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Title	**Simple Path Management by Encapsulation in MMR system**
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Re:	This is a response to Call for Technical Proposals issued by IEEE 802.16j.
Abstract	We suggest the simple path management by encapsulation in MMR system.
Purpose	The objective of this contribution is to propose path management for MMR system.
Notice	
Release	
Patent Policy and Procedures	

Simple Path Management by Encapsulation in MMR System

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Introduction

In MMR system like Figure 1, the existence of multiple and multi-hop path between a BS and an MS is not spec ial. So, in order to decide the path to transmit bursts, we have to manage the paths.

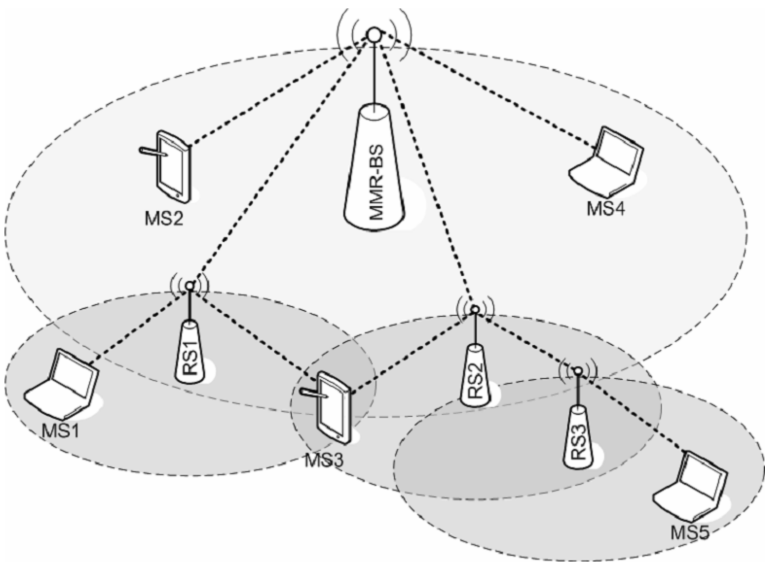

Figure 1. MMR System

The simplest method of managing paths is flooding. But it extremely wastes the bandwidth, so it is not suitable for MMR system. Ad-hoc routing protocol like AODV, DSR, and etc. is very powerful method of managing pat h. But it is very complex and it acts on the network layer (L3) that the specification of IEEE 802.16 doesn't cov er.

SPAME(Simple PAth Management by Encapsulation)

SPAME uses the encapsulation/decapsulation to manage paths. Encapsulation is to attach the additional header to the received PDU, and decapsulation is to remove the additional header from the received PDU. This method is not required to modify a legacy MS, and acts on the link layer(L2).
The additional header has the essential fields described in Table 1.

Table 1. The essential fields in the additional header

CID	No. of Hop	Length
Header Owner	Hop count from source node	Length of payload

Encapsulation/Decapsulation

The PDU from an MS to a BS via an RS is encapsulated, that is, the additional header is attached to the PDU. The additional header has the information related to the path. Figure 2 simply describes encapsulation/decapsul ation. In this figure, node2 that received PN1 from node1 attach HN2 to PN1, and sends it to node3. (HN2 has t he CID of node2.)

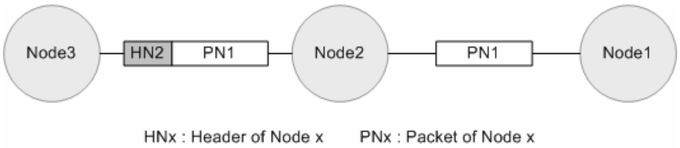

Figure 2. Encapsulation/Decapsulation

Node3 extracts an additional header from the received PDU, and organizes the look-up table as Table 2 for man aging paths.

Table 2. The look-up table of node3

Destination Node	Child Node	No. of Hop
Node1	Node2	2
Node2	-	1

The PDU from a BS to an MS via an RS is decapsulated.
Our SPAME has two modes, CPMM(Centralized Path Management Mode) and DPMM(Distributed Path Mana gement Mode).

