Post ASO Experience: LTE/DVB-T2 Interference Prediction – Planning & Issues

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ITU Regional Forum on Digital Terrestrial Television Broadcast Services in Arab Region,
17th May 2014,
Gloria Hotel Dubai, United Arab Emirates

Agenda

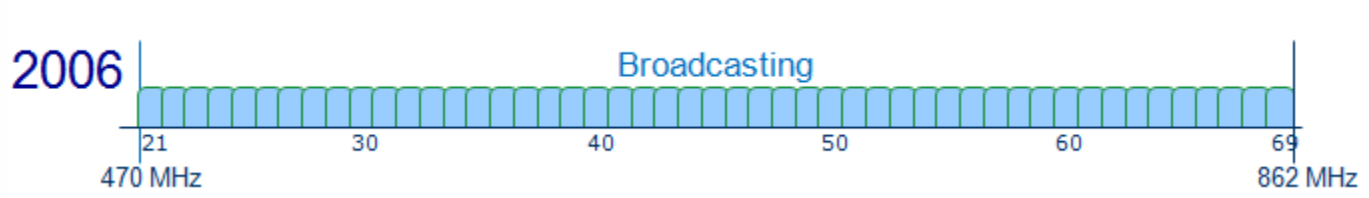
- Introduction
- DSO and Digital Dividend I & II
- Interference mechanisms DVB-T2 – LTE
- Sharing scenarios & Planning criteria
- UK Example

About LS telcom

- Based in Germany, Worldwide presence
- 20+ Years of Experience in Broadcast, Regulatory, Telecommunications', Utilities and Military Markets
- More than 250 highly specialised employees
- One-Stop-Company (Consultancy, Software & Hardware, Digital Mapping Data, System Integration, Support and After-Sales Services)
- Successfully Completed Projects (Consulting, Software Solutions and System Integration) in more than 90 Countries
- Extensive Expertise and Reliability proven in numerous Engineering and Consulting Projects
- Market Leader and Trendsetter in Broadcast Solutions

Analog to Digital Switchover
GE06 Frequency Plan

- UHF band 470 – 862 MHz (49 channels) planned for DVB-T in Region 1
- Up to 7 coverage layers (Multiplexes)



- Transition from analogue to digital
  - higher number of programmes, a better quality
  - much more spectrum efficient than analogue

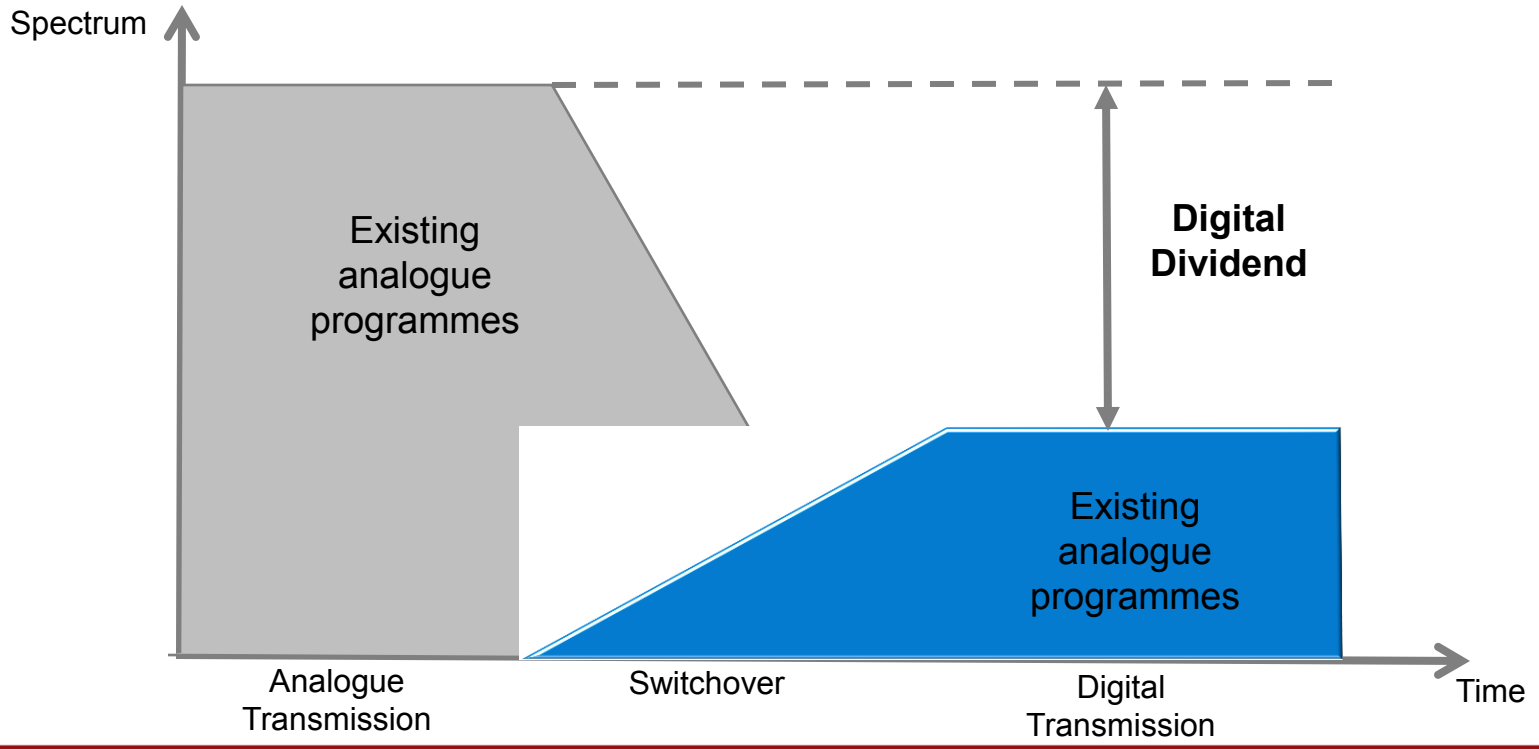
    Analog: 1 channel = 1 TV program

    Digital: 1 channel = 4 to 7 programs
  - spectrum made available by the transition of terrestrial television broadcasting from analogue to digital, especially for mobile broadband

