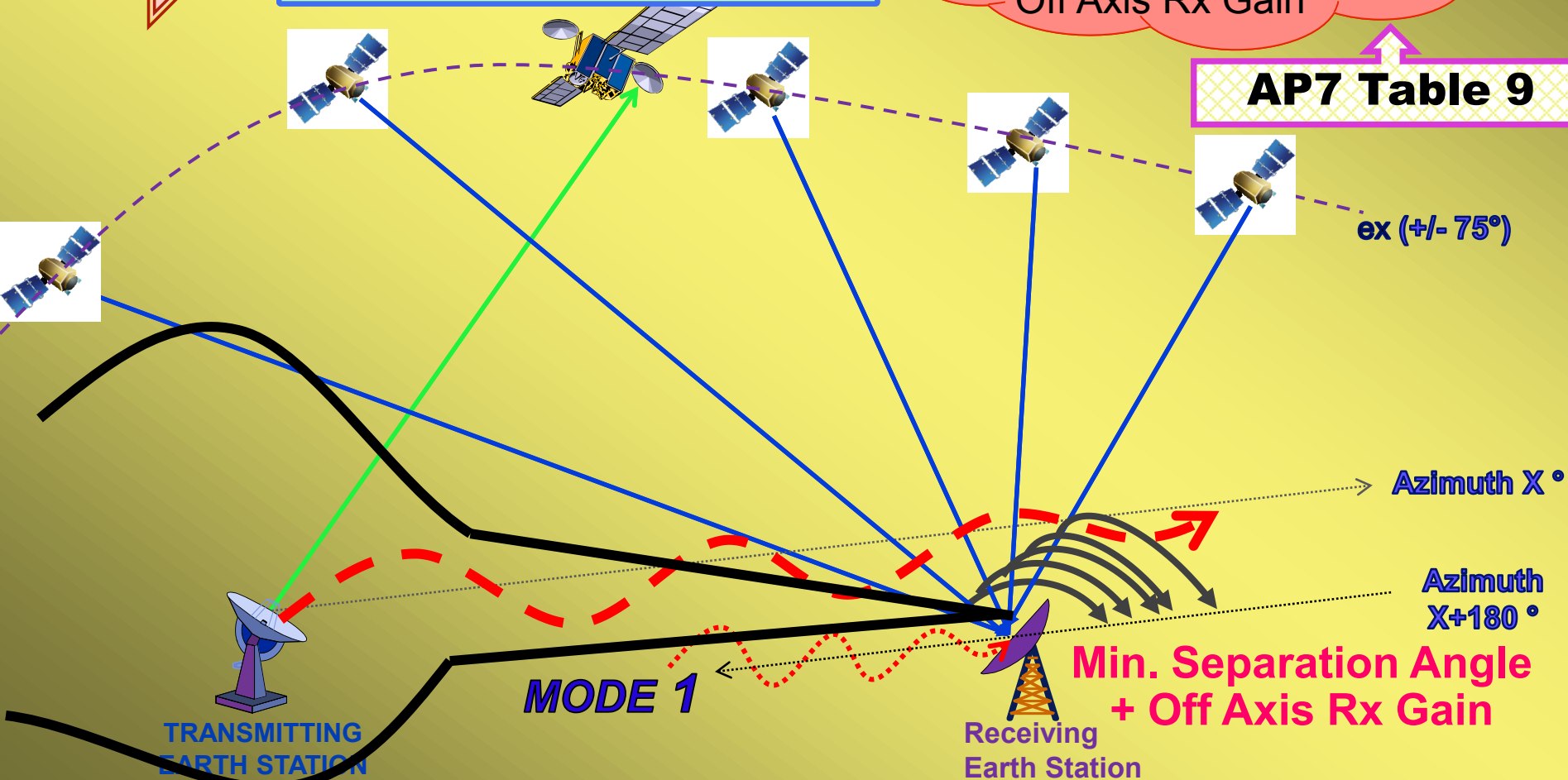
MODE 1 Appendix 7 - Annex 3 & 5 + Table 9

Worst Case Scenario
(for Rx E/S)

- Horizon ele. angle (Rx E/S) = 0°
- Orbit inclination = 0°
- Anywhere in GSO orbit ($> \epsilon_{\min}$)
- 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

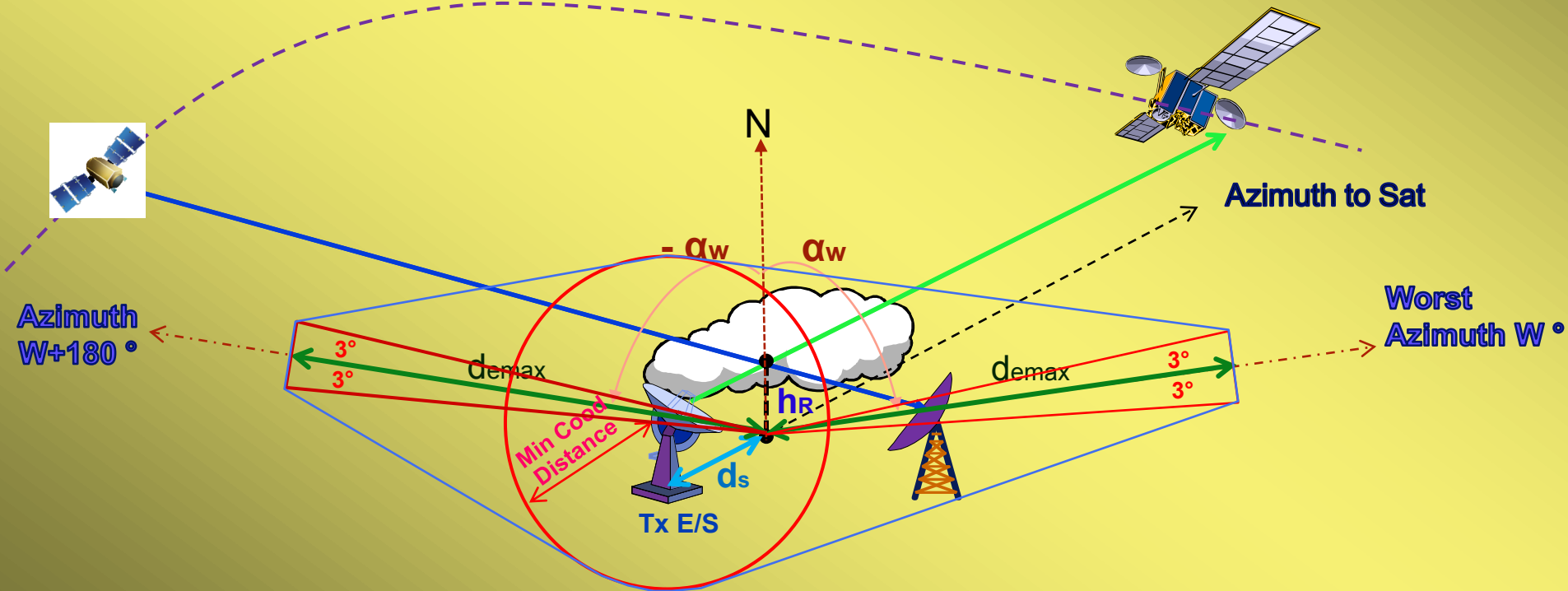
Worst Case Scenario +
(as Mode1)

