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# Jetstream Overview: A national research and education cloud

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<https://www.jetstream-cloud.org/research/publications.php>

# What is Jetstream and why does it exist?

- NSF's first production cloud facility
- Focus on ease-of-use, broad accessibility
- User-selectable library of preconfigured virtual machines
- Provides **on-demand** interactive computing and analysis or persistent services such as gateways
- Enables configurable environments; **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 VMs and workflows
- Science gateway creators using Jetstream as either the frontend or processor for scientific jobs
- STEM Educators teaching on a variety of subjects



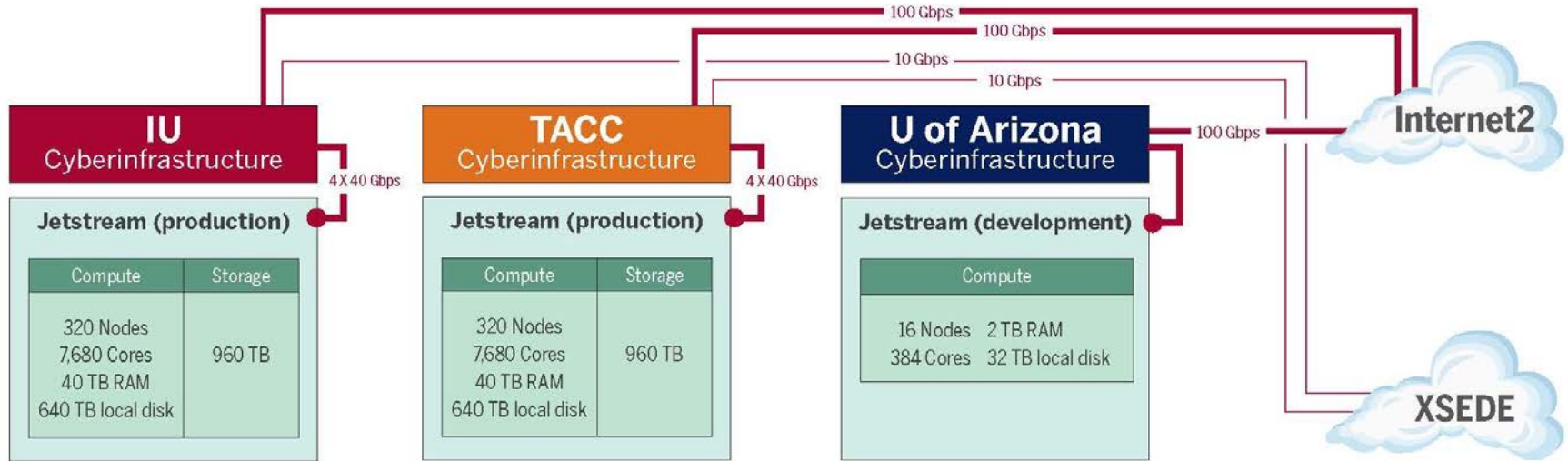
# What Jetstream isn't...

- 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 (Sort of...)
- It isn't Amazon, Azure, or GCE (similar, but...)



