Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Proposal for differentiating bandwidth request based on service class and retry attempts**
Date Submitted	**2009-07-06**
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Re:	Call for Comments on IEEE 802.16m-09/0010r2 IEEE 802.16m Amendment text/Area: Chapter 15.2.11.1.1. (Bandwidth Request)
Abstract	Proposal for differentiating bandwidth request based on service class and retry attempts
Purpose	For inclusion in AWD
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Proposal for differentiating bandwidth request based on service class and retry attempts

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Introduction:

The 802.16m contention-based BR protocol proposed in Amendment Working document(1) provides an asynchronous access opportunity to each AMS on a common BR channel. Contention causes BR collisions, and the colliding AMS must retry (possibly more than once) after waiting for the BR response for the retry timeout interval. The current backoff scheme is common to all service classes. However, the contending AMS may be negotiating BR for flows belonging to different service classes. Thus the BR protocol must take into account the priority or service class of each contending flow. This need for differentiation in the BR protocol has been acknowledged in the current AWD. However, it does not include a specification of the differentiation method.

We propose a differentiation method that ensures better BR performance for higher service classes and reduces the failure rate. We define a term “connection priority” which is used to set the contention window while performing bandwidth request.

The standard way of incrementing contention window is to double it with each retry. This means standard scaling factor is two. We show with the help of following simulations that other scaling factors like 3,4 can also be used, and the optimal one depends on the user density and available resources. So ABS should advertise the scaling factors based on condition of its resources. We introduce scaling factors for contention window in the Dsx message to perform this operation.

Connection Priority:

Connection priority is defined as a function of service class of the user data and the number of retries the user has performed. In order to achieve service differentiation for users with different service classes and reduce the outage probability of the contention based bandwidth request contention window should be set based on 'connection priority'.

Motivation for including service class in connection priority is, the users who has high priority data (e.g. Delay sensitive) should be given access before other users with low priority data (Delay insensitive). Including No of retries in connection priority is, to reduce the outage probability of the BR mechanism by giving more preference to users who are near outage (more no of retries) in bandwidth request procedure. Also the user who has contended for performing bandwidth request (BR) before should be given more priority than the new users so that no user is neglected and everyone gets a fair chance to perform BR.

Service class	Default contention window size
0	100ms
1	90ms
2	80ms

Table 1: An example of contention window values for different service classes.

Table-1 gives an example of setting contention window based on service class. Please note that above values are to just show the dependence of contention window on services class , actual values of contention window are advertised by ABS.

The following simulations show the effect of differentiation contention window for users based on service class. Simulations are done with 40 users in each class. Full buffer traffic model is assumed at users.

1)Service class:

1)Figure 1 is the curve of throughput vs grant ratio. Blue line is for higher priority users whose contention window is half the size of the Red lower priority users. Throughput is the average number of successful bandwidth requests a user of a class has performed. Grant is the number of requests ABS can accept. This figure clearly illustrates the fact that different classes can be given priority by adjusting the contention window size.

