Implementation of Start-Time Fair Queuing Algorithm in OPNET

CMPT885/ENSC835 Final Project

by

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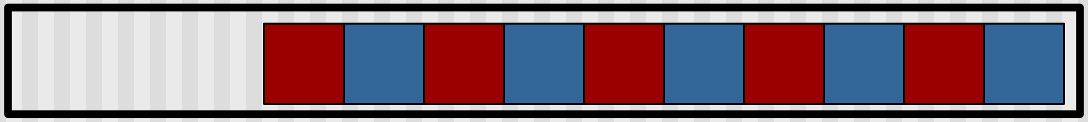
Road map

- Background and Introduction to *Start-Time Fair Queuing* (SFQ)
- Project Implementation
- Some Simulation Results
- Conclusion
- References

Queuing in Routers - FIFO

- Buffers in routers allow multiple sources share one outgoing link
- Router schedules order in which packets leave
- Almost all FIFO/FCFS queuing

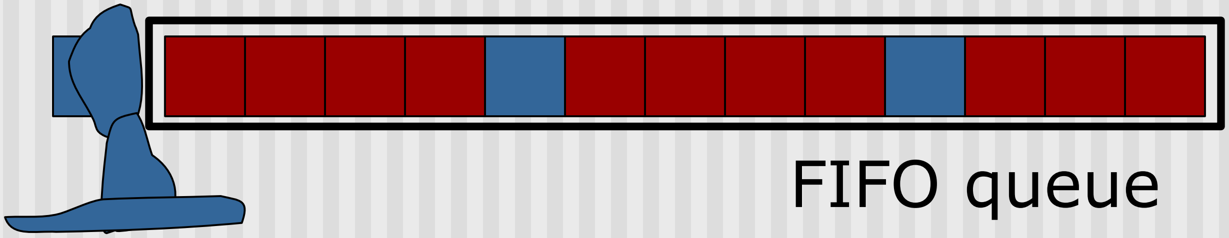
  (First-In, First-Out / First-Come First-Serve)
  - Simple, Cheap
  - Yet: Unfair?



FIFO queue

Queuing in Routers – FIFO unfair

- No bandwidth guarantee in the presence of congestion
- Misbehaving sources can steal bandwidth from behaving sources



FIFO queue

Fair Queuing (FQ)

- Concept: Everyone gets a fair share of router bandwidth [Nagle RFC970, 1985]
- Assign a 'weight' to each data flow or category

	(Cost)	
WFQ [Demers89]	Expensive	✘ Unfair for VBR
WF^2Q [Bennett96]	Expensive	
DRR (Deficit Round Robin) [Shreedhar95]	Cheap	✘ Not guaranteed
Virtual Clock[Zhang90]	Okay	✘ Punishes use of idle time [Parekh93]

Start-Time Fair Queuing (SFQ)

- Proposed in 1996 by Goyal,Vin and Cheng [Goyal96]
- Like most FQ, assign weights to flows to give minimum bandwidth and maximum delay guarantees.

✓ Simple algorithm (unlike WFQ)

✓ Fair for VBR (unlike most FQ algrothms)

✓ Fair use of idle bandwidth (unlike Virtual Clock)

