



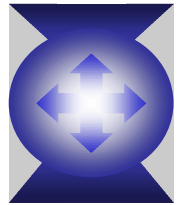
**LANTERN**  
COMMUNICATIONS

# Metro Packet Ring Simulation Results

Adisak Mekkittikul  
August 28, 2000

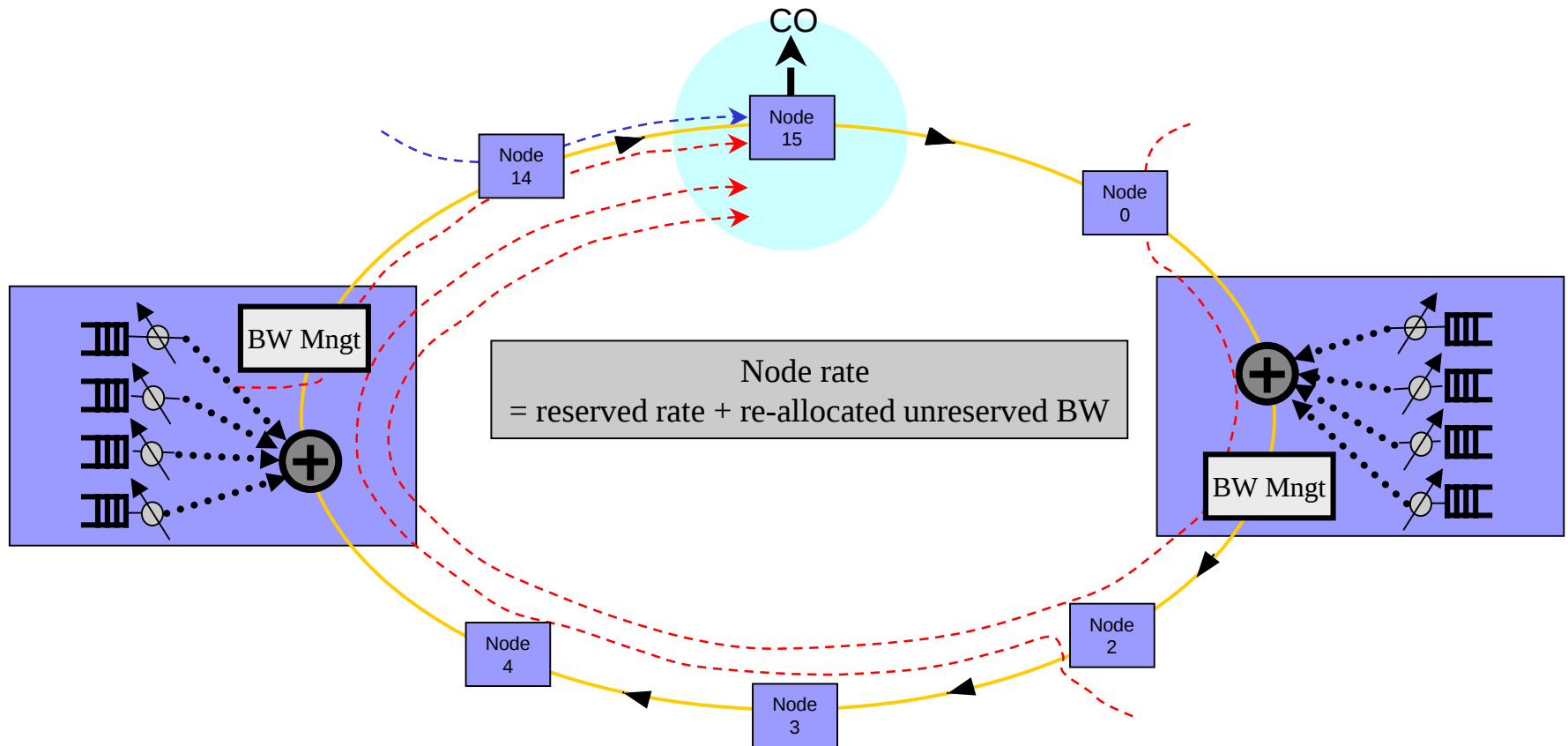
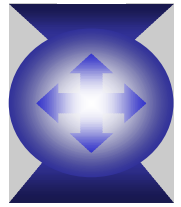
# Outline

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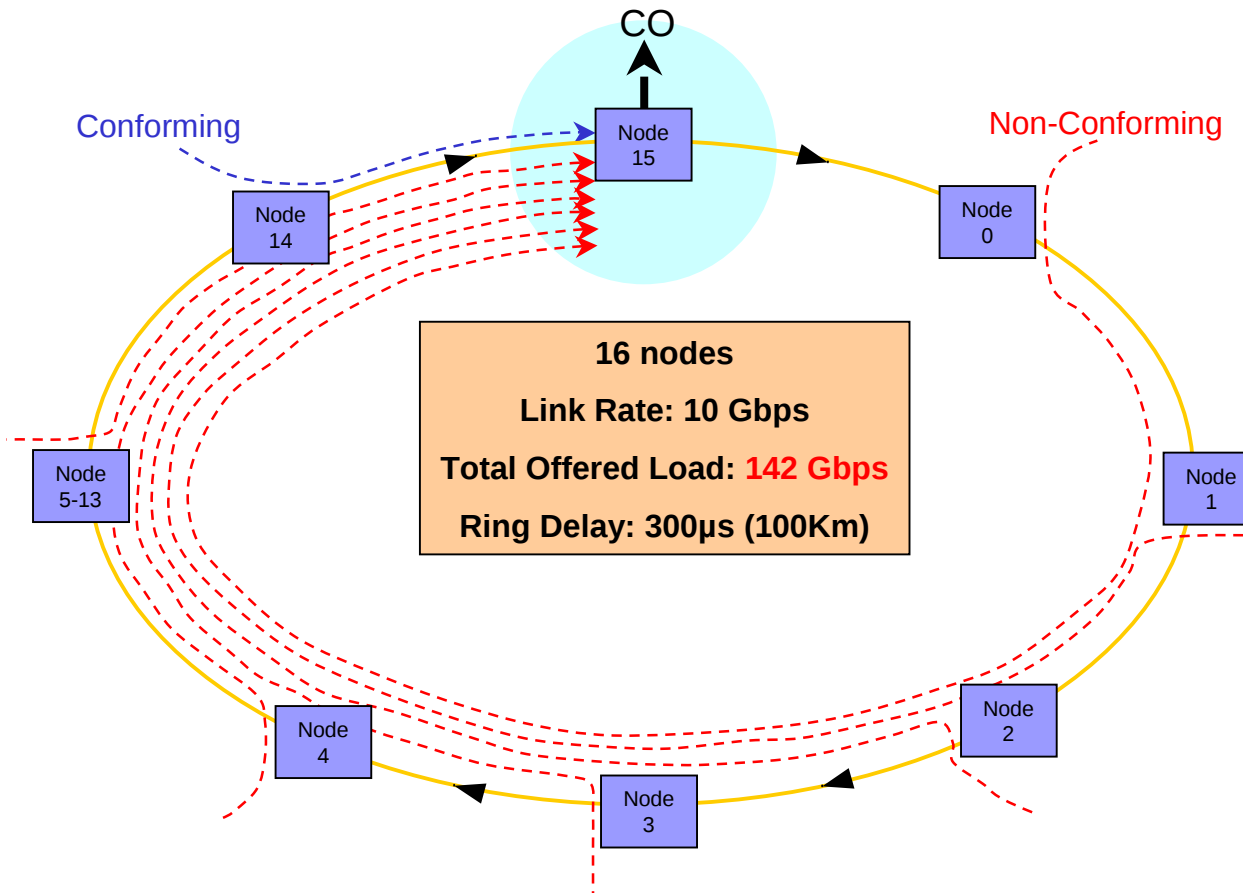
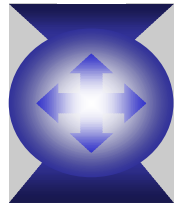


- ◆ Flow Control Concept
- ◆ Scenarios
  - 16 Node Hubbing
  - 128 Node Hubbing
  - 16 Node Switch-Over (Hubbing)
- ◆ Results
  - Bandwidth
  - Delay Characteristics
  - Fairness
  - Link Utilization

