Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
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Re:	This is a response to Call for Technical Proposals regarding IEEE Project P802.16j.	
Abstract	The document contains technical proposals for IEEE P802.16j that would provide a control method in R-UL ranging control.	
Purpose	The document is submitted for review by 802.16 Working Group members.	
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R-UL Ranging Control of RS within Cell Coverage

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ETRI

1. Introduction

The MAC management messages exchanged between MMR-BS and RS require small transmission delay. RS's information on measurements of uplink received signal quality and detections of ranging CDMA codes from MS is reported to inform the MMR-BS of RS's radio environment. This RS information is required by the MMR-BS to manage and allocate radio resources effectively. The time delay of information notification results in an opportunity loss and reduces radio resource utilization. Especially there is long time delay in uplink because the MMR-BS mainly manages most of radio resource in the cell and the RS requires bandwidth request process in R-UL additionally.

IEEE 802.16 specifications describe several methods to request bandwidth and radio resource in uplink.

Piggyback with grant management subheader

Polling

Contention-based bandwidth request with ranging CDMA code

Piggyback can be applied only when there is a requested resource in uplink. In Polling scheme the BS periodically assigns the uplink resource allocation for sending the bandwidth request for every uplink users. This Polling wastes the uplink allocation if the bandwidth request is not required and requires the transmission procedures of bandwidth request header in uplink.

Contention-based bandwidth request of them increases time delay in the respect of two factors: the one is contention and the other is the transmission procedures of bandwidth request header in uplink. Nevertheless, Contention-based bandwidth request has a benefit of resource utilization because the CDMA code and the bandwidth are utilized only when the event occurs.

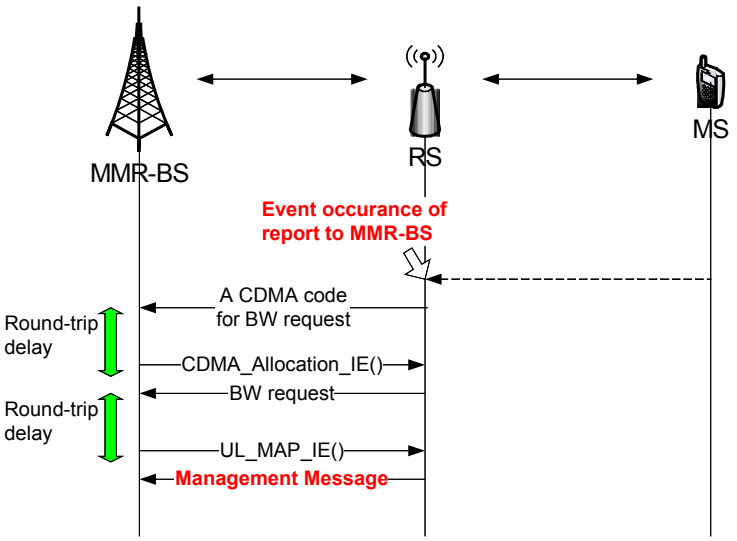

Figure 1 Contention-based CDMA code and MAC management message.

Figure 1 shows that contention-based bandwidth request procedure has two round-trip time delays. The one is for the contention-

based CDMA code procedure and the other is for the transmission of bandwidth request header. The bandwidth request head includes the requested CID and the required bandwidth.

The RS within MMR-BS's coverage shall adjust transmission parameters for the purpose of maintaining the communication quality to the MMR-BS. There are three ranging processes: initial ranging, handoff ranging, and periodic ranging. The initial and handoff ranging processes are used for network entry and network re-entry, respectively. After the network entry procedures, the RS can operate its relay function and require the periodic ranging. If the RS and MS use the same CDMA codes, the receiver can not distinguish the RS's transmission from the MS's transmission.

2. Proposed Solution

This proposal intends to reduce delay latency in R-UL with reduction of related procedures. The RS has a requirement of low delay latency before sending RS's information to the MMR-BS. The two proposed methods have a latency of one round-trip delay, which is half the delay compared to the legacy contention-based bandwidth request.

