OPTIMIZATION OF COMPUTER NETWORKS USING QoS

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Abstract: Recently, a need for an end to end quality of service over hybrid networks (containing wired and wireless segments) has become evident. Delay, jitter and reliability are also important properties for the quality of network connection. This is because different applications has different needs, and therefore require different properties from the network. In this Paper the focus was on the following two Queuing schemes: First In First Out (FIFO), Priority Queuing (PQ). The implementation of the schemes will be carried out using OPNET. The results were evaluated by making the comparison of the performance of the two queuing schemes. In FIFO, On Analysi s it is inevitable that the traffic is queued in "router A" because of the bottleneck. Since "router A" has limited buffer capacity, some packets are dropped when the buffer usage reaches its full capacity. The application response time can be seen to reach a threshold because packets that arrive on a full queue always get dropped. The maximum delay that an arriving packet observes is the delay encountered as a result of servicing all the packets ahead of it in an almost full queue. In Priority Queuing, the analysis illustrate that the traffic is queued in "router A" because of the bottleneck. Priority queuing mechanism differentiates between queues according to its priority. In this priority is based on type of service (TOS). Queue 4 sends packets as long it is not empty. Queue 3 sends packets when queue 4 is empty. Queue 2 sends packets when queue 3 and 4 are empty. Queue 1 sends packets when all the other queues are empty. As a result of this classification traffic with higher TOS gets better delay.

Keywords: QoS, FIFO, PQ

1. INTRODUCTION

During the last few years, users all over the world have become more and more accustomed to the availability of broadband access. This has boosted the use of a wide variety both of established and recent multimedia applications. However, there are cases where it is too expensive for network providers to serve a community of users. The Quality of Service (QoS) research investigations in Wired and Wireless networks have been conducted mostly in isolation. Recently, a need for an end to end quality of service over hybrid networks (containing wired and wireless segments) has become evident. IEEE 802.11e work group has set up the standards for wireless network quality of service which became part of the comprehensive approved 802.11 wireless networks standards late 2006. The most recent version of IEEE 802.11 standard states that there is plenty of room for improvement and development in the area of integrating QoS in wireless and wired networks.

Queuing schemes provide predictable network service by providing dedicated bandwidth, controlled jitter and latency, and improved packet loss characteristics. The basic idea is to pre-allocate resources (e.g., processor and buffer space) for sensitive data. Each of the following schemes require customized configuration of output interface queues.

Queuing schemes:

- First in First Out (FIFO),
- Priority Queuing (PQ),
- Custom Queuing (CQ), and
- Weighted Fair Queuing (WFQ).

In this Paper the focus will be on the following two Queuing schemes:

1. First In First Out (FIFO),
2. Priority Queuing (PQ),

The implementation of the schemes will be carried out using OPNET. The results will indicate the comparison of the performance of the two queuing schemes.

