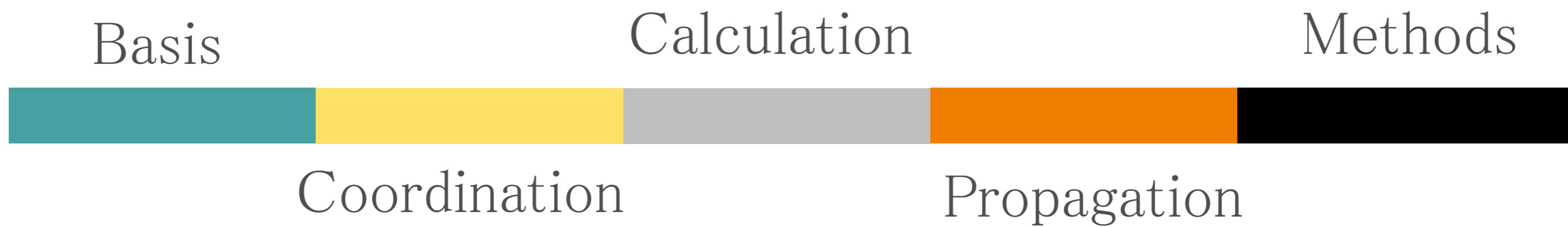# International Coordination (Terrestrial service)

State Radio Monitoring Center of China Frequency Engineering Department

国家无线电监测中心
The State Radio Monitoring Center

State Radio Monitoring Center of China
Frequency Engineering Department

Basis

Calculation

Methods

Coordination

Propagation

State Radio Monitoring Center of China
Frequency Engineering Department

1. Basis

Basis

International Telecommunication Union(ITU):

- – Radio Regulation (RR)
- – Regulation of Procedure (RoP)
- – ITU-R Recommendation and Report
- – CPM Report to WRC
- – Master International Frequency Register(MIFR)

Basis

Purpose for frequency coordination:

- Limited resources: reasonable、efficient、fair
- Insure interference-free operation of radio stations
- Control interference, Coexist
- International cooperation, mutual benefit
- International recognition and protection

Basis | State Radio Monitoring Center of China
Frequency Engineering Department

Radio Regulation:

- Allocation
  - 0~3000GHz
  - Article 5: frequency allocation
  - Primary , Secondary service

- Two method of share frequency
  - Coordination: efficient, first come first use
  - Plan: fair, considering future use, demand of countries

Basis

State Radio Monitoring Center of China
Frequency Engineering Department

Plan Name/Type	Radiocommunication service	Frequency band	Geographical Area
AP 25 (Allotment)	Maritime Mobile	4000 - 27500 kHz	Worldwide
AP26 (Allotment)	Aeronautical Mobile (OR)	3025 - 18030 kHz	Worldwide
AP27 (Allotment)	Aeronautical Mobile (R)	2850 - 22000 kHz	Worldwide
GE85-MM-R1 (Allotment)	Maritime Mobile (DSC)	435 - 2160 KHz	Region 1
GE85-MAR-R1 (Assignment)	Maritime Mobile	415 - 2160 KHz	Region 1
GE85-MAR-R1 (Assignment)	Aeronautical Radionavigation	415 – 526.5 KHz	Region 1
GE85-EMA (Assignment)	Maritime Radionavigation	283.5 - 315 KHz	European Maritime Area
The List (Assignment)	Various (Chapter 4 of Annex 2 to GE06 Agreement)	Parts of 174-230 MHz and 470-862 MHz	Parts of Region1 and Region3

Basis

Band	Frequency (kHz/MHz)	BC/BT	Region Geo. zone	Plan
LF	148.5 – 283.5 kHz	BC	R1	GE75
MF	526.5 – 1606.5 kHz	BC	R1 and R3	GE75
	525 – 1605 kHz	BC	R2	RJ81
	1605 – 1705 kHz	BC	R2	RJ88
VHF /UHF	47 – 68 MHz	BC, BT	EBA	ST61
	47 – 68 MHz	BT	ABA	GE89
	66 – 68 MHz	BC	EBA	ST61
	87.5 – 100 MHz	BT	EBA	ST61
	87.5 – 108 MHz	BC	R1+IRN+AFG	GE84
	162 – 170 MHz	BT	MRC	ST61
	(170 MRC) 174 – 230 MHz	BC, BT	R1-MNG+IRN	GE06
	230-238, 246-254 MHz	BT	See RR 5.252	GE89
	470 – 862 MHz	BT	R1-MNG+IRN	GE06

Basis

State Radio Monitoring Center of China
Frequency Engineering Department

RR & RoP

- Volume 1: Articles
  - Article 1: Terms and definitions
  - Article 4: General rules for assignment and use of frequency
  - Article 5: Table of frequency allocations and footnotes
  - Article 9: Procedure for coordination
  - Article 11: Notification and recording of assignments
  - Article 21: Sharing between terrestrial and space services above 1 GHz

- Volume 2: Appendices
  - APP1: Classification of emissions and necessary bandwidths
  - APP4: Characteristics to be notified
  - APP5: Identification of affected administration for coordination
  - App7: Determination of coordination area

- Other provisions:

  Art.24 (FS), Art. 43(AMS), Art.51,52(MMS), AP25(MMS),AP26(AM(OR)S), AP27(AM(R)S)

Bilateral agreement examples

- SM.1049
- HCM-Agreement

Other reference

- Handbook
- Recommendation and Report from ITU and other organizations

2. Coordination

国家无线电监测中心
The State Radio Monitoring Center

Coordination

State Radio Monitoring Center of China
Frequency Engineering Department

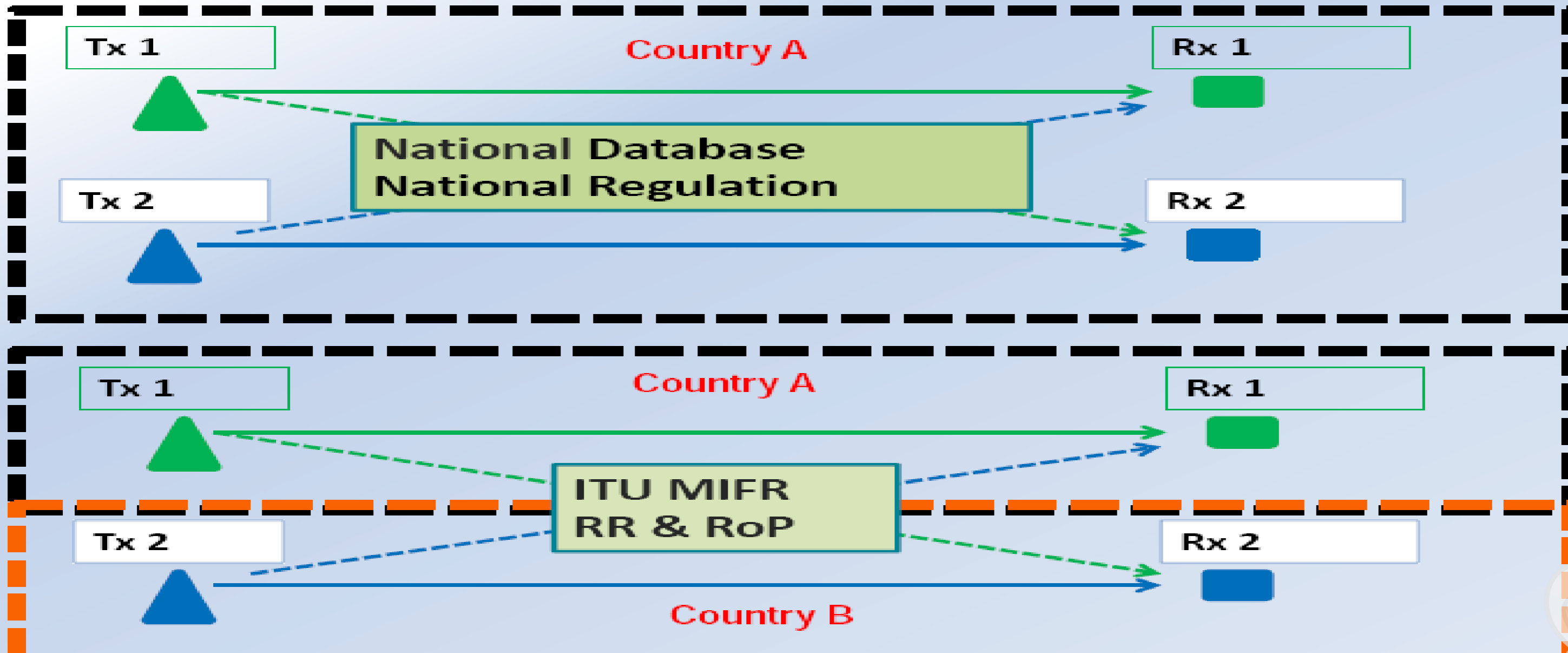## For a New Station or a New Frequency Assignment:

- Comply with international frequency allocation and plan
- Sign and carry out bilateral agreement
- Coordination according to RR or bilateral agreement
- Reply coordination requirement in time
- Notify to BR to be Recognized: right and obligation
- Interference complain

STATIONS COODRINATION

Country A

Tx 1   Rx 1

National Database
National Regulation

Tx 2   Rx 2

Country A

Tx 1   Rx 1

ITU MIFR
RR & RoP

Tx 2   Rx 2

Country B

Coordination

Station coordination Procedure

- Services：
  - Fixed
  - Mobile
  - Broadcasting
  - Radionavigation
  - Radiolocation
  - Space, etc.

- Time limit for coordination:
  - Fix and Mobile：bilateral agreement
  - Earth station：1 month acknowledgement, 4 months reply
  - Broadcasting: Reginal plan, bilateral agreement
  - Plan for the services: Appendix 25, 26 27, 30, 30A

Classification of coordination

- **Mandatory coordination**

  Assignments to be coordinated prior to bringing into use, Coordination with the assistance of BR, Appendix 5 to identify affected administration for coordination, Appendix 4 charateristics of stations
    - Terrestrial services shared with space services above 100 MHz : Appendix 7(determination of coordination area of terrestrial service), 9.16, 9.18, 9.19
    - Obtaining agreement required in footnote of Article 5：9.11A，9.21
    - Limit or coordination requirement : pfd, WRC Resolution
    - Coordination of stations of non-planned terrestrial services operating in the bands and geographical areas covered by different Regional Agreements

- **Voluntary coordination**

  Direct coordination between administrations concerned ,BR has no obligation to check if the coordination is finished.
    - Bilateral agreement: Article 6 (special agreement)
    - Without assistance of BR

Coordination of terrestrial stations vis-à-vis receiving earth stations in the bands above 100 MHz shared with equal rights between terrestrial and space service and allocated to space services in space to Earth direction of transmission if the terrestrial station is located in the coordination area of an earth station (RR9.16 or RR9.18)
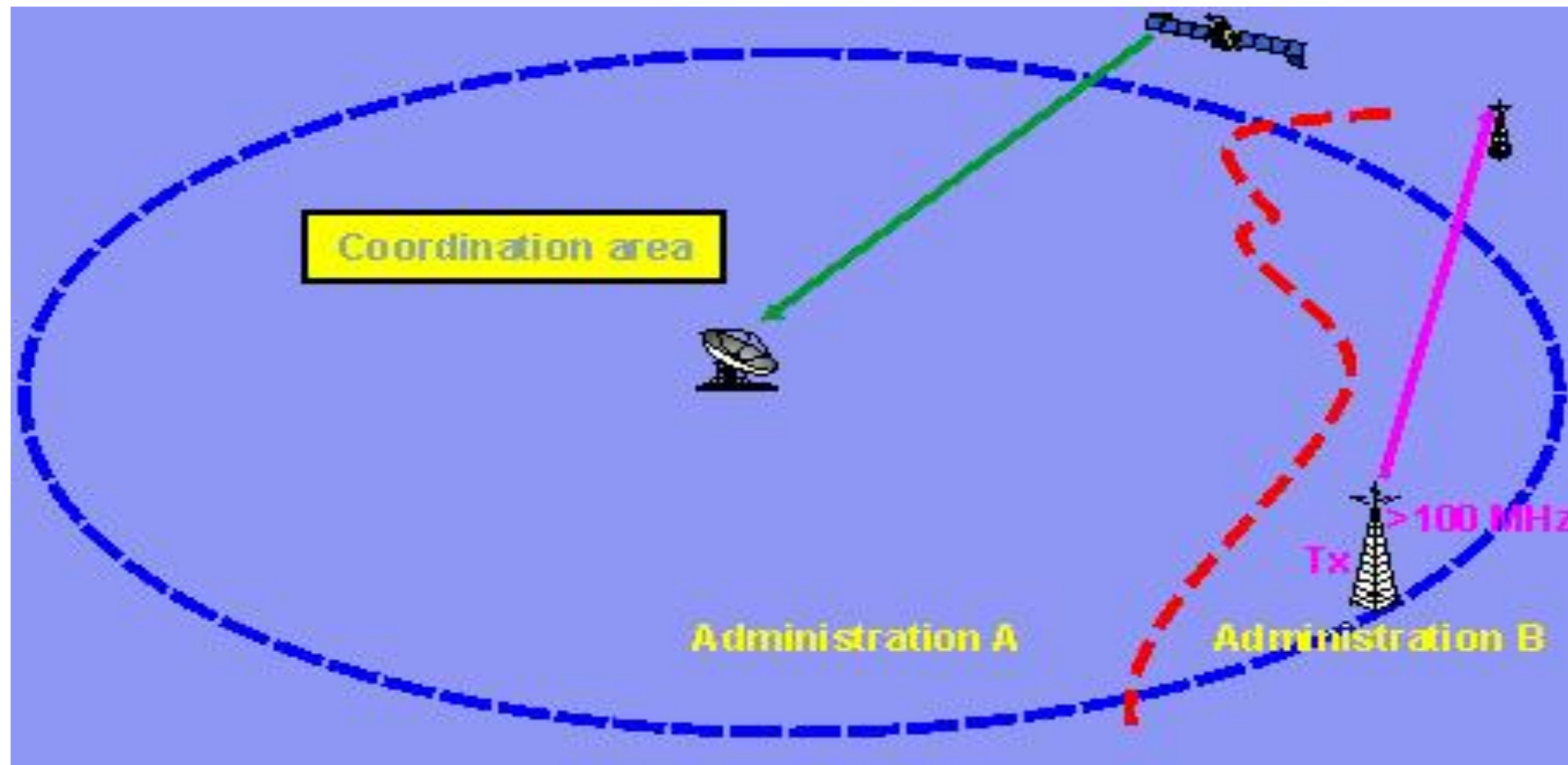
Coordination of transmitting terrestrial station vis-à-vis typical earth station included in the service area of a space station in the broadcasting-satellite service in the bands shared with equal rights between terrestrial and broadcasting-satellite service (RR9.19)

