Enhancing Network Applications on VNode and GENI
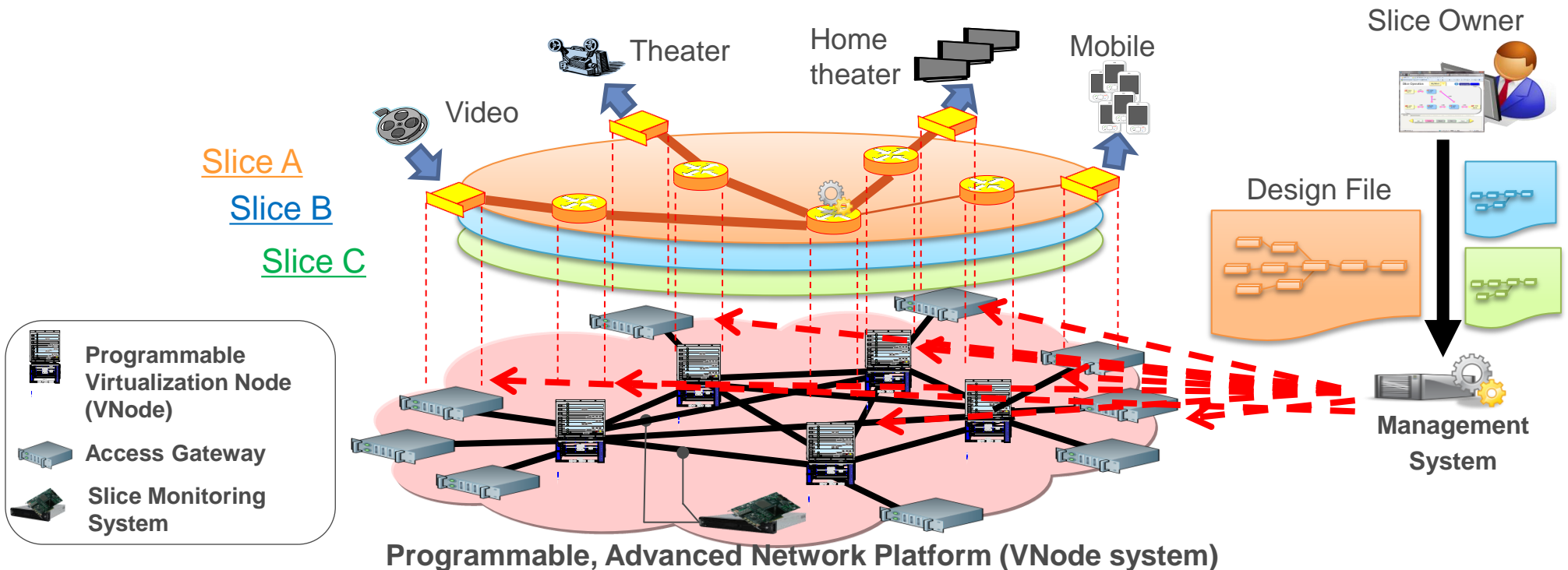## VNode: Deeply Programmable Network Testbed

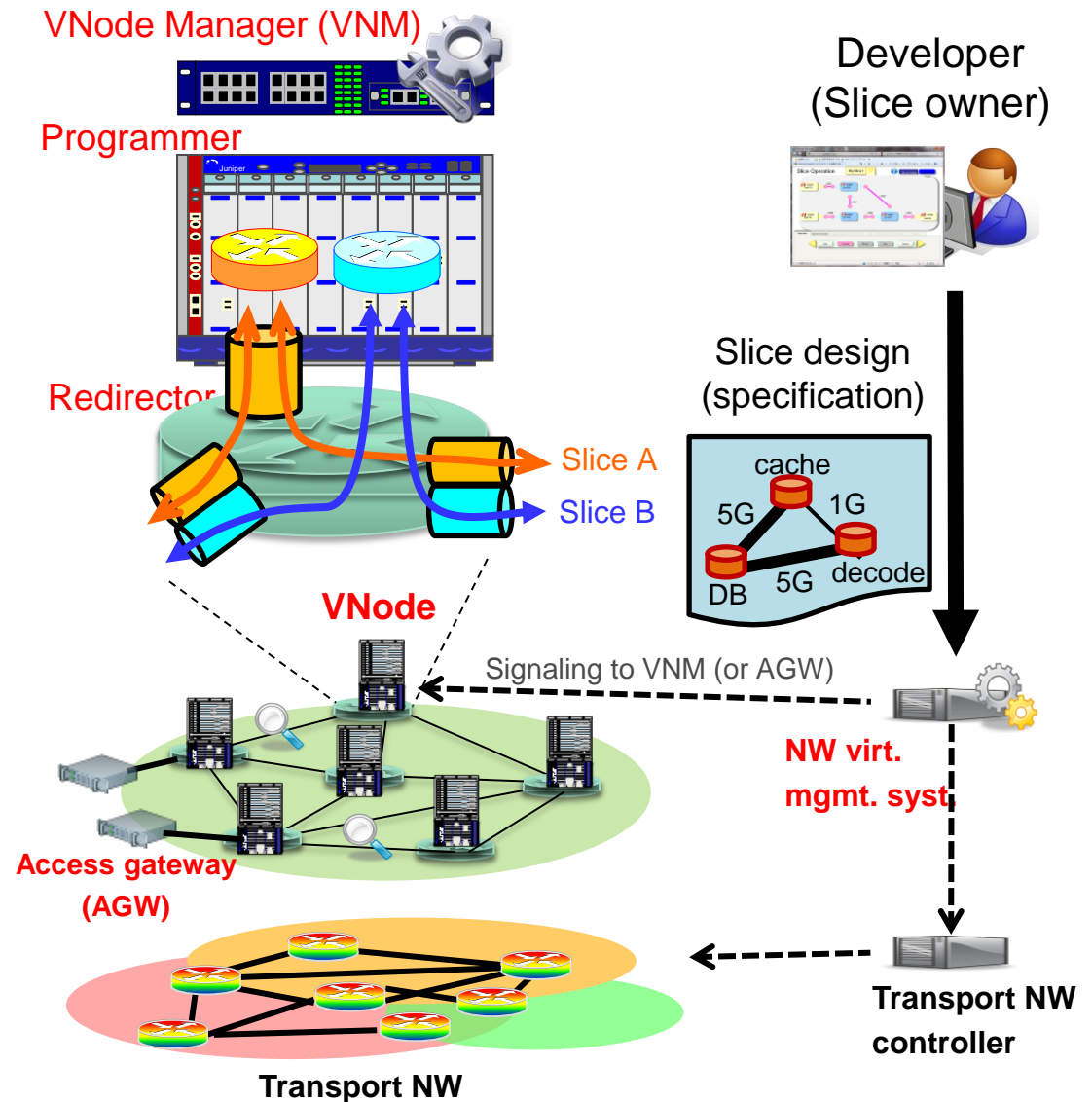NTT, Fujitsu, Hitachi, NEC, Tokyo Univ., KDDI R&D Labs.

