Experiences with Measurement Data Collection on R&E Networks

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Indiana University

The Global Research NOC

- Formed in 1998 to provide operations for the Abilene Network
- Groups
  - Service Desk: 24x7x365 Call Center & Monitoring Center
  - Network Engineering: 16 engineers providing troubleshooting & planning
  - Systems Engineering & Tool Development: 11 engineers
    - Developing & supporting GRNOC toolset and systems
    - Operating research platforms like the Internet2 Observatory and NLRview
    - Measurement collection and visualization
    - GENI Meta Operation Center (GMOC)

The Global Research NOC

CEN

C·I·C 1958 – 2008 OmniPoP

gMOC GENI META-OPERATIONS CENTER

HOPI HYBRID OPTICAL PACKET INFRASTRUCTURE

I-LIGHT Indiana's Optical Network

Indiana GigaPOP indiana.gigapop.net

INDIANA UNIVERSITY

INTERNET2®

IP grid

manLan Manhattan Landing Exchange Point

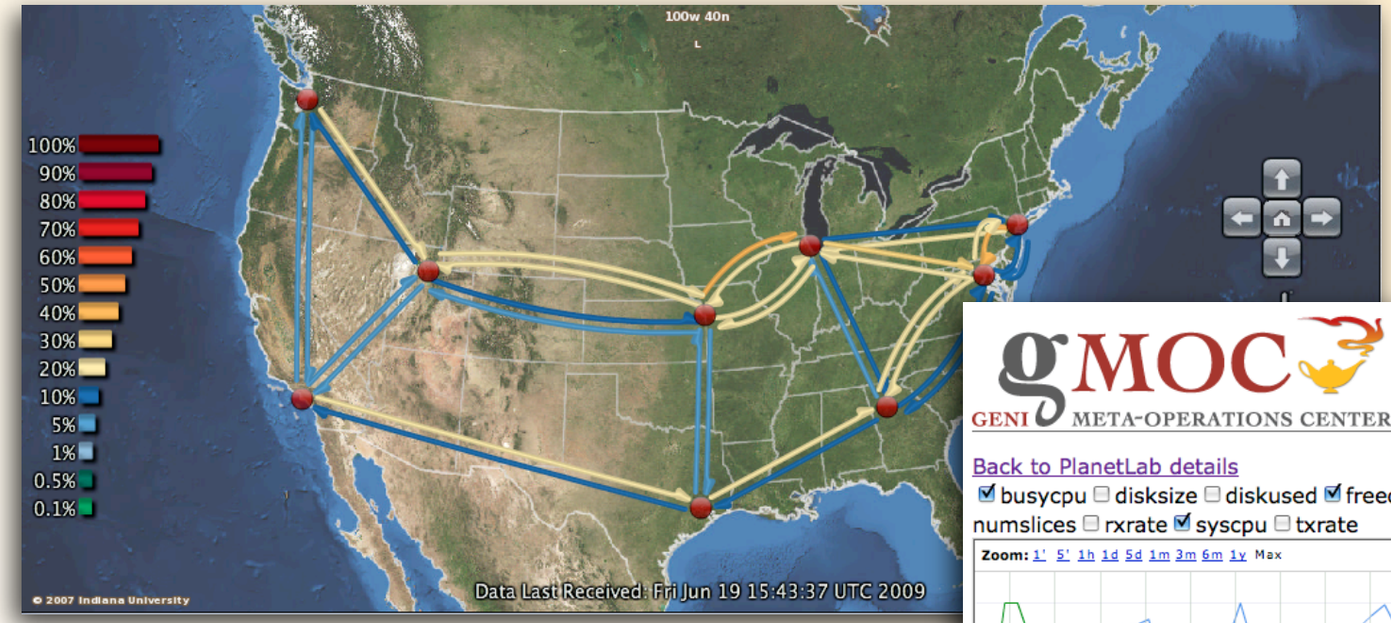
NLR light the future

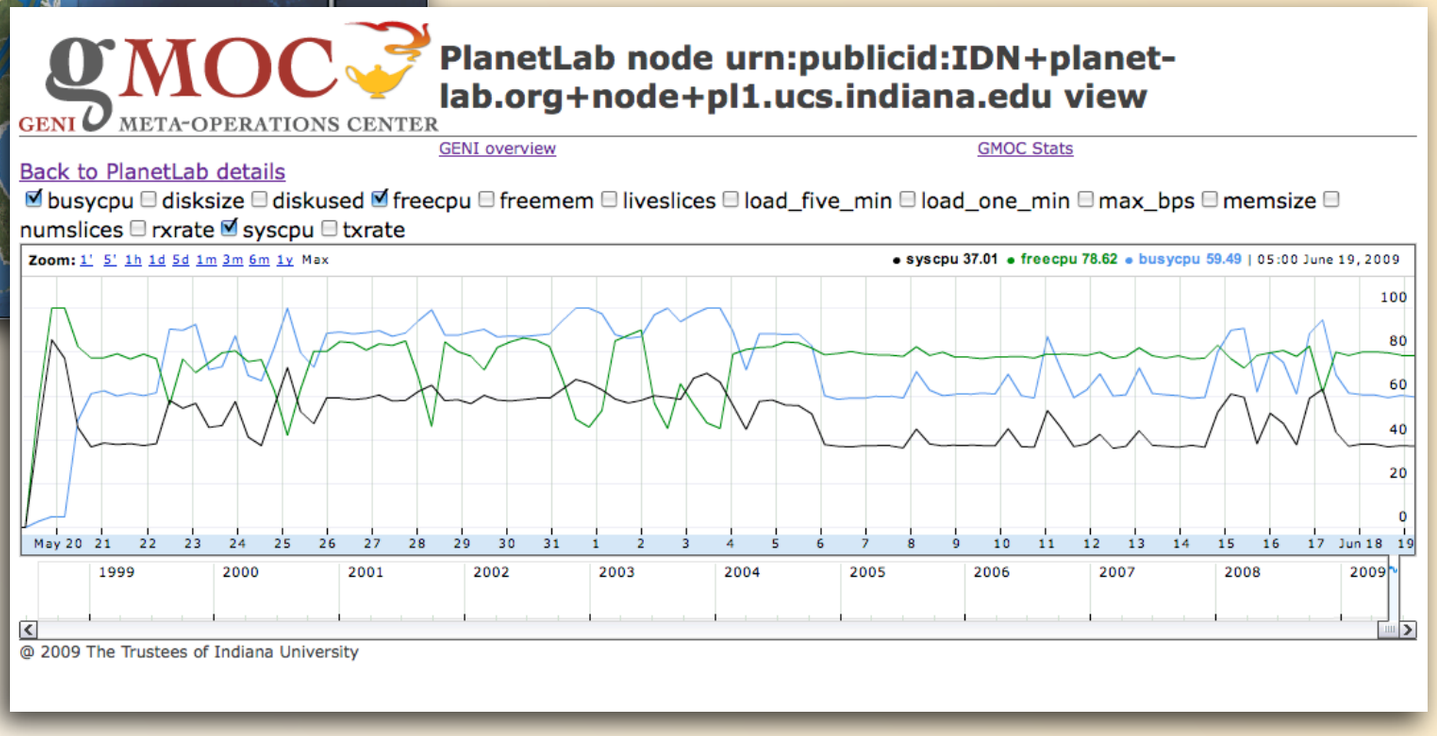
TransPAC2®

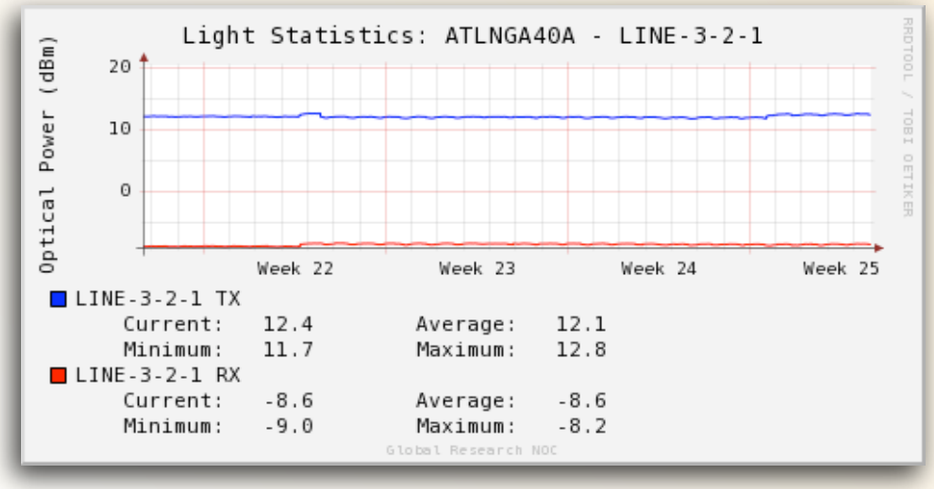
IU GlobalNOC and Measurement

- GENI Meta Operations Center (GMOC)
  - Operations and Management will need inputs to understand the state of the network
