Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	Enhanced initial ranging and BW request ranging	
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Re:	IEEE P802.16e/D4-2004	
Abstract	This contribution proposes to add a new IE to allow the BS to acknowledge successful reception of CDMA code and to assign a CDMA access ID to refer to the specific ranging attributes used by the MSS. The CDMA access ID is used to identify the MSS when sending the Enhanced CDMA_Alloc_IE. This contribution reduces the ranging overhead and allows BS the flexibility in assigning UL resource. Revision is marked in 'green'.	
Purpose	Review and Adopt the suggested changes into P802.16e/D4	
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1 Introduction

In the current 802.16e standard, the CDMA based ranging method is defined for OFDMA PHY, where a MSS can transmit a code on ranging channel for different purposes.

For the initial ranging case, a MSS transmits an initial ranging code, and then the BS transmits RNG-RSP with timing and power adjustment and ranging status. At the point where the RNG-RSP is sent with 'ranging status = success', the BS sends a CDMA Allocation IE to assign dedicated UL resource for the MSS to continue performing ranging (sending RNG_REQ message). In RNG-RSP message, since the BS cannot tell which MSS sent the CDMA initial ranging code, the BS broadcast the RNG-RSP message that advertises the ranging code attributes that it receives: received CDMA ranging code index (8 bits) as well as ranging slot (8 bits of LSB of frame number, 6 bits of subchannel reference and 10 bits of OFDM time symbol reference) (refer to section 6.3.10.3.1). Due to the same reason, the CDMA_Allocation IE also needs to indicate the similar ranging attributes: 8 bits of ranging code index, 8 bits of ranging symbol and 7 bits of subchannel. Thus, those ranging attributes are used twice over the air which causes unnecessary overhead. In addition, both MSS and BS must keep the record regarding the ranging attribute which cause additional implementation complexity (refer to Fig.1).

For the BW request case, the MSS transmits a BW request code, after the code is detected, a BS sends the CDMA_Allocation IE to assign the UL resource for the MSS to send BW request header or UL traffic. However, in some case, the BS may not have sufficient UL resource to assign to the MSS immediately after the detection of the BW request code. This requires that the BS delay sending CDMA Allocation IE and may cause the MSS to perform a retrial.

2 Proposed Enhancements

In this contribution, a simple solution is proposed:

- Define a CDMA Ack IE which is used to acknowledge a successful CDMA code detection (it means that the timing, power and frequency of a code transmission is within an acceptable ranging)
- Introduce CDMA_Access_ID which uniquely identifies a specific ranging attributes
- Introduce an optional TLV of CDMA_Access_ID to RNG-RSP message
- Define an Enhanced CDMA Allocation IE which is used to allocate UL resource to a MSS whose code transmission has been pre-acknowledged by CDMA_Ack IE or by RNG-RSP with CDMA_Access_ID assigned
- Define the following procedure
    - For the initial ranging case (refer to Fig. 2):
        - A MSS transmits an initial ranging code
        - BS then sends RNG-RSP for timing, power and frequency correction
        - At the point where the timing, power and frequency are within an acceptable range, the BS either sends CDMA_Ack IE to acknowledge the successful ranging or sends RNG-RSP message with 'ranging status' being set to 'success'. In CDMA_Ack IE or RNG-RSP message, the CDMA_Access_ID may be assigned. The one-to-one relation thus is established between the MSS who sent a CDMA code using Ranging Attributes parameters indicated in CDMA_Ack IE/RNG-RSP message and the CDMA_Access_ID
        - A BS then can assign UL resource to the MSS to send RNG-REQ message by sending Enhanced_CDMA_Allocation IE, which uses CDMA_Access_ID to identify the MSS
        - The MSS then use to the assigned UL resource to send RNG-REQ message.
        - At the MSS side, upon obtaining basic CID, the CDMA_Access_ID is automatically de-allocated. At the BS side, upon receiving the first message with the assigned basic CID, the CDMA_Access_ID is automatically de-allocated
    - For the BW request case (refer to Fig.3):
        - A MSS sends a BW request code
        - A BS, upon receives the code transmission, sends either CDMA_Allocation IE if there is sufficient UL resource or sends CDMA_Ack IE if there is no sufficient UL resource. The CDMA_Ack IE shall include the CDMA_Access_ID assigned to the MSS whose code transmission has been received
        - For the case where the BS sends CDMA_Ack IE, the BS can send Enhanced_CDMA_Allocation IE later to the MSS to assign UL resource

- At the MSS side, upon receiving dedicated UL resource allocation requested by BW request MAC header the CDMA_Access_ID is automatically de-allocated. At the BS side, upon receiving the BW request MAC header, the CDMA_Access_ID is de-allocated

The proposed method provides more flexibility of handling the CDMA ranging procedure with reduced overhead and reduced implementation complexity.

