Evaluating Effects of QCN Enhancements to BCN in the Multihop Output Generated Hotspot Scenario

Bruce Kwan & Brad Matthews

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Overview

- Key Observations
- Simulation Setup
- Effects of QCN Enhancements
- Summary

Key Observations

- QCN offers a reduction in control messaging overhead
  – 25-30% reduction in control messages generated relative to BCN in output generated multiple hop scenario.
- Quantization of Fb (no self increase, fast recovery)
  – 5-6 bits of Quantization Appears to be Sufficient
  – Regardless of quantization, oversampling still provides the benefits of improving response time and reducing frame drops

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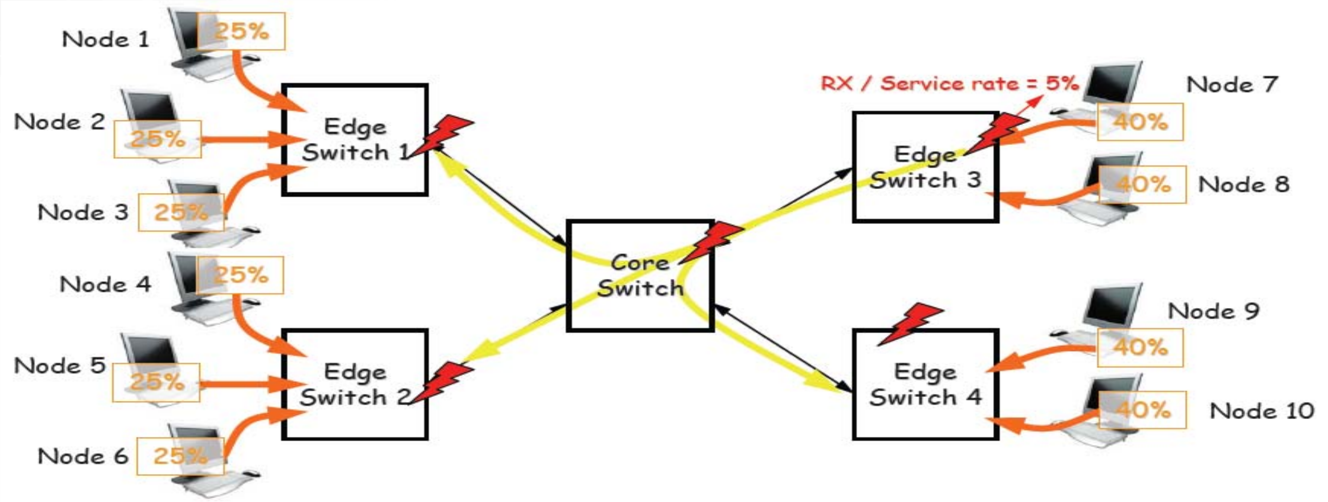
Topology and Workload



- Multi-stage Output-Generated Hotspot Scenario
  - Link Speed = 10Gbps for all links
  - Loop Latency = 16us
- Traffic Pattern
  - 100% UDP (or Raw Ethernet) Traffic
  - Destination Distribution: Uniform distribution to all nodes (except self)
  - Frame Size Distribution: Fixed length (1500bytes) frames
  - Offered Load
    - Nodes 1-6 = 25% (2.5Gbps)
    - Nodes 7-10 = 40% (4Gbps)
- Congestion Scenario
  - Node 7 temporary reduce its service rate from 10Gbps to 500Mbps between [50ms, 1050ms]

** Topology and Workload based on IBM Zurich's topology and workload as specified in Experiment #1 found:* *http://www.ieee802.org/1/files/public/docs2006/au-sim-Zurich-Hotspot-Benchmark-OG-MS-r2.pdf. Picture is from that presentation.*

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Parameters

- Switch Parameters
  - Core switch and edge switches are all 4 port switches
  - Buffer Size (B)
    - 600Kbytes/Port
  - Shared Memory Switch Devices, total switch memory size = 4 * B
- BCN Parameters
  - Frame Sampling
    - Frames are periodically sampled (on avg) every 75KB (2%)
  - W is located at CP (W = 2)
  - Qeq = B/4
  - Ru = 1Mbps
  - Gi (Initial)
    - Computed as (Linerate/10) * [1/((1+2*W)*Q_eq)]
    - Same as in baseline
  - Gd (Initial)
    - Computed as 0.5*1/((1+2*W)*Q_eq)
    - Same as in baseline
  - BCN-MAX
  - Other BCN Enhancements
    - No BCN(0,0)

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QCN Enhancements to BCN

- Switch Computes Fb and Only Delivers Decrease BCN Messages
  - Makes sense for switch to convey congestion information relative to its capabilities
  - Switch only delivers Fb when Fb < 0 (decrease only messages)
    - Fb may be quantized
  - Association between switch and reaction point removed
    - Enables BCN to operate without the need for RL-tags