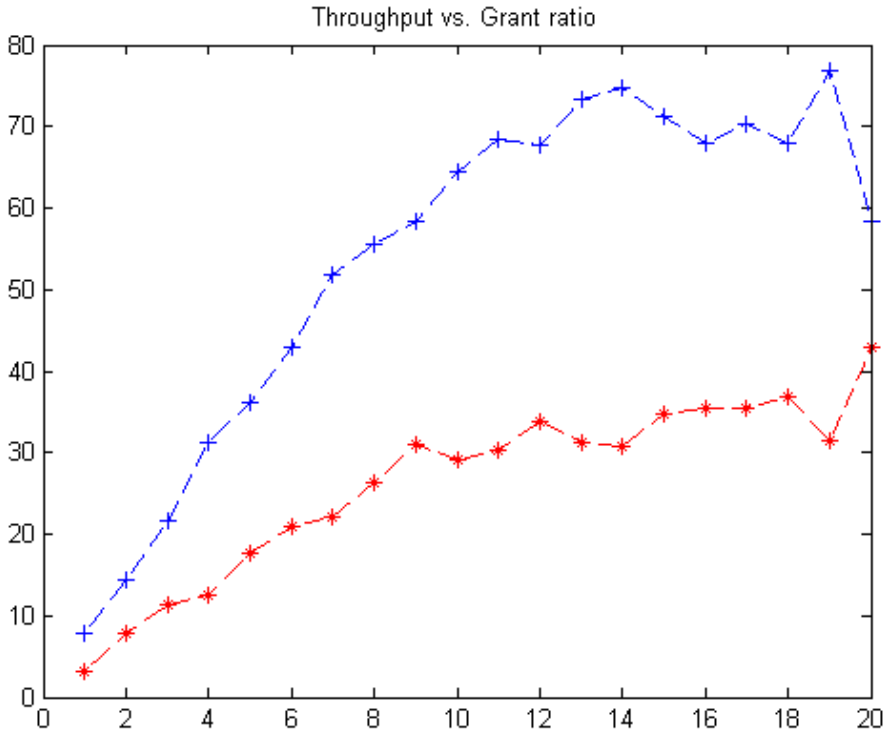

Figure 1: Average throughput vs Grant ratio

2)No of Retries:

In the following simulations the factor no of retries performed by a user is considered in calculation of contention window. In each case Red indicates contention window is independent of no of retries, whereas Blue indicates contention window is dependent on no of retries performed.

2)Figure 2 is a plot between no of failures and grant ratio for two cases. Failure occurs for a user after performing a fixed no of retires.

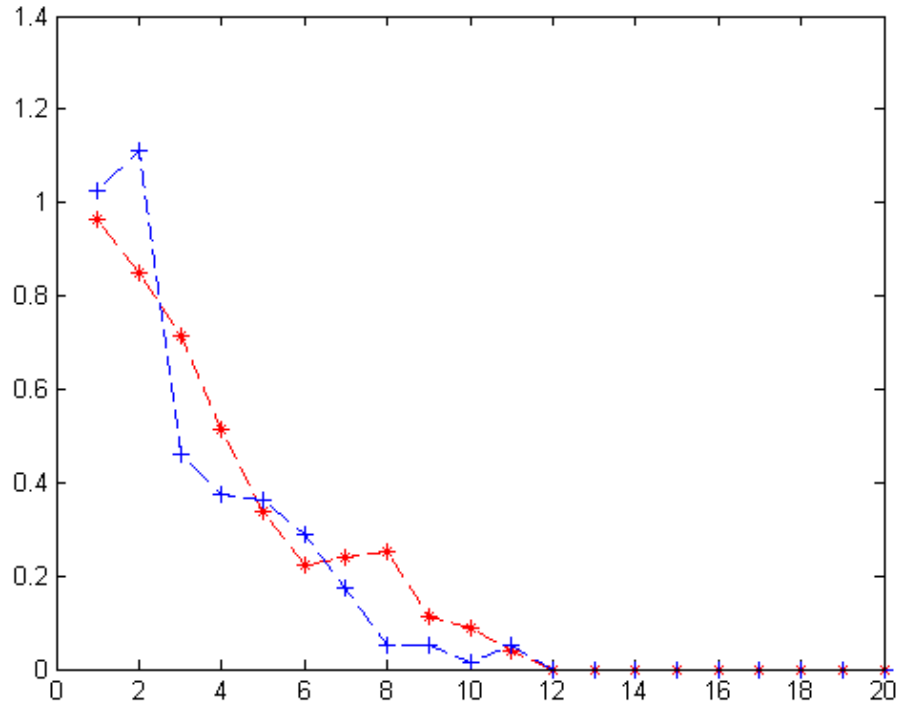

Figure 2: Average failures vs Grant ratio

3)Figure 3 is a plot of average delay and grant ratio. Delay is the duration between beginning of a bandwidth request procedure for a user, upto the grant of bandwidth.

4)Figure 4 is a plot of average throughput and grant ratio. It can be noticed that calculating contention window based on no of retries doesnt affect throughput. It just improves failure rate and delay by giving more priority to users with more no of retries.

