

The 2nd International OFC/NFOEC Workshop on the Future of Optical Networking (FON)

Ballroom C, Anaheim Convention Center, Anaheim, CA, USA

Sunday 25th March 2007

Empowered by Innovation

**NEC**

# **Photonic Service Gateways in the Japan's Lambda Utility Project**

**March 25, 2007**

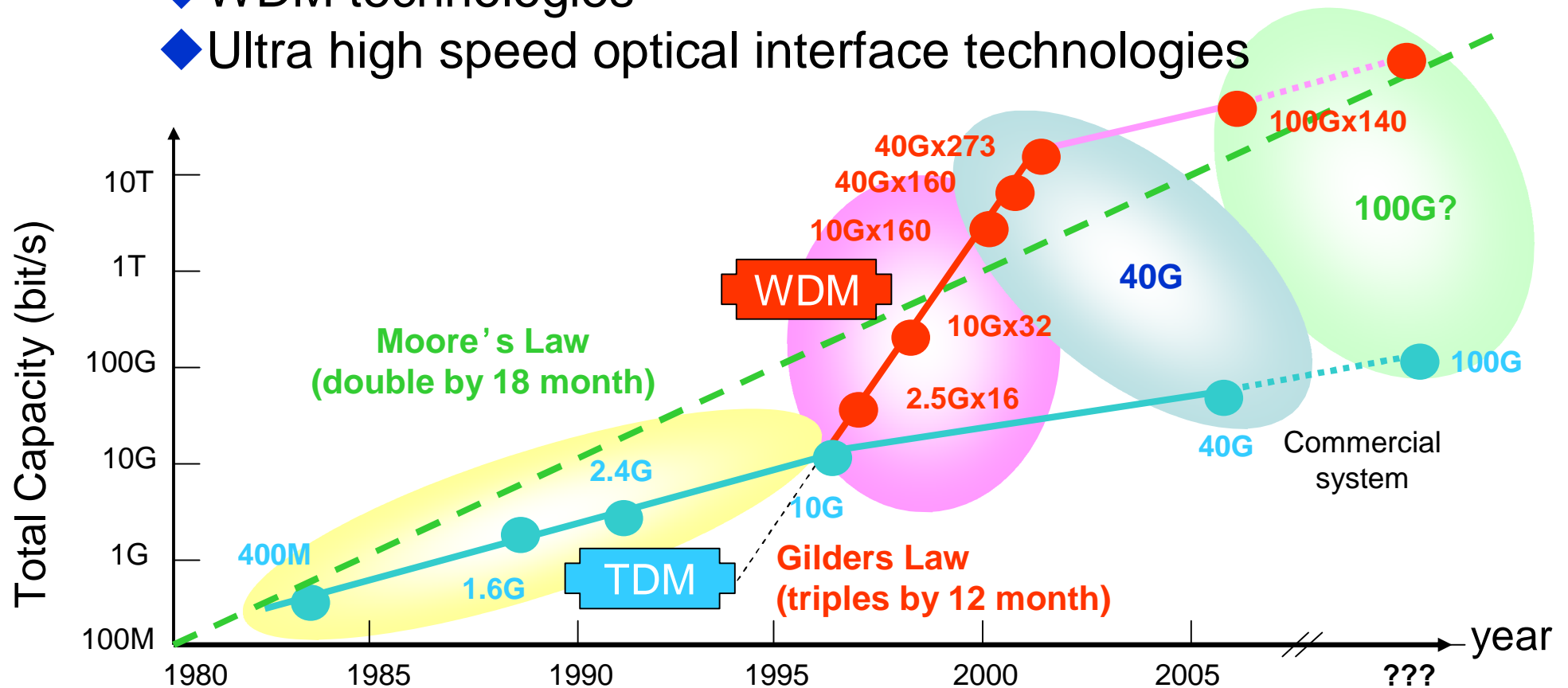
**Soichiro Araki**

**System Platforms Research Laboratories,  
NEC Corporation, JAPAN**

# Trend of Optical Transmission Technologies

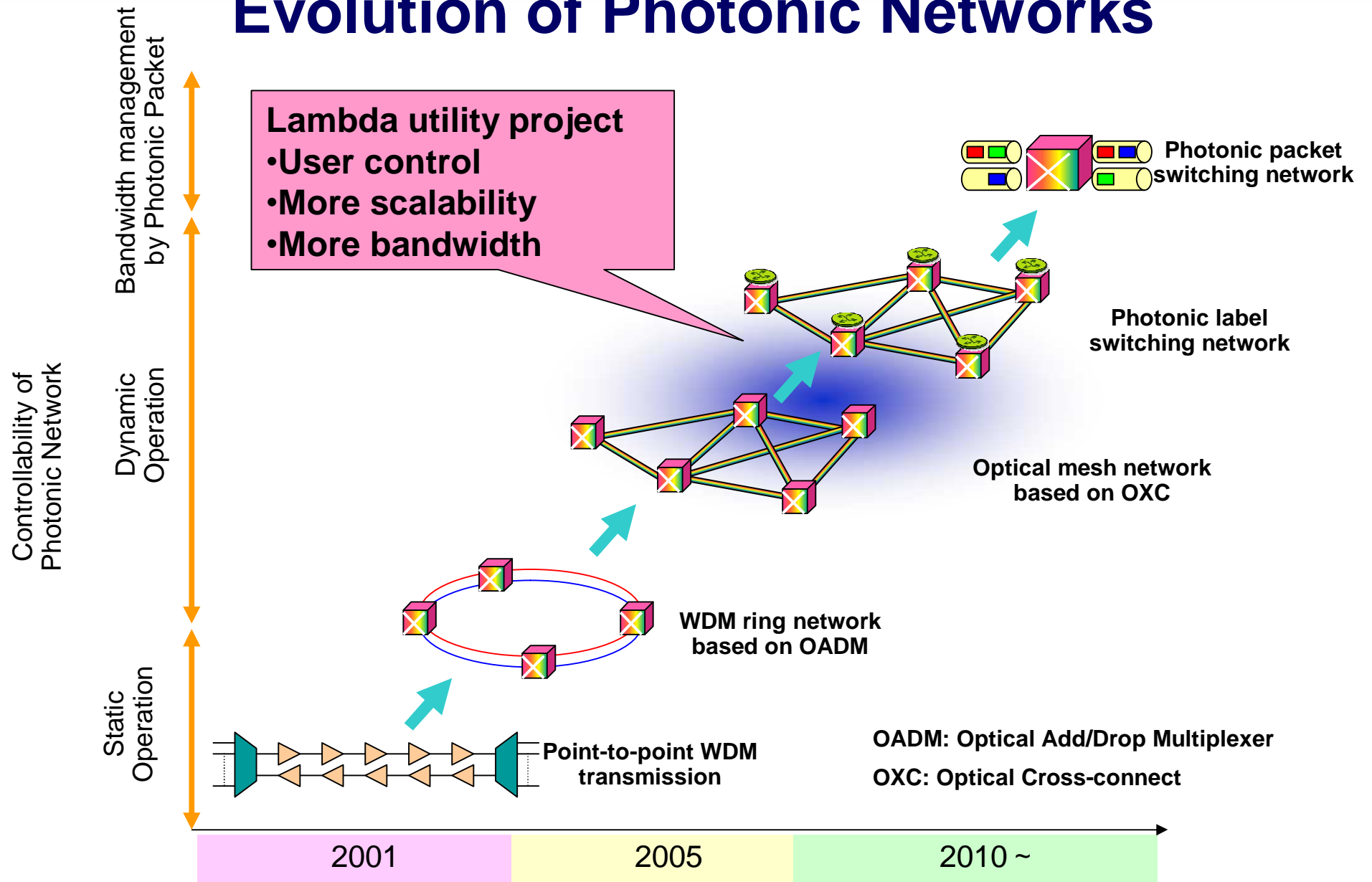
Networking technologies evolve beyond Moore's law.