- Reaction Point Self Increase
  - Increase Factor (I)
    - Amount of increase incrementally distributed over 1 second
    - $R(t) = R(t-1) + R(t-1) * I * \tau$
  - Self increases occur every τ

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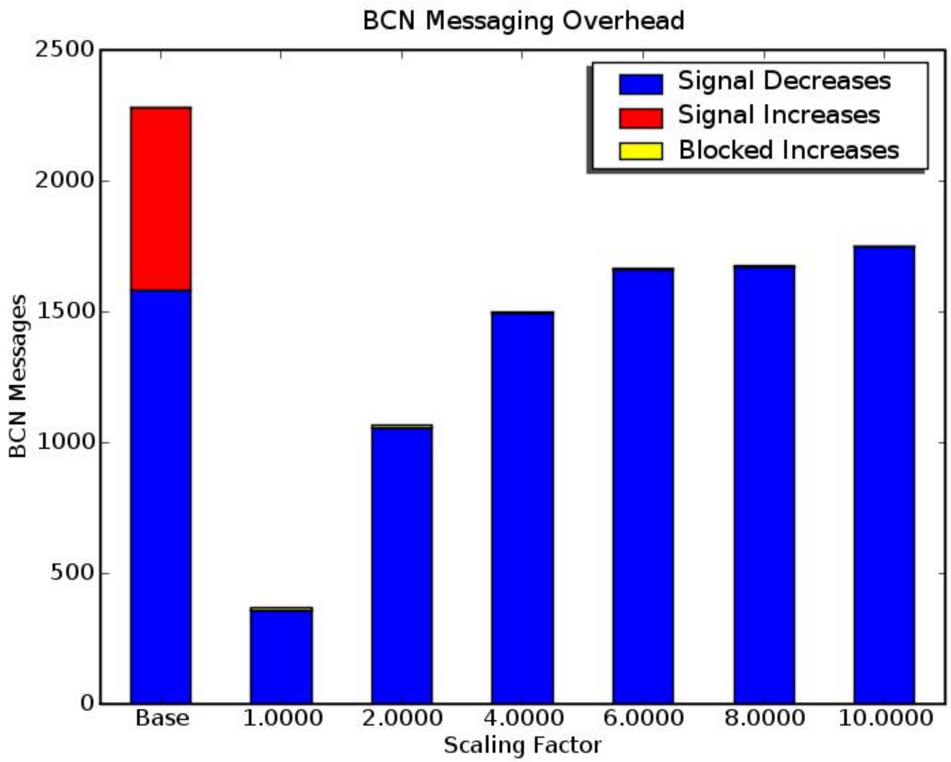
BCN Message Reduction



- BCN w/ BCN-Max
  - Frames are sampled every 75 kB (2%)
  - No PAUSE
- Self-Increase Only
  - $R_t = R_{t-1} + (R_{t-1} * I * \tau)$
  - $\tau = 10\ \mu s$

By supporting self increase only, BCN messages may be reduced by ~30% for the multihop output generated hotspot scenario.

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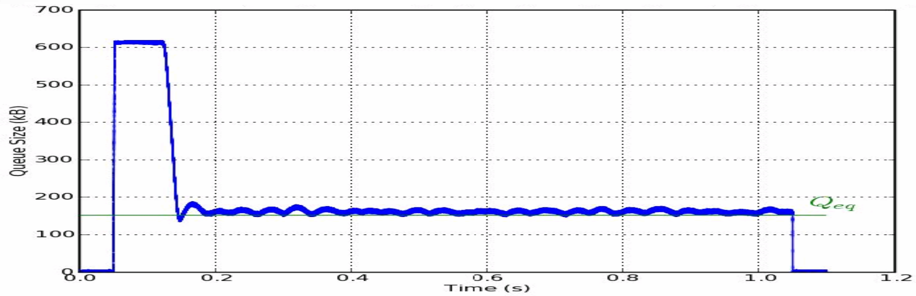
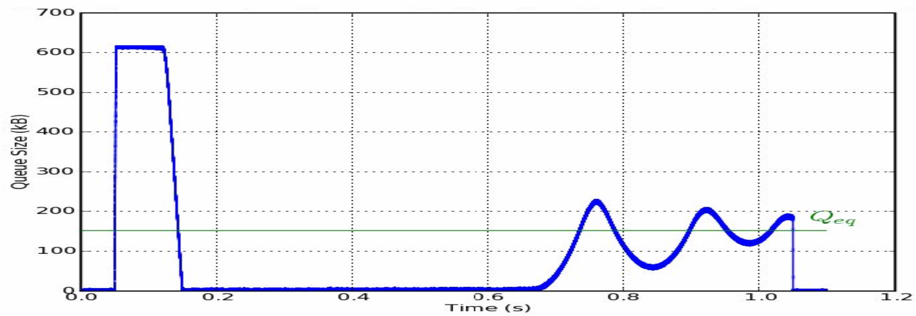
Effects of Self-Increase on Queue Size

