



# GENI

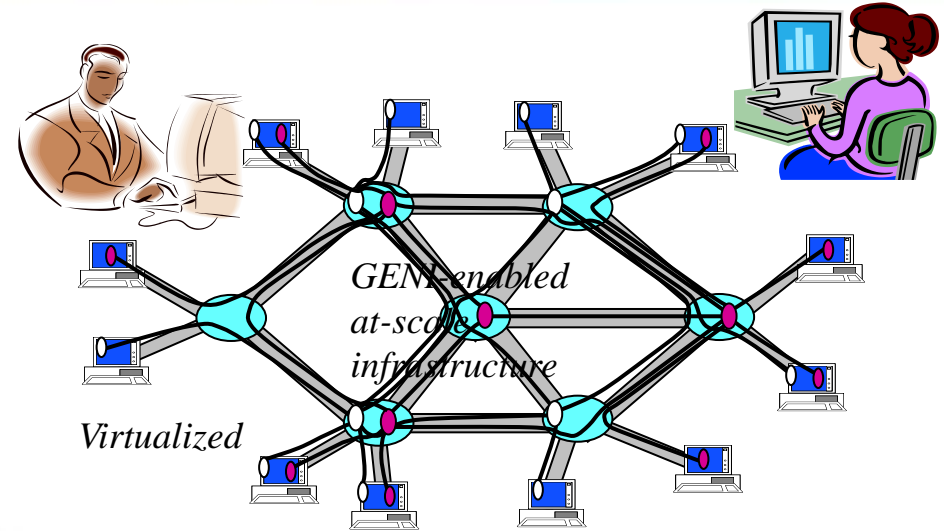
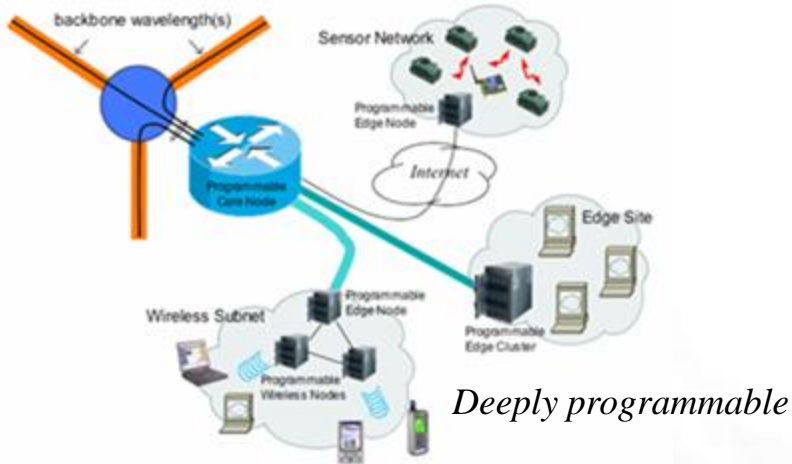
## Exploring Networks of the Future

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GENI Project Office  
March 23, 2010  
[www.geni.net](http://www.geni.net)

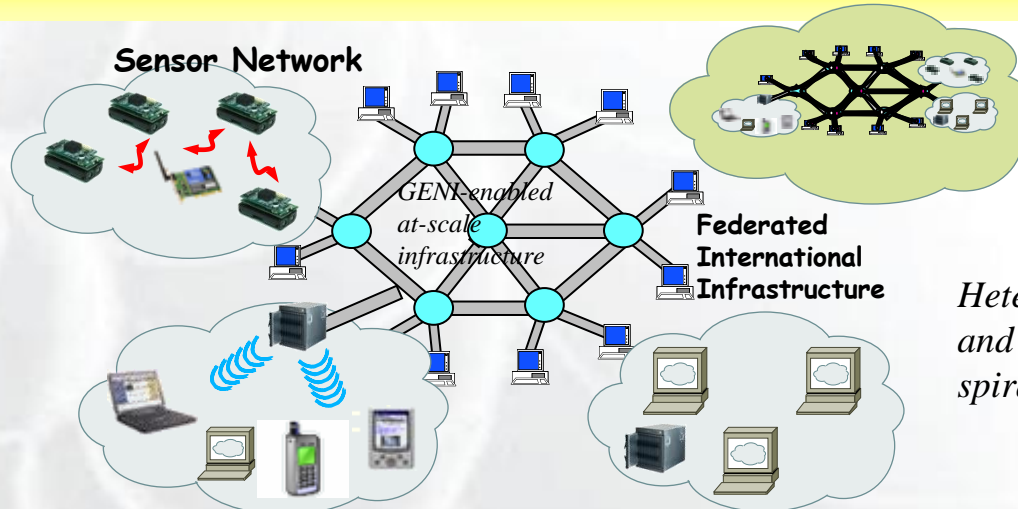
- GENI is a virtual laboratory for exploring future internets at scale.
- GENI creates major opportunities to *understand, innovate, and transform* global networks and their interactions with society.
- GENI opens up new areas of research at the frontiers of network science and engineering, and increases the opportunity for significant socio-economic impact.

