“Innovation for network businesses by the world's first SDN WAN technologies”
- O_3 project -

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O_3 project
NEC, NTT, NTT Communications, Fujitsu, Hitachi

Agenda

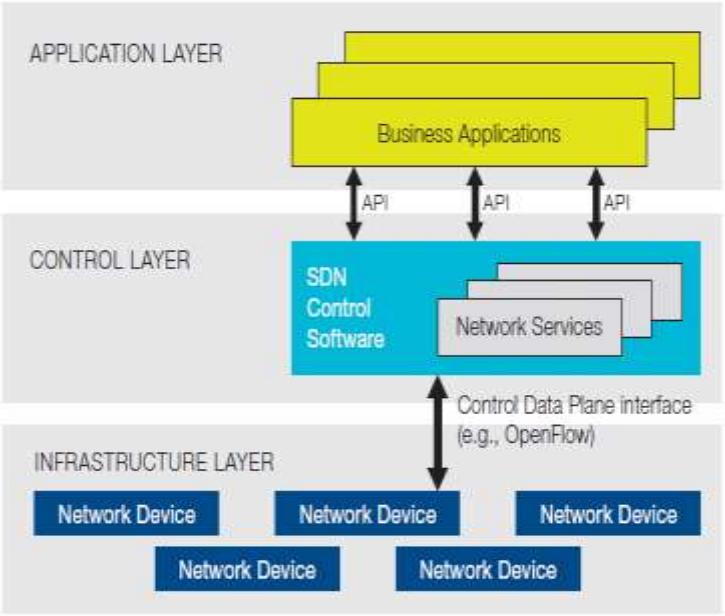
- Background and mission
- Motivation(User's and operator's viewpoint)
- The goal of O_3 project: User-oriented SDN
- What we did in O_3 project
- Developed proof of concept system
- The demonstration

Background and mission

Software-Defined Networking (SDN)

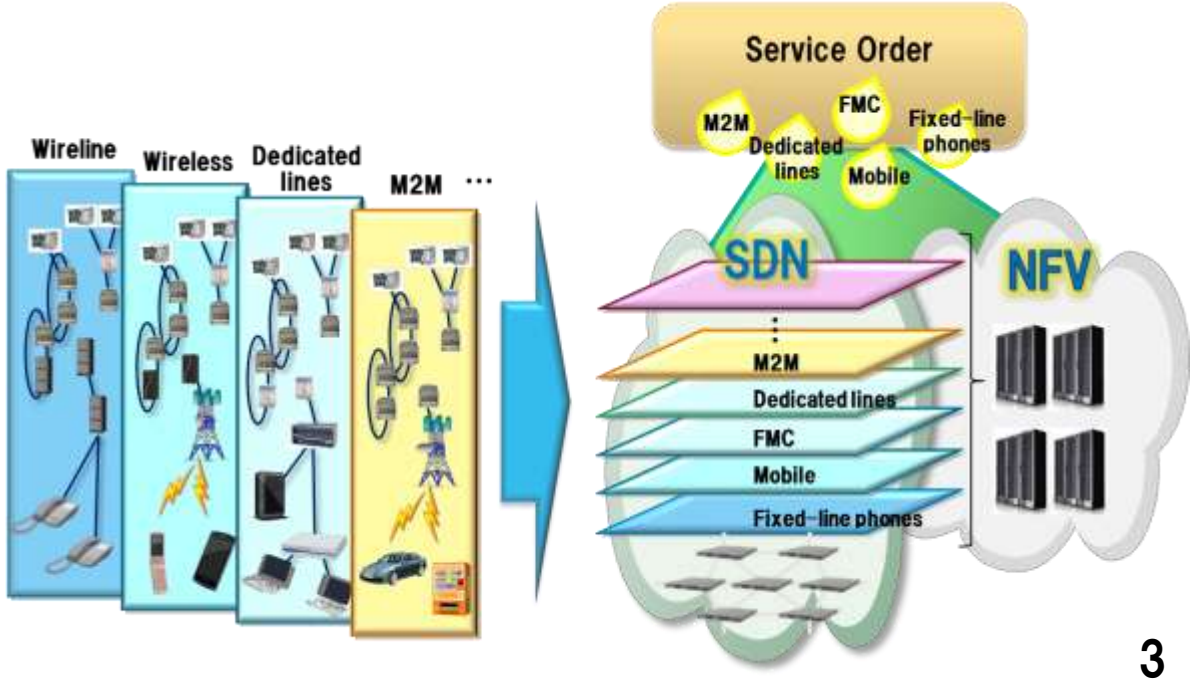
- SDN is a technology to innovate new services and to accelerate businesses. Network will be designed, deployed and operated by business application and orchestration system.

SDN architecture



Source: ONF white paper

SDN+NFV applied to wide area network

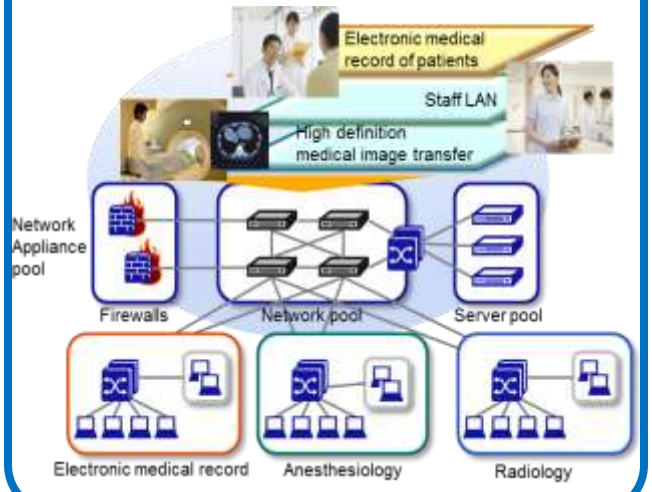


Motivation
(User's and operator's viewpoint)

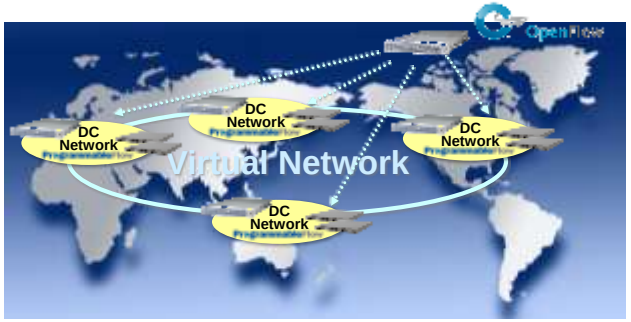
Current status of commercial SDN technology

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

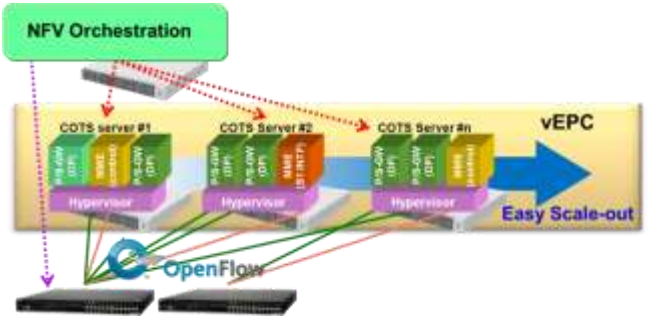
Enterprise



Data center



Mobile core



Secure virtual network infrastructure

Global multiple distributed DCs

Load-based flexible resource allocation

Current issues of WANs (operator's viewpoint)

- Current business environment
  - Change of service cycle: short life cycle
  - Change of usage model : global optimization and collaboration

- Issues of existing WANs
  - Time-consuming process to deploy, operate, terminate network services, due to negotiations between networks and/or layers.
  - Difficulty of resource optimization for each service, since service resource in each layer are independently managed.
  - Difficult to interoperate or migrate over multiple networks and/or layers between different services.
  - Difficult to integrate operation and management due to the vendor-specific/-defined networking.

Solution using SDN (operator's viewpoint)

- For short life cycle

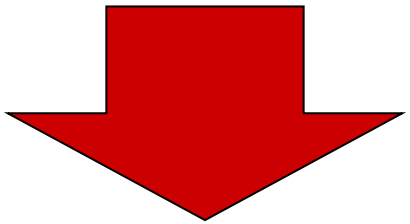
  ⇒ Provides rapid deployment, operation and termination of services

- For global optimization

  ⇒ Optimize WAN service by multi-layer resource orchestration

- For free of vendor -specific/-defined networking

  ⇒ Service-oriented rapid and flexible network deployment



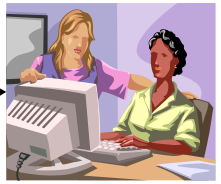
Enable SDN to provide wide-area multi-layer technologies and resource abstraction technologies

Current issues of WANs (user's viewpoint)

- Application Programming Interface (API)
  - Usually lead to “network-oriented” API instead of “user-oriented” API, and is not sufficiently enough for application developers to develop network service programs.

Application Programming Interface (API)

Orchestration system



Northbound API

Network-oriented API is not enough for application developers to utilize.

