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Re:	IEEE 802.16j-06/027: "Call for Technical Proposals regarding IEEE Project P802.16j"
Abstract	This contribution describes the proposed frame structure for supporting both relay link and access link in a single TDD OFDMA frame.
Purpose	Propose the frame structure for IEEE 802.16j specification
Notice	
Release	
Patent Policy and Procedures	

Proposal for Relaying Frame Structure

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1 Introduction

This contribution proposes a frame structure to support both relay links and access links in a TDD OFDMA frame. Based on the related contributions [1]-[3] and discussion for relaying frame structure in past MMR SG meetings and Relay TG meetings, we explain how to support backward compatibility for access link and capability for relay link in the frame structure.

2 Description of Proposed Relaying Frame Structure

2.1 Example of relay system for illustration

To help for description of the proposed relaying frame structure, we depict a simple relay system in Figure 1, which consists of an MR-BS, three RSs, and four MSs. RS1 directly connects with MR-BS via a radio link and supports a coverage area which is fully overlapped within the coverage of MR-BS for throughput enhancement purpose. RS2 connects with MR-BS via a two-hop connection through RS1 (i.e., RS1 is the one-hop super-ordinate of RS2). RS3 directly connects with MR-BS and support a coverage area that is possibly non-overlapped within the coverage of MR-BS for coverage extension purpose. Based on the relay system, we can explain how to specify a relaying frame structure to support throughput enhancement, coverage extension, and multihop relay.

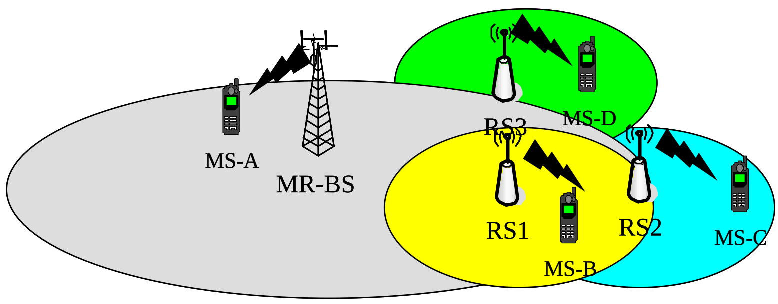

Figure 1 Example of a relay system

2.2 Downlink frame Consideration

To employ TDD mode for a multihop system, an OFDMA TDD frame should be partitioned into several fields to support both access links and relay links. Within DL subframe, a legacy MS shall detect preamble, FCH, and MAP to get downlink synchronization, start-of-frame time, and resource allocation information. Therefore, the format of preamble, FCH, and MAP for MR-BS and RSs shall be the same as the specifications in IEEE 802.16-2004 and IEEE 802.16e-2005 to support backward compatibility. An RS may transmit preamble, FCH, MAP and DL bursts for one-hop subordinate MSs and RSs dependent of operation conditions. The most general and simple manner is to enable each RS to transmit its individual preamble, FCH, and MAP in non-overlapped OFDMA symbols to support downlink synchronization, start-of-frame time, and resource allocation for its one-hop subordinate MSs and/or RSs. Therefore, the general DL subframe for relay can be shown as Figure 2.