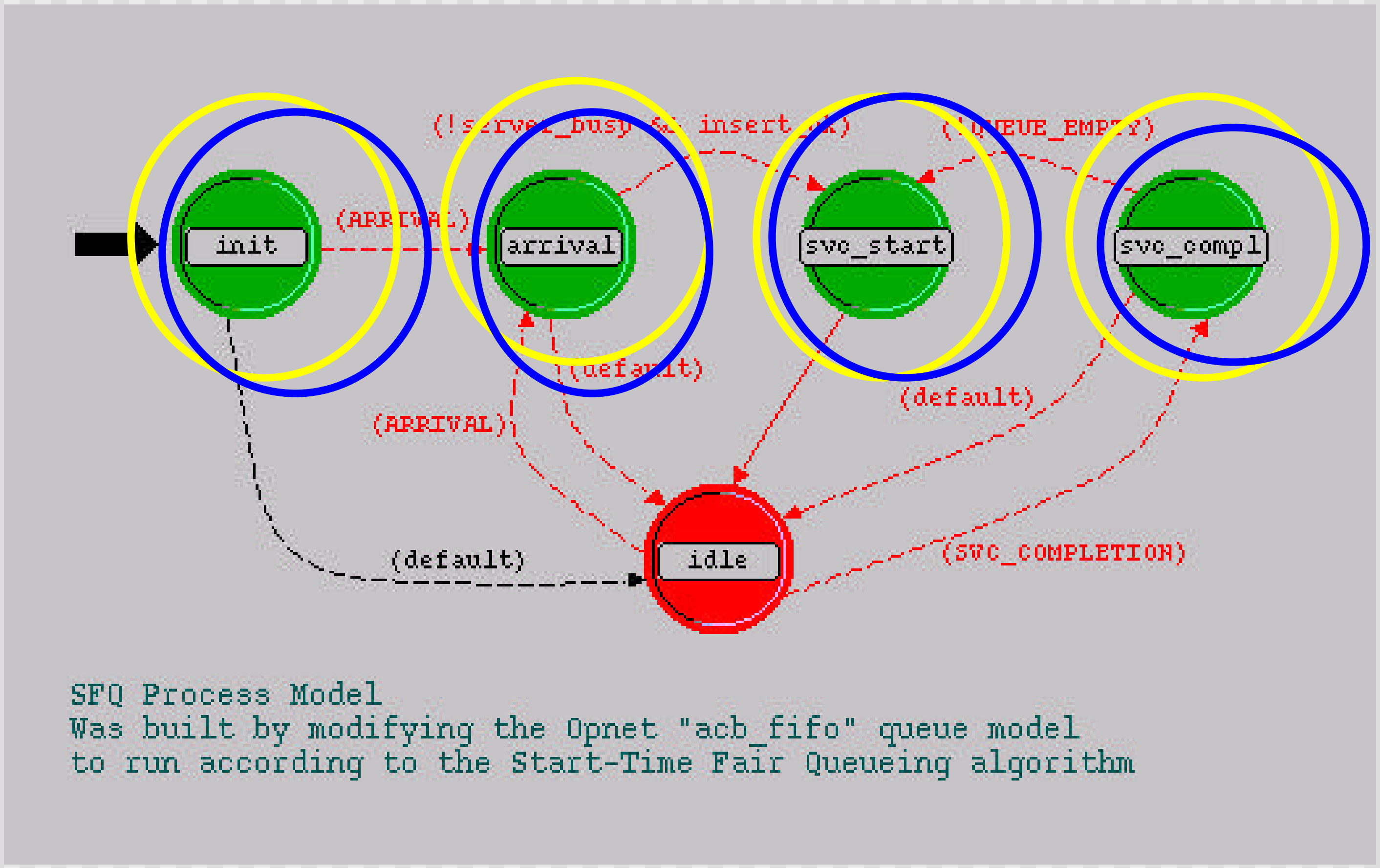
SFQ Overview

- Basic idea:
  - Choose packet to send by lowest "start tag" among all flows
  - Start Tags in a flow generally increment by: $\frac{\textit{Packet Size}}{\textit{Flow Service Rate}}$
    - If packets arrive as agreed, they are all served with guaranteed maximum and average delay
    - If packets arrive faster than agreed, they will be delayed so they don't affect other flows

Project Proposal

- Implement SFQ in OPNET as a queue module
- Create network incorporating SFQ in a router
- Run simulations to compare performance with other scheduling algorithms (e.g. WFQ and Virtual Clock)
- If possible, test with a real traffic trace

