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| *Project* | ***IEEE 802.16j Mobile Multihop Relay Task Group*** | |
| *Title* | ***Enabling MAC tunneling over HARQ in 802.16j*** | |
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| *Re:* | *Response to the call for technical proposal regarding IEEE Project 802.16j (i.e., IEEE 802.16j-06/034, "Call for Technical Proposals regarding IEEE Project P802.16j", December 12, 2006).* | |
| *Abstract* | *This contribution describes essential mechanisms that enable MAC tunneling over HARQ for 802.16j.* | |
| *Purpose* | *To adopt the mechanisms proposed herein into IEEE 802.16j.* | |
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# Enabling MAC Tunneling over HARQ in 802.16

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## 1. Introduction

This contribution proposes essential mechanisms to enable MAC tunneling over HARQ in 802.16j networks.

- A tunnel MAC header shall be appended when tunneling has to operate above HARQ.
- SDU sequence number (SN) extended subheader shall be inserted immediately after the tunnel MAC header to address the potential out-of-order data delivery problem at HARQ.
- Proper form of the tunnel CID shall be used in reduced CID (RCID) field for HARQ.

## 1.1 Tunnel CID (T-CID)

As shown in Figure 1, a tunnel may be established between an MR-BS and an access RS to facilitate traffic handling.

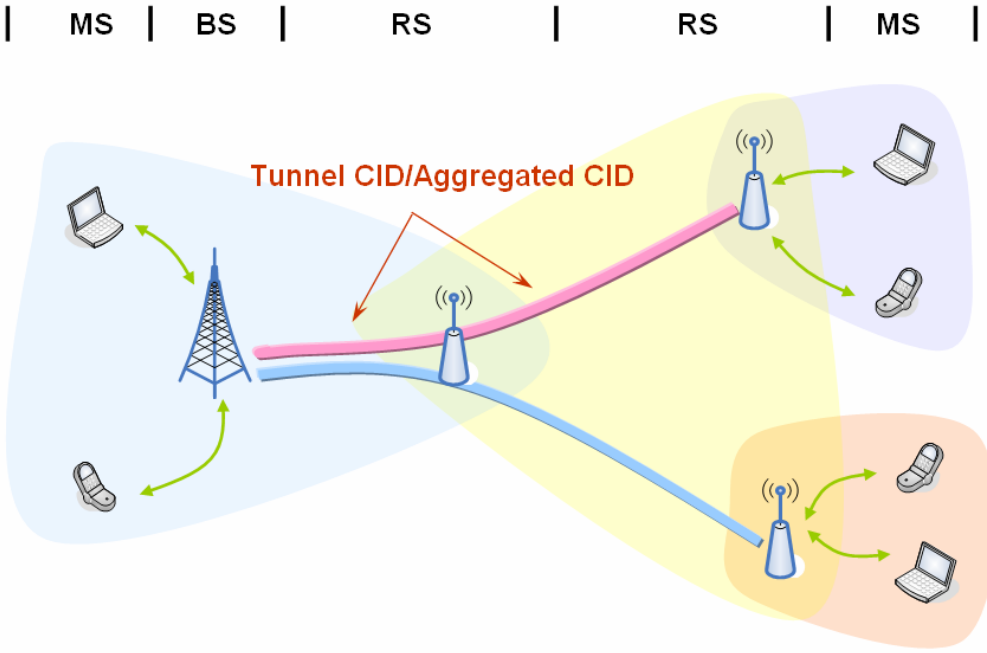


**Figure 1: An illustration of MAC tunneling in an MMR network.**

One or multiple individual MAC connection can be contained in a MAC tunnel connection, which essentially forms a unique mapping between the tunnel MAC connection and the multitude of individual MAC connections. MAC PDUs belonging to those individual MAC connection are transported in such a MAC tunnel. RS(s) between the MR-BS and the access RS forward the MPDUs of these constituent MAC connection, as illustrated in Figure 2.

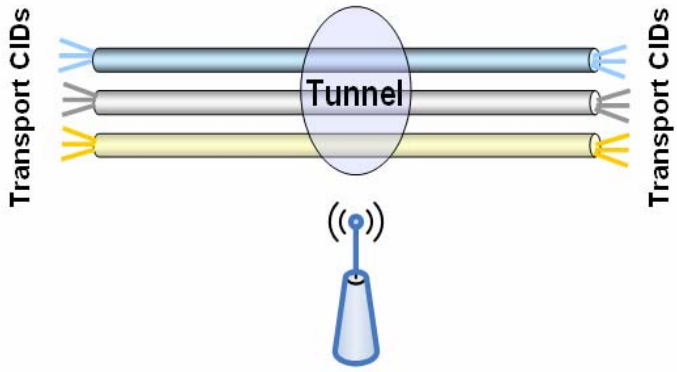


**Figure 2: Forwarding at RS.**

## 1.2 Tunnel Connection Identification in HARQ

The MAC at MR-BS and access RS aggregate multiple transport CIDs into a single tunnel connection, which is uniquely identified by a tunnel connection identifier (T-CID). When handled by HARQ, the MAC tunnel shall be perceived as a single connection. Thus, it is a natural solution to use the proper form of T-CID in the reduced CID (RCID) field. Figure 3**Error! Reference source not found.** illustrates the connection mapping relation in the MMR network.

