



Clearing the Fog! Getting Started on Cumulus: a Near to the Ground On Campus Cloud Solution

Getting Started on CUMulus

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Slides and tutorial:
https://github.com/ResearchComputing/CUMulus_tutorials

Survey at: <http://tinyurl.com/curc-survey18>

Learning Objectives

- [Logging into CUMulus with Horizon](#) (the CUMulus web portal)
- [Creating your instance](#) (i.e. virtual machine)
- [Logging into your instance](#) via ssh

Outline

- CURC Overview
- What is CUmulus?
- CUmulus Access
 - Access to CUmulus and the allocation process
 - Logging into Horizon (CUmulus web portal)
 - Creation of an instance
 - Logging into your instance
- Demo workflow one might use on CUmulus:
 - Web App & Database

CU Research Computing Overview

- Provides Computing and Data Beyond the Desktop resources:
 - High Performance Computing (HCP), clusters include:
 - Alpine (beta)
 - Summit
 - Blanca
 - Storage of Research Data
 - PetaLibrary
 - High-Speed Data Transfer
 - Globus Endpoint
 - Consulting in Computational Science and Data Management
 - **Cloud Resources**
 - **CUmulus**

What is CUmulus?

- **CUmulus** is CU Research Computing's free-to-use on-premise cloud service
- Supports cases not well-suited for HPC such as:
 - Research-Oriented Web Servers
 - Databases
 - Long-Running Services
- Provides users with persistent or ongoing availability by allocating logically isolated section of the cloud

What is CUMulus?

- You get your own virtual “world” for experimentation - an environment that can be easily created/tested/removed
 - Install Software
 - Administer your instance (you’re in control!)
 - Run applications and jobs
 - Interface w/ other CURC services: Blanca, Alpine, PetaLibrary
- You can request specific resources (CPU, storage, memory) and can set up persistent storage

CUmulus Access

CUmulus Access and Allocation

Submit a proposal for your use case (email rc-help@colorado.edu)

- Describe your CUmulus workflow
- Describe why your workflow is appropriate for CUmulus
- Estimate the resources you require:
 - Operating System, CPU cores, Disk Space, Memory

This is an *iterative process* where we work with you to make sure the request for resources fits your (and our) needs

- Learn more about the allocation request process at <https://www.colorado.edu/rc/userservices/allocations>

Log in to Horizon

There are 3 current authentication/login methods at cumulus.rc.colorado.edu/:

1. CU Boulder
2. CSU Fort Collins
3. XSEDE* (all other RMACC institutions)
 - a. Create account: <https://portal.xsede.org/#/quest>
 - b. Configure 2FA (Duo): <https://portal.xsede.org/mfa>

*Don't *need* an RC account with XSEDE for this class, but will make things *easier*

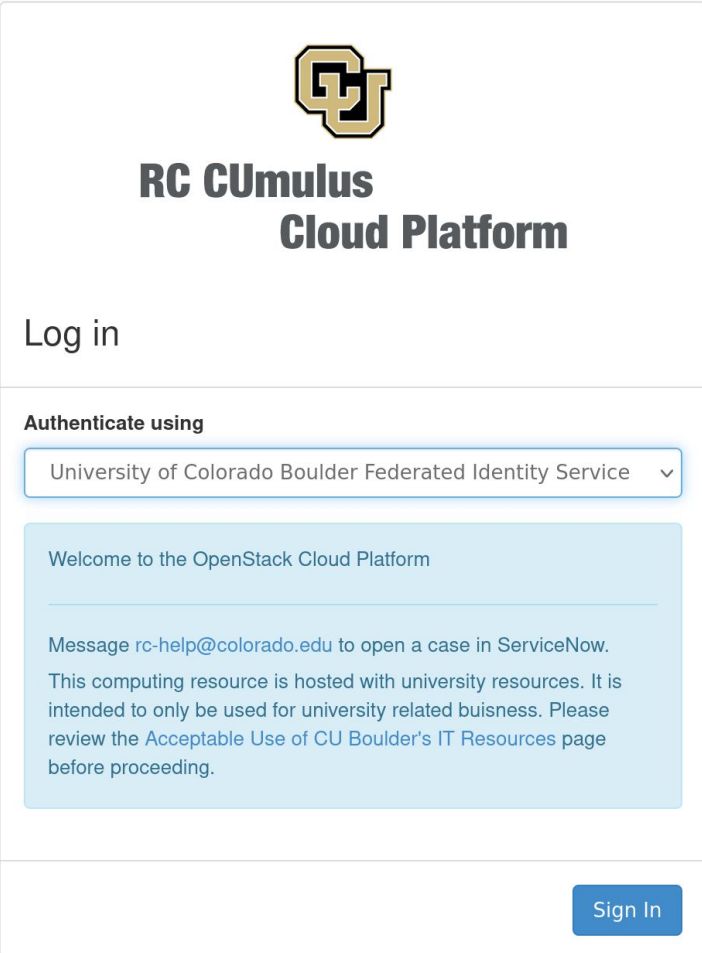
RC account check

- Who does ***not*** have a CU Research Computing account who would like to use a temporary account*?
- If you don't have access to the CU VPN *or* don't have an RC account, you will *need* a temp account to connect to a VM

