Project	IEEE 802.16j Mobile Multihop Relay Task Group
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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 for MMR network
Purpose	The contribution is provided as input for the IEEE 802.16j amendment
Notice	
Release	

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Macro Diversity Handover and Fast Access Station Switching for MMR Networks – Decision to Termination

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1. Introduction

In this proposal, we discuss the MAC MDHO and FASS handover decision to termination 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.

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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. Problem Statement

Due to the introduction of RSs in to the network infrastructure, there are two main categories of MDHO or FASS handover, as discussed in contribution [1]:

(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. Here, we are focus on system where 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. 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 handover decision, initiation, execution and termination. . In contribution [1] we address handover network topology acquisition.

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.

3.2 MDHO/FASS decision and initiation

The MR-BS or RS supporting MDHO or FASS shall broadcast the DCD message that includes the H_Add Threshold and H_Delete Threshold. These thresholds are used by the FASS/MDHO capable MS to determine if MOB_MSHO-REQ should be sent. When long term CINR of a anchor station is less than H_Delete Threshold, the MS shall send MOB_MSHO-REQ to require dropping this anchor station from the diversity set; when long-term CINR of a neighbor MR-BS or RS is higher than H_Add Threshold, the MS shall send MOB_MSHO-REQ to require adding this neighbor MR-BS or RS to the diversity set.

As defined in IEEE 802.16e-2005, MOB_BSHO-REQ and MOB_BSHO-RSP messages include the following information about possible target access stations for a particular MS:

--- Service level prediction
--- Preamble index/subchannel index
--- HO process optimization
--- Network assisted HO supported
--- HO authorization policy support

This information was obtained over the backbone in 802.16e networks, however it may need to be obtained over the relay links as well as the backbone. Therefore we define two new MAC management messages MR_HOINFO-REQ and MR_HOINFO-RSP in order to for exchange of the information to take place efficiently among the potential stations in a diversity set. Figure 1 shows the message flows for decision and initiation for case 9.

The decision to update the Diversity Set begins with a notification by the MS through the MOB_MSHO-REQ message or by the BS/RS through MOB_BSHO-REQ management message. The process of Anchor BS/RS update may begin with MOB_MSHO-REQ from MS or MOB_BSHO-REQ from the Anchor BS. Acknowledgement with MOB_BSHO-RSP is required. Specifically for Case 9, as an example, this process is passed onto the Anchor BS and to the target RS of another cell using the new command MR_HOINFO-REQ and MR_HOINFO-RSP as illustrated in Figure 1.

