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Title	**Proposal for MS handover procedure in an MR Network**	
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Re:	IEEE 802.16j-06/034:"Call for Technical Proposals regarding IEEE Project P802.16j"	
Abstract	This document provides the handover procedure and corresponding MAC management messages over relay links so that a legacy IEEE 802.16e MS can handover seamlessly within an IEEE 802.16j network.	
Purpose	This contribution is provided as input for the IEEE 802.16j amendment.	
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1. Introduction

In this proposal, we define the handover procedure and corresponding MAC management messages over relay links so that a legacy IEEE 802.16e MS can handover seamlessly within an IEEE 802.16j network.

1.1 Terminologies and Definitions used in this contribution

transparent RS: An RS that does not transmit its own preamble, FCH and MAC management messages on a broadcast connection on the access DL [1].

non-transparent RS: An RS that transmits its own preamble, FCH and MAC management messages on a broadcast connection on the access DL [1].

virtual cell (VC): one or more stations that share the same frame header. A VC can consist of a MR-BS and its subordinate transparent RSs, or a number of non-transparent RSs, which transmit the same frame header, and their subordinate transparent RSs. Note that RSs belonging to the same VC may not have to transmit data bursts simultaneously.

VC head: the station that performs the resource allocation for a VC. A VC head is an MR-BS (or a non-transparent RS) if a centralized (or decentralized) resource allocation is adopted for the VC.

1.2 Problem statement

Due to the introduction of RSs into the network infrastructure, two handover scenarios illustrated in Figure 1 are possible to occur in an MR network. The two handover scenarios are: intra-VC handover and inter-VC handover.

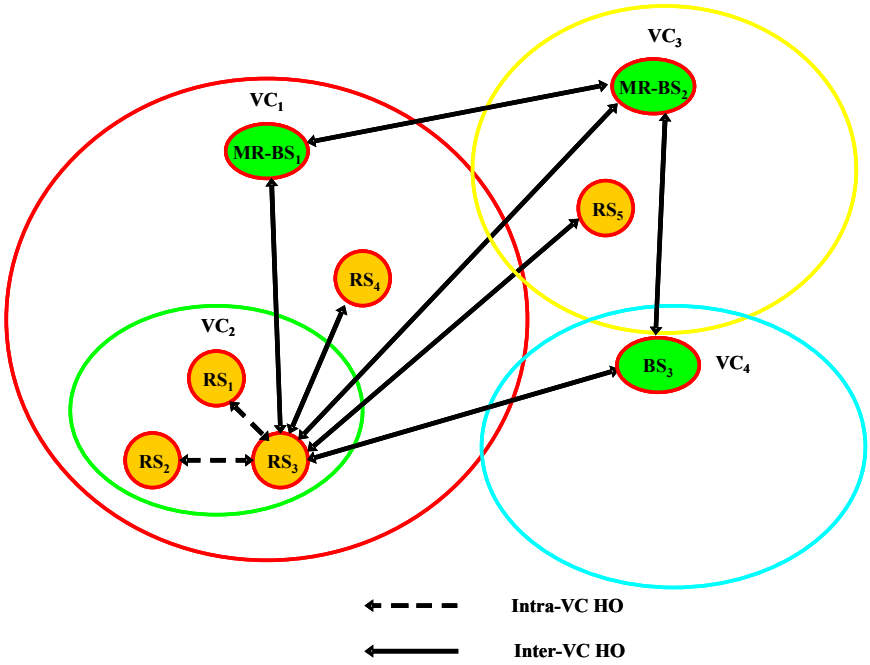

Figure 1 Two handover scenarios in an MR network

Intra-VC handover refers to the handover within a VC. That is, handover is occurred among the stations (MR-BS or RSs) with same frame header (preamble/FCH/ MAP)and the handover MS cannot aware the handover event. Inter-VC handover refers to the handover between two VCs. That is, handover is occurred among stations (MR-BSs, BSs, or RSs) with different frame headers and the handover MS can aware the handover event.. Note that, both intra-VC handover and inter-VC handover should work together to support the mobility of MS in 802.16j.

