

Jetstream Overview: A national research and education cloud

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Jeremy Fischer – jeremy@iu.edu

Senior Technical Advisor,
UITS Research Technologies

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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 in 2017 – 18 petaflops)
- Comet – ~2.0 petaflops, 2014

Has funded research into building clouds and computer science

- CloudLab (renewed for 2nd phase)
- Chameleon (renewed for 2nd phase)

Now funding clouds to do research

- Bridges (Hybrid system)
- Jetstream



funded by the National Science Foundation
Award #ACI-1445604



Jetstream - Expanding NSF XD's reach and impact

Lots of stats below –

tl;dr summary: no one has enough computing resources...but most aren't using XSEDE in any capacity at all.

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>

Identifying the potential users

“But I really don’t have research needs...I don’t need the national research cyberinfrastructure.”

--- multiple researchers at a number of small colleges and universities

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
- Provides on-demand *interactive* computing and analysis or persistent gateways
- Enables *configurable* environments and **programmable cyberinfrastructure**

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...)



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...

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...

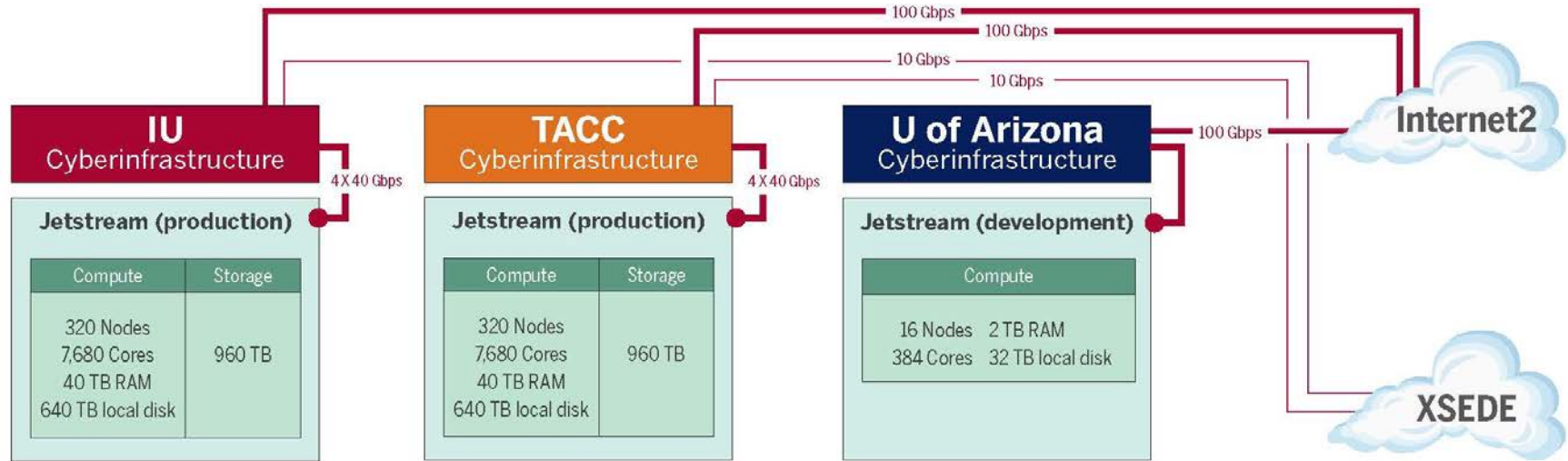


Cows, not pets: pets take great amount of care, feeding, and you name them; cows you intend to have high turnover and you give them numbers.

-- Mike Lowe (Jetstream architect)

