Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Reliable Transmission for Critical MAC Management Messages**
Date Submitted	**2008-03-10**

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Re:	IEEE 802.16m-08/005, “Call for Contributions on Project 802.16m System Description Document (SDD)”. In response to the following topics: •comments on the content of section 8
Abstract	This contribution discusses the benefit of MAC management messages over ARQ/HARQ channel for IEEE 802.16m system
Purpose	For discussion on the transmission of MAC management message issue and adoption on proposed text modification to SDD by TGm
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Reliable Transmission for Critical MAC Management Messages

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1. Motivation

Since the wireless channel is error-prone, it is inevitable that some MAC management messages may be lost during the transmission. According to IEEE 802.16m System Requirements [1], 802.16m systems *shall* support a maximal state transition latency of 100ms and maximal intra-frequency handoff interrupt time of 30ms. The current request-and-response retransmission scheme for MAC management message cannot meet the requirement. Therefore, it is desirable to transport MAC management messages over reliable ARQ/HARQ channels so as to comply with the time constraint. Another benefit of reliable message transmission is to simplify the design of MAC operations.

2. Introduction

Currently, as illustrated in Fig. 1, the MAC management messages are not transported with ARQ protection. The rationale is that
"The Management messages would be operated in request-and-response manner, that is, if there is no response, sender retransmits request. Therefore additional ARQ operation is not required." [2]
However, it is well-known that the wireless channel is error-prone. If the MAC message is lost during the transmission, the sender can only retransmit it after the timer is expired. For mobile stations (MS), the long retransmission time of MAC management message is undesirable, especially for time-critical operations.

Take the operation of network entry from the idle mode as an example. The network entry may contain initial ranging, capability negotiation, authorization, registration and other operations. After sending out SBC-REQ for capability negotiation, the MS waits for SBC-RSP from base station (BS) and starts a timer T18. The default value of T18 is 50ms [3]. If the SBC-REQ is not correctly received by the base station, T18 expires and the message is retransmitted. The negotiation time would be longer than 50ms. As a consequence, the overall time for state transition from IDLE_STATE to ACTIVE_STATE exceeds the latency constraint, 100ms.

The timer-based retransmission undoubtedly can provide the transmission reliability, but it is not suitable for time-critical MAC operations. Aside from transmission reliability, another objective of MAC-level timer is to provide response time tolerance for the receiver. To enhance the system performance, the timer could be short so that the sender can start the retransmission as soon as possible. However, to ease the response time constraint, the timer could be long. The response time includes the message processing time and UL access time in the MS side or DL resource scheduling in BS side. To break the dilemma, we suggest the MAC management messages are transmitted over ARQ or HARQ channels, as illustrated Fig. 2. As for the MAC-level timer, it could be designed to tolerate the response delay of the receiver. Some similar discussion can be found in [4]. Their result showed that the access delay is lower than 80ms when HARQ transmission is employed in the new 802.16m frame structure.

