



Overlay Network / Network Virtualization

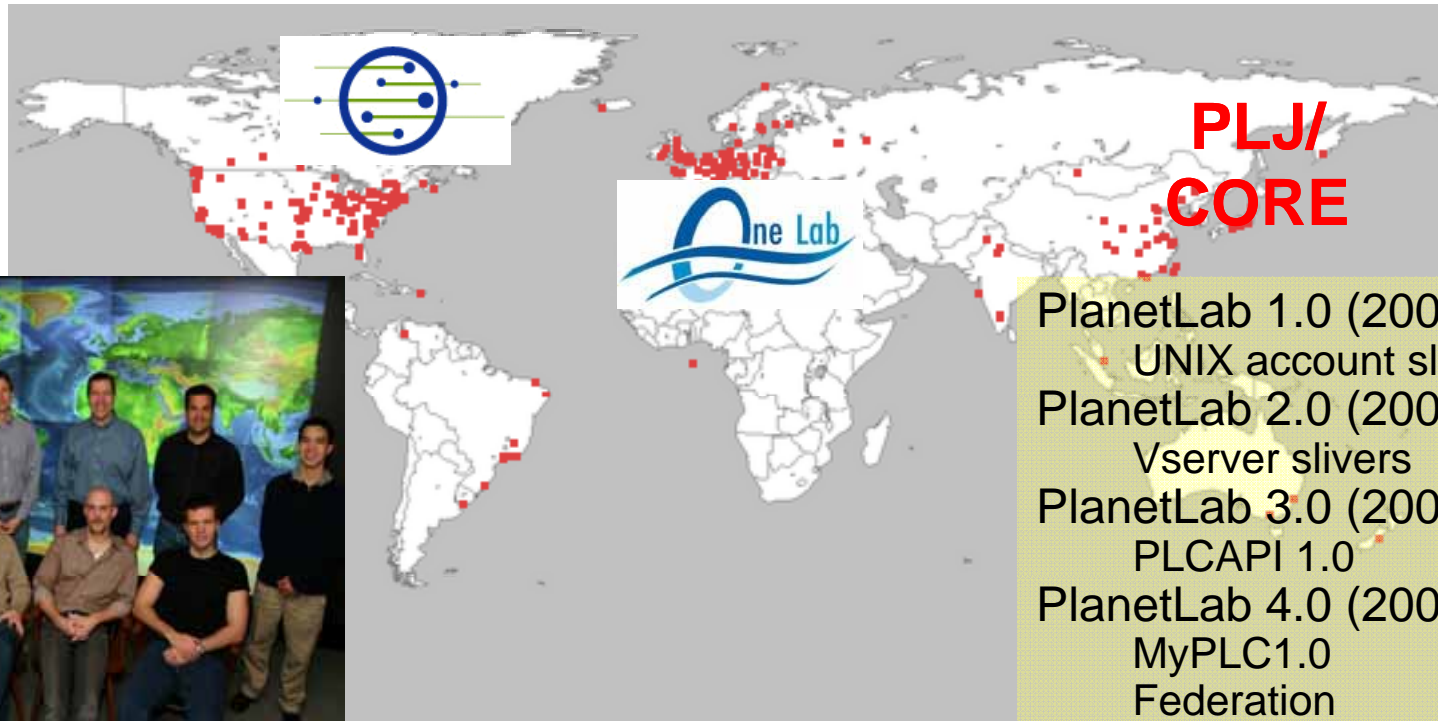
Towards New Generation Network Architecture

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PlanetLab Overlay Network

- The largest and most popular **overlay network testbed**
- Currently consists of 842 nodes at 416 sites (30+ countries)
- 850+ Projects
- **Universities and JGN2/NICT Collocation(Japan)**
- **Federation on going...**



PlanetLab 1.0 (2002-3)
UNIX account slivers
PlanetLab 2.0 (2003-4)
Vserver slivers
PlanetLab 3.0 (2004-2006)
PLCAPI 1.0
PlanetLab 4.0 (2007-)
MyPLC1.0
Federation

