

v.2016-06-25 (d503676)

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## 11 CloudLab OpenStack Tutorial

This tutorial will walk you through the process of creating a small cloud on CloudLab using OpenStack. Your copy of OpenStack will run on bare-metal machines that are dedicated for your use for the duration of your experiment. You will have complete administrative access to these machines, meaning that you have full ability to customize and/or configure your installation of OpenStack.

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### 11.1 Objectives

In the process of taking this tutorial, you will learn to:

- Log in to CloudLab
- Create your own cloud by using a pre-defined profile
- Access resources in a cloud that you create
- Use administrative access to customize your cloud
- Clean up your cloud when finished
- Learn where to get more information

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### 11.2 Prerequisites

This tutorial assumes that:

- You have an existing account on **either**:
  - CloudLab (Instructions for getting an account can be found [here](#).)
  - The [GENI portal](#). (Instructions for getting an account can be found [here](#).)

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## 12.4 Logging In

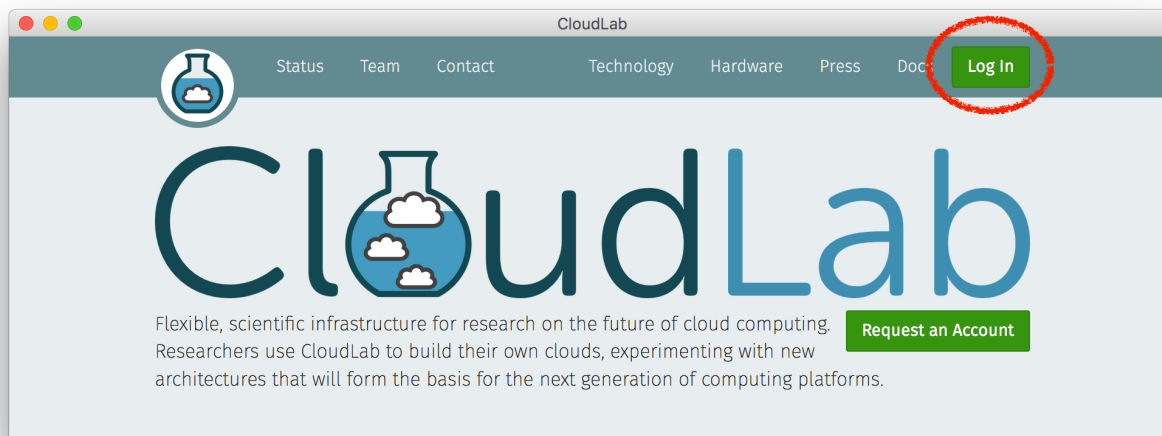
The first step is to log in to CloudLab; CloudLab is available to all researchers and educators who work in cloud computing. If you have an account at one of its federated facilities, like [Emulab](#) or [GENI](#), then you already have an account at CloudLab.

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### 12.4.1 Using a CloudLab Account

If you have signed up for an account at the CloudLab website, simply open <https://www.cloudlab.us/> in your browser, click the “Log In” button, enter your username

and password, and **skip to the next part of the tutorial.**



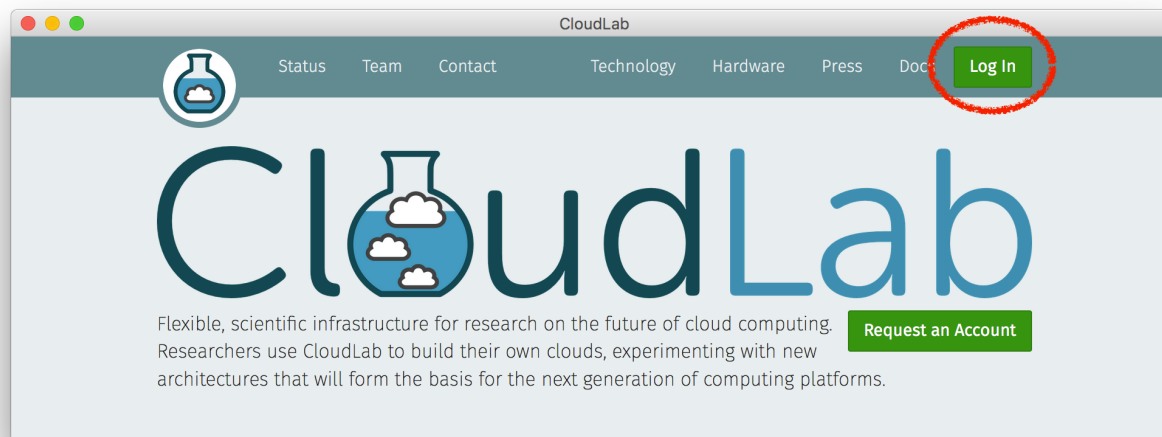
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## 12.4.2 Using a GENI Account

If you have an account at the GENI portal, you will use the single-sign-on features of the CloudLab and GENI portal.

### 1. Open the web interface

To log in to CloudLab using a GENI account, start by visiting <https://www.cloudlab.us/> in your browser and using the “Log In” button in the upper right.



### 2. Click the "GENI User" button

On the login page that appears, you will use the “GENI User” button. This will start the GENI authorization tool, which lets you connect your GENI account with CloudLab.

CloudLab - Login

Home Manual Sign Up

**Login**

**Username** CloudLab.us or Emulab.net Username

**Password** Password

Forgot Password? **Geni User?** Login

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### 3. Select the GENI portal

You will be asked which facility your account is with. Select the GENI icon, which will take you to the GENI portal. There are several other facilities that are federated with CloudLab, which can be found in the drop-down list.

GENI Authorization Tool

The GENI Authorization Tool allows you to authorize applications to speak on your behalf to allocate slices or slivers. Your GENI certificate and private key are stored in your web browser and your passphrase is never transmitted over the network.

You can download your GENI certificate and private key from a GENI Member Authority or paste your GENI certificate and private key into the box below.

Identity Provider Certificate

Where is your account? Clear Cookies

**geni**  
Exploring Networks  
of the Future

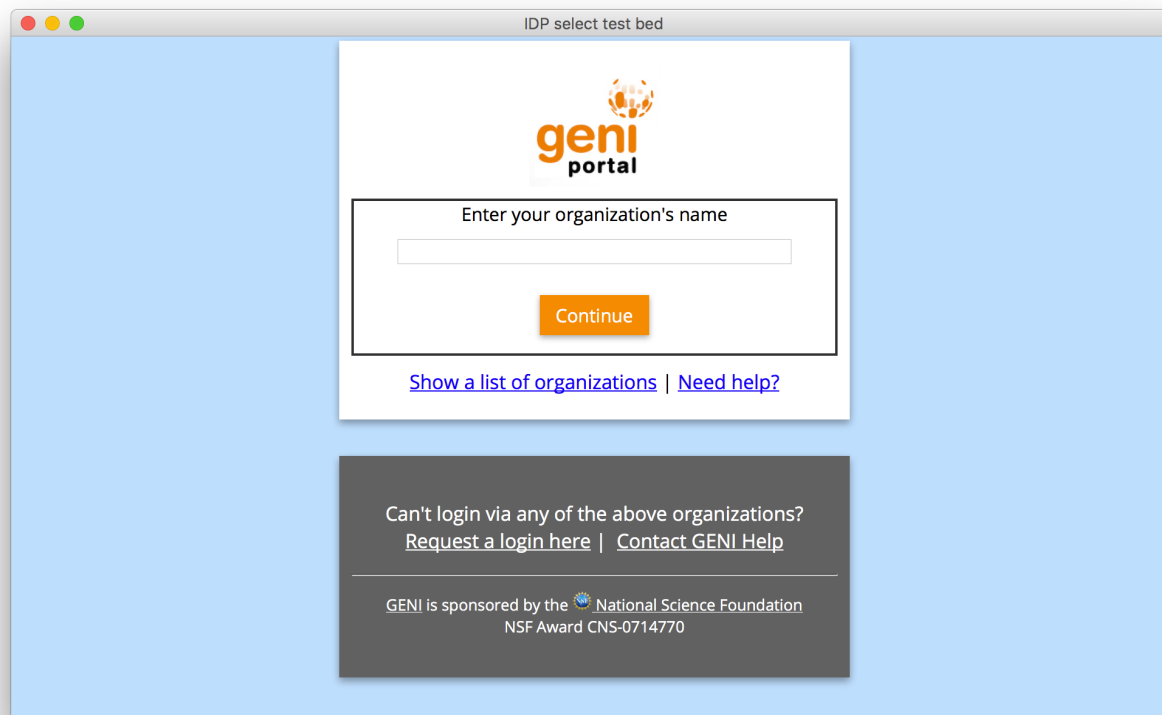
OR

Select your Member Authority

Download Certificate

#### 4. Log into the GENI portal

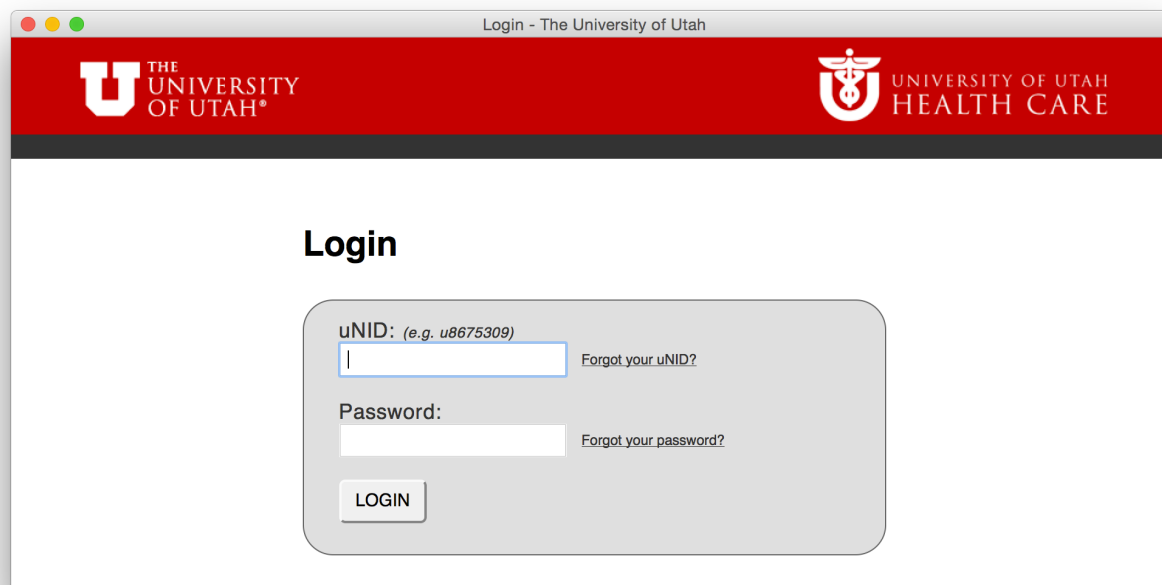
You will be taken to the GENI portal, and will need to select the institution that is your identity provider. Usually, this is the university you are affiliated with. If your university is not in the list, you may need to log in using the “GENI Project Office” identity provider. If you have ever logged in to the GENI portal before, your identity provider should be pre-selected; if you are not familiar with this login page, there is a good chance that you don't have a GENI account and need to [apply for one](#).



