



Cognitive radio systems for efficient sharing of TV white spaces in European Context

DVB-T and Wireless Microphone Exclusion Area Computation Through Interference Analysis

Rogério Dionísio
Instituto de Telecomunicações - Portugal

COGEU project

Overview of SEAMCAT

Exclusion area computation

- Case study 1: Interference from TVWS BS / UE to DVB-T
- Case study 2: Interference from TVWS BS / UE to DVB-T with sensing
- Case study 3: Interference from TVWS UE to PMSE

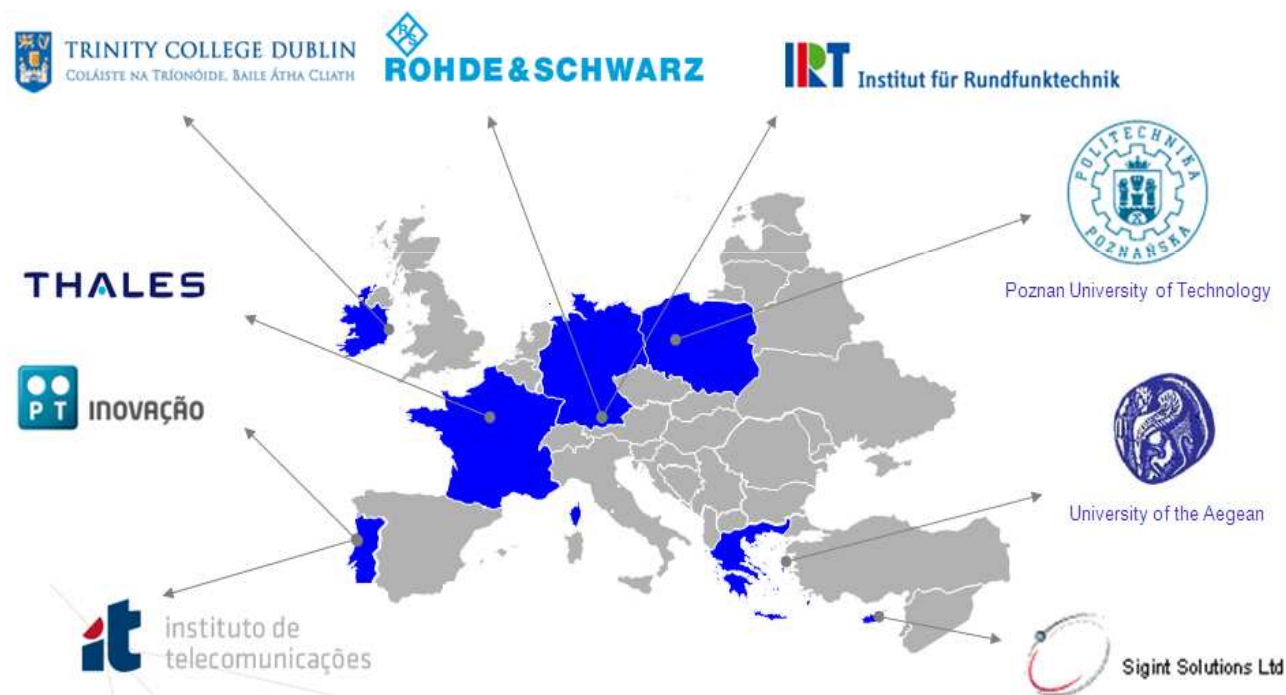
Final comments

STREP Project (www.ict-cogeu.eu)

Duration: Jan 2010 – Dec 2012

9 partners

EAB (RIM, Huawei)

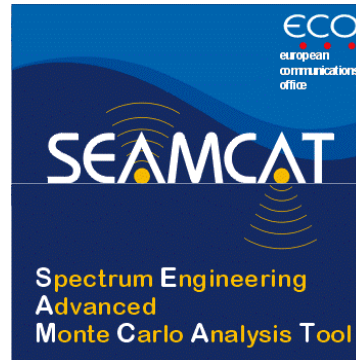


Exclusion Area Computation

Overview of SEAMCAT

What is SEAMCAT?

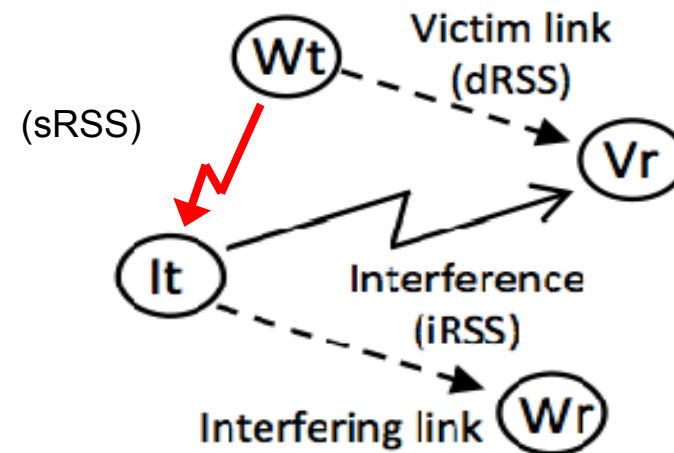
SEAMCAT (Spectrum Engineering Advanced Monte Carlo Analysis Tool) is a statistical simulation model that uses a method of analysis called Monte Carlo to assess the potential interference between different radio communication systems.



Developed and maintained by **ECO**

Build on a **Java platform**

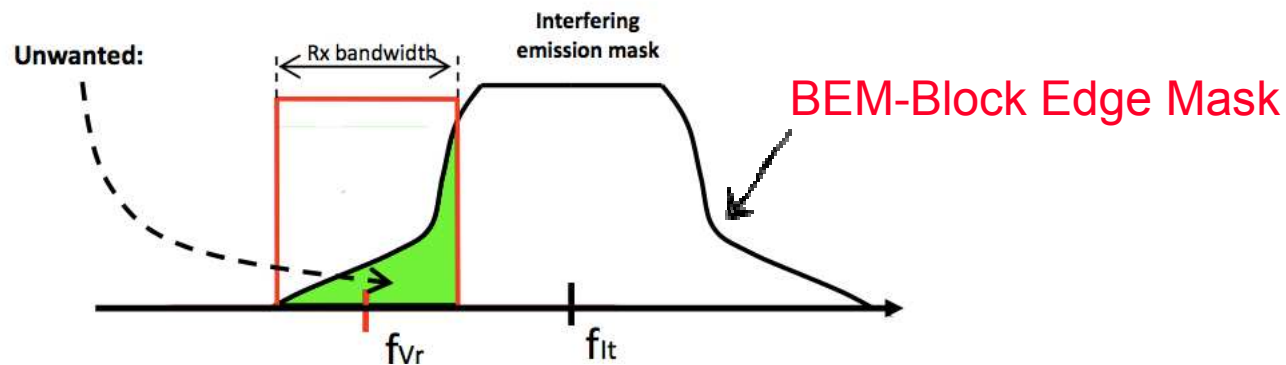
- **Wt**: Wanted transmitter
- **Vr**: Victim receiver
- **It**: Interfering transmitter
- **Wr**: Wanted receiver



