Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**Path Management in multi-hop relay System**	
Date Submitted	**Jan-12-2007**	
Source(s)	Haihong Zheng, Yousuf Saifullah, Shashikant Maheshwari Nokia 6000 Connection Drive, Irving, TX	Voice: +1 972 894 5000 Haihong.1.Zheng@nokia.com, Yousuf.Saifullah@nokia.com, Shashikant.Maheshwari@nokia.com
	David Comstock, John Lee, Shang Zheng, Aimin Zhang Huawei Technologies No.98, Lane91, Eshan Road, Shanghai, P.R.C	dcomstock@huawei.com Voice: +1 858 735 9382
Re:	This is in response to the call for proposal, 80216j-06_027.pdf, sent out by 802.16j TG.	
Abstract	This contribution proposes path management procedures in multi-hop relay system. The path management procedures include path calculation, path establishment and path selection. The relevant changes to the specification are also defined.	
Purpose	Add proposed spec changes.	
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>.	

Path Management in multi-hop relay System

Haihong Zheng, Yousuf Saifullah and Shashikant Maheshwari
Nokia

David Comstock, John Lee, Shang Zheng and Aimin Zhang
Huawei Technologies Co. Ltd

1. INTRODUCTION

In single hop system, MS directly attaches to BS, and therefore BS knows the 1-hop path to the MS. In the multi-hop relay system, there could be one or more RSs between an MR-BS and an MS. However, there is no existing mechanism for the MR-BS to determine and manage the relay path between an MS and itself.

This contribution proposes a simple path management scheme for multi-hop relay system along with the relevant changes to the standard to support such scheme. The MR-BS decides the path based on multiple metrics, and establishes the path by informing all the RS on the path of the path information. The MR-BS also informs RS of the mapping between a connection (identified by a CID) and an established path. The connection could be a regular connection established for a SS (as defined in 802.16d) or a tunnel connection as proposed in [3], and the CID could be a regular CID or a tunnel CID [3]. RS builds up its routing table based on path and mapping information. With this scheme, the path management solution is coordinated by the MR-BS and requires less complexity in the RSs.

2. PATH MANAGEMENT

After MR-BS discovers the topology between a newly attached MS or RS and itself [2], or detects a topology update due to events such as mobility, MR-BS may remove an old path, establish a new path and inform the new path information to all the RSs on the path. When connections are established or removed, MR-BS may distribute the mapping information between the connection and the path to all the RSs on the path. The path management procedures are specified below.

2.1 Path Calculation

Assuming all the radio links in the multi-hop relay system is duplex link, then based on the topology information obtained from topology discovery or update process as discussed in [2], MR-BS makes centralized calculation for the relay path between MR-BS and MS for both uplink and downlink direction. The two end points of a path associated to an MS are MR-BS and the RS to which the MS directly attaches. Therefore, if two MSs attach to the same RS directly, these two MSs could share the same path between MR-BS and the RS to which they directly attach. A path id is assigned to uniquely identify a path within a MMR cell. Figure 1 illustrates relay path in an 802.16j system. The algorithm and criteria to be used to calculate the path based on the topology is out of the scope of this contribution.

