Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Tunnel Establishment**
Date Submitted	**2007-03-14**
Source(s)	Changkyoon Kim, Hyung Kee Kim, Mi-kyoung Lee, Young-jae Kim, Kyu Ha Lee Samsung Thales Co., Ltd San 12-1, Nongseo-Dong, Giheung-Gu, Yongin-City, Gyeonggi-Do, Korea 446-712 Voice: +82-31-280-9919 Fax: +82-31-280-1620 E-mail: changkyoon.kim@samsung.com E-mail: kyuha.lee@samsung.com Sunggeun Jin, Young Jin Moon, Young-il Kim ETRI 161, Gajeong-Dong, Yuseong-Gu, Daejeon, Korea 205-350 Voice : +82-42-860-1757 Fax: +82-42-861-1966 E-mail: sgjin@etri.re.kr
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.
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>.

Tunnel Establishment

Changkyoon Kim, Hyung Kee Kim, Mi-kyoung Lee, Young-jae Kim, Kyu Ha Lee
Samsung Thales
Sunggeun Jin, Young Jin Moon, Young-il Kim
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].

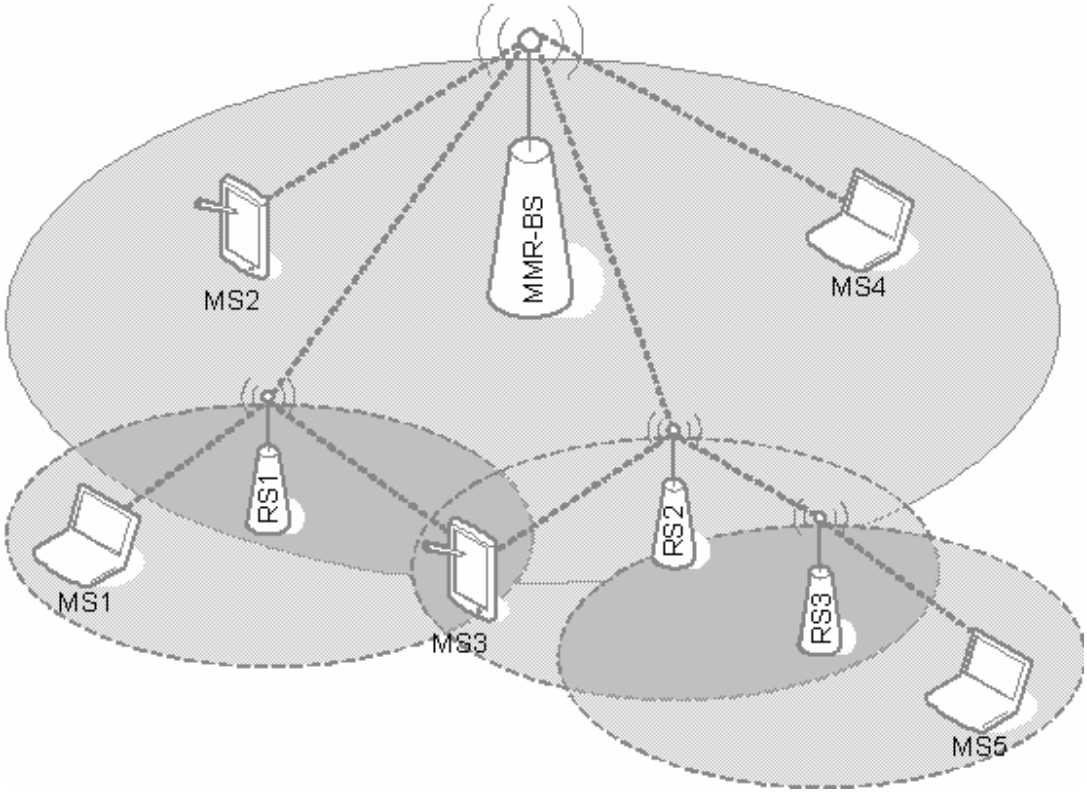

Figure 1 MMR System

So it is important to decide the suitable path from the MR-BS to the MSs. 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.

For tunneling, 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 the basic CID of the access RS is used to identify the specific tunnel.

