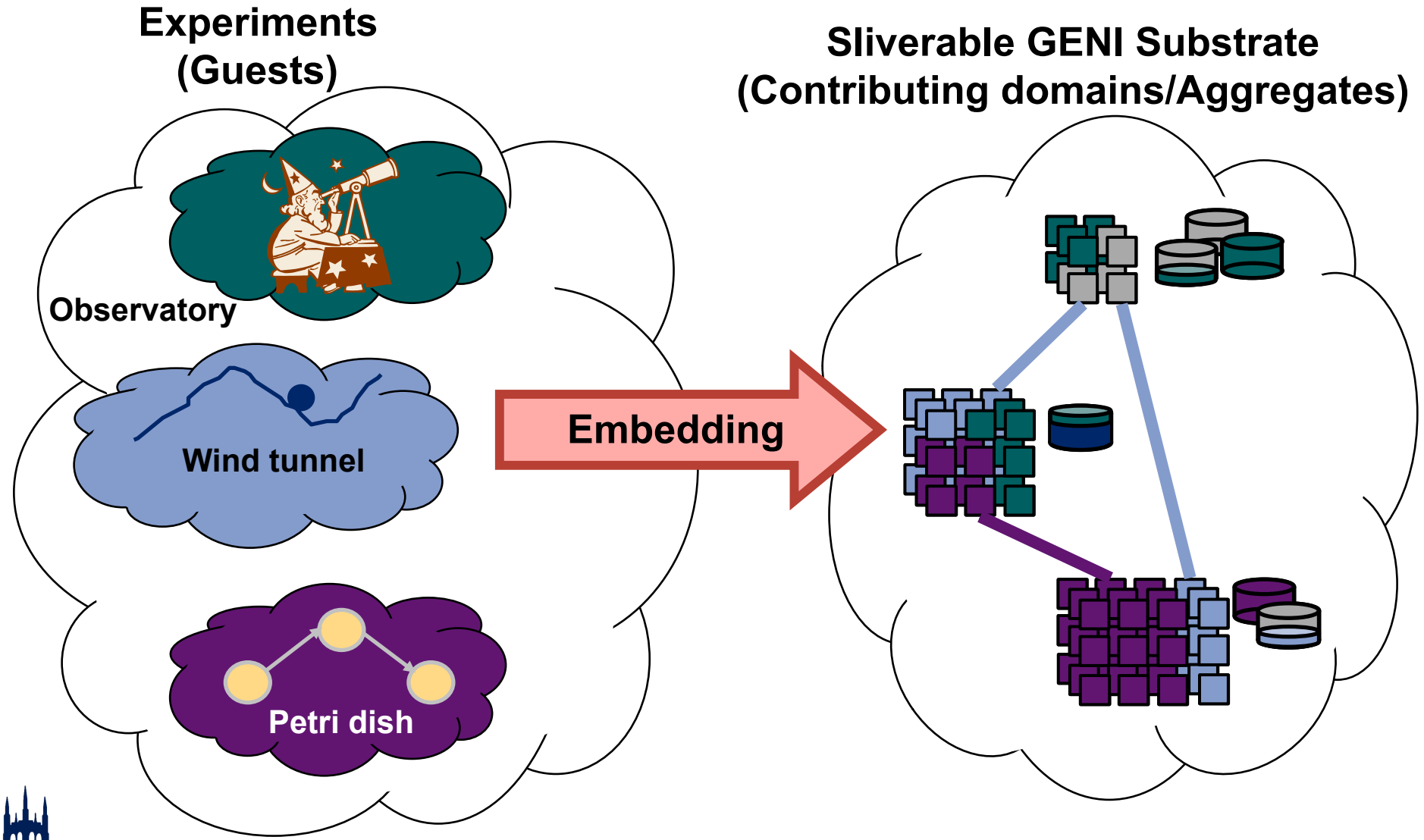
Perspectives on the GENI Control Plane

Jeff Chase

GEC 2 NSF 3/4/08

Duke Systems

Setting the Stage



Define: Control Plane

GGF+GLIF: "Infrastructure and distributed intelligence that controls the establishment and maintenance of connections in the network, including protocols and mechanisms to disseminate this information; and algorithms for automatic delivery and on-demand provisioning of an optimal path between end points."