Southbound API

Physical links and nodes

Solution using SDN (user's viewpoint)

- User-driven network innovation

  ⇒ User community develops new innovative software

- Agile cross-industry collaboration

  ⇒ Chaining different services builds collaborative services quickly

- Realize user-defined networking

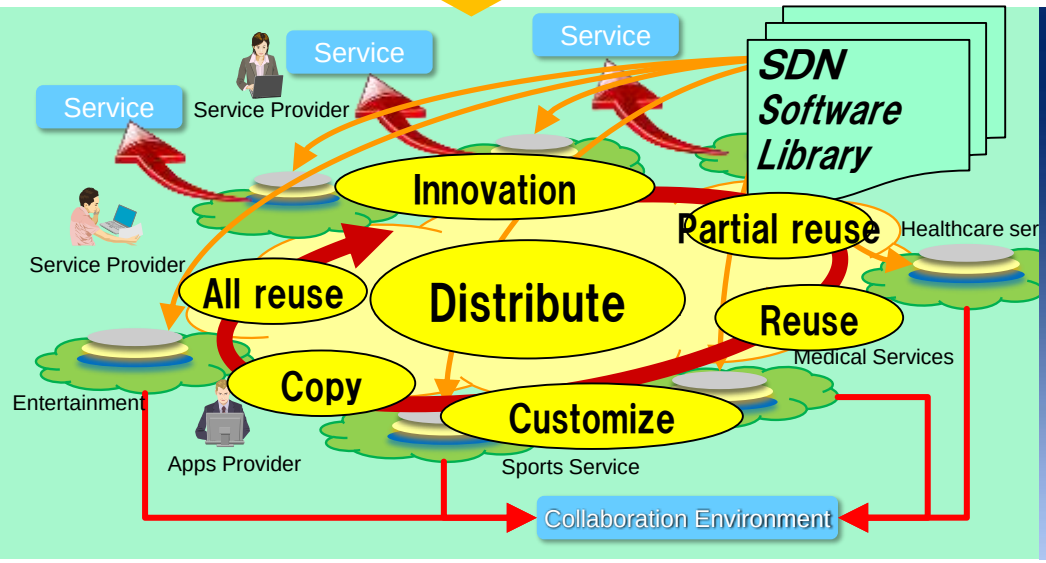
  ⇒Users innovates new services quickly and flexibly

Enable SDN to provide user-friendly development framework without detailed network knowledge (via tools)

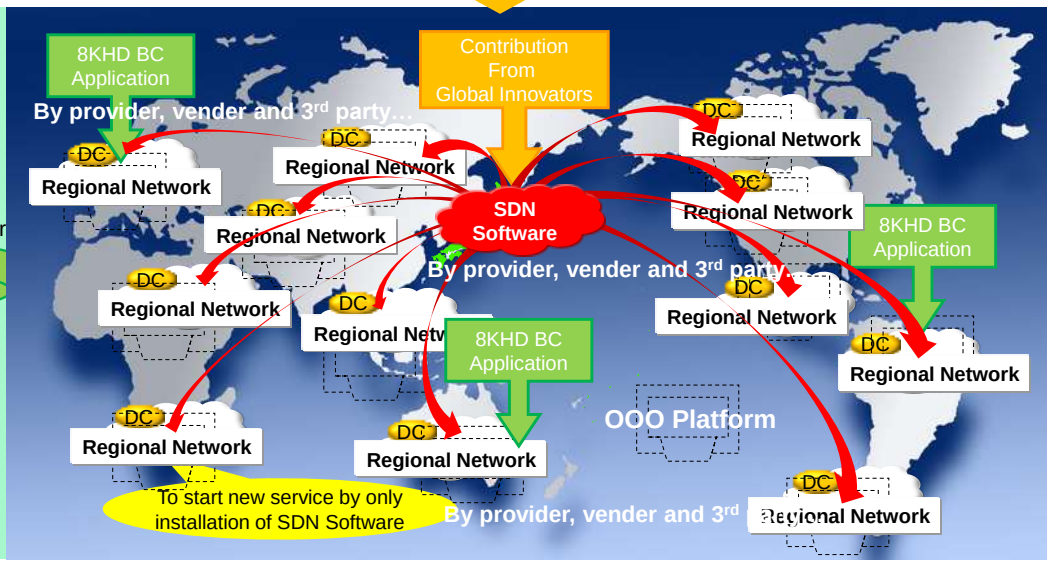
Goal of SDN WAN

- Distributing SDN software library enables
  - ➢ “agile end-to-end service deployments and operations” to satisfy service SLA/QoS.

Distributing SDN software library among different businesses



Distributing SDN software library to different regional networks for global cloud services



The goal of O_3 project: User-oriented SDN

Introduction to O_3 project concept

- Open
  - Open the project results with open source software (plan to release in 2014 – 2015)
- Organic
  - Neutral activities for all communities
- Optima
  - Network resource optimization in terms of quality, cost, performance

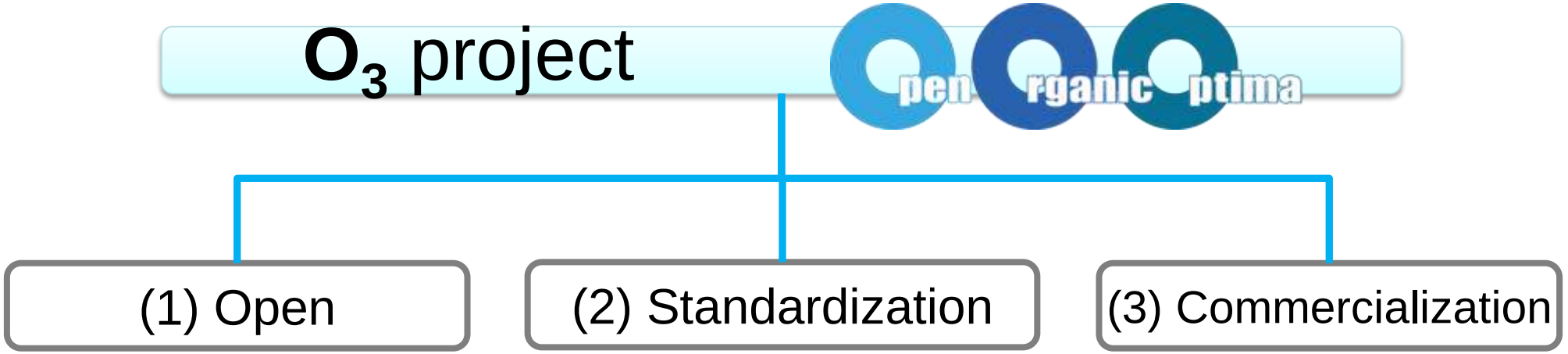
Toward open user-oriented SDN

Accelerate three items for user-oriented SDN

(1) Open development with OSS

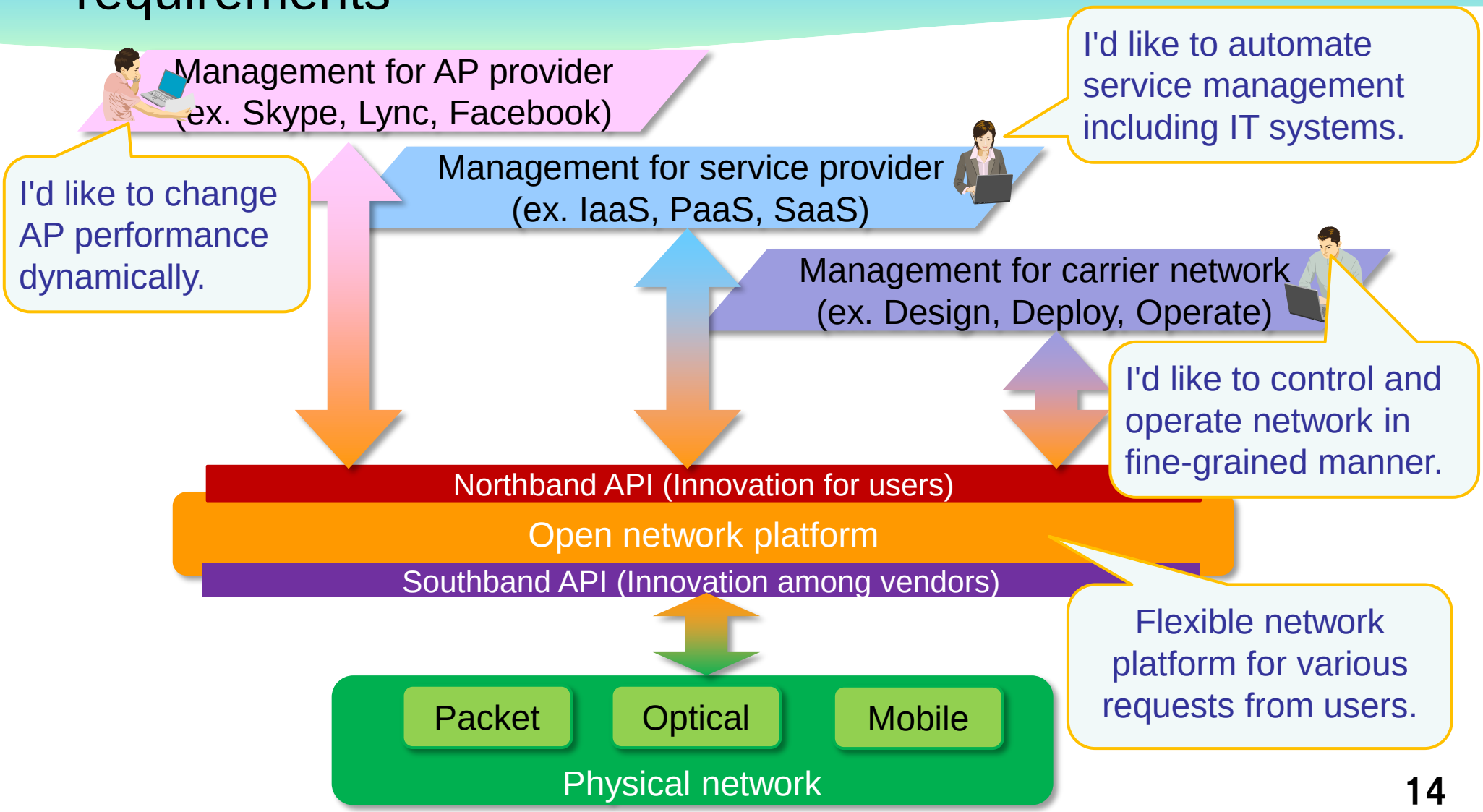
(2) Standardization of architecture and interface