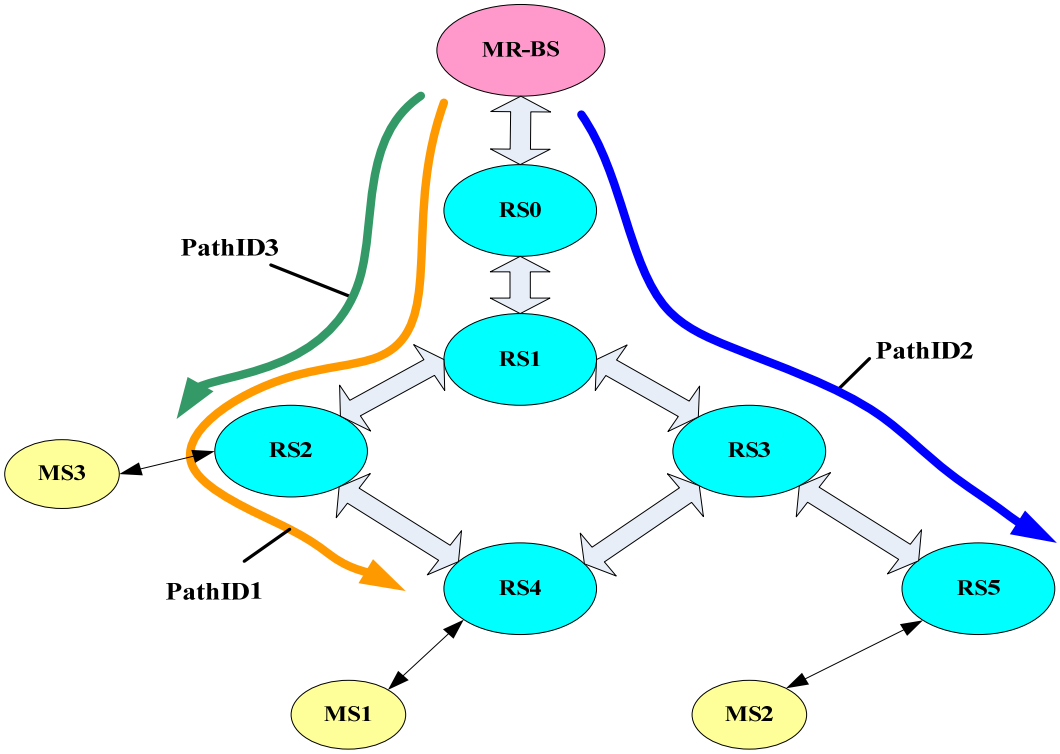

Figure 1: Relay Path in 802.16j System

2.2 Path Establishment and Removal

When a new path is calculated and determined as discussed in section 2.1 for RS, MR-BS sends a path establishment command to distribute the path information to all the RSs on that path. Such command is carried in a PATH_Update-REQ message with the Update_Type_ADD bit set. An uniquely assigned path id as well as the complete path information or the instruction of how to generate the complete path information is also included.

If the MR-BS decides to delete an existing path, it sends PATH_Update-REQ message with the Update_Type_DEL bit set. The RSs receiving such PATH_Update-REQ message should remove the associated record for the path and replies with a PATH_Update-RSP message.

The transmission schemes of the PATH_Update-REQ and PATH_Update-RSP are specified in [1]. The type of transmission scheme to be used depends on the application scenarios as described in [1].

The MR-BS may aggregate multiple path establishment or removal commands in one PATH_Update-REQ message to save bandwidth. When the paths of different path establishment or removal commands in the same message divaricates in an RS, the RS separates the path establishment or removal commands into different messages and transmits them to the appropriate next-hop RSs.

The MR-BS may establish the path in the following ways:

- Distributing the complete path information (including ids of all the RSs on the path) to the RSs on the path.
- Instructing the RSs how to generate the detailed path information based on the existing path. In this case, when a RS receives a PATH_Update-REQ message, if there are further hops on the path updated by the PATH_Update-REQ message, the RS will regenerate a PATH_Update-REQ message by deleting unused information in the old one, and send it to its subordinate neighbor RS. As an example, as shown in Figure 1, path1 (identified by PathID1) can be established by concatenating path 3 (identified by PathID3) and RS4. Since path 3 is known to RS0, RS1 and RS2, the MR-BS only needs to instruct RS0, RS1 and RS2 to build up path 1 by adding RS4 to the last hop of path 3. Therefore, only Path ID3 and RSID of RS4 are included in the PATH_Update-REQ. When RS2 generates the PATH_Update-REQ message, only RSID of RS4 is included if there is no need for RS4 to have the knowledge of the previous hops.

2.3 Path Selection and Cancellation

When a new connection is established for an MS, the MR-BS selects one or more path to carry the traffic for the new connection. When multiple paths exist between the MR-BS and a MS, the metrics for the MR-BS to select one or more particular path include but are not limited to link condition, hop count, load condition, overall delay, etc. The metrics of each radio link are obtained by the MR-BS through the means that are not covered in this contribution.

In order to inform all the RSs of the mapping between the selected paths and the traffic information such as CID and QoS requirement, the MR-BS sends PATH_Update-REQ message to all the RSs on the selected path. Such PATH_Update-REQ message contains the CIDs of the connections that will be routed through the specified path, the path-id and optionally the SFID and the QoS requirement for each of the associated service flow. When a RS on the path receives such PATH_Update-REQ, it retrieves the CIDs and path id information, and builds up the routing table, which will be used to route the traffic in the future. If the SFID and the QoS requirement are also present for certain connection, the RS also record such information that will be used for scheduling the traffic for the specified CID. Each RS then replies with the PATH_Update-RSP.

