



CloudLab





Today's Plan

- Everyone will build their own clouds
 - Using an OpenStack profile supplied by CloudLab
 - Each is independent, with it's own compute and storage resources
- Log in using GENI accounts
- Create a cloud
- Explore the CloudLab interface
- Use your cloud
- Administer your cloud
- **CloudLab is about more than OpenStack**



Prerequisites

- Account on the GENI portal (sent to you as “pre work”)
- Optional, but will make your experience better:
 - SSH keypair associated with your GENI portal account
 - Knowledge of how to use the private SSH key from your laptop
- Known to work best in Chrome and Firefox browsers
- Tablets might work, but not well tested





Crash Course in CloudLab

- Underneath, it's GENI
 - Same APIs, same account system
 - Even many of the same tools
 - Federated (accept each other's accounts, hardware)
- Physical isolation for compute, storage (shared net.*)
- Profiles are one of the key abstractions
 - Defines an environment – hardware (RSpec) / software (images)
 - Each “instance” of a profile is a separate
 - Provide standard environments, and a way of sharing
 - Explicit role for domain experts
- “Instantiate” a profile to make an “Experiment”
 - Lives in a GENI slice

* Can be dedicated in some cases



What Is CloudLab?

Slice A

*Geo-Distributed
Storage Research*

Slice B

*Stock
OpenStack*

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

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



CloudLab's Hardware

One facility, one account, three locations

- About 5,000 cores each (15,000 total)
- 8-16 cores per node
- Baseline: 8GB 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*