- ◆ WDM technologies
- ◆ Ultra high speed optical interface technologies



Study Group on Ubiquitous Networking, Ministry of Internal Affairs and Communications

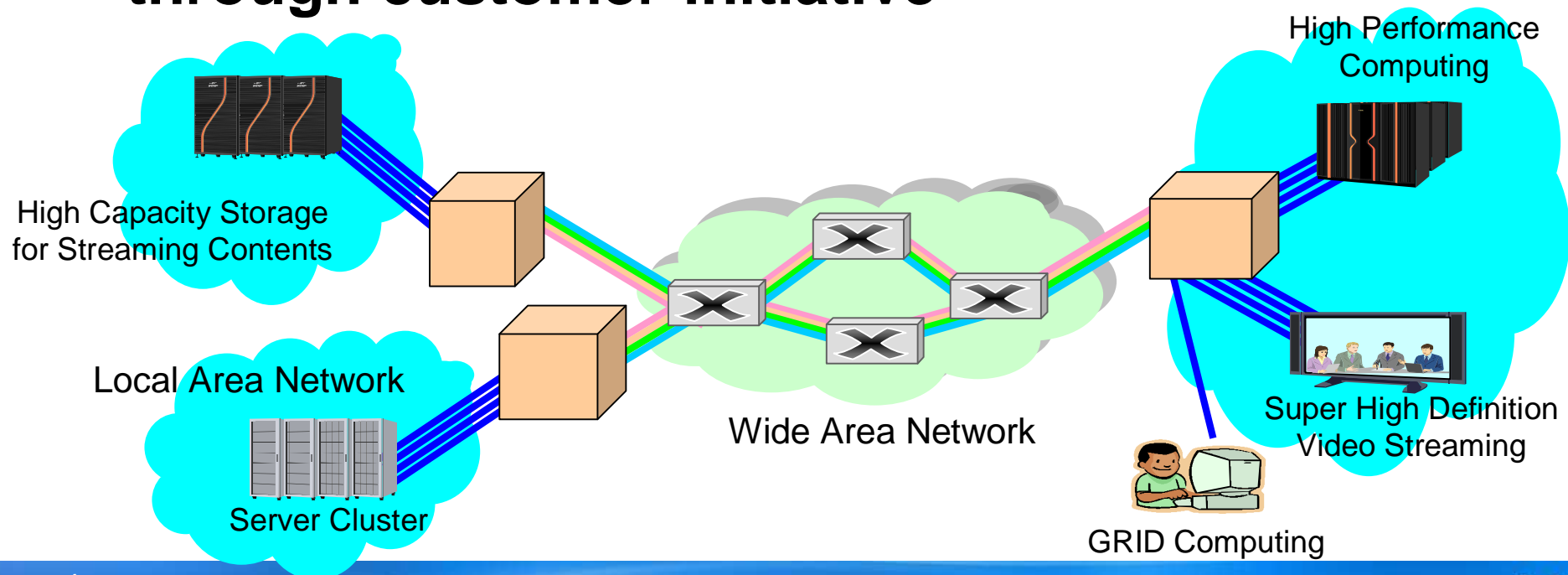
# Evolution of Photonic Networks



Photonic network revolution, Photonic Internetworking Forum, 2002

# On-demand Lambda Connection

- **Bandwidth-rich applications**
  - Grid computing
  - Real-time streaming: digital cinema, medical, education
  - e-Commerce: Network storage
- **Lambda connection anywhere on demand through customer-initiative**



# Government-supported Photonic Network R&D Program in Japan

**4 major projects supported by the Ministry of Internal Affairs and Communications (MIC) and National Institute of Information and Communications Technology (NICT) Japan**

## **Photonic node with multiple granularity switching capability**

- 100 Tera-bps class photonic nodes
- Peta-bps class backbone networks control

## **Lambda Access**

- Terabit LAN in geographical scale
- Network access at 100Gbps and beyond with single or multiple lambda interfaces

## **Lambda Utility**

- Controlling and managing an optical path over multiple carrier networks with high scalability of more than 1000 nodes
- Highly-spectral-efficient transmission link technology at 100Gbps and beyond
- Modulation-format-independent all-optical 3R technology at 100Gbps and beyond

## **Optical RAM for all-optical packet switching**

- Ultra-fast optical random access memory based on nano-structured optical devices

# Lambda Utility Project

- Member organizations
  - NEC Corporation,
  - Osaka University,
  - Fujitsu Limited,
  - Mitsubishi Electric Corporation,
  - Oki Electric Industry Co., Ltd.
  
- Project period
  - Started in September, 2006.
  - Five-year project (FY2006 to FY2010)

