

***Getting started with O3 Project Achievement  
~ Innovating Network Business  
through SDN WAN Technologies ~***

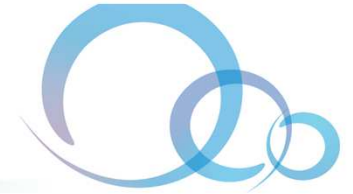
***April 20, 2015***

***Yoshiaki Kiriha***

***O3 project (NEC, NTT, NTT Communications, Fujitsu, Hitachi)***

# Agenda

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- ***Innovation through O3 User-oriented SDN***
- ***O3 Technologies for SDN WAN***
- ***SDN Use Cases in O3 Project***
- ***Getting started with O3 Project Achievement***



O3project



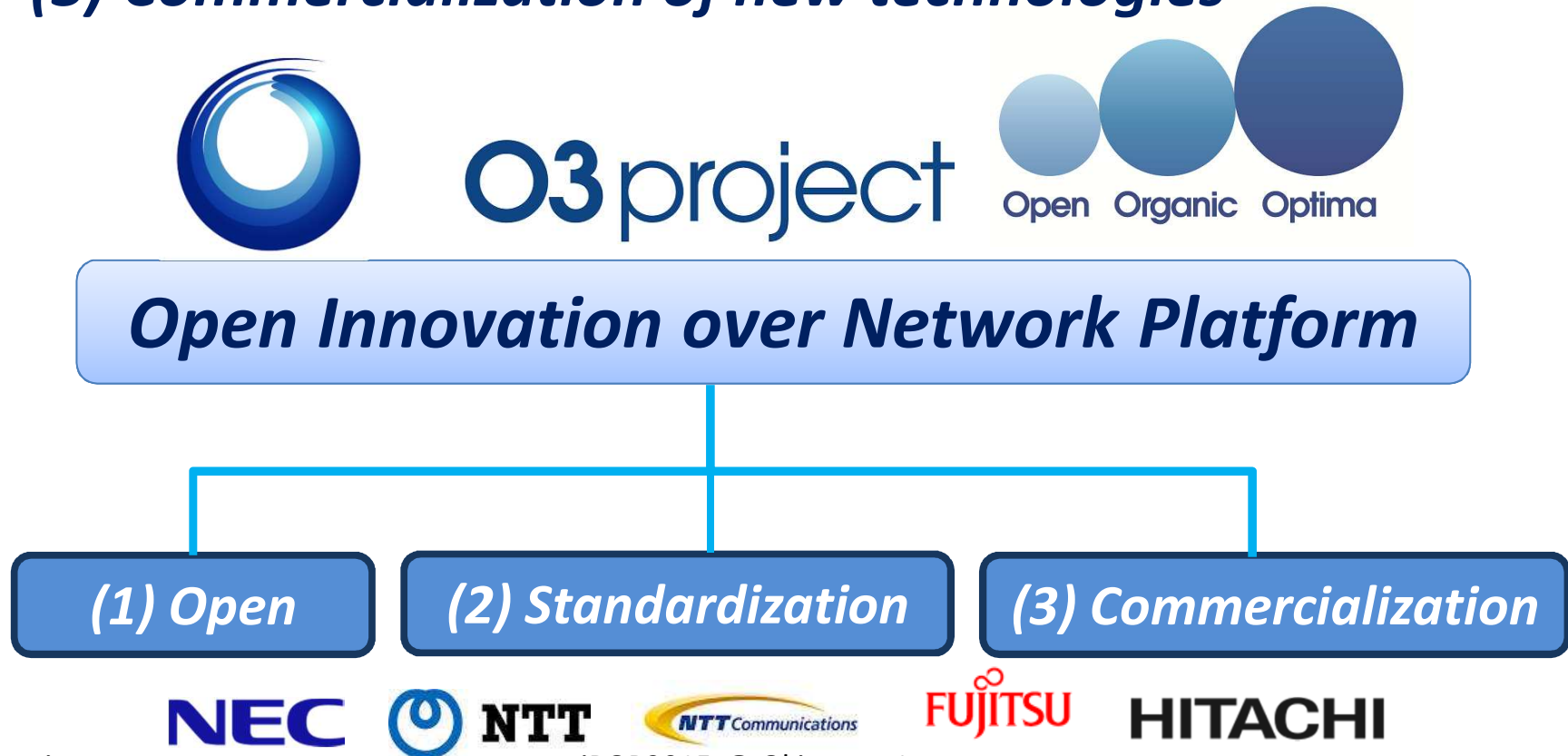
# ***Innovation through O3 User-oriented SDN***

# Toward open User-oriented SDN



## ■ 3 Contributions for User-oriented SDN

- (1) Open development with OSS
- (2) Standardization of architecture and interface
- (3) Commercialization of new technologies



# ***O3 Project Concept, Approach & Goal***

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## **■ *Open, Organic, Optima***

- *Anyone, Anything, Anywhere*
- *Neutrality & Efficiency for Resource, Performance, Reliability, ....*
- *Multi-Layer, Multi-Provider, Multi-Service*

## **■ *User-oriented SDN for WAN***

- *Softwarization: Unified Tools and Libraries*
- *On-demand, Dynamic, Scalable, High-performance*

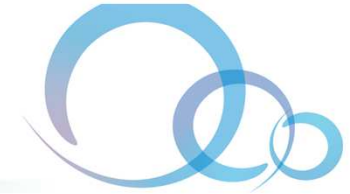
## **■ *Features***

- *Object-defined Network Framework*
- *SDN WAN Open Source Software*
- *SDN Design & Operations Guideline*

