Project	IEEE 802.16j Mobile Multihop Relay Task Group
Title	MDHO and FASS for MMR Networks – Topology Acquisition
Date	2007-03-05
Source(s	Koon Hoo Teo, Shengjie Zhao Voice: 617-621-{7527, 7545, 7557, 7595} 617 Jeffrey Tao, Jinyun Zhang Fax: 617-621-7550 Mitsubishi Electric Research Lab {sizhao,teo, tao, jzhang}@merl.com 201 Broadway Cambridge, MA 02139 USA Toshiyuki Kuze Voice: +81-467-41-2885 Mitsubishi Electric Corp Fax: +81-467-41-2486 5-1-1 Ofuna Kamakura, Kanagaw Kuze.Toshiyuki@ah.MitsubishiElectric.co.jp 2478501, Japan
Re:	Response to the call for technical proposal regarding IEEE Project 802.16j (i.e., IEEE 802.16j-07/007r2, “Call for Technical Comments and Contributions regarding IEEE Project P802.16j”, Feb 02, 2007).
Abstract	This contribution describes MDHO and FASS Network Topology Acquisition for MMR network
Purpose	The contribution is provided as input for the IEEE 802.16j amendment
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussic and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE’s name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE’s sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributc also acknowledges and accepts that this contribution may be made public by IEEE 802.16.
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Macro Diversity Handover and Fast Access Station Switching for MMR Networks– Topology Acquisition

Koon Hoo Teo, Shengjie Zhao , Jeffrey Tao, Jinyun Zhang
Mitsubishi Electric Research Lab
201 Broadway
Cambridge, MA 02139 USA

Toshiyuki Kuze
Mitsubishi Electric Corp
5-1-1 Ofuna Kamakura, Kanagawa
2478501, Japan

Table of Contents

Macro Diversity Handover and Fast Access Station Switching for MMR Networks– Topology Acquisition

Koon Hoo Teo, Shengjie Zhao , Jeffrey Tao, Jinyun Zhang
Mitsubishi Electric Research Lab
201 Broadway
Cambridge, MA 02139 USA

Toshiyuki Kuze
Mitsubishi Electric Corp
5-1-1 Ofuna Kamakura, Kanagawa
2478501, Japan

1. Introduction

In this proposal, we discuss the MAC MDHO and FASS handover network topology acquisition procedures and corresponding MAC management messages over relay links so that an IEEE 802.16e compliant MS can handover seamlessly within an IEEE 802.16j network.

.

In the simple HO mode the MS communicates with just one access station, which allows only low speed mobility (portability or simple mobility). For higher speed mobility (full mobility) FASS and MDHO are implemented. In MDHO mode MS can communicate simultaneously with all active stations in a diversity active set. In uplink (downlink), active access stations or network (MS) are capable of diversity combining of received signals. In contrast to MDHO, in FASS the data are sent to all active stations in diversity active set but without diversity combining and the data are processed in anchor station only. This handover type does not need to use explicit handover signaling messages when anchor station is changed.

2. Definitions and terminologies used in this contribution

Anchor Station : A station where a MS or MRS is synchronized, performs ranging and monitors the downlink for control information. The anchor station can be a RS, BS, or MR-BS.

Fast Access Station Switching (FASS): Method by which an MS can change its access station frame to frame depending on the station selection mechanism. The access station can be an RS, BS, or MMR-BS. The MS is transmitting/receiving data to/from one of the active stations (the anchor station) during any given frame.

Macro Diversity Handover (MDHO): The process in which a mobile station (MS) migrates from the air-interface provided by one or more access stations to the air-interface provided by one or more other access stations. This process is accomplished in the downlink (DL) by having two or more access stations transmitting the same MAC/PHY protocol data unit (PDU) to the MS such that diversity combining can be performed by the MS. In the uplink (UL) it is accomplished by having two or more access stations receiving (demodulating, decoding) the same PDU from the MS, such that diversity combining of the received PDU can be performed among the access stations.

Active Station: A station that is informed of the necessary MS or MRS MAC/PHY information to enable it to provide access to the MS or MRS in the context of macro diversity.

MMR Diversity Set: The list of active stations of a given MS. This set is applicable to macro diversity handover, cooperative relay, and fast access station switching.

Serving Station: For any MS, the serving station is the station with which the MS has most recently completed registration at initial entry or during a handover. A serving station can be a BS or MMR-BS.

Neighbor Station: For any MS or RS, a neighbor station is a station (other than the anchor station) whose downlink transmission can be received by the MS or RS. A neighbor station can be a RS, BS, or MMR-BS.

Target Access Station: A station which is the primary candidate for MS network access following a handover. The target access station can be an RS, BS, or MMR-BS.

Target Anchor Station: For any MS or MRS, the station which is the primary candidate to be the anchor station following a handover. A target anchor station can be a RS, BS or MR-BS.

Target Serving Station: A station which is the primary candidate for MS registration following a handover. The target serving station can be a BS or MMR-BS.

3. Problem Statement

Due to the introduction of RSs in to the network infrastructure, there are two main categories of MDHO or FASS handover:

(1) Intra MR-BS handover the diversity set is updated among a group of RSs or the MR-BS controlled by the same serving MR-BS which consists of four cases:
Case 1: the current anchor station and target anchor station is MR-BS ;
Case 2: the current anchor station is RS and target anchor station is MR-BS ;
Case 3: the current anchor station is MR-BS and target anchor station is RS ;
Case 4: the current anchor station and target anchor station is the same RS ;
Case 5: the current anchor station and target anchor station is the different RSs ;

(2) Inter MR-BS handover if the diversity set is updated among a group of RSs controlled by the multiple MR-BSs which consists of four cases:
Case 6: the current anchor station and target anchor station is the different MR-BSs ;

Case 7: the current anchor station is MR-BS and target anchor station is RS controlled by the different MR-BS ;

Case 8: the current anchor station is RS and target anchor station is MR-BS in a different MR-cell ;

Case 9: the current anchor station and target anchor station are the different RSs and also they are located in different MR-cells.

