Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Interference from a BFWA PMP system to a PP link system (co-channel case; frequency range 2: 23.5 to 43.5 GHz).
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Source(s)	Philip Whitehead Radiant Networks Plc The Mansion, Chesterford Park Little Chesterford, Essex CB10 1XL UK Voice: +44 1799 533600 Fax: +44 1799 533601 mailto:pw@radiantnetworks.co.uk
Re:	Amendment to Coexistence Recommended Practice IEEE 802.16.2-2001
Abstract	This paper provides the results of an analysis of scenarios in which BFWA PMP systems may cause interference to point- to - point links operating in adjacent areas, on the same channels. The point- to- point links are assumed to be individually licensed and to have “protected” status.
Purpose	To provide simulation results and draft coexistence guidelines for scenarios 1 and 2 in IEEE C802/16.2a-02/06 (interim considerations from simulations).
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Patent Policy and Procedures	

Interference from a BFWA PMP system to a PP link system (co-channel case; frequency range 2: 23.5 to 43.5 GHz).

This paper provides the results of an analysis of scenarios in which BFWA PMP systems may cause interference to point- to - point links operating in adjacent areas, on the same channels. The point- to- point links are assumed to be individually licensed and to have "protected" status. Thus, the PMP system must be designed to avoid creating any interference above the acceptable threshold level. The scenarios correspond to nos. 1 and 2 in IEEE C802.16.2a-02/06 [1].

The analysis is carried out at two frequencies; 25 GHz and 38 GHz. Relevant PP system parameters are taken from the results of an earlier IEEE 802.16 study and can be found in [4].

Interference scenarios

In this case, the interferer is either a single transmitter (BS) or a collection of user stations (SS), which may or may not transmit simultaneously. Since the PP link must be protected from all cases of interference above the acceptable threshold, a worst-case analysis is appropriate.

In the case of a typical PMP BS, the antenna beam-width and height above surrounding terrain are such that terrain losses (over and above free space) for distances less than the horizon distance cannot be relied on. Therefore, all such paths for the worst - case analysis should be assumed to be clear, line of sight.

For over the horizon paths, additional losses above free space will occur. The calculation of the excess loss is complex and terrain dependent. A methodology for estimating such losses can be found in ITU –Rec.452 [2]. The calculation of horizon distance can be found in the IEEE 802.16.2 Recommended Practice [3].

The interference model for the case where the BS is the interferer is shown in fig 1. A corresponding model for the SS case is shown in fig 2.

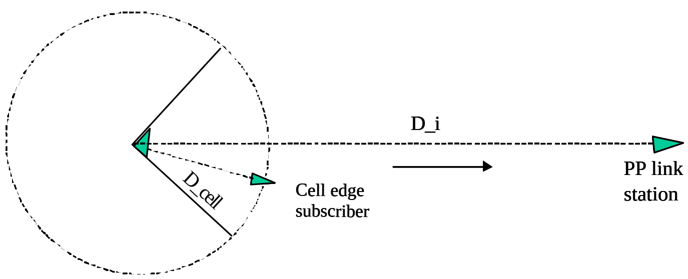

Fig. 1 Interference geometry (PMP BS to PP link)

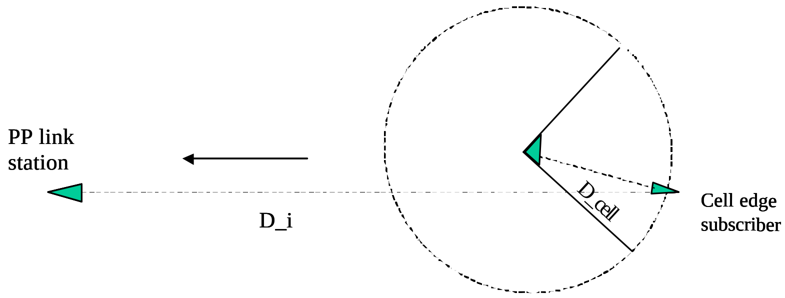

Fig. 2 Interference geometry (PMP SS to PP link station)

