Interference study for LTE co-existing with DVB-T For NPT

Issue 1

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Introduction

The purpose of this report is to assess the potential impact of a LTE mobile service operating in the 800 MHz band (also known as digital dividend spectrum) upon the existing UHF networks using the DVB-T system that provides a public service in Norway. The outcome of this analysis will be the number of people potentially interfered by the future LTE network. Additionally, mitigation options will be discussed.

Scope of Work

- Determination of potential interference from LTE network into DVB-T network.
- Considering only downlink interference from LTE into DVB-T for analysis
- Only FDD1 and FDD2 are considered as potential interferer
  - In cases of high interference, FDD3 was also taken into account
- Analysis of Interfernce from adjacent channel (**out of band**) and interference through **blocking**
- Testing mitigation mitigation options in sample area

Background

The World Radiocommunication Conference 2007 (WRC-07) allocated the spectrum for 790-862 MHz in Region 1 to the mobile service on a primary basis from June 2015 primarily to serve the needs of International Mobile Telecommunication (IMT) .

NPT will auction these frequencies to mobile providers in the near future. The lowest block of spectrum to be auctioned, is immediately adjacent to the allocation for digital broadcasting as proposed in harmonised plan in CEPT report 31. Whilst there is a small guard band between the two services, there is the potential for interference between the digital broadcast network and LTE wireless broadband network.

Spectrum Plan

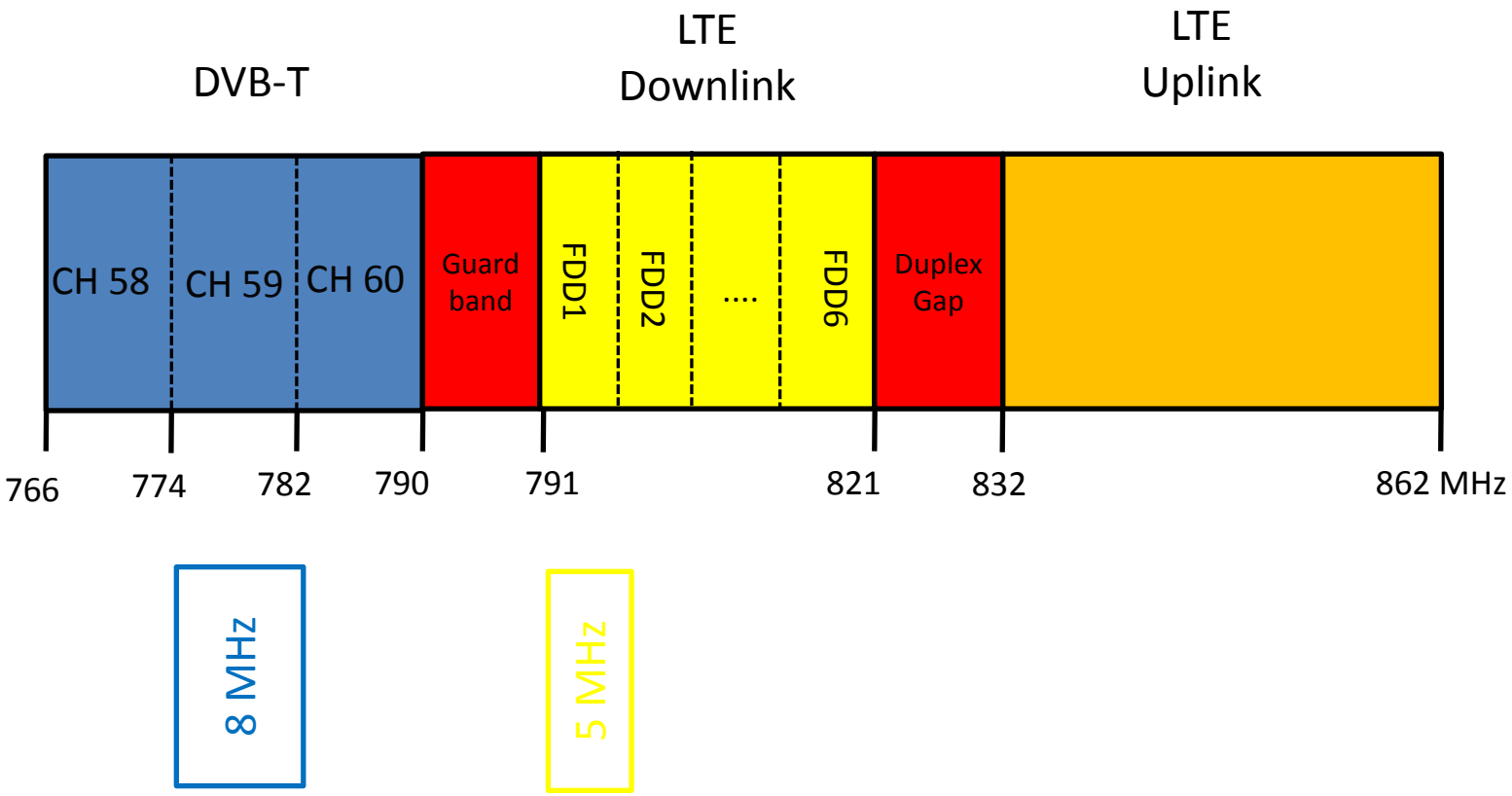
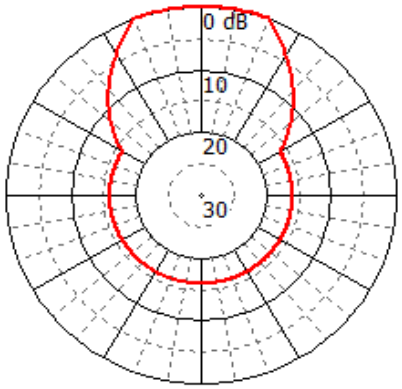


