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LTE into Wi-Fi Additional Analysis

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Table of Contents

1 INTRODUCTION

(1) This document describes the modelling work undertaken to examine the impact of interference from LTE base stations (BSs) and mobile stations (MSs) operating in the band 2340 – 2390 MHz into WLAN receivers operating in the band 2400 – 2483.5 MHz.

2 MODELLING APPROACH

(2) In order to assess the impact of interference into WLAN receivers, the results of measurements conducted by DSTL (Ref: Tests to Assess the Potential for Interference Caused by 4G LTE TDD Transmissions, 2350 – 2390 MHz, to WLAN Systems, 2400 – 2483.5 MHz, January 2013) have been used.

(3) Table 1 shows measured parameter values used in the analysis.

Table 1: Measured Parameters used in the Analysis

WLAN Receiver Type	Value	Notes
WLAN RX Minimum Usable Signal (MUS) Level *(Measured for 20 MHz LTE BS / MS TX at 2380 MHz and WLAN RX at 2412 MHz, i.e. Channel 1)*		
Commercial Use 22 Mbps Access Point	-87 dBm	
Domestic Use 24 Mbps Access Point	-87 dBm	
WLAN RX Protection Ratio (C/I) *(Measured for C= MUS + 20 dB when 20 MHz LTE BS / MS TX at 2380 MHz and WLAN RX at 2412 MHz i.e. Channel 1)*		
Commercial Use 22 Mbps Access Point	-31 dB	Measured values were -33 dB for LTE BX TX and -31 dB for LTE MS TX
Domestic Use 24 Mbps Access Point	-35 dB	Measured values were -35 dB for LTE BX TX and -37 dB for LTE MS TX

(4) As can be seen, measurements were conducted for two types of receiver. The minimum usable signal level corresponds to a signal level required to support 1 Mbps data rate. The protection ratios were measured when the WLAN received signal level was 20 dB above the minimum usable signal level. The interference analysis based on these protection levels therefore provides protection for higher data rates corresponding to the signal level 20 dB above the minimum usable signal.

(5) The analysis requires representative LTE and WLAN link budgets in order to assess the impact of interference. The representative LTE link budget used in the modelling is summarised in the following table. The link budget parameters are based on the agreed values given in the document titled 'Proposed LTE Parameters for modelling in PSSR Project' (Ref: UK/2011/EC231986/AH17/2292/V1.0).

Table 2: Representative LTE Link Budget

Parameter	Value	Notes
LTE Channel Bandwidth	20 MHz	
LTE BS Maximum Ant Gain	18 dBi	
LTE MS Maximum Ant Gain	0 dBi	Isotropic antenna
LTE BS Height	20 m	
LTE MS Height	1.5 m	
LTE BS Antenna Pattern	ITU-R Rec F.1336	Horizontal and vertical patterns are taken into consideration in the statistical analysis.
Fade Margin	39 dB	Based on 95% indoor coverage, path loss variation modelled by normal distribution with 17 dB standard deviation (in line with CEPT modelling tool SEAMCAT), additional building penetration loss is modelled by normal distribution with 10 dB mean and 5 dB standard deviation (in line with CEPT modelling tool SEAMCAT).
Downlink		
LTE BS TX EIRP	67 dBm	
LTE MS Noise Figure	9 dB	
LTE MS Noise Floor	-92 dBm/20MHz	SNR = -2 dB
LTE MS Minimum Received Signal Level	-94 dBm/20MHz	
Maximum Path Loss	121.8 dB	EIRP – (Noise Floor + SNR)+ RX Gain – Fade Margin
Downlink Range	270 m (Hata Urban) 600 m (Hata Suburban) 2.2 km (Hata Rural)	Based on Hata model implemented in CEPT modelling tool SEAMCAT
Uplink		
LTE MS TX EIRP	23 dBm	
LTE BS Noise Figure	2 dB	
LTE BS Noise Floor	-99 dBm/20MHz	SNR = 3.5 dB
LTE BS Minimum Received Signal Level	-95.5 dBm/20MHz	
Maximum Path Loss	117.8 dB	EIRP – (Noise Floor + SNR)+ RX Gain – Fade Margin
Uplink Range	200 m (Hata Urban) 460 m (Hata Suburban) 1.7 km (Hata Rural)	Based on Hata model implemented in CEPT modelling tool SEAMCAT
Cell Radius		
LTE Cell Radius	**200 m**	Assume urban deployment with a set of parameters as stated above

(6) As implied in the table above, some of the key assumed parameters (for example, the fade margin) are determined by the values incorporated in the CEPT modelling tool SEAMCAT which is used in this study to implement statistical analysis of interference into WLAN receivers.

(7) The representative WLAN link budgets are summarised in Table 3.

Table 3: Representative WLAN Link Budgets

Parameter	Value	Notes
Access Point / Client Device TX EIRP	20 dBm	
Access Point / Client Device Maximum Antenna Gain	0 dBi	Isotropic antenna
Access Point Antenna Height	3 m (Outdoor) 2 m (Indoor)	
Client Device Antenna Height	1.5 m (Outdoor and Indoor)	
Bandwidth	20 MHz	
Client Device to Access Point Outdoor Deployment		
Minimum Usable Signal (MUS) Level	-87 dBm	Measured for commercial and domestic use access points
Fade Margin	18 dB	Based on 95% coverage, path loss variation modelled by normal distribution with 11 dB standard deviation (in line with SEAMCAT).
Maximum Path Loss	89 dB	EIRP – MUS + RX Gain – Fade Margin
WLAN Range	**70 m**	Based on Urban Hata SRD model implemented in SEAMCAT
Client Device to Access Point Indoor Deployment		
Minimum Usable Signal (MUS) Level	-87 dBm	Measured for commercial and domestic use access points
Fade Margin	16.5 dB	Based on 95% coverage, path loss variation modelled by normal distribution with 10 dB standard deviation (in line with SEAMCAT).
Maximum Path Loss	90.5 dB	EIRP – MUS + RX Gain – Fade Margin
WLAN Range	**20 m**	Based on indoor propagation model implemented in SEAMCAT

(8) As mentioned in the table above, some of the assumed WLAN link budget parameter values are determined by the values incorporated in SEAMCAT.

3 INTERFERENCE ANALYSIS

(9) Initially, a number of scenarios have been analysed to determine minimum separation distances required to protect the WLAN access point receivers from LTE BS / MS interference. This is followed by statistical modelling aimed at deriving interference probabilities.

3.1 Minimum Separation Distance Requirements

(10) Table 4 below shows separation distance requirements for two types of WLAN access point receiver (assumed to be located outdoors) when they are interfered with by an outdoor LTE BS transmitter. The Extended Hata model implemented in SEAMCAT is used to calculate the path loss between the LTE BS transmitter and WLAN receiver. The 'Notes' column in the table provides the key parameter values used in each scenario.