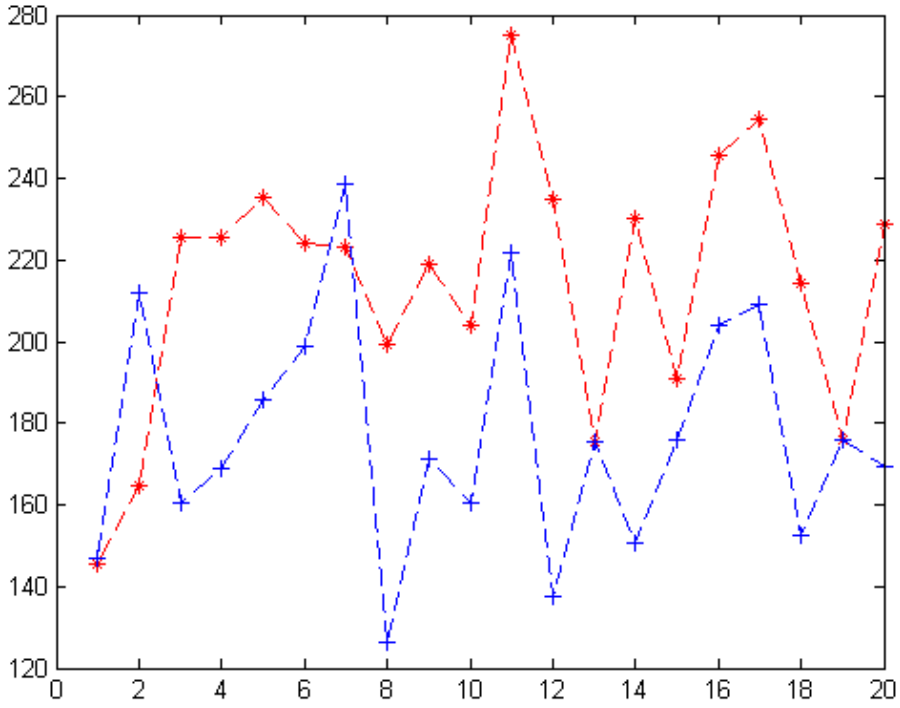

Figure 3: Average delay vs Grant ratio

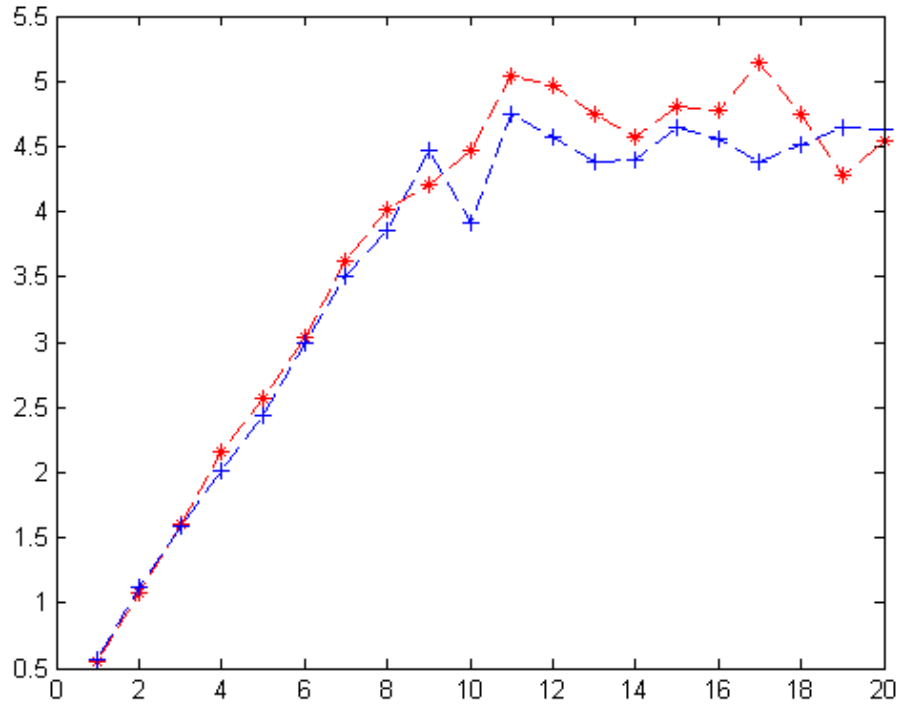

Figure 4: Average throughput vs Grant ratio

3) Scaling Factor:

Figure 5,6,7 are for comparison of scaling factor 4,2. In the following figures Red is for scaling factor 4, Blue is for scaling factor 2.

