MPLS/GMPLS Migration Network Architecture

February 22, 2005

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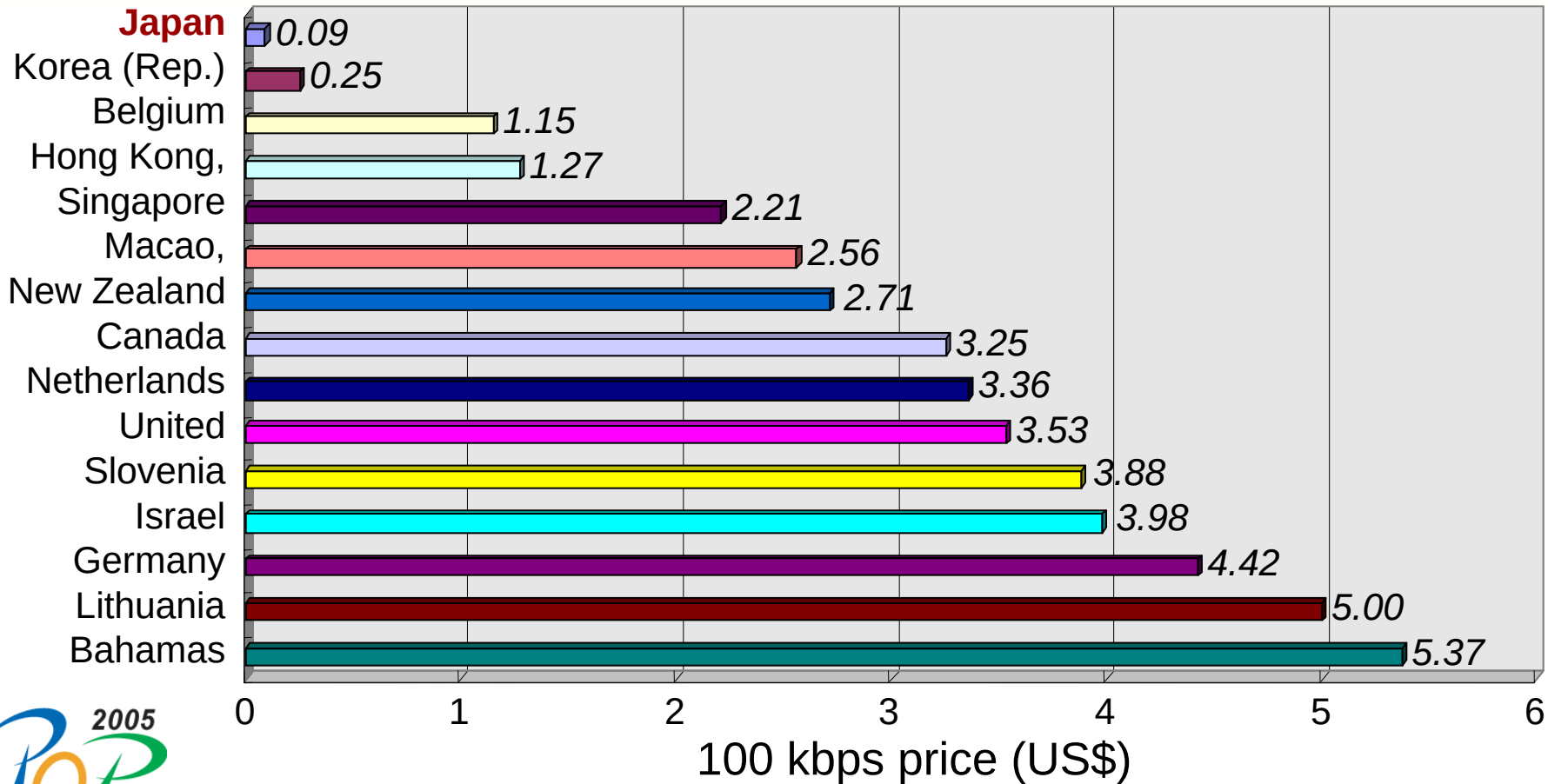
Outline

- Background
- GMPLS-based IP optical network
- Requirements for MPLS/GMPLS interworking
- MPLS/GMPLS interoworking network architecture
- New features of GMPLS protocols
- Issues on MPLS/GMPLS interworking
- Issues on migration from MPLS to GMPLS

