Cloud Computing for Science

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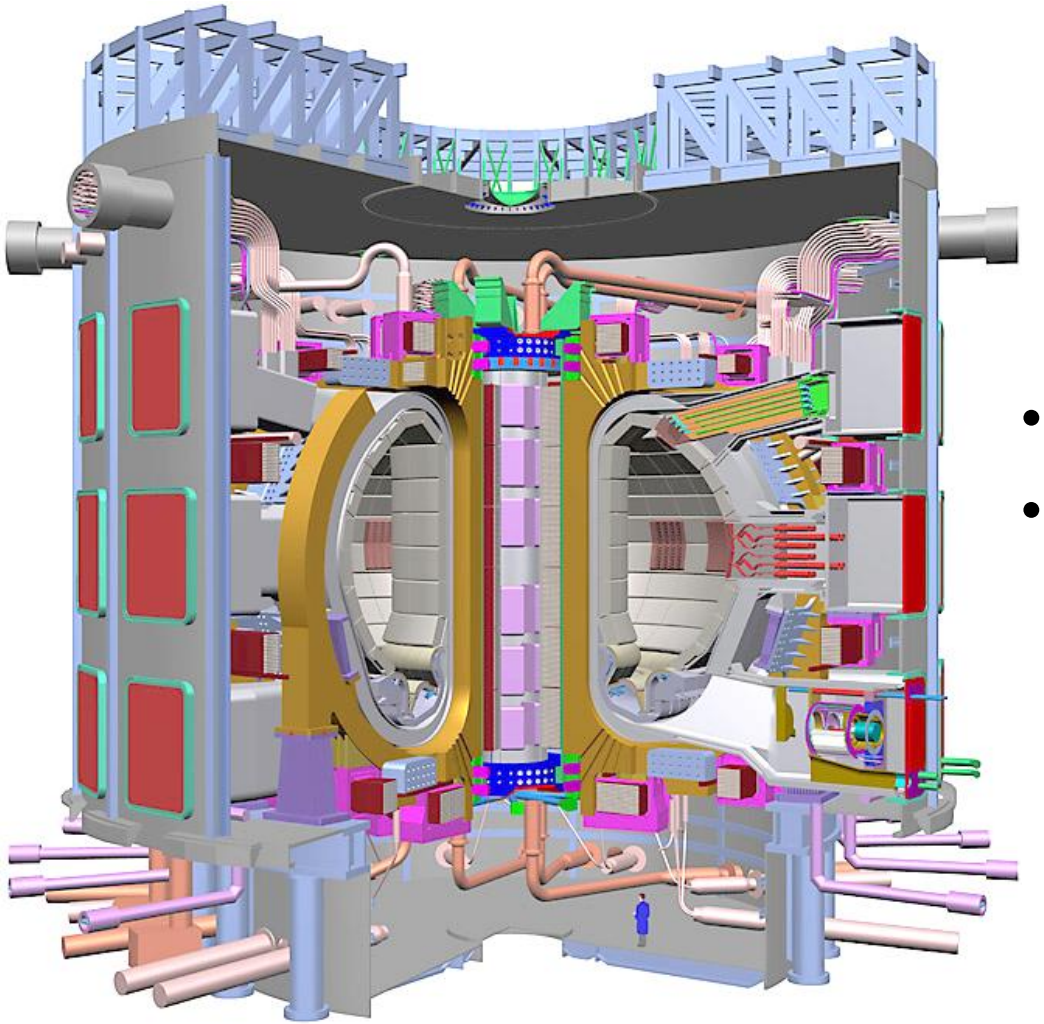
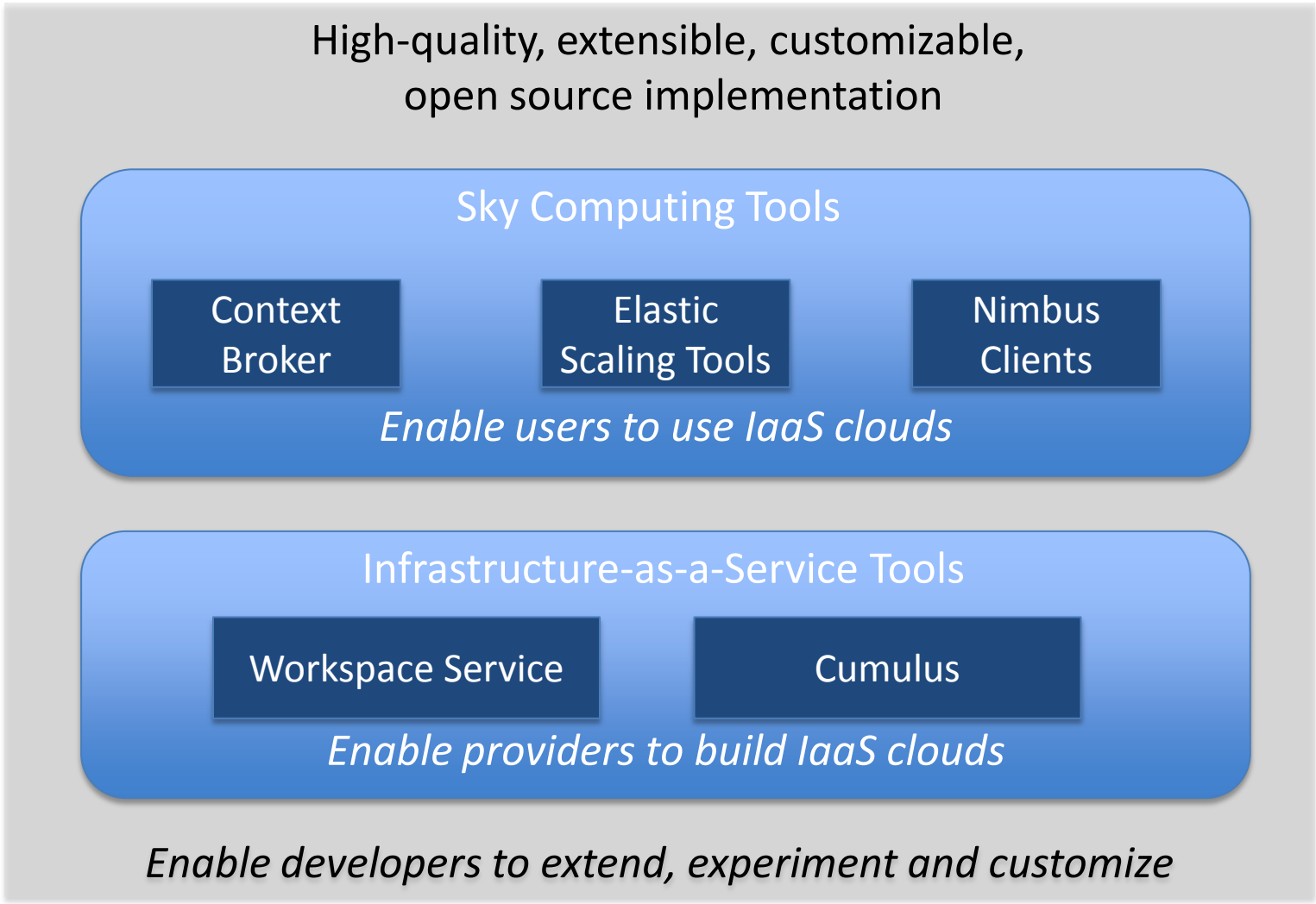