The screenshot shows a web browser window titled "IDP select test bed". The page features the GENI portal logo at the top center. Below the logo is a form with the text "Enter your organization's name" and a text input field. An orange "Continue" button is positioned below the input field. Underneath the form are two blue links: "Show a list of organizations" and "Need help?". At the bottom of the page, there is a dark grey box containing the text "Can't login via any of the above organizations?" followed by two blue links: "Request a login here" and "Contact GENI Help". At the very bottom, it states "GENI is sponsored by the National Science Foundation NSF Award CNS-0714770".

#### 5. Log into your institution

This will bring you to your institution's standard login page, which you likely use to access many on-campus services. (Yours will look different from this one.)



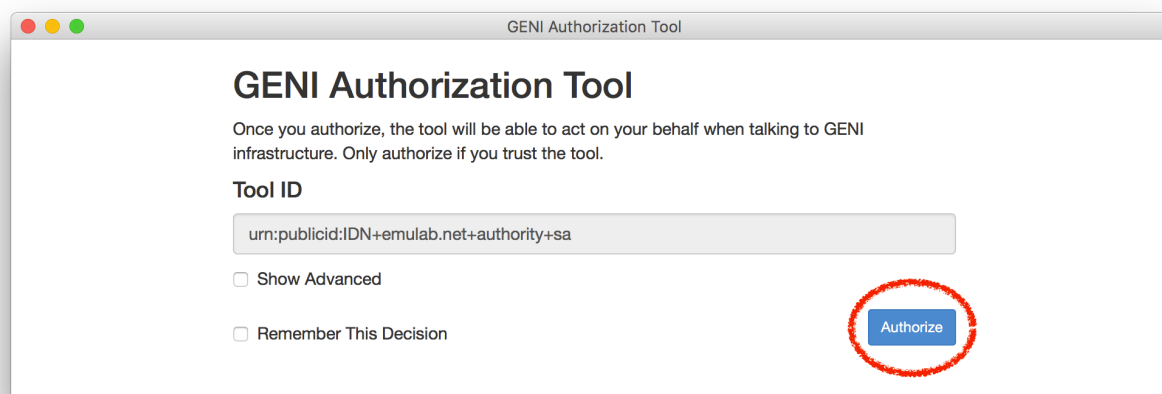
The screenshot shows a web browser window titled "Login - The University of Utah". The page has a red header with the University of Utah logo on the left and the University of Utah Health Care logo on the right. The main content area is white and features a "Login" heading. Below the heading is a gray rounded rectangle containing a login form. The form has two input fields: "uNID: (e.g. u8675309)" and "Password:". Each field has a "Forgot your uNID?" or "Forgot your password?" link to its right. A "LOGIN" button is positioned at the bottom of the form.

## 6. Authorize CloudLab to use your GENI account

What's happening in this step is that your browser uses your GENI user certificate (which it obtained from the GENI portal) to cryptographically sign a **"speaks-for" credential** that authorizes the CloudLab portal to make **GENI API calls** on your behalf.

Click the "Authorize" button: this will create a signed statement authorizing the CloudLab portal to speak on your behalf. This authorization is time-limited (see "Show Advanced" for the details), and all actions the CloudLab portal takes on your behalf are clearly traceable.

If you'd like, you can click "Remember This Decision" to skip this step in the future (you will still be asked to log in to the GENI portal).



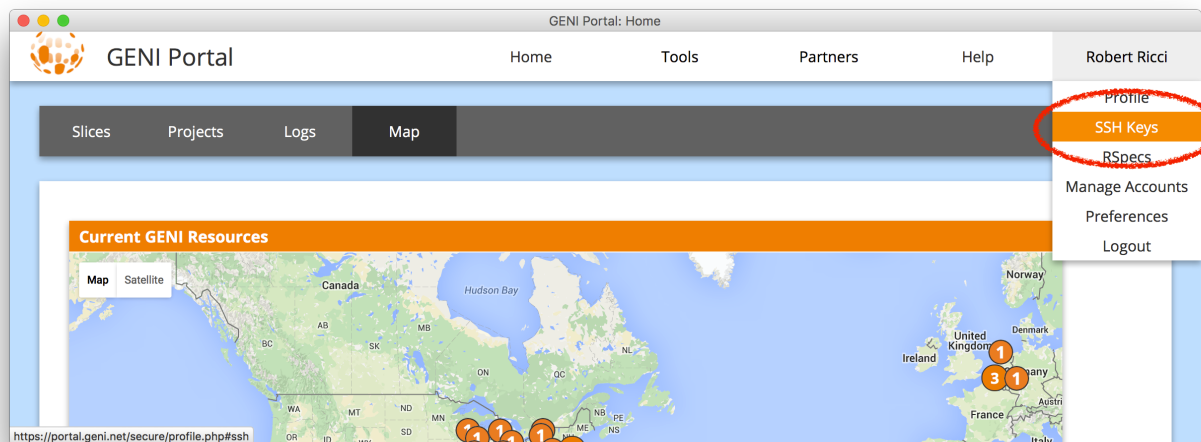
The screenshot shows a web browser window titled "GENI Authorization Tool". The page has a white background and a gray header. The main heading is "GENI Authorization Tool". Below the heading is a paragraph: "Once you authorize, the tool will be able to act on your behalf when talking to GENI infrastructure. Only authorize if you trust the tool." Underneath is a section titled "Tool ID" with a text input field containing "urn:publicid:IDN+emulab.net+authority+sa". Below the input field are two checkboxes: "Show Advanced" and "Remember This Decision". A blue "Authorize" button is located at the bottom right of the form, circled in red.

## 7. Set up an SSH keypair in the GENI portal

Though not strictly required, many parts of this tutorial will work better if you have an `ssh` public key associated with your GENI Portal account. To upload one, visit [portal.geni.net](http://portal.geni.net) and use the “SSH Keys” item on the menu that drops down under your name.

If you are not familiar with `ssh` keys, you may skip this step. You may find [GitHub’s ssh key page](#) helpful in learning how to generate and use them.

When you create a new experiment, CloudLab grabs the set of `ssh` keys you have set up at the time; any `ssh` keys that you add later are not added to experiments that are already running.



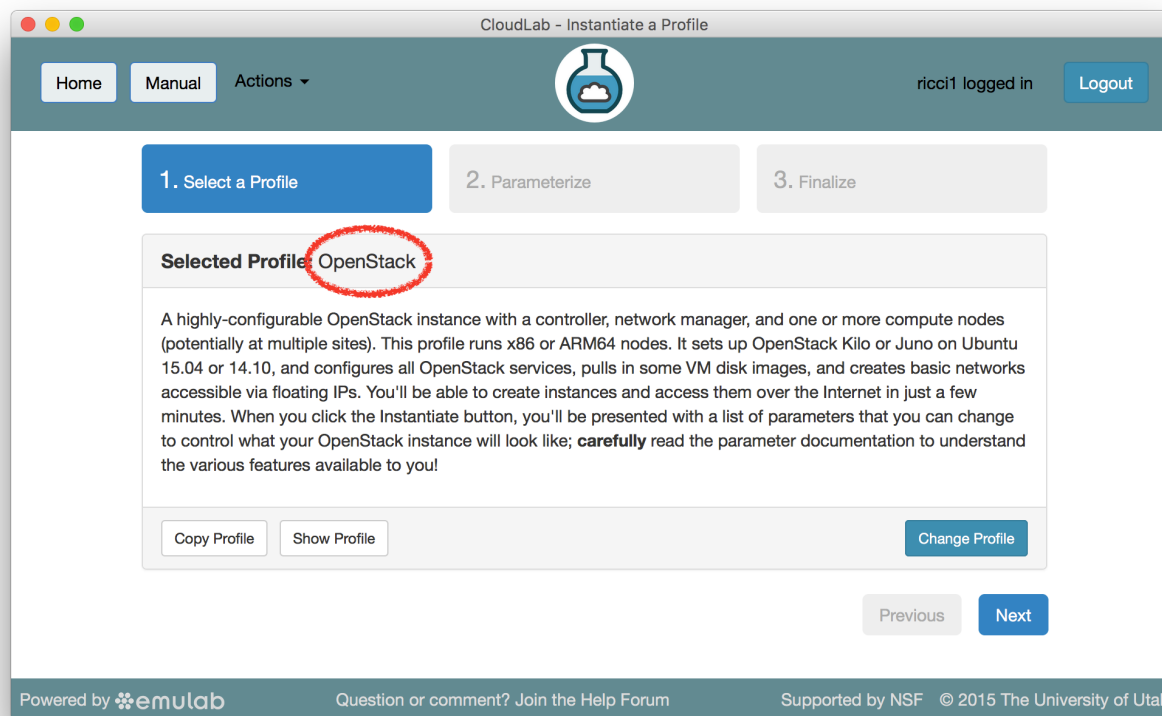
## 11.4 Building Your Own OpenStack Cloud

Once you have logged in to CloudLab, you will “instantiate” a “[profile](#)” to create an [experiment](#). (An experiment in CloudLab is similar to a “[slice](#)” in GENI.) Profiles are CloudLab’s way of packaging up configurations and experiments so that they can be shared with others. Each experiment is separate: the experiment that you create for this tutorial will be an instance of a profile provided by the facility, but running on resources that are dedicated to you, which you have complete control over. This profile uses local disk space on the nodes, so anything you store there will be lost when the experiment terminates.

The OpenStack cloud we will build in this tutorial is very small, but CloudLab has [large clusters](#) that can be used for larger-scale experiments.

For this tutorial, we will use a basic profile that brings up a small OpenStack cloud. The CloudLab staff have built this profile by capturing [disk images](#) of a partially-completed OpenStack installation and scripting the remainder of the install (customizing it for the specific machines that will get allocated, the user that created it, etc.) See this manual’s [section on profiles](#) for more information about how they work.

