Performance Evaluation of Scheduling Algorithms in WLAN Network with CBR Application using Qualnet

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ABSTRACT : Scheduling algorithms can be implemented on CBR, VBR, ABR and UBR applications but in this research scheduling algorithms is implemented on CBR application and the performance of WLAN network is evaluated by delivering different traffic load. QoS parameters (turnaround time, throughput, jitter and delay with response time) will be considered as the performance metrics on this study. The comparative study of various algorithms can show the best scheduling algorithm in WLAN with CBR application.

Keywords: CBR, VBR, ABR, UBR, QoS, throughput, delay, response time etc.

I. INTRODUCTION

Internet technologies are one of the most demanding technologies in the recent trends, we can easily observe that wireless networking is the most attractive trend that has been discussed and developed for over decades. The significant change is mobility. Internet users are no longer sitting in front of desktops; instead, carrying wireless mobile devices connecting to the Internet has become a new phase of network communication. The desire behind this evolution is to build up an ultimate environment for Internet access and achieve the convenience and the flexibility for life [1].

In recent years, the most active area in networking is-data, voice and video integration. Business users are beginning to combine real-time applications such as voice and video, which have a limited tolerance for network latency, with non-real time data traffic. With Voice over IP (VoIP) technology - defined as the ability to make telephone calls (real-time voice) over IP-based data networks with a suitable QoS and a much superior cost benefit-systems can provide simultaneous voice and Internet access over the same connection, or integrate existing phone connections with the Internet through VoIP Gateways [2].

Queue scheduling algorithms has been proved to be a very efficient, high throughput scheme for scheduling in input queue scheduling [3]. To queue something is to store it, in order, while it waits processing. In a computer network, when data packets are sent out from a host, they enter a queue where they await processing by the operating system. The operating system then decides which queue and which packet (s) from that queue should be processed. The order in which the operating system selects the packets to process can affect network performance.

Note that queuing is only useful for packets in the outbound direction. Once a packet arrives on an interface in the inbound direction it's already too late to queue it - it's already consumed network bandwidth to get to the interface that just received it. The only solution is to enable queuing on the adjacent router or, if the host that received the packet is acting as a router, to enable queuing on the internal interface where packets exit the router.

The scheduler is what decides which queues to process and in what order. When a packet arrives, it is immediately placed in a queue that is dedicated to its outgoing port, where it will wait for its turn to depart. [4]. Various types of scheduling algorithms are Strict Priority, Round Robin, weighted fair and Weighted Round Robin and can be implemented on different IP Queue types. Fig. 1 shows the functionality of scheduler.
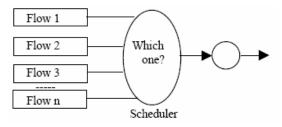

Fig. 1. Functionality of Scheduler.

In a data communication network packets belonging to different traffic flows often share links in the way to their destination. When a node cannot send all the packets it receives in a particular moment, packet queues are originated [5].

The distinguishing feature of the Scheduling algorithms is the support of different levels of quality of service as required by subscribers and their applications. QoS is an end-to- end concept that has to be satisfied through the inter-working of all the entities that the data is passing through. As a matter of fact, every different application has

its own QoS contract and every contract has its own QoS parameters such as end to end delay, jitter, packet loss, response, and turnaround time and throughput which in general could vary with continuity. This all can be done by the simulation in the Qualnet and scenario of the simulation is shown in Fig. 2.
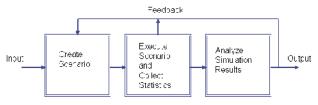

Fig. 2. shows the Scenario based simulation.

II. RELATED WORK

Goncalo Quadros et al. [1996] [6] investigated that One of the most challenging demands for the new generation of network elements able to provide quality of service (QoS) is to provide better ways to manage packet queues lengths, as it was well known that some form of "active queue management" was needed to obtain better performance levels of the communication system for instance, less transit delay, less packet loss level, better use of the available bandwidth, etc. and has to achieve three main goals were to develop mechanisms to provide effective QoS capabilities in Network Elements (NE), to conceive ways to select adequate and QoS-aware paths for packet forwarding along communication systems to implement effective ways for system management, including a strategy for traffic admission control [6].