# GENI Conceptual Design

## Infrastructure to support at-scale experimentation



***Programmable & federated, with end-to-end virtualized "slices"***

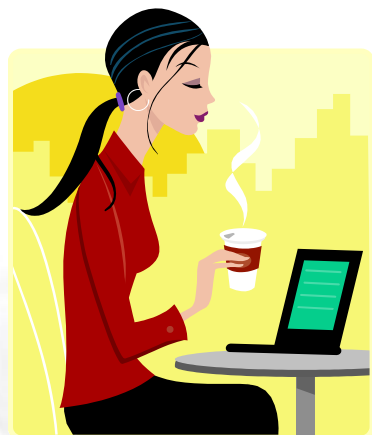


*Heterogeneous, and evolving over time via spiral development*

# GENI for the Short-Attention Span

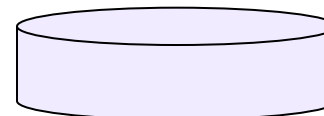
# Resource discovery

## Aggregates publish resources, schedules, etc., via clearinghouses



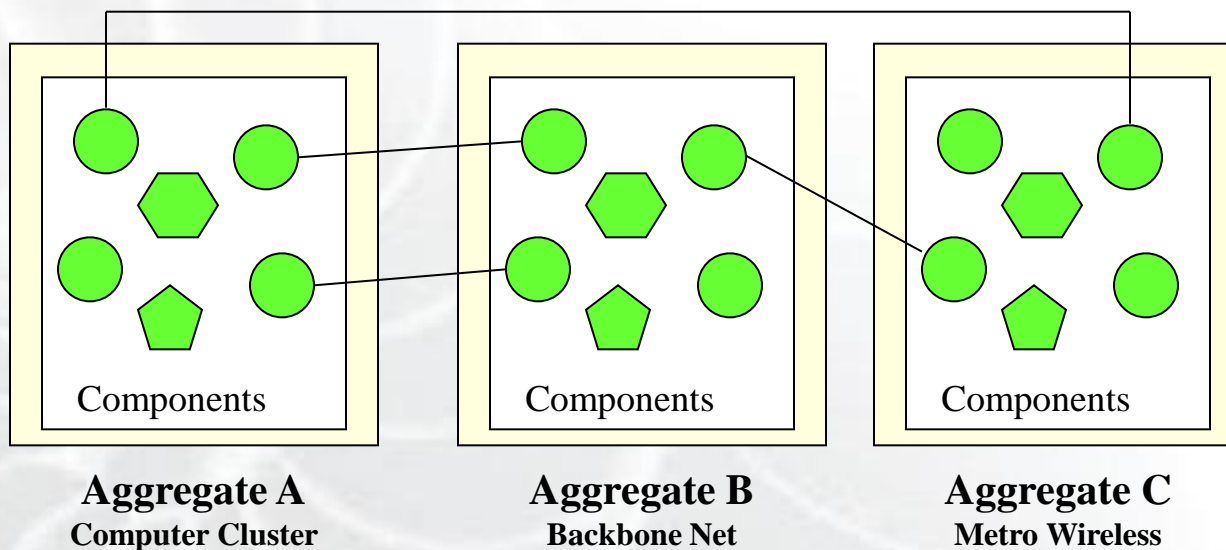
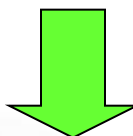
Researcher

What resources can I use?

