

# **DVB-T2 planning & issues with LTE/DTT interference prediction as a consequence of DSO**

Milos Pavlovic  
LS telcom AG, Germany

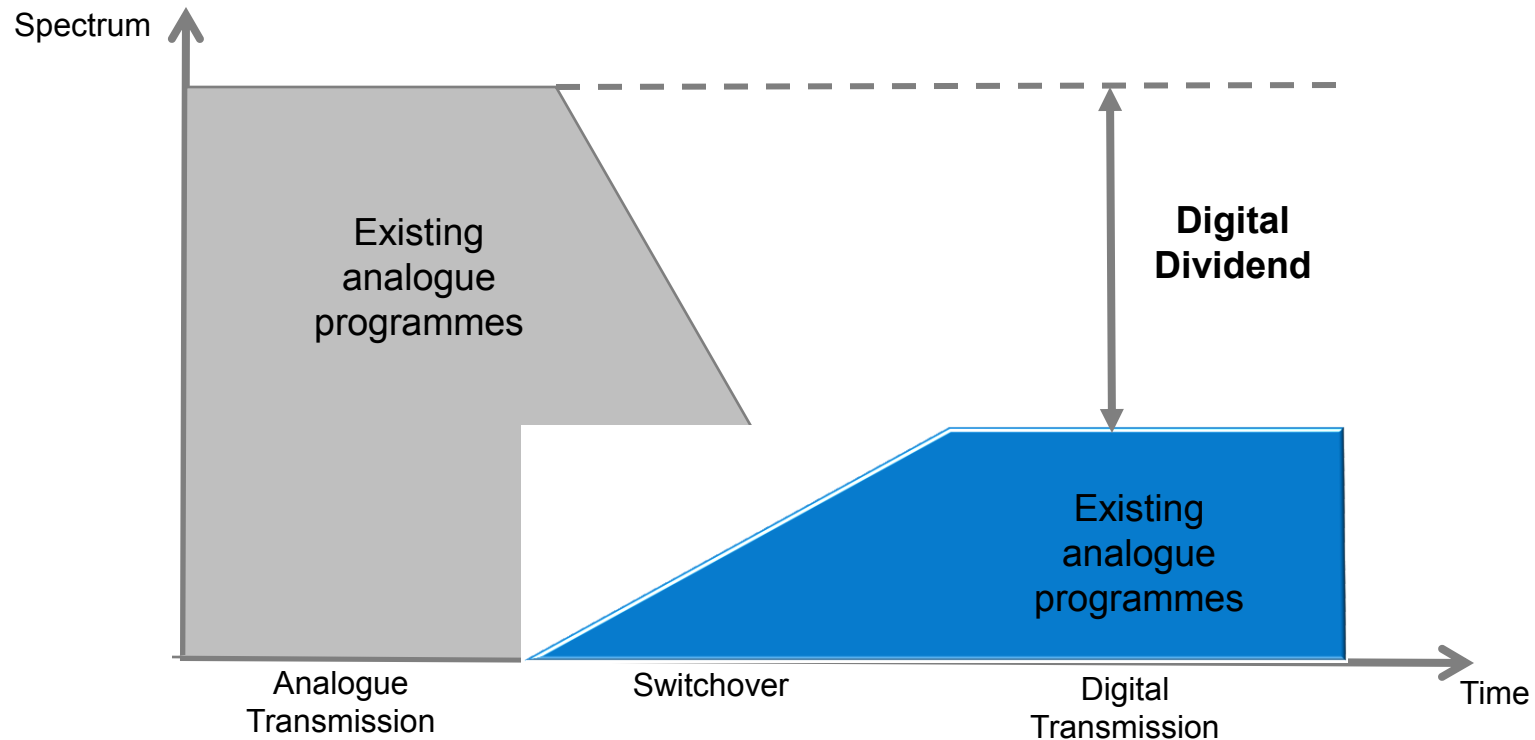
**ITU-D and NMHH Regional Seminar:  
“Transition to Digital Terrestrial Television Broadcasting and  
Digital Dividend in Europe”**

**Hotel Mercure Buda, Budapest, Hungary - Thursday January 30<sup>th</sup>, 2014**

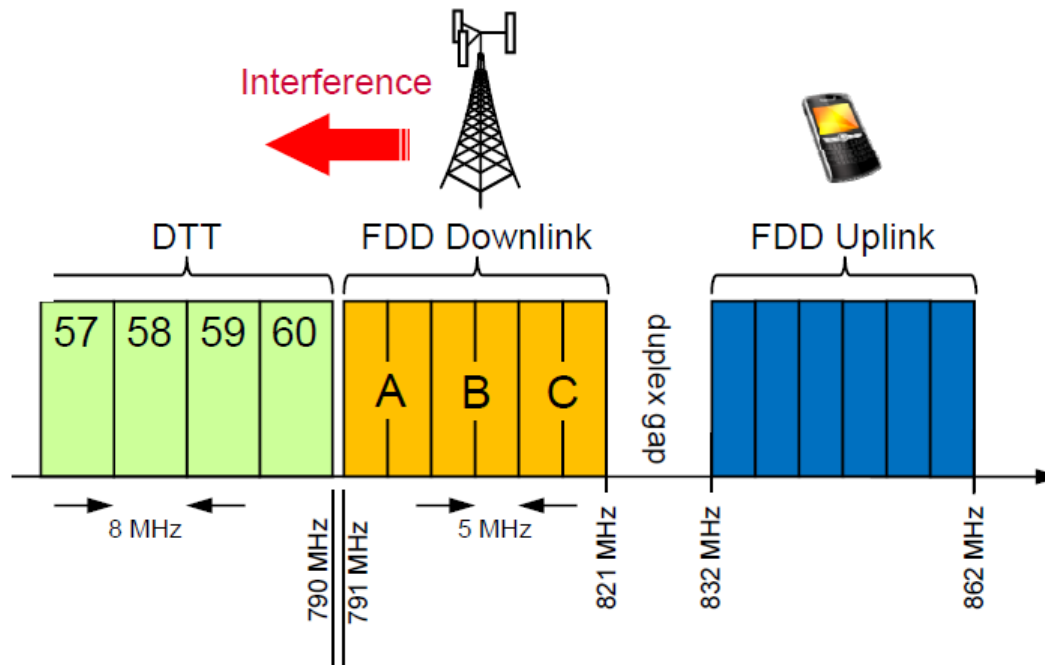
	More Coverage	Same Coverage
More Bitrate	<p>Trade - off</p>	
Same Bitrate	<p>E<sub>min</sub>: ~ -6dB</p>	<p>TX power reduction to 1/4</p>

- Definition of the Digital Dividend

***The Digital Dividend is the amount of spectrum made available by the transition of terrestrial television broadcasting from analogue to digital (Source: ITU – Insights of spectrum decisions)***



- Auction in Germany 2010
- 6 blocks in the 800 MHz band, blocks in the 2.6 GHz band for LTE
- Revenues about € 4.4 billions (€ 3.5 billions for 800 MHz spectrum)
- African and Arabic request for 694-790 MHz in ITU Region 1 on WRC-12

