Simulation Modeling of BCN V2.0 Phase 1: Model Validation

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IEEE 802.1 Congestion Group Meeting, Denver, March 8, 2006

These slides are available on-line at:

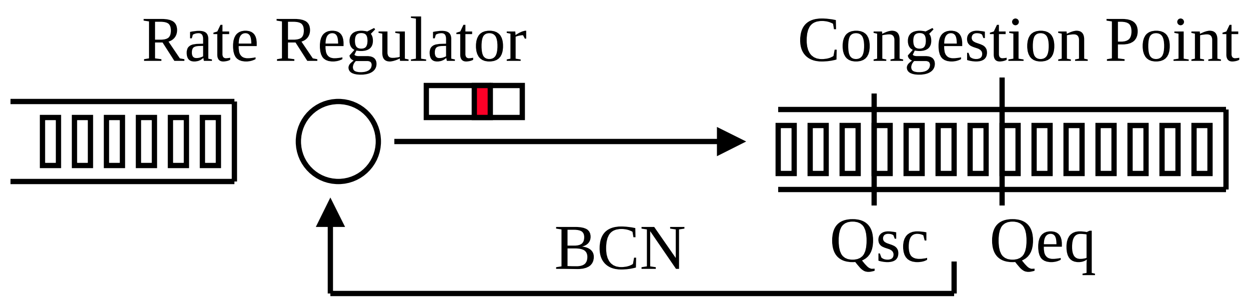
http://www.cse.wustl.edu/~jain/ieee/bcn603.htm

- Congestion Management Components
- BCN Mechanism
- Simulation Results
- Observations
- Parameter Selection
- Near Future Steps

Congestion Management Components

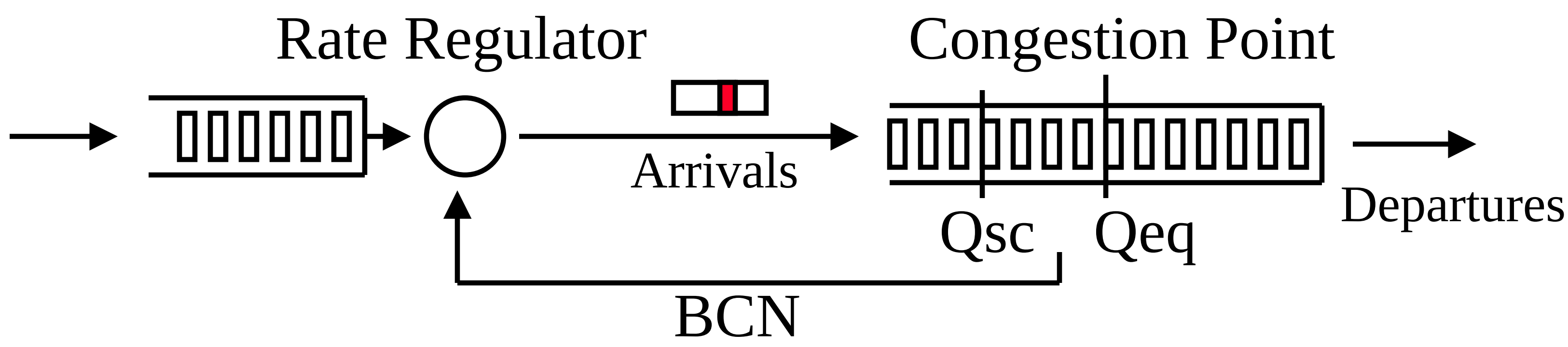
1. **Signaling**: Users need to tell/negotiate their QoS requirements with the network
2. **Admission Control**: Network can deny requests that it can not meet
3. **Shaping**: Traffic is smoothed out so that it is easier to handle
4. **Policing**: Ensuring that the users are sending at the rate they agreed to.
5. **Marking/Classification**: Packets are classified based on the source, destination, TCP ports (application)
6. **Scheduling :** Different flows get appropriate treatment. Priority Scheduling.
7. **Drop Policies**: Low priority packets are dropped. **Per priority Pause**
8. **Routing**: Packets are sent over paths that can meet the QoS
9. **Traffic Monitoring and Feedback**: Sources may be asked to reduce their rates to meet the loss rate and delay guarantees

BCN Mechanism



- Backward Congestion Notification - Closed loop feedback
  - **Detection**: Monitor the buffer utilization at possible congestion point (Core Switch, etc)
  - **Signaling**: Generate proper BCN message based the status and variation of queue buffer
  - **Reaction**: At the source side, adjust the rate limiter setting according to the received BCN messages
    - Additive Increase Multiplicative Decrease (AIMD)
- Ref: new-bergamasco-backward-congestion-notification-0505.pdf

