Network Virtualization
Research Activities in Japan

WiVi and VNode2

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Vision: Network-Virtualization Infra. for diverse NWs

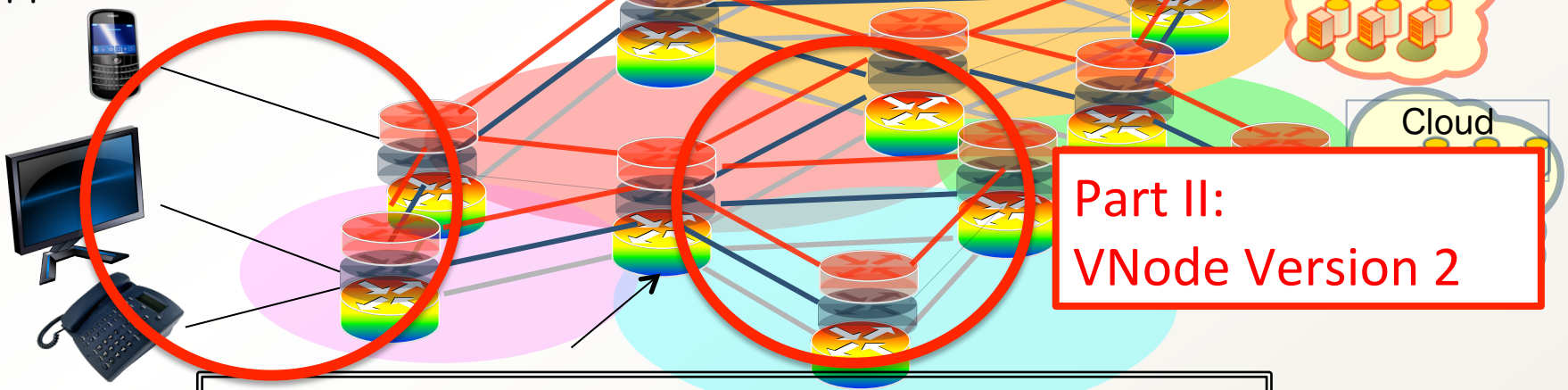
Slice 1 Slice 2 Slice N

Cache Oriented NW | Sensor Processing NW | Cloud Access NW | ID/Loc NW | Content Oriented NW | TV Broadcast NW | Legacy NW | Future NW

"Slices" accommodate diverse NWs

Part I:
Wireless Access Network Virtualization

Appliances, Sensors,…



Part II:
VNode Version 2

Network Virtualization Infrastructure

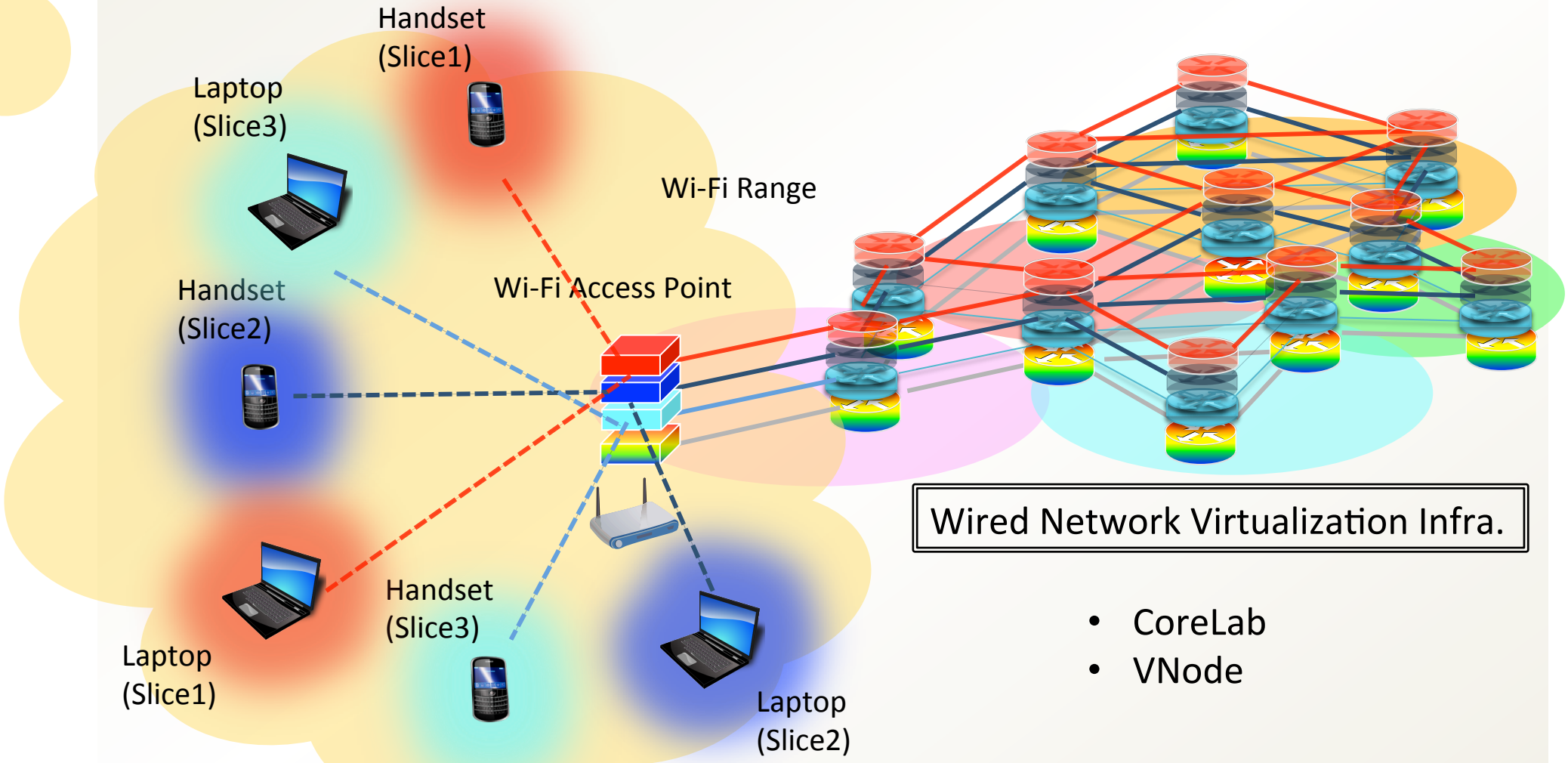
Part I:

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



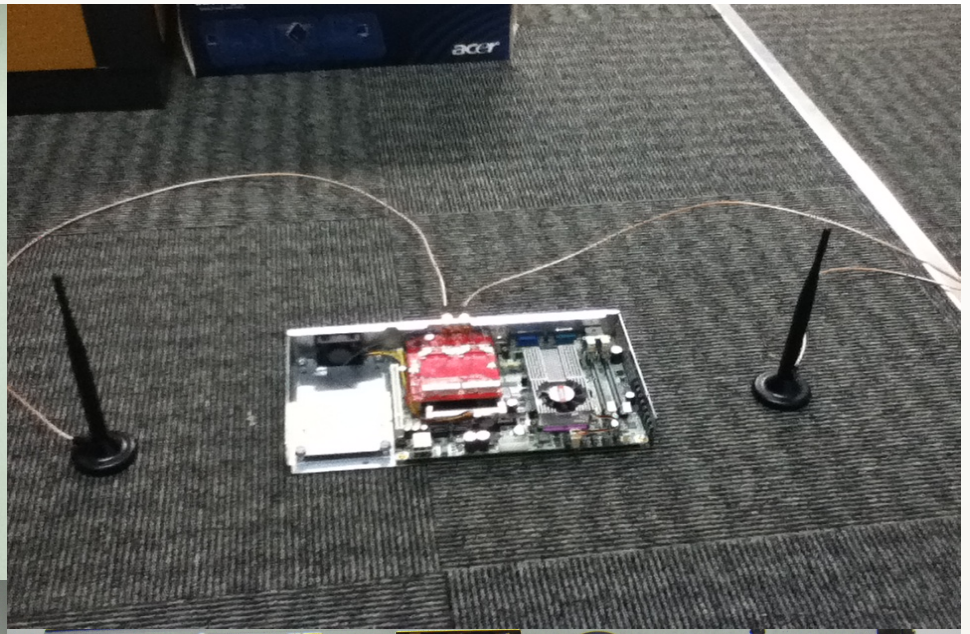
Wired Network Virtualization Infra.

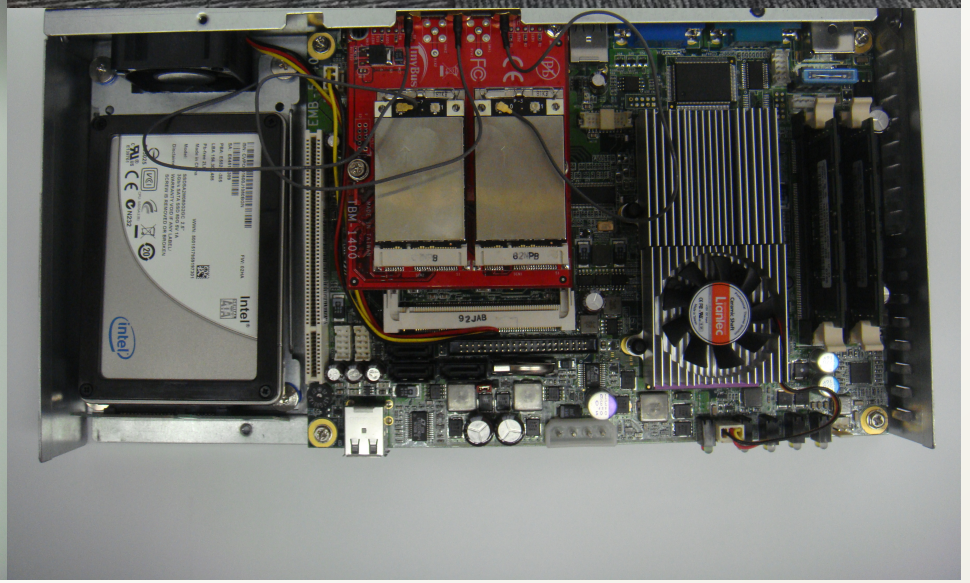
- CoreLab
- VNode

Wi-Fi Network Virtualization Infra.

