Performance Simulation of Nortel OPE-RPR Ring

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May 22, 2001

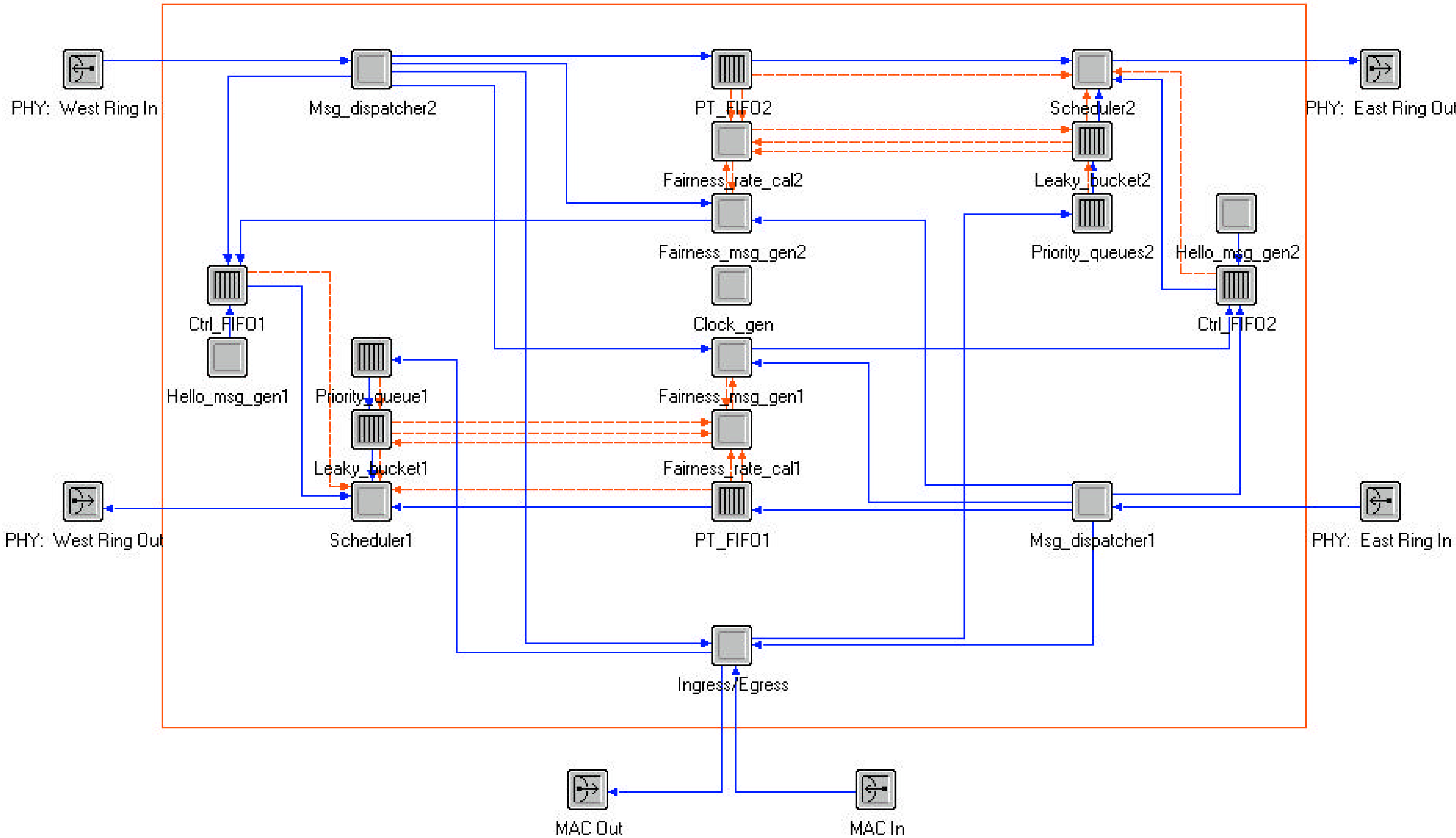
Agenda

- Objectives
- Simulation setup
- Transient simulation results
- Steady-State simulation results
- Conclusions
- What’s next

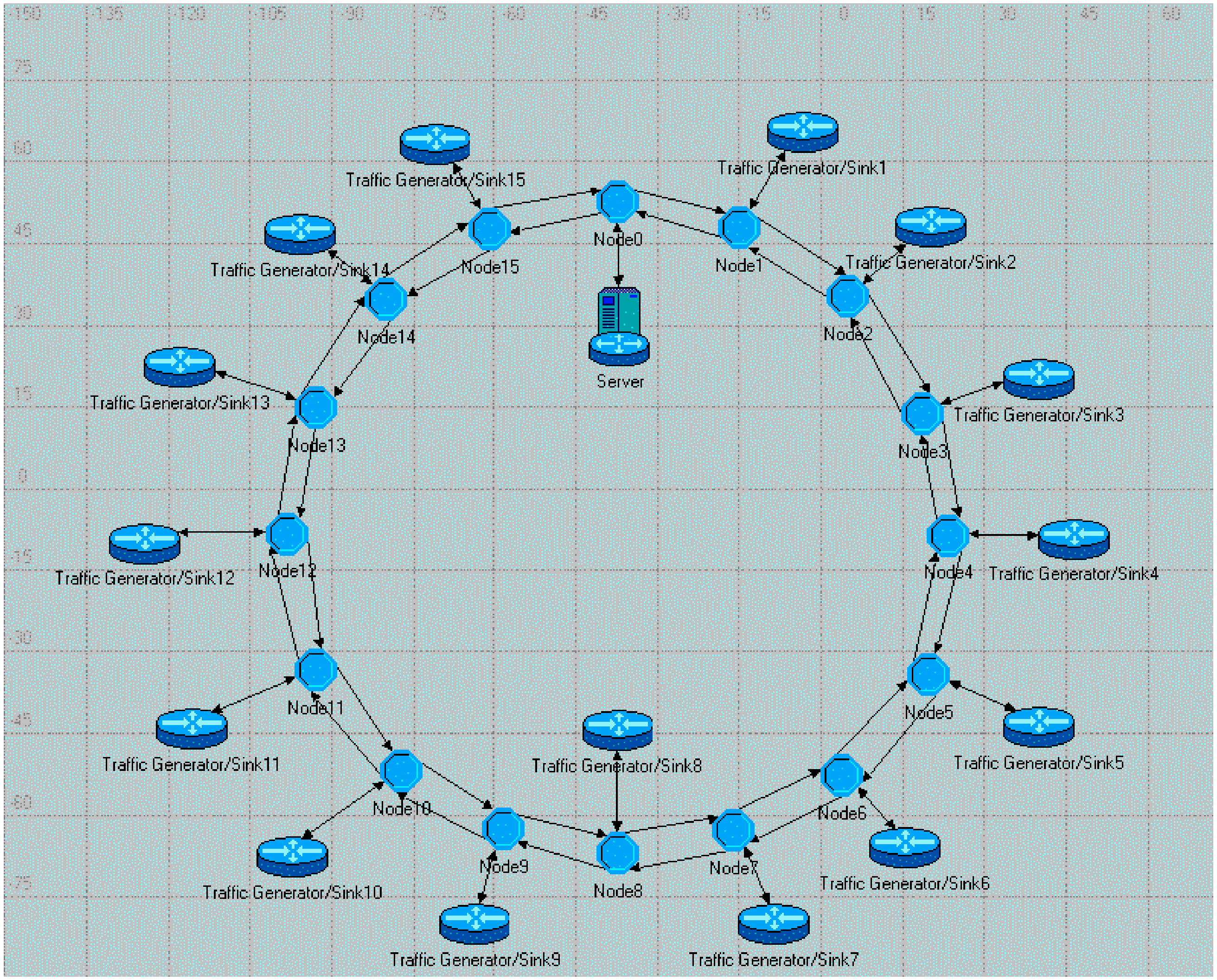
Objectives

- Phase I
  - Simulation environments follow the specifications by 802.17 performance ad-hoc group
  - Examine the transient performance of OPE-RPR ring under raw traffic model
  - Examine the steady-state performance of OPE-RPR ring under bursty raw traffic model

Simulation setup: Node model



Simulation setup: Ring model



Definitions

- **MAC end-to-end delay:** Time between the arrival of an end of packet at the MAC transmit buffer of the source node and the time that this packet is completely delivered to the next protocol layer of the destination node on the same ring.
- **Medium access delay:** Time required for a head-of-the-line packet in the MAC transmit buffer to gain access to the medium. This delay is only caused by the medium competition and the fairness mechanism, not by the node's own traffic. This delay does not include the packet transmission time.

