Virtualized Programmable Platform and Federated Testbeds for Future Internet Research

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Why Virtualized Programmable Platform ?

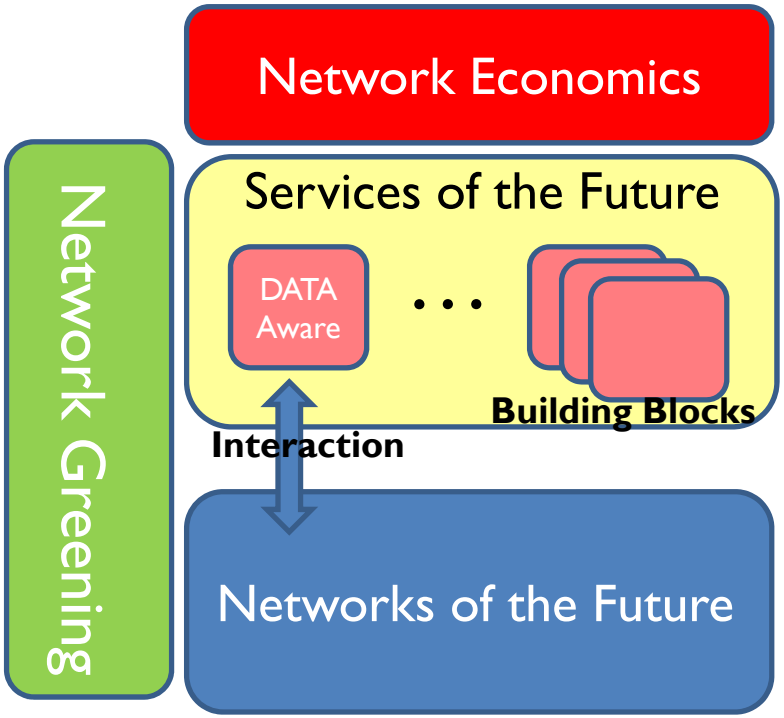
- The current Internet architecture is under serious reconsideration and people started thinking about alternatives.
  - Redefining Internet architecture requires many challenged works
- It's necessary to support a variety of the new different architectures to accommodate the heterogeneity of Future Internet (FI).
  - A common platform should be provided to accommodate the new heterogeneous architecture research and experiments in a shared infrastructure and testbed.

Two Objectives

- Future Internet Testbed as a short-term solution for architecture experiments
  - Running multiple experiments simultaneously in a shared experimental testbed
  - E.g., GENI
- Future Internet Architecture as a long-term solution for the future Internet
  - Virtualization, programmability, and federation would be an integral part of Future Internet Architecture
  - E,g, CABO and FP7 4WARD, Trilogy, …

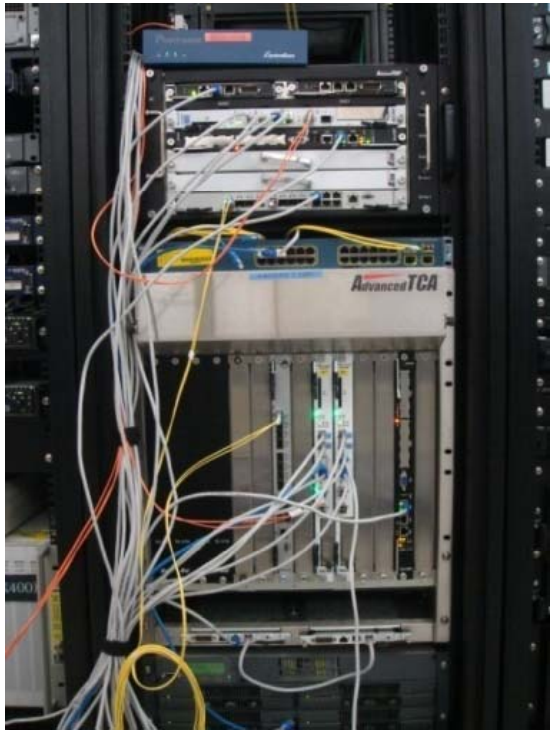
My Own View on Future Internet

- Service and Network Interaction
- Data-oriented Networking
- Network Economics
- Network Greening

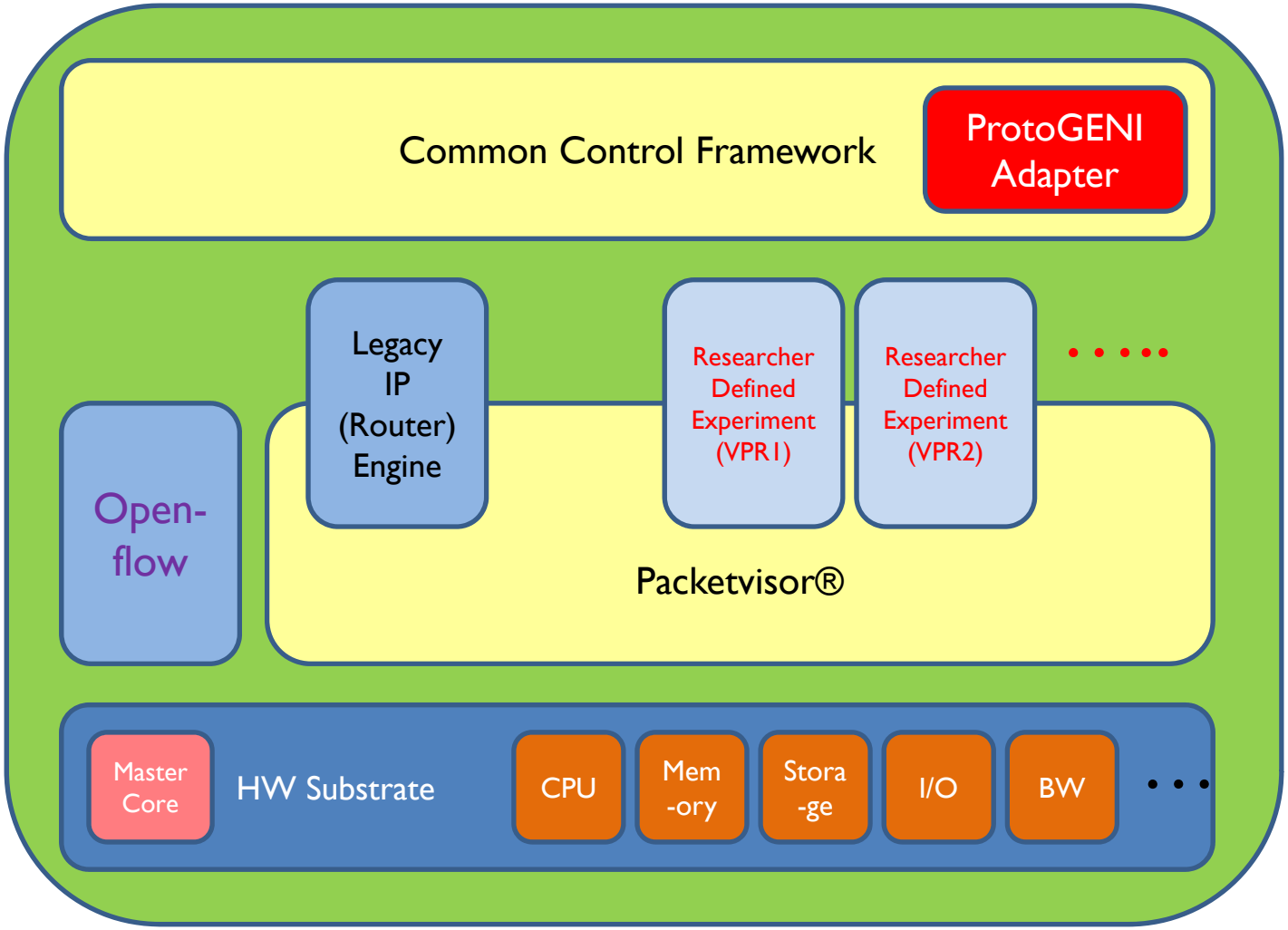


ETRI Platform Prototype

- NP-based hardware platform
  - Virtualized programmable substrate that operate at high speed (ATCA hardware)
- Virtualized programmable routers
  - Researcher-defined "Silver-based Virtual Routers"
- Common Platform APIs
  - Programming APIs for Researchers
  - Open substrate interfaces
- Capabilities and functions
  - Dynamic End-to-end Slice Operations
    - Control Framework APIs (GENI-compatible)
  - Openflow enabled