Table 4: Separation Requirements for Outdoor Scenarios

Separation Distances Calculated for Outdoor Scenarios		
WLAN Receiver	**Distance**	**Notes**
Commercial Use 22 Mbps Access Point	**105 m**	WLAN RX wanted power is -87 dBm + 20 dB = -67 dBm, PR is -31 dB. Interference threshold is therefore (-67) – (-31) = -36 dBm. WLAN RX is at 3 metres height and LTE BS TX is at 20 m height. LTE BS antenna gain is 18 dBi and WLAN RX antenna gain is 0 dBi.
Domestic Use 24 Mbps Access Point	**91 m**	WLAN RX wanted power is -87 dBm + 20 dB = -67 dBm, PR is -35 dB. Interference threshold is therefore (-67) – (-35) = -32 dBm. WLAN RX is at 3 metres height and LTE BS TX is at 20 m height. LTE BS antenna gain is 18 dBi and WLAN RX antenna gain is 0 dBi.

(11) Table 5 shows separation distances calculated for the indoor scenarios where the LTE MS transmitter interferes with the WLAN access point receivers. The path loss calculations are based on free space and the indoor propagation model implemented in SEAMCAT modelling tool. As before, the 'Notes' column in the table provides the key parameter values used in each scenario.

Table 5: Separation Requirements for Indoor Scenarios

Separation Distances Calculated for Indoor Scenarios		
WLAN Receiver	**Distance**	**Notes**
Commercial Use 22 Mbps Access Point	**9 m** (FSPL) **5.1 m** (SEAMCAT Indoor Model)	WLAN RX wanted power is -87 dBm + 20 dB = -67 dBm, PR is -31 dB. Interference threshold is therefore (-67) – (-31) = -36 dBm. LTE MS TX (at 1.5 m height) and WLAN RX (at 2 m height) are located indoors. Antenna gains are 0 dBi.
Domestic Use 24 Mbps Access Point	**5.7 m** (FSPL) **4 m** (SEAMCAT Indoor Model)	WLAN RX wanted power is -87 dBm + 20 dB = -67 dBm, PR is -35 dB. Interference threshold is therefore (-67) – (-35) = -32 dBm. LTE MS TX (at 1.5 m height) and WLAN RX (at 2 m height) are located indoors. Antenna gains are 0 dBi.

(12) Table 6 below shows separation distances required to protect the WLAN access point from interference originating from an outdoor LTE BS transmitter. It is assumed that 10 dB building penetration loss applies to the interference path.

Table 6: Separation Requirements for Outdoor to Indoor Scenarios

Separation Distances Calculated for Indoor Scenarios		
WLAN Receiver	**Distance**	**Notes**
Commercial Use 22 Mbps Access Point	**71 m**	WLAN RX wanted power is -87 dBm + 20 dB = -67 dBm, PR is -31 dB. Interference threshold is therefore (-67) – (-31) = -36 dBm. WLAN RX is at 2 metres height (located indoors) and LTE BS TX is at 20 m height (located outdoors). LTE BS antenna gain is 18 dBi and WLAN RX antenna gain is 0 dBi. 10 dB building penetration loss is assumed.
Domestic Use 24 Mbps Access Point	**64 m**	WLAN RX wanted power is -87 dBm + 20 dB = -67 dBm, PR is -35 dB. Interference threshold is therefore (-67) – (-35) = -32 dBm. WLAN RX is at 2 metres height (located indoors) and LTE BS TX is at 20 m height (located outdoors). LTE BS antenna gain is 18 dBi and WLAN RX antenna gain is 0 dBi. 10 dB building penetration loss is assumed.

3.2 Statistical Analysis with SEAMCAT

(13) On the basis of the single entry interference scenarios examined in the previous section, SEAMCAT simulation models have been developed to derive interference statistics for each scenario.

(14) SEAMCAT simulation runs are based on Monte Carlo trials. In each trial, interfering and victim system transmitters / receivers are randomly located within the simulation area and wanted and interfering signal powers are calculated at the victim receiver. Using these power levels, interference statistics in the form of a C/N+I cumulative distribution function are derived over a number of trials simulated. This is then compared against the protection ratio to determine the probability of interference.

(15) An example SEAMCAT snapshot representing a number of trials is illustrated below where interference from an outdoor LTE BS transmitter into an outdoor WLAN commercial access point is analysed.

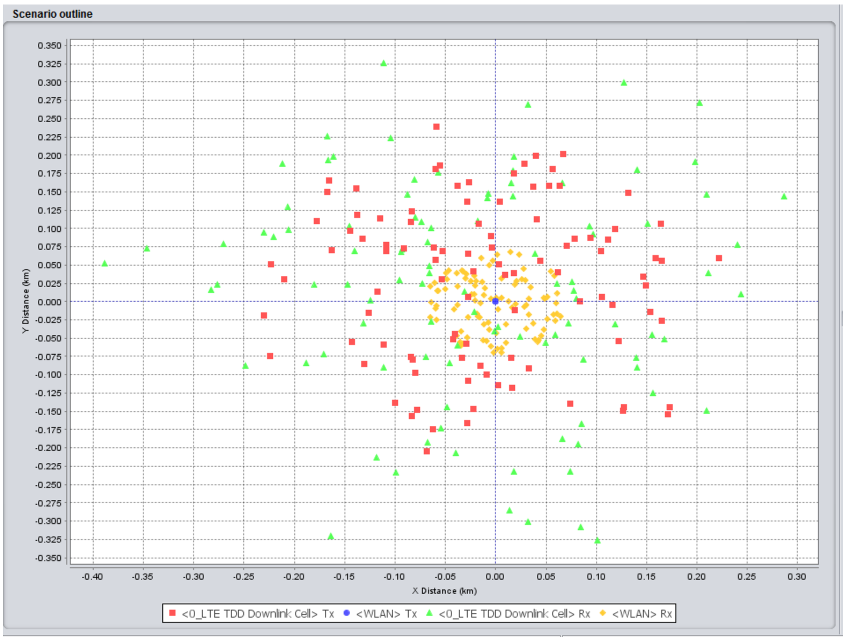

Figure 1: Example SEAMCAT Snapshot

(16) As can be seen, the WLAN transmitter is located at the centre of the simulation area. The WLAN receiver is then located randomly within 70 m of the transmitter (as calculated in the WLAN link budgets presented earlier). The interfering LTE BS transmitter is located within 200 m (corresponding to the LTE link range calculated earlier) of the victim WLAN receiver. The LTE MS receiver is then located within 200 metres of the BS transmitter to complete the interfering and victim link configurations.

(17) An example geometry is illustrated in the following figure where a WLAN RX operating at the edge of WLAN and LTE coverage areas is interfered by an LTE BS transmitter. While the simulation area is effectively a circle having a radius equal to the sum of the LTE range and the WLAN range, the WLAN RX victim is always within the area defined by the LTE range. The percentage probability figures therefore always relate an area defined by the LTE range (i.e. the LTE cell size). When considering an area greater than the LTE cell, if the rest of the area is covered by additional similarly sized cells with no overlap then the probability of interference in each cell will be the same and the probability across the whole area will therefore also be the same. If there are parts of the larger area that do not have LTE coverage then the probability of interference will be correspondingly diluted. Conversely, if there is any significant overlap between the LTE cells then the probability of interference will increase.

