Project	IEEE 802.16 Broadband Wireless Access Working Group <**http://ieee802.org/16**>	
Title	**MS MAC Handover Procedure in an MR Network – Handover Decision and Initiation**	
Date Submitted	2007-01-1608	
Source(s)	Hyunjeong Kang hyunjeong.kang@samsung.com Sungjin Lee, Hyoung Kyu Lim, Jungje Son Samsung Electronics 416, Maetan-3dong, Youngtong-gu, Suwon-si, Gyeonggi-do, Korea Rakesh Taori Samsung Advanced Institute of Technology Yanling Lu luyanling@hisilicon.com Ting Li Hisilicon Technologies Harbour Building, No.8, Dongbeiwang West Road, HaiDian District, Beijing, China	Hyunjeong Lee hyunjeong.hannah.lee@intel.com Wendy C. Wong, Jerry Sydir, Kerstin Johnsson Intel Corporation 2111 NE 25th Ave Hillsboro, OR 97124 Sujean Yang sujean35@ewhain.net Meejeong Lee lmj@ewha.ac.kr Dept. of Computer Science and Engineering Ewha Womans University, Seoul, Korea David Comstock dcomstock@huawei.com John Lee, Shang Zheng, Jingning Zhu Huawei Technologies No.98, Lane91, Eshan Road, Shanghai, P.R. C
Re:	Submitted in response to Call for technical proposals issued by IEEE 802.16j on 2006-12-12	
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 of [1] for terminologies used in this contribution.

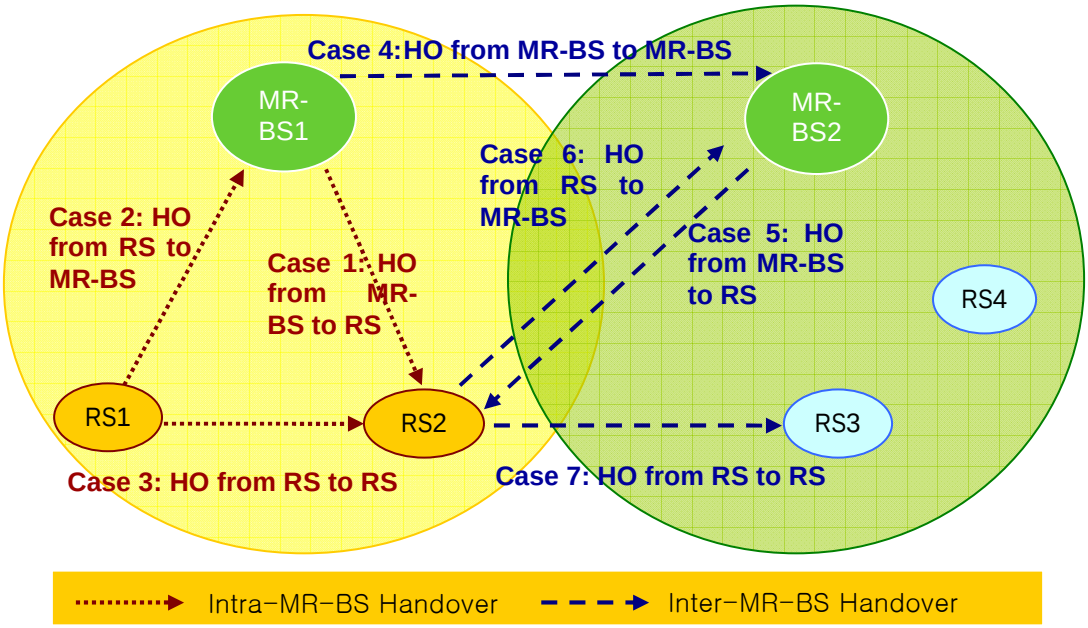


Figure 1 Seven Handover Cases in an MR network

In this handover decision and initiation process it is assumed that RSs as well as MR-BSs transmit their own broadcast control messages such as preamble, FCH, DCD, UCD, DL-MAP and UL-MAP. In a distributed MR network, an RS may have a capability of authentication on management messages from/to an MS.

2. MS handover decision and initiation

An MS handover can be initiated by the decision originated at the MS, at the access station, or at the serving MR-BS.