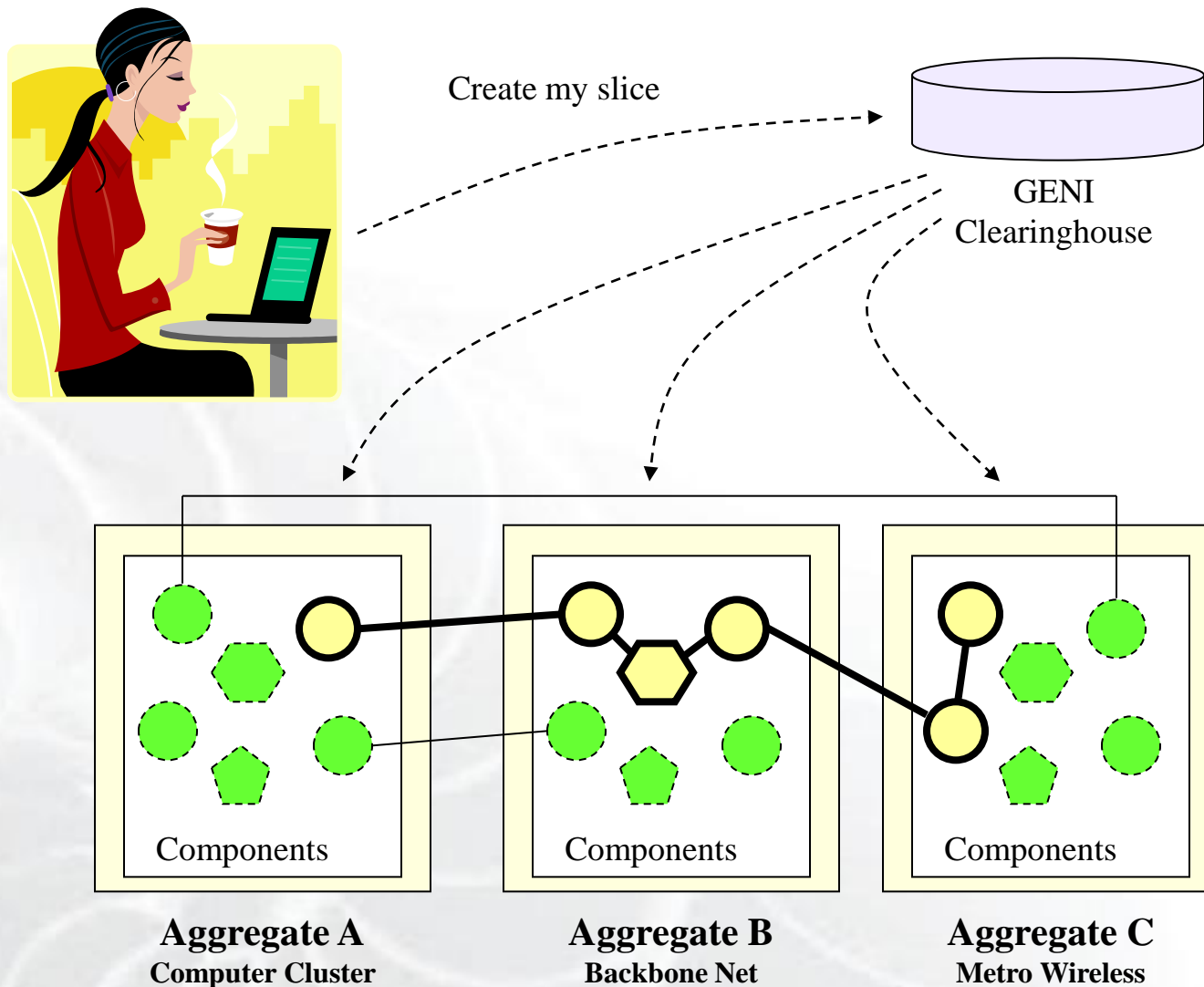


GENI  
Clearinghouse

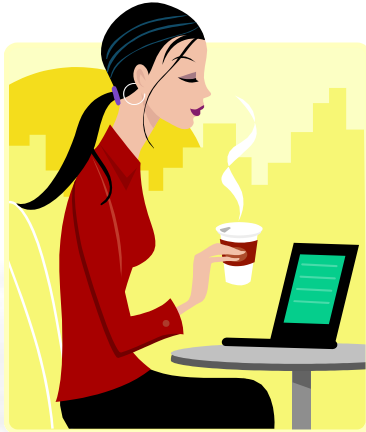
These



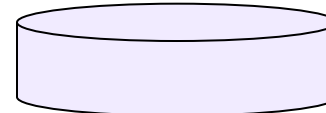
Clearinghouse checks credentials & enforces policy  
Aggregates allocate resources & create topologies



