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Abstract	This contribution proposes two transmission schemes for the MAC management message sent from MMR-BS towards a group of RSs. The relevant changes to the specification are also defined	
Purpose	Add proposed spec changes.	
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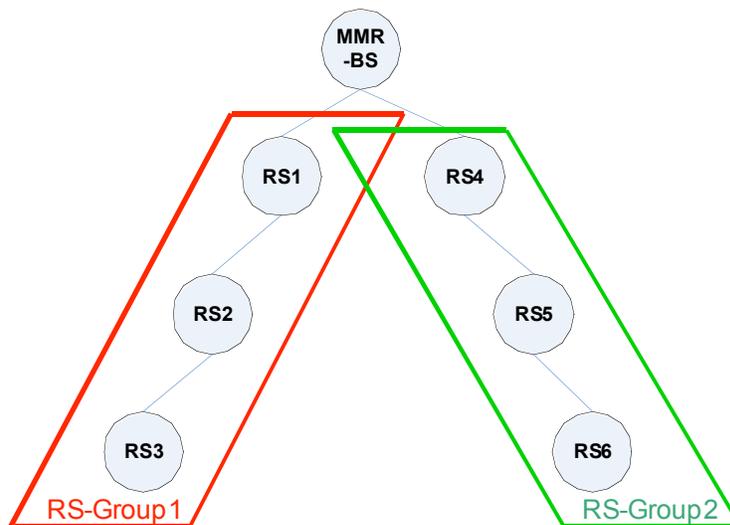
# Transmission Scheme of MAC Management Message towards a RS Group in multi-hop relay System

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## 1. INTRODUCTION

In single-hop system, the MAC management messages are transmitted between BS and MS. However, in the multi-hop relay system, where one or more RSs are introduced between MMR-BS and MS, additional MAC management messages (termed as MAC-Mng-Msgs) are defined and used between MMR-BS and RSs. These MAC-Mng-Msgs may include but not limited to routing messages to deliver path information to RS group, RS configuration messages, MAC signaling messages for relaying purposes, measurement messages etc. In certain circumstances, the MMR-BS sends the MAC-Mng-Msg to a group of RSs with the same content. As an example, the MMR-BS may define and distribute the mapping information between an established relay path and connection IDs for the flows that will be routed through the specified path. Such mapping information is the same for every RS on the defined relay path.

Multiple transmission schemes can be used to transmit the MAC-Mng-Msg with the same content from a MMR-BS to a group of RSs (termed as RS-Group in this contribution). A typical example of a RS-Group is a group of RS on a relay path between the MMR-BS and a MS. As shown in Figure 1, RS1, RS2 and RS3 that are on the relay path between MMR-BS and all the MSs directly attached to RS3 consist of RS-Group1, while RS4, RS5 and RS6 that are on the relay path between MMR-BS and all the MSs directly attached to RS6 consist of RS-Group2.



**Figure 1 Example of RS-Group in 802.16j System**

This contribution proposes two schemes for MMR-BS to transmit MAC-Mng-Msg to a RS-Group, followed by the recommendation of the schemes to be applied for different application scenarios.

## 2. TRANSMISSION SCHEME FOR MAC-MNG-MSG TO A RS-GROUP

### 2.1 End-to-End Unicast

MMR-BS unicasts the MAC-Mng-Msg to each RS in the RS-Group. The response message (if required) from each RS is unicast directly to the MMR-BS. The unicast messages are protected by the SA (Security Association) established between each RS and the MMR-BS.

Such end-to-end unicast scheme is simple and straightforward. MMR-BS just transmits the MAC-Mng-Msg to the respective RS just as all the other type of MAC management messages defined in IEEE Std 802-16-2004 and 802.16e-2005. However, the overhead introduced by this scheme is non-trivial especially if the number of RSs on one relay path is large. For example, as shown in Figure 2, the MAC-Mng-Msg marked in RED is targeting at RS1 and is only transmitted over the MMR-BS-RS1 link. However, the MAC-Mng-Msg marked in YELLOW is targeting at RS2 and is transmitted over MMR-BS-RS1 link and RS1-RS2 link. The MAC-Mng-Msg marked in PURPLE is targeting at RS3 and is transmitted over MMR-BS-RS1 link, RS1-RS2 link and RS2-RS3 link. The overhead introduced by this scheme is not trivial.