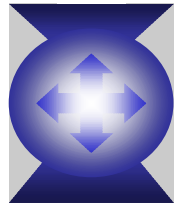
# Conceptual View of Flow Control



# 16 Node Hubbing



# Ingress Traffic Pattern

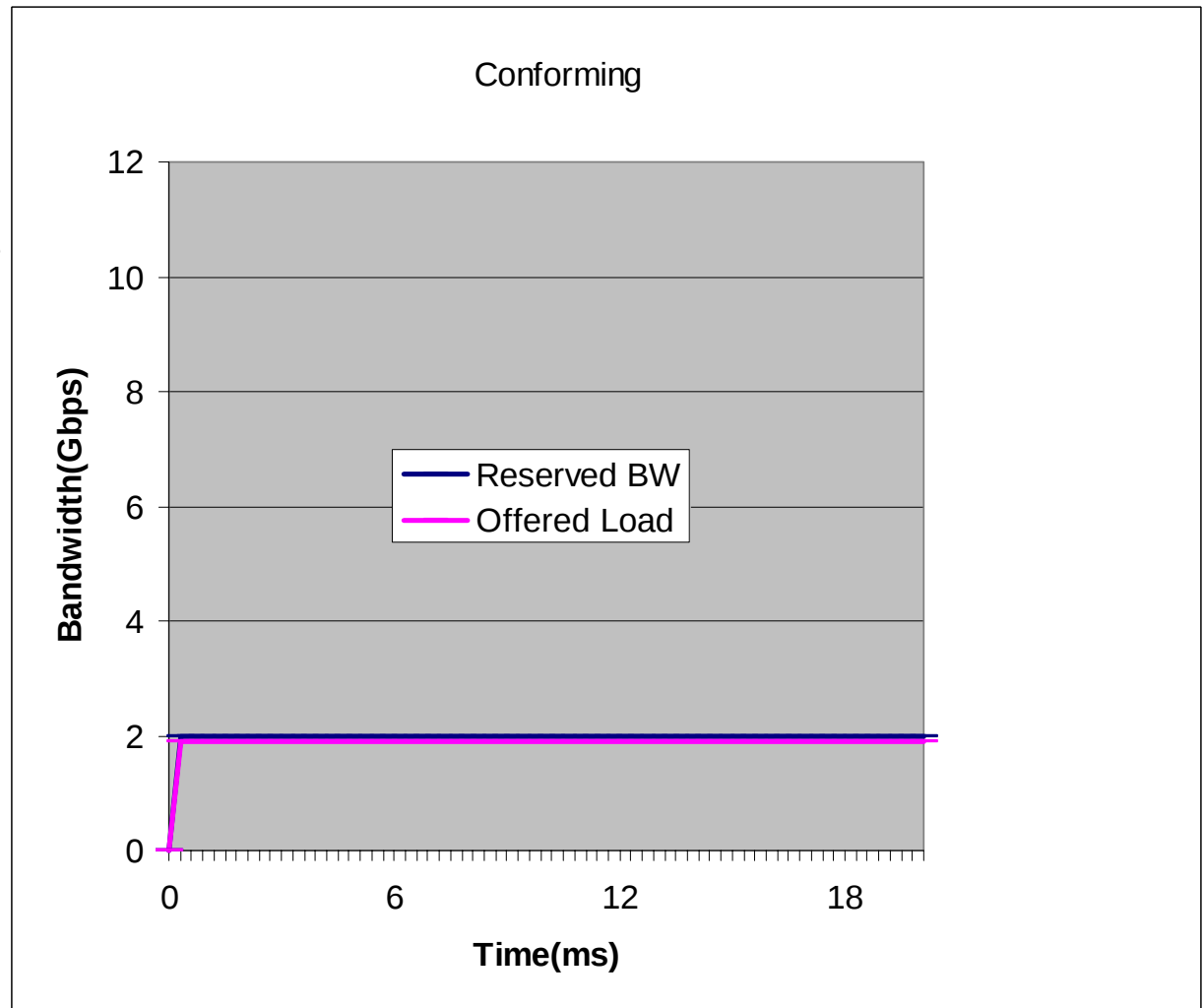


## ◆ Conforming

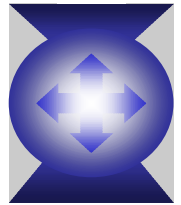
Node 14

Packet size: 1000 bytes

$r_i$ (Reserved Bandwidth): 2 Gbps



# Ingress Traffic Pattern



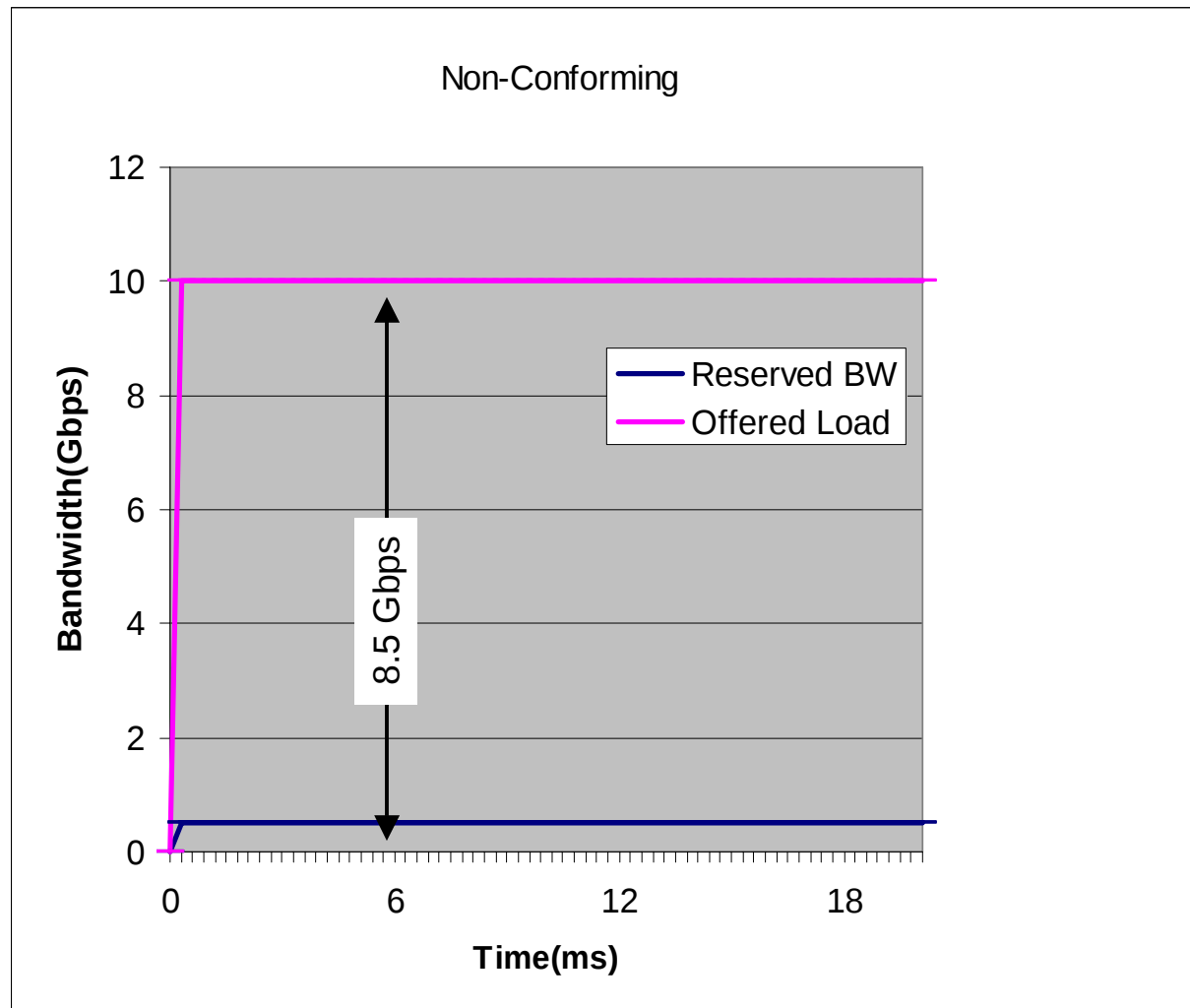
## ◆ Non-conforming

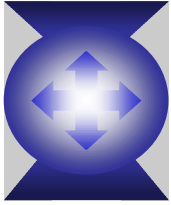
Nodes 0 - 13

Packet size: 1000 bytes

$r_i = 0.5$  Gbps

offered load = 10Gbps

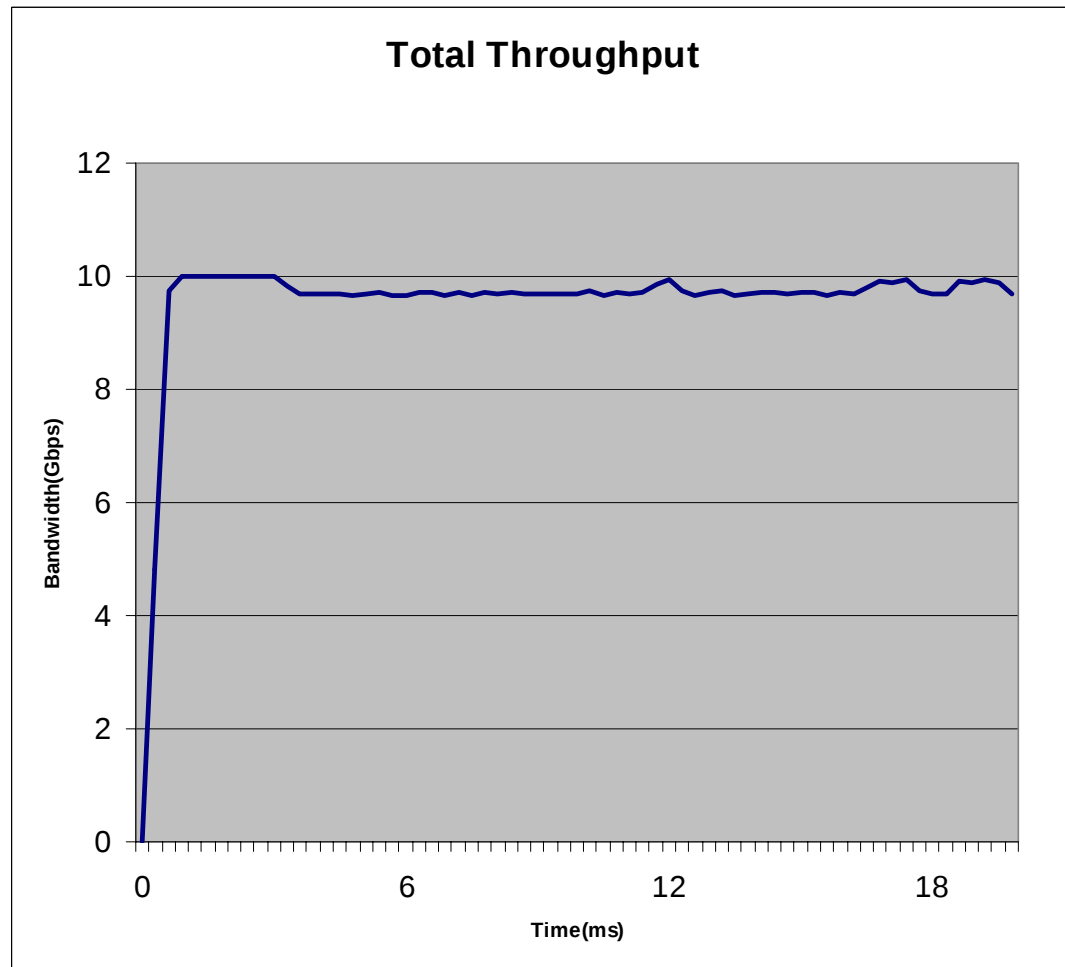
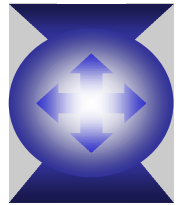




