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Re:	This is a response to Call for Technical Proposals issued by IEEE 802.16j.
Abstract	We suggest the procedure of tunnel establishment.
Purpose	The objective of this contribution is to propose the procedure of tunnel establishment in MMR system.
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Tunnel Establishment

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ETRI

Introduction

In MMR system as depicted in figure 1, there exists multiple and multi-hop path between an MR-BS and an MS [1].

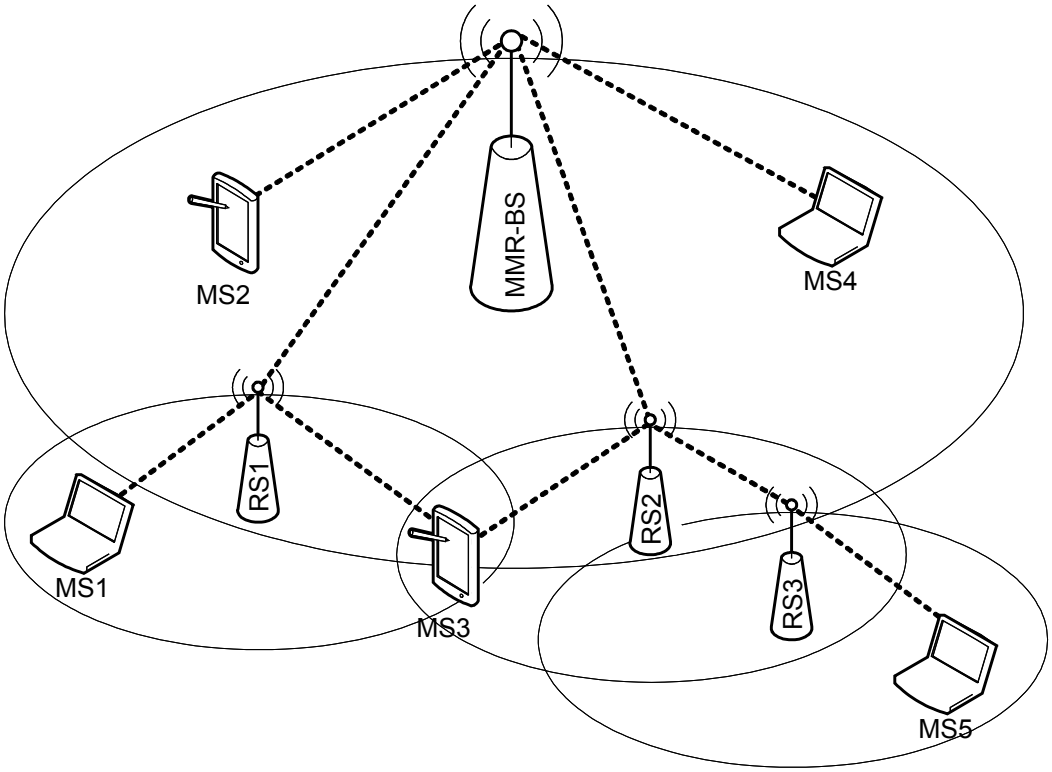

Figure 1—MMR System

So it is important to decide the suitable path from the MR-BS to the MS. For this purpose, the MR-BS and RSs have to maintain and manage the path information.

There exist several path management methods, but tunneling is more efficient method than others.

In general path management, when the MS moves from one RS to another, the MR-BS, intermediate RS(s) and access RS have to update the path information related to the MS.

In the tunneling, intermediate and access RSs would not change any path information, but the only MR-BS selects other tunnel toward access RS connected with moved MS.

So we propose the way to establish tunnels by using encapsulation.

The procedures

Herein we define the tunnel as the direct path between the MR-BS and the access RS and encapsulated RNG, DSx and DREG messages are used to establish a tunnel. This method is suitable for only fixed RS. But, after declaring the procedure of RS movement detection, our method would be extended to support moving RS.

The first case is the initial ranging of multi-hop RS.

In this case, we are not interested in how intermediate RSs relay a ranging code and its response (first RNG-RSP).