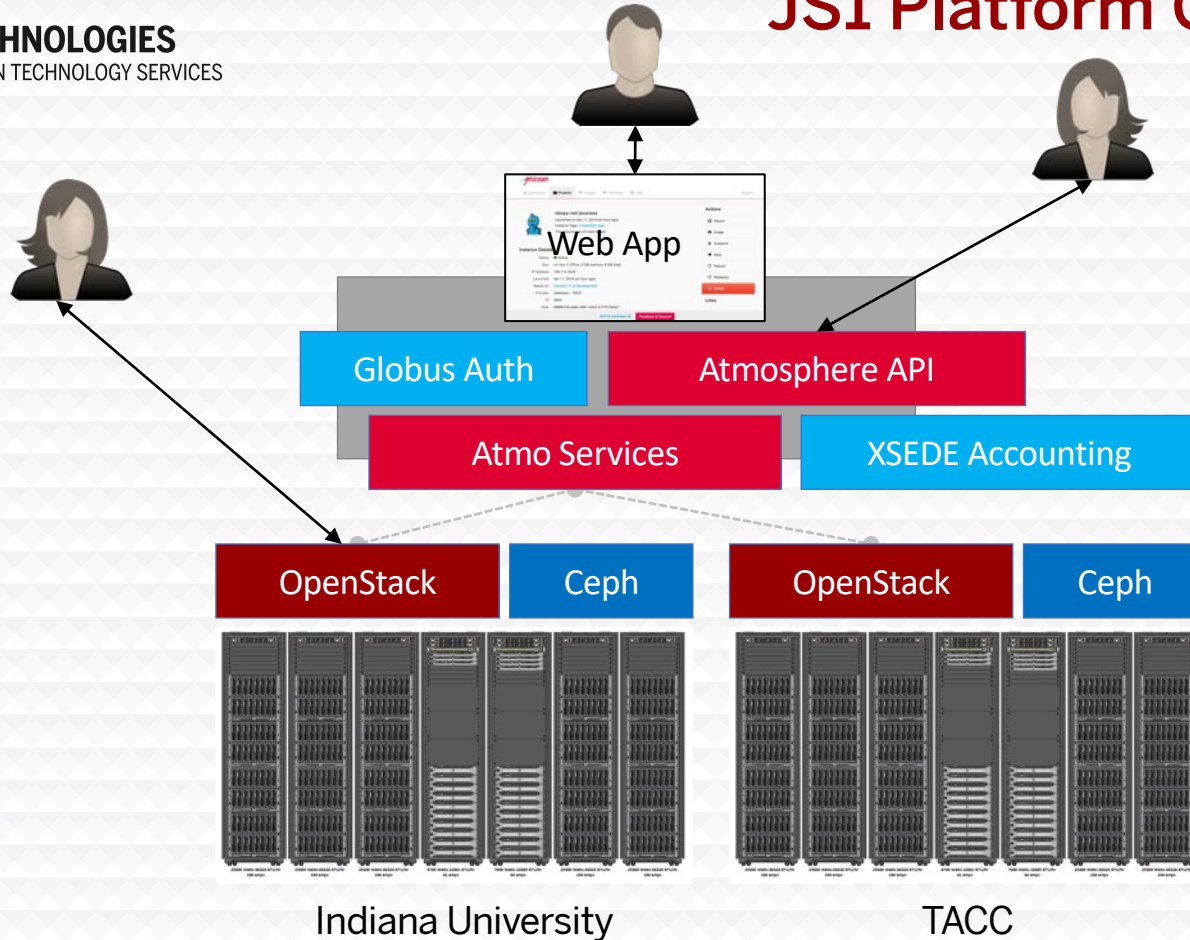


# Jetstream 1 Architecture





# JS1 Platform Overview





# The Jetstream Atmosphere web interface

The screenshot shows the Jetstream Atmosphere web interface dashboard. At the top, there is a navigation bar with the Jetstream logo and menu items: Dashboard, Projects, Images, Help, and Admin. The user's name 'jfischer' is visible in the top right corner.

### Getting Started

- Launch New Instance**: Browse Atmosphere's list of available images and select one to launch a new instance.
- Browse Help Resources**: View a video tutorial, read the how-to guides, or email the Atmosphere support team.
- Change Your Settings**: Modify your account settings, view your resource quota, or request more resources.

### Resources Used

[Need more?](#)

#### Allocation Source

Allocation Source	Percent of Allocation Used
TG-STA1100245	5.06%
TG-ASC160018	32.23%
TG-CDA160007	23.15%
TG-TRA160003	17.61%
TG-TRA160027	0%

#### 10 Instances

- active
- shutoff

#### 4 Volumes

- available

#### Provider Resources

Provider	CPU
Jetstream - Indiana University	9.09%
Jetstream - TACC	0%

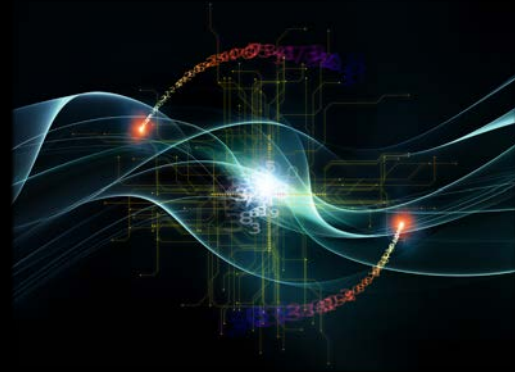
©2017 Jetstream-Cloud [Feedback & Support](#)



# 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

Research Data Alliance workshops, Galaxy workshops, data analysis in finance using R, security and intrusion detection, and principles in cloud computing...





