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The University of Texas at Austin

# Cloud Computing

A Basic Introduction to  
TACC Resources

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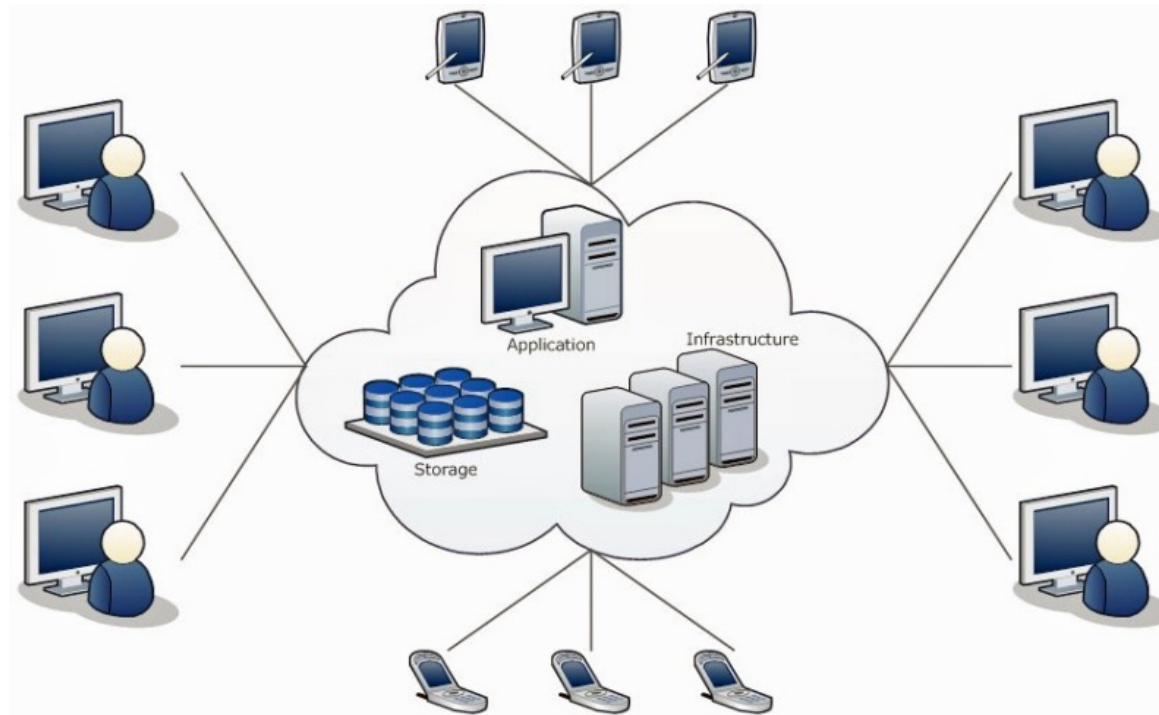
[vtrueheart@tacc.utexas.edu](mailto:vtrueheart@tacc.utexas.edu)

# Overview

- What is Cloud Computing
- What Can I Use It For
- Choosing Systems
- Images vs. Bare Metal
- Using the Resources

# What is a Cloud?

A “cloud” is a computer system that provides users with shared access to on-demand computing resources via the internet.



# Why is it Useful?

- Resource Utilization
- Scalability and Elasticity
- Reproducibility by way of Programmability
- Reliability through redundancy

# Cloud vs. HPC

## Cloud

- Availability
- Multi-level API Interactions
- On-demand/Interactive Use
- Using Commodity Components

## HPC

- Utilization
- Capability or Capacity Science
- Checkpoint/Restart I/O
- Memory/Network Bandwidth & Latency

# Who Uses Clouds?

## System Administrators

- Help automate operations

## Software Developers

- Build applications on cloud servers and platforms

## Computational Scientists

- Write codes to analyze scientific data that resides in the cloud

# Service Models

## Infrastructure-as-a-service (IaaS)

- Virtual servers, networks, firewalls, etc. (AWS, Azure)

## Platform-as-a-service (PaaS)

- Deploy application without managing virtual servers (Google App Engine, Heroku)

## Software-as-a-service (SaaS)

- Ready to use software applications (Gmail, Office365)

## Functions-as-a-service (FaaS)

- Run on demand without knowing the infrastructure (hook.io, AWS Lambda)

# IaaS with Virtual Machines

## Emulations

- Gives the appearance of any typical personal machine
- Simulates architectures

## Operating Systems

- Generally Linux in scientific communities but proprietary ones available through branded IaaS options