Overlay Network to Network Virtualization

● Overlay Network

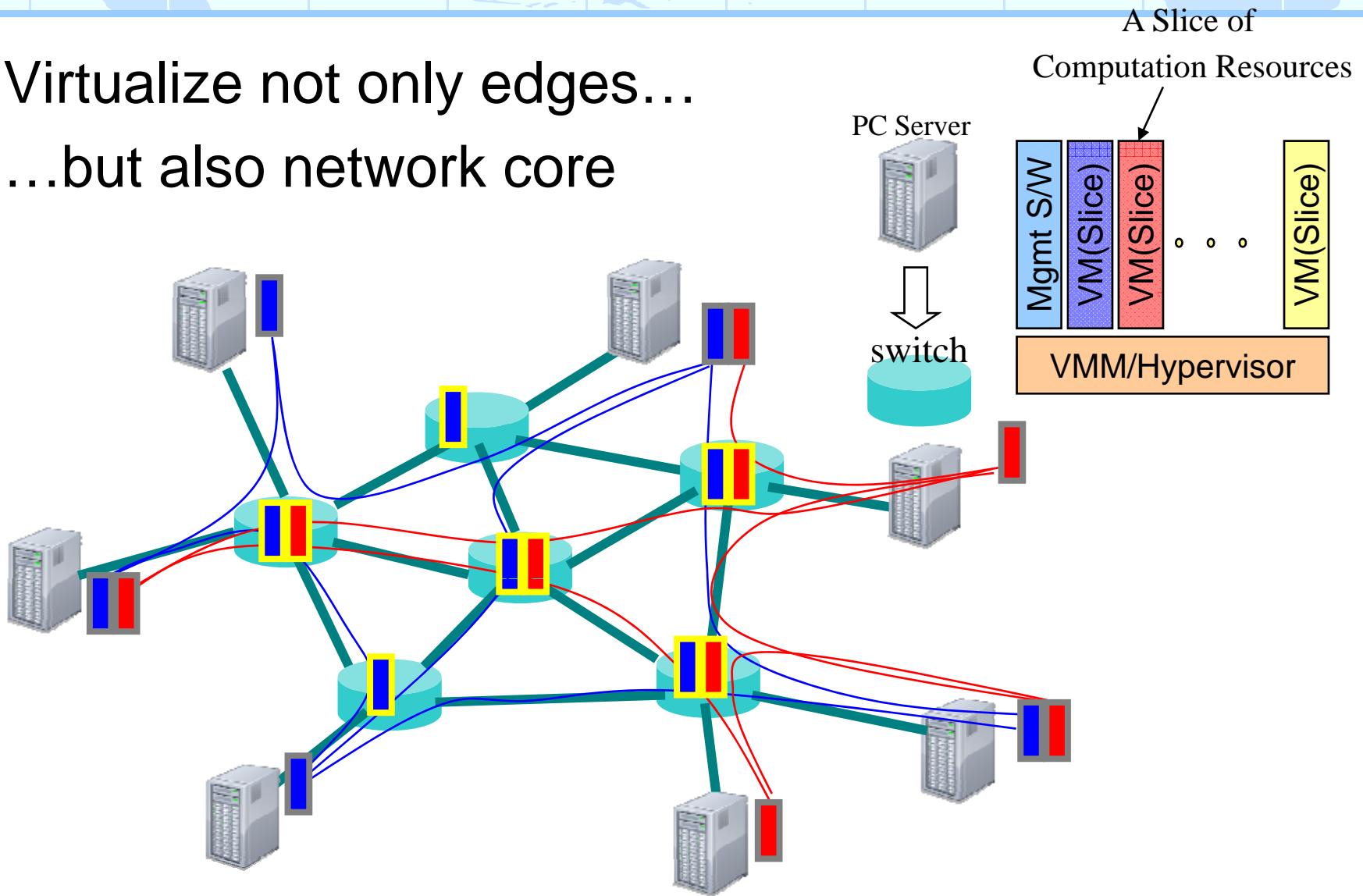
- Mostly for developing **network services**
- Some attempted to evaluate new network architecture
- Virtualize resources at the network edges

● Network Virtualization

- Focuses on developing **network architecture**
- Key technology for constructing NwGN network test-beds
- Could be (part of) the new generation network architecture

Overlay to Network Virtualization

- Virtualize not only edges...
- ...but also network core



PlanetLab to GENI... Similar efforts in several countries...