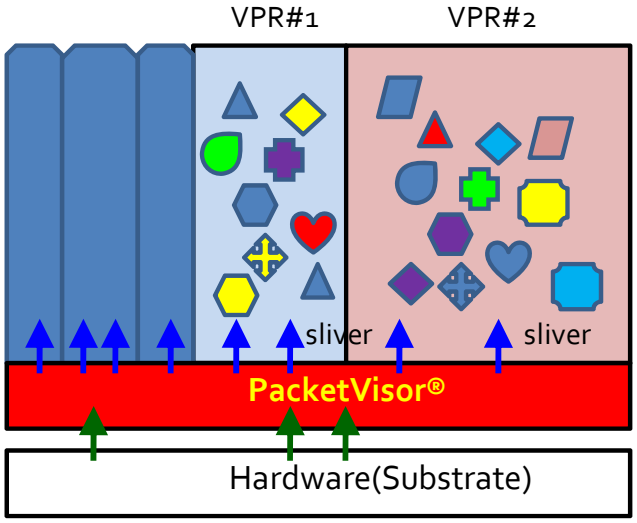


Platform Architecture

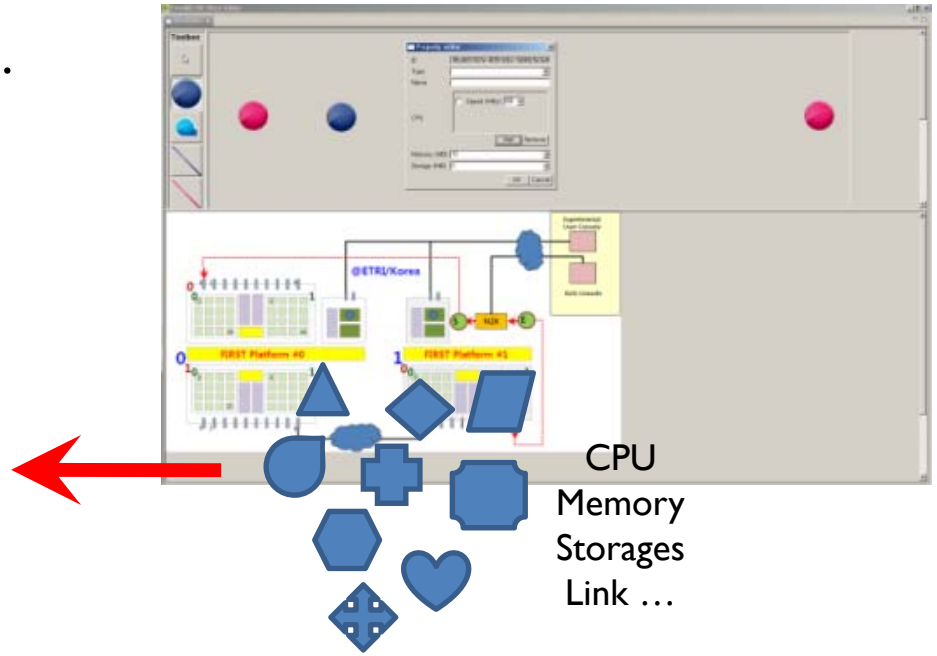


Researcher-defined "Virtualized Programmable Routers (VPR)"

- Dynamic resource allocation to sliver/link
  - Computing resources
    - CPU, memory, storage…
  - Network resources
    - Bandwidth/Link …



VPR - Virtualized Programmable Router

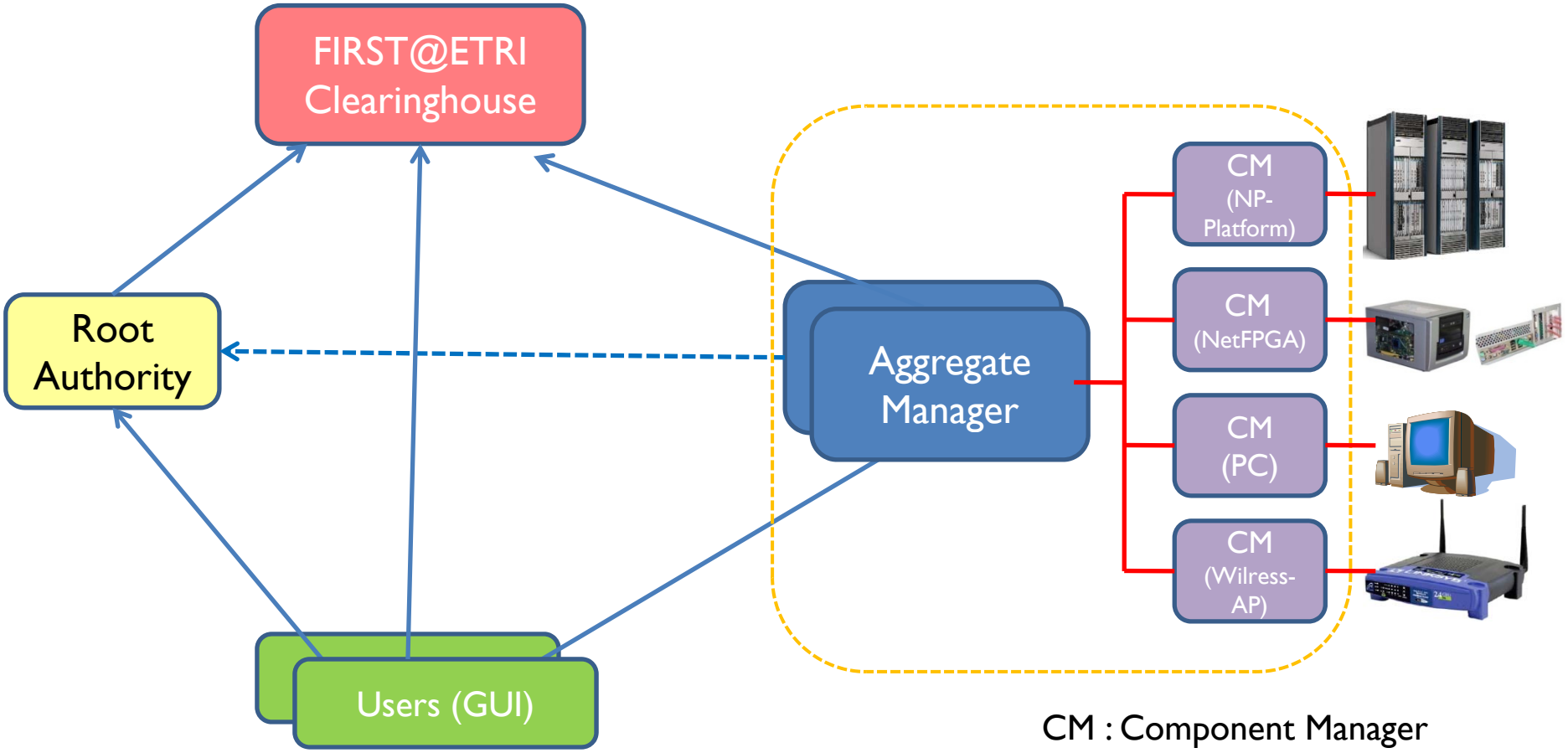


Resources

ETRI Platform Technologies

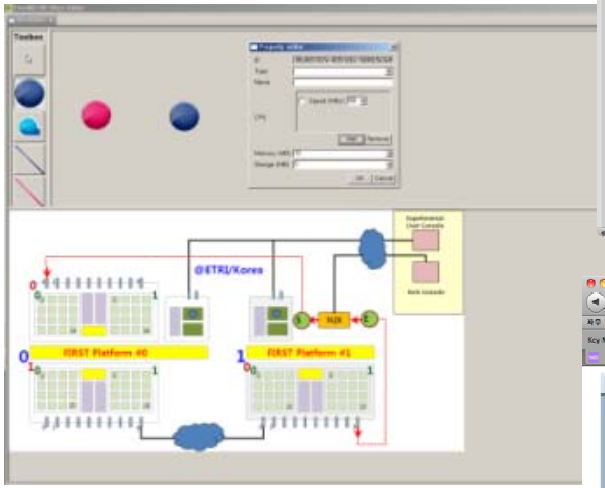
- Common Control Framework and GUI
- Open Substrate Interfaces
- Programming APIs for Researchers
- Packetvisor®

