Accessing Jetstream via the OpenStack Command Line Interface

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Terms & Definitions
Cloud Computing Terms ...simplified

- **Image**: a file on a disk. It will be booted to create an…
- **Instance**: a running virtual server; i.e. something you can log into.
- **Running**: the instance is up & running
- **Suspended**: the instance is memory resident but not running
- **Stopped**: the instance is shutdown akin to powering down
- **Shelved**: the instance is shutdown, backedup, and stored
Cloud Computing Terms  ...simplified

- **Flavor**: the size of a running instance; i.e. #core, RAM, disk
- **Hypervisor**: the thing the instance runs on; something akin to a software defined hardware compute server.
- **Snapshot**: the process of taking an instance and turning it to an image.
- **State**: something worth remembering; i.e. the state of the system
Cloud Computing Terms ...simplified (Cont.)

- **Object store**: a blob of bits; it has a starting address & a size. There may be metadata associated with the object. The data is consumed in a streaming manner.

- **Block store**: a software defined entity akin to an unformatted hardware disk drive.

- **Filesystem**: hierarchical in nature, directories & files, ability to open, seek, read, write.

- **Persistent storage**: If you pull the plug, it will still exist when power is restored. Safe to store data or state here.

- **Ephemeral storage**: If you pull the plug, it no longer exists. (Don’t put your data here!!!)
What is Jetstream
What is Jetstream?

• **User-friendly**, widely accessible cloud environment
  • **User-selectable library** of preconfigured virtual machines
    • Interactive computing
    • Software maintained by domain specialist
    • No need for system administration skills
    • The “Atmosphere” side

• **Programmable cyberinfrastructure**
  • Go beyond batch computing
  • Implement modern cloud computing techniques
  • Common modality for science gateways
  • The “API” side
“Long tail” of the Science

Large HPC systems requiring sophisticated distributed memory programming skills
~3% researchers supported by the NSF

Everyone else
Mostly node level parallelism

Supercomputer  Scale  laptop

http://jetstream-cloud.org/

funded by the National Science Foundation
Award #ACI-1445604
What is Jetstream?

• **Primary goal** is to **expand the user base** of NSF’s eXtreme Digital (XD) program resources beyond the current community of users.

• **Lowering the hurdle** to onboard to XSEDE resources
  • Working to **ease** the **allocation request** process
  • **Easy-Button**; quick access but limited ability. (Beta)

• **Making Science Easy** for domain researchers, engineers, & educators
  • Domain software installed & maintained by the professionals
  • No sys-admin skills necessary

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What is Jetstream? (Cont.)

- Creating communities
  - Domain developers **create, install, and maintain** the software
  - **Encourage collaboration** within the domains
  - **Operating system** level software is professionally **patched and maintained**

- **Repeatability**: store & publish images via IU Scholarworks & create a DOI

- **Science Gateways**:

- **Programmatic Cyberinfrastructure**
  - More on this in a minute
  - What this class will be covering today
What is Jetstream?

- **Cloudy Technologies:** clouds are more than just virtual machines (VM)
  - **Old way:** robust (expensive) infrastructure, weak (cheap) software
    - You expect the hardware to not fail
    - State in maintained in volatile data structures
  - **Cloudy way:** commodity infrastructure, robust software
    - Expect & plan for infrastructure to fail
    - Put intelligence into the software to handle infrastructure failure
- **Cows, not pets:**
  - pets have **state**, you name them, you get attached to them, you put forth great amount of care and effort
  - cows **do not** have **state**, you expect to have high turnover, you do not get attached to them, you give them numbers instead of names
What is Jetstream?

- **Software layers**
  - **Atmosphere** web interface (*covered this morning*)
    - library of images, generic, domain specific
    - simplify VM administration
  - **OpenStack**: software tools for building and managing cloud computing platforms for public and private clouds.
  - **KVM** hypervisor: what the VMs run on
  - **Ceph**: storage platform that stores data on a single distributed computer cluster, and provides interfaces for **object-**, **block-** and **file-level** storage.
  - **Operating systems**: CentOS, Ubuntu, Windows?
  - **Applications**: e.g. software developed by the domain specialist, gateways, etc.

