

GMPLS and Path Computation Element based Multi Layer Service Network Architecture

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Outline

- **Background**
- **Multi-Layer Service (MLS) Network Architecture**
- **Multi layer traffic engineering with PCE**
- **Numerical Evaluation**
- **Standardization**

Requirements for future carriers' backbone networks

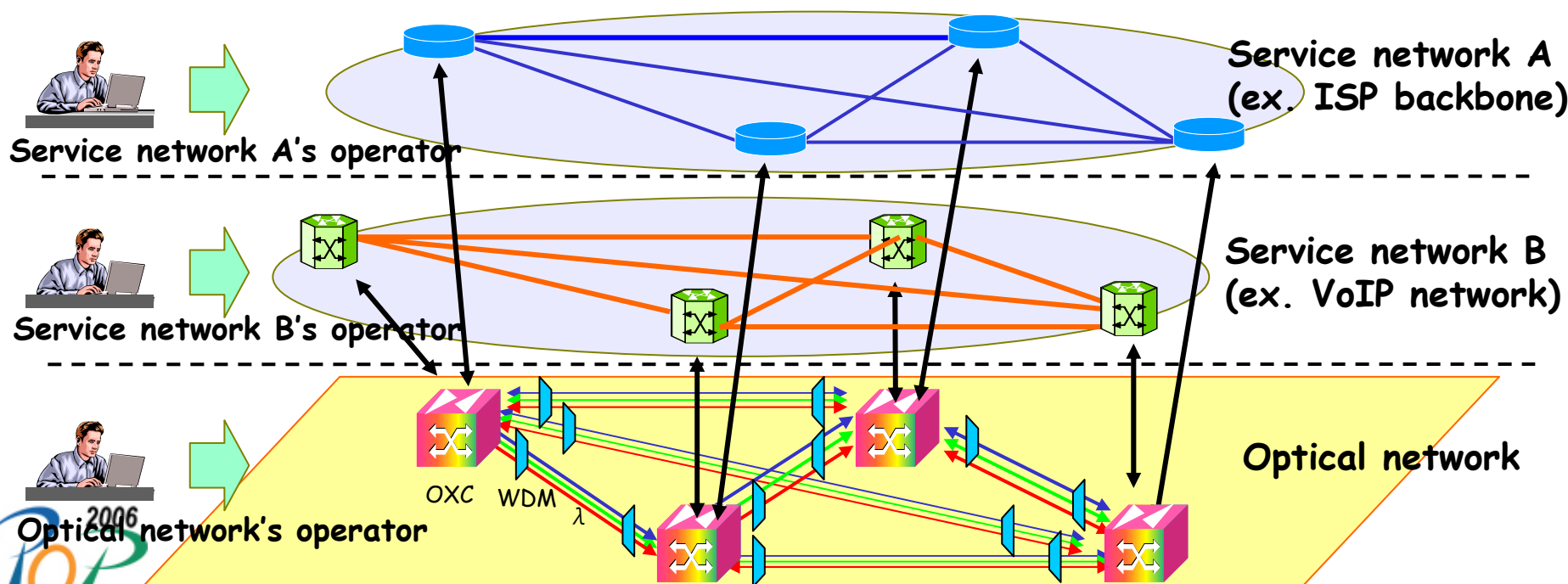
- **High capacity (rapid traffic growth)**
- **Flexibility**
 - **Uncertain demand**
 - **Rapid new service provision**
 - **Multi-layer TE**
- **Multiple service network accommodation**
 - **Share a single optical infrastructure**
- **Easy migration from existing networks**
 - **Little or no impact on services**

Flexibility

- **Flexibility is a critical issue for future carriers' backbone networks:**
 - **Traffic demand forecast of IP-based services tends to be difficult.**
 - **Carriers need a new provisioning tool to build and expand a service network rapidly.**
- **GMPLS and Multi-layer TE are solutions.**
 - **GMPLS will be a useful tool for provisioning optical layer paths.**
 - **Multi-layer TE enables more advanced provisioning by considering both of optical network and IP/MPLS service networks.**

