

Network Virtualization
Research Activities in Japan

WiVi and VNode2

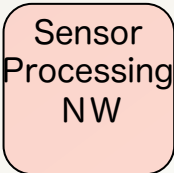
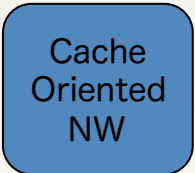
Aki Nakao
University of Tokyo
2011/3/15

Vision: Network-Virtualization Infra. for diverse NWs

Slice 1

Slice 2

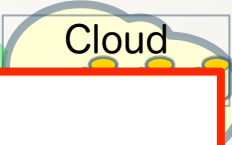
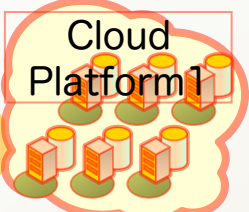
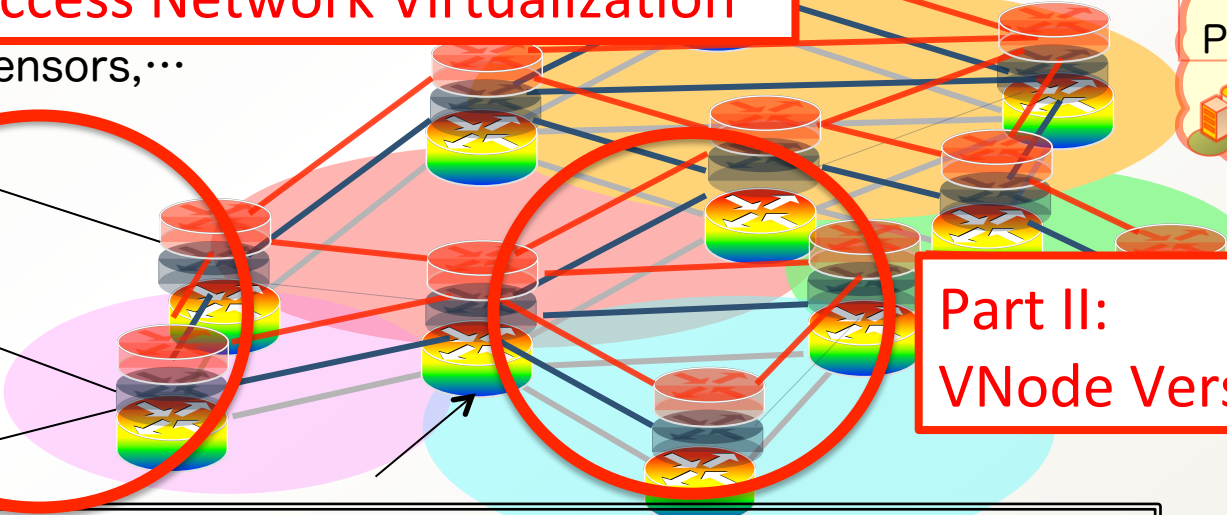
Slice N



"Slices" accommodate diverse NWs

Part I:
Wireless Access Network Virtualization

Appliances, Sensors, ...



Part II:
VNode Version 2

Network Virtualization Infrastructure



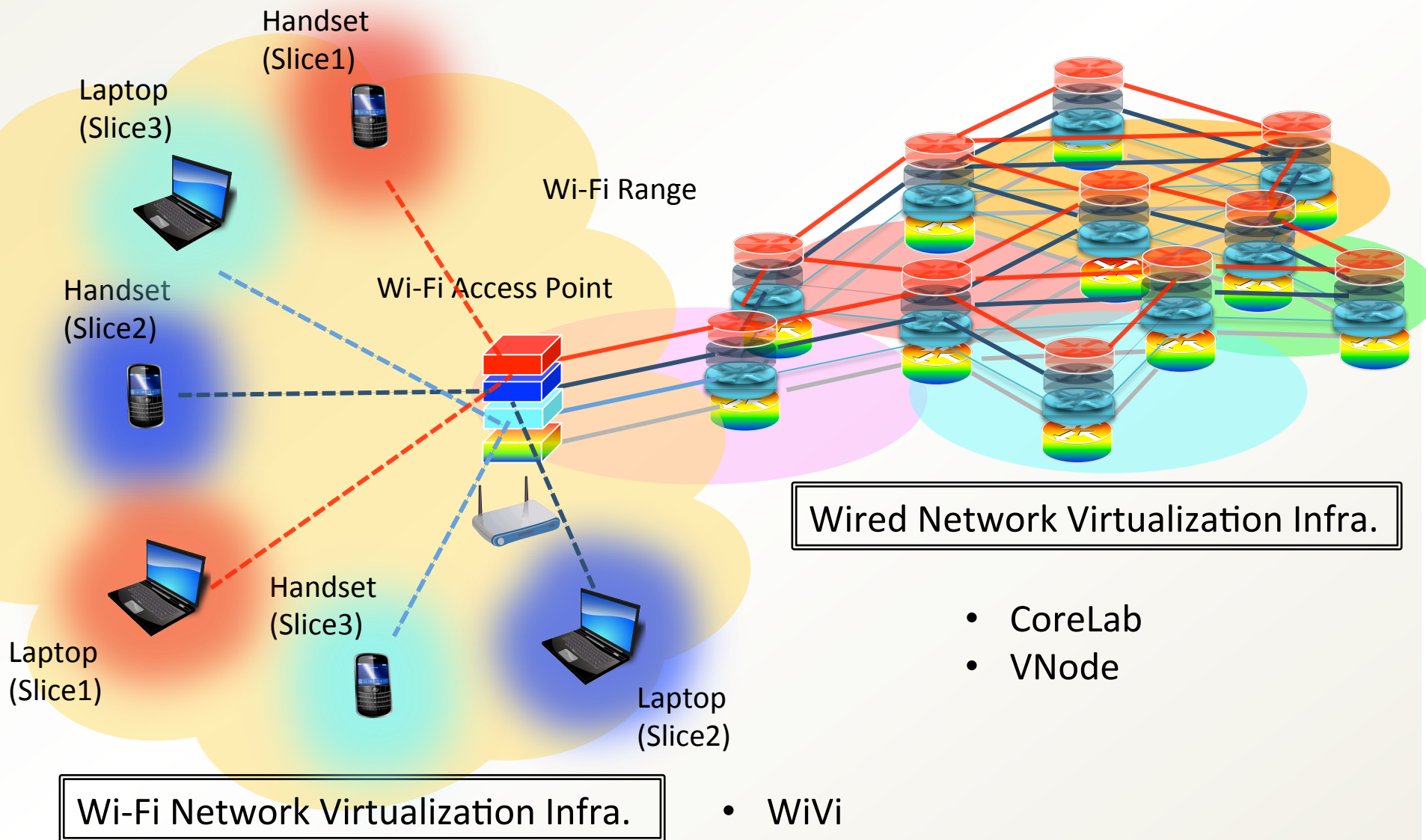
Part I:

WiVi [wi:vi:]

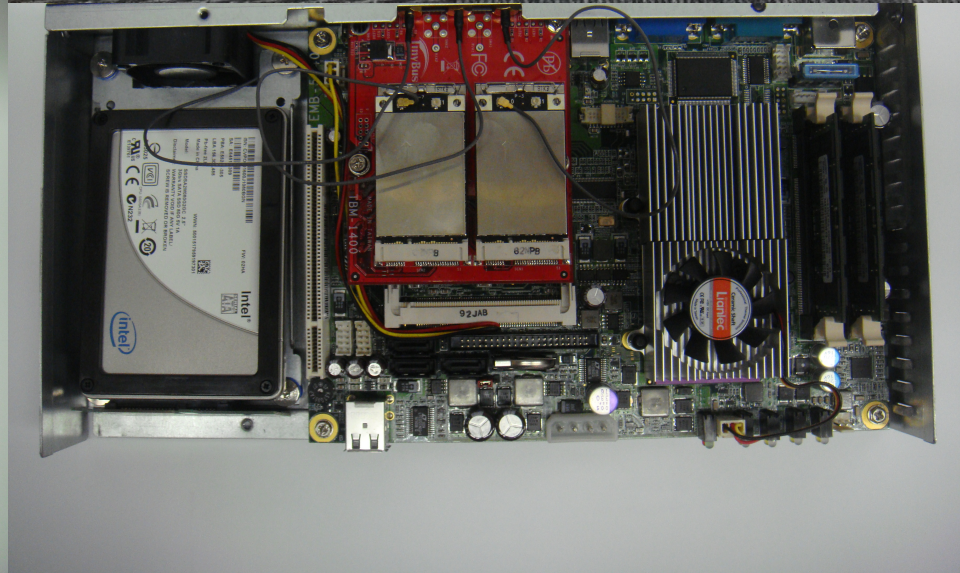
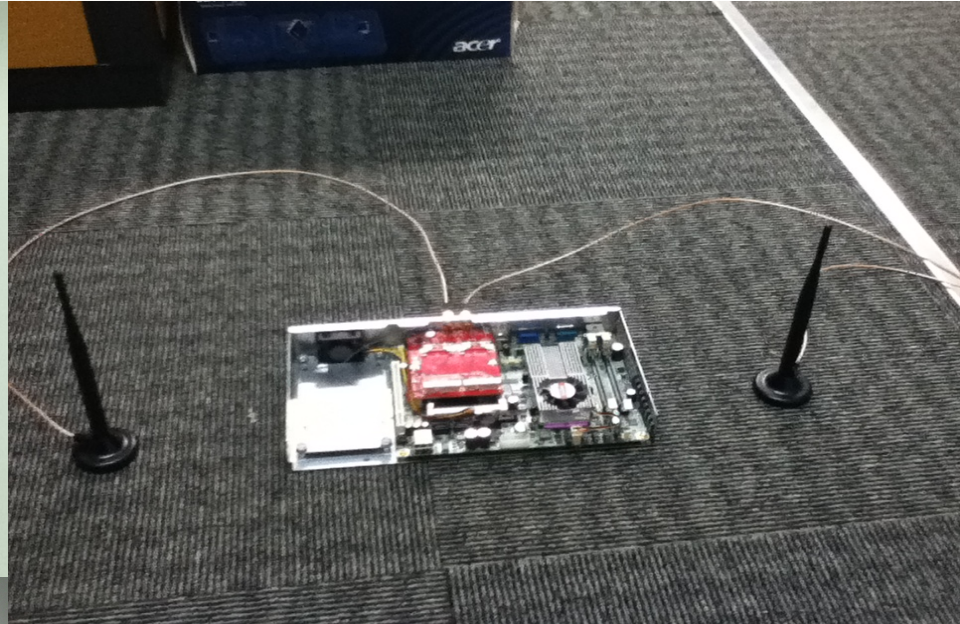
Wi-Fi Network Virtualization Infrastructure

