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Re:	This is a response to Call for Technical Proposals regarding IEEE Project P802.16j.
Abstract	The document contains technical proposals for IEEE P802.16j that would provide a handover method on the Mobile RS.
Purpose	The document is submitted for review by 802.16 Working Group members.
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Mobile RS Handover

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1. Introduction

The Mobile RS (MRS) is mounted on the vehicle, such as a bus or train, provides a fixed access link to MS riding on the platform. In general, the quality of the link between MR-BS and MRS is better than that of the link between MR-BS and MS. Moreover, the usage of MRS needs small feedback information (that is, CQI reports, BW request, MIMO feedback, etc.), which it can cover entire feedback of several MSs riding on the vehicle. In this usage scenario, the MRS shall endeavor to maintain reliable radio links to the MSs and also the MRS must have the capability of handover.

Based on the conventional 802.16e system, we can consider the situations of handover with the MRS as the following:

- Case 1: During HO, the MSs on the vehicle can communicate with the serving MR-BS without the MRS relay.
- Case 2: The MRS provides an isolated cell to the MSs or some discontinuation of communication between the serving MR-BS and the MS occurs due to signal fading or interference levels at the handover region.

In MRS operation scenario, the following figures show the examples of handover procedures according to IEEE 802.16e specifications. We note that the MRS is apt to start handover earlier than the MS. In addition, all MS would start handover procedures almost at the same time as the condition of handover occurs (see the Figure-1). In addition, the links between MR-BS and MS may be unstable in the handover regions.
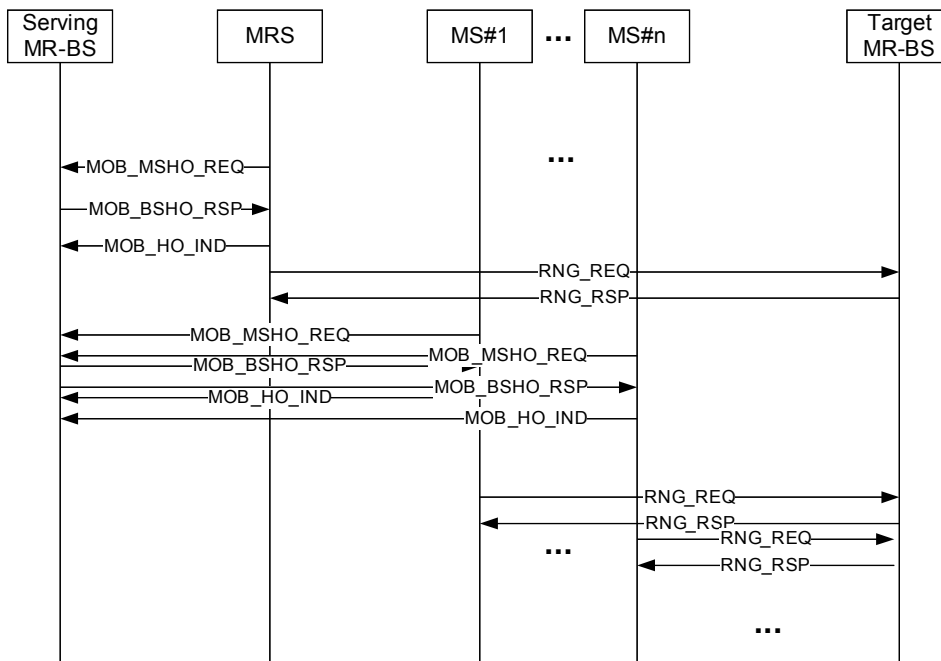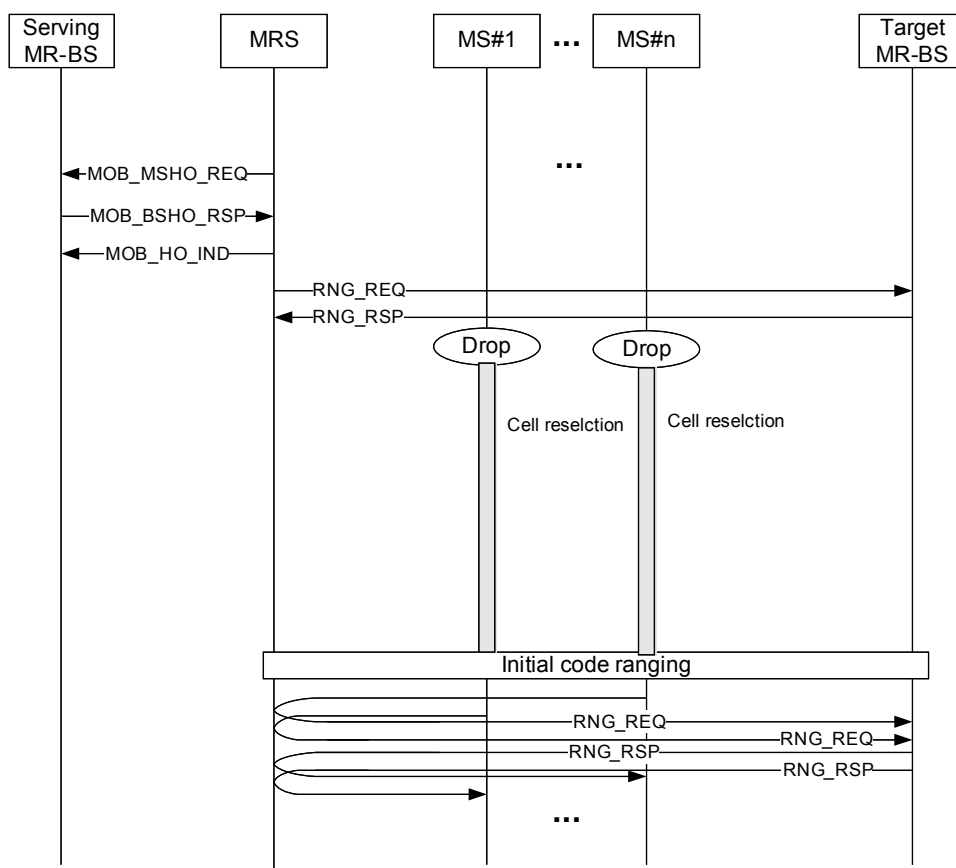
Figure 1. Example of handover procedures at case 1

