

Expectations for the GENI Project and Technical Challenges for a Next Generation Internet

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Atsushi Iwata

NEC Corporation

E-mail: a-iwata@ah.jp.nec.com

Outline

- **History of C&C concept**
- **What's a vehicle of future network research ?**
- **Expectations to GENI projects, node architecture and service architecture**
- **NEC's activities**
 - **Toward high performance Programmable Edge Cluster (PEC)**
 - **(1) Virtual link (flow) scheduling**
 - **(2) 10Gbps IDS Flexible Platform**
 - **(3) I/O virtualization bridge**
- **Conclusions**

C&C concept

- The integration of Computers & Communications -

Keynote speech at Intelecom77
In Atlanta, on Oct.10th, 1977



Chairman,
Koji Kobayashi

If I am asked about my vision for communications in the future, and if I am allowed to talk beyond my ability, my imagination goes to such extent that social needs for communications might be "to talk and see between any persons, at any time, at any place on the earth, in the early days of the next century."

Assuming that this comes true, all technology, communications, computer and television will be, and should be, integrated for such needs at such time. And therefore, it is important to help developing countries to be able to participate in such a world telecommunications system.

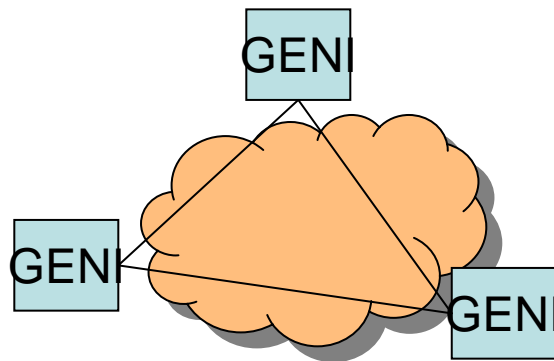
- The 30th year anniversary of C&C concept
- Expect that FIND research goal with GENI will achieve this "C&C" society.

What's a vehicle of future network research ?

- **Key elements of integrated computing & networking technologies**
 - **Open architecture**
 - Easy to integrate modules for new features
 - **Virtualization:**
 - Dynamic grouping, partitioning and allocation of resources for ease of management
 - **Modularity:**
 - Dynamic in-service plug-in of software and hardware
 - **Programmability**
 - Evolve to new computer & network architecture
- **These GENI's components will be key for multi-purpose research platform**

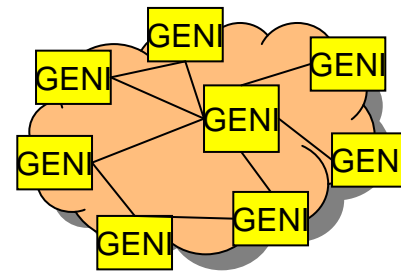
Expectations to overall GENI projects

- Expect to accelerate many trials of new internet research activities through instant globally virtualized networks.
- Expect future innovative FIND research, combined with specifically customized GENI node for it, to be a basis of next generation internet.
- Expect to collaborate with Japanese research projects (New generation network(NwGN))



1st Generation:
Virtualized programmable overlay network

Evolved to 2nd Gen.



2nd Generation:
Next generation internet

Expectations to GENI's node architecture

- **Current node architecture**

- PlanetLab-VINI (Princeton Univ.) as a baseline of virtualization software (based on UML)
 - Overlay routing/forwarding control on virtual network interfaces
- Supercharge-PlanetLab (SIGCOMM07, WUSTL) as a hardware assisted virtualized node
 - Significantly offload processing to linecards with NPs/FPGAs

- **What's possible next for another supercharge ?**

- Higher performance of virtual machine platform (Xen-based from UML?)
- Higher resource utilization & partitioning by many core CPUs with direct I/O and shared I/O capabilities

