
Terabit OBS Super-Net Experiments

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Agenda

1. Introduction

- Goal of this research
- The conventional optical network
- Key points in implementing the e-Japan program
- Network requirements

2. Proposed architecture

- Concept of a terabit OBS super net
- Outline of proposed technologies
- Traffic-driven optical path control technology
- Application-driven optical path control technology
- Network policy control technology

3. Experiments on optical test bed (Japan Gigabit Network II)

4. Conclusion

1. Introduction

Goal of this research

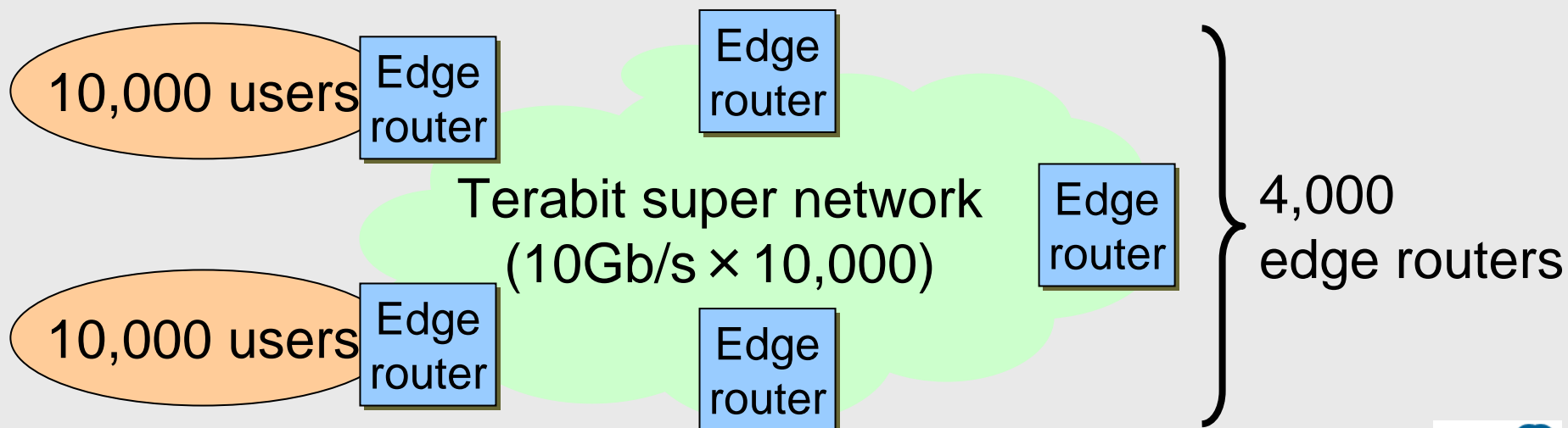
Implementation of the e-Japan strategy

- Broadband access (10Mb/s) by 30 million users
 - Super broadband access (100Mb/s) by 10 million users
- Terabit-class forwarding performance is needed



Accommodate forty million users using **4,000 edge routers**
(Each edge router accommodates 10,000 users)

Connect 4,000 edge routers by **10,000 optical paths**
(Bandwidth of optical path is 10Gb/s)