An MS initiates handover by transmitting a MOB_MSHO-REQ message. Upon receiving the MOB_MSHO-REQ message, the access station responds this with a MOB_BSHO-RSP message.

If an access RS receives MOB_MSHO-REQ, it may relay the received MOB_MSHO-REQ message to a serving MR-BS or reply with a MOB_BSHO-RSP message after collecting the necessary information. If the serving MR-BS receives the relayed MOB_MSHO-REQ message over relay links, it generates and transmits a MOB_BSHO-RSP message to the access RS so that the access RS forwards the received MOB_BSHO-RSP to the MS as a response.

An access station may initiate a handover by transmitting a MOB_BSHO-REQ message.

If a serving MR-BS decides to trigger the handover of an MS which is served in one of its subordinate RS cells, it may generate a MOB_BSHO-REQ message and send this to the access RS so that the RS forwards the received MOB_BSHO-REQ message to the MS.

When an access RS receives a MOB_HO-IND message with HO_IND_type=0b00, it relays the MOB_HO-IND message to its serving MR-BS indicating that the MS declares performing handover to a specific target access station. When an access RS receives a MOB_HO-IND message with HO_IND_type=0b10 indicating HO rejection for the handover initiated by the access RS, the access RS may reconfigure recommended target access station list and send a new MOB_BSHO-RSP message with the new list. If an MS signals rejection through a MOB_HO-IND message with HO_IND_type=0b10 for the handover initiated by the serving MR-BS, the access RS relays the received MOB_HO-IND message to the serving MR-BS. Then, the MR-BS may reconfigure a new recommended target access stations list and transmit the MOB_BSHO-RSP message with the new list.

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 station(s) for a particular MS. ~~While this information was obtained over the backbone in an 802.16e network,~~This information can be obtained over the backbone in a centralized MR network. In addition, 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 over the relay links in a distributed MR network, respectively. The process of exchanging these messages can be found in Table 2 (a) and (b).

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 may be set to 1. Those values are used to indicate the omission of some network re-entry message exchanges including SBC-REQ/RSP messages, REG-REQ/RSP messages, 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 messages for six cases of Figure 1 (except Case 4) in a distributed MR network. Case 4 is not included because it follows the 802.16e procedure exactly. Note that the serving MR-BS initiated case is meaningful when the current access station is an RS.

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

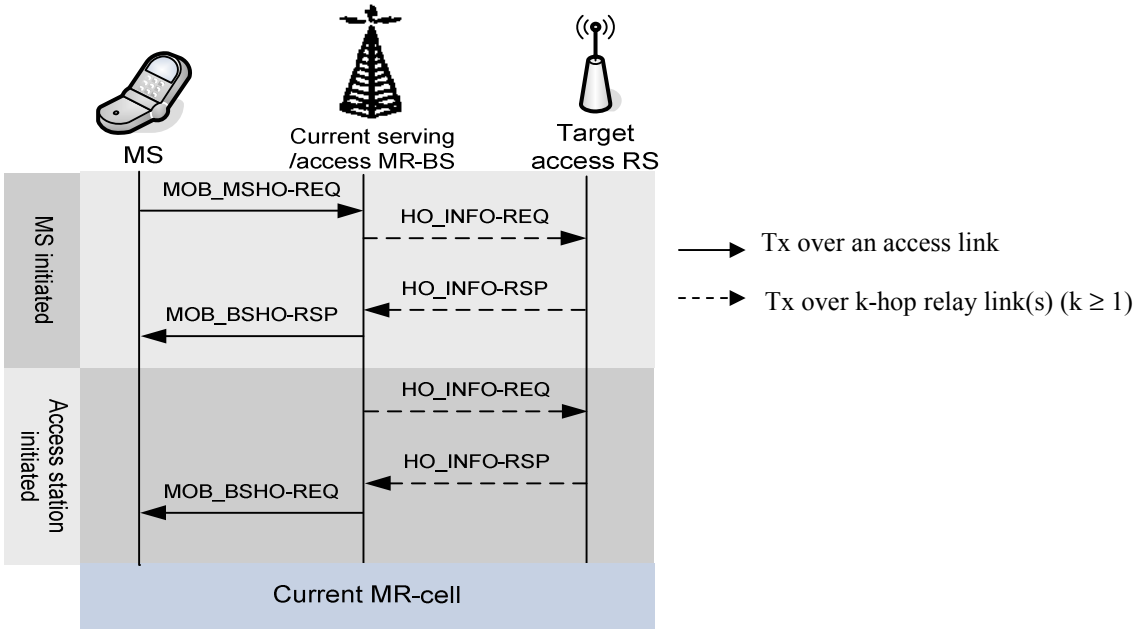
Table 2. Signaling process for HO_INFO-REQ/RSP messages
(a) when the recommended target is for Intra MR-BS handover