(3) Commercialization of new technologies



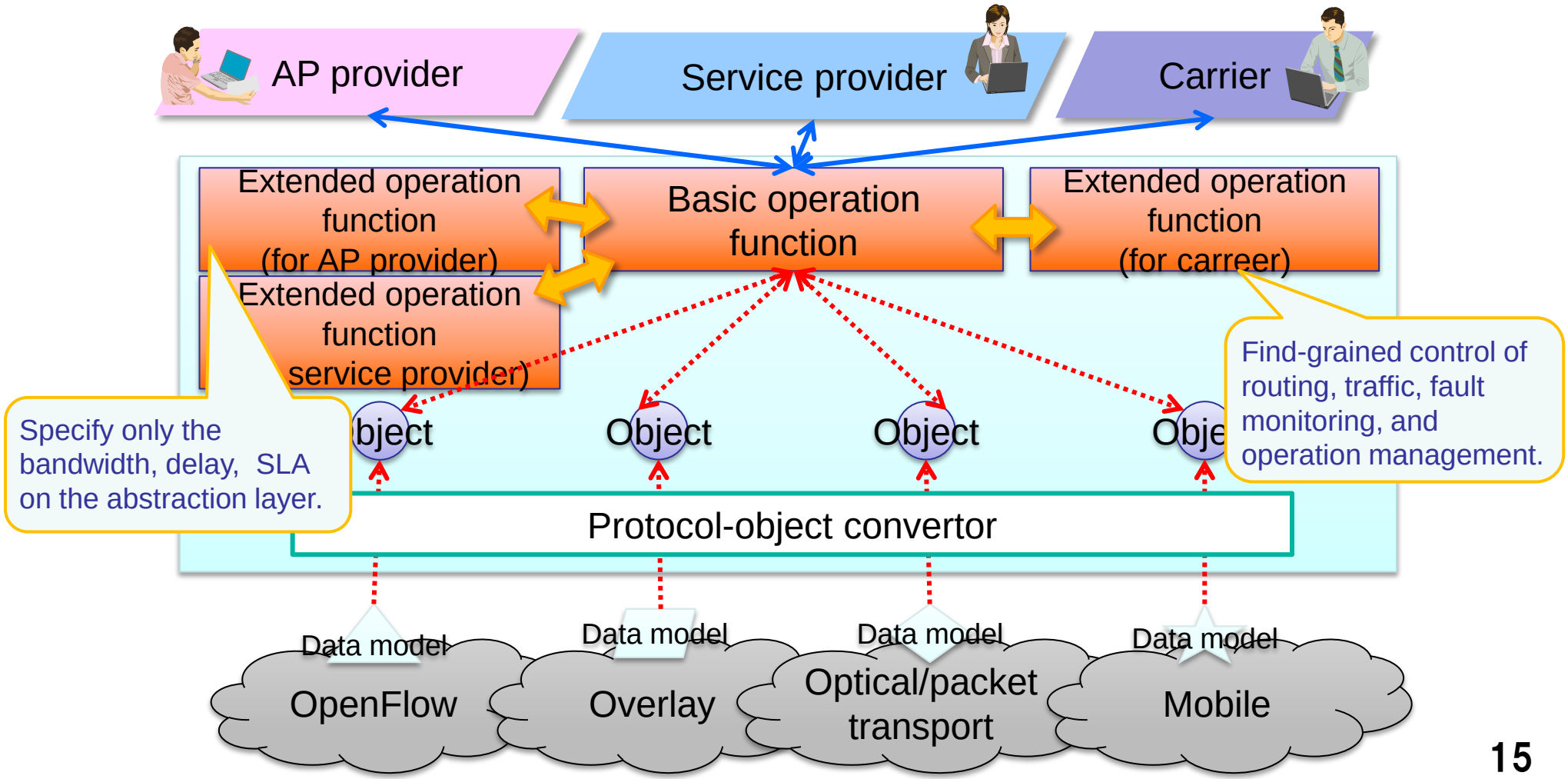
Requirements of user-oriented SDN

- Provides orchestration systems for different user requirements



Object-defined network platform of O_3 project

- Object-defined network platform realizes
  - Fine-grained customized network control for carriers, and
  - simple operation for AP providers and service providers.



The expected goal of O_3 project

[1] Service modeling to describe end-to-end services, including SLA/QoS

Differentiated tools (OSS or proprietary)

[2] Designing, deploying and operating network services where SLA/QoS are satisfied.

Differentiated tools (OSS or proprietary)

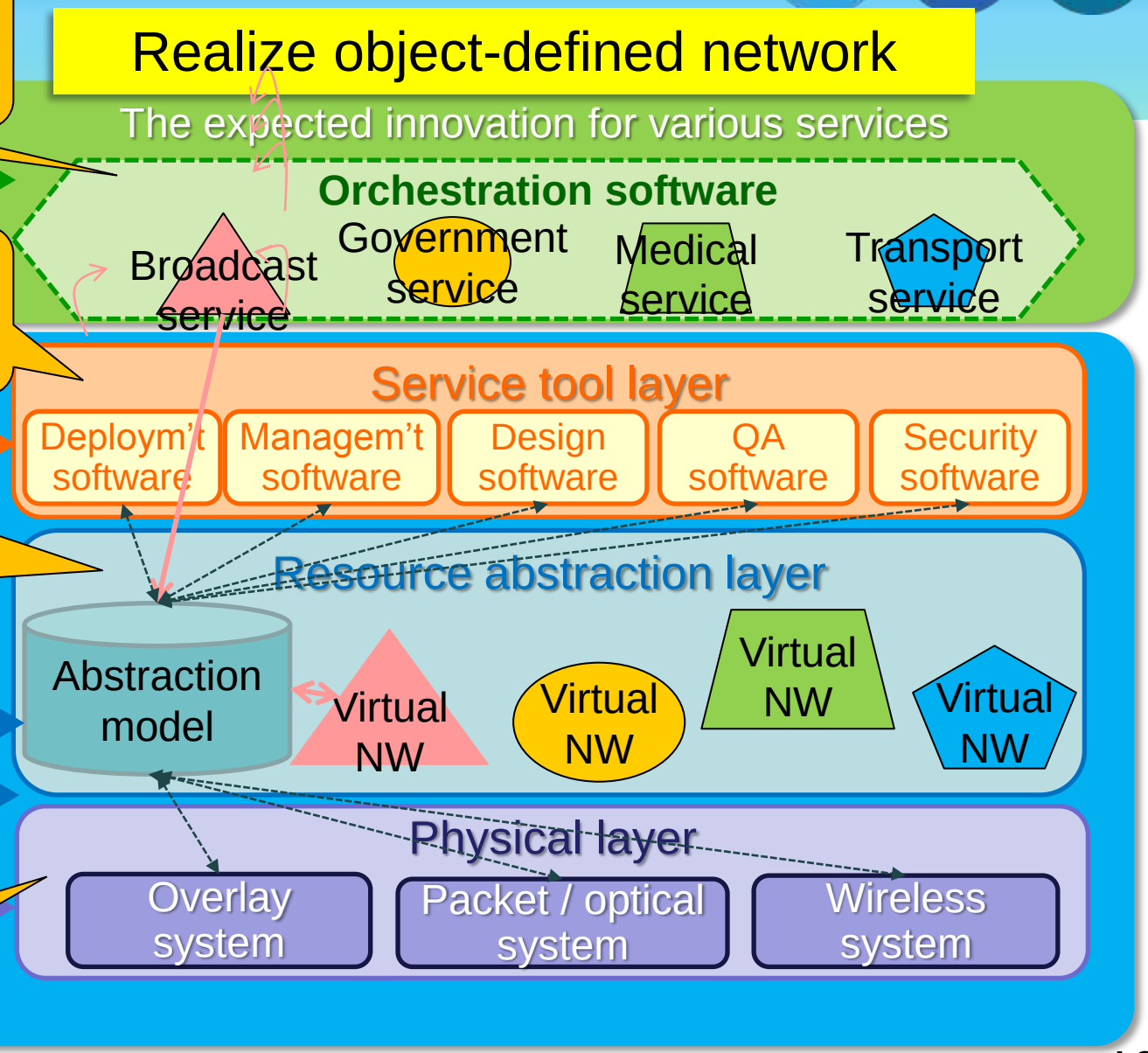
[3] Abstraction of physical NW resource and optimizing logical NW and physical NW

Open framework (OSS)

Open Interface

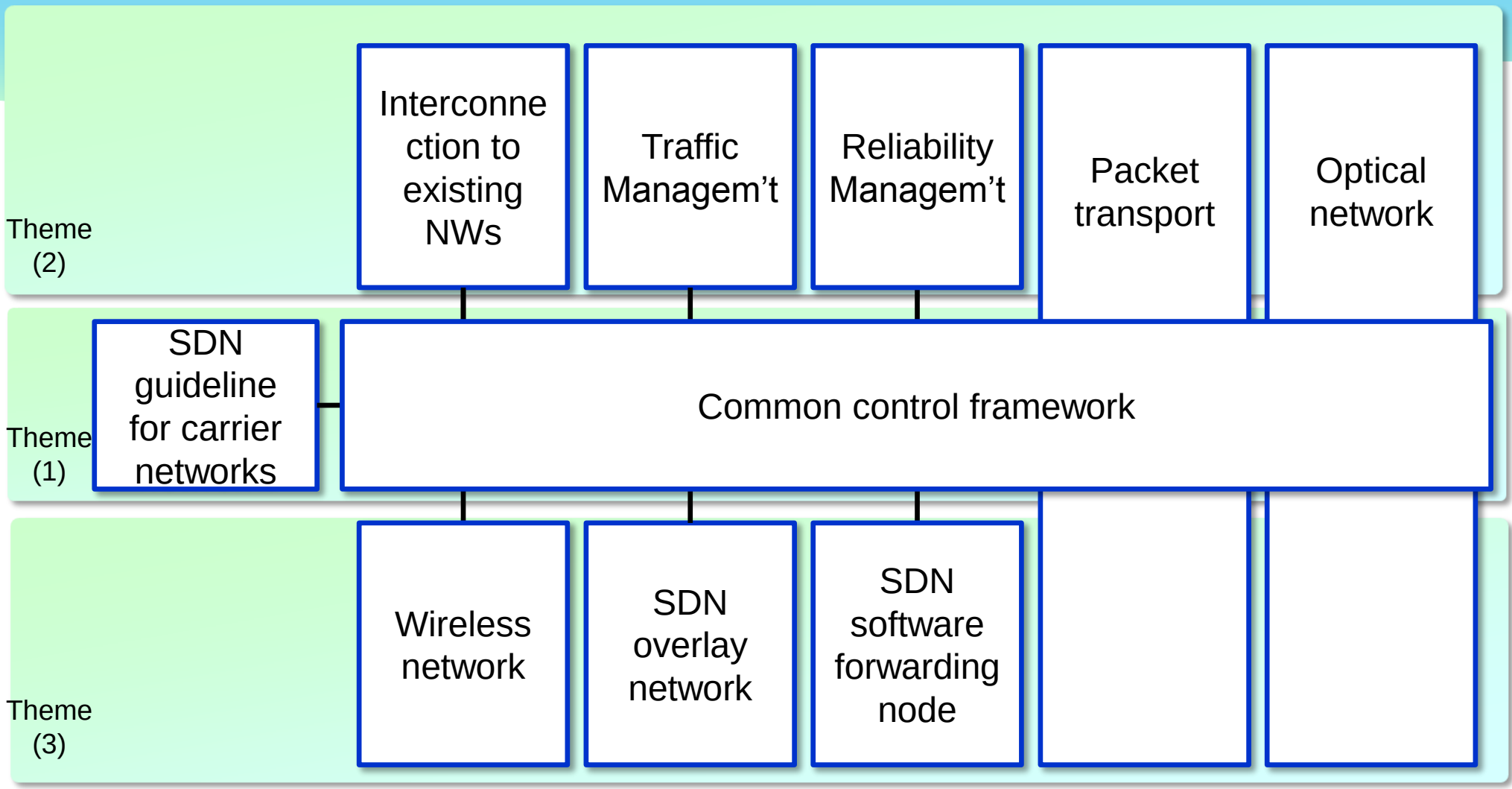
Differentiated tools (OSS or proprietary)