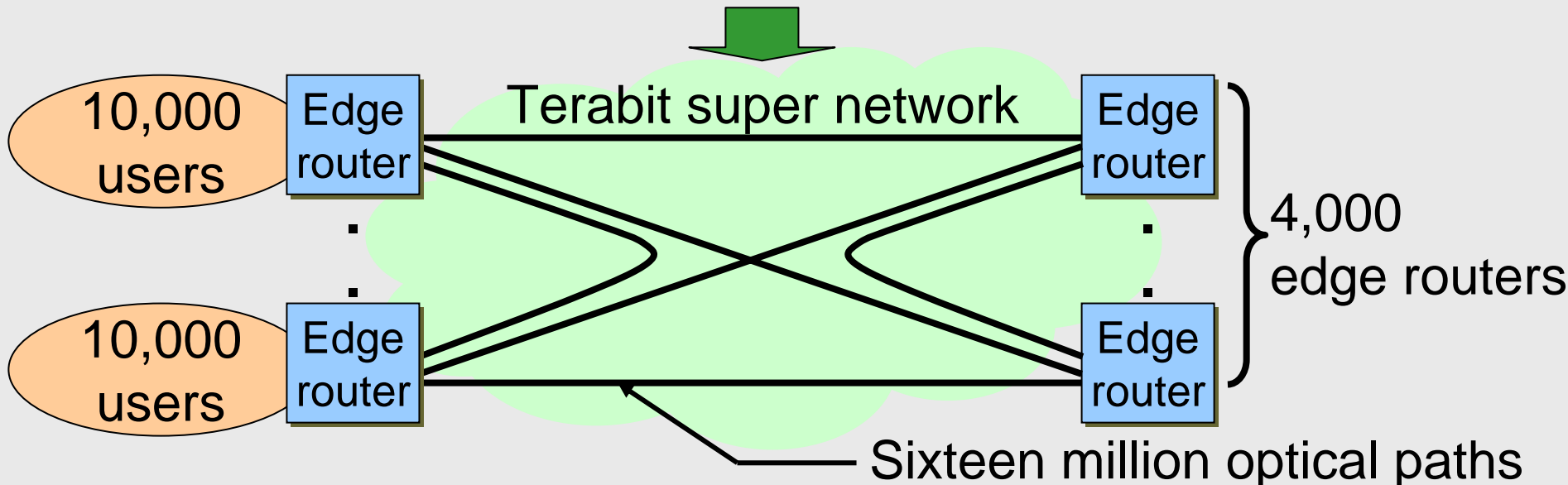
The conventional optical network

Deploy optical network to achieve high network bandwidth

- Connect all edge routers using optical paths
 - Establish full mesh of optical paths
between all edge routers to maintain reachability
- Full mesh topology isn't economical

Ex. 16 million optical paths would be needed

→ Total bandwidth would be petabit class: **"over spec"**



Key points in implementing the e-Japan program

Point 1 for implementation of the e-Japan strategy :
Use an electronic network to maintain reachability

Point 2 for implementation of the e-Japan strategy :
Assign optical paths dynamically to improve performance

Concentration of traffic load

Electrical IP router

Maintain reachability by using 4,000 optical paths

Edge router

Edge router

Edge router

Edge router

4,000 edge routers

Optical router

Optical router

Direct connection between edge routers → Expand bandwidth

Cut-through optical path

Network requirements

Point 2 for implementation of the e-Japan strategy :
Assign optical paths dynamically to improve performance


Improve the performance of the whole network

- Avoid congestion
 - Accommodate many users
-  Optimize the network topology

Demands from specific users

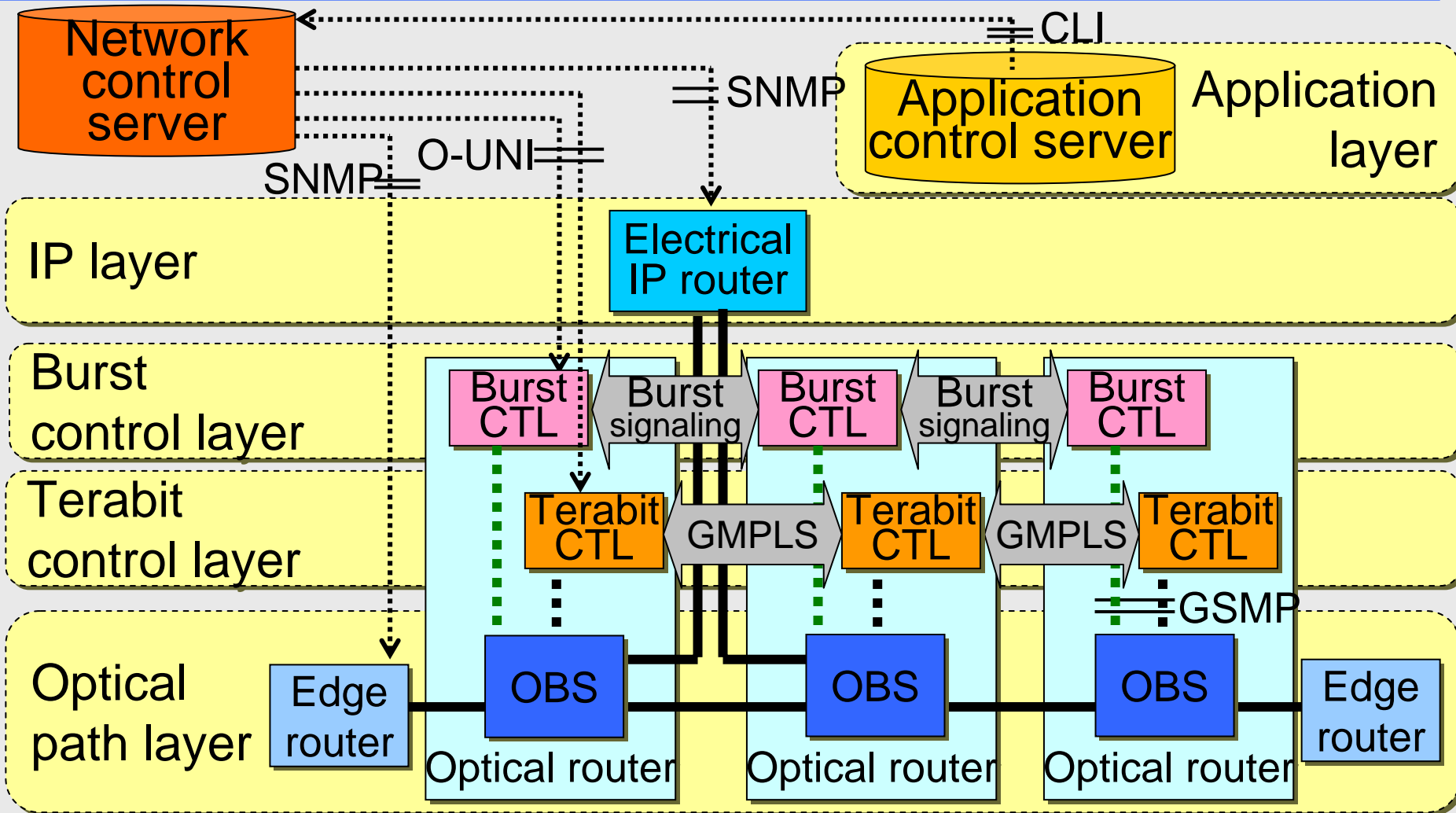
- Provide assured quality
 - Supply services
-  Assign specific optical paths as fast as possible

