Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Clarifications to OFDMA CDMA Ranging**
Date Submitted	**2004-08-20**
Source(s)	Ran Yaniv, Tal Kaitz **Alvarion Ltd.**
	Voice: +972-37674583 mailto: ran.yaniv@alvarion.com
Re:	Call for comments, maintenance task group
Abstract	
Purpose	Adopt into maintenance 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>.

Clarifications to OFDMA CDMA Ranging

Ran Yaniv, Tal Kaitz
Alvarion

1 Problems with the current definition

1. The terms 'ranging subchannel' and 'ranging channel' are used interchangeably in the text. It should be clarified that a single ranging channel may exist in an UL OFDMA symbol, and this channel is comprised of one or more ranging subchannels.

2. The exact definition of 'ranging slot' is unclear. It should be clarified that a ranging slot corresponds to one time-frequency transmission opportunity in which a single CDMA code is transmitted. Specifically, in the case of initial-ranging, a ranging slot is 1 ranging subchannel x 2 OFDMA symbols. In the case of periodic ranging, a ranging slot is 1 ranging subchannel x 1 OFDMA symbol.

3. The slot alignment is unclear. It should be clarified that a ranging transmission shall start on a ranging slot boundary. For example, if the ranging slot consists of 1 ranging subchannel x 2 OFDMA symbols, then a ranging transmission may commence at every 2nd OFDMA symbol.

4. The text occasionally refers to clocking the CDMA-code PRBS in multiples of 120, while the code length is 144.

5. The reference to *'the default case of two subchannels in the ranging channel'* on (page 582, section 8.4.7.3) is unclear, since a default case is not defined, and there is no case of transmitting a ranging code over two subchannels.

6. The definition of b0…b15 (section 8.4.7.3, page 581) is not consistent with figure 243.

2 Proposed Text Changes

Section 6.3.10.3:

[Modify section 6.3.10.3 as follows]

The WirelessMAN-OFDMA PHY specifies a ranging channel that consists of one or more ranging subchannels ~~Ranging Subchannel~~ and a set of special pseudonoise Ranging Codes. Subsets of codes shall be allocated in the UCD Channel Encoding for Initial Ranging, Periodic Ranging and Bandwidth Requests, such that the BS can determine the purpose of the received code by the subset to which the code belongs. A ranging slot is defined as a single ranging subchannel over one or two OFDMA symbols, depending on the

ranging type (see section 8.4.7). Ranging slots shall start on slot boundaries. An example of Ranging Channel in OFDMA frame structure is specified in Figure 218.

Section 6.3.10.3.1:

[Modify text in section 6.3.10.3.1, page 208 lines 11-16 as follows]

-- The SS, after acquiring downlink synchronization and uplink transmission parameters, shall choose randomly a Ranging Slot (with the use of a binary truncated exponent algorithm to avoid possible re-collisions) as the time and ranging subchannel in which to perform the ranging, then it chooses randomly a Ranging Code (from the Initial Ranging domain) and sends it to the BS (as a CDMA code).

Section 6.3.10.3.2:

[Modify text in section 6.3.10.3.2, page 212 lines 41-44 as follows]

-- The SS, shall choose randomly a Ranging Slot (with the use of a binary truncated exponent algorithm to avoid possible re-collisions) as the time and ranging subchannel in which to perform the ranging, then it chooses randomly a Ranging Code (from the Periodic Ranging domain) and sends it to the BS (as a CDMA code).

Section 8.4.7:

[Modify section 8.4.7 page 579 lines 18-29 as follows]

When used with the WirelessMAN-OFDMA PHY, the MAC layer shall define a single ranging channel. This ranging channel is composed of one or more ~~groups of six adjacent subchannels, where the groups are defined starting from the first subchannel~~ adjacent ranging subchannels, each defined as a group of six adjacent subchannels. The ranging subchannels are enumerated starting from the first subchannel. Optionally, a ranging subchannel can be composed of eight adjacent subchannels using the symbol structure defined in 8.4.6.2.5. The indices of the subchannels that compose the ranging channel are specified in the UL-MAP message. Users are allowed to collide on this ranging channel. To effect a ranging transmission, each user randomly chooses one ranging code from a bank of specified binary codes and a ranging slot. A ranging slot is defined as a single ranging subchannel over one or two consecutive OFDMA symbols (depending on the ranging type), in which a single distinct code is transmitted. The slots in the ranging region shall be aligned to slot boundaries. ~~These codes are~~The code is then BPSK modulated onto the subcarriers of each symbol in the ranging slot ~~in the ranging channel~~, one bit per subcarrier (subcarriers used for ranging shall be modulated with the waveform specified in 8.4.7.1/8.4.7.2 and are not restricted to any time grid specified for the the data subchannels).

