

Introduction to CloudLab

Linh B. Ngo
Clemson CITI

Hands-on Preparation

- Create a GitHub account at www.github.com
- Setup shell access
 - Windows
 - MobaXTerm: <https://mobaxterm.mobatek.net/download-home-edition.html>
 - Use Installer Edition
 - Mac and Linux
 - Default terminal

Joining CloudLab without prior account

Go to www.cloudlab.us

- Username: xxxxxxxx
- Email: Your_Clemson_Email
- Institutional Affiliation: Clemson University

- Ignore SSH Public Key file for now.
- Provide and confirm a secure password
- Join Existing Project: ClemsonCITI



Sign Up Login Docs ▾

Request to join a project Please see our [Acceptable Use Policy](#)

Personal Information

Username
Full Name
Email
Institutional Affiliation
Select Country
Select State/Province/Region
City

SSH Public Key file ([SSH Tutorial](#))
Choose File no file selected

Password
Confirm Password

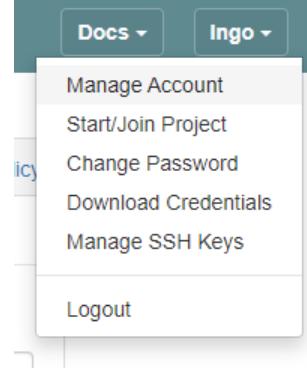
Join Existing Project Start New Project

ClemsonCITI

Submit Request

Join ClemsonCITI project with existing CloudLab/GENILab account

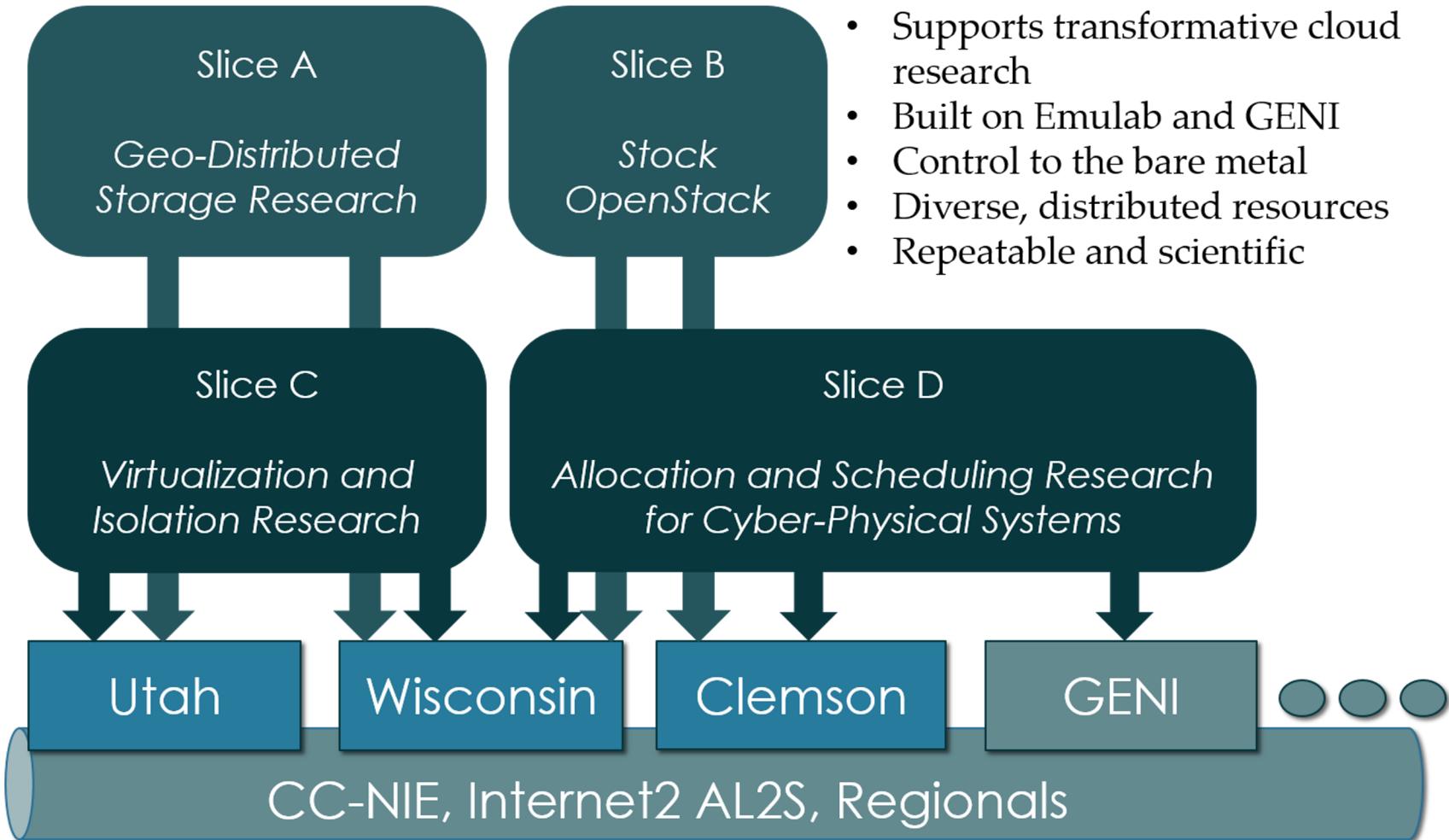
- Login to your existing CloudLab account.
- Upper right corner: Start/Join Project
- Join Existing Project: ClemsonCITI



The screenshot shows a web form titled "Request to join a project". At the top right, it says "Please see our [Acceptable Use Policy](#)". Below the title, there's a section for "Project Information" with two radio buttons: "Join Existing Project" (selected) and "Start New Project". A search bar contains the text "ClemsonCITI". At the bottom right is a blue "Submit Request" button.

What is CloudLab?

- Experimental testbed for future computing research
- Allow researchers control to the bare metal
- Diverse, distributed resources at large scale
- Allow repeatable and scientific design of experiments



What is GENI?

