Jetstream Overview
A national research and education cloud

9th workshop on Scientific Cloud Computing (ScienceCloud) – June 11, 2018 – Tempe, AZ
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Senior Cloud Engineer,
UITS Research Technologies

NSF Funding Areas in HPC

Traditionally concentrated on enabling petascale capability
- Blue Waters – 13.3 petaflops, 2012 (under re-compete)
- Stampede – 9.6 petaflops, 2013 (extended to Stampede2, going into service now)
- Comet – ~2.0 petaflops, 2014

Has funded research into building clouds and computer science
- CloudLab
- Chameleon (renewed for 2nd phase)

Now funding clouds to do research
- Bridges (Hybrid system)
- Jetstream
Jetstream - Expanding NSF XD’s reach and impact

Lots of stats below –

**tl;dr summary: no one has enough computing resources. Ever. But they need easy access and use.**

Around 350,000 researchers, educators, & learners received NSF support in 2015

- Less than 2% completed a computation, data analysis, or visualization task on XD/XSEDE program resources
- Less than 4% had an XSEDE Portal account
- 70% of researchers surveyed* claimed to be resource constrained

Why are the people not using XD/XSEDE systems not using them?

- Perceived ease of access and use
- HPC resources – the traditional view of what XSEDE offers - are often not well-matched to their needs
- They just don’t need *that much* capability

*XSEDE Cloud Survey Report - [http://hdl.handle.net/2142/45766](http://hdl.handle.net/2142/45766)*

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Award #ACI-1445604

http://jetstream-cloud.org/
What is Jetstream and why does it exist?

- NSF’s first production cloud facility
- Part of the NSF eXtreme Digital (XD) program
- Focus on ease-of-use, broad accessibility
- User-selectable library of preconfigured virtual machines
- Provides on-demand *interactive* computing and analysis or persistent gateways (SEAGrid, Galaxy, GenApp NAMDRunner, CIPRES and others)
- Enables *configurable* environments and *programmable cyberinfrastructure*
- Reproducibility: Share VMs and then store, publish via IU Scholarworks (DOI)
Who uses Jetstream?

• The researcher needing a handful of cores (1 to 44/vCPU)
• Software creators and researchers needing to create their own customized virtual machines and workflows
• Science gateway creators using Jetstream as either the frontend or processor for scientific jobs
• STEM Educators teaching on a variety of subjects
What Jetstream isn’t…

• It’s not traditional HPC
• There’s no shared filesystem (think cloudy!)
• There’s no high-end interconnect fabric (keep thinking cloudy!)
• There aren’t GPUs (yet…stay tuned)
• It isn’t Amazon, Azure, or GCE (similar, but…)

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HPC vs Cloud

Adapting to a different environment:

• No reservations, no queueing – more interactive usage

• Being your own admin – hey, we have root!!

• You really can have almost any (linux) software you want!!

• Constantly getting new features (https://www.openstack.org/software/project-navigator/)

** Here there be dragons…
Thinking about VMs…

Cows, not pets: pets take great amount of care, feeding, and you name them; cows you intend to have high turnover and you give them numbers.
Jetstream System Overview

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

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

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

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http://jetstream-cloud.org/
# 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” 24 cores @ 2.5 GHz 128 GB RAM 2 TB local disk</td>
<td>Compute hosts OpenStack services</td>
</tr>
<tr>
<td>Dell PowerEdge R630 1U server</td>
<td>7</td>
<td>2x Intel E5-2680v3 “Haswell” 24 cores @ 2.5 GHz 128 GB RAM 2 TB local disk</td>
<td>Cluster management High Availability Databases RabbitMQ</td>
</tr>
<tr>
<td>Dell PowerEdge R730xd 2U servers</td>
<td>20</td>
<td>2x Intel E5-2680v3 “Haswell” 24 cores @ 2.5 GHz 64 GB RAM 48 TB storage for Ceph pool</td>
<td>~1 PB Ceph storage</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 Spine</td>
</tr>
</tbody>
</table>

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**Hardware and Instance "Flavors"**

<table>
<thead>
<tr>
<th>Flavor</th>
<th>vCPUs</th>
<th>RAM</th>
<th>Storage</th>
<th>Per 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>xlarge</td>
<td>24</td>
<td>60</td>
<td>240/60*</td>
<td>2</td>
</tr>
<tr>
<td>xxlarge</td>
<td>44</td>
<td>120</td>
<td>480/60*</td>
<td>1</td>
</tr>
</tbody>
</table>

* s1.* storage-rich instances are not eligible to be saved into a customized image

- Short-term *ephemeral* storage comes as part of launched instance
- Long-term storage is XSEDE-allocated
- Implemented as OpenStack Volumes and object storage
- Default storage is modest, but more is available via allocation
Using Jetstream VMs

Manipulating Jetstream VMs:
• Jetstream Atmosphere web interface
• Direct API access via OpenStack command line or Horizon access
  - API access enables Science Gateways and other always on services or on demand use cases; e.g. elastic compute techniques

