Project	IEEE 802.16 Broadband Wireless Access Working Group <**http://ieee802.org/16**>	
Title	MMR Network centralized tunnel connection management	
Date Submitted	2007-03-05	
Source(s)	G.Q. Wang, Wen Tong, Peiying Zhu Hang Zhang, David Steer, Gamini Senarath, Derek Yu, Mo-Han Fong Nortel 3500 Carling Avenue Ottawa, Ontario K2H 8E9 Erwu Liu, Dongyao Wang, Gang Shen, Kaibin Zhang, Jimin Liu, Shan Jin Alcatel Lucent, R&I Shanghai, No.388, Ningqiao Road, Shanghai, P.R.C. Torsten Fahldieck Alcatel-Lucent R&I Holderaeckerstr.35, Stuttgart, Germany	Voice: 1-613-763-1315 [mailto:wentong@nortel.com] [mailto:pyzhu@nortel.com] Voice: 86-21-50551240-8194 Fax: 96-21-50554554 {Erwu.liu, Dongyao.Wang, Gang.A.Shen, Kaibin.Zhang, Jimin.Liu, Shan.Jin} @alcatel-sbell.com.cn Voice: +4971182132163 Fax: +4971182132453 torsten.fahldieck@alcatel-lucent.de
Re:	A response to a Call for Technical Proposal, http://www.wirelessman.org/relay/docs/80216j-07_007r2.pdf	
Abstract	This document provides text descriptions for routing and connection management sections defined in ToC of IEEE 802.16j-06/026r2	

Purpose	To incorporate the proposed text into the P802.16j Baseline Document (IEEE 802.16j-06/026r1)
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>.

MMR Network End-to-End Centralized Tunnel Connection Management

G.Q. Wang, Wen Tong, Peiying Zhu, Hang Zhang, Gamini Senarath,
David Steer, Derek Yu, Mo-Han Fong

Nortel

Erwu Liu, Torsten Fahldieck, Dongyao Wang, Shen Gang, Kaibin Zhang, Jimin Liu, Shan Jin

Alcatel-Lucent

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. Tunnel management can be handled in both centralized MR cell control and distributed MR cell control environment. This contribution focuses on centralized MR cell control, 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 centralized topology schema
- In centralized routing schema, the tunnel is globalize in a single routing domain, where the end-to-end routing path is determined by BS
- Applying constraint-based routing to support globalize tunnel to guarantee end-to-end connection integrity
- CID/Path binding operation and its application to relay data forwarding
- 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.

Overview

Relay network discovery and route creation

MMR network topology is constituted by BS and set of RS and their access relationship over air links. Within a MMR cell, the topology-related operations include topology discovery, routing path creation/optimization, route population and routing maintenance caused by the topology updates (e.g., node mobility or node failure). MMR network topology provides two interfaces: the relay interface over R-link and the access interface over access link (Figure 1). A routing path is created by the radio resource manager and routing controller which resides on BS (centralized routing). A path consists of an array of relay node identifier, and it is determined in a MMR cell subject to the constraints of available radio resource within a spectrum usage domain.

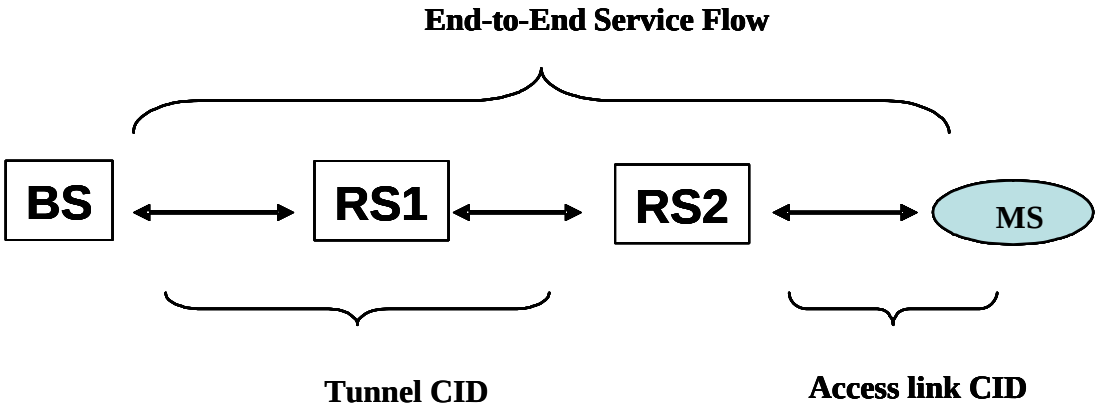

Figure 1. End-to-end Service Flow over MMR connection

MMR connectivity consists of R-link connectivity and access link connectivity, where R-link connectivity is defined as transport connections (a.k.a, Tunnel CID) over multiple R-links, and access link connectivity is defined as transport connections (a.k.a., Access CID) over access link. Tunnel CID is used to support data burst aggregation, with a coarser QoS (e.g., per-class-QoS associated with the tunnel) processing for relaying data upstream and downstream. While access link CID, as defined for MS transport CID in 802.16-2005, represents a per-flow connection with finer QoS parameters associated with each service flow. Both tunnel CID and access link CID are bounded to a given routing path. Based on the different data forwarding schema, this CID/path

binding information may be stored at different relay nodes along the path. Working together, R-link connections and access link connections provide an end-to-end connectivity to support end-to-end service flow between BS and MS.

