Project	IEEE 802.16 Broadband Wireless Access Working Group <**http://ieee802.org/16**>	
Title	**MS MAC Handover Procedure in an MR Network – Handover Execution**	
Date Submitted	2007-01-08	
Source(s)	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	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
Re:	Submitted in response to Call for technical proposals issued by IEEE 802.16j on 2006-12-12	
Abstract	This document proposes a MS network entry/re-entry procedure to perform actual handover in 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.	
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion 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 contributor 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>.	

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 the handover execution process defined in subclauses 6.3.22.2.7 and 6.3.22.2.8 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.

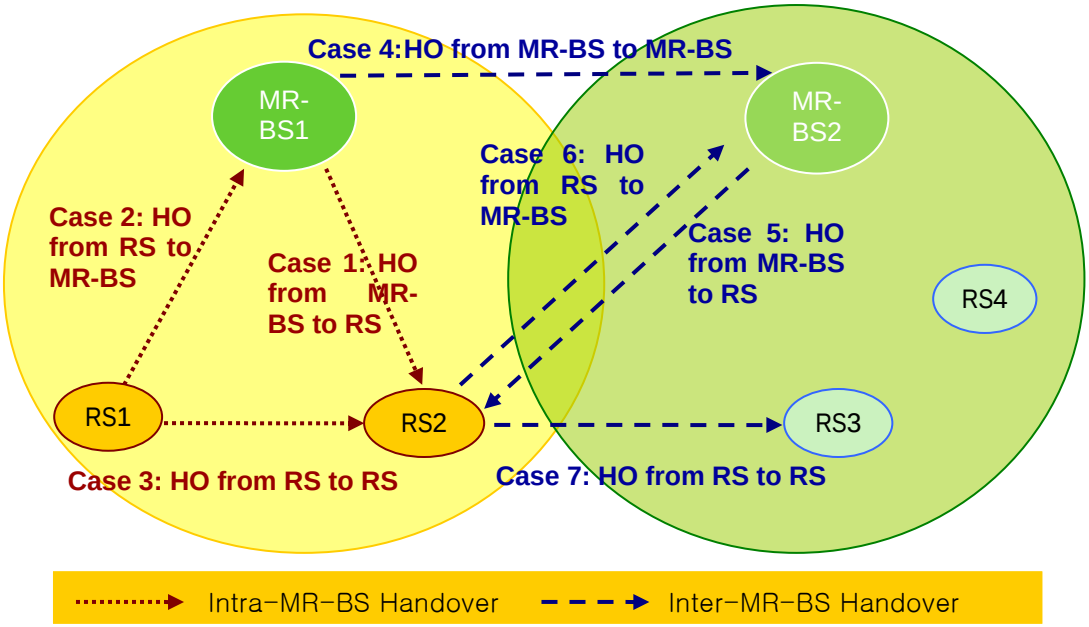


Figure 1. Seven Handover Cases in an MR network

2. MS Network entry/re-entry for handover

Unless indicated otherwise, MS network entry/re-entry due to handover in 802.16j systems is processed according to subclauses 6.3.9 and 6.3.22.2.7 of IEEE 802.16e-2005.

An MS and a target access station shall conduct ranging by exchanging RNG-REQ and RNG-RSP messages. An MS can indicates a handover attempt by sending a RNG-REQ message which

- includes a serving BSID TLV and
- sets bit number 0 of the ranging purpose indication TLV set to 1.

Upon receiving such a RNG-REQ message, the target access station transmits a RNG-RSP message including MS Basic CID and Primary management CID to the MS. Assuming that CIDs are managed by the serving MR-BS for the entire MR-Cell, the MS may continuously use the same CIDs before and after an intra MR-BS handover. Therefore, target access station may send the same CIDs to the MS. For inter MR-BS handover, CID assignment and update is determined by the target serving MR-BS, and the target serving MR-BS makes the CIDs assignment for each new MS and, if a target access station is an RS, sends them to the target

access RS. CID treatments in intermediate RSs over multi-hop are out of the scope of this contribution.

