WiMAX Service Classes and CAC Mechanisms: A brief Introduction

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ABSTRACT

Worldwide Interoperability for Microwave Access (WiMAX) is an emerging wireless network technology that gaining popularity as a solution to last mile problem. Various area in WiMAX specifically the Service Classes and the Call Admission Control (CAC) mechanisms to such Service Classes are of much challenge in the current scenario of high data rate user demand. In this paper, we are presenting an overview the Service Classes and various CAC mechanisms currently supporting by WiMAX technology. Our intention is to bring to the information of readers and to build up interest to work in this upcoming area of research.

General Terms

Wireless communication

Keywords

WiMAX, IEEE 802.16, Service Class, CAC.

1.INTRODUCTION

Worldwide Interoperability for Microwave Access (WiMAX) is a wireless broadband access standard aiming to provide wireless data over the long range in many ways as an alternative to cable and Digital Subscriber Link (DSL). It is standardized by IEEE 802.16 as an emerging technology for wireless communication. It is considered as the most suitable and high data rate solution for the last mile connection in wireless Middle Area Network (MAN). This standard of the wireless network was mainly designed for the delivery of IP centric data over a wide area for wireless technology in an optimized way. It supports a data rates of 70 Mbps (approx.) with the larger coverage area up to 50 km in line of sight [1]. WiMAX is very useful in a scenario where wired infrastructures are not available or not possible for the remoteness of the location. It can be used with the many applications such as hotspots, an office network, LAN segment, and can connect mobile user via the WiMAX base station in remote area, it also provides high speed connectivity for business customers. WiMAX supports both mesh and Point to Multi Point (PMP) networks [3]. The Figure 1 shows a WiMAX point to multipoint deployment that demonstrates the network of one base station and N subscribers in a typical scenario [8]. As standardized, WiMAX uses orthogonal frequency division multiplexing (OFDM) in its physical layer [9]. It enables users in the remote area connecting wireless in a scenario as shown in the figure. WiMAX uses connection oriented Medium Access Control, so before transmitting the data the subscriber station need to send the request for

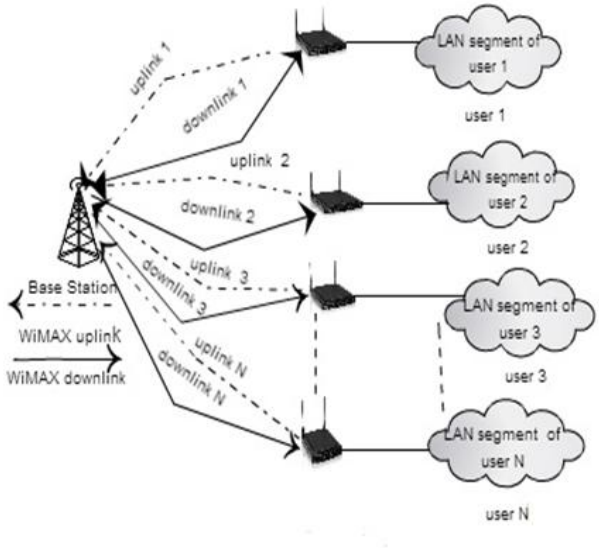

Figure 1. WiMAX point-to-multipoint networks

connection to the base station, after receiving the request the Base Station (BS) check whether the available resources are enough to handle the requested services without the degradation of Quality of Services(QoS) of existing connections [4]. This Quality of Services (QOS) aware scheme is called as call admission control (CAC) [10]. CAC serves as useful tool for WiMAX which is responsible to ensure that the resources are not over subscripted and there by all existing connections can provide guaranteed Quality of Services. Granting or denying network access is the main responsibilities of the CAC procedure. Based on the network status and resources requirement of new call the decision are made to accept or reject an incoming connection.Call admission control in WiMAX is of much interest in the current day research. Many research works are been reported in this area of research but still the topic needs more exhaustive analysis in order to make the technology robust and popular. In this paper, we are giving an overview of the problem in order to understand the area of research and to increase the popularity and understanding of the same for further research in this advanced topic of wireless network. Rest of the paper is organized as follows. Section 2 is the information regarding various service classes supported by WiMAX network. Section 3 describes CAC mechanism in general.