s/connections/slices/
s/optimal path/embedded slices
provisioning += and programmed instantiation

Global Lambda Integrated Facility

Define: Control Plane

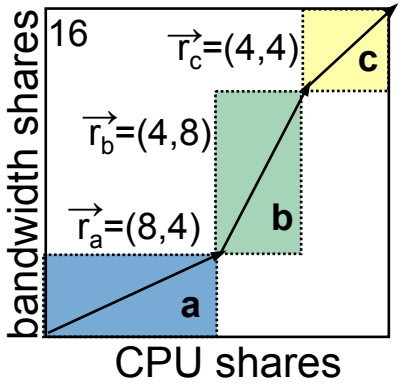
Control plane defines “the set of entities that interact to establish, maintain, and release resources and provide…connection control functions”.

At bottom this is about modularity and interfaces.

If the entities are owned, operated, and developed by different stakeholders over long time spans, then we call it “architecture”.

The GENI Control Plane

- Programmable sliver allocation + control
  - Delegation of authority etc.
  - Instrumentation (feedback)
- Resource representation and exchange
- Foundation for resource discovery, path discovery, topology discovery



Design Tensions

- Governance vs. freedom
- Coordination vs. autonomy
- Control vs. manageability
- Assurance vs. robustness
- Predictability vs. efficiency
- Quick vs. right
- Inclusion vs. entanglement
- Etc. etc. …

Design Tensions, continued

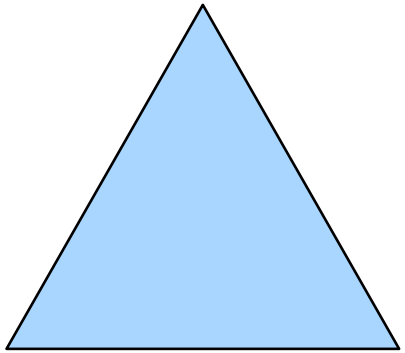
- *What is standardized vs. what is open to innovation?*
- I am taking an aggressive view about openness to innovation.
  - Because we want it to last a long time
  - Because that is what it is for
- Standardization kills innovation.
  - "Apocalypse of the two elephants" [Clark]

Modularize Innovation

- Control plane design should enable local innovation within each entity.
- Can GENI be a platform for innovation of platforms? Management services?
  - Enhance PlanetLab's unbundled management
- A plea for pluralism...
- Key: no one-size-fits-all standard for information exchange.

A Platform for “Utility Networking”

Hosting centers (utilities)
Untrusted/untrusting guests
Virtualization and isolation



ISPs
Traffic policing

Grid
Multiple domains

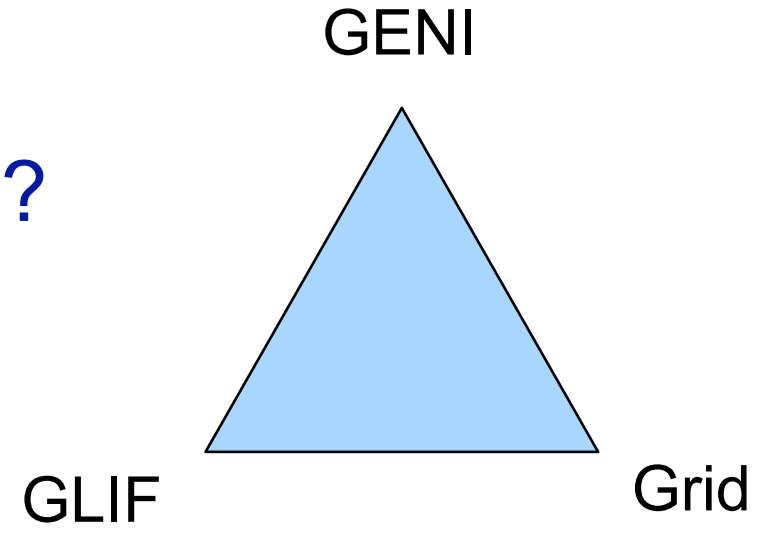
Experiences Building PlanetLab, OSDI 06

PLANETLAB

A Platform for "Utility Networking"

Programmable substrate
Dynamic end-to-end slivering

Cooperate
or compete?



