Coordination of broadcasting and fixed services

N. Vassiliev
Radiocommunication Bureau, ITU

International Telecommunication Union

Introduction

- Sharing situation
  - Country A uses television broadcasting service
  - Country B uses land mobile service (cellular)
- Objectives:
  - Determine interference distances between TV and mobile
  - Determine possible measures for sharing
  - Coordinate stations in the border area
- Steps of coordination
  - Identification of affected administration i.e. need for coordination
  - Detailed coordination, using real parameters and terrain

Identification of affected administrations

- Criteria: trigger field strength (TFS) at the border. If interference field strength exceeds the trigger -> coordination is necessary
- Method:
  - to determine protection requirements (TFS) for broadcasting and mobile services
  - to determine station parameters and network topology; if not known, make assumptions
  - to choose propagation model, percentage of time and locations, effective antenna heights
  - to calculate interfering field strength at the border and compare with TFS
  - To identify affected administrations

Trigger field strength

- Where to find
  - Recommendations ITU-R (LMS: SM.851 , DTT: BT. 1368, BT. 2033)
  - Regional agreements, e.g. GE06
  - Values agreed between countries concerned
- Example of TFS (GE06)

Coordination trigger field strength for the protection of the Broadcasting Service	
Protection of the analogue TV	22 dBµV/m/8 MHz at 10 m at the border
Protection of the digital TV	25 dBµV/m/8 MHz at 10 m at the border
Coordination trigger field strength for the protection of the Mobile Service	
Protection of the mobile station	31,2 dBµV/m/8 MHz (NB) at 1,5 m
Protection of the base station	18 dBµV/m/8 MHz (NA) at 20 m 14,6 dBµV/m/8 MHz (NB) at 20 m

Calculations of TV trigger field strength

Fint = Fmed + fcorr – PR – CF

- *Fmed*: minimum median field strength (at 10 m) of victim TV system (e.g.
- 56 dBμV/m for fixed reception, 78 dBμV/m for portable outdoor reception)
- *fcorr*: frequency correction (for fixed reception, fcorr = 20 log10 (f/fr), f is the actual frequency and fr = 650 MHz ; for portable mobile, fcorr = 30 log10 (f/fr))
- *PR:* relevant protection ratio
- CF: relevant combined location correction factor (e.g. $CF = \mu\sqrt{\sigma_w^2 + \sigma_n^2}$ dB
- where σw is the standard deviation of location variation for the wanted signal (5.5dB) and σn the standard deviation of location variation for the nuisance signal (dB), and μ =1.64 is for 95% locations coverage with Recommendation ITU-R P.1546

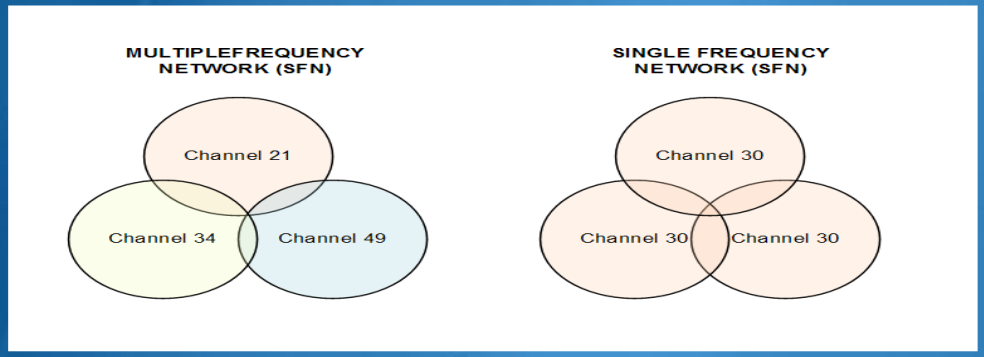
Example of interference field strength values F_{int} for DVB-T as interferer at 800 MHz, 10 m height					
Planning Configuration	F_{med} (50% of time)	f_{corr}	*PR*	*CF*	F_{int} (1% of time)
RPC-1	56.0	1.8	21.0	12.8	24.0

