Robust and Efficient Control Method for Multilayered GMPLS Networks

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Outline

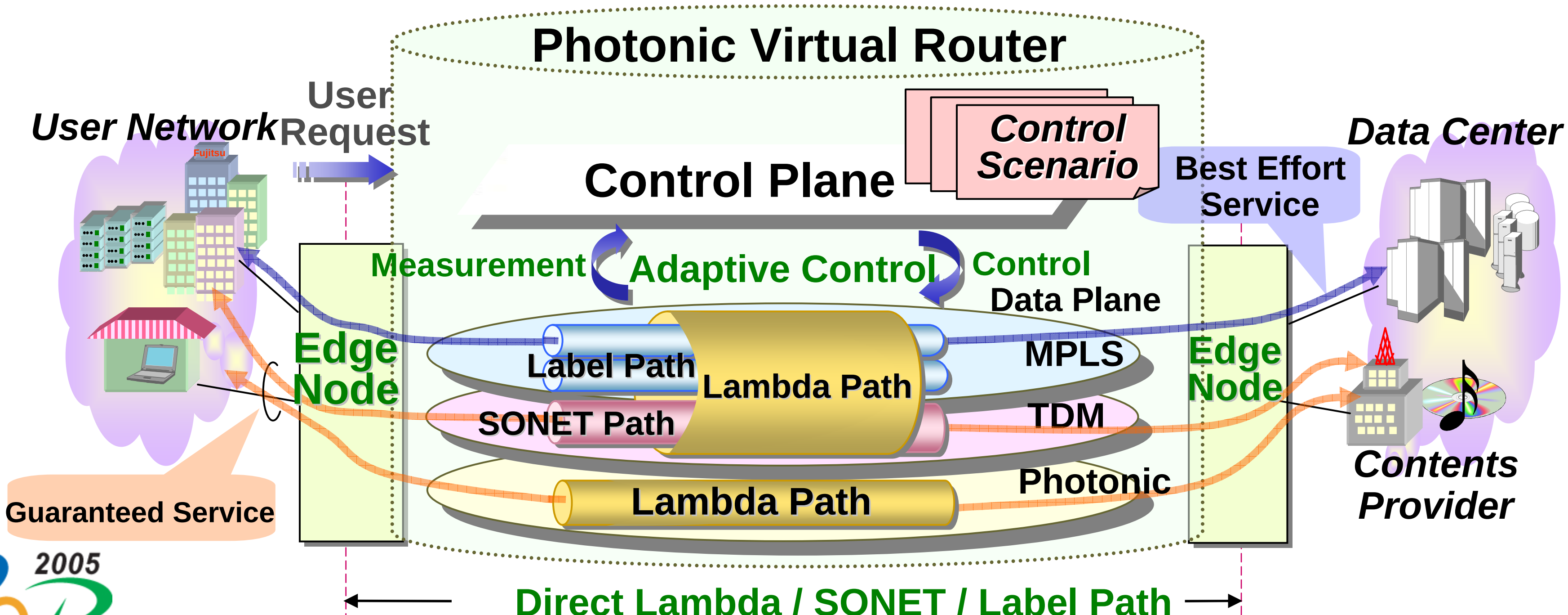
1. Requirements for Next Generation Network (NGN)
2. Photonic Virtual Router
   - Multilayer Traffic Engineering Scenario
   - Fault Recovery Scenario
3. Evaluation of Fault Recovery
4. Conclusion

Requirements for NGN

- Support for accommodation of explosive traffic volumes
  - Resolve router bottlenecks (limitations as to electrical processing)
- Support for various services
  - Interactive service like VoIP
  - Huge data transfers (e.g. Grid computing)
  - Multilayer VPNs (L1/L2/L3 VPN)
- Easy and low cost network operation, administration and maintenance (OAM)

Photonic Virtual Router

- Introducing photonic technologies into router network
- Simplify the network
- Offer of various transport plane pipes according to a network service
- Autonomous and automatic network control using control plane



