Design Method of Logical Topologies in WDM Network with Quality of Protection

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Background

- Protection : backup paths are prepared for each primary lightpath for recovery from a failure
- Many researchers have proposed several logical topology design algorithms with protection.
  - example objective : minimize # of wavelength、minimize the blocking rate
- few research mention the quality of protection

☐QoP (Quality of Protection)

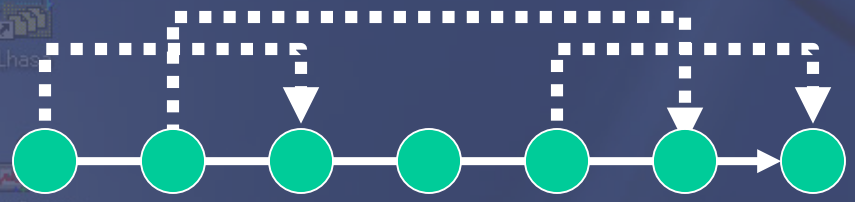
- ■one realization of QoS suitable to the WDM network
- ■QoS for failure tolerance
- ■Dr. O. Gerstel propose probability-based QoP

☐SLSP (Short Leap Shared Protection)

- ■Dr. Pin-Han. Ho propose a protection method
- ■he propose new QoP based on the length of protection paths

SLSP : Short Leap Shared Protection

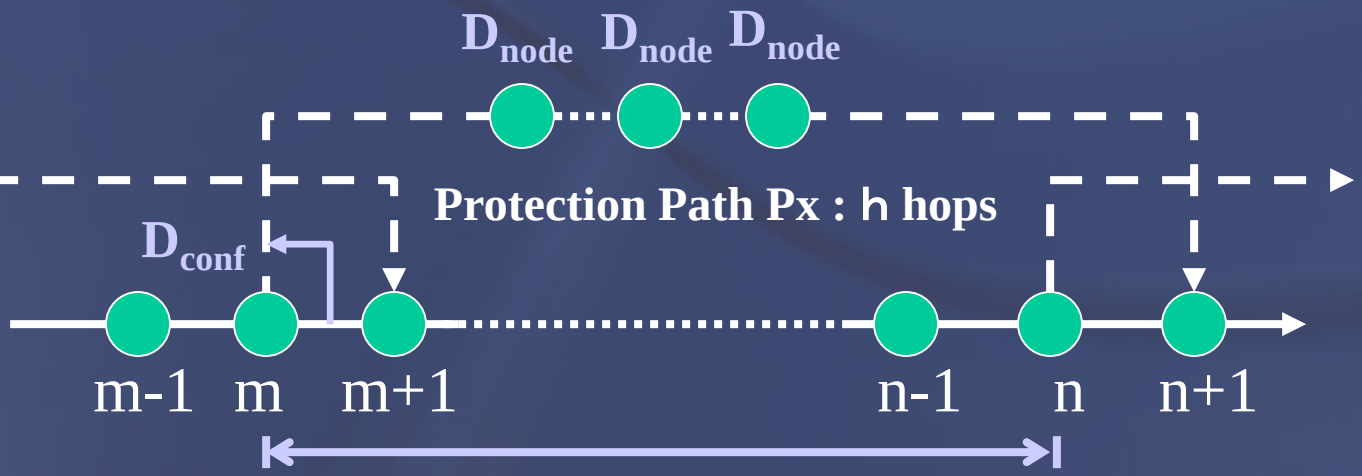
SLSP Sample Model



- configure the length of protection paths by selecting the end nodes for each protection path to satisfy the required QoP

- **Original SLSP**
  - require QoP to determine the maximum length of protection paths for each primary lightpath
- **Our Proposal**
  - set QoP as a QoS to determine the maximum recovery time for each primary lightpath
  - propose logical topology with SLSP design algorithm which can deal with our proposed QoP

