

LANTERN
COMMUNICATIONS

Dynamic Bandwidth Control

IEEE 802.17

March 12-15, 2001

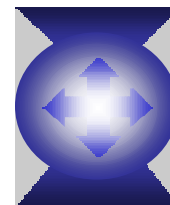
Nader Vije

nader@lanterncom.com

Adisak Mekkittikul

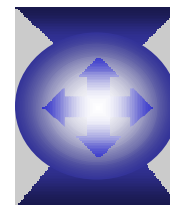
adisak@lanterncom.com

Features



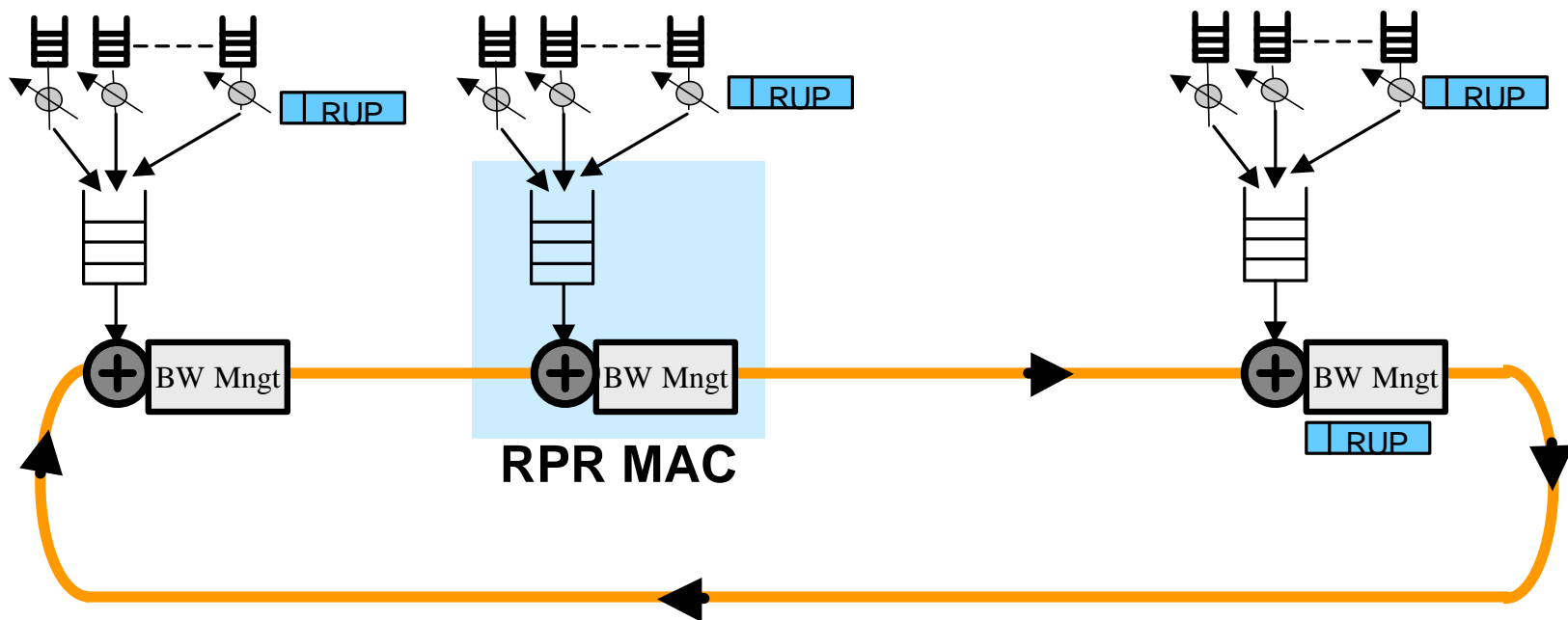
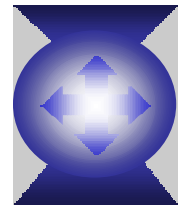
- ◆ WFQ Model of bandwidth allocation
- ◆ Support per-SLA QoS guarantee
- ◆ No upstream unfairness (BW, delay, Jitter)
- ◆ High utilization (> 95% per link)
- ◆ 100% spatial reuse
- ◆ Scalable (#nodes, #rings, # customers)
- ◆ Simple and **robust** (aggregate) congestion control signaling