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

Apply Geometrical construction

- Min. Coord. Distance (for some Azimuths)
- two 6° sectors => worst-case distance

No auxiliary contours (No calculation)



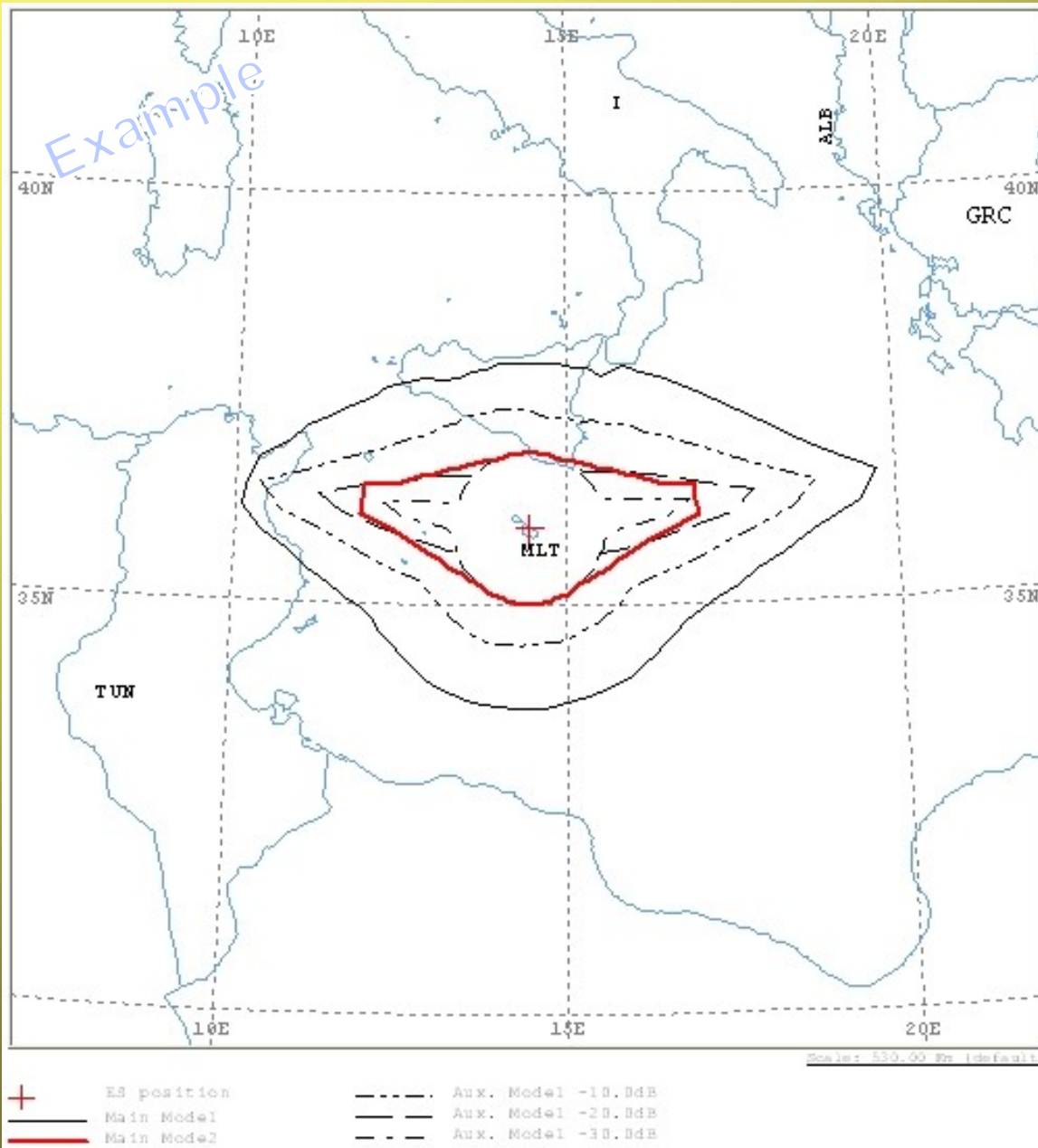
• h_R : rain height

• d_s : horizontal distance

• α_w : Azimuth to possible Rx E/S (by Latitudes, ϵ_{min})