Examples of system parameters and network topology

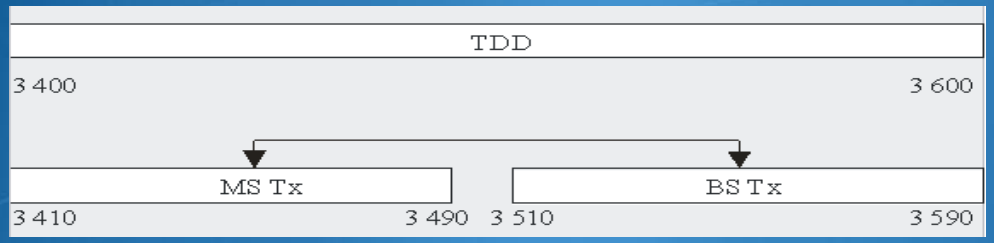
- Case 1 - interference from base stations to TV reception
  - LMS: radiated power = 27 dBW, antenna height = 60 m
  - TV: fixed reception at 10 m
- Case 2 - interference from mobile stations to TV reception
  - LMS: radiated power = 0 dBW, antenna height = 1.5 m
  - TV: fixed reception at 10 m
- Case 3 - interference from TV to base station reception
  - TV: radiated power = 33 dBW, antenna height = 150 m
  - LMS: antenna height 60 m
- Case 4 - interference from TV to mobile devices
  - TV: radiated power = 33 dBW, antenna height = 150 m
  - LMS: antenna height 60 m

Network topology

- To identify types of broadcasting networks - SFN or MFN



- To define the channelling arrangements for LMS – FDD or TDD



- TDD: base stations and users terminals transmit in the same band -> consideration of all Cases TV<-> BS or TV <-> MS
- FDD: base stations and users terminals transmit in different bands -> consideration of sharing TV<-> BS and TV <-> MS

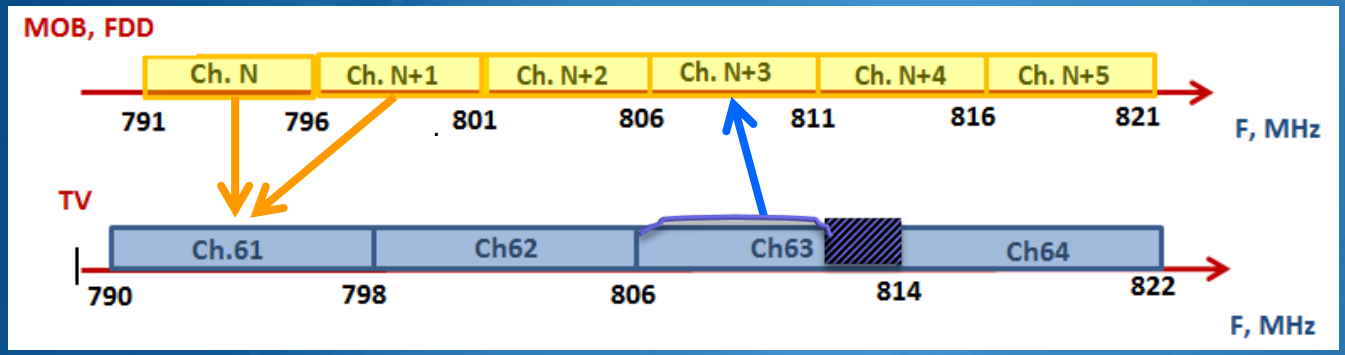
Propagation models and terrain maps

- Propagation prediction methods can be found in ITU-R Recommendations, e.g. P. 1546 (30 MHz to 3 000 MHz, no terrain), P.1812 (VHF/UHF, terrain + software), P.2001 (30 MHz to 50 GHz, software, terrain could be loaded)
- Calculations depends on frequency percentage of time and locations, effective antenna height
  - e.g. protection of TV for 50% of locations, 99% of time
  - e.g. protection of LMS for 50% of locations, 90% of time
  - h_{eff} can be identified using program:

    http://www.itu.int/SRTM3/index.html
- Use of digital maps, preferably with terrain

