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Title	**MS MAC Handover Procedure in an MR Network – Handover Decision and Initiation**	
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Re:	Submitted in response to Call for technical proposals issued by IEEE 802.16j on 2006-10-15	
Abstract	This document proposes a MS handover decision and initiation procedure for IEEE 802.16j networks where both MR-BS and its subordinate RSs in an MR-cell transmit their own broadcast control message such as preamble, FCH, DCD, UCD, DL-MAP and UL-MAP.	
Purpose	This contribution is provided as input for the IEEE 802.16j amendment.	
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1. Introduction

The proposed MAC handover scheme will enable an 802.16e compliant MS to handover seamlessly in an MR network following the MAC handover procedure defined in subclause 6.3.22 of IEEE 802.16e-2005. This contribution proposes additions/modifications to handover decision and initiation process defined in subclause 6.3.22.2.2 of IEEE 802.16e-2005.

Figure 1 depicts the seven handover cases that are covered in this contribution.
Please refer to Sections 1.1 and 1.3 of [1] for terminologies and assumptions used in this contribution.

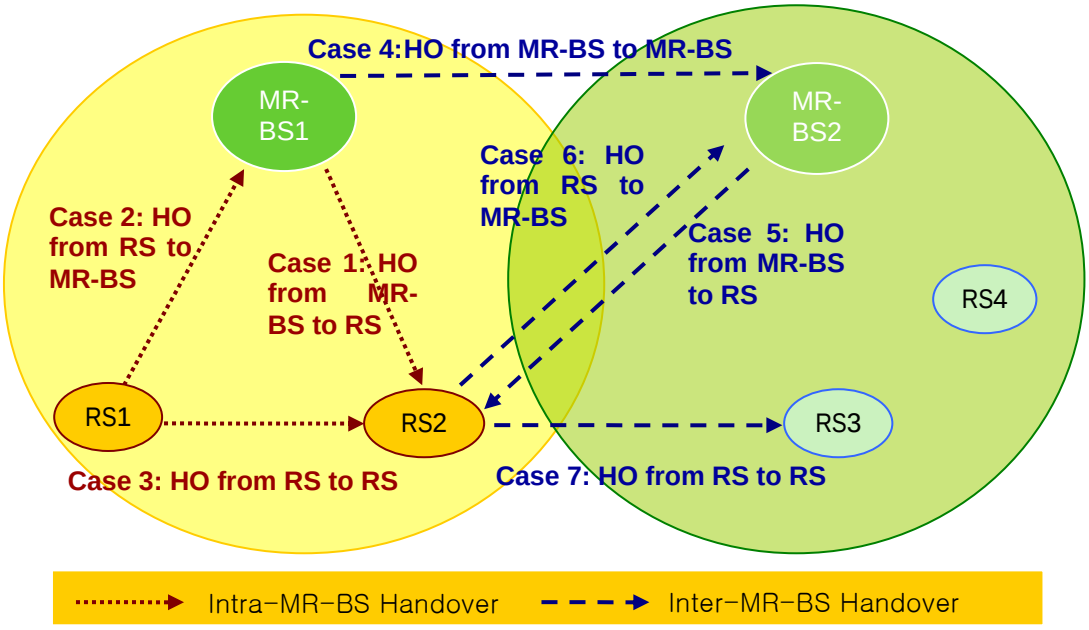

Figure 1 Seven Handover Cases in an MR network

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2. MS handover decision and initiation

An MS handover can be initiated by the decision originated either at the MS or at the access station (i.e., MR-BS or RS). An MS initiates handover by transmitting a MOB_MSHO-REQ message. Upon receiving MOB_MSHO-REQ, the access station acknowledges this with a MOB_BSHO-RSP message. Or an access station initiates a handover by transmitting a MOB_BSHO-REQ. As defined in IEEE 802.16e-2005, MOB_BSHO-REQ and MOB_BSHO-RSP messages include the information (see Table 1) about the possible target access stations for a particular MS. While this information was obtained over the backbone in an 802.16e network, it may need to be obtained over the relay links as well as over the backbone. Therefore, we define two new MAC management messages *HO_INFO-REQ* and *HO_INFO-RSP* in order to exchange the information about the potential target access stations, respectively. The process of exchanging these messages can be found in Table 2 (a) and (b).

