The Power to Be Precise

Interference Impact of IMT on UWB

FiRa™ Consortium |

Summary

Ultra-wideband (UWB) operates in spectrum that is being studied for use by high-power IMT system. UWB applications have already been distributed globally and are used ubiquitously (i.e., both outdoor and indoor). In this

Therefore, two Monte Carlo simulations were carried out. Both evaluate the effect of IMT systems on the performance of co-located UWB deployments. One considers outdoor macro urban IMT cells, while the other looks at indoor small cell IMT deployments.

The high power IMT base stations causes very significant interference to UWB devices even far away from base station in the main beam direction. The indoor base stations cause even more significant interference to UWB devices.

Consequently, it can be concluded that UWB cannot coexist with either of the considered IMT deployments. Both urban macro cell IMT and indoor small cell IMT cause unacceptable levels of interference.

Simulation Modelling

UWB deployment characteristics

The configuration of UWB is set up as a victim receiving interference from IMT. The interference criterion of -78 dBm/500 MHz for UWB is based on ECC Report 302.

Parameter	Value	Note
Center frequency	7950 MHz	Channel 9
UWB bandwidth	500 MHz	
UWB height	1.5 m	
Body loss	4 dB	
Antenna peak gain	0 dBi	
Antenna pattern	Omni-directional	
UWB deployment	Uniformly distributed in a hexagonal shape	(Outdoor) in a center cell of 19 cells (Indoor) in the small cell of 120 m x 50 m
Interference criteria	-78 dBm / 500 MHz	Based on ECC Report 302

Figure A-1 Key UWB parameters for both interference scenarios

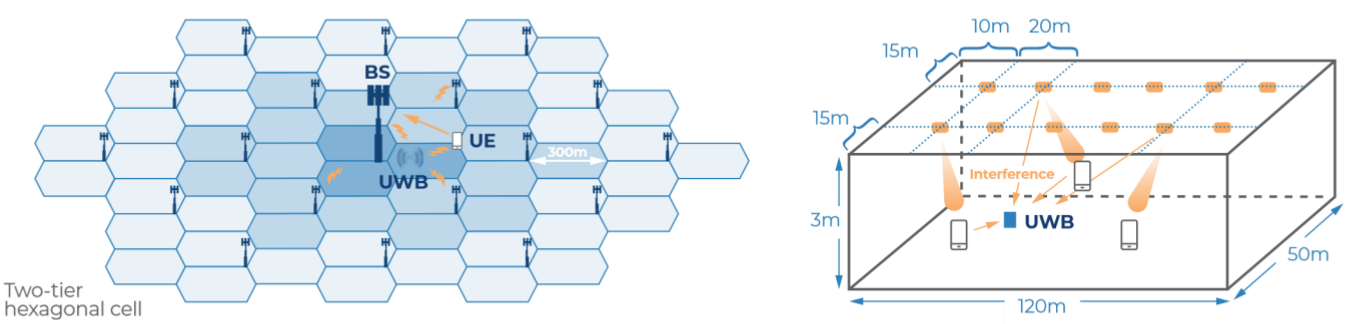
IMT deployment characteristics

The outdoor deployment configuration of IMT is based on sharing studies of WRC-27 A.I. 1.7 in ITU-R[1].

The indoor deployment configuration of IMT is based on 3GPP TR 38.901[2]. In addition, the technical and operational characteristics of IMT are based on sharing studies of WRC-27 A.I. 1.7 in ITU-R.

	Macro Urban Cell (Outdoor)	Small Cell (Indoor)
Base station (BS) total power	78.3 dBm/100 MHz EIRP	36.5 dBm/MHz EIRP
	= 43 dBm/100 MHz + 3dB polarization+ 32.2 dBi (16x8x3 sub-array elements, 2 dB Ohmic loss)	= 21 dBm/100 MHz + 15.5 dBi (4x4 array elements, 2 dB Ohmic loss)
BS installation	6° down tilting ant. at 18 m height	Ceiling mounted at 3 m height
BS configuration	300 m cell range, 3 hexagonal sectors	20 m x 25 m, a rectangular sector
Cell configuration	2 tiers (19 cells)	12 cells in 120 m x 50 m
Multi MNO frequency (channel 9)	f_1=7850 MHz, f_2=7950 MHz, f_3=8050 MHz	
Muti MNO configuration	BSs positioned at the angles of the hexagon from each others	
Number of UEs served per sector	3	1

