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Qos Analysis Of Wimax Network 802.16

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Abstract: WiMAX is one of the important broadband wireless technologies .Being an emerging technology, WiMAX supports multimedia applications such as voice over IP (VoIP), voice conference and online gaming. It is necessary to provide Quality of Service (QoS) guaranteed with different characteristics, quite challenging, however, for Broadband Wireless Access (BWA) networks.. Many traffic scheduling algorithms are available for wireless networks, e.g. Round Robin, scheme. WiMax (IEEE 802.16) is one such standard specifies general QoS .In this paper, we analysed and simulated the different scheduling algorithms for WiMAX.

Keywords: Qos Class, Scheduling Algorithm, WiMAX

I. INTRODUCTION

WiMAX (Worldwide interoperability for Microwave Access) is one of the most emerging technologies based on IEEE 802.16 standard [1-5] for Broadband Wireless Access (BWA) in metropolitan areas by providing an exciting addition to the current broadband techniques for the last mile access. The standard defines two operational modes: PMP (Point to Multi Point) network, traffic only occurs between BS and SSs and Mesh network, the traffic occurs between BS and SSs and can also be routed directly between SSs. Scheduling algorithms for a particular network need to be selected based on the type of applications or users and their QoS requirements. For real-time applications such as delay and delay jitter are the most important QoS requirements. On the other hand, for non-real time applications such as file transfer (FTP), throughput is the most important QoS requirement. Some applications, such as web-browsing and email do not have any QoS requirements. In a network, different types of applications, with diverse QoS requirements can exist. A scheduling algorithm's task in a multi-class network is to categorize the users into one of the pre-defined classes. Each user is assigned a priority, taking into account its QoS requirements. Subsequently, according to the priority of the users /bandwidth is allocated as well as ensuring that fairness between the users is maintained. Packet scheduling algorithms are implemented at both the BS and SSs. A scheduling algorithm at the SS is required to distribute the bandwidth allocation from the BS among its connections. A scheduling algorithm at the SS is not needed if the BS grants bandwidth to each connection of the SS separately when the Grant Per Connection (GPC) procedure is followed and if the Grant Per Subscriber Station (GPSS) procedure is followed, then the scheduling algorithm at the SS needs to decide on the allocation of bandwidth among its connections. The scheduling algorithm implemented at the SS can be different than that at the BS. The MAC layer in WiMAX basically provides intelligence to the PHY layer. The IEEE 802.16- 2004 MAC layer specifies four scheduling services: Unsolicited Grant Service (UGS), real-time Polling Service (rtPS), non-real time Polling Service (nrtPS) and Best Effort (BE) QoS classes. UGS scheduling service is designed to support applications that generate fixed size data packets periodically. To support the real-time needs of such applications and reduce overhead by the bandwidth request- grant process, the BS allocates fixed size data grants without receiving explicit requests from the SS. The size of the grants is based on the maximum rate that can be sustained by the application and is negotiated at connection setup. Such applications are T1/E1 and VoIP. rtPS scheduling service is designed to support real-time applications that generate variable size packets on a periodic basis such as MPEG video or VoIP. The BS allows the SSs to make periodic unicast requests and allows them to specify the size of the desired grant. Since a dedicated grant request is contention-free, the bandwidth request is guaranteed to be received by the SS in time. nrtPS is designed to support non-real time applications that require variable size data grant bursts on a regular basis. This scheduling service supports applications that are delay tolerant but may need high throughput such as File Transfer Protocol (FTP) applications. Contention request opportunities are used by the SSs of this class. In BE on space-available basis the bandwidth request by such applications is granted. The SS is allowed to use both contention based and contention-free

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bandwidth requests, although when the system load is high contention-free is not granted. This traffic class contains applications that do not require any QoS /guarantee like World Wide Web (WWW) access. The IEEE 802.16 MAC layer keeps scheduling algorithms to be used as an open issue. Vendors and operators have the choice among many existing scheduling techniques. The existing implementation also does not differentiate between the different QoS classes. This technique is not suitable for systems with different levels of priority and systems with strongly varying sizes of traffic. The PHY layer of WiMAX is the physical transport of data for frequencies. To distinguish whether the PHY layer is Single Carrier (SC) or uses OFDM technology, variants of the PHY layer are used. OFDM (Orthogonal Frequency Division Multiplexing) allows sub- channels to be spaced much close to each other reducing the required bandwidth and at the same time keeping the modulated signals orthogonal to each other so they do not interfere with each other. OFDMA (Orthogonal Frequency Division Multiple Access) allows certain sub-carriers to be assigned to different users. A group of sub carriers constitutes a sub-channel with each sub-channel belonging to a particular SS.

