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Re:	802.16-REVd Sponsor ballot recirc	
Abstract	Text modifications to provide clarifications for OFDMA PHY initial ranging	
Purpose	Adopt suggested changes into P802.16-REVd/D4 draft	
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Initial Ranging clarifications for OFDMA PHY

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General

The motivation of the proposed changes is to add editorial clarifications for the OFDMA initial ranging process, which is currently ambiguously described in the standard.

Editorial instruction is indicated by a **red bold** text with square brackets. Deletions are indicated by a ~~strikethrough~~ text and new text insertion is indicated by an underline.

Proposed changes

[Modify the text in section 6.3.5.9 page 156, line 50 to page 158, line 24 as shown below]

6.3.5.9 Initial ranging and automatic adjustments

Ranging is the process of acquiring the correct timing offset and power adjustments such that the SS's transmissions are aligned to a symbol that marks the beginning of a minislot boundary in SC and Sca PHY, or aligned with the BS receive frame for OFDM and OFDMA PHY, and received within the appropriate reception thresholds. The timing delays through the PHY shall be relatively constant. Any variation in the PHY delays shall be accounted for in the guard time of the uplink PHY overhead.

[Insert new section header 6.3.5.9.1]

6.3.5.9.1 Contention based Initial ranging and automatic adjustments

First, an SS shall synchronize to the downlink and learn the uplink channel characteristics through the UCD MAC management message. At this point, the SS shall scan the UL-MAP message to find an Initial Ranging Interval. The BS shall allocate an Initial Ranging Interval consisting of one or more transmission opportunities. For SC, SCa and OFDM PHY, ~~T~~the size of each transmission opportunity shall be as specified by the UCD TLV, Ranging request opportunity size.

For SC, SCa and OFDM PHY, ~~T~~the SS shall put together a RNG-REQ message to be sent in an Initial Ranging Interval. The CID field shall be set to the noninitialized SS value (zero). For the OFDMA PHY, the initial ranging process shall begin by sending initial-ranging CDMA codes on the UL allocation dedicated for that purpose (for more details see section 6.3.10.3), instead of RNG-REQ messages sent on contention slots.

Ranging adjusts each SS's timing offset such that it appears to be colocated with the BS. The SS shall set its initial timing offset to the amount of internal fixed delay equivalent to colocating the SS next to the BS. This amount includes delays introduced through a particular implementation and shall include the downlink PHY interleaving latency, if any.

When the Initial Ranging transmission opportunity occurs, the SS shall send the RNG-REQ message (or a CDMA code in case of the OFDMA PHY). Thus, the SS sends the message as if it were colocated with the BS.

The SS shall calculate the maximum transmit signal strength for initial ranging, $P_{TX\_IR\_MAX}$, from:

$$P_{TX\_IR\_MAX} = EIRxP_{IR,max} + BS\_EIRP - RSS \quad (1)$$

where the $EIRxP_{IR,max}$ and BS_EIRP are obtained from the DCD, and RSS is the measured RSSI, by the SS, as described in the respective PHY.

In the case that the receive and transmit gain of the SS antennae are substantially different, the SS shall use the equation:

$$P_{TX\_IR\_MAX} = EIRxP_{IR,max} + BS\_EIRP - RSS + (G_{Rx\_SS} - G_{Tx\_SS}). \quad (2)$$

where

— G_{Rx_SS} is the SS receive antenna gain
— G_{Tx_SS} is the SS transmit antenna gain

In the case that the $EIRxP_{IR,max}$ and/or BS_EIRP are/is not known, the SS shall start from the minimum transmit power level defined by the BS

NOTE—The $EIRxP_{IR,max}$ is the maximum equivalent isotropic received power, which is computed for a simple single-antenna receiver as $RSS_{IR,max}$ - GANT_BS_Rx, where the $RSS_{IR,max}$ is the received signal strength at antenna output and GANT_BS_Rx is the receive antenna gain. The BS_EIRP is the equivalent isotropic radiated power of the base station, which is computed for a simple single-antenna transmitter as P_{Tx} + GANT_BS_Tx, where P_{Tx} is the transmit power and GANT_BS_Tx is the transmit antenna gain.

