Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>	
Title	**Source QoS Control for Data Forwarding**	
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Re:	IEEE 802.16j-07/019: "Call for Technical Comments Regarding IEEE Project 802.16j"	
Abstract	We propose a relative simple QoS control for data forwarding; source QoS control where station creating a packet to be forwarded provides scheduling instruction.	
Purpose	To incorporate the proposed text into the P802.16j Baseline Document (IEEE 802.16j-06/026r4)	
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Source QoS Control for Data Forwarding

Hang Zhang, Peiying Zhu, Mo-Han Fong, Wen Tong, David Steer, Gamini Senarath, G.Q. Wang, Derek Yu, Israfil Bahceci, Robert Sun and Mark Naden

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1. Introduction

In 802.16e/d standard, a service flow is associated with a QoS profile (or service class) which includes QoS requirements such as minimum reserved data rate, maximum latency, tolerable jitter, etc. Those parameters are defined from the perspective of access network. For example, the maximum latency is defined as the maximum interval between the reception of a packet at Convergence sub-layer of BS (DL) or MS (UL) and the arrival of the packet to the peer device. If this parameter is defined, it represents a service commitment and shall be guaranteed. In an 802.16e system, there is only one hop between a BS and a MS. The BS can determine the transmission time for DL based on the service QoS profile. If the BS is able handle the traffic scheduling based on the QoS profile of a service, from the perspective of the MS receiving this service, the QoS provided by the access network is satisfied.

For a 16j system, however, for data forwarding, it will become difficult to require each of RSs in a forwarding path to make scheduling decision based on single QoS profile of one service flow. Taking the maximum latency as one example, in order to provide the required maximum latency, this required latency needs to be carefully allocated to each hops on the forwarding path of this service. However this is difficult to be implemented since topology may change and the delay of per hop may be varying. Such a change in one or more hops on a forwarding path means that QoS profiles of all service flows associated with this path will be modified and repopulated by MR-BS to all RSs in this path. Another parameter - tolerable jitter has the same issue. Due to the above reasons, it may be difficult or very complicated to have intermediate RSs in a path to take the responsibility of QoS control based on service QoS profile.

2. Proposal

In this contribution, we propose a relative simple QoS control for data forwarding called as source QoS control where station creating a packet to be forwarded provides scheduling instruction. A MR-BS is responsible for providing this instruction for each of packet it creates to be forwarded downstream. For UL, each access RS is responsible for providing the scheduling instruction for each packet it created to be forwarded upstream. For DL data forwarding case, if the MR-BS can provide scheduling instruction regarding the transmission time of the access RS to its MS based on QoS profile, and all intermediate RSs and access RS are able to follow this instruction, the QoS received by the MS should be the same as if there were no RSs between MR-BS and the MS and the QoS can be guaranteed from the perspective of the MS. Similar argument is valid for UL data forwarding.

In order to support the above source QoS control in a distributed scheduling scheme, MR-BS shall keep the QoS profile for each of DL services and an access RS shall keep the QoS profile for each of UL services it provides and all intermediate RSs in a path may not be required to keep QoS profile for each of service flow it needs to forward. To support source QoS control for data forwarding, the following three components need to be defined:

1. transmission deadline
   This parameter is defined as the absolute frame number and may be attached to an R-MAC PDU to provide

the scheduling instruction of its payload. For DL case, this parameter indicates the frame number where the access RS shall start to transmit the payload encapsulated in an R-MAC PDU. In UL case, this parameter indicates the frame number where the RS (one-hop-away from MR-BS) to start to transmit the payload encapsulated in an R-MAC PDU.

2. QoS class
   A QoS class is associated with a QoS profile and is uniquely assigned a QoS class identifier (QoS class ID) by a MR-BS. The QoS class 1 represents the highest class. All service flows with the same QoS profile can be mapped to one QoS class. The mapping rule is determined by MR-BS and is implementation dependent. The total number of QoS classes shall be lessen than the total number of service flows supported by a MR-BS. In other word, a QoS class is an aggregation of service flows sharing the similar QoS profiles. The traffic on a basic connections, primary connections and secondary connections of MSs are defined as three distinct QoS classes. At a UL service flow setup, the MR-BS shall indicate to the access RS of the QoS class of this new service flow. It is the responsibility of the MR-BS (for DL) and an access RS (UL) to map a packet of a service flow/MAC messages of MSs to a QoS class. The QoS class ID shall be attached with an R-MAC to indicate the QoS class of its payload. In principle the order of packets belonging to a QoS class shall be kept unchanged though the entire forward procedure. The transmission deadline of each packet explicitly determines the transmission order of packets with in one QoS class.
3. Intermediate RS scheduling rules
   In order for an intermediate RS to make scheduling decision, three parameters are required:
   - Deadline indicated in the R-MAC PDU
   - Number of hops away from an access RS (for DL data forwarding) or from MR-BS (for UL data forwarding)
   - Performance estimation of each hop in the downstream (for DL case) or in upstream (for UL case). (The performance estimation method is described in a separate contribution “Forwarding Performance Estimation Method”).
   - QoS class

The transmission time of a packet by an intermediate RS (Tx_IR) may be calculated by taking the deadline, the number of hops and per-hop performance estimation in the path into the consideration.