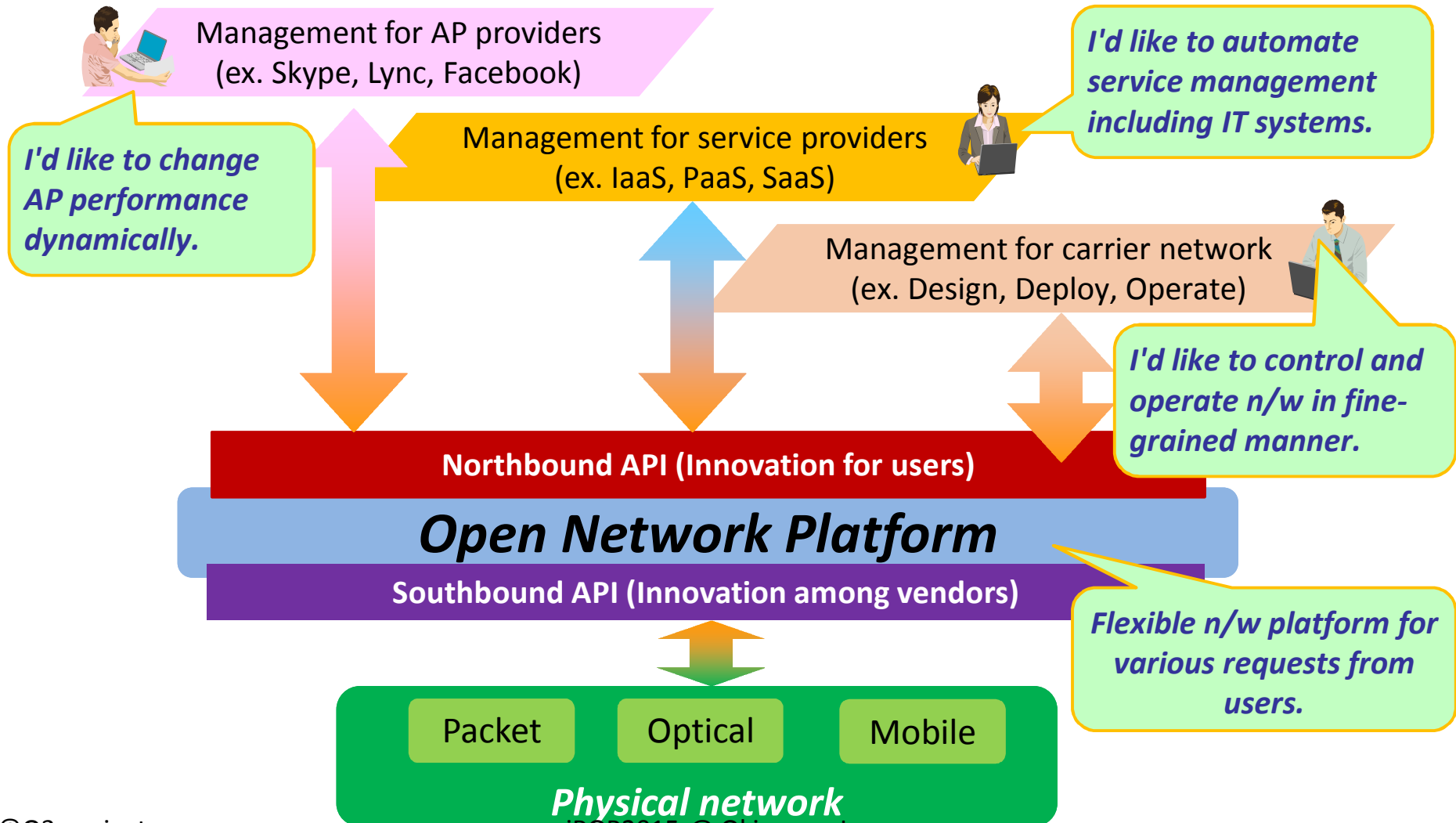
## **■ *Accelerates***

- *Service Innovation, Re-engineering, Business Eco-System*

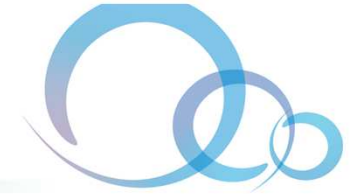
# 03 Deliverables: User-oriented SDN



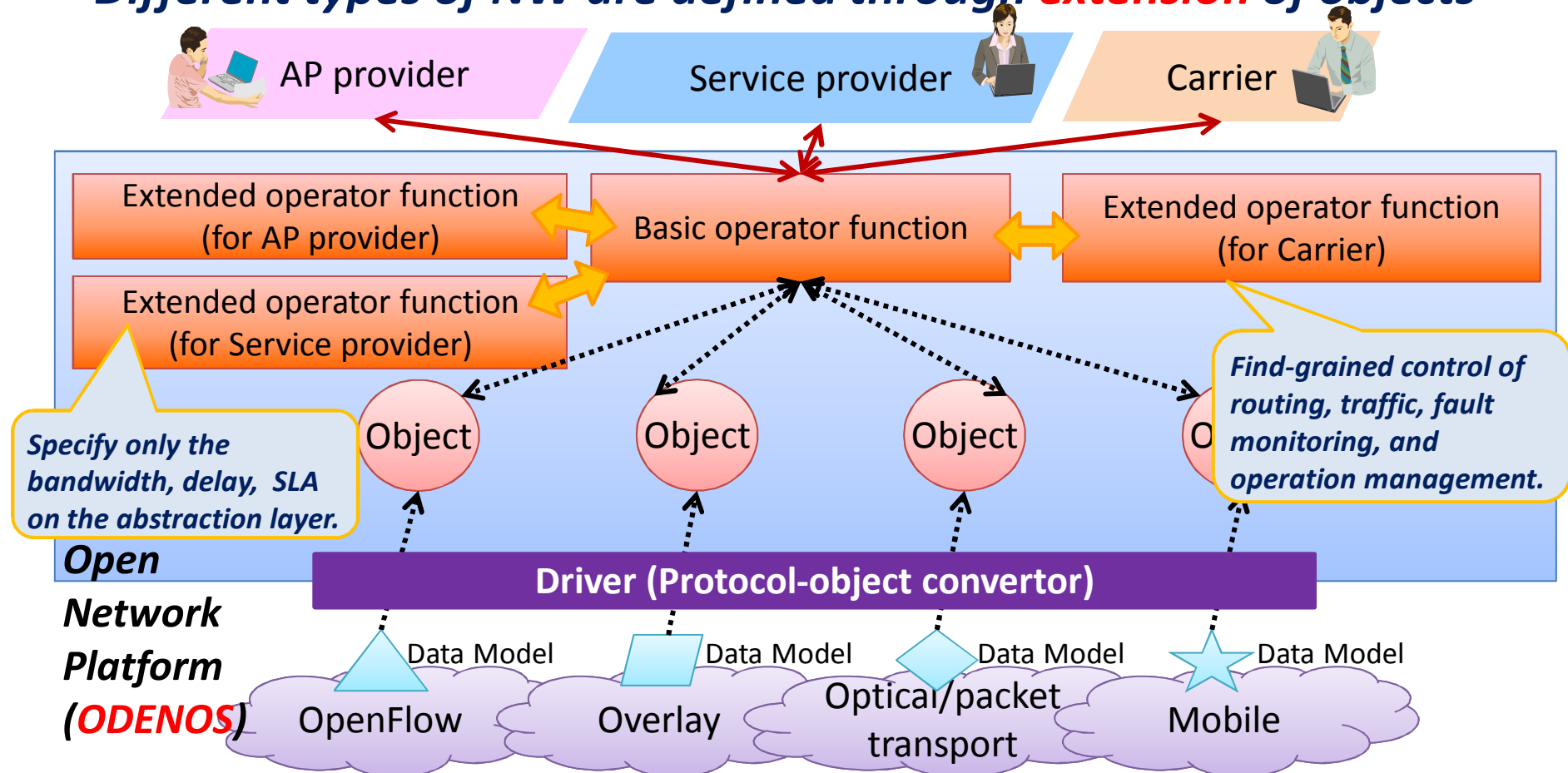
## ■ Provides **Orchestration** for different user requirements



# 03 Object-defined Network Platform



- Network is abstracted as graph of base **objects**
- Control functions are the **operators** for the objects
- Different types of NW are defined through **extension** of objects

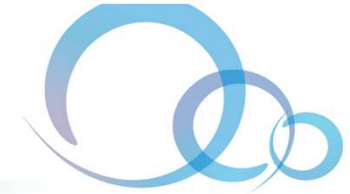




# ***O3 Technologies for SDN WAN***

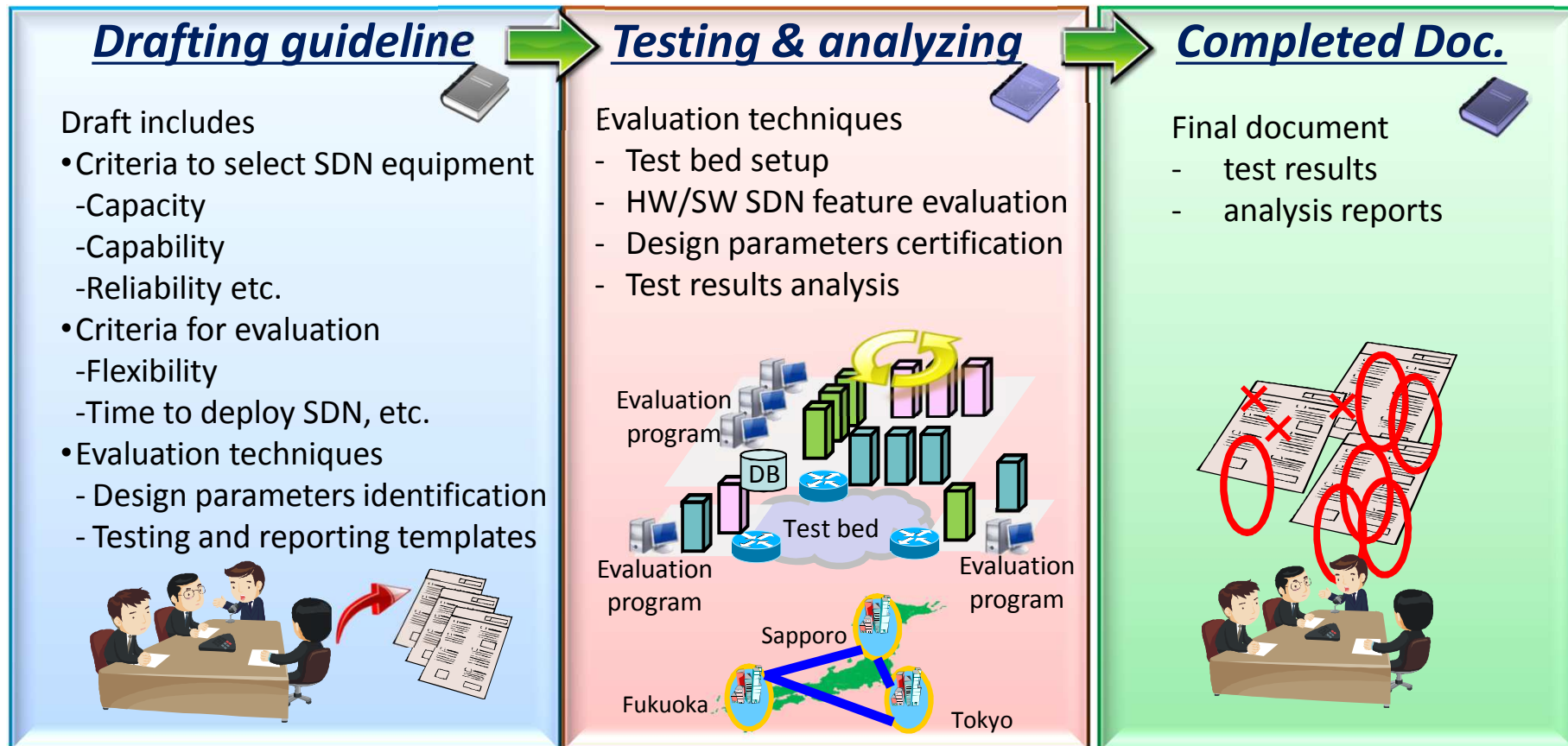


# SDN Design & Operations Guideline



## ■ Established the SDN guideline for carrier networks

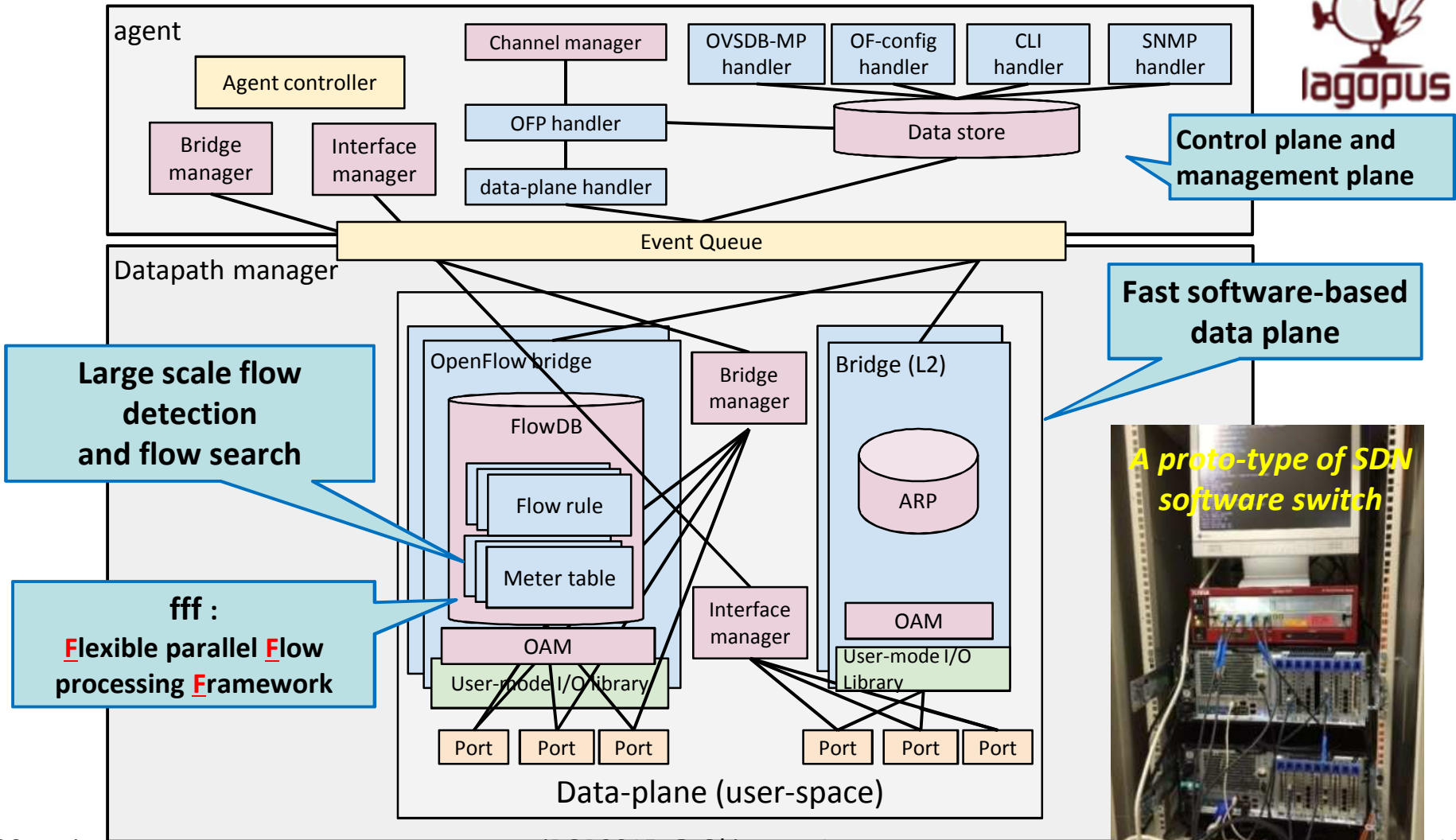
The guideline is required to design, deploy and operate large-scale SDN in the following steps.



