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Re:	This is a response to the call for proposals 80216j-06_027.pdf	
Abstract	This contribution describes MS handover procedure in presence of relays. It also proposes Mobile RS handover procedure.	
Purpose	Add proposed spec changes in P802.16j Baseline Document (IEEE 802.16j-06/026)	
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Relay Handover

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Introduction

The MS hard handover procedure is defined between MS and BS. With Relay, the following aspects of hard handover need consideration:

- MS handover in Relay Network
- Mobile RS (MRS) Handover

MS Handover in Relay Network

When MS is connected to MMR-BS through one or more RS, then we need to determine about the handover states anchor point or location in the network. There are two options either keep the states on the RS or the MMR-BS.

This contribution proposes that the handover states in the network for an MS connected through an RS should stay anchored in the BS. This provides the following advantages:

- Less complexity for RS,
- No change from the 16e mobility model, where BS holds the mobility state.
- Less handovers in the system, as the BS is a higher entity in the air interface hierarchy.

The target station could be a BS or RS. If it is RS, then MS does ranging with the RS and MMR-BS during network re-entry procedure. The ranging procedure for relays is described in [1].

Table 1: Different serving and target station scenarios for an MS handover

Serving \ Target	BS	FRS	MRS
BS	1	2	2
FRS	1	2	2
MRS	1	2	2

1 = 16e mobility procedure

2 = 16e mobility procedure + Ranging with RS and MMR-BS

Mobile RS Handover

Mobile RS handover introduces a new mobility issue. The mobile RS moves along with the MSs attached with it. When a mobile RS moves from one BS to another, it would trigger handover for all the attached MSs. This

will increase signaling load. Also, it increases chance of failure as too many MSs are contending for the medium at the same time.

This contribution suggests an efficient handover procedure for MRS. When MRS moves from source BS to the target BS, it exchanges messages on behalf of all the attached MSs with the source BS for initiating handover. The BS moves all of the MSs together with one set of messages with RS, instead of individual set of handover messages with each MS.

The following figure illustrates the proposed mobile RS handover procedure along with its attached MSs. The figure assumes two MSs attached to an RS.

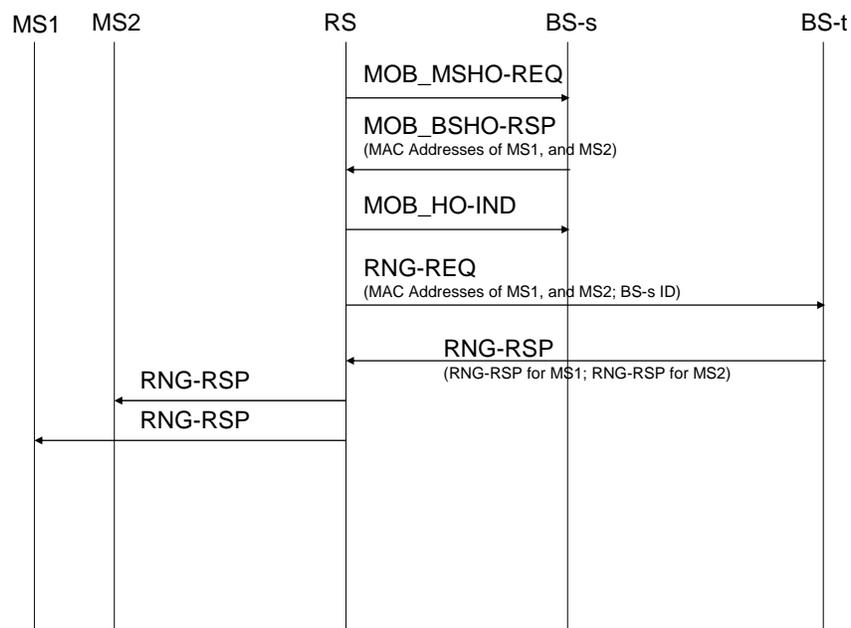


Figure 1: Mobile RS Handover

1. RS sends MOB_MSHO-REQ message to the serving BS on its basic CID for initiating handover.
2. The serving BS sends MOB_BSHO-RSP message to the RS. Being a relay, the RS doesn't have the MAC addresses of the attached MSs. The serving BS sends these MAC addresses as a TLV to the RS. Alternatively, the serving BS may send HO_ID in the MOB_BSHO-RSP message. This information is needed by the RS in performing network re-entry, as shown in a later step.
3. The RS sends MOB_HO-IND message to the serving BS.