If the MR-BS decides to cancel an existing mapping between a path and one or more CID, it sends a PATH_Update-REQ message to the associated RSs. Such PAHT-Update-REQ message includes the Path-Id and the affected CIDs. The RSs receiving such PATH_Update-REQ should remove the related entry in the routing table, and replies with the PATH_Update-RSP.

Deleted: CID

The transmission schemes of the PATH_Update-REQ and PATH_Update-RSPare specified in [1]. The type of transmission scheme to be used is determined by the MR-BS and depends on the application scenarios as described in [1].

The MR-BS may aggregate multiple path selection and cancellation commands in one PATH_Update-REQ message to save bandwidth. In addition, when a path is established for a connection, the path selection procedure can be conducted together with path establishment procedure by sending a single PATH_Update-REQ to save bandwidth.

2.4 Illustration of Topology Discovery and Path Management Procedures

Figure 2 shows the initial topology discovery and path management procedure of a multi-hop relay system.

- When RS1 attempts to conduct initial ranging, it sends regular RNG-REQ. After receiving a regular RNG-REQ, the MR-BS determines that RS1 directly attaches to it. MR-BS then sends the RNG-RSP to

RS1. The other initial network entry procedures remain the same as MS. Such procedure may trigger the routing table update for RS1 in the MR-BS by including the basic and primary management CID of RS1.

- When RS2 attempts to conduct initial ranging, it sends regular RNG-REQ. After receiving a regular initial RNG-REQ, RS1 replaces the Initial Ranging CID with its basic CID and sends it to the MR-BS. Upon receiving the RNG-REQ, MR-BS replaces RS1's basic CID with Initial Ranging CID and processes it. Then MR-BS determines that RS2 attaches to RS1 directly. It generates a RNG-RSP for RS2 and sends to RS1 using RS1's basic CID. Upon receiving the RNG-RSP, RS1 replaces its basic CID with Initial Ranging CID and sends it to RS2. The other initial network entry procedures remain the same as MS. Such procedure may trigger routing table update and path update. MR-BS may generate a new path id for the path between itself and RS1, log RS2's basic/ primary management CID in the routing table and send relevant PATH_Update-REQ message.
- After obtaining the topology between MR-BS and RS2 during RS2 initial network entry procedure, the MR-BS determines a path between RS2 and itself, and sends a relevant PATH_Update-REQ. The transmission mechanism of PATH_Update-REQ message depends on application scenarios as defined in [1] and the hop-by-hop unicast with end-to-end response scheme is used here as an illustration. Each RS receiving the PATH_Update-REQ replies with a PATH_Update-RSP.
- When MS attempts to conduct initial network entry, it sends a regular RNG-REQ to RS2. RS2 replaces the Initial Ranging CID with its basic CID and sends it to the MR-BS. RS1 will just simply forward it to the MR-BS. Upon receiving the RNG-REQ, MR-BS replaces RS2' basic CID with the Initial Ranging CID and processes it. It then determines that MS attaches to RS2 directly. It then calculates the relay path to be used toward MS (in this example, it's the relay path MR-BS – RS1 – RS2), and then generates the basic and primary management CID for the MS. Such procedure may trigger routing table update and path update. MR-BS may generate a new path id for the path between itself and RS2 and log MS's basic/ primary management CID in the routing table.
- In order to inform all the RSs on the path of the routing information and optionally the service flow requirement for the basic and primary management CID of the MS, the MR-BS sends PATH_Update-REQ to all the RSs on the path. The transmission mechanism of PATH_Update-REQ message depends on application scenarios as defined in [1] and the hop-by-hop unicast scheme with end-to-end response is used here as an illustration. Each RS receiving the request replies with a PATH_Update-RSP. The further traffic sent over the basic and primary management CID will be routed by each RS through the identified path. The MR-BS then generates a RNG-RSP for MS and sends to RS2 using RS2's basic CID. Upon receiving the RNG-RSP, RS2 replaces its basic CID with the Initial Ranging CID and sends it to the MS. The other initial network entry procedures remain the same.