Figure 2. Example of handover procedures at case 2

In Figure 2, however, the case 2 may raise large delay access to be connected with a new MR-BS because of cell reselection process and congestion on the random access channel for initial access.

Therefore, we propose a method of handover for the MRS and the MSs attached with it. Our contributions are able to keep QoS of the ongoing calls and save the radio resources.

2. Proposed Solution

The MRS can perform a handover, which this is similar to the conventional HO procedures as defined in 6.3.22. In this case, MOB_HO related messages can be still used at both the MRS and the MR-BS with small changes as the MRS fakes an MS. When the MR-BS receives a MOB_HO related message, it can recognize the sender as MRS by parsing a "basic CID" field into the generic MAC header.

When a MRS moves from one BS to another, the following two scenarios are possible:
- MRS preamble is re-assigned
- MRS keeps the same preamble

In former case, MRS should change its PHY configuration, such as preamble index, subcarrier-permutation, frame configuration, etc. It will depend on new target MR-BS and co-channel interference due to the RS mobility. In this case, the MRS can operate as non-transparent RS as well as transparent RS. This contribution deals with the former case. While, we can consider that the MRS keeps the same preamble. In this case, [1] suggests an efficient handover procedure for MRS.

This contribution introduces a scheme called Group HO on the MRS, which enables a MRS to control handover of MSs. We can assume that the MR-BS and the MRS maintain a list of MSs that are served through the corresponding relay link. During a Group handover, in order to derive MS handover naturally, a MRS may transmit or boost up the signals (preamble, FCH, MAP, etc) of target MR-BS or a new preamble to be allocated in the target MR-BS as well as the current its own signals in the serving MR-BS simultaneously. If the target MR-BS decides the MRS to change its preamble after the handover, the Preamble Index TLV can be contained into the MOB_BSHO-REQ/RSP messages [2].

