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A Survey of WiMAX IEEE 802.16e Standard and Proposed QoS Providence model for WiMAX PMP mode

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Abstract: ***Now days the use of Wireless technologies has been spread rapidly, wireless accessibility is being deployed increasingly in office and public environments.***

IEEE 802.16e technology also called as WiMAX (Worldwide Interoperability for Microwave Access) is one of the latest standard for wireless network, which provide broadband wireless access over long distance.

There are different amendments of this standard was released with different services and support. This paper provides an overview of WiMAX IEEE 802.16e , features of mobile WIMAX and providing Proposed QoS Providence model for WiMAX PMP mode and also present the literature survey of the papers of several authors in which they deal with the scheduling algorithms and the implementation, compared the results of algorithm of different authors in which they have already done the research in this field.

Keywords: MAC, IEEE 802.16, WiMAX , QoS , PMP mode.

I. INTRODUCTION

IEEE 802.16 standard also known as WiMAX has promised to offer broadband wireless access over metropolitan area networks. The WiMAX technology is based on IEEE 802.16 standard and capable of providing a platform to deliver the applications for convergence of data , voice & video services [1].

WiMAX is one of popular wireless network & provides the high speed of broadband wireless access for mobile users across cities and countries through a variety of devices. It is organized like a cellular network architecture.

This standard includes all the features of IEEE 802.16-2004 with additional functionality. The frequency bandwidth coverageis within the range from 2 to 66 GHz. This technology operates in two operational modes, defined by the MAC layer - Point to Multi-point (PMP) and Mesh Mode [2]. In both modes, MAC layer is designed to support quality of service (QoS) in order to enhance the performance parameters in terms of bandwidth utilizing, latency, jitter and reliability to the end users [2]. In PMP mode communication occurs in two direction that are Downlink and Uplink mode. IEEE 802.16 standards specifies the interface including medium access control (MAC), Physical Layers (PHY) of BWA.

II. OVERVIEW OF IEEE 802.16E

Since 2001 it has involved 802.16 to 802.16d for fixed wireless access & to the new IEEE 802.16e standard with mobability support [3]. IEEE organization The IEEE organization allowed the IEEE 802.16e-2005 amendment to the existing IEEE 802.16-2004 standard in December 2005. The IEEE 802.16e-2005 standard is a further development of 802.16-2004, and it is a further expansion of WiMAX in the frequency range up to 6 GHz with the objective of allowing mobile applications and even roaming [2]. 802.16e standard has portable broadband access.

The structure of IEEE 802.16e contains two layers MAC and PHY as shown in Fig 1.

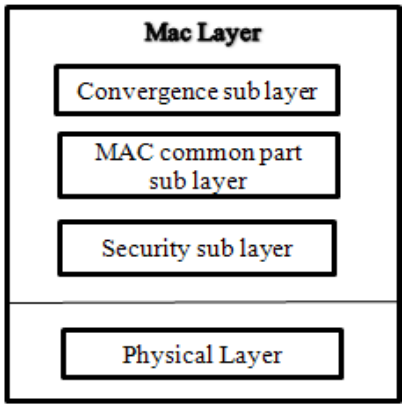

Fig. 1 Structure of IEEE 802.16e standard

Physical Layer : Physical Layer uses scalable OFDMA (Orthogonal Frequency Division Multiple Access) technology in which multiple access can be achieved. This technology allows signals may be divided into many sub-channels to increase the resistance. When the signal is good, a highly efficient 64 QAM coding is used whereas when the signal is poorer, a more robust BPSK coding mechanism is used[8].To provide good Non-line of sight propagation (NLOS) characteristics and hybrid automatic repeat request (HARQ) for good error correction performance PHY Layer includes support for multiple-input multiple-output (MIMO) antennas.

MAC Layer : MAC Layer consist of three sublayers upper layer is Convergence sub layer(CS), middle layer is MAC common part sub(MAC CPS) and lower layer Security sub layer .The main functionality of the CS is to transform data from upper layers into appropriate Mac service data units(SDUs) for the MAC CPS and classifies incoming data. The MAC Common Part Sublayer (CPS) provides the core MAC functionality of system access , allocation of bandwidth, and connection establishment and maintenance. This sublayer also handles the QoS aspect of data transmission. The security sublayer provides functionalities such as authentication, secure key exchange, and encryption. [4].

The subscriber station (SS) cannot transmit data unit it has been allocated a channel by the base station (BS). This allows 802.16e to provide strong support for quality of service (QoS) [4]. Like ATM, the 802.16 standard was designed with variety of traffic types in mind. 802.16 has to handle the requirements of very-high-data-rate applications, such as voice over IP (VoIP) and video or audio streaming, as well as low-data-rate applications, such as web surfing, and handle extremely bursty traffic over the Internet. Some network applications simply cannot work without QoS [5]. Quality of service is one of the major factor to support different types of traffic in WiMAX network. QoS depends upon a number of implementation details like scheduling, buffer management and traffic shaping. The responsibility of scheduling and BW management is to allocate the resources efficiently based on the QoS requirement of the service classes.

