IP+Optical Network Operation, and Network Virtualization

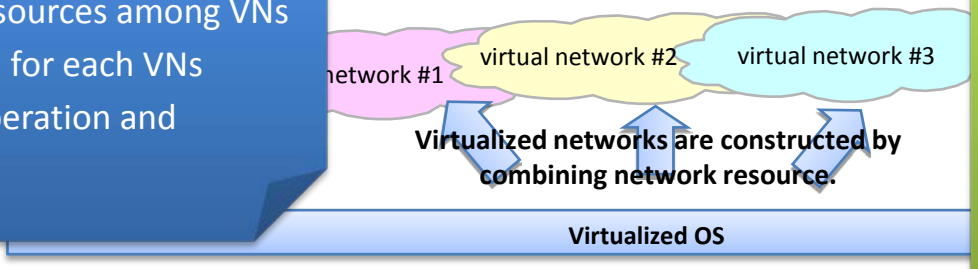
We study operation management techniques targeted at layer1,2, and 3 networks to reduce network CAPEX/OPEX.

- •Network virtualization technique
- •Multi-layer network integrated network architecture
  - •Transfer offloading
  - •Operation management offloading

Network Virtualization

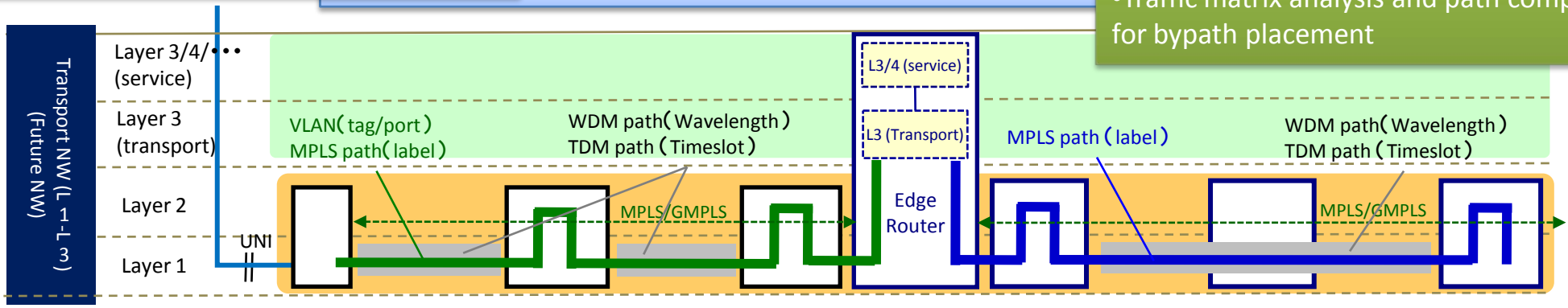
- •Sharing multi-layer network resources among VNs
- •Dynamic resource re-allocation for each VNs
- •Independent and automatic operation and configuration for each VNs

VN: virtual network



Data transport function offloading

- •Router-offloading networks for increasing traffic
- •Scalable and fast routing convergence by route server, along with various fast routing convergence techniques
- •Traffic matrix analysis and path computation for bypath placement



Operation function and action offloading

- •GPMLS operation enabling interoperability between WSON-supported and -unsupported nodes.

Virtual network architecture over IP-optical network

Overview

Recent trends in telecommunication have focused on converging services in a shared IP network. However, it is assumed that the innovative applications in the future will have so diverse requirements that they cannot be easily converged in a common IP network. Our technology aims to create multiple virtual networks upon a common physical network infrastructure, leveraged by the integrated control of optical and IP networks. It enables to launch services quickly and to operate them independently. Feasibility of the technique is confirmed through demonstrations and experiments in real networks.

