Cloud Computing with Nimbus

April 2010

Condor Week

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Nimbus Project

University of Chicago

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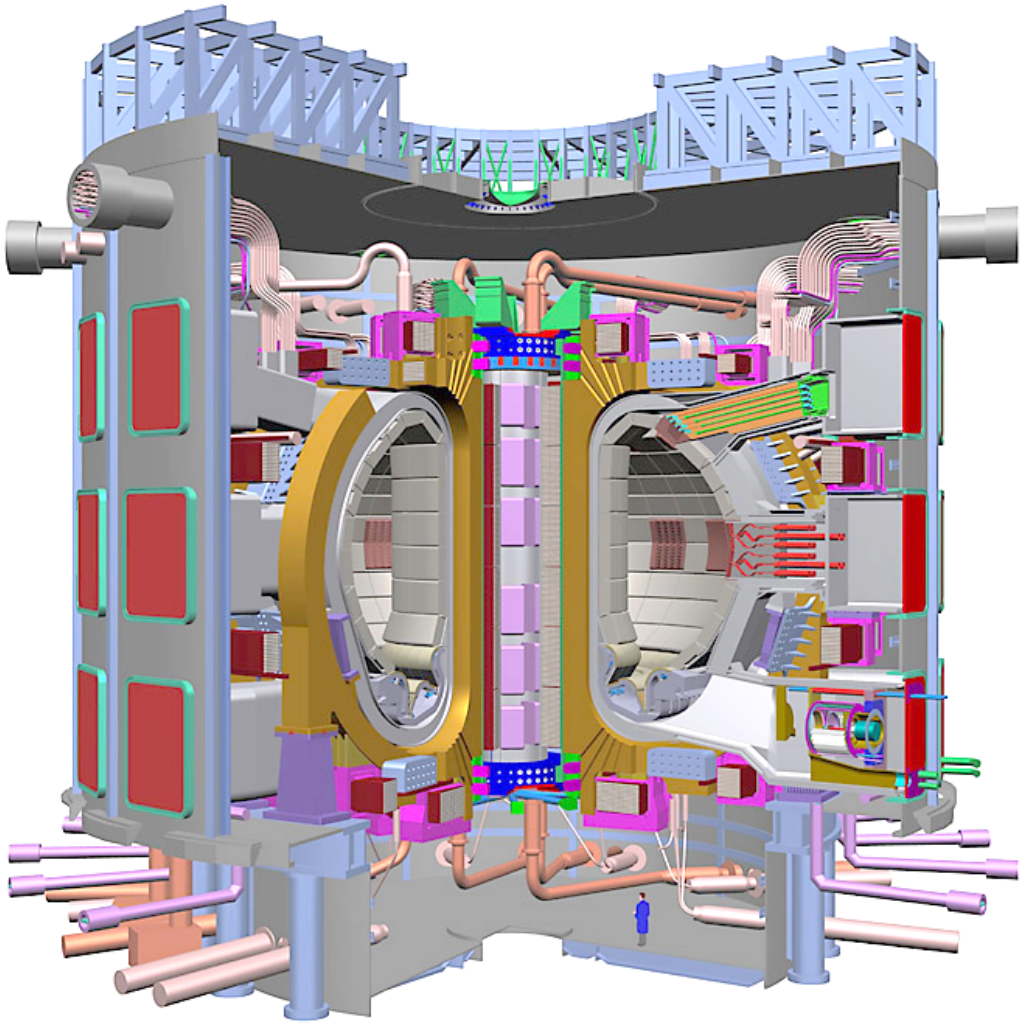
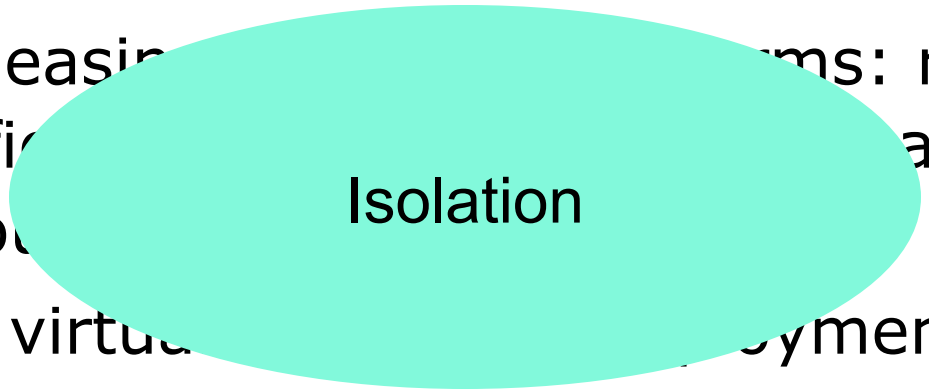
Cloud Computing for Science



- Environment
  - Complexity
  - Consistency
- Availability

"Workspaces"