Implementation: Queue Process Model

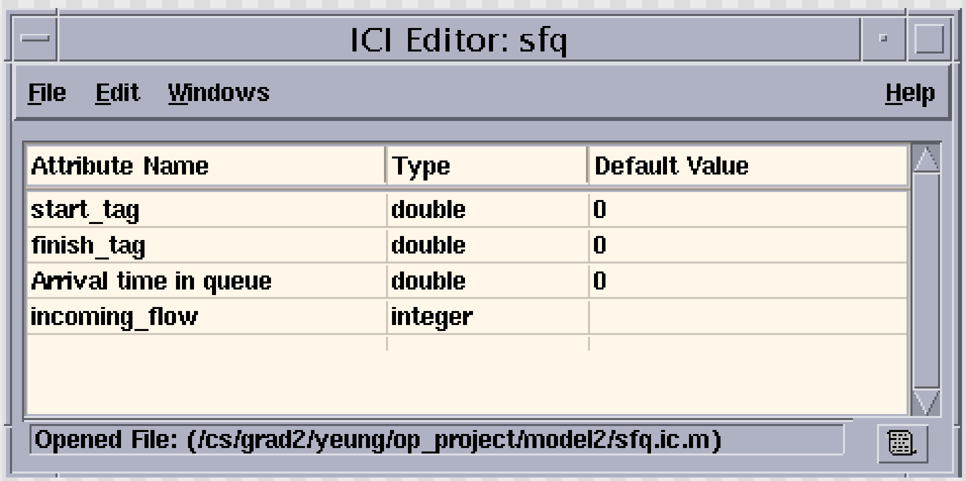


Implementation: ICI

- Opnet “Interface Control Information”
  - Use to associate data fields with packets

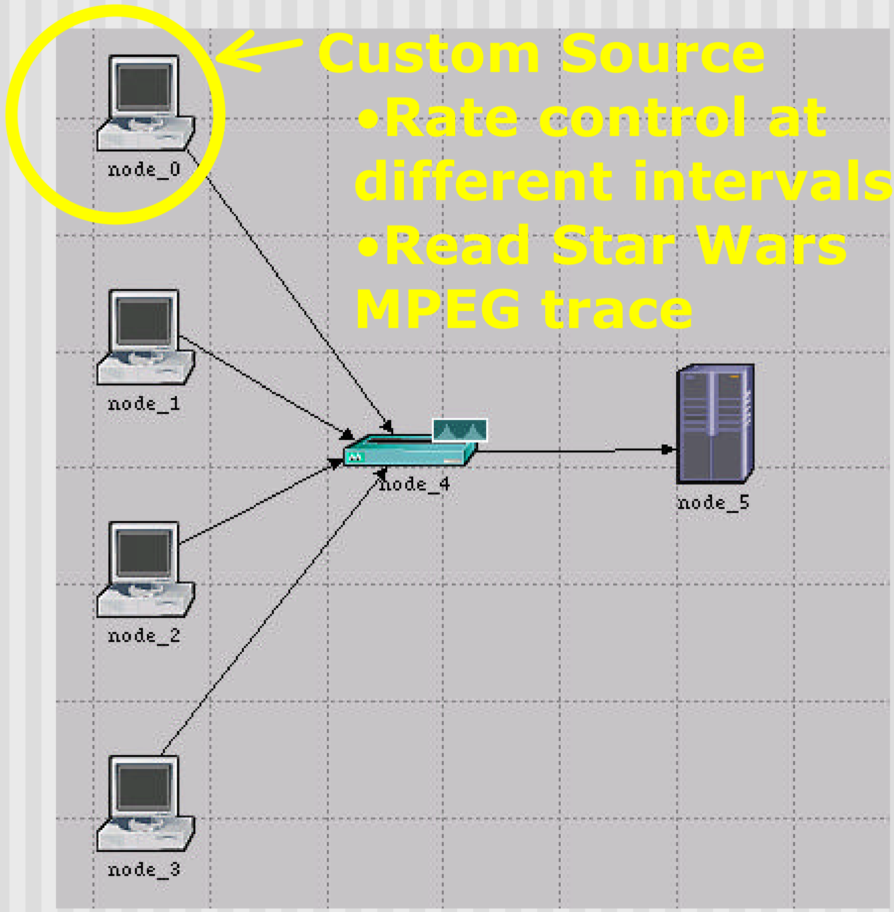
- SFQ fields:
  - Start Tag
  - Finish Tag

- VC fields
  - Virtual clock
  - Auxiliary Virtual Clock



Attribute Name	Type	Default Value
start_tag	double	0
finish_tag	double	0
Arrival time in queue	double	0
incoming_flow	integer	

