Infrastructure For Building Cyber Experimentation Testbeds

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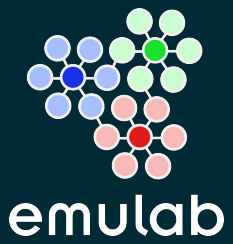
August 2017



Diversity in Environments for Cyber Experimentation

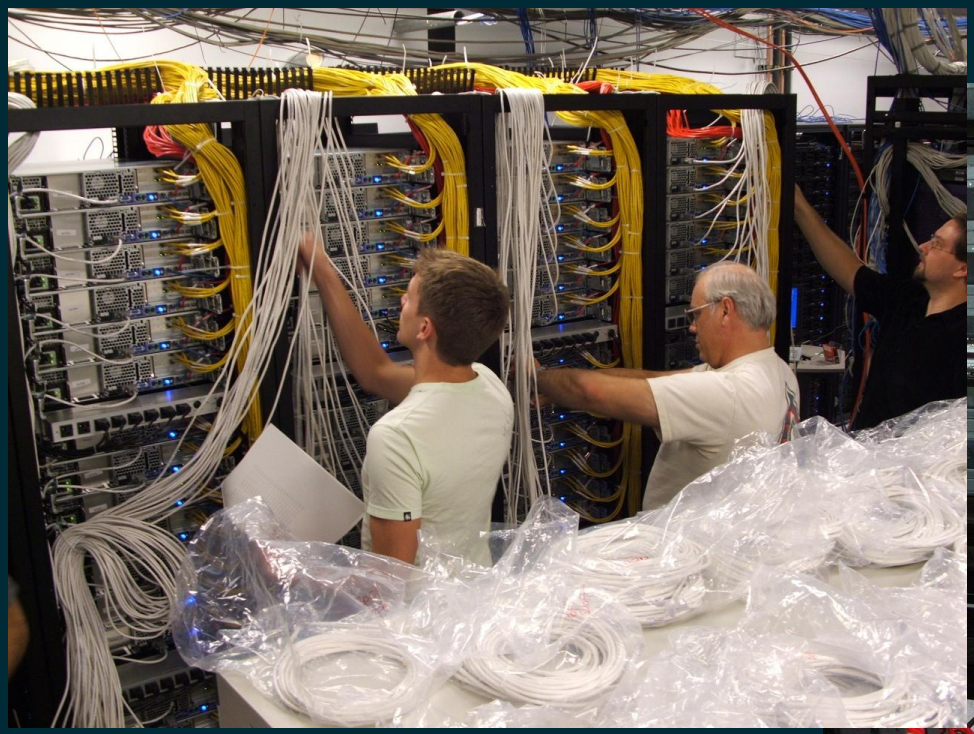

USA MEX
ONE SIZE
DOES NOT
FIT ALL
30°C
Von links bügeln/

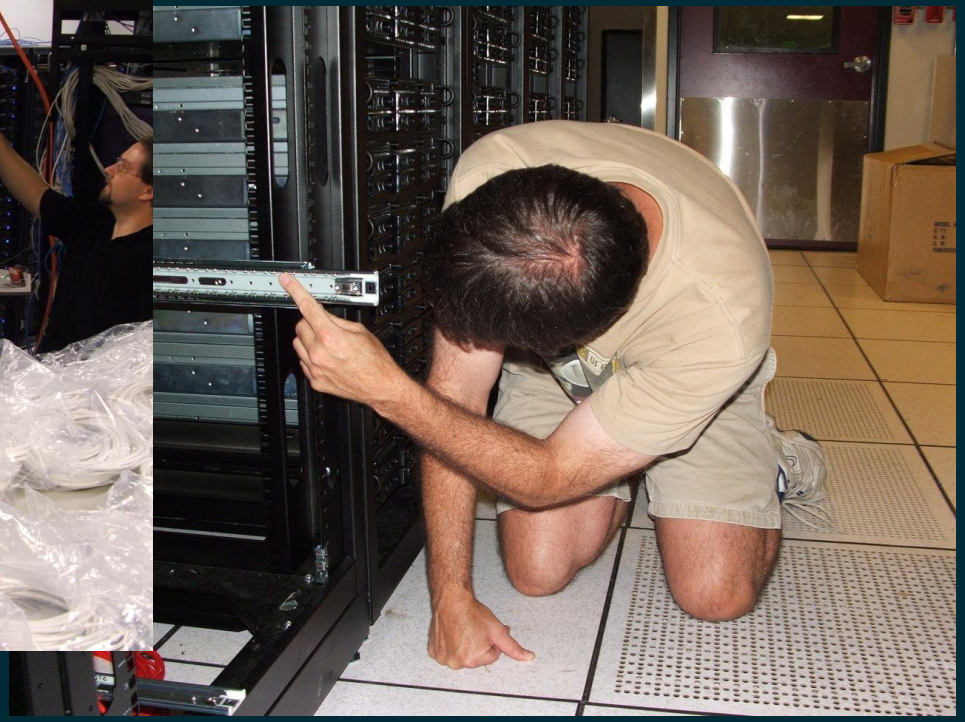
Dimensions of Diversity

- Level of control
- Level of isolation
- Operating systems
- Application software
- Attack/defense tools
- Types of hardware
- Specialized devices
- Network technologies
- Network topology
- Storage
- User community
- Disciplines
- Ease of use
- User interface
- Dataset control
- Access policies
- User participation
- Red / blue teams
- Workflows
- ...

Building New Cyber-Experimentation Infrastructure

Building a Testbed Is Hard





Building a Testbed is Expensive

Building a New Testbed is Risky

A Proposed Solution:

Build infrastructure for building infrastructure

“Meta Infrastructure”