Detail procedure of how to process the received RNG_REQ (i.e., forwarding the received RNG_REQ, transmitted newly defined MAC management message to handle RNG_REQ from individual MS, etc) will follow the subclause 6.3.9.

To notify an MS of possible omission of re-entry process management messages, the target access station includes a HO Process Optimization TLV in a RNG-RSP message. HO process optimization bitmap is determined according to Subclause 6.3.22 of IEEE 802.16e-2005. As indicated in the HO Process Optimization TLV settings, the target access station may use the previously obtained MS service and operational context information. The target access station may request the MS information if it has not received yet. Regardless of having received MS information, the target access station may request MS information over the relay links as well as the backbone network.

We propose two new MAC management messages *MS_INFO-REQ* and *MS_INFO-RSP* to request and response MS information over relay links.

For intra MR-BS handover, if the target access station is the MR-BS, the MS information already exists at the MR-BS because it was the serving station of the MS. Hence, no signaling is required. However, if ARQ has been used hop by hop and the continuity of ARQ or SDU_SN enabled connections is to be maintained, then the ARQ status must be transmitted from the current access RS to the MR-BS over the relay links. The procedure to exchange *MS_INFO-REQ* and *MS_INFO-RSP* messages is summarized in Table 1(a).

For inter MR-BS handover, if the target access station is an MR-BS, the MS information can be obtained over the backbone as defined in IEEE 802.16e-2005. If the target access station is an RS, the target access station may request and receive the information using *MS_INFO-REQ* and *MS_INFO-RSP* messages over the relay links. The procedure to exchange these messages is summarized in Table 1 (b).

During a handover, the target access station may set the bit #7 of *MS DL data pending element* of the HO process optimization TLV item in RNG-RSP to notify the MS of post-HO re-entry MS DL data pending. Upon the MS's successful re-entry at the target access station, the target access station (i.e., new access station) can forward the data to the MS. For inter MR-BS handover, the MS may re-establish IP connectivity after receiving of all the forwarded data. The new serving MR-BS may send a backbone message to the old serving MR-BS or other network entity to stop forwarding pre-HO pending MS DL data.

Figure 2 provides an example of signaling to obtain MS information when a target access station receives RNG-REQ from an MS for six cases of Figure 1 (except Case 4). Case 4 is not included because it follows the 802.16e procedure exactly.

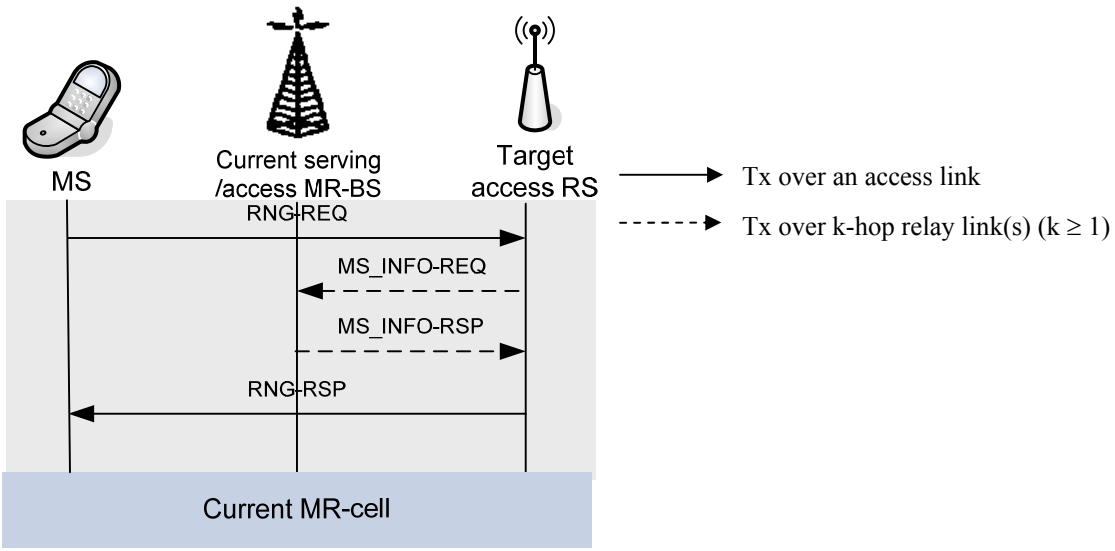
Table 1. **Signaling process for MS_INFO-REQ/RSP messages**
(a) when the target is for Intra MR-BS handover