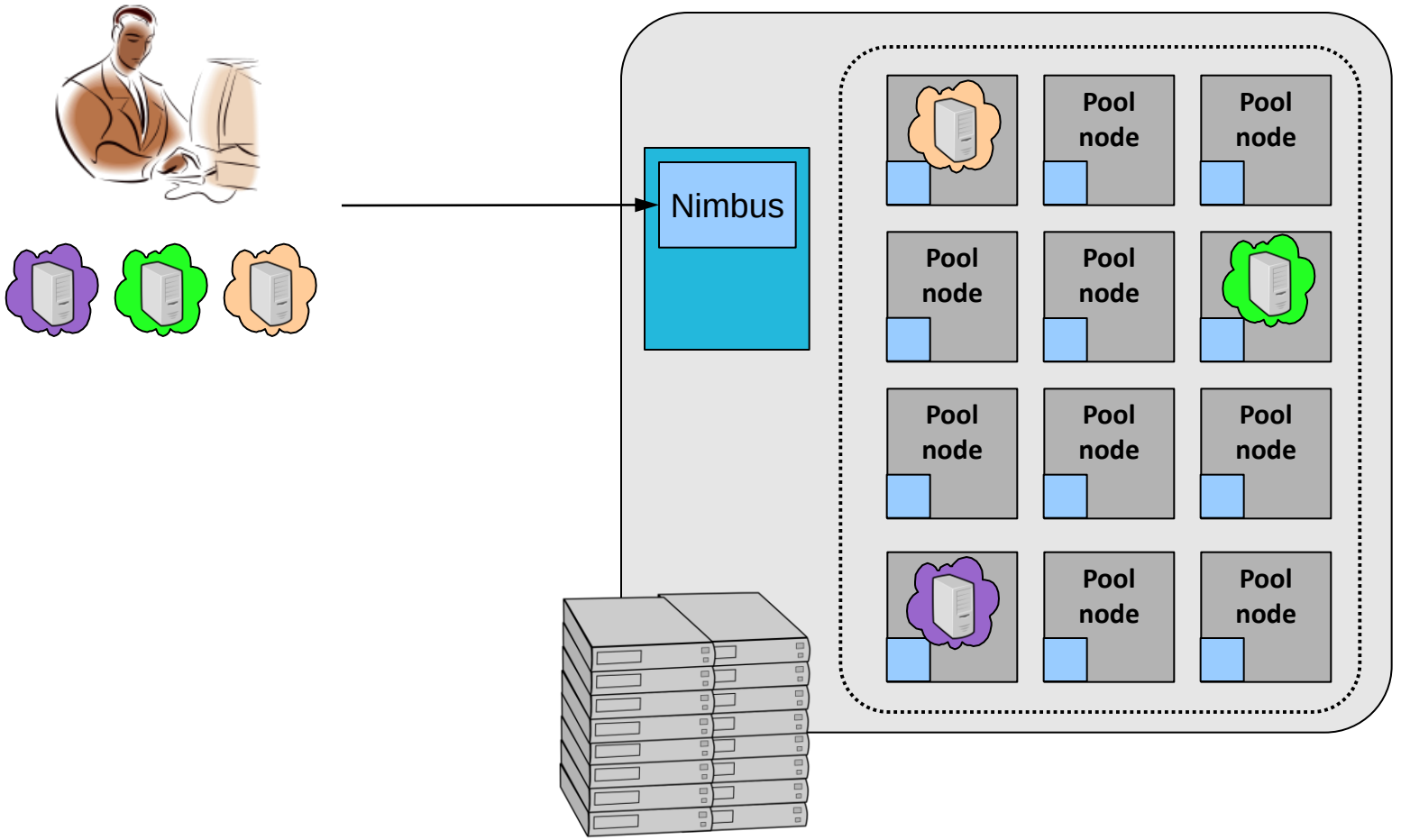
- On-demand computing
- Control over environment