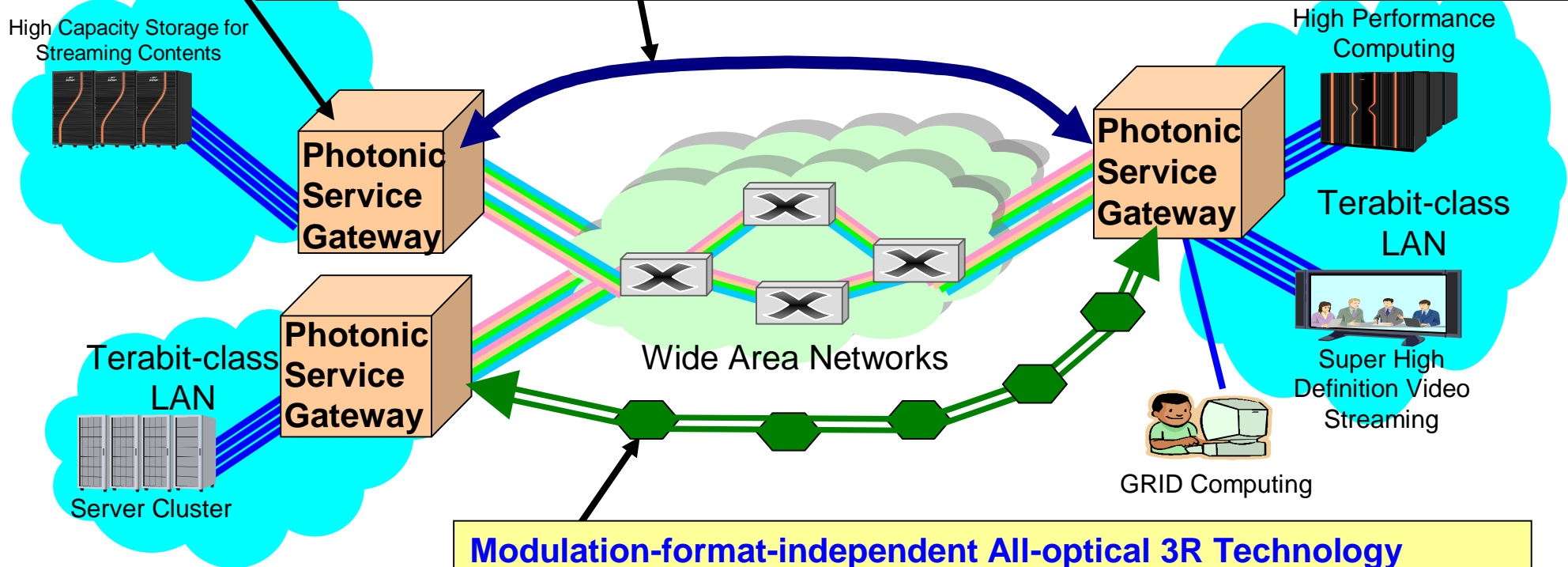
# Lambda Utility Project

## Borderless Optical Path Control and Management Technology

- Photonic service gateway technology **controlling and managing an optical path** over multiple carrier networks with **high scalability of more than 1000 nodes**

## Highly-spectral-efficient Transmission Link Technology

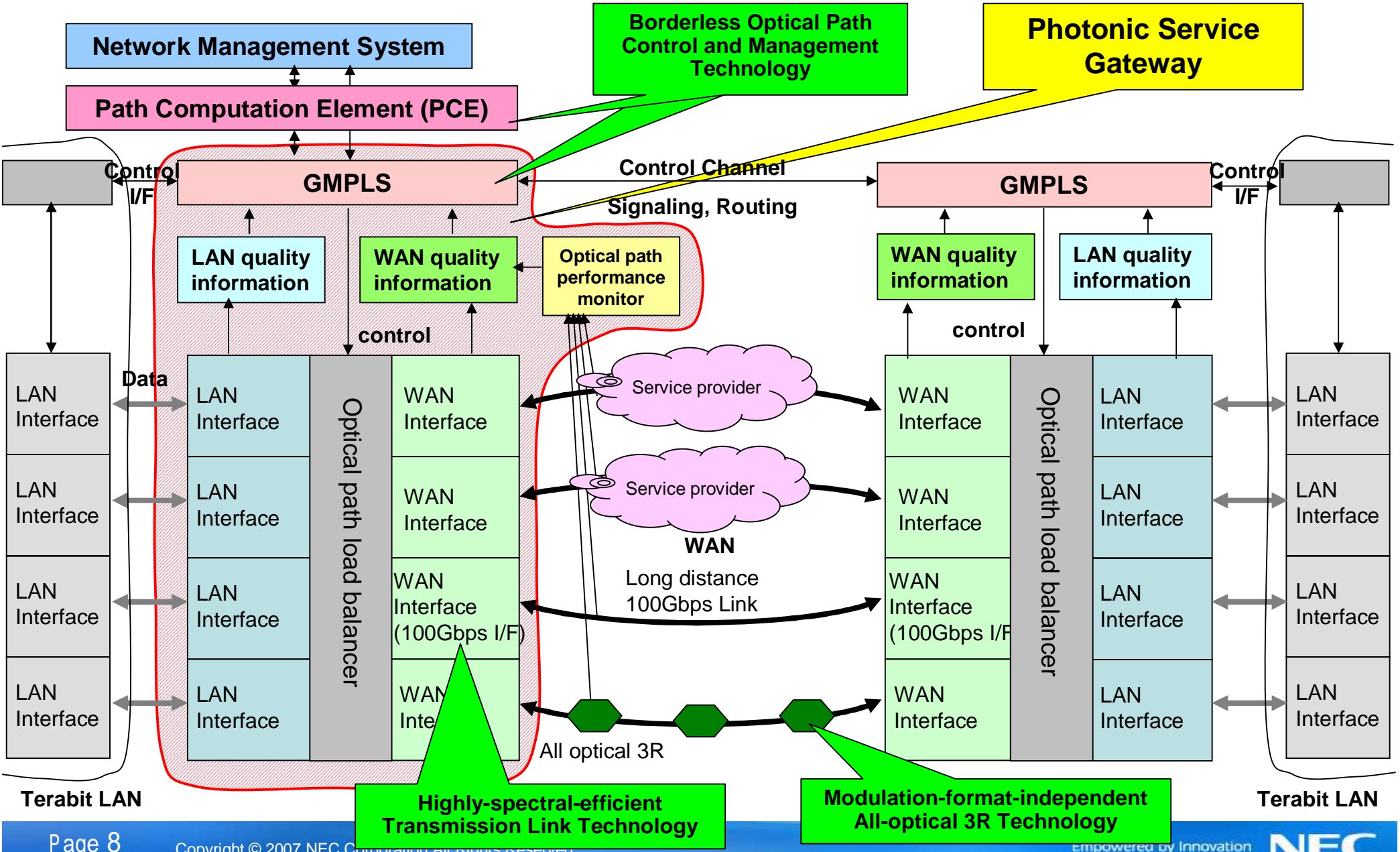
- **Multi-level modulation** and demodulation technology at **100Gbps and beyond**
- **High-coding-gain forward error correction code** for multi-level modulation format