Network virtualization platform

- Common SDN
  - Software based manageable network with separating C-plane/D-plane
  - Cutting OPEX/CAPEX by automation by software and Constructing NW by common HW
- Network virtualization platform
  - Realizing "Deep programmability" by total virtualization of networking and computing adding separating C/D-plane
  - Realizing service chaining without limitation of physical network

Slice A
Slice B
Slice C

Theater
Home theater
Mobile
Video
Slice Owner
Design File
Management System

Programmable Virtualization Node (VNode)
Access Gateway
Slice Monitoring System

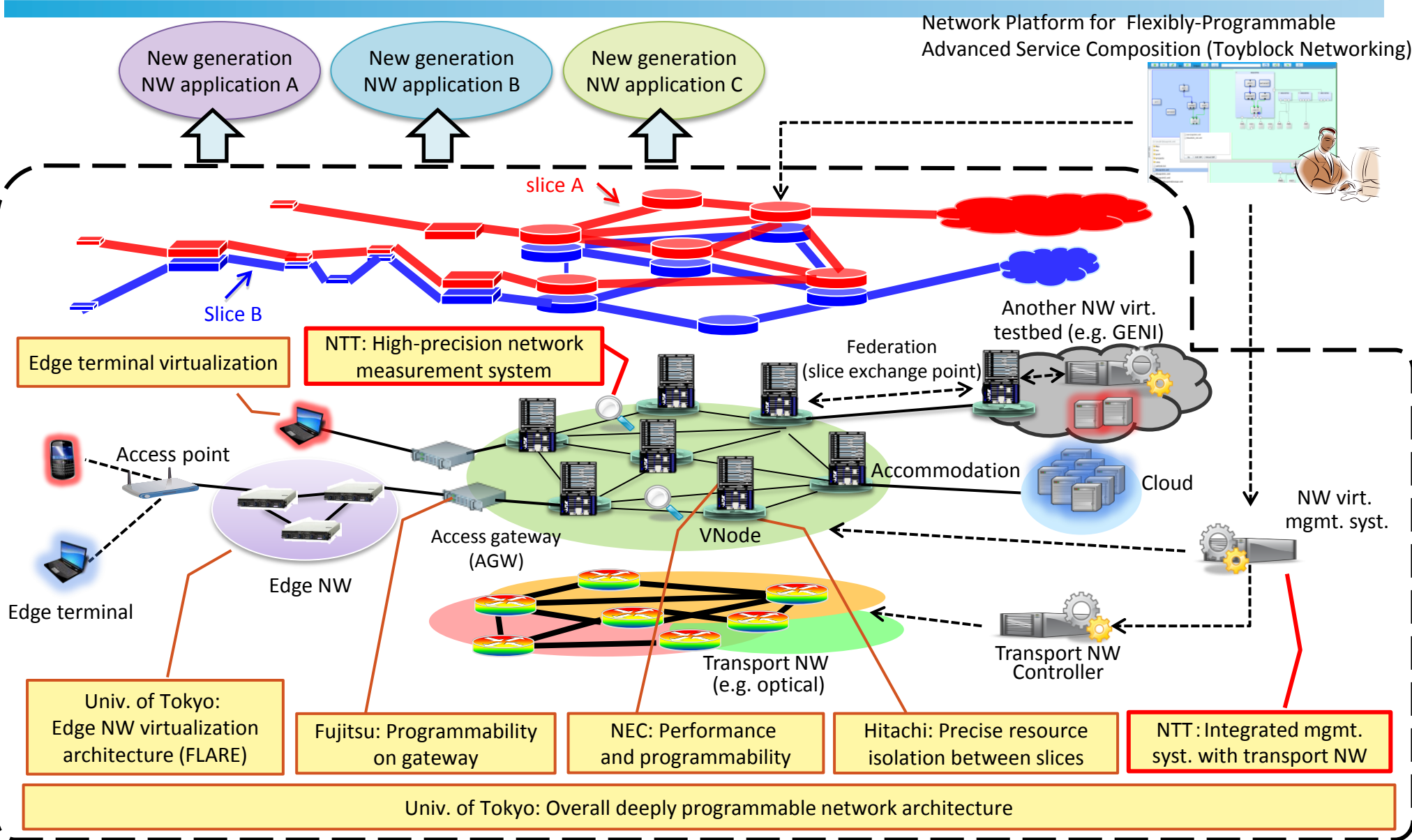**Programmable, Advanced Network Platform (VNode system)**

