White Space Devices – Compatibility with FWA in the 3.4 to 3.8 GHz Band

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November 2014

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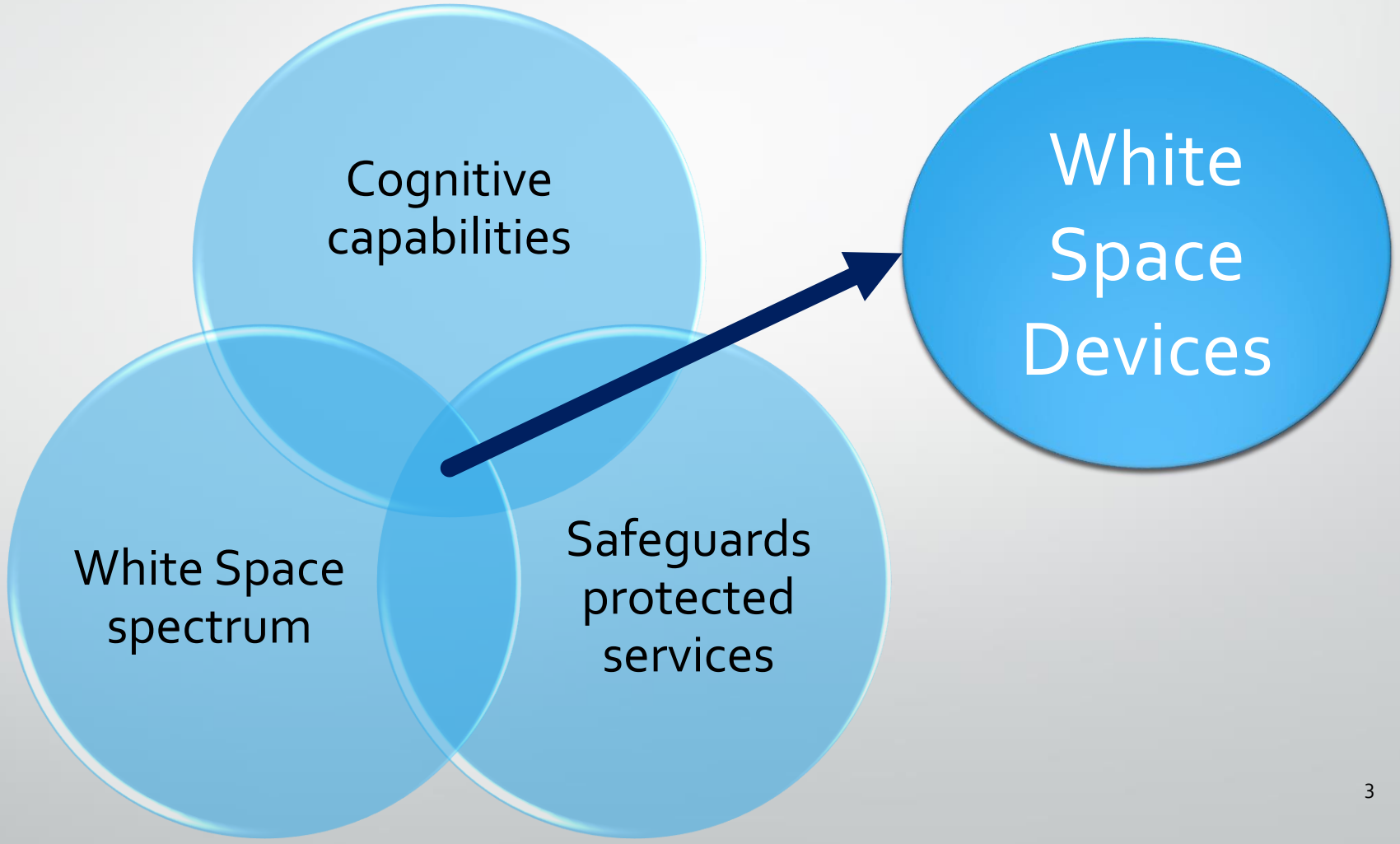
Introduction – WSDs

(1/2)



Introduction – WSDs technologies (2/2)

Technologies

- Spectrum Sensing;
- Beacon Signals;
- Geolocation Databases, or;
- Combination of technologies.

Services considered:

- Fixed;
- Nomadic;
- Offloading.

Motivation and Goals

Alternatives for the UHF Band;

Bands allocated for the Fixed Service (FS): could be considered as first option, given the fixed nature of the stations as well the possibility to take on-board mitigation techniques.

Other bands not considered due to ongoing works

3.4 to 3.8 GHz Band

The Fixed Wireless Access (FWA) was preferred allocated to the 3.4-3.6 GHz band, through the approval of the CEPT/ERC/REC 13-04, for P-P and P-MP links.

The 3.4-3.8 GHz band has been partly used for FWA regional licences.

European Commission has adopted the Decision 2014/276/UE [4] as well a total new BEM. The power limits from the base station and terminal station adopted by 2014/276/UE will be considered.