Figure shows the allocation of channels based on CEPT report 31

DVB-T System Characteristics

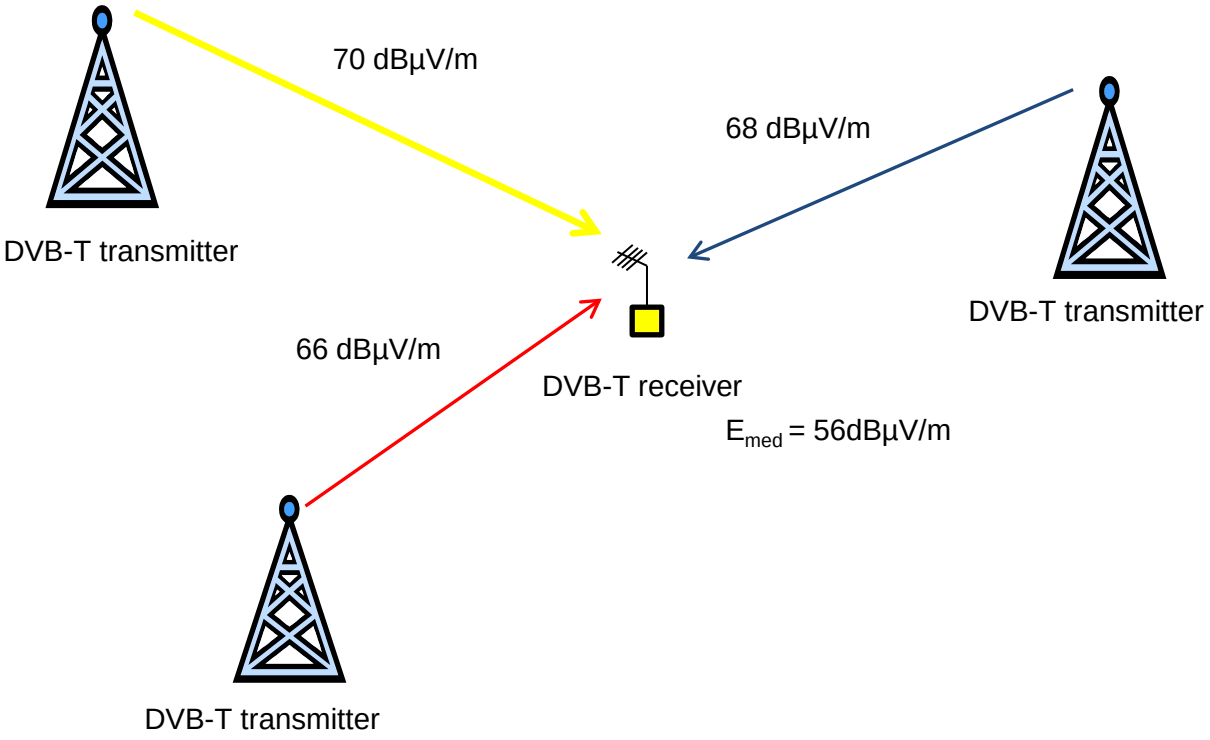
- Transmitter location from assignment data
- GE06 RPC 1 as reference for receiver antennas
  - Fixed roof top antennas
  - 10m above ground
- ITU-R BT 419 as receiver antenna model
- 64 QAM 2/3 system



