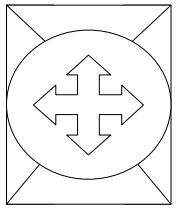

LANTERN
COMMUNICATIONS

Dynamic Bandwidth Control

IEEE 802.17

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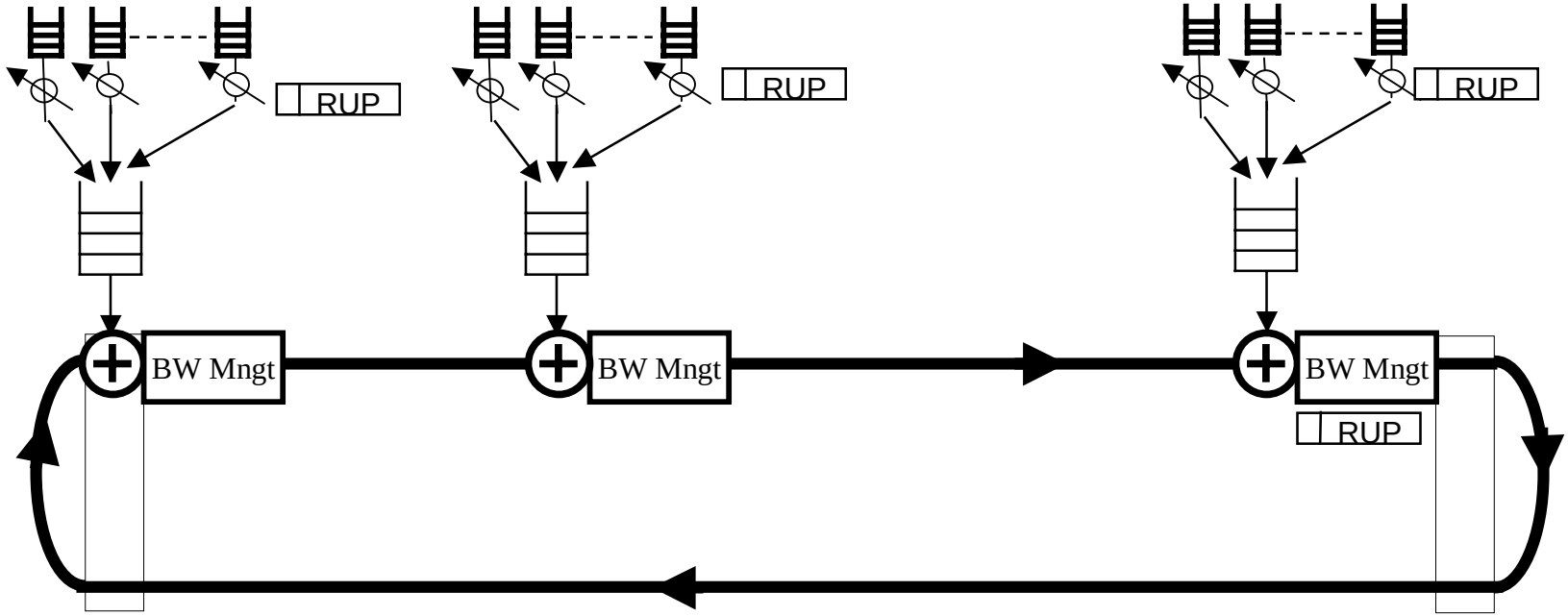
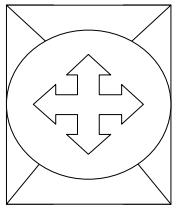
High-Level System Overview