This contribution introduces and defines the MAC handover procedures for an MR network with transparent and/or non-transparent RSs. The focus of this contribution will be on defining a MS MAC handover procedure with *fixed or nomadic* RS. The mobility of MS due to the movement of mobile RS should be governed by the *mobile RS* handover procedure, which is out of the scope of this proposal, instead of the MS handover procedure. The optional handover features such as MDHO and FBSS in IEEE 802.16e-2005 are not included in this contribution.

2. Proposed Handover Procedures

2.1 Intra-VC Handover

Intra-VC handover is occurred among stations with same frame header (preamble/FCH/ MAP). In this case, the access station, which relays the data bursts to and from a given MS, may always measure the transmission quality of the MS. The VC head will be notified by the measurement report of the access station. With the measurement report, the VC head may decide to trigger an intra-VC handover if the transmission quality of the MS falls below a given threshold. During the intra-VC handover, the VC head will request all or part of RSs belonging to the same VC to scan MS's signal quality via measuring the data bursts sent to the access station. The scanning results will be reported to the VC head via assigned dedicated channels and the VC head will directly indicate the HO decision result via path management procedure. Note that, in intra-VC handover, MS is not aware of the handover and thus, no modification at the MS is required.

The intra-VC handover decision can be done in a centralized or a decentralized manner. In case that the resource is centralized allocated by the MR-BS (VC head), a centralized handover decision is required because only the MR-BS can determine resource allocation to the MS. Figure 2 shows a example of centralized handover decision procedure. Scanning reports shall be relayed to the MR-BS and the MR-BS is responsible for triggering the measurement and making the final handover (or path reselection) decision. In this example, the required new MAC management messages are marked as red color in the figure.

In contrast, a decentralized handover decision can be adopted if the resource is decentralized allocated by a non-transparent RS (VC head). In this case, the VC head RS is responsible for triggering the measurement (i.e., RS scanning) and makes the final handover decision. An example of the decentralized intra-VC handover decision is illustrated in Figure 3. Similarly, the required new MAC management messages are marked as red color in the figure. Note that, the decentralized intra-VC handover decision can be informed to the MR-BS after intra-VC handover completion for location management purpose.