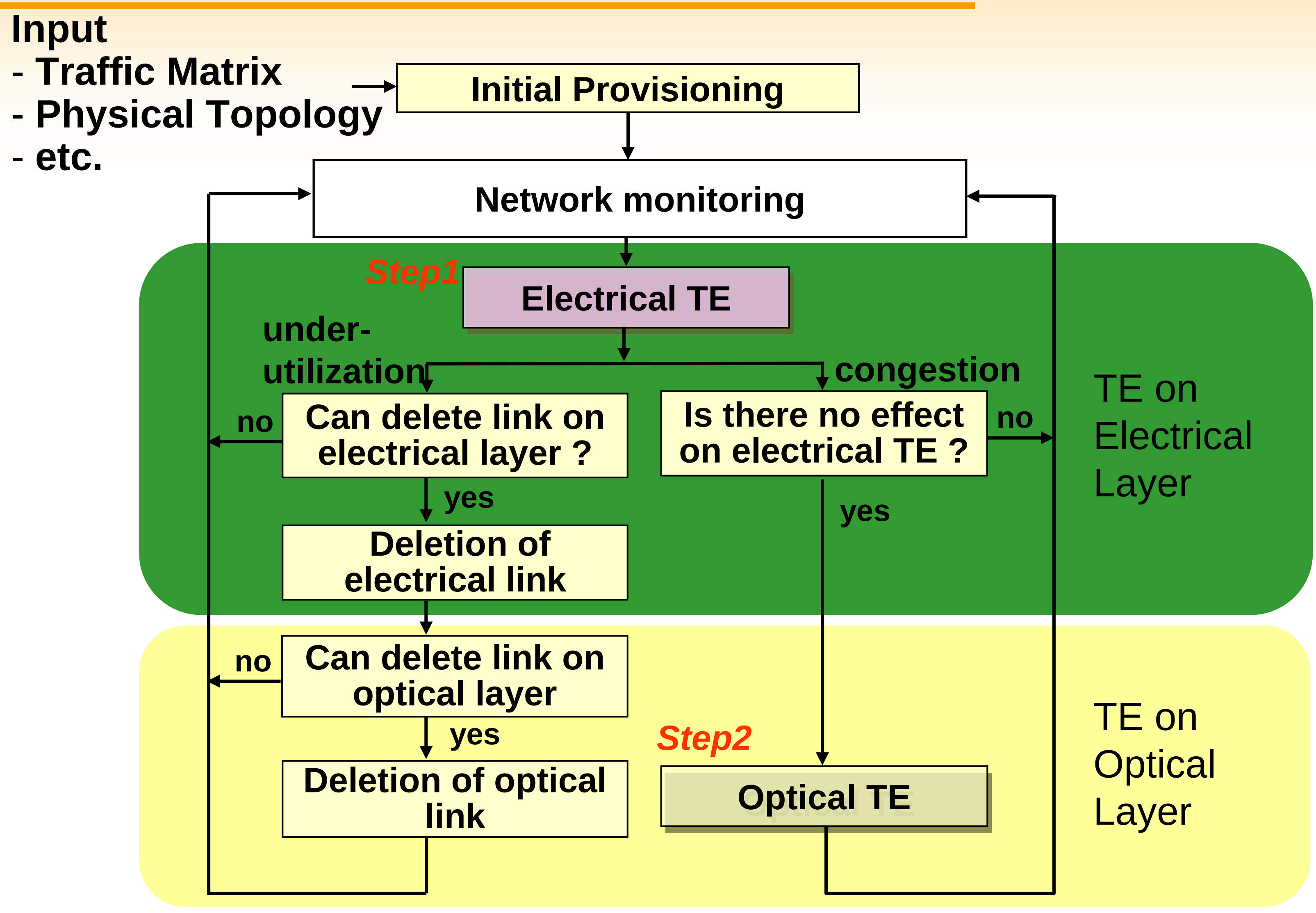
Scenario1: Multilayer TE Scenario

- Definition

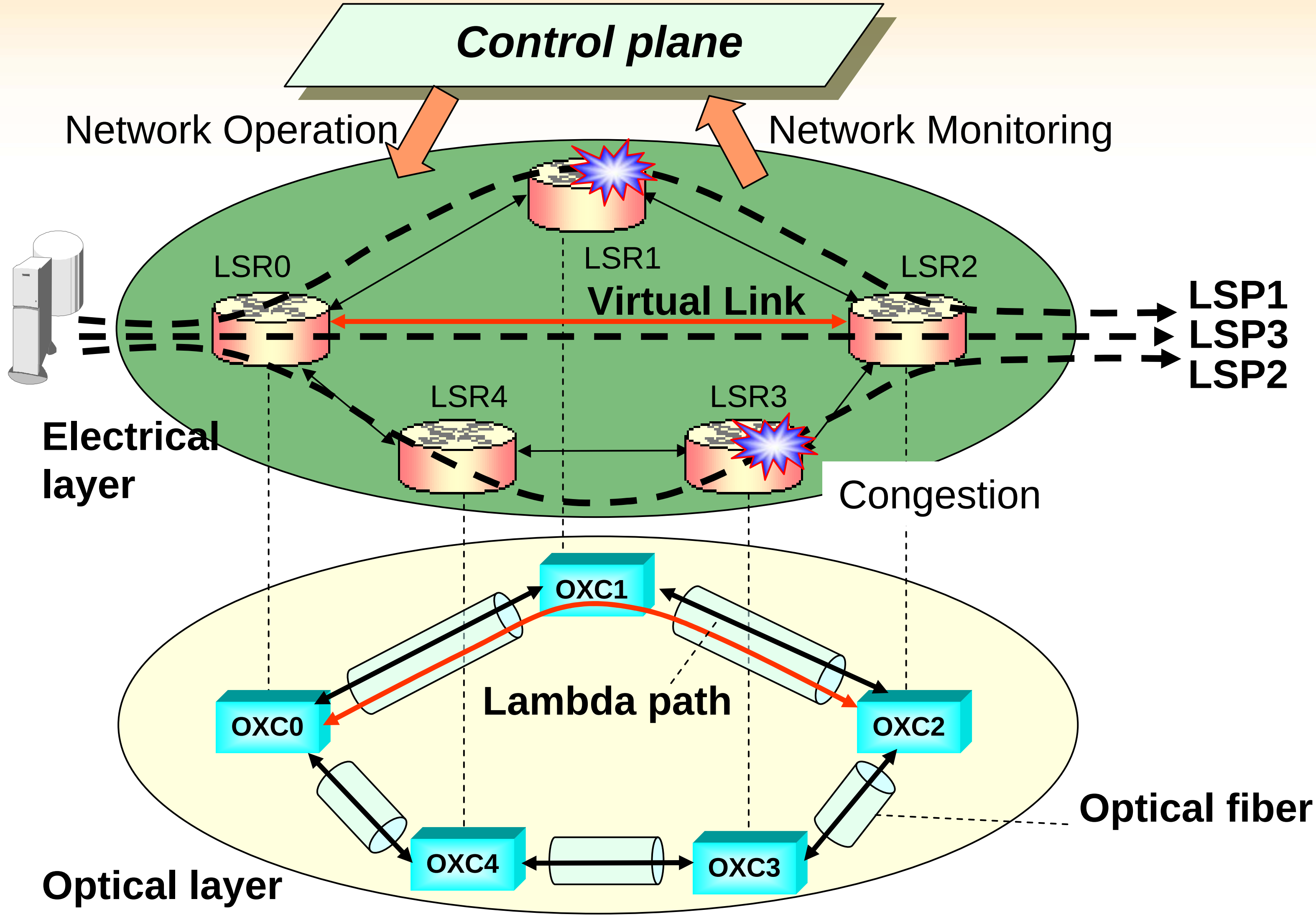
  A mechanism that offers transport paths according to user demand and operator's policy by controlling multi layer paths and routes in order to adjust to meet dynamic traffic changes

- Basic functions
  - Network monitoring
    - Measurement or estimation of network statistics
  - Control decision
    - Admission control
    - Route calculation of paths to be shortcut or aggregated
  - Network operation
    - Path setup signaling
    - Label setup in transport device
    - Path switching