Note: definitions same as “Terms and Definitions” by Harmen R. van-As

Trigger conditions of fairness algorithm

- Two trigger conditions:
  - triggered by high utilization
    - controlled by target utilization and weights
    - tandem and add-in rate estimator
      - *ESTIMATEDrate(t) = ESTIMATEDrate(t-1)* - *(ESTIMATEDrate(t-1))/WEIGHT1 + (CURRENTrate)/WEIGHT2*
  - triggered by high HOL delay
    - controlled by HOL timer

Traffic description

- The packet interarrival distribution is exponential (Poisson traffic)
- Packet size distribution is trimodal (60% 64B, 20% 512B, 20% 1518B)
- The mean packet size is 444.4B
- Hub application
  - Node 0 is the hub node
  - Node 1 to 15 send traffic to node 0 along counter-clock direction

Simulation scenarios for transient performance study

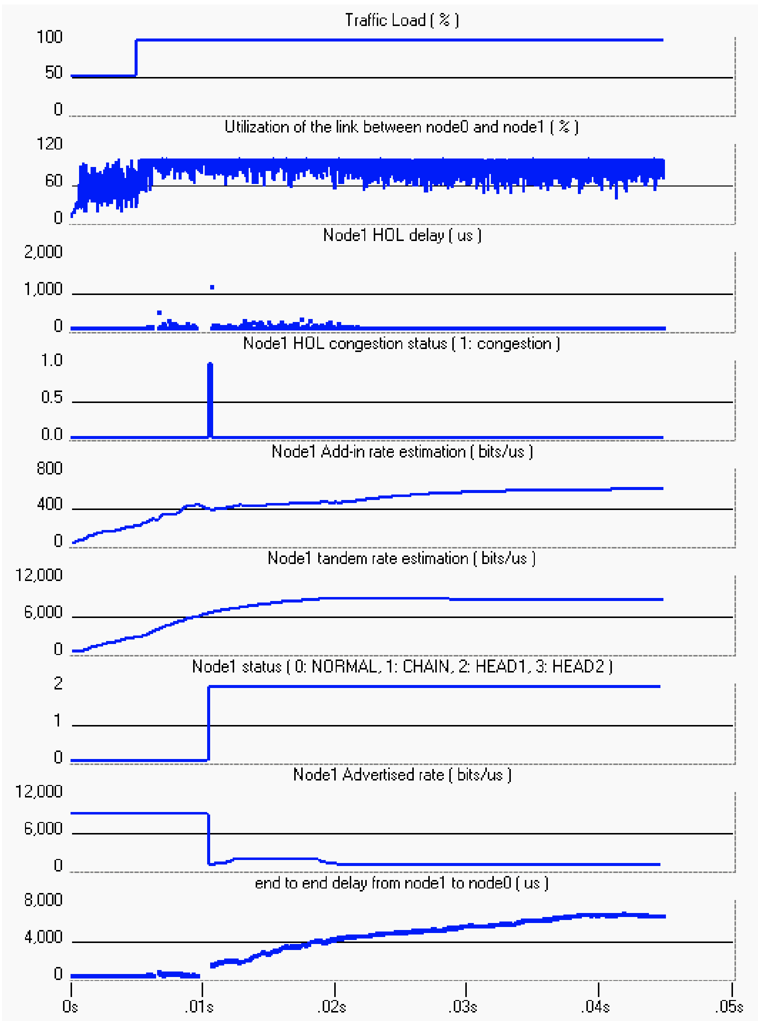
- Two types of scenarios:
  - nonoverloading
  - overloading
- Common parameters:

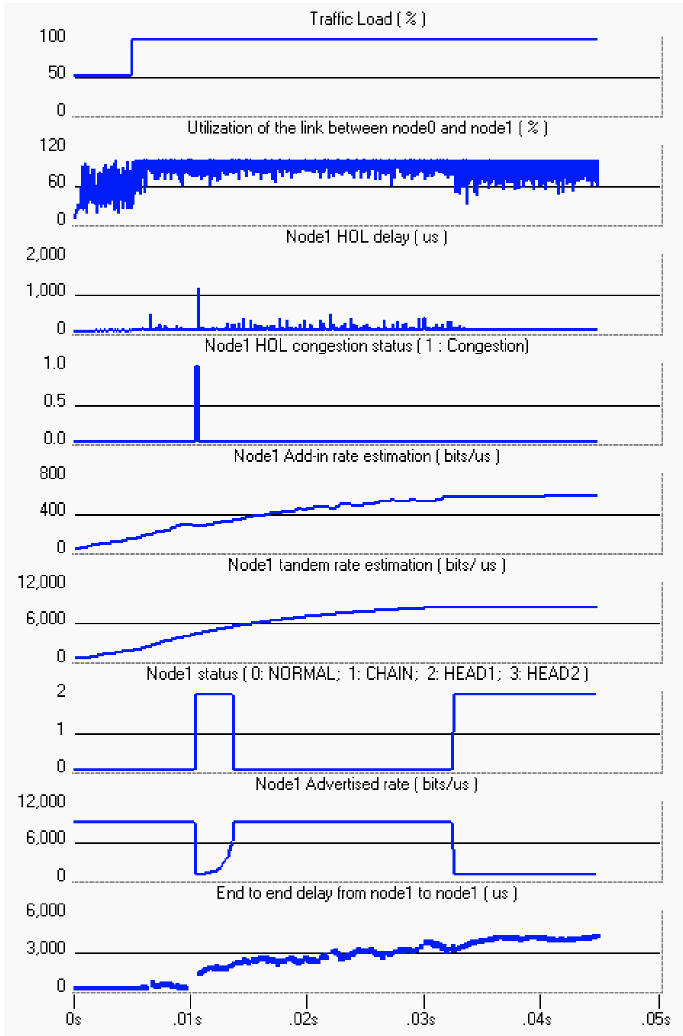
Link Utilization Max Threshold :	0.9
HOL Delay Threshold:	1,000us
Sample Window:	200 us
Token Size:	1,000 bits
Token Bucket Size:	15,000 bits
Tandem Rate Min Threshold :	0.0001
Add Rate Min Threshold:	0.0001
Link rate :	10 G bps
Propagation delay:	70 us (20 KM)

Scenarios in detail

	Data rate per node (mean value)	Weight for Tandem rate and Add rate Estimators	Simulation duration	Comment
Scenario 1 - 1	50%*10G/15 bps (0 < t <= 5 ms) 100%*10G/15 bps (t>5 ms)	32	45 ms	Mean utilization of the link between Node_1 and Node_0 jumps from 50% to 100% at time t = 5 ms following the input load jumps.
Scenario 1 - 2	50%*10G/15 bps (0 < t <= 5 ms) 100%*10G/15 bps (t>5 ms)	64	45 ms	Mean utilization of the link between Node_1 and Node_0 jumps from 50% to 100% at time t = 5 ms following the input load jumps.
Scenario 2 - 1	100%*10G/15 bps (0 < t <= 5 ms) 150%*10G/15 bps (t>5 ms)	32	45 ms	Mean utilization of the link between Node_1 and Node_0 jumps from 100% to 150% at time t = 5 ms following the input load jumps.
Scenario 2 - 2	100%*10G/15 bps (0 < t <= 5 ms) 150%*10G/15 bps (t>5 ms)	64	45 ms	Mean utilization of the link between Node_1 and Node_0 jumps from 100% to 150% at time t = 5 ms following the input load jumps.
Scenario 2 - 3	100%*10G/15 bps (0 < t <= 5 ms) 200%*10G/15 bps (t>5 ms)	32	45 ms	Mean utilization of the link between Node_1 and Node_0 jumps from 100% to 200% at time t = 5 ms following the input load jumps.
Scenario 2 - 4	100%*10G/15 bps (0 < t <= 5 ms) 200%*10G/15 bps (t>5 ms)	64	45 ms	Mean utilization of the link between Node_1 and Node_0 jumps from 100% to 200% at time t = 5 ms following the input load jumps.