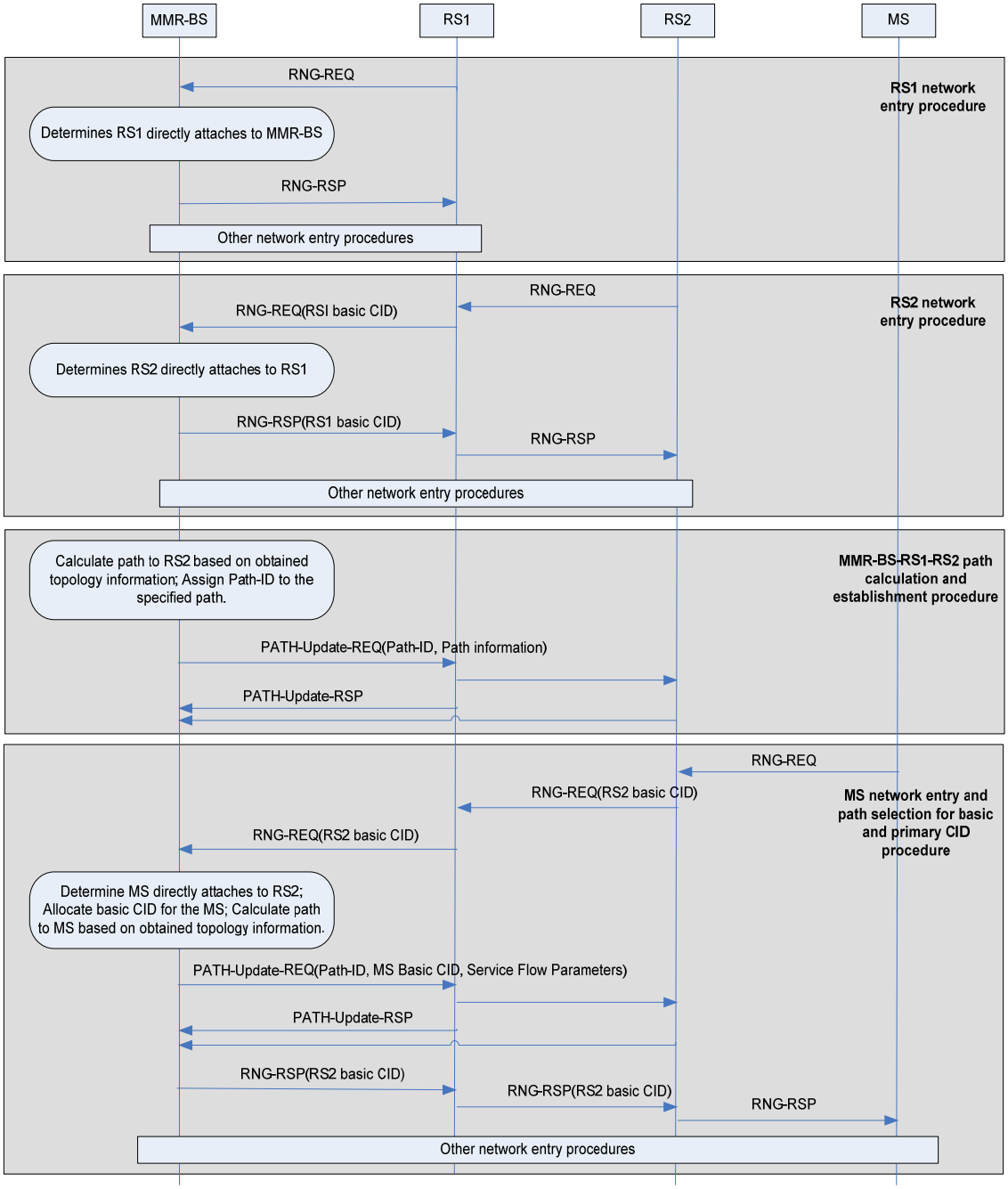

Figure 2: Illustration of Path Management Procedures During Network Entry

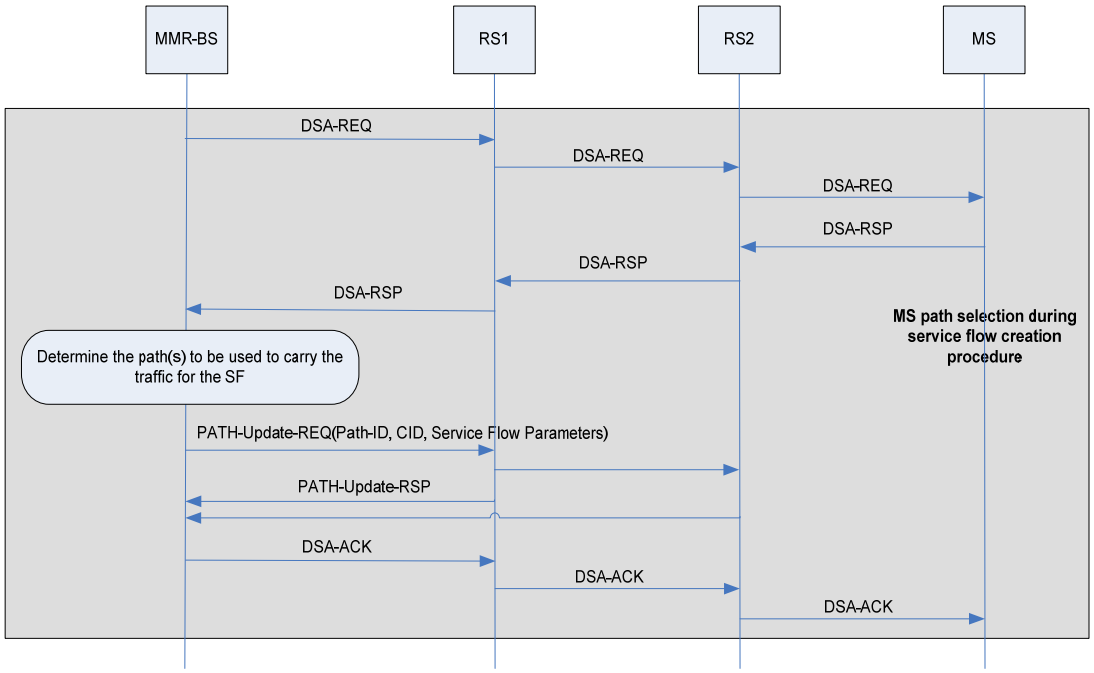

Figure 3: Illustration of Path Selection Procedures During Service Flow Creation

As another example, Figure 3 shows the path selection procedure in multi-hop relay system during the MR-BS initiated service flow creation procedure.

- When MR-BS wishes to establish an uplink or downlink dynamic service flow, it sends DSA-REQ. The DSA-REQ is forwarded by RS1 and RS2 to the MS. MS then responds with DSA-RSP, which is also forwarded by RS2 and RS1 to the MR-BS.
- Upon receiving a successful DSA-RSP, the MR-BS determines the path(s) to be used to carry the service flow. It then sends PATH_Update-REQ including the selected Path-ID, the CID associated with the service flow and optionally the service flow parameter set to all the RSs on the path. The transmission mechanism of PATH_Update-REQ message depends on application scenarios as defined in [1] and the hop-by-hop unicast with end-to-end response scheme is used here as an illustration.
- Upon receiving the PATH_Update-REQ, each RS on the path obtains the mapping between the Path-ID and CID, which will be used to route the traffic for the specified service flow. The service flow parameters can be used for the RS to schedule the traffic for the specified service flow accordingly. The RS then responds with a PATH_Update-RSP.
- The MR-BS completes the transaction by sending the acknowledgement message DSA-ACK to the MS.

2.5 Fault Case

In the case that there is no path information associated with a received CID (other than initial ranging CID) due to the events such as MR-BS or RS fault or failure, the following two cases apply:

- If the traffic is over uplink, the RS should send management message to MR-BS to report the error. Meanwhile, Depending upon the implementation, RS could be able to decide the next hop to send the traffic. The criteria for such decision could be number of hops towards MR-BS, overall delay, etc, which is not within the scope of this contribution.
- If the traffic is over downlink and the error occurs in the RS, the RS should send management message to MR-BS to report the error.

After receiving the error report or if the error occurs in the MR-BS, the MR-BS should use the most up-to-date topology information and reestablish the path as described in the previous sections.

2.6 Optimization for Mobility Support

When an MS attaches to a RS, a new path with a uniquely assigned Path-ID could be established. If the new path completely overlaps with any existing path, it is not needed to distribute the complete path information to all the RSs on the path but just the path id of the existing path. The RSs on the path just simply copy the path information from its existing routing table.

With such optimization, when the MS detaches from the RS, the MR-BS only needs to remove a particular path associated with the MS by sending a PATH_Update-REQ just with the Path-ID associated with the MS, instead of all the related CIDs of the MS mapped to an existing path.