The PMP cell is shown as a circle. A nominal cell radius of 5km is assumed. The victim station is one end of a PP link. The distance from the BS or SS to the victim link station is D_i. The following parameters are assumed for the analysis:

Parameter	**Value**	**Note**
PMP cell radius (D_cell)	5km	Larger radius leads to worse interference scenario
Frequency	25 GHz / 38 GHz	PP link antenna patterns for these frequencies are available in [5]
BS antenna gain (25/ 38 GHz)	19dBi / 20 dBi	Typical for 90 degree sector antenna
SS antenna gain (25/ 38 GHz)	36dBi / 38dBi	Typical values for narrow beam antennas
Link antenna gain (25/ 38 GHz)	40 dBi / 42dBi (Note 1)	From [4]
Nominal SS Rx input level	-73dBm	Assuming 16 QAM modulation
Note 1: The range of values proposed in [4] is 40 - 42dB		

Table 1: Parameters for PMP to PP interference scenarios

Results

The results of the analysis are summarised in table 2 (BS interference) and table 3 (SS interference). The threshold for acceptable interference is taken as –100 dBm, corresponding to –114.5dBm/ MHz in a 28 MHz channel. The tables show the level of interference for various combinations of distance (D_i) and PP link antenna offset angle. Line of sight propagation is assumed. Acceptable results are highlighted in the tables.

interference from BS to PP Rx			25 GHz	25 GHz	25 GHz		38 GHz	38 GHz	38 GHz
(co-channel, adjacent area)									
Frequency GHz		25	25.0	25.0			38.0	38.0	38.0
Tx power, max	dBm	26							
wanted path length (SS - BS) km	D_cell	5							
SS-BS path loss dB (25 GHz)		-123-20log d	-137.0	-137.0	-137.0				
SS-BS path loss dB (38 GHz)		-126.4-20log d					-140.4	-140.4	-140.4
interference path length, km	D_i		**20.00**	**50.00**	**180.00**		**20.0**	**50.0**	**180.0**
interference path loss dB			-149.0	-157.0	-168.1		-152.5	-160.4	-171.5
Link antenna gain dBi		40	40	40	40		42	42	42
BS antenna gain dBi		19	19	19	19		20	20	20
SS antenna gain dBi		36	36	36	36		38	38	38
wanted SS Rx input, 16 QAM, dBm		-73							
BS Tx power, no fade dBm			9.0	9.0	9.0		9.4	9.4	9.4
interference power, no fade, dBm			-81.0	-89.0	-100.1		-81.1	-89.0	-100.1
Less off axis RPE factor (25 GHz)	3 degrees	-8	-89.0	-97.0	-108.1		n/a	n/a	n/a
	5.8 degrees	-19	-100.0	-108.0	-119.1		n/a	n/a	n/a
	10 degrees	-22	-103.0	-111.0	-122.1		n/a	n/a	n/a
Less off axis RPE factor (38 GHz)	2 degrees	-8	n/a	n/a	n/a		-89.1	-97.0	-108.1
	4 degrees	-19	n/a	n/a	n/a		-100.1	-108.0	-119.1
	7 degrees	-25	n/a	n/a	n/a		-106.1	-114.0	-125.1

Table 2 BS to PP link Interference (25 and 38 GHz)