Digital Dividend – Introduction

- 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)

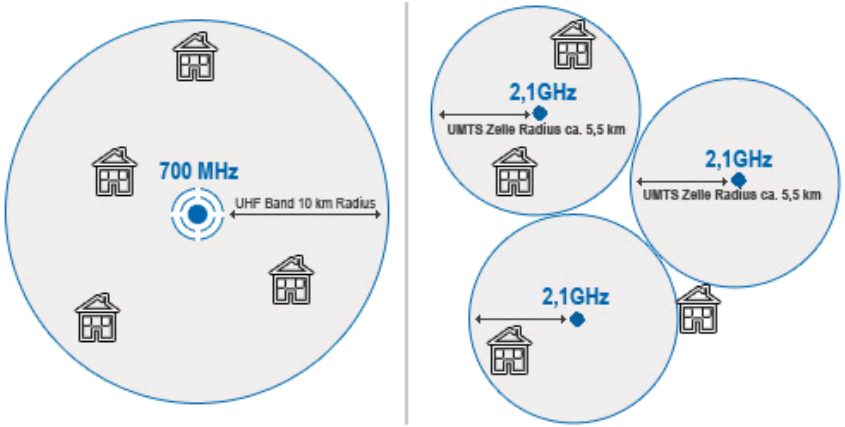


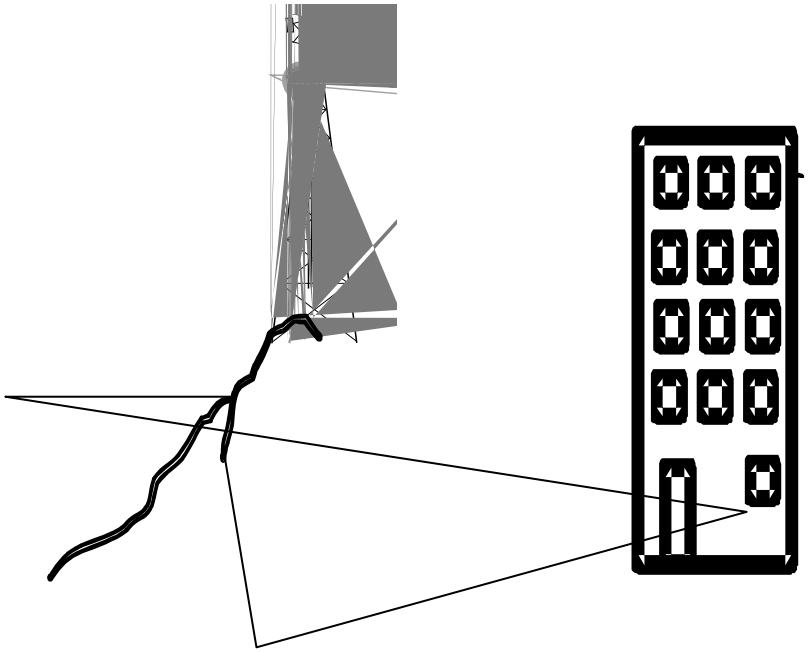
Digital Dividend - Introduction

- Potential usage of the Digital Dividend
  - Broadcasting Services
    - Provision of more programmes
    - High Definition programmes
    - 3D programmes
    - Mobile TV
  - Other Services (e.g. IMT, PMSE…)
    - Operation under the envelope of the planned broadcasting assignment/allotment
    - Operation in a distinct, harmonized frequency allocation (e.g. IMT)
    - Operation in white spaces of the BC frequency plan (e.g. PMSE)

Digital Dividend

- Why UHF? Lower frequency means…
  - …more diffraction
  - …less shadow
  - …better wall penetration



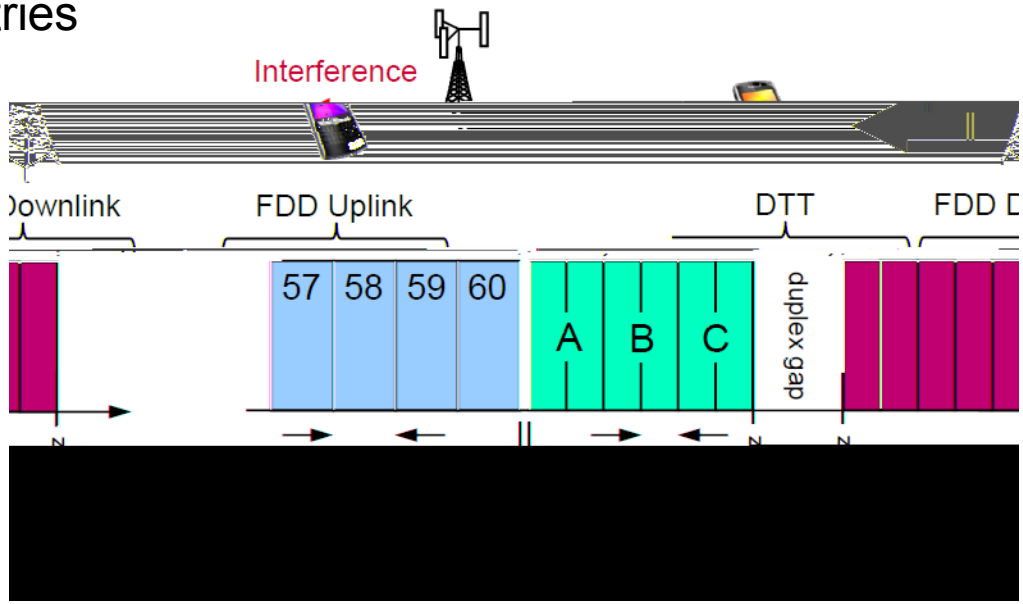


Digital Dividend I
Spectrum Allocation

WRC 2007

- Allocation of the band 790 – 862 MHz to MS (mobile services) on a co-primary basis in ITU Region 1
- MS in ch. 61 – 69 possible due to low Broadcast usage
- Band 790 – 862 MHz auctioned off in several European countries as “Digital Dividend”
- Re-Planning (Re-Farming of broadcast frequencies) necessary in lot of the countries