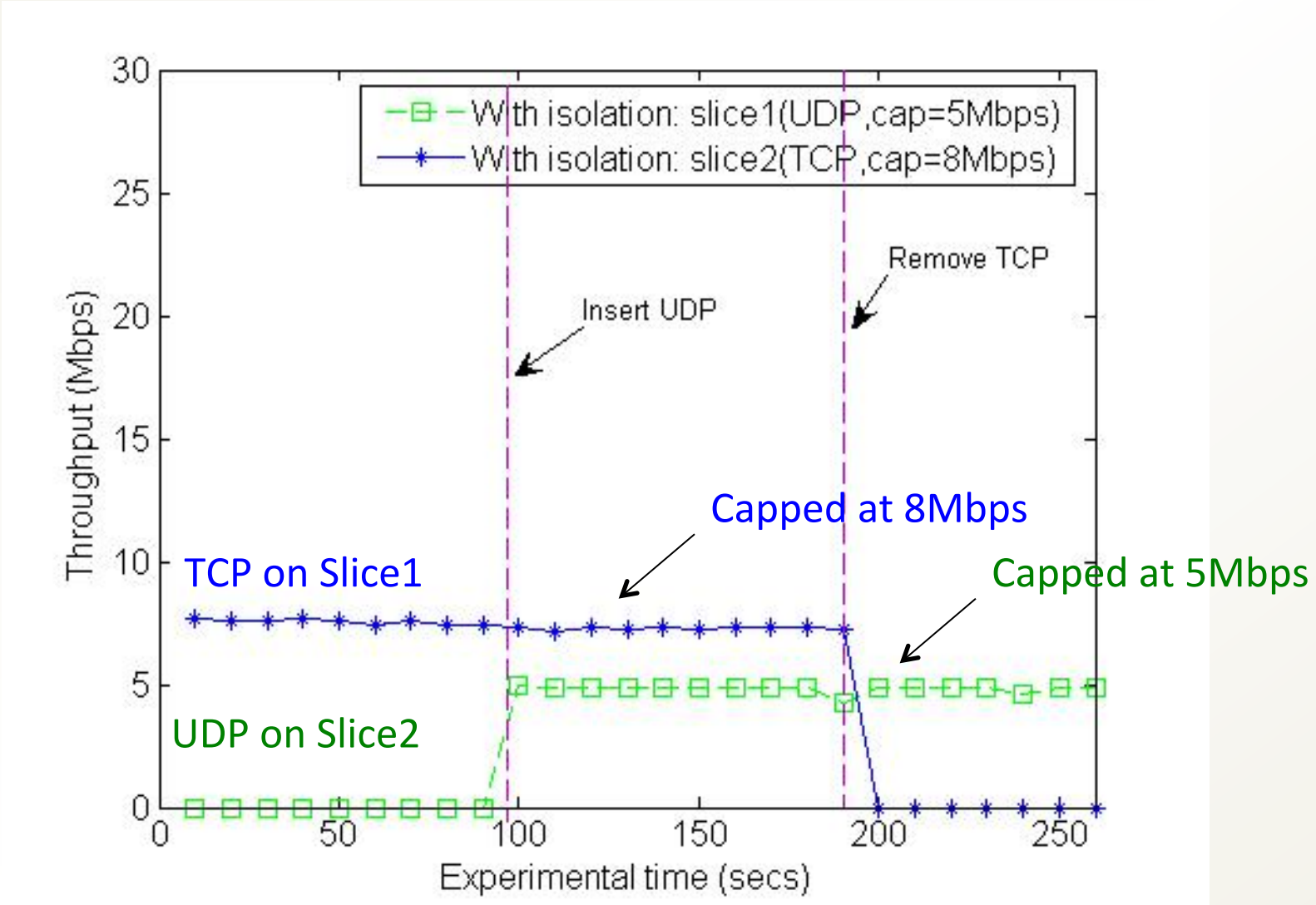
- WiVi

Prototypes





Performance Isolation



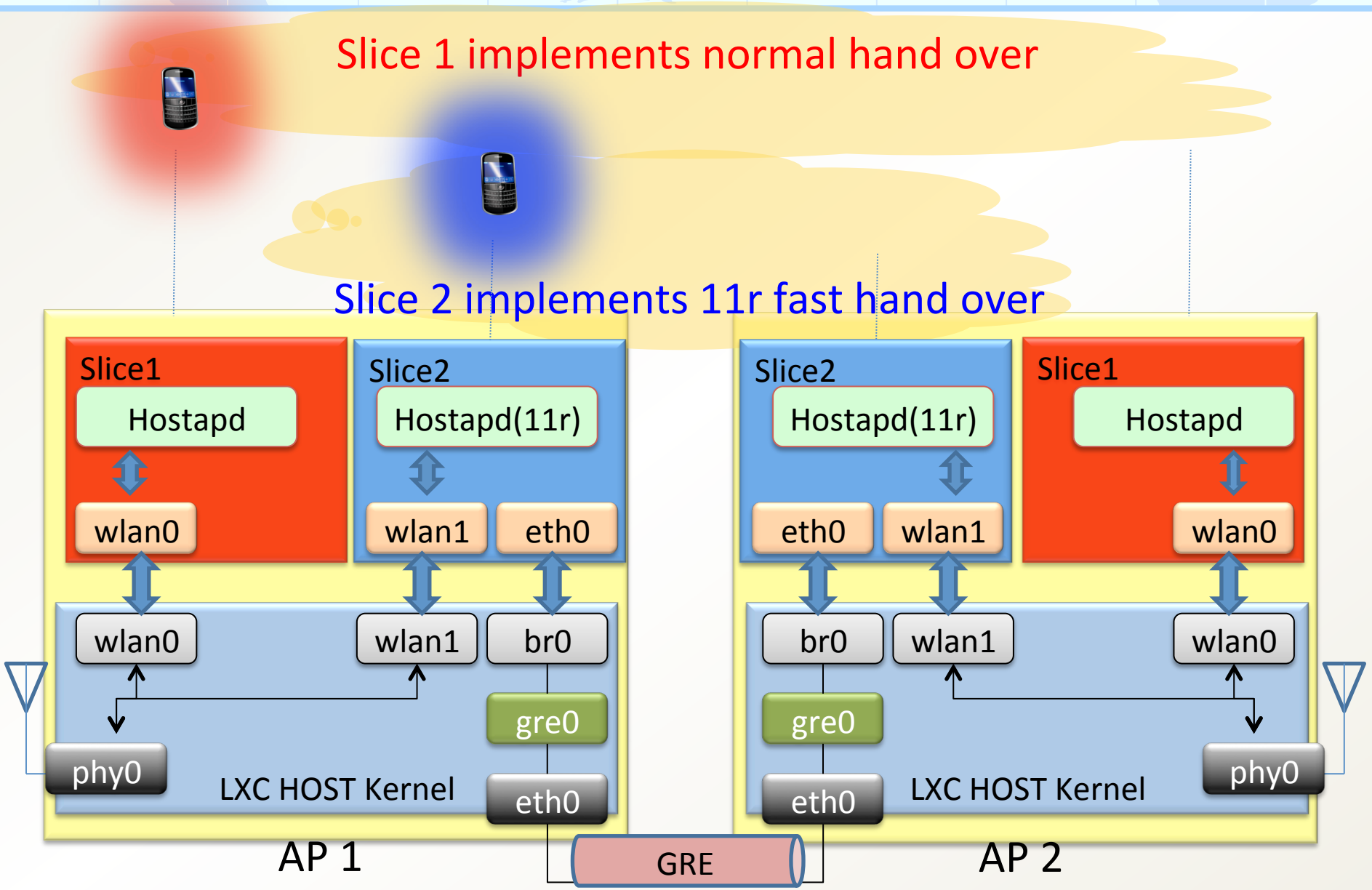
→ TCP flow on Slice1 and UDP flow on Slice2 are BW-capped

Performance Isolation (Bandwidth Policing)

WiVi [wi:vi:]

Application of Programmability

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



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

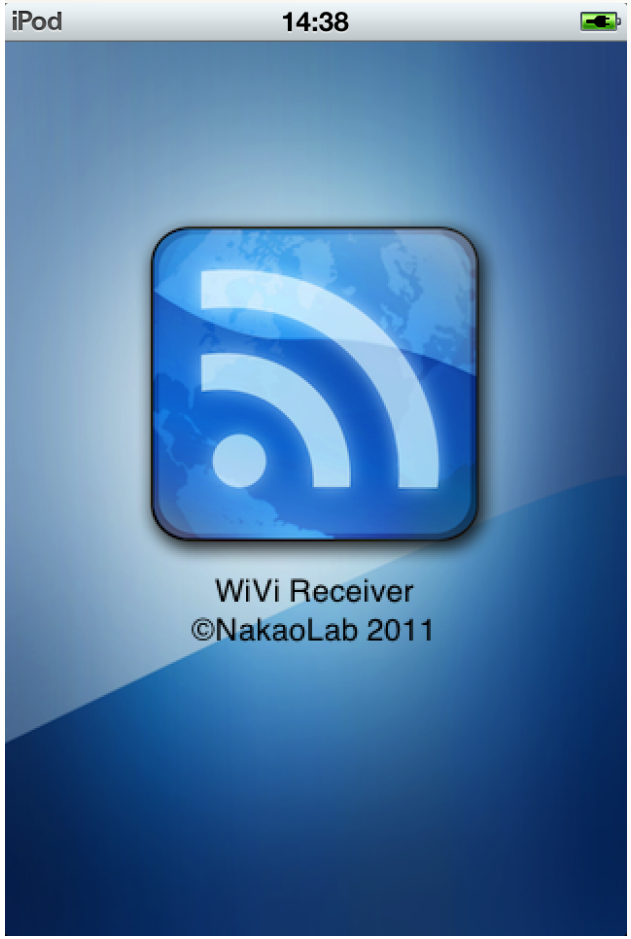
App2: Cache Slice and No-Cache Slice

WiVi Demo

Transparent Proxy for YouTube Broadcast Yourself™

App3 : Beacon Push Advertisement

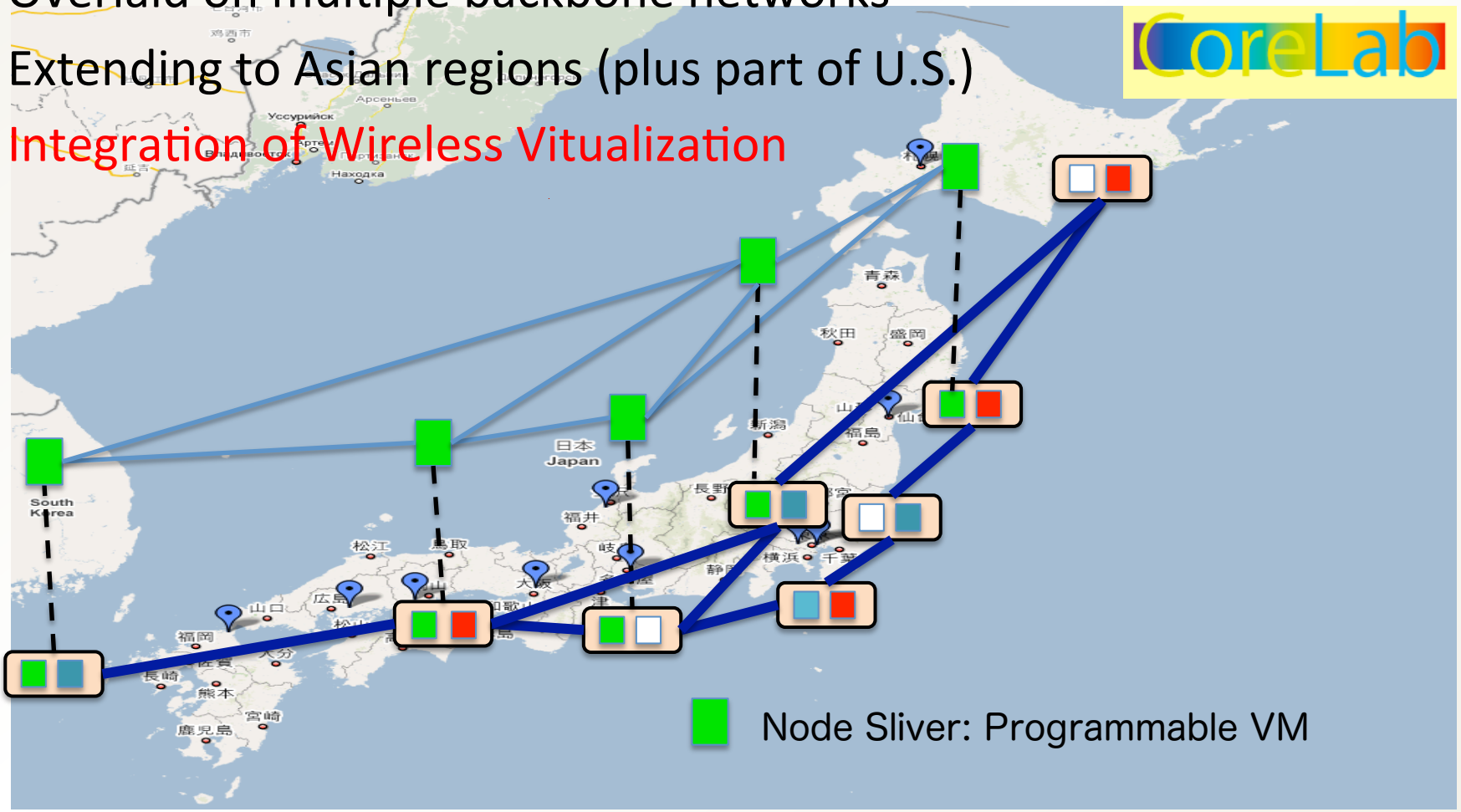
Non-Authenticated Beacon Communication
Applied for Ad-Targeting / Digital Sinage