Globalize Tunnel

In centralized routing control schema, the tunnel is created within a single routing domain. In this scenario, the routing controller resides on MR BS and the tunnel is identified by an end-to-end tunnel CID from MR BS to the designated access RS.

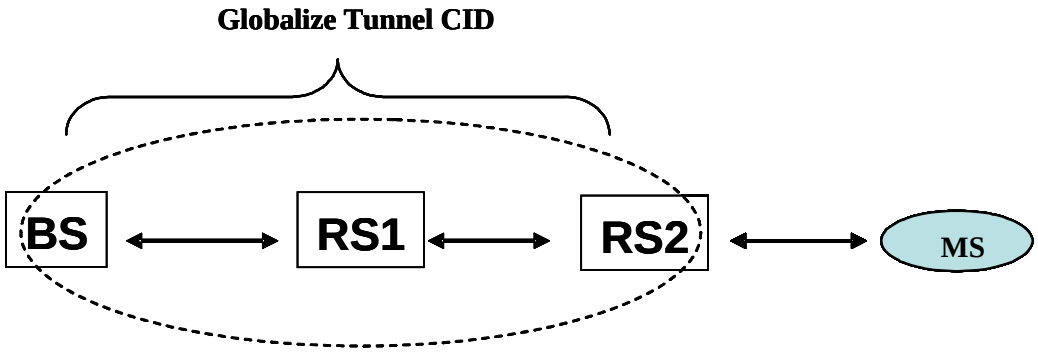

Figure 2. Globalize Tunnel CID

Constraint-based Routing and Tunnel Creation

MMR network topology is constituted by BS and set of RS and their access relationship over air links. Within a MMR cell, the topology-related operations include topology discovery, routing path creation/optimization, route population and routing maintenance caused by the topology updates (e.g., node mobility or node failure). MMR network topology provides two interfaces: the relay interface over R-link and the access interface over access link (Figure 1). A routing path is created by the radio resource manager and routing controller which either reside on BS (centralized routing) or some RS cell head (distributed routing). A path consists of an array of relay node identifier, and is determined in a MMR cell subject to the constraints of available radio resource within a spectrum usage domain.

Before path to be setup, the routing controller selects an appropriate forwarding criterion to determine a path according to the following constrains:

- QoS constrains of the connection
- Type of connection (data or management)
- Available resources in MMR cell
- Current topology of MMR cell

Constraint-based routing is used to support both globalize tunnel connections. In constraint-based routing, the explicit route and associated path ID are used in signaling message such as DSx (x represents Add, Change or Delete). A per-domain-based explicit route is an array of relay nodes and is determined by the routing controller using constraint policies. Note that in explicit route, the last node always specifies the end point of the globally end-to-end connection. When BS issues DSA-Req message to create an end-to-end tunnel with a new path, BS should put the end-to-end explicit route TLV and assigned path ID TLV in the message body. As well BS should specify the tunnel-end-point RS CID in generic MAC header, and the transport tunnel CID in DSA message body. In globalize tunnel case, the tunnel-end-point RS is the designated access RS, and the transport tunnel CID is functional to the single routing domain. Upon received DSA-Req, the RS should check whether it is the targeted destination node or not. If not, RS should conduct CID/Path binding operation (as illustrated in the following section), and further forward DSA to the next hop specified in the explicit route TLV. This procedure will be repeated hop-by-hop until the destination access RS in the explicit route is reached. The destination RS should send DSA-Rsp back to BS to confirm the establishment of the end-to-end CID/Path binding operation.

Figure 3 illustrates how explicit route, tunnel-end-point basic and transport tunnel CID to be presented in DSA signaling message MAC pdu. Figure 4 shows the working flow behavior at each RS which specifies how constraint-based routing is used to support end-to-end connection management.