### 1. Select a profile



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

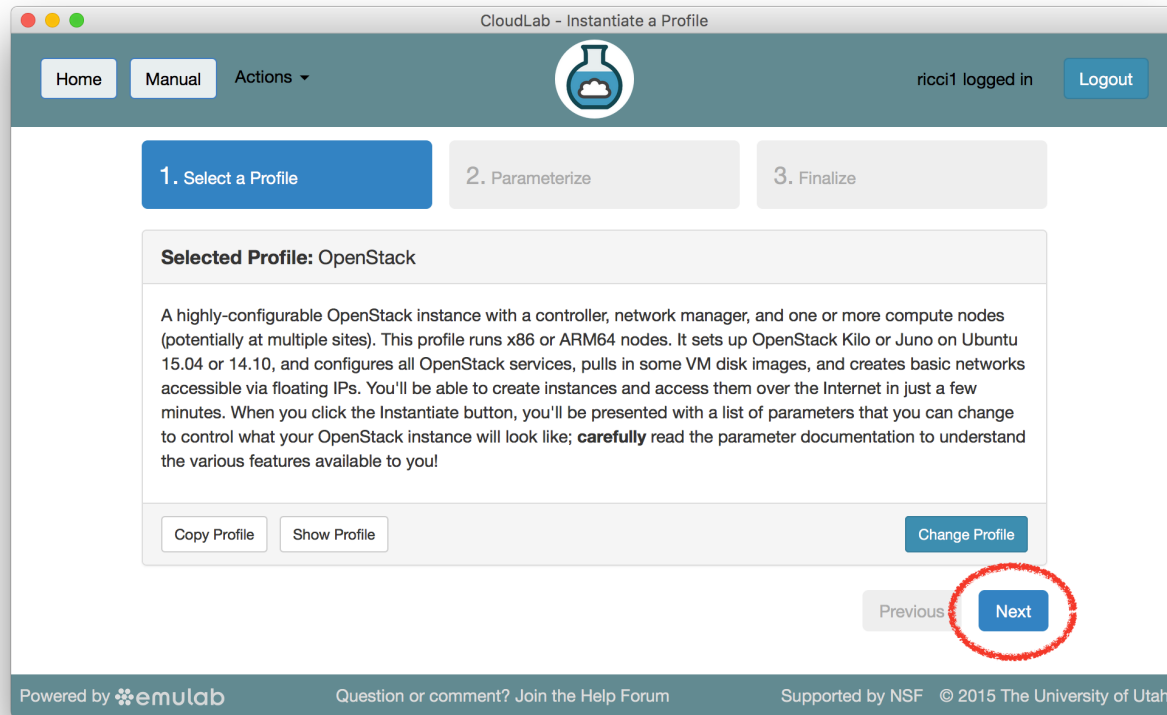
Previous Next

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After logging in, you will be taken to the “[Start an Experiment](#)” page automatically if you do not have any current, running experiments. You can get back to this page at any time by selecting the “Start Experiment” link from the “Actions” menu.

The “Start an Experiment” page is where you will select a profile to instantiate. We will use the **OpenStack** profile; if it is not selected, follow [this link](#) or click the “Change Profile” button, and select “OpenStack” from the list on the left.

Once you have the correct profile selected, click “Next”



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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## 2. Set parameters

Profiles in CloudLab can have *parameters* that affect how they are configured; for example, this profile has parameters that allow you to set the size of your cloud, spread it across multiple clusters, and turn on and off many OpenStack options.

For this tutorial, we will leave all parameters at their defaults and just click “next”.



CloudLab - Instantiate a Profile

Home Manual Actions ▾ ricci1 logged in Logout

1. Select a Profile 2. Parameterize 3. Finalize

This profile is parameterized; please make your selections below, and then click to continue.

+ Show All Parameter Help

OpenStack Release <sup>?</sup> Kilo

Number of compute nodes (at Site 1) 1

Number of public IP addresses <sup>?</sup> 4

+ Advanced Parameters

Previous Next

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### 3. Select a cluster

CloudLab has multiple clusters available to it. Some profiles can run on any cluster, some can only run on specific ones due to specific hardware constraints, etc.

**Note:** If you are at an in-person tutorial, the instructor will tell you which cluster to select. Otherwise, you may select any cluster.

The dropdown menu for the clusters shows you both the health (outer ring) and available resources (inner dot) of each cluster. The “Check Cluster Status” link opens a page (in a new tab) showing the current utilization of all CloudLab clusters.

CloudLab - Instantiate a Profile

Home Manual Actions ▾ ricci1 logged in Logout

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

ctl cp-1 nm

Previous Finish

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#### 4. Click Finish!

When you click the “finish” button, CloudLab will start provisioning the resources that you requested on the cluster that you selected.

You may optionally give your experiment a name—this can be useful if you have many experiments running at once.

CloudLab - Instantiate a Profile

Home Manual Actions ▾ ricci1 logged in Logout

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](#)

Previous Finish

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## 5. CloudLab instantiates your profile

CloudLab will take a few minutes to bring up your copy of OpenStack, as many things happen at this stage, including selecting suitable hardware, loading disk images on local storage, booting bare-metal machines, re-configuring the network topology, etc. While this is happening, you will see this status page:

CloudLab - Experiment Status

Home Manual Actions ▾ ricci1 logged in Logout

Please wait while we get your experiment ready

Progress bar: [██████████] [ ]

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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Provisioning is done using the [GENI APIs](#); it is possible for advanced users to bypass the CloudLab portal and call these provisioning APIs from their own code. A good way to do this is to use the [geni-lib library for Python](#).

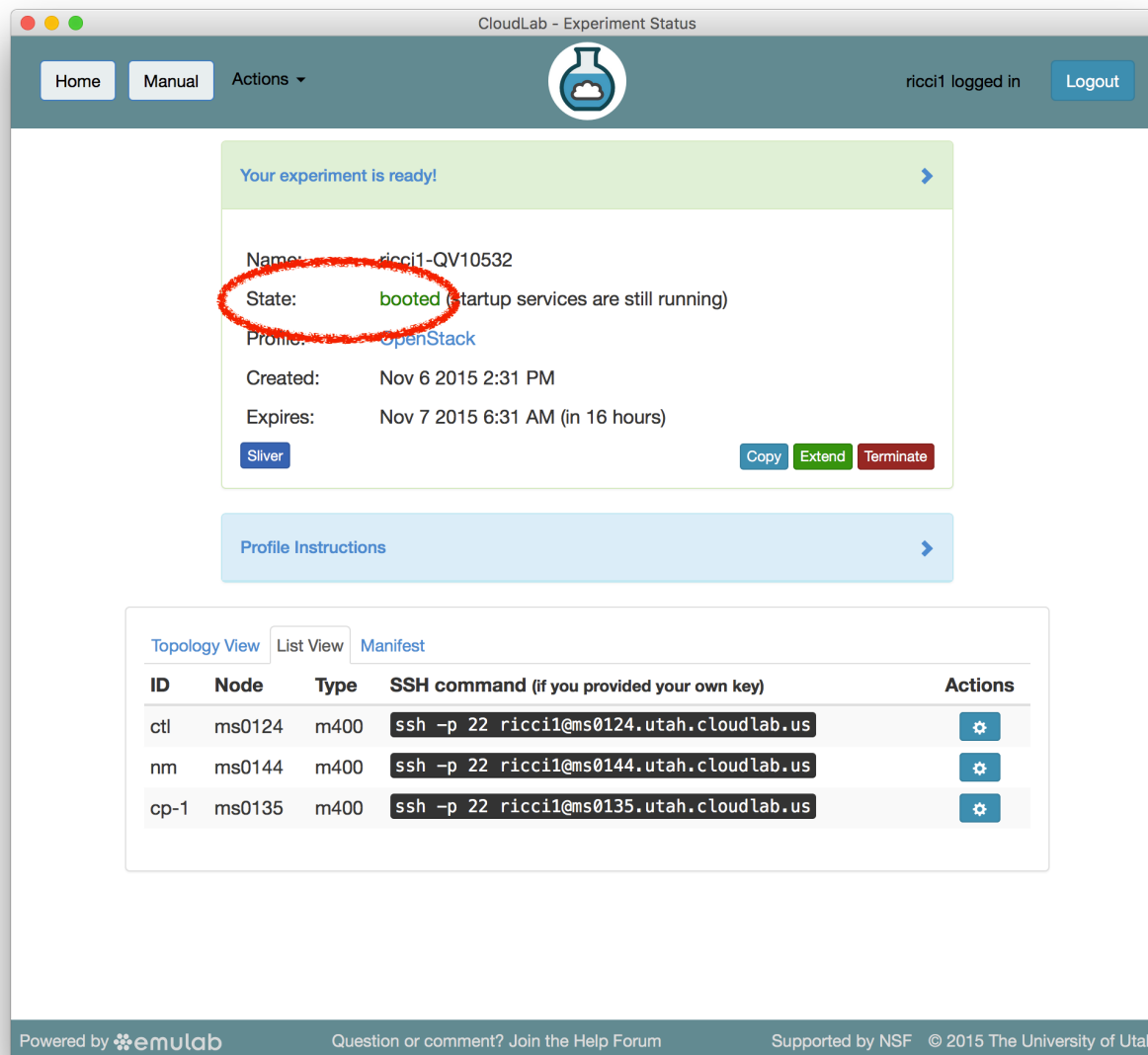
As soon as a set of resources have been assigned to you, you will see details about them at the bottom of the page (though you will not be able to log in until they have gone through the process of imaging and booting.) While you are waiting for your resources to become available, you may want to have a look at the [CloudLab user manual](#), or use the “Sliver” button to watch the logs of the resources (“slivers”) being provisioned and booting.

## 6. Your cloud is ready!

When the web interface reports the state as “Booted”, your cloud is provisioned, and you can proceed to the next section.

**Important:** A “Booted” status indicates that resources are provisioned and booted; this particular profile runs scripts to complete the OpenStack setup, and it will be a few more

minutes before OpenStack is fully ready to log in and create virtual machine instances. You will be able to tell that this has finished when the status changes from “Booted” to “Ready”. For now, don’t attempt to log in to OpenStack, we will explore the CloudLab experiment first.



CloudLab - Experiment Status

Home Manual Actions ricci1 logged in Logout

Your experiment is ready!