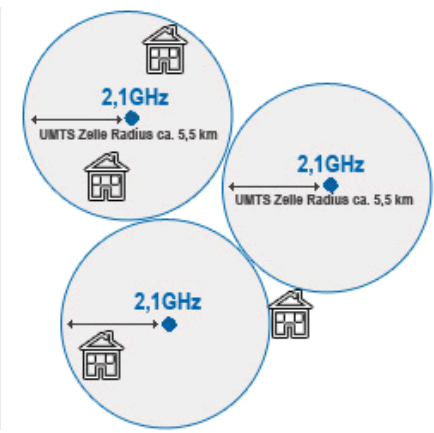
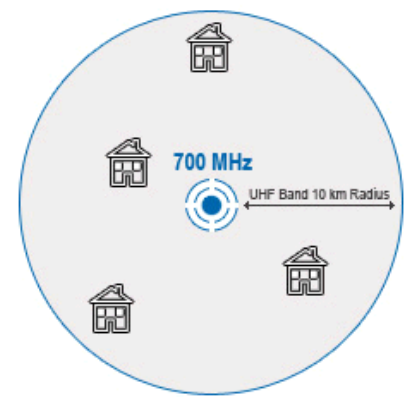
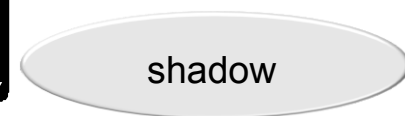
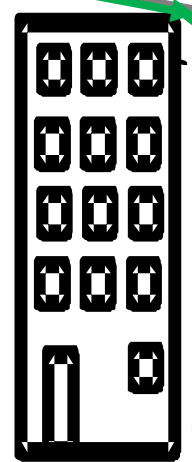
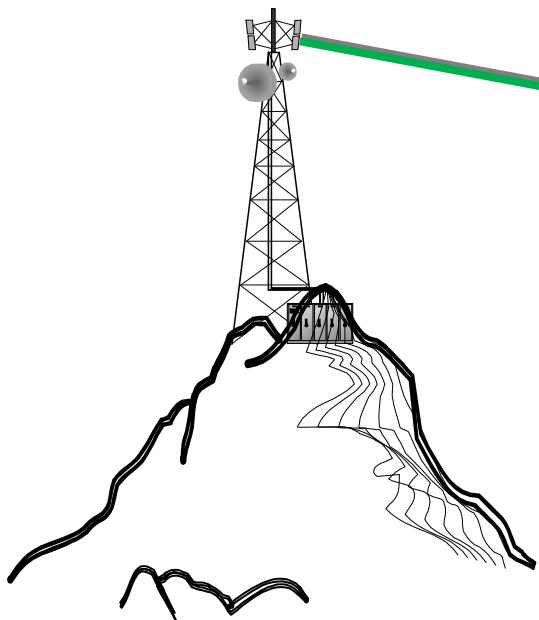


# Overview recent licensing processes for the use of the digital dividend bands by the mobile service

Digital Dividend spectrum allocations	USA	Germany	Sweden	Spain	France	Italy	Switzerland
Frequency bands considered in the same process	700 MHz (698–787 MHz)	800 MHz, 1.8 GHz, 1.9/2.1 GHz & 2.6 GHz	800 MHz	800 MHz, 900 MHz & 2.6 GHz	800 MHz	800 MHz, 1.8 GHz, 2.0 GHz & 2.6 GHz	800, 900 MHz 1.8 GHz, 2.1 & 2.6 GHz (FDD & TDD)
Date of licensing decision	24/1/2003-3/2/2012	12/10/2009	4/3/2011	May 2012	17/01/2012	18/05/2011	May 2012
Licence duration	10 years	15 years	25 years	Until 31 December 2030	20 years	17 years	12-16 years. Until 31.12.2028
Type of licensing process	Auction	Auction	Auction	Auction	Auction + weighted commitments	Auction	Auction
Packaging of DD band	Three 2x6 MHz, one 2x11 MHz, and two unpaired 6 MHz blocks = 70 MHz	3x2x10 MHz = 60 MHz	6x(2x5) MHz = 60 MHz	6x(2x5 MHz)= 60 MHz	3 blocks of 2x10 MHz = 60 MHz	6 blocks of 2x5 MHz	Each of the 3 bidders (Orange, Sunrise, Swisscom) won a package of 2 x 10 MHz.
Amount raised for DD band	19.1 GUSD (Sum of net bids in auctions 44, 49, 60, 73, and 92)	1.212 GEUR 1.210 GEUR 1.154 GEUR  Total 3.576 GEUR	2054 MSEK (220 MEUR)	3 operators got two blocks of 2x5 MHz each. For each block of 2x5 MHz: 170 MEUR 221.9 MEUR 230.0 MEUR 226.3 MEUR 228.5 MEUR 228.5 MEUR Total 1.305 MEUR	3 operators got one block each:  683 MEUR 891 MEUR 1065 MEUR  Total 2.639 GEUR	3 operators got 2 blocks each:  978 MEUR 992 MEUR 992 MEUR Total 2.96 GEUR	N/A (During the auction, bidders could bid on different packages consisting of frequency blocks in different bands. Therefore the prices are per package)

- Why UHF? Lower frequency means...

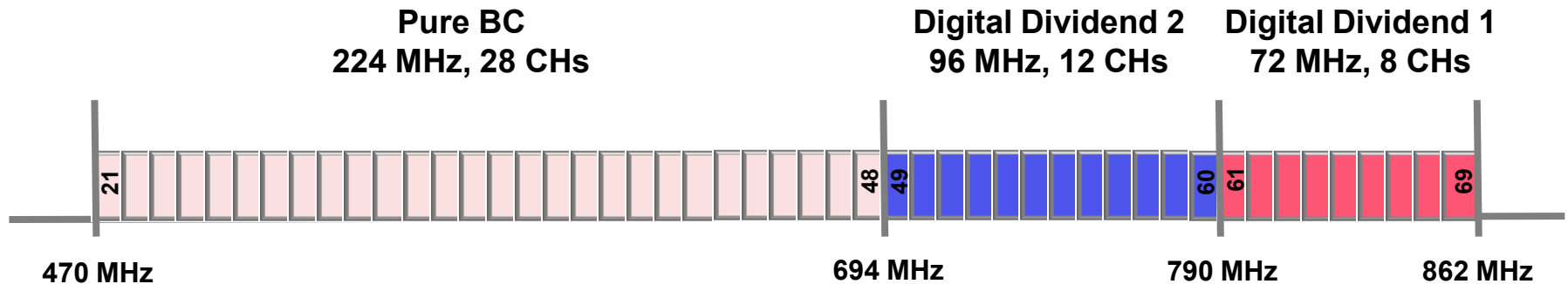
- ▶ ...more diffraction
- ▶ ...less shadow
- ▶ ...better wall penetration