The signaling between the involved access stations occurs over the wireless relay links as well as over the wired backbone. In MMR networks, to make RSs more efficient and simpler, new MAC management messages over relay links are required. Handover procedure can be different depending on the coordination between an MR-BS and its subordinate RSs with regards to broadcast control messages such as preamble, FCH, DL-MAP, UL-MAP, DCD and UCD. In a synchronous broadcast system only the MR-BS transmits all the broadcast control messages or RSs in the same MR-cell would forward the same broadcast control messages. In asynchronous broadcast system a RS can transmit its own preamble, FCH, DL-MAP, UL-MAP, DCD, and UCD. The contribution discusses the MDHO handover and FASS handover in MR-cell network and defines the MAC handover procedure for an asynchronous broadcast system. The proposed MAC handover procedure and MAC messages will enable 802.16e compliant MS to handover seamlessly following the handover procedure defined in sub-clause 6.3.22 of 802.16e-2005. The proposed schemes in this contribution will address the network topology advertisement. In contribution [1] and [2] we address handover decision, initiation, execution and termination.

3.1 Macro diversity handover and fast access station switching

The MDHO or FASS capability can be enabled or disabled in the REG-REQ/RSP message exchange. With MDHO or FASS enabled, the MS shall perform the following stages:

--- MDHO Decision: A MDHO begins with a decision for an MS to transmit to and receive from multiple MR-BS and/or RSs at the same time. A MDHO can start with either MOB_MSHO-REQ message by the MS or MOB_BSHO-REQ message by the anchor station.

--- FASS Decision: A FBSS handover begins with a decision for an MS to receive/transmit data from/to the anchor station that may change within the Diversity Set. A FASS handover can be triggered by either MOB_MSHO-REQ by the MS or MOB_BSHO-REQ message by the anchor station.

--- Diversity Set Selection/Update: An MS may scan the neighbor stations and to select those stations that are suitable to be included in the diversity set. The MS shall report the selected stations. The diversity set update procedure shall be performed by the anchor station and the MS.

--- Anchor Station Selection/Update: an MS is required to continuously monitor the signal strength of the stations that are included in the diversity set. The MS shall select one station from its current Diversity Set to be the Anchor station and reports the selected anchor station on CQICH or MOB_MSHO-REQ messages.

4. Topology of MDHO and FASS handover

This section summarizes new MAC management message exchange flows and topology with regard to the related MDHO and FASS handover for the nine cases which is depicted in Figure1 1-9. In these figures, the solid arrowed lines denote the MS handover direction and the dotted arrowed lines the anchor update direction.

Figure 1 depicts handover case 1 Intra MR-BS handover, the current anchor station and target anchor station

Shared the same MR-BS and only diversity set updates in the same MR cell. Figure 2 depicts handover case 2 Intra MR-BS handover, the current anchor station is RS 1 and target anchor station is its serving MR-BS. Figure 3 depicts the handover for case 3 Intra MR-BS handover, the current anchor station is MR-BS and target anchor station is its RS 4 in the same MR-BS. Figure 4 depicts the handover case 4 Intra MR-BS handover, the current anchor station and target anchor station is the same RS. Figure 5 depicts the handover case 5 Intra MR-BS handover, the current anchor station and target anchor station are the different RSs, but still in the same MR cell. Figure 6 depicts the handover case 6 Inter MR-BS handover, the current anchor station and target anchor station is the different MR-BSs. Figure 7 depicts the handover for case 7 Inter MR-BS handover, the current anchor station is MR-BS and target anchor station is RS controlled by the different MR-BS. Figure 8 depicts the handover for case 8 Inter MR-BS handover, the current anchor station is RS and target anchor station is MR-BS in a different MR-cell. Figure 9 depicts the handover for case 9 Inter MR-BS handover, the current anchor station and target anchor station are the different RSs and also they are located in different MR-cells.