Infrastructure-as-a-Service Cloud Computing: the Nimbus Toolkit

Nimbus Goals



IaaS: How it Works

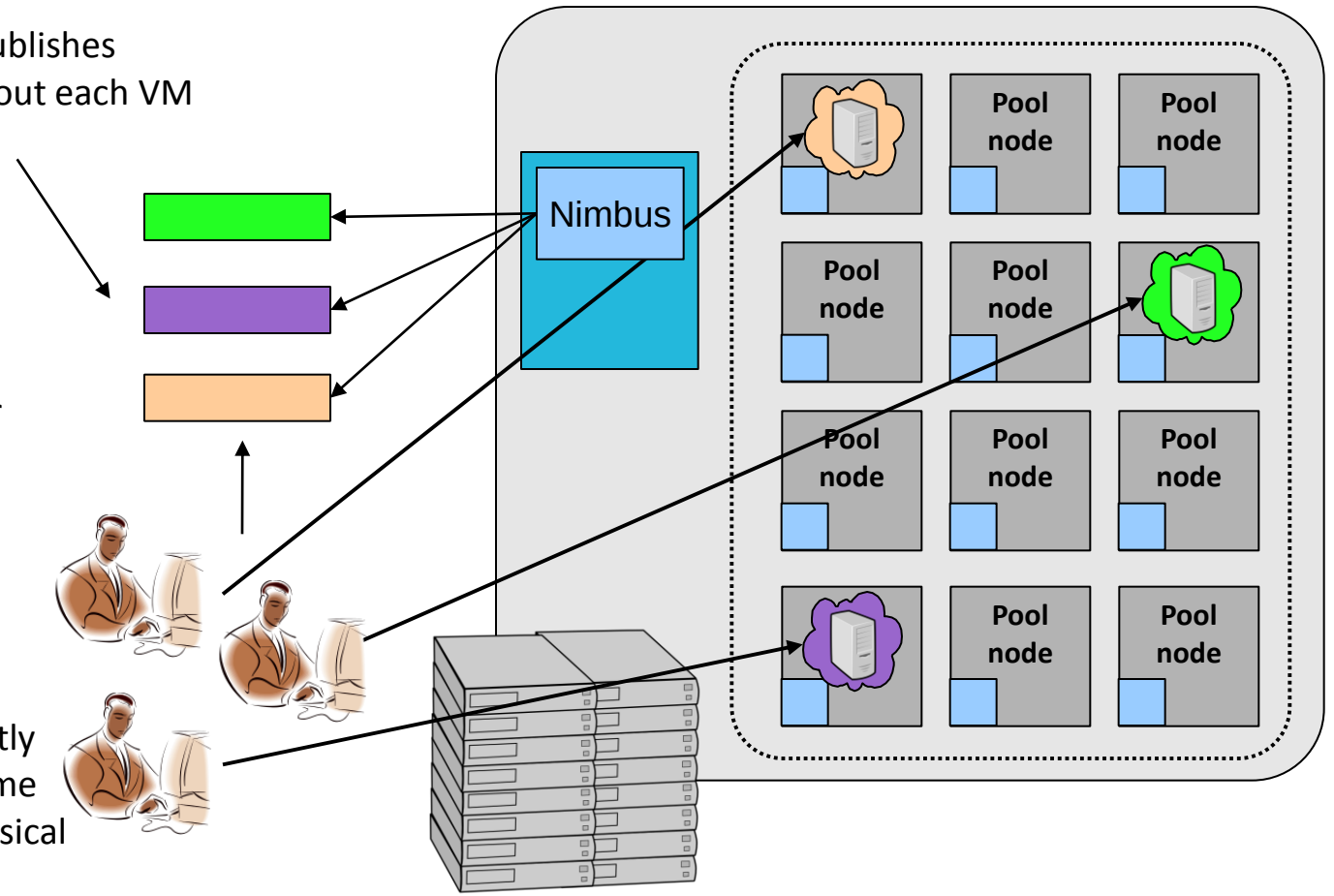


IaaS: How it Works

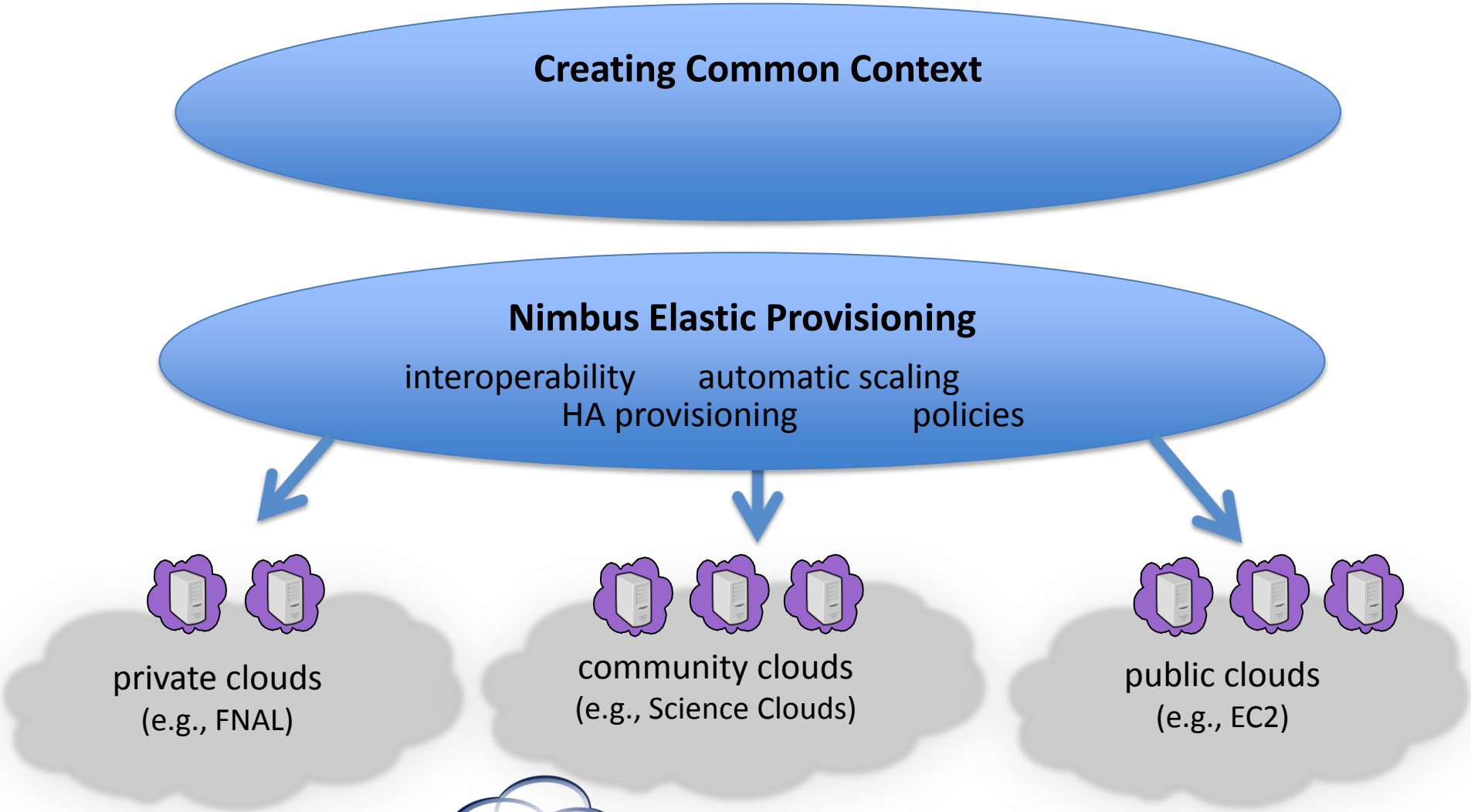
Nimbus publishes information about each VM

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

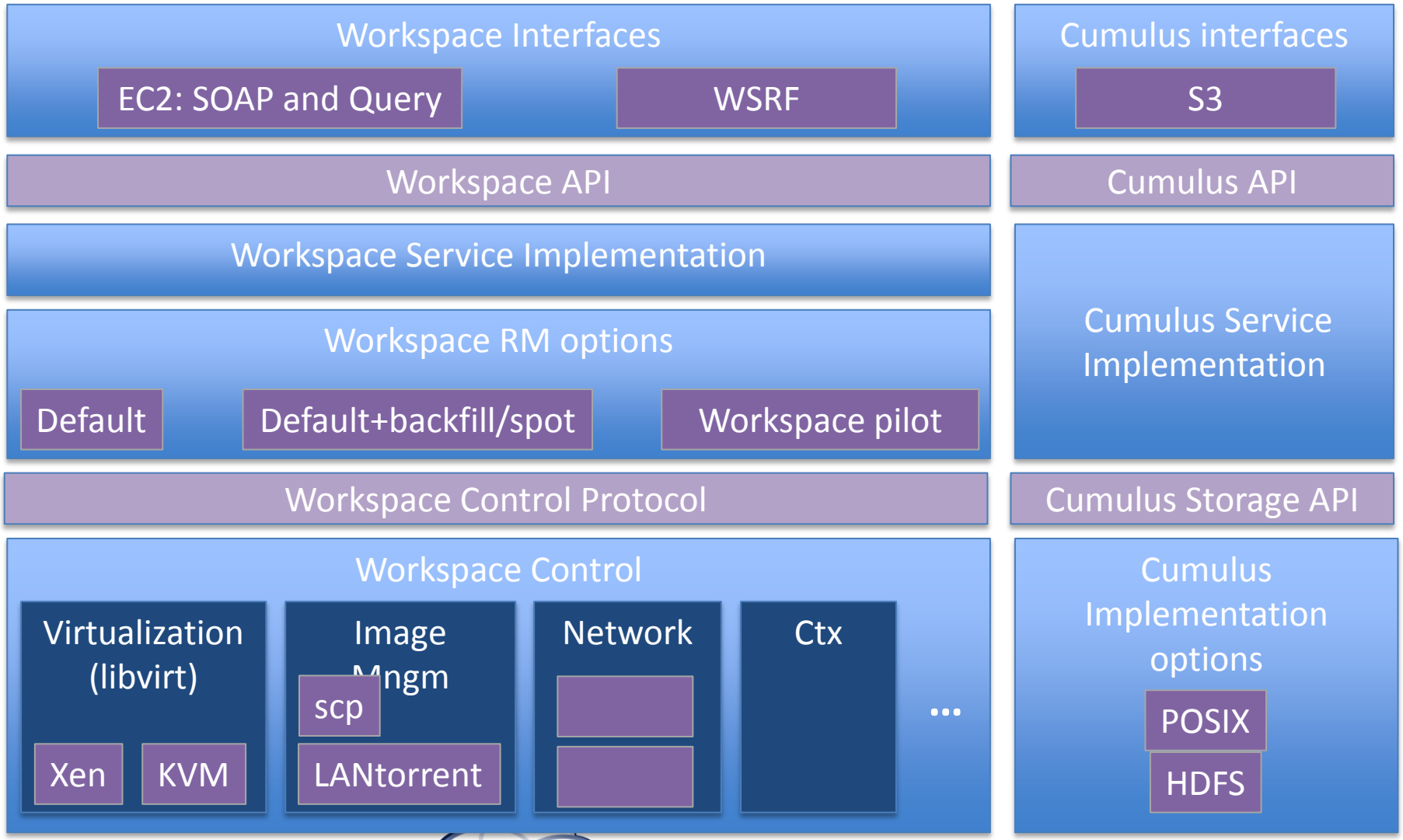
Users can interact directly with their VM in the same way the would with a physical machine.