In our method, the encapsulated RNG, DSx and DREG messages is used to establish a tunnel, and all traffic be tween the MR-BS and the MS is encapsulated with the basic CID of the access RS.

This method is suitable only to a fixed RS. But, after declaring the procedure of RS movement detection, our method would be extended to support moving RS.

We are not interested in how intermediate RS(s) relay a ranging code and its response (first RNG-RSP). But, we are just interested in how intermediate RS(s) relay an RNG-REQ and its response (second RNG-RSP) and e stablish a tunnel and a look-up table.

We use two initial ranging CID, one is for the MS and another is for the RS. And we suggest the initial rangin g CID for RS is set to 0x0001, but the specific value is not fixed.

The first case is 1-hop RS initial ranging.

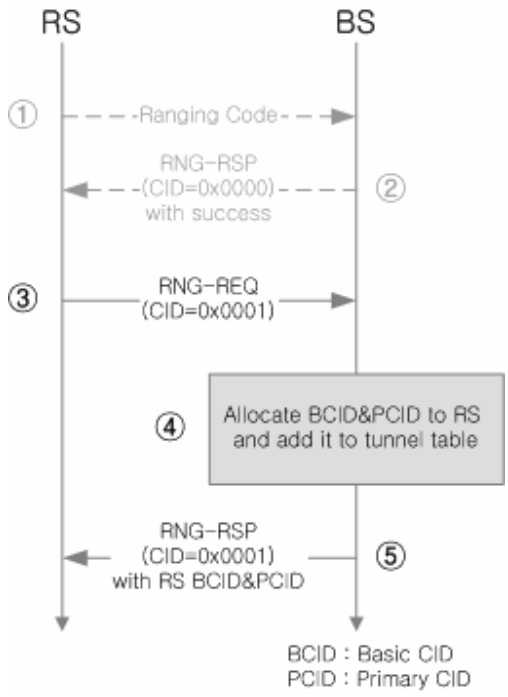

Figure 2 The procedure of 1-hop RS initial ranging

① The RS transmits an initial ranging code.
② The BS sends an RNG-RSP (CID=0x0000) with status=success.
- If BS can distinguish the RS from the MS at this time, CID should be set to 0x0001.

③ The RS sends an RNG-REQ (CID=0x0001).
④ The BS allocates a basic and a primary CID to an RS and adds it to tunnel table.
⑤ The BS sends an RNG-RSP (CID=0x0001) with an RS basic and primary CID.

Table 1 MR-BS tunnel table (The case of 1-hop RS)

Destination (CID)	Tunnel (CID)
RS BCID	-
RS PCID	-

After the initial ranging of 1-hop RS is finished, Table 1 is made by the MR-BS

The second case is multi-hop RS initial ranging.