[4] Supporting API to realize flexible physical layer



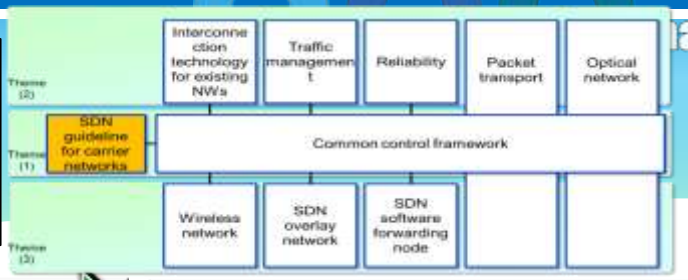
What we did in O_3 project

All topics of O_3 project



SDN guideline for carrier networks

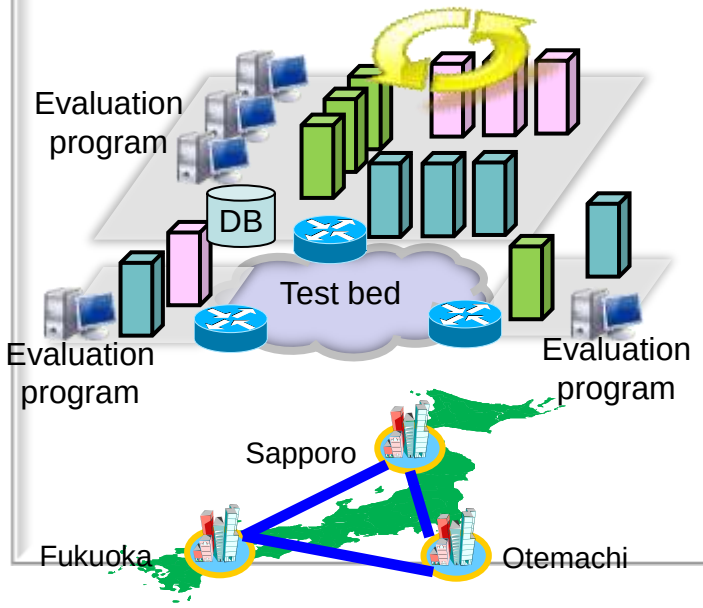
- Establish the SDN guideline for carrier networks which is required to design, deploy and operate the large scale of SDN in the following steps:



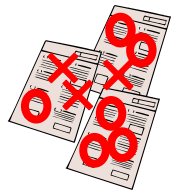
Guideline draft creation → **Feature** testing & analysis → **Documentation** completion

Draft includes
- Criteria to select SDN equipment
  - Capacity
  - Capability
  - Reliability etc.
- Criteria for evaluation
  - Flexibility
  - Time to deploy SDN etc.
- Evaluation techniques
  - Design parameters identification
  - Testing and reporting templates

Evaluation techniques
- Test bed setup
- HW/SW SDN feature evaluation
- Design parameters certification
- Test results analysis

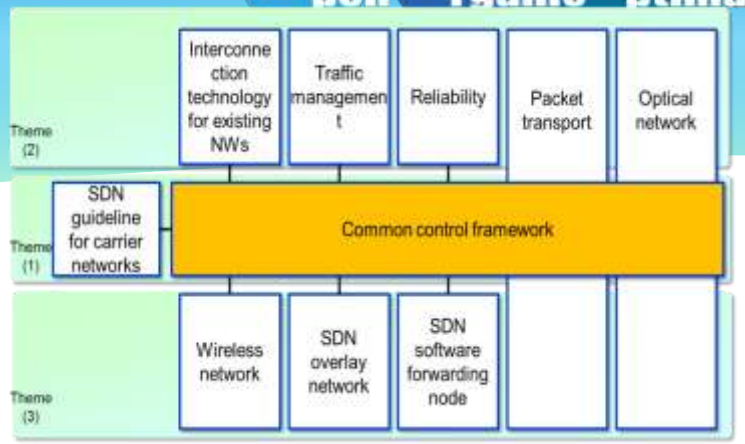


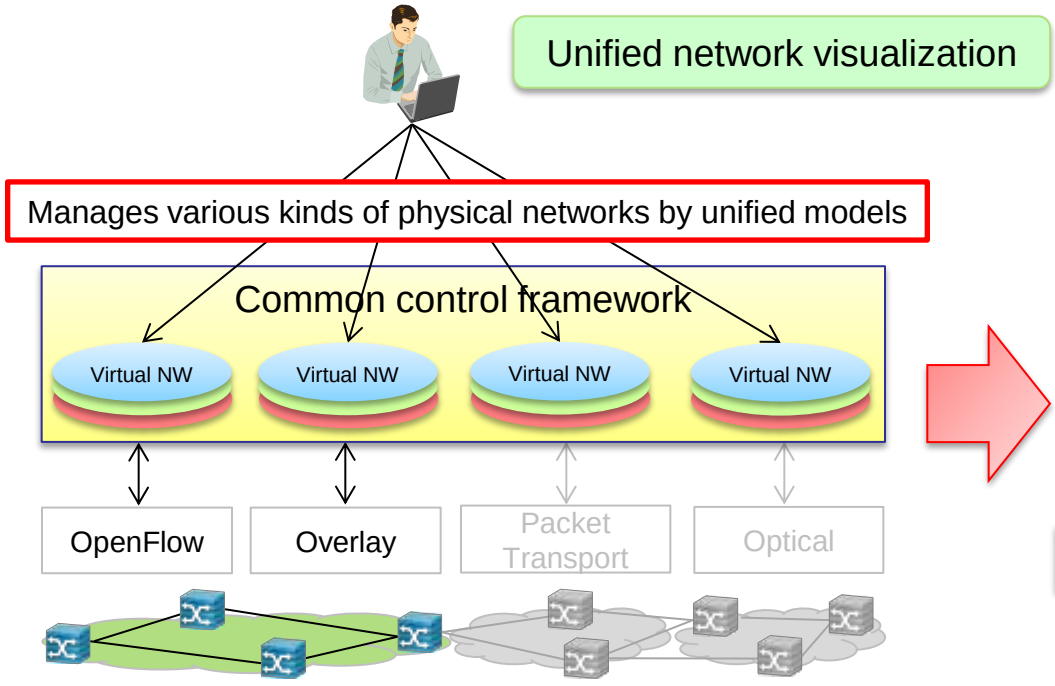
Final document
- test results
- analysis reports

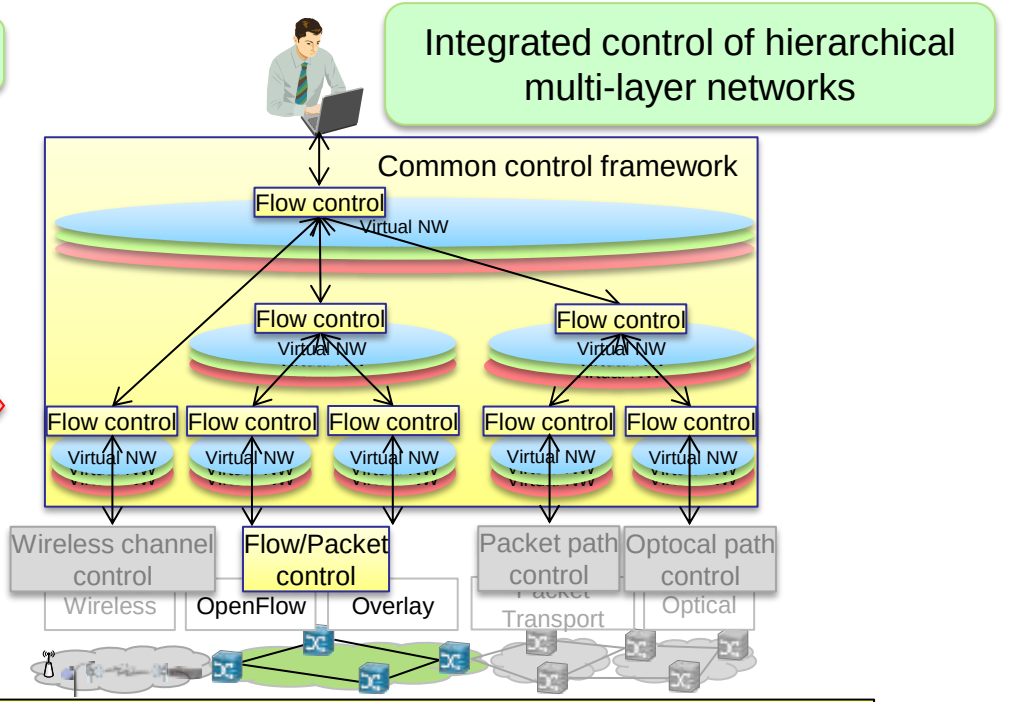


Common control framework

- Provide flexible network service and quick service delivery by building a virtual network over various kinds of physical networks.
- Reduce operation cost for complex multi-layer physical networks by using unified management.