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API Access to Jetstream

• What was unexpected
  – Demand for programmable cyberinfrastructure
  – Great platform for learning system administration skills
  – Great platform for teaching & learning cloudy technologies

• Command line clients
• Horizon dashboard very popular; but, incomplete
• Programmatic control; python is popular
• Slack channel for collaboration API users of Jetstream
OpenStack
OpenStack Organization

The OpenStack Mission: to produce the ubiquitous Open Source Cloud Computing platform that will meet the needs of public and private clouds regardless of size, by being simple to implement and massively scalable.

OpenStack is open source, openly designed, openly developed by an open community.

OpenStack Project Teams are the building blocks to achieve OpenStack’s mission. One can think of Project Teams as teams of people using tools (code repository, bug tracker, etc) and coordinated processes to produce a number of deliverables, in order to achieve a clearly stated objective.

Browse the official list of OpenStack project teams.

OpenStack software is produced by the OpenStack Foundation.

http://jetstream-cloud.org/

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OpenStack : the Project Navigator

http://www.openstack.org/software/project-navigator/

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Openstack Projects ...the core services

<table>
<thead>
<tr>
<th>Service</th>
<th>Name</th>
<th>Adoption</th>
<th>Maturity</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identity</td>
<td>Keystone</td>
<td>96%</td>
<td>7/8</td>
<td>5 yrs</td>
</tr>
<tr>
<td>Images</td>
<td>Glance</td>
<td>95%</td>
<td>6/8</td>
<td>7 yrs</td>
</tr>
<tr>
<td>Block device</td>
<td>Cinder</td>
<td>88%</td>
<td>7/8</td>
<td>5 yrs</td>
</tr>
<tr>
<td>Networking</td>
<td>Neutron</td>
<td>93%</td>
<td>7/8</td>
<td>5 yrs</td>
</tr>
<tr>
<td>Compute</td>
<td>Nova</td>
<td>95%</td>
<td>8/8</td>
<td>7 yrs</td>
</tr>
<tr>
<td>Object device</td>
<td>Swift</td>
<td>52%</td>
<td>7/8</td>
<td>7 yrs</td>
</tr>
</tbody>
</table>

https://www.openstack.org/software/project-navigator/
## Openstack Projects ... some other services

<table>
<thead>
<tr>
<th>Service</th>
<th>Name</th>
<th>Adoption</th>
<th>Maturity</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dashboard</td>
<td>Horizon</td>
<td>87%</td>
<td>6/8</td>
<td>5 yrs</td>
</tr>
<tr>
<td>Telemetry</td>
<td>Ceilometer</td>
<td>55%</td>
<td>1/8</td>
<td>4 yrs</td>
</tr>
<tr>
<td>Orchestration</td>
<td>Heat</td>
<td>67%</td>
<td>6/8</td>
<td>4 yrs</td>
</tr>
<tr>
<td>Containers</td>
<td>Magnum</td>
<td>11%</td>
<td>2/8</td>
<td>2 yrs</td>
</tr>
<tr>
<td>Map/Reduce</td>
<td>Sahara</td>
<td>10%</td>
<td>3/8</td>
<td>3 yrs</td>
</tr>
</tbody>
</table>

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Openstack Projects  ...some other services

<table>
<thead>
<tr>
<th>Service</th>
<th>Name</th>
<th>Adoption</th>
<th>Maturity</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared Filesystems</td>
<td>Manila</td>
<td>14%</td>
<td>5/8</td>
<td>3 yrs</td>
</tr>
<tr>
<td>Workflow</td>
<td>Mistral</td>
<td>5%</td>
<td>1/7</td>
<td>1 yr</td>
</tr>
<tr>
<td>Load Balancing as a Service</td>
<td>Octavia</td>
<td>&gt;0%</td>
<td>1/7</td>
<td>1 yr</td>
</tr>
</tbody>
</table>

https://www.openstack.org/software/project-navigator/

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Hardware & Infrastructure
## Production Cloud Hardware (per site)

