

Jetstream Overview

A national research and education cloud

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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



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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>



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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)



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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



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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...



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Jetstream and way of the cloud...

- **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 is 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
- **And my favorite...**

Thinking about VMs...

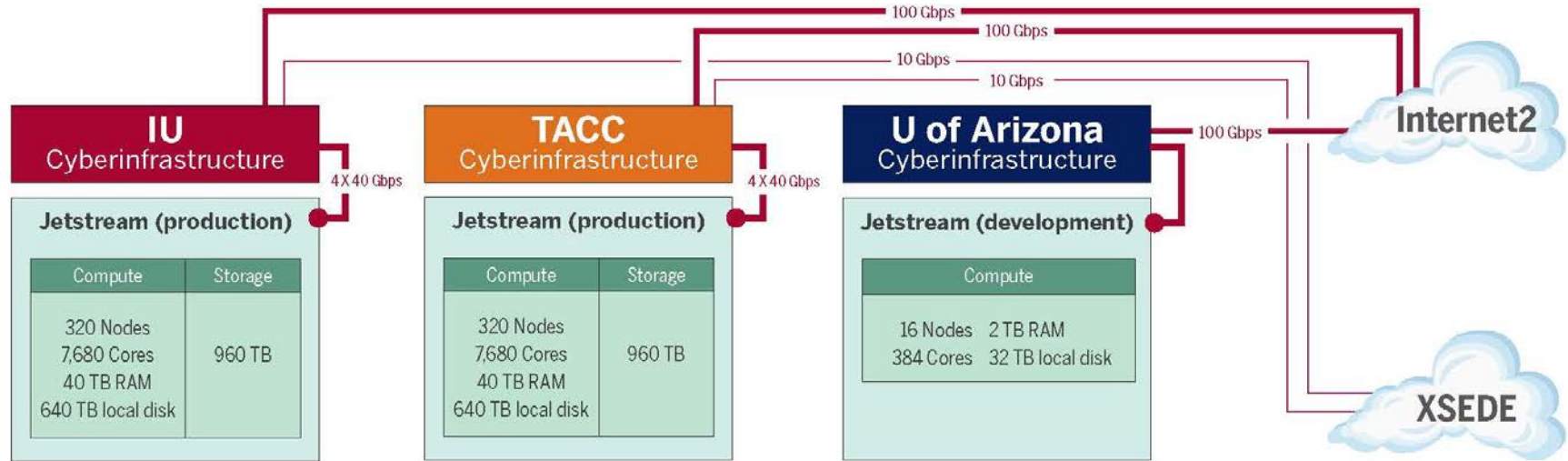


Cows, not pets: pets take great amount of care, feeding, and you name them; cows you intend to have high turnover and you give them numbers.

-- Mike Lowe (Jetstream architect)