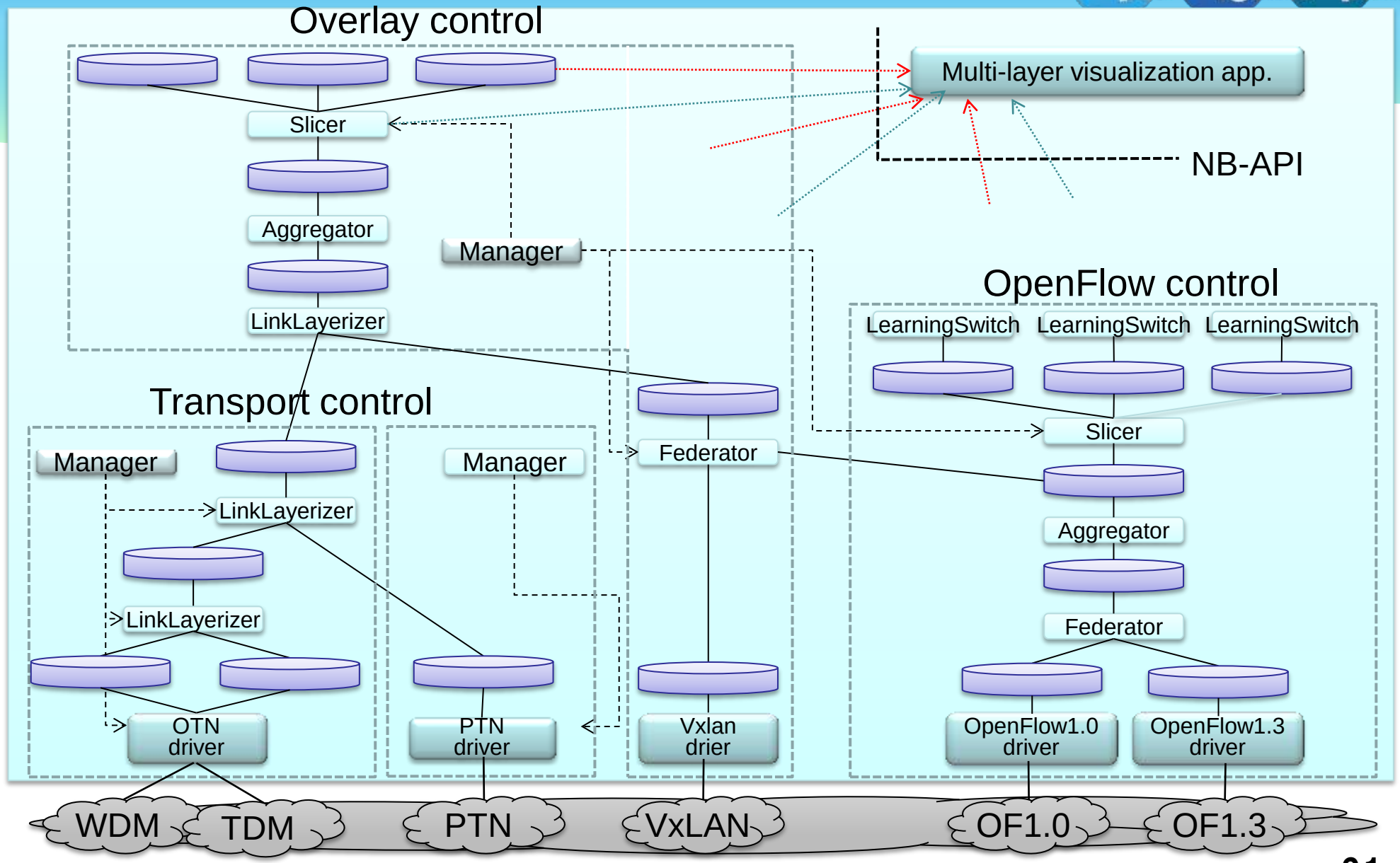






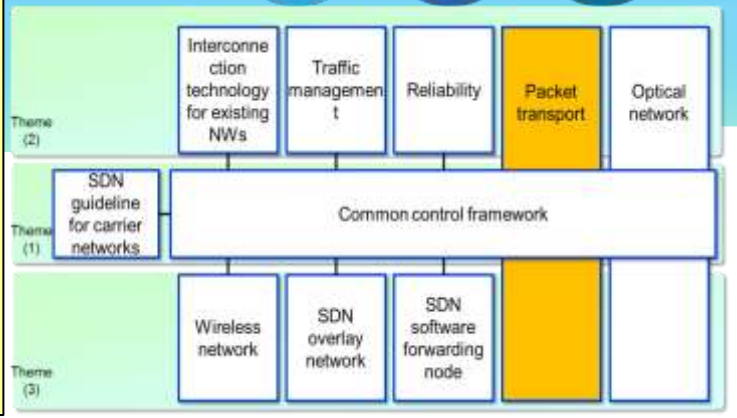
Achievements: Implemented a common control framework to visualize multi-layer network topologies, including OpenFlow, overlay and packet/optical transport.

Example of multi-layer network management

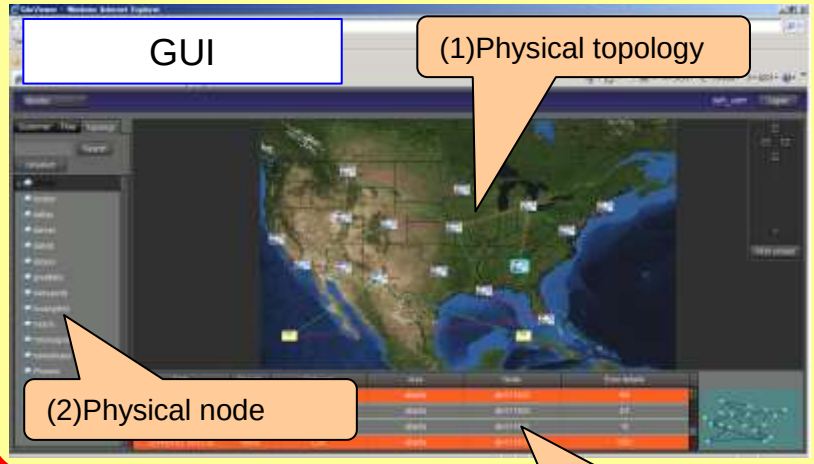


Packet transport

- In a 1,000-node-scale packet transport network, it enables to provide networks and services promptly, just like in a cloud environment.
- Large-scale multiple failure restoration with hundreds of virtual networks is achieved within 10 seconds, 1/10 duration compared with the existing technologies.



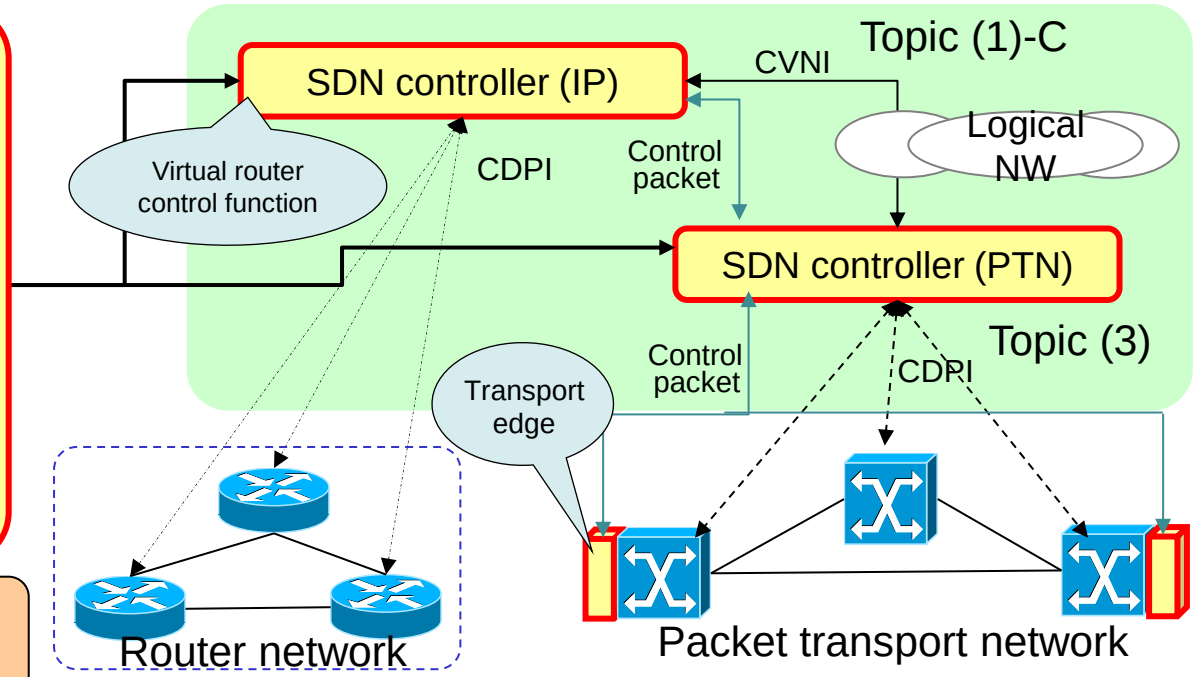
Topic (2) : Multi-Layer Orchestrator (MLO)



Achievements in this year

(3) Alarm status display ->Certain alarm will be selected automatically

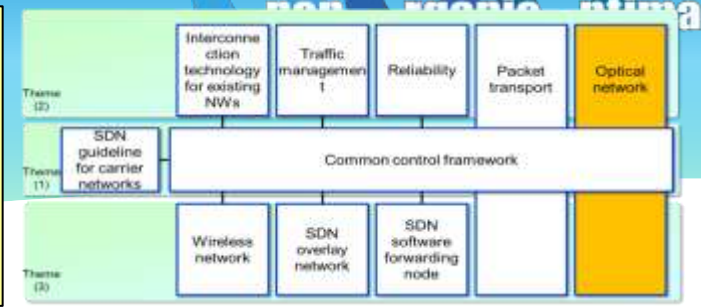
CDPI: Control Data Plane IF
CVNI: Control Virtual NW IF



Achievements: Developed prototype node and integrated management GUI.

Optical network

Unified operation over packet and optical core layers
- Enables to adapt to end users needs promptly, and to reduce the communication expenses for end users.
- Improves network resource utilization for operators, and reduces CAPEX and power consumption.