ETRI Control Framework - Entities

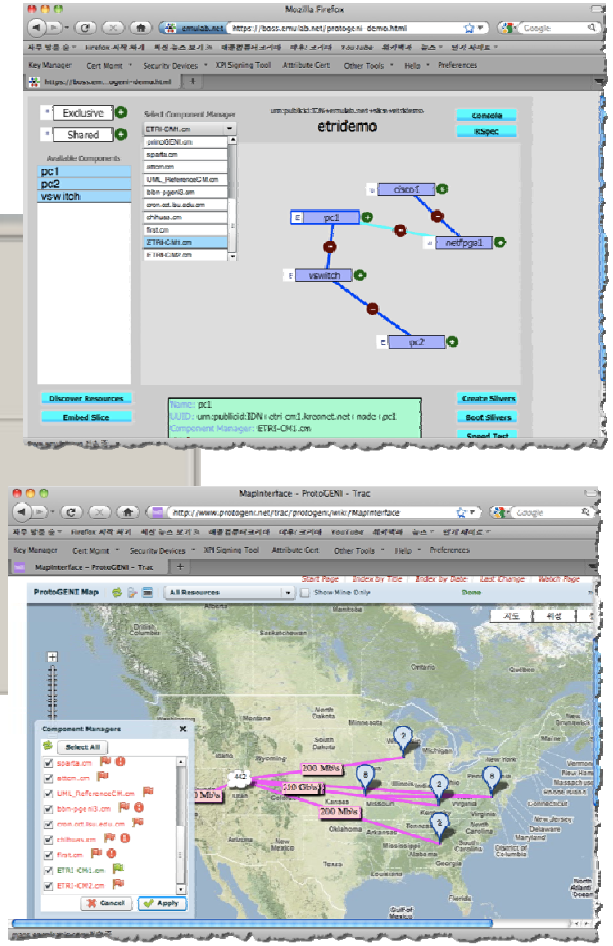


CM : Component Manager

Graphical Interfaces for Researcher



Java Interface

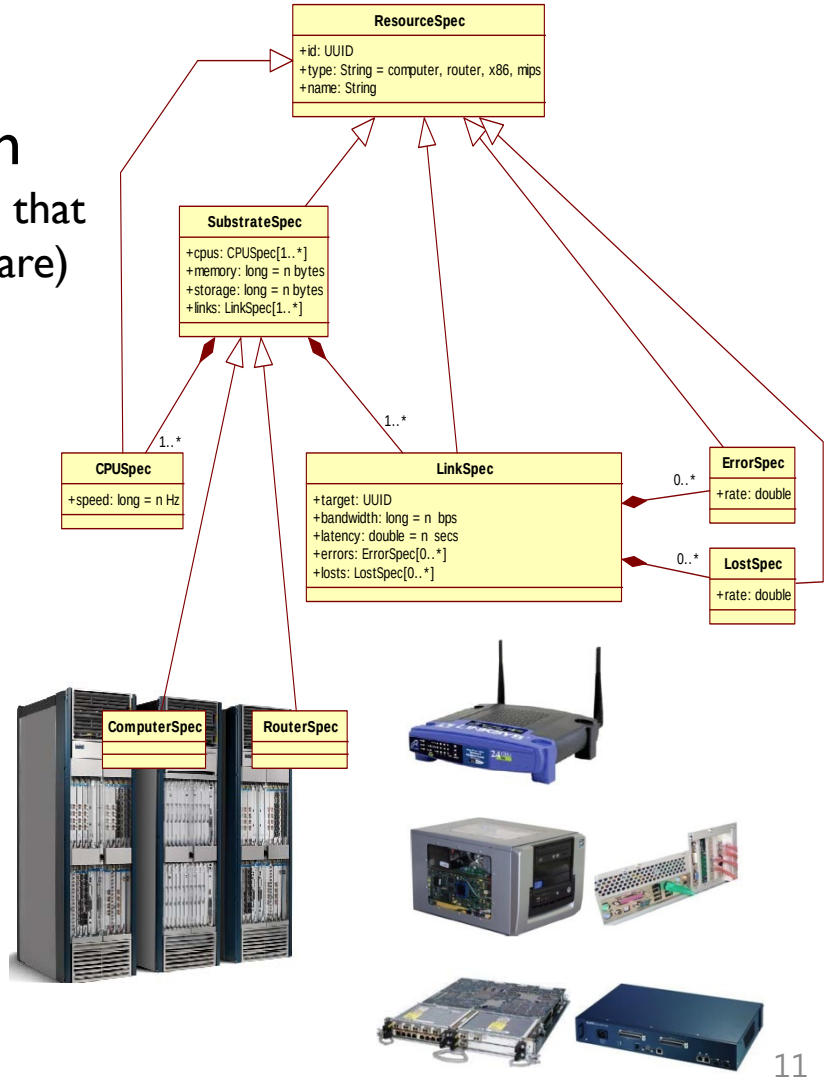


ProtoGENI Interface

SmartPhone Interface

Open Substrate Interfaces

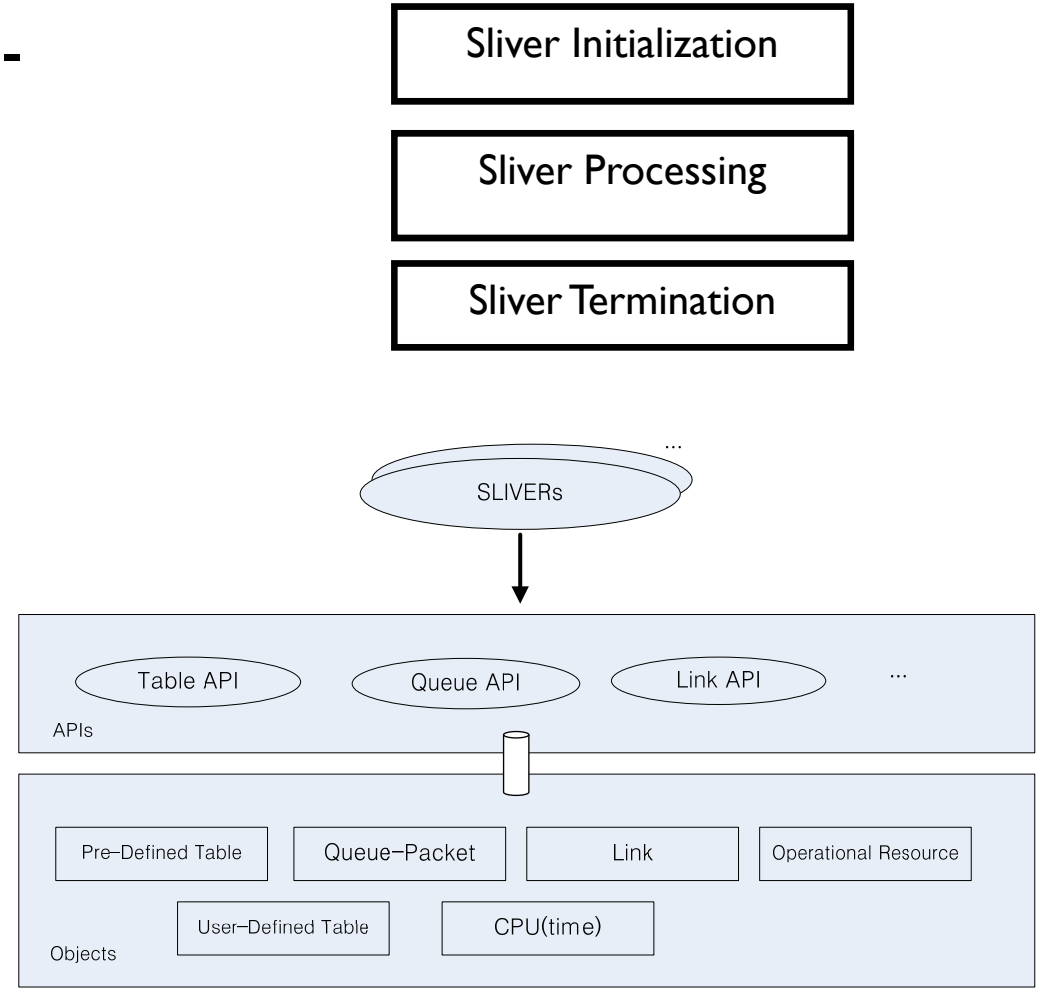
- Multiple Substrate Support
  - NP-based hardware Platform
    - •Virtualized programmable substrate that operate at high speed (ATCA hardware)
  - NetFPGA/PC, Wireless AP, etc.