App3 : Beacon Push Advertisement

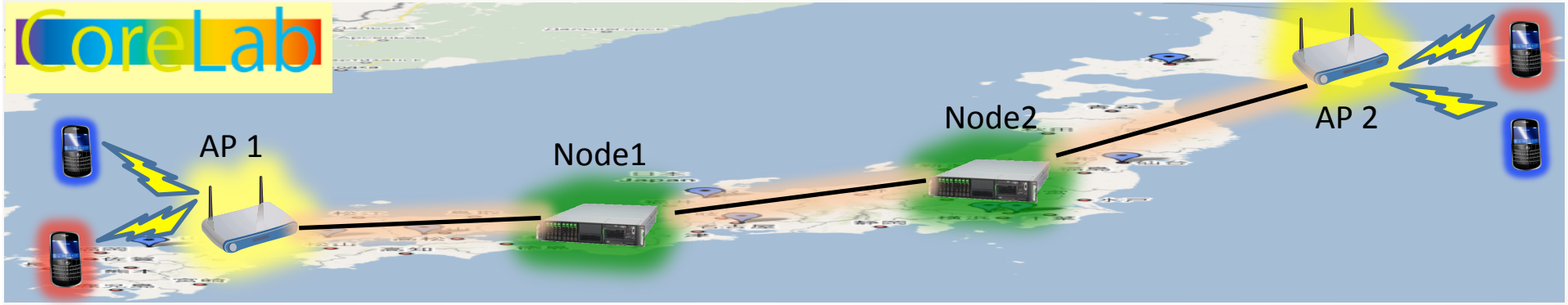
Immediate Future Plan: CoreLab + WiVi

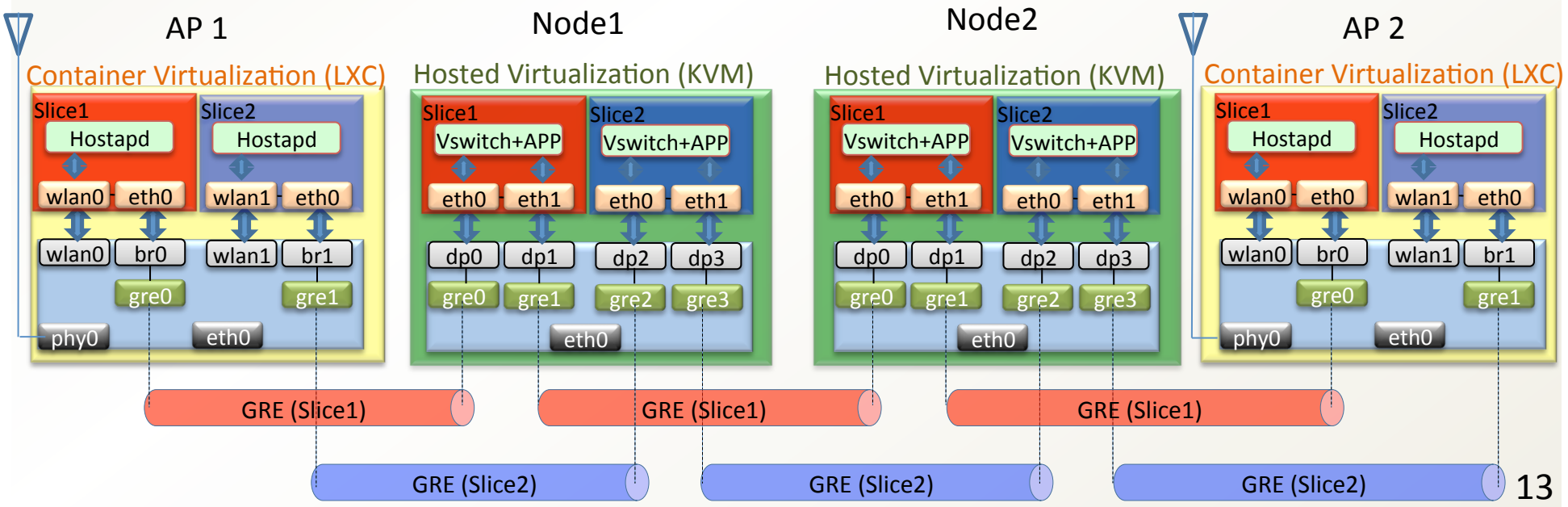
- Network Virtualization Platform
- Creates slices across Japan (24+ nodes)
- Overlaid on multiple backbone networks
- Extending to Asian regions (plus part of U.S.)
- Integration of Wireless Vitualization



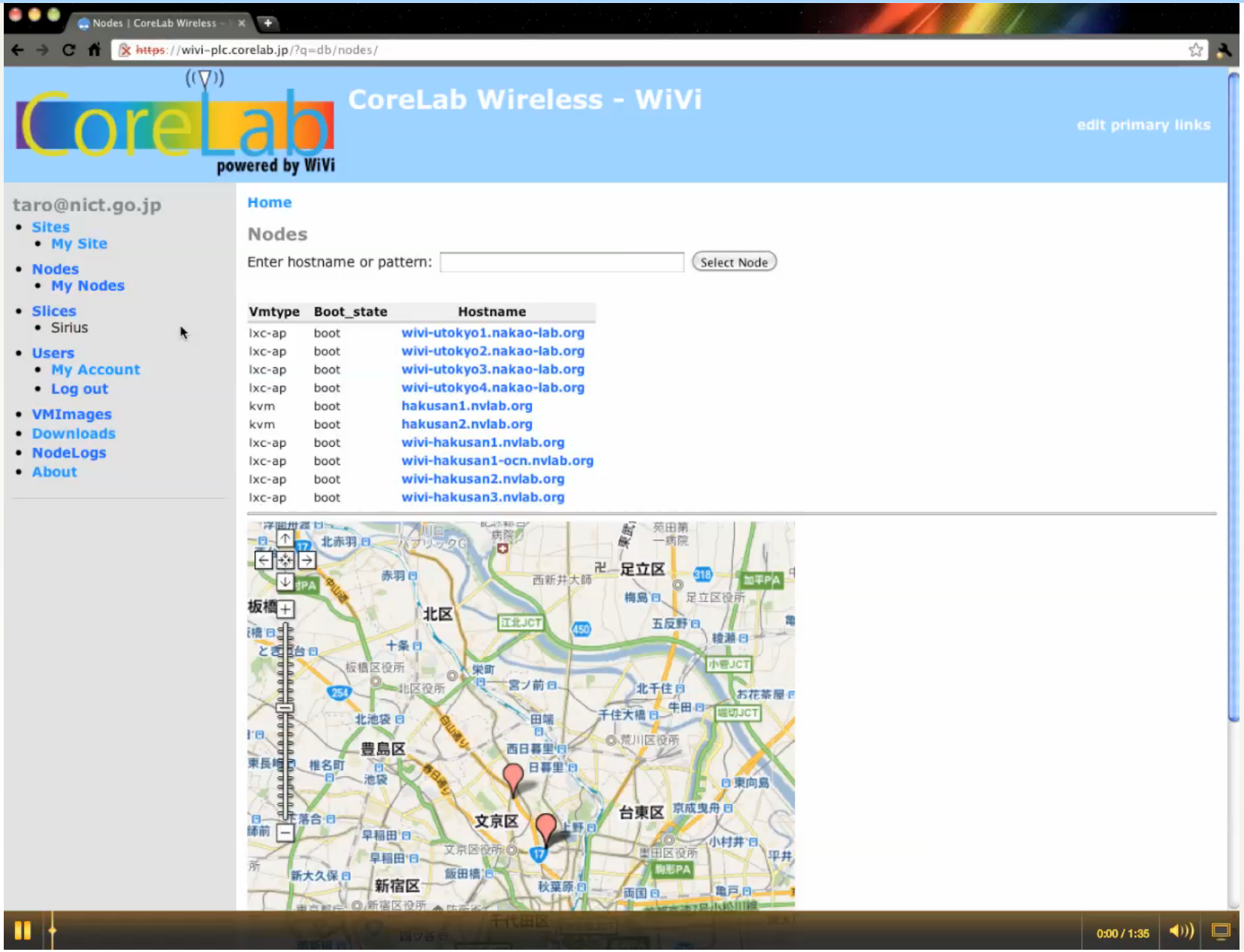
Wired/Wireless Integrated Virtualization

- 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



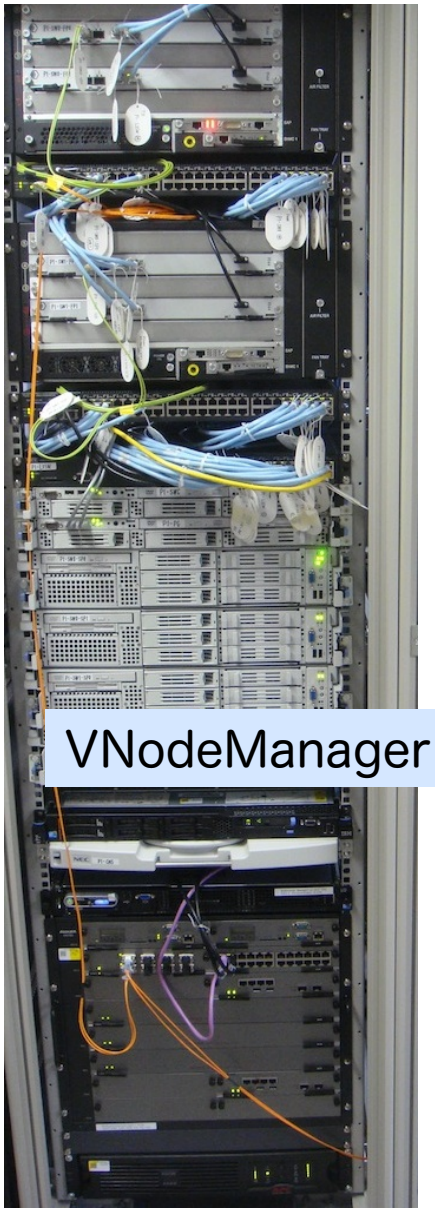
Part II:

VNode Version 2

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

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

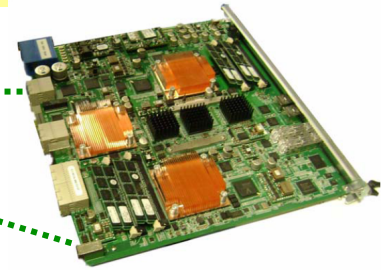
VNode: Nuts and Bolts View



VNodeManager

Programmer Part
(IA Serverx4 +ATCAx2+OpenFlow SWx2)