CloudLab

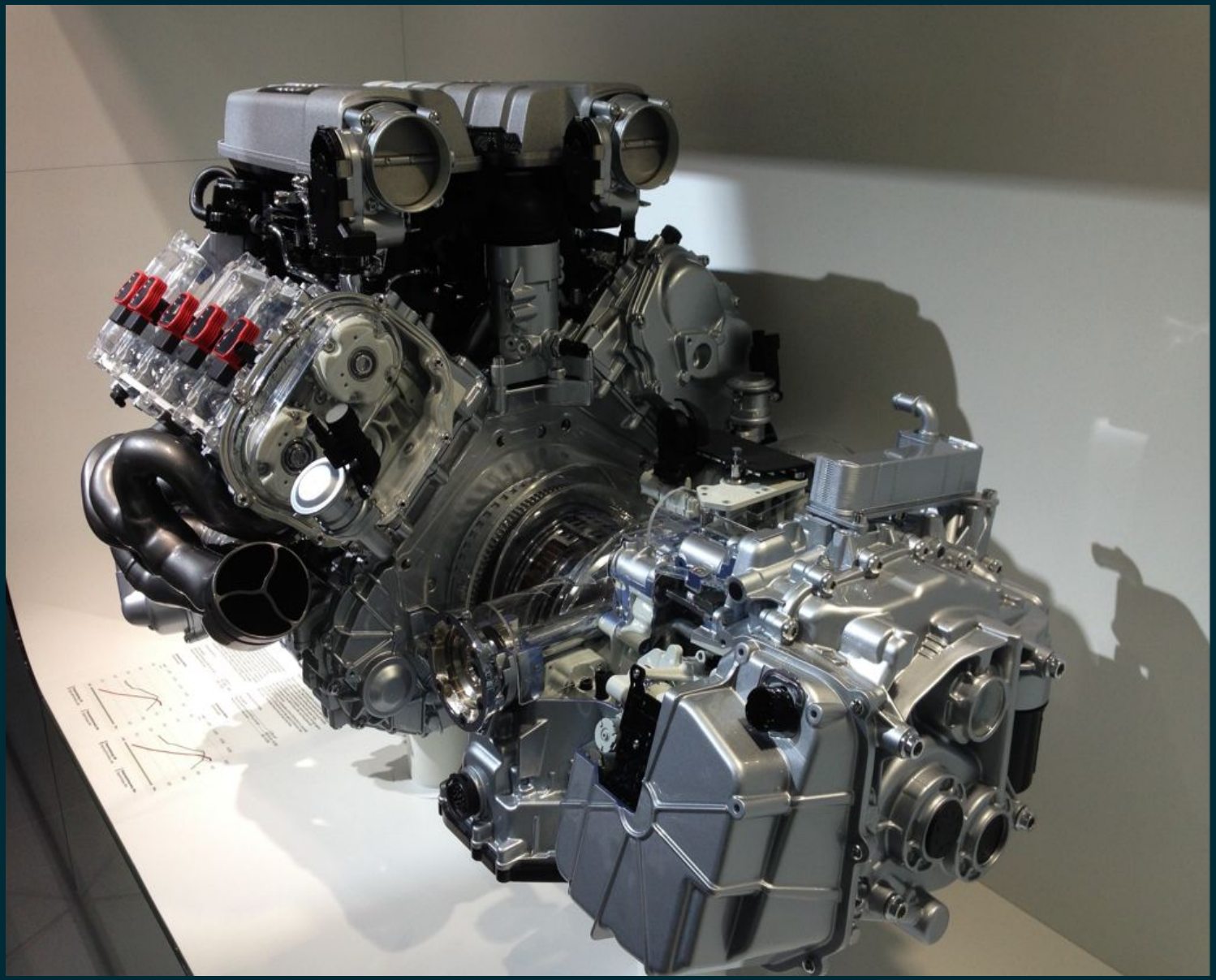
The Problem with Cloud Research

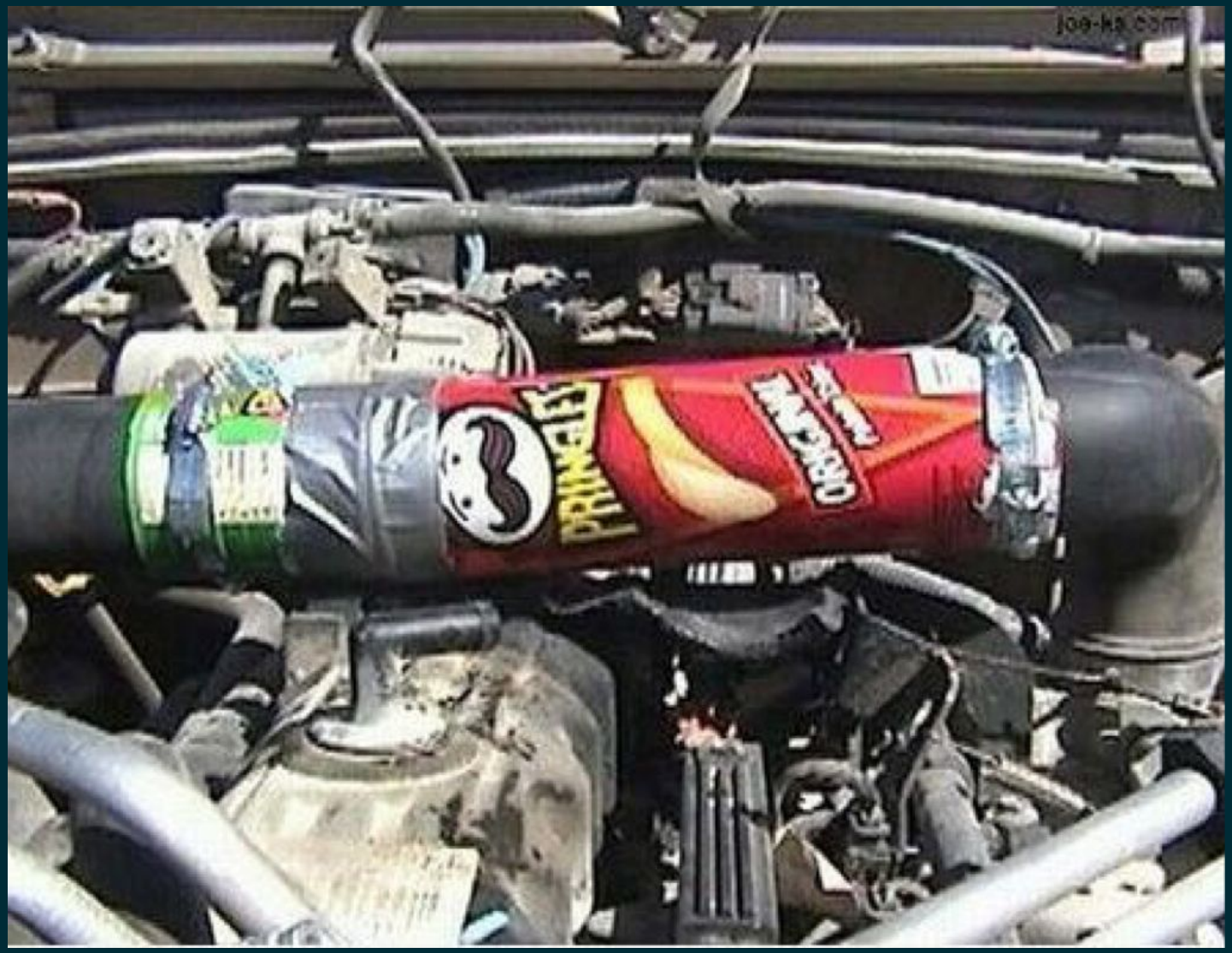
The CloudLab Vision

- A “meta-cloud” for building clouds
- Build your own cloud on our hardware resources
- Run any cloud software
- Control and visibility all the way to the bare metal
- “Sliceable” for multiple, isolated experiments at once