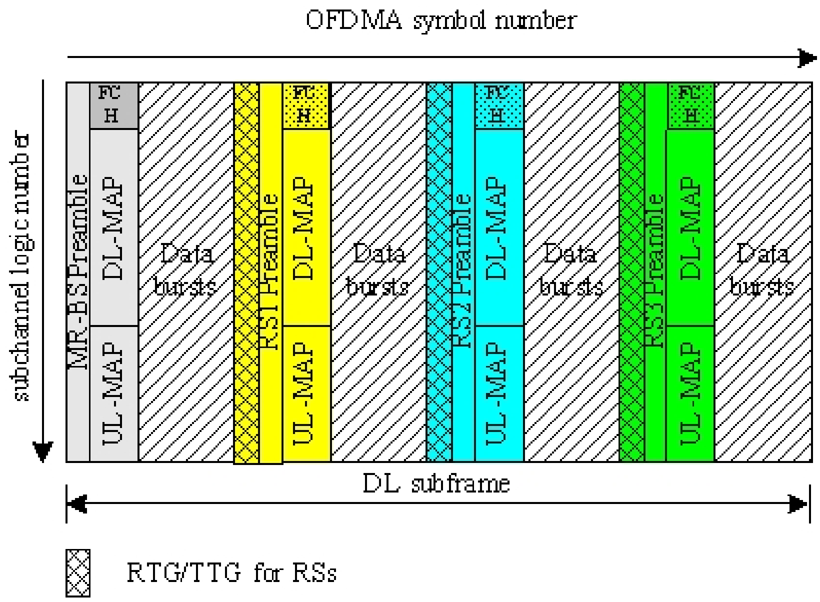

Figure 2 General DL subframe in relaying frame structure

However, for the relay system in Figure 1, RS1 has a coverage area fully overlapped within the coverage of MR-BS so that it can enable relaying without transmission of preamble, FCH, and MAP. All one-hop subordinate MSs and RSs of RS1 can get downlink synchronization, start-of-frame time, and resource allocation by detecting preamble, FCH, and MAP from MR-BS, respectively. Therefore, the OFDMA symbols (marked by yellow block) for RS1 RTG, preamble, FCH, and MAP can be reallocated for data bursts. On the other hand, RS2 and RS3 has a coverage area partially overlapped or fully disjointed with the coverage of MR-BS so that it shall transmit individual preamble, FCH, and MAP for its one-hop subordinate MSs and RSs.

Since preamble and FCH are used to support downlink synchronization and notice the start-of-frame time, the position of an RS preamble can be configured dependent on the requirements of relay network operation but it shall be fixed to maintain a fixed start-of-frame time for one-hop subordinate MSs and/or RSs. Figure 3 shows distributed and compact allocation for frame header (RTG, preamble, FCH, and MAP). For distributed allocation, all frame headers are separated by data parts so that MAPs can be extended if there are more active radio links to be allocated in MAPs. Since all data bursts are allocated with a reference time to the synchronized preamble, part 1 of data bursts can only be allocated by MR-BS MAP and part 2 of data bursts can only be allocated by MR-BS and RS2 MAPs while part 3 of data bursts can be allocated by all MAPs. By contrast, compact allocation lets data bursts behind all MAPs and be allocated by all MAPs. However, each MAP has a fixed size after configuration done.

