



CloudLab





The Need Addressed by CloudLab

- Clouds are changing the way we look at a lot of problems
 - Impacts go far beyond Computer Science
- ... but there's still a lot we don't know, from perspective of
 - Researchers (those who will transform the cloud)
 - Users (those who will use the cloud to transform their own fields)
- To investigate these questions, we need:
 - Flexible, scalable **scientific infrastructure**
 - That enables exploration of **fundamental** science in the cloud
 - Built **by** and **for** the research community



The CloudLab Vision

- A “meta-cloud” for building clouds
- Build your own cloud on our hardware resources
- Agnostic to specific cloud software
 - Run existing cloud software stacks (like OpenStack, Hadoop, etc.)
 - ... or new ones built from the ground up
- Control and visibility all the way to the bare metal
- “Sliceable” for multiple, isolated experiments at once

With CloudLab, it will be as easy to get a cloud tomorrow as it is to get a VM today



What Is CloudLab?

Slice A

*Geo-Distributed
Storage Research*

Slice B

*Stock
OpenStack*

- Supports transformative cloud research
- Built on Emulab and GENI
- Control to the bare metal
- Diverse, distributed resources
- Repeatable and scientific

Slice C

*Virtualization and
Isolation Research*

Slice D

*Allocation and Scheduling Research
for Cyber-Physical Systems*

Utah

Wisconsin

Clemson

GENI

CC-NIE, Internet2 AL2S, Regionals



Cloud Architecture Research

- Exploring **emerging and extreme** cloud architectures
- Evaluating **design choices** that exercise hardware and software capabilities
- Studying **geo-distributed** data centers for low-latency applications
- Developing different **isolation** models among tenants
- Quantifying **resilience** properties of architectures
- Developing new **diagnostic** frameworks
- Exploring cloud architectures for **cyber-physical systems**
- Enabling **realtime** and near-realtime compute services
- Enabling data-intensive computing (“**big data**”) at high performance in the cloud



Application Research Questions

- Experiment with **resource allocation** and scheduling
- Develop enhancements to **big data frameworks**
- Intra- and inter-datacenter **traffic engineering** and routing
- New tenant-facing **abstractions**
- New **mechanisms** in support of cloud-based services
- Study adapting **next-generation stacks** to clouds
- New troubleshooting and **anomaly detection** frameworks
- Explore different degrees of **security** and isolation
- **Composing** services from heterogeneous clouds
- **Application-driven** cloud architectures



CloudLab's Hardware

One facility, one account, three locations

- About 5,000 cores each (15,000 total)
- 8-16 cores per node
- Baseline: 4GB RAM / core
- Latest virtualization hardware
- TOR / Core switching design
- 10 Gb to nodes, SDN
- 100 Gb to Internet2 AL2S
- *Partnerships with multiple vendors*

Wisconsin

- **Storage and net.**
- Per node:
 - 128 GB RAM
 - 2x1TB Disk
 - 400 GB SSD
- Clos topology
- *Cisco*

Clemson

- **High-memory**
- 16 GB RAM / core
- 16 cores / node
- Bulk block store
- Net. up to 40Gb
- High capacity
- *Dell*

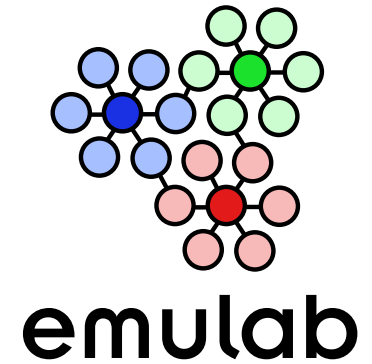
Utah

- **Power-efficient**
- ARM64 / x86
- Power monitors
- Flash on ARM64s
- Disk on x86
- Very dense
- *HP*