## Modulation-format-independent All-optical 3R Technology

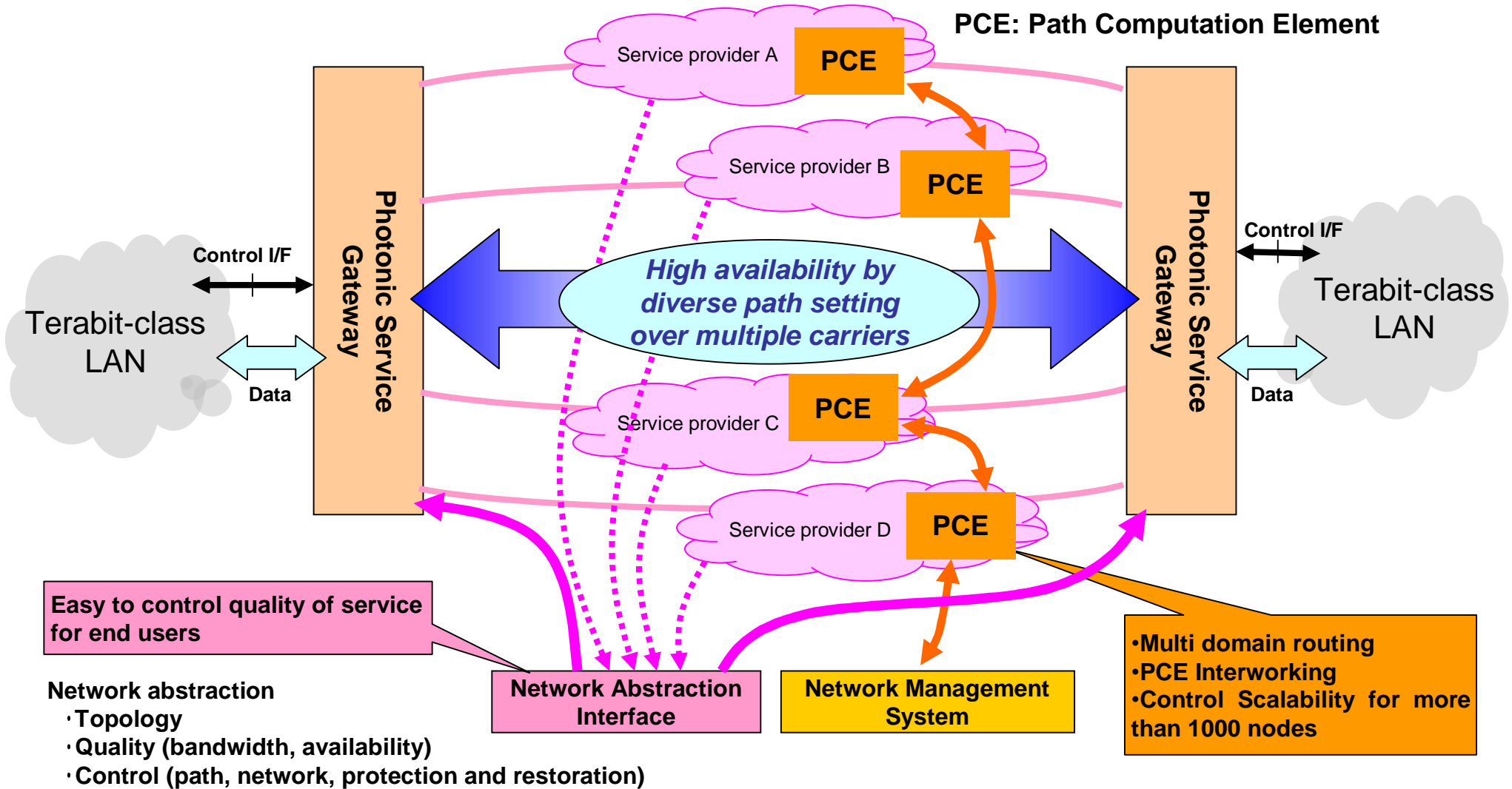
- **All-optical signal regeneration** technology for both phase and intensity modulation format signals at **100Gbps and beyond**

# Photonic Service Gateway



# Borderless Optical Path Control and Management

## GMPLS network



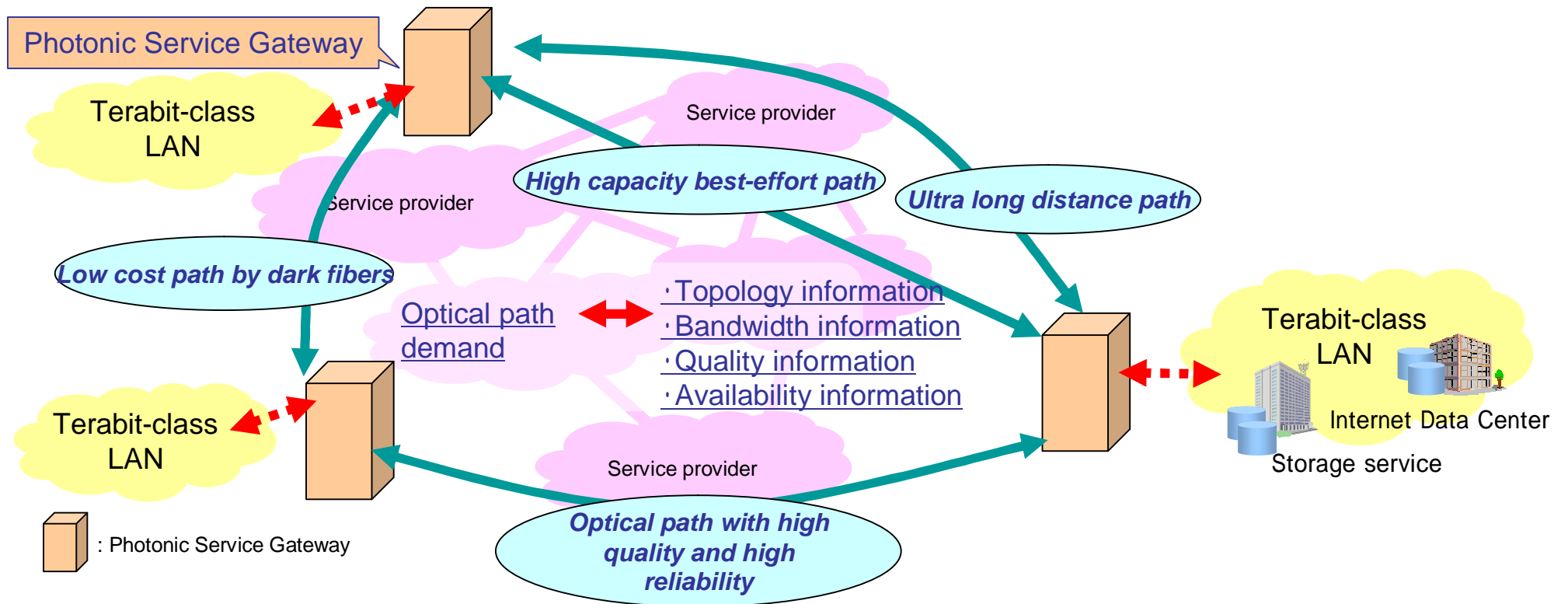
# Borderless Optical Path Control and Management

- Network abstraction interface
- Optical path performance monitor and control
- Inter-domain path control, protection and restoration
- Cooperation between distributed control and centralized management