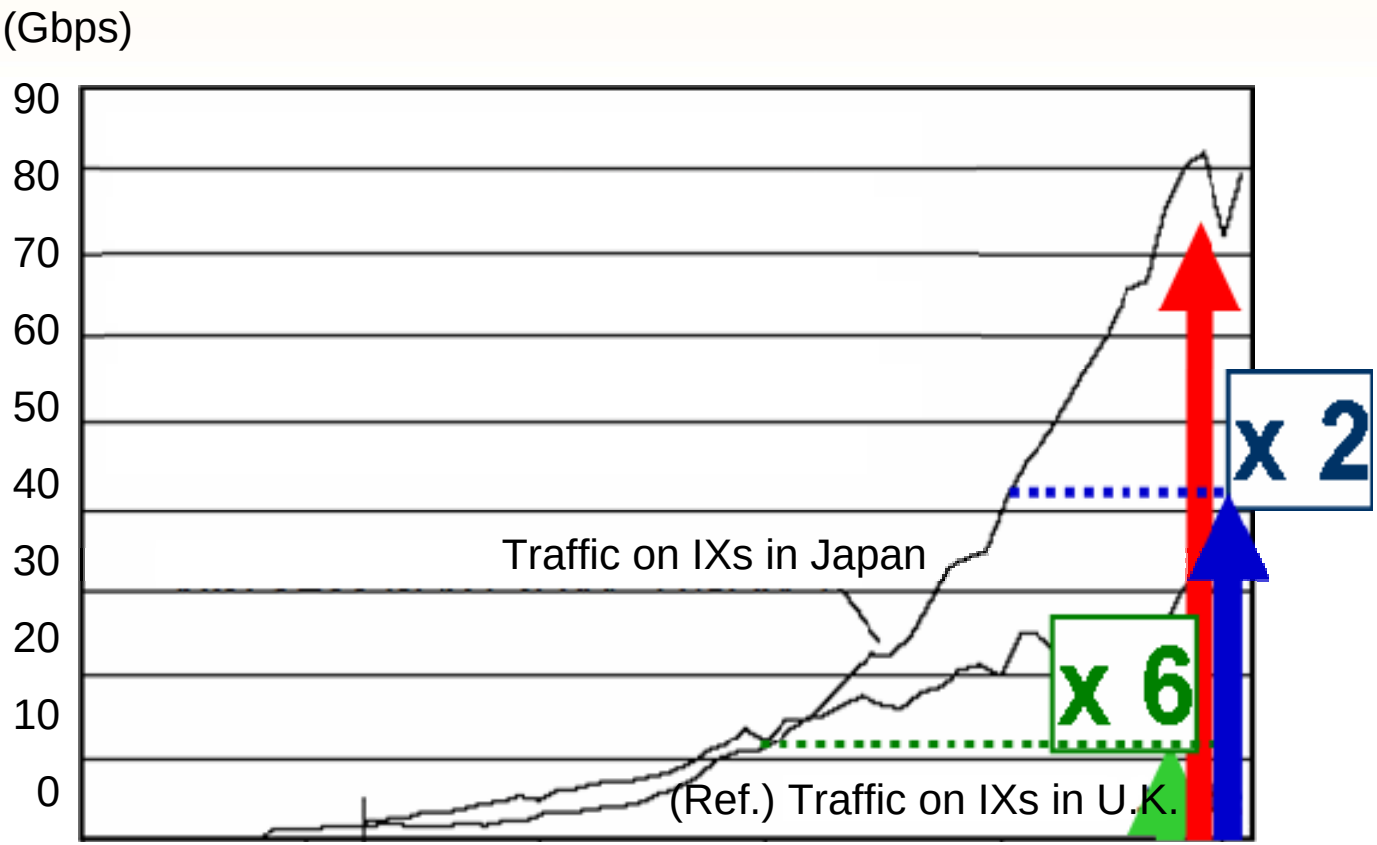
Broadband service price comparison

- Cheapest in the world thanks to fierce competition
- But, no ISPs can profit enough money to invest new tech.