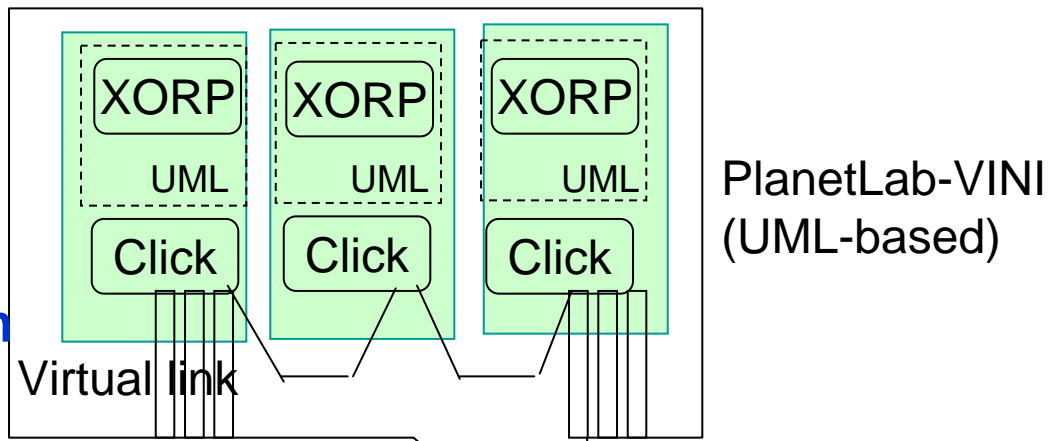
Expectations to GENI's service architecture

- **Current service architecture**
 - **GENI Management Control Interface (GMCI) defines**
 - Naming, addressing and privileges for users to access
 - Capability of creating a slice, consisting of nodes and links with configured specific topology.
 - Module interface between software and hardware with ForCES
- **What's possible next for service infrastructure?**
 - **Robust infrastructure via autonomic dynamic management system** of monitoring, analyzing, and control of GENI platform
 - For platform management and internal slice management
 - **More flexible pluggable software architecture** with specifically higher layer common module (routing / switching / forwarding / monitoring) I/Fs on VM

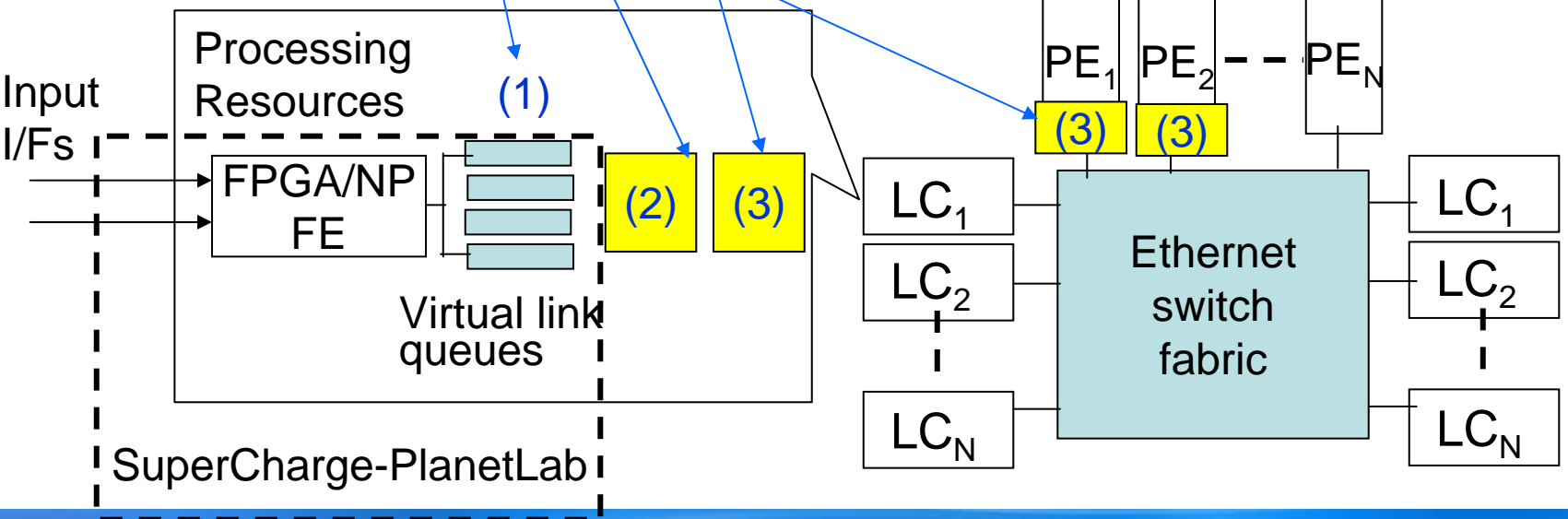
Toward High Performance Programmable Edge Cluster (PEC)