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Number</th>
<th>Specifications</th>
<th>Function (IU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell PowerEdge M630 blades</td>
<td>320</td>
<td>2X Intel E5-2680v3 “Haswell”</td>
<td>Compute hosts, OpenStack services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 cores @ 2.5 GHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>128 GB RAM</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 TB local disk</td>
<td></td>
</tr>
<tr>
<td>Dell PowerEdge R630 1U server</td>
<td>7</td>
<td>2X Intel E5-2680v3 “Haswell”</td>
<td>Cluster management, High Availability, Databases, RabbitMQ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 cores @ 2.5 GHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>128 GB RAM</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 TB local disk</td>
<td></td>
</tr>
<tr>
<td>Dell PowerEdge R730xd 2U servers</td>
<td>20</td>
<td>2X Intel E5-2680v3 “Haswell”</td>
<td>~1 PB Ceph storage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 cores @ 2.5 GHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>64 GB RAM</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>48 TB storage for Ceph pool</td>
<td></td>
</tr>
<tr>
<td>Dell S6000-ON network switches</td>
<td>9</td>
<td>32+2 40 Gb/s ports</td>
<td>Top of Rack &amp; Spine 2 to 1 Fat Tree topology</td>
</tr>
</tbody>
</table>

*Funded by the National Science Foundation Award #ACI-1445604*
Benchmarks – single node
## HPCC results: VM vs BareMetal Comparison

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>VM/BareMetal</th>
<th>Units</th>
<th>What’s tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPL</td>
<td>97%</td>
<td>FLOPS</td>
<td>floating point execution rate for solving a system of linear equations</td>
</tr>
<tr>
<td>DGEMM</td>
<td>98%</td>
<td>FLOPS</td>
<td>floating point execution rate for double precision real matrix-matrix multiplication</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>88%</td>
<td>B/s</td>
<td>bytes/unit_time it takes to transmit a 2MB message from one node to another</td>
</tr>
<tr>
<td>Latency</td>
<td>97%</td>
<td>s</td>
<td>time required to send an 8-byte message from one node to another</td>
</tr>
</tbody>
</table>
## HPCC results: VM vs BareMetal Comparison (Cont.)

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>VM/BareMetal</th>
<th>Units</th>
<th>What’s tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>80%</td>
<td>up/s</td>
<td>rate of random updates of memory</td>
</tr>
<tr>
<td>Stream</td>
<td>77%</td>
<td>B/s</td>
<td>sustained memory bandwidth</td>
</tr>
<tr>
<td>MPI-FFT</td>
<td>67%</td>
<td>FLOPS</td>
<td>floating point rate of execution of double precision complex one-dimensional Discrete Fourier Tranform</td>
</tr>
<tr>
<td>Ptrans</td>
<td>64%</td>
<td>B/s</td>
<td>rate of transfer for large arrays of data from multiprocessor’s memory</td>
</tr>
</tbody>
</table>

http://jetstream-cloud.org/  

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### VM Instance Sizes (Flavors)

<table>
<thead>
<tr>
<th>Instance Type</th>
<th>vCPUs</th>
<th>RAM(GB)</th>
<th>Storage(GB)</th>
<th>Instances/Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiny</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>46</td>
</tr>
<tr>
<td>Small</td>
<td>2</td>
<td>4</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Medium</td>
<td>6</td>
<td>16</td>
<td>60</td>
<td>7</td>
</tr>
<tr>
<td>Large</td>
<td>10</td>
<td>30</td>
<td>120/60*</td>
<td>4</td>
</tr>
<tr>
<td>X-Large</td>
<td>22</td>
<td>60</td>
<td>240/60*</td>
<td>2</td>
</tr>
<tr>
<td>XX-Large</td>
<td>44</td>
<td>120</td>
<td>480/60*</td>
<td>1</td>
</tr>
</tbody>
</table>

Node config: dual Intel E-2680v3 “Haswell”, 24 physical cores/node @ 2.5 GHz, 128 GB RAM, dual 1 TB local disks.

* Effective 29-Mar-2017
Jetstream Systems

Jetstream (production)
- Compute: 320 Nodes, 7,680 Cores, 40 TB RAM, 640 TB local disk
- Storage: 960 TB

Jetstream (development)
- Compute: 16 Nodes, 2 TB RAM, 384 Cores
- Storage: 32 TB local disk

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http://jetstream-cloud.org/
Platform Overview

- OpenStack API access
- Atmosphere API access (work in progress)
- S3 access to Ceph (it’s working!)

