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Performance Analysis of Integrated Service over Differentiated Service for Next Generation Internet

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Abstract—This paper discusses on next generation Internet how we can provide Quality of Services (QoS) to the users while today's internet provides the BES (Best Effort Services), that does not guaranteed the QoS. Here, we proposed an internet service for next generation internet where integrated and differentiated services are combined. Today's internet uses only one queue for data, voice and video which degrades the performance. To increase the performance of real time internet service for next generation, we can use different queues for data, voice and video individually. For three different applications, we can assign three different queues. Based on the priority, it can be assigned to video applications, voice and FTP applications. Integrated Services (IntServ) and Differentiated Services (DiffServ) are two of the current approaches to provide QoS guarantees in the next generation Internet. IntServ aims at providing guarantees to end applications (individual connections) which give rise to scalability issues in the core of the network. On the contrary, DiffServ is designed to provide QoS to aggregates, and does not suffer from scalability. It is therefore, believed that the combination of IntServ at the edge and DiffServ at the core will be able to provide QoS guarantees to end applications. In this paper, we tried to set up a network that carries three applications: FTP, Video, and VoIP and designed the architecture using OPNET ITGURU Academic edition. Besides this, we generated graphs for three different applications and examined these graphs and compared with each other, which can provide a better solution for next generation internet.

Index Terms— QoS, DiffServ, IntServ, Internetworking, Next Generation Internet.

1 INTRODUCTION

In traditional network Router maintain only one queue for all types of services. Process all the application like FTP, voice, and video in same queue whereas the types of application are not same. They have different size. for example if we want to send one page email with one page a picture, the normal FTP file needs only 2kB for one page data, while one page of color video screen need 2MB.so there is a big difference between FTP application and video application. We needs thousand times for video application than FTP application, as a result network performance is degrade.

The main objective of this proposal to get better service than existing service, for this we propose different queue for different services and each queue has its own processing power. So that we can get:

- Less delay of network
- High throughput of the network
- High bandwidth.

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Generally we want a QoS from the network instead of BE.

1.1 Real Life Example

Model description can be better understood if a real life example is cited. A real life example is a sport ground where different events may be observed from outer periphery of the ground or by purchasing ticket and observing from gallery. The gallery area may be classified as normal or VIP enclosure. A person willing to enter the ground through the gate has to show the ticket to the ticket checker. After verification the person allowed to enter the ground. Immediately after his entrance into field a second grout ascertain whether the ticket holder will be directed towards the VIP gallery or normal gallery. The observation from the outer periphery of the ground may be defined as Best effort (BE) and a person observing from gallery may be defined as recipient of quality of service. The best effort may be compared as the present internet system and Quality of service may be compared with the next generation internet system. Where IntServ is seen as a solution that provides QoS in edge network, whereas, DiffServ is a popular in candidate core network.