Basic components of VNode system

- VNode (NE)
  - VNode Manager (EMS)
    - Integration of Programmer(s) and Redirector(s).
    - Negotiation of neighbor VNodes.
  - Programmer (Router)
    - Programmable processing units for routing/forwarding engine (VM, NPU, etc…).
  - Redirector (Transmission)
    - Tunnel creation for virtual link.
- Access gateway (Gateway)
  - Programmable gateway units for connecting user terminals and slices.
- NW virt. mgmt. syst. (NMS)
  - Integrated slice management in a domain.
- Transport NW
 - Provides the underlay connectivity or reachability between VNodes.

VNode Manager (VNM)

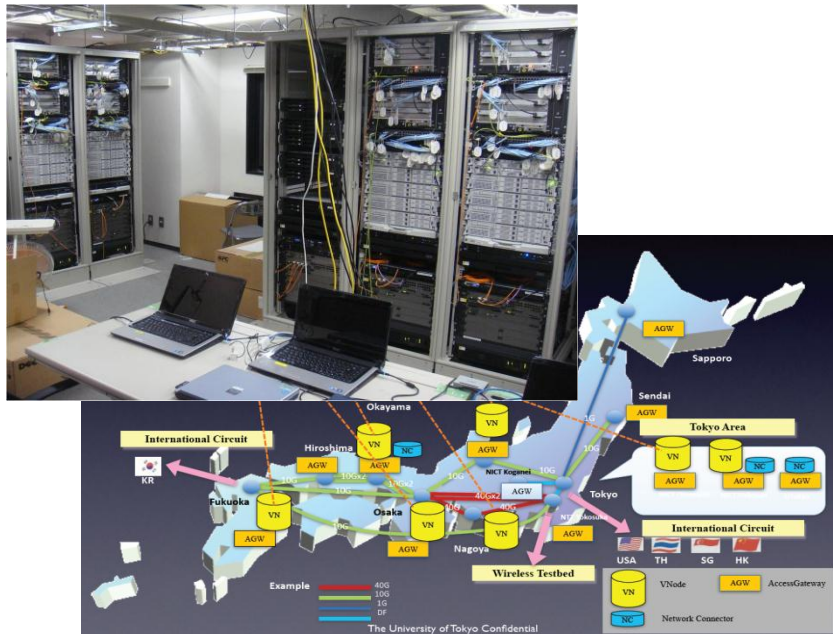Programmer

Redirector

Slice A

Slice B

VNode

Access gateway (AGW)

Transport NW

Developer (Slice owner)

Slice design (specification)

cache

5G   1G

DB   5G   decode

Signaling to VNM (or AGW)

NW virt. mgmt. syst.

Transport NW controller

Architecture and summery of our activities

New generation NW application A

New generation NW application B

New generation NW application C

Network Platform for Flexibly-Programmable Advanced Service Composition (Toyblock Networking)

slice A

Slice B

Edge terminal virtualization

NTT: High-precision network measurement system

Another NW virt. testbed (e.g. GENI)

Federation (slice exchange point)

Access point

Accommodation

Cloud

NW virt. mgmt. syst.

Access gateway (AGW)

VNode

Edge NW

Edge terminal

Transport NW (e.g. optical)

Transport NW Controller

Univ. of Tokyo: Edge NW virtualization architecture (FLARE)

Fujitsu: Programmability on gateway

NEC: Performance and programmability

Hitachi: Precise resource isolation between slices

NTT: Integrated mgmt. syst. with transport NW

Univ. of Tokyo: Overall deeply programmable network architecture

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Prototype system (extended to U.S.)