Examples of NEC's activities

- (1) Virtual link (flow) scheduling
- (2) 10Gbps IDS Flexible Platform
- (3) I/O virtualization bridge (PCI-Express over Ethernet bridge)

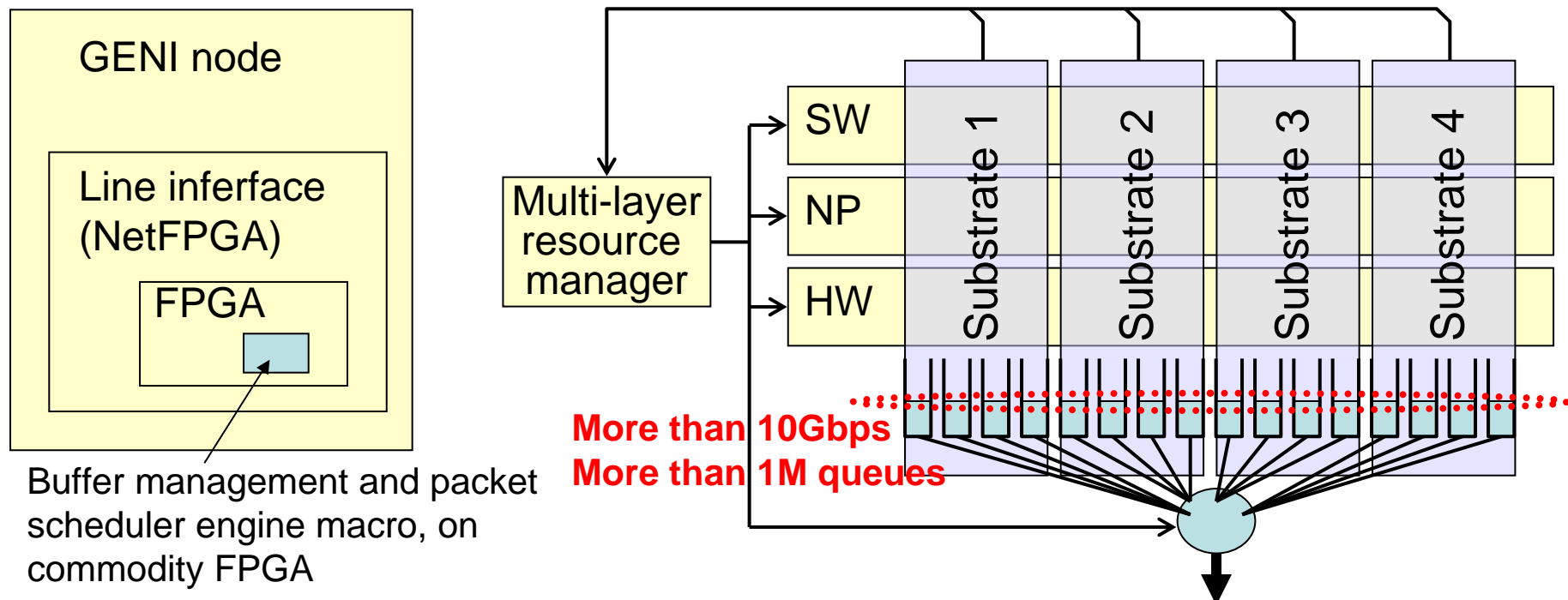


Processing Engines



(1) Virtual link scheduling - Super charging bandwidth sharing -

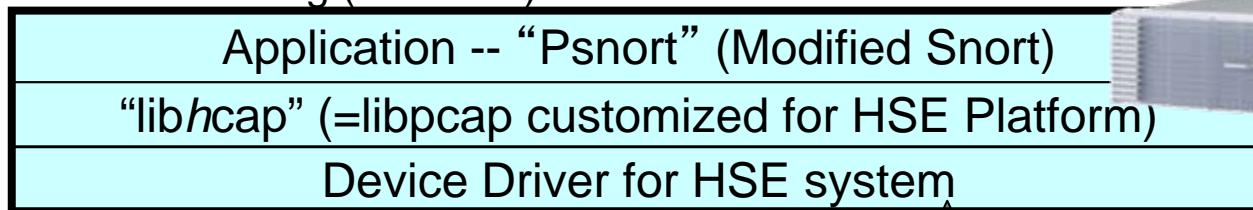
- Large-scale and fine-grain bandwidth sharing
 - Large number of substrates share bandwidth
 - Each substrate deals large number of application flows
- Special super-charger for bandwidth sharing
 - Makes GENI node provide much faster and rich/guaranteed service