3. CHANGES TO THE SPECIFICATION

6.3.25 Path Management for Relay

After MR-BS discovers the topology between a newly attached MS or RS and itself, or detects a topology update due to events such as mobility, MR-BS may remove an old path, establish a new path and inform the new path information to all the RSs on the path. When connections are established or removed, MR-BS may distribute the mapping information between the connection and the path to all the RSs on the path. The connection could be a regular connection established for a SS (as defined in 802.16d) or a tunnel connection, and the CID could be a regular CID or a tunnel CID. The path management procedures are specified below.

6.3.25.2 Path Calculation

Based on the topology information obtained from topology discovery or update process as specified in [2], MR-BS makes centralized calculation for the path between MR-BS and MS for both uplink and downlink direction.

6.3.25.3 Path Establishment and Removal

When a new path is discovered and calculated as specified in section 6.3.25.2, MR-BS sends a path establishment command to distribute the path information to all the RSs on that path by sending a PATH_Update-REQ message with the Update_Type_ADD bit set. An uniquely assigned path id as well as the complete path information or the instruction of how to generate the complete path information is also included.

If the MR-BS decides to remove an existing path, it sends PATH_Update-REQ message with the PATH-Update_Type_DEL bit set and the path id. The RSs receiving such PATH_Update-REQ message should remove the associated record for the path specified by the path id and replies with a PATH_Update-RSP message.

The MR-BS may aggregate multiple path management commands into one PATH_Update-REQ message to save bandwidth. When the paths of different path management commands in the same message divaricates in

an RS, the RS separates the path establishment or removal commands into different messages and transmits them to the appropriate next-hop RSs.

The MR-BS may establish the path in the following ways:

- Distributing the complete path information (including ids of all the RSs on the path) to the RSs on path
- Instructing the RSs how to generate the detailed path information based on the existing path. With this approach, each RS on the path forwards the instruction to the next hop RS on the path, as long as the next hop is aware of the existing path information; otherwise, the RS needs to generate the complete or remaining path information and send to the next hop RS. In the second case, when a RS receives a PATH_Update-REQ message, if there are further hops on the path updated by the PATH_Update-REQ message, the RS will regenerate a PATH_Update-REQ message by deleting unused information in the old one, and send it to the next hop RS.

The transmission scheme used for PATH_Update-REQ and PATH_Update-RSP message could be End-to-end unicast or Hop-by-hop unicast with end-to-end response or Hop-by-hop unicast with hop-by-hop response. MR-BS decides on the type of transmission scheme and set the Transmission Type field in the PATH_Update-REQ/RSP accordingly.

6.3.25.4 Path Selection and Cancellation and CID Mapping

When a new connection is established for an MS, the MR-BS selects one or more path to carry the traffic for the new connection. and informs all the RSs on the path of the mapping between the path id and the supported CIDs by sending a PATH_Update-REQ message to all the RSs on the specified path. Such PATH_Update-REQ message contains the CIDs of the connections that will be routed through the specified path, the path-id and optionally the SFID and the QoS requirement for each of the associated service flow. When a RS on the path receives such PATH_Update-REQ message, it retrieves the CIDs and path id information and builds up the routing table, which will be used to route the traffic in the future for the specified CIDs. If the SFID and the QoS requirement are also present for certain connection, the RS saves them for scheduling the traffic for the specified CID. Each RS then replies with the PATH_Update-RSP.

If the MR-BS decides to cancel an existing mapping between a path and one or more CID, it sends a PATH_Update-REQ message with the Path-Id and the affected CIDs to the associated RSs. The RSs receiving such PATH_Update-REQ should remove the record of the correspondent mapping in the routing table and responds with a PATH_Update-RSP.

Multiple PATH_Update-REQ messages can be sent for same CID to establish multiple paths to MS. This can be utilized for dynamic switching of traffic among multiple paths based on traffic condition or in case of macro diversity handoff.

The MR-BS may aggregate multiple path selection and cancellation commands in one PATH_Update-REQ message to save bandwidth. In addition, when a path is established for one or more connection, the path selection procedure can be conducted together with path establishment procedure by sending a single PATH_Update-REQ to save bandwidth.

The transmission schemes of the PATH_Update-REQ and PATH_Update-RSP message could be End-to-end unicast or Hop-by-hop unicast with end-to-end response or Hop-by-hop unicast with hop-by-hop response. MR-BS decides on the type of transmission scheme and set the Transmission Type field in the PATH_Update-REQ/RSP accordingly.