- Global Environment for Networking Innovation
- "Combining heterogeneous resource types, each virtualized along one or more suitable dimensions, to produce a single platform for network science researchers"
- Key components:
 - GENI racks: virtualized computation and storage resources
 - Software-defined networks (SDNs): virtualized, programmable network resources
 - WiMAX: virtualized cellular wireless communication

Berman, M., Chase, J.S., Landweber, L., Nakao, A., Ott, M., Raychaudhuri, D., Ricci, R. and Seskar, I., 2014. GENI: A federated testbed for innovative network experiments. Computer Networks, 61, pp.5-23.

Key experimental concepts

- Sliceability: the ability to support virtualization while maintaining some degree of isolation for simultaneous experiments
- Deep programmability: the ability to influence the behavior of computing, storage, routing, and forwarding components deep inside the network, not just at or near the network edge.

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 ARMs
- Disk on x86
- Very dense
- *HP*

Utah/HP: Low-power ARM64 (785 nodes)

- 315 m400: 1X 8-core ARMv8 at 2.4GHz, 64GB RAM, 120GB flash
- 270 m510: 1X 8-core Intel Xeon D-1548 at 2.0 GHz, 64GB RAM, 256 GB flash
- 200 xl170: 1X 10-core Intel E5-2640v4 at 2.4 Ghz, 64 GB RAM, 480 GB SSD

Suitable for experiments that

- explore power/performance tradeoff
- want instrumentation of power and temperature
- want large numbers of nodes and cores
- need bare-metal control over switches
- want tight ARM64 platform integration

Wisconsin/Cisco (530 nodes)

- 90 c220g1: 2X 8-core Intel Haswell at 2.4GHz, 128GB RAM, 1X 480GB SDD, 2X 1.2TB HDD
- 10 c240g1: 2X 8-core Intel Haswell at 2.4GHz, 128GB RAM, 1X 480GB SDD, 1X 1TB HDD, 12X 3TB HDD
- 163 c220g2: 2X 10-core Intel Haswell at 2.6GHz, 160GB RAM, 1X 480GB SDD, 2X 1.2TB HDD
- 7 c240g2: 2X Intel Haswell 10-core at 2.6GHz, 160GB RAM, 2X 480GB SDD, 12X 3TB HDD
- 224 c220g5: 2X 10-core Intel Skylake at 2.20GHz, 192GB RAM, 1TB HDD
- 32 c240g5: 2X 10-core Intel Skylake at 2.20GHz, 192GB RAM, 1TB HDD, 1 NVIDIA P100 GPU
- 4 c4130: 2X 8-core Intel Broadwell at 3.20GHz, 128GB RAM, 2X 960GB HDD, 4 NVIDIA V100 GPU

Suitable for experiments that

- want large number of nodes/cores, and bare metal control over nodes/switches
- want network I/O performance, intra-cloud routing, and transport
- network virtualization
- in-memory big data frameworks
- cloud-scale resource management and scheduling

Clemson/Dell (256 nodes)

- 96 c8220: 2X 10-core Intel Ivy Bridge at 2.2GHz, 256GB RAM, 2X 1TB HDD
- 4 c8220x: 2X 10-core Intel Ivy Bridge at 2.2GHz, 256GB RAM, 8X 1TB HDD, 12X 4TB HDD
- 84 c6420: 2X 14-core Intel Haswell at 2.0GHz, 256GB RAM, 2X 1TB HDD
- 2 c4130: 2X 12-core Intel Haswell at 2.5GHz, 256GB RAM, 2X 1TB HDD, 2 NVIDIA K40m GPU
- 2 dss7500: 2X 6-core Intel Haswell at 2.4GHZ, 128GN RAM, 2X 126GB SSD, 45X 6TB HDD
- 72 c6420: 2X 16-core Intel Skylake at 2.6GHZ, 386GB RAM, 2X 1TB HDD

Suitable for experiments that

- need large per-core memory
- want to experiment with IB and/or GbE networks
- need bare-metal control over switches

CloudLab

- Setup SSH Key
- Creating your first CloudLab profile using the GUI
- Instantiating your first experiment

Setup SSH key and passwordless SSH

- Open up your terminal.
- Run the following command:

```
$ cat ~/.ssh/id_rsa.pub
```

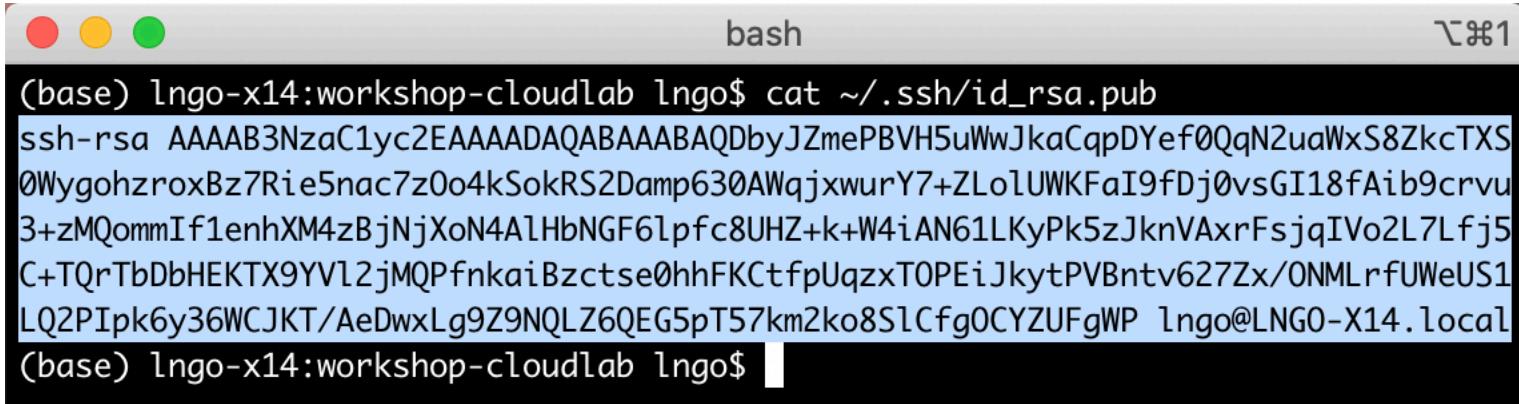
- If you do not have id_rsa.pub, run:

```
$ ssh-keygen -t rsa
```

