

# ***O3 Project***

***~ User Oriented SDN for WAN ~***

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

***.... Network Business Innovation by SDN WAN Technologies ....***

# Agenda



- *Trend on Future Information Networking*
- ***Innovation through O3 User-oriented SDN***
- ***O3 Technologies for SDN WAN***
- ***SDN Use Cases in O3 Project***
- ***SDN Ready Open Source Software***
- ***Conclusion & Future Work***



**O3**project



# ***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



Open Organic Optima

*Open Innovation over Network Platform*

*(1) Open*

*(2) Standardization*

*(3) Commercialization*

NEC



FUJITSU

HITACHI

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



## **■ *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*

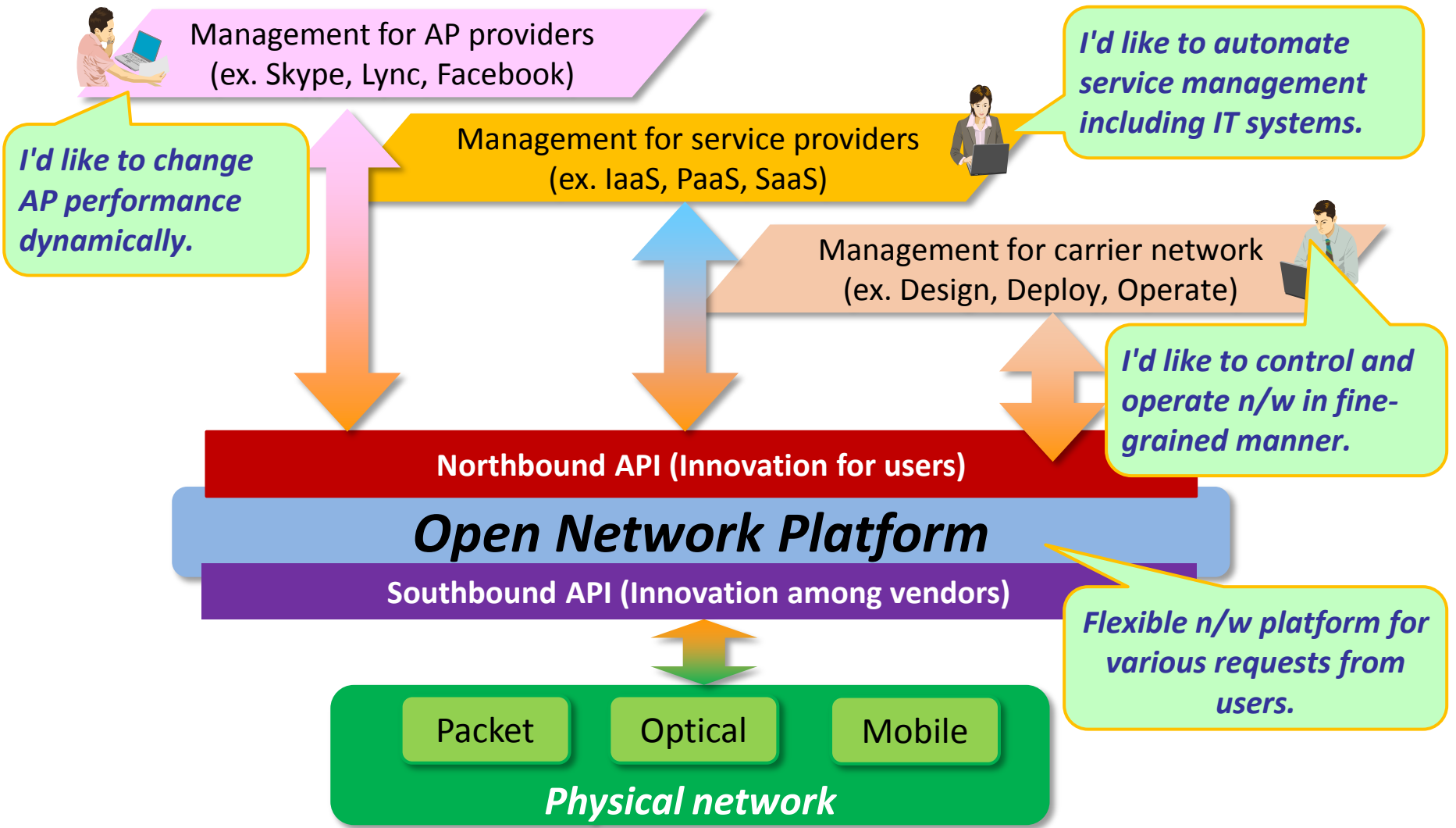
## **■ *Accelerates***

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



# 03 Deliverables: User-oriented SDN

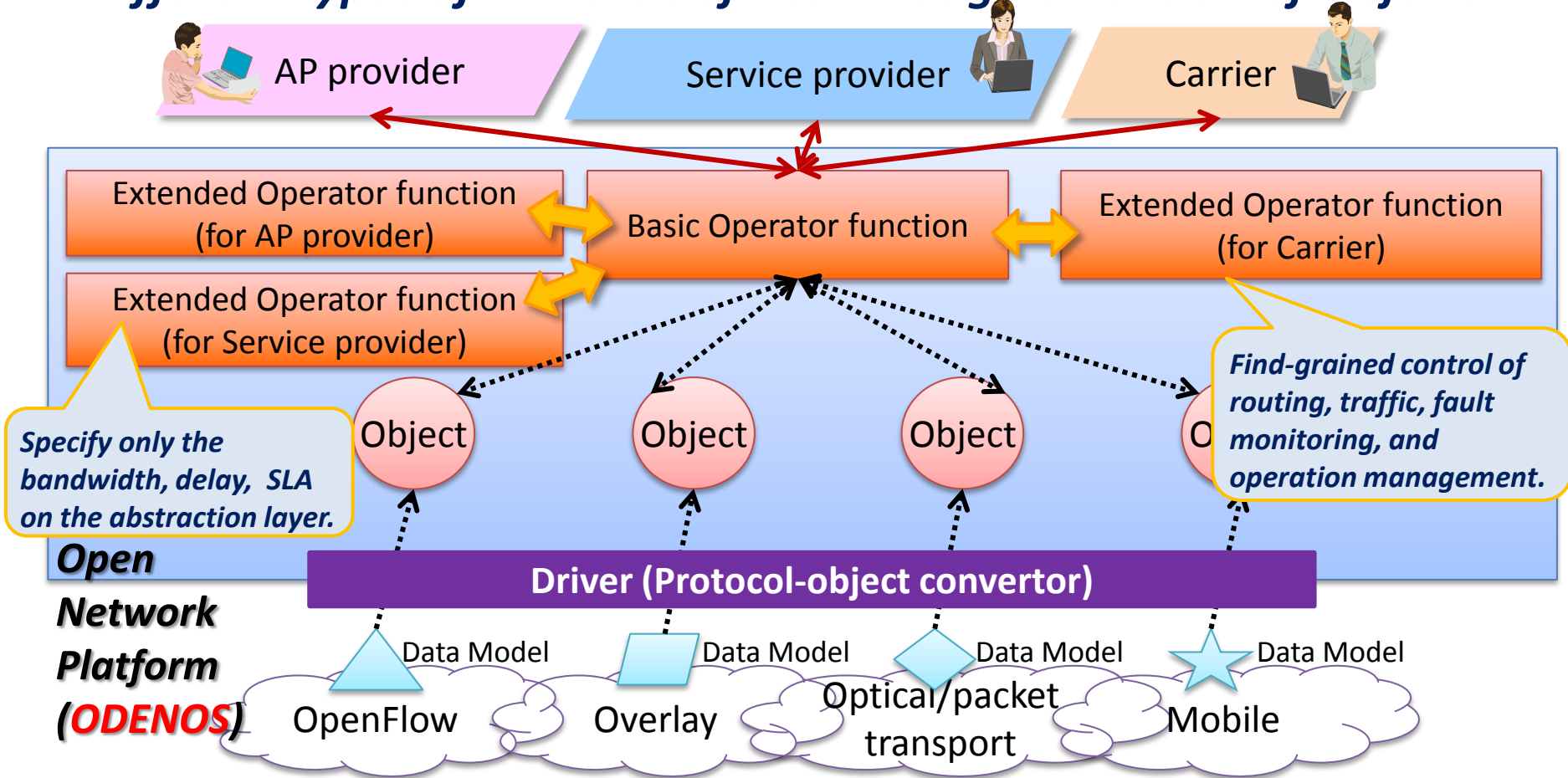
■ Provides **Orchestration** for different user requirements