Calculations are complex ⟹ computer program is needed

Other elements for consideration in coordination

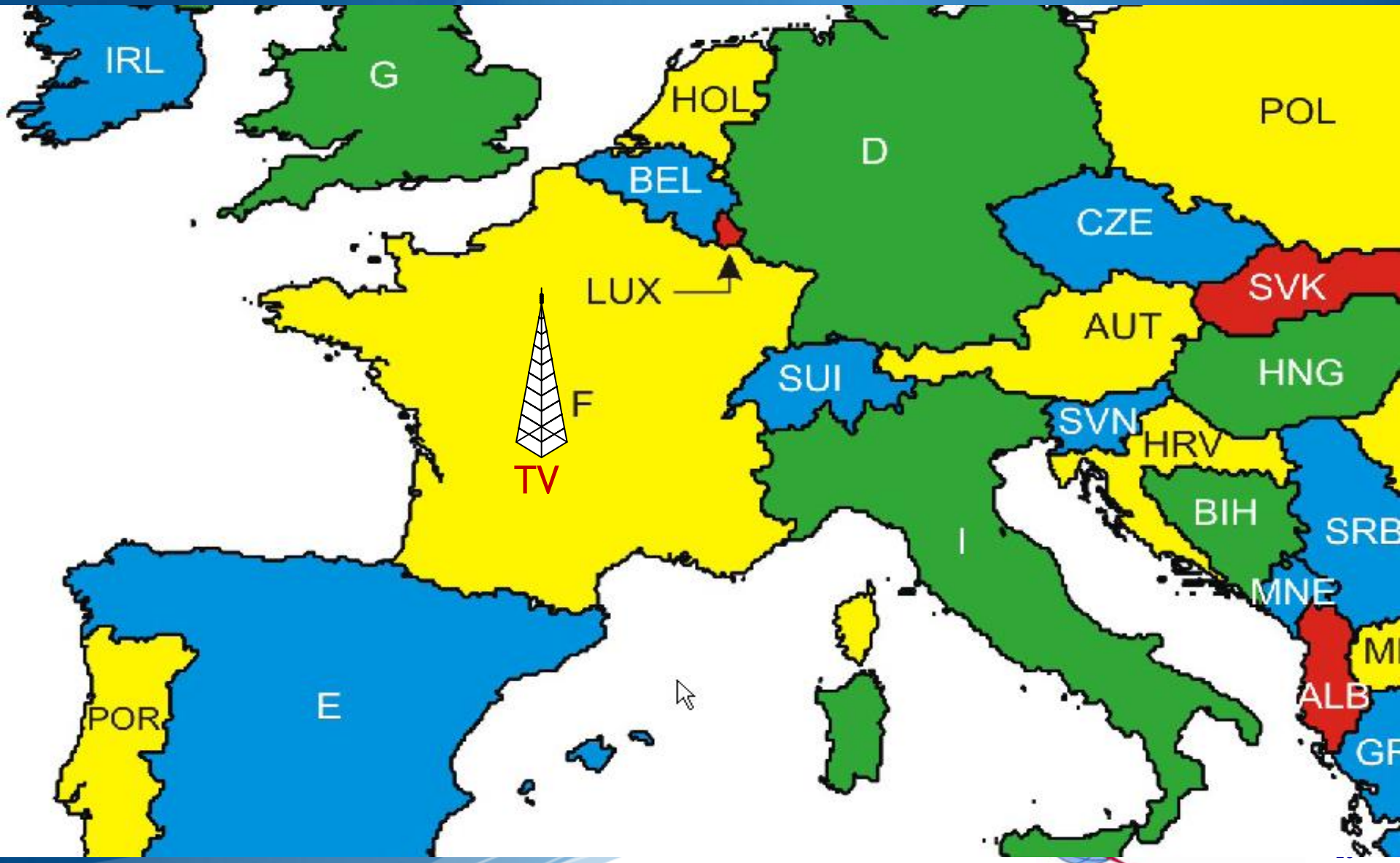


- Multiple interference from several station into one receiver -> aggregation of interference (power sum, Monte-Carlo, etc.)