Workflow of Multilayer TE

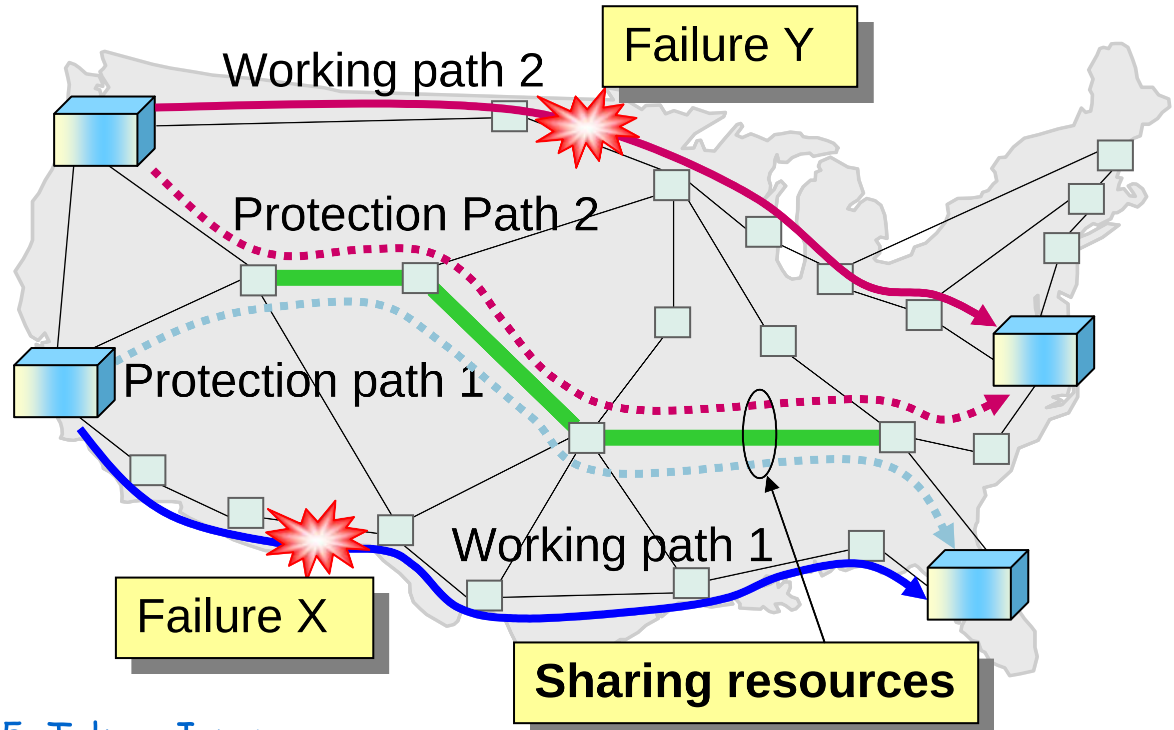


Example of Multilayer TE



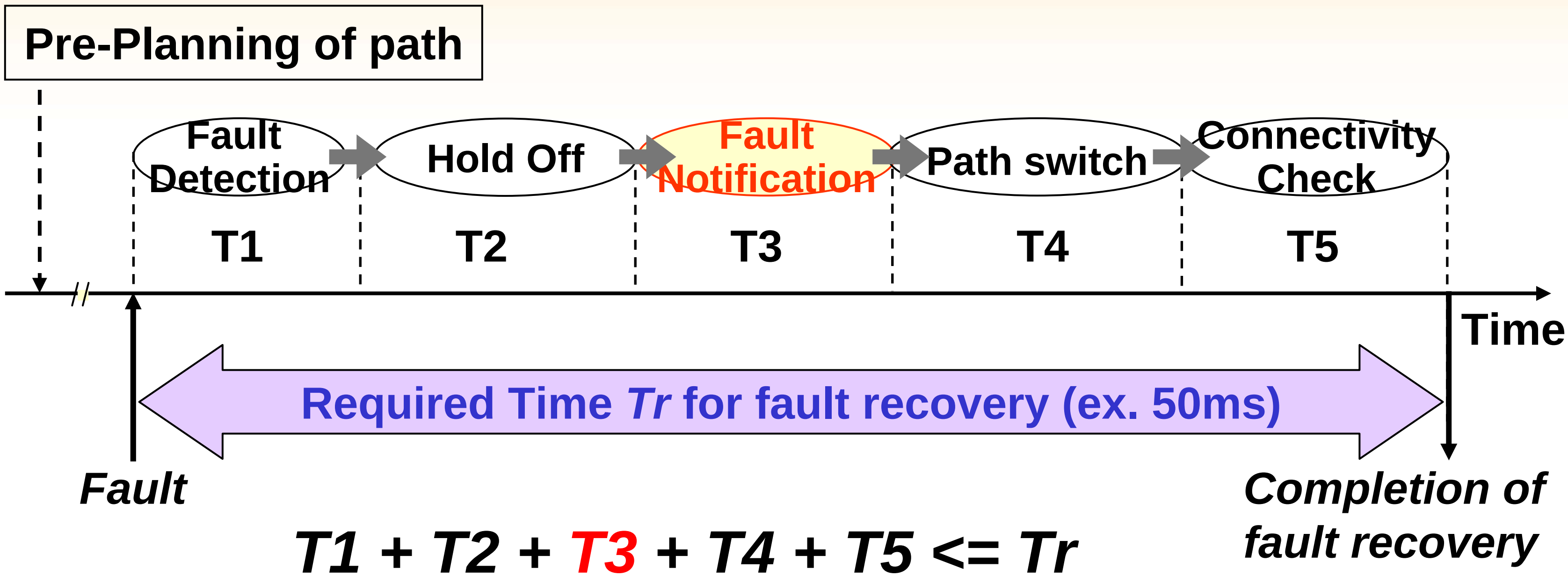
Scenario2: Fault Recovery Scenario

- **Requirements**
  - **Efficient usage of data-plane resource such as lambdas**
  - **Meeting timing requirements**
  - **Reduction of the number of control messages for recovery**
  - **Recovery of multiple connections by fiber cutting**
- **Functions**
  - **Shared mesh-based recovery**
  - **Pre-planed route calculation**
  - **Segment Repair**
  - **Flooding-based fault notification**