(2) 10Gbps IDS Flexible Platform for Network Security

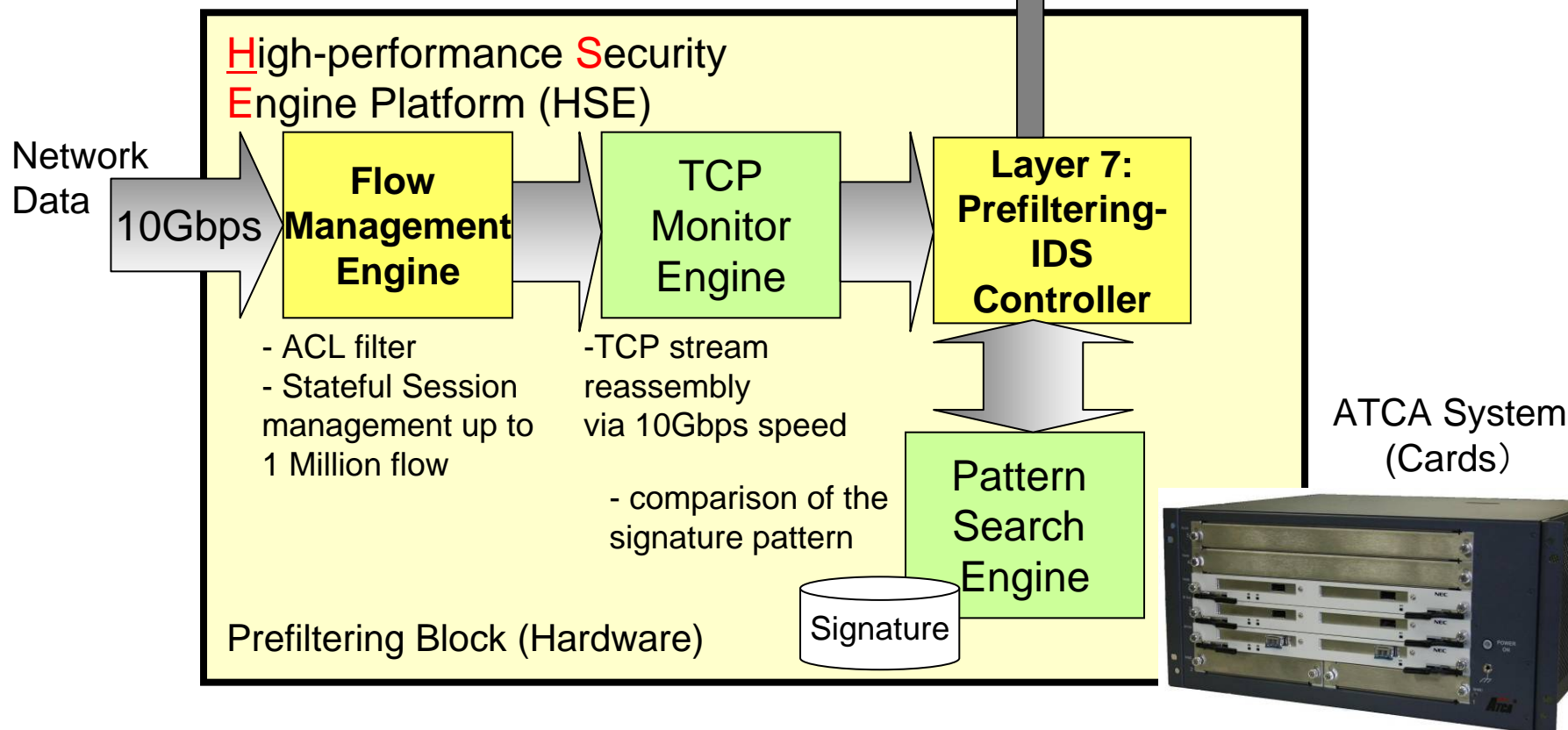
Intel Architecture Server

Detail Checking (Software)



PCI-Express

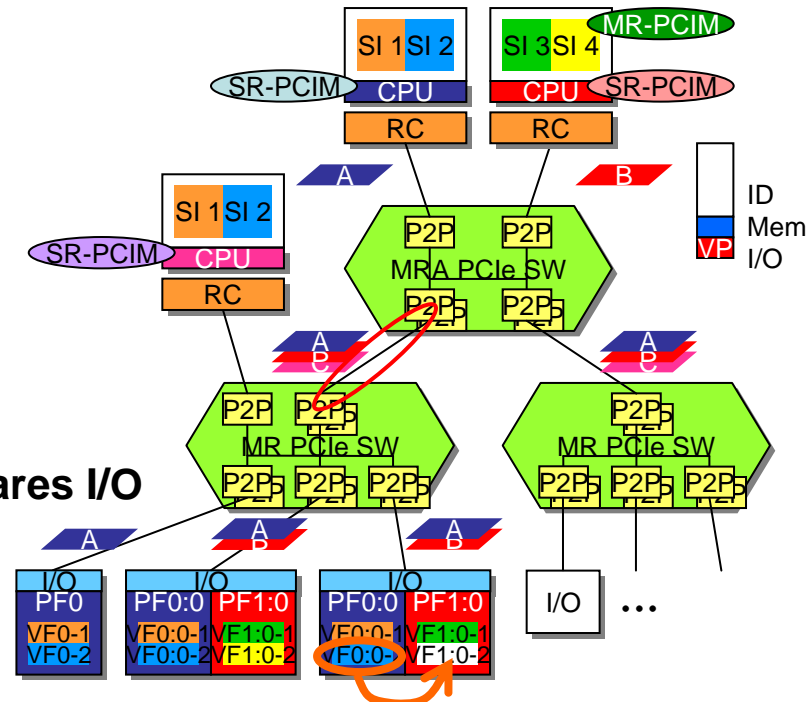
Suspicious Traffic Data



(3) I/O virtualization bridge

- I/O Virtualization

- Standardization trend of PCI-SIG
- PCI Express I/O Virtualization (IOV)
 - Single-Root IOV (SR-IOV)
 - Multiple VMs on CPU shares I/O
 - Multi-Root IOV (MR-IOV)
 - Multiple VMs on different CPUs shares I/O



- Direct I/O (Intel)