Slicing Wi-Fi Access Point

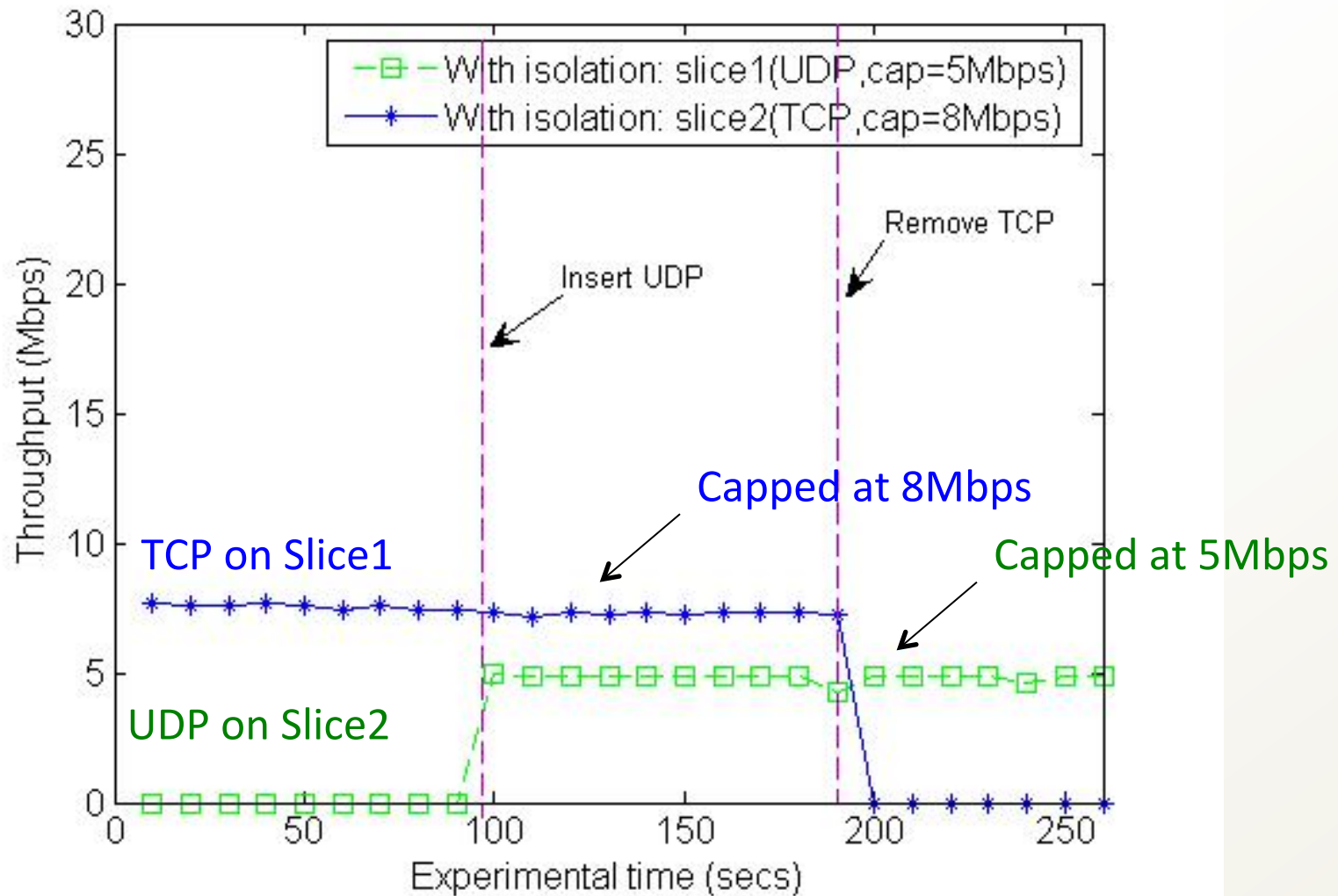
Goal : Slicing Wi-Fi Access Point to extend our reach from wired slices to wireless ones



Prototypes



Performance Isolation



→ TCP flow on Slice1 and UDP flow on Slice2 are BW-capped
Performance Isolation (Bandwidth Policing)



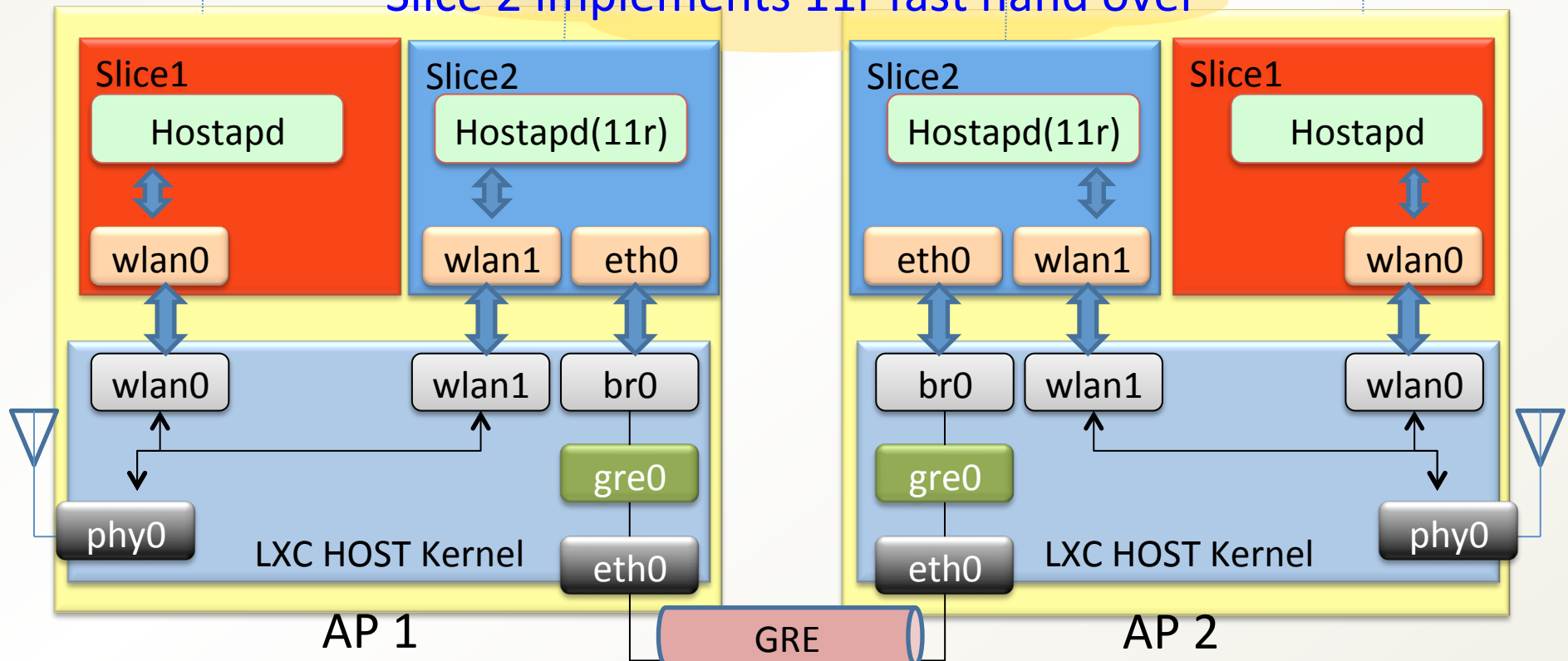
WiVi [wi:vi:]

Application of Programmability

App1 : 802.11r Fast Hand Over (1/2)

Slice 1 implements normal hand over

Slice 2 implements 11r fast hand over



Authentication data flows through L2 Wired Network Virtualization (GRE-Tap)