2. LITERATURE SURVEY

The discussion about the quality of service (QoS) in providing internet protocol (IP) based service in wireless and wired networks have been carried by *Jukka Manner* et.al (2002). The study focused on the shortcomings of real time transport protocol (RTTP), insiginia and itsumo protocols. The study focused on the methodologies like strict flow shaping at the network edge, coupling of micro-mobility and quality of service (QoS) protocols, advanced reservations, pre handover negotiations and context transfer methodologies were adopted for improvement in quality of service (QoS). *Taeyeon Park and Dadej* (2003) discussed the OPNET simulation modeling and analysis of enhanced Mobile. To facilitate simulation studies of Mobile IP performance and comparative analysis of enhanced mobile IP handover mechanisms, development was done based on simulation model of Mobile IP using OPNET modeling environment. This study provided basic design concepts and implementation details of the simulation model, as well as descriptions of the advanced features of IP mobility architectures implemented as part of the model, e.g. buffering and regional registration. Based on the analysis of simulation results obtained using the developed simulation models, a few suggestions were made for the use of Mobile IP and related enhanced mechanisms in selected wireless Internet scenarios. The discussion on the credibility of manet simulations was made by *Andel, T.R.* (2006) for the lack of rigor with which it's applied threatened the credibility of the published research within the manet research community. Mobile ad hoc networks (manets) allowed rapid deployment because they don't depend on a fixed infrastructure. Manet nodes can participate as the source, the destination, or an intermediate router. This flexibility was attractive for military applications, disaster-response situations, and academic environments where fixed net working infrastructures might not be viable. *Mohorko, J.* et.al (2007) discussed about Modeling methods in OPNET simulations of Tactical Command and Control Information Systems. Slovenia was a member of MIP (multilateral interoperability programme), the task of which was to provide interpretations of national C2IS systems for successfully harmonizing joint action by international military peacekeeping forces. Interpretability within MIP was carried-out by a unified model based on controlled data replication between the databases of C2IS systems. Systematics IRIS replication mechanism software (IRM) was used for data replication. This paper presented methods of measuring and analyzing traffic that causes IRM. *Chow and Jocelyn* (1999) discussed that wireless channel models must take into account the effects of a non-free space environment with obstructions and time-varying interference factors (a common RF environment). OPNET was a widely used simulation tool which provides a skeleton of a 14-stage radio pipeline. Wireless channel models were developed efficiently when the pipeline framework was usable for the specific channel modeling application. The pipeline as supplied simulates a free space path loss channel model for a given transmitter and receiver pair with additive Gaussian noise and interference. The interference was modeled as the sum of the average power of the interfering sources. This study investigated different approaches to channel modeling, and demonstrates their implementation in OPNET.

3. PROBLEM FORMULATION

Queuing schemes provide predictable network service by providing dedicated bandwidth, controlled jitter and latency, and improved packet loss characteristics. The basic idea is to pre-allocate resources (e.g., processor and buffer space) for sensitive data. Each of the following schemes require customized configuration of output interface queues.

Queuing Schemes

Priority Queuing (PQ) assures that during congestion the highest priority data does not get delayed by lower priority traffic. However, lower priority traffic can experience significant delays. PQ is designed for environments that focus on mission critical data, excluding or delaying less critical traffic during periods of congestion.

Custom Queuing (CQ) assigns a certain percentage of the bandwidth to each queue to assure predictable throughput for other queues. It is designed for environments that need to guarantee a minimal level of service to all traffic.

Weighted Fair Queuing (WFQ) allocates a percentage of the output bandwidth equal to the relative weight of each traffic class during periods of congestion.

QoS Attribute Configuration Object

The QoS Attribute Configuration object defines profiles for the following technologies:

- FIFO
- WFQ
- Custom Queuing
- Priority Queuing

Each queuing-based profile (e.g., FIFO, WFQ, PQ, CQ) contains a table in which each row represents one queue. Each queue has many parameters such as queue size, classification scheme, RED parameters etc. Some examples of setting queue priorities are:

- Weight for WFQ profile. Higher priority is assigned to the queue with a higher weight.
- Byte count for Custom Queuing profile. More traffic is served from the queue with a higher byte count.
- Priority label for Priority Queuing. Higher priority is assigned to the queue with a higher priority label.

This project includes three scenarios. The role of each of the scenario is as follows:

1. None: This scenario is a reference scenario. No queuing is defined at the IP layer.
2. FIFO : This scenario illustrates FIFO queuing at the IP layer.
3. Priority Queuing : This scenario illustrates Priority Queuing at the IP layer.

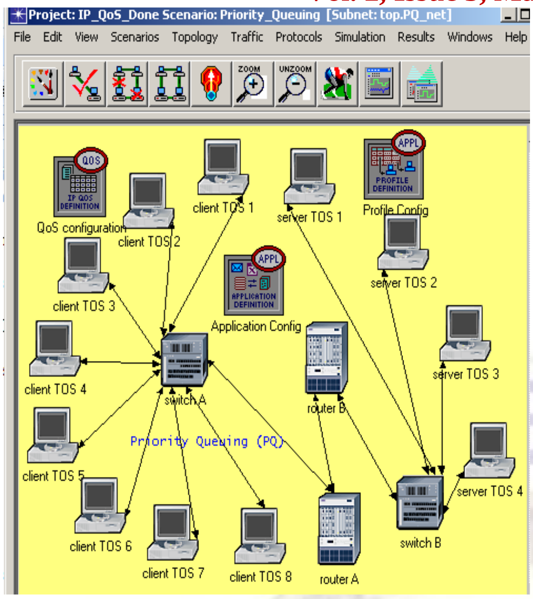

Fig 1 Network Scenario of the Case studies

CASE STUDY 1:

No Queuing: In this no queuing is defined at the IP layer. In the network scenario the network is composed of four pairs of video clients. Each pair uses a distinct TOS (Type of Service) for data transfer. The link between the two routers is a "potential" bottleneck. The analysis indicate that the traffic is queued in "router A" because of the bottleneck. Since "router A" has unlimited buffer capacity no packets get dropped. The application response time keeps on increasing as the packets get queued indefinitely without ever getting dropped.

Table 1 Attributes of the Case Study 1

Attribute	**Value**
Number of Queries	60 %
Transaction Inter arrival Time	10 sec
Transaction Size	32768 bytes
TOS	Best Effort
Receive Inter Arrival Time	360 secs
Inter Request Time	3600 secs
File Size	50000 bytes

The File size and the transaction size may var according to the type of the server to be configured. The types of Servers configured may be database server, FTP server, Print server , Email Server etc.

CASE STUDY II

FIFO: In this scenario FIFO queuing is used at the IP layer. The network is composed of four pairs of video clients. Each pair uses a distinct TOS for data transfer. Again the link between the two routers is a "potential" bottleneck. FIFO queuing can be enabled on each interface. Queuing profile and queuing processing mechanism are set in attribute "QoS info". Queuing profile defines the number of queues and the classification scheme. Queuing profiles are defined in the QoS configuration object. This object is found in "utilities" palette.

Table 2 Attributes of the Case Study 2

Attribute	**Value**
Number of Queries	60 %
Transaction Inter arrival Time	10 sec
Transaction Size	32768 bytes
TOS	Best Effort
Receive Inter Arrival Time	360 secs
Inter Request Time	3600 secs
File Size	50000 bytes
Buffer Size	1 Mbyte
Queuing Scheme	FIFO
Queuing Profile	FIFO Profile

On Analysis it is inevitable that the traffic is queued in "router A" because of the bottleneck. Since "router A" has limited buffer capacity, some packets are dropped when the buffer usage reaches its full capacity. The application response time can be seen to reach a threshold because packets that arrive on a full queue always get dropped. The maximum delay that an arriving packet observes is the delay encountered as a result of servicing all the packets ahead of it in an almost full queue.

CASE STUDY III

Priority Queuing: This scenario illustrates Priority Queuing at the IP layer. The network is composed of four pairs of video clients. Each pair uses a distinct TOS for data transfer. Again the link between the two routers is a "potential" bottleneck. In this queues are serviced using "Priority Queuing" mechanism. Priority queuing can be enabled on each interface in routers. Queuing profile and queuing processing mechanism are set. Queuing profile defines the number of queues and the classification scheme. Queuing profiles are defined in the QoS configuration object. This object is found in "utilities" palette.

Table 3 Attributes of the Case Study 3

Attribute	**Value**
Number of Queries	60 %
Transaction Inter arrival Time	10 sec
Transaction Size	32768 bytes
TOS	Best Effort
Receive Inter Arrival Time	360 secs
Inter Request Time	3600 secs
File Size	50000 bytes
Buffer Size	1 Mbyte
Queuing Scheme	Priority Queuing
Queuing Profile	TOS Based

The analysis illustrate that the traffic is queued in "router A" because of the bottleneck. Priority Queuing mechanism differentiates between queues according to its priority. In this priority is based on type of service (TOS). Queue 4 sends packets as long it is not empty. Queue 3 sends packets when queue 4 is empty. Queue 2 sends packets when queue 3 and 4 are empty. Queue 1 sends packets when all the other queues are empty. As a result of this classification traffic with higher TOS gets better delay.

4. RESULTS

The File size and the transaction size may vary according to the type of the server to be configured. The types of Servers configured may be database server, FTP server, Print server , Email Server etc.