Purpose of Network Virtualization

- Existing test-beds
 - Emulab
 - PlanetLab/OneLab/EverLab/CORE
- Future test-beds using network virtualization
 - GENI
 - VINI (planetlab community)
 - ProtoGENI (emulab community)
 - Others
 - OneLab2/EU ???
 - CORE/Japan

“Network Virtualization” has been evolving
as a technique to enable test-beds

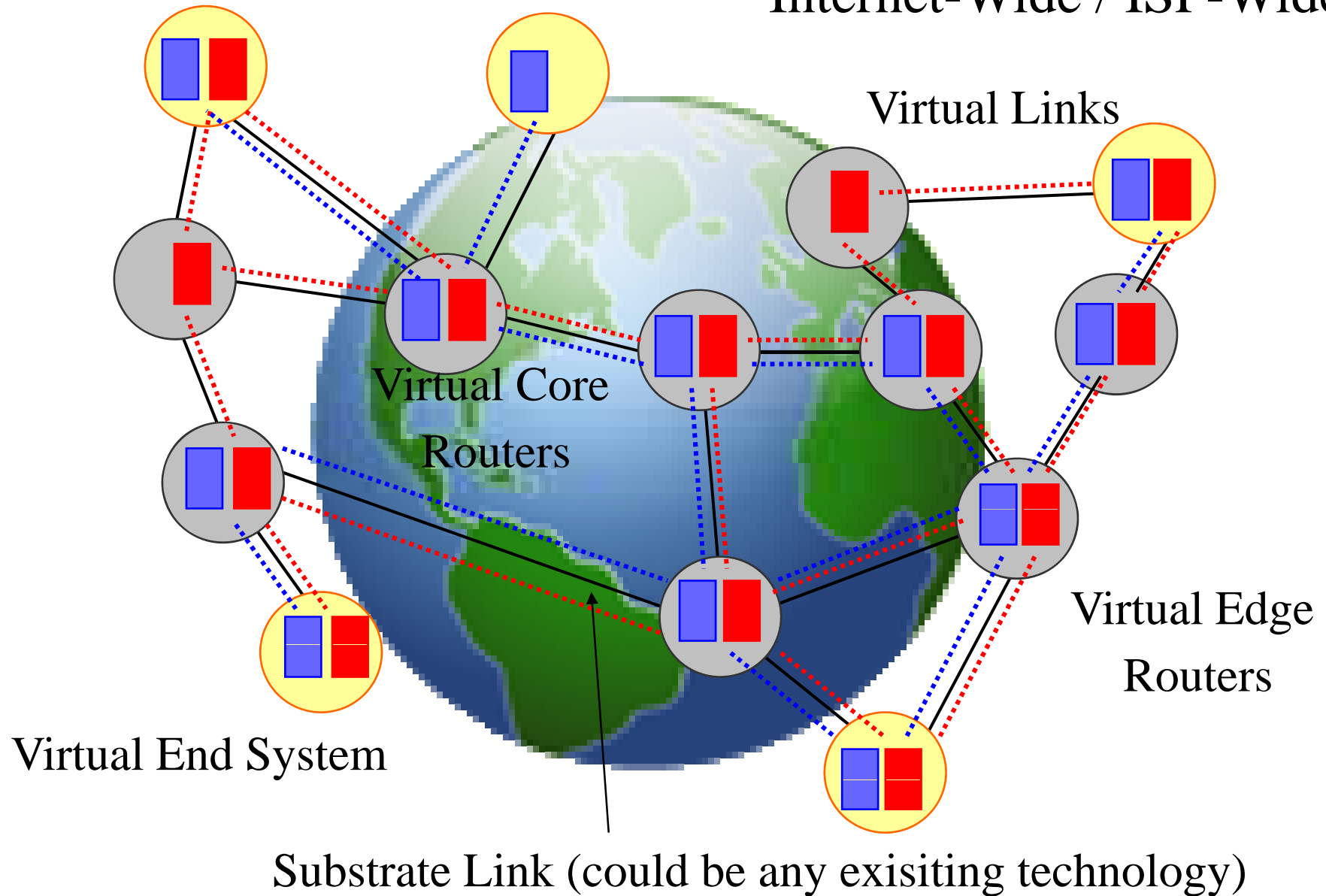
Can Net-Virtualization be Architecture Itself?