# SDN Software Switch: Lagopus

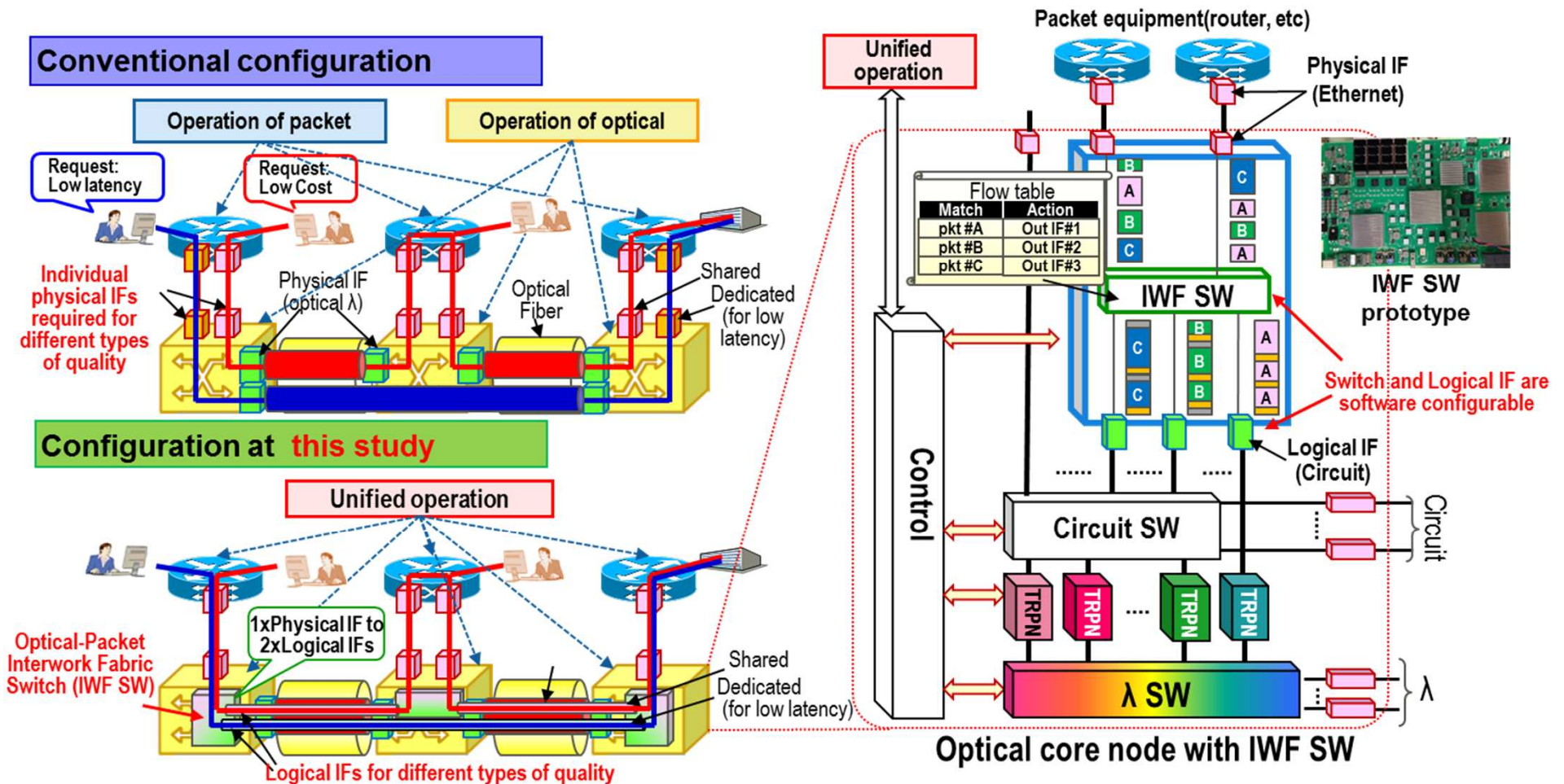


## SDN 10Gbps S/W forwarding node with 1M flows



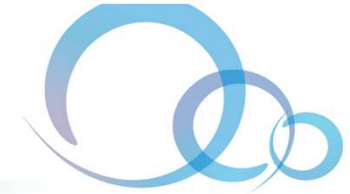
# Signal Interwork between Optical & Packet

- Enables ....  
a wide variety of service quality & rapid service tune-up

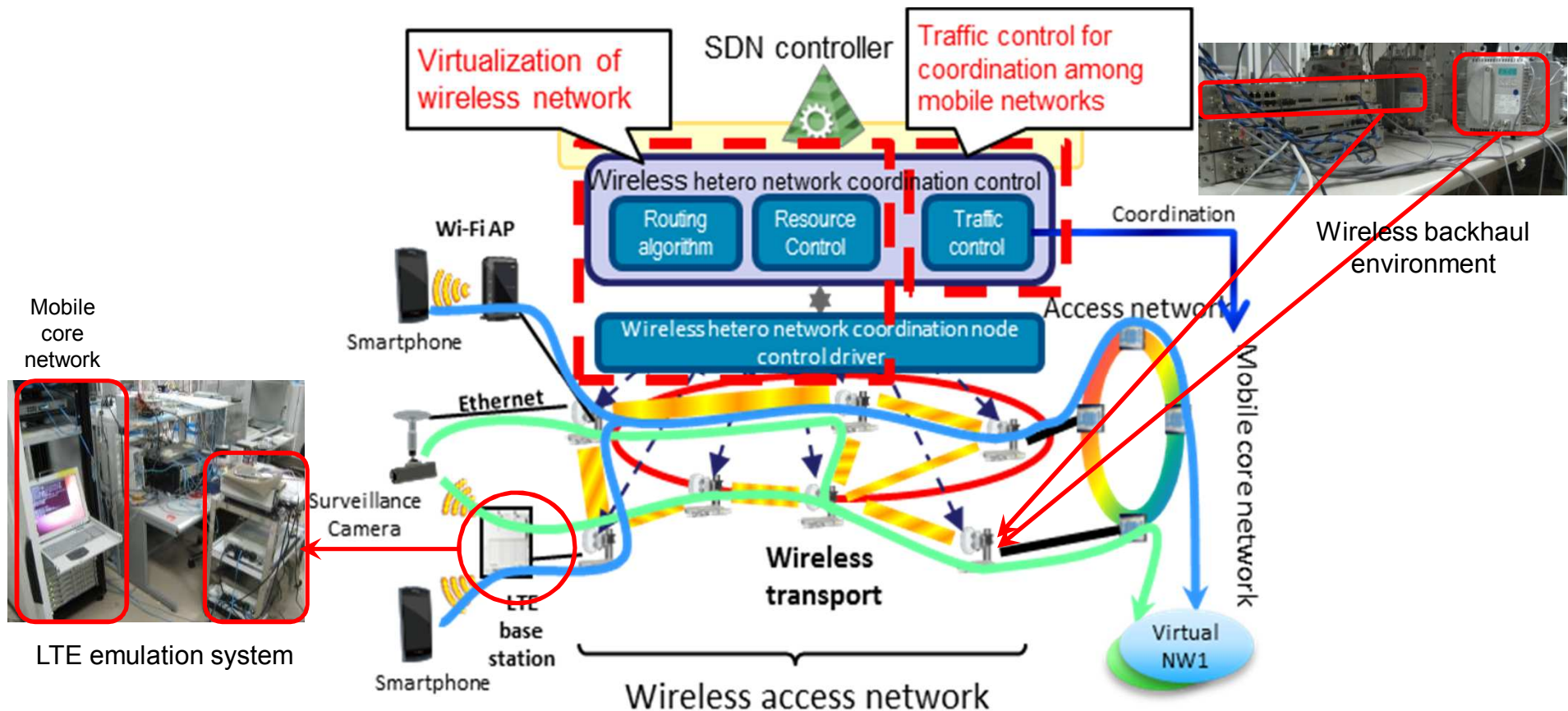




# Virtual Wireless Networks



- Support multiple virtual networks over wireless networks while avoiding degradation of high priority traffic even when traffic demand and data rate of wireless link changes over time



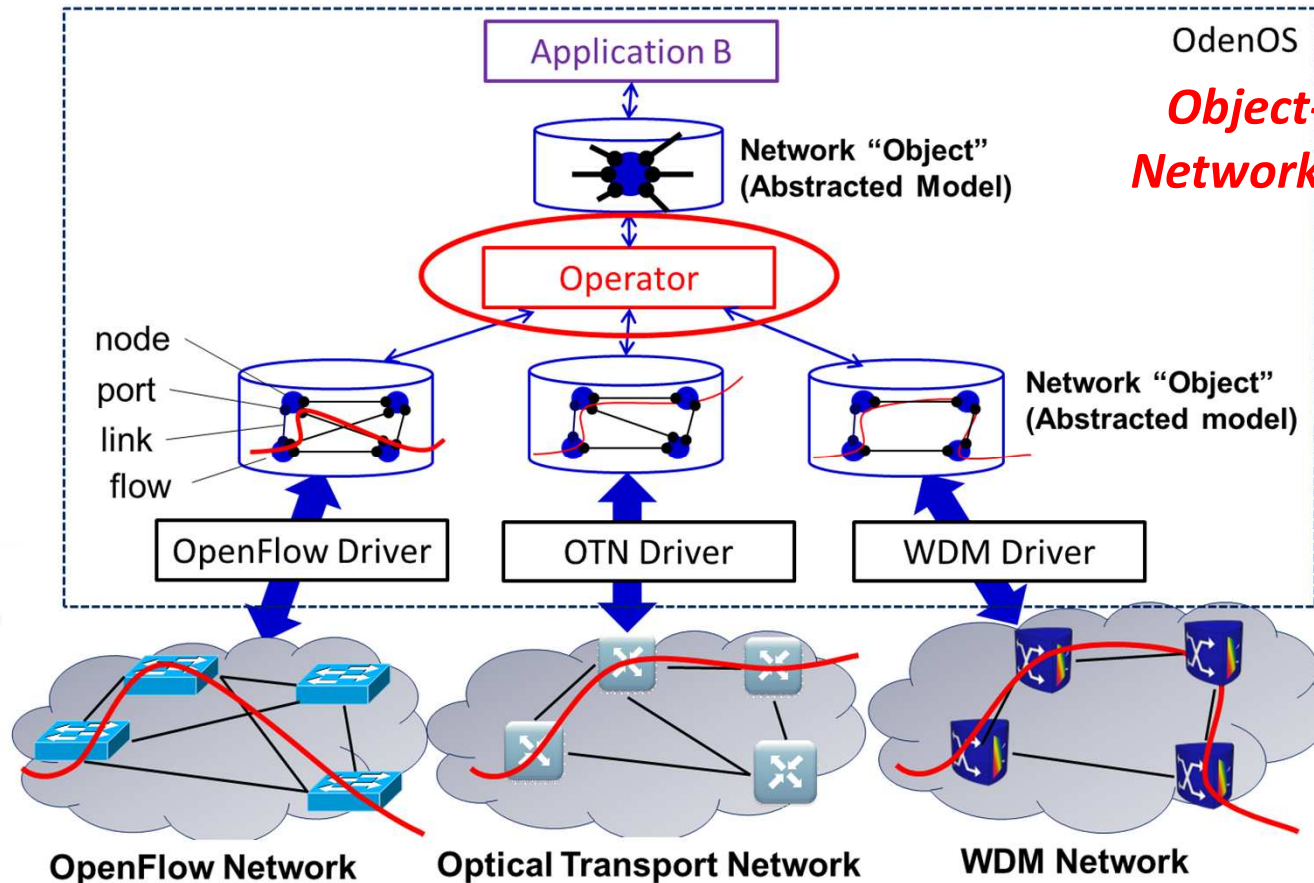
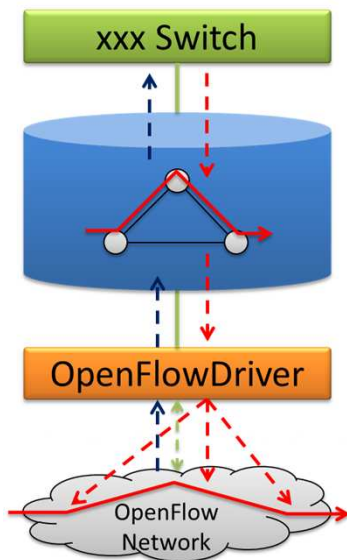
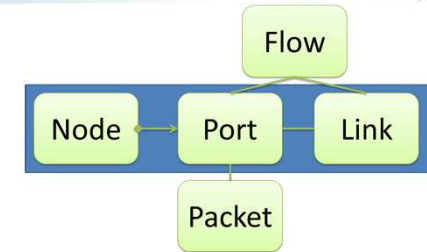
# SDN Framework: ODENOS