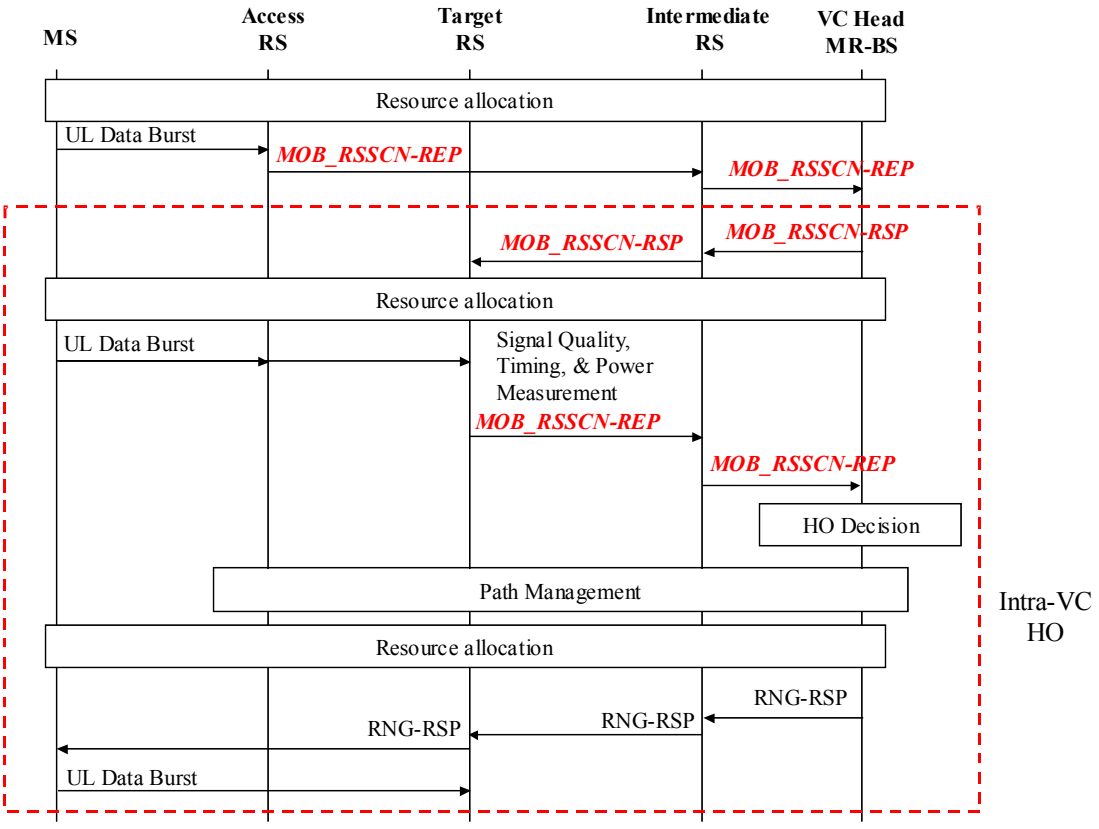

Figure 2 Centralized intra-VC handover decision.

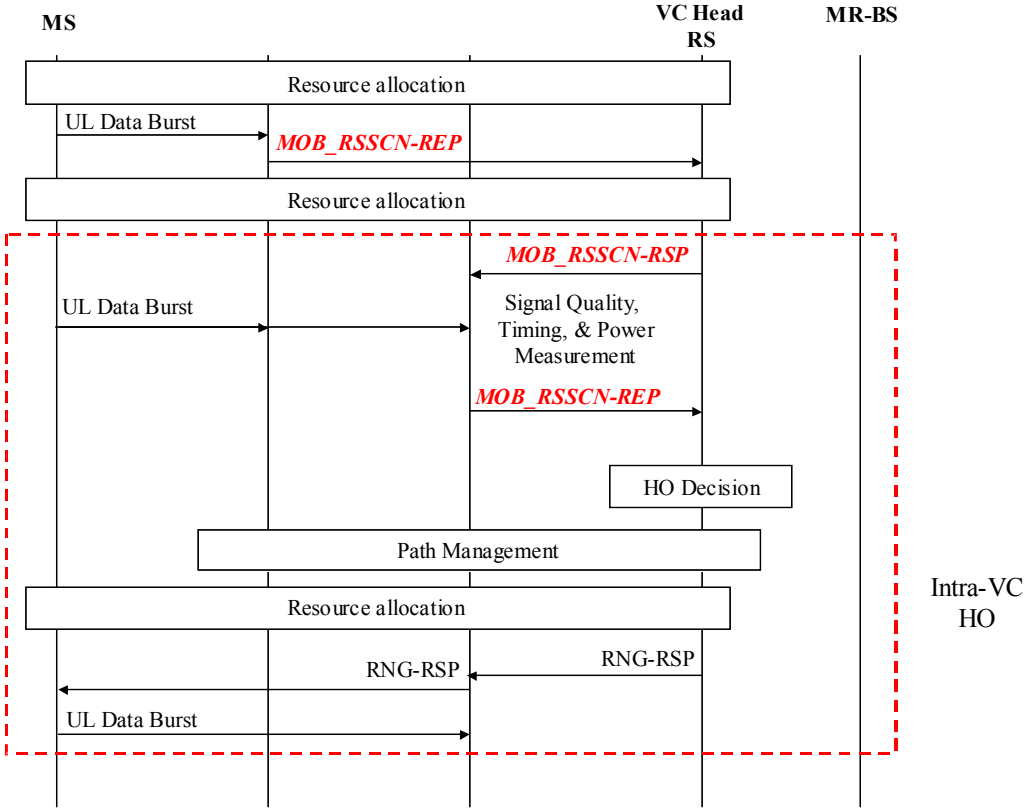

Figure 3 Decentralized intra-VC handover decision.