Recomm / Current	MR-BS in the same MR cell	RS in the same MR cell
MR-BS	N/A	An MR-BS may send and receive *HO_INFO-REQ/RSP* messages to and from the recommended access RS to compose MOB_BSHO-REQ/RSP messages if some values are unknown to the MR-BS in a distributed system.
RS	(1) The current 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 the recommended RSs cannot communicate directly: (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 send and receive *HO_INFO-REQ/RSP* messages to and from the recommended access RS to compose *HO_INFO-RSP* for the current access RS if some values are unknown to the MR-BS in a distributed system. If the access and the recommended RSs can communicate directly over the 1-hop relay link between them: (1) The access RS may issue 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.

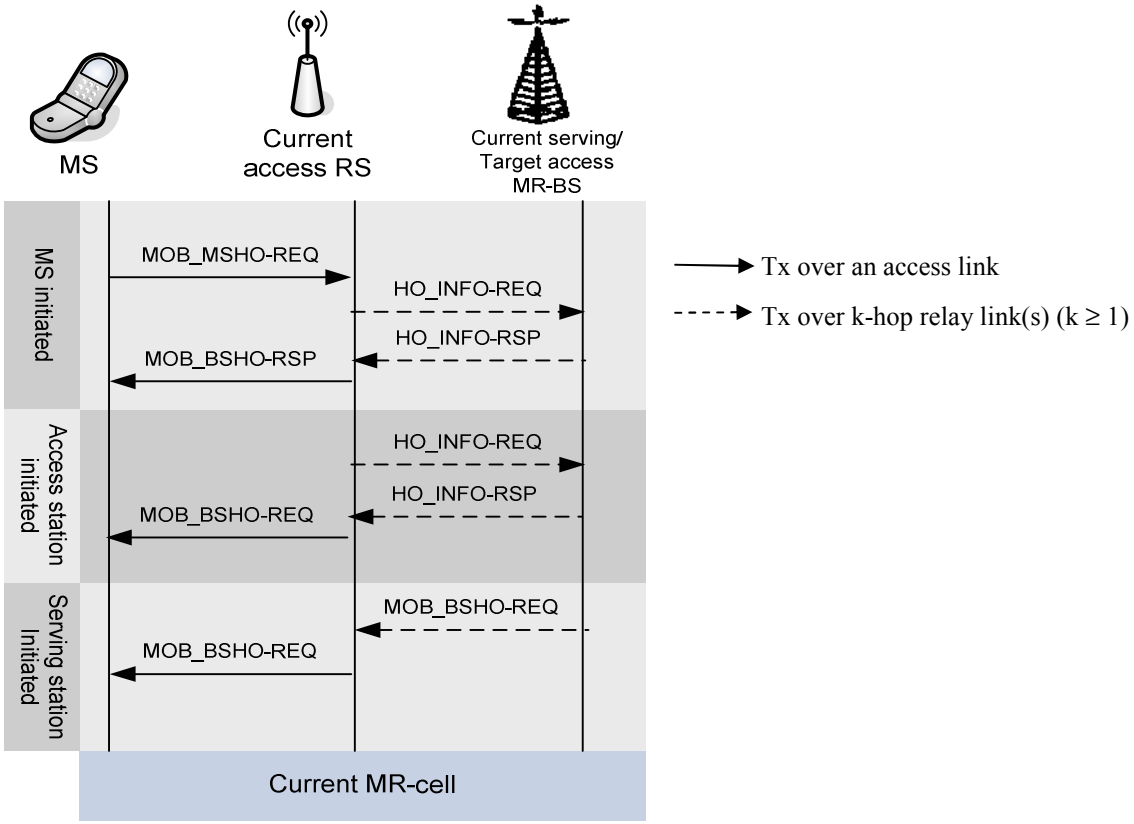
(b) when the recommended target is for Inter MR-BS handover