- allocateSliver/deallocateSliver …
- allocatePort/dealloctePort …
- allocateLink/deallocateLink …
- uploadProgram/upgradeProgram …
- getSliverStatus …
- getPortStatus …
- getProgramStatus

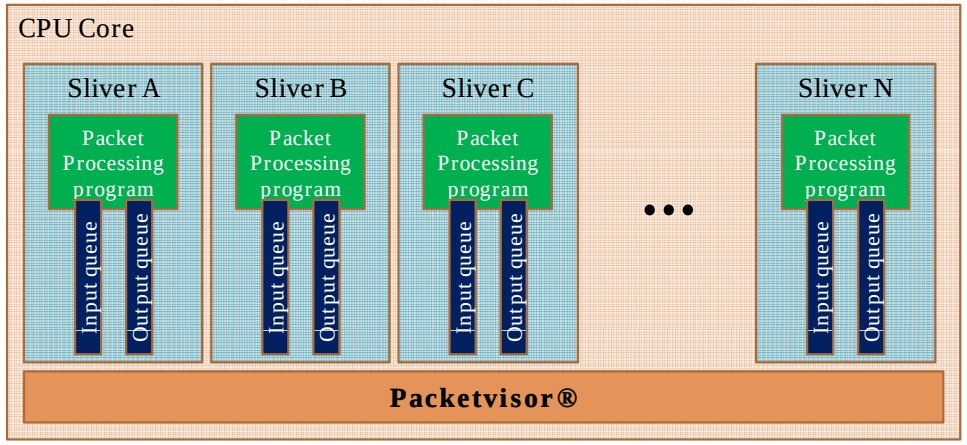
Programming APIs for Researchers

– E.g., To support hardware-based packet processing
  - work_request_sync()
    /* get_work */
  - send_packet_prepare()
    /* packet building */
  - send_packet_finish()
    /* packet sending */
  - …



Packetvisor®

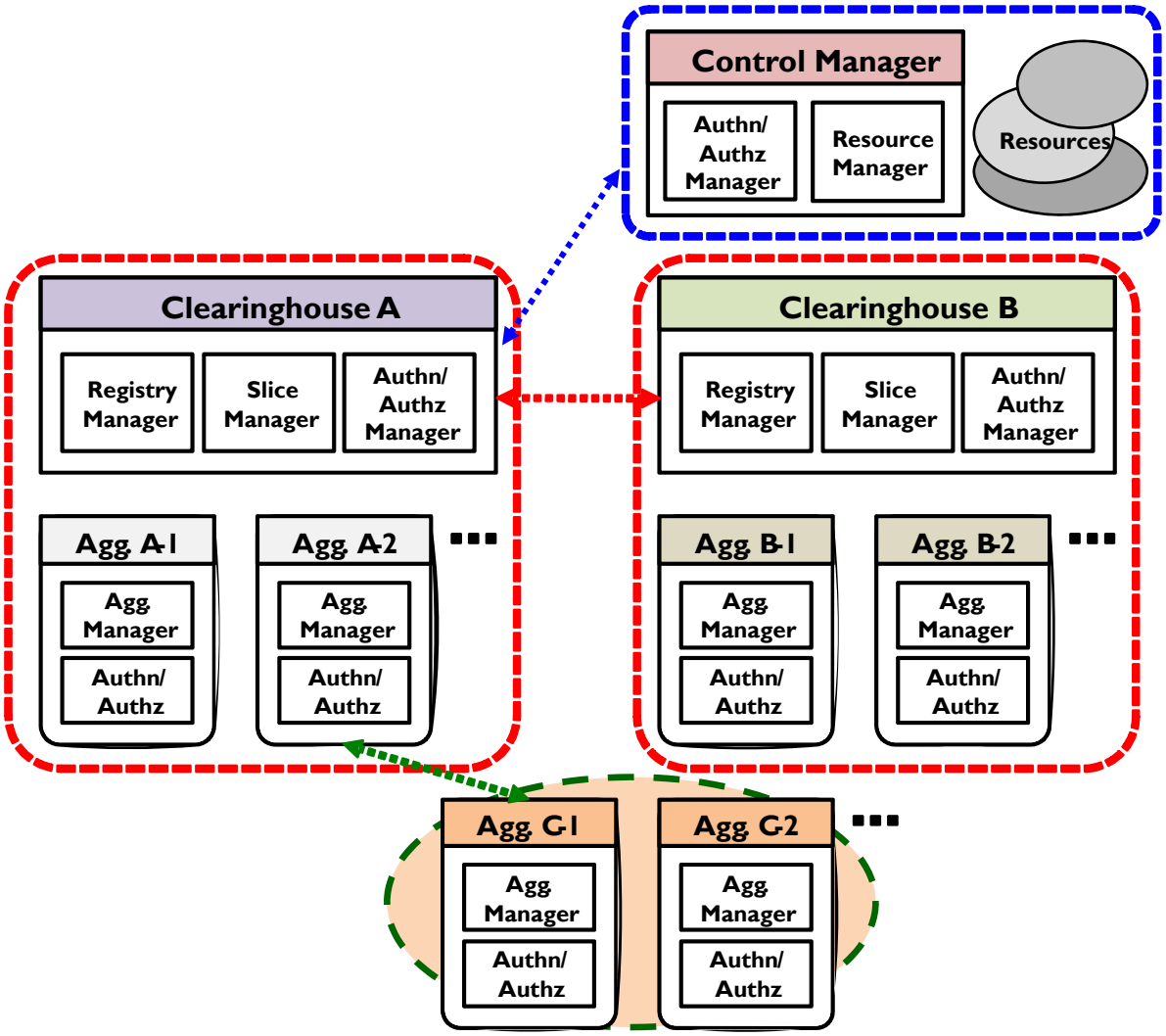
- Packetvisor
  - Load multiple images (experiments) on 1 CPU Core
    - Multiple slivers scheduling
  - Dynamic CPU resource allocation on slivers
  - I/O queues virtualization
  - Memory, storage …
  - Bandwidth/Link



Why Federated Testbeds ?

- No – "one-size-fits-all" at this moment
  - aligned with "heterogeneous/multiple FI networks/architecture"
- 5 metrics for testbed
  - Scale, openness, geographical, commercial, short-long term
- Take all the benefits from each testbed
  - cf. resource federation → network federation

Federation Scenarios



<u>Scenario A</u>
Federation among independent Infrastructures (with different CF)
e.g., GENI, FIRE, Japan, and Korea

<u>Scenario B</u>
Federation among independent Infrastructures (with same CF)
e.g., KOREN and KREONET