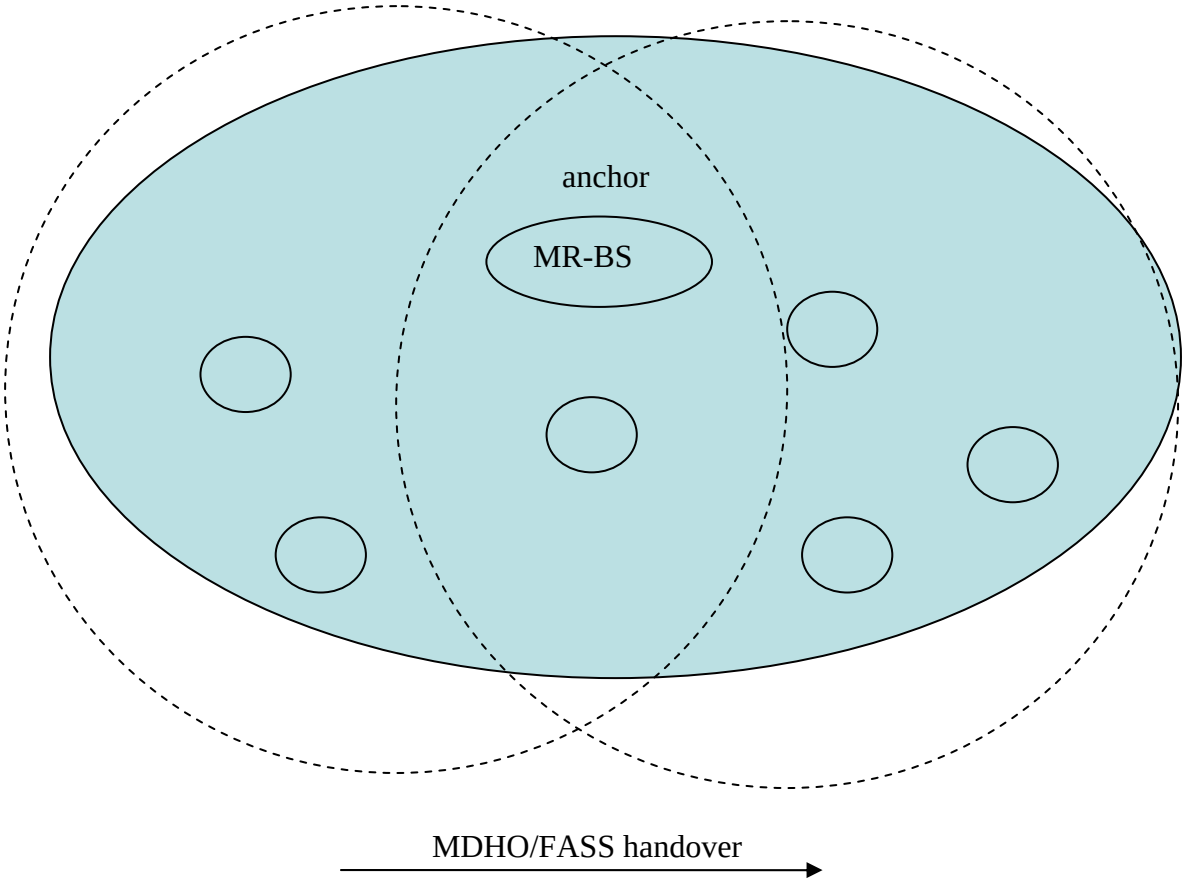

Figure 1 : Intra MR-BS handover, the current anchor station and target anchor station is the same MR-BS

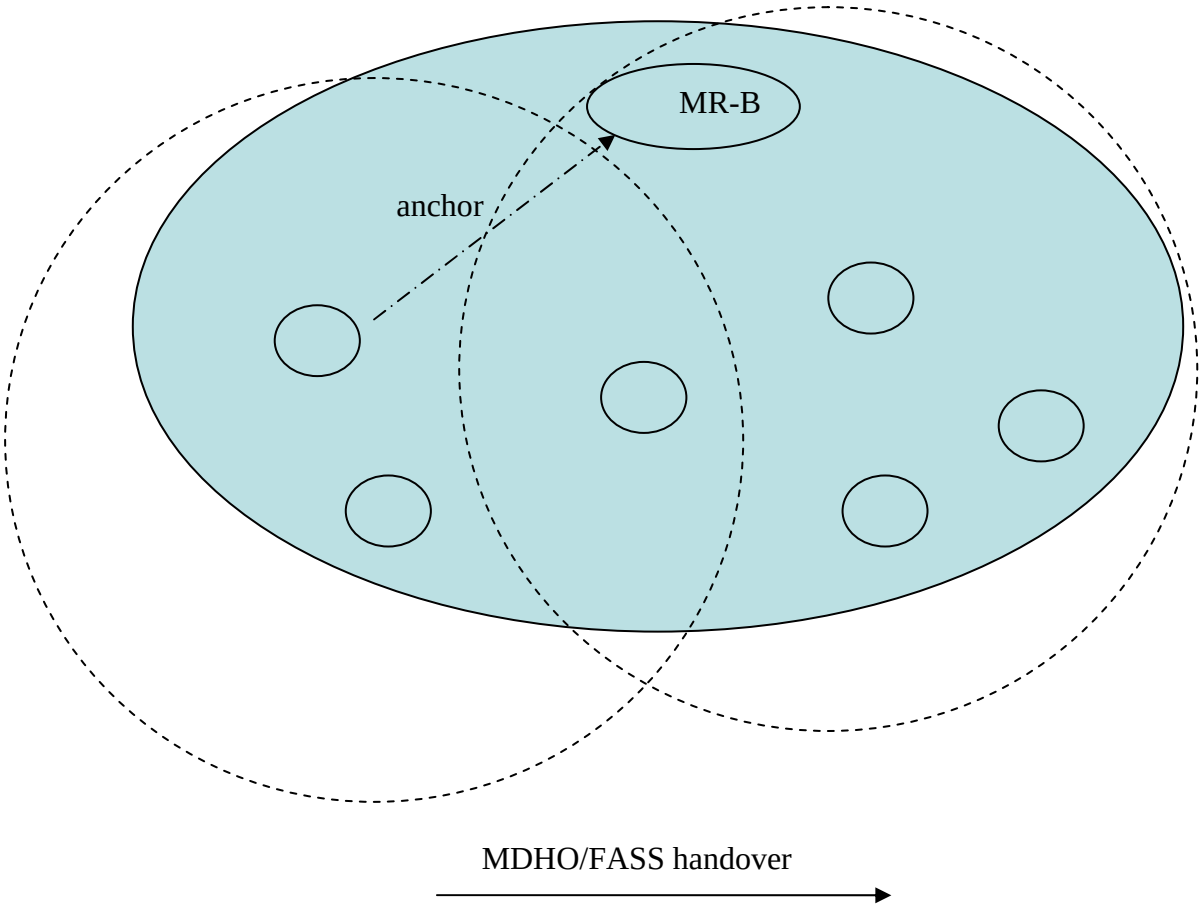

Figure 2 : Intra MR-BS handover, the current anchor station is RS 1 and target anchor station is its MR-BS