- We are promoting constructing a testbed to install our technologies and services in future networks.
  - The testbed has been deployed on JGN-X of NICT. The latest version works from June 2014
  - It is publicly in service (7 VNodes, 2 Network Connectors, 6 Access Gateways)
- SDX (Software Defined eXchange) Project
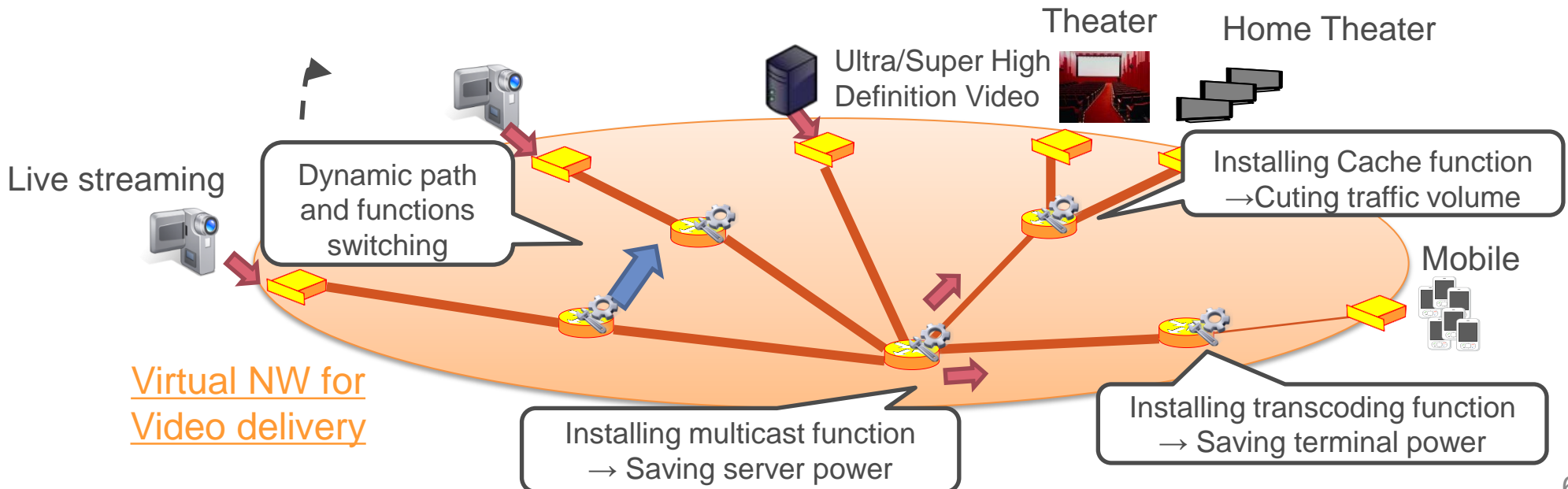 (A VNode in University of Utah connected to ProtoGENI)
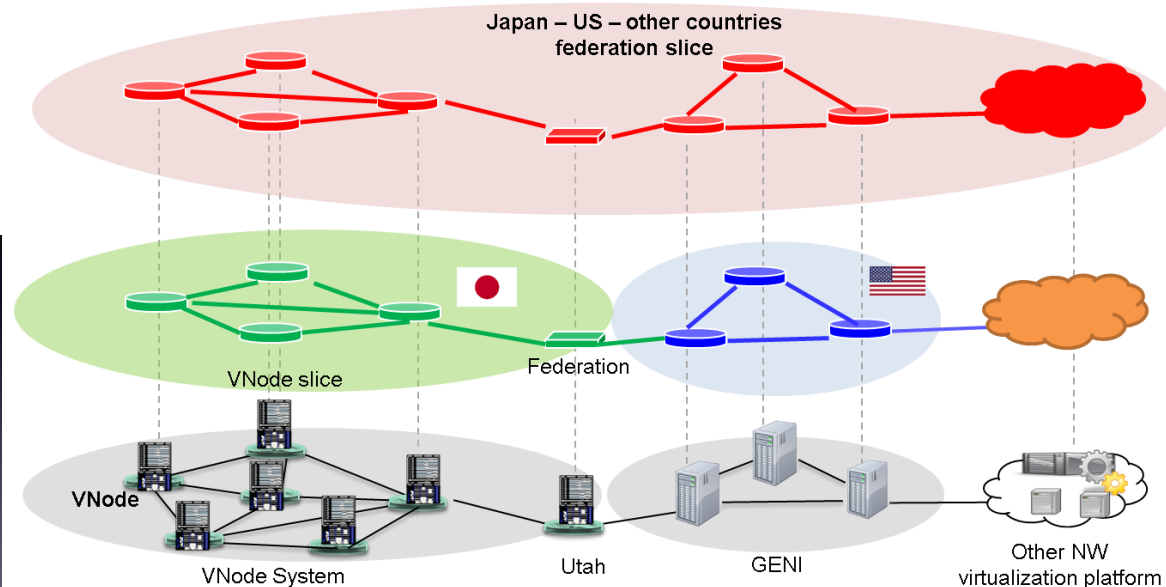
Prototype system of programmable network virtualization technologies made in a project funded by NICT

Applications image using VNode system

Realizing video delivery service optimized for network and node resources by programmability of VNode system

➢ **Delivering ultra/super high definition video**

→Realizing by installing cache function, multicast function, etc.

➢ **Live streaming from mobile terminals**

→Realizing by dynamic path switching, adaptive installing functions, etc.

➢ **Delivering video optimized terminal performance and location**

→Realizing by installing multicast function, transcoding function, etc.