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 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 serving MR-BS of the recommended RS may exchange *HO_INFO-REQ/RSP*

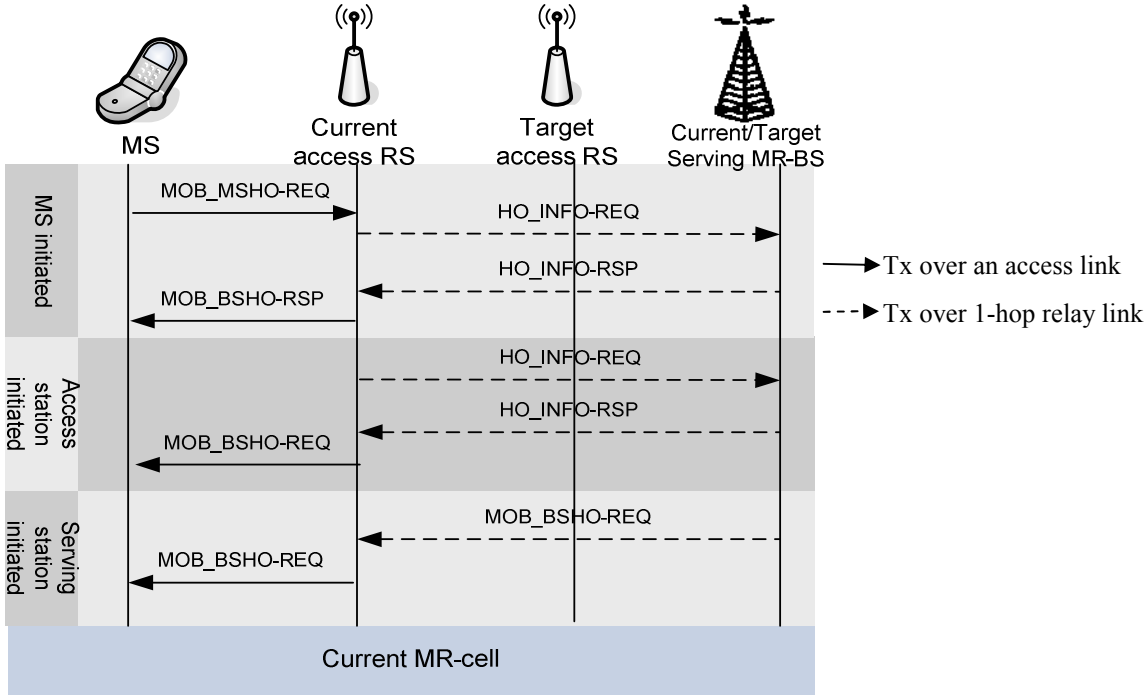
		messages with the recommended RS if some values are unknown to the MR-BS in a distributed system.
RS	(1) The current access RS issues a *HO_INFO-REQ* message destined to its serving MR-BS. (2) Then, the current serving MR-BS transmits the request message to the recommended MR-BS over the backbone and receives the information. (3) Based on the received information, the current serving MR-BS transmits the *HO_INFO-RSP* message to the current access RS.	(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 serving MR-BS of the recommended access RS over the backbone and receives the information. The serving MR-BS of the recommended access RS may exchange *HO_INFO-REQ/RSP* messages with the recommended RS if some values are unknown to the MR-BS in a distributed system. (3) Based on the received information, the current serving MR-BS transmits the *HO_INFO-RSP* message to the current access RS.