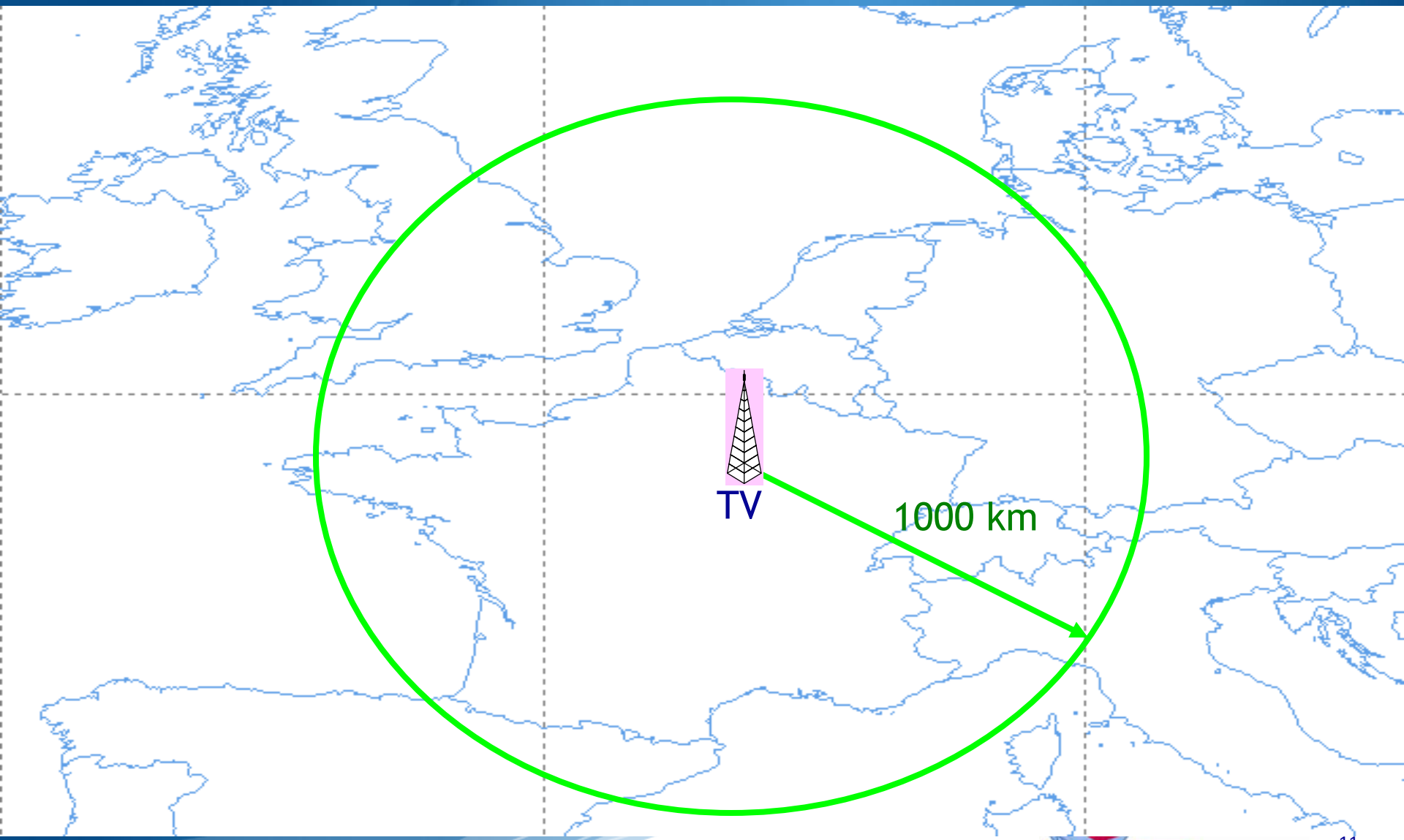
e.g.: $$\text{Sum} = 10\ \log\left(\sum 10^{\frac{E_i}{10}}\right)$$

- Sometimes only part of interfering signal enters into receiver -> overlap correction factor, e.g. $10 \log_{10} (B_o/B_v)$, where B_o - overlapping bandwidth, B_v- victim receiver bandwidth
- Adjacent channel interference