Section 8.4.7.1:

[Modify section 8.4.7.1 starting on page 579 line 33 up to page 580 line 3, as follows]

The initial ranging transmission shall be used by any SS that wants to synchronize to the system channel for the first time. An initial ranging slot occupies a single ranging subchannel over two consecutive OFDMA symbols. An initial-ranging transmission shall be performed on a single ranging slot ~~during two consecutive symbols~~. The same ranging code is transmitted on the ranging subchannel during each symbol, with no phase discontinuity between the two symbols. A time-domain illustration of the initial-ranging transmission is shown in Figure 239.

~~The~~ Alternatively, the BS can allocate two consecutive initial ranging slots on the same ranging subchannel, onto those the SS shall transmit the two consecutive initial ranging codes (starting code shall always be a multiple of 2), as illustrated in Figure 240:

Section 8.4.7.2:

[Modify section 8.4.7.2, page 580 lines 33-41 as follows]

A ranging slot for periodic ranging/bandwidth-request occupies a single ranging subchannel over one OFDMA symbol. To perform either a periodic-ranging or bandwidth-request transmission, the SS can send a transmission in one of the following ways:
a) Modulate one ranging code on ~~the ranging subchannel~~ a single ranging slot ~~for a period of one OFDMA symbol~~. Ranging subchannels are dynamically allocated by the MAC layer and indicated in the UL-MAP. A time domain illustration of the periodic-ranging or bandwidth-request transmission is shown in Figure 241.

[Modify section 8.4.7.2, starting on page 580 line 62 up to page 581 line 3, as follows]

b) Modulating three consecutive ranging codes (starting code shall always be a multiple of 3) onto three consecutive ranging slots occupying the same ranging subchannel ~~on the ranging subchannel for a period of three OFDMA symbols (one code per symbol)~~. Ranging sub-channels are dynamically allocated by the MAC layer and indicated in the UL-MAP. A time-domain illustration of the periodic-ranging or bandwidth-request transmission is shown in Figure 242

Section 8.4.7.3:

[Modify section 8.4.7.3, page 581 lines 27-30 as follows]

The binary codes are the pseudonoise codes produced by the PRBS described in Figure 243, which implements the polynomial generator . The PRBS generator shall be initialized by the seed b0...b15 = 1,0,0,1,0,1,0,1,~~1,~~s0,s1,s2,s3,s4,s5,s6 where s6 is the MSB, and s6:s0 = UL_PermBase~~IDcell~~.

[Modify caption of figure 243, page 581 as follows]

Figure 243—PRBS for ranging code generation. Initialization sequence assumes UL_PermBase = 0.

[Modify section 8.4.7.3, page 581 lines 49-57 as follows]

The binary ranging codes are subsequences of the pseudonoise sequence appearing at its output . The length of each ranging code is 144 bits. These bits are used to modulate the subcarriers in a ranging subchannel ~~group of six (eight, for the permuttaion defined in 8.4.6.2.5) adjacent subchannels~~. The index of the lowest numbered subchannel in the ranging subchannel ~~six (eight, for the permuttaion defined in 8.4.6.2.5)~~ shall be an integer multiple of the number of subchannels in the ranging subchannel ~~six (eight, for the permuttaion defined in 8.4.6.2.5). The six (eight, for the permuttaion defined in 8.4.6.2.5) subchannels are called a ranging subchannel~~. The ranging subchannel is referenced in the ranging and Bandwidth Request messages by the index of its lowest numbered subchannel.

[Modify section 8.4.7.3, page 582 lines 1-16 as follows]

The number of available codes is 256, numbered 0..255. Each BS uses a sub-group of these codes, where the sub-group is defined by a number *S*, 0 S 255. The group of codes will be between *S* and *((S+N+M+L) mod 256)*.
— The first *N* codes produced are for initial-ranging and are obtained by clocking ~~For example, for the default case of two sub-channels in the ranging channel, clock~~ the PRBS ~~*120*~~ *144* x *(S mod 256)* times to ~~*120*~~ *144* *x ((S + N) mod 256) – 1* times.
— The next *M* codes produced are for periodic-ranging and are obtained by clocking ~~For example, for the default case of two sub-channels in the ranging channel, clock~~ the PRBS ~~*120*~~ *144* *x ((N + S) mod 256)* times to ~~*120*~~ *144* *x ((N + M + S) mod 256) -1* times.

— The next *L* codes produced are for bandwidth-requests and are obtained by clocking ~~For example, for the default case of two sub-channels in the ranging channel, clock~~ the PRBS ~~*120*~~ *144 x ((N + M + S) mod 256)* times to ~~*120*~~ *144 x ((N + M + L + S) mod 256) -1* times.