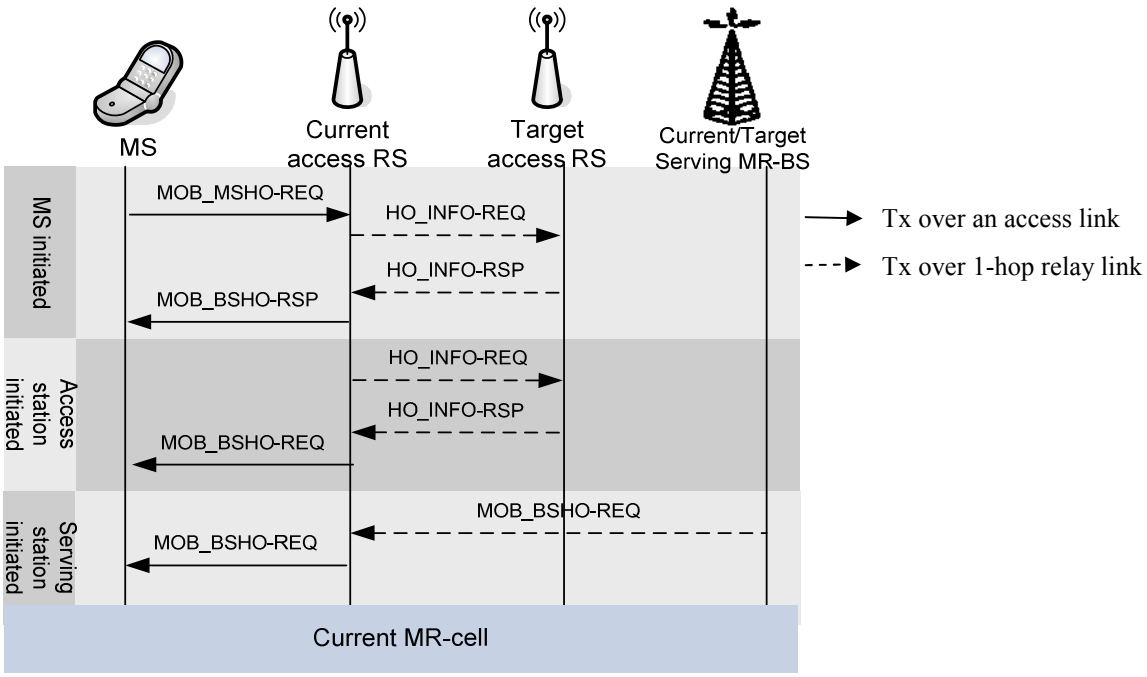
(a) Case1: The current access station is an MR-BS and the target access station is an RS in the same MR cell.



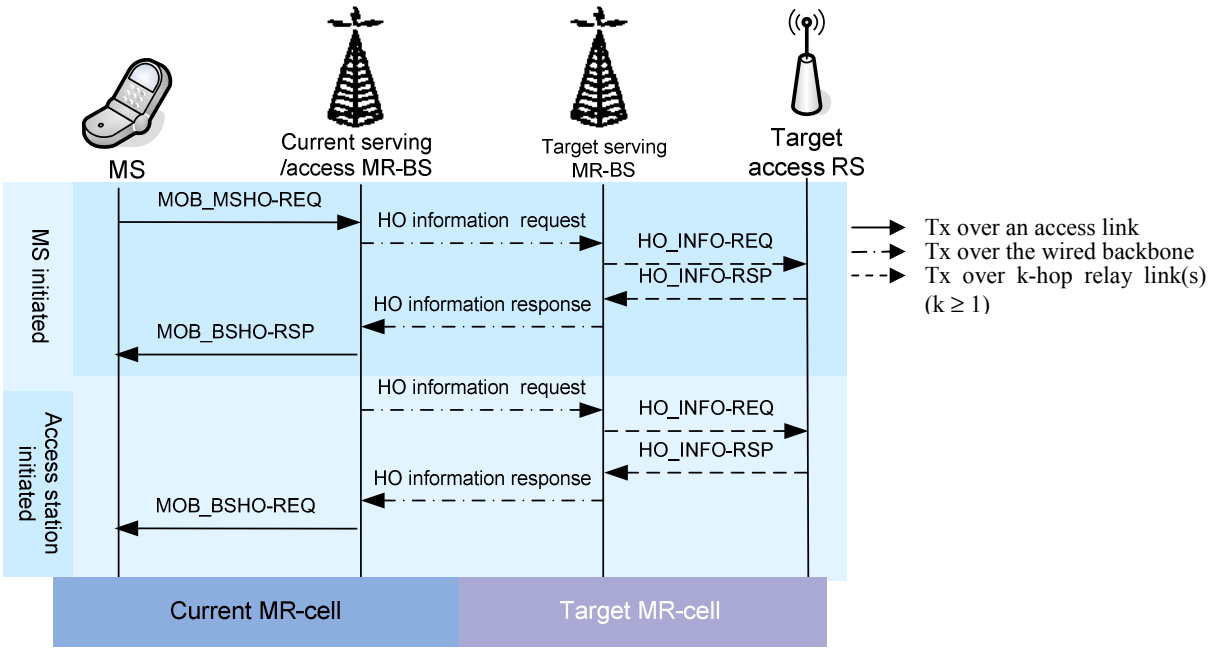
(b) Case2: The current access station is an RS and the target access station is the serving MR-BS in the same MR-cell