The following figures illustrate the proposed MRS handover procedure along with its attached MSs.
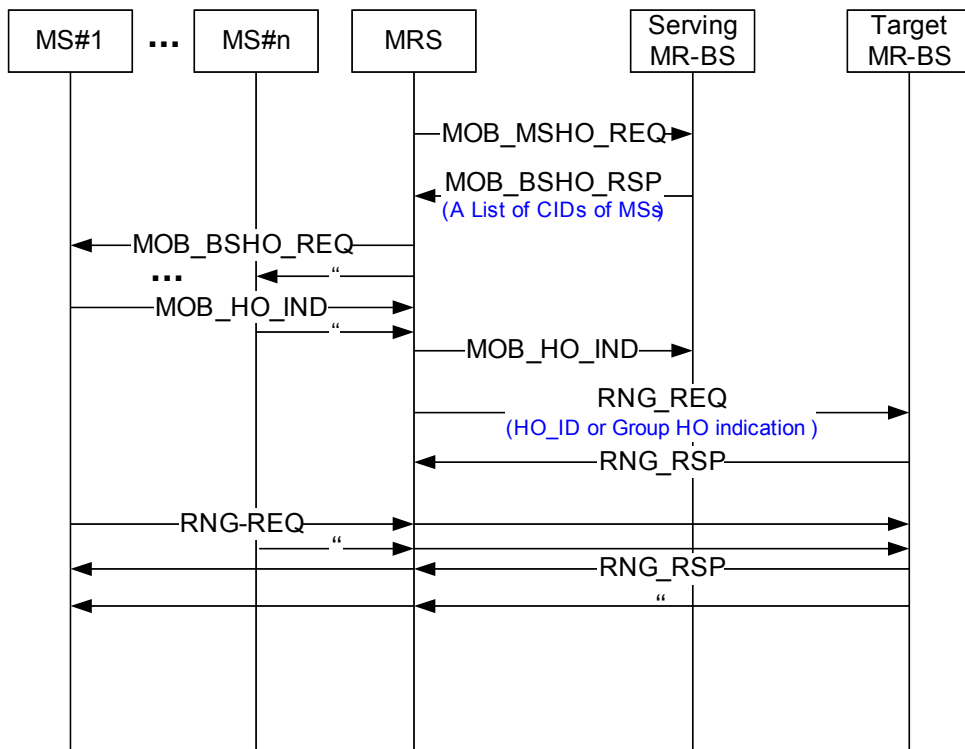
Figure 3-a. The example of group handover in case that the MRS shares security keys for MS with the MR-BS (MRS-initiated)
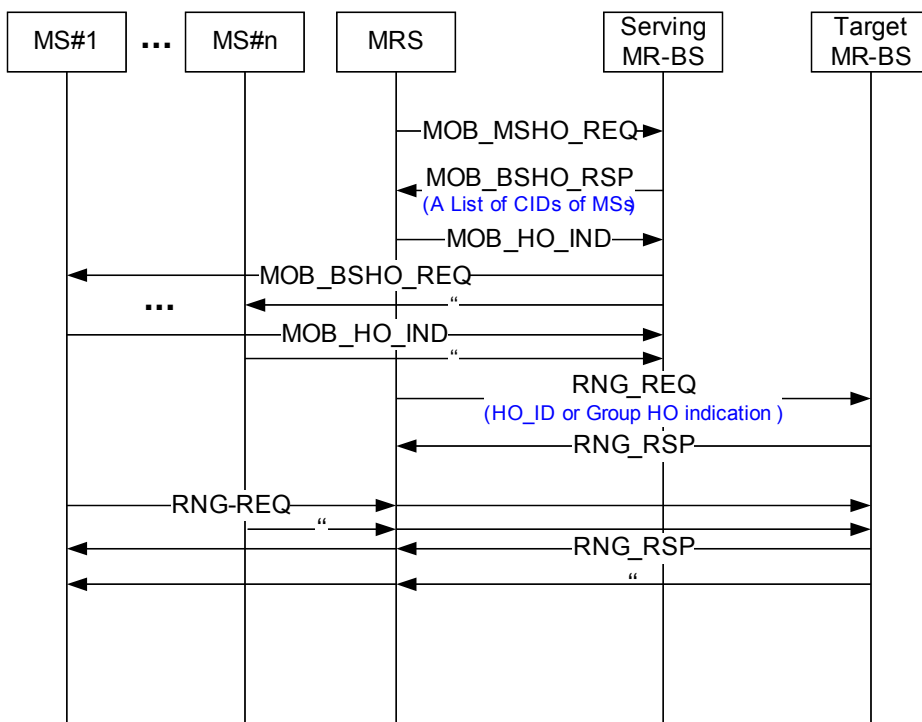