OpenGridForum
OPEN FORUM | OPEN STANDARDS

glif
Global Lambda Integrated Facility

OASIS DCML Standardizing Information Exchange for the Data Center Environment

Network Description Language

```
<ndl:Interface rdf:about="#tdm3.amsterdam1.netherlight.net:501/3">
  <ndl:name>tdm3.amsterdam1.netherlight.net:501/3</ndl:name>
  <ndl:connectedTo
    rdf:resource="http://networks.internet2.edu/manlan/manlan.rdf#manlan:if1"/>
  <ndl:capacity
    rdf:datatype="http://www.w3.org/2001/XMLSchema#float">1.244E+9</ndl:capacity>
</ndl:Interface>
<ndl:Interface rdf:about="http://networks.internet2.edu/manlan/manlan.rdf#manlan:if1">
    <rdfs:seeAlso rdf:resource="http://networks.internet2.edu/manlan/manlan.rdf"/>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:ndl="http://www.science.uva.nl/research/sne/ndl#"
   xmlns:geo="http://www.w3.org/2003/01/geo/wgs84_pos#">
<!-- Description of Netherlight -->
<ndl:Location rdf:about="#Amsterdam1.netherlight.net">
   <ndl:name>Netherlight Optical Exchange</ndl:name>
   <geo:lat>52.3561</geo:lat>
   <geo:long>4.9527</geo:long>
</ndl:Location>
<!-- TDM3.amsterdam1.netherlight.net -->
<ndl:Device rdf:about="#tdm3.amsterdam1.netherlight.net">
      <ndl:name>tdm3.amsterdam1.netherlight.net</ndl:name>
      <ndl:locatedAt rdf:resource="#Amsterdam1.netherlight.net"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:501/1"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:501/2"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:501/3"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:501/4"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:502/1"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:502/2"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:502/3"/>
>
```

UvA Universiteit van Amsterdam

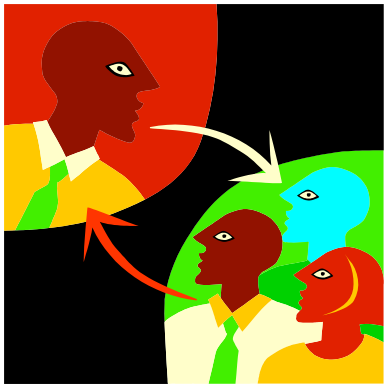
Key Questions

- Who are the entities (actors)?
- What are their roles and powers?
- Whom do they represent?
- Who says what to whom?

Control plane defines “the set of entities that interact to establish, maintain, and release resources and provide…connection control functions”.

GENI Principals

Researcher: A user that wishes to run an experiment or service in a slice, or a developer that provides a service used by other researchers.



A **slice authority (SA)** is responsible for the behavior of a set of slices, vouching for the users running experiments in each slice and taking appropriate action should the slice misbehave.

A **management authority (MA)** is responsible for some subset of substrate components: providing operational stability for those components, ensuring the components behave according to acceptable use policies, and executing the resource allocation wishes of the component owner.

Aaron Falk, BBN

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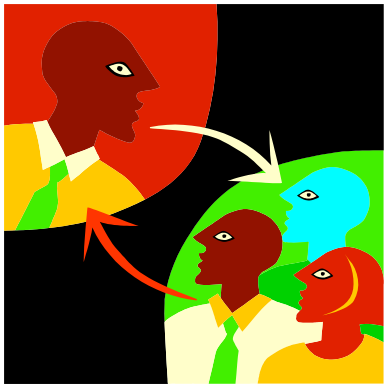
Programmatic?
Automated?



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Who does it represent?
Policing or helper?

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Who does it represent?
Policing or helper?