Implementation: Network Model



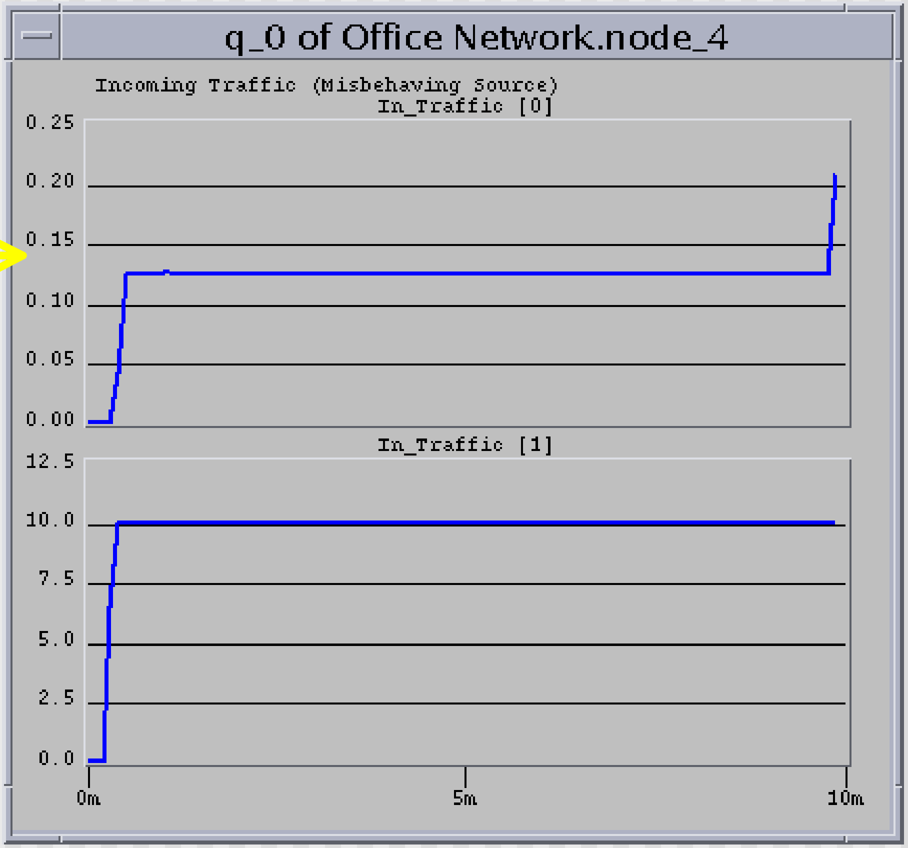
Result 1: FIFO unfair

Incoming traffic per flow

