Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Interference Nulling in AAS**
Date Submitted	**2004-04-22**
Source(s)	Vladimir Yanover et al. Alvarion Ltd. 21 A Habarzel St. P.O. Box 13139, Tel-Aviv 61131, Israel Voice: +972-36457834 Fax: +972-36456222 mailto:vladimir.yanover@alvarion.com
Re:	802.16REVd/D4 Sponsor Ballot
Abstract	The document contains Sponsor Ballot comment information
Purpose	The document is contributed to support certain comment on 802.16REVd/D4 Sponsor Ballot
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 text 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 (Version 1.0) <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, if there is technical justification in the opinion of the standards-developing committee and provided the IEEE receives assurance from the patent holder that it will license applicants under reasonable terms and conditions for the purpose of implementing 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:r.b.marks@ieee.org> as early as possible, in written or electronic form, of any patents (granted or under application) that may cover technology that is under consideration by or has been approved by IEEE 802.16. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Interference Nulling in AAS

Vladimir Yanover, Tal Kaitz, Naftali Chayat (Alvarion Ltd.)

Suppose there is a cell using 802.16 technology based on OFDM modulation with capability of beamforming (Advanced Antenna System or AAS) at Base Station (BS). Downlink (DL) transmissions of the cell may cause interference to DL transmissions in close cells using same technology and operating at same frequency channel.

BS may decide to decrease interference by adjusting transmission power and/or AAS beamforming. The problem is to provide the BS with information on

- Timing of DL transmission in neighbor cells
- Estimation of path loss between the BS and subscriber stations (SSs) to which the transmissions are addressed
- Location of above SSs

1. Assumptions

The following are the assumptions:

- All cells operate at TDD with synchronized DL and uplink (UL) sub-frames
- DL transmissions must be scheduled one frame in advance (see Figure MMM), using unicast DL-MAP IEs.

2. Solution

DL-MAP Information Elements (DL IEs) specify location, modulation etc. of DL bursts. Then SS, after completion of DL-MAP Rx has already information on future DL transmissions to the SS.

BS shall allocate ***Allocation Indication Zone*** (AI Zone) starting at the beginning of UL sub-frame. This zone is intended for AI signals to be transmitted by SSs.

AI Zone is divided into AI transmission opportunities (TOs). Each transmission opportunity is specified as certain number N of consequent subcarriers over M symbol duration intervals. The TOs are numbered in the order “subcarriers first”. Such order provides 1-1 correspondence between TOs and DL allocations, so implicitly each TOs is allocated to certain SS (see example at Figure MMM).

1. Number of TOs in AI zone must be sufficient for maximum expected number of subsequent DL allocations.
2. If an SS receives a DL allocation, it transmits in the correspondent TO a subchannelized preamble or other well known waveform as e.g. focused contention, signal (with different combinations contention channel / code in each cell)
3. BS listens at AI TOs and thus collects AI information on future DL transmissions of SSs in neighbor cells, including their location, distance, path loss, transmit power. This information may be used later in DL beamforming to null interference for those SSs.

3. Specific changes in 802.16REVd/D4

[In 8.3.5.3.1, change in the Table 225—OFDM UIUC values]

UIUC	Usage
0	~~Reserved~~ AAS Allocation Indication Zone

[Insert a new section after 8.3.4.2, page 431 line 7]

8.3.4.3 Optional AAS Allocation Indication Feature

This section describes optional AAS Allocation Indication Feature that provides tools for mitigation of interference caused by the BS to DL transmissions at neighbor cells assuming the BS has capability of beamforming.

One of scenarios includes the following assumptions:

1. All cells operate at TDD at the same frequency channel
2. DL and UL sub-frames of all cells are synchronized
3. All DL allocations are multiples of N OFDM symbols where N is a parameter, which must be configured over network management; default N = 2
4. DL transmissions to SSs under protection must be scheduled one frame in advance (see Figure MMM), using unicast DL-MAP IEs.