Name: ricci1-QV10532

State: **booted** (startup services are still running)

Profile: openStack

Created: Nov 6 2015 2:31 PM

Expires: Nov 7 2015 6:31 AM (in 16 hours)

Sliver Copy Extend Terminate

Profile Instructions

Topology View List View Manifest

ID	Node	Type	SSH command (if you provided your own key)	Actions
ctl	ms0124	m400	ssh -p 22 ricci1@ms0124.utah.cloudlab.us	⚙️
nm	ms0144	m400	ssh -p 22 ricci1@ms0144.utah.cloudlab.us	⚙️
cp-1	ms0135	m400	ssh -p 22 ricci1@ms0135.utah.cloudlab.us	⚙️

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## 11.5 Exploring Your Experiment

Now that your experiment is ready, take a few minutes to look at various parts of the CloudLab status page to help you understand what resources you’ve got and what you can do with them.

### 11.5.1 Experiment Status

The panel at the top of the page shows the status of your experiment—you can see which profile it was launched with, when it will expire, etc. The buttons in this area let you make a copy of the profile (so that you can [customize it](#)), ask to hold on to the resources for longer,

or release them immediately.

CloudLab - Experiment Status

Home Manual Actions ricci1 logged in Logout

Your experiment is ready! >

Name: ricci1-QV10532  
 State: **booted** (startup services are still running)  
 Profile: [OpenStack](#)  
 Created: Nov 6 2015 2:31 PM  
 Expires: Nov 7 2015 6:31 AM (in 16 hours)

Sliver Copy Extend Terminate

Profile Instructions >

Topology View List View Manifest

ID	Node	Type	SSH command (if you provided your own key)	Actions
ctl	ms0124	m400	<code>ssh -p 22 ricci1@ms0124.utah.cloudlab.us</code>	
nm	ms0144	m400	<code>ssh -p 22 ricci1@ms0144.utah.cloudlab.us</code>	
cp-1	ms0135	m400	<code>ssh -p 22 ricci1@ms0135.utah.cloudlab.us</code>	

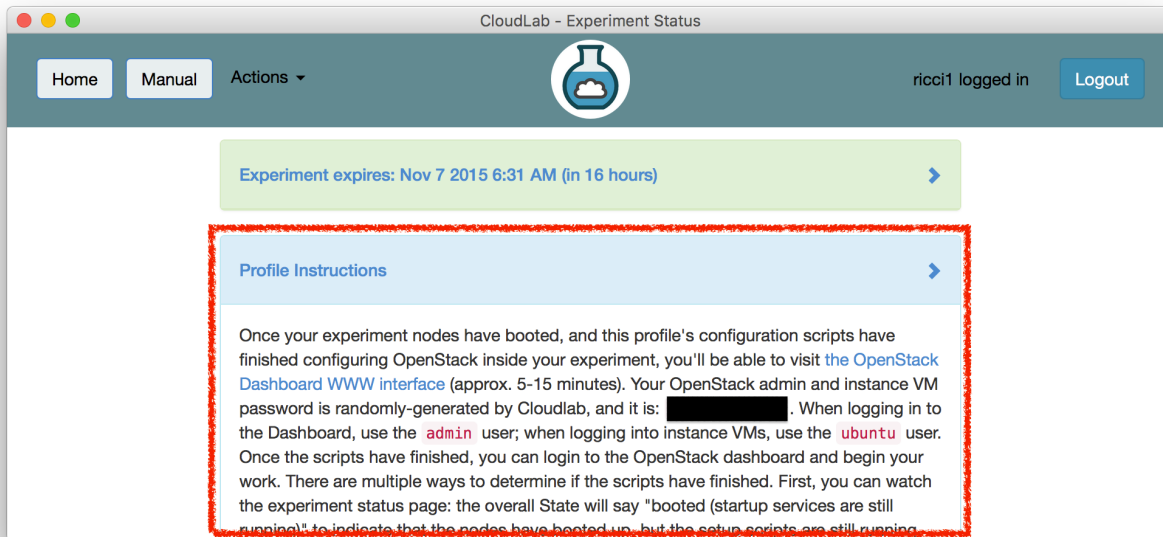
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Note that the default lifetime for experiments on CloudLab is less than a day; after this time, the resources will be reclaimed and their disk contents will be lost. If you need to use them for longer, you can use the “Extend” button and provide a description of why they are needed. Longer extensions require higher levels of approval from CloudLab staff. You might also consider [creating a profile](#) of your own if you might need to run a customized environment multiple times or want to share it with others.

You can click the title of the panel to expand or collapse it.

## 11.5.2 Profile Instructions

Profiles may contain written instructions for their use. Clicking on the title of the “Profile Instructions” panel will expand (or collapse) it; in this case, the instructions provide a link to the administrative interface of OpenStack, and give you passwords to use to log in. (Don’t log into OpenStack yet—for now, let’s keep exploring the CloudLab interface.)



CloudLab - Experiment Status

Home Manual Actions ricci1 logged in Logout

Experiment expires: Nov 7 2015 6:31 AM (in 16 hours)

Profile Instructions

Once your experiment nodes have booted, and this profile's configuration scripts have finished configuring OpenStack inside your experiment, you'll be able to visit the [OpenStack Dashboard WWW interface](#) (approx. 5-15 minutes). Your OpenStack admin and instance VM password is randomly-generated by Cloudlab, and it is: [REDACTED]. When logging in to the Dashboard, use the `admin` user; when logging into instance VMs, use the `ubuntu` user. Once the scripts have finished, you can login to the OpenStack dashboard and begin your work. There are multiple ways to determine if the scripts have finished. First, you can watch the experiment status page: the overall State will say "booted (startup services are still running)" to indicate that the nodes have booted up, but the setup scripts are still running.

---

### 11.5.3 Topology View

At the bottom of the page, you can see the topology of your experiment. This profile has three nodes connected by a 10 Gigabit LAN, which is represented by a gray box in the middle of the topology. The names given for each node are the names assigned as part of the profile; this way, every time you instantiate a profile, you can refer to the nodes using the same names, regardless of which physical hardware was assigned to them. The green boxes around each node indicate that they are up; click the "Refresh Status" button to initiate a fresh check.

If an experiment has “startup services” (programs that run at the beginning of the experiment to set it up), their status is indicated by a small icon in the upper right corner of the node. You can mouse over this icon to see a description of the current status. In this profile, the startup services on the compute node(s) and network manager typically complete quickly, but the control node may take much longer.

It is important to note that every node in CloudLab has at least *two* network interfaces: one “control network” that carries public IP connectivity, and one “experiment network” that is isolated from the Internet and all other experiments. It is the experiment net that is shown in this topology view. You will use the control network to `ssh` into your nodes, interact with their web interfaces, etc. This separation gives you more freedom and control in the private experiment network, and sets up a clean environment for [repeatable research](#).

## 11.5.4 List View

The list view tab shows similar information to the topology view, but in a different format. It shows the identities of the nodes you have been assigned, and the full `ssh` command lines to connect to them. In some browsers (those that support the `ssh://` URL scheme), you can click on the SSH commands to automatically open a new session. On others, you may need to cut and paste this command into a terminal window. Note that only public-key authentication is supported, and you must have set up an `ssh` keypair on your account **before** starting the experiment in order for authentication to work.



CloudLab - Experiment Status

Home Manual Actions ricci1 logged in Logout

Experiment expires: Nov 7 2015 6:31 AM (in 16 hours)

Profile Instructions

Topology View **List View** Manifest

ID	Node	Type	SSH command (if you provided your own key)	Actions
ctl	ms0124	m400	<code>ssh -p 22 ricci1@ms0124.utah.cloudlab.us</code>	
nm	ms0144	m400	<code>ssh -p 22 ricci1@ms0144.utah.cloudlab.us</code>	
cp-1	ms0135	m400	<code>ssh -p 22 ricci1@ms0135.utah.cloudlab.us</code>	

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## 11.5.5 Manifest View

The final default tab shows a [manifest](#) detailing the hardware that has been assigned to you. This is the “request” [RSpec](#) that is used to define the profile, annotated with details of the hardware that was chosen to instantiate your request. This information is available on the nodes themselves using the [geni-get](#) command, enabling you to do rich scripting that is fully aware of both the requested topology and assigned resources.

Most of the information displayed on the CloudLab status page comes directly from this manifest; it is parsed and laid out in-browser.

CloudLab - Experiment Status

Home Manual Actions ▾ ricci1 logged in Logout

Experiment expires: Nov 7 2015 6:31 AM (in 16 hours) >

Profile Instructions >

Topology View List View **Manifest**

```
<rspec xmlns="http://www.protogeni.net/resources/rspec/3" xmlns:emulab="http://www.protogeni.net/resources/rspec/ext/jacks/1" xmlns:emulab:
<node xmlns:jacks="http://www.protogeni.net/resources/rspec/ext/jacks/1" xmlns:emulab:
  <sliver_type name="raw-pc">
    <disk_image name="urn:publicid:IDN+utah.cloudlab.us+image+emulab-ops//UBUNTU15-04-
  </sliver_type>
  <interface client_id="ctl:if0" component_id="urn:publicid:IDN+utah.cloudlab.us+inte
    <ip address="10.11.10.1" netmask="255.255.0.0" type="ipv4"/>
  </interface>
  <services>
    <login authentication="ssh-keys" hostname="ms0124.utah.cloudlab.us" port="22" use:
    <emulab:console server="boss.utah.cloudlab.us"/>
    <execute shell="sh" command="sudo mkdir -p /root/setup & & sudo -H /tmp/se
    <install url="http://www.emulab.net/downloads/openstack-setup-v15.tar.gz" install_
  </services>
  <emulab:vnode name="ms0124" hardware_type="m400"/>
  <host name="ctl.ricci1-QV10532.cloudlab-PG0.utah.cloudlab.us"/>
</node>
<node xmlns:jacks="http://www.protogeni.net/resources/rspec/ext/jacks/1" xmlns:emulab:
  <sliver_type name="raw-pc">
    <disk_image name="urn:publicid:IDN+utah.cloudlab.us+image+emulab-ops//UBUNTU15-04-
  </sliver_type>
```

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## 11.5.6 Actions

In both the topology and list views, you have access to several actions that you may take on individual nodes. In the topology view, click on the node to access this menu; in the list view, it is accessed through the icon in the “Actions” column. Available actions include rebooting (power cycling) a node, and re-loading it with a fresh copy of its disk image (destroying all data on the node). While nodes are in the process of rebooting or re-imaging, they will turn yellow in the topology view. When they have completed, they will become green again. The [shell](#) and [console](#) actions are described in more detail below.