Interconnection of IntServ and DiffServ, in order to exploit the individual advantages of IntServ (per flow QoS guarantee) and DiffServ (good scalability in the backbone), requires a mapping from IntServ traffic flows to DiffServ classes to be performed at the ingress to the DiffServ network. Some preliminary work has been carried out in the area of interconnecting IntServ and DiffServ. Balmer presents a concept [1] for the integration of IntServ and DiffServ, and describes a prototype implementation using commercial routers. Budiardjo [2] suggests some preliminary ideas on a packet forwarding algorithm to forward packets from the Guaranteed Class traffic of IntServ to Expedited Forwarding class of DiffServ. Chahed [3] shows that packet loss in the DiffServ network can result in bursty loss to the IntServ applications. Detti [4] have proposed an architecture for supporting IntServ and DiffServ and have carried out a scalability analysis. Harju [5] present results to determine performance differences between IntServ and DiffServ, as well as some characteristics about their combined use. Mamais [6] proposes a new DiffServ class for carrying RSVP signaling originating from the edge IntServ domain. However, the above studies do not present any numerical result to evaluate the QoS guarantee that can be achieved by end applications. The authors are not aware of any study which quantitatively shows the QoS that can be achieved by IntServ end applications when IntServ and DiffServ are interconnected. The objective of this paper is to quantitatively measure the QoS guarantees that can be obtained by end applications when IntServ is run over DiffServ. In our study, to map services from IntServ to DiffServ, we have proposed a mapping function between the two domains. Traffic arriving from the IntServ domain are appropriately mapped into the corresponding Behavior Aggregates of DiffServ, and then marked with the appropriate Differentiated Service Code Point (DSCP) for routing in the DiffServ domain. To determine the QoS obtained by end IntServ applications, we have used good put of applications, the queue size at the router, and drop ratio of packets as the performance criteria. To prove the effectiveness of the admission control mechanism, we also measured the non-conformant ratio (the ratio of non-conformant packets to the in-profile packets). When IntServ runs over a DiffServ network where the DiffServ is considered a network element to the edge IntServ networks. The rest of this paper is organized as follows. In Sections 2 and 3, we briefly present the main features of IntServ and DiffServ, respectively. In Section 4, we describe our approach of mapping traffic from IntServ to DiffServ. In Section 5, we analyze the simulation results. Concluding remarks are finally given in Section 6.

2 INTEGRATED SERVICES

The basic framework of integrated services [7] is implemented by four components: the signaling protocol, the admission control routine, the classifier and the packet scheduler. This model requires explicit signaling mechanism to convey information to routers so that they can provide the requested resources to flows that require them. RSVP is one of the most widely known examples of such a signaling mechanism which will be described in detail in Section 2.1. In addition to the best effort service, the integrated services model provides two services as follows.

- Guaranteed service [8] for applications requiring firm bounds on end-to-end queuing delays.
- Controlled-load service [9] for applications requiring services closely equivalent to that provided to uncontrolled best effort traffic under unloaded (lightly loaded) network.

The above two services will be discussed in Section ns 2.2 and 2.3.

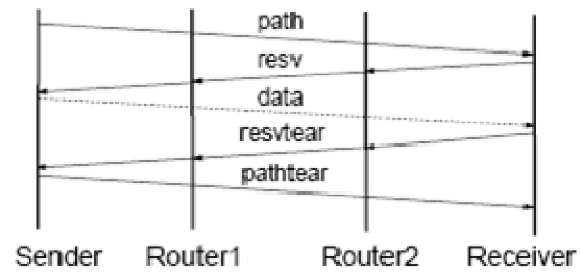

Fig. 1 RSVP signaling for resource reservation.

2.1 RSVP Signaling

RSVP is a signaling protocol to reserve network resources for applications. Figure 1 illustrates the setup and teardown procedures of the RSVP protocol. The sender sends a PATH message to the receiver specifying the characteristic of the required traffic. Every intermediate router along the path forwards the PATH message to the next hop determined by the routing protocol. If the receiver agrees to the advertised flow, it sends a RESV message, which is forwarded hop by Hop via RSVP capable routers towards the sender of the PATH message. Any intermediate router along the path may reject or accept the request. If the request is accepted, resources are allocated, and RESV message is forwarded. If the request is rejected, the router will send a RESV-ERR message back to the sender of the RESV message. Receipt of a RESV message by the sender implies that resources have been reserved and data can be transmitted. To terminate a reservation, a RESV-TEAR message is transmitted to remove the resource allocation, and a PATH-TEAR message is sent to delete the path states in every router along the path.

2.2 Guaranteed Service

Guaranteed service guarantees that datagram's will arrive within the guaranteed delivery time and will not be discarded due to queue overflows, provided the flow's traffic stays within its specified traffic parameters. The service provides assured level of bandwidth or link capacity for the data flow. It imposes a strict upper bound on the end-to-end queuing delay as data flows through the network. The packets encounter no queuing delay as long as they conform to the flow specifications. It means packets cannot be dropped due to buffer overflow and they are always guaranteed the required buffer space. The delay bound is usually large enough even to accommodate cases of long queuing delays.