- Experience with research infrastructure
  - >200 I2 Observatory, NLRView, CIC, I-Light, Gigapop, IU campus, etc.. measurement points
  - Co-located research equipment
- Substrate operator
  - Currently collect data that can be added to measurement repositories
- Visualization systems

Measurement Data and Visualization







Typical Measurement Points

- 1-10 servers per pop -- 1 and 2U rackmount, central data collection
- 10 gig capable
- Time source (GPS or CDMA)
- Software
  - Netflow/sflow, packet capture
  - Active measurements (BWCTL, OWAMP, NPAD, NDT)
  - Routing data (ISIS and BGP)
  - SNMP stats (Utilization, Environmental, etc..)
  - “Visible Network”, Router/Switch/NE Proxy, LLAMA

Researcher questions (#1)

- What is the state of the network?
  - Researcher often doesn't know what they are looking for but see an anomaly in their data
  - Topology (Virtual and Physical), Outages, Utilization, etc..
  - Can you tell me what happened on the night of Mat 10th 2007?
  - Time period can be exact or very loose
  - R&E networks are fairly static in topology yet hard to describe changes to researchers

Researcher questions (#2)

- Where is the data?
  - Data is often hard to find
  - Human readable vs. Machine readable
  - Raw data vs. "Cooked" data