Coordination

Obtaining agreement for a terrestrial station operating in the bands mentioned in a footnote to the Table of Frequency Allocations of RR Article 5, making reference to the provision of RR9.21
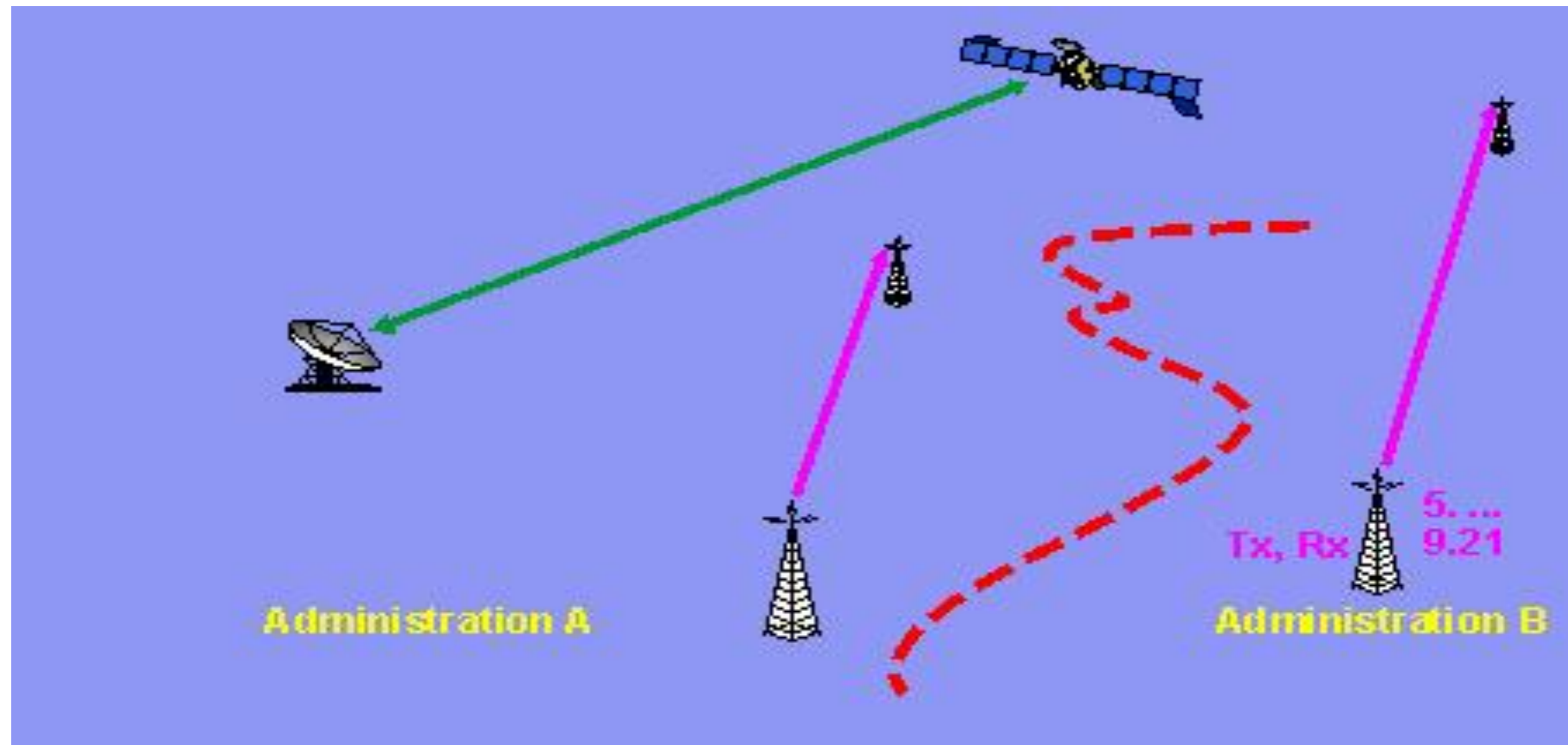
3. Calculation

- Interference calculation:

    Assignments to be coordinated prior to bringing into use, Coordination with the assistance of BR, Appendix 5 to identify affected administration for coordination, Appendix 4 data

    – Transmitting parameters：Coordinates, frequency, bandwidth, elevation, orientation and height of antenna
    – Antenna Gain: figure, main lobe, side lobe
    – Propagation: loss
    – Coordination trigger: pfd, field strenth, coordination contour
    – Criteria: E, protection ratio, Maximum permissible interference, C/I, I/N ,C/N, pfd,
    – Interference calculation：
    – Compare to criteria:

P_C

P_T

$G_T - L_T$

L

$G_R - L_R$

P_I

$P_{T'}$

$G_{T'} - L_{T'}$

L'
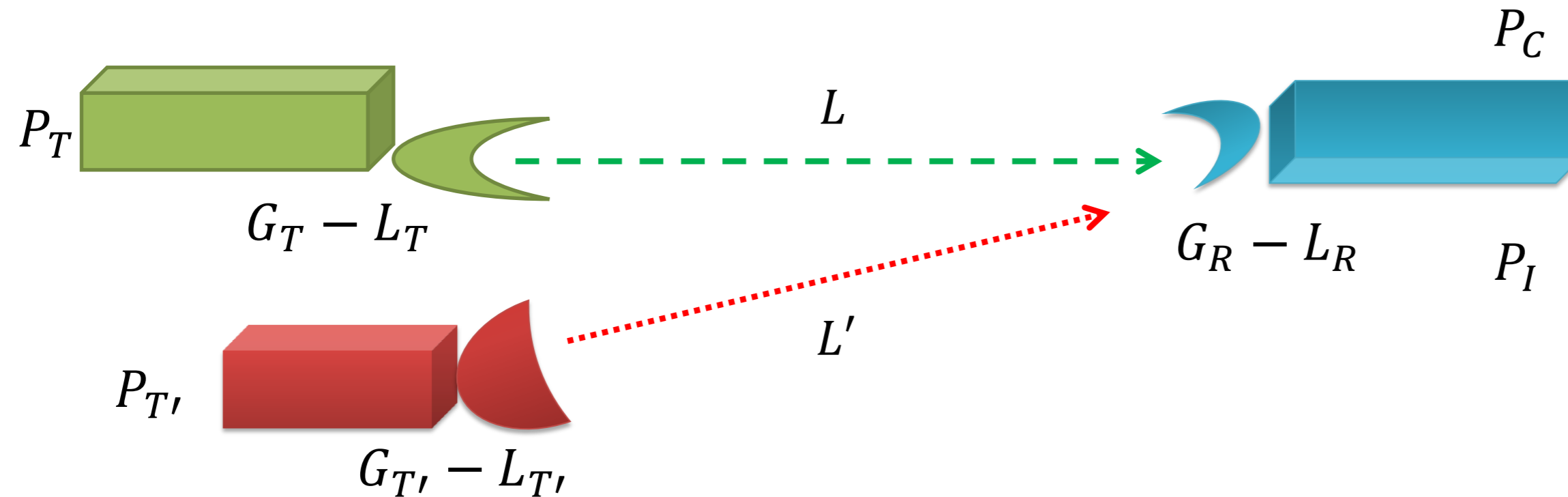
Wanted signal：
$$P_C = P_T + G_T - L_T - L + G_R - L_R$$

Unwanted signal(Interference)：
$$P_I = P_{T'} + G_{T'} - L_{T'} - L' + G_R - L_R$$

C
卫星

O

$\angle EL$ $\angle \omega$

A
地球站 $\angle \omega'$

B
微波站

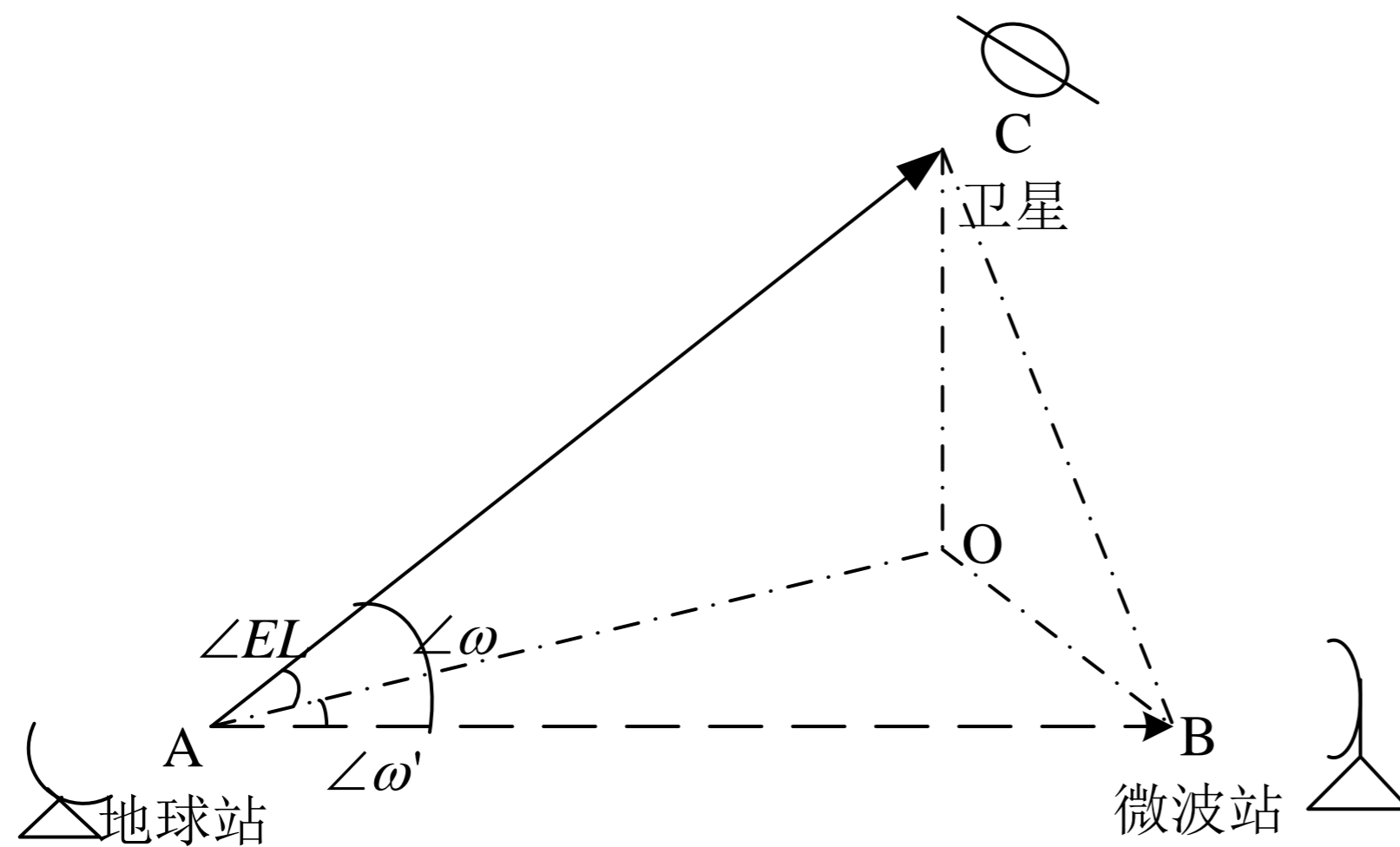**Power flux-density:**

$$s = \frac{e^2}{120\pi} = \frac{4\pi\, p_r}{\lambda^2} \qquad \text{(W/m}^2\text{)}$$

Noise:

$$N = 10\log_{10} T - 228.6 + 10\log_{10} B$$

Conversion Formula

Field strength for a given isotropically transmitted power:

$$E = Pt - 20 \log d + 74.8$$

Isotropically received power for a given field strength:

$$Pr = E - 20 \log f - 167.2$$

Free-space basic transmission loss for a given isotropically transmitted power and field strength:

$$L = Pt - E + 20 \log f + 167.2$$

Power flux-density for a given field strength:

$$S = E - 145.8$$

Where:

Pt : isotropically transmitted power (dB(W))
Pr : isotropically received power (dB(W))
E :   electric field strength (dB(mV/m))
f :   frequency (GHz)
d :   radio path length (km)
L : free-space basic transmission loss (dB)
S :   power flux-density (dB(W/m²)).