Change Table 14 (MAC Management Messages) as indicated

Type	Message Name	Message Description	Connection
67	PATH_Update-REQ	Path Update Request	Basic
68	PATH_Update-RSP	Path Update Response	Basic

Insert new subclause 6.3.2.3.68

6.3.2.3.68 Path-Update Request (PATH_Update-REQ) message

An MR-BS shall send a PATH_Update-REQ message with Transmission Type equal to End-to-end unicast to all the RSs on the path, or send a PATH_Update-REQ message with Transmission Type equal to Hop-by-hop unicast with end-to-end response or Hop-by-hop unicast with hop-by-hop response to the next RS on the path, when one or more of the following events happens.

- Establish a new path
- Add a mapping between a path and CID(s)
- Remove an existing path
- Delete a mapping between a path and CID(s)

An MR-BS shall generate PATH_Update-REQs in the form shown in Table T3.

When a RS receives a PATH_Update-REQ with Transmission Type equal to Hop-by-hop unicast with end-to-end response or Hop-by-hop unicast with hop-by-hop response, and it is not the last hop on the relay path, it shall also generate PATH_Update-REQ in the form shown in Table T3 and send it to the next hop on the path.

Table T3 – PATH_Update-REQ message format

Syntax	Size (bits)	Notes
PATH_Update-REQ() {		
Management Message Type = TBD	8	
Transaction ID	16	
Transmission Type	2	Type of Transmission Scheme
Update_Type_ADD	1	0x00: no ADD operation 0x01: Add a new path and/or add the mapping information between the specified CIDs and the path
Update_Type_DEL	1	0x00: no DEL operation 0x01: Delete an existing path or delete the mapping between the specified CIDs and the path
Reserved	4	
If (Update_Type_ADD) {		
N_Updates_ADD	8	the number of updates
for (i=0; i<N_Updates_ADD; i++) {		
Path_ID	8	The path id of the specified path
Add_Update_Indicator	2	0x00: Add a new path by copying the

		detailed path information from an existing path 0x01: Add a new path by using the included detailed path information 0x10: Add a new path by concatenating the detailed path information from an existing path and the included detailed path information for the remaining parts 0x11: No path information updated, but just mapping of CIDs to the path if N_CIDs>0
N_CIDs	4	The number of CID to be mapped to the specified path
Reserved	2	
CID_SF_Bitmap	((N_CIDs-1)/8+1)*8	The bitmap indicating the presence of service flow parameters below; each bit in N_CIDs_SF corresponds to each CID in the CID list above
if (N_CIDs>0) {		
for (j=0; j<N_CIDs; j++) {		The list of CIDs to be mapped to the specified path
CID	16	
if (CID_SF_Bitmap[jth bit]==1)		
Service Flow Parameters	Variable	The service flow parameter associated with the CID
}		
}		
if (Add_Update_Indicator == 0x00) {		
Path_ID	8	The path id of an existing path
}		
if (Add_Update_Indicator == 0x01) {		
N_RSIDs	4	The number of RSs on the path
for (j=0; j<N_RSIDs; j++) {		
RS_ID	48	The ordered list of RSID of the RSs on the specified path
}		
}		
if (Add_Update_Indicator == 0x10 {		
Path_ID	8	The path id of an existing path
N_RSIDs	4	
for (j=0; j<N_RSIDs; j++) {		
RS_ID	48	The ordered list of RSID of the remaining RSs on the specified path
}		
}		
}		
}		
If (Update Type_DEL) {		
N_Updates_DEL	8	the number of updates

for (i=0; i<N_Updates_DEL; i++) {		
Del_Update_Indicator	2	0x00: Delete the complete path specified by the Path ID 0x01: Delete the mapping between the specified CIDs and the path 0x10: Delete the mapping between all the CIDs currently mapped to the path except the specified ones 0x11: Delete the mapping between all the CIDs currently mapped to the path
N_CIDs	4	The number of CIDs to be removed if Del_Update_Indicator==0x01 or to be kept if Del_Update_Indicator==0x10; otherwise should be set to 0
Reserved	2	
Path_ID	8	The path id of the specified path
if (Del_Update_Indicator == 0x01) {		
for (j=0; j<N_CIDs; j++) {		The list of CIDs to be removed
CID	16	
}		
}		
If (Del_Update_Indicator == 0x10) {		
for (j=0; j<N_CIDs; j++) {		The list of CIDs to be kept
CID	16	
}		
}		
}		
}		
TLV Encoded Information	Variable	TLV specific
}		

The PATH_Update-REQs shall include the following parameters:

Transaction ID
Unique identifier for this transaction assigned by the sender
Transmission Type (see section 11.1.S2)
The type of transmission scheme for MAC management messages targeting to all the RSs on a relay path
Update Type (see section 11.1.S1)
The type of updates for the path management

The presence of some other parameters depends on the value of Update_Type as shown in Table T3.