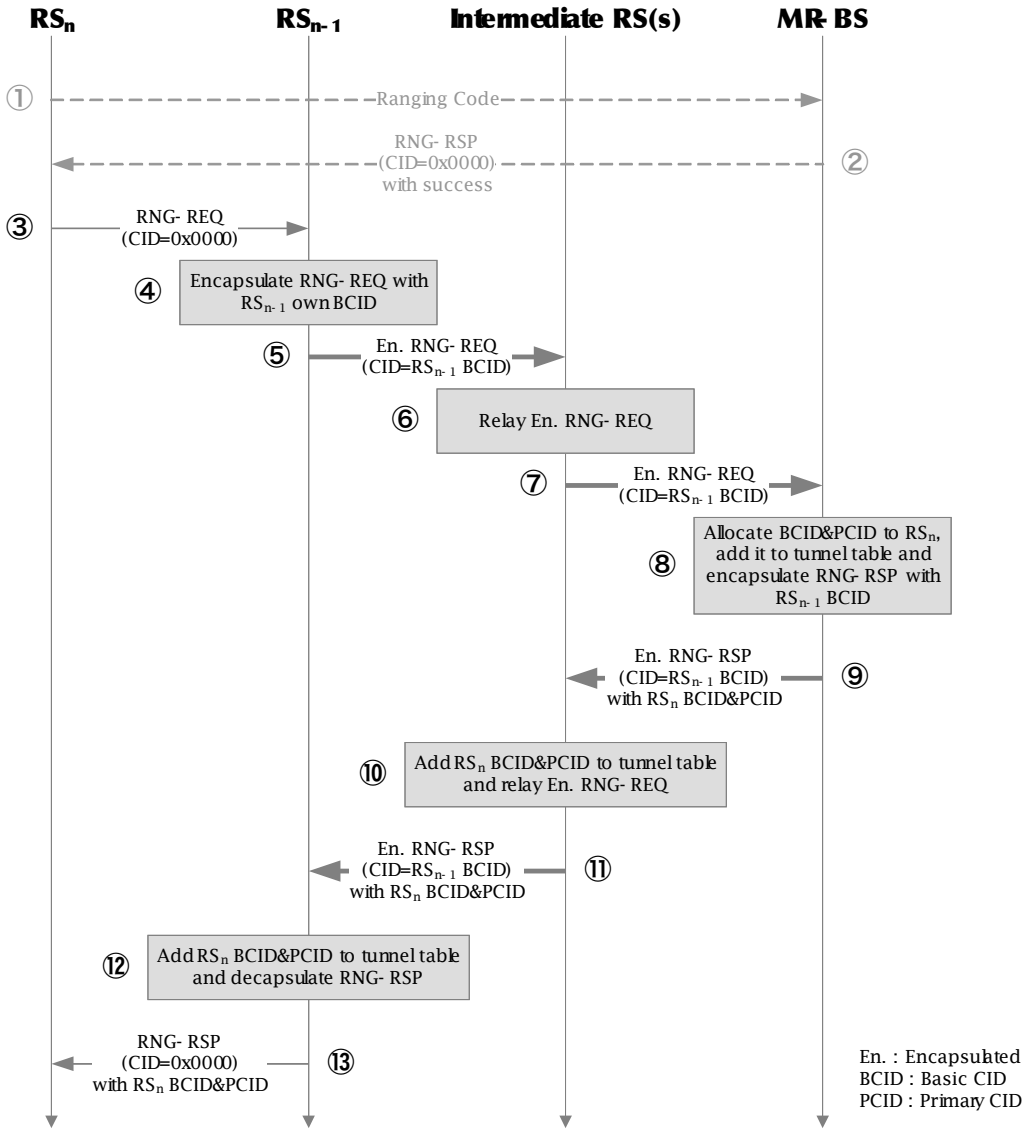

Figure 2—The initial ranging of multi-hop RS

1 The RS$_n$ transmits an initial ranging code.
2 The MR-BS sends an RNG-RSP (CID=0x0000) with status=success.
3 The RS$_n$ sends an RNG-REQ (CID=0x0000).
4 The RS$_{n-1}$ encapsulates an RNG-REQ with its own basic CID.
5 The RS$_{n-1}$ sends an encapsulated RNG-REQ (CID=RS$_{n-1}$ BCID).

6 Intermediate RSs check whether an RS_{n-1} BCID exists in a tunnel table.
7 Intermediate RSs relay an encapsulated RNG-REQ (CID=RS_{n-1} BCID).
8 The MR-BS allocates a basic and a primary CID to RS_n, adds it to a tunnel table and encapsulates an RNG-RSP with an RS_{n-1} BCID.
9 The MR-BS sends an encapsulated RNG-RSP (CID=RS_{n-1} BCID) with an RS_n basic and primary CID.
10 If RS_{n-1} BCID exists in a tunnel table, intermediate RSs add an RS_n basic and primary CID to a tunnel table.
11 Intermediate RSs send an encapsulated RNG-RSP (CID=RS_{n-1} BCID) to next node.
12 The RS_{n-1} adds an RS_n basic and primary CID to a tunnel table and decapsulates an encapsulated RNG-RSP (CID=RS_{n-1} BCID).
13 The RS_{n-1} sends an RNG-RSP (CID=0x0000) to the RS_n.

After the initial ranging of RS_n is finished, the tunnel table of the MR-BS, RS_{n-1} and intermediate RSs includes a basic and primary CID of RS_n.

The second case is the deregistration of multi-hop RS.

