

Project	IEEE 802.16 Broadband Wireless Access Working Group < http://ieee802.org/16 >	
Title	Ranging in MMR System	
Date Submitted	2007-01-08	
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Re:	This is a response to Call for Technical Proposals issued by IEEE 802.16j.	
Abstract	Ranging scheme in MMR system is defined in this contribution.	
Purpose	The objective of this contribution is to propose ranging scheme for MMR system.	
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Ranging in MMR System

1. Introduction

Existed ranging scheme is not suitable for MMR system, because RS doesn't exist in previous standard. So we have to define new ranging scheme suitable for MMR system by modifying existed one. The objective of this document is to define new ranging scheme.

In this document, we assume that RS has the ability to perform all functions of MS like network entry, initialization, and etc.

2. Ranging of RS

Ranging of RS is same to one of MS in previous standard (IEEE 802.16e-2005). But, in the case of initial ranging, RS uses the initial ranging CID for RS in RNG-REQ message. So BS can distinguish between RNG-REQ messages from MS and RS. And if needed, optional TLV, CDMA code allocation, can be added at second RNG-RSP message in initial ranging. Figure 1 simply describes the initial ranging of RS.

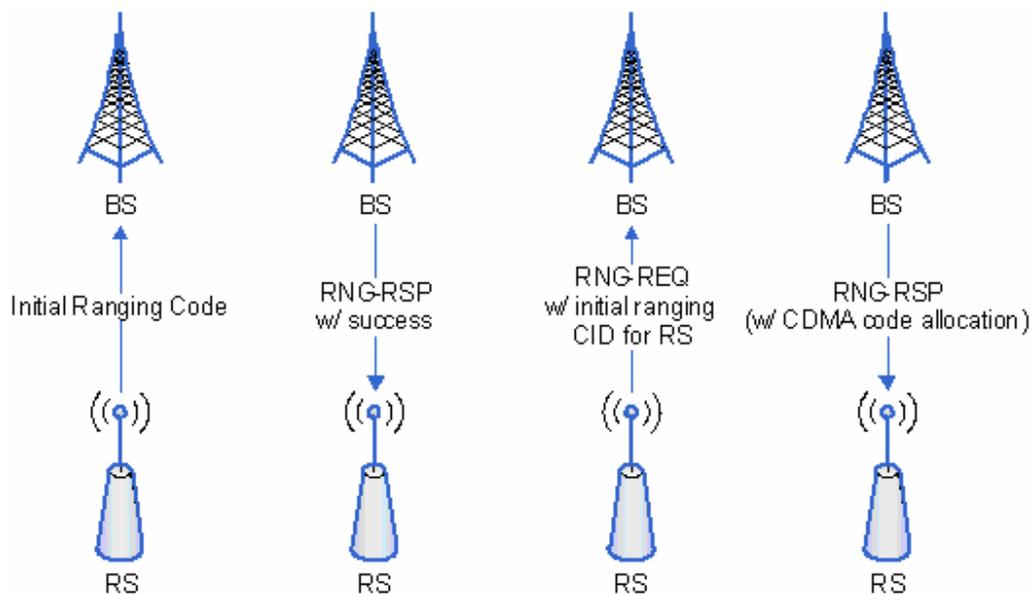


Figure 1—Initial ranging of RS

3. Ranging of MS in relay mode

3.1 Relaying support of RS

Because multi-hop MS/RS cannot directly communication with BS, they shall be supported by RS. Figure 2 simply describes the procedure of relaying ranging code from MS in relay mode.