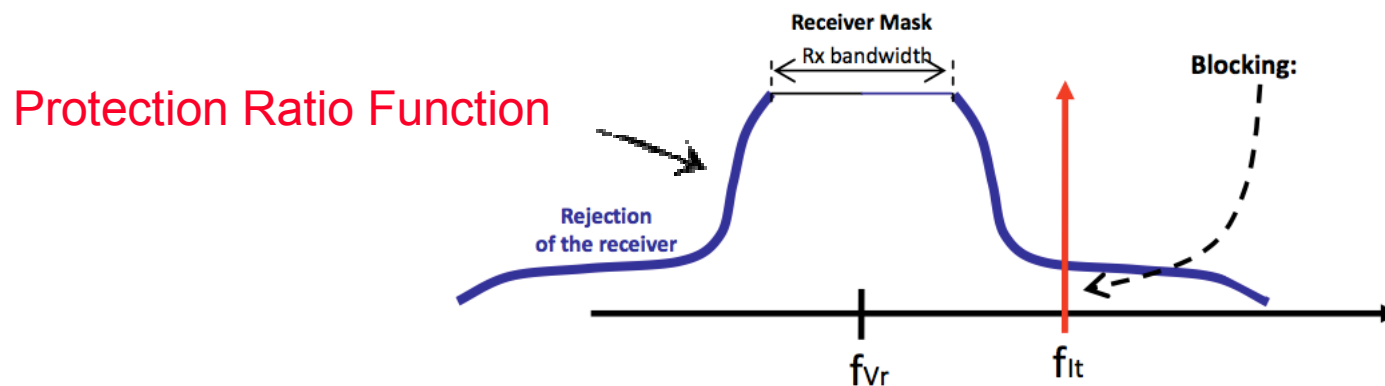
- **dRSS**: desired Received Signal Strength
- **iRSS**: interfering Received Signal Strength
- **sRSS**: sensing Received Signal Strength

Interference mechanism

Unwanted emissions:

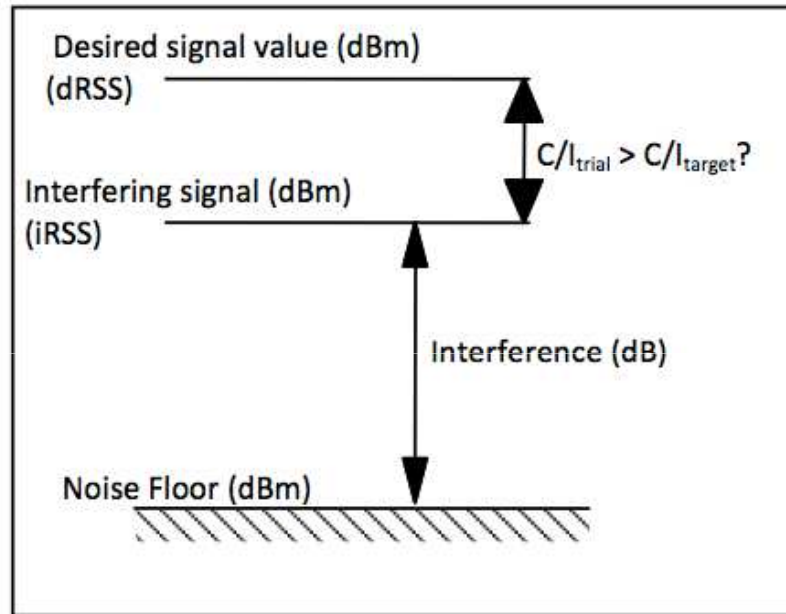


Receiver blocking:



Interference computation

- For each random event where $dRSS > \text{sensitivity}$:



- If $C/I_{\text{trial}}^i > C/I_{\text{target}}$: "good" event
- If $C/I_{\text{trial}}^i < C/I_{\text{target}}$: "interfered"

- Finally, after cycle of N_{all} events:
Overall $P_{\text{interference}} = 1 - (N_{\text{good}}/N_{\text{all}})$



Exclusion Area Computation

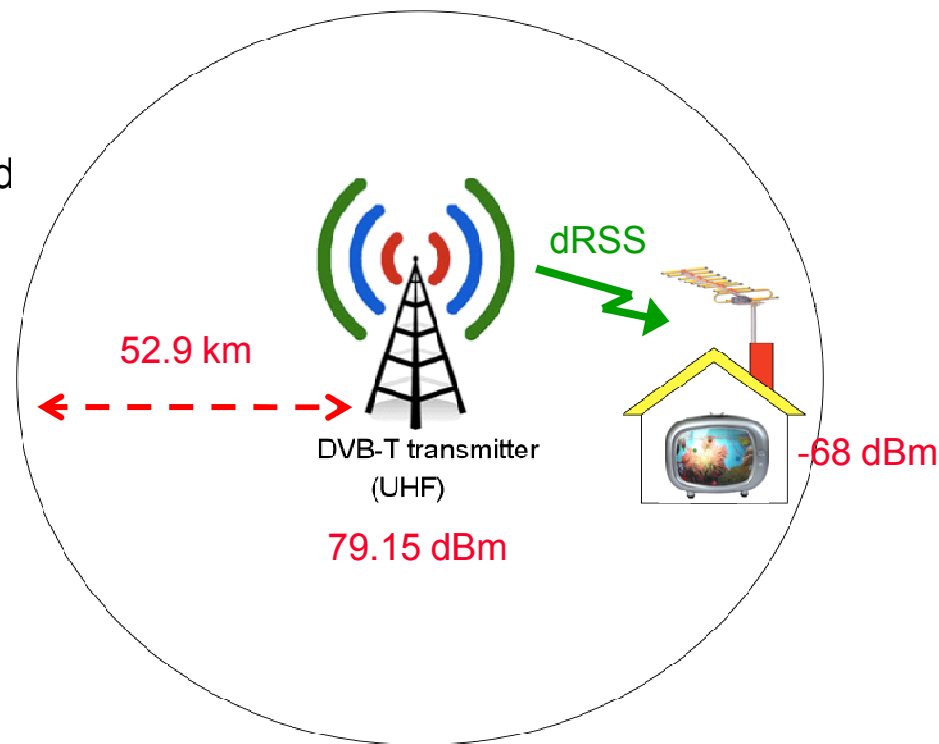
Case study 1: Interference from TVWS BS / UE to DVB-T