Contention-based bandwidth request with a CDMA code partitioning

Codeword usage in CQICH

Also this contribution is to separates CDMA codes used by the RS from CDMA codes used by the MS. The RS or MMR-BS receiving a CDMA code shall identify whether the transmitter of the CDMA code is the RS or not. This identification gives an opportunity of controlling the RS separately in R-UL ranging control. The MS shall maintain good communication quality to the selected RS.

CDMA-code partitioning

Legacy contention-based bandwidth request uses a CDMA code that informs the BS of event indication. The CID and bandwidth are sent next as bandwidth request header so that the BS utilizes this information to determine uplink allocation with modulation and channel coding in addition to bandwidth. The BS stores radio channel information for a user, represented by CID. Two round-trip delays before MAC management message is transmitted to the BS, are required in legacy contention-based bandwidth request.

The CDMA-code partitioning for the RS is proposed to reduce the latency delay of contention-based bandwidth request procedure. The proposed CDMA-code partitioning gives a subset of CDMA codes allocated for the RS to request RS control bandwidth. A CDMA code in the subset is mapped to the information on MCS level and bandwidth. This mapping information is broadcasted by additional field in UCD message. The number of required CDMA codes depends on the MCS level because an allocated uplink resource has various data sizes according to the applied MCS level. Given a data size, the poor radio channel requires more radio resources. The required number of quantized levels in data size increases to optimize uplink resource utilization. For an example, Figure 2 shows a subset of CDMA codes between RS and MMR-BS. The subset consists of 10 CDMA codes. M_i and B_j note the i-*th* MCS level and the j-*th* bandwidth size, respectively. The M_0 has 5 bandwidth sizes and M_2 has 2 bandwidth sizes. This information is broadcasted by UCD message and shared between RS and MMR-BS.

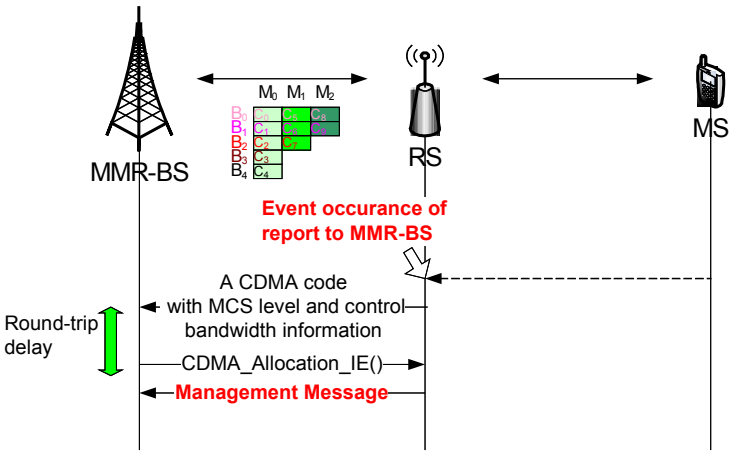

Figure 2 Proposed contention-based CDMA code and MAC management message.

When the RS needs to report the uplink received signal quality and detections of ranging CDMA codes to the MMR-BS, it selects a CDMA code among the subset of CDMA codes. The MCS level is given because the RS has adjusted the radio channel and has known the required MCS level between RS and MMR-BS. The RS decides the required bandwidth and selects a CDMA code satisfying the requirements of the MCS level and the bandwidth. If there are several CDMA codes using the same uplink allocation, the RS selects a CDMA code with equal probability. The selected CDMA code is transmitted onto the Ranging subchannel and transmitted during the appropriate uplink allocation. Also the RS selects the Ranging subchannel with equal probability if there are several available Ranging subchannels in an uplink subframe.

Upon detection, the BS shall provide uplink allocation in R-UL for the RS. The BS detects a CDMA code and gets information on MCS level and bandwidth. This information is utilized to determine the size of uplink allocation. The BS sends CDMA_allocation_IE() with information on both uplink allocation and the CDMA code. Then the RS sends MAC management messages in the uplink allocation. Figure 2 shows the procedure of the proposed contention-based CDMA code and the reduced delay latency. Only one round-trip delay is required before RS's sending MAC management messages.

