Implementation and evaluation of fast lightpath setup method in wavelength-routed WDM networks

Masatoshi Ohashi
Graduate School of Information Science and Technology
Osaka University, Japan
m-oohashi@ist.osaka-u.ac.jp

Background

WDM (Wavelength Division Multiplexing)
- The wavelength channel (lightpath) is configured on demand basis
- Control plane: routing and wavelength assignment, resource management
- Data plane: the data is transferred
- Lightpath setup trial continues until it succeed

Lightpath setup delay
- From when a lightpath setup request arises to when the lightpath is completely configured

Reduce the lightpath setup delay.
- The network is utilized more effectively.

Research Purpose

✓ Hybrid lightpath setup method [5]
  - Integration of existing forward and backward methods
  - We have evaluated by computer simulation
  - The method has not been evaluated by experiments
    ✓ The effect of the transmission, processing and OXC configuration delay of control packets is unknown

• Implementation of the hybrid lightpath setup method
• Evaluation by experiments


Implementation of hybrid lightpath setup method

✓ The implementation program is based on standard GMPLS
  - Resource reservation module (RSVP Controller)
  - Routing module (OSPF Controller)
  - Link management module (LMP Controller)
  - OXC control module (GSMP Controller)

The node (Control plane)
OSPF Controller
LMP Controller
GSMP Controller
OXC
Specify route
Send and receive link state information
Link establishment/ Connection keeping
Wavelength Reservation signaling
RSVP Controller
Neighbor node (Control plane)

Experimental environment

✓ Control plane
  - The implementation program runs on each of three nodes
  - Only node 2 has an OXC
✓ Data plane
  - IP packets are sent (node1 to node 3)
  - We observe the packet arrivals on node 3
  - Lightpath setup delay is calculated by the interval
Lightpath setup request arrival model

- The lightpath setup requests
  - The arrival rate of \( \lambda \) (Poisson process)
  - The requests are one direction
- The lightpath holding time follows an exponential distributed (1 sec)
- 8 wavelengths \( (w_1 \sim w_8) \) are available
  - Only one wavelength \( (w_1 \& \text{node 1 to node 3}) \) is actually switched by the OXC

Compare with backward reservation method

- The average lightpath setup delay of the requests \( (W_1 \& \text{node 1 to node 3}) \)
  - OXC configuration delay: 9ms
  - Packet processing delay: 5ms
- Hybrid method takes smaller lightpath setup delay
  - Under heavy-load
    - The setup delay of hybrid method is greater

Consideration for the result

- The reason why hybrid method is inferior under heavy load
  - Half-finished lightpath is obstructive
    - It appears when it fails wavelength reservation
  - Hybrid method is more likely to make half-finished lightpath
    - Hybrid method attempts lightpath establishment twice during RTT.
- This is an exception
  - Networks are not operating actually such heavy-load

Conclusion and future work

- Conclusion
  - We have proposed the hybrid lightpath setup method to reduce lightpath setup delay
  - We implemented the hybrid method
  - We evaluated hybrid lightpath setup method through experiments
    - Hybrid method takes smaller lightpath setup delay than the backward method in realistic use
- Future work
  - Examine various routing methods
  - Evaluate the lightpath setup delay.

Compare with simulation result

- The larger the RTT is, the more effective our hybrid method works.
  - Our hybrid method works more effectively in experimental result because the OXC configuration delay works as it add to RTT.