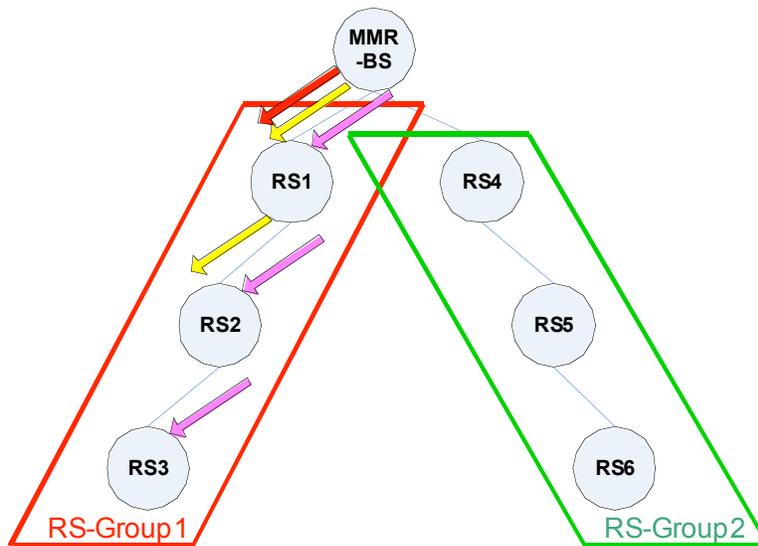


Figure 2 End-to-End Unicast MAC-Mng-Msg to RS-Group1

### 2.2 Hop-by-Hop unicast with end-to-end response

The MAC-Mng-Msg is unicast from MMR-BS to the first RS on the specified path or from one RS to another RS in the RS-Group following the specified path and processed by each RS in the RS-Group. Upon receiving the MAC-Mng-Msg, each RS replies with a response directly targeting to the MMR-BS. The detailed procedure is listed as following. Figure 3 is used as an example to illustrate the procedure.

- When a MMR-BS sends a MAC-Mng-Msg to a RS-Group, it generates the MAC-Mng-Msg, which includes the message information, a Path-Id TLV, an optional Path-Information TLV and an optional Basic-CID-Information TLV. The Path-Id TLV contains the ID of the path to which all the RS in the RS-Group belong. The Path-Information TLV contains an ordered list of RSs on the path identified by the Path-Id. The Basic-CID-Information carries a list of basic CID, each of which corresponds to the RS as listed in the Ordered-List-of-RS in the Path-Information TLV. Basic-ID-Information TLV and Path-Information TLV are only present if the MAC-Mng-Msg is used to advertise complete path information along with the message to specify how this MAC-Mng-Msg will be routed or to establish and advertise

new path between MMR-BS and RS group, i.e. Path-ADV-REQ message with the Action-Type field set to ESTABLISH (see [1]). The MMR-BS then unicasts the message to the first RS on the path (e.g., RS1). The MAC-Mng-Msg is protected by the SA established between MMR-BS and the first RS on the path.

- When a RS receives a MAC-Mng-Msg from its upstream neighbor, it first processes the message.
  - o If the processing fails, it immediately sends a response with the Failure confirmation code back to MMR-BS and then aborts the process.
  - o If the processing succeeds, the RS then obtains the path id contained in the Path-Id TLV, and then retrieves the path information based on the path id and finds out the next RS to which it needs to further transmit the MAC-Mng-Msg. The path information is obtained from the Path-Information TLV carried in the MAC-Mng-Msg if it is provided in the MAC-Mng-Msg or from a PATH-ADV-REQ with the Action-Type field set to ESTABLISH and should be recorded by the RS for further use; otherwise, it is retrieved based on the path-id using the record the RS obtained from the previous operation. The RS also sends a response with the Success confirmation code back to MMR-BS. If the RS (e.g., RS2) has a downstream neighbor on the path, it then regenerates the MAC-Mng-Msg using the same information it received from its upstream neighbor on the path and unicasts it to its downstream neighbor on the path. The MAC-Mng-Msg is protected by the SA established between the RS and its downstream neighbor on the path. The CID to be used to unicast the MAC-Mng-Msg is obtained from the Basic-CID-Information TLV if it is provided with in the message or if it is a PATH-ADV-REQ with the Action-Type field set to ESTABLISH and should be recorded by the RS for further use; otherwise, it is retrieved based on the path-id using the record the RS obtained from the previous operation.
- MMR-BS should maintain individual timer (MAC-Mng-Msg-RES-Timer) for the response from each RS on the path. The value of MAC-Mng-Msg-RES-Timer for each RS varies and depends on the possible transmission and processing latency between MMR-BS and the RS. Such latency could be estimated for example based on the number of hops between MMR-BS and the RS.
  - o If the MMR-BS receives a response from a RS within the corresponding MAC-Mng-Msg-RES-Timer but with a Failure confirmation code, or doesn't receive a response from the RS within the corresponding MAC-Mng-Msg-RES-Timer, the MMR-BS determines that the RS doesn't receive the MAC-Mng-Msg and may fail the chained operation due to error processing or link loss. The MMR-BS may reissue the MAC-Mng-Msg and directly send it to the first failure RS. The message is protected by the SA established between MMR-BS and the failure RS. The processing of such message follows the same procedure described above.

