# CloudLab

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CLEMSON UNIVERSITY

Raytheon
BBN Technologies

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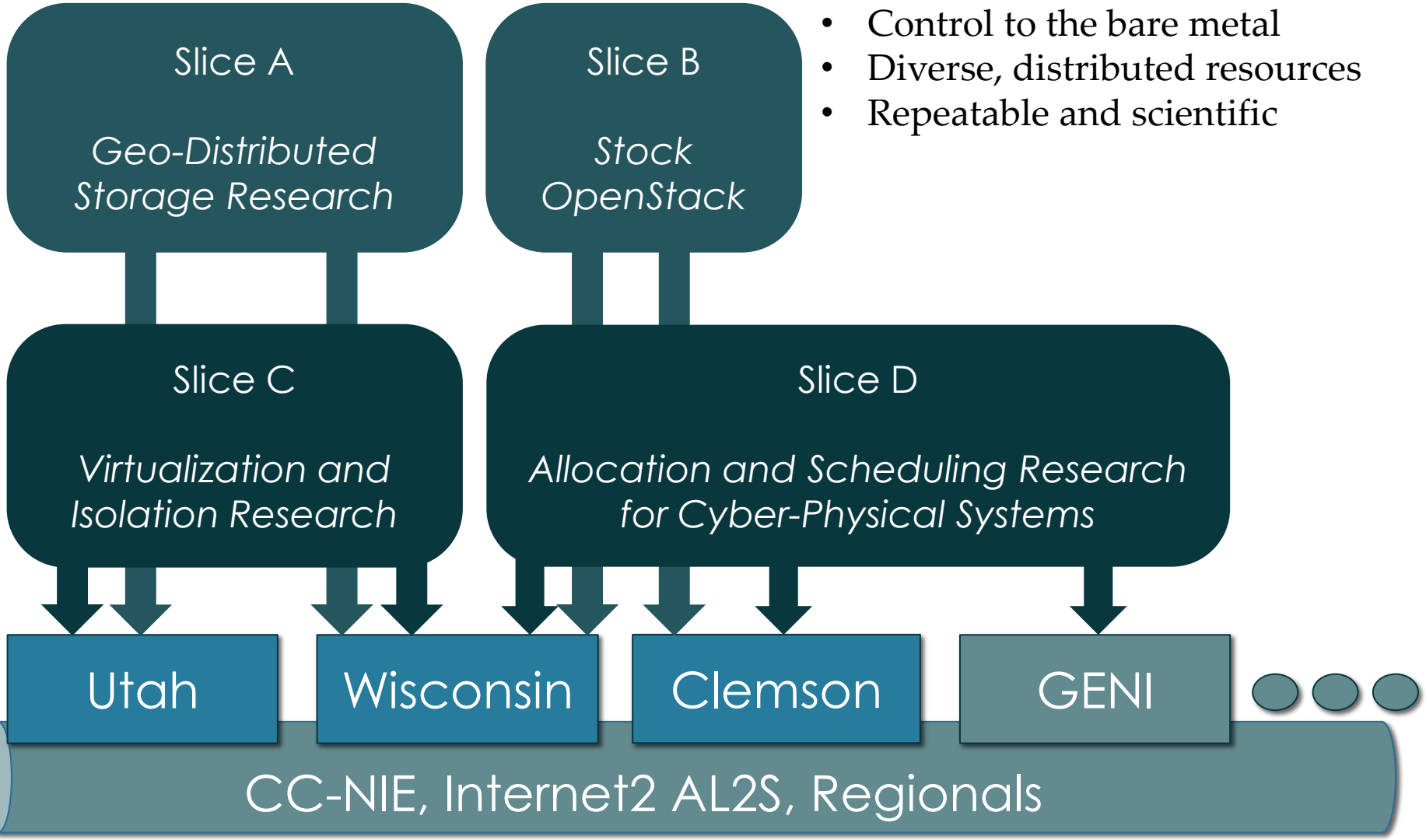
# Crash Course in CloudLab

- 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 physical realization
  - 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?