Figure 3-b. The example of group handover in case that the MRS doesn't share security keys for MS with the MR-BS (MRS-initiated)

Figure 3-a and Figure 4-a show the case that the MRS shares the security keys for MS with the MR-BS. While, Figure 3-b and Figure 4-b show the case that the security keys are distributed only between the MR-BS and the MS. In this case, MRS just deliver MOB HO-related messages received from the serving MR-BS to the MS.
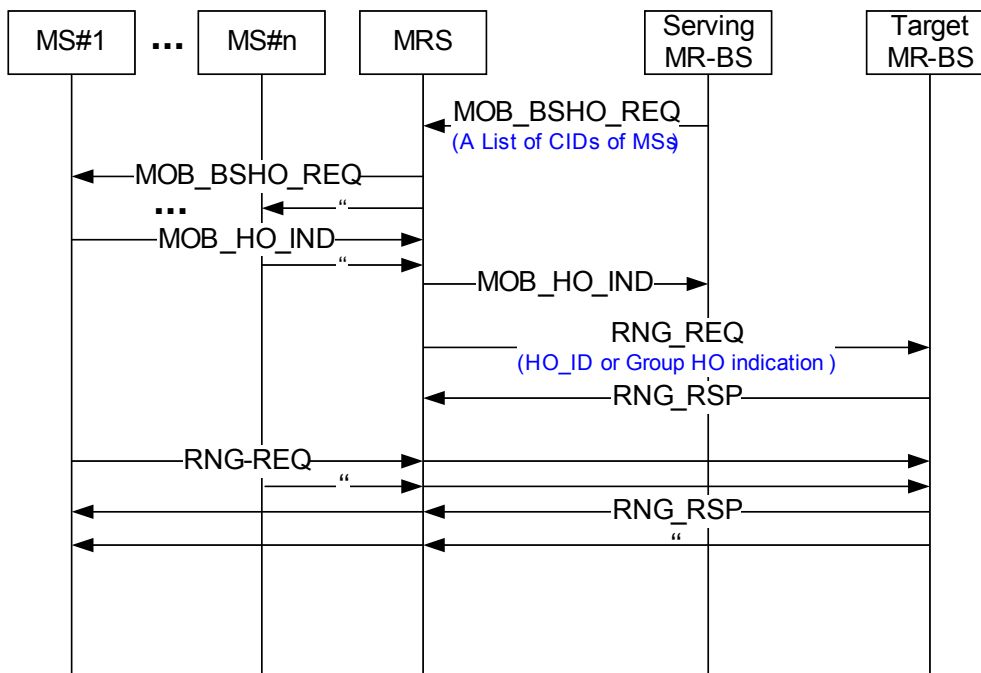