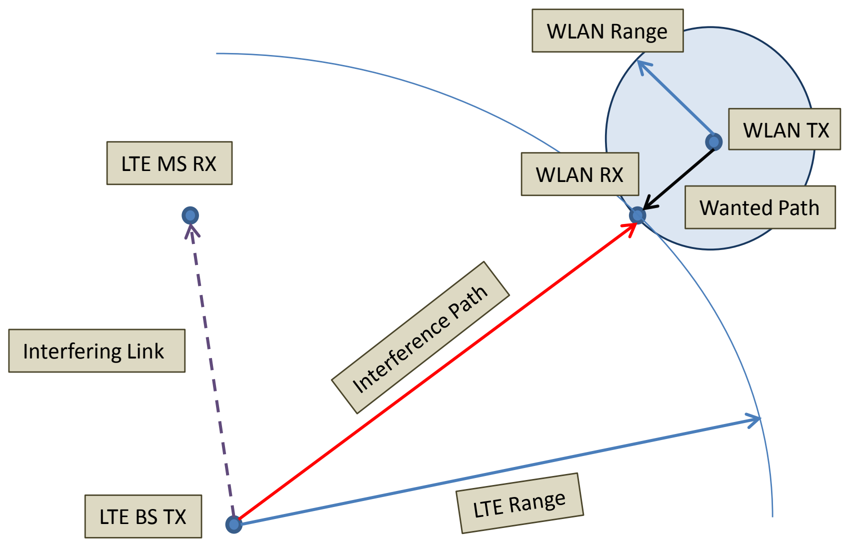

Figure 2: Example Interference Geometry

(18) The resultant C/(N+I) cumulative distribution function together with the protection ratio criterion are shown in Figure 3.

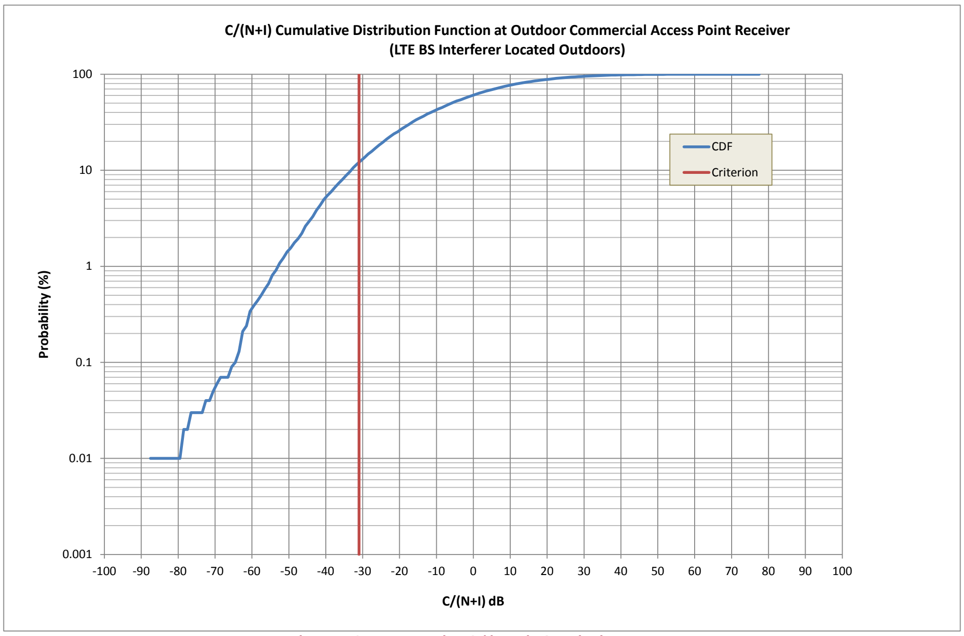

Figure 3: Example C/(N+I) Statistics

(19) The detailed results suggest that the C/(N+I) curve remained below the protection ratio in 12.1% of Monte Carlo trials. The probability of interference is therefore 12.1%.

(20) In addition to the outdoor environment, the implications of interference in indoor environment have also been examined. Indoor interference scenarios assume that the LTE MS interferer is located within the same building as the victim WLAN transmitter and receiver. The LTE BS receiver is assumed to be located outdoors.

(21) In the simulation run, interfering and victim link distance is varied randomly. The LTE MS transmitter power control is applied. Depending on the distance, the implications of loss between rooms and floors are taken into consideration. Figure 4 shows SEAMCAT parameters used to model propagation variations.

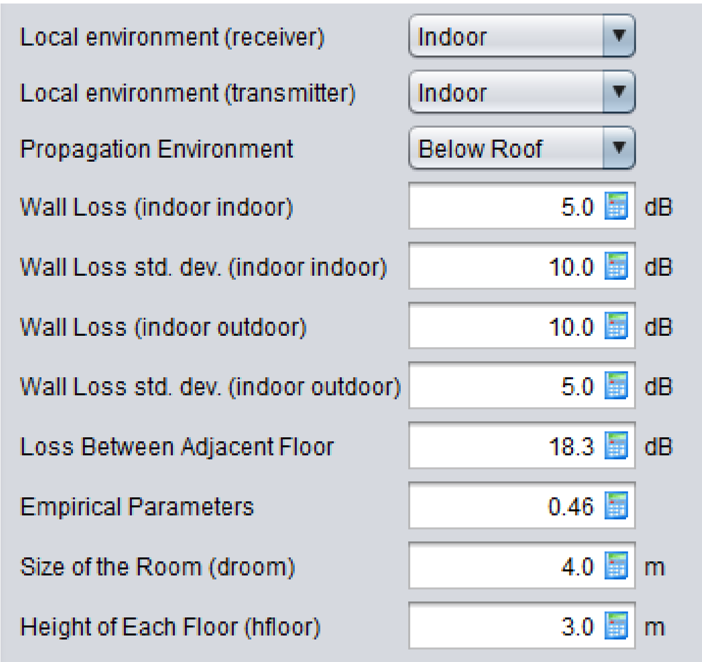

Figure 4: SEAMCAT Indoor Environment Modelling Parameters

(22) The parameters indicate that, for example, when the difference between the LTE MS and WLAN receiver heights is less than 3 metres and the distance is less than 4 metres they are assumed to be operating within the same room. If these values are exceeded then the corresponding additional wall and floor loss values are applied to the path loss.

(23) Table 7 below is shown the probability of interference for each scenario simulated using SEAMCAT. When interpreting these results there are two aspects worth noting:

(24) In effect the probability largely relates to particular geometries occurring, recognising that propagation variability also plays a part. Where mobile devices are involved the likelihood of interference therefore changes. For fixed access points and the potential impact of (fixed) LTE Base Stations the geometry is invariant and if a particular alignment has a high likelihood of experiencing interference it will experience that interference for most of the time. Conversely, a fixed geometry having a low likelihood of interference will remain so.