Current / Target	MR-BS in the same MR cell	RS in the same MR cell
MR-BS	N/A	Since the MR-BS is the current serving

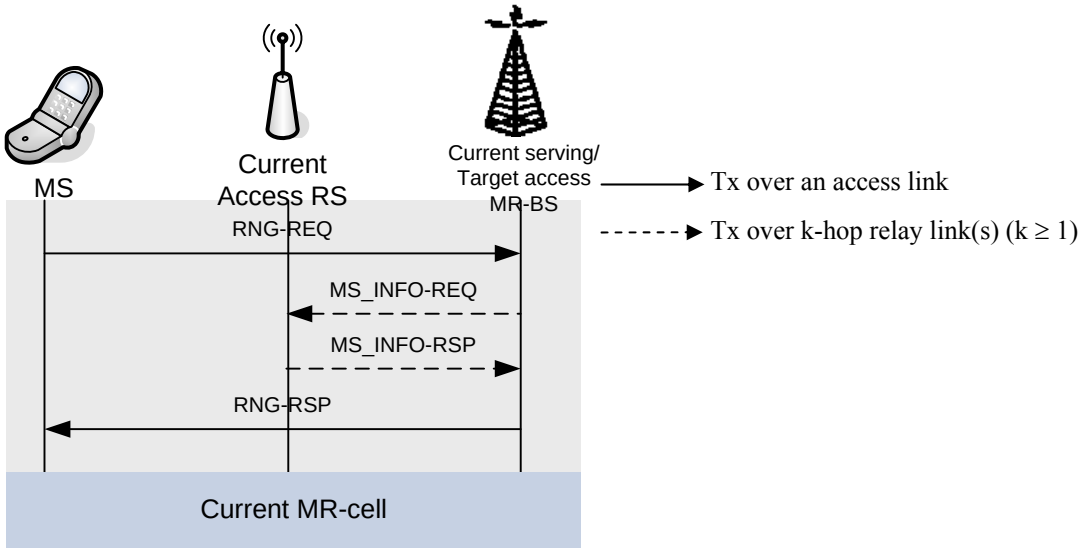
		MR-BS and thus already owns all the MS information, there is no need to exchange MS information. Only if the continuity of hop by hop ARQ or SDU_SN enabled connections is requested, (1) The target access MR-BS issues a *MS_INFO-REQ* message destined to the current access RS. (2) The current access RS responds to the target access MR-BS with encoded ARQ state information in a *MS_INFO-RSP* message.
RS	(1) The target access RS issues a *MS_INFO-REQ* message to the current access MR-BS which is its serving station. (2) Upon receiving the request, the current access MR-BS replies to the target access RS with a *MS_INFO-RSP* message.	If the target and current access RSs cannot communicate directly (i.e., no 1-hop relay link between them): (1) The target access RS issues a *MS_INFO-REQ* message destined to its serving MR-BS. (2) Only if the continuity of hop by hop ARQ or SDU_SN enabled connections is requested, the MR-BS sends the request message to the old access RS to obtain ARQ or SDU_SN information. If not, the MR-BS can respond to the target access RS with a *MS_INFO-RSP* message (Skip (3) and (4)). (3) Upon receiving the request on ARQ or SDU_SN information, the old current access RS replies to the MR-BS with a *MS_INFO-RSP* message with ARQ status. (4) Then, the MR-BS passes transmits *MS_INFO-RSP* message including the ARQ status the response message to the target access RS. If the target and the current RSs can communicate with each other directly over the 1-hop relay link: (1) The target access RS issues a *MS_INFO-REQ* message directly towards the current access RS. (2) Upon receiving the request message, the current access RS responds to the target access RS with a *MS_INFO-RSP* message.