# Network abstraction interface

## Target

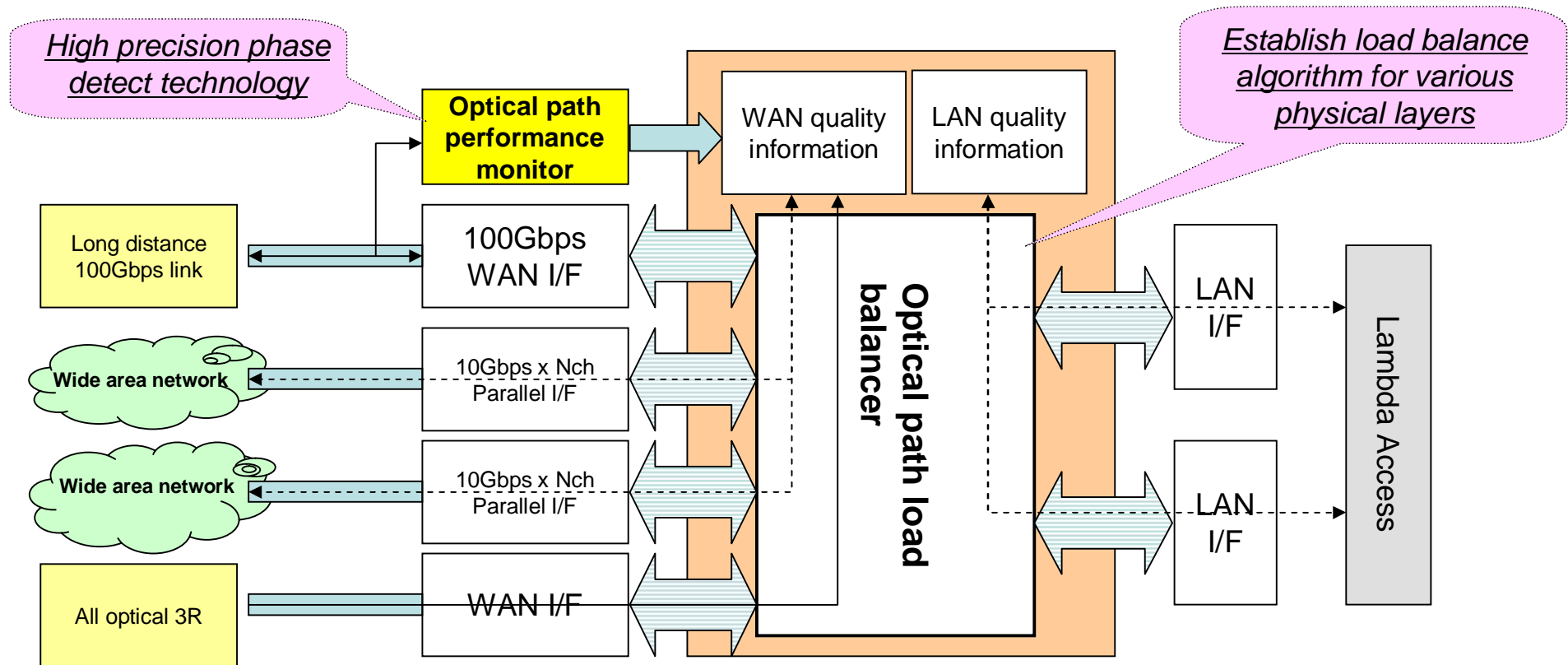
- Enable end users to control networks with simple parameters.
- Abstraction of network information, such as bandwidth, quality and availability, which dynamically changes among Terabit-class LANs
- Establish network modeling technology, topology discovery technology, network optimization technology in heterogeneous network environments.



# Optical path performance monitor and control

## Target

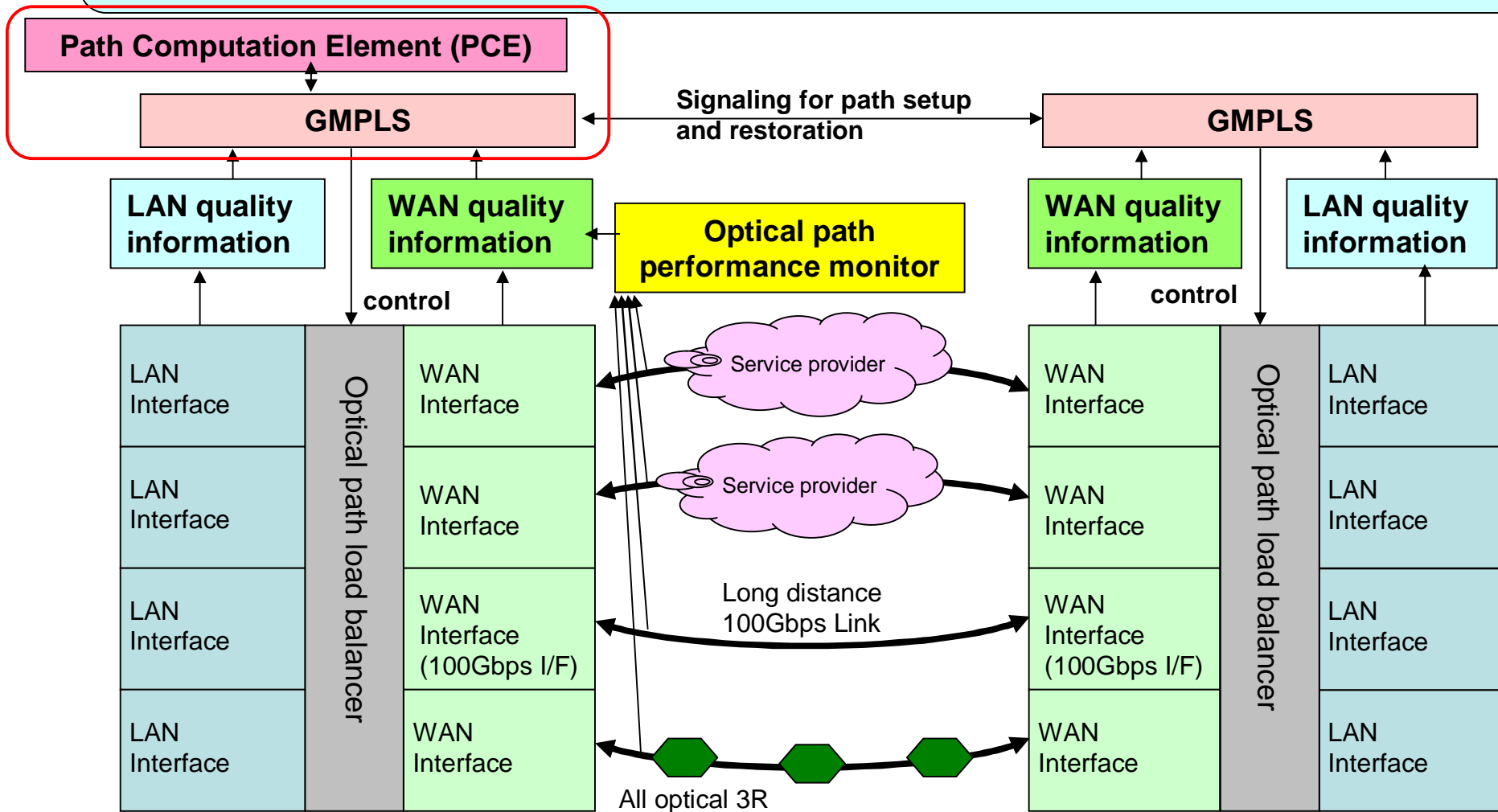
- Achieve optical path performance monitoring at 100Gbps and beyond.
- Establish optical path load balancing over multiple carrier networks.