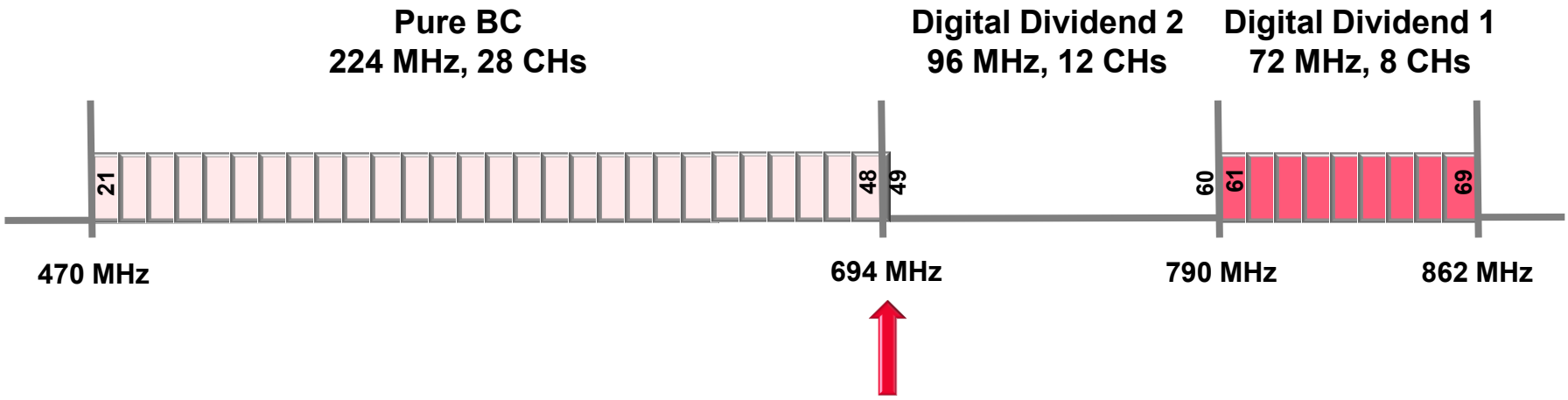
European Harmonized Band Plan 790–862MHz



Digital Dividend II
Spectrum Demands

WRC 2012

- Two important agenda items
  - Compatibility and sharing in the band 790 – 862MHz
  - More spectrum for IMT at WRC-15
- Input from African and Arabian countries request the allocation of the 700 MHz band during WRC-12
  - 800 MHz band not usable for MS
  - 694 -790 MHz already allocated for MS in ITU regions 2 & 3 by WRC 2007



Overview of the allocation for mobile services in a number of countries

Country	National situation
Australia	• Analogue TV switch-off in 2013 • 694 – 820 MHz allocated to mobile broadband services • Auction of licences in 2012
Finland	• Analogue TV switch-off in 2007 • 790 – 862 MHz allocated to mobile broadband services ronautical Radionavigation services from mobile mber 2010 band • Agreement with Russia on protection of Aer services in the band 790 – 862 MHz in Dece • Re-allocation of PMSE services to 790 MHz
France	L in Metropolitan France and overseas • Analogue TV switch-off finalized on 30 November 2011 territories • 790 – 862 MHz allocated to mobile broadband services
Germany	• Migration of broadcasting and military from 790 – 862 MHz • Auction of licences in December 2011 • Analogue TV switch-off in 2008 • Migration of broadcasting from 790 – 862 MHz • Auction of licences in December 2010
India	• Analogue TV switch-off in 2015 • Aug. 698 – 806 MHz allocated to mobile broadband services 2011 mobile broadband services
Japan	• Analogue TV switch-off in 2 • 710 – 780 MHz allocated to

Source: Digital Dividend Rapport – ITU 2012

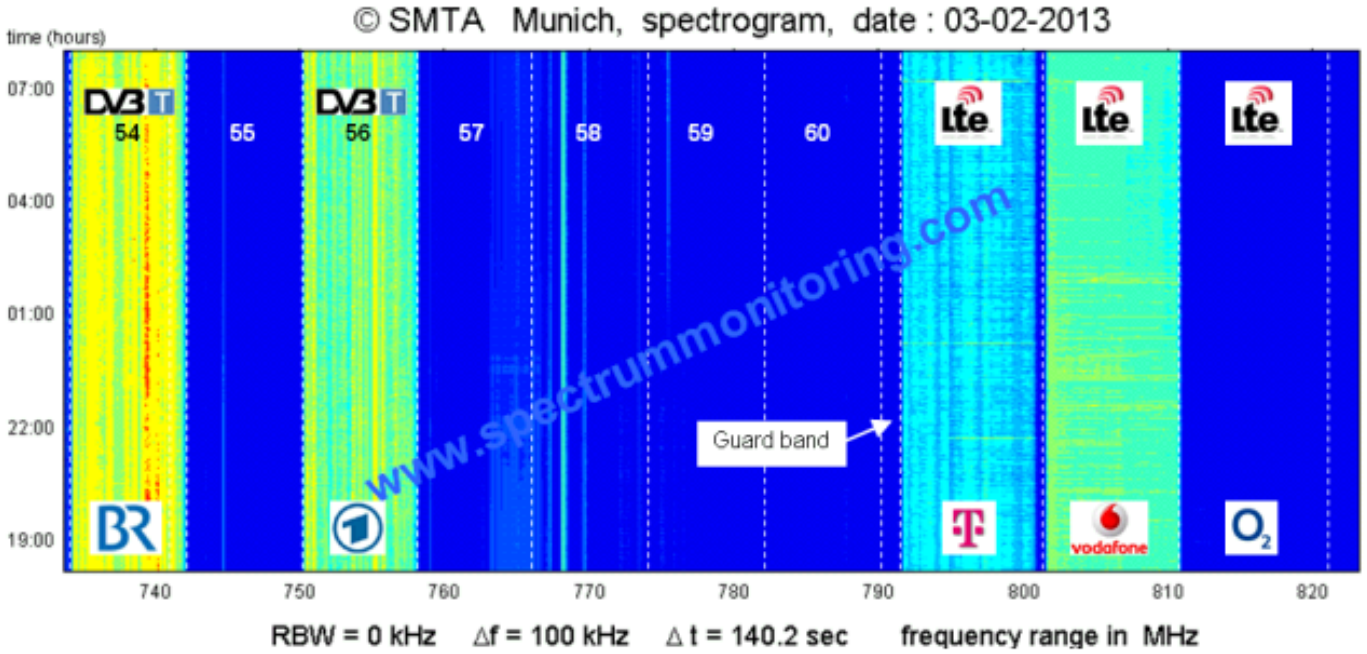
Overview of the allocation for mobile services in a number of countries