Steps for Fault Recovery

- Steps for Fault Recovery



$$T1 + T2 + T3 + T4 + T5 \le Tr$$

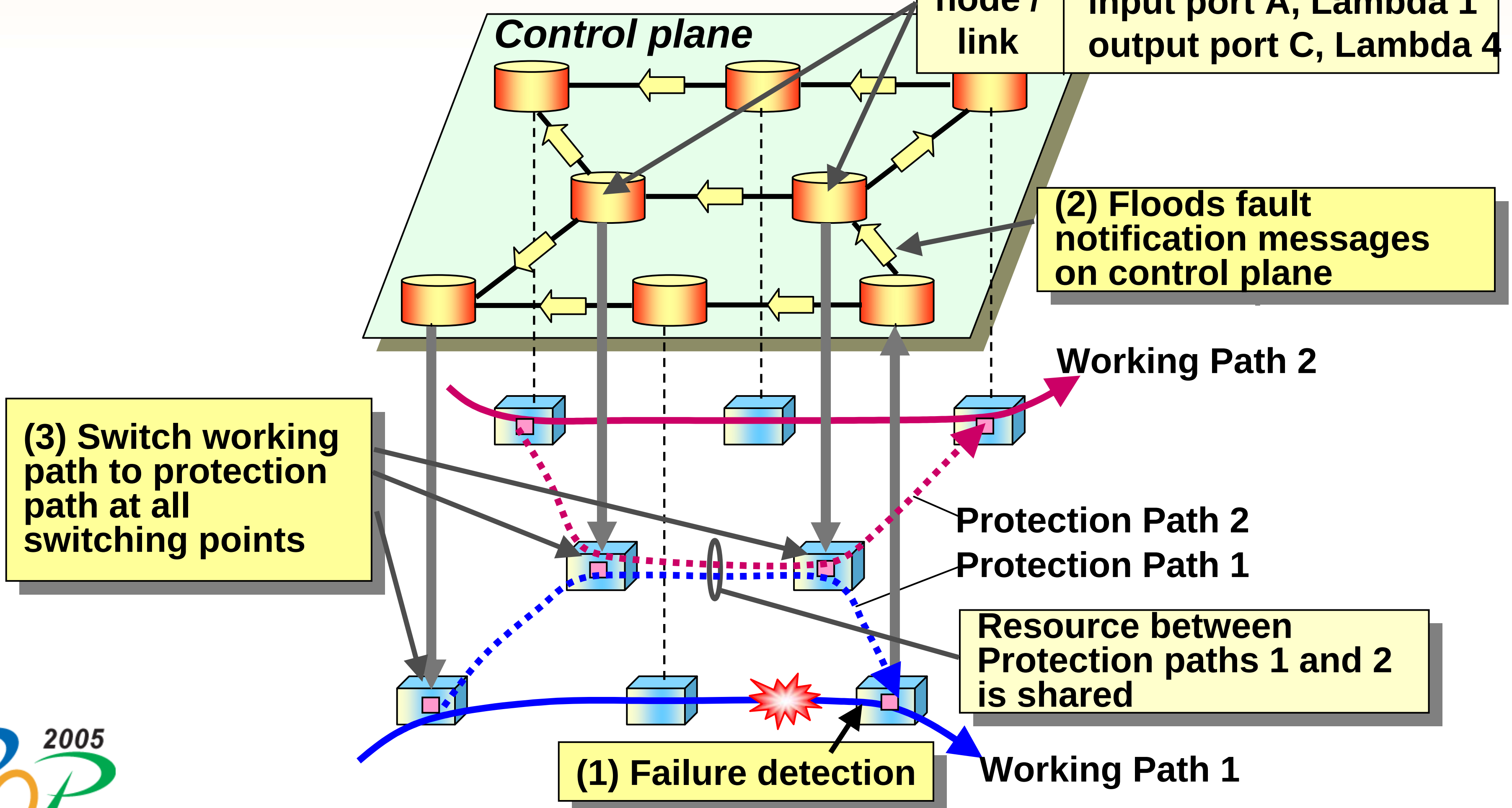
Hardware dependent time (T1 + T2, T4 + T5)

- T3 is a key to recover from a failure within a required time
- Fault notification is done by control plane network
- Advantage: complicated control functions can be removed from data plane and can extend for the future function

Flooding-based Fault Notification Method

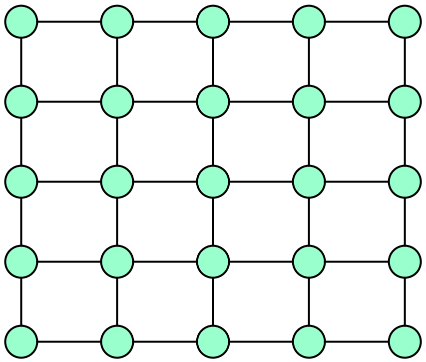
Fault-Recovery Table

Fault ID	Operation Information
node / link	input port A, Lambda 1 output port C, Lambda 4