• d_{max} : Max calculation distance by h_R

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



Freq: 8025-8350 GHz

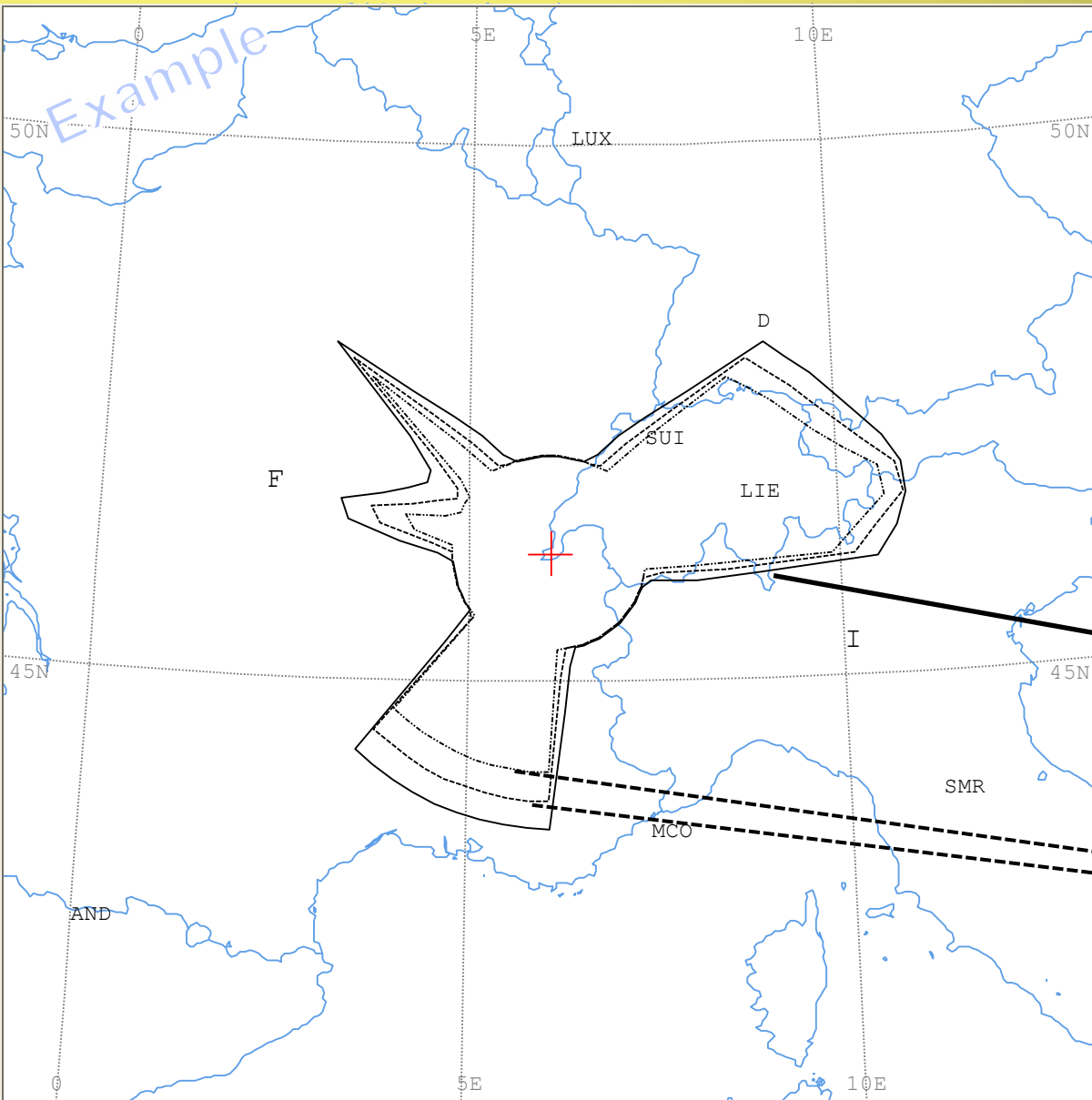
Sat longitude : 1 W

Horizon Ele. Angle : 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

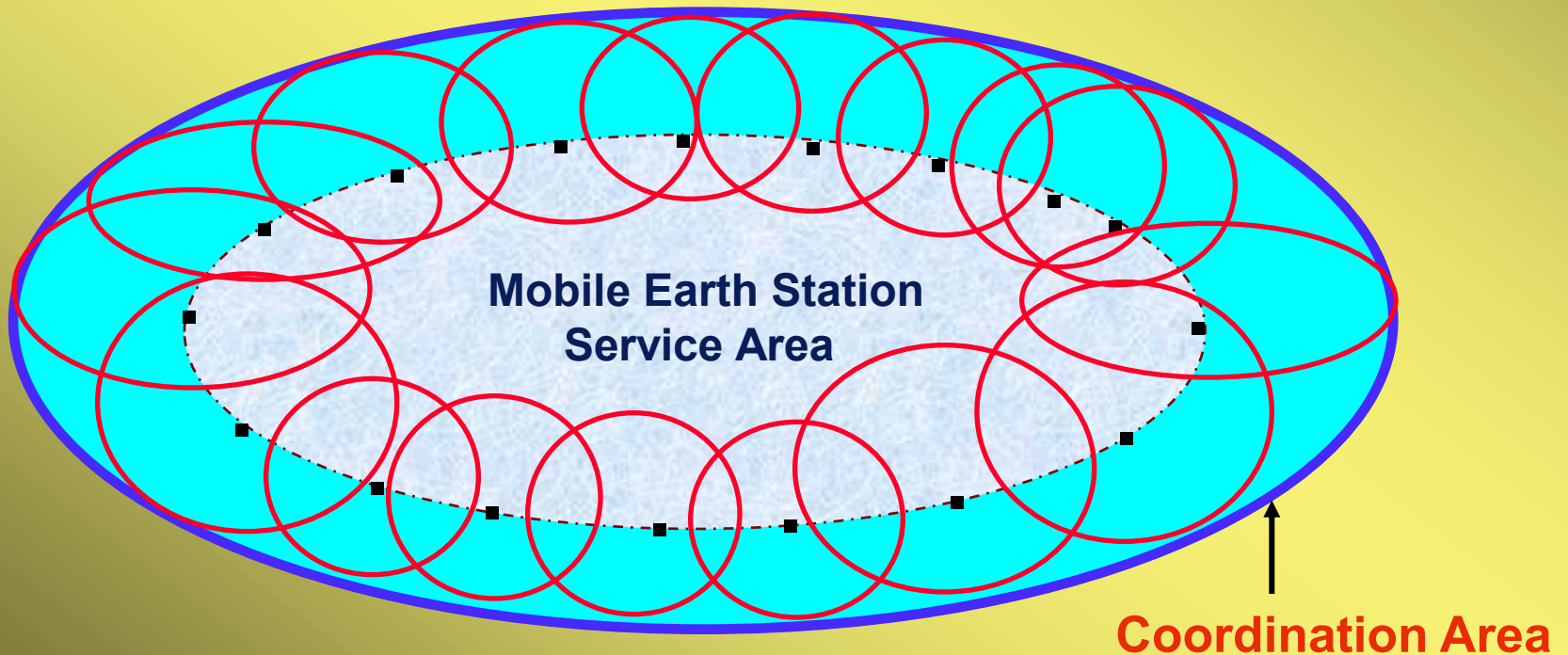
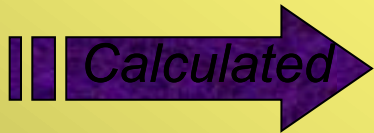
Tracking Antenna reduce the probability of Mode2.

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).



Predetermined Coordination distance

(Table 10 of Appendix 7)



AP7 Table 10

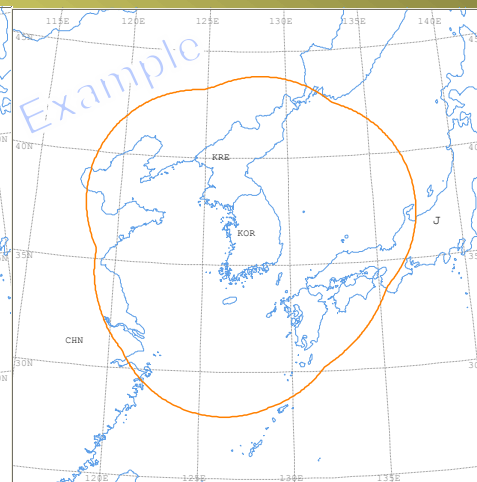
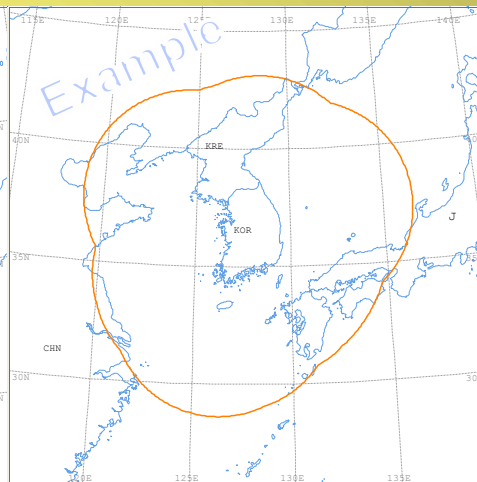
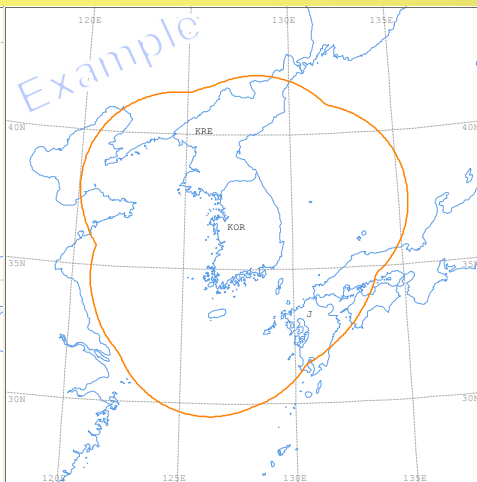
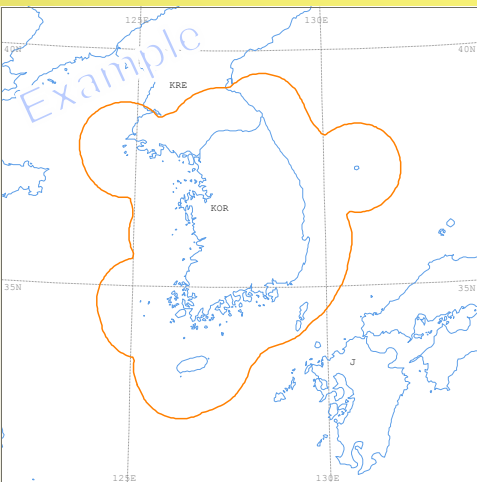
(Example Adm: KOR)