Aggregates? Clearinghouse? GSC?

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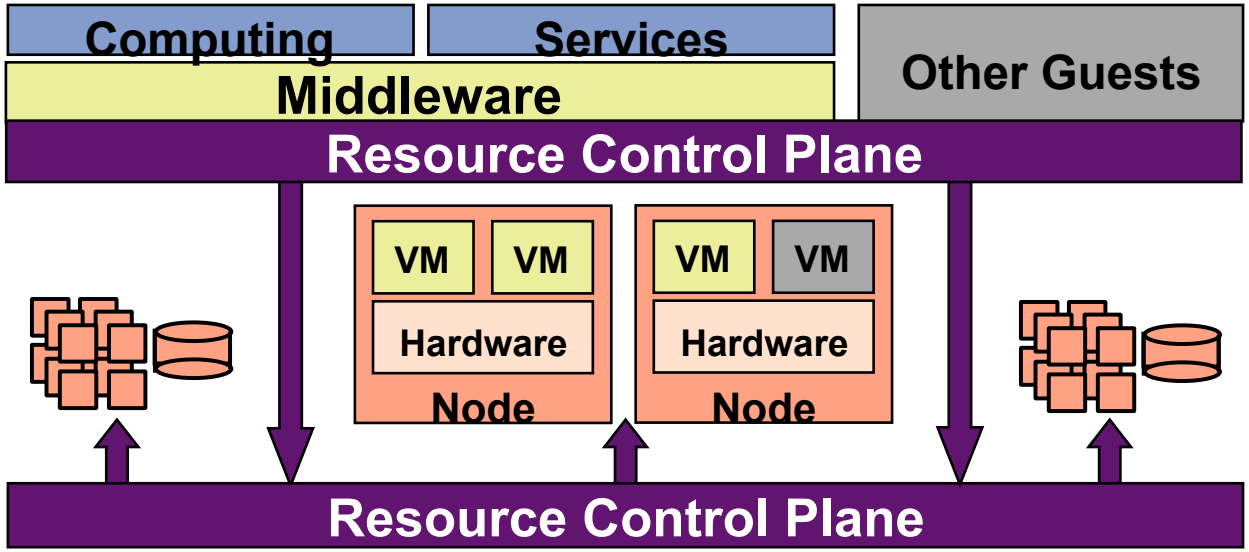
Open Resource Control Architecture (Orca)



- Contract model for resource management
- Programmatic interfaces and protocols
- Automated lease-based allocation and assignment
- Share infrastructure among multiple guests
- *http://nicl.cod.cs.duke.edu/orca/*

Who Are the Actors?

- Principle #1: Entities (actors) in the architecture represent the primary stakeholders.

1. Resource owners
2. Slice owners/controllers (guests)
3. The facility itself, or resource scheduling services acting on its behalf.

Others (e.g., institutions) are primarily endorsing entities in the trust chains.

Contracts

- Principle #2: provide pathways for contracts among actors.
  - Accountability
- Be open with respect to what promises an actor is *permitted* to make.
  - Open innovation for contract languages and tools
  - Yes, need a least one least common denominator
    - RSpec == HTML 1.0?
    - Fear of the Tower of Babel

Rules for Contracts

- Don't make promises you can't keep…but don't hide power. [Lampson]
- There are no guarantees, ever.
  - Have a backup plan for what happens if "assurances" are not kept.

- Provide sufficient power to represent what promises the actor is explicitly NOT making.
  - E.g., temporary donation of resources
- Incorporate time: start/expiration time
  - Resource contracts are *leases* (or *tickets*).