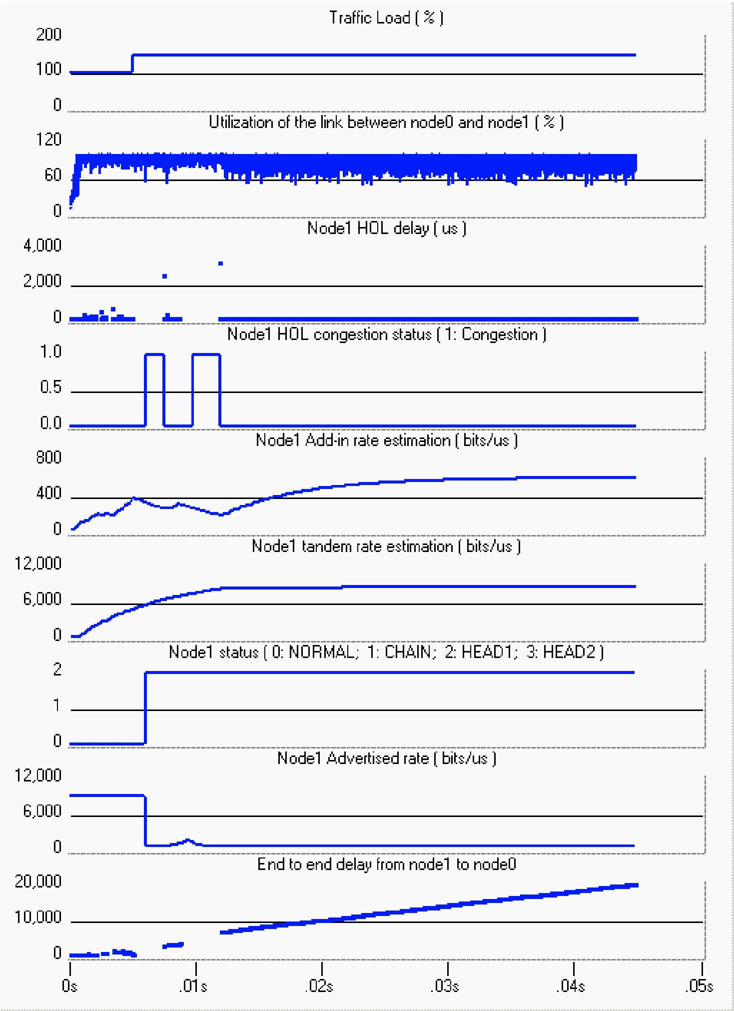
Selective results

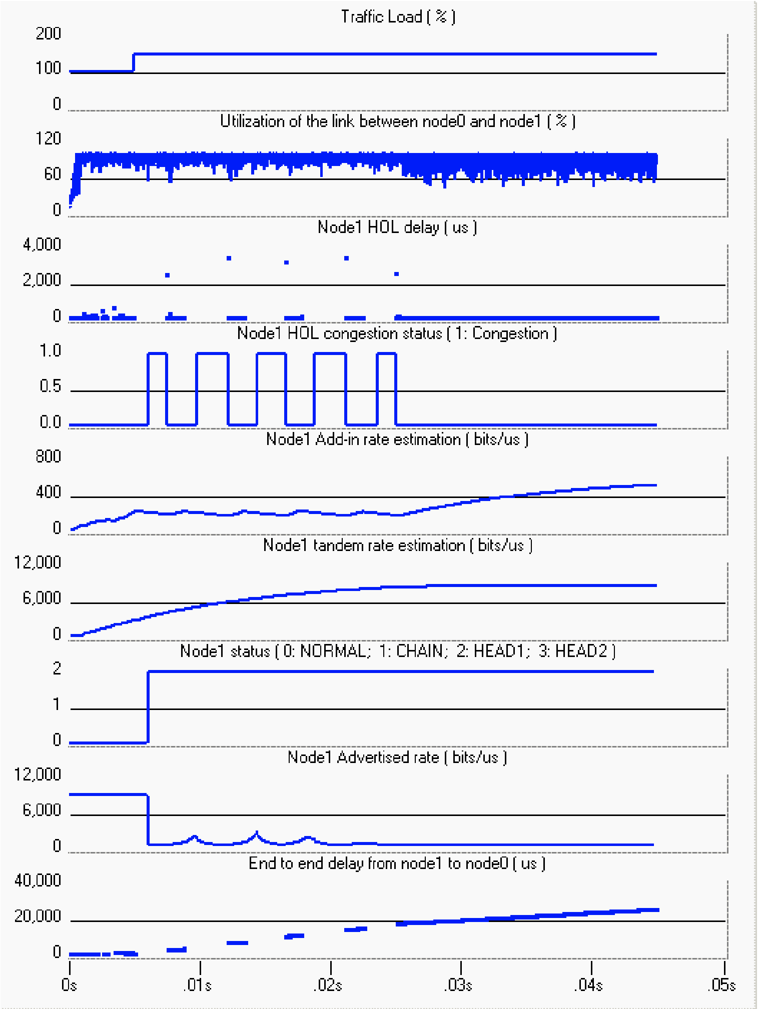




Scenario 1-1 vs. Scenario 1-2

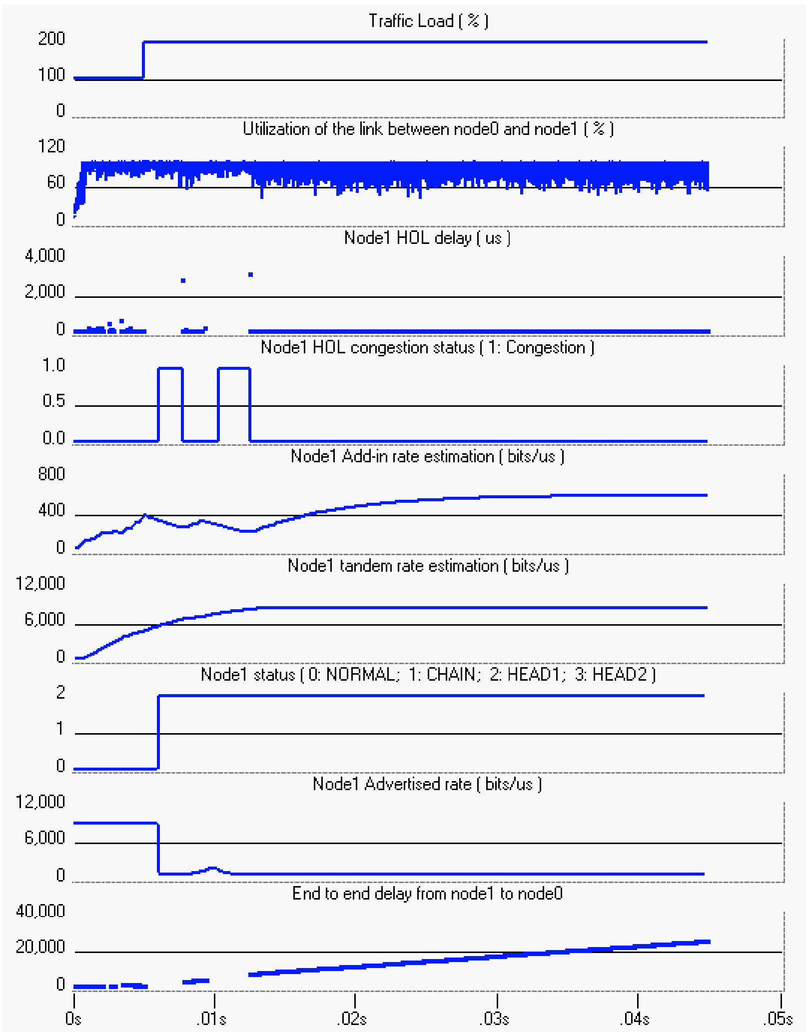
Selective results (cont'd)

