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Re:	Call for Technical Proposals regarding IEEE Project P802.16j (IEEE 802.16j-06/027)	
Abstract	This contribution describes a way of MAP construction for multihop relay.	
Purpose	Adoption of proposed text into P802.16j	
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MAP construction and transmission for a relay station

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1 Introduction

This contribution describes a way of MAP construction for multihop relay. For the construction of MAP at RS, some kinds of instruction is necessary from BS to RS regardless of whether the multihop relay network is centralized or distributed. However the transmission of the instruction between BS and RS consumes radio resource. This contribution proposes radio resource profile and coded MAP that reduce the transmission of instruction between BS and RS.
In order to facilitate the incorporation of this proposal in to IEEE 802.16j standard, specific changes to the baseline working document IEEE 802.16j-06/026[3] are listed in Section 6.

2 General Description

2.1 Reference Model

Figure 1 shows reference model of MAC level frame structure.

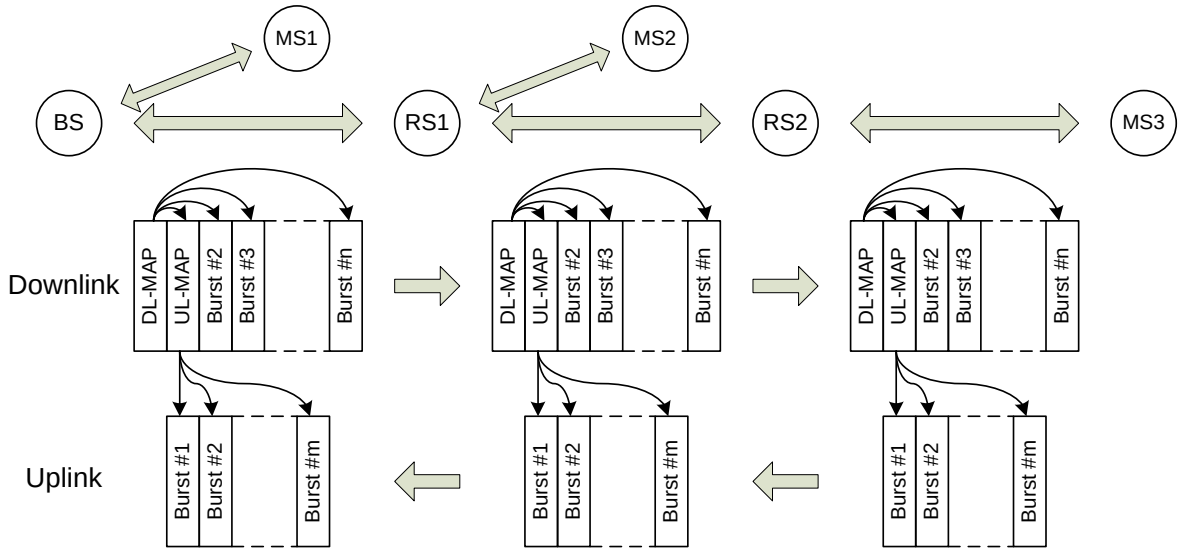

Figure 1 Reference Model of MAC Frame Structure

In 802.16e, BS generates DL-MAP and UL-MAP for radio resource allocation of downlink subframe and uplink subframe, respectively. For the coverage extension scenario[4], RS is expected to transmit DL-MAP and UL-MAP as well as BS. This contribution focuses on the MAP construction at RS.

3 Variety of MAP Construction in Multihop Relay

3.1 Instruction for Relay Station

3.1.1 MAP Instruction

Figure 2 shows the simplified figure for the transmission of data payload between BS and MS3 through two relay stations (RSs). When the data payload is exchanged, some kinds of instructions are needed for RSs to assist data and message forwarding.