Country	National situation
Korea	• Analogue TV switch-off in 2012 • 698 – 806 MHz allocated to mobile broadband services • Frequency plan for 698 – 806 MHz to be developed
Spain	• Analogue TV switch-off in 2010 • 790 – 862 MHz allocated to mobile broadband services • Migration of broadcasting from 790 – 862 MHz • Auction of licences in July 2011
Sweden	• Analogue TV switch-off in 2007 • 790 – 862 MHz allocated to mobile broadband services • Migration of broadcasting from 790 – 862 MHz • Auction of licences in February 2011
UK	• Analogue TV switch-off in 2012 • 790 – 862 MHz allocated to mobile broadband services • Migration of broadcasting from 790 – 862 MHz • Auction of licences planned in 2012
USA	• Analogue TV switch-off in 2009 • 698 – 806 MHz allocated to mobile broadband services, mobile TV and public safety services • Auction of licences in 2008 and before

Source: Digital Dividend Rapport – ITU 2012

Spectrum Occupancy

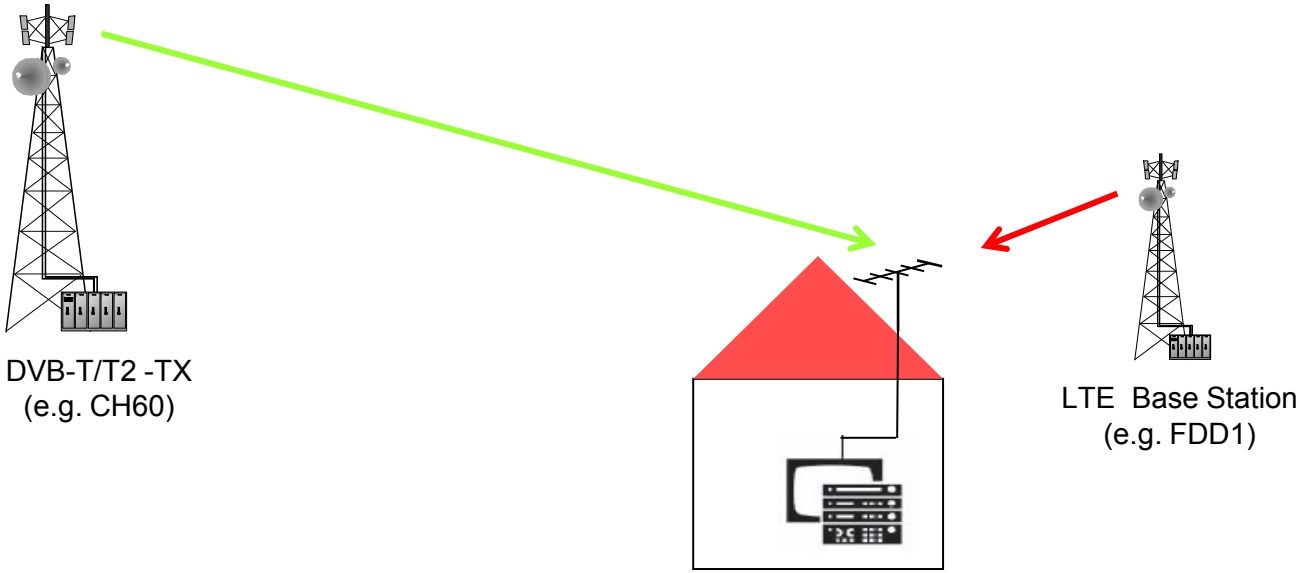
- Digital Dividend 1
  - The spectrogram recorded in Munich shows the DVB-T signals next to the new 4G LTE carriers. Both T-Mobile and Vodafone D2 launched a 10 MHz LTE service.



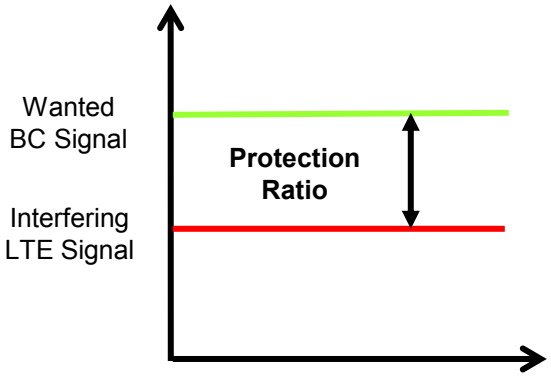
LTE – DTT: Interfacing different ‘worlds’

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

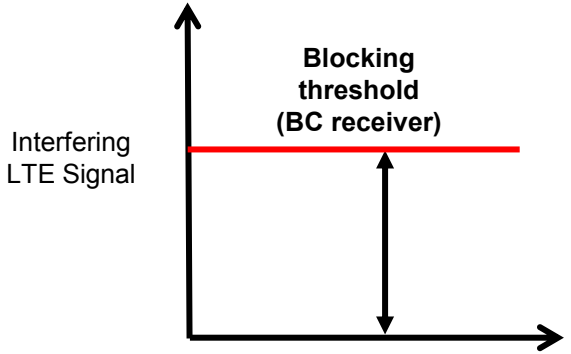
Interference LTE versus Broadcast
Basic Interference Mechanism



C/I (Coverage Probability)



Receiver Overload



DTT vs. LTE

- Calculated Values for Interference and Overloading

Channel offset N (8 MHz channels)	Centre frequency offset (MHz)	LTE BS	
		PR (dB)	O_{th} (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