ITU-R BT 419 antenna pattern

DVB-T Service Area Calculation

Best server analysis was undertaken to determine the service area

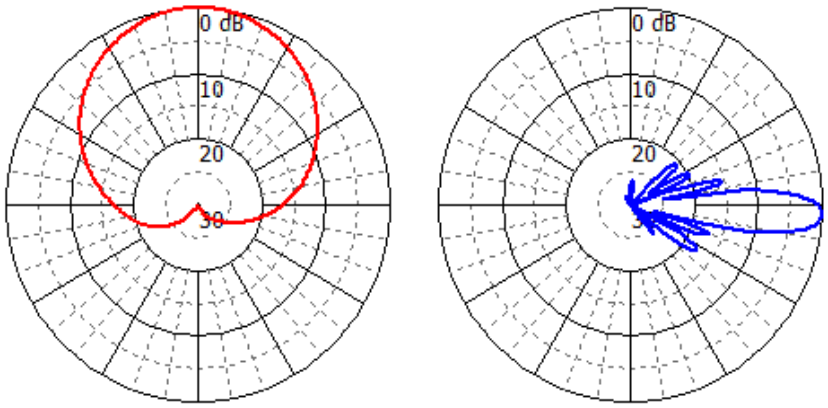


E_{med} = minimum median field strength

LTE Station Characteristics

Each site in the mobile network has the following characteristics:

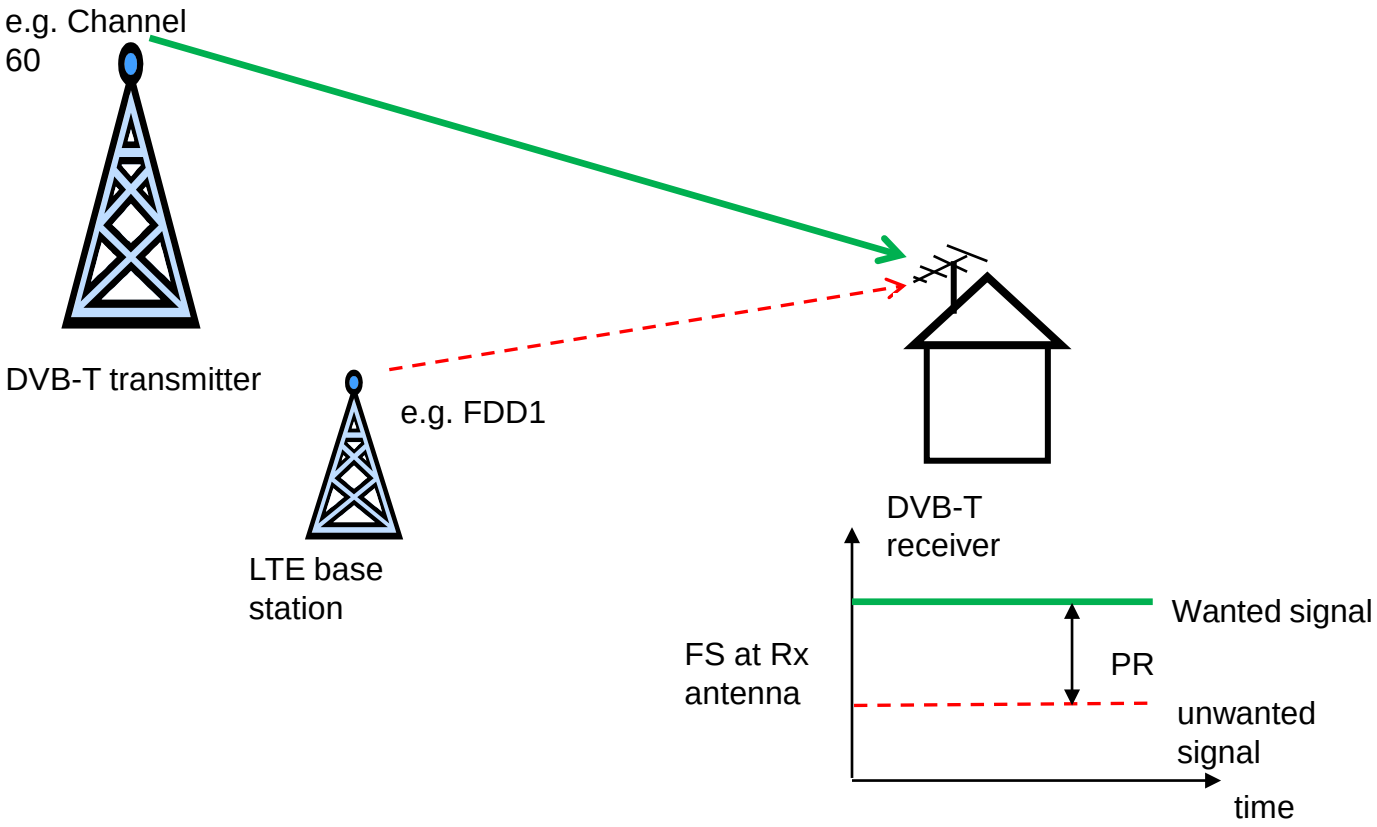
- Kathrein 800 10293
  - Gain: 16.5 dBi
- Nominal power: 20 W
- Channel bandwidth: 5 MHz
- Polarization: dual slant polarization (+45º / -45º polarization)



