Preliminary Simulation Results on FECN In Symmetric Topology w/Single Hot Spot Scenario

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Overview

- Key Observations
- System Parameters & Work Load
- Validating FECN Simulation
- Sensitivity Analysis (N0 and Qeq)
- Conclusion

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Key Observations

- FECN does converge quickly in the 4 to 1 scenario
- The system is sensitive to the selection of N0
- Qeq does have an effect on stability as the control loop delay** in the system increases for the 4-to-1 scenario as suggested in Monterey* interim meeting
- *Note: Not yet entirely accurate simulation of FECN*
  - *Not capturing slow start aspect where new flows begin at a rate of C/8.*
  - *Does not take into account new adjustments to the limited rate increase enhancement.*
  - *Does not implement variable capacity adjustment.*

**http://www.ieee.802.org/1/files/public/docs2007/au-prabhakar-monterey-proposal-070124.pdf*

***This is actually the round trip time from one end to the other.*

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FECN Overview

- Source
  - Tagging Frames
    - After time τ, subsequent outgoing frame is tagged with two RD tags with rate field initialized to -1.
  - Response to Rate Adjustments
    - When receiving returning RD tag, adjust rate based on information carried in RD tag
- Switch
  - Rate Computation
    - After measurement interval, T, compute advertised rate to be included in forward RD tag
  - Congestion Notification
    - If incoming frame has forward RD tag, include advertised rate if lower than rate included in forward RD tag of the frame.
- Receiver
  - Reflecting Rate Information Back to Source
    - Copy forward RD tag into returning RD tag.

More details, see http://www.ieee802.org/1/files/public/docs2007/au-jain-fecn-20070124.pdf

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Basic System Parameters

- No PAUSE
- Switch Parameters
  - Buffer Size (B)
    - 600Kbytes/Port.
  - Discard Threshold:
    - 600 Kbytes / Port
- FECN Parameters
  - Queue Control Function
    - Hyperbolic Function
    - a = 1.1
    - b = 1.002
    - c = 0.1
  - Measurement Interval
    - T = 1ms
  - Qeq
    - B / 4 or
    - 16 * 1500 byte packets
  - FECN Enhancements
    - Exponential Averaging of Computed Weight
      - $\alpha = 0.5$
    - Limited Rate Increase in Switch*
      - $\Delta r = r0 = C/N0$
    - Time Based Sampling at the Source
      - $\tau = 1ms$

**Based on algorithm specified in http://www.ieee802.org/1/files/public/docs2007/au-jain-fecn-20070124.pdf*

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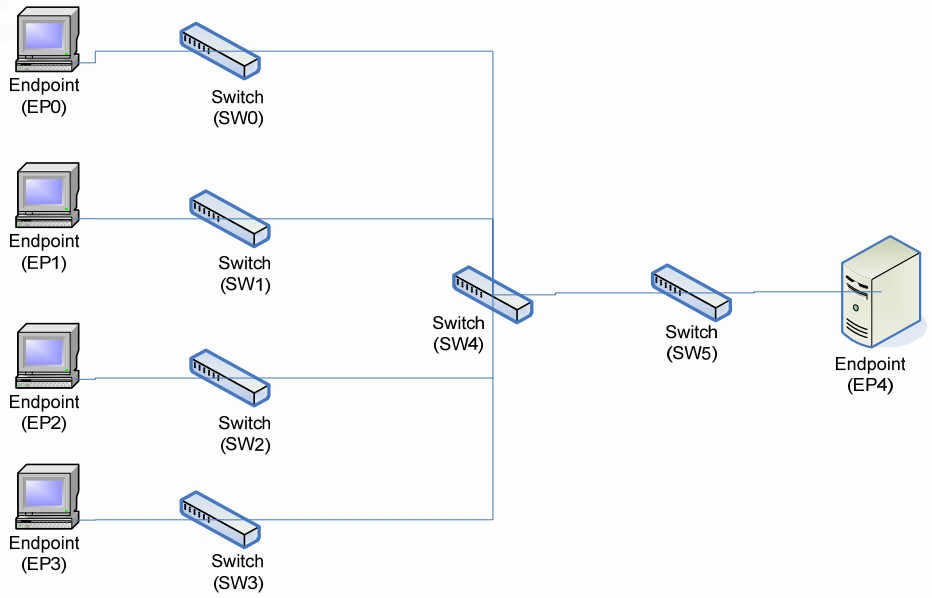
Symmetric Topology Single HS – Non Bursty (Similar to Required Scenario #5)