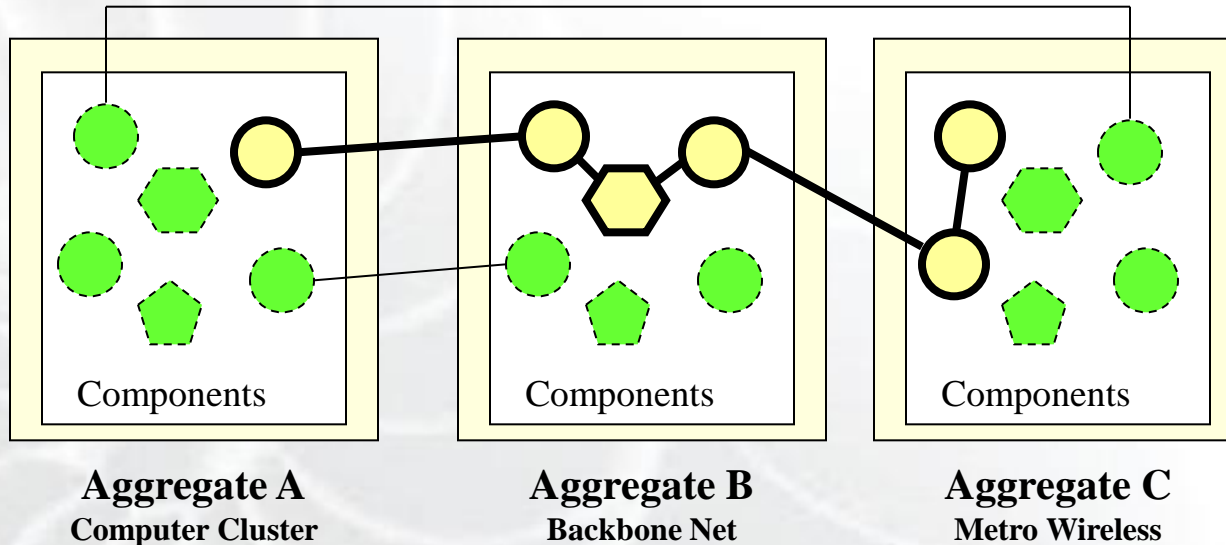
Researcher loads software, debugs, collects measurements



Experiment – Install my software,  
debug, collect data, retry, etc.

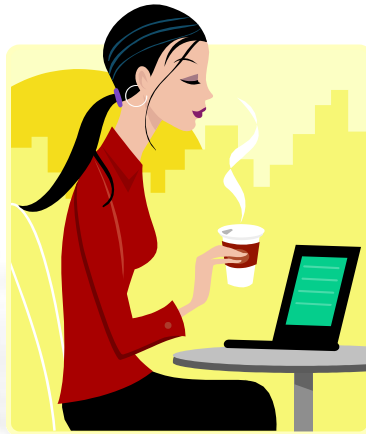


GENI  
Clearinghouse



# Slice growth & revision

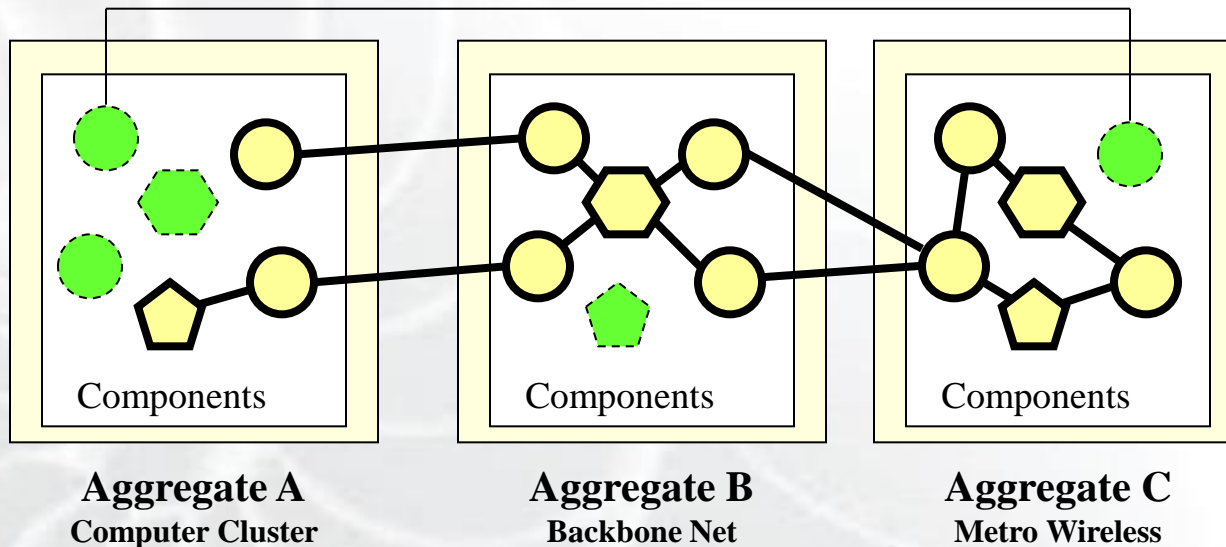
Allows successful, long-running experiments to grow larger



Make my slice bigger !