Traffic on IXs of Japan

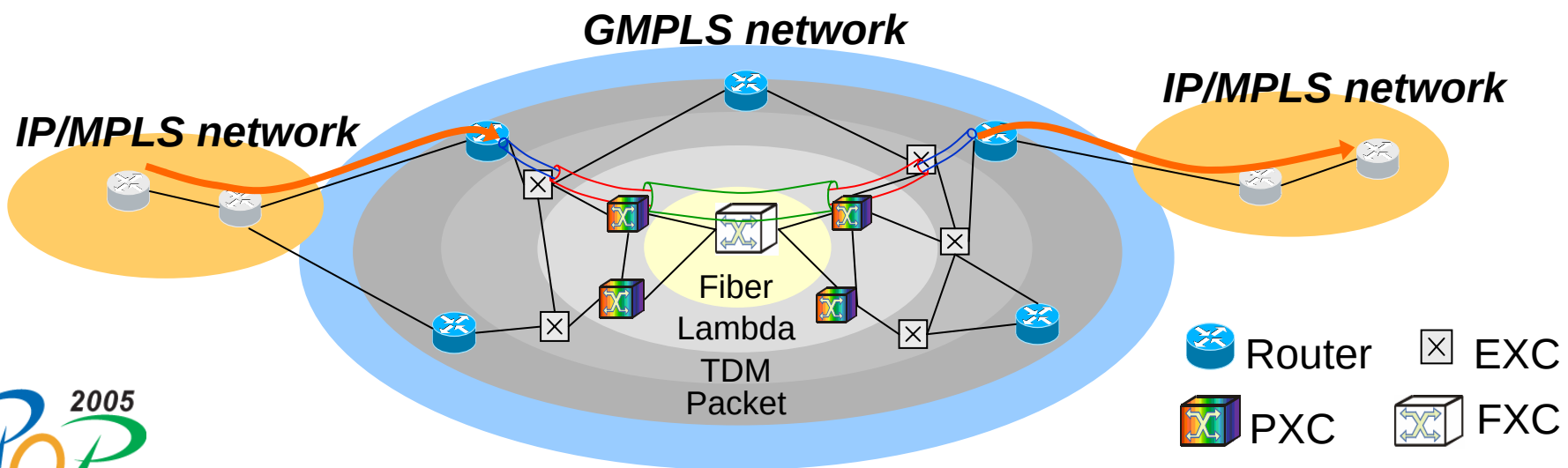
- The amount of traffic has been increasing rapidly.



Excerpt from report from Study Group on Next Generation IP-based Info-communications Infrastructure set up by MPHPT