## Software

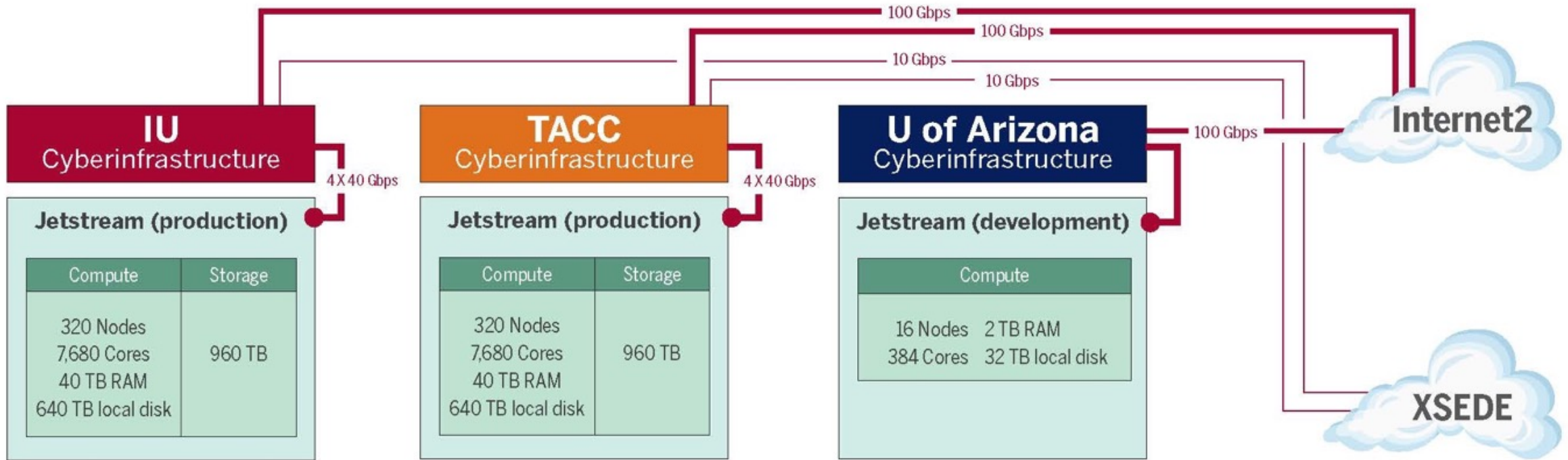
- Allows for installation of software in a way that generally doesn't require building from the binary



# Jetstream

- NSF funded production cloud facility
- On-demand interactive computing and analysis
- Configurable environments
- User-friendly, widely accessible cloud environment
- Library of preconfigured virtual machines

# Architecture Overview



## Getting Started



### Launch New Instance

Browse Atmosphere's list of available images and select one to launch a new instance.



### Browse Help Resources

View a video tutorial, read the how-to guides, or email the Atmosphere support team.



### Change Your Settings

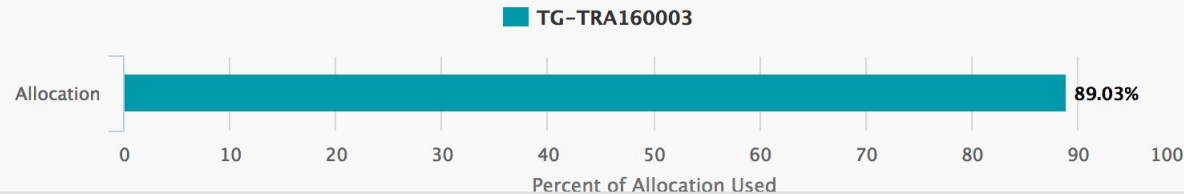
Modify your account settings, view your resource quota, or request more resources.

## Resources Used

[NEED MORE ?](#)

### Allocation Source

0 Instances



# Virtual Machines


- These configurations are available when choosing a VM.
- You should always request the smallest VM size that can accommodate your work.
- Local storage is ephemeral and will be lost when your session dies.
- For long term storage you will need an XSEDE-allocated Volume.

| VM Size    | vCPUs | RAM (GB) | Local Storage (GB) | SU cost per hour* | Can be saved as an <i>image</i> ? |
|------------|-------|----------|--------------------|-------------------|-----------------------------------|
| m1.tiny    | 1     | 2        | 8                  | 1                 | ✓ yes                             |
| m1.small   | 2     | 4        | 20                 | 2                 | ✓ yes                             |
| m1.medium  | 6     | 16       | 60                 | 6                 | ✓ yes                             |
| m1.large   | 10    | 30       | 60                 | 10                | ✓ yes                             |
| m1.xlarge  | 24    | 60       | 60                 | 24                | ✓ yes                             |
| m1.xxlarge | 44    | 120      | 60                 | 44                | ✓ yes                             |
| s1.large   | 10    | 30       | 120                | 10                | ✗ No                              |
| s1.xlarge  | 24    | 60       | 240                | 24                | ✗ No                              |
| s1.xxlarge | 44    | 120      | 480                | 44                | ✗ No                              |

This allocation information may be subject to changes in the future.