Hemant M. Chaskar et al [1999][7] they performed that the scheduling scenario considered here arises when a number of packet streams, called sessions, share an output link at the router. Each session maintains a separate queue of its packets waiting for access to the transmission link. Packet transmissions must be scheduled so as to achieve the various objectives such as guaranteed minimum bandwidth to each session, fair excess bandwidth sharing (proportional or state-dependent fairness, worst-case fairness, efficient scaling of latency with the number of sessions [7].

Roberto Cusani [2000] [8] concluded that An ideal packet scheduler should have a low complexity, preferably with respect to the number of flows serviced, while providing fairness among the flows. While the definition of the complexity of a packet scheduling algorithm was well understood, the concept of fairness needs further elaboration. Many fairness criteria for packet schedulers have been proposed. He also proposed a scheduling mechanism provided within proposed access network architecture, employed to perform a QoS experiment. W-CDMA was the strongest candidate for the air interface technology. Dynamic Resource Scheduling (DRS) was proposed as a framework

that will provide QoS provisioning for multimedia traffic in W-CDMA systems. The proposed resource allocation algorithm, applied with a congestion control mechanism, allows the access network to guarantee the appropriate QoS contract agreed at connection set-up between the users and the access network operator, obtaining a fair distribution of the available resources between the users and high link utilization. The simulation results show that the maximum end-to-end delay and packet loss probability parameters are respected for each kind of traffic [8].

R. Morris [2000][9] investigated that buffer management can be used to lower down loss rate of TCP connections. However, since the queuing delay significantly increases from additional buffers, it was suitable for delay-insensitive traffic like FTP, in which throughput was more important than delay or jitter.

J. Joutsensalo and T. Hamlinen[2002] [10] found that WFQ was used with routers, and it gives weights for different classes in such a way that the performance of the low priority queues was quaranteed.

Vittorio Bilo [2003] [11] revised some of the most relevant aspects concerning the Quality of Service in wireless networks, providing, along the research issues we are currently pursuing, both the state-of-the-art and our recent achievements. More specifically, first of all network survivability was focused, that was the ability of the network of maintaining functionality as a consequence of a component failure. Then, a data access and network service in a distributed environment was done. Finally, a basic network optimization task was focused, that was routing design in wireless ATM networks. The QoS was concerned in wireless networks that was survivability, data access and layout design, by providing both the state-of-the-art and the research issues.

Haibo Wang et al. [2004][12] investigated end-to-end quality of service (QoS) provisioning approaches for networks in a DiffServ IP network environment. The effort was put on QoS classes mapping from DiffServ to network, Access Control, buffering and scheduling optimization. QoS parameters of each service class, especially for real time applications, as well as to improve the bandwidth utilization. Simulation results showed that the enhanced algorithm provides flexible and efficient QoS guarantees for multiple classes.

Scalable Network Technologies [2007] [13] performed the in-depth visualization and analysis of a network scenario designed in Design mode. As simulations are running, users can watch packets at various layers flow through the network and view dynamic graphs of critical performance metrics. Real-time statistics are also an option, where we can view dynamic graphs while a network scenario simulation was running.

Byoung Chul Kim et al. [2007][14] investigated that besides constant rate transmission, contemporary VoIP codecs use a buffer at the receiver side to compensate for shortly delayed packets. It has ability to recover from bursty or sudden loss increase in the network.

Trúchly Peter et al. [2008] [15] concluded that tool Qualnet contribution was oriented to the analyses was, investigation and comparison of current leading network simulators on the abilities to simulate a new emerging system called IP multimedia subsystem. This was identifies relevant representatives of simulators and their main supported features (networks, protocols and methods).