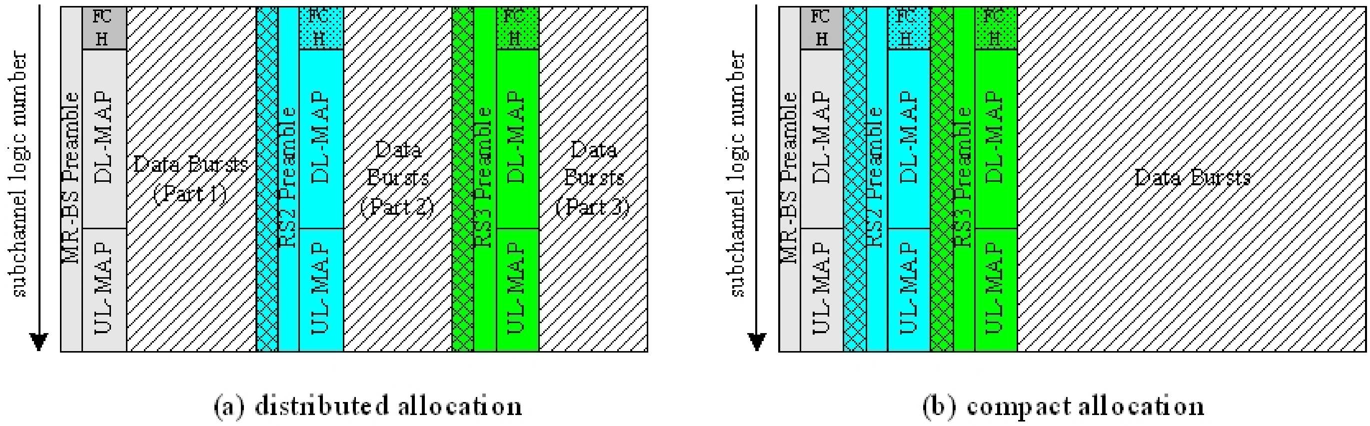

Figure 3 Example for frame header allocation in the multihop relay system.

Regardless distributed allocation or compact allocation, data bursts can be dynamically shared in TDM (time-division multiplexing) manner for BS, RS1, RS2 and RS3 transmissions. The purpose of TDM-based sharing manner is to guarantee the pilot reception for MSs under permutation for subchannel configuration.

2.3 Uplink subframe Consideration

Within UL subframe, there are two major parts. The first part is allocated for access links to support uplink transmissions of MSs and the other part is allocated for relay link to support uplink transmissions of RSs. The first part is the same as the UL-subframe where all MS UL bursts and ranging subchannel are allocated in the same ways specified in IEEE 802.16-2004 and IEEE 802.16e-2005. The second part is allocated for RSs uplink transmissions. Since RSs should receive MSs uplink data bursts from access links and transmit uplink data burst in relay links, the two parts shall be allocated in TDM manner to avoid reception and transmission at same time for RSs and block allocations are proposed to use for UL bandwidth allocations of relay links.

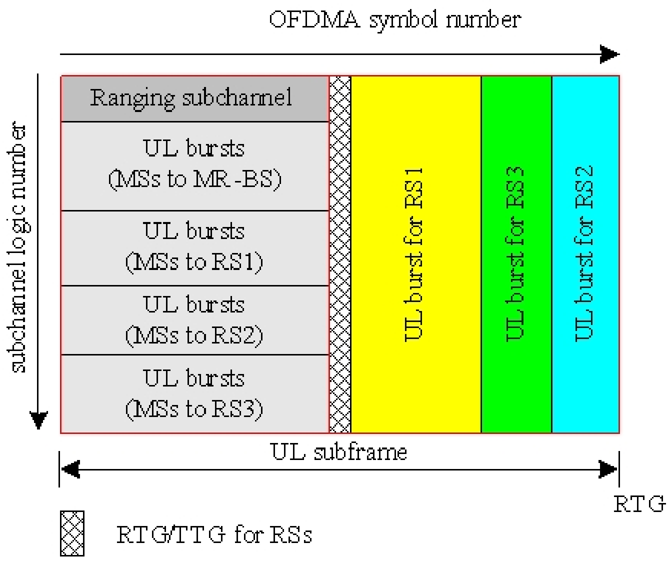

Figure 4 General UL subframe in relaying frame structure

As shown in Figure 4, uplink allocation for access links and relay links are partitioned in time domain. For access links, there are further partitioned into ranging subchannel and some uplink bursts the same as the specifications in IEEE 802.16-2004 and IEEE 802.16e-2005. For legacy MSs, ranging subchannel is used to transmit CDMA initial ranging, periodic CDMA ranging, and bandwidth request. Here, we propose that RSs shall transmit their initial ranging in ranging channel by the same procedure of MS initial ranging. After an RS successfully enters the network, its can perform RS periodic ranging and send bandwidth request in dedicate uplink bursts because each RS shall periodically provide feedback information to maintain the relay system.