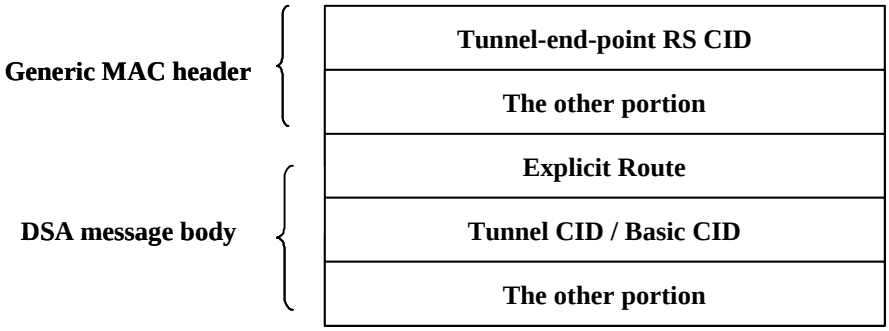

Figure 3. DSA MAC PDU format for end-to-end connection signaling

CID/Path binding operation and its application to relay data forwarding

In globalize tunnel connection, every BS and RS should store a routing table with established mapping relationship between the given path and CIDs. The operation to establish this mapping is called "CID/Path binding". DSx messages are used to support this CID/Path binding operation. As specified in previous section, DSA-REQ should include explicit route, path ID, transport tunnel CID and associated tunnel-end-point RS CID. Upon the received DSA message, the RS should determine whether it would drop, process CID/Path binding, or further forward the DSA to the next hop. If the RS is in the explicit route, RS would create a new path in routing table (if it is a new path) and establish CID/Path mapping entry and associated air interface in forwarding table. CID/Path biding operation should be done hop-by-hop until the last node in explicit route is reached.

Note that a path ID is assigned to a new path. Once a path is created, DSA can be used to re-signaling more CID/Path binding to the RS by applying path ID and associated CIDs. For all existing paths, the path ID, instead of explicit route, is used in DSx messages to coordinate path-related maintenance operations.

Transparent forwarding with globalize tunnel CID

In transparent forwarding, the tunnel CID in the data burst MAC PDU header is never changed during the forwarding processing along the path between the tunnel endpoints. The data forwarding is done at each RS by checking tunnel CID against the routing table to determine the next hop. The routing path management at the source end assigns the tunnel CID and takes care of a unanimous assignment. Furthermore the assignment of the tunnel 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 CID and per-service-flow CID .

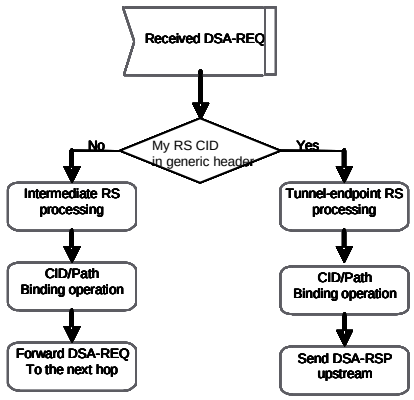

Figure 4. Constraint-based DSA signaling call flow for tunnel creation

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

Globalize Tunnel

In centralized routing control schema, the tunnel is created within a single routing domain. In this scenario, the routing controller resides on MR BS and the tunnel is identified by an end-to-end tunnel CID from MR BS to the designated access RS.

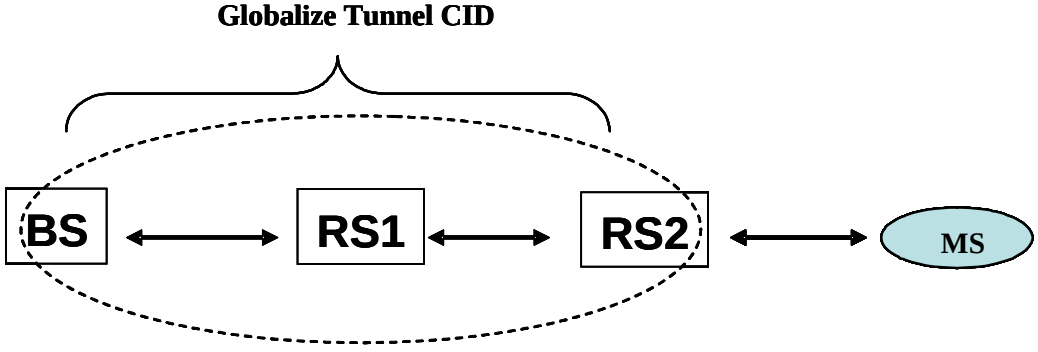

Figure 2. Globalize Tunnel CID

Constraint-based Routing and Tunnel Creation

MMR network topology is constituted by BS and set of RS and their access relationship over air links. Within a MMR cell, the topology-related operations include topology discovery, routing path creation/optimization, route population and routing maintenance caused by the topology updates (e.g., node mobility or node failure). MMR network topology provides two interfaces: the relay interface over R-link and the access interface over access link (Figure 1). A routing path is created by the radio resource manager and routing controller which either reside on BS (centralized routing) or some RS cell head (distributed routing). A path consists of an array of relay node identifier, and is determined in a MMR cell subject to the constraints of available radio resource within a spectrum usage domain.