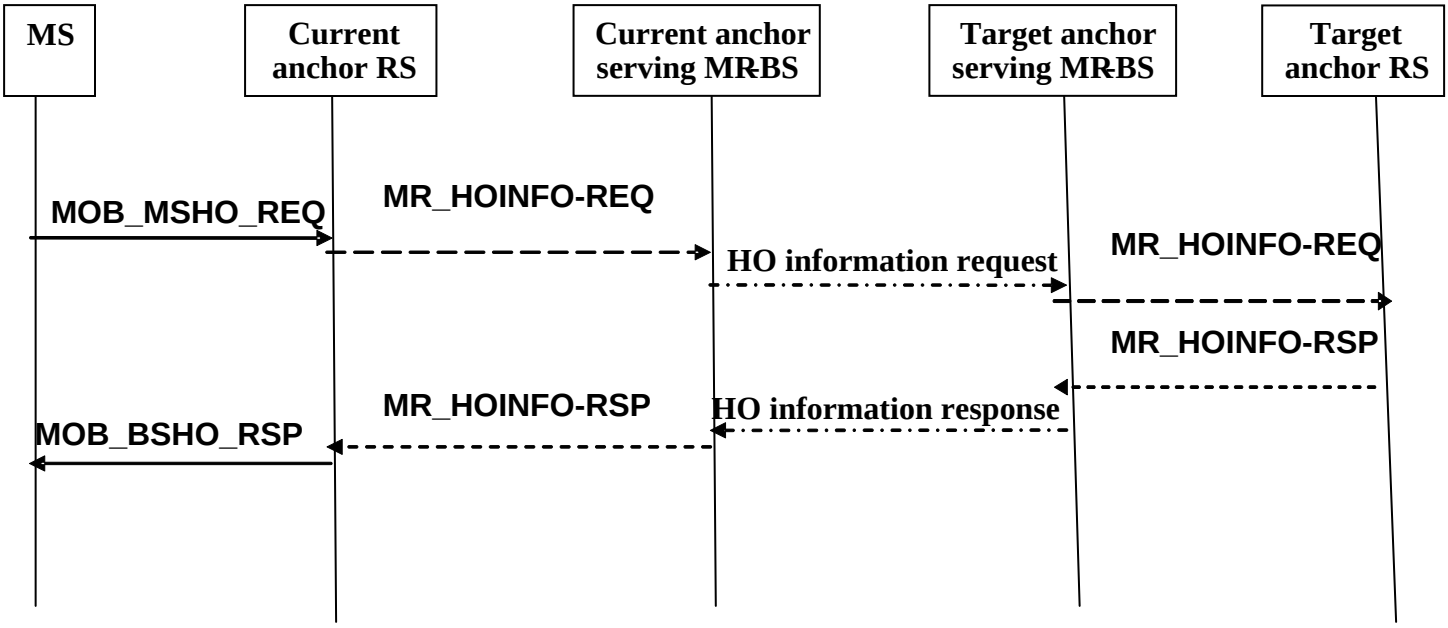

Figure 1: MDHO/FASS handover decision and initiation message flows for case 9 in reference 1 (inter cell MDHO).

3.3 Diversity Set update for MDHO/FBSS

When MOB_MSHO-REQ is sent by an MS, the MS may provide a possible list of MR-BSs and/or RSs to be included in the MS' Diversity Set. The MS may evaluate the possible list of MR-BSs and/or RSs through the received MOB_NBR-ADV message, and previously performed signal strength measurement, propagation delay measurement, scanning, ranging, and association activity as discussed in contribution [1]. When MOB_BSHO-RSP is sent by the Anchor station in the MS's current Diversity Set, the MR-BSs may provide a list of MR-BSs or RSs recommended for incorporation into the MS' Diversity Set.

An MS and the potential access stations in the diversity set shall conduct ranging by exchanging RNG-REQ and RNG-RSP. An MS can indicate a handover attempt by sending RNG-REQ message which includes a station ID TLV and sets bit number of the ranging purpose indication TLV set to 1.

3.4 MDHO/FBSS handover termination

In IEEE 802.16e-2005, the old anchor BS is informed over the backbone of the successful MS network attachment at the diversity set. However in 802.16j, this attachment may be informed over the relay links as well as the backbone, so we propose a new MAC management message MR_HO-IND. This information is used to inform the old anchor station of the successful MS network attachment at a new anchor MR-BS and/or RS. Figure 2 shows the message flows of handover execution and termination for case 9.