4. The RS performs network re-entry by sending RNG-REQ containing MAC addresses or HO_ID of MS1 and MS2. It also sends serving BS ID and an indication that RNG-REQ is from mobile RS. If the RS shares a security association with the target BS, it sends HMAC/CMAC in the message. Otherwise, it performs authentication procedure with the MS for establishing security association. The RS may not be able to receive MAC addresses or HO_IDs from the serving BS, if the MOB_BSHO-RSP message is not received by the RS. In this case, the RS sends the serving BS ID to the target BS. The target BS uses the serving BS ID to contact the serving BS and retrieves the MAC addresses of the MSs using backbone procedures.
5. BS composes RNG-RSP messages for all the MS including HMAC/CMAC tuple. It encapsulates them in a RS_RNG-RSP to the RS with the HMAC/CMAC tuple TLV. The RS decapsulates the messages and sends them to individual MSs. This procedure allows RS and MSs to verify the corresponding HMAC/CMAC of the RNG-RSP from BS.

Figure 1 shows RS initiated handoff. A BS initiated HO for mobile RS is similar. The only difference is that the MSs MAC addresses is carried in MOB_BSHO-REQ.

Advantages

The proposed mobile RS handover procedure has the following advantages:

- The handoff is faster, as only one station (RS) is involved instead of multiple MS. Easier and faster to schedule one station for the fast ranging.
- The handoff is bandwidth efficient. There is only one set of signaling message over the RS-BS link for all the MS attached through the RS.
- Less complexity for RS. The contribution introduces minor changes to the existing mobility related messages from 802.16e-2005. Existing messages are used with the addition of few TLVs.

Spec Changes

Change Table 14 as indicated:

Type	Message name	Message description	Connection
67-255		Reserved	-
<u>67</u>	<u>RS_RNG-RSP</u>	<u>Mobile RS Ranging Response</u>	<u>Basic</u>
68-255		Reserved	

Insert new subclause after section 6.3.22.2

6.3.22.3 MS Handover in Relay Network

The mobility states in the network for an MS connected through a fixed RS shall stay anchored in the BS. The fixed RS relays all the signaling transparently between MS and MMR-BS. The mobile RS moves all the attached MS as specified in section 6.3.25.

Insert new subclause after section 6.3.24

6.3.25 Mobile RS Handover Process

The Mobile RS Handoff process hands off all the MS attached to an RS along with the MRS to a target BS. It follows the same main procedures as described for an MS handoff in section 6.3.22.2. The procedures, where certain steps are different, are described in this section.

6.3.25.1 HO Decision and Initiation

When mobile RS makes a decision for handover, it sends MOB_MSHO-REQ message on its basic CID to the Serving MMR-BS. The MMR-BS, knowing that the basic CID belongs to a RS, sends MOB_BSHO-RSP message with the MS MAC Address List TLV. Alternatively, it may send list of HO_IDs for each potential target BS.

The serving MMR-BS initiates handoff for a mobile RS by sending MOB_BSHO-REQ message on the mobile RS basic CID. It includes MS MAC Address List TLV or HO_ID List in the message.

6.3.25.2 Network Entry/re-Entry

A mobile RS shall conduct ranging with target MMR-BS for network entry/re-entry during handover. The mobile RS informs the MMR-BS, that the RNG-REQ is from a mobile RS. It also includes MS MAC Address List TLV or HO_ID List in the RNG-REQ. If the mobile RS didn't send the MS MAC Address List TLV or the HO_ID List TLV, the MMR-BS uses the serving BSID TLV to find the serving BS. It exchanges the backbone messages with the serving BS to retrieve the MAC addresses or HO_ID of all the MS attached to the RS. The details of the backbone messages are beyond the scope of IEEE 802.16j.