- Intel VT-d technology
 - Allows VM to access directly to I/O without Xen's Dom0 forwarding

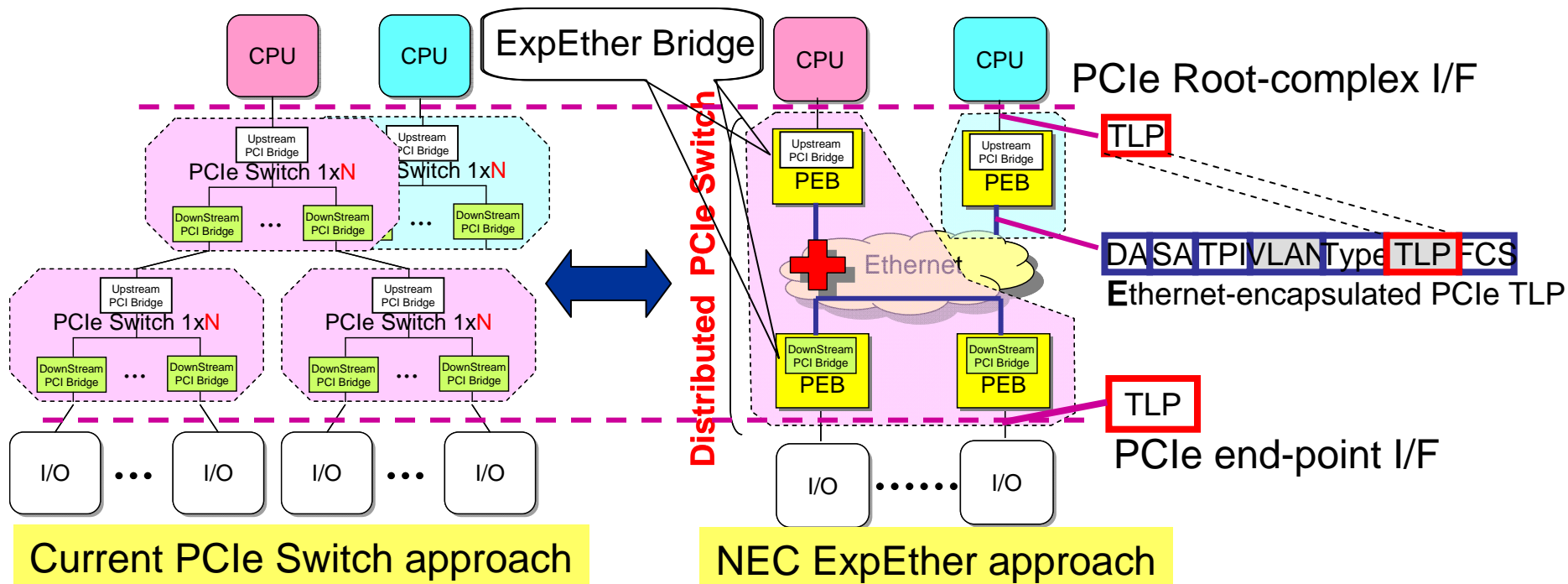
- I/O modularization/virtualization

- NEC ExpEther™ technology
 - Virtualization of PCI-Express Interconnect over Ethernet
 - SR-IOV and MR-IOV compliant I/O sharing

(3) ExpEther™ Technology (PCIe over Ethernet)