- 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)
- 8-20 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/HP*

## Clemson

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

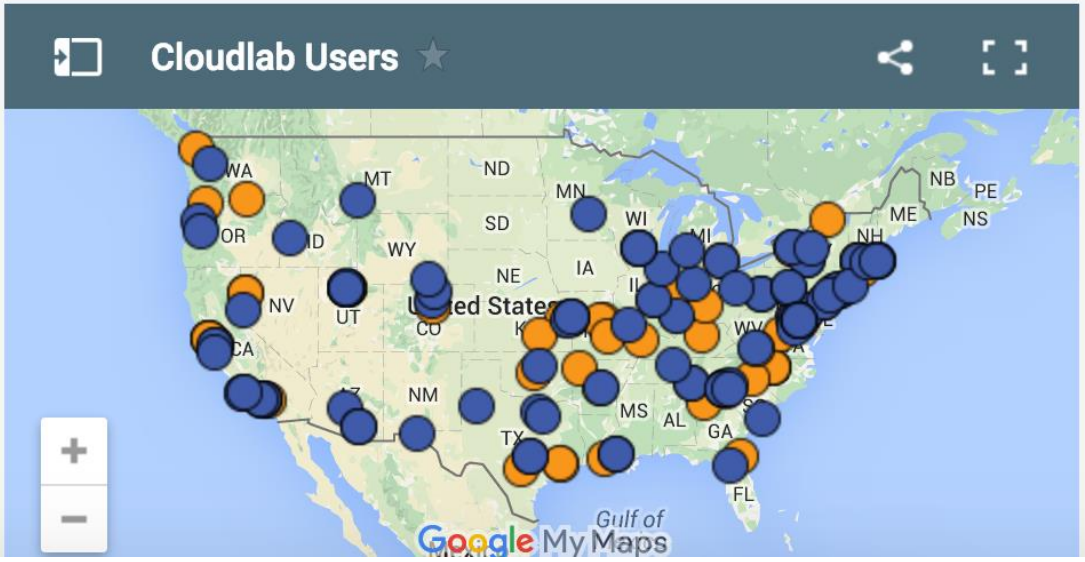
## Utah

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

| Cluster Status | | | Activity | |
|---|---|---|---|---|
| Active Experiments: | | 107 | Projects | 216 |
| Utah | Up | 31% | Users | 862 |
| Clemson | Up | 100% full | Profiles | 1,459 |
| Wisconsin | Up | 99% full | Experiments | 12,700 |

**Federated Facilities**

| Emulab | Apt | Kentucky | iMinds | Utah DDC |
|---|---|---|---|---|
| Up | Up | Up | Up | Up |