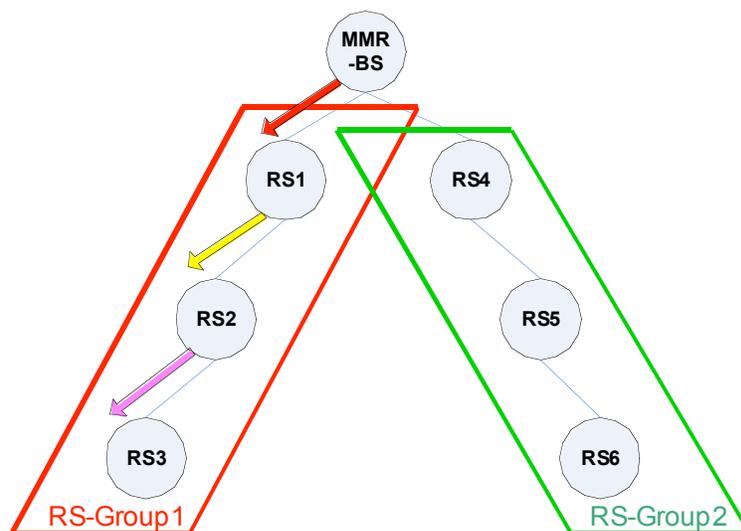


Figure 3: Hop-by-Hop Unicast MAC-Mng-Msg to RS-Group1

## 2.3 Comparison

The End-to-end unicast scheme is simple and straightforward. However, the overhead introduced by this scheme is non-trivial especially if the number of RSs on one relay path is large. Therefore, this scheme is more applicable to the scenario where the number of RSs on a relay path is small (e.g., 2-3 hop relay) or the RS is with low capability. This scheme is suitable where SA association exists only between MMR-BS and RS.

The Hop-by-hop unicast scheme reduces a lot of bandwidth overhead especially when the relay path contains a large number of RSs, however at the price of processing complexity in the RSs. Therefore, this scheme is more applicable to the scenario where a large number of high-capability RSs are present on a single relay path. When paths are pre-established, this scheme is more suitable for relaying MAC-Mng-Msg between MMR-BS to RS without message processing at RS. This scheme is suitable where SA association exists not only between MMR-BS and RS but also between RSs.

The transmission scheme to be used can be decided by the MMR-BS based on the application scenario. MMR-BS indicates the type of the scheme by setting the Transmission Type field to the correspondent value in the MAC-Mng-Msg it issues.

## 3. CHANGES TO THE SPECIFICATION

### *Insert new subclause 6.3.25*

#### **6.3.25 Transmission Scheme for MAC Management Message toward RS Group in multi-hop relay System**

Two transmission schemes can be used to transmit the MAC management message with the same content from a MMR-BS to a group of RSs (termed as RS-Group), as described in section 6.3.25.1 and 6.3.25.2. The MAC management messages that use such transmission scheme are listed in Table T1. The MMR-BS decides on the type of the transmission scheme and sets the appropriate value in Transmission Type field of the related MAC management message.

**Table T1 – MAC Management Messages Targeting to a RS Group**

<b>MAC Management Message</b>	<b>Reference</b>
<u>PATH-ADV-REQ</u>	<u>TBD</u>
<u>PATH-SEL-REQ</u>	<u>TBD</u>
<u>AC-REQ</u>	<u>TBD</u>
<u>AF-REQ</u>	<u>TBD</u>

#### **6.3.25.1 End-to-End Unicast**

MMR-BS unicasts the MAC management message to each RS in the RS-Group. The response message from each RS is unicast directly to the MMR-BS. The unicast messages are protected by the SA established between each RS and the MMR-BS.

