Project	IEEE 802.16 Broadband Wireless Access Working Group <**http://ieee802.org/16**>
Title	**Evaluation of interference with different power rules during sub-frames**
Date Submitted	2007-05-05
Source(s)	Mariana Goldhamer Alvarion Tel Aviv, 21 HaBarzel Street Israel Voice: +972 3 6456241 Fax: +972 3 645 6204 mailto:mariana.goldhamer@alvarion.com
Re:	[If this is a proposed revision, cite the original document.] [If this is a response to a Call for Contributions, cite the name and date of the Call for Contributions to which this document responds, as well as the relevant item number in the Call for Contributions. Contributions that are not responsive to this section of the template, and contributions which do not address the topic under which they are submitted, may be refused or consigned to the "General Contributions" area.]
Abstract	[Description of document contents.]
Purpose	[Description of what the author wants 802.16 to do with the information in the document.]
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Evaluation of interference with different power rules during sub-frames

(AI 78 and 95 from session #48 relative to comments 2080 and 2144L)

Mariana Goldhamer
Alvarion

1 Introduction

This contribution first explains the Master, Slave, Common and Shared sub-frames need to be seen in the context of a cellular deployment and also taking into consideration the adjacent channel interference.
The deployment is outdoor and the used propagation model is Hata Open. The BS sector is 120deg.

2 The CX Sub-frames in cellular deployment

We have chosen to allow only 3 systems separating their interference in time domain. However, this may create confusion, because actually the interference is an accumulated energy which can be produced by systems on the same channel in adjacent geographical locations and also by systems using at the same location the adjacent or alternate adjacent channels.
It is difficult to introduce all these factors in a deployment simulation, however few situation analyzed with a deployment tool may better explain the situation.

2.1 Master sub-frames occupancy order

The first BS in an area is not affected by interference. Lets suppose that BS1 will use the Master sub-frame 1. Now lets suppose that the 2nd and the 3d Master BS have occupied their Master DL sub-frames, having the location as in fig. 1. The Base Stations are numbered in their installation order.

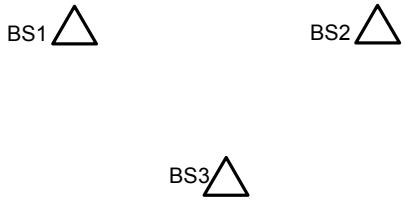

Figure 1 Topology for the first 3 BSs in the area

Lets suppose that the 4th system will occupy the position shown in fig. 2.

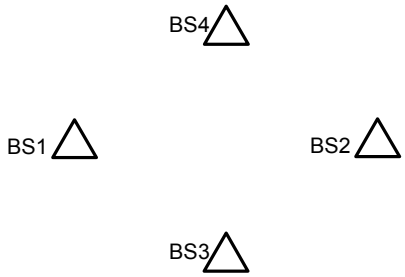

Figure 2 Topology for the first 4 BSs in the area

The BS4 is looking now for the less occupied Master Frame, by listening to the CXCC. It constructs its Master interference MAP, which is looking as in Fig.3. The MCR (modulation and coding rate) situation of the BS4, as compared with BS3, is shown in fig.4.

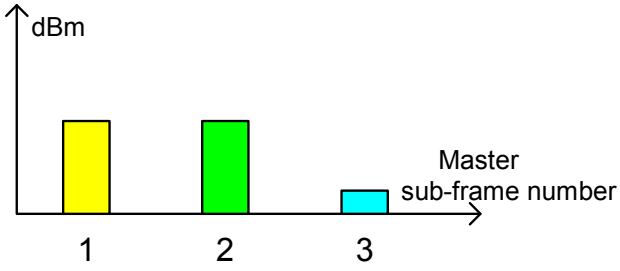

Figure 3 Interference MAP at the arrival of the 4th BS in the CX Community

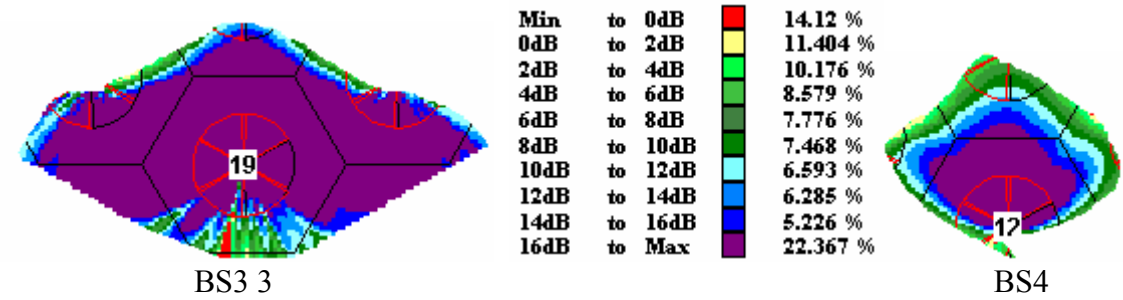

Figure 4 Coverage and MCR for North sector of BS3 and BS4 (both Master 3)

The following BS (5) may chose Master sub-frames depending of its relative topology. Anyone of the 3 Master sub-frames may be selected.
This means that **there is no direct linkage between the temporal order of installation and the occupied Master sub-frame number. The topology adds an important dimension to the selection of the Master sub-frame. The selection of the proper Master sub-frame shall be based ONLY on interference sensing.** The correct interference will be sensed only by using **Radio Signatures (analog signals)**. The analog signals "claim" a slot by their transmitted power and their contribution to the cumulated interference magnitude. However, further announcements can be made by a communication protocol.