    - Information is often available but hard to find/construct
    - Descriptions of data transformation (anonymization, sampling, filtering)
- Data Reuse - Does this fit in the GENI model?

Researcher questions (#3)

- Why can't I get the data?
  - Privacy
    - Policy needs to be well defined
    - Drives what data collected and architecture
  - Cost
    - If OTDR/DAG card needed at every pop it will get expensive
    - Data Retention
  - Disruptive - Breakable networks
  - Technology - probably the easiest

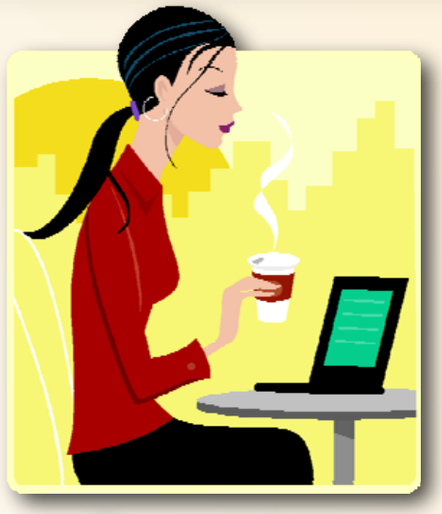
GENI Relevance

- Slightly different model than R&E networks
  - Separation of experiments
  - Is shared data useful in GENI?
    - Intermediate results
    - Repeatable of experiment
    - Manage your own experiment and data
    - “An Experimentation Workbench for Replayable Networking Research” [Eide, Stoller and Lepreau NSDI 07]

Data Management

- What possible things can be done to streamline research?
  - Metadata attached to measurement data
    - Operational Data - state of slice (and all slivers)
    - Data transformations
    - Slice Provisioning as a source of data
    - Experiment description language
    - Policy info??
    - Formats??? (RSpec, OGF schemas, Workflow Languages)