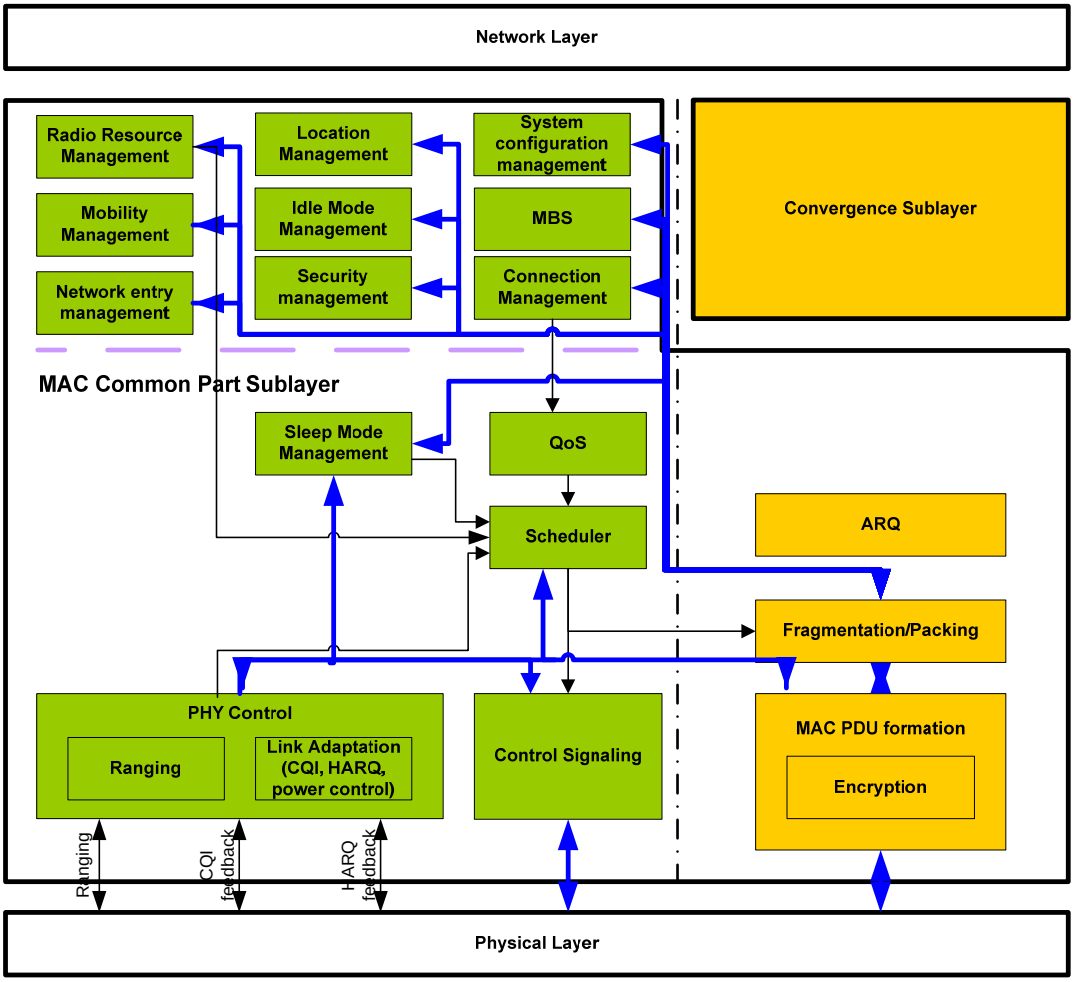

Fig. 1: IEEE 802.16e MS/BS Control Plane Processing Flow [2]

3. Reliable ARQ/HARQ-enabled transmission

Both ARQ and HARQ can provide reliability for data transmission. HARQ scheme performs better than ARQ one because it employs the benefit of soft-combining. It provides a fast retransmission method when the received HARQ sub-burst cannot be correctly decoded and the corresponding NACK message is received by the sender. For MAC management messages requiring packet error rate of 10^{-3}, HARQ ensure enough reliability. But, for those messages requiring packet error rate of 10^{-6}, ARQ/HARQ-enabled transmission is recommended [4]. ARQ could further enhance the transmission reliability when HARQ does not work properly. There is a maximal retransmission count for each HARQ sub-burst. When the upper bound is reached, the HARQ sub-burst is discarded. Therefore, a stall problem would incur if the MAC management messages are segmented. That is, some segments of the MAC message are discarded by the HARQ sender if their retransmission exceeds the upper threshold. To solve it, HARQ receiver could detect the stall problem by a timer and employ a go-back-one ARQ mechanism for fast MAC-level retransmission. Therefore, we suggested that go-back-one ARQ in conjunction with HARQ is used for time-critical MAC management messages.