EMC

Decide permitted interference

Interference calculation

Analog system

Digital system

Transmmiting parameters

Bit error rate

Propagation

E_b/N_0

Receiving parameters

Permitted interference

Interference

Compare

Conclusion
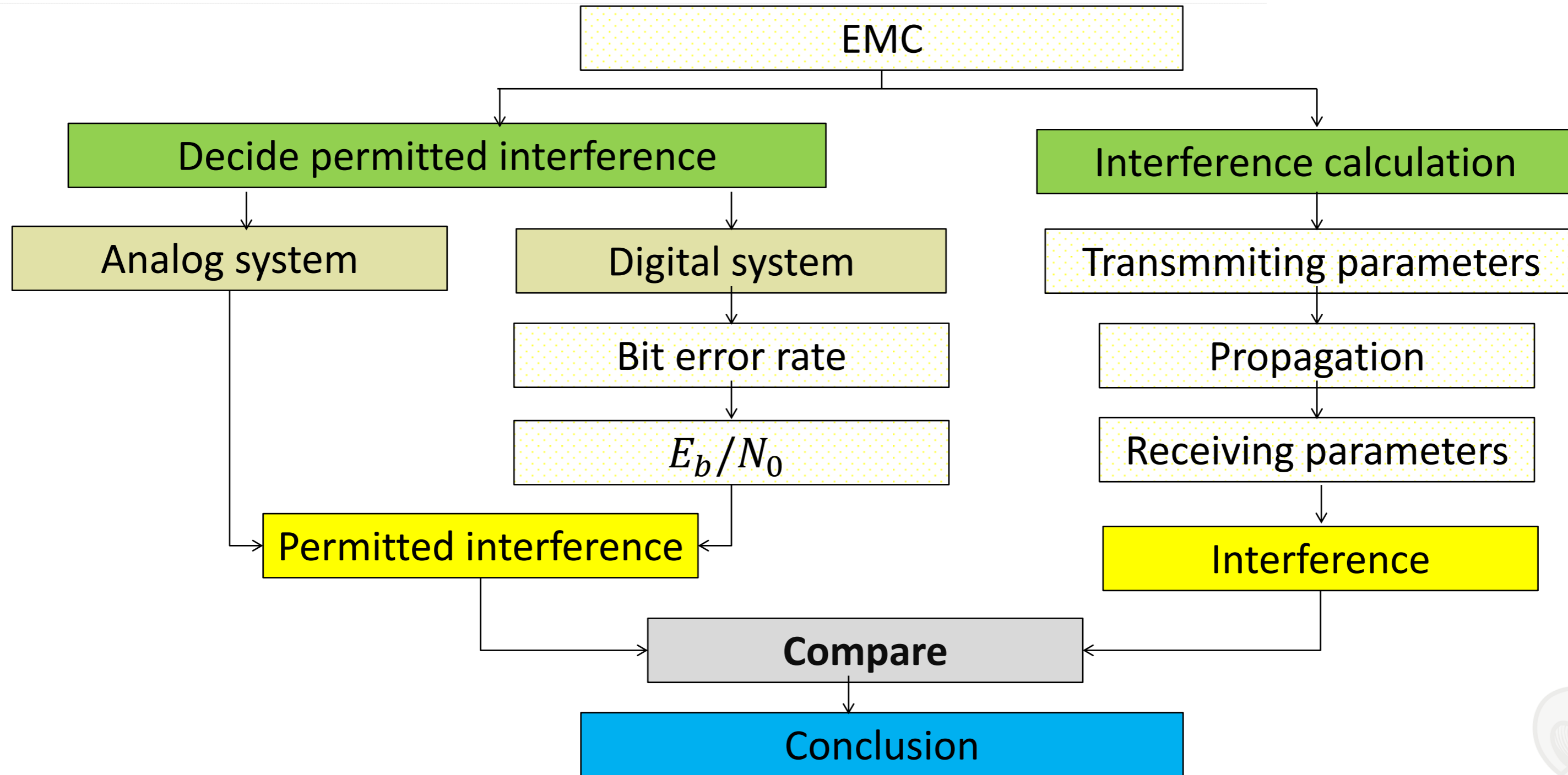
Calculation

Link calculation and interference margin

C_{target} = target unfaded C

M_{fade} = fade margin

RSL = minimum C to provide required $C/(N+I)$

M_s = system margin

$T(C/(N+I))$ = threshold $C/(N+I)$

$N+I_{agg}$ = noise plus interference

M_I = interference margin

N = receiver noise

I_{agg}/N

I/N

I_{agg} = aggregate interference

I = single-entry interference
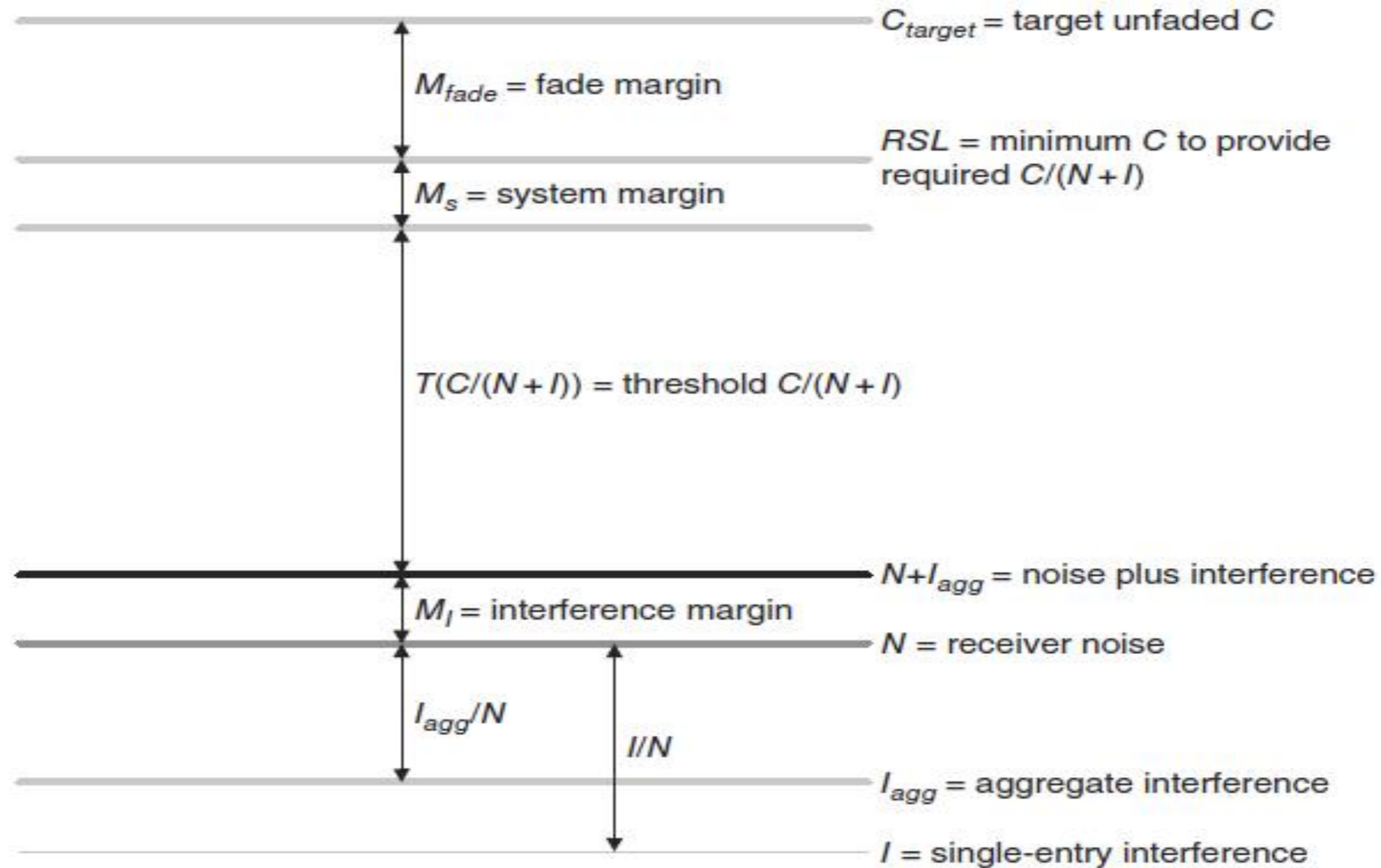
State Radio Monitoring Center of China
Frequency Engineering Department

4. Propagation

Propagation

Propagation model

- – Satellite-satellite/space to earth: free space ITU-R Rec. P.525

- – Diffraction：ITU-R Rec. P.526

- – Fix/ES: ITU-R Rec. P.452(>0.1GHz, profile), P-P

- – Mobile\Broadcasting：ITU-R Rec. P.1546 (30-3GHz, P-MP)，

- – Hata/COST231

- – Appendix 7

Free space attenuation: ITU Rec. P.525

ideal medium, no reflection, refraction, absorption, scattering, heat loss.

1. Point to area link:

$$e_{\mathrm{mV/m}} = 173 \; \frac{\sqrt{p_{\mathrm{kW}}}}{d_{\mathrm{km}}}$$

(mV/m)

2. Point to point link:

$L_{bf} = 20 \log (4\pi d / \lambda)$ (dB)

$L_{bf} = 32.4 + 20 \log f(MHz) + 20 \log d(km)$

ITU Rec.P.526 : Multi-edged diffraction

Obstruction within the path's Fresnel zone, combined with another model

Fresnel zones

ITU Rec. P.452 Propagation Model

f> 0.1 GHz, station on the surface, $0.001 \le p \le 50\%$

The procedure uses the propagation models listed below:

– line-of-sight (including signal enhancements due to multipath and focusing effects)

$$L_{bfsg} = 92.5 + 20 \log f + 20 \log d + A_g \qquad dB$$

Ag: Atmospheric absorption

Total loss: blending mechanism, with a terrain database, path profile

– Multipath
– Diffraction (embracing smooth-Earth, irregular terrain and sub-path cases)
– Tropospheric scatter
– Surface ducting
– Layer reflection and refraction
– Hydrometeor scatter
– Ducting

Depending on the type of path, as determined by a path profile analysis, one or more of these models are exercised in order to provide the required prediction of basic transmission loss.