Figure 4-a. The example of group handover in case that the MRS shares security keys for MS with the MR-BS(MR-BS-initiated)
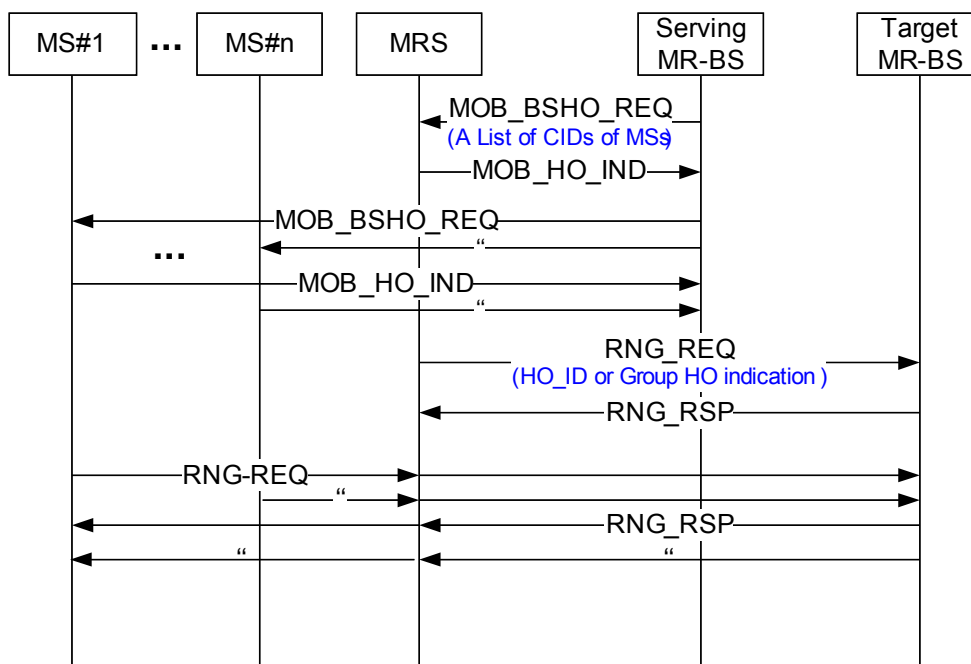

Figure 4-b. The example of group handover in case that the MRS doesn't shares security keys for MS with the MR-BS (MR-BS-initiated)

Figure 3 shows an example of procedures of a MRS initiating group handover. When MOB_MSHO-REQ is sent by a MRS, the MRS may indicate one or more possible target MR-BS. In addition, it may contain basic CIDs of MSs which are served on the MRS relay link. When receiving this message, the MR-BS prepares HO process for the corresponding MSs and sends a MOB_BSHO-RSP message to the MRS with several parameters of service level prediction, HO optimization, action time, HO_ID, etc. In addition, MR-BS should contain basic CIDs of MSs for group handover.

In case that MRS shares the security keys for MS with the MR-BS, the MRS begins HO for each MS. At this time, the MRS may transmit its own signals in the serving MR-BS as well as a new preamble to be allocated in the target MR-BS simultaneously. After the all handover request/response handshakes between a MRS and multiple MSs have completed, the MRS send a MOB_HO-IND message to the serving MR-BS in order to notify the completion of Group HO and its result indicated at the HO_IND_type fields. If the MRS doesn't receive all MOB_HO-IND messages from the MSs, the MRS shall include a "MS CID List" TLV to indicate actual MSs performing a handover.

In case security keys are not distributed from MR-BS to MRS, such as Figure 3-b and Figure 4-b, the MR-BS will initiate handover individually to all the sub-ordinate MS.

In some instance, the MRS may need to indicate the number of MSs for the group handover. The MRS can include "Group Handover indication" into the RNG-REQ message. At the Target MR-BS, the "Group Handover indication" parameter into RNG-REQ message sent by the MRS may be used for determining the amount of the code ranging resources for HO in order to avoid large access delay owing to congestion of random access.

Figure 4 shows an example of procedures of a MR-BS initiating group handover. This is similar to the case of MRS initiating.