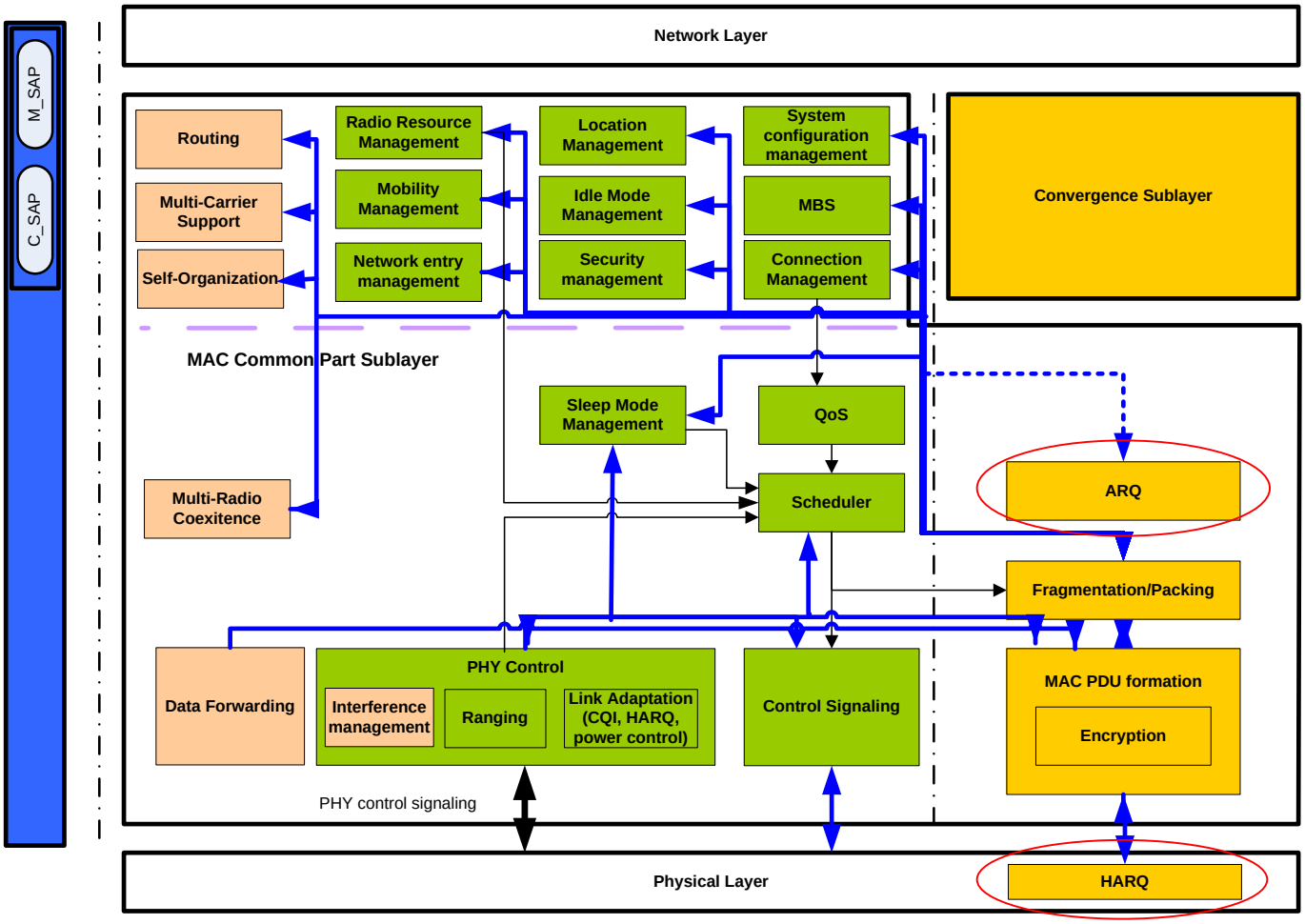

Figure 2 The IEEE 802.16m MS/BS Control Plane Processing Flow

The other benefit is that, with the ARQ/HARQ-enabled mechanisms, the sender can make sure that the MAC message is correctly received by the receiver. Without the acknowledgement from the receiver, the sender and receiver may operate in different direction. This is important for handover operation. For example, problems of the lost of handover message were reported in [6]. When MS sends MOB_HO-IND to cancel the handover operation and serving BS (SBS) does not correctly receive it, MS goes back to the normal operation but SBS stops the resource scheduling for the MS. Additional complicated MAC procedures are required to solve this kind of problem. Obviously, it would not happen in the ARQ/HARQ-enabled transmission.

To facilitate ARQ/HARQ-enabled transmission, additional feedback bandwidth is required to transmit the acknowledgement. For some time non-critical MAC messages or broadcast messages, reliable transmission protection may not be necessary. Therefore, we suggested that the MAC management messages should be categorized into two sets:

- critical MAC management message, and
- non-critical MAC management messages.

For critical MAC management messages, the ARQ/HARQ function is required; otherwise, it is optional.

4. Text proposal

[Insert the italic text modification begin from line#5, page#17 (section 8.2.2) of SDD [5]]

The following figure shows the MAC CPS control plane signaling flow and processing at the BS and the MS. On the transmit side, the blue arrows show the flow of control plane signaling from the control plane functions

to the data plane functions and the processing of the control plane signaling by the data plane functions to form the corresponding MAC signaling (e.g. MAC management messages, MAC header/sub-header) to be transmitted over the air. ***For critical MAC messages, they are transported over ARQ/HARQ channels to maintain high transmission reliability*****…..**

[Replace Fig. 9 by the following figure]