Before path to be setup, the routing controller selects an appropriate forwarding criterion to determine a path according to the following constrains:

- QoS constrains of the connection
- Type of connection (data or management)
- Available resources in MMR cell
- Current topology of MMR cell

Constraint-based routing is used to support both globalize tunnel connections. In constraint-based routing, the explicit route and associated path ID are used in signaling message such as DSx (x represents Add, Change or

Delete). A per-domain-based explicit route is an array of relay nodes and is determined by the routing controller using constraint policies. Note that in explicit route, the last node always specifies the end point of the globally end-to-end connection. When BS issues DSA-Req message to create an end-to-end tunnel with a new path, BS should put the end-to-end explicit route TLV and assigned path ID TLV in the message body. As well BS should specify the tunnel-end-point RS CID in generic MAC header, and the transport tunnel CID in DSA message body. In globalize tunnel case, the tunnel-end-point RS is the designated access RS, and the transport tunnel CID is functional to the single routing domain. Upon received DSA-Req, the RS should check whether it is the targeted destination node or not. If not, RS should conduct CID/Path binding operation (as illustrated in the following section), and further forward DSA to the next hop specified in the explicit route TLV. This procedure will be repeated hop-by-hop until the destination access RS in the explicit route is reached. The destination RS should send DSA-Rsp back to BS to confirm the establishment of the end-to-end CID/Path binding operation.

Figure 3 illustrates how explicit route, tunnel-end-point basic and transport tunnel CID to be presented in DSA signaling message MAC pdu. Figure 4 shows the working flow behavior at each RS which specifies how constraint-based routing is used to support end-to-end connection management.

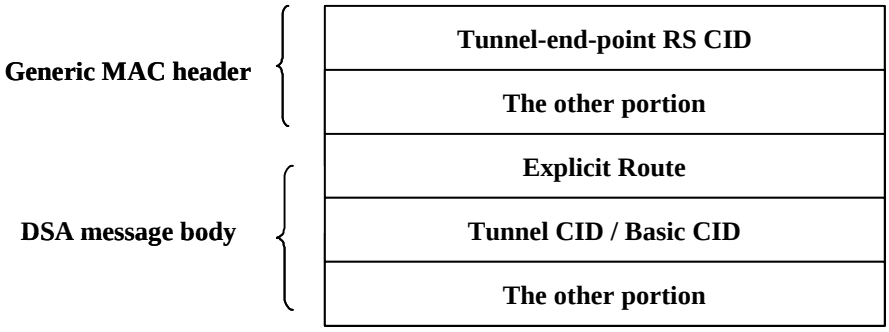

Figure 3. DSA MAC PDU format for end-to-end connection signaling

CID/Path binding operation and its application to relay data forwarding

In globalize tunnel connection, every BS and RS should store a routing table with established mapping relationship between the given path and CIDs. The operation to establish this mapping is called “CID/Path binding”. DSx messages are used to support this CID/Path binding operation. As specified in previous section,

DSA-REQ should include explicit route, path ID, transport tunnel CID and associated tunnel-end-point RS CID. Upon the received DSA message, the RS should determine whether it would drop, process CID/Path binding, or further forward the DSA to the next hop. If the RS is in the explicit route, RS would create a new path in routing table (if it is a new path) and establish CID/Path mapping entry and associated air interface in forwarding table. CID/Path biding operation should be done hop-by-hop until the last node in explicit route is reached.

Note that a path ID is assigned to a new path. Once a path is created, DSA can be used to re-signaling more CID/Path binding to the RS by applying path ID and associated CIDs. For all existing paths, the path ID, instead of explicit route, is used in DSx messages to coordinate path-related maintenance operations.

Transparent forwarding with globalize tunnel CID

In transparent forwarding, the tunnel CID in the data burst MAC PDU header is never changed during the forwarding processing along the path between the tunnel endpoints. The data forwarding is done at each RS by checking tunnel CID against the routing table to determine the next hop. The routing path management at the source end assigns the tunnel CID and takes care of a unanimous assignment. Furthermore the assignment of the tunnel 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 CID and per-service-flow CID .

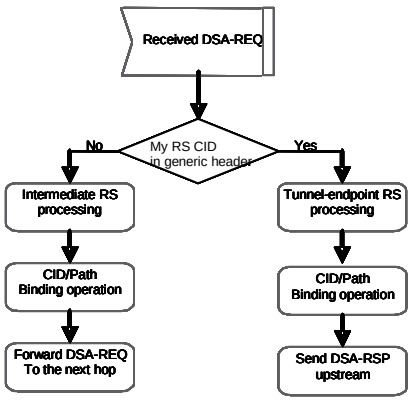

Figure 4. Constraint-based DSA signaling call flow for tunnel creation

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