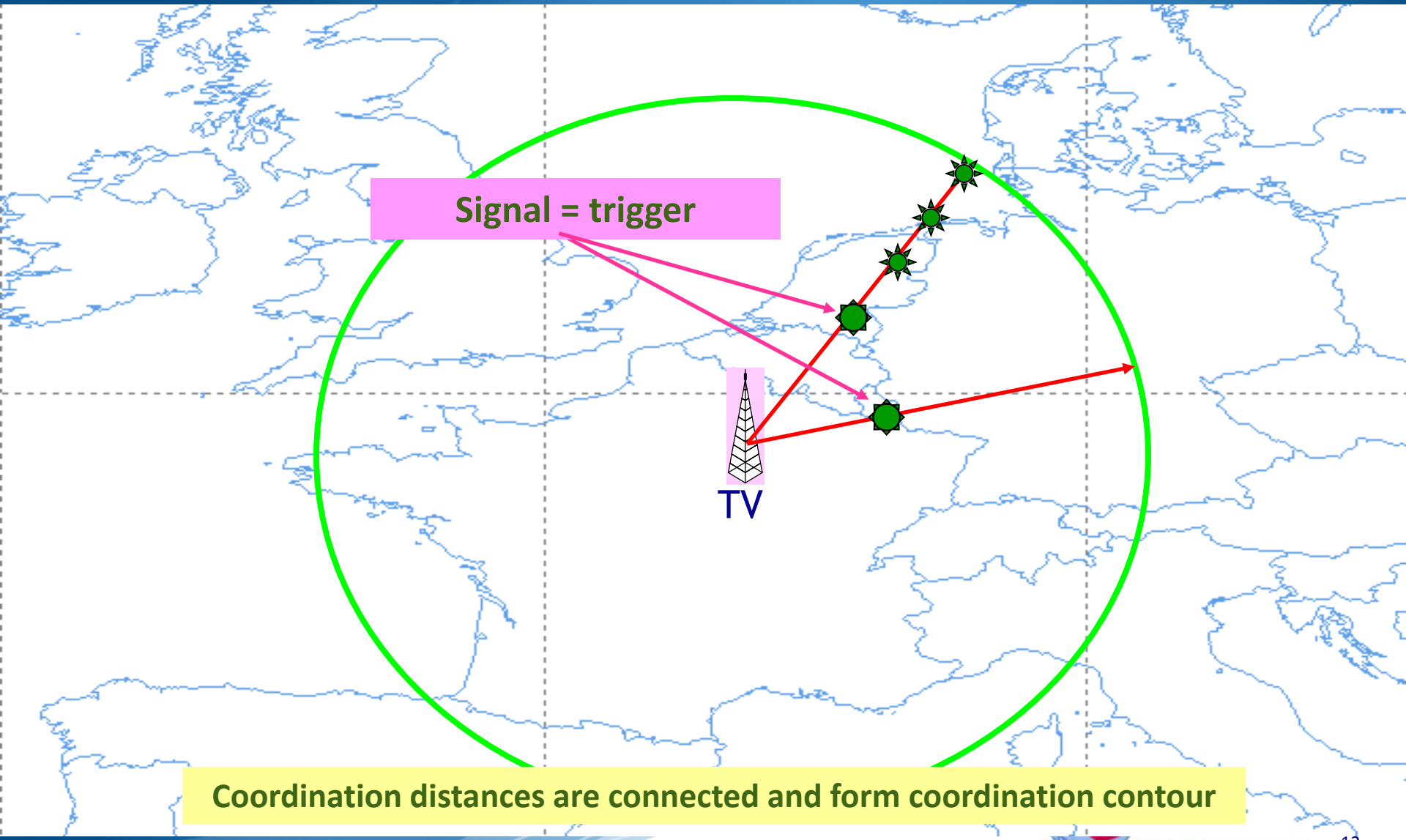
Example of method for identification of affected countries