**some caveats for gateways...

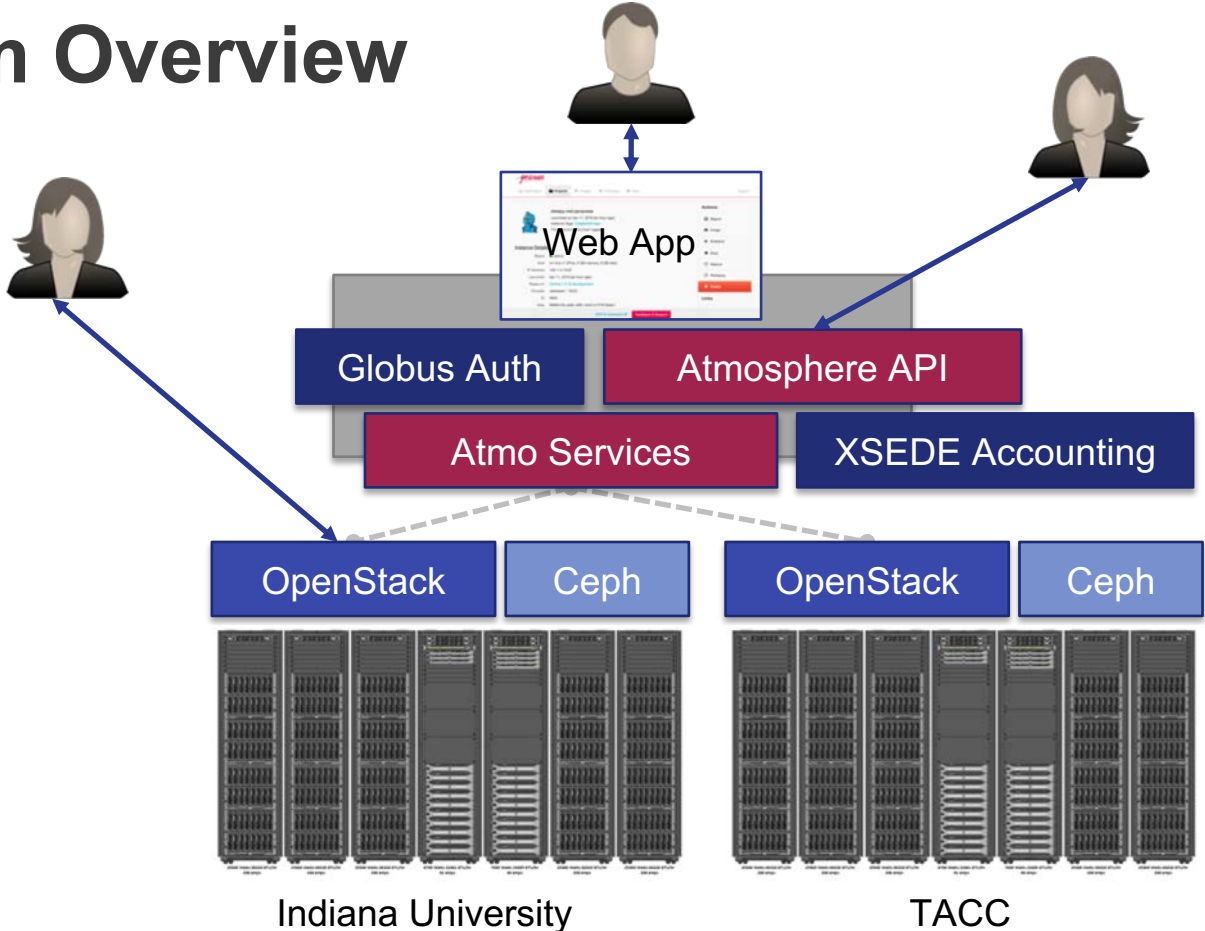
Jetstream System Overview



