Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Definition of Data Delivery Services**
Date Submitted	**31-Oct-2003**
Source(s)	Vladimir Yanover Leonid Shousterman Ronnie Shechter Alvarion Ltd. 11/5 Shtern Str. Herzlya, Israel Voice: +972-36457834 Fax: +972-36456222 mailto:vladimir.yanover@alvarion.com mailto::leonid.shousterman@alvarion.com mailto:ronnie.shechter@alvarion.com
Re:	Call for task Group review of 802.16e-03/07r4 Working Document
Abstract	The document contains suggestions for definition of Data Delivery Srevices for 802.16e from the prospect of 1) types of QoS contracts 2) set of parameters for each contract 3) system behavior
Purpose	The document is contributed to support certain comment on the 802.16e Working Document
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate text contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures (Version 1.0) <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, if there is technical justification in the opinion of the standards-developing committee and provided the IEEE receives assurance from the patent holder that it will license applicants under reasonable terms and conditions for the purpose of implementing the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:r.b.marks@ieee.org> as early as possible, in written or electronic form, of any patents (granted or under application) that may cover technology that is under consideration by or has been approved by IEEE 802.16. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Definition of Data Delivery Services

Vladimir Yanover, Leonid Shousterman, Ronnie Shechter
Alvarion Ltd.

1. References

[1] IEEE P802.16/D5-2001, IEEE Draft Standard for Local and Metropolitan Area Networks – Part 16: Air Interface for Fixed Broadband Wireless Access Systems, 2001-10-18
[2] IEEE P802.16-REVd/D1-2003, IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems ((Draft Revision of IEEE Std 802.16-2001)
[3] IEEE 802.16e-03/07r4 TGe Working Document (2003-08-12)
[4] IEEE 802.16.1mc-00/03 "802.16 BWA Air Interface Medium Access Control. Proposal for Standard" by Vladimir Yanover and Leonid Shousterman

2. The Document's Goal

The document's goal is to propose a definition of Data Delivery Services for 802.16e from the prospect of 1) types of QoS support 2) set of QoS parameters for each type of service 3) system behavior. The proposal was derived from contribution "Classes of Services Definition" section of IEEE 802.16.1mc-00/03 "802.16 BWA Air Interface Medium Access Control. Proposal for Standard" by Vladimir Yanover and Leonid Shousterman further developed in IEEE 802.16e-03/56. Essential change to the latter contribution was that instead of redefinition of the term "Class of Service" (already used in 802.16 MAC) a new term "Data Delivery Service" is introduced. Section numbers refer to [2] .

3. Incentive for Adding Definition of Data Delivery Services

There is no ***direct*** specification of data delivery services in QoS terms in 802.16 MAC, except UGS service in 6.2.5 "Uplink scheduling service". Note that UGS service is for UL only. Other definitions in that section refer to request / grant process but not data delivery. For example, definition of Real-Time Polling Service (rtPS) in 6.2.5.2: "The service offers real-time, periodic, unicast **request** opportunities, which meet the flow's real-time needs and allow the SS **to specify the size of the desired grant**." Note that BS is not explicitly prescribed to react to the request.

Reason for that lays in the scope of the standard, that does not include specifications related to scheduling.

On the contrary, 802.16e needs tools for description of data delivery services in the terms of QoS parameters (rate, delay etc.) for both DL and UL. These descriptions will become elements for Service Context specification

4. Specific changes in the Standard

This chapter contains specific changes suggested in IEEE 802.16e-03/07r4.

[Insert before section 6.4.14]

6.4.14 Data Delivery Services

Data delivery service is associated with certain predefined set of QoS-related Service Flow parameters. For example, Continuing Grant Service has the following parameters:

- SDU Size
- SDU Inter-arrival Interval
- Time Base
- Maximum Latency
- Minimum Tolerable Traffic Rate

Note that definition of Data Delivery Service does not include assignment of specific values to the parameters.

6.4.14.1.1 Types of Data Delivery Services

Type of Data Delivery Service identifies specific set of QoS parameters – see Table AAA.

Table AAA - Type of Data Delivery Services

Type	Symbolic Name of Service Type	Meaning
0	CG	Continuing Grant Service For UL connections should be supported by UGS Scheduling Service
1	CG-AD	Continuing Grant with Activity Detection service
2	RT-VR	Real Time – Variable Rate service For UL connections should be supported by rtPS Scheduling Service
3	NRT-VR	Non-Real Time – Variable Rate service For UL connections should be supported by nrtPS Scheduling Service
4	BE	Best Efforts service For UL connections should be supported by BE Scheduling Service

See below detailed definitions for the data delivery services of different types.

6.4.14.1.2 Continuing Grant (CG) Service

This type of service is to support real-time applications generating fixed-size data packets on a periodic basis.

The following are the parameters of the service:

Table BBB. Continuing Grant Service (CG) Parameters

Parameter	Meaning
SDU Size	According to 11.4.9.16.

Parameter	Meaning
SDU Inter-arrival Interval	Interval between arrivals of consequent SDUs to MAC SAP of the transmitter
Time Base	Parameter T as specified in 11.4.9.9; should be much larger than Maximum Latency
Maximum Latency	As specified in 11.4.9.14
Minimum Tolerable Traffic Rate	Optional parameter described in 11.4.9.10. This value should be less than (SDU Size)*8/(SDU Inter-arrival Interval). The difference between these two values reflects SDUs' loss rate. Default = 0.