2.3 Controlled-load Service

The controlled-load service does not accept or make use of specific target values for control parameters such as delay or loss. Instead, acceptance of a request for controlled-load service is defined to imply a commitment by the network elements to provide a service closely equivalent to that provided to uncontrolled (best effort) traffic under lightly loaded conditions. The service aims at providing the same QoS under heavy loads as under unloaded conditions. Though there is no specified strict bound on delay, it ensures that a very high percentage of packets do not experience delays highly greater than the minimum transit delay due to propagation and router processing.

3 DIFFERENTIATED SERVICES

The IntServ / RSVP architecture described in Section 2 can be used to provide QoS to applications. All the routers are required to be RSVP-aware and capable of performing admission control, MF classification and packet scheduling [1][2]. These require maintaining of information for each flow at each router, giving rise to scalability concerns in large networks.2 Because of the difficulty in implementing and deploying integrated services and RSVP, differentiated services is currently being developed by the IETF.4 Differentiated services (DiffServ) is intended to enable the deployment of scalable service discrimination in the Internet without the need for per-flow state and signaling at every hop [4]. The premise of DiffServ networks is that routers in the core network handle packets from different traffic streams by forwarding them using different per-hop behaviors (PHBs). The PHB to be applied to a packet is indicated by a DiffServ Code point (DSCP) in the IP header of the packet. The advantage of such a mechanism is that several different traffic streams can be aggregated to one of a small number of behavior aggregates (BA), each of which is forwarded using the same PHB at the router, thereby simplifying the processing and associated storage [9]. There is no signaling since QoS is invoked on a packet-by-packet basis [9]. The DiffServ architecture is composed of a number of functional elements, including a small set of per-hop forwarding behaviors, packet classification functions, and traffic conditioning functions which includes metering, marking, shaping and policing. This architecture provides Expedited Forwarding (EF) service and Assured Forwarding (AF) service in addition to best-effort (BE) service as described below.

3.1 Expedited Forwarding (EF)

This service is also been described as Premium Service. The EF service provides a low loss, low latency, low jitter, assured bandwidth, end-to-end service [10]. Loss, latency and jitter are due to the queuing experienced by traffic while transiting the network. Therefore, providing low loss, latency and jitter for some traffic aggregate means there are no queues (or very small queues) for the traffic aggregate. At every transit node, the aggregate of the EF traffic's maximum arrival rate must be less than its configured minimum departure rate so that there is almost no queuing delay for these premium packets. Packets exceeding the peak rate are shaped by traffic conditioners to bring the traffic into conformance.

3.2 Assured Forwarding

This service provides reliable services for customers even during network congestion. Classification and policing are first done at the edge routers of the DiffServ network. The assured service traffic is considered in-profile if the traffic does not exceed the bit rate allocated for the service; otherwise, the excess packets are considered out-of-profile. The in-profile packets should be forwarded with high probability. However, the out-of-profile packets are delivered with lower priority than the in-profile packets. Since the network does not reorder packets that belong to the same micro flow, all packets, irrespective of whether they are in-profile or out-of-profile, are put into an assured queue to avoid out-of-order delivery. Assured Forwarding provides the delivery of packets in four independently forwarded AF classes. Each class is allocated a configurable minimum amount of buffer space and bandwidth. Each class is in turn divided into different levels of drop precedence. In the case of network congestion, the drop precedence determines the relative importance of the packets within the AF classes. Fig. 3 shows four different AF classes with three levels of drop precedence.

Fig. 3 AF classes with drop precedence levels

3.3. Best Effort

This is the default service available in DiffServ, and is also deployed by the current Internet. It does not guarantee any bandwidth to customers, but can only get the available bandwidth. Packets are queued when buffers are available, and dropped when resources are over committed.

4. INTEGRATED SERVICES OVER DIFFERENTIATED SERVICES NETWORKS

In this section, we describe in detail the mapping strategy to connect the IntServ and DiffServ domains.