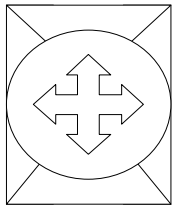


Our Design Goal



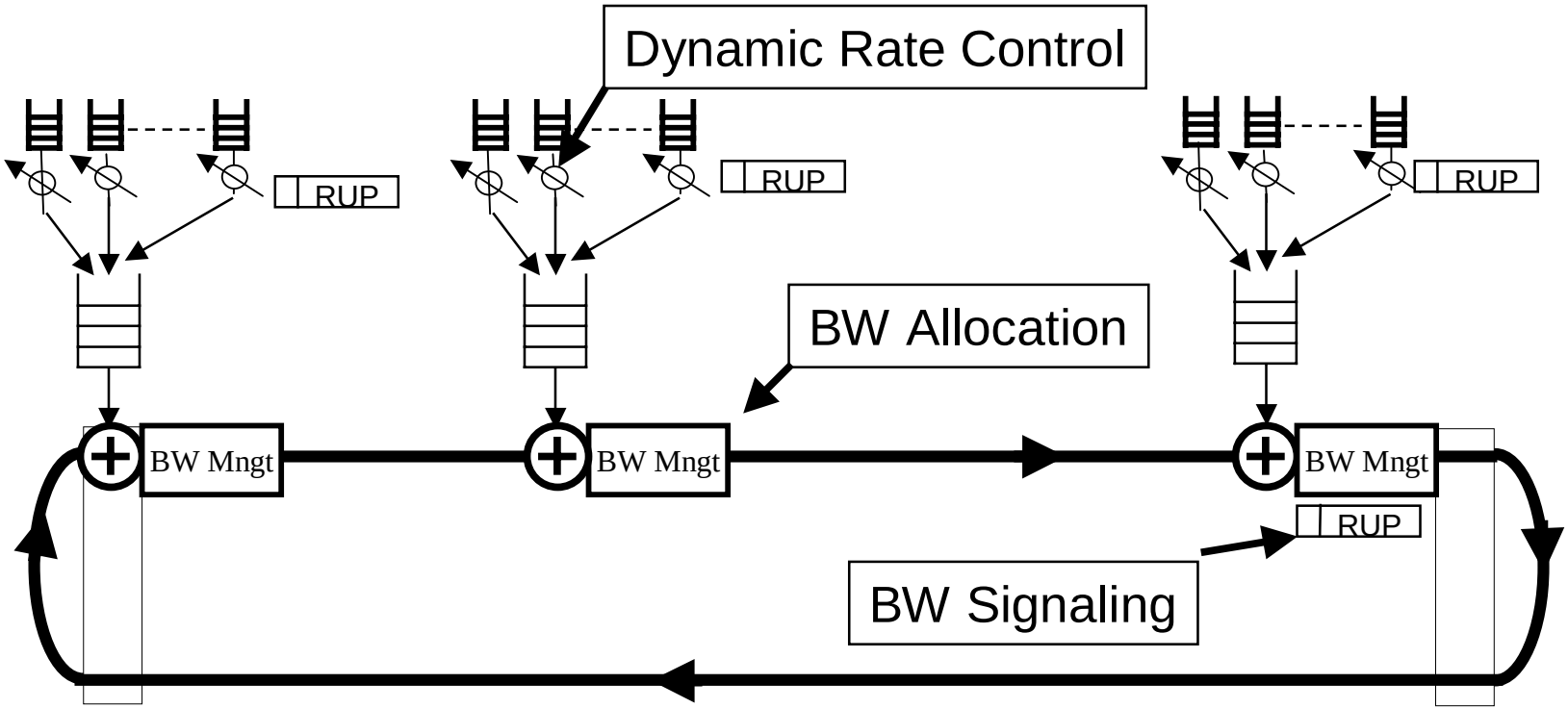
- Global fairness
- Support per-SLA QoS guarantee
- No upstream unfairness (BW, delay&Jitter)
- High utilization (> 95% per span)
- Scalable (#nodes, #rings, # customers)
- Simple and ***robust*** (aggregate) congestion control signaling

A Few Useful Data Points

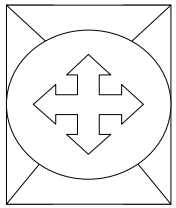


- Fiber Propagation Delay (free-space)
  - 100kM ➔ 0.33 ms
  - 1000kM ➔ 3.3 ms
- Store-Forward Delay (Jitter)
  - 1500 Bytes @ 10G ➔1.2 us/node; 256 nodes ➔ 0.3 ms
  - 1500 Bytes @ OC12 ➔ 19.2 us/node; 256 nodes ➔ 4.9 ms
  - 1500*100 Bytes @ OC12 ➔ 1.92 ms/node; 256 nodes ➔ 490 ms
  - 1500*1000 Bytes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

Ring Access Control Overview



BW Management:(BW Allocation)