For SC, SCa and OFDM PHY, ~~T~~the SS shall send the RNG-REQ at a power level below $P_{TX\_IR\_MAX}$, measured at the antenna connector. If the SS does not receive a response, the SS shall resend the RNG-REQ at the next appropriate Initial Ranging transmission opportunity at one step higher power level. If the SS receives a response containing the frame number in which the RNG-REQ was transmitted, it shall consider the transmission attempt unsuccessful but implement the corrections specified in the RNG-RSP and issue another RNG-REQ message after the appropriate backoff delay. If the SS receives a response containing its MAC Address, it shall consider the RNG_RSP reception successful.

When a WirelessMAN-SCa or WirelessMAN-OFDM BS detects a transmission in the ranging slot that it is unable to decode, it may respond by transmitting a RNG-RSP that includes transmission parameters but identifies the frame number and frame opportunity when the transmission was received instead of the MAC Address of the transmitting SS.

For OFDMA, the SS shall send a CDMA code at a power level below $P_{TX\_IR\_MAX}$., measured at the antenna connector. If the SS does not receive a response, the SS shall send a new CDMA code at the next appropriate Initial Ranging transmission opportunity at one step higher power level. If the SS receives a RNG-RSP message containing the parameters of the code it has transmitted and status continue, it shall consider the transmission attempt unsuccessful but implement the corrections specified in the RNG-RSP and issue another CDMA code after the appropriate backoff delay. If the SS receives an UL-MAP containing a CDMA allocation IE with the parameters of the code it has trans-

mitted, it shall consider the RNG_RSP reception successful, and proceed to send a unicast RNG-REQ on the allocated BW. More details on this procedure can be found in 6.3.10.3.

Once the BS has successfully received the RNG-REQ message, it shall return a RNG-RSP message using the initial ranging CID. Within the RNG-RSP message shall be the Basic and Primary Management CIDs assigned to this SS. The message shall also contain information on RF power level adjustment and offset frequency adjustment as well as any timing offset corrections. At this point the BS shall start using invited Initial Ranging Intervals addressed to the SS's Basic CID to complete the ranging process, unless the status of the RNG-RSP message is success, in which case the initial ranging procedure shall end.

If the status of the RNG-RSP message is continue, ~~T~~the SS shall now wait for an individual Initial Ranging interval assigned to its Basic CID. Using this interval, the SS shall transmit another RNG-REQ message using the Basic CID along with any power level and timing offset corrections.

The BS shall return another RNG-RSP message to the SS with any additional fine tuning required. The ranging request/response steps shall be repeated until the response contains a Ranging Successful notification or the BS aborts ranging. Once successfully ranged (RNG-REQ is within tolerance of the BS), the SS shall join normal data traffic in the uplink. In particular, state machines and the applicability of retry counts and timer values for the ranging process are defined in Table 295.

NOTE—The burst profile to use for any uplink transmission is defined by the Uplink Interval Usage Code (UIUC). Each UIUC is mapped to a burst profile in the UCD message.

For SC, SCa and OFDM PHY, ~~T~~Uhe message sequence chart (Table 101) and flow charts (Figure 83, Figure 84, Figure 85, and Figure 4) on the following pages define the ranging and adjustment process which shall be followed by compliant SSs and BSs. For OFDMA PHY, these details can be found in 6.3.10.3.

[Modify the text in section 6.3.10.3 page 186, line 57 as shown below]

6.3.10.3 OFDMA-based ranging

The WirelessMAN-OFDMA PHY specifies a 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. An example of Ranging Channel in OFDMA frame structure is specified in Figure 213.