**only available during session*

Log in to Horizon

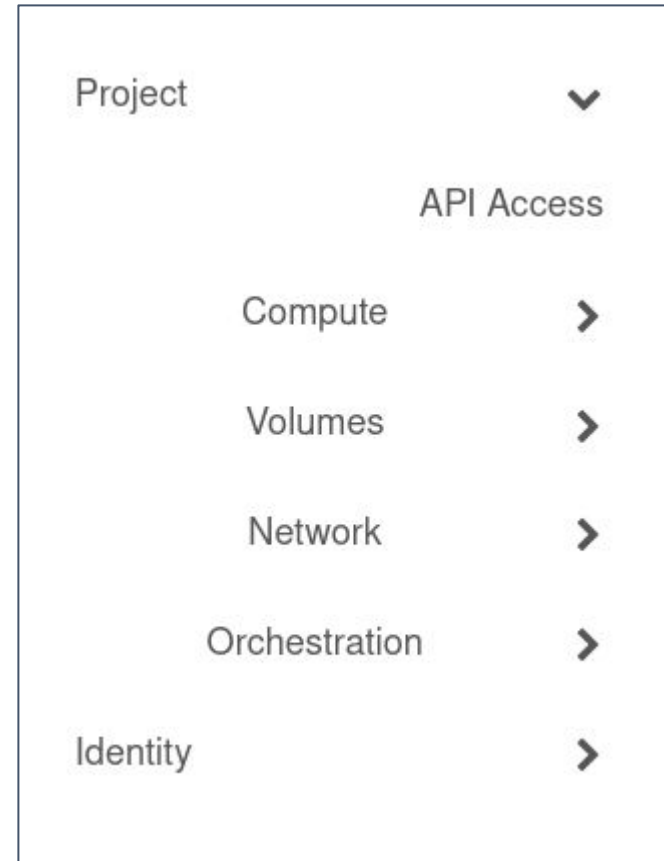
- Horizon is the CUMulus web portal
 - cumulus.rc.colorado.edu/
- Let's take a brief tour of Horizon
- Log in with your institution's credentials:



The screenshot shows the login interface for the RC CUMulus Cloud Platform. At the top is the CU Boulder logo and the text "RC CUMulus Cloud Platform". Below this is a "Log in" section. Under the heading "Authenticate using", there is a dropdown menu currently set to "University of Colorado Boulder Federated Identity Service". Below the dropdown is a light blue informational box containing the text: "Welcome to the OpenStack Cloud Platform", "Message rc-help@colorado.edu to open a case in ServiceNow.", and "This computing resource is hosted with university resources. It is intended to only be used for university related business. Please review the Acceptable Use of CU Boulder's IT Resources page before proceeding." At the bottom right of the page is a blue "Sign In" button.

