Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Proposal on addresses, identifiers and types of connections for 802.16j
Date Submitted	2006-11-07
Source(s)	Jerry Sydir Kerstin Johnsson Hannah Hyunjeong Lee Wendy C Wong Sungjin Lee Hyunjeong Kang Hyoungkyu Lim Jungje Son Kenji Saito, Haruki Izumikawa, Takashi Inoue, Keizo Sugiyama	Intel Corporation 2200 Mission College Blvd., Santa Clara, CA 95054, USA. jerry.sydir@intel.com Samsung Electronics Voice:　+82 31 279 5248 Fax:　　+82 31 279 5130 steve.lee@samsung.com KDDI R&D Laboratories Inc. Hikarino-oka 7-1, Yokosuka, Kanagawa 239-0847, Japan Voice: +81 46 847 6347 Fax:　　+81 46 847 0947 saito@kddilabs.jp
Re:	Call for Technical Proposals (IEEE 802.16j-06/027)
Abstract	In this contribution we specify the addresses, identifiers and types of connections that we propose for 802.16j networks.
Purpose	This contribution is submitted for discussion and adoption in 802.16j.
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>.

Proposal on addresses, identifiers and types of connections for 802.16j

Introduction

This contribution describes a proposal on the types of connections, addresses, and identifiers in a multihop relay network. The proposal defines the identifiers to be used in the network and specifies the messages in which they are used. It specifies the different types of management connections in an 802.16j network. It proposes the use of tunnel connections to simplify handover of Mobile Relay Stations (MRSs).

Addresses Identifiers in 802.16j

In this section we describe the types of identifiers we propose for 802.16j:
- Relay Station Identifier (RS ID) – 48-bit identifier whose format is the same as the Base Station Id (BS ID); assigned from the same space as the BS IDs (See section 6.3.2.3.2 of 802.16e-2005 for the definition of BS ID)

- MR-BS Identifier – Same as BS ID

- Service Flow Identifier (SFID) – the 32-bit SFID is applicable to two types of service flows:

  o Service flows between an MR-BS and MS. The SFID uniquely identifies a service flow to the MS.

  o Tunnels comprised of one or more service flows between an MR-BS and RS (see section 0 for details).

- Connection Identifier (CID) – the CID defined in section 3.13 of 802.16-2004 is applicable to three types of connections:

  o Management and transport connections between the MR-BS and MS. These connections may traverse 0 or more RSs.

  o Management connections between the MR-BS and RSs and between RSs.

  CIDs are unique within an MR cell. The size of the CID is the same as in 802.16e (16 bits).

- T-CID(Tunnel CID) - A unique identifier taken from the connection identifier (CID) address space that uniquely identifies tunnel connections between the MMR-BS and RSs. All packets sent through a tunnel use the T-CID in their header.

Management Connections

Management connections are established between the MR-BS and MS (as defined in the 802.16e standard). These include basic, primary and secondary connections (CIDs). Basic, primary, and secondary connections are also established between the MR-BS and RSs within the MR-cell. Finally, basic and primary management connections are established between RSs that are adjacent in the topology. Figure 1 shows the different participants in management connections.
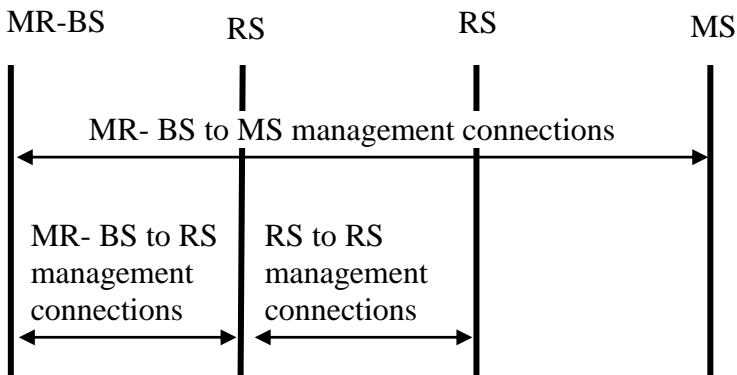
Figure 1 Management Connections

Tunnels and Encapsulation

Tunnel Connections

We propose the definition of a new type of connection called a tunnel connection. A tunnel connection is a unidirectional connection between the MR-BS and an RS (in either direction) that is used to carry MPDUs from a set of service flows assigned to traverse the tunnel. Each tunnel is assigned a Service Flow identifier (SFID) and a Tunnel-connection identifier (T-CID). The SFID uniquely identifies the tunnel and its QoS parameters. The Tunnel-CID is assigned in the same way as CIDs are assigned to service flows and is drawn from the same space as CIDs assigned to individual service flow, however, a specific range of CIDs is assigned to indicate the connection is for tunnel.

