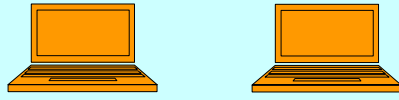




- SONET/SDH
- Ethernet
- · - Virtual data link

GMPLS network in Japan

Protocol viewer



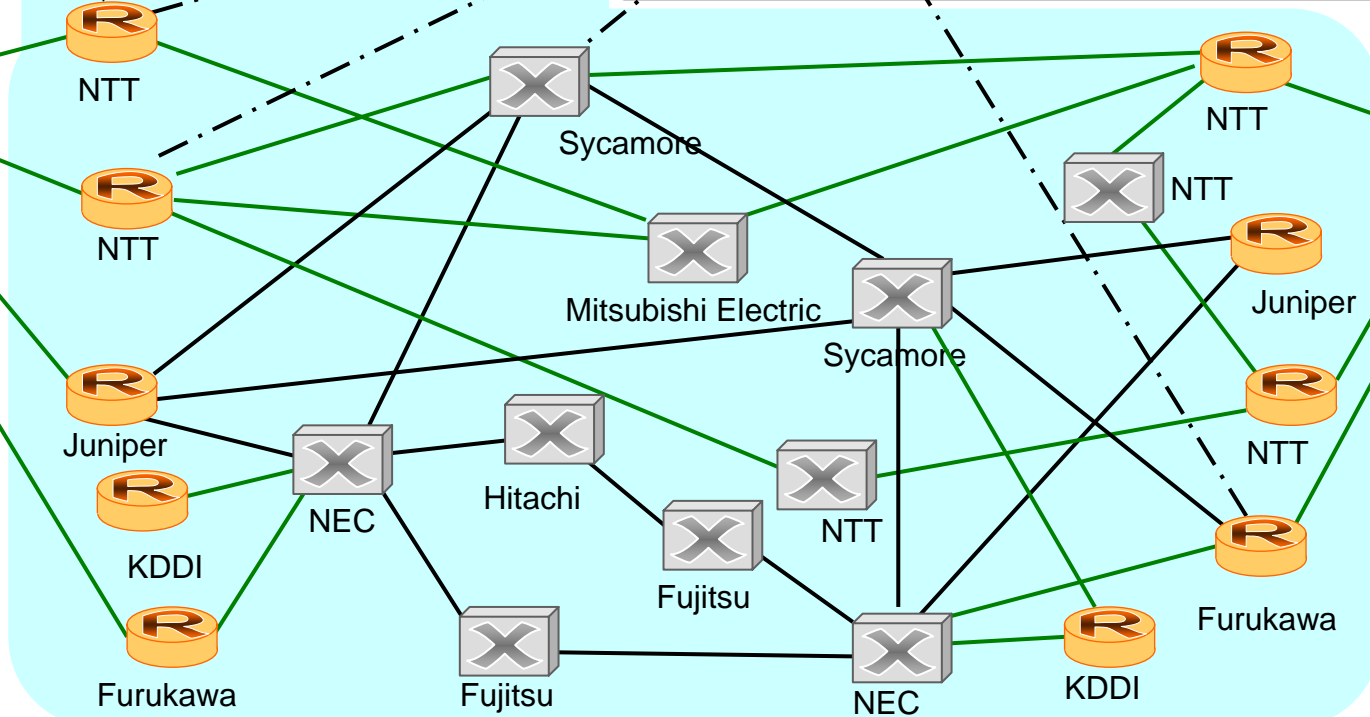
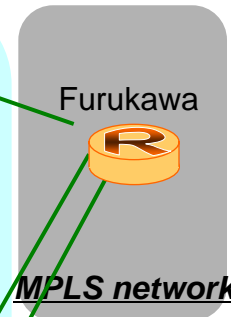
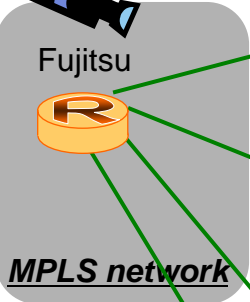
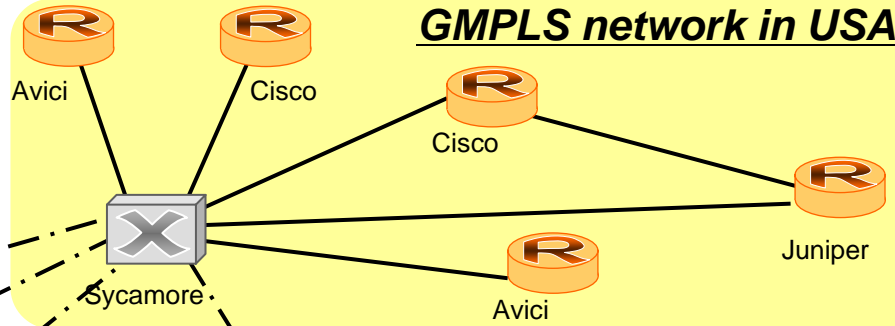
NTT-AT