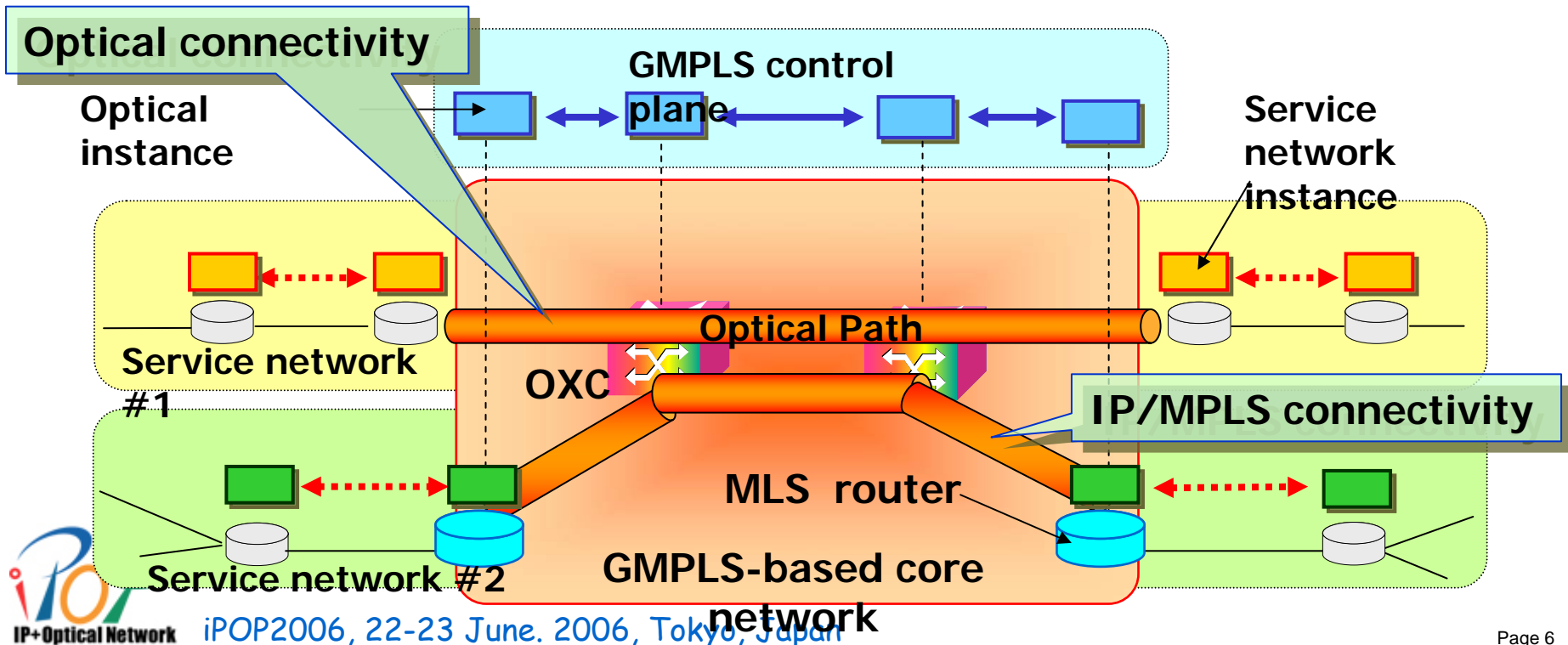
Multiple service network accommodation

- Today, multiple service networks are managed independently along with its own policy.
- An optical infrastructure is to be shared.
- Need migrating without impact on;
 - IP address conflict, routing instability, ...



Multi-Layer Service (MLS) Network Architecture

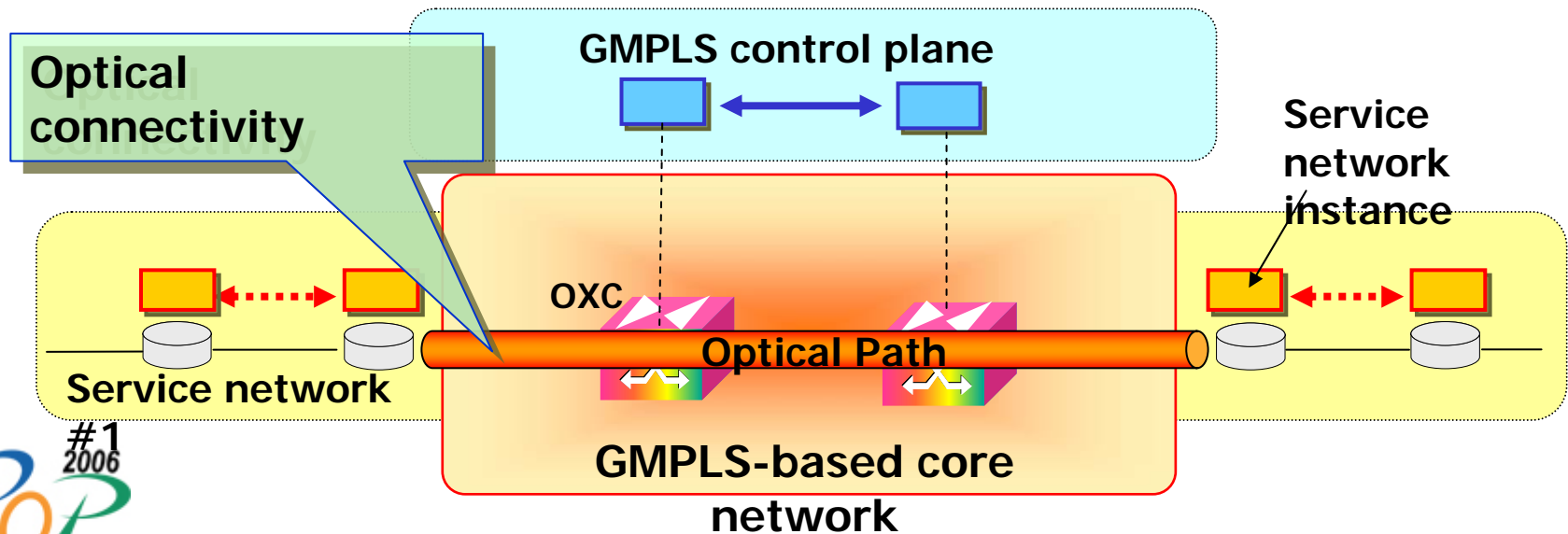
- An optical-based network architecture which provides optical connectivity and IP/MPLS connectivity to service networks to meet the needs of service specifications.
 - Bandwidth, QoS, Reliability, Management-independency, etc.