Respond to many kinds of requirement

 Use cooperating optical network control technologies

2. Proposed architecture

A terabit OBS Super Net




GMPLS: Generalized Multi-Protocol Label Switching
 GSMP: General Switch Management Protocol, OBS: Optical Burst Switch
 CTL: Controller, CLI: Command Line Interface

An outline of proposed technologies

Cut-through optical path control technologies


Traffic-driven optical path control technology


- Maximize network throughput  Optimization

 Implement traffic engineering by terabit controllers

- Maximize use of all optical paths

Application-driven optical path control technology

- Assign optical paths according to user demand  Time

 Implement optical burst functions in burst controllers

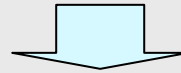
- Minimize control time required to establish optical paths

Network policy control technology

- Select from two types of controller according to type of demand

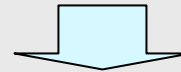
Traffic-driven optical path control technology(1/3)

- Maximize network throughput
 - Requires control according to traffic condition of IP layer



- Detect congestion using a network control server by referring to traffic load in IP routers
- Avoid congestion by establishing a cut-through optical path
- Maximize use of all optical paths by dynamically redistributing them

Select and control terabit controllers



- Maximize total network throughput by distributing traffic load

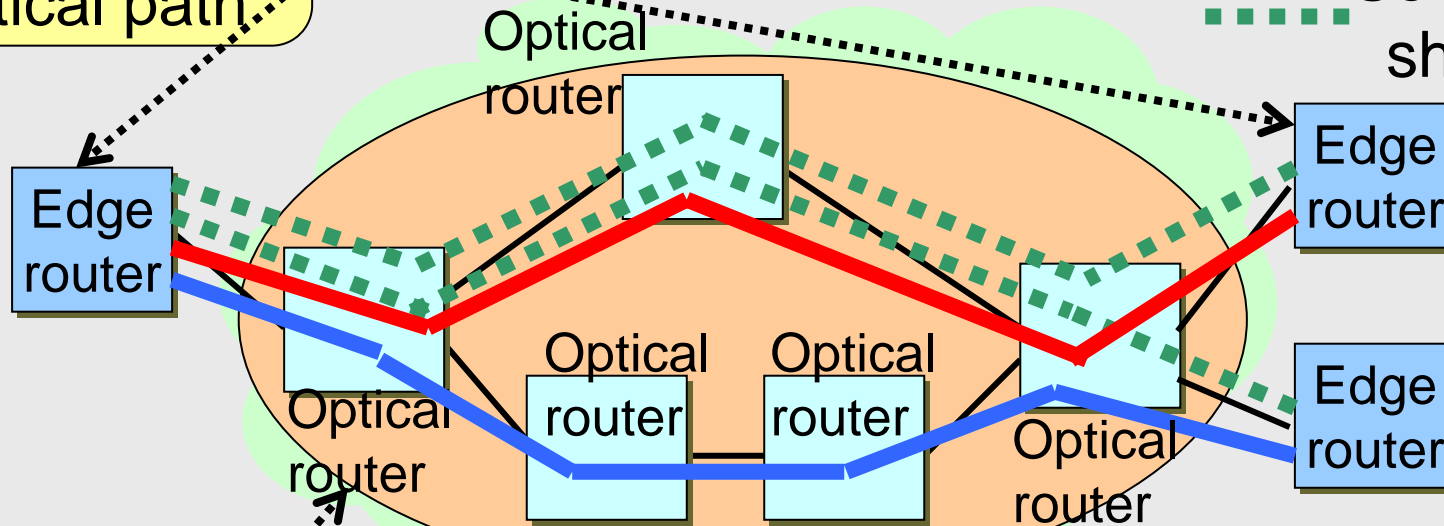
Traffic-driven optical path control technology(3/3)