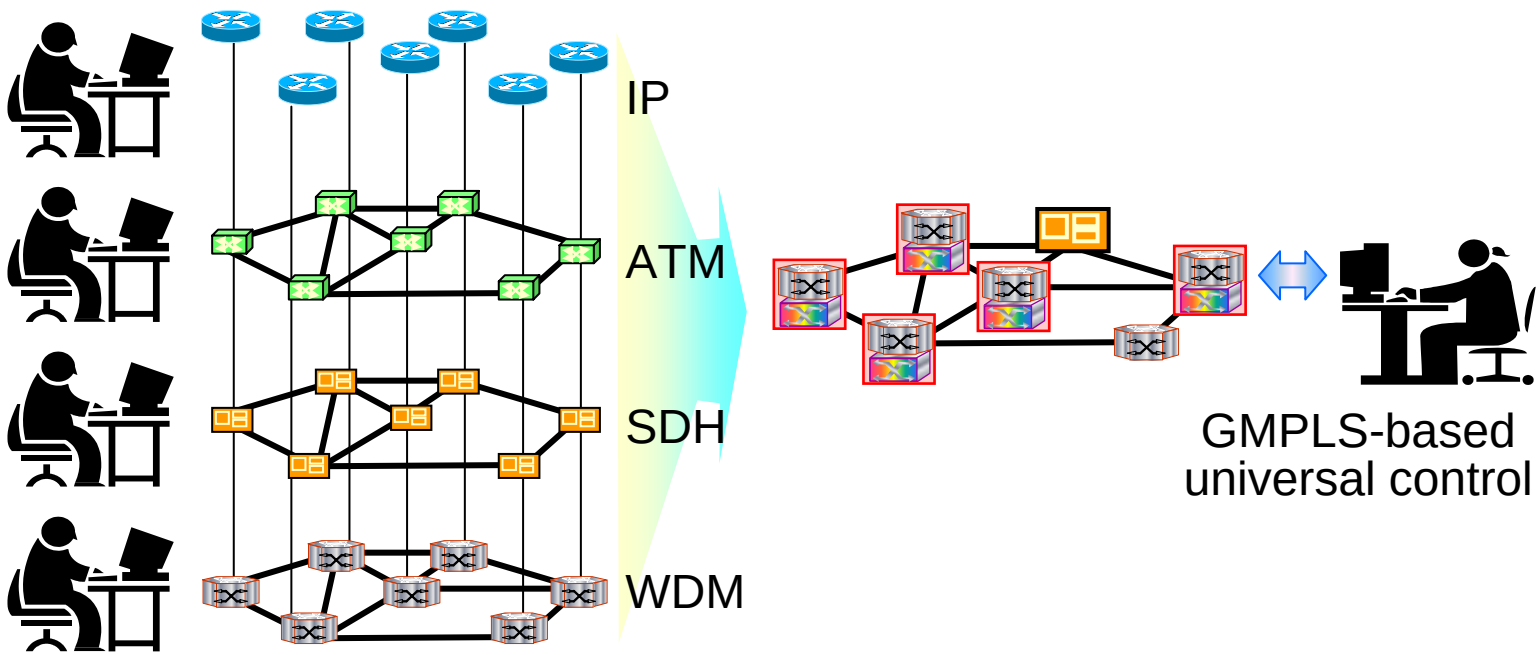
GMPLS-based IP optical network

- Targets
  - High capacity
  - Low-cost services
- GMPLS: Generalized Multi-Protocol Label Switching
  - Extends IP control technique to optical IP layers (TDM, wavelength, fiber)
- Merits of GMPLS-based IP optical network
  - Simplify network operation
  - Increase network efficiency by IP optical traffic engineering



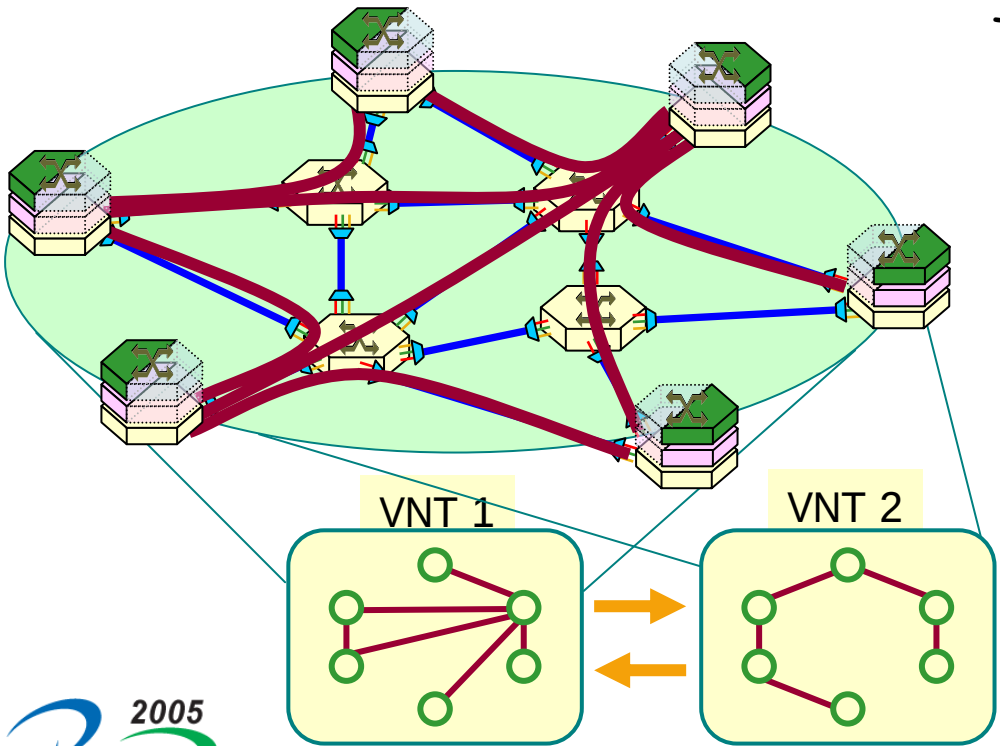
Simplified network operation

- Conventional network operation
  - Each operation system required at each layer.
- Network operation simplified by GMPLS protocols that integrated several layers.
  - Distributed network management in the same way as IP layer
    - Path setup: signaling
      - » Topology information collection: routing



IP optical traffic engineering

- Optical-layer provides virtual network topologies (VNT) for IP layer.
- VNT is reconfigured according to traffic demand fluctuation.
- VNT reconfiguration is performed by setup/release of optical paths.



