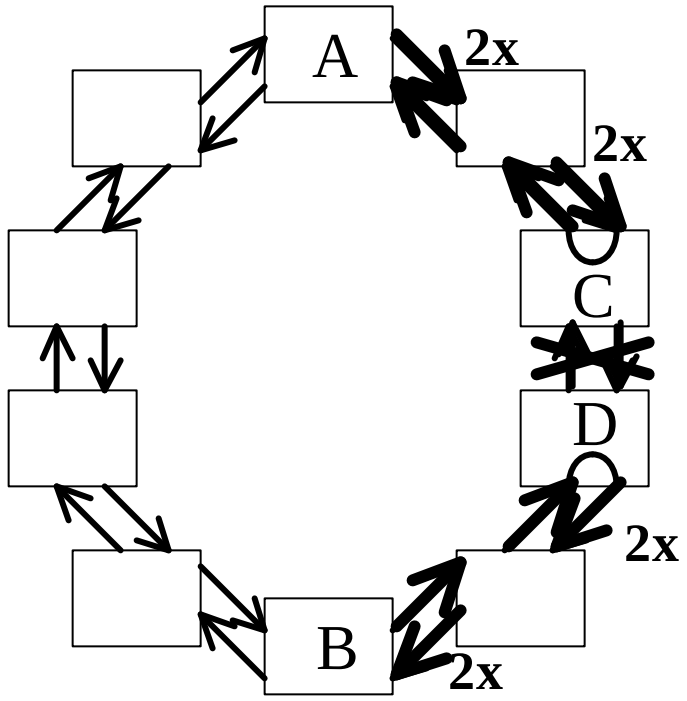
A Study of Protection Switching: Wrapping or Steering

Jason Fan

Luminous Networks, Inc.

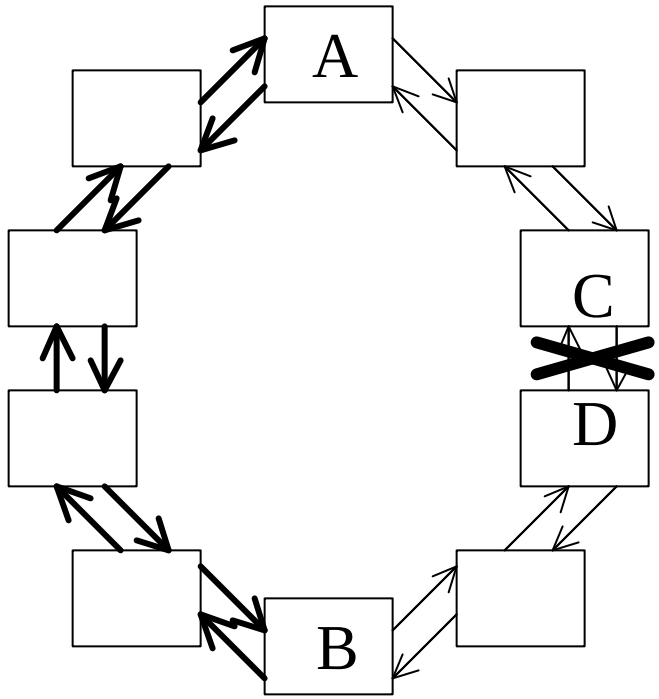
Wrapped Protection

- Wrapped protection is analogous to BLSR
  - Wrapping occurs locally at C and D
  - Signaling of span status changes to other nodes would be in RPR layer



Steered Protection

- Steered protection occurs at each source
  - C and D would signal span status changes to other nodes in RPR layer but would not wrap
  - Each source independently reroutes traffic using topology knowledge