MR-BSs perform the control activities to determine all the parameters values listed in Table 1 (i.e., it own all the necessary information to generate a *HO_INFO-RSP* message for its subordinate RSs). However, the service level prediction (SLP) parameter requires network level knowledge along the multi-hop path between the potential access RS and its serving MR-BS.

Therefore, the target serving MR-BS may or may not have SLP information (when it is queried) for all of its subordinate RSs along the related relay path depending on the distribution of control functions between an MR-BS and its subordinate RSs. An RS or an MR-BS shall perform the following:

- Default: As the simplest solution, SLP in a MOB_BSHO-REQ or MOB_BSHO-RSP message can be set to *"3 = No service level prediction available"* for the recommended station. However, this implies that the MS will not be informed of its predicted QoS level.
- Optional: SLP value can be obtained solely from the MR-BS or from RSs along the related relay path together with the MR-BS. This case can provide the MS with the expected MS QoS performance at the potential target access RS.

If a handover to the potential target access station is an Intra MR-BS handover, the bit numbers 0-7 of HO process optimization field in MOB_BSHO-REQ or MOB_BSHO-RSP can be set to 1. Those values are used to indicate the omission of some network re-entry message exchanges including SBC-REQ message, PKM authentication messages, network address acquisition messages, time of day acquisition messages, and TFTP management messages as well as to enable full service/operational state transfer and post handover data forwarding.

Figure 2 provides an example of signaling in relation to MOB_BSHO-REQ/RSP, MOB_MSHO-REQ, and HO_INFO-REQ/RSP for six cases of Figure 1 (except Case 4). Case 4 is not included because it follows the 802.16e procedure exactly.

Table 1. Parameters in MOB_BSHO-REQ and MOB_BSHO-RSP messages that need to be obtained from potential target stations

MOB_BSHO-REQ/RSP
• Service level prediction • Preamble index / Subchannel Index • HO process optimization • N/W assisted HO supported • HO_authorization policy support

Table 2. Signaling process for HO_INFO-REQ/RSP messages
(a) when the recommended target is for Intra MR-BS handover

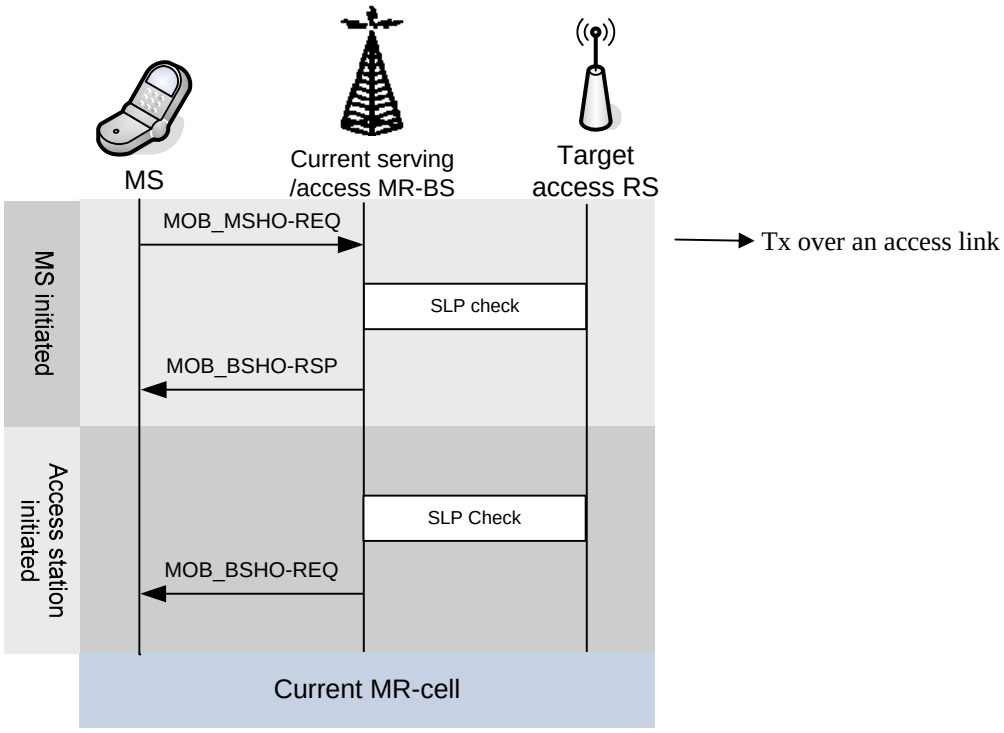
Recomm / Current	MR-BS in the same MR cell	RS in the same MR cell
MR-BS	N/A	Because the MR-BS owns all the information, the MR-BS can transmit a MOB_BSHO-REQ or MOB_BSHO-RSP message without exchanging HO_INFO-REQ/RSP. The MR-BS may have SLP value or initiates a SLP check procedure.