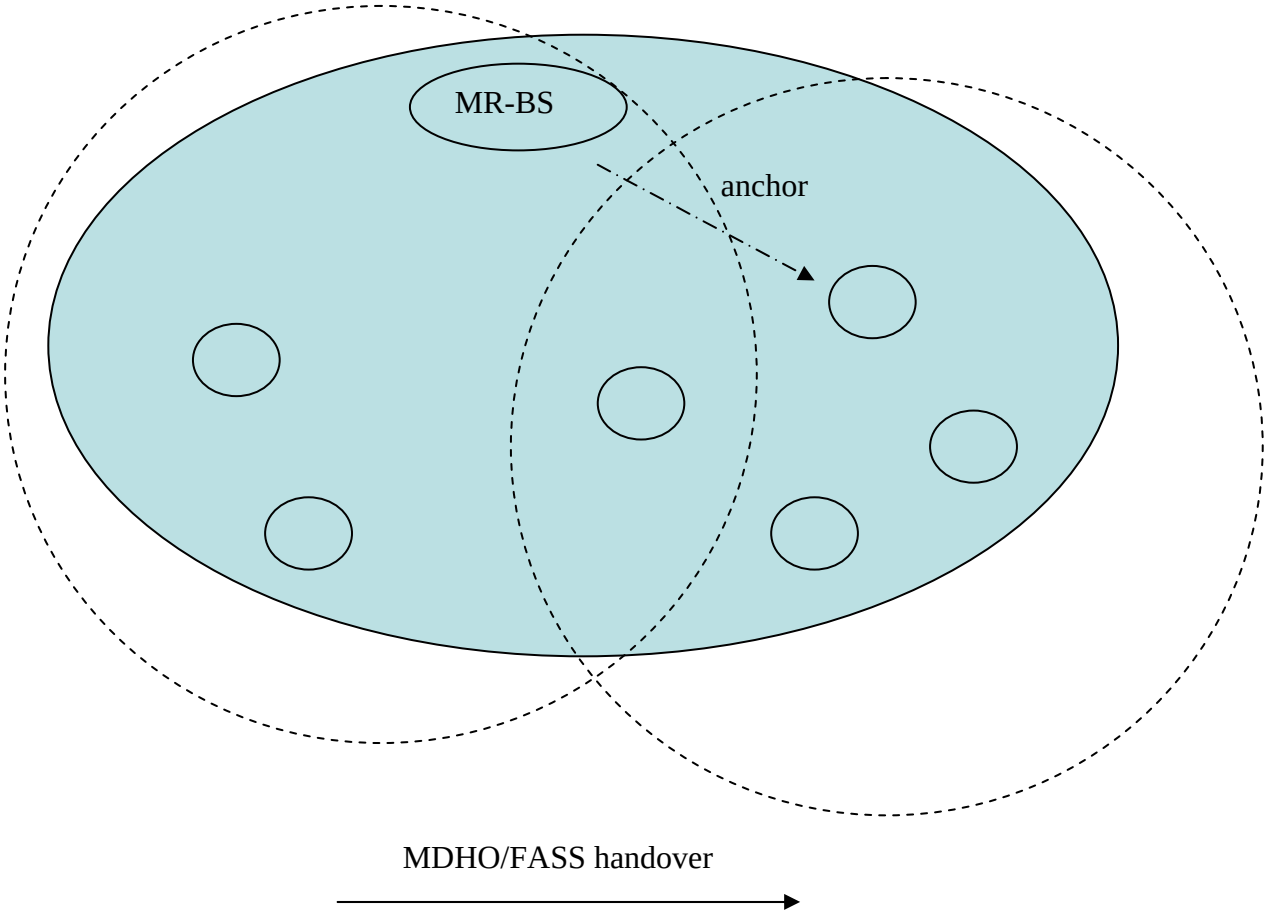

Figure 3 : Intra MR-BS handover, the current anchor station is MR-BS and target anchor station is its RS 4 in the same MR cell

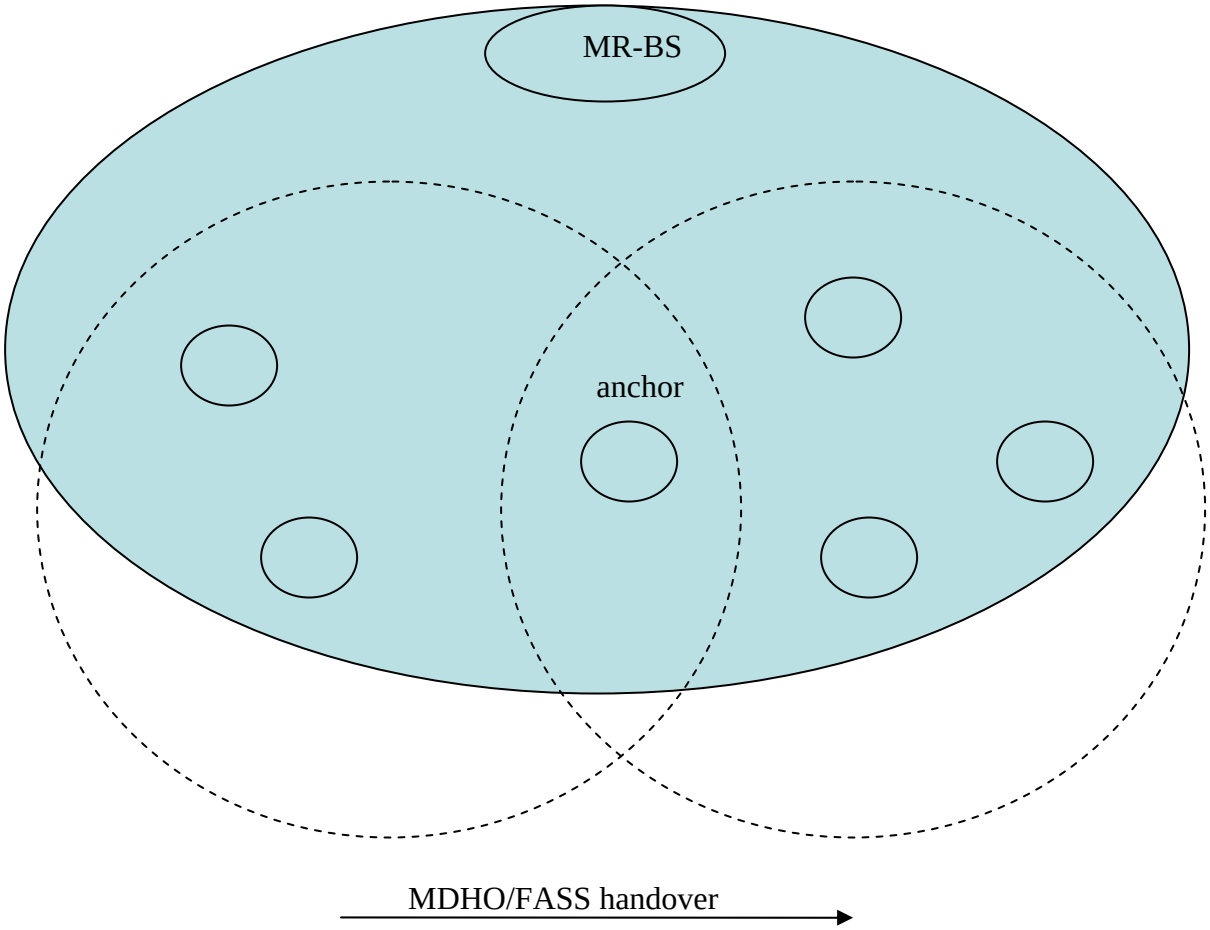

Figure 4 : Intra MR-BS handover, the current anchor station and target anchor station is the same RS