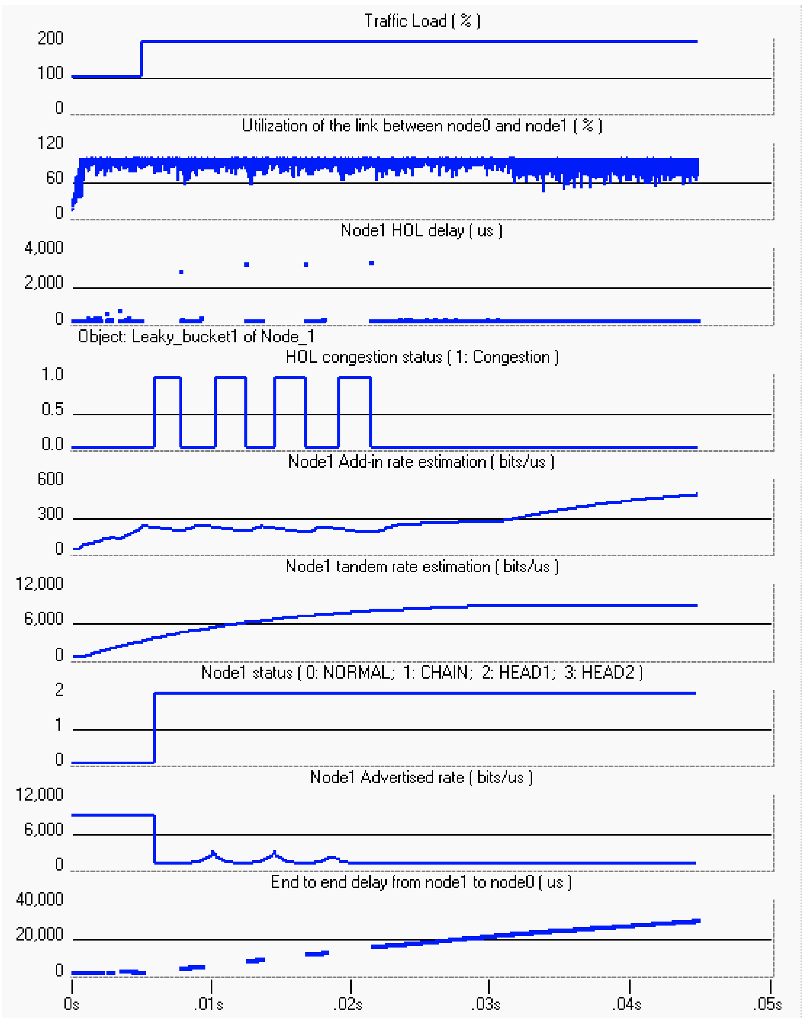




Scenario 2-1 vs. Scenario 2-2

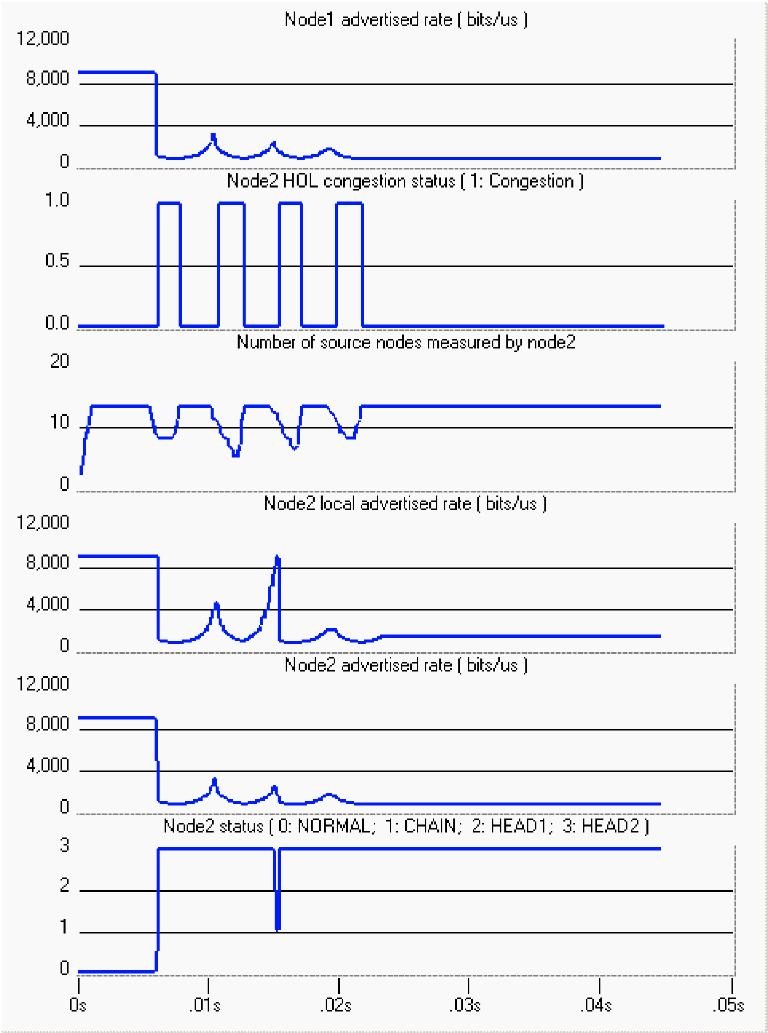
Selective results (cont'd)





Scenario 2-3 vs. Scenario 2-4

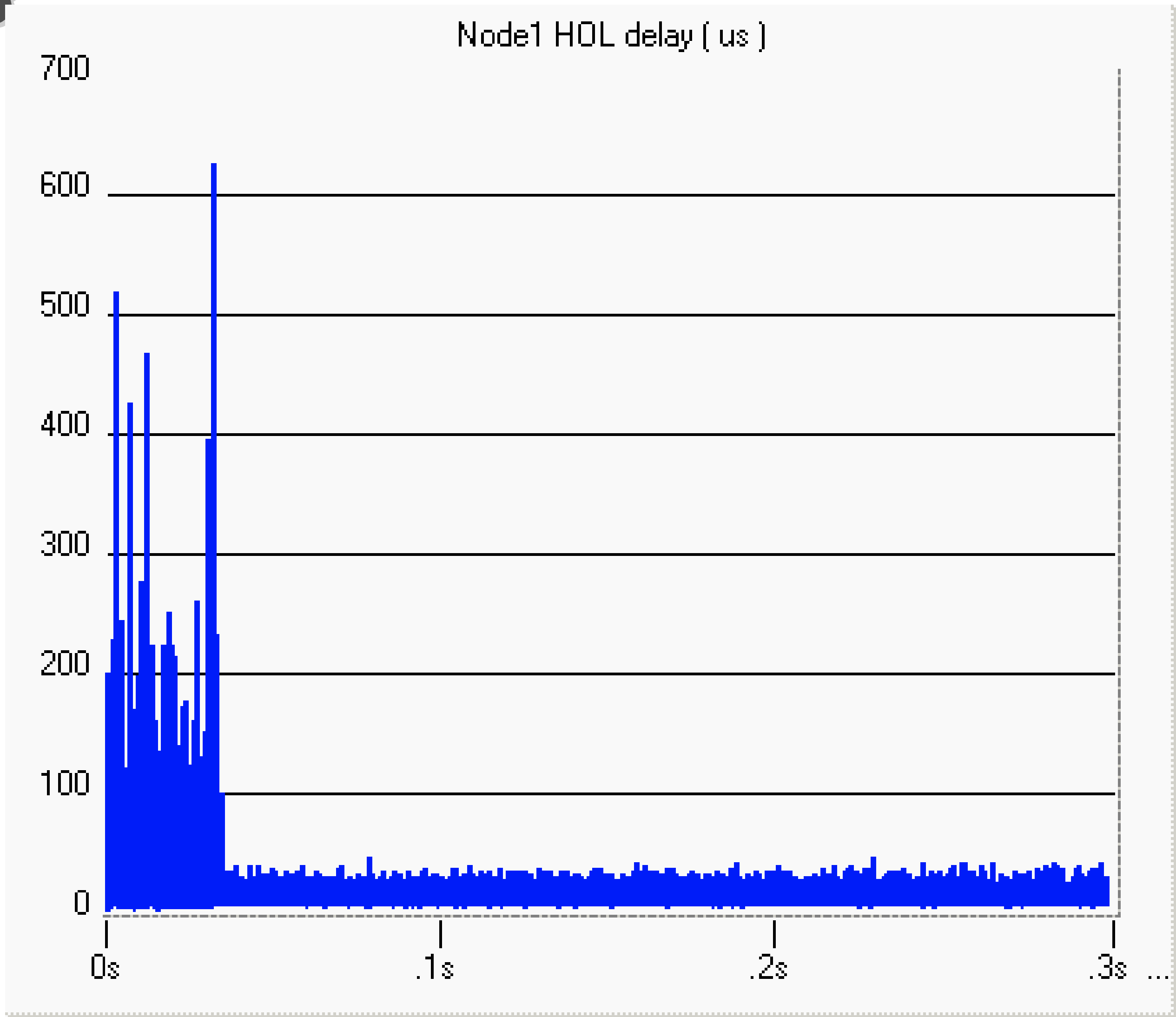
Fully distributed algorithm in operation



Node Status:
0 Normal
1 Chain
2 Head1
3 Head2

Scenario 2-4
(CBR traffic)