interference from SS to PP Rx			25 GHz	25 GHz	25 GHz		38 GHz	38 GHz	38 GHz
(co-channel, adjacent area)									
Frequency GHz		25	25.0	25.0	25.0		38.0	38.0	38.0
Tx power, max	dBm	26							
wanted path length (SS - BS) km	D_cell	5							
SS-BS path loss dB (25 GHz)		-123-20log d	-137.0	-137.0	-137.0				
SS-BS path loss dB (38 GHz)		-126.4-20log d					-140.4	-140.4	-140.4
interference path length, km	D_i		**100.00**	**150.00**	**250.00**		**80.0**	**120.0**	**250.0**
interference path loss dB			-163.0	-166.5	-171.0		-164.5	-168.0	-174.4
Link antenna gain dBi		40	40	40	40		42	42	42
BS antenna gain dBi		19	19	19	19		20	20	20
SS antenna gain dBi		36	36	36	36		38	38	38
wanted SS Rx input, 16 QAM, dBm		-73							
SS Tx power, no fade dBm			9.0	9.0	9.0		9.4	9.4	9.4
interference power, no fade, dBm			-78.0	-81.5	-86.0		-75.1	-78.6	-85.0
Less off axis RPE factor (25 GHz)	3 degrees	-8	-86.0	-89.5	-94.0		n/a	n/a	n/a
	5.8 degrees	-19	-97.0	-100.5	-105.0		n/a	n/a	n/a
	10 degrees	-22	-100.0	-103.5	-108.0		n/a	n/a	n/a
Less off axis RPE factor (38 GHz)	2 degrees	-8	n/a	n/a	n/a		-83.1	-86.6	-93.0
	4 degrees	-19	n/a	n/a	n/a		-94.1	-97.6	-104.0
	7 degrees	-25	n/a	n/a	n/a		-100.1	-103.6	-110.0

Table 3 SS to PP link interference (25 and 38 GHz)

In the case where the BS is the interferer, it can be seen that for the worst pointing direction, a large system spacing is required, almost certainly corresponding to an over the horizon path. More acceptable distances are possible when the link antenna is pointing at an angle to the path to the BS (e.g. 20km is sufficient when the angle is 5.8 degrees or more).

It must be noted that in practice there may well be several BS and a calcultion must be carried out for each one separately, unless the PP link is well over the horizon.

In the case where the SS is the interferer, the level of interference is greater and the number of stations that may interfere is much higher. Although the SS antenna beam-width is narrower, there are many stations distributed across the cell/ sector, so that the probability of interference may still be high. It is usually impractical to coordinate every time a new user station is deployed. A more conservative approach will therefore usually be required than for the BS case. An advantage in the SS case is that the antenna heights are generally much lower than for the BS. Therefore the horizon distance will be much shorter and excess losses more likely at reasonable distances. Where the pointing direction of the PP link is relied on for additional isolation, the worst- case position of a potential SS in the coverage area of the PMP BS must be considered.

Conclusions for the PMP to PP co-channel scenarios

Interference Scenario	Frequency	Guideline	Notes
BS to PP link station	25 GHz	PP link must be over the horizon or at least 180 km spacing from BS. OR Approx 20km spacing with PP antenna offset.	Coordination usually required. Multiple BS interferers may have to be considered
BS to PP link station	38 GHz	PP link must be over the horizon or at least 180 km spacing from BS. OR Approx 20km spacing with PP antenna offset.	Coordination usually required. Multiple BS interferers may have to be considered
SS to PP link station	25 GHz	PP link must be over the horizon, or have a very large pointing offset plus a significant spacing from nearest SS	Coordination usually required. SS interference is worst case unless terrain losses can be relied on
SS to PP link station	38 GHz	PP link must be over the horizon, or have a very large pointing offset plus a significant spacing from nearest SS	Coordination usually required. SS interference is worst case unless terrain losses can be relied on

Table 4 Summary of results

A study carried out in ETSI TM4 also partly covers this topic. Further information can be found in [6].

References

[1] IEEE C802.16.2a-02/06; "Interim considerations from simulations".
[2] Rec. ITU-R P.452.9; "Prediction procedure for the evaluation of microwave interference between stations on the surface of the earth at frequencies above about 0.7 GHz."
[3] IEEE 802.16.2-2001; "Recommended Practice for coexistence of Fixed Broadband Wireless Access Systems."
[4] IEEE C802.16.2a-01/06; "System parameters for point to point links for use in Coexistence Simulations (revision 1)"
[5] IEEE 802.16.2-01/14; "Proposed Antenna Radiation Pattern Envelopes for Coexistence Study".

[6] ETSI Technical Report TR 101 853 v1.1.1 (2000-10); “Fixed Radio Systems; Point to point and point to multipoint equipment; Rules for the coexistence of point to point and point to multipoint systems using different access methods in the same frequency band.”

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