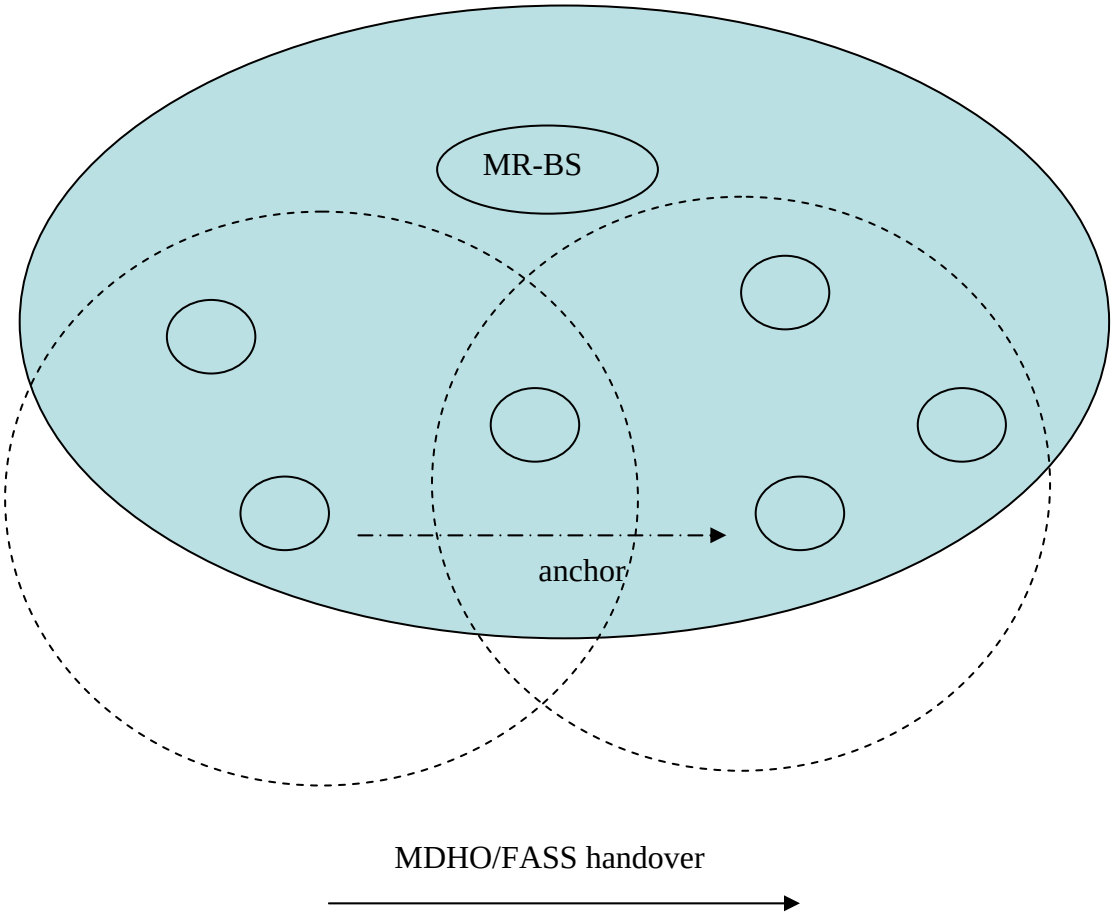

Figure 5 : Intra MR-BS handover, the current anchor station and target anchor station is the different RSs in the same MR cell

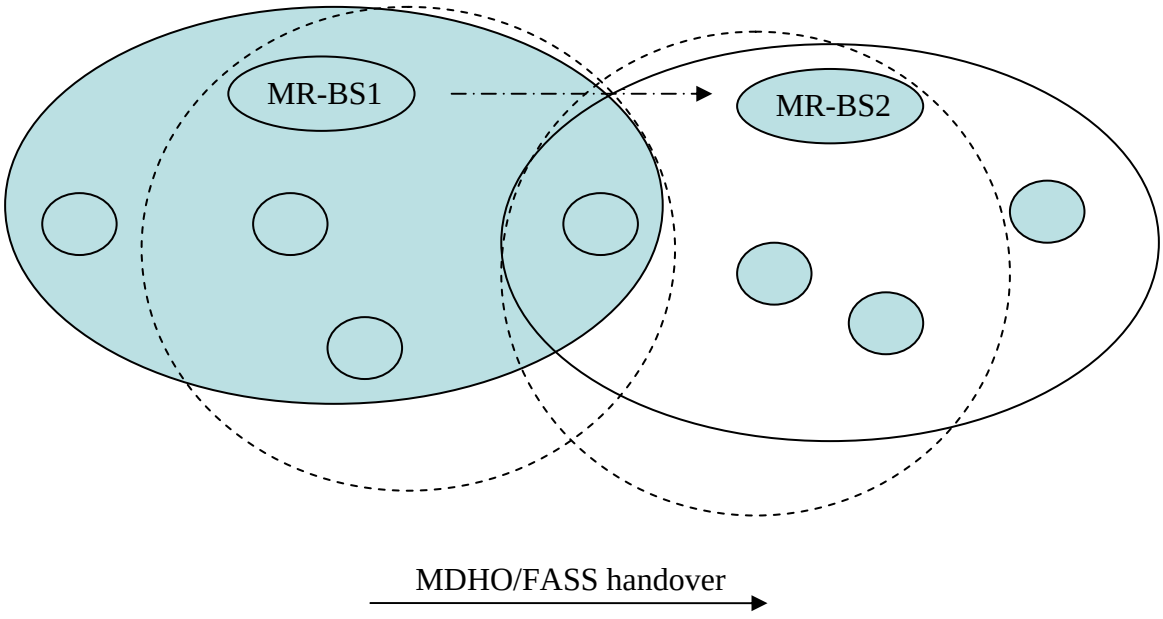

Figure 6 : Inter MR-BS handover, the current anchor station and target anchor station is the different MR-BSs

