Topology Discovery and Path Management in IEEE 802.16j System

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David Comstock, John Lee, Shang Zheng, Aimin Zhang
Huawei Technologies
No. 98, Lane 91, Eshan Road, Shanghai, PRC
Voice +1 858 735 9382
E-mail: dcomstock@huawei.com

Haihong Zheng, Yousuf Saifullah,
Shashikant Maheshwari
Nokia Inc.
6000 Connection Drive, Irving TX 75063, US
Voice: +1 972-894-5000
E-mail: haihong.1.zheng@Nokia.com,
yousuf.saifullah@nokia.com
shashikant.maheshwari@nokia.com

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Base Document:

IEEE C802.16j-06/164 http://dot16.org/CSUpload//upload/Relay_db/C80216j-06_164.pdf
IEEE C802.16j-06/195 http://dot16.org/CSUpload//upload/Relay_db/C80216j-06_195.pdf

Purpose:

The purpose of this slide set is to introduce merged C802.16j-06_164 and C802.16j-06_195. This contribution is proposing topology discovery and path management schemes in multi-hop relay system. Changes in the standard are partially described in contribution C802.16j-06_164.pdf.

Outline

- Introduction
- Relay Path
- Routing DB
- MAC PDU routing
- Routing DB Update (Path Management)

Introduction

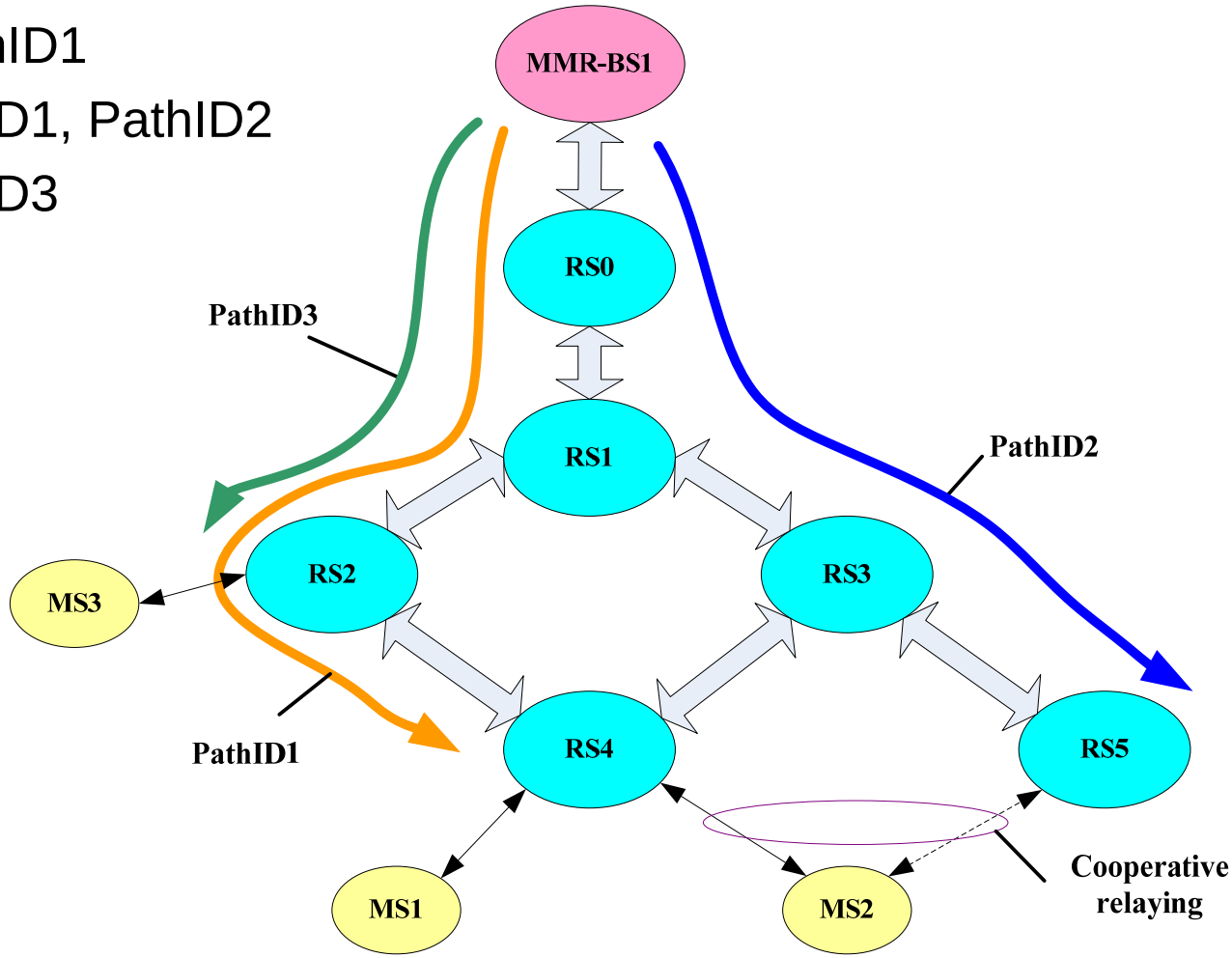
- The technical requirements document (C802.16j-06/050r4) specifies that “The specifications shall support the creation of more than one multi-hop path between an MMR and MS”
- The topology (i.e., the connections between the MMR-BS and RSs) might be very complex and varies from time to time due to the mobility and power-on and off of the relay stations
- Highly efficient procedures shall be defined to facilitate path management