Before

Independent operation of each layer

May not meet the needs of end users

End user A

I need high bandwidth and redundancy…

End user B

Only fixed menus are provided

Menu A
- High bandwidth
- Low latency

Menu B
- Redundancy
- Security

Operation of packet NW

NW administrator

Independent operation

Operation of optical core NW

NW administrator

Packet network layer

Optical core network layer

After

Unified operation of multilayer

Can provide optimum network for end users

End user A

End user B

Low cost

Low latency

Redundancy

High BW

Security

Virtual resource pool

NW administrator

Unified operation

Virtual management over multilayer

Packet network layer

Optical cut through

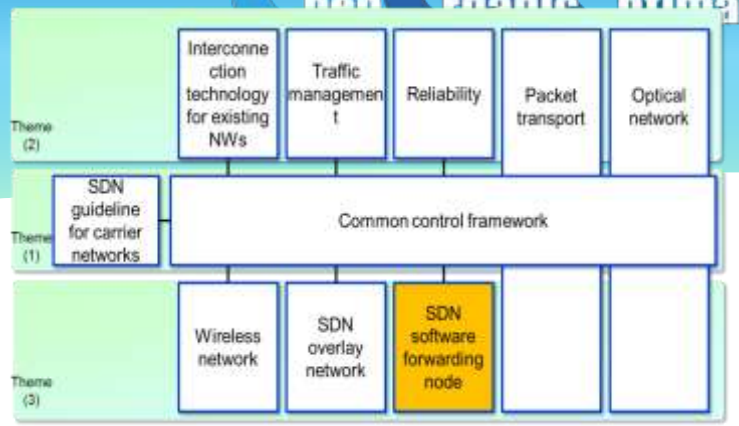
Evaluation board for signal Interworking

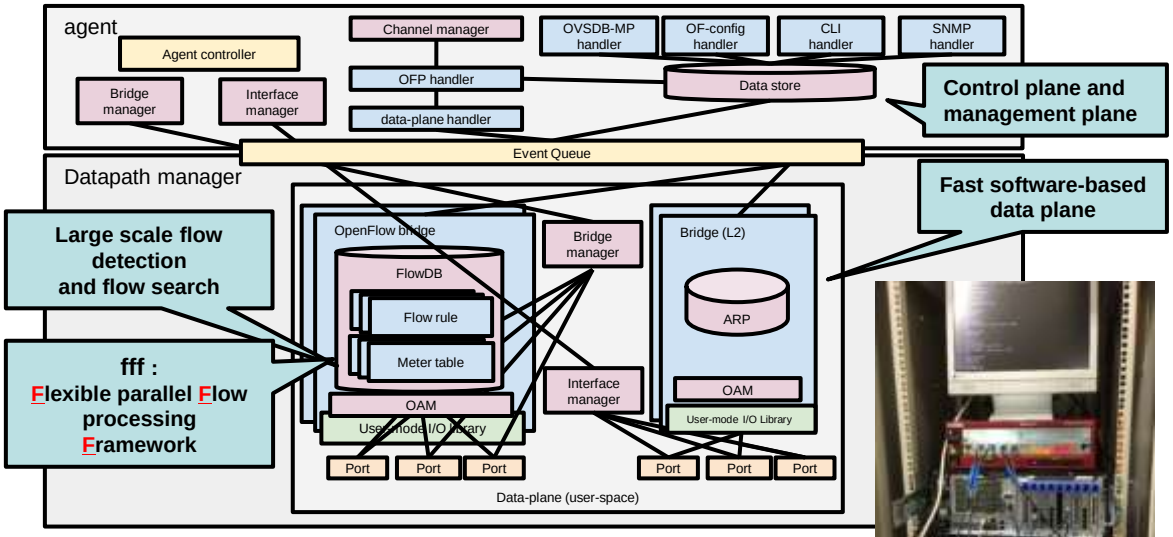
Optical core network layer

Achievement: Configuration of 1000-node-scale network was changed in 10 minutes.
Prototype of evaluation board for interworking packet/optical signals has been developed.

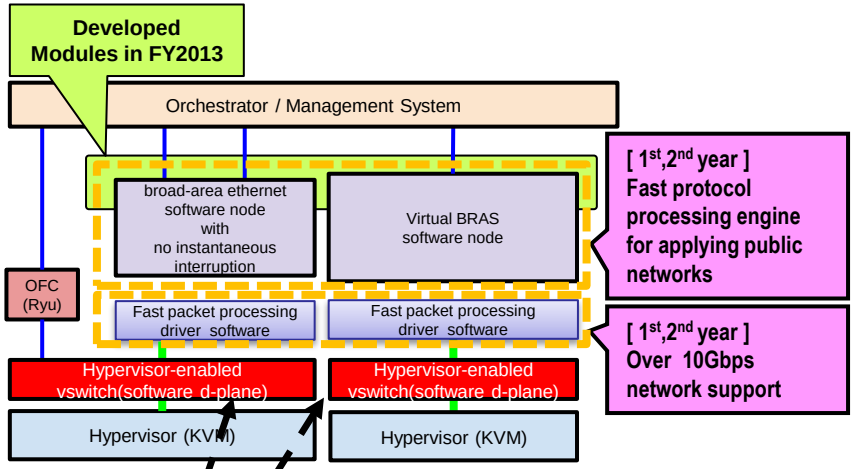
SDN software forwarding node

- As its functional expandability and flexibility, it is easy to deploy new network services and new protocols on that node, and also to accommodate unpredictable network changes.
- The node has sufficient packet processing performance and network functions, applicable for a large-scale network.





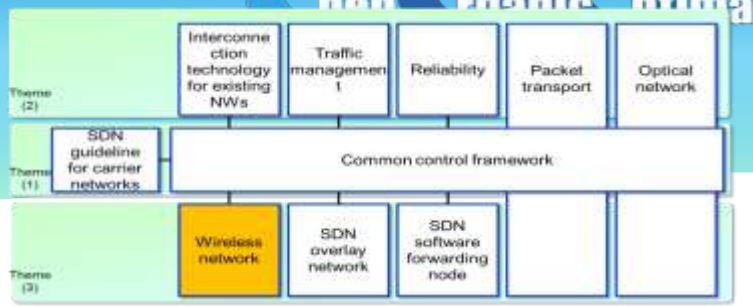
A proto-type of SDN software switch

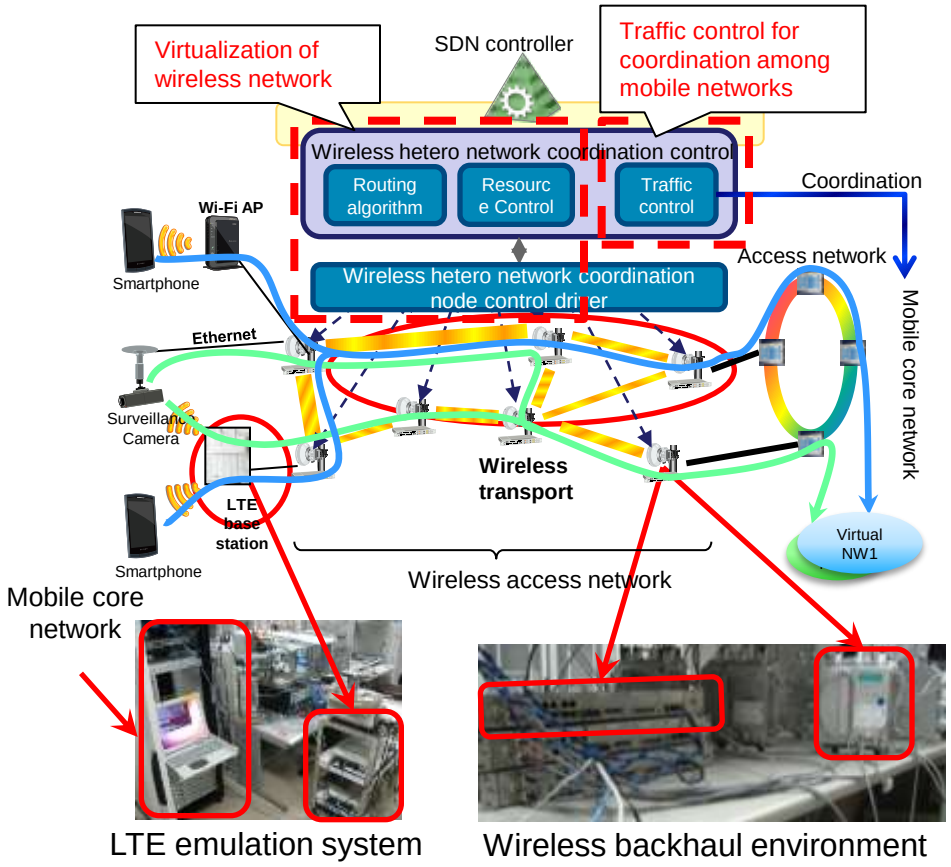


Achievements: Achieved 10Gbps enabled SDN software forwarding node with 1M flows

Wireless network

- 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.





LTE emulation system

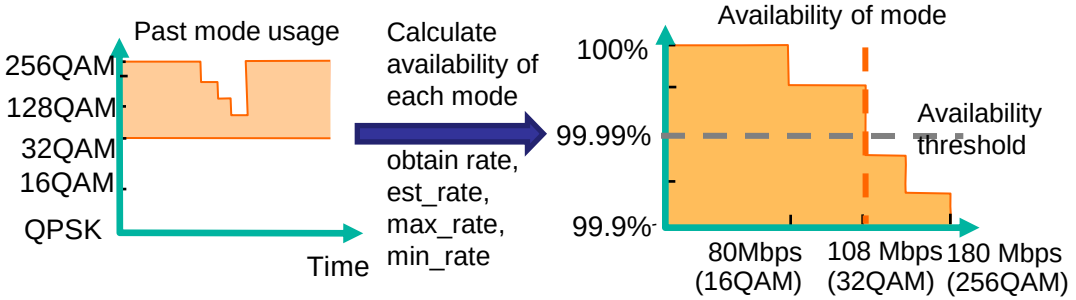
Wireless backhaul environment

Completed modeling of wireless transport Link

Parameters specifically for wireless transport link

Tx/Rx frequency, Channel bandwidth, Mode (Modulation and coding)

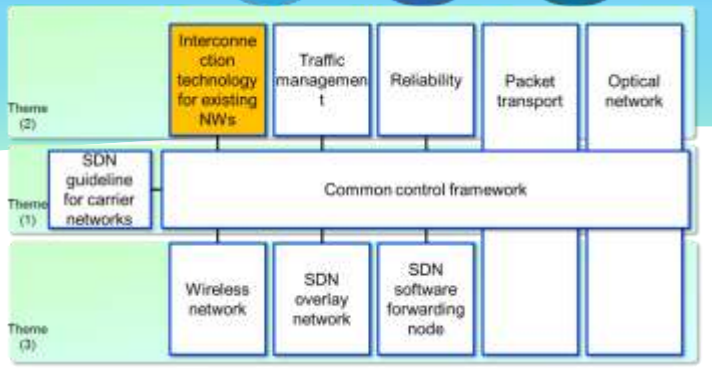
+ Mode usage information of wireless transport link