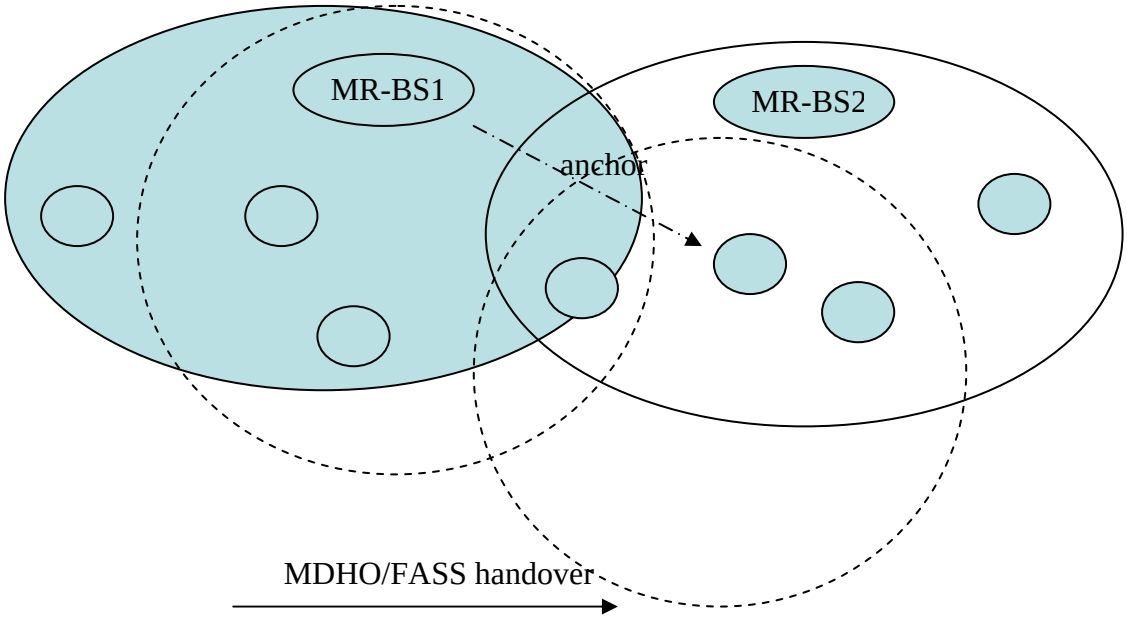

Figure 7 : Inter MR-BS handover, the current anchor station is MR-BS and target anchor station is RS controlled by the different MR-BS

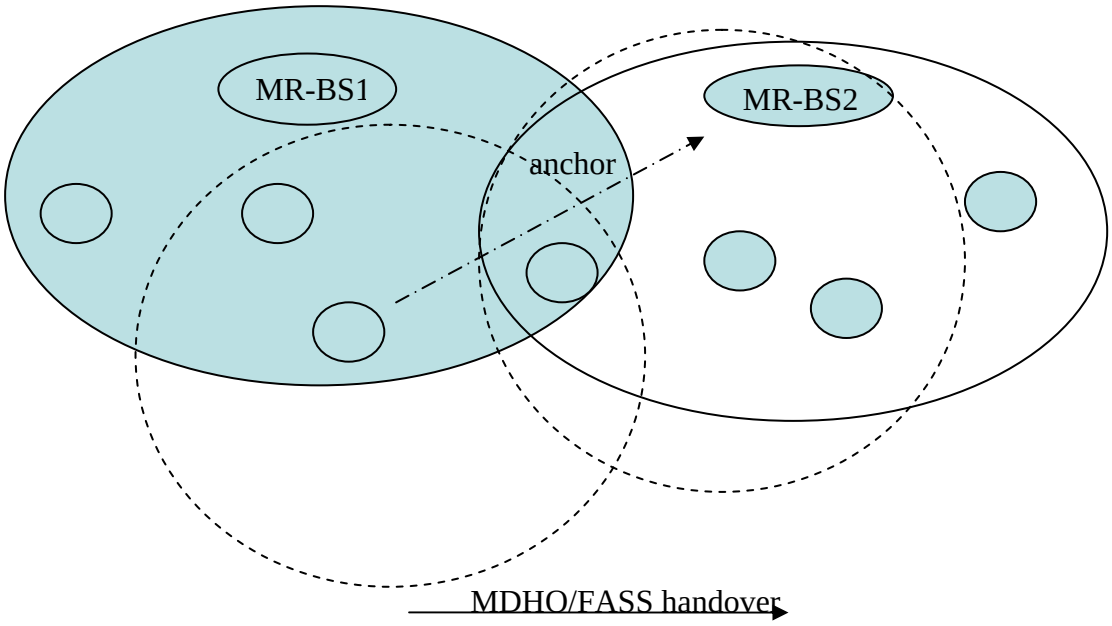

Figure 8 : Inter MR-BS handover, the current anchor station is RS and target anchor station is MR-BS in a different MR-cell