(25) These results are based on single entry interference which implicitly assumes that there is always a dominant interferer. The impact of aggregation in the time and power domains is not represented here.

Table 7: Interference Probabilities

Interference Scenario	**Interference Probability**
LTE BS interference into Commercial Use 22 Mbps Access Point (Outdoor)	**12.1%**
LTE BS interference into Domestic Use 24 Mbps Access Point (Outdoor)	**8.3%**
LTE MS interference into Commercial Use 22 Mbps Access Point (Indoor)	**3.9%**
LTE MS interference into Domestic Use 24 Mbps Access Point (Indoor)	**2.6%**
LTE BS interference into Commercial Use 22 Mbps Access Point (Outdoor to Indoor)	**4.3%**
LTE BS interference into Domestic Use 24 Mbps Access Point (Outdoor to Indoor)	**2.9%**

(26) The results indicate that the impact of interference into WLAN access points occurs with a probability between 2.6% – 12.1%.

4 SENSITIVITY ANALYSIS

(27) In this section, the implications of variations in the WLAN range and the LTE BS height have been analysed using the fixed C/(N+I) values from measurements.

4.1 WLAN Range

(28) The WLAN coverage range used in the analysis presented previous section is associated with the measured minimum usable signal (MUS) level which corresponds to a minimum data rate of 1 Mbps. On the other hand, the protection ratios were based on measurements where the WLAN received signal level was 20 dB above the MUS level. The use of measured protection ratios therefore provides over-protection for the WLAN RX located at distances (from WLAN TX) corresponding to the signal levels between MUS+20 and MUS. This, in turn, results in pessimistic interference probabilities.

(29) In the scenario where interference from an outdoor LTE BS into an outdoor commercial access point is examined the WLAN range is calculated to be 70 m using the MUS level of 87 dBm. In SEAMCAT, at this distance, the standard deviation of the propagation variations is approximately 11 dB. If the calculation was based on MUS+20dB the range would be approximately 50 metres. At this distance, the standard deviation of the propagation variations in SEAMCAT is approximately 5.5 dB.

(30) Using the 50 m WLAN range that corresponds to MUS+20dB, the interference probability is calculated to be 4.5%. This corresponds to a reduction of 7.6% compared to the results obtained for the 70 m WLAN range (12.1%).

(31) Using the above approach, the access point interference scenarios have been re-examined and the calculated interference probabilities are shown in Table 8. It should be noted that, in the indoor interference scenarios, the standard deviation of the propagation variations is assumed to be 10 dB.

Table 8: Interference Probabilities (WLAN Range Sensitivity)

Interference Scenario	(MUS) dB		(MUS + 20) dB	
	WLAN Range	Interference Probability	WLAN Range	Interference Probability
LTE BS interference into Commercial Use 22 Mbps Access Point (Outdoor)	**70 m**	**12.1%**	**50 m**	**4.5%**
LTE BS interference into Domestic Use 24 Mbps Access Point (Outdoor)	**70 m**	**8.3%**	**50 m**	**2.4%**
LTE MS interference into Commercial Use 22 Mbps Access Point (Indoor)	**20 m**	**3.9%**	**10 m**	**1.3%**
LTE MS interference into Domestic Use 24 Mbps Access Point (Indoor)	**20 m**	**2.6%**	**10 m**	**0.7%**
LTE BS interference into Commercial Use 22 Mbps Access Point (Outdoor to Indoor)	**20 m**	**4.3%**	**10 m**	**0.7%**
LTE BS interference into Domestic Use 24 Mbps Access Point (Outdoor to Indoor)	**20 m**	**2.9%**	**10 m**	**0.4%**

(32) The results indicate that the modified WLAN range reduces the interference probability from the range 2.6 – 12.1% to the range 0.4 – 4.5%. In effect these ranges are bounds on what the actual result would be if the protection ratio were to be varied dynamically.

4.2 LTE BS Height

(33) The analysis presented so far assumes 20 m height for LTE BS transmitter. Interference probability results for 10 m and 30 m LTE BS transmitter heights are shown in the following table for outdoor access point receivers. It should be noted that the LTE cell range is 140 m for 10m height and 260 m for 30 m height.

Table 9: Interference Probabilities (LTE BS Height Sensitivity)

Interference Scenario	Interference Probability		
	10 m	20 m	30 m
LTE BS interference into Commercial Use 22 Mbps Access Point (Outdoor)	**18.1%**	**12.1%**	**9.4%**
LTE BS interference into Domestic Use 24 Mbps Access Point (Outdoor)	**13%**	**8.3%**	**6.1%**

(34) As can be seen, when the LTE BS height is reduced (i.e. the LTE cell range reduced) the probability of interference increases. When the height is increased (i.e. LTE cell range is increased) the probability of interference is reduced.

(35) The explanation for this result is due to the behaviour of field strength decay as follows. According to the Hata propagation model used in this analysis the field strength decays more rapidly for lower LTE Base Station antenna heights. Give that the LTE cell size is determined by the same minimum field strength at the cell edge, the cell sizes range from a radius of 140 m for a 10 m high Base station to 260 for a 30 m high Base Station in urban areas. Noting that interference to WLANs will occur nearer to Base stations rather than towards the cell edge, it can be shown that the area over which a higher range of field strengths exists (i.e. away from the cell edge and more towards the Base Station) relative to the whole area of the cell is greater for smaller cells with their higher rate of field strength decay than for larger cells with their more gradual rate of field strength decay.

(36) When making this comparison it can be observed that there is a crossover point the other side of which the converse applies. For lower field strengths (i.e. towards the cell edge / away from the Base Station) the relative area is greater for larger cells. This implies that for situations where, for example, LTE user terminals are victims of potential interference from other services it would be the larger LTE cells that experience a higher probability of interference.

5 SUMMARY AND CONCLUSIONS

(37) Based on the results of the minimum coupling loss and statistical simulation analysis presented in the preceding sections (where it is assumed that the LTE transmitter with 20 MHz bandwidth is operating at 2380 MHz and the WLAN receiver is operating at 2412 MHz), the following conclusions can be drawn.

- The minimum separation distance calculations indicate that more than 91 metres separation is required to protect outdoor WLAN access points from LTE BS transmitters. In the case of indoor environment, the co-existence of an LTE MS transmitter and a WLAN access point receiver in the same room (i.e. no wall or floor attenuation) may not be feasible.
- The statistical analysis results show that the probability of interference into WLAN access points is between 2.6% – 12.1%, noting that links from some client devices at edge of WLAN coverage are being over-protected.
- The sensitivity analysis to correct for the above over-protection using a reduced WLAN range indicates that the corresponding interference probabilities are between 0.4% - 4.5%. While the range in the previous bullet represents an upper bound on the likely interference, the range here can be taken to represent a lower bound.
- Further sensitivity analysis with LTE BS transmitter heights shows that the interference probability is increased from 12.1% to 18.1% due to the cell range decrease resulting from the LTE BS height reduction from 20 metres to 10 metres. Similarly, the probability is reduced from 12.1% to 9.4% when the LTE BS height is increased from 20 metres to 30 metres. This reflects the relative difference in field strength decay between different cell sizes.