2.2 Inter-VC Handover

Inter-VC handover is occurred between stations belonging to different VCs. In this case, the access and target stations (MR-BSs, BSs, or RSs) will have different frame header (preamble/FCH/ MAP) and thus, an MS is aware of the handover. Therefore, the legacy 802.16e handover procedure with the modification of signaling flows among the involved stations can be reused.

The inter-VC handover may be triggered by the MS or the VC head (RS or MR-BS). The measurement is performed at MS by scanning the preambles of neighboring VCs. The path selection and target access station decision algorithms may be required between the involved MR-BSs and its subordinate RSs to establish relay links.

The inter-VC handover decision can be done in a centralized or a decentralized manner. In centralized inter-VC handover decision, as shown in Figure 4, the legacy 802.16e MS handover procedure is directly applied and no new MAC management message is required. The centralized inter-VC handover may be triggered by the MS, VC head RS, or the MR-BS. If MS triggers inter-VC handover, the access RS only forwards the MOB_MSHO-REQ to the MR-BS and the MR-BS is responsible for making the final handover decision. The handover notification is then exchanged through MR-BS and the wired backbone. The relay link(s) from the target RS to its corresponding MR-BS may need to be established during handover. As in the legacy 802.16e handover, the old MR-BS should send the MOB_BSHO-REP message to the MS via relay links and get the confirmation from the MS. As soon as the old MR-BS get the MOB_HO-IND from the MS, it shall release the wireless relay links to the access RS and forward the MS context to the new MR-BS. At the same time, the MS shall synchronize with the target RS and then receive data bursts from the target RS. Note that, in the centralized inter-VC handover decision, all RSs are transparent for the handover procedure. The RSs in the old VC will notice the MS handover until it receives message from the MR-BS indicating the release of wireless relay links.

In decentralized inter-VC handover decision, as shown in Figure 5, the legacy 802.16e MS handover procedure can also be applied but requires new MAC management messages, which are marked as red color in the figure. The decentralized inter-VC handover may be triggered by the MS or the non-transparent RS (i.e., VC head RS). In this case, the VC head RS should be able to decode the MOB_MSHO-REQ sent by the MS for making the handover decision. The old VC head shall send an *MOB_RSHO-REQ* to MR-BS triggering the handover notification to the new VC head RS through the wired backbone and the wireless relay links. Similarly, the wireless relay link(s) from

the target RS to its root MR-BS may need to be established during handover. The old MR-BS will send an *MOB_RSHO-RSP* back to the old VC head RS for handover confirmation. As in the legacy 802.16e handover, the old VC head RS should send the MOB_BSHO-REP message to the MS via relay links and get the confirmation from the MS. As soon as the old VC head RS get the MOB_HO-IND from the MS, it shall notify its root MR-BS for forwarding the MS context to the new MR-BS. At the same time, the MS shall synchronize with the target RS and then receive data bursts from the target RS. Note that, in decentralized inter-VC handover, the handover decision made by the VC head RS should be approved by its root MR-BS and thus, the complexity and signaling overhead are almost the same as the centralized inter-VC handover.