- Symmetric Topology Single HS
  - Link speed : 10Gbps for all links
- Traffic Pattern
  - Traffic Type: 100% UDP (or Raw Ethernet) Traffic
  - Destination Distribution: EP0-EP3 send to EP4 @ 5ms, EP0 and EP1 stop @80ms
  - Frame Size Distribution: Fixed length (1500 bytes) frames
  - Arrival Distribution: Bernoulli temporal distribution
  - Offered Load/Endpoint = 50%

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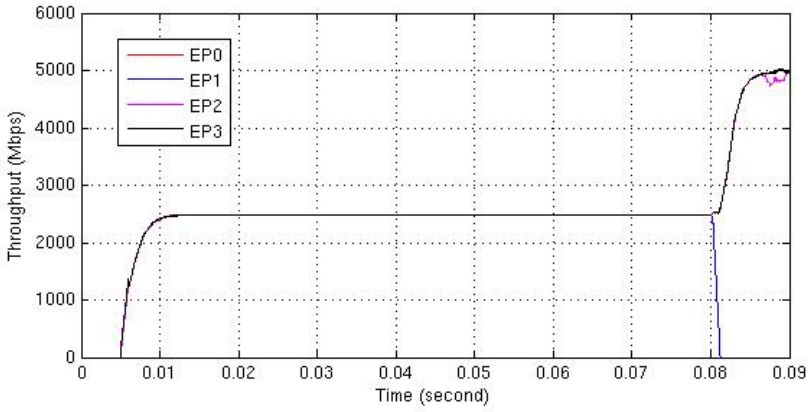
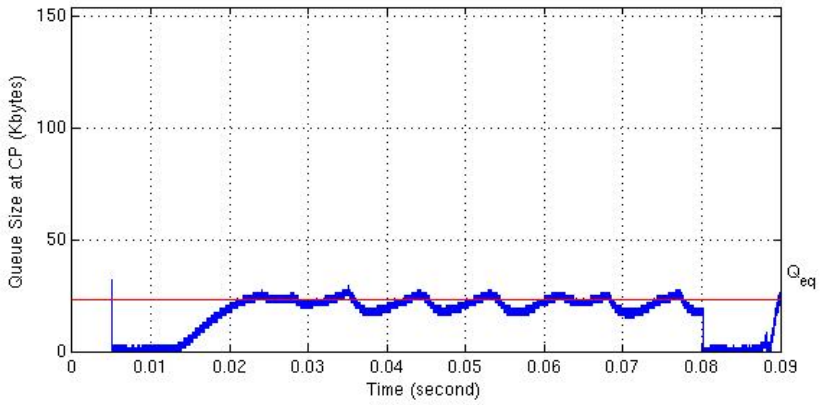
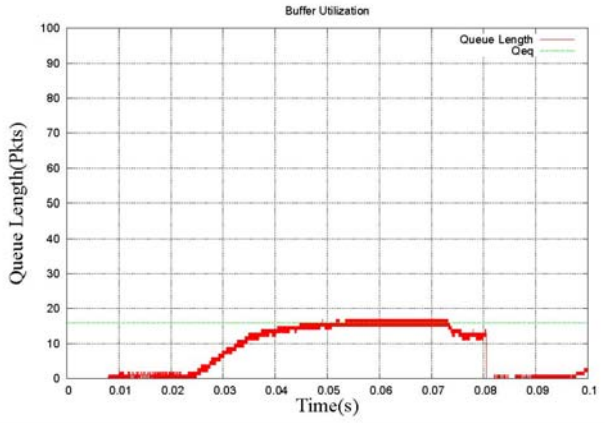
Validation of FECN





- Setup:
  - One flow per end point
  - N0 = 8
  - T = 1ms
  - Qeq = 16packets
- Observations:
  - Generally lines up with existing FECN simulation results*
  - Differences
    - Spike at the beginning occurs due to different implementation at the start. In this implementation, queue is not rate limited to C/8 and leads to small spike.
    - More oscillation in steady state.