<u>Scenario C</u>
Federation with resources
e.g., KAIST, SNU …

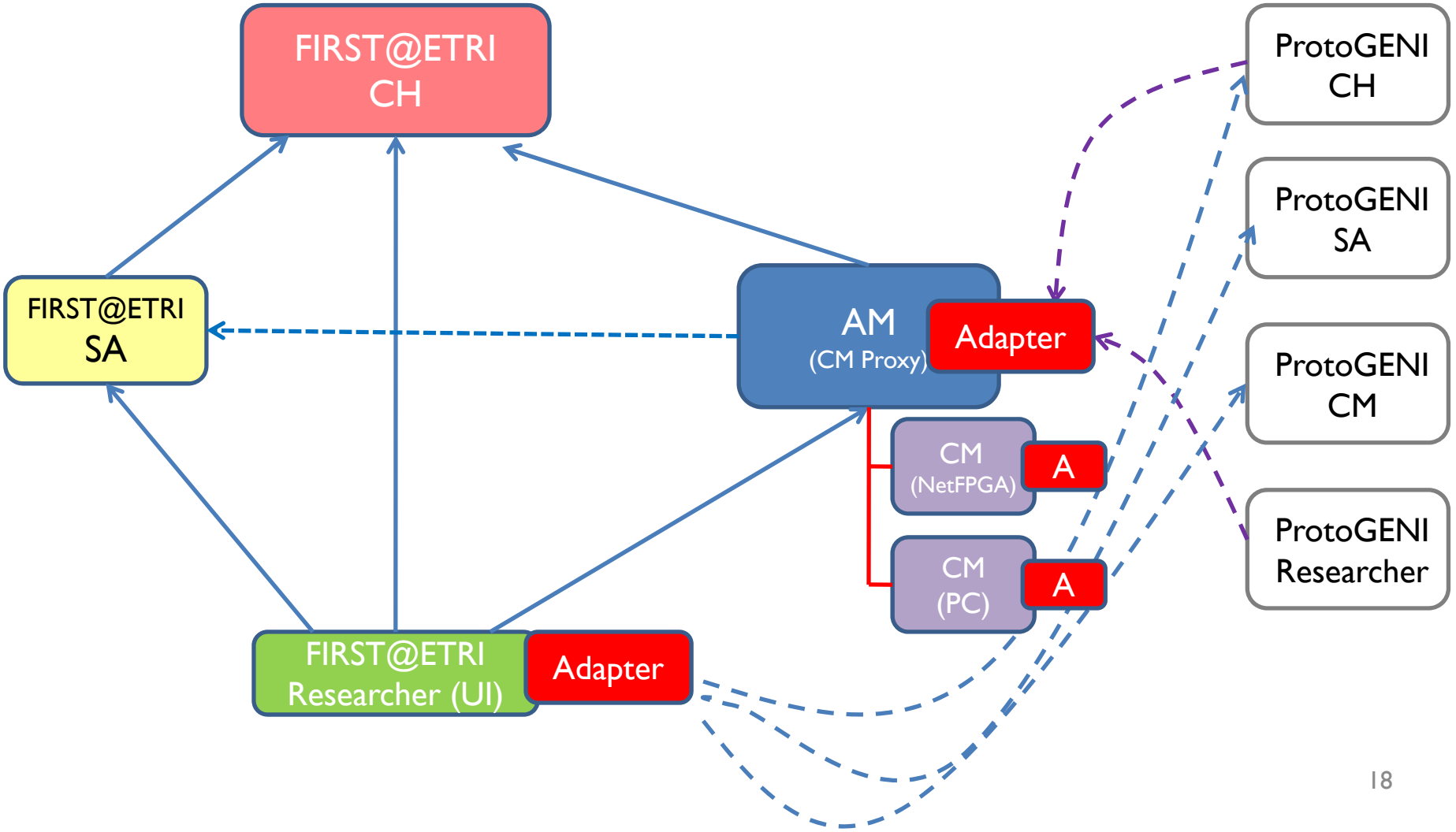
Problem Spaces

- Different identity/authority management
  - Identity allocation/authorization policy/mechanism
    - E.g.,) GID, ABAC (SFA 2.0)
- Different control procedures
  - Control flows and interfaces/APIs
    - E.g.,) GENI AM/CM/Slice APIs
- Different resources and experiments description
  - Resource description schemes (syntax, context, entity, …)
  - Description of experiments, services, experimental results
    - E.g.,) RSpec

Federation Solutions

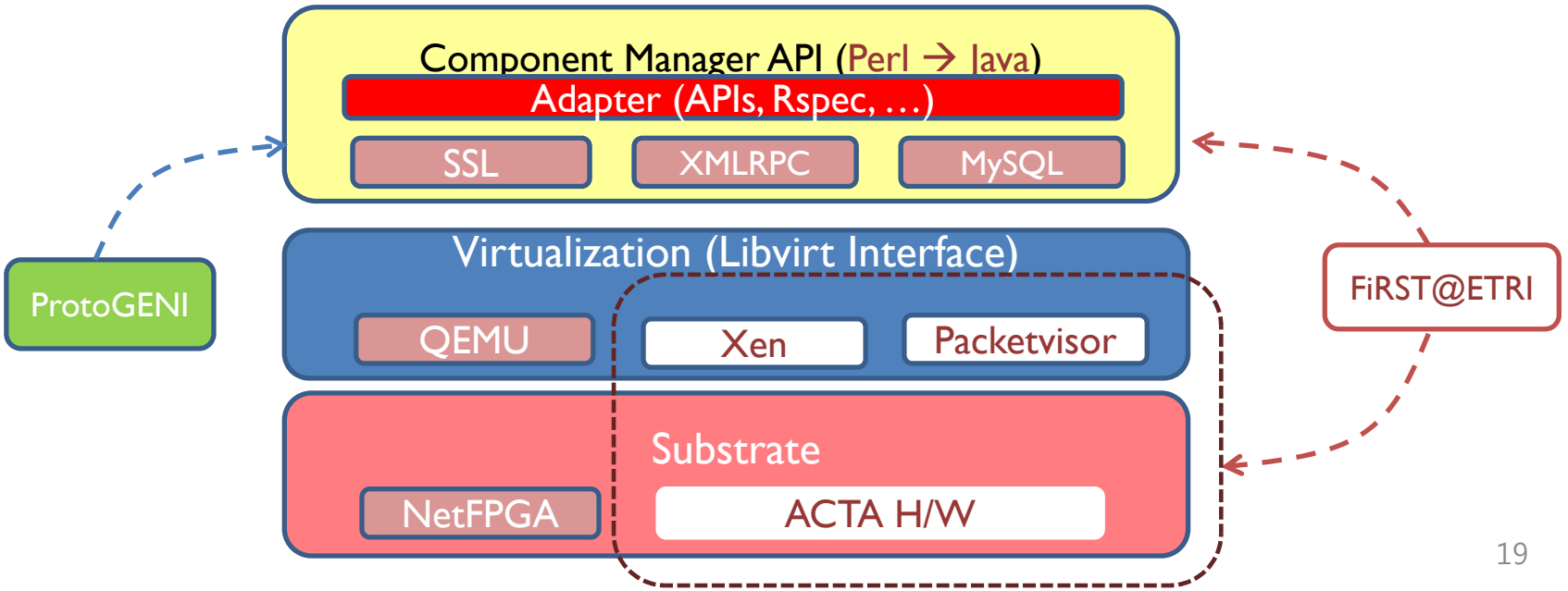
- Adapter-based approach
  - Short-term approach
  - Modification on Control Framework entities
  - Simple but not scalable
- Broker-based approach
  - Long-tem approach
  - No (minimum) modification on CF entities
  - Complex (credential issue) but scalable

Adapter-based approach for GENI



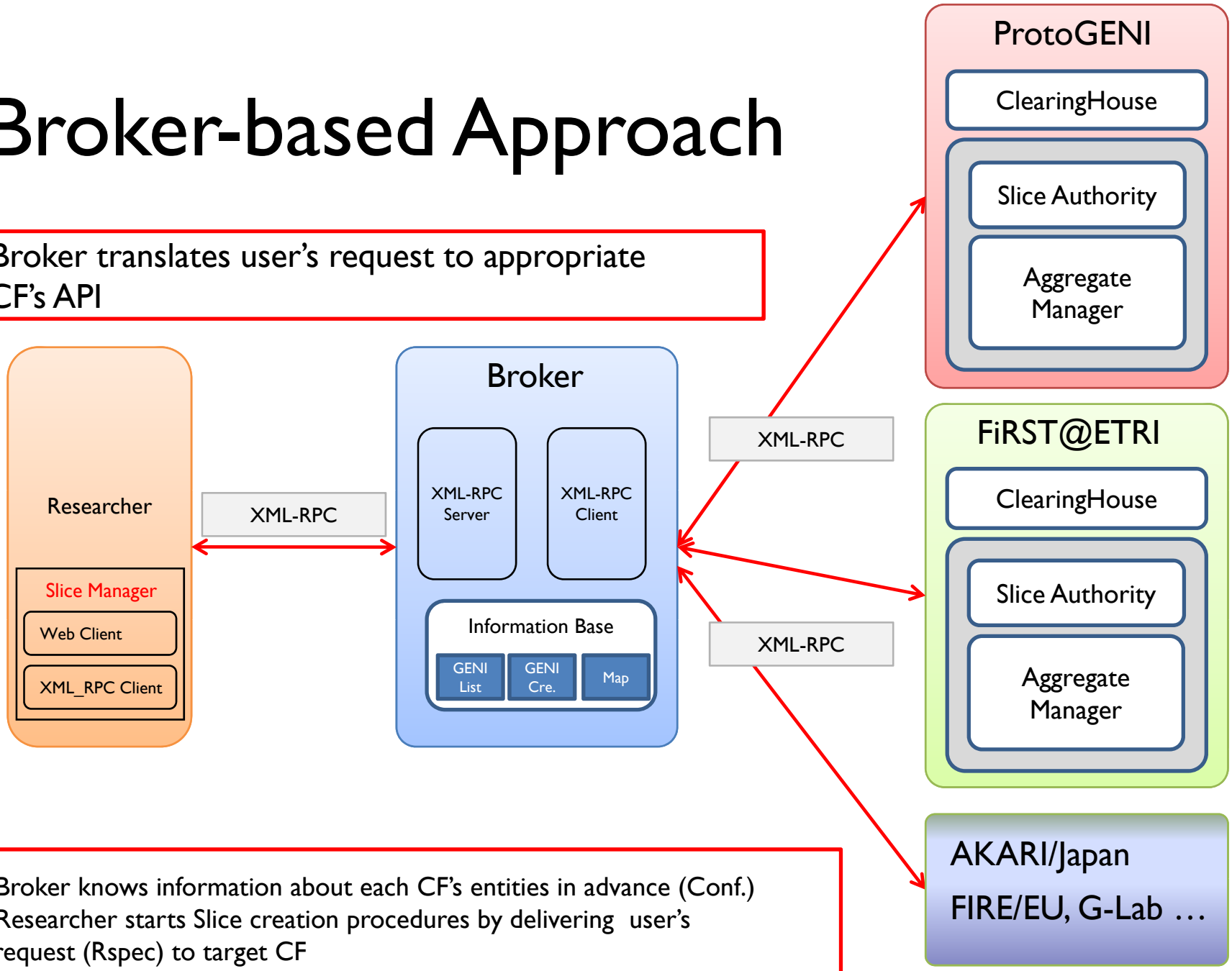
ProtoGENI Adapter in CM

- ProtoGENI Adapter
  - Build up the Adaptor from the CM codes
  - Java Implementation
  - Xen and Packetvisor virtualization support for backend



