A national science & engineering cloud

UIISO/UIPO Chalk Talk: Jetstream

Mike Lowe – jomlowe@iu.edu
George Turner – turnerg@iu.edu

Research Technologies - High Performance Systems

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What is Jetstream?

• **User-friendly**, widely accessible cloud environment

• **User-selectable library** of preconfigured virtual machines; no need for system administration skills.

• **NSF’s first production cloud** facility supporting all areas of science and engineering within NSF’s scope

• **Enable discoveries across disciplines** such as biology, atmospheric science, economics, network science, observational astronomy, and social sciences.
What is Jetstream? (cont)

- Particularly focused on researchers working in the “long tail” of science with born digital data

“Long tail” of the NSF XD Ecosystem

Capability class machines
Traditional HPC, HTC systems

A self-provisioned, scalable science & engineering cloud environment
What is Jetstream?  (cont)

• Primary goal is to **expand the userbase** of XD program resources beyond the current community of users.

• **Reproducibility**: store, publish via IU Scholarworks (DOI)

• **Cloudy**: clouds are more the just virtual machines (VM)
  • old way: robust infrastructure, weak software
  • Cloudy way: commodity infrastructure, robust software
  • cows, not pets
What is Jetstream? (cont)

- Software layers
  - **Atmosphere** web interface
    - 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?
Who will use Jetstream

- Researchers & students needing access to interactive computing and data analysis resources on demand. “A few processors now instead of thousands next week.”

- Researchers & software developers creating & maintaining domain specific software packages

- As a backend supporting science gateways
21st century workforce development

- Jetstream will include **virtual Linux desktops** and applications specifically aimed to enable research and research education at small colleges and universities including HBCUs (Historically Black Colleges and Universities), MSI (Minority Serving Institutions), Tribal colleges, and higher-Ed institutions in EPSCoR States.
Jetstream System Overview

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

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

U of Arizona Cyberinfrastructure
- Jetstream (development)
  - Compute: 16 Nodes, 384 Cores, 2 TB RAM, 32 TB local disk
  - Storage: 640 TB

Connections:
- 4 X 40 Gbps from IU to TACC
- 4 X 40 Gbps from TACC to U of Arizona
- 10 Gbps from IU to XSEDE
- 10 Gbps from TACC to Internet2
- 100 Gbps from U of Arizona to XSEDE
- 100 Gbps from IU to Internet2
- 100 Gbps from TACC to XSEDE
- 100 Gbps from U of Arizona to Internet2
Jetstream hardware
# VM Instance Sizes (Flavors)

<table>
<thead>
<tr>
<th>Instance Type</th>
<th>vCPUs</th>
<th>RAM</th>
<th>Storage</th>
<th>Instances/Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiny</td>
<td>1</td>
<td>2</td>
<td>20</td>
<td>46</td>
</tr>
<tr>
<td>Small</td>
<td>2</td>
<td>4</td>
<td>40</td>
<td>23</td>
</tr>
<tr>
<td>Medium</td>
<td>6</td>
<td>16</td>
<td>130</td>
<td>7</td>
</tr>
<tr>
<td>Large</td>
<td>10</td>
<td>30</td>
<td>230</td>
<td>4</td>
</tr>
<tr>
<td>X-Large</td>
<td>22</td>
<td>60</td>
<td>460</td>
<td>2</td>
</tr>
<tr>
<td>XX-Large</td>
<td>44</td>
<td>120</td>
<td>920</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.
Software Stack: Metal to Atmosphere
Jetstream click-through agreement

XSEDE Acceptable Use Policy: https://portal.xsede.org/usage-policy
Jetstream Partner Organizations

<table>
<thead>
<tr>
<th>Initial construction (funded partners)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indiana University</td>
</tr>
<tr>
<td>The University of Texas at Austin</td>
</tr>
<tr>
<td>TACC</td>
</tr>
<tr>
<td>The University of Arizona</td>
</tr>
<tr>
<td>The University of Chicago</td>
</tr>
<tr>
<td>Globus</td>
</tr>
<tr>
<td>Johns Hopkins University</td>
</tr>
<tr>
<td>UTSA</td>
</tr>
<tr>
<td>Cornell University</td>
</tr>
<tr>
<td>University of Hawai‘i</td>
</tr>
<tr>
<td>University of Arkansas at Pine Bluff</td>
</tr>
<tr>
<td>Penn State</td>
</tr>
<tr>
<td>National Snow and Ice Data Center</td>
</tr>
<tr>
<td>The Odum Institute</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Planned funded partners (O&amp;M phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Texas at San Antonio</td>
</tr>
<tr>
<td>Cornell University</td>
</tr>
<tr>
<td>University of Hawai‘i</td>
</tr>
<tr>
<td>University of Arkansas at Pine Bluff</td>
</tr>
<tr>
<td>NSIDC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unfunded partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Texas at San Antonio</td>
</tr>
<tr>
<td>Penn State</td>
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<td>The Odum Institute</td>
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</tbody>
</table>

