LLQ in IP Networks

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Abstract

The Mobile Applications such as Audio and Video streaming, VOIP, Video conference, FTP, HTTP etc demanding a fast access. In the internet there is no differentiation for voice and data packets. But the present day application requires to have the differentiation in these packets. So this means that we need to have the QoS and the Network which offers performance assurance and the service differentiation is called QoS. The purpose of QoS is to provide guarantees on the ability of a network to deliver the predictable results. In this paper QoS provisioning architecture is considered for WiMAX advanced technology with the help of IP QoS algorithm, we propose a new scheduling algorithm for service traffic depending on QoS requirements can be achieved and the performance metrics such as response time, traffic received and sent, Ethernet delay and TCP delay can be simulated using OPNET 14.5.

Key Terms: LLQ, CBWFQ, WiMAX, IP QoS.

1. INTRODUCTION

WiMAX refers to broadband wireless network that are based on the IEEE 802.16 standard[1]. This technology is very promising Broadband Wireless Access which ensures the compatibility and interoperability between broadband wireless access equipment which deals with end to end services as an IP connectivity and security, QoS and mobility. WiMAX is designed for "last mile" services as a large coverage and high throughput can achieve 75 Mbit/s. However, WiMAX has an inherent QoS protocol and it is designed to operate over long distance.

Wireless technology has transformed our lives in many ways. Mobile WiMAX, the standard defines IEEE 802.16d networks become a fast growing technology for its promised high bandwidth over long-range transmission with quality of service supports. Nowadays we use our mobile phones for online banking, online gaming and many more. The purpose of 4th generation is increasing the data transmission speed. 4G technology offers high data rates. The expectation of 4G is basically the high quality of audio/video streaming over end to end Internet Protocol.

The 4G technology which stands for Mobile Multimedia anywhere at any time and global mobility solution over Integrated wireless and customized services. The main difference between 3G and 4G is not only the speed mainly it covers the large area. Another significant advantage of 3G over 4G is QoS support.Though, the WiMAX architecture is fully based on the IP networks.

1.1 WHAT IS QoS

QoS refers to the ability of a network to provide improved service to selected network traffic over wired based technologies and wireless based technology. QoS feature provides more improved and predictable network service by providing the following services:

- Supporting dedicated bandwidth
- Improving loss characteristics

- Avoiding and managing network congestion
- Shaping network traffic
- Setting traffic priorities across the network

2. QUALITY OF SERVICE (QoS) IN WIMAX

The fundamental basis of the IEEE 802.16 MAC architecture is QoS. It defines Service Flows which can route to DiffServ code points that enable end-to-end IP based QoS. QoS is enabled by the bandwidth request and grant mechanism between various subscriber stations and base stations. Primarily there are four scheduling services for the prioritization of traffic: (1) Unsolicited Grant Service (UGS), (2) Real-Time Polling Service (rtPS), (3) Non-Real Time Polling Service (nrtPS), and (4) Best Effort (BE) to provide the service-class classification for video, audio, and data services, as they all require various levels of QoS requirements.

2.1 Unsolicited Grant Service (UGS)

UGS is designed to support real time service flows for Constant-Bit-Rate (CBR) services such as VoIP, which means that achieving low latency and low jitter. UGS flows are configured to send fixed-size packets at recurring intervals with as little latency and jitter as possible.

UGS service flows are given strictly higher priority versus nrtPS and BE service flows, which implies that the system serves nrtPS and BE packets only after it has finished transmitting all outstanding UGS packets.

2.2 Real-Time Polling Service (rtPS)

It is designed to support real-time service flows that generate variable size data packets such as MPEG video. Unlike UGS, the polling overhead exists even when the flows are idle, and for as long as they are active. This service requires more request overhead than UGS, but supports variable grant sizes for optimum data transport efficiency.

2.3 Non-Real-Time Polling Service (nrtPS)

This service class is intended to support non-real-time service flows that require variable size data packets, and a minimum data rate, such as FTP.

2.4 Best Effort (BE)

The BE service is intended to support data streams that don't require minimum guaranteed rate, and could be handled on best available basis. BE packets may therefore take a long time to transmit during network congestions.

Table 1. Lists the scheduling service types and their applications

Service class	Application
UGS	VOIP
rtPS	MPEG
nrtPS	FTP, HTTP
BE	Email

3. QoS ARCHITECTURE

The traditional IP networks were designed for best effort services and did not include any QoS provisioning. Some form of QoS can be provided by relying on different end to end transport layer protocols that run over IP. For ensuring end to end latency and throughput, QoS need to be place in Network layer.