Indiana University

OpenStack

Ceph

TACC

OpenStack

Ceph

Globus Auth

Atmosphere API

Atmo Services

XSEDE Accounting

Web App

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Platform Overview

OpenStack API access

S3 access to Ceph (work in progress)

Globus Auth  Atmosphere API
Atmo Services  XSEDE Accounting

Web App

Indiana University  TACC

Agave API access (work in progress)

OpenStack  Ceph  OpenStack  Ceph

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Platform Overview

- OpenStack API access
- Atmosphere API
- Globus Auth
- Atmo Services
- XSEDE Accounting

OpenStack API access
S3 access to Ceph (work in progress)

Indiana University
TACC

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http://jetstream-cloud.org/
OpenStack Overview

[Diagram showing relationships between Client, Keystone, Nova, Glance, Ceph, Cinder, and Compute with arrows indicating connections and dependencies.]
How do we onboard users onto Jetstream?

- An **XSEDE User Portal (XUP) account** is required. They are free! Get one at [https://portal.xsede.org](https://portal.xsede.org)

- **Work with your XSEDE Campus Champion.**

- Submit an **allocations request**
  - Read the Allocations Overview - [https://portal.xsede.org/allocations-overview](https://portal.xsede.org/allocations-overview)
  - Writeup an allocation request – **start with a Startup or Education request** - [https://portal.xsede.org/successful-requests](https://portal.xsede.org/successful-requests)

- **Easy Button**: instant access to small, limited instances while the allocation request is processed and the user is vetted.
Jetstream Information Sources

• Twitter: @jetstream-cloud

• Jetstream’s web interface: https://use.jetstream-cloud.org/
  No login required to browse image library

• XSEDE User Portal account is required to actually login:
  https://portal.xsede.org Create account in seconds.

• Jetstream Home page: https://jetstream-cloud.org/

• Jetstream’s public documentation: https://wiki.jetstream-cloud.org
Jetstream Information Sources  (Cont.)

• Paper describing Jetstream *Jetstream: A self-provisioned, scalable science and engineering cloud environment*

• Configuration management:  [https://github.com/jetstream-cloud/Jetstream-Salt-States](https://github.com/jetstream-cloud/Jetstream-Salt-States)

For questions, comments, etc. of any manner  
[help@jetstream-cloud.org](mailto:help@jetstream-cloud.org)
Jetstream Partners

funded by the National Science Foundation
Award #ACI-1445604
Questions?

Project website: http://jetstream-cloud.org/
Project email: jethelp@iu.edu
Direct email: turnerg@iu.edu

License Terms

- Jetstream is supported by NSF award 1445604 (Craig Stewart, IU, PI)
- XSEDE is supported by NSF award 1053575 (John Towns, UIUC, PI)
- This research was supported in part by the Indiana University Pervasive Technology Institute, which was established with the assistance of a major award from the Lilly Endowment, Inc. Opinions presented here are those of the author(s) and do not necessarily represent the views of the NSF, IUPITI, IU, or the Lilly Endowment, Inc.
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Resources for this class

- The **Computational Science in the Cloud Institute** class
  - [https://tacc.github.io/CSC2017Institute/docs/day4/intro_to_openstack.html](https://tacc.github.io/CSC2017Institute/docs/day4/intro_to_openstack.html)
  - Utilizes Jupyter notebooks
  - Cut & Paste examples
  - Use only the “new” commands
  - The ”old” commands give insight into the various OpenStack Projects
Resources for this class

- General API access to Jetstream information
  - https://iujetstream.atlassian.net/wiki/spaces/JWT/pages/39682057/Using+the+Jetstream+API

- Setting up the openrc
  - https://iujetstream.atlassian.net/wiki/spaces/JWT/pages/39682064/Setting+up+openrc.sh

- Openstack Command Line examples for today’s class
  - https://iujetstream.atlassian.net/wiki/spaces/JWT/pages/35913730/OpenStack+command+line
  - Cut-&-Paste examples
Resources for this class

- Openstack Command Line example

- Jetstream-cloud.org
  - Click Get Started
  - Click Jetstream wiki in first paragraph
    - In the left column, scroll to near bottom
  - Click on Using the Jetstream API
    - Entry will expand
  - ~3 lines down, click on OpenStack Command Line
Getting started

• ssh utsa-class-cmd.jetstream-cloud.org
• username and password on paper
• cat openrc
• source openrc
• printenv | grep OS | grep –v PASS
• openstack image list
  – Is it working?