Yang et al.[2010] [16] Scheduling algorithm concerning different network aspects provides an effective control on end-to-end packet delay, jitter and loss, leading to graceful real-time service degradation as load increases. Indeed, with the packet delay and jitter effectively bounded at each network node, guaranteeing real-time service requirements becomes a simpler task: the packet loss performance on the end-to-end shortest paths was a function of network offered load.

ITU-T Recommendation G.711 Appendix I [17]: Besides constant rate transmission, contemporary VoIP codecs use a buffer at the receiver side to compensate for shortly delayed packets. It has ability to recover from burst or sudden loss increase in the network [17].
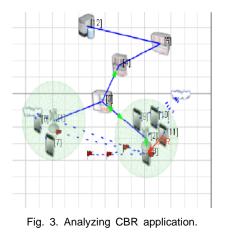
III. SYSTEM DESCRIPTION

For the implementation of scheduling disciplines, the main issue is to accommodate as many as possible numbers of users in a given bandwidth without interference. Also it is necessary for user to access the data with high efficiency. For that it is necessary to evaluate the performance of the system at different data rates and mobility. We are using models where CBR applications in networks that can be simulated by Qual Net [13]. For QoS support, parameters namely throughput, end to end delay and jitter are introduced that have a significant role in system resource allocation and scheduling modeling. The main objective of this work is to carry out a simulation study to evaluate the performance of scheduling algorithms at different packets size and mobility for different applications. For application Constant Bit Rate (CBR) traffic generator generates traffic at a constant rate by transmitting packets (also called "items") of a fixed size at a fixed rate. It is generally used to provide background traffic that affects the performance of other applications being analyzed or to simulate generic multimedia traffic. The simulations have been performed using Qualnet [13], software that provides scalable simulations of wireless networks. Qualnet is a comprehensive suite of tools for modeling large wired and wireless networks. It uses simulation and emulation to predict the behavior and performance of networks to improve their design, operation and management.

In the simulation model, CBR application targets to simulate the various scheduling algorithms on an all-IP network by implementing the algorithms like Strict Priority, Round Robin, Weighted fair and Weighted Round Robin.

After running several simulations it will be easy to think that the best option in traffic management is having CBR source because the number of lost packets and the variations of received packets have minimum fluctuations. But the truth is that it is almost impossible to maintain this kind of level of efficacy in network where the packets present different sizes, lengths, even they are not transmitted at the same time, and, the most important thing is the types of traffic are also variable in each connection. Finally the best option is to implement the various Scheduling disciplines where all the active links are serviced according with the amount of information needed. It is also truth that the connections which receive more service are that one which is paying for a guaranteed service.

In this research, we develop a simple and effective scheduling policy based on this concept for the environments where packets have predefined hop-by-hop time schedule. To forward a packet, a router first assigns an appropriate profit function to the packet based on its timeliness and QoS class as well as the loading status in its succeeding routers along its predefined traveling path and then inserts the packet into an appropriate position in the output queues. The challenge is to find the best way to assign proper profit functions to different classes of packets in order to utilize resources more wisely, e.g. urgent and important packets get precedence. Fig. 3 shows the analyzing CBR application to run various scheduling algorithms on Qualnet.

Fig. 3. Analyzing CBR application.

IV. RESULTS AND DISCUSSION

QoS in Scheduling algorithms on WLAN with CBR application means the required throughput and delay in a particular service. The various traffic loads used to observe QoS are with 50000 bytes. Load can be increased and decreased as per the requirements. Table 4.1 shows the various QoS parameters with various scheduling algorithms.

Table 1: QoS parameters with different scheduling algorithms.