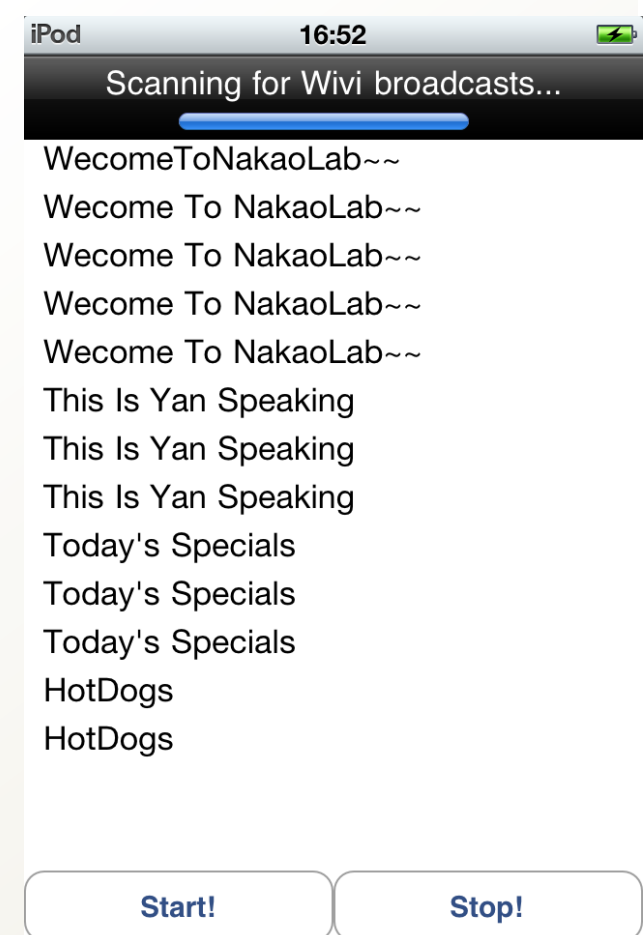
App2: Cache Slice and No-Cache Slice



Transparent Proxy for **You Tube**
Broadcast Yourself™

App3 : Beacon **Push** Advertisement

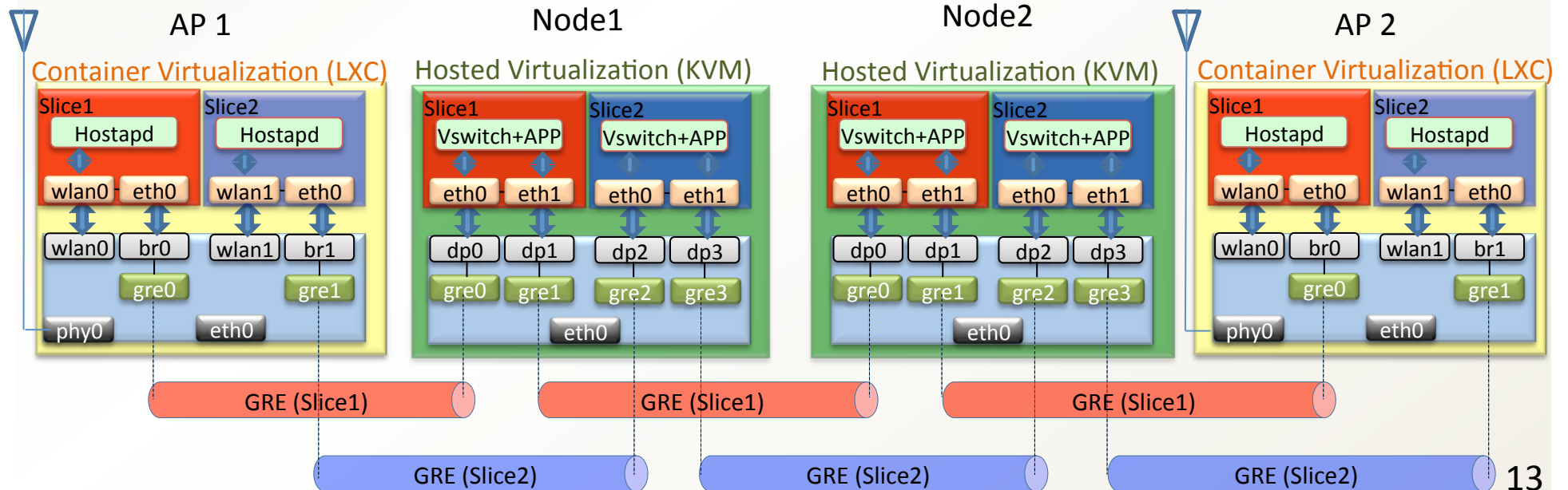
Non-Authenticated Beacon Communication
Applied for Ad-Targeting / Digital Sinage



App3 : Beacon **Push** Advertisement

Wired/Wireless Integrated Virtualization

- Combine different types of OS virtualization techniques
 - Resource-scarce network edges (APs) employ containers (LXC)
 - Resource-rich network cores (Nodes) employ hosted virtualization (KVM)



CoreLab + WiVi Integration

The screenshot shows a web browser window displaying the CoreLab Wireless - WiVi interface. The browser's address bar shows the URL `https://wivi-plc.corelab.jp/?q=db/nodes/`. The page header features the CoreLab logo with the text "CoreLab Wireless - WiVi" and "powered by WiVi". A navigation menu on the left lists various site and user management options. The main content area is titled "Nodes" and includes a search input field and a "Select Node" button. Below this is a table listing various nodes with their VM types, boot states, and hostnames. At the bottom of the page, there is a map of Tokyo with several red location pins.

Navigation menu (left sidebar):

- taro@nict.go.jp
 - Sites
 - My Site
 - Nodes
 - My Nodes
 - Slices
 - Sirius
 - Users
 - My Account
 - Log out
 - VMImages
 - Downloads
 - NodeLogs
 - About

Nodes table:

Vmtype	Boot_state	Hostname
lxc-ap	boot	wivi-utokyo1.nakao-lab.org
lxc-ap	boot	wivi-utokyo2.nakao-lab.org
lxc-ap	boot	wivi-utokyo3.nakao-lab.org
lxc-ap	boot	wivi-utokyo4.nakao-lab.org
kvm	boot	hakusan1.nvlab.org
kvm	boot	hakusan2.nvlab.org
lxc-ap	boot	wivi-hakusan1.nvlab.org
lxc-ap	boot	wivi-hakusan1-ocn.nvlab.org
lxc-ap	boot	wivi-hakusan2.nvlab.org
lxc-ap	boot	wivi-hakusan3.nvlab.org

Map: A map of Tokyo showing various districts and landmarks. Red location pins are placed on the map, indicating specific nodes or locations. The map includes labels for districts like 北区 (Kita-ku), 豊島区 (Hoshima-ku), 文京区 (Bunkyo-ku), and 台東区 (Taitoh-ku).



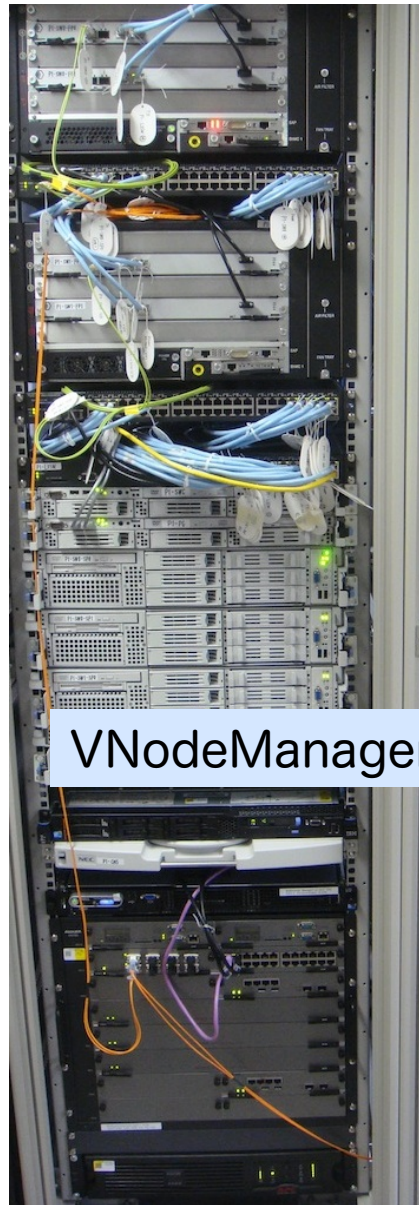
Part II:

VNode **Version 2**

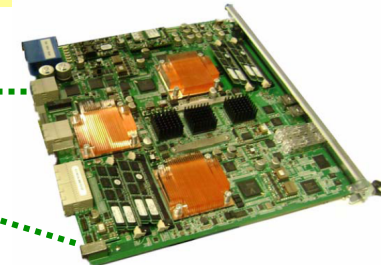
(UTokyo, NICT, NTT, NEC, Hitachi, Fujitsu)

Enabling net-virt **via H/W based on production routers**

VNode: Nuts and Bolts View



Programmer Part
(IA Serverx4 +ATCAx2+OpenFlow SWx2)



OpenFlow Switch (10G
x4)

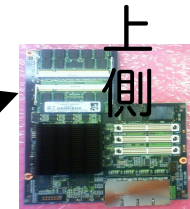
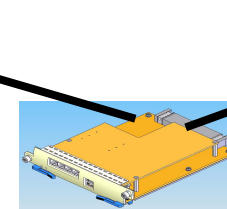
Fast-Path
Network Processor
Card

Redirector Part (AX6700+SMCx2)

AX6708S



Service Module Card



A Prototype System (4 VNodes)



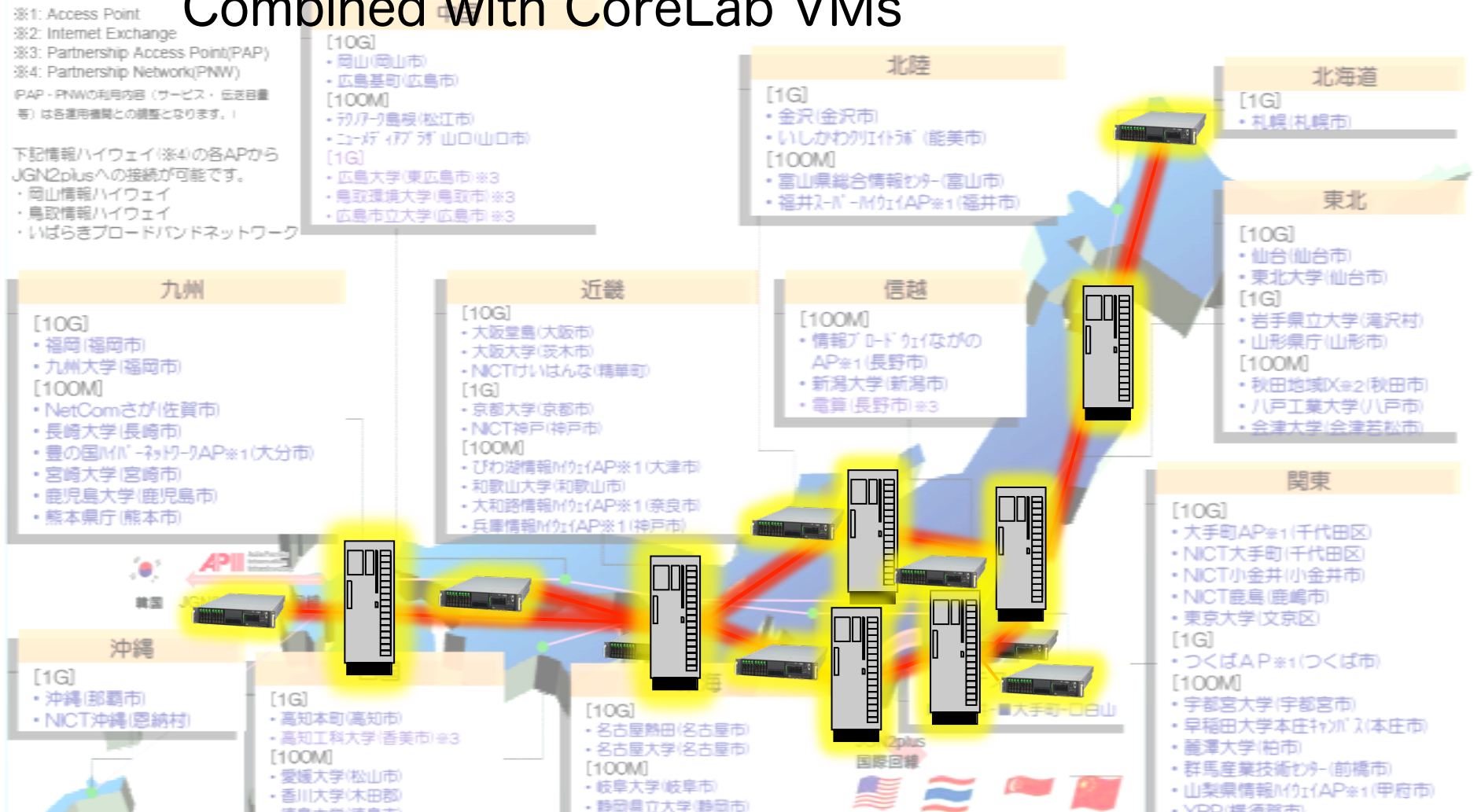
VNode Deployment on JGN2Plus

4 VNodes deployed and in operation as of now



VNode Deployment on JGN-X

7 Vnodes will be deployed in coming summer
Combined with CoreLab VMs



Highlights : VNode Version 2

⊕ Resource Isolation

- ⊠ Resource-aware slice operation
- ⊠ Isolate bandwidth per link sliver (policing/shaping)

⊕ Scalable Experimentation

- ⊠ CoreLab + VNode Integration

⊕ Network Accommodation

- ⊠ Physical and Logical networks integration
- ⊠ ANIAS (Any Network In A Slice) / OFIAS (OpenFlow In A Slice)

⊕ Dynamic Slice Reconfiguration

- ⊠ Dynamic topology modification

⊕ Programmability

- ⊠ Stream Computing
- ⊠ In-Network Processing
- ⊠ Protocol Conversion
- ⊠ Non-IP protocols

Slice Operation

NTT Network Innovation Lab.