4.1. Mapping Considerations for IntServ over DiffServ

In IntServ, resource reservations are made by requesting a service type specified by a set of parameters known as Tspec (Traffic Specification). Each set of parameters determines an appropriate priority level. When a connection with a certain priority level is mapped to the DiffServ domain, the following basic requirements should be satisfied.

PHBs in the DiffServ domain must be appropriately selected for each requested service in the IntServ domain. The required policing, shaping and marking must be done at the edge router of the DiffServ domain. Taking into account the resource availability in DiffServ domain, admission control must be implemented for traffic arriving from the IntServ domain.

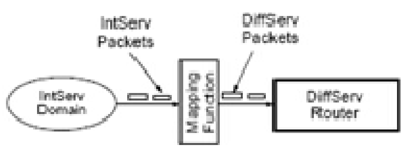

Fig. 4 Mapping function for integrated service over differentiated service.

4.2. Mapping Function

The mapping function is used to assign an appropriate DSCP code to packets arriving from a flow specified by the Tspec parameters in the IntServ domain. This is to ensure that the appropriate QoS can be achieved for IntServ flows when running over a DiffServ domain. To achieve the above goal, we introduce a mapping function at the boundary router in the DiffServ domain as shown in Figure 4. Every packet in the flow from an IntServ domain has a flow ID indicated in the flow-id field in the IP (Internet Protocol) header. The flow ID attributed with the Tspec parameters is used to determine which flow the packet belongs to. Packets specified by Tspec parameters in IntServ domain are first mapped to the corresponding PHBs in the DiffServ domain by appropriately assigning a DSCP according to the mapping function. The packets are then routed in the DiffServ domain where they receive treatment based on their DSCP code. The packets are grouped into BAs in the DiffServ domain. Table 1 shows an example mapping function. As an instance, a flow in the IntServ domain specified by r = 0:7 Mb, b = 5000 bytes and Flow ID=0 is mapped to EF PHB (with corresponding DSCP code of 101110) in the DiffServ domain. r and b represent the token bucket rate and depth respectively.

TABLE 1

AN EXAMPLE MAPPING FUNCTION BETWEEN INSTSERV AND DIFFSERV

Tspec	Flow ID	PHB	DSCP
r=0.7 Mb, b=5000 bytes	0	EF	101110
r=0.7 Mb, b=5000 bytes	1	EF	10 1110
r=0.5 Mb, b=8000 bytes	2	AF	001010
r=0.5 Mb, b=8000 bytes	3	AF	001010
r=0.5 Mb, b=8000 bytes	4	AF	001010

The sender initially specifies its requested service using Tspec. Note that it is possible for different senders to use the same Tspec. However, they are differentiated by the flow ID. In addition, it is also possible that different flows can be mapped to the same PHB in DiffServ domain.

5 SIMULATION AND PERFORMANCE ANALYSIS

In our simulation we used OPNET to examine the effect of different queuing disciplines on packet delivery and delay. As part of the resource allocation mechanisms, each router has some queuing discipline that governs how packets are buffered while waiting to be transmitted. Various queuing disciplines can be used to control which packets get transmitted (bandwidth allocation) and which packets get dropped (buffer space). The queuing discipline also affects the latency experienced by a packet, by determining how long a packet waits to be transmitted. Examples of the common queuing disciplines are first-in-first-out (FIFO) queuing, priority queuing (PQ), and weighted-fair queuing (WFQ).

The idea of FIFO queuing is that the first packet that arrives at a router is the first packet to be transmitted. Given that the amount of buffer space at each router is finite, if a packet arrives and the queue (buffer space) is full, then the router discards (drops) that packet. This is done without regard to which flow the packet belongs to or how important the packet is. PQ is a simple variation of the basic FIFO queuing. The idea is to mark each packet with a priority; the mark could be carried, for example, in the IP Type of Service (ToS) field. The routers then implement multiple FIFO queues, one for each priority class. Within each priority, packets are still managed in a FIFO manner. This queuing discipline allows high priority packets to cut to the front of the line.