Multi-Layer Service Network Architecture

Optical connectivity service

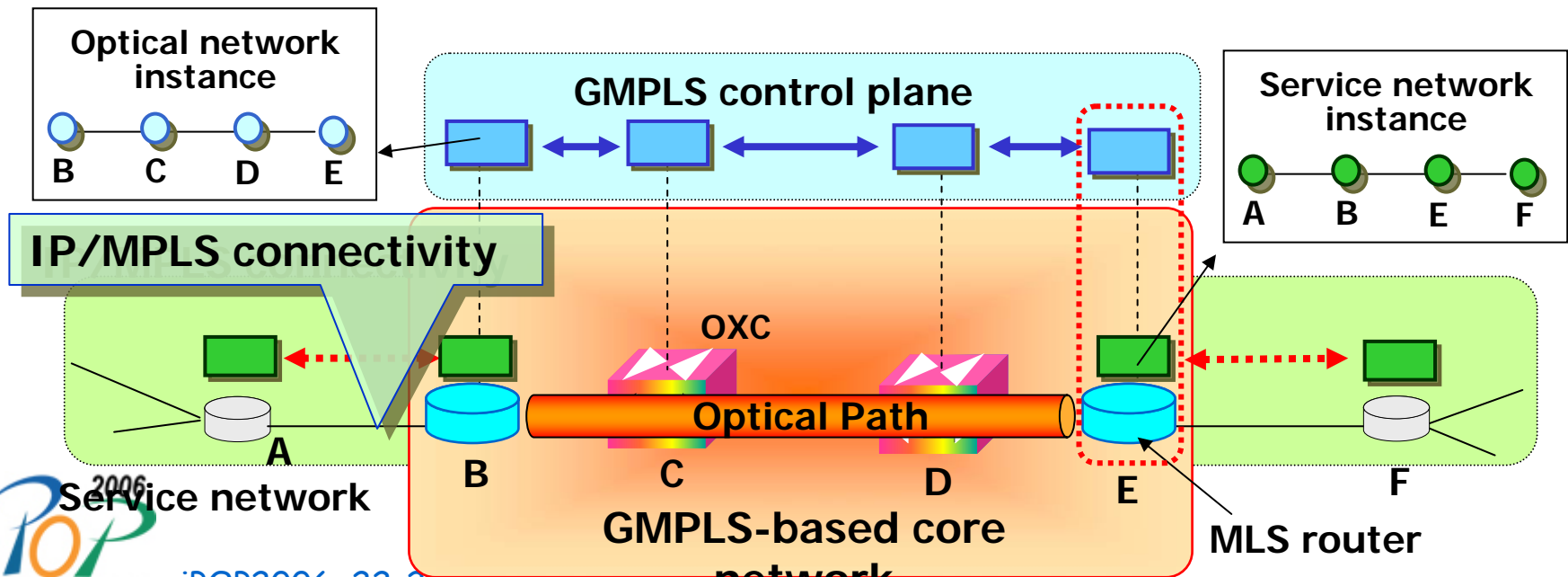
- Service networks are separated using layer 1 path. (wavelength, optical fiber and TDM channel)
 - High independence among service networks
- GMPLS provides optical connectivity, P&R, TE etc. to service networks.



Multi-Layer Service Network Architecture

IP/MPLS connectivity service

- **MLS routers have one (1) optical and one-or-more service network control instances.**
 - **Visibility of both layers for multi-layer TE**
 - **No need for pure “peer” GMPLS**
- **GMPLS provides IP/MPLS connectivity to service networks.**