2.1GHz

700 MHz

- Digital Dividend 1 + 2



- Digital Dividend 2: WRC-12 considered further spectrum allocations to the mobile service, including International Mobile Telecommunications (IMT). This issue has been placed on the WRC-15 Agenda together with the need to consider additional spectrum allocations for the mobile service



- Part of the “IMT” family at the ITU
- Is being specified by 3GPP
- Exists in a number of variants
  - ▶ OFDMA (SC-FDMA on uplink), as FDD and TDD
  - ▶ Modulation QPSK, 16-QAM, 64-QAM
  - ▶ Bandwidth: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
  - ▶ can use MIMO, max. 4 antennas
- There are about “40 LTE bands” around the world



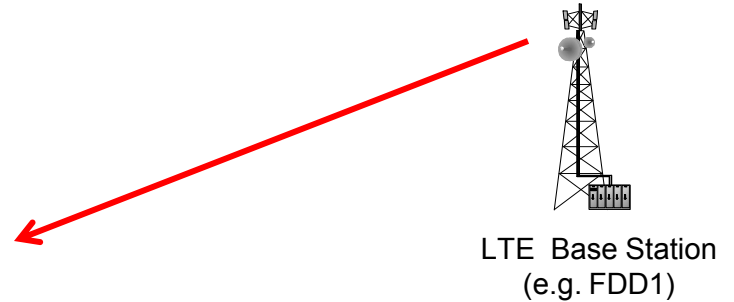
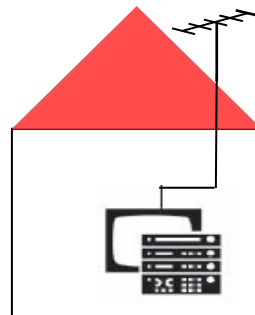
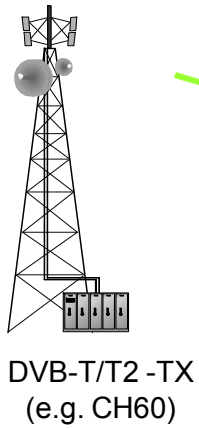
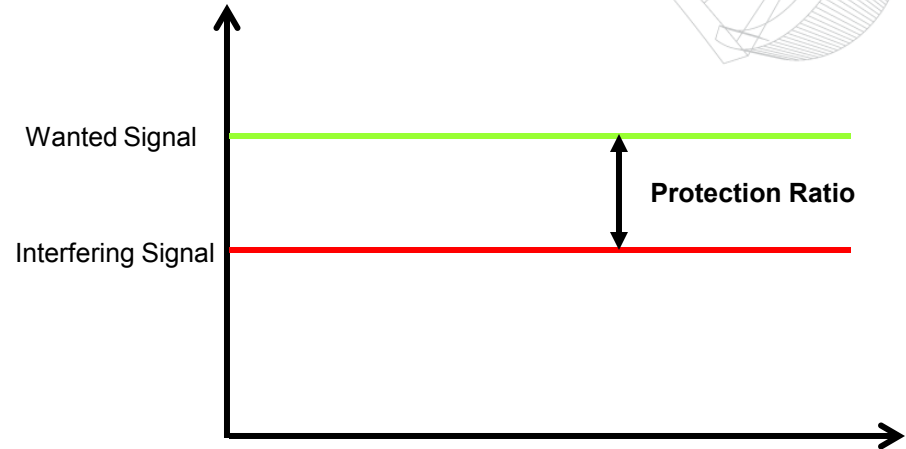
- Broadcasting works with field strengths ( $\text{dB}\mu\text{V}/\text{m}$ ) and the (measurement) bandwidth is the one of the respective broadcast service
- Mobile Radio works with received power ( $\text{dBm}$ )
- In broadcasting, antenna gain is referenced to  $\lambda/2$  dipole ( $\text{dBd}$ ), while in mobile radio, this is referenced to isotropic antenna ( $\text{dBi}$ )
- In broadcasting, emitted power is usually ERP in kW related to  $\lambda/2$  dipole, while in mobile radio, this is  $\text{dBm}$  (related to 1 mW, isotropic)

# DVB-T2 interfered with by LTE (base station)



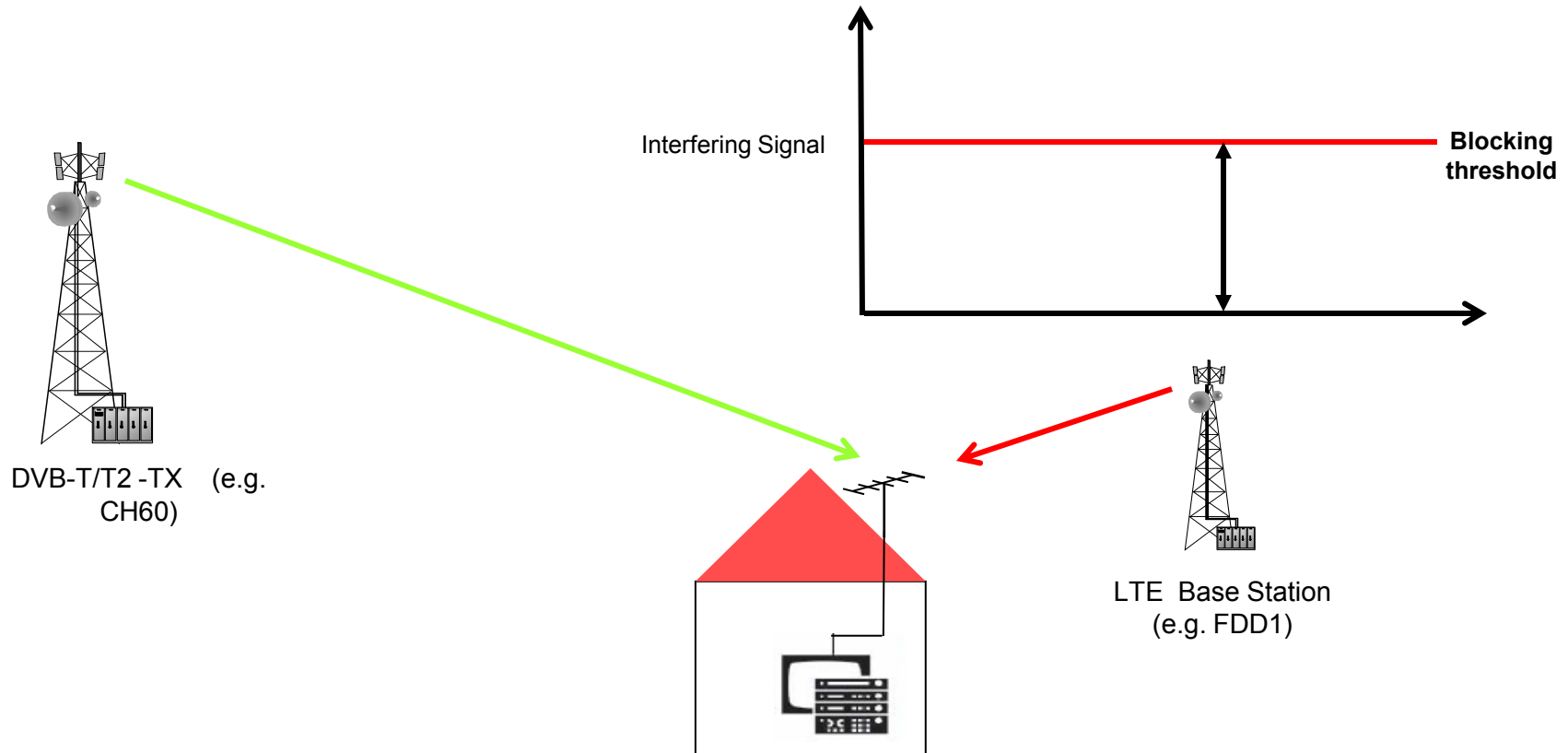
- Protection ratios (PR)

Note: Consideration of location probability margin and antenna-polarization discrimination !