Traffic demand

$$\begin{pmatrix} r_{1,1} & r_{1,2} & \cdots & r_{1,n} \\ r_{2,1} & r_{2,2} & \cdots & r_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n,1} & r_{n,2} & \cdots & r_{n,n} \end{pmatrix}$$

Current VNT

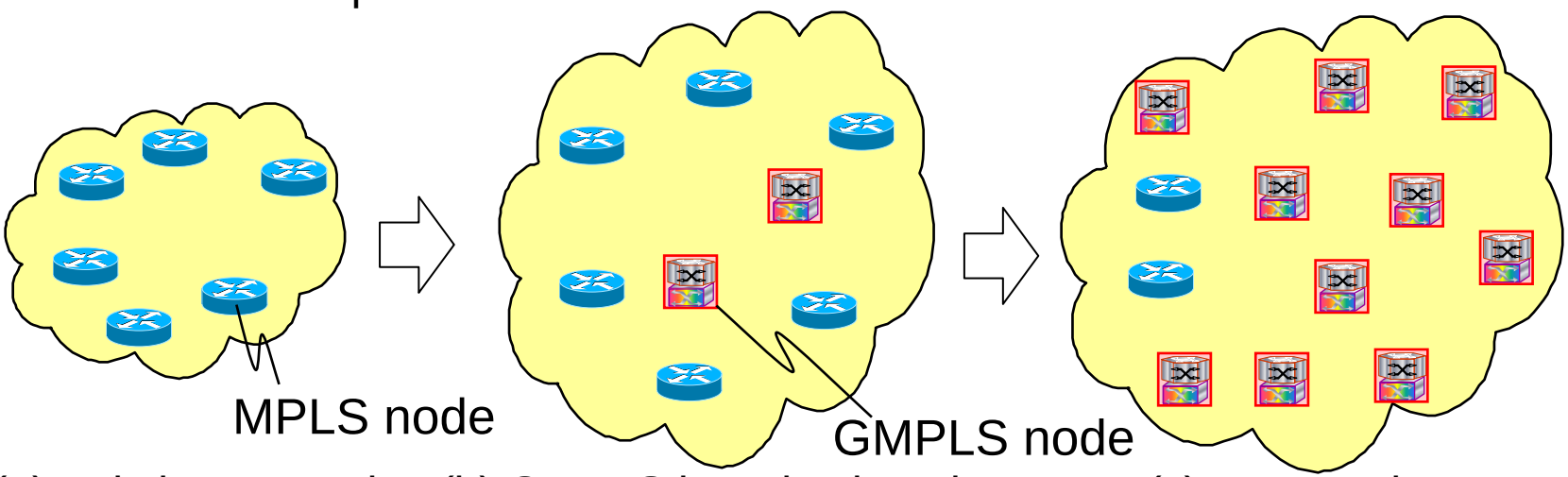
$$\begin{pmatrix} P_{1,1} & P_{1,2} & \cdots & P_{1,n} \\ P_{2,1} & P_{2,2} & \cdots & P_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ P_{n,1} & P_{n,2} & \cdots & P_{n,n} \end{pmatrix}$$

New VNT

$$\begin{pmatrix} P_{1,1} & P_{1,2} & \cdots & P_{1,n} \\ P_{2,1} & P_{2,2} & \cdots & P_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ P_{n,1} & P_{n,2} & \cdots & P_{n,n} \end{pmatrix}$$

Introduction of GMPLS technologies

- Interworking between MPLS networks and GMPLS networks
  - GMPLS nodes co-exit in GMPLS introduction phase
  - How to interwork these networks?
- MPLS/GMPLS Migration
  - How to migrate from MPLS to GMPLS networks?
  - Should we replace MPLS nodes with GMPLS nodes?