DVB-T transmitter:

- Frequency: 658 MHz
- Power: 79.15 dBm
- Antenna height: 200 m
- antenna type: 0 dBi omnidirectional
- Antenna azimuth and elevation aligned with DVB-T receiver antenna

DVB-T receiver:

- Antenna height: 10 m
- Antenna peak gain: 9.15 dBi
- Noise floor: -98.17 dBm
- Sensitivity: -77.17 dBm
- Reception bandwidth: 7,610 MHz



Propagation model (dRSS):

- ITU-R P.1546

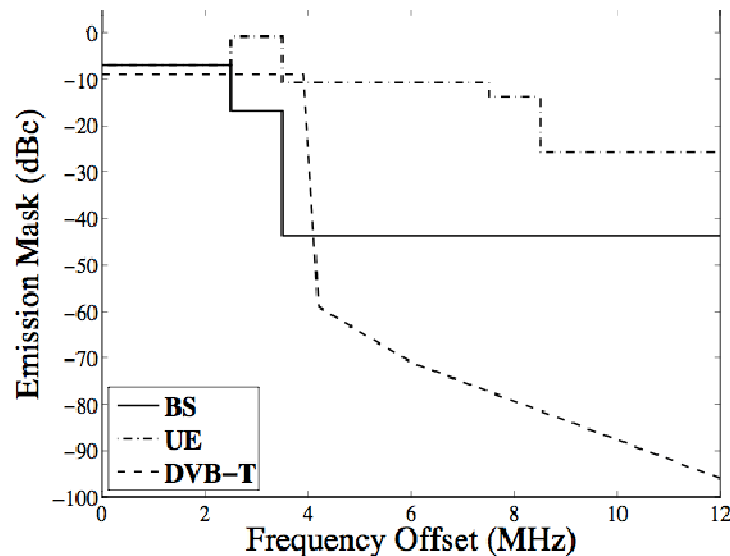
Secondary user

LTE BS transmitter:

- Frequency: 658 MHz
- Antenna height: 10 m
- Antenna: tri-sectorized directional
- EIRPmax: 56 dBm
- Spectral emission mask (5 MHz BW):

LTE UE transmitter:

- Frequency: 658 MHz
- Antenna height: 1.5 m
- Antenna: Omnidirectional
- EIRPmax: 23 dBm
- Spectral emission mask (5 MHz BW):



Interference scenario

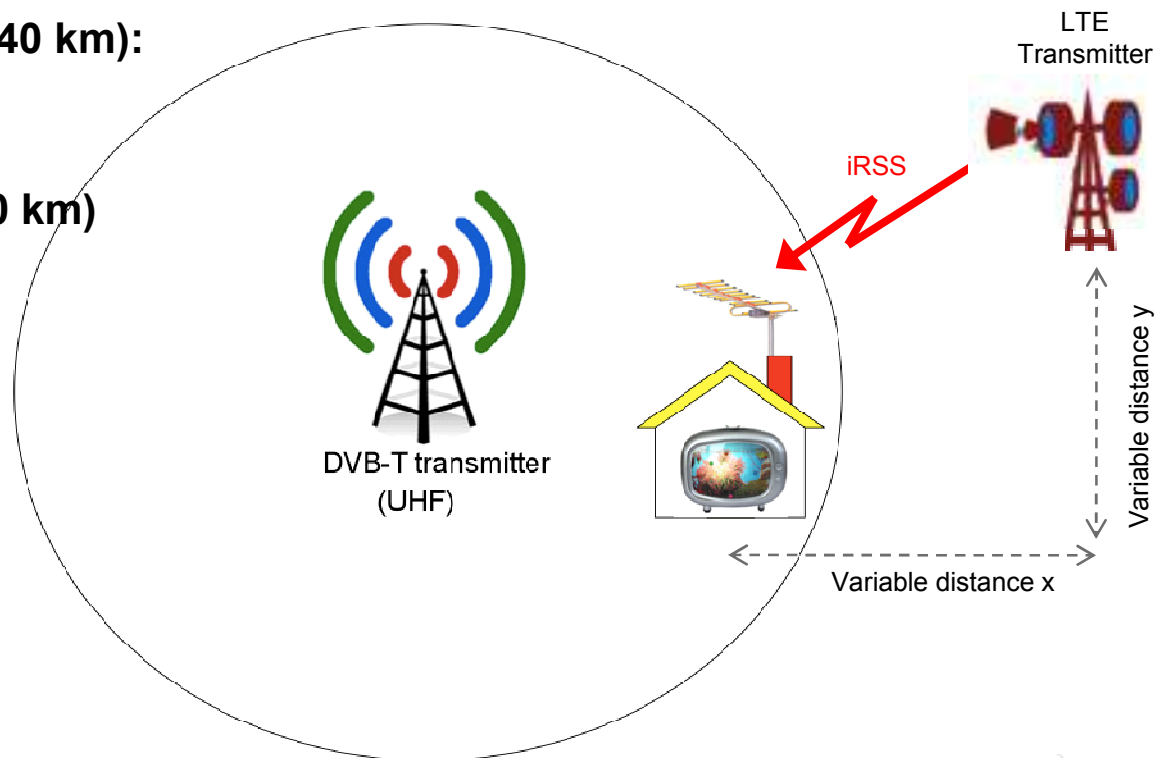
For each Monte-Carlo trial:

- Move the relative position (x,y) of the LTE BS / UE around the DVB-T receiver

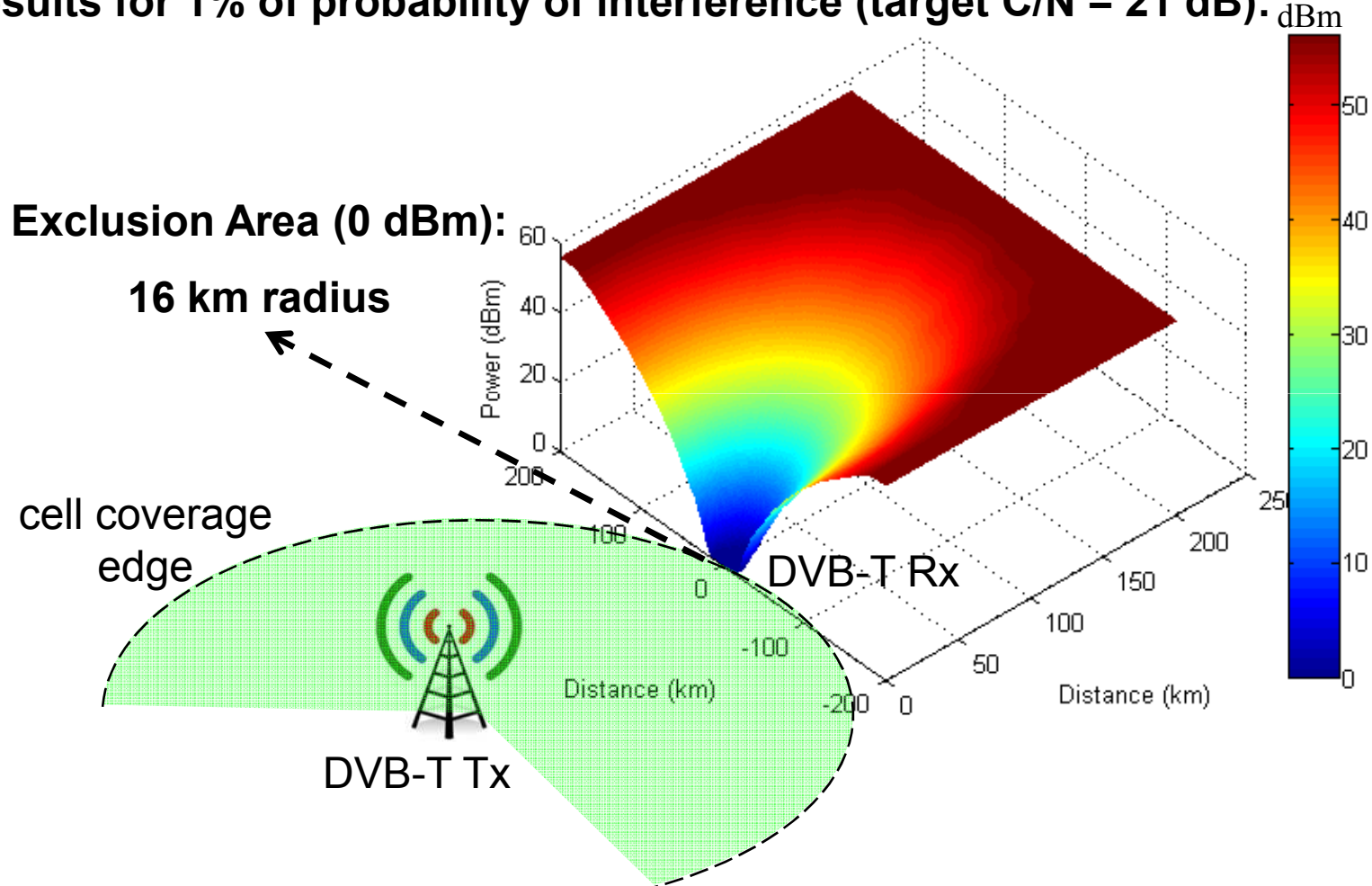
Propagation model (iRSS):

- **Extended Hata (below 40 km):**
 - Above roof for BS
 - Below roof for UE
- ITU-R P.1546 (above 40 km)

Co-channel interference



Results for 1% of probability of interference (target C/N = 21 dB):



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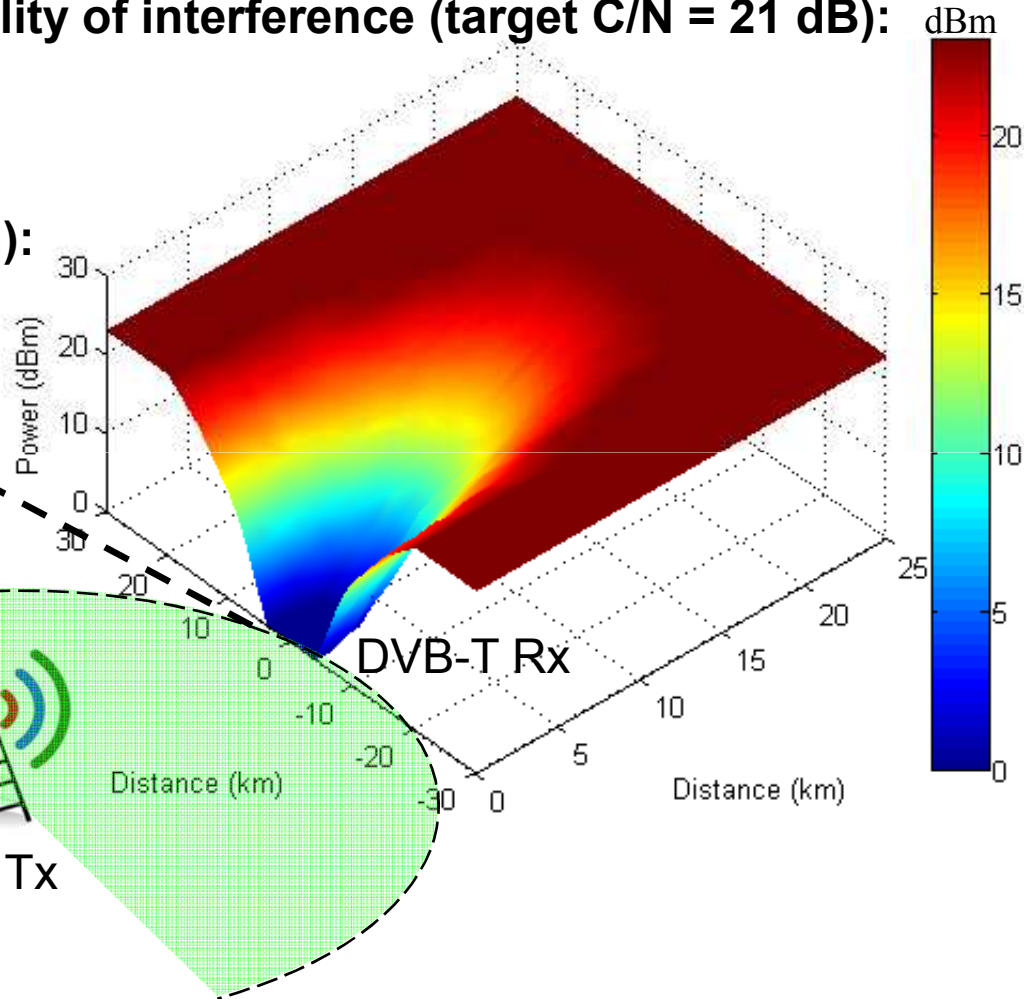
Exclusion Zone (0 dBm):