RS	The access RS and recommended MR-BS can be k-hop (k≥1) away from each other. They know a relay path to reach each other because the RSs are under control of the access MR-BS. Therefore, they communicate with each other using this k-hop path. (1) The access RS issues a *HO_INFO-REQ* message destined to the serving MR-BS. (2) Upon receiving the request, the serving MR-BS replies with a *HO_INFO-RSP* message.	If the access and recommended RSs can communicate directly over the 1-hop relay link between them: (1) The access RS issues a *HO_INFO-REQ* message directly destined to the recommended RSs. (2) Upon receiving the request, the recommended RS replies to the access RS with a *HO_INFO-RSP* message. The recommended RS initiates a SLP check procedure. The current access RS has a k-hop (k≥1) relay path to the serving MR-BS. If the access and recommended RSs cannot communicate directly (i.e., no 1-hop relay link between them): (1) The current access RS transmits a *HO_INFO-REQ* message to the serving MR-BS. (2) Then, the MR-BS replies with a *HO_INFO-RSP* message. The MR-BS may have SLP value or initiates a SLP check procedure.

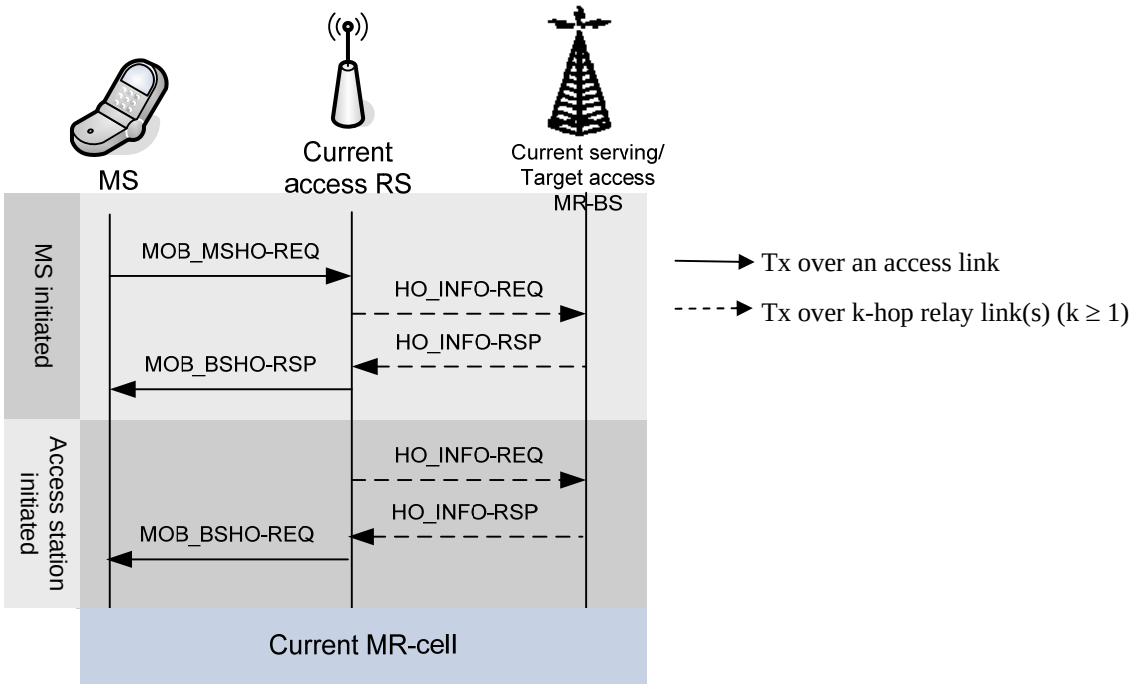
(b) when the recommended target is for Inter MR-BS handover

Recomm / Current	MR-BS in a different MR cell	RS in a different MR cell
MR-BS	Follows the procedure as defined in IEEE 802.16e-2005-2005	The current access MMS-BS and recommended RSs don't have knowledge of a relay path to reach each other because the RSs are under control of the different MR-BS. The current access MR-BS transmits the request over the backbone destined to the serving MR-BS of the recommended access RS. Then, the serving MR-BS of the recommended access RS replies to the current access MR-BS over the backbone. The target serving MR-BS may have SLP value or initiates a SLP check procedure.