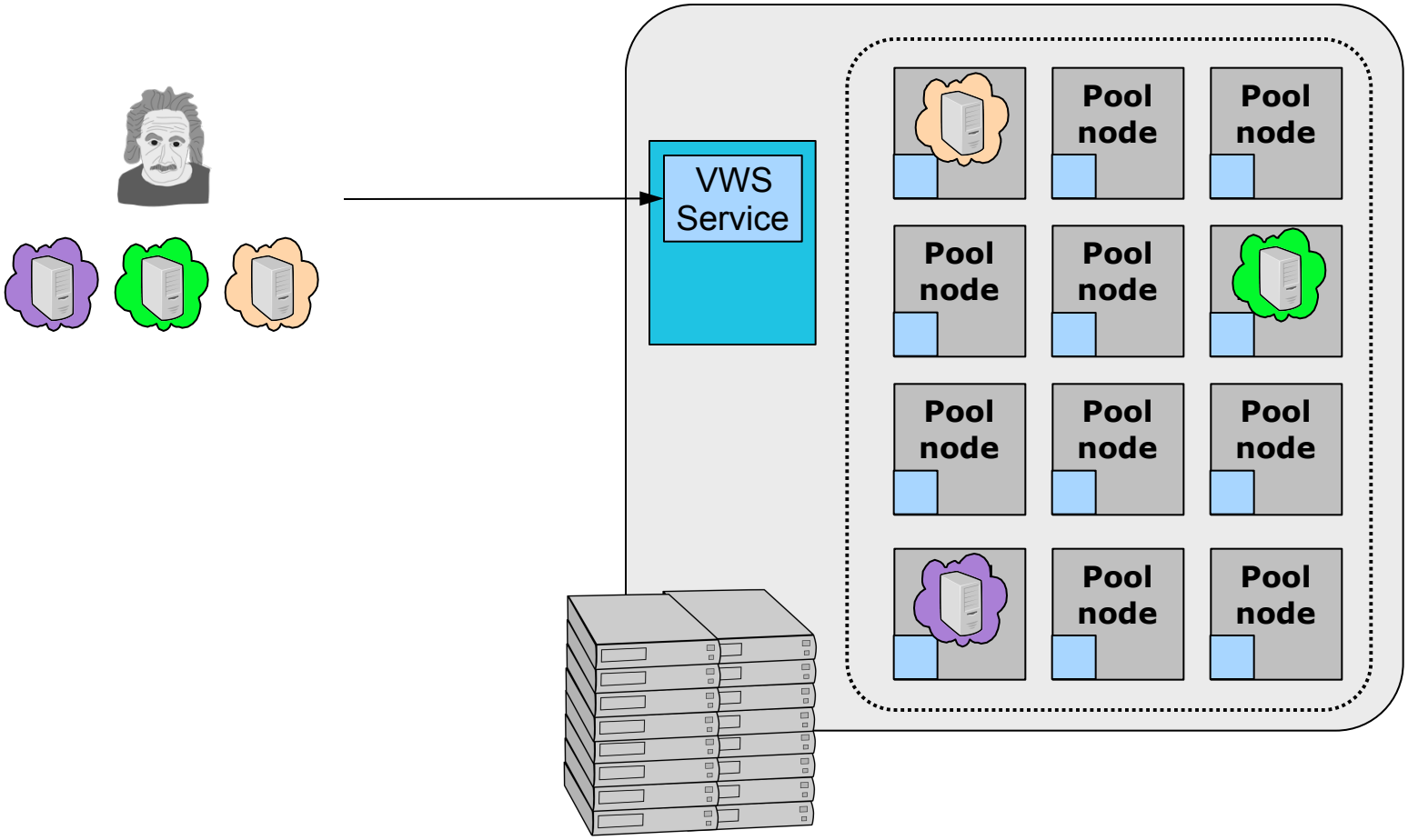
- Dynamically provisioned environments
  - Environment control
  - Resource control
- Implementations
  - Via leasi ms: reimaging, confi amic acco
  - Via virtu yment



Nimbus: Cloud Computing for Science

- Allow providers to build clouds
  - Workspace Service: a service providing EC2-like functionality
  - WSRF-style and EC2-style (both SOAP and REST) interfaces
  - Support for Xen and KVM
- Allow users to use cloud computing
  - Do whatever it takes to enable scientists to use IaaS
  - Context Broker: turnkey virtual clusters
  - Currently investigating scaling tools
- Allow developers to experiment with Nimbus
  - For research or usability/performance improvements
  - Open source, extensible software
  - Community extensions and contributions: UVIC (monitoring), IU (EBS, research), Technical University of Vienna (privacy, research)
- Last release is 2.4: www.nimbusproject.org