# 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





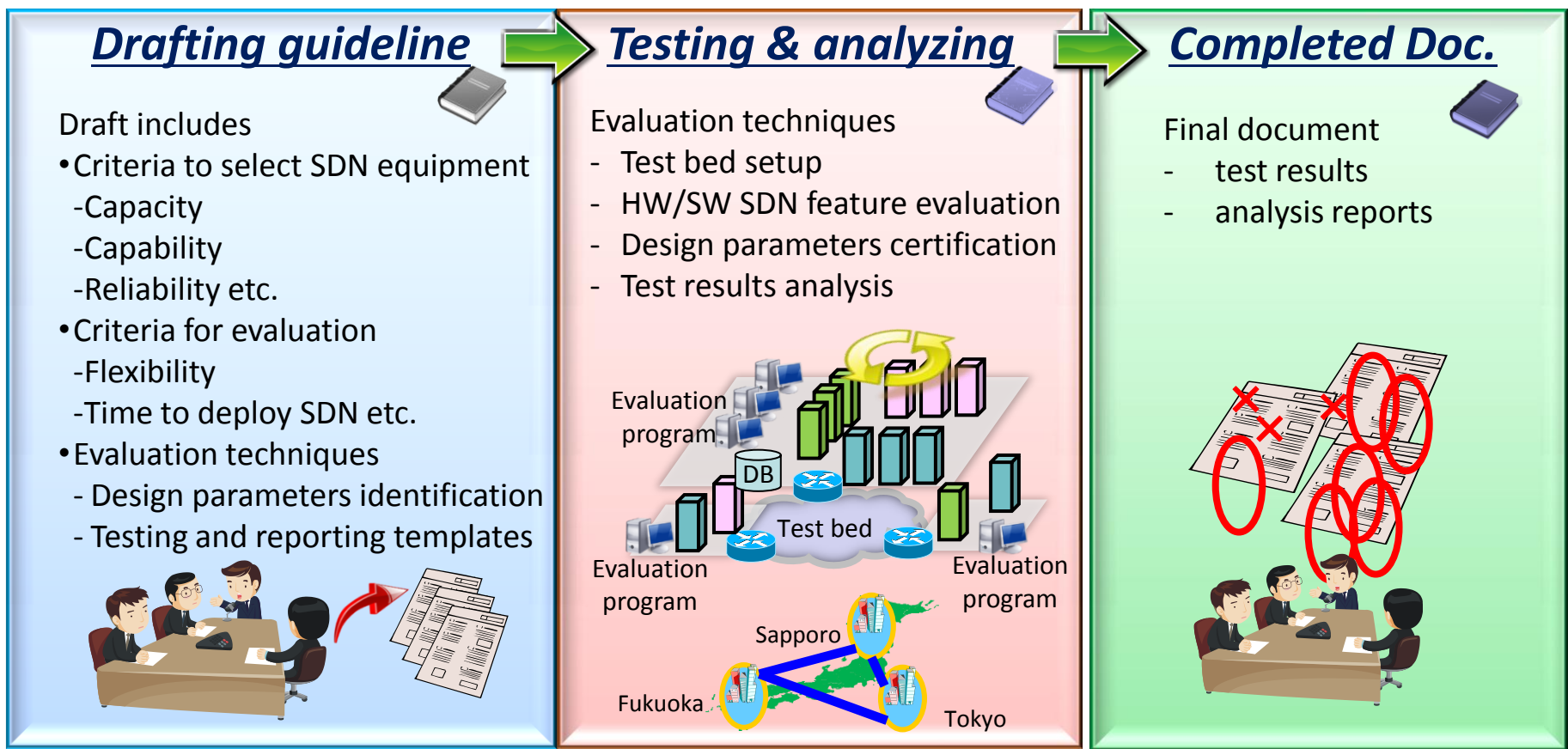
# ***O3 Technologies for SDN WAN***





# SDN Design & Operations Guideline

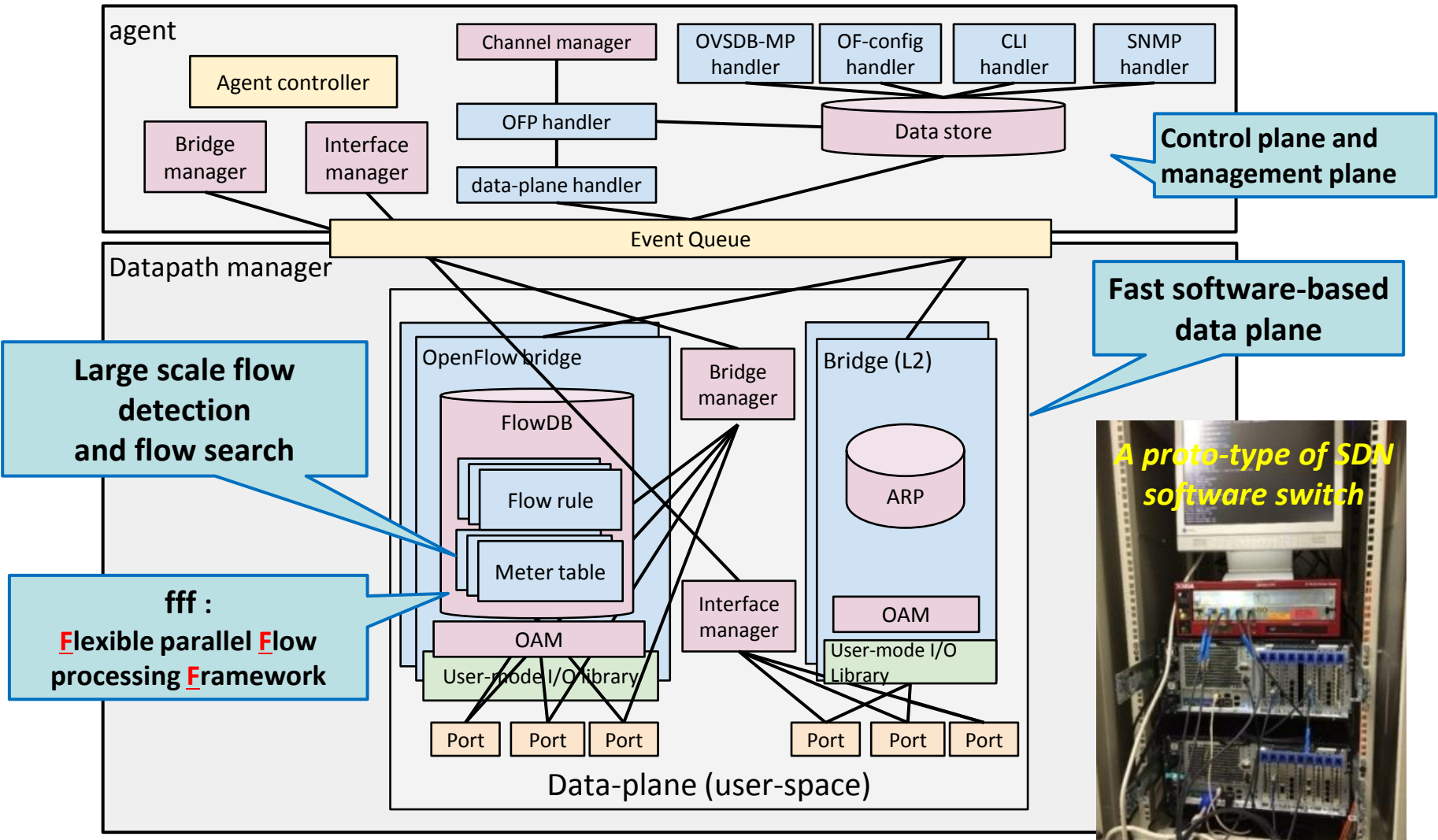
■ **Established the SDN guideline for carrier networks which is required to design, deploy and operate the large scale of SDN in the following steps;**





# SDN Software Switch: Lagopus

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

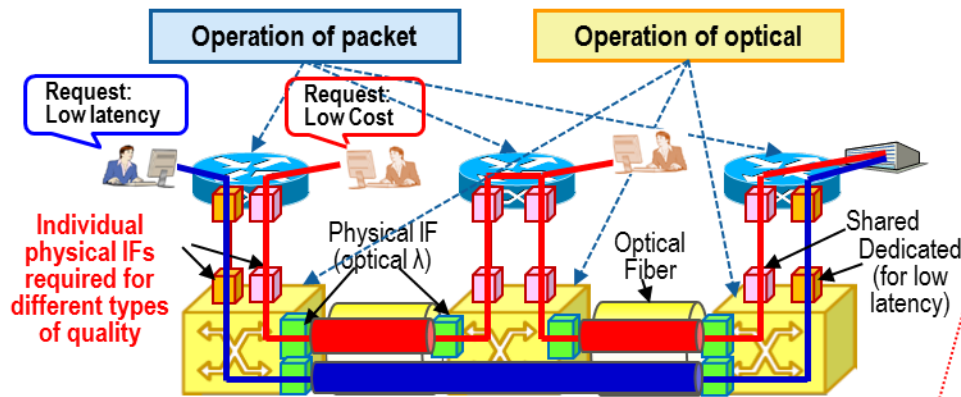




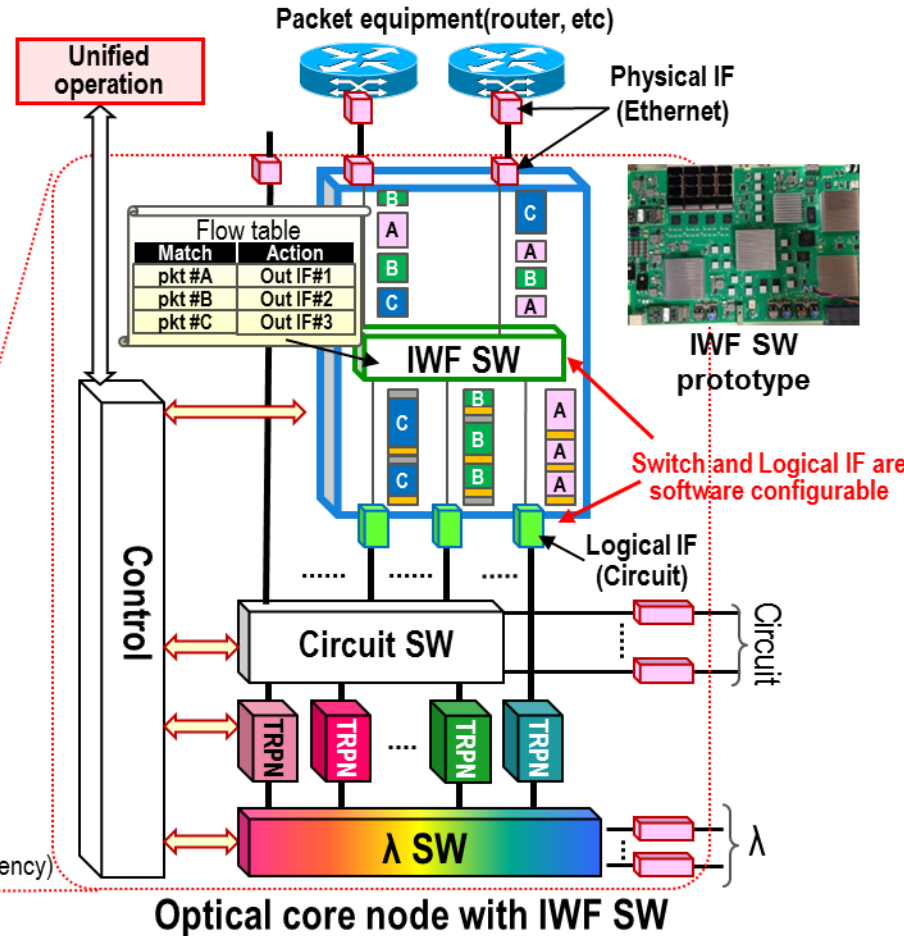
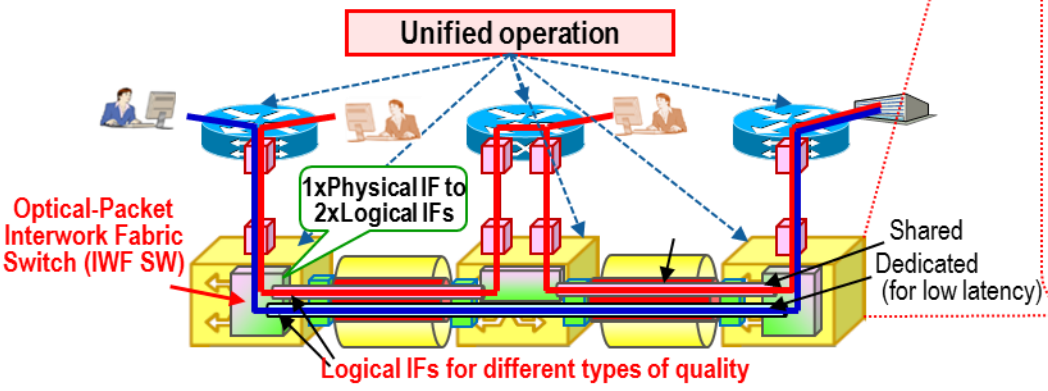
# Signal Interwork between Optical & Packet

