Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
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Re:	This is a response to a call for comments on draft 802.16m evaluation methodology document http://ieee802.org/16/tgm/docs/80216m-07_023.pdf.
Abstract	This document provides some comments on the fairness criterion and the performance metrics for delay sensitive applications.
Purpose	For consideration when specifying fairness criterion and performance metrics.
Notice	
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Comments on Draft 802.16m Evaluation Methodology Document

1.0 Introduction

This document provides comments on the fairness criterion, which is in Section 13.3, and the performance metrics for delay sensitive applications, which is in Section 13.2.2, in the draft 802.16m evaluation methodology document.

2.0 Short-term Fairness Criterion

The fairness criteria in Section 13.3 of the evaluation methodology document considers only the long-term fairness, in other words, fairness after an entire simulation run. As a result, it is not clear whether fairness is maintained in any given short interval. It is suggested that short-term fairness is also considered through specifying an upper bound on the difference between amounts of service received by different users in a short interval.

2.1 Upper Bound on the Difference between Received Services

For generality, consider a controllable fairness criterion that can guarantee the share of resource for all users who are admitted in the system based on the weighting function of each user. Assume the weighting function of the *i*th user is $f_i(\phi_i, CQI_i)$, where ϕ_i and CQI_i are the weighted value and the channel quality indicator, respectively, of *i*th user. The short-term fairness is measured by

$$\varepsilon_{ij} = \left| \frac{\varphi_i}{f_i(\phi_i, CQI_i)} - \frac{\varphi_j}{f_j(\phi_j, CQI_j)} \right| \qquad (1)$$

where φ_i is the actual service counted in bits received by the *i*th user in a time interval of length τ. An upper bound ε is put on the ε_{ij}'s at all times such that the difference between the ratios of the received service to the weighting function of any two arbitrary users in the system will be less than ε. This fairness measurement is widely adopted in literatures such as [1]-[5]. It is suggested that the 802.16m evaluation methodology document to define the length τ of the time interval and the weighting functions for calculating ε_{ij}'s, and to specify an upper bound ε for measuring the short-term fairness.

3.0 Performance Metrics for Delay Sensitive Applications

In Section 13.2.2, performance metrics for delay sensitive applications are specified. However, these metrics do not explicitly indicate whether the quality of service (QoS) is met. It is suggested that, in addition to delay metrics, lateness metrics should also be provided for delay sensitive applications. Following is the suggested text to be inserted in Section 13.2.2.

3.1 Definition of Lateness

Assuming that the deadline of the *j*th packet of the *i*th packet call destined for user *u* in downlink (uplink) channel is $D_{j,i,u}^{DL(UL)}$ and successfully delivered to the MS (BS) MAC-SAP at time $T_{j,i,u}^{dep,DL(UL)}$, then the packet lateness of the *j*th packet of the *i*th packet call destined for user *u* is defined as

$$lateness_{j,i,u}^{DL(UL)} = \left| T_{j,i,u}^{dep,DL(UL)} - D_{j,i,u}^{DL(UL)} \right| \quad (2)$$

Lateness is a measurement to see if the received packet is out of time or not, and such a measurement is one of very fundamental QoS parameters.

3.2 User Average Lateness

The average packet lateness for use u in downlink (uplink) channel is defined as

$$lateness_u^{avg,DL(UL)} = \frac{\sum_{i=1}^{p_u^{DL(UL)}} \sum_{j=1}^{q_{i,u}^{DL(UL)}} \left(\left| T_{j,i,u}^{dep,DL(UL)} - D_{j,i,u}^{DL(UL)} \right| \right)}{\sum_{i=1}^{p_u^{DL(UL)}} q_{i,u}^{DL(UL)}} \quad (3)$$

where $p_u^{DL(UL)}$ is the number of packet calls for user u, and $q_{i,u}^{DL(UL)}$ is the number of packets of the ith packet call for user u in downlink (uplink) channel.