TOYO

PCE

GTEP

GMPLS network in USA



Next Generation networking technologies for IP and Optical networks

Environment

Largest GMPLS interoperability demonstration in Japan

- **Trans-Pacific demonstration with C/D-plane between Isocore site (USA) and TFT site (Japan)**
- **Multiple carrier/vendor equipments and protocol analyzers**
- **Cover all switching capabilities (Packet, TDM, Lambda, Fiber)**

Areas

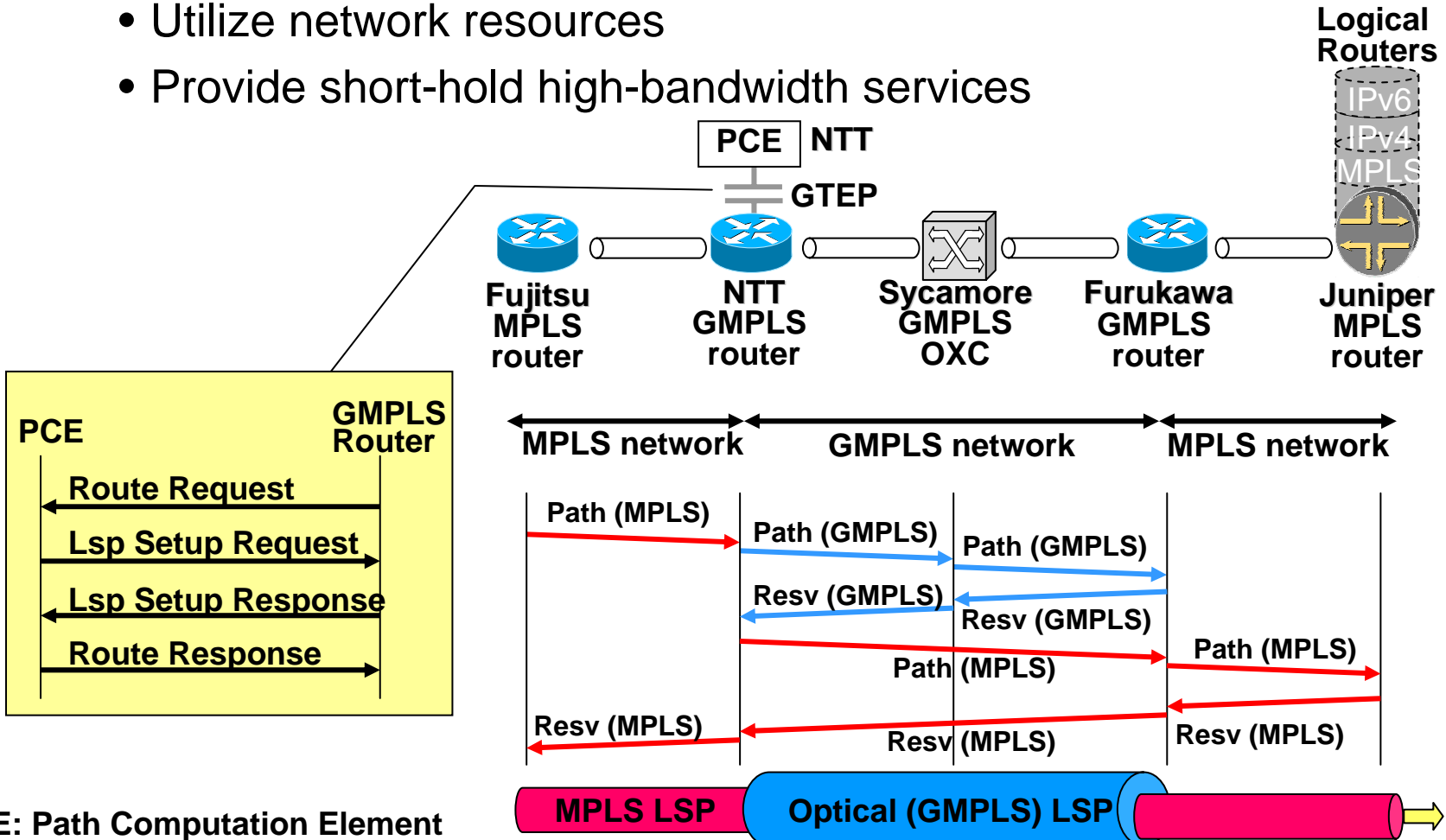
- **Basic GMPLS Protocols**
- **MPLS/GMPLS Migration**
- **OUNI**
- **Protection & Restoration**
- **Multi-region Traffic Engineering**
- **Multi Layer/Region LSP control**
- **PCE (Path Computation Element)**
- **Logical Routers**