Kathrein 800 10293 antenna pattern

Out of Band Interference

occurs when the unwanted signals, from an adjacent channel, are received and interferes with the receiver preventing it from decoding the wanted signal correctly.



PR = minimum ratio between wanted and unwanted

Calculation - Out of Band Interference

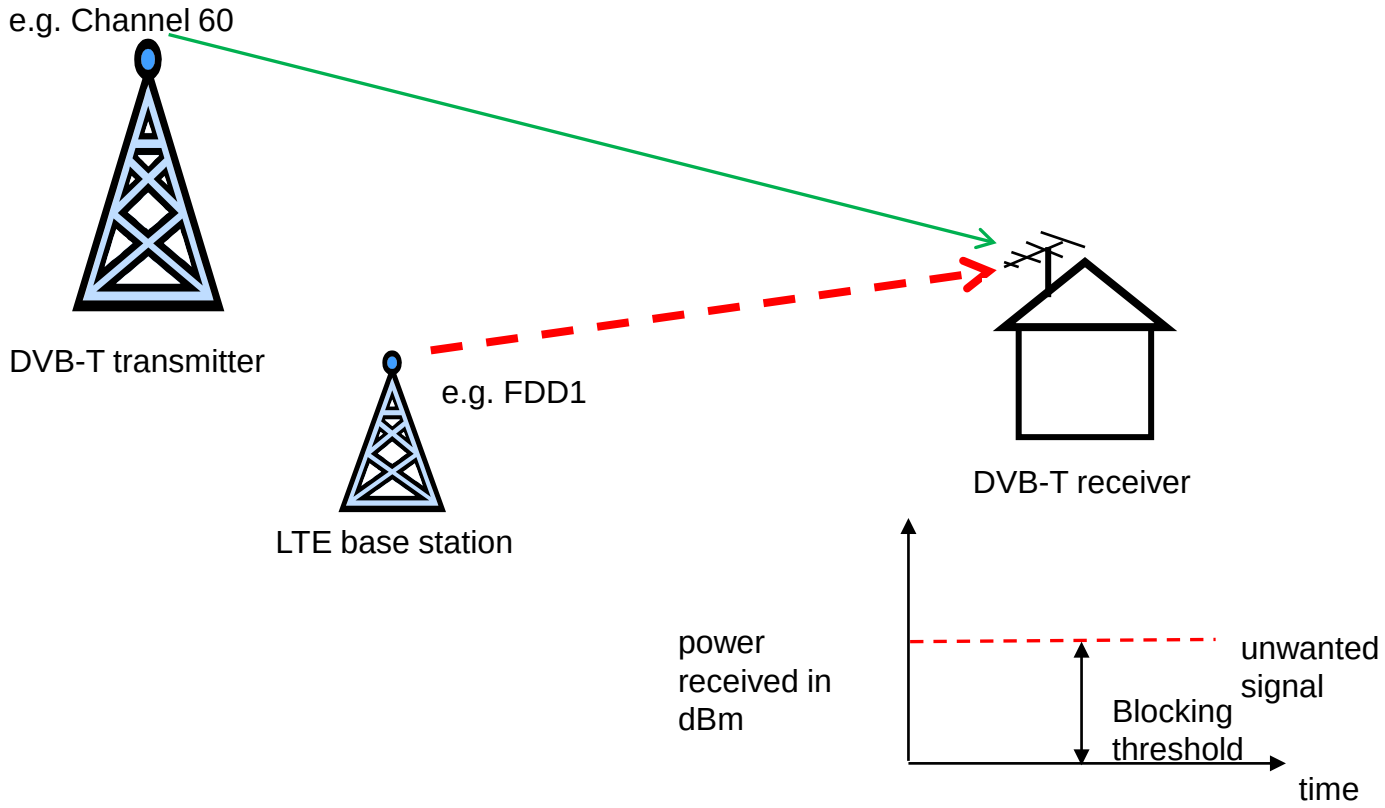
The following table shows the analysed interference pairs, frequency separation and used PR.