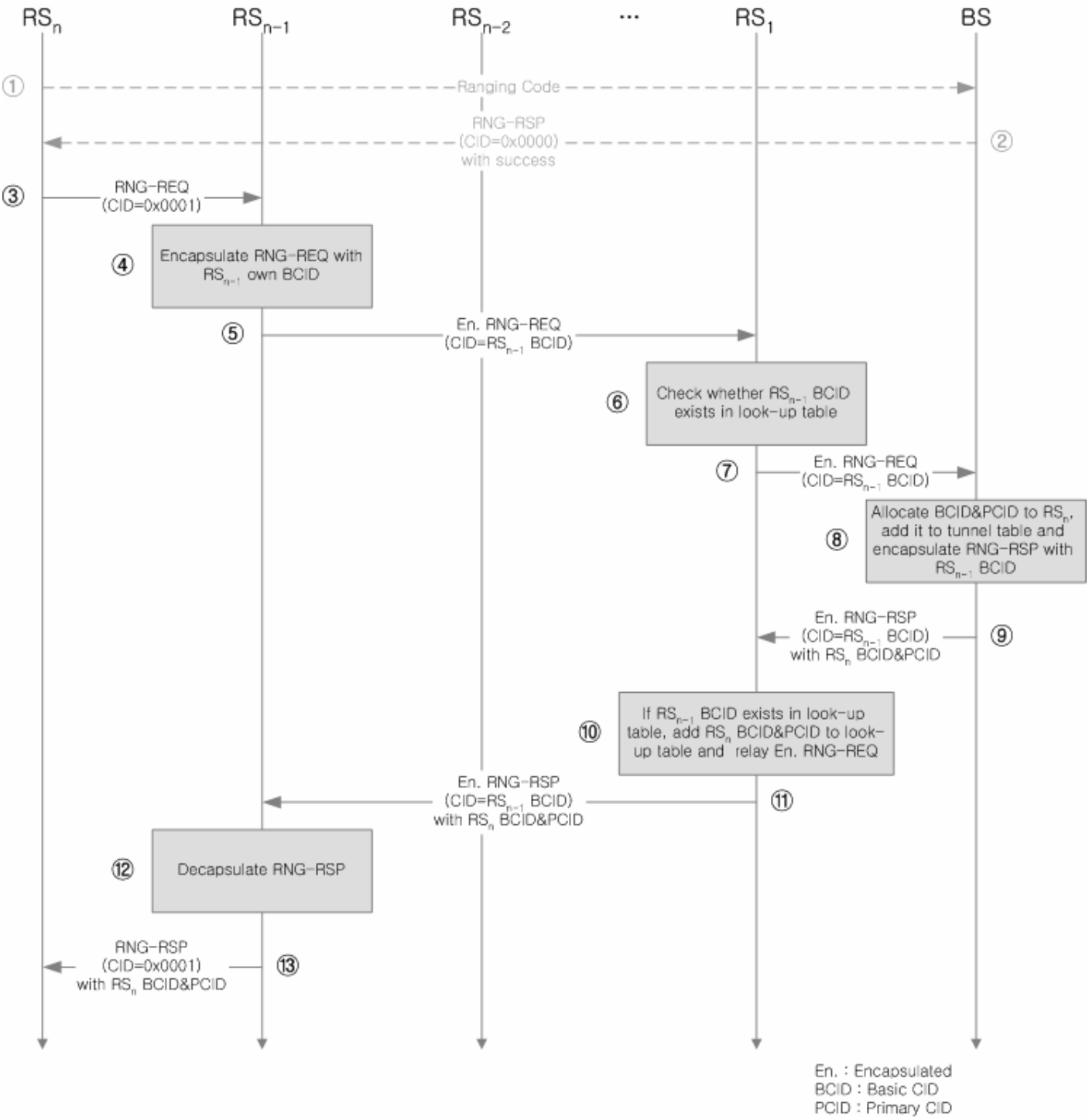

Figure 3 The procedure of multi-hop MS/RS initial ranging

① The RS_n transmits an initial ranging code.
② The BS sends an RNG-RSP (CID=0x0000) with status=success.
- If BS can distinguish the RS from the MS at this time, CID should be set to 0x0001.

③ The RS_n sends an RNG-REQ (CID=0x0001).
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 look-up table.
⑦ Intermediate RSs relay an encapsulated RNG-REQ (CID= RS_{n-1} BCID).
⑧ The BS allocates a basic and a primary CID to MS/RS_n, adds it to tunnel table and encapsulates an RNG-RSP with an RS_{n-1} BCID.
⑨ The 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 look-up table, intermediate RSs add an RS_n basic and primary CID to look-up table.
⑪ Intermediate RSs send an encapsulated RNG-RSP (CID=RS_{n-1} BCID) to next node.
⑫ The RS_{n-1} decapsulates an encapsulated RNG-RSP (CID=RS_{n-1} BCID).
⑬ The RS_{n-1} sends an RNG-RSP (CID=0x0001) to the RS_n.

Table 2 MR-BS tunnel table (The case of multi-hop RS)

Destination (CID)	Tunnel (CID)
RS_1 BCID	-
RS_1 PCID	-
RS_2 BCID	RS_1 BCID
RS_2 PCID	RS_1 BCID
…	…
RS_n BCID	RS_{n-1} BCID
RS_n PCID	RS_{n-1} BCID

Table 3 RS_1 tunnel table (The case of multi-hop RS)

Destination (CID)	Tunnel (CID)
RS_2 BCID	-
RS_2 PCID	-
…	…
RS_n BCID	RS_{n-1} BCID
RS_n PCID	RS_{n-1} BCID

Table 4 RS_{n-1} tunnel table (The case of multi-hop RS)

Destination (CID)	Tunnel (CID)
RS_n BCID	-
RS_n PCID	-

After the initial ranging of multi-hop RS, Table 2 is updated by the MR-BS, the look-up table like Table 3 or Table 4 is updated by intermediate RSs.