**Please note that s1.\* based customized instances will NOT be able to be used to create images in Atmosphere.**

# Images









 Dashboard Projects Images Help vtrue

## Image Search

Search across image name, tag or description

Showing 100 of 181 images

### Featured Images

|   |   |  |   |
|---|---|--|---|
|    | <b>CentOS 6 (6.9) Development GUI</b><br>Jan 10th 18 03:36 by <a href="#">jfisher</a> | <b>Based on CentOS 6 (6.9) Development</b><br>◦ updated from 6.8 to 6.9<br>Installation size ~ 4.4GB<br>CentOS desktop development Featured gui iRODS vnc          |    |
|    | <b>BioLinux 8</b><br>Jan 10th 18 01:39 by <a href="#">jfisher</a>                     | <b>Based on Ubuntu 14.04.3 -Trusty Tahr - server - cloudimg</b><br>-- **REQUIRES m1.small instance ...<br>bioinformatics desktop Featured gui m1_small Ubuntu x2go |    |
|  | <b>Centos 7 (7.4) Development GUI</b><br>Jan 4th 18 02:30 by <a href="#">jfisher</a>  | <b>Centos 7 (7.4) Development GUI</b><br>Installation size ~ 4.5GB<br>CentOS development docker docker-compose Featured gui iRODS                                  |  |
|  | <b>Intel Development (CentOS 7)</b><br>Jan 4th 18 01:54 by <a href="#">jfisher</a>    | <b>Intel compilers and development environment</b><br>***REQUIRES a m1.small or larger VM to la ...  |  |

# Images cont.

Launch an Instance / Basic Options

×

## Basic Info

### Instance Name

MATLAB (Based on CentOS 6)

### Base Image Version

1.11

### Project

demos

## Resources

### Allocation Source

TG-TRA160003

### Provider

Jetstream - Indiana University

### Instance Size

m1.medium (CPU: 6, Mem: 16 GB, Disk: 60 GB)