4.5 km radius

cell coverage edge

DVB-T Tx

DVB-T Rx



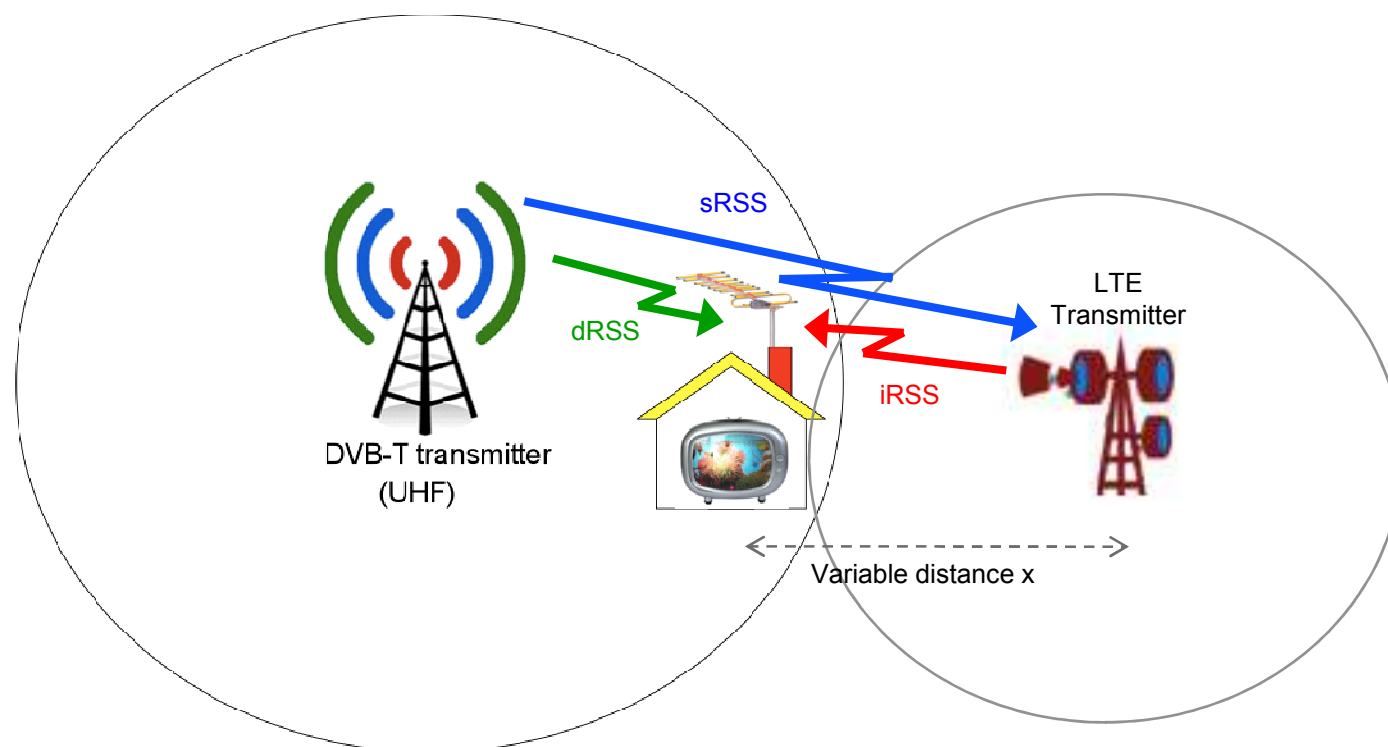
Exclusion Area Computation

Case study 2: Interference from TVWS BS / UE with sensing capabilities, to DVB-T

Interference scenario

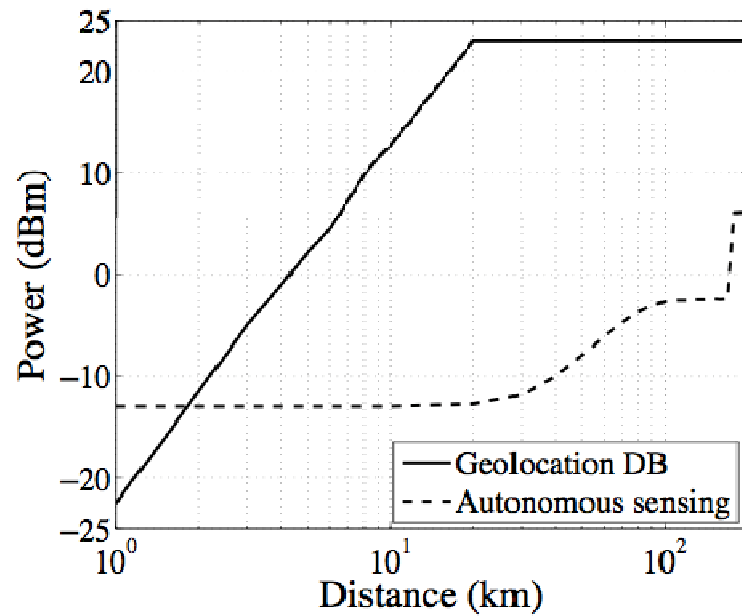
Change the relative position (x,0) of the LTE interferer (BS or UE) from the DVB-T receiver.

- Detection Threshold: -123 dBm
- Sensing bandwidth: 8 MHz

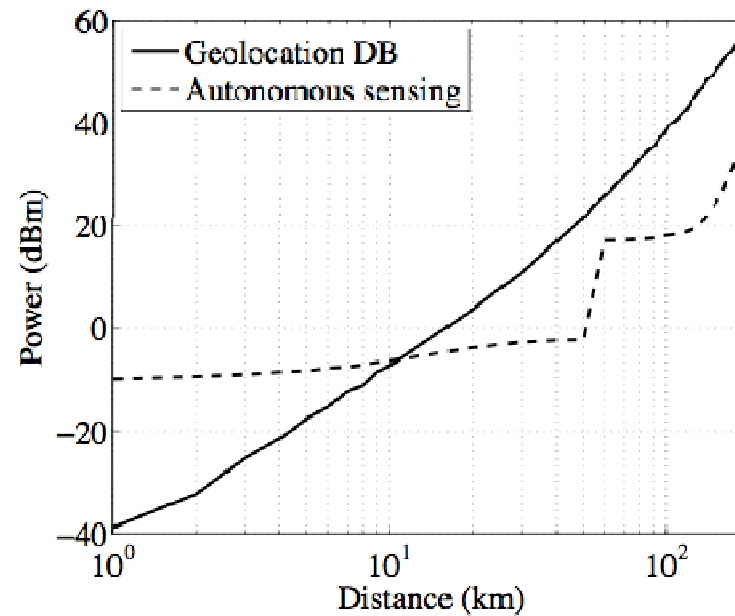


Results for 1% of probability of interference (target C/N = 21 dB):