Theater

Home Theater

Ultra/Super High Definition Video

Live streaming

Dynamic path and functions switching

Installing Cache function →Cuting traffic volume

Mobile

Virtual NW for Video delivery

Installing multicast function → Saving server power

Installing transcoding function → Saving terminal power

Enhanced Video Streaming Application

Demo Scenario

- Traffic Congestion
  ①Detect congestion
  ②Put transcoder and decrease traffic volume

- Join New User
  ③Detect user request
  ④Put splitter and multicasting without additional core network traffic
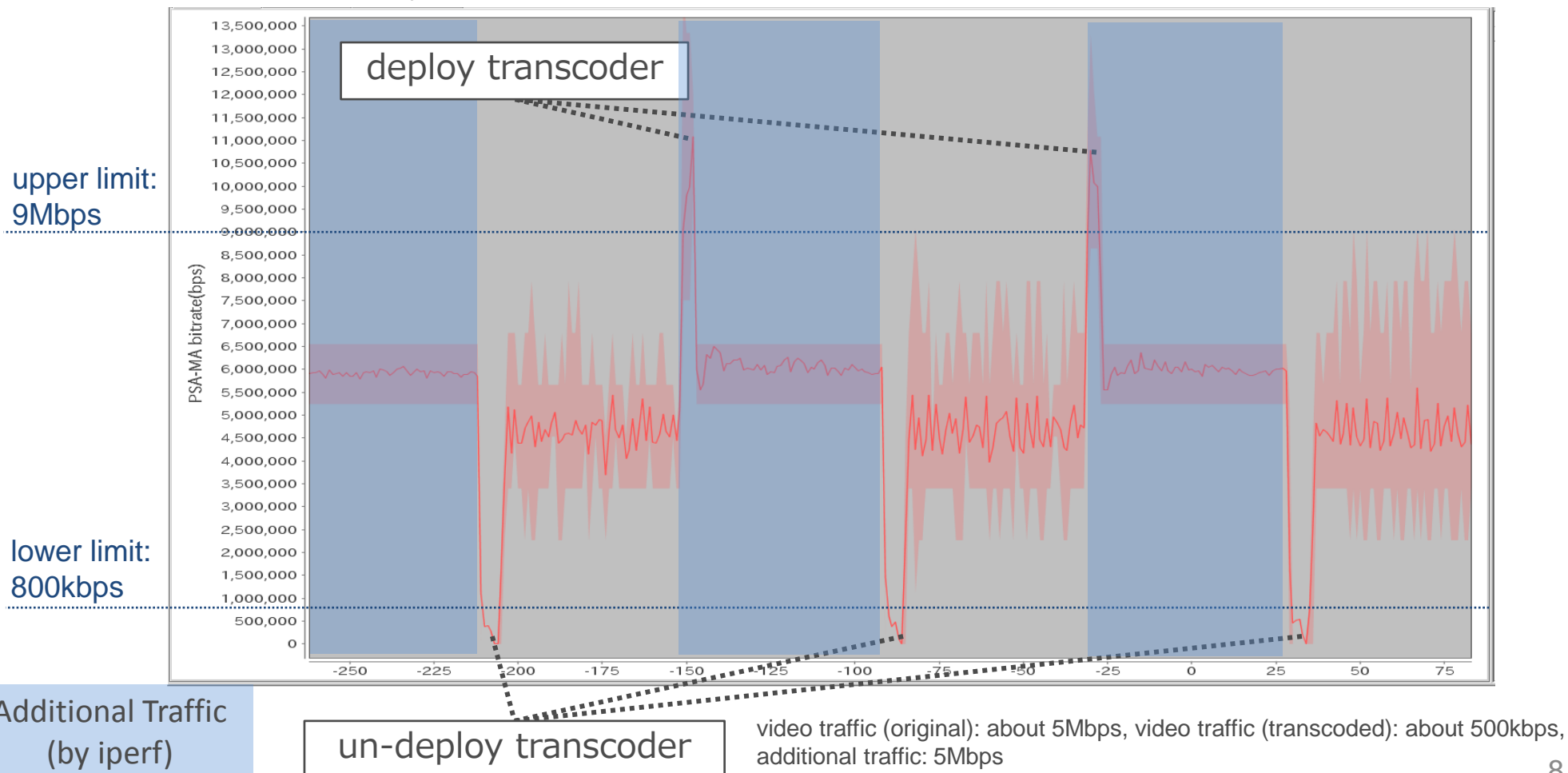
Merit