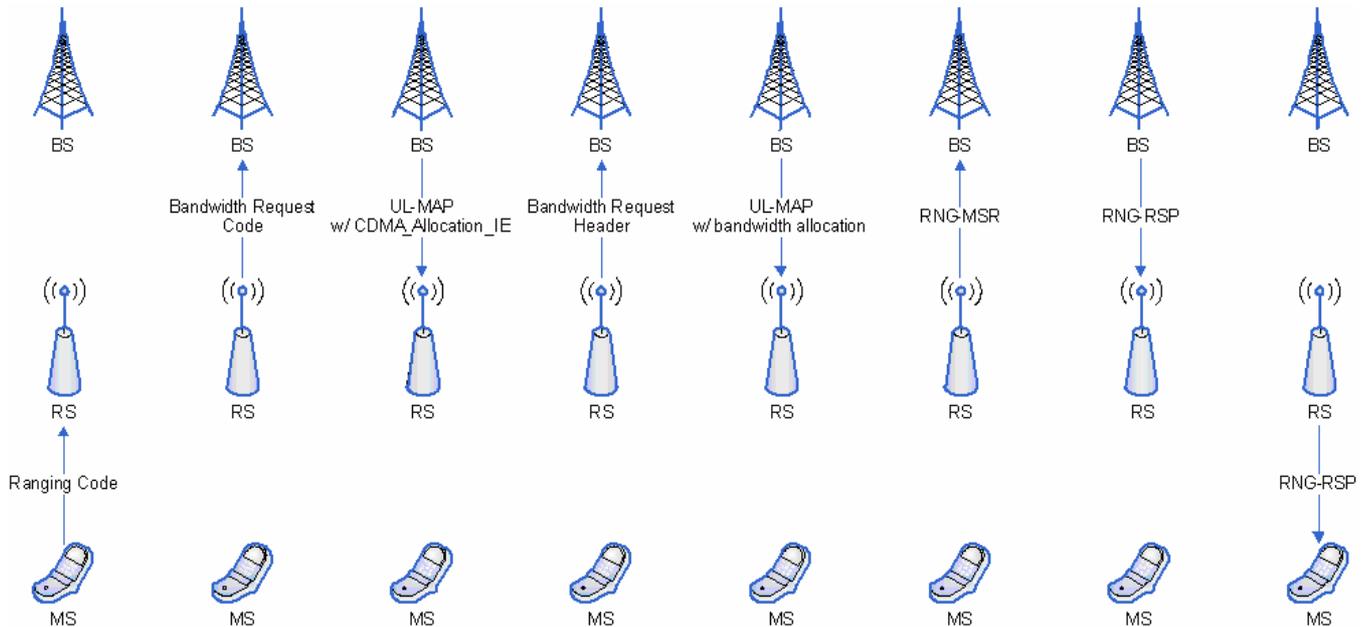


Figure 2—The procedure of ranging in relay mode

Because of the procedure of bandwidth request, the latency of this method is unpredictable.

The procedure is that:

- MS (or RS) sends ranging code to RS.
- RS measures the value of adjustment of received codes and sends bandwidth request code to BS to transmit bandwidth request header.
- BS broadcast UL-MAP with CDMA_Allocation_IE.
- RS sends bandwidth request header to BS to transmit RNG-MSR.
- BS broadcast UL-MAP with bandwidth allocation for RS to transmit RNG-MSR.
- RS sends RNG-MSR with the measured value for each code to BS.
- BS makes RNG-RSP based on RNG-MSR and sends it to RS.
- RS relays RNG-RSP to MS.

3.2 Optional relaying support by relayed-ranging code

There are too many transactions in the procedure described in section 3.1. So, we defined another procedure to reduce some steps.

3.2.1 Relayed-ranging code

Relayed-ranging code is a part of CDMA code set, and its region can be announced by additional TLV of UC D. All RSs share relayed-ranging code. Figure 3 shows relayed-ranging code set in CDMA code set.

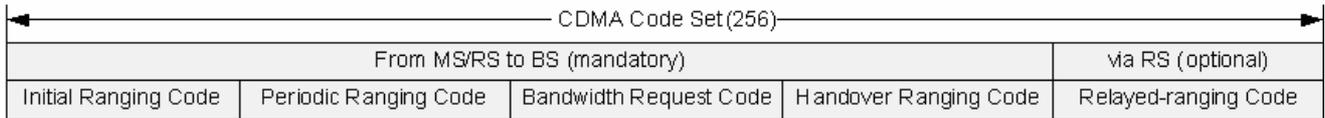


Figure 3—Relayed-ranging code

Relayed-ranging code informs BS what number of codes RS received through contention-based channel. Table 1 shows the relationship between each relayed-ranging code index from n to n+i and the number of received codes.

Table 1—The relationship between the index and the number of received codes

Relayed-ranging code index	n	n+1	n+2	n+3	...	n+i
No. of received codes	1	2	3	4	...	i+1

Relayed-ranging code can represent the number of code RS received and the bandwidth needed by RS.

For example, if RS received ranging code from three MSs, RS chooses (n+2)th relayed-ranging code and sends it to BS. And then BS can know that any RS have RNG-MSR to send BS and BS can guess the size of RNG-MSR. So BS assigns RS suitable bandwidth to transmit RNG-MSR.