II BASIC PROTOCOL STRUCTURE OF MOBILE WIMAX

The high-level MAC/PHY protocol structure for mobile WiMAX as specified in IEEE 802.16-2005[5] is shown in Fig. 1 This structure is built on a simple OFDMA-based PHY and a MAC layer composed of two sub layers: the CS and MAC common part sub layer (MAC CPS).

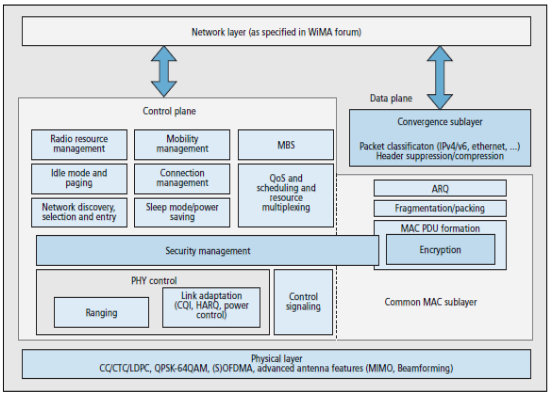

Figure 1: MAC/PHY protocol structure in mobile WiMAX[1]

The functional blocks in the CPS may be logically classified into upper MAC functions responsible for mobility control and resource management, and lower MAC functions that focus on control and support for the physical channels defined by the PHY. Although not formally separated in the standard, one may also classify functions into control plane and data plane functions. The upper MAC functional group includes protocol procedures related to radio resource control and mobility related functions such as:

- Network discovery, selection, and entry
- Paging and idle mode management
- Radio resource management
- Layer 2 mobility management and handover protocols
- QoS, scheduling, and connection management
- Multicast and broadcast services (MBS)

On the control plane, the lower MAC functional group includes features related to layer 2 Security and sleep mode management as well as link control and resource allocation and multiplexing functions. The PHY control block handles PHY signaling such as ranging, measurement/feedback (CQI), and hybrid automatic repeat request (HARQ) acknowledgment (ACK)/negative ACK (NACK). The control signaling block generates resource allocation messages. On the data plane, the ARQ block handles MAC ARQ function. For ARQ-enabled connections, the ARQ block logically splits MAC signaling data units (SDUs) into ARQ blocks and numbers each logical ARQ block. The fragmentation/ packing block performs fragmenting or packing MSDUs based on scheduling results from the scheduler block.

III. SCHEDULING ARCHITECTURE

EEE 802.16 architecture includes one Base Station (BS) and multiple Subscriber Stations (SS). Communication occurs in two directions: from BS to SS is called Downlink and from SS to BS is called Uplink. During downlink BS broadcasts data to all subscribers and subscribers selects packets destined for it. While Uplink channel is shared by multiple SSs and to ensure this sharing this channel is slotted and this slots are allocated by BS to various SSs in one uplink frame by using Time Division Duplexing (TDD) or Frequency Division Duplexing (FDD). This slot allocation information is broadcasted by the BS through the Uplink Map Message (UL-MAP) at the beginning of each frame. UL-MAP contains Information Element (IE) which includes the transmission opportunities, i.e., and the time slots in which the SS can transmit during the uplink subframe. After receiving the UL-MAP, each SS will transmit data in the predefined time slots as indicated in IE.

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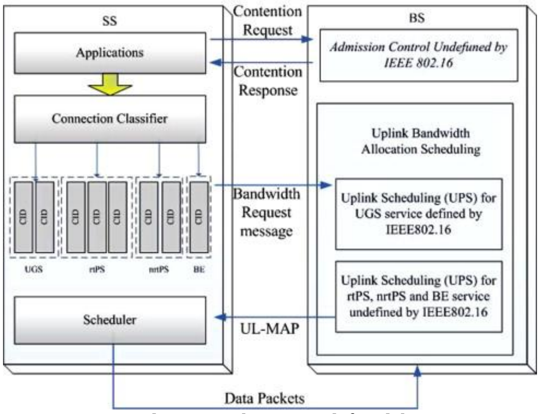

Figure. 2: General QoS architecture defined by IEEE 802.16 Standard[6]

Qos Architecture For Ieee 802.16 Mac Protocol

IEEE 802.16 can support multiple applications (data, voice, and video) with different QoS requirements [1]. The MAC layer protocol defines four QoS services: ·

Unsolicited Grant Service (UGS): It is designed for services which require Constant Bit Rate (CBR) such as voice application and T1/E1.