- **Blocking or overloading**

(Receiver blocking is the effect of a strong out-of-band interfering signal on the receiver's ability to detect a low-level wanted Signal)



# DVB-T2 interfered with by LTE – Recommended sharing study values of PR and Oth for a DVB-T2

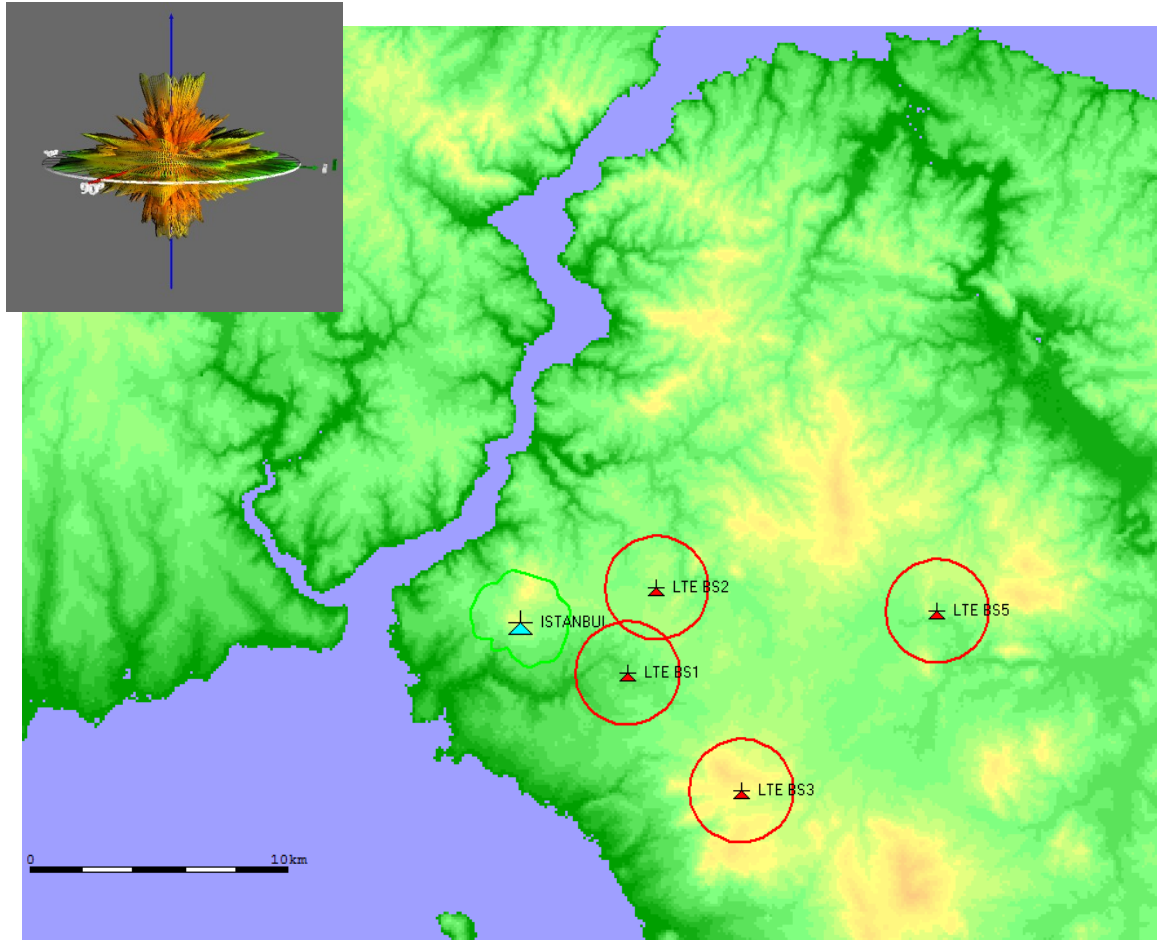


Source: ITU-R BT.2033

DVB-T2 Mode Parameters:  
 32Ke, 256-QAM, 2/3,  
 1/128  
 Maximum Bitrate: 40,2  
 Mb/s

Channel offset N (8 MHz channels)	Centre frequency offset (MHz)	LTE BS		LTE UE	
		PR (dB)	O <sub>th</sub> (dBm)	Corrected PR (dB)	O <sub>th</sub> (dBm)
Co-channel (AWGN)	0	19	–	19	–
Co-channel (LTE)	0	19	–	19	–
1	10	–25	–16	–6	–30
2	18	–33	–12	–13	–11
3	26	–36	–11	–28	–10
4	34	–40	–13	–37	–20
5	42	–43	–11	–38	–10
6	50	–46	–11	–40	–9
7	58	–47	–11	–42	–9
8	66	–46	–11	–43	–10
9	74	–46	–10	–44	–10