FWA Antenna Diagram

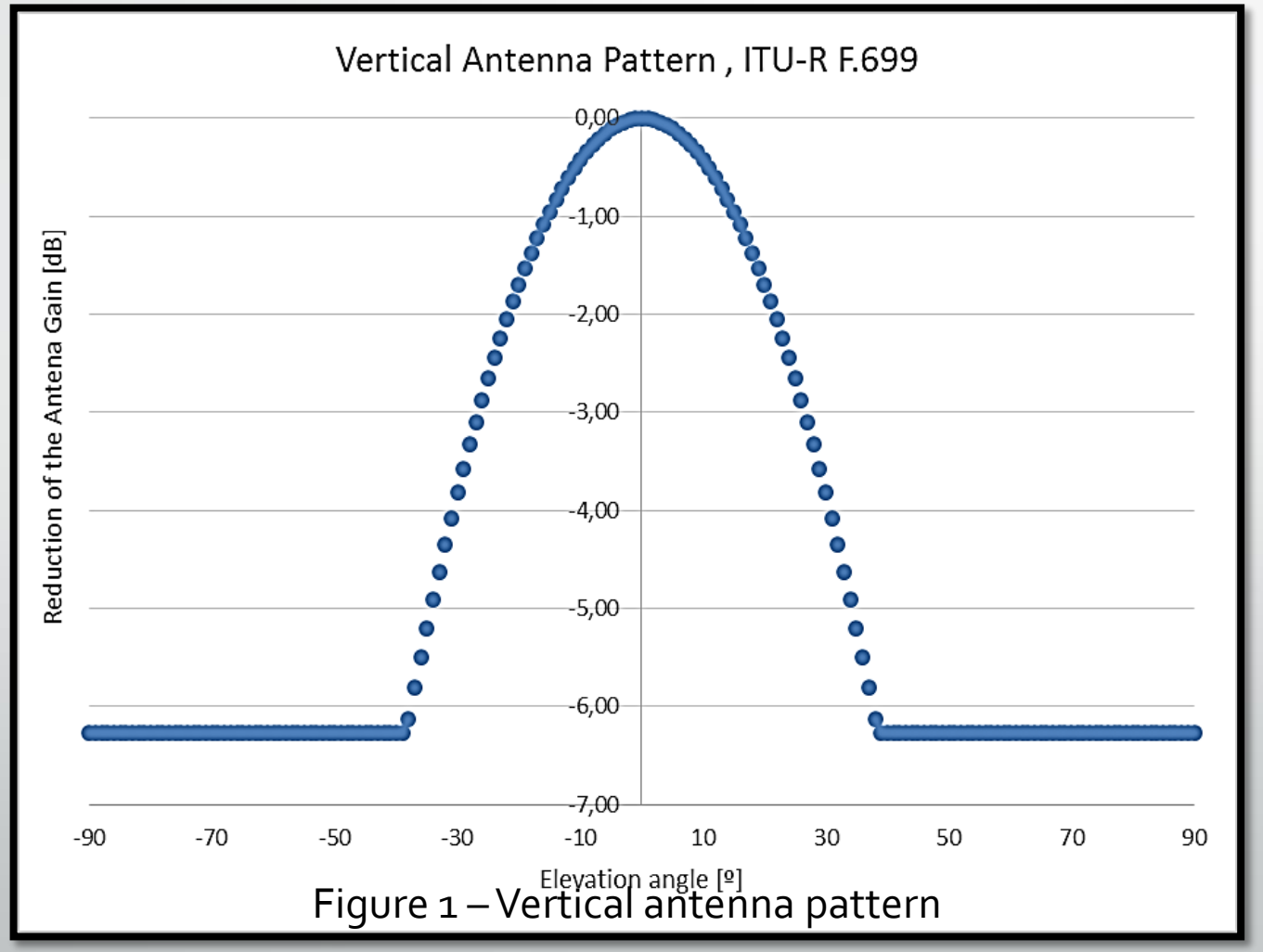
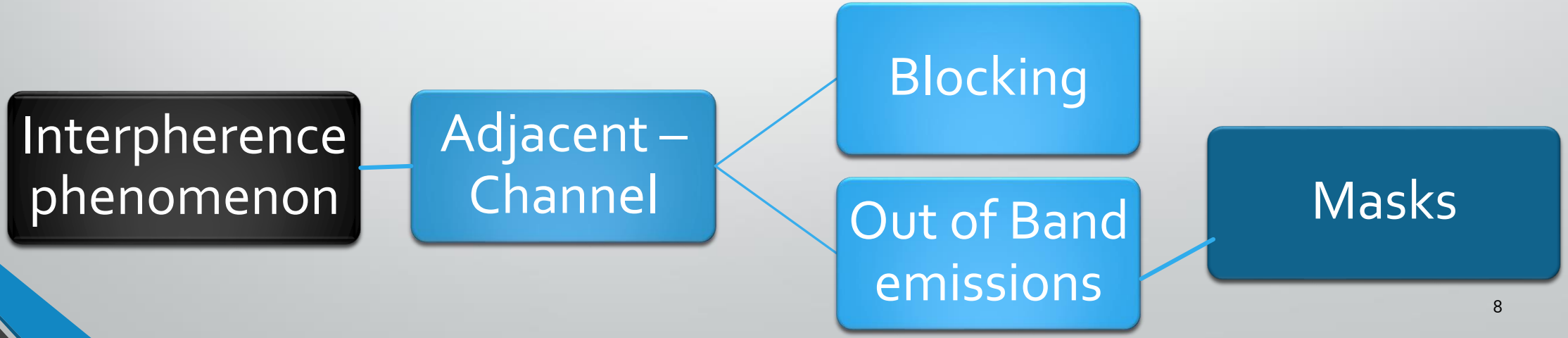


Figure 1 – Vertical antenna pattern

Co-channel vs Adjacent Channel (1/2)

EC Decision (2014/276/UE), i.e., multiples of 5 MHz, the WSD will operate at adjacent channel with a minimum guard band, in relation to the FWA spectrum, of 2 MHz .



Co-channel vs Adjacent Channel (2/2)