The Workspace Service

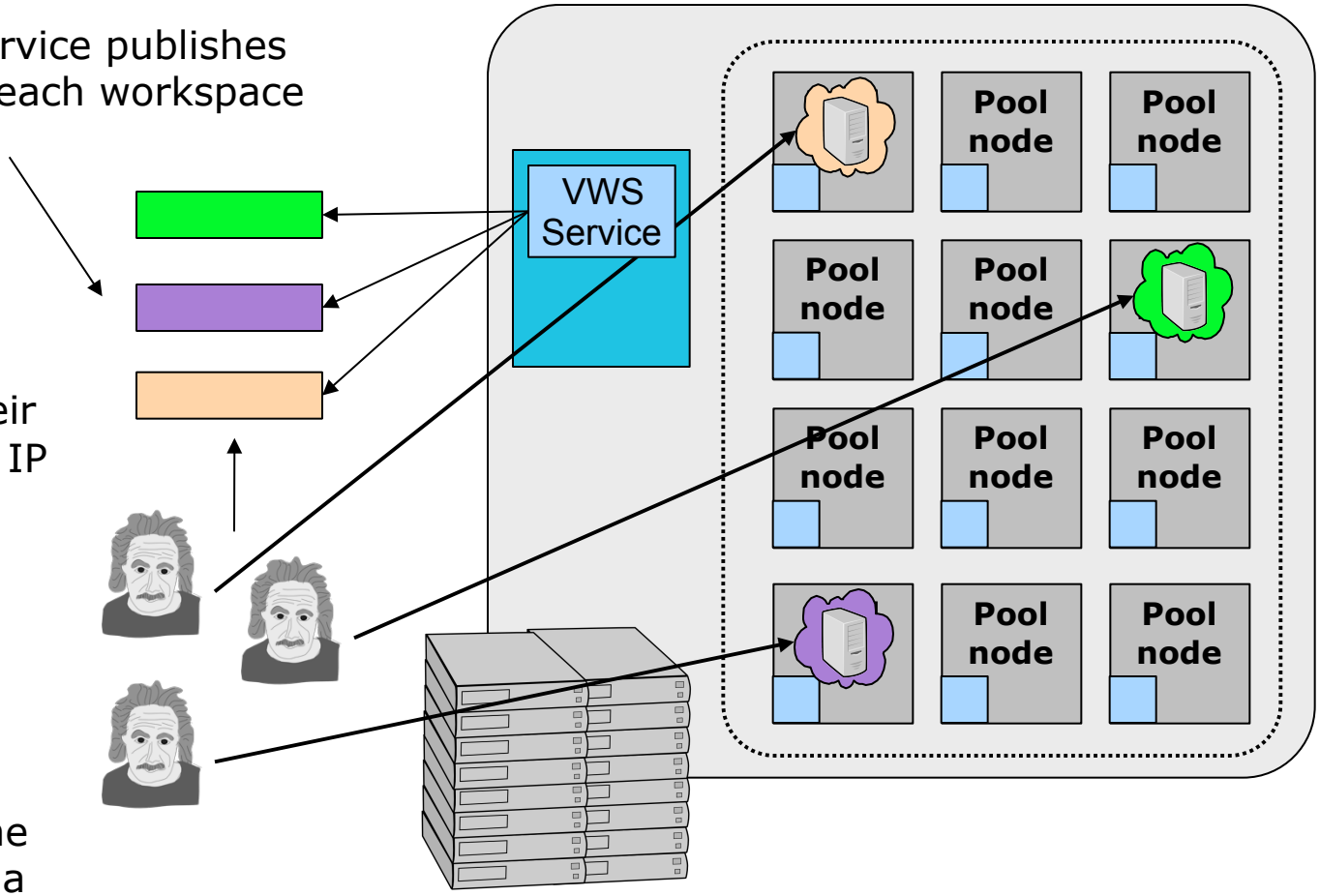


The Workspace Service

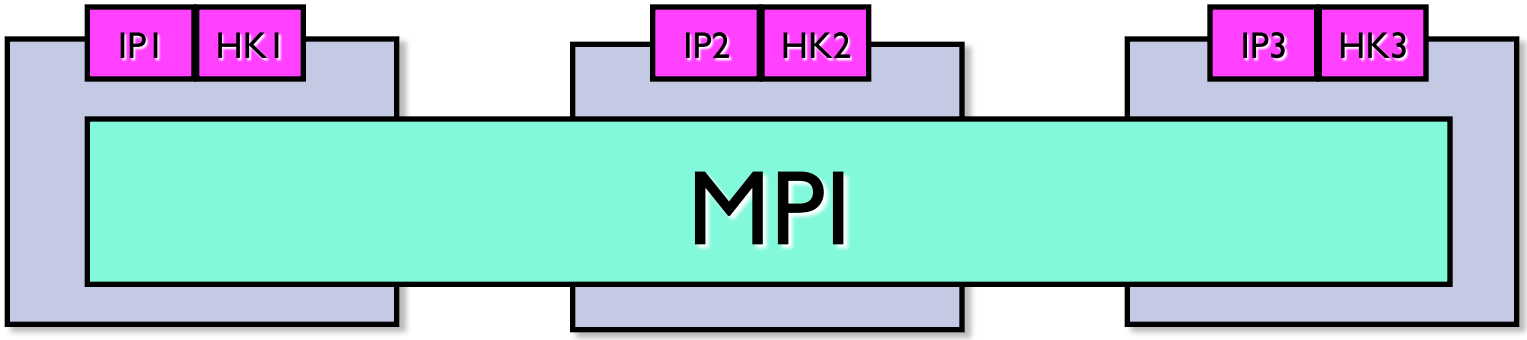
The workspace service publishes information about each workspace

Users can find out information about their workspace (e.g. what IP the workspace was bound to)

Users can interact directly with their workspaces the same way the would with a physical machine.



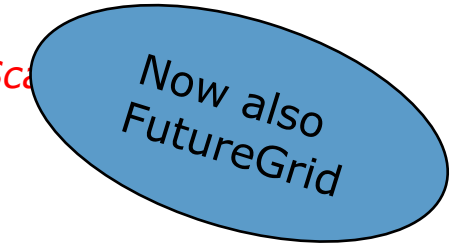
Turnkey Virtual Clusters



- Turnkey, tightly-coupled cluster
  - Shared trust/security context
  - Shared configuration/context information
- Context Broker goals
  - Every appliance
  - Every cloud provider
  - Multiple distributed cloud providers
- Used to contextualize 100s of virtual nodes for EC2 HEP STAR runs, Hadoop nodes, HEP Alice nodes…
- Working with rPath on developing appliances, standardization

Science Clouds

- Participants
  - University of Chicago (since 03/08), University of Florida (05/08, access via VPN), Wispy @ Purdue (09/08)
  - International collaborators
    - *Congratulations to Pierre Riteau for winning the Large Sc… Challenge on Grid5K!*
  - Using EC2 for large runs

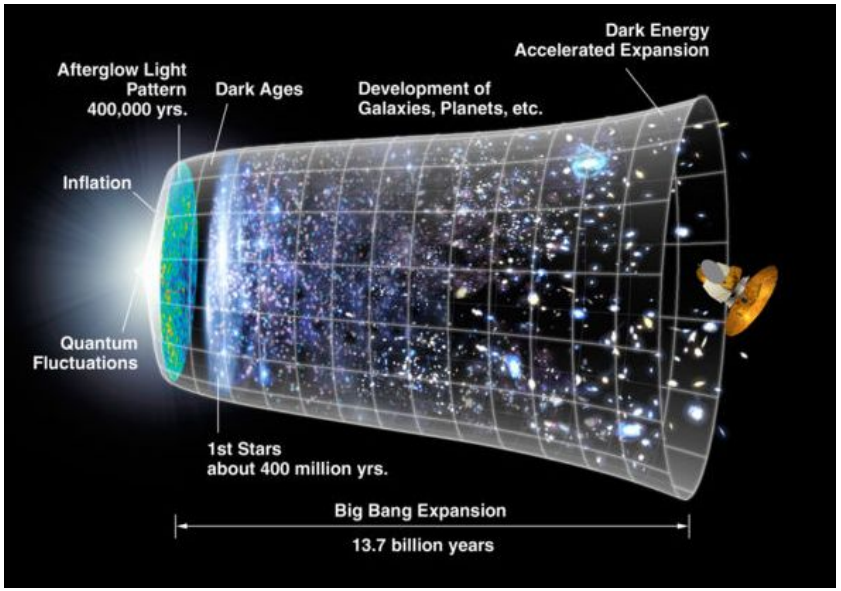


- Science Clouds Marketplace: OSG cluster, Hadoop, etc.
- 100s of users, many diverse projects ranging across science, CS research, build&test, education, etc.
- Come and run: **www.sciencecloud.org**