Total Drops 9009



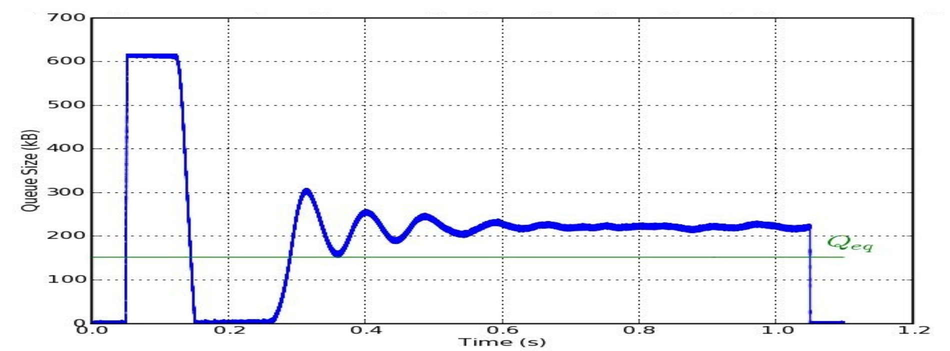
Baseline BCN (no self increase)

Total Drops 9078



BCN + Self Increase Only (Increase Factor = 1)

Total Drops 9590



BCN + Self Increase Only (Increase Factor = 5)

BCN with self increase only can result in underutilization. Increase factor may be used to minimize underutilization but can result in increased frame drops.

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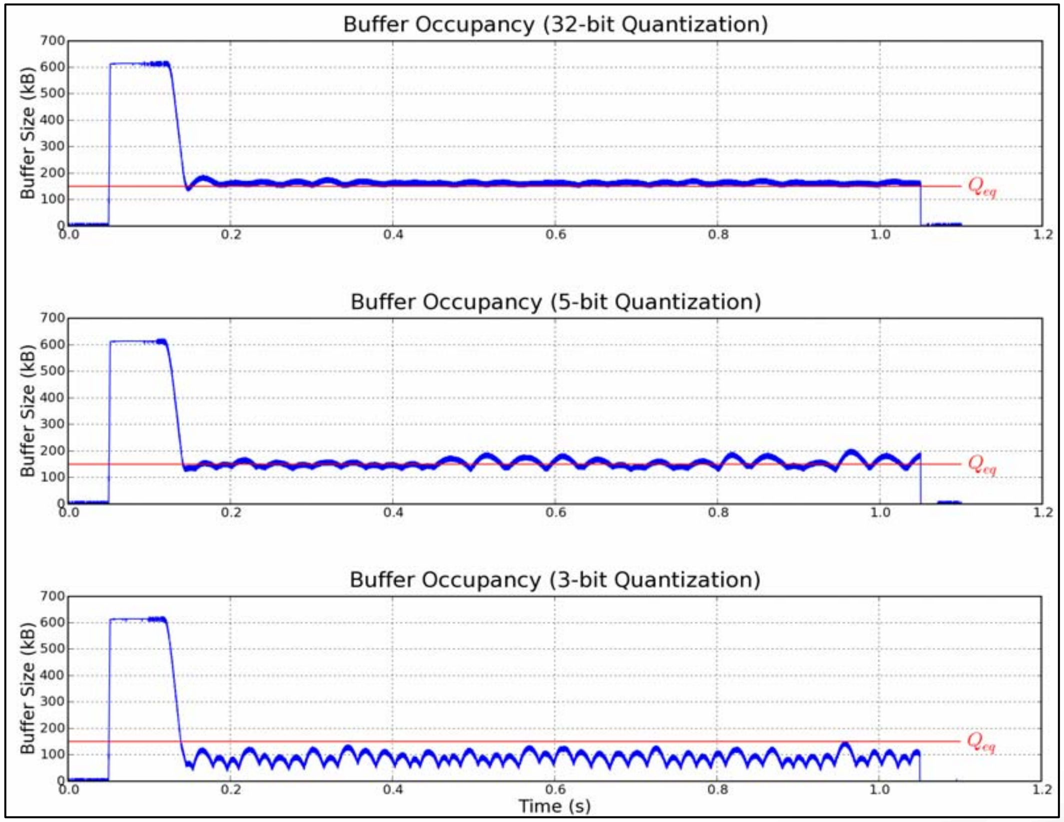
Effect of Quantization on Buffer Occupancy (BCN with Fb Quantization)

- BCN w/ BCN-Max
  - Frames are sampled every 75 kB (2%)
  - No Self-increase algorithms

Fb Quant. Bits	Packet Loss (# of drops)
32	9010
5	9112
3	9320



With Baseline BCN and ONLY varying the degree of quantization of reported Fb signal and no self increase, 5 bits of quantization achieves reasonable performance.