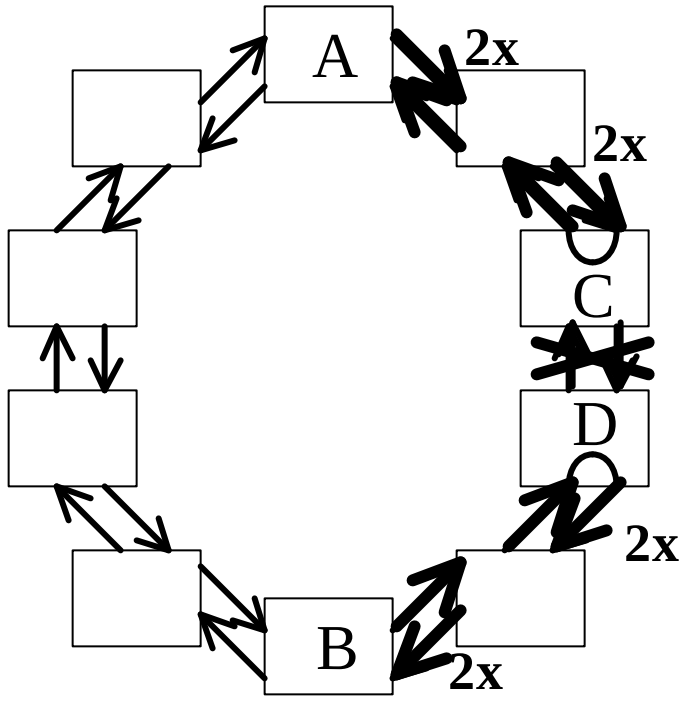


Areas of Study

- Bandwidth Reservation
- Switching Time
- Packet Reordering/Loss on Failure
- Packet Reordering/Loss on Manual Span Down
- Packet Reordering/Loss on Span Up
- Topology Flexibility

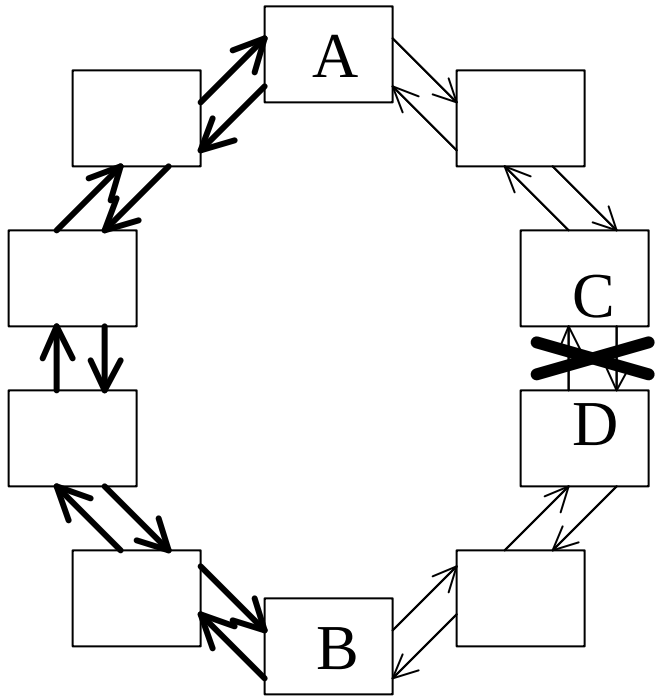
Bandwidth Reservation (I)

- Wrapping:
  - Protected bandwidth BPmax through most heavily loaded failed span must be reserved on all other spans
  - Bandwidth available for unprotected traffic is total bandwidth available B - BPmax



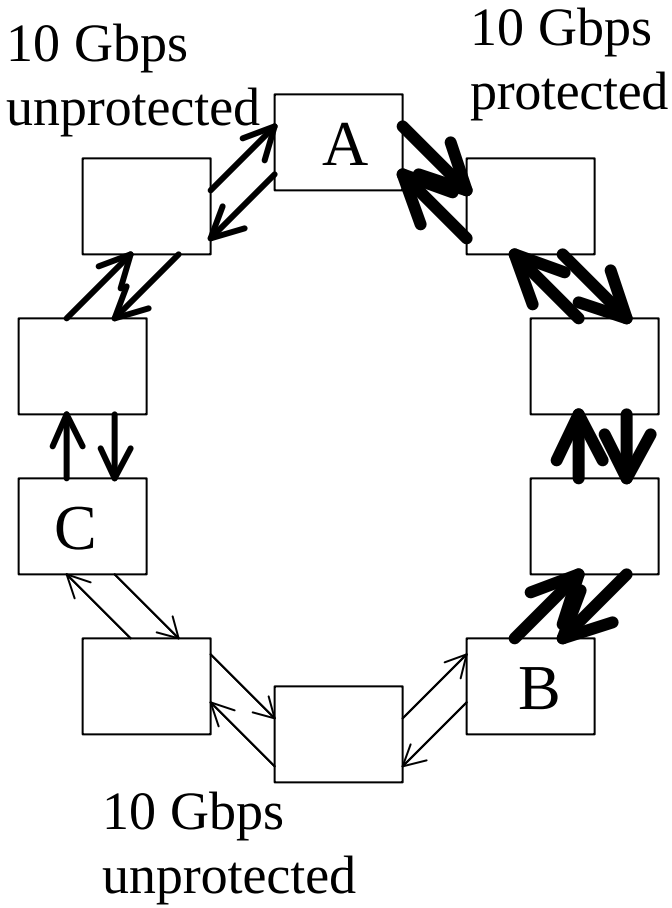
Bandwidth Reservation (II)