5)Figure 5 is a plot of average delay and grant ratio both as defined before.
6)Figure 6 is a plot of average failures and grant ratio.
7)Figure 7 is a plot of average throughput and grant ratio.

One can notice from these three figures that in average failures and delay scaling factor 4 has better performance. In average throughput scaling factor 2 dominates at higher grant ratio, whereas both scaling factors 2 and 4 has same performance at low grant ratios. Therefore selecting scaling factor 4 gives better performance in terms of failures, delay and throughput compared to 2 at low grant ratios. We have noticed similar trends with other scaling factors also. So ABS has to decide which scaling factors should be used and advertise them.

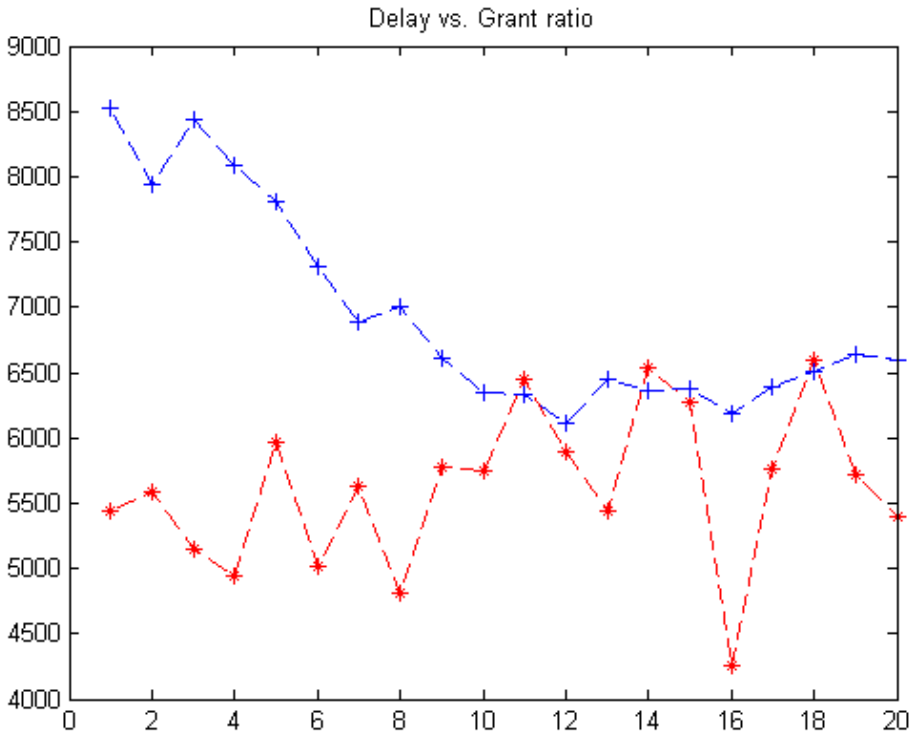

Figure 5: Average delay vs Grant ratio

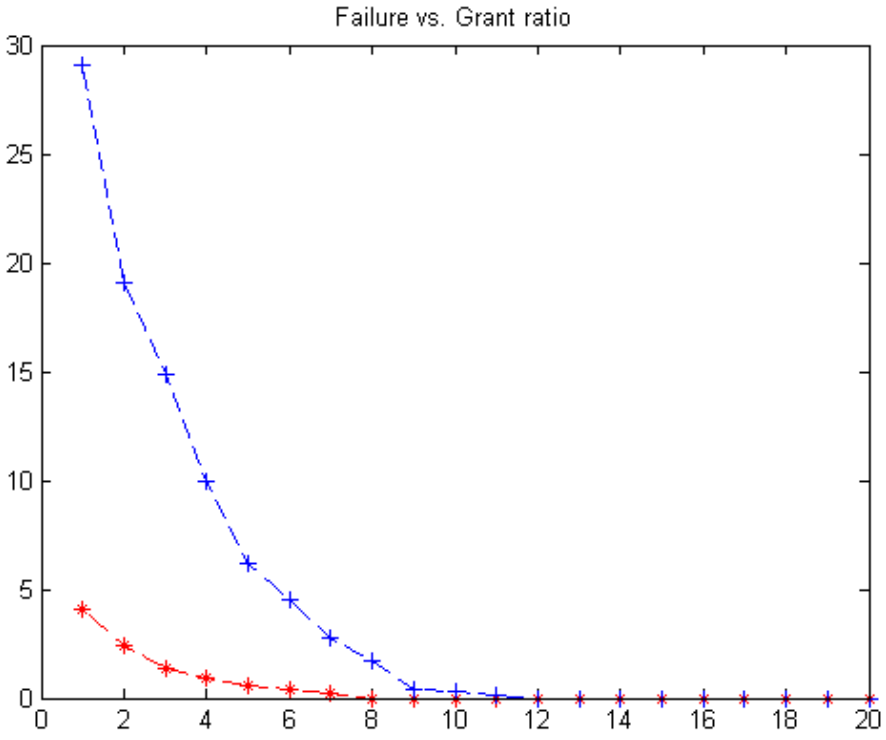