**some caveats for gateways...

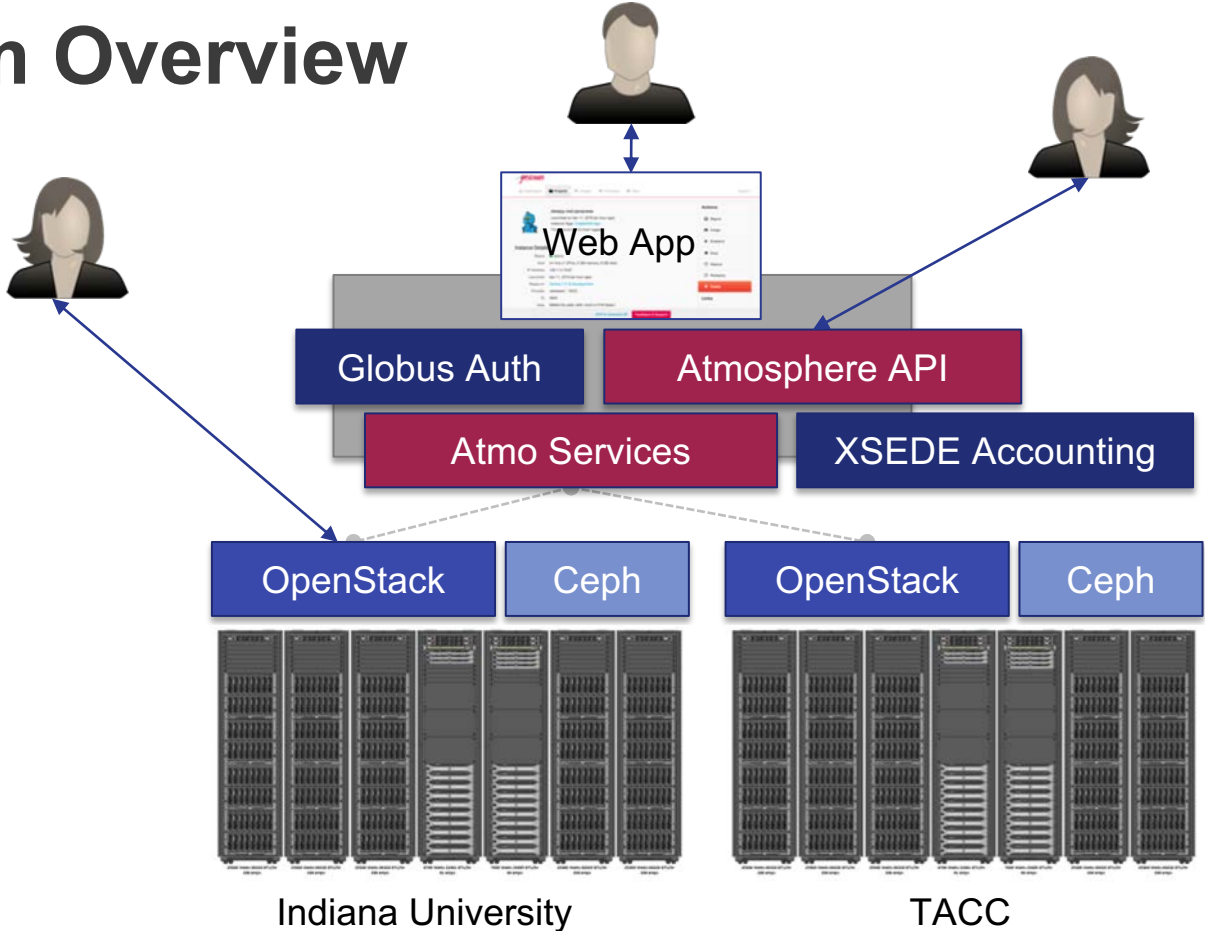
Jetstream System Overview



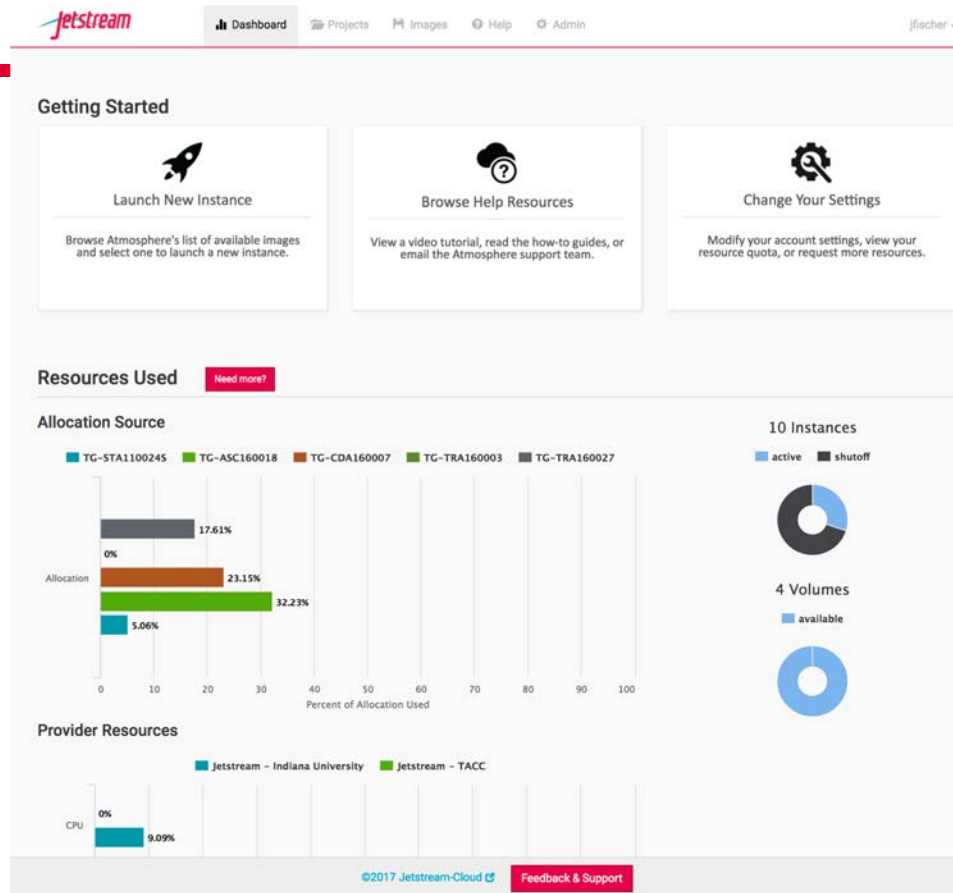
Production cloud hardware (per site)