(38) The small change in protection ratio with frequency offset as determined through measurement indicates that blocking (i.e. the main LTE interfering signal entering through the WLAN selectivity skirt) rather than in-band interference (i.e. LTE out-of-band emissions falling in the WLAN receiver pass band) is the dominant factor The analysis contained in ECC Report 172 relates to the impact of LTE OOB emissions so the results in that report are not directly comparable with the results presented here which it has been concluded are dominated by blocking.

(39) The following table provides a summary of probabilities obtained for a full range of assumed C/(N+I) and MUS levels as contained in Appendix A.

Table 10: Summary of Calculated Interference Probabilities

Interferer	Victim	Interference Probabilities for Assumed C/(N+I) and MUS Range
LTE BS TX Outdoor	WiFi RX Outdoor at 2 m	0.05% – 48.9%
	WiFi RX Outdoor at 5 m	0.3% - 70.53%
	WiFi RX Indoor at 2 m	0.01% - 21.57%
LTE UE TX Outdoor	WiFi RX Outdoor at 2 m	0% - 1.48%
	WiFi RX Outdoor at 5 m	0% - 1.57%
	WiFi RX Indoor at 2 m	0% - 0.76%
LTE UE TX Indoor	WiFi RX Outdoor at 2 m	0% - 1.08%
	WiFi RX Outdoor at 5 m	0% - 1.16%
	WiFi RX Indoor at 2 m	0.07% - 18.52%

(40) The results indicate that:

- Interference probability can be as high as 70.53% when LTE BS interferes with an outdoor WiFi receiver with C/(N+I) threshold level of -10 dB and MUS level of -95 dBm. However, for the same scenario, the interference probability is less than 3.17% for all MUS levels when the C/(N+I) threshold is -60 dB.
- The range of probabilities obtained for LTE UE interferer remains below 1.57% except for scenarios where the interferer and victim are within the same building (of 20 m) for which the probabilities are between 0.07% - 18.52% over the assumed C/(N+I) and MUS range.

Appendix A ADDITIONAL ANALYSIS

A further set of results based on a wider range of C/(N+I) values and MUS levels have been produced. The modelling assumptions for this further analysis are outlined below:-

- Minimum Usable Signal Strength (MUS) levels for Wi-Fi receivers are -95, -85 and -75 dBm;
- Each MUS level is used as an input in Wi-Fi link budget calculations to determine corresponding Wi-Fi link range. For each MUS level, two ranges are calculated to represent indoor and outdoor Wi-Fi links. Furthermore, two outdoor Wi-Fi receiver heights at 2 m and 5 m are used. The link range calculations are based on SEAMCAT Hata SRD and Hata Indoor propagation models to be consistent with simulation models;
- Each calculated Wi-Fi link range is used as an input to the corresponding simulation model to randomly locate the Wi-Fi transmitter and its associated receiver;
- Interference from a single outdoor LTE BS transmitter, outdoor LTE UE transmitter and indoor LTE UE transmitter is calculated in simulations;
- Simulation results are presented in the form of 'probability of interference'. The probability is calculated for six C/N+I ratios representing a range of Wi-Fi receiver equipment performance. C/(N+I) ratios are -60, -50, -40, -30, -20 and -10 dB.

The following figures provide calculated interference probabilities for each scenario simulated.

In SEAMCAT, for the indoor WiFi receiver scenarios, the maximum WiFi link range needs to be 20m so that the transmitter and receiver are in the same building. For an MUS level of -95 dBm, the range is 27m which implies that samples in simulations might include additional two building losses leading to distorted statistics. The range in indoor WiFi receiver scenarios is therefore capped at 20m for MUS levels of -95 dBm and -85 dBm resulting in same interference probabilities for a given C/(N+I) ratio.

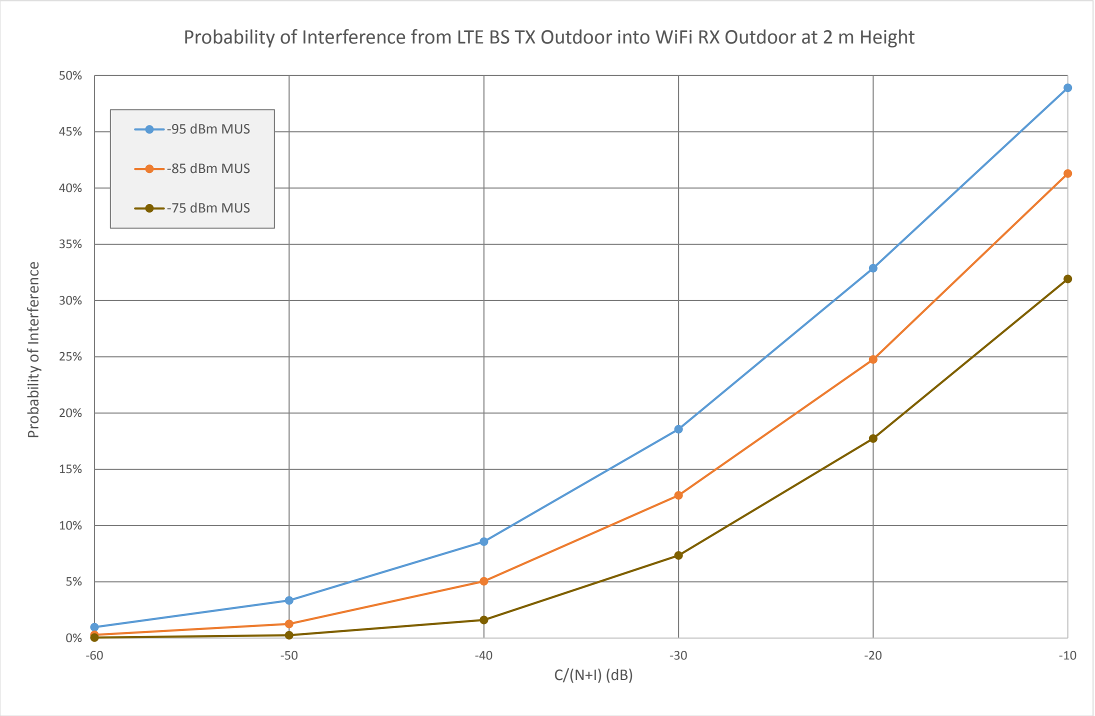

Figure 5: Interference Probabilities
(LTE BS TX Outdoor into WiFi RX Outdoor at 2m Height)