The third case is the service flow addition.

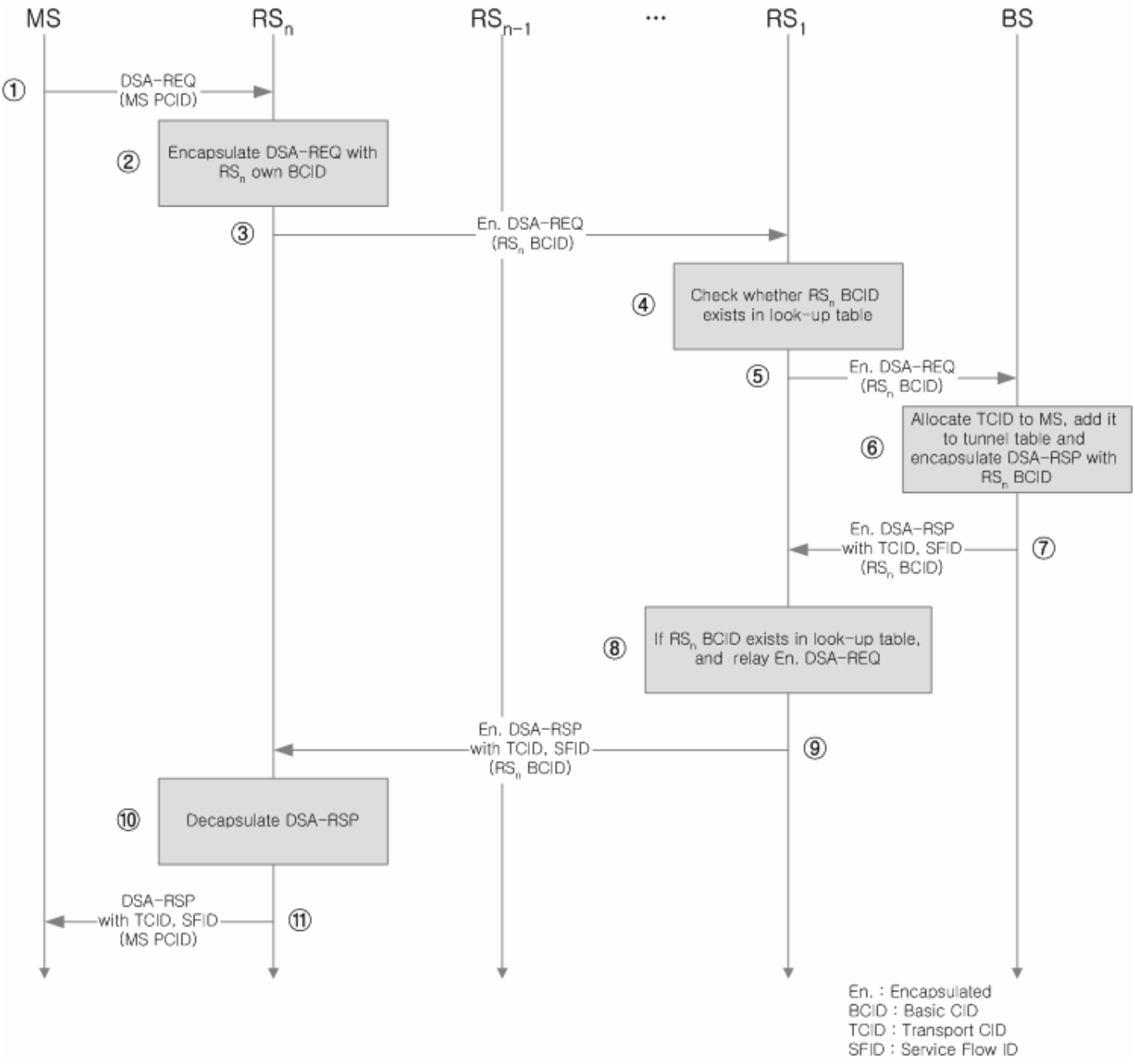

Figure 4 The procedure of multi-hop MS service flow addition

① The MS sends a DSA-REQ (CID=MS PCID).
② The RS_n encapsulates a DSA-REQ with its own basic CID.
③ The RS_n sends an encapsulated DSA-REQ (CID= RS_n BCID).
④ Intermediate RSs check whether an RS_n BCID exists in a look-up table.
⑤ Intermediate RSs relay an encapsulated DSA-REQ (CID= RS_n BCID).
⑥ The BS allocates a transport CID to MS, adds it to tunnel table and encapsulates a DSA-RSP with an R S_n BCID.
⑦ The BS sends an encapsulated DSA-RSP (CID=RS_n BCID) with an MS transport CID.
⑧ Intermediate RSs check whether RS_n BCID exists in a look-up table.

⑨ Intermediate RSs send an encapsulated DSA-RSP (CID=RS_n BCID) to next node.
⑩ The RS_n decapsulates an encapsulated DSA-RSP (CID=MS BCID).
⑪ The RS_n sends a DSA-RSP (CID=MS PCID) to the MS.

Table 5 MR-BS tunnel table (The case of multi-hop MS)

Destination (CID)	Tunnel (CID)
RS_1 BCID	-
RS_1 PCID	-
RS_2 BCID	RS_1 BCID
RS_2 PCID	RS_1 BCID
…	…
MS BCID	RS_n PCID
MS PCID	RS_n PCID
MS TCID	RS_n PCID

After the service flow addition of MS is finished, Table 5 is updated by the MR-BS.

The fourth case is the service flow deletion.