DVB-T Channel	FDD	Δf in MHz	PR in dB
58	1	17	-33
59	1	9	-29
60	1	1	-22
58	2	22	-36
59	2	14	-32
60	2	6	-27

The shown values were derived from ECC report 148 and include location margin (12.8dB) , polarisation discrimination (3dB) and a correction factor (1.1dB).

Blocking Interference

occurs even when the wanted signal is high and is not as frequency selective as adjacent channel interference. Blocking requires a large signal and is likely to occur in close proximity to the LTE base stations.



Blocking threshold: maximum interfering signal before receiver loses the ability to discriminate against unwanted signals at adjacent frequencies

Calculation - Blocking Interference

- blocking level are expressed as unwanted field strength levels
- blocking for FDD1 with receiver antenna pointing directly at the LTE base station
- Assessment considered ITU-R BT.419-3 as the antenna discrimination, pointing at the DVB-T receiver's best server

Channel edge separation (MHz)	DVB-T Frequency (MHz)	Blocking level (dBm)	Blocking field strength (dBµV/m)
1	786	-19	116
9	778	-14	121
17	770	-25	110
25	762	-19	116
33	754	-14	121
41	746	-12	123
49	738	-11	124
57	730	-11	124
65	722	-12	123

Table shows blocking thresholds for FDD1 calculated from ECC report 148

Results - Out of Band

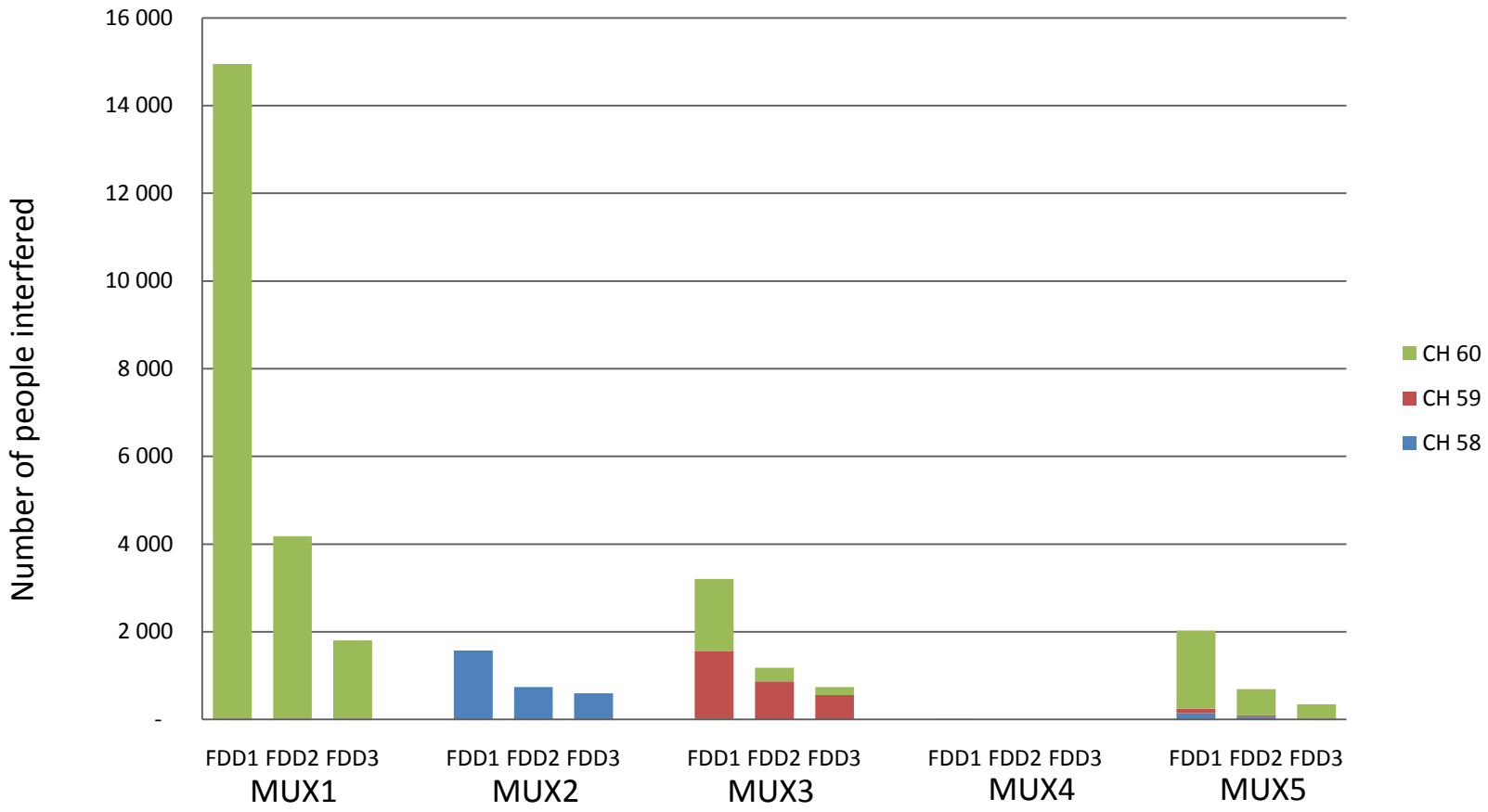
- Each MUX will be analysed individually from FDD1 and FDD2 on DVB-T channel 58, 59 and 60.
- FDD3 (fc = 803.5 MHz) was taken into account in case of more than 100 people

	FDD1	FDD2	FDD3
MUX1	14,949	4,182	1,800
MUX2	1,576	739	596
MUX3	3,208	1,180	741
MUX4	2	0	0
MUX5	2,025	692	348
Total	21,760	6,793	3,485

Table gives result overview about affected people per MUX

Note: Population affected by FDD2 and FDD3 will also be affected by FDD1, i.e. total population affected by out of band interference is 21,760

