Scalable GMPLS Control Plane for Fault-Recovery Performance

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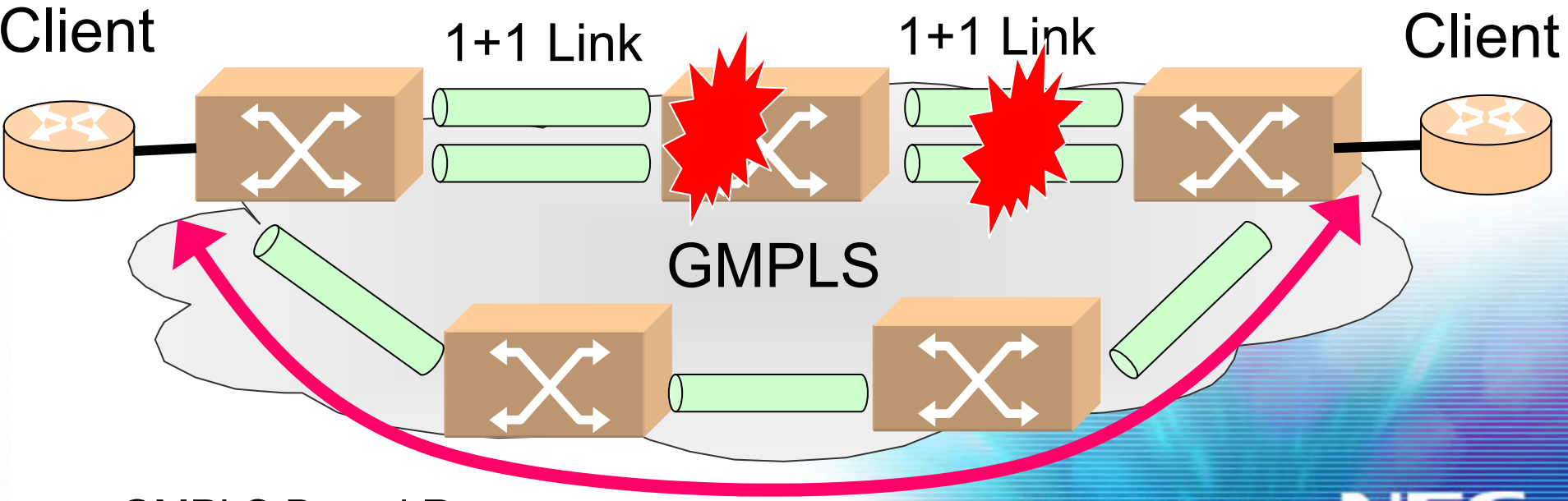
Outline

- Backgrounds for GMPLS based Recovery
- Performance Problems
- Proposed Approaches
  - Path Bundling
  - Prioritized processing in failure condition
- Experimental Results
- Summary

Application of GMPLS Based-Recovery

End-to-End high availability

- Link protection between nodes (Not GMPLS based)
- GMPLS re-routing;
  - ✓Redundant links failure, or node failure
  - ✓End-to-end recovery, or segment recovery