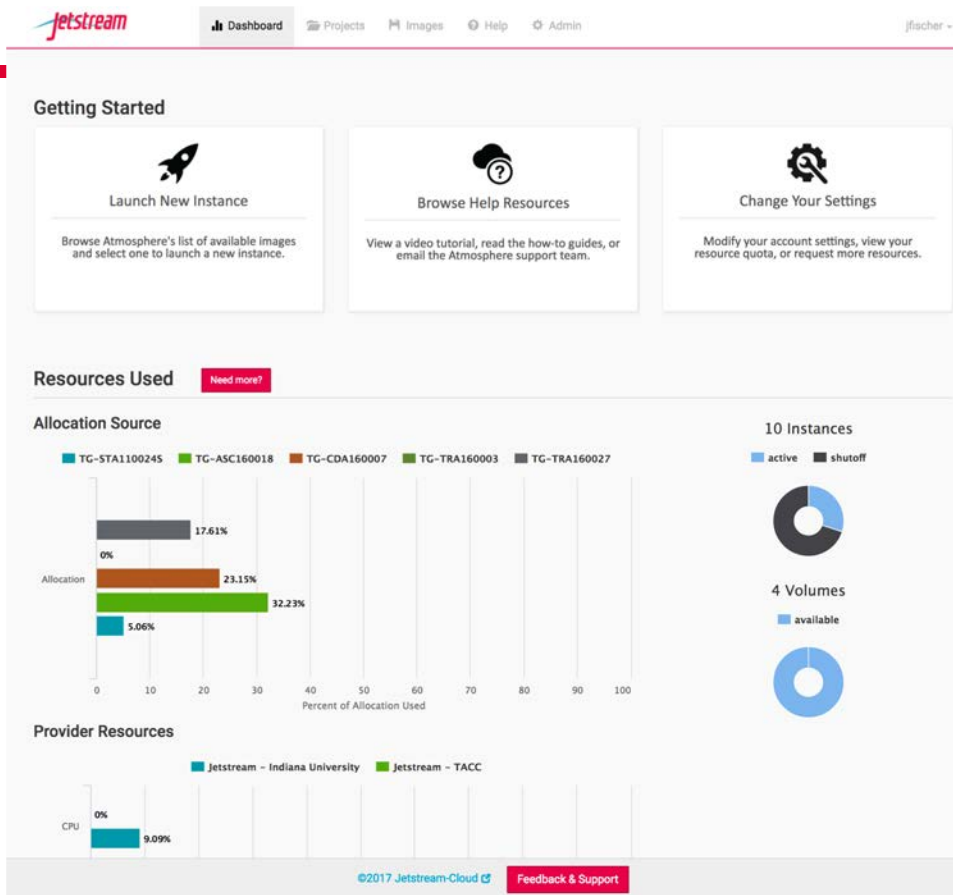
Production cloud hardware (per site)