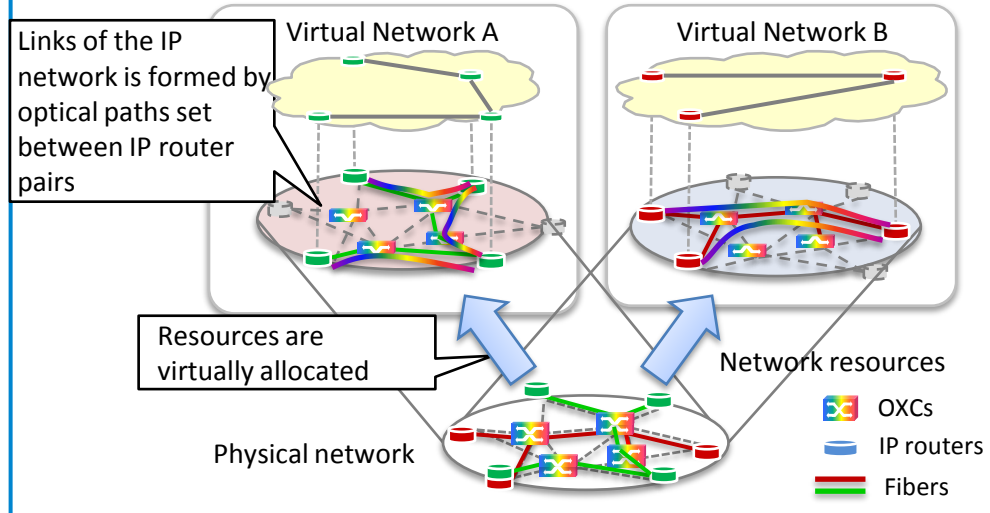
Features

- **Resource isolation in the physical layer ensures to avoid traffic conflicts between virtual networks**
- **Dedicated use of the dynamic optical paths supports on-demand use of gigabit-class communication**
- **Amount of the allocated resource and the topology of the virtual network can be dynamically re-optimized in accordance to the change in traffic patterns**
- **It can be deployed without modifications to general routers and optical cross-connects that support the standard protocol: GMPLS**

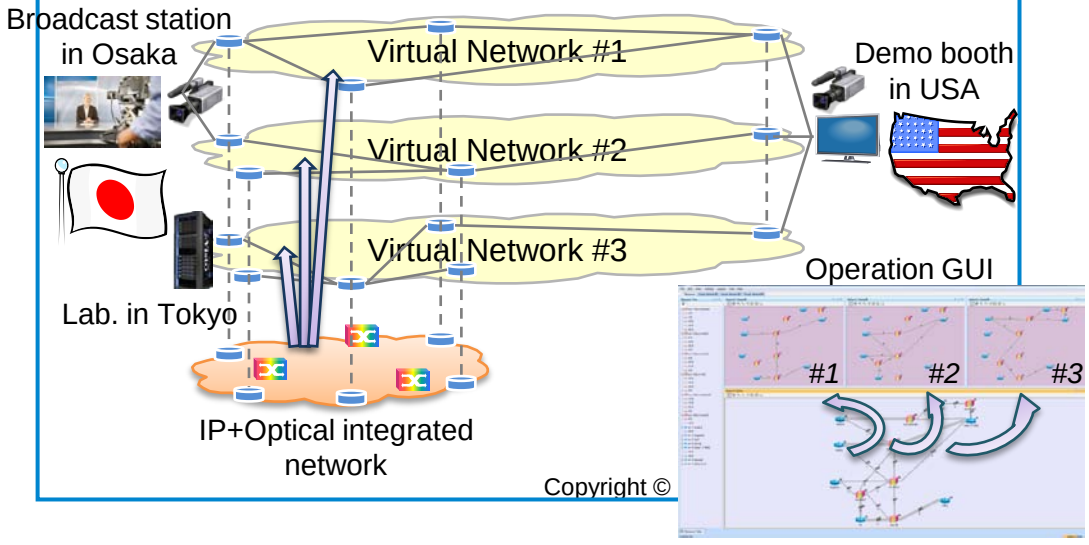
Application scenarios

- **Carrier backbone networks**
- **Large-scale data center networks**
- **Ultra wide-band services in the future such as uncompressed 3D and HD video transmission**
- **On-demand wide-area VPN**

Integrated control of optical paths and IP



Demonstration in real network



Multi-Layer Network Operation Management

Overview

Router-offloading is a promising approach for increasing traffic. Router-offloading changes the network architecture, thus technologies are needed to make router-offloading realistically applicable.

The first challenge is IP routing scalability and convergence time at the edge. Route server is a future direction, along with various fast routing convergence techniques.

The second challenge is networking planning. Traffic matrix analysis, path computation and routing simulation are important techniques to operate the network.

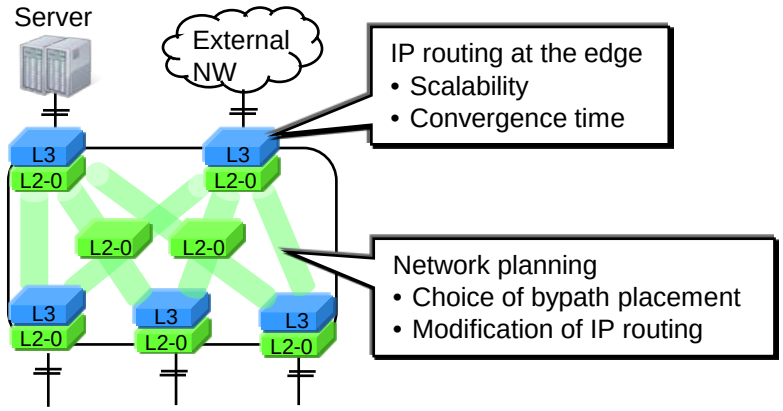
Features

- Router-offloading networks for increasing traffic
- Scalable and fast routing convergence by route server, along with various fast routing convergence techniques
- Traffic matrix analysis and path computation for bypath placement
- Routing simulation for installing new routing policies.

