SFU

ENSC 427
Communication Networks

Final Project Presentation – Spring 2011

Comparison and analysis of FIFO, PQ, and WFQ Disciplines in OPNET

Shervin Asgari Pour
Shadi Rohani Vadeghani

Presentation Structure

- Shadi: Introduction
- Shadi: Background Information
- Shervin: OPNET Implementation
- Shervin: Simulation Results
- Conclusion and Questions

Introduction and Motivation

- Queuing methods are used to handle network resources
- Real-time applications such as voice and video conferencing are especially susceptible to delays and packet losses
- The Quality of Service (QoS) network devices must employ proper queuing methods to differentiate among arriving packets
- Queuing disciplines are implemented in routers
- We seek to provide an answer to the question:
  - What is the best queuing discipline to use for a given application?

Overview

Comparison and analysis of queuing disciplines in OPNET

- Focus on:
  - FIFO First-in, First Out
  - PQ Priority Queuing
  - WFQ Weighted Fair Queuing
- Apply each queuing method towards:
  - FTP
  - Voice
  - Video Conferencing

Overview

Global and Object statistics collected and analyzed *

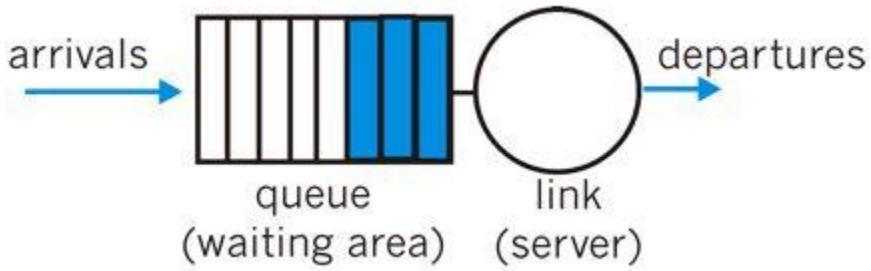
Statistics for	Global Statistics
FTP	• **Traffic Sent** • **Traffic Received**
VoIP	• **End-to-End Delay** • **Jitter** • **Mean Opinion Score** • Packet Delay Variation • Traffic Sent • Traffic Received
Video Conferencing	• End-to-End Delay • Packet Delay Variation • Traffic Sent • Traffic Received
IP	• **Traffic Dropped**

Statistics for	Object Statistics
Point-to-point	• Average Queuing Delay -> • Throughput -> • Utilization ->

* Only a selected set of these statistics analyzed in presentation, the rest appear in project document

Background - FIFO

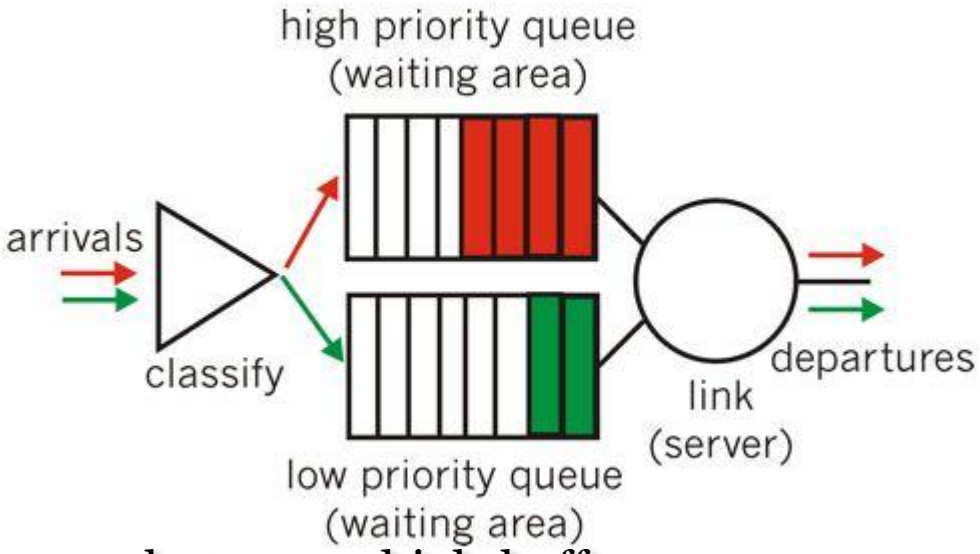
FIFO : First-In, First-Out Queuing



- Simplest queuing discipline
- First packet to arrive into buffer is the first packet to leave buffer
- All packets treated equally
- Packets dropped if buffer full, regardless of importance of packets