Propagation

State Radio Monitoring Center of China
Frequency Engineering Department

Long term ⇨
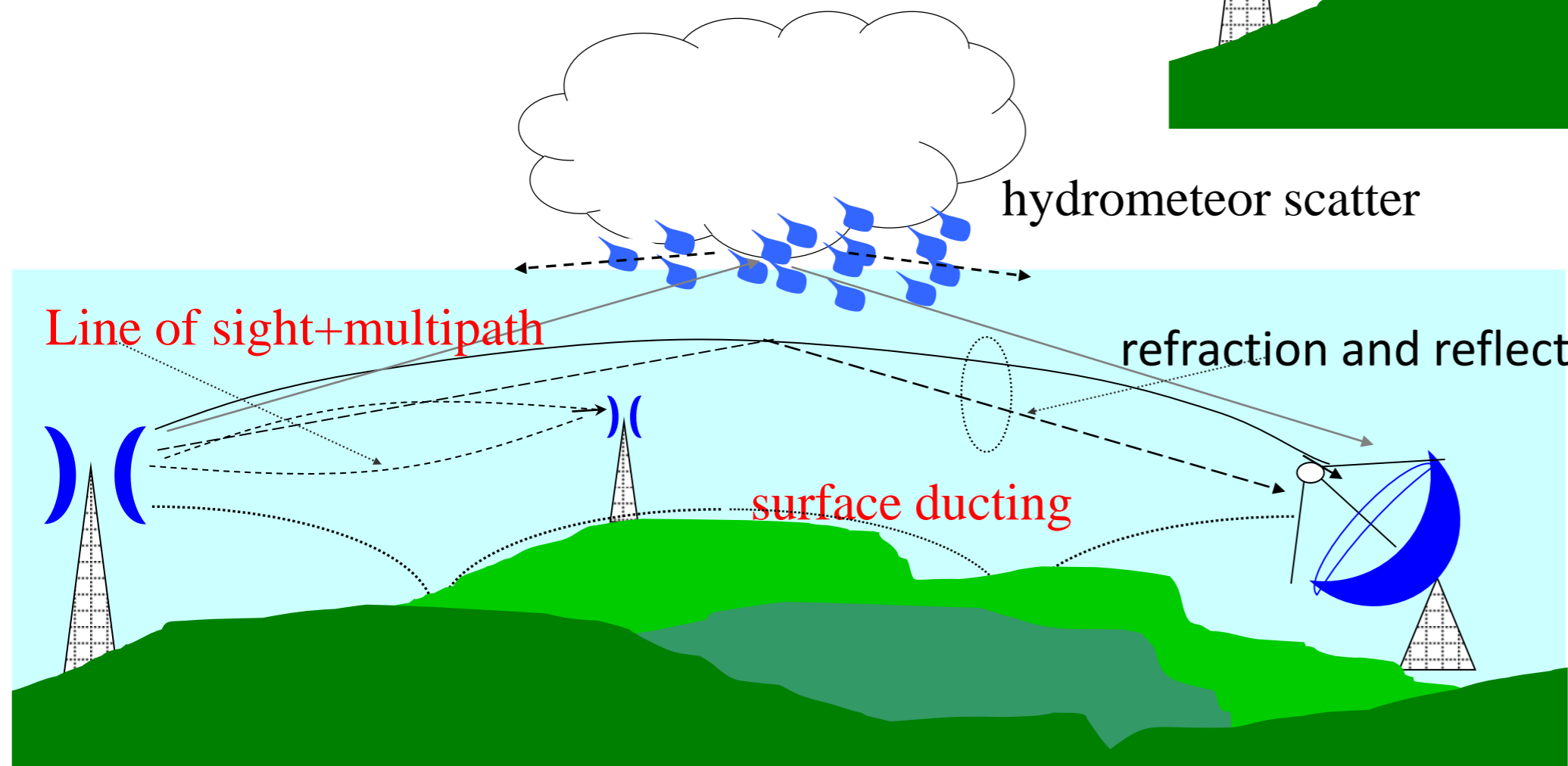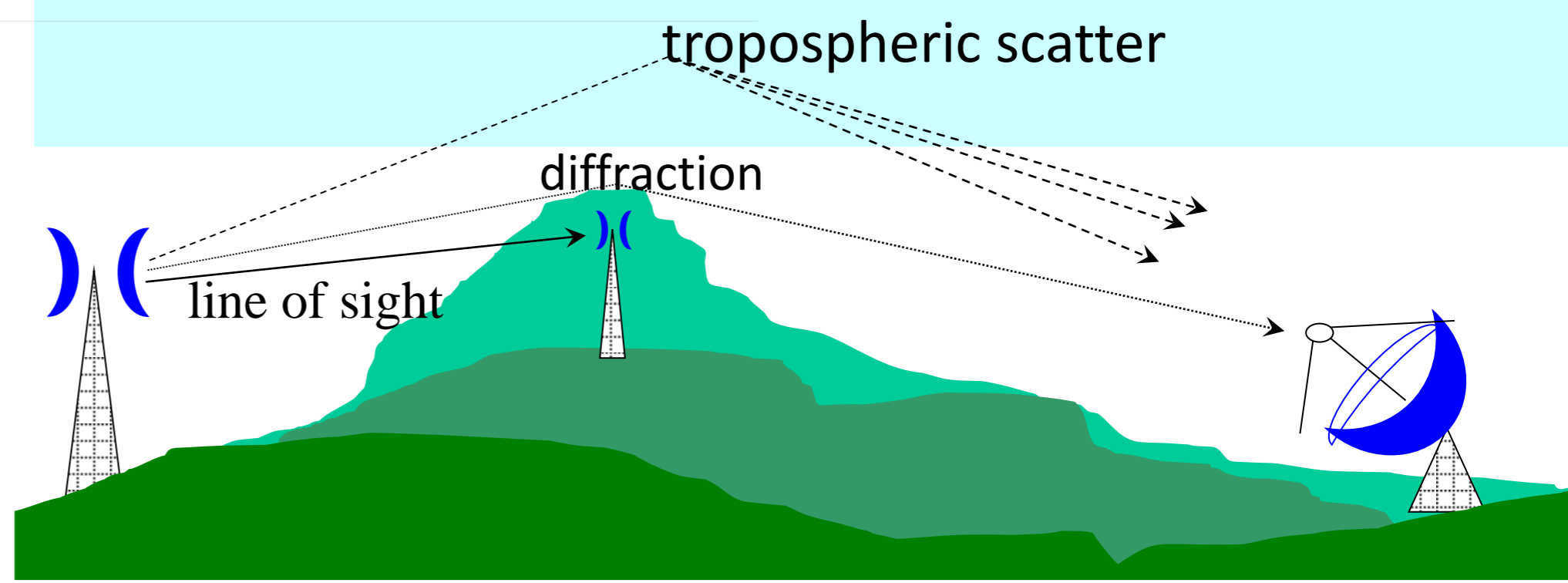
tropospheric scatter

diffraction

line of sight

hydrometeor scatter

Line of sight+multipath

refraction and reflection

⇦ Short term

surface ducting

Propagation

State Radio Monitoring Center of China
Frequency Engineering Department

ITU Rec. P.1546 : coverage prediction

- Curves represent field strength exceeded at 50% of locations for 1kW ERP transmission as function of:
  - Frequency:1-3G, 100, 600, 2000 MHz
  - Time: 50%, 10%, 1%
  - Tx antenna height: 10 to 1200 m; Rx antenna height: local clutter height (minimum 10 m)
  - Path type: land, warm sea, cold sea
  - Distance: 1 to 1000 km
  - Interpolation method for all of above
- Curves are based on extensive measurement campaigns in Europe, North America, the North Sea and Mediterranean.

2 000 MHz, land, 10% time
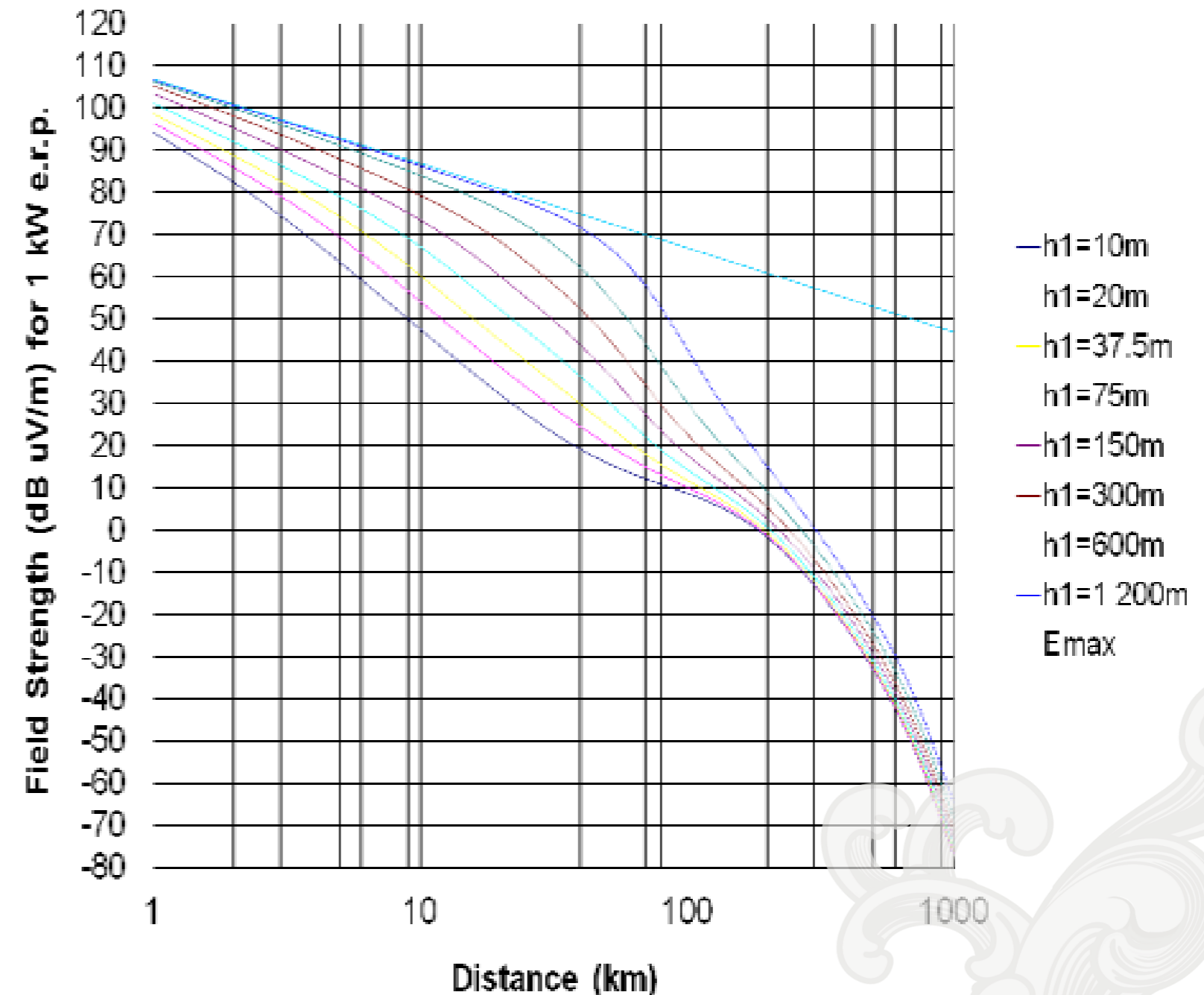
Hata/COST 231: CEPT ERC Rep. 68, average path loss

- The scope of application

 d: 1-100km

F: 100-3000MHz

T: 50%

Height of antenna: 20～200m

Height of mobile: 1～10m

Condition: Urban, suburban, rural

$$E = 69.82 - 6.16 \log f + 13.82 \log H_1 + a(H_2) - (44.9 - 6.55 \log H_1)(\log d)^b$$

Appendix 7:

- Coordination contour around a satellite earth station

- ITU-R SM.1448

- 100MHz-105GHz

- Mode 1: great circle smooth earth propagation

   similar to P.452

- Mode 2: hydrometeor scatter

CONTOURS DE COORDINATION DE LA STATION TERRIENNE DE TRANSMISSION
TRANSMITTING EARTH STATION COORDINATION CONTOURS
CONTORNOS DE COORDINACION DE LA ESTACION TERRENA TRANSMISORA

OTCS   J /J
127E540126N2953
GOSAT
2043.7- 2044.8 MHZ

506540541
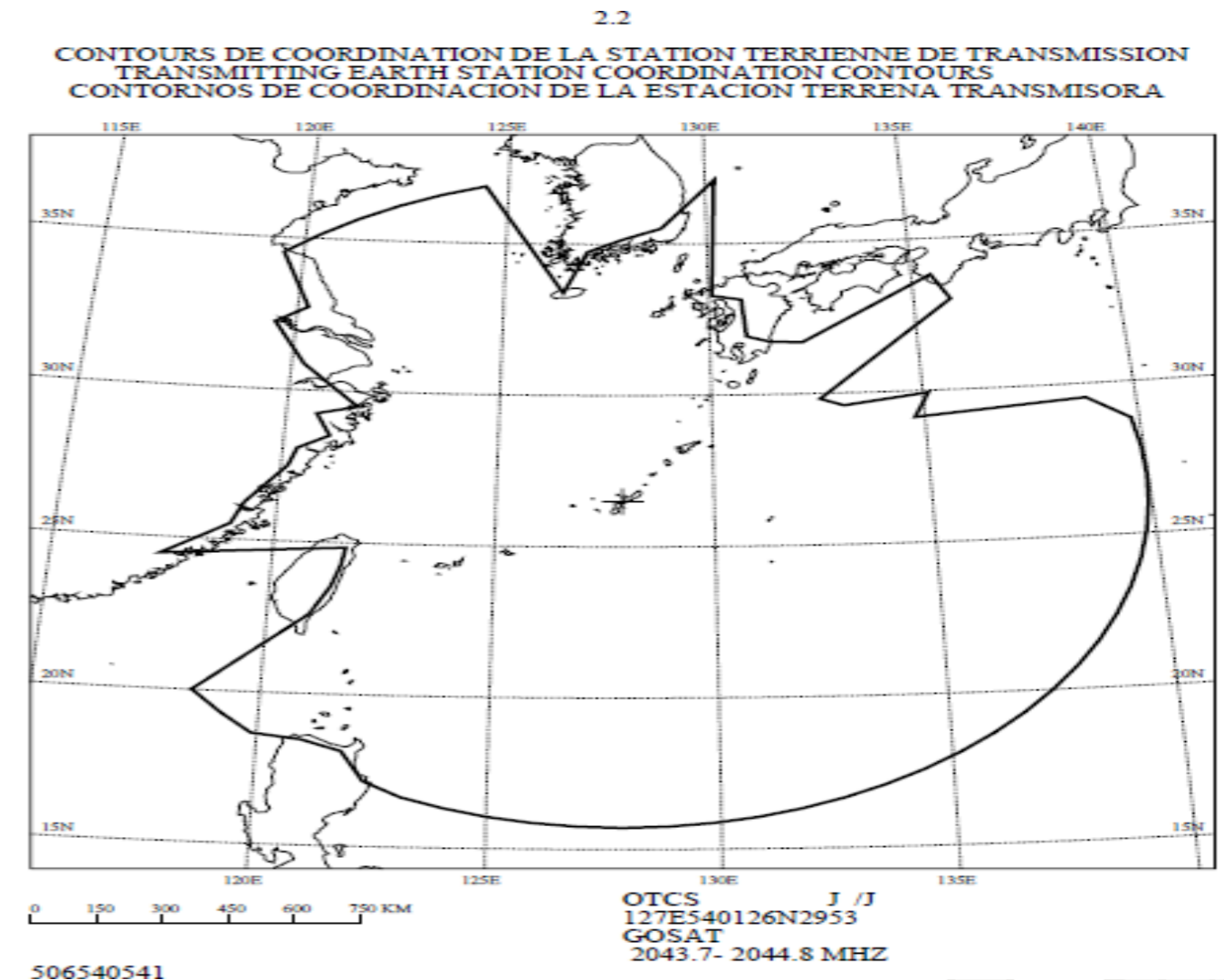
State Radio Monitoring Center of China
Frequency Engineering Department

