Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**REVd Sponsor Ballot Recirc #1 - Resolution to issues regarding comment 150**	
Date Submitted	**2004-04-24**	
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Re:	Sponsor ballot recirc #1 on document ***IEEE P802.16REVd/D4-2004***	
Abstract	Suggested text to resolve issues with changes implemented for comment 150 in D4 6.3.5. The text is based on ***IEEE C802.16d-04_42r1*** with the alterations specified by the accepted resolutions for comments 150 and 151 and additional suggestions inspired by or proposed in ***IEEE C802.16d-04_60r0.***	
Purpose	Suggested remedy for issues raised regarding implementation of comment 150.	
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Replace the contents of RevD/D4 section 6.3.5 with the following:

6.3.5 Scheduling services

Scheduling services represent the data handling mechanisms supported by the MAC scheduler for data transport on a connection. Each connection is associated with a single data service. Each data service is associated with a set of QoS parameters which quantify aspects of its behavior. These parameters are managed using the DSA and DSC message dialogs. Four services (11.13.12) are supported: Unsolicited Grant Service (UGS), Real-time Polling Service (rtPS), Non-real-time Polling Service (nrtPS), and Best Effort (BE). The following text provides a brief description of each of the supported scheduling services, including the mandatory QoS parameters that shall be included in the service flow definition when the scheduling service is enabled for a service flow. A detailed description of each QoS parameter is provided in 11.12.

The UGS is designed to support real-time data streams consisting of fixed-size data packets issued at periodic intervals, such as T1/E1 and Voice over IP without silence suppression. Mandatory QoS service flow parameters for this scheduling service are Maximum Sustained Traffic Rate (11.13.7), Maximum Latency (11.13.15), Tolerated Jitter (11.13.14), Time Base (11.13.11), and Request/Transmission Policy (11.13.13). If present, the Minimum Reserved Traffic Rate parameter (11.13.9) shall have the same value as the Maximum Sustained Traffic Rate parameter.

The rtPS is designed to support real-time data streams consisting of variable-sized data packets that are issued at periodic intervals, such as moving pictures experts group (MPEG) video. Mandatory QoS service flow parameters for this scheduling service are Minimum Reserved Traffic Rate (11.13.9), Maximum Sustained Traffic Rate (11.13.7), Maximum Latency (11.13.7), Time Base (11.13.11), and Request/Transmission Policy (11.13.13).

The nrtPS is designed to support delay-tolerant data streams consisting of variable-sized data packets for which a minimum data rate is required, such as FTP. Mandatory QoS service flow parameters for this scheduling service are Minimum Reserved Traffic Rate (11.13.9), Maximum Sustained Traffic Rate (11.13.7), Traffic Priority (11.13.6), Time Base (11.13.11), and Request/Transmission Policy (11.13.13).

The BE service is designed to support data streams for which no minimum service level is required and therefore may be handled on a space-available basis. Mandatory QoS service flow parameters for this scheduling service are Maximum Sustained Traffic Rate (11.13.7), Traffic Priority (11.13.6), Time Base (11.13.11), and Request/Transmission Policy (11.13.13).

6.3.5.1 Outbound transmission scheduling

Outbound transmission scheduling selects the data for transmission in a particular frame/bandwidth allocation and is performed by the BS for downlink, and SS for uplink. In addition to whatever other factors the scheduler may deem pertinent, the following items are taken into account for each active service flow:

— The scheduling service specified for the service flow.
— The values assigned to the service flow's QoS parameters.
— The availability of data for transmission.
— The capacity of the granted bandwidth.

6.3.5.2 Uplink request/grant scheduling

Uplink request/grant scheduling is performed by the BS with the intent of providing each subordinate SS with bandwidth for uplink transmissions or opportunities to request bandwidth. By specifying a scheduling service and its associated QoS parameters, the BS scheduler can anticipate the throughput and latency needs of the uplink traffic and provide polls and/or grants at the appropriate times.