If the number of codes RS received is greater than (i+1), RS cannot use this method.

3.2.2 Procedure

Figure 4 simply describes the procedure of relaying ranging code from MS by relayed-ranging code.

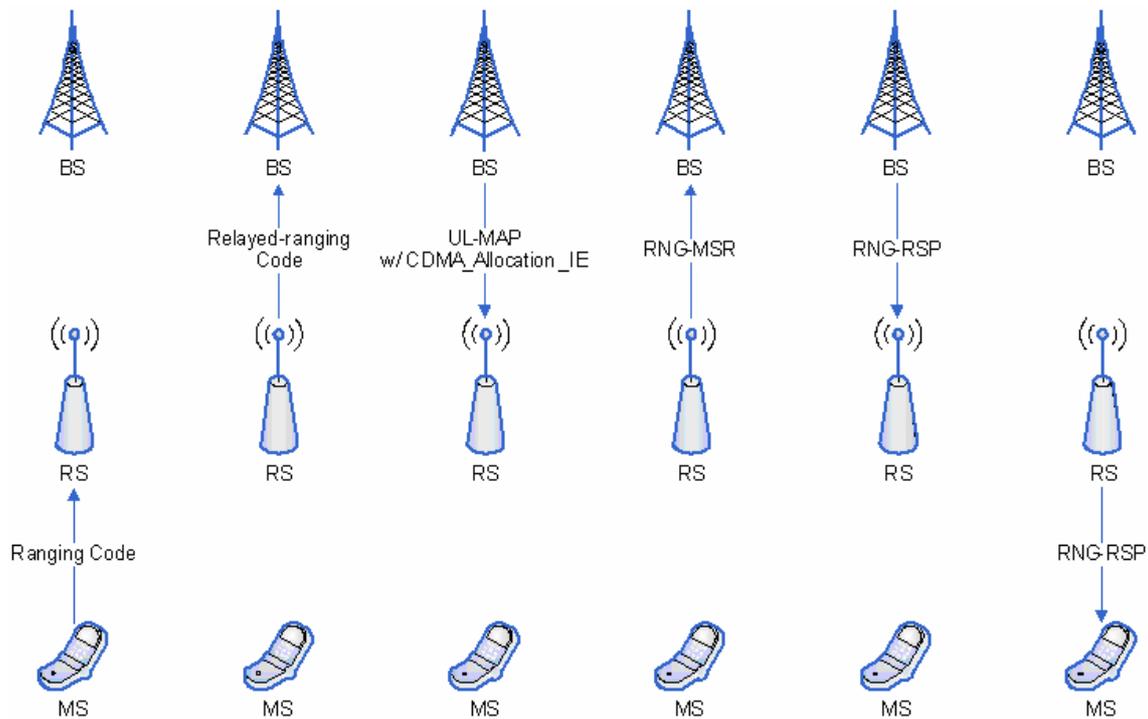


Figure 4—The procedure of ranging supported by relayed-ranging code

This method can remove two steps from procedure described in section 3.1. But the latency of this method is unpredictable, too.

The procedure is that:

- MS (or RS) sends ranging code to RS.
- RS measures the value of adjustment of received codes and sends relayed-ranging code to BS.
- BS broadcast UL-MAP with CDMA_Allocation_IE for RS to transmit RNG-MSR.
- RS sends RNG-MSR with the measured value for each code to BS.
- BS makes RNG-RSP based on RNG-MSR and sends it to RS.
- RS relays RNG-RSP to MS.

3.3 Optional relaying support by RS-dedicated code

3.3.1 RS-dedicated code

RS-dedicated code is a part of CDMA code set, and its region can be defined by additional TLV of RNG-RSP. Some specific RS can use RS-dedicated code. Figure 5 shows RS-dedicated code set in CDMA code set.

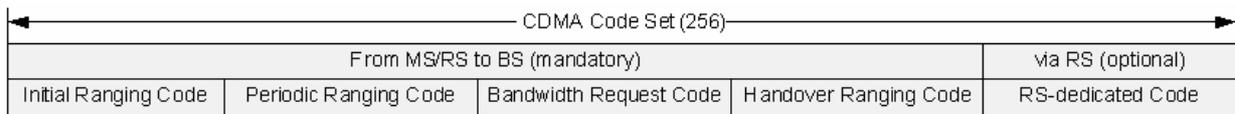


Figure 5—RS-dedicated code

Figure 6 shows the order of allocation between relayed-ranging code and RS-dedicated code.