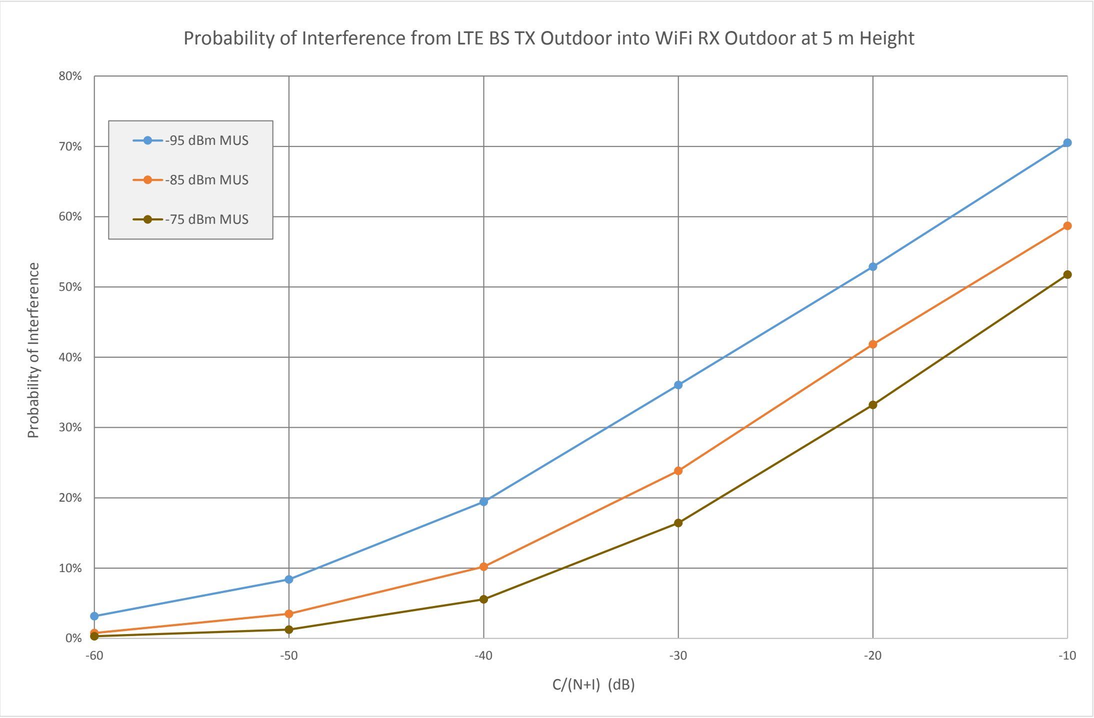

Figure 6: Interference Probabilities
(LTE BS TX Outdoor into WiFi RX Outdoor at 5m Height)

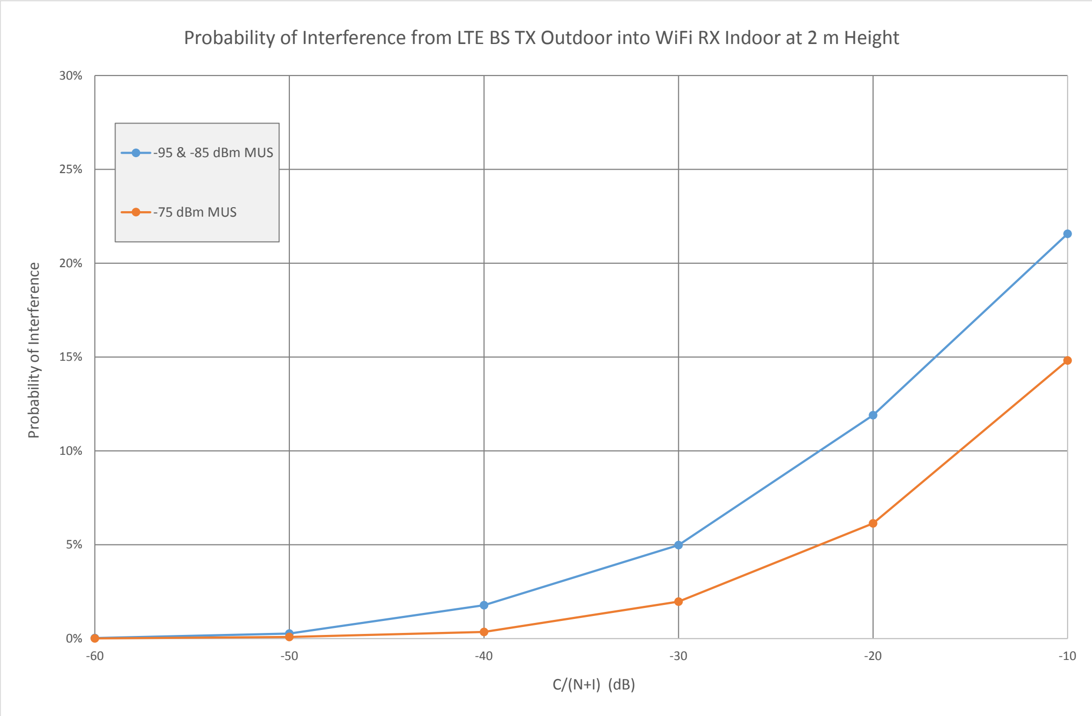

Figure 7: Interference Probabilities
(LTE BS TX Outdoor into WiFi RX Indoor at 2m Height)

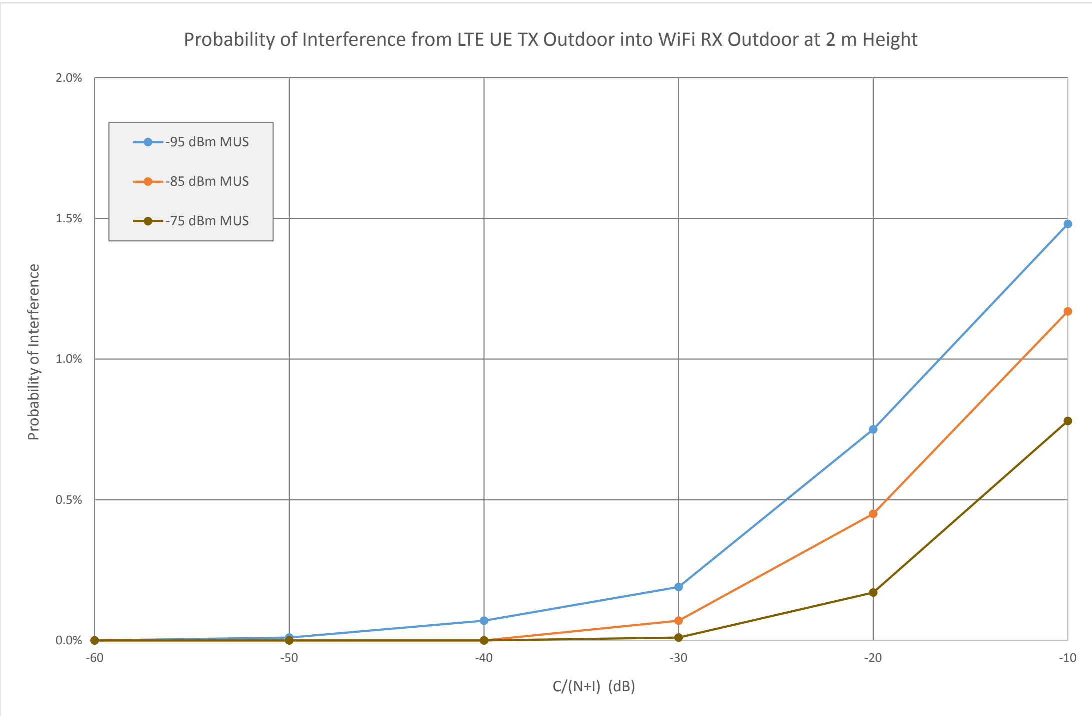

Figure 8: Interference Probabilities
(LTE UE TX Outdoor into WiFi RX Outdoor at 2m Height)