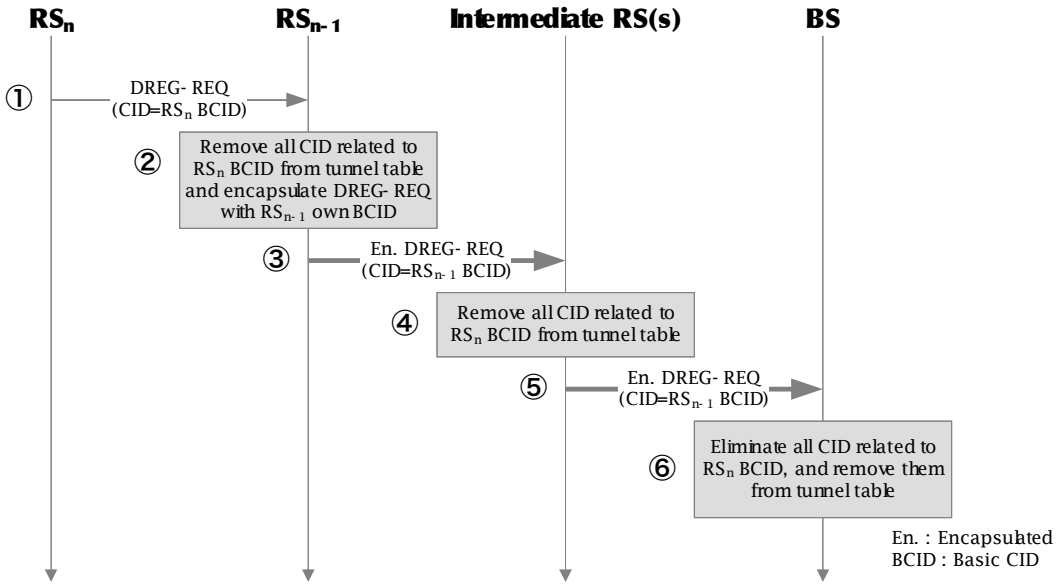

Figure 3—The deregistration of multi-hop RS

1 The RS_n sends a DREG-REQ (CID=RS_n BCID).
2 The RS_{n-1} all CID related to an RS_n BCID from a tunnel table and encapsulates a DREG-REQ with its own basic CID.
3 The RS_{n-1} sends an encapsulated DREG-REQ (CID=RS_{n-1} BCID).
4 Intermediate RSs remove all CID related to an RS_n BCID from a tunnel table.
5 Intermediate RSs relay an encapsulated RNG-REQ (CID=RS_{n-1} BCID).
6 The MR-BS de-allocates all CID related to RS_n BCID, and removes them from tunnel table.

After the deregistration of RS_n is finished, the tunnel table of the MR-BS, RS_{n-1} and intermediate RSs includes no CIDs related to RS_n.

The third case is the initial ranging of multi-hop MS.

In this case, we are not interested in how intermediate RSs relay a ranging code and its response (first RNG-RSP).