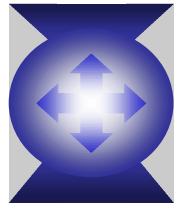
**LANTERN**  
COMMUNICATIONS

# RESULTS

# Link Utilization (last link)



# Bandwidth

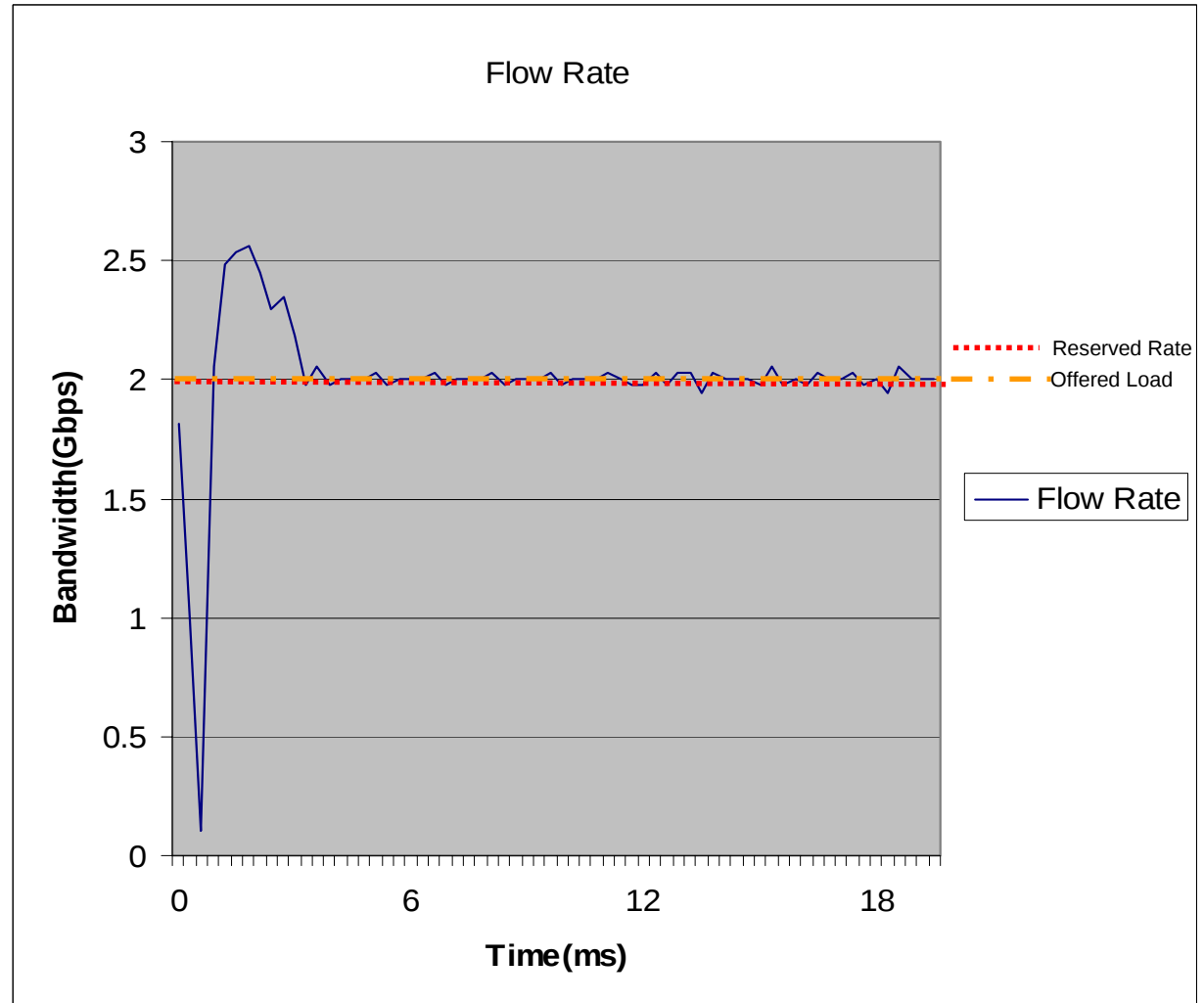


## ◆ Conforming

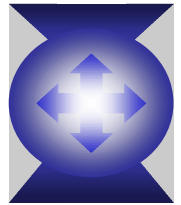
Node 14

Packet size: 1000 bytes

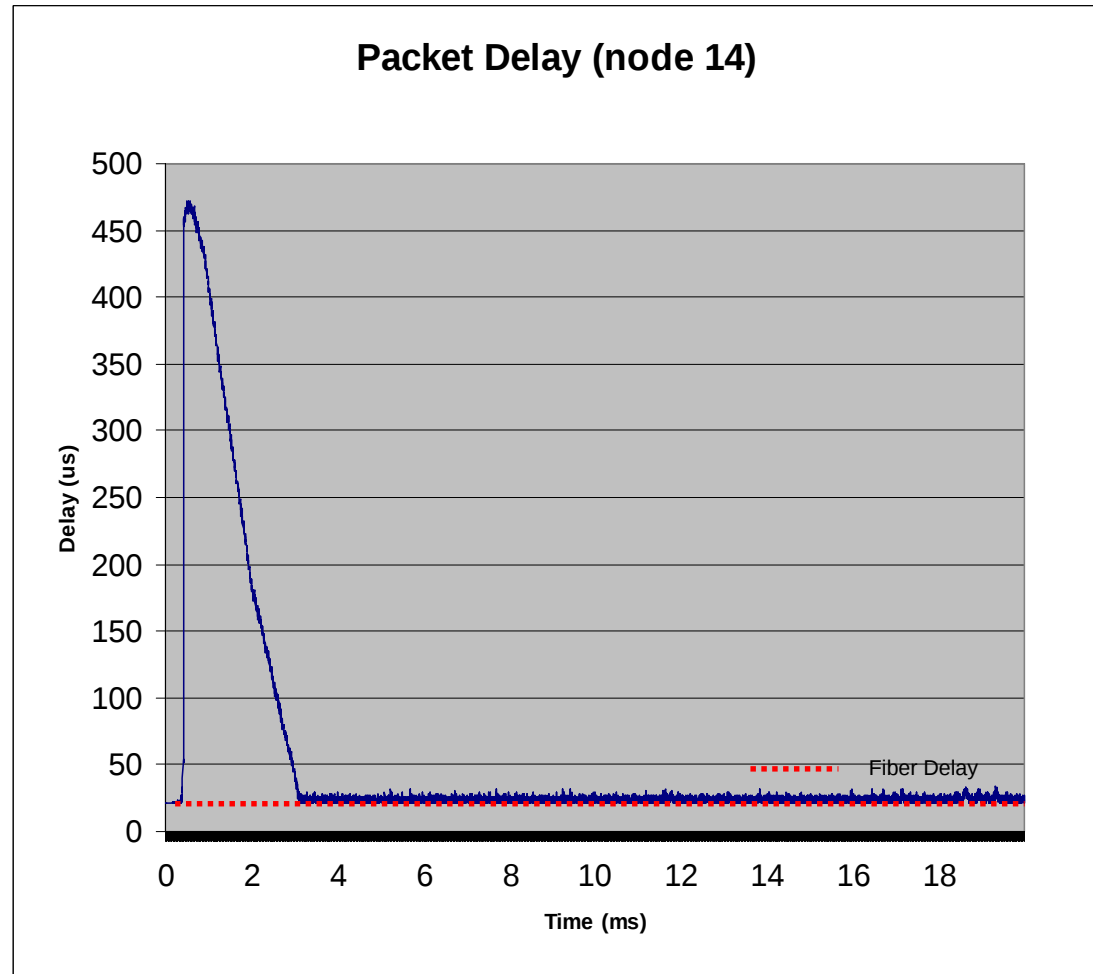
$r_i$  (Reserved Bandwidth): 2 Gbps



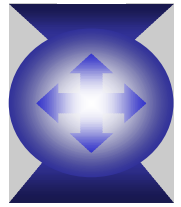
# Delay and Jitter



- ◆ Conforming

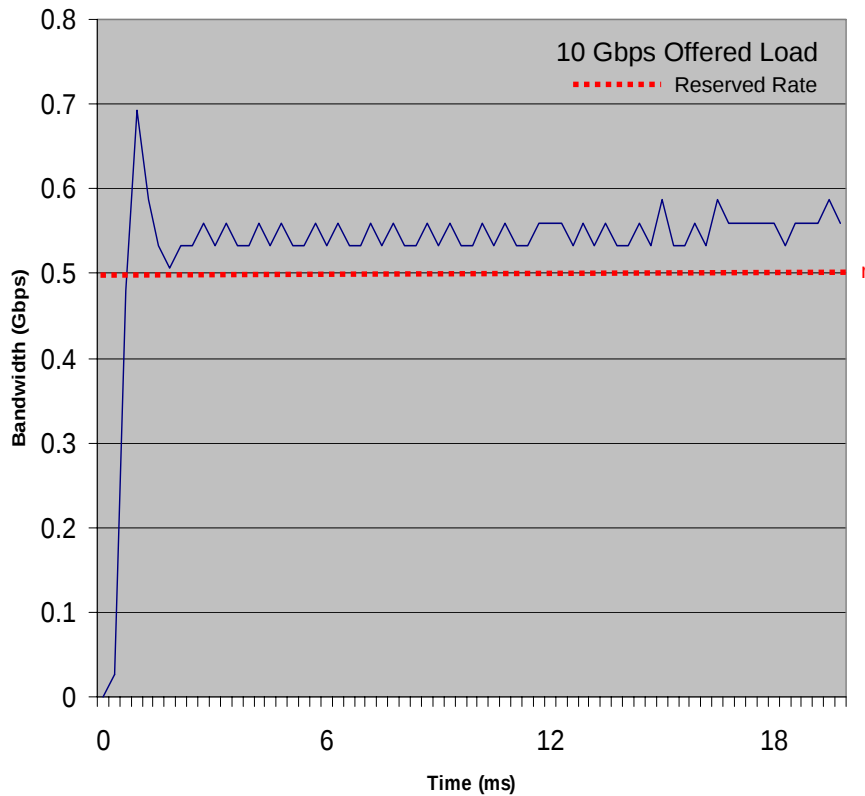


# Fairness

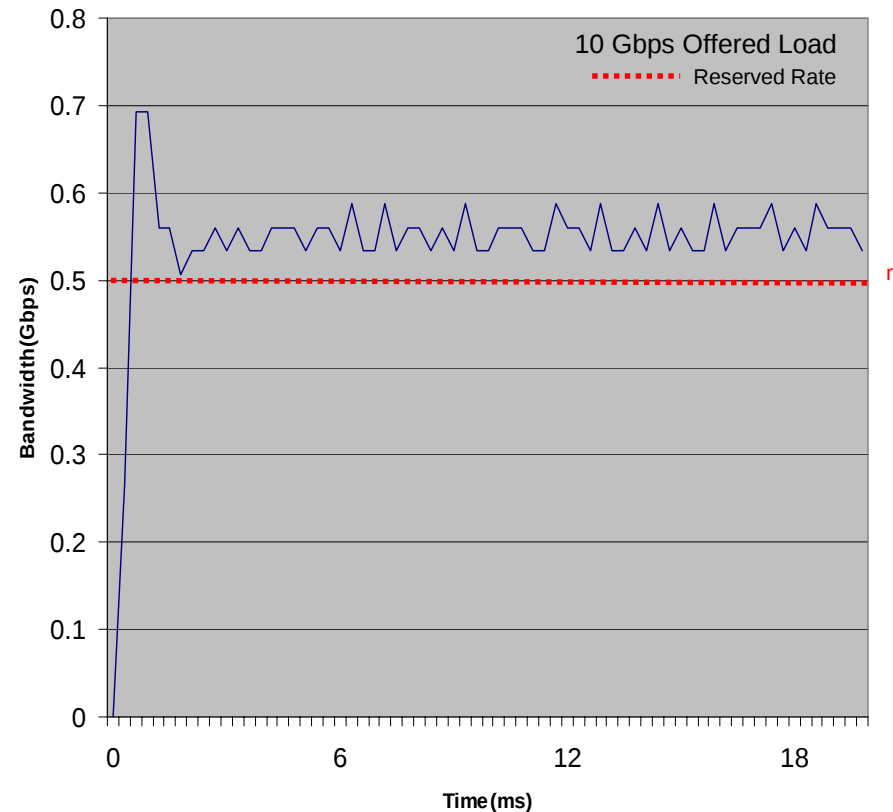


## ◆ Non-conforming (10 Gbps offered load/node)

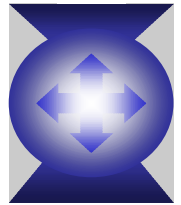
Throughput (Node 0)



Throughput (Node 8)

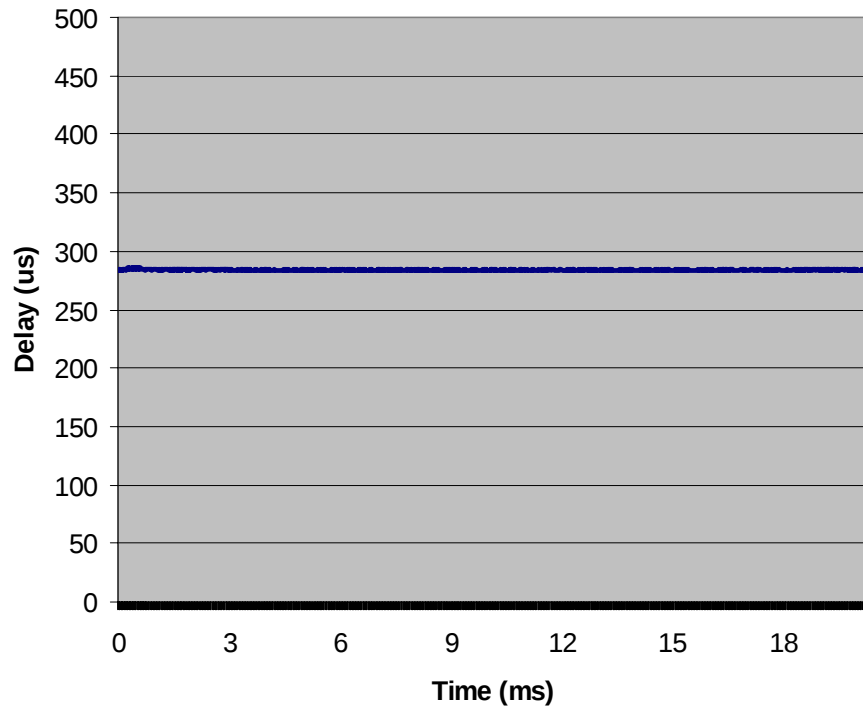


# Delay and Jitter

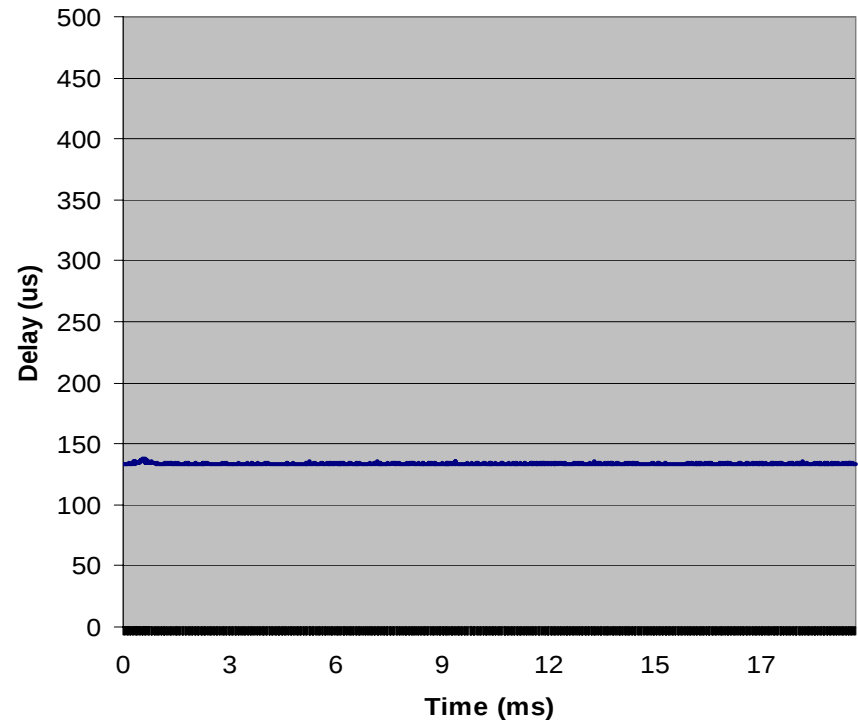


## ◆ Non-conforming

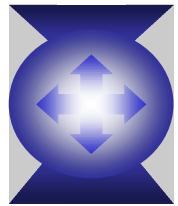
Packet Delay (Node 0)



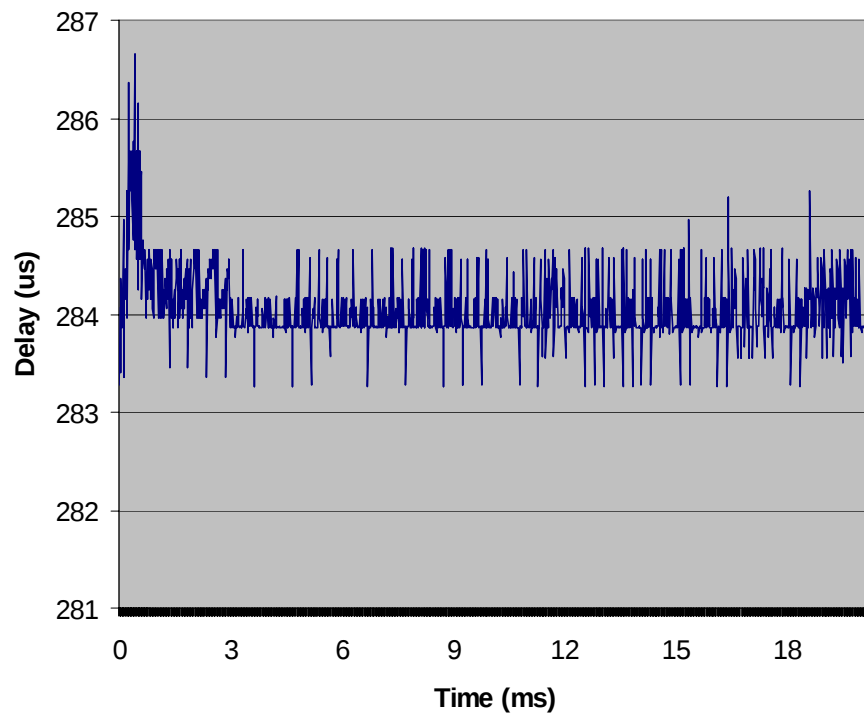
Packet Delay (Node 8)