- Maximize use of all optical paths
 - It is important to distribute optical paths

Assign a cut-through optical path

Specify an ingress-egress edge router pair

Select the shortest route

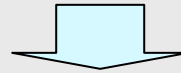


Traffic engineering on optical layer

Route distribution on optical layer

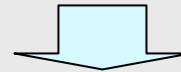
Application-driven optical path control technology(1/3)

- Assign an optical path according to a user demand
 - Requires immediate control to meet user demand



- Accept user demand
 - by cooperating with application control server
- Assign optical path
 - by establishing a cut-through optical path
- Minimize control time
 - by using burst signaling in place of GMPLS

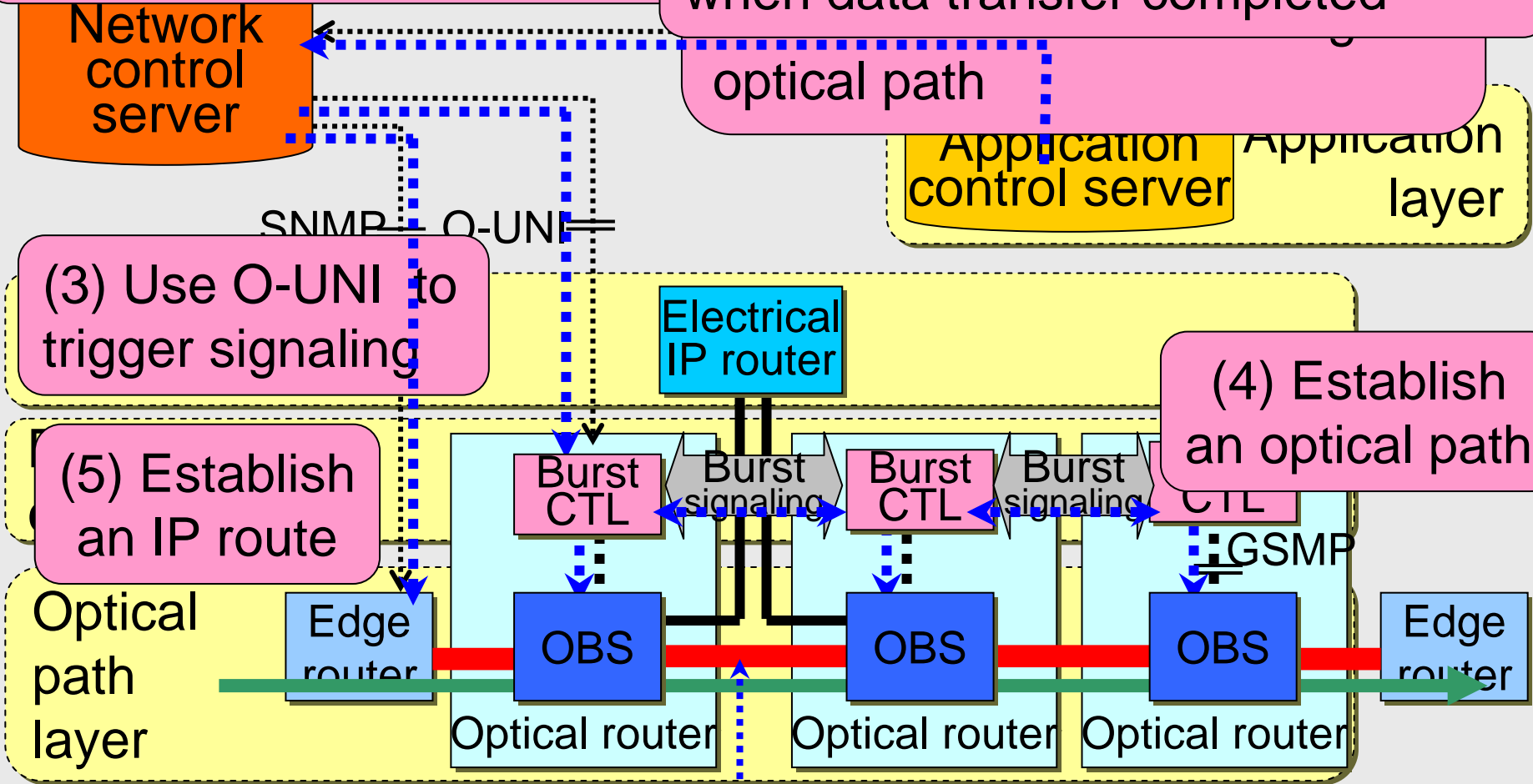
Select and control burst controllers



- Minimize total transfer time of user data
- Implement a user service offering assured quality