Parameters for BCN

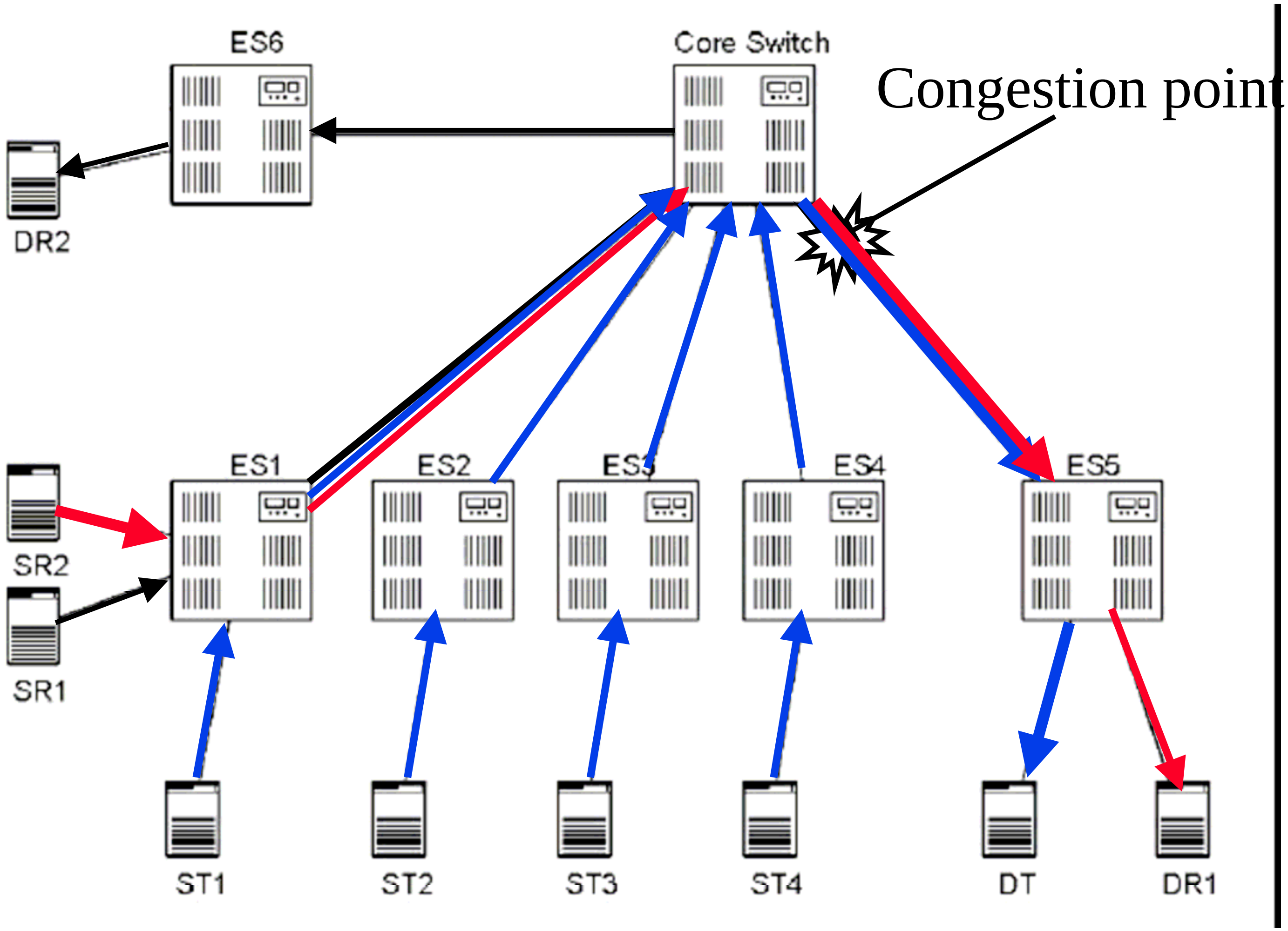


- Key Parameters
  - Threshold for buffer:
    - *Qeq* (Equilibrium),
    - *Qsc* (Severe Congestion),
- Queue Variation : *Qoff, Qdelta*
  - *Queue is sampled randomly with 0.01 probability*
  - *Qlen* (current length)
  - *Qoff = Qeq-Qlen, [-Qeq, +Qeq]*
  - *Qdelta = #pktArrival-#pktDeparture, [-2Qeq, +2Qeq]*

AIMD Algorithm

- Source Rate *R*
- Feedback
  - $Fb = (Qoff - W \times Qdelta)$
- Additive Increase ($Fb > 0$)
  - $R = R + Gi \times Fb \times Ru$
- Multiplicative Decrease (Fb < 0)
  - $R = R \times (1 - Gd \times Fb)$
- Parameters used in AIMD:
  1. Derivative weight *W*
  2. Additive Increase gain *Gi*,
  3. Multiplicative Decease Gain *Gd*,
  4. Rate Unit *Ru*