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

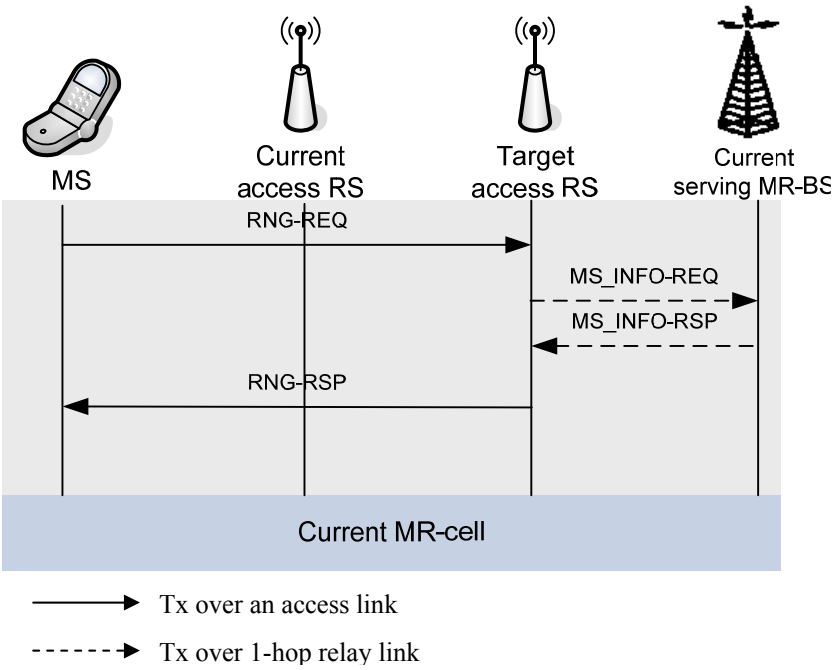
Current / Target	MR-BS in a different MR cell	RS in a different MR cell
MR-BS	Follows the procedure as defined in IEEE 802.16e-2005	The procedure as defined in IEEE 802.16e-2005 is used to obtain MS information from the old serving MR-BS over the backbone. Only if the continuity of hop by hop ARQ or SDU_SN enabled connections is requested, (1) Upon receiving the MS information request from the target serving MR-BS over the backbone, the old serving MR-BS issues a *MS_INFO-REQ* message destined to the old access RS. (2) The old access RS responds to the old serving MR-BS with encoded ARQ state information in a *MS_INFO-RSP* message. (3) The old serving MR-BS transmits all the MS information together with ARQ state to the target MR-BS over the backbone.
RS	(1) The target RS issues a *MS_INFO-REQ* message to the target serving MR-BS. (2) Upon receiving the request, the target serving MR-BS transmits a backbone message in order to obtain the MS information from the old access MR-BS. (3) Upon receiving the reply from the old access MR-BS, the target serving MR-BS transmits the *MS_INFO-RSP* message to the target access RS.	(1) The target access RS issues a *MS_INFO-REQ* message to the target serving MR-BS. (2) Then, the target serving MR-BS transmits the request message to the old serving MR-BS over the backbone. (3) Only if the continuity of hop by hop ARQ or SDU_SN enabled connections is requested, the old serving MR-BS forwards this request message to the old access RS. If not, the old serving MR-BS responds over the backbone without querying the old access RS (Skip (4)). (4) If the old access RS receives the *MS_INFO-REQ* message, it responds with a *MS_INFO-RSP* message with ARQ state to the old serving MR-BS. (5) The old serving MR-BS transmits all the MS information together with ARQ state (if necessary) to the target MR-BS over the backbone. (6) The target serving MR-BS transmits the *MS_INFO-RSP* message to the target access RS.