A service flow established between the MR-BS and MS may traverse a tunnel between the MR-BS and the Access RS. (The access RS is the RS with which the MS communicates over an access link). A service flow which traverses a tunnel is assigned an SFID and a CID, as specified in 802.16e. In addition, the QoS parameters of the service flow are included in the QoS parameters of the tunnel. The QoS parameters of the tunnel are an aggregate of the QoS parameters of the service flows that have been assigned to traverse the tunnel.

When a new service flow is created, the MR-BS or access RS determines whether the service flow should traverse a tunnel that exists between them (if such a tunnel has been established). If the service flow is to traverse the tunnel, the MR-BS or Access RS modifies the QoS parameters of the tunnel to include QoS requirements of the service flow. The QoS parameters of both the tunnel and service flow are sent as part of the connection setup messages (DS* messages). The Access RS and MR-BS use the QoS parameters of both the individual service flow and the tunnel in performing admission control and resource reservation, while intermediate RSs traversed by the tunnel, may ignore the QoS parameters of the individual service flows.

We propose two types of tunnels, one for carrying MPDUs from management connections and one for carrying MPDUs from transport connections. More than one tunnel connection can be created between the MR-BS and a given RS in the MR-Cell. It is likely that separate tunnels will be created for different service classes in order to enable more precise QoS treatment of tunneled packets.
Figure 2 shows an example where four connections (each to a different MS) are supported via a tunnel between the MR-BS and the access RS.

For tunnels that carry MPDUs from management connections, T-CIDs are assigned during the Network Entry process using the REG-RSP or SBC-RSP messages. Tunnels that carry MPDUs from transport connections are established using the DSA* messages. These tunnels can be established during network entry as after the RS has entered the network.
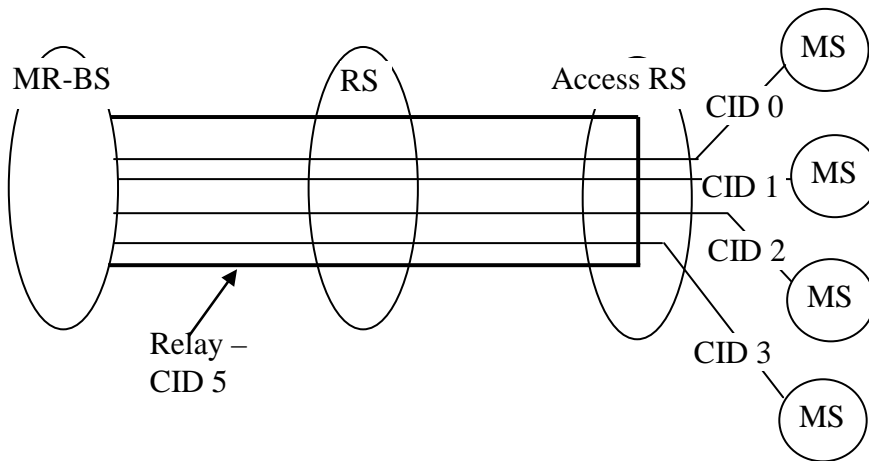
Figure 2 Example of a Tunnel

Packets that traverse a tunnel are encapsulated in a new type of header which carries the T-CID of the tunnel. This new header along with the encapsulated MPDUs is called a tunnel packet. Multiple MPDUs from connections that traverse the tunnel can be combined into a tunnel packet for transmission. The station at the ingress of the tunnel is responsible for encapsulating the MPDUs into tunnel packets, and the station at the egress of the tunnel is responsible for removing the tunnel header and forwarding the encapsulated MPDUs based on their individual CIDs. Stations through which a tunnel traverses simply forward the tunnel packets based on the T-CID in the tunnel header. Figure 3 shows an example tunnel packet based on the tunnel and individual CIDs shown in Figure 2. Two MPDUs from CID 0, one MPDU from CID2, and one MPDU from CID 3 are encapsulated into a tunnel packet.

Tunnel Header T-CID = 5	MPDU CID = 0	MPDU CID = 0	MPDU CID = 2	MPDU CID = 3

Figure 3 Example Tunnel Packet

MRS handover is one example of a process in which tunnels can improve efficiency. If individual CIDs are used to perform routing/forwarding of all connections passing through the MRS, RSs in the MR cell will have to modify the routing/forwarding table entries for every connection that they support. This could potentially be a large number of entries. However, if the individual connections passing through the MRS are transported through a tunnel connection, then only the tunnel connection needs to be reestablished as part of the handover procedure.

Encapsulation of Management Messages

In 802.16e, the BS and MS establish basic, primary and optionally secondary management connections used to exchange different types of management messages. In 802.16j, the management messages sent between the MR-BS and MS will potentially traverse one or more RSs.

