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| Project        | IEEE 802.16 Broadband Wireless Access Working Group < <a href="http://ieee802.org/16">http://ieee802.org/16</a> >   |  |
| Title          | MMR Network distributed tunnel connection management  |  |
| Date Submitted | 2007-03-05  |  |
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| Re:            | A response to a Call for Technical Proposal, <a href="http://www.wirelessman.org/relay/docs/80216j-07_007r2.pdf">http://www.wirelessman.org/relay/docs/80216j-07_007r2.pdf</a>  |  |
| Abstract       | This document provides text descriptions for routing and connection management sections defined in ToC of IEEE 802.16j-06/026r2   |  |

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| Purpose                      | To incorporate the proposed text into the P802.16j Baseline Document (IEEE 802.16j-06/026r1)  |
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# **MMR Network End-to-End Distributed Tunnel Connection Management**

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## **1 Introduction**

In IEEE 802.16j-06/014r1 it has defined the concepts of access link, relay link (R-link) and relay path to describe MMR network topology. These terminologies are used to support end-to-end connection management and data forwarding schema over MMR relay topology. The concept of “tunnel” has been discussed in many contributions for end-to-end data connections over R-link. This contribution focuses on how tunnel connections are handled in distributed MR cell control environment, and the tunnel connection processing related to routing path management. To enable backward compatibility and efficient multi-hop relay operations, this harmonized contribution describes the general specification for Section 6.1.1 (IEEE 802.16j-06/017-r2), “Relaying extension to MAC Common part sublayer”. The contribution covers the following text descriptions:

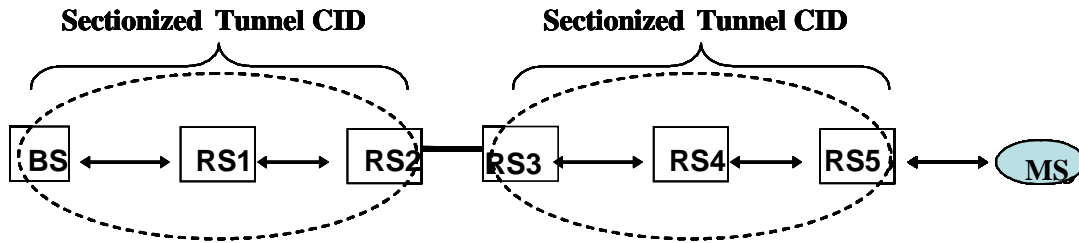
- End-to-end tunnel usage scenario with radio resource control in distributed topology schema, where the tunnel is sectionized in multiple routing domains
- Applying constraint-based routing to support sectionized tunnel to guarantee end-to-end connection integrity
- CID/Path binding operation and its application to relay data forwarding in distributed routing domains
- Path management related to MR-BS to RS connection, RS to RS connection, and RS to MS connection

This contribution proposes a suit of common relay MAC sub-layer (R-MAC) functions for relay operations.

### **Sectionized Tunnel in distributed routing domain**

In distributed routing control schema, there exist multiple routing domains. In each routing domain, the routing controller either resides on MR BS, or the RS cell head. In distributed manner, the routing path within each cell is determined individually by the routing controller with their own radio resource allocation and localized topology knowledge. In this case, the tunnel CID within each domain only has local sense for connections scoped in that domain. In distributed routing control, the end-to-end connection from BS to the designated RS is represented by the concatenation of localized tunnel CIDs, along the given path. In this scenario, when a data burst travels across the boundary of the routing domains, it has to replace the original tunnel CID by a new tunnel CID. This operation is called “tunnel CID swapping”.

The Figure 1 shows the usage of sectionized tunnel which is established across multiple routing domains.



**Figure 1.** Sectionized Tunnel usage in distributed routing domain

**Constraint-based Routing for sectionized tunnel**

Similar to globalize tunnel management, constraint-based routing is also used to support sectionized tunnel connections within distributed routing domains. In constraint-based routing, the explicit route and associated path ID are specified in signaling message such as DSx (x represents Add, Change or Delete) by BS. Different from globalize tunnel creation, in the initial explicit route, the BS only specifies its local topology, next cell routing domain boundary node and the destination node. For example, in Figure 1, BS only specifies BS—RS1—RS2—RS3—RS5 in initial explicit route. These topological nodes are pre-known to BS, but RS4 is not visible to BS as it is a local topology information of RS3 (we assume RS3 is next RS cell head). In DSA message header, the initial tunnel-end-point RS CID is the next RS cell head and the transport tunnel CID is the one BS has allocated to the next RS cell head (i.e., RS3). Upon received DSA, the RS cell head should check

whether itself is the targeted destination node (by examining the explicit route), and if it should create a new sectionized tunnel for the rest of the relay path. If it needs, the RS cell head should replace the next tunnel-end-point RS CID in generic MAC header, assign the new transport tunnel CID in DSA body, and update the explicit route in extended sub-header accordingly. RS cell head should also create a mapping relationship between the original transport tunnel CID and the newly assigned transport tunnel CID. This procedure will be repeated cell-by-cell until the destination access RS in the explicit route is reached.

