Review Article Impact Factor: 4.226 ISSN: 2319-507X
Avinash S. Kapse, IJPRET, 2015; Volume 3 (9): 1712-1722 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

OVERVIEW OF WIMAX IEEE 802.16E

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Accepted Date: 05/03/2015; Published Date: 01/05/2015

Abstract: IEEE 802.16e standard is a one of the emergent technology in the wireless world. It is Worldwide Interoperability for Microwave Access. The main goal of WiMAX is to deliver wireless communication with quality of service in secure environment. This paper introduces the IEEE 802.16e standard. It also describe the key features of the IEEE 802.16e scheduling algorithm at MAC layer, layer classification and their survey in which several authors have already done the research in this field. In this paper we are going to describe existing system in terms of rtPS throughput and delay analysis and also proposed system for improve or maximize throughput and decrease delay.

Keywords: 802.16e, rtPS, MAC layer Scheduling algorithm

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How to Cite This Article:

Avinash S. Kapse, IJPRET, 2015; Volume 3 (9): 1712-1722

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INTRODUCTION

WiMAX (World Wide Interoperability for Microwave Access) is an IEEE standard (IEEE 802.16d/e) that promises high bandwidth solution with long range for metropolitan area networks. IEEE 802.16 is able to cover large geographical area since the distance between the Base Station (BS) and the Subscriber Station (SS) can extend up to 30 miles[3].The WiMAX technology is based on the IEEE802.16 standard and is capable of providing a platform to deliver the applications for the convergence of data, voice and video services [8].The IEEE 802.16 is likely to emerge as a recent technology for cost effective for everywhere broadband wireless access, supporting fixed, roaming, portable and fully mobile operations offering integrated voice, video and animation data services. The point-to-multipoint (PMP) architecture of IEEE 802.16 can be installing in easy and cost effective manner in large geographical areas and rural areas where no wired infrastructure is available [6].

The WiMAX technology developed based IEEE802.16e-2005[12], is capable of providing network accessto buildings through external antennas connected to radioBase Stations (BSs). The frequency bandwidth coverageis within the range from 2 to 66 GHz. This technologyoperates in two operational modes, defined by the MAC layer - Point to Multi-point (PMP) and Mesh Mode. PMPis a centralized architecture where all the traffics between subscriber stations (SSs) and base station (BS), are controlled by a BS. Traffic direction is used to distinguish two types of data channels: uplink (UL) channel where the data is sent from the SS to the BS and downlink (DL) channel where the burst data is sent from BS to SS. 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 Overview of IEEE 802.16e-

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-2005standard is a further development of 802.16-2004, and itis a further expansion of WiMAX in the frequency range up to 6 GHz with the objective of allowing mobile applications and even roaming. This standard includes all the features of IEEE 802.16-2004 as well as additional functionality. The number of carriers can vary over a wide range depending on permutation zones and FFT (Fast Fourier Transform) base (128,512, 1024, and 2048).Unchallenged, WiMAX wireless network has proven to be lower cost than fixed cable services, despite the many benefits. The FCH (Frame Control Header) content has been shortened and modified for FFT size 128. This amendment adds the features and attributes to thestandard necessary features to support mobility [9].

PHY-

802.16e uses scalable OFDAM to carry data, supporting channel bandwidth of between 1.25 MHz and 20 MHz, with up to 2048 subcarriers. It supports the adaptive modulation and coding, so that in condition of good signal, a highly efficient 64 QAM coding scheme is used, whereas when the signal is poorer, a more robust BPSK coding mechanism is used. In intermediate conditions, 16 QAM and QPSK can also be employed. Other PHY features includes support for multiple-input multiple-output (MIMO) antennas in order to provide good non-line-of-sight propagation (NLOS) characteristics (or higher bandwidth) and hybrid automatic repeat request (HARQ) for good error correction performance [9].

Although the standards allow operation in any band from 2 to 66 GHz, mobile operation is best in the lower bands which are also the most crowded, and therefore most expensive[9].

MAC-

The 802.16 MAC describes a number of Convergence Sub layers which describes how wire line technologies such as Ethernet, Asynchronous Transfer Mode (ATM) and Internet Protocol (IP) are encapsulated on the air interface, and hoe data is classified, etc. It also describes how secure communications are delivered, by using secure key exchange during authentication, and encryption using AES or DES during data transfer. Further feature of the MAC include power saving mechanisms (using sleep mode and idle mode) and handover mechanisms. A key feature of 802.16 is that it is a connection-oriented technology. 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) [9].