GENI Slice Creation

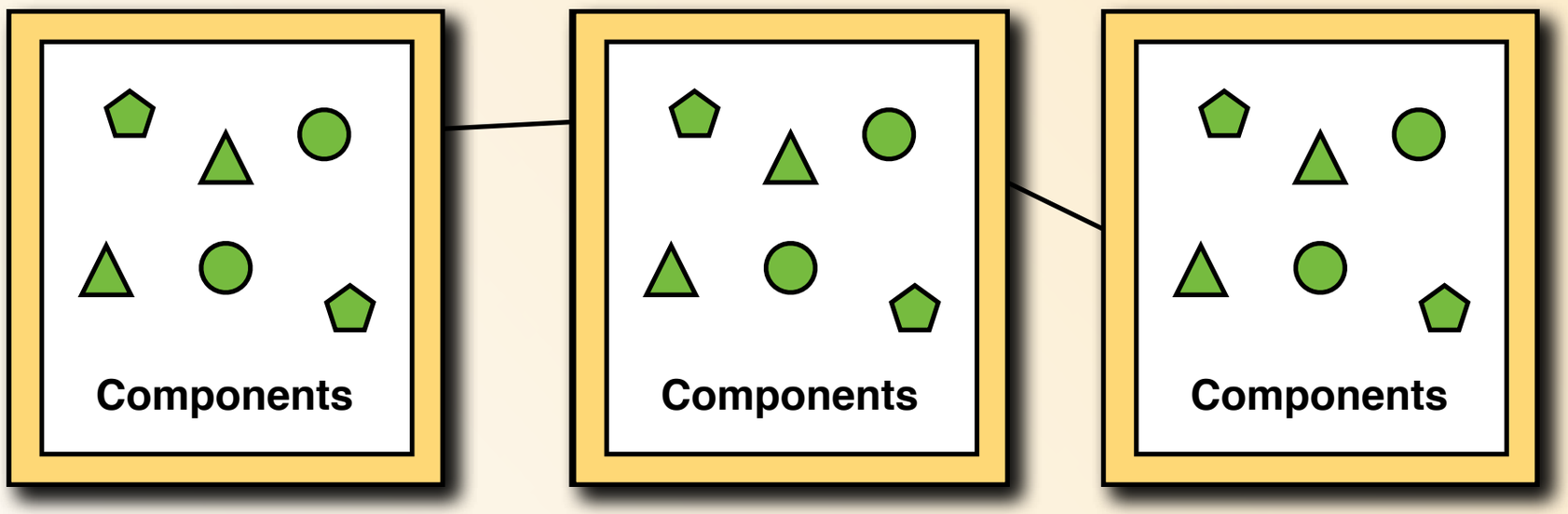


Researcher

GENI Experimental Workflow Tools

GIMS (GENI Instrumentation and Measurement Systems)

GMOC Operation DataSet



Aggregate A
Compute Nodes

Aggregate B
Backbone Net

Aggregate C
Mobile Net

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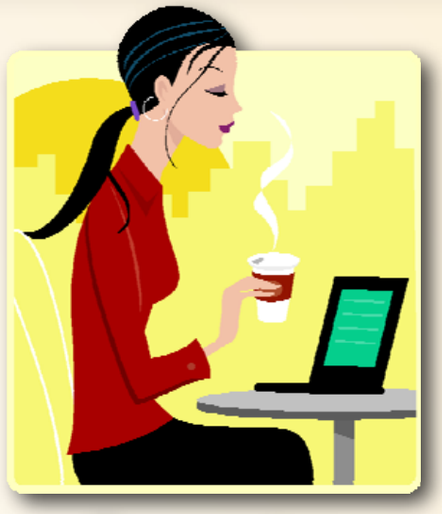

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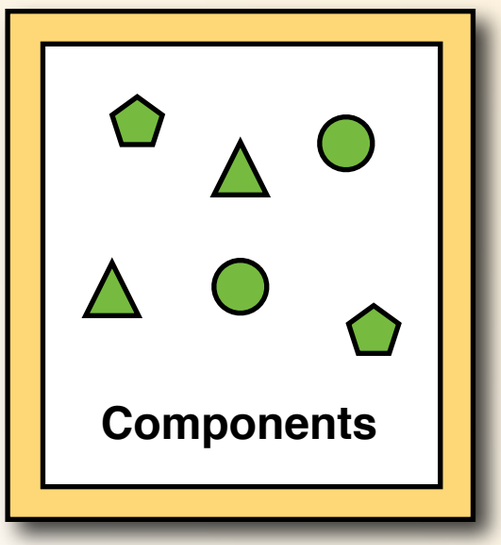