SSs that wish to perform one of the aforementioned operations shall select, with equal probability, one of the codes of the appropriate subset, modulate it onto the Ranging Subchannel and subsequently transmit in a ~~with equal probability selected (pair of) OFDMA symbol(s) within the appropriate uplink allocation~~ranging slot selected with equal probability from the available ranging slot on the UL sub-frame. Details on the modulation and Ranging Codes are specified in 8.4.7.

6.3.10.3.1 Contention based initial ranging and automatic adjustments

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 corrections) and a status notification.

— When the BS receive an initial-ranging CDMA code, that results in sending a RNG-RSP message with success status, the BS shall allocate BW for the SS, using the CDMA_Allocation_IE, to send a RNG-REQ message.

— Upon receiving Ranging Response message with continue status, the SS shall continue the ranging process as done on the first entry with ranging codes randomly chosen from the Periodic Ranging domain.

— Using the OFDMA ranging mechanism, the ~~periodic~~initial ranging timer is controlled by the SS, not the BS.

— ~~The BS may send an unsolicited RNG-RSP as a response to a CDMA-based bandwidth-request.~~

— ~~When the SS receives an unsolicited RNG-RSP message after transmitting the bandwidth-request code, it shall reset the periodic ranging timeout, adjust the parameters (timing and power, etc.) as notified in the RNG-RSP message.~~

Adjustment of local parameters (e.g., transmit power) in an SS as a result of the receipt (or nonreceipt) of a RNG-RSP is considered to be implementation-dependent with the following restrictions:

a) All parameters shall be within the approved range at all times.

b) Power adjustment shall start from the initial value selected with the algorithm described in 6.3.5.9 unless a valid power setting is available from nonvolatile storage, in which case this value may be used as the starting point.

c) Power adjustment shall be capable of being reduced or increased by the specified amount in response to RNG-RSP messages.

d) If, during initialization, power is increased to the maximum value (without a response from the BS) it shall wrap back to the minimum

On receiving a RNG-RSP, the SS shall not transmit until the RF signal has been adjusted in accordance with the RNG-RSP and has stabilized.

The message sequence chart (Table 101) and flow charts (Figure 83, Figure 84, and Figure 85) on the following pages define the ranging and adjustment process which shall be followed by compliant SSs and BSs.

[Insert new table 101]

Table 101—CDMA Ranging and automatic adjustments procedure

BS		SS
[time to send the CDMA Initial Ranging opportunity]		
send map containing CDMA Initial Ranging IE with a broadcast Connection ID	----------UL-MAP---------->	
	<---------Ranging Code-------	Transmit randomly selected Initial Ranging code in a randomly selected Ranging Slot from available Ranging Region
[Receive Ranging Code]		

Table 101—CDMA Ranging and automatic adjustments procedure (Continued)

BS		SS
Send RNG-RSP with Time & Power Corrections and original Ranging Code and Ranging Slot Status = Continue		
	----------RNG-RSP------->	
		Receive RNG-RSP message with Ranging Code and Ranging Slot matching sent values Adjust Time & Power parameters
[time to send the CDMA Initial Ranging opportunity]		
send map containing CDMA Initial Ranging IE with a broadcast Connection ID	----------UL-MAP---------->	
	<---------Ranging Code-------	Transmit randomly selected Periodic Ranging code in a randomly selected Ranging Slot from available Ranging Region
[Receive Ranging Code]		
Send RNG-RSP with Time & Power Corrections and original Ranging Code and Ranging Slot Status = Success		
	----------RNG-RSP------->	
		Receive RNG-RSP message with Ranging Code and Ranging Slot matching sent values Adjust Time & Power parameters
[time to send the next map]		
send map containing anonymous BW allocation with original Ranging Code and Ranging Slot	----------UL-MAP---------->	
	<---------RNG-REQ-------	Transmit RNG-REQ and continue with regular Initial network entry

[Insert new figures 83-85]