LTE UE



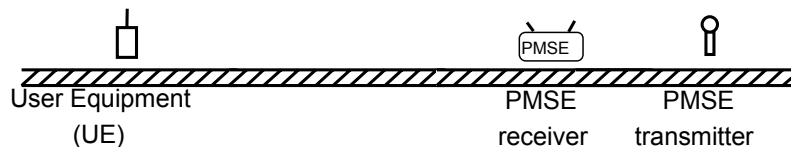
LTE BS



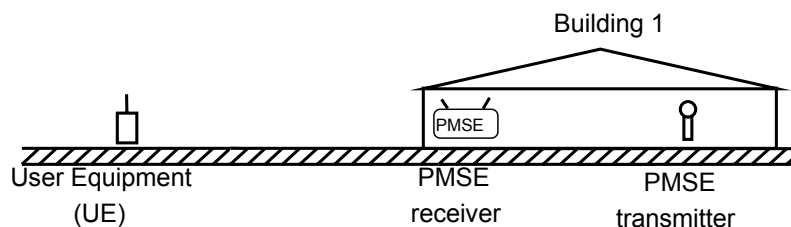


Exclusion Area Computation

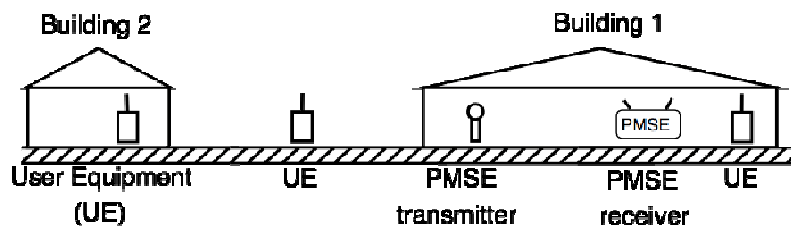
Case study 3: Interference from TVWS BS / UE to PMSE



Scenario 1: PMSE and TVWS UE outdoor;



Scenario 2: PMSE indoor and TVWS UE outdoor;



Scenario 3: PMSE and TVWS UE indoor, but in separate buildings.

PMSE Transmitter (W. Mic.):

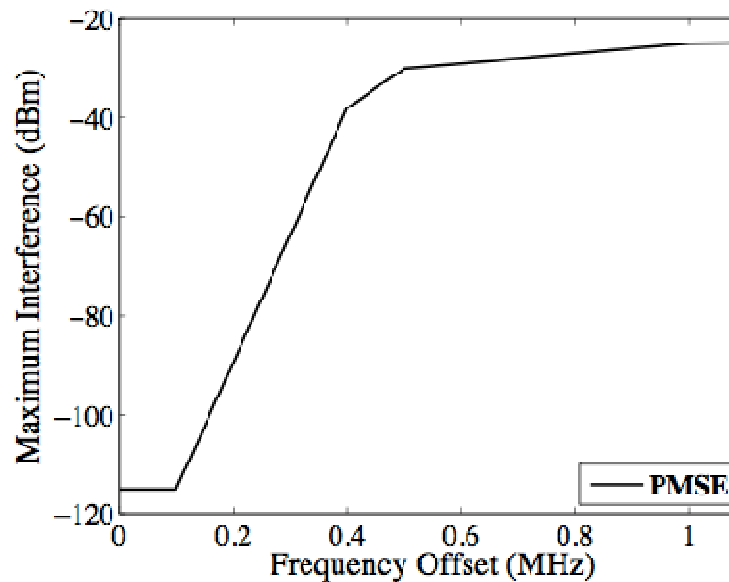
- Frequency: 658 MHz
- Power: 10 dBm
- Antenna height: 1.5 m
- antenna type: $\lambda/4$ or $\lambda/2$ dipole, 0 dBi
- Antenna azimuth and elevation aligned with PMSE receiver antenna.

LTE UE Transmitter:

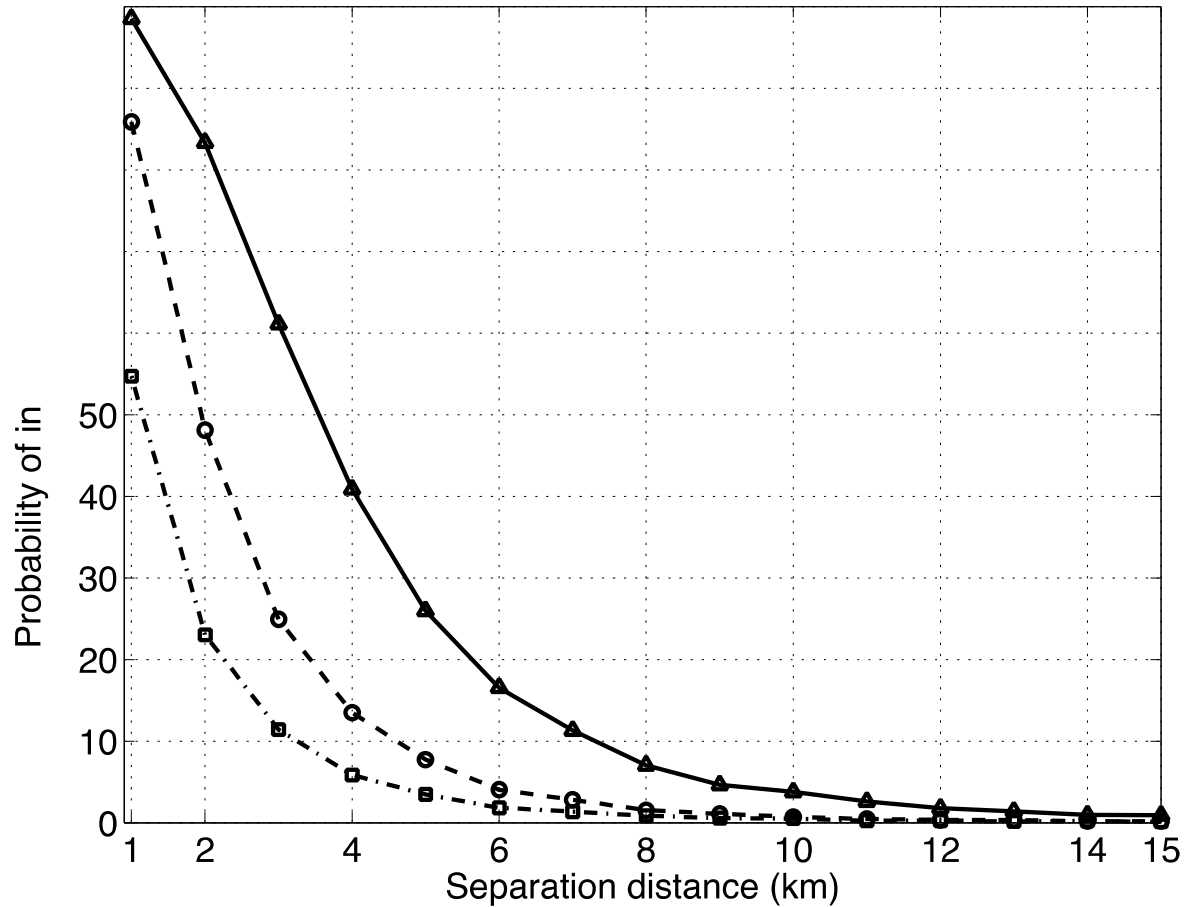
- Frequency: 658 MHz
- EIRP: **23 dBm**
- Antenna height: 1.5 m
- Antenna: Omnidirectional
- Spectral emission mask (5 MHz BW)