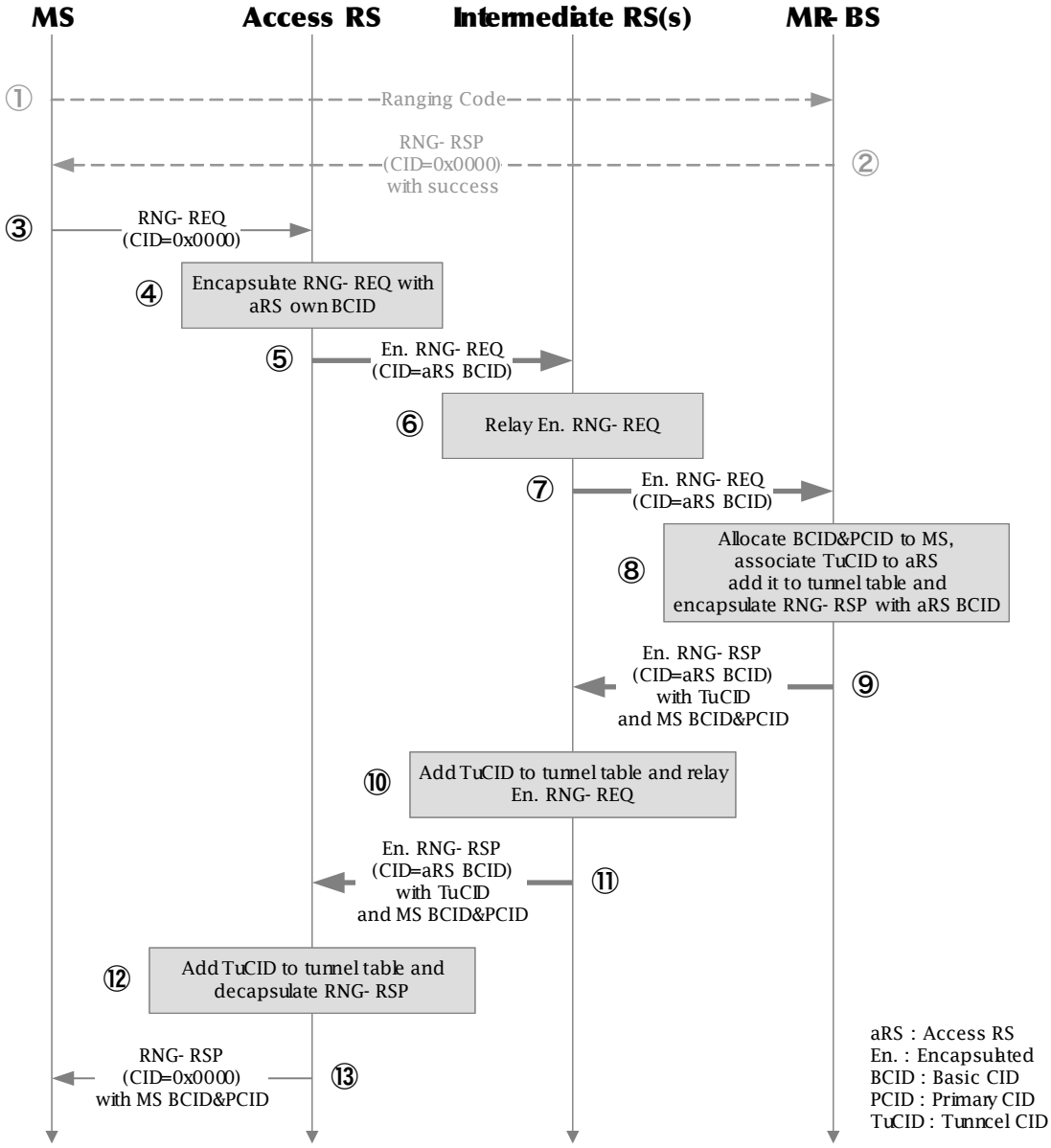

Figure 4—The initial ranging of multi-hop MS

1 The MS transmits an initial ranging code.
2 The MR-BS sends an RNG-RSP (CID=0x0000) with status=success.
3 The MS sends an RNG-REQ (CID=0x0000).
4 The access RS encapsulates an RNG-REQ with its own basic CID.
5 The access RS sends an encapsulated RNG-REQ (CID=access RS BCID).
6 Intermediate RSs check whether an access RS BCID exists in a tunnel table.
7 Intermediate RSs relay an encapsulated RNG-REQ (CID=access RS BCID).
8 The MR-BS allocates a basic and a primary CID to MS, associates a tunnel CID to access RS, adds them to a tunnel table and encapsulates an RNG-RSP with an access RS BCID.
9 The MR-BS sends an encapsulated RNG-RSP (CID=access RS BCID) with a tunnel CID and an MS

basic and primary CID.

10 If access RS BCID exists in a tunnel table, intermediate RSs add a tunnel CID to a tunnel table.
11 Intermediate RSs send an encapsulated RNG-RSP (CID=access RS BCID) to next node.
12 The access RS associates a tunnel CID with an MS basic and primary CID and decapsulates an encapsulated RNG-RSP (CID=access RS BCID).
13 The access RS sends an RNG-RSP (CID=0x0000) to the MS.

After the initial ranging of MS is finished, the tunnel table of the MR-BS, access RS and intermediate RSs includes a tunnel CID related to MS.

The fourth case is the deregistration of multi-hop MS.

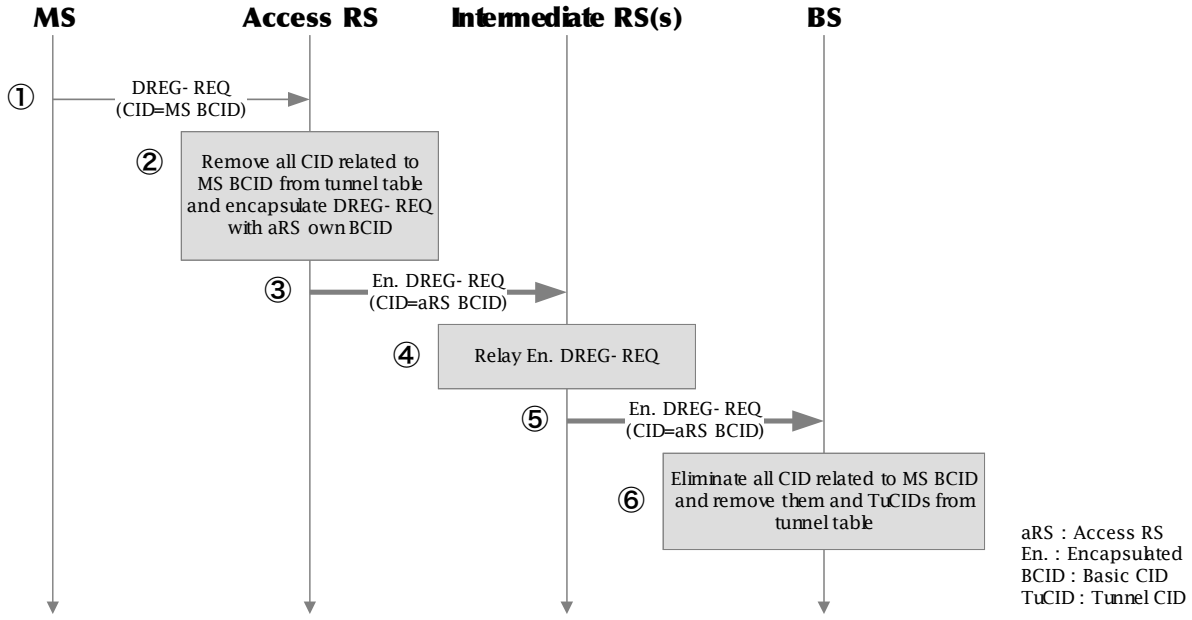

Figure 5—The deregistration of multi-hop MS

1 The MS sends a DREG-REQ (CID=MS BCID).
2 The access RS remove all CID related to a MS BCID from a tunnel table and encapsulates a DREG-REQ with a tunnel CID and an access RS BCID.
3 The access RS sends an encapsulated DREG-REQ (CID=access RS CID).
4 Intermediate RSs check whether the access RS BCID is in the tunnel table.
5 Intermediate RSs relay an encapsulated RNG-REQ (CID=access RS BCID).
6 The MR-BS de-allocates all CID related to MS BCID, and removes them and a tunnel CID from tunnel table.