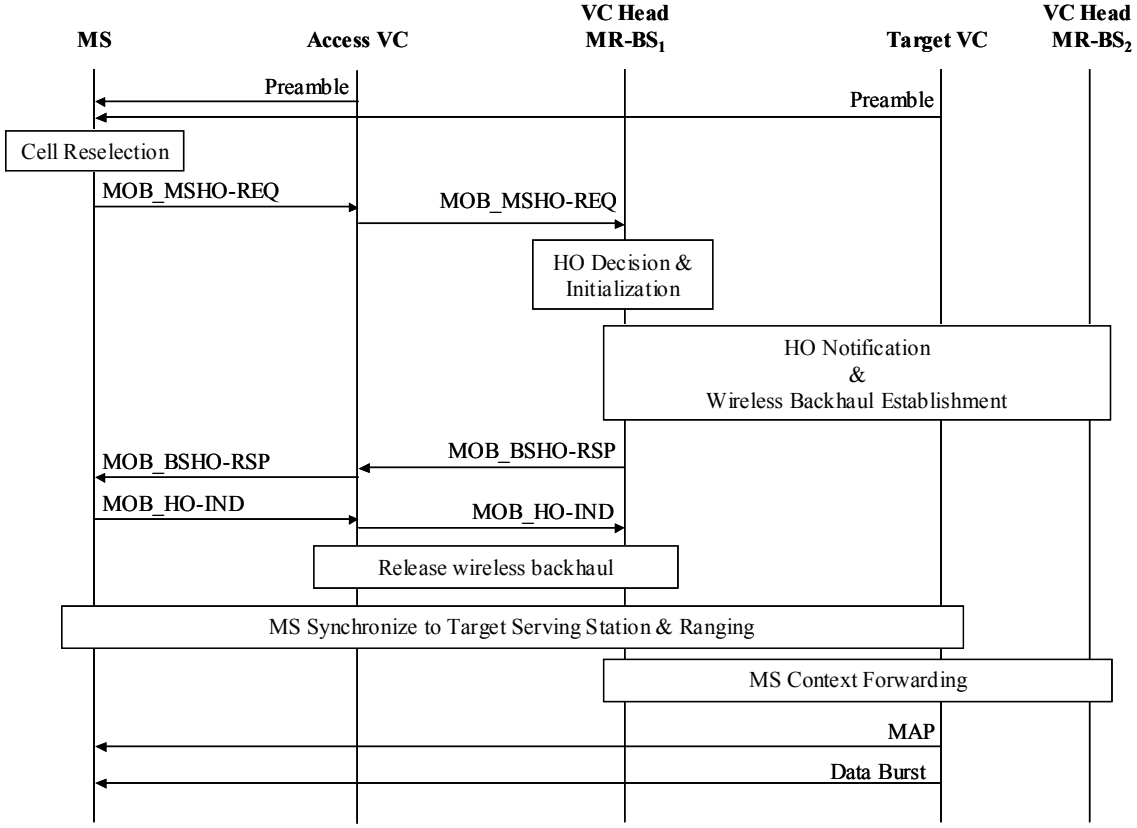

Figure 4 Centralized inter-VC handover decision.

2.3 Summary

From the implementation complexity and the backward compatibility points of view, decentralized intra-VC handover and centralized inter-VC handover would be a preferred handover solution for 802.16j. The reasons are listed as follows.

- Intra-VC handover
  - MS will not be aware the intra VC handover so that the intra VC handover can be executed by resource allocation procedure.
  - Resource allocation of a VC is determined by its VC head so that the intra-VC handover decision shall be performed at VC head. Therefore, we concludes that the intra-VC handover is preferred to be centralized controlled at VC head.
- Inter-VC handover
  - Inter-VC handover procedure need inter-VC communication which shall be supported through MR-BS. Therefore, inter-VC handover decision is preferred to be executed at MR-BS.

Therefore, only two new MAC management messages, MOB_RSCSN-REQ and MOB_RSCSN-RSP need to be defined.

3. Proposed texts

----------Start text proposal----------

3 Definitions

[Insert the following at the end of section 3]

3.94 transparent RS: An RS that does not transmit its own preamble, FCH and MAC management messages on a broadcast connection on the access DL.

3.95 non-transparent RS: An RS that transmits its own preamble, FCH and MAC management messages on a broadcast connection on the access DL.

3.96 virtual cell (VC): one or more stations that share the same frame header. A VC can consist of a MR-BS and its subordinate transparent RSs, or a number of non-transparent RSs, which transmit the same frame header, and their subordinate transparent RSs. Note that RSs belonging to the same VC may not have to transmit data bursts simultaneously.

3.97 VC head: the station that performs the resource allocation for a VC. A VC head is an MR-BS (or a non-transparent RS) if a centralized (or decentralized) resource allocation is adopted for the VC.

6.3.22 MAC layer handover procedures

[Insert the following subclause and text into this section]

6.3.22.2.10 MAC layer handover procedures in MR network

Due to the introduction of RSs into the network infrastructure, two handover scenarios: intra-VC handover and inter-VC handover are possible to occur in an MR network.