The idea of the fair queuing (FQ) discipline is to maintain a separate queue for each flow currently being handled by the router. The router then services these queues in a round robin manner. WFQ allows a weight to be assigned to each flow (queue). This weight effectively controls the percentage of the link's bandwidth each flow will get. We could use ToS bits in the IP header to identify that weight. In this network simulation we set up a network that carries three applications: FTP, Video, and VoIP. We study how the choice of the queuing discipline in the routers can affect the performance of the applications and the utilization of the network resources.

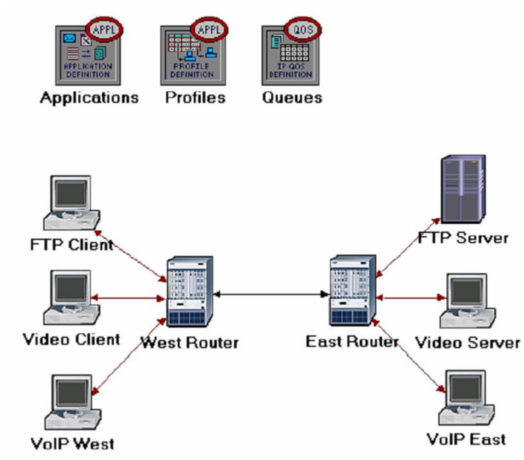

Fig. 5 Network with three different applications Procedure

5.1 Graph analysis

To test the performance of the applications defined in the network, we collected some statistics as follows:

IP	Video conferencing	Voice
Traffic dropped	Traffic Received (packets /sec)	-Packet delay variation
		Packet End-to-End Delay(sec)
		Traffic Received(bytes/sec)

Configure Application:

Application	Load	Inter-request time(s)	Type of service (ToS)
FTP	High load to FTP	Start time: constant(100) Duration: end of simulation.	Best effort(0)
Video	Low resolution video to video conferencing	Start time: constant(100) Duration: end of simulation.	Streaming multimedia(4)
VoIP	PCM quality speech to voice	Start time: constant(100) Duration: end of simulation.	Interactive voice(6)

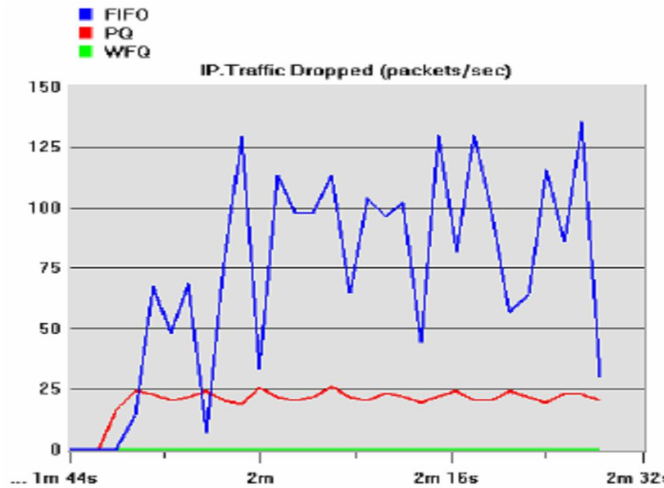

Fig. 5.1 IP packet drops (packets/sec)

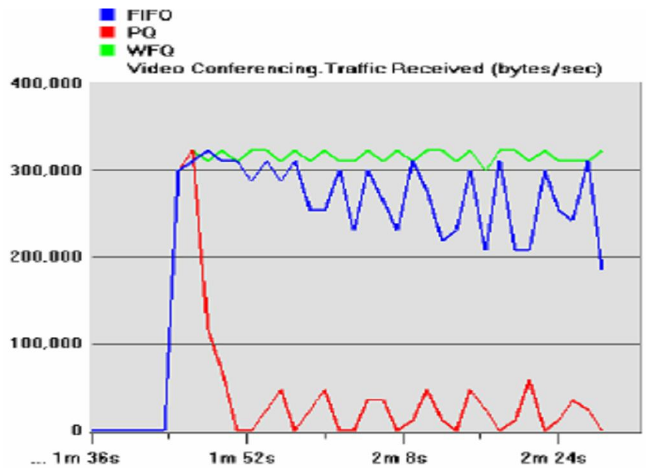

Fig. 5.2 Graph for Video Conferencing Traffic Received.