Sky Computing Tools: Working with Hybrid Clouds



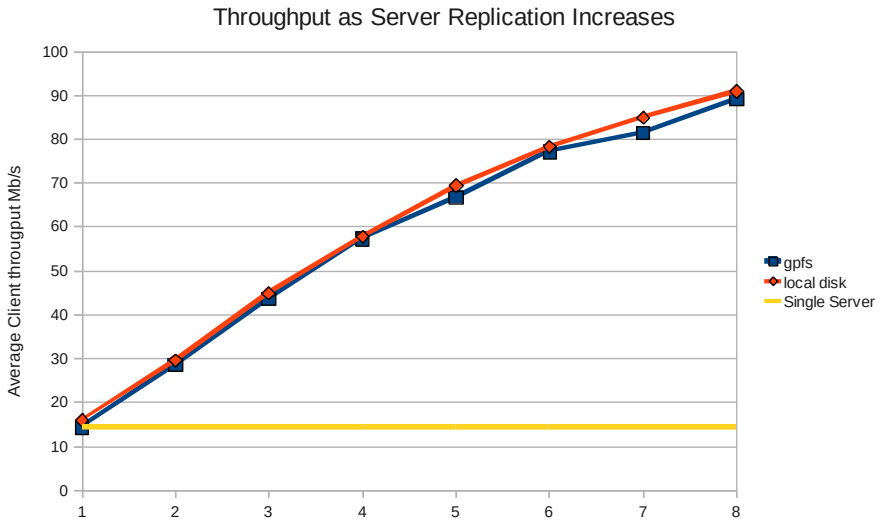
Nimbus: A Highly-Configurable IaaS Architecture

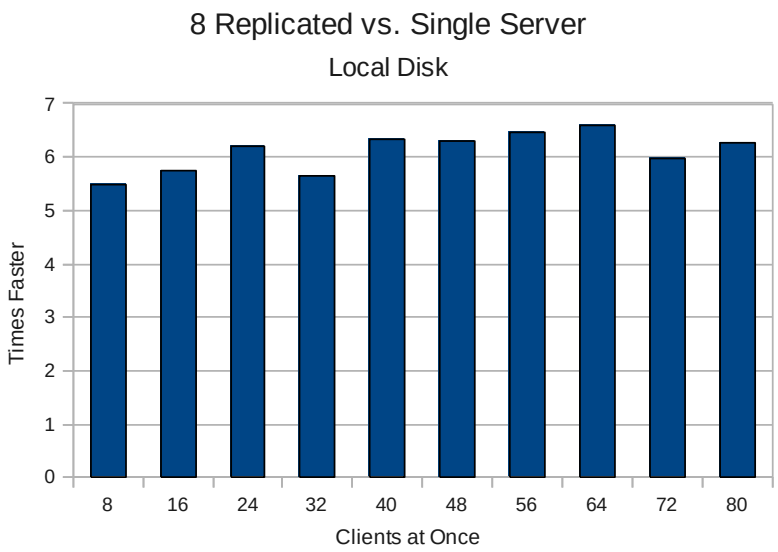


Recent Highlights

Cumulus: a Scalable Storage Cloud

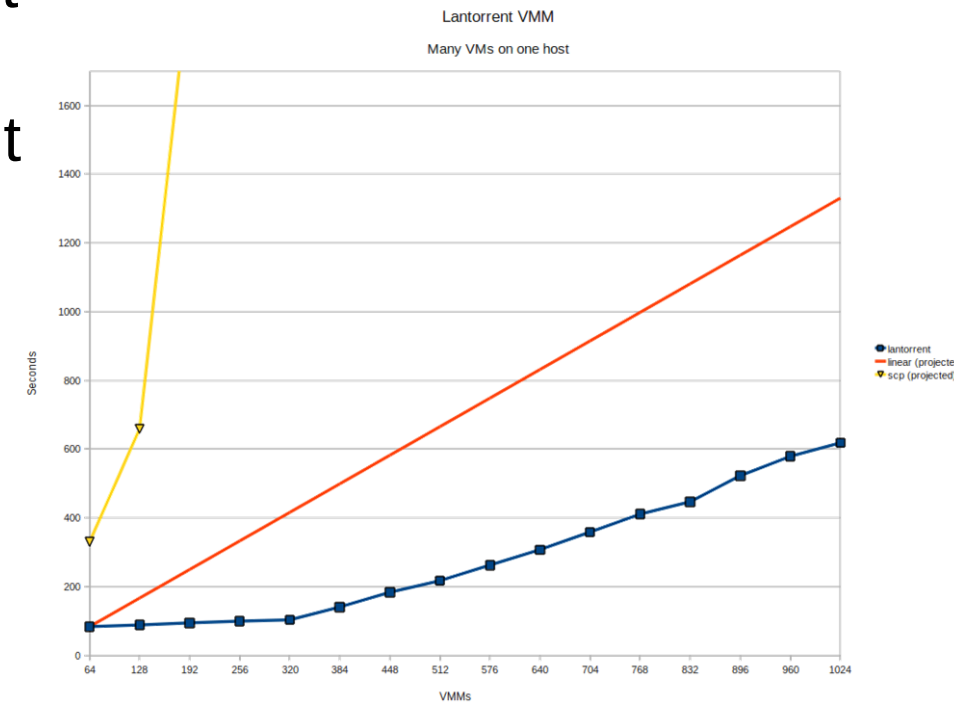
- Challenge: a scalable storage cloud
- S3-compatible open source storage cloud
- Quota support for scientific users
- Pluggable back-end to popular technologies such as POSIX, HDFS, potentially also Sector and BlobSeer
- Configurable to take advantage of multiple servers
- SC10 poster





LANTorrent: Fast Image Deployment

- Challenge: image deployment
- Moving images is the main component of VM deployment
- LANTorrent: the BitTorrent principle on a LAN
- Streaming
- Minimizes congestion at the switch
- Detecting and eliminating duplicate transfers
- Benefit: a thousand VMs in 10 minutes
- Nimbus release 2.6