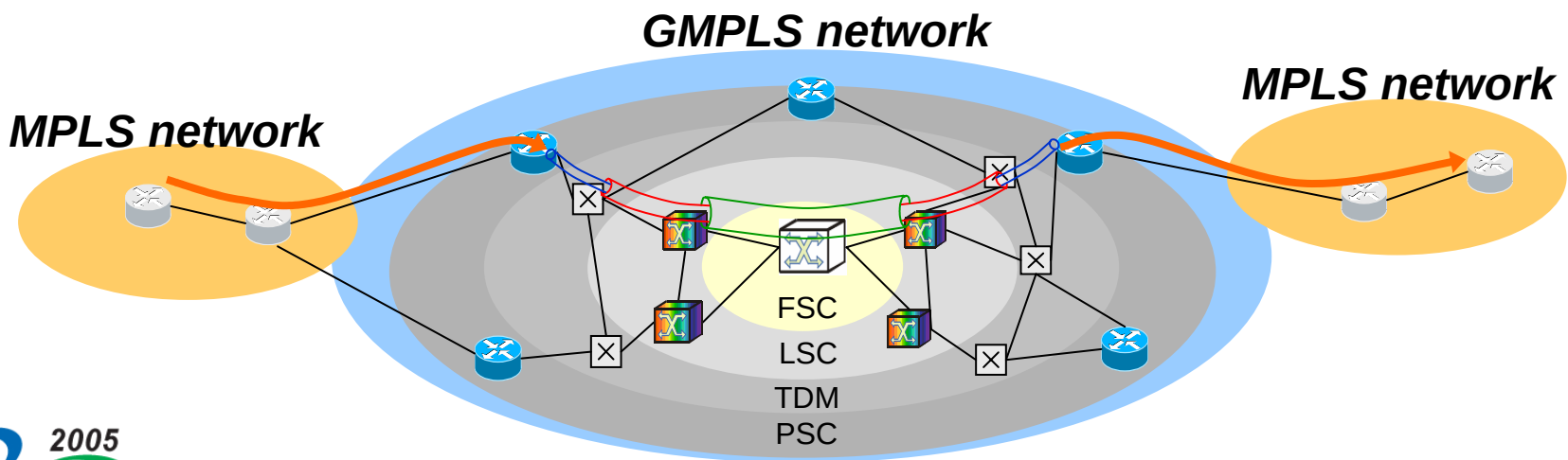
(a) Existing network (b) GMPLS introduction phase (c) Mature phase

Network models

- Network models proposed by IETF and OIF.
  - Overlay model
  - Peer model

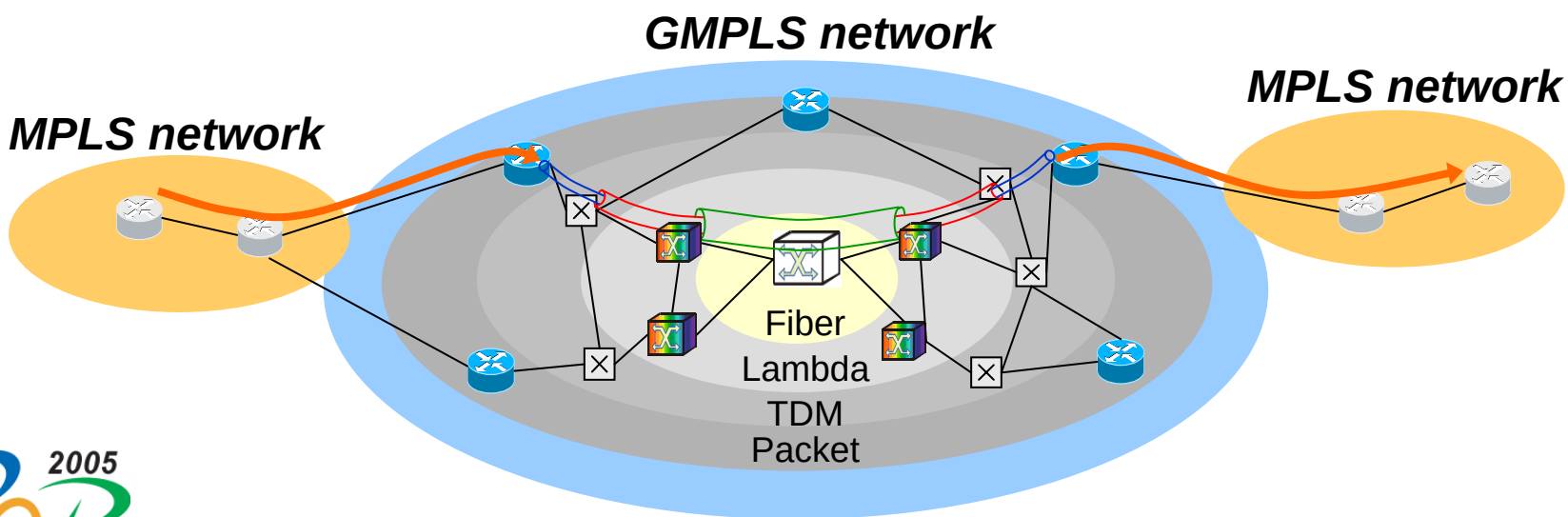
Overlay model

- Pros
  - MPLS nodes do not have to be updated to GMPLS.
- Cons
  - MPLS network cannot perform efficient TE considering GMPLS network resources.
  - MPLS network cannot exchange TE info via GMPLS network.



Peer model

- Pros
  - MPLS network can perform efficient TE considering GMPLS network resources.
  - MPLS network can exchange TE info via GMPLS network.
- Cons
  - Necessary to update MPLS to GMPLS.