Table A-2 Key IMT parameters for both interference scenarios



(a) Outdoor macro urban cell deployment

(b) Indoor office small cell deployment

Figure A-1 Outdoor macro urban and indoor office interference environments

[1] Characteristics of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-27, Annex Annex 4.15 to 5D/563, ITU-R Working Party 5D

[2] Study on Channel model for frequencies from 0.5 to 100 GHz, 3GPP TR 38.901

Monte Carlo Simulation Results

The results are summarized in Figure A-2. It shows very significant interference from IMT to UWB in the two deployment environments. UWB gets unacceptable interference in 75% of the events in an outdoor macro urban cell. In the indoor office small cell, the interference increases to 95% of the events.[3]

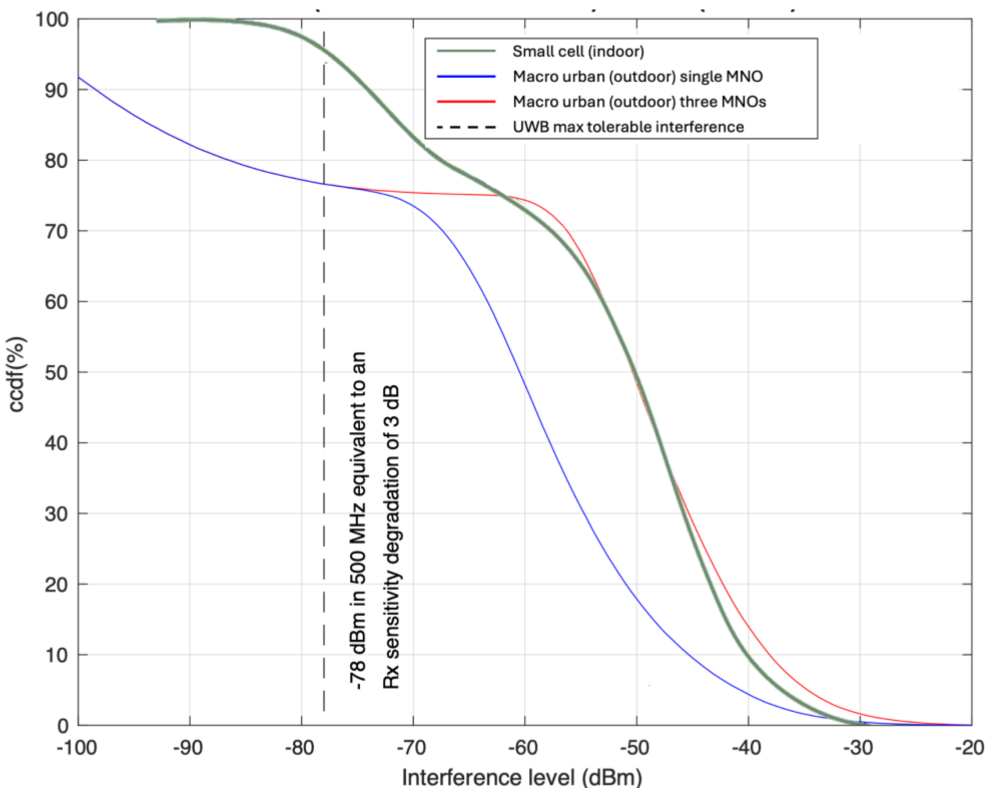


Figure A-2 Statistical Monte Carlo simulation results for outdoor and indoor usage of IMT and UWB

For outdoor IMT deployments, the base station (BS) employs beamforming towards the target user equipment. The high power of the BS causes very significant interference to many UWB devices far away from BS in the main beam direction. On the other hand, for indoor IMT deployments, the BS has a lower transmitted power than the macro urban case but covers a wider area and is positioned closer to the UWB device than in outdoor scenarios.

[3] An event is seen as area/space occurrence.

The indoor base stations, therefore, cause more significant interference to UWB devices. For the macro urban case, interference results for a single and 3 multi MNOs (mobile network operators) with 3 UEs served per sector are presented.