Configuration



Configuration Parameters

- Configuration same as in Davide, IEEE 802.1, May 05
- Link Capacity = 10 Gbps (all links)
- Switch latency = 1 us (all switches)
- Propagation delay = 0.5 us (all links)
- TCP only
  - ST1-ST4: 10 parallel connections transferring 1MB each and repeat
  - SR1: 1 connection transferring 10 KB (wait 16 us after finishing, then repeat)
  - SR2: 1 connection transferring 10 KB (wait 1us after finishing, then repeat)
- Our simulation Platform: *NS2* simulator

AIMD parameters

$$Fb = (Qoff - W \times Qdelta)$$
$$R = R + Gi \times Fb \times Ru$$
$$R = R \times (1 - Gd \times Fb)$$

- Cisco's settings
  - Derivative weight: $W = 2$
  - Increase Gain: $Gi = 4$
  - Decrease Gain: $Gd = 1/64$
  - Rate Unit: $Ru = 8$ *Mbps*
- Our settings
  - W, Gi, and Ru are same with Cisco
  - Decrease Gain: $Gd = 0.0124$
  - Since Fb's range is [-80, 80]
    R becomes negative with Gd = 1/64
  - In our simulation, $Gd=0.0124$ to make sure R is always positive

Simulation Results: Throughput

- Cisco's results with BCN v1.0

	Reference Flow 1			Reference Flow 2		
CM	Throughput(Tps)	Throughput(Gbps)	Latency(μs)	Throughput(Tps)	Throughput(Gbps)	Latency(μs)
None	609	0.05245	1625	6325	0.54476	157.100
BCN	4491	0.3868	206.394	31515	2.71437	30.730

  - Bulk Traffic:

CM	Average Source Throughput	Standard Deviation/Average (%)
None	2.486	0.73
BCN	2.403	5.66

- Our Results with BCN v2.0

	Reference Flow 1			Reference Flow 2		
CM	Throughput(Tps)	Throughput(Gbps)	Latency(μs)	Throughput(Tps)	Throughput(Gbps)	Latency(μs)
None	501	0.0442	1977.46	3560	0.3087	279.89
BCN	8697	0.7532	98.88	23485	2.0331	41.56

  - Bulk Traffic:

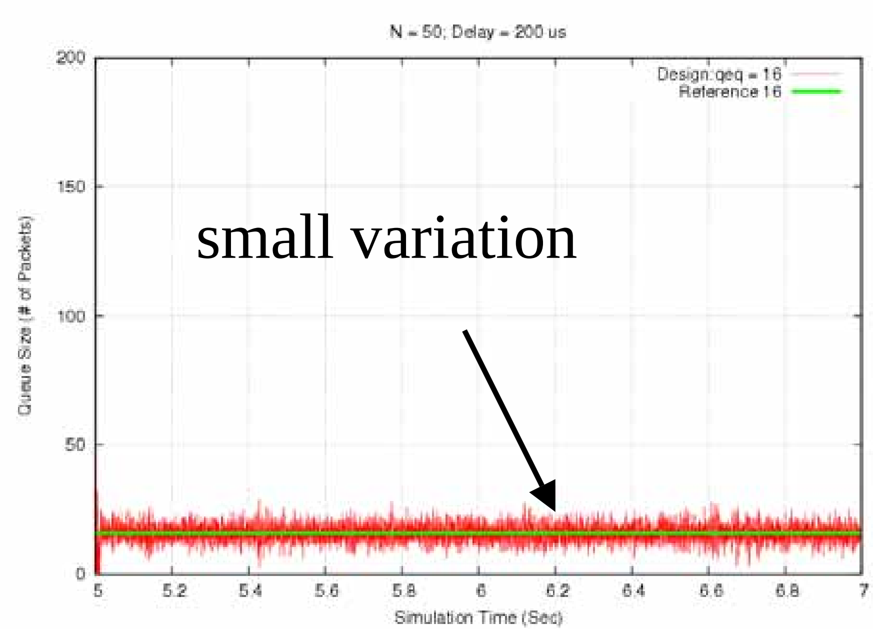
CM	Average Source Throughput	Standard Deviation/Average (%)
None	2.5484	4.44
BCN	2.2022	11.49