Background - PQ

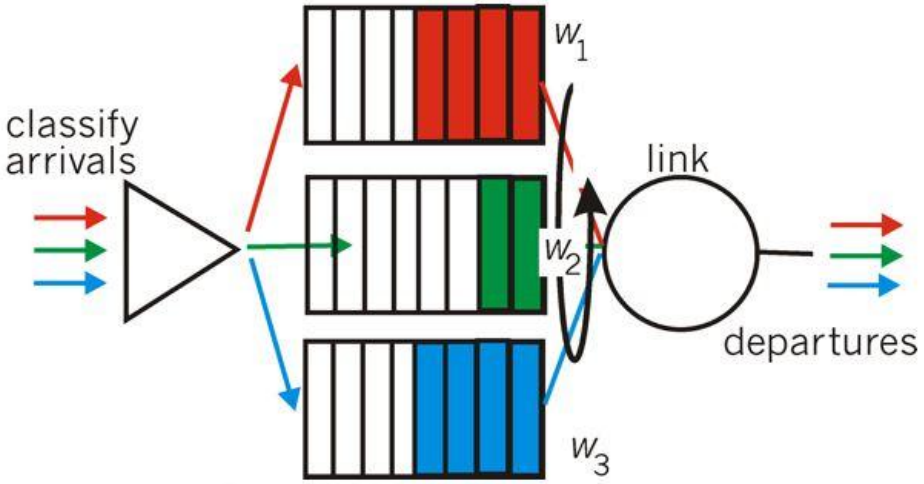
PQ : Priority Queuing



- Based on FIFO queues, but use multiple buffers
- Arriving packets are tagged to reflect their importance
- High priority packets are serviced and transmitted first
- Packets dropped if they arrive at a full buffer

Background - WFQ

WFQ : Weighted Fair Queuing



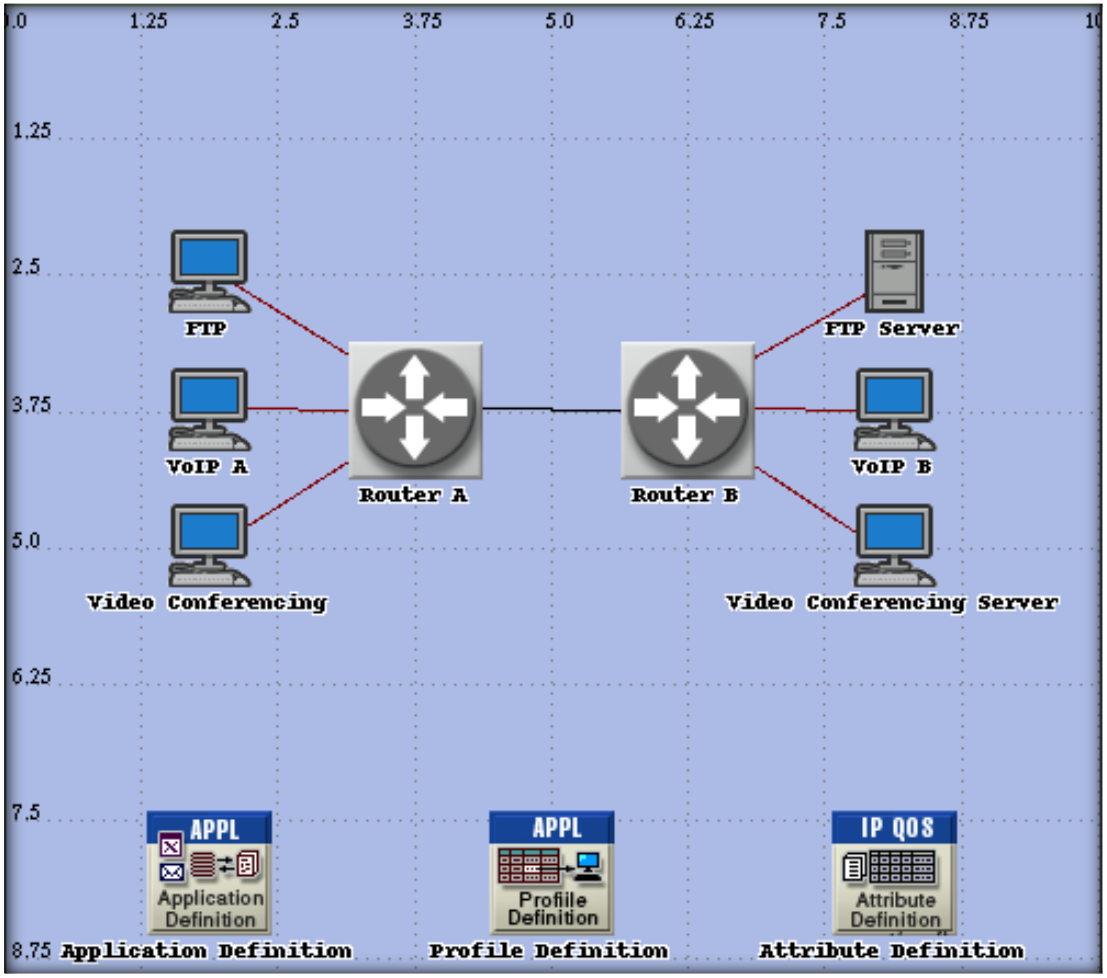
- Arriving packets are tagged and placed in separate queues
- Allocation and sharing of bandwidth is determined by weight factor given to each buffer
- WFQ scheduler serves buffers in circular manner
- WFQ is work-conserving: service is provided to next queue upon finding an empty queue