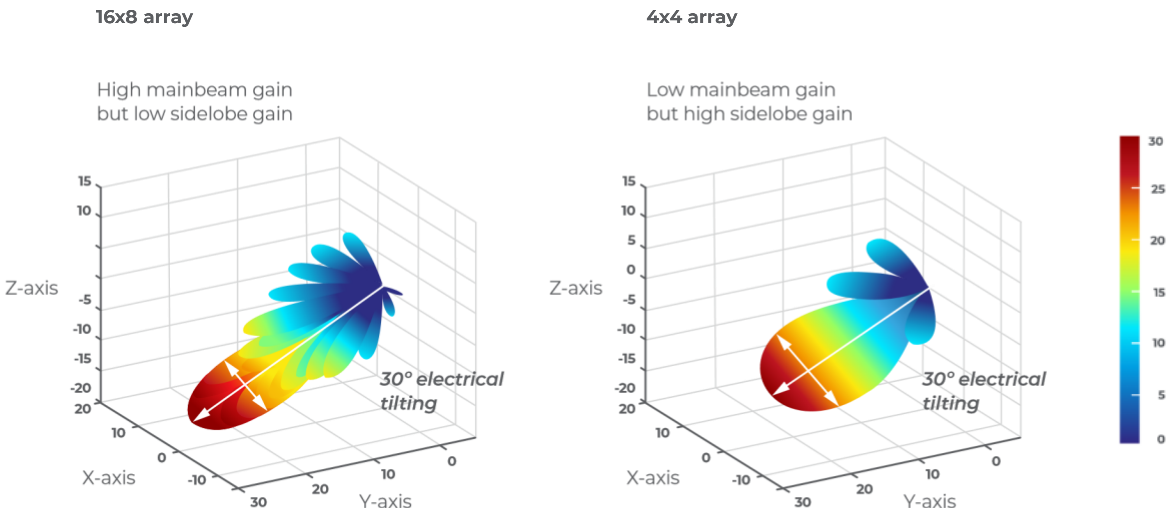


Figure A-3 Consideration on AAS beamforming effect of IMT base station

Consequently, it can be concluded that UWB cannot coexist with either of the considered IMT deployments. Both urban macro cell IMT and indoor small cell IMT cause unacceptable levels of interference.

Practical Performance Impact of IMT on UWB

Performance impact on UWB coverage

A 3 dB sensitivity reduction implies that:

- **Range of the transmission is reduced to 70% of its initial coverage; and**
- **Area of coverage is halved (i.e., proportional to r^2) meaning about twice as many anchors (UWB beacons) are needed to cover a given area.**

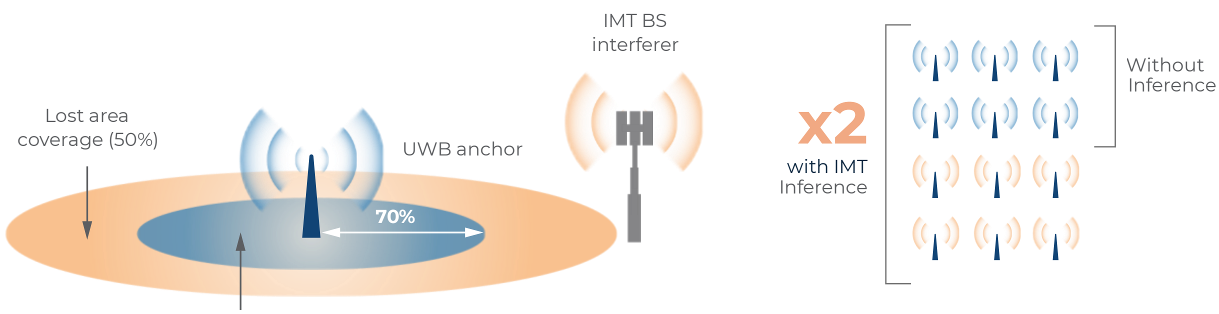
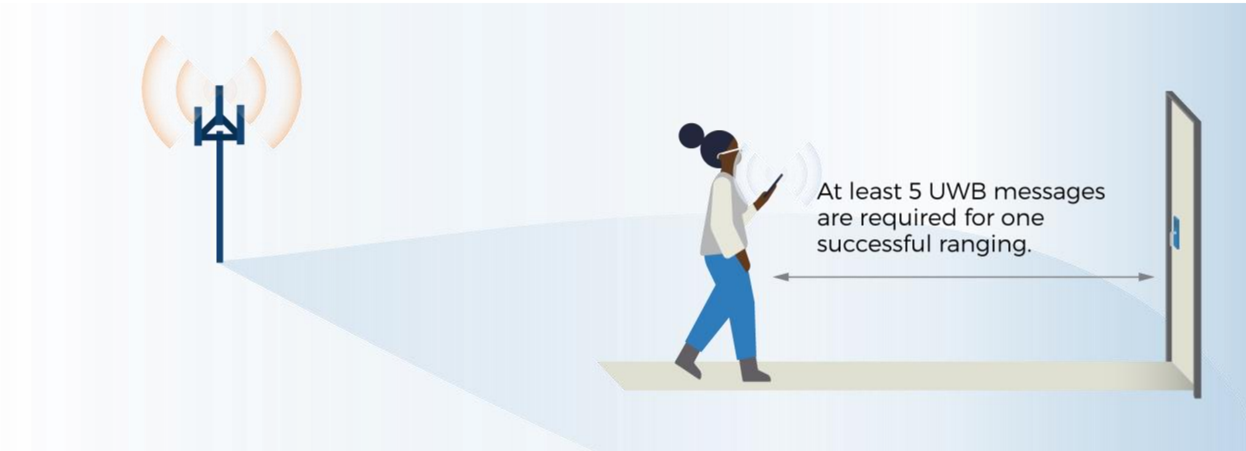