1. Slice operation console





Slice 1

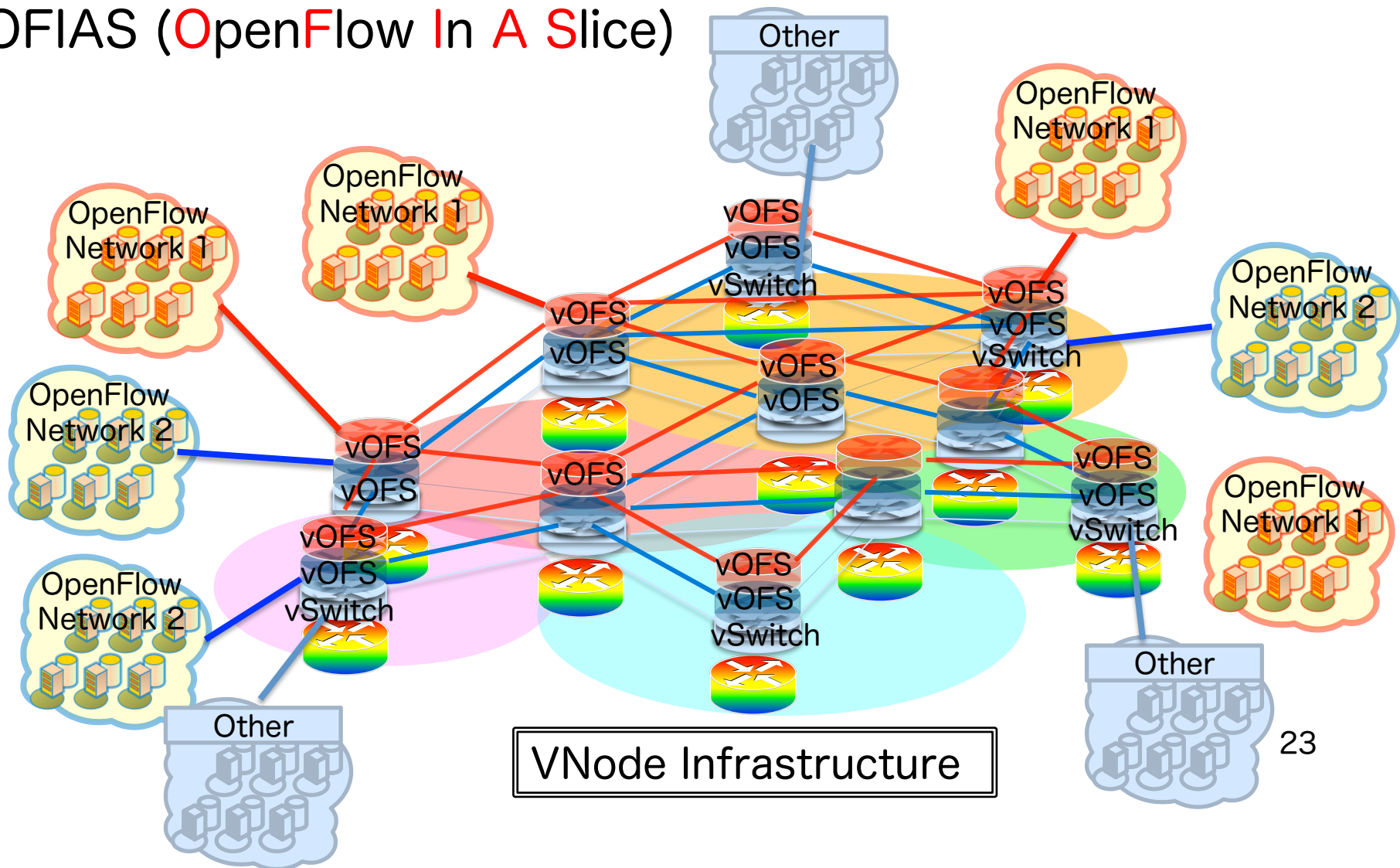
ANIAS (AnyNetwork In A Slice)
OFIAS (OpenFlow In A Slice)

Demonstrating...

- ⊕ Network Accommodation
- ⊕ Programmability

Slice 1: ANIAS (Any Network In A Slice)

OFIAS (OpenFlow In A Slice)



Goals of ANIAS/OFIAS

⊕ Attempting to encourage transitions:

How to **use** OpenFlow ->

How to **improve** OpenFlow ->

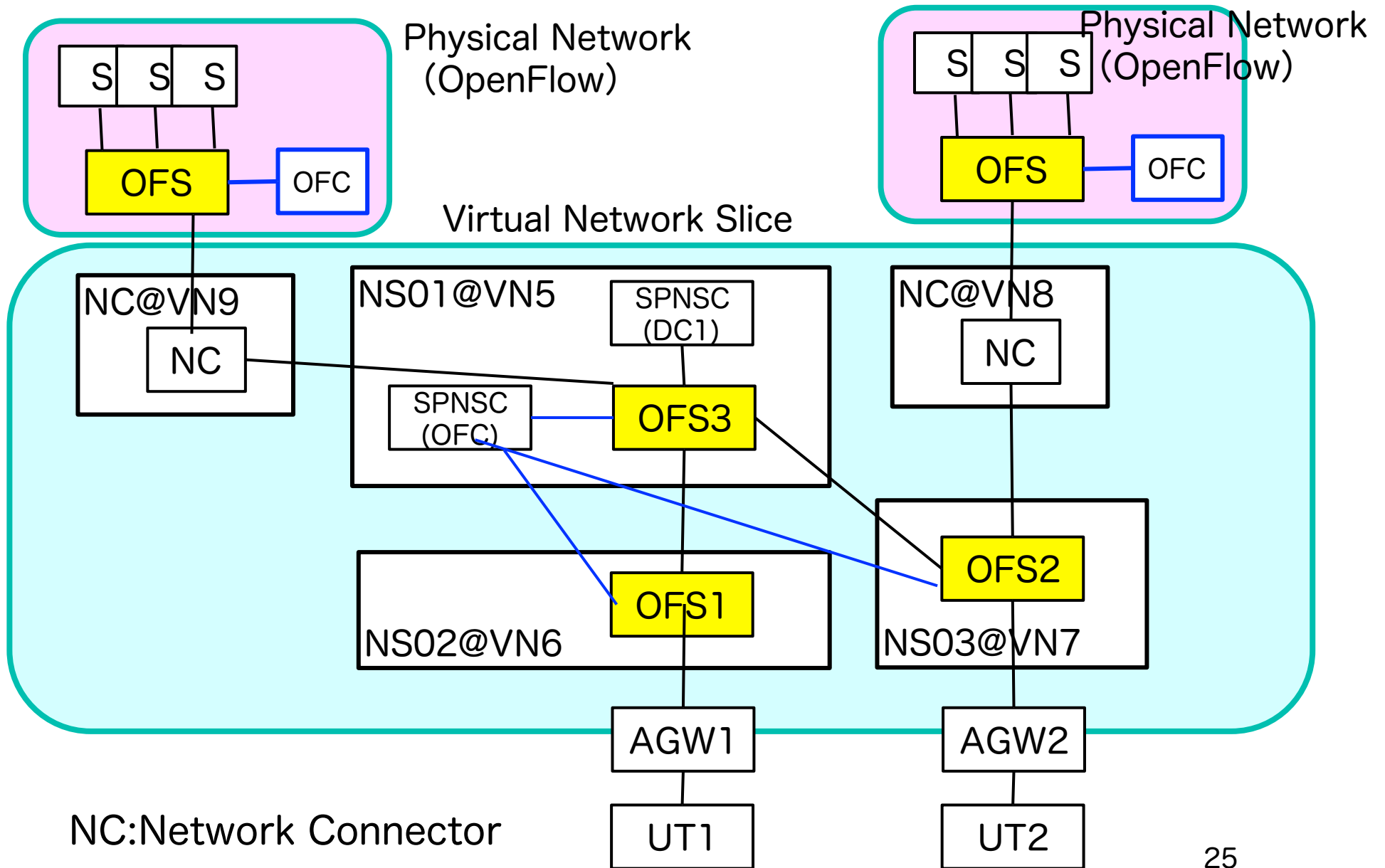
How to **invent** OpenXXX

R. Furuhashi & A. Nakao,

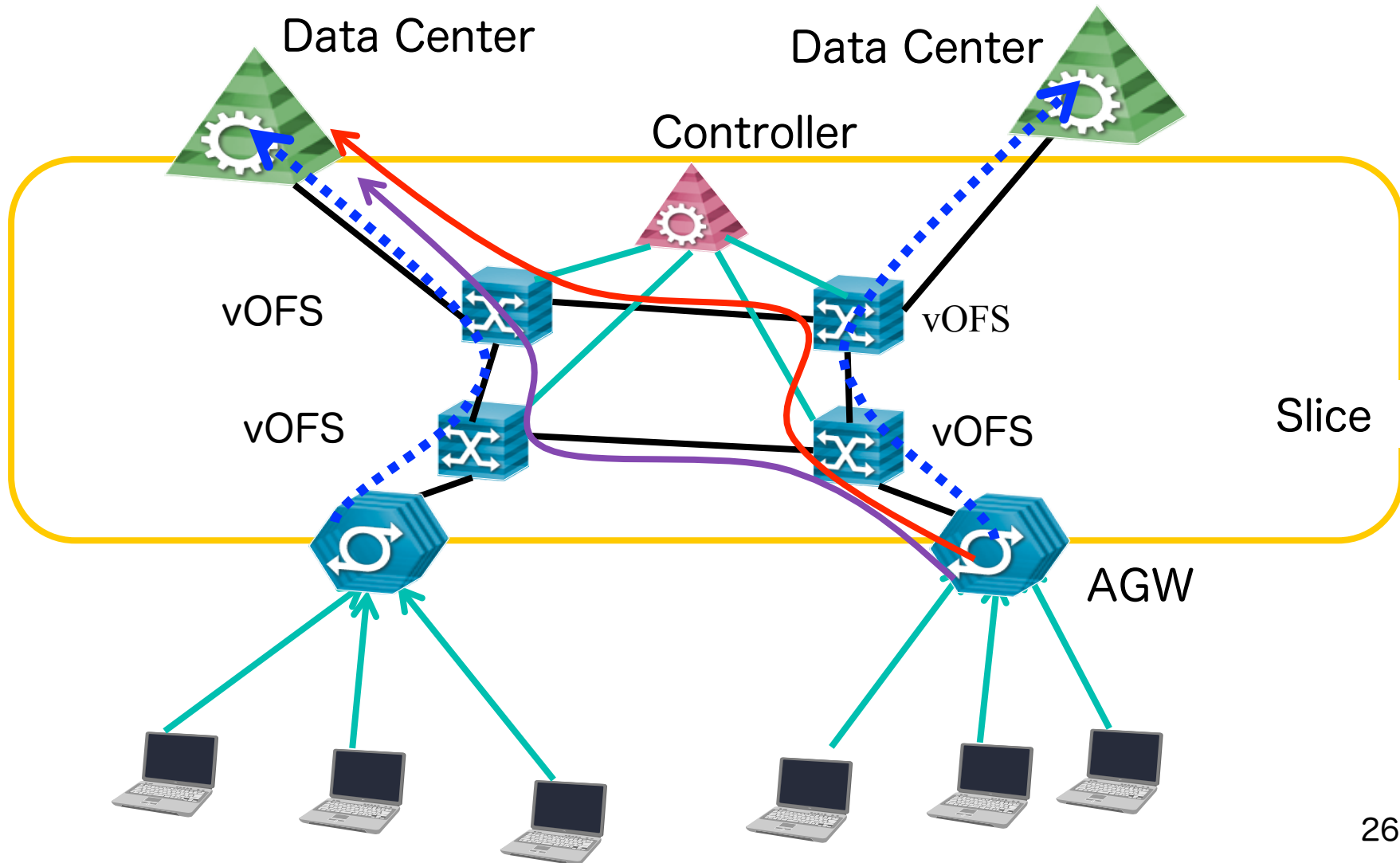
“OpenTag: Tag-based network slicing for wide-area coordinated in-network packet processing”

IEEE ICC FutureNet IV

OFIAS (Physical + Virtual Integrated)



Seamless Access to Multiple Data Centers



OpenFlow In A Slice Cloud Access Demo

Developer : Slice Operation - Windows Internet Explorer

http://vnode7.ipcore.c.nec.co.jp:8081/gui/Developer/SliceListView.do

Developer : Slice Operation

mp

Main

User

Physical Info

Resource Info

Slice

Preview

Reservation

Slice Operation

Sliver Delete

Logout

UserID:dev-nec1

Slice Operation NEC_Slice_NC_02

Slice View Hybrid View

x0.795

```
graph TD; NCD5["NCD5 [rp-nh9]"] --- LS05 --- NS01["NS01 [rp-nh5]"]; NS01 --- LS01 --- NS02["NS02 [rp-nh6]"]; NS01 --- LS02 --- NS03["NS03 [rp-nh7]"]; NS02 --- LS03 --- NS03; NS03 --- LS04 --- NCD4["NCD4 [rp-nh8]"]; NS02 --- LS11 --- AG02["AG02 [agw-f11]"]; NS03 --- LS12 --- AG03["AG03 [agw-f17]"];
```

ローカル イン트라ネット 100%



Slice 2

Cache Oriented Network Architecture

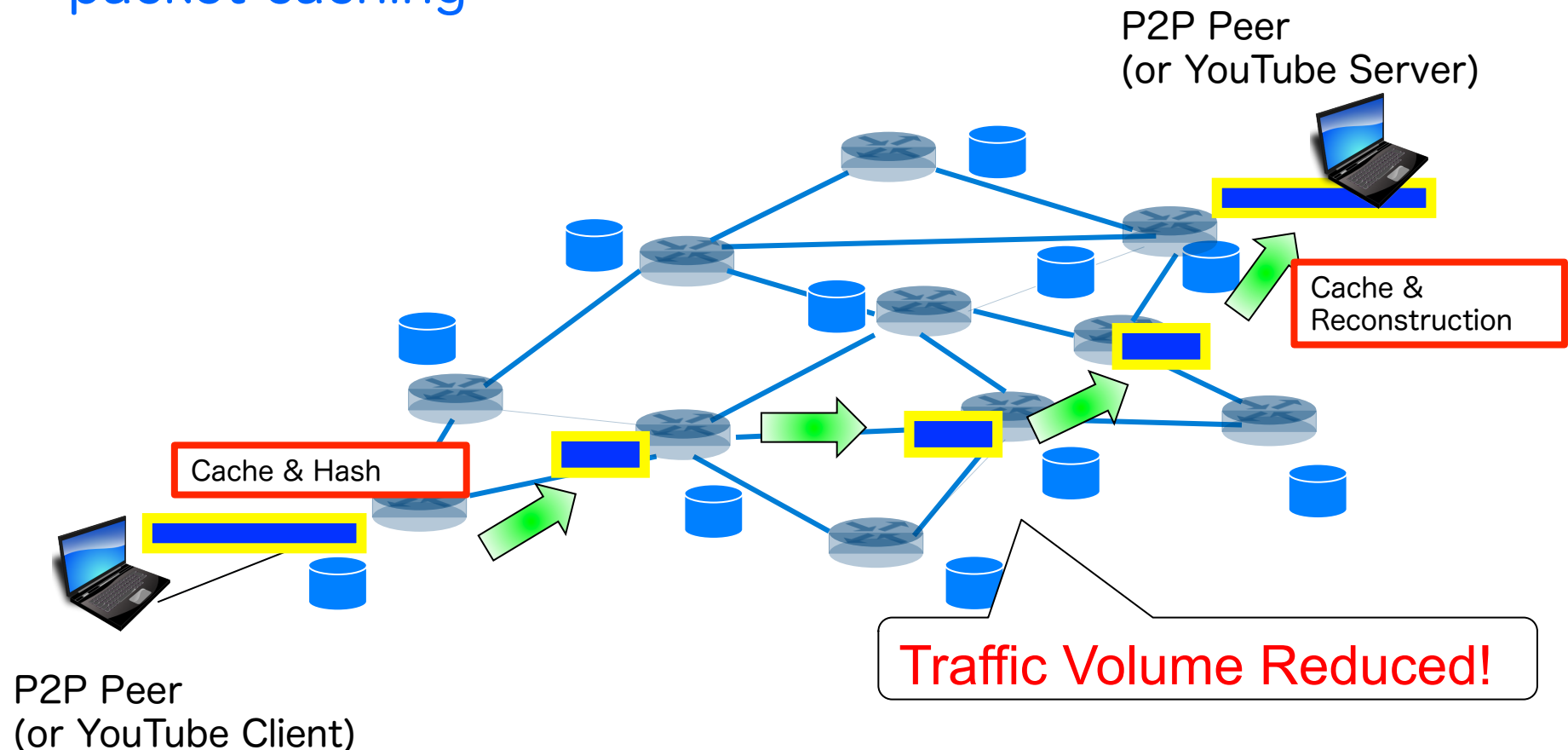
Demonstrating...

- Scalable Experimentation
- Programmability

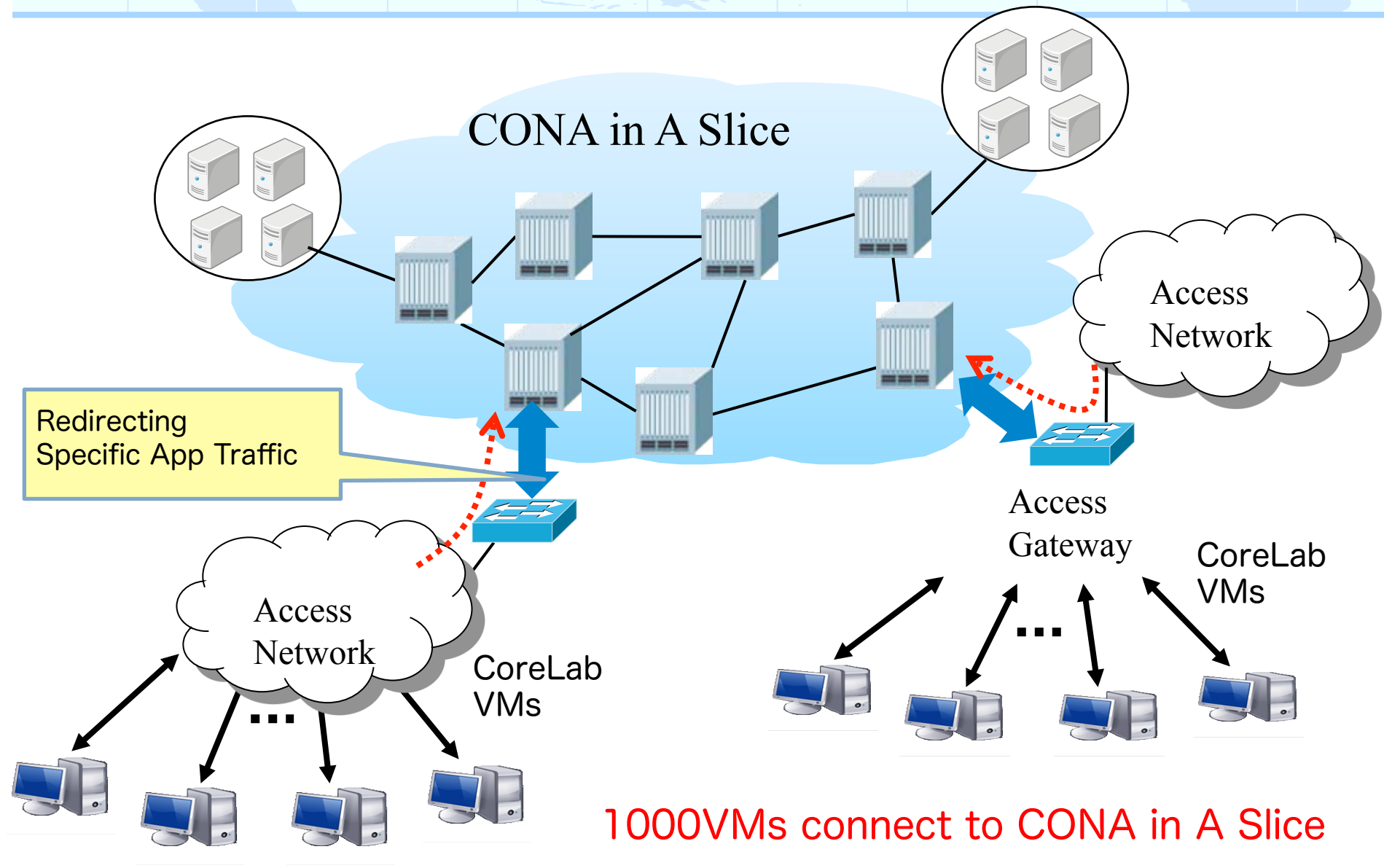
Slice 1: Cache Oriented NW Architecture

Goal : Reduce redundant traffic in P2P and Cloud Streaming

- Utilize **programmability** and **storage** in VNode
- Confine P2P and YouTube Traffic to a slice and perform **packet caching**