CPMM(Centralized Path Management Mode)

CPMM is that only BS manages total paths. That is, the look-up table of paths is maintained by BS. Figure 3 si mply describes the CPMM.

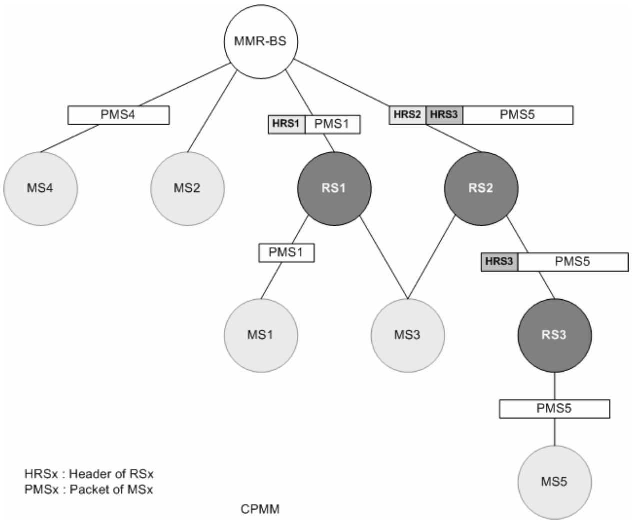

Figure 3. CPMM

First, An RS3 that received a PMS5 from an MS5 adds an HRS3 to a PMS5 and sends it to an RS2. (HRS3 incl udes the CID of RS3.)
Second, an RS2 adds an HRS2 to the (HRS3 + PMS5) and sends it to a BS. (HRS2 includes the CID of RS2.)
Finally, a BS extracts all additional header from the received PDU (HRS2 + HRS3 + PMS5), and organizes the look-up table based on all additional header. Table 3 is the look-up table generated by headers.

Table 3. The look-up table of BS in CPMM

Destination Node	Child Node	No. of Hop
RS2	-	1
RS3	RS2	2
MS5	RS3	3

If a BS communicates with all MSs, the final look-up table is organized as Table 4.

Table 4. The final look-up table of BS in CPMM

Destination Node	Child Node	No. of Hop

RS1	-	1
RS2	-	1
RS3	RS2	2
MS1	RS1	2
MS2	-	1
MS3	RS1	2
MS3	RS2	2
MS4	-	1
MS5	RS3	3

This mode is robust, but has bigger redundancy.

DPMM(Distributed Path Management Mode)

PPMM is that both a BS and each RS manage paths. That is, the look-up table of paths is maintained in a BS an d RSs. Figure 4 simply describes the DPMM.

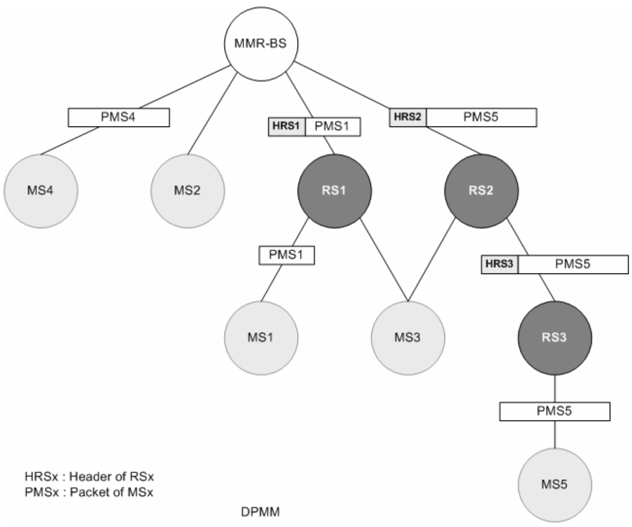

Figure 4. DPMM

First, An RS3 that received a PMS5 from an MS5 adds an HRS3 to a PMS5 and sends it to an RS2. (HRS3 incl udes the CID of RS3.)
Second, an RS2 extracts an HRS3 from the received PDU, organizes the own look-up table, adds an HRS2 to a PMS5 and sends it to a BS. (HRS2 includes the CID of RS2.)