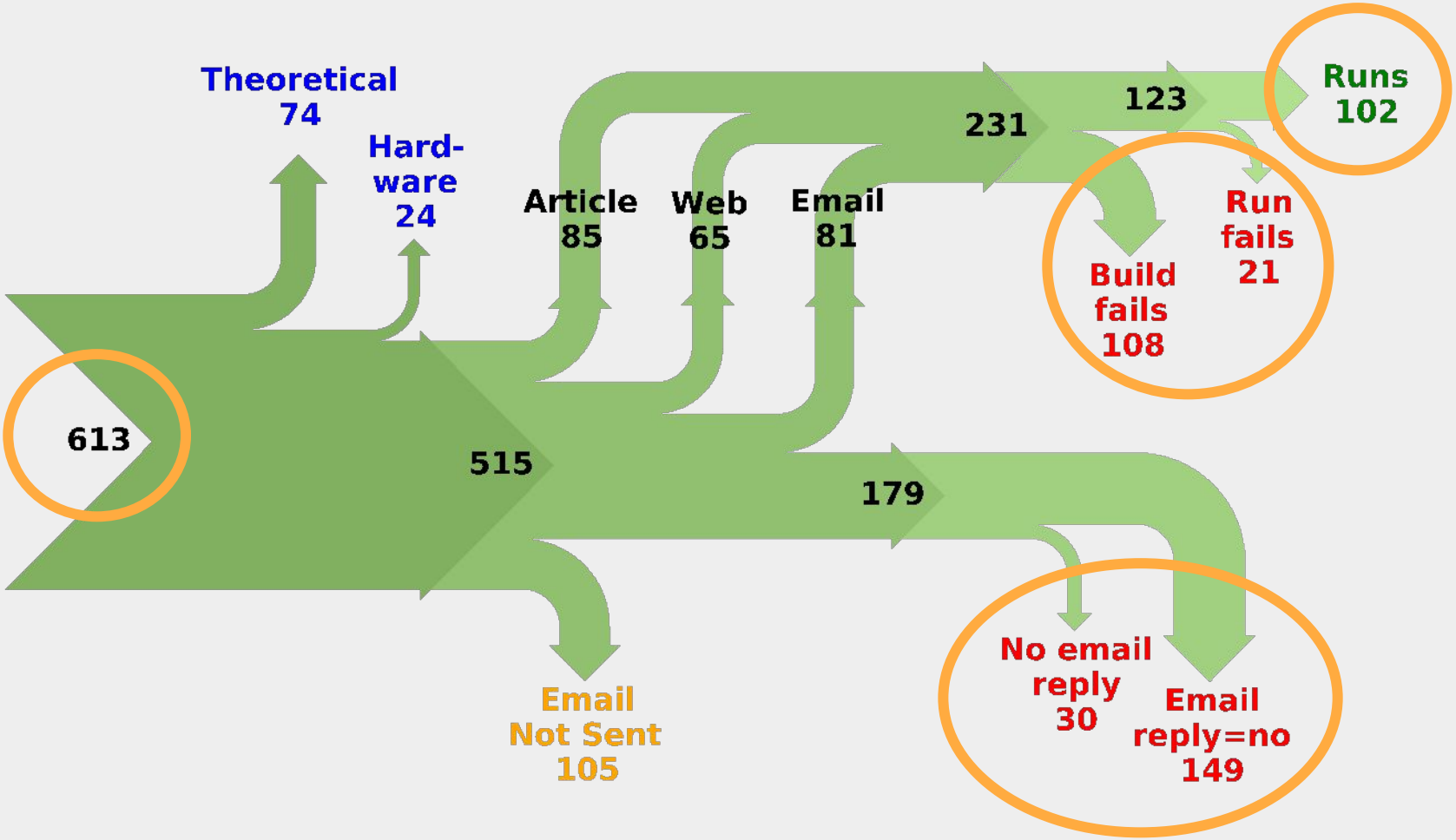
With CloudLab, it’s as easy to get *an entire cloud* as it is to get a VM *in* a cloud

Building on Each Other's Work




joe-ka.com
PRIMARY
COMPANY

The Difficulty of Reproducing Papers



From Collberg et al. - http://reproducibility.cs.arizona.edu/

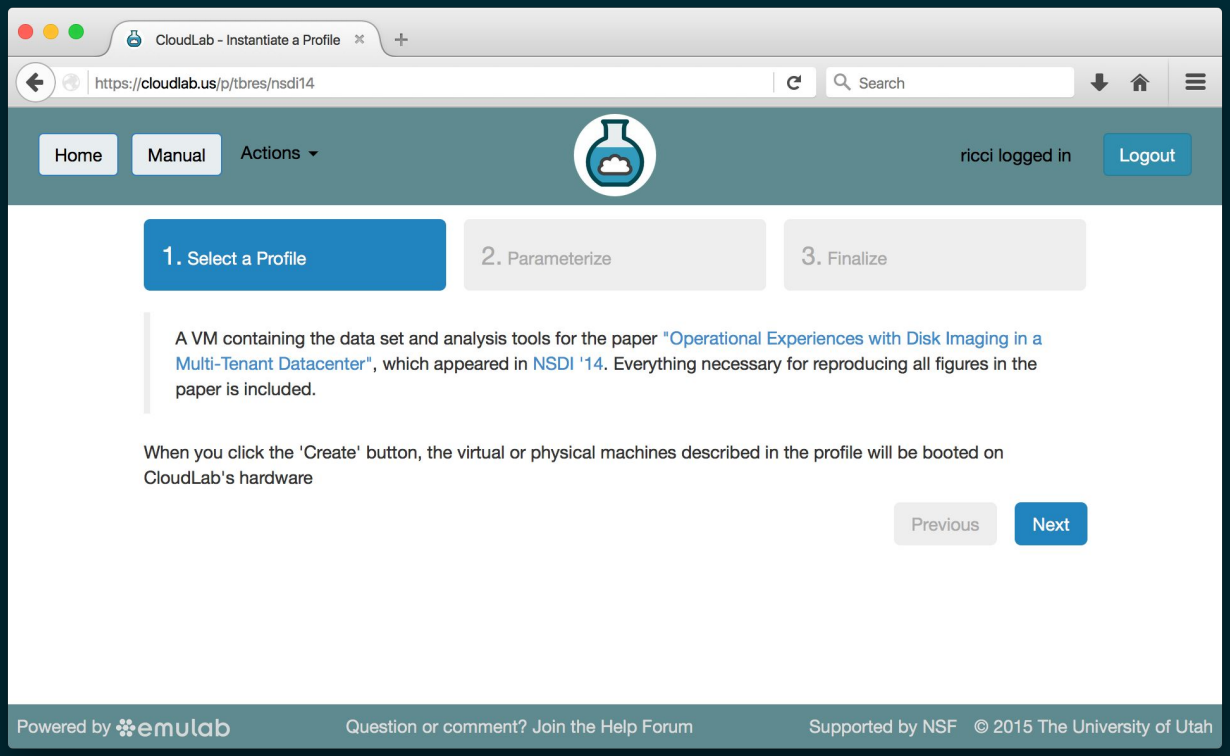
A Proposed Solution:

Make it easy to encapsulate everything about an experimental environment

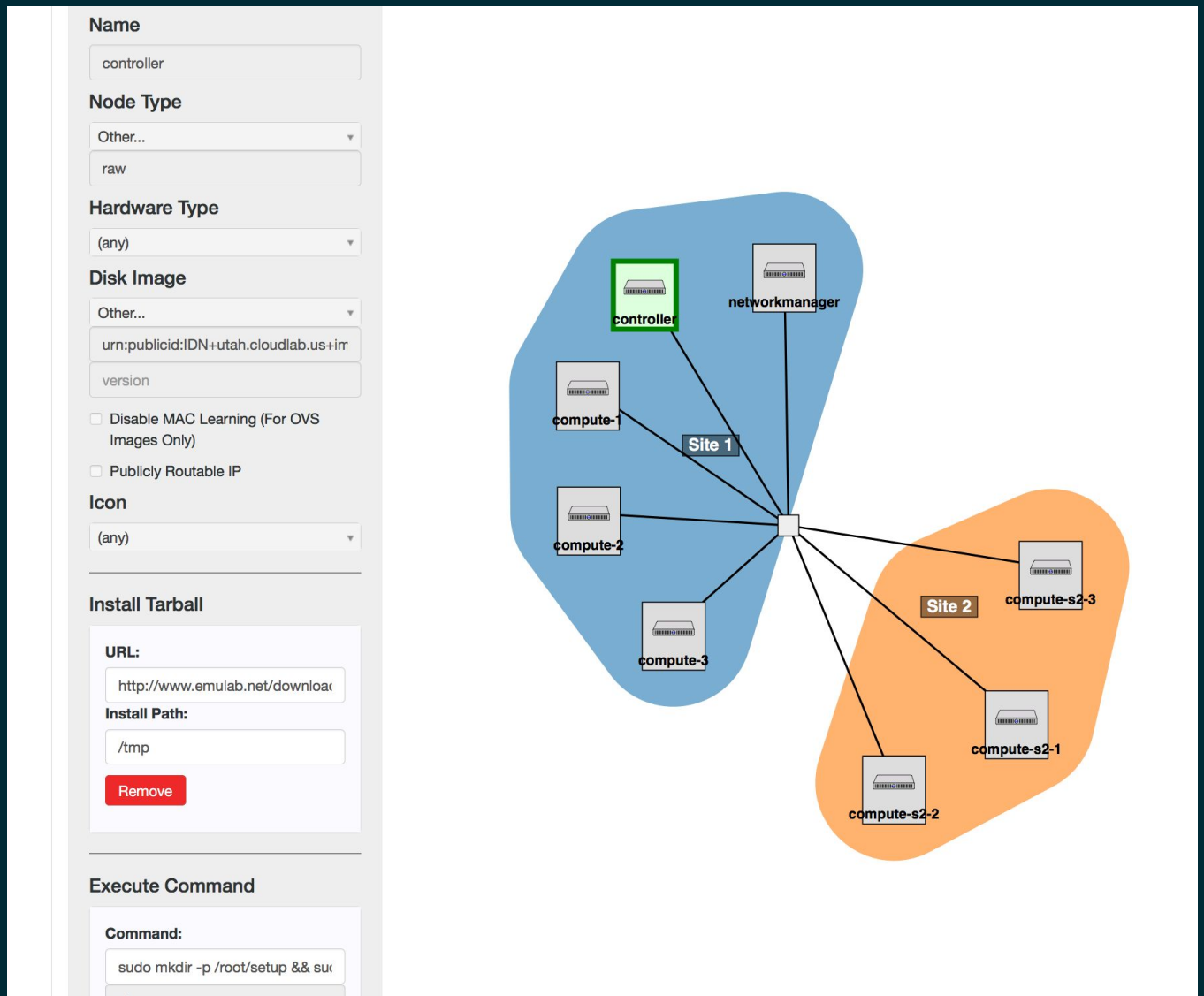
An Example of The Solution: Profiles

Profile URLs

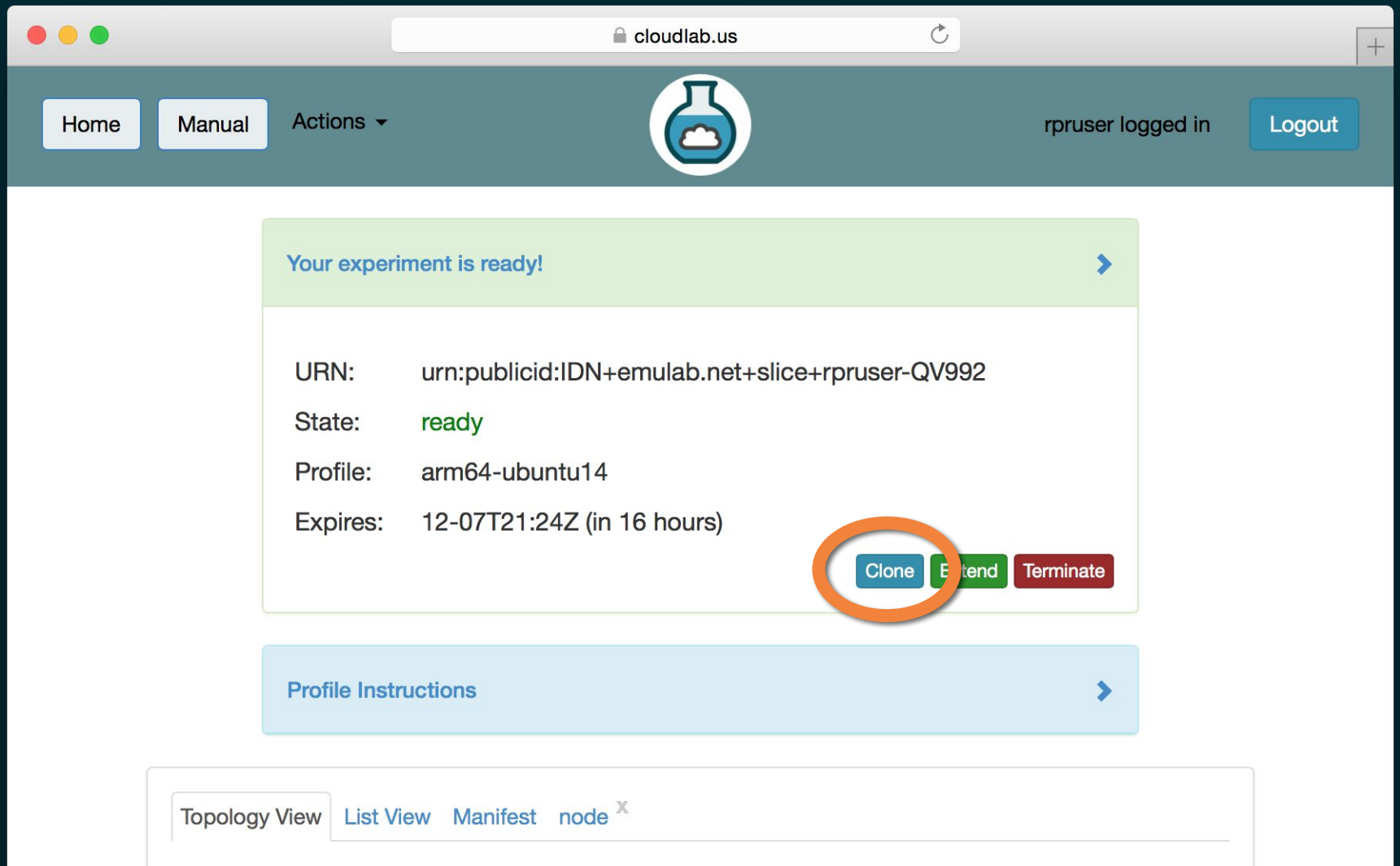
https://cloudlab.us/p/tbres/nsdi14



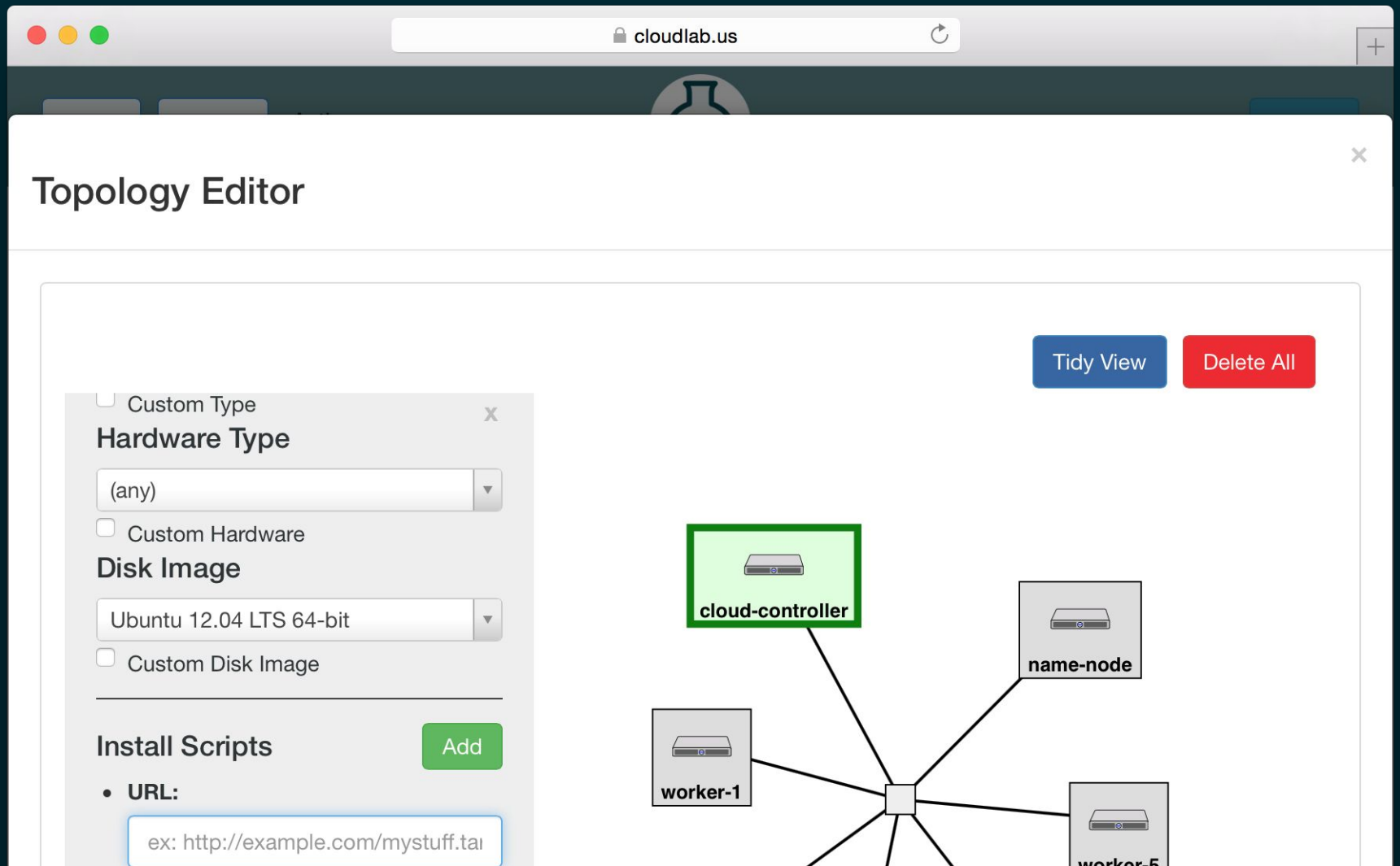
What a Profile Contains



Copy an Existing Profile



Use a GUI


cloudlab.us
Topology Editor
Tidy View
Delete All
Custom Type
Hardware Type
(any)
Custom Hardware
Disk Image
Ubuntu 12.04 LTS 64-bit
Custom Disk Image
Install Scripts
Add
URL:
ex: http://example.com/mystuff.tai
cloud-controller
name-node
worker-1

