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QoS Providence and Management in WiMAX using PMP mode

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Abstract. WiMAX (Worldwide Interoperability for Microwave Access) IEEE 802.16 is the most promising wireless technology for providing broadband access. WiMAX is both suited for fixed as will as for mobile infrastructure. As the application demands increases the level of QoS requires for it to transmit the traffic across the network also increase. WiMAX is best suited for applications requiring more bandwidth and high data rate. WiMAX operates in PMP and Mesh Mode. In this study we will be primarily focusing on providing QoS across WiMAX to the applications considering the PMP mode. This study will propose a QoS model for WiMAX. The model take into consideration the incoming traffic, performs traffic policing, provision QoS to various incoming flows and use an appropriate scheduling algorithm accordingly. The model uses two modulation types that are; 64QAM3/4 and 64QAM2/3. Further we will study various scheduling algorithms for different types of traffic like UGS, rTPS, nrTPS, and BE. At the end we will use ns-2 simulator for validating the proposed QoS model.

Keywords: PMP mode, BS, SS, 64QAM3/4, 64QAM2/3

1. Introduction

WiMAX or IEEE 802.16 is an efficient broadband technology providing much greater bandwidth along with high data rates. This is the reason why; it has got greater attention in industry, as well as in research in the last few years. WiMAX is best suited for fixed as will as mobile infrastructure, because of the flexibility it provides. WiMAX 802.16 has QoS capability specified in its standards, providing an ease of QoS provisioning to the applications. The WiMAX Supports various types of multimedia applications requiring on demand bandwidth and high data rates, such as VOIP (Voice over IP), video conferencing, online games, Video on demand etc. In order to provide guaranteed data rates and on demand bandwidth, some level of QoS needs to be implemented, that should fulfill the needs of such applications. The WiMAX Solution of providing QoS is quite cost effective, due to installation of it and its compatibility with the already existing network. The WiMAX operates in two modes that are; PMP (Point-to-multipoint) and mesh mode. In this paper we will be focusing on QoS provisioning in WiMAX PMP mode.

There are two directions, in which the communication occurs in PMP mode that are Downlink and Uplink mode. The IEEE 802.16 MAC protocol has defined TDD (Time Division Duplex) and FDD (Frequency Division) for two types of connections; from BS to SSs and from SS to BS. In next section we will study the existing QoS model for WiMAX. Then we will move to the proposed QoS providence model for WiMAX PMP mode.

2. Existing QoS Model for WiMAX

The general QoS architecture defined by IEEE 802.16 standard is analyzed in this section. In this model there is on BS (Base Station) and multiple SS's (Subscriber Stations). There are two directions in which SS and BS communicates with one another; uplink and downlink. The SS communicates with BS in Uplink direction and the BS communicates with the SS in downlink fashion. In PMP different SS shares mode of WiMAX the Uplink connection. The uplink channel is divided in TDD fashion. Where as the downlink channel is broadcast channel, where each of the SS is assigned a specific frequency, using FDD multiplexing.

The information about the time slot division is broadcasted by the BS to the SS using uplink Map Messages (UL-MAP) at the beginning of each frame [3].

All the uplink bandwidth allocation is done at the BS for managing the uplink packet transmission. As MAC 802.16 protocol is connection oriented. The first step is the connection request from the SS for each service flow. Each connection is assigned a unique identifier, CID (Connection Identifier) [3] that helps distinguish among different connections. The service flow is in provisioned state at this stage. Once the connection is established, each connection request for its required bandwidth for its transmission. The incoming traffic is classified into four types by the traffic-policing component at the SS side. The types of services supported are; Unsolicited Grant of Service (UGS) is type of service that require constant bit rate, where packet size is fixed and require throughput and jitter guarantee like voice traffic VOIP.

3. PROPOSED QoS PROVIDENCE MODEL FOR WIMAX PMP MODE

QoS provisioning is performed in order to give some level of service differentiation to the service flows, depending on their needs. The incoming traffic is classified in to service classes that are assigned to different service flow for transporting their data across the network. In this section we are going to 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 for managing traffic across SS and another at BS for managing connections requests coming from the SSs to the BS. As IEEE 802.16 MAC protocol [4], as WiMAX standard is connection oriented. 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.