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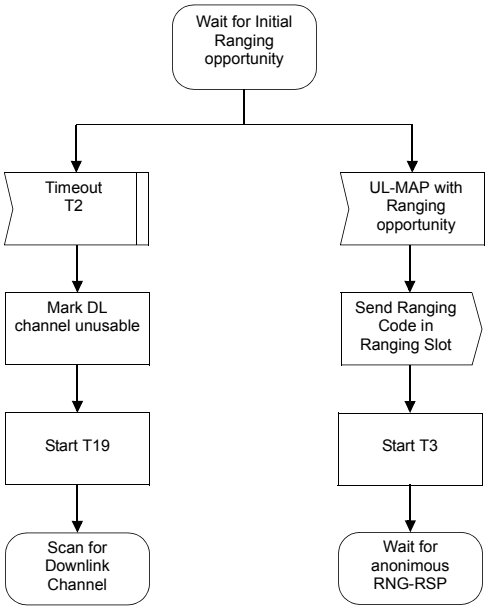
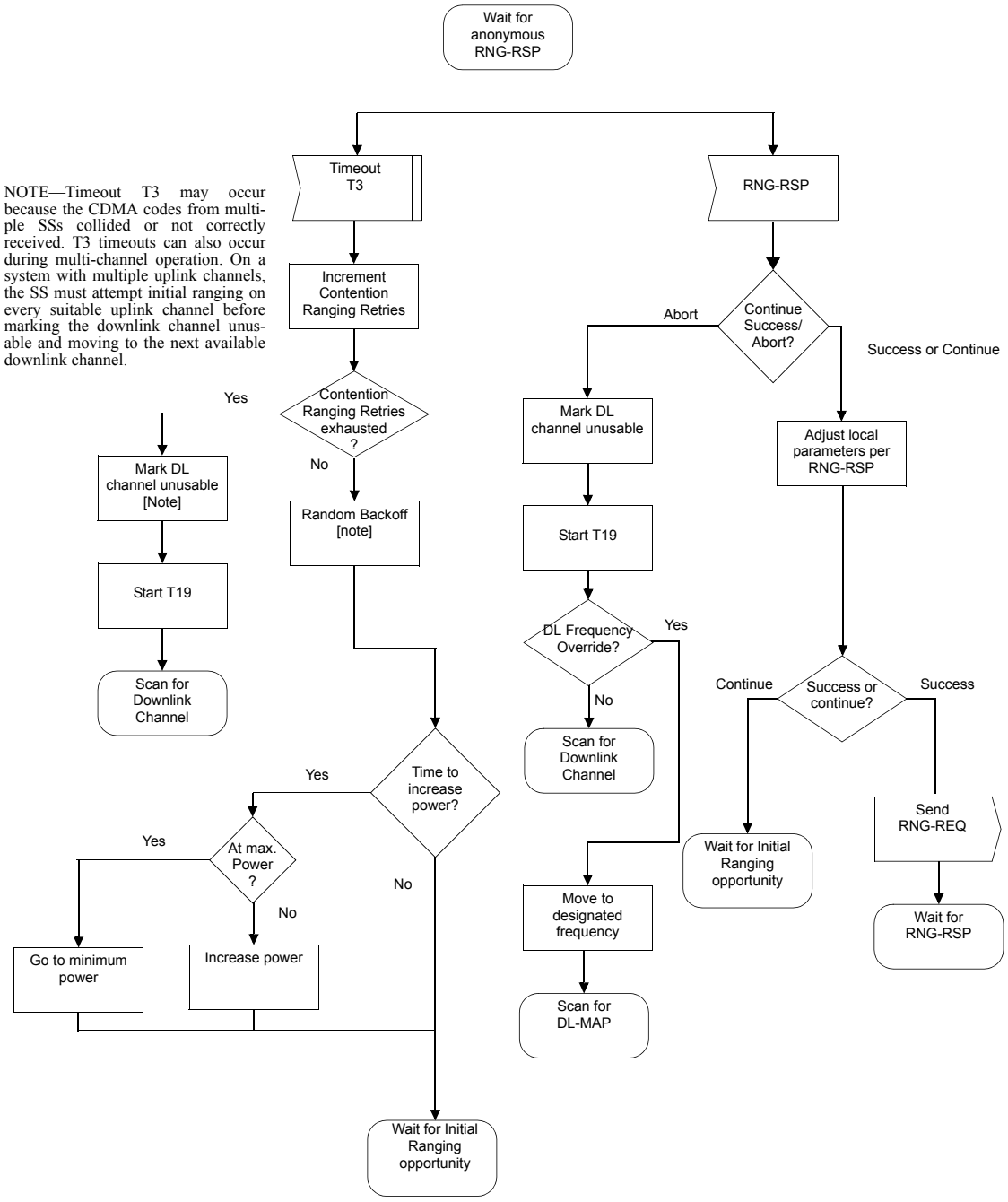