# Inter-domain path control, protection and restoration

## Target

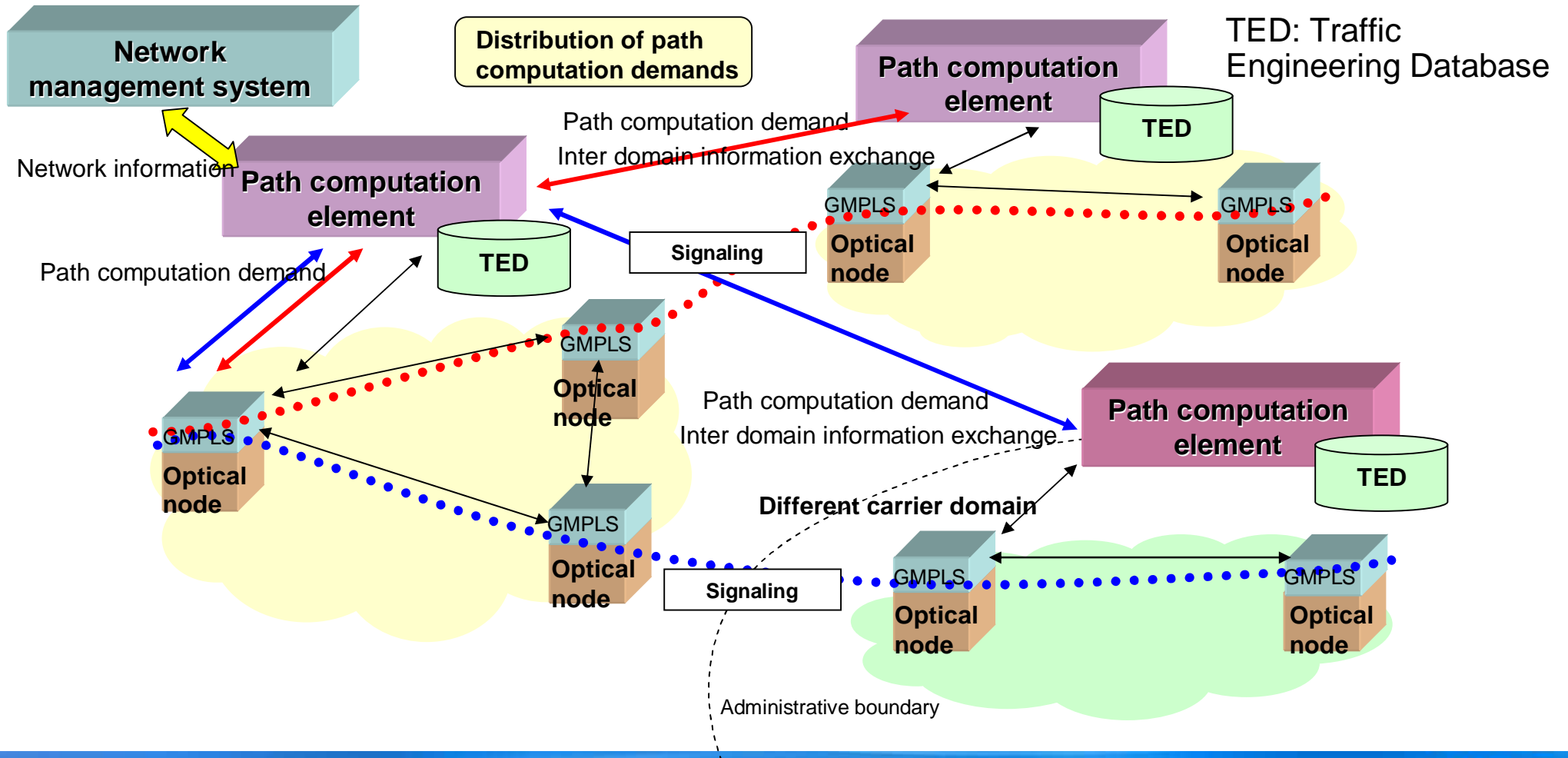
- Enable end users to choose an optimal protection mechanism automatically.
- Rapid path provisioning with a backup path across multi domains.



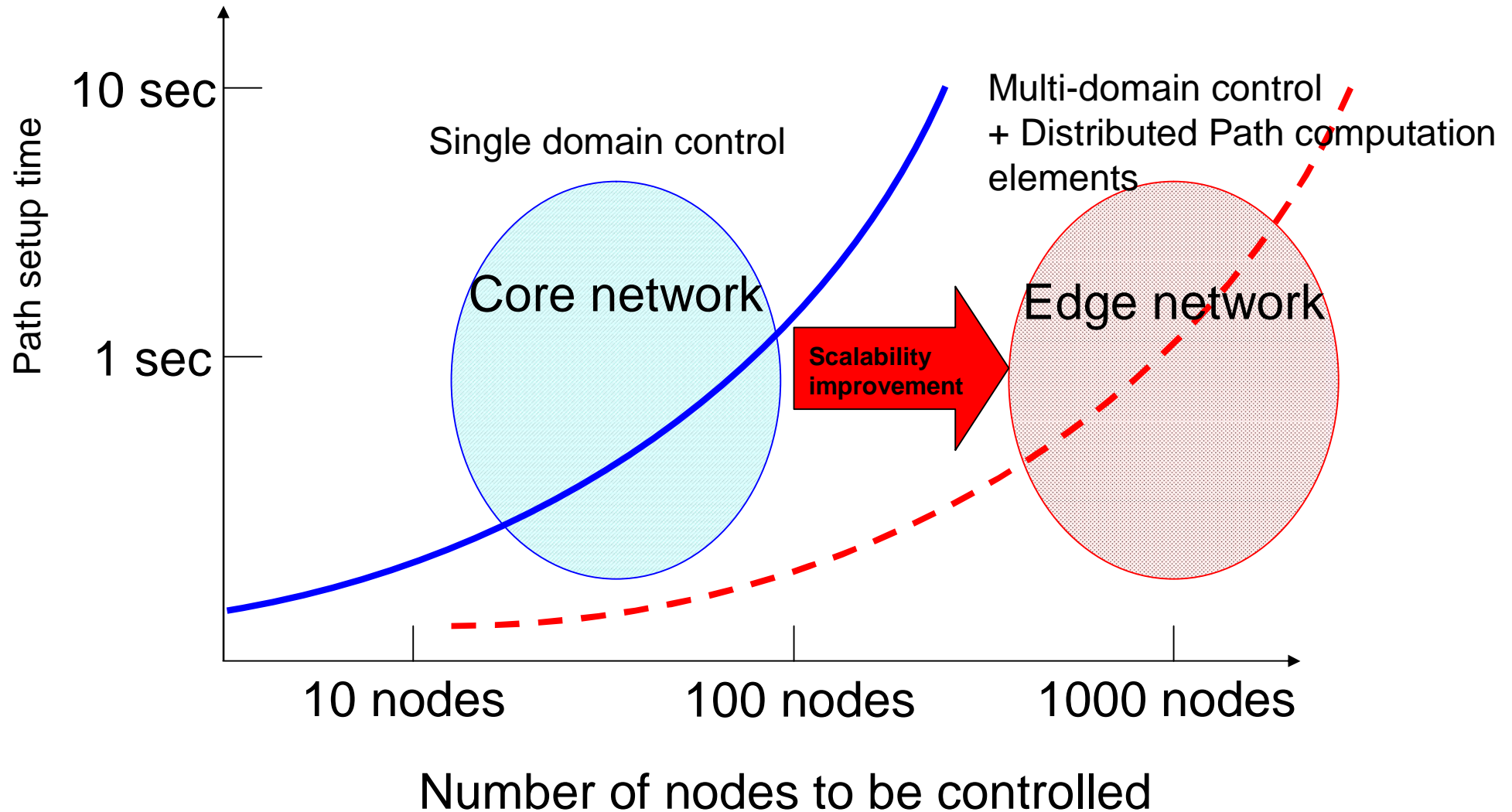
# Cooperation between distributed control and centralized management