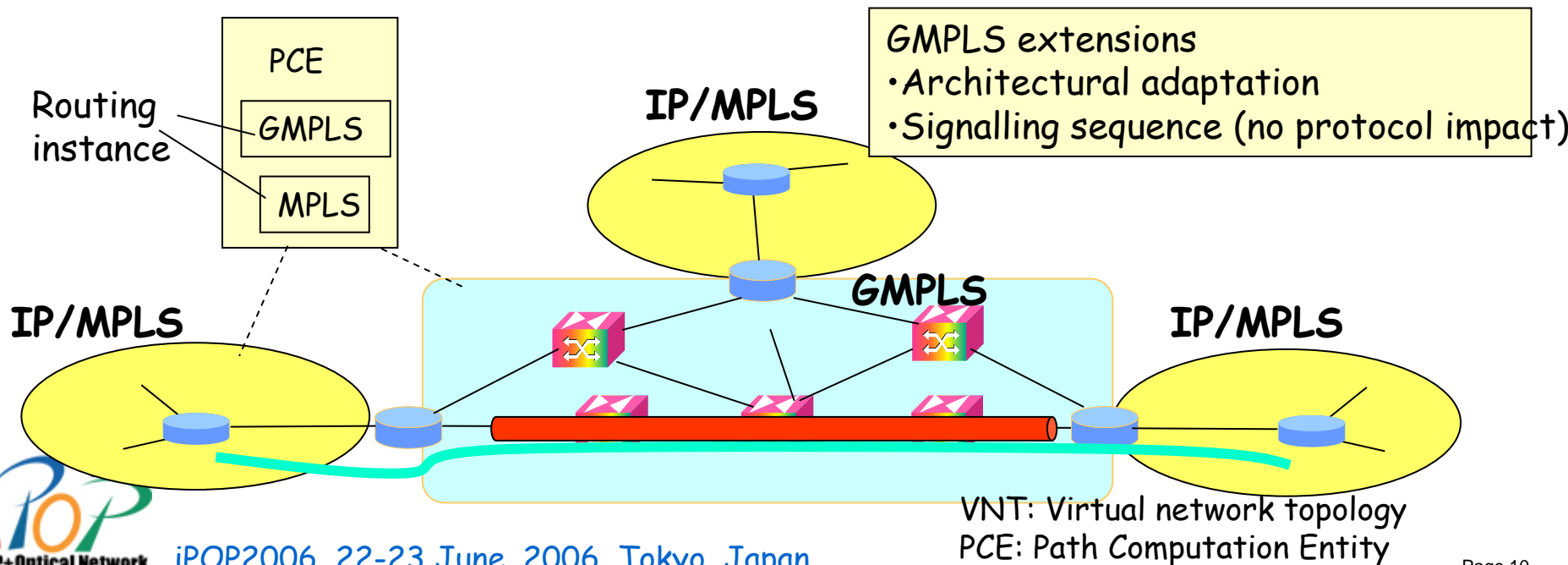


Comparison with existing network models

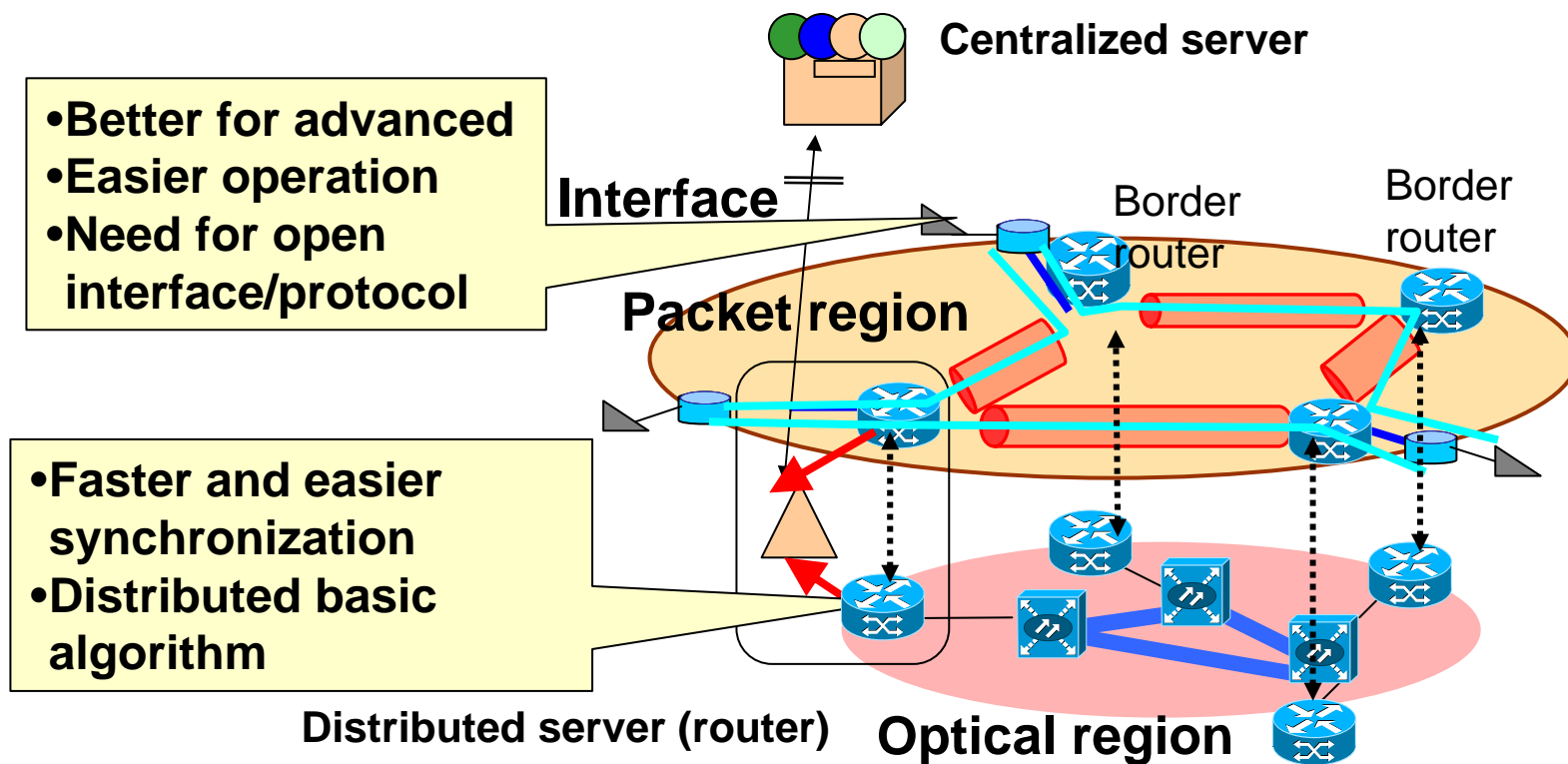
	Multi-layer Service Network	Peer model	Overlay model
Architecture			
Routing instance	Separate	Share	Separate
Existing Protocol	GMPLS	GMPLS	GMPLS UNI OIF UNI
Evaluation			
Multiple service network support	Good	Poor	Good
Multi-layer TE	Good	Good	Poor
Ease of migration	Good	Poor	Good