STAR experiment

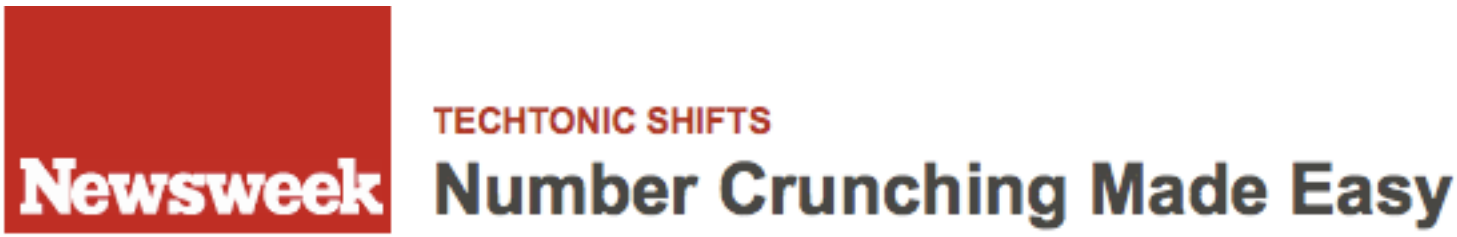
Work by Jerome Lauret, Leve Hajdu, Lidia Didenko (BNL), Doug Olson (LBNL)

- STAR: a nuclear physics experiment at Brookhaven National Laboratory
- Studies fundamental properties of nuclear matter
- Problems:
  - Complexity
  - Consistency
  - Availability



STAR Virtual Clusters

- Virtual resources
  - A virtual OSG STAR cluster: OSG headnode (gridmapfiles, host certificates, NFS, Torque), worker nodes: SL4 + STAR
  - One-click virtual cluster deployment via Nimbus Context Broker
- From Science Clouds to EC2 runs
- Running production codes since 2007
- The Quark Matter run: producing just-in-time results for a conference: http://www.isgtw.org/?pid=1001735



Priceless?

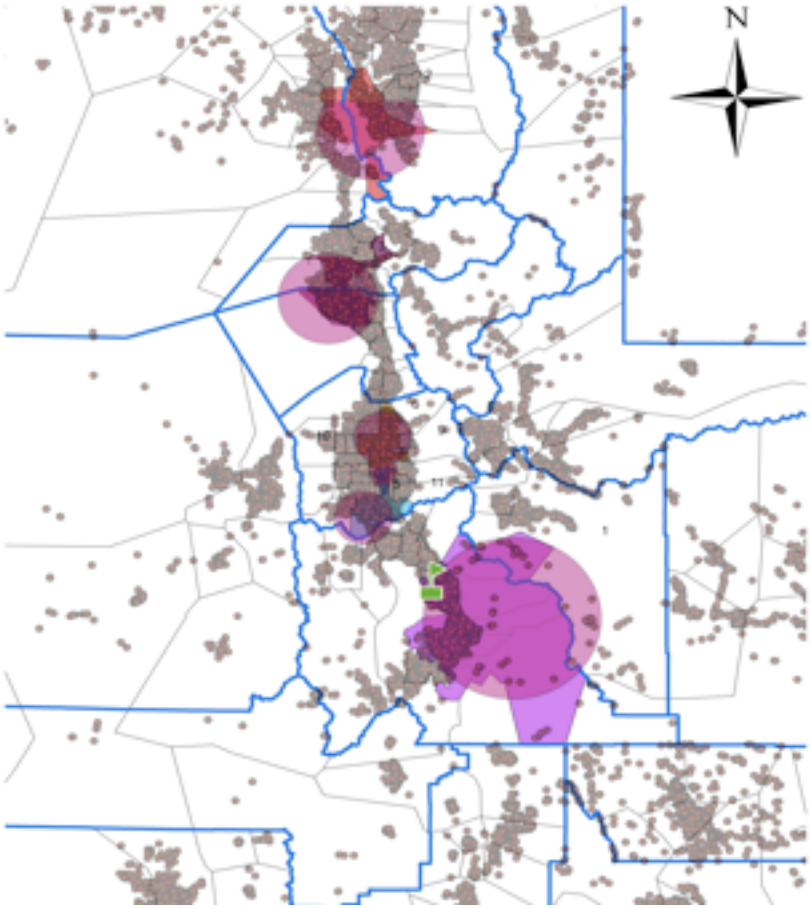
- Compute costs: $ 5,630.30
  - 300+ nodes over ~10 days,
  - Instances, 32-bit, 1.7 GB memory:
    - EC2 default: 1 EC2 CPU unit
    - High-CPU Medium Instances: 5 EC2 CPU units (2 cores)
  - ~36,000 compute hours total
- Data transfer costs: $ 136.38
  - Small I/O needs : moved <1TB of data over duration
- Storage costs: $ 4.69
  - Images only, all data transferred at run-time
- Producing the result before the deadline…

…$ 5,771.37

Modeling the Progression of Epidemics

Work by Ron Price and others, Public Health Informatics, University of Utah

- Can we use clouds to acquire on-demand resources for modeling the progression of epidemics?
- What is the efficiency of simulations in the cloud?
  - Compare execution on:
    - a physical machine
    - 10 VMs on the cloud
    - The Nimbus cloud only
  - 2.5 hrs versus 17 minutes
  - Speedup = 8.81
  - 9 times faster