PMSE receiver:

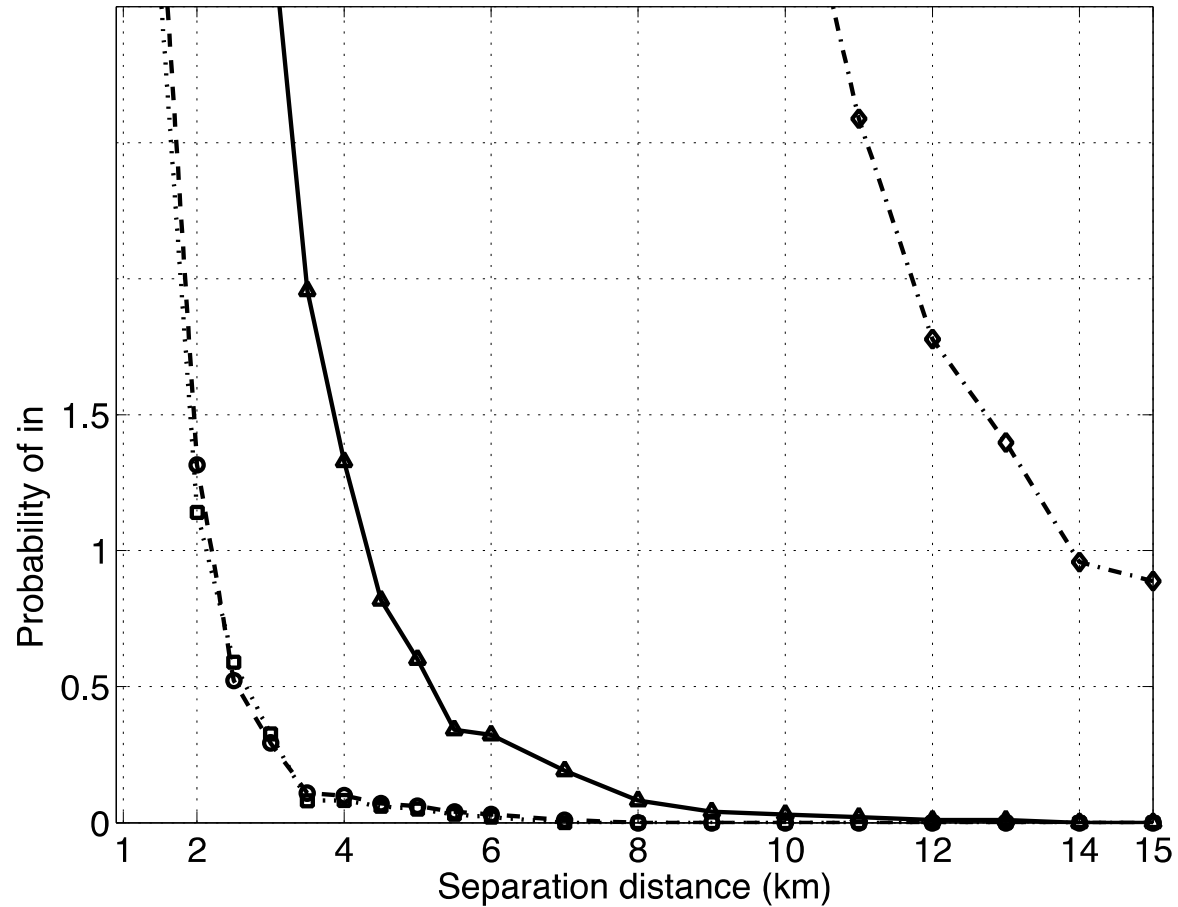
- Noise floor: -115 dBm
- Sensitivity: -95 dBm
- Reception bandwidth: 200 kHz
- Antenna height: 1.5 m
- Antenna peak gain: 2.15 dBi
- Antenna: Omnidirectional