Relay path

- Definition of relay path
  - Defined in C802.16j-06/041r2
  - Concatenation of k consecutive relay links (k >= 1) between the MMR-BS and the designated access RS
- Requirements
  - Data belong to different connections can travel along the same relay path (R1)
  - Data belong to the same connection can simultaneously travel along different relay paths (MDHO, Cooperative relaying, etc) (R2)
  - Data belong to different connections but originates from or destines to the same MS can travel along different paths (Load balancing, Selection combine in cooperative relaying, etc) (R3)

Illustration of relay path

- MS1.CID → PathID1
- MS2.CID→PathID1, PathID2
- MS3.CID→PathID3

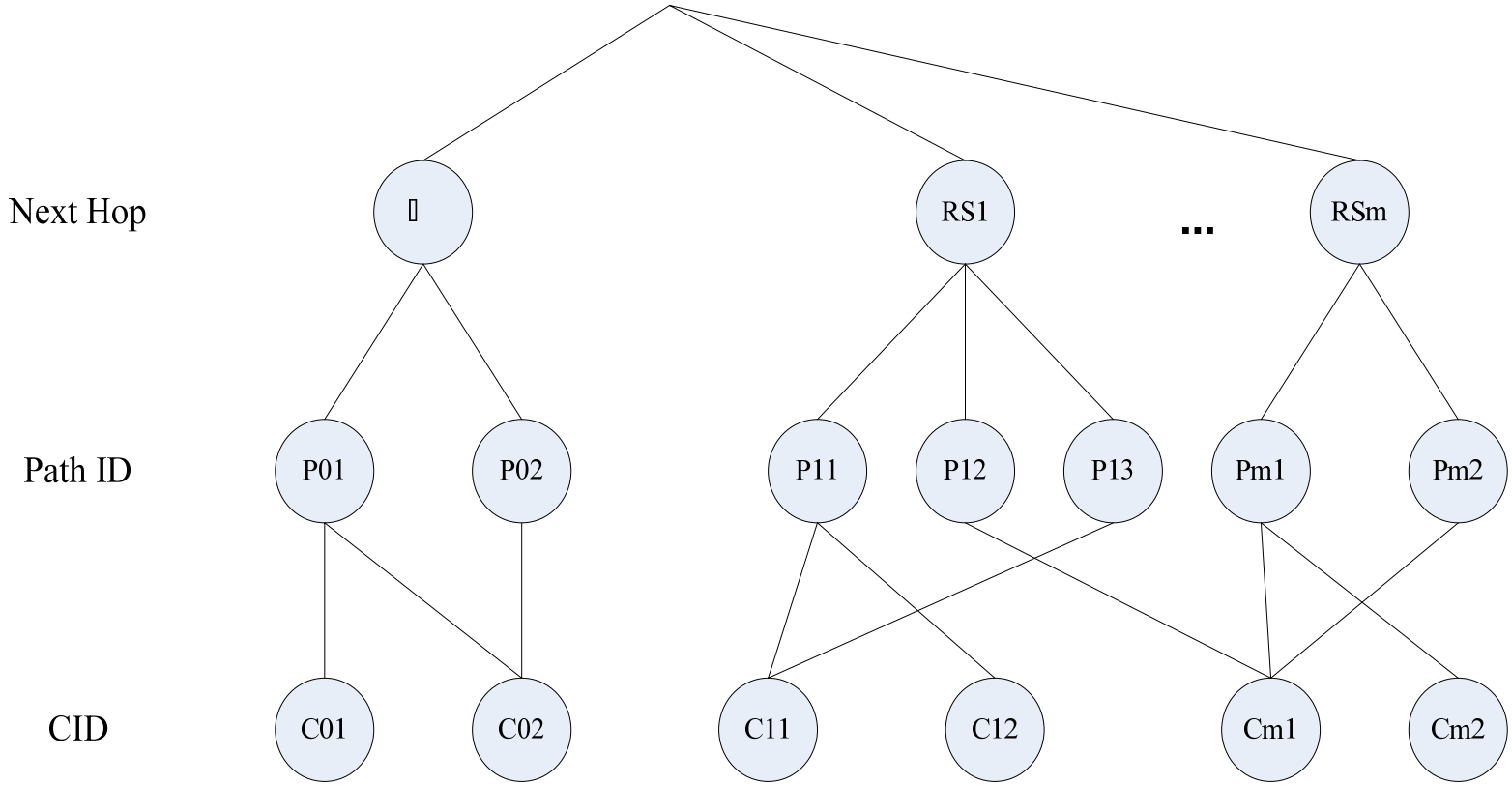


Terms related to routing & path management

- Relay Path ID (RPID)
  - Identifies the paths within the MMR-BS cell
  - Saves radio resource during path management (i.e., path addition, path deletion, etc)
- Routing Database
  - A database for the purpose of MAC PDU forwarding which contains MS CIDs, RPIDs, RS IDs, as well as the relationship between them
  - Exists in MMR-BS and every Intermediate RS

Suggestion to add these two terms to the terminology document.

Basic structure of Routing Data Base



This routing DB structure meets all the requirements (R1, R2, R3) well.