5. Methods

Land Mobile Service

- In the case of the Land Mobile Service the effective radiated power and the effective antenna height of stations shall be chosen so that their range is confined to the area to be covered.
- Excessive antenna heights and transmitter outputs shall be avoided by using several locations and low effective antenna heights.
- Directional antennas shall be used in order to minimise the potential of interference to the neighbouring country.

Fixed Service

- The effective radiated power and the antenna height of stations in the Fixed Service shall be chosen according to the radio links lengths and the required quality of service.
- Excessive antenna heights, excessive transmitter outputs and too low antenna directivities shall be avoided in order to minimise the potential of interference to the country affected.

Methods

Mobile Service Coordination

- Station by station coordination
- Agreement:

– **Preferential frequency:**

Frequencies which the Administrations concerned may assign, without prior co-ordination, on the basis of bi- or multilateral agreements, greater flexibility and can operate at higher powers

–**Non-preferential frequency:**

The frequency which was used by the other Administrations as preferential frequency

–**Share frequency:**

Frequencies which may be shared without prior co-ordination, on the basis of bi- or multilateral agreements

–**Frequencies using preferential codes:**

Frequencies which the Administrations concerned may assign, without prior co-ordination, on the basis of bi- or multilateral agreements

Methods

Frequency Separation

Synchronization

Country A

Country B
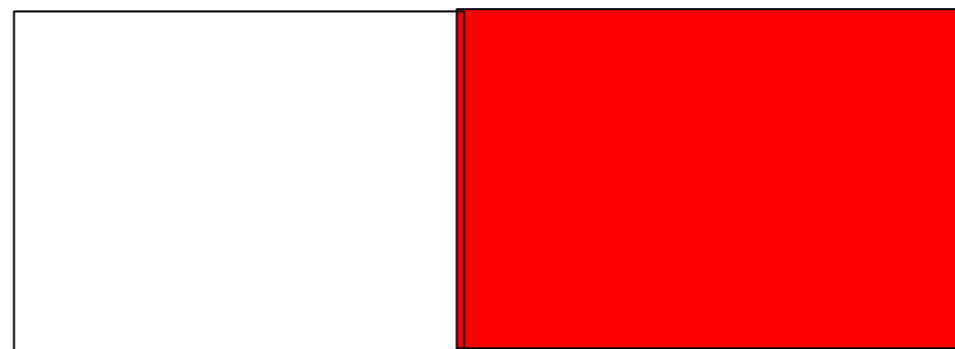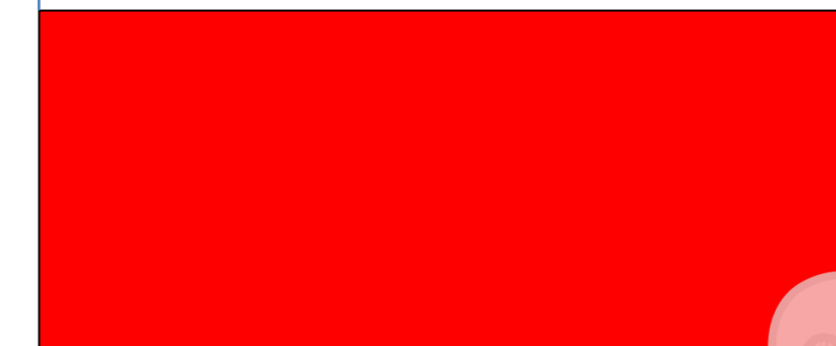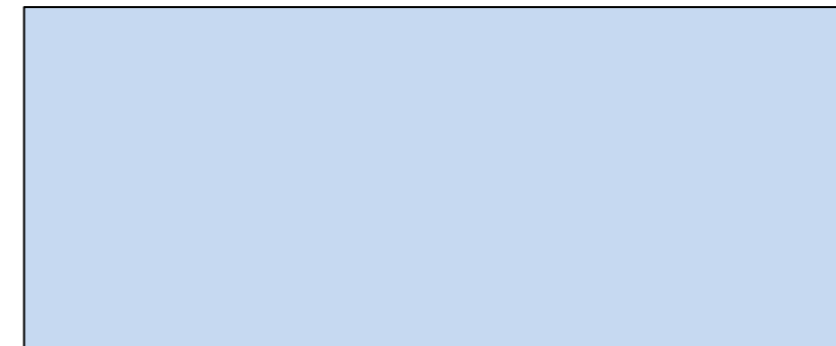
Methods

Country X

Country Y

Border line

BS2

BS1

Preferential frequency

BS2

Non-preferential frequency

Share frequency

Share frequency

Coordination area

d Km

d Km

Methods

Example of Preferential Frequency

1 18	19 25	26 42	43 59	60 66	67 83	84 87	88 95 104	105 112	113 124
A	shared	B	B	shared	A		B	shared	A

Preferential :
    L1=d1 km,   E1≤
non-preferential:
    L2=d2 km,   E2≤
shared channels:
    L3=d3 km,   E3≤

L=cross-border distance
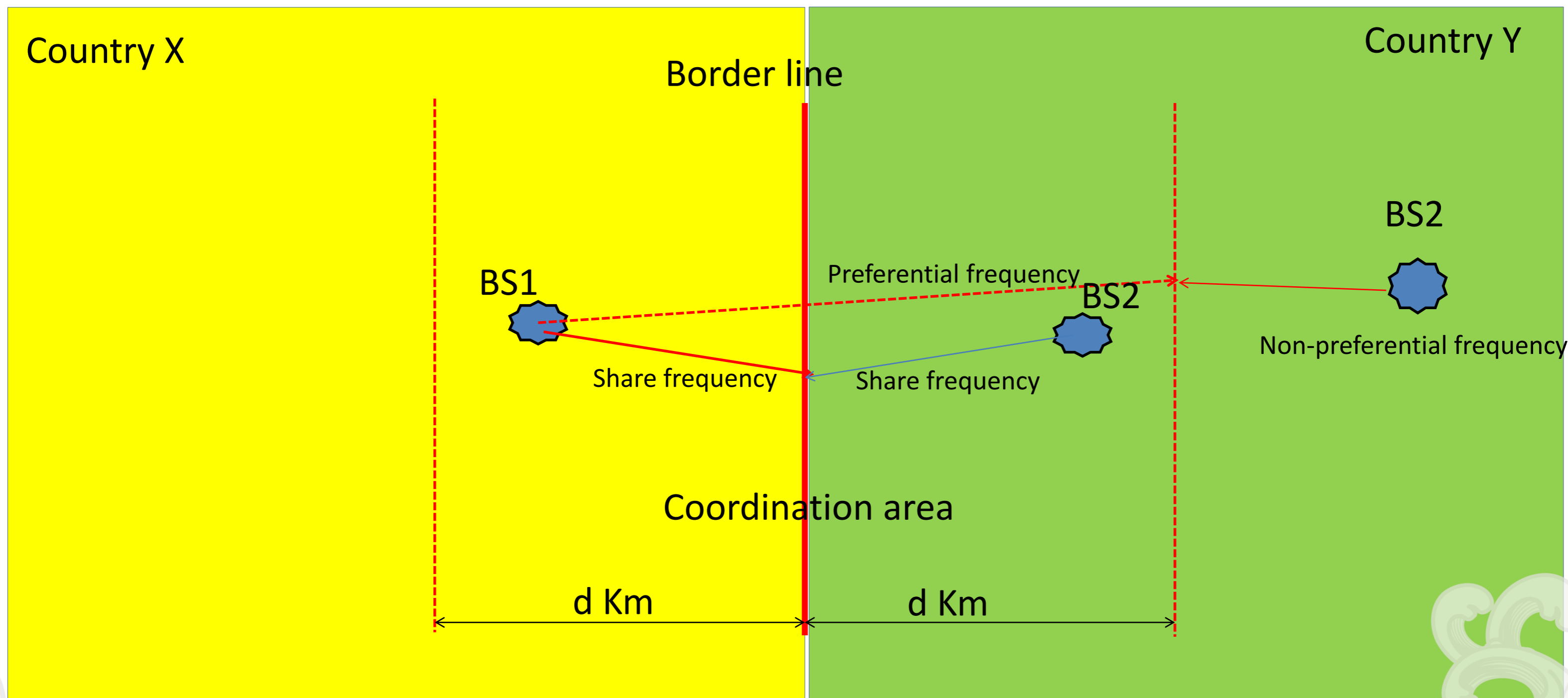
Methods

Rec. SM.1049

Table

Frequency Bands (MHz)	Max. Field Strength of Interference Allowed dB(μV/m)	Max. Range of Interference on the Border km
29.7-47.0	0	100
47.0-108.0	6	100
108.0-380.0	12	80
380.0-400.0	18	60
400.0-606.0	20	50
606.0-960.0	26	30