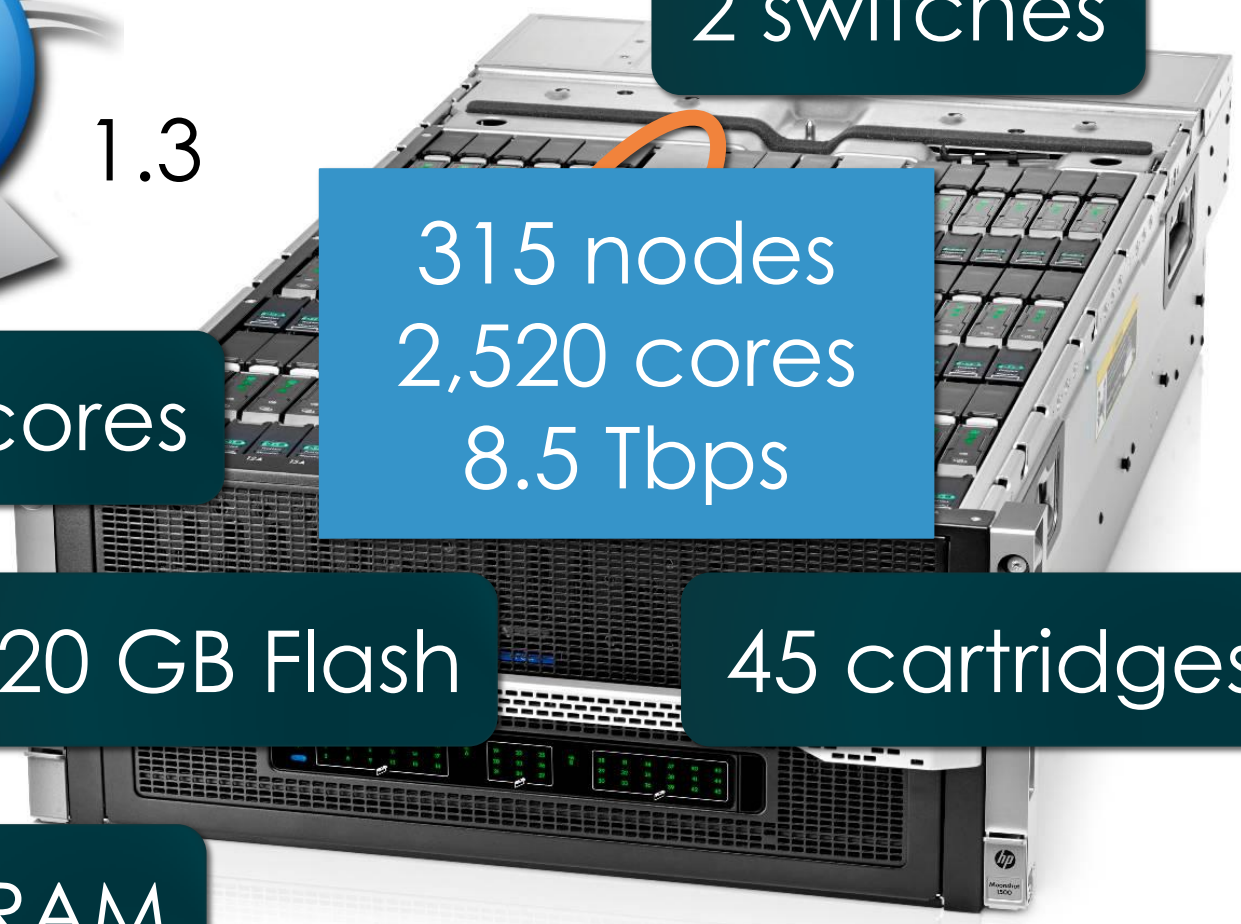


# CloudLab Hardware

# Utah/HP: Very dense

# Utah/HP: Low-power ARM64

1.3



2 switches

315 nodes
2,520 cores
8.5 Tbps

8 cores

120 GB Flash

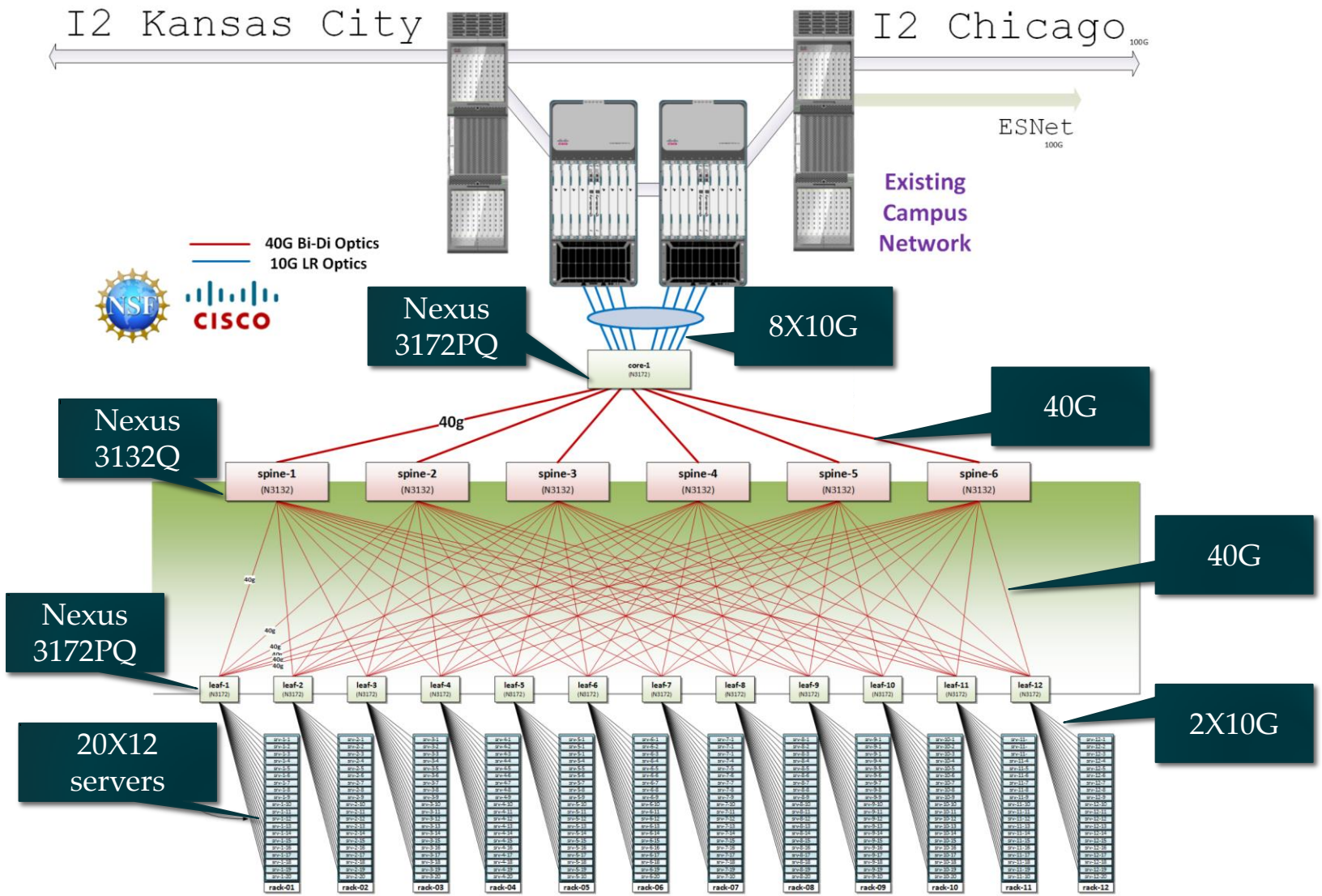
45 cartridges

64 GB RAM

# 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

- 1X 1TB HDD
- 12X 3TB HDD
(donated by Seagate)

Soon: ≥ 160 additional servers; OF1.3 ToR switches (HP)
Limited number of accelerators, e.g., FPGAs, GPUs (planned)

# 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/SparkSQL/Tachyon)
- … 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 chasses/rack