Routing Data Base Example

Syntax	Notes
RSID_Num	The number of RSID for the next hop
for i = 1 to RSID_Num	
{	
RSIDi	0xff express the Null RSID
Path_Num	The path number passing through the ith RS
for j = 1 to Path_Num	
{	
PathIDj	
CID_Num	The CID number associate with the PathIDj
for k = 1 to CID_Num	
{	The CID list associate with the PathIDj
CIDk	
}	
}	
}	

MAC PDU Routing

- MS’s CIDs are allocated and managed by MMR-BS
- Data dedicated to MS is transmitted using MS’s CID from BS
- When BS generates a MAC PDU (MPDU), it looks up the Routing DB using the CID as a key, according to the CID-PathID-RSID relation, next hop RS(s) is(are) found
- BS transmits the MPDU to the next hop RS(s) accordingly
- Any intermediate RS uses similar table lookup procedure until the MPDU finally get to the destination

Triggering conditions for RDB Updat

Since the MPDU routing is based on the CID field in the MPDU header, the routing database update should be triggered when one of the following events occurs:

- MS/RS network entry;
- Establishment of secondary management connection;
- MS handover;
- MS de-registration;
- DSx (Dynamic Service Add, Del, Change)
- BS detection of MS connection lost;
- BS decision to change the relay path of certain CID for load balancing or other purposes