Technology Foundations

- Built on Emulab and GENI (“ProtoGENI”)
- In active development at Utah since 1999
- Several thousand users (incl. GENI users)
- Provisions, then gets out of the way
 - “Run-time” services are optional
- Controllable through a web interface and GENI APIs
- *Scientific instrument for repeatable research*
 - Physical isolation for most resources
 - *Profiles* capture everything needed for experiments
 - Software, data, and hardware details
 - Can be shared and published (eg. in papers)



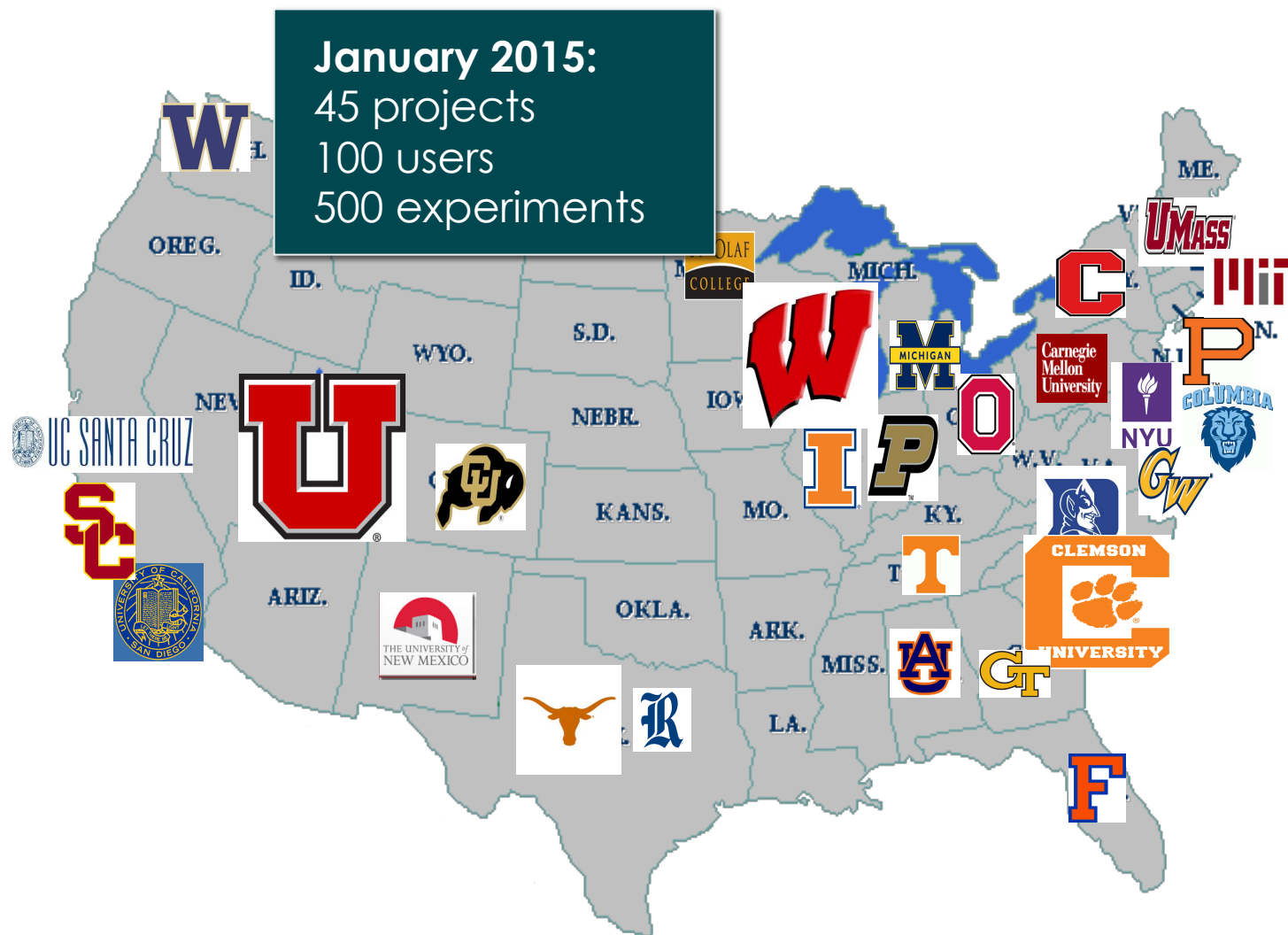


Who can use CloudLab?