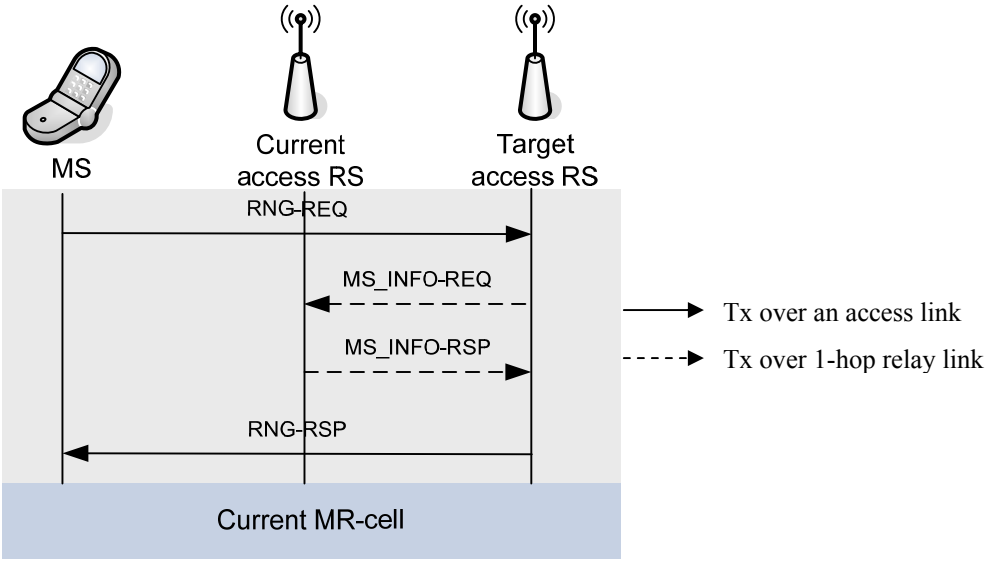
(a) Case1: The current access station is an MR-BS and the target access station is an RS in the same MR cell



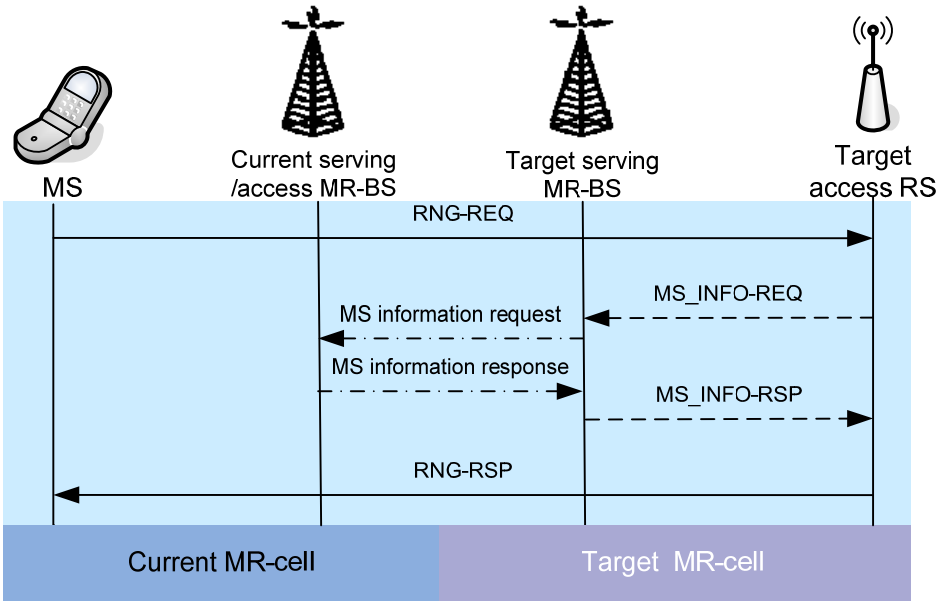
(b) Case 2: The current access station is an RS and the target access station is a serving MR-BS. MS_INFO-REQ/RSP messages are exchanged only when hop by hop ARQ or SDU_SN is supported.