1 Pk/ 8 sec

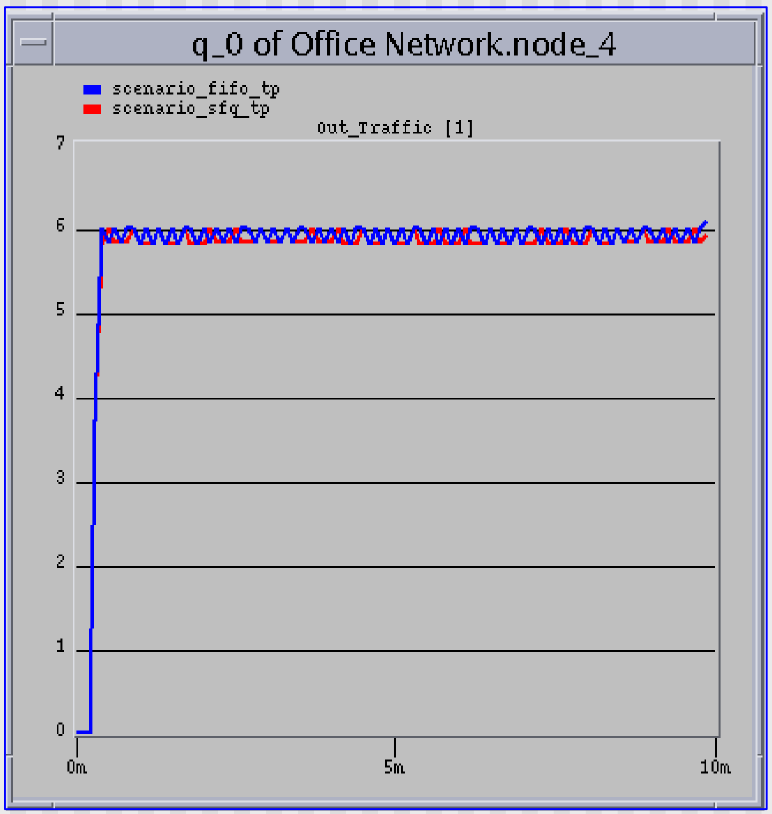
10 Pks/sec

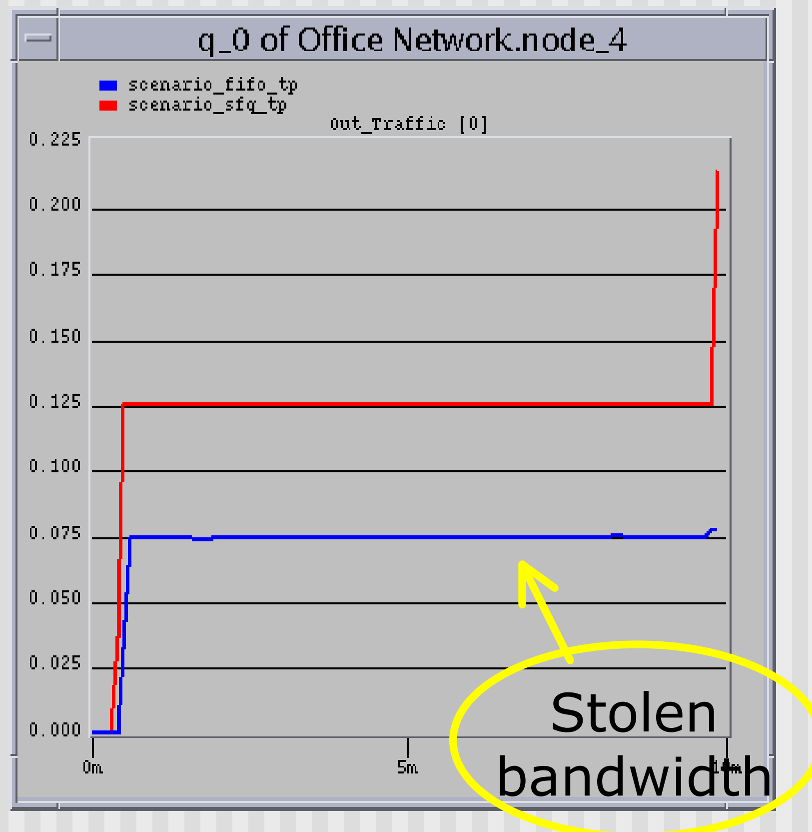
Misbehaving!