# Jetstream for education – in action at AMS2020

- Unidata-led workshop at American Meteorological Society (AMS) 2020 conference
- 127 users actively participating
- Participants used a JupyterHub running on Jetstream (40 node Kubernetes cluster of 6 core m1.medium VMs) for a 90 minute Unidata PyAOS (Python for the Atmospheric and Oceanic Sciences) workshop
- The students were successfully able to run their interactive Python code notebooks as the instructors presented their material





# 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  
(<https://docs.openstack.org/openstacksdk/latest/>)

## What worked?

- Allowing API access and full control (root privileges)
- Allowing allocations to run continuously – as long as the PI renewed – allowing workflows to run indefinitely
- Development of trial allocations



## What didn't work?

- Forcing small allocations into the research allocation process
- Lack of multi-year allocations
- Lack of shared data set storage



# M87 black hole: how cloud computing supports astronomy



*Event Horizon Telescope*



*M87 black hole image  
generated by EHT*

- Event Horizon Telescope (a telescope array consisting of a global network of radio telescopes), a large number of scientists, NASA spacecraft, and a variety of computing resources enabled the first image of a black hole.
- For the M87 black hole image, two critical steps were done in the cloud and piloted on Jetstream
  - correcting for anomalies, so that further image processing could occur, and
  - large survey study of how image reconstruction algorithms affect the final images.
- The team is also developing new methods to correlate data from multiple telescopes (to reduce data from petascale to terascale) in the cloud



# AI for Everyone – Recognizing Frog Calls



American Toad



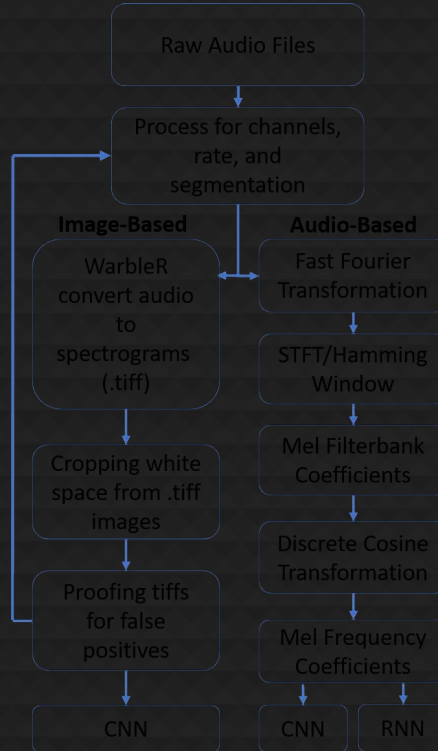
Spring Peeper



Chorus Frog



Green Frog



2019 Jetstream REU participants examined best-practices for supporting AI projects for field biologists



Brainlife.io is a science gateway for neuroscience analysis.

Allows creation of custom workflows that can be saved and shared

Began using only Jetstream and other XSEDE resources and has grown to use

Expanded to use Microsoft's Azure cloud via the Midwest Big Data Hub

Backed with multiple virtual Slurm clusters on IU and TACC clouds





# Jetstream usage highlights – 1 Apr 2021

- 406 XSEDE projects covering 62 fields of science and over 2500 **active users** representing **406 institutions**
- **80%** of Jetstream users have **not used any other XSEDE system**
- >394M CPU hours allocated to XSEDE projects since June 2016
- 54 active science gateways serving over 61,000 users
- 46 education/teaching allocations serving over 950 students
- 1127 mean active VMs in O&M YR5, 1610 peak active VM count
- **Highest** user satisfaction in most recent XSEDE survey