After the deregistraion of MS is finished, the tunnel table of the MR-BS, access RS and intermediate RSs includes no CIDs related to MS.

The fifth case is the service flow addition.

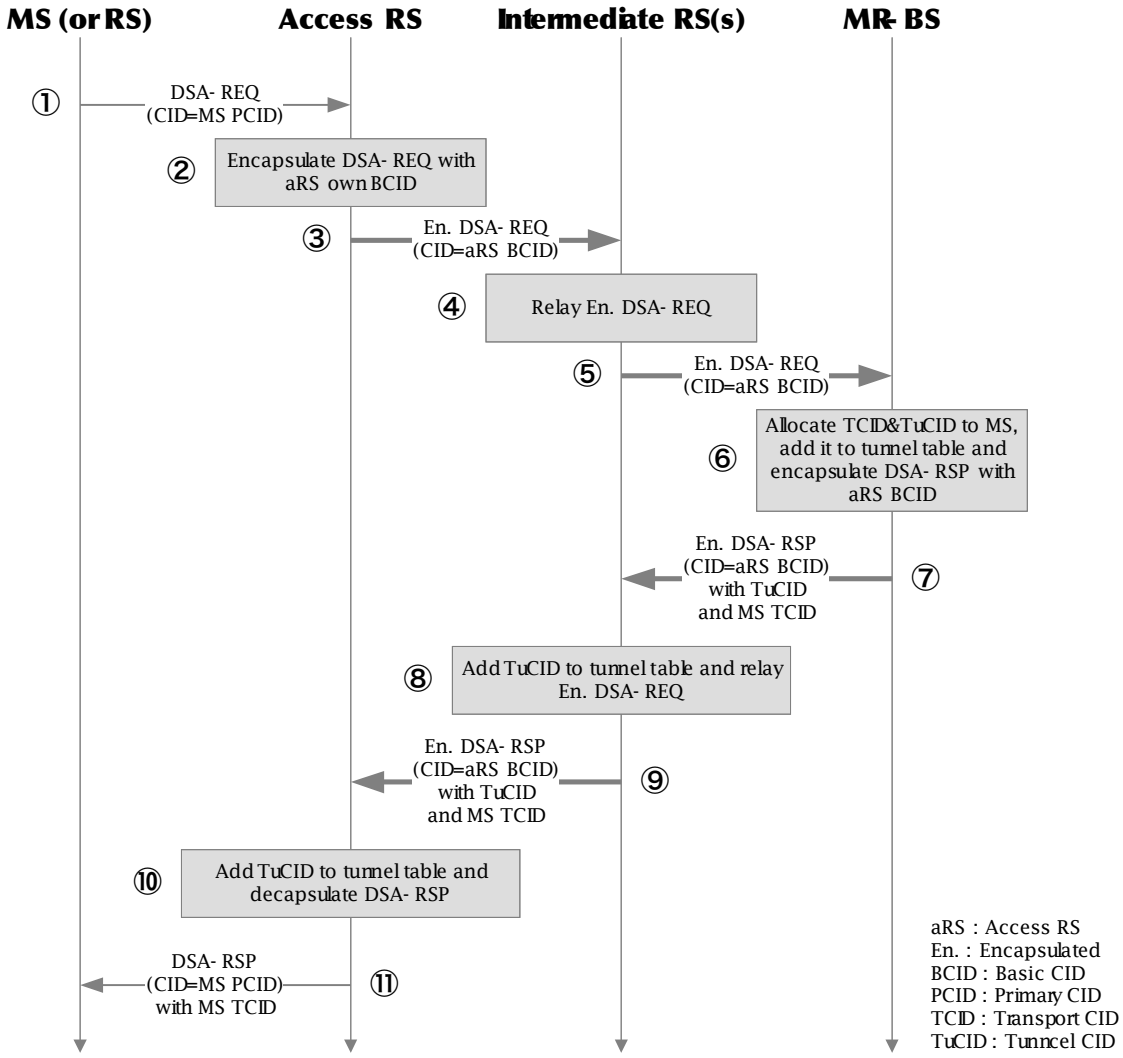

Figure 6—The service flow addition of multi-hop MS (or RS)

1 The MS (or RS) sends a DSA-REQ (CID=MS PCID).
2 The access RS encapsulates a DSA-REQ with its own basic CID.
3 The access RS sends an encapsulated DSA-REQ (CID=access RS BCID).
4 Intermediate RSs check whether an access RS BCID exists in a tunnel table.
5 Intermediate RSs relay an encapsulated DSA-REQ (CID=access RS BCID).
6 The MR-BS allocates a transport CID to MS, associates a tunnel CID to access RS, adds them to a tunnel table and encapsulates a DSA-RSP with an access RS BCID.
7 The MR-BS sends an encapsulated DSA-RSP (CID=access RS BCID) with a tunnel CID and an MS transport CID.
8 If access RS BCID exists in a tunnel table, intermediate RSs add a tunnel CID to a tunnel table.
9 Intermediate RSs send an encapsulated DSA-RSP (CID=access RS BCID) to next node.
10 The access RS associates a tunnel CID with an MS transport CID and decapsulates an encapsulated DSA-RSP (CID=access RS BCID).
11 The access RS sends a DSA-RSP (CID=MS PCID) to the MS.