There are five service classes which are defined in IEEE 802.16e standard[2]. They are as follows:

1. Unsolicited Grand Services (UGS): UGS is designed to support constant bit rate (CBR) services like voice application and provide a fixed periodic bandwidth allocation.
2. Real Time Polling Services (rtPS): rtPS is designed to support variable bit rate like MPEG video.
3. Extended real time polling Services (ertPS): Service flows that generate variable sized data packets on a periodic basis .ex. VoIP.
4. Non Real Time Polling Services (nrtPS): nrtPS is designed to support non real time services that require variable size data grant burst types on a regular basis.
5. Best Effort (BE) Services: BE is designed to support internet for web surfing[2].

III. LITERATURE SURVEY

In [6], the authors have describe implemented scheduling algorithms and its obtained results based on its taxonomy and provide a survey of recently proposed scheduling algorithms and give detailed information about WiMAX characteristics that need to be considered in developing a scheduler, also analyze which schedulers are best suited for various classes on different situation.

Based on the comprehensive survey [7], the scheduling algorithms are classified into 3 categories:

» Homogenous scheduling algorithm

» Hybrid scheduling algorithm

» Opportunistic scheduling algorithm

After dealing with the scheduling algorithms the author conclude that there are homogenous algorithms like WFQ, WRR, DS, SCFQ which can have a better performance but not for all the QoS classes. WRR is good for better throughput, WFQ is best for end to end delay and real-time classes (UGS, rtPS and ertPS), PF and TCP Aware Uplink algorithm are best suited for BE QoS class, RR algorithm was the best in terms of packet latency (Jitter), SP is not suited for multimedia data and DFPQ for achieving higher bandwidth utilization. To satisfy all the QoS traffic classes homogenous alone cannot handle the traffic, so we must have a hybrid or opportunistic schedulers (cross layer scheduler) to achieve the goals of IEEE 802.16 e QoS standard at MAC layer [6].

In [8] this work, a detailed simulation study was carried out for some scheduling algorithms such as WFQ, Round Robin, WRR and Strict-Priority, analyzing and evaluating the performance of each scheduler to support the different QoS classes. The simulation is carried out via the QualNet 4.5 simulator evaluation version and the results show that effective scheduling algorithm can provide high service standards to support the QoS required by different type of traffic as well as different type of user. The authors have used a simulation study to compare the performance of each scheduler on the different QoS classes. The simulations verified that the Strict-Priority scheduler has the highest throughput and minimum delay for high QoS classes. However it caused bandwidth starvation for the BE and the nrtPS classes. The average end-to-end delay in the Strict-Priority has large value for the rtPS traffic.

The RR scheduler has better performance for low QoS classes on the expense of the high QoS classes. Both WFQ and WRR can control the performance of each class by assigning different weight to each queue.

In [9], the authors present a performance comparison of different WiMAX base station (BS) scheduling algorithms: Deficit Round-Robin (DRR) vs. Proportional Fair (PF) vs. Weighted Deficit Round-Robin (WDRR). This paper studies scheduling in a WiMAX BS. For these purposes, authors run several simulation scenarios and apply different scheduling algorithms. simulations show that PF scheduler is clearly a better choice for BE traffic than DRR scheduler. For VoIP and other real-time traffic, DRR is still the best choice.

In[10], this paper aims to evaluate the implementation of the various types of scheduling algorithms of WiMAX wireless network technology namely: Diffserv-Enabled (Diffserv), Round Robin (RR), Self-Clocked-Fair (SCF), Strict-Priority (SP), Weighted-Fair Queuing (WFQ) and Weighted-Round Robin (WRR). A detailed simulation study via the QualNet 5.0 simulator evaluation version was carried out with the aim to analyze and evaluate the performance of each scheduler to support the different QoS classes. One of the best scheduling algorithms is WF, in terms of the amount of end-to-end delay. The other is RR, in terms of packet latency (Jitter). Finally WRR outperforms the rest by producing the highest rate of throughput of data packet in the network. As to the best scheduling algorithms in terms of the amount of delay time with respect to QoSs classes are WF, SP, and WRR respectively[10].

IV. PROPOSED QOS PROVIDENCE MODEL FOR WIMAX PMP MODE

In a cellular network such as WiMAX, traffic from the BS to the SSs is distinguish as downlink traffic while that from the SSs to the BS is distinguish as uplink traffic. A scheduling algorithm implemented at the BS has to deal with both uplink and downlink traffic. In some cases, separate scheduling algorithms are implemented for the uplink and downlink traffic [11]. This section describe the basic components of the proposed model, and how different components work together to provide QoS to the flows of different SSs.

This model has two portions one SS for managing traffic and another at BS for managing connections requests coming from the SSs to the BS. Whenever an SS wants to communicate with BS or with another SS, it will first send a connection requirement to the BS, upon receiving which, the BS will determine whether to allow the connection to be established or not . The Figure 1 shows the proposed QoS model for WiMAX PMP mode [12].