Result 1:
FIFO unfair

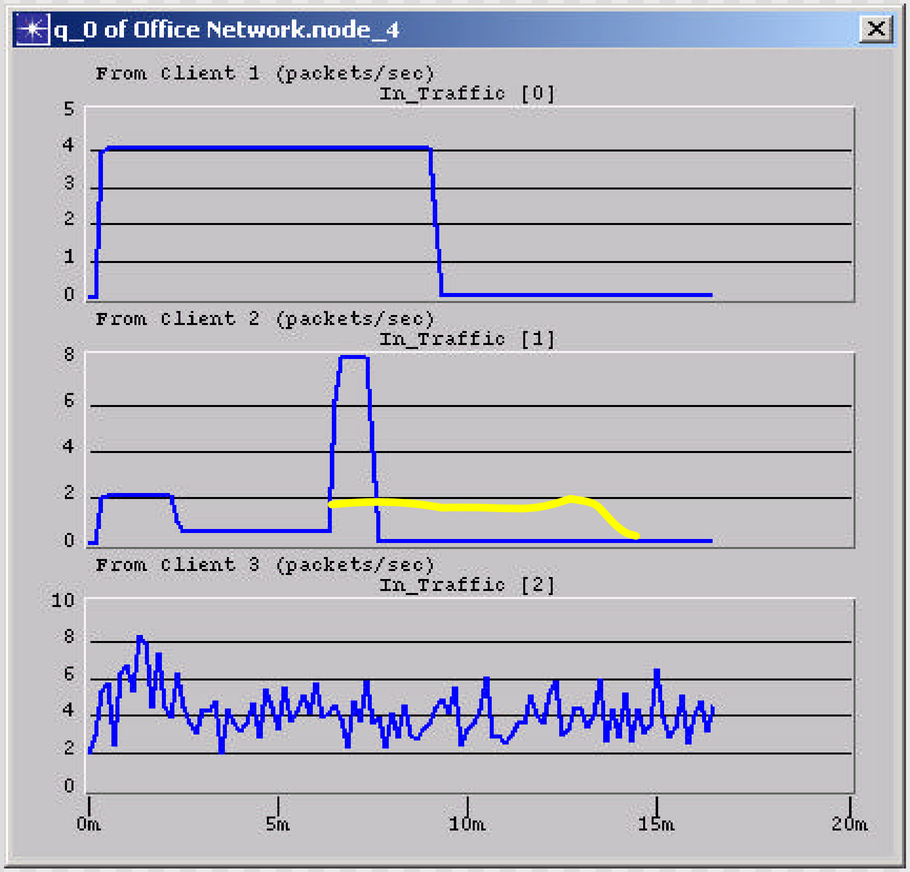
Throughput per flow





FIFO = SFQ =

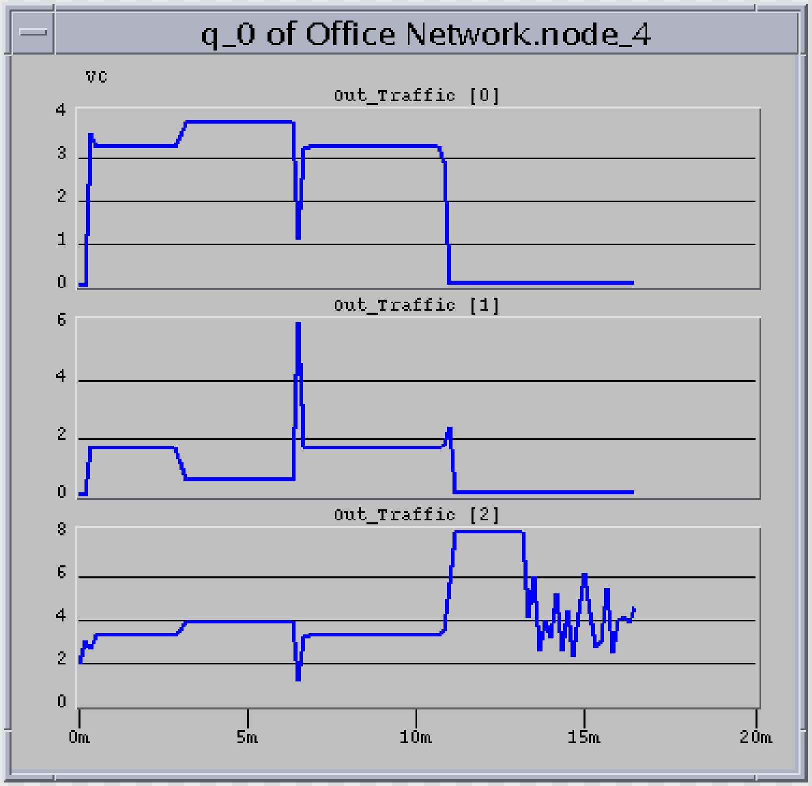
Result 2:
Verification of Fairness