Observations

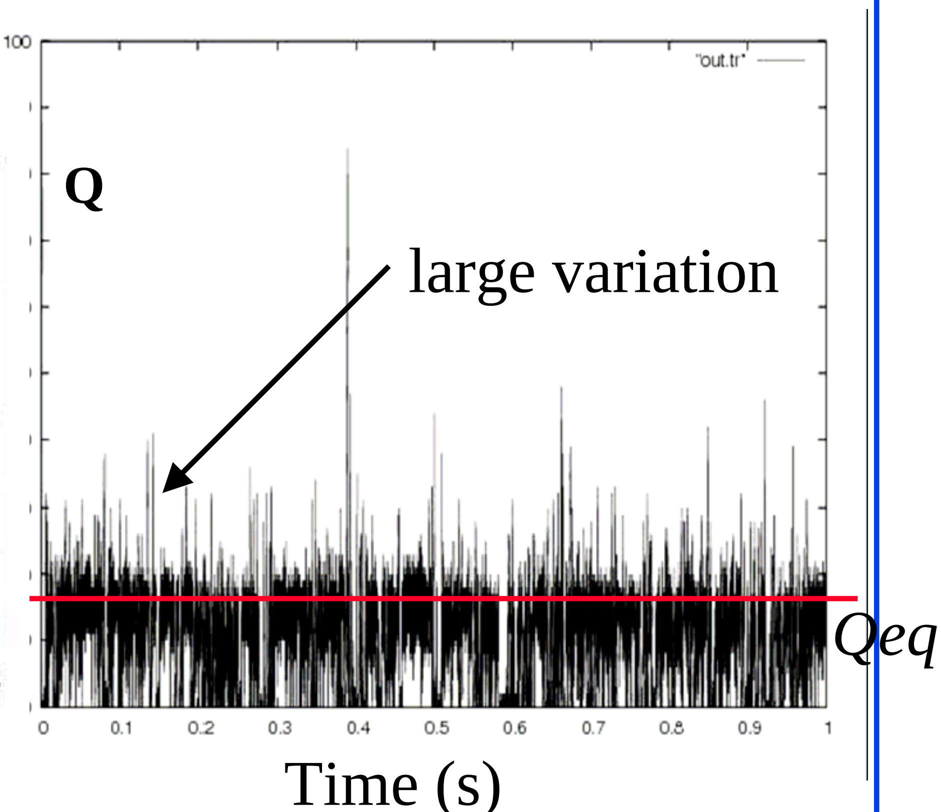
- For reference flow, BCNv2 in our simulation performs better than BCNv1(by Cisco), nearly double the rate of BCNv1;
- For bulk flow, BCNv2 in our simulation performs similar to BCNv1(by Cisco). Maybe it is because Reference Flows have higher data rates,
- Fairness: Our current results always have larger deviation reported by Cisco. Even with None-CM, we have larger standard deviation. Time to fairness is longer.

Symmetric Topology-Buffer Utilization

- Compared with Cisco's result, the equilibrium is almost the same. However, in our results, there are larger variations. (Reasons: Tradeoff between oscillation size and time to fairness)



BCNv2 Cisco



Parameter Selection

$$R = R + Gi \times Fb \times Ru$$

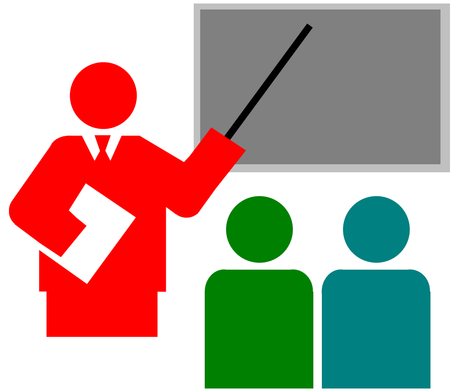
$$R = R \times (1 - Gd \times Fb)$$

- *Qoff*, *Qdelta* are #packets per observation, then *Fb* is #packets per observation (sampling time gap)
- *Ru* is 8 Mbps
- *Gi and Gd are not dimension less* $\Rightarrow$ *Link rate dependent*
  $\Rightarrow$ Fb should be normalized to be dimensionless
- Our preliminary simulation results show that optimal parameter values depend upon link speeds.
  $\Rightarrow$ Need to simulate mixed 1G and 10G environments
- AIMD parameters should be carefully chosen to optimize BCN performance

Near Future Steps

- Fix the dimensioning problem
- Asymmetric Topology
- Multi-bottleneck case
- Larger/smaller Bandwidth×Delay product networks
- Bursty Traffic
- Non-TCP traffic
- Interaction with TCP congestion mechanism
- Effect of BCN/Tag messages getting lost

Summary



1. BCN V2 simulation validate Cisco's results on throughput
2. Time to Fairness and oscillation trade-off needs to be studied further
3. Parameter setting needs more work
   Need to modify formula so that parameters are dimensionless
4. Need to simulate more configurations:
   asymmetric, larger bandwidth delay, and multi-bottleneck cases

References

http://ieee802.org/1/files/public/docs2005/

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