*http://www.ieee802.org/1/files/public/docs2007/au-jain-fecn-20070124.pdf

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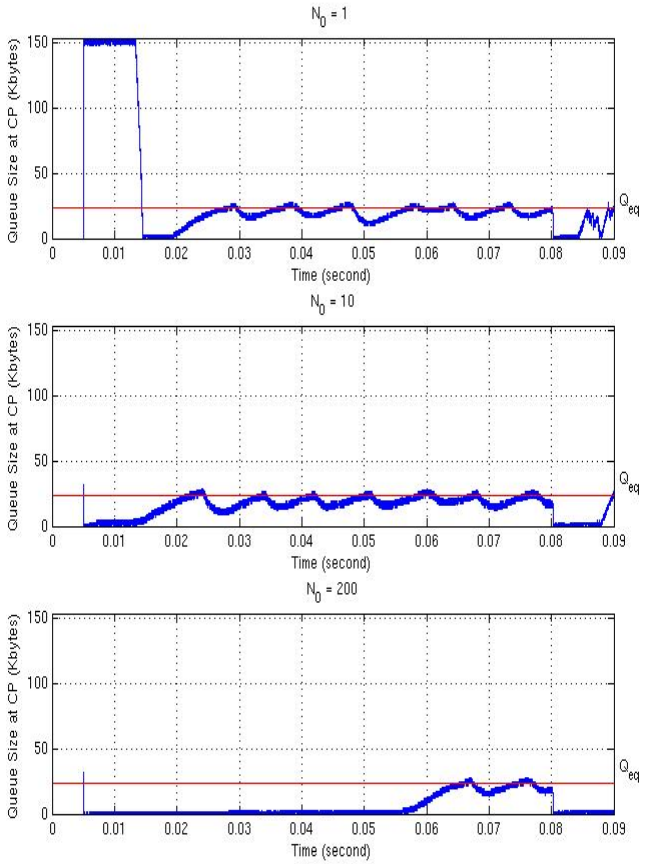
Sensitivity Analysis of N0 Queue Size @ CP

- Setup:
  - One flow per end point
  - T = 1ms
  - Qeq = 16 packets
- Observations:
  - N0 is the estimated number of flows
  - Estimate of N0 needs to be somewhat accurate in order to achieve optimal throughput performance.



N0	#drops	Throughput
1	5509	9.95Gbps
10	0	9.836Gbps
200	0	6.730Gbps

These results do not include the recent (3/13) modifications to FECN which changed the way the increases to the rate are limited or bounded.

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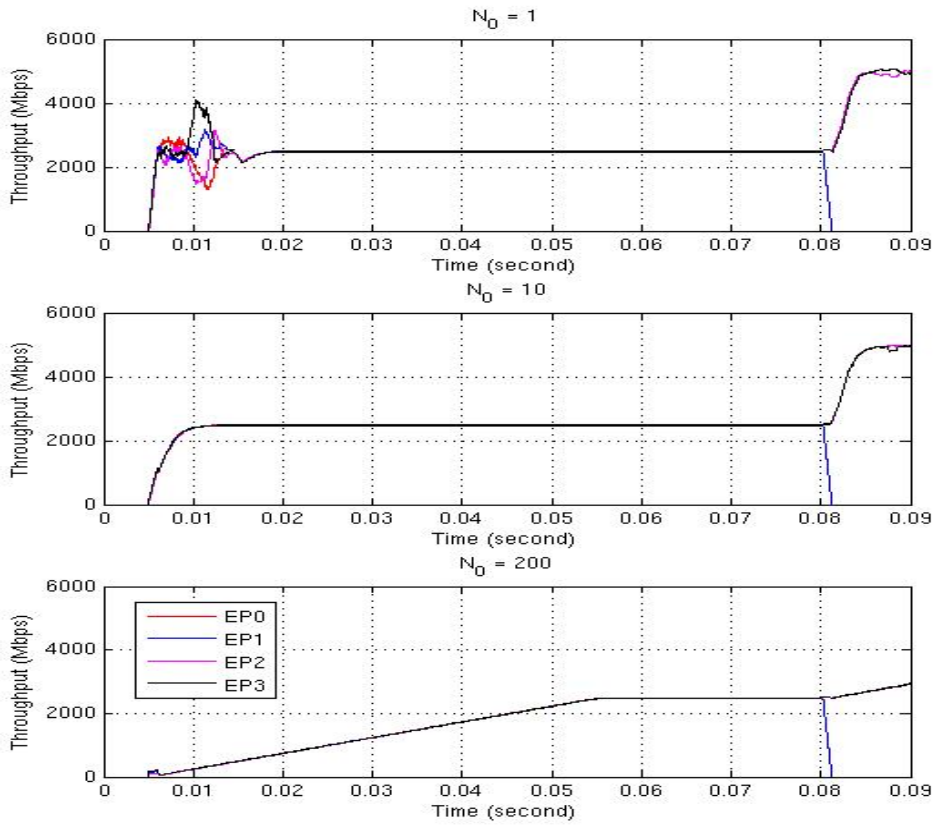
Sensitivity Analysis of N0 Throughput per Flow