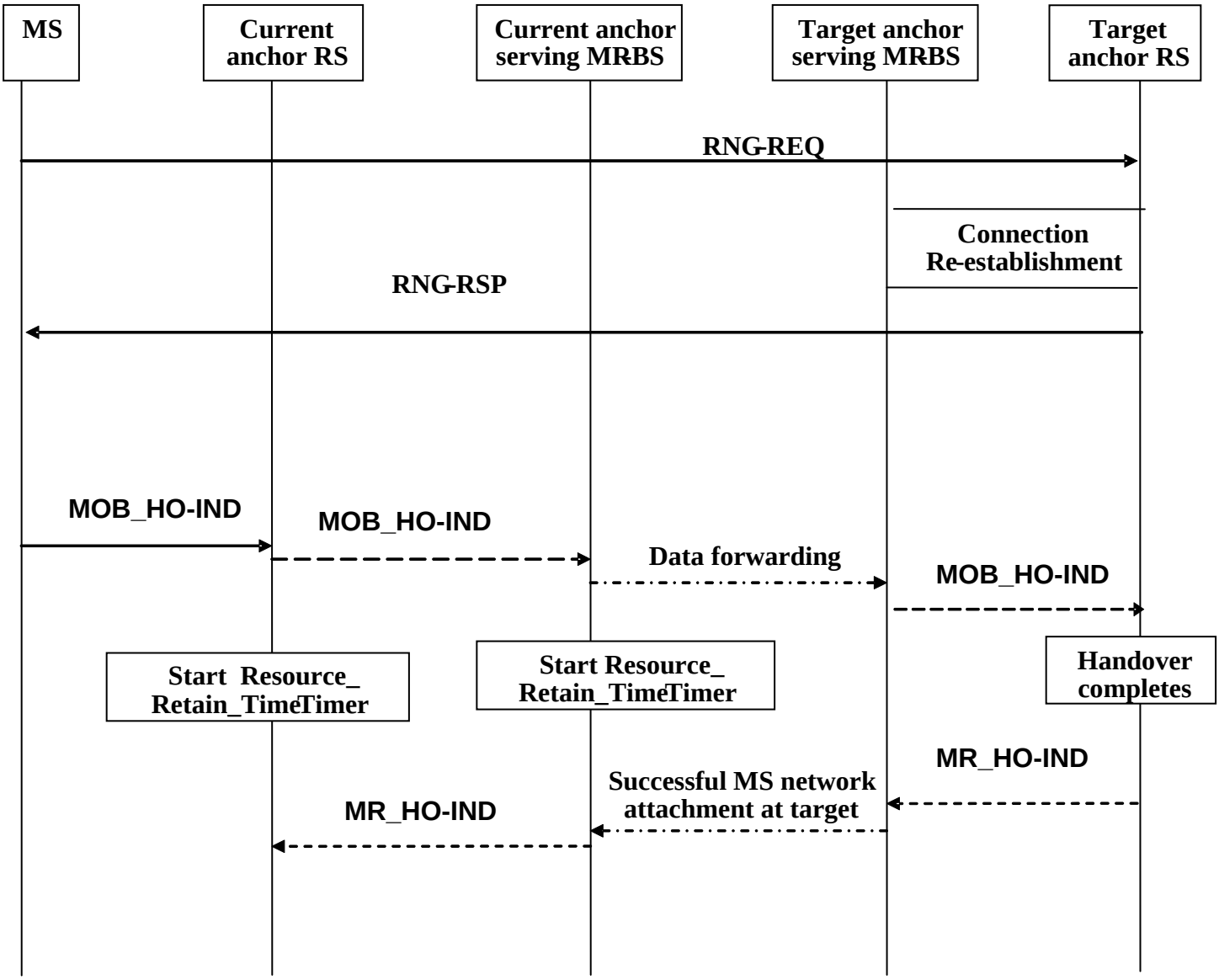

Figure 2: the message flows of the MDHO/FASS handover execution and termination for case 9

3. Summary of New MAC management messages

The following table lists the proposed new MAC management messages for stations in an 802.16j network for handover decision to termination procedures.

Table 1 : new MAC management messages over relay links

New MAC messages	MS handover phase	Descriptions
MR_HOINFO-REQ MR_HOINFO-RSP	MDHO/FASS decisi and initiation	These two messages are used to pass the handover related information of potential target anchor station to the current anchor station over relay links
MR_HO-IND	Handover terminatio	This message is used to notify successful handover to the current anchor station and to the target anchor station.

4. Proposed text change

[Insert the following at the end of subclause 6.3.22.2.2.1]

6.3.2.22.2.2.1 MDHO/FASS decision and initiation for MMR

An MS initiates handover by transmitting a MOB_MSHO-REQ message. Upon receiving MOB_MSHO-REQ, the anchor access station responses it with a MOB_BSHO-RSP message. If an anchor access RS receives MOB_MSHO-REQ, it may relay the received MOB_MSHO-REQ message to a serving MR-BS or response with a MOB_MSHO-RSP message after collecting necessary information. If the serving MR-BS receives the relayed MOB_MSHO-REQ, it generates and transmits a MOB_BSHO-RSP message to the anchor access RS so that the anchor access RS forwards the received MOB_BSHO-RSP to the MS as a response.

The MOB_BSHO-REQ/RSP messages contain the recommended target active stations list for a diversity set and their information related to handover support. These information can be gathered over the relay links as well as over the wired backbone and MR network. The information maybe obtained over the relay links using MR_HOINFO-REQ/RSP messages which include a possible target active stations of a diversity set and HO process optimization information as well as the expected service level of an MS at each active access station.

[Insert the following as a new subclause 6.3.2.3.51.1]

6.3.2.3.51.1 Multiple relay handover information request (MR_HOINFO-REQ) message

An active access station sends this message to obtain handover related information on the recommended active access stations.

Syntax	Size (bits)	Notes
MR_HOINFO-REQ_Message_format() {	-	-
Management message type = TBD	TBD	
MS_ID	48	MAC address
Network assisted HO supported	1	
Mode	3	Same as MOB_BSHO-REQ
HO operation mode	1	
N_recommended_active_stations	8	
For(i=0;i<N_recommended_active_stations;i++)) {		
Recommended_target_active_station_ID	48	
TLV encoded information	variable	

[Insert the following as a new subclause 6.3.2.3.51.2]

6.3.2.3.51.2 Multiple relay handover information response (MR_HOINFO-RSP)message

This message response to a MR_HOINFO-REQ message

Syntax	Size (bits)	Notes
MR_HOINFO-REQ_Message_format() {	-	-
Management message type = TBD	TBD	
MS_ID	48	MAC address
Network assisted HO supported	1	
Mode	3	Same as MOB_BSHO-REQ
HO operation mode	1	
N_recommended_active_stations	8	
For(i=0;i<N_recommended_active_stations;i++)) {		
Recommended_target_active_station_ID	48	
Service level prediction	8	
HO process optimization	8	
HO authorization policy support	8	
Arrival time difference	4	
Frame offset	3	
TLV encoded information	variable	

Service level prediction
The service level prediction value indicates the level of service the MS can expect from this recommended target access station. The following encodings apply:
0 = No service possible for this MS
1 = Some service is available for one or several service flows authorized for the MS.
2 = For each authorized service flow, a MAC connection can be established with QoS specified by the AuthorizedQoSParamSet.
3 = No service level prediction available.