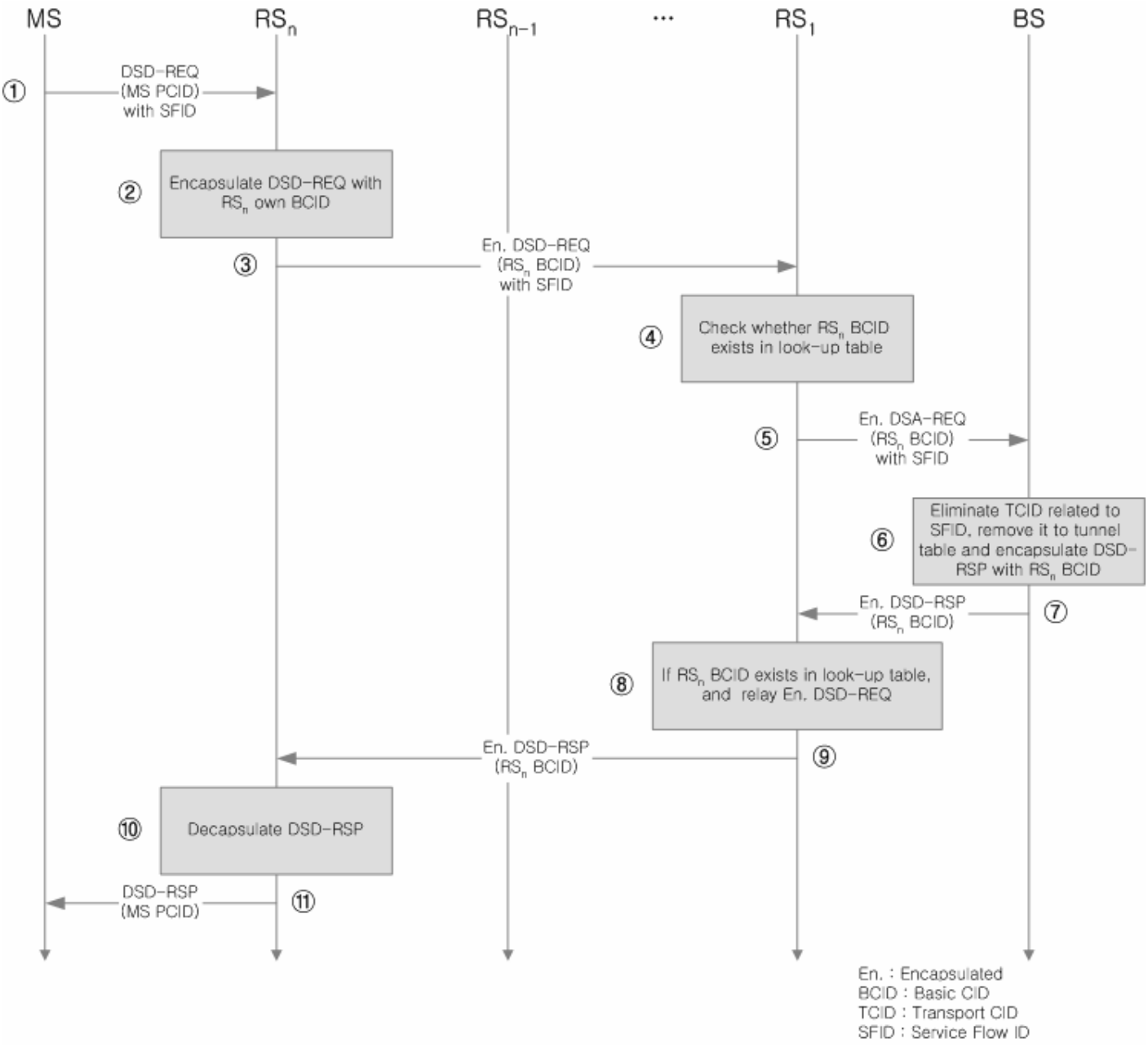

Figure 5 The procedure of multi-hop MS service flow deletion

① The MS sends a DSD-REQ (CID=MS PCID) with an SFID.
② The RS_n encapsulates a DSD-REQ with its own basic CID.
③ The RS_n sends an encapsulated DSD-REQ (CID= RS_n BCID).
④ Intermediate RSs check whether an RS_n BCID exists in a look-up table.
⑤ Intermediate RSs relay an encapsulated DSD-REQ (CID= RS_n BCID).
⑥ The BS eliminates a transport CID related to SFID, removes it from tunnel table and encapsulates a DS D-RSP with an RS_n BCID.
⑦ The BS sends an encapsulated DSD-RSP (CID=RS_n BCID).
⑧ Intermediate RSs check whether RS_n BCID exists in a look-up table.
⑨ Intermediate RSs send an encapsulated DSD-RSP (CID=RS_n BCID) to next node.

⑩ The RS_n decapsulates an encapsulated DSD-RSP (CID=MS BCID).
⑪ The RS_n sends a DSD-RSP (CID=MS PCID) to the MS.

Table 6 MR-BS tunnel table (The case of multi-hop MS)

Destination (CID)	Tunnel (CID)
RS_1 BCID	-
RS_1 PCID	-
RS_2 BCID	RS_1 BCID
RS_2 PCID	RS_1 BCID
…	…
MS BCID	RS_n BCID
MS PCID	RS_n BCID
~~MS TCID~~	~~RS_n BCID~~

After the service flow deletion of MS is finished, Table 6 is updated by the MR-BS.

The fifth case is the RS deregistration.