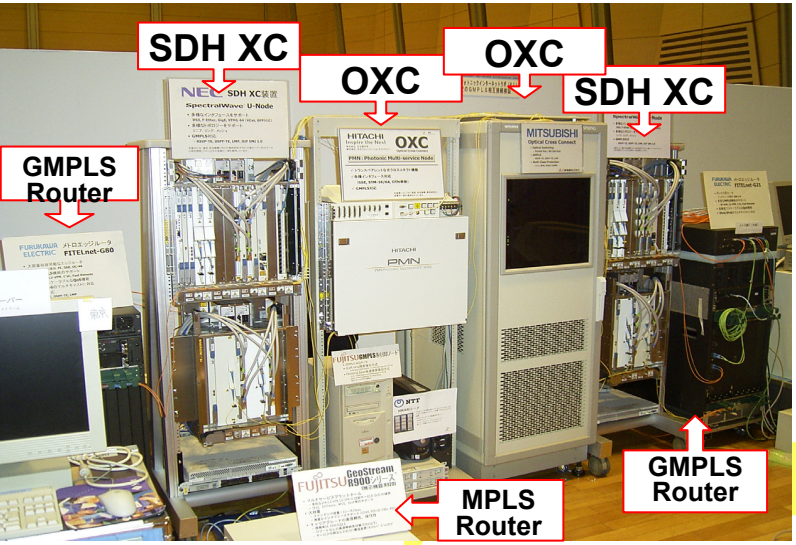


GMPLS Based Recovery

GMPLS Based Recovery Types

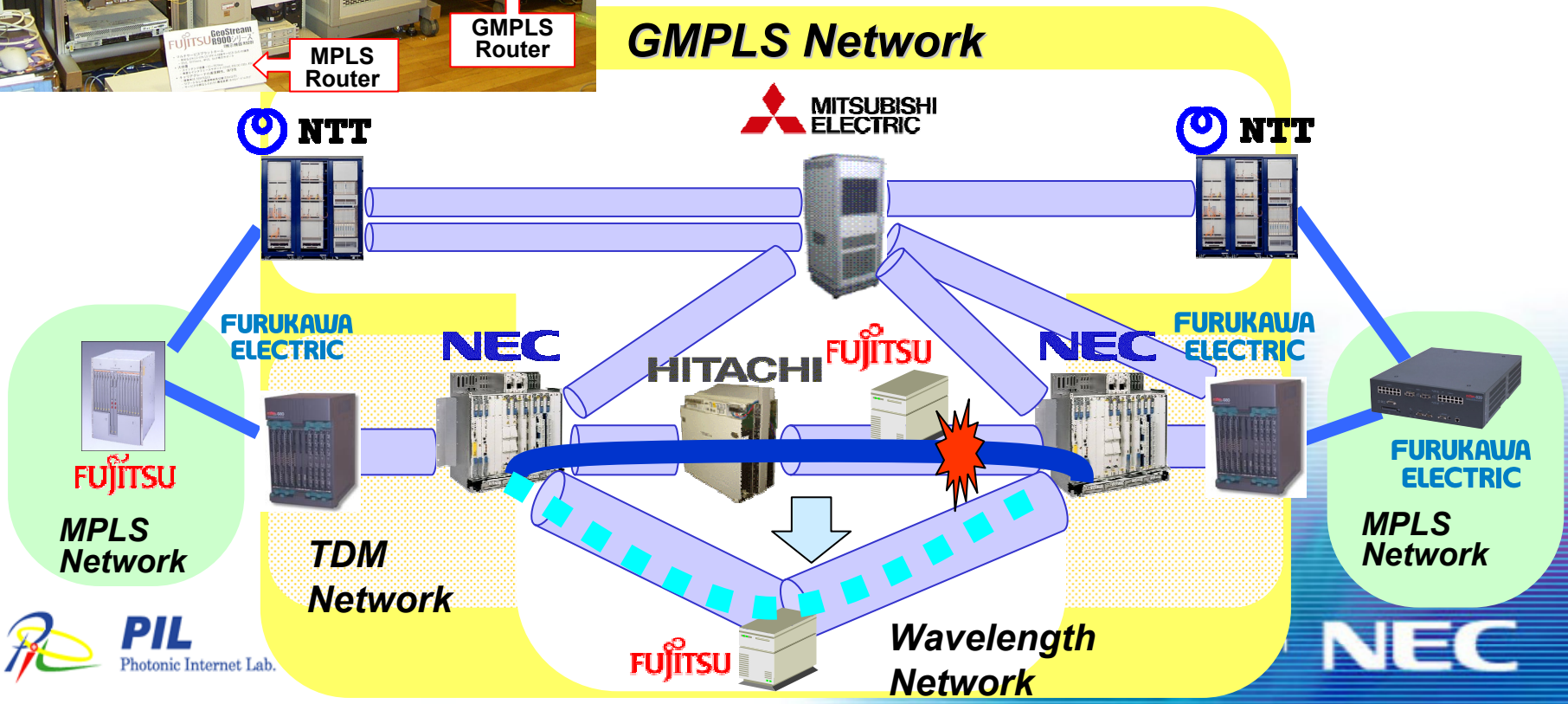
Recovery Type	Recover Time	Fault Tolerance	Required Resources
Dedicated LSP protection	~50 ms	High	2 (1+1)
LSP Protection with Extra-traffic			< 2
Pre-planned LSP re-routing	~ few sub-seconds	High	< 2 (1:1)
		Fair	<1.7 (shared)
Full LSP re-routing	~ few seconds	Best-effort	1
Unprotected	---	No tolerance	1

Interoperability Demonstration in Jan. 2004



Achievement:

- Interoperability for GMPLS based Recovery
- Wavelength re-routing
  with Pre-Planned LSP re-routing