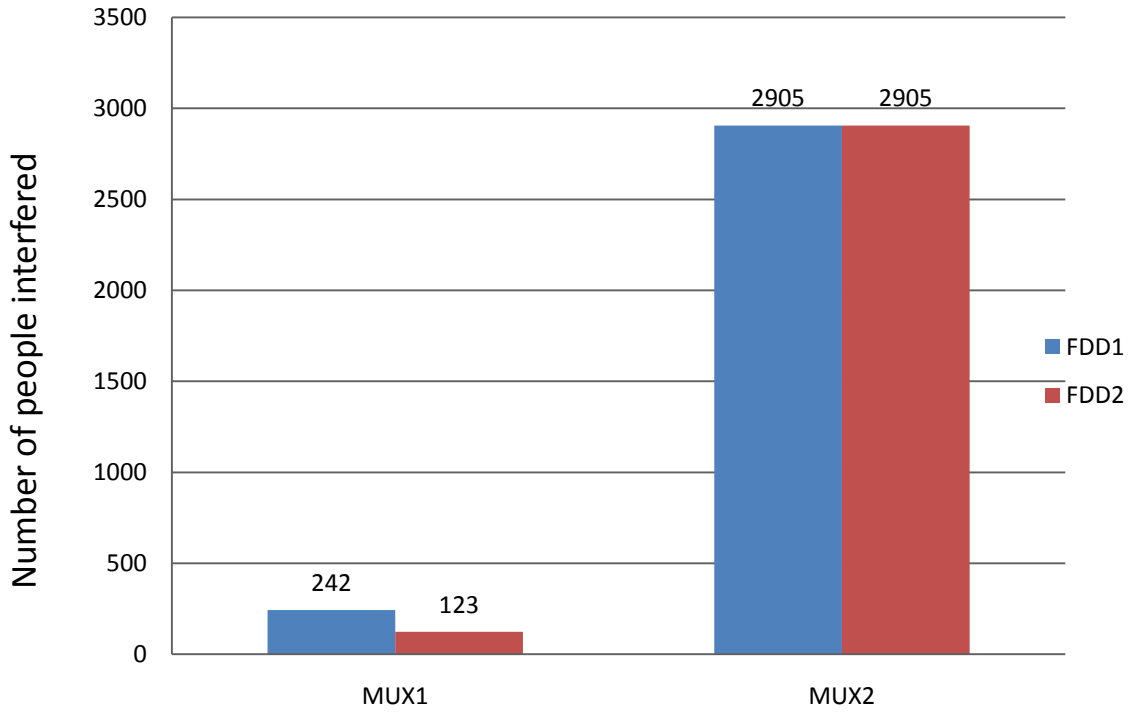
Results - Out of Band



The diagram shows the number of people interfered over the whole country

Results Blocking

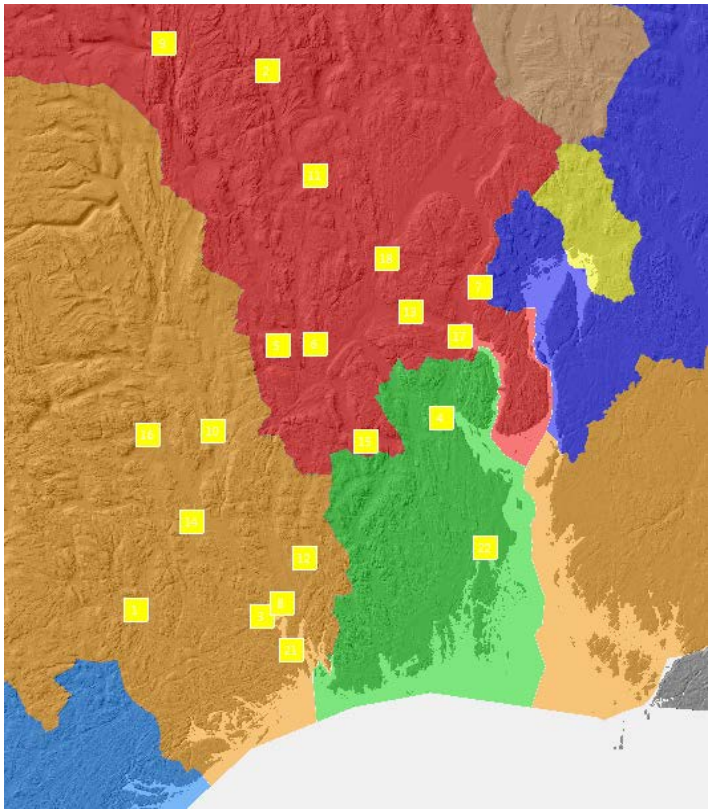
Calculation over all DVB-T channels (21-60) was limited to MUX 1 and MUX2



The diagram shows the number people interfered by blocking per MUX

Mitigation

6 mitigation techniques have been assessed individually in a sample area in the south west of Oslo. The analysis considered Channel 60 (at MUX1) being interfered by FDD1.