- **Network Abstraction Model: Hierarchical**

- *Node, Port, Link, Flow, and Packet*

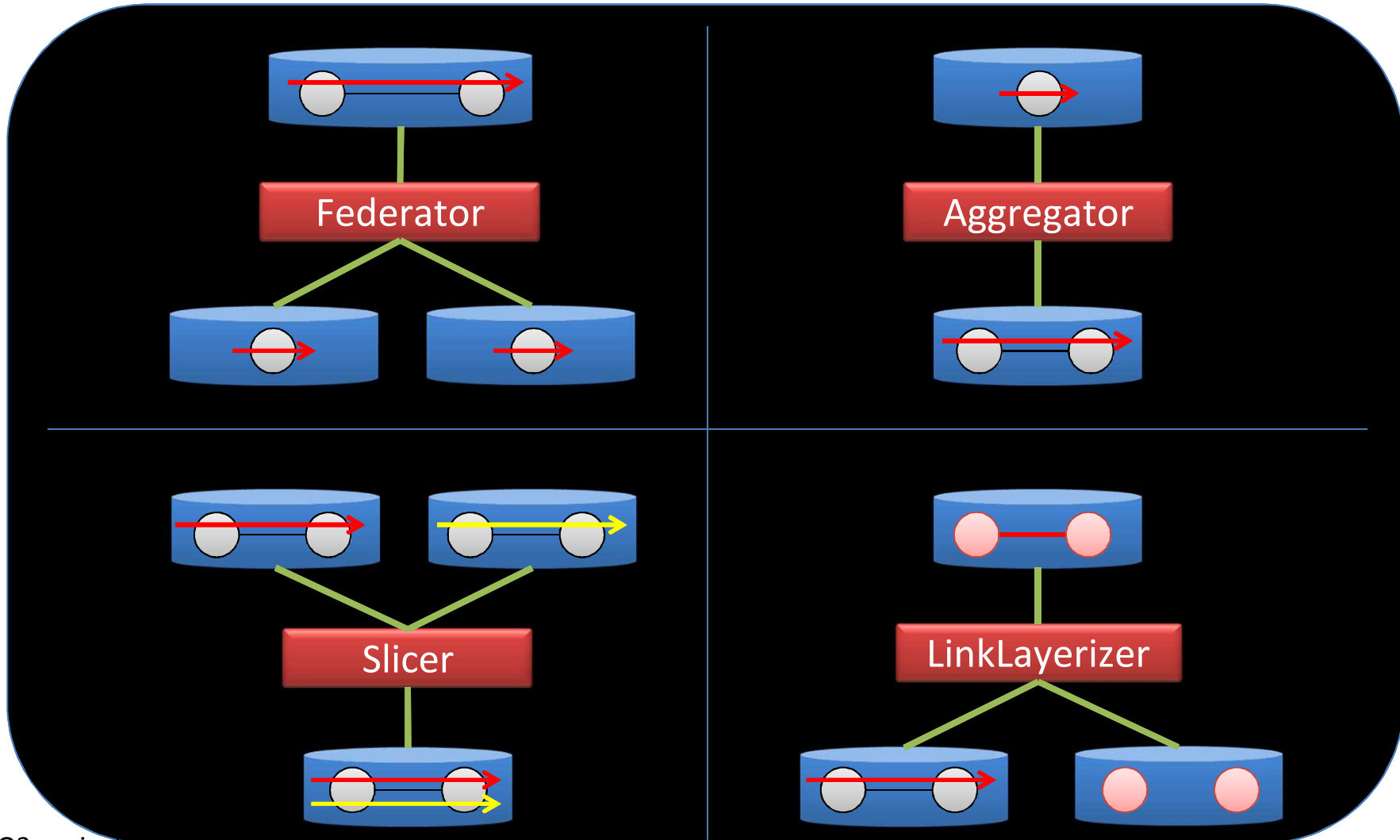
- **Enables easy extension & customization**



**Object-defined  
Network Platform**

# Abstract Network Operators in ODENOS

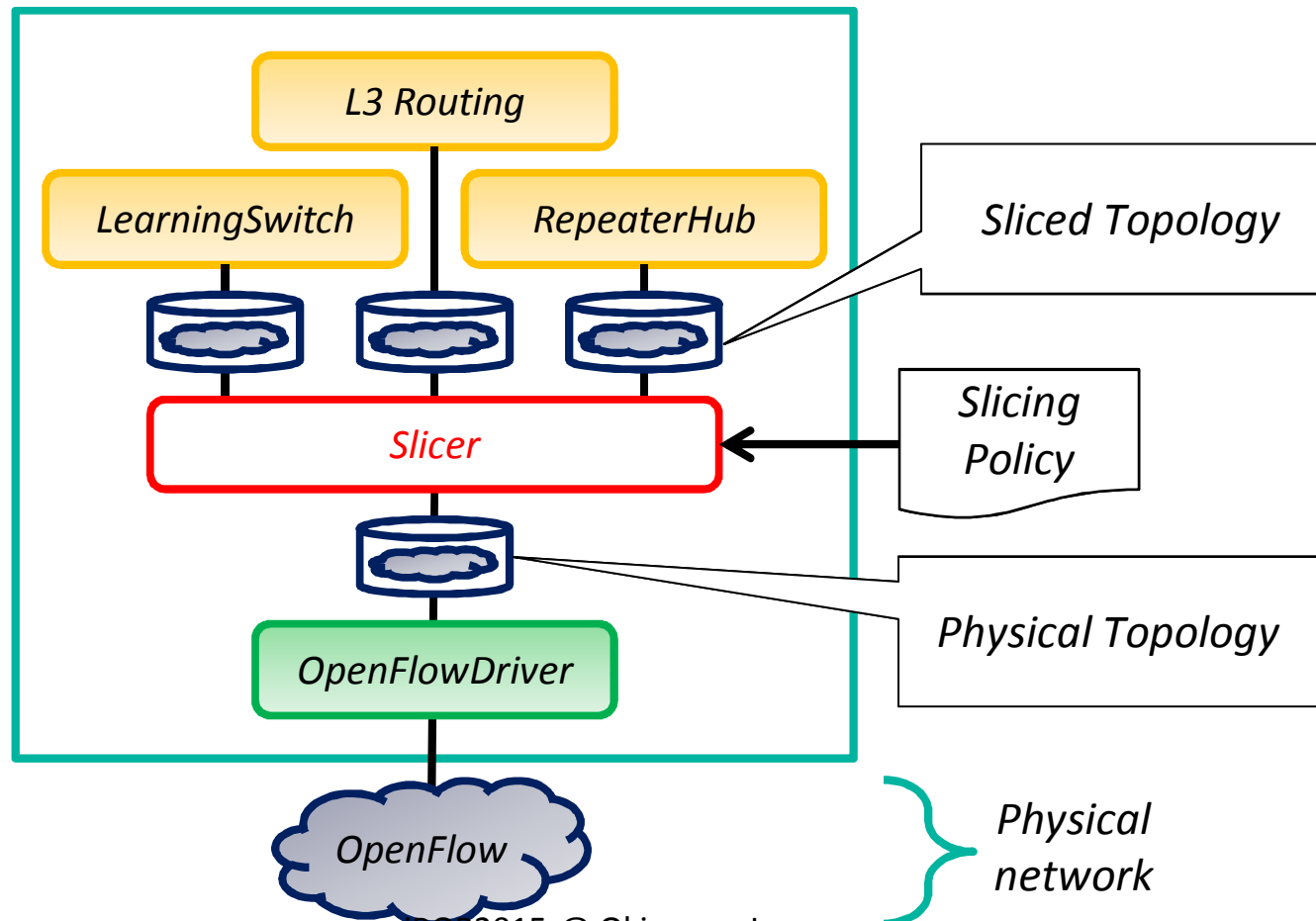
## ■ Slicer, Federator, Aggregator and Link-Layerizer





# NW Operator: Slicer

- *Slicer: creates copies of the network object based on the given policy: Edge ports, TCP/UDP port number (i.e., application)*
- *Enables multi-tenancy, multiple applications*