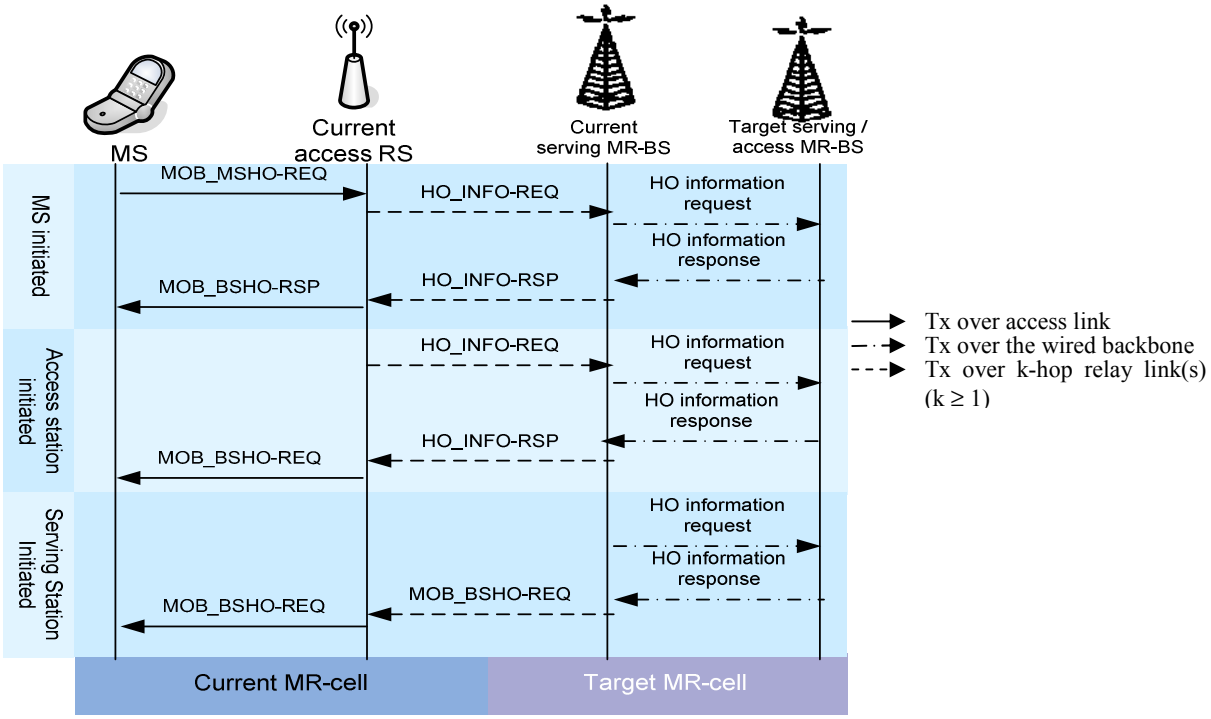
(c) Case3: The current access station is an RS and the target access station is another RS in the same MR-cell. This flow is an example when a direct 1-hop relay link doesn't exists between the current and potential target access RSs.