QoS Parameters	Scheduling Algorithms			
	Strict Priority	**Round Robin**	**Weighted Fair**	**Weighted Round Robin**
Throughput	4137	4140	4148	4157
Jitter	0.0134173	0.13	0.011	0.011
Delay	0.014	0.014	0.013	0.012

(1) Throughput–Throughput is the average rate of successful message delivery over communication channel. It is measured in bits per second (bit/s or bps) and sometimes in data packets per second or data packets per time slot. Due to varying load from other users sharing the same network resources, the bit-rate (the maximum Throughput) that can be provided to a certain data stream may be too low for real time multimedia services if all data streams get the same scheduling priority. Figure 4 shows the throughput taken for CBR application. The throughput at the server is calculated as,

$$Throughput = \frac{Total\ bytes\ sent*8}{Time\ last\ packet\ received - time\ first\ packet\ received}$$
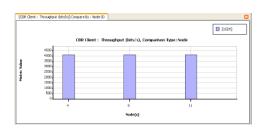

Fig. 4. Analyzing throughputs for load of 50000 bytes.

(2) Average Jitter–As the packets from source to destination will reach the destination with different delays. A packet's delay varies with its position in the queues of the routers along the path between source and destination and this position can vary unpredictably. This variation in delay is known as Jitter. Jitter can seriously affect the quality of streaming audio and/or video. As we know jitter is the variation in delay suffered by different data packets reaching a destination, thus it is an unwanted parameter. But it is also unavoidable in IP based communication systems as we use routers for the data packets and different data packets

choose different routes for attaining bandwidth utilization. Figure 5 shows the average jitter by client.

$$Average\ Jitter = \frac{Total\ packet\ jitter\ of\ all\ received\ packets}{Number\ of\ packets\ received - 1}$$

Where,

Packet jitter = transmission delay of the current packet - transmission delay of the previous packet.
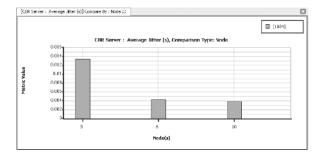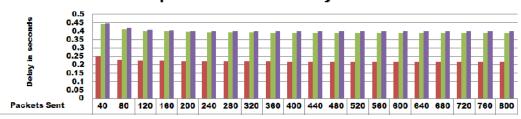

Fig. 5. Analyzing Average Jitter.

(3) Average end-to-end delay-Due to queuing and different routing paths, a data packet may take a longer time to reach its destination .Figure 6 shows the graph for end to end delay. The end-to-end delay experienced by the packets for each flow the individual packet delay are summed and the average is computed.

$$Throughput = \frac{Total\ of\ transmission\ delays\ of\ all\ received\ packets}{Number\ of\ packets\ received}$$

Where,

Transmission delay of a packet = (time packet received at server - time packet transmitted at client), Where the times are in seconds.

Fig. 6. Analyzing end to end delay.

VI. CONCLUSION

This paper gives overview f or the implementation of Scheduling Algorithms with its architecture and emphasizing to the Quality of Service in the CBR application. In this paper, the Quality of Service is analyzed by changing the value of the packet size and load send in the CBR application. As the throughput is the ratio of the total amount of data that reaches the receiver to the time it takes. So a high throughput is always desirable in a communication system. In case of jitter only a little amount of jitter present in the system is tolerable. Due to queuing and different routing paths, a data packet may suffer with time delay before reception at the destination. Thus, throughput and average end to end delay are directly proportional to the packets size whereas average jitter is inversely proportional and all parameters is inversely proportional to the number of packets size. It is found in this research that weighted round robin is the optimum scheduling algorithm which has high throughput and low Jitter and delay as compare to other scheduling algorithms. Fig. 7. shows the graphical representation of scheduling algorithms with QoS.
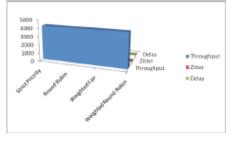

Fig. 7. Graphical view of Scheduling algorithms with QoS parameters.

For future work the performance of different scheduling algorithms on WLAN network scenarios can be analyzed under different applications (VBR, UBR and ABR).

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[17] ITU-T Recommendation G.711 Appendix I:" A High Quality Low-Complexity Algorithm for Packet Loss Concealment with G.711"