| Hardware | Number | Specifications | Function (IU) |
|----------------------------------|--------|--|--|
| Dell PowerEdge M630 blades | 320 | 2x Intel E5-2680v3 "Haswell" 24 cores @ 2.5 GHz 128 GB RAM 2 TB local disk | Compute hosts OpenStack services |
| Dell PowerEdge R630 1U server | 7 | 2x Intel E5-2680v3 "Haswell" 24 cores @ 2.5 GHz 128 GB RAM 2 TB local disk | Cluster management High Availability Databases RabbitMQ |
| Dell PowerEdge R730xd 2U servers | 20 | 2x Intel E5-2680v3 "Haswell" 24 cores @ 2.5 GHz 64 GB RAM 48 TB storage for Ceph pool | ~1 PB Ceph storage |
| Dell S6000-ON network switches | 9 | 32+2 40 Gb/s ports | Top of Rack Spine |

Platform Overview



The Jetstream Atmosphere web interface



The Jetstream Atmosphere web interface

The screenshot displays the Jetstream Atmosphere web interface. At the top, there is a navigation bar with the Jetstream logo, a dashboard icon, and menu items for Dashboard, Projects, Images (selected), and Help. A user profile 'jftest' is visible in the top right. Below the navigation bar is a search bar and several filters: SEARCH, FAVORITES (0), MY IMAGES (0), MY IMAGE REQUESTS, and TAGS. The main content area is titled 'Image Search' and contains a search input field with the placeholder text 'Search across image name, tag or description'. Below the search bar, it indicates 'Showing 57 of 57 Images'. A section titled 'Featured Images' lists six image entries, each with a thumbnail icon, title, creation date, author, and a list of tags. The tags are displayed in red rounded rectangles. The entries are: 1. Centos 7 (7.2) Development GUI (Jan 13th 17 03:21 by jfischer) with tags: CentOS, development, Featured, gui, iRODS. 2. BioLinux 8 (Jan 2nd 17 03:34 by jfischer) with tags: bioinformatics, desktop, Featured, gui, m1_small, Ubuntu, x2go. 3. Ubuntu 14.04.3 Development GUI (Jan 2nd 17 01:24 by jfischer) with tags: desktop, development, Featured, gui, iRODS, Ubuntu, vnc. 4. Intel Development (CentOS 7) (Nov 30th 16 12:04 by jfischer) with tags: CentOS, desktop, development, Featured, gui, intel, m1_small, vnc. 5. R with Intel compilers (CentOS ...) (Nov 30th 16 11:53 by jfischer) with tags: CentOS, desktop, development, Featured, gui, intel, m1_small, vnc. 6. Galaxy Standalone (Nov 15th 16 04:49 by admin) with tags: community-contributed, Featured, m1_large, Ubuntu. At the bottom of the interface, there is a footer with the copyright notice '©2017 Jetstream-Cloud' and a 'Feedback & Support' button.