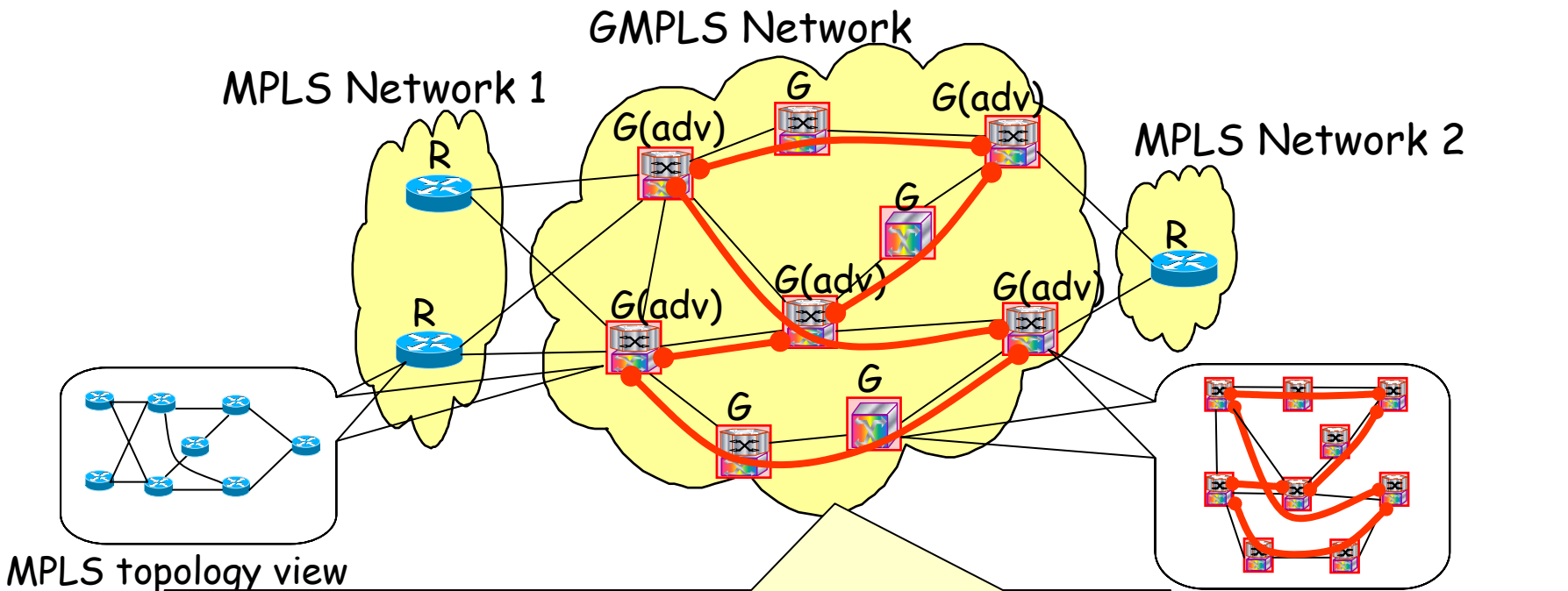


Requirements for MPLS/GMPLS interworking

- Take both advantages of peer and overlay models
  - MPLS nodes do not have to be updated to GMPLS.
  - MPLS network can perform efficient TE considering GMPLS network resources.
  - MPLS network can exchange TE info via GMPLS network.

MPLS/GMPLS interworking architecture

- MPLS routers can co-exist with GMPLS network without upgrading their protocols.
- MPLS routers collect appropriate abstracted TE information from GMPLS network.
- MPLS router handles MPLS-based TE topology.
- Traffic engineering in both MPLS network and GMPLS network is performed.