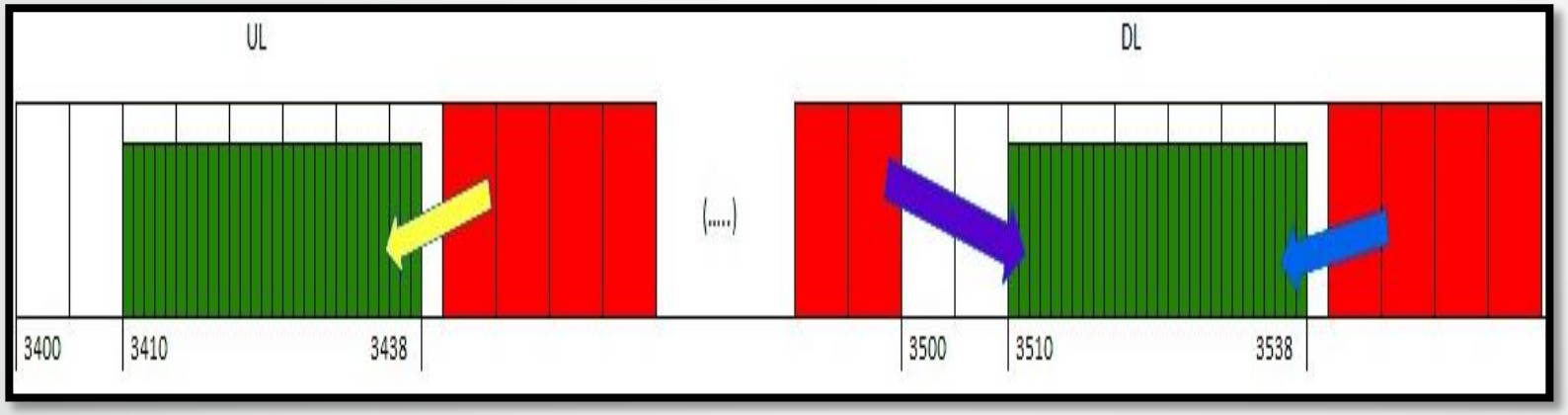


Figure 2 – Allocated Band Spectrum

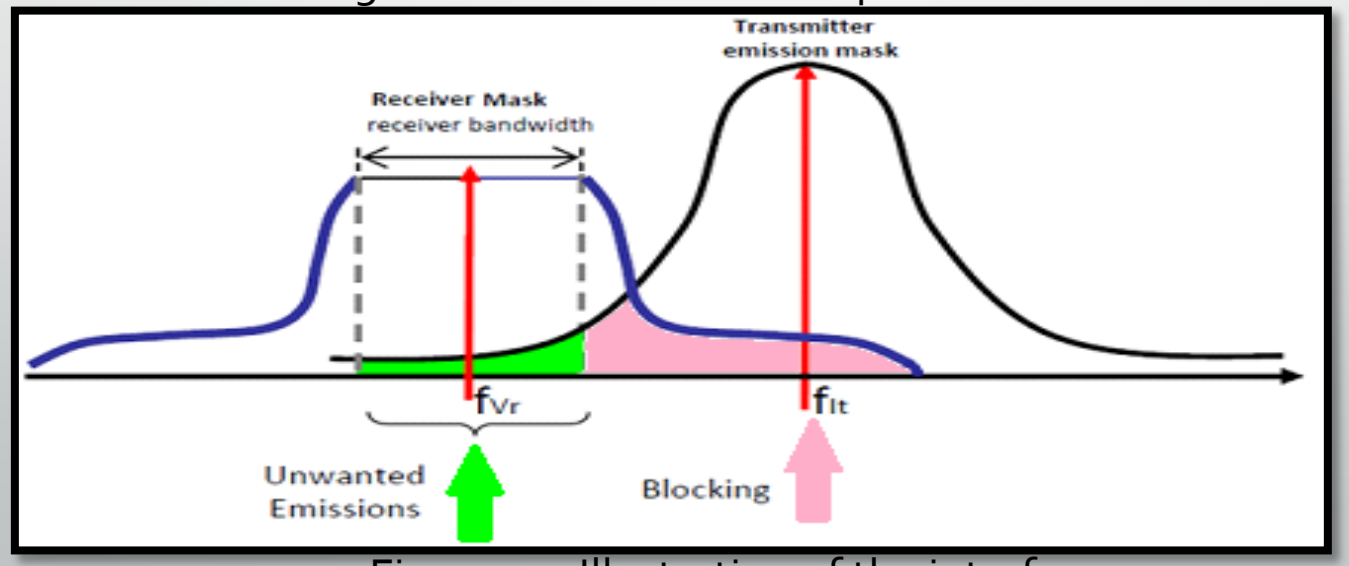


Figure 3 – Illustration of the interference

Considered Parameters for MCL: C/I e I/N

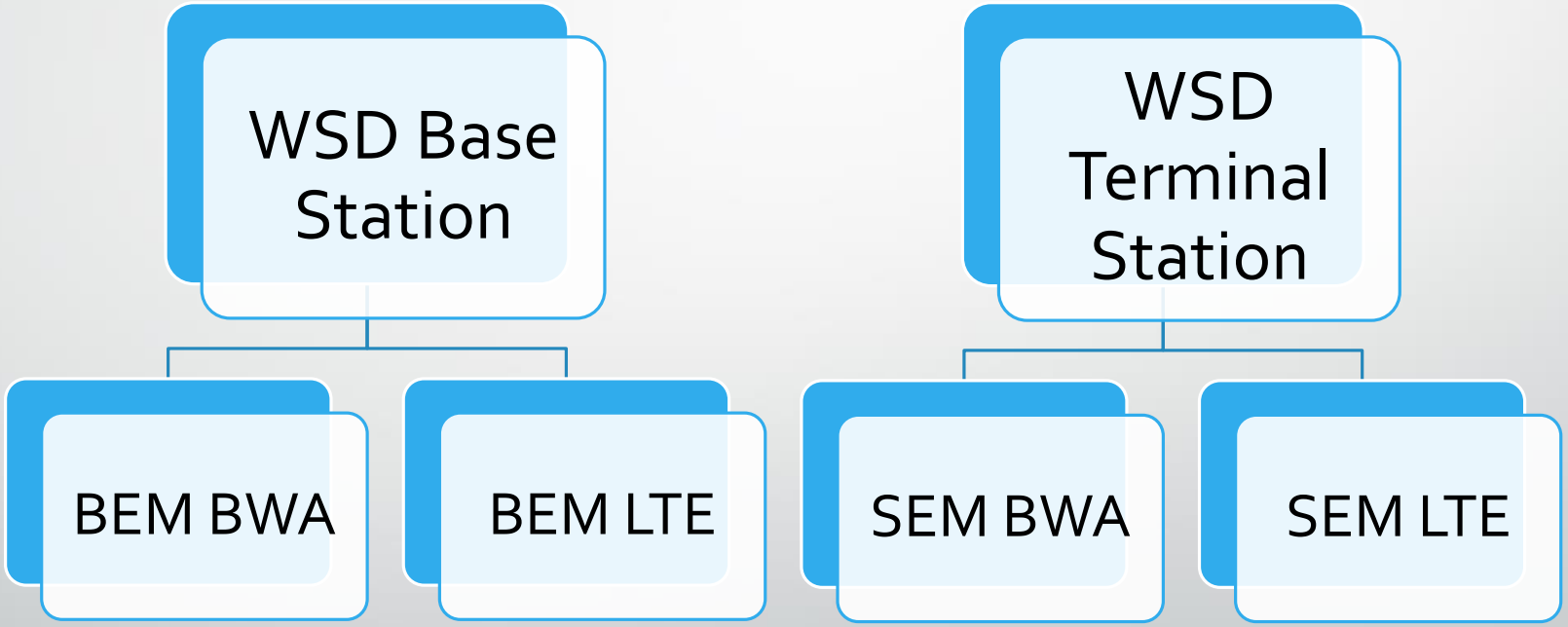
Co-channel

- C/I=45 dB – conservative value – ITU-R REC. F. 755-2
- C/I= 28dB – manufacturer value
- I/N=-6dB

Adjacent - Channel

- Blocking – C/I=0 dB
- Out of band emissions - C/I=28dB and considered masks

Masks


WSD Base Station
BEM BWA
BEM LTE
WSD Terminal Station
SEM BWA
SEM LTE

Minimum Coupling Loss (MCL)

Minimum distance loss including antenna gain measured between antenna connectors

$$MCL = -Imax + GRx + GTx + PITx - PropLoss$$

Considered Propagation Models

FSL

- LOS environment.