Figure 83—CDMA Initial Ranging—SS (part 1)



NOTE—Timeout T3 may occur because the CDMA codes from multiple SSs collided or not correctly received. T3 timeouts can also occur during multi-channel operation. On a system with multiple uplink channels, the SS must attempt initial ranging on every suitable uplink channel before marking the downlink channel unusable and moving to the next available downlink channel.

Figure 84—CDMA Initial Ranging—SS (part 2)

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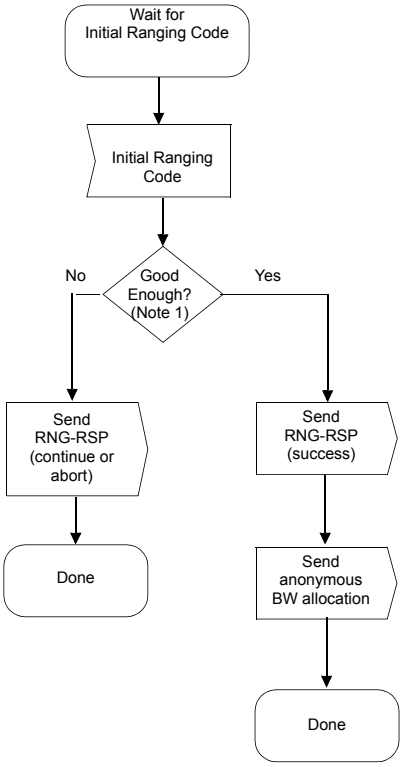


NOTE 1—Means ranging is within the tolerable limits of the BS.

Figure 85—CDMA Initial Ranging—BS

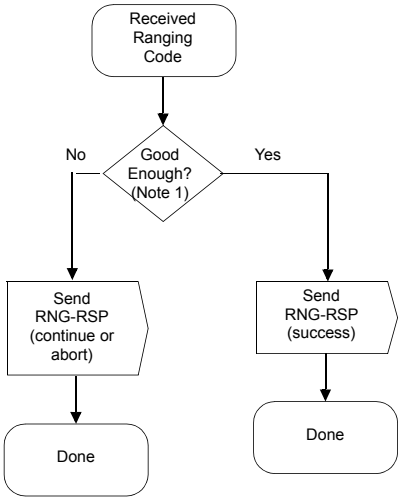
[Insert new section header 6.3.10.3.2 on page 187, line 32]

6.3.10.3.2 Periodic ranging and automatic adjustments

A SS that wishes to perform periodic ranging shall take the following steps, - 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 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).

- 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 corrections) and a status notification.
- Upon receiving Ranging Response message with continue status, the SS shall continue the ranging process with further ranging codes randomly chosen from the Periodic Ranging domain.
- Using the OFDMA ranging mechanism, the periodic ranging timer is controlled by the SS, not the BS.
- The BS may send an unsolicited RNG-RSP as a response to a CDMA-based bandwidth-request, or any other data transmission from the SS.
- When the SS receives an unsolicited RNG-RSP message, it shall reset the periodic ranging timer and adjust the parameters (timing and power, etc.) as notified in the RNG-RSP message.

[Modify existing figure 84, on page 188, line 38 as follows]



NOTE 1—Means ranging is within the tolerable limits of the BS.

Figure 86—Periodic ranging—Received ranging code—BS