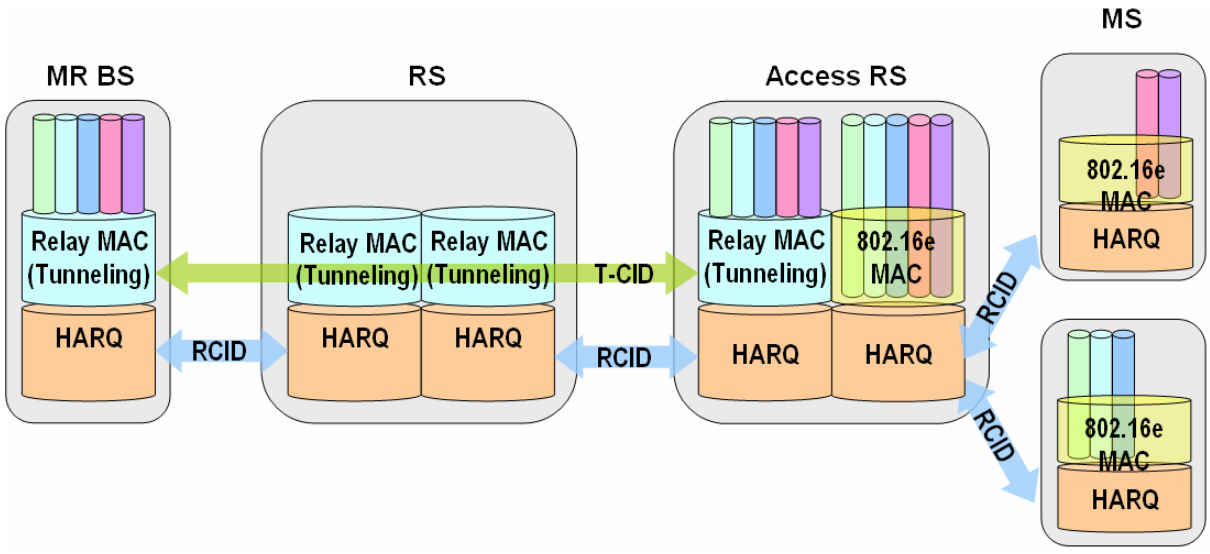


**Figure 3: Connection mapping – an end-to-end approach.**

## 1.3 Tunnel Packet Ordering in HARQ

To construct a tunnel packet, MPDUs belonging to individual constituent MAC connection can be concatenated. As an alternative, a tunnel packet can be formed by appending a MAC header in front of the concatenation, which is sometimes called encapsulation [1].

Unfortunately, without proper measure, out-of-order data delivery may occur, when multiple HARQ channels are used to transport a tunnel packet. To address this problem, a PDU sequence number (SN) extended subheader shall be inserted in front of the concatenated MPDUs. To make the resultant packet syntaxically complete, a MAC header shall also be appended before the PDU SN extended subheader, as shown in Figure 4. In another word, tunneling packet should be constructed by using encapsulation, and the PDU SN extended subheader should be inserted between the MAC header and concatenated MPDUs, if tunneling packet will be processed by HARQ. With the PDU SN extended subheader, HARQ receiver then can recover the data in the correct order before delivering them to the MAC layer.