OPNET Implementation

Scenarios and applications considered

	Scenario 1	Scenario 2	Scenario 3
Queuing discipline	First-in, First-out Queuing	Priority Queuing	Weighted Fair Queuing
Simulation Time	• 5 minutes	• 5 minutes	• 5 minutes
Applications considered	• FTP • VoIP • Video Conferencing	• FTP • VoIP • Video Conferencing	• FTP • VoIP • Video Conferencing

OPNET Implementation



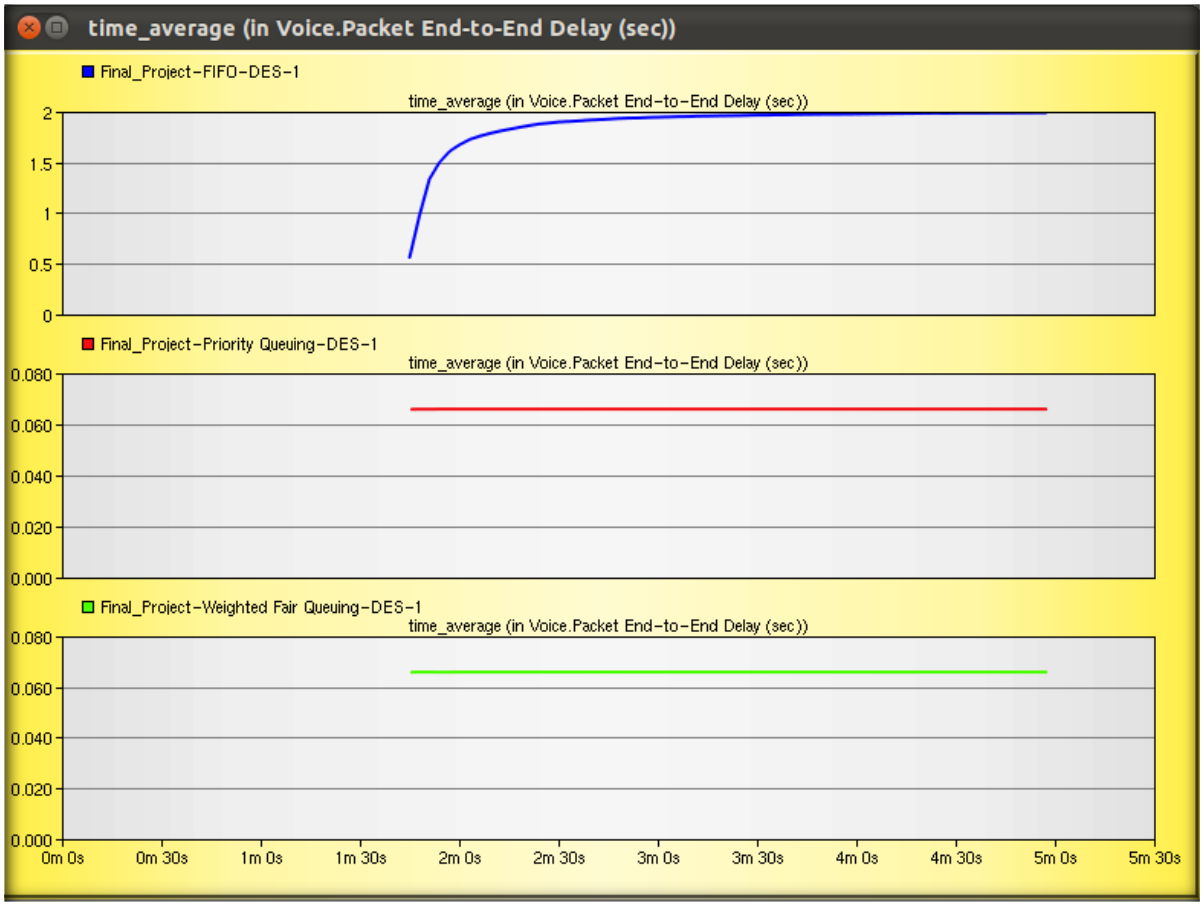
- Network Topology
- Campus network 10 x 10 km
- 5 workstations
- 2 routers
- 1 Ethernet server
- Application, Profile, and QoS Definitions