cloudlab.us/tutorial



CloudLab Hardware



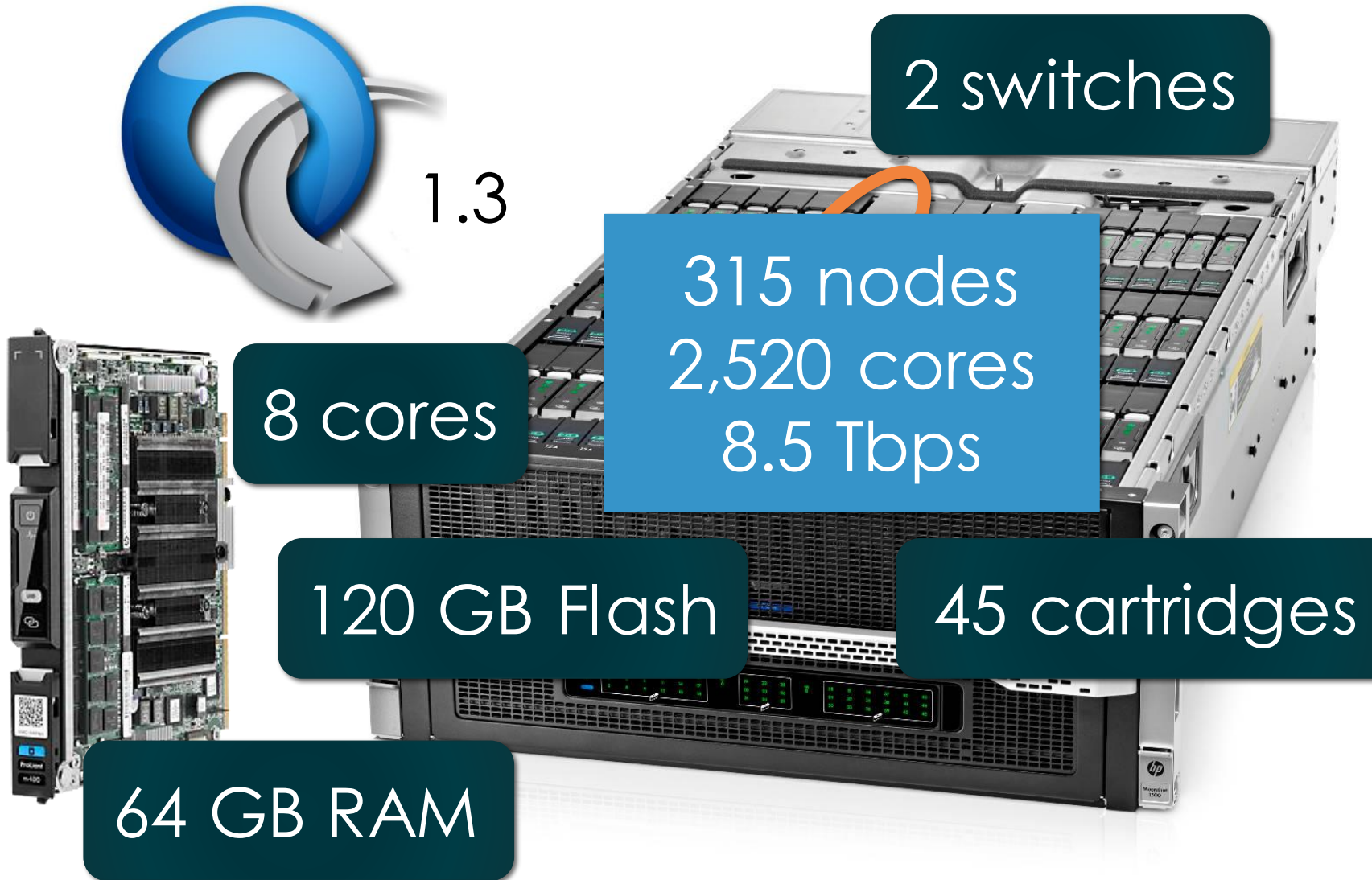


Utah/HP: Very dense



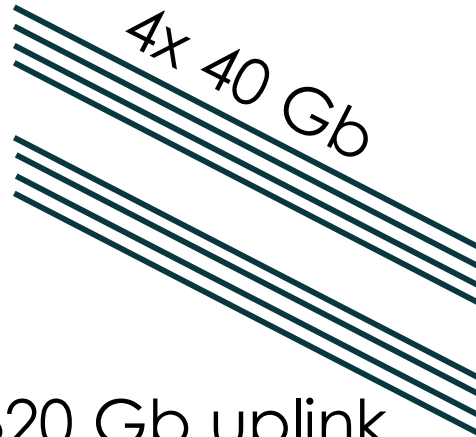


Utah/HP: Low-power ARM64





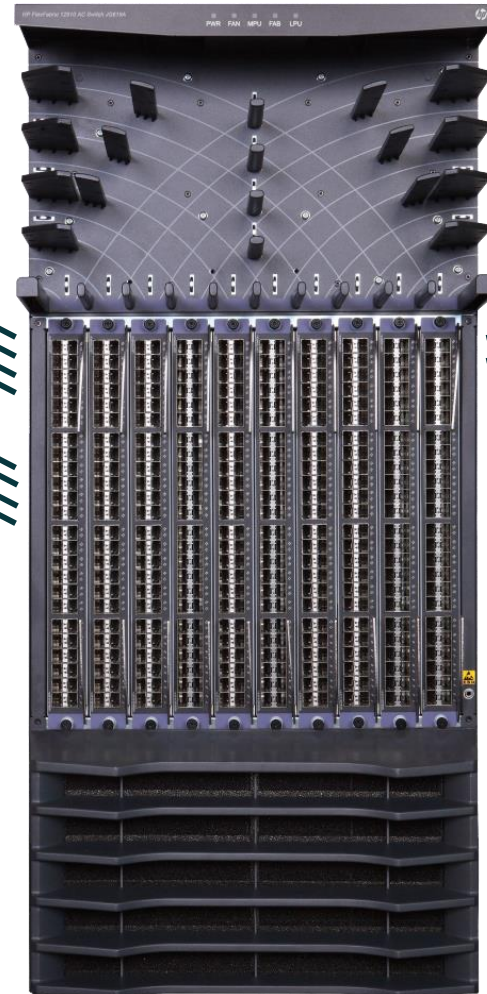
Utah/HP Network: Core switch



320 Gb uplink



x7



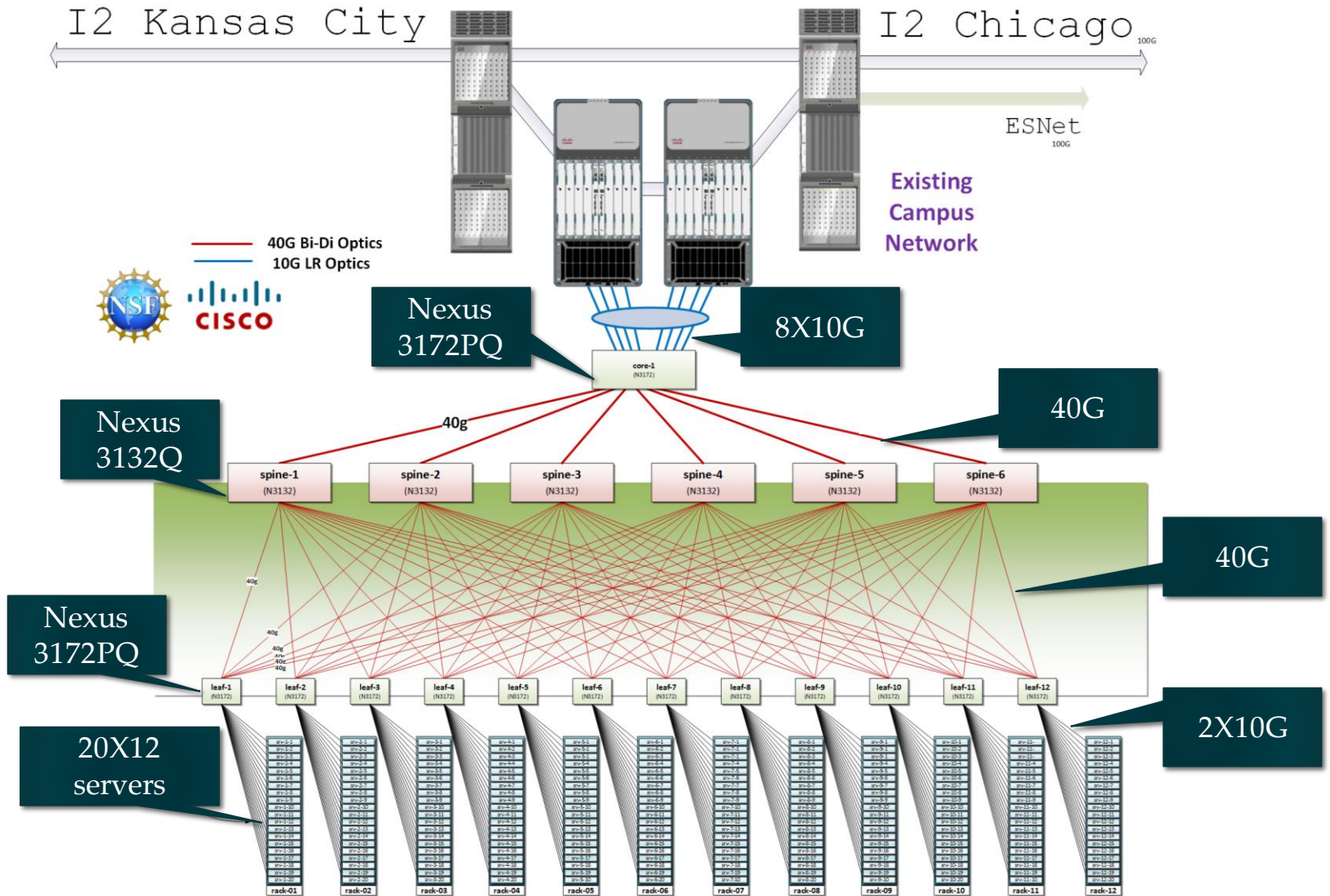


Utah - Suitable for experiments that:

- ... explore power/performance tradeoffs
- ... want instrumentation of power and temperature
- ... want large numbers of nodes and cores
- ... want to experiment with RDMA via RoCE
- ... need bare-metal control over switches
- ... need OpenFlow 1.3
- ... want tight ARM64 platform integration



Wisconsin/Cisco





Compute and storage

90X Cisco 220 M4



10X Cisco 240 M4



- 2X 8 cores @ 2.4GHz
 - 128GB RAM
 - 1X 480GB SSD
 - 2X 1.2 TB HDD
- | | |
|--|---|
| | <ul style="list-style-type: none">• 1X 1TB HDD• 12X 3TB HDD (donated by Seagate) |
|--|---|

Over the next year: ≥ 140 additional servers;

Limited number of accelerators, e.g., FPGAs, GPUs (planned)



Networking

Nexus 3132q



Nexus 3172pq



- OF 1.0 (working with Cisco on OF 1.3 support)
- Monitoring of instantaneous queue lengths
- Fine-grained tracing of control plane actions
- Support for multiple virtual router instances per router
- Support for many routing protocols



Experiments supported

Large number of nodes/cores, and bare-metal control over nodes/switches, for sophisticated network/memory/storage research