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

## Conventional configuration



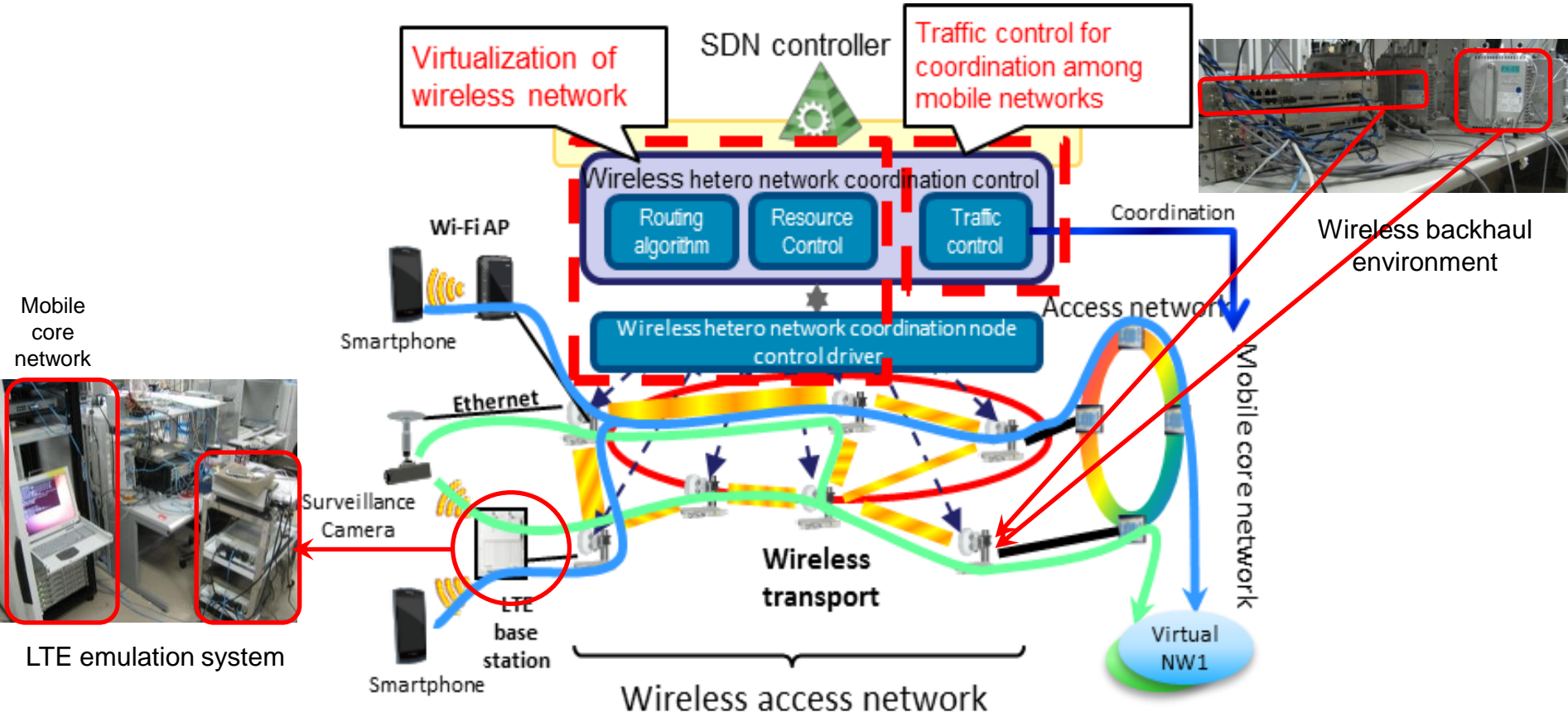
## Configuration at this study





# Virtual Wireless Networks

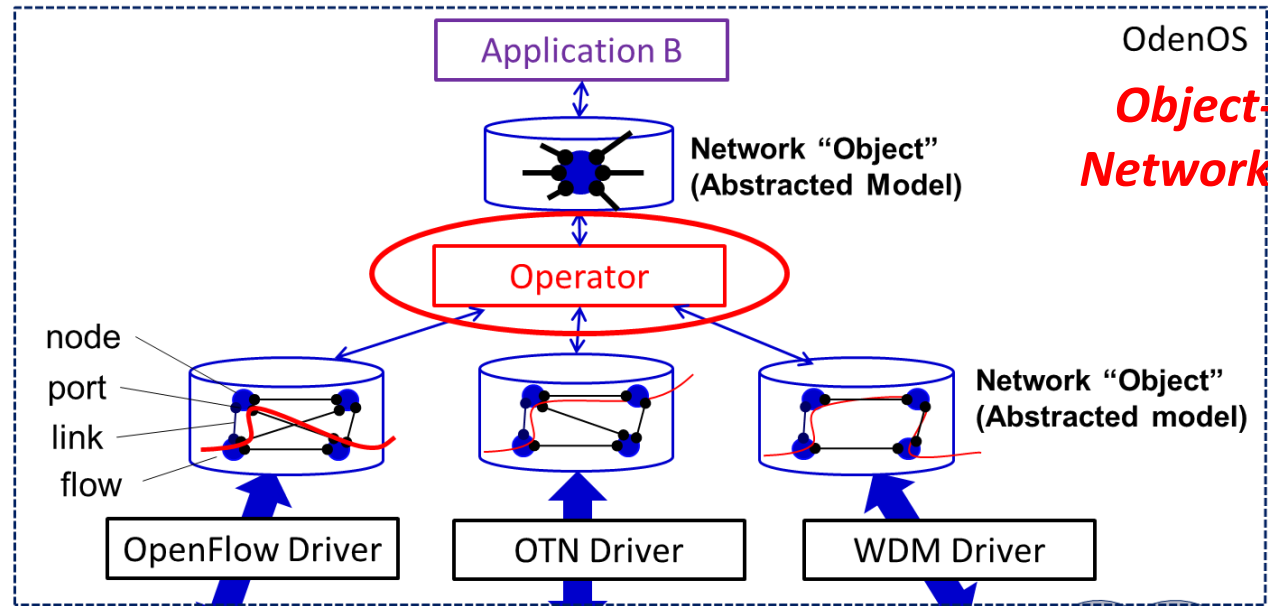
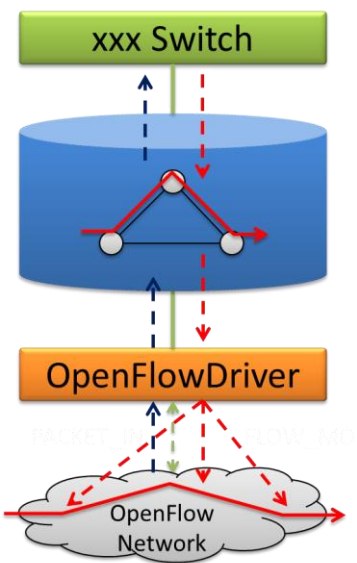
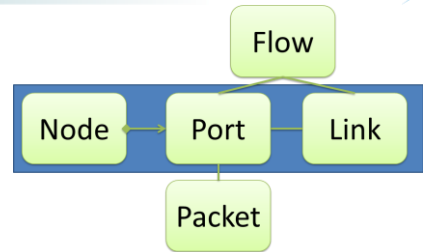
- Support multiple virtual networks over wireless networks while avoiding degradation of high priority traffic even when traffic demand and data rate of wireless link changes over time