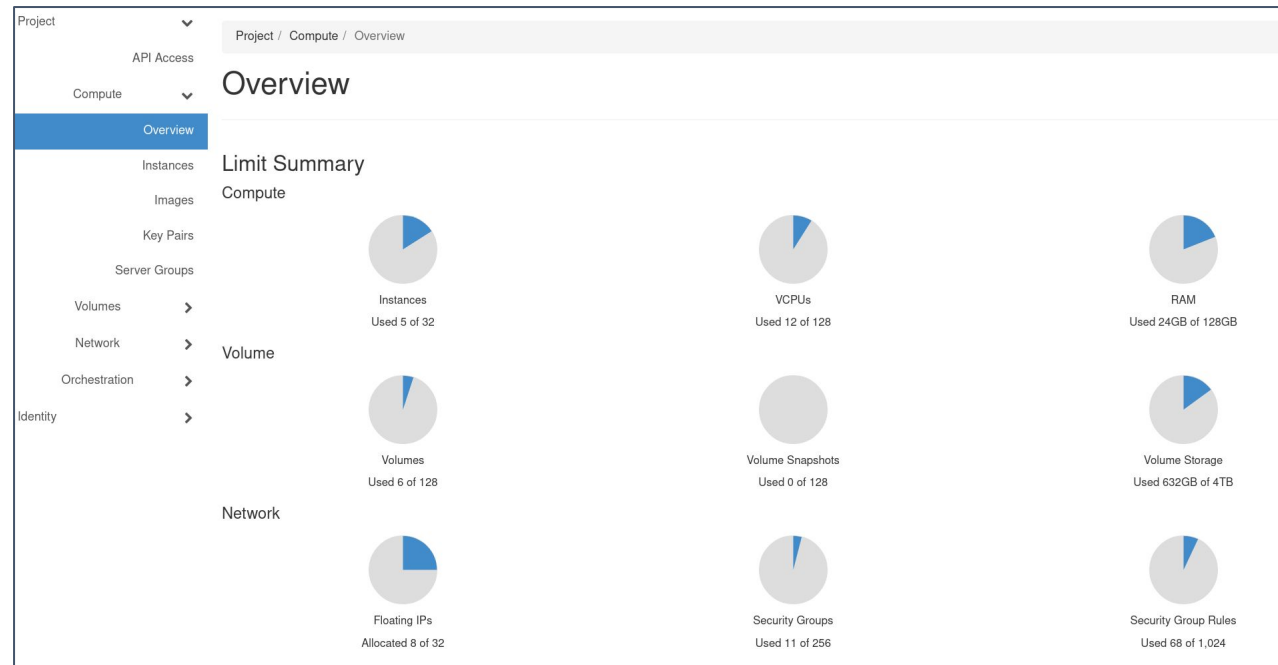
Navigate Horizon

- Choose your project (top left)
 - Generally users only have 1 project
- 4 main sections
 - Compute
 - Volumes
 - Networks
 - Orchestration



Navigate Horizon: Overview

- Land on the Overview page under “Compute”
 - quick summary of your project



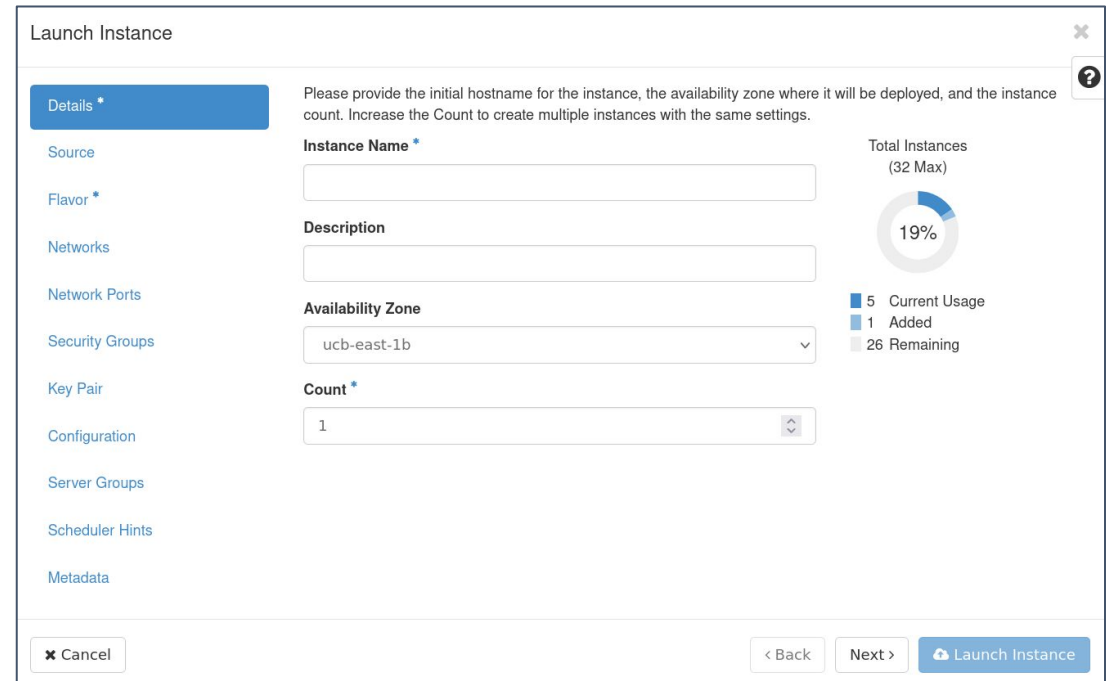
Navigate Horizon: Instances

- Navigate to:
 - Project->Compute->Instances
- Instances are **virtual machines** that run inside the cloud, more simply: an instance is just a digital version of a physical computer
 - Instances can perform almost all of the same functions as a computer, including running applications and operating systems