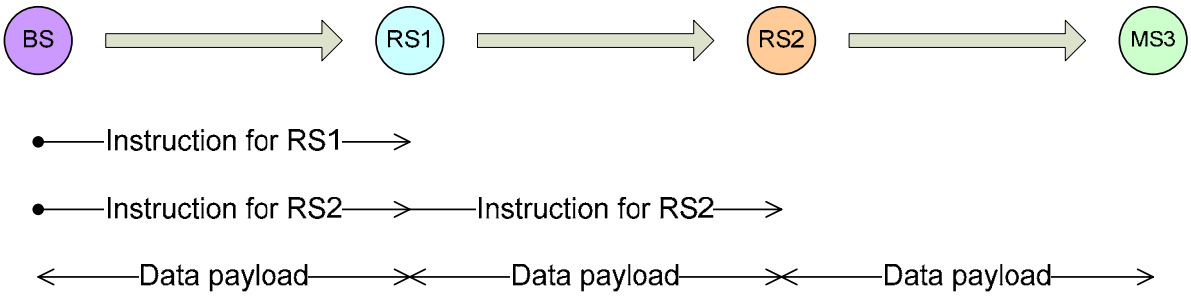

Figure 2 Simplified Figure for Data Payload Transmission

A typical instruction is for a MAP related instruction. BS may instruct RS1 what radio resource is available. Similarly, BS may instruct RS2 what radio resource is available. Required instruction depends on multihop relay operation discussed in section 4.

3.1.2 DL-MAP Based Instruction

Figure 3 shows DL-MAP based MAP instruction.

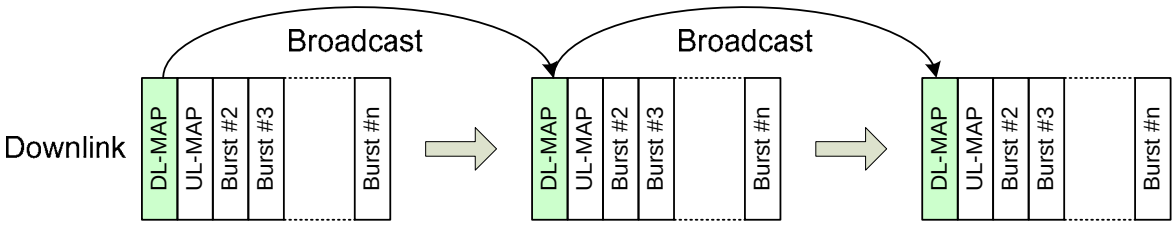

Figure 3 DL-MAP Based Instruction

DL-MAP is modified to include the MAP instruction for next hop.

3.1.3 DL-Burst Based Instruction

Figure 4 shows DL-burst based MAP instruction.

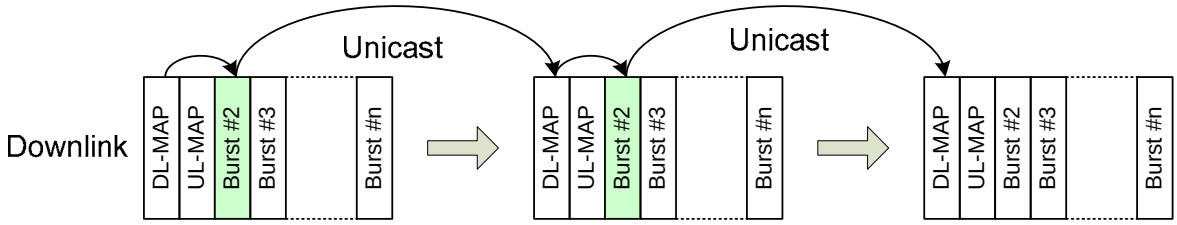

Figure 4 DL-Burst Based Instruction

DL-Burst includes the MAP instruction and is transmitted to next hop. New MAC management message defines the MAP instruction and is carried by basic CID.

3.1.4 Comparison

Table 1 shows comparison between DL-MAP based instruction and DL-burst based instruction.

Table 1 Comparison of Instruction Method

	MAP-based instruction	DL-burst-based instruction
CID	Broadcast CID	Basic CID (unicast)
Realization	Modification to DL-MAP_IE	New MAC Management Messages
Impact to the specification	Modify MAP_IE considering influences to 802.16e	Insert new subsection
Operation of Legacy MS	Ignore new fields of MAP_IE	Ignore if the basic CID is not for the MS

We propose to use the DL-burst based instruction because it is easier to handle the specification independent of the original texts of 802.16d/e[1][2].

3.2 Centralized and Distributed Operation

Two types of operation can be considered for multihop relay system. One is centralized operation and the other is distributed operation. Accurate definitions of the operation if the multihop relay is centralized system or distributed system is difficult. One of the definitions is a method of radio resources allocation that is defined as MAP in IEEE802.16. Each operation would have individual benefit.