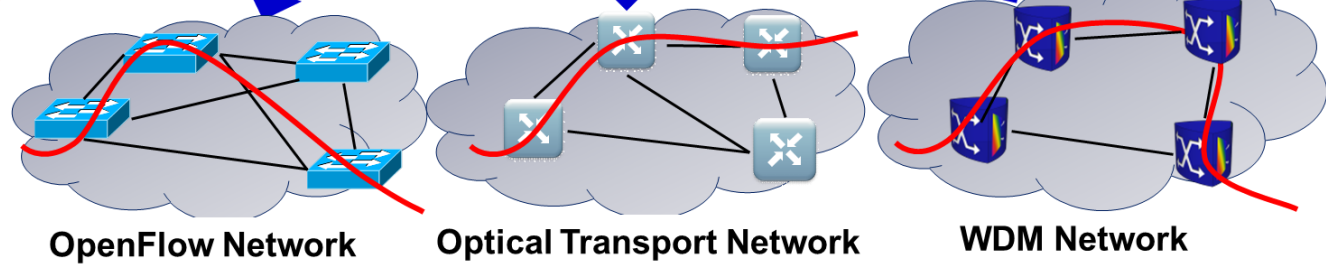


# SDN Framework: ODENOS

- **Network Abstraction Model: Hierarchical**
  - Node, Port, Link, Flow, Packet
- **Enables easy Extension & Customization**



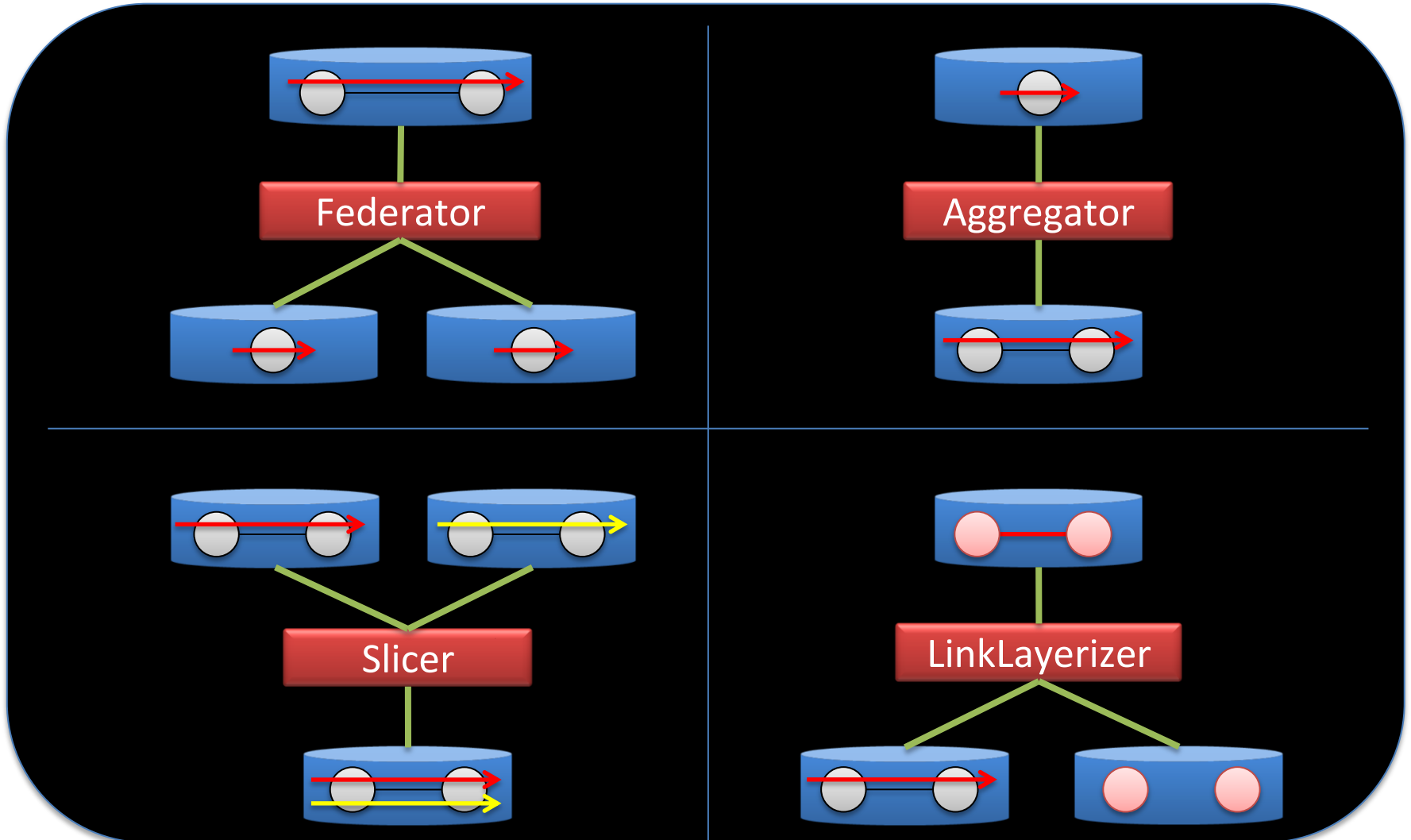
**Object-defined  
Network Platform**





# Abstract Network Operators in ODENOS

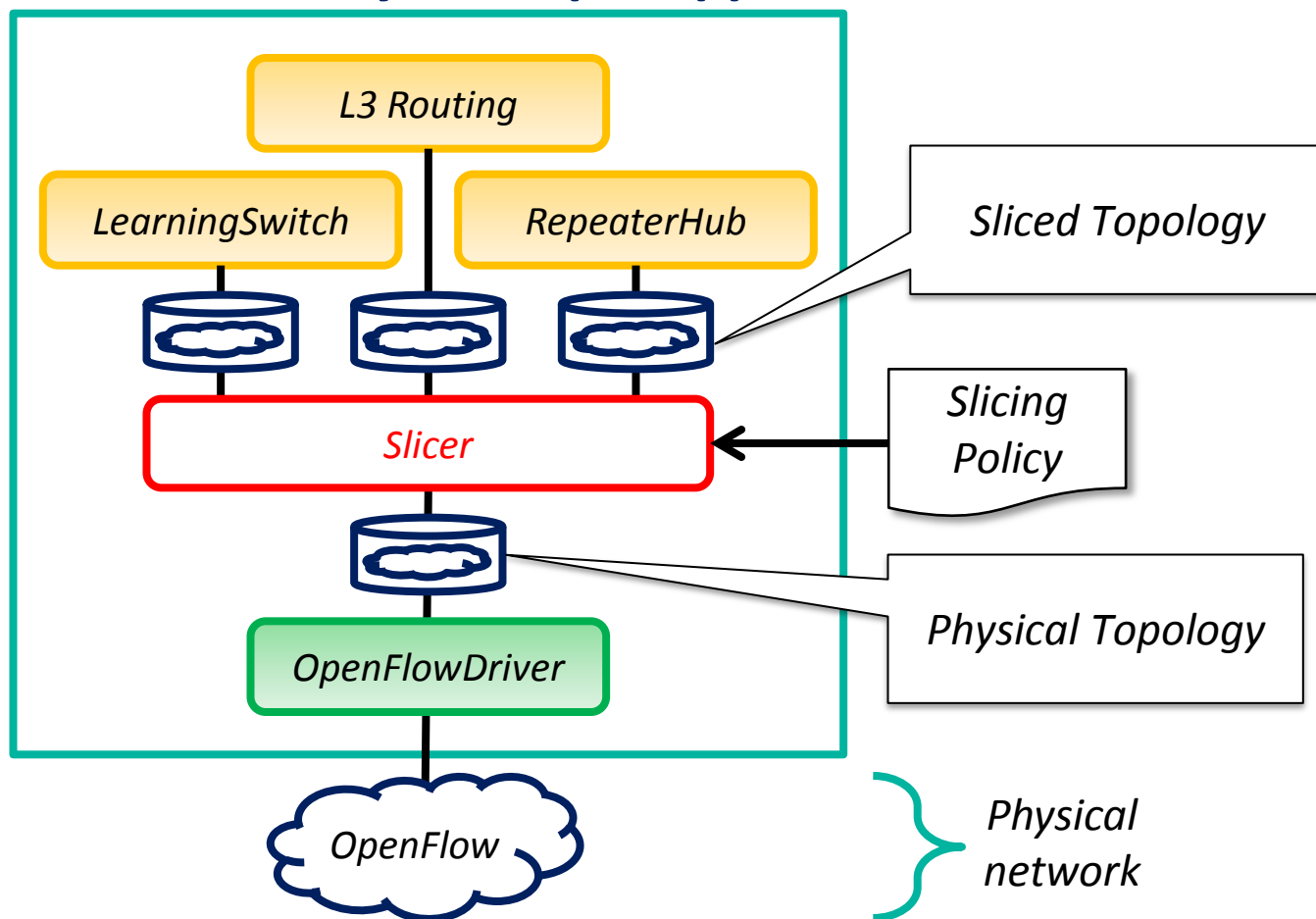
## ■ Slicer, Federator, Aggregator, Link-Layerizer