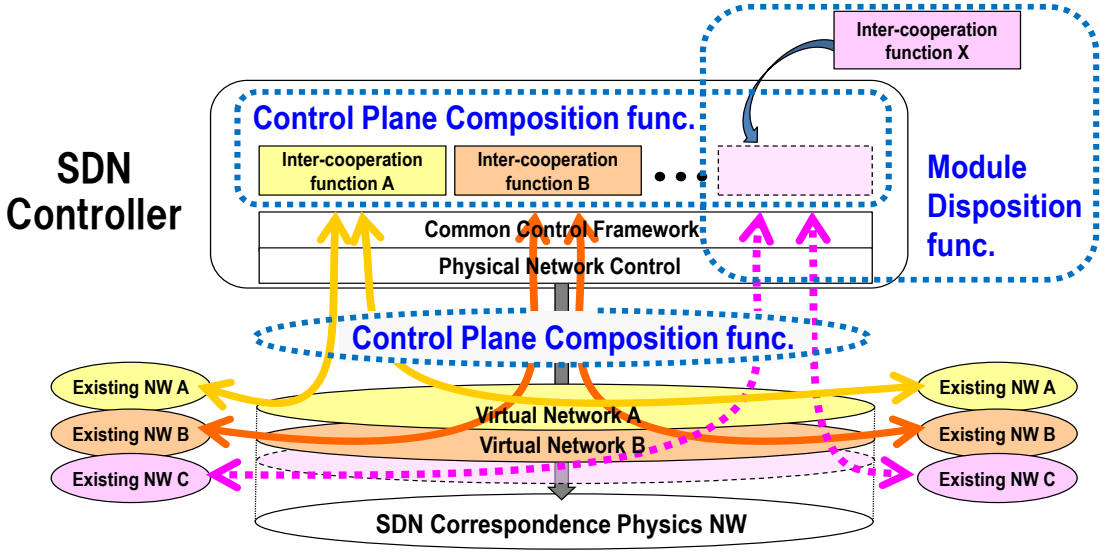


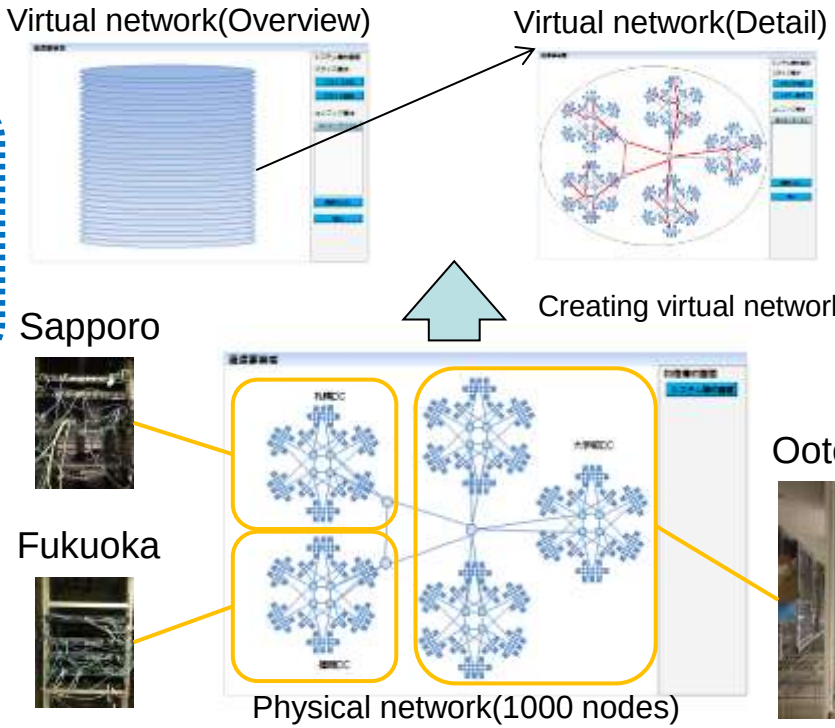
Achievements: Achieved modeling of wireless transport link and path control scheme

Interconnection to existing NWs

- Rapid creation of 1000-node-scale virtual networks which connects to existing networks by legacy inter-domain routing protocol.
- Reduction of operation cost of large-scale networks to accommodate any user requests, by centralized control of SDN controller.



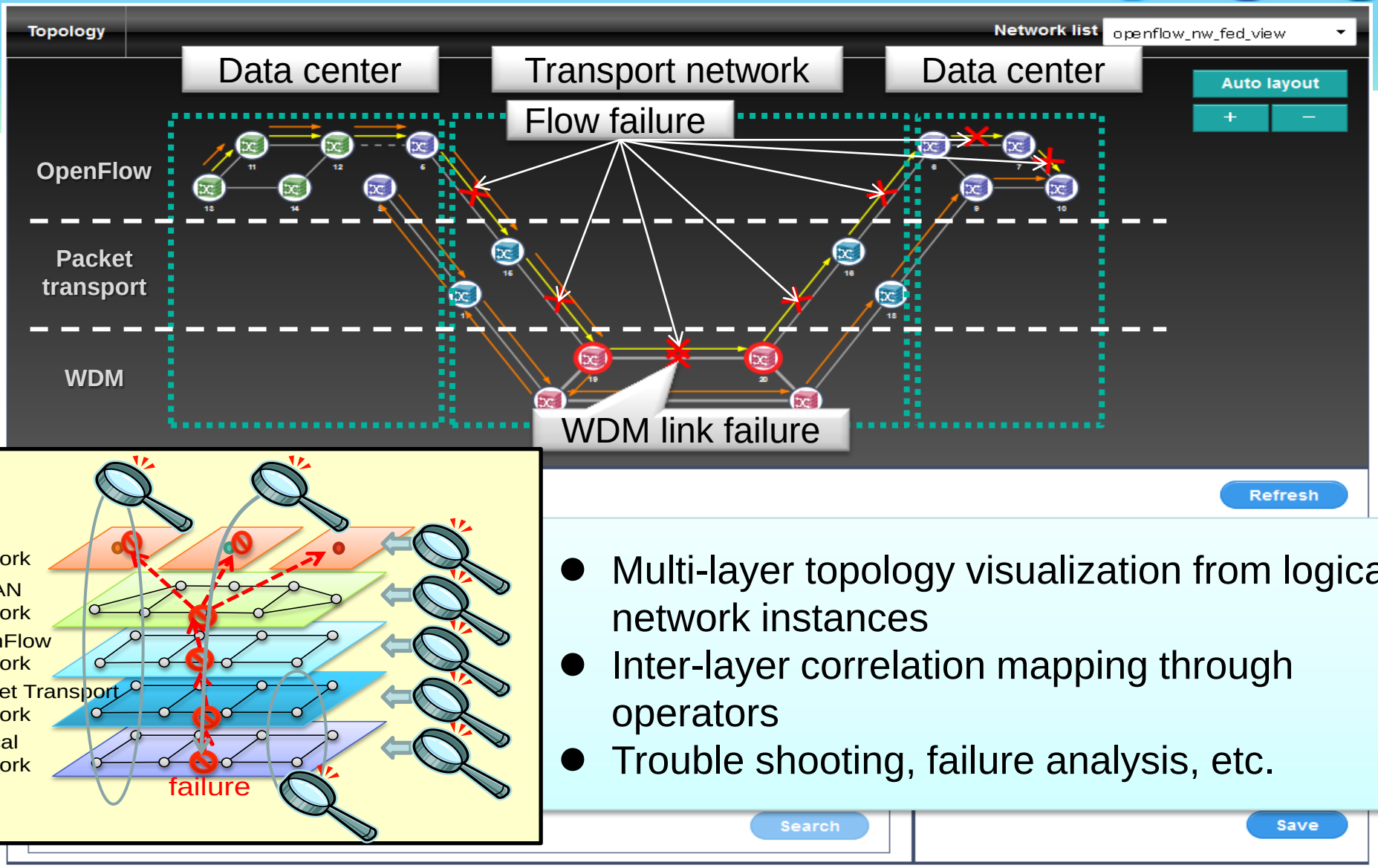




Achievements: Achieve 100 slice interconnections among1000 nodes within 10 minutes.

Developed proof of concept system

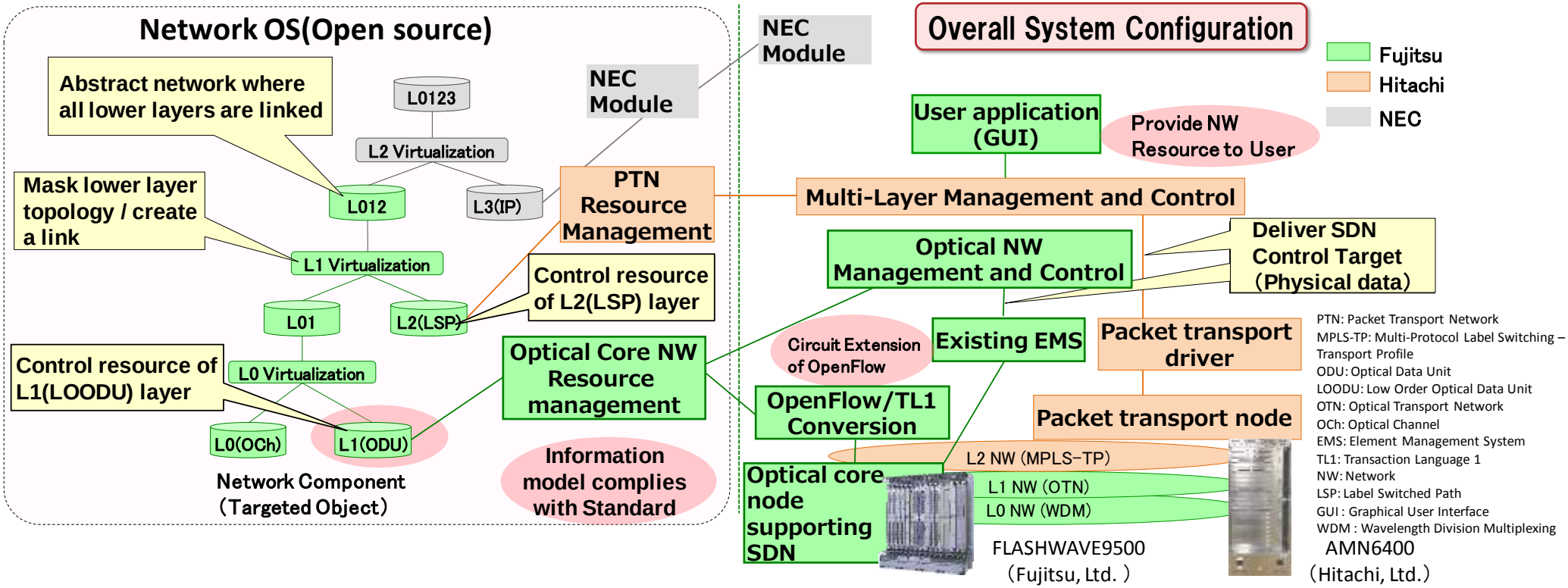
Visualizer for multi-layer, multi-domain networks



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

Packet / Optical integrated management

- Advanced control of Packet/Optical transport network
  - Control of transport network based on simple requirements from users such as transmission speed and response time
  - Flexible utilization of multilayer resources to meet requirements from users