- ... Network I/O performance, intra-cloud routing (e.g., Conga) and transport (e.g., DCTCP)
- ... Network virtualization (e.g., CloudNaaS)
- ... In-memory big data frameworks (e.g., Spark/Shark)
- ... Cloud-scale resource management and scheduling (e.g., Mesos; Tetris)
- ... New models for Cloud storage (e.g., tiered; flat storage; IOFlow)
- ... New architectures (e.g., RAM Cloud for storage)



Clemson/Dell: High Memory, IB

20 cores/node

1 x 40 Gb IB/node

8 nodes/chassis

2*x 10 GbE OF/node

10 chassis/rack

2*x 1 GbE OF/node



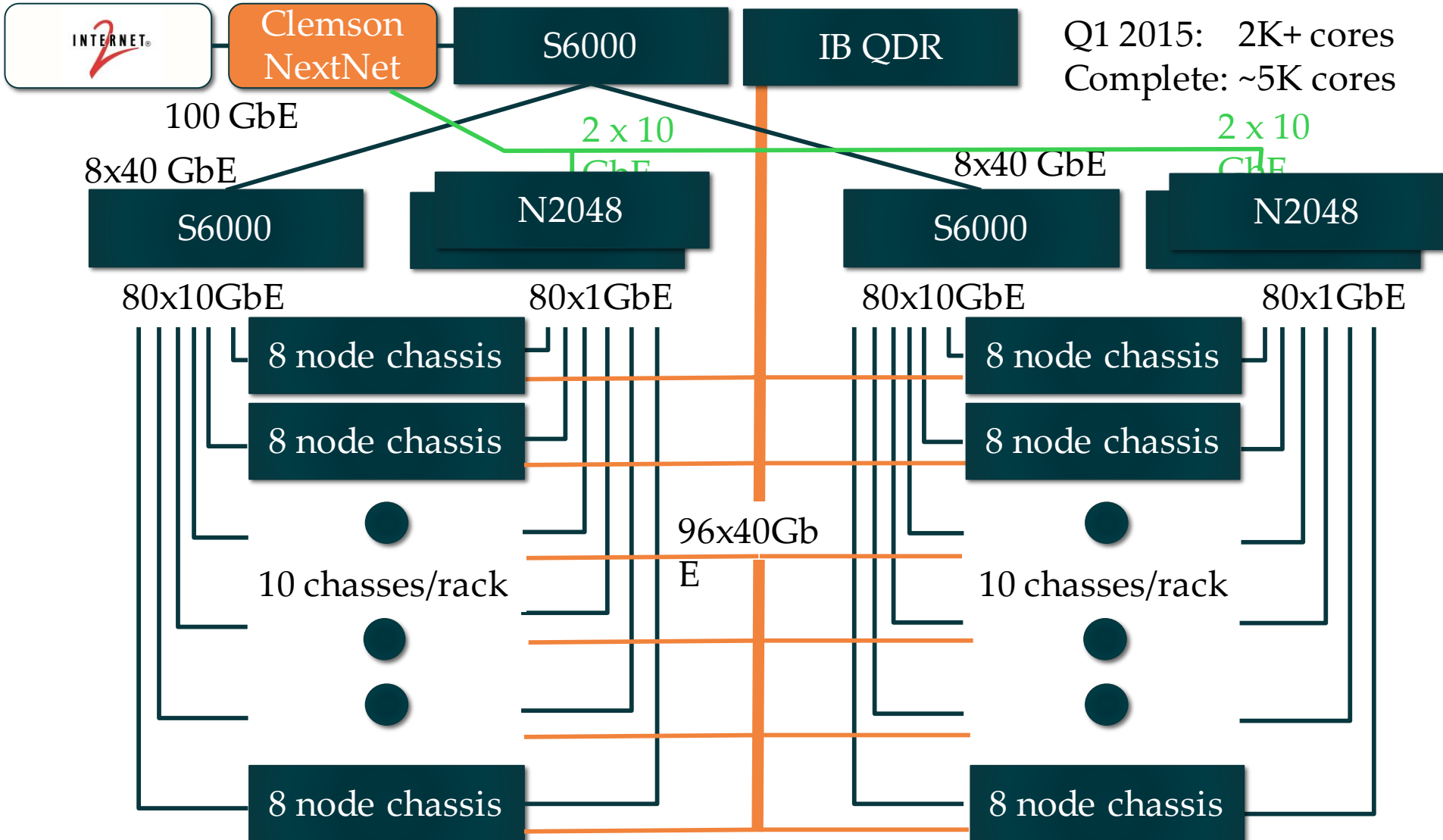
256 GB RAM/node

2 x 1 TB drive/server

* 1 NIC in 1st build



Clemson/Dell Network: IB + 10 GbE





Clemson - Suitable for experiments that:

- ... need large per-core memory
 - e.g., High-res media processing
 - e.g. Hadoop
 - e.g., Network Function Virtualization
- ... want to experiment with IB and/or GbE networks
 - e.g., hybrid HPC with MPI and TCP/IP
 - e.g., cyber physical system
- ... need bare-metal control over switches
- ... need OpenFlow 1.3



Building Profiles






Copy an Existing Profile

The screenshot shows a web browser window at cloudlab.us. The navigation bar includes 'Home', 'Manual', 'Actions', the CloudLab logo, 'rpruser logged in', and a 'Logout' button. A green notification box states 'Your experiment is ready!' with a right-pointing arrow. Below this, the experiment details are listed: URN: urn:publicid:IDN+emulab.net+slice+rpruser-QV992, State: ready, Profile: arm64-ubuntu14, and Expires: 12-07T21:24Z (in 16 hours). At the bottom right of this box are three buttons: 'Clone' (blue), 'Extend' (green), and 'Terminate' (red). The 'Clone' button is circled in orange. Below the notification is a blue box for 'Profile Instructions' with a right-pointing arrow. At the bottom, a control bar shows 'Topology View' selected, with 'List View', 'Manifest', and 'node x' as other options.

cloudlab.us

Home Manual Actions  rpruser logged in Logout

Your experiment is ready! [▶](#)

URN: urn:publicid:IDN+emulab.net+slice+rpruser-QV992
State: ready
Profile: arm64-ubuntu14
Expires: 12-07T21:24Z (in 16 hours)

Clone Extend Terminate

Profile Instructions [▶](#)

Topology View List View Manifest node ^x



Use a GUI (Jacks)

The screenshot shows the CloudLab Topology Editor interface. The browser address bar displays `cloudlab.us`. The main window is titled "Topology Editor" and contains a network diagram with a central hub and several nodes: `cloud-controller`, `name-node`, `worker-1`, and `worker-5`. The `cloud-controller` node is highlighted with a green border. On the left, there is a configuration sidebar with sections for "Hardware Type" (set to "(any)"), "Disk Image" (set to "Ubuntu 12.04 LTS 64-bit"), and "Install Scripts" (with an "Add" button and a URL input field). In the top right of the editor area, there are "Tidy View" and "Delete All" buttons.



Write Python Code (geni-lib)

```
two-vm.py (~/Desktop) - VIM
import geni.rspec.pg as pg
rspec = pg.Request()

# Create XenVM nodes
node1 = pg.XenVM("node1")
node2 = pg.XenVM("node2")

# Create interfaces for each node.
iface1 = node1.addInterface("if1")
iface2 = node2.addInterface("if2")

rspec.addResource(node1)
rspec.addResource(node2)

# Create a link with the type of LAN.
link = pg.LAN("lan")

# Add both node interfaces to the link.
link.addInterface(iface1)
link.addInterface(iface2)
```



GENI-LIB

<http://geni-lib.readthedocs.org/>


or

<http://geni-lib.readthedocs.io/en/latest/>




Build From Scratch

cloudlab.us


Home Manual Actions  rpruser logged in Logout


Create Profile

Name 

Project

Your rspec

Description 

Instructions 

List on the home page for anyone to view.

Who can instantiate your profile?

Anyone on the internet (guest users)

Only registered users of the website



Sign Up





Sign Up At CloudLab.us

cloudlab.us

Home Manual Sign Up Login

Start Project

| Personal Information | Project Information |
|--|--|
| <input type="text" value="Username"/> | <input type="radio"/> Join Existing Project <input checked="" type="radio"/> Start New Project |
| <input type="text" value="Full Name"/> | <input type="text" value="Project Name"/> |
| <input type="text" value="Email"/> | <input type="text" value="Project Title (short sentence)"/> |
| <input type="text" value="Institutional Affiliation"/> | <input type="text" value="Project Page URL"/> |
| <input type="text" value="Please Select Country"/> | <input type="text" value="Project Description (details)"/> |
| <input type="text" value="Please Select State"/> | |
| <input type="text" value="City"/> | |