MPLS/GMPLS Migration



Dynamic optical path control triggered by MPLS path setup

- Utilize network resources
- Provide short-hold high-bandwidth services

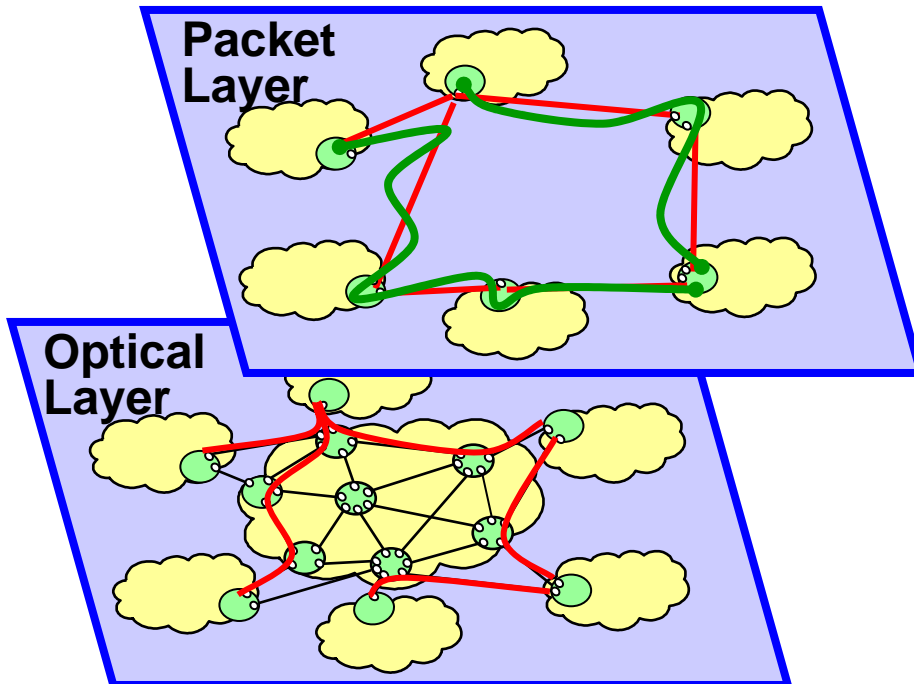


PCE: Path Computation Element

GTEP: Generalized Traffic Engineering Protocol

High network resource utilization

- Optical layer provides virtual network topologies (VNT) for packet 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