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

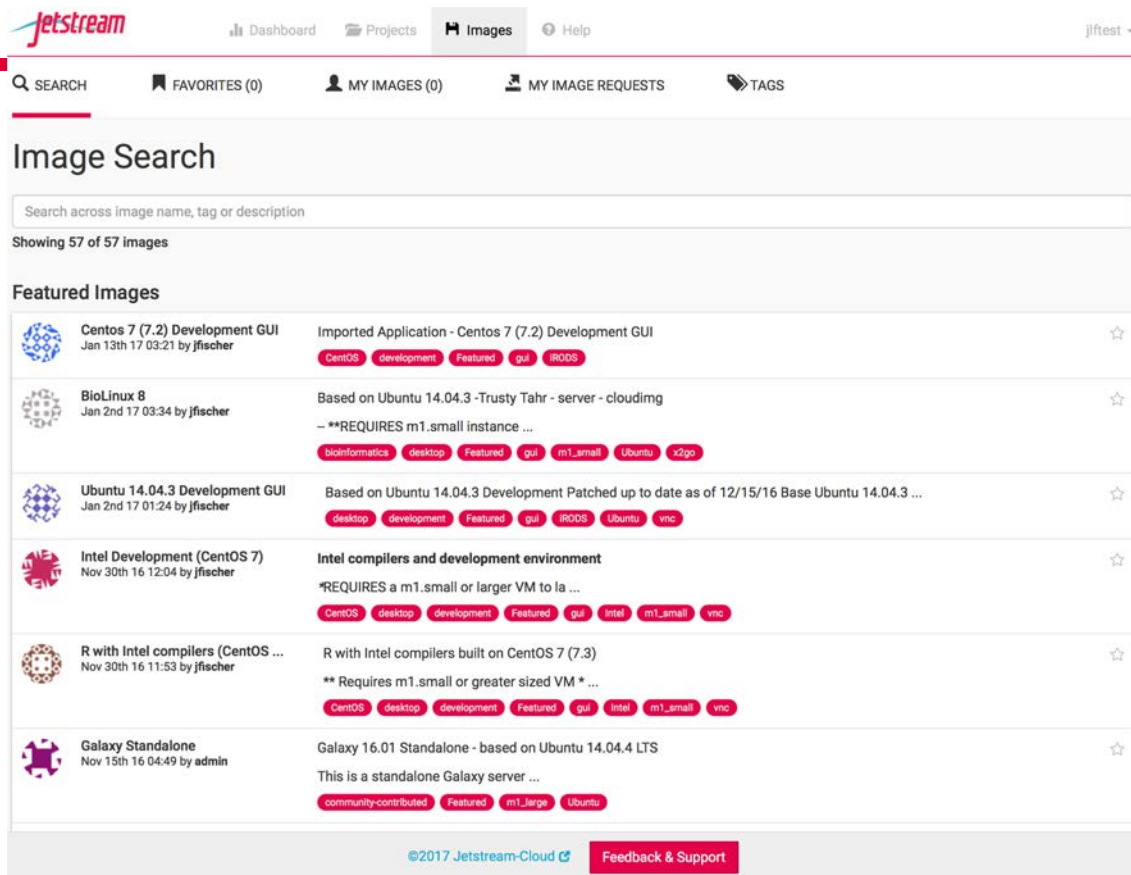
Platform Overview



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', 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, title, date, author, and a list of tags. The tags are displayed in red rounded rectangles.

Image Icon	Image Name	Author	Description	Tags
	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



Look! It's more Jetstream web interface!

The screenshot displays the Jetstream web interface. A modal dialog titled "Launch an Instance / Basic Options" is centered on the screen. The background page shows a project named "JLF Test" with a "NEW" button and a list of instances. 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 background page shows the "JLF Test" project with a "NEW" button and a list of instances. The list includes "Build - R with Int", "Test 4 - JLF Pri", and "KVM image to b". Below the list are sections for "Volumes" and "Images".

Jetstream
<http://jetstream-cloud.org/>

Jetstream Homepage - Jetstream Partners - Citing Jetstream - Jetstream is supported by NSF ACI-1445604

FEEDBACK & SUPPORT



Even more Jetstream web interface...

The screenshot displays the Jetstream web interface for a project named 'JLF Test'. The navigation bar includes 'Dashboard', 'Projects', 'Images', 'Help', and 'Admin'. The user 'jfischer' is logged in. The main content area shows the project name 'JLF Test' and a breadcrumb 'Resources > KVM image to build Win10'. A large orange geometric icon represents the project. Below it, the 'Allocation Source' is 'TG-CIE170025' and the 'Allocation Used' is '0% of 250000 SUs from TG-CDA160007'. The 'Instance Details' section lists: Status: Active (green dot), Activity: N/A, Size: s1.large (10 CPUs, 30 GB memory, 120 GB disk), IP Address: 149.165.156.191 (with a copy icon), Launched: Apr 6, 2017 (2 months ago), and Based on: Myers L533 Image. On the right, an 'Actions' sidebar contains buttons for Report, Image, Suspend, Shelf, Stop, Reboot, Redeploy, and Delete (highlighted in red). Below the actions are 'Links' for 'Open Web Shell' and 'Open Web Desktop'. The footer contains the Jetstream logo, the URL 'http://jetstream-cloud.org', and a 'FEEDBACK & SUPPORT' button.


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
- Shelf
- 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

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

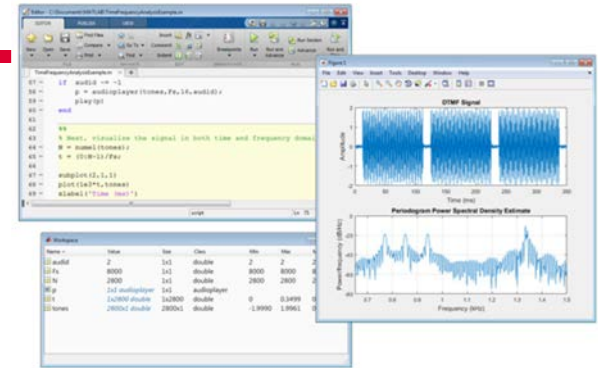
- Interactive user access via web interface with VNC/SSH
- Direct VNC/SSH to individual instances

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

Jetstream for Education

Jetstream has been used in multiple graduate and undergraduate courses

- Management, Access, and Use of Big and Complex Data
- Multiple informatics and general bioinformatics courses
- Business Intelligence (big data and analysis)
- Research Topics in Music
- Multiple genetics and sequencing courses
- Multiple information security and assurance courses
- ...and others...