- Distributed PCIe switch architecture -

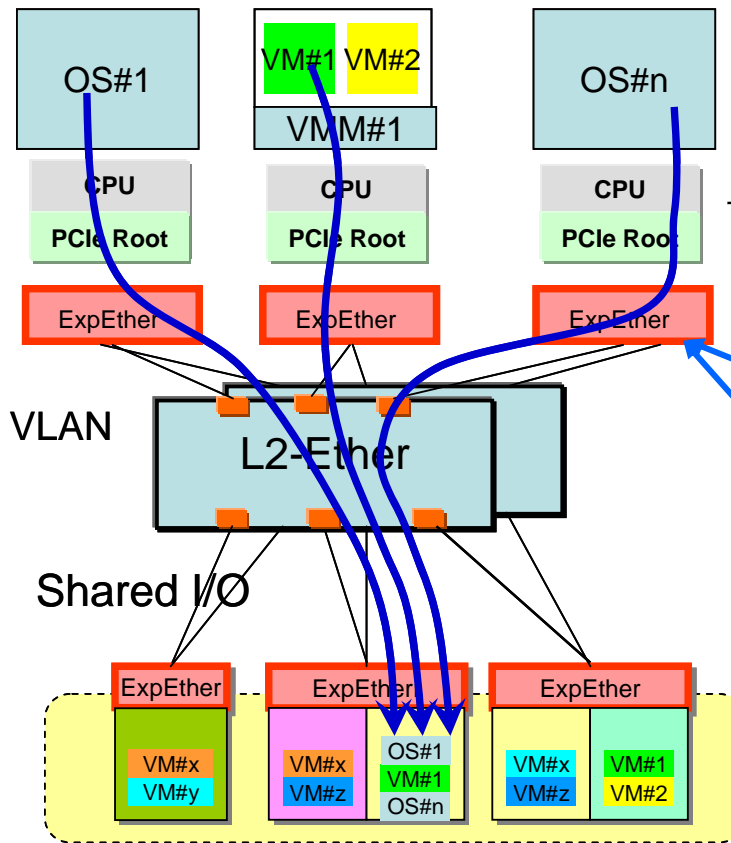
- **Virtualization of PCI-Express interconnect**
 - Enable a large scale “low-cost” PCIe switch.
 - Efficiently shares I/O
- **Potential use of ExpEther interconnect within GENI’s node**
 - Simply use ExpEther NIC card to virtualize large-scale PCI-e interconnect



(3) Usage model of ExpEther NIC card

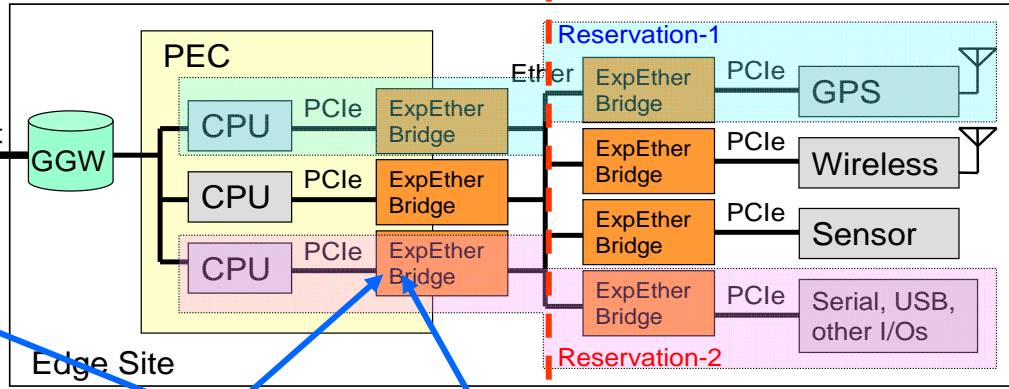
- **Shared I/O**

- enables different VMs and different cores to share the same line cards



- **Remote / Modular I/O**

- CPU drives remotely located (CPU-less) PCI-Express devices
- E.g. Storage, GPS, Wireless, Sensor, other peripherals



Remotely located CPU-less PCI-e devices



PCIex4-10GbE bridge



PCIx1-1GbEx2 bridge

Conclusion

- **Hope that GENI projects will provide a good research platform**
 - to accelerate future internet research and
 - to pursue a next generation network/node architecture
- **Can contribute to GENI projects with US university partners.**
- **Possible collaboration with Japanese government research projects (New generation network (NwGN))**