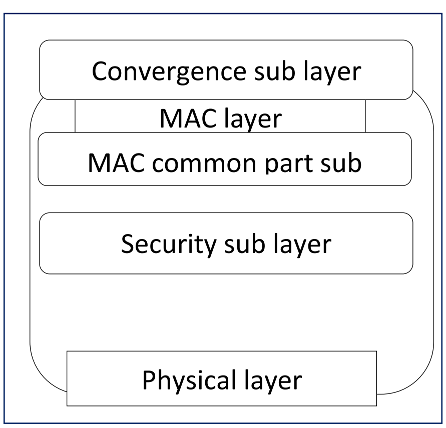


Figure 1. Architecture of IEEE 802.16e

IEEE 802.16e [3] is expected to provide QoS for fixed and mobile users. 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 IEEE802.16e standard. They are as follows:

- Unsolicited Grant Services (UGS): Designed to support Constant bit rate services like voice applications.
- Real Time Data Polling Services (RTPS): Designed to support real time services that generates variable size data packets on a periodic basis like MPEG but insensitive to delay.
- Extended Real Time Polling Services (ERTPS): Designed to support real time applications with variable data rates which require guaranteed data and delay. Example: Voice Over Internet Protocol (VOIP) with silence suppression
- Non Real Time Polling Services (NRTPS): Designed to support non real time and delay tolerant services that require variable size data grant burst types on a regular basis such as File Transfer Protocol (FTP).
- Best Effort (BE): Designed to support data streams that do not require any guarantee in QoS such as Hyper Text Transfer Protocol (HTTP) The QoS provision in Wimax requires complete scheduling mechanism which is not defined in the standard. The scheduling mechanisms have to provide guarantee to the bandwidth required by SS as well as wireless link usage. The goal of designing a scheduler is to minimize power consumption and Bit Error Rate (BER) and to maximize the total throughput. Wired networks scheduling algorithms are unfit for wireless networks due to location dependency and burst channel errors. Thus, the scheduling algorithm should take WiMAXQoS classes and service requirements into consideration.

3 Scheduling Algorithm-

Scheduling algorithm provide mechanisms for bandwidth allocation and multiplexing at the packet level. A suitable scheduling mechanism will provide the necessary QoS guarantees required by heterogeneous classes of traffic while utilizing the resources as efficiently as possible. It is an important concept in IEEE 802.16 networks. Admission control and congestion control policies are all dependent on the specific scheduling disciplines used [8].

As scheduling algorithms perform critical role in band-width sharing and packet scheduling process, every algorithm should have some purpose or aim, on the basis of which it is used. First of all, used algorithm should have capability to share total amount of bandwidth in fair manner. Secondly, every SS in network should have minimum guaranteed bandwidth. Thirdly, should have capability to reduce variations in latency. All these purposes are helpful in provision of QoS [11].

A. Priority Queue (PQ

In [11] Priority Queue, initially packets are classified by using scheduler according to their class. After this, these classified packets moved into different queues according to their classes. PQ will serve the queue which has highest priority. Highest priority queue will be served until it gets empty. After this, second highest priority queue will be served. Due to this scheduling mechanism, bandwidth starvation will occur for low priority data traffics.

B. Weighted Fair Queue (WFQ)

Weighted Fair Queue specifically used to schedule packets of various sizes to provide prioritization in traffic management. WFQ serve every queue fairly by terms of byte count, which creates a bit wise fairness. It is usually used under conditions, where a consistent response time is required for heavy and light network users. Advantage of WFQ is that, a queue does not starve for Bandwidth and any bandwidth that is not used by any flow, will be divided up among remaining flows [11].

B. Deficit Round Robin (DRR)

Deficit Round Robin (DRR) also known as Deficit Weighted Round Robin (DWRR). In [11] this DRR algorithm, each queue has a deficit counter that is initially set to quantum of queue. Whereas, quantum is the configurable value of credit given to a queue during its serving duration. This quantum value is in the form of bits/bytes and represents the credit of bits/bytes a queue may require. Usually it can say that, increasing the value of quantum directly relates (proportional) with the assigning weight to queue.

As in DRR, a specific quantum credit is assigned to each queue. If size of a packet at head of the queue exceeds to the size of queue quantum, remainder credit of quantum for that serving queue is added to the new quantum that will assign to this queue for next round. Similarly like quantum, remaining packets from queue are compensated in next round. At start of the process, all of the deficit counters have zero value and scheduler or pointer starts from the top of list [11].