- Hit **Enter** for ALL questions (including the one about password)

id_rsa.pub

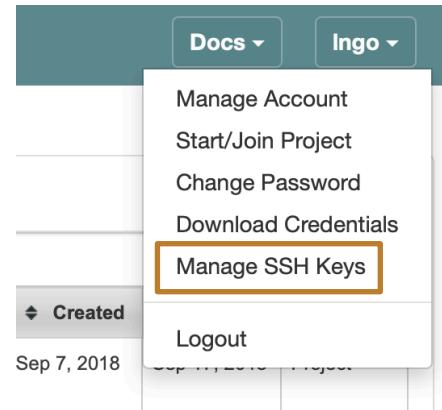
- The below screenshot is an example of public keys from Mac
- Paint and copy the entire key.



```
bash
(base) lngo-x14:workshop-cloudlab lngo$ cat ~/.ssh/id_rsa.pub
ssh-rsa AAAAB3NzaC1yc2EAAAQABAAQDbyJZmePBVH5uWwJkaCqpDYef0QqN2uaWxS8ZkcTXS
0WygohzroxBz7Rie5nac7z0o4kSokRS2Damp630AWqjxwurY7+ZLolUWKFaI9fDj0vsGI18fAib9crvu
3+zMQommIf1enhXM4zBjNjXoN4AlHbNGF6lpfc8UHZ+k+W4iAN61LKyPk5zJknVAxrFsjqIVo2L7Lfj5
C+TQrTbDbHEKTX9YVl2jMQPfnkaiBzctse0hhFKCtfpUqzxT0PEiJkytPVBntv627Zx/ONMLrfUWeUS1
LQ2PIpk6y36WCJKT/AeDwxLg9Z9NQLZ6QEG5pT57km2ko8S1Cfg0CYZUFgWP lngo@LNGO-X14.local
(base) lngo-x14:workshop-cloudlab lngo$
```

Log into Cloud

- On the upper right corner, click on your username then **Manage SSH Keys**
- Paste the copy key into the box and click **Add Key**
- If you know where the `id_rsa.pub` file is, you can also use the **Load from file** option



Add Key

Upload a file or paste it in the text box. This will allow you to login using your favorite ssh client. Without a SSH key, you will be limited to using a shell window in your browser. Don't know how to generate your SSH key? See [this tutorial](#).

Key

public key

Load from file Clear Form

Add Key

Notes

- CloudLab secure access to experiments (security **OF** the cloud) by disabling passworded access by default.
- You can only SSH into your experiment from a local terminal if you have added the SSH key or if you ~~enable direct password access~~ (**DO NOT DO THIS, THIS IS BAD HABIT**).
- You can add as many keys as you want (for access from different locations).
- Without a key, you can still access your experiment via an in-browser terminal (slow and inconvenient).

Terminology

- **Profile:** describing how you want to setup your experiment. The description includes selections regarding hardware (physical or virtual, X86-64 or ARM), operating systems (distro, versions, ...), and how the software stack inside individual components (compute nodes) of the experiments should be installed and configured. A profile can be created via a GUI interface (limited) or via a Python program (extremely expressive).
- **Experiment:** A deployment instance of a profile in CloudLab infrastructure. A profile can have multiple experiments instantiated simultaneously.
- **Analogy:** similar to object-oriented programming, a profile is equivalent to a class, while an experiment is an object instance of that class.

Log into CloudLab

The screenshot shows the CloudLab web interface. At the top, there are navigation tabs: 'Experiments' (with a dropdown menu), 'Storage' (with a dropdown menu), 'Docs', and 'Ingo'. On the left, there's a sidebar with 'Experiments' selected, followed by 'Search', 'Name' (with a dropdown menu showing 'full_cluster'), and links for 'My Experiments', 'My Profiles', 'My Reservations', and 'My History'. The main content area has a header with 'Start Experiment', 'Create Experiment Profile' (which is highlighted with an orange border), 'Reserve Nodes', 'Resource Availability', and 'Cluster Status'. Below this is a summary: '0 Node Hours, Prev Week: 598, Prev Month: 4786 (30 day rank: 32 of 405 users)'. There are tabs for 'Datasets', 'Membership', 'Usage', and 'Account'. A table follows, with columns for 'Name', 'Created', 'Last Use', and 'Privacy'. The first row in the table is for a profile named 'full_cluster', which is described as providing a full research cluster with various components. The second row is for a profile named 'Customize_Cloud', which is described as providing a highly-configurable OpenStack instance with a controller and compute nodes.

Name	Created	Last Use	Privacy
full_cluster	Sep 7, 2018	Sep 17, 2018	Project
Customize_Cloud	Jan 17, 2018	Mar 5, 2019	Project

Use the Topology GUI

- Mouse over question marks for more information.
- If you are part of multiple projects, the Project box is in drop-down mode.

The screenshot shows a user interface for creating a topology. At the top, there is a text input field with the placeholder "alphanumeric, dash, underscore, no whitespace". Below it, there are two input fields: "Name" containing "firstcloud-Ingo" and "Project" containing "ClemsonCITI". A dropdown arrow is visible next to the project name. At the bottom, there are several buttons: "Source code" with a question mark icon, "Upload File", "Create Topology" (which is highlighted with an orange border), "Edit Code", and "Git Repo". There is also an "or" button between "Edit Code" and "Git Repo". In the bottom right corner, there is a blue "Create" button.