For uplink connections, Table 92 summarizes the scheduling services and the poll/grant options available to each.

Table 92—Scheduling services and usage rules

Scheduling type	PiggyBack Request	Bandwidth stealing	Polling
UGS	Not allowed	Not allowed	PM bit is used to request a unicast poll for bandwidth needs of non-UGS connections.
rtPS	Allowed	Allowed	Only unicast polling is allowed.
nrtPS	Allowed	Allowed	Scheduling may restrict a service flow to unicast polling via the transmission/request policy; otherwise all forms of polling are allowed.
BE	Allowed	Allowed	All forms of polling allowed.

The following subclauses define service flow scheduling services for uplink operations.

6.3.5.2.1 UGS

The UGS offers fixed-size grants on a periodic basis, which eliminate the overhead and latency of SS requests and assure that grants are available to meet the flow's real-time needs. The BS shall provide data grants to the SS at periodic intervals based upon the Maximum Sustained Traffic Rate specified for the service flow. The size of these grants shall be sufficient to hold the fixed-length data associated with the service flow (with associated generic MAC header and Grant management subheader) but may be larger at the discretion of the BS scheduler. In order for this service to work correctly, the Request/Transmission Policy (see 11.13.13) setting shall be such that the SS is prohibited from using any contention request opportunities for this connection.

The Grant Management subheader (6.4.2.2.2) is used to pass status information from the SS to the BS regarding the state of the UGS service flow. The most significant bit of the Grant Management field is the Slip Indicator (SI) bit. The SS shall set this flag once it detects that this service flow has exceeded its transmit queue depth. Once the SS detects that the service flow's transmit queue is back within limits, it shall clear the SI flag. The flag allows the BS to provide for long-term compensation for conditions, such as lost maps or clock rate mismatches, by issuing additional grants. The poll-me (PM) bit (6.4.6.3.3) may be used to request to be polled for a different, non-UGS connection.

The BS shall not allocate more bandwidth than the Maximum Sustained Traffic Rate parameter of the Active QoS Parameter Set, excluding the case when the SI bit of the Grant Management field is set. In this case, the BS may grant up to 1% additional bandwidth.

6.3.5.2.2 rtPS

The rtPS offers periodic unicast request opportunities, which meet the flow's real-time needs and allow the SS to specify the size of the desired grant. This service requires more request overhead than UGS, but supports variable grant sizes for optimum data transport efficiency.

The BS shalll provide periodic unicast request opportunities. In order for this service to work correctly, the Request/Transmission Policy setting (see 11.4.9.13) shall be such that the SS is prohibited from using any contention request opportunities for that connection. The BS may issue unicast request opportunities as prescribed by this service even if prior requests are currently unfulfilled. This results in the SS using only unicast request opportunities in order to obtain uplink transmission opportunities (the SS may still use unso-

licited data grants as well). All other bits of the Request/Transmission Policy are irrelevant to the fundamental operation of this scheduling service and should be set according to network policy.

6.3.5.2.3 nrtPS

The nrtPS offers unicast polls on a regular basis, which assures that the service flow receives request opportunities even during network congestion.

The BS shall provide timely unicast request opportunities. In order for this service to work correctly, the Request/Transmission Policy setting (see 11.4.9.13) shall be set such that the SS is allowed to use contention request opportunities. This results in the SS using contention request opportunities as well as unicast request opportunities and unsolicited data grants. All other bits of the Request/Transmission Policy are irrelevant to the fundamental operation of this scheduling service and should be set according to network policy.

6.3.5.2.4 BE service

The intent of the BE service is to provide efficient service for best effort traffic. In order for this service to work correctly, the Request/Transmission Policy setting shall be set such that the SS is allowed to use contention request opportunities. This results in the SS using contention request opportunities as well as unicast request opportunities and unsolicited data grants. All other bits of the Request/Transmission Policy are irrelevant to the fundamental operation of this scheduling service and should be set according to network policy.