The following figures present the problem identified and the corresponding solution proposed in this contribution.

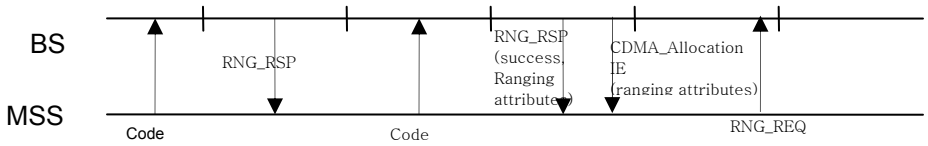

Fig. 1. Current initial ranging procedure.

Based on the current standard, BS must use CDMA Allocation IE in the frame following the frame where a CDMA code transmission of a MSS was detected and the timing, power and frequency of this code transmission are at an acceptable level, although it may not be a best time to assign UL resource for sending RNG_REQ message by this MSS.

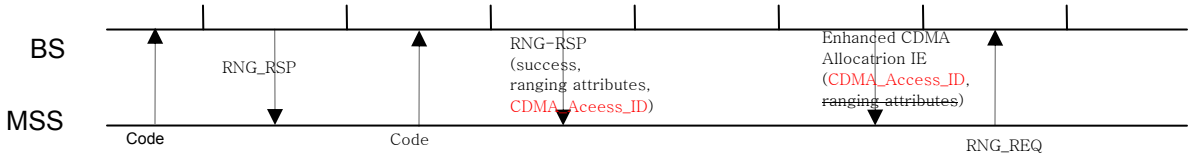

Fig. 2. Proposed initial ranging procedure.

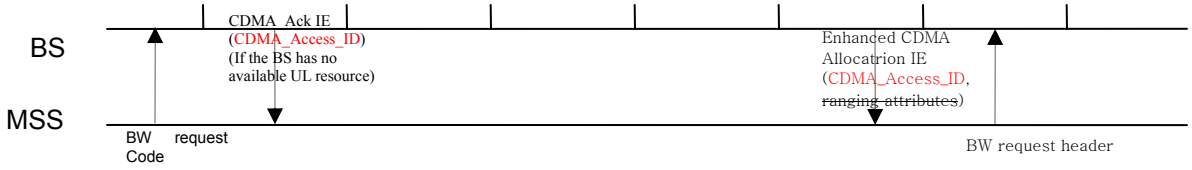

Fig.3. Proposed BW request ranging procedure.

By this proposal, the overhead is reduced by introducing the CDMA_Access_ID and also, a BS is allowed to send CDMA Ack IE first to acknowledge the successful code detection if there is not enough UL resource to assign at that time. The BS may assign UL resource to the MSS later when resource is available. This solution provides BS a more flexibility to handle resource management.

3 Proposed Text Changes

The following modification is based on p802.16e/D4.

[Insert the following sentence into the end of 6.3.2.3.6]

For OFDMA PHY, the following TLV may be included if the ranging status TLV is set to 'success':

CDMA_Access_ID (see 11.6 Table 365a) TLV is used to identify a MSS who has sent the CDMA code in the ranging slot identified by Ranging Attribute TLV field.

[Modify the section 6.3.6.5]

[…]

As specified in 6.3.10.3, the OFDMA-based PHY specifies a Ranging Subchannel and a subset of Ranging codes that shall be used for contention-based Bandwidth Requests. The SS, upon needing to request bandwidth, shall select, with equal probability, a Ranging Code from the code subset allocated to Bandwidth Requests. This Ranging Code shall be modulated onto the Ranging Subchannel and transmitted during the appropriate uplink allocation.