alphanumeric, dash, underscore, no whitespace

Name ? firstcloud-Ingo

Project ClemsonCITI

Source code ? Upload File Create Topology Edit Code or Git Repo

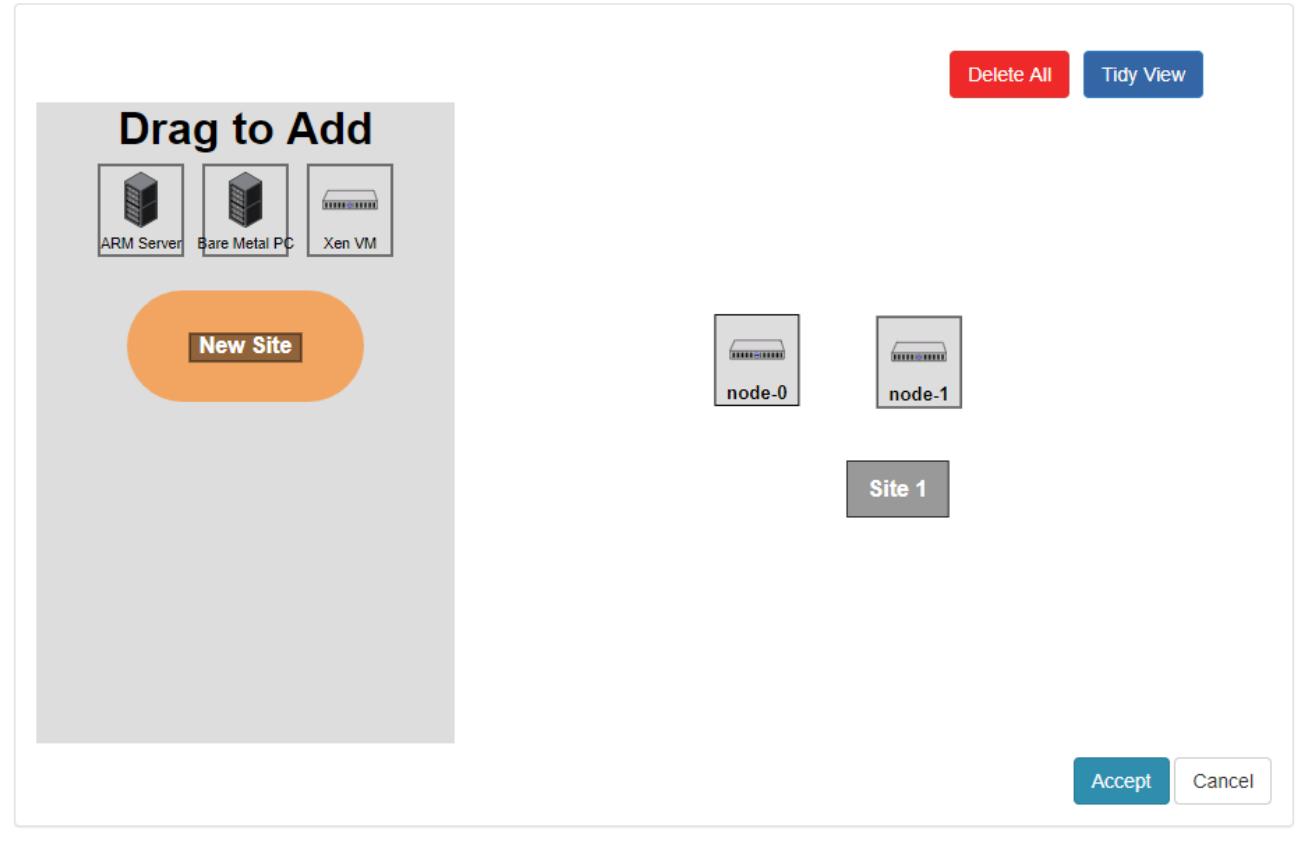
Create

Topology Editor



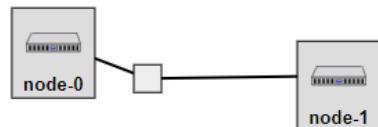
Drag a
XenVM
square to
the right.

Topology Editor



Drag
another
XenVM
square to
the right.

Topology Editor

Drag to Add**New Site****Delete All****Tidy View****Site 1****Accept****Cancel**

Hold and drag a line from one node to another

Topology Editor

Node Type ?

Hardware Type ?

Disk Image - ?

Disable MAC Learning (For OVS Images Only)

Require Routable IP

Icon ?

Install Tarball

Delete All

Site 1

Accept

Click on
node-0
and
check
**“Require
Routable
IP”**
then
Accept

[Experiments](#) ▾[Storage](#) ▾[Docs](#) ▾

Current Usage: 0 Node Hours, Prev Week: 598, Prev Month: 4786 (30 day rank: 32 of 405 users) [?](#)

Create Profile

Name [?](#) Project

Source code [?](#) [Edit Topology](#) [Edit Code](#) or [Git Repo](#)

Description [?](#)

Instructions [?](#)

[Show/Edit Tour](#)

Who can instantiate your profile?

Anyone Only members of your project

Allow members of your project to modify this profile. [?](#)

Create

Fill out the Description and then Create

Instantiate an experiment from the profile

Modify Profile ClemsonCITI/firstcloud-Ingo

Source code [?](#) [Edit Topology](#) [Edit Code](#) [Convert to geni-lib](#) NEW!

Description [?](#) This is a simple two-VMs network

Instructions [?](#) Provide optional instructions for users of your profile.

Show/Edit Tour

Who can instantiate your profile?

Anyone

Only members of your project

Allow members of your project to modify this profile. [?](#)

[Delete](#) [Copy](#) [Share](#) [Instantiate](#) [Save](#) [Cancel](#)

Please review the selections below and then click Next.

Name: Optional

Project: ClemsonCITI

Cluster: Please Select

 Advanced Options

Check

Please Select

Cloudlab Wisconsin



Cloudlab Clemson



APT Utah



Federated Clusters

Emulab

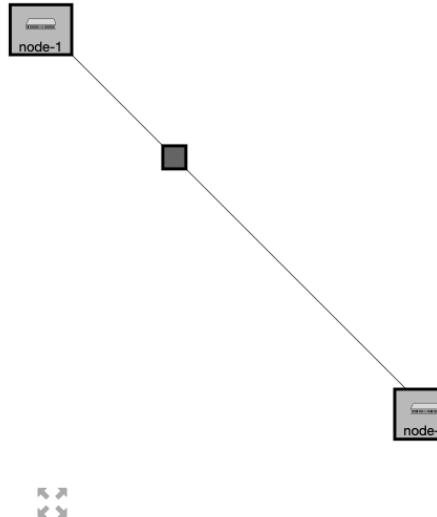


OneLab



Cloudlab Utah

Massachusetts



Previous

Next

You can select where you want to deploy this particular cluster. Click next when done

Finish ...

Current Usage: 0 Node Hours, Prev Week: 596, Prev Month: 4786 (30 day rank: 32 of 405 users) [?](#)

1. Select a Profile

2. Parameterize

3. Finalize

4. Schedule

Please select when you would like to start this experiment and then click Finish.