# LTE-DTT Interference Prediction Scenarios



Assumptions:  
Existing site

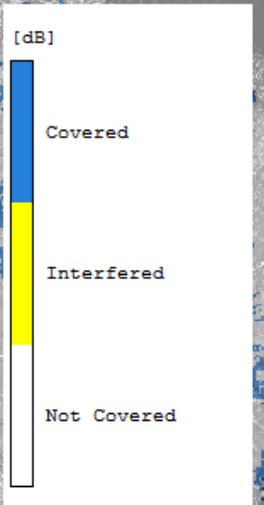
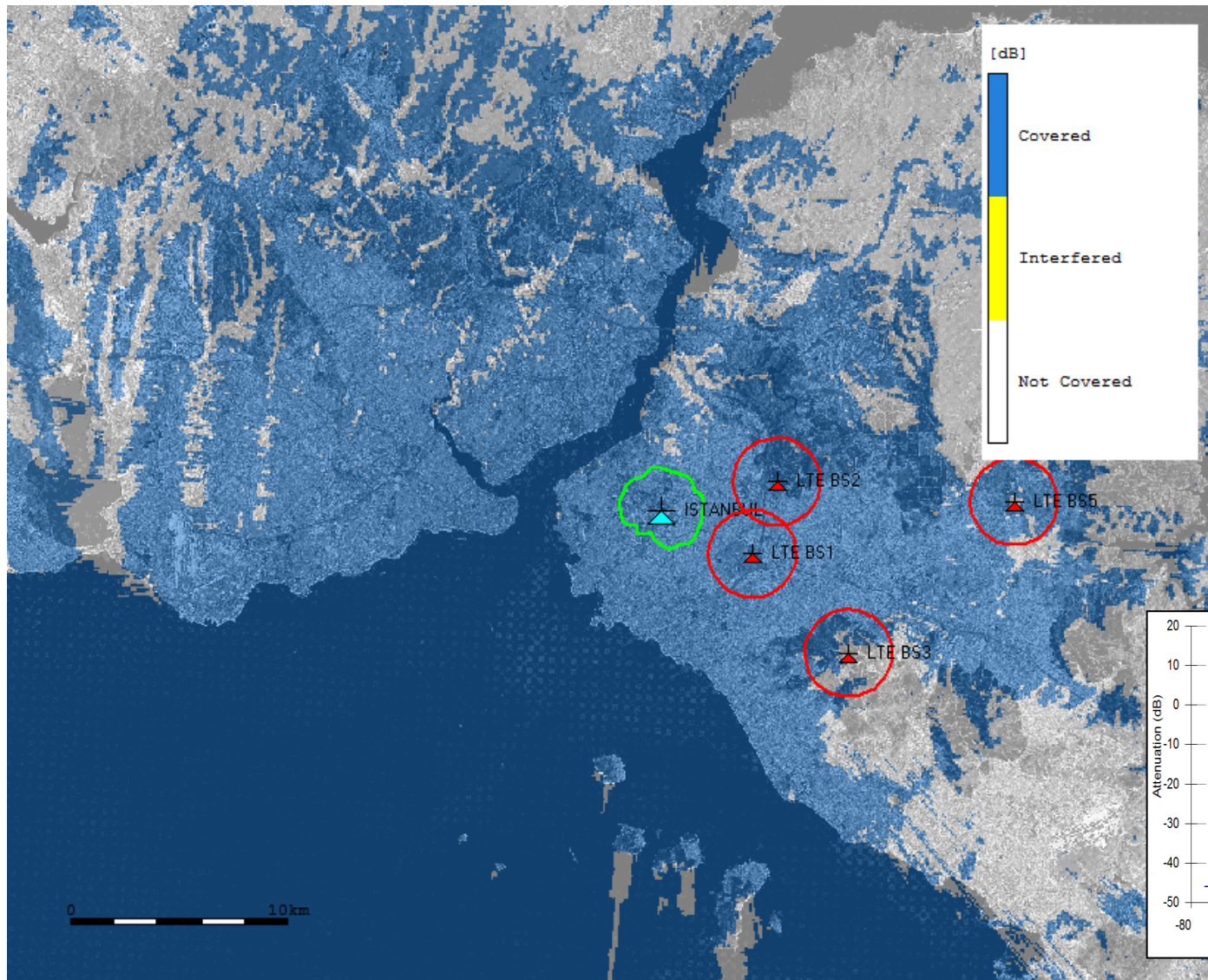
LTE BS: nearest approx. 5 km away  
from the DVB-T2 site

## ERPs

DVB-T2 stations	20 kW
LTE BS:	800 W

- Prediction Model Used for the  
Study: Okumura Hata prediction  
model.

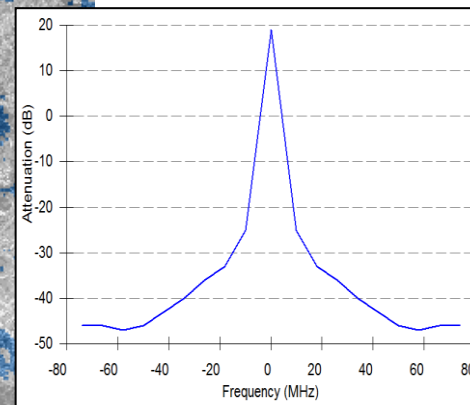
# DVB-T2 interfered with by LTE BS: CH60 Coverage reserve, no LTE BS (switched off)



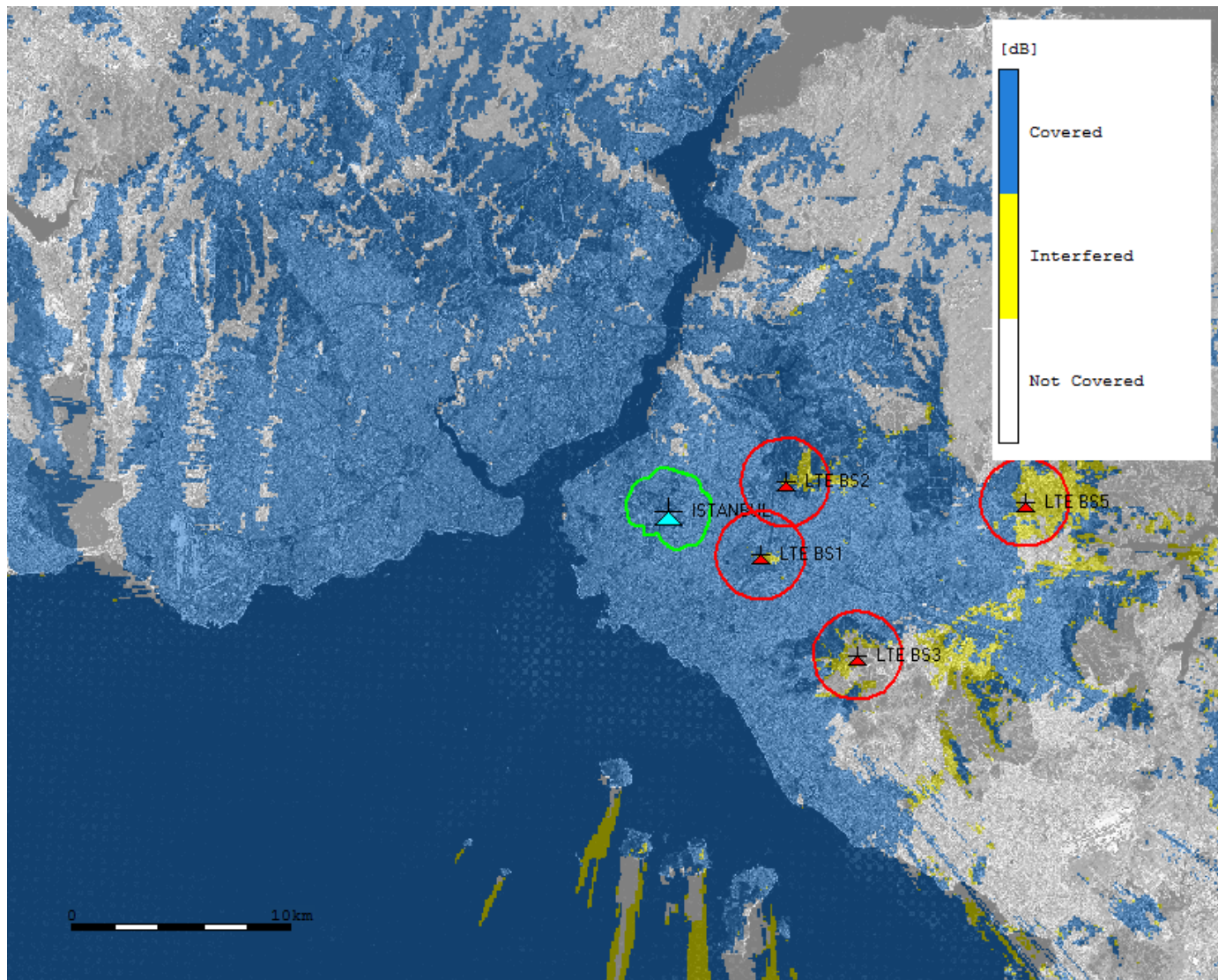
DVB-T2 Station:  
Channel 60 (Freq. 786 MHz)  
ERP: 20 kW