CloudLab - Experiment Status

Home Manual Actions ricci1 logged in Logout

Experiment expires: Nov 7 2015 6:31 AM (in 16 hours)

Profile Instructions

Topology View List View Manifest

cp-1 nm st

Shell  
Console  
Console Log  
Reboot  
Reload  
Snapshot

Click on a node for more options. Click and drag to move things around. Refresh Status

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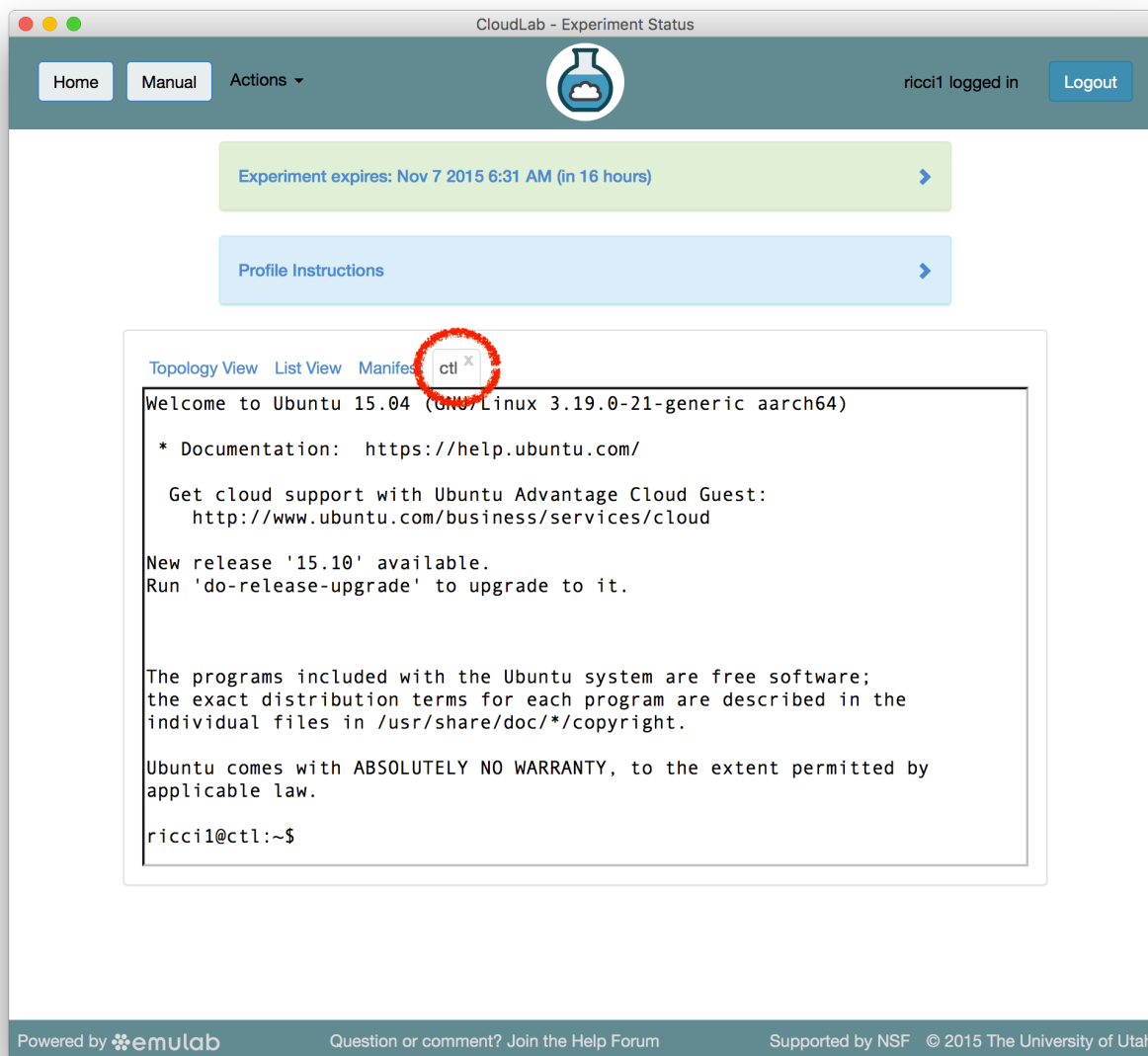
## 11.5.7 Web-based Shell

CloudLab provides a browser-based shell for logging into your nodes, which is accessed through the action menu described above. While this shell is functional, it is most suited to light, quick tasks; if you are going to do serious work, on your nodes, we recommend using a standard terminal and `ssh` program.

This shell can be used even if you did not establish an `ssh` keypair with your account.

Two things of note:

- Your browser may require you to click in the shell window before it gets focus.
- Depending on your operating system and browser, cutting and pasting into the window may not work. If keyboard-based pasting does not work, try right-clicking to paste.



The screenshot shows the CloudLab Experiment Status interface. At the top, there are navigation links for Home, Manual, and Actions, along with a user profile for ricci1 logged in and a Logout button. Below the navigation bar, there are two main action buttons: "Experiment expires: Nov 7 2015 6:31 AM (in 16 hours)" and "Profile Instructions". The central part of the page features a terminal window titled "Topology View List View Manifests ctl". The terminal output displays the Ubuntu 15.04 boot sequence, including the GNU/Linux version, documentation links, and system information. The prompt "ricci1@ctl:~\$" is visible at the bottom of the terminal. A red circle highlights the "ctl" tab in the terminal window's title bar.

## 11.5.8 Serial Console

CloudLab provides serial console access for all nodes, which can be used in the event that normal IP or `ssh` access gets intentionally or unintentionally broken. Like the browser-based shell, it is launched through the access menu, and the same caveats listed above apply as well. In addition:

- If you look at the console for a node that is already booted, the console may be blank due to a lack of activity; press enter several times to get a fresh login prompt.
- If you need to log in, do so as **root**; your normal user account does not allow password login. There is a link above the console window that reveals the randomly-generated root password for your node. Note that this password changes frequently for security reasons.

CloudLab - Experiment Status

Home Manual Actions ricci1 logged in Logout

Experiment expires: Nov 7 2015 6:31 AM (in 16 hours)

Profile Instructions

Topology View List View Manifests **ctl-Cons** Password

```
No directory, logging in with HOME=/,
Trying 127.0.0.1...
Connected to localhost.
Escape character is 'off'.

Ubuntu 15.04 ctl.ricci1-qv10532.cloudlab-pg0.utah.cloudlab.us ttyS0

ctl login:
Ubuntu 15.04 ctl.ricci1-qv10532.cloudlab-pg0.utah.cloudlab.us ttyS0

ctl login: [ ]
```

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## 11.6 Bringing up Instances in OpenStack

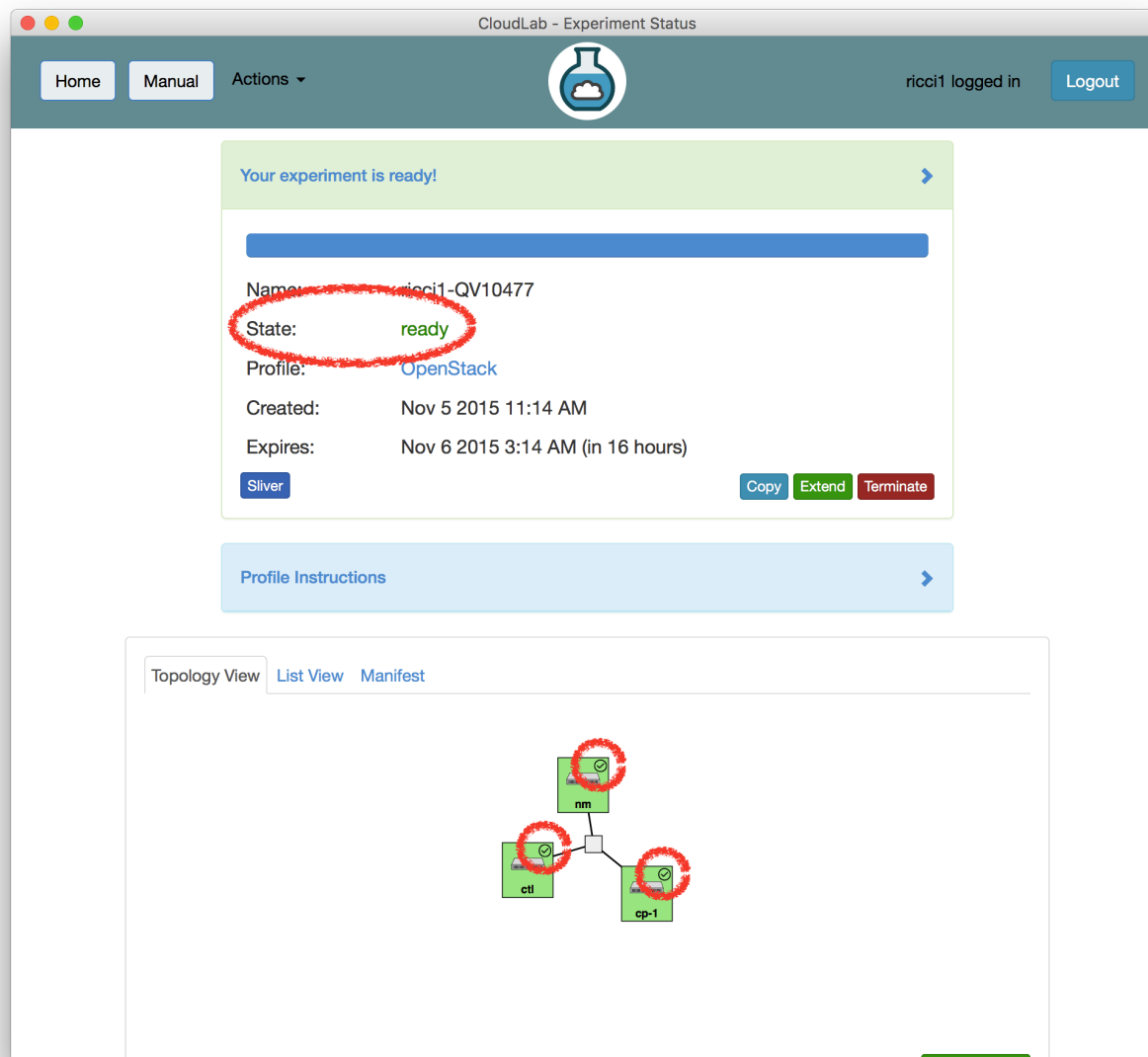
Now that you have your own copy of OpenStack running, you can use it just like you would any other OpenStack cloud, with the important property that you have full `root` access to every machine in the cloud and can modify them however you'd like. In this part of the tutorial, we'll go through the process of bringing up a new VM instance in your cloud.

We'll be doing all of the work in this section using the Horizon web GUI for OpenStack, but you could also `ssh` into the machines directly and use the command line interfaces or other APIs as well.