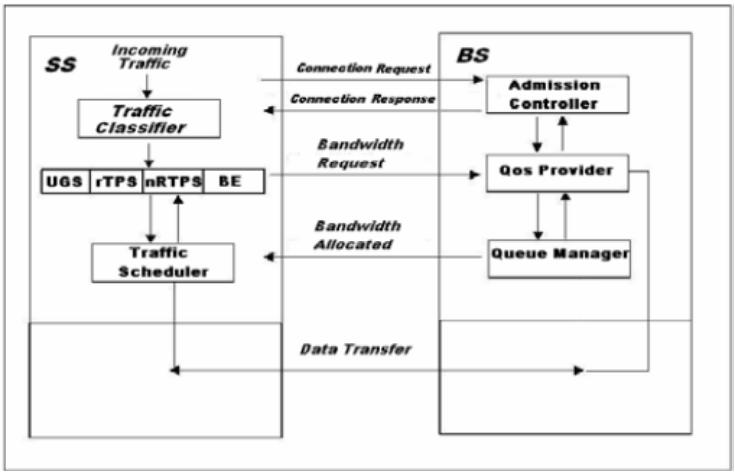

Figure 1 Proposed QoS Model for WiMAX PMP mode

In this model BS requires the service flows to be registered, which will be used later on by both by BS and SS for communication.

The proposed model provide the QoS to the service flows by passing through the following steps [12].

a) Connection Setup

It is the first phase of the communication establishment in WiMAX. The SS that wants to communicate with BS or another SS has to consult with the BS in PMP mode.

The SS sends a connection request to the BS containing the QoS attributes. Admission Controller in BS by consulting with QoS provider entity will make a decision whether to admit the newly service flow of the SS or not and whether it has enough resources to serve the given service flow. If it has enough resources, will send a connection response message that contains, CID (Connection ID) for that connection. The CID is used to differentiate one connection from another that will be used by the QoS provider entity, at the time of scheduling the services, at service providence time [12].

b) Traffic Classifier

Once the SS receives acknowledgement from the BS, it then classifies the incoming traffic into four classes based on their nature and requirements, that are; UGS (Unsolicited grant of service), rTPS (Real -Time Polling Service), nrTPS (Non real time polling service), BE (Best Effort service).

c) QoS Provider

Once the connection is established between the BS and the SS, The traffic classifier classifies the traffic into different classes.

The SS then assign the traffic to different service flows, and sends bandwidth request to the QoS BS for serving the service flow. The QoS provider at the BS then either admits the service flow or rejects. If the requested resources to satisfy the service flow are available then the service flow is admitted to the appropriate queue and resources are reserved for it. If the requested resources are not available to satisfy the flows requirement it rejects the request. The QoS provider is the main component of the model, that is responsible for providing service differentiation and scheduling the service flows by consulting with the Queue manager. If it has enough resources to fulfill the needs of a particular service flow, it forwards to the queue manager, assigning it a priority level according to which it will be serviced. The queue manager stores the service flow traffic in the queue according to its priority. The queue manager then sends the bandwidth response, assigns the service flow the time slots for transmission [12].

d) **Scheduling Strategies**

In order to provide and manage the resource allocation, certain scheduling schemes are used. The QoS provider used different scheduling techniques rely on different scheduling algorithms for serving different service classes for matching their QoS requirements. In order to provide QoS, the QoS provider uses crosslayer scheduling algorithm [13].

e) **Queue Manager**

It is responsible for assigning the incoming service flows, an appropriate queue based in their priority level. The QoS provider upon receiving the bandwidth request for each service flow examines the requirements. If it can satisfy the request of the service flow, it consults with the queue manager, to sends the acknowledgement to the SS, and assigns the service flow an appropriate queue. If the resources are not enough to satisfy a particular service flow's requirement, it sends a negative acknowledgement. The queue manager maintains information about each service flow that is used by the QoS provider for scheduling the service flows accordingly [12].

f) **Traffic Scheduler**

The main purpose of traffic scheduler handles how to and in which order to provide the services to the service flows. At the BS side the QoS provider is the main component for handling request from the service flows coming from the SS side. Once the BS admits the Service flow, to the queue to be service signal the SS to continue the data transfer, through UL-MAP message. The UL-MAP message contains all the information regarding the time slots for each of the service flow, in which the SS will serve the service flows.

V. FEATURES OF MOBILE WIMAX STANDARDS

Features of mobile WiMAX Standards

1) Wimax offer high speed broardband access to mobile internet.
2) It support for both TDD and FDD.
3) Range of Wimax can reach about 80-90 KM.
4) Wimax have flexible bandwidth from 1.25 to 20 MHZ.
5) QoS support.
6) It uses OFDM based physical layer.
7) WiMax offer very high data rate.
8) Wimax MAC layer is connection oriented [14].

VI. Conclusion

This paper presents an overview of the IEEE 802.16e standard, features of mobile WiMAX and QoS Providence model for WiMAX PMP mode. The wide use of applications such as video conferencing, VOIP, online gaming, the need of broadband wireless access has increased. IEEE 802.16e standard provide high speed broadband internet access for fixed and mobile station. QoS model is best fit for PMP mode of the WiMAX. The research area for future direction is to design effective algorithm used for scheduling the traffic.

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