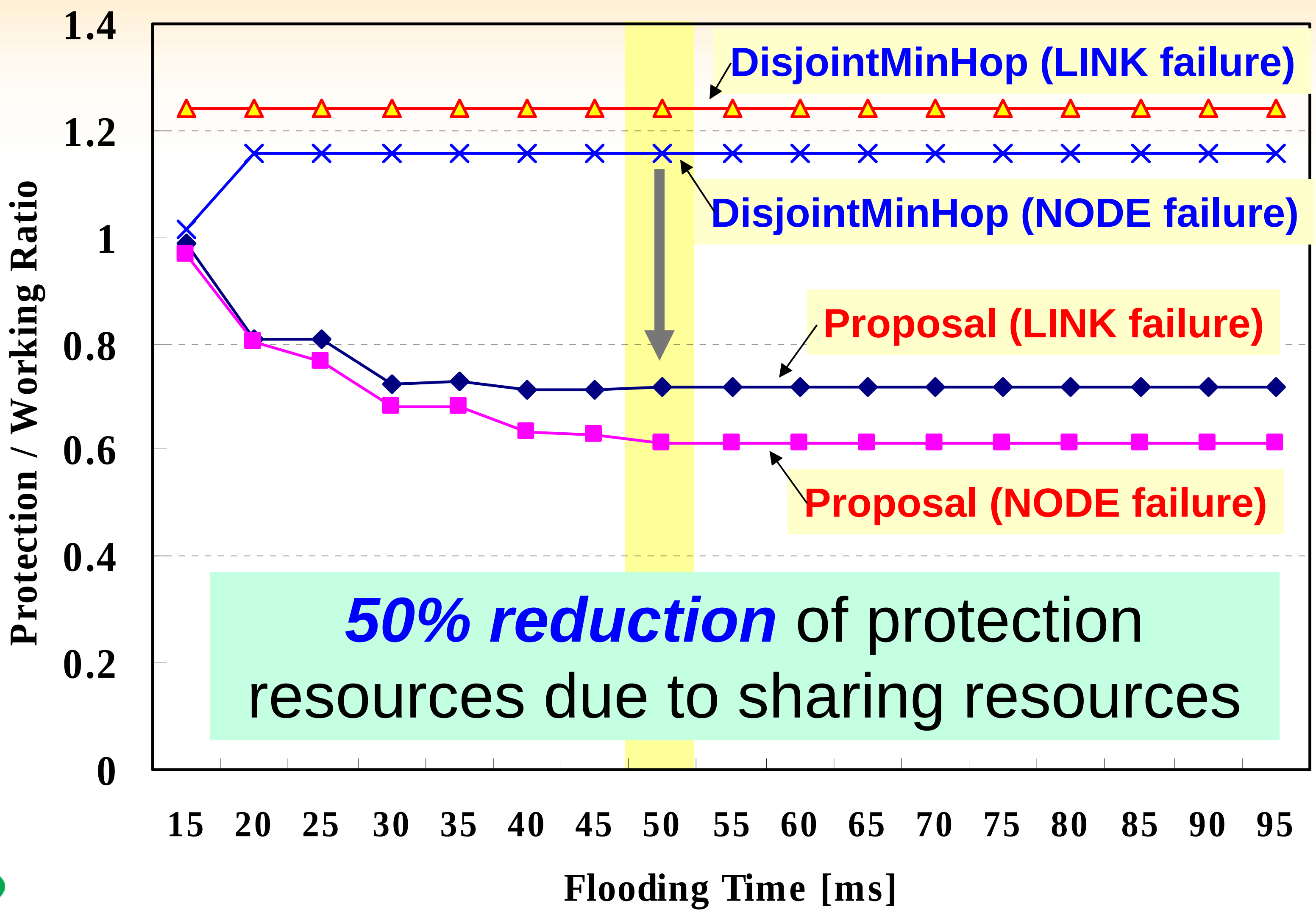
Evaluation of Shared Mesh Recovery

- 5 x 5 grid network
  - Average link distance = 400 km
  - Each node generates 10 connection requests to all other nodes
- Transmitting fault notification messages
  - Transmission delay = 5 msec/km
  - Forwarding delay per node = 1 msec/node
- Comparison of algorithms
  - Disjoint Minimum Hop algorithm to recover from a LINK failure
  - Disjoint Minimum Hop algorithm to recover from a NODE failure
  - Shared mesh algorithm to recover from a LINK failure
  - Shared mesh algorithm to recover from a NODE failure