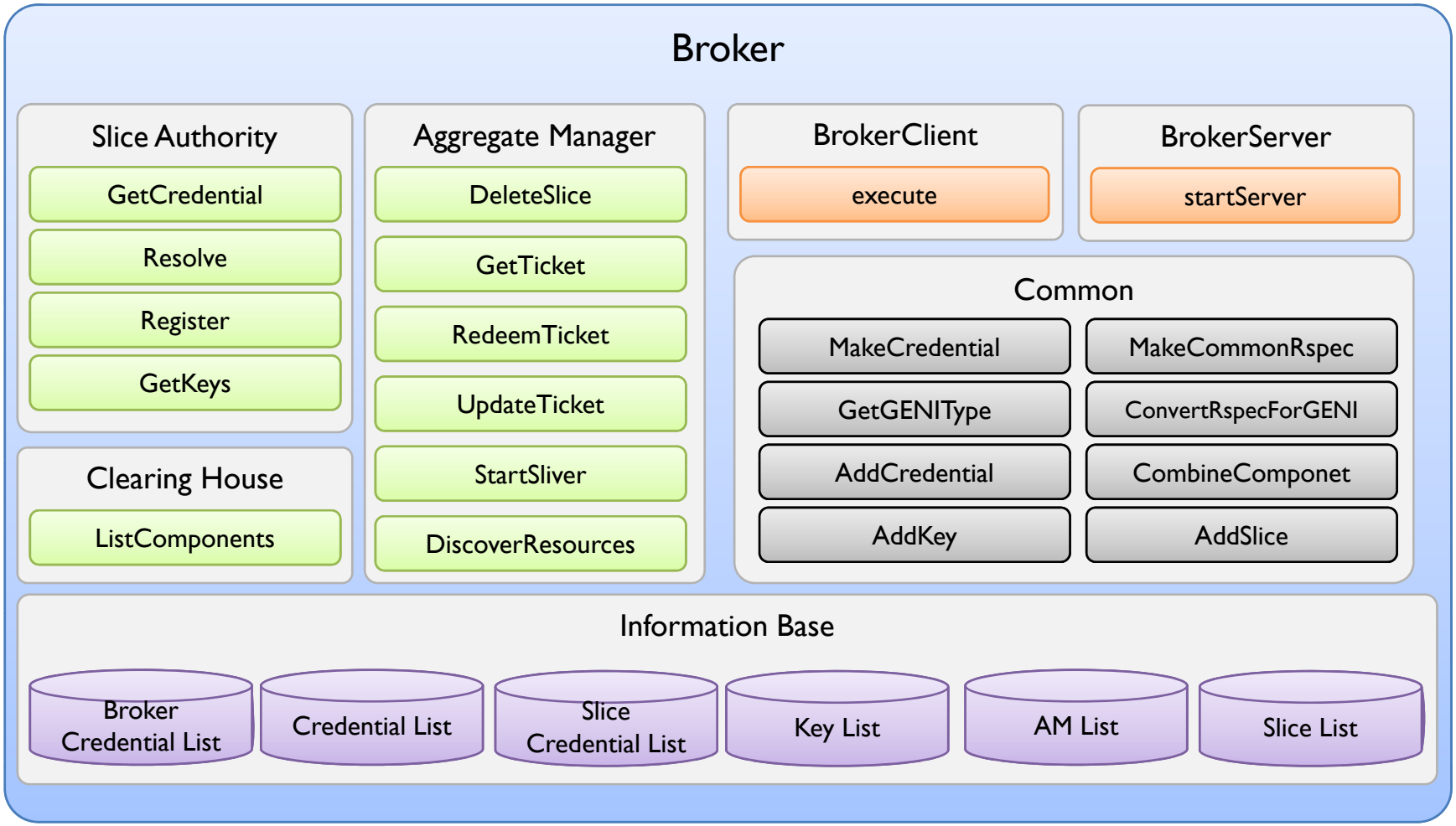
Broker-based Approach

•Broker translates user's request to appropriate CF's API



- Broker knows information about each CF's entities in advance (Conf.)
- Researcher starts Slice creation procedures by delivering user's request (Rspec) to target CF