Start on date/time (optional) [?](#)

MM/DD/YYYY

Time

Experiment Duration

16

hours

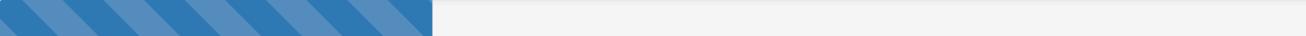
[?](#)

Previous

Finish

Created and Provisioning

▼ Please wait while we get your experiment ready



Name:	Ingo-QV68725
State:	provisioning
Profile:	firstcloud-Ingo
Creator:	Ingo
Project:	ClemsonCITI
Created:	Apr 8, 2020 2:03 PM
Started:	Apr 8, 2020 2:03 PM
Expires:	Apr 9, 2020 6:03 AM (in 16 hours)

[Copy](#) [Extend](#) [Terminate](#)

▼ Please wait while we get your experiment ready

Name: Ingo-QV68725
State: booting
Profile: firstcloud-Ingo
Creator: Ingo
Project: ClemsonCITI
Created: Apr 8, 2020 2:03 PM
Started: Apr 8, 2020 2:03 PM
Expires: Apr 9, 2020 6:03 AM (in 16 hours)

Logs

Performance History

Create Disk Image

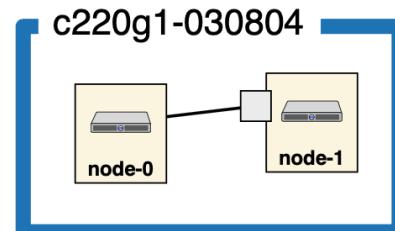
Copy

Extend

Terminate

Booting

Topology View List View Manifest



▼ Your experiment is ready!

Name: Ingo-QV68725
State: ready
Profile: firstcloud-Ingo
Creator: Ingo
Project: ClemsonCITI
Created: Apr 8, 2020 2:03 PM
Started: Apr 8, 2020 2:03 PM
Expires: Apr 9, 2020 6:03 AM (in 16 hours)

Logs

Performance History

Create Disk Image

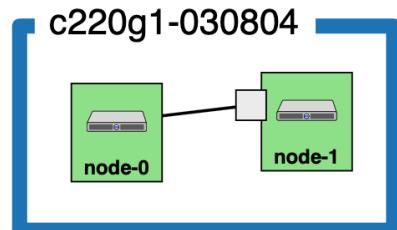
Copy

Extend

Terminate

Ready to
go

Topology View List View Manifest Graphs



What do we have

- Two VM nodes inside one physical node
- node-0 (VM) has a public IP (hence SSH port 22 and hostname is different from physical node).
- node-1 (VM) does not have a public IP, so SSH go through an alternative port from the physical node.

Topology View								List View	Manifest	Graphs
◆ ID	◆ Node	◆ Type	◆ Status	◆ Startup	◆ Image	SSH command (if you provided your own key)		<input type="checkbox"/>	Actions	
node-0	c220g1-030804vm-1	pcvm	ready	n/a	n/a	<code>ssh -p 22 lngo@c220g1-030804vm-1.wisc.cloudlab.us</code>		<input type="checkbox"/>		
node-1	c220g1-030804vm-2	pcvm	ready	n/a	n/a	<code>ssh -p 28011 lngo@c220g1-030804.wisc.cloudlab.us</code>		<input type="checkbox"/>		
c220g1-030804	c220g1-030804	c220g1	n/a	n/a	n/a	<code>ssh -p 22 lngo@c220g1-030804.wisc.cloudlab.us</code>		<input type="checkbox"/>		

How to access (if you have SSH key setup properly)

node-0	c220g1-030804vm-1	pcvm	<u>ready</u>	n/a	n/a	<code>ssh -p 22 lngo@c220g1-030804vm-1.wisc.cloudlab.us</code>
node-1	c220g1-030804vm-2	pcvm	<u>ready</u>	n/a	n/a	<code>ssh -p 28011 lngo@c220g1-030804.wisc.cloudlab.us</code>
c220g1-030804	c220g1-030804	c220g1	n/a	n/a	n/a	<code>ssh -p 22 lngo@c220g1-030804.wisc.cloudlab.us</code>

```
(base) lngo-x14:workshop-cloudlab lngo$ ssh -p 22 lngo@c220g1-030804vm-1.wisc.cloudlab.us
```

```
The authenticity of host 'c220g1-030804vm-1.wisc.cloudlab.us (128.105.146.153)' can't be established.
```

```
RSA key fingerprint is SHA256:/ooH3X5gHoyIFYFol8R2u0XpxMGgmlvRznPYsuBdGuU.
```

```
Are you sure you want to continue connecting (yes/no)? yes
```

```
Warning: Permanently added 'c220g1-030804vm-1.wisc.cloudlab.us,128.105.146.153' (RSA) to the list of known hosts.
```

```
Welcome to Ubuntu 16.04.1 LTS (GNU/Linux 4.4.0-174-generic x86_64)
```

```
* Documentation: https://help.ubuntu.com
* Management: https://landscape.canonical.com
* Support: https://ubuntu.com/advantage
```

```
New release '18.04.4 LTS' available.
```

```
Run 'do-release-upgrade' to upgrade to it.
```

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

```
lngo@node-0:~$
```

```
(base) lngo-x14:workshop-cloudlab lngo$ ssh -p 28011 lngo@c220g1-030804.wisc.cloudlab.us
The authenticity of host '[c220g1-030804.wisc.cloudlab.us]:28011 ([128.105.145.207]:28011)' can't be established.
RSA key fingerprint is SHA256:/ooH3X5gHoyIFYFol8R2u0XpxMGgmlvRznPYsuBdGuU.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '[c220g1-030804.wisc.cloudlab.us]:28011,[128.105.145.207]:28011' (RSA) to the list of known hosts.
Welcome to Ubuntu 16.04.1 LTS (GNU/Linux 4.4.0-174-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage
New release '18.04.4 LTS' available.
Run 'do-release-upgrade' to upgrade to it.
```