OpenFlow Switch (10G x4)

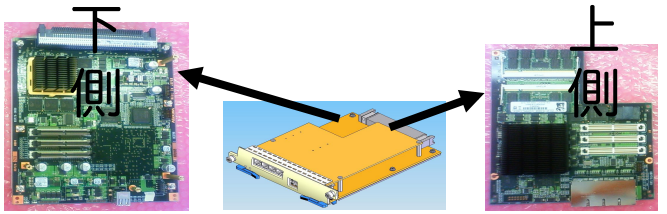


Fast-Path Network Processor Card

Redirector Part (AX6700+SMCx2)

AX6708S

Service Module Card



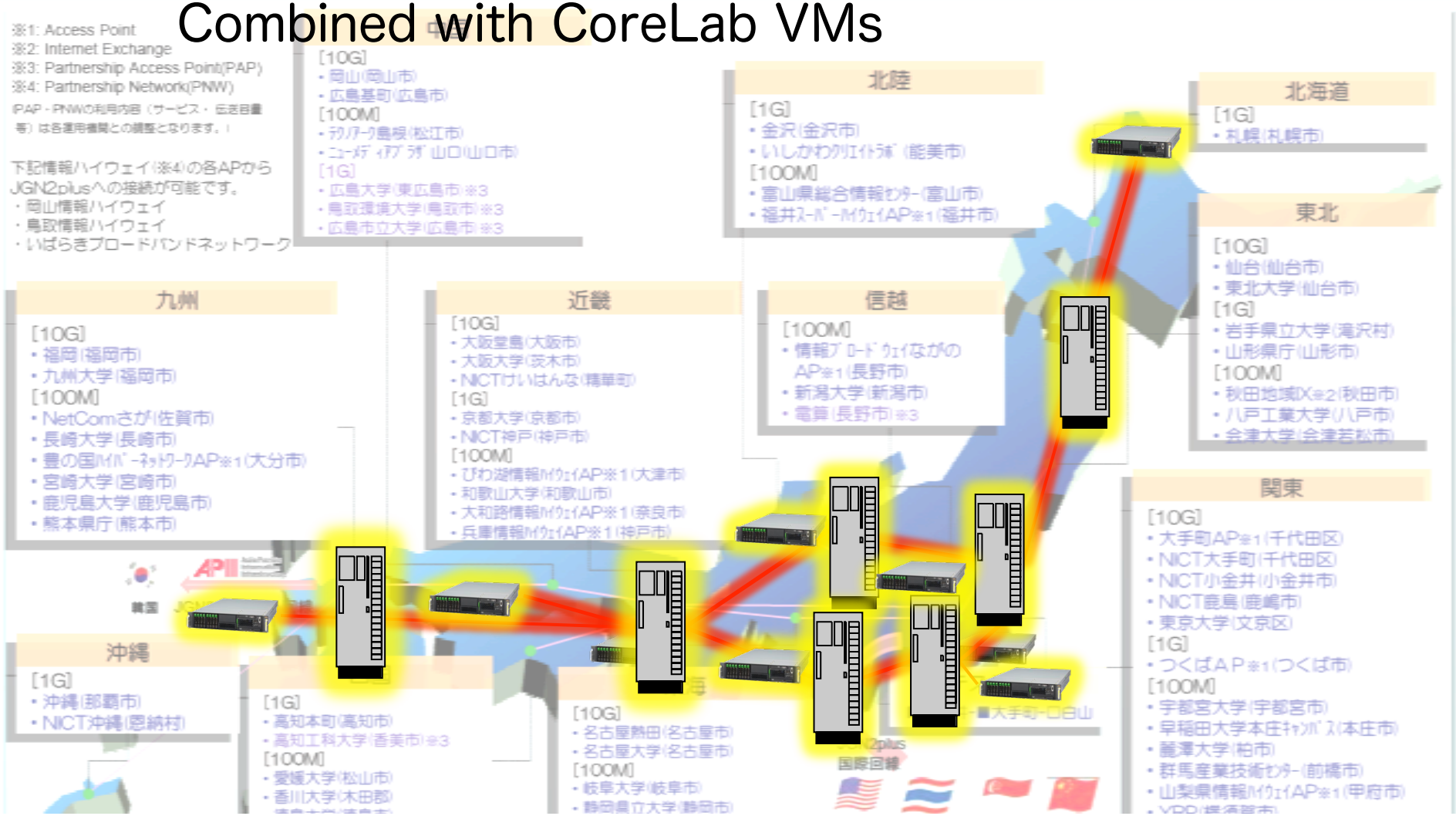
A Prototype System (4 VNodes)

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

1. Slice operation console

Slice 1

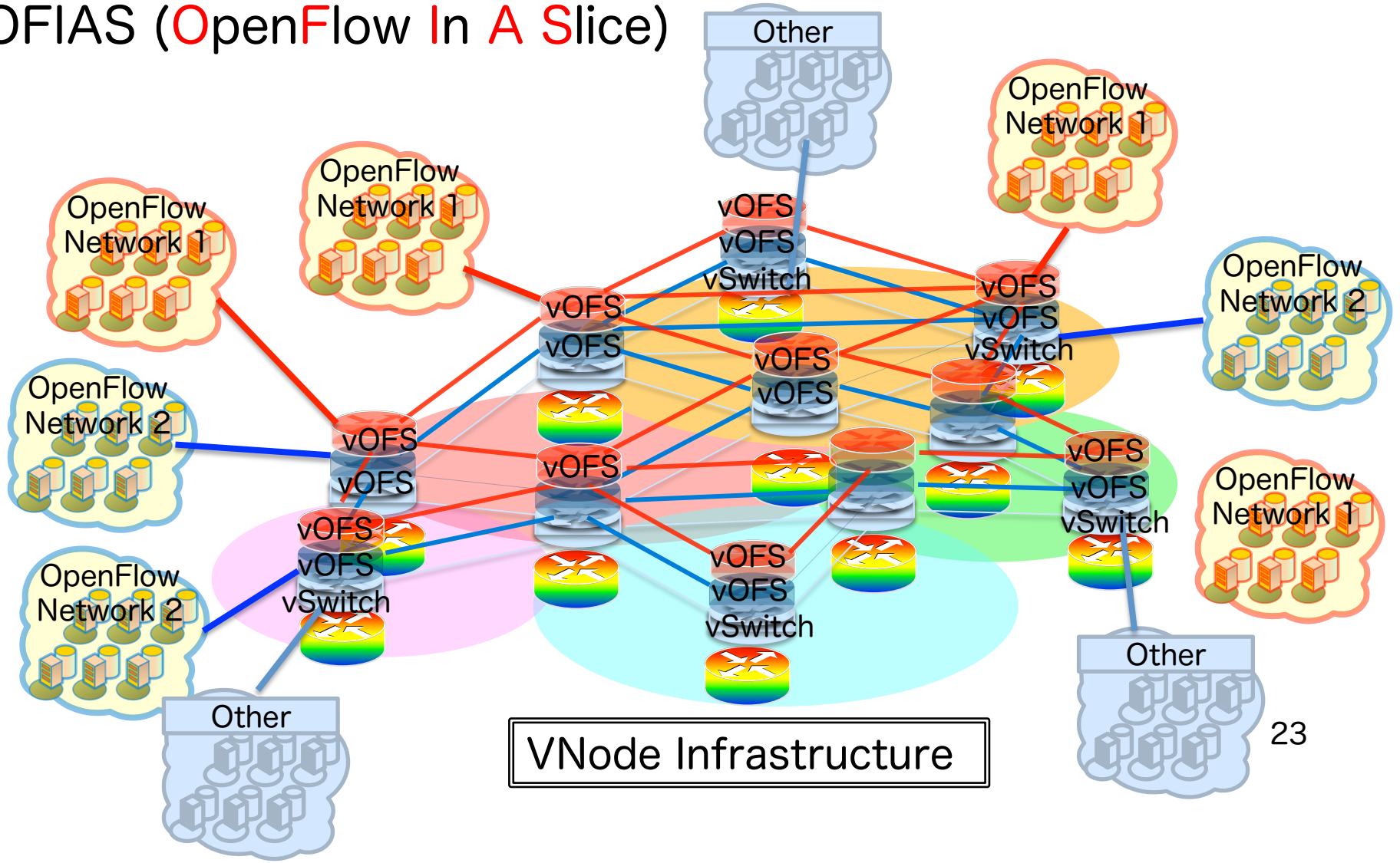
ANIAS (AnyNetwork In A Slice)
OFIAS (OpenFlow In A Slice)

Demonstrating…

- Network Accommodation
- Programmability

Slice 1: ANIAS (Any Network In A Slice)

OFIAS (OpenFlow In A Slice)



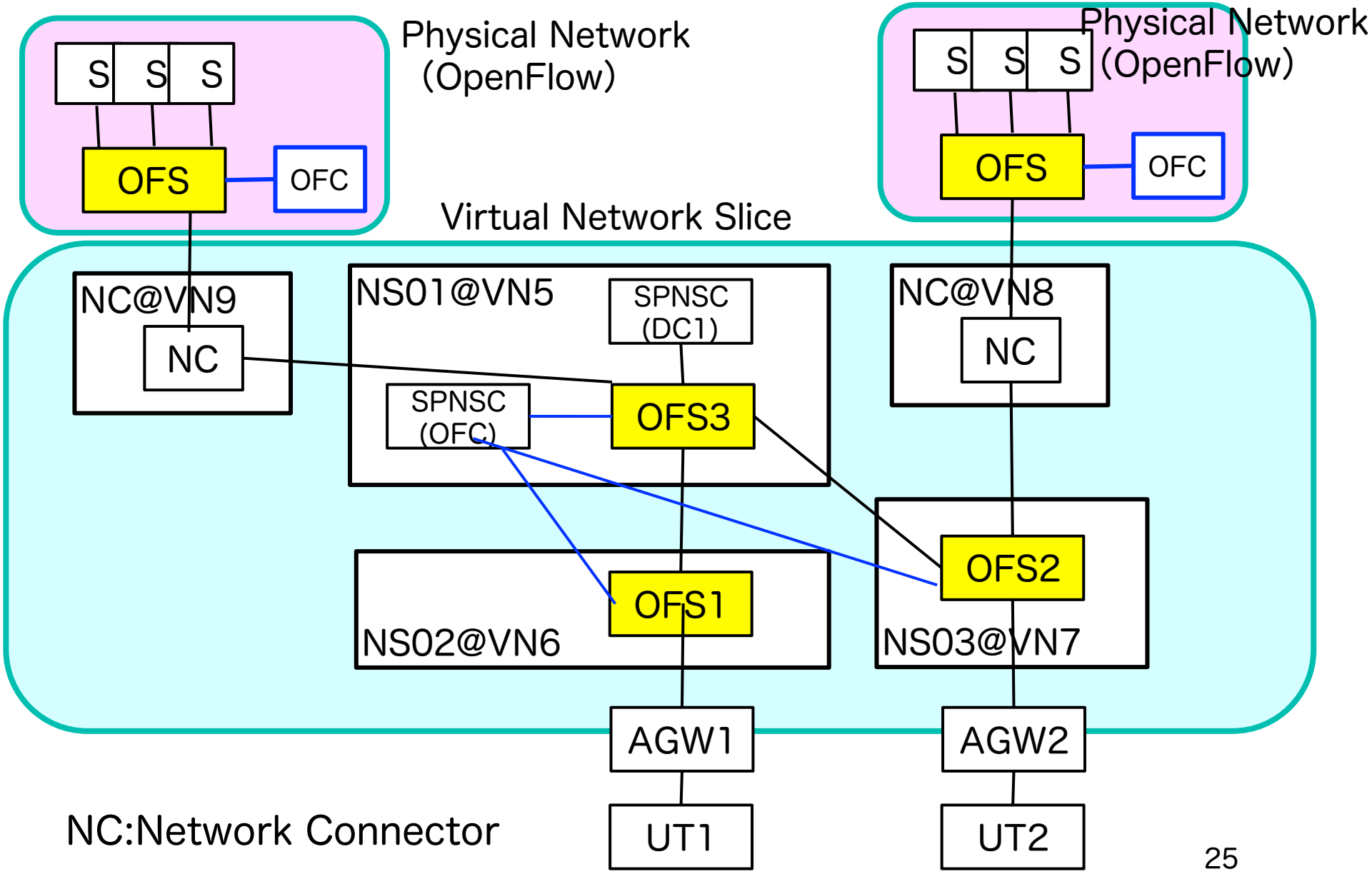
Goals of ANIAS/OFIAS

- Attempting to encourage transitions:

How to use OpenFlow ->
How to improve OpenFlow ->
How to invent OpenXXX

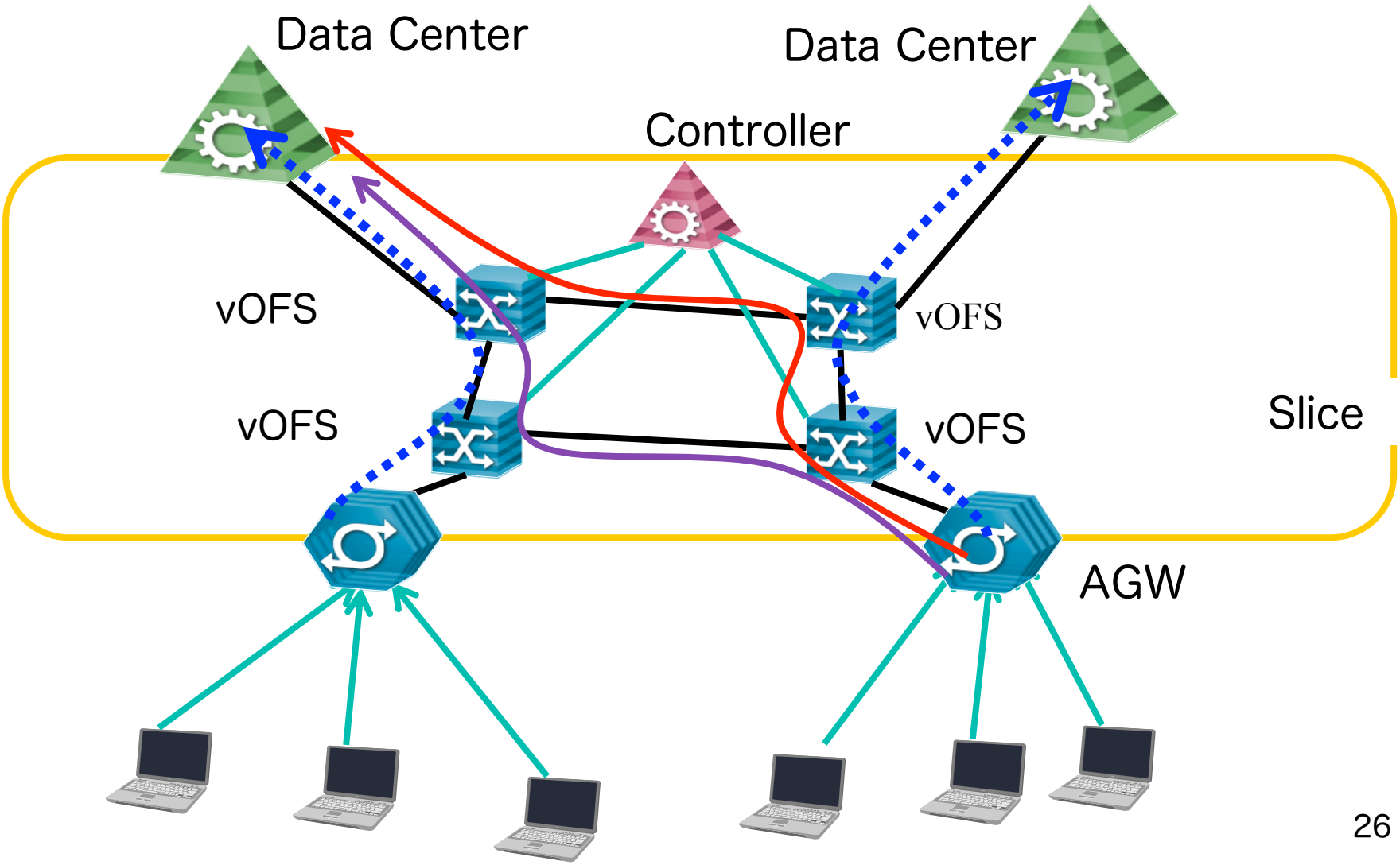
R. Furuhashi & A. Nakao,
"OpenTag: Tag-based network slicing for wide-area coordinated in-network packet processing'
IEEE ICC Futurenet IV

OFIAS (Physical + Virtual Integrated)