OPNET Implementation

Application Definition Attributes			
Application Name	FTP	VoIP	Video Conferencing
Description	High Load	PCM Quality Speech	Low Resolution Video
Type of Service (ToS)	Best Effort (0)	Interactive Voice (6)	Streaming Multimedia (4)

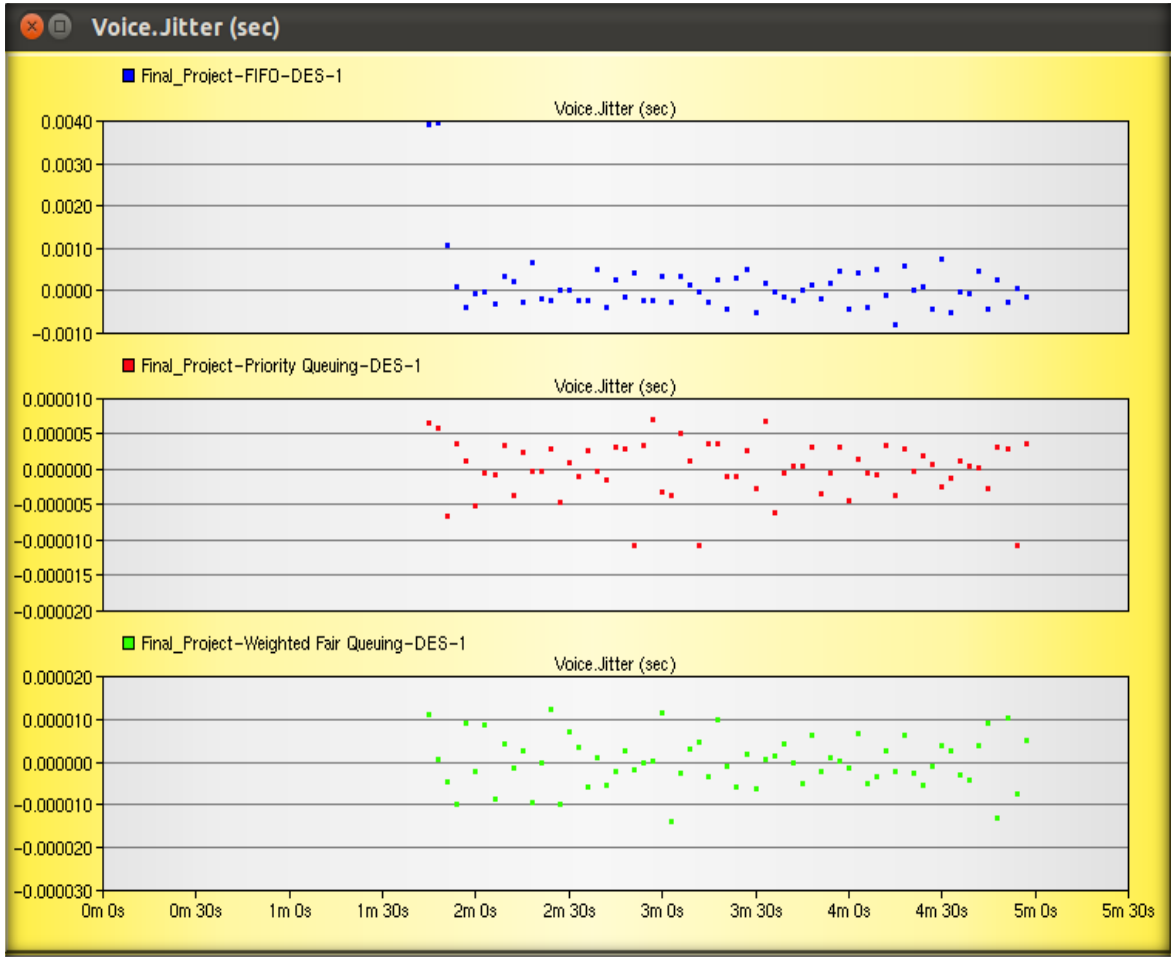
Application Attributes

Simulation Results – End-to-End Delay



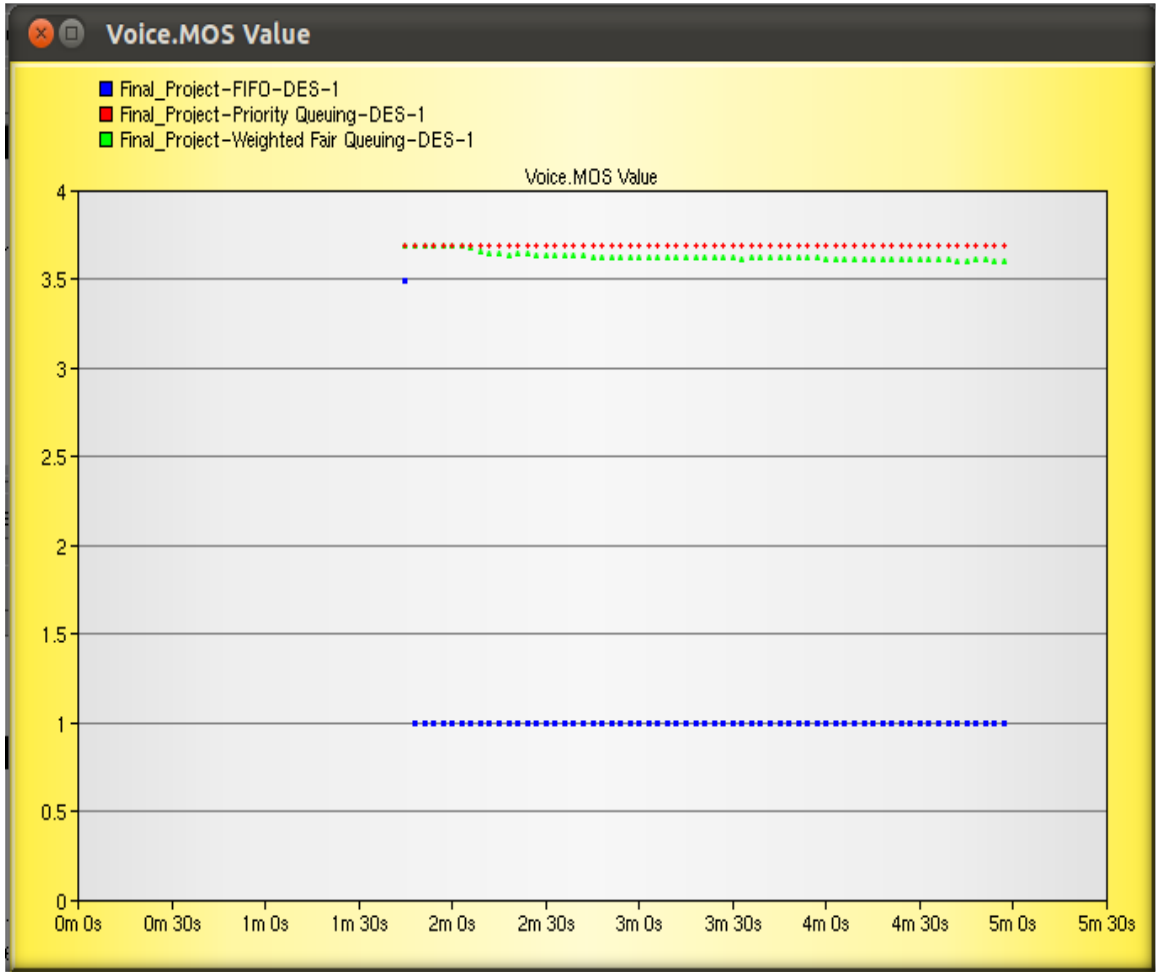
- Time taken for packets to be transmitted from source to destination.
- Application : Voice, Video
- ETE in voice and video should be small to provide natural conversation
- FIFO shows most ETE Delay (~ 2 sec)
- PQ and WFQ have lower ETE delay(~ 0.063 sec)