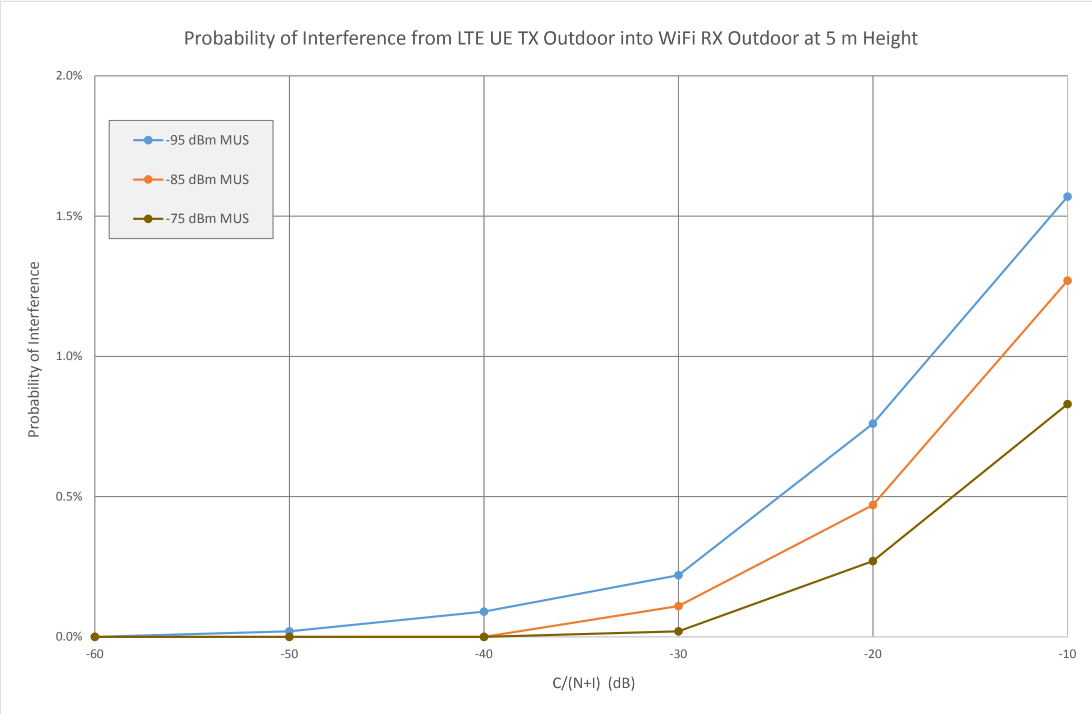

Figure 9: Interference Probabilities
(LTE UE TX Outdoor into WiFi RX Outdoor at 5m Height)

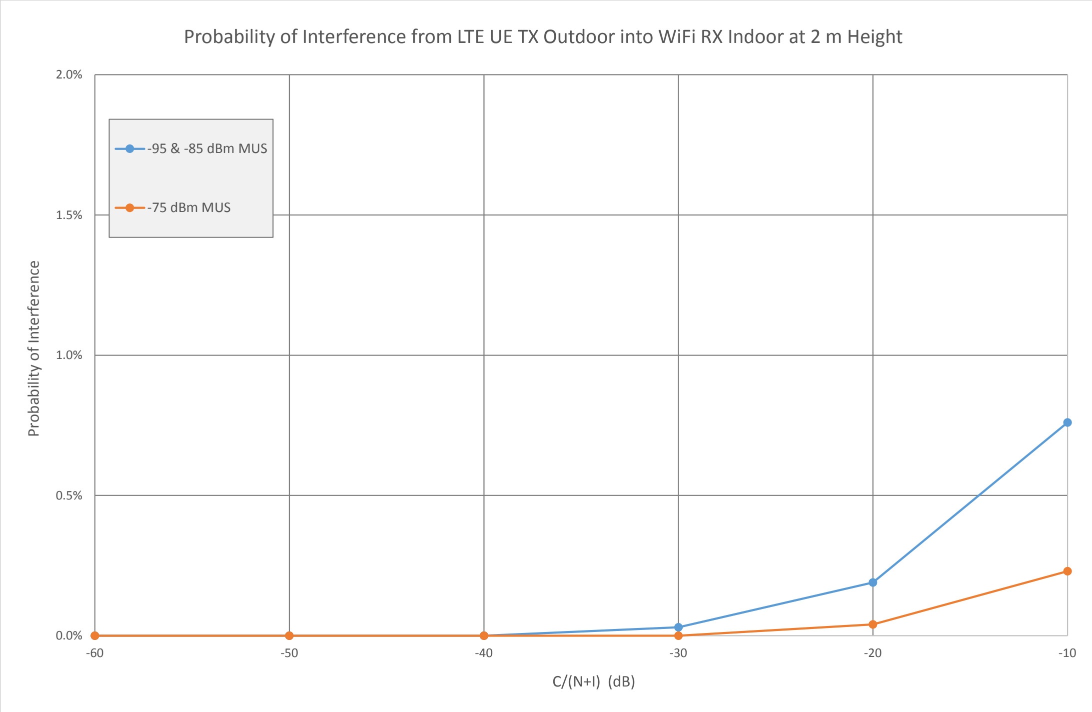

Figure 10: Interference Probabilities
(LTE UE TX Outdoor into WiFi RX Indoor at 2m Height)