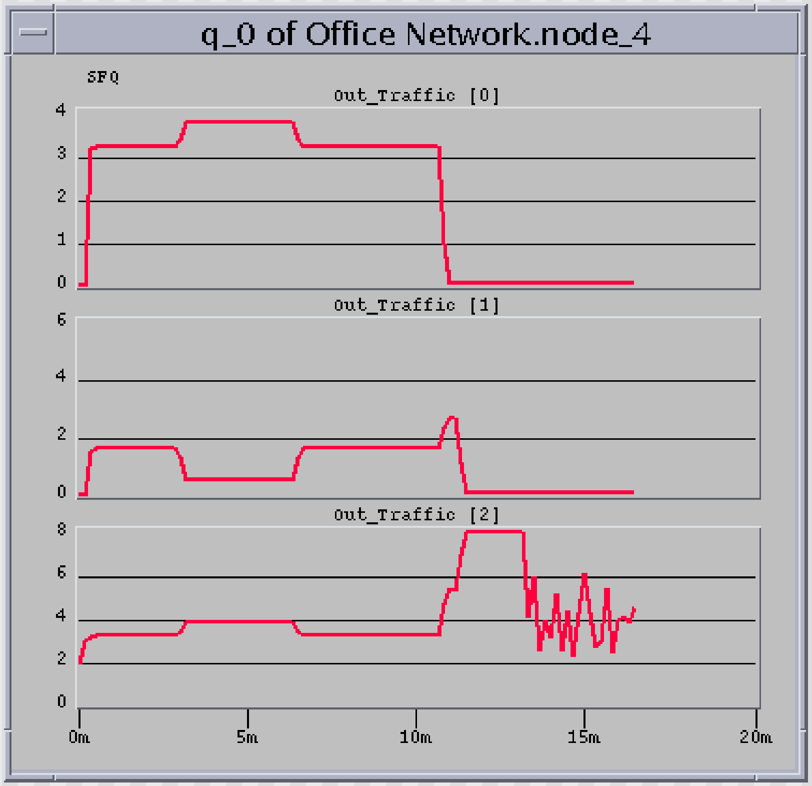


- Source traffic as in VC paper [Alborz01]
  - src1: CBR 4 pk/s
  - src2:misbehaves
    - Fair queues make it wait
  - src3: VBR, avg. 4 pk/s
- Congestion