Instance Creation

Let's create a simple instance together

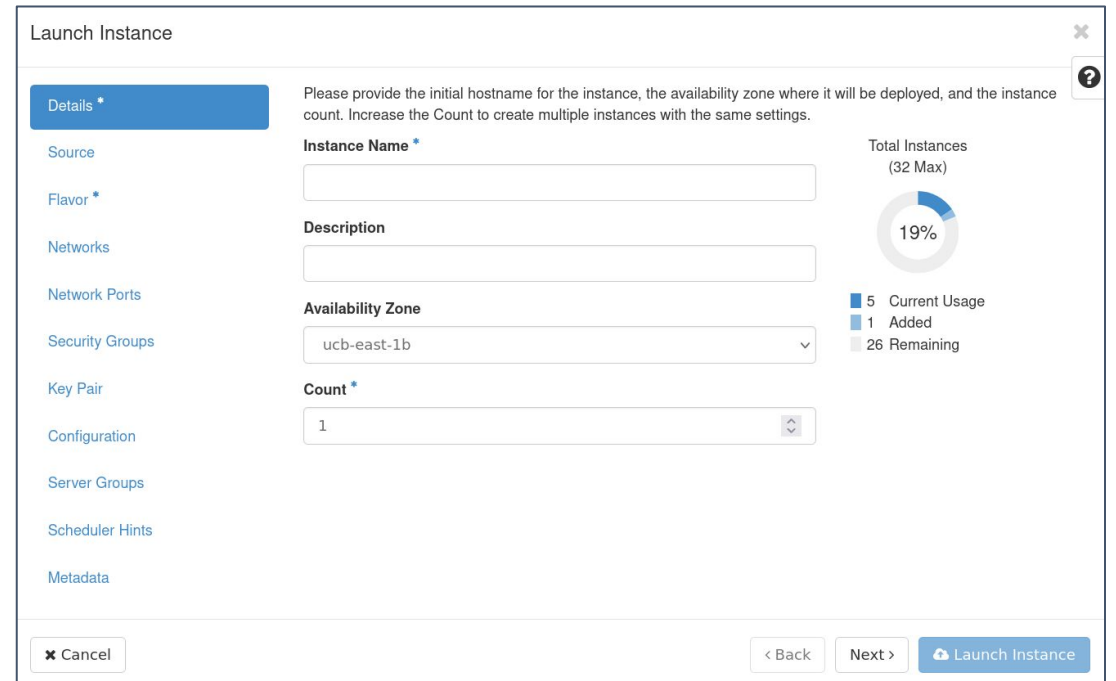
- From the instances page click on “Launch Instance”
- The Instance Creation Launcher will pop up giving us options to create our virtual machine



The screenshot shows the 'Launch Instance' dialog box. On the left is a sidebar with tabs: Details (selected), Source, Flavor, Networks, Network Ports, Security Groups, Key Pair, Configuration, Server Groups, Scheduler Hints, and Metadata. The main area contains a form with the following fields: 'Instance Name' (text input), 'Description' (text input), 'Availability Zone' (dropdown menu showing 'ucb-east-1b'), and 'Count' (dropdown menu showing '1'). Above the 'Instance Name' field is a note: 'Please provide the initial hostname for the instance, the availability zone where it will be deployed, and the instance count. Increase the Count to create multiple instances with the same settings.' To the right of the form is a circular progress indicator showing '19%' usage, with a legend indicating '5 Current Usage', '1 Added', and '26 Remaining' out of a '32 Max'. At the bottom are buttons for 'Cancel', '< Back', 'Next >', and 'Launch Instance'.

Details

- Fill out Instance details, including a name and description
 - availability zone and count can be left as defaults



The screenshot shows a 'Launch Instance' dialog box with a sidebar on the left containing links to 'Details *', 'Source', 'Flavor *', 'Networks', 'Network Ports', 'Security Groups', 'Key Pair', 'Configuration', 'Server Groups', 'Scheduler Hints', and 'Metadata'. The 'Details *' tab is active. The main area contains a text box for 'Instance Name *', a text box for 'Description', a dropdown menu for 'Availability Zone' (set to 'ucb-east-1b'), and a dropdown menu for 'Count *' (set to '1'). A message at the top right says: 'Please provide the initial hostname for the instance, the availability zone where it will be deployed, and the instance count. Increase the Count to create multiple instances with the same settings.' On the right side, there is a circular progress indicator showing '19%' and a legend: '5 Current Usage', '1 Added', and '26 Remaining'. At the bottom, there are buttons for 'Cancel', '< Back', 'Next >', and 'Launch Instance'.

Category	Value
Instance Name	
Description	
Availability Zone	ucb-east-1b
Count	1

Total Instances (32 Max): 19%

- 5 Current Usage
- 1 Added
- 26 Remaining

Source

- Choose an image from the available list
- A virtual machine image (“image”) is **a single file that contains a virtual disk that contains a bootable operating system**
- Choose to have your storage volume deleted on instance deletion
 - If you select “no” be aware of “zombie” volumes

Launch Instance

Details *
Source
Flavor *
Networks
Network Ports
Security Groups
Key Pair
Configuration
Server Groups
Scheduler Hints
Metadata

Instance source is the template used to create an instance. You can use an image, a snapshot of an instance (image snapshot), a volume or a volume snapshot (if enabled). You can also choose to use persistent storage by creating a new volume.