Text Proposals
6.3.2.3.52 BS HO Request (MOB_BSHO-REQ) message

Add the following text at the end:

The MOB_BSHO-REQ message shall include the following parameter encoded as TLV tuple for MRS:

        MS CID List (see 11.15.x)
        Preamble Index (see 11.15.x)

6.3.2.3.53 MS HO Request (MOB_MSHO-REQ) message

Add the following text at the end:

The MOB_MSHO-REQ message may include the following parameter encoded as TLV tuple for MRS:
        MS CID List (see 11.15.x)

6.3.2.3.54 BS HO Response (MOB_BSHO-RSP) message

Add the following text at the end:

The MOB_BSHO-RSP message shall include the following parameter encoded as TLV tuple for MRS:
        MS CID List (see 11.15.x)
        Preamble Index (see 11.15.x)

6.3.2.3.54 HO Indication (MOB_HO-IND) message

Add the following text at the end:

The MOB_HO-IND message may include the following parameter encoded as TLV tuple for MRS:
        MS CID List (see 11.15.x)

11.15.x MS CID List

The MS CID List carries a list of the basic CIDs of the MSs attached to an RS.

Name	Type	Length	Value
MS CID List	xx	Variable	List of the CIDS of the MSs for MRS group handover Bit#0~7: the number of MSs Each two bytes represents the basic CID of the MS: this will be repeated number of MS times.

11.15.x Preamble Index

This TLV is used for re-assignment of the preamble during the MRS handover.

Name	Type	Length	Value
Preamble Index	xx	1	A preamble index assigned to the MRS at the target MR-BS.

[Insert new Table xx-RNG-REQ message encodings for RS-WirelessMAN-OFDMA:]

Name	Type	Length	Value
Group Handover indication	xx	1	Presence of item in message indicates the RS is currently attempting to group handover, and its value indicates the number of MS which attempts handover RNG.

[Insert new subsection 6.3.24:]
6.3.24 Mobile RS Handover Process

This subclause deals with MRS handover process, which hands off an MRS as well as all the MS attached to it.

A mobile RS can control MS handover. The MR-BS and the mobile RS would maintain a list of MS which are served through the relay link. A Group HO begins with a decision for a mobile RS to handover itself and to lead the MS to handover from a serving MR-BS to a target MR-BS. The decision may originate either at the mobile RS or the serving MR-BS.

The operation of Group HO divides two steps. First, Group HO notification is recommended as the procedure between a serving MR-BS and a mobile RS, but not required. Acknowledgement of MOB_MSHO-REQ with MOB_BSHO-RSP is required.

If the target MR-BS decides the MRS to change its preamble after the handover, the Preamble Index TLV can be contained into the MOB_BSHO-REQ/RSP messages.

Second, the mobile RS begins HO for each MS, if MRS has the security keys to authenticate messages. Otherwise, the MR-BS begins HO for each MS. After the all handover request/response handshakes between a mobile RS and multiple MSs have completed, the MRS send a MOB_HO-IND message to the serving MR-BS in order to notify the completion of Group HO and its result indicated at the HO_IND_type fields. If the MRS doesn't receive all MOB_HO-IND messages from the MSs, the MRS shall include a "MS CID List" TLV to indicate actual MSs performing a handover.

In some instance, the MRS may need to indicate the number of MSs for the group handover. At the Target MR-BS, the "Group Handover indication" parameter into RNG-REQ message sent by the mobile RS may be used for determining the amount of the code ranging resources for HO in order to avoid large access delay owing to congestion of random access. If the target MR-BS is one of the recommended BSs, "Group Handover indication" TLV doesn't be contained into the RNG-REQ message.

References

[1] MRS Handover in 802.16j (MMR) System, C802.16j-07_037.doc; Yousuf Saifullah, Shashikant Maheshwari, and Haihong Zheng; Nokia

[2] Mobile Relay-Station Preamble Segment Re-assignment Scheme, C802.16j-07_041.doc, Peter Wang, Adrian Boariu, Shashikant, Maheshwari, and Yousuf Saifullah, Nokia.