### 1. Check to see if OpenStack is ready to log in

As mentioned earlier, this profile runs several scripts to complete the installation of OpenStack. These scripts do things such as finalize package installation, customize the installation for the specific set of hardware assigned to your experiment, import cloud images, and bring up the hypervisors on the compute node(s).

If exploring the CloudLab experiment took you more than ten minutes, these scripts are probably done. You can be sure by checking that **all** nodes have completed their startup scripts (indicated by a checkmark on the Topology view); when this happens, the experiment state will also change from “Booting” to “Ready”



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

nm

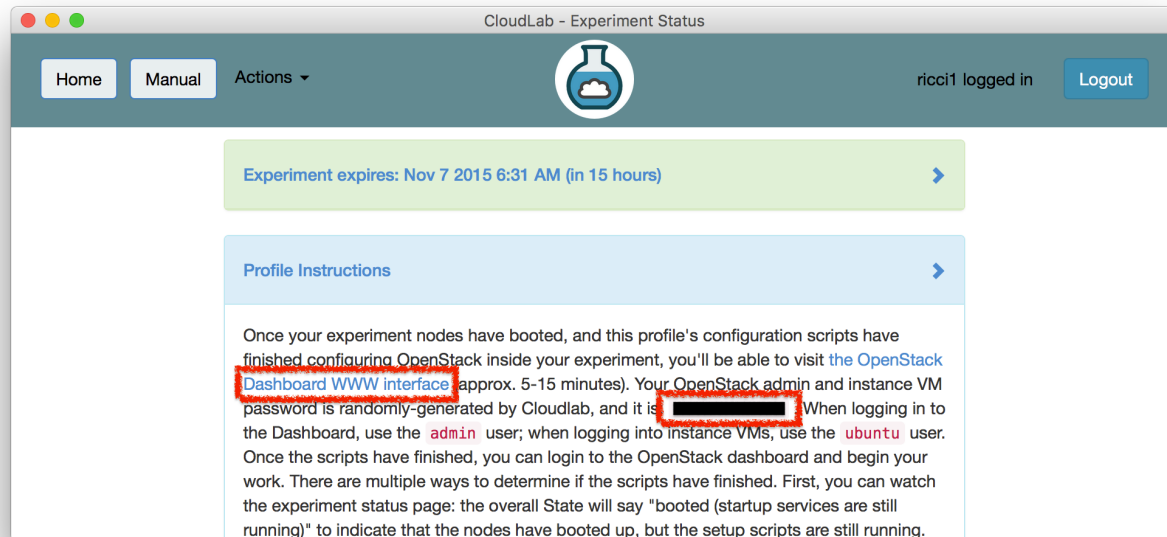
ct1

cp-1

If you continue without verifying that the setup scripts are complete, be aware that you may see temporary errors from the OpenStack web interface. These errors, and the method for dealing with them, are generally noted in the text below.

## 2. Visit the OpenStack Horizon web interface

On the status page for your experiment, in the “Instructions” panel (click to expand it if it’s collapsed), you’ll find a link to the web interface running on the `ct1` node. Open this link (we recommend opening it in a new tab, since you will still need information from the CloudLab web interface).



CloudLab - Experiment Status

Home Manual Actions ▾ ricci1 logged in Logout

Experiment expires: Nov 7 2015 6:31 AM (in 15 hours) >

Profile Instructions >

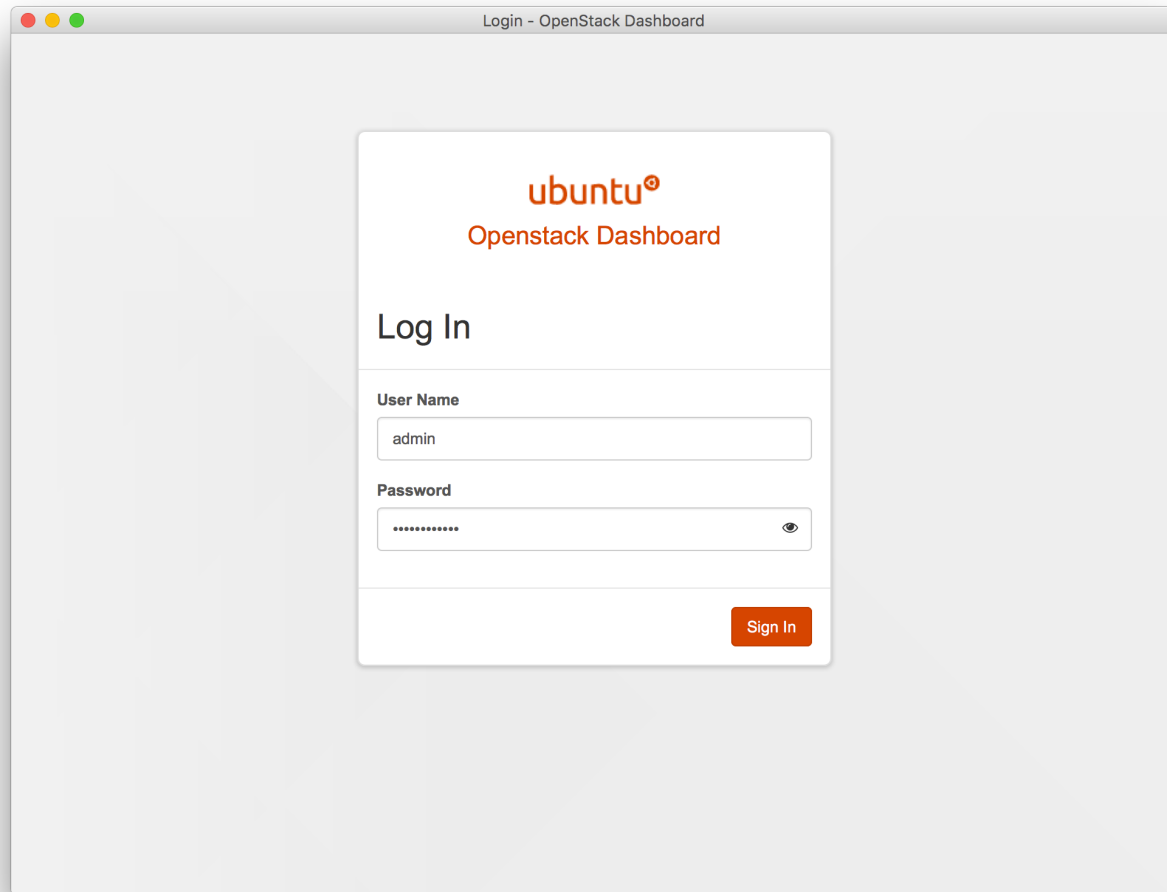
Once your experiment nodes have booted, and this profile's configuration scripts have finished configuring OpenStack inside your experiment, you'll be able to visit [the OpenStack Dashboard WWW interface](#) (approx. 5-15 minutes). Your OpenStack admin and instance VM password is randomly-generated by Cloudlab, and it is [REDACTED]. When logging in to the Dashboard, use the `admin` user; when logging into instance VMs, use the `ubuntu` user. Once the scripts have finished, you can login to the OpenStack dashboard and begin your work. There are multiple ways to determine if the scripts have finished. First, you can watch the experiment status page: the overall State will say "booted (startup services are still running)" to indicate that the nodes have booted up, but the setup scripts are still running.

### 3. Log in to the OpenStack web interface

Log in using the username `admin` and the password shown in the instructions for the profile.

This profile generates a new (random) password for every experiment.

**Important:** if the web interface rejects your password, wait a few minutes and try again. If it gives you another type of error, you may need to wait a minute and reload the page to get login working properly.



#### 4. Launch a new VM instance

Click the "Launch Instance" button on the "Instances" page of the web interface.



Instances - OpenStack Dashboard

ubuntu

admin

admin

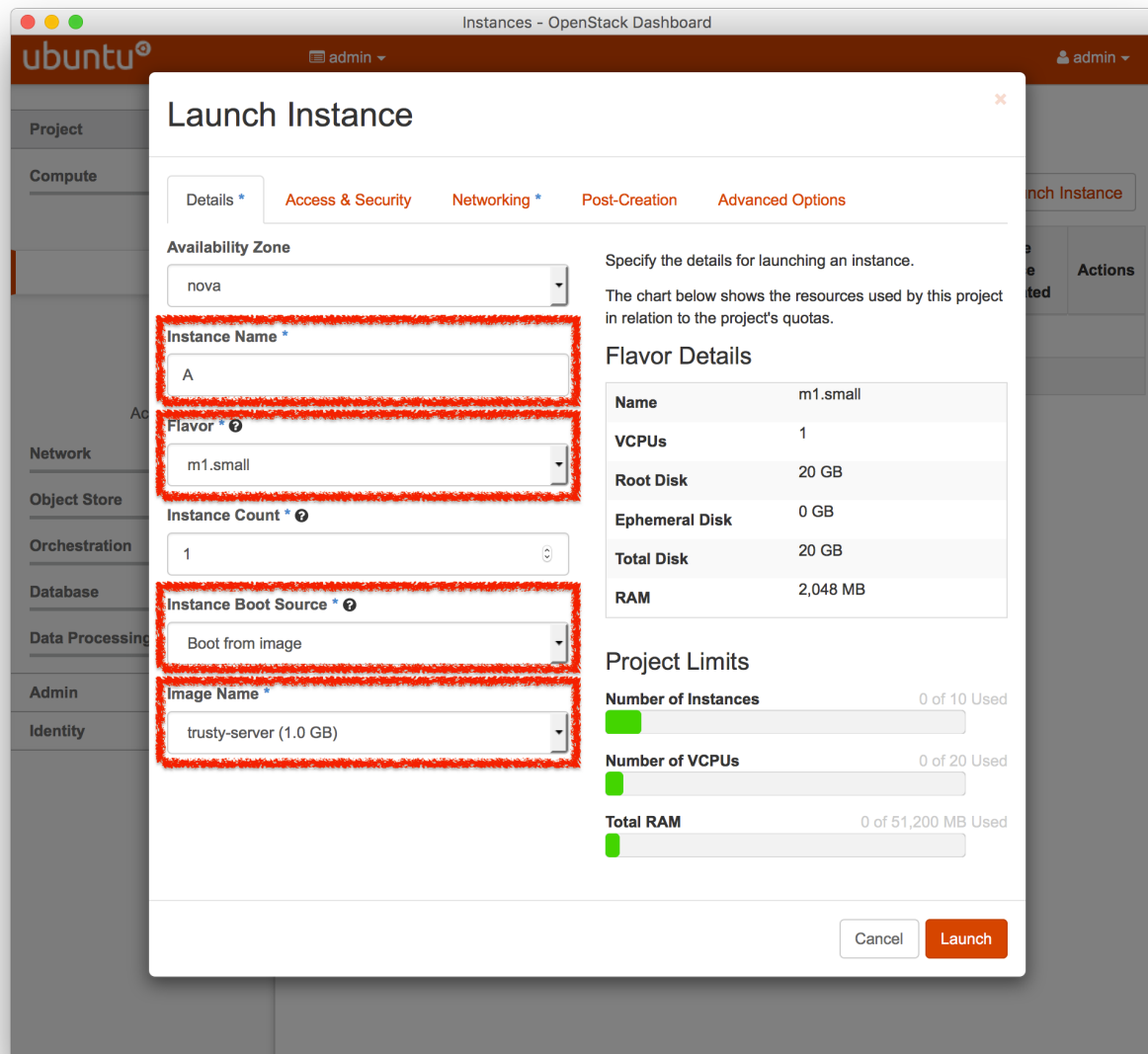
# Instances

Instance Name Filter Filter **Launch Instance**

Instance Name	Image Name	IP Address	Size	Key Pair	Status	Availability Zone	Task	Power State	Time since created	Actions
No items to display.										
Displaying 0 items										