GENI  
Clearinghouse



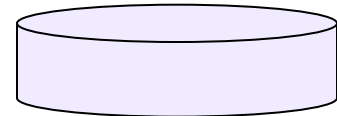


# Federation of Clearinghouses

Growth path to international, semi-private, and commercial GENIs



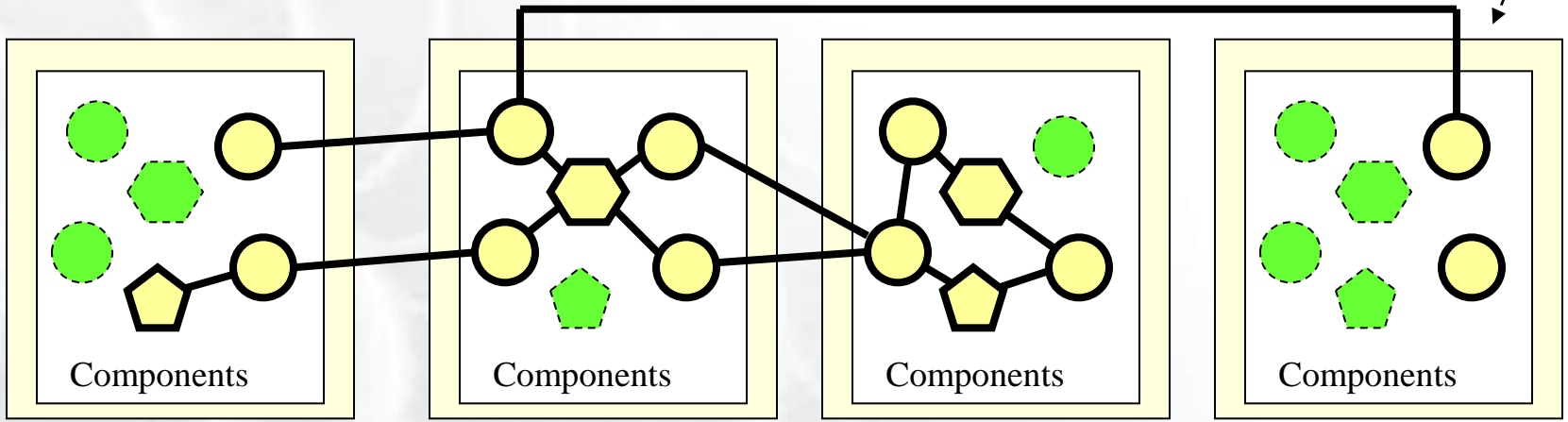
Make my slice even bigger !