(2) Specify ingress-egress edge routers which are accommodate us

(6) Request removal of optical path when data transfer completed

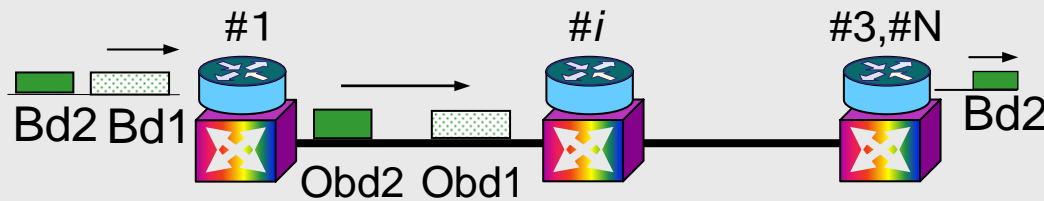


GMPLS : Generalized Multiprotocol Label Switching
 GSMP : General Switch Management Protocol
 OBS : Optical Burst Switch, CTL: Controller, CLI: Command Line Interface

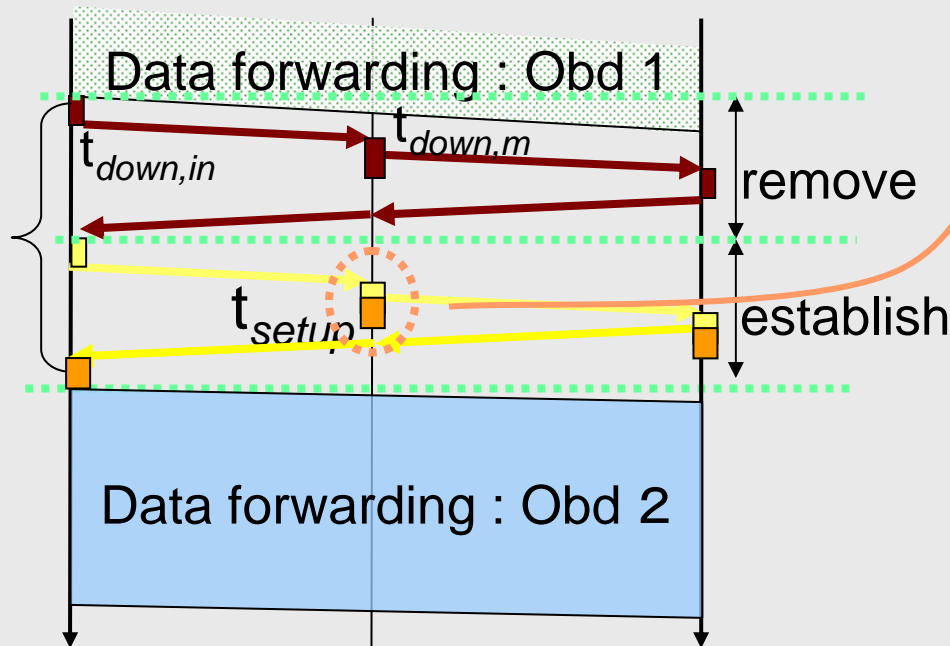
Application-driven cut-through optical path

Application-driven optical path control technology(3/3)

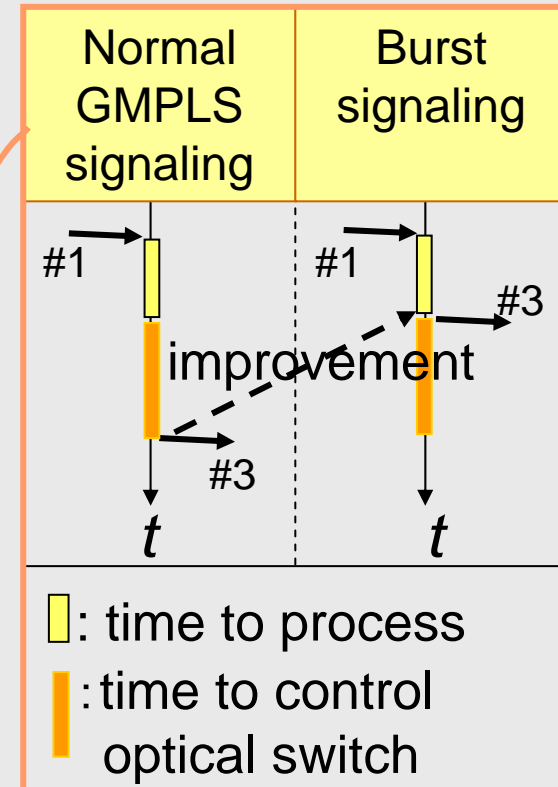
Use burst signaling, which can reducing control time
by sending signaling to the next node
before controlling optical switch