Select Boot Source
Image

Create New Volume
Yes No

Volume Size (GB) *
1

Delete Volume on Instance Delete
Yes No

Allocated
Displaying 0 items

Name	Updated	Size	Type	Visibility
Select an item from Available items below				

Displaying 0 items

▼ Available 9 Select one

Click here for filters or full text search.

Displaying 9 items

Name	Updated	Size	Type	Visibility
> CentOS 7	6/3/21 6:54 AM	847.81 MB	QCOW2	Public
> CentOS 8	9/20/21 9:22 PM	1.19 GB	QCOW2	Private

Flavor

- Choose from a list of pre-selected resources:
 - A flavor defines the compute, memory, and storage capacity of our instance.

Launch Instance

Details *
Source
Flavor *
Networks
Network Ports
Security Groups
Key Pair
Configuration
Server Groups
Scheduler Hints
Metadata

Flavors manage the sizing for the compute, memory and storage capacity of the instance.

Allocated

Name	VCPUS	RAM	Total Disk	Root Disk	Ephemeral Disk	Public
Select an item from Available items below						

▼ Available 8 Select one

Q Click here for filters or full text search. X

Name	VCPUS	RAM	Total Disk	Root Disk	Ephemeral Disk	Public	
> m5.nano	2	512 MB	0 GB	0 GB	0 GB	No	↑
> m5.micro	2	1 GB	0 GB	0 GB	0 GB	No	↑
> m5.small	2	2 GB	0 GB	0 GB	0 GB	No	↑
> m5.medium	2	4 GB	0 GB	0 GB	0 GB	No	↑
> c5.xlarge	4	8 GB	0 GB	0 GB	0 GB	No	↑

Networks & Network Ports

- Select a project network, which determines **routability of either a public/internet or campus/internal floating IP**.
 - We'll choose an external network: **projectnet26140-private**
- Ports provide extra communication channels to your instances
- You can select ports instead of networks or a mix of both

Launch Instance

Details *
Source
Flavor *
Networks
Network Ports
Security Groups
Key Pair
Configuration
Server Groups
Scheduler Hints
Metadata

Networks provide the communication channels for instances in the cloud.

▼ Allocated 1 Select networks from those listed below.

	Network	Subnets Associated	Shared	Admin State	Status
1	projectnet2021-private	projectnet2021-private-subnet	No	Up	Active

▼ Available 0 Select at least one network

Click here for filters or full text search.