Finally, a BS extracts an additional header from the received PDU (HRS2 + PMS5), and organizes the own look -up table. From Table 5 to Table 7 are the look-up tables.

Table 5. The look-up table of BS in DPMM

Destination Node	Child Node	No. of Hop
RS2	-	1
MS5	RS2	3

Table 6. The look-up table of RS2 in DPMM

Destination Node	Child Node	No. of Hop
RS2	-	1
MS5	RS2	2

Table 7. The look-up table of RS3 in DPMM

Destination Node	Child Node	No. of Hop
MS5	-	1

If a BS communicates with all nodes, the final look-up tables are organized as below.

Table 8. The final look-up table of BS in DPMM

Destination Node	Child Node	No. of Hop
RS1	-	1
RS2	-	1
RS3	RS2	2
MS1	RS1	2
MS2	-	1
MS3	RS1	2
MS3	RS2	2
MS4	-	1
MS5	RS2	3

Table 9. The final look-up table of RS1 in DPMM

Destination Node	Child Node	No. of Hop
MS1	-	1
MS3	-	1

Table 10. The final look-up table of RS2 in DPMM

Destination Node	Child Node	No. of Hop
RS3	-	1
MS3	-	1
MS5	RS3	2

Table 11. The final look-up table of RS3 in DPMM

Destination Node	Child Node	No. of Hop
MS5	-	1

This mode has a fixed redundancy, but is weaker than CPMM.

Proposed Text

6.3.2.1 MAC header formats

Replace Table 4 in 6.3.2.1 with the following table:

Table 4—MAC header format

Syntax	Size	Notes
MAC Header() {		
HT	1 bit	0 = Generic MAC header 1 = Bandwidth request header
EC	1 bit	If HT = 1, EC = 0
If(HT==0) {		
If(EI==0) {		
Type	6 bits	
ESF	1 bit	
CI	1 bits	
EKS	2 bits	
~~*reserved*~~EI	1 bit	Shall be set to zero
LEN	11 bits	
}		
else {		
reserved	6 bits	Reserved for Metric
HOP	4 bits	
EI	1 bit	Shall be set to one
LEN	11 bits	
}		

}		
else {		
Type	3 bits	
BR	19 bits	
}		
CID	16 bits	
HCS	8 bits	
}		

6.3.2.1.1 Generic MAC header

Replace Figure 19 in 6.3.2.1.1 with the following figure:

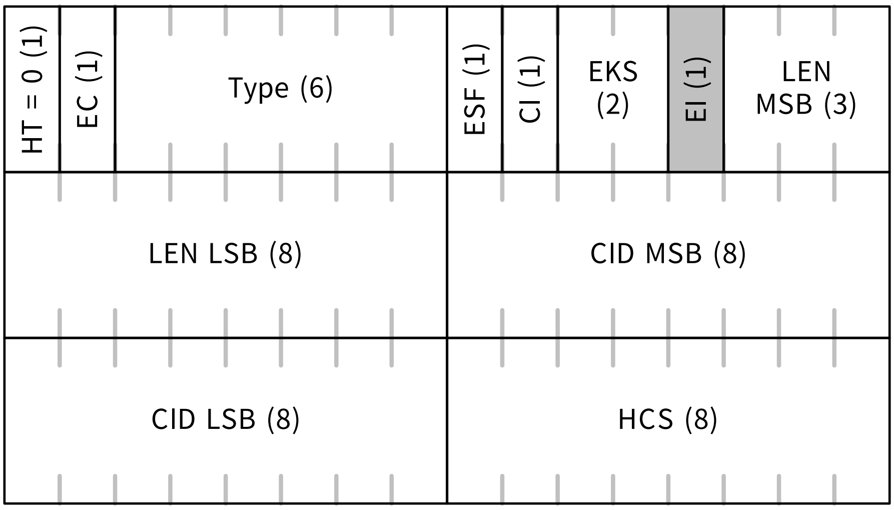

Figure 19—Generic MAC header format

Insert the following row into Table 5:

Table 5—Generic MAC header fields

Name	Length (bits)	Description
HOP	4	Hop counter field. When the MPDU is encapsulated, hop counter would be incre ased. And when the MPDU is decapsulated, hop counter wou ld be decreases.
EI	1	Encapsulation indicator

		0 = no encapsulation 1 = encapsulation

6.3.25 Relay path management and routing

Insert the following at the end of 6.3.25:

6.3.25.1 Relay path management

6.3.25.1.1 Simple path management by encapsulation

For managing paths, the encapsulation and decapsulation are used.

6.2.25.1.1.1 Encapsulation/Decapsulation

The PDU from an MS to a BS via an RS is encapsulated, that is, the additional header is attached to the PDU. The additional header has the information related to the path. Figure xxx simply describes encapsulation/decapsulation. In this figure, node2 that received PN1 from node1 attach HN2 to PN1, and sends it to node3. (HN2 has the CID of node2.)

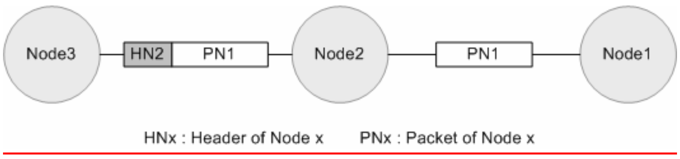

Figure xxx. Encapsulation/Decapsulation

Node3 extracts an additional header from the received PDU, and organizes the look-up table for managing paths. The PDU from a BS to an MS via an RS is decapsulated.

6.3.25.1.1.2 Centralized path management mode

The centralized path management mode is that only BS manages total paths. That is the look-up table of paths in maintained by a BS.

Each node acts as below:

- An MS receives/sends PDUs from/to the parent node.
- If an RS received PDU from the child node
  - Attach the own encapsulation header to the received PDU
  - Send it to the parent node.
- If an RS received PDU from the parent node
  - Remove the encapsulation header from the received PDU
  - Send it to the child node.
- If a BS received PDU from the child node and its encapsulation indicator is set

  - Extract encapsulation headers from the received PDU
  - Organize the look-up table.
- If a BS received PDU from the child node and its encapsulation indicator is clear
  - Organize the look-up table.
- If a BS has to send the PDU to an MS and the distance to an MS is 1-hop
  - Directly send the PDU to an MS.
- If a BS has to send the PDU to an MS and the distance to an MS is multi-hop
  - Sequentially attach the encapsulated headers to the PDU, and send it to the child node.

6.3.25.1.1.3 Distributed path management mode

The distributed path management mode is that a BS and all RSs manage partial paths. That is the look-up table of paths in maintained by a BS and all RSs.

Each node acts as below:

- An MS receives/sends PDUs from/to the parent node.
- If an RS received PDU from the child node and its encapsulation indicator is set
  - Extract encapsulation headers from the received PDU
  - Organize the look-up table
  - Attach the own encapsulation header to the received PDU
  - Send it to the parent node.
- If an RS received PDU from the parent node and the child node of the RS is an RS
  - Remove the encapsulation header from the received PDU
  - Attach the child's encapsulation header to the received PDU
  - Send it to the child node.
- If an RS received PDU from the parent node and the child node of the RS is an MS
  - Remove the encapsulation header from the received PDU
  - Send it to the child node.
- If a BS received PDU from the child node and its encapsulation indicator is set
  - Extract an encapsulation header from the received PDU
  - Organize the look-up table.
- If a BS received PDU from the child node and its encapsulation indicator is clear
  - Organize the look-up table.
- If a BS has to send the PDU to an MS and the distance to an MS is 1-hop
  - Directly send the PDU to an MS.
- If a BS has to send the PDU to an MS and the distance to an MS is multi-hop
  - Sequentially attach the child's encapsulated headers to the PDU
  - Send it to the child node.