Result 2: Verification of Fairness

Throughput per flow

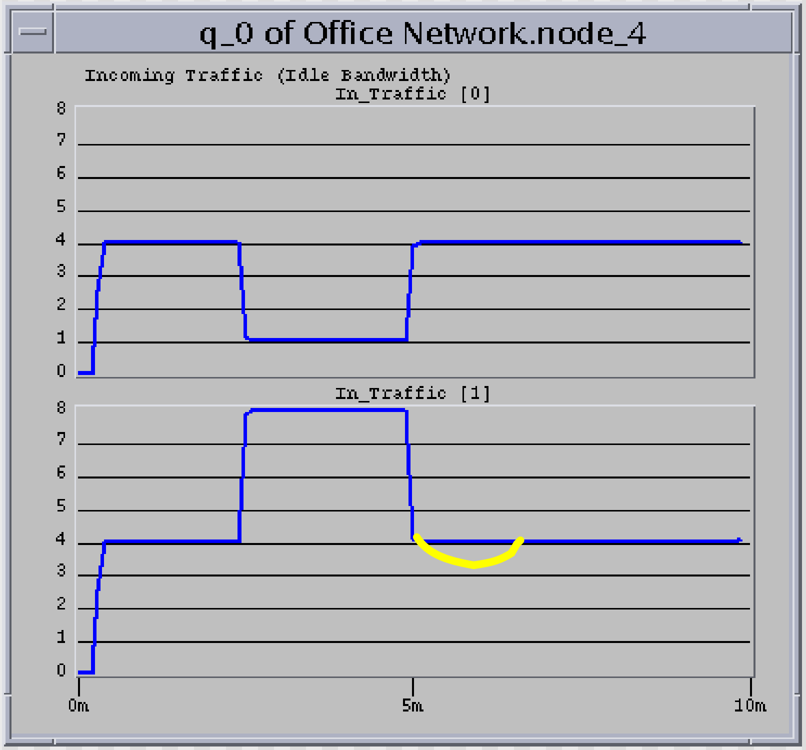




Virtual Clock =

SFQ =

Result 3: Fair Use of Idle Bandwidth

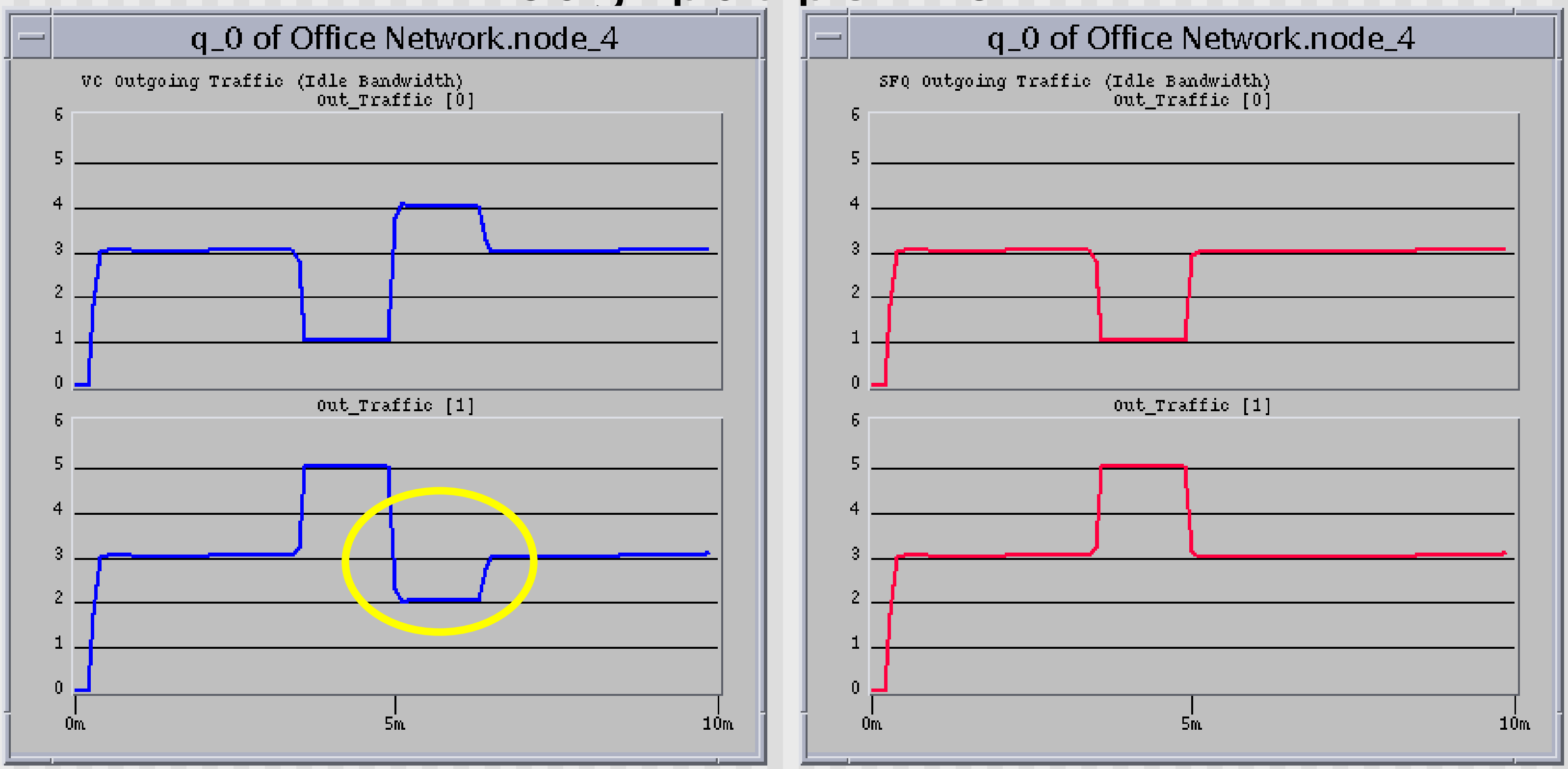


Input Traffic per flow

- 2 clients
  - Client 0 (4 pks/sec) has a period of low arrival rate
  - Client 1 (4 pks/sec) has a period of high arrival rate at same time
  - There is congestion (8 pks/sec sharing 6 pks/sec)

Result 3:
Fair Use of Idle Bandwidth

Throughput per flow



Virtual Clock =

SFQ =

Conclusion:
Project Proposal - Revisited

- ✓ Implemented SFQ in OPNET as a queue module
- ✓ Created network incorporating SFQ in a router
- ✓ Ran simulations to compare performance with other scheduling algorithms (FIFO, WFQ and Virtual Clock)
- ✓ Used a real traffic trace (Star Wars MPEG)
- ✓ Converted/Implemented Virtual Clock as a queue module in Opnet

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