2.2 Interference during Shared sub-frames

Fig. 5 shows the MCR for the situation in which max. power (same as in Master sub-frames) will be used during the Shared sub-frames. The BS are supposed to be part of a large deployment. The cell margin is covered at relatively low data rate, but still covered. With non-regular deployment of the sites the coverage may be affected.
Comparing this figure with fig. 3, results that the SINR is interference-limited. With other words, may be too much power transmitted just to fight the interference. This power in turn creates more interference.

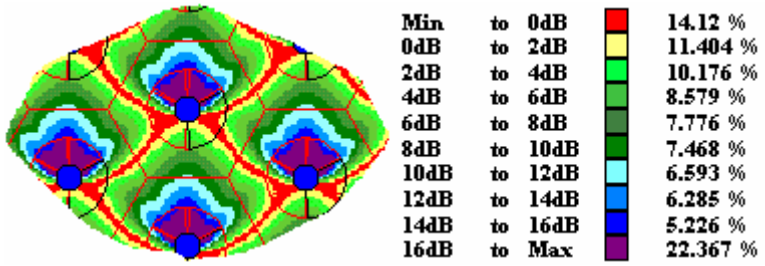

Figure 5 Coverage and MCR for North sector during Shared sub-frames

2.3 Interference created by a Slave to the Master, during its Common sub-frame

Assuming the Master operating at its maximum power also during the Common sub-frame preceding the Master sub-frame, the situation in fig.6 reflects the interference created by a Slave system, operating 6dB under the Master power:

Figure 6 Coverage and MCR for North sector during Common sub-frames

It can be seen that the Master Sector is well covered and the situation is better as compared with the Shared Frames, where all the systems transmit at the highest power. We recommend to keep the rule of the power transmission during the Common sub-frames and to increase the power during the Common sub-frames preceding a Master sub-frame at the Master sub-frame level (see Replay comment).

3 First deployed system

The 16h draft mentions rules related to the occupancy of the Master sub-frames, by the first, 2nd and third systems. However, in the case of systems deployed in adjacent geographical areas, is needed an interference threshold to determine what is the 1st, 2nd and 3d system.
We propose the following rule:
"If during the CXCC slot for interference assessment the interference level measured by a Base Station is less than 1dB above the noise level, the corresponding Master sub-frame is considered "free". If a system assess that all the three Master sub-frames are "free", this system will be the first system in the area.

4 Interference tolerance limit

Fig. 4 shows the MCR at the cell limit, for Master systems. It can be seen the difference between a single Master system and a second system suffering from another Master interference. The difference in coverage at a

MCR corresponding to 16dB is aprox. double, corresponding to 8-9dB reciprocal interference. The Master tolerance to Slaves needs to be defined as a supplementary margin to the Master-Master interference.
We consider that at least a margin of 3dB is needed for tolerance to other Master systems which will reuse the Master sub-frame.

5 Influence of different channel sizes and powers

The Master sub-frame is reused by all the systems in the Community. Those systems may use different channel sizes (ex: 5, 10, 20MHz), but they will try to reuse the same interference separation in time domain.
As result the cumulated interference in a Master sub-frame and CXCC channel will give the cumulated interference image, including the adjacent channel influence. The interference domain needs to be seen as least as bi-dimensional. An example is shown below:

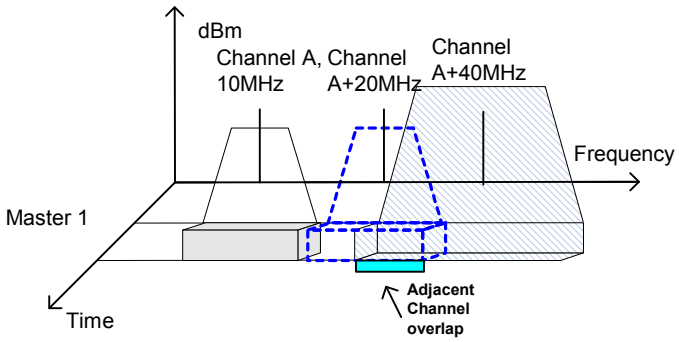

Figure 7 Interactions with the adjacent channel in the Master sub-frame

The system occupying the Master 1 sub-frame, due to its interference into the adjacent channel, may not be able to use the SMI for exchanging information.

6 Conclusions

1. The Master sub-frame is interfered by other Master sub-frames.
2. The power in the Common sub-frame preceding the Master sub-frame may be increased at the level of Master's power.
3. Shared sub-frames can use the max. power, however this creates cumulated interference drastically reducing the coverage. Same coverage can be achieved with less transmitted power.
4. The occupancy order depends on topology and different interference powers and channel widths
5. The adjacent channel interference is to be considered in establishing occupancy rules, especially when is made room for 802.11 systems with other Tx/Rx pattern as compared with 802.16 systems
6. The rules of the Master / Common / Shared slot occupancy should be based on general rules. The cases in which the inter-system communication can be used should be regarded as particular cases.