# NW Operator: Slicer

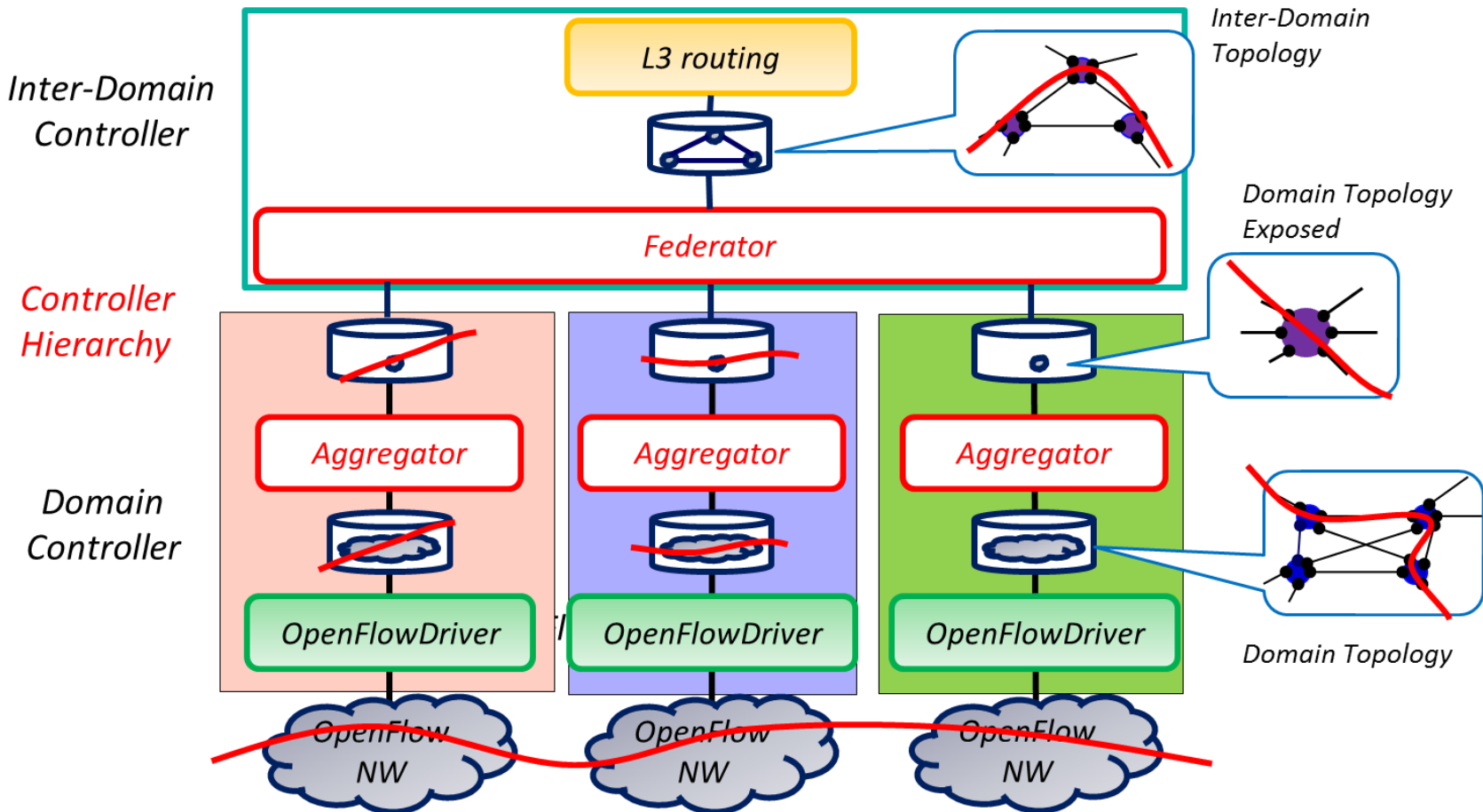
- *Slicer: creates copies of the network object based on the given policy: Edge ports, TCP/UDP port number (i.e., application)*
- *Enables multi-tenancy, multiple applications*





# NW Operator: Aggregator & Federator

- **Aggregator: Creates single big-switch abstraction**
- **Federator: Connects multiple networks**
- **Use Case: Multi-domain controller (with controller hierarchy)**

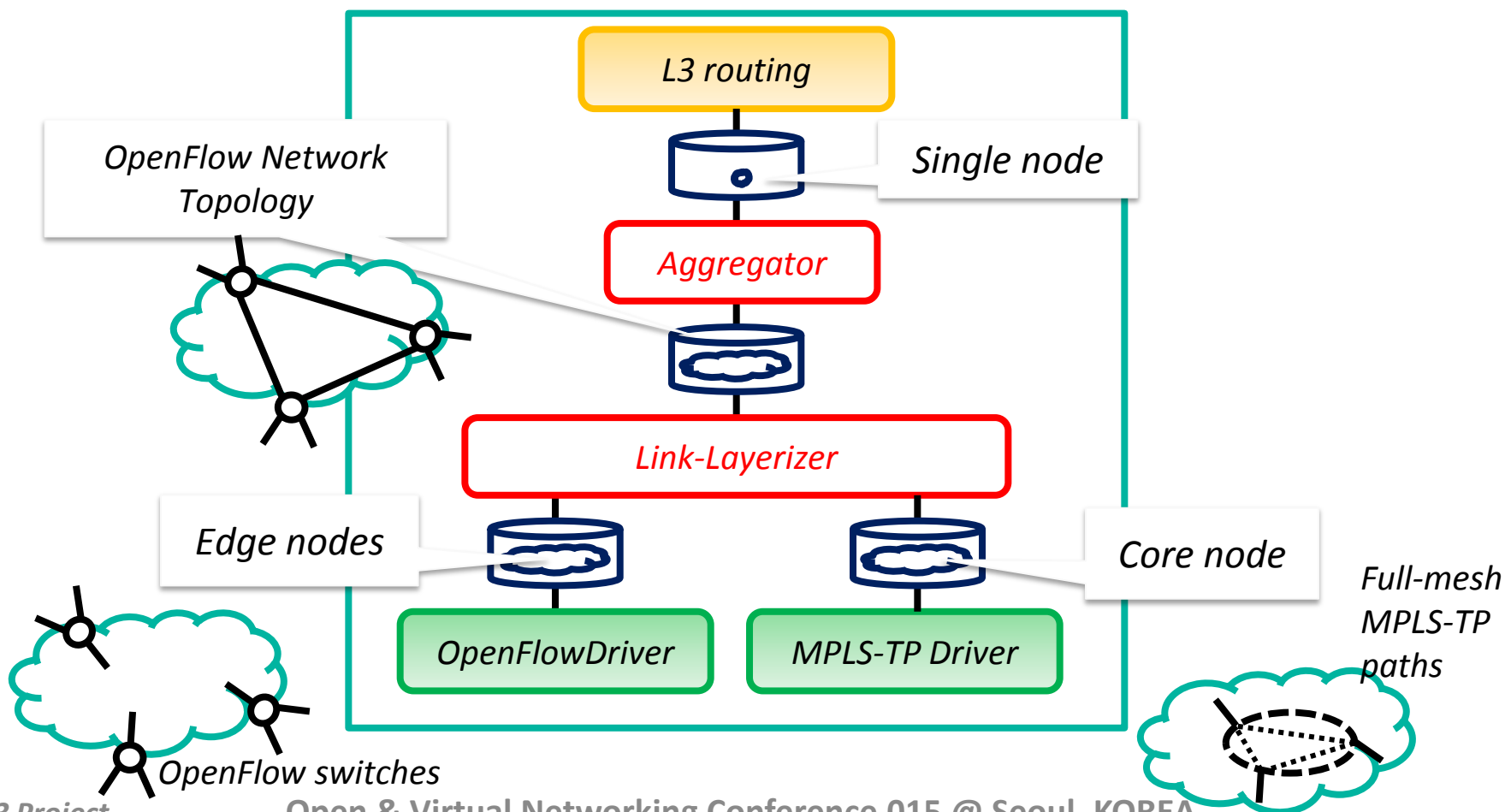






# NW Operator: Link-Layerizer

- **Link-Layerizer: Creates a network from the upper-layer nodes and lower-layer “paths” (flows)**
- **Use Case: Unified Control of Multi-layer Networks**



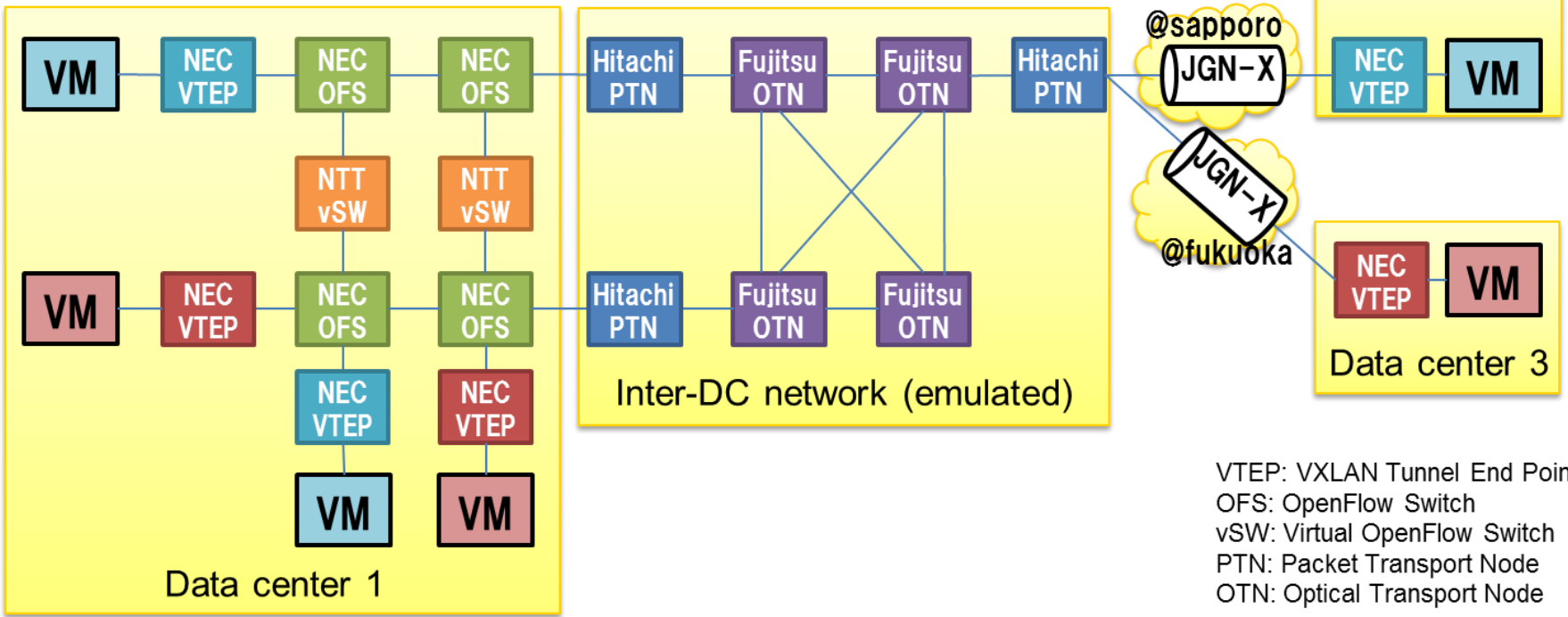
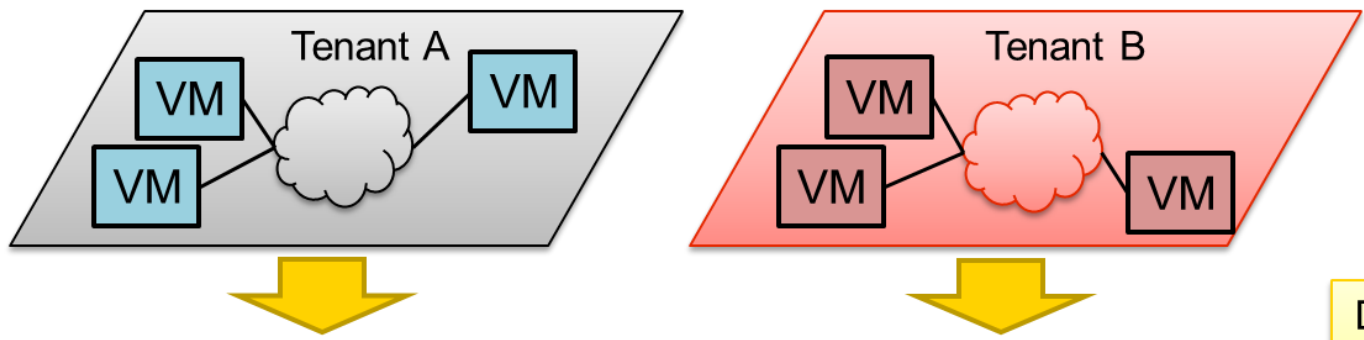