Routing DB update procedure

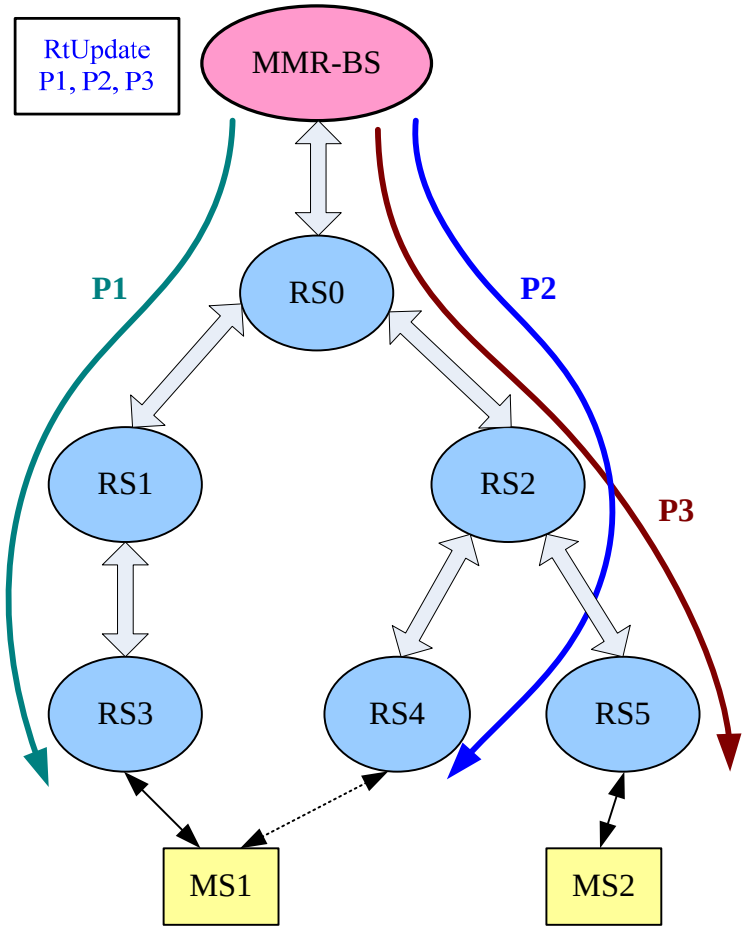
When a triggering condition occurs, the MMR-BS should initiate the routing database update procedure, which is comprised of the following steps:

- MMR-BS send Path-Update-REQ according to the triggering condition to update each affected RS's RDB;
- MMR-BS send Path-Update-REQ message to the first-hop RSs;
- When a RS receives Path-Update-REQ message , it performs the following:
  - Updates its RDB according to the command,
  - Generate a new Path-Update-REQ message,
  - Sends the message to the related next-hop RS.
- This procedure continues until the relay path update command reaches the final RS, i.e., the RS at the end of the relay path.
- The final RS updates its RDB accordingly, then send Path-Update_RSP message back to the MMR-BS.
- The relay path update procedure is successful when the MMR-BS receives a relay path update feedback message with a positive acknowledgement