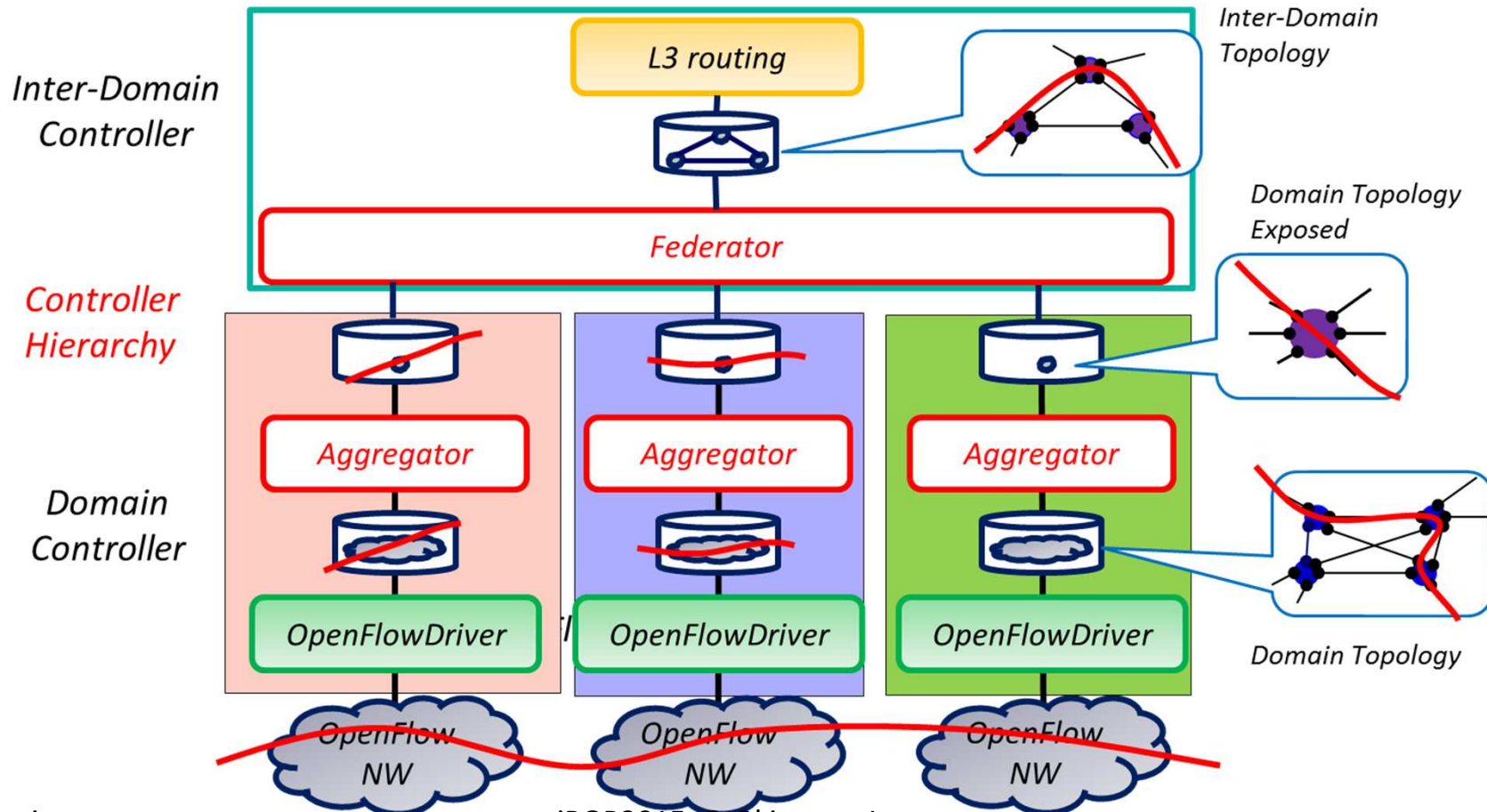




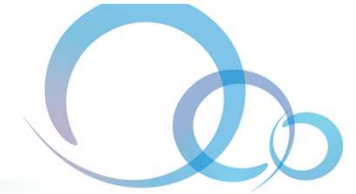
# NW Operator: Aggregator & Federator



- **Aggregator:** creates single big-switch abstraction
- **Federator:** connects multiple networks
- **Use Case:** multi-domain controller (with controller hierarchy)

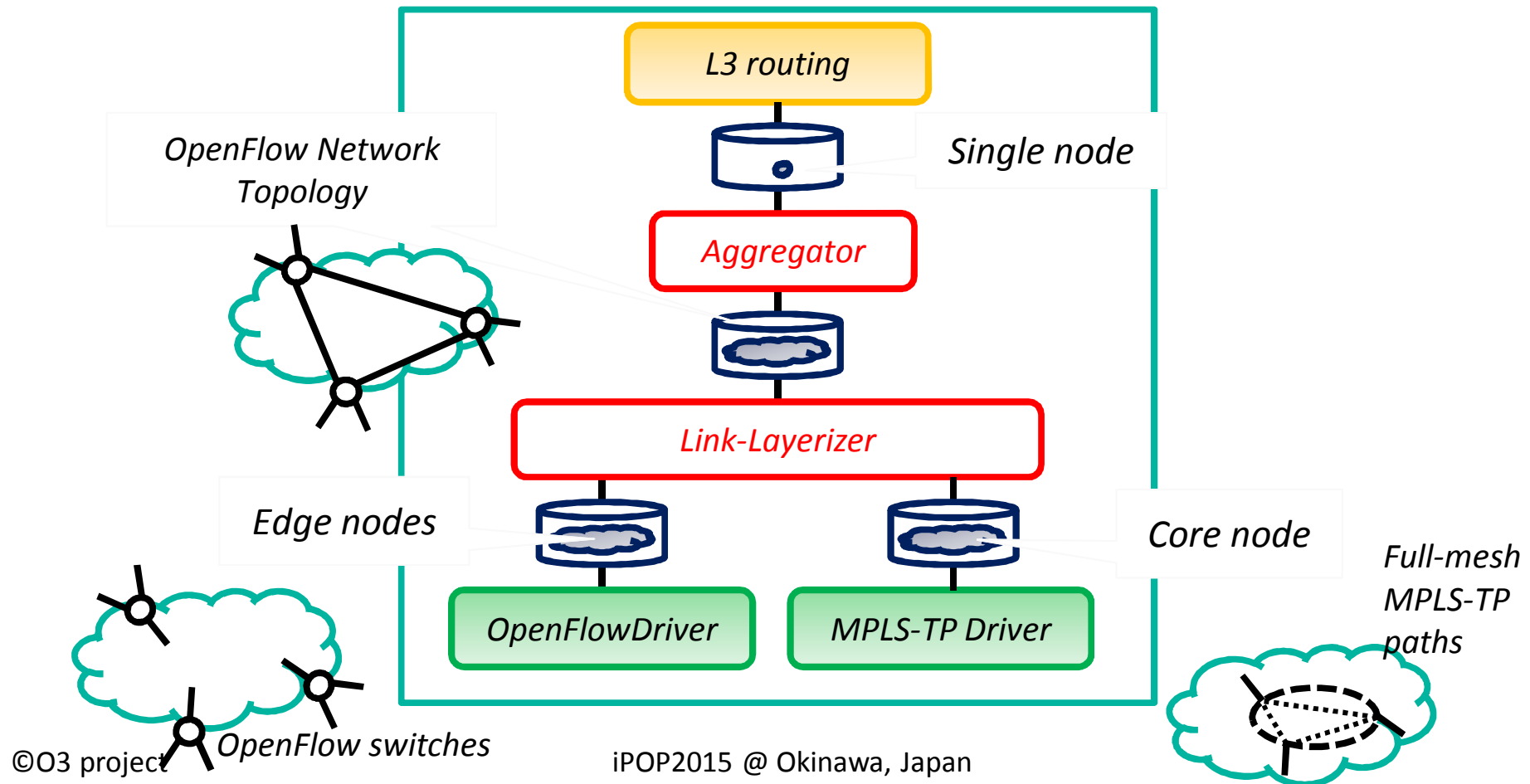






# NW Operator: Link-Layerizer

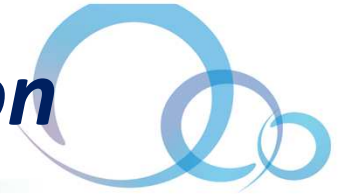
- **Link-Layerizer: creates a network from the upper-layer nodes and lower-layer “paths” (flows)**
- **Use Case: unified control of multi-layer networks**