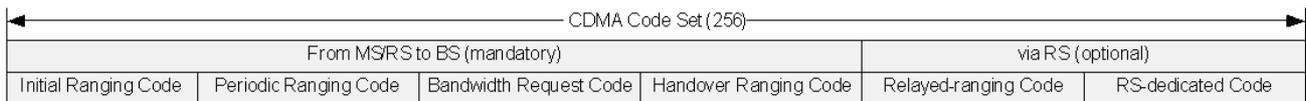


Figure 6—The order of Relayed-ranging code and RS-dedicated code

RS-dedicated code is used to inform BS what number of codes specific RS received through contention-free channel.

3.3.2 Procedure

Figure 7 simply describes the procedure of relaying ranging code from MS by RS-dedicated code.

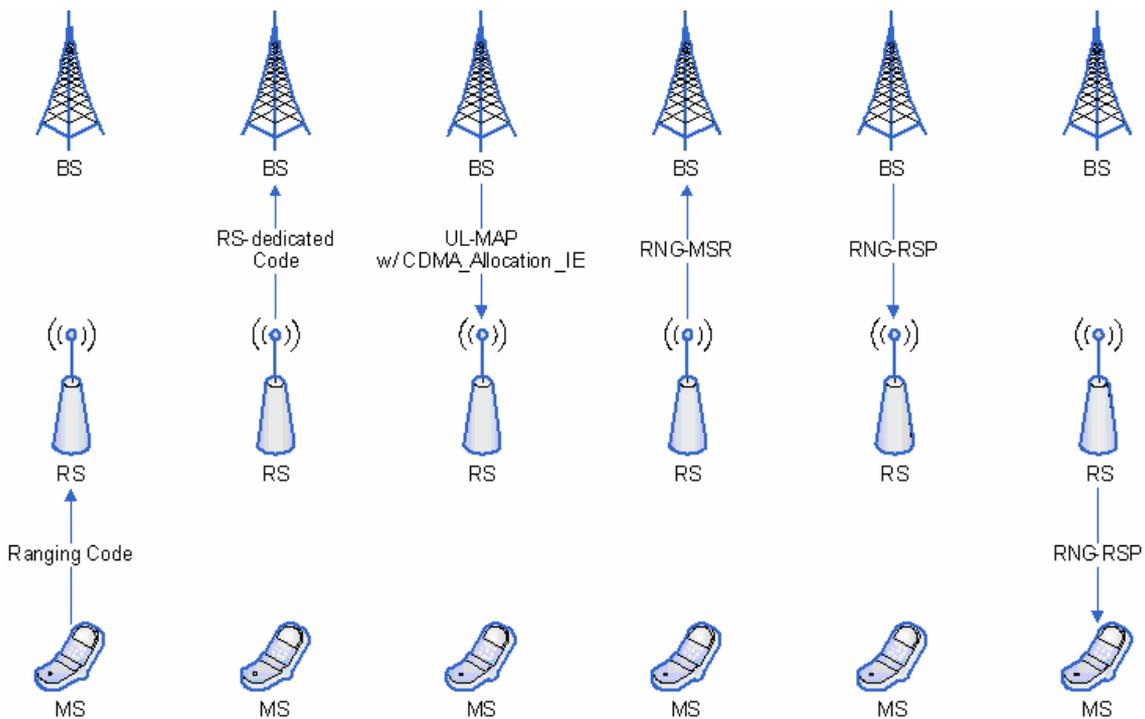


Figure 7—The procedure of ranging supported by RS-dedicated code

Because this method uses contention-free channel, the latency is predictable.

The procedure is that:

- MS (or RS) sends ranging code to RS.
- RS measures the value of adjustment of received codes and sends RS-dedicated code to BS.
- BS broadcast UL-MAP with CDMA_Allocation_IE for RS to transmit RNG-MSR.
- RS sends RNG-MSR with the measured value for each code to BS.
- BS makes RNG-RSP based on RNG-MSR and sends it to RS.
- RS relays RNG-RSP to MS.