● Fully Virtualized Network

- ▣ Network-virtualization capable routers everywhere...
- ▣ No single new generation network architecture
 - Each proposed architecture implemented in a slice
 - “Competition Principles” and “Natural Selection”
 - Only successful slices (architectures) will survive...!!
 - We can continuously inventing the Internet!!
- ▣ Or fully virtualized network could be a single new generation network architecture...

Planetary-Scale Network Virtualization

Internet-Wide / ISP-Wide



What's possible with Virtualized Internet

- This will be an intense research area!
- **Isolation** enabled by network virtualization
 - Control/Data plane separation
 - 4D Architecture [*A.Greenberg, J.Rexford et.al. ACM Sigcomm 2005*]
 - SORA [*J.R.Lane and A.Nakao et.al. ACM ROADS 2007*]
 - Remove cross-talks between various QoS networks
 - “Application Specific Internet”&
 - Achieve better robustness
 - PathSplicing [*N.Feamster et.al. ACM HotNets 2007*]
 - Can purchase and lease “your own Internet”
 - CABO [*N.Feamster et.al. ACM CCR2007*]
 - Virtual Topology Embedding
 - Embed a desirable virtual topology into a real network
 - DDoS Mitigation via Virtualization
 - Burrows [*S.H.Khor and A.Nakao et.al. ACM Sigcomm LSAD 2007*]
 - Overfort [*S.H.Khor and A.Nakao to appear in IEEE IPDPS 2008 SSN*]

Our Research Efforts in Japan

● Network Virtualization / Overlay Research Lab

- Practically started in Oct. 2007 as an NICT project
- Conducting research on...
 - Next Generation Network Services (Overlay Network)
 - Next Generation Network Architecture (Network Virtualization)

● Budget x Period

- \$2.4M x 4 years

● Members

- 10 full-timers and 10+ part-timers
- Still hiring!

So this is a great opportunity for EuroJapan collaboration

- Absolutely no language barriers!

Research Lab Location

● Hakusan, Tokyo (near Utokyo)



3-Floors (3F, 4F, 6F)
Under Renovation

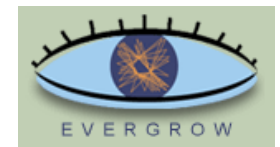


Objectives

- Most benefits **in user's eyes** boil down to **robustness** and **efficiency** (plus **controllability**)
- We focus on more **robust**, more **efficient**, and more **controllable** network services **through overlay network and network virtualization**
 - ▣ Infrastructure
 - Network Virtualization as “Network Architecture”
 - Test-beds Enhancement / Federation
 - ▣ Applications/ Architecture
 - Robust Network
 - DDoS Mitigation, Multipath Routing, Self-Organization,...
 - Efficient Network
 - Content Distribution

Current Research Activity

- Network Virtualization Infrastructure
- Test-bed Federation (Princeton, OneLab)
- Enhanced Private PlanetLab (CORE)
- Advanced Routing
- P2P Poisoning
- P2P Carrier Incentives
- Content Distribution
- Self-Organizing Network
- ...and more