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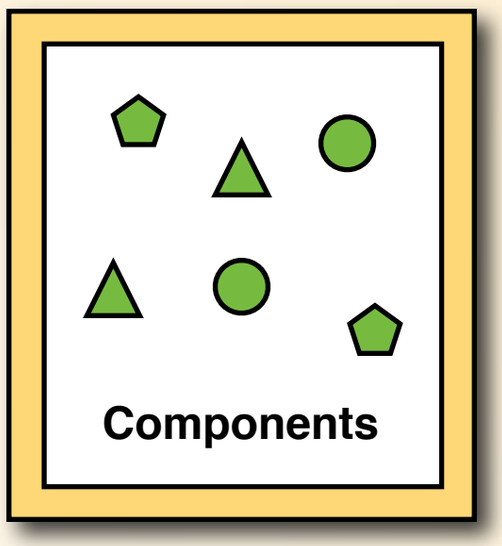
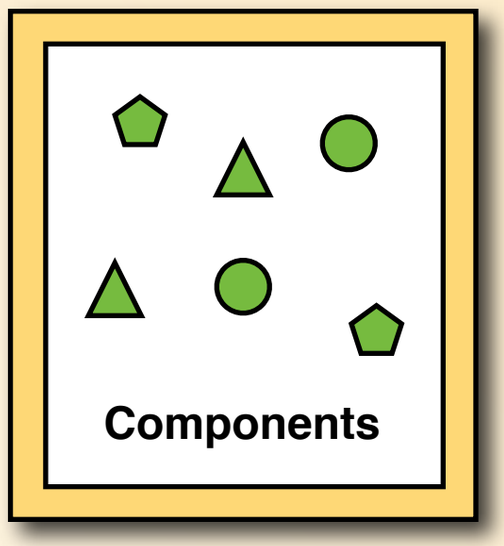


Aggregate B
Backbone Net



Aggregate C
Mobile Net

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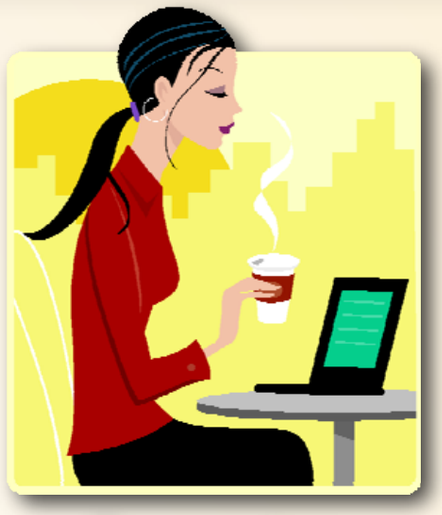

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GENI:
"Slice Allocated"