Time to control optical path

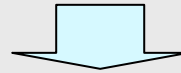


Signaling at Node#2

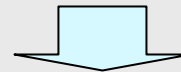


Network policy control technology (1/2)

- Assign an optical path according to different kinds of demand
→ Requires selection of controller according to kind of demand

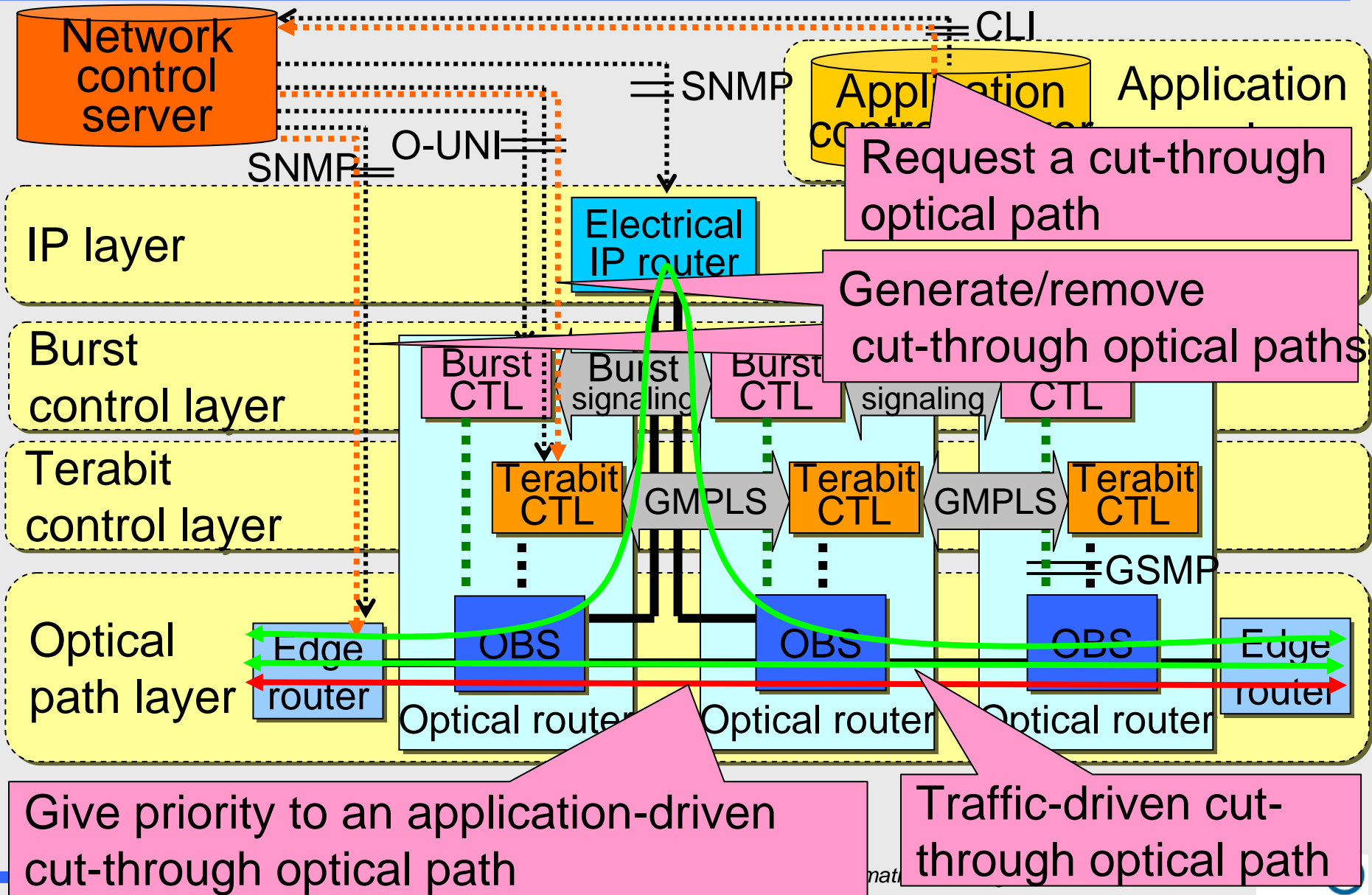


- In the case of **traffic demand**, establish cut-through optical path by selecting **terabit controllers**
- In the case of an **application request**, establish cut-through optical path by selecting **burst controllers**
- Give **priority to application requests** over traffic demands by policy management at the network control server