GENI  
Clearinghouse



Federated  
Clearinghouse



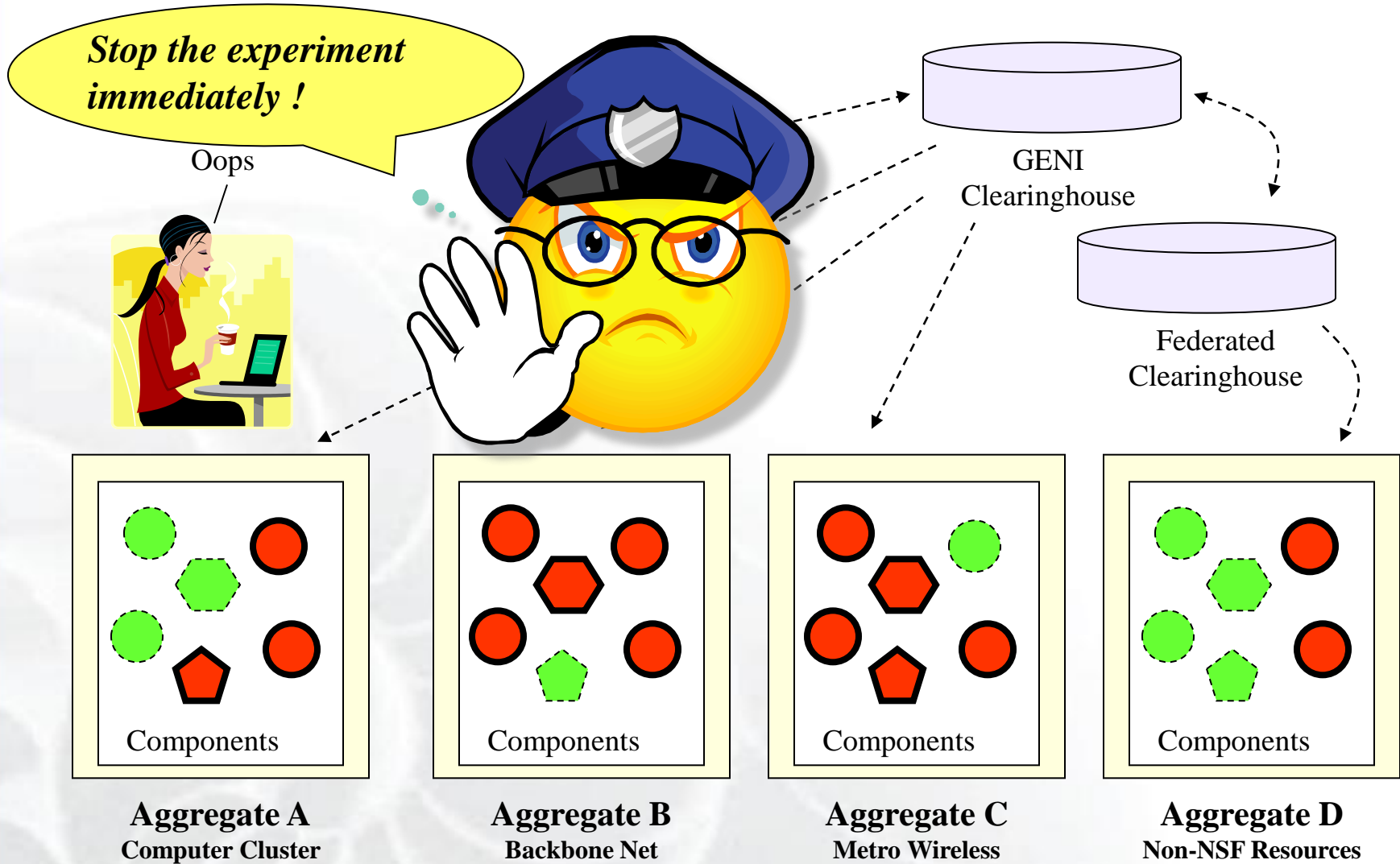
**Aggregate A**  
Computer Cluster

**Aggregate B**  
Backbone Net

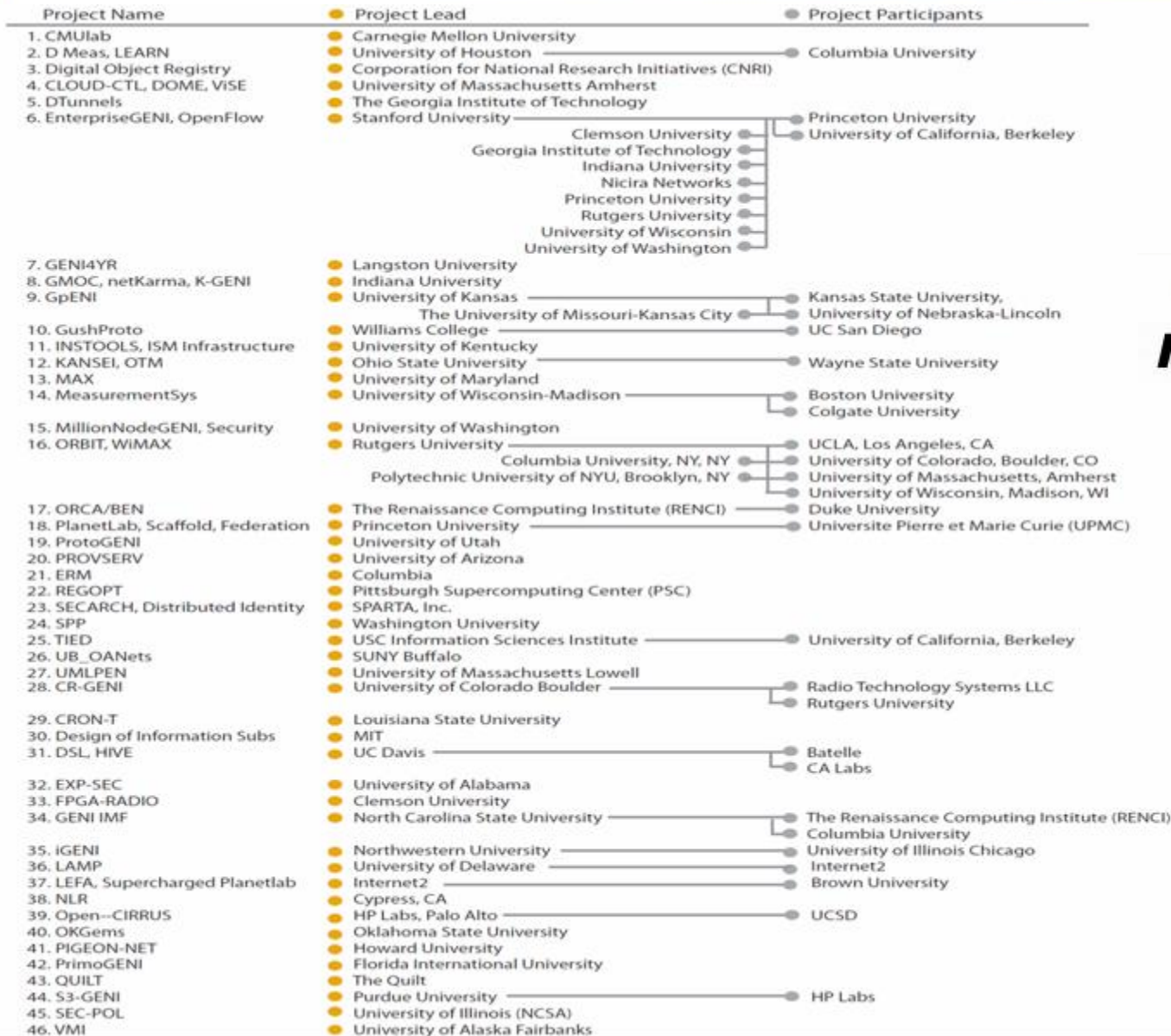
**Aggregate C**  
Metro Wireless

**Aggregate D**  
Non-NSF Resources

Always present in background for usual reasons  
Will need an 'emergency shutdown' mechanism