Multi layer traffic engineering with PCE

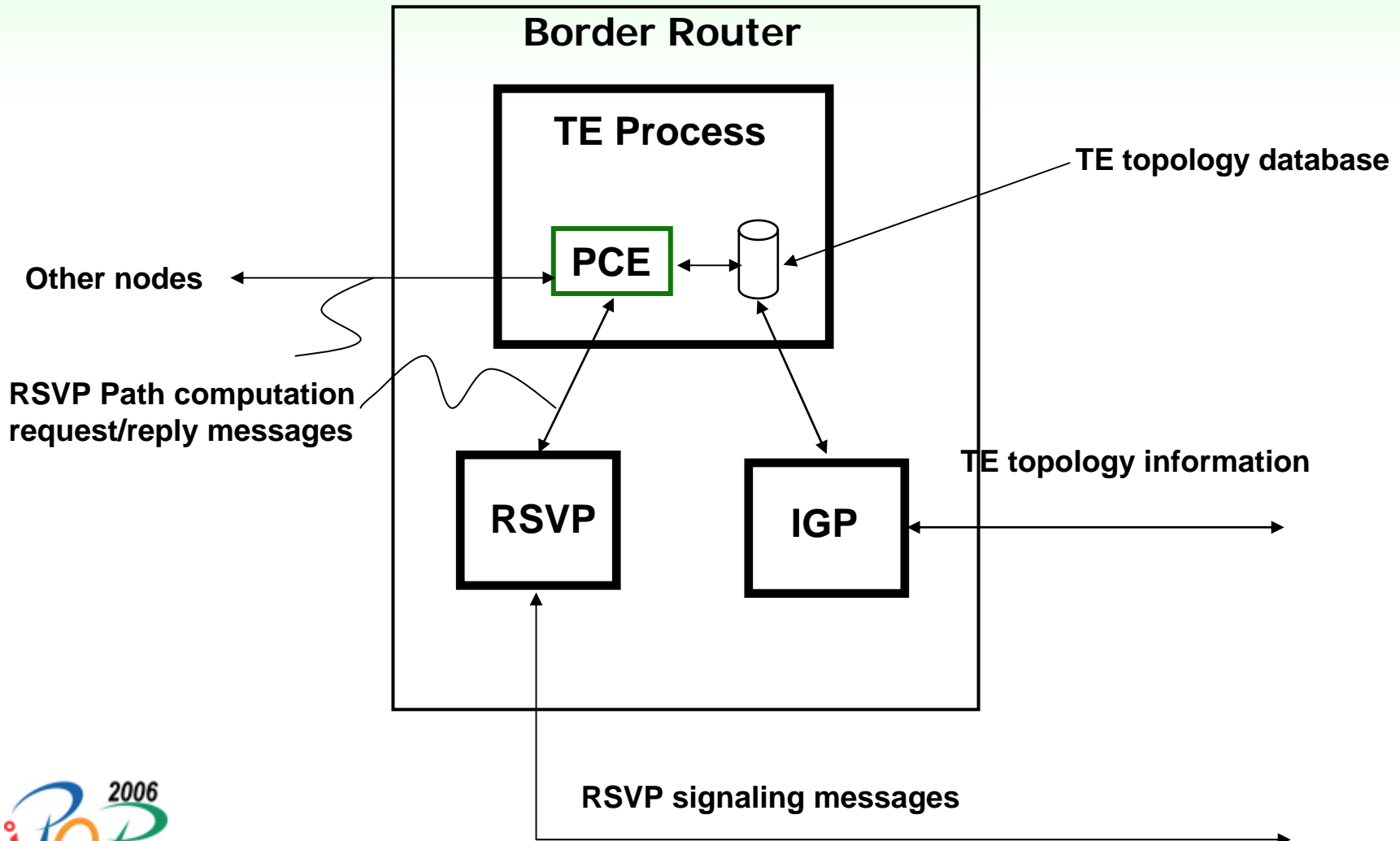
- PCE resides at border(s) of different regions and/or layers and/or domains
 - Knows both topology & resource
 - Participates both routing operations
 - Computes end-to-end path
 - Can create/modify path if needed (optional)
- PCE enables carrier policy based multi layer TE for advanced control