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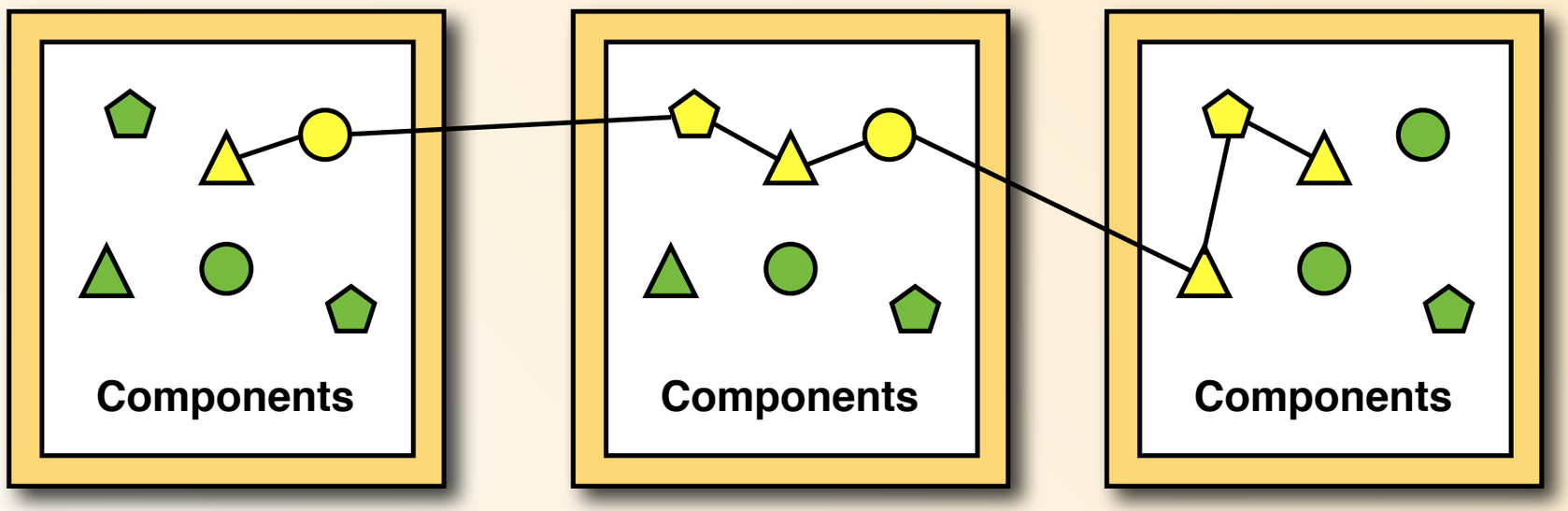

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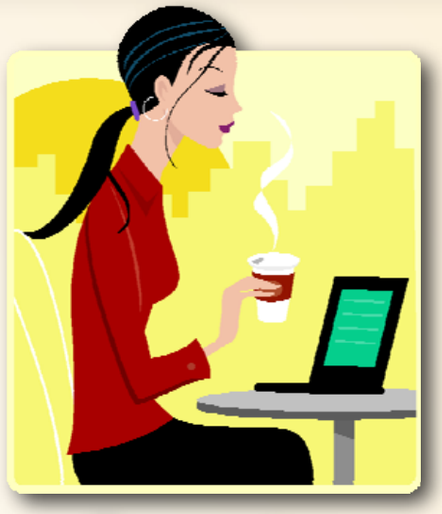


Researcher

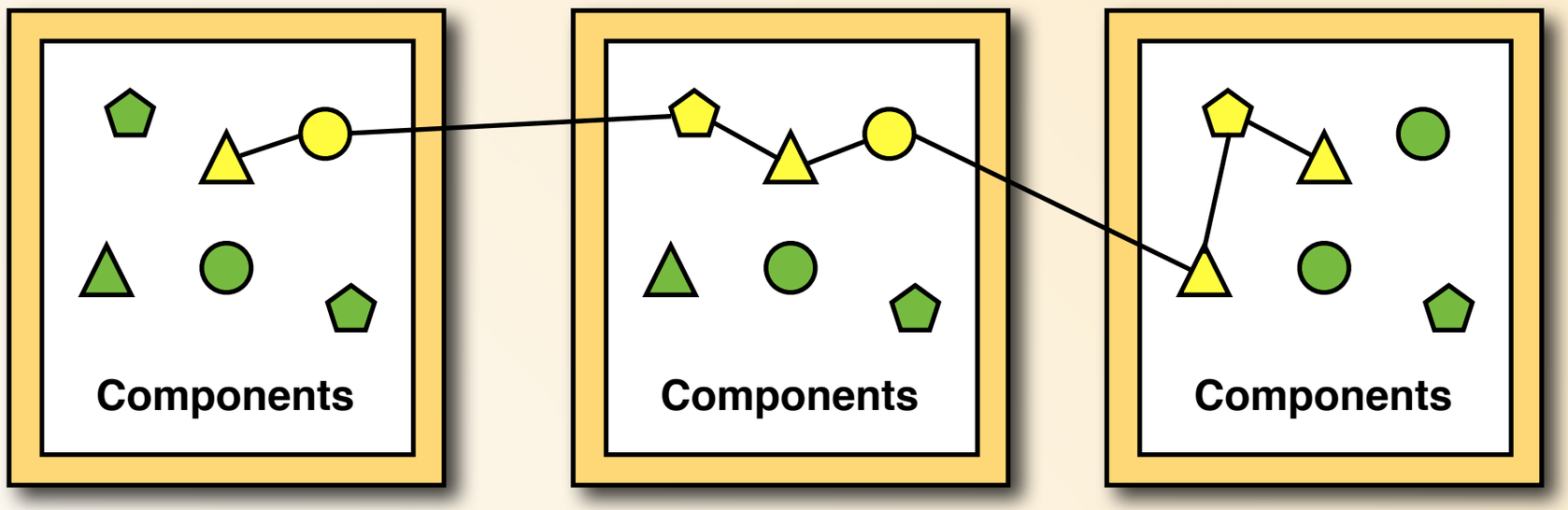
Researcher:
"Start Experiment"