## Target

- Photonic network control and management for **more than 1000 nodes**.
- Establish scalable photonic network control and management architecture.

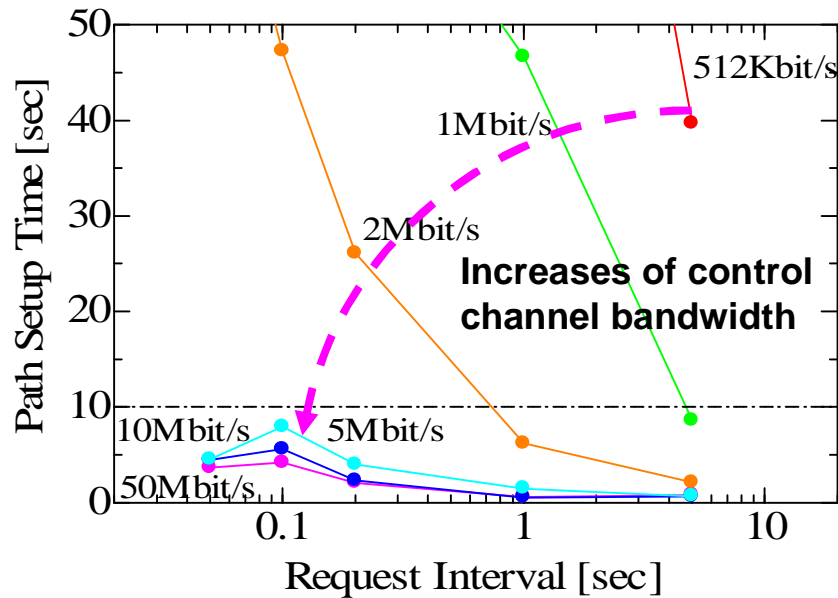


# Scalability in GMPLS network

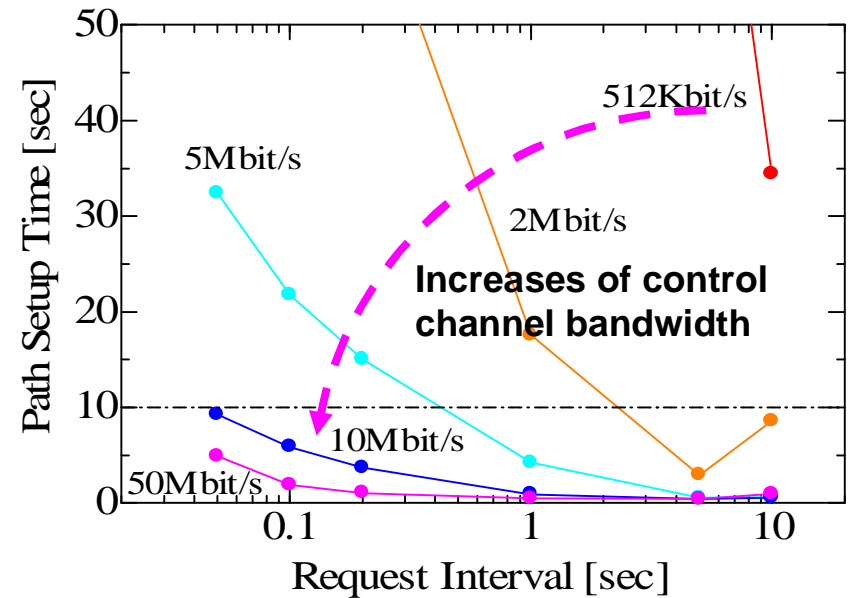


# GMPLS Scalability Evaluation

Control channel bandwidth dependencies of path setup time



64 nodes network



128 nodes network

Path setup time increases due to congestion of control messages in a limited control channel bandwidth.