For achieving QoS guarantees for end to end in an IP Networks, The Internet Engineering Task Force (IETF) developed the two QoS architectures are defined. They are IntServ (Integrated Service) and diffServ (Differentiated Service).

3.1 Integrated Service

Integrated service is an architecture that specifies the elements to guarantees per Flow QoS on the network. The idea of IntServ is implemented that every router has to make an individual Resource reservation. Although the architecture uses RSVP (Resource Reservation Protocol) provides the highest level of IP QoS guarantee it does have some major limitations. So it does not work well in wireless networks.

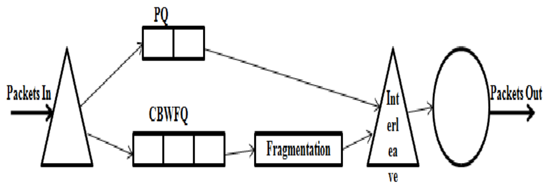
3.2 Differentiated Service

DiffServ is a simple architecture that specifies coarse grained mechanism for classifying and managing network traffic and providing QoS on IP network, since DiffServ is only useful in IP based networks. DiffServ divides the traffic into number of classes and treats each each class differently. It supports the TOS based QoS so it does not require resource reservation and there is no need to Per Flow guarantees. DiffServ can be used to provide low latency to the critical network traffic such as VOIP, streaming multimedia and also provide best effort service to the non critical traffic like ftp, http etc.

4. LOW LATENCY QUEUING

We can say LLQ is the improved version of CBWFQ. By combining CBWFQ (Class Based

Weighted Fair Queuing) with strict PQ (Priority Queuing) scheduling algorithm, it has the characteristics of Priority Queuing and Class Based Weighted Fair Queuing. The traffic is assigned to strict Priority Queue using the priority command is serviced up to its assigned bandwidth before all other CBWFQ queues are serviced. Here we considered CBWFQ because DiffServ divides the traffic into the number of classes based on Types of Service.



CBWFQ ensures that larger data packets can be fragmented and interleaved with higher priority packets which decrease the variation in delay and ensures that large best effort packets do not delay in real-time packets.

4.1 Priority Queuing

PQ is considered for higher priority traffic classes, for example real time traffic of VOIP. The PQ consists of separate queue based on the priority of high, medium and low. Traffic must be assigned to these queues. Packets from the high queue are always processed before the packets from the medium queue. Likewise, packets from the medium queue are processed before the packets from the low. As long as the packet in the high queue is empty.

Once the high queue is empty, then the packets in the medium queue are processed but only if no new packets arrive in the high queue. This refers to the strict form of queuing. As a result, PQ provides delay guarantee for high priority queue packets and not for other queues. Hence Voice packets can dominate network resources and starve data packets.

4.2 Class Based Weighted Fair Queuing

It is an upgraded version of WFQ. In WFQ dynamically creates the queues are weighted in FIFO order within a queue based on the flow type and can support variable length packets. All the queues are serviced Round Robin manner like a packet from one queue and a packet from another queue and so on. WFQ works well for networks where the most delay-sensitive traffic requires less bandwidth. So it doesn't work for the real-time applications like VOIP but works well for non real time applications like http, ftp. In order to overcome this CBWFQ is placed, but the packets are assigned a class (for example the queues are separated by real-time queues, non real-time queues like that) and placed into the queue for that the class of service. Here also the packets are accessed in Round Robin style but the classes can be given priorities. Example four packets from the higher priority class might be serviced followed by two from a medium priority class and then from the low priority class.

CBWFQ allows the user to retain minimum bandwidth for each queue. On the CBWFQ scheduler, it gives a percentage of the bandwidth to each class, based on the configured values. But the drawback of CBWFQ is the lack of a PQ-like feature, which means that delay sensitive traffic still suffers, even when enough bandwidth has been reserved by CBWFQ, because the scheduler can serve other queues when a VoIP or video packet is waiting in a queue. So it is not advised for Voice and Video traffic, since both of them need strict priorities. With CBWFQ we can define traffic classes and assign guaranteed amount of minimum bandwidth for traffic classes during congestion, these classes can get more bandwidth if it's available, but they always get the minimum bandwidth assigned to them.

4.3 LLQ Implementation

LLQ improves the quality of service for delay sensitive traffic by adding Priority Queuing to the CBWFQ. The Priority Queue is used only for Voice / Video or mission critical traffic, without having the Queue Starvation for other Queues[2]. The starvation is avoided using the policing, the traffic in Priority Queue is policed and the Queue can get to whatever the bandwidth it was assigned. It can however go over the assigned bandwidth if there is no congestion. The strict policing applies only in times of congestion and that to the traffic in the Priority Queue so it does not starve other queues.