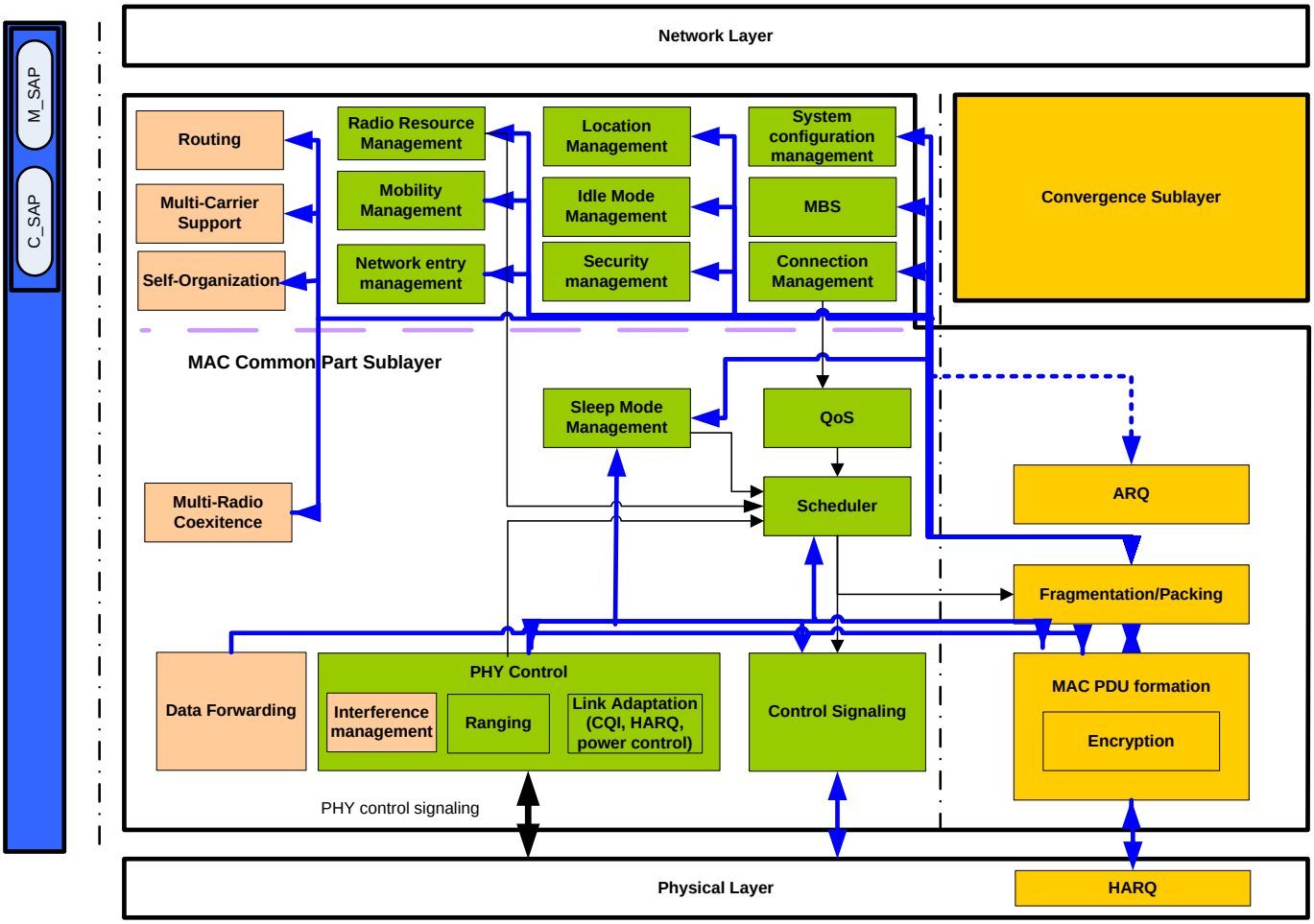

Fig 9: The IEEE 802.16m MS/BS Control Plane Processing Flow

--------- Text End ----------

REFERENCES

[1] IEEE 802.16m-07/002r4, “IEEE 802.16m System Requirements.”
[2] IEEE 802.16m-08/003, “The Draft IEEE 802.16m System Description Document.”
[3] IEEE 802.16Cor2D4, “Part 16: Air Interface for Broadband Wireless Access System”.
[4] IEEE 802.16m-08/082, “Proposal for IEEE 802.16m Frame Structure.”
[5] IEEE 802.16m-08/003, “The Draft of IEEE 802.16m System Description Document.”
[6] IEEE 802.16maint-08_069, “Fixes for Loss Handover Messages.”