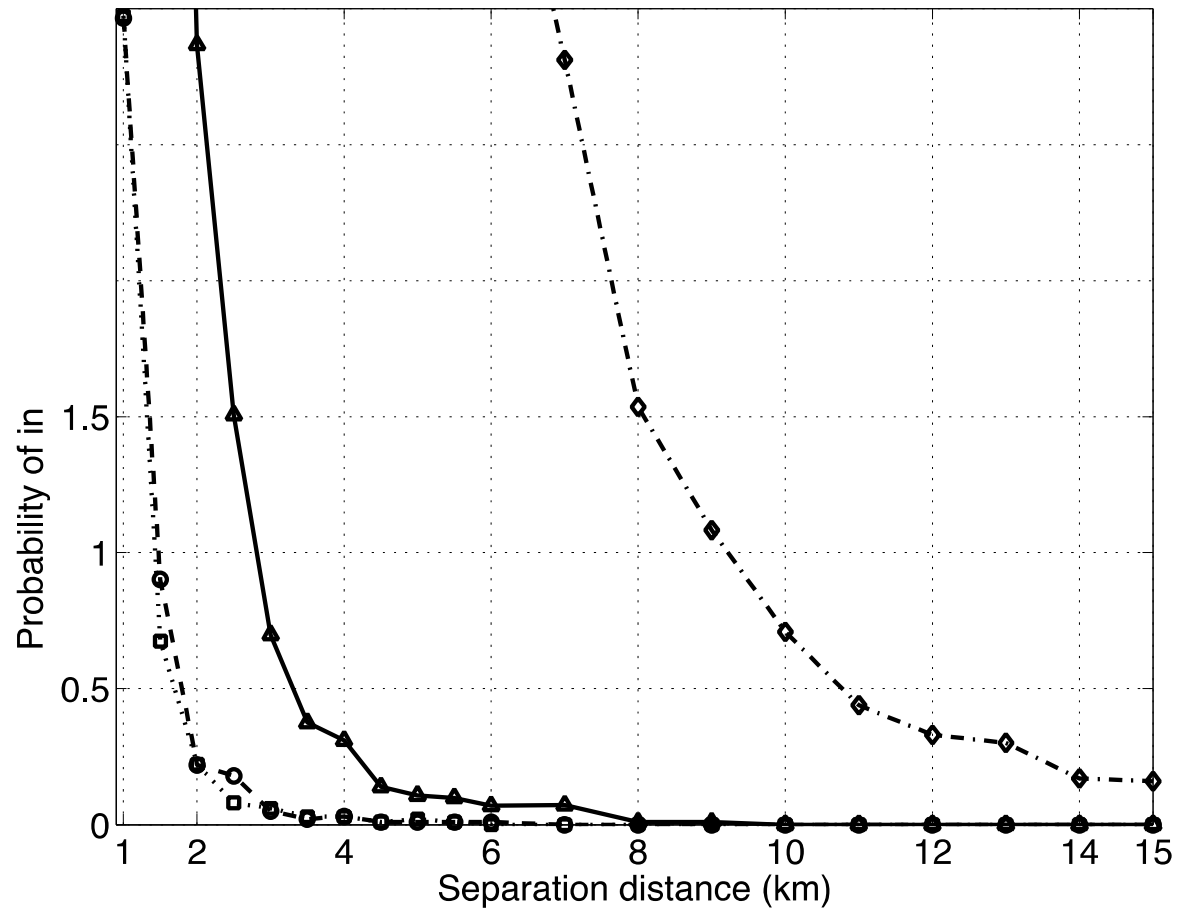
Scenarios



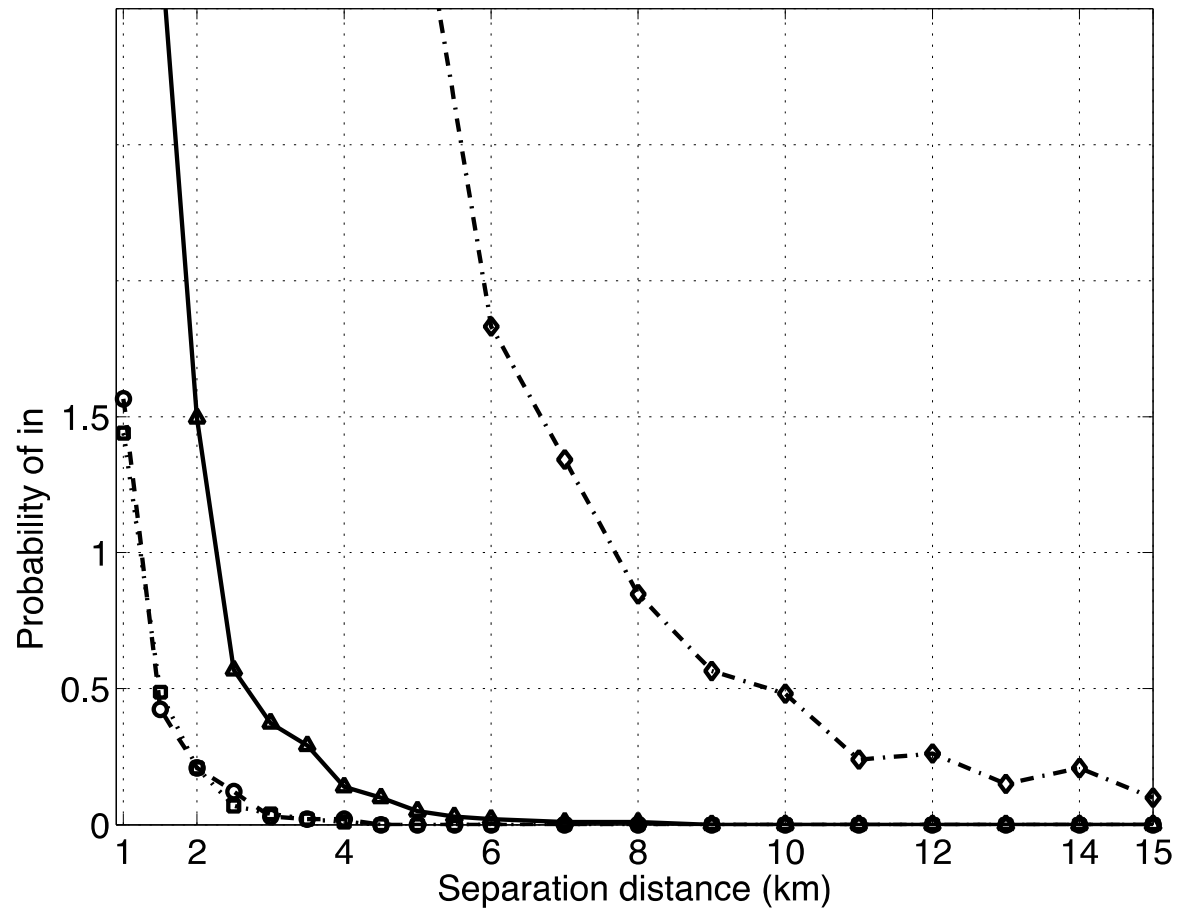
Scenario



Scenario 7



Scenario 5



Exclusion Area Computation

Conclusions

DVB-T:

- LTE downlink limits the white space area (in LOS with the DVB-T aerial antenna)
- Exclusion distance is **16 km** for LTE BS and **4.5 km** for LTE UE (0 dBm).
- Autonomous sensing artificially limits the maximum transmit power allowed for TVWS Devices (hidden node margin).
- Geo-location database allows a more efficient use of TVWS.

PMSE exclusion distance:

- Co-channel: between **7.7 km** and **13.9 km**
- Adjacent channel (8 MHz gap): between **2.3 km** and **4.3 km**
- Second adjacent channel (16 MHz gap): between **1.2 km** and **2.2 km**
- No further improvements for channel gap above 16 MHz.

Thank you!

Questions?