**PLJ/
CORE**

GENI

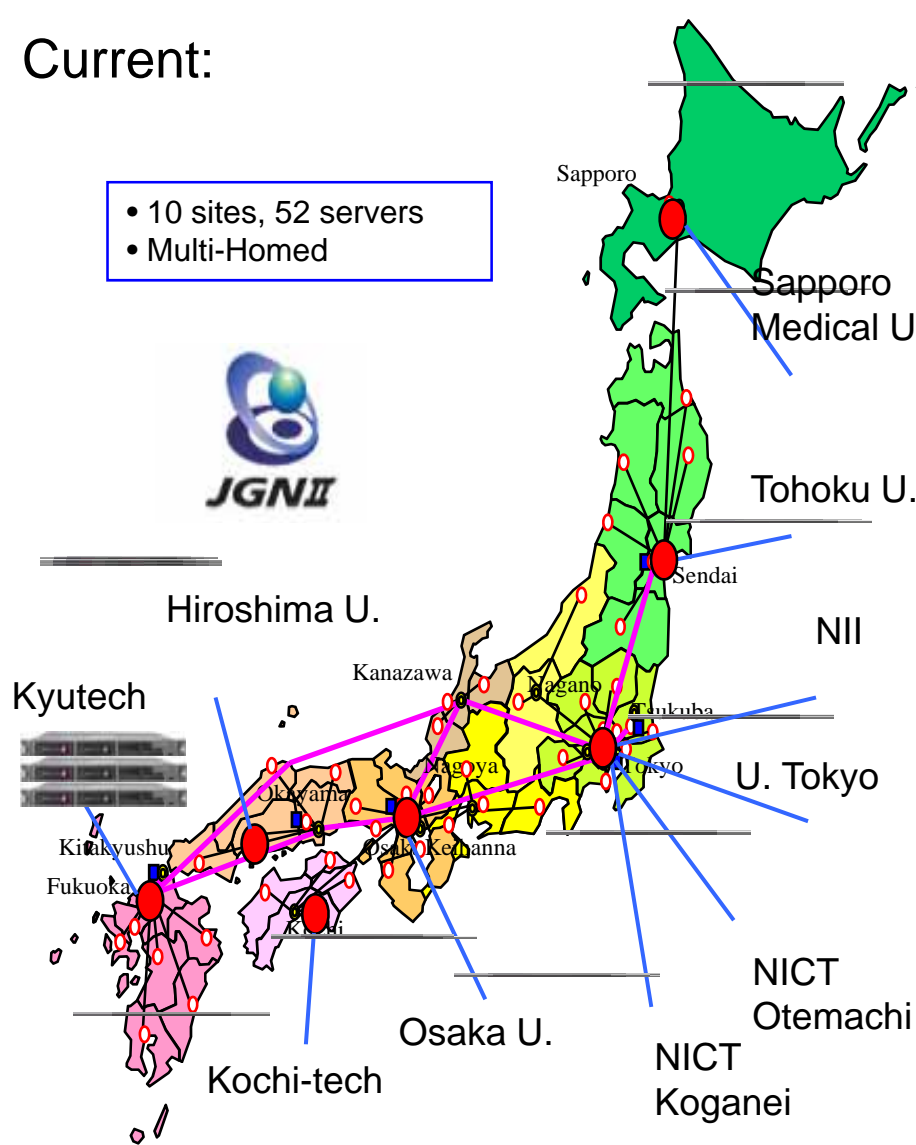
Current Goal: Robustness, Efficiency, and Controllability



CORE: Private PlanetLab

Current:

- 10 sites, 52 servers
- Multi-Homed



THE UNIVERSITY OF TOKYO



CORE

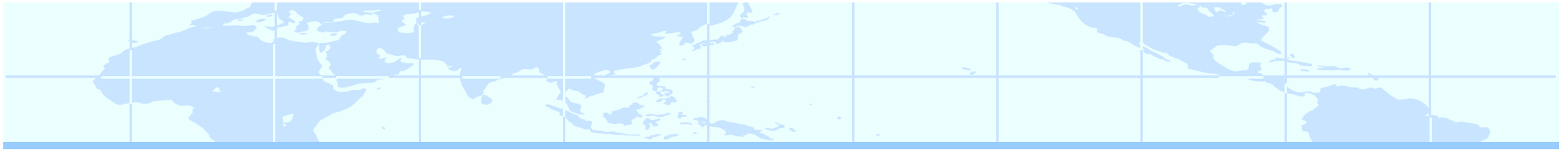
- Collaborative Overlay Research Environment
 - Overlay test-bed based on “Private PlanetLab”
 - Provision resources for mission critical services
- Features we would like to have...
 - Custom hardware to optimize overlay forwarding
 - PoP/Core collocation (nodes “inside” network)
 - Custom hardware to optimize overlay forwarding
- Federation (e.g. PlanetLab, OneLab)
- Target overlay research
 - Not just on distributed system apps
 - More on network core architectures
- Utilize both private & public environments
 - Local v.s. Global / Provisioned v.s. Best-Effort

New Generation Perspectives to Overlay Network

- Testbed for prototype and evaluate a new generation network design
- Evolutional nature of overlay network to incorporate into the design

Conclusion

- Game has just started...
 - Everybody has its own agenda
 - Cooperative competition – **Coopetition necessary**
- Network Virtualization / Overlay is one of the key technologies for proceeding further in defining NwGN architecture(s)
- EuroJapan efforts will play a crucial part in this global, planetary-scale coopetition



JGN2/NICT PlanetLab Collocation

● JGN2/NICT Collocation

- Princeton has donated machines
- PIs: NICT/UTokyo Researchers



[About](#) | [Status](#) | [Support](#) | [Documentation](#) | [Community](#) | [Software](#)

PlanetLab

- ▼ **About**
 - ▶ Consortium
 - Federation
 - History
 - Sites
 - Projects
- Status
- ▼ **Support**
 - Site Assistant
- ▼ **Documentation**

Federation

PlanetLab is engaged in a federation trial with the OneLab Project. The plan is to migrate European nodes and slices to an independent EU authority. Follow the [federation link](#) to learn more.