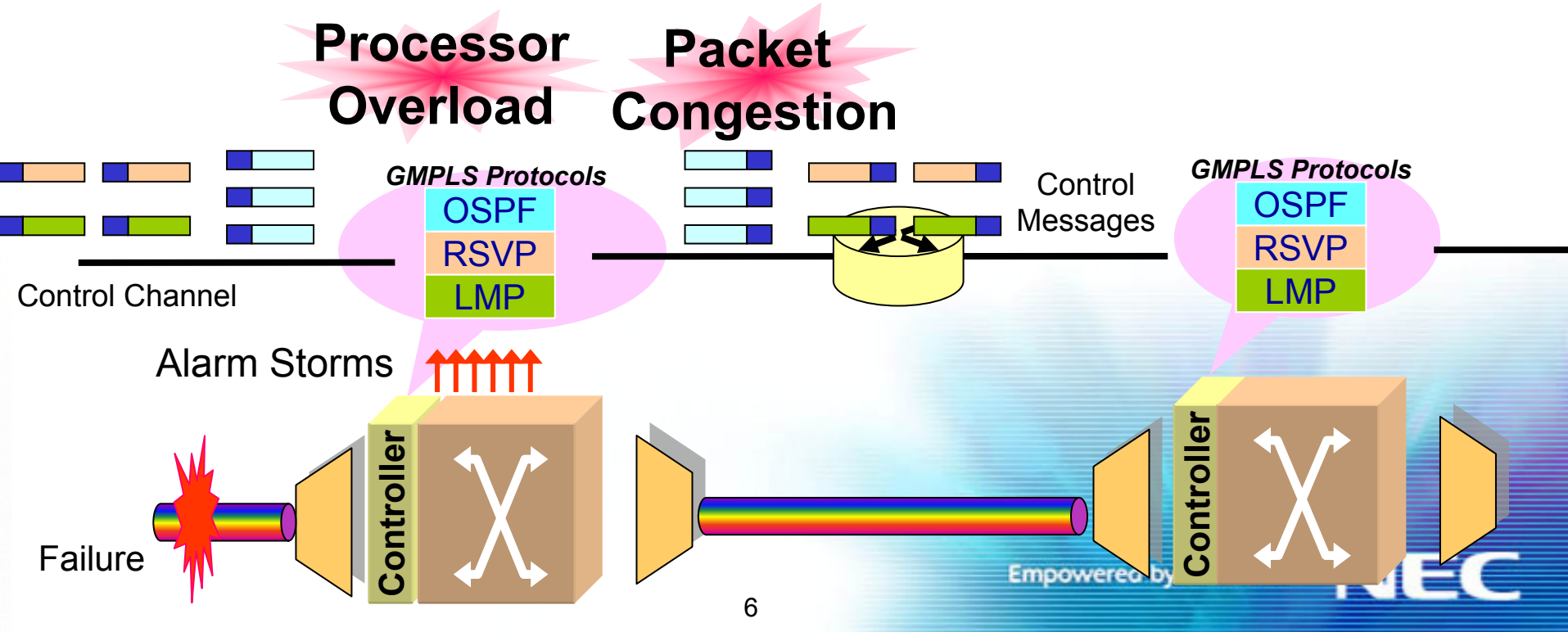


Performance Problems for GMPLS Re-routing

- Alarm Storms
- Limited Control Resources
  - ✓Processor power limitation
  - ✓Control channel BW limitation

Possessing latency

Performance Problem



Approaches

Performance problem
in GMPLS based recovery

Enhancement of GMPLS Controller

- Hardware processing of GMPLS protocols

→ High cost approach.
→ Not feasible approach.

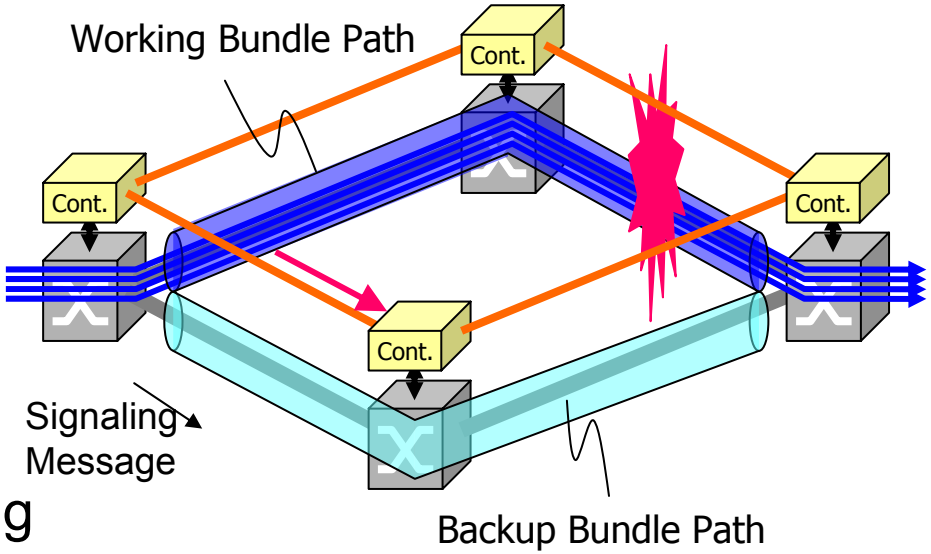
Improvement of GMPLS re-routing process

- Reduce re-routing workload on GMPLS controller
  - ✓ **Path bundling**, and
  - ✓ **Prioritized processing**