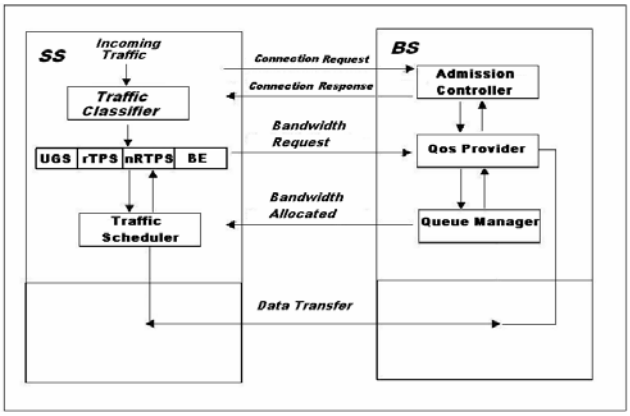


Figure 1 Proposed QoS Model for WiMAX PMP mode

First the BS requires the service flows to be registered, which will be used later on by both by BS and SS for communication. This connection-orientation feature of the MAC 802.16 makes greater flexibility to the network to have a great control over the network resources, to share these resources among different service flows for providing them good level of QoS.

The proposed model provide the QoS to the service flows by passing through the following steps

3.1. Connection Setup

The First phase of the communication establishment in WiMAX is connection setup. The SS that wants to start communication with BS or another SS has to consult with the BS in PMP mode. The SS sends a connection request to the BS that contains the QoS attributes for that connection. The BS has Admission controller, that is the main entity, that will make a decision whether to admit the newly service flow of the SS or not, by consulting with QoS provider entity below the Admission controller. The admission controller upon receiving the connection request, will consult the QoS provider 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.

3.2. 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: UGS (Unsolicited grant of service) is type of service in which the packet size is fixed and requires constant bit rate such as VOIP (Voice over IP) and T1/E1. rTPS: Real -Time Polling Service (rTPS) is designed for services that require transportation of variable size packets with bounded delay on the board, like streaming videos. nrTPS: Non real time polling service is designed for applications that requires minimum data rate, requesting bandwidth by polling, but can tolerate delay. The example of such traffic is FTP. BE: Best Effort service requires no guarantee but PER (packet Error rate) [5] should be maintained. The example of such applications is http, email.

3.3. QoS Provider

Once the connection is established between the BS and the SS, the service flow is in provisioned state. The traffic classifier classifies the traffic in to 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 and queue and resources are reserved for it. It rejects the request if the requested resources are not available to satisfy the flows requirement. 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 it 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.

3.4. 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 cross-layer scheduling algorithm [3]. In this algorithm the parameters and properties of the service classes are used to calculate the appropriate priority level of each service class. At the first step fixed numbers of timeslots are kept aside for UGS services [3]. Once the UGS service class is given its part of resources, the remaining resources are allocated to particular service among rTPS, nrTPS and BE services according to their priority level.

3.5. Queue Manager

The queue manager 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. The UGS service is assigned queue 3, the rTPS is assigned the 2, nrTPS is assigned 1, and the BE is assigned 0.

3.6. Traffic Scheduler

The traffic scheduler is the backbone of for any QoS model, because it 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

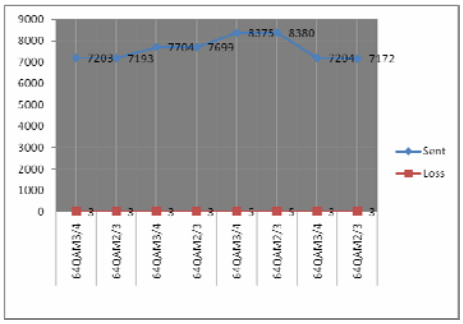
the queue to be service signal the SS to continue the data transfer, through UL-MAP message. The UL-MAP message contains all the information regarding the time slots for each of the service flow, in which the SS will serve the service flows. The WiMAX is capable of handling the requirements of very-high-data-rate applications, such as voice over IP (VoIP) and video or audio streaming, and has the ability to handle extremely bursty traffic over the Internet [7].

4. SIMULATION

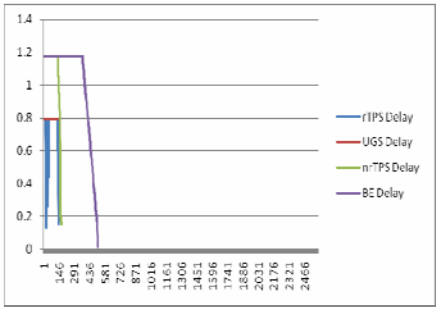
In this section we are going to describe the simulation regarding the model this study has proposed. For simulation we have used ns-2 simulator. Our model is QoS model for WiMAX or IEEE 802.16 PMP mode. We will see four types of traffic described in this model that are UGS, rTPS, nrTPS, and BE traffic.