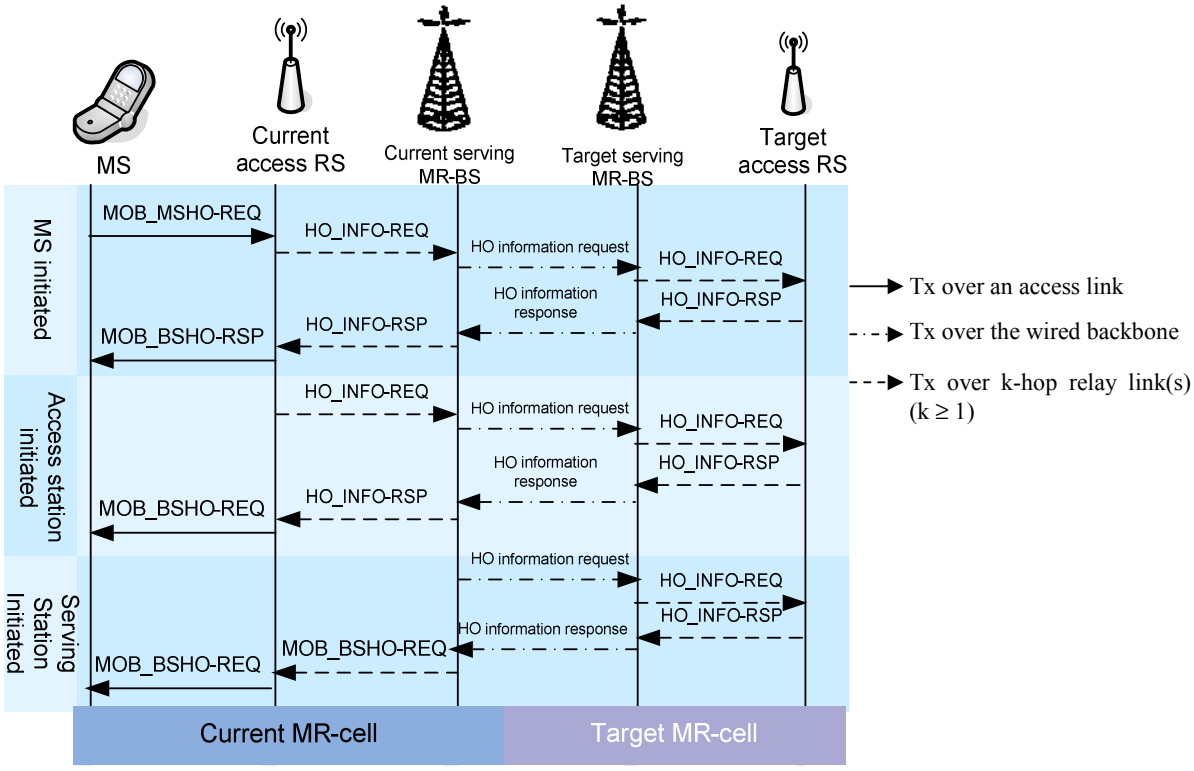
(d) Case3: The current access station is an RS and the target access station is another RS in the same MR-cell. This flow is an example when a direct 1-hop relay link exists between the current and potential target access RSs.



(e) Case 5: The current access station is an MR-BS and the target access station is an RS in a different MR cell.



(f) Case 6: The current access station is an RS and the target access station is an MR-BS in a different MR cell



(g) Case7: The current access station is an RS and the 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 in a distributed MR network (Other flows are possible for each case)

3. Proposed text

[Insert the following at the end of subclause 6.3.22.2.2]

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.

If an access RS receives MOB_MSHO-REQ, it ~~may~~ relays the received MOB_MSHO-REQ message to a serving MR-BS in a centralized MR network. If the serving MR-BS receives the relayed MOB_MSHO-REQ, it generates and transmits a MOB_BSHO-RSP message to the access RS so that the access RS forwards the received MOB_BSHO-RSP to the MS as a response. In a distributed MR network an access RS may ~~or~~ reply with a MOB_BSHO-RSP message after collecting necessary information upon receiving MOB_MSHO-REQ. MS handover signal processing by the access RS is based on the capability negotiated during initial network entry of the RS. ~~If the serving MR-BS receives the relayed MOB_MSHO-REQ, it generates and transmits a MOB_BSHO-RSP message to the access RS so that the access RS forwards the received MOB_BSHO-RSP to the MS as a response.~~

An access station may initiate a handover by transmitting a MOB_BSHO-REQ message.

If a serving MR-BS decides to trigger the handover of an MS which is served in one of its subordinate RS cells, it may generate a MOB_BSHO-REQ message and send this to the access RS so that the RS forwards the received MOB_BSHO-REQ to the MS.