Typical, 100Km

Typical, 400Km

Typical, 500Km

Typical, 580Km

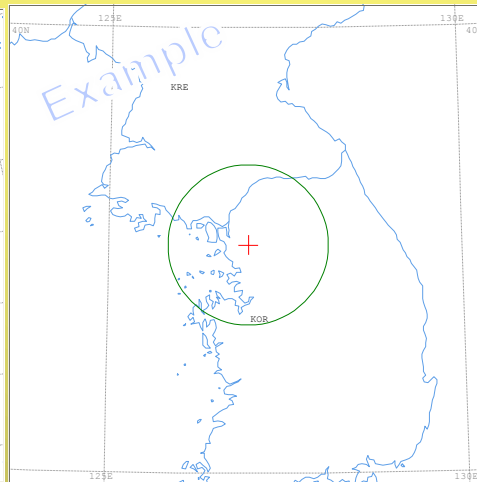


Typical, 1000Km

Typical, 1080Km

Specific, 100Km

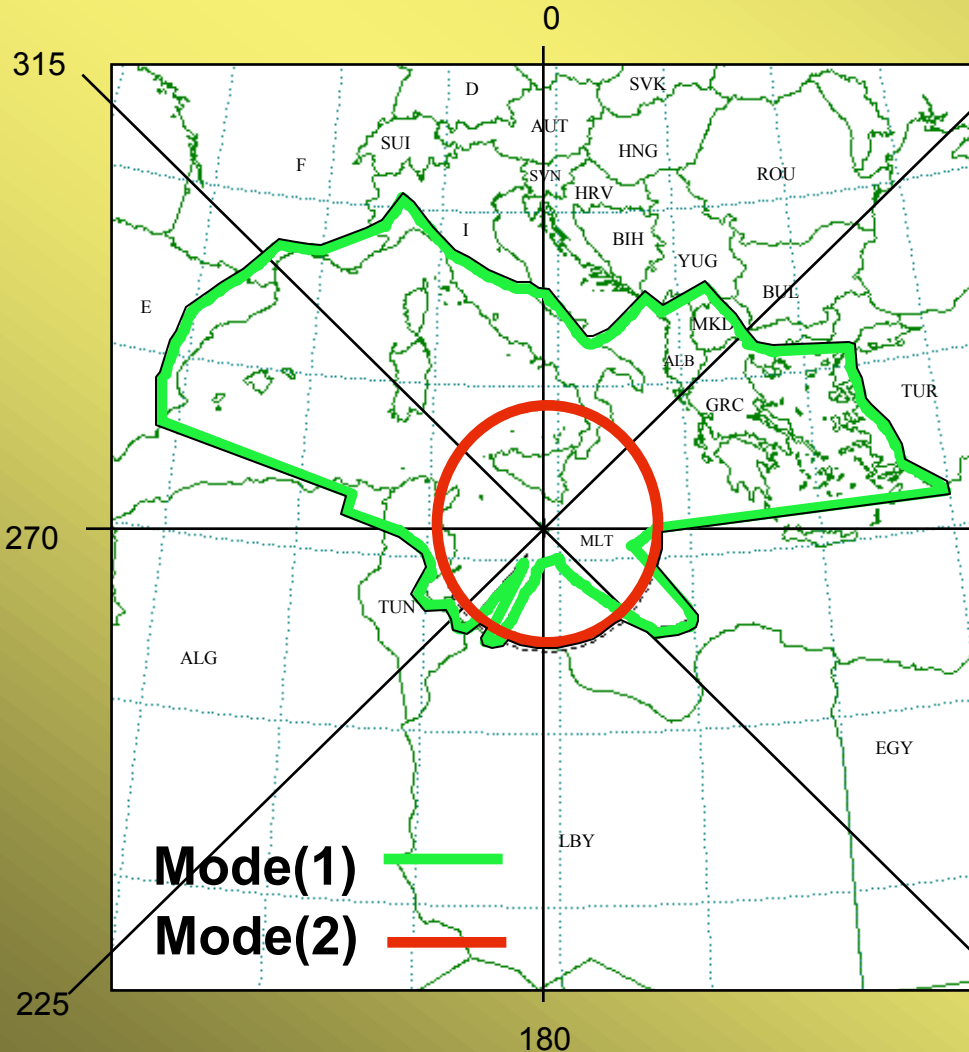
Specific, 580Km





APPENDIX 7

Definition of the Coordination Area



45
Coordination contours with the greatest coordination distance

However

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

i.e.


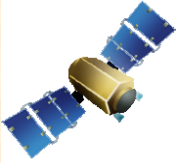



It's **not** a **exclusion zone.**

means

More detailed calculations and discussions need to be performed.

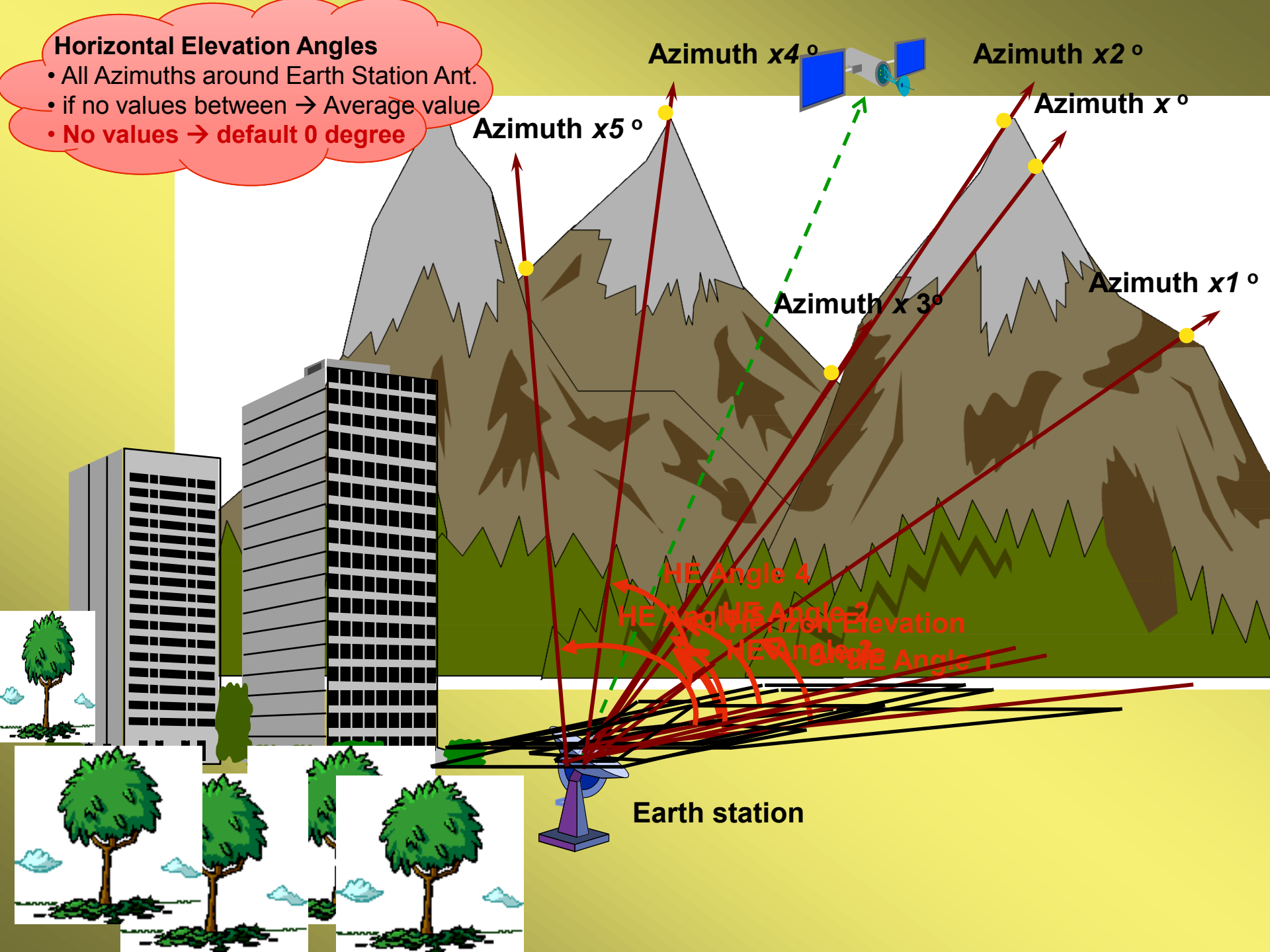
Coordination data (Appendix 4)