Upon detection, the BS shall perform one of the following two procedures. In the first procedure, the BS shall provide (an implementation dependent) uplink allocation for the SS, but instead of indicating a Basic CID, the broadcast CID shall be sent in combination with a CDMA_Allocation_IE, which specifies the transmit region and Ranging Code that were used by the SS. This allows an SS to determine whether it has been given an allocation by matching these parameters with the parameters it used. The SS shall use the allocation to transmit a Bandwidth Request MAC PDU and/or data. The SS may only omit the Bandwidth Request PDU when the BS indicated so in the CDMA_Allocation_IE (see Table 288). Alternatively, the BS shall send the CDMA_Ack IE to only acknowledge the successful detection of Bandwidth Request ranging from the MSS. The BS does not need to provide uplink allocation for the SS immediately. The BS can provide uplink allocation for the MSS by using Enhanced_CDMA_Allocation IE later when there is available UL resource.

If the BS does not issue the uplink allocation described above, or the BS does not send the CDMA_Ack_IE, or the Bandwidth Request MAC PDU does not result in a subsequent allocation of any bandwidth, the SS shall assume that the Ranging Code transmission resulted in a collision and follow the contention resolution as specified in 6.3.8.

[…]

[Modify the section 6.3.10.3.1]

[…]

A SS that wishes to perform initial ranging shall take the following steps,

- 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 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).
- The BS cannot tell which SS sent the CDMA ranging request, therefore upon successfully receiving a CDMA Ranging Code, the BS broadcasts a Ranging Response message that advertises the received Ranging Code as well as the ranging slot (i.e., OFDMA symbol number, subchannel, etc) where the CDMA ranging code has been identified. This information is used by the SS that sent the CDMA ranging code to identify the Ranging Response message that corresponds to its ranging request. The Ranging Response message contains all the needed adjustment (e.g., time, power and possibly frequency corretions) and a status notification.
- When the BS receives an initial-ranging CDMA code ~~that results in sending~~ transmission with acceptable time, power and frequency, the BS may send an RNG-RSP message with success status and in this case the BS shall provide BW allocation for the SS using CDMA_Allocation IE to the MSS to send an RNG-REQ message. Alternatively, the BS can send the CDMA_Ack IE to only acknowledge the successful ranging. The BS does not need to provide BW allocation for the SS immediately. The BS can provide BW allocation for the MSS by using Enhanced_CDMA_Allocation IE later when there is available UL resource.
- Upon receiving Ranging Response message with continue status, the SS shall continue the ranging process as done on the first entry with ranging code randomly chosen from the ~~Periodic~~ Initial Ranging domain.
- ~~Using the OFDMA ranging mechanism, the periodic ranging timer is controlled by the SS, not the BS.~~

[…]

[Add Section 8.4.5.4.21 CDMA Ack Information Element]

Table xxx-CDMA Ack IE Format

Syntax	Size	Notes
CDMA_Ack_IE() {		
Extended UIUC	4 bits	CDMA_ACK = 0x06
Length	4 bits	Length of the message in bytes
Ranging Code	8 bits	
Ranging Symbol	8 bits	
Ranging Subchannel	7 bits	
CDMA_Access_ID	8 bits	
reserved	1 bits	Padding bits to ensure octet aligned
}		

[Add section 8.4.5.4.22 Enhanced CDMA Allocation Information Element]

Table xxx-Enhanced CDMA Allocation IE Format

Syntax	Size	Notes
Enhanced CDMA_Allocation_IE() {		
Extended UIUC	4 bits	CDMA_ACK = 0x07
Length	4 bits	Length of the message in bytes
Num_assignments	4 bits	
For (i = 0; i <Num_assignments; i++) {		
CDMA_Access_ID	8 bits	
Duration	6 bits	
UIUC	4 bits	
Repetition Coding Indication	2 bits	0b00 – No repetition coding 0b01 – Repetition coding of 2 used 0b10 – Repetition coding of 4 used 0b11 – Repetition coding of 6 used
}		
reserved	variable	Padding bits to ensure octet aligned
}		

[Add one row in Table 365a]

Table 365a-RNG-RSP Message Encodings

Name	Type (1 byte)	Length	Value
CDMA_Access_ID	XX	1	This value is assigned as CDMA_Access_ID