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



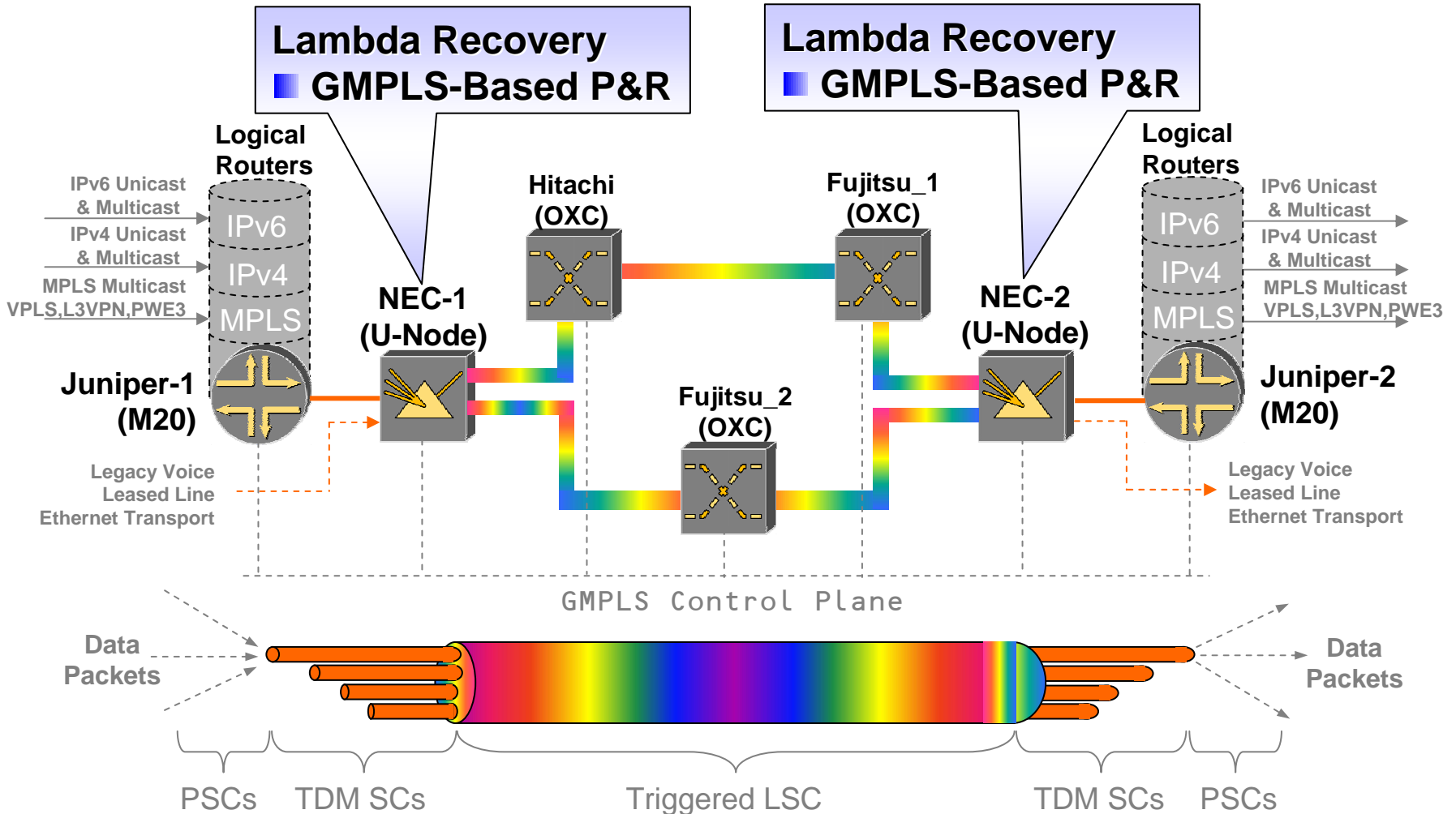
New VNT

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

VNT: Virtual network topology

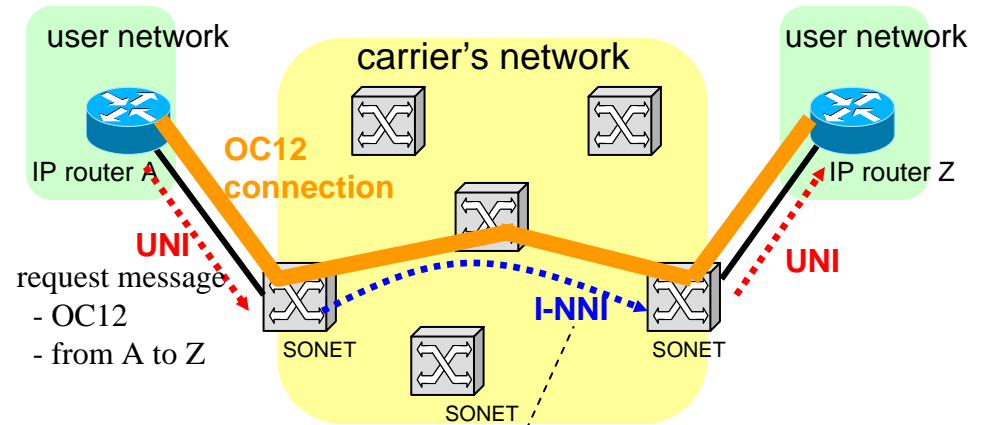
Protection & Restoration

Multi-Layer High Availability in IP + Optical



High usability between user's network and carrier's

OIF-UNI specification provides high usability and interoperability between transport network elements (SONET/SDH, Optical Switch, etc) and Layer 2/3 client elements (Ethernet, IP, etc).



➤ User's benefits:

Can request **connection setup / teardown on demand** via UNI message only.

➤ Carrier's benefits:

Can **eliminate manual operations** for user requested connection setup / teardown.