The MOB_BSHO-REQ and MOB_BSHO-RSP messages contain the recommended target access station list and their information related to handover support. This information can be obtained over the backbone in a centralized MR network. In addition, ~~This information can be gathered over the relay links as well as over the backbone in an MR network. T~~the information may be obtained over relay links using HO_INFO-REQ and HO_INFO-RSP messages which include a possible target access station list and HO process optimization information as well as the expected service level of an MS at each target access station.

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 may be set to 1.

When an access RS receives a MOB_HO-IND message with HO_IND_type=0b00, it relays the MOB_HO-IND message to its serving MR-BS indicating that the MS declares performing handover to a specific target access station. When the access RS receives a MOB_HO-IND message with HO_IND_type=0b10 indicating a handover rejection for the handover initiated by the access RS, it may reconfigure the recommended target access station list and send a new MOB_BSHO-RSP message with the new list. If the MOB_HO-IND message which is relayed by the access RS to an MR-BS contains HO_IND_type=0b10 for the handover initiated by the serving MR-BS, the serving MR-BS may reconfigure the recommended target access station list and transmit a new MOB_BSHO-RSP message including the new list.

[Insert new subclause 6.3.2.3.xx]

6.3.2.3.XX HO_INFO-REQ

A infrastructure station sends this message over relay links to obtain handover related information on the recommended access 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	
MS ID	48	
SF_indicator	1	This indicator is set to 1 to indicate that the MS's service flow information is included.
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.
}		
}		
N_Recommended	8	
For (i=0;i<N_Recommended;i++){		
Recommended target access station ID	48	
}		
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	
MS ID	48	
N_Recommended	8	
For (i=0;i<N_Recommended;i++){		
Recommended target access station ID	48	
TLV encoded information	variable	
}		
Padding	variable	Padding to reach byte boundary
}		

The following TLV parameters can be included:

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

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 HO procedure. 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.

[Insert new subclause 11.xx]

11.XX HO_INFO-RSP Management Message Encoding

Name	Type (1byte)	Length (1 byte)
Service Level Prediction	1	1
Preamble Index/ Subchannel Index	2	1
HO Process Optimization	3	1
HO_authorization_policy_support	5	1
HO_ID	6	1
Network Assisted HO supported	7	1

Annex I
(informative)
MAC management message flow related to handover in MR networks

I.XX HO_INFO-REQ/RSP message flow related to handover decision and initiation

In a distributed MR network, tThe procedure to exchange HO_INFO-REQ/RSP messages is:

- Intra MR-BS handover
  - If the current and the recommended access stations are an MR-BS and an RS, respectively, the MR-BS may own all the information. Therefore, the MR-BS can transmit a MOB_BSHO-REQ or MOB_BSHO-RSP message without using HO_INFO-REQ and HO_INFO-RSP messages. The MR-BS may send and receive HO_INFO-REQ and HO_INFO-RSP messages to and from the recommended access RS if some information is unknown to the MR-BS in a distributed MR networksystem.
  - If the current and the recommended access stations are an RS and an MR-BS, the RS send and receive HO_INFO-REQ and HO_INFO-RSP messages to and from the MR-BS.
  - If both the current and the recommended access stations are RSs, the current access RS may send and receive HO_INFO-REQ and HO_INFO-RSP messages to and from the serving MR-BS, respectively. The MR-BS may have to transmit and receive HO_INFO-REQ and HO_INFO-RSP messages to and from the recommended access RS. In an MR network with distributed scheduling, if the access and the recommended RSs can communicate directly over the 1-hop relay link between them, the current access RS may transmit and receive HO_INFO-REQ and HO_INFO-RSP messages directly to and from the recommended access RS.

- Inter MR-BS handover
  - In a distributed MR network iIf the current access station is an RS, the RS sends and receives HO_INFO-REQ and HO_INFO-RSP messages to and from the current serving MR-BS.
  - If the current serving MR-BS receives the HO_INFO-REQ or if an MR-BS is the current access station, it transmits a request and receives the information to and from the serving MR-BS of the recommended access station over the backbone.
  - If an MR-BS receives a request on handover information about its subordinate RS over the backbone, if some values are unknown to the MR-BS in a distributed system,

the MR-BS may transmit and receive HO_INFO-REQ and HO_INFO-RSP messages to and from the recommended access RS.

References

[1] IEEE C802.16j-07/082r1, "Overview of the proposal for MS MAC handover procedure in an MR Network," Jan. 2007