Write Code

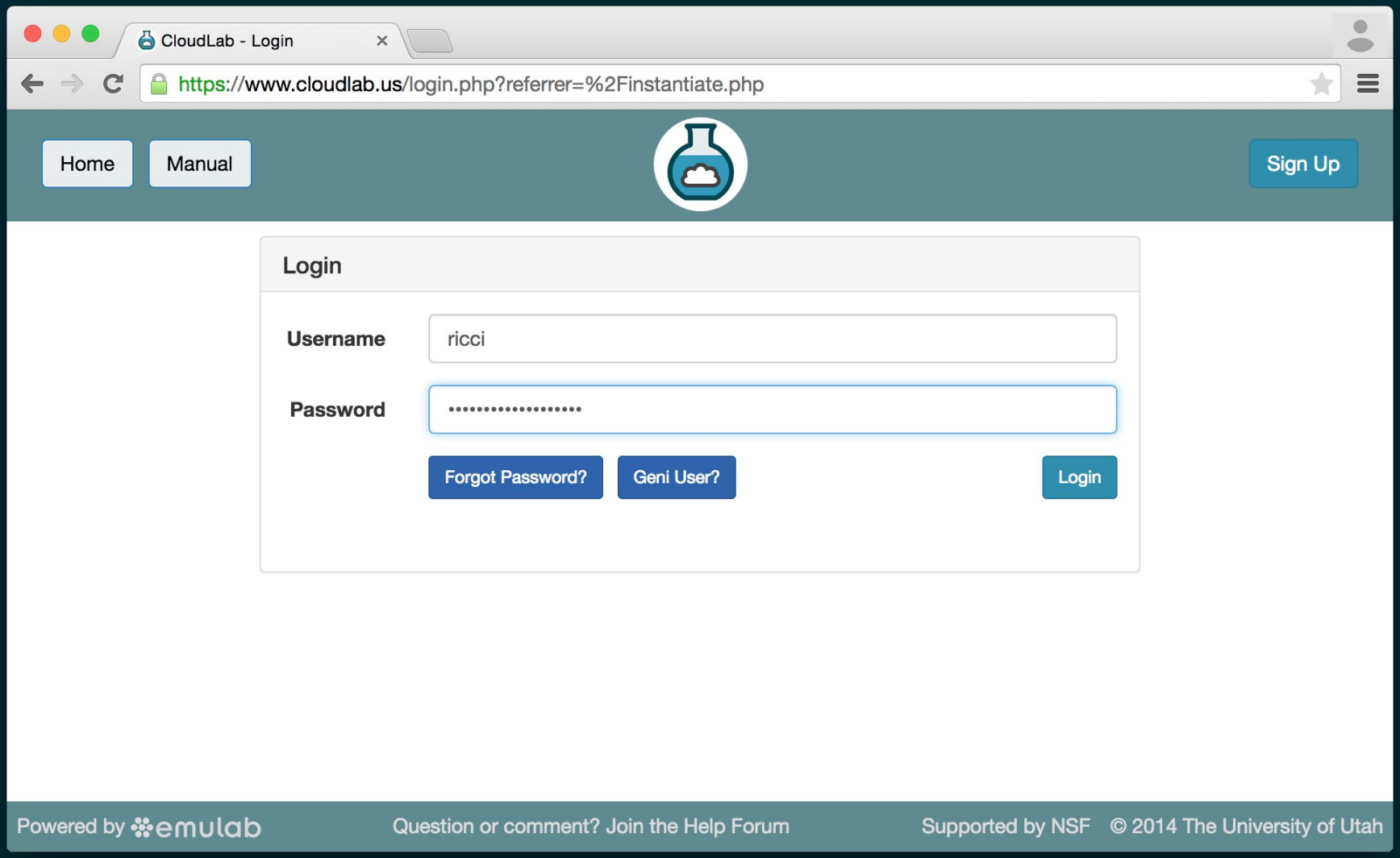
```
#!/usr/bin/env python
"""An example of constructing a profile with a single physical
host. Instructions: Wait for the profile instance to start,
and then log in to the VM via the ssh port specified below.
"""

import geni.rspec.pg as rspec
import geni.portal as portal

# Create the Portal context.
rspec = portal.context.makeRequestRSpec()

# Create a raw machine and add it to the RSpec.
node = rspec.RawPC("node")

# Print the RSpec to the enclosing page.
portal.context.printRequestRSpec()
```

A More Complex Profile

```
# Describe the parameter(s) this profile script can accept.
pc.defineParameter( "n", "Number of VMs", portal.ParameterType.INTEGER, 1)

# Retrieve the values the user specifies during instantiation.
params = pc.bindParameters()

# Check parameter validity.
if params.n < 1 or params.n > 8:
    pc.reportError(
        portal.ParameterError(
                "You must choose at least 1 and no more than 8 VMs."))

for i in range( params.n ):
    # Create a raw node and add it to the RSpec.
    node = rspec.RawPC( "node" + str( i ) )
```

Demo

https://www.cloudlab.us/p/emulab-ops/OpenStack


CloudLab - Login
https://www.cloudlab.us/login.php?referrer=%2Finstantiate.php
Home
Manual
Sign Up
Login
Username
ricci
Password
Forgot Password?
Geni User?
Login
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Question or comment? Join the Help Forum
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CloudLab - Instantiate a Profile

Home | Manual | Actions | ricci1 logged in | Logout

1. Select a Profile | 2. Parameterize | 3. Finalize

Selected Profile: OpenStack

A highly-configurable OpenStack instance with a controller, network manager, and one or more compute nodes (potentially at multiple sites). This profile runs x86 or ARM64 nodes. It sets up OpenStack Kilo or Juno on Ubuntu 15.04 or 14.10, and configures all OpenStack services, pulls in some VM disk images, and creates basic networks accessible via floating IPs. You'll be able to create instances and access them over the Internet in just a few minutes. When you click the Instantiate button, you'll be presented with a list of parameters that you can change to control what your OpenStack instance will look like; **carefully** read the parameter documentation to understand the various features available to you!