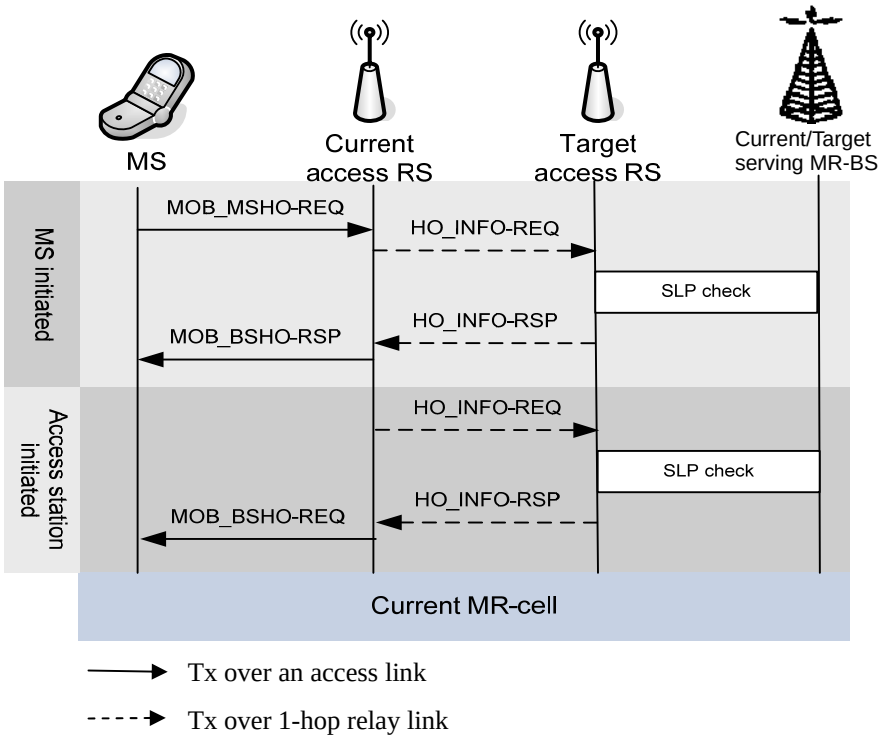
RS	The current access RS and the recommended MR-BSs don't have knowledge of a relay path to reach each other because the RS is not under control of the recommended MR-BS. (1) The current access RS issues a *HO_INFO-REQ* message destined to its serving MR-BS. (2) Then, the current serving MR-BS transmits the request message to the target serving MR-BS over the backbone and receives the information. (3) Based on the received information, the current serving MR-BS transmits the *HO_INFO-RSP* message to the current RS.	The current access RS has a k-hop (k≥1) relay path to its serving MR-BSs. (1) The current access RS issues a *HO_INFO-REQ* message destined to the current serving MR-BS. (2) Then, the current serving MR-BS transmits the request message to the target serving MR-BS over the backbone and receives the information. The target serving MR-BS may have SLP value or initiates a SLP check procedure. (3) Based on the received information, the current serving MR-BS transmits the *HO_INFO-RSP* message to the current RS.