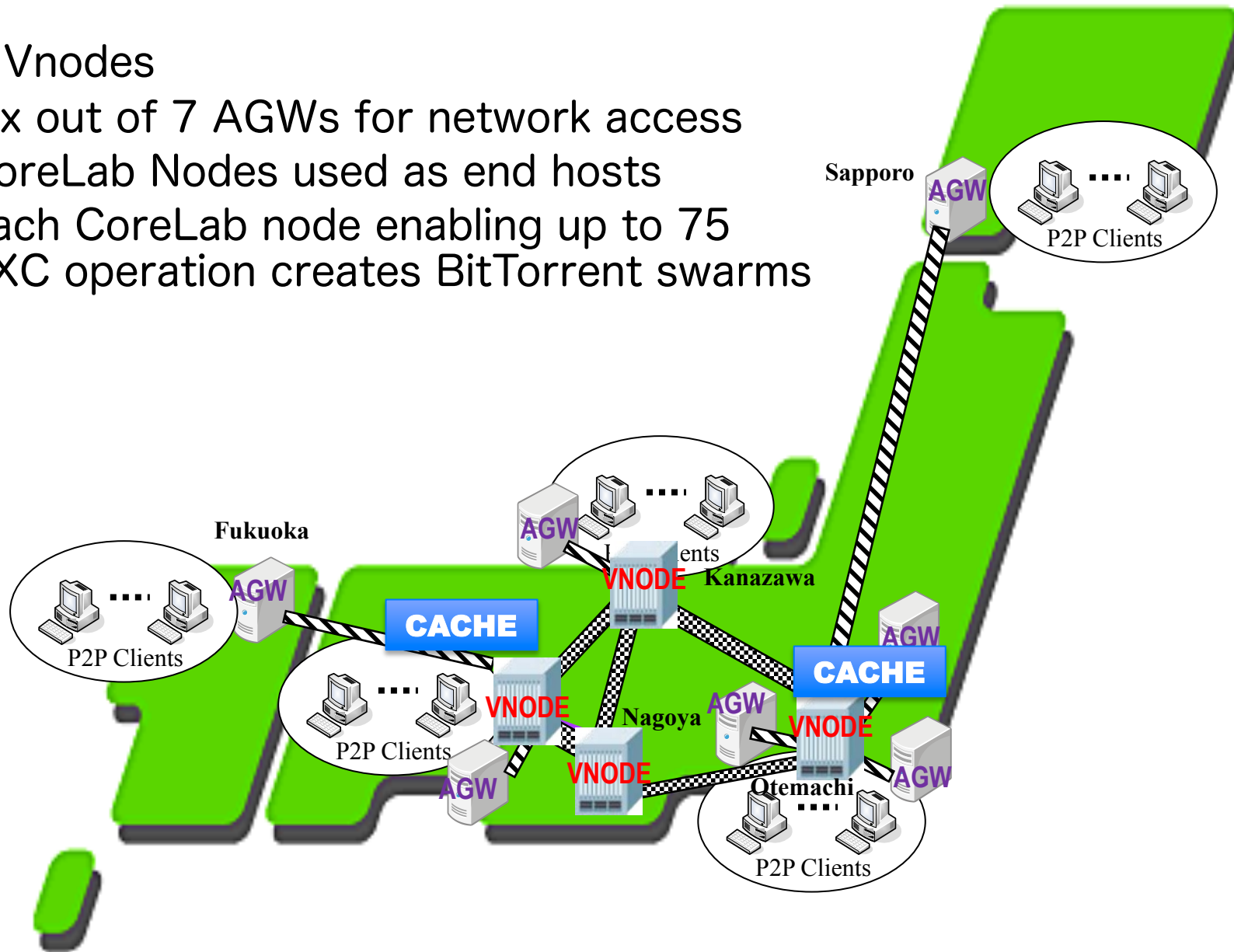
CONA in JGN2Plus 2/2



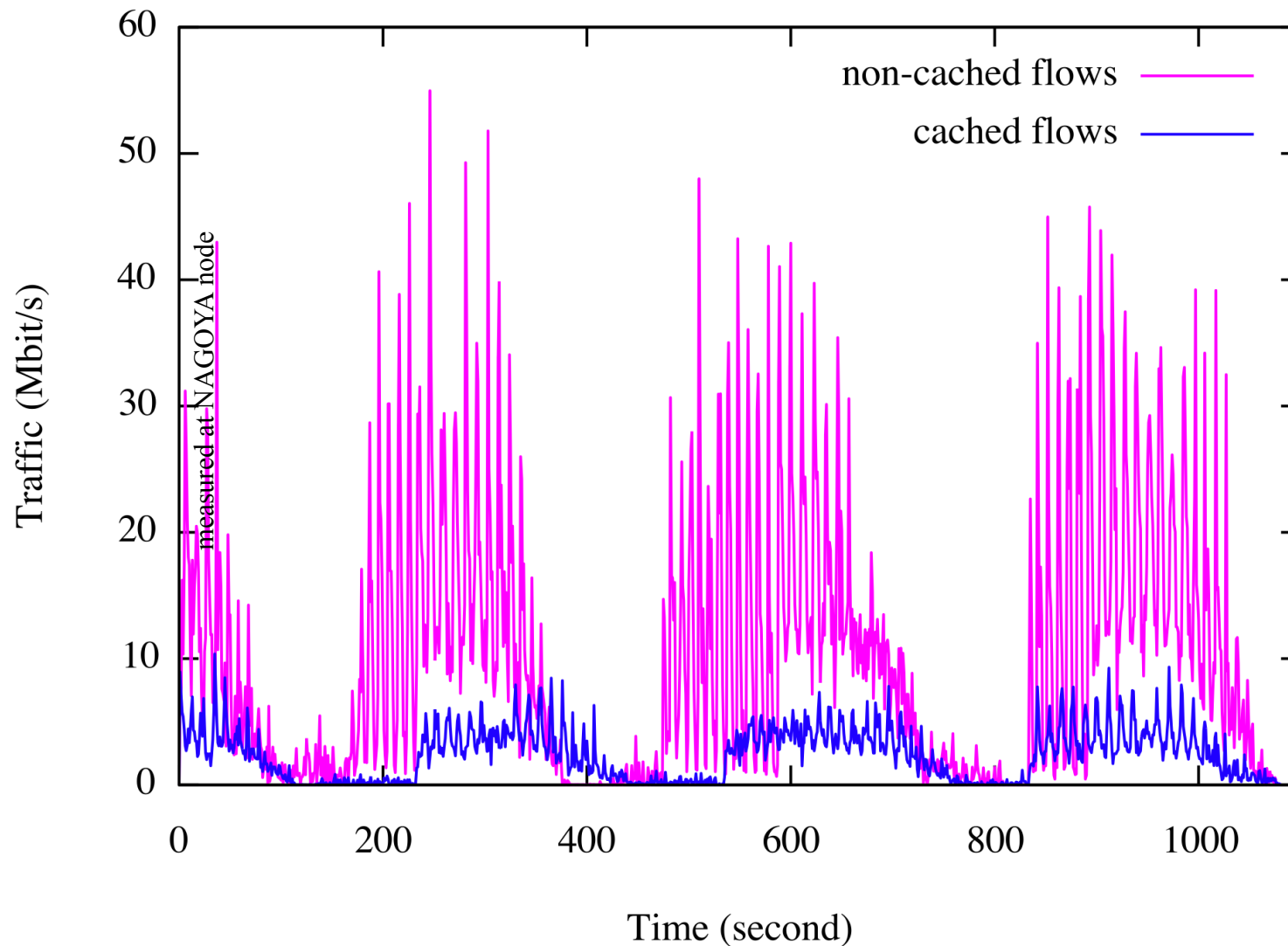
1000VMs connect to CONA in A Slice

CONA In JGN2plus Network

- 4 Vnodes
- Six out of 7 AGWs for network access
- CoreLab Nodes used as end hosts
- Each CoreLab node enabling up to 75 LXC operation creates BitTorrent swarms



Traffic Reduction by Packet Cache



- BitTorrent swarms created by LXC based 101peers (84 leechers + 17 seeders) using 10MB data file
- Packet cache effectively reduced repetitive traffic

CONA in JGN2Plus 2/2





Slice 3

In-Network Ad-Targeting

Demonstrating...

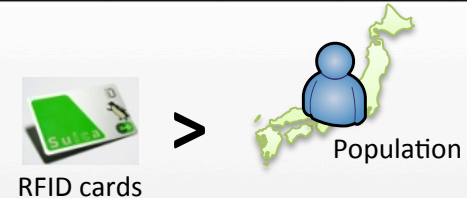
- Scalable Experimentation
- Programmability

Demo: Ad-Targeting in Real World

Characteristics of Japan

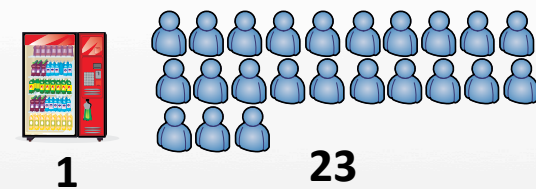
1. Rechargeable **Electronic Money Card** is commonly used.