DVB-T2 parameters:  
256QAM, 2/3, 32Ke, 1/128

Reception mode: Fixed  
Location probability: 95%  
E-min equiv: 54,83 dB $\mu$ V/m



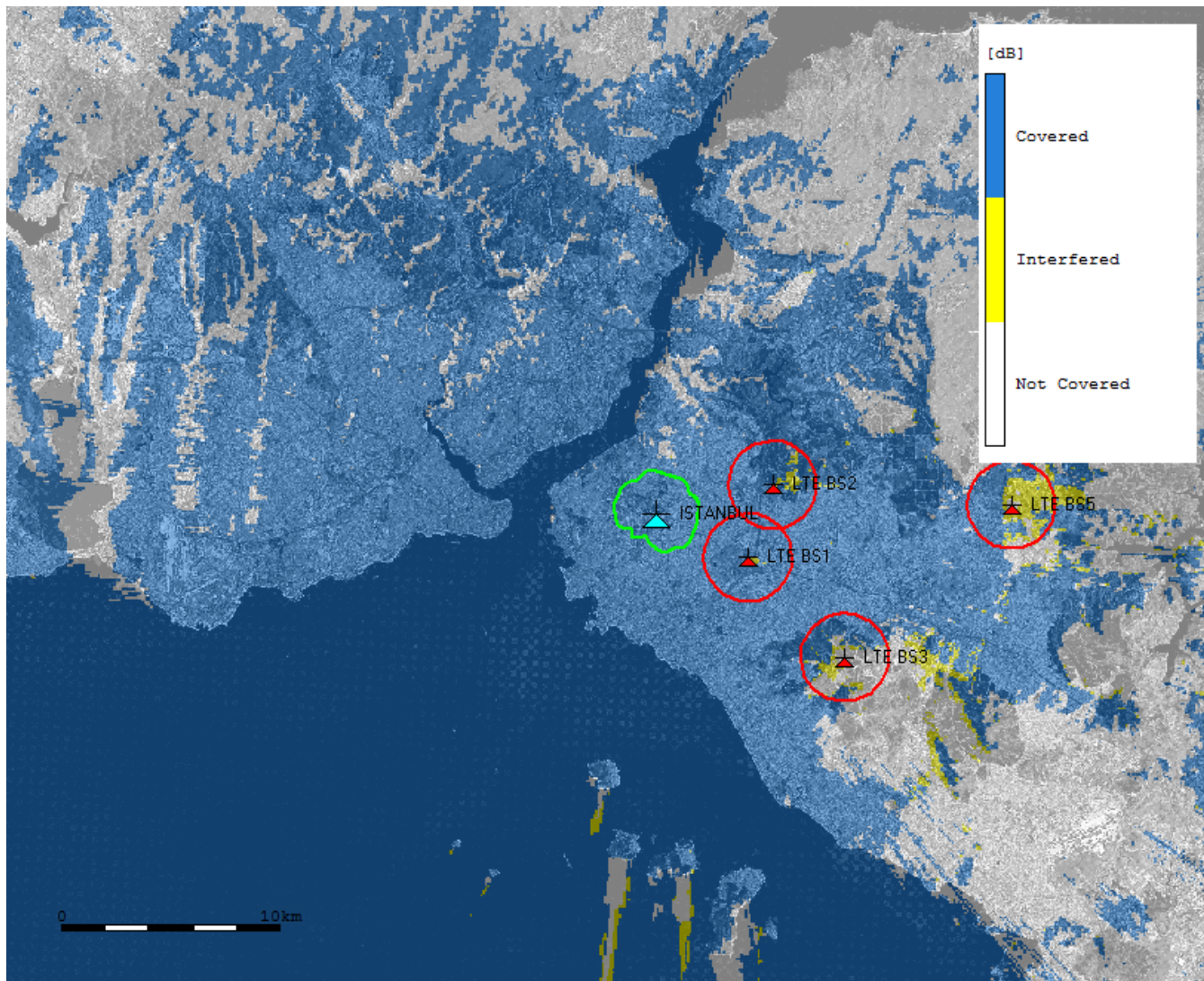
# DVB-T2 interfered with by LTE BS: CH60 Coverage reserve interfered by LTE800 BS



DVB-T2 Station:  
Channel 60 (Freq. 786  
MHz)  
ERP: 20 kW

LTE 800 Station:  
Bandwidth 10 MHz  
Central freq: 796 MHz  
ERP: 800 W  
PR: -25 dB