(c) Case 3: 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 exist between the current and the target access RSs.



(c) Case 3: 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 the target access RSs.

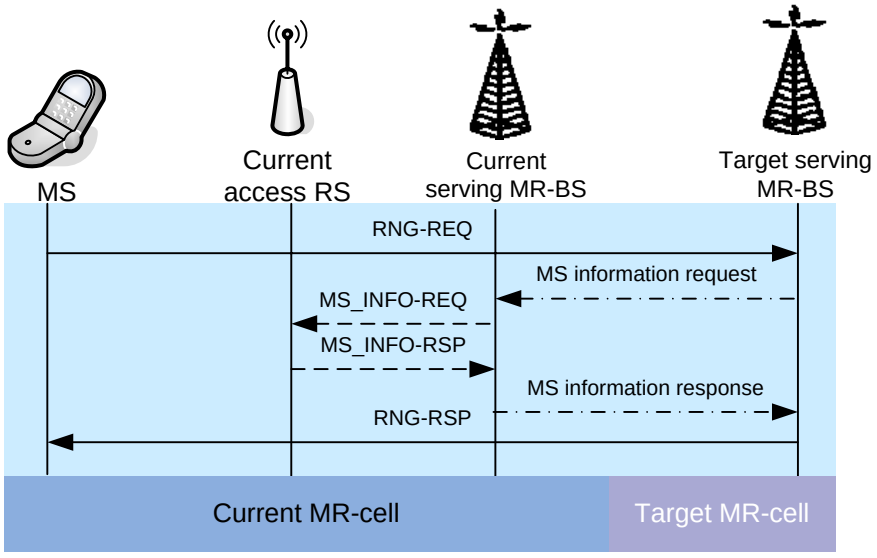


Tx over an access link

Tx over k-hop relay link(s) (k ≥ 1)