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

lngo@node-1:~\$

```
(base) lngo-x14:workshop-cloudlab lngo$ ssh -p 22 lngo@c220g1-030804.wisc.cloudlab.us
The authenticity of host 'c220g1-030804.wisc.cloudlab.us (128.105.145.207)' can't be established.
ECDSA key fingerprint is SHA256:gCA/XL0rje9tfd/WFosdeYpJ6jo5DqMF5RElwVbN+xA.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'c220g1-030804.wisc.cloudlab.us,128.105.145.207' (ECDSA) to the list of known hosts.
Welcome to Ubuntu 18.04.1 LTS (GNU/Linux 4.15.0-88-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

 * Kubernetes 1.18 GA is now available! See https://microk8s.io for docs or
install it with:

      sudo snap install microk8s --channel=1.18 --classic

 * Multipass 1.1 adds proxy support for developers behind enterprise
firewalls. Rapid prototyping for cloud operations just got easier.

      https://multipass.run/

 * Canonical Livepatch is available for installation.
  - Reduce system reboots and improve kernel security. Activate at:
      https://ubuntu.com/livepatch

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.
```

lngo@vhost-0:~\$

How to
access?
Via
external
ssh in the
long term.
Browser

Topology View List View Manifest Graphs

ID	Node	Type	Status	Startup	Image	SSH command (if you provided your own key)	Actions
node-0	c220g1-030804vm-1	pcvm	ready	n/a	n/a	<code>ssh -p 22 lngo@c220g1-030804vm-1.wisc.cloudlab.us</code>	<input type="checkbox"/>  Actions <input type="checkbox"/>  Shell <input type="checkbox"/> Console <input type="checkbox"/> Console <input type="checkbox"/> Recovery <input type="checkbox"/> Delete Node
node-1	c220g1-030804vm-2	pcvm	ready	n/a	n/a	<code>ssh -p 28011 lngo@c220g1-030804.wisc.cloudlab.us</code>	<input type="checkbox"/>
c220g1-030804	c220g1-030804	c220g1	n/a	n/a	n/a	<code>ssh -p 22 lngo@c220g1-030804.wisc.cloudlab.us</code>	<input type="checkbox"/>

Shell give you user's terminal access

Topology View List View Manifest Graphs node-0 X

```
Welcome to Ubuntu 16.04.1 LTS (GNU/Linux 4.4.0-174-generic x86_64)
```

```
* Documentation:  https://help.ubuntu.com
* Management:    https://landscape.canonical.com
* Support:       https://ubuntu.com/advantage
```

```
New release '18.04.4 LTS' available.
```

```
Run 'do-release-upgrade' to upgrade to it.
```

```
Last login: Wed Apr  8 13:25:35 2020 from 68.84.212.241
Ingo@node-0:~$
```

Console give you root and password

The screenshot shows a web-based interface for managing a testbed. At the top, there are tabs: Topology View, List View, Manifest, Graphs, and node-0-Cons (which is active). Below the tabs, there is a 'Password' field containing the value 'd8be68e0e491', which is highlighted with an orange border. The main area displays a terminal session log:

```
[ 26.809809] testbed[835]: Checking Testbed trace configuration ...
[ 26.992077] testbed[835]: Checking Testbed trafgen configuration ...
[ 27.067186] testbed[835]: Checking Testbed Tarball configuration ...
[ 27.142281] testbed[835]: Checking Testbed RPM configuration ...
[ 29.918647] testbed[835]: Skipping nodechecks tmcc does not support h
winfo
[ 30.018561] testbed[835]: Starting linktest daemon
[ 30.060129] testbed[835]: Informing Emulab Control that we are up and
running
[ 30.150209] testbed[835]: Checking Testbed Experiment Startup Command
...
[ 30.156089] testbed[835]: Booting up vnodes
[ 30.284117] testbed[835]: Booting up subnodes
[ 30.392144] testbed[835]: No subnodes. Exiting gracefully ...

Ubuntu 16.04.1 LTS node-0.lngeo-qv68725.clemsonciti-pg0.wisc.cloudlab.us
hvc0

node-0 login: root
Password:
```

Name: Ingo-QV68725
State: ready
Profile: firstcloud-Ingo
Creator: Ingo
Project: ClemsonCITI
Created: Apr 8, 2020 2:03 PM
Started: Apr 8, 2020 2:03 PM
Expires: Apr 9, 2020 6:03 AM (in 16 hours)

Logs

Performance History

Create Disk Image

Copy

Extend

Terminate

Extend to request extension,
Terminate to kill your experiment

Important

- CloudLab is for experimental work, not production work

CloudLab

- CloudLab profile via GitHub and Python

GitHub

- Log in to your GitHub account (or create one if you don't already have one!)
- Create a new repository titled **citi-workshop**, with options as shown in the screenshot.

Create a new repository

A repository contains all project files, including the revision history. Already have a project repository elsewhere? [Import a repository](#).

Owner **Repository name ***

 linhbngo  / citi-workshop 

Great repository names are short and memorable. Need inspiration? How about [miniature-waffle](#)?

Description (optional)

 **Public**
Anyone can see this repository. You choose who can commit.

 **Private**
You choose who can see and commit to this repository.

Skip this step if you're importing an existing repository.

Initialize this repository with a README
This will let you immediately clone the repository to your computer.



GitHub

- Click **Create new file** to add a new file to your repository.
- Name the file **profile.py**
- Add the contents from <https://github.com/linhbngo/citi-workshop/blob/master/profile.py> to this file.
- Click **Commit new file** at bottom of page to save the file.

 **Commit new file**

Create profile.py

Add an optional extended description...

Ingo@clemson.edu

Choose which email address to associate with this commit

Commit directly to the `master` branch.