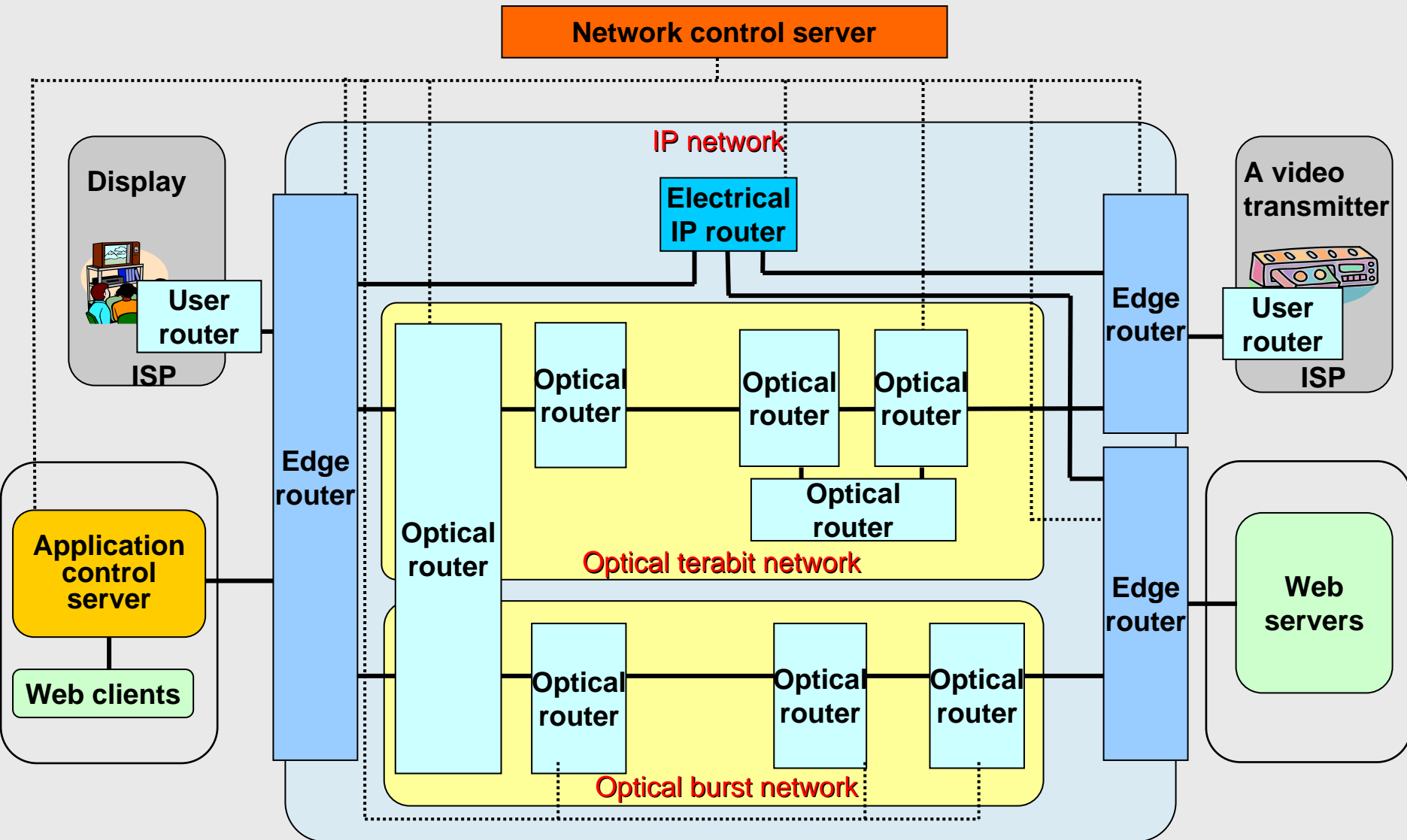
- Recognize importance of a user service while maintaining terabit-class performance economically

Network policy control technology (2/2)



3. Experiments on optical test bed (Japan Gigabit Network II: JGN II)

The experimental network structure



Results of the experiment (1/3)