Simulation Results - Jitter



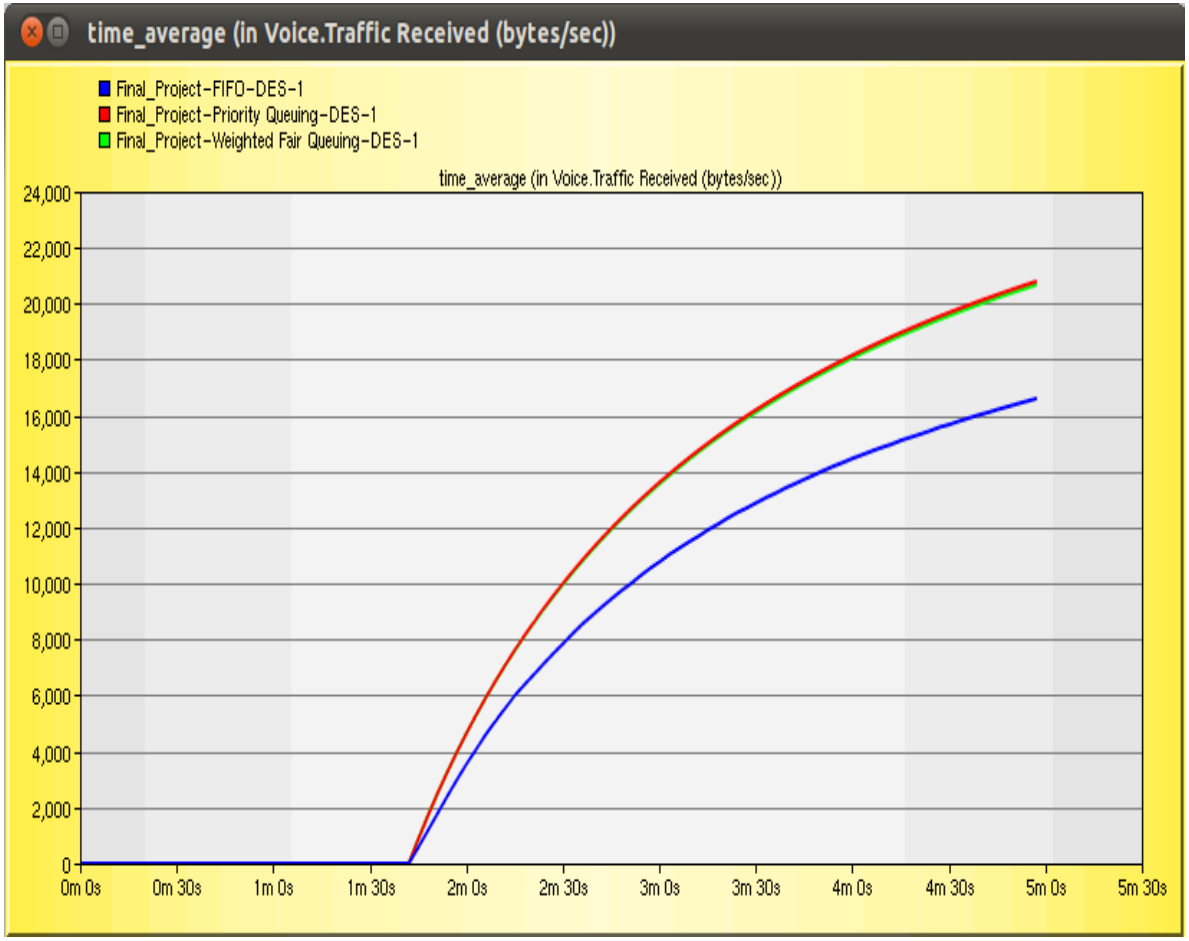
- Jitter is the variation in ETE Delay
- Application : Voice, Video
- Jitter should be minimized especially in real time applications
- FIFO shows most jitter
- PQ and WFQ show less jitter than FIFO