D. Modified Deficit Round Robin (MDRR)

Modified Deficit Round Robin scheduling algorithm is an extension of the above mentioned DRR algorithm. There are different modifications that were introduced in this algorithm, due to this, overall it is known as MDRR. As MDRR algorithm depends on DRR scheduling fundamental principles, however, in MDRR, quantum value given to the queues is based on weights associated with them. MDRR scheduling scheme adds a PQ into consideration with DRR. Purpose of Priority Queuing scheme is to isolates high demanding data or flows from other flows for better quality of service provisioning [11].

4 Existing polling services-

A.Real-time polling service (rtPS)

This service is for real-time VBR-like flows such as MPEG video. These applications have specific bandwidth requirements as well as a deadline (maximum delay). Late packets that miss the deadline will be useless.

BW-Request: used only in the contention-free mode. The current queue size that represents the current bandwidth demand is included in the BW-Request.

Uplink Scheduler: Not defined in the current IEEE 802.16.

rtPS packet scheduling (EDF)

Schedule the rtPS packets in the rtPS database until eitherthere are no rtPS packets left or there is no more bandwidth left (i.e. all Nuplink bits havebeen exhausted). After scheduling the packets, update Nuplink ðNuplink Nuplink P ½all bits allocated for rtPSÞ: In case the total number of bits in the column is greater thanNuplink; Nuplink will be distributed to each connection based on its weight(Wi ¼ ri=Pri; i ¼ rtPS connections: For example, connection i will be scheduled withWiNuplink bits. If there are still packets left in the current time frame interval and Nuplink isequal to zero, these packets will miss the deadline. We can take the following two actionsfor the packets that missed their deadline:

(1) Drop the packets, or

(2) Reduce the priority ofthe packets by moving them to the BE database, i.e. these packets will be scheduled withthe same priority as BE. After scheduling the packets, update the UL-MAP and the rtPSdatabase.

Scheduling algorithm for rtPS queues

For rtPS service, each packet entering the rtPS queues should be marked with a delivery deadline equal to t + tolerated delay, where it is the arrival time and tolerated delay is the Maximum Latency for such a service flow. The packet with smaller deadline will be transmitted earlier. This greatly reduces the end-to-end delay of rtPS service.

The rtPS algorithm is designed to support real time service flow, such as MPEG video or teleconference, that generate variable size data assigns UL resources that are sufficient for packets periodically. In this algorithm, the BS assigns UL resources that are sufficient for unicast bandwidth request to the voice users. This is called polling process. The duration for which the BS continues to poll an SS with process of the connection. The SSs utilize the assigned polling resources to send their bandwidth requests, reporting the exact bandwidth need for their rtPS connection. The BS in response then allocated the exact bandwidth requested to the SS for transmission of the data.

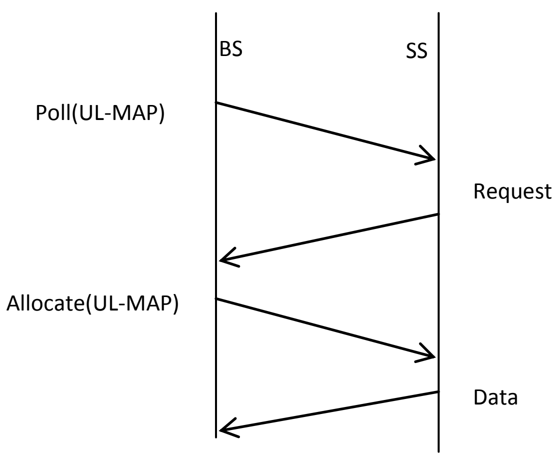


Figure 2: Polling process in rtPS [9]

Because rtPS always carry out polling process, it is able to adaptively determine suitable resource allocation from frame to frame. This adaptive request-grant process goes on until the connection is terminated. Because of the dynamic request-grant process, the algorithm has more optimum data transport efficiency than the UGS algorithm. This is a major advantage over the UGS algorithm. The drawback of the rtPS algorithm however is that the dynamic polling process causes MAC overhead and access delay. Hence rtPS has more MA Cover head and larger access delay than the UGS.

5 Proposed System-

In [12] author modified the ImSIR scheduling algorithm for handling the delay in the rtPS traffic flow with varying QoS requirements in WiMAX while maintaining channel quality. The deadline is associated with each and every packet belonging to rtPS. If packets are not served with in this deadline then packets are removed from the servicing

Queue.