4. Proposed Text

6.3.2.3 MAC management messages

Change table 14 as indicated:

Table 14—MAC Management messages

Type	Message name	Message description	Connection
4	RNG-REQ	Ranging Request	Initial Ranging <u>for MS/RS</u> or Basic
5	RNG-RSP	Ranging Response	Initial Ranging <u>for MS/RS</u> or Basic
8	—RNG-MSR	Reserved Ranging Measurement	—Initial Ranging for RS or Basic

6.3.2.3.6 Ranging response (RNG-RSP) message

Insert the following at the end of 6.3.2.3.6:

The following optional parameter may be included in the RNG-RSP message to dedicate specific codes to RS:

CDMA Code Allocation (see 11.6)

Indicates the specific codes are dedicated to RS.

Insert new subclause 6.3.2.3.62:

6.3.2.3.62 Ranging measurement (RNG-MSR) message

An RNG-MSR shall be transmitted by the RS to inform the value of adjustment of received codes from MSs. The format of the RNG-MSR message is shown in Table 109z. The RNG-MSR message may be sent in ranging of relay mode.

Table 109z—RNG-MSR message format

<u>Syntax</u>	<u>Size</u>	<u>Notes</u>
<u>RNG-MSR Message Format() {</u>		
<u>Management Message Type=0x08?</u>	<u>8 bits</u>	
<u>N_MEASUREMENT</u>	<u>8 bits</u>	
<u>for(i=0;i<N_MEASUREMENT;i++) {</u>		
<u>Frame Number</u>	<u>24 bits</u>	
<u>CDMA Code Index</u>	<u>8 bits</u>	
<u>Timing Adjust</u>	<u>32 bits</u>	
<u>Offset Frequency Adjust</u>	<u>32 bits</u>	
<u>Power Level Adjust</u>	<u>8 bits</u>	
<u>Ranging Status</u>	<u>8 bits</u>	
<u>}</u>		
<u>}</u>		

The following parameters shall be included in the RNG-MSR message:

Frame Number

Frame number in which CDMA code was received.

CDMA Code Index

Indicate the index of code RS received.

Timing Adjust Information

Power Adjust Information

Frequency Adjust Information

Ranging Status

6.3.10.3 OFDMA based ranging

Insert new subclause 6.3.10.3.4:

6.3.10.3.4 Relaying support for OFDMA based ranging

Insert new subclause 6.3.10.3.4.1:

6.3.10.3.4.1 Relaying support of RS

An RS or MS that wishes to perform ranging in relay mode shall take the following steps:

- The MS (or RS) shall choose randomly a Ranging Slot (with the use of a binary truncated exponent algorithm to avoid possible re-collisions) at the time to perform the ranging, choose randomly a Ranging Code and send it to the RS (as a CDMA code).
- The RS shall measure the value of adjustment of received codes, choose randomly a Ranging Slot (with the use of a binary truncated exponent algorithm to avoid possible re-collisions) at the time to perform the ranging, then it chooses randomly a bandwidth request code and sends it to the BS.
- After successfully receiving a bandwidth request code, the BS broadcasts a UL-MAP with CDMA Allocation IE for the RS to transmit a bandwidth request header.
- The RS sends bandwidth request header to the BS to transmit an RNG MSR message through an allocated bandwidth.
- After receiving a bandwidth request header, the BS broadcasts a UL-MAP with bandwidth allocation for the RS to transmit an RNG MSR message.
- The RS sends an RNG MSR message with the measured value for each code to the BS through an allocated bandwidth.
- After receiving an RNG-MSR message, the BS makes an aggregated RNG RSP message based on a received RNG MSR message and sends it to the RS.
- After receiving an aggregated RNG-RSP message, if needed, the RS divides it to multiple RNG-RSP(s) and relays multiple RNG RSP(s) to each MS.

The message sequence chart (Table 121a) defines the ranging and adjustment process that shall be followed by compliant MSs, RSs and BS.

Table 121a—The procedure of ranging in relay mode

<u>MR-BS</u>	<u>RS</u>	<u>RS/MS</u>
<u>[Time to send the CDMA ranging opportunity]</u> <u>Send map containing CDMA Ranging IE with a broadcast connection ID</u>	<u>--- UL-MAP --></u> <u>Relay UL-MAP</u>	<u>--- UL-MAP --></u> <u>Measure the value of adjustment of each codes and randomly select bandwidth request code from available ranging region</u>
		<u><-ranging code-</u> <u>Transmit randomly selected ranging code in a randomly selected ranging slot from available ranging region</u>

[Time to send the CDMA ranging opportunity]