The proposed contention-based bandwidth request of RS control has the same contention resolution scheme in legacy specifications except several control variables. If the RS's transmission of selected CDMA code results in a corruption after there is no uplink allocation after "RS contention-based reservation timeout", the RS follows a truncated binary exponential backoff, with the initial back window and the maximum backoff window. The specified two windows are controlled by two fields, "RS control bandwidth request backoff start" and "RS control bandwidth request backoff end". The contention windows of the proposed scheme are separated from the contention window of legacy scheme because the requirement of delay latency is less small than one of legacy scheme.

This proposal is required for the RS to have information on the uplink MCS level. Two methods are available. At first, the RS uses the information on the history of uplink burst allocation. The other is that the BS informs the RS of the recommended MCS level using the R-UL UIUC Change Request/Response (RUC-REQ/RSP) messages. If the RS has no information on the uplink MCS level, the RS shall select the most robust MCS level among available ones.

Codeword usage in CQICH

The proposed codeword usage in CQICH defines a subset of codeword allocated for the RS to request RS control bandwidth. A codeword in the subset is mapped to the bandwidth information. This mapping information is broadcasted by additional fields in UCD message. The CQICH is utilized for a RS exclusively and the bandwidth mapped by a codeword is requested by the RS. For an example, Figure 3 shows a subset of codewords between RS and MMR-BS. The subset consists of 5 codewords. B_i notes the i-*th* bandwidth size. 5 bandwidth sizes are defined in the figure. This information is broadcasted by UCD message and shared between RS and MMR-BS.

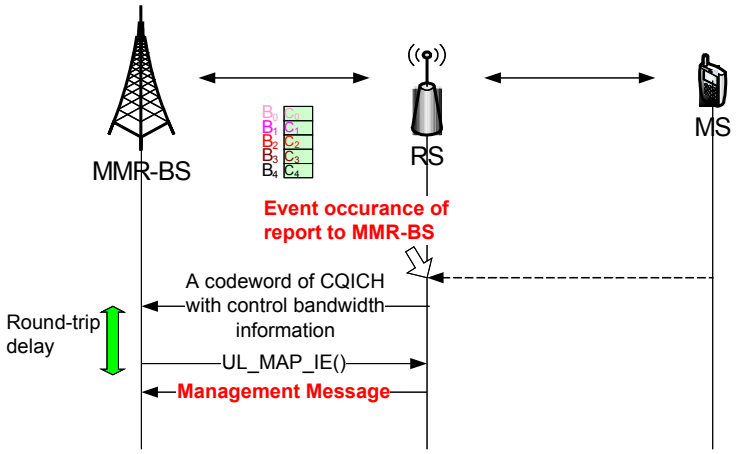

Figure 3 Proposed codeword usage of CQICH and MAC management message.

When the RS needs to send MAC management messages to the MMR-BS, it selects a CQICH codeword among the subset of CQICH codeword if CQICH allocation is available. The MCS level is given because the RS has adjusted the radio channel and has known the required MCS level between RS and MMR-BS. The RS decides the required bandwidth and selects a CQICH codeword satisfying the requirements of the bandwidth. The selected CQICH codeword is transmitted onto the allocated uplink CQICH in an uplink allocation.

Upon detection, the BS shall provide uplink allocation in R-UL for the RS. The BS detects a CQICH codeword and gets information on bandwidth and RS. The identification of RS allows the BS to select MCS levels because the RS has adjusted the parameters of the radio channel and has known the required MCS level between the RS and the MMR-BS. This information is utilized to determine the size of uplink allocation. The BS sends UL-MAP_IE() with information on both uplink allocation and the basic CID of RS. Then the RS sends MAC management messages in the uplink allocation. Figure 3 shows the procedure of the proposed codeword usage of CQICH and the reduced delay latency. Only one round-trip delay is required before RS's sending MAC management messages.

