Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Proposal for MAC protocol modification for 802.16.3 Application**
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Source(s)	Burcak Beser Victor Hou Chao-Chun Wang Pacific Broadband Communications 3103 N. First Street San Jose, CA 95134 Voice: 408-468-6137 Fax: 408-468-6297 mailto: burcak@pbc.com vhou@pbc.com ccwang@pbc.com
Re:	IEEE 802.16 Task Group 3 Call For Contributions:Proposed MAC Enhancements,Key Characteristics,and Evaluation Criteria:Session #11 ,802.16.4-00/25.
Abstract	The following changes are proposed in this contribution: - includes version number in the header - modifies request and grant format - supports multiple outstanding grants - adds two new messages for prompt response - assures consistency in AD
Purpose	The document is submitted as a part of development of 802.16.3 MAC given TG1 MAC as a baseline
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Proposal for MAC protocol modification for 802.16.3 Application

Burcak Beser
Victor Hou
Chao-Chun Wang

Pacific Broadband Communication
3103 N. First Street
San Jose, CA 95134

Introduction

To further enhance the robustness of the 802.16.3 MAC protocol to improve the performance of IP traffic, this contribution proposes

(1) A modification to the MAC message header
(2) Enhancements to the request and grant formats
(3) Proposition to assure consistency of the 802.16.3 MAC protocol

Recommended Changes

Header

- The generic header should carry version information.

The Generic MAC Header contains a two-bit field RSVD. It is suggested that this field be used to include the version number of the MAC Header. The current version will be 0. If an SS or BS sees a MAC Header with versions other than zero, it will drop the packet. The introduction of version assures that if in the future the MAC Header changes (e.g. the length of the MAC Header is increased to 10), the current SSs will not be affected by the change.

Proposed changes based on 802.16.1 [**IEEE 802.16.1/D1 - 2000**]:

P 37. Figures 5, 6, 7: change Rsvd to Vrsn.
P. 39 Add to table 1: Vrsn MAC Header version shall be set to 0.
P. 36 Add following paragraph after Figure 4. “When packets with version numbers other than 0 are received, the packets shall be dropped.”

Requests and Grants

The MAC must allow full use of the flexible parameters of the physical layer. One important attribute of the MAC related to this involves how the MAC computes and makes its request. First of all, there is the

question of whether a request made by a modem includes or does not include the physical layer overhead in addition
to the actual bytes of the MAC PDU. Secondly, there is the issue of what are the units in which requests are made and in which grants are given.

In order to allow the base station to be able to freely assign upstream physical layer parameters to the modem on a burst by burst basis, it is important that in the process of making a bandwidth request, the CM does not make assumptions about the physical layer. In other words, the amount that the modem requests is based solely on the number of bytes in the MAC PDU to be sent and does not include the physical layer overhead. Thus, in the grant that the base station sends to the modem, it can select a burst profile (a set of physical layer parameters) or burst profiles (in the case of a multi-carrier physical layer) that the CM would use in that particular transmission. Of course, consideration must be given to how much time it would take to configure the physical layer after receiving the grant with the burst profile information. However, the grant of course would not specify individual physical layer parameters, but just an index to a particular burst profile that is already specified in the Upstream Channel Descriptor message (or whatever name is given to it). Thus, the specification will have to address the issue of the minimum number of burst profiles supported by the modems. On one hand, a specific number of burst profiles could be specified. Alternatively, during the registration process, modems could report to the base station how many burst profiles they can support, and the base station would appropriately assign burst profiles in grants depending on the number that the modem supports and some rules about which burst profiles to incorporate when a modem supports fewer burst profiles than the number provided in the Upstream Channel Descriptor message.

Regarding the issue of what units requests are made in, there basically is a tradeoff between request economy and request resolution. By request economy, we mean how many bits are in the request field. By request resolution, we get to the issue of how much of a request is unused due to the quantizing of the request size. In addition, there is an impact on the units in which the grant is allocated. It is not necessarily required that the units in which requests are made and the units in which grants are given have to be the same.

It is proposed that requests be made in units of bytes. It is also proposed that grants, at least from a time perspective, should be allocated in units of time with respect to some system timebase. The resolution of these time units should be finer than the time to transmit 8 bits at the maximum symbol rate and the maximum order of modulation. Note that since the physical layer modulation technique for 802.16.3 is not fully defined, the actual format of grants that have to reflect additional dimensions in addition to time (e.g., frequency, codes, etc.) are not being proposed now.