# Issues for GMPLS scalability

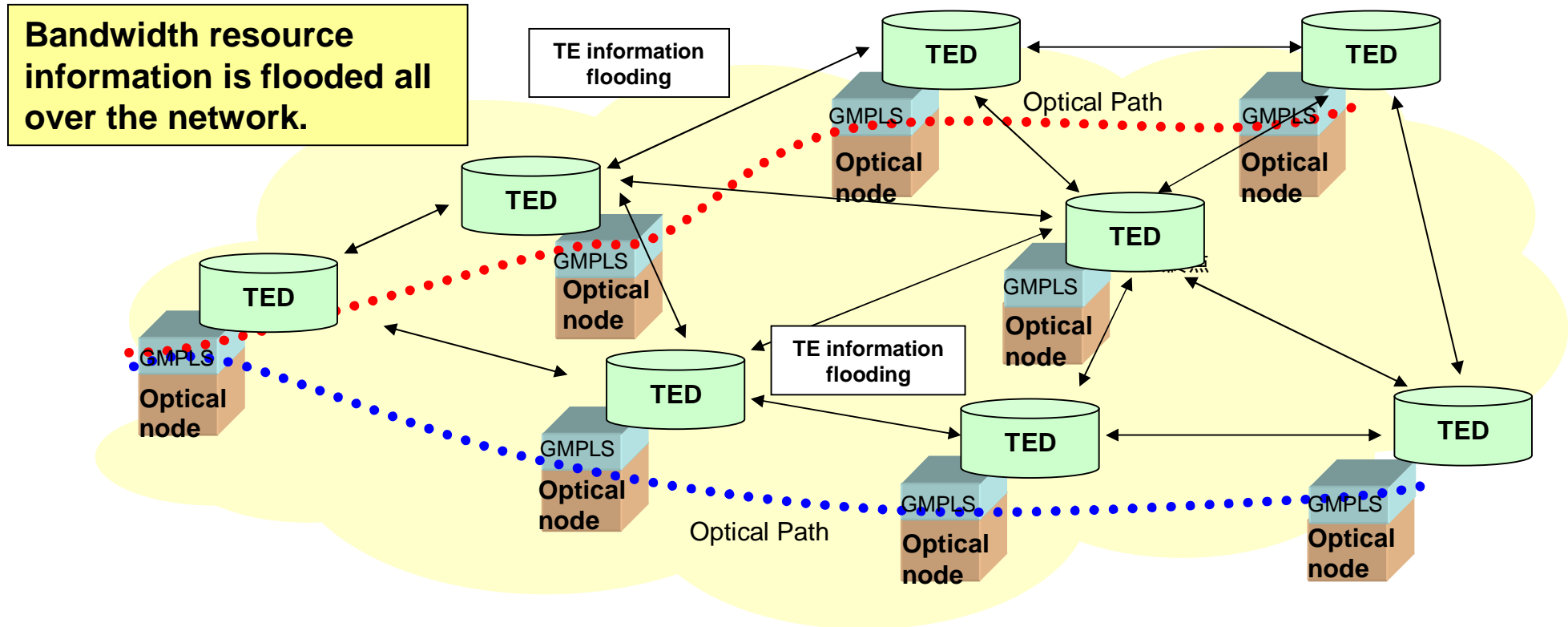
## Issue 1

Increase of nodes  
Increase of TE information flooding

## Issue 2

Multi domain routing scheme is not established.

TED: Traffic Engineering Database



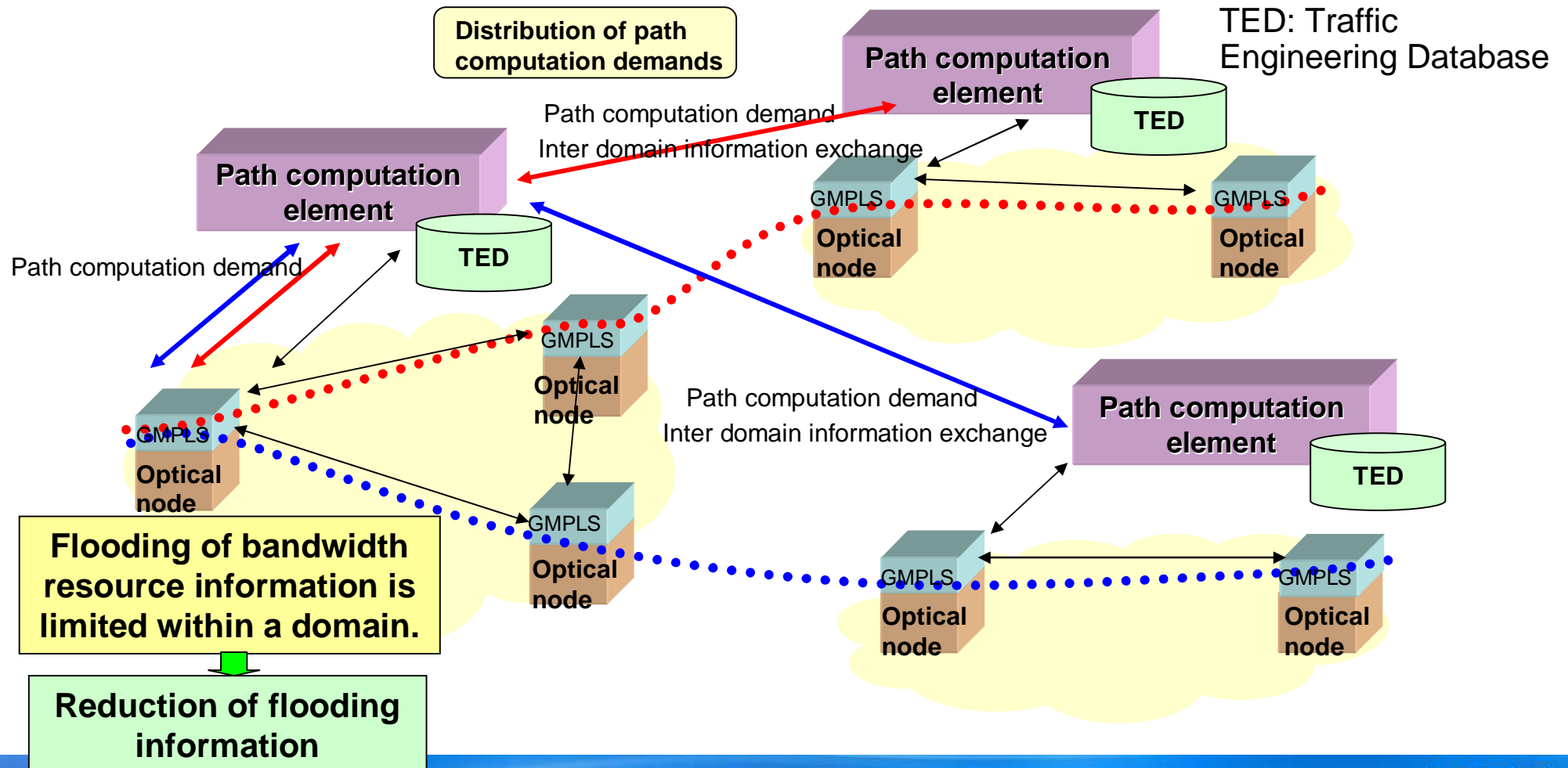
# Solutions for GMPLS scalability improvement

## Solution 1

Multi domain routing  
Reduce flooding information

## Solution 2

Path computation elements  
Establish information exchange scheme for inter-domain routing



# Summary

- Lambda utility project is one of the government-supported photonic network R&D projects in Japan.
- The project includes three research themes,
  - Borderless Optical Path Control and Management Technology,
  - Highly-spectral-efficient Transmission Link Technology,
  - Modulation-format-independent All-optical 3R Technology.
- These technologies will be implemented in a photonic service gateway, and will provide lambda connection anywhere on demand through customer-initiative.

# Acknowledgement

This work was partly supported by National Institute of Information and Communications Technology (NICT).