Ranging channel can be aggregate allocations for MR-BS and RSs or separate allocations for each MR-BS or RS. To aggregate a common ranging subchannel, MR-BS and RSs shall notify same ranging channel allocation in their MAPs while they can indicate separate allocations for their individual ranging channel as shown in

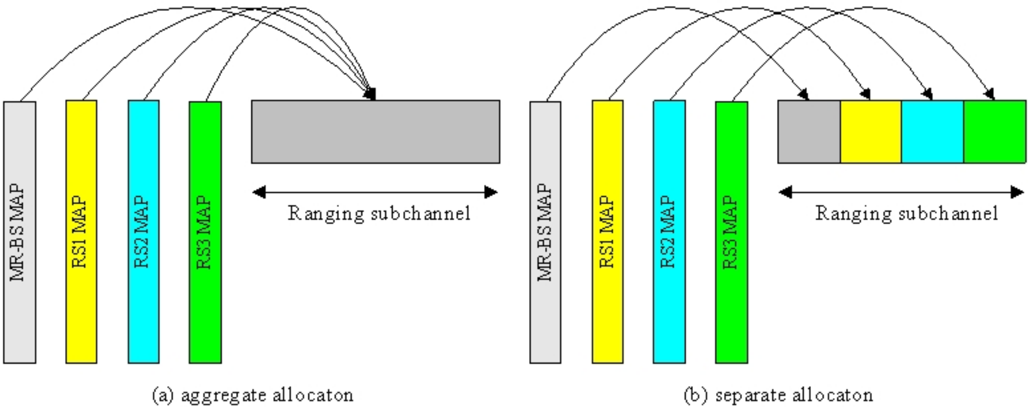

Figure 5. When a new RS camps on the relay network, the associate MR-BS shall determine to adopt aggregate allocations or split allocations schemes.

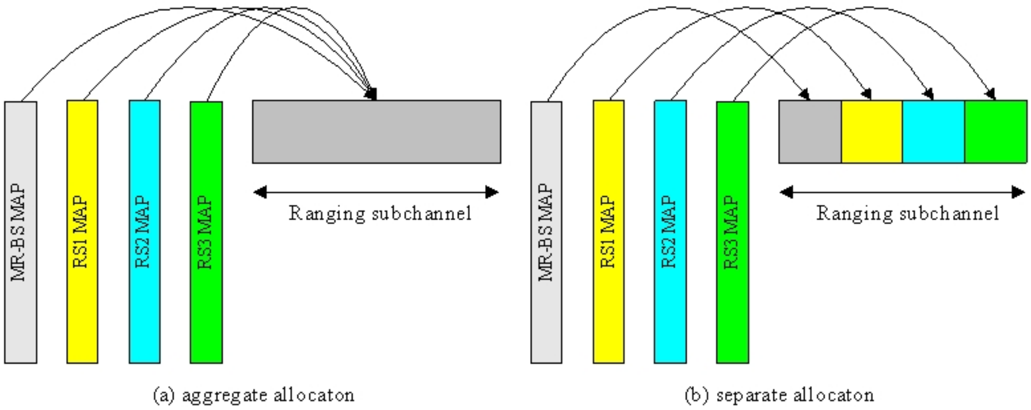

Figure 5 UL ranging channel partition method

To support slot allocations for UL bandwidth allocations in access links, a virtual UL burst allocation is proposed shown in Figure 6.

[1] RS1 allocates a virtual UL burst to address the number of slots allocated for uplink from MSs to MR-BS.

[2] RS2 allocates a virtual UL burst to address the number of slots allocated for uplink from MSs to MR-BS and RS1.

[3] RS3 allocates a virtual UL burst to address the number of slots allocated for uplink from MSs to MR-BS, RS1 and RS2.