Packets loss, Delay Variation, and Throughput Variation for UGS, rTPS, nrTPS, and BE

We have run the simulations two times, where we changed the gap size between each packet transmitted. The graph 1 shows the packet loss for each of the four types.



Graph 1 Packet loss for Various Service Types



Graph 2 Delay (ms) for Various Service Type

As WiMAX provides very huge bandwidth with high data rates, providing much more efficiency in giving the flexibility of quality of service level. Extensive simulation shows that the packets loss is very rare in case of WiMAX for each class of the traffic. We can see from the graph that only a few out of thousands packets transmitted from SS to the BS. We have run the simulation for each type of traffic. We have used 64QAM3/4 and 64QAM2/3 modulation schemes. We have run the simulation for 25 seconds. The UGS has the smallest delay, as it cannot bear delay after a specific value. The nrTPS and BE has more delay, as compared to UGS and rTPS. The overall picture shows that out of 3000packets transmitted; only 450 packets have experienced delay. The maximum delay experienced is by BE traffic that is 1.75ms, that is very much respectable result. The rTPS has a delay of 0.794ms and nrTPS has 1.75. Whereas the UGS has a very less delay 0.793.

The simulation results shows that UGS and rTPS have a very good throughout that are 157.6715 kbps and 160.123kbps. The nrTPS has 116.2063kbps and BE has 68.28Kbps.

5. CONCLUSION

The multimedia data has got great attention in the last decade, because of its on demands need and the features it provides to the people. It has lead to the need for high bandwidth and high data rate requirement on the part of the network, which will be responsible for transporting such services from the internet to the customers. In this paper we have discussed the QoS model that has shown various level of service to the traffic of different types like UGS, rTPS, nrTPS and BE as will. The model is best fit for PMP mode of the WiMAX. However it is flexible to be used in case of mesh mode, when the mobility is high.

The Simulation results discussed above shows that our model is quite efficient in terms of delay, packet loss and throughput for various traffic types that are scheduled across the network. Our proposed model strength is of providing scheduling for UGS, rTPS, nrTPS and BE traffic. The first three require priority level that is supported by this model shown by the simulation results.

6. FUTURE DIRECTIONS:

The WiMAX or IEEE 802.16 standard is still not very matured requires lot of research, of how it should be used in different situation effectively. The main quality of the WiMAX is its cost effectiveness in implementing from small to large backhauls. It is compatible with existing technologies, so can be integrated with the existing networks like GSM and UMTS etc. It has shown very good response to the vendors, allowing them to make use of it in any possible situation. As WiMAX provides high bandwidth and high data rates, thus allowing various levels of QoS to be given to various applications, having bursty nature. The main research area for future direction is to design effective algorithm used for scheduling the traffic, making it much more attractive for the applications to be serviced differentially from other applications.

7. References

[1] QoS in Wireless Mesh Networks: Challenges, Pitfalls, and Roadmap to its Realization By Parag S. Mogre, Matthias Hollick, Ralf Steinmetz, 2007 *ACM 978-1-59593-746-9/06/2007*

[2] Modeling Quality of Service in I*EEE 802.16* Networks By Giuseppe Iazeolla, Pieter Kritzinger and Paolo Pileggi

[3] Comparative Study of Scheduling Algorithms for WiMAX by Ashish Jain and Anil K. Verma.

[4] A Heuristic Strategy for *IEEE 802.16* WiMAX scheduler for Quality of Service
By G.S. Paschos, I. Papapanagiotou, C.G. Argyropoulos and S.A. Kotsopoulos

[5] QoS Provisioning and Radio Resource Allocation in OFDMA based WiMAX Systems By Raj Iyengar, KoushikKar, BiplabSikdar, Xiang Luo

[6] Low-cost QoS-enabled Wireless Network with Interworked WLAN and WiMAX By Humaira Haffajee and H. Anthony Chan

[7] An Analysis of the Design and Implementation of QoS over *IEEE 802.16* By Mark C.Wood http://cec.wustl.edu/~mcw2/QoS_over_802_16/QoS_over_802_16.html