Step 1 – construction of limiting contour

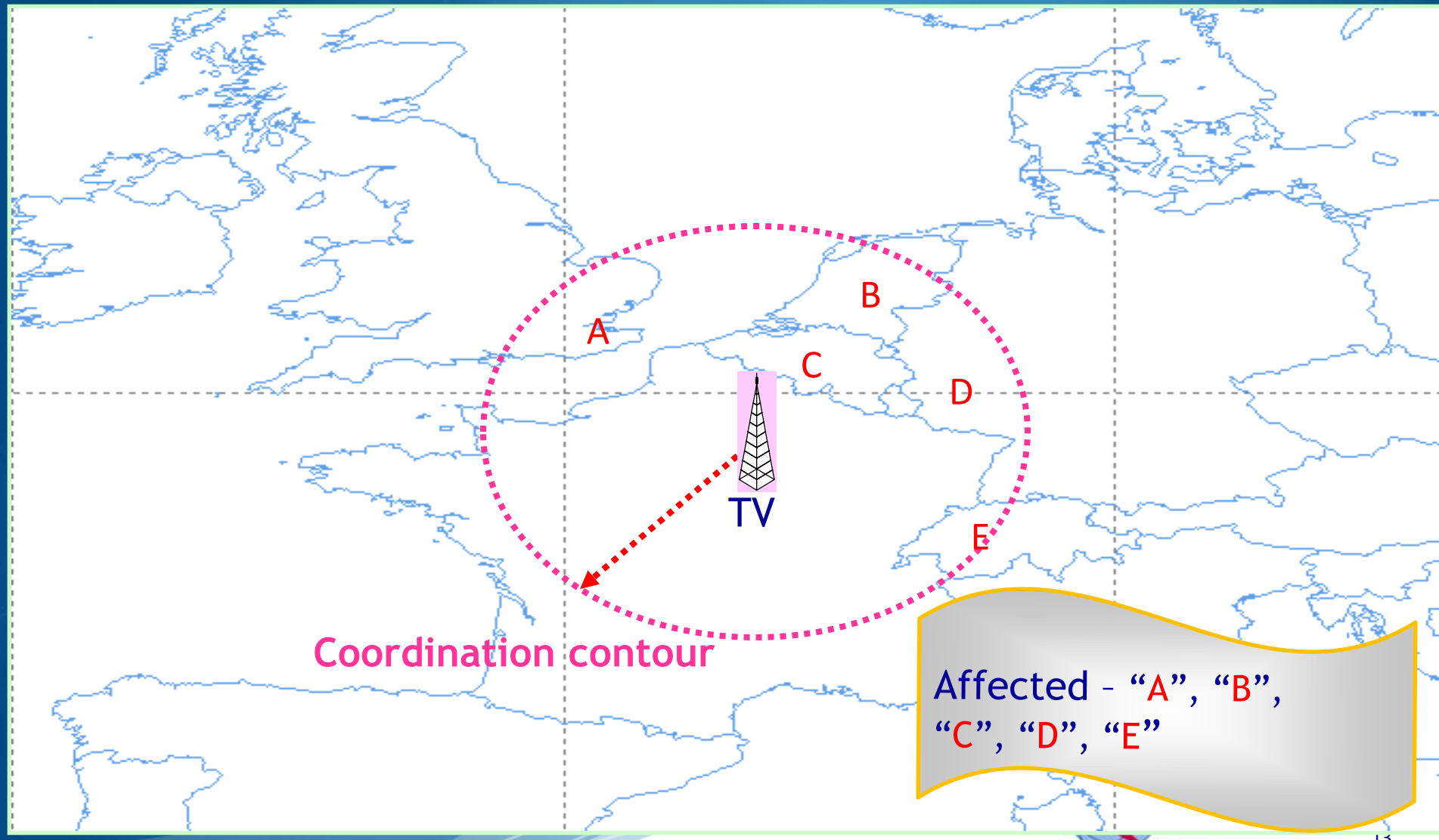


Construction of coordination contour



Coordination distances are connected and form coordination contour

Identification of affected administrations



Some calculation results

Interference ranges for sharing between TV and mobile service calculated in the 800 MHz band

Scenario	Interference range	Victim station protection criteria	Interfering station parameters
TV-> mobile devices	29 km	42 dBµV/m, h=1.5 m	e.i.r.p = 33 dB, h=150 m
TV-> base station	**157 km**	24.7 dBµV/m, h=60 m	e.i.r.p = 33 dB, h=150 m
Base station-> TV	107 km	48.9 dBµV/m, h=10 m	e.i.r.p = 27 dB, h=60 m

Directions of interference

- The worst interference case: from TV transmitters to base stations receivers -> up to 150 – 180 km
- Mobile devices are less vulnerable, reasons:
  - Less sensitive
  - Antenna gain is lower
  - Antenna height is lower (e.g.: height loss correction factor between 10 m and 1.5 m is 18 dB)
  - Building attenuation is substantal (for indoor interference)
- In general, interference ranges are high

what to do ?

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How to reduce interference

- Frequency methods:
  - Avoid using TV and MOB on same frequencies -> divide band between countries (take account of adjacent channel interference)
  - Avoid worst case: sharing between TV and BS reception
- Power, antenna and station locations
  - Reduce power towards the border
  - Put additional transmitters to compensate for interference
  - Accept higher interference
  - Point base station receive antennas away from the interferer
  - Avoid line of sight between TV and base stations
- Modern technology
  - Use multiple access interference cancellation techniques (e.g.OFDMA)
  - Use adaptive antennas to cancel incoming interference
  - Use polarization diversity

Gracias!