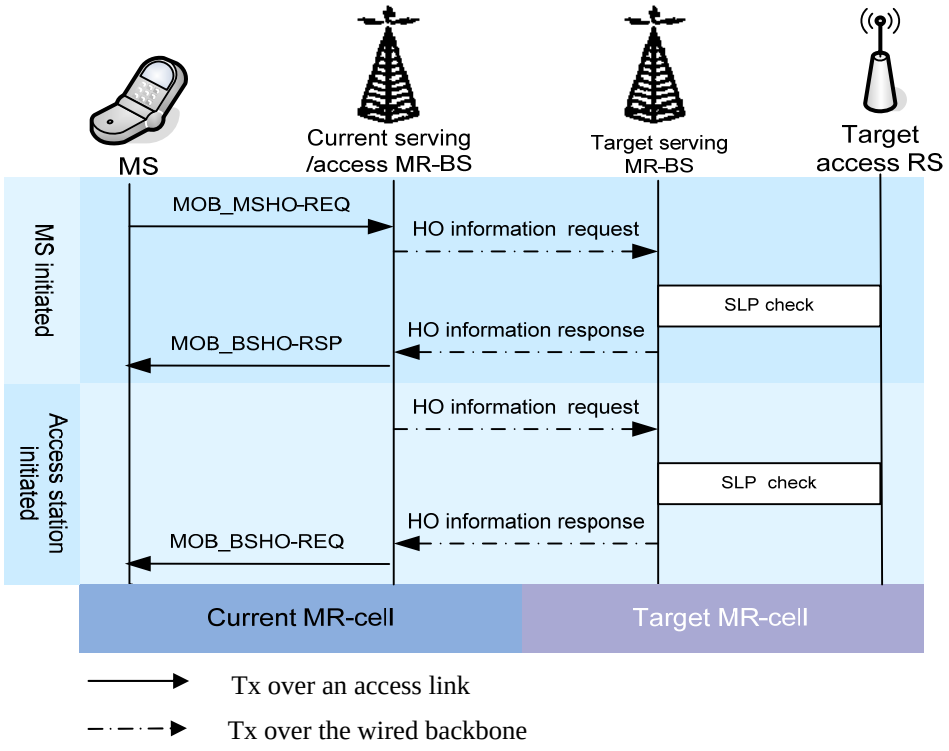
(a) Case1: Current access station is an MR-BS and target access station is an RS in the same MR cell



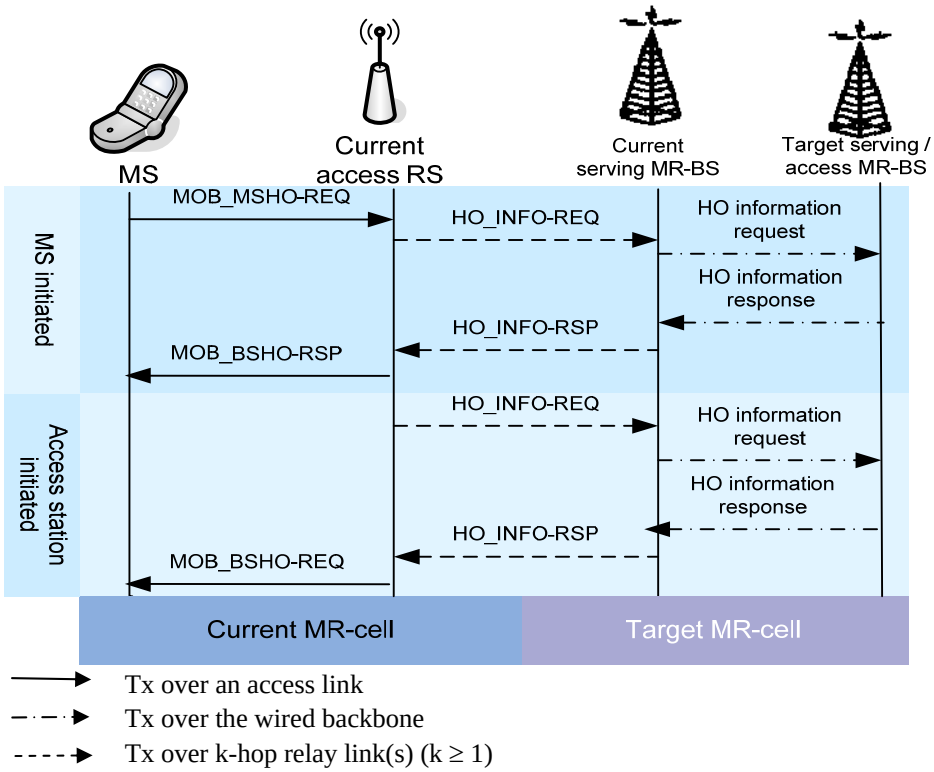
(b) Case2: Current access station is an RS and target access station is the serving MR-BS in the same MR-cell