- US academics and educators
 - Researchers in cloud architecture and novel cloud applications
 - Teaching classes, other training activities
- No charge: free for research and educational use
- International federations expected
- Apply on the website at www.cloudlab.us
 - Everyone with a GENI or Emulab account (several thousand)



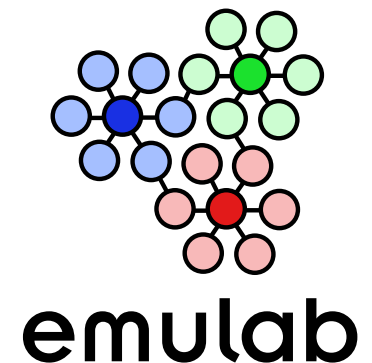
Early Users of CloudLab





Federated with GENI

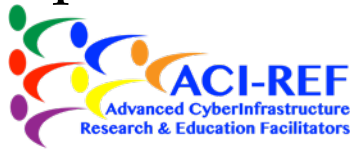
- *CloudLab can be used with a GENI account, and vice-versa*
- GENI Racks: ~ 50 small clusters around the country
- Programmable wide-area network
 - Openflow at dozens of sites
 - Connected in one layer 2 domain
- Large clusters (100s of nodes) at several sites
- Wireless and mobile
 - WiMax at 8 institutions
 - LTE / EPC testbed (“PhantomNet”) at Utah
- International partners
 - Europe (FIRE), Brazil, Japan





Community Outreach

- Applications in areas of national priority
 - Medicine, emergency response, smart grids, etc.
 - Through 
- “Opt in” to compute jobs from domain scientists



- Summer camps
 - Through Clemson data-intensive computing program
- Under-represented groups





Availability and Schedule

- Availability:
 - ✓ **Open and in use!**
- Hardware being deployed in stages:
 - ✓ Fall 2014: Utah / HP cluster
 - Winter 2015: Wisconsin / Cisco cluster
 - Winter 2015: Dell / Clemson cluster
- Hardware refreshes in 2015 and 2016



Your Own Cloud in One Click

The screenshot shows a web browser window with the address bar displaying "cloudlab.us". The page has a dark teal header with navigation links: "Home", "Manual", and "Actions" (with a dropdown arrow). The CloudLab logo is centered in the header, and on the right, it says "rpruser logged in" next to a "Logout" button. The main content area has the heading "What is CloudLab?" followed by "Run an Experiment". A box titled "Selected Profile: ARM64OpenStack" contains the text "An ARM64 OpenStack instance with a controller, network manager, and three compute nodes." Below this text are two buttons: "Copy Profile" and "Change Profile". Further down, a "Cluster:" label is next to a dropdown menu showing "Utah Cloudlab". At the bottom of the main content area is a large green "Create!" button. The footer is dark teal and contains three items: "Powered by emulab" (with the emulab logo), "Question or comment? Join the Help Forum", and "Supported by NSF © 2014 The University of Utah".

cloudlab.us

Home Manual Actions

What is CloudLab?

Run an Experiment

Selected Profile: ARM64OpenStack

An ARM64 OpenStack instance with a controller, network manager, and three compute nodes.

Copy Profile Change Profile

Cluster: Utah Cloudlab

Create!

Powered by emulab Question or comment? Join the Help Forum Supported by NSF © 2014 The University of Utah



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Challenges We Can Use Help With

- Looking down the road: where is cloud research going?
 - Applications, software layer, hardware, software, new use cases, service models, etc.
- Build profiles for cloud software stacks
 - Both general, and those used by particular communities
 - Standard platforms to build innovations on
- Study the facility itself
 - What data would be useful for us to collect and make available?
- Merging cloud and other computing paradigms
 - Our provisioning system is not limited to cloud



Learn more, sign up:

www.CloudLab.us



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