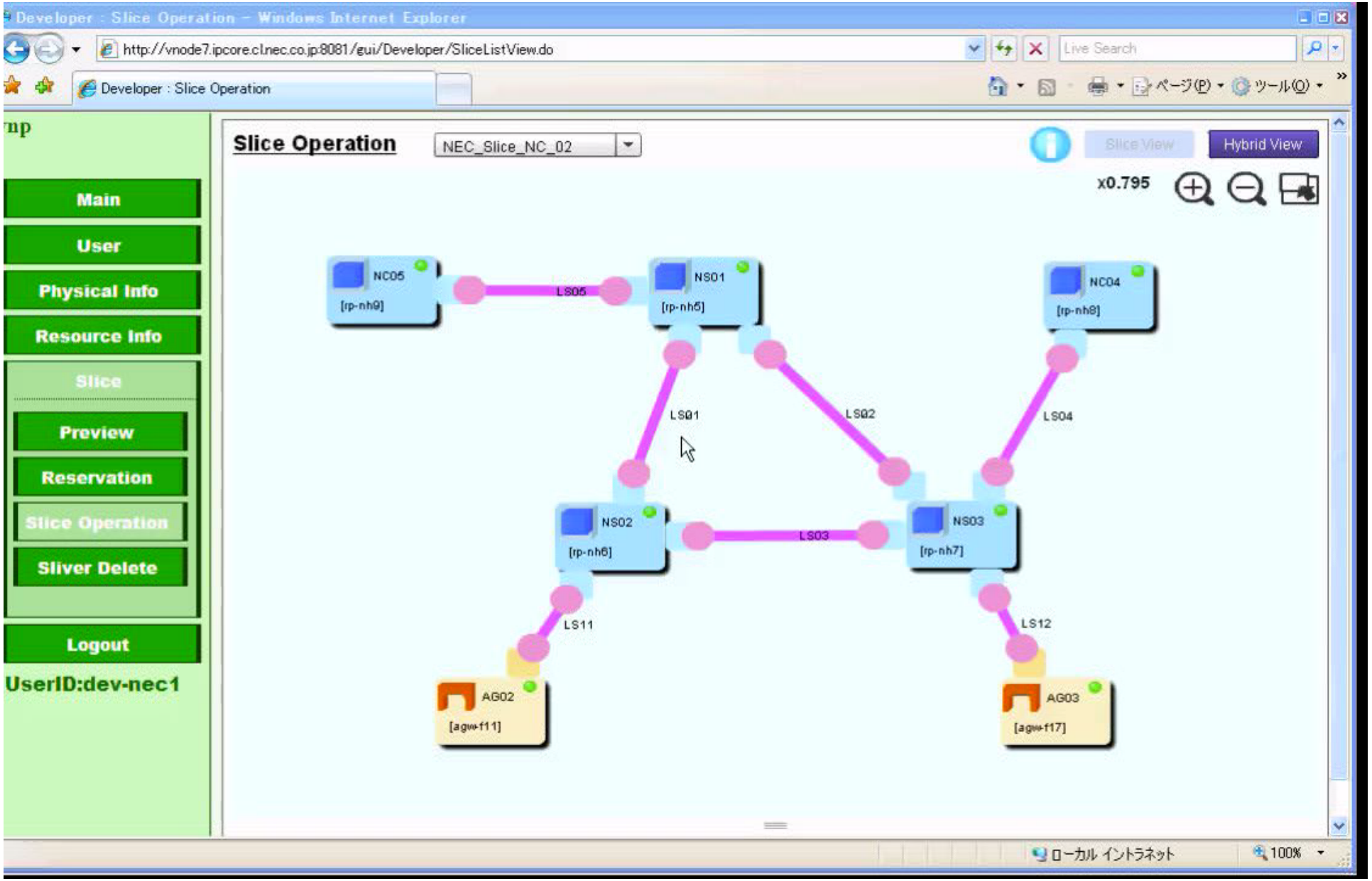


NC:Network Connector

Seamless Access to Multiple Data Centers



OpenFlow In A Slice Cloud Access Demo



Slice 2

Cache Oriented Network Architecture

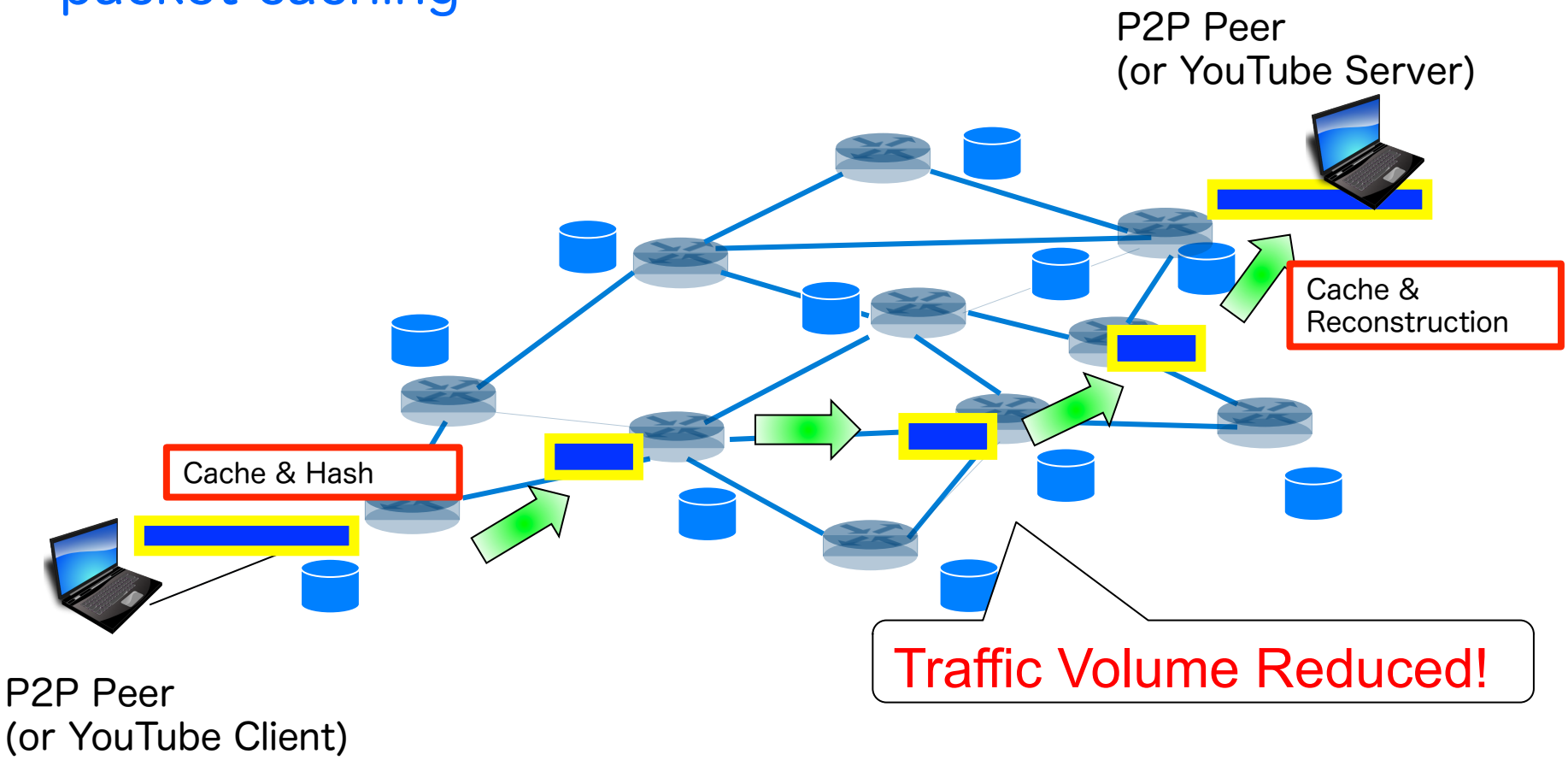
Demonstrating…

- Scalable Experimentation
- Programmability

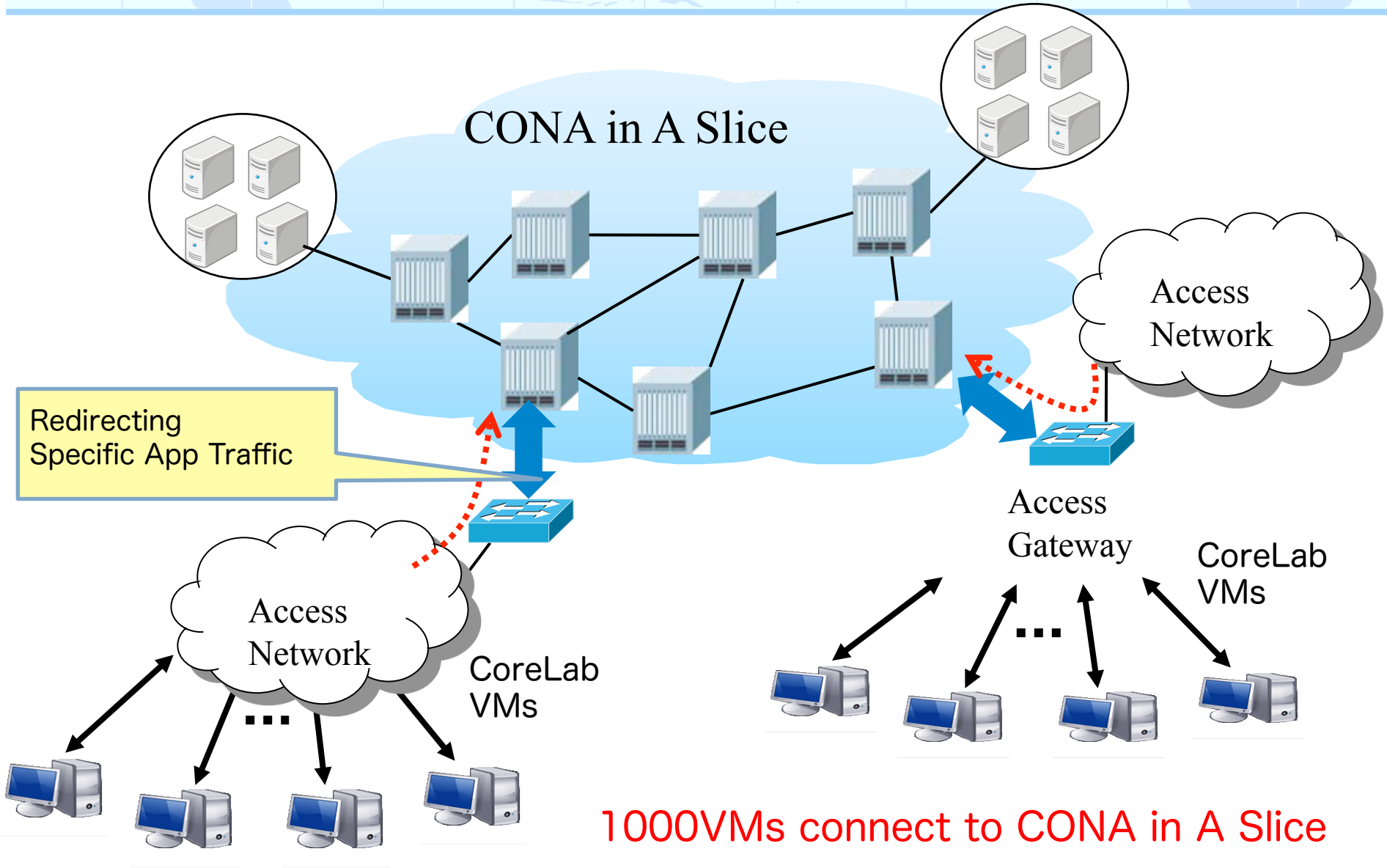
Slice 1: Cache Oriented NW Architecture

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

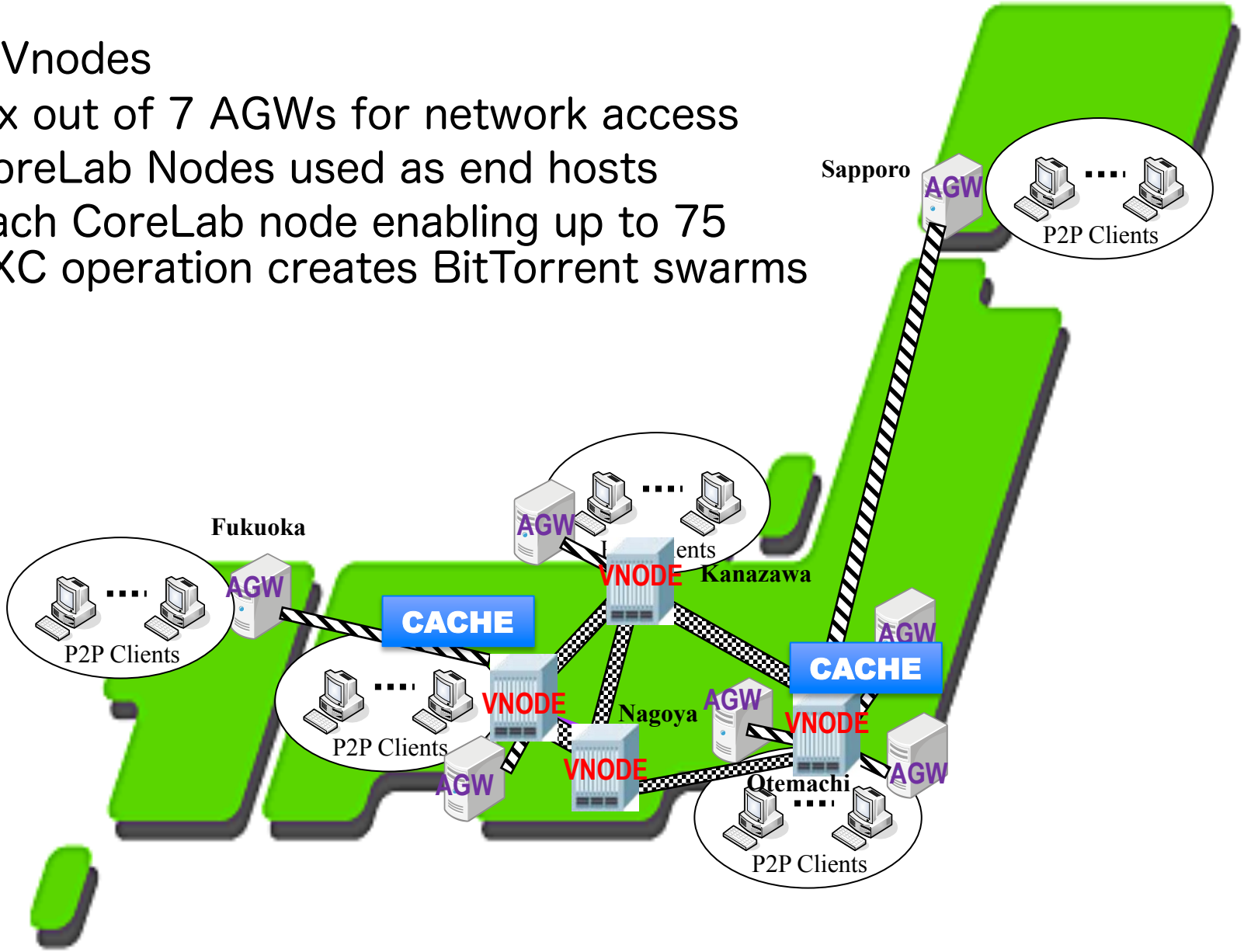


CONA in JGN2Plus 2/2

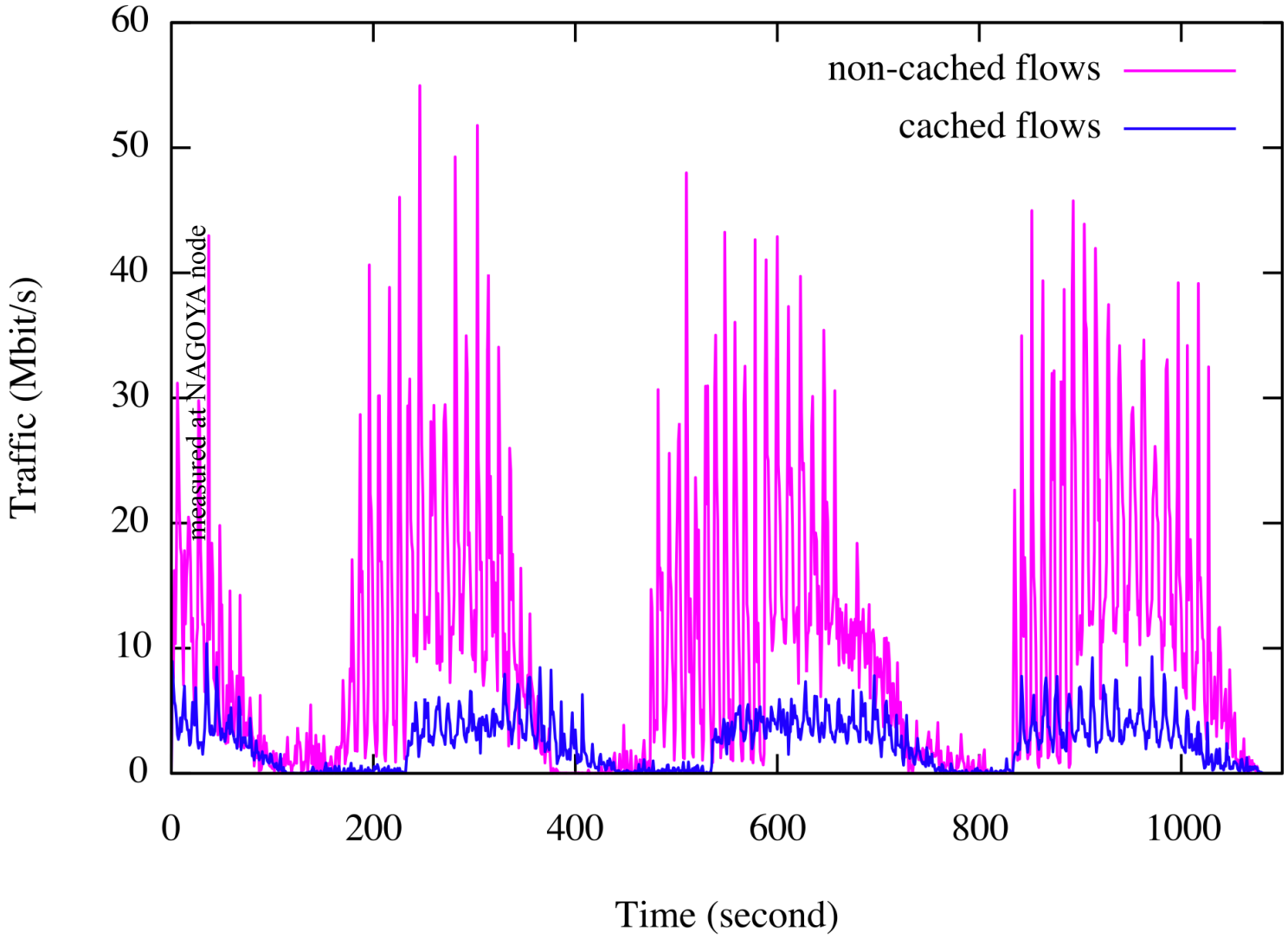


CONA In JGN2plus Network

- 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

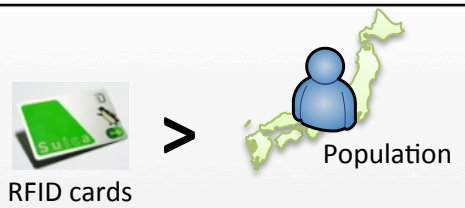
Demonstrating…

- Scalable Experimentation
- Programmability

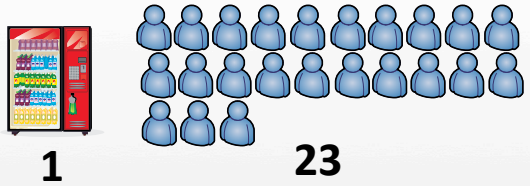
Demo: Ad-Targeting in Real World