P.526-2

- Evaluates the effect of diffraction (by terrain irregularities) on the received field strength, applicable to different obstacle types and to various path geometries.

Erceg

- NLOS environment and nomadic/mobile applications.

Cross-Border Requirements

Two different approaches:

$$\text{UIT} - \text{R P.525: } E_{dB\mu V/m} = Pt_{dBm} - 20\ log\ d_{km} + 74.8$$

From WRC-07 – the power flux-density (pfd) produced at 3 m above ground shall not exceed - 154.5 dB(W/(m² * 4 kHz)) for more than 20% of time at the border of the territory of any other administration.

For the geographic areas established for FWA and BWA it was considered -122 dBW/MHz/m².

Scenarios

- In this paper it was assumed that the WSD will operate under the channelization presented in the new EC Decision

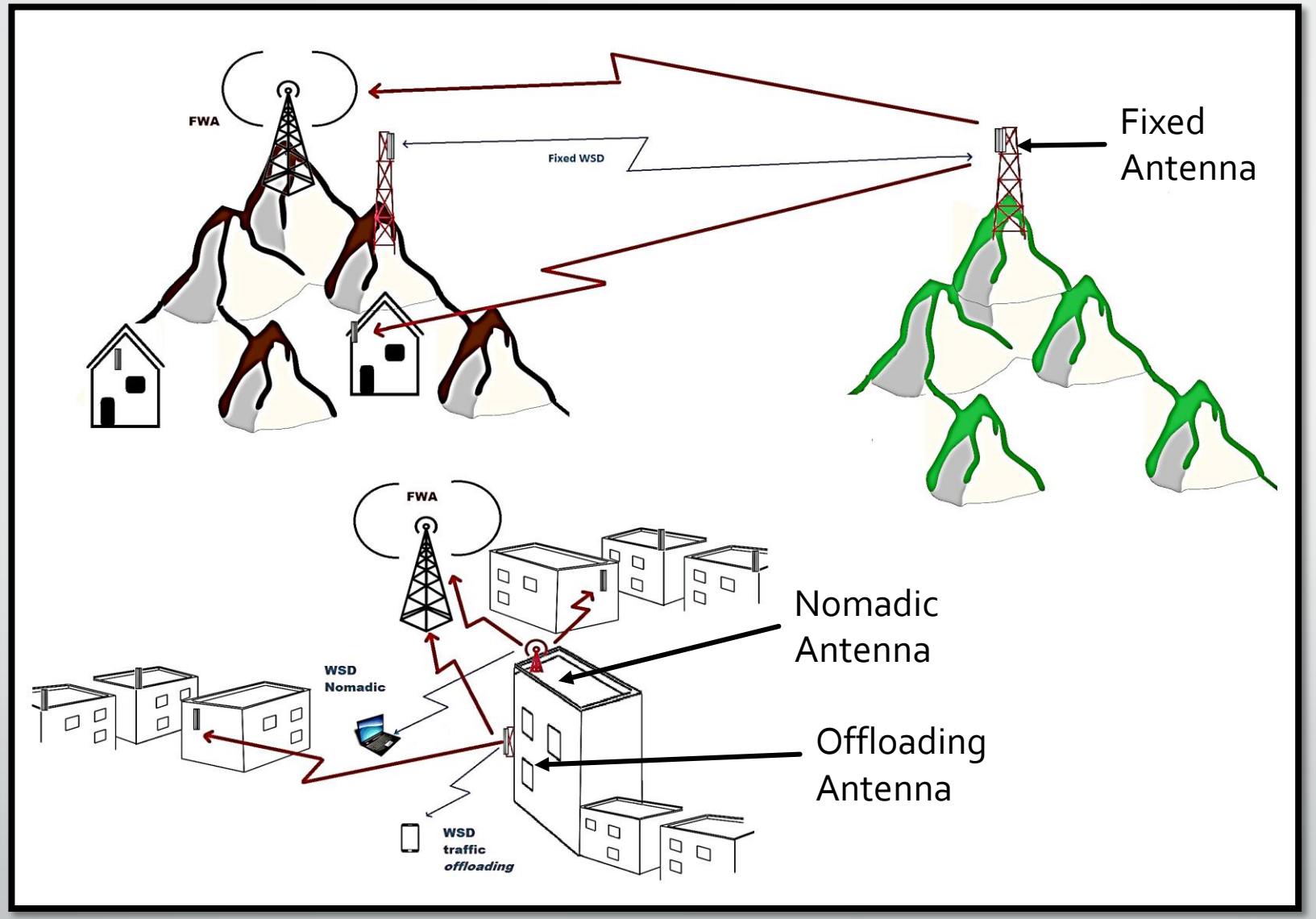


Figure 4 - Global representation of all considered scenarios

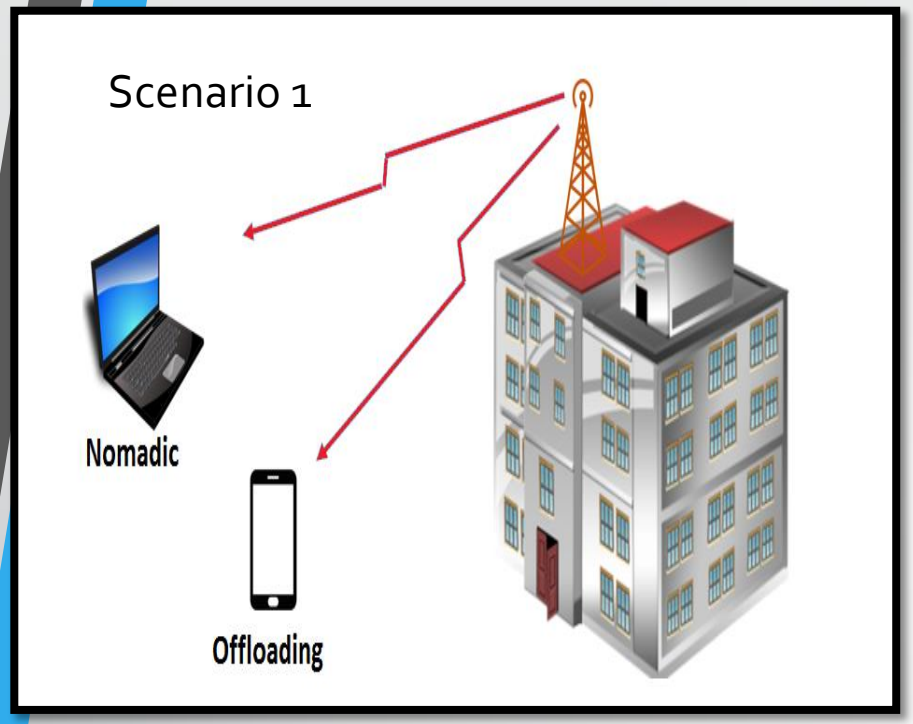


Figure 5 –Scenario 1, interference between a WSD Ts and a FWA Bs