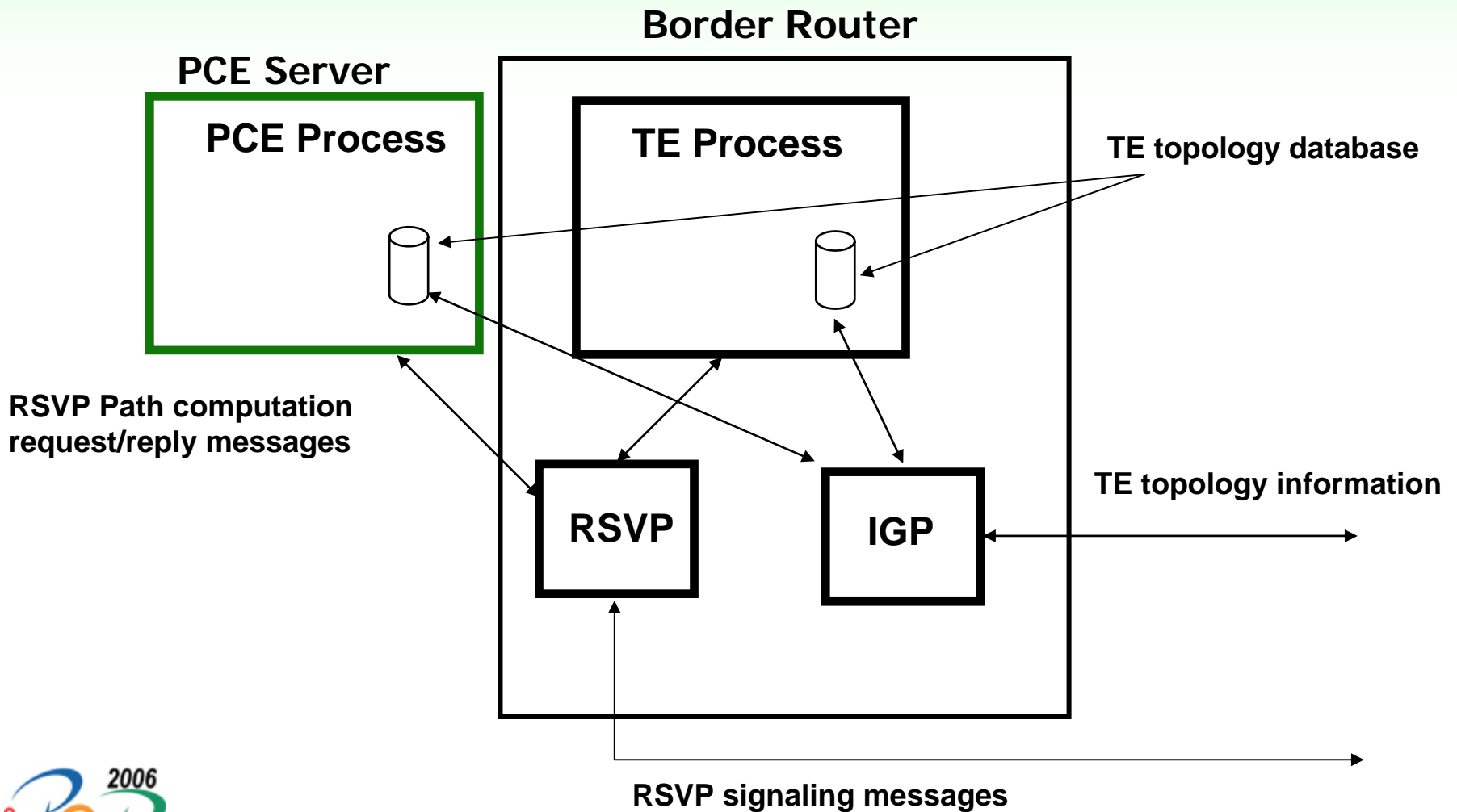
PCE based MLS Network Architecture



Composite PCE



External PCE



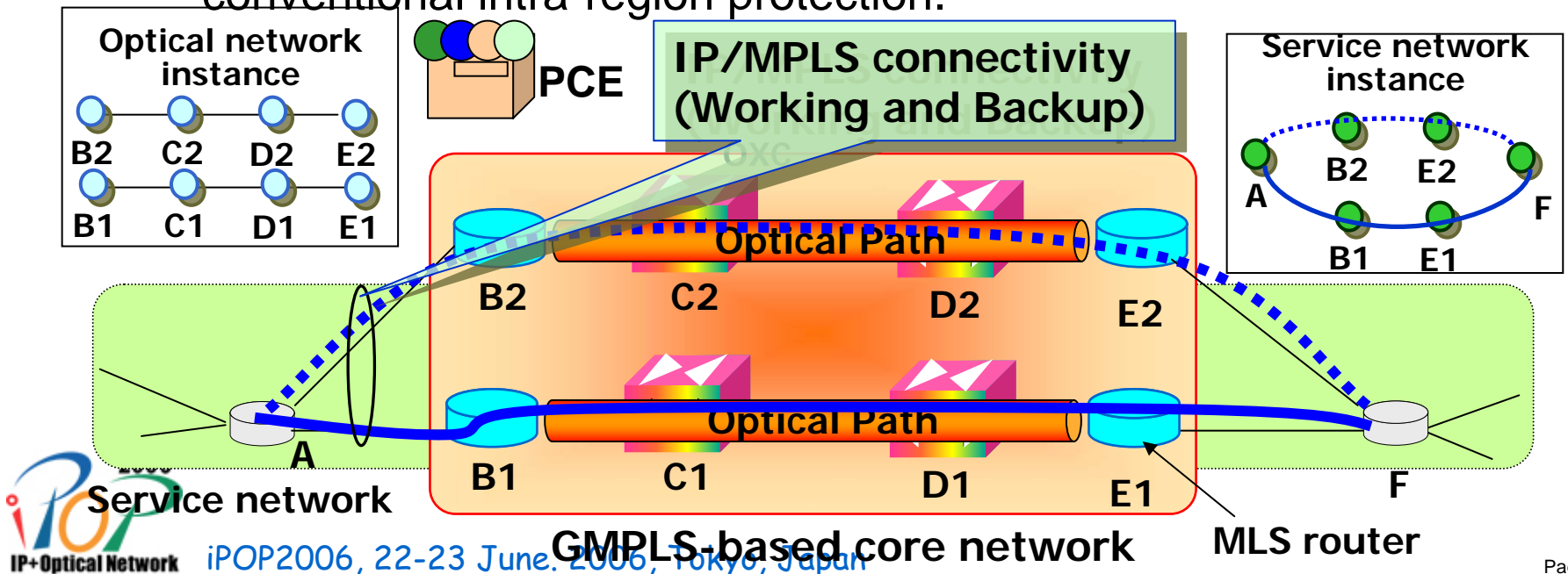
Numerical Evaluation –conditions-

1. Performance of Multi Layer connection

- Improves E2E reliability comparing conventional single route connection
- Establishing disjoint paths for dual route connection requires interaction between packet and optical regions.

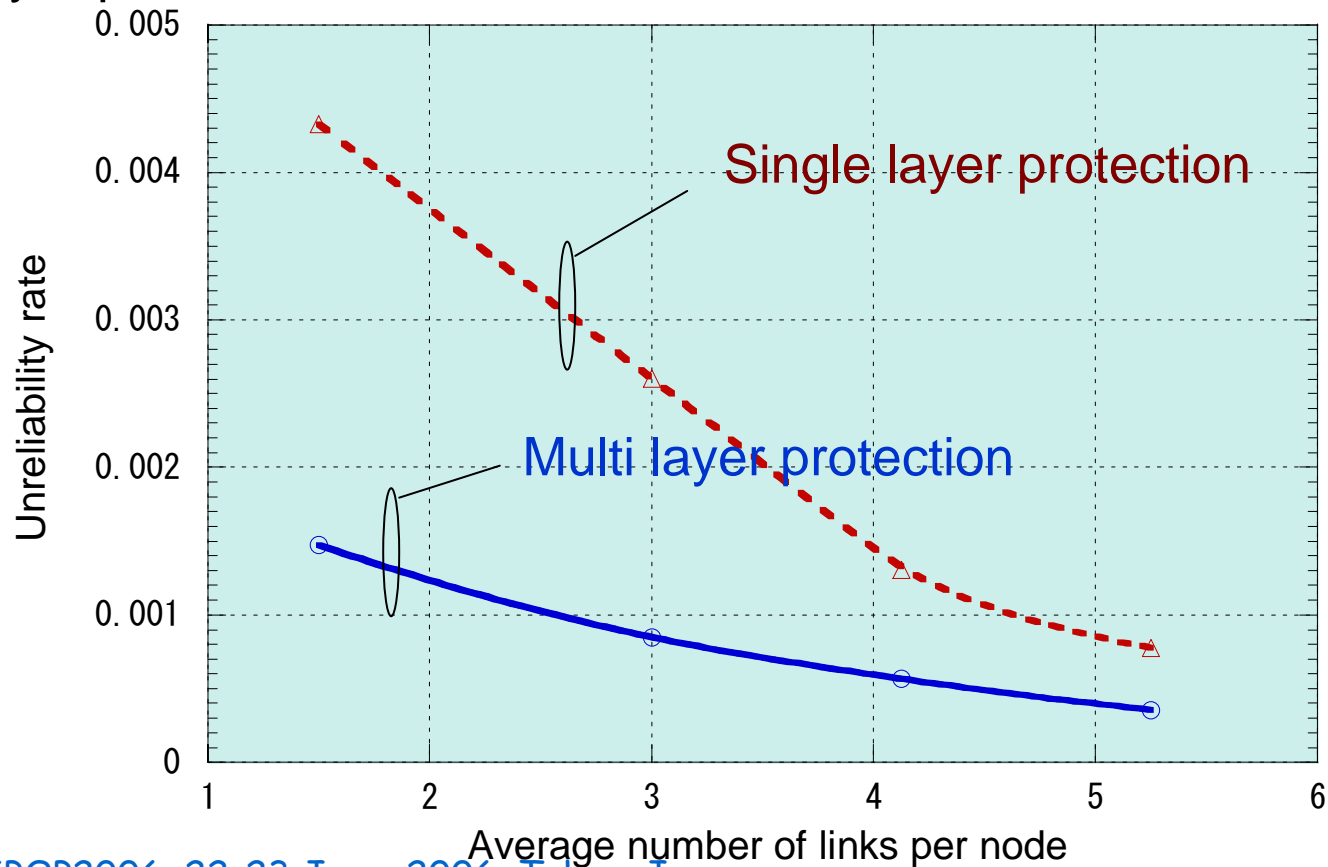
2. Simulation conditions

- Randomly configured 150 LSPs on 16-node grid-form network.
- Compare performance with single route connection with conventional intra-region protection.