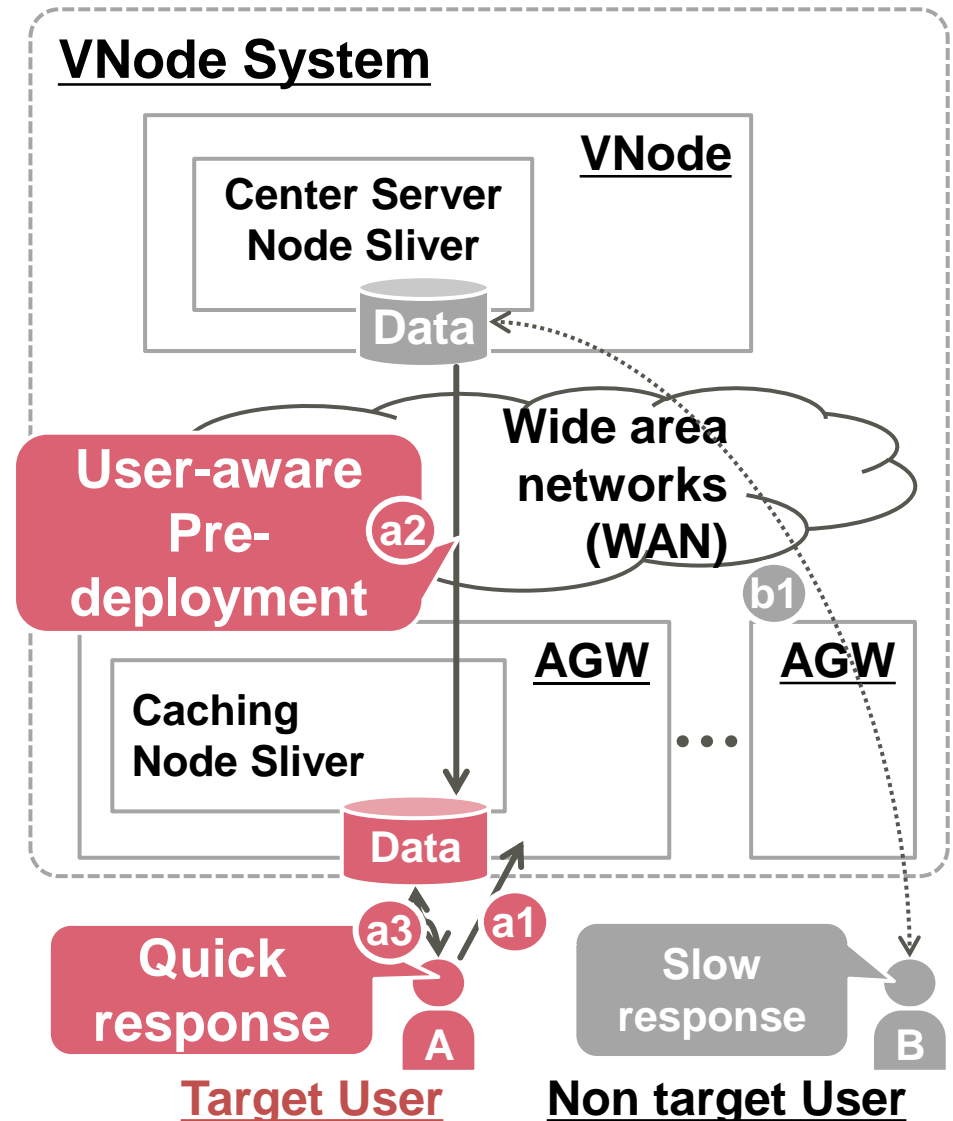- Realize low cost and high performance service by deploying software functions on programmable network
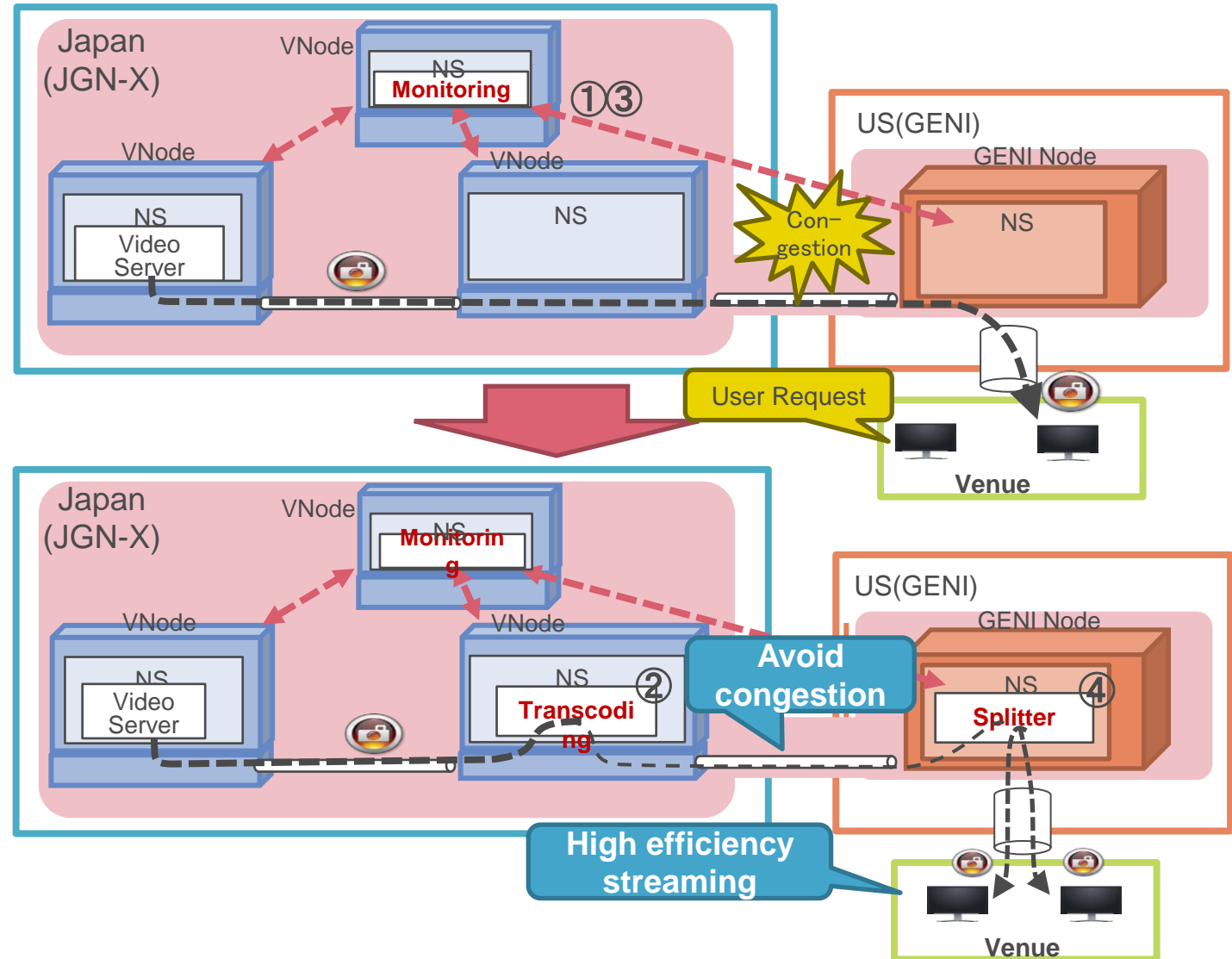
Control Result