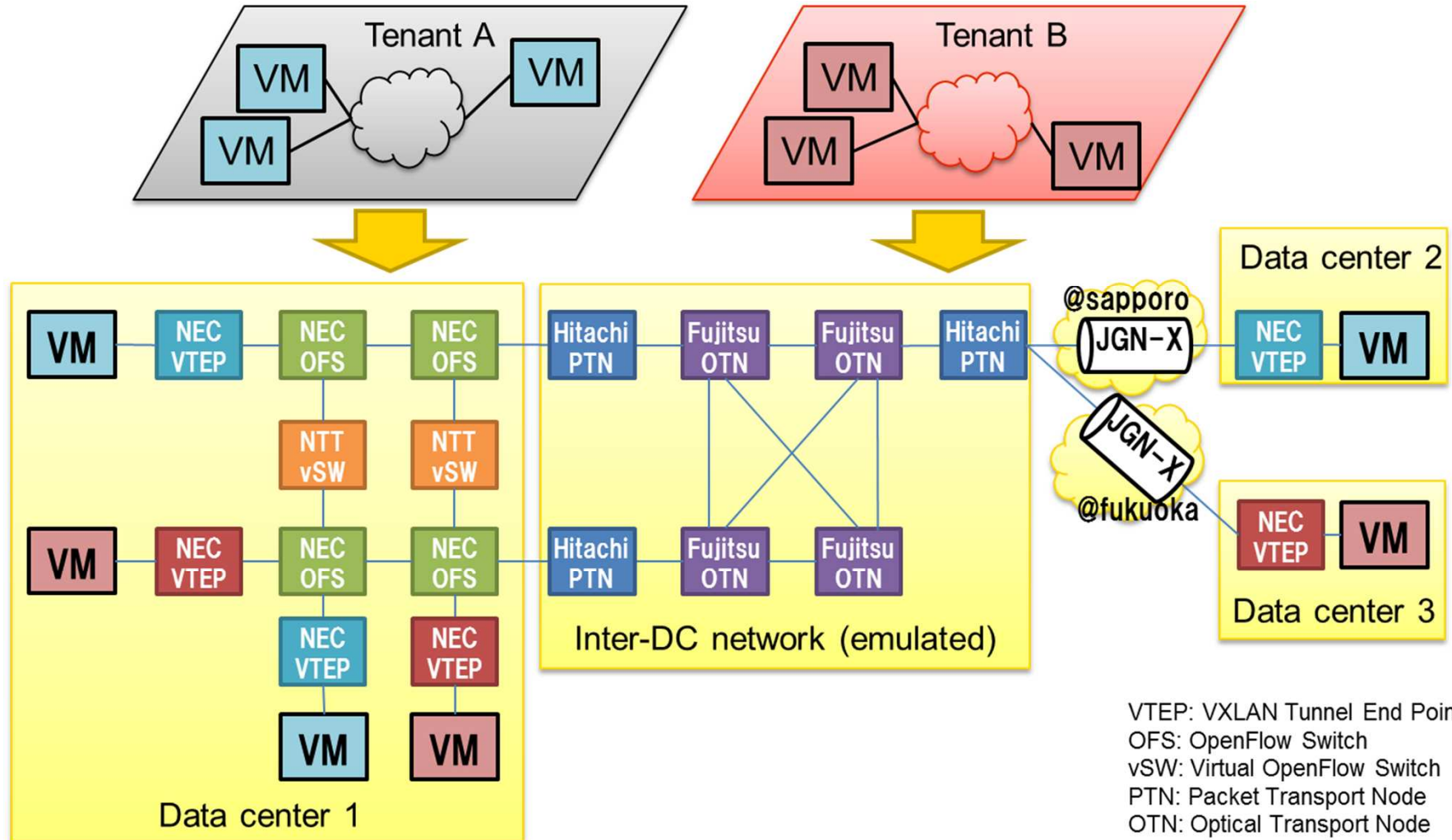


# ***SDN Use Cases in O3 Project***

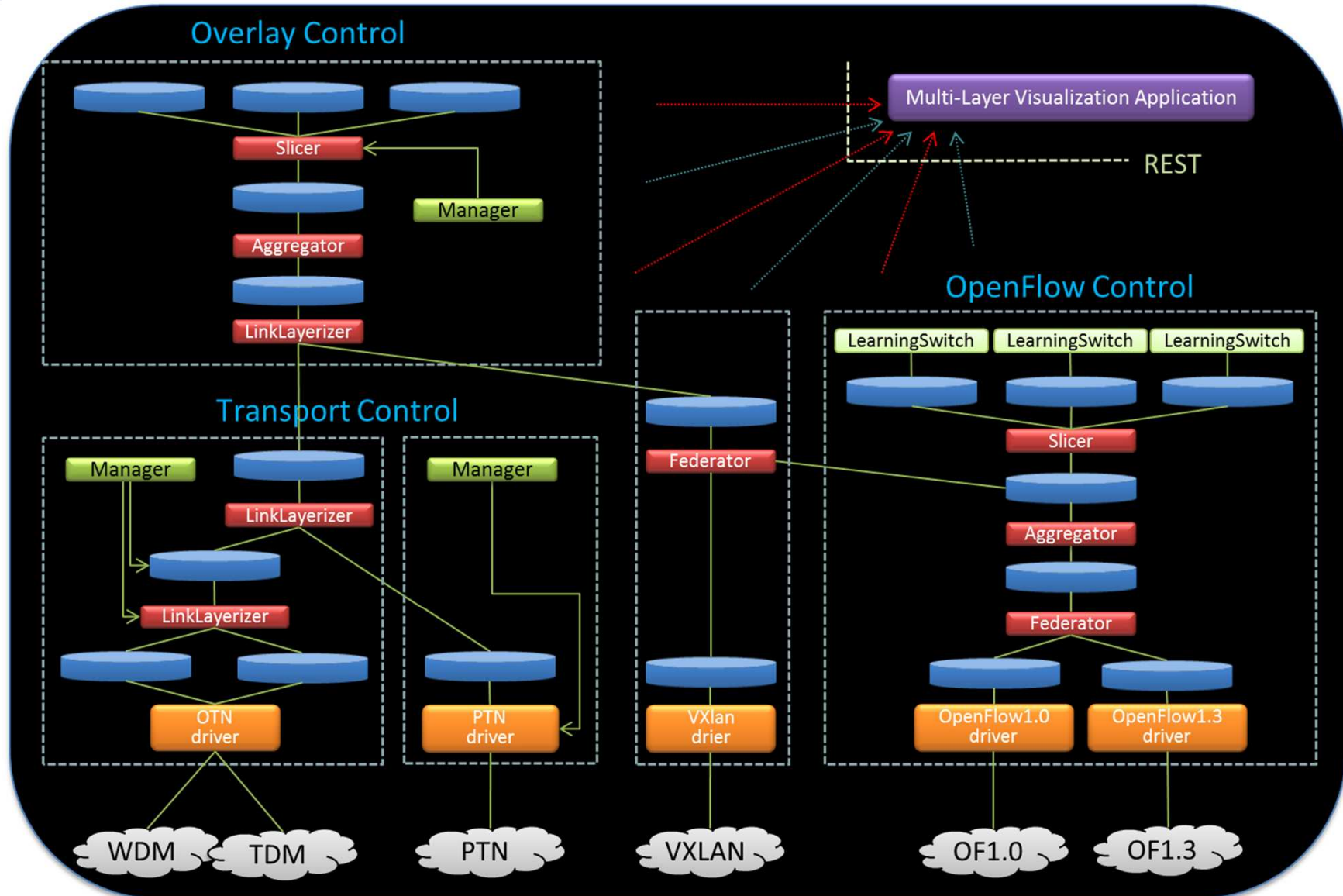
# Proof-of-Concept: Physical Configuration



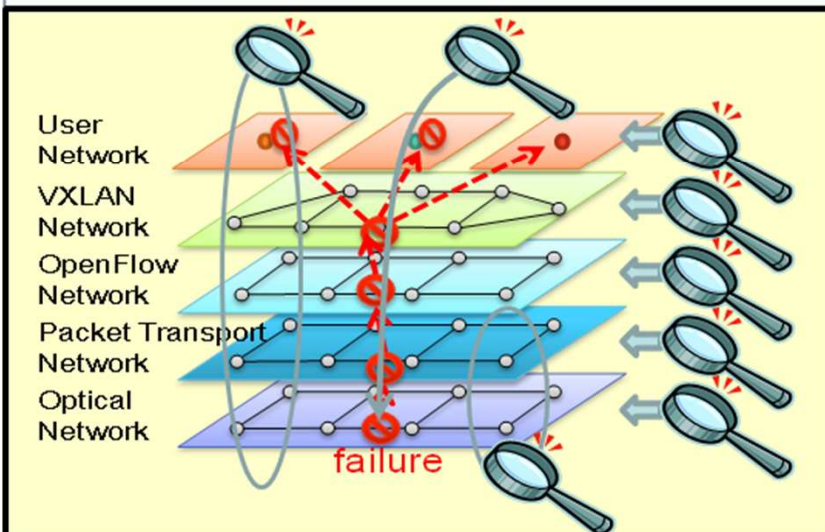
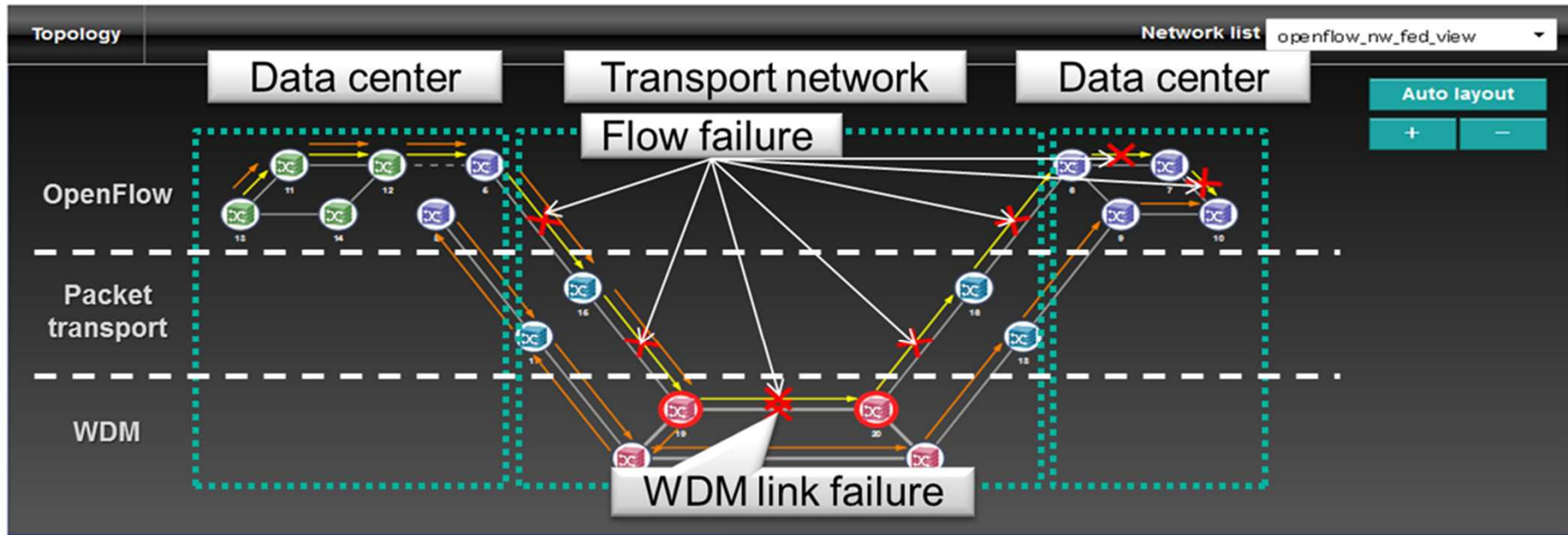
## ■ WAN experiments with multi-vendor equipment



# PoC on Multi-Layer & Domain Control



# PoC on Network Visualization



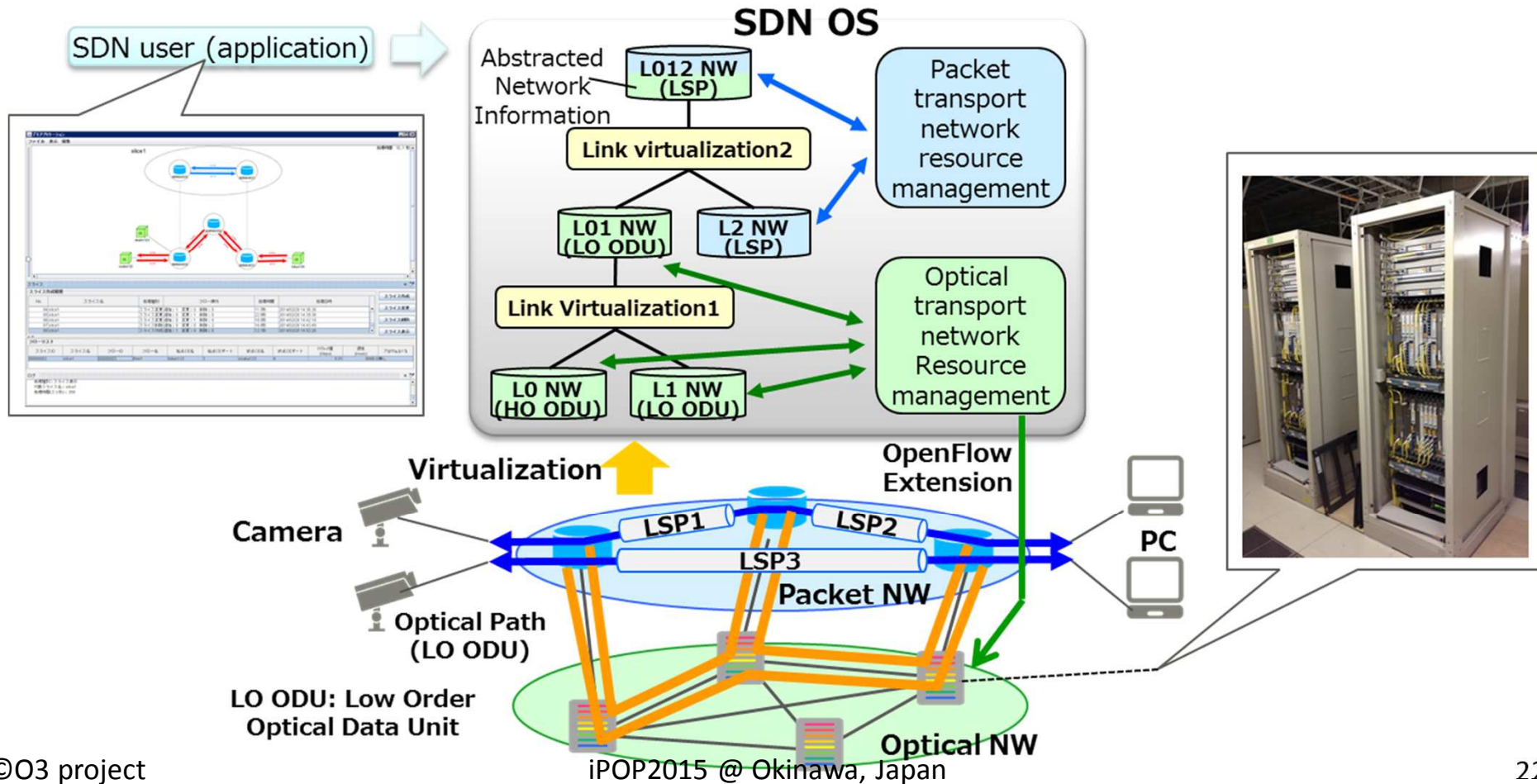
- Multi-layer topology visualization from logical network instances
- Inter-layer correlation mapping through operators
- Trouble shooting, failure analysis, etc.