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

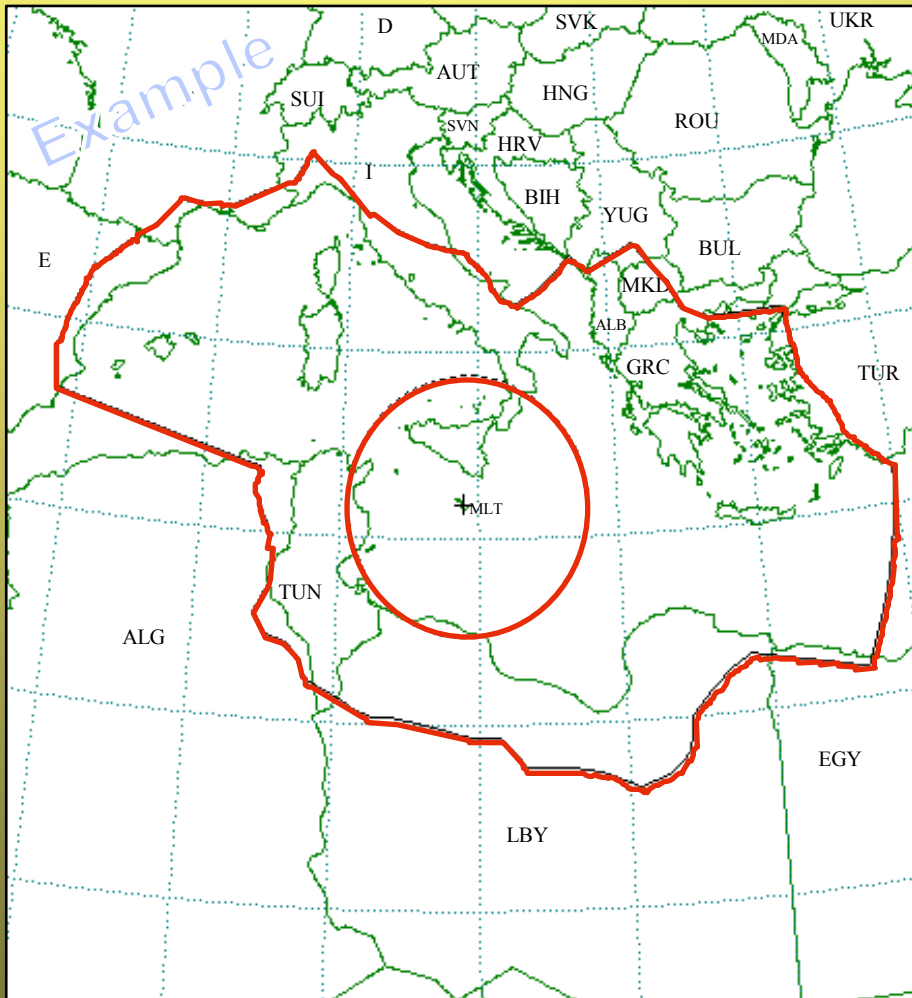
- All Azimuths around Earth Station Ant.
- if no values between → Average value
- **No values → default 0 degree**



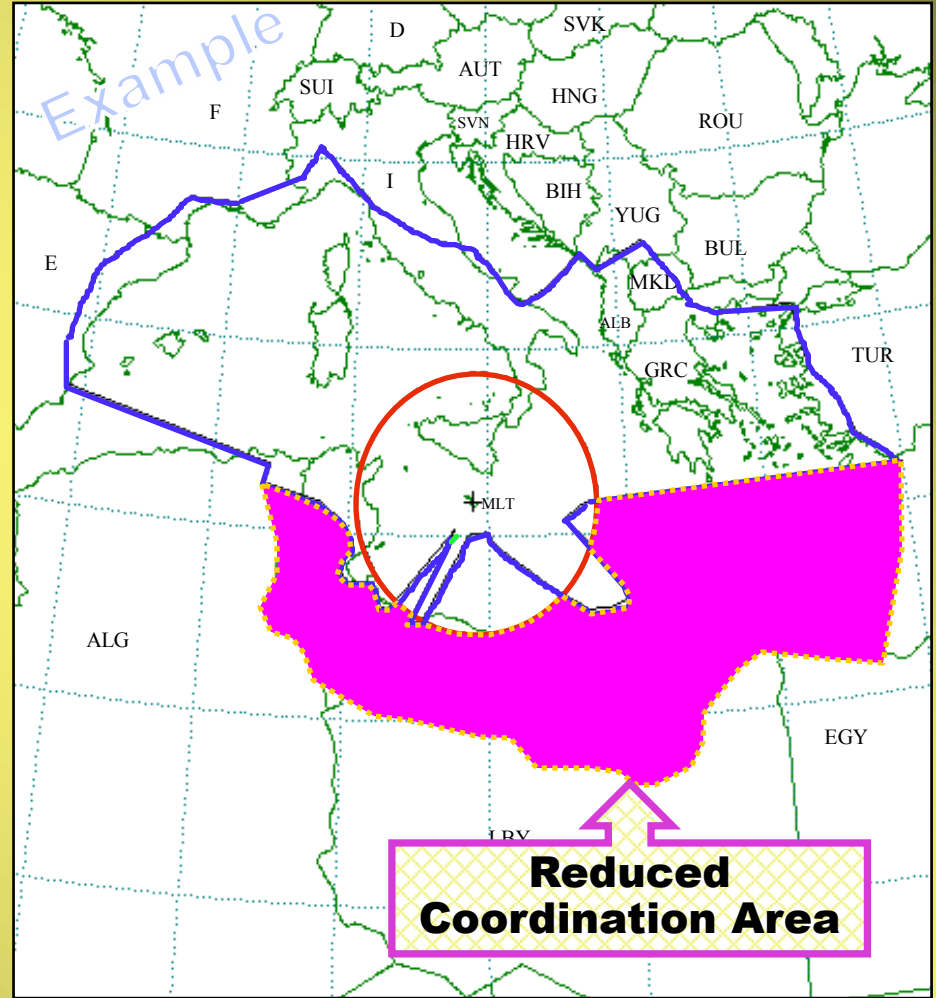
Effect of Horizon Elevation Angle

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

Graphical Interface for Batch Programs

Appendix 8 PFD (terrestrial serv.) PFD (space serv.)
Appendix 7 Appendix 30B Appendix 30 30A Tools / Options