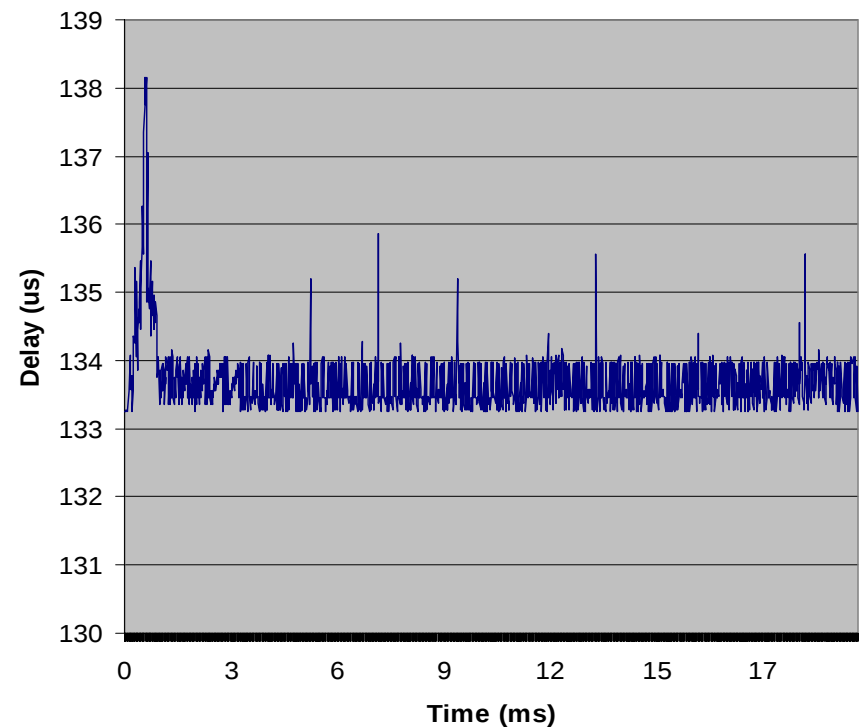
# Close-up



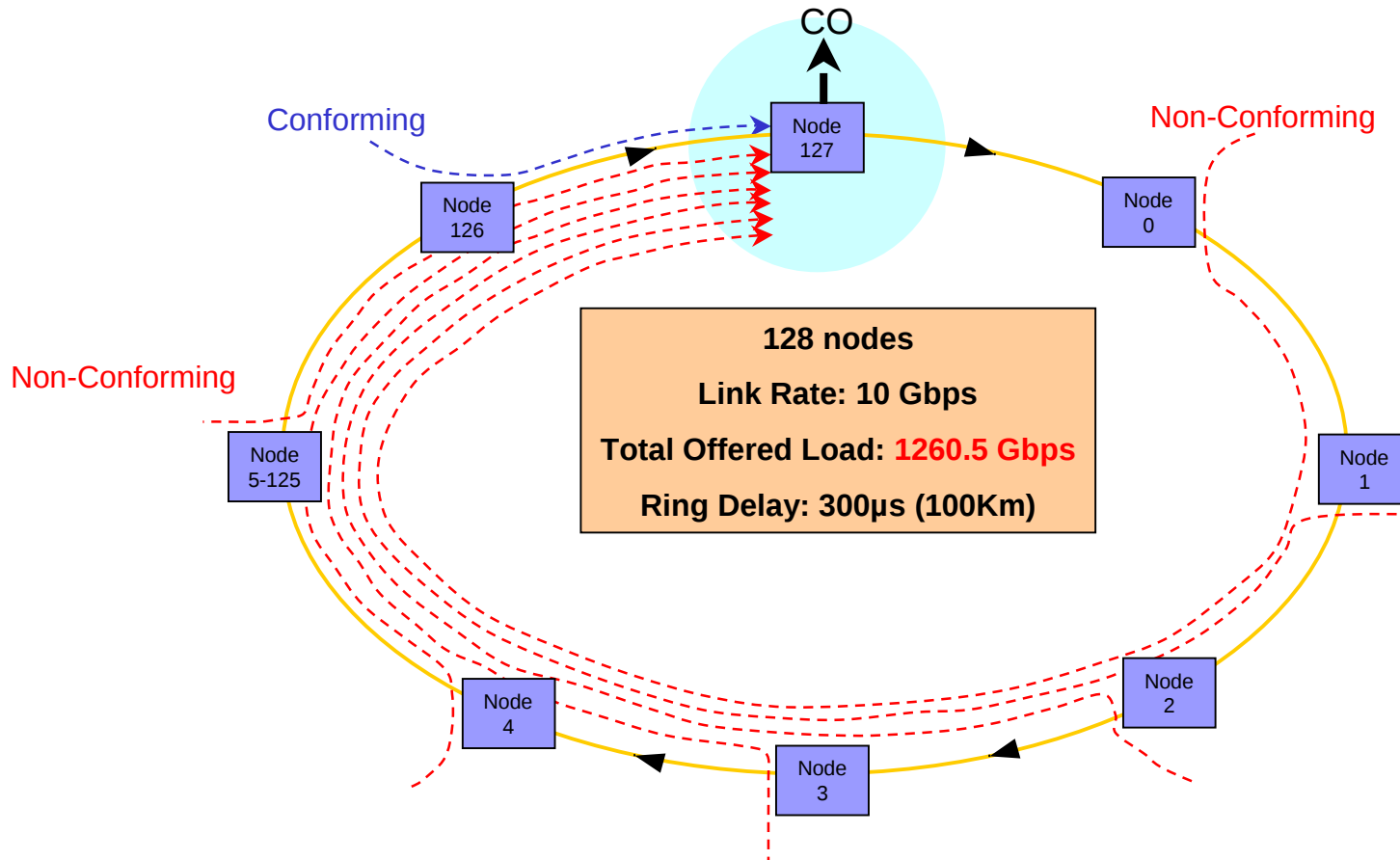
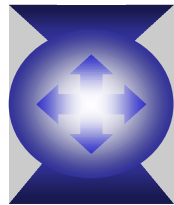
Packet Delay (Node 0)



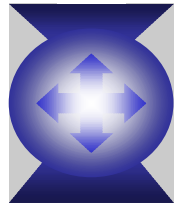
Packet Delay (Node 8)



# 128 Node Hubbing



# Link Utilization (last link)



## ◆ Non-conforming

Nodes 0 - 125

Packet size: 1000 bytes

$r_i = 0.06$  Gbps

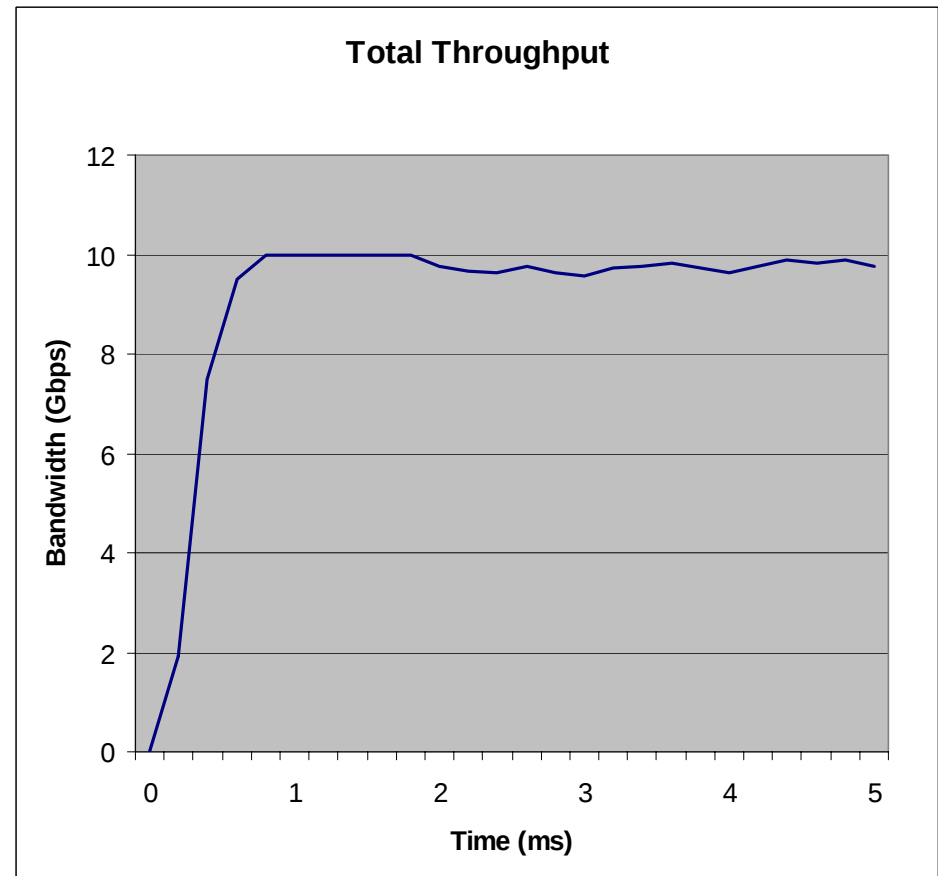
offered load = 10Gbps

## ◆ Conforming

Node 126

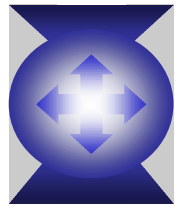
Packet size: 1000 bytes

$r_i$ (Reserved Bandwidth): 0.5 Gbps



# Bandwidth Guarantee

(128 nodes)