Primary methods of logging into Jetstream VMs to work
• Interactive user access via web interface with VNC/SSH
• Direct VNC/SSH to individual instances

http://jetstream-cloud.org/
<table>
<thead>
<tr>
<th>Discipline or area of interest</th>
<th># of Jetstream allocations</th>
<th>SUs allocated on Jetstream</th>
<th>% of SUs allocated on Jetstream</th>
<th>% of all SUs allocated on other XSEDE-supported systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astronomy</td>
<td>2</td>
<td>1,108,096</td>
<td>3.04%</td>
<td>8.61%</td>
</tr>
<tr>
<td>Atmospheric Sciences</td>
<td>4</td>
<td>2,752,400</td>
<td>7.55%</td>
<td>3.73%</td>
</tr>
<tr>
<td>Biological Sciences</td>
<td>57</td>
<td>5,199,000</td>
<td>14.27%</td>
<td>4.95%</td>
</tr>
<tr>
<td>Campus/Domain Champions</td>
<td>123</td>
<td>6,105,500</td>
<td>16.76%</td>
<td>0.09%</td>
</tr>
<tr>
<td>Computational Science</td>
<td>11</td>
<td>1,150,000</td>
<td>3.16%</td>
<td>0.92%</td>
</tr>
<tr>
<td>Computer Science</td>
<td>15</td>
<td>4,944,302</td>
<td>13.57%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Education Allocations</td>
<td>24</td>
<td>2,847,600</td>
<td>7.82%</td>
<td>0.01%</td>
</tr>
<tr>
<td>Engineering</td>
<td>1</td>
<td>100,000</td>
<td>0.27%</td>
<td>3.81%</td>
</tr>
<tr>
<td>Geosciences</td>
<td>10</td>
<td>1,978,400</td>
<td>5.43%</td>
<td>2.87%</td>
</tr>
<tr>
<td>Humanities/Social Sciences</td>
<td>10</td>
<td>560,000</td>
<td>1.54%</td>
<td>0.45%</td>
</tr>
<tr>
<td>Molecular Biosciences</td>
<td>8</td>
<td>4,647,520</td>
<td>12.75%</td>
<td>17.65%</td>
</tr>
<tr>
<td>Network Science</td>
<td>3</td>
<td>200,000</td>
<td>0.55%</td>
<td>0.06%</td>
</tr>
<tr>
<td>Ocean Science</td>
<td>3</td>
<td>230,000</td>
<td>0.63%</td>
<td>1.30%</td>
</tr>
<tr>
<td>Physics</td>
<td>4</td>
<td>2,252,400</td>
<td>6.18%</td>
<td>16.43%</td>
</tr>
<tr>
<td>Training &amp; Development</td>
<td>11</td>
<td>2,362,000</td>
<td>6.48%</td>
<td>0.16%</td>
</tr>
</tbody>
</table>
Jetstream usage highlights – 1 May 2018

- 313 active XSEDE projects covering 71 fields of science and **2411 active users** representing **205 institutions**
- **80%** of Jetstream users have **not used any other XSEDE system**
- >117M CPU hours allocated to XSEDE projects since June 2016
- 14 active science gateways
- 41 education/teaching allocations serving over 850 students
- 1151 (avg concurrent) active VMs in current qtr, 955 in PY2*
- **Highest** user satisfaction in most recent XSEDE survey
- **100%** system availability, **99.2%** cap availability in PY2*
- **98.8%** “job” completion in PY2*

*NSF-funded, Award ACI-1445604
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*M&O PY2 to date 11/12 months*
Power

- 2MW supplied by generators tested weekly with minimum 7 days fuel storage
- ½ ton flywheels to condition and provide ~20 seconds of power
- Battery UPS with ~20 min run time
Physical Security

• 24/7/365 operations staff

• Reinforced concrete on six sides with earth berm rated to withstand F5 tornado

• Biometric access controls
Jetstream Fun: Happy cluster / Angry Cluster

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Networking

- Every blade has fully redundant paths to top of rack switch via a pair of stacked chassis switches
- Every top of rack switch has redundant paths to a pair of spine switches
- Spine switches have redundant paths to core

** Top of rack is a single point of failure
Cloud Services

- All cloud services (vm, volume, image, network create/read/update/delete: cloud controller) are run in triplicate with rack level failure domains
- Two load balancers monitor health, balance requests across 3 cloud controllers, will take over for each other if one load balancer is down
- Backed by 3 way replicated galera database cluster and 3 way replicated rabbitmq message bus
Data Storage

Ceph self healing replicated object storage

- Host level failure domain
- Root and image block storage is 2 x replication, volumes 3x
- Cephfs (experimental) and S3/Swift object storage is erasure coded
Where can I get help?


User guides: https://portal.xsede.org/user-guides

XSEDE KB: https://portal.xsede.org/knowledge-base

Email: help@xsede.org

Campus Champions: https://www.xsede.org/campus-champions

Introduction to Jetstream Virtual Workshop: https://cvw.cac.cornell.edu/jetstream/

Jetstream Allocations Virtual Workshop: https://cvw.cac.cornell.edu/JetstreamReq/
Jetstream Partners

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http://jetstream-cloud.org/
Questions?

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

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