Advanced Network Architecture Research Group

Distributed Wavelength Reservation Method for Fast Lightpath Setup in WDM Networks

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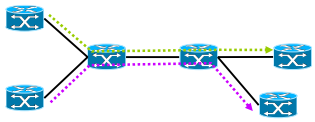
Wavelength-routed WDM networks

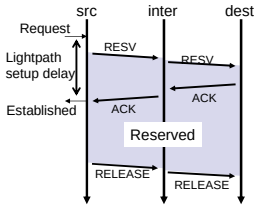
- Distributed control
  - No central controller exists
  - High scalability and survivability
- Dynamic lightpath establishment
  - A lightpath is…
    - Set up for each connection request
    - Released after the data transfer

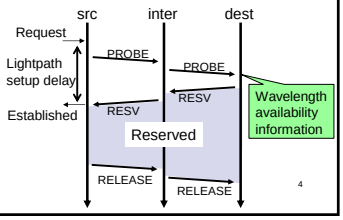


Lightpath on wavelength λ1
Lightpath on Wavelength λ2

Conventional lightpath setup methods

- Forward Reservation
  - A wavelength is reserved in forward direction
  - The source node knows only next link-state
- Backward Reservation
  - Wavelength availability information is collected in forward direction
  - A wavelength is reserved in backward direction





Performance metrics

- In the previous works, the blocking probability is evaluated
  - Backward Reservation outperforms Forward Reservation

- The lightpath setup delay is more important
  - When a reservation is blocked, a retrial is necessary
  - The data transfer is much affected by such retrials

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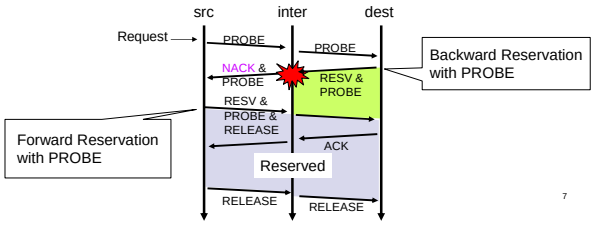
Our Proposal

- Forward Reservation + Backward Reservation
- The Reservation is performed in both direction
  - Faster retrial is possible
  - Same to Backward Reservation unless reservation failures occur

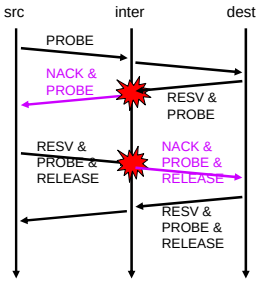


Fast retrial in our proposal

- When a backward reservation is blocked,
  - RESV → NACK
  - Forward reservation with PROBE & RELEASE packets
- When a forward reservation is blocked,
  - RESV → NACK
  - Backward reservation with PROBE & RELEASE packets

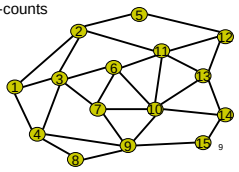
	The number of retrials
Conventional	N
Proposal	2N - 1

N: The number of round-trip times

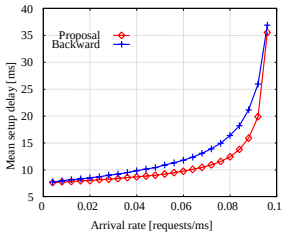


Simulation model

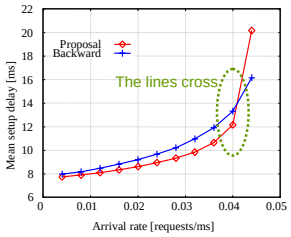
- Random network with 15 nodes
- The number of wavelengths in each link: 32
- Lightpath setup requests: Poisson process
- Connection holding time: Exponential distribution with mean $1/\mu$
- Mean link propagation delay: 1.77[ms]
- Routing: Predetermined based on min-hop routing
  - Mean distance between nodes: 2.2 hop-counts
- Retrial when a request is blocked



Mean lightpath Setup Delay



Connection holding time $1/\mu$ = 100ms

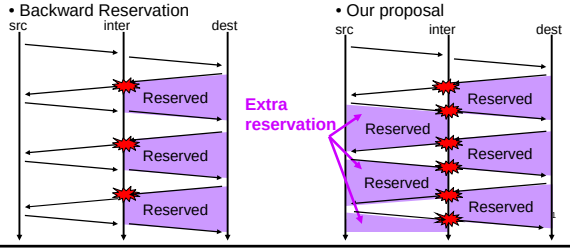


Connection holding time $1/\mu$ = 10ms

- Our proposal shows better performance (except for the high arrival rate)
- The lines cross in case of $1/\mu$ =10ms

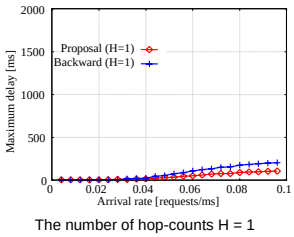
Why do the lines cross?

- When the intermediate-node blocking occurs,
  - Some finite time is necessary before the wavelength is released
  - Network resources are wasted
- Our proposal may waste more network resources

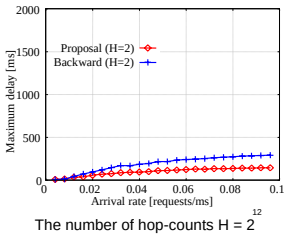


Maximum Setup Delay (1/2)

- To get rid of the irregular value, we cut upper 0.1%
- Mean connection holding time $1/\mu$ =100ms
- As expected, the maximum setup delay is reduced to 1/2 of Backward Reservation

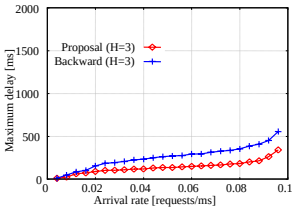


The number of hop-counts H = 1

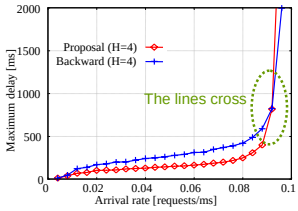


The number of hop-counts H = 2

Maximum Setup Delay (2/2)



The number of hop-counts H = 3



The number of hop-counts H = 4

- Our proposal reduces the maximum setup delay greatly
- The lines cross in case of H=4

Summary

- A novel lightpath setup method:
  - Integrate Forward / Backward Reservation
    - Under the low arrival rate, it works same as Backward Reservation
    - With the arrival rate increases, the reservation is performed in both direction
  - Except for under the high arrival rate,
    - Improve the mean lightpath setup delay
    - Reduce the maximum setup delay
- Future work
  - Numerical analysis for the lightpath setup delay
  - Investigation on back-off mechanisms

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Thank you