After the service flow addition of MS (or RS) is finished, the tunnel table of the MR-BS, access RS and intermediate RSs includes a tunnel CID related to MS (or RS).

The sixth case if the service flow deletion.

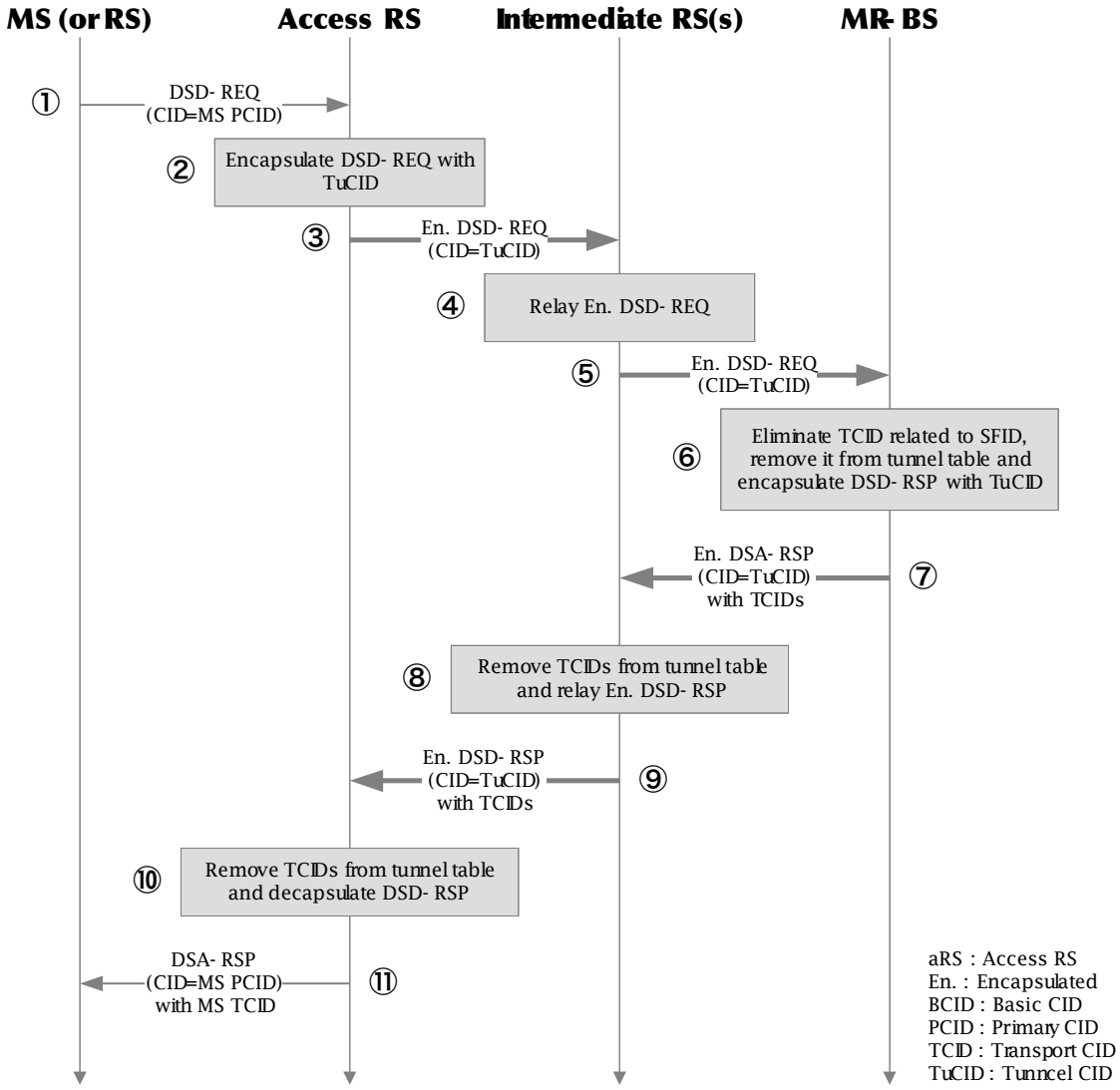

Figure 7—The service flow deletion of multi-hop MS (or RS)

1 The MS (or RS) sends a DSD-REQ (CID=MS PCID).
2 The access RS encapsulates a DSD-REQ with a tunnel CID.
3 The access RS sends an encapsulated DSD-REQ (CID=tunnel CID).
4 Intermediate RSs check whether a tunnel CID exists in a tunnel table.
5 Intermediate RSs relay an encapsulated DSD-REQ (CID=tunnel CID).
6 The MR-BS eliminates transport CIDs related to SFID, removes it from a tunnel table and encapsulates a DSD-RSP with a tunnel CID and eliminated transport CIDs.
7 The MR-BS sends an encapsulated DSD-RSP (CID=tunnel CID).
8 Intermediate RSs remove transport CIDs from a tunnel table.
9 Intermediate RSs send an encapsulated DSD-RSP (CID=tunnel CID) to next node.
10 The access RS removes transport CIDs from a tunnel table and decapsulates an encapsulated DSD-RSP (CID=tunnel CID).
11 The access RS sends a DSD-RSP (CID=MS PCID) to the MS.