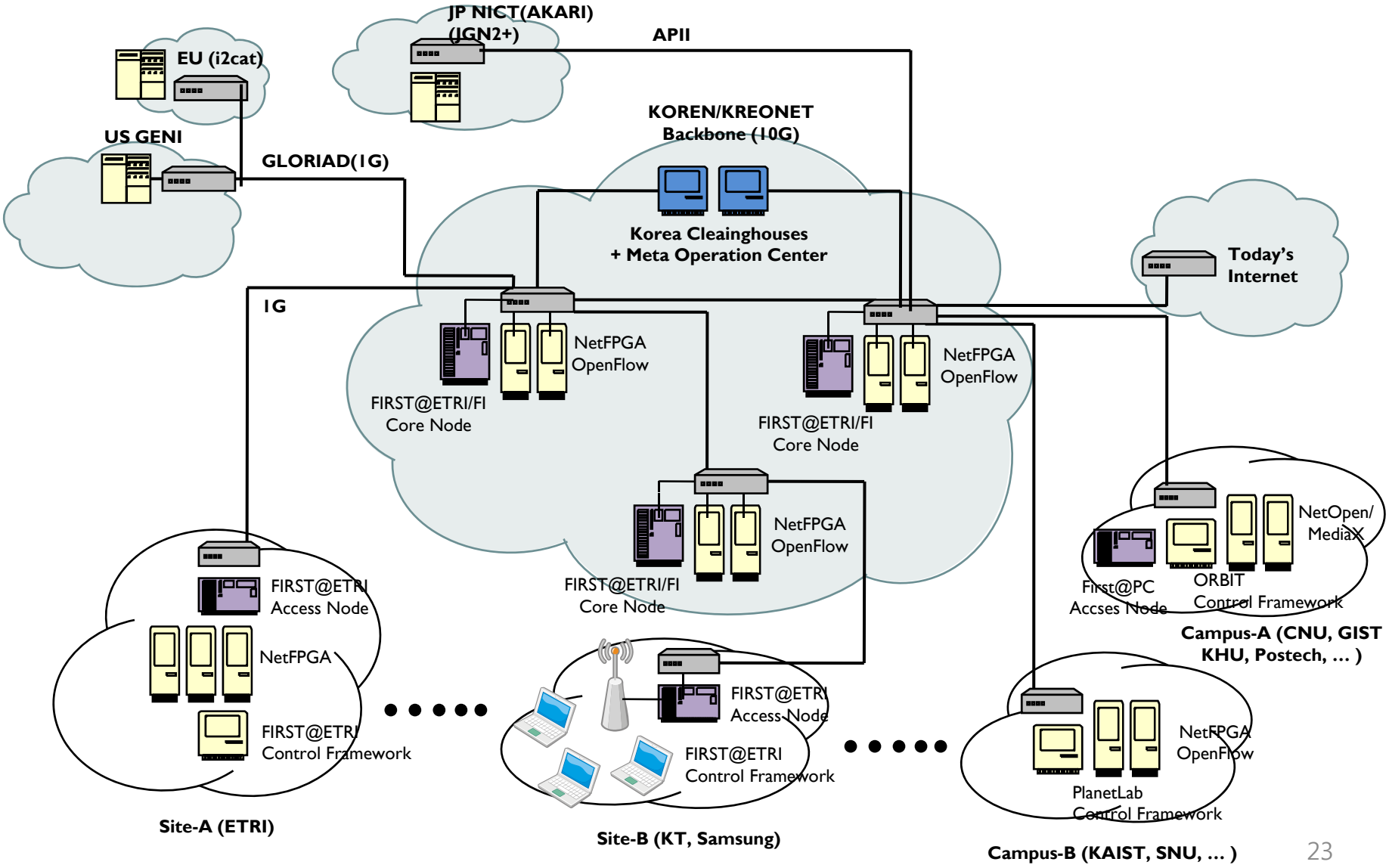
Functional Architecture of Broker



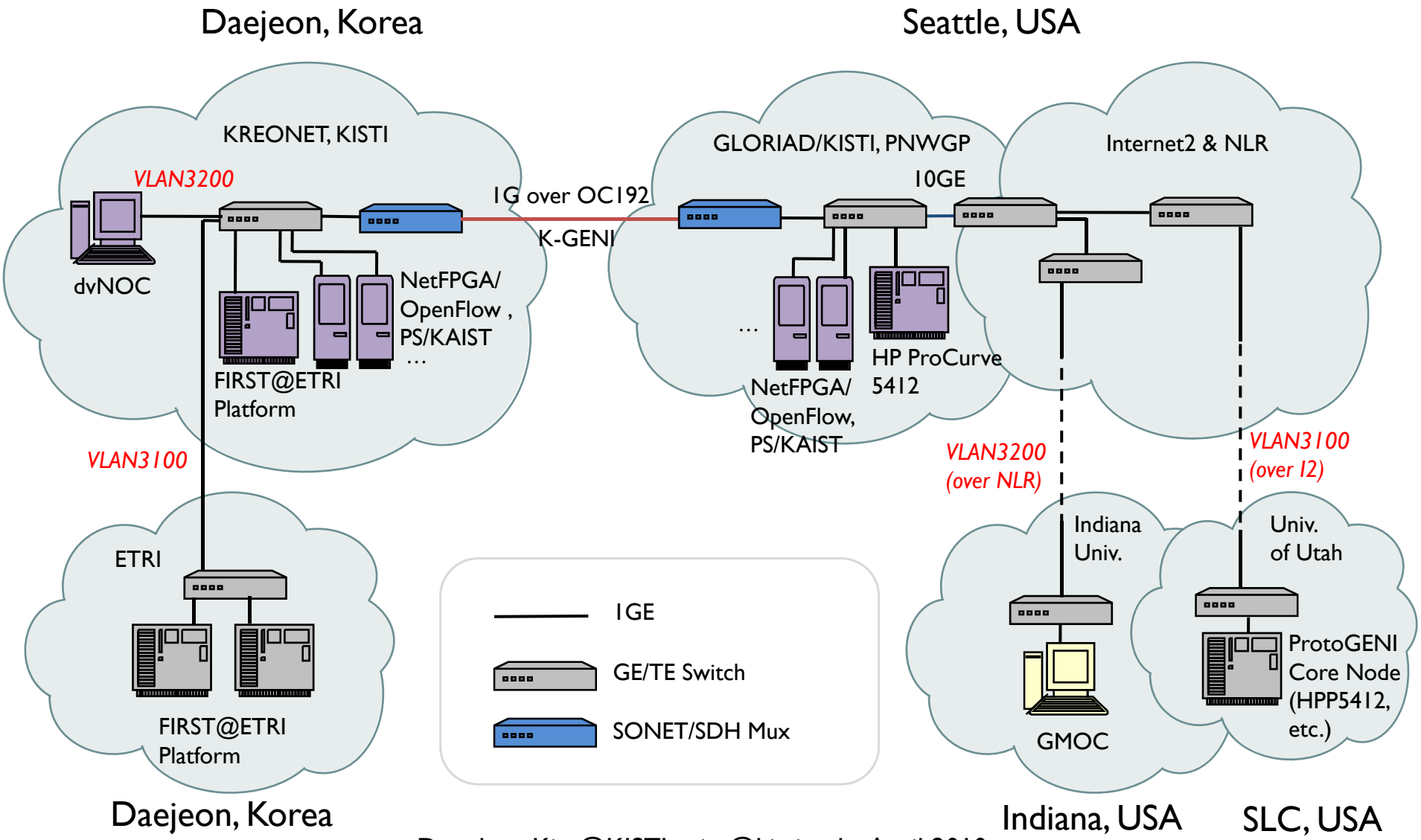
Issues for Federation Broker

- Broker performs API and RSpec translation
  - Researcher can use single UI for accessing different CFs or testbeds
  - Broker provides researchers with transparent access to resources in different CFs
- How to cope with heterogeneous federated requests?
  - The translation support for CFs should be flexible & manageable
- How to handle users credential?
- How to inject or negotiate access policy?

Testbed and Deployment Plan



Korea – GENI Connection



DongkyunKim@KISTI, mirr@kisti.re.kr, April 2010

ETRI Global Partners and Projects

- US GENI
  - Spiral-2, 3
    - Integrating New Projects into the ProtoGENI Control Framework
      - University of Utah : ProtoGENI (Cluster C)
    - K-GENI: Establishment of operational linkage between GENI and ETRI/KISTI-Korea for international federation
      - Indiana University (GMOC), KISTI
- EU FP7
  - FEDERICA II (Call 9)
- Japan
  - AKARI/NICT

ETRI (Pre-)Standardization Efforts

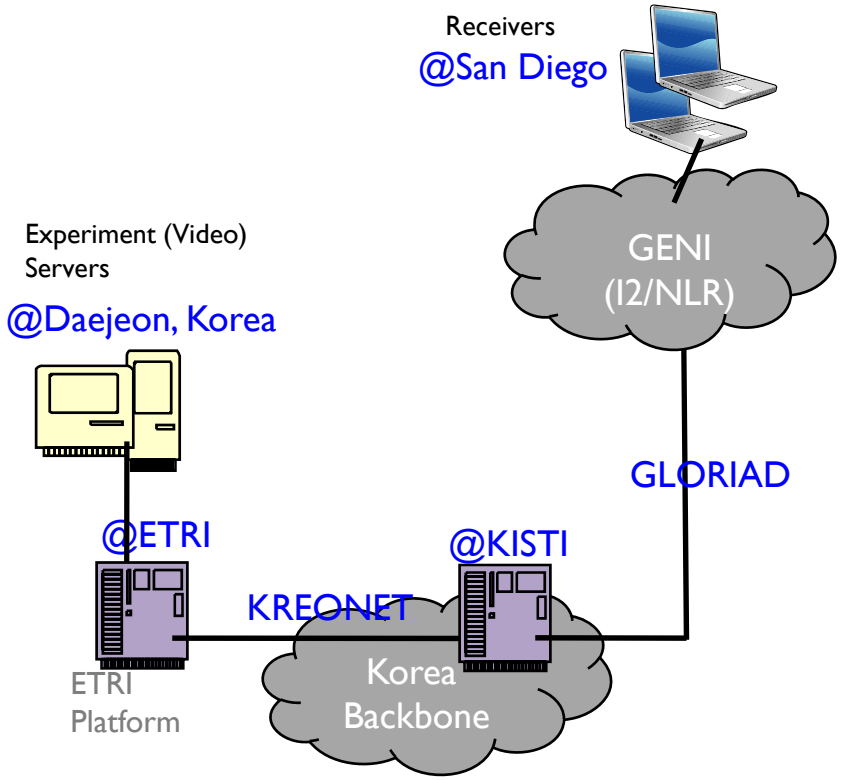
- ITU-T
  - Q.21/13
    - Y.3001, Future Network : Objectives and Design Goals
    - Y.FNvirt, Framework of Network Virtualization for Future Networks
- ISO/IEC JTC 1/SC 6
  - WG7
    - PDTR 29181-1, Future Network, Part 1 – Overall aspects
- GENI
  - Control Framework WG
    - Specification - Federation scenarios and requirements
- IETF/IRTF
  - VNRG (Virtual Network Research Group)
    - draft-jeong-vnrg-virtual-networks-ps-00