Copy Profile | Show Profile | Change Profile

Previous | Next

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CloudLab - Instantiate a Profile

Select a Profile

Use Classic Picker

Search

Recent -

- OpenStack System
- arm64-ubuntu15-10 CloudLab
- two-site-demo flux
- two-nodes utahstud
- geni-lib-ramcloud-test utahstud

CloudLab -

- arm64-ubuntu15-10
- Tutorial-OpenStack
- ARM64OpenStack-Tutorial
- Example
- Hadoop_skollu0
- ShrutiSaumya_Profile
- rogile
- profile-1

OpenStack

Add to Favorites

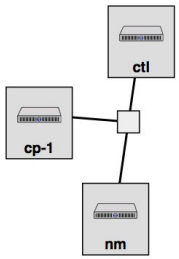
Created By:
johnsond

Project:
System

Latest Version:
26

Last Updated:
2016-02-25 16:21:27

Description:
This profile provides a highly-configurable OpenStack instance with a controller, network manager, and one or more compute nodes (potentially at multiple Cloudlab sites). This profile runs x86 or ARM64 nodes. It sets up OpenStack Liberty, Kilo, or Juno (on Ubuntu 15.10, 15.04, or 14.10) according to your choice, and configures all OpenStack services, pulls in some VM disk images, and creates basic networks accessible via floating IPs. You'll be able to create instances



Select Profile Cancel

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1. Select a Profile | 2. Parameterize | 3. Finalize

Please review the selections below and then click Finish.

Profile: OpenStack

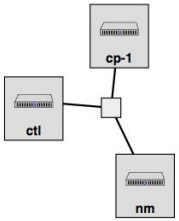
Name: Optional

Cluster: Please Select

- Please Select
- Cloudlab Utah
- Cloudlab Wisconsin
- Cloudlab Clemson

Federated Clusters

- Emulab
- APT Utah
- IG UtahDDC



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1. Select a Profile | 2. Parameterize | 3. Finalize

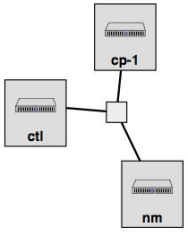
Please review the selections below and then click Finish.

Profile: OpenStack

Name: Optional

Cluster: Please Select

Check Cluster Status



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CloudLab - Experiment Status

Home | Manual | Actions | ricci1 logged in | Logout

Please wait while we get your experiment ready

Name:	ricci1-QV6643
State:	booting
Profile:	Tutorial-OpenStack
Created:	Jun 10 2015 12:43 PM
Expires:	Jun 11 2015 4:43 AM (in 16 hours)

Sliver | Copy | Extend | Terminate

Profile Instructions

Topology View | List View | Manifest

ID	Node	SSH command (if you provided your own key)	Actions
ctl	ms0503	`ssh -p 22 ricci1@ms0503.utah.cloudlab.us`	
nm	ms0520	`ssh -p 22 ricci1@ms0520.utah.cloudlab.us`	
cp1	ms0512	`ssh -p 22 ricci1@ms0512.utah.cloudlab.us`	

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CloudLab - Experiment Status

Home | Manual | Actions | ricci1 logged in | Logout

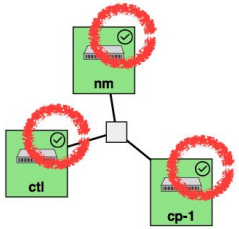
Your experiment is ready!

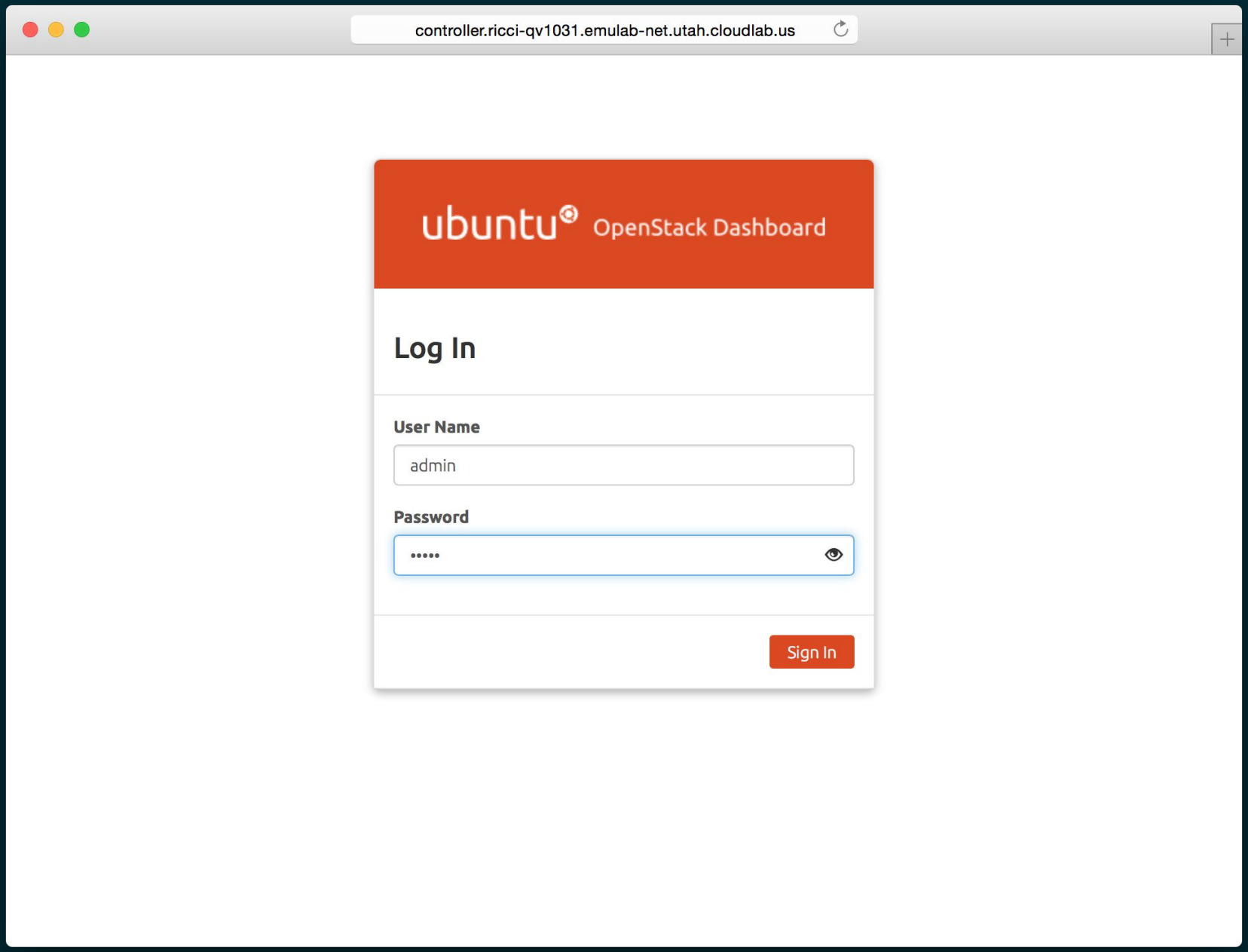
Name: ricci1-QV10477
State: ready
Profile: OpenStack
Created: Nov 5 2015 11:14 AM
Expires: Nov 6 2015 3:14 AM (in 16 hours)