Create a new branch for this commit and start a pull

Commit new file **Cancel**

Branch: master ▾ New pull request **Create new file** Upload files Find File Clone or download ▾

citi-workshop / profile.py **Cancel**

Edit new file **Preview**

```
1 import geni.portal as portal
2 import geni.rspec.pg as rspec
3
4 # Create a Request object to start building the RSpec.
5 request = portal.context.makeRequestRSpec()
6 # Create a XenVM
7 node = request.XenVM("node")
8 node.disk_image = "urn:publicid:IDN+emulab.net+image+emulab-ops:UBUNTU18-64-STD"
9 node.routable_control_ip = "true"
10
11 node.addService(rspec.Execute(shell="/bin/sh",
12                         command="sudo apt update"))
13 node.addService(rspec.Execute(shell="/bin/sh",
14                         command="sudo apt install -y apache2"))
15 node.addService(rspec.Execute(shell="/bin/sh",
16                         command='sudo suwf allow in "Apache Full"'))
17 node.addService(rspec.Execute(shell="/bin/sh",
18                         command='sudo systemctl status apache2'))
19 # Print the RSpec to the enclosing page.
20 portal.context.printRequestRSpec()
```

Create a new CloudLab profile using Git Repo

The screenshot shows the CloudLab web interface. At the top, there is a navigation bar with icons for Experiments, Storage, Docs, and Ingo. On the left, there is a sidebar with links for Start Experiment, Create Experiment Profile (which is highlighted with a red box), Reserve Nodes, Resource Availability, Cluster Status, My Experiments, My Profiles, My Reservations, and My History. The main content area displays performance metrics: 16 Node Hours, Prev Week: 17, Prev Month: 17 (30 day rank: 501 of 572 users). It also shows a Project dropdown set to ClemsonCITI and a 'Create' button. Below these, there are four buttons: Upload File, Create Topology, Edit Code, and Git Repo (which is also highlighted with a red box).

[Create new file](#)[Upload files](#)[Find file](#)[Clone or download ▾](#)

Clone with HTTPS ⓘ

[Use SSH](#)

Use Git or checkout with SVN using the web URL.

<https://github.com/linhbngo/citi-work>[Open in Desktop](#)[Download ZIP](#)

11 minutes ago



Copy the URL of your repository into the box

Create a Repository-based Profile

Provide a git url to a public repository, and we will create your profile from that repository.

[Confirm](#)[Cancel](#)

Repository based profiles are a great way to combine a git repository (for source code control) and a Cloudbuild profile (for experiment control). A demonstration Git repository for you to look at it can be found at <https://github.com/lbstoller/my-profile.git>. Please take a look at this repository for more information on how to set up your Git repository so that it can be the basis for your profile.

Create the profile (with your username)

Create Profile

Name [?](#) **Project** [▼](#)

Source code [?](#) [View Topology](#) [View Code](#) [View XML](#) or [Git Repo](#)

Description [?](#)

Instructions [?](#)

[Show/Edit Tour](#)

Who can instantiate your profile?

Anyone

Only members of your project

Allow members of your project to modify this profile. [?](#)

Create

Modify Profile

Name: citi-webserver
Project: ClemsonCITI
Creator: Ingo
Created: Apr 8, 2020 3:27 PM

Repository Info

Refspec: refs/heads/master
Commit: 30b51ec
Date: Apr 8, 2020 3:03 PM
Author: Linh B Ngo
Est. Size: 1 MiB
Push URL: <https://www.emu>
Log: Create profile.py

Modify Profile ClemsonCITI/citi-webserver

Source code [?](#)

[View Topology](#)[View Code](#)[View XML](#)

Repository

<https://github.com/linhbngo/citi-workshop.git>

[Update](#) [?](#)

Description [?](#)

This is a simple web server

Description set by geni-lib script [?](#)

Instructions [?](#)

Instructions set by geni-lib script [?](#)

[Show/Edit Tour](#)

Who can instantiate your profile?

 Anyone Only members of your project

Allow members of your project to modify this profile. [?](#)

[Delete](#)[Copy](#)[Share](#)[Instantiate](#)[Save](#)[Cancel](#)

Repository

Branches [Tags](#)

master [default](#)

Create profile.py

30b51ec

[Instantiate](#)

Setup webhook

Update GitHub
will automatically
update CloudLab
profile

The screenshot shows the CloudLab Modify Profile interface for a project named "citi-webserver". The "Repository Info" section is highlighted with a red box around the "Push URL" field, which contains the value "https://www.emulab.net:51369/githook/6148c2d4f297f2143c7067". Below this, the "Log:" field shows "Create profile.py".

Modify Profile

Name: citi-webserver
Project: ClemsonCITI
Creator: Ingo
Created: Apr 8, 2020 3:27 PM

Repository Info

Refspec: refs/heads/master
Commit: 30b51ec
Date: Apr 8, 2020 3:03 PM

Push URL: https://www.emulab.net:51369/githook/6148c2d4f297f2143c7067

Log: Create profile.py

Modify Profile ClemsonCITI/citi-webserver

Source code [View Topology](#) [View Code](#) [View XML](#)

Repository <https://github.com/linhbngo/citi-workshop.git> [Update](#)

Description [Edit](#) This is a simple web server

Instructions [Edit](#) Instructions set by geni-lib script

Show/Edit Tour

Who can instantiate your profile?

Anyone

Only members of your project

Allow members of your project to modify this profile.

[Delete](#) [Copy](#) [Share](#) [Instantiate](#) [Save](#) [Cancel](#)

The screenshot shows the GitHub Repository interface for the "citi-webserver" repository. The "Instantiate" button is highlighted with a red box.

Repository

Branches Tags

master default

Create profile.py

30b51ec Instantiate

[Code](#)[Issues 0](#)[Pull requests 0](#)[Actions](#)[Projects 0](#)[Wiki](#)[Security](#)[Insights](#)[Settings](#)

Options

[Manage access](#)[Branches](#)[Webhooks](#)[Notifications](#)[Integrations](#)[Deploy keys](#)

Settings

Repository name

citi-workshop

[Rename](#) **Template repository**

Template repositories let users generate new repositories with the same directory structure and files. Indicate if `linhbngo/citi-workshop` can be used as a template for creating other repositories.

[Social preview](#)

Webhooks

Add webhook

Webhooks allow external services to be notified when certain events happen. When the specified events happen, we'll send a POST request to each of the URLs you provide. Learn more in our [Webhooks Guide](#).

Payload URL *

https://example.com/postreceive

Content type

application/x-www-form-urlencoded

Secret

Which events would you like to trigger this webhook?

- Just the push event.
- Send me everything.
- Let me select individual events.

Active

We will deliver event details when this hook is triggered.

Add webhook

Paste the URL emulab.net ..
URL copied from slide here,
then click Add webhook

Instantiate the profile on the master branch

Repository

Branches Tags

master default

Create profile.py

30b51ec

Instantiate

The screenshot shows a GitHub repository interface. At the top right, it says 'Repository'. Below that, there are two tabs: 'Branches' (which is selected) and 'Tags'. Underneath, it shows a list item 'master default' followed by 'Create profile.py'. To the right of this list item is a blue button with the text '30b51ec'. Further to the right is another blue button with the text 'Instantiate', which is enclosed in a red rectangular box, indicating it is the target of the user's action.