Network ID: 109500000 Calculate Report

Warning Error Progress

Message	Module	Code
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Calculation Output

Out DB: C:\BR_TEX_RESULTS\APP7\ESCC.MDB

RTF Report Generation
C:\BR_TEX_RESULTS\APP7\ESCC.MDB

Print Auxiliary Scale (km) []

Version
2.0.0.0 Appendix 7

EXIT Help

Auxiliary Contour

Extra coordination lines inside main contour

Auxiliary and Supplementary Contours

Mode 1 (dB) Mode 2 (deg)

Add [] dB Add [] deg

-10.0
-15.0
-5.0

2.0
3.0
5.0

Clear all Clear All

OK Cancel

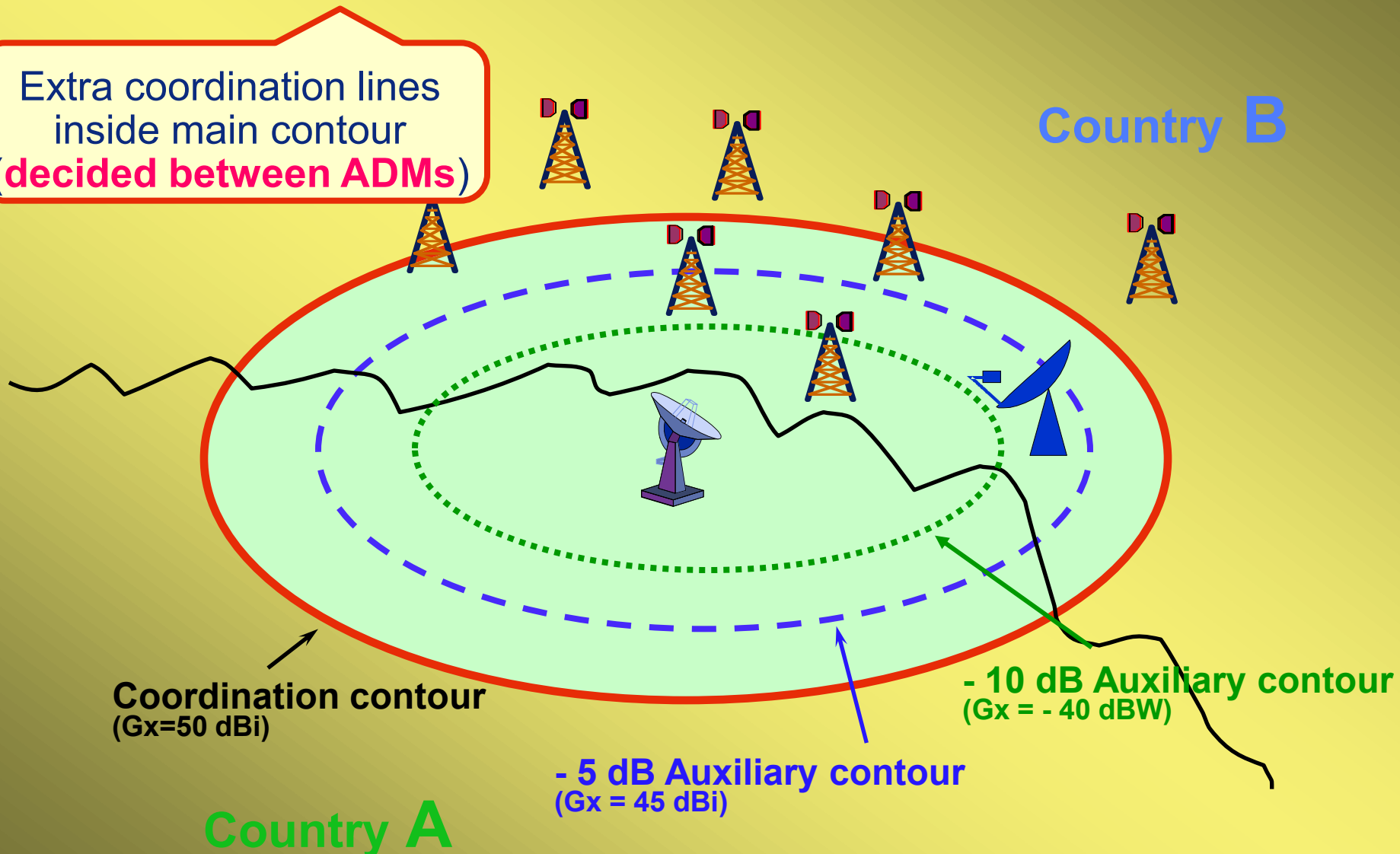
It's all Complementary information.

Auxiliary Contour - Mode 1 (& 2)

Appendix 7 - Annex 6

Extra coordination lines
inside main contour
(decided between ADMs)