Tx over the wired backbone

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

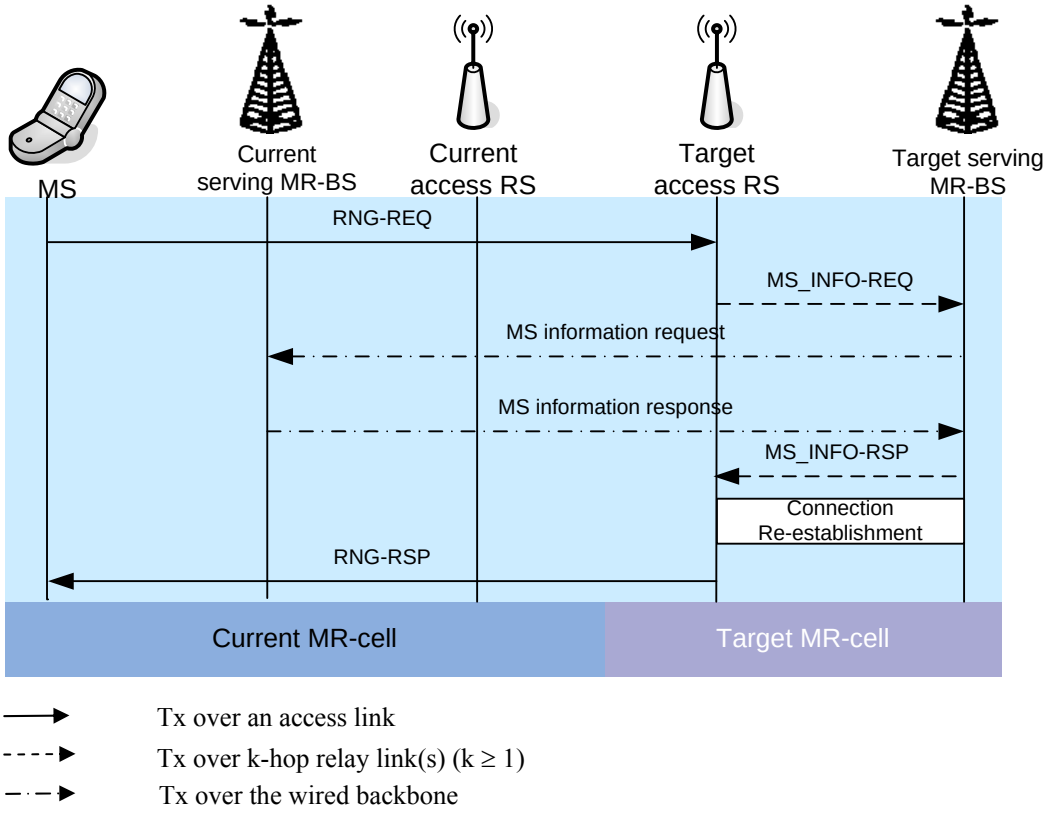


Tx over an access link

Tx over k-hop relay link(s) (k ≥ 1)

Tx over the wired backbone

(e) Case 6: The current access station is an RS and the target access station is an MR-BS in a different MR-cell. MS_INFO-REQ/RSP message exchange between the access RS and the serving MR-BS is required only when hop by hop ARQ or SDU_SN is supported.



(f) Case 7: 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 signaling message exchanges for obtaining MS information when a target access station receives a RNG-REQ message from an MS. (Other flows are possible for each case)

3. Proposed text

[Insert the following at the end of subclause 6.3.22.2.7]

In MR networks, an MS and a target access station shall conduct ranging by exchanging RNG-REQ and RNG-RSP messages. When an RNG-REQ message indicates an MS handover attempt by including a serving BSID TLV and ranging purpose indication TLV with the bit #0 set to 1, the target access station may request the MS information if it has not received yet.

To notify an MS of possible omission of re-entry process management messages, the target access station includes a HO Process Optimization TLV in the RNG-RSP message. As indicated in the HO Process Optimization TLV settings, the target access station may use the previously obtained MS service and operational context information.

The target access RS may make an MS information request by sending a MS_INFO-REQ message to its serving MR-BS. Upon receiving the MS_INFO-REQ message, the serving MR-BS sends a MS_INFO-RSP message with the MS information. The serving MR-BS may obtain the MS information via the backbone network or over the relay links. If a new access RS and an old access RS has 1-hop relay link, the new access RS may send a MS_INFO-REQ message to

the old access RS and the old access RS responds with a MS_INFO-RSP message.
If an RS is an old access station, and ARQ has been used hop by hop and the continuity of ARQ or SDU_SN enabled connections is to be maintained, then the ARQ status must be transmitted from the current access RS to the MR-BS over the relay links. Therefore, an old serving MR-BS may exchange MS_INFO-REQ and MS_INFO-RSP messages with an old access RS.

During a handover, the target access station may set the bit #7 of *MS DL data pending element* of the HO process optimization TLV item in a RNG-RSP message to notify the MS of post-HO re-entry MS DL data pending. Upon the MS's successful re-entry at the target access station, the target access station (i.e., new access station) can forward the data to the MS. For inter MR-BS handover, the MS may re-establish IP connectivity after receiving of all the forwarded data. The new serving MR-BS may send a backbone message to the old serving MR-BS or other network entity to stop forwarding pre-HO pending MS DL data.