The MMR-BS assigns the CIDs and composes individual RNG-RSP for all the MS. The MMR-BS has security association with the MSs. It calculates HMAC/CMAC tuples for each of the RNG-RSP message to the MS. The MMR-BS encapsulates them in the RNG-RSP to the RS, with its HMAC/CMAC tuple. The RS decapsulates the individual RNG-RSP and relays them to individual MSs. In this way, this procedure allows RS and MSs to verify the integrity of the RNG-RSP from BS.

The serving BSID can only be used in the RNG-REQ before the expiry of the serving BS ID Aging-Timer. If the timer expires, the RS sends RNG-REQ without the serving BSID. The BS after recognizing that the RNG-REQ is for mobile RS HO, and there is no serving BSID info and MAC address/HO_ID list TLV, initiates individual handoff to all the MS.

Modify the following entry in Table 342

MS, <u>mobile RS</u>	Serving BS ID AGING-TIMER	Nominal time for aging of serving BS association. Timer recycles on successful serving BS DL-MAP read	-	-	5 s
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6.3.2.3.5 Ranging request (RNG-REQ) message

Add the following text at the end:

The following parameter may be included in the RNG-REQ message when the RS is attempting to perform network entry, re-entry, association or handover:

RS Type TLV (see 11.5)

Insert new subclause (6.3.2.3.61):

6.3.2.3.61 RS Ranging Response message

The RS_RNG-RSP shall be transmitted in response to RNG-REQ from a mobile RS. The message carries encapsulated RNG-RSP for the individual MSs attached to the mobile RS. TLV encoded information for RS. The TLVs are same as in RNG-RSP.

A BS shall generate RNG-RSPs in the form shown in Table x, including all of the following parameters:

Table x

Syntax	Size	Notes
RS_RNG-RSP_Message_Format () {		
Management Message Type = x	8 bits	

Num_MS	8 bits	Number of MS
for (i=0; i < Num_MS; i++) {		
RNG-RSP		Individual MAC management message with complete MAC header
}		
TLV Encoded Information	Variable	TLV Specific
}		

6.3.2.3.52 BS HO Request (MOB_BSHO-REQ) message

Add the following structure in the for loop of the nbr BS list under mode==0:

Syntax	Size	Notes
HO_ID_list_included_indicator	1 bit	Indicates if the field HO_IND is included.
If (HO_ID_list_included_indicator == 1) {		
Num_HO_ID	8 bits	
For (i=0 ; i < Num_HO_ID++ ; i++) {		
HO_ID	8 bits	
}		

Add the following text at the end:

The MOB_BSHO-REQ message shall include the following parameter encoded as TLV tuples for mobile RS:
MS MAC Address List (see 11.15.2)

6.3.2.3.54 BS HO Response (MOB_BSHO-RSP) message

Add the following structure in the for loop of the nbr BS list under mode==0:

Syntax	Size	Notes
HO_ID_list_included_indicator	1 bit	Indicates if the field HO_IND is included.
If (HO_ID_list_included_indicator == 1) {		
Num_HO_ID	8 bits	
For (i=0 ; i < Num_HO_ID++ ; i++) {		
HO_ID	8 bits	

}		
---	--	--

Add the following text at the end:

The MOB_BSHO-REQ message shall include the following parameter encoded as TLV tuples for mobile RS:
MS MAC Address List (see 11.15.2)

Insert new subclause (11.15.2):

11.15.2 MS MAC Address List

The MS MAC Address List carries a list of the MAC addresses of the MSs attached to an RS.

Type	Length	Value
-	Variable	See the following table

Field	Length	Note
Number of MS	2 bytes	
MAC Address	6	This will be repeated number of MS times

11.5 RNG-REQ message encodings

Add the following row in Table 364:

Name	Type (1 byte)	Length	Value (variable-length)
RS Type	-	1	0: Fixed RS 1: Mobile RS 2-255: Reserved

References

[1] Ranging in 802.16j (MMR) System, C80216j-06_193.doc; Shashikant Maheshwari, Yousuf Saifullah, and Haihong Zheng; Nokia