- Steering:
  - Protected bandwidth BPmax through most heavily loaded failed span must be reserved on a fraction of all other spans
  - If all shortest-hop paths are equally likely and equally weighted, there is a reduction of 30% in terms of aggregate span-bandwidth product reserved



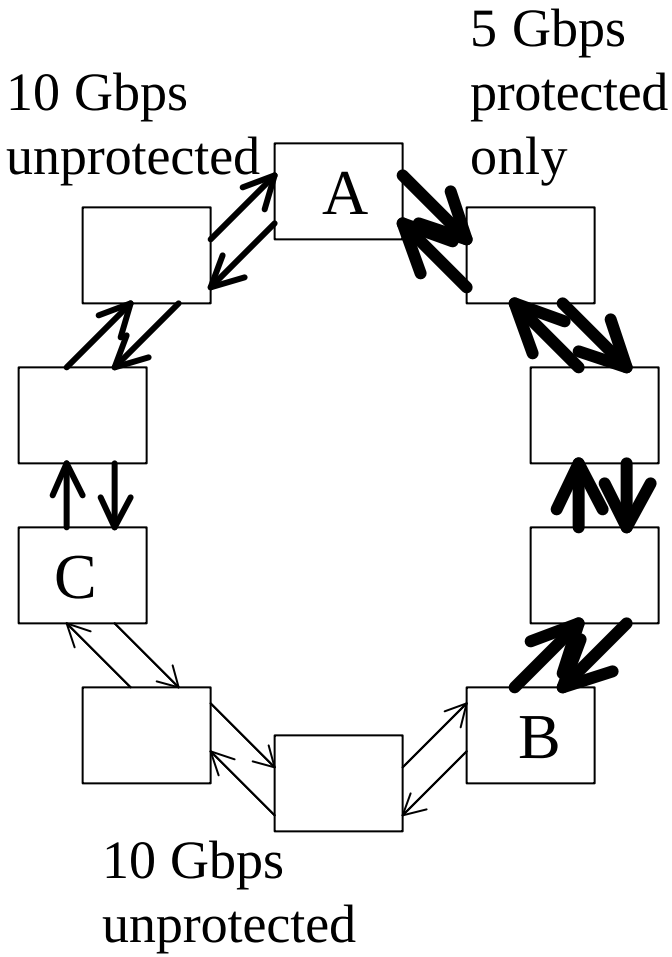
Bandwidth Provisioning Example (I)

- Goal (10 Gbps ring):
  - Provision 10 Gbps bi-directional protected traffic from A to B
  - Provision 10 Gbps bi-directional unprotected traffic from B to C
  - Provision 10 Gbps bi-directional unprotected traffic from A to C
- This can easily be supported using reservation for steered protection



Bandwidth Provisioning Example (II)

- The provisioning configuration cannot be supported using reservation for wrapped protection
  - Wrapped protection cannot exceed 5 Gbps protected traffic on a span
  - If 10 Gbps protected traffic from A to B is supported by routing 5 Gbps protected traffic in both ring directions, then 10 Gbps of unprotected traffic is lost