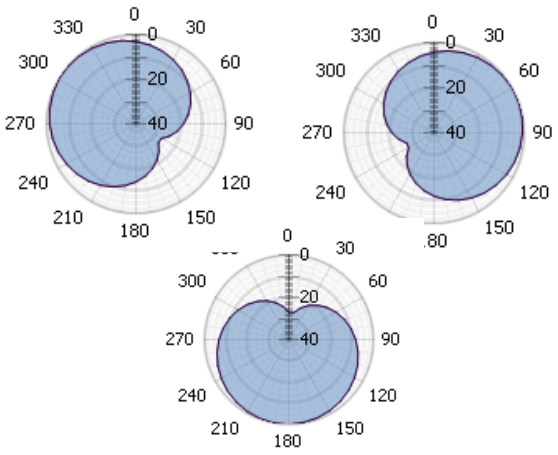
Centre freq. Offset (MHz)	Oth (dBm)	Oth (dBµV/m)
10	-16	110.1
18	-12	114.1
26	-11	115.1
34	-13	113.1
42	-11	115.1
50	-11	115.1
58	-11	115.1
66	-11	115.1
74	-10	116.1

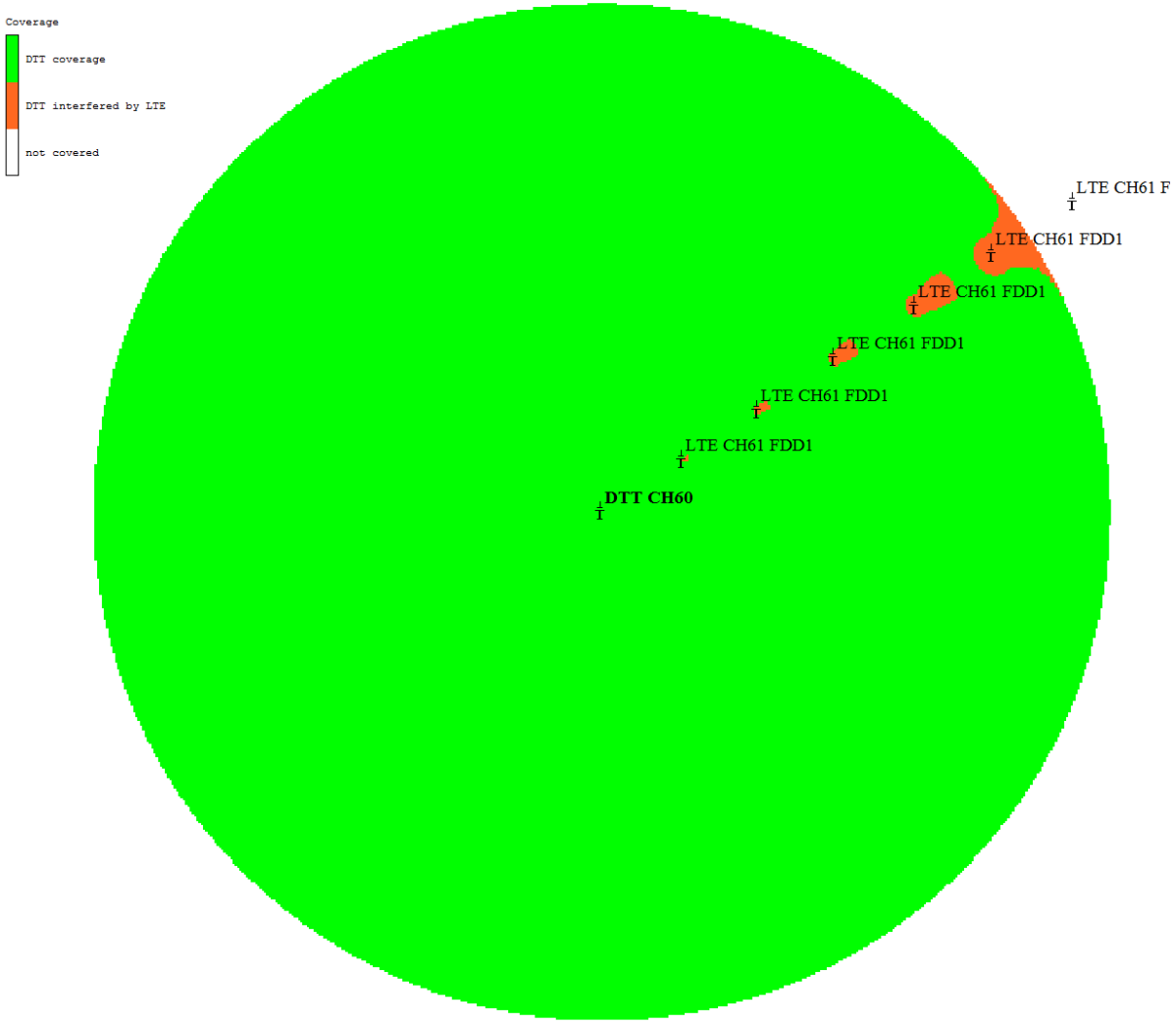
Conversion from dBm to dBµV/m:
- Frequency 800 MHz
- System gain 7 dB (12 dBd antenna gain and 5 dB feeder loss according to Final Acts GE06)

DTT vs. LTE

- Protection Ratios:

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





DTT vs. LTE

- Overloading:

Site

Service	LTE	
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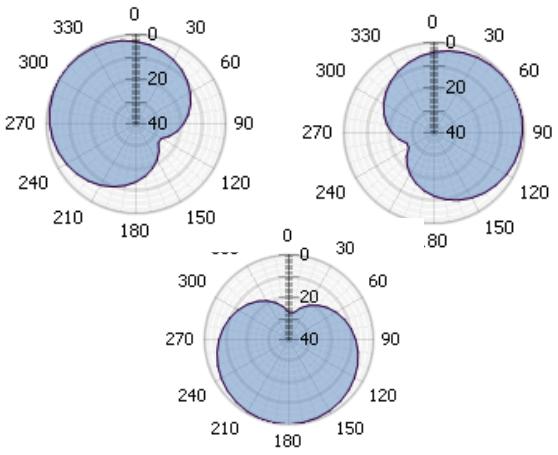
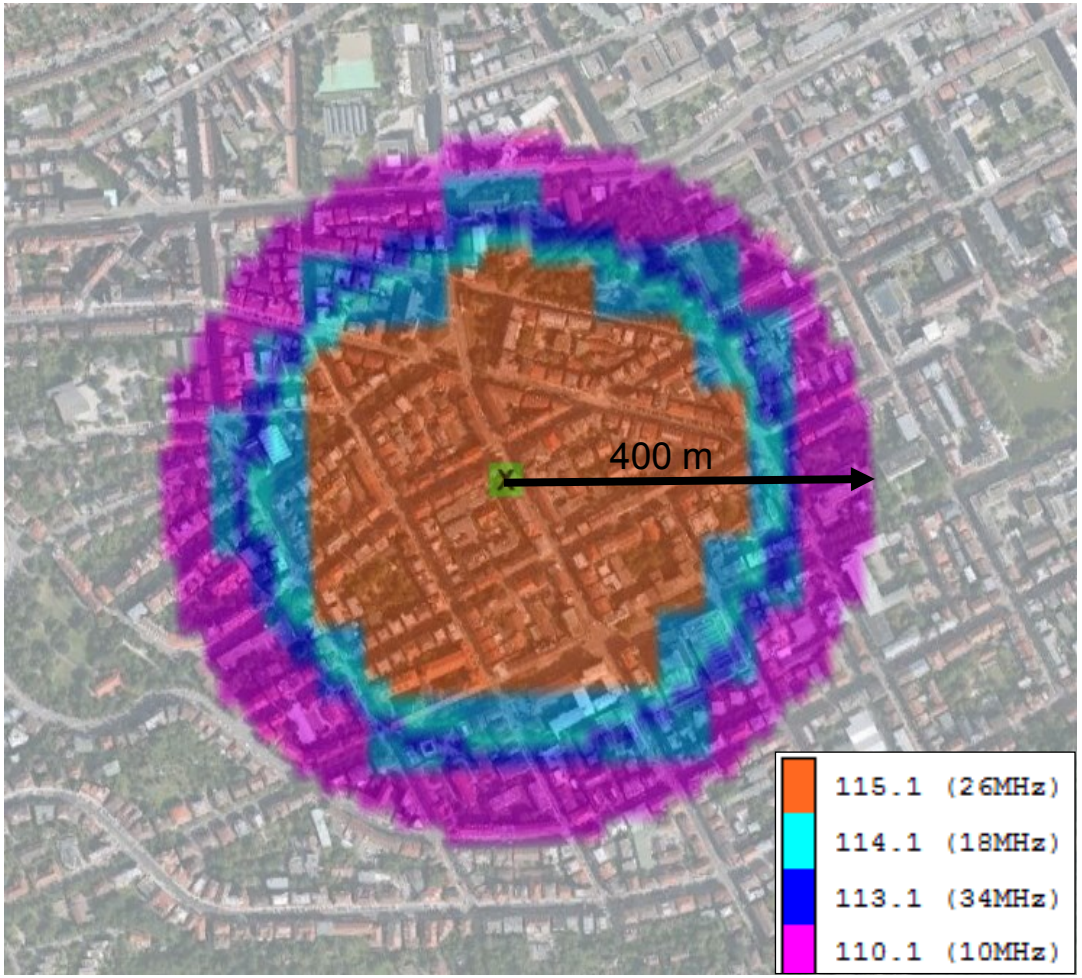
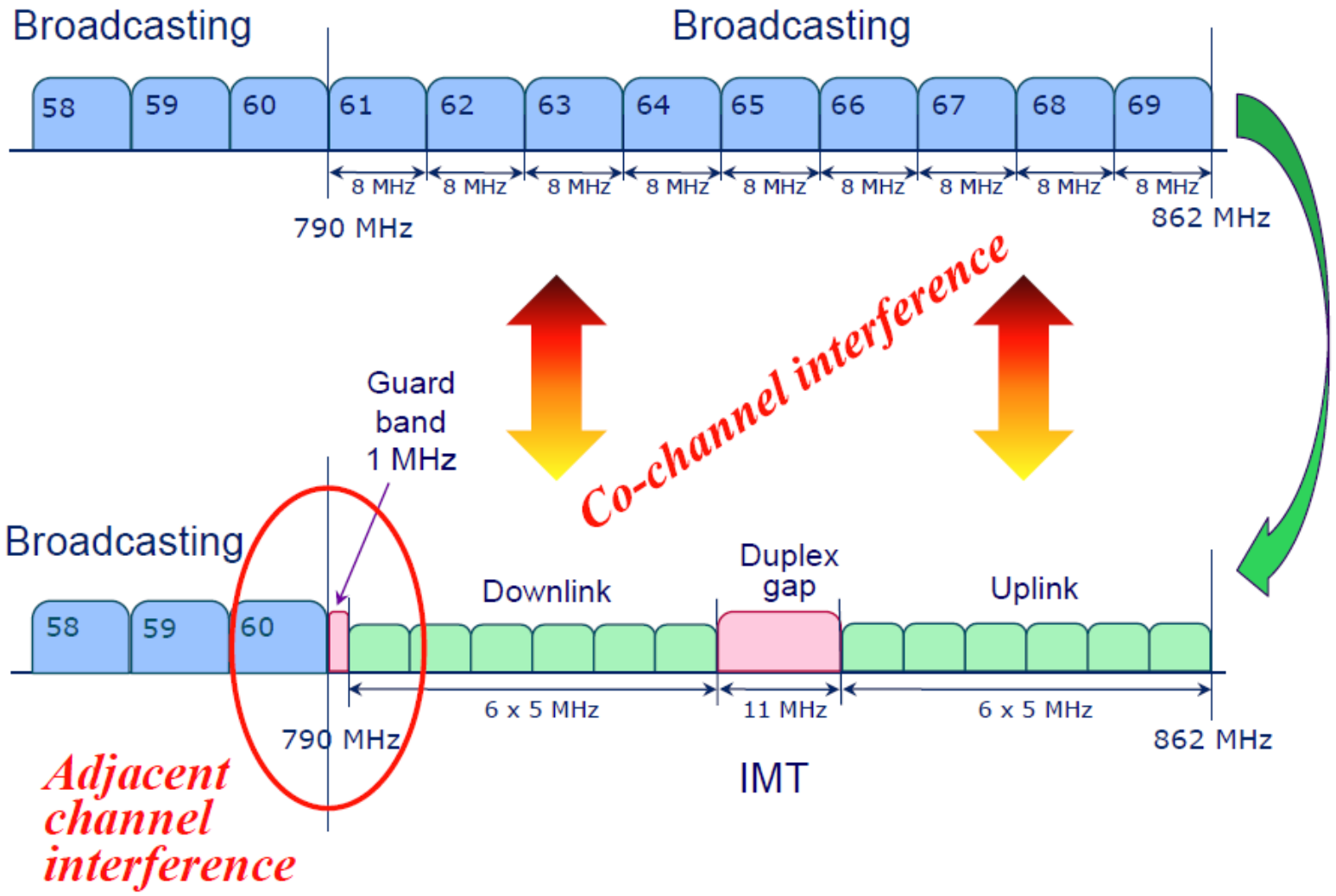


