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Jetstream2: Accelerating science and engineering on-demand

David Y. Hancock – Indiana University

Director for Advanced Cyberinfrastructure

Jetstream2 Primary Investigator

NITRD MAGIC Subcommittee – 1 February 2023

Jetstream2

NSF Vision and Blueprint

U.S. National Science Foundation (NSF) envisions an **agile, integrated, robust, trustworthy and sustainable CI ecosystem that drives new thinking and transformative discoveries in all areas of S&E research and education.**

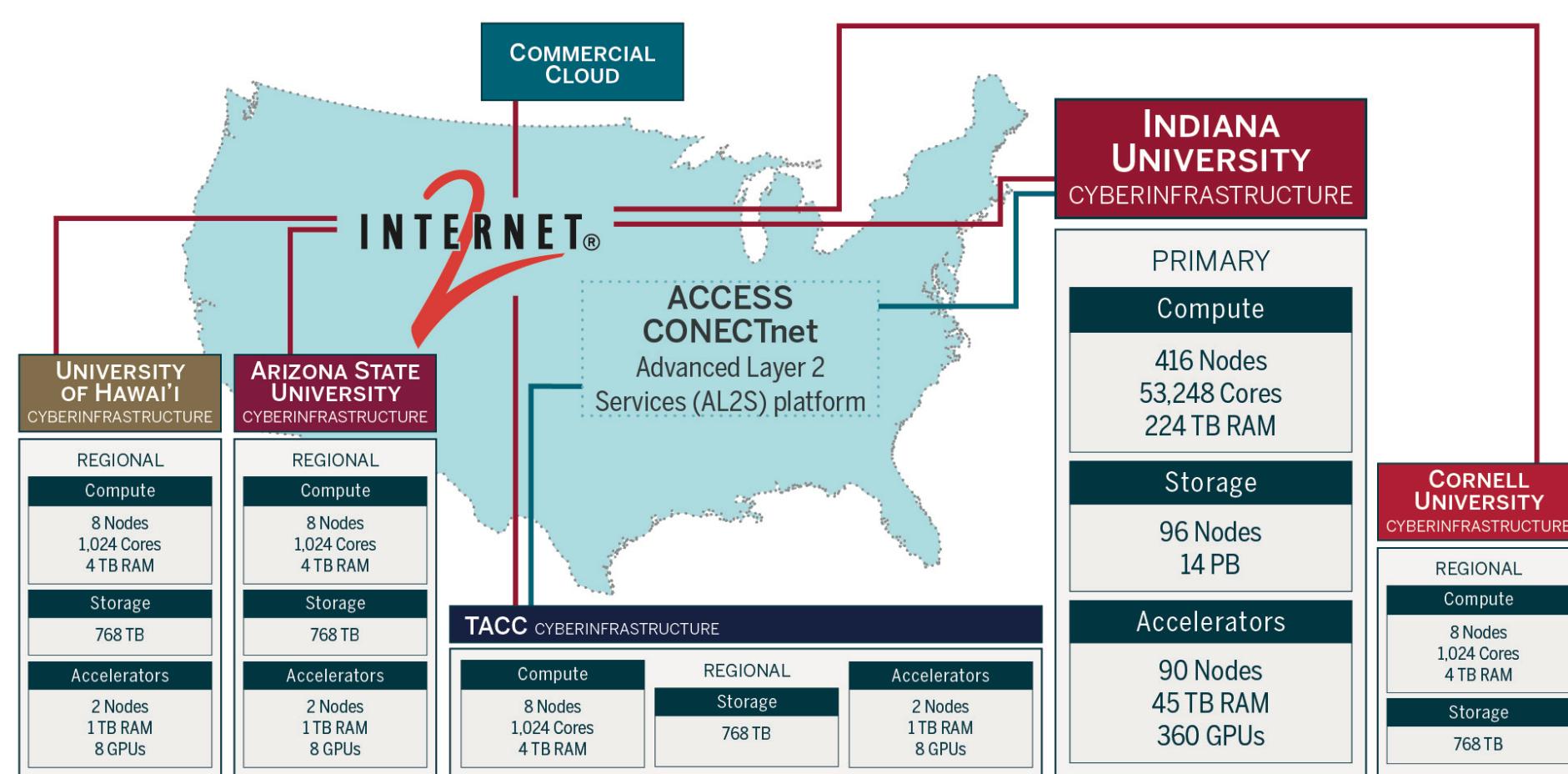
- View CI more holistically...
- Recognize and support the translational research continuum...
- Develop a strategy that balances innovations with stability and continuity...
- Work closely with the diverse S&E communities to tightly couple discovery and innovation...
- Achieve new levels of usability by easing the pathways for discovering, accessing, understanding, and utilizing powerful CI capabilities...