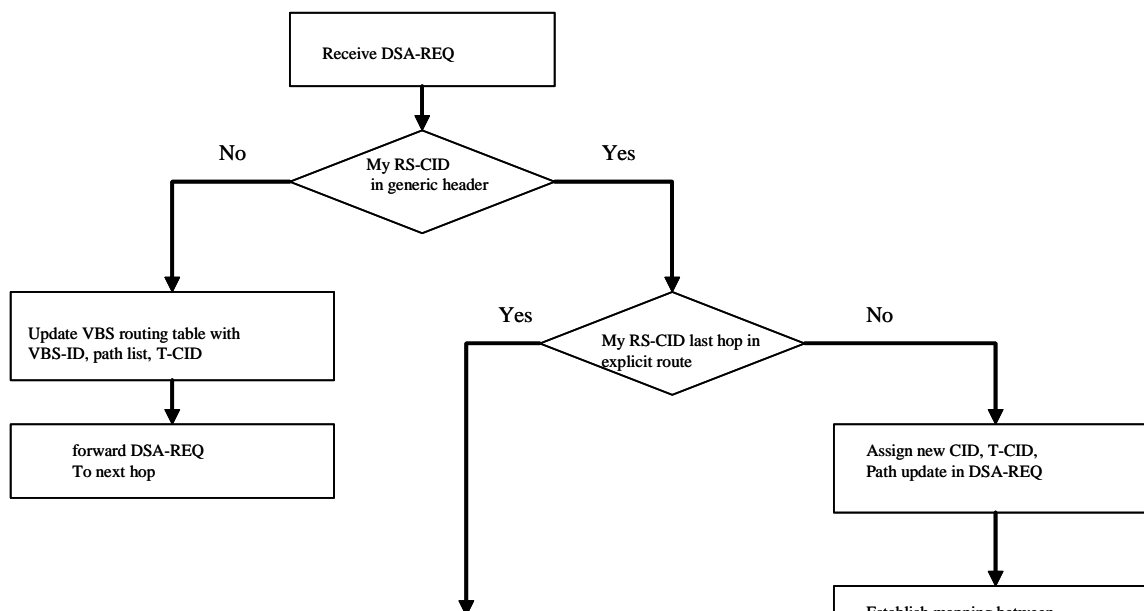
Figure 2 shows the working flow behavior at each RS which specifies how constraint-based routing is used to support end-to-end distribute connection management.

### Tunnel CID mapping between routing domains

In sectionized tunnel connection setup, the operation of CID/Path binding is similar to globalize tunnel creation. But for the received DSA-Req message, each intermediate RS has to determine if it is the tunnel-end-point of the sectionized tunnel. If it is the tunnel-end-point, then RS should further check whether itself is the last node in the explicit route or not. If not, it implies a new sectionized tunnel needs to be created. In this case, the RS should create mapping relationship between the original tunnel CID and the newly allocation tunnel CID, and assign transport tunnel CID in DSA message. RS may also expand the local route in explicit route TLV (e.g., RS4 in Fig 1), and further forward DSA to the next hop. This operation should be done hop-by-hop until the last node in explicit route is reached.

### Forwarding by sectionized tunnel CID

In this mode the tunnel CID may change from cell-by-cell (hop-by-hop) up to the final destination. The RS replaces the new CID value in the header and adapts further information fields in the header if necessary. The determination of the new CID and the type of forwarding action is done by a forwarding table lookup. As in transparent forwarding the assignment of the CID's and the binding to the per-service-flow CID has to be done in a manner that the tunnel end point can determine the mapping/aggregation between tunnel/basic CID and per-service-flow CID .