- Automatic transcoding function deployment and un-deployment
  - traffic exceed upper limit → transcoder is deployed and traffic volume decrease
  - traffic fall under lower limit → transcoder is un-deployed and traffic volume get back
- Splitter function deployment → Link traffic DON'T increase

video traffic (original): about 5Mbps, video traffic (transcoded): about 500kbps, additional traffic: 5Mbps

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# Users' location aware data deployment beforehand for better QoE

➢ **Target of this technology**

– Avoiding performance degradation because of the large latency and instability of WAN.

– Utilizing the programmability near users provided by AGW-VNode

➢ **Details of this demonstration**

(A) With user-aware data deployment

(a1) Users' locations are detected

(a2) Data is deployed near users in advance of users' access

(a3) Users get quick responses

(B) Without user-aware data deployment

(b1) Data is located far from users and users get only slow response

VNode System

VNode

Center Server Node Sliver

Data

User-aware Pre-deployment (a2)

Wide area networks (WAN)

(b1)

AGW

Caching Node Sliver

...

AGW

Data

(a3) (a1)

Quick response

A

Target User

**Slow response**

B

Non target User

IPON: Switching by IP Addresses — A Non-IP Protocol Demo —

➢ Non-IP and non-Ethernet protocols can be used in VNode infrastructure.
➢ In this demo, instead of IP/Ethernet, IPON (IP/null) is used; IP addresses are used for both WAN routing and LAN switching.
➢ This method solves "address redundancy problem" that causes complexity and inefficiency.
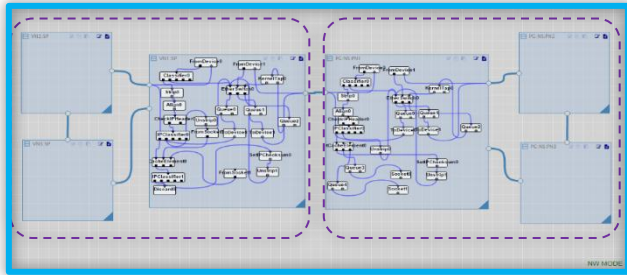
Communication in LAN and WAN using IPON
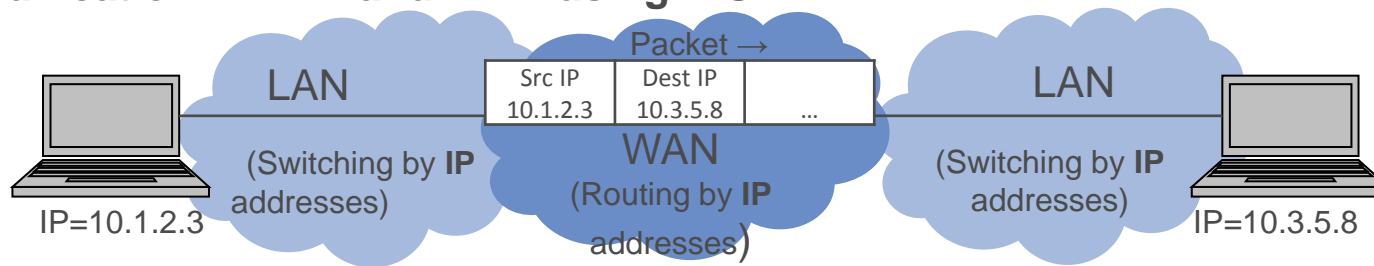
Network structure used for the demo
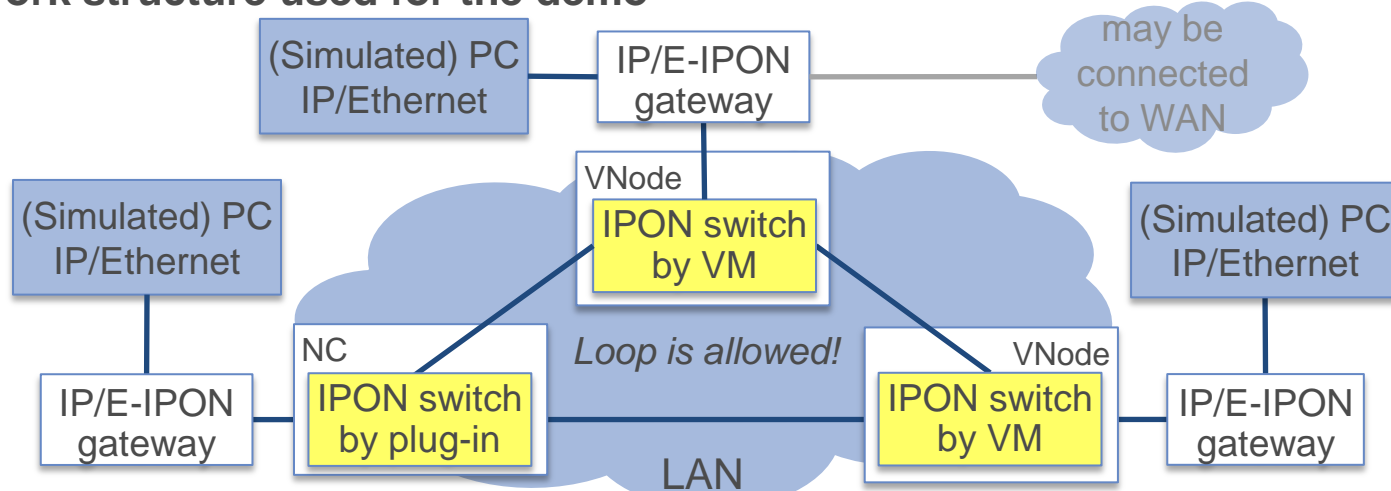
Service Designing, Deployment and Re-organization