Simulation Results – MOS Value



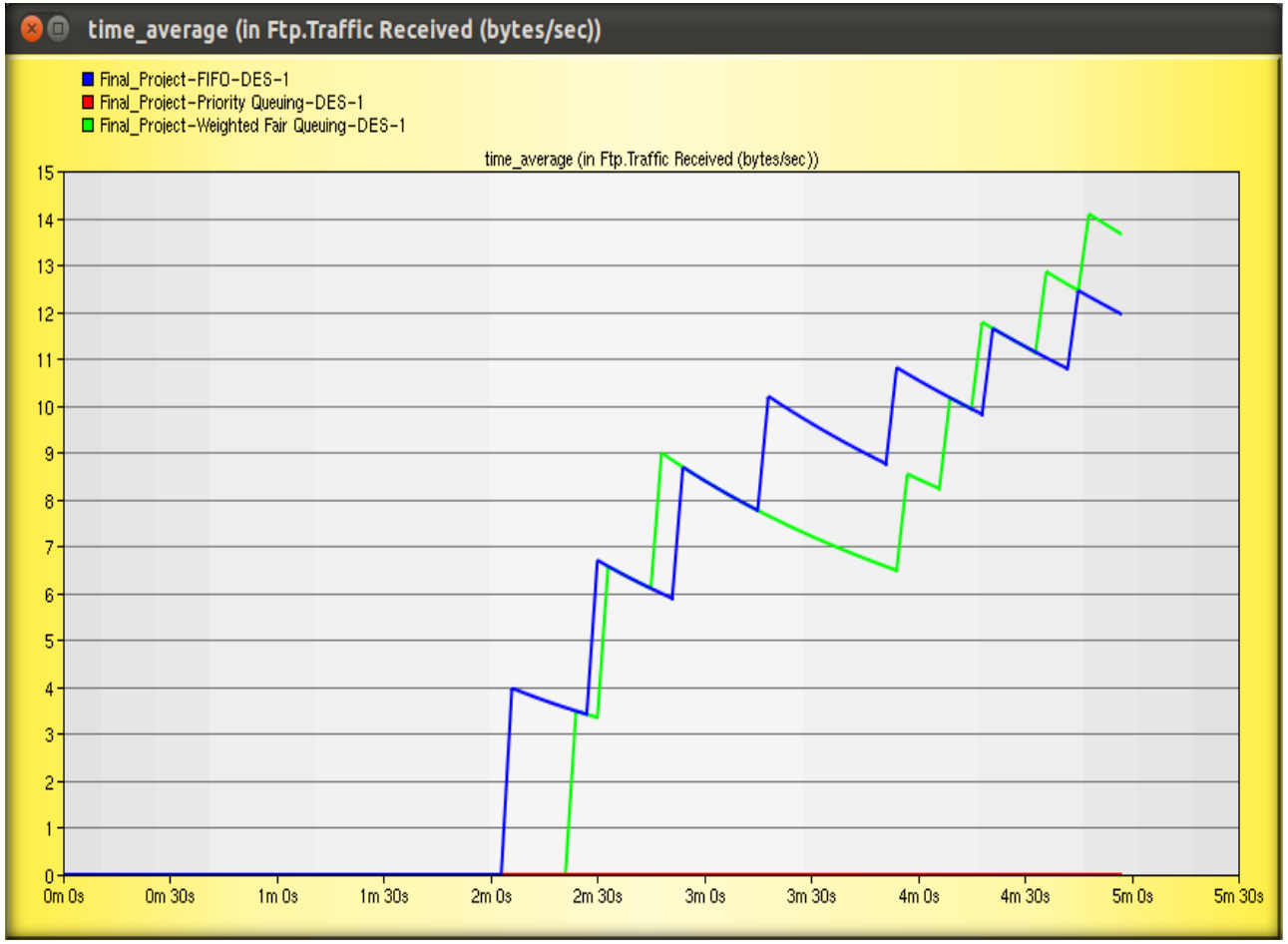
- Mean Opinion Score defines the perceived voice quality
- MOS scale : 1-5
  - 1: Bad
  - 2: Poor
  - 3: Fair
  - 4: Good
  - 5: Excellent
- FIFO shows bad perceived audio quality
- PQ and WFQ in between fair and good perceived audio quality