N 0

1

10

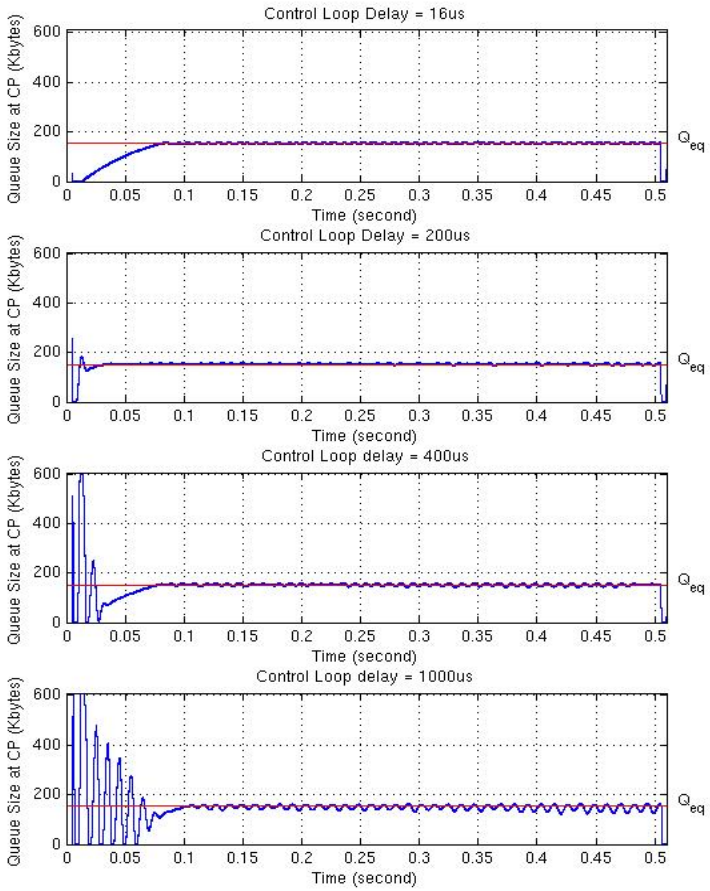
200



Effects of Qeq
Queue Size @ CP

- Setup
  - Buffer Size = 600Kbytes
  - N0 = 10
  - Qeq = 150Kbytes (B/4)

Effects of Qeq
Queue Size @ CP



Ctrl Loop Delay	# of drops	Throughput
16us	0	9.975Gbps
200us	0	9.972Gbps
400us	424	9.965Gbps
1000us	1460	9.921Gbps

Given a Qeq of 150kbytes, FECN performs well despite increase in control loop delay.