# PoC on Packet & Optical Integrated Mgmt



- Control of transport network based on simple requirements from users such as transmission speed and response time
- Flexible multilayer resource utilization to meet user requirements





# ***Getting started with O3 Project Achievement***



# Conclusion & Future Work

- *We have released the following O3-project deliverables on line.*

**Doc** ● *SDN Design, Deployment & Operations Guideline\**

*\*Currently only the Japanese version is available.*

**OSS** ● *SDN Framework: ODENOS*

- ◆ *Object-defined Network Platform*

- ◆ *Network Abstractions and Programming Model*

**OSS** ● *SDN-enabled WAN nodes*

- ◆ *SDN Software Forwarding and Control (Lagopus)*

- ◆ *Optical core resource driver and Packet transport*



For Japanese Language :<http://www.o3project.org/ja/download/index.html>

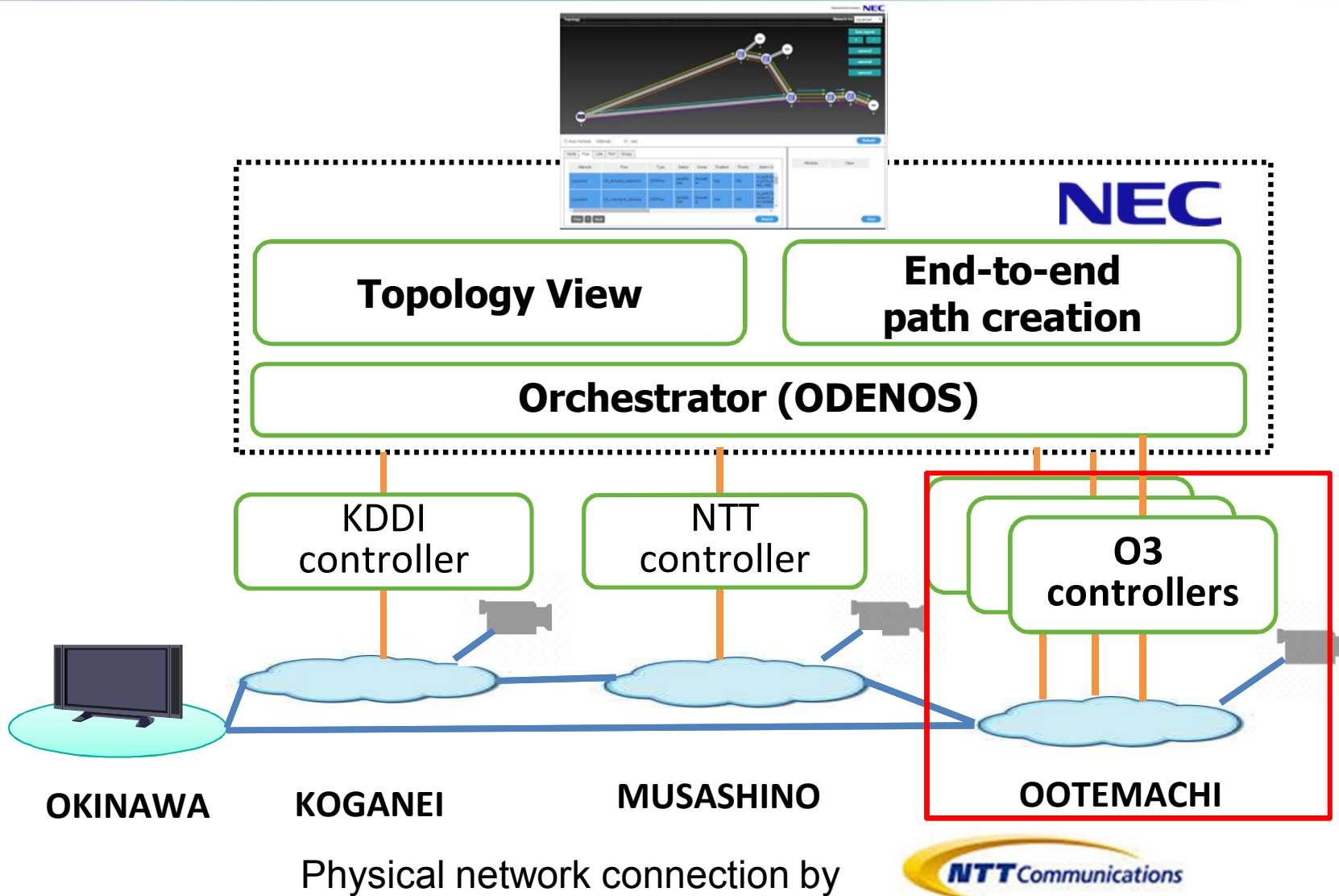
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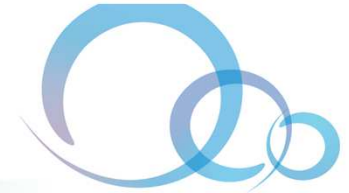


# ***Demonstration at O3 project booth***

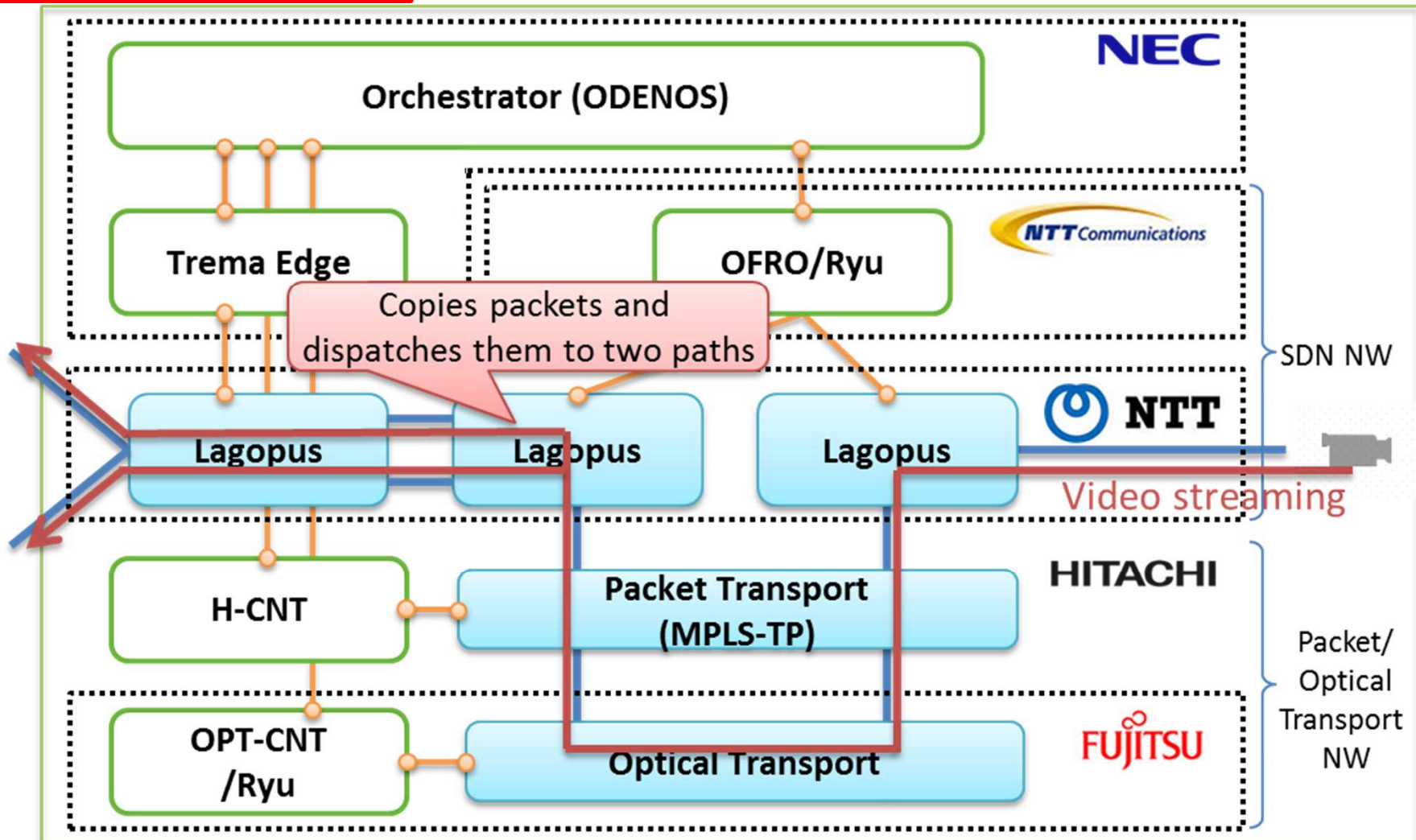
# Demonstration(1)



# Demonstration(2)



## OOTEMACHI

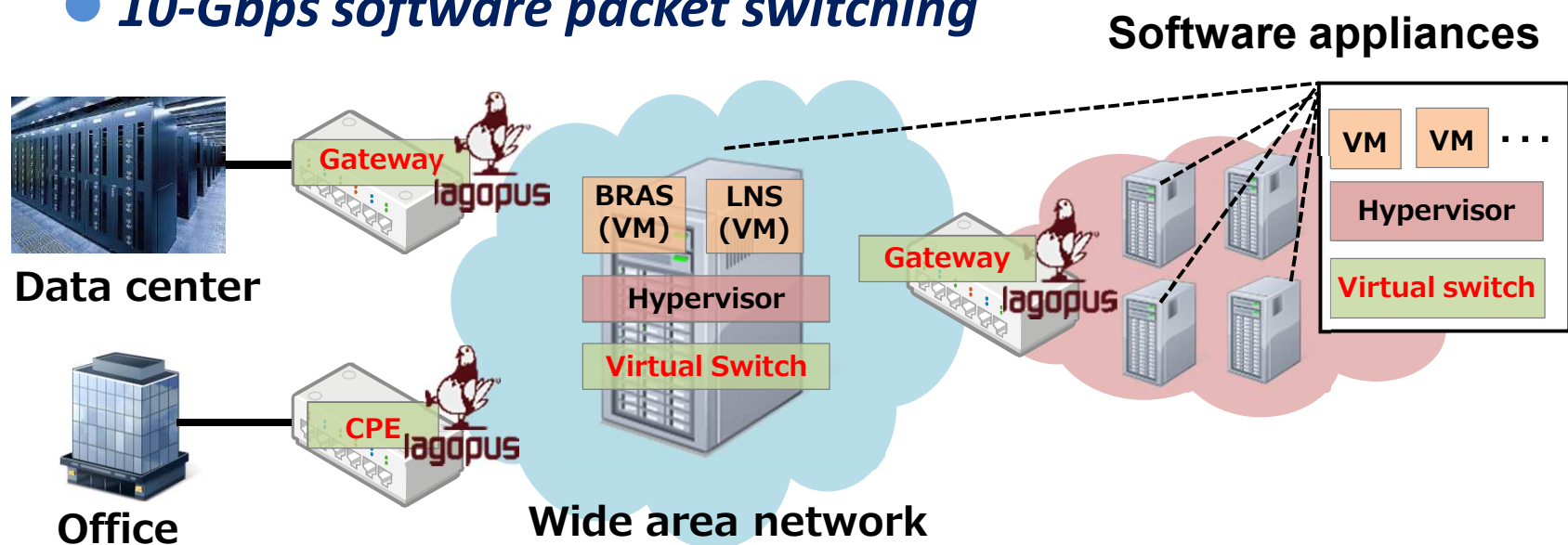


# Software Switch: Lagopus



lagopus

- **Supported protocols/interfaces**
  - *OpenFlow 1.3.4 (latest stable version)*
  - *WAN protocols (MPLS, PBB, and QinQ)*
  - *OF-CONFIG, OVSDDB, CLI, SNMP, and Ethernet OAM*
- **High-performance packet processing**
  - *Large-scale 1-M flow entries*
  - *10-Gbps software packet switching*