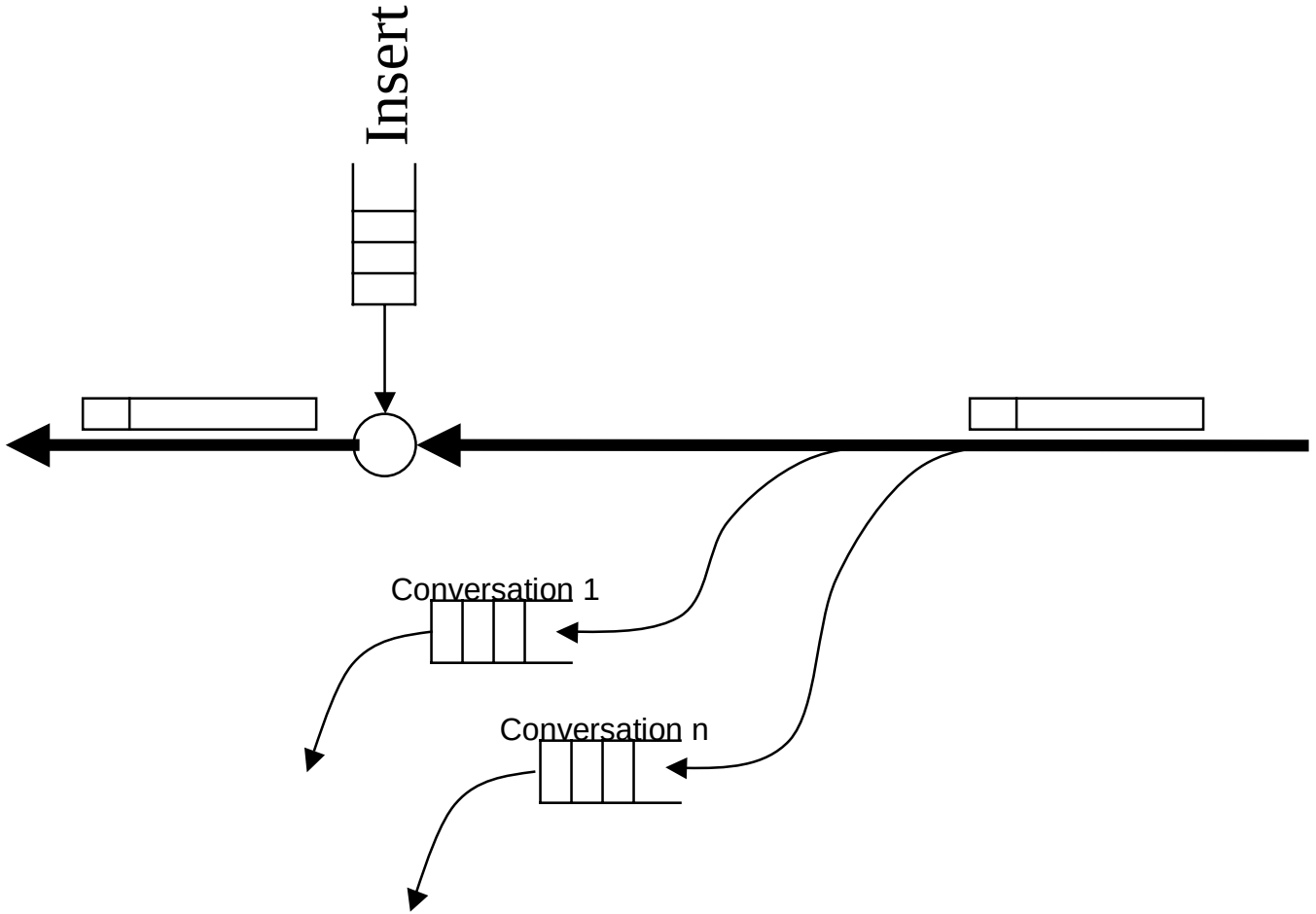
- Per-SLA BW allocation scheme

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

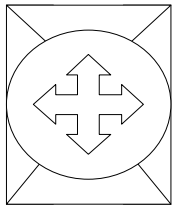
- BW allocation Factor (BAF)

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

Virtual Queue



Dynamic Rate Control



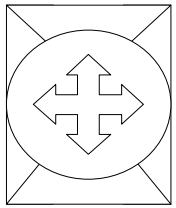
- Satisfy global fairness and fit in the pipe

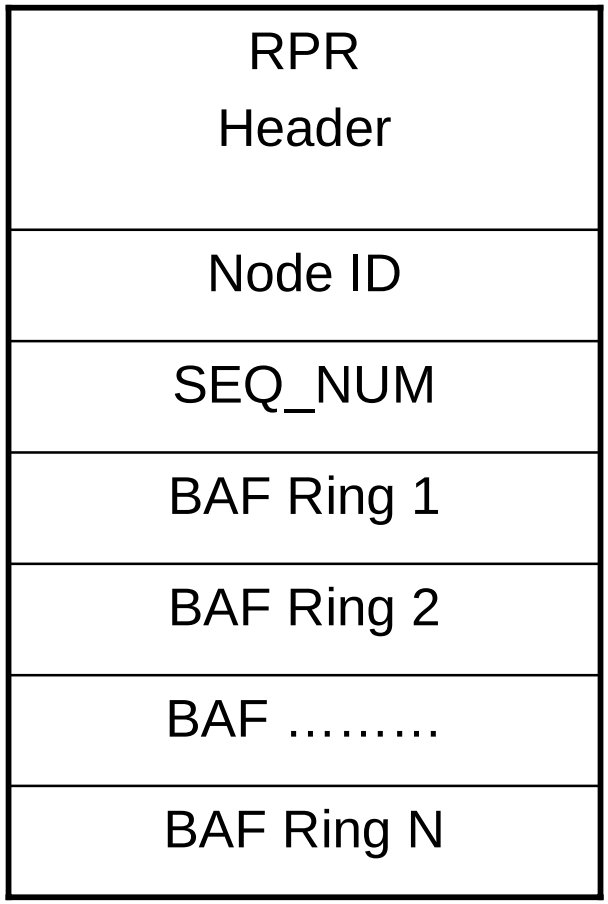
$$insert\_rate = \min(f_j) \Rightarrow \min_{src->dest}(BAF_j)$$

- Per-SLA insert rate

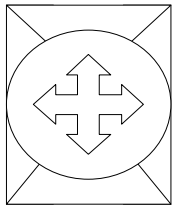
$$insert\_rate = r_i + w_i * \min_{src->dest}(BAF_j)$$

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 Signalling
- Support Plug & Play
- Reasonable Complexity
- No (1 MTU) transit buffer