For some management messages sent from the MS to the MR-BS or vice versa, the RSs will simply relay them as they would any other data. In this case, the management message is sent by the MR-BS or MS on the appropriate management connection (CID) that has been established between the MR-BS and MS. The RSs simply forward the MPDUs per their forwarding tables.

There will also be management messages sent between the MR-BS and MS that the RSs will need to process before they forward them. For these types of messages we propose that encapsulation be used to indicate to intermediate RSs that they need to process the message before forwarding it. At each hop that terminates at an RS, the message is encapsulated into a second header containing the CID of the management connection specified for the link between the current and next station in the preferred path.

In Figure 4 we provide a simple example. A message from the MS to the MR-BS is transmitted by the MS on one of its management connections (CID 1 in the figure). RS2 receives the message, decodes it, and determines that it is the type of message that needs to be processed by each hop. RS2 encapsulates the message and sends it on CID 3 RS1 receives it, decapsulates and decodes it, performs the necessary processing, and encapsulates it for transmission to the MR-BS over the connection with CID 2.
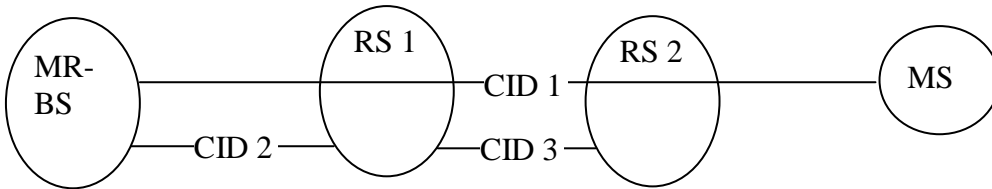

Figure 4 Example management connections

MPDU Headers

The MPDU format cannot be changed since there is a backwards compatibility requirement for the MS.
A new header used in tunnel packets is defined. This header contains a CID which identifies the tunnel itself. This header is created and removed by the MR-BS and RS and is never seen by the MS, so it does not violate backwards compatibility constraints. The definition of this header is left for further study.

Proposed Changes

[Insert the following text into section 6.3.1.3]
Addressing and connections as perceived by the SS/MS are defined in the same manner as in the PMP mode. Please refer to section 6.3.1.1 for the specification. This section specifies the additional addressing and connection definitions that apply to relay functions. Each air interface in the RS shall have a 48-bit universal MAC address, as defined in IEEE Std 802®-2001. This address uniquely defines the air interface of the RS from within the set of all possible vendors and equipment types. It is used during the initial ranging process to establish the appropriate connections for an RS. It is also used as part of the authentication process by which the MR-BS and RS each verify the identity of the other.

RSs that broadcast a preamble, FCH, and DL Map shall be assigned a unique Base Station ID. The format of the Base Station ID is defined in section 6.3.2.3.2.

In MR networks, connections can span multiple hops. Connections shall be identified by the connection ID (CID) as specified in section 6.3.1.1. CIDs are unique within an MR cell. In MR networks all connection types specified in PMP mode shall be supported between the MR-BS and MS. In MR networks, these connections may pass through one or more RSs.

Basic and primary management connections shall be established between the MR-BS and all RSs within the MR cell. A secondary management connection may be established between the MR-BS and RSs within the MR cell. These connections shall be used for the exchange of management messages between the MR-BS and RS and may pass through one or more intermediate RSs.

Basic and primary management connections shall be established between RSs which are adjacent in the MR cell topology. RSs are considered adjacent if they are directly connected via a relay link. These connections shall not pass through any intermediate RSs. Bearer or data services shall never be transferred on the basic, primary, or secondary management connections.

An additional type of connection called a tunnel connection may be established between the MR-BS and an RS. Tunnel connections shall be identified using the T-CID. Tunnel connections shall be used for transporting MPDUs from one or more connections that terminate in the MR-BS and pass through the RS. Tunnel connections may pass through one or more intermediate RSs. There shall be

two types of tunnel connections. Management tunnel connections shall be used for transporting MPDUs from management (basic, primary, or secondary) connections. Management tunnel connections shall not be used to transport MPDUs from transport connections. Transport tunnel connections shall be used for transporting MPDUs from transport connections. Transport tunnel connections shall not be used to transport MPDUs from management connections.

[Insert the following text into section 6.3.2.3 immediately before the start of section 6.3.2.3.1]
In MR networks, some management messages sent between the MR-BS and MS and between the MR-BS and RS shall be transported over management connections established between adjacent RSs along the path to the destination.

[Insert the following text at the end of section 6.3.14.2]
In MR networks, a service flow may traverse one or more RSs.

[Add following text into section 3]
3.89 T-CID(**Tunnel CID**) : A unique identifier taken from the connection identifier (CID) address space that uniquely identifies Tunnel connections between the MR-BS and RSs. All packets sent through a tunnel use the T-CID in their header..