[Announcements](#) | [Larry](#)

PlanetLab

PlanetLab is a global research network that supports the development of new network services. Since the beginning of 2003, more than 1,000 researchers at top academic

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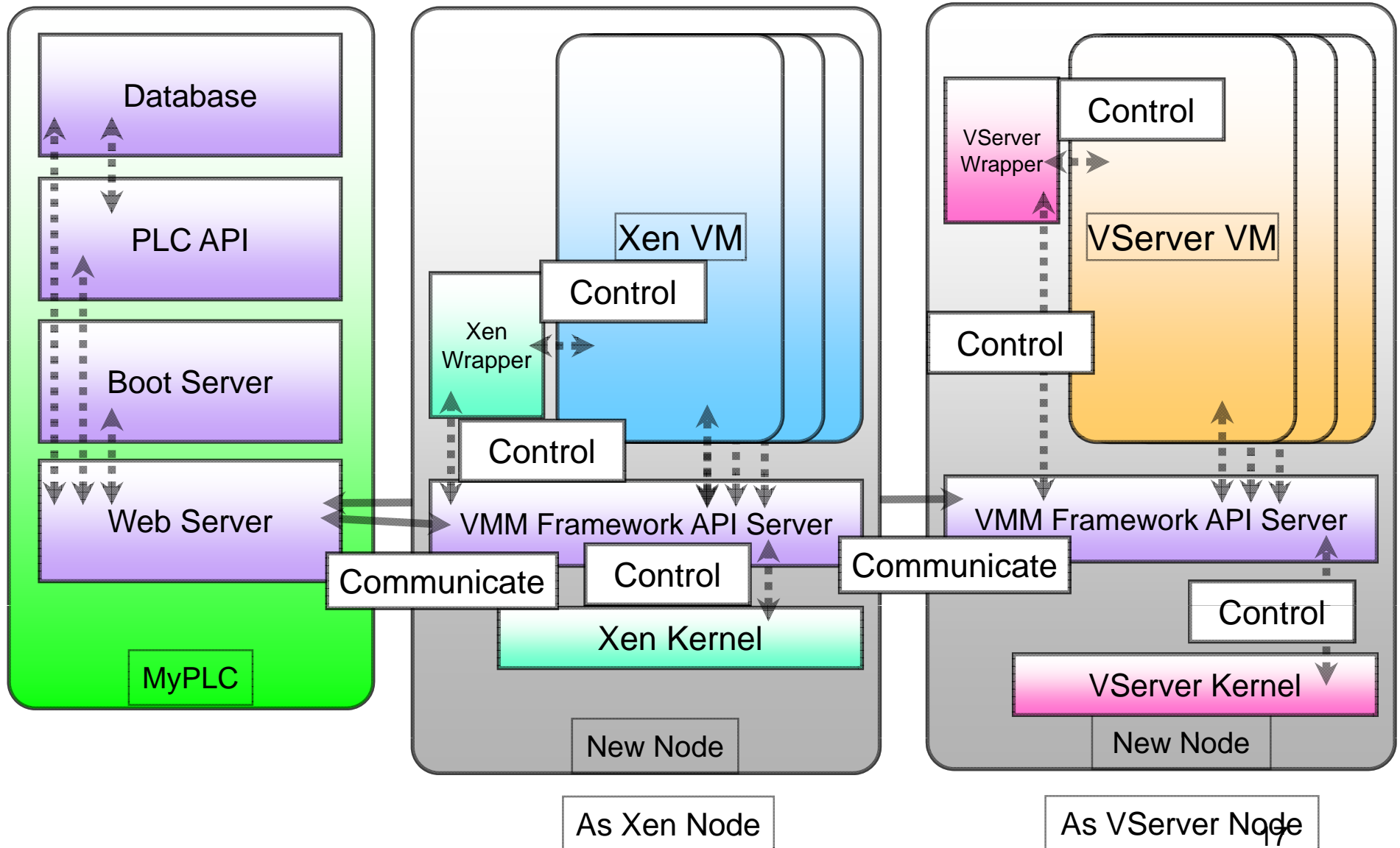
◦ Sites