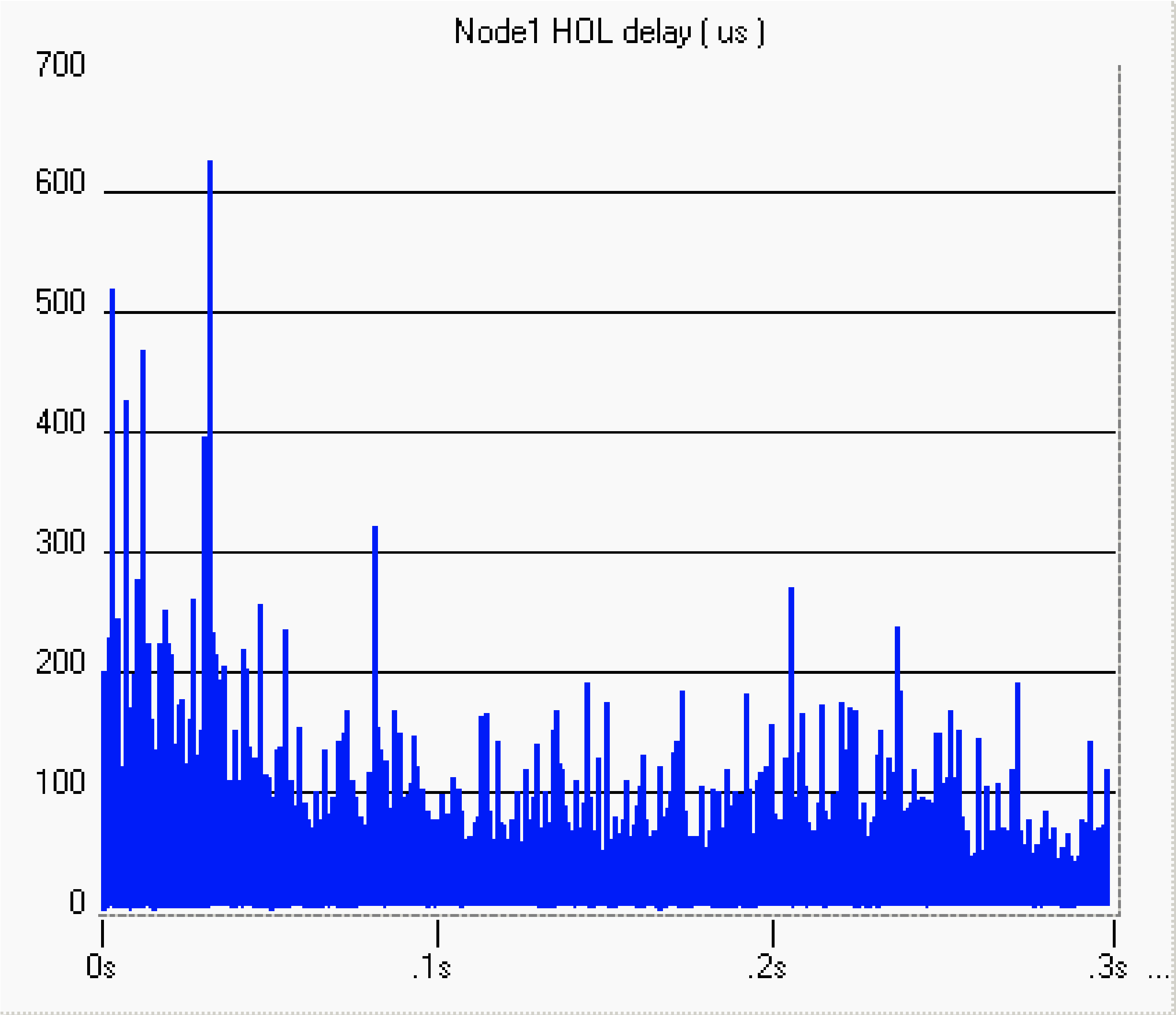
Steady state results with bursty traffic



Bucket size:
2000bits
Utilization:
97%

Enter steady state
after 40ms

Steady state results (cont'd)