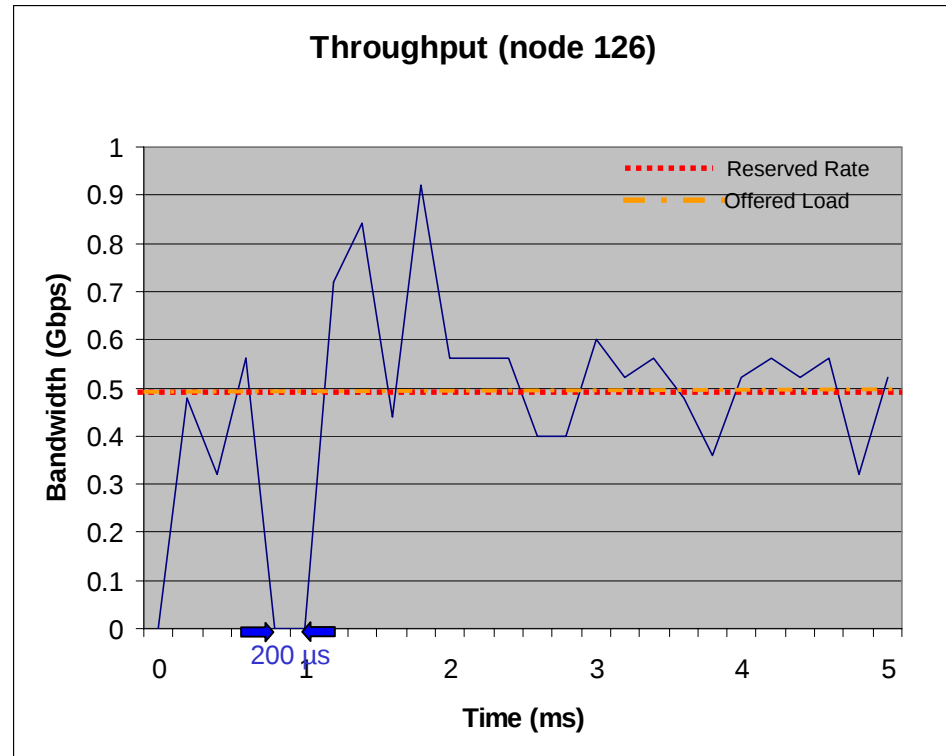


## ◆ Conforming

Node 126

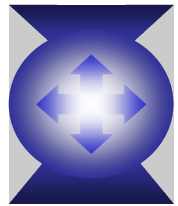
Packet size: 1000 bytes

$r_i$  (Reserved Bandwidth): 0.5 Gbps

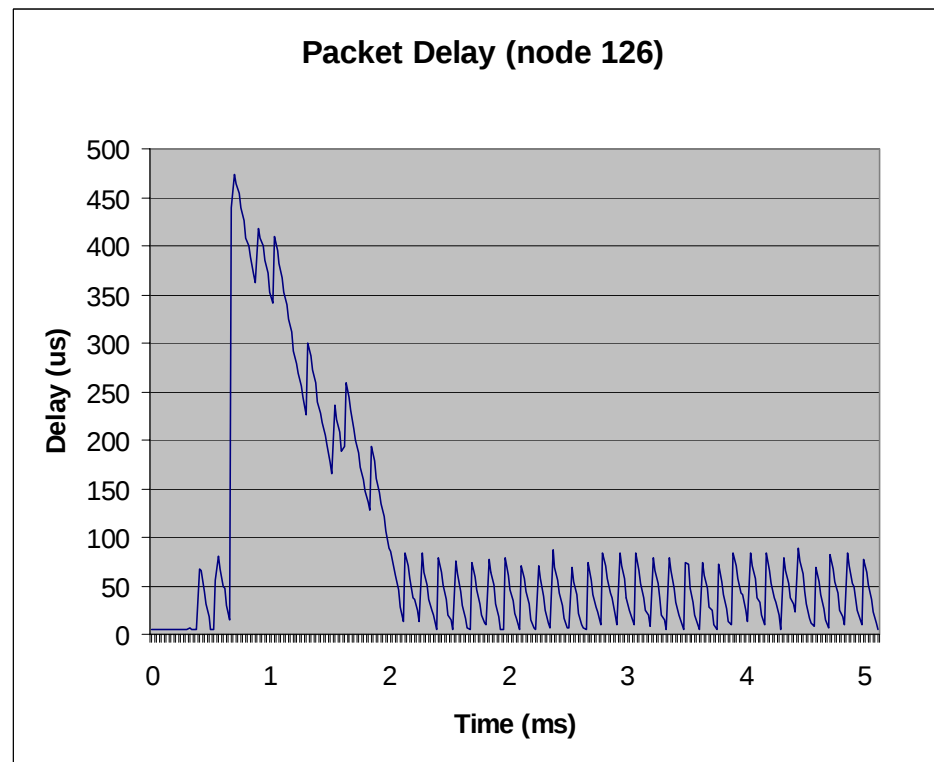


# Delay and Jitter

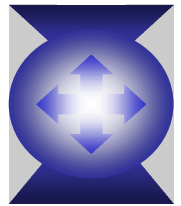
(128 nodes)



## ◆ Conforming

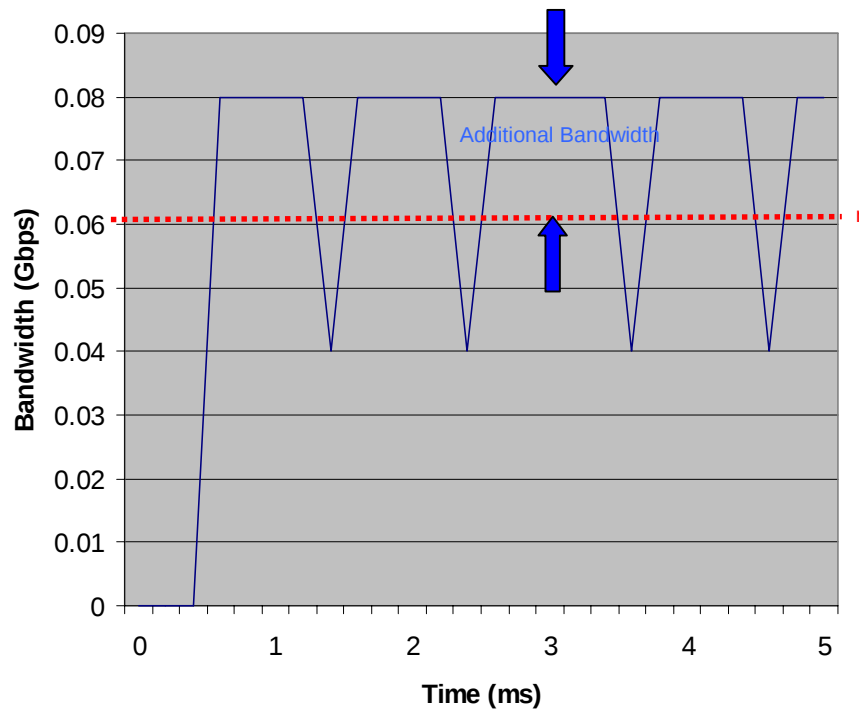


# Fairness

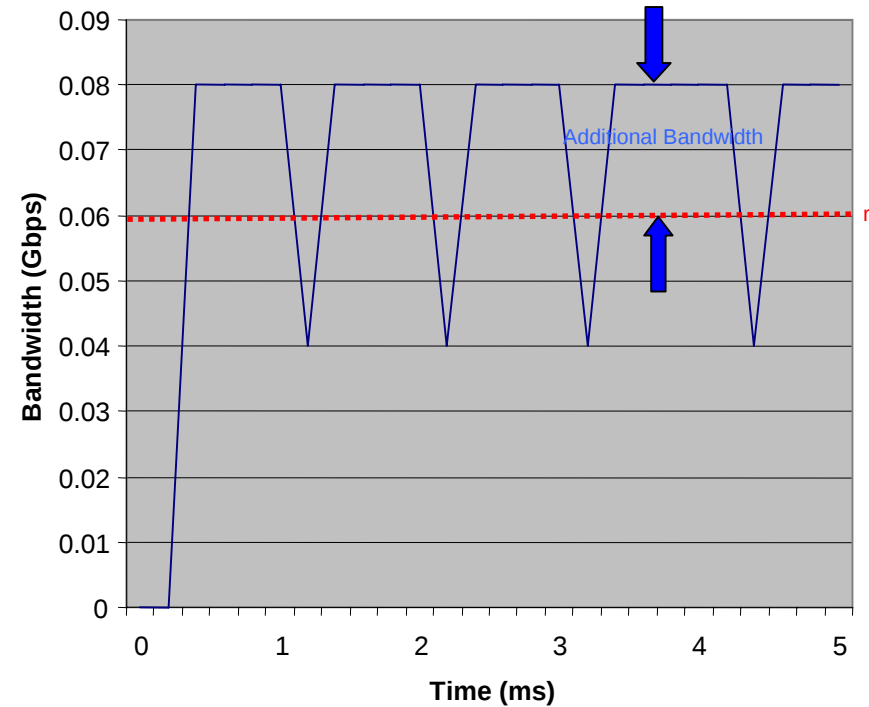


## Non Conforming

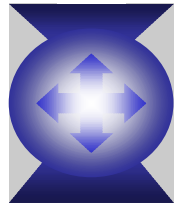
Throughput (node 0)



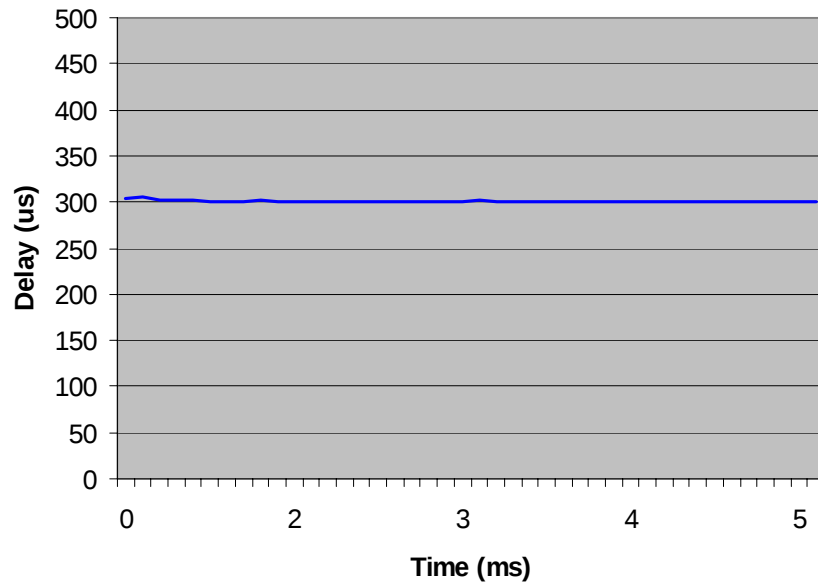
Throughput (node 64)



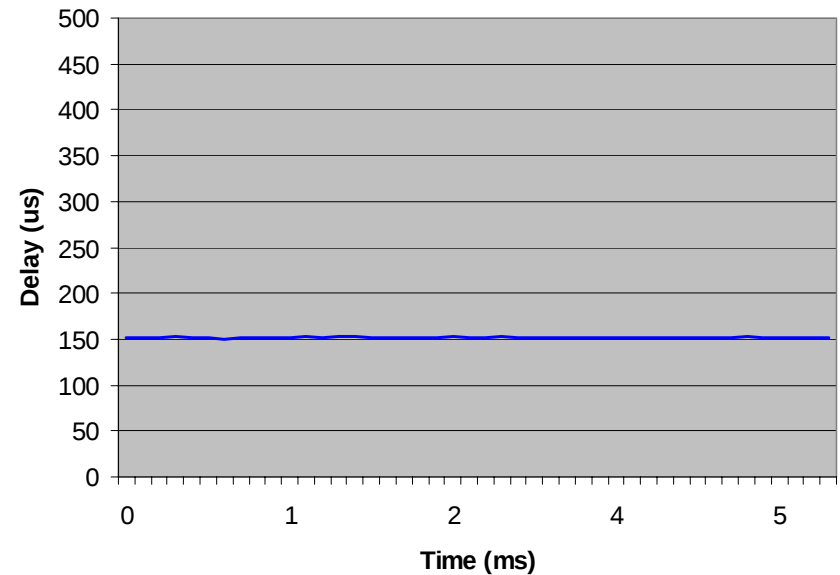
# Delay and Jitter



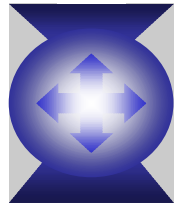
**Packet Delay (node 0)**



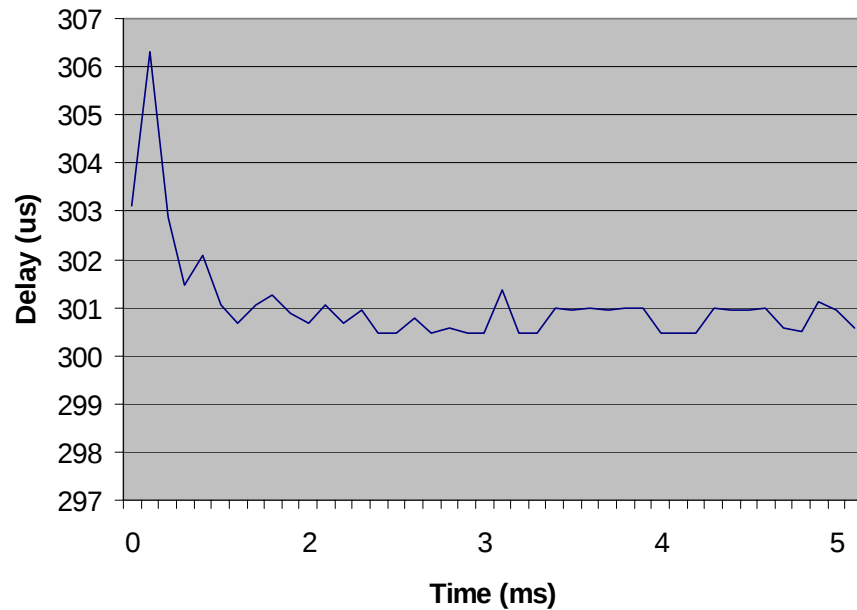
**Packet Delay (node 64)**



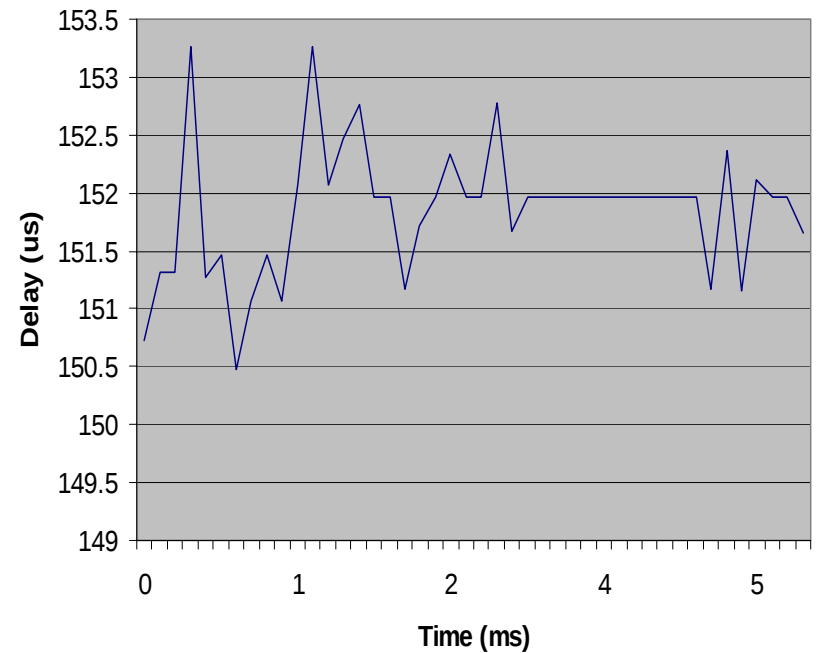
# Delay (close-up)