3.3 X% Miss Deadline Packet Per User

The X% miss deadline packet simply means that there is X% of packets for user u with lateness greater than zero, and is defined as follows.

$$X_u^{DL(UL)} = \frac{\sum_{i=1}^{p_u^{DL(UL)}} \sum_{j=1}^{q_{i,u}^{DL(UL)}} \gamma_{j,i,u}^{DL(UL)} (T_{j,i,u}^{dep,DL(UL)}, D_{j,i,u}^{DL(UL)})}{\sum_{i=1}^{p_u^{DL(UL)}} q_{i,u}^{DL(UL)}} \quad (4)$$

where $\gamma_{j,i,u}^{DL(UL)} (T_{j,i,u}^{dep,DL(UL)}, D_{j,i,u}^{DL(UL)})$ defined as

$$\gamma_{j,i,u}^{DL(UL)} (T_{j,i,u}^{dep,DL(UL)}, D_{j,i,u}^{DL(UL)}) = \begin{cases} 1, & if \ T_{j,i,u}^{dep,DL(UL)} - D_{j,i,u}^{DL(UL)} > 0 \\ 0, & otherwise \end{cases} \quad (5)$$

is the packet lateness indication function of the jth packet of the ith packet call for user u . (5) means that if the lateness of the jth packet of the ith packet call for user u is greater than zero, then the packet lateness indication function of the jth packet of the ith packet call for user u (that is, $\gamma_{j,i,u}^{DL(UL)} (T_{j,i,u}^{dep,DL(UL)}, D_{j,i,u}^{DL(UL)})$) equals to 1; otherwise, it equals to zero. Therefore, the numerator of (4) can be considered as the total number of packets which miss the deadline for user u in the sector, and (4) is the percentage of packets that miss their deadline for user u.

3.4 System Average Lateness

The average packet lateness of the system in downlink (uplink) channel is defined as

$$lateness_{sys}^{avg,DL(UL)} = \frac{\sum_{u=1}^{N}\sum_{i=1}^{p_u^{DL(UL)}}\sum_{j=1}^{q_{i,u}^{DL(UL)}}\left(\left|T_{j,i,u}^{dep,DL(UL)} - D_{j,i,u}^{DL(UL)}\right|\right)}{\sum_{u=1}^{N}\sum_{i=1}^{p_u^{DL(UL)}} q_{i,u}^{DL(UL)}} \quad (6)$$

where N is the number of users in the system. (6) can also be used to represent the average lateness of each sector by using if N is replaced by N_{sub} (which is the number of users in a sector) .

3.5 X% Miss Deadline Packets of the System

$$X_{sys}^{DL(UL)} = \frac{\sum_{u=1}^{N}\sum_{i=1}^{p_u^{DL(UL)}}\sum_{j=1}^{q_{i,u}^{DL(UL)}} \gamma_{j,i,u}^{DL(UL)}(T_{j,i,u}^{dep,DL(UL)}, D_{j,i,u}^{DL(UL)})}{\sum_{u=1}^{N}\sum_{i=1}^{p_u^{DL(UL)}} q_{i,u}^{DL(UL)}} \quad (7)$$

where $\gamma_{j,i,u}^{DL(UL)}(T_{j,i,u}^{dep,DL(UL)}, D_{j,i,u}^{DL(UL)})$ is defined the same as in (5). (7) can also be used to represent the X% miss deadline packets of each sector if N is replaced by N_{sub}.

3.6 Hard QoS Applications Packet Loss Ratio

For hard QoS constraint applications, the packet which misses the deadline should be considered as a loss packet, even though the packet is successfully received. The packet loss ratio per user with hard QoS applications is defined as

$$packet\ loss\ ratio_{(hard\ QoS)} = 1 - \frac{Total\ number\ of\ successfully\ received\ and\ not\ miss\ deadline\ packets}{Total\ number\ of\ successfully\ transmitted\ packets} \quad (8)$$

4.0 References

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