If the RS's transmission of the selected CQICH codword results in a corruption after there is no uplink allocation after "RS CQICH bandwidth reservation timeout", the RS repeats codeword selection and its following steps.

RS ranging CDMA codes

The RS can conduct ranging procedures using the RS ranging CDMA codes: RS initial ranging CDMA code and RS periodic ranging CDMA code. The separation of CDMA codes used by RS from CDMA codes used by MS, has the following benefits:

The BS can allocate a different amount of radio resources for the CDMA code. For example, the initial RNG-REQ messages from the MS can have different size from the initial message from the RS.

The BS can adjust transmission parameters of the RS which is different from ones of the MS. The used algorithms to determine transmission parameters are different. For example, it is possible that the RS maintains good communication link to the MMR-BS and the MS does to the selected RS.

Text Proposals

[Insert the text after 6.3.2.3.61:]

6.3.2.3.62 R-UL UIUC Change Request (RUC-REQ) message

If the MMR-BS is required to change the UIUC of the RS in selecting CDMA code, it shall send the R-UL UIUC Change (RUC-REQ) message in the form shown in Table aaa to the RS. The RS sends a CDMA code mapped to the UIUC when requesting control bandwidth using contention-based CDMA codes.

Table aaa- RUC-REQ format

Name	Length	Value (Variable-length)
RUC-REQ_Message_Format() {		
Management Message Type = (? 70)	8 bits	
Transaction ID	16 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	2 bits	
TLV Encoding Information	variable	TLV specific
}		

An RS shall generate RUC-REQ messages in the form shown in Table aaa, including the following parameters:

CID (in the generic MAC header)

RS's Basic CID.

Transaction ID

Unique identifier for this transaction assigned by the sender

The following parameters shall be included in the RUC-REQ message:

UIUC

UIUC used for the burst, which is allocated after control bandwidth request of the RS.

Repetition coding indication

Indicates the repetition code used inside the allocated burst.

The RM-RPT message shall contain the following:

HMAC Tuple (see 11.1.2)

The HMAC Tuple attribute contains a keyed message digest (to authenticate the sender). The HMAC Tuple attribute shall be the final attribute in this message's attriute list.

6.3.2.3.63 RS R-UL UIUC Change Response (RUC-RSP) message

The RS shall send the RUC-RSP message in response to a received RUC-REQ message.

Table bbb- RUC-RSP format

Name	Length	Value (Variable-length)
RUC-RSP_Message_Format() {		
_Management Message Type = (? 70)	8 bits	
_Transaction ID	16 bits	
_Confirmation Code	8 bits	
_TLV Encoding Information	variable	TLV specific
}		

An RS shall generate RUC-RSP messages in the form shown in Table bbb, including the following parameters:

CID (in the generic MAC header)

RS's Basic CID.

Transaction ID

Transaction ID from corresponding RUC-REQ message.

Confirmation Code

The appropriate Confirmation Code (CC) for the corresponding RUC-RSP message.

The RUC-RSP message shall contain the following:

HMAC Tuple (see 11.1.2)

The HMAC Tuple attribute contains a keyed message digest (to authenticate the sender). The HMAC Tuple attribute shall be the final attribute in this message's attriute list.

[Insert the text after 6.3.6.7:]

6.3.6.8 bandwidth requests of RS to MMR-BS

The MMR PHY shall support two additional bandwidth request mechanisms: The RS either send the CDMA codes or CQICH codewords for RS control. Those methods enable the MMR-BS to allocate a R-UL radio resource required for RS to send the MAC management messages after the MMR-BS receives the bandwidth request.

6.3.6.8.1 Contention-based CDMA bandwidth requests of RS

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 CDMA bandwidth requests of RS control. When the RS needs to request bandwidth for sending MAC management messages to MMR-BS, it selects a CDMA code from the code subset allocated to bandwidth requests of RS. This CDMA code needs to satisfy the requirements of required RS's MCS level and buffered bandwidth for RS's MAC management messages. The requested bandwidth is aggregate one for basic CID of RS.