Real -Time Polling Service (rtPS): It is designed for services which generate variable size data packets but delay requirements should be met e.g. MPEG video.

Non-Real-Time Polling Service: It is designed for services which require good average data rate performance but can tolerate delay e.g. FTP.

Best Effort (BE) service: It is designed for services which don't require any specific QoS guarantee e.g. HTTP and Web Browsing.

Figure 1 shows the existing QoS architecture of IEEE 802.16. Uplink Bandwidth Allocation scheduling resides in the BS to control all the up link packet transmissions. Since IEEE 802.16 MAC protocol[8-9]l is connection oriented, the application first establishes the connection with the BS as well as the associated service flow (UGS, rtPS, nrtPS or BE). BS will assign the connection with a unique connection ID (CID). Each connection requests for desired bandwidth to the BS. Bandwidth is granted per connection or per subscriber in which per connection allocation is done by SS. IEEE 802.16 defines: 1)The signaling mechanism for information exchange bet ween BS and SS such as the connection setup, BW-Request and UL-MAP. 2) The Uplink Scheduling for UGS service flow. And IEEE 802.16 does not define: 1) the Uplink Scheduling for rtPS, nrtPS and BE service flow. 2) The Admission Control and Traffic Policing process. Out of these undefined parts, next we discusses various approaches to provide Uplink Scheduling for rtPS, nrtPs and BE service flow.

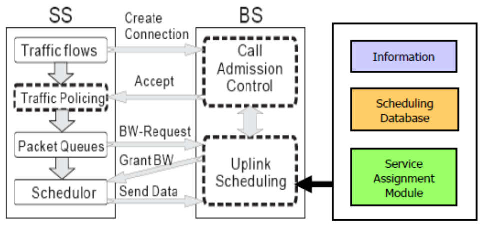

Figure 3: Qos Architecture of Mobile WiMAX

Here is a brief description of the different steps in this new QoS architecture:

- At the beginning of each time frame, the Information Module collects the queue size information from the BW-Requests received during the previous time frame. The Information Module will process the queue size information and update the Scheduling Database Module.
- The Service Assignment Module retrieves the information from the Scheduling Database Module and generates the UL-MAP.
- BS broadcasts the UL-MAP to all SSs in the downlink subframe.
- BS's scheduler transmits packets according to the UL-MAP received from the BS.

IV. WIMAX SCHEDULING ALGORITHMS

Figure. 4 shows the module structure. When a packet arrives at the MAC layer from the higher layers, it is classified into a particular service flow. The service flow, associated with a connection, is configured by the user, who defines the QoS requirements. Each SS has an uplink and a downlink default connection to transmit management messages and all traffic that cannot be classified to any other service flow. When the simulation starts, each SS registers itself at the BS by simulating the registration phase. The BS allocates a CID to each connection and stores the service flow parameters in a table. The main flow parameters include service type, QoS requirements,and fragmentation/concatenation piggybacking capability. The BS has both an uplink scheduler and a downlink scheduler. The downlink scheduler decides which packets coming from the upper layer will be transmitted in the next downlink subframe. This decision is based on the QoS requirements and on the queue status of the various downlink connections. The uplink scheduler decides which uplink connections can transmit in the next uplink subframe as well as the number of slots these connections can use. This decision is based on the QoS requirements of the uplink connections and on the bandwidth requests sent either by polling or piggybacking by the SSs.Aggregate requests are sent in intervals defined by the user. Bandwidth is allocated using the Grant Per Connection (GPC) approach, since schedulers for the SSs are still under development. The Grant Per SS (GPSS) approach as well as schedulers for the SSs will be implemented in the near future.

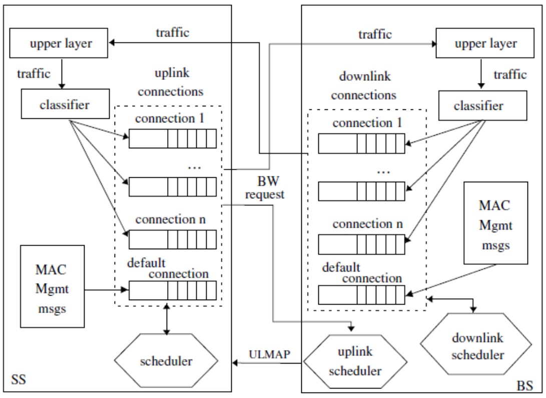

Figure. 4. Structure of the WiMAX module.