Preliminary data using the Magellan resource
At Argonne National Laboratory

Backfill: Lower the Cost of Your Cloud

- Challenge: utilization, catch-22
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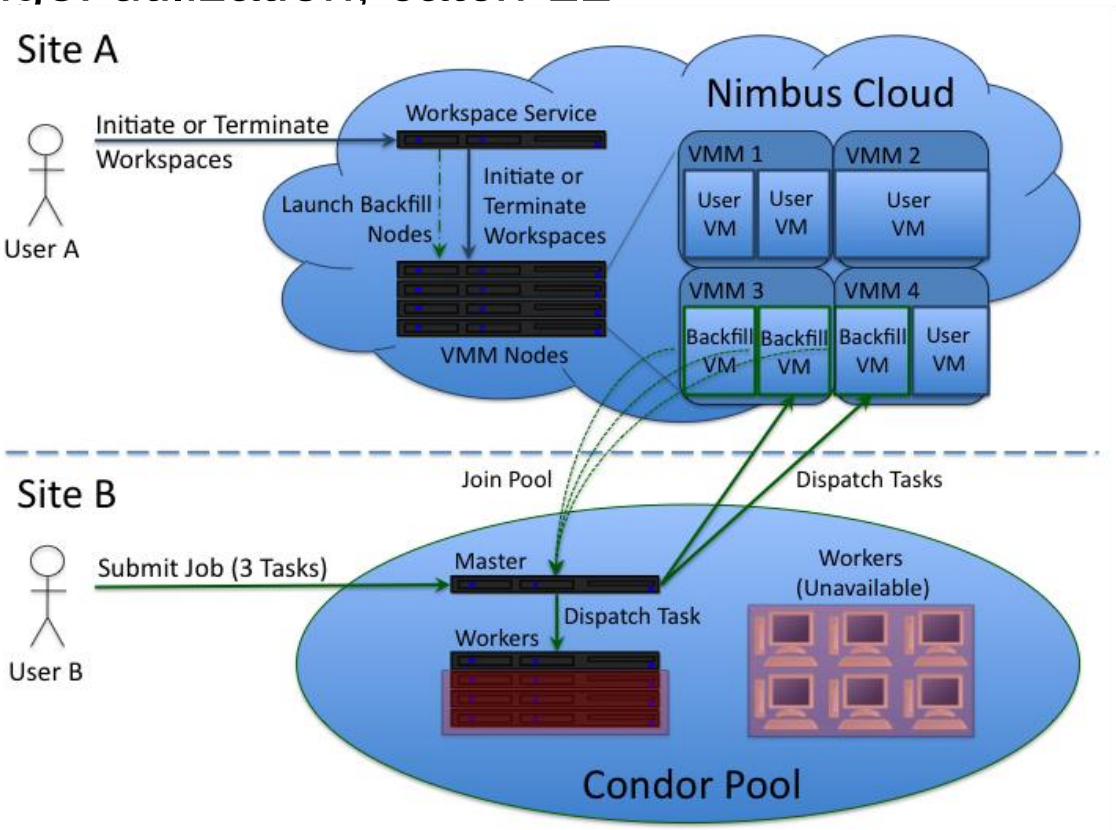
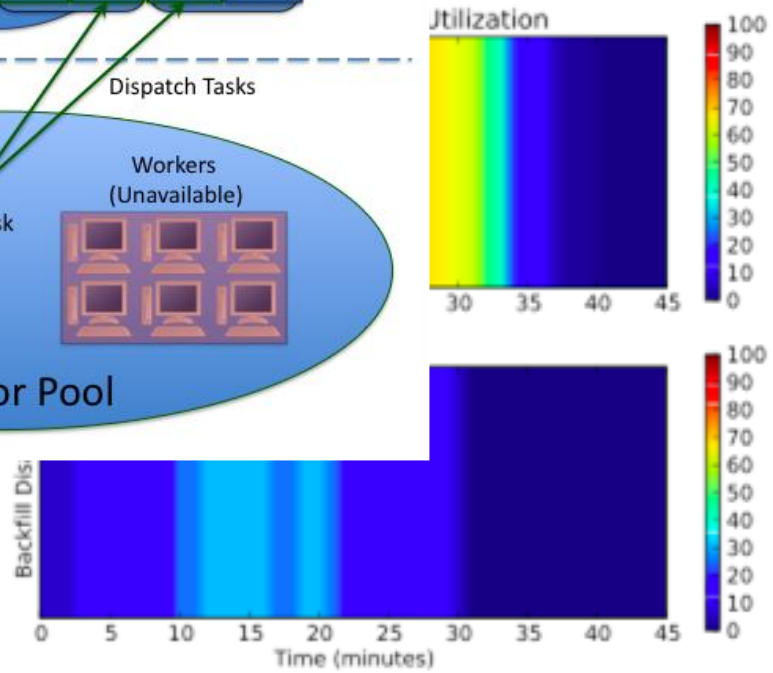
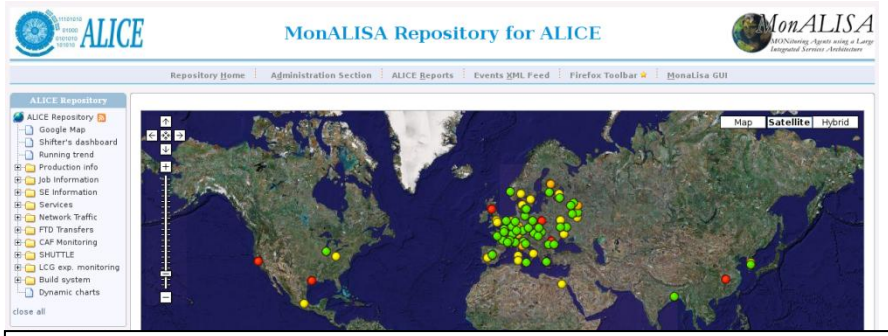
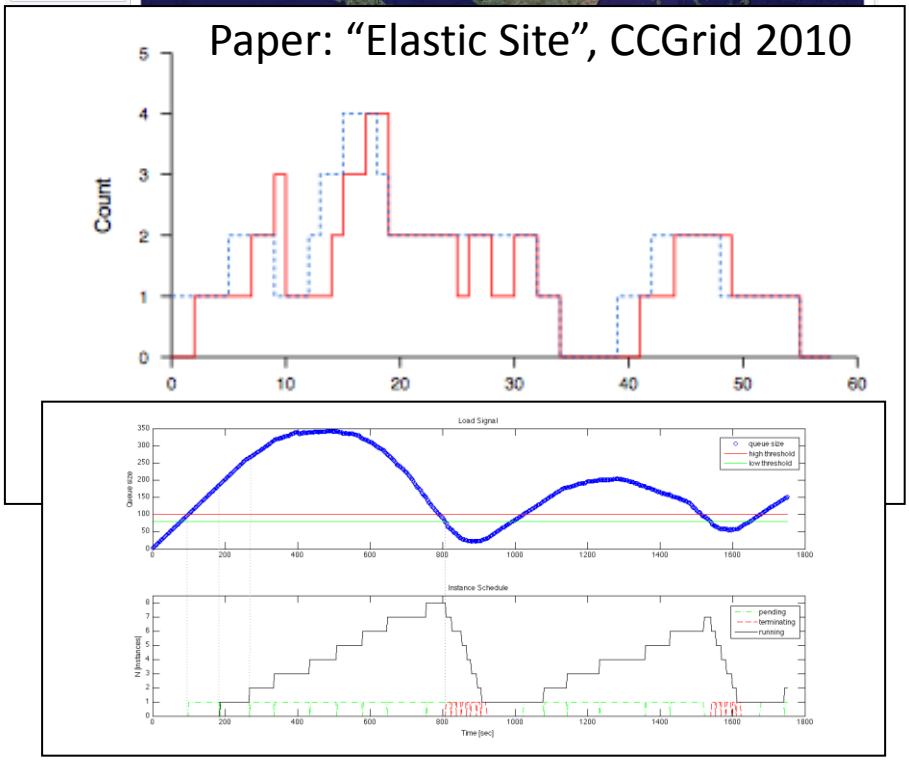




Elastic Scaling Tools: Towards Bottomless Resources

- Early efforts:
  - 2008: The ALICE proof-of-concept
  - 2009: ElasticSite prototype
  - 2009: OOI pilot
- Towards a generic HA Service Model
  - React to sensor information
  - Queue: the workload sensor
  - Scale to demand
  - Across different cloud providers
  - Use contextualization to integrate machines into the network
  - Customizable
  - Latest tests scale to 100s of nodes on EC2
- Release in 2011