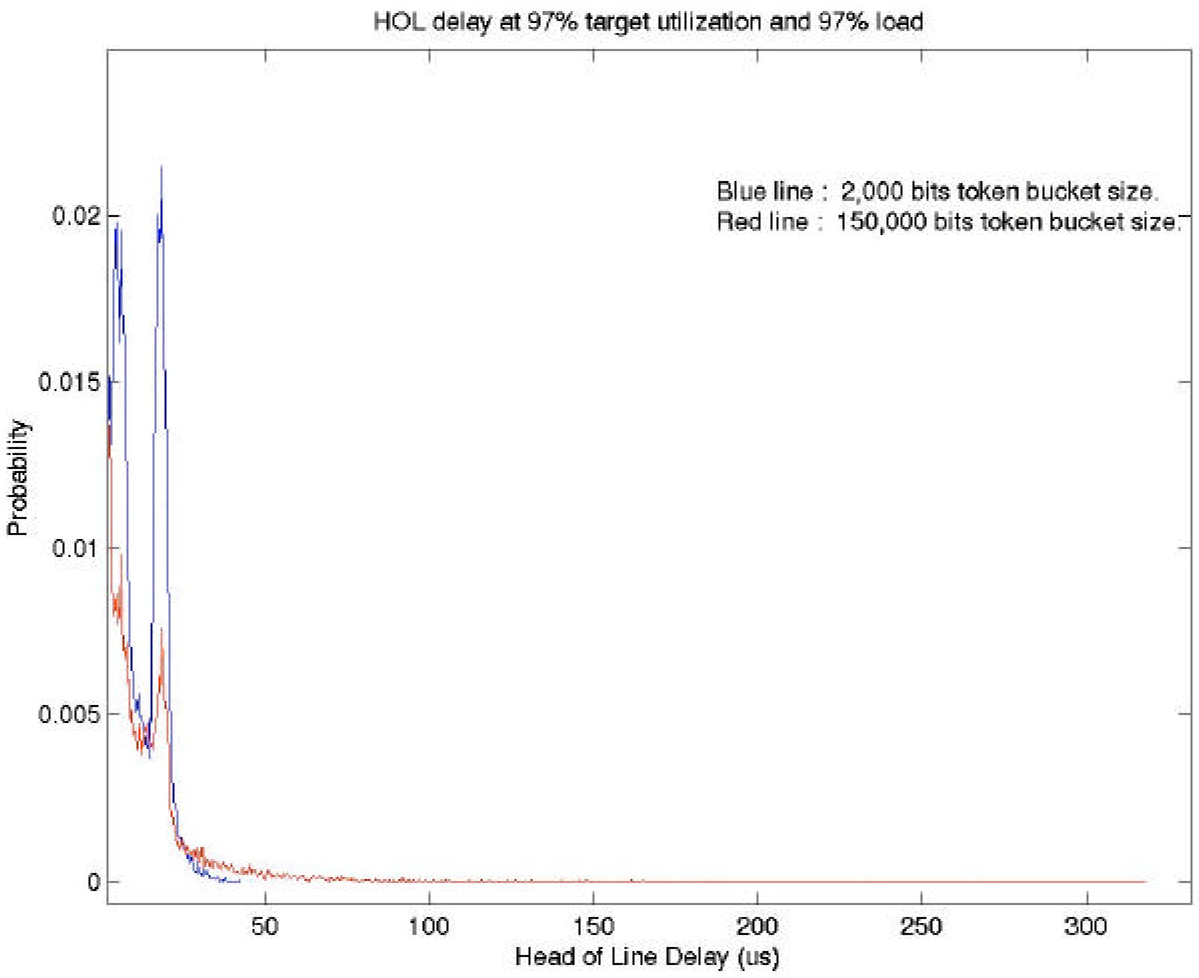


Bucket size: 150000 bits
Utilization: 97%

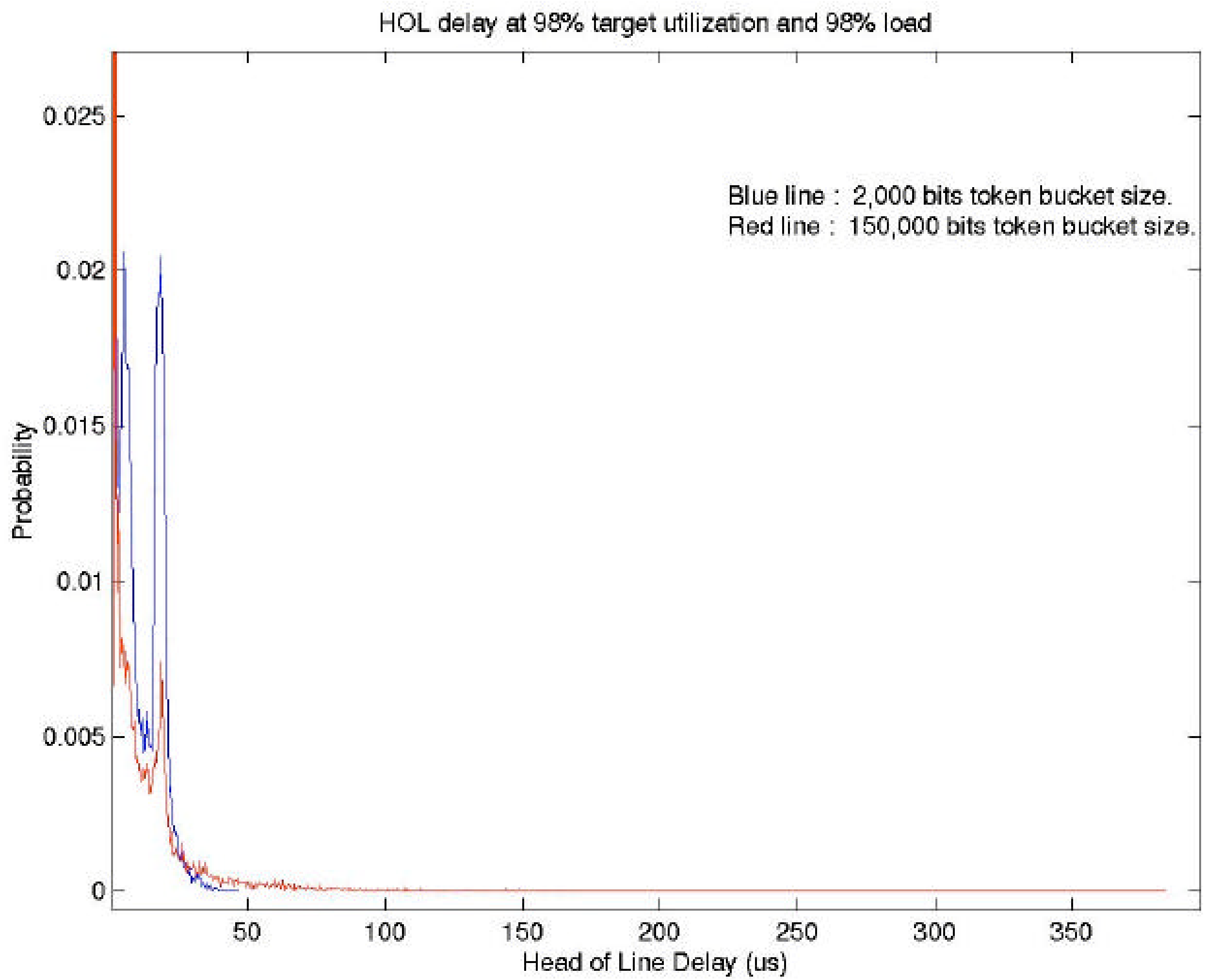
BIR effects.

Enter steady state after 40ms.