All the other parameters are coded as TLV tuples.

The PATH_Update-REQ shall contain the following TLVs:

CMAC/HMAC Tuple (see 11.1.2)

The CMAC/HMAC Tuple attribute contains a keyed message digest (to authenticate the sender). The CMAC/HMAC Tuple attribute shall be the final attribute in the PATH-ADV-REQ message's attribute list.

Insert new subclause 6.3.2.3.69

6.3.2.3.69 Path-Update Response (PATH_Update-RSP) message

Upon receiving a PATH_Update-REQ message, a RS replies with a PATH_Update-RSP in the form shown in Table T4.

Table T4 – PATH_Update-RSP message format

Syntax	Size (bits)	Notes
PATH_Update-RSP() {		
Management Message Type = TBD	8	
Transaction ID	16	
If (Update_Type_ADD) {		the value of Update_Type_ADD is specified in the correspondent PATH_Update_REQ message
for (i=0; i<N_Updates_ADD; i++) {		The value of N_Updates_ADD is specified in the correspondent PATH_Update_REQ message
for (j=0; j<N_CIDs; j++) {		The feedback for each CID mapping update; The value of N_CIDs is specified in the N_Add_CIDs field in the correspondent PATH_Update_REQ message; All the feedback bits compose a Path_Update_CID_Feedback bitmap
Path_Update_CID_Feedback	1	0 – ACK 1 – NACK
}		
for (j=0; j<N_NACK; j++) {		The value of N_NACK is the number of NACKs in the Path_Update_CID_Feedback bitmap
Path_Update_Add_CID_ErrorCode	2	The error code for each NACK in the Path_Update_CID_Feedback bitmap; (Value – TBD)
}		
Padding	variable	The padding bits to keep byte alignment
Path_Update_Add_ConfirmationCode	8	The confirmation code for each add update; (Value – TBD)
}		
}		
else If (Update Type == DEL) {		the value of Update_Type is specified in the correspondent PATH_Update_REQ message
for (i=0; i<N_Updates; i++) {		The value of N_Updates is specified in the correspondent PATH_Update_REQ message

for (j=0; j<N_CIDs; j++) {		The feedback for the CID mapping update; The value of N_CIDs is specified in the N_Del_CIDs field in the correspondent PATH_Update_REQ message
Path_Update_CID_Feedback	1	0 – ACK 1 – NACK
}		
for (j=0; j<N_NACK; j++) {		The value of N_NACK is the number of NACKs in the Path_Update_CID_Feedback bitmap
Path_Update_Del_CID_ErrorCode	2	The error code for each NACK in the Path_Update_CID_Feedback bitmap; (Value – TBD)
}		
Padding	variable	The padding bits to keep byte alignment
Path_Update_Del_ConfirmationCode	8	The confirmation code for each removal update; (Value – TBD)
}		
}		

Parameters shall be as follows:

Transaction ID
Transaction ID from corresponding PATH-ADV-REQ

The presence of some other parameters depends on the value of Update_Type as shown in Table T4.

The PATH_Update-RSP should contain the following TLVs:

CMAC/HMAC Tuple (see 11.1.2)
The CMAC/HMAC Tuple attribute contains a keyed message digest (to authenticate the sender). The CMAC/HMAC Tuple attribute shall be the final attribute in the PATH_Update-RSP message's attribute list.

4. SUMMARY

This contribution proposes a path management scheme for multi-hop relay system. The MR-BS makes centralized decision on path management across the multi-hop relay system under its coverage area based on feedback information from the RSs and MSs, and informs RSs of the routing information. This contribution specifies the relevant MAC procedures. The changes to the existing specification are also included.

5. REFERENCES

[1] C802.16j-07_033.pdf Transmission Scheme of MAC Management Message towards a RS Group in multi-hop relay System, Nokia

[2] C802.16j-07_032.pdf Topology Discovery in Multi-hop Relay System, Nokia and Huawei

[3] C802.16j-06/274r3.pdf, Proposal on address, identifiers and types of connections for 802.16j, Intel et. al.