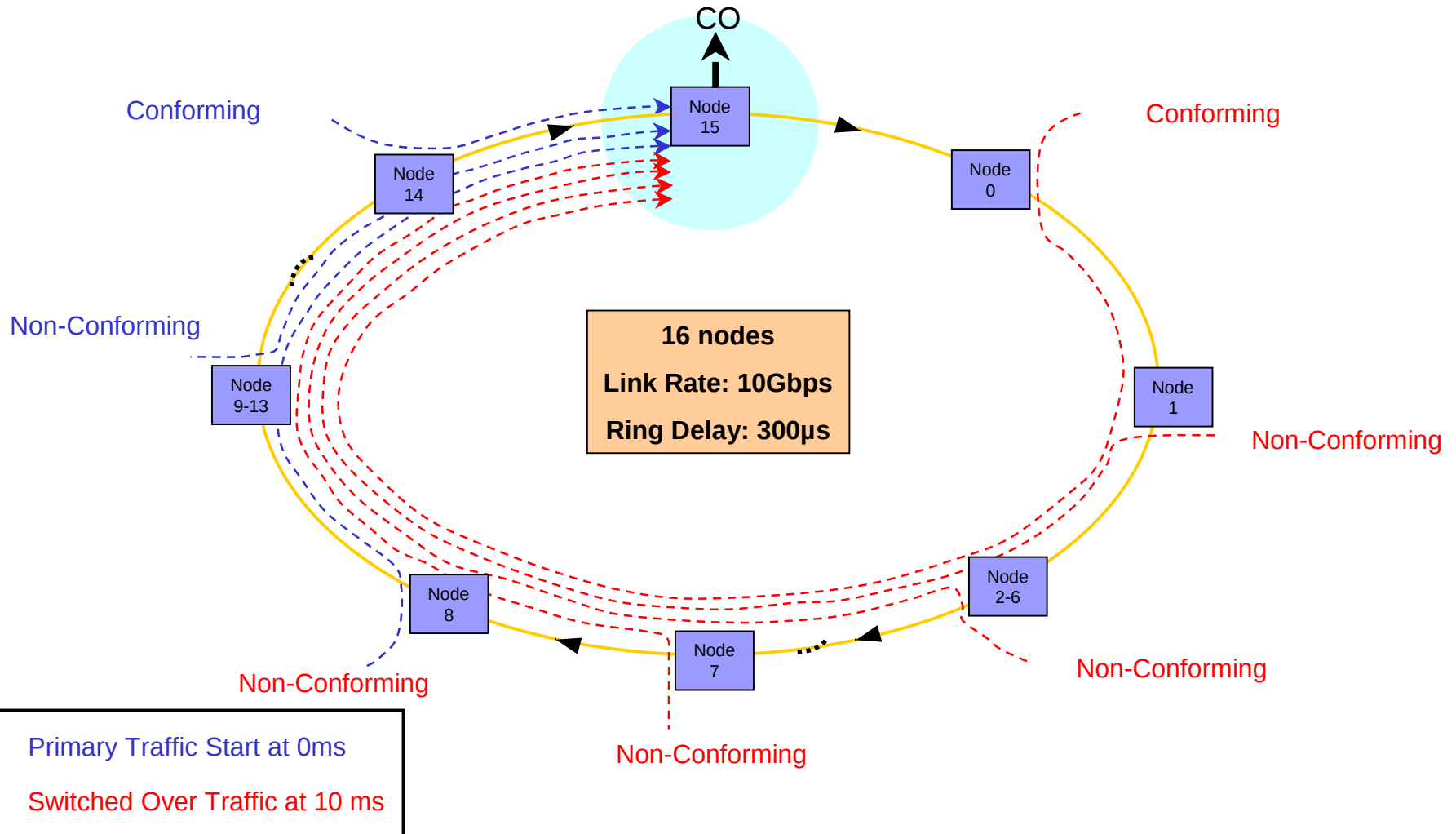
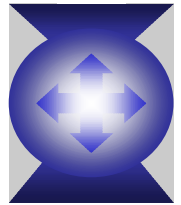
**Packet Delay (node 0)**