- The packet with the earliest transmission time (by an intermediate RS) Tx_IR shall be transmitted first
- For packets with the same calculated transmission time Tx_IR, the packet with high QoS class shall be transmitted first

By using the above QoS control, when topology changes or per-hop average performance changes, the MR-BS/access and other RSs in a path can simply adjust its scheduler accordingly. No any QoS profile update and re-population is required.

3. Proposed text change

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3.1 Source QoS control description

[Insert the following subclause after Section 6.3.14.10]

6.3.14.11 Source QoS control

In source QoS control, the station creating a packet to be forwarded provides scheduling instruction. In order to support source QoS control in a distributed scheduling scheme, MR-BS shall keep the QoS profile for each of DL services and an access RS shall keep the QoS profile for each of UL services it provides and all intermediate RSs in a path may not be required to keep QoS profile for each of service flow it needs to forward. A MR-BS is responsible for providing this instruction for each of packet it creates to be forwarded downstream. For UL, each access RS is responsible for providing the scheduling instruction for each packet it created to be forwarded upstream.

To support source QoS control for data forwarding, the following three components need to be defined:

1. transmission deadline
   This parameter is defined as the absolute frame number and may be attached to an R-MAC PDU to provide the scheduling instruction of its payload. For DL case, this parameter indicates the frame number where the access RS shall start to transmit the payload encapsulated in an R-MAC PDU. In UL case, this parameter indicates the frame number where the RS (one-hop-away from MR-BS) to start to transmit the payload encapsulated in an R-MAC PDU.
2. QoS class
   A QoS class is associated with a QoS profile and is uniquely assigned a QoS class identifier (QoS class ID) by a MR-BS. The QoS class 1 represents the highest class. All service flows with the same QoS profile can be mapped to one QoS class. The mapping rule is determined by MR-BS and is implementation dependent. The total number of QoS classes shall be lessen than the total number of service flows supported by a MR-BS. In other word, a QoS class is an aggregation of service flows sharing the similar QoS profiles. The traffic on a basic connections, primary connections and secondary connections of MSs are defined as three distinct QoS classes. At a UL service flow setup, the MR-BS shall indicate to the access RS of the QoS class of this new service flow and the QoS profile of this QoS class. It is the responsibility of the MR-BS (for DL) and an access RS (UL) to map a packet of a service flow/MAC messages of MSs to a QoS class. The QoS class ID shall be attached with an R-MAC to indicate the QoS class of its payload. In principle the order of packets belonging to a QoS class shall be kept unchanged though the entire forward procedure. The transmission deadline of each packet explicitly determines the transmission order of packets with in one QoS class.
3. Intermediate RS scheduling rules
   In order for an intermediate RS to make scheduling decision, three parameters are required:
   - Deadline indicated in the R-MAC PDU
   - Number of hops away from an access RS (for DL data forwarding) or from MR-BS (for UL data forwarding)
   - Performance estimation of each hop in the downstream (for DL case) or in upstream (for UL case).
   - QoS class

The transmission time of a packet by an intermediate RS (Tx_IR) may be calculated by taking the deadline, the number of hops and per-hop performance estimation in the path into the consideration.

- The packet with the earliest transmission time (by an intermediate RS) Tx_IR shall be transmitted first by the intermediate RS
- For packets with the same calculated transmission time Tx_IR, the packet with high QoS class shall be transmitted first by the intermediate RS

3.2 QoS class assigned to a UL service flow

[Please insert the following to the end of 6.3.2.3.10]

The DSA-REQ may include the following TLV:

QoS class ID

QoS class ID assigned to a UL service.

[Please insert the following to the end of 6.3.2.3.11]

The DSA-RSP may include the following TLV:

QoS class ID

QoS class ID assigned to a UL service.

[Please add the following section 11.13.38 QoS class ID. Enditor: the section 11.21 in baseline seems not match the correct section number]

11.13.38 QoS class ID

This TLV is used by a MR-BS to assign a QoS lass to UL service flow. This TLV is sent by MR-BS to the corresponding access RS when the UL service flow QoS profile is populated to the access RS.

Name	Type	Length	Value	Scope
QoS class ID	TBD	1	b0-b5: QoS class 0-63 b6-7: reserved	DSA-REQ DSA-RSP

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