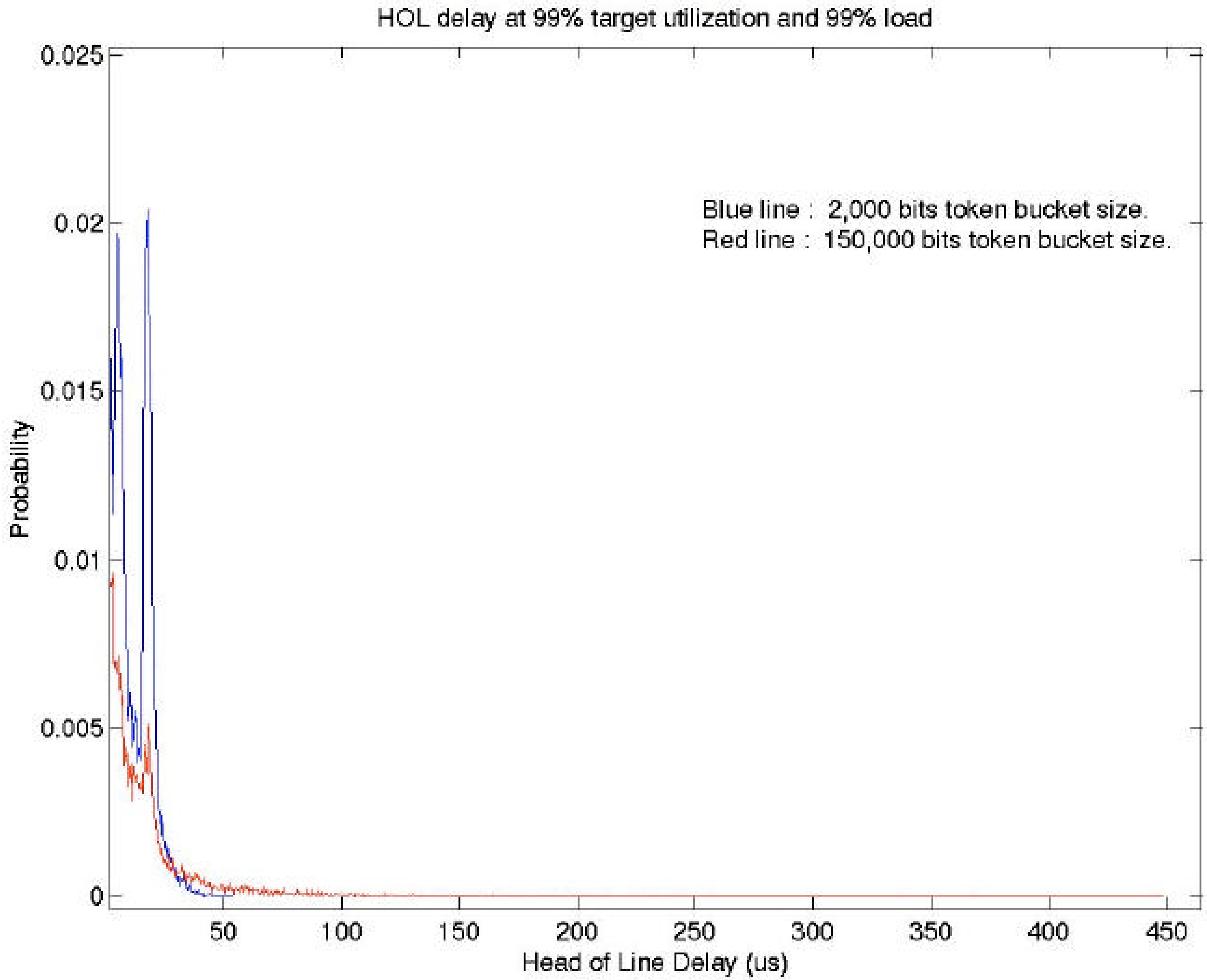
Statistical results of steady state



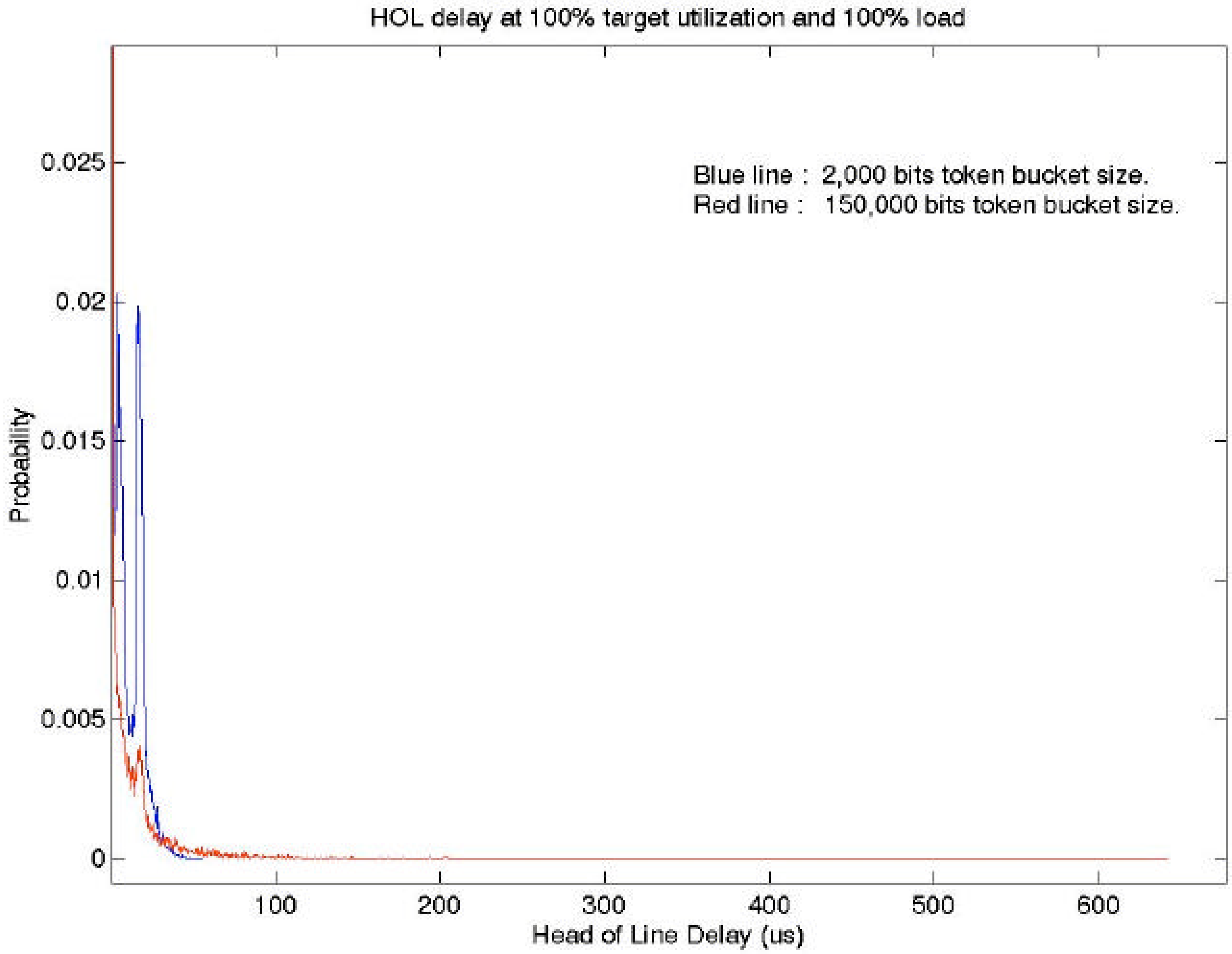
Statistical results (cont'd)



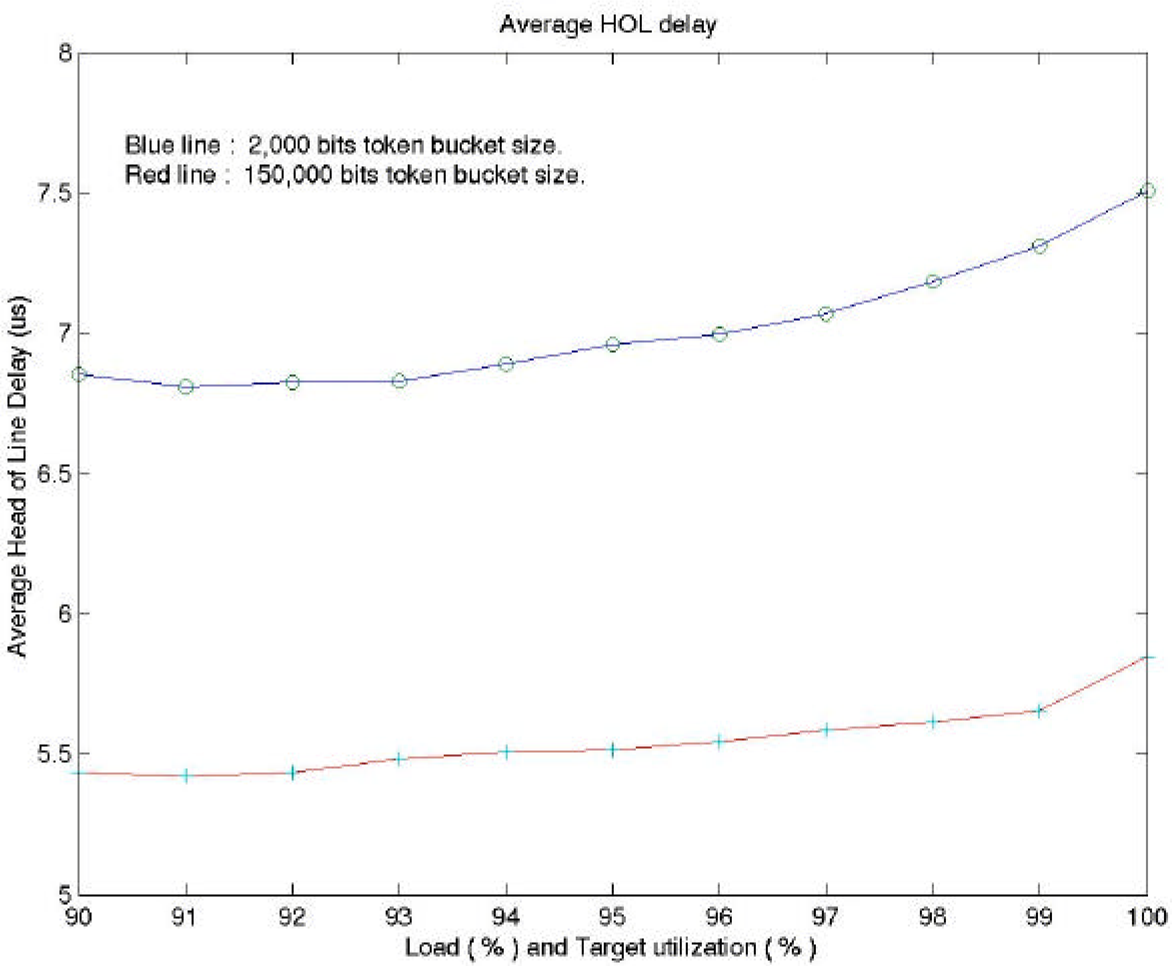
Statistical results (cont'd)



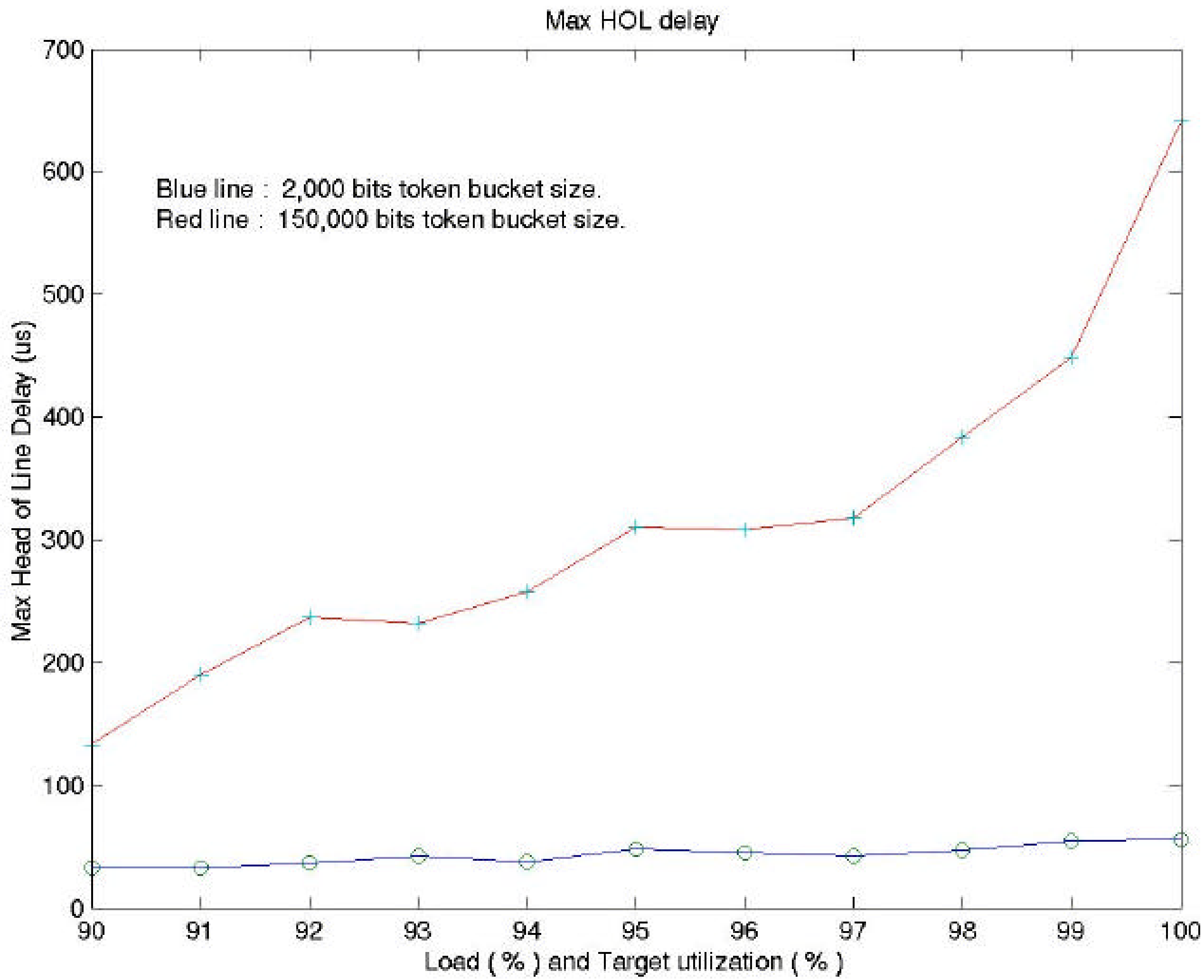
Statistical results (cont'd)