# Spiral 2 Academic-Industrial Teams



# Building the GENI Meso-scale Prototype

## Current plans for locations & equipment

### OpenFlow

- Stanford
- U Washington
- Wisconsin
- Indiana
- Rutgers
- Princeton
- Clemson
- Georgia Tech

### ShadowNet

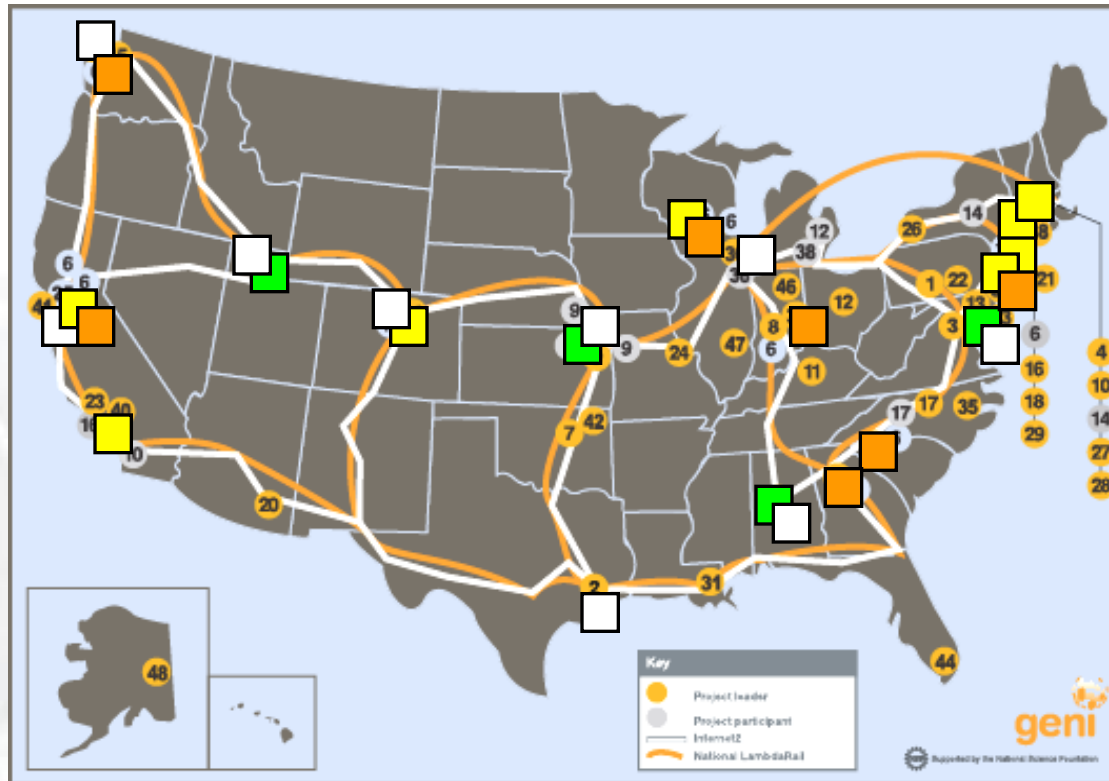
- Salt Lake City
- Kansas City
- DC
- Atlanta