**Figure 2.** Constraint-based DSA signaling call flow for sectionized tunnel creation

## 2. Proposed text changes

+++++++ start text proposal ++++++

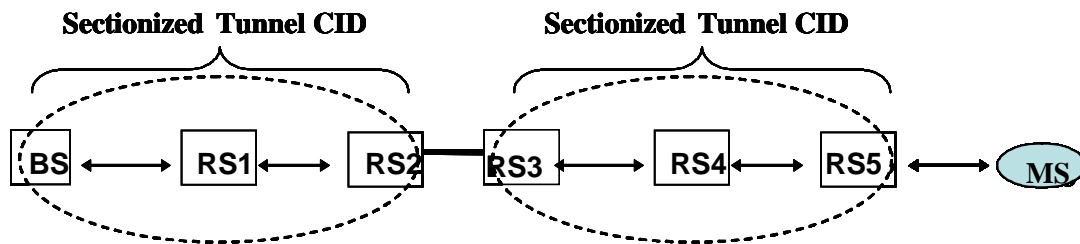
[Insert the followings after the end of section 6.3.24:]

### 6.3.25 Relay path management and routing

#### Sectionized Tunnel in distributed routing domain

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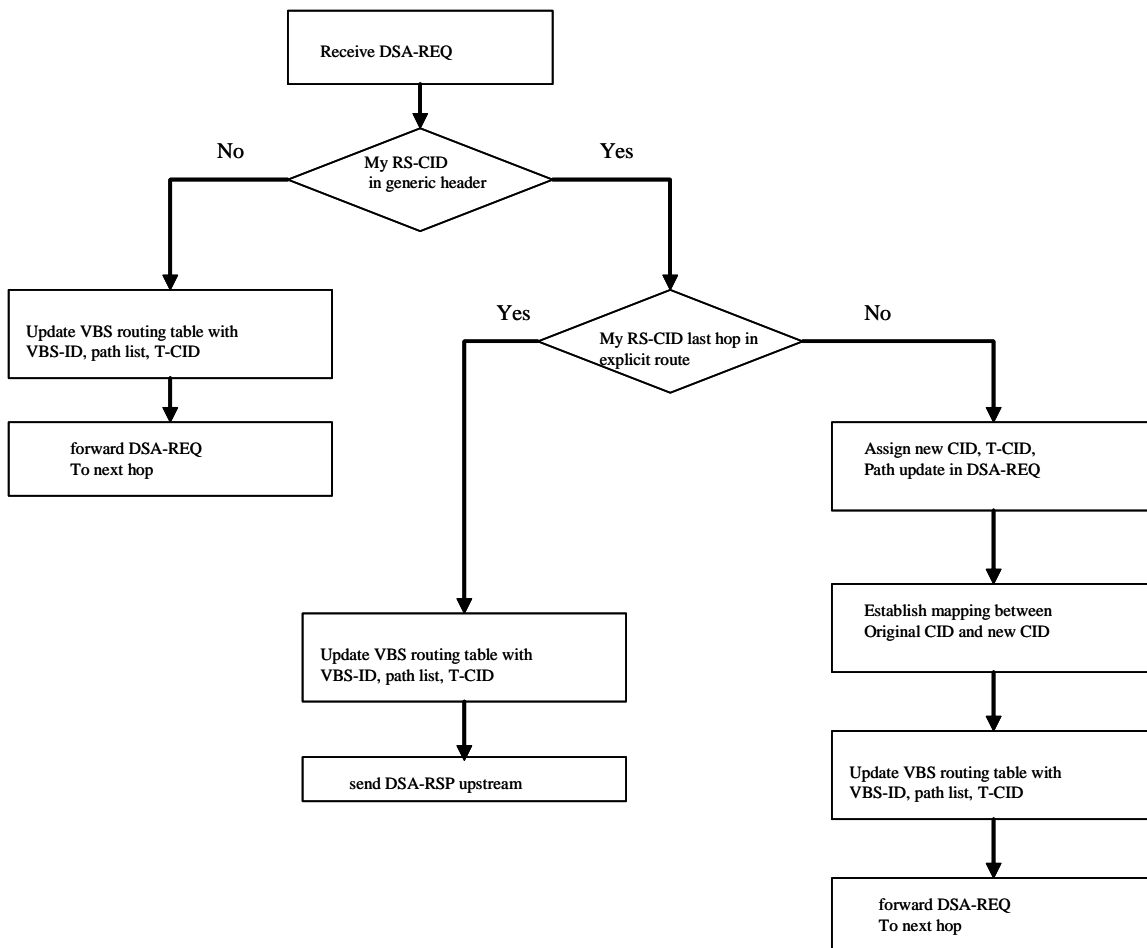
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**Figure 2.** Constraint-based DSA signaling call flow for sectionized tunnel creation

+++++ *End of text proposal* +++++