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Effects of Qeq Throughput

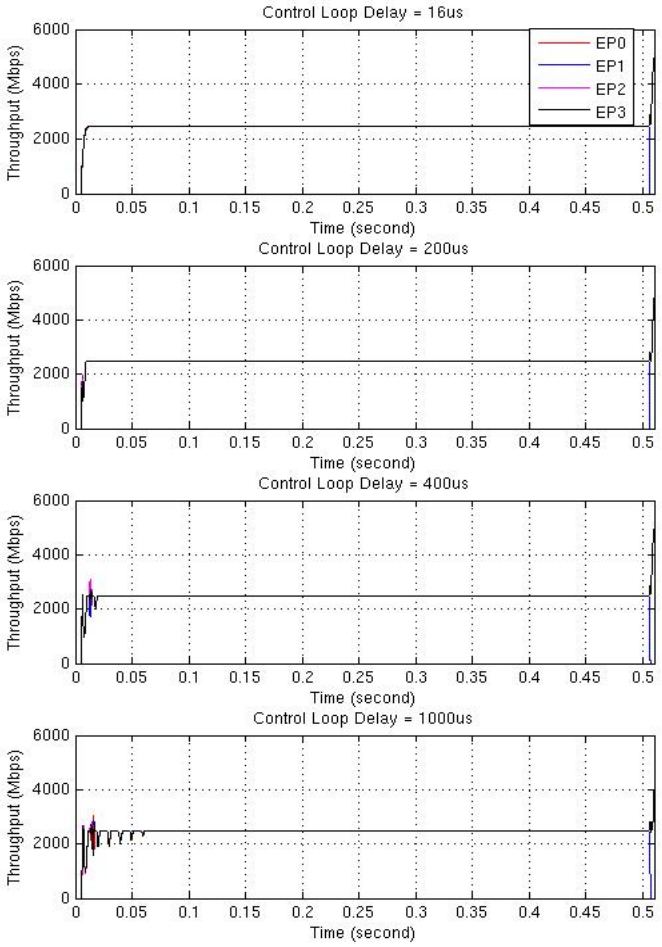
Control Loop Delay

16us

200us

400us

1000us



Good fairness can be achieved, even with large control loop delay

Effects of Low Qeq Queue Size @ CP

- Setup
  - Buffer Size = 600Kbytes
  - N0 = 10
  - Qeq = 24K (16 Packets)

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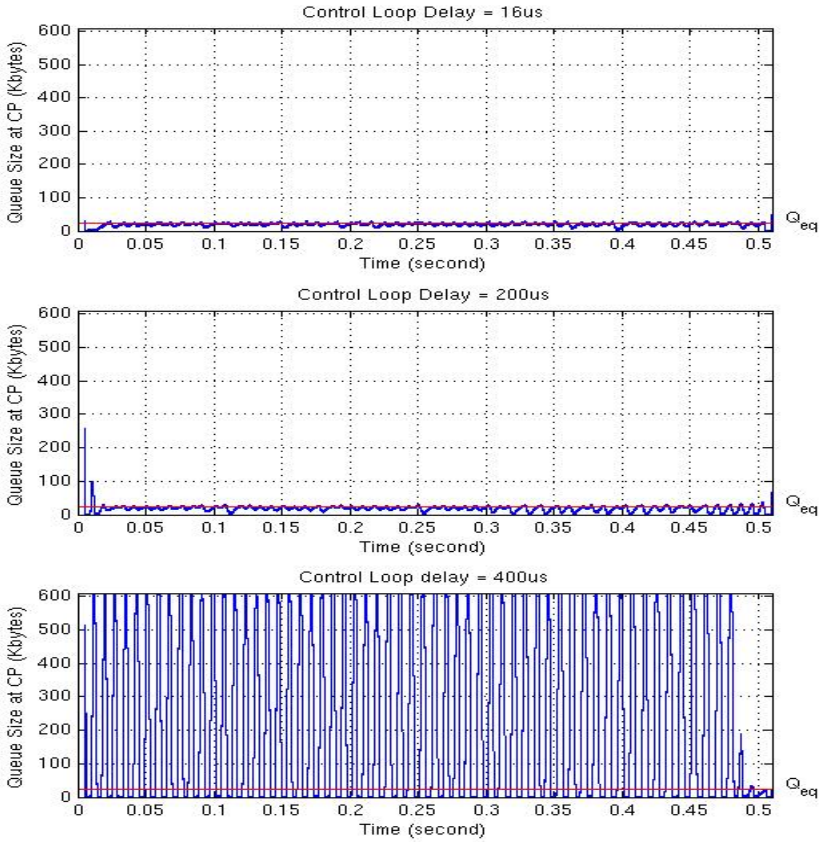
Effects of Qeq
Queue Size @ CP



Ctrl Loop Delay	# of drops	Throughput
16us	0	9.975Gbps
200us	0	9.969Gbps
400us	21772	7.985Gbps

Given a small Qeq, FECN is not well behaved as the control loop delay rises above 400us.

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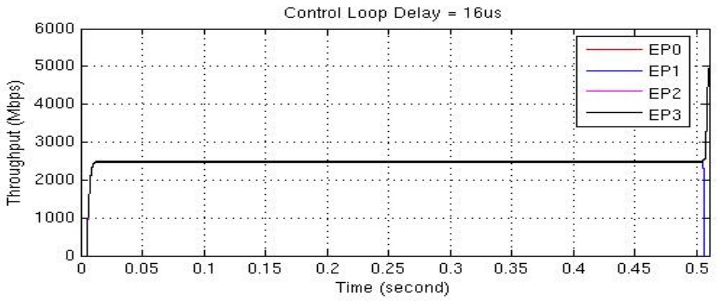
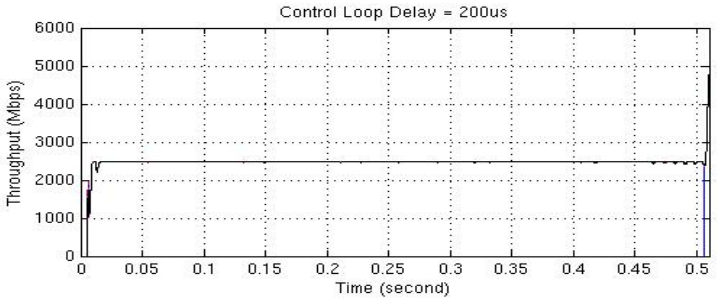
Effects of Qeq Throughput