GENI Experimental Workflow Tools

GIMS (GENI Instrumentation and Measurement Systems)

GMOC Operation DataSet

Experiment Configuration and Software pushed to slice



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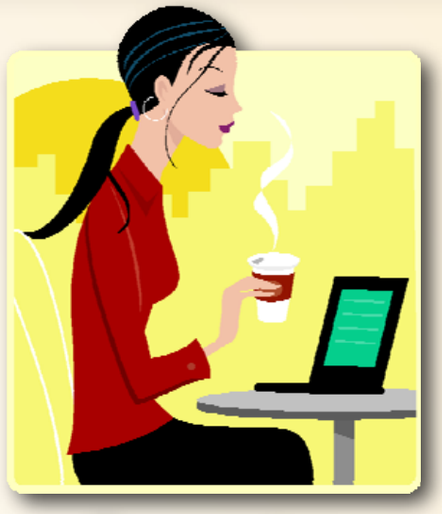

Researcher

Researcher: "Start Experiment"

Can this workflow be captured and tied to the data collected in the experiment?

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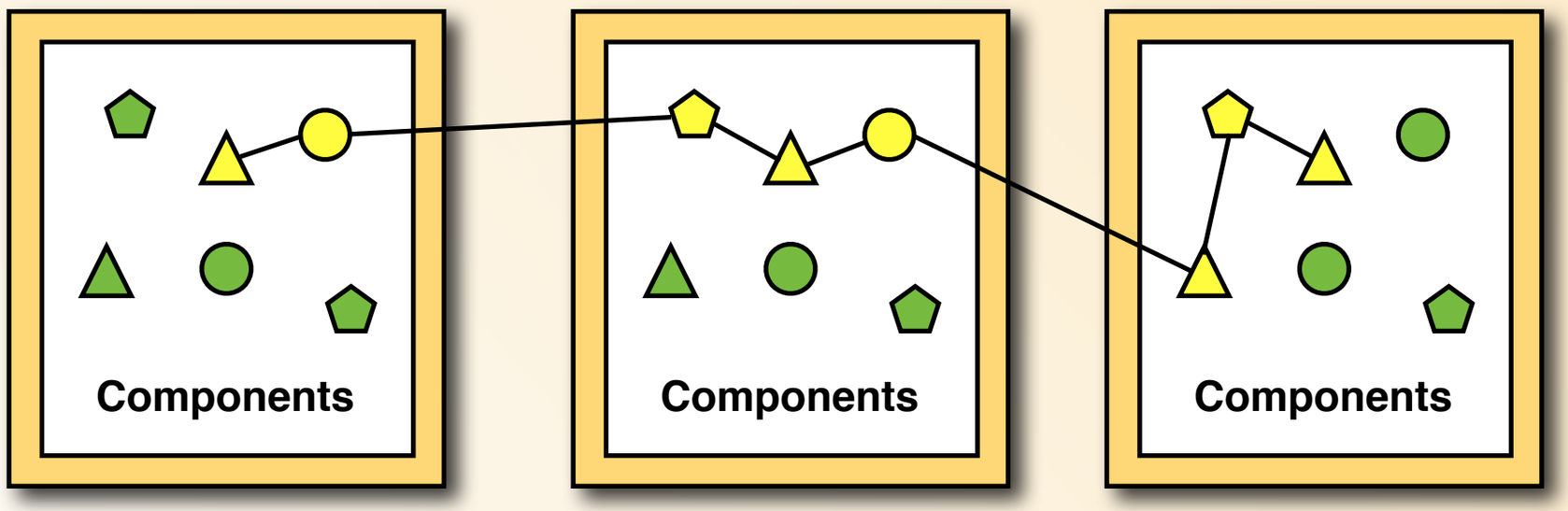