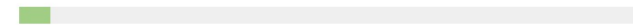
### Allocation Used

89% of 5500000 SUs from TG-TRA160003



### Resources Instance will Use

A total 6 of 132 allotted CPUs



A total 16 of 360 allotted GBs of Memory



⚙️ Advanced Options

CANCEL

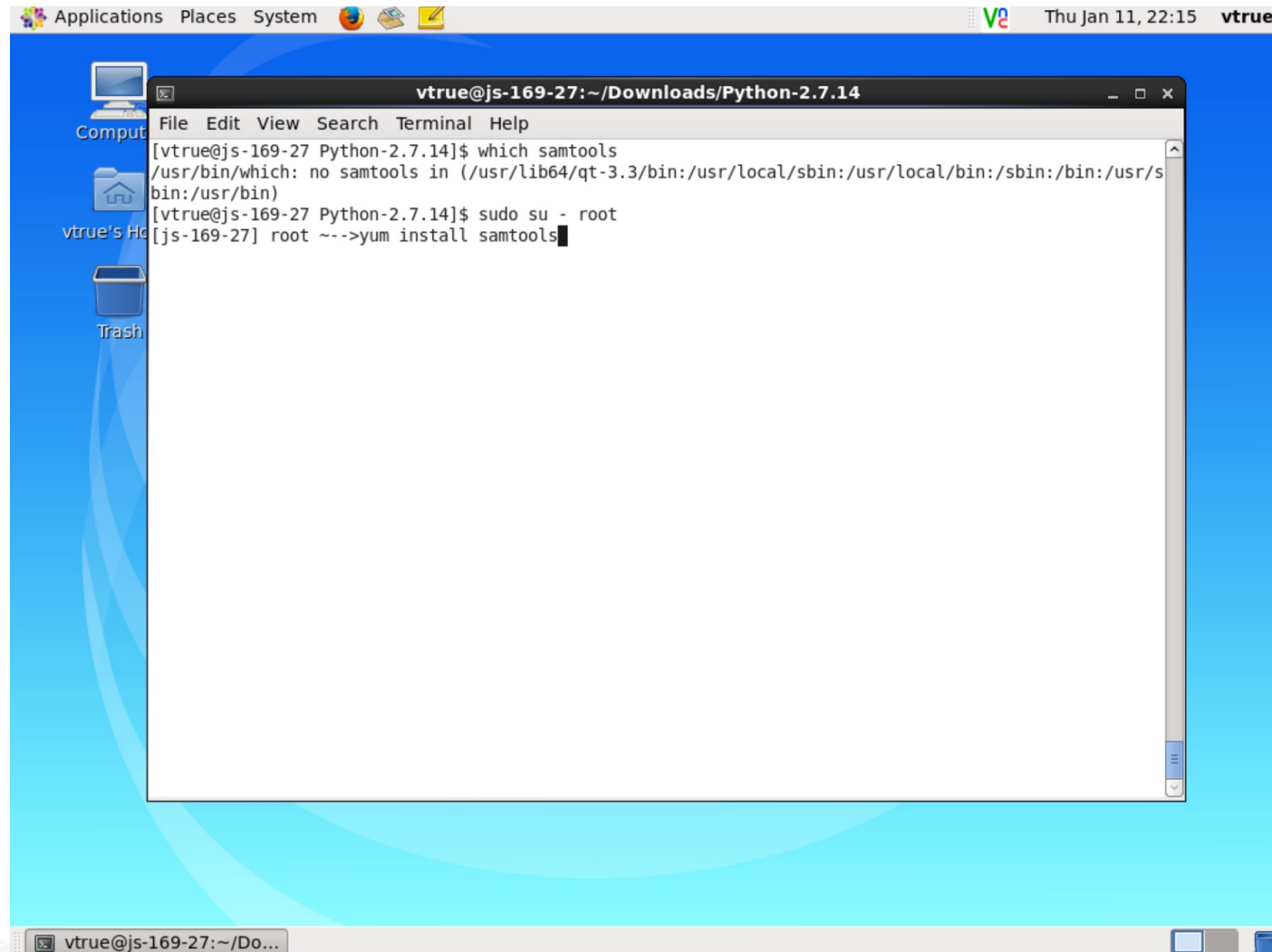
LAUNCH INSTANCE

# Images cont.





# Modifying an Image



The screenshot shows a Linux desktop with a blue background. A terminal window is open, displaying the following commands and output:

```
vtrue@js-169-27:~/Downloads/Python-2.7.14
File Edit View Search Terminal Help
[vtrue@js-169-27 Python-2.7.14]$ which samtools
/usr/bin/which: no samtools in (/usr/lib64/qt-3.3/bin:/usr/local/sbin:/usr/local/bin:/sbin:/bin:/usr/sbin:/usr/bin)
[vtrue@js-169-27 Python-2.7.14]$ sudo su - root
[js-169-27] root ~-->yum install samtools
```

The terminal window title is "vtrue@js-169-27:~/Downloads/Python-2.7.14". The desktop has icons for "Computer", "vtrue's Home", and "Trash". The system menu at the top shows "Applications", "Places", and "System". The system clock shows "Thu Jan 11, 22:15" and the username "vtrue".