Delegation

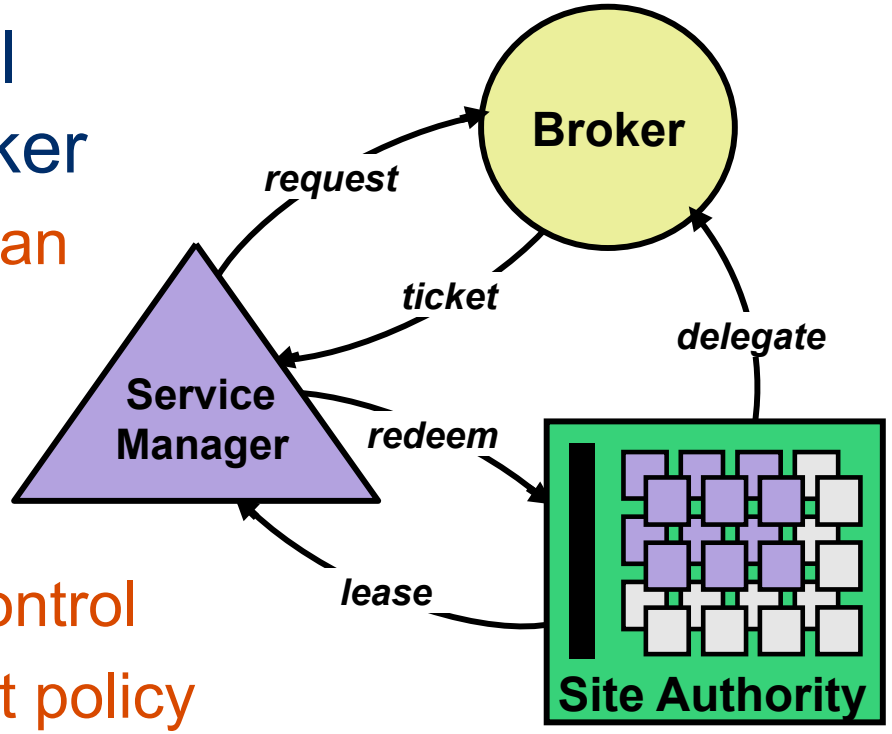
- Principle #3: Contracts enable delegation of powers.
  - Delegation is voluntary and provisional.
- It is a building block for creating useful concentrations of power in architecture.
  - Creates a potential for governance
  - Calendar scheduling, reservation
  - Double-edged sword?