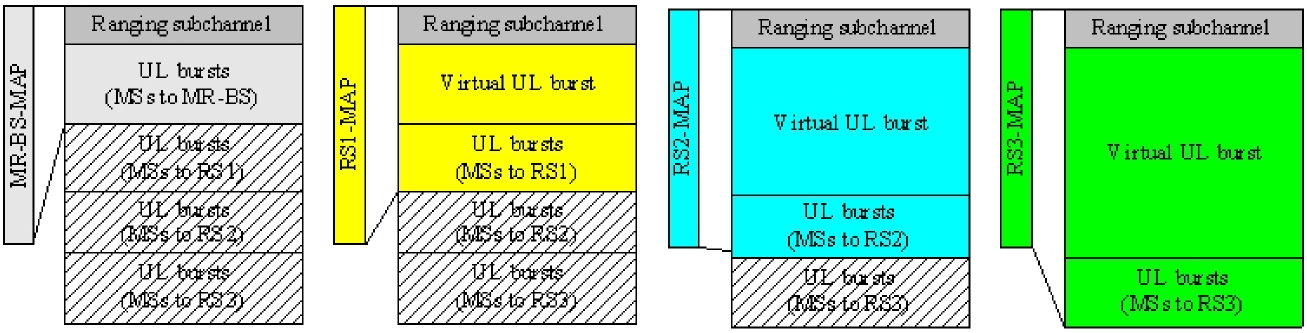

Figure 6 Virtual UL burst allocation

3 Proposed Text

[Add the following text into section 8.4.4.8]

8.4.4.8 Relaying Frame Structure

In TDD relaying systems, an MR-BS shall coordinate the bandwidth allocation for radio links in each hop. In DL-subframe, the MR-BS shall allocate DL bursts for direct access MSs and one-hop subordinate RSs to transmit downlink information. Downlink bandwidth allocation is specified as block allocations (subchannel by symbol) with an absolute offset. However, the downlink burst for an RS shall occupy all subchannels to provide complete pilot transmission within the allocated symbols. If an RS is configured to transmit individual preamble, FCH, MAP, the start time of respective downlink burst shall be fixed in each frame to keep a constant start-of-frame time for those stations camped on the RS. On the other hand, if an RS does not transmit individual preamble, FCH, MAP, the start time of DL burst for the RS can be changed frame-by-frame.

In UL subframe, it shall be partitioned two mandatory zones. The first zone, including ranging subchannel and MS uplink burst, is the same as PMP frame structure specified in section 8.4.4.2. The second zone is used to support RS uplink bursts. RS uplink burst is assigned by block allocations and each RS cannot be assigned uplink bursts to transmit to one-hop super-ordinate RS or MR-BS and receive from one-hop subordinate RSs within same symbols.