Jetstream

Dashboard Projects Images Help jftest







SEARCH FAVORITES (0) MY IMAGES (0) MY IMAGE REQUESTS TAGS

Image Search

Search across image name, tag or description

Showing 57 of 57 Images

Featured Images

| | | | |
|---|--|--|---|
|  | Centos 7 (7.2) Development GUI Jan 13th 17 03:21 by jfischer | Imported Application - Centos 7 (7.2) Development GUI CentOS development Featured gui iRODS | ☆ |
|  | BioLinux 8 Jan 2nd 17 03:34 by jfischer | Based on Ubuntu 14.04.3 -Trusty Tahr - server - cloudimg --**REQUIRES m1_small instance ... bioinformatics desktop Featured gui m1_small Ubuntu x2go | ☆ |
|  | Ubuntu 14.04.3 Development GUI Jan 2nd 17 01:24 by jfischer | Based on Ubuntu 14.04.3 Development Patched up to date as of 12/15/16 Base Ubuntu 14.04.3 ... desktop development Featured gui iRODS Ubuntu vnc | ☆ |
|  | Intel Development (CentOS 7) Nov 30th 16 12:04 by jfischer | Intel compilers and development environment *REQUIRES a m1_small or larger VM to la ... CentOS desktop development Featured gui intel m1_small vnc | ☆ |
|  | R with Intel compilers (CentOS ...) Nov 30th 16 11:53 by jfischer | R with Intel compilers built on CentOS 7 (7.3) ** Requires m1_small or greater sized VM * ... CentOS desktop development Featured gui intel m1_small vnc | ☆ |
|  | Galaxy Standalone Nov 15th 16 04:49 by admin | Galaxy 16.01 Standalone - based on Ubuntu 14.04.4 LTS This is a standalone Galaxy server ... community-contributed Featured m1_large Ubuntu | ☆ |

©2017 Jetstream-Cloud Feedback & Support

Look! It's more Jetstream web interface!

The screenshot displays the Jetstream web interface with a modal dialog box titled "Launch an Instance / Basic Options". The background interface shows a sidebar with "RESOURCES" and "Instances" sections, and a main content area for a project named "JLF Test".

The dialog box is divided into two columns: "Basic Info" and "Resources".

Basic Info:

- Instance Name: R with Intel compilers (CentOS 7)
- Base Image Version: 1.14
- Project: JLF Test

Resources:

- Allocation Source: TG-CIE170025
- Provider: Jetstream - Indiana University
- Instance Size: m1.tiny (CPU: 1, Mem: 2 GB, Disk: 8 GB)

Allocation Used: 0% of 140000 SUs from TG-CIE170025

Resources Instance will Use:

- A total 14 of 132 allotted CPUs
- A total 38 of 360 allotted GBs of Memory

At the bottom of the dialog, there are buttons for "Back", "Advanced Options", "CANCEL", and "LAUNCH INSTANCE".


The footer of the page includes the Jetstream logo and URL (<http://jetstream-cloud.org/>), navigation links for "Jetstream Homepage", "Jetstream Partners", "Citing Jetstream", and "Jetstream is supported by NSF ACI-1445604", and a "FEEDBACK & SUPPORT" button. A large red Greek letter Psi (Ψ) is visible in the bottom right corner.

Even more Jetstream web interface...

Jetstream Dashboard Projects Images Help Admin jfischer

JLF Test

Resources > KVM image to build Win10

 KVM image to build Win10

Allocation Source

TG-CIE170025

Allocation Used

0% of 250000 SUs from TG-CDA160007

Instance Details

| | |
|------------|---|
| Status | ● Active |
| Activity | N/A |
| Size | s1.large (10 CPUs, 30 GB memory, 120 GB disk) |
| IP Address | 149.165.156.191 Copy |
| Launched | Apr 6, 2017 (2 months ago) |
| Based on | Myers L533 Image |

Actions

- Report
- Image
- Suspend
- Shelve
- Stop
- Reboot
- Redeploy
- Delete**

Links

- Open Web Shell
- Open Web Desktop

Jetstream Homepage - Jetstream Partners - Citing Jetstream - Jetstream is supported by NSF ACI-1445604 [FEEDBACK & SUPPORT](#)

Hardware and Instance "Flavors"

| Flavor | vCPUs | RAM | Storage | Per Node |
|---------|-------|-----|---------|----------|
| tiny | 1 | 2 | 8 | 46 |
| small | 2 | 4 | 20 | 23 |
| medium | 6 | 16 | 60 | 7 |
| large | 10 | 30 | 120/60* | 4 |
| xlarge | 24 | 60 | 240/60* | 2 |
| xxlarge | 44 | 120 | 480/60* | 1 |

** 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



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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



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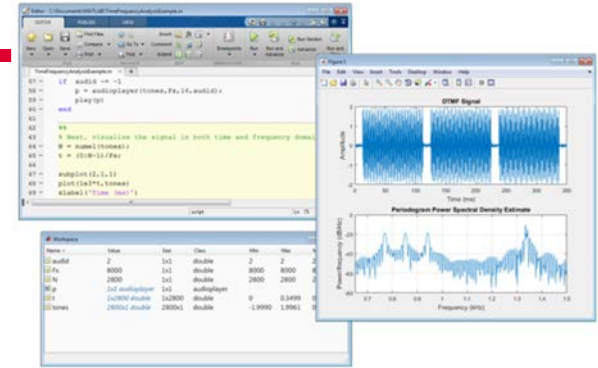


| Discipline or area of interest | #of Jetstream allocations | SUs allocated on Jetstream | % of SUs allocated on Jetstream | % of all SUs allocated on other XSEDE-supported systems |
|-----------------------------------|---------------------------|----------------------------|---------------------------------|---|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

Jetstream for engineering researchers (and others)

Matlab and SimuLink and additional toolkits are installed on Jetstream

You do NOT need to have a local license to use MATLAB on Jetstream



If you are a researcher, and MATLAB or SimuLink... you're ready to go!