→proven approach via our prototype systems

Approach (I): Path Bundling

- Bundle multiple path
- Re-routing per bundled path



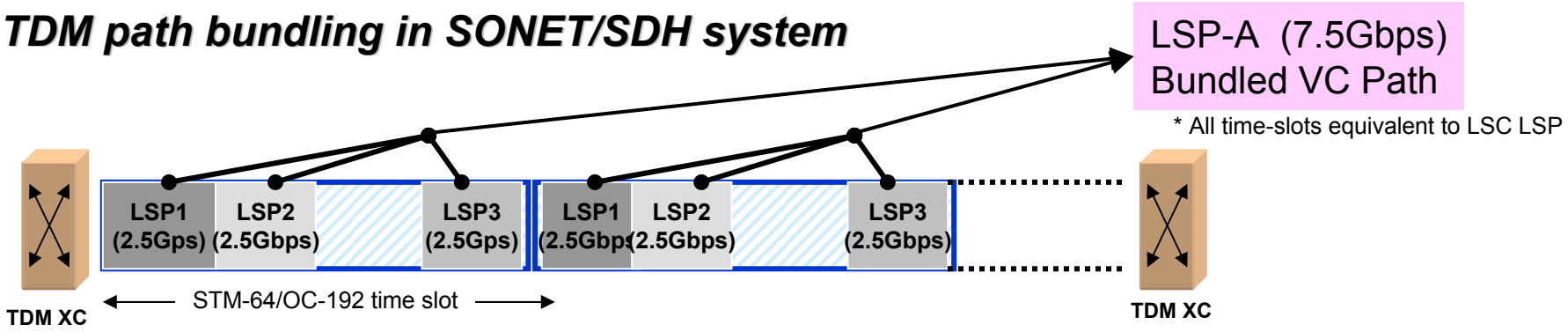
- Reduce signaling msgs. for re-routing
- Reduce workload on controller embedded in OXC

Cover all switching capabilities

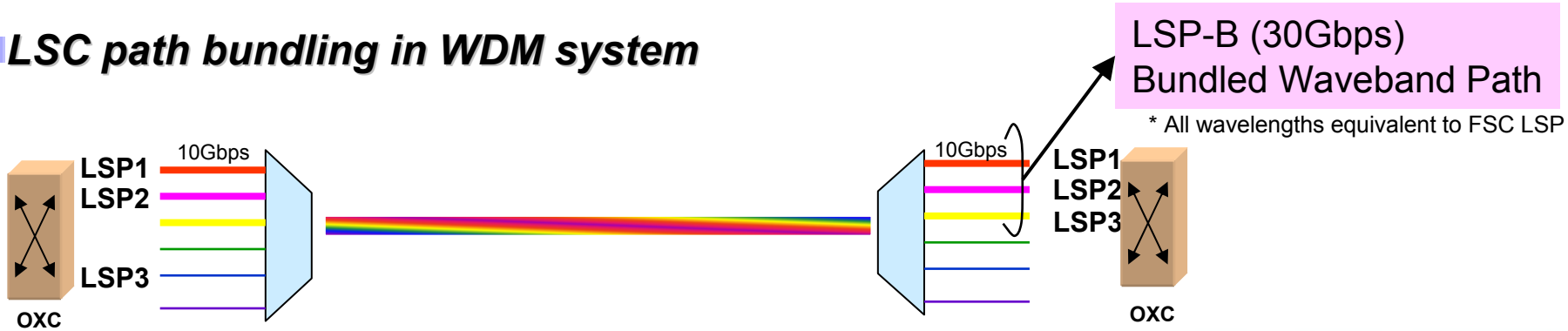
- (G)MPLS [Packet]: Label Stacking
- GMPLS [TDM, LSC, FSC]: Path Bundling