# Modifying an Image cont.

```
vtrue@js-169-27:~/Downloads/Python-2.7.14
File Edit View Search Terminal Help

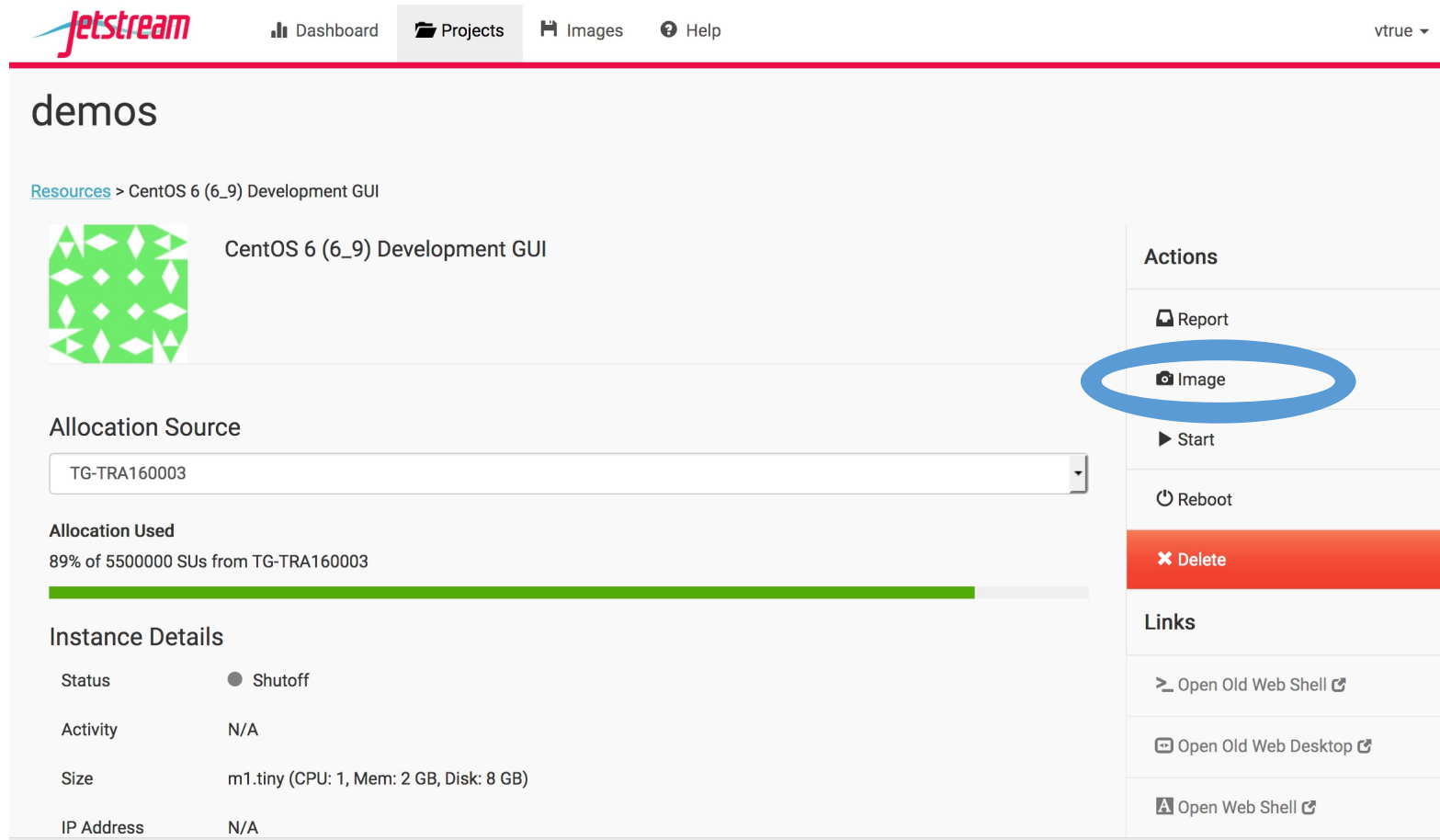
Transaction Summary
=====
Install      1 Package(s)

Total download size: 421 k
Installed size: 1.0 M
Is this ok [y/N]: y
Downloading Packages:
Setting up and reading Presto delta metadata
Processing delta metadata
Package(s) data still to download: 421 k
samtools-0.1.18-2.el6.x86_64.rpm                | 421 kB    00:00
Running rpm_check_debug
Running Transaction Test
Transaction Test Succeeded
Running Transaction
  Installing : samtools-0.1.18-2.el6.x86_64      1/1
  Verifying  : samtools-0.1.18-2.el6.x86_64      1/1

Installed:
  samtools.x86_64 0:0.1.18-2.el6

Complete!
[js-169-27] root ~-->which samtools
/usr/bin/samtools
[js-169-27] root ~-->exit
logout
[vtrue@js-169-27 Python-2.7.14]$ which samtools
/usr/bin/samtools
[vtrue@js-169-27 Python-2.7.14]$
```

# Saving an Image




The screenshot shows the Jetstream web interface. The top navigation bar includes the Jetstream logo, a dashboard icon, and links to Dashboard, Projects, Images, and Help. The user 'vtrue' is logged in. The main content area is titled 'demos' and shows a breadcrumb trail: Resources > CentOS 6 (6\_9) Development GUI. Below this is a green geometric icon and the text 'CentOS 6 (6\_9) Development GUI'. The 'Allocation Source' is set to 'TG-TRA160003'. The 'Allocation Used' section shows '89% of 5500000 SUs from TG-TRA160003' with a green progress bar. The 'Instance Details' table shows the status as 'Shutoff', activity as 'N/A', size as 'm1.tiny (CPU: 1, Mem: 2 GB, Disk: 8 GB)', and IP address as 'N/A'. On the right, the 'Actions' menu is visible, with the 'Image' button circled in blue. Other actions include Report, Start, Reboot, Delete, and a Links section with Open Old Web Shell, Open Old Web Desktop, and Open Web Shell.