- Total number of cards exceed Japanese population.
- Used as Money, **Train Ticket**, etc.



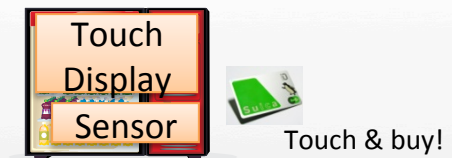
2. Highest Number of **Vending Machines**

- 1 vending machine per 23 people



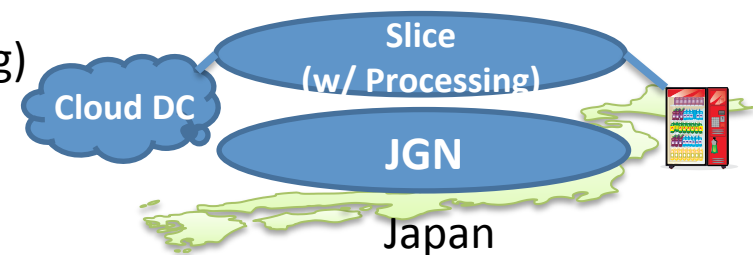
3. Vending Machine comes to **Digital Signage (Ad Display)**

- w/ Huge Touch Display and Sensors
- **Pay by touching** Electronic Money Card



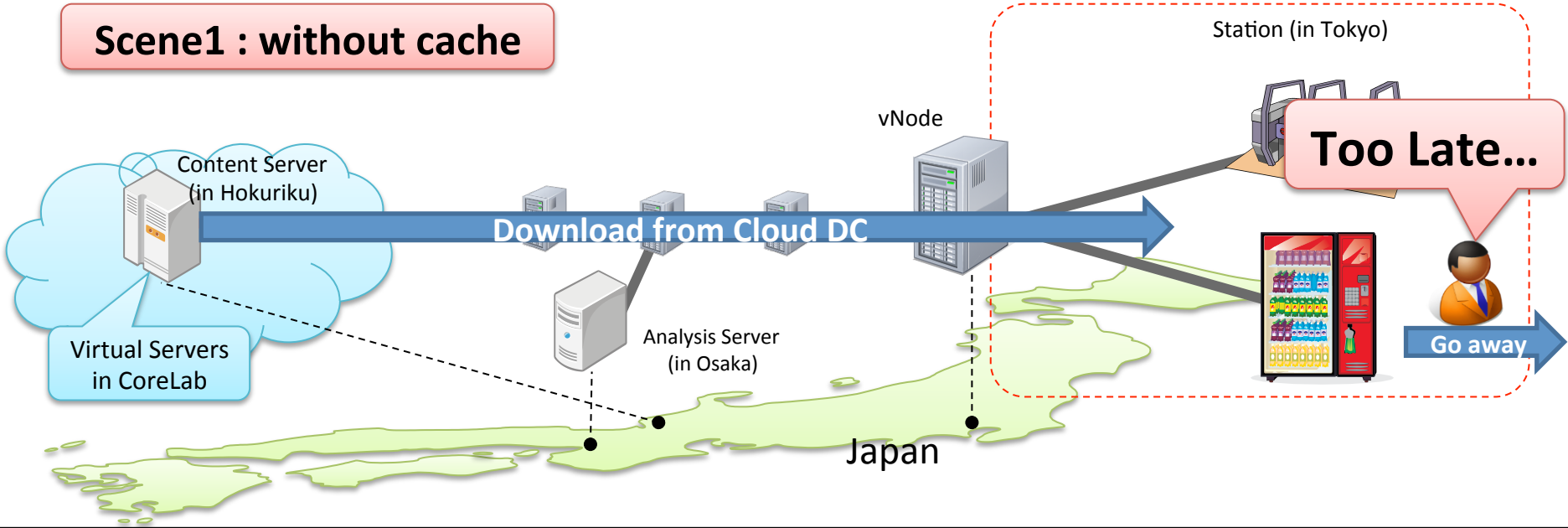
This Demo Shows

1. In-Network Processing (Cache NW for Ad-Targeting)
2. Implemented in JGN Network
3. Connected with Cloud Data Center

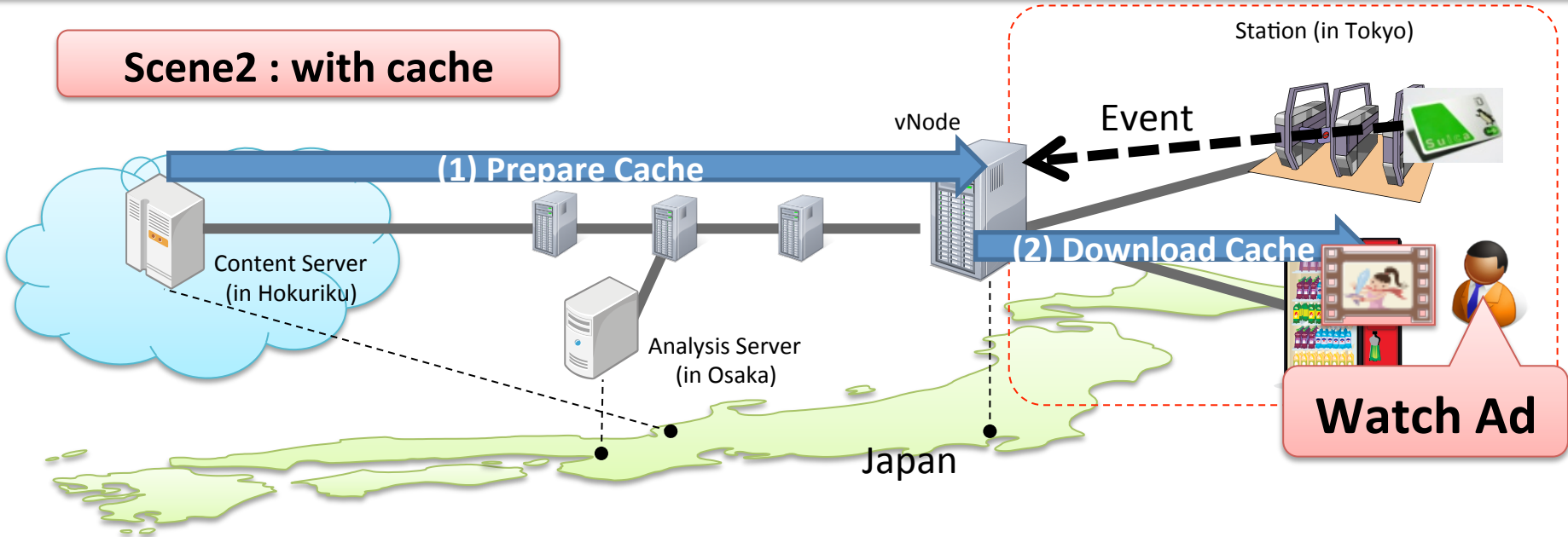


Demo: Prototype system for ad-targeting video delivery

Scene1 : without cache



Scene2 : with cache



vNode Project Demonstration Ad Targeting

Fujitsu Laboratories Ltd.
Fujitsu Ltd.



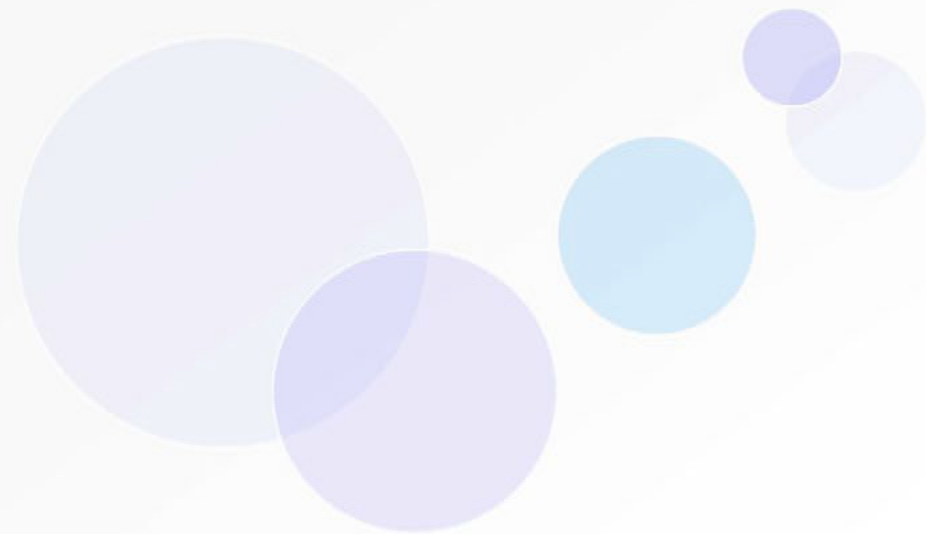
Slice 4

Resource Isolation

Demonstrating...

- Resource Isolation
- Dynamic Slice Reconfiguration
- Scalable Experimentation
- Programmability

2. 4K stream transfer on Slice





Slice 5

Cloud Access (Non-IP)

Demonstrating...

- Network Accommodation
- Scalable Experimentation
- Programmability

- **Summary**

- A group of VMs are switched (e.g., migrated) between distant data centers using an IPEC-based slice.
 - IPEC (IP-Ether-Chimera) is a non-IP (non-Ethernet) protocol.

- **Focus**

- **Network accommodation:**

Two data centers and a user site are accommodated to IPEC-based slice using the network accommodation function of the VNode.

- **Protocol conversion:**

VMs and user PCs communicate using IP/Ethernet through IPEC-based slice using Ethernet-IPEC protocol conversions.

- **Group learning in IPEC:**

IPEC learns hosts (VMs and PCs) by group, so the learning overhead is much lower than Ethernet that learns them by host.