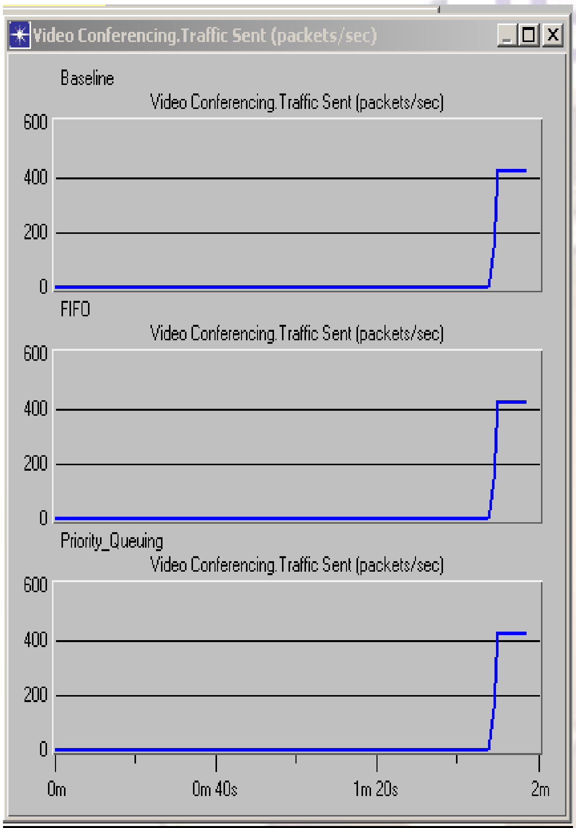

Figure 2 Traffic sent (packets /sec)

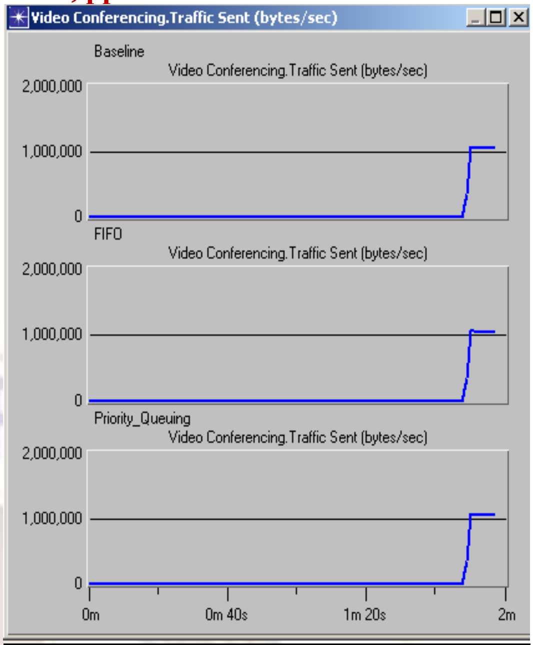

Figure 3 Traffic sent (bytes /sec)

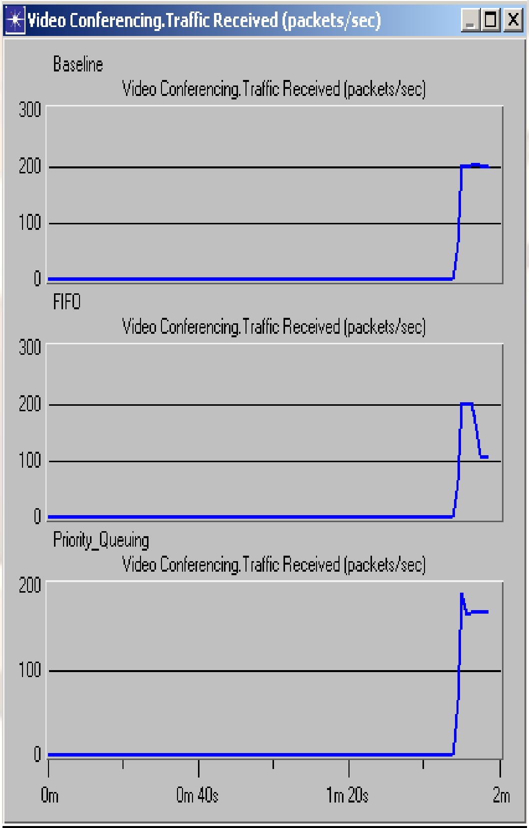

Figure 4 Traffic Received (packets /sec)