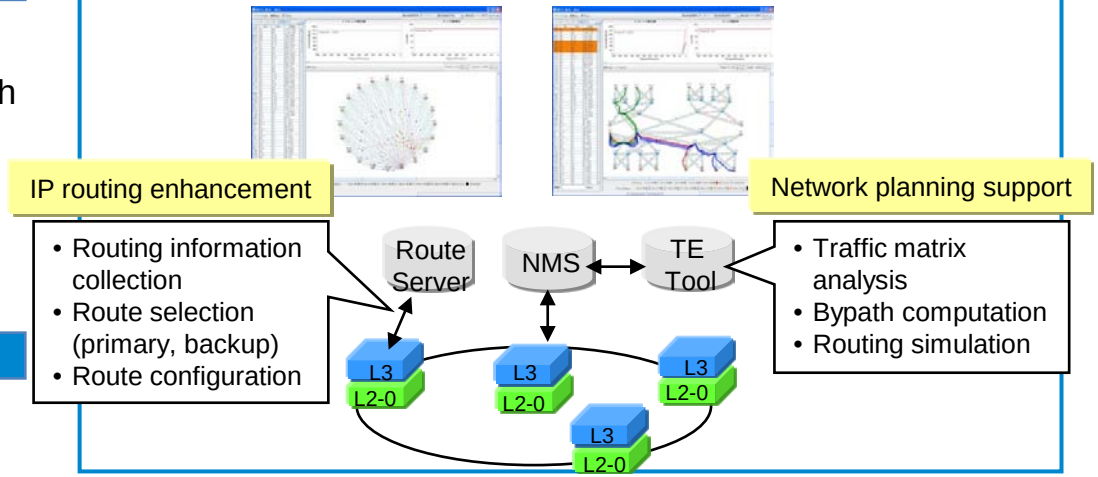
Application scenarios

- Carrier backbone networks

Router-Offloading Challenges



Multi-Layer Network Operation for Router-Offloading



Optical network operation management

Overview

WSON is a promising optical network in that it provides broadband and energy-saving transmission. Recently, WSON-supported ROADMs and OXCs appear and interoperating experiments have been demonstrated. On the other hand, there are few commercially-available routers working in WSON. Our technology aims to GMPLS operation to interoperate WSON-unsupported nodes and WSON-supported ones, while commercially-available routers (WSON-unsupported nodes) have no impact on interoperating WSON.

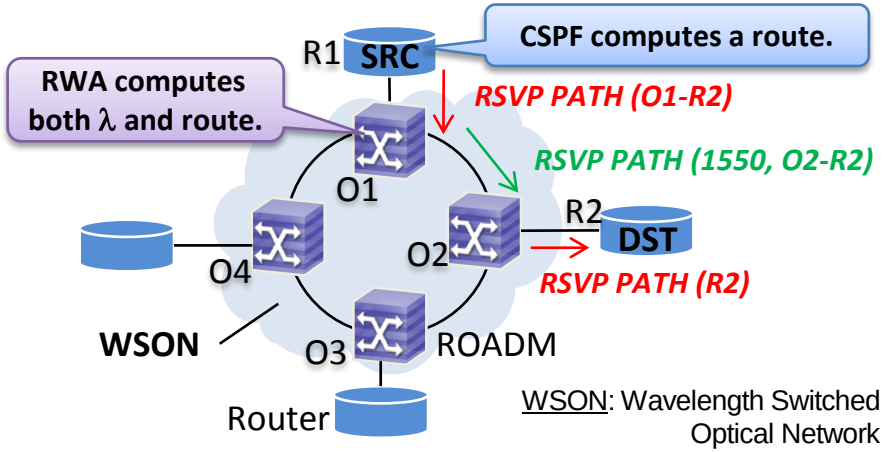
Features

- Commercially-available routers don't have to add new function to interoperate with WSON.
- Nodes at the border of WSON handle WSON-extended information (ex. λ).
- There are several computation models in terms of "who computes what".

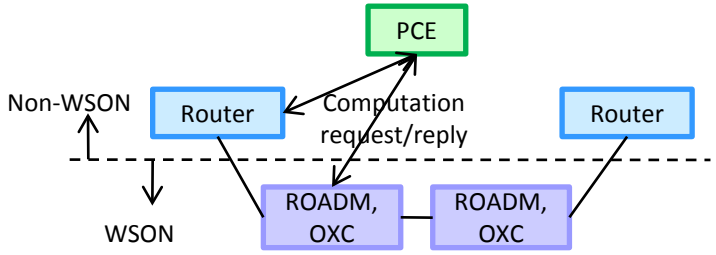
Application scenarios

- Carrier backbone networks

WSON and non-WSON interoperability



Computation model



Function deployment model

What	Who
Path route	Router
Wavelength RWA	Node at the border of WSON PCE