Network	Subnets Associated	Shared	Admin State	Status
No available items				

Cancel < Back Next > Launch Instance

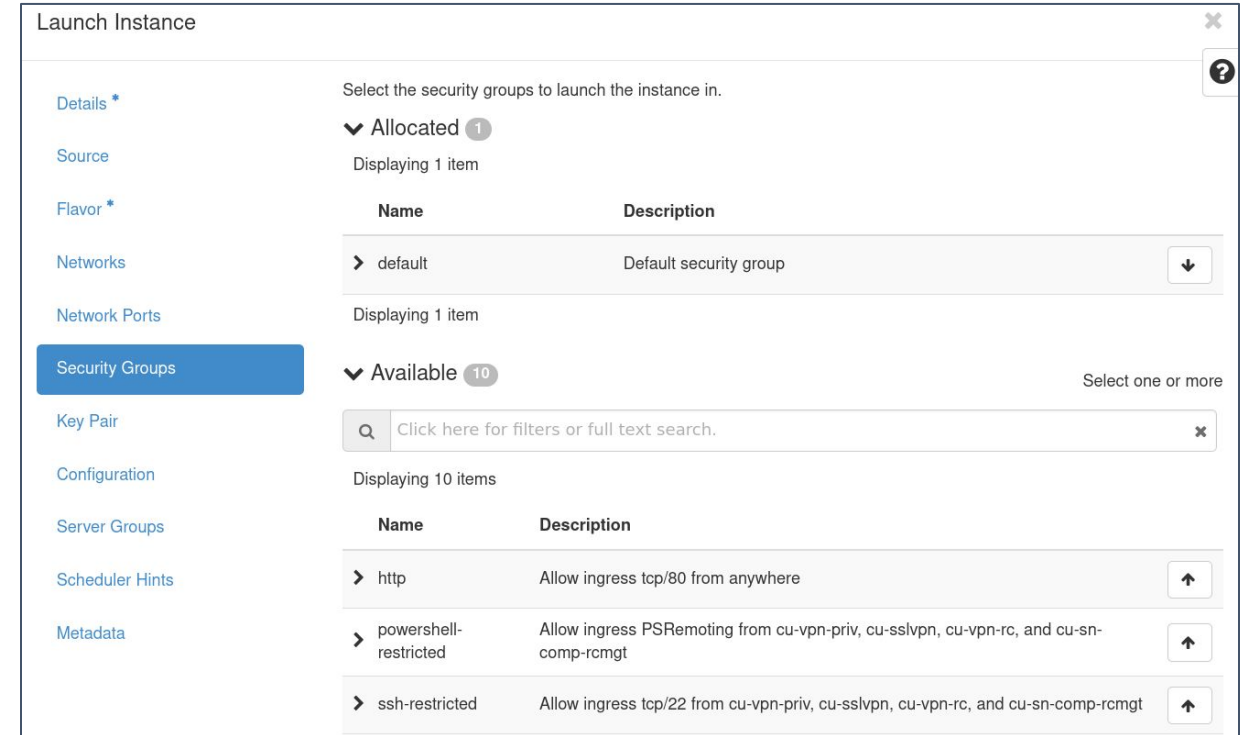
Networks: An aside

Two network types are provided:

1. **172.18.XX.XX** - restricts your instance to CU **internal** network
 2. **172.26.XX.XX** - allows certain ingress/egress from the **public** internet (for certain access, e.g http, https)
- Direct shell access (e.g. *ssh*, *powershell*) is restricted to the CU internal network due to multi-factor-authentication requirements
 - This means that you will need to be on the CU network to access your instance (either VPN or through RC).

Security Groups

- Security Groups act as a **virtual firewall** for your instance to control inbound and outbound traffic.
- We'll choose ssh-curc, ssh-restricted, http, and https for our demo



Launch Instance

Select the security groups to launch the instance in.

▼ Allocated ¹

Displaying 1 item

Name	Description
> default	Default security group

Displaying 1 item

▼ Available ¹⁰ Select one or more

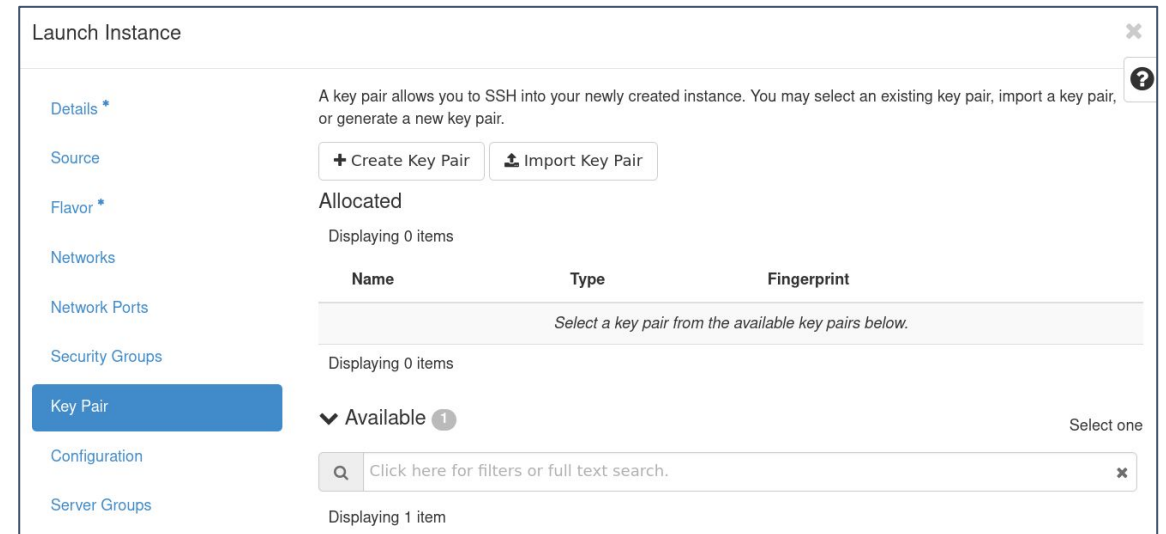
Click here for filters or full text search.