HO process optimization
HO Process Optimization is provided as part of this message is indicative only. HO process requirements may change at time of actual HO. For each Bit location, a value of '0' indicates the associated reentry management messages shall be required, a value of '1' indicates the reentry management message may be omitted. Regardless of the HO Process Optimization TLV settings, the target access station may send unsolicited SBC-RSP and/ or REG-RSP management messages:
Bit #0: Omit SBC-REQ/RSP management messages during re-entry processing
Bit #1: Omit PKM Authentication phase except TEK phase during current re-entry processing
Bit #2: Omit PKM TEK creation phase during re-entry processing
Bit #3: Omit REG-REQ/RSP management during current re-entry processing
Bit #4: Omit Network Address Acquisition management messages during current reentry processing
Bit #5: Omit Time of Day Acquisition management messages during current reentry processing
Bit #6: Omit TFTP management messages during current re-entry processing
Bit #7: Full service and operational state transfer or sharing between serving BS and target BS (ARQ, timers, counters, MAC state machines, etc…)

HO_authorization_policy_support
To indicate if authorization negotiation is used in the HO procedures. If this encoding is not presented, the same EAP authorization and the same value of the MAC mode field of the current access station are applied as authorization policy. Otherwise, the following values are applied:
0: RSA authorization
1: EAP authorization
2: Authenticated-EAP authorization
3: HMAC supported
4: CMAC supported
5: 64-bit short-HMAC
6: 80-bit short-HMAC
7: 96-bit short-HMAC

HO_ID
ID assigned for use in initial ranging to the recommended target access station once this access station is selected as the target BS.

Network Assisted HO supported
Indicates that the recommended target access station supports Network Assisted HO.

Arrival Time Difference
The Arrival Time Difference parameter indicates the delay of downlink signal relative to the anchor access station, as measured by the MS for the neighbor access station. For OFDM and OFDMA PHY mode, this value shall be interpreted as a signed fraction with a range of +7/8 to –1 one cyclic prefix time of the anchor access station. A positive value indicates that the signal of the neighbor access station arrived after that of the anchor access station (for example, the value of 0x02 indicates that the neighbor signal is delayed by 25% ±6.25% of the CP).

The following TLV parameters can be included:

Preamble index/ Subchannel Index
This parameter defines the PHY specific preamble for the recommended target access station.

[Insert the following at the end of 6.3.22.3.4.2.1]

6.3.22.3.4.2.1 MDHO/FASS execution for MMR

In MR networks, an MS and a target anchor access station shall conduct ranging by exchanging RNG-REQ/RSP messages. To notice an MS of possible omission of re-entry process management messages, the target anchor access station includes a HO Process Optimization TLV in the RNG-RSP message. As indicated in the HO Process Optimization TLV settings, the target anchor access station may use the previously obtained MS service and operational context information.

[Insert a new subclause following subclause 6.3.2.3.51.3]

6.3.22.3.6 MDHO/FBSS handover termination for MMR

Upon receiving a MOB_HO-IND message with HO_IND type =0b00 from an MS, the old anchor access RS shall relay it to the old serving anchor MR-BS and may start its resource retain time timer. Upon expiration of resource retain time timer or receiving the successful MS network attachment, the old anchor access RS shall remove all the MS context information. An old serving anchor MR-BS can receive a MOB_HO-IND message directly from an MS or a relayed one from its subordinate RS. When an MR-BS receives a MOB_HO-IND message, the MR-BS shall start resource retain time timer in the case that a target access station in the MOB-HO-IND message is not managed by the MR-BS. The successful MS network attachment at a target anchor station is informed to the old

anchor access station, old serving anchor station, target serving anchor station by transmitting MR_HO_IND message over the relay links.

[Insert a new subclause following subclause 6.3.2.3.55.1]

6.3.2.3.55.1 Multiple relay mobile station information response (MR_HO-IND) message

This message is to inform mobile station network attachment to a target anchor access station.

Syntax	Size (bits)	Notes
MR_HO-IND_Message_format() {	-	-
Management message type = TBD	TBD	
MS_ID	48	MAC address
Target BS/RS_ID	48	Applicable only when HO_IND_type is set to 0b00
MDHO/FASS_IND_Type	2	0b00: confirm Anchor BS/RS update
Anchor BS/RS_ID	3	TEMP_BSID of the anchor BS/RS

5. Reference

[1] IEEEC802.16j-07_199, “MDHO and FASS for MMR Networks - Topology Acquisition,” March, 2007.