# DVB-T2 interfered with by LTE BS: CH59 Coverage reserve interfered by LTE800 BS

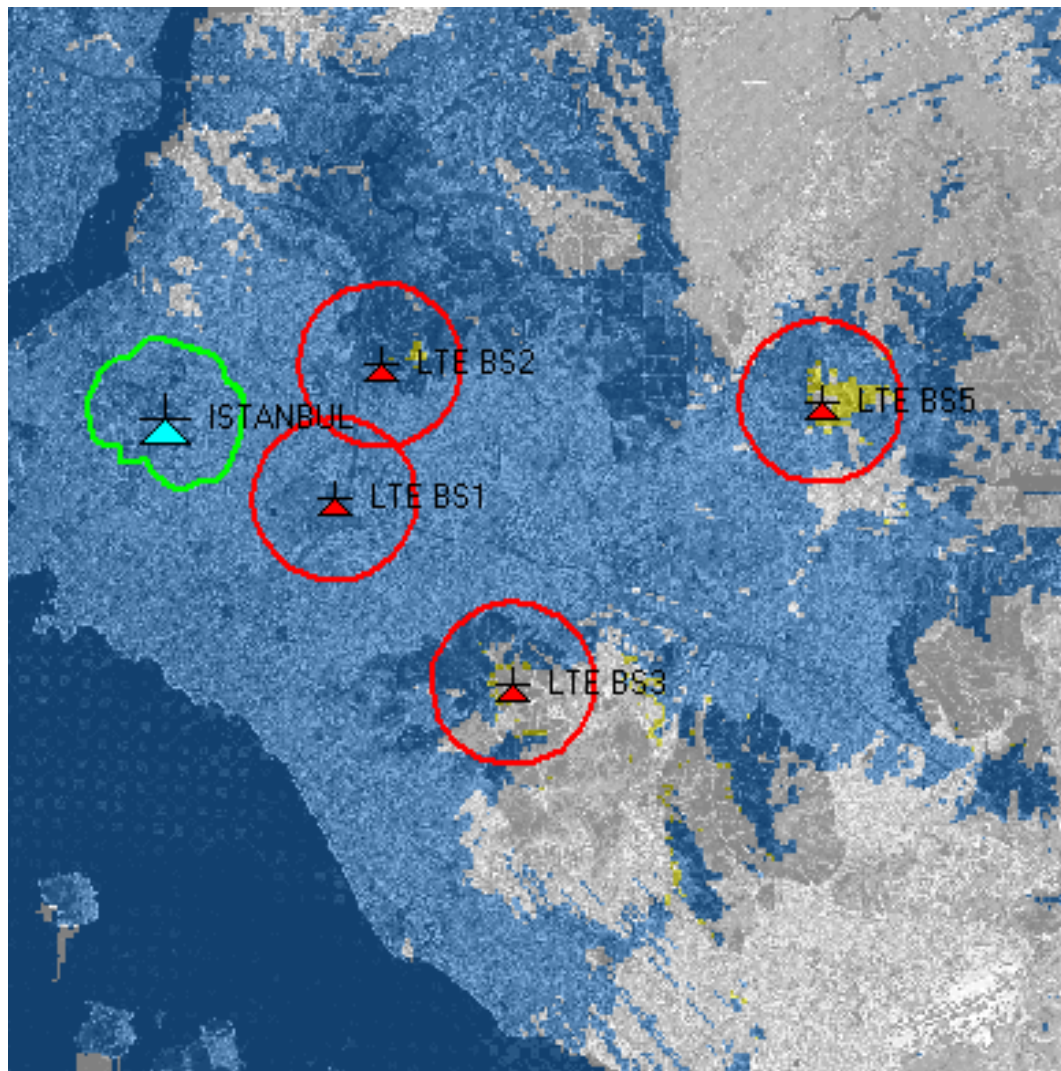


DVB-T2 Station:  
Channel 59 (Freq. 778 MHz)  
ERP: 20 kW

LTE 800 Station:  
Bandwidth 10 MHz  
Central freq: 796 MHz  
ERP: 800 W  
PR: -33 dB



# DVB-T2 interfered with by LTE BS: CH52 Coverage reserve interfered by LTE800 BS



DVB-T2 Station:  
Channel 52 (Freq.  
722 MHz)  
ERP: 20 kW

LTE 800 Station:  
Bandwidth 10 MHz  
Central freq: 796  
MHz  
ERP: 800 W  
PR: -46 dB



■ Overloading:

Channel offset N (8 MHz channels)	Centre frequency offset (MHz)	LTE BS	
		PR (dB)	O <sub>th</sub> (dBm)
Co-channel (AWGN)	0	19	-
Co-channel (LTE)	0	19	-
1	10	-25	-16
2	18	-33	-12
3	26	-36	-11
4	34	-40	-13
5	42	-43	-11
6	50	-46	-11
7	58	-47	-11
8	66	-46	-11
9	74	-46	-10

Centre freq. Offset (MHz)	Oth (dBm)	Oth (dBμV/m)
10	-16	110.1
18	-12	114.1
26	-11	115.1
34	-13	113.1
42	-11	115.1
50	-11	115.1
58	-11	115.1
66	-11	115.1
74	-10	116.1

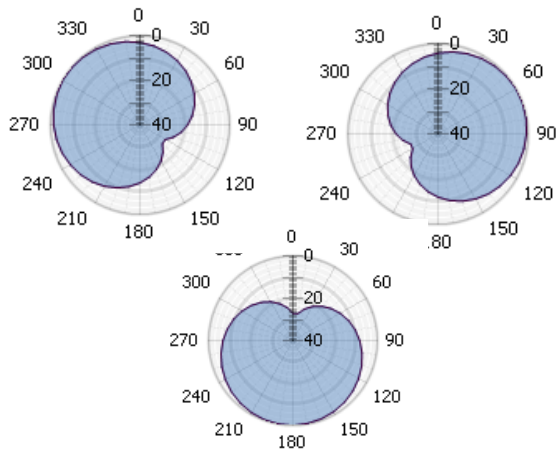
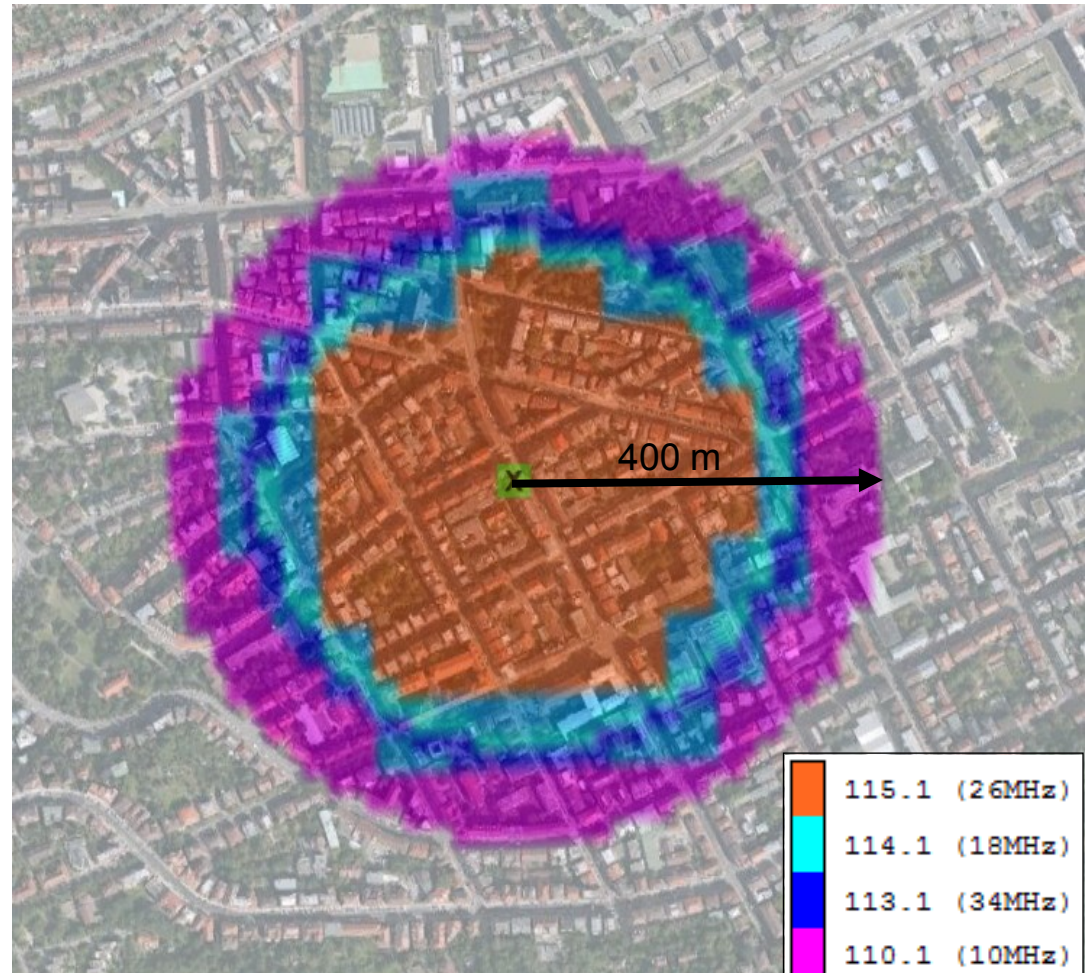
Conversion from dBm to dBμV/m:

- Frequency 800 MHz

- System gain 7 dB (12 dBd antenna gain and 5 dB feeder loss according to Final Acts GE06)

- Overloading:

Site	
Service	LTE
Site Name	LTE FDD1
System	
Long./East.	008E57 29.601
Lat./North.	49N54 15.763
Antenna Height	40.0 m
Angle of Inclination	0.0 °
Number of Sectors	3
ERP	1000 W
Frequency	796 MHz

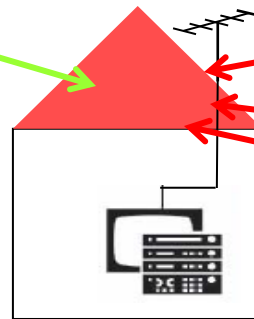
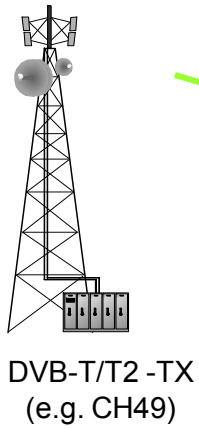
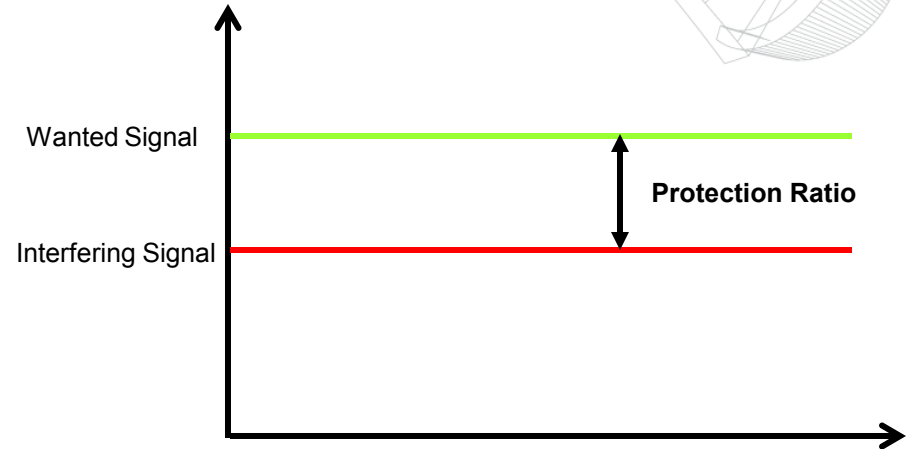


# DVB-T2 interfered with by LTE (UE)



- Protection ratios (PR)

Note: Consideration of location probability margin and antenna-polarization discrimination !



LTE UE



- Digital Mobile Spectrum Limited (DMSL)
- Funded by and represent the UK mobile operators launching 4G services at 800 MHz: Vodafone, O2, Three, EE
- Governance: The Board reports to the regulator (Ofcom) and the Department for Media, Culture and Sports (DCMS). The Board is comprised of both of representatives of 4G licensees and the terrestrial television
- DMSL is owned by 4G liceneses
- Each operator provides corrective supports for housholds affected by the deployment of 4G at 800 MHz

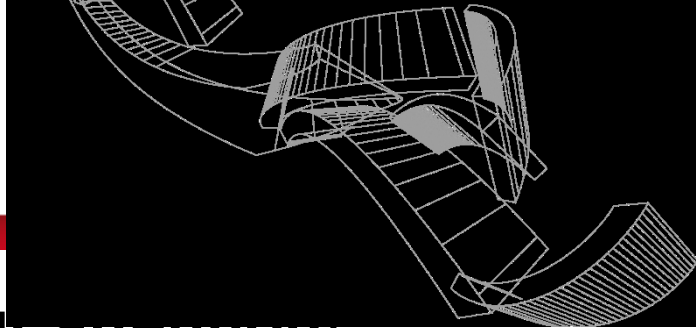
- Responsible for forecasting which households are likely to be affected
- Estimation: ~90,000 affected households with DTT as primary TV service
- Affected households located in proximity of LTE base stations
- Symptoms for those who are affected: loss of sound, blocky or pixelated image for some or all channels
- Most of the disturbance will be solved by supplying free filters in advance to those affected
- most viewers will be able to fix the problem themselves in a matter of minutes
- Range of support: mailing useful information before service launch

- The rollout program could last three years – need for the DMSL Prediction tool able to calculate degradation in location probability of DTT coverage
- Support of Development of Prediction Tool in respect of the specific features:
  - The Hata Model (according to Ofcom, SEAMCAT, SE42, etc)
  - The Probability degradation algorithm
  - Summation(s) used for the summation of LTE interferers (according to Ofcom)
- The assumptions about the receiver antenna and amplifier situation represented by the set of protection ratios used, e.g. ‘Standard Domestic Installation’ (SDI) or ‘Domestic Installation, Amplified’ (DIA).
- The LTE interferer situation represented by the MNO transmitter data.

- Provision 36 of the national frequency band allocation Ordinance: mobile service in the 790-862 MHz frequency band must not cause any interference into the broadcasting service.
- The aim is to guarantee protection for broadcasting services in all relevant application situations – particularly relevant if there is a residential area within a certain radius of a mobile service base station in the broadcast coverage area
- The probability of interference below DVB-T channel 52 in individual cases has not been looked at
- Maximum (protection) radius of approximately 1.1 km is considered sufficient.
- Defined steps for computer-assisted standard procedure for determining compatibility between LTE and broadcasting in specific cases before setting the site-related usage parameters for an LTE base station
- ~4600 base stations in 800 MHz band (condition to start with operations); 400 were deployed by the end of 2012
- Up to now approximately 10 complaints in respect of interference which have been easily solved by adjustments of DVB-T reception antenna system



- Coexistence of DTT and LTE services in adjacent bands must be planned carefully
- LTE BS out of band interference especially on the edge the coverage area
- Interference caused by overloading of DTT/DVB-T2 receiver in close proximity of LTE BS (several hundreds m), even in zones of high C/N (not depending on DVB-T2 station)
- If LTE BS is moved closer into the coverage zone of DVB-T2 station, dominant interference comes from DTT receivers' blocking
- LTE UE interference cannot be easily predicted. Special model/clutter category might be required.



**Thank you for your attention!**



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