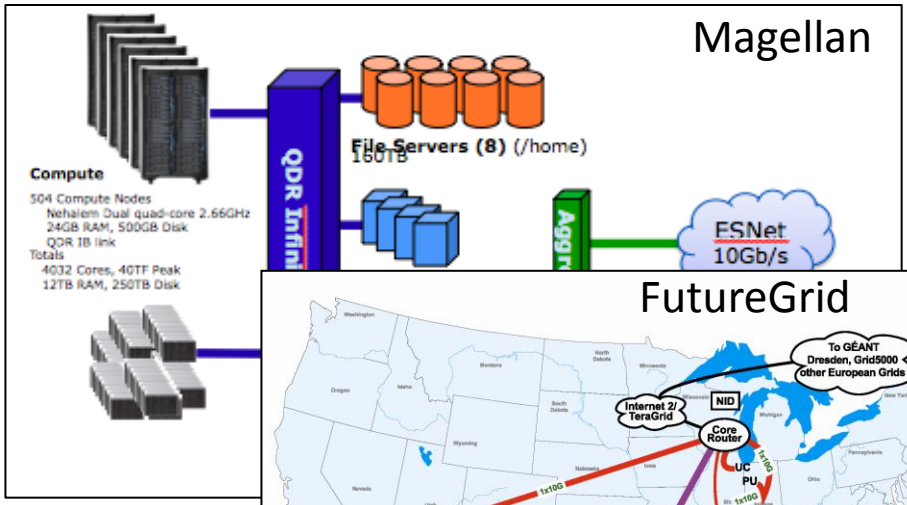


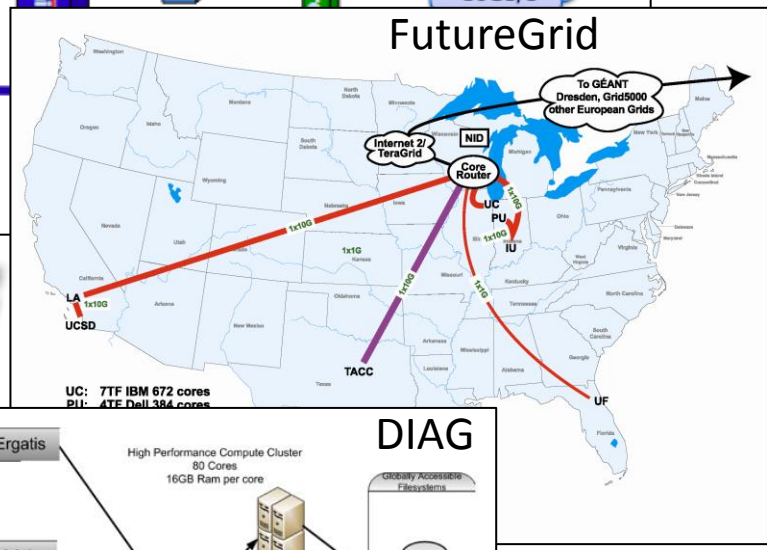


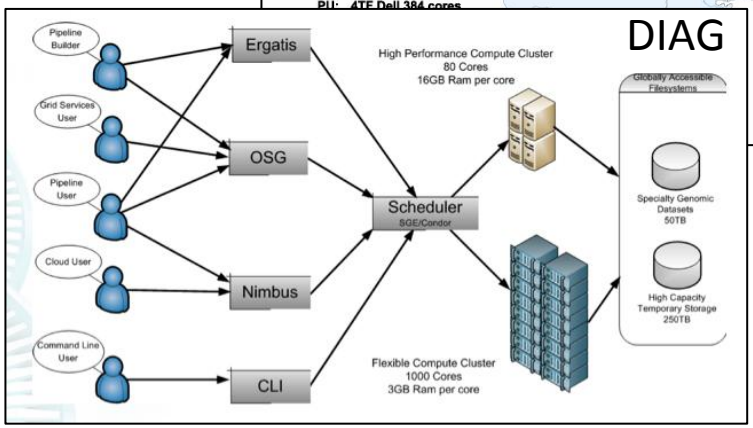
Resources, Applications and Ecosystem

Scientific Cloud Resources

- Science Clouds
  - UC, UFL, Wispy@Purdue
  - ~300 cores
- Magellan
  - DOE cloud @ ANL&LBNL
  - ~4000 cores@ANL
- FutureGrid
  - ~6000 cores
- DIAG =
  - Data Intensive Academic Grid
  - U of Maryland School of Medicine in Baltimore
  - ~1200-1500 cores
- Outside of US:
  - WestGrid, Grid5000







Work by Jerome Lauret (BNL) et al.

- STAR: a nuclear physics experiment at Brook Labora
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  - Nim EC2
  - Virtu Nim
- Impac
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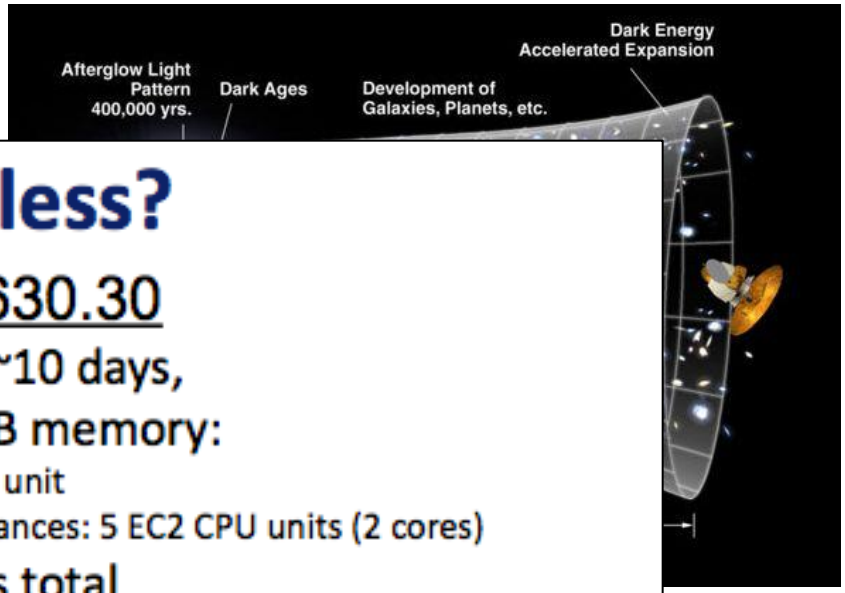
  - The dea time



Priceless?