A Few Useful Data Points

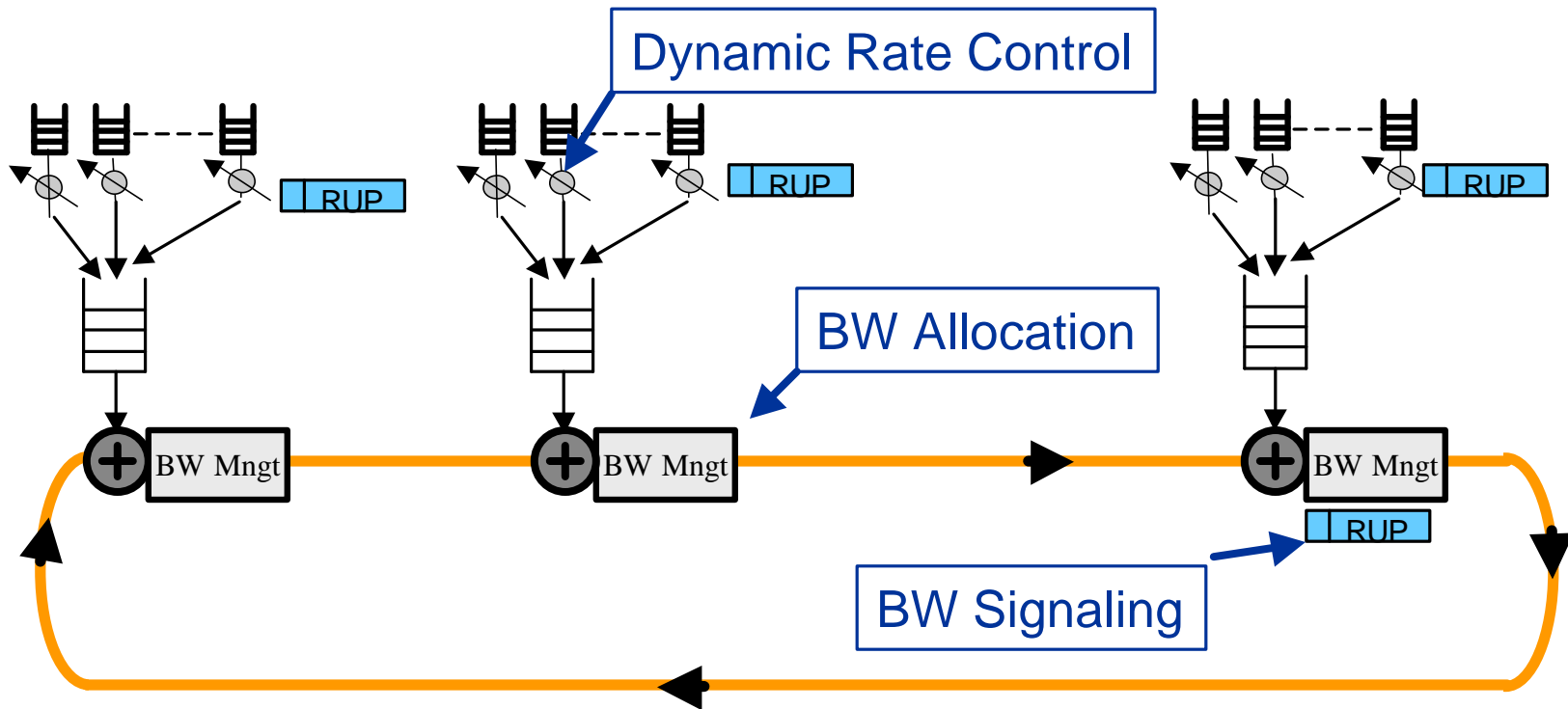
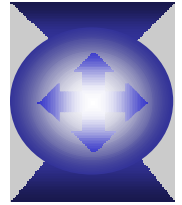