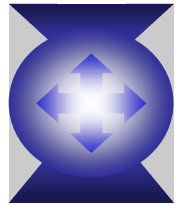
**Packet Delay (node 64)**



# Switch Over Case



# Traffic Pattern: Primary Traffic

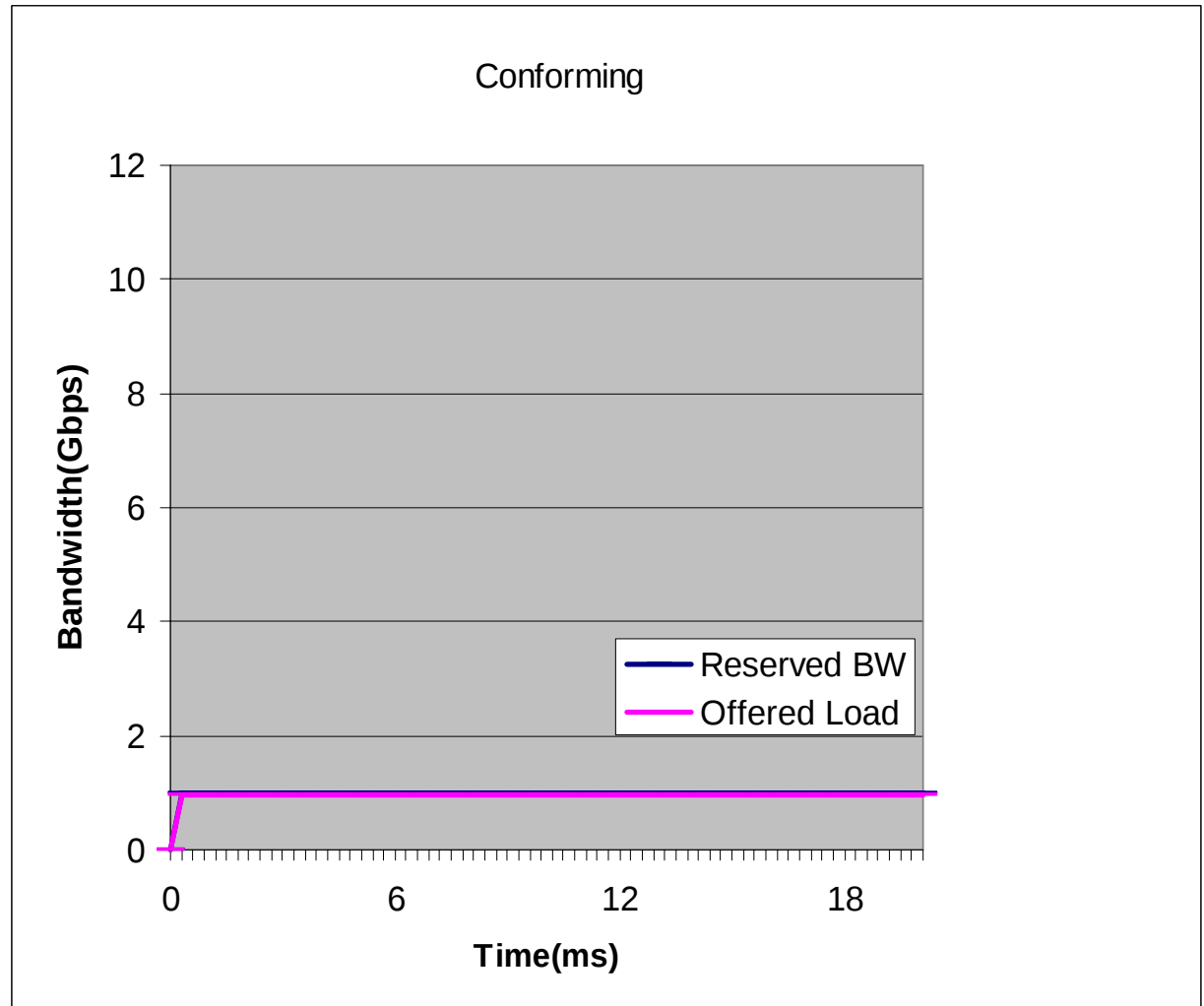


## ◆ Conforming

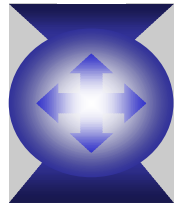
Node 14

Packet size: 1000 bytes

$r_i$ (Reserved Bandwidth): 1 Gbps



# Traffic Pattern: Primary Traffic

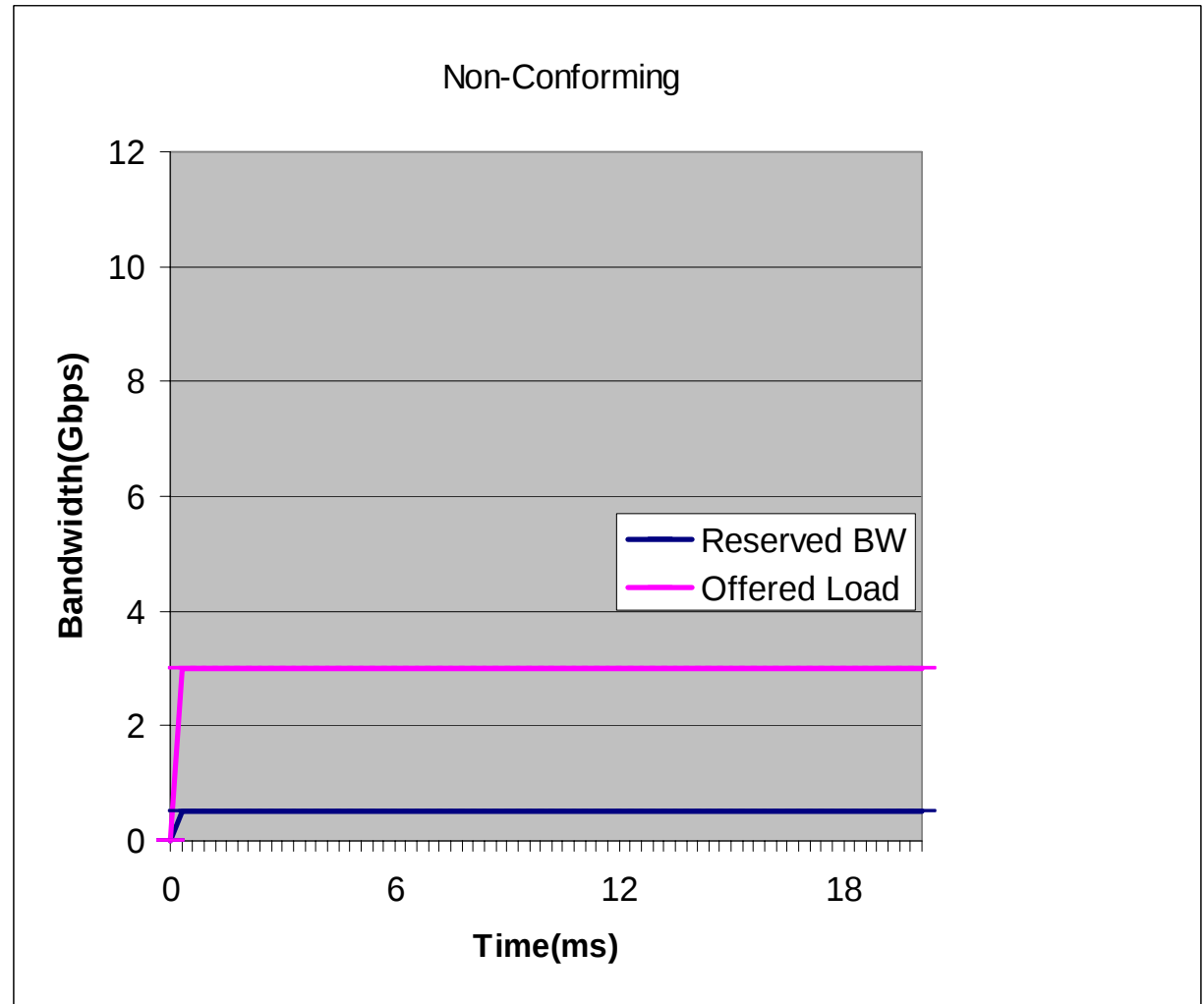


## ◆ Non-Conforming

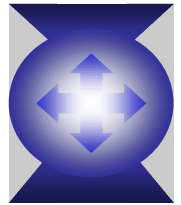
Node 8-13

Packet size: 1000 bytes

$r_i$  (Reserved Bandwidth): 0.5 Gbps



# Traffic Pattern:SW Traffic

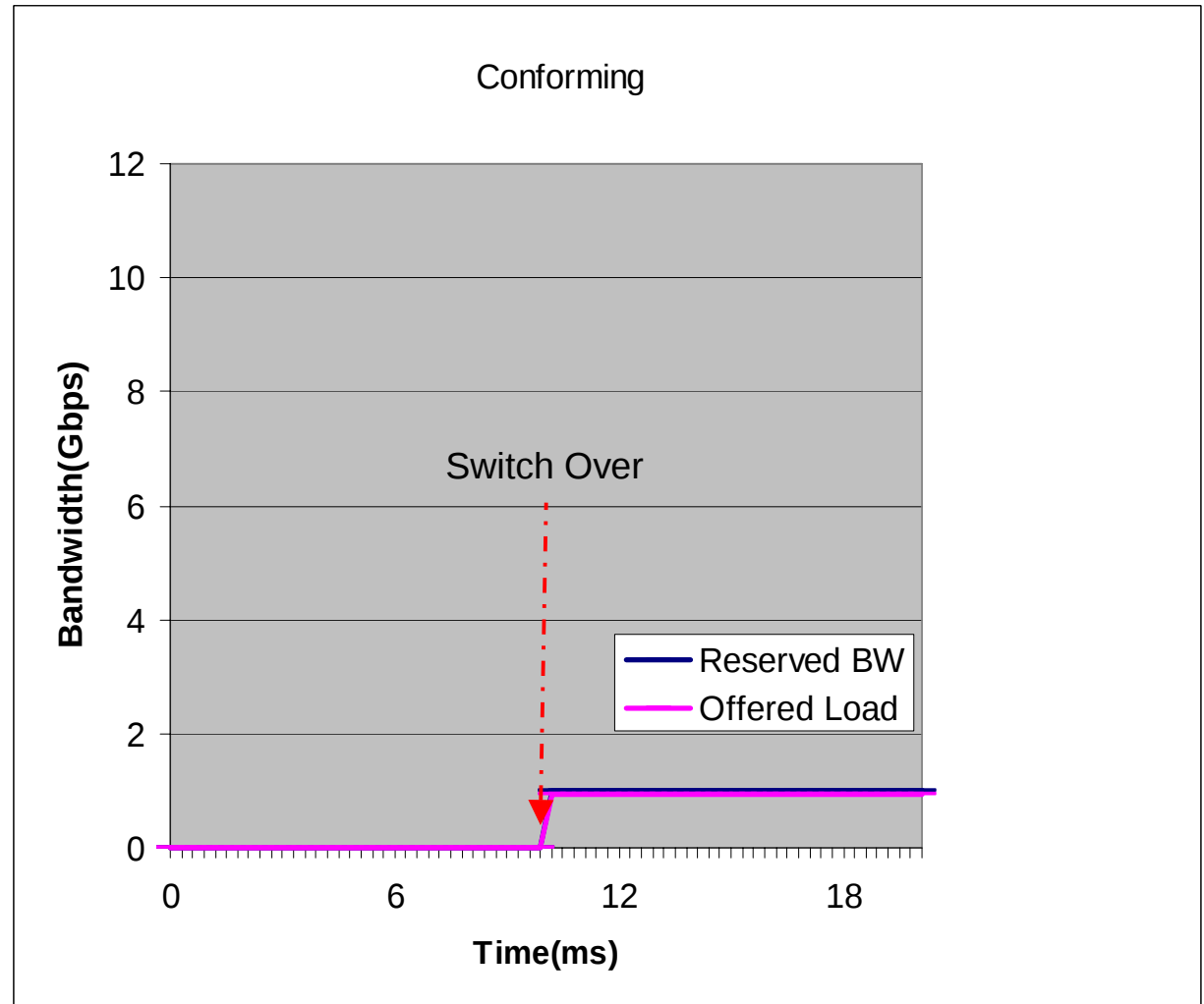


## ◆ Conforming

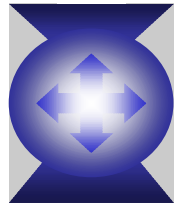
Node 14

Packet size: 1000 bytes

$r_i$ (Reserved Bandwidth): 1 Gbps



# Traffic Pattern: Switched Over Traffic



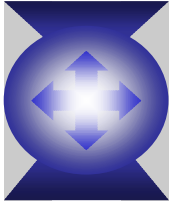
## ◆ Non-Conforming

Node 1-7

Packet size: 1000 bytes

$r_i$  (Reserved Bandwidth): 0.5 Gbps

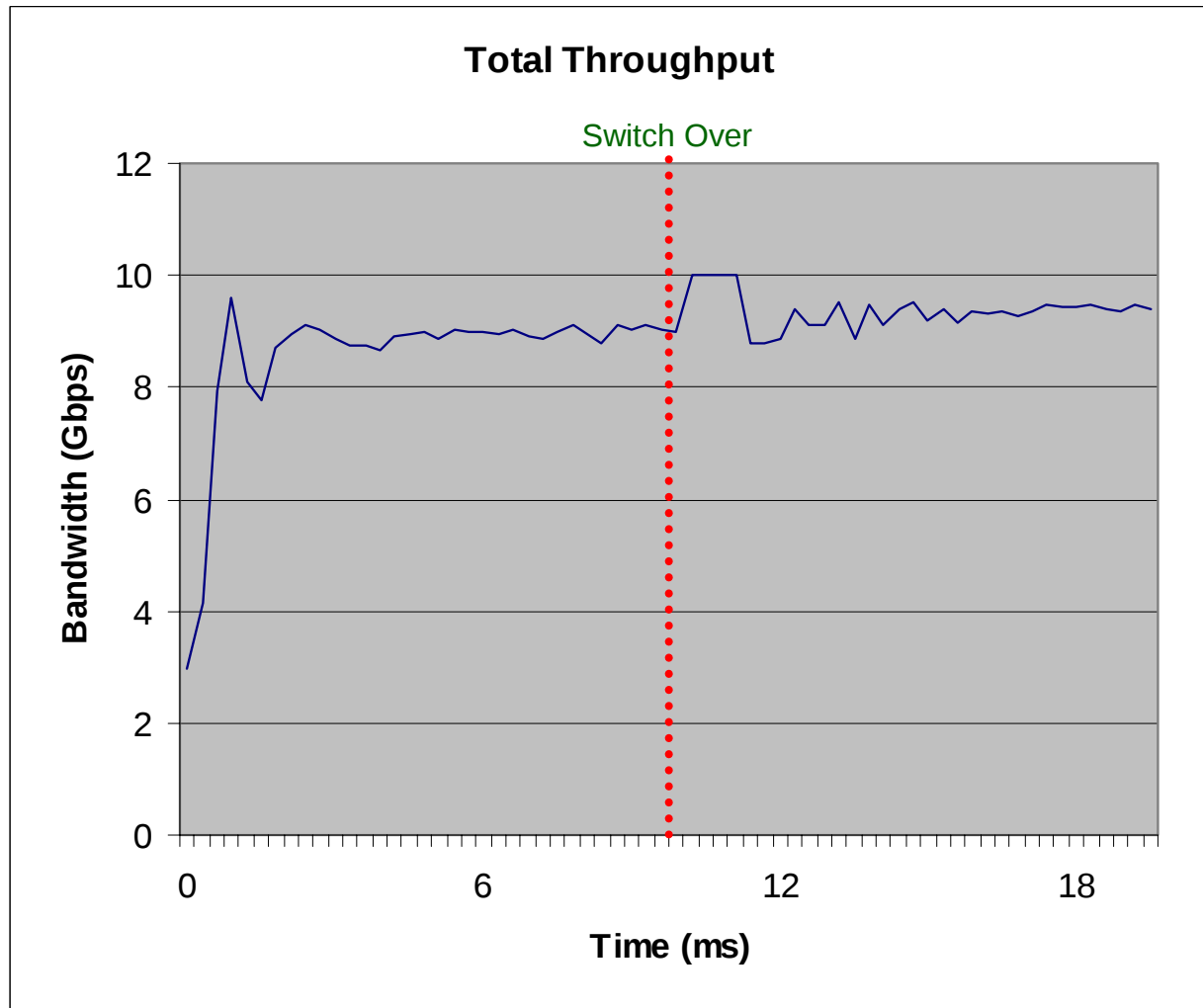
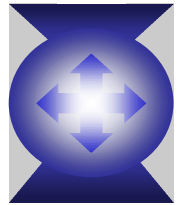




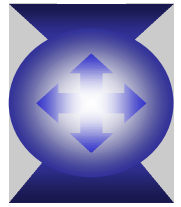
**LANTERN**  
COMMUNICATIONS

# RESULTS

# Link Utilization (last link)



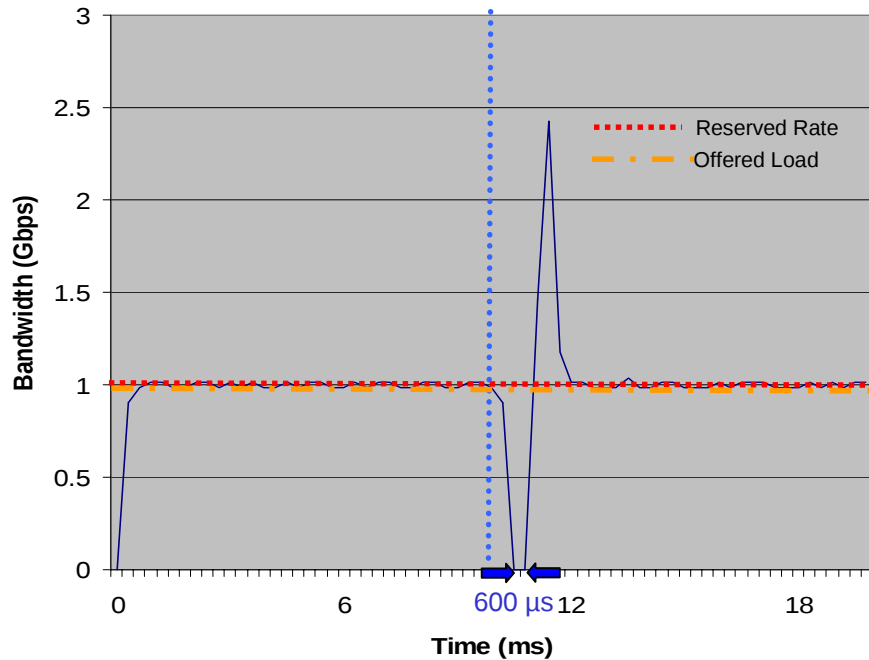
# Bandwidth



## ◆ Conforming

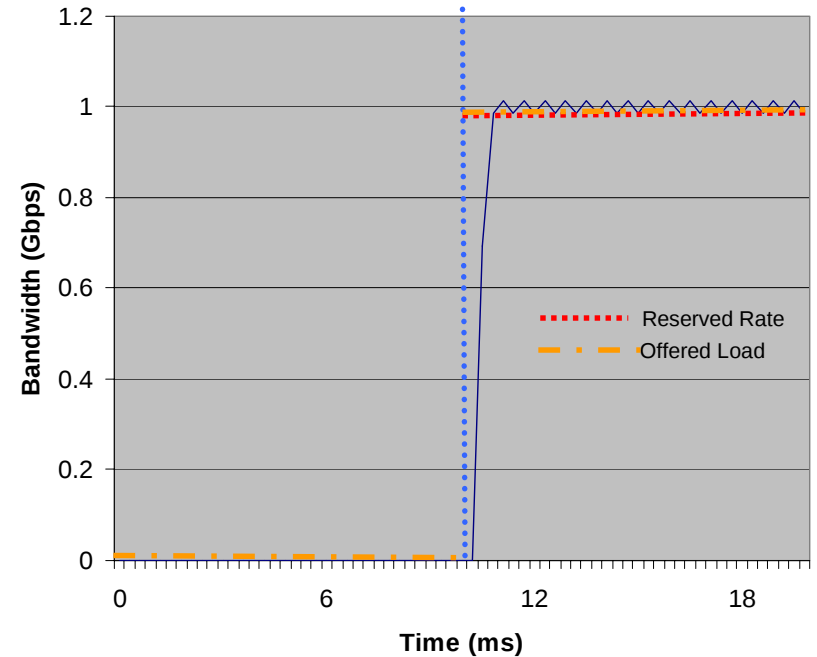
Throughput (node 14)