Send map containing CDMA Ranging IE with a broadcast connection ID --- UL-MAP --> Relay UL-MAP --- UL-MAP -->

<- bandwidth request code Transmit selected bandwidth request code

[Receive bandwidth request code]

Assign RS bandwidth to send bandwidth request header\

[Time to send UL-MAP]

Send map containing CDMA Allocation IE with a broadcast CID --- UL-MAP --> Relay UL-MAP --- UL-MAP -->

<----- BR ----- Send the bandwidth request to request the bandwidth to send RNG-MSR

[Receive BR]

Assign RS bandwidth to send RNG-MSR

[Time to send UL-MAP]

Send map containing bandwidth allocation with CID of RS --- UL-MAP --> Relay UL-MAP --- UL-MAP -->

	<u><--RNG-MSR--</u>	<u>Send RNG-MSR with time, frequency and power corrections, original ranging codes, ranging slots, ranging status and frame number</u>	
<u>[Time to send map]</u>			
<u>Send map containing the location of RNG-RSPs with CID of RS</u>	<u>--- DL-MAP --></u>	<u>Relay DL-MAP</u>	<u>--- DL-MAP --></u>
<u>[Receive RNG-MSR]</u>			
<u>Send RNG-RSP containing the information of RNG-MSR with CID of RS</u>	<u>--RNG-RSP--></u>	<u>Divide RNG-RSP with CID of RS to RNG-RSPs with CIDs of RS/MS</u>	
<u>[Time to send map]</u>			
<u>Send map containing the location of RNG-RSPs with CIDs of RS/MS</u>	<u>--- DL-MAP --></u>	<u>Relay DL-MAP</u>	<u>--- DL-MAP --></u>
		<u>Send RNG-RSPs to RS/MS</u>	<u>--RNG-RSP--></u>

Insert new subclause 6.3.10.3.4.2:

6.3.10.3.4.2 Optional relaying support by relayed-ranging code

An RS or MS that wishes to perform optional ranging supported by relayed-ranging code in relay mode may take the following steps:

- The MS (or RS) shall choose randomly a Ranging Slot (with the use of a binary truncated exponent algorithm to avoid possible re-collisions) at the time to perform the ranging, choose randomly a Ranging Code and send it to the RS (as a CDMA code).
- The RS shall measure the value of adjustment of received codes, choose randomly a Ranging Slot (with the use of a binary truncated exponent algorithm to avoid possible re-collisions) at the time to perform the ranging, then it chooses randomly a relayed-ranging code and sends it to the BS.
- After receiving a relayed-ranging code, the BS broadcasts a UL-MAP with bandwidth allocation for the RS to transmit an RNG MSR message.

- The RS sends an RNG MSR message with the measured value for each code to the BS through an allocated bandwidth.
- After receiving an RNG-MSR message, the BS makes an aggregated RNG RSP message based on a received RNG MSR message and sends it to the RS.
- After receiving an aggregated RNG-RSP message, if needed, the RS divides it to multiple RNG-RSP(s) and relays multiple RNG RSP(s) to each MS.

The message sequence chart (Table 121b) defines the ranging and adjustment process that shall be followed by compliant MSs, RSs and BS.

Table 121b—The procedure of ranging supported by relayed-ranging code

<u>MR-BS</u>		<u>RS</u>		<u>RS/MS</u>
<u>[Time to send the CDMA ranging opportunity]</u>				
<u>Send map containing CDMA Ranging IE with a broadcast connection ID</u>	<u>--- UL-MAP --></u>	<u>Relay UL-MAP</u>	<u>--- UL-MAP --></u>	
		<u>Measure the value of adjustment of each codes and select relayed-ranging code related to the number of received codes</u>	<u><-ranging code-</u>	<u>Transmit randomly selected Ranging Code in a randomly selected Ranging slot from available ranging region</u>
<u>[Time to send the CDMA ranging opportunity]</u>				
<u>Send map containing CDMA Ranging IE with a broadcast connection ID</u>	<u>--- UL-MAP --></u>	<u>Relay UL-MAP</u>	<u>--- UL-MAP --></u>	
	<u><- relayed-ranging code</u>	<u>Transmit selected relayed-ranging code</u>		
<u>[Receive relayed-ranging code]</u>				

Assign RS bandwidth to send RNG-MSR

[Time to send UL-MAP]

Send map containing CDMA Allocation Information with a broadcast CID --- UL-MAP --> Relay UL-MAP --- UL-MAP -->