Recovery time modeling



Recovery time of segment (m, n) = D_p **Maximum failure detection time**

\+

$D_{node} \times h$ **path configuration time**

\+

D_{conf} **path switching time**

Proposed QoS considering recovery time

- Each path connection between node pairs require QoP

For all segment(m,n) of primary path

QoP_n

$D_{min} + (n-1) \times D_{scale}$ $\geqq$ Recovery time of segment (m, n)

$D_p + D_{node} \times h + D_{conf}$

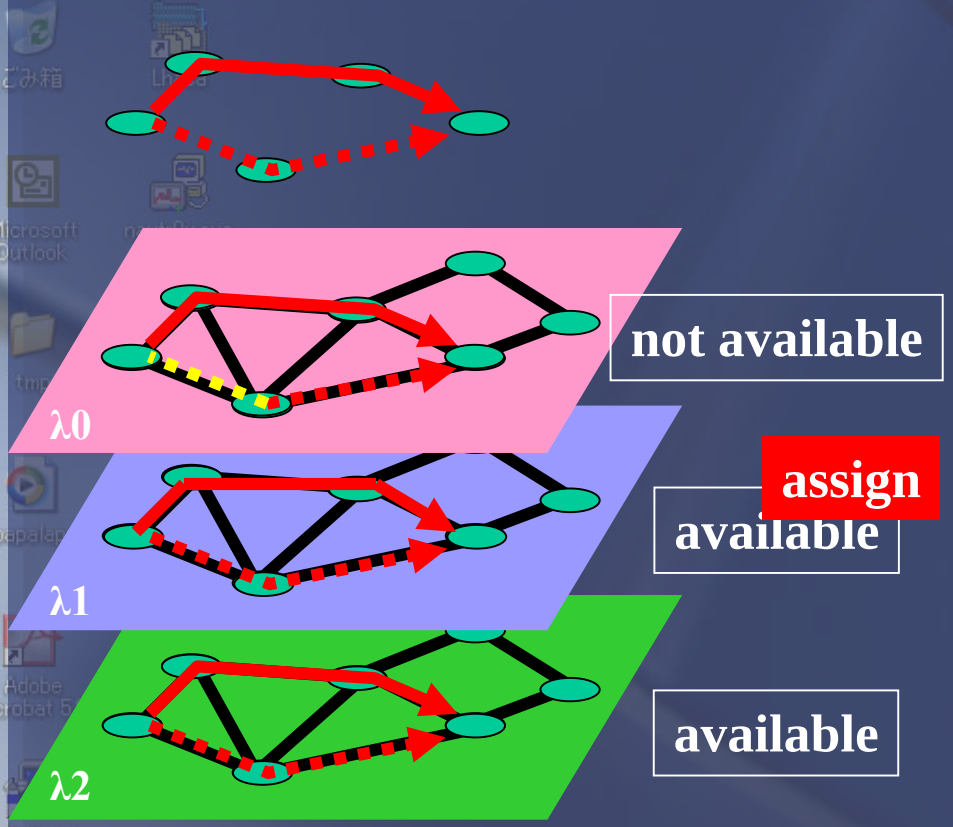
D_{min} : minimum waiting time to recover from a failure
D_{scale} : step-width of the recovery time