Aggregation

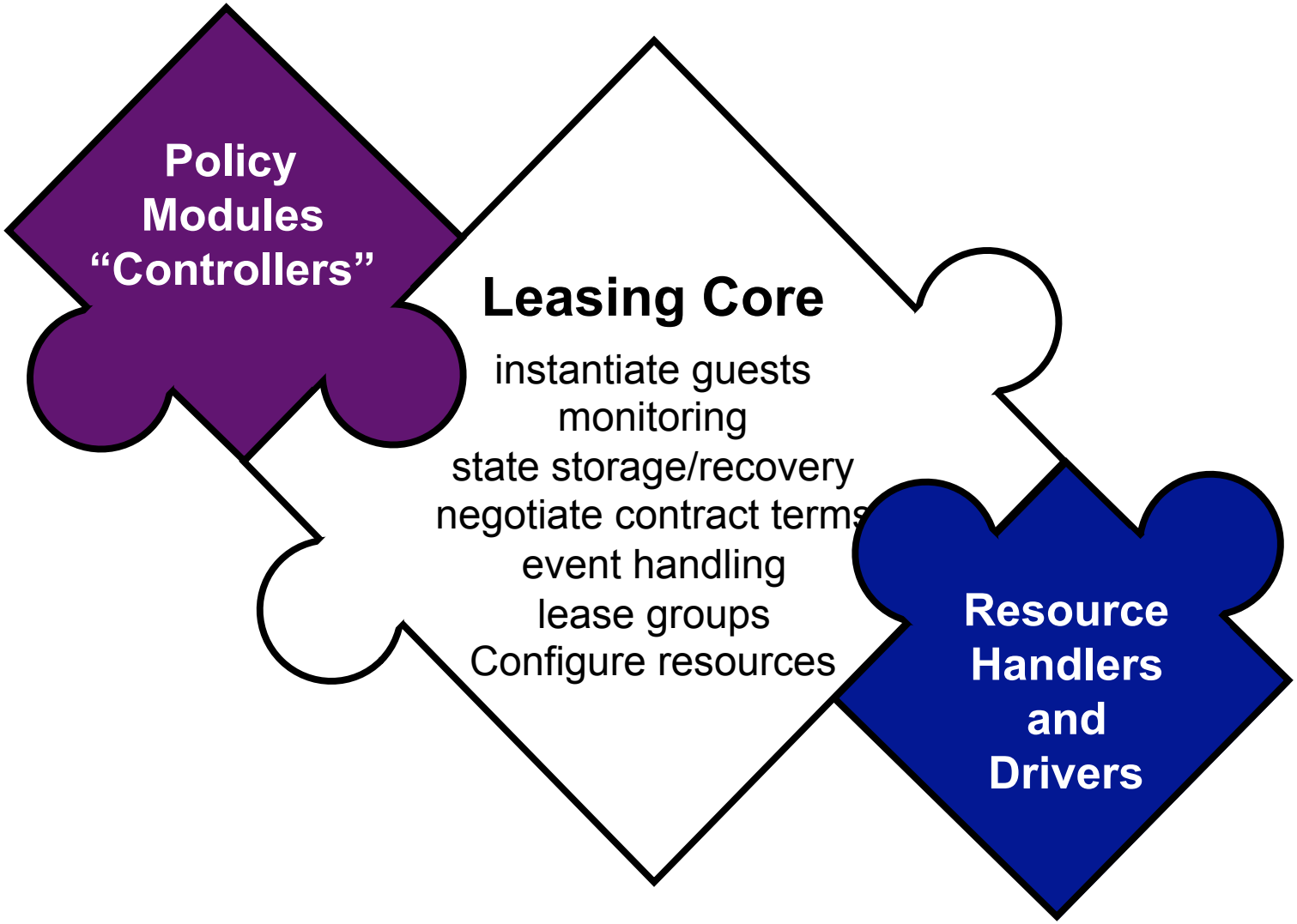
- Principle #4: aggregate the resources for a site or domain.
  - Primary interface is domain/site authority
- Abstraction/innovation boundary
  - Keep components simple
  - Placement/configuration flexibility for owner
  - Mask unscheduled outages by substitution
  - Leverage investment in technologies for site/domain management