<--RNG-MSR-- Send RNG-MSR with time, frequency and power corrections, original ranging codes, ranging slots, ranging status and frame number

[Time to send map]

Send map containing the location of RNG-RSPs with CID of RS --- DL-MAP --> Relay DL-MAP --- DL-MAP -->

[Receive RNG-MSR]

Send RNG-RSP containing the information of RNG-MSR with CID of RS --RNG-RSP--> Divide RNG-RSP with CID of RS to RNG-RSPs with CIDs of RS/MS

[Time to send map]

Send map containing the location of RNG-RSPs with CIDs of RS/MS --- DL-MAP --> Relay DL-MAP --- DL-MAP -->

Send RNG-RSPs to RS/MS --RNG-RSP-->

Insert new subclause 6.3.10.3.4.3:

6.3.10.3.4.3 Optional relaying support by RS-dedicated code

An RS or MS that wishes to perform optional ranging supported by RS-dedicated code in relay mode may take the following steps:

- The MS (or RS) shall choose randomly a Ranging Slot (with the use of a binary truncated exponent algorithm to avoid possible re-collisions) at the time to perform the ranging, choose randomly a Ranging Code and send it to the RS (as a CDMA code).
- The RS shall measure the value of adjustment of received codes, choose randomly a Ranging Slot (with the use of a binary truncated exponent algorithm to avoid possible re-collisions) at the time to perform the ranging, choose randomly an RS-dedicated code and send it to the BS.
- After receiving an RS-dedicated code, the BS broadcasts a UL-MAP with bandwidth allocation for the RS to transmit an RNG MSR message.
- The RS sends an RNG MSR message with the measured value for each code to the BS through an allocated bandwidth.
- After receiving an RNG-MSR message, the BS makes an aggregated RNG RSP message based on a received RNG MSR message and sends it to the RS.
- After receiving an aggregated RNG-RSP message, if needed, the RS divides it to multiple RNG-RSP(s) and relays multiple RNG RSP(s) to each MS.

The message sequence chart (Table 121c) defines the ranging and adjustment process that shall be followed by compliant MSs, RSs and BS.

Table 121c—The procedure of ranging supported by RS-dedicated code

<u>MR-BS</u>	<u>RS</u>	<u>RS/MS</u>
<p><u>[Time to send the CDMA ranging opportunity]</u></p> <p><u>Send map containing CDMA Ranging IE with a broadcast connection ID</u></p>	<p><u>Relay UL-MAP</u></p> <p><u>Measure the value of adjustment of each codes and select RS-dedicated code related to the number of received codes</u></p>	<p><u>Transmit randomly selected Ranging Code in a randomly selected Ranging slot from available ranging region</u></p>
<p><u>[Time to send the CDMA ranging opportunity]</u></p>		

<u>Send map containing CDMA Ranging IE with a broadcast connection ID</u>	<u>--- UL-MAP --></u>	<u>Relay UL-MAP</u>	<u>--- UL-MAP --></u>
	<u><-RS-dedicated-code</u>	<u>Transmit selected RS-dedicated code</u>	
<u>[Receive relayed-ranging code]</u>			
<u>Assign RS bandwidth to send RNG-MSR</u>			
<u>[Time to send UL-MAP]</u>			
<u>Send map containing CDMA Allocation IE with a broadcast CID</u>	<u>--- UL-MAP --></u>	<u>Relay UL-MAP</u>	<u>--- UL-MAP --></u>
	<u><--RNG-MSR--</u>	<u>Send RNG-MSR with time, frequency and power corrections, original ranging codes, ranging slots, ranging status and frame number</u>	
<u>[Time to send map]</u>			
<u>Send map containing the location of RNG-RSPs with CID of RS</u>	<u>--- DL-MAP --></u>	<u>Relay DL-MAP</u>	<u>--- DL-MAP --></u>
<u>[Receive RNG-MSR]</u>			
<u>Send RNG-RSP containing the information of RNG-MSR with CID of RS</u>	<u>--RNG-RSP--></u>	<u>Divide RNG-RSP with CID of RS to RNG-RSPs with CIDs of RS/MS</u>	
<u>[Time to send map]</u>			

Send map containing the location of RNG-RSPs with CIDs of RS/MS --- DL-MAP --> Relay DL-MAP --- DL-MAP -->

Send RNG-RSPs to RS/MS --RNG-RSP-->

8.4.5.4.3 CDMA allocation UL-MAP IE format

Change Table 290 as indicated:

Table 290—CDMA Allocation IF format

Syntax	Size	Notes
<u>RS Ranging or</u> BW request mandatory	1 bits	1=yes, 0=no

8.4.7.3 Ranging Codes

Change the fourth paragraph as indicated:

The number of available codes is 256, numbered 0..255. Each BS uses a subgroup of these codes, where the subgroup is defined by a number S, $0 \leq S \leq 255$. The group of codes will be between S and $((S+Q+P+O+N+M+L) \bmod 256)$.