Bundling Examples for Switching Capabilities

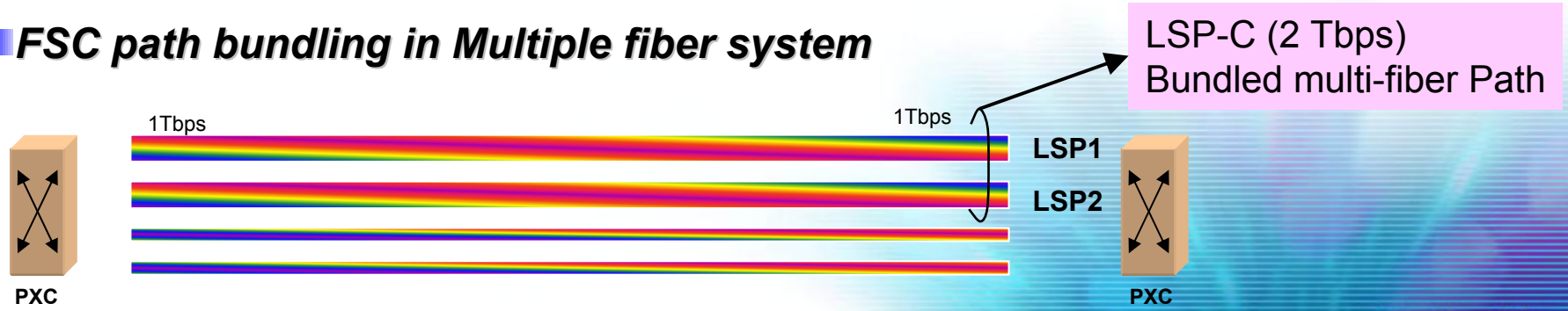
TDM path bundling in SONET/SDH system



LSC path bundling in WDM system



FSC path bundling in Multiple fiber system

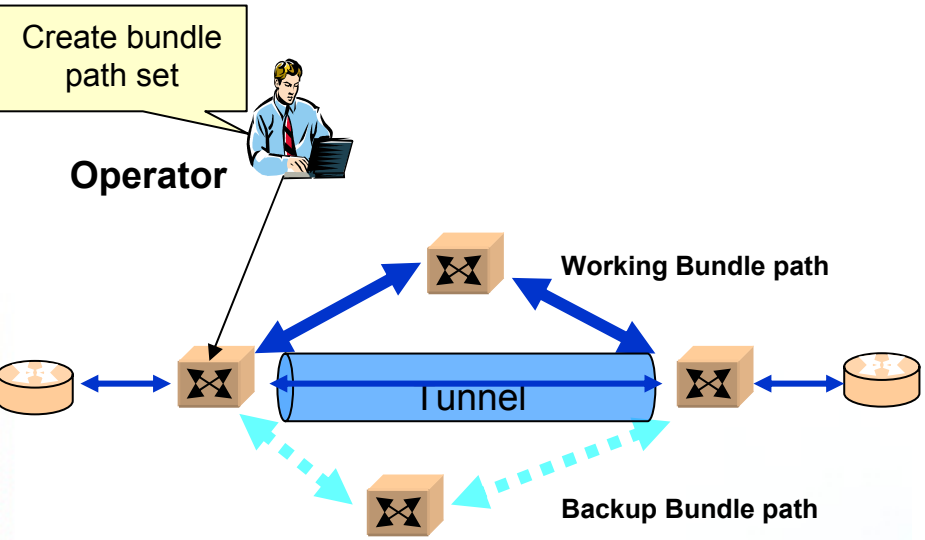


How Can We Setup Bundled Path

Working and backup bundle paths
treated as a single LSP Tunnel (or FA) !!

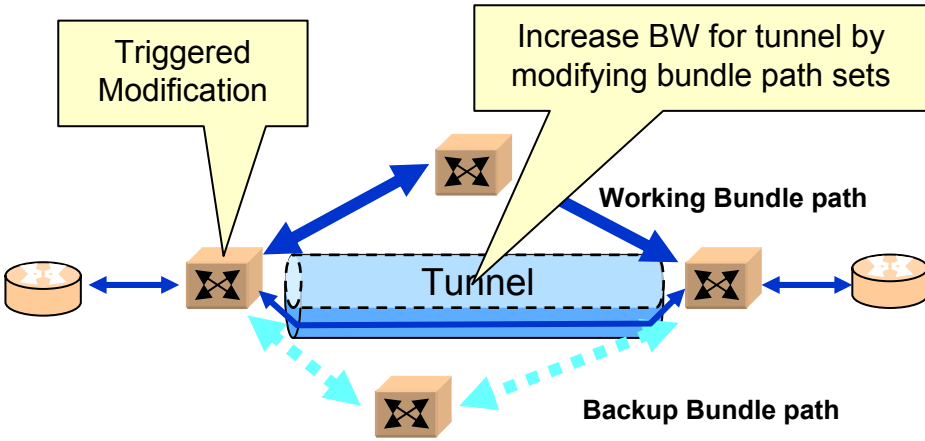
Pre-Provisioned Tunnel

- Static configuration by operator
- With fixed bandwidth
- Advertised as a FA through OSPF.