2. SERVICE CLASSES OF WIMAX

The term Quality of Service refers to as a qualitative measure of how reliable and consistent a network is, there are a number of parameters that can be used to measure it

quantitatively include throughput, transmission delay or packet delay, delay jitter, percentage of packets lost etc. To meet all the different QoS requirements IEEE802.16 WiMAX standard defines five service classes to provide a wealth of services according to the demand of various users. This service classes are as follow:

2.1 Unsolicited Grant Service (UGS)

It is a real time application in which transmission system automatically and periodically provides fixed size packets at recurring intervals with as little latency and jitter as possible that is used by a particular receiver [1]. It is normally used to provide services that require a constant bit rate (CBR) such as voice over IP (VoIP) or leased line (e.g. T1 or E1) circuit emulation[1].

2.2 Real time Polling Service (rtPS)

The rtPS algorithm is intended to support real-time service flows, such as MPEG video or tele-conference, that generate variable size data packets at periodic interval [4]. For example Moving Pictures Expert Group (MPEG) video uses this service class. Base station provides resources to continuously poll an SS with rtPS connection. SS utilizes the polling resource which is assigned by BS to send their bandwidth requests, reporting the exact bandwidth need for their rtPS connection. The BS then allocates the exact bandwidth requested to the SS for the transmission of the data[4].

2.3 Extended Real time Polling Service (ertPS)

It is a combination of UGS and rtPS in which unsolicited unicast grants are provided by the BS. It is intended to support real-time service flows, such as Voice (VoIP) with silence suppression, that generate variable size data packets at periodic interval [6]. Minimum reserved rate, Maximum sustained rate, Maximum latency tolerance, Jitter tolerance, Traffic priority are various specifications of this class.

2.4 Non-real time Polling Service (nrtPS)

This service class is intended to support non-real-time application and delay-tolerant data streams that requires a minimum amount of bandwidth and variable size data packets, issued at a regular interval such as FTP [6]. Here SS to make periodic unicast grant requests to BS, just like the rtPS scheduling service, but the requests are issued at longer intervals. It will ensure that the SSs receive request even during network congestion. Nominal polling interval along with minimum reserved traffic rate, maximum sustained rate and traffic priority are the key parameters for this service flow.

2.5 Best Effort Service (BE)

The BE service is designed to support in data stream that doesn't require minimum guaranteed rate and specific bandwidth. Web-browsing and email such as telnet or World Wide Web (WWW) are the example of BE service. The SS is authorized to use both contention-free and contention based bandwidth requests, although contention-free is not granted when the system load is high [6]. Maximum sustained rate, traffic priority are the key parameters of this service flow. The table shows various parameters of each QoS service classes discussed above:

Table 1: Wimax Services Class Summary

QoS parameter	Delay Tolerance	Jitter Tolerance	Loss tolerance	Bandwidth requirement
Unsolicited Grant Service	High	High	Moderate	Low
Real Time Polling Service	High	Moderate	High	High
Extended Real-time Polling Service	High	High	Moderate	Low
Non-real Time Polling Service	Low	Low	None	Low
Best Effort Service	Moderate	Low	None	Low to Moderate

The WiMAX CAC mechanisms vary based on the types of services that requested by the subscribers. In the next section we are giving an overview of the CAC mechanisms which is determined by the service classes discussed in this section.

3. CALL ADMISSION CONTRTOL MECHANISM

With the handling of users in the WiMAX network, there are two terms associated most often together. The Call Admission Control (CAC) and Scheduling. The CAC procedure is implemented at the BS that ensures the load supplied by the Subscriber Station (SS)s can be handled by the network. While the scheduling mechanism ensures that the required amount of resources is allocated to the connections, so that the QoS (Quality of Service) requirements are met, the admission control mechanism limits the number of connections to the network so the network is not overloaded by many users. In this section we will mainly focused of CAC. The main objective of the CAC is to control the ongoing active connections. The call admission is regarding accepting or rejecting the incoming connection. Call Admission control is used at each subscriber station to limit the number of ongoing connections through that subscriber station. At each subscriber station, traffic from all uplink connections is aggregated into a single queue. The size of this queue is finite in which some packets will be dropped if the queue is full upon their arrivals. For Point to Multipoint Mode (PMP), Threshold based CAC and Queue aware CAC algorithms are followed. The connection and packet-level performances of both CAC schemes have been studied based on the queuing theory. Poisson process is considered for the connection arrival and the packet arrival for a connection by Markov Model of Poisson Process (MMPP) process[7]. All the CAC mechanisms are discussed next.