Control Loop Delay

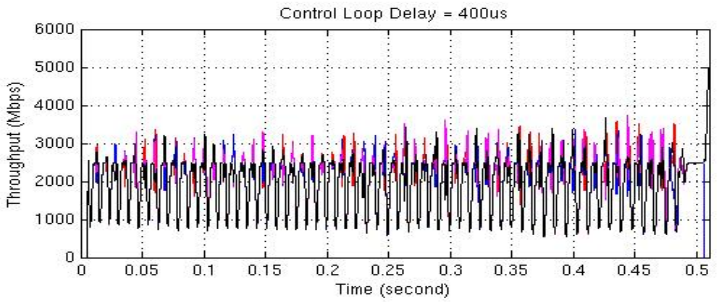
16us



200us



400us



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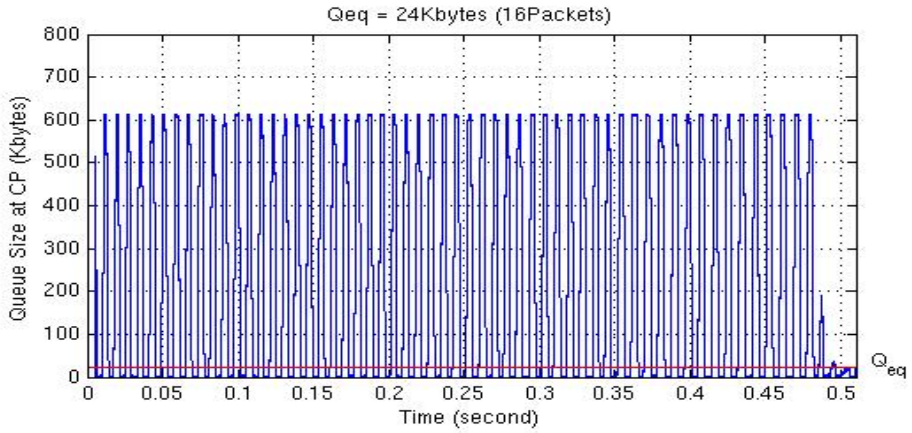
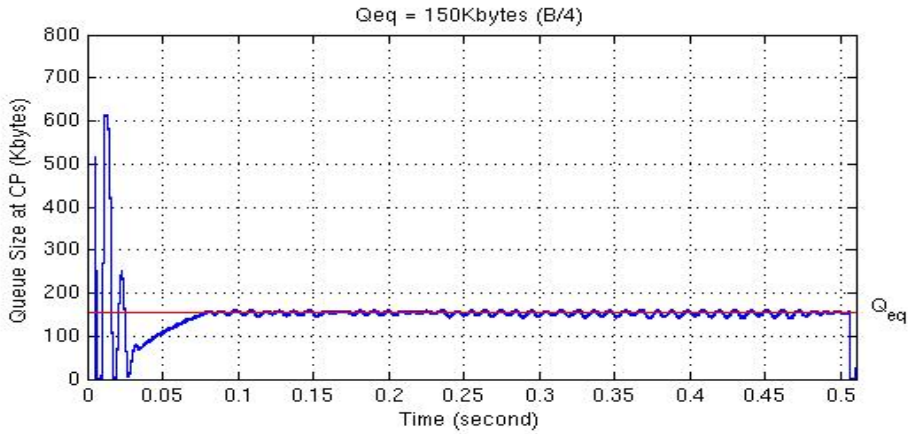
Comparison of Queue Behavior for Different Qeq

- Setup
  - Control Loop Delay = 400us
  - Qeq
    - 24 kbytes
    - 150 kbytes
- Observations
  - As expected, more queuing is required as the control loop delay increases.





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Conclusion

- It is challenging to choose a proper initial divider (N0) for different network scenario*
  - Low N0 could result in packet drops
  - High N0 could result in underutilization
- Qeq has effects on achieving stability when delay is high
  - FECN has better performance with high Qeq.

**This issue may be addressed by recent enhancements to FECN.*

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