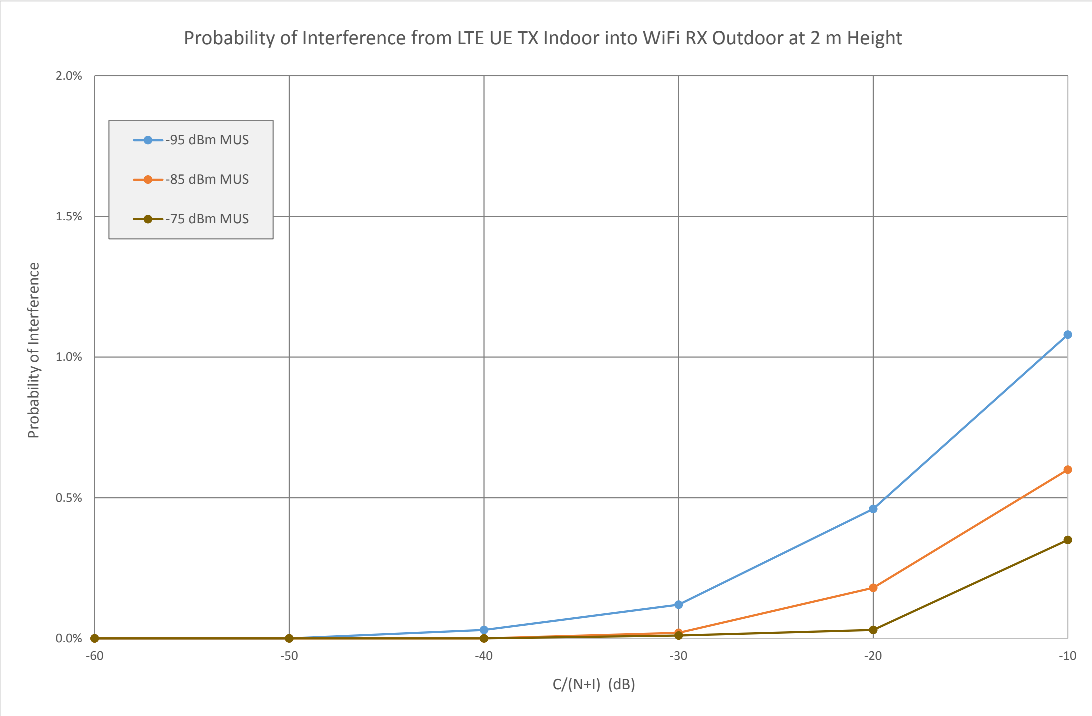

Figure 11: Interference Probabilities
(LTE UE TX Indoor into WiFi RX Outdoor at 2m Height)

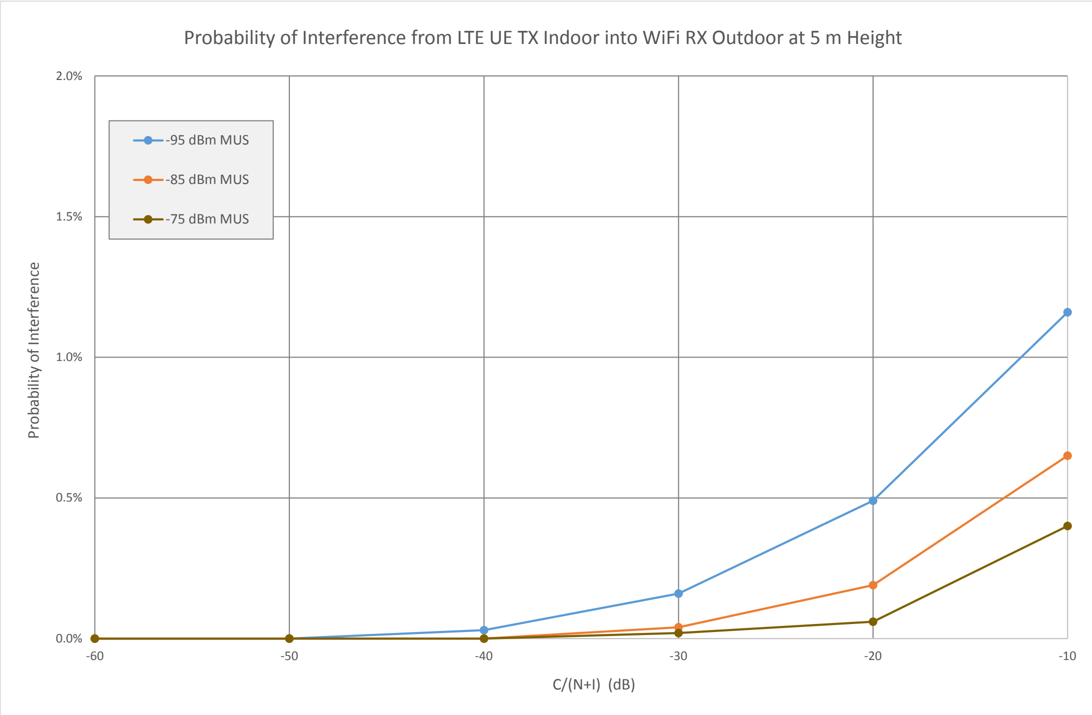

Figure 12: Interference Probabilities
(LTE UE TX Indoor into WiFi RX Outdoor at 5m Height)

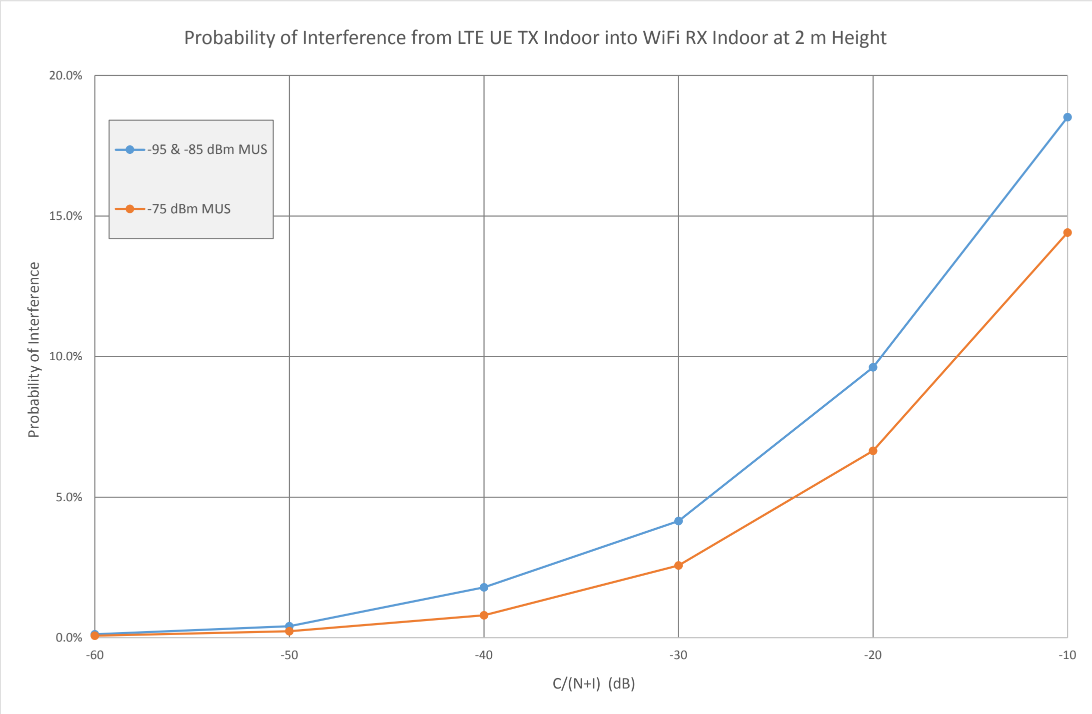

Figure 13: Interference Probabilities
(LTE UE TX Indoor into WiFi RX Indoor at 2m Height)

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