Figure A-4 Performance impact to UWB coverage by interference from IMT

Response time (delay) degradation in building access case

For 75% of the events in outdoor macro urban cells, the interference impact will be worse than 3 dB sensitivity reduction. If packet reception probability is reduced by 75% (i.e., from 1 to ¼), then the probability that the UWB device will correctly receive all five messages required to open the door is reduced to 1/1024 (i.e. $(¼)^5$). Taking into account that the minimum interval between each trial is about 0.1 s, that means the expected delay is increased from **0.1 s to 102.4 s** (i.e., 1024 x 0.1 s).



UWB operation for door lock case in outdoor IMT deployment

The situation is even worse for indoor deployments. There, for 95% of the events, the interference impact will be worse than 3 dB sensitivity reduction.

If the packet reception probability is reduced by 95% (i.e., from 1 to 1/20), then the probability that the UWB device will correctly receive all five messages required to open the door is reduced to 1/3,200,000 (i.e., $(1/20)^5$). Taking into account that the minimum interval between each trial is about 0.1 s, that means the expected delay is increased from **0.1 s to 320,000 s** (i.e., 3,200,000 x 0.1 s). In short, such a delay results in the door not opening (building access fails).

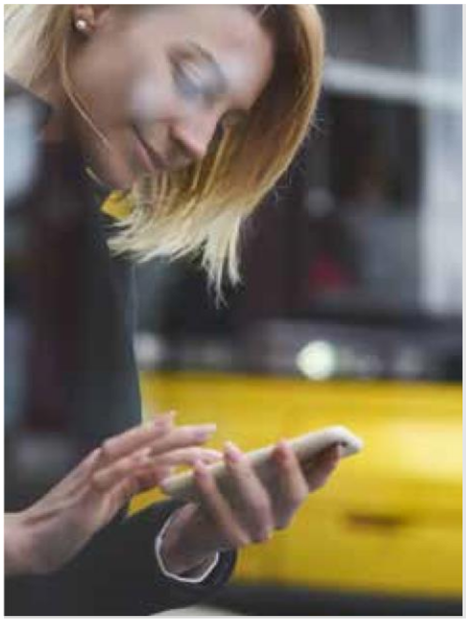
Figure A-6 UWB operation for door lock case in indoor IMT deployment

Conclusions

Monte Carlo analysis using assumptions agreed in ITU-R WP 5D presented evidence of a high risk of interference in both outdoor macro urban environments and indoor small cell environments.