- produces an interference field strength exceeding the maximum permissible value as given the form at a station entered in the Frequency Register or completing coordination
- does not meet the conditions governing the maximum cross-border ranges of harmful interference as given in the form.
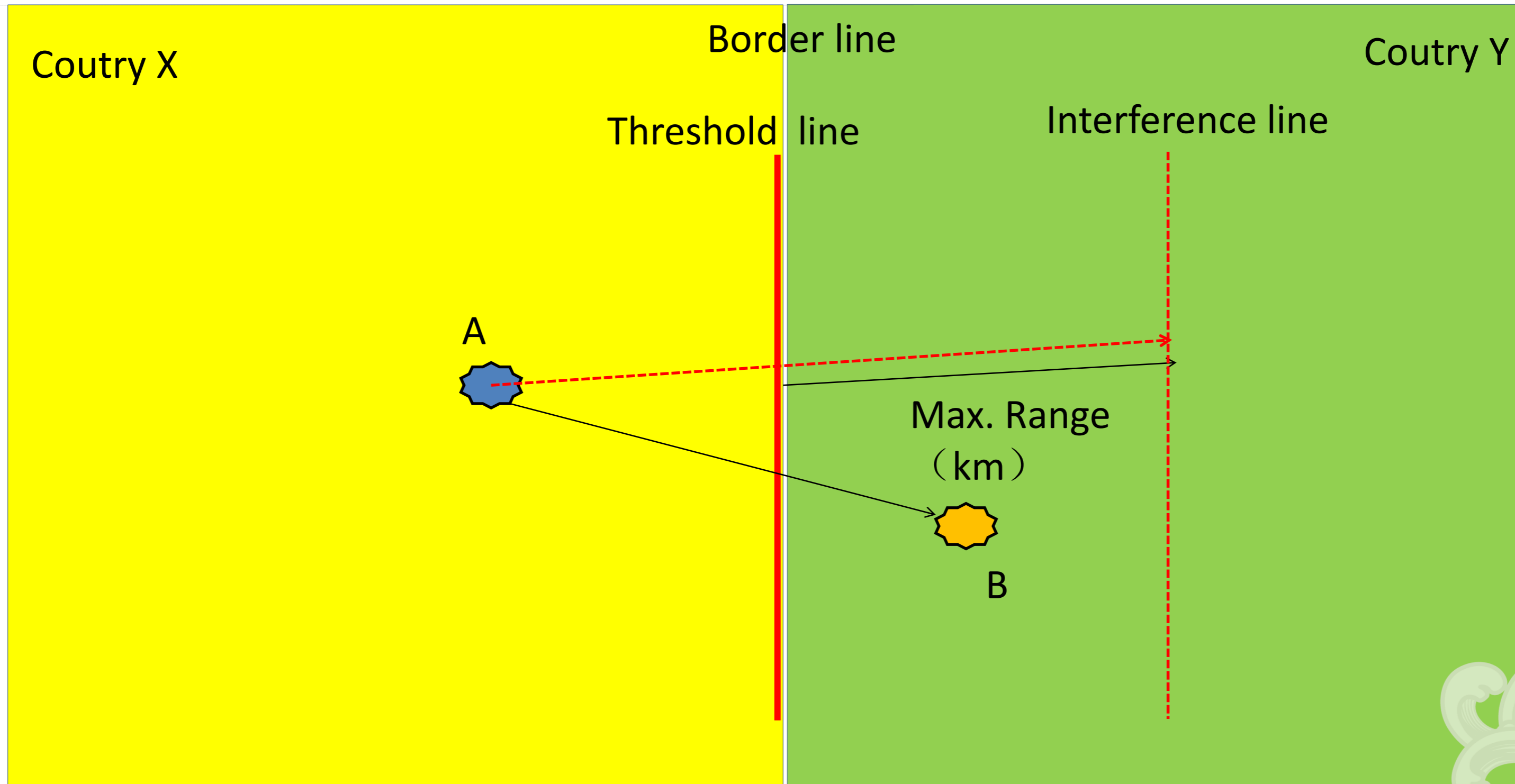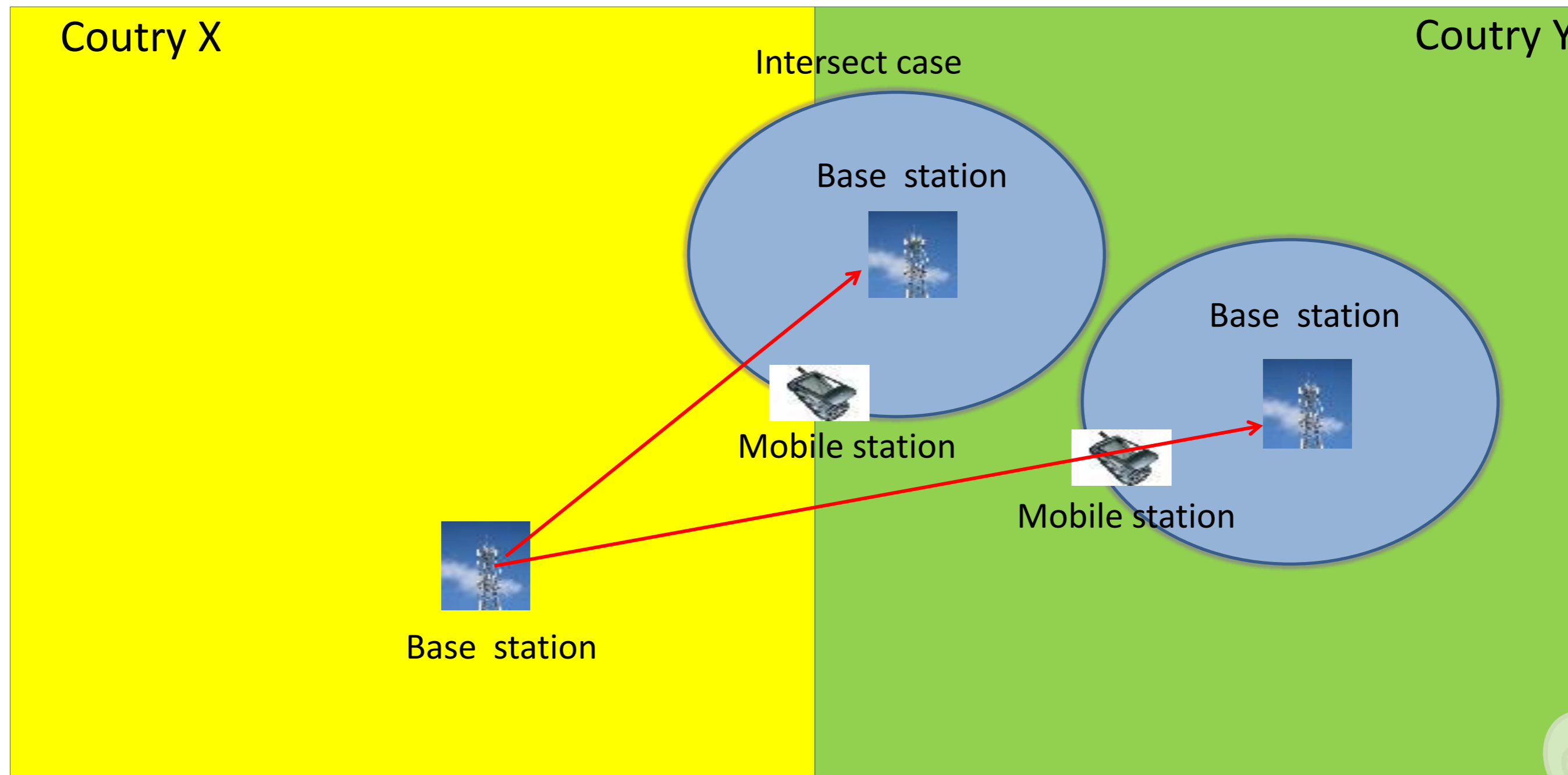
Fixed Service Coordination

1.1 The co-ordination distance depends on the frequency range. The distances in the following table are recommended:

Frequency range [GHz]	Co-ordination distance [km]
1 - 5	200*
>5 - 10	150*
>10 - 12	100
>12 - 20	80
>20 - 24.5	60
>24.5 - 30	40
>30 - 39.5	30
>39.5 - 43.5	20

* The co-ordination distance for frequencies below 10 GHz is limited to 100 km for antenna heights below 300m above sea level.
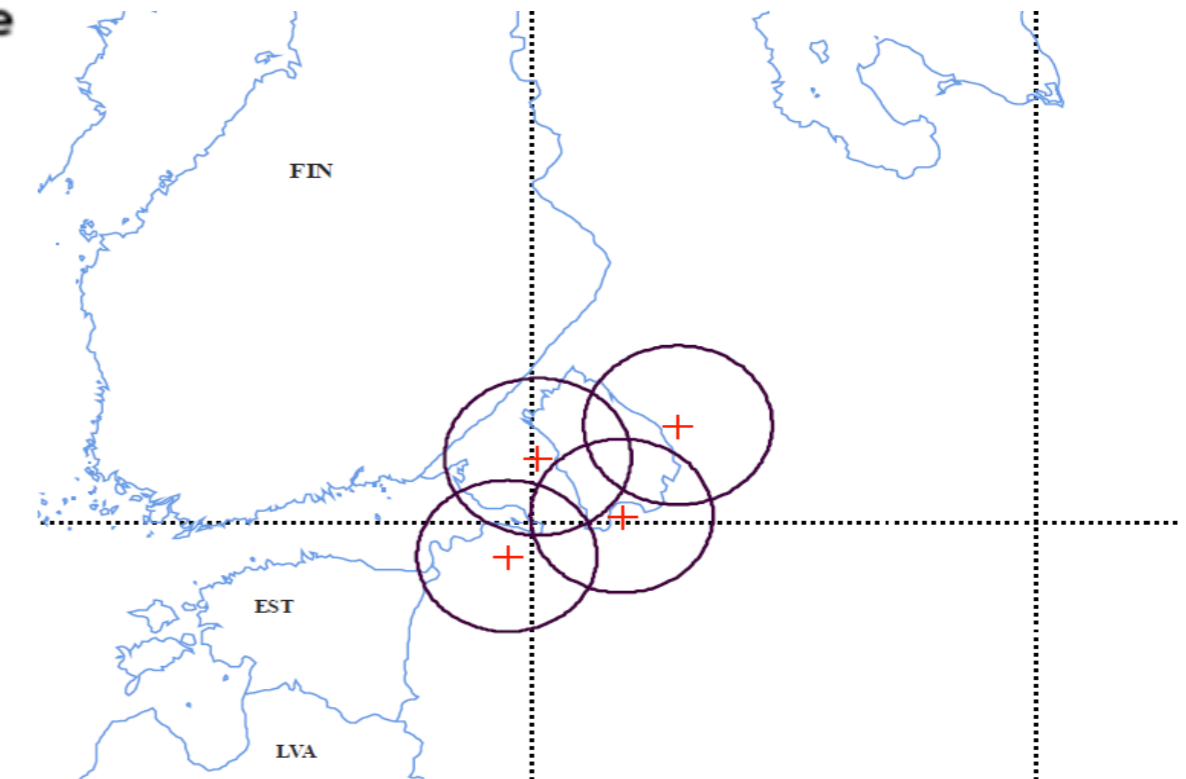
Note: All stations which may cause harmful interference to stations in other countries or need protection shall be coordinated regardless of the distance.

Guidance for bilateral-multilateral discussions on the use of frequency range 1 350 MHz - 43.5 GHz by fixed service systems

ITU-R Rec.F.1095: Coordination distance between stations of fixed service
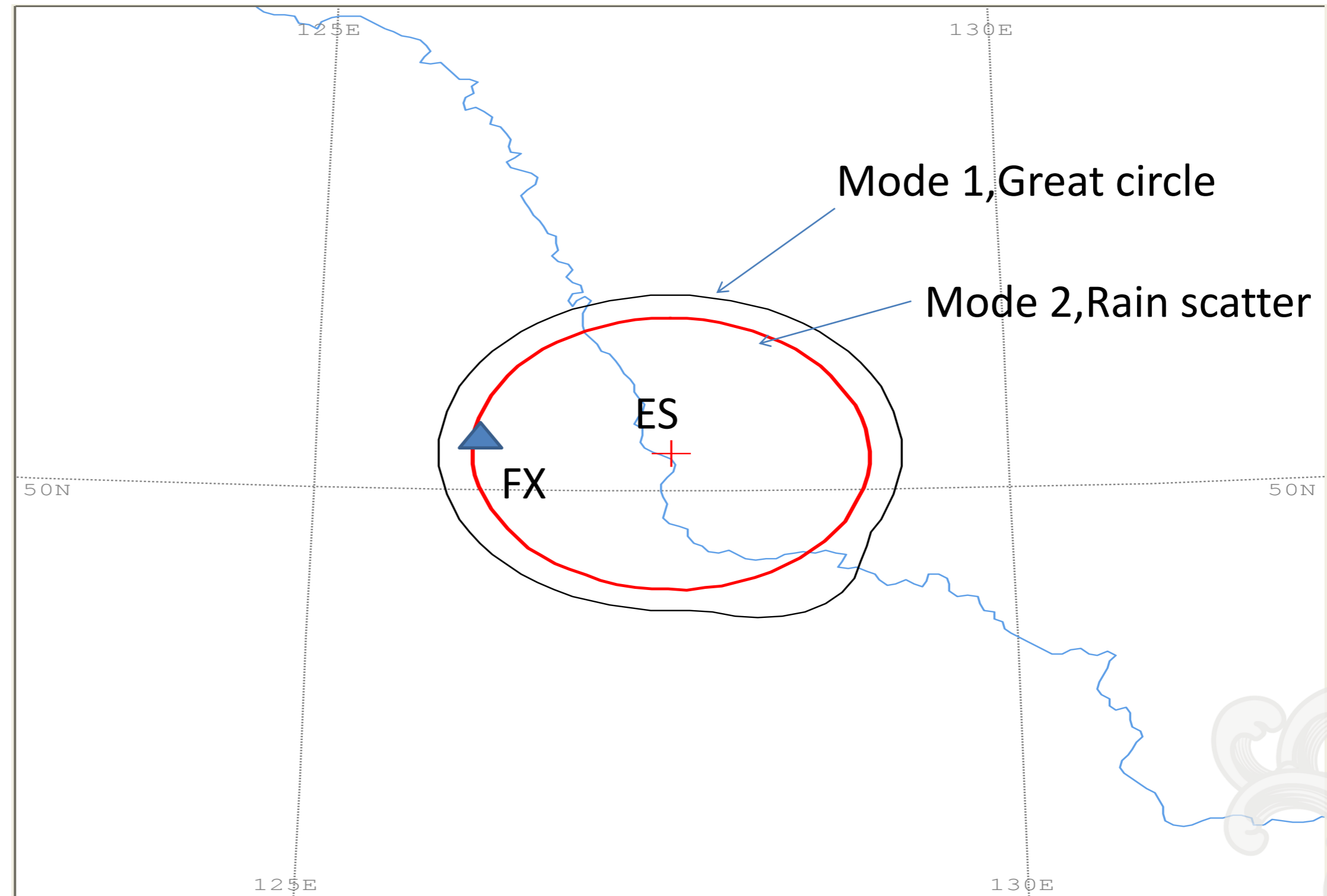
Methods State Radio Monitoring Center of China
Frequency Engineering Department