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Replace the text contents of RevD/D4, section 11.13.7 (page 626) with the following:

11.13.7 Maximum sustained traffic rate

This parameter defines the peak information rate of the service. The rate is expressed in bits per second. The parameter specifies the maximum amount of SDU data (when available) that shall be carried on the associated connection averaged over an interval of time. The value represents the amount of SDU data delivered by the CS at the CS SAP of the receiver. For ARQ-enabled connections, the rate corresponds to the actual rate of delivery. For non-ARQ connections, the rate corresponds to the theoretical rate of delivery assuming no loss of data within the air interface.

The limitition imposed by this parameter shall be satisfied when the following is true. Let S denote additional demand accumulated at the MAC SAP of the transmitter during an arbitrary time interval of length T. Then the amount of data delivered during this interval shall be no more than min {S, R * T}.

If the parameter is omitted or set to zero, there is no explicitly mandated maximum rate. This field specifies only a bound, not a guarantee that the rate is available. The algorithm for policing to this parameter is left to vendor differentiation and is outside the scope of the standard.

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Replace the text contents of RevD/D4, section 11.13.9 (page 627) with the following:

11.13.9 Minimum reserved traffic rate

This parameter specifies the minimum SDU data transfer rate for the associated service flow. The rate is expressed in bits per second and specifies the minimum amount of SDU data (when available) to be transported on the associated connection averaged over an interval of time. The parameter represents the amount of SDU data delivered by the CS at the CS SAP of the receiver. For ARQ-enabled connections, the rate corresponds to the actual rate of delivery. For non-ARQ connections, the rate corresponds to the theoretical rate of delivery assuming no loss of data within the air interface.

The limitition imposed by this parameter shall be satisfied when the following is true. Let S denote additional demand accumulated at the MAC SAP of the transmitter during an arbitrary time interval of length T. Then the amount of data delivered during this interval shall be no less than min {S, R * T}.

The BS shall be able to satisfy bandwidth requests for a service flow up to its Minimum Reserved Traffic Rate. If less bandwidth than its Minimum Reserved Traffic Rate is requested for a service flow, the BS may reallocate the excess reserved bandwidth for other purposes. The aggregate Minimum Reserved Traffic Rate of all service flows may exceed the amount of available bandwidth. If this parameter is omitted, then it defaults to a value of 0 bits per second (i.e., no bandwidth is reserved for the service flow).

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Replace the text contents of RevD/D4, section 11.13.10 (page 627) with the following

11.13.10 Minimum tolerable traffic rate

This parameter specifies the minimum acceptable SDU data transfer rate for the associated service flow. The rate is expressed in bits per second and specifies the minimum acceptable amount of SDU data (when available) to be transported on the associated connection averaged over an interval of time. The value corresponds to the actual amount of SDU data delivered by the CS at the CS SAP of the receiver.

The limitition imposed by this parameter shall be satisfied when the following is true. Let S denote additional demand accumulated at the MAC SAP of the transmitter during an arbitrary time interval of length T. Then the amount of data delivered during this interval shall be no less than min {S, R * T}.

Realized rates below this level may indicate the need to take special action such as moving to a more robust burst profile or deletion of the connection.

If this parameter is omitted, then it defaults to a value of 0 bits per second.

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Insert the following in Table 337 following the entry for Type 28 (page 621, line 61) with the following

Type	Parameter
29	Time base

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Insert the following section 11.13.11 (page 628) with the following

11.13.11 Time base

This parameter specifies the length of the sampling interval used for calculation of connection SDU traffic rates. The rate of interest is computed by taking the number of SDU data bits handled within a sampling interval and dividing it by the length of the sampling interval.

Type	Length	Value	Scope
[145/146].29	2	Time base value in ms	DSA-REQ DSA-RSP DSA-ACK