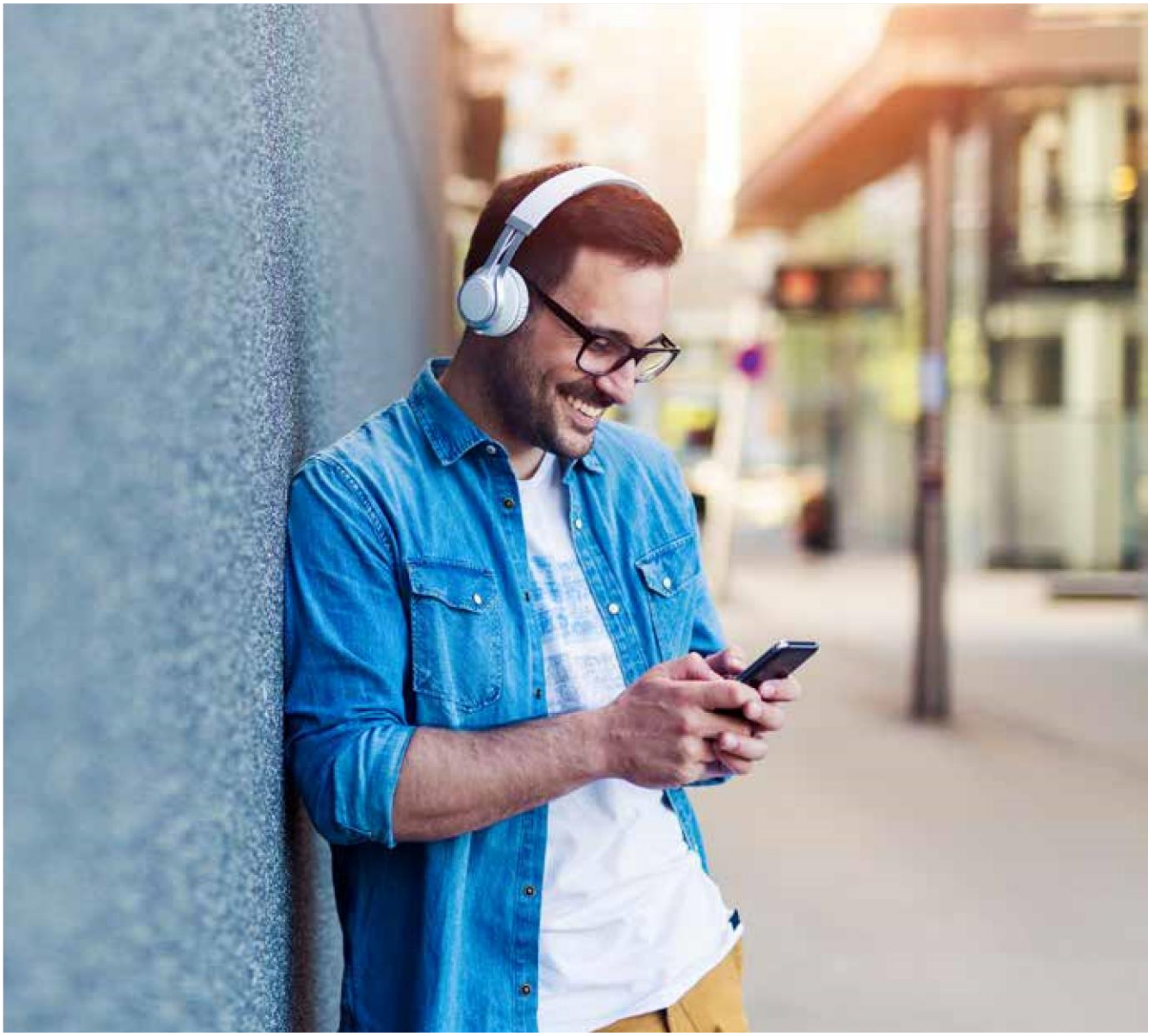
The high power of the IMT base stations causes very significant interference to many UWB devices even far away from base station in the main beam direction. The indoor base stations cause even more significant interference to UWB devices.

Consequently, it can be concluded that UWB cannot coexist with either of the considered IMT deployments. Both urban macro cell IMT and indoor small cell IMT cause unacceptable levels of interference.



About FiRa Consortium

The FiRa Consortium is a member-driven organization dedicated to transforming the way we interact with our environment by enabling precise location awareness for people and devices using the secured fine ranging and positioning capabilities of ultra-wideband (UWB) technology. FiRa does this by driving the development of technical specifications and certification, advocating for effective regulations and by defining a broad set of use cases for UWB. To learn more about UWB and the FiRa Consortium, visit **www.firaconsortium.org**.



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