Intra-VC handover refers to the handover within a VC. That is, handover is occurred among the stations (MR-BS or RSs) with same frame header (preamble/FCH/ MAP). Inter-VC handover refers to the handover between two VCs. That is, handover is occurred among stations (MR-BSs, BSs, or RSs) belonging to different VCs. Both intra-VC handover and inter-VC handover should work together to support the mobility of MS in 8022.16j.

6.3.22.2.10.1 Intra-VC handover

The access station in the VC, which relays the data bursts to and from a given MS, shall always measure the transmission quality of the MS. The VC head will be notified by the measurement report of the access station through MOB_RSSCN-REP message. With the measurement report, the VC head may decide to trigger an intra-VC handover if the transmission quality of the MS falls below a given threshold. During the intra-VC handover, the VC head will send MOB_RSSCN-RSP message to all or part of RSs belonging to the same VC to request to scan MS's signal quality via measuring the data bursts sent to the access station and the scanning results will be reported to the VC head. After VC head making decision, it shall perform path management (refer to section 6.3.25) to notify the target RS will replace original access RS with taking over the transmission for this MS and then the VC head will directly indicate the HO decision result by RNG-RSP.

Figure xxx-1 shows the intra-VC HO VC head state flow diagram.

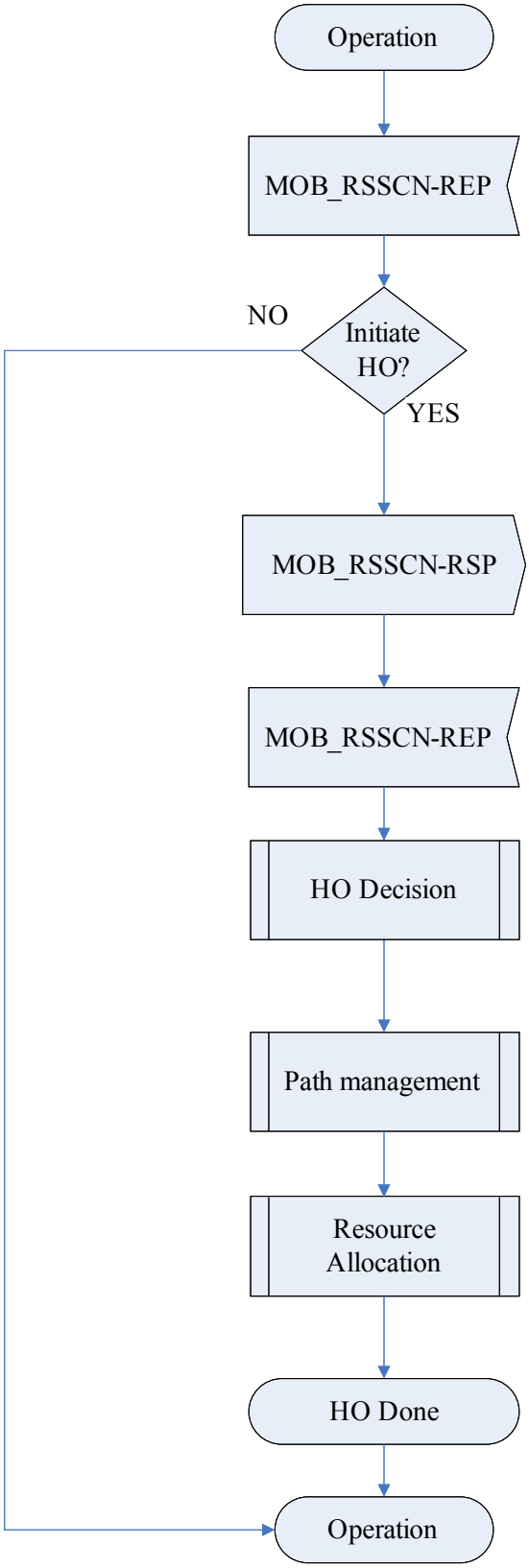

Figure XXX- Intra-VC HO VC head state flow diagram

6.3.22.2.10.2 Inter-VC handover

Inter-VC handover can be triggered by MS, MR-BS and VC head (RS).