Insert the following at the end of 8.4.7.3:

- The next optional P codes produced are for relayed-ranging. Clock the PRBS generator $144 \times ((N + M + L + O + S) \bmod 256)$ times to $144 \times ((N + M + L + O + P + S) \bmod 256) - 1$ times.
- The next optional Q codes produced are for RS-dedicated. Clock the PRBS generator $144 \times ((N + M + L + O + P + S) \bmod 256)$ times to $144 \times ((N + M + L + O + P + Q + S) \bmod 256) - 1$ times.

Insert new subclause 8.4.7.3.1:

8.4.7.3.1 Optional codes in relay mode

Two optional codes, relayed-ranging and RS-dedicated, are defined to support relay mode. They are used to inform the BS what number of codes the RS received.

Because a relayed-ranging code is shared by all RSs, it is sent by the contention-based method. But, because a n RS-dedicated code is dedicated to the specific RS, it is sent by the contention-free method.

Table 316f shows the relationship between each code index (from n to n+i) and the number of codes the RS received.

Table 316f—The relationship between the index and the number of received codes

<u>Code index</u>	<u>n</u>	<u>n+1</u>	<u>n+2</u>	<u>n+3</u>	<u>...</u>	<u>n+i</u>
<u>No. of received code</u> <u>s</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>...</u>	<u>i+1</u>

The code can represent the number of code the RS received and the bandwidth to transmit an RNG-MSR message (see 6.3.2.3.62).

For example, if the RS received ranging code from three MSs, the RS shall choose (n+2)th code and sends it to the BS. And then the BS can know that any RS have an RNG-MSR message to send the BS and the BS can give

ss the size of an RNG-MSR message. So the BS assigns the RS suitable bandwidth to transmit an RNG-MSR message.

If the number of codes the RS received is greater than (i+1), the RS cannot use this code.

10.4 Well-known addresses and identifiers

Change Table 345 as indicated:

Table 345—CIDs

CID	Value	Description
Initial Ranging <u>for MS</u>	0x0000	Used by MS and BS during initial ranging process.
<u>Initial Ranging for RS</u>	<u>0x0001</u>	<u>Used by RS and BS during initial ranging process.</u>
Basic CID	0x000 <u>12</u> - m	The same value is assigned to both the DL and UL connection.

11.3.1 UCD channel encodings

Change Table 353 as indicated:

Table 353— UCD PHY-specific channel encodings—WirelessMAN-OFDMA

Name	Type (1 byte)	Length	Value
<u>Relayed-ranging code</u>	<u>203</u>	<u>1</u>	<u>Number of handover ranging CDMA codes. Possible values are 0-255.</u>
<u>Relayed-ranging backoff start</u>	<u>204</u>	<u>1</u>	<u>Initial backoff window size for relayed-ranging contention, expressed as a power of 2. Values of n range 0-15 (the highest order bits shall be unused and set to 0) This TLV shall be used in NBR-ADV message only to represent corresponding values that appear in UCD message fields.</u>
<u>Relayed-ranging backoff end</u>	<u>205</u>	<u>1</u>	<u>Final backoff window size for relayed-ranging contention, expressed as a power of 2. Values of n range 0-15 (the highest order bits shall be unused and set to 0) This TLV shall be used in NBR-ADV message only to represent corresponding values that appear in UCD message fields.</u>

11.6 RNG-RSP management message encodings

Insert the following row to Table 367:

Table 367—RNG-RSP message encodings

Name	Type (1 byte)	Length	Value (Variable-length)	PHY Scope
<u>CDMA Code Allocation</u>	<u>34?</u>	<u>2</u>	<u>Used to indicate the specific CDMA codes are dedicated to RS.</u> <u>Byte #1: start index</u> <u>Byte #2: number of index</u>	<u>All</u>