be determined properly for each network environment

First Fit wavelength assignment method

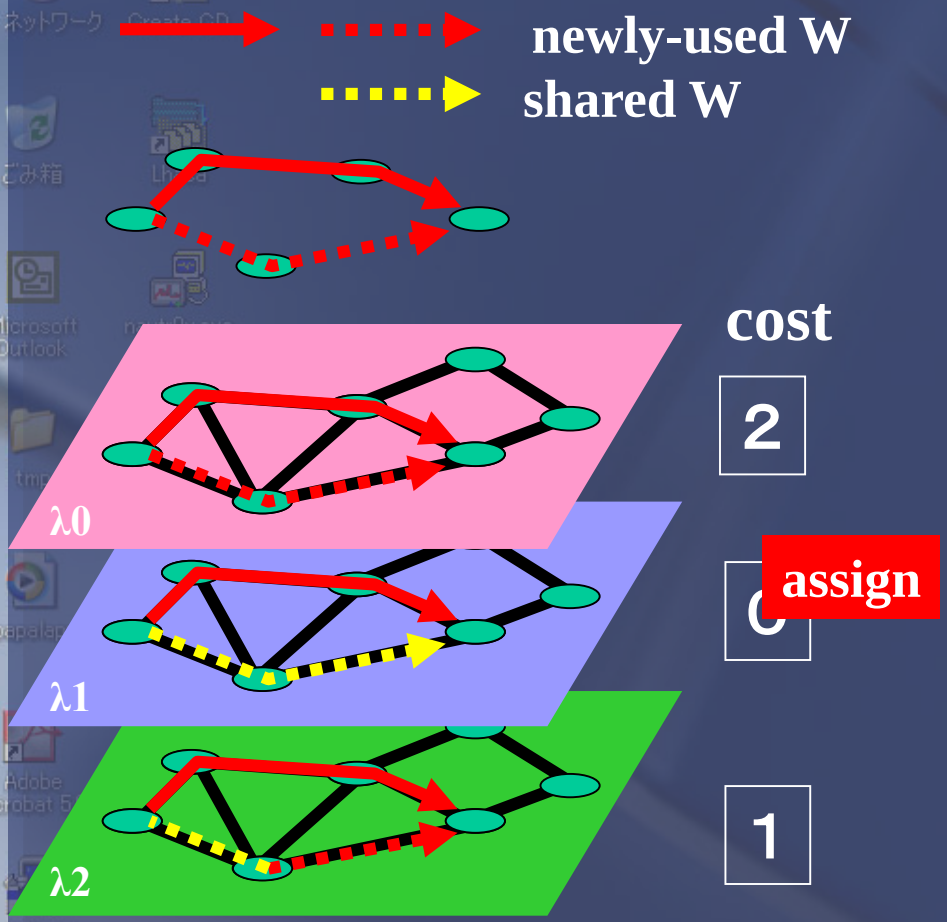
available Wavelength

not available Wavelength



■assign paths to the assignable wavelength with the smallest index of λ

Max Share wavelength assignment method



- assign paths to maximize the number of shared wavelength cannel by protection paths
- Cost : the number of newly-used wavelength cannel by protection paths

proposed Logical Topology Design Algorithms

- **Propose 2 Algorithms**
  - **Protection Method**
    - **both algorithms use SLSP**
  - **Routing of primary and protection path**
    - **both algorithms use shortest path between each each node pair for primary lightpath**
    - **both algorithms use shortestpath between selected end nodes for protection path**
  - **Wavelength Assignment Method**
    - **Algorithm 1 use First Fit**
    - **Algorithm 2 use Max Share**

Evaluation Model

- Network model：NSFNET(14nodes, 21links)
- Traffic matrix：0.1-20.0Gbps real traffic trace value
- Wavelength capacity：10Gbps / wavelength
- QoP：set 1 to ∞ for each node pair
- Performance metric：# of necessary wavelengths