Country B



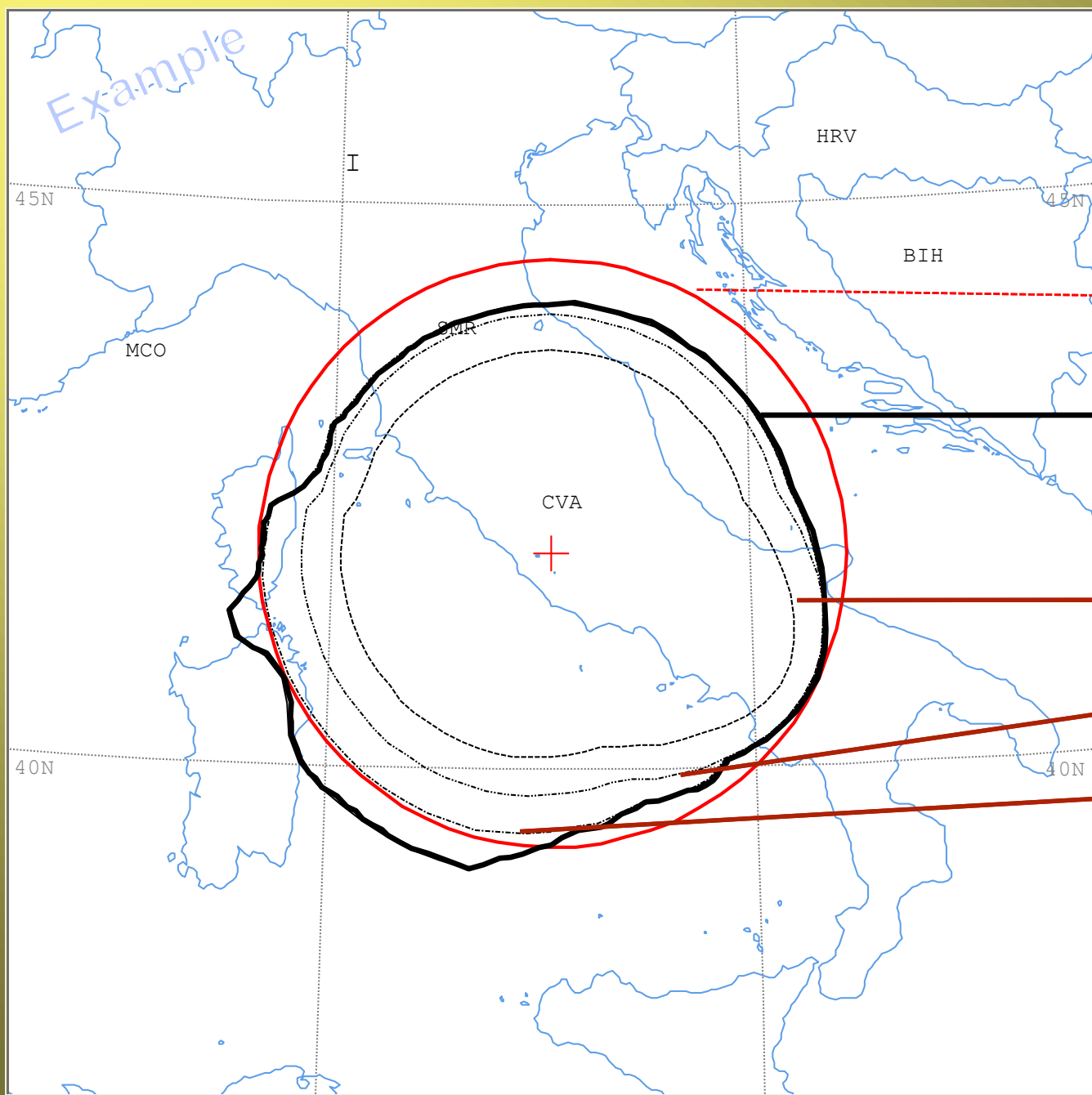
Coordination contour
($G_x = 50$ dBi)

- 5 dB Auxiliary contour
($G_x = 45$ dBi)

- 10 dB Auxiliary contour
($G_x = -40$ dBW)

Country A

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)