- ◆ Fiber Propagation Delay (free-space)
 - 100kM → 0.33 ms
 - 1000kM → 3.3 ms
- ◆ Store-Forward Delay (Jitter)
 - 1500 Bytes @ 10G → 1.2 us/node; 256 nodes → 0.3 ms
 - 1500 Bytes @ OC12 → 19.2 us/node; 256 nodes → 4.9 ms
 - 1500*100 Bytes @ OC12 → 1.92 ms/node; 256 nodes → 490 ms
 - 1500*1000 Bytes @ OC12 → 19.2 ms/node; 16 nodes → 307 ms
- ◆ Worst Case Ring Delay (In-flight Packets)
 - Total delay = Fiber + nodal + access (insert)

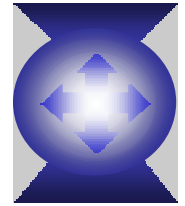
High-Level System Overview



Ring Access Control Overview



BW Management:(BW Allocation)



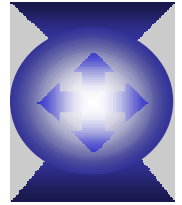
- ◆ Per-SLA BW allocation scheme

$$f_i = r_i + w_i \frac{(C - \sum_{active} r_i)}{\sum_{active} w_i}$$

- ◆ BW allocation Factor (BAF)

$$BAF = \frac{(C - \sum_{active} r_i)}{\sum_{active} w_i}$$

Dynamic Rate Control



- ◆ Satisfy global fairness and fit the link capacity

$$insert_rate = \min(f_j) \Rightarrow \min_{src \rightarrow dest} (BAF_j)$$

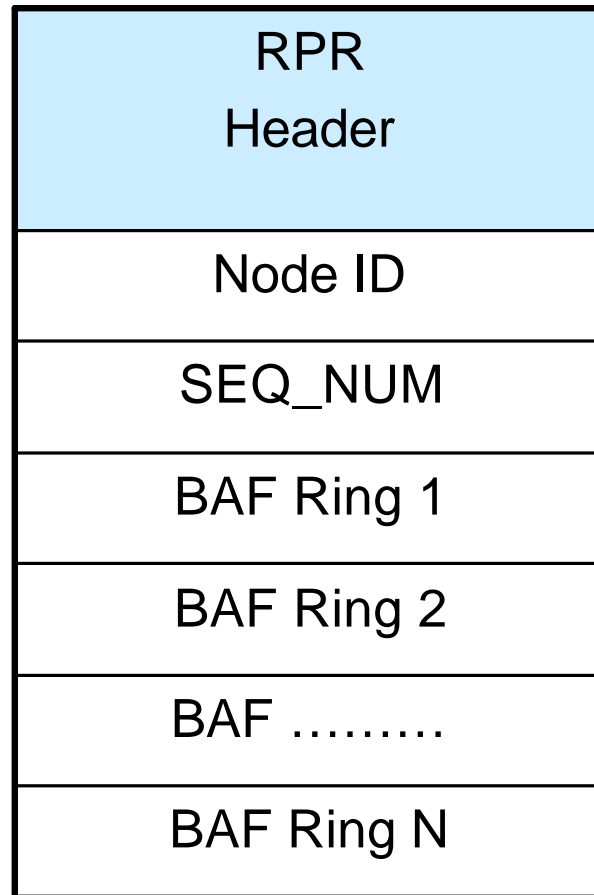
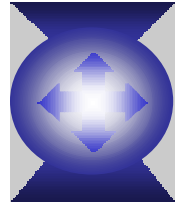
j: Link

- ◆ Per-SLA insert rate

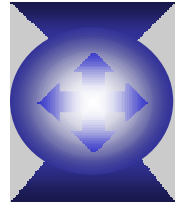
$$insert_rate = r_i + w_i * \min_{src \rightarrow dest} (BAF_j)$$

i: SLA (flow)

Rate Update Packet (RUP)



Summary



- ◆ Global fairness
- ◆ Support per-SLA QoS guarantee
- ◆ 95+% link utilization
- ◆ Fast response time
- ◆ Scalable
 - Nodes, Ring Speed, SLA
- ◆ Simple BW allocation Signaling
- ◆ Reasonable Complexity
- ◆ Cut through / 1 MTU transit buffer