- University of Tokyo
- NICT JGN2 Sendai
- NICT JGN2 Nagoya
- NICT JGN2 Osaka
- NICT JGN2 Okayama
- NICT JGN2 Hiroshima
- NICT JGN2 Kochi
- NICT JGN2 Fukuoka

◦ Nodes

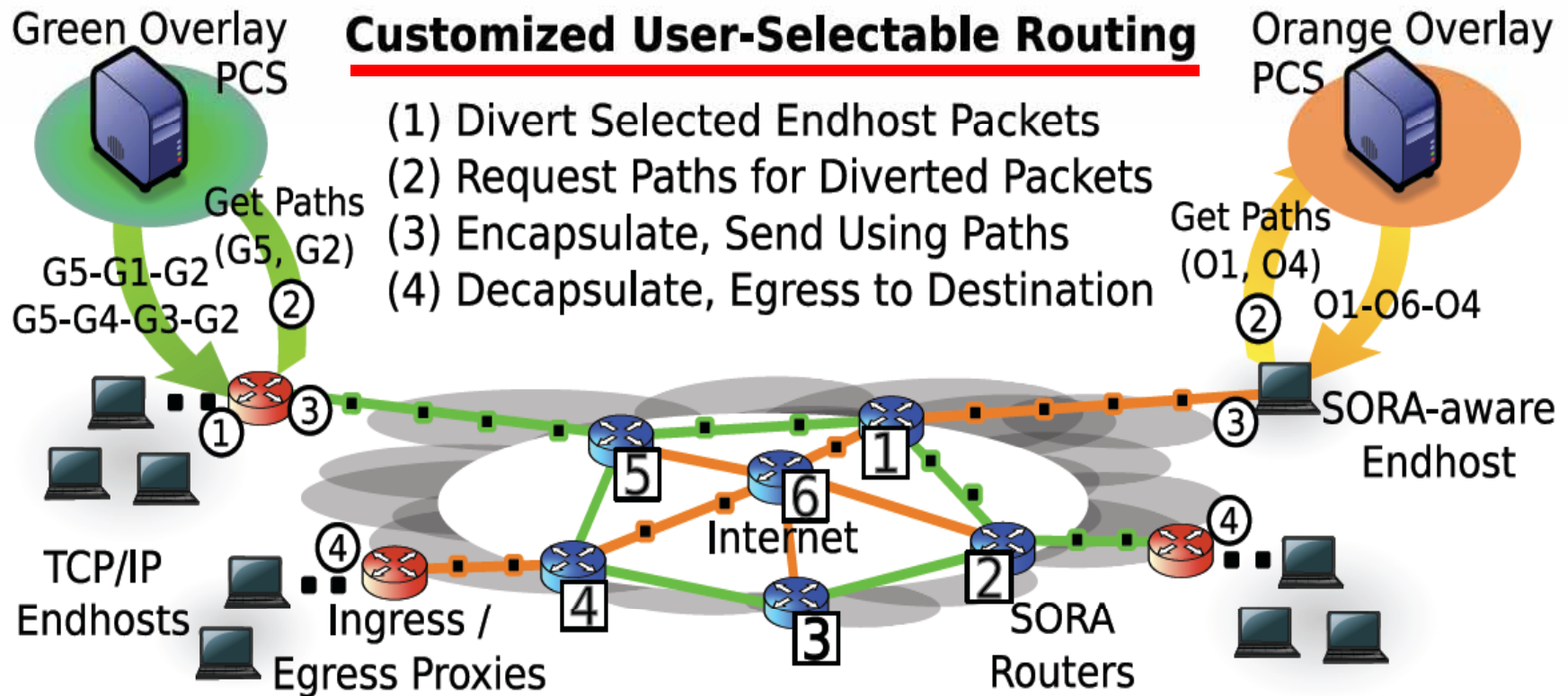
- University of Tokyo

Xen-Enabled Private PlanetLab



SORA Overview

SORA makes Routing-Overlay scalable...



SORA is designed to provide flexible, robust network routing, responsive to the needs of end users and applications: customized user-selectable routing.