Switch Over

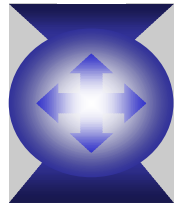


Throughput (node 0)

Switch Over

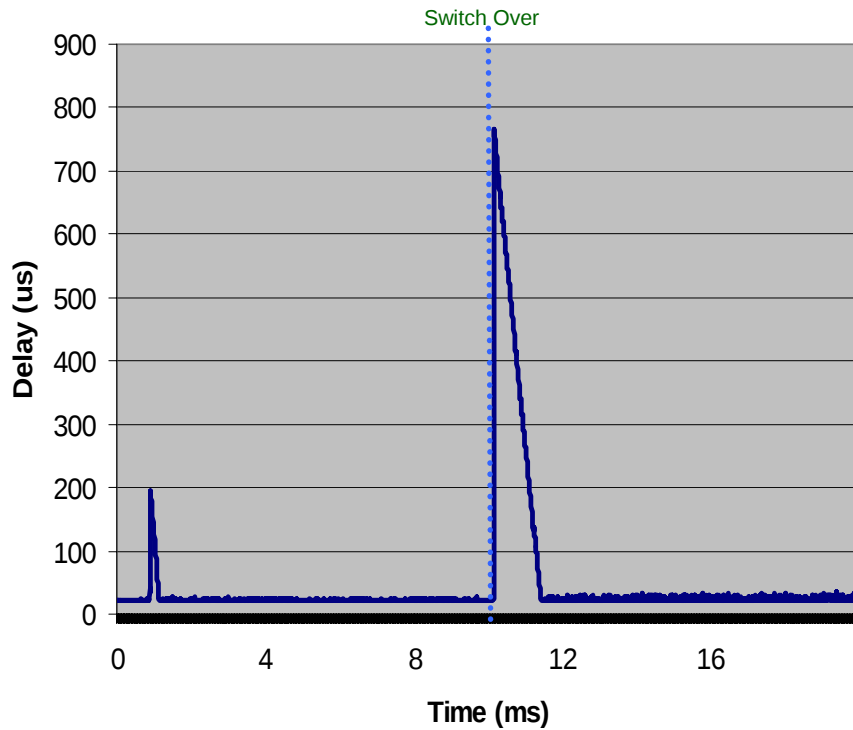


# Delay and Jitter

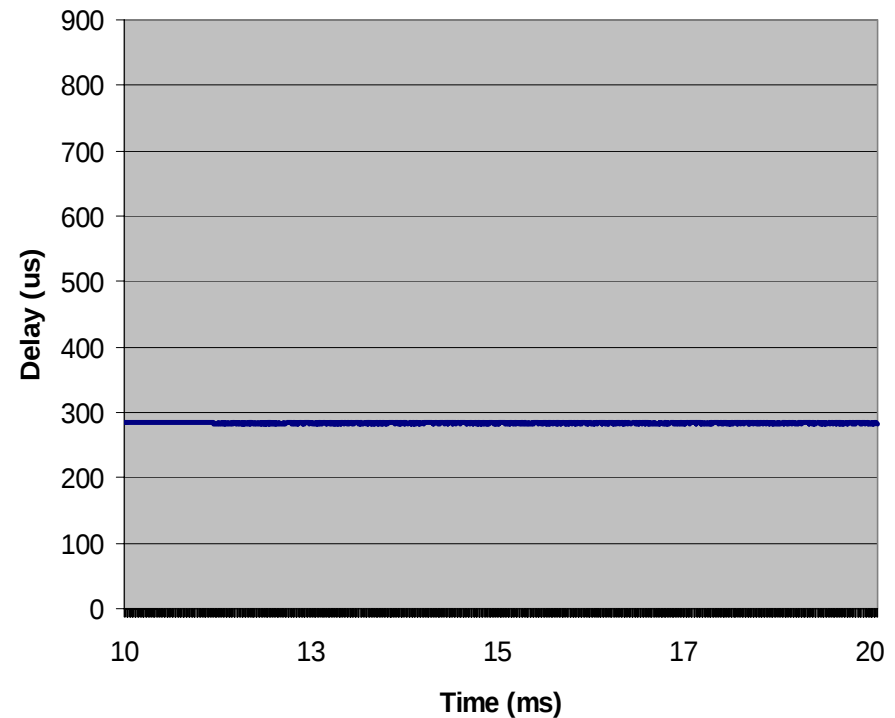


## ◆ Conforming

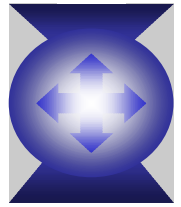
Packet Delay (node 14)



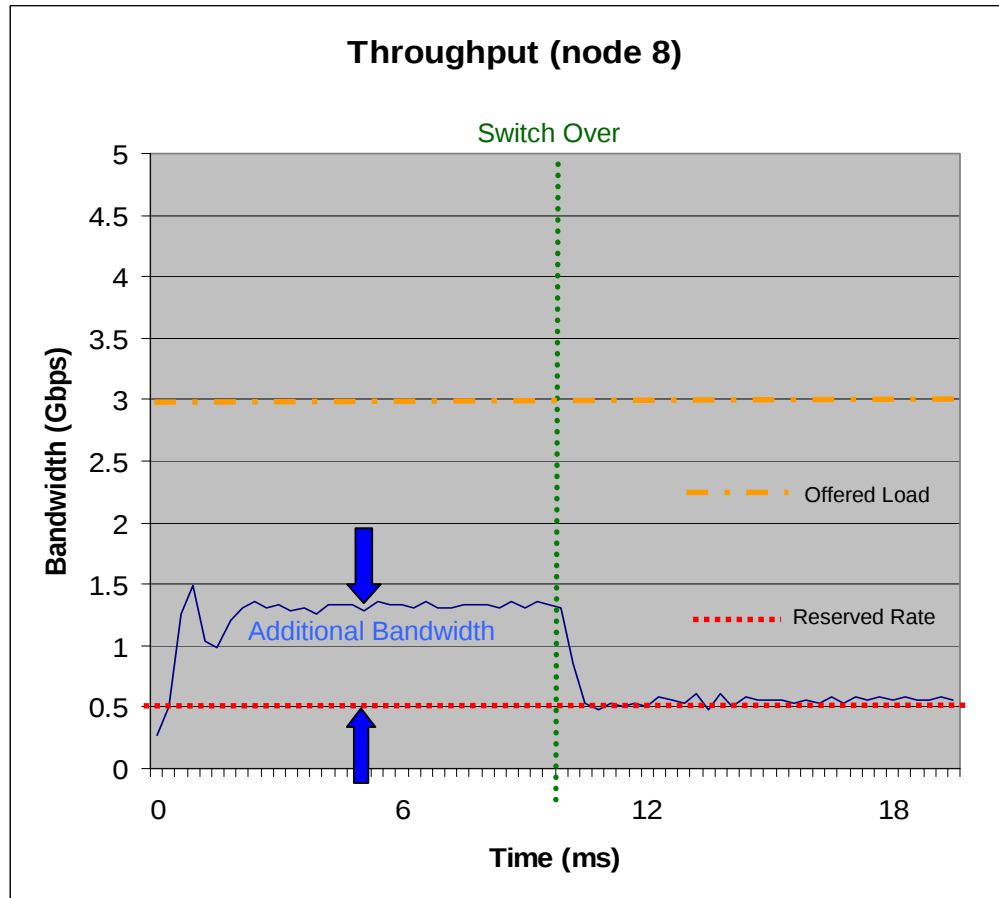
Packet Delay (node 0)



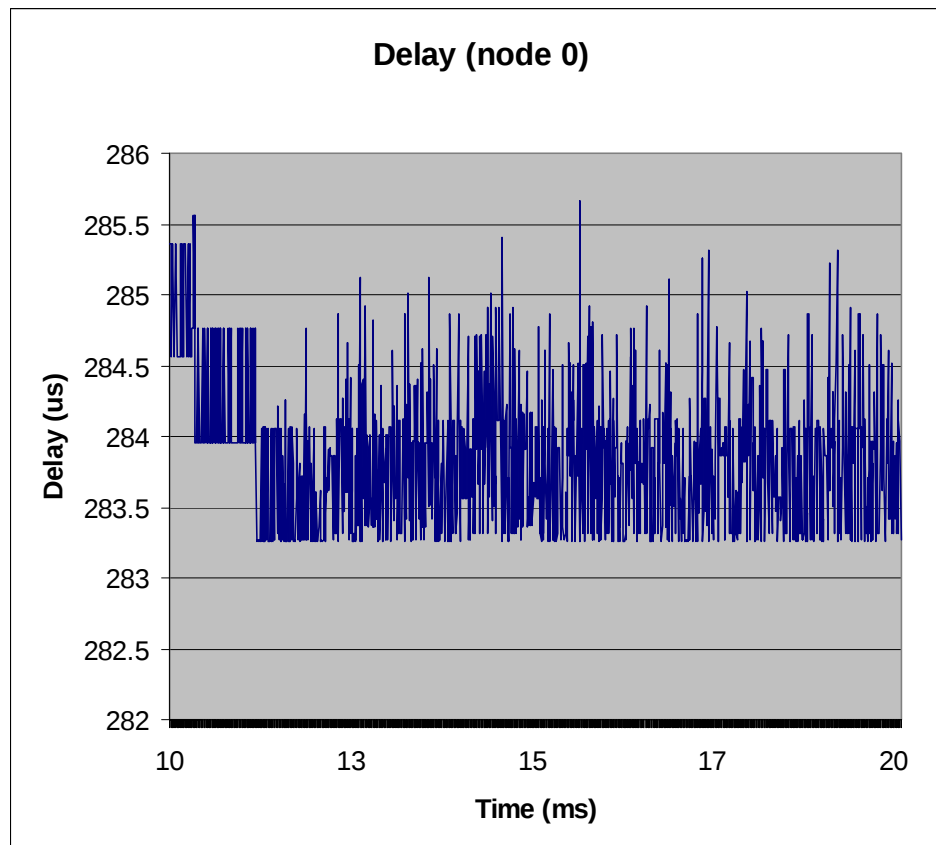
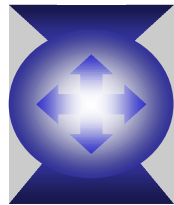
# BW Re-allocation



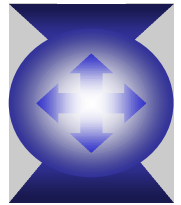
- ◆ Non-conforming



# Delay (close-up)

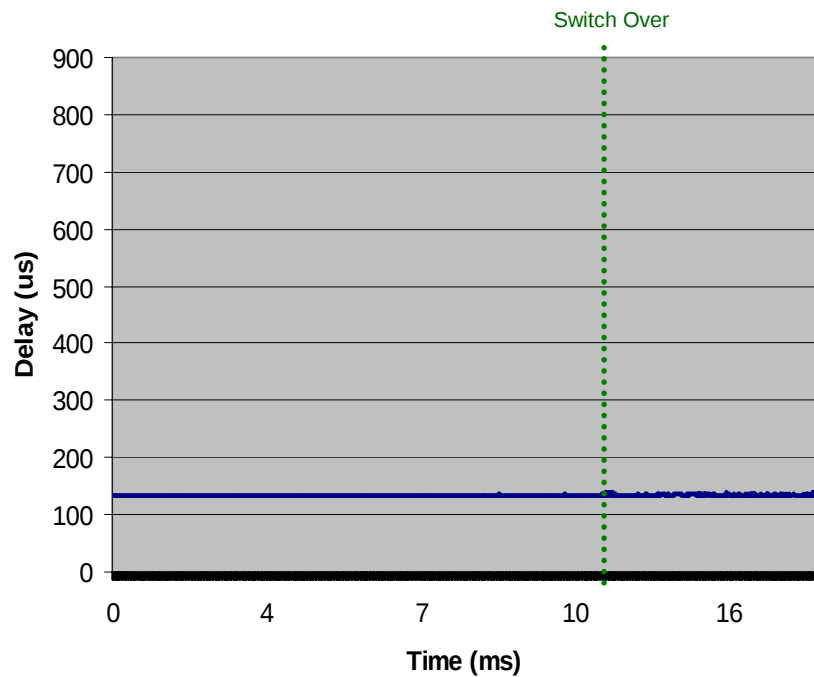


# Delay and Jitter



## ◆ Non-conforming

Packet Delay (node 8)



Packet Delay (node 8)