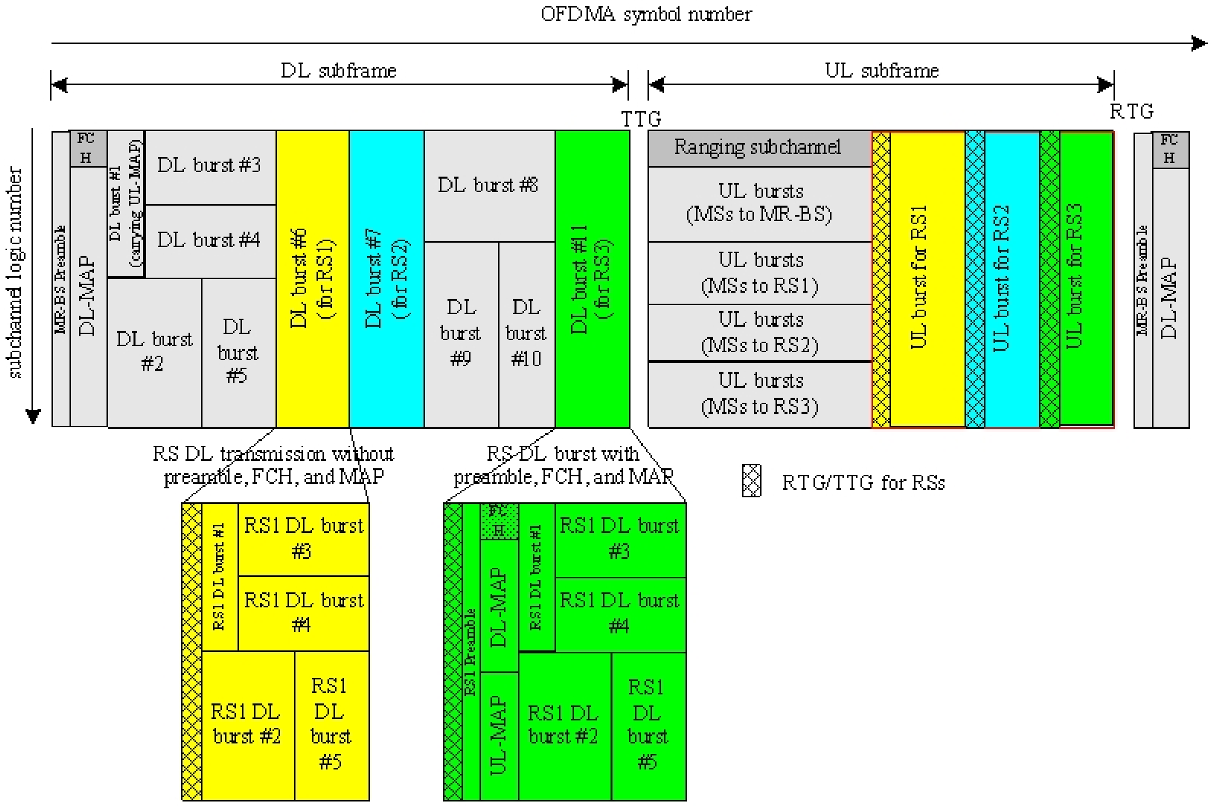

Figure xxx – Example of relaying frame in TDD mode

8.4.5.4 UL-MAP IE format

[Change text in 8.4.5.4 as indicated]

The OFDMA UL-MAP IE defines uplink bandwidth allocations. Uplink bandwidth allocations are specified either as block allocations (subchannel by symbol) with an absolute offset, or as an allocation with duration in slots with either a relative or absolute slot offset. Block allocations are used for fast feedback (UIUC=0), CDMA ranging and BW request allocations (UIUC=12) as well as PAPR/Safety zone allocations (UIUC=13) and Relay zone allocations (UIUC=15, extended UIUC=0B). Slot allocations are used for all other UL bandwidth allocations for MSs. For UL allocations in non-AAS zones, the starting position for the allocation is determined considering the prior allocations appearing in the UL-MAP. For UL allocations in an AAS UL Zone, the starting position is included in the UL IE indicating an absolute slot offset from the beginning of the AAS zone. If an OFDMA UL-MAP IE with UIUC = 0 or UIUC = 12 or UIUC = 13 exists, they shall always be allocated first.

For the first OFDMA UL-MAP IE, with UIUC other than 0, 12, 13, or with extended UIUC other than 0x0B, the allocation shall start at the lowest numbered non-allocated subchannel on the first non-allocated OFDMA symbol defined by the allocation start time field of the UL-MAP message that is not allocated with UIUC = 0 or UIUC = 12 or UIUC = 13 (See Figure 217 for an example). These IEs shall represent the number of slots provided for the allocation. For allocations not in an AAS zone, each allocation IE shall start immediately following the previous allocation and shall advance in the time axis. If the end of the UL zone has been reached, the allocation shall continue at the next subchannel at first OFDMA symbol allocated to that zone that is not allocated with UIUC = 0 or UIUC = 12 or UIUC = 13. The CID represents the assignment of the IE to either an unicast, multicast, or broadcast address. A UIUC shall be used to define the type of uplink access and the burst type associated with that access. A Burst Descriptor shall be specified in the UCD for each UIUC to be used in the UL-MAP. For further details on allocations in an UL AAS zone, see 8.4.4.6.