Confirm implementation of our architecture

Objectives of experiments

Confirm server functions

- Select and control each type of controller
- Implement policy control

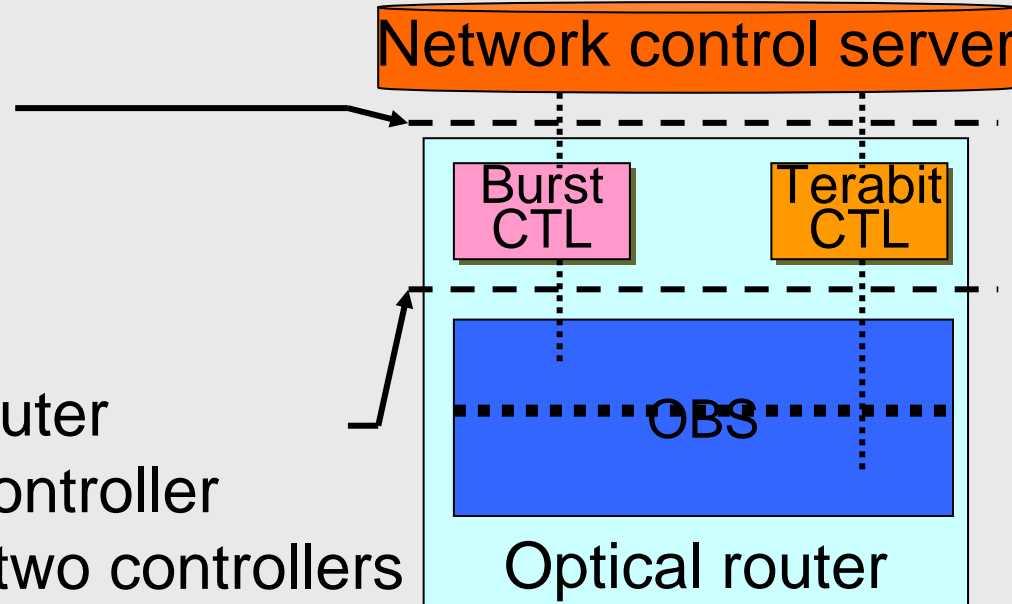
Confirm functions of optical router

- load and run two kinds of controller
- sharing one OBS between two controllers

Results of experiments

It was possible to implement both key network features.

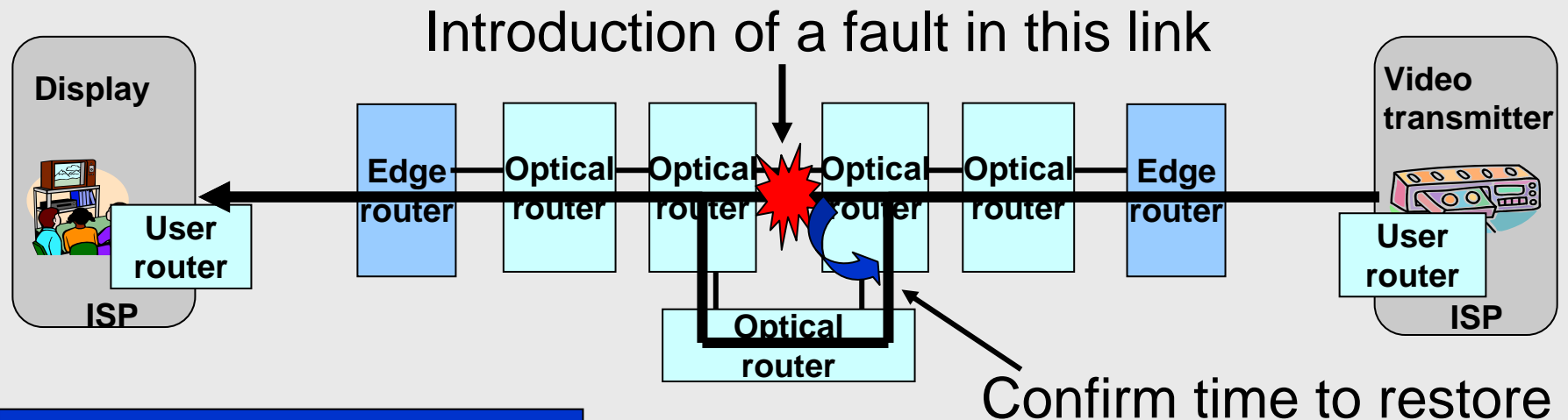
The proposed technology can incorporate two kinds of controller in one physical OBS network



Results of the experiment (2/3)

Confirm optical path distribution in an optical terabit network

Details of experiment



Results of experiments

The restoration time is a few milliseconds, so real-time video streaming was not interrupted

The proposed technology can implement optical path distribution and protection control can be performed in a few milliseconds

Results of the experiment (3/3)

Compare the control time for normal GMPLS signaling with a control time for burst signaling

Results of experiments

	Using normal GMPLS	Using burst control
Control time for assigning an optical path for a user request *	3214 ms	413 ms
Time for signaling in the control time	3103 ms	285 ms

The proposed technology can improve the control time by using a burst signaling

4. Conclusion

Conclusion

The goal

Implementation of the “e-Japan strategy”

The
proposed
network

Cut-through optical path control technologies

- A traffic-driven control technology
Maximizes network throughput
- An application-driven control technology
Assigns optical paths in response to user requests
- A network policy control technology
Selects GMPLS or burst signaling
according to kind of demands

Effect

Implementing “Terabit OBS Super-Net” will allow 40 million users to be accommodated economically

Supported by



Appendix 1

Traffic-driven optical path control technology

Assign a new cut-through optical path by removing an old one if the traffic for the new one is larger than that for the old one

(2) Assign cut-through optical path to traffic flow which is larger than that on old path

(1) Shortage of ports due to existence of old cut-through optical path