The focus is on scheduling algorithms executed at the BS for the uplink traffic in WiMAX /i.e. traffic from the SSs to the BS. A scheduling algorithm for the uplink traffic is faced with/challenges not faced by an algorithm for the downlink traffic. An uplink scheduling algorithm has to made complex decisions because it does not have queue information of SSs and it has to coordinate with all SSs to implement its scheduling mechanism. On the other hand a downlink algorithm negotiates its decision locally at the BS. We can distinguish between three categories of scheduling algorithms for the uplink traffic in WiMAX.

V HOMOGENEOUS SCHEDULING ALGORITHMS

In this section we discuss the design of some known legacy scheduling algorithms. Algorithms in this category do not address the issue of link channel quality.

1) Round Robin (RR) [2] is one of the simplest scheduling algorithms, also called cyclic scheduler, designed especially for a time sharing system. Where the time slots without priority are assigned to each queue in equal portions by the scheduler. Once a queue is served, it is not visited again until all the other SSs in the system have been served and every queue is allocated with the same portion of system resources regardless of the channel condition and ultimately utilizing the same resources. Also, it cannot guarantee different QoS requirements for each queue. Therefore such conditions are not relevant to WiMAX context.

2) Weighted Round Robin (WRR) Scheduler [3] assigns static weight to each SS and the bandwidth is then allocated according to these static weights. The algorithm will not provide good performance in the presence of variable size packets. So that relative priority of a SS is set because the subscriber do not using the same MCS and traffic therefore they need different resources. Therefore different queues are assigned different values of weights so that different resources could be granted. Higher weights are assigned to SSs of the rtPS class as compared to the weight assigned to SSs of the nrtPS and BE classes.

3) Earliest Deadline First (EDF) [4] due to its ability in work saving behavior, EDF was originally proposed for real-time applications in wide area networks. The algorithm allocates bandwidth to the SS that has the packet with the earliest deadline and assigns deadline to each packet. Deadlines can be assigned to packets of a SS based on the SS's maximum delay requirement. The EDF algorithm is suitable for SSs belonging to the UGS and rtPS scheduling services, since SSs in this class have stringent delay requirements. Since SSs belonging to the nrtPS service do not have a delay requirement, SSs from the nrtPS or BE class can potentially starve.

4) Weighted Fair Queuing (WFQ) Scheduler [4] used for the uplink traffic in WiMAX. WFQ assigns finish times to packets and packets are selected in increasing order according to their finish times. The finish times of packets of a SS are calculated based on the size of the packets and the weight assigned to the SS. The disadvantage of the WFQ algorithm is that it does not consider the start time of a packet.

VI RESULTS AND DISCUSSION

The Simulator used is Qualnet 5.The table 2 shows the system parameters used for simulation.

Table 2:Simulation parameters

Parameters	Value
Channel Bandwidth	10MHz
FFT Size (FFT)	2048
Cyclic prefix or guard time	1/16
BS range	1000m
Frame Duration	20ms
Simulation type	30s
Antenna height	20m
Antenna type	Omni
Antenna gain	12dB
Modulation	16 QAM (1/2)
Sub carrier frequency spacing	10.94KHz
Symbol duration	102.9ms
Noise (dBm)	-102.8 dBm

Path Loss Model Characterization And Received SNR Calculation:

The basic path loss equation with correction factors is calculated as,

$$PL = A + 10\Upsilon \log_{10}\left(\frac{d}{d_0}\right) + X_f + X_h$$

where, d is the distance between the transmitter and the receiver antennas in meters, d_0 = 100 m. The other parameters are defined as,

$$A = 20\log\left(\frac{4\pi d_0}{\lambda}\right)$$

$$\gamma = a - bh_b - c / h_b$$

where h_b is base station height above ground in meters and a, b and c are constant. The correction factors for the operating frequency and for SS height are given as

$$X_f = 6\log_{10}\left(\frac{f}{2000}\right)$$

$$X_h = -20\log_{10}\left(\frac{h_r}{2}\right)$$

where f is the frequency in MHz and h_r is the SS antenna height above ground in meters. Further, the received signal strength can by estimated by following equation

$$P_r = P_t - PL$$

The SNR is computed as

$$SNR = P_r - Noise$$

where Noise represents either only thermal noise (when no interference is introduced, or summation of thermal noise and interference received by disturbers.