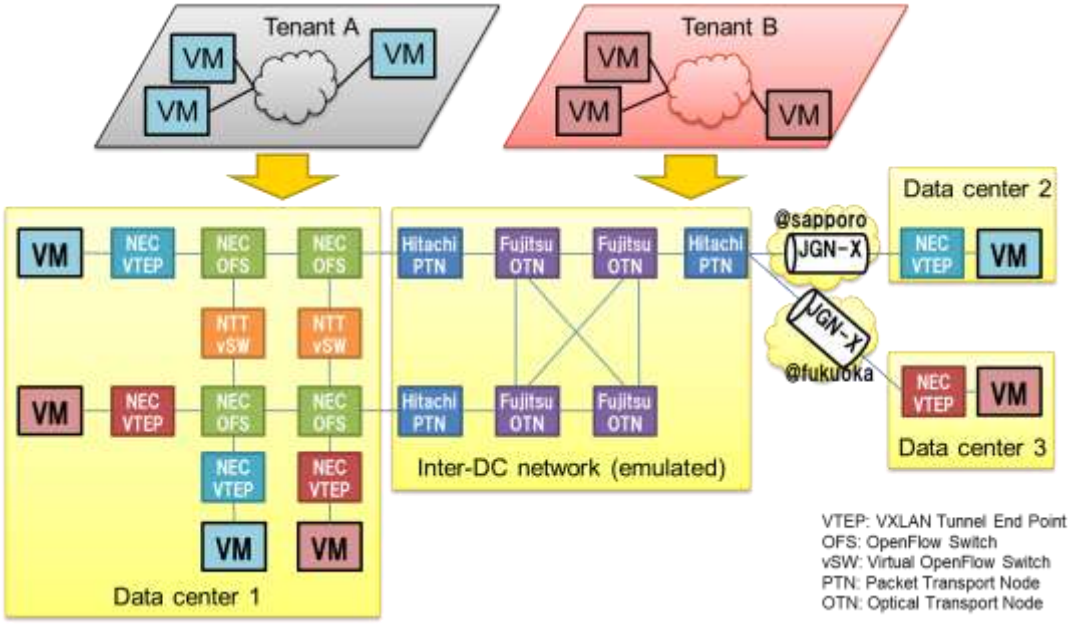
Conclusion

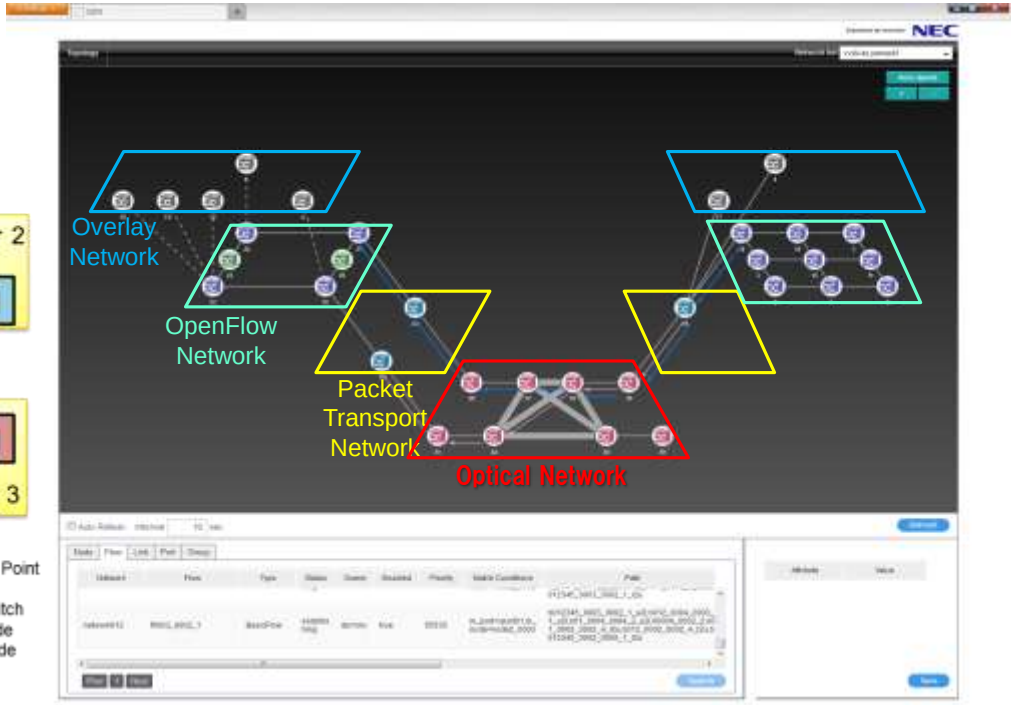
- Introduction to O3 project
  - SDN guideline
    - For SDN operations
  - Common control framework
    - For network abstractions and programming model
  - SDN-enabled WAN nodes
    - For Packet transport control
    - For Optical network control
    - For wireless network control
    - For SDN software forwarding plane and control
- Future plan
  - Plan to release O_3 project results in OSS, to explore new innovations with outside community.
  - Release of software modules will be in 2014 – 2015

The demonstration

Demonstration 1

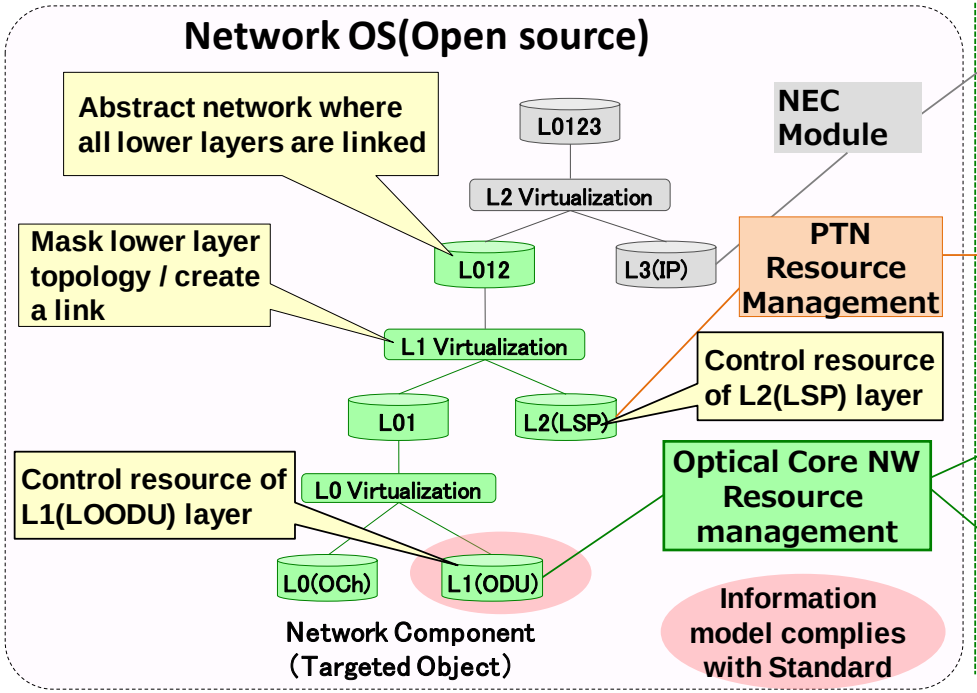
- Integrated network management system for WAN
  - Management of multi-layer, multi-vendor and multi-domain networks
- Multi-layer topology visualization
  - Inter-layer correlation mapping through operators

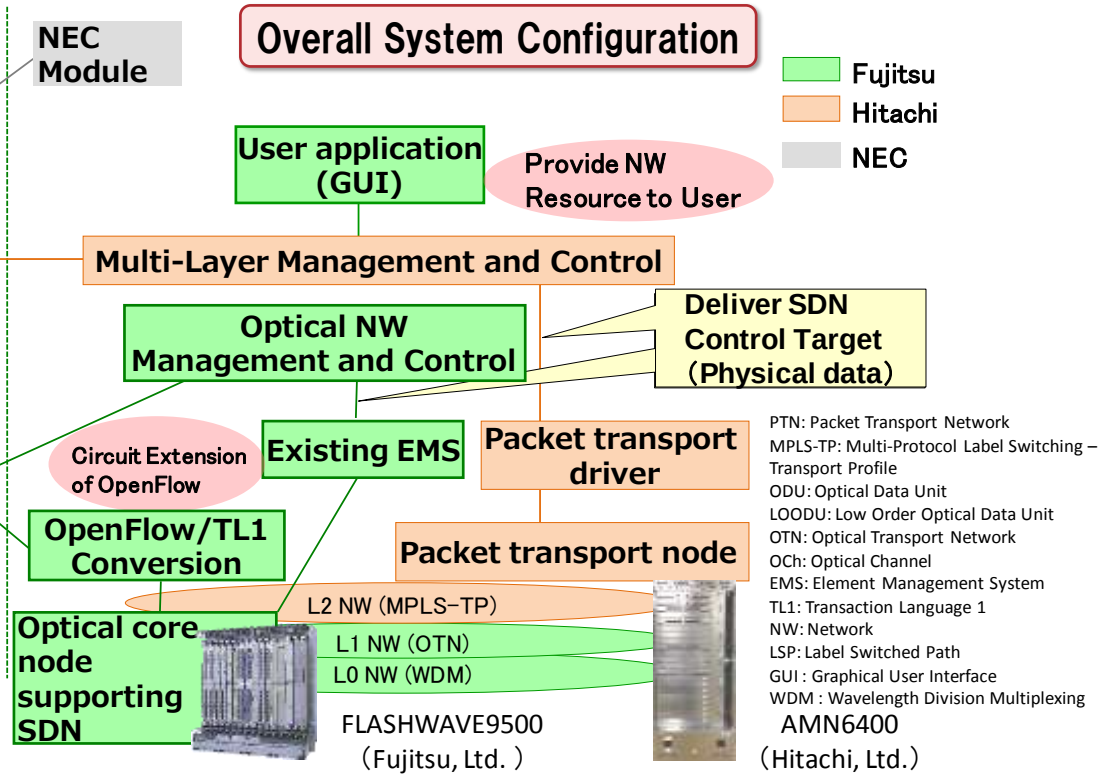




Demonstration 2

- Advanced control of transport network system that responds to simple requirements from users
  - Control of transport network based on simple requirements from users such as transmission speed and response time
  - Flexible utilization of multilayer resources to meet requirements from users





Thank you for your attention!

This program 'Virtualized network technology research and development' is funded by Ministry of Internal Affairs and Communications