Multiple Research Data Alliance Workshops, multiple workshops/classes on Galaxy, data analysis in finance using R, security and intrusion detection, and principles in cloud computing and more!



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

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: The Neuroscience Gateway, UltraScan III, and others



Jetstream usage highlights – 1 October 2018

- 413 active XSEDE projects covering 75 fields of science and **2558 active users** representing **190 institutions**
- **80%** of Jetstream users have **not used any other XSEDE system**
- >143M CPU hours allocated to XSEDE projects since June 2016
- 15 active science gateways
- 47 education/teaching allocations serving over 904 students
- 1151 (avg concurrent) active VMs in previous qtr, 955 in PY2*
- **Highest** user satisfaction in most recent XSEDE survey

Jetstream Timeline...what comes next?

- Completed our second year of operations on September 1, 2018
- 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
<http://wiki.jetstream-cloud.org/Jetstream+Trial+Access+Allocation>
- You can request startup allocations anytime. (Startups are simple!)
<http://wiki.jetstream-cloud.org/Jetstream+Allocations>
- You can request allocations for educational use anytime.
- Next submission period for large allocations is 15 Sept - 15 Oct 2018.
- Research allocation: Main project description (up to 10 pages) and Scaling doc (up to 5 pages) – We can help!

Expanding the reach: Jetstream REU Program



- NSF Supplement for undergraduates
- 4 students participated in 2017
- 6 students participated in 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>

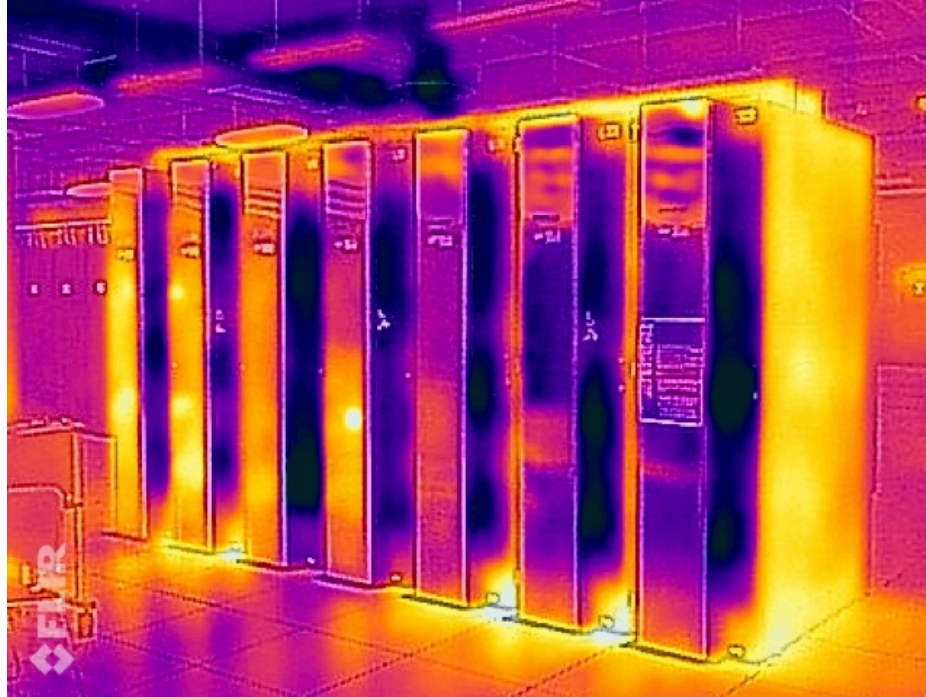
Introduction to Jetstream Virtual Workshop: <https://cvw.cac.cornell.edu/jetstream/>

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

Jetstream Fun: Happy cluster / Angry Cluster



Infrared image of Jetstream



ChilledDoor™
Rack Cooling System
motivair™



Jetstream Partners



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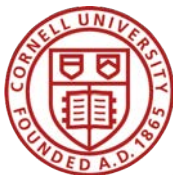


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Questions?

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

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

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