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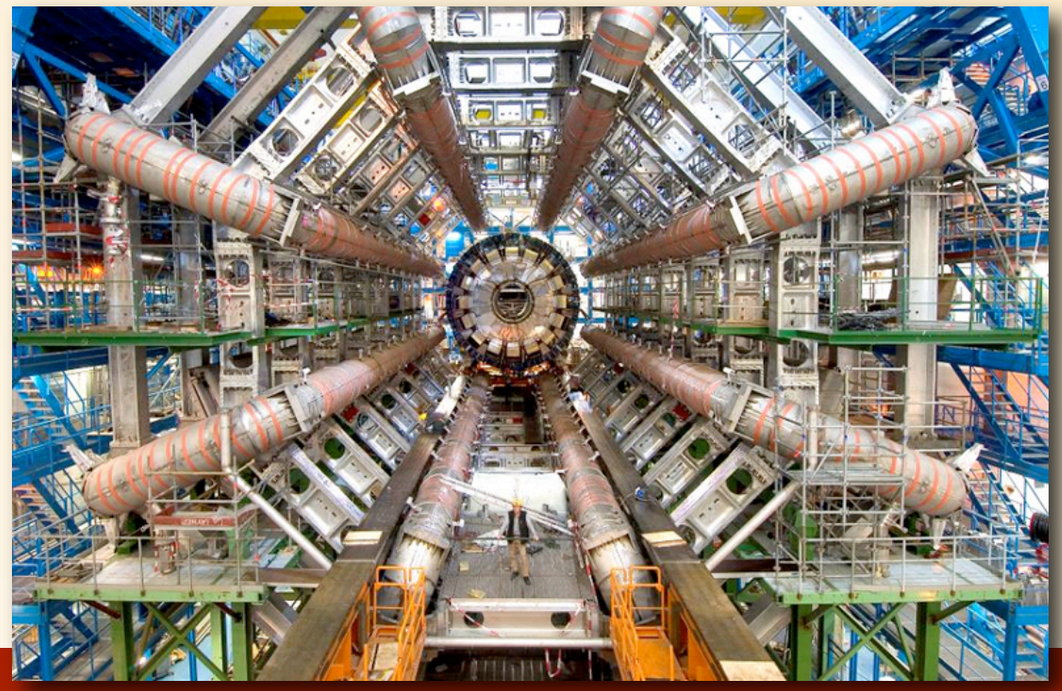
Data Management - Finding Data

- Data Discovery mechanisms
  - Portals - One or many
  - Web Services
  - Handle service
  - Find data “in the slice”
  - Storage - Where? Does it exist after the slice is released? Can it be used as an incentive to make data available to others.

Possible relevant work

- Grid
  - Data provenance - Karma, Workflow languages (BPEL, YAML)
    - Use Workflow Language to describe an experiment and infrastructure state
  - OGF schemas - PerfSonar
- Other Sciences (HEP, Astronomy, Meteriology)
- Emulab/Flexlab -- replayable experiments
- DATCAT
- CRAWDAD



Links

- IU GlobalNOC - http://globalnoc.iu.edu/
- GMOC - http://gmoc.grnoc.iu.edu/
- NSDI07 Replayable Research - http://www.cs.utah.edu/flux/papers/workbench-nsdi07-base.html
- Karma (Data Provenance) - http://www.dataandsearch.org/provenance/?q=taxonomy/term/3
- DatCat - http://www.datcat.org/
- Workflow Languages - http://www.gridworkflow.org/snips/gridworkflow/space/Workflow+Description+Languages