# ***SDN Use Cases in O3 Project***



# Proof-of-Concept: Physical Configuration

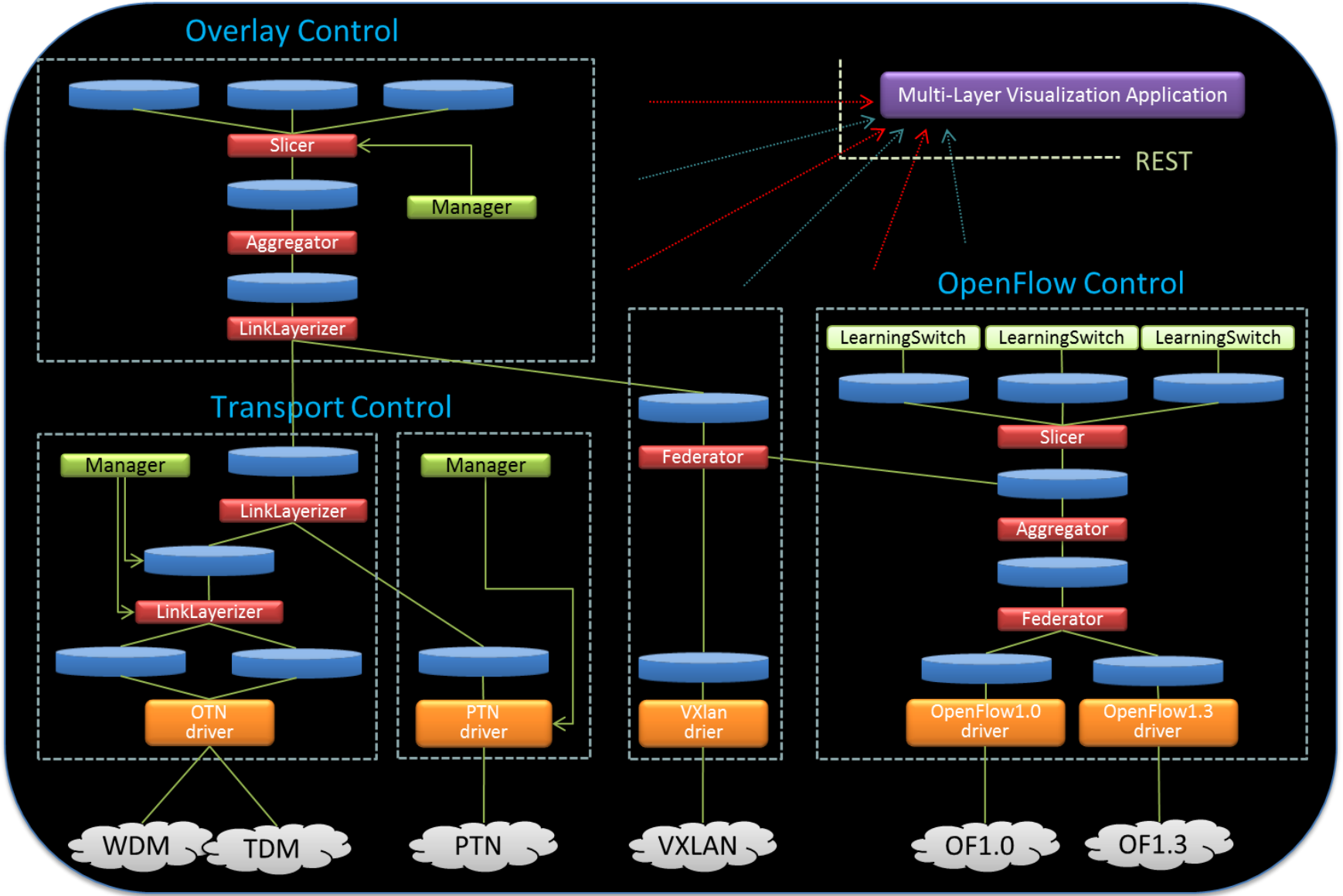
## WAN experiments with Multi-vendor Equipment



VTEP: VXLAN Tunnel End Point  
OFS: OpenFlow Switch  
vSW: Virtual OpenFlow Switch  
PTN: Packet Transport Node  
OTN: Optical Transport Node

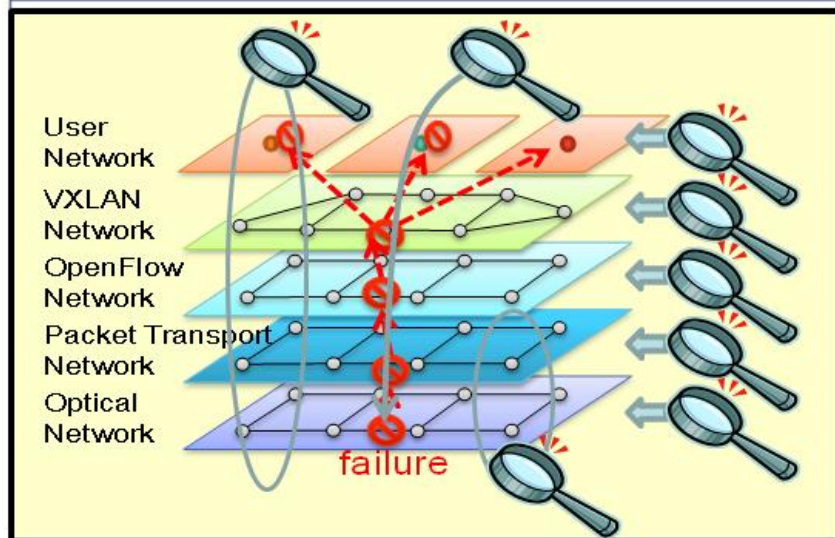
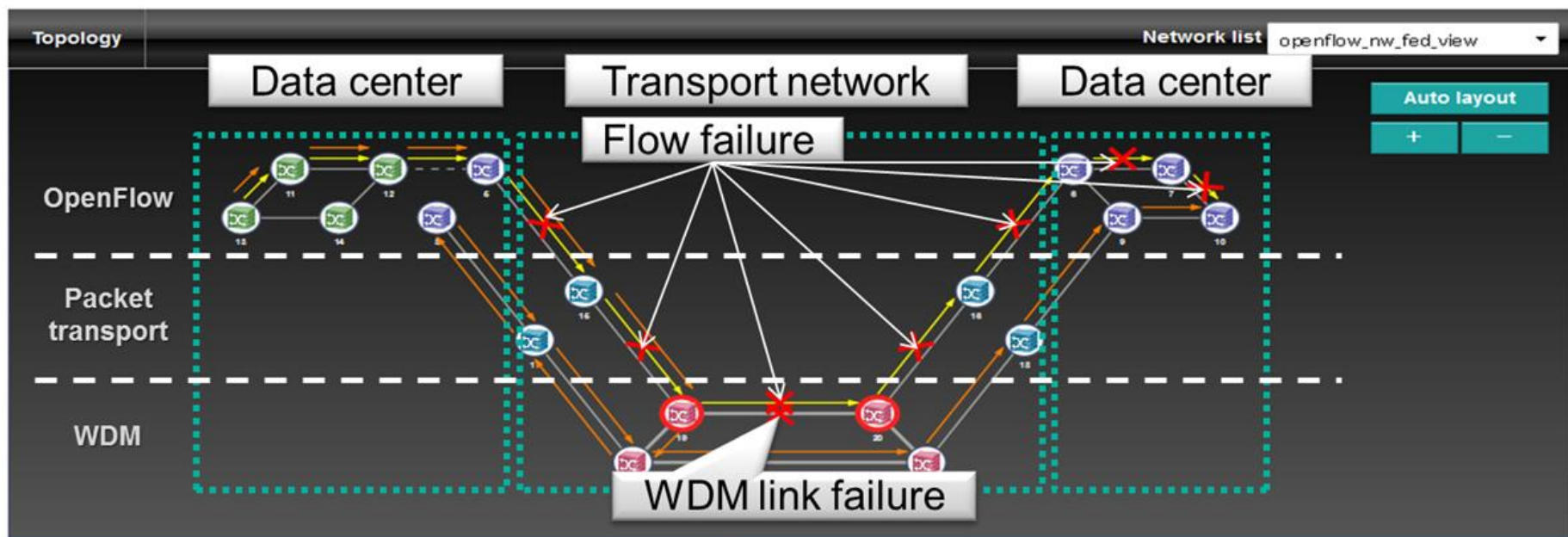