[Insert new subclause 6.3.2.3.xx]

6.3.2.3.XX MS_INFO-REQ

Target access station issues this message to obtain the MS information.

Syntax	Size (bits)	Notes
MS_INFO-REQ_Message_format() {		
Management Message Type = TBD	TBD	
Old access station ID	48	
HO_ID_Indicator	1	
If (HO_ID_Indicator = = 1){		
HO_ID	8	
}		
Else{		
MS ID	48	
}		
Information field Indicator	TBD	Each bit indicates if the corresponding field is required to appear in MS_INFO-RSP. − Bit #0: Basic CID − Bit #1: Primary Management CID − Bit #2: Secondary Management CID − Bit #3: CID_Update − Bit #4: Information on SBC − Bit #5: Information on REG − Bit #6: Information on PKM − Bit #7 – TBD Reserved.
Padding	TBD	Padding to reach byte boundary
}		

[Insert new subclause 6.3.2.3.xx]

6.3.2.3.XX MS_INFO-RSP

This is the reply message to a MS_INFO-REQ message.

Syntax	Size (bits)	Notes
MS_INFO-RSP_Message_format() {		
Management Message Type = TBD	TBD	
HO_ID_Indicator	1	
If (HO_ID_Indicator == 1) {		
HO_ID	8	
}		
Else{		
MS_ID	48	
}		
Information field Indicator	TBD	Each bit indicates if the corresponding field appear in MS_INFO-RSP. − Bit #0: Basic CID − Bit #1: Primary Management CID − Bit #2: Secondary Management CID − Bit #3: CID_Update − Bit #4: Information on SBC − Bit #5: Information on REG − Bit #6: Information on PKM − Bit #7 TBD Reserved.
If Information Field Indicator Bit#0 == 1 {		
Basic CID	16	
}		
If Information Field Indicator Bit#1 == 1 {		
Primary Management CID	16	
}		
If Information Field Indicator Bit#2 == 1 {		
Secondary Management CID	16	
}		
If Information Field Indicator Bit#3 == 1 {		
N_CID	TBD	
For (i =0; i<N_CID, i++){		
SFID	32	
CID	16	
}		
}		
TLV encoded information	variable	HO Process Optimization items (information on SBC, REG, PKM, and so on.), ARQ related parameter (TBD) such as counter, timer, etc.
Padding	variable	Padding to reach byte boundary
}		

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

I.XX MS_INFO-REQ/RSP message flow related to execution

The procedure to exchange MS_INFO-REQ/RSP messages is:

- Intra MR-BS handover
  - If the new access station is an RS, it may transmit a MS_INFO-REQ message to the serving MR-BS. If the old access station is also an RS and there exists 1-hop relay link between the old and the new access RSs, the new access RS may transmit a MS_INFO-REQ message directly to the old access RS. Upon receiving a MS_INFO-REQ message, the infrastructure station transmits a MS_INFO-RSP message.
  - If the old access station is an RS, and ARQ has been used hop by hop and the continuity of ARQ or SDU_SN enabled connections is to be maintained, then the serving MR-BS may transmit and receive MS_INFO-REQ and MS_INFO-RSP messages to and from the old access RS.

- Inter MR-BS handover
  - If the new access station is an RS, it transmits and receives MS_INFO-REQ and MS_INFO-RSP messages to and from its serving MR-BS, respectively.
  - The new serving MR-BS transmits a request to the old serving MR_BS over the backbone in order to obtain MS information for itself or on behalf of the new access RS as it receives a MS_INFO-REQ message.
  - When an MR-BS receives a backbone message to request MS information, the MR-BS responds over the backbone. If the old access station was its subordinate RS, and ARQ has been used hop by hop and the continuity of ARQ or SDU_SN enabled connections is to be maintained, then the old serving MR-BS may transmit and receive MS_INFO-REQ and MS_INFO-RSP messages to and from the old access RS.

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