Simulation Results – Traffic Received



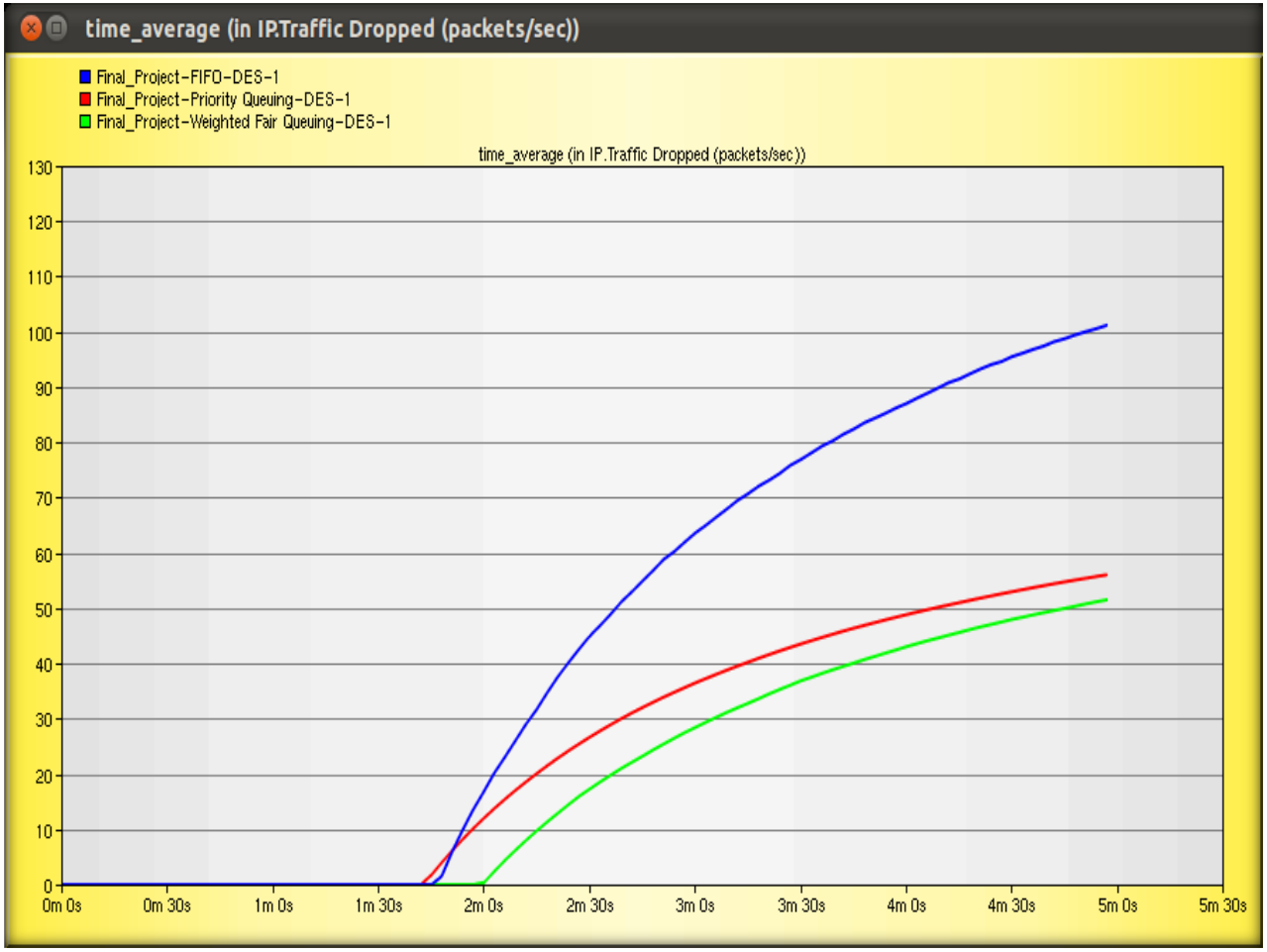
- Voice Traffic received in bytes/s
- Traffic received roughly equal initially
- Degree of loss increases over time
- FIFO queuing results in fewer bytes received
- PQ and WFQ result in more traffic received