Please refer the contribution c80216j-164.pdf for more details

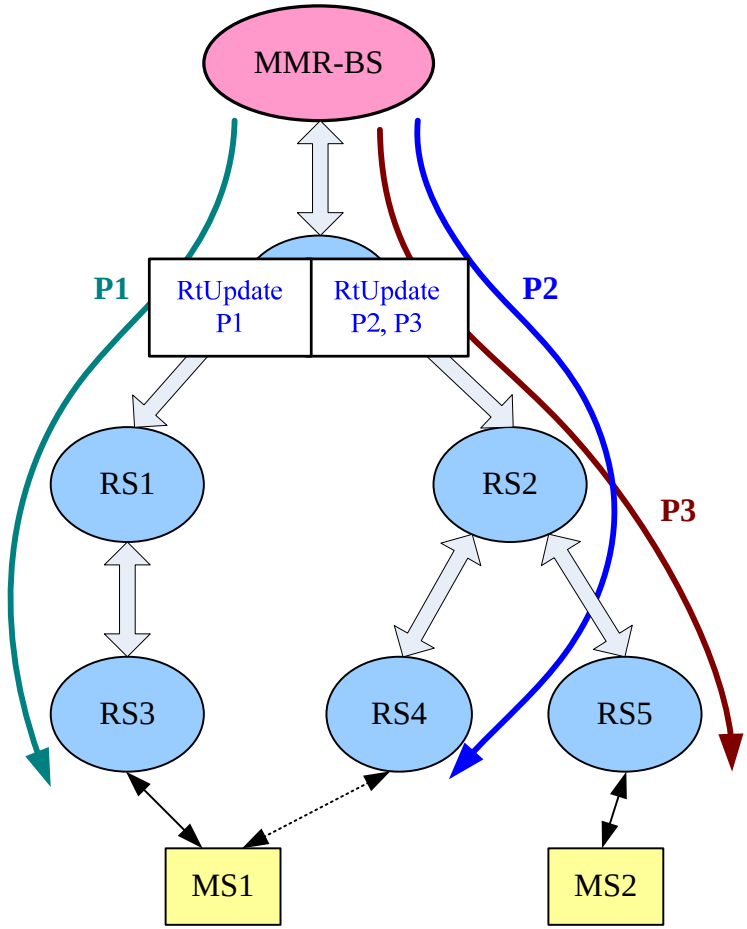
Routing DB update procedure Example

- MMR-BS initiate the route update procedure, and the *RtUpdate {P1, P2, P3}* command is sent out in order to update the route for MS1 and MS2:
  - RtUpdate command can add or delete a path for a service flow;
  - RtUpdate command can allocate a new PathID or delete an unused PathID for a path;



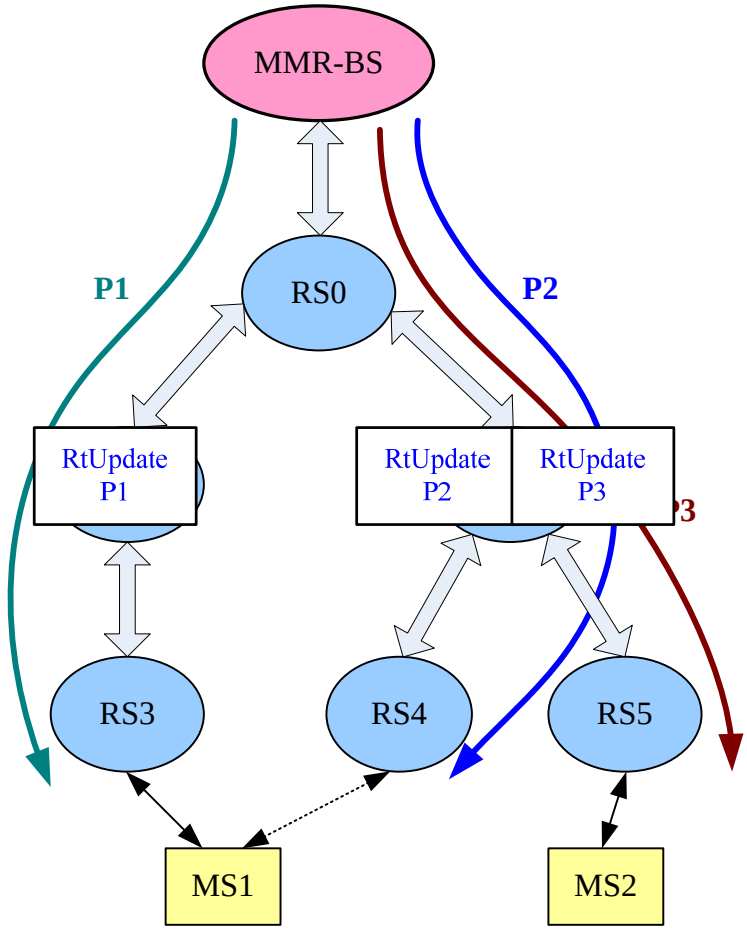
Routing DB update procedure Example

- RS0 parsing the received RtUpdate command, and update the routing data base. Because the next hop RS of P1 is different from that of P2&P3, R0 send different command to RS1 & RS2.
  - RS0→RS1
    RtUpdate{P1}
  - RS0→RS2
    RtUpdate{P2, P3}



