Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Coexistence Studies for frequencies below 11 GHz and with point to point links**
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Re:	Call for interest in new coexistence studies, for discussion at session #12
Abstract	This document identifies the need for new simulation models to support the possible extension of coexistence studies to new frequency bands and types of system
Purpose	To assist in the planning of future coexistence studies and possible extensions to the Recommended Practice.
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Coexistence Studies for frequencies below 11 GHz and with point to point links

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1. Introduction

This paper presents some background to the coexistence studies carried out for FBWA systems in the 10-66 GHz frequency range, resulting in the current draft Recommended Practice, which is now entering the sponsor ballot phase.

IEEE 802.16 task group 2 has studied and reported on coexistence of fixed broadband wireless access systems, with an emphasis on the frequency range 23.5 – 43.5 GHz. Interest has now been shown in extensions to this work to cover other frequency ranges and to study issues related to the use of point to point links. There is particular interest in studies of systems operating below 11 GHz, in order to support the work of 802.16 task group 3. Some of the work may also be useful in support of possible systems operating in unlicensed bands, though additional techniques (sharing etiquettes) will also be necessary for such systems.

During the preparation of the current coexistence practice, it was found necessary to develop simulation tools, to analyze the various modes of interference and provide, in many cases, statistical results derived from a large number of random simulation trials (Monte Carlo method). The number of different interference modes is significant and the most severe case for a particular system configuration is not necessarily easy to predict. Thus, there is no easy way to avoid carrying out a systematic and thorough analysis.

Apart from Monte Carlo simulations, other methods of analysis may also be used for certain of the interference cases. These include:

- Worst case analysis
- Interference Area method
- ISOP (Interference Scenario Occurrence Probability)

All of these are described in the current draft Recommended Practice. The last method is the only one not used in the preparation of the document, although results based on this method can be found in a CEPT report on coexistence of FBWA systems operating in the 26 GHz frequency band.

Some interference cases may involve multiple interferers on the same channel at the same time. This can significantly increase the interference level and must be taken into account in the modelling.

2. Procedure

TG2 found that the analysis of interference cases was a much more complex task than originally expected. Nevertheless, it is an essential pre-requisite to making any recommendations for coexistence. Extensions to sub - 11GHz and point- to - point scenarios will require significant changes to the simulation models. It should also be noted that none of these models is currently is available in the public domain. The five main tools used (see

appendix, below) were developed by TG2 contributors and are not published. TG2 was not able to find any useful public domain simulation tools.

Therefore, a priority for new studies is to describe new propagation models, identify all the potential interference mechanisms and thus to specify requirements for new simulation tools. The availability of previously used tools and the possibility to develop them further could be explored with the original contributors.

Only when the interference analysis is completed should the rest of the coexistence document be drafted. It is likely that a significant amount of the present recommended practice could be used as a basis for new text.

3. Coexistence with Point to Point Links

Point to point links are licensed in different ways in different countries. In many cases, links are managed individually. Each is assigned specific frequencies and coexistence is calculated by the relevant regulatory body. The operator can not change antennas, directions or other link parameters without agreement. Interference problems, if they occur, are managed by regulatory bodies. Links managed in this way have a “protected” status. In some case, the probability of interference between point to point and P-MP systems is considered by regulatory bodies to be such that the two types of system are not allowed in the same frequency band. An investigation into this will therefore be an important issue in future studies.

In other cases, links can be deployed in any arrangement chosen by an operator, within a frequency block assignment, provided certain boundary conditions are met. These boundary conditions may relate amongst other things to emissions outside the block and to maximum eirps within the block, together with equipment and antenna parameters. The sharing of frequency bands between P-MP and flexibly organized point to point systems requires a different analysis from the above case and will lead to a different simulation model.

4. Coexistence below 11 GHz

Many parameters and assumptions in the existing simulation models will be different below 11 GHz. Moreover, there are considerable differences between the lowest and highest frequencies below 11 GHz that are under consideration. Some of the differences are as follows:

- non - line of sight propagation may be acceptable at some frequencies
- multipath problems may be significant
- rain fading is frequency dependent
- antenna beam-widths may be relatively wide
- cell re-use patterns may be different
- FBWA system architecture may be different from the higher frequencies

These and other likely differences could lead to significantly different simulation tools from those used previously.

For systems that operate in unlicensed bands, additional methods are required to limit interference. Normally, some kind of sharing etiquette is essential (unless the probability of interference can be shown to be low enough without such techniques – this is improbable in most cases). Although propagation aspects could be dealt with in new coexistence studies, the definition of sharing etiquettes was outside the scope of the previous task group 2 work, so that little contribution on this aspect is available.

5. Sharing with non – FBWA Systems

The present draft Recommended Practice has not studied interference to or from non - FBWA systems in any detail. The significance of such additional interference mechanisms should be considered in the bands below 11 GHz and in any other new bands studied.

6. Conclusion

The development of simulation tools should be a significant priority for future work. An early priority task should be to define the requirements for such tools and to determine whether previously used tools could be made available and suitably modified.

7. Appendix- Summary of simulation work undertaken in the current Recommended Practice

In addition to simple calculations carried out for the "worst case" analysis, five different simulation models were developed, using Monte Carlo and Interference Area methods. These are summarized in the table below and more details can be found in the Recommended Practice itself.

#	**Source**	**method**	**frequency range**	**Scenario**
1	Harris	Monte Carlo	Circa 28 GHz	PMP – PMP (several scenarios)
2	Crosspan	Monte Carlo	Circa 28 GHz	Multiple PMP hub interferers to single victim
3	TTPCom	IA/ Monte Carlo	Circa 28 GHz	PMP – PMP (several scenarios)
4	Radiant Networks	Monte Carlo	28 GHz and 40 GHz	MP-MP to PMP (several scenarios, including multiple interferers)
5	Radiocommunications Agency (UK)	Monte Carlo	28 GHz and 40 GHz	Calculation of acceptable psfd trigger values at system boundaries

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