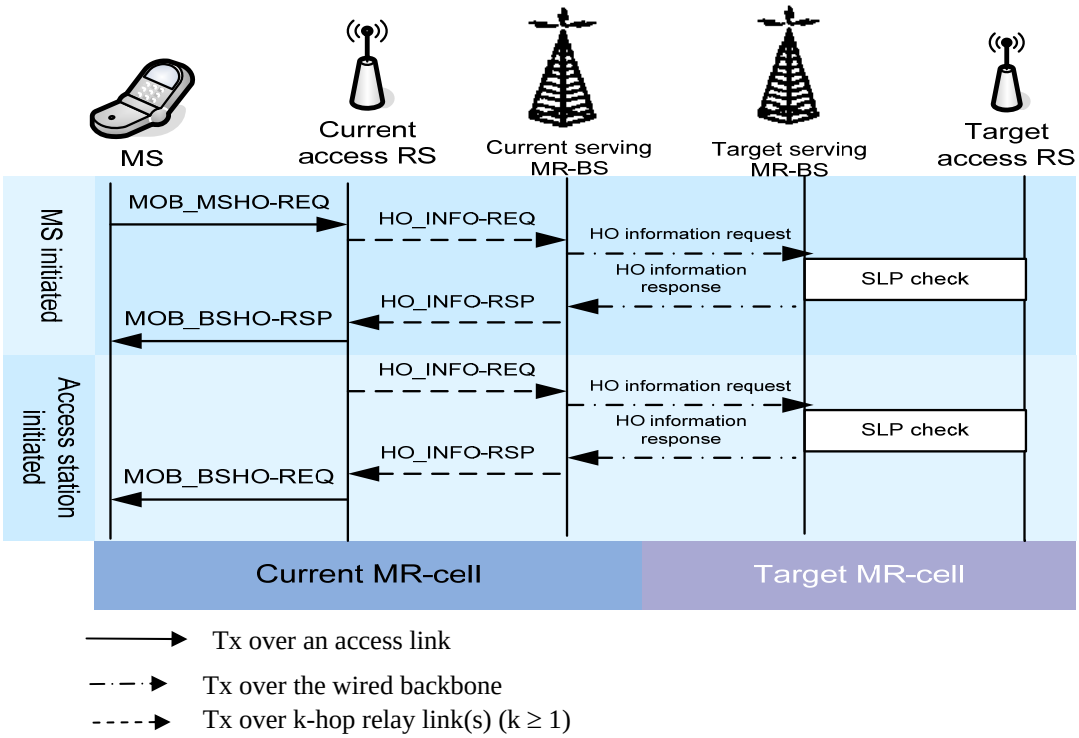
I Case3: Current access station is an RS and target access station is another RS in the same MR-cell. This flow is an example when a direct 1-hop relay link exists between the current and potential target access RSs.



(d) Case 5: Current access station is an MR-BS and target access station is an RS in a different MR cell



(e) Case 6: Current access station is an RS and target access station is an MR-BS in a different MR cell



(f) Case7: Current access station is an RS and target access station is another RS in a different MR cell.

Figure 2. An example of signal message exchanges for MS handover decision and initiation (Other flows may be possible for each case)

3. Proposed text

[Editor's note: Figure and table numbers are subject to change when the text is inserted into the amendment. The figures and tables appeared in the above sections will not be repeated in this section]

[Insert the following at the end of subclause 6.3.22.2.2]

In MR networks, an MS initiates handover by transmitting a MOB_MSHO-REQ message. Upon receiving MOB_MSHO-REQ, the access station acknowledges this with a MOB_BSHO-RSP message. Or an access station initiates a handover by transmitting a MOB_BSHO-REQ. Handover related information is encoded in MOB_BSHO-REQ and MOB_BSHO-RSP messages including the expected MS performance at the possible target access stations. Access station may obtain this information over relay links as well as over the backbone. Two MAC management messages *HO_INFO-REQ* and *HO_INFO-RSP* are used in order to request and receive the information about potential target access stations over the relay links. The process of exchanging these messages can be found in

Table 2 (a) and (b).