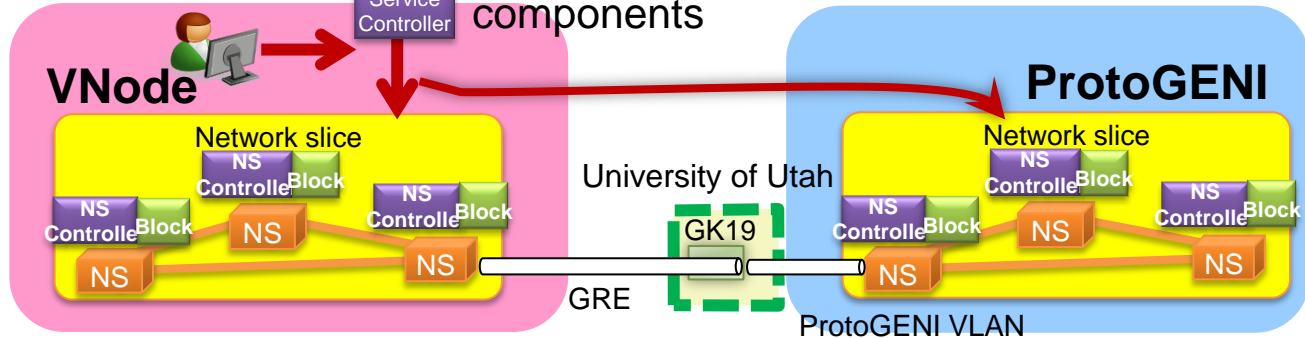## Designing and Deployment
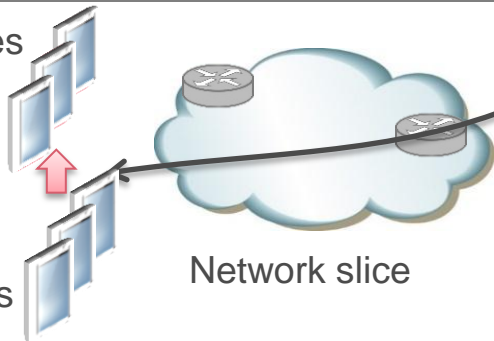
WEB based network service design tool

upload

GitHub

Composition of Service system components

Service Controller

VNode

Network slice

NS Controller Block

NS Controller Block

NS

NS

University of Utah

GK19

GRE

ProtoGENI

Network slice

NS Controller Block

NS Controller Block

NS

NS

ProtoGENI VLAN

VNode

ProtoGENI

Federated Slice over VNode/ProtoGENI

Service System Re-organization

User devices

New comers

Contents server

Network slice

Re-organization

Caching component
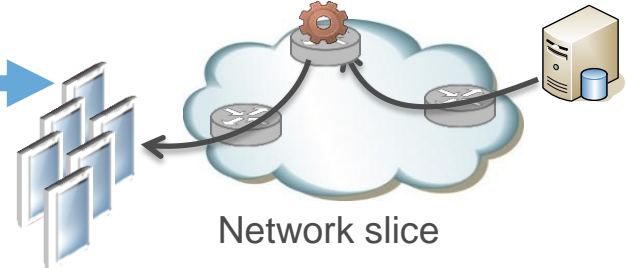
Network slice

Initial component assignment

Server | Client
Ingress Cache | Router | Egress Cache
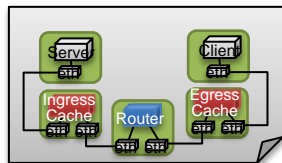
Automatic generation of task flow for system change from initial design to final designs

Server | Client
Ingress Cache | Router | Egress Cache

Final component assignment