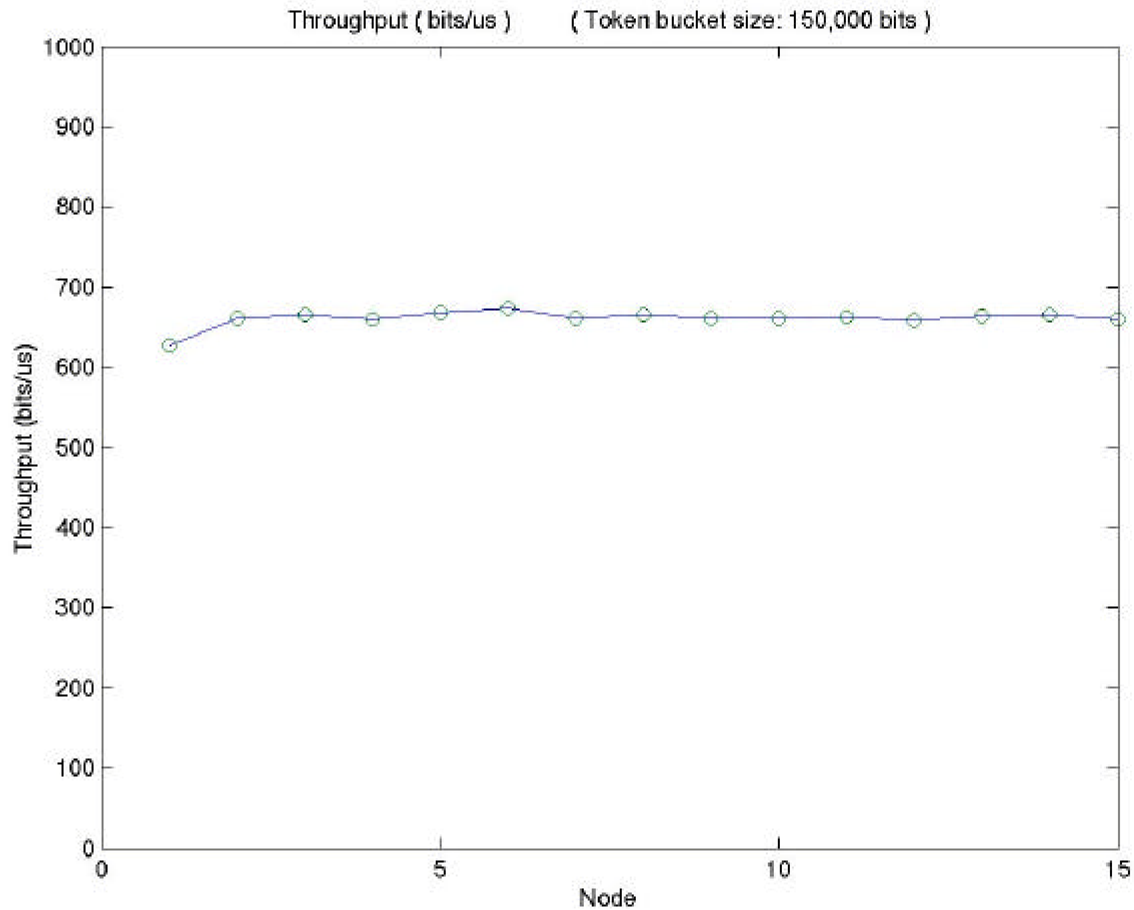
Statistical results (cont'd)



Statistical results (cont'd)

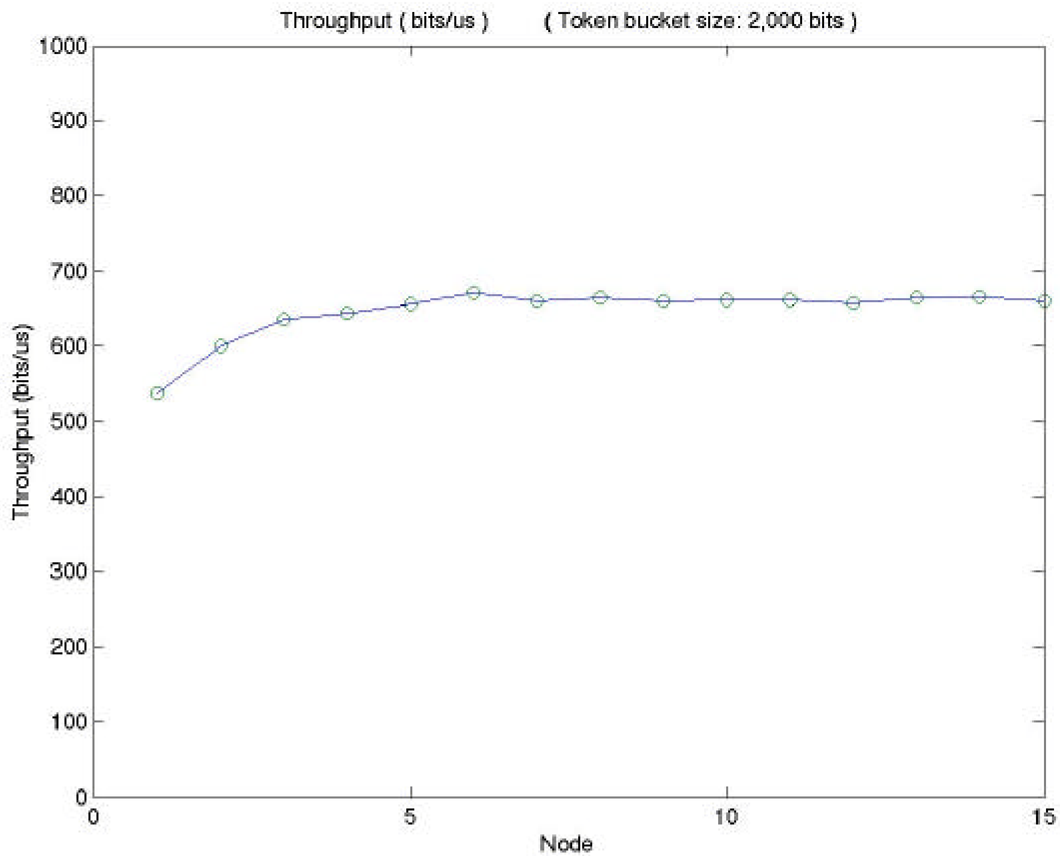


Statistical results (cont'd)



Target utilization 100% and load 100%

Statistical results (cont'd)



Target utilization 100% and load 100%

Conclusions

- OPE-RPR ring can achieve more than 95% utilization and low MAC end-to-end delay with **single insertion buffer**
  - OPE-RPR fairness algorithm is stable under steady and bursty traffic
  - OPE-RPR fairness algorithm is fair to all nodes under congestion
  - OPE-RPR fairness algorithm works effectively as predicted

What's next

- Distributed applications (multiple servers)
- Multiple classes
- BW unfairness services
- TCP applications