Displaying 10 items

Name	Description
> http	Allow ingress tcp/80 from anywhere
> powershell-restricted	Allow ingress PSRemoting from cu-vpn-priv, cu-sslvpn, cu-vpn-rc, and cu-sn-comp-rcmgt
> ssh-restricted	Allow ingress tcp/22 from cu-vpn-priv, cu-sslvpn, cu-vpn-rc, and cu-sn-comp-rcmgt

Key Pairs

- A key pair allows you to SSH into your new instance
 - You may select an existing key pair, import a key pair, or generate a new key pair
-
- I find it easiest to create a keypair on my machine and import it
 - <https://www.ssh.com/academy/ssh/public-key-authentication>



The screenshot shows the 'Launch Instance' page in the AWS Management Console. The 'Key Pair' tab is selected in the left-hand navigation menu. The main content area explains that a key pair allows SSH access to a new instance and provides buttons for '+ Create Key Pair' and '+ Import Key Pair'. Below this, there are sections for 'Allocated' (displaying 0 items) and 'Available' (displaying 1 item). The 'Available' section includes a search bar and a 'Select one' dropdown menu. A table header is visible with columns for 'Name', 'Type', and 'Fingerprint', but no data rows are shown.

Key Pairs: An aside

- You will need to create an SSH key *from* or copy it *to* a computer you have CU internal access to:
- If you have an RC account already, login as follows from a terminal:

```
$ ssh <username>@login.rc.colorado.edu  
# Where <username> is your identikey
```

- If you don't have an RC account, log into a temporary account from a terminal:

```
$ ssh user<XXXX>@tlogin1.rc.colorado.edu  
# Where user<XXXX> is your temporary username, RC will provide pw
```

Key Pairs: An aside

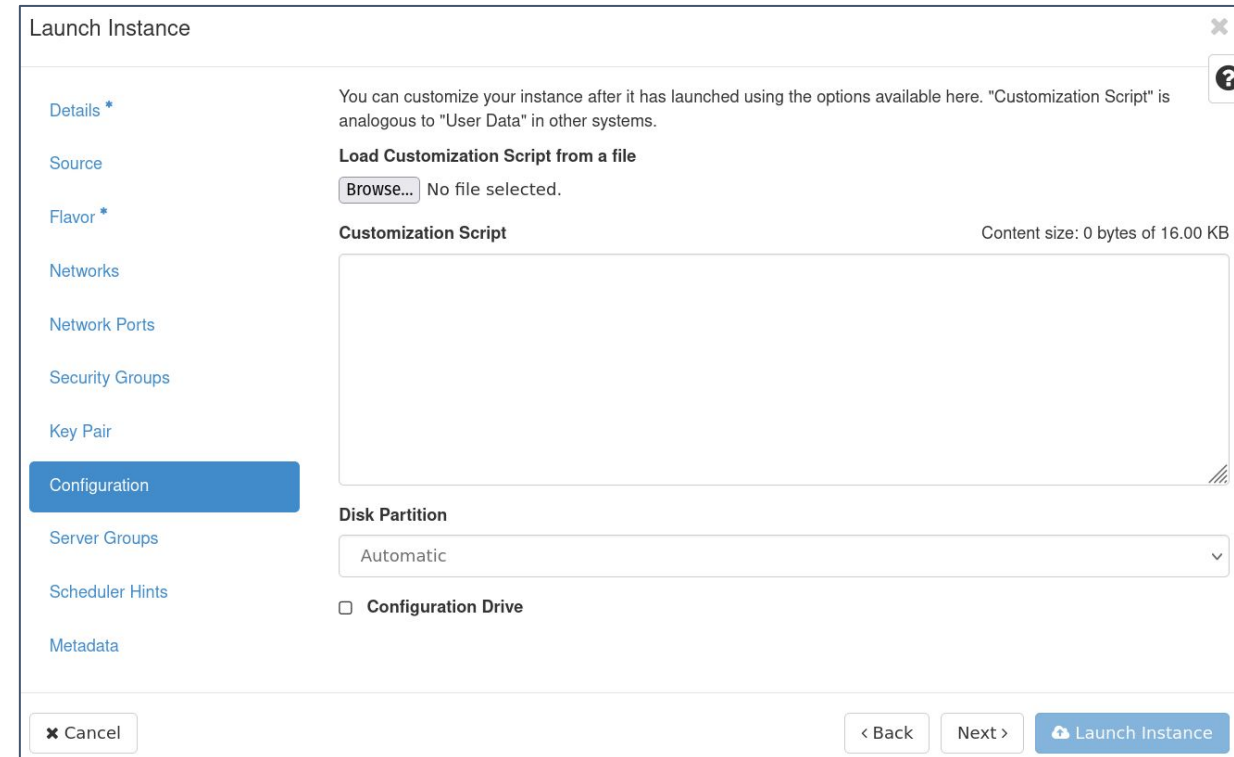
- SSH keys are an access credential that is used in the SSH protocol
- They can be tricky to set up however, so we'll go over a simple example here. From your terminal in a local machine use the ssh-keygen command to create a new ssh keypair:

```
$ ssh-keygen -t ed25519  
Generating public/private ed25519 key pair.  
Enter file in which to save the key (/home/username/.ssh/id_ed25519):
```

- Our new keypairs have been created at `/home/username/.ssh/` and are called `id_ed25519` and `id_ed25519.pub`. The public key (.pub) can be transferred to other remote servers (*this is the key we will import to our CUMulus instance*) but the private key (no suffix) should *never* leave the host machine.