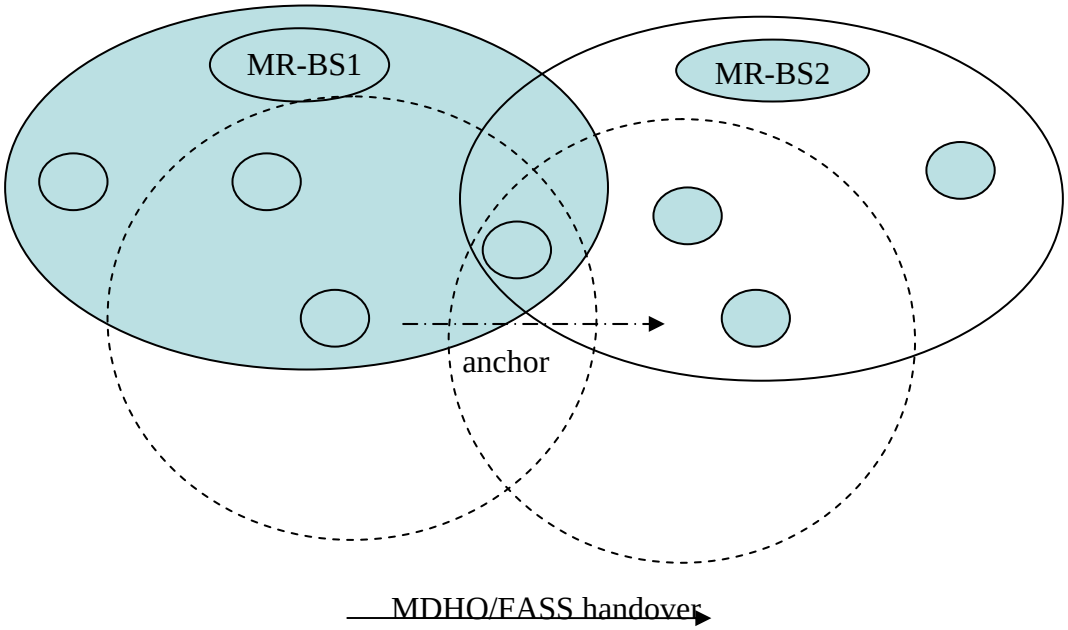

Figure 9 : Inter MR-BS handover, the current anchor station and
target anchor station are the different RSs and also they are located in different MR-cells

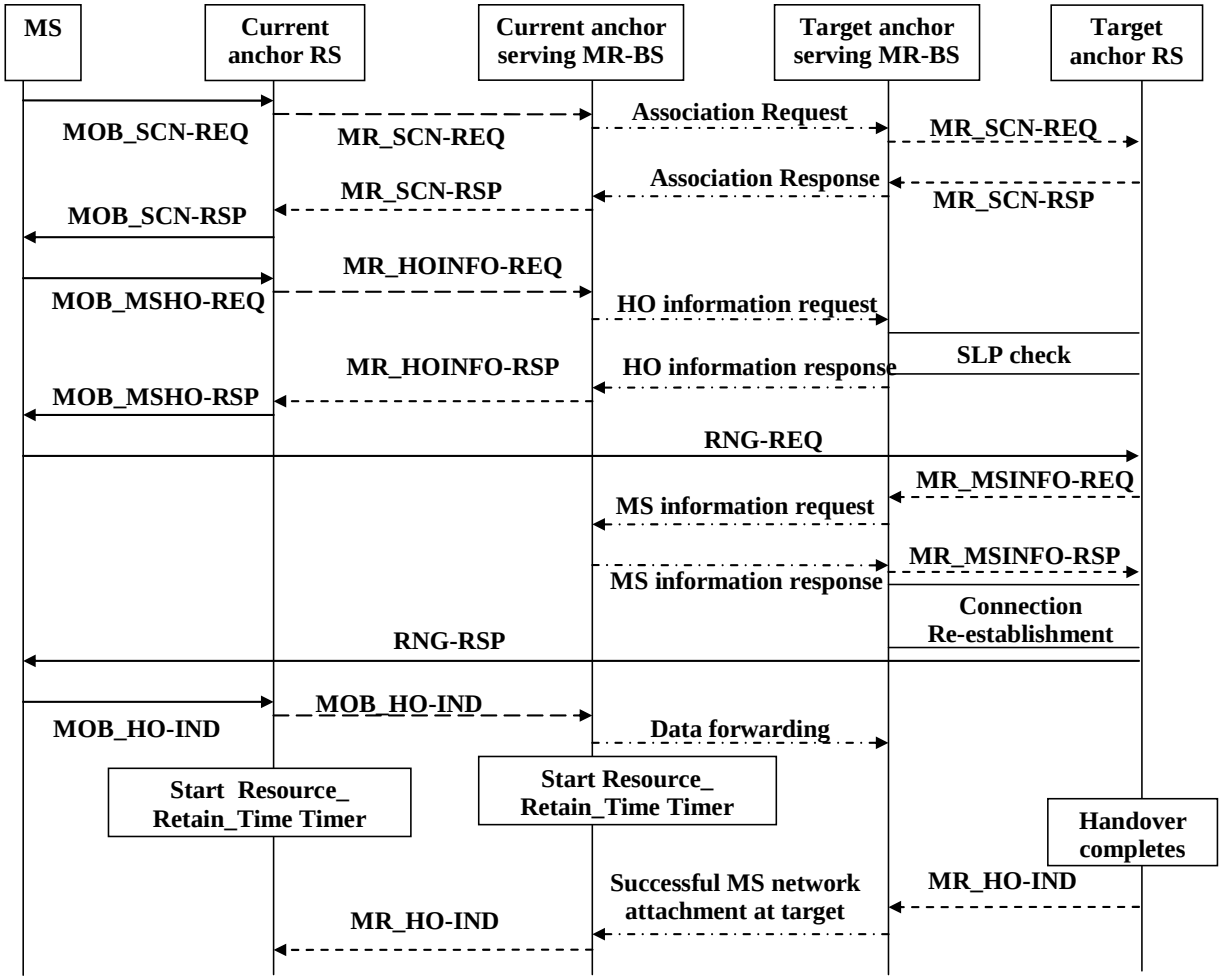

Figure 10 : an example of MDHO/FASS handover flow for case 9

5. Summary of New MAC management messages

Figure 10 gives an example on the MDHO/FASS handover message flow for case 9. The following table lists the proposed new MAC management messages for stations in an 802.16j network for network topology acquisition.

Table 1 : new MAC management messages over relay links

New MAC messages	MS handover phase	Descriptions
MR_SCN-REQ MR_SCN-RSP	MS scanning	These two messages are used to coordinate an association for an MS at target anchor station
MR_NBR-REQ	Info request	Request for access channel information from other stations
MR_NBR-RSP	Ack	Acknowledgement of transmission of MOB_NBR-ADV by serving station

6. Proposed text change

Modify the following text in 6.3.22.1.1

6.3.22.1.1 Topology of MDHO and FASS handover

A BS or RS shall broadcast information about the network topology using the MOB_NBR-ADV message. The message provides channel information for neighboring base stations or relay stations normally provided by each access station's own DCD/UCD message transmissions. A BS or RS may obtain that information over the backbone or through the relay link.