Switching Time

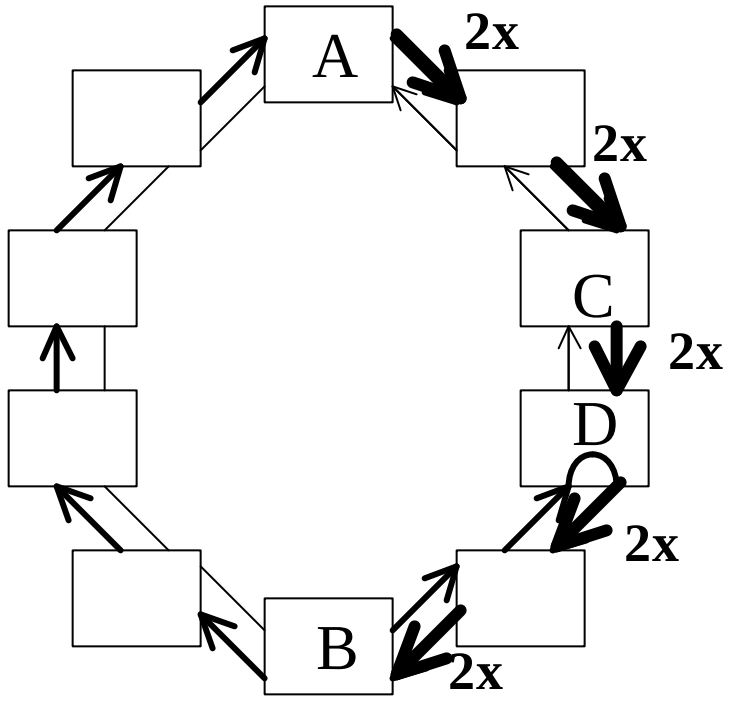
- Wrapping:
  - Switching Time = Detection (<=10 ms) + Wrap (minimal)
- Steering:
  - Control message with span status sent by each node detecting a failure condition
  - Switching Time = Detection (<=10 ms) + Control message propagation (ring circumference (km)/200) ms + Time to re-steer (minimal)
- Difference becomes significant only for very large rings; in these scenarios, steering and wrapping could be combined

Pkt Reordering/Loss on Failure

- Wrapping:
  - Pkts lost = Pkts transmitted during switching time
- Steering:
  - Pkts lost = Pkts transmitted during switching time
- For a 200 km ring circumference, steering results in loss of an additional 1 ms worth of packets

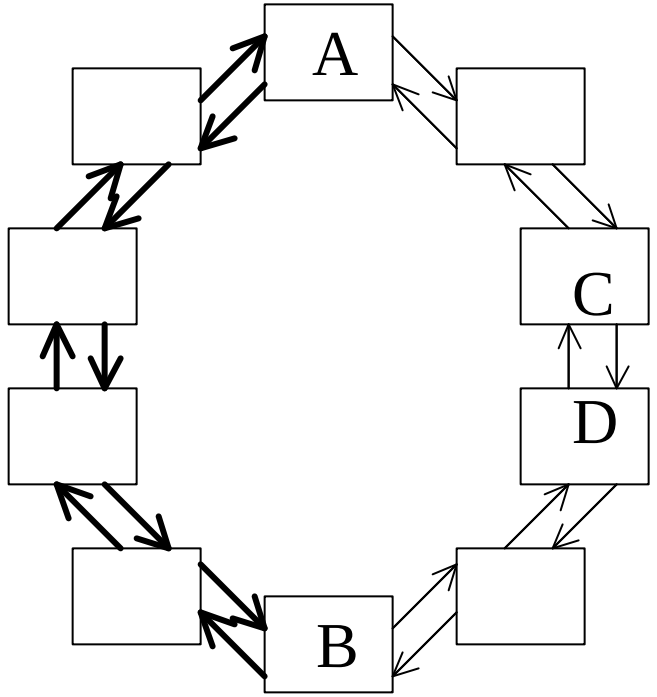
Pkt Reordering/Loss on Manual Span Down (I)

- Wrapping:
  - Synchronization of execution of manual span down command on two sides of the span must be better than (ring circumference (km)/200) ms, otherwise there will be loss of wrapped packets at D



Pkt Reordering/Loss on Manual Span Down (II)

- Steering:
  - There may be packet reordering due to the propagation time difference between the two ring directions, but there is no packet loss



Pkt Reordering/Loss on Span Up

- Wrapping:
  - There will be packet reordering for a period equal to the propagation time over the entire ring circumference
- Steering:
  - If there was packet reordering on span down, there will be no packet reordering on span up (and vice versa)
  - Note that packet reordering is only for a period equal to the difference in propagation times between each source and destination

Topology Flexibility

- Wrapping:
  - Works specifically with a two-fiber bidirectional ring
- Steering:
  - Works generally with N-fiber (N-wavelength) rings, where the number of fibers (wavelengths) in each direction is unequal

Summary

- Steering has advantages over wrapping in terms of:
  - Bandwidth reservation efficiency
  - Packet reordering/Loss on manual span down and up
  - Topology flexibility
- Wrapping has advantages over steering in terms of:
  - Switching Time
  - Packet Reordering/Loss on Failure
- However, the advantages of wrapping over steering are minimal for metropolitan area rings
- Recommendation: Steering be used as the preferred approach, with wrapping optional