Upon detection, the BS shall allocate, with priority, R-UL resources for the RS and send CDMA_allocation_IE() with the transmit region and CDMA code that were used by the RS. The RS determines whether it has been given an allocation by matching these parameters with parameters it used. If matched, the RS transmits MAC management messages in the R-UL allocation, in which the MCS level is applied as the CDMA_allocation_IE() describes. If the bandwidth request of another CID is required, the RS sends the bandwidth request header in the allocated R-UL resource additionally.

If the BS does not issue the R-UL allocation described above within the given time, RS contention-based reservation timeout, the SS shall assume that the CDMA code transmission resulted in a collision and follow the contention resolution as specified in 6.3.8. During the contention resolution, the RS uses two fields, RS control bandwidth request backoff start and RS control bandwidth request backoff end, instead of two fields, bandwidth request backoff and bandwidth request backoff end, respectively.

If the RS has no information on the R-UL MCS level, the RS shall select the most robust MCS level among available ones. At f first the RS uses the information on the history of the uplink burst allocations. And the BS can change the RS's MCS level using RUC-REQ/RSP messages. When the BS receives unicast data including either feedback channel or PHY burst of the RS, it determines the required UIUC. The RUC-REQ message with new MCS level is sent to the RS and the RS sends the RUC-RSP message in response to the RUC-REQ message. After updating its MCS level, the RS shall select a CDMA code from the codes subset of new MCS level.

6.3.6.8.2 Bandwidth requests of RS using CQICH codewords

The codeword subset for RS's bandwidth request is defined by the UCD message. Upon needing to request bandwidth for sending MAC management messages to MMR-BS, the RS selects a codeword from the codeword subset allocated to bandwidth request. This codeword needs to satisfy bandwidth required for RS to transmit MAC management messages to MMR-BS. The requested bandwidth is aggregate one for basic CID of RS.

Upon detection, the BS shall allocate, with priority, R-UL resources for the RS and send UL-MAP_IE() with RS's basic CID. If the MCS level for the RS can be available, the BS uses its information in determining the uplink duration. The RS transmits MAC management messages in the R-UL allocation, in which the MCS level is applied as the UL-MAP_IE() describes. If the bandwidth request of another CID is required, the RS sends the bandwidth request header in the allocated R-UL resource additionally.

If the BS does not issue the R-UL allocation described above within the given time, RS CQICH bandwidth reservation timeout, the RS shall assume that the CQICH codeword transmission resulted in a corruption. The RS repeats codeword selection and its following steps.

[Insert the text at 6.3.10.3.4:]

6.3.10.3.4 Relaying support for OFDMA based ranging

6.3.10.3.4.1 RS ranging

The RS are required to perform the three ranging procedures: initial ranging, periodic ranging, and handoff ranging. Those rangings of RS shall take similar procedures to MS's ranging ones, which are defined in sections (6.3.10.3.1, 6.3.10.3.2, and 6.3.10.3.3), with following modifications. Three sets of CDMA ranging codes for RS are defined: RS initial ranging codes, RS periodic ranging codes, and RS handoff ranging codes. In the initial, periodic, and handoff ranging procedures, the RS uses the RS initial ranging codes, RS periodic ranging codes, and RS handoff ranging codes, instead of the initial ranging codes, periodic ranging codes, and handoff ranging codes, respectively.

[Insert the text after 8.4.5.10.15:]

8.4.5.4.10.16 Bandwidth request of RS

Each codeword in a codeword subset, defined by the UCD message, is utilized for the RS to request a selected bandwidth for the purpose of transmitting MAC management messages.

[Change the following text in 8.4.7.3 Ranging codes 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 <= S <= 255. The group of codes will be between S and ((S+ O+N+M+L) mod 256).