http://jetstream-cloud.org/
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

• Read the Allocations Overview - https://portal.xsede.org/allocations-overview

• Write a successful allocation request – start with a Startup or Education request - https://portal.xsede.org/successful-requests
Jetstream Information Sources

• Jetstream: https://use.jetstream-cloud.org/

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

• User guide: http://jetstream-cloud.org/training.php

• Paper describing Jetstream Jetstream: A self-provisioned, scalable science and engineering cloud environment
## 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>4 yrs</td>
</tr>
<tr>
<td>Images</td>
<td>Glance</td>
<td>94%</td>
<td>6/8</td>
<td>6 yrs</td>
</tr>
<tr>
<td>Block device</td>
<td>Cinder</td>
<td>86%</td>
<td>7/8</td>
<td>4 yrs</td>
</tr>
<tr>
<td>Networking</td>
<td>Neutron</td>
<td>89%</td>
<td>7/8</td>
<td>4 yrs</td>
</tr>
<tr>
<td>Compute</td>
<td>Nova</td>
<td>96%</td>
<td>8/8</td>
<td>6 yrs</td>
</tr>
<tr>
<td>Object store</td>
<td>Swift</td>
<td>62%</td>
<td>7/8</td>
<td>6 yrs</td>
</tr>
</tbody>
</table>

http://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>95%</td>
<td>6/8</td>
<td>4 yrs</td>
</tr>
<tr>
<td>Telemetry</td>
<td>Ceilometer</td>
<td>61%</td>
<td>6/8</td>
<td>3 yrs</td>
</tr>
<tr>
<td>Database</td>
<td>Trove</td>
<td>27%</td>
<td>1/8</td>
<td>2 yrs</td>
</tr>
<tr>
<td>Orchestration Heat</td>
<td>Heat</td>
<td>68%</td>
<td>6/8</td>
<td>3 yrs</td>
</tr>
<tr>
<td>Provisioning</td>
<td>Ironic</td>
<td>17%</td>
<td>2/8</td>
<td>2 yrs</td>
</tr>
<tr>
<td>Object store</td>
<td>Swift</td>
<td>62%</td>
<td>7/8</td>
<td>6 yrs</td>
</tr>
<tr>
<td>Elastic Map Reduce</td>
<td>Sahara</td>
<td>20%</td>
<td>1/8</td>
<td>2 yrs</td>
</tr>
</tbody>
</table>

http://www.openstack.org/software/project-navigator/
Glance - Cinder - Ceph

Monitor ➔ Client

OSD 1 ➔ OSD 2 ➔ ... ➔ OSD N
VXLAN Packet

Diagram showing the structure of a VXLAN packet:

- **Ethernet**
  - **IP/UDP**
    - **Ethernet**
      - **IP**
Neutron Networking

- Hypervisor
  - VM
  - Bridge
  - VXLAN

- Network node
  - VXLAN
  - Bridge
  - NetNS
  - Bridge

- Internet

http://jetstream-cloud.org/
Authentication

Globus Auth

Atmosphere

XSEDE Username

Redirect

XSEDE

TACC

XSEDE to TACC

Keystone Trust

Atmosphere

User Token

Openstack

User Token

http://jetstream-cloud.org/

Award #1445604

jetstream
Compute Chassis & Network Topology

Chassis

8 Blades

10 Gb/s per blade

Switch

Switch

10 Gb/s per blade

8 Blades

2 x 40 Gb/s Inter-switch links

Cooling

To Top of Rack

http://jetstream-cloud.org/
Network Topology

Chassis to Top of Rack
Network Topology …cont.
Load Balancer 1

Load Balancer 2

IP1 – IP2

Keep Alive

DNS Round Robin
IP1 – IP2
Questions?

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

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