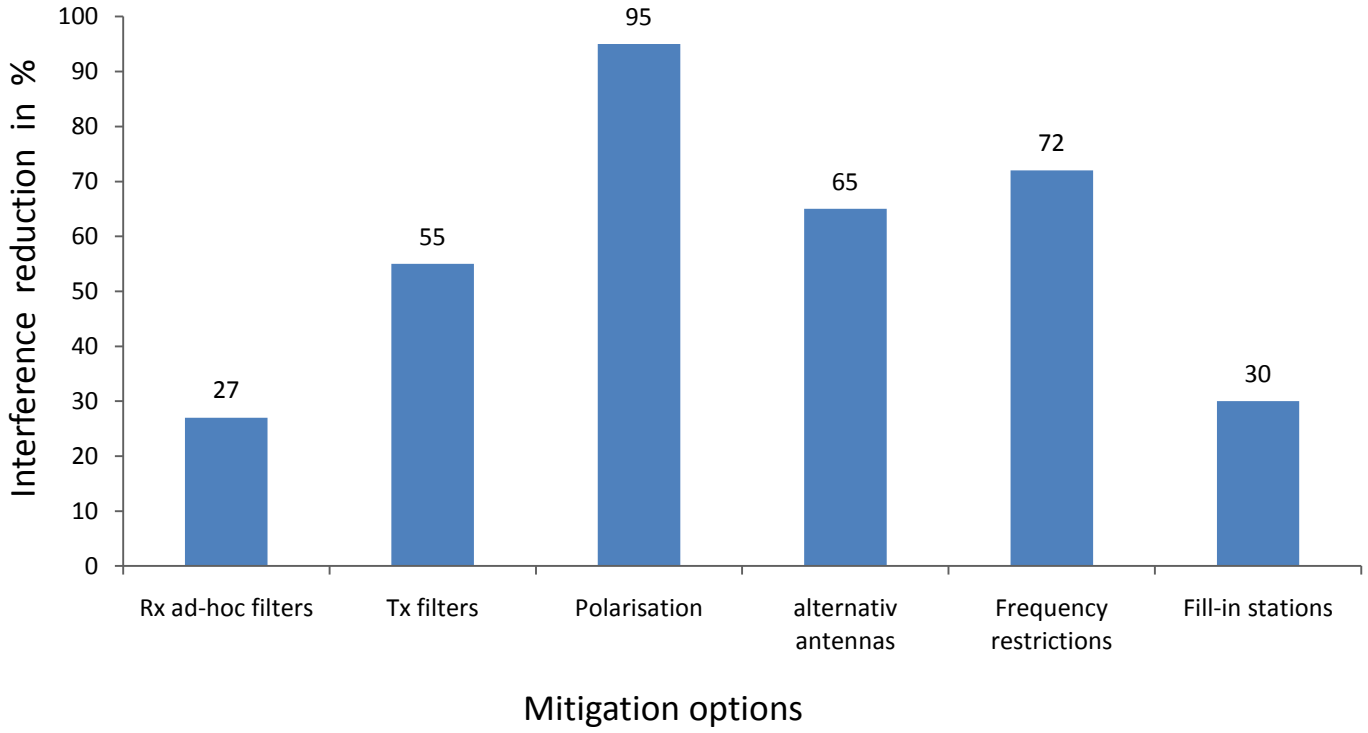


Yellow squares identify DVB-T transmitter

Mitigation Techniques

1. Ad-hoc RX filter:
   - Medium reduction of interference
   - Reduce blocking and out of band interference
2. Transmitter filter:
   - Medium to high reduction of interference (depending on filter attenuation)
   - Reduce out of band interference only
3. Polarisation arrangement:
   - High reduction of interference
   - Reduce blocking and out of band interference
4. Alternative Antennas
   - Medium reduction of interference
   - Reduce out of band interference only
5. Frequency restrictions
   - Medium to high reduction of interference
   - Reduce blocking and out of band interference
6. Fill-in stations:
   - Low reduction of interference
   - Reduce blocking and out of band interference

Mitigation Results



The diagram shows the percentage of interference reduction per analysed mitigation technique.

Conclusion

1. The out of band interference had bigger impact than blocking
2. The impact of the LTE signal is related to the population in the area
3. None of the mitigation techniques is a panacea (patent remedy)
4. All mitigation options were analysed individually – combinations of techniques might improve results
5. No Transmit Power Control (TPC) was considered - out of band and blocking interference will be significantly lower
6. DVB-T was considered as only broadcasting source – Satellite, cable or broadband were not considered