Rec. SF.1006: Max. Permitted Interference

Mode 1: Long term

$$P_r(p_1) = 10 \log(kT_rB) + J - W \qquad \text{dBw}$$

Mode 2: Short term

$$P_r(p_2/n_2) = 10\log(kT_rB) + 10\log(10^{M_s/10} - 1) + N_L - W \quad \text{dBw}$$

Methods

State Radio Monitoring Center of China
Frequency Engineering Department

Frequency range (GHz)		1-10		1-10	1-10		10-15		10-15		15-40	15-40
Service of interfering system		Fixed-satellite		Fixed-satellite	Fixed		Fixed		Fixed-satellite		Fixed	Fixed-satellite
Wanted system	Service	Fixed		Fixed	Fixed-satellite		Fixed-satellite		Fixed		Fixed-satellite	Fixed
	Station type	Radio-relay		Trans-horizon	Earth station		Earth station		Radio-relay		Earth station	Radio-relay
	Modulation	A	N	A	A	N	A	N	A	N	N	N
p_1 (%)		20	20	20	20	20	20	20	20	20	20	20
p_2 (%)		0.01	0.005	0.01	0.03	0.005	0.03	0.005	0.01	0.005	0.003	0.005
n_2		2	3	1	3	3	2	2	2	3	2	1
B (Hz)		4×10^3	10^6	4×10^3	10^6	10^6	10^6	10^6	4×10^3	10^6	10^6	10^6
J (dB)		9	−6	0 (1)	−10	−10	−8.5	−8.5	13	−2 (2)	−7	0 (2)
W (dB)		0	0	0	4	0	4	0	0	0	0	0
T_r (K) (3)		750	750	500	100	100	200	200	1 500	1 500	300	3 200
M_s (dB)		33	37	26	2	2	4	4	33	37	6	25
N_L (dB)		0	0	0	1	1	1	1	0	0	1	0

Sharing between terrestrial and space service

- **Share band:**
  - allocation to both of the service with equal rights
  - >100MHz, more than 60 bands are shared bands

- **Protection of space service from terrestrial service:**
  - Protection of receiving space station(uplink): Article 21

    Power limit :21.5,

    Max. e.i.r.p: 21.3

    e.i.r.p to GSO: 21.4

  - Protection of receiving earth station(downlink):

    Appendix 7, coordination required when a terrestrial transmitting station is located within coordination area

Methods

Max. e.i.r.p for Transmitting Station in Fixed and Mobile Service to Protect satellite:
RR 21.2, 21.3 etc.

TABLE **21-1**

Frequency band (GHz)	e.i.r.p. value (dBW) (see also Nos. 21.2 and 21.4)	Minimum separation angle with respect to geostationary-satellite orbit (degrees)
1-10	+35	2
10-15	+45	1.5
25.25-27.5	+24 (in any 1 MHz band)	1.5
Other bands above 15 GHz	+55	No limit[3]
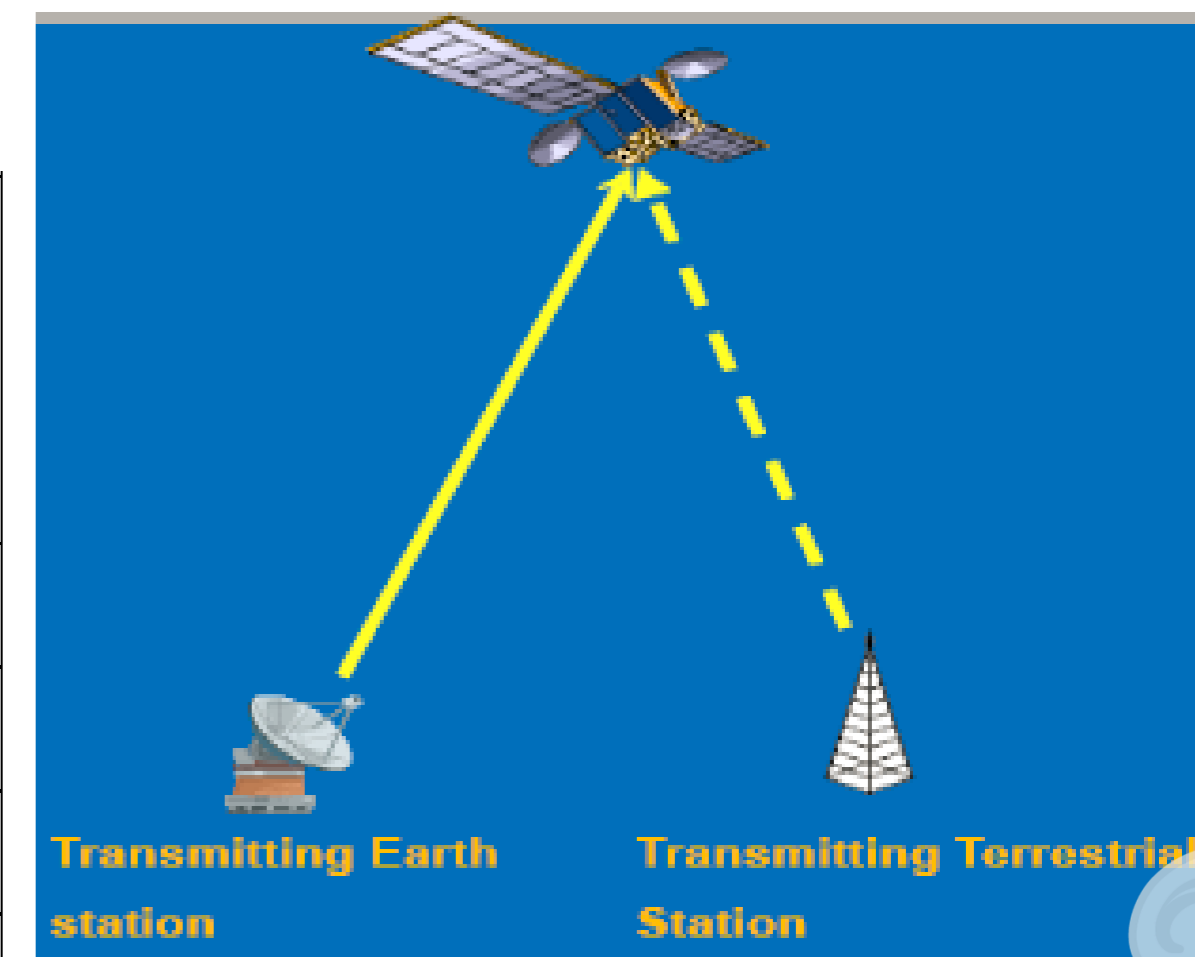
Transmitting Earth station

Transmitting Terrestrial Station

Protection of terrestrial service from space service :

– Protection of receiving terrestrial service from space station(downlink) : pfd in 21.4

– Protection of receiving terrestrial service from transmitting earth station (uplink):

Appendix 7, coordination is required when a receiving terrestrial station is located within coordination area of transmitting ES

RR 21.14,21.15: Minimum angle of elevation for ES

RR 21.8,21.10: Power limits for ES

Methods

State Radio Monitoring Center of China
Frequency Engineering Department

Power Flux-Density(pfd) to Protect Terrestrial Service From Space Stations

TABLE 21-4 (Rev.WRC-07)

Frequency band	Service*	Limit in dB(W/m²) for angles of arrival (δ) above the horizontal plane					Reference bandwidth
		0°-5°		5°-25°		25°-90°	
1 670-1 700 MHz	Earth exploration-satellite Meteorological-satellite	−133 (value based on sharing with meteorological aids service)					1.5 MHz
1 518-1 525 MHz (Applicable to the territory of the United States in Region 2 between the longitudes 71° W and 125° W)	Mobile-satellite (space-to-Earth)	$0° \leq \delta \leq 4°$	$4° < \delta \leq 20°$	$20° < \delta \leq 60°$	$60° < \delta \leq 90°$		4 kHz
		−181.0	$-193.0 + 20\log\delta$	$-213.3 + 35.6\log\delta$	−150.0		

Receiving Terrestrial station

Methods

Example of EMC Software
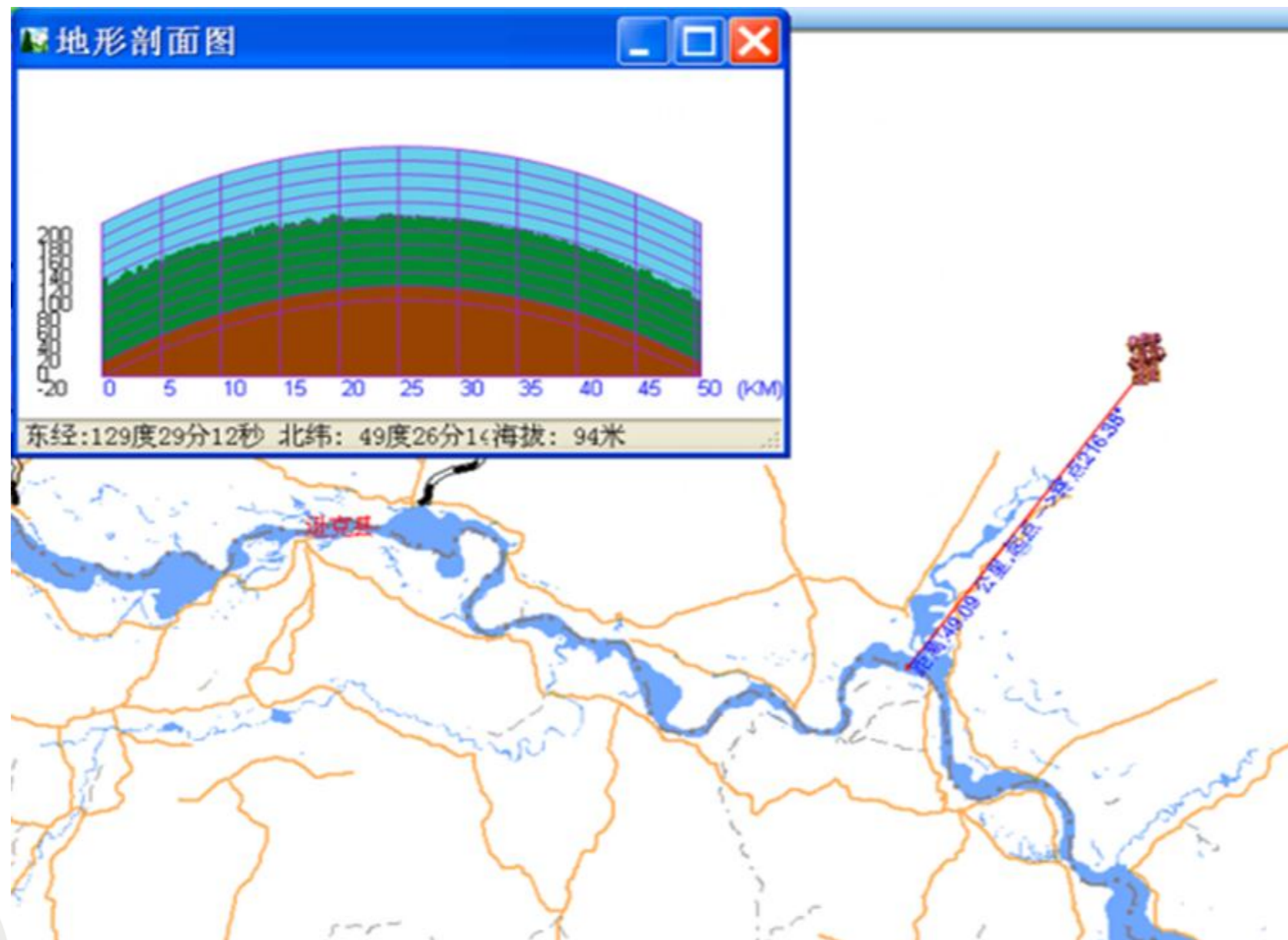
Methods

State Radio Monitoring Center of China
Frequency Engineering Department

Methods

State Radio Monitoring Center of China
Frequency Engineering Department

Monitoring

Frequency measurement result of the FFT-based monitoring system using Hanning weighting (400 lines FFT)