Jetstream

Dashboard Projects Images Help vtrue

## demos

Resources > CentOS 6 (6\_9) Development GUI

 CentOS 6 (6\_9) Development GUI

Allocation Source

TG-TRA160003

Allocation Used

89% of 5500000 SUs from TG-TRA160003

Instance Details

|            |   |
|------------|---|
| Status     | ● Shutoff                               |
| Activity   | N/A                                     |
| Size       | m1.tiny (CPU: 1, Mem: 2 GB, Disk: 8 GB) |
| IP Address | N/A                                     |

Actions

- Report
- Image**
- Start
- Reboot
- Delete

Links

- Open Old Web Shell
- Open Old Web Desktop
- Open Web Shell

# In Summary

- The longer your instance runs the more SUs you consume
- Be aware that you are on a shared resource
- You have root access, but the original image stays intact
- This is only the basic level of what you can do with Jetstream; there are many more options available in the Wiki

# IaaS with Bare Metal

## Direct access to the node

- Choose how you want to interact with the system

## Build your own interface

- Select and install your own OS
- Install software to your exact specifications

## OpenStack

- Cloud based OS to help control your environment
- Provides dashboard based management in addition to command line

# Chameleon

## Select the hardware you want

- Instead of images you can select 'flavors' to determine memory, cpus, root disk, etc


## Network options

- Generate IPs for external access

## Develop APIs

- Use APIs to provide dashboards, monitor activity, etc

# OpenStack

TACC-HPC vtrue

Project

Compute

Overview

Instances

Volumes

Images

Access & Security

Network

Identity

## Images

Project (0)

Shared with Me (0)

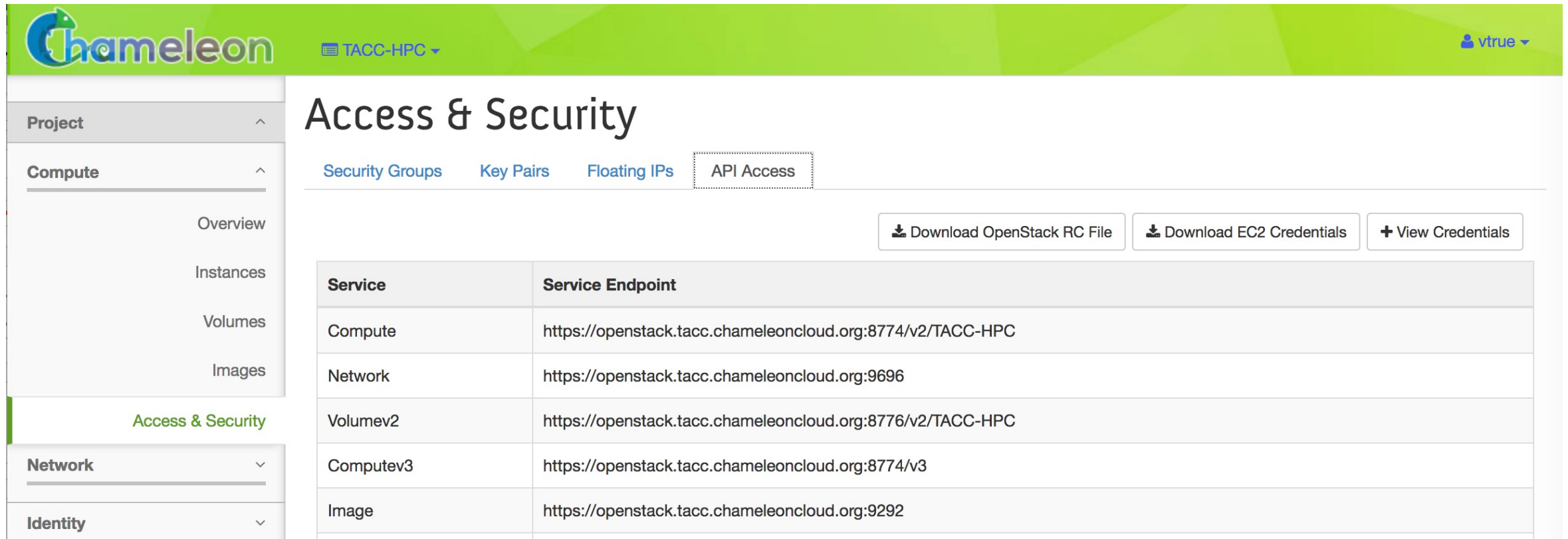
Public (61)