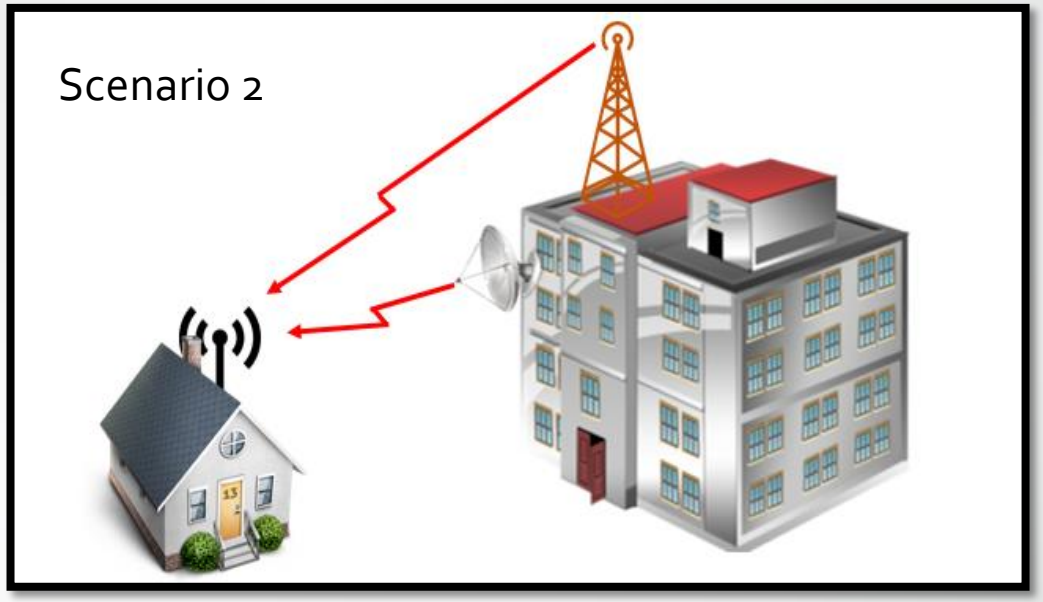


Figure 6 –Scenario 2, interference between a WSD Bs and a FWA Ts

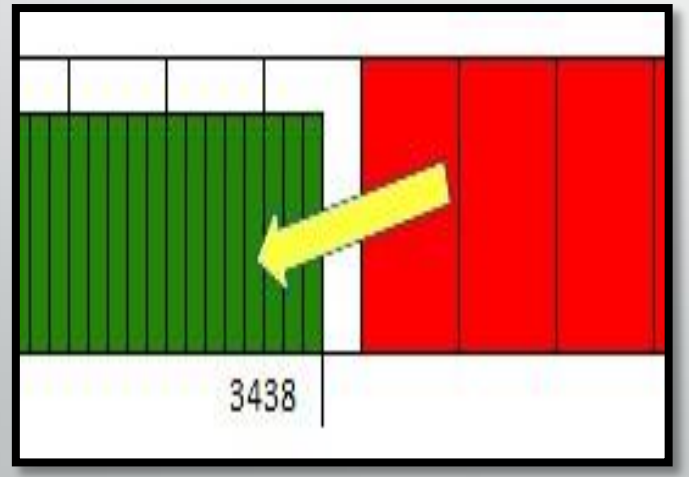


Figure 7 – Channel representation of scenario 1

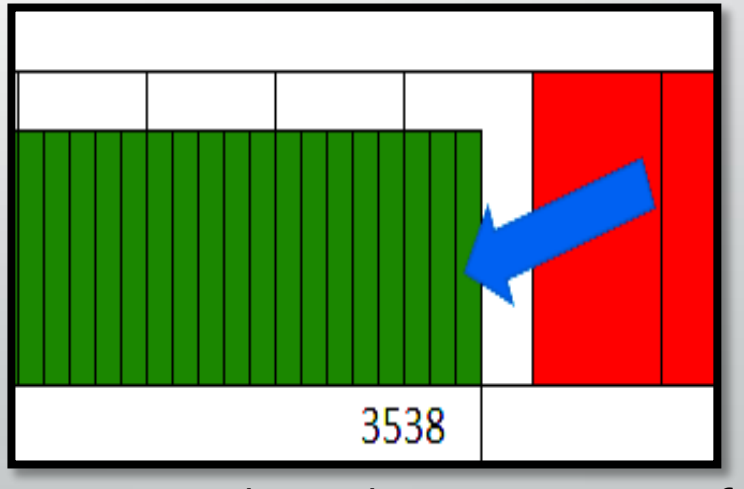


Figure 8 – Channel representation of scenario 2

Results – Scenario 4

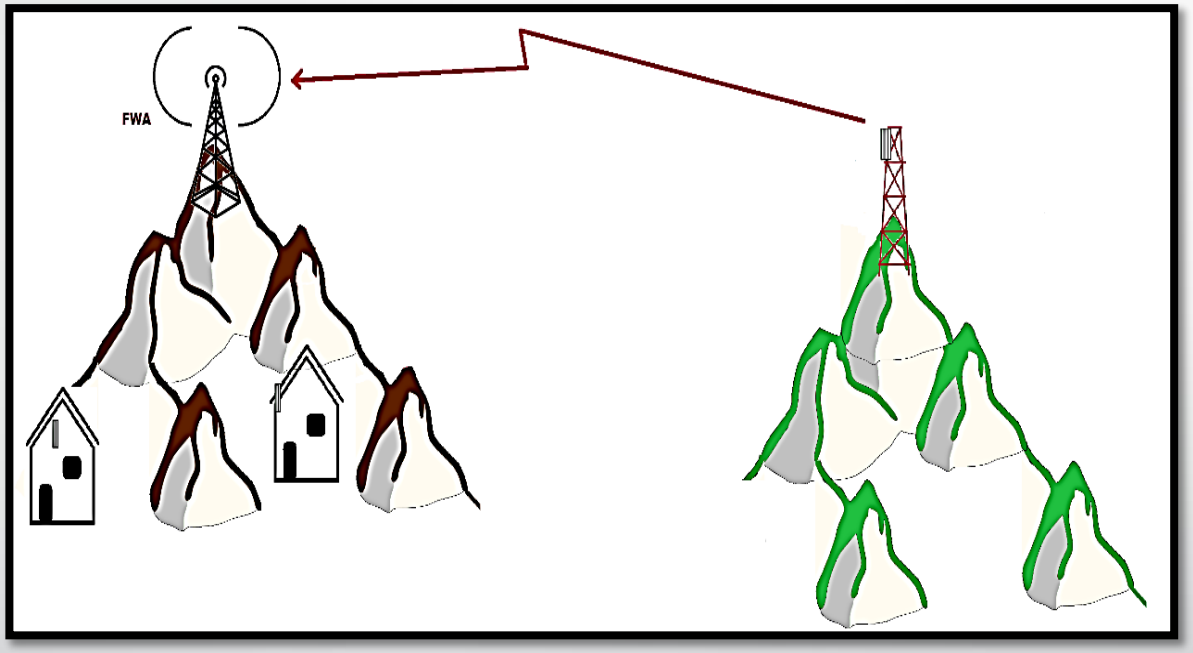


Figure 9 - Scenario 4: WSD Base Station interference with the FWA Base Station

Co-Channel – FSL model

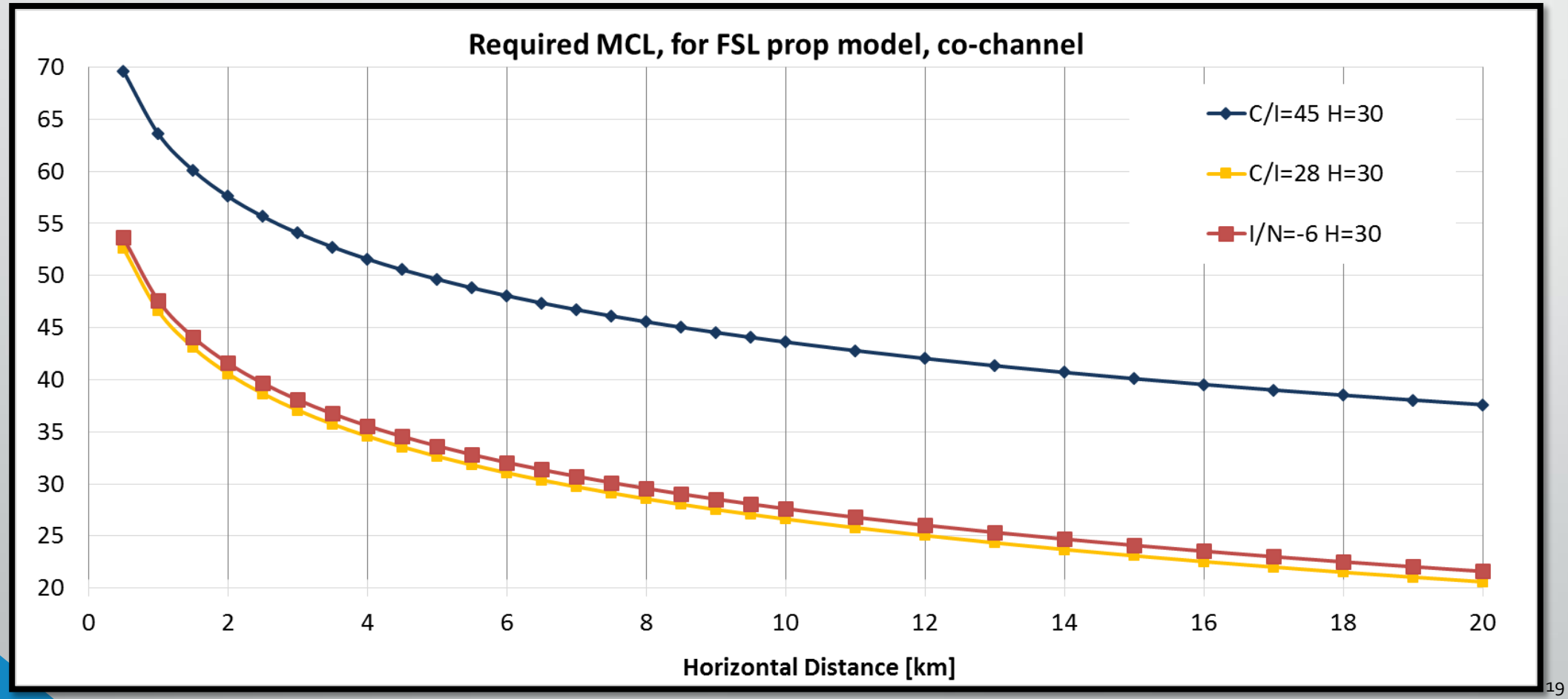


Figure 10 - Required MCL, for FSL propagation model, Co-channel

Co-Channel – Erceg propagation model

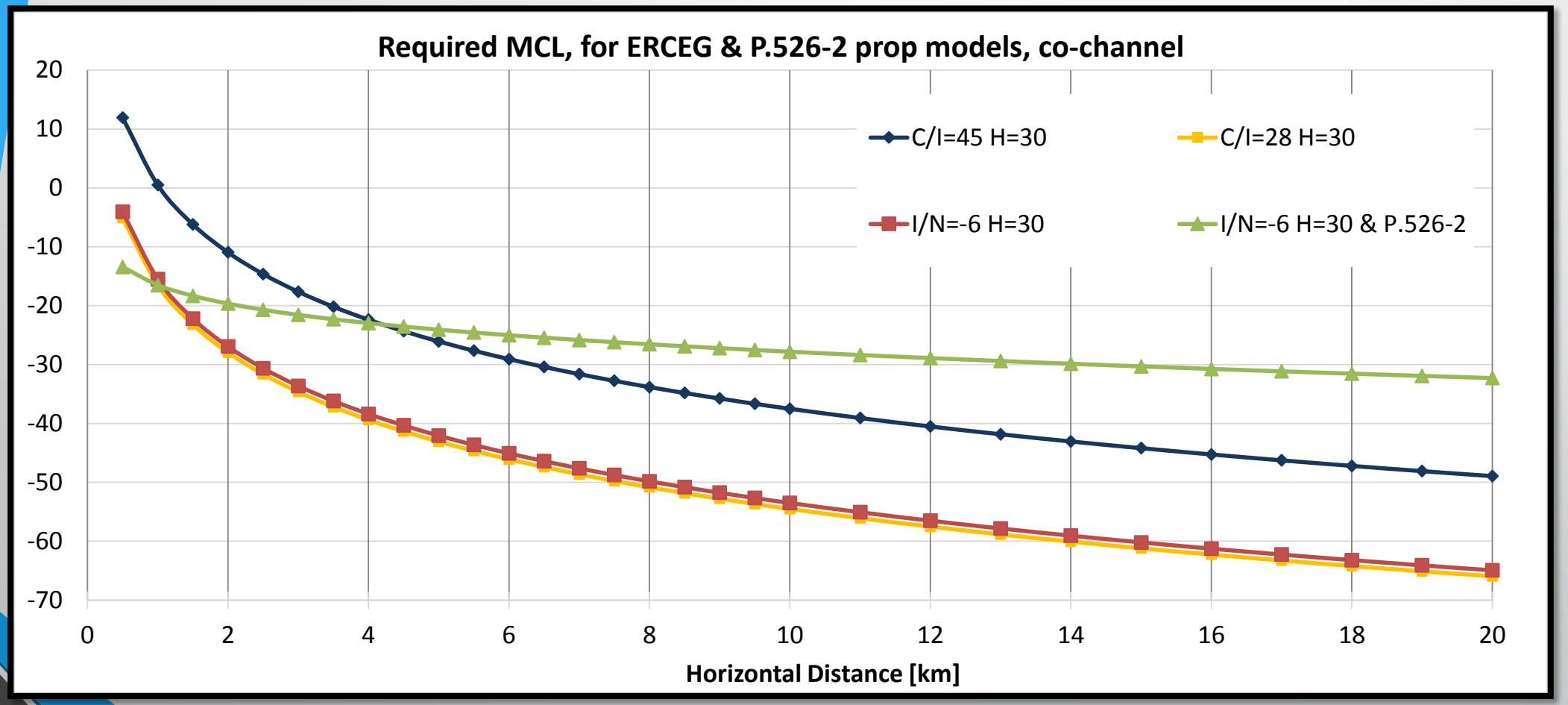


Figure 11 - Required MCL, for ERCEG & P.526-2 propagation model, Co-channel

Adjacent – Channel – FSL model

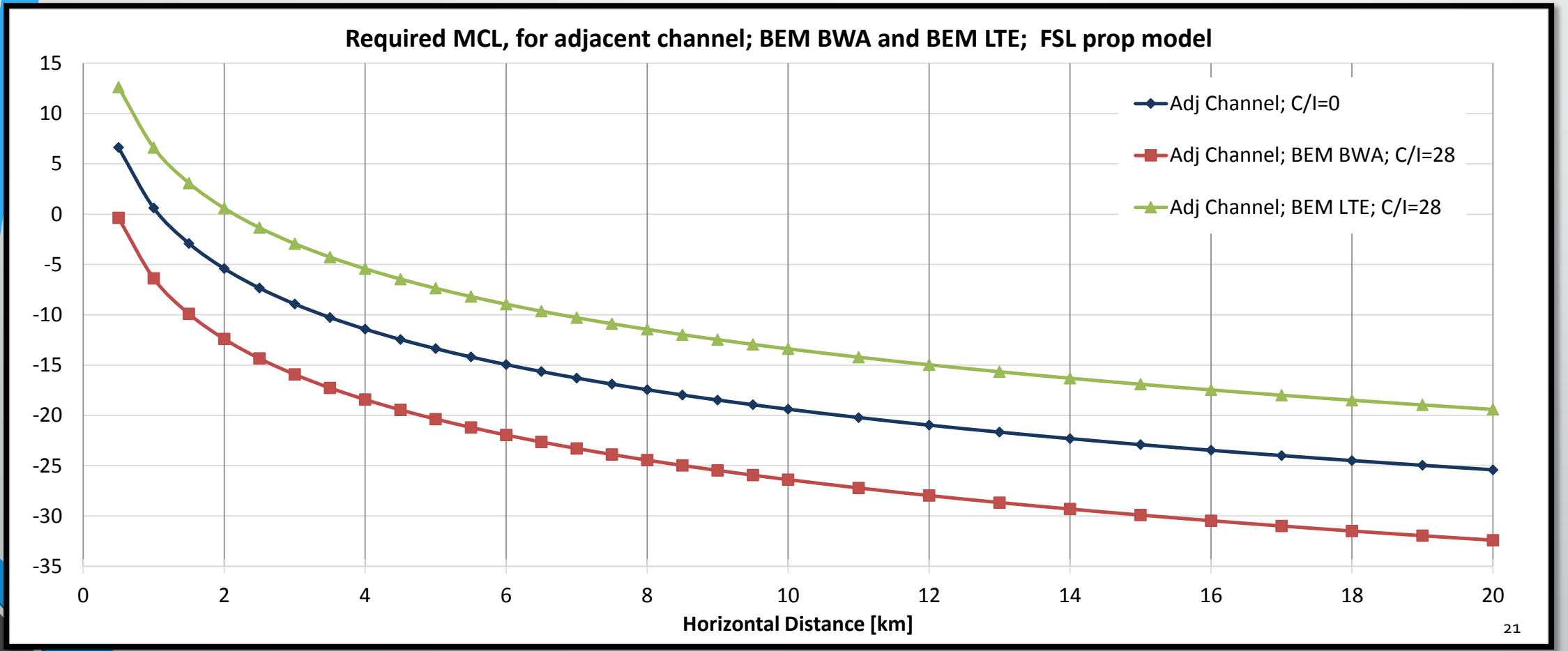


Figure 12 - Required MCL, for FSL propagation model, Adjacent-channel

Adjacent – Channel – Erceg Model

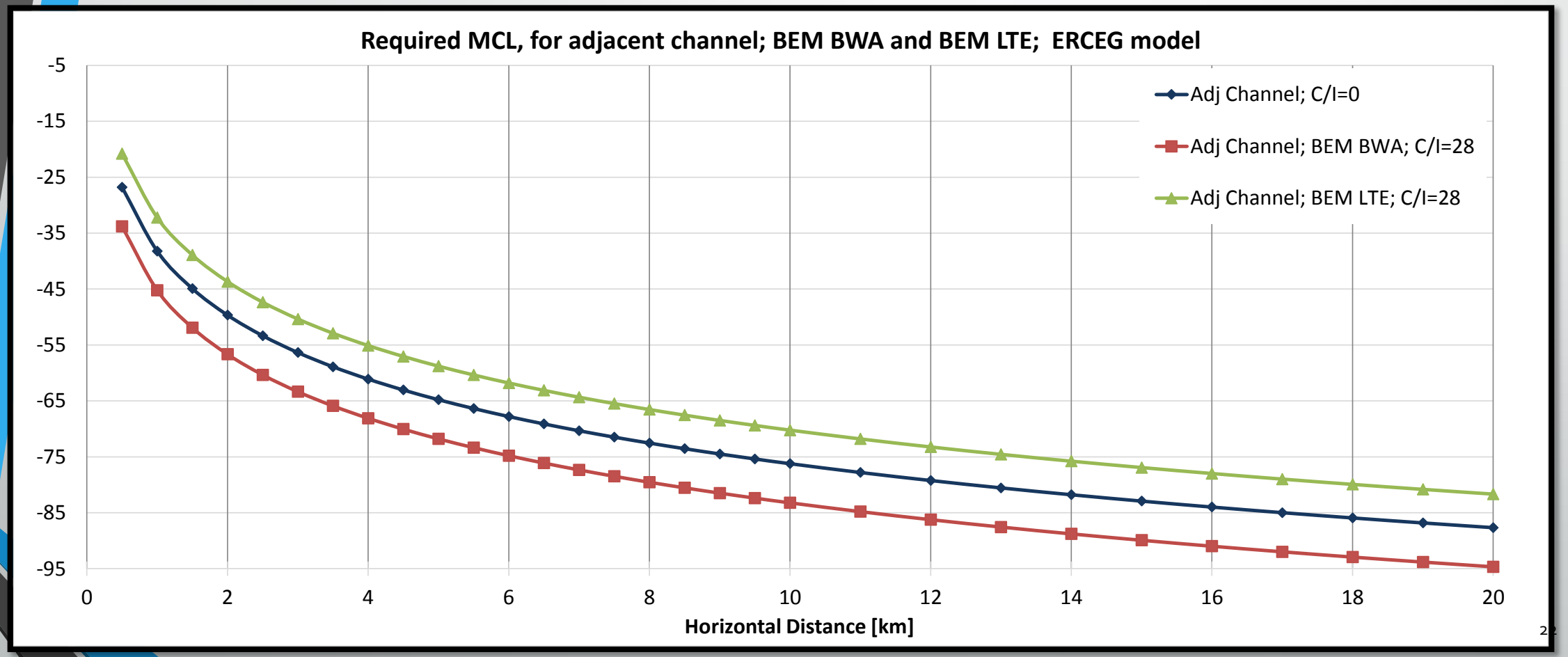


Figure 13 - Required MCL, for ERCEG propagation model, Adjacent-channel