Carrier 1 = 872 999.843 Hz

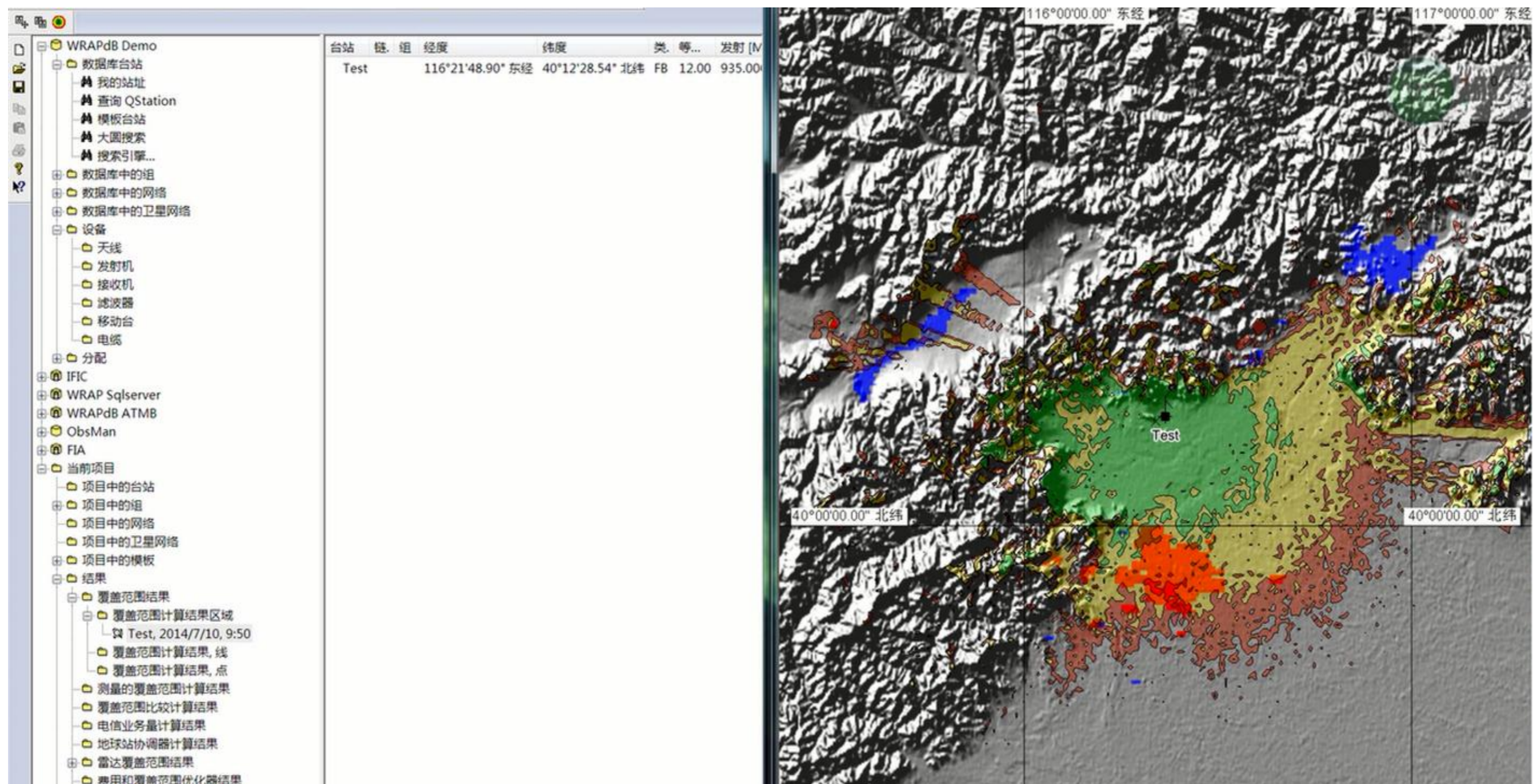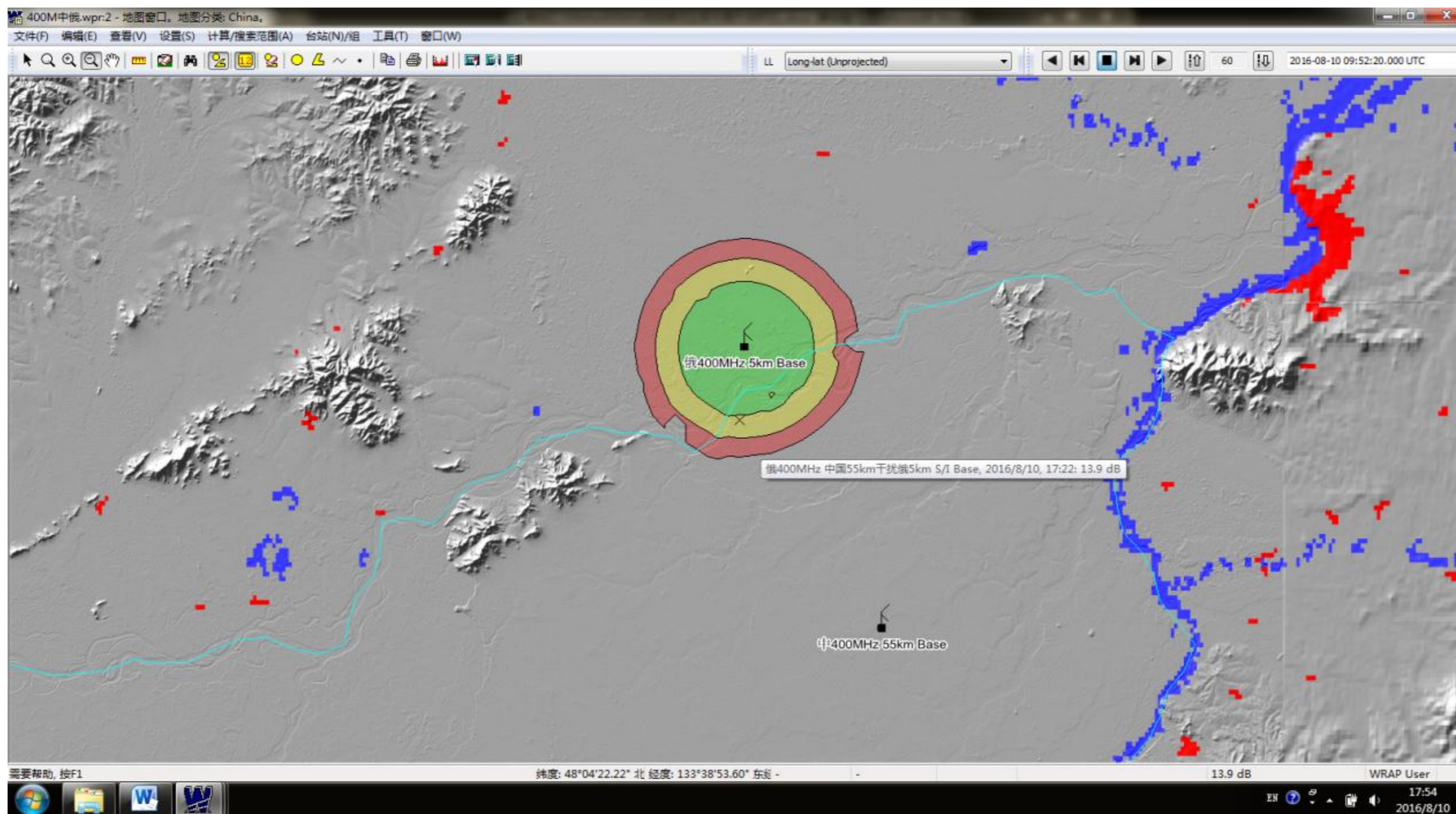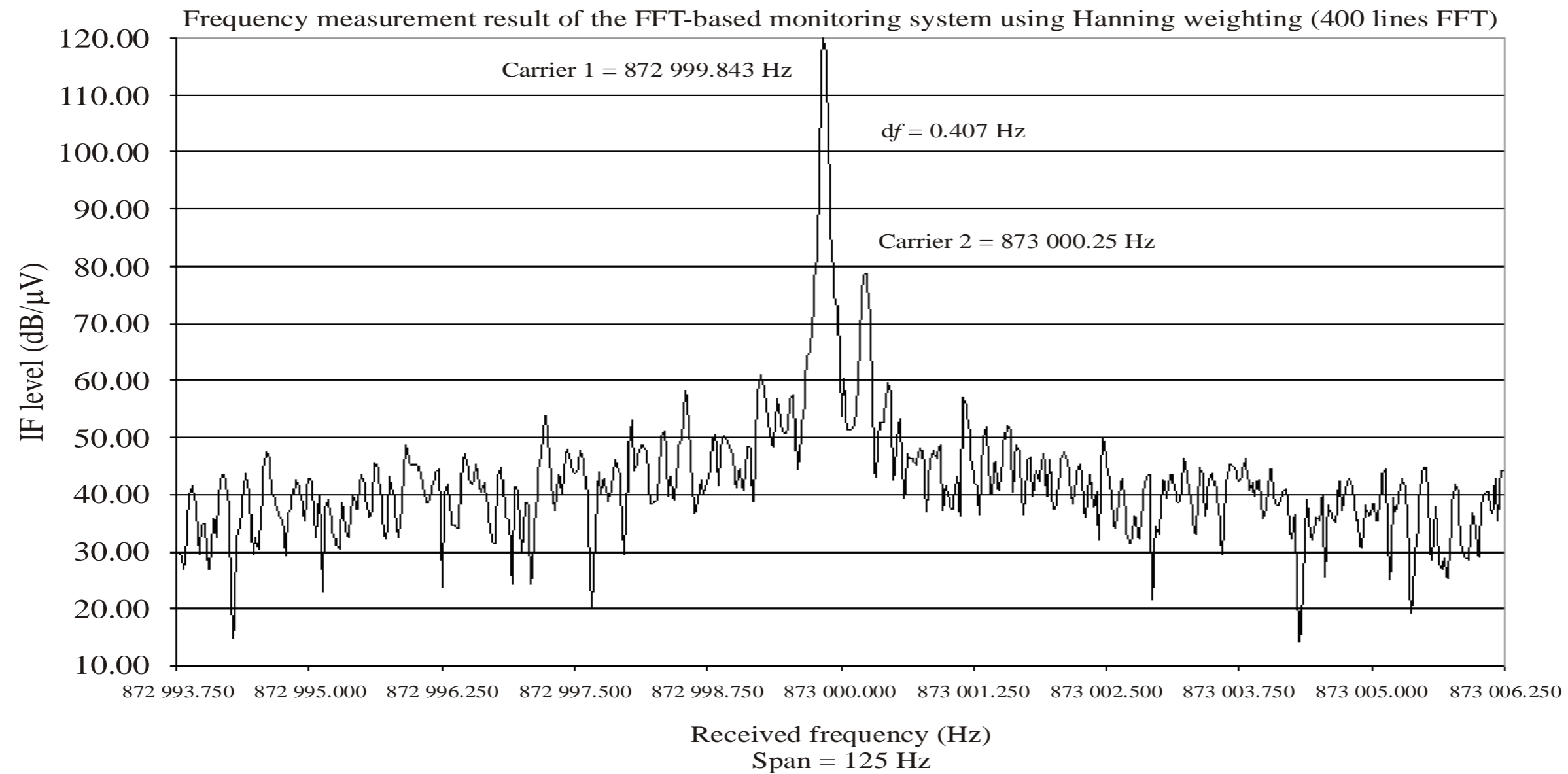df = 0.407 Hz

Carrier 2 = 873 000.25 Hz

Received frequency (Hz)
Span = 125 Hz

Spectrum-4.2-04

Methods

State Radio Monitoring Center of China
Frequency Engineering Department

Harmful Interference : Appendix 10

AP10-1

APPENDIX 10 (REV.WRC-07)

Report of harmful interference

(See Article **15**, Section VI)

Particulars concerning the station causing the interference:

a   Name, call sign or other means of identification   ....

b   Frequency measured   ....

        Date: ....

        Time (UTC):   ....

c   Class of emission[1]   ....

d   Bandwidth (indicate whether measured or estimated)   ....

e   Measured field strength or power flux-density[2]   ....

        Date: ....

        Time (UTC):   ....

f   Observed polarization   ....

g   Class of station and nature of service   ....

h   Location/position/area/bearing (QTE[3]) (WRC-07)   ....

i   Location of the facility which made the above measurements   ....

Particulars concerning the transmitting station interfered with:

j   Name, call sign or other means of identification   ....

k   Frequency assigned   ....

AP10-2

l   Frequency measured   ....

        Date: ....

        Time (UTC):   ....

m   Class of emission[4]   ....

n   Bandwidth (indicate whether measured or estimated, or indicate the necessary bandwidth notified to the Radiocommunication Bureau)   ....

o   Location/position/area   ....

p   Location of the facility which made the above measurements   ....

Particulars furnished by the receiving station experiencing the interference:

q   Name of station   ....

r   Location/position/area   ....

s   Dates and times (UTC) of occurrence of harmful interference   ....

t   Bearings (QTE[5]) or other particulars (WRC-07)   ....

u   Nature of interference   ....

v   Field strength or power flux-density of the wanted emission at the receiving station experiencing the interference[6]   ....

        Date: ....

        Time (UTC):   ....

w   Polarization of the receiving antenna or observed polarization   ....

x   Action requested   ....

NOTE – For convenience and brevity, telegraphic reports shall be in the format above, using the letters in the order listed in lieu of the explanatory titles, but only those letters for which information is provided should be used. However, sufficient information shall be provided to the administration receiving the report, so that an appropriate investigation can be conducted.

Remarks

International Coordination Is:

- Based on Regulation and Bilateral Agreement
- Right and obligation
- Share frequency bands on equal basis
- A kind of technical measures to safeguard the interests for both countries

Thanks