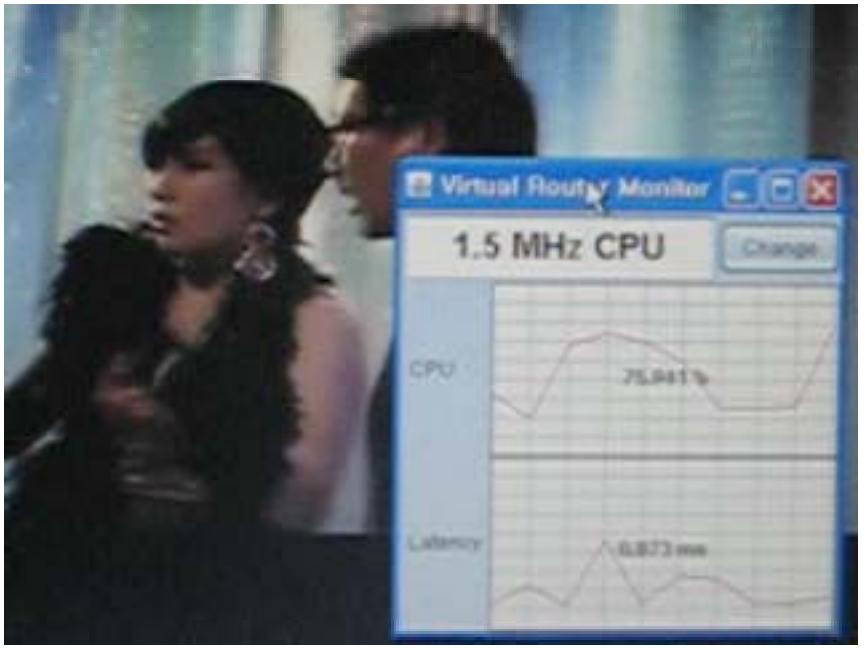
Demo and some screenshots

<u>Packetvisor Demo@GEC7</u>

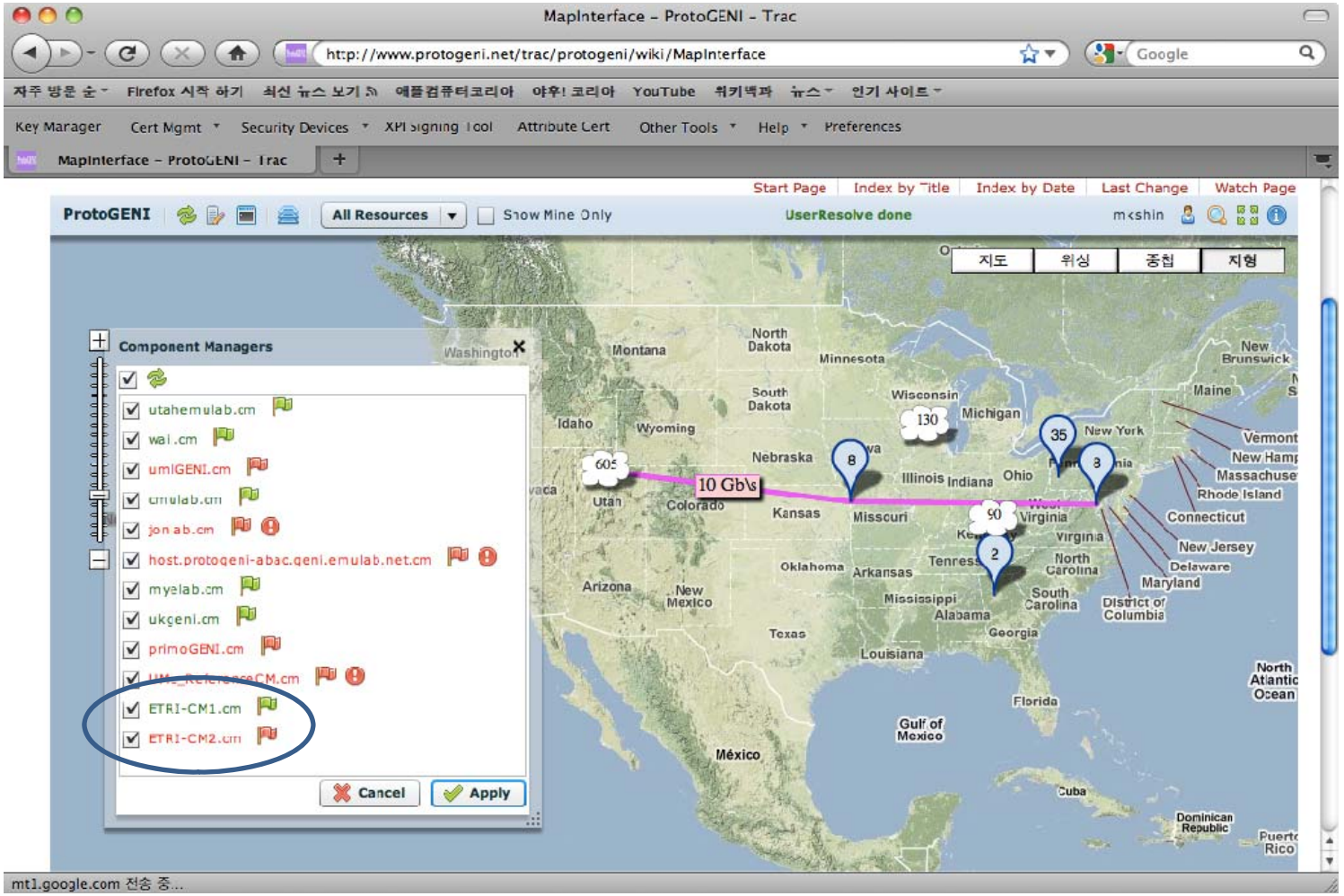
Dynamic CPU Resource Allocation

1.5MHz Router → 3MHz Router

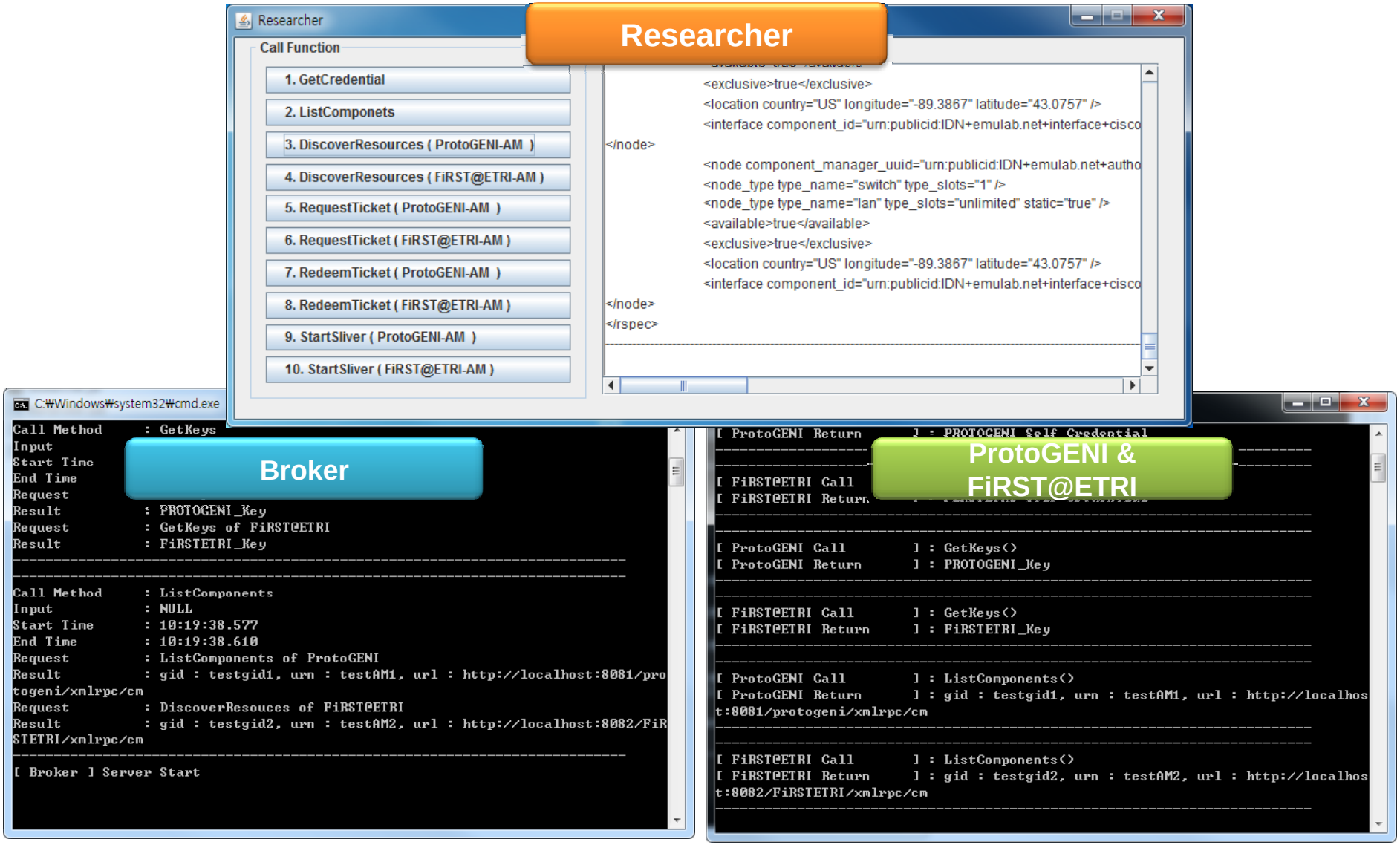




ProtoGENI CM and Adapter



Federation Broker



GUI App for Smart Phone Users