Dynamic Modified Tunnel

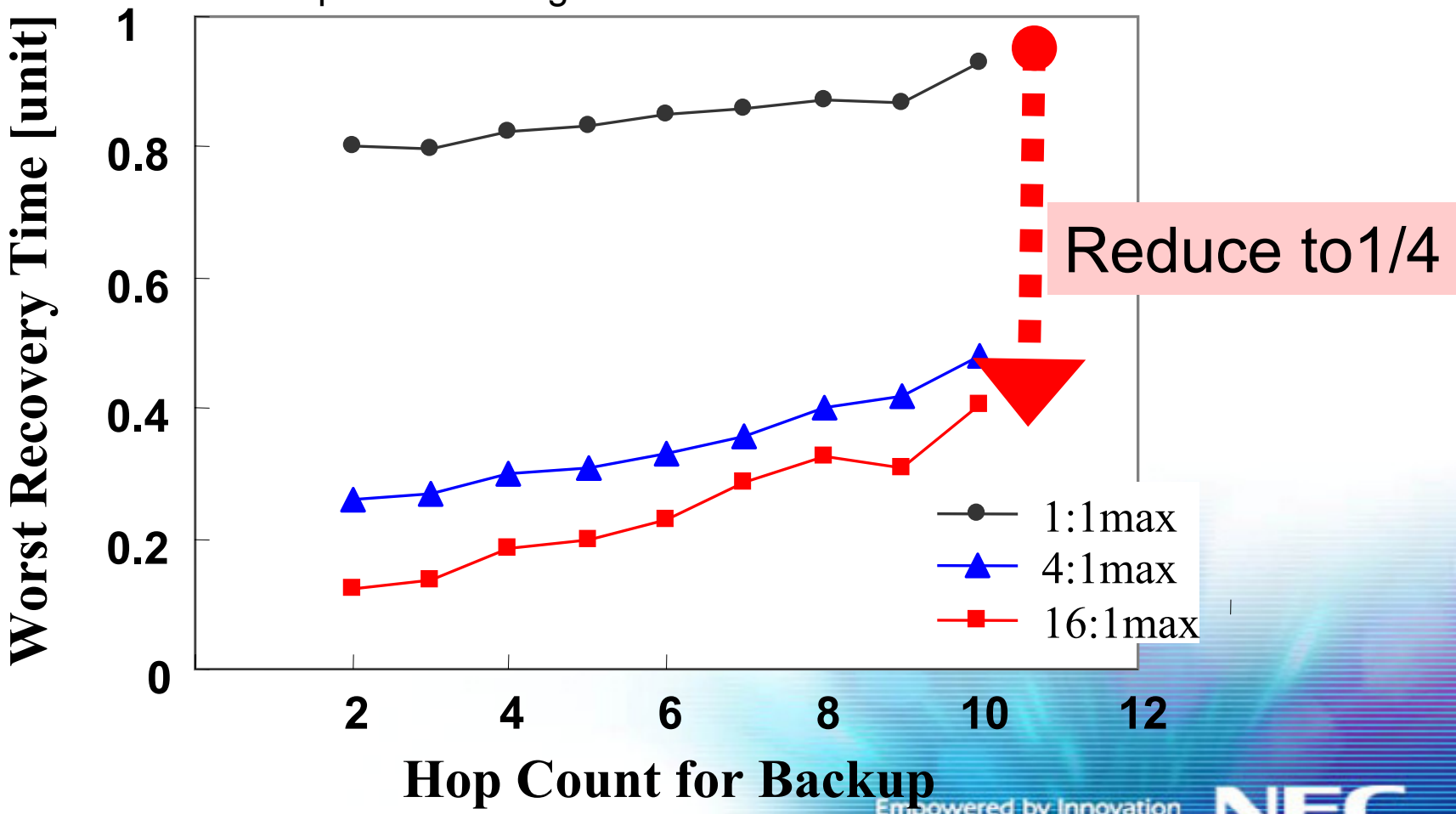
- Dynamic configuration by ingress node
- With modified bandwidth
- not advertised as a FA.



Performance Result of Path Bundling

G: # of Paths in Bundle path

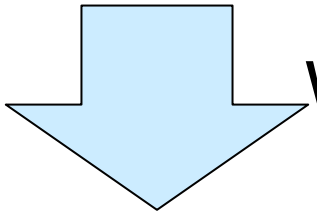
- G=1: 16 Bundle path simultaneous re-routing
- G=4: 4 Bundle path simultaneous re-routing
- G=16: 1 Bundle path re-routing



Approach (II): Process Prioritizing

GMPLS process when failure occur.