+ Create Image

Delete Images

| <input type="checkbox"/> | Image Name                              | Type  | Status | Public | Protected | Format | Size     | Actions         |
|--------------------------|---|-------|--------|--------|-----------|--------|----------|-----------------|
| <input type="checkbox"/> | <a href="#">CC-Ubuntu16.04</a>          | Image | Active | Yes    | No        | QCOW2  | 679.7 MB | Launch Instance |
| <input type="checkbox"/> | <a href="#">CC-Ubuntu14.04</a>          | Image | Active | Yes    | No        | QCOW2  | 507.8 MB | Launch Instance |
| <input type="checkbox"/> | <a href="#">CC-CentOS7</a>              | Image | Active | Yes    | No        | QCOW2  | 755.6 MB | Launch Instance |
| <input type="checkbox"/> | <a href="#">CC-Ubuntu16.04-20180413</a> | Image | Active | Yes    | No        | QCOW2  | 677.8 MB | Launch Instance |
| <input type="checkbox"/> | <a href="#">CC-Ubuntu14.04-20180410</a> | Image | Active | Yes    | No        | QCOW2  | 507.5 MB | Launch Instance |
| <input type="checkbox"/> | <a href="#">CC-CentOS7-1802.1</a>       | Image | Active | Yes    | No        | QCOW2  | 754.4 MB | Launch Instance |
| <input type="checkbox"/> | <a href="#">CC-Ubuntu14.04-20180330</a> | Image | Active | Yes    | No        | QCOW2  | 503.4 MB | Launch Instance |

# APIs, SSH, and IPs



The screenshot shows the Chameleon TACC-HPC dashboard. The left sidebar contains navigation links for Project, Compute, Overview, Instances, Volumes, Images, Access & Security (highlighted), Network, and Identity. The main content area is titled 'Access & Security' and features tabs for Security Groups, Key Pairs, Floating IPs, and API Access (which is selected and highlighted with a dashed border). Below the tabs are three buttons: 'Download OpenStack RC File', 'Download EC2 Credentials', and 'View Credentials'. A table lists the service endpoints for various OpenStack services.

| Service   | Service Endpoint  |
|-----------|---|
| Compute   | <a href="https://openstack.tacc.chameleoncloud.org:8774/v2/TACC-HPC">https://openstack.tacc.chameleoncloud.org:8774/v2/TACC-HPC</a> |
| Network   | <a href="https://openstack.tacc.chameleoncloud.org:9696">https://openstack.tacc.chameleoncloud.org:9696</a>                         |
| Volumev2  | <a href="https://openstack.tacc.chameleoncloud.org:8776/v2/TACC-HPC">https://openstack.tacc.chameleoncloud.org:8776/v2/TACC-HPC</a> |
| Computev3 | <a href="https://openstack.tacc.chameleoncloud.org:8774/v3">https://openstack.tacc.chameleoncloud.org:8774/v3</a>                   |
| Image     | <a href="https://openstack.tacc.chameleoncloud.org:9292">https://openstack.tacc.chameleoncloud.org:9292</a>                         |

# Command Line Access

## Install OpenStack

- Install python
- `pip install python-openstackclient`

## Download an RC File

- Pull from your Chameleon account
- `source <path/to/openstack_rc_file>`
- If you are a Windows user you'll need to manually provide environment variables



## For Mac

```
vtrue-mbpr:~ vtrue$ python --version
Python 2.7.15
vtrue-mbpr:~ vtrue$ pip install python-openstackclient
Collecting python-openstackclient
  Downloading
https://files.pythonhosted.org/packages/33/84/c739b13aacc47d887cae58acc7dd921240918aa20a9
add6ab64d932d1a6a/python_openstackclient-3.15.0-py2.py3-none-any.whl (823kB)
  100% |████████████████████████████████████████████████████████████████████████████████| 829kB 8.0MB/s
Collecting oslo.utils>=3.33.0 (from python-openstackclient)
  Downloading
https://files.pythonhosted.org/packages/6c/bb/308293b06400625b721795657c0c50c8a5942fde58d
9532b40f57758a158/oslo.utils-3.36.2-py2.py3-none-any.whl (91kB)
  100% |████████████████████████████████████████████████████████████████████████████████| 92kB 4.6MB/s
Collecting osc-lib>=1.8.0 (from python-openstackclient)
  Downloading
https://files.pythonhosted.org/packages/de/b7/91ed1a58756390fa006a5777ceb44578f021a9b67ff
ec0729f5037fff51a/osc_lib-1.10.0-py2-none-any.whl (81kB)
  100% |████████████████████████████████████████████████████████████████████████████████| 81kB 17.4MB/s
Collecting python-glanceclient>=2.8.0 (from python-openstackclient)
```

# For Windows

```
openstack --os-auth-url <OS_AUTH_URL> \  
--os-project-id <OS_PROJECT_ID> \  
--os-project-name <OS_PROJECT_NAME> \  
--os-user-domain-name <OS_USER_DOMAIN_NAME> \  
--os-username <OS_USERNAME> \  
--os-password <OS_PASSWORD> \  
--os-region-name <OS_REGION_NAME> \  
--os-interface <OS_INTERFACE> \  
--os-identity-api-version <OS_IDENTITY_API_VERSION>
```

# On the Command Line

```
vtrue-mbpr:~ vtrue$ openstack  
Readline features including tab completion have been disabled since no  
supported version of readline was found. To resolve this, install  
pyreadline on Windows or gnureadline on Mac.
```

```
(openstack)
```

There are options available in the command line that are not available in the GUI

- Gnocchi metrics
- Advanced networking

# Selecting Hardware

## Chameleon Resource Browser

Filter nodes using the options below, then generate a reservation script to reserve those nodes.