Simulation Results – Traffic Received



- FTP traffic received in bytes/s
- FTP Packets given lowest priority hence
- PQ has no traffic received
- WFQ shows more traffic received than FIFO over the long run
- FTP traffic not sensitive to jitter, delay

Simulation Results – IP Traffic Dropped



- IP traffic dropped packets/sec
- Drop in IP Traffic results due to insufficient queue space
- PQ and WFQ shows less drop in IP packets
- FIFO shows most drop

Conclusion

- Voice Applications:
  - Best: Priority Queues
  - Worst: FIFO
- Video Applications:
  - Best: Weighted Fair Queues
  - Worst: Priority Queues
- FTP Applications:
  - Best: Weighted Fair Queues
  - Worst: Priority Queues

Future Work

- Should study effects of other Queuing Disciplines such as DWRR, Custom Queues, SPQ, and SFQ
- Should study effects of Random-Early Drop (RED) and Drop-tail Policy
- Should consider various other applications such as online gaming.
- Should consider different voice and video qualities to better understand and justify best type of Queue to choose

References

[1] S.P. Morgan. "Queueing Disciplines and Passive Congestion Control in Byte-Stream Networks." in *INFOCOM '89 Proc. 8th Annu. Joint Conference IEEE Computer and Communications Societies,* 1989, pp. 1097-1106.

[2] L.G. Widjaja and I. Widjaja. *Communication Networks*. New York, NY: McGraw-Hill, 2004, pp. 539- 547.

[3] K. James, and R. Keith. "Scheduling and Policing Mechanisms." http://www3.gdin.edu.cn/jpkc/dzxnw/jsjkj/chapter6/6-6.htm [Apr. 3, 2011].

[4] B. Dekeris, T. Adomkus, and A. Budnikas. "Analysis of QoS Assurance using Weighted Fair Queueing (WQF) Scheduling Discipline with Low Latency Queue (LLQ)." in *28th Int. Conf. Information Technology Interfaces*, 2006, pp. 507-512.

[5] P. Calyam et al. "Impact of Router Queuing Disciplines on Multimedia QoE in IPTV Deployments." in *QoMEx 2009 Int. Workshop Quality of Multimedia Experience*, 2009, pp. 92-97.

[6] S. Minseok, C. Naehyuck, and S. Heonshik. "A New Queue Discipline for Various Delay and Jitter Requirements in Real-Time Packet-Switched Networks." in *Proc. 7th Int. Conf. Real-Time Computing Systems and Applications*, 2000, pp. 191-198.

[7] Z. Ni, X. Lu, and D. Liu. "Simulation of Queuing Systems with Different Queuing Disciplines Based on Anylogic." in *Int. Conf. Electronic Commerce and Business Intelligence,* 2009, pp.164-167.

[8] T. Velmurugan, H. Chandra, and S. Balaji. "Comparison of Queuing Disciplines for Differentiated Services Using OPNET." In *ARTCom '09 Int. Conf. Advances in Recent Technologies in Communication and Computing*, 2009, pp.744-746.

Thank You!