Demo: Wide-Area VM Switching Using IPEC

**Comparing IPEC-based and
Ethernet-based VM Switching**



Slice 6

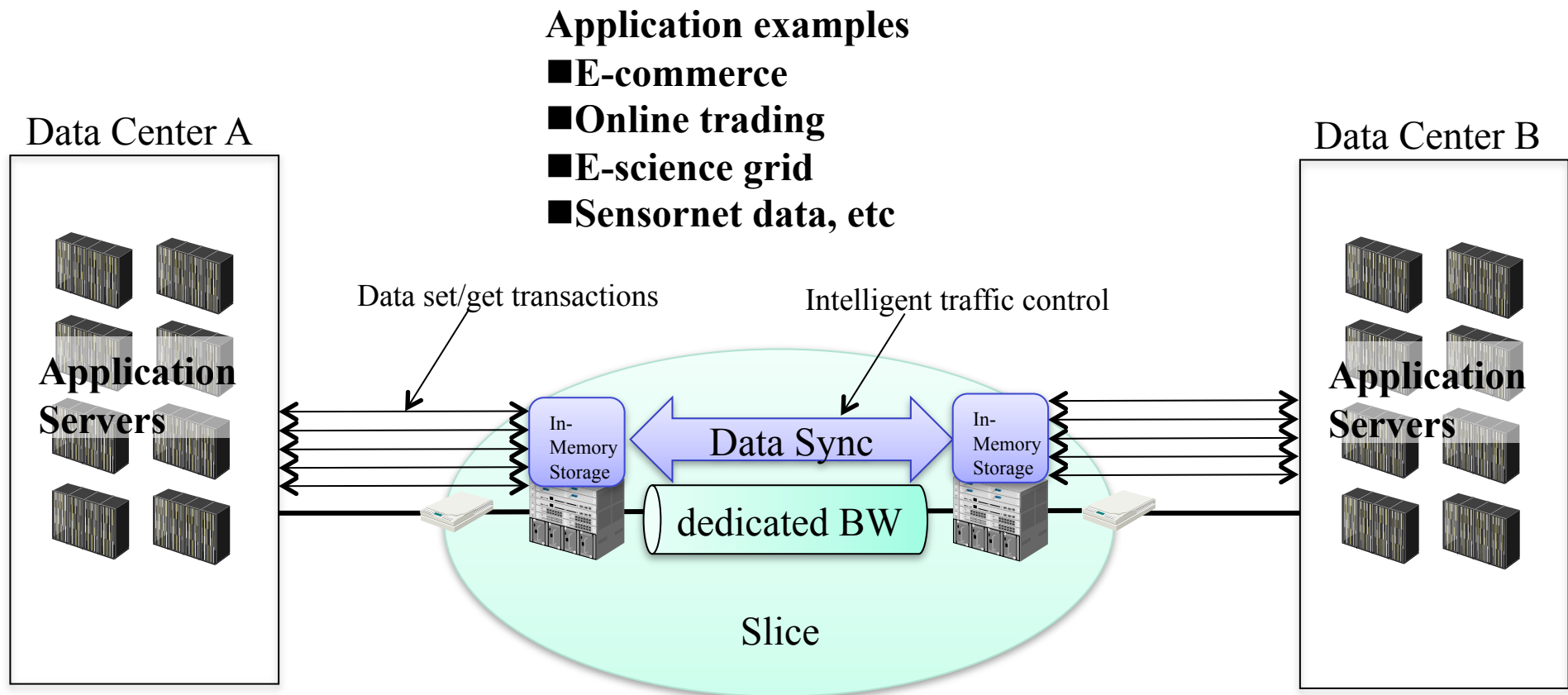
Inter-Cloud QoS

Demonstrating...

- Scalable Experimentation
- Programmability

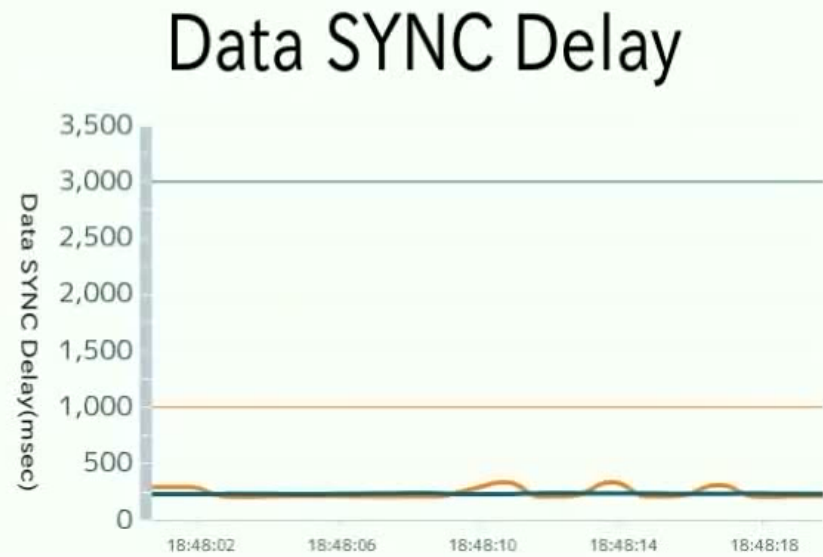
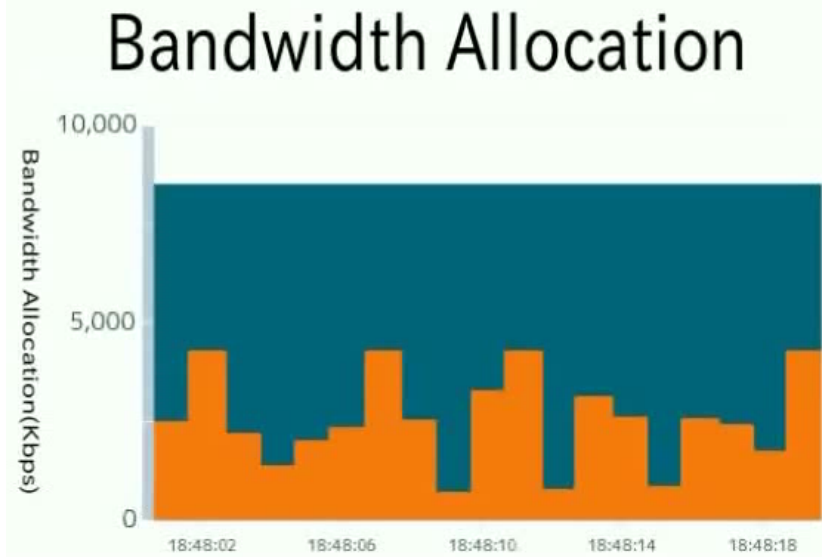
Data Sync Platform for Distributed Data Centers

- Dedicated resource(bandwidth) is strictly allocated to the virtual link.
- Intelligent traffic control for sync delay guarantee and efficient bandwidth usage. (demo)



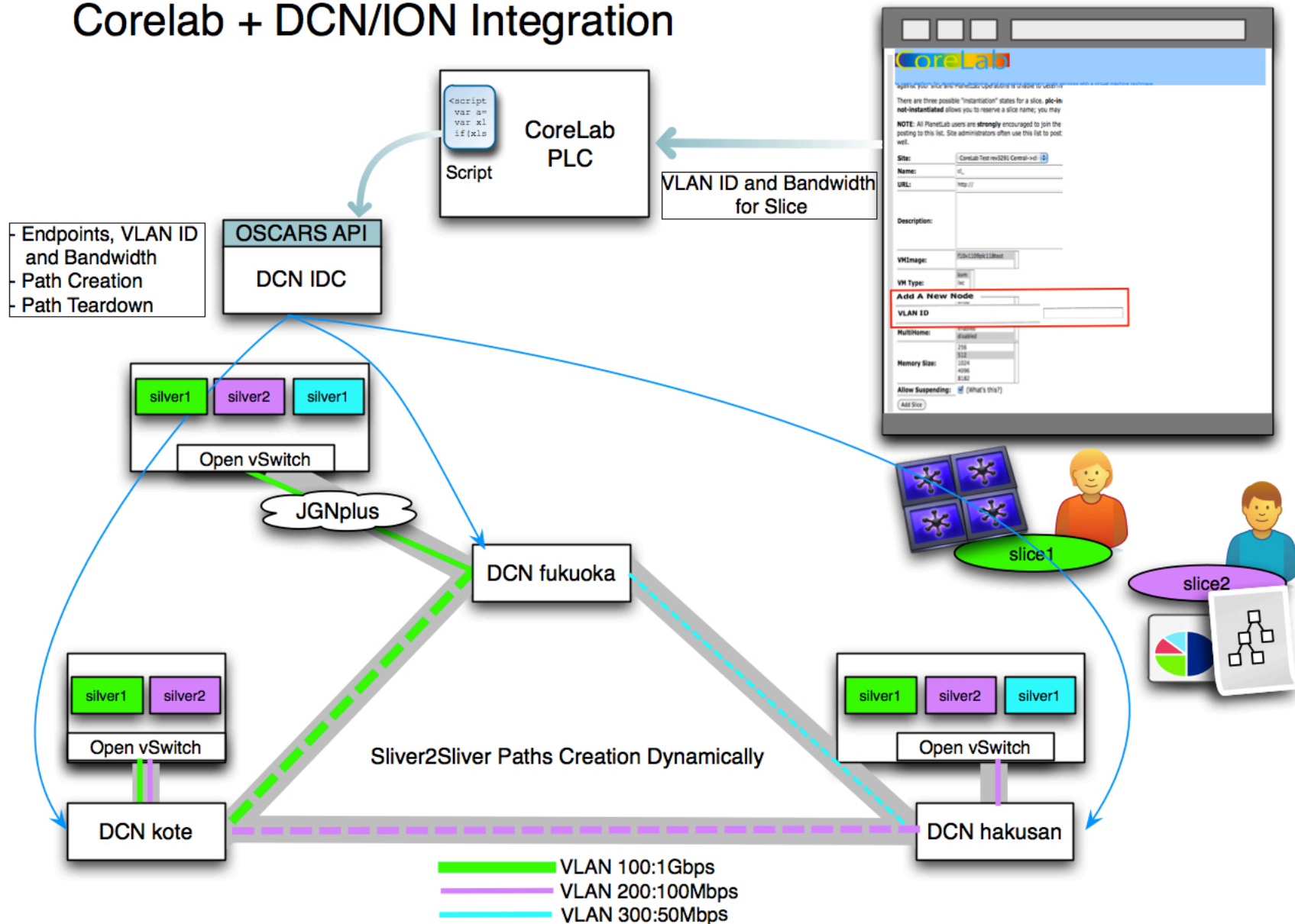
Part of this project is funded by National Institute of Information and Communications Technology (NICT).

Data Sync Platform: Demo Video



CoreLab Short Update

Corelab + DCN/ION Integration



Future Directions

- ANIAS (OpenFlow, OpenTag..)
- Optical Path Integration
- Cloud Computing & Networking
- Wired & Wireless Integration

GENI

- WiVi (Looking for collaboration)
- VNode2 / CoreLab @ Utah, UCSD