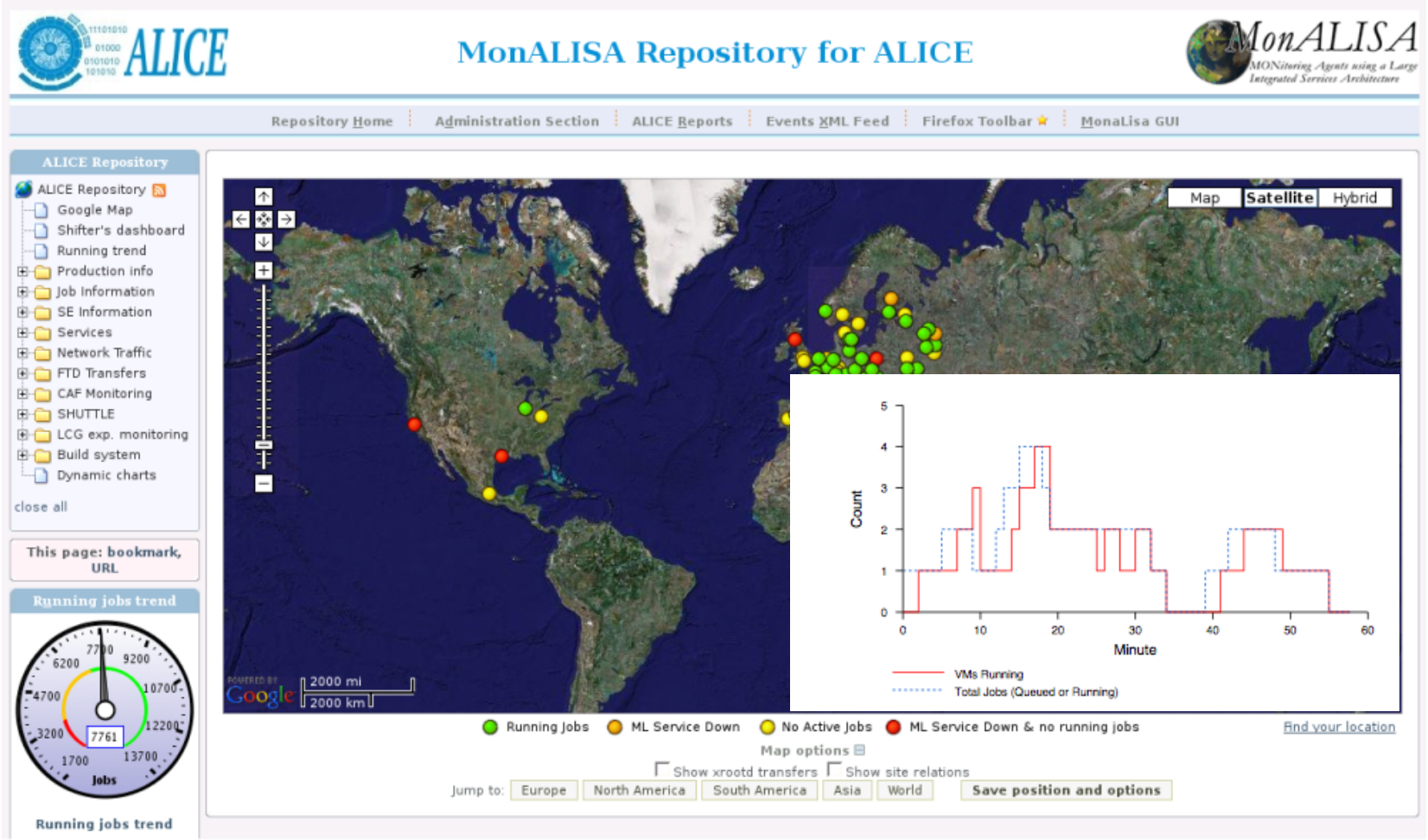


A Large Ion Collider Experiment (ALICE)