Characteristics of Japan

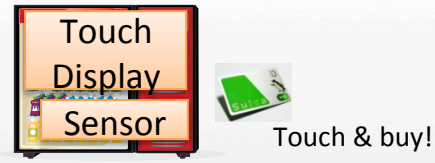
1.Rechargeable **Electronic Money Card** is commonly used.
- Total number of cards exceed Japanese population.
- Used as Money, Train Ticket, etc.



2.Highest Number of **Vending Machines**
- 1 vending machine per 23 people

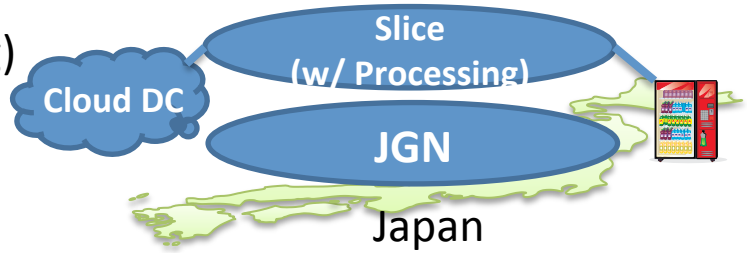


3.Vending Machine comes to **Digital Signage (Ad Display)**
- w/ Huge Touch Display and Sensors
- **Pay by touching** Electronic Money Card

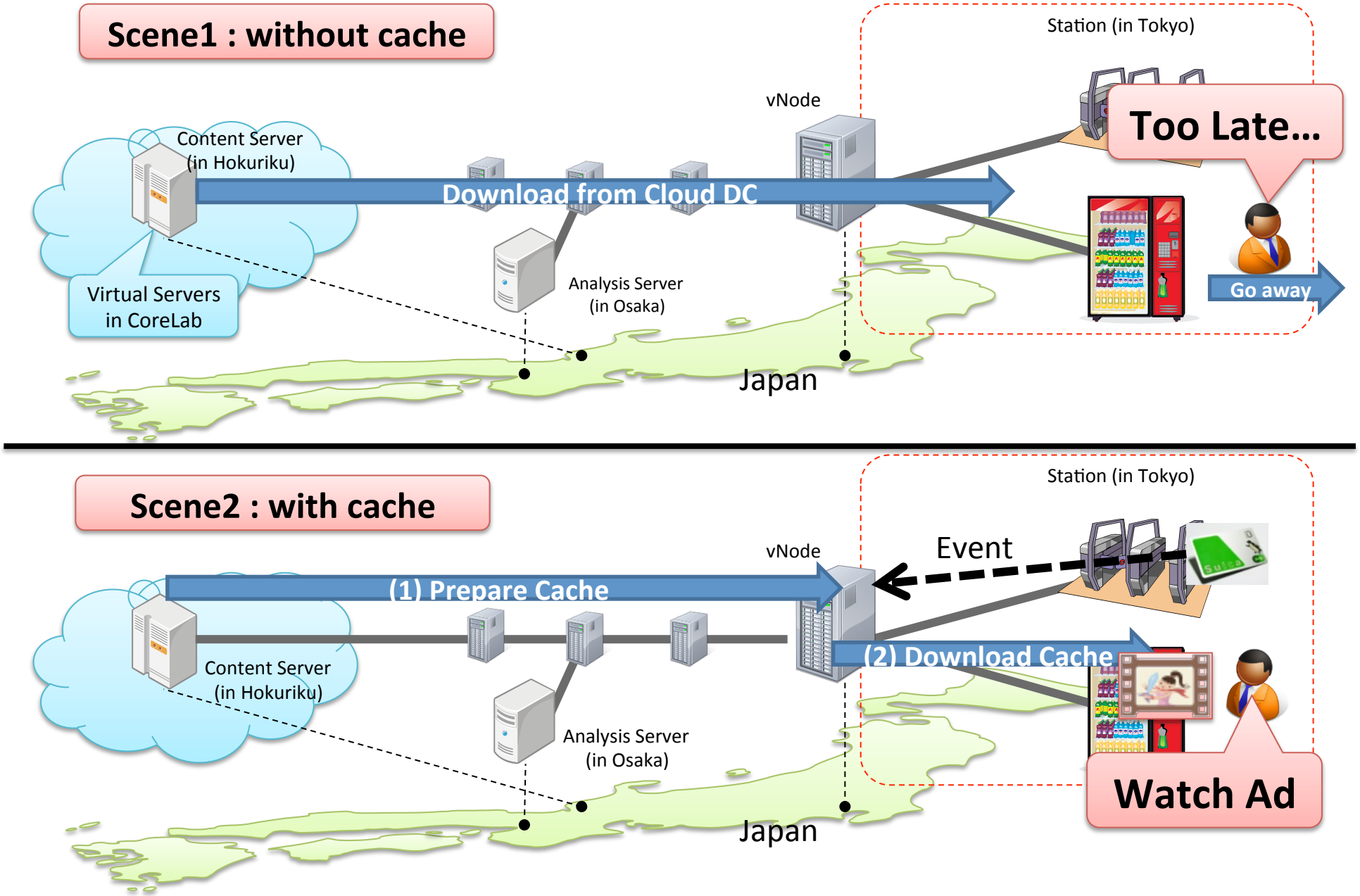


This Demo Shows

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



FUJITSU

shaping tomorrow with you

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…

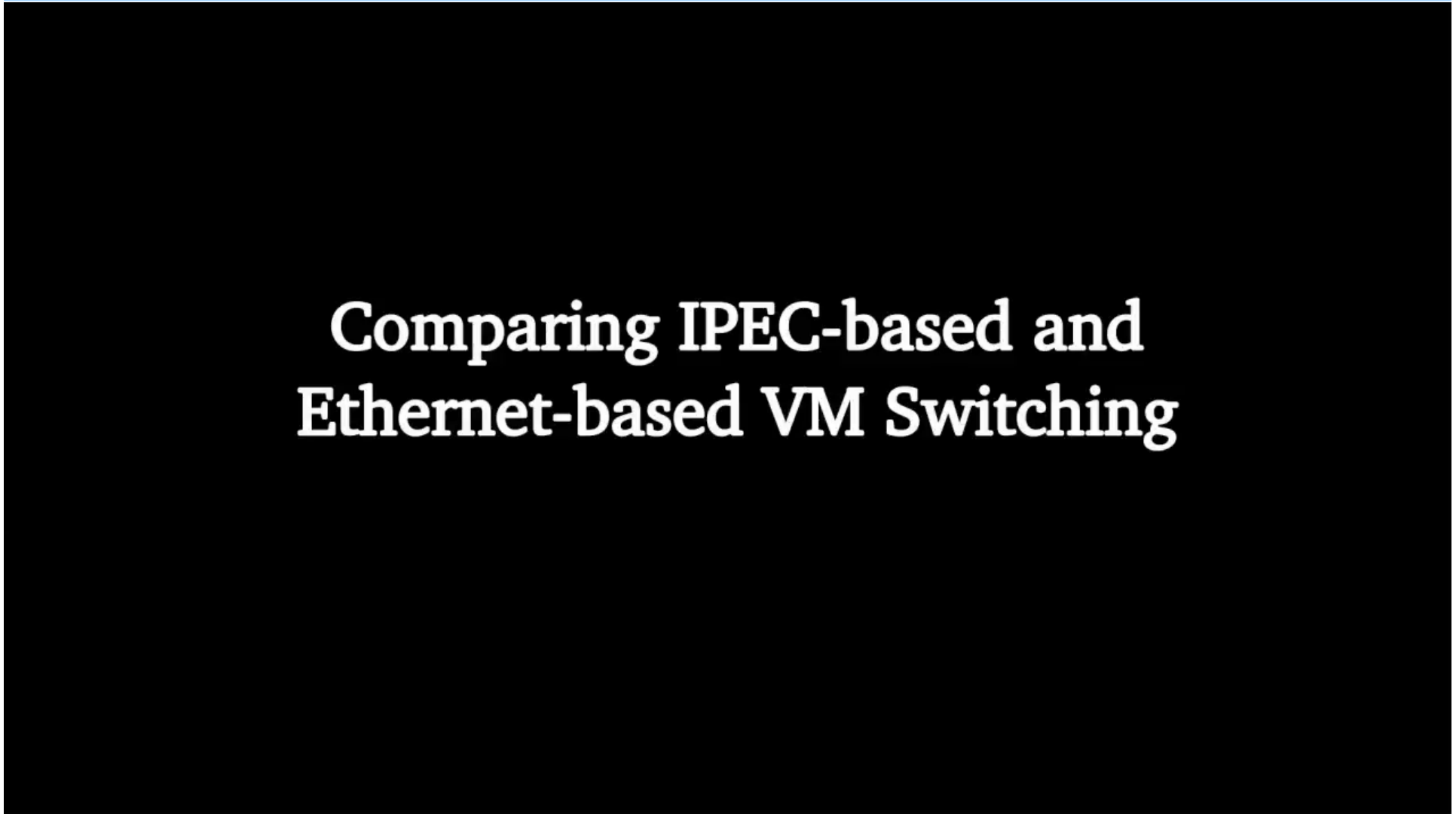
- Network Accommodation
- Scalable Experimentation
- Programmability