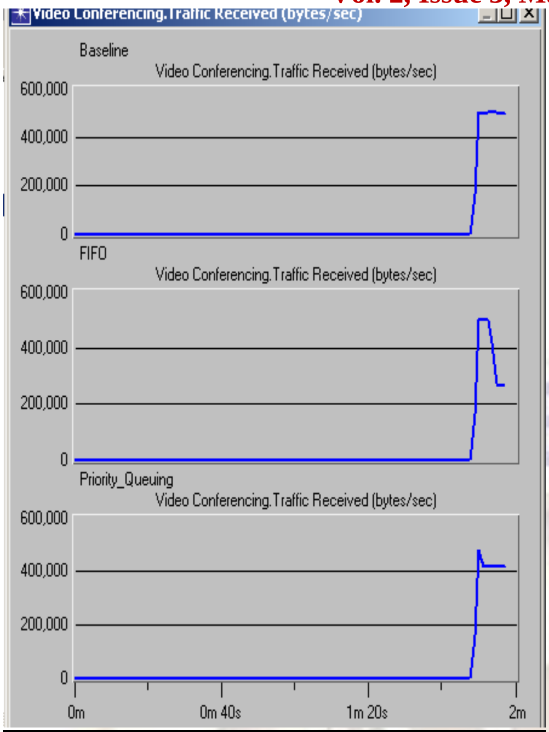

Figure 5 Traffic Received (bytes /sec)

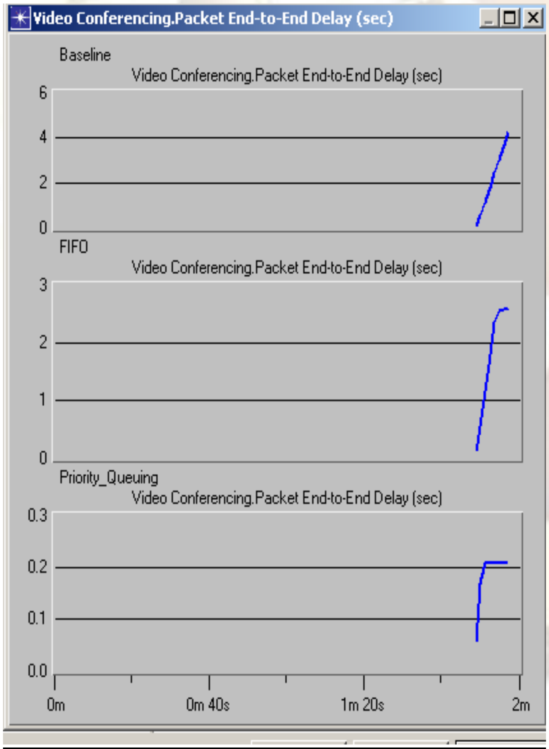

Figure 6 End-to-End Delay (sec)

In FIFO, On Analysis it is inevitable that the traffic is queued in "router A" because of the bottleneck. Since "router A" has limited buffer capacity, some packets are dropped when the buffer usage reaches its full capacity. The application response time can be seen to reach a threshold because packets that arrive on a full queue always get dropped. The maximum delay that an arriving packet observes is the delay encountered as a result of servicing all the packets ahead of it in an almost full queue. In Priority Queuing, the analysis illustrate that the traffic is queued in "router A" because of the bottleneck. Priority Queuing mechanism differentiates between queues according to its priority. In this priority is based on type of service (TOS). Queue 4 sends packets as long it is not empty. Queue 3 sends packets when queue 4 is empty. Queue 2 sends packets when queue 3 and 4 are empty. Queue 1 sends packets when all the other queues are empty. As a result of this classification traffic with higher TOS gets better delay.

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