Description of the service

The BS is supposed during each time interval of the length (Time Base) to grant to the connection resources sufficient for transferring at least N SDUs of the given size where N = (Time Base) / (SDU Inter-arrival Interval) so that each SDU shall be delivered within time interval (Maximum Latency). If the data rate at the connection falls below (Minimum Tolerable Traffic Rate), the BS may close the connection releasing resources to other services.

6.4.14.1.3 Continuing Grant Service with Activity Detection (CG-AD)

This service is to support real-time applications generating fixed-size data packets on a periodic basis, which may become inactive for long periods of time.

All parameters described in the Table BBB are relevant; one more parameter needed:

Table CCC - Continuing Grant Service with Activity Detection Additional Parameters

Parameter	Meaning
Activity Ramp up Time	Maximum time (sec) allocated for the system to recognize a demand that appears after certain period of inactivity

Description of the service

The service has two states: ACTIVE and INACTIVE. In ACTIVE state service performs same way as CG service.. In INACTIVE state delivery of SDUs is not guaranteed (and then the SDUs are discarded). If the service is in INACTIVE state and an SDU arrived to transmitter's MAC SAP, the service should switch to ACTIVE state within (Activity Ramp up Time) seconds. It is not specified on which condition the service switches from ACTIVE to INACTIVE state.

6.4.14.1.4 Real-Time Variable Rate (RT-VR) Service

This service is to support real-time data applications with variable bit rates which require guaranteed data rate and delay. The following are the parameters of the service:

Table DDD. Real Time Variable Rate QoS Service Parameters

Parameter	Meaning
Maximum Latency	As specified in 11.4.9.14
Time Base	Parameter T as specified in 11.4.9.9; should be much larger than Maximum Latency
Minimum Reserved Traffic Rate	As defined according to 11.4.9.9 with time base = T

Parameter	Meaning
Minimum Tolerable Traffic Rate	As specified in 11.4.9.10, with time base = T. This value should be less than Minimum Reserved Traffic Rate. The difference between these two values reflects SDUs' loss rate
Maximum Sustained Traffic Rate	Optional parameter; see 11.4.9.7. If specified, should be greater than Minimum Tolerable Traffic Rate. If not specified, the default is equal to Minimum Tolerable Traffic Rate

Description of the service

Let S denote the amount of data arrived to the transmitter's MAC SAP, during time interval T = Time Base; R = Minimum Reserved Traffic Rate. Then the BS is supposed during each time interval of the length (Time Base) to grant to the connection resources sufficient for transferring amount of data at least min {S, R * T}. Any SDU should be delivered within time interval D = Maximum Latency. In the case when the amount of data submitted to the transmitter's MAC SAP exceeds (Maximum Sustained Traffic Rate) * T, delivery of each specific SDU is not guaranteed.

6.4.14.1.5 Non-Real-Time Variable Rate (NRT-VR) Service

This QoS profile shall support applications that require a guaranteed data rate but are insensitive to delays. It is desirable in certain cases to limit the data rate of these services to some maximum rate. The QoS profile is defined by the following parameters defined as in the Table DDD (note absence of Maximum Latency parameter):

- ?? Time Base
- ?? Minimum Reserved Traffic Rate
- ?? Minimum Tolerable Traffic Rate
- ?? Maximum Sustained Traffic Rate

Description of the service

Let S denote the amount of data arrived to the transmitter's MAC SAP, during time interval T = Time Base; R = Minimum Reserved Traffic Rate. Then the BS is supposed during each time interval of the length (Time Base) to grant to the connection resources sufficient for transferring amount of data at least min {S, R * T}. In the case when the amount of data submitted to the transmitter's MAC SAP exceeds (Maximum Sustained Traffic Rate) * T, delivery of each specific SDU is not guaranteed

6.4.14.1.6 Best Effort (BE) Service

This service is for applications with no rate or delay requirements. The following are the parameters of the service:

Table EEE. Best Effort Service Parameters

Parameter	Meaning
Maximum Sustained Traffic Rate	As specified in 11.4.9.7

Description of the service

In the case when the amount of data submitted to the transmitter's MAC SAP exceeds (Maximum Sustained Traffic Rate) * T, delivery of each specific SDU is not guaranteed

[Change at the section 11.4.9.9]

11.4.9.9 Minimum reserved traffic rate

This parameter specifies the minimum rate~~, in bits per second,~~ reserved for this service flow.

Minimum Reserved Traffic Rate = R (bits/sec) with time base T(sec)" means the following. Let S denote additional demand accumulated at the MAC SAP of the transmitter during an arbitrary time interval of the length T. Then the amount of data forwarded to PHY (in bits) during this interval should be not less than min {S, R * T}.

The BS should 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. The value of this parameter is calculated from the byte following the MAC header HCS to the end of the MAC PDU payload. If this parameter is omitted, then it defaults to a value of 0 bits per second (i.e., no bandwidth is reserved for the flow by default). ~~This field is only applicable at the BS and shall be enforced by the BS.~~

[Add new heading before section 11.4.8.10]

11.4.9.10. Minimum Tolerable Traffic Rate

"Minimum Tolerable Traffic Rate = R (bits/sec) with time base T(sec)" means the following. Let S denote additional demand accumulated at the MAC SAP of the transmitter during an arbitrary time interval of the length T. Then the amount of data forwarded at the receiver to CS (in bits) during this interval should be not less than min {S, R * T}.

In the case of DL connection, Minimum Tolerable Traffic Rate should be monitored by the BS to make decisions on rate change or deletion of the connection in the case SDUs' loss ratio is too high. So SS has to measure and report certain parameters to BS as specified in NNN .