Demo: Wide-Area VM Switching Using IPEC

HITACHI
Inspire the Next

- **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



Slice 6

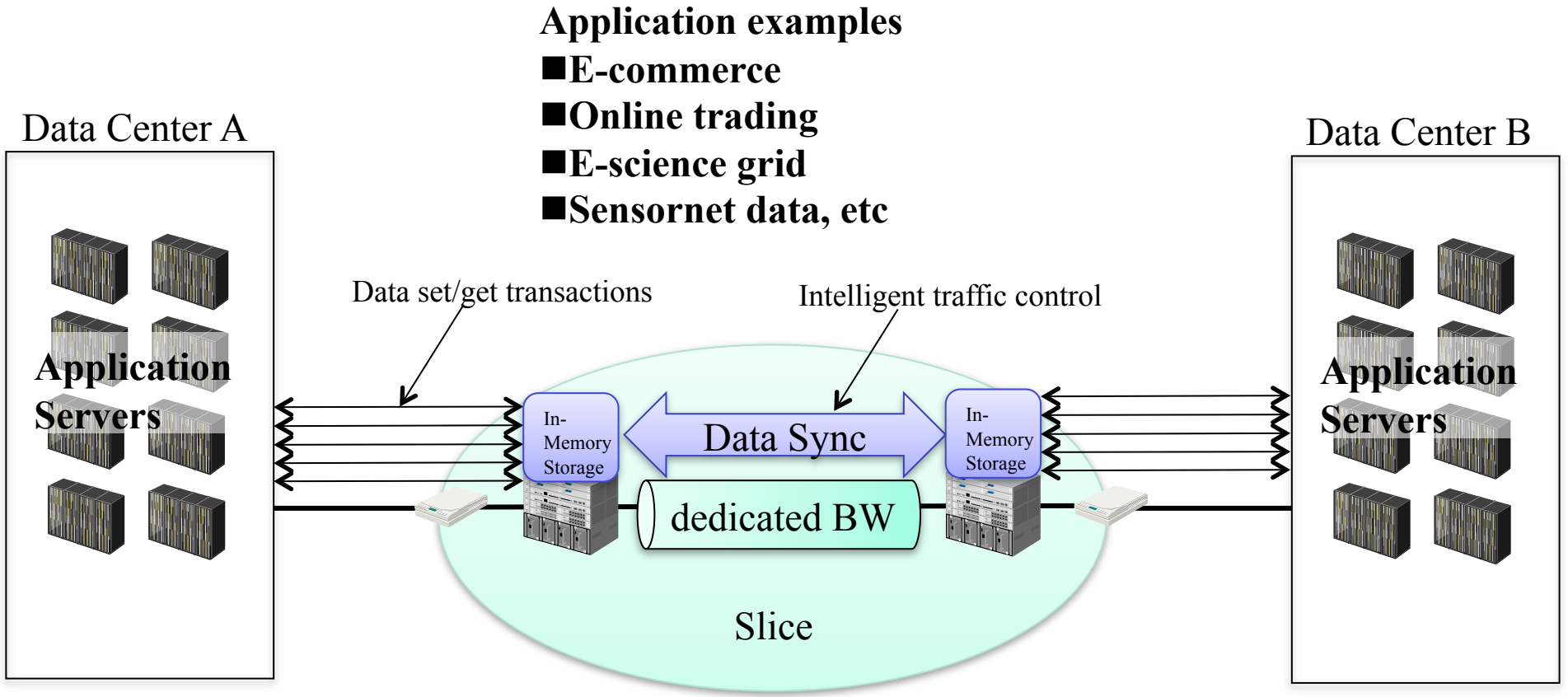
Inter-Cloud QoS

Demonstrating…

- Scalable Experimentation
- Programmability

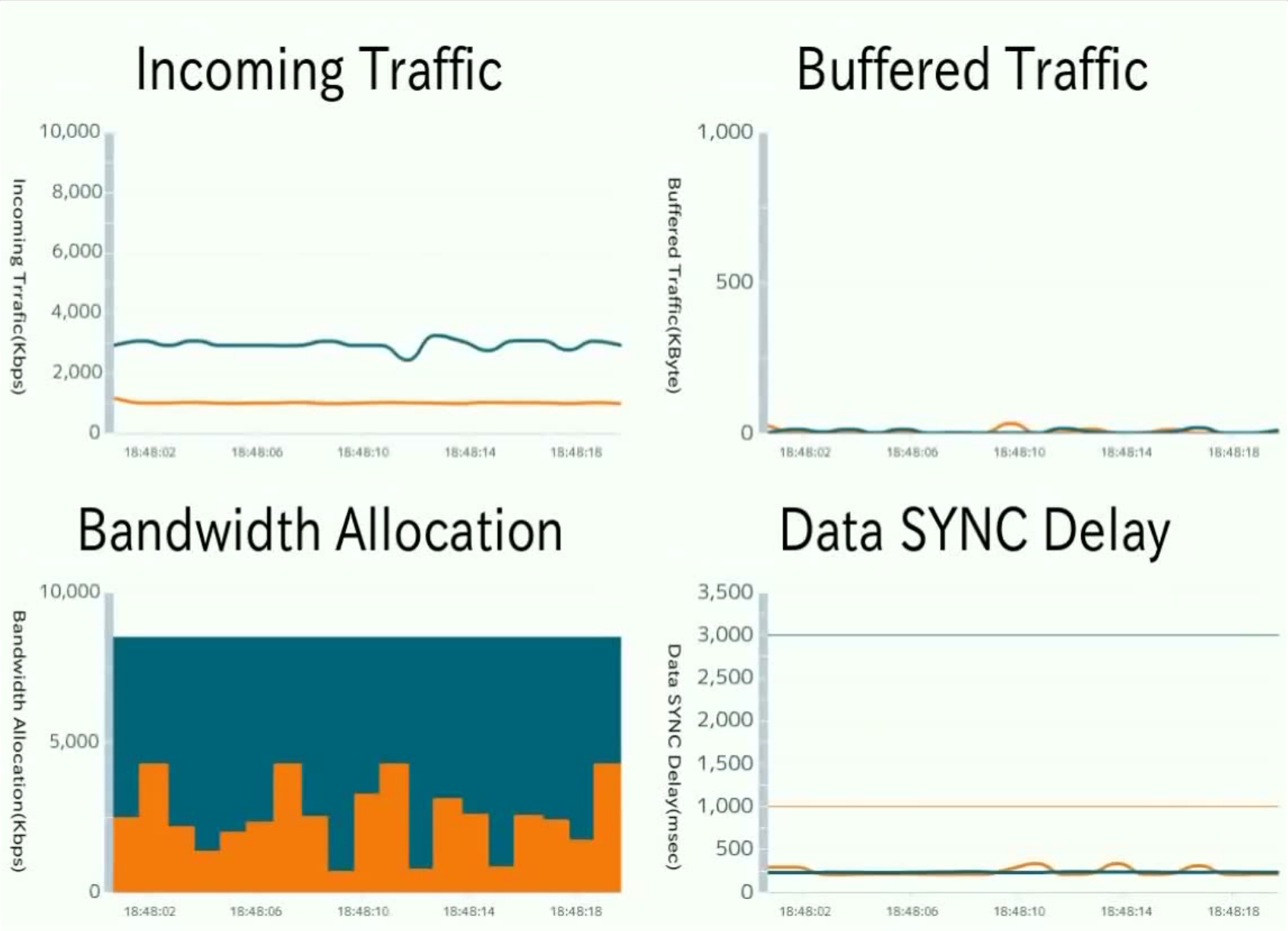
Data Sync Platform for Distributed Data Centers

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

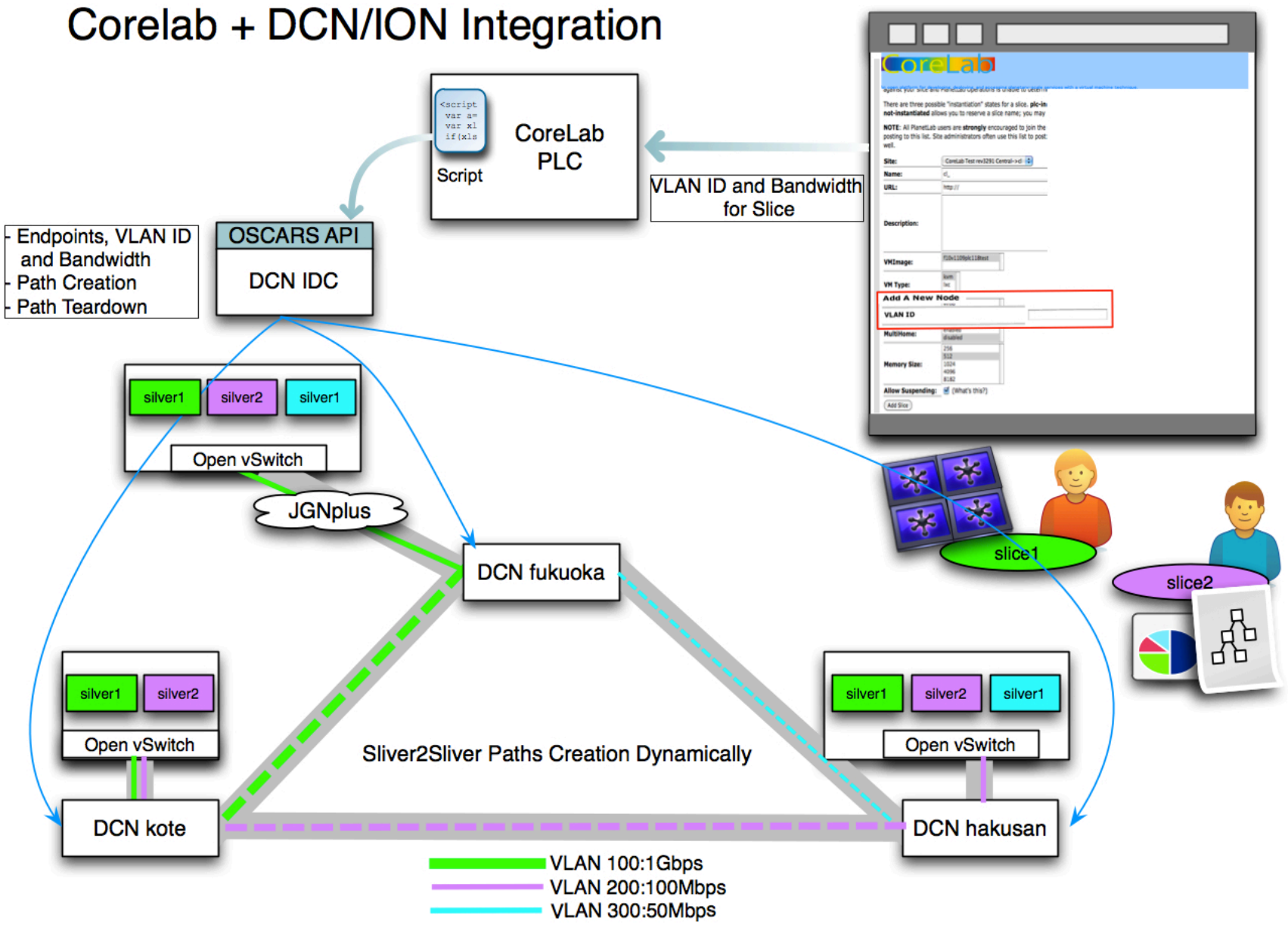


Part of this project is funded by National Institute of Information and Communications Technology (NICT).

Data Sync Platform: Demo Video



CoreLab Short Update



Future Directions

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

GENI

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