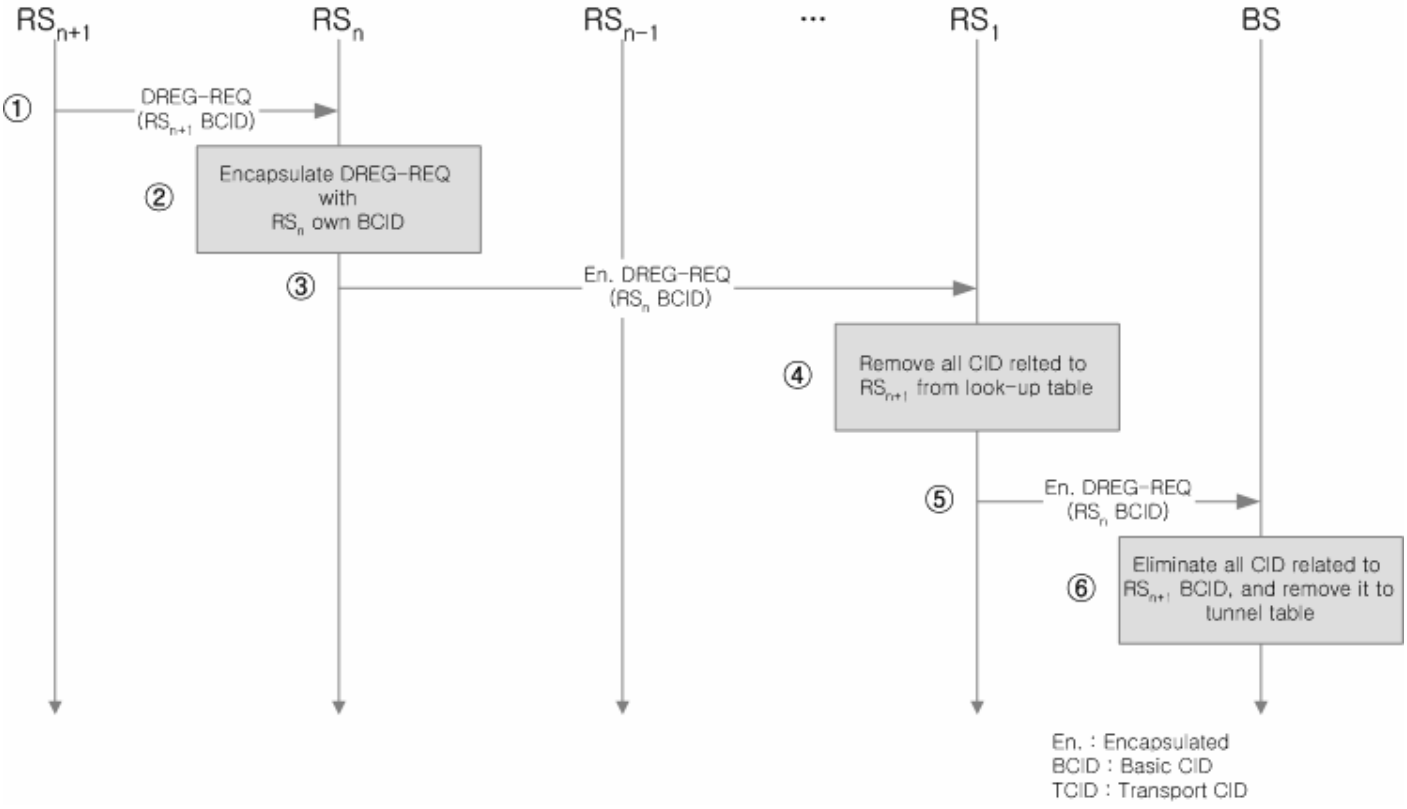

Figure 6 The procedure of multi-hop RS deregistration

① The RS_{n+1} sends a DREG-REQ (CID= RS_{n+1} BCID).
② The RS_n encapsulates a DREG-REQ with its own basic CID.
③ The RS_n sends an encapsulated DREG-REQ (CID= RS_n BCID).

④ Intermediate RSs remove all CID related to RS_{n+1} from the look-up table
⑤ Intermediate RSs relay an encapsulated DREG-REQ (CID= RS_n BCID).
⑥ The BS eliminates all CID related to RS_{n+1}, and removes it from tunnel table.

Table 7 MR-BS tunnel table (The case of multi-hop MS)

Destination (CID)	Tunnel (CID)
RS_1 BCID	-
RS_1 PCID	-
RS_2 BCID	RS_1 BCID
RS_2 PCID	RS_1 BCID
…	…
~~RS_{n+1} BCID~~	~~RS_n BCID~~
~~RS_{n+1} PCID~~	~~RS_n BCID~~
~~MS BCID~~	~~RS_{n+1} BCID~~
~~MS PCID~~	~~RS_{n+1} BCID~~

Table 8 RS_1 tunnel table (The case of multi-hop MS)

Destination (CID)	Tunnel (CID)
RS_2 BCID	-
RS_2 PCID	-
…	…
~~RS_{n+1} BCID~~	~~RS_n BCID~~
~~RS_{n+1} PCID~~	~~RS_n BCID~~

Table 9 RS_n tunnel table (The case of multi-hop MS)

Destination (CID)	Tunnel (CID)
~~RS_{n+1} BCID~~	-
~~RS_{n+1} PCID~~	-

After the deregistration of RS, Table 7 is updated by the MR-BS, and the look-up table like Table 8 or Table 9 is updated by intermediate RSs.