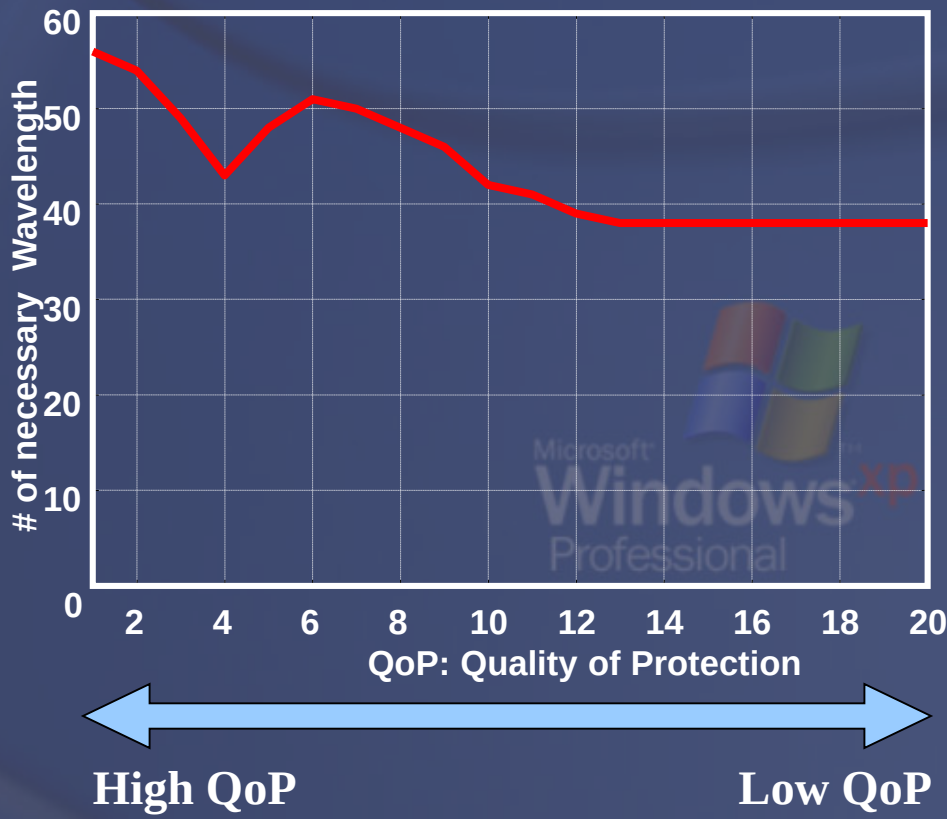
D_{min}	minimum waiting time for the recovery	10ms
D_{scale}	step-width of the QoP	2ms
D_{node}	path configuration time at each node	1ms
D_{conf}	path switching time	0ms

Evaluation1 : QoP vs # of necessary wavelengths assigned by First Fit

- **QoP requirement for each node pairs is set identically**

the number of necessary wavelengths is

- decreasing according to the decreasing of the QoP level
  - fixed at low QoP
  - dropping at QoP4 and not showing simple decrease at high QoP