- The first N codes produced are for initial-ranging. Clock the PRBS generator 144 x (S mod 256) times to 144 x ((S + N) mod 256) - 1 times.
- The next M codes produced are for periodic-ranging. Clock the PRBS generator 144 x ((N + S) mod 256) times to 144 x ((N + M + S) mod 256) - 1 times.
- The next L codes produced are for bandwidth-requests. Clock the PRBS generator 144 x ((N + M + S) mod 256) times to 144 x ((N + M + L + S) mod 256) -1 times.
- The next O codes produced are for handover-ranging. Clock the PRBS generator 144 x ((N + M + L + S) mod 256) times to 144 x ((N + M + L + O + S) mod 256) -1 times.

Additionally, The MMR-BS uses a subgroup of these codes only for the RS, where the subgroup is defined by a number T = (N + M + L + O + S) mode 256, 0<=T<=255. The group of codes only for the RS will be between T and ((T+I+P+Q+R) mode 256).

- The next P codes produced are for initial-ranging of RS. Clock the PRBS generator 144 x (T mod 256) times to 144 x ((T + P) mod 256) - 1 times.
- The next Q codes produced are for periodic-ranging of RS. Clock the PRBS generator 144 x ((P + T) mod 256) times to 144 x ((P + Q + T) mod 256) - 1 times.
- The next R codes produced are for bandwidth-requests of RS. Clock the PRBS generator 144 x ((P + Q + T) mod 256) times to 144 x ((P + Q + R + T) mod 256) -1 times.

- The next I codes produced are for handover-ranging of RS. Clock the PRBS generator 144 x ((P + Q + R + T) mod 256) times to 144 x ((P + Q + R + I + T) mod 256) -1 times.

[Insert the following entries into table 353-UCD PHY-specific channel encodings-WirelessMAN-OFDMA:]

Name	Type (bytes)	Length	Value
RS control bandwidth request backoff start	???	1	Initial backoff window size for contention BW requests of RS control, expressed as a power of 2. Values of n rang 0-15 (the highest order bits shall be unused and set to 0). This TLV shall not be used in NBR-ADV message.
RS control bandwidth request backoff end	???	1	Final backoff window size for contention BW requests of RS control, expressed as a power of 2. Values of n rang 0-15 (the highest order bits shall be unused and set to 0). This TLV shall not be used in NBR-ADV message.
RS contention-based reservation timeout	???	1	Number of UL-MAPs to be received before contention-based reservation is attempted again for the same RS.
RS bandwidth codes for UIUC and control bandwidth	???	variable	See Table yyy for description
RS initial ranging codes	???	1	Number of RS initial ranging CDMA codes.
RS periodic ranging codes	???	1	Number of RS periodic ranging CDMA codes
RS handoff ranging codes	???	1	Number of RS handoff ranging CDMA codes
RS CQICH bandwidth reservation timeout	???	1	Number of UL-MAPs to be received before CQICH bandwidth reservation is attempted again for the same RS.
RS CQICH codewords for control bandwidth	???	variable	See Table zzz for description

[Insert the following tables below Table 353-UCD PHY-specific channel encodings-WirelessMAN-OFDMA:]

Table yyy- RS bandwidth codes for UIUC and control bandwidth

Name	Length	Value (Variable-length)
N_MCS_levels	8 bits	
For (i=0; i<N_MCS_levels; i++) {		
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	2 bits	
N_control_BW_codes_MCS	8 bits	The number of control bandwidth CDMA codes for the MCS level
For (j=0;j<N_control_BW_codes_MCS;j++) {		
Requested RS control bandwidth	8 bits	For a CDMA code. When multiple CDMA codes are allocated to a RS control bandwidth given the MCS level, RS shall select a RS CDMA code with equal

		probability.
}		
}		

Table zzz- RS CQICH codewords for RS control bandwidth

Name	Length	Value (Variable-length)
CQICH codeword offset	8 bits	The lowest codeword index used for control bandwidth, starting from codeword 0.
N_control_BW_codewords	8 bits	
For (i=0; i< N_control_BW_codewords; i++) {		
Requested RS control bandwidth	8 bits	For a CQICH codeword
}		