[Add following new CID into table 345-CIDs in section 10.4]
Table 345—CIDs

CID	Value	Description
Initial Ranging	0x0000	Used by SS and BS during initial ranging process.
Basic CID	0x0001 - *m*	The same value is assigned to both the DL and UL connection.
Primary management	*m*+1 - 2*m*	The same value is assigned to both the DL and UL connection.
Tunnel CID	2*m*+1 – n	Used by MMR-BS or RS for tunneling packets.
Transport CIDs, Secondary Mgt CIDs	*n*+1 - FE9F	For the secondary management connection, the same value is assigned to both the DL and UL connection.
Multicast CIDs	0xFEA0 - 0xFEFE	For the downlink multicast service, the same value is assigned to all MSs on the same channel that participate in this connection.
AAS initial ranging CID	0xFEFF	A BS supporting AAS shall use this CID when allocating a an ASS AAS Initial Ranging period (using AAS Ranging Allocation IE)
Multicast polling CIDs	0xFF00 - 0xFFF9	A BS may be included in one or more multicast polling groups for the purposes of obtaining bandwidth via polling. These connections have no associated service flow.
Normal mode multicast CID	0xFFFA	Used in DL-MAP to denote bursts for transmission of DL broadcast information to normal mode MS.
Sleep mode multicast CID	0xFFFB	Used in DL-MAP to denote bursts for transmission of DL broadcast information to Sleep mode MS. May also be used in MOB_TRF-IND messages.

Idle mode multicast CID	0xFFFC	Used in DL-MAP to denote bursts for transmission of DL broadcast information to Idle mode MS. May also be used in MOB_PAG-ADV messages.
Fragmentable Broadcast CID	0xFFFD	Used by the BS for transmission of management broadcast information with fragmentation. The fragment sub header shall use 11-bit long FSN on this connection.
Padding CID	0xFFFE	Used for transmission of padding information by SS and BS.
Broadcast CID	0xFFFF	Used for broadcast information that is transmitted on a downlink to all SS.

[Add following text into new section 6.3.3.8]
6.3.3.8 MMR construction and transmission of MAC PDUs
MPDUs from connections that traverse a tunnel are encapsulated in an MPDU header which carries the T-CID of the tunnel. This header along with the encapsulated MPDUs is called a tunnel packet. Multiple MPDUs from connections that traverse the tunnel can be concatenated into a tunnel packet for transmission. The station at the ingress of the tunnel is responsible for encapsulating the MPDUs into tunnel packets, and the station at the egress of the tunnel is responsible for removing the tunnel header and forwarding the encapsulated MPDUs based on their individual CIDs. Stations through which a tunnel traverses may forward the tunnel packets based on the T-CID in the tunnel header.

[Add following new section11.20.x Relay transport CID]

11.20.x Tunnel CID

For RS supporting Tunnel CID, the Tunnel CID is assigned in REG-RSP messages by the Serving BS.

Type	Length (byte)	Value	Scope
Xx	2	Tunnel CID allocated to the RS	REG-RSP

[Insert the following text at the end of section 6.3.14]
6.3.14.10 Tunnel Service Flows
In MR networks, a tunnel connection may be established to carry MPDUs from individual service flows. A tunnel connection is a unidirectional connection between the MR-BS and an RS (in either direction) that is used to carry MPDUs from a set of service flows assigned to traverse the tunnel. Each tunnel shall be assigned a Service Flow identifier (SFID) and a connection identifier (CID). The SFID is 32 bits and uniquely identifies the tunnel and its QoS parameters within the MR Cell. The CID is assigned in the same way as CIDs are assigned to service flows and is drawn from the same space as CIDs assigned to individual service flow, however, a specific range of CIDs is assigned to support tunnels.

A service flow established between the MR-BS and MS may traverse a tunnel between the MR-BS and the Access RS. (The access RS is the RS with which the MS communicates over an access link). A service flow which traverses a tunnel shall be assigned an SFID and a CID, as specified in sections 6.3.14.1 through 6.3.14.9. In addition, the QoS parameters of the service flow are included

in the QoS parameters of the tunnel. The QoS parameters of the tunnel are an aggregate of the QoS parameters of the service flows that have been assigned to traverse the tunnel.

When a new service flow is created, the MR-BS or access RS determines whether the service flow should traverse a tunnel that exists between them (if such a tunnel has been established). If the service flow is to traverse the tunnel, the MR-BS or Access RS modifies the QoS parameters of the tunnel to include QoS requirements of the service flow. The QoS parameters of both the tunnel and service flow are sent as part of the connection setup messages (DS* messages). The Access RS and MR-BS use the QoS parameters of both the individual service flow and the tunnel in performing admission control and resource reservation, while intermediate RSs traversed by the tunnel, may ignore the QoS parameters of the individual service flows.