Sliver | Copy | Extend | Terminate

Profile Instructions

Topology View | List View | Manifest




controller.ricci-qv1031.emulab-net.utah.cloudlab.us
ubuntu OpenStack Dashboard
Log In
User Name
admin
Password
•••••
Sign In

controller.ricci-qv1031.emulab-net.utah.cloudlab.us

Admin

System

Overview

Hypervisors

Host Aggregates

Instances

Flavors

Images

Networks

Routers

Defaults

System Information

Identity

Hypervisor Summary

VCPU Usage
Used 0 of 24

Memory Usage
Used 1.5GB of 188.9GB

Disk Usage
Used 0Bytes of 327GB

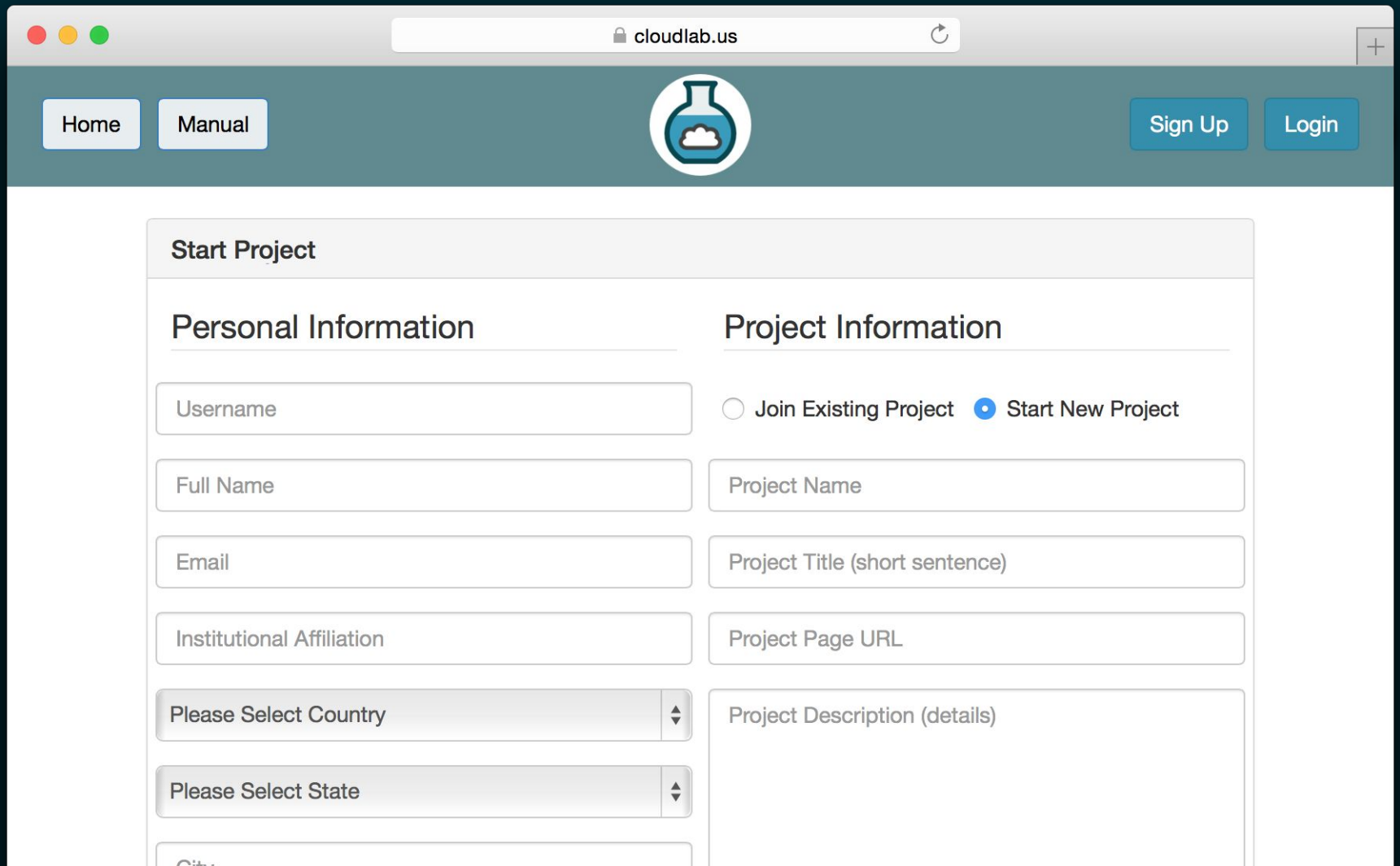
Hypervisor | Compute Host

Hypervisors

Hostname	Type	VCPUs (used)	VCPUs (total)	RAM (used)	RAM (total)	Storage (used)	Storage (total)	Instances
compute2.ricci-qv1031.emulab-net.utah.cloudlab.us	QEMU	0	8	512MB	63GB	0Bytes	109GB	0
compute3.ricci-qv1031.emulab-net.utah.cloudlab.us	QEMU	0	8	512MB	63GB	0Bytes	109GB	0
compute1.ricci-qv1031.emulab-net.utah.cloudlab.us	QEMU	0	8	512MB	63GB	0Bytes	109GB	0

Displaying 3 items

Sign Up At CloudLab.us



Thoughts for Future Cyberinfrastructure

- Build flexible platforms, and testbeds on top
  - Like the cloud, but lower level and security-focused
  - Use economies of scale
  - Reduce risk -> encourage more diversity
- Capture entire environments
  - Cyber experiments are often messy
  - Often require a known-good state
  - Encourage collaboration and building on each other's work

CloudLab

emulab

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