2*x 1 GbE OF/node

256 GB RAM/node

2 x 1 TB drive/server

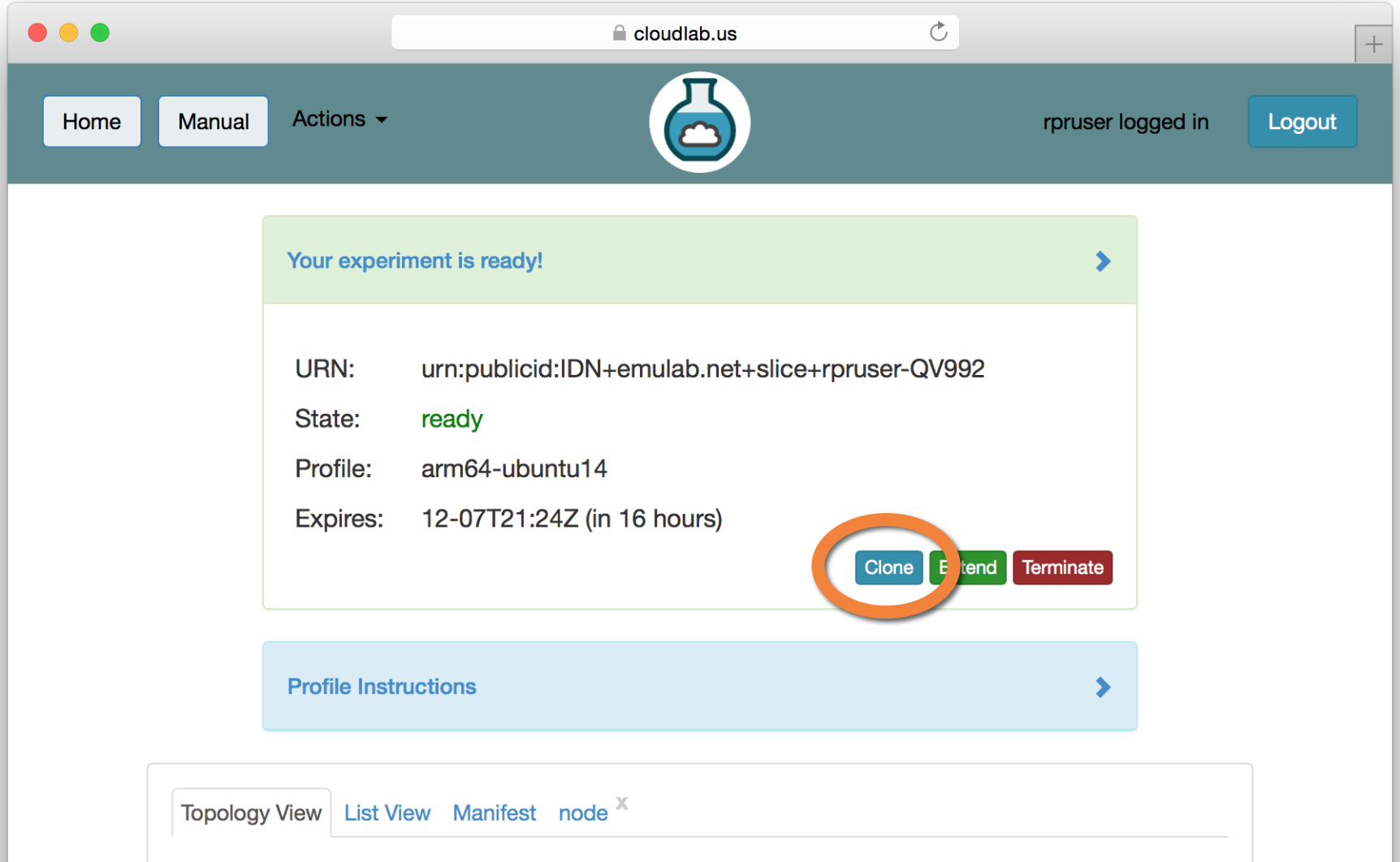
* 1 NIC in 1st build

# Clemson - Suitable for experiments that:

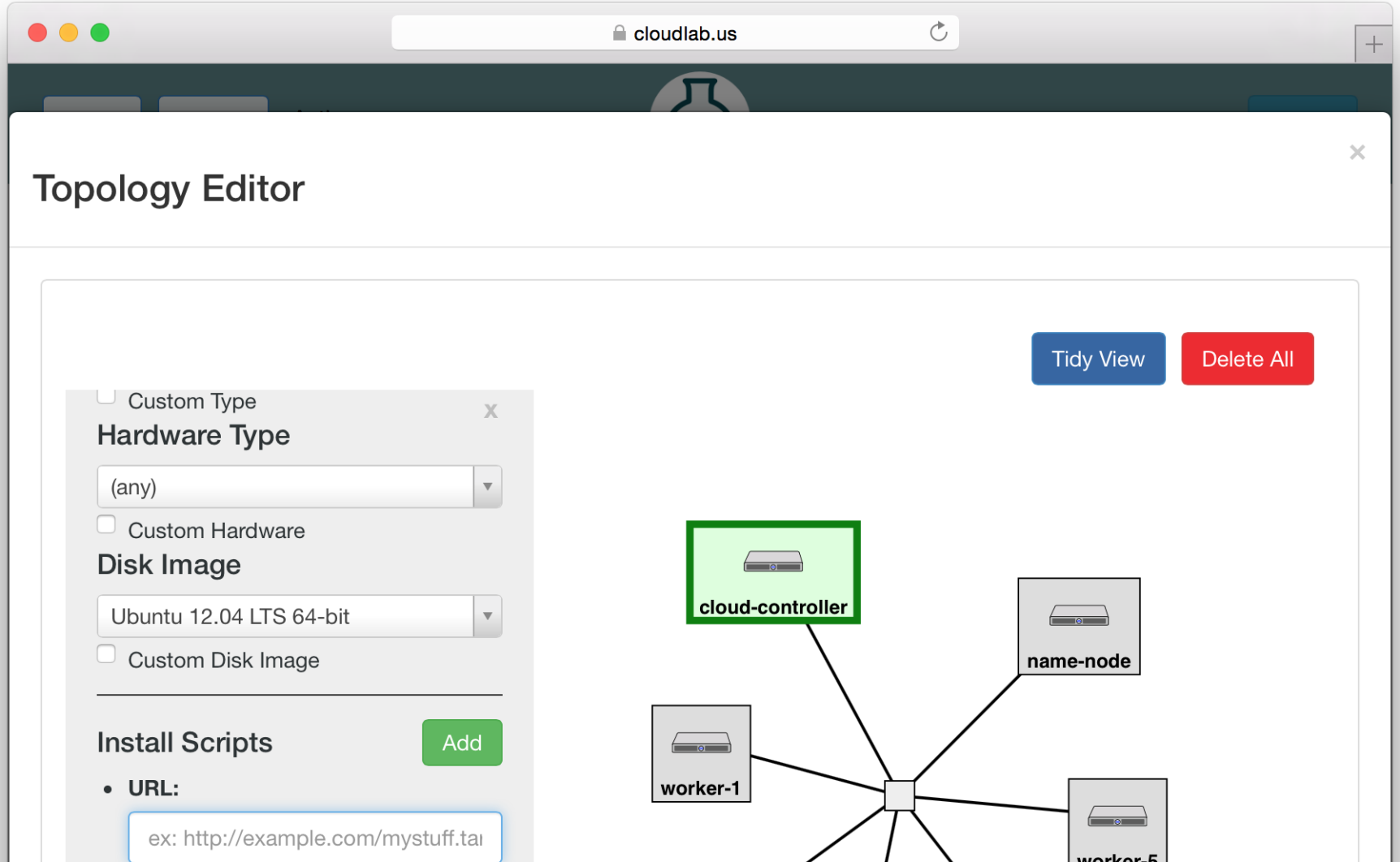
- … need large per-core memory
  - e.g., High-res media processing
  - e.g. Hadoop
  - e.g., Network Function Virtualization
- … want to experiment with IB and/or GbE networks
  - e.g., hybrid HPC with MPI and TCP/IP
- … need bare-metal control over switches
- … need OpenFlow 1.3