# PoC on Multi-Layer & Domain Control





# PoC on Network Visualization

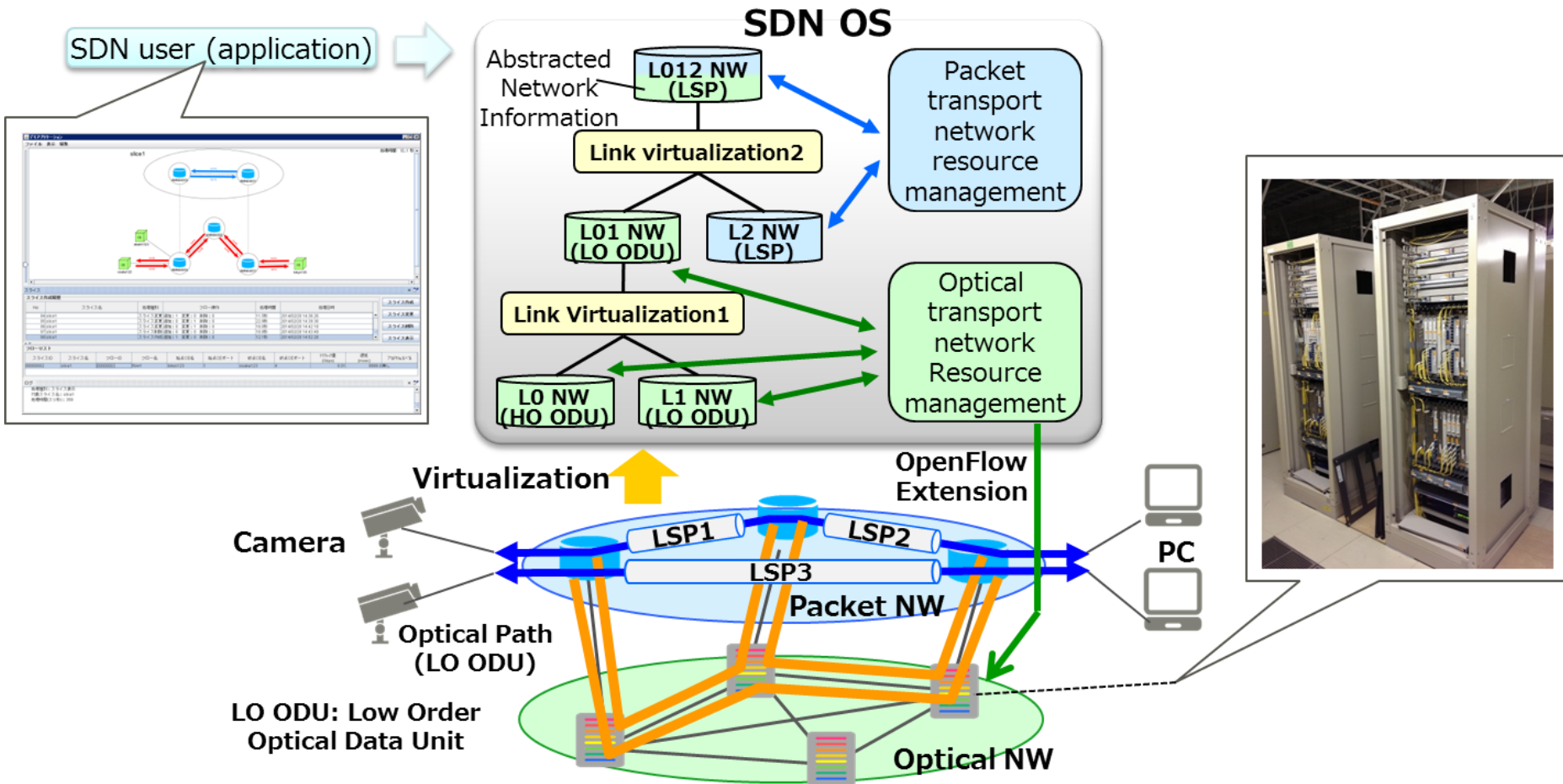


- Multi-layer topology visualization from logical network instances
- Inter-layer correlation mapping through operators
- Trouble shooting, failure analysis, etc.



# 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





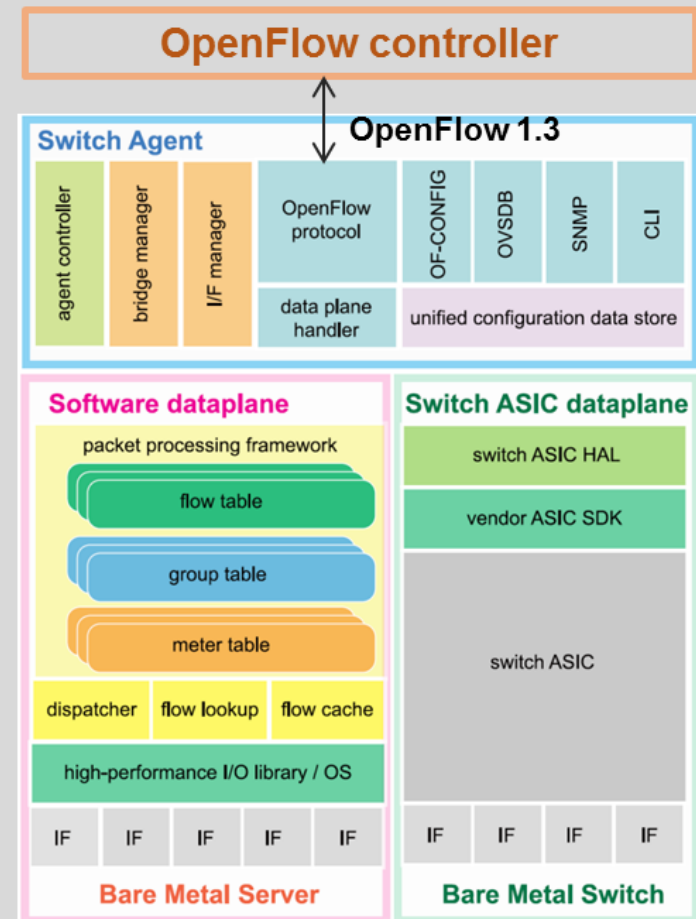
# ***SDN Ready Open Source Software***

# SDN Software Switch: Lagopus



## “Lagopus” features and targets

- **High-performance packet processing**
  - Support for 1M flow control rules
  - Forwarding performance over 10 Gbps
- **Support for various protocols**
  - Extensive support for latest stable specification OpenFlow 1.3.4 (including MPLS, PBB, and QinQ in wide area networks)
    - Top score in “Ryu certification tests”  
<http://osrg.github.io/ryu/certification.html>
- **Support for various config/mgmt interfaces**
  - OF-CONFIG, OVSDb, CLI, SNMP, and Ethernet OAM (including features under development)
- **Modular architecture**
  - New protocol modules or management interface modules easily deployed on “unified configuration data store” basis.
- **Support for multiple data planes**
  - General-purpose servers (IA servers)
    - Parallelized and multi-threaded packet processing
    - I/O acceleration by leveraging Intel DPDK
  - Bare metal switches (under development)
    - For general-purpose hardware switches



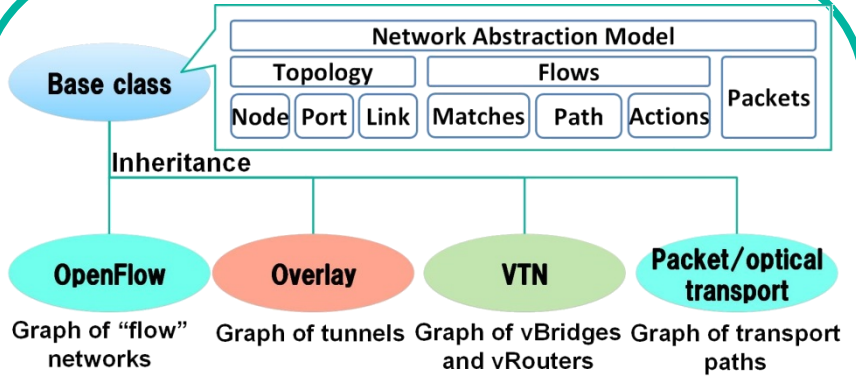
- **Open source**
  - Released as open source software at <http://lagopus.github.io/>





# SDN Framework: ODENOS

## Network abstraction model

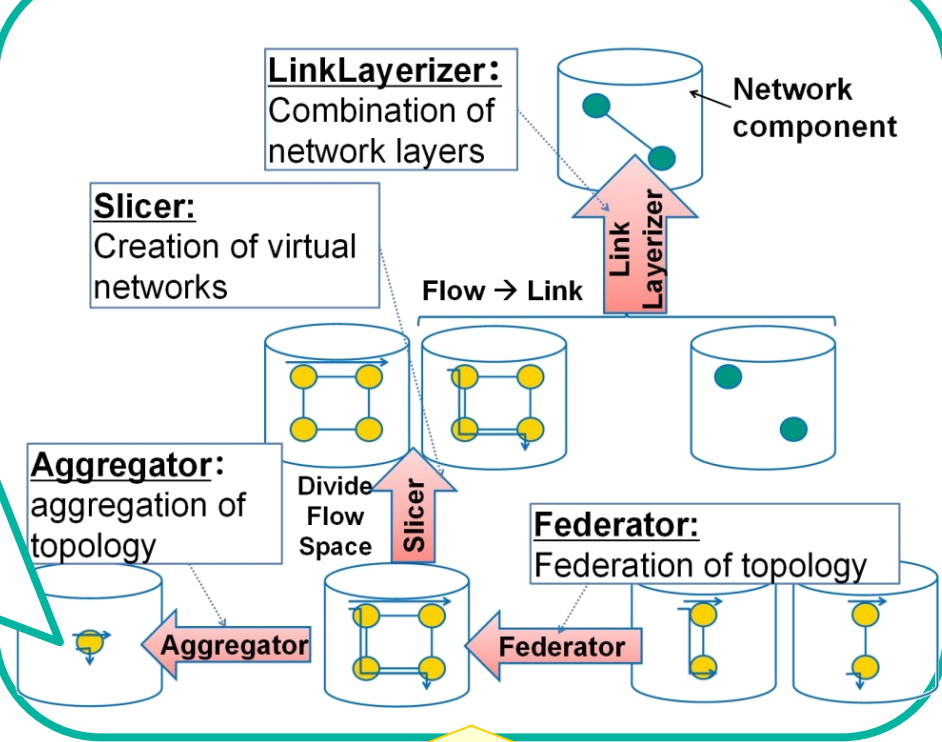


**Topology:** graph-based representation of network structure and statistics

**Flow:** point/multipoint-to-point/multipoint communications (OpenFlow path, MPLS / optical paths, and overlay tunnels)

**Packet:** OpenFlow packet\_in/out.

## Network control structure model



**Instance of various logical network**

**Operators for network instances**

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



# ***Conclusion & Future Work***



# Conclusion & Future Work

- **O3 project provides SDN ready environment**
  - **SDN Design, Deployment & Operations Guideline**
  - **SDN Framework: Object-defined Network Platform**
    - ◆ *Network Abstractions and Programming Model*
  - **SDN-enabled WAN nodes**
    - ◆ *SDN Software Forwarding and Control*
    - ◆ *Optical, Packet and Wireless Network Control*