- RSVP: Re-routing for failure recovery
- OSPF: Advertising of failure link
  to notify that link is not available now.
- LMP: Fault localization (all optical NW)



Workload Scheduling

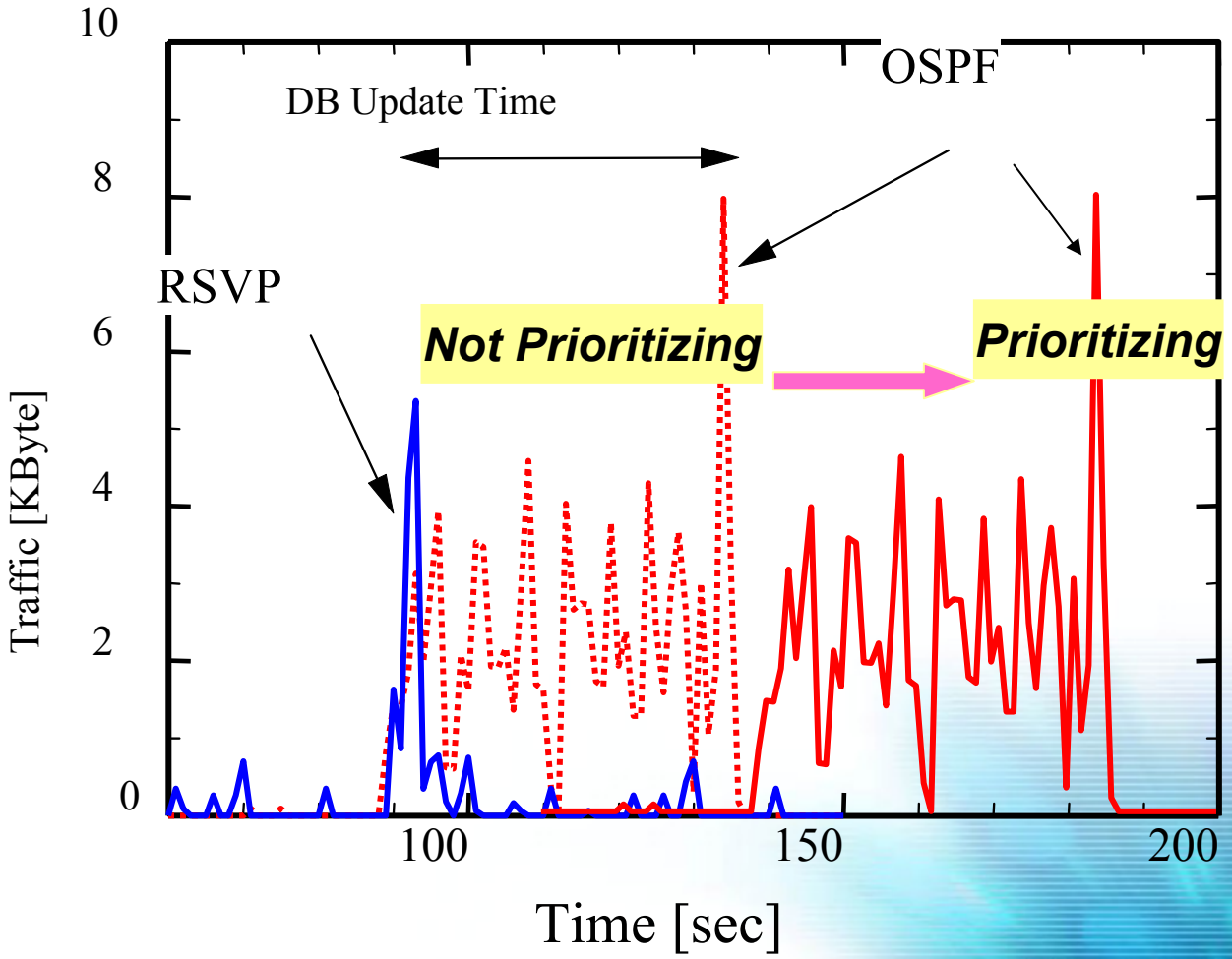
Prioritized processing “only” in failure condition

- Higher priority : RSVP Re-routing, OSPF/LMP Hello
- Lower priority : OSPF advertising, LMP fault localization