- Amount of control message
  Centralized multihop relay may increase control overhead compared to distributed multihop relay due to its instruction messages from BS to RSs
- RS processing capability
  Distributed multihop relay may require an RS to have higher processing capability compared to that of centralized multihop relay due to localized operations
- Accuracy of link condition
  Centralized multihop relay may require BS to collect measurement reports of link condition for all possible paths and allocate appropriate radio resource. However the allocation may not be up-to-date compared to distributed system where RS may allocate radio resource in a distributed manner

- Use of memory size
  Distributed multihop relay may require an RS to have large memory compared to that of centralized multihop relay because localized processing.

Multihop relay should support both operations.

4 MAP Categorization for Multihop Relay

4.1 Centralized MAP

Centralized map is defined that BS provides detailed radio resource allocation for RS. Full set of or partial MAP is created at BS and informed to RS.

4.1.1 Full instruction

- BS creates full set of MAP and transmits it to RS
- Full set of MAP is encapsulated in a DL-burst
- The RS receives the full set of MAP from upstream station and simply rebroadcast it to downstream station as MAP
- The RS may not conduct reconstruction of MAC PDU
- RS just forward the MAC PDU according to the received MAP

4.1.2 Partial instruction

- BS prepares partial information for MAP creation at RS and transmits to the RS
- The RS receives partial MAP from upstream station, expands it to complete MAP, and transmits it to downstream station
- Several methods are considered to realize partial instruction

4.2 Distributed MAP

Distributed MAP is defined that RS creates MAP independently within given radio resource. Minimum amount of instruction is provided by BS.

4.2.1 Resource Reservation

- BS informs radio resource block reserved for the RS
- RS receives assigned radio resource block and create MAP and transmit it to downstream station
- RS may decide modulation and coding scheme (DIUC and UIUC)
- RS may conduct MAC level packet scheduling
- RS may equip queue buffer

4.3 New MAC Management Message

To accommodate all the categories, new MAC management message is introduced. The new MAC management message is relay instruction message (RLY-IST) as defined in section 6.

5 MAP Instruction Message Reduction

DL-MAP_IE specifies two dimensional radio resources. For PUSC of OFDMA PHY, following parameter sets are used.

- OFDMA Symbol Offset: 8bits
- Subchannel Offset: 6bits
- Number of OFDMA Symbols: 7bit
- Number of Subchannels: 6bit

Total 27 bits are used for radio resource allocation for one burst.
From backward compatibility viewpoints, RS is also required to transmit the DL-MAP_IE. If the multihop relay employs centralized operation, the information related to DL-MAP_IE should be transmitted from BS to RS.
Encapsulated DL-MAP_IE from BS to RS is a concept of complete centralized operation. However it consumes radio resources between BS and RS.
We propose coded MAP_IE method with radio resource profile to reduce the instruction.
Example of the radio resource profile for downlink is shown as Table 2. 8 bits downlink resource usage code (DRUC) is defined.

Table 2 Downlink radio resource profile example

Index No. (DRUC)	Start of subchannel No.	End of subchannel No.	Start of OFDMA Sym No.	End of OFDMA Sym No.	Remark
0x01	1	5	1	20	
0x02	6	12	1	20	
0x03	13	50	1	10	
0x04	13	50	11	20	
0xff					

The radio resource profile is sent by DCD and shared between BS and RS in advance. 8 bits DRUC is used to instruct the usage of radio resource for RS.

6 Proposed Text Change

6.3.2.3 MAC Management Messages

[Insert following row in Table-14]

Table––14 MAC Management Messages

Type	Message name	Message description	Connection
xx	RLY-IST	Relay station instruction	Basic CID

6.3.2.3. xx Relay station instruction (RLY-IST) message

[Insert following text and table]

The RLY-IST message instructs how to create broadcast messages for a relay station in downstream.