3.1 Threshold based CAC algorithm:

In this algorithm, threshold C is set to limit the number of ongoing connections. When a new call arrive, the admission

control module checks whether the total number of connections should be less than or equal to the threshold C [2]. If it returns true, then the new connection is accepted, otherwise it is rejected. It is analytically analyzed. As the length of a frame T is very small compared with connection arrival and departure rates, the maximum number of arriving and departing connections in a frame is one. Otherwise it is increased or decreased depending on the state.In the performance is evaluated and it shows that when the connection arrival rate increases, the number of ongoing connections and connection blocking probability increase[2].

3.2 Queue aware CAC algorithm

This algorithm functions based on connection acceptance probability which is determined based on the queue status. The packet arrival for a connection is following the MMPP [7] (Markov Model of Poisson Process) which is identical for all connections in the same queue. The connection inter-arrival time and the duration of a connection are assumed to be exponentially distributed. An MMPP is a stochastic process in which the intensity of a Poisson process is defined by the states of a Markov chain[7]. While the threshold-based CAC scheme simply fixes the number of active connections, the queue-aware CAC scheme considers the number of packets in the queue for the admission control decision to make a new connection.

The performances such as connection blocking probability, the average number of active connections are evaluated analytically. The same parameters are also evaluated numerically. The average length of queue, the average delay and the average queue throughput are evaluated. The performance measurement not depend the queue size and the number of active connection. The bandwidth allocation is made for the call connected user. The user demand must satisfy with the allotment of bandwidth. If the number of user is increased then the call admission is made based on available bandwidth [2].

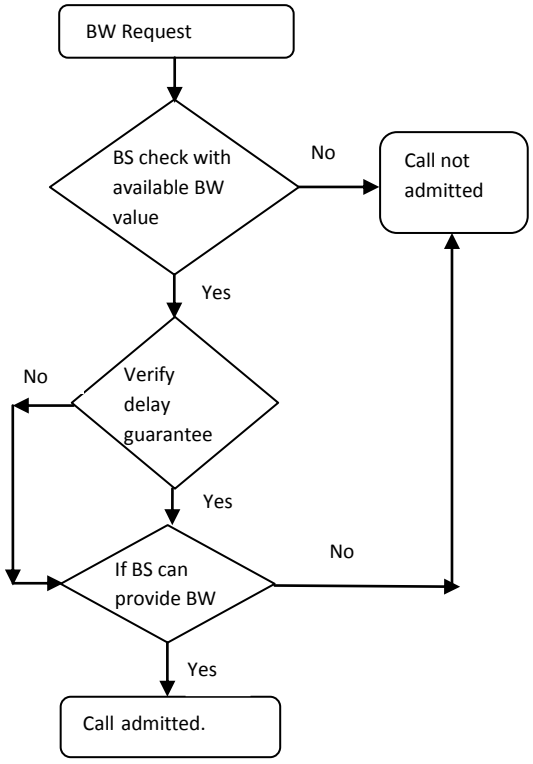

Fig. 2 Call Admission Control flow chart

The flow chart for CAC is given in Fig. 2 [2]. Numerical result reported in various paper [8] shows that, the performance parameters of connection-level and packet-level are significantly impacted by the connection-level rate. Threshold level CAC and queue aware CAC schemes result the better packet-level performances compared with those without CAC scheme. When channel quality is good, then the performances based on the packet transmission become good. The performance based on the connection-level for the threshold-based CAC scheme and those without CAC scheme are not impacted by the channel quality. The admission control decision for the queue-aware CAC based on the queue status which is desirable for a system with high traffic fluctuations

4. CONCLUSION

The paper is a study of WiMAX service classes and CAC mechanisms in order to give readers an idea about the most prominent research area in WIMAX technology. The various service classes and CAC mechanisms are described in the paper. Work is going on in the simulation of these CAC mechanism and a comparative study of these protocols are expected very soon.

5. ACKNOWLEDGMENT

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