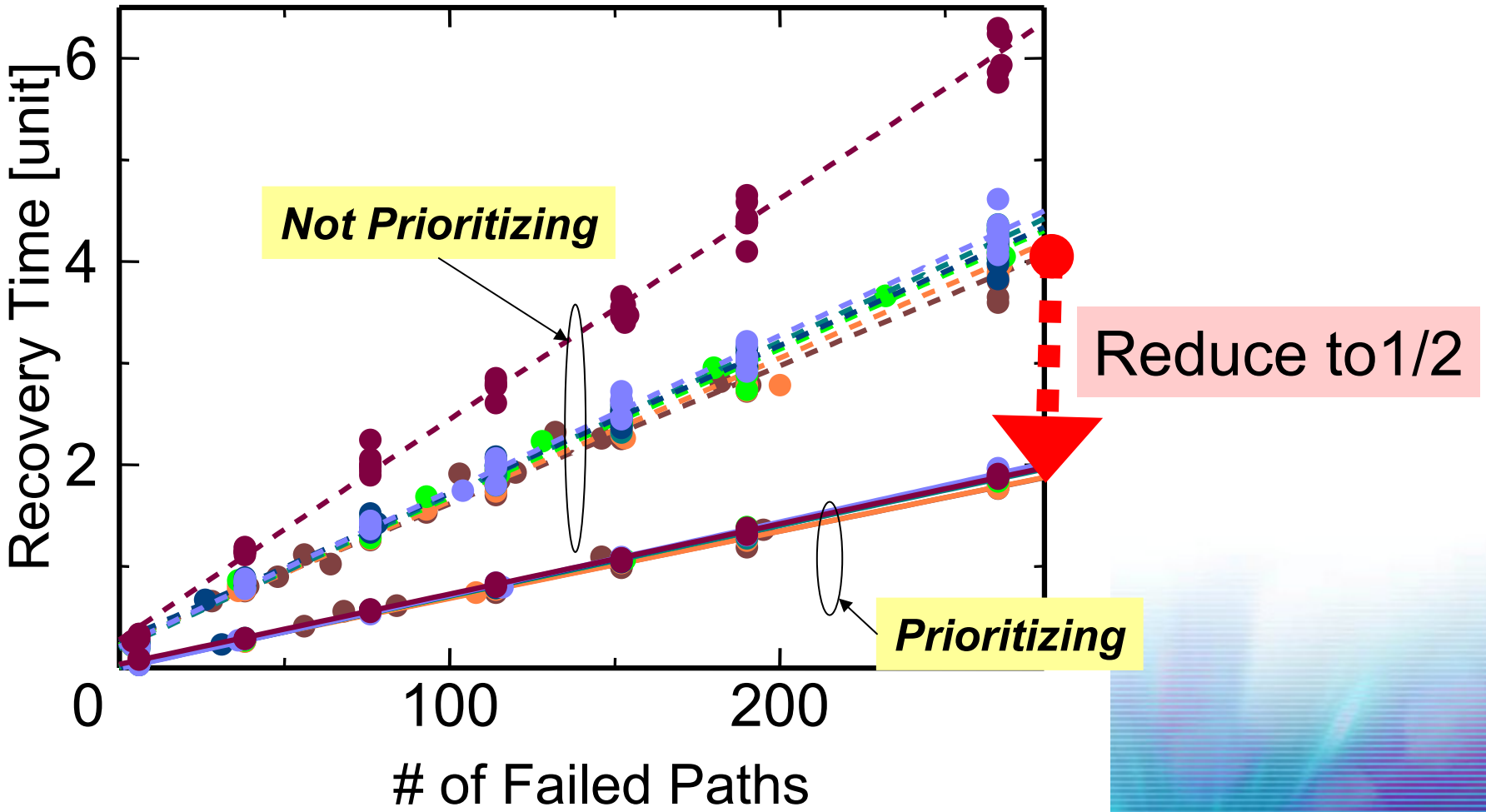
(Note : OSPF/LMP should send hello messages to keep neighbor relationship.)

Control Traffic in Prioritized Processing

RSVP-OSPF Prioritizing



Performance Result of Prioritizing



Full Compatibility with GMPLS Standards

- Path Bundling
  - GMPLS RSVP protocol can carry multiple labels in a single session.
  - Path bundling processed by RSVP is fully compatible with GMPLS RSVP signaling.

- Prioritized processing
  - Every protocol continue to send alive information (i.e. hello msg.)
  - Prioritizing among GMPLS protocols does not affect other GMPLS node.

Summary

- Two approaches are proposed to improve fault recovery performance on GMPLS control plane.
- Experimental results show;
  - Path bundling → 75 % improvement
  - Prioritized processing → 50 % improvement
- These approaches are fully compatible with GMPLS standards.

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