From: OAC Vision & Blueprint: Overview and Computational Ecosystem (Apr 2019)

- NSF-funded production cloud environment
 - Ease-of-use focus, rapid on-ramp to XSEDE/ACCESS
 - **On-demand** interactive computing and persistent services for science gateways
 - Enables configurable environments; **programmable cyberinfrastructure**

Now with GPUs,
large-memory,
more faster PB!

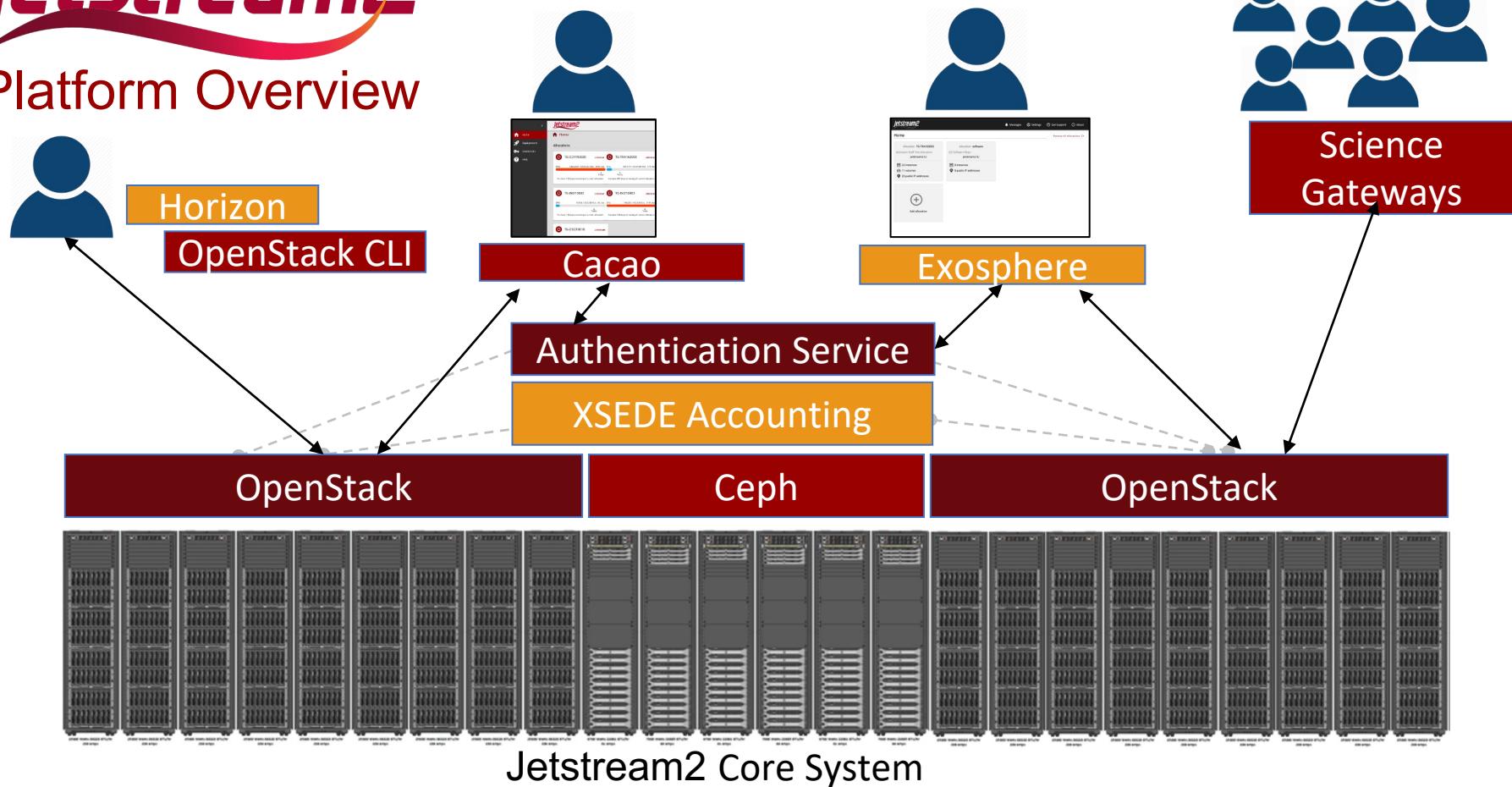




Jetstream²

Jetstream2

Platform Overview



Exosphere

Jetstream

Messages Settings Get Support About Logout ↗

Home > Project TG-CCR190024

iu.jetstream-cloud.org - TG-CCR190024

Remove Allocation ↗ Create ↘

Instances

Instances used 11 of 25 total Cores used 26 of 132 total RAM used 100 of 388 GB

Select All

Ready formally_trusty_urchin

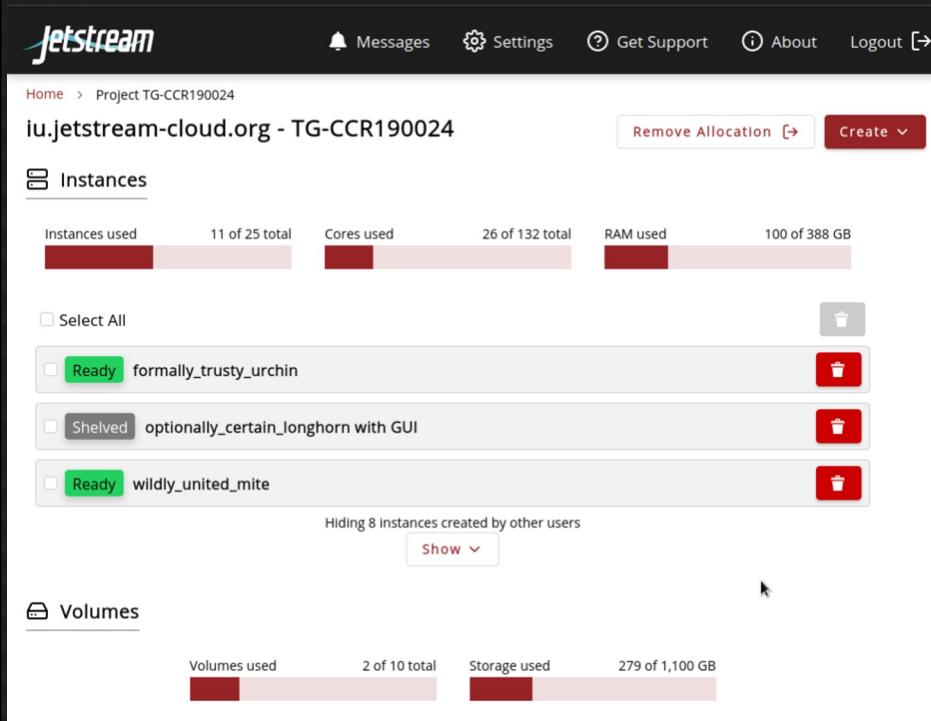
Shelved optionally_certain_longhorn with GUI

Ready wildly_united_mite

Hiding 8 Instances created by other users Show ↘

Volumes

Volumes used 2 of 10 total Storage used 279 of 1,100 GB



jetstream

Messages Settings Get Support About Logout ↗

Home > Project TG-CCR190024 > Instances > Instance formally_trusty_urchin
iu.jetstream-cloud.org - TG-CCR190024

Remove Allocation ↗ Create ↘

Instance formally_trusty_urchin

Created 19 minutes ago ⓘ / by user tg836338
/ from image JS-API-Featured-CentOS-Latest

Status Ready ⓘ ⓘ

UUID 2bc77f59-73bf-470f-95b6-51dc31d7577f ⓘ

Flavor m1.small

SSH Public Key Name cmart

IP addresses 149.165.157.3 ⓘ

Public IP Address Unassign

Lock Prevent further instance actions until it is unlocked

Suspend Save execution state to disk

Shelve Shut down instance and offload it from compute host

Image Create snapshot image of instance

Reboot Restart instance

Delete Destroy instance

Actions

Volumes Attached
(none) Attach volume

Interactions

➔ Web Shell ⓘ

🖼 Web Desktop ⓘ