Table—xx RLY-IST message format

Syntax	Size (bits)	Notes
RLY_IST_message (){		
Management Message Type = xx	8	
RLY_IST_IE()	variable	see RLY_IST_IE
}		

Table—xx RLY_IST_IE types

RLY_IST Type	Description
0	Complete
1	Compressed (TBD)
2	Coded MAP type I
3	Coded MAP type II
4-7	reserved

Table—xx RLY_IST_IE for complete message

Syntax	Size (bits)	Notes
RLY_IST_IE(){		
RLY_IST Type=0	4	
Broadcast_messages	8	Type of broadcast message included in this message Bit#0=1, FCH is included Bit#1=1, DL-MAP is included, Bit#2=1, UL-MAP is included, Bit#3=1, DCD is included, Bit#4=1, UCD is included, Bit#5-7 Reserved
if bit#0==1{		
DL_Frame_Prefix_Format()	24	OFDMA downlink Frame Prefix format
}		
if bit#1==1{		
DL-MAP_Message_Format()	variable	
}		
if bit#2==1{		

Syntax	Size (bits)	Notes
UL-MAP_Message_Format()	variable	
}		
if bit#3==1{		
DCD_Message_Format()	variable	
}		
if bit#4==1{		
UCD_Message_Format()	variable	
}		
Padding	Variable	Padding bits to ensure Byte aligned
}		

Table–-xx RLY_IST_IE for coded MAP type I

Syntax	Size (bits)	Notes
RLY_IST_IE(){		
RLY_IST Type=2		
Broadcast_messages	8	Type of broadcast message included in this message Bit#0=1, FCH is included Bit#1=1, DL-MAP is included, Bit#2=1, UL-MAP is included, Bit#3=1, DCD is included, Bit#4=1, UCD is included, Bit#5-7 Reserved
if bit#0==1{		
FCH	24	
}		
If bit#1==1{		
DL-MAP	1	
Frame duration code	8	
Frame number	24	
DCD Count	8	
Base Station ID	48	
Coded_DL_MAP_IE(){	–	
DIUC	4	
if(DIUC==0 to 12){	–	
N_CID	8	
CID	16	
DRUC	8	
Boosting	3	

Syntax	Size (bits)	Notes
Repetition coding indication	2	
}		
}		
}		
}		

Table–-xx RLY_IST_IE for coded MAP type II

Syntax	Size (bits)	Notes
RLY_IST_IE(){		
RLY_IST Type=3		
Broadcast_messages	8	Type of broadcast message included in this message Bit#0=1, FCH is included Bit#1=1, DL-MAP is included, Bit#2=1, UL-MAP is included, Bit#3=1, DCD is included, Bit#4=1, UCD is included, Bit#5-7 Reserved
If bit#1==1{		
DRUC	8	granted radio resource for a relay station
Start frame number	8	
Duration	4	
Grant pattern	4	0x00 every frame 0x01 every second frame 0x02 every third frame 0x03 every fourth frame 0x04-0x0f reserved
}		
}		

6.3.6.7 Relaying support for scheduling

6.3.6.7.1 Distributed scheduling

[insert following text in this subsection]

In distributed scheduling, BS provides reserved radio resource block for RS. RS utilizes the radio resource block arbitrarily.

6.3.6.7.2 Centralized scheduling

[insert following text in this subsection]

In centralized scheduling, BS provides detailed radio resource allocation for RS.

11 TLV Encoding (11.xx)

[insert following subsection with appropriate numbering and table with appropriate numbering of type]

11.xx.xx.xx Downlink radio resource profile types

Type	Length	Value	Scope
xxx	5	Bit #0-7: DRUC Bit #8-15: OFDMA Symbol Offset Bit #16-23: Subchannel Offset Bit #24-31: Number of OFDMA Symbols Bit #32-39: Number of Subchannels	Relevant MAC Management Message and section

7 Reference

[1] IEEE Std 802.16-2004 “IEEE Standard for Local and Metropolitan Area Networks–Part 16: Air Interface for Fixed Broadband Wireless Access Systems”, IEEE Std 802.16™-2004 (Revision of IEEE Std 802.16-2001), October 1, 2005

[2] IEEE Std 802.16e-2005/802.16cor1, “IEEE Standard for Local and Metropolitan Area Networks–Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands,” 802.16E-2005 &802.16/COR1, ISBN: 0-7381-4857-1

[3] “P802.16j Baseline Document,” IEEE 802.16j-06/026, October 12, 2006 (http://ieee802.org/16/relay/docs/80216j-06_026.pdf)

[4] J. Sydir, “Usage Models,” IEEE 802.16j-06/015, September 5, 2006, (http://ieee802.org/16/relay/docs/80216j-06_015.pdf)