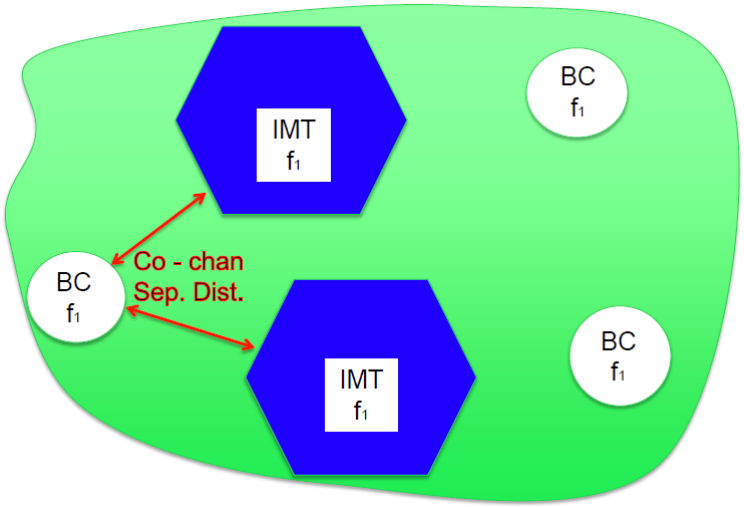


Interference LTE versus Broadcast
Co- and Adjacent Channel

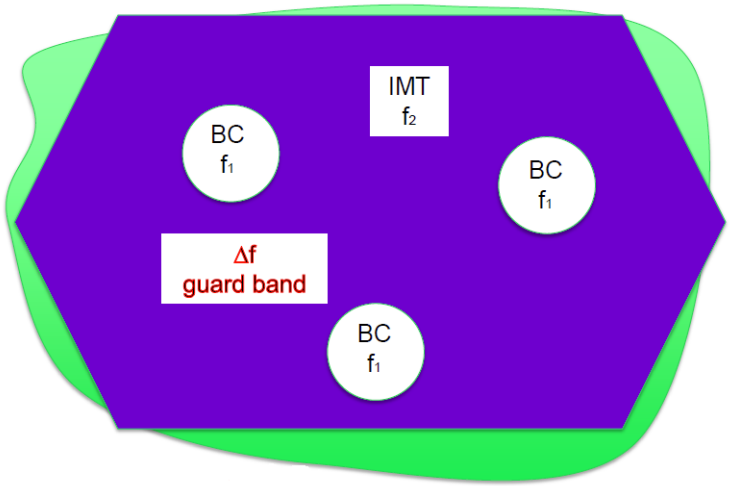


Sharing Scenarios - National
Co- and Adjacent Channel Interference

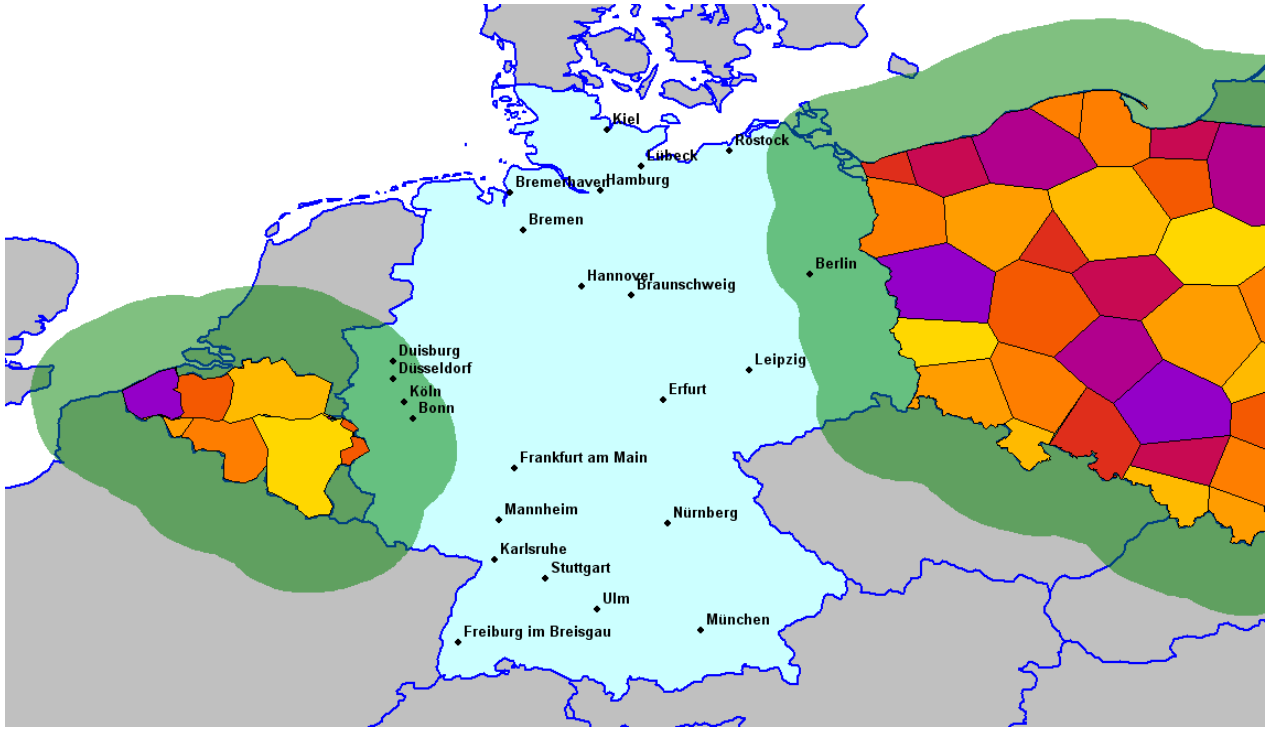
- Co-Channel → Separation distance
  - Broadcast in cities
  - Mobile in rural areas