New features of GMPLS protocols

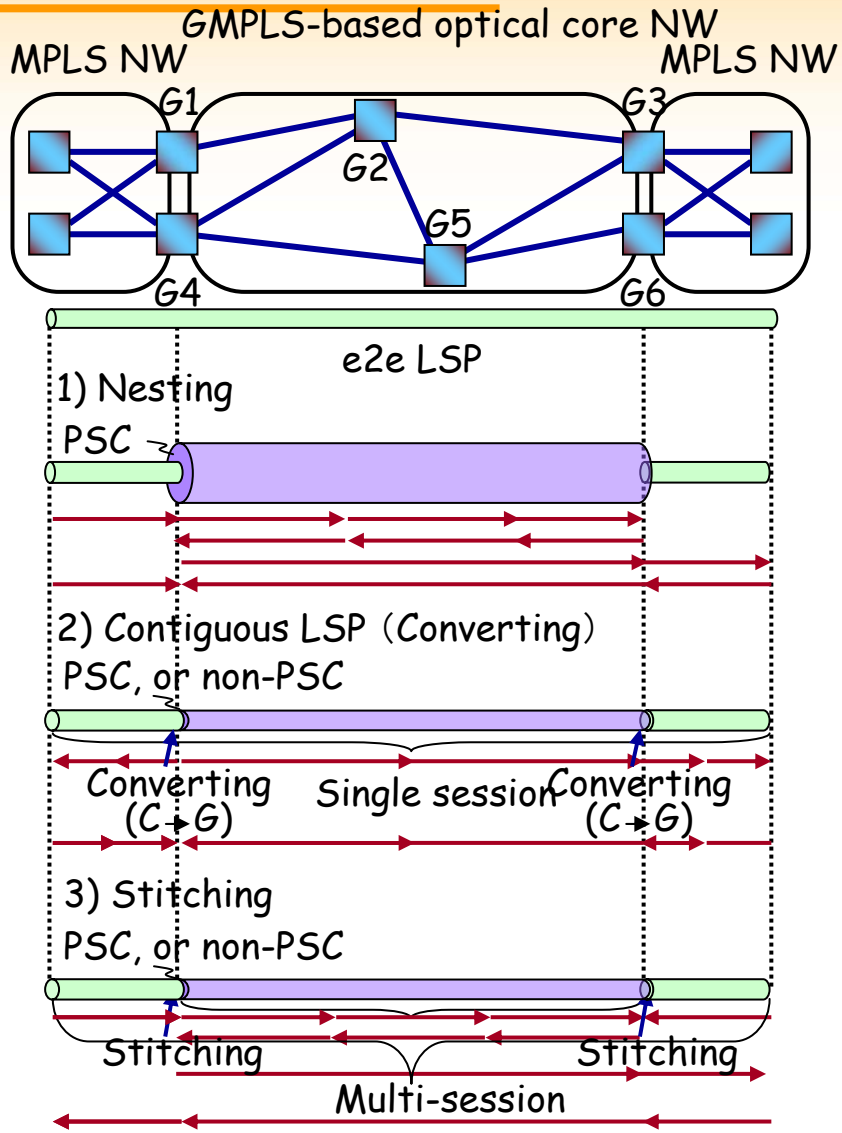
- General
  - Control plane data plane separation
- OSPF Routing
  - Opaque TE extensions
    - Interface Switching Capability sub-TLV
    - Protection and SRLG sub-TLVs
    - Link Local/Remote Identifiers sub-TLV
- RSVP signaling
  - Generalized Label Object
  - Upstream Label Object
  - Protection Object
  - Etc.

Routing issues

- MPLS nodes cannot understand GMPLS TE link.
  - GMPLS TE links need to be transform into MPLS TE links at GMPLS border nodes.
- MPLS networks consider the GMPLS control plane as data plane
  - Data traffic from MPLS network should not be carried into the GMPLS control plane.

Signaling issues

- Signaling schemes
  - Nesting
    - MPLS LSP is nested into GMPLS LSP
    - Hierarchy LSP
  - Contiguous LSP (Converting)
    - Protocol conversion between MPLS and GMPLS
  - Stitching
    - Stitches MPLS LSP segment and with GMPLS segment
- Issues
  - Which scheme should be adopted?
  - Protocol extensions required?



Issues on MPLS/GMPLS migration

- New functions of GMPLS
  - Bi-directional signaling support
  - GMPLS protection & restoration
  - Graceful tear down, graceful restart
  - etc.
- Packet LSP: GMPLS PSC LSP or MPLS LSP?
  - Integrate into GMPLS PSC LSP
    - Generalized Label Request Object used
    - All GMPLS in future
  - Integrate into MPLS LSP
    - Label Request Object used
    - MPLS LSP includes GMPLS functions
      - What GMPLS function is necessary?
    - GMPLS PSC LSP will not be used.

Discussion in IETF

- Discussion on “MPLS/GMPLS migration” has started in IETF CCAMP WG last year.
- Related draft
  - draft-oki-ccamp-gmpls-ip-interworking-04.txt, October 2004.

Summary

- GMPLS-based IP optical network
- Requirements for MPLS/GMPLS interworking
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- Issues
  - MPLS/GMPLS interworking
  - Migration from MPLS to GMPLS
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