Beam Avoidance Angle = X°

Main Mode 2

Auxiliary Mode 2

Protection Angle

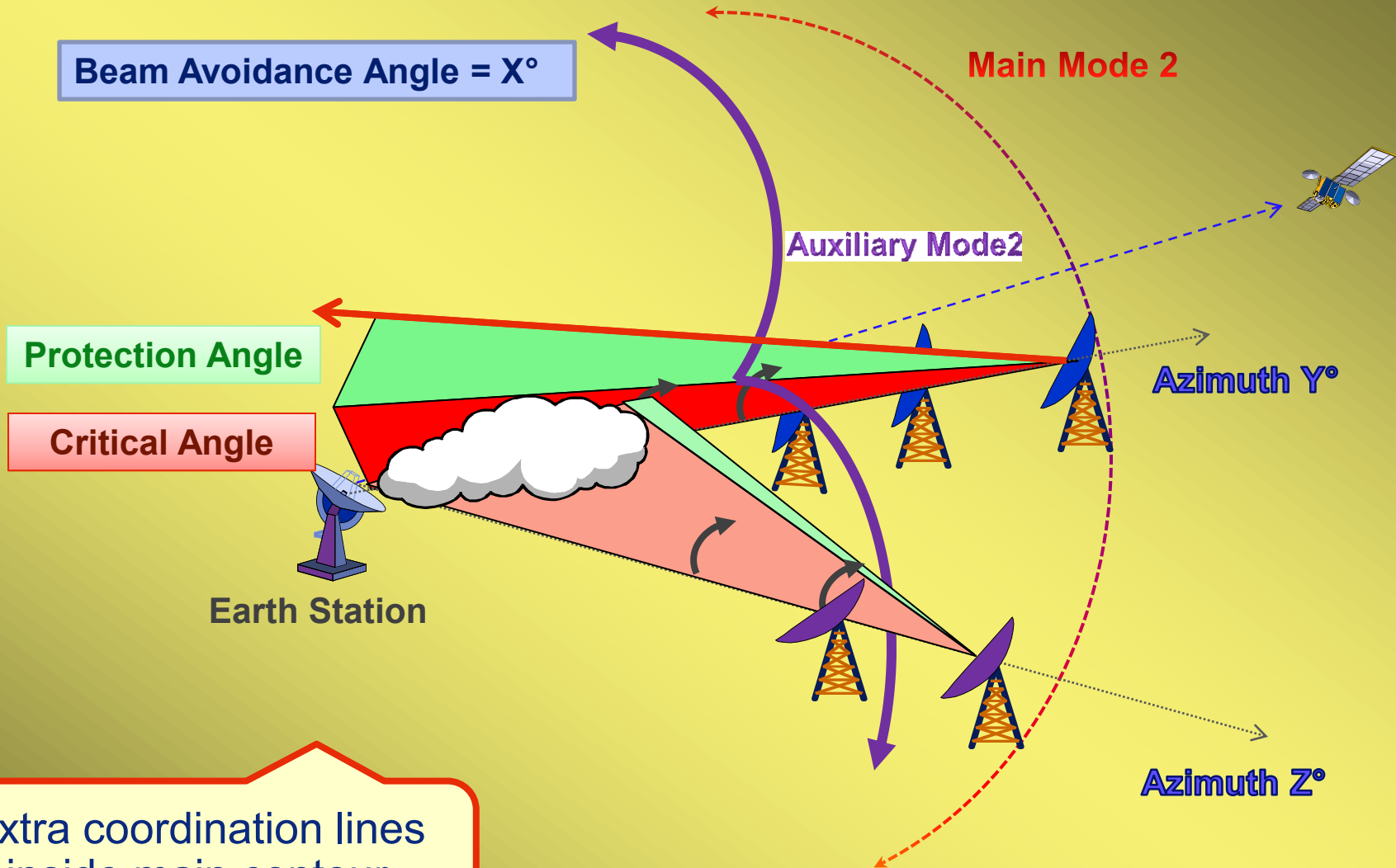
Critical Angle

Azimuth Y°

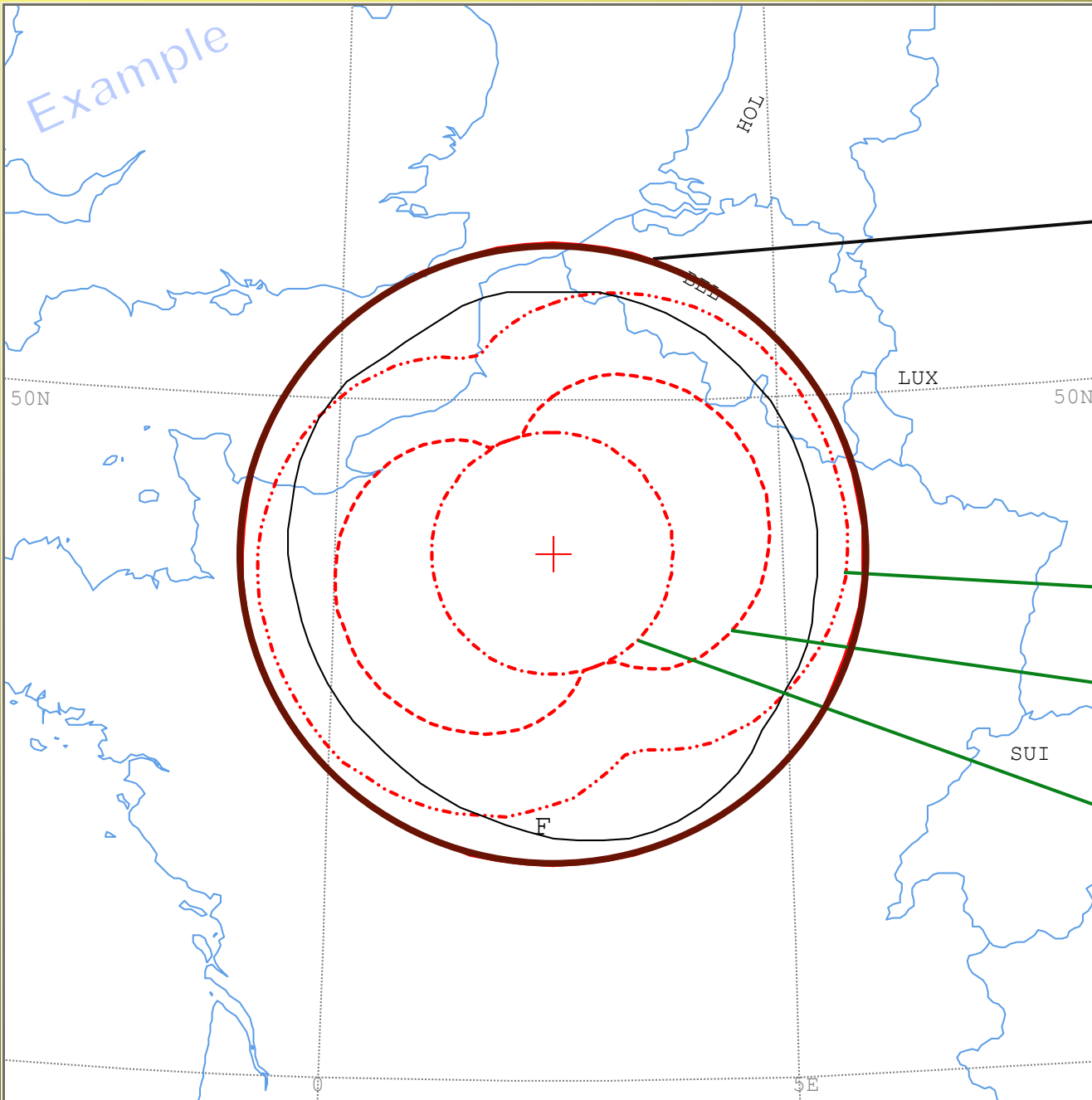
Earth Station

Azimuth Z°

Extra coordination lines
inside main contour
(decided between ADMs)



Auxiliary Contour - Mode 2



Main Mode2

Auxiliary Mode2

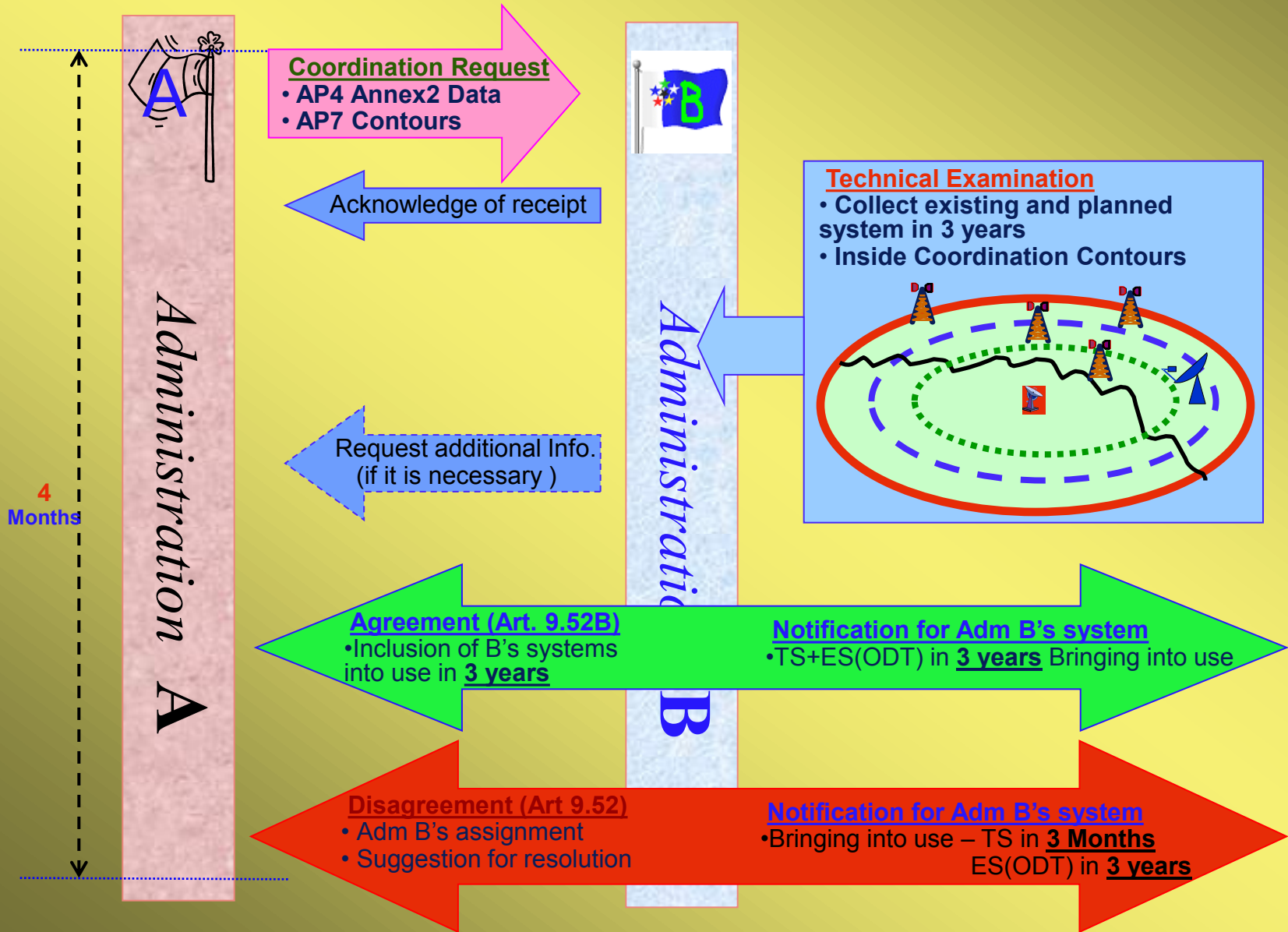
Avoidance angle 2.0 °

Avoidance angle 3.0 °

Avoidance angle 5.0 °

Response by Administration B

(to Coordination Request from A)



Result 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.**

3 Things to Do
on Coordination of Earth Stations

1. Define Affected ADM (AP7)
2. Send Data (AP4 & AP7)
3. Do Coordination (with cooperation)

Question ?



Answer!



if