After tunnels are established, all the traffic to the multi-hop MS is relayed through tunnel. In this case, the traff ic is encapsulated with the extended subheader

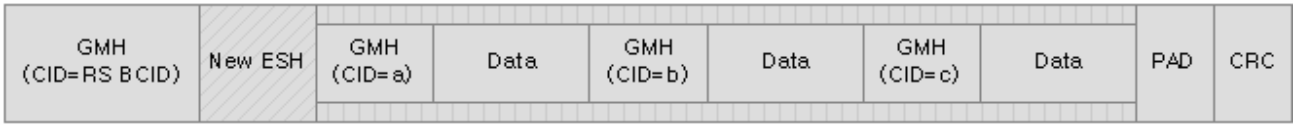

Figure 7 the example of encapsulation [2]

Proposed Text

3 Definitions

Insert new terminology as followed:

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

6.3.2.2.7 Extended subheader format

Change Table 13b as indicated:

Table 13b—Description of extended subheaders types (DL)

ES type	Name	ES body size	Description
~~6-127~~6	~~Reserved~~Encapsulation Extended Subheader	—2 bytes	—See 6.3.2.2.7.9
7-127	Reserved	—	—

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 all traffic through tunnel. This subheader is solely used, so other extended subheader and subheader shall be not followed. The format of the encapsulation subheader is as described in Table 13m.

Table 13m—Encapsulation subheader

Name	Size	Description
Message Type	2 bytes	Specify the type of message Bit #0 : RNG-REQ Bit #1 : RNG-RSP Bit #2 : DSA-REQ Bit #3 : DSA-RSP Bit #4 : DSA-ACK Bit #5 : DSC-REQ Bit #6 : DSC-RSP Bit #7 : DSC-ACK Bit #8 : DSD-REQ Bit #9 : DSD-RSP Bit #10 : DREG-CMD Bit #11 : DREG-REQ Bit #12 - #14 : Reserved Bit #15 : Traffic

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 passes via tunnel. In the tunnel, all MPDU is encapsulated with the encapsulation extended subheader.

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

In the procedure of RS initial ranging, 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 RS.
- The 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 RS, adds new entry related to the RS to the tun nel table, and sends an encapsulated RNG-RSP with the basic CID of the access RS to the RS.
- Intermediate RS(s) updates its own look-up table and relays the encapsulated RNG-RSP to the access RS.
- Access RS updates its own look-up table, decapsulates the encapsulated RNG-RSP, and sends it to the R S.

In the procedure of RS deregistration, 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 look-up table, encapsulates a DREG-R EQ with its own basic CID and sends it to the MR-BS.
- Intermediate RS(s) eliminate the entry related to the RS from its own look-up table, and relay the encaps ulated DREG-REQ to the MR-BS.
- The BS eliminates entries related to the RS from the tunnel table.

In the procedure of MS service flow addition, the node act as followed:

- The MS sends a DSA-REQ with its own basic 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 BS allocates a new transport CID to the MS, adds new entry related to the MS to the tunnel table and sends an encapsulated DSA-RSP with the basic CID of the access RS to the MS.
- Intermediate RS(s) relay the encapsulated DSA-RSP to the access RS.
- The access RS decapsulates an encapsulated DSA-RSP and sends it to the MS.

In the procedure of MS service flow deletion, nodes act as followed:

- The MS sends a DSD-REQ with its own basic CID and an SFID.
- The access RS encapsulates a DSD-REQ with its own basic 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 basic CID of the access RS to the MS.
- Intermediate RS(s) relay the encapsulated DSD-RSP to the access RS.
- The access RS decapsulates an encapsulated DSD-RSP and sends it to the MS.

10.4 Well-known addresses and identifiers

Change Table 345 as indicated:

Table 345—CIDs

CID	Value	Description
Initial Ranging for MS	0x0000	Used by MS and BS during initial ranging process.
Initial Ranging for RS	0x0001	Used by RS and BS during initial ranging process.
Basic CID	0x0001~~2~~ - m	The same value is assigned to both the DL and UL connection.

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