Applied Filters: None

**428 nodes**

Compute (291)

Infiniband Support (41)

GPU (24)

Storage (26)

Storage Hierarchy (2)

FPGA (4)

Low Power Xeon (8)

Atom (8)

ARM64 (24)

|                                     |   |  |                                  |                                   |  |
|-------------------------------------|---|--|----------------------------------|-----------------------------------|--|
| <b>Site</b>                         | <b>Cluster</b>                                      | <b>Platform Type</b>                   | <b># CPUs</b>                    | <b># Threads</b>                  | <b>RAM Size</b>                        |
| <input type="checkbox"/> Tacc (337) | <input checked="" type="checkbox"/> Chameleon (428) | <input type="checkbox"/> Aarch64 (24)  | <input type="checkbox"/> 1 (40)  | <input type="checkbox"/> 40 (26)  | <input type="checkbox"/> 128 GiB (360) |
| <input type="checkbox"/> Uc (91)    |   | <input type="checkbox"/> X86 #64 (404) | <input type="checkbox"/> 2 (388) | <input type="checkbox"/> 48 (358) | <input type="checkbox"/> 32 GiB (16)   |
|                                     |   |  |                                  | <input type="checkbox"/> 56 (4)   | <input type="checkbox"/> 512 GiB (2)   |
|                                     |   |  |                                  | <input type="checkbox"/> 8 (40)   | <input type="checkbox"/> 64 GiB (50)   |

[Show Advanced Filters](#)

**428 nodes**

Reserve



View

Reset

# Check on Resources with REST API

```
vtrue-mbpr:~ vtrue$ curl -i https://api.chameleoncloud.org/  
HTTP/1.1 200 OK  
Server: nginx/1.6.2  
Date: Tue, 12 Jun 2018 22:35:34 GMT  
Content-Type: application/vnd.grid5000.item+json; charset=utf-8  
Content-Length: 757  
Connection: keep-alive  
Allow: GET  
  
...  
{  
  "type": "grid",  
  "uid": "chameleoncloud",  
  "version": "0aa787fa5c97c34bd0b7a583d4e2fab693010daa",  
  "release": "3.5.7",  
  "timestamp": 1528842934,  
  "links": [  
    {  
      "rel": "sites",  
      "href": "/sites",  
      "type": "application/vnd.grid5000.collection+json"  
    },  
    {  
      "rel": "self",  
      "type": "application/vnd.grid5000.item+json",  
      "href": "/"  
    }  
  ]  
}
```

# Reservations

 CH-819870  jchuah

Project

Compute

Network

Orchestration

Object Store


Reservations

Leases


Identity

Project / Reservations /

## Leases

 Lease Calendar

+ Create Lease

 Delete Leases

Displaying 1 item

| <input type="checkbox"/> | Lease name                      | Start date           | End date             | Action | Status   | Reason                     | Actions                 |
|--------------------------|---------------------------------|----------------------|----------------------|--------|----------|----------------------------|-------------------------|
| <input type="checkbox"/> | <a href="#">my-custom-lease</a> | 2018-03-08 17:00 UTC | 2018-03-08 18:00 UTC | STOP   | COMPLETE | Successfully stopped lease | <div>Delete Lease</div> |


Displaying 1 item

# Complex Appliances

*Complex Appliances* allow you to specify not only what image you want to deploy but also on how many nodes you want to deploy that image, what roles the deployed instances should boot into (such as e.g., head node and worker node in a cluster), what information from a specific instance should be passed to another instance in that *Complex Appliance*, and what scripts should be executed on boot so that this information is properly used for configuring the “one click” cluster.

[+ Add an appliance](#)



## Appliance Catalog



### ARM



**ARM64 (Ubuntu 16.04)**

Chameleon-supported Ubuntu 16.04 LTS image for ARM64 machines



### CentOS 7

The default Chameleon appliance



### COMPSS 1.3

COMPSS is a task based programming model for distributed platforms.



### CUDA 7.5

CUDA appliance based on CentOS 7



# Managing and Monitoring

- Need to be launched the same way an Image is
- Select the Stack from the GUI once it is up
- SSH to it with a floating IP just like with an Image
- You can also do this from the command line with OpenStack



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# Q&A

<https://chameleoncloud.readthedocs.io/en/latest/technical/index.html>

<https://iujetstream.atlassian.net/wiki/spaces/JWT/pages/17465367/System+Overview>