# OpenFlow OAM Tools

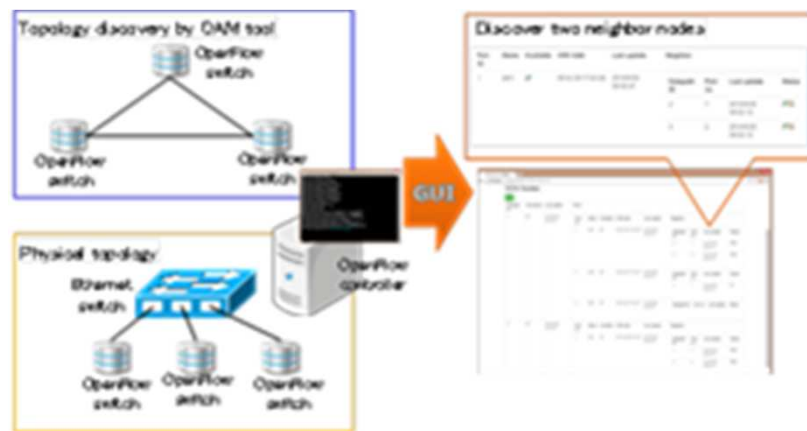
## ■ Topology tool

*OAM functions for OpenFlow NW is necessary to operate SDN-WAN. To confirm availability of flows, NW topology management and relationship of FlowEntry and flow information is important. NTT Com developed and evaluated topology discovery tools that works under universal circumstances.*

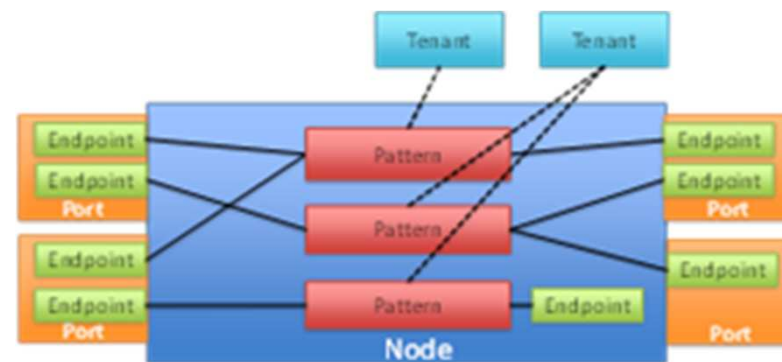
## ■ Entry manage

*To manage flows, it is necessary to create FlowEntry form highly abstracted flow information such as location information, bandwidth and so on. We studied data model that describes necessary information manage SDN networks.*

### Topology tool



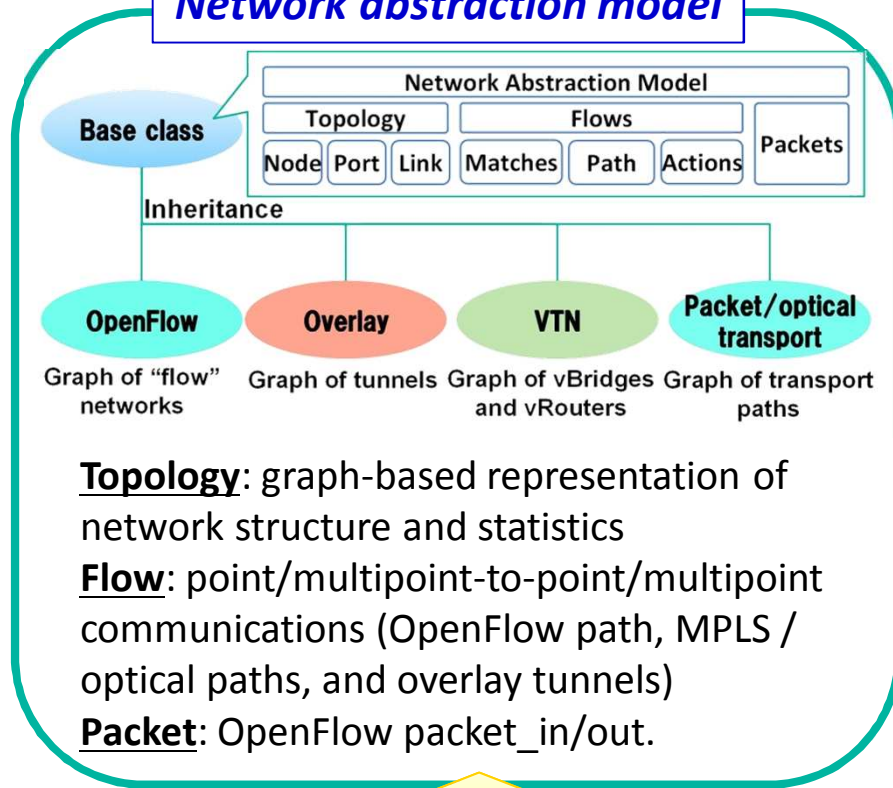
### Entry manage



# SDN Framework: ODENOS

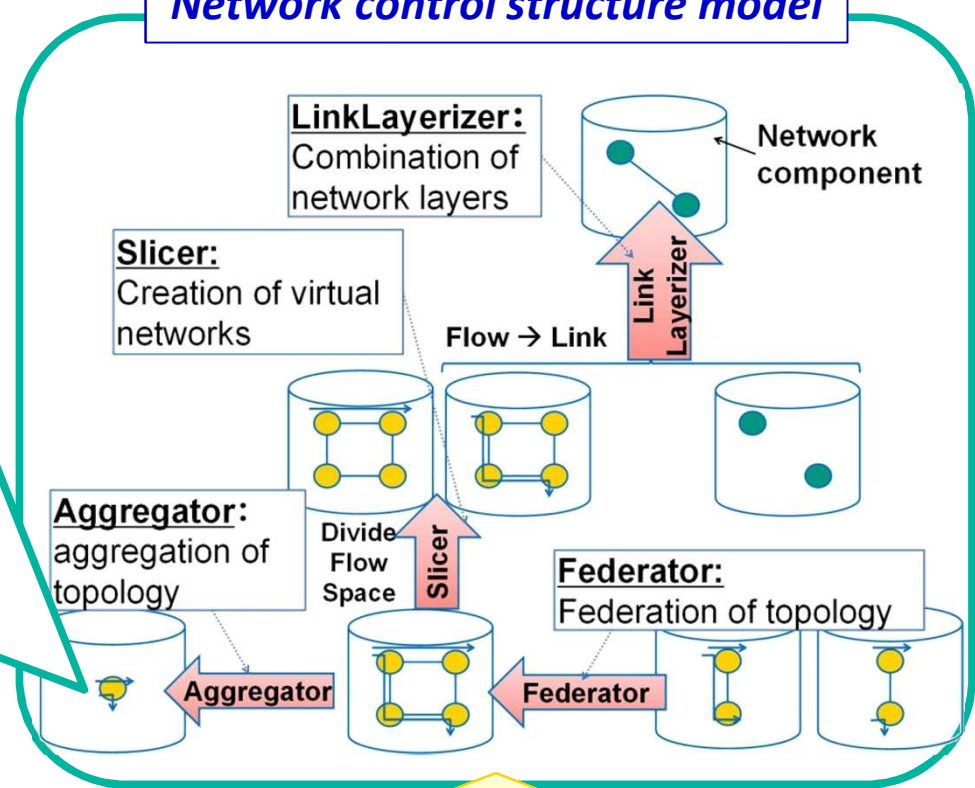


## Network abstraction model



*Instance of various logical network*

## Network control structure model



*Operators for network instances*

**Design a SDN controller as an arbitral combination of logical networks and operators**



# SDN Transport Network Technology with User Control



## ■ Purpose

- Provide a simpler method for user to use a wide area network control technology that is becoming more complex
- Satisfy user demand by consolidating management and control of multi-layer network comprised of packet and optics

## ■ Technology content

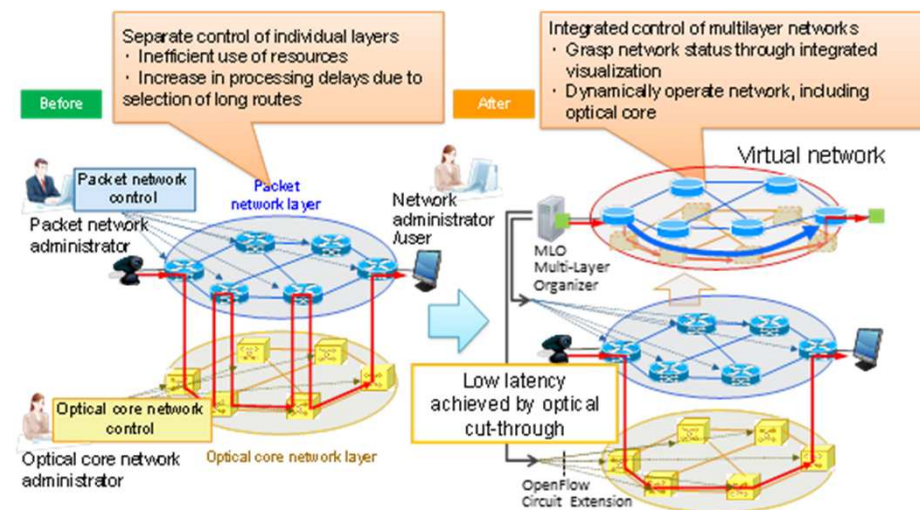
- Multi-layer management and control (Hitachi, Ltd.)

Based on network resource request from an application, resource management and control feature finds a resource from a lower layer resource pool and allocates it to a higher layer traffic

- Optical Cut-through technology (Fujitsu, Ltd.) Provide low latency network to user by configuring an end-to-end optical direct path by using packet and optical core network path

## ■ OSS

- PKT-Transport of O3 Orchestrator & Controller suite & Compatible nodes (MLO) (Hitachi, Ltd.)
- OPT-Transport Apps of O3 Orchestrator & Controller Suite (Fujitsu, Ltd.)



**Thank you for your attention!**



**O3 project**

***[www.o3project.org/](http://www.o3project.org/)***

*This research is executed under a part of a “Research and Development of Network Virtualization Technology” program commissioned by the Ministry of Internal Affairs and Communications.*