[Insert the following at the end of 6.3.22.1.1]

6.3.22.1.1 Topology of MDHO and FASS handover

Due to the introduction of RSs in to the network infrastructure, there are two main categories of MDHO or FASS handover: (1) Intra MR-BS handover the diversity set is updated among a group of RSs or the MR-BS controlled by the same serving MR-BS which consists of four cases:

Case 1: the current anchor station and target anchor station is MR-BS ;
Case 2: the current anchor station is RS and target anchor station is MR-BS ;
Case 3: the current anchor station is MR-BS and target anchor station is RS ;
Case 4: the current anchor station and target anchor station is the same RS ;
Case 5: the current anchor station and target anchor station is the different RSs .

(2) Inter MR-BS handover if the diversity set is updated among a group of RSs controlled by the multiple MR-BSs which consists of four cases:

Case 6: the current anchor station and target anchor station is the different MR-BSs ;
Case 7: the current anchor station is MR-BS and target anchor station is RS controlled by the different MR-BS ;
Case 8: the current anchor station is RS and target anchor station is MR-BS in a different MR-cell ;
Case 9: the current anchor station and target anchor station are the different RSs and also they are located in different MR-cells .

[Include Figures 1-10 here]

[Insert a new subclause 6.3.2.3.47.1]

6.3.2.3.47.1 Mutiple relay neighbor station request (MR_NBR-REQ) message

The access station prepares a MOB_NBR-ADV message based on the information collected form the received MR_NBR-REQ messages. Then the access station transmits the MOB_NBR-ADV messages to its associated MSs. MR_NBR-RSP message acknowledges the completion of the task of MOB_NBR-ADV to the MR_NBR-REQ message.

MR_NBR-REQ message is used by an RS or MR-BS to make a request of access channel information of other stations to the serving MR-BS or upstream RS. The CID encoded in the general MAC header is the primary CID between an RS and an MR-BS or between the requesting RS and its upstream RS.

Syntax	Size (bits)	Notes
MR_NBR-REQ_Message_format() {	-	-
Management message typ = TBD	TBD	
N_Stations		Number of stations for requesting the channel information
For (i=0;i<N_Stations; i++) {		
Station ID	48	
Padding	TBD	
}		
}		

MOV_NBR-ADV message is used by RS or MR-BS to respond to MR_NBR-REQ over the relay link.

[Insert a new subclause following subclause 6.3.2.3.48.1]

6.3.2.3.48.1 Mutiple relay scanning interval allocation request (MR_SCN-REQ) message

An access station may allocate scanning intervals to an MS seeking and monitoring suitability of a potential target access station for a handover. As defined in IEEE 802.16e-2005, an MS may request an allocation of scanning intervals and a certain type of association with each potential target access station using a MOB_SCN-

REQ message. In IEEE 802.16e-2005, three association levels: Association Level 0, Association Level 1, and Association Level 2, are defined. The requested association level is encoded in the scanning type field of the MOB_SCN-REQ message. Upon receiving a MOB_SCN-REQ message, the access station responds with a MOB_SCN-RSP message. In IEEE 802.16e-2005, coordination between BSs can be achieved over backbone. However the coordination needs to occur over the relay links as well as the backbone in 802.16j networks. We define two new MAC management messages MR_SCN-REQ and MR_SCN-RSP for the coordination over relay links.

A current access station send messages MR_SCN-REQ message to negotiate the association level with a upstream relay station, or even MR-BS to provide MSs with the appropriate scanning opportunity.

Syntax	Size (bits)	Notes
MR_SCN-REQ_Message_format () {	-	-
Management Message Type = TBD	TBD	
N_recommended_station	TBD	
For(i=0; i<N_recommended_station;i++)		
Recommended Station ID	48	
Recommended Type	3	
}		
Current access station ID	48	
Current MS ID	48	
Padding	TBD	Padding to reach byte boundary
}		

[Insert a new subclause following subclause 6.3.2.3.49.1]

6.3.2.3.49.1 Mutiple relay scanning interval allocation respo.1nse (MR_SCN-RSP) message

MR_SCN-RSP message is a response to MR_SCN-RSP

Syntax	Size(bits)	Notes
MR_SCN-REQ_Message_format () {		
Management Message Type = TBD	TBD	
N_recommended_station	TBD	
For(i<0; i<N_recommended_station;i++		
Recommended station ID	48	
Scanning Type	3	

If(scanning type.0) {		
Rendezvous time	8	
CDMA code	8	
Transmission opportunity offset	8	
}		
}		
Current access station ID	48	
Associated MS ID	48	
Padding	TBD	Padding to reach byte boundary
}		

Recommended Station ID

Recommended BS or RS ID list for scan with or without association. If Scanning type > 0b001 Serving BS or RS may request, over the backbone or relay link from Recommended Station allocation of non-contention based ranging opportunity for MS association activity. When conducting initial ranging to Recommended BS or RS, MS shall use allocated non-contention based ranging opportunity, f available.

Modify 6.3.2.3.51 Association Result Report (MOB_ASC-REP)

When association level 2 is used, the MS does not have to wait for RNG-RSP from the Target BS or RS after sending RNG-REQ or ranging code to the Target BS or RS. Instead, the RNG-RSP info may be sent by each Target BS or RS to the Serving BS or RS (over the backbone or relay links). The Serving BS or RS may aggregate all the RNG-RSP messages to a single MOB_ASC-REP message, which the Serving BS or RS then sends to the MS. This message is transmitted using the primary management CID.

7. Reference

[1] IEEE C802.16j-07_200, “MDHO and FASS for MMR Networks – Decision to Termination,” March, 2007.

[2] “Harmonized definitions and terminology for 802.16j Mobile Multihop Relay,” IEEE 802.16j-06/014r1 http://www.ieee802.org/16/relay/index.html, October 2006.