# Building Profiles

# Copy an Existing Profile



# Use a GUI (Jacks)

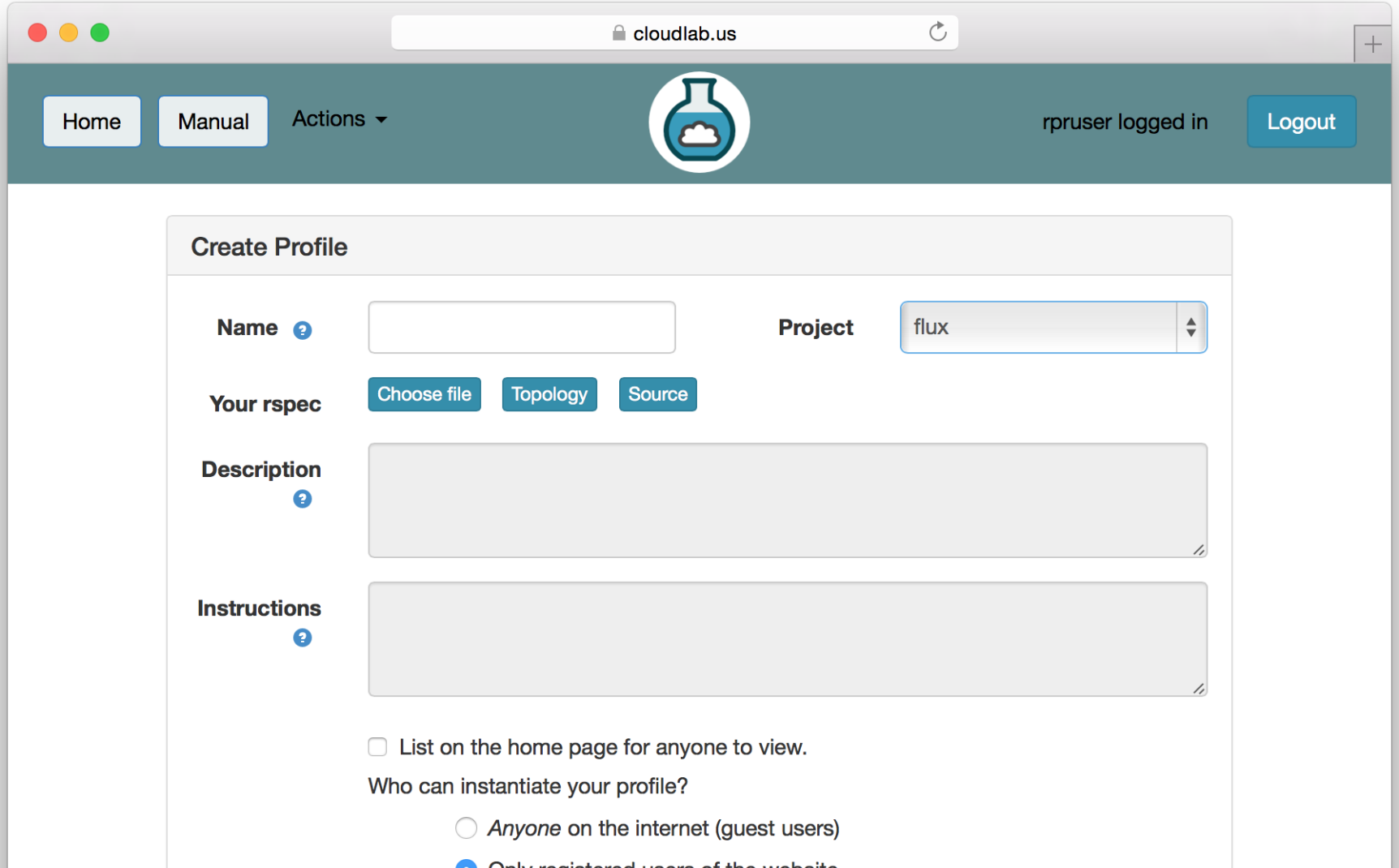


# Write Python Code (geni-lib)

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)
```

# Build From Scratch



# Sign Up

# Sign Up At CloudLab.us