- Compute costs: $ 5,630.30
  - Fdsf 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

Made Easy

OCEAN OBSERVATORIES INITIATIVE

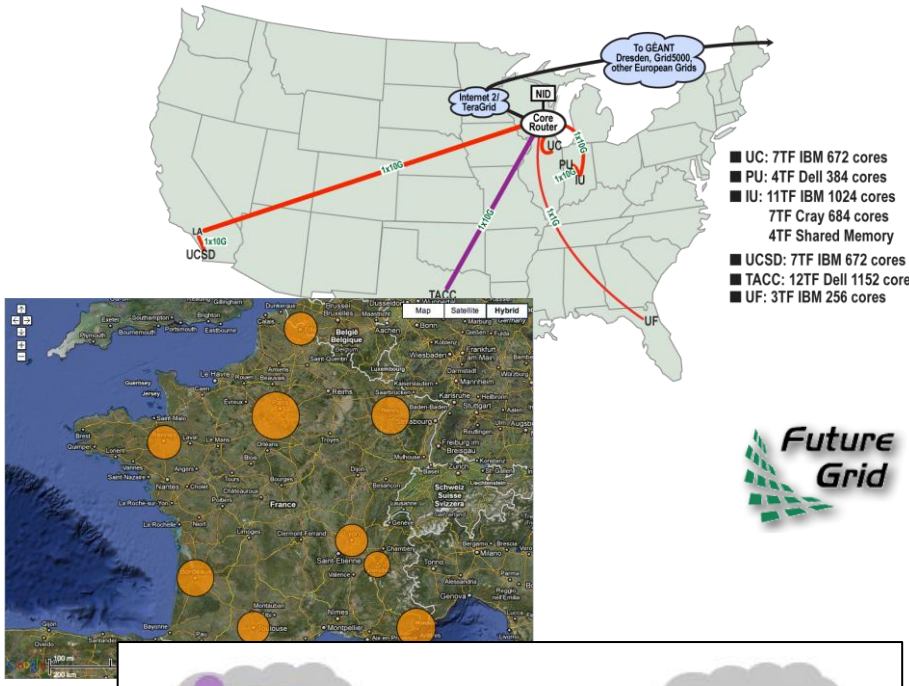
- Large NSF-funded observatory with requirements for adaptive, reliable, elastic computing
- Approach:
  - Private Nimbus regional clouds -> commer uds
  - Highly Availab ices that provisi on many cl eed
  - Signif infra and se ent based on th
- Statu
  - Scalability and reliability tests on 100s of EC2, FutureGrid and Magellan resources
  - HA elastic services release in Spring 2011

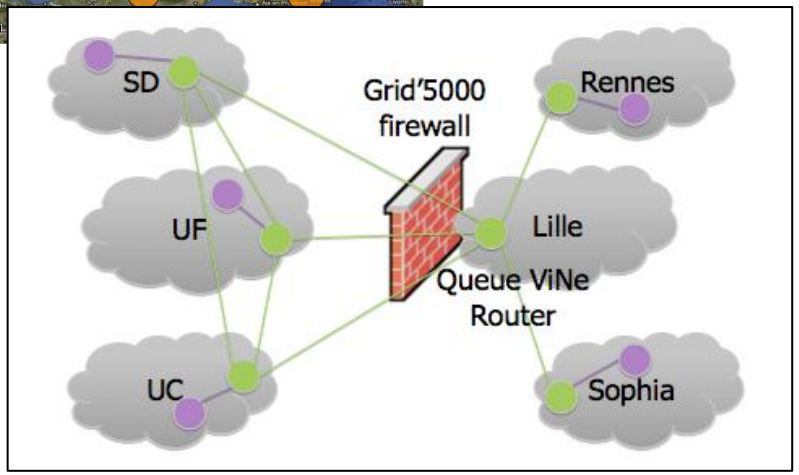
Trail-blazing project

Sky Computing @ Scale

Work by Pierre Riteau et al, University of Rennes 1

- Approach:
  - Combine resources obtained in multiple Nimbus clouds in FutureGrid and Grid' 5000
  - Deployed a virtual cluster of over 1000 cores on Grid5000 and FutureGrid – largest ever of this type
  - Combine Context Broker, ViNe, fast image deployment
- Grid'5000 Large Scale Deployment Challenge award
- Demonstrated at OGF 29 06/10
- TeraGrid '10 poster



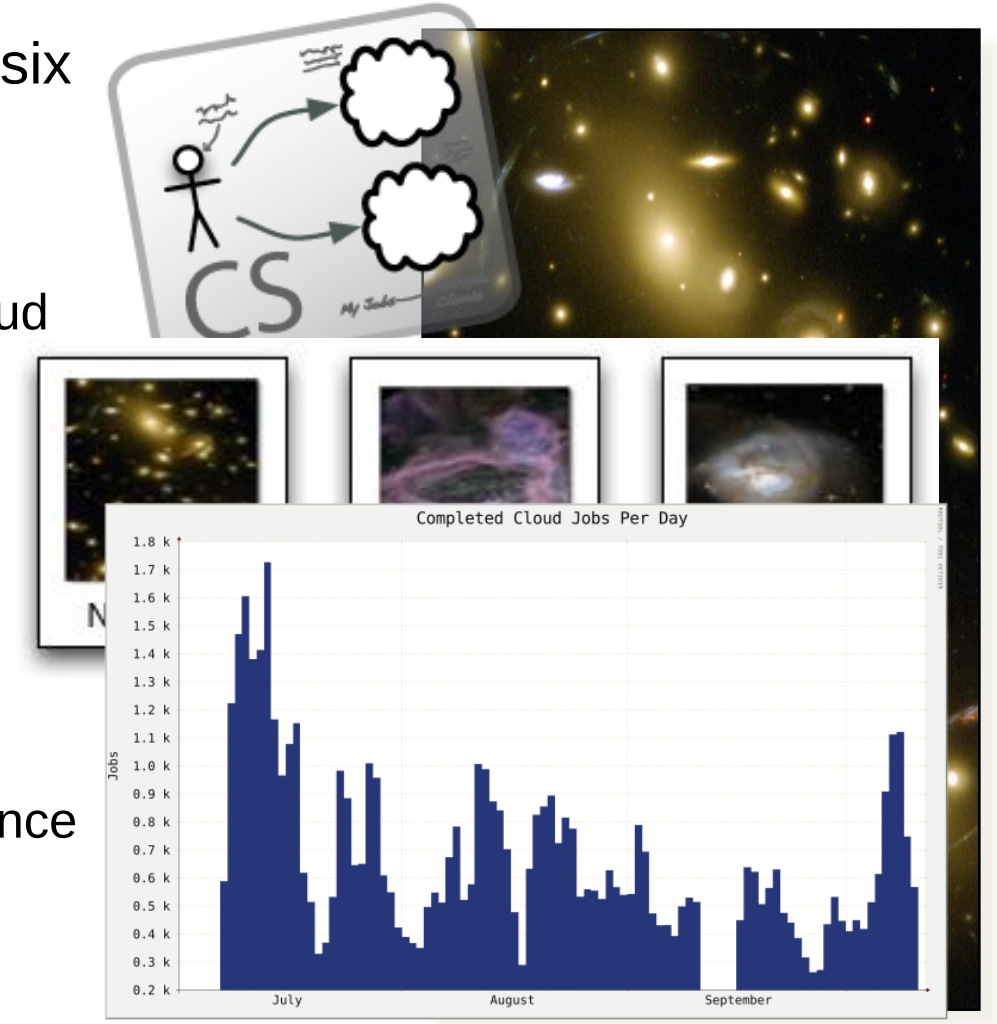


CANFAR
Canadian Advanced Network for Astronomical Research

University of Victoria NRC·CNRC

Work by the UVIC team

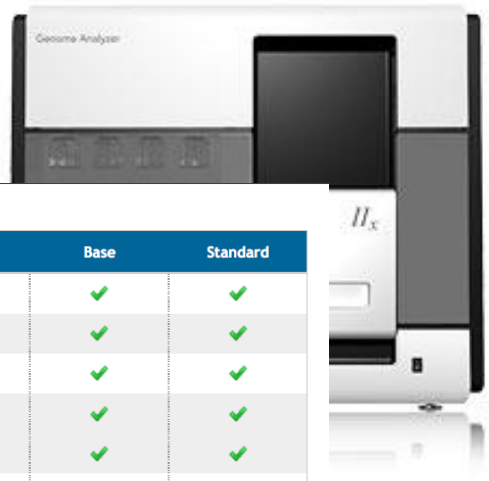
- Provide infrastructure for six observational astronomy survey projects
- Strategy:
  - Running on a Nimbus cloud on WestGrid
  - Dynamic Condor pool for astronomy
  - Appliance creation and management
- Status:
  - MACHO experiment Dark Matter search
  - In production operation since July 2010