Figure 6: Average failures vs Grant ratio

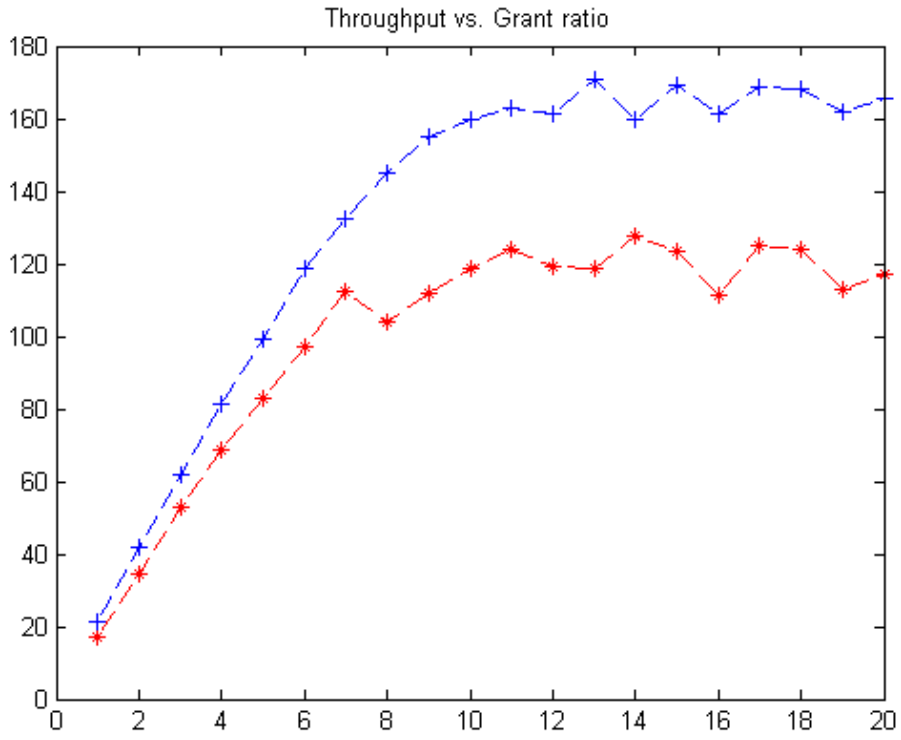

Figure 7: Average throughput vs Grant ratio

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15.2.11.1.1(Line 38):

Connection priority is a function of service class and No of retries the user performs. The BR Timer value is the differentiated value defined for the service flow based on connection priority. The exact size of contention window and its scaling factors are advertised by ABS in DSx message.

Part of DSx message which provides the required parameters for performing bandwidth request.

Connection priority/Service class	4 bits
Max window size	11 bits
Min window size	8 bits
Max window size scale factor	4 bits
Min window size scale factor	4 bits

----------End of the Text----------

References:

[1] IEEE 802.16m-09/0010r2, “IEEE 802.16m Amendment Working Document”