If such scheme is used to transmit the MAC management message, the Transmission Type field in the MAC management message shall be set to End-to-end unicast.

#### **6.3.25.2 Hop-by-Hop Unicast with End-to-End Response**

The MAC management message is unicast from MMR-BS to the first RS on the specified path or from one RS to another RS in the RS-Group following the specified path and processed by each RS in the RS-Group. Upon receiving the MAC management message, each RS replies with a response, if required directly targeting to the MMR-BS. The detailed procedure is listed as following.

- When a MMR-BS intends to send a MAC management message to a RS-Group, it generates the MAC management message, which includes the message information, a Path-Id TLV, an optional Path-Information TLV and an optional Basic-CID-Information TLV. The Path-Id TLV contains the ID of the path to which all the RS in the RS-Group belong. The Path-Information TLV contains an ordered list of RSs on the path identified by the Path-Id. The Basic-CID-Information carries a list of basic CID, each of which corresponds to the RS as listed in the Ordered-List-of-RS in the Path-Information TLV. Basic-ID-Information TLV and Path-Information TLV are only present if the MAC management message is a Path-ADV-REQ message with the Action-Type field set to ESTABLISH (see [1]). The MMR-BS then unicast the message to the first RS on the path. The MAC management message is protected by the SA established between MMR-BS and the first RS on the path.
- When a RS receives a MAC management message from its upstream neighbor, it first processes the message.
  - o If the processing fails, it immediately sends a response with the Failure confirmation code back to MMR-BS and then aborts the process.
  - o If the processing succeeds, the RS then obtains the path id contained in the Path-Id TLV, and then retrieves the path information based on the path id and finds out the next RS to which it needs to further transmit the MAC management message. The path information is obtained from the Path-Information TLV carried in the MAC-Mng-Msg if it is a PATH-ADV-REQ with the Action-Type field set to ESTABLISH and should be recorded by the RS for further use; otherwise, it is retrieved based on the path-id using the record the RS obtained from the previous operation. The RS also sends a response with the Success confirmation code back to MMR-BS. If the RS has a downstream neighbor on the path, it then regenerates the MAC management message using the same information it received from its upstream neighbor on the path and unicasts it to its downstream neighbor on the path. The new MAC-Mng-Msg is protected by the SA established between the RS and its downstream neighbor on the path. The CID to be used to unicast the MAC management message is obtained from the Basic-CID-Information TLV if it is a PATH-ADV-REQ with the Action-Type field set to ESTABLISH and should be recorded by the RS for further use; otherwise, it is retrieved based on the path-id using the record the RS obtained from the previous operation.
- MMR-BS should maintain individual timers (MAC-Mng-Msg-RES-Timer) for the response from each RS on the path. The value of MAC-Mng-Msg-RES-Timer for each RS varies and depends on the possible transmission and processing latency between MMR-BS and the RS.
  - o If the MMR-BS receives a response from a RS within the corresponding MAC-Mng-Msg-RES-Timer but with a Failure confirmation code, or doesn't receive a response from the RS within the corresponding MAC-Mng-Msg-RES-Timer, the MMR-BS determines that the RS doesn't receive the MAC-Mng-Msg and may fail the chained operation due to error processing or link loss. The MMR-BS may reissue the MAC-Mng-Msg and directly send it to the first failure RS. The message is protected by the SA established between MMR-BS and the failure RS. The processing of such message follows the same procedure described above.

If such scheme is used to transmit the MAC management message, the Transmission Type field in the MAC management message shall be set to Hop-by-hop unicast with end-to-end response.

#### **4. SUMMARY**

This contribution proposes two schemes for transmission of MAC management message from the MMR-BS to a group of RS. Each scheme has its advantage and disadvantage, and could be employed in different types of environment, as recommended in this contribution as well. The changes to the specification are also specified in this contribution.

#### **5. REFERENCE**

- [1] C802.16j-06\_195.pdf Topology Discovery and Path Management in multi-hop relay System by Haihong Zheng, Yousuf Saifullah and Shashikant Maheshwari