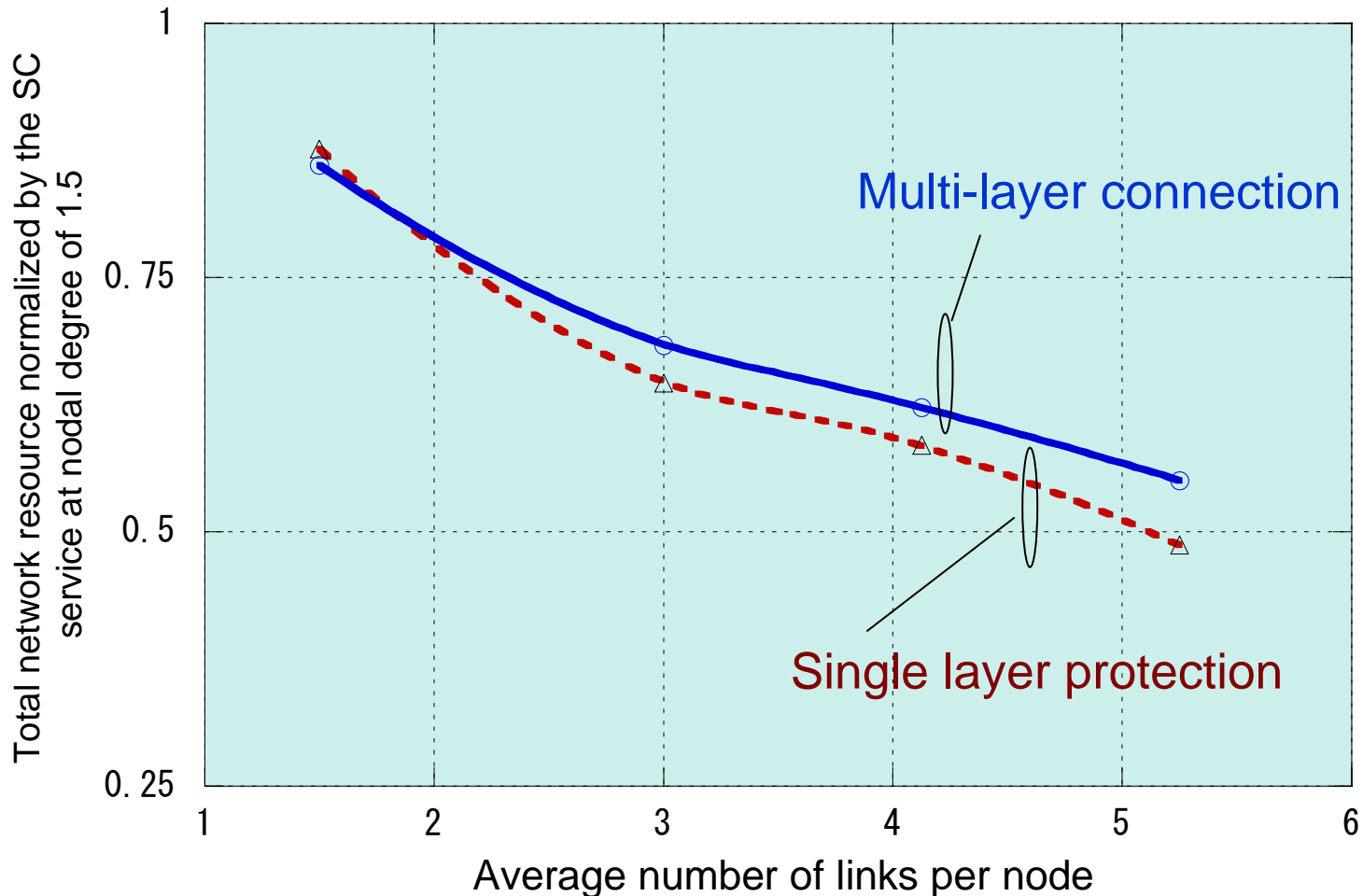
Numerical results on Service Availability

- Single layer protection (redundant paths within a layer) cannot recover from edge node failure, which increases service unavailability rate.
- Proposed algorithm improves availability of connection by introducing multi layer protected connection.



Numerical results on Resource Utilization

- Slight decrease in resource utilization by introducing dual route connection.