Work by Artem Harutyunyan and Predrag Buncic, CERN

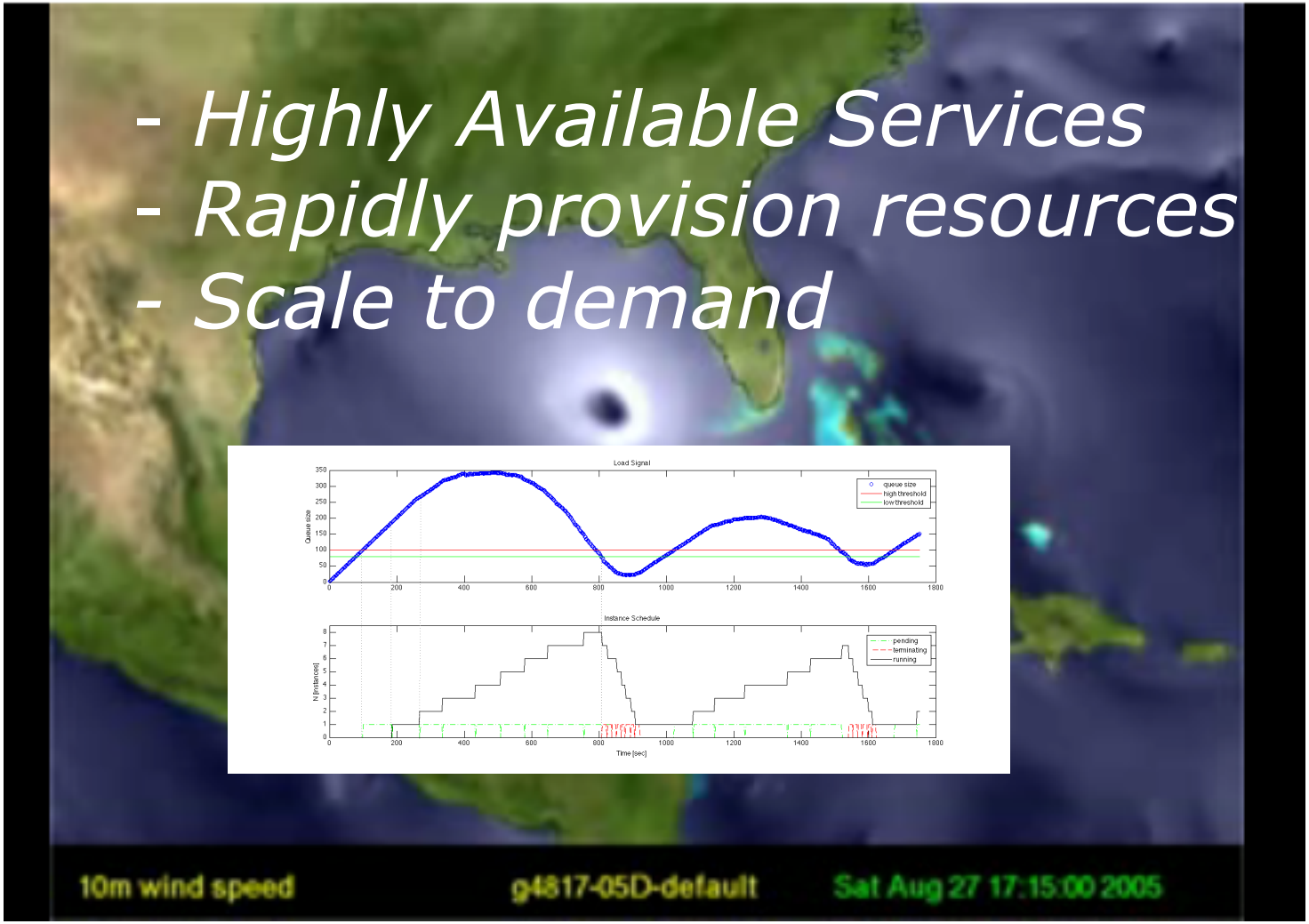
- Heavy ion simulations at CERN
- Problem: integrate elastic computing into current infrastructure
- Collaboration with CernVM project
- Elastically extend the ALICE testbed to accommodate more computing

Elastically Provisioned Resources



- *CHEP 2009 paper, Harutyunyan et al., Collab. with CernVM*
- *CCGrid 2010 paper, Marshall et al., "Elastic Sites"*

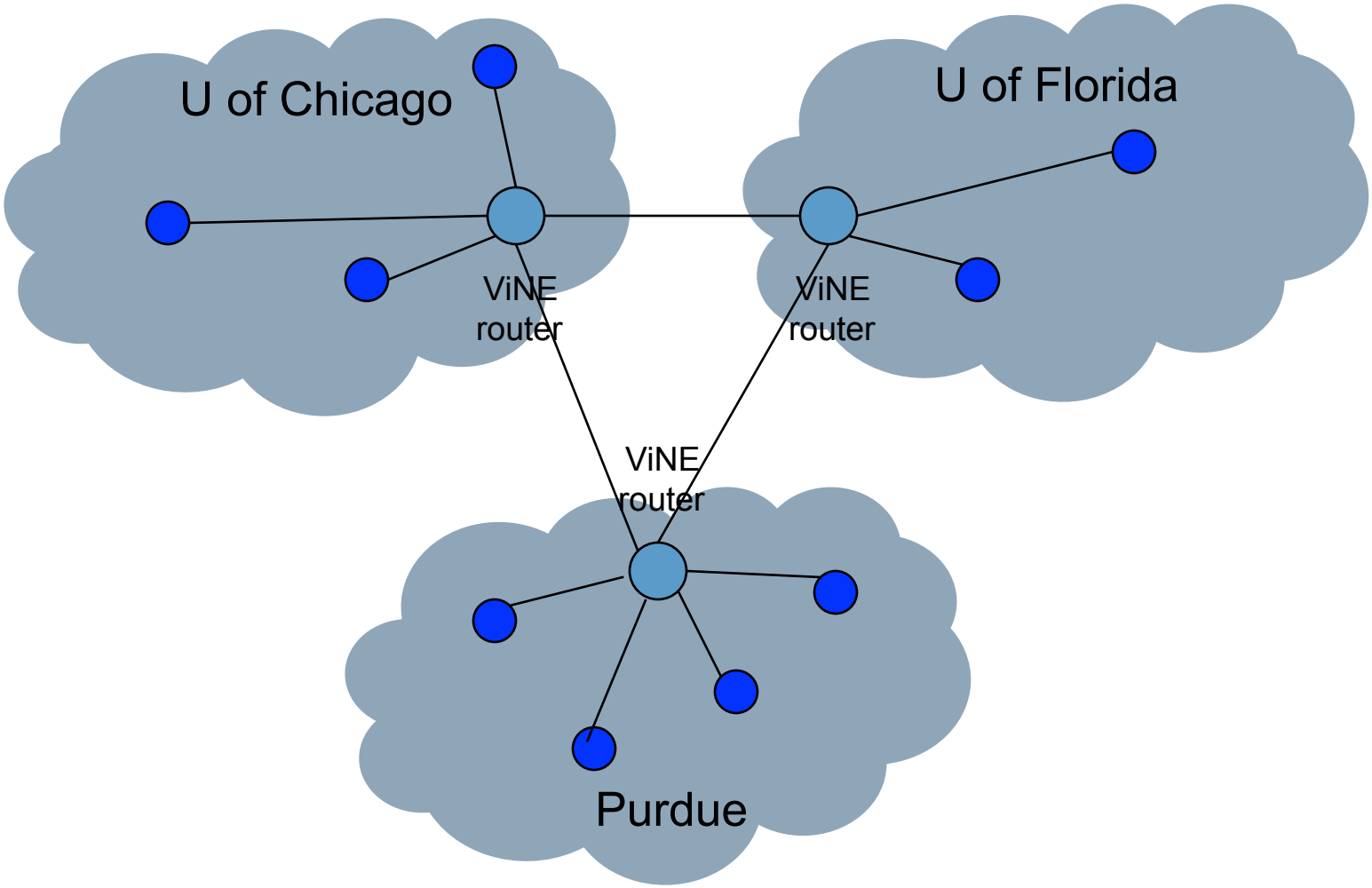
Ocean Observatory Initiative (OOI)