Brokers and Ticketing

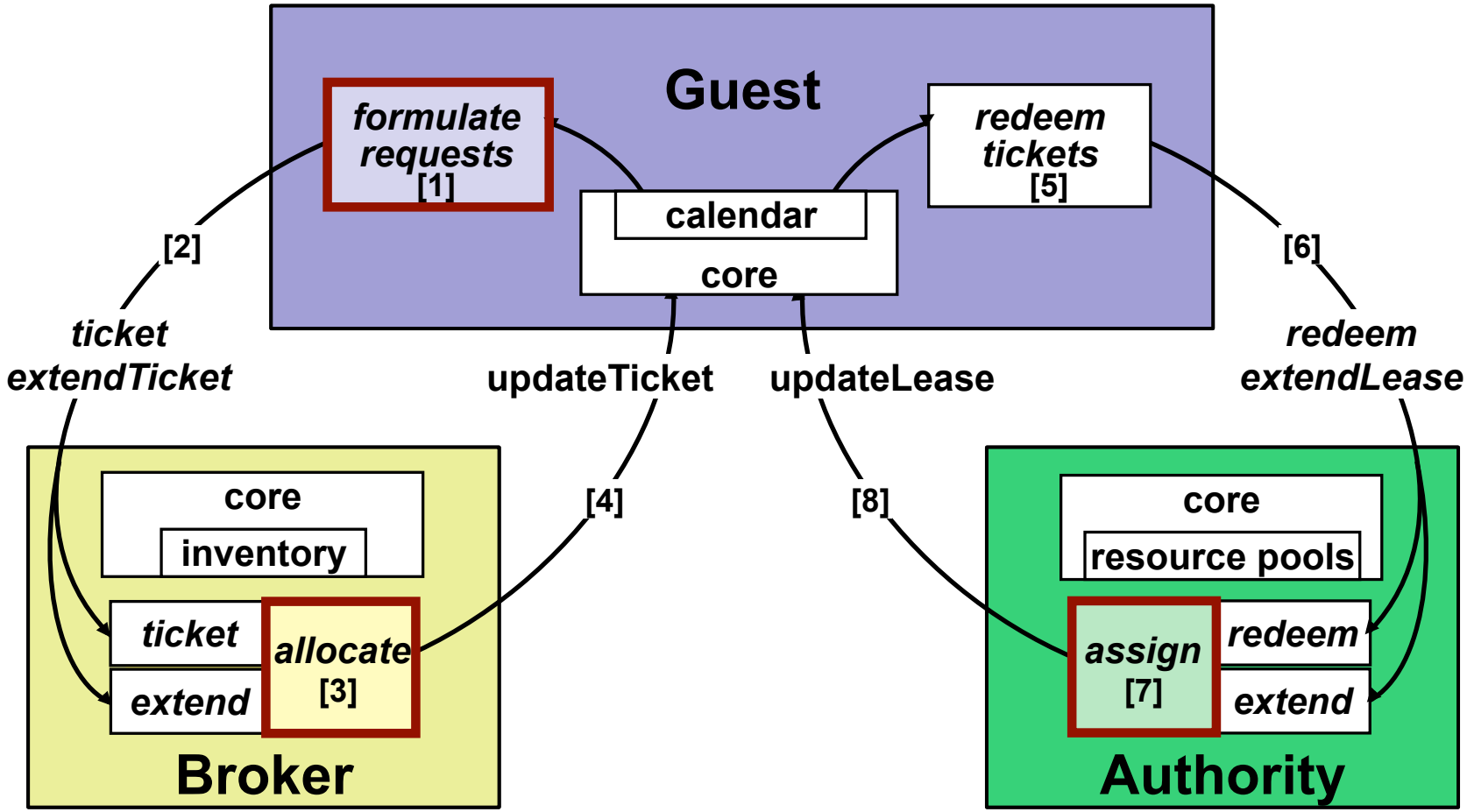
- Sites delegate control of resources to a broker
  - Intermediary/middleman
- Factor allocation policy out of the site
  - Broker arbitrates resources under its control
  - Sites retain placement policy
- "Federation"
  - Site autonomy
  - Coordinated provisioning



Pluggable Resources and Policies



Orca: Actors and Protocols



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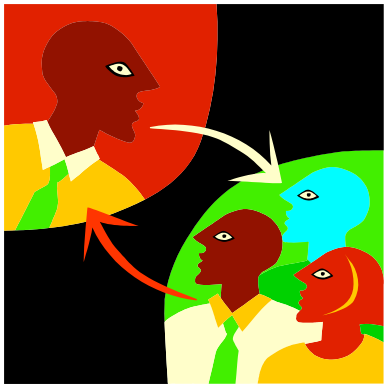

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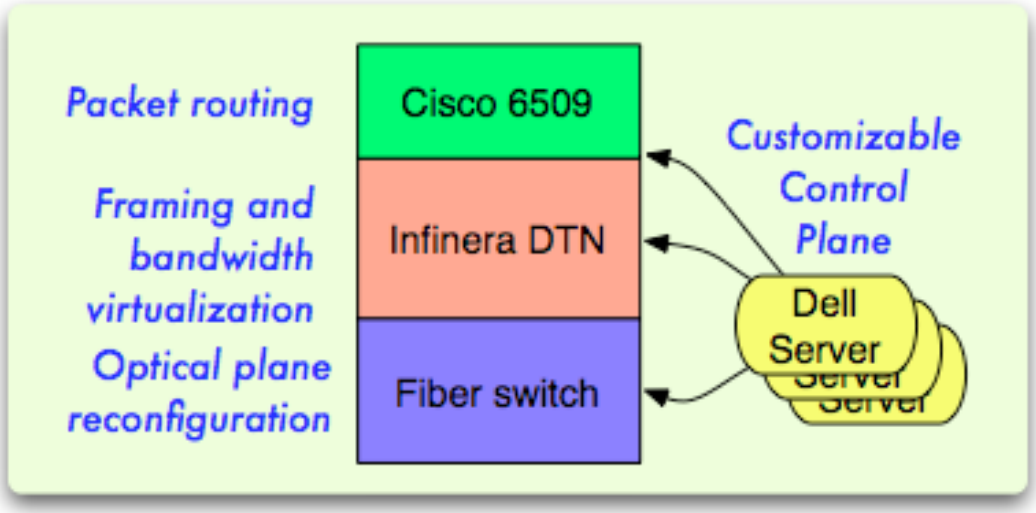
Breakable Experimental Network