An MS triggers handover by transmitting a MOB_MSHO-REQ message. RSs only need to forward this message to MR-BS. Upon receiving MOB_MSHO-REQ, the MR-BS responses this with a MOB_BSHO-RSP 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 MS. Upon receiving this, RS forwards the received MOB_BSHO-REQ to the MS.

A VC head may trigger a handover for specified MSs by transmitting a MOB_RSHO-REQ message. After receiving this message, MR-BS can decide to initiate the HO by transmitting the MOB_BSHO-RSP to VC head and then directly forward to MS.

After triggering inter-VC HO, the legacy 802.16e handover procedure specified in section 6.3.22.1 and 6.3.22.2.1~6.3.22.2.8 is directly applied without any modifications. The process would be executed between the MS and the MR-BS. RSs only need to forward the received messages to MR-BS/MS and support the procedures of network re-entry specified in section 6.3.9.16. during inter-VC HO process.

6.3.2.3 MAC management messages

[Insert the following text into this section]
[Add the columns into Table 14 as indicated.]

Table 14—MAC Management messages

Type	Message name	Message description	Connection
69	MOB_RSSCN-REP	RS scanning report	Basic
70	MOB_RSSCN-RSP	Intra-VC HO trigger message	Basic
71	MOB_RSHO-REQ	VC head inter-VC HO trigger message	Basic

6.3.2.3.62 MOB_RSSCN-REP message

Access-RS shall transmit an MOB_RSSCN-REP message to report the measurement results to VC head after received MS's UL data burst. The message shall be transmitted on the Basic Management CID.

The format of the MOB_RSSCN-REP message is depicted in Table A.

Table A-MOB_RSSCN-REP message format

MOB_RSSCN-REP_Message_format(){	—	—
Management Message Type=69	8 bits	—
N_CID	8 bits	Number of CID to be reported
For (j=0; j<N_CID; j++){	—	—
Basic CID	16 bits	Basic CID of MS
RSSI info	16 bits	The value shall be interpreted as an unsigned byte with units of 0.25 dB, such that 0x00 is interpreted as –103.75 dBm, an RS shall be able to report values in the range –103.75 dBm to –40 dBm.
Frame number	12 bits	frame number where RS measures the corresponding MS
}	—	—
}	—	—

6.3.2.3.63 MOB_RSSCN-RSP message

An MOB_RSSCN-RSP message is transmitted by VC head to candidate RSs in its managed virtual cell. This message will trigger candidate RSs to receive and measure the data burst of corresponding MS based on the indicated MAP information.

The format of the MOB_RSSCN-RSP message is depicted in Table B.

Table B-MOB_RSSCN-RSP message format

MOB_RSSCN-RSP_Message_format(){	—	—
Management Message Type=70	8 bits	—
N_CID	8 bits	Number of CID needed to receive
For (j=0; j<N_CID; j++){	—	—
Basic CID	16 bits	Basic CID of MS
Frame number	12 bits	frame number where RS needs to receive & measure the data burst of corresponding MS basic CID based on the MAP information
}	—	—
}	—	—

6.3.2.3.64 MOB_RSHO-REQ message

A VC head can transmit the MOB_RSHO-REQ message to MR-BS for requesting that inter-VC HO for specified MS is recommended. The message shall be transmitted on the Basic Management CID.

The format of the MOB_RSHO-REQ message is depicted in Table C.

Table A-MOB_RSSCN-REP message format

MOB_RSSCN-REP_Message_format(){	—	—
Management Message Type=71	8 bits	—
N_Recommended	8 bits	Number of recommended MS to be trigger inter-VC HO
For (j=0; j<N_Recommended; j++){	—	—
Basic CID	16 bits	Basic CID of MS
}	—	—
}	—	—

References

[1] IEEE C80216j-06/290, Definitions, abbreviations and acronyms for P802.16j baseline document.