**Jump-start with O3 Open Source Software !!**

## Future plan

Achievement	2014	2015
O3 Website	<b>Released</b>	<b>Expansion, Customization &amp; Maintenance</b>
SDN guideline	<b>Plan to release by 3/E</b>	
Common control FW (OSS)	<b>Plan to release 2/20</b>	
SDN-enabled WAN nodes (OSS) Lagopus---	<b>Lagopus: Released</b>	



**Thank you for your attention!**



**O3 project**

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

*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.*



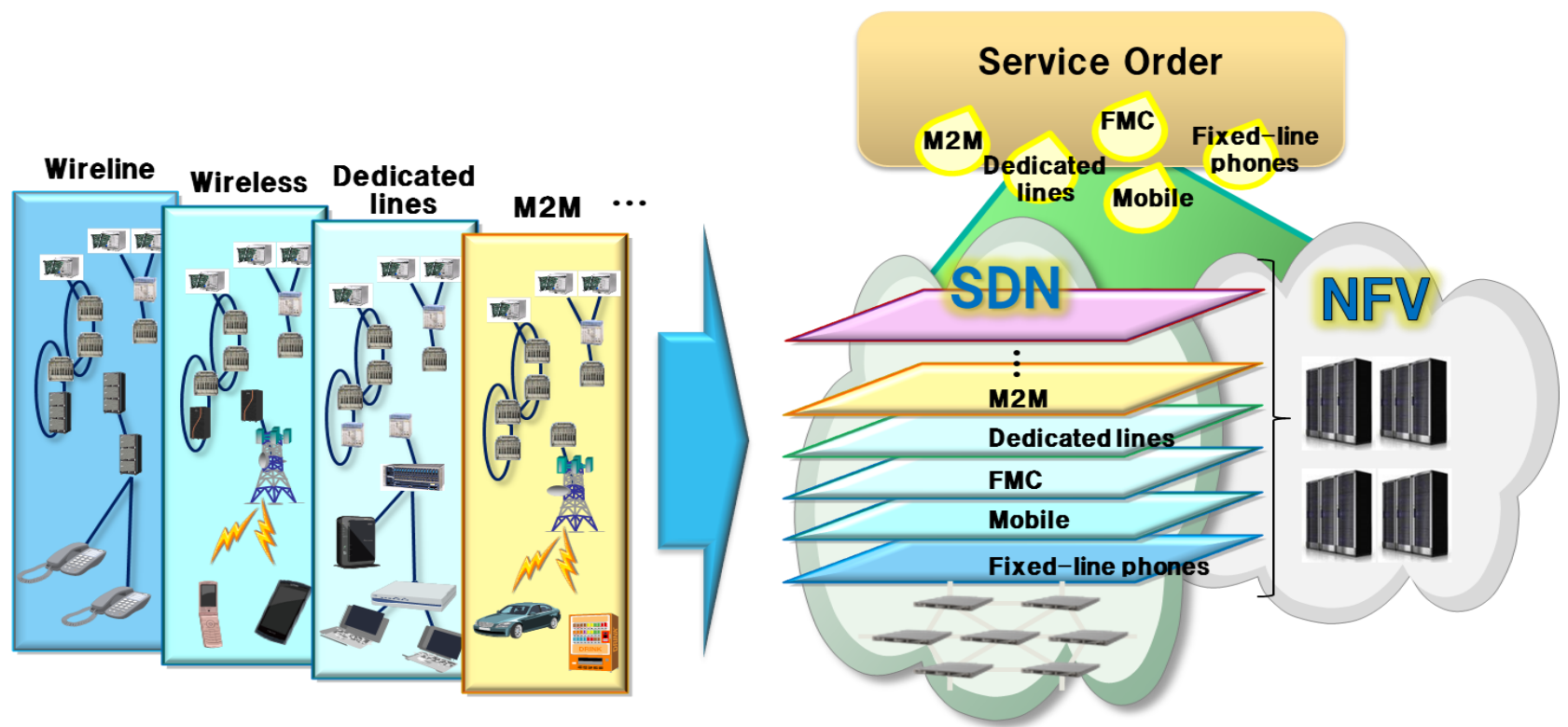


# ***Trend on Future Information Networking***



# Software-Defined Networking (SDN)

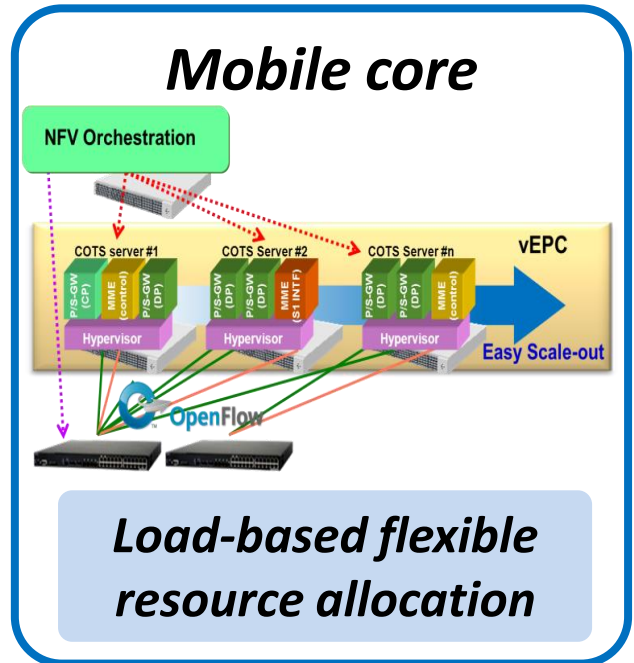
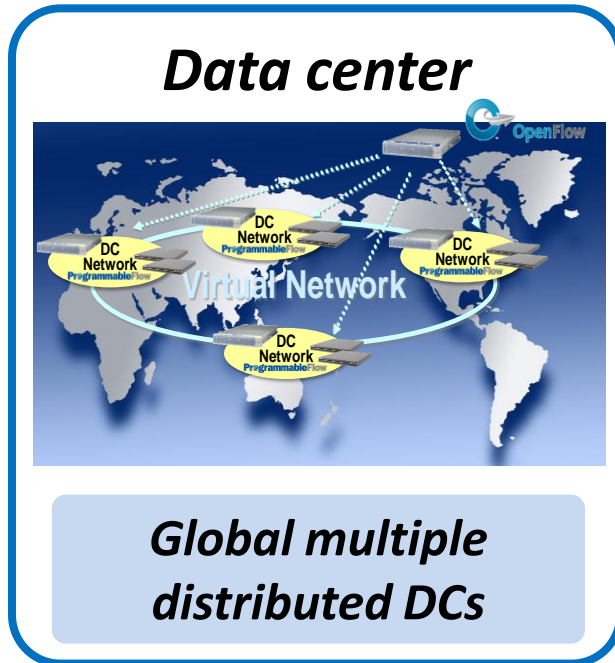
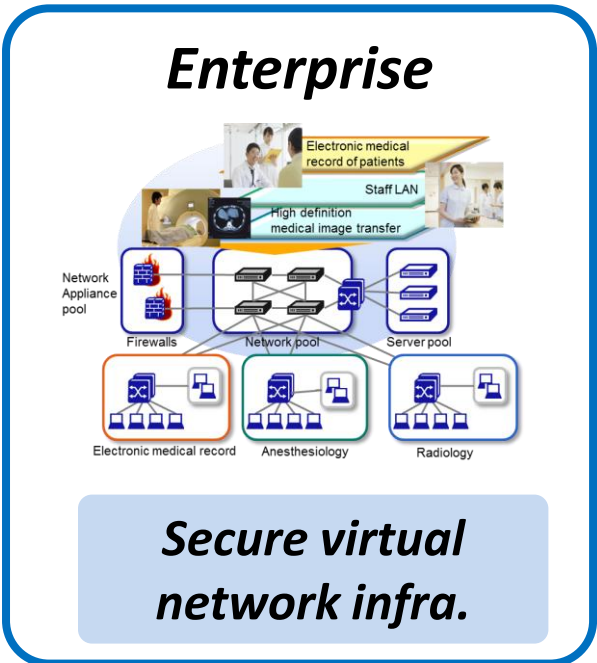
- SDN is a technology to innovate new services and to accelerate businesses
- Network will be designed, deployed and operated by business application and orchestration system





# SDN/NFV Future Direction

Commercial SDN technologies are mainly applied to “closed domain networks”, such as enterprise, datacenter, and mobile core



**Open & Agile end-to-end service deployments and operations to satisfy service SLA/QoS for various users**