Resume of Results – Fixed Service

Type of Channel	Co-Channel	Adjacent Channel
FSL	Never reached operating conditions	-
FSL with antenna discrimination		-
P-526.2	25 km for C/I=28 dB, with a 100 m height antenna	• Blocking: 0.50 km for C/I=0 dBs and h=100m • Out of band emissions: 1 km for C/I= 28 dBs for BEM LTE and h=1000 m
P-526.2 with antenna discrimination	3.50 km for C/I=28 dB, with a 100 m height antenna	No restrictions
Cross Border Coordination	336.16 km with antenna discrimination and 844.39 km without.	8.44 km; 5.98 km and 0.27 km with LTE mask

Nomadic Service

Type of channel	Co-channel	Adjacent -Channel
Base Station (28 dBs, h=30 m and Erceg Model)	• 1.5 km • 1 km with antenna discrimination	No restrictions (1 km and 2.5 km for Blocking and BEM LTE for FSL)
Terminal Station (28 dBs, h=30 m and Erceg Model)	1 km without antenna discrimination	No restrictions (2.5 km for Blocking and SEM LTE for FSL)
Cross border cordination	336.16 km with antenna discrimination and 844.39 km without for Bs directive antenna 267.02 km for Ts omni antenna	8.44 km; 5.98 km and 0.27 km, with LTE mask

Offloading Scenarios

Type of Channel	Co – Channel	Adjacent – Channel
Base Station (Erceg model, h=10 and C/I=28dBs)	1 km	No restrictions FSL: 1 km BEM LTE Blocking 4.5 km
Terminal Station (Erceg model, h=10 and C/I=28dBs)	0.5 km	No restrictions FSL: 2.5 km SEM BWA
Cross border cordination	106.30 km – Bs directive antenna 23.26 km – Ts omni antenna	1.89; 0.02 and 0.0 km for BWA mask 8.44; 5.98 and 0.27 km for LTE mask

Conclusions

- It is therefore concluded the possibility of WSD implementation along the 3.4 to 3.8 GHz band, for the studied scenarios, if the minimum required operating distances are applied.

- As a final conclusion it is seen that even though it was calculated the restrictions distances in the cross border coordination, those are not our worst case scenario, as some of the tested scenarios, never reached operating distances.

Future Work

- Aggregated antennas;
- Implementation study of adjacent Adjacent-Channels;
- Implementation studies in other considered bands.

Bibliography

- [1] ITU-R. ITU-R Report SM.2152.
- [2] ECC report 159 on technical and operational requirements for the possible operation of Cognitive Radio Systems in the 'white spaces' of the frequency band 470-790 MHz
- [3] CEPT Report 24, Report C from CEPT to the European Commission, in response to the Mandate on: "Technical considerations regarding, harmonisation options for the Digital Dividend".
- [4] Decision 2008/411/EC
- [5] http://tractool.seamcat.org/wiki/Manual/Introduction/Background. –Visited on August 2014
- [6] 3G TR 25.951 V0.0.1 (2000-09), 3rd generation partnership project; Technical Specification Group Radio Access Network; FDD Base Station Classification (Release 2000)
- [7] http://en.wikipedia.org/wiki/Johnson%E2%80%93Nyquist_noise –Visited on September 2014
- [8] Implementing Geolocation, Summary of consultation responses and next steps, Ofcom

Thank you