[Editor's note: Insert Table 2 (a) and (b) of this contribution here]

MR-BSs perform the control activities to determine all the parameters values listed in MOB_BSHO-REQ and MOB_BSHO-RSP for its subordinate RSs (i.e., it owns all the necessary information to generate a *HO_INFO-RSP* message for its subordinate RSs). However, the service level prediction (SLP) parameter requires network level knowledge along the multi-hop path between the potential access RS and its serving MR-BS. Therefore, the target serving MR-BS may or may not have SLP information (when it is queried) for all of its subordinate RSs along the related relay path depending on the distribution of control functions between an MR-BS and its subordinate RSs. An RS or an MR-BS shall perform the following:

- Default: SLP in a MOB_BSHO-REQ or MOB_BSHO-RSP message can be set to *"3 = No service level prediction available"* for the recommended station. The MS will not be informed of its predicted QoS level.
- Optional: SLP value can be obtained solely from the MR-BS or from RSs along the related relay path together with the MR-BS. The MS is provided with the expected MS QoS performance at the potential target access RS.

If a handover to the potential target access station is an Intra MR-BS handover, the bit numbers 0-7 of HO process optimization field in MOB_BSHO-REQ or MOB_BSHO-RSP can be set to 1. Those values are used to indicate the omission of network re-entry message exchanges including SBC-REQ message, PKM authentication messages, network address acquisition messages, time of day acquisition messages, and TFTP management messages as well as to enable full service/operational state transfer and post handover data forwarding.

[Insert new subclause 6.3.2.3.xx]

6.3.2.3.XX HO_INFO-REQ

A current access station issues this message to obtain handover related information from the recommended stations that will be listed in MOB_BSHO-REQ or MOB_BSHO-RSP.

Syntax	Size (bits)	Notes
HO_INFO-REQ_Message_format() {		
Management Message Type = TBD	TBD	
Current access station ID	48	
MS ID	48	
N_Recommended	8	
For (i=0;i<N_Recommended;i++){		
Recommended target station ID	48	
SF_indicator	1	This indicator is set to 1 to indicate that the MS's service flow information is included. For example, the request is transmitted to a serving MR-BS from its subordinate RS, the indicator is set to 0.
If (SF_indicator = 1){		
N_SF	TBD	Number of admitted service flows for the MS
For (j=0;j<N_SF;j++){		
TLV encoded information	variable	Service flow parameters defined in subclause 11.13 of IEEE 802.16e-2005. This information is necessary if the current access RS transmit the HO_INFO-REQ message to the target

		access RS instead of its serving MR-BS.
}		
}		
}		
Padding	variable	Padding to reach byte boundary
}		

[Insert the following as a new subclause 6.3.2.3.xx]

6.3.2.3.XX HO_INFO-RSP

This is a reply message to HO_INFO-REQ.

Syntax	Size (bits)	Notes
HO_INFO-RSP_Message_format() {		
Management Message Type = TBD	TBD	
Current access station ID	48	
Recommended target station ID	48	
MS ID	48	
TLV encoded information	variable	
Padding	variable	Padding to reach byte boundary
}		

The following TLV parameters can be included:

Preamble index/ Subchannel Index

For the SCa and OFDMA PHY this parameter defines the PHY specific preamble for the neighbor BS. For the OFDM PHY the 5 LSB contain the DL subchannel index (as defined in Table 211) used in the Neighbor BS' sector. The 3 MSB shall be Reserved and set to 0.

Service level prediction

The service level prediction value indicates the level of service the MS can expect from this BS. 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 BS 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 indicator
To indicate if authorization negotiation is used in HO procedure:
0: EAP authorization and the value of the MAC mode field in the current BS (default)
1: The authorization policy for the target BS is negotiated.

HO_authorization_policy_support
To indicate if authorization negotiation is used in HO procedure.
0: EAP authorization and the value of the
MAC mode field in the current BS (default)
1: The authorization policy for the target BS is negotiated.

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

Network Assisted HO supported
Indicates that the BS supports Network Assisted HO.

[Insert new subclause 11.xx]

11.XX HO_INFO-REQ Management Message Encoding

Name	Type (1bytes)	Length (bits)
Service Level Prediction	1	8
Preamble Index/ Subchannel Index	2	8
HO Process Optimization	3	8
HO_authorization policy indicator	4	1
HO_authorization_policy_support	5	8
HO_ID	6	8
Network Assisted HO supported	7	1

References
[1] IEEE C802.16j-06/217, “Overview of the proposal for MS MAC handover procedure in an MR Network,” Nov. 2006