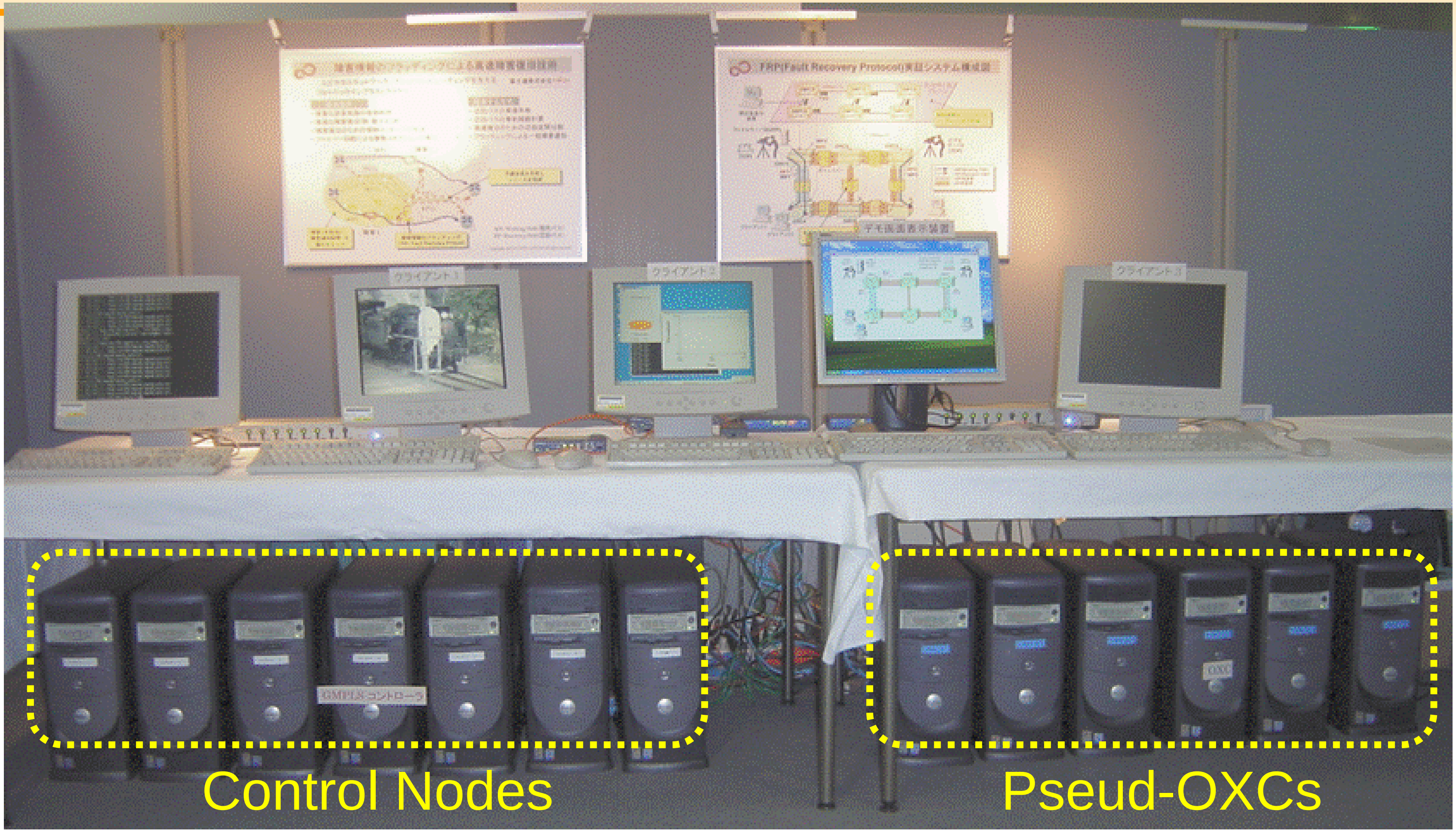


- Algorithm for shared mesh
  - Time-constrained recovery path (TCRP)
  - Calculates recovery path satisfying recovery time and optimize routes

Simulation Result



Overview of Prototype System



1.3 ms by 6 control plane nodes

Conclusion

- A concept of photonic virtual router is proposed
  - Multilayer Traffic Engineering scenario
  - Fault recovery scenario
- Flooding based fault notification method is proposed
  - Fast fault notification method using control plane network
- Effectiveness of shared mesh recovery
  - About 50% reduction of protection resource compared with a disjoint minimum hop algorithm

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THE POSSIBILITIES ARE INFINITE