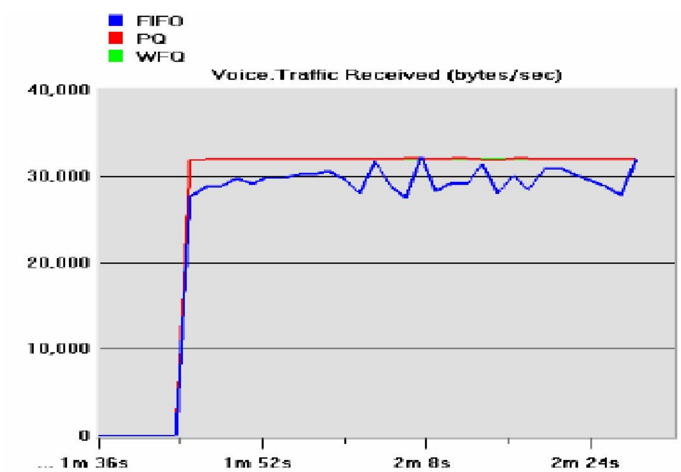

Fig. 5.3 Graph for Voice Traffic Received.

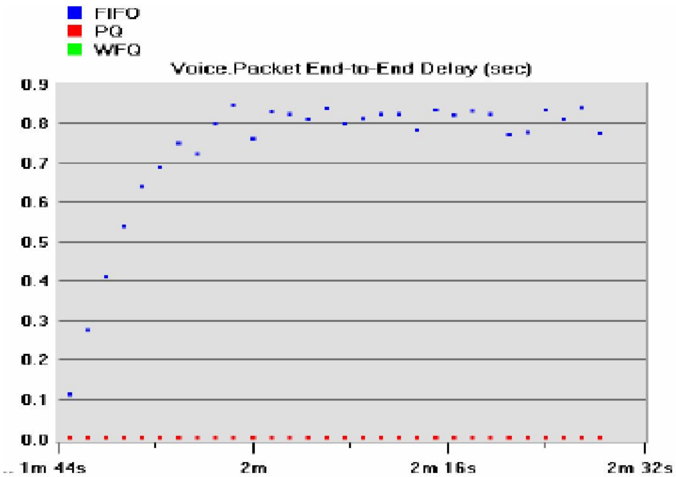

Fig. 5.4 Graphs for Voice Packet End-to-End Delay

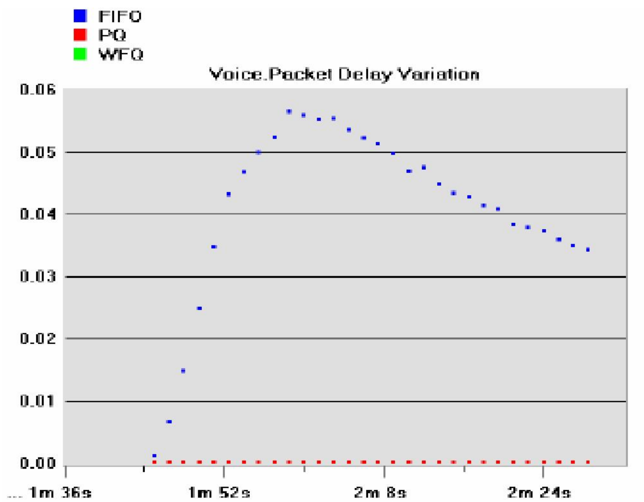

Fig. 5.5 Graph for the Voice Packet Delay

5.2 Graphical Result

Analyzing graphs, we examined the overlapping of the voice packets with end to end delay and voice packet delay variation graphs. Compared the three queuing disciplines and explained their effect on the performance of the three applications. The first graph shows that the highest rate of dropped packets occurs with the FIFO queuing discipline. The lowest rate is provided by the WFQ queuing discipline. This is because, FIFO drops packets without regard to which flow the packet belongs to but only depending on its arrival time. PQ and WFQ disciplines implement multiple FIFO queues and provide a service that depends on the ToS value associated with the packets. The following graph compares the queuing delay for the FIFO, PQ, and WFQ disciplines. It shows that the highest delay is experienced by the FIFO queuing discipline. The best delay is provided by the WFQ as expected.

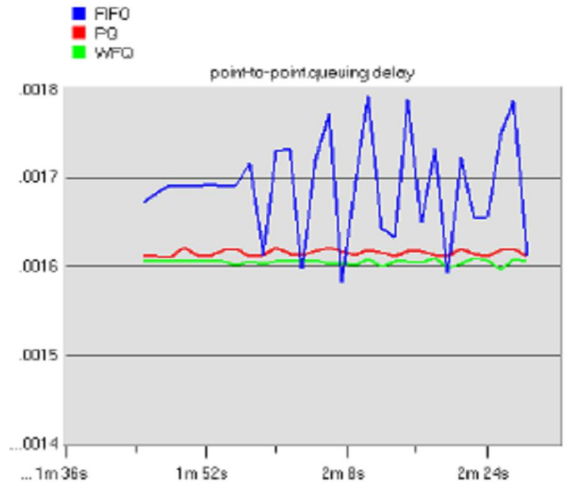

Fig. 5.6 Point to point queuing delay

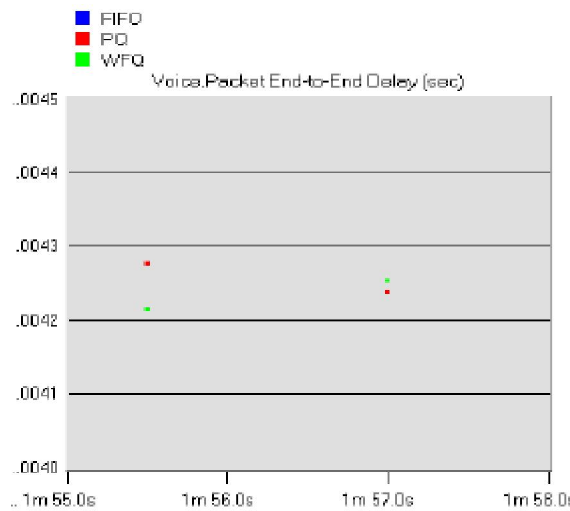

Fig. 5.7 Voice packet End-to-End delay (sec)

The above graph shows that the values for WFQ (green dots) are very close to the values for PQ (red dots). This explains the above overlap. The above graphs show that the voice packets experience higher delay and jitter in case of FIFO queuing discipline. Both PQ and WFQ provide better and almost the same delay and jitter for the voice packets.

6 Conclusion

In this paper, we evaluated the QoS that can be obtained by end applications when Integrated Services (IntServ) sub networks are connected together using Differentiated Services (DiffServ) network. Traffic from various IntServ classes with different priorities is mapped into appropriate DiffServ services such that QoS can be guaranteed to individual applications. We proposed a queuing mechanism to traditional network router to achieved quality of services. Results of different queuing for QoS management of IntServ / DiffServ networks, is reported. Our plan is to do more rigorous study of the scalability of the IntServ, and to implement the total architecture of IntServ over DiffServ under OPNET simulation tools. We studied with various parameters to get high throughput of the network and confirmed theoretically that the improved queue technique is more acceptable and provides QoS.

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