8.4.5.4.4.1 UL-MAP extended IE format

[Modify Table 290a as indicated]

Table 290a Extended UIUC Code Assignment for UIUC=15

Extended UIUC (hexadecimal)	Usage
00	Power_control_IE
01	Mini-subchannel_allocation_IE
02	AAS_UL_IE
03	CQICH_Alloc_IE
04	UL Zone IE
05	PHYMOD_UL_IE
06	MIMO_UL_Basic_IE
07	UL-MAP_Fast_Tracking_IE
08	UL_PUSC_Burst_Allocation_in_Other_Segment_IE
09	Fast_Ranging_IE
0A	UL Allocation Start IE
0B	UL_Relay_IE
0C … 0F	Reserved

[Insert new subclause 8.4.5.4.29]

8.4.5.4.29 UL_Relay IE format

In the UL-MAP, an MR-BS may transmit UIUC = 15 with the UL_Relay_IE() to indicate that the subsequent allocations shall be used for relay traffic.

Table xxx UL_Relay IE format

Syntax	Size	Notes
Relay_Zone_Allocation_IE(){	—	—
Extended UIUC	4 bits	Relay_Zone=0x0B
Length	4 bits	Length=0x05
OFDMA symbol offset	8 bits	—
Subchannel offset	7 bits	—
No. OFDMA symbols	7 bits	—
No. subchannels	7 bits	—
RTG/TTG index	1 bit	0=No need of RTG or TTG in the block allocation. 1=Yes, the first symbol in this block allocation is used for RTG or TTG.
Reserved	2 bits	Shall be set to zero
}	—	—

10.4 Well-known addresses and identifiers

[Modify Table 345 as indicated]

Table 345—CIDs

CID	Value	Description
Initial Ranging	0x0000	Used by SS and BS during initial ranging process.
Virtual CID	0x0001	Used to indicate virtual UL burst
Basic CID	0x0002 - m	The same value is assigned to both the DL and UL connection.
Primary management	m+1 - 2m	The same value is assigned to both the DL and UL connection.
Transport CIDs, Secondary Mgt CIDs	2m+1 - FE9F	For the secondary management connection, the same value is assigned to both the DL and UL connection.
Multicast CIDs	0xFEA0 - 0xFEFE	For the downlink multicast service, the same value is assigned to all MSs on the same channel that participate in this connection.
AAS initial ranging CID	0xFEFF	A BS supporting AAS shall use this CID when allocating an AAS Ranging period (using AAS Ranging Allocation IE).
Multicast polling CIDs	0xFF00 - 0xFFFC9	A BS may be included in one or more multicast polling groups for the purposes of obtaining bandwidth via polling. These connections have no associated service flow.
Normal mode multicast CID	0xFFFA	Used in DL-MAP to denote bursts for transmission of DL broadcast information to normal mode MS.
Sleep mode multicast CID	0xFFFB	Used in DL-MAP to denote bursts for transmission of DL broadcast information to Sleep mode MS. May also be used in MOB_TRF-IND messages.
Idle mode multicast CID	0xFFFC	Used in DL-MAP to denote bursts for transmission of DL broadcast information to Idle mode MS. May also be used in MOB_PAG-ADV messages.
Fragmentable Broadcast CID	0xFFFD	Used by the BS for transmission of management broadcast information with fragmentation. The fragment sub header shall use 11-bit long FSN on this connection.
Padding CID	0xFFFE	Used for transmission of padding information by SS and BS.
Broadcast CID	0xFFFF	Used for broadcast information that is transmitted on a downlink to all SS.

4 References

[1] IEEE C802.16mmr-05/027r2, Recommendation on PMP Mode Compatible TDD Frame Structure (Fang-Ching Ren, Chang-Lung Hsiao, Chun-Chieh Tseng, and Wern-Ho Sheen; 2005-11-16)

[2] IEEE C802.16j-06/002, Some Considerations on Mobile Multi-hop Relay Based System (Aimin Zhang, Zheng Shang, Yuanyuan Wang, John Lee; 2006-05-02)

[3] IEEE C802.16j-06/004r1, Recommendations on IEEE 802.16j (Gang Shen, Xiaobing Leng, Wei Zou, Wei Ni, Kaibin Zhang, Shan Jin, Torsten Fahldieck, Roland Muenzner; 2006-04-30)