### WiMAX

- Stanford
- UCLA
- UC Boulder
- Wisconsin
- Rutgers
- Polytech
- UMass
- Columbia

### OpenFlow Backbones

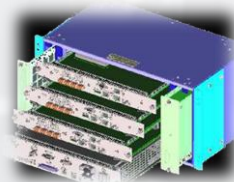
- Seattle
- Salt Lake City
- Sunnyvale
- Denver
- Kansas City
- Houston
- Chicago
- DC
- Atlanta



HP ProCurve 5400 Switch



Juniper MX240 Ethernet Services Router



NEC WiMAX Base Station



Cisco 6509 Switch



Arista 7124S Switch

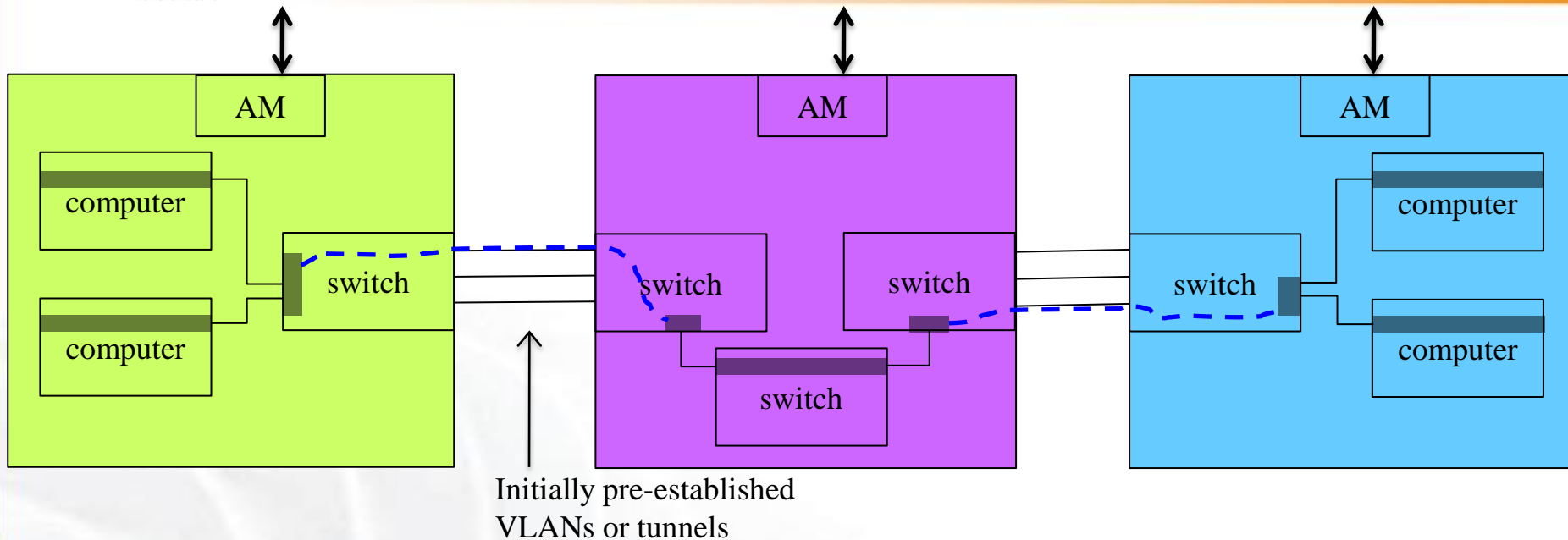


NEC IP8800 Ethernet Switch

- GENI uses multiple network virtualization strategies...
  - Tunnels over IP (GRE, OpenVPN)
  - Ethernet VLANs (incl QinQ Ethernet tunnels)
  - OpenFlow (switch forwarding rules based on any header field)
- ...to connect sliceable computation
  - Dedicated hosts (e.g., Emulab)
  - Virtual machines (e.g., PlanetLab, XEN, OpenVZ)
  - Clouds (e.g., Amazon EC2, Eucalyptus)
- ...and programmable network devices
  - Programmable switches (e.g., OpenFlow)
  - FPGA-based switches & routers (e.g., PEN, SPP, netFPGA)
  - Virtualizable routers (e.g., Juniper M7i)



# What is stitching?



- “Aggregate managers” orchestrate resource allocation locally
- “Stitching” is used to connect aggregates
- Establishes linkages among slivers or other entities created by different AMs
  - The near term emphasis is on Ethernet carriage, i.e., VLANs and tunnels that can carry Ethernet frames
  - Will want to extend this to other layers
  - Several stitching approaches are under consideration