GMPLS issues and possible extensions

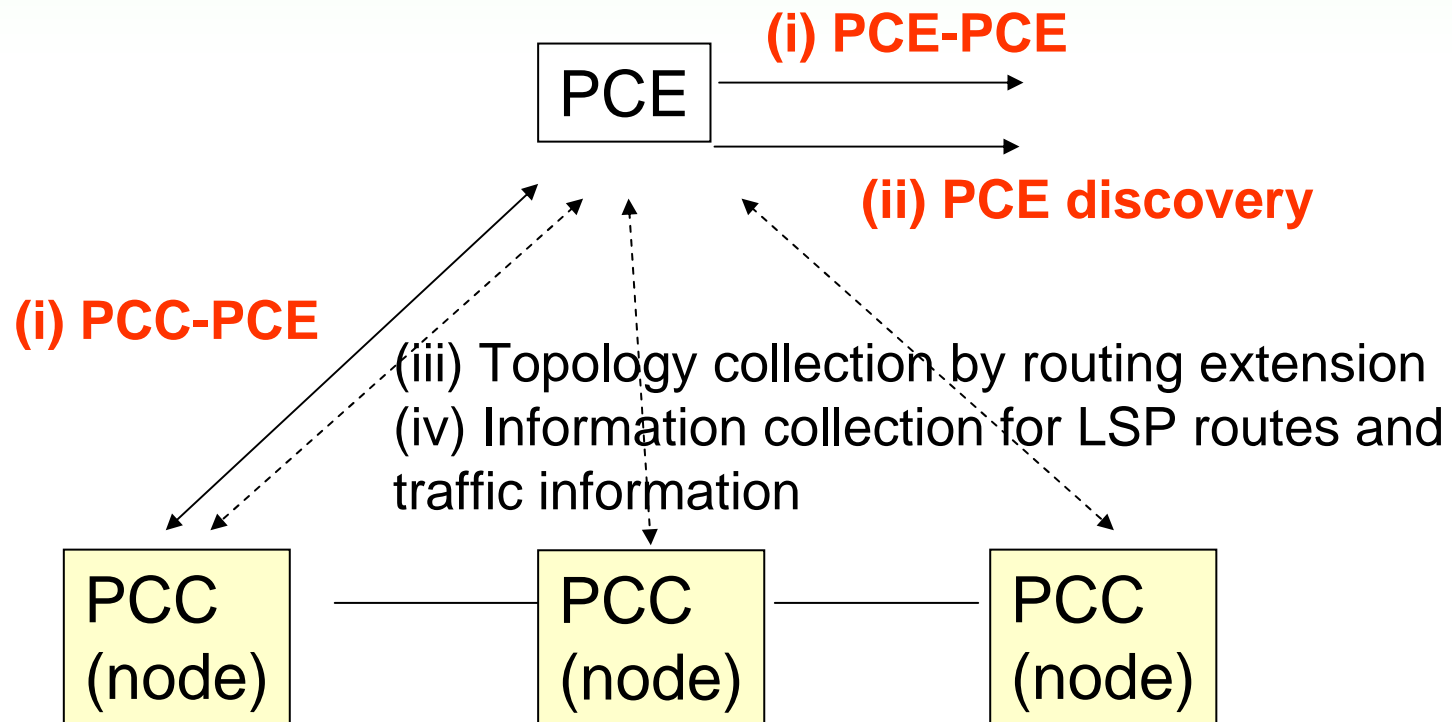
1. GMPLS interoperability issues

- Separation of control and data planes
- Specifying routes/interfaces
- Recovery (timer) of control plane

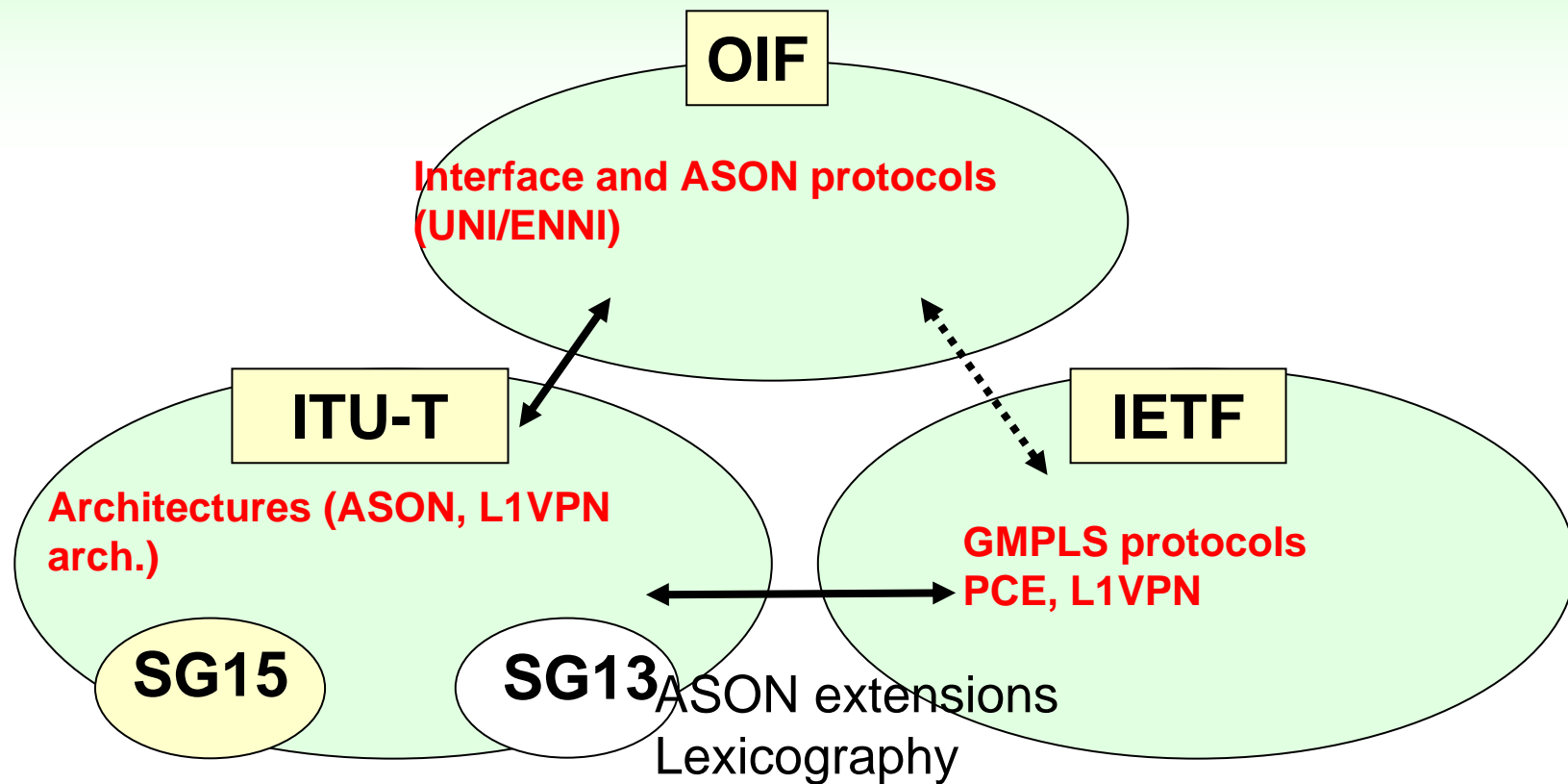
2. GMPLS possible extensions

- Dynamic path setup and advertisement (FA-LSP)
- Interworking of MPLS and GMPLS
- Extensions for MR/ML Network

Protocols for PCE



Standardization bodies



UNI: User Network Interface

NNI: Network Node Interface

SG: Study Group



Liaisons

Thank you !