The active SSs are sorted on the basis of SIR and categorized in high, medium and low category designed on the basis of chances they receive from the BS to get served. For the SSs, deadline queue is maintained only for rtPS traffic flow. If any packet of rtPS traffic flow is encountered then, deadline is calculated for that. If deadline is meeting in the next frame then, schedule this packet accordingly. Otherwise, there may be two conditions either deadline expired or there is time to schedule this packet. The packet having time, will wait in queue till its deadline meet. For checking the deadline condition, it is compared with n+3. Assuming, current frame is n, the map will be sent in frame (n+1) and grant will be given in frame (n+2). Therefore, if deadline expires in frame n+3, the packet must be served in this frame. These SSs are again sorted within the category for queue length of calculated deadline to get served.

The proposed approach also reduces the packet drop at the SSs due to taking deadline of real time traffic data into consideration. However, due to these categories and deadline parameter with in the category, proposed approach provides decreased end-to-end delay and packet loss.

Following figure shows the main steps of proposed approach and algorithm of proposed approach.

Algorithm-

Schedule_DImSIR (Packet P)

Step1 :1. for each PeerNode of rtPS type

normalqueue_ ----> enque (P)

Step2: Calculate the deadline of PacketrtPS

last_granttime = last_granttime + rtPS_grant_interval

deadline = last_granttime + maximum latency

Step3: Deadline verification

If((deadline-current_time)/frame_Duration)==3)

Schedule in next frame

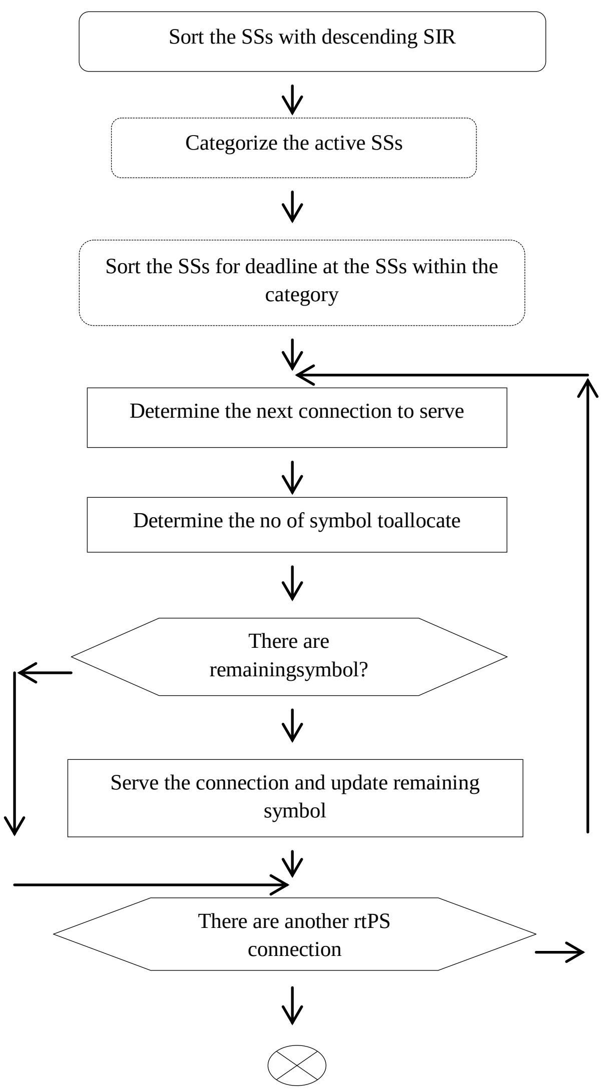
Else if((deadline-current_time/frame_duration)>3)

Wait in queue

Else

Drpo packet.

Figure: 3 Algorithm of proposed approach[12]



6 CONCLUSION

The active SSs are sorted on the basis of SIR and categorized in high, medium and low category designed on the basis of chances they receive from the BS to get served.The proposed approach also reduces the packet drop at the SSs due to taking deadline of real time traffic data into consideration. However, due to these categories and deadline parameter with in the category, proposed approach provides decreased end-to-end delay and packet loss.

ACKNOWLEDGMENT

Authors are thankful to all researchers whose research papers are used as a reference. The author is also thankful to Dr. V. M. Thakare Dr. M. U. Kharat and Dr. M. V. Kadu for their valuable guidance.

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