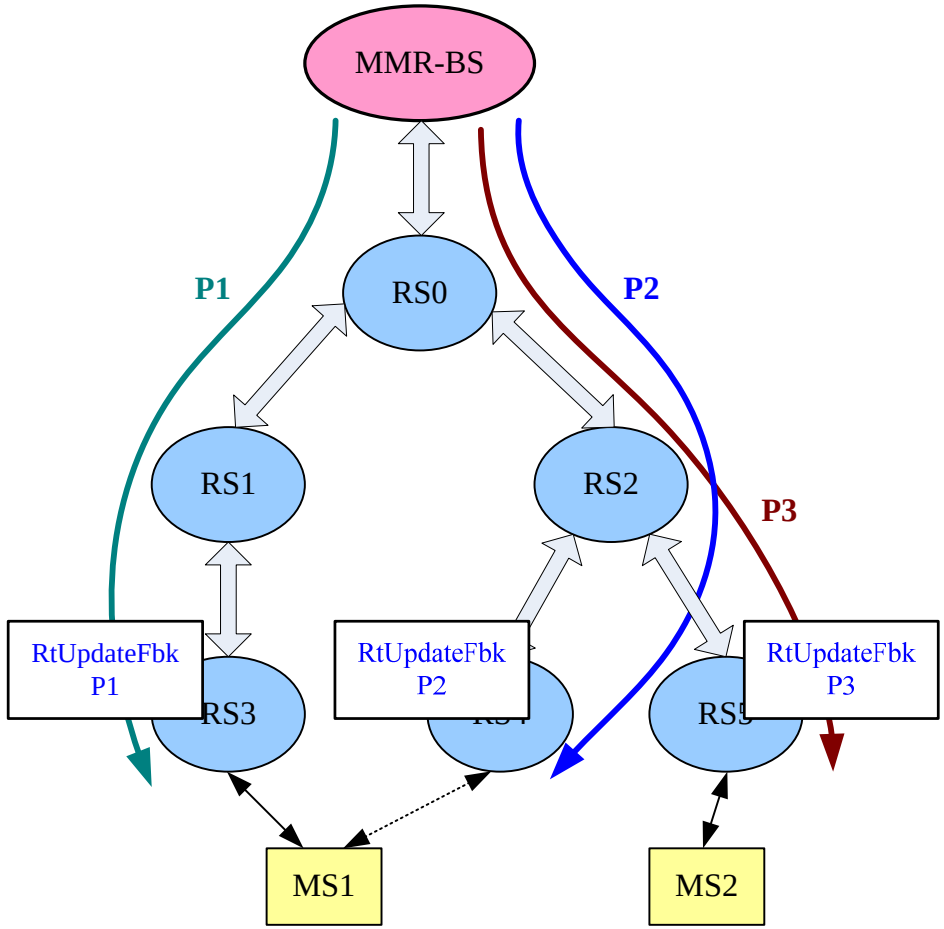
Routing DB update procedure Example

- RS1&RS2 parsing the received command, and update the routing data base. After that, the updated routing command is send to the next hop node.
  - RS1→RS3
    RtUpdate{P1}
  - RS2 →RS4
    RtUpdate{P2}
  - RS2 →RS5
    RtUpdate{P3}



Routing DB update procedure Example

- RS3/4/5 parsing the received RtUpdate command, and update the routing data base separately. For it's the last hop node, a feedback message is generated and send to MMR-BS.
  - RS3 → MMR-BS
    RtUpdateFbk{P1}
  - RS4 → MMR-BS
    RtUpdateFbk{P2}
  - RS5 → MMR-BS
    RtUpdateFbk{P3}



The final Relay DB in each RS