The mission critical traffic gets the bandwidth it is assigned and other queues get whatever minimum bandwidth they were assigned, plus if there is no congestion all the queues can go over their assigned bandwidth if needed.

The Voice traffic is handled by the PQ Scheduler and the remaining traffic is handled by the CBWFQ handler. The policed bandwidth for traffic in PQ is only during the time of congestion, if there is no congestion then the traffic in PQ (typically voice) can go over the bandwidth assigned to it. Packets that exceed the configured maximum in the PQ are dropped.

LLQ offers much more flexibility than CBWFQ. LLQ is applied on voice and data network for critical traffic can be classified and transmitted from the PQ.

5. SIMULATION RESULTS

The primary focus is to improve the quality of service in IP networks for fast access to the users. In simulation, that we analyzed the performance for insufficient network bandwidth on real time service and non real time service during congestion condition. The LLQ scheduler is compared with CBWFQ in terms of queuing delay. Figure 1 shows the response time for downloading and uploading purpose in terms of delay.

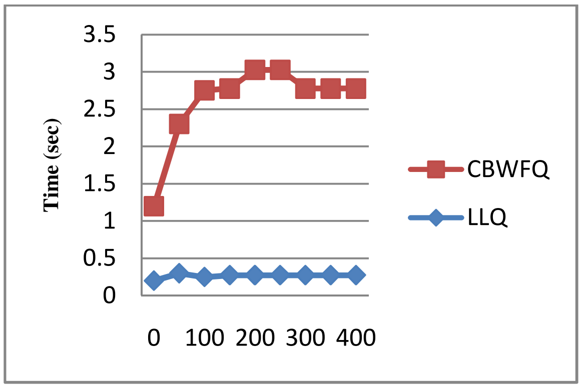


Figure 1: Response time of LLQ and CBWFQ

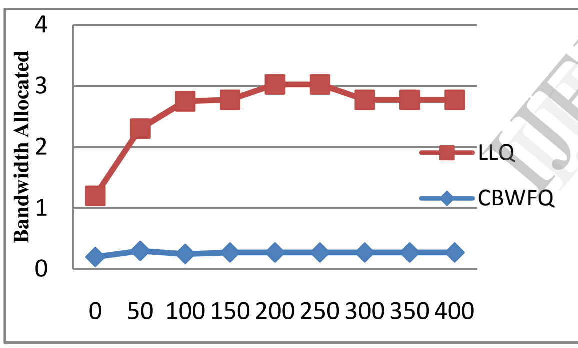


Figure 2: Bandwidth allocated for LLQ and CBWFQ

The figure 2 shows the jitter for voice using LLQ scheduling algorithm. It is due to minimum bandwidth reserved in CBWFQ. But the LLQ provides more efficient bandwidth is allocated for voice jitter. Though the jitter is more for LLQ system, it does not cause any problem for receiving the voice in continuous manner since the jitter is small.

The LLQ system has good voice quality in WiMAX since it has high priority combination with CBWFQ. It is due to high data rate of bandwidth is more for LLQ system, it does not cause any problem

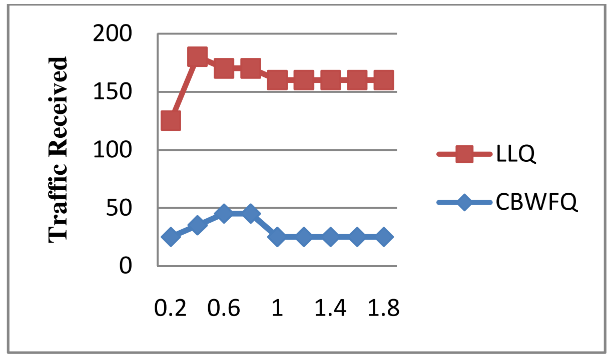


Figure 3: Traffic received with respect to time

for receiving the voice in continuous manner since the jitter is small. The figure 3 shows the no of traffic received with minimum time.

The LLQ system has good voice quality in WiMAX since it has high priority combination with CBWFQ. It is due to high data rate of WiMAX.

6. CONCLUSION

This paper has resulted on delay performance of LLQ, which is compared with CBWFQ under DiffServ (differentiated Service) network of real time and non real time traffic services. CBWFQ provides better result of delay for Best Effort services. The advantage of having LLQ in IP networks provides constant packet delay for traffic queued in PQ depends on arrival rate of traffic.

7. REFERENCES

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