www.nimbusproject.org

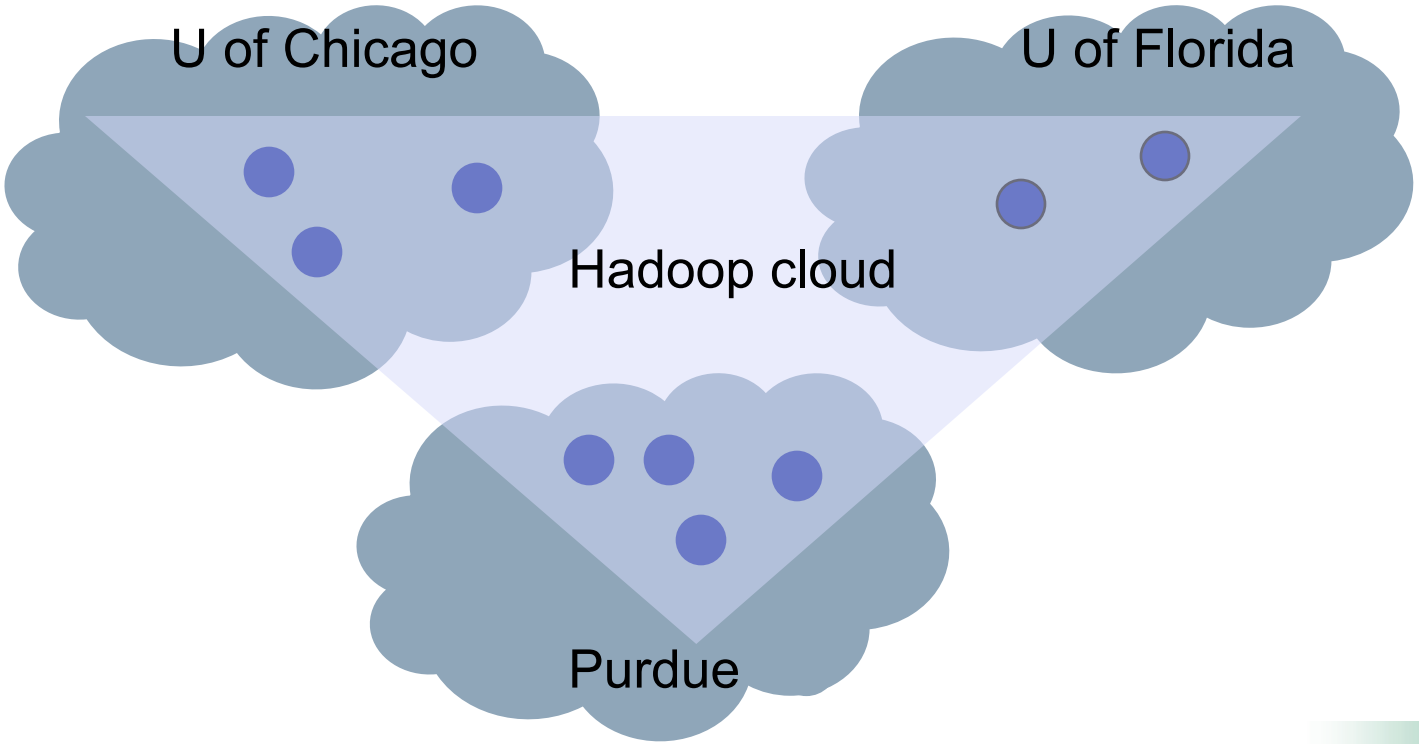
“Sky Computing” Environment

Work by A. Matsunaga, M. Tsugawa, University of Florida



Creating a seamless environment in a distributed domain

Hadoop in the Science Clouds

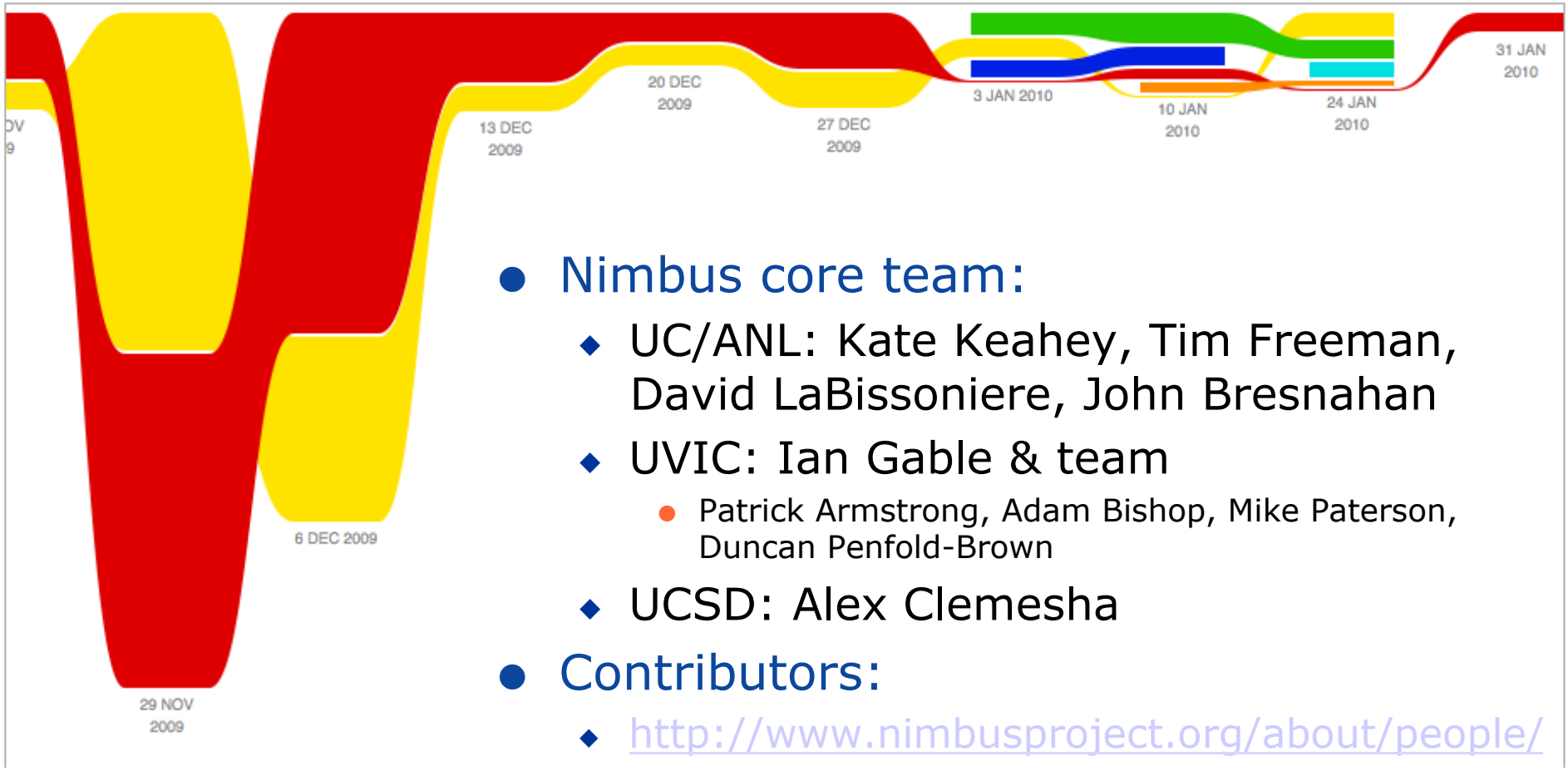


- *Papers:*
  - *"CloudBLAST: Combining MapReduce and Virtualization on Distributed Resources for Bioinformatics Applications" by A. Matsunaga, M. Tsugawa and J. Fortes. eScience 2008.*
  - *"Sky Computing", by K. Keahey, A. Matsunaga, M. Tsugawa, J. Fortes, to appear in IEEE Internet Computing, September 2009*
- *Large Scale Deployment Challenge on Grid5K, Pierre Riteau*

New & Noteworthy…

- FutureGrid: experimental testbed
  - Infrastructure-as-a-Service for FutureGrid
  - IaaS cycles for science
  - New capabilities: “sky computing” scenarios
- Ocean Observatory Infrastructure (OOI)
  - Highly available services
  - Elastic provisioning

Nimbus: Friends and Family

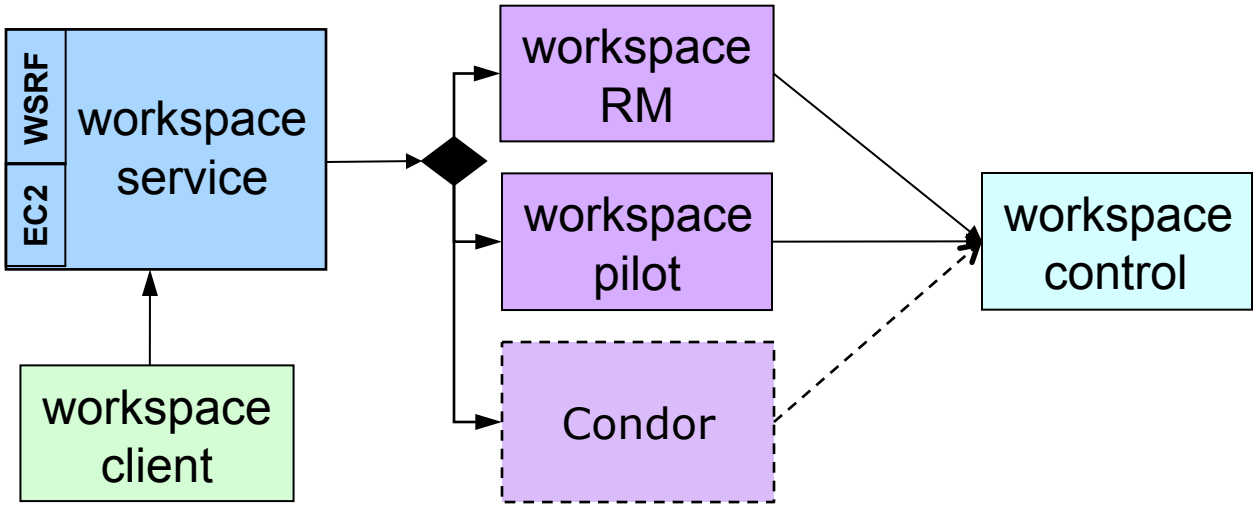


- Nimbus core team:
  - UC/ANL: Kate Keahey, Tim Freeman, David LaBissoniere, John Bresnahan
  - UVIC: Ian Gable & team
    - Patrick Armstrong, Adam Bishop, Mike Paterson, Duncan Penfold-Brown
  - UCSD: Alex Clemesha
- Contributors:
  - http://www.nimbusproject.org/about/people/

Nimbus and Condor

- Two Nimbus projects using Condor starting this summer
  - Using Condor as scheduler for VMs
  - Using HTC to backfill cloud computing jobs

Nimbus and Condor



- Leverage Condor capabilities for RM
- Workspace control for VM management
  - Wrapper for a collection of modules/libraries
  - VM image management and construction, VM control (via libvirt), VM networking, contextualization, ssh-based notifications

Parting Thoughts

- Infrastructure-as-a-Service for science
  - Easy access to the "right configuration"
  - Makes resource sharing more efficient
- Understanding how to leverage these capabilities for science
  - Challenges in building ecosystem, security, usage, price-performance, use of existing tools, etc.
- Working on it! ;-)