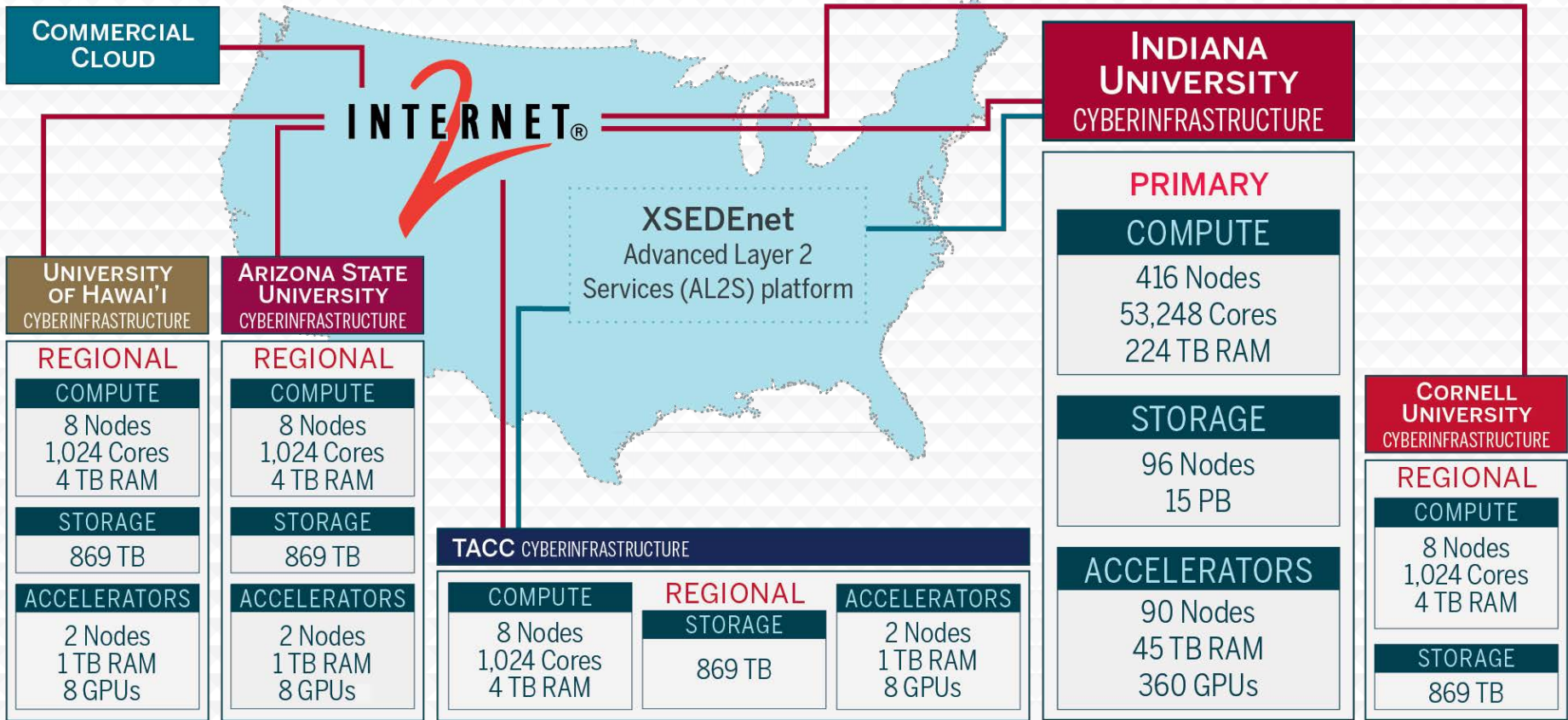


*And introducing...*

# *Jetstream2*



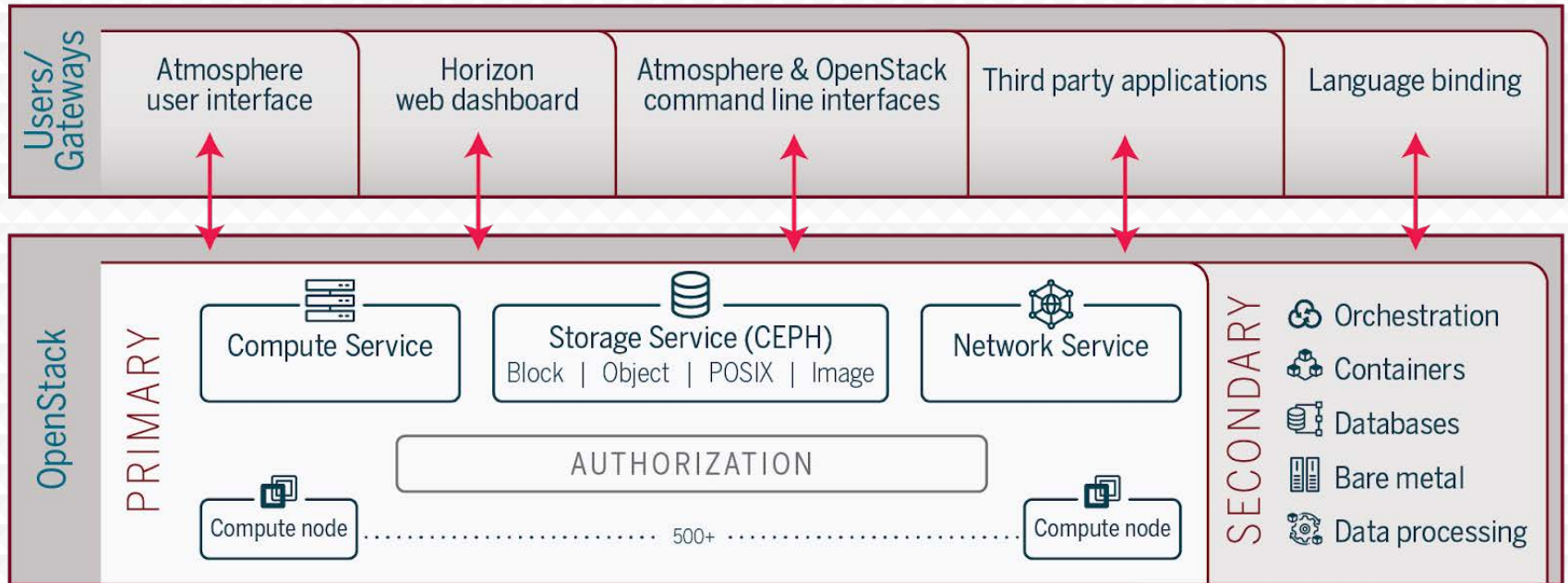
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## Jetstream2 Proposed Architecture



# Conceptual Jetstream2 Architecture



# What improvements are planned?

- Increasing VM sizes (cores and RAM)
- Widely-available GPUs (90 nodes, 360 GPUs total)
- Improving access to higher level orchestration
- Improving documentation and training for orchestration
- Implementing “push button” virtual clusters
- Federating JupyterHubs and making the implementation of JupyterHubs a simple process
- Creating a shared application service for VMs to make common scientific software more accessible
- Improved storage access, including object storage and storage that is sharable between VMs in the same allocation



# Future Plans with Jetstream2

- Focusing on *programmable cyberinfrastructure* using technologies like Terraform to make creating infrastructure easy on Jetstream2, commercial clouds, or other private clouds
- Making enhanced container support for interoperability a priority
- Planned collaborations with commercial clouds:
  - AWS to provide workshops on cloud interoperability
  - Bursting to Azure via on-premises data gateway
  - Implementation of Google's Cloud Service Platform (allowing management of hybrid cloud environments via gcloud CLI or Google GUI).
- Interactive GPU access and the ability to have long-running training for AI workloads



# Where can I get help?

- **Wiki / Documentation:** <http://wiki.jetstream-cloud.org>
- API CLI Tutorial: <https://github.com/jlf599/JetstreamAPITutorial>
- User guides: <https://portal.xsede.org/user-guides>
- XSEDE KB: <https://portal.xsede.org/knowledge-base>
- Email: [help@xsede.org](mailto:help@xsede.org)



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# Jetstream2 partners

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<http://jetstream-cloud.org/>  
National Science Foundation  
Award #ACI-2005506