After the service flow deletion of MS (or RS) is finished, the tunnel table of the MR-BS, access RS and intermediate RSs includes no CIDs related to MS (or RS).

The encapsulation

A RNG, DREG, DSx messages from the MR-BR and the access RS is encapsulated with an encapsulation subheader depicted as Figure 8. The encapsulation subheader could be added to one MPDU or several MPDUs.

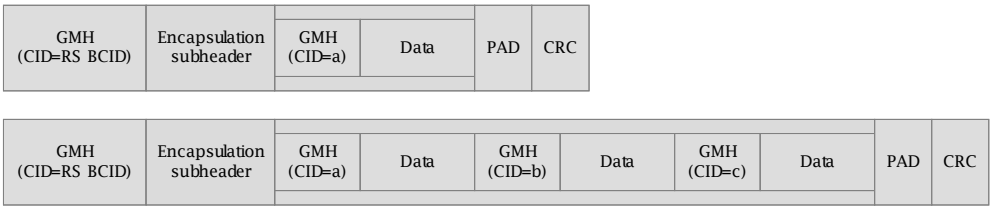

Figure 8—The example of encapsulation [2]

The encapsulation subheader includes CIDs related to the tunnel. Especially the tunnel CID is used for the access RS and intermediate RSs to manage the tunnel.

Proposed Text

3 Definitions

Insert new terminology as followed:

3.x tunnel : A logically direct path from the MR-BS to the access RS

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) {		
Type	6 bits	
ESF	1 bit	
CI	1 bits	
EKS	2 bits	
~~*reserved*~~EI	1 bit	Indicate whether encapsulated or not
LEN	11 bits	
}		
}		

6.3.2.1.1 Generic MAC header

Replace Figure 19 in 6.3.2.1.1 with the following figure:

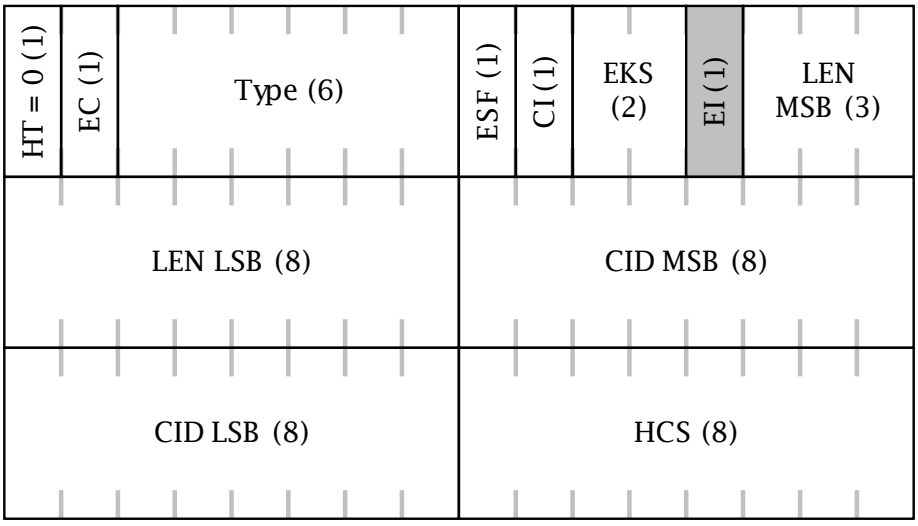

Figure 19—Generic MAC header format

Insert the following row into Table 5:

Table 5—Generic MAC header fields

Name	Length (bits)	Description
EI	1	Encapsulation indicator 0 = no encapsulation 1 = encapsulation

6.3.2.2. MAC subheaders and special payloads

Insert new subclause 6.3.2.2.8 at the end of 6.3.2.2:

6.3.2.2.8 Encapsulation subheader

Encapsulation subheader is used to establish a tunnel and is added to RNG, DREG, DSx from/to multi-hop RS and MS. This subheader is solely used, so other subheader and extended subheader shall be not followed. The format of the encapsulation subheader is as described in Table 13m.

Table 13m—Encapsulation subheader

Syntax	Size	Notes
Encapsulation subheader_format() {		
TYPE	3 bits	0b000 : RNG-REQ 0b001 : RNG-RSP 0b010 : DREG-REQ 0b011 : reserved 0b100 : DSA-REQ 0b101 : DSA-RSP 0b110 : DSD-REQ 0b111 : DSD-RSP
N_CID	5 bits	Number of CIDs
For(i=0; i<N_CID; i++) {		
CID	16 bits	Basic, Primary, Tunnel CID
}		
}		

6.3.25 Relay path management and routing

Insert the following at the end of 6.3.25:

6.3.25.1 Tunnel Establishment

Tunnel is defined as a logically direct path between the MR-BS and the access RS. All traffic to the multi-hop MS is transmitted via tunnel. In the tunnel, all RNG, DREG, DSx messgaes are encapsulated with the encapsulation subheader.

Tunnel is established during the initial ranging and the service flow addition of RS and MS, and is eliminated during the deregistration and the service flow deletion of RS and MS.