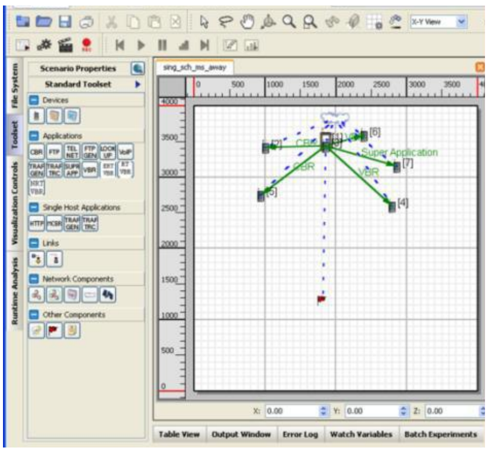

Figure 5- Wimax Simulation Model

These results are graphically analysed using matlab. The results shown in Figure 6 shows performance of SP, WRR, and WF scheduling techniques in WiMAX .The result shown in Figure 6 clearly shows that WRR technique has achieved the highest value of throughput for different numbers of MS compared to the other techniques.

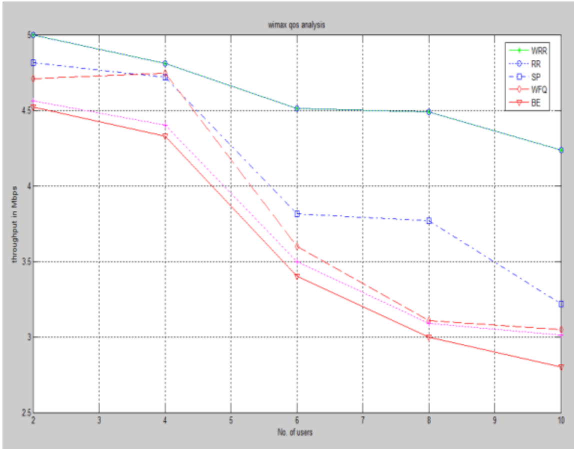

Figure 6- Throughput vs number of users for different QoS classes of WiMax Scheduler

CONCLUSION

In this paper, we presented Qos analysis of WiMax 802.16 networks. We evaluated the performance of wimax and the simulation result shows that WRR is the best scheduling algorithm to achieve the required grade of service in WiMAX .

REFERENCES

[1] 802.16-2004, IEEE Standard for local and metropolitan area networks, Air Interface for Fixed Broadband Wireless Access Systems,Oct 2004. [2]C.F. Ball, E. Humburg, K. Ivanov, and F. Treml, “Comparison of IEEE802.16 WiMAX Scenarios with Fixed and Mobile Subscribers in Tight Reuse”, the 14th IST Mobile & Wireless Communication Summit, Dresden, 19 - 23 June 2005.

[3]C.Cicconetti, A.Erta, L.Lenzini and E.Mingozzi, “Performance Evaluation of the IEEE 802.16 MAC for QoS Support”,*IEEE Transactions on Mobile Computing*, vol.6, no.1, pp.26-38,January 2007.

[4] N.Ruangchaijatupon, L.Wang and Y.Ji, “A Study on the Performance of Scheduling Schemes for Broadband Wireless Access Networks”, *Proceedings of International Symposium on Communications and Information Technology*, pp. 1008-1012, October 2006.

[5]M.Shreedhar and G.Varghese, “Efficient Fair Queuing using Deficit Round Robin”, *IEEE/ACM Transactions on Networking*, vol.1, no.3, pp.375-385, June 1996.

[6] T.Tsai, C.Jiang and C.Wang, “CAC and Packet Scheduling Using Token Bucket for IEEE 802.16 Networks”, *Journal of Communications*, vol.1, no2., pp.30-37, May 2006.

[7] H.Rath, A.Bhorkar and V.Sharma, “An Opportunistic Uplink Scheduling Scheme to Achieve Bandwidth Fairness and Delay for Multiclass Traffic in Wi-Max (IEEE 802.16) Broadband

[8] Wireless Networks",*Proceedings of IEEE Global Telecommunications Conference*, pp.1-5,November 2006.

[9] R. Mukul, P. Singh, D. Jayaram, D. Das, N. Sreenivasulu, K. Vinay, and A. Ramamoorthly,"An Adaptive Bandwidth Request Mechanism for QoS Enhancement in WiMax Real Time Communication", Wireless and Optical Communications Networks, 2006 IFIP International Conference on, Bangalore, India, 11 - 13 April 2006

[10] K. Wongthavarawat, and A. Ganz, "Packet scheduling for QoS support in IEEE 802.16 broadband wireless access systems", *International Journal of Communication Systems*, vol. 16, issue 1, pp. 81-96, February 2003.

[11] K.Vinay, N.Sreenivasulu, D.Jayaram and D.Das, "Performance evaluation of end-to-end delay by hybrid scheduling algorithm for QoS in IEEE 802.16 network",*Proceedings of International Conference on Wireless and Optical Communication Networks*, 5 pp., April 2006.