## 5. Set Basic Settings For the Instance

There a few settings you will need to make in order to launch your instance:

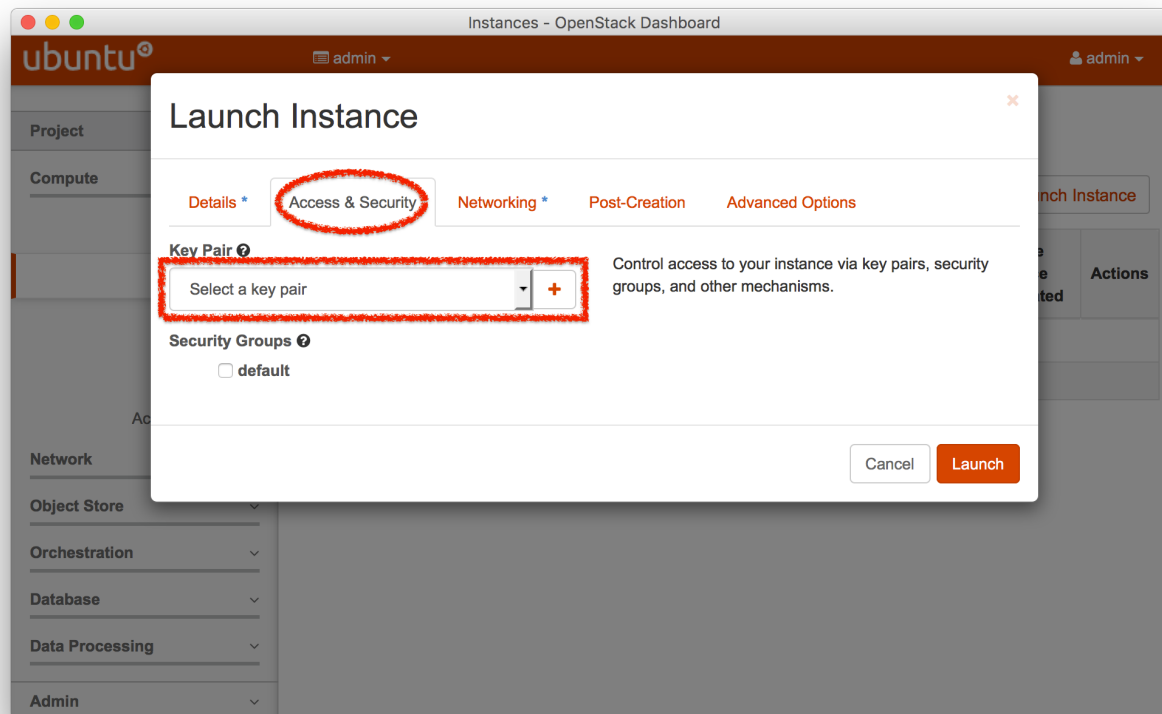


- Pick any “Instance Name” you wish
- Set the “Flavor” to `m1.small`—the disk for the default `m1.tiny` instance is too small for the image we will be using, and since we have only one compute node, we want to avoid using up too many of its resources.
- For the “Instance Boot Source”, select “Boot from image”
- For the “Image Name”, select “trusty-server”

**Important:** If you do not see any available images, the image import script may not have finished yet; wait a few minutes, reload the page, and try again.

## 6. Set an SSH Keypair

On the “Access & Security” tab, you will add an `ssh` keypair to log into your node. If you configured an `ssh` key in your GENI account, you should find it as one of the options in this list. If not, you can add a new keypair with the red button to the right of the list. Alternately, you can skip this step and use a password for login later.

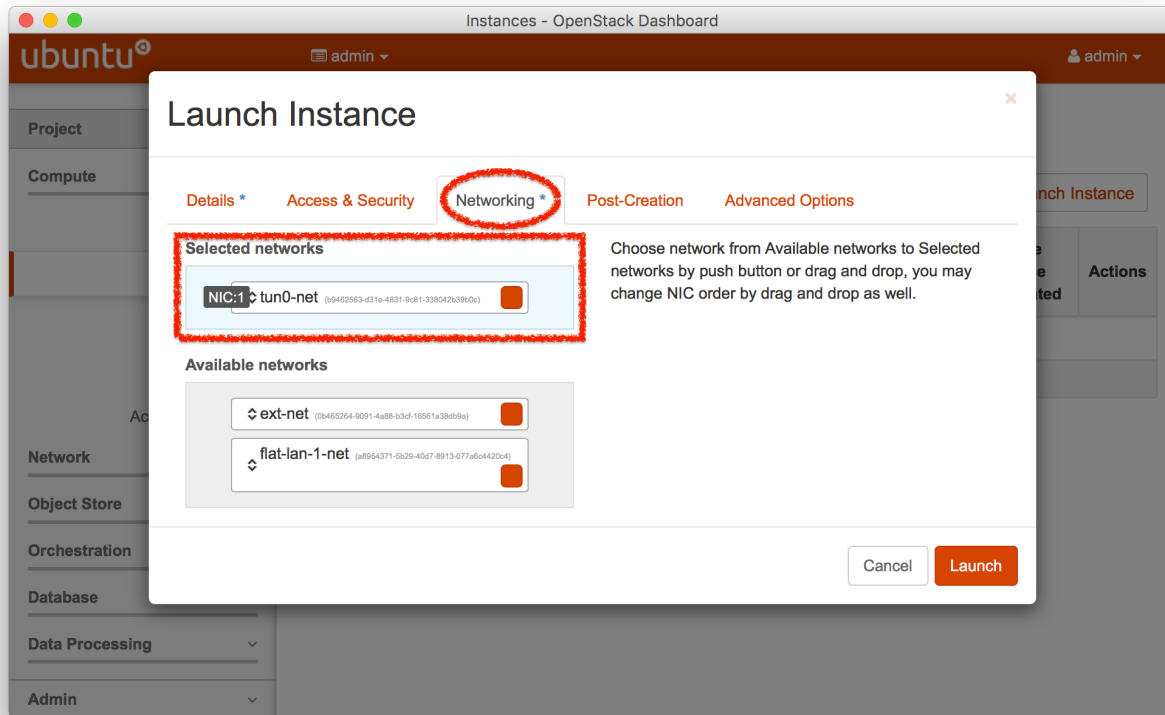


## 7. Add a Network to the Instance

In order to be able to access your instance, you will need to give it a network. On the “Networking” tab, add the `tun0-net` to the list of selected networks by clicking the “+” button or dragging it up to the blue region. This will set up an internal tunneled connection within your cloud; later, we will assign a public IP address to it.

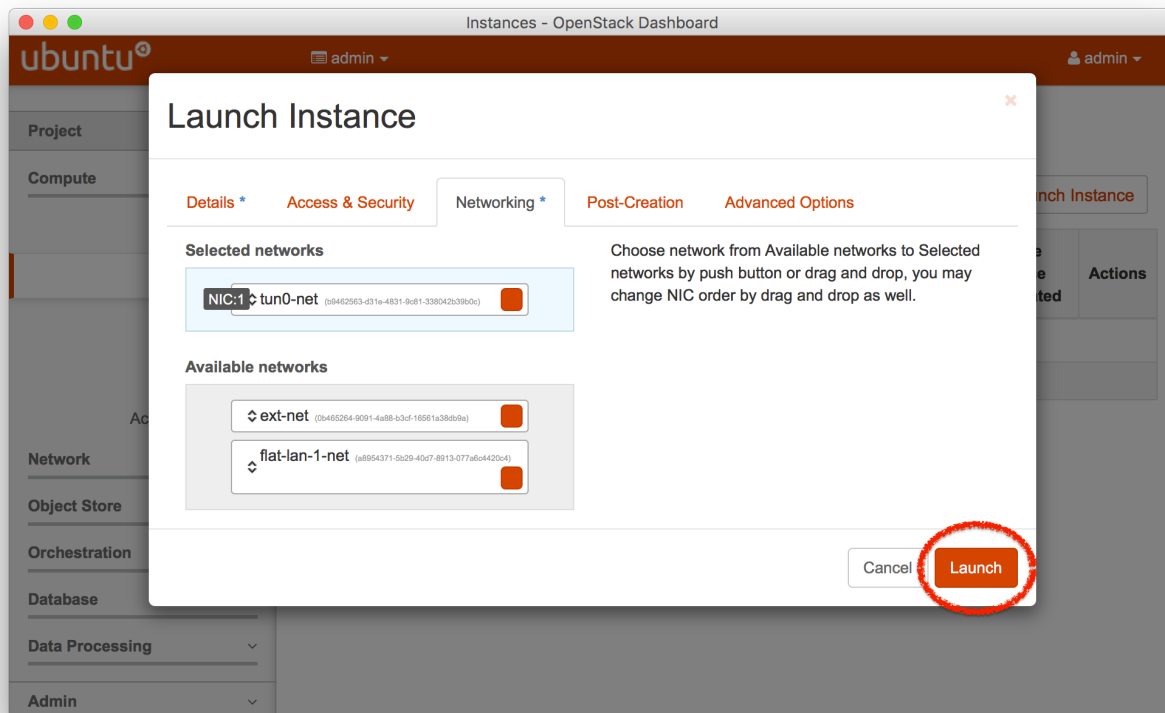
The `tun0-net` consists of EGRE tunnels on the CloudLab experiment network.