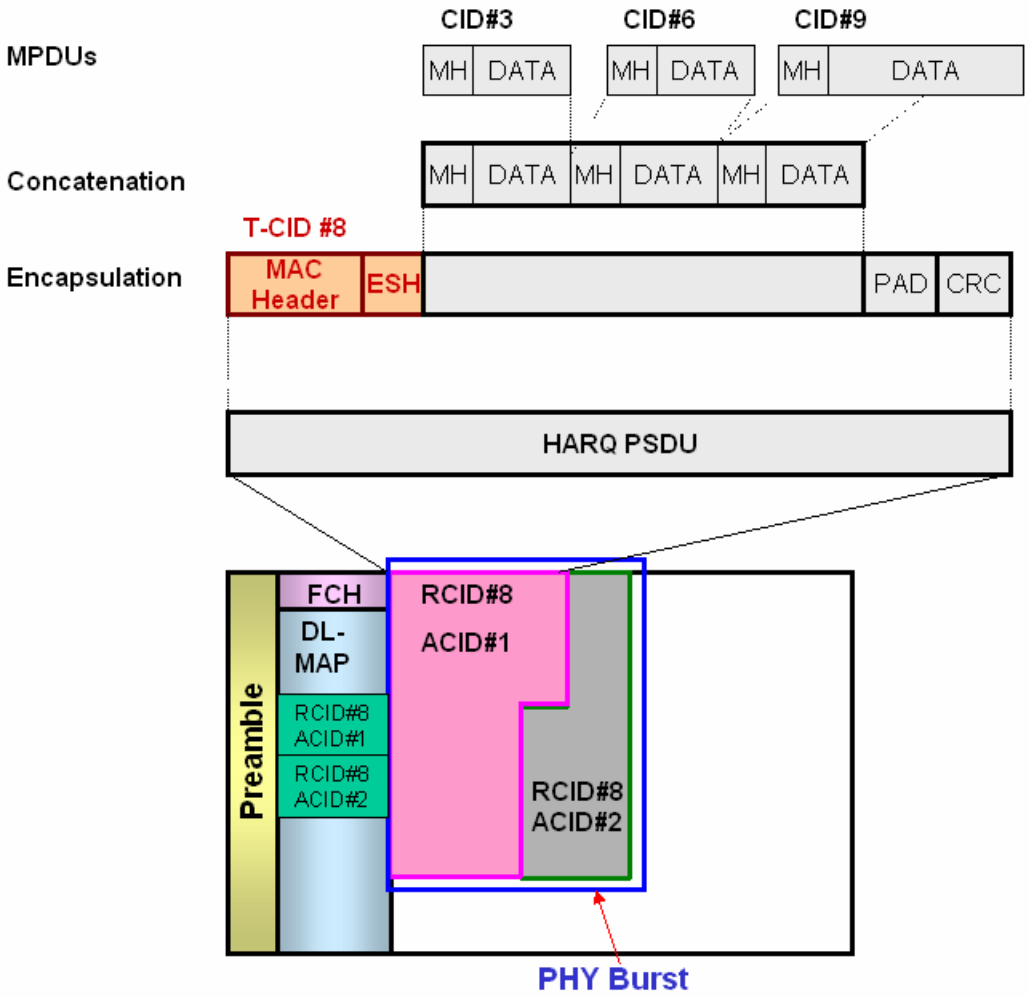


**Figure 4: PDU SN extended subheader.**

## 2. Proposed Text Changes

***6. MAC common part sublayer***

*[Add following text into new section 6.3.3.8]*

***6.3.3.8 MMR construction and transmission of Tunneling MAC PDUs***

*[Insert the following text]*

*If a tunnel MAC PDU will be processed by HARQ, the tunnel MAC PDU shall contain a MAC header and a PDU SN extended subheader.*

***8. PHY***

***8.4.5.3.21 HARQ DL MAP IE***

*[Change the description in this subclause as follows:]*

Each HARQ Map IE and sub-burst IE shall be nibble-aligned. When there is an if-else clause, regardless of whether the 'if' clause or the 'else' clause is executed, the resulting Map IE shall be nibble-aligned. When there is a loop, nibble-alignment shall be required before the loop starts and inside the loop.

*If MAC tunneling is used, a proper form of tunnel CID should be used as RCID in the related DL HARQ sub-burst IE for the corresponding burst*.

***8.4.5.4.24 HARQ UL MAP IE***

*[Change the description in this subclause as follows:]*

The HARQ UL MAP IE defines one or more bursts. Each burst is separately encoded.

*If MAC tunneling is used, a proper form of tunnel CID should be used as RCID in the related UL HARQ sub-burst IE for the corresponding burst*.

***11 TLV Encodings***

***11.13.36 PDU SN extended subheader for HARQ reordering***

*[Change the description in this subclause as follows:]*

This TLV is valid only in HARQ enabled connection. It specifies whether PDU SN extended subheader should be applied by the transmitter on every PDU on this connection. *The PDU can be tunneling MAC PDU. If the PDU in tunnel CID is a MPDU concatenation, a MAC header should be placed in front of the PDU SN extended subheader.* This SN may be used by the receiver to ensure PDU ordering.

## 3. References

[1] Jerry Sydir, et al. “Proposal on addresses, identifiers and types of connections for 802.16j”, IEEE 802.16j contribution document C802.16j-06/274r2, November 16 2006.

[2] “IEEE Standard for Local and Metropolitan Area Networks − Part 16: Air Interface for Fixed Broadband Wireless Access Systems, Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands,” IEEE Computer Society and the IEEE Microwave Theory and Techniques Society, February 2006.