- BEN is a metro network testbed jointly operated by researchers at Triangle Universities
- Designed to facilitate disruptive cross-layer research starting from the physical layer up
- 4 sites interconnected by dark fiber

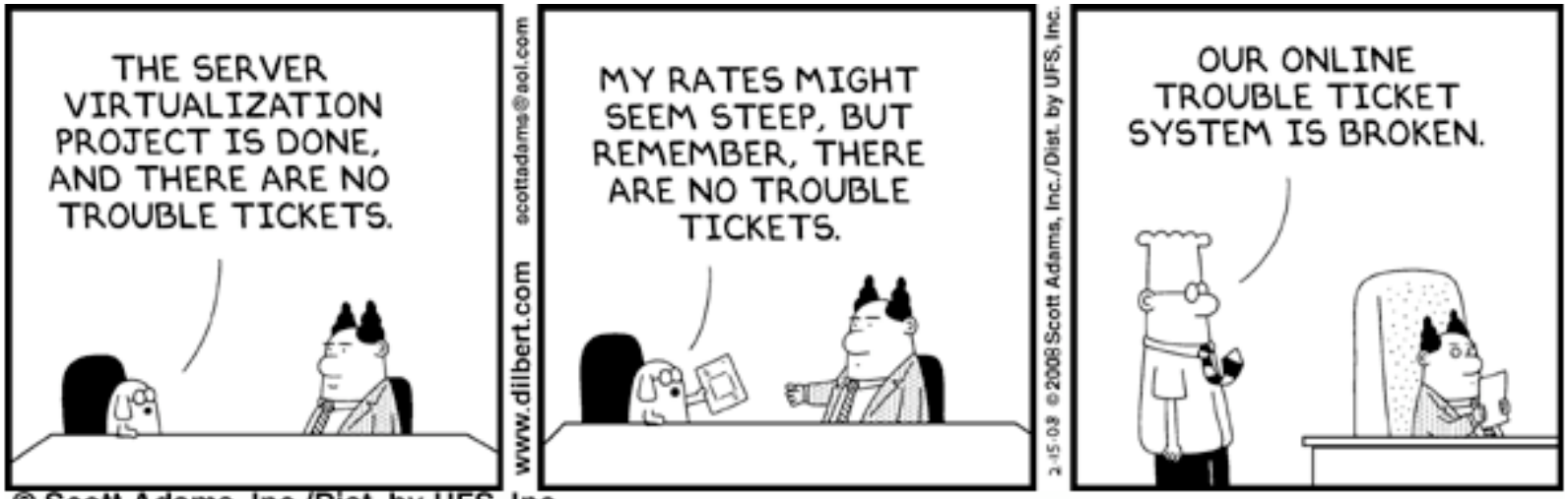


Renci
Renaissance Computing Institute
Catalyst for Innovation

Summary

- Factor actors/roles along the right boundaries.
  - stakeholders, innovation, tussle
- Open contracts with delegation
- Specific recommendations for GENI:
  - Aggregates are first-class entities
  - Component interface: permit innovation
  - Clearinghouse: enable policies under GSC direction

Thanks!


THE SERVER VIRTUALIZATION PROJECT IS DONE, AND THERE ARE NO TROUBLE TICKETS.
MY RATES MIGHT SEEM STEEP, BUT REMEMBER, THERE ARE NO TROUBLE TICKETS.
OUR ONLINE TROUBLE TICKET SYSTEM IS BROKEN.
www.dilbert.com scottadams@aol.com
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