6.3.25.1.1 The initial ranging of multi-hop RS

In the initial ranging of multi-hop RS, the MR-BS and RSs act as followed:

- New RS transmits an initial ranging code.
- The access RS and intermediate RS(s) relay the code to the MR-BS.
- The MR-BS sends an RNG-RSP with status=success
- Intermediate RS(s) and access RS relay the RNG-RSP to the new RS.
- The new RS sends an RNG-REQ.
- The access RS encapsulates an RNG-REQ with its own basic CID and sends it to the next node.
- Intermediate RS(s) relays the encapsulated RNG-REQ to the MR-BS.
- The MR-BS allocates a new basic and primary CID to the new RS, adds new entry related to the new RS to the tunnel table, and sends an encapsulated RNG-RSP with the basic CID of the access RS to the new RS.
- Intermediate RS(s) updates its own tunnel table and relays the encapsulated RNG-RSP to the access RS.
- The access RS updates its own tunnel table, decapsulates the encapsulated RNG-RSP, and sends it to the new RS.

6.3.25.1.2 The deregistration of multi-hop RS

In the deregistration of multi-hop RS, the MR-BS and RSs act as followed:

- The RS sends a DREG-REQ with its own basic CID.
- The access RS eliminates the entry related to the RS from its own tunnel table, encapsulates a DREG-REQ with its own basic CID and sends it to the MR-BS.
- Intermediate RS(s) relay the encapsulated DREG-REQ to the MR-BS.
- The BS eliminates entries related to the RS from the tunnel table.

6.3.25.1.3 The initial ranging of multi-hop MS

In the initial ranging of multi-hop MS, the MR-BS and RSs act as followed:

- New MS transmits an initial ranging code.
- The access RS and intermediate RS(s) relay the code to the MR-BS.
- The MR-BS sends an RNG-RSP with status=success
- Intermediate RS(s) and access RS relay the RNG-RSP to the new MS.
- The new MS sends an RNG-REQ.
- The access RS encapsulates an RNG-REQ with its own basic CID and sends it to the next node.
- Intermediate RS(s) relays the encapsulated RNG-REQ to the MR-BS.
- The MR-BS allocates a new basic and primary CID and a tunnel CID to the new MS, adds new entry related to the new MS to the tunnel table, and sends an encapsulated RNG-RSP with the basic CID of the

access RS to the new MS.

- Intermediate RS(s) updates its own tunnel table and relays the encapsulated RNG-RSP to the access RS.
- The access RS updates its own tunnel table, decapsulates the encapsulated RNG-RSP, and sends it to the new MS.

6.3.25.1.4 The deregistration of multi-hop MS

In the deregistration of multi-hop MS, the MR-BS and RSs act as followed:

- The MS sends a DREG-REQ with its own basic CID.
- The access RS eliminates the entry related to the MS from its own tunnel table, encapsulates a DREG-REQ with its own basic CID and sends it to the MR-BS.
- Intermediate RS(s) relay the encapsulated DREG-REQ to the MR-BS.
- The BS eliminates entries related to the MS from the tunnel table.

6.3.25.1.5 The service flow addition

In the service flow addition, the node act as followed:

- The node sends a DSA-REQ with its own primary CID.
- The access RS encapsulates a DSA-REQ with its own basic CID and sends it to the next node.
- Intermediate RS(s) relay the encapsulated DSA-REQ to the MR-BS.
- The MR-BS allocates a new transport CID to the node, assigns a tunnel CID to the node, adds them to the tunnel table and sends an encapsulated DSA-RSP with the basic CID of the access RS to the node.
- Intermediate RS(s) add a tunnel CID to its own tunnel table and relay the encapsulated DSA-RSP to the access RS.
- The access RS adds a tunnel CID to its own tunnel table and decapsulates an encapsulated DSA-RSP and sends it to the node.

6.3.25.1.6 The service flow deletion

In the service flow deletion, nodes act as followed:

- The node sends a DSD-REQ with its own primary CID and an SFID.
- The access RS encapsulates a DSD-REQ with a tunnel CID and sends it to the next node.
- Intermediate RS(s) relays an encapsulated DSD-REQ to the MR-BS.
- The BS eliminates a transport CID related to SFID, removes entries related to the transport CID from tunnel table and sends an encapsulated DSD RSP with the tunnel CID and eliminated transport CIDs to the node.
- Intermediate RS(s) remove transport CIDs from its own tunnel table and relay the encapsulated DSD-RSP to the access RS.
- The access RS removes transport CIDs from its own tunnel table and decapsulates an encapsulated DSD-RSP and sends it to the node.

11.5 RNG-REQ management message encodings

Change Table 364 as indicated:

Table 364—RNG-REQ message encodings

Name	Type (1 byte)	Length	Value (variable-length)	PHY Scope
RS Indicator	TBD	0		OFDMA

References

[1] C. K. Kim, et. Al, "Simple Path Management by Encapsulation in MMR System", IEEE C802.16j-07/168, IEEE 802.16 meeting #47, London, Jauary 2007

[2] J. Z. Tao, et. Al, "Relay Tunnel Connection for 802.16j", IEEE X802.16j-07/115r3, IEEE 802.16 meeting #47, London, January 2007