If you are an engineering researcher, and you need other tools... Let us know – we are happy to consider other requests

Not just the usual suspects...

Physics, chemistry, and other “usual” HPC suspects are represented, but Jetstream also is home to projects on:

- Financial analysis / Economics
- Political science
- Humanities / Text analysis
- Network analysis
- Computer Science / Machine learning
- Satellite data analysis



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Jetstream for Education

Jetstream has been used in multiple IU Informatics Graduate Courses

- INFO 535 – Management, Access, and Use of Big and Complex Data
- INFO 590 – Topics in Informatics

BlueWaters Workflow Workshop

Multiple Research Data Alliance Workshops

Upcoming workshops/classes on Galaxy, data analysis in finance using R, security and intrusion detection, and principles in cloud computing



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Another Use Case: Galaxy riding Jetstream

Galaxy is a platform for biomedical research, focused on accessibility, transparency and reproducibility

- The main project instance (usegalaxy.org) has more than 100,000 registered users executing 300,000+ jobs each month
- Many users need more capacity than the public quota, or other customizations (e.g., new tools)

Use Jetstream as a *bursting* platform

- From Galaxy Main, offload jobs onto a remote Slurm cluster running on Jetstream instances
- Run Galaxy Interactive Environments (i.e., Dockerized IPython/RStudio containers) in an isolated environment on a Swarm cluster running on Jetstream

Use Jetstream as a *self-service* platform

- Pre-built Galaxy image configured with hundreds of tools and access to TBs of genomic reference data, available via the self-launch model within minutes
- Allows users to acquire (free) resources, and gives them complete control



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Jetstream Gateway Highlights

- IRIS
 - Serving large scale earthquake and geographical data for analysis
- Unidata
 - Providing distribution and analysis of meteorological data
- OpenMRS
 - Providing medical records systems for the resource-constrained
- SEAGrid
 - Computational chemistry, molecular and fluid dynamics, and structural mechanics gateway
- NAMDRunner
 - Based on the GenApp gateway – over 1 million computing hours used to date for MD
- ChemCompute Gateway
 - Providing a computational chemistry gateway for educational use
- Coming gateways: CIPRES Gateway, The Neuroscience Gateway, UltraScan III

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*



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*M&O PY2 to date 11/12 months

Jetstream Timeline...what comes next?

- Completed our first year of operations on September 1, 2017
- Soliciting Research allocation requests plus Startup and Education allocations – including Science Gateways!
- Adding services as deemed useful/mature (Heat, Magnum, Trove, Manila, etc)
- Atmosphere enhancements on a regular cycle
- Working on partnerships with groups like HubZero and others to extend the value of Jetstream

Requesting access to Jetstream

- Trial allocations available TODAY
- You can request startup allocations anytime. (Startups are simple!)
- You can request allocations for educational use anytime.
- Next submission period for large allocations is 15 June 2018– 15 July 2018.
- Research allocation: Main project description (up to 10 pages) and Scaling doc (up to 5 pages) – We can help!

Jetstream REU Program 2018



- NSF Supplement for undergraduates
- 6 students selected for 2018
- REU student videos on YouTube
<https://www.youtube.com/user/IUPTI>

Where can I get help?

Wiki / Documentation: <http://wiki.jetstream-cloud.org>

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/>



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Jetstream Fun: Happy cluster / Angry Cluster



Infrared image of Jetstream



ChilledDoor[®]
Rack Cooling System
by
motivair[®]

Jetstream Partners



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Questions?

Project website: <http://jetstream-cloud.org/>

Project email: help@jetstream-cloud.org Direct email: jeremy@iu.edu

License Terms

- Fischer, Jeremy. May 30, 2018. Jetstream Overview – Great Plains Network Annual Conference. Also available at: <http://jetstream-cloud.org/research/publications.php>
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