Then all or some BSs may be configured to use AAS Allocation Indication Feature: each BS may allocate at the beginning of UL sub-frame AAS Allocation Indication Zone (AI Zone) using UIUC = 0. AI Zone allocation covers all subchannels. BS may decide to provide such allocation to protect certain SSs, which will be destination of DL transmissions at the following DL sub-frame. So AI Zone may appear in some or all frames. Maximum duration of AI Zone is configured over network management system and is known to all BSs.

AI Zone is logically divided into AI Transmission Opportunities (TOs). Each transmission opportunity is specified as a single subchannel over 2 OFDM symbols. In each TO a SS may transmit AI signal which is a subchannelized preamble cyclically extended to 2 OFDM symbols. The TO shall be numbered in the order “subchannels first” according to table 192. Such ordering provides 1-1 correspondence between each TO and a group of consequent OFDM symbols at the next DL sub-frame, not including initial preamble. For example, if N = 10 then 1st TO corresponds to first 10 symbols in DL sub-frame. Each SS, if received allocation in DL-MAP, shall transmit AI signal in TOs corresponding to the allocation. For example, (see Figure MMM) if DL allocations are to SSs #2, #3 and #6 and so are AI TOs. As allocation to SS #6 is 2*N symbols long, SS transmits in 2 consequent TOs.

BS receives AI signals from SSs that could belong to different cells. Processing of the signals provides the BS with information on location of the SSs and timing of following DL transmission to the SSs from their BSs. Then the BS may decide to adjust DL beams and/or transmitting power when transmitting within those time intervals and thus mitigate the interference caused to transmissions from neighbor BSs to their SSs.

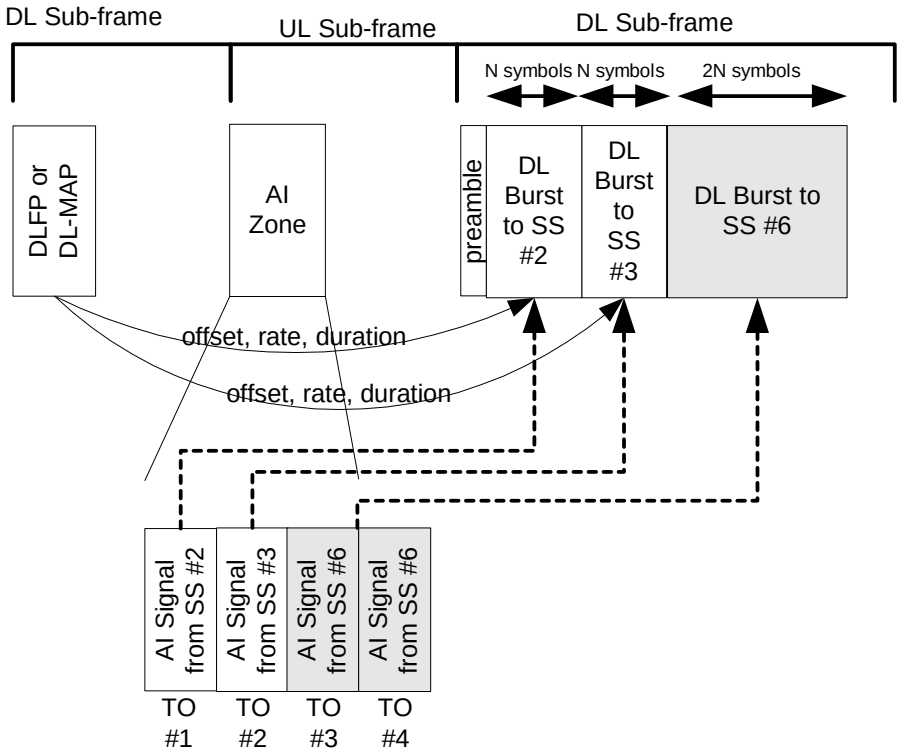

Figure MMM. Correspondence between AI TOs and DL allocations

4. References

[1] IEEE Standard for Local and metropolitan area networks, Part 16: Air Interface for Fixed Broadband Wireless Access Systems IEEE P802.16-REVd