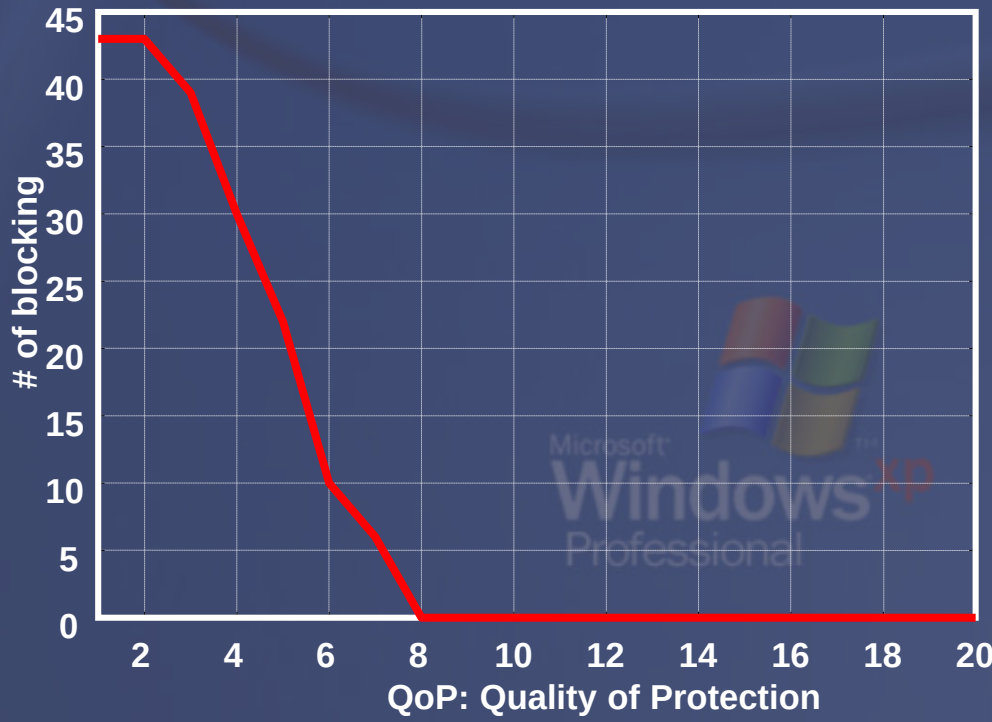


Evaluation1 : the reason for the dropping of the # of necessary wavelengths

There are some node pairs not to satisfy the required QoP

REASON

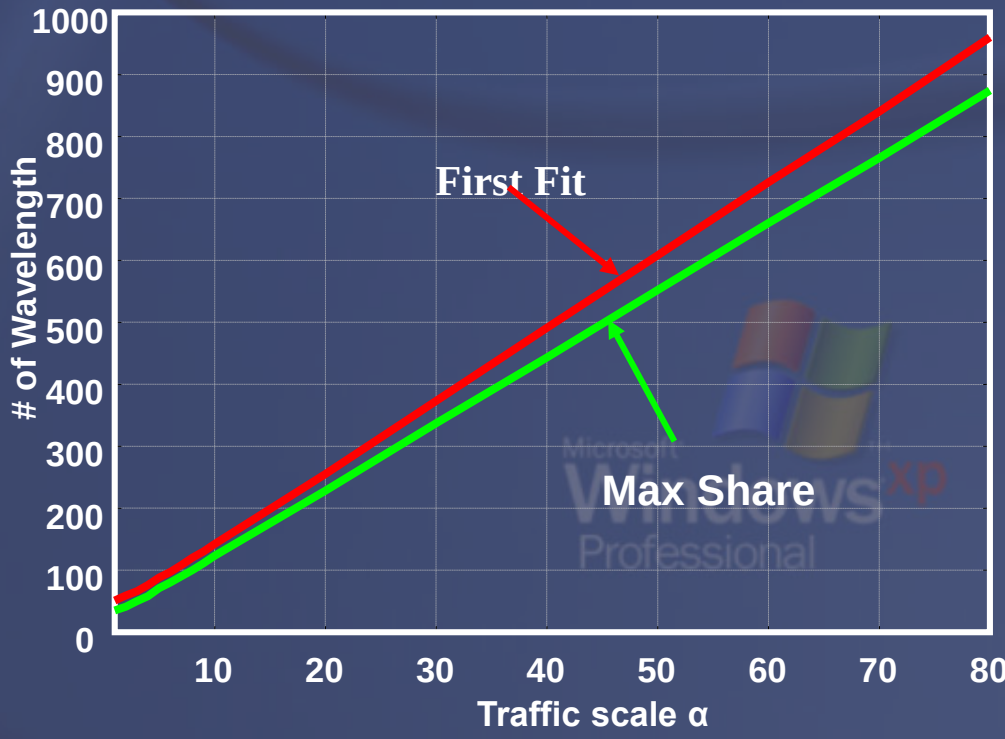
- lack of route for protection path which is enough short to satisfy the required QoP
- we call this blocking
- In this case, only primary path is set up



Evaluation2：comparison of two wavelength assignment method

- randomly set QoP requirement for each node pairs
- given traffic： traffic matrix multiplied by α

- proposed algorithm 2 needs less # of wavelengths
- algorithm 2 tries to share wavelength by more protection paths than algorithm 1



Conclusions and future works

- Conclusions
  - propose QoP considering the recovery time form failure
  - propose two logical topology design algorithms with QoP
  - show the relationship between QoP and the number of necessary wavelengths
  - algorithm 2 show effective utilization of wavelengths
- Future works
  - evaluations under non-blocking condition
  - to gain the performance by changing the routing of paths
  - to design logical topology applying the behavior of upper layer protocol (e.g. IP)