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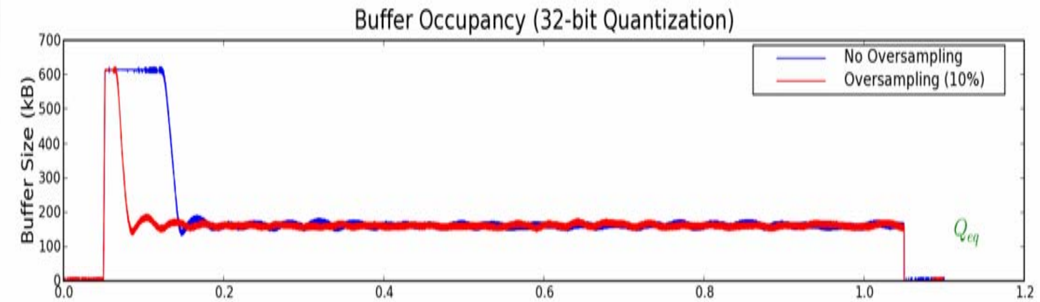
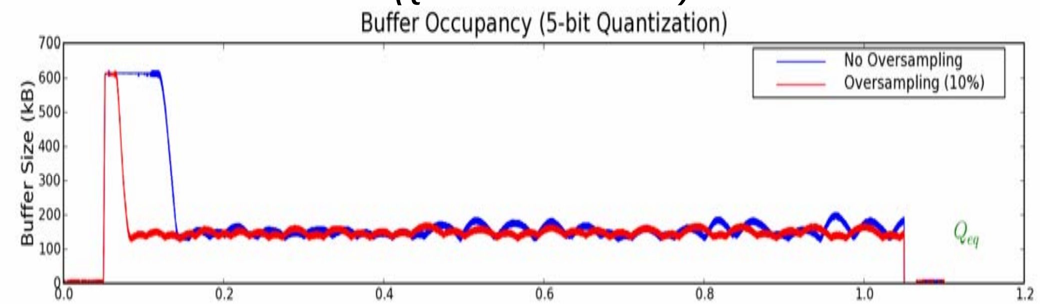
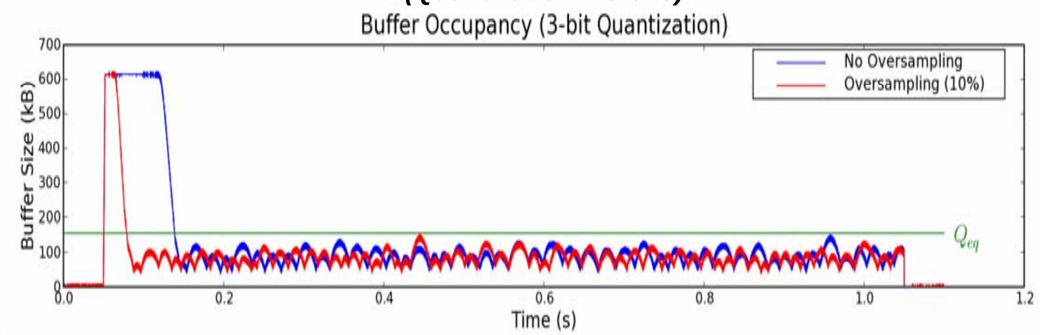
Effect of Quantization with Oversampling on Buffer Occupancy (BCN with Fb Quantization)



BCN (Quantized) w & w/o Oversampling (Quantization = 32 bits)



BCN (Quantized) w & w/o Oversampling (Quantization = 5 bits)



BCN (Quantized) w & w/o Oversampling (Quantization = 3 bits)

Oversampling can improve convergence time and reduce packet drops.

Quantization	Over Sampling	Drops
32 bit	None	9009
	Yes (10%)	1689
5 bits	None	9112
	Yes (10%)	1636
3 bits	None	9320
	Yes (10%)	1582

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- Reduction in messaging can be achieved using self-increase algorithms (~30% in simulated case)

- Self-increase algorithm can produce link utilization issues when selection of increase value is poor

- Quantization
  - When quantizing Fb, 5-6 bits appears to be sufficient to achieve reasonable performance.
  - Oversampling still provides enhancements even when quantizing

- Queue settling point can land higher than target Qeq
  - As increase factor is raised

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Next Steps

- Parameter sensitivity analysis
  - Oversampling to reduce packet drops and improve convergence time
  - Impact of reducing ‘w’
- Impact of delay
- Binary Increase Fast Recovery algorithm

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