To summarize the proposals on the topics of how modems request and how grants are given:

- Modems shall make requests in units of bytes that do not include physical layer overhead.
- Base stations in providing bandwidth grants based upon requests shall indicate the burst profile to be used. To simplify implementation, a reasonable number of burst profiles shall be specified in the Upstream Channel Descriptor message.

- The grants given by BS to the requesting SS shall include the physical overhead required to transmit the MAC PDU based upon the burst profile assigned.

Because of differences of burst profiles, the BS is required to grant enough resources not only for the payload but also the physical overhead for the burst profile assigned.

Proposed changes based on 802.16.1 [**IEEE 802.16.1/D1 - 2000**]:

P.333 [section 11.4.12.18]: The grant size should include the physical overhead required to transmit the entire MAC PDU.

- The grants given by the base station shall be in units of time that are at least as fine as the time to transmit 8 bits at the maximum symbol rate and the maximum order of modulation.

Proposed changes based on 802.16.1 [**IEEE 802.16.1/D1 - 2000**]:

P.333 [section 11.4.12.18]: The value of this parameter specifies the unsolicited grant size in units of time that are at least as fine as the time to transmit 8 bits at the maximum symbol rate and the maximum order of modulation.

Multiple outstanding grants

- The system should support multiple outstanding requests per service flow.

To further improve the performance, the system should allow more than one request outstanding per CID. Having more than one request outstanding increases the responsiveness of the BS and reduces the upstream delay.

Proposed changes based on 802.16.1 [**IEEE 802.16.1/D1 - 2000**]:

Section 6.2.2.2.1. Requests:

Change the following paragraph from

"In GPC mode, the SS shall have only one request outstanding at a time per Connection ID. If the BS does not immediately respond with a Data Grant Burst Type, the SS is able to unambiguously determine that its request is still pending because the BS shall continue to issue a Data Grant Burst Type Pending in every MAP for as long as a request is unsatisfied."

to

"**In GPC mode the SS shall not request more than *MAXIMUM NUMBER OF OUTSTANDING REQUESTS* at any time per Connection ID**. If the BS does not immediately

respond with a Data Grant Burst Type, the SS is able to unambiguously determine that its request is still pending because the **BS shall continue to issue a Data Grant Burst Type Pending for each request outstanding in every** MAP for as long as a request is unsatisfied."

Add a new section 11.4.12.22:

11.4.12.22. *MAXIMUM NUMBER OF OUTSTANDING REQUESTS*:

The value determines the maximum number of outstanding requests for the Connection ID. The default value is 1. An SS shall not request more than the maximum number of outstanding requests at any time.

A new dynamic service message

- One new message, DSx_RVD (received) is proposed for 802.16.3 proposed for the 802.16.3.

The DOCSIS 1.1 specification introduced dynamic service messaging. Per the PacketCable specification, the DSA/DSC message requires significant authentication and/or authorization. Because of this the timeout and resend interval is specified to be a large number with a maximum value of 1 second.

The introduction of a DSx_RVD (received) message will make sure that if the DSx_REQ message is not received by the BS/SS, then the retransmission will occur much quicker than the timeout period, which must include the CMTS authorization time; instead, the timeout will be based on the message parsing time. In the current PacketCable realm, a timeout of 1 second delay can make the call a defect.

The message flow is as follows:

```
          DSx_REQ
sender ----------> receiver

          DSx_RVD
        <----------  (sender has avery short timeout period)

          DSx_RSP
        <----------  (I am not even sure there is any need for a timeout here)

          DSx_ACK
        ---------->  (mission accomplished)
```

Scheduling service

- The operation of UGS active detection is not clearly defined. The freedom given to BS instead of SS, which is closer to the application needs AD, leads inconsistency of AD behavior from BS to BS.

The detection of AD should be left to SS, and the SS should communicate the AD in an interoperable way to BS.

Proposed changes based on 802.16.1 [**IEEE 802.16.1/D1 - 2000**]:

P 92. line 11: Change the following paragraph from

(The BS can detect flow inactivity by detecting unused grants. However, the algorithm for detecting a flow changing from an active to an inactive state is dependent on the BS implementation).

to

The SS can detect the flow inactivity by detecting unused grants. However, the algorithm for detecting a flow changing from an active to an inactive state is dependent on the SS implementation. The SS shall communicate the AD by zeroing the active grants field."

REFERENCES

1. V. Yanover, S. Varma and H. Ye, ‘‘Using the TG1 MAC for TG3 Purposes,” *Contribution Number 802.16.3p-00/5*6, November 2000.
2. ‘‘Draft Standard for Air Interface for Fixed Broadband Wireless Access Systems”, *Document Number IEEE 802.16.1/D1-200*0, December 2000.