Config, Server Group, Scheduler Hints, and Metadata

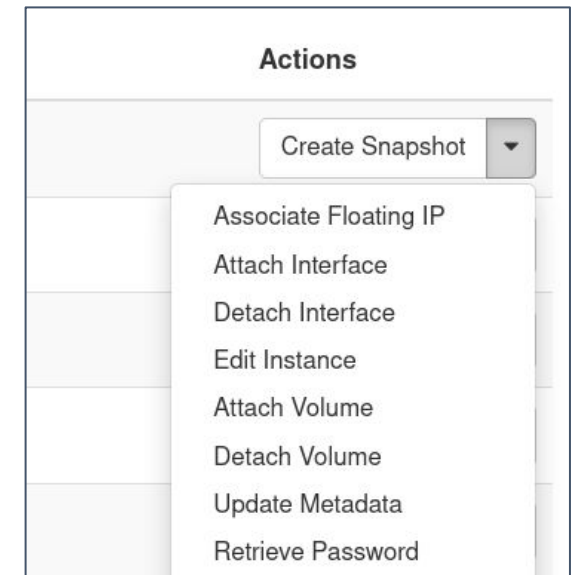
- We'll leave these as defaults as they are extra configuration we can provide our instances, but not necessary



The screenshot shows the 'Launch Instance' dialog box with a sidebar on the left containing the following links: Details *, Source, Flavor *, Networks, Network Ports, Security Groups, Key Pair, Configuration (highlighted in blue), Server Groups, Scheduler Hints, and Metadata. The main content area has a title bar 'Launch Instance' with close and help icons. Below the title bar is a text block: 'You can customize your instance after it has launched using the options available here. "Customization Script" is analogous to "User Data" in other systems.' This is followed by a section 'Load Customization Script from a file' with a 'Browse...' button and the text 'No file selected.' Below this is a 'Customization Script' section with a large text area and a 'Content size: 0 bytes of 16.00 KB' label. Further down is a 'Disk Partition' section with a dropdown menu set to 'Automatic' and a checkbox for 'Configuration Drive' which is currently unchecked. At the bottom of the dialog are three buttons: 'Cancel' (with a close icon), '< Back', and 'Next >', followed by a blue 'Launch Instance' button with a cloud icon.

Launch Instance and Associate IP

- Launch instance and wait for it to be set up
- In the meantime we can associate a Floating IP which will allow us to access the instance from outside of the CU network
 - On the right hand side of the newly created instance choose “Associate Floating IP” under the “actions” dropdown



Associate IP

- Select from available IP addresses
 - If needed you can add a floating IP
- Select port to be associated
 - This should be pre-populated with the internal IP of your new instance

Manage Floating IP Associations

IP Address *

Select an IP address

+

Port to be associated *

Select a port

Select the IP address you wish to associate with the selected instance or port.

Cancel

Associate

Logging into your Instance

Logging In

- You must be on the CU internal to connect via ssh (CURC restriction)

- Open up an ssh connection providing the identity (key) file:

```
$ ssh -i ~/.ssh/<private key> <hostname>@<external floating IP>
```

- For an ubuntu instance this will look something like:

```
$ ssh -i ~/.ssh/testkey ubuntu@123.456.789.123
```

Logged In

- Congratulations! You are now logged into your instance
- You can now:
 - Install Software
 - Administer your instance
 - Run applications and jobs

Demo

Demo workflow: Twitter API with DB

- There are a (nearly) *infinite* number of workflows you could run on your CUMulus instance*

**As long as the workflow is related to research, personal projects are not permitted*

- We'll demo a *potential* workflow: a web application which allows users to query using the Twitter API and store this data persistently to a mysql database
- This demo showcases a few important features of CUMulus not possible on HPC:
 - A persistent workflow not limited by wall clock times
 - User administration of compute resources (using root privileges for applications such as Docker)
 - Routable floating IPs available on the Public Internet

Demos:

1. [Setting up an Instance](#)
2. [Twitter API with Database](#)
3. [CUmulus integration with CURC HPC](#)
4. [Mounting a remote filesystem from a CUmulus Virtual Machine](#)

Users that are *not* using tutorial accounts may access CUmulus and your instances for the next week to test and run through tutorials

Thank you!

- Survey:
- Help Desk:

<http://tinyurl.com/curc-survey18>
rc-help@Colorado.edu