CloVR

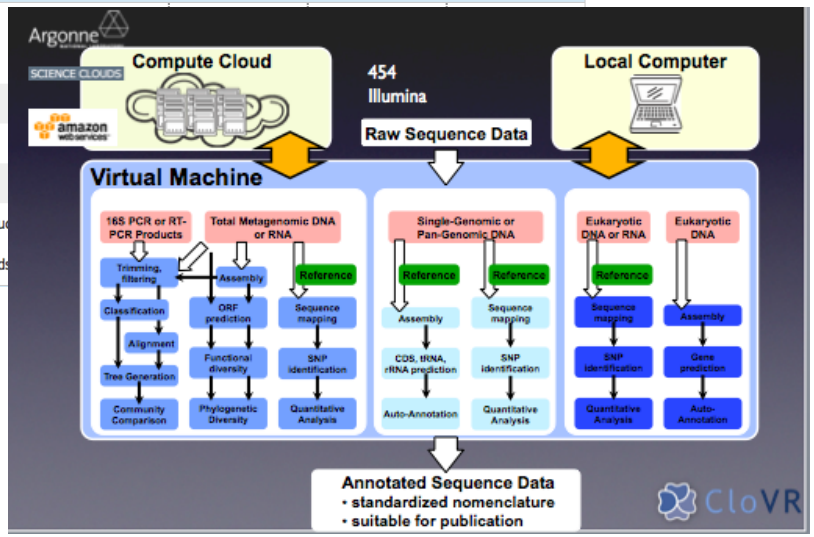
Sam Angiuoli
Institute for Genome Sciences
University of Maryland School of Medicine

- The emergent need for processing
- A virtual appliance for automated and portable sequence analysis
- Strategy:
  - Running on Nimbus Science Clouds, Magellan and EC2
  - A platform for building appliances representing push-button pipelines
- Impact
  - From desktop to cloud
  - http://clovr.org

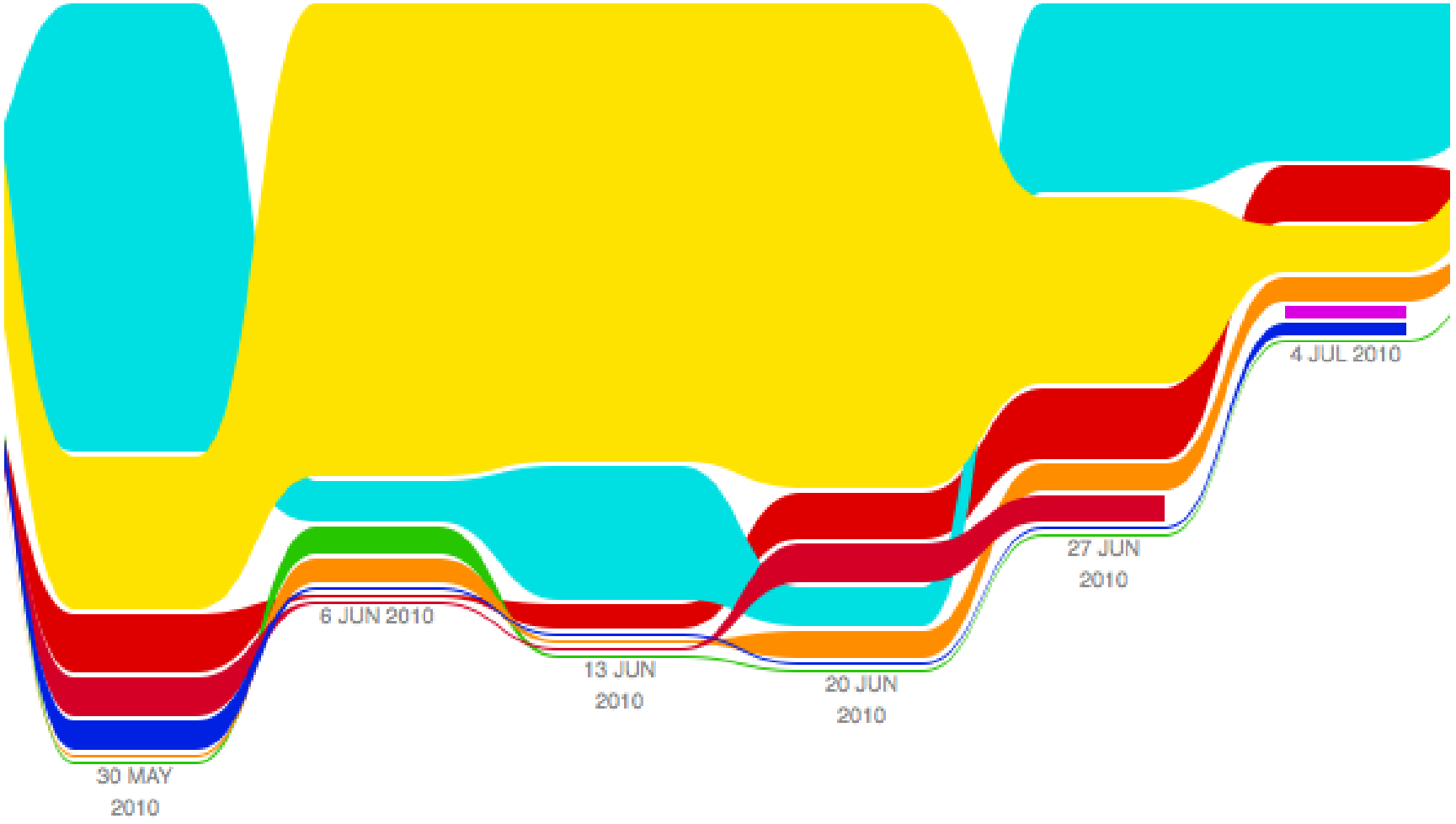


Edition Comparison

	Skeleton	Base	Standard
Ubuntu 10.04	✔	✔	✔
Grid Engine	✖	✔	✔
Hadoop	✖	✔	✔
Ganglia	✖	✔	✔
Vappio	✖	✔	✔
Ergatis	✖	✖	✔
Platforms			
EC2			
Eucalyptus			
VirtualBox			
VMware			
Xen			
Magellan Clou			
Science Clouds			



The Nimbus Team



The Nimbus Team

- Project lead: Kate Keahey, ANL&UC
- Committers:
  - Tim Freeman - University of Chicago
  - Ian Gable - University of Victoria
  - David LaBissoniere - University of Chicago
  - John Bresnahan - Argonne National Laboratory
  - Patrick Armstrong - University of Victoria
  - Pierre Riteau - University of Rennes 1, IRISA
- Github Contributors:
  - *Tim Freeman, David LaBissoniere, John Bresnahan, Pierre Riteau, Alex Clemesha, Paulo Gomez, Patrick Armstrong, Matt Vliet, Ian Gable, Paul Marshall, Adam Bishop*
- *And many others*
  - *See http://www.nimbusproject.org/about/people/*

Parting Thoughts

- Cloud computing is here to stay
- A change of paradigm -> a change of pattern
  - New technology requirements
    - Cost comparisons, scaling, data management, appliance management, etc.
  - New work patterns and new opportunities
- Better together: open source collaboration!