**Important:** If you are missing the Networking tab, you may have logged into the OpenStack web interface before all services were started. Unfortunately, reloading does not solve this, you will need to log out and back in.



## 8. Launch, and Wait For Your Instance to Boot

Click the “Launch” button, and wait for the status on the instances page to show up as “Active”.



## 9. Add a Public IP Address

The screenshot shows the OpenStack Dashboard 'Instances' page. The table below is a representation of the data shown in the image:

Instance Name	Image Name	IP Address	Size	Key Pair	Status	Availability Zone	Task	Power State	Time since created	Actions
A	trusty-server	10.254.0.3	m1.small	-	Build	nova	Spawning	No State	0 minutes	<ul style="list-style-type: none"> <li>Associate Floating IP</li> <li>Disassociate Floating IP</li> <li>Edit Instance</li> <li>Lock Instance</li> <li>Unlock Instance</li> <li>Terminate Instance</li> </ul>

At this point, your instance is up, but it has no connection to the public Internet. From the menu on the right, select “Associate Floating IP”.

Profiles may request to have public IP addresses allocated to them; this profile requests four (two of which are used by OpenStack itself.)

On the following screen, you will need to:

- a. Press the red button to set up a new IP address
- b. Click the “Allocate IP” button—this allocates a new address for you from the public pool available to your cloud.
- c. Click the “Associate” button—this associates the newly-allocated address with this instance.

The public address is tunneled by the **nm** (network manager) node from the control network to the experiment network.

You will now see your instance’s public address on the “Instances” page, and should be able to ping this address from your laptop or desktop.

The screenshot shows the OpenStack Dashboard 'Instances' page. The table below is a representation of the data shown in the image:

Instance Name	Image Name	IP Address	Size	Key Pair	Status	Availability Zone	Task	Power State	Time since created	Actions
A	trusty-server	10.254.0.2 Floating IPs: 128.110.155.194	m1.small	-	Build	nova	Spawning	No State	1 minute	Associate Floating IP

## 10. Log in to Your Instance

You can `ssh` to this IP address. Use the username **ubuntu**; if you provided a public key earlier, use your private `ssh` key to connect. If you did not set up an `ssh` key, use the same password you used to log in to the OpenStack web interface (shown in the profile instructions.) Run a few commands to check out the VM you have launched.

---

## 11.7 Administering OpenStack

Now that you've done some basic tasks in OpenStack, we'll do a few things that you would not be able to do as a user of someone else's OpenStack installation. These just scratch the surface—you can upgrade, downgrade, modify or replace any piece of your own copy of OpenStack.

---

### 11.7.1 Log Into The Control Nodes

If you want to watch what's going on with your copy of OpenStack, you can use `ssh` to log into any of the hosts as described above in the [List View](#) or [Web-based Shell](#) sections. Don't be shy about viewing or modifying things; no one else is using your cloud, and if you break this one, you can easily get another.

Some things to try:

- Run `ps -ef` on the `ctl` to see the list of OpenStack services running
- Run `ifconfig` on the `nm` node to see the various bridges and tunnels that have been brought to support the networking in your cloud
- Run `sudo virsh list --all` on `cp1` to see the VMs that are running

---

## 11.7.2 Reboot the Compute Node

Since you have this cloud to yourself, you can do things like reboot or re-image nodes whenever you wish. We'll reboot the `cp1` (compute) node and watch it through the serial console.

### 1. Open the serial console for cp1

On your experiment's CloudLab status page, use the action menu as described in [Actions](#) to launch the console. Remember that you may have to click to focus the console window and hit enter a few times to see activity on the console.

### 2. Reboot the node

On your experiment's CloudLab status page, use the action menu as described in [Actions](#) to reboot `cp1`. Note that in the topology display, the box around `cp1` will turn yellow while it is rebooting, then green again when it has booted.

### 3. Watch the node boot on the console

Switch back to the console tab you opened earlier, and you should see the node starting its reboot process.

CloudLab - Experiment Status

Home Manual Actions ricci1 logged in Logout

Experiment expires: Nov 7 2015 6:31 AM (in 15 hours)

Profile Instructions

Topology View List View Manifests **cp-1-Cons** Password

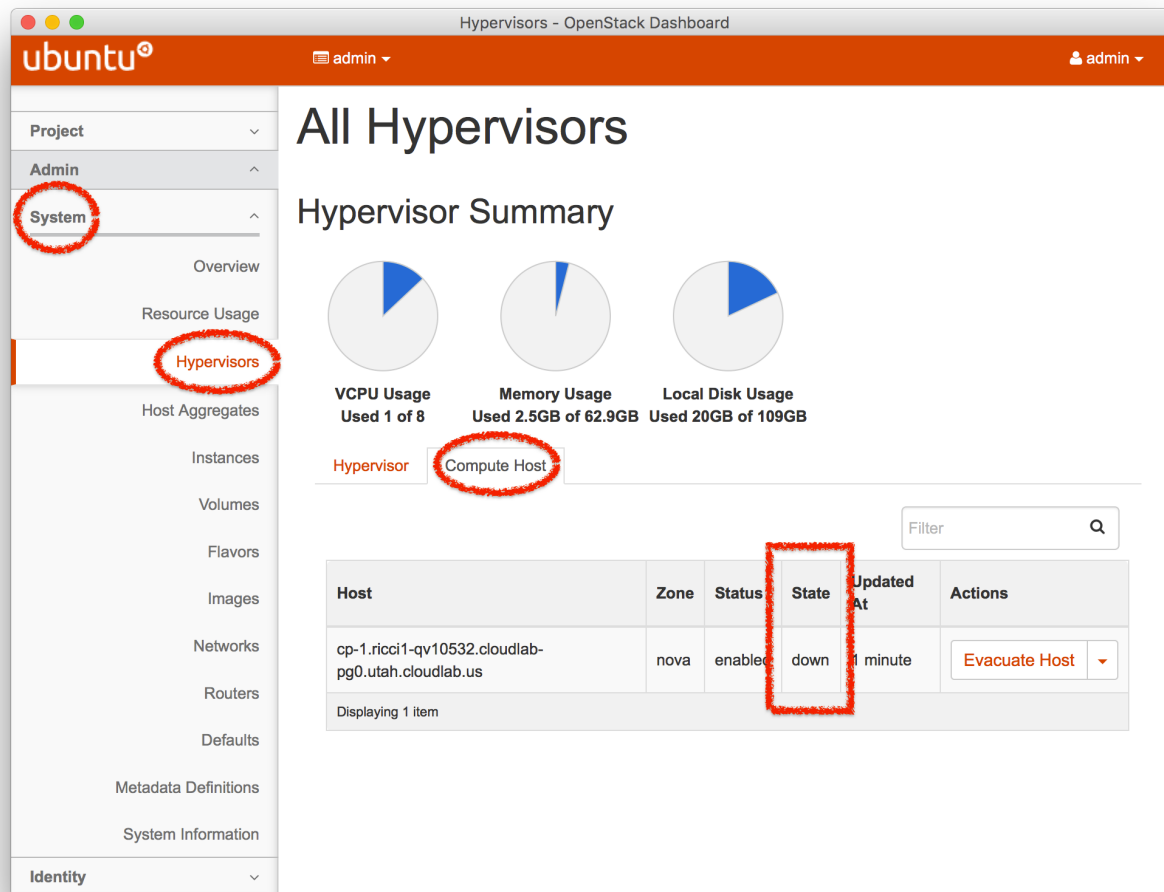
```
Node Boot Start Time: 2015-11-06T22:43:30
Node Serial Number: CN7438V6NN
Cartridge Chassis Slot ID: 35
Cartridge Serial Number: CN7438V6NN
Chassis Serial Number: USE443D2DR
Chassis Asset Tag:
Node UUID: C2FCB96F-F34D-50E4-899A-18E388DB9EBD
Product ID: 721717-B21
Timezone Name: America/Denver
SCSI: Target spinup took 0 ms.
AHCI2 0001.0300 32 slots 2 ports 6 Gbps 0x3 impl SATA mode
flags: 64bit ncq pm only pmp fbss pio slum part ccc
scanning bus for devices...
  Device 0: (4:0) Vendor: ATA      Prod.: XR0120GEBLT Rev: HPS4
            Type: Hard Disk
            Capacity: 114473.4 MB = 111.7 GB (234441648 x 512)
Found 1 device(s).
Boot: PXE, M.2
Mellanox ConnectX3 U-Boot driver version 1.1
```

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#### 4. Check the node status in OpenStack

You can also watch the node's status from the OpenStack Horizon web interface. In Horizon, select "Hypervisors" under the "System" menu, and switch to the "Compute Host" tab.





**Note:** This display can take a few minutes to notice that the node has gone down, and to notice when it comes back up. Your instances will not come back up automatically; you can bring them up with a “Hard Reboot” from the “Admin -> System ->Instances” page.

## 11.8 Terminating the Experiment

Resources that you hold in CloudLab are real, physical machines and are therefore limited and in high demand. When you are done, you should release them for use by other experimenters. Do this via the “Terminate” button on the CloudLab experiment status page.

CloudLab - Experiment Status

Home Manual Actions ricci1 logged in Logout

Your experiment is ready!

Name: ricci1-QV10532  
 State: ready  
 Profile: OpenStack  
 Created: Nov 6 2015 2:31 PM  
 Expires: Nov 7 2015 6:31 AM (in 15 hours)

Silver Copy Extend Terminate

Profile Instructions

Topology View List View Manifest

ID	Node	Type	SSH command (if you provided your own key)	Actions
ctl	ms0124	m400	ssh -p 22 ricci1@ms0124.utah.cloudlab.us	⚙️
nm	ms0144	m400	ssh -p 22 ricci1@ms0144.utah.cloudlab.us	⚙️
cp-1	ms0135	m400	ssh -p 22 ricci1@ms0135.utah.cloudlab.us	⚙️

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**Note:** When you terminate an experiment, all data on the nodes is lost, so make sure to copy off any data you may need before terminating.

If you were doing a real experiment, you might need to hold onto the nodes for longer than the default expiration time. You would request more time by using the “Extend” button on the status page. You would need to provide a written justification for holding onto your resources for a longer period of time.

## 11.9 Taking Next Steps

Now that you’ve got a feel for what CloudLab can do, there are several things you might try next:

- [Create a new project](#) to continue working on CloudLab past this tutorial
- Try out some profiles other than OpenStack (use the “Change Profile” button on the “Start Experiment” page)

- Read more about the [basic concepts](#) in CloudLab
- Try out different [hardware](#)
- Learn how to [make your own profiles](#)