- Adjacent-Channel → Guard Band
  - Adjacent channel(s) blocked for DTT



Sharing Scenarios - International
Co-Channel Interference BC - MS



Example: GE06 Allotments in Belgium and Poland

- 61 (790 - 798 MHz)
- 62 (798 - 806 MHz)
- 63 (806 - 814 MHz)
- 64 (814 - 822 MHz)
- 65 (822 - 830 MHz)
- 66 (830 - 838 MHz)
- 67 (838 - 846 MHz)
- 68 (846 - 854 MHz)
- 69 (854 - 862 MHz)

2 Scenarios

- Loss in the “Mobile” country – 100km region along the border
- Loss in the “Broadcast” country – Allotments along the border cannot be used

Interference LTE versus DVB-T2
ITU Rec. BT 2033

Recommendation ITU-R BT.2033
(01/2013)

Planning criteria, including protection ratios, for second generation of digital terrestrial television broadcasting systems in the VHF/UHF bands

TABLE 11

Recommended sharing study values of PR and O_{th} for a DVB-T2 signal (defined in Table 1) in a clear channel, interfered with by an LTE BS or UE signal in adjacent channels for 3 can and 11 silicon tuners combined

	Channel offset N (8 MHz channels)	Centre frequency offset (MHz)	LTE BS		LTE UE	
			PR (dB)	O_{th} (dBm)	Corrected PR (dB)	O_{th} (dBm)
	Co-channel (AWGN)	0	19	–	19	–
	Co-channel (LTE)	0	19	–	19	–
60	1	10	–25	–16	–6	–30
59	2	18	–33	–12	–13	–11
58	3	26	–36	–11	–28	–10
57	4	34	–40	–13	–37	–20
56	5	42	–43	–11	–38	–10
55	6	50	–46	–11	–40	–9
54	7	58	–47	–11	–42	–9
53	8	66	–46	–11	–43	–10
52	9	74	–46	–10	–44	–10

(Additional correction values available for different system variants and various reception conditions)

UK (I)
Interference Evaluation Procedure

- ‘Initial’ coverage probability of the broadcast stations (UKPM method)
- Calculate the ‘**combined**’ interference for broadcast and LTE stations

  ➔ Consider the individual interference contributions including protection ratios and/or receiving antenna discrimination using a statistical summation procedure (e.g. Schwarz &Yeh)
- Calculate the ‘final’ coverage probability
- 2 different DTT reception scenarios are considered
  - Standard Domestic Installation (SDI)
  - Domestic Installation with Amplifier (DIA)
- Protection ratios are dependant on the reception scenario and the wanted DTT level
- All channels are considered (from channel 60 to 21)

Technical analysis of interference from mobile network base stations in the 800 MHz band to digital terrestrial television

Technical report

Publication date: 10 June 2011

UK (II)
The DMSL Project

- Calculate the influence of LTE sites on Broadcast coverage in the UK
  - Broadcast coverage provided by Arqiva (around 3600 broadcast frequencies)
  - LTE sites/sectors provided by the mobile operators (around12’000 to 35’000 LTE sectors/frequencies at current, up to 100’000 possible in the final network configuration)
  - Planning tool calculates the ‘degradation’ in coverage probability
  - All needs to be done in a highly automated mode (→ Macro function)
    - Import the BC stations and the coverage files
    - Import the LTE stations
    - Calculate the interfering field strength of the LTE stations
    - Calculate the coverage probability degradation of every single affected BC station
    - Calculate the overall coverage degradation for all stations of a certain MUX
    - Repeat the calculation for each MUX (up to 6) and with two different set of PRs
  - Calculation results must be close to results from the broadcast operator

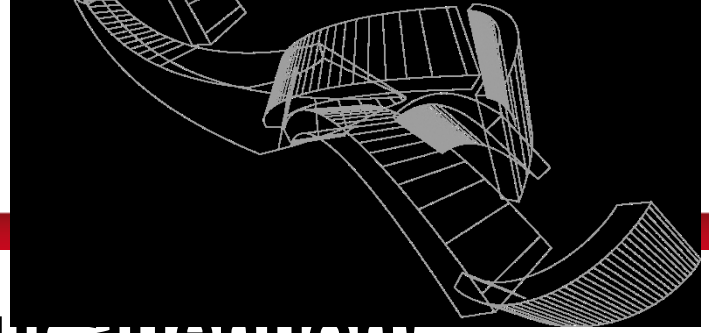
Preparing and informing about DTT-LTE (potential) interferences

- https://at800.tv/

- http://www.recevoirlatnt.fr/en-savoir-plus/actualites/ret-actu/1/actu/comment-savoir-si-je-suis-concernee-par-une-interference-entre-la-reception-tnt-et-la-4g/#.U3ceVldNk4c
- http://www.recevoirlatnt.fr/fileadmin/contenu/PRO_4G/Brochure__4G_12-04-2014.pdf

Conclusion

- Coexistence between DTT and LTE is possible !
- Key issues are proper planning and anticipation as well as efficient monitoring!
- LS telcom is pleased to support you in this process !



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