Pay attention to the repo hash (matched with GitHub)

1. Select a Profile

2. Parameterize

3. Finalize

4. Schedule

Selected Profile: citi-webserver (Rephash: 30b51ec809de56342d70d43f1279793d9cb30de1)

Hmm, no description for this profile

Show Profile

Previous

Next

Select a site

Profile: citi-webserver:0 Source

Please review the selections below and then click Next.

Name: Optional

Project: ClemsonCITI

Cluster: Cloudlab Wisconsin Selected

Advanced Options

Cloudlab Wisconsin Selected

Cloudlab Utah Available

Cloudlab Wisconsin Available

Cloudlab Clemson Available

APT Utah Available

Federated Clusters

Emulab Available

OneLab Available

Massachusetts Available



Previous Next

How long do we initially have?

Current Usage: 0 Node Hours, Prev Week: 46, Prev Month: 46 (30 day rank: 328 of 612 users) [?](#)

1. Select a Profile 2. Parameterize 3. Finalize 4. Schedule

Please select when you would like to start this experiment and then click Finish.

Start immediately

or

Start on date/time

MM/DD/YYYY Time [?](#)

Experiment Duration

16 hours [?](#)

[Previous](#) [Finish](#)

▼ Your experiment is ready!

Name: Ingo-QV68741

State: **ready**

Profile: [citi-webserver](#)

RefSpec: refs/heads/master (30b51ec809de56342d70d43f1279793d9cb30de1)

Creator: [Ingo](#)

Project: [ClemsonCITI](#)

Created: Apr 8, 2020 5:18 PM

Started: Apr 8, 2020 5:18 PM

Expires: Apr 9, 2020 9:18 AM (in 16 hours)

[Logs](#)

[Create Disk Image](#)

[Extend](#)

[Terminate](#)

[Topology View](#) [List View](#) [Manifest](#) [Graphs](#)

ID	Node	Type	Status	Startup	Image	SSH command (if you provided your own key)	Actions
node	aptvm065-2	pcvm	ready	Finished	emulab-ops/UBUNTU18-64-STD	<code>ssh -p 22 lngo@aptvm065-2.apt.emulab.net</code>	<input type="checkbox"/>



Apache2 Ubuntu Default Page

It works!

This is the default welcome page used to test the correct operation of the Apache2 server after installation on Ubuntu systems. It is based on the equivalent page on Debian, from which the Ubuntu Apache packaging is derived. If you can read this page, it means that the Apache HTTP server installed at this site is working properly. You should **replace this file** (located at `/var/www/html/index.html`) before continuing to operate your HTTP server.

If you are a normal user of this web site and don't know what this page is about, this probably means that the site is currently unavailable due to maintenance. If the problem persists, please contact the site's administrator.

Configuration Overview

Ubuntu's Apache2 default configuration is different from the upstream default configuration, and split into several files optimized for interaction with Ubuntu tools. The configuration system is **fully**

What is CloudLab doing?

- Logs of custom script execution are stored under `/var/tmp`
- `startup-0` is basically the cloning of the git repository
- `startup-* .txt` (from 1 onward) log execution process of all statements done by `pg.Execute`
- `startup-* .status` briefly provide a final status of execution. 0 means success, 1 means failure.

```
lndo@node:/var/tmp$ ls -l
total 64
-rwxr-xr-x 1 geniuser clemsonciti-PG0 2351 Apr  8 15:19 geni_startup.node
-rw-r--r-- 1 geniuser clemsonciti-PG0     2 Apr  8 15:23 startup-0.status
-rw-r--r-- 1 geniuser clemsonciti-PG0   693 Apr  8 15:23 startup-0.txt
-rw-r--r-- 1 geniuser clemsonciti-PG0     2 Apr  8 15:23 startup-1.status
-rw-r--r-- 1 geniuser clemsonciti-PG0 4301 Apr  8 15:23 startup-1.txt
-rw-r--r-- 1 geniuser clemsonciti-PG0     2 Apr  8 15:24 startup-2.status
-rw-r--r-- 1 geniuser clemsonciti-PG0 4803 Apr  8 15:24 startup-2.txt
-rw-r--r-- 1 geniuser clemsonciti-PG0     2 Apr  8 15:24 startup-3.status
-rw-r--r-- 1 geniuser clemsonciti-PG0    30 Apr  8 15:24 startup-3.txt
-rw-r--r-- 1 geniuser clemsonciti-PG0     2 Apr  8 15:24 startup-4.status
-rw-r--r-- 1 geniuser clemsonciti-PG0   755 Apr  8 15:24 startup-4.txt
-rw-r--r-- 1 geniuser clemsonciti-PG0   605 Apr  8 15:24 startup.log
drwx----- 3 root      root          4096 Apr  8 15:24 systemd-private-32e
e5-apache2.service-Tdr4kA
drwx----- 3 root      root          4096 Apr  8 15:22 systemd-private-32e
e5-systemd-resolved.service-fzkQRX
lndo@node:/var/tmp$
```

Repository location

- GitHub content is stored at
`/local/repository`

```
Ingo@node:~$ ls /local/repository/
LICENSE  profile.py  README.md
Ingo@node:~$ more /local/repository/profile.py
import geni.portal as portal
import geni.rspec.pg as rspec

# Create a Request object to start building the RSpec.
request = portal.context.makeRequestRSpec()
# Create a XenVM
node = request.XenVM("node")
node.disk_image = "urn:publicid:IDN+emulab.net+image+emulab-ops:UBUNTU18-64-STD"
node.routable_control_ip = "true"

node.addService(rspec.Execute(shell="/bin/sh",
                               command="sudo apt update"))
node.addService(rspec.Execute(shell="/bin/sh",
                               command="sudo apt install -y apache2"))
node.addService(rspec.Execute(shell="/bin/sh",
                               command='sudo suwf allow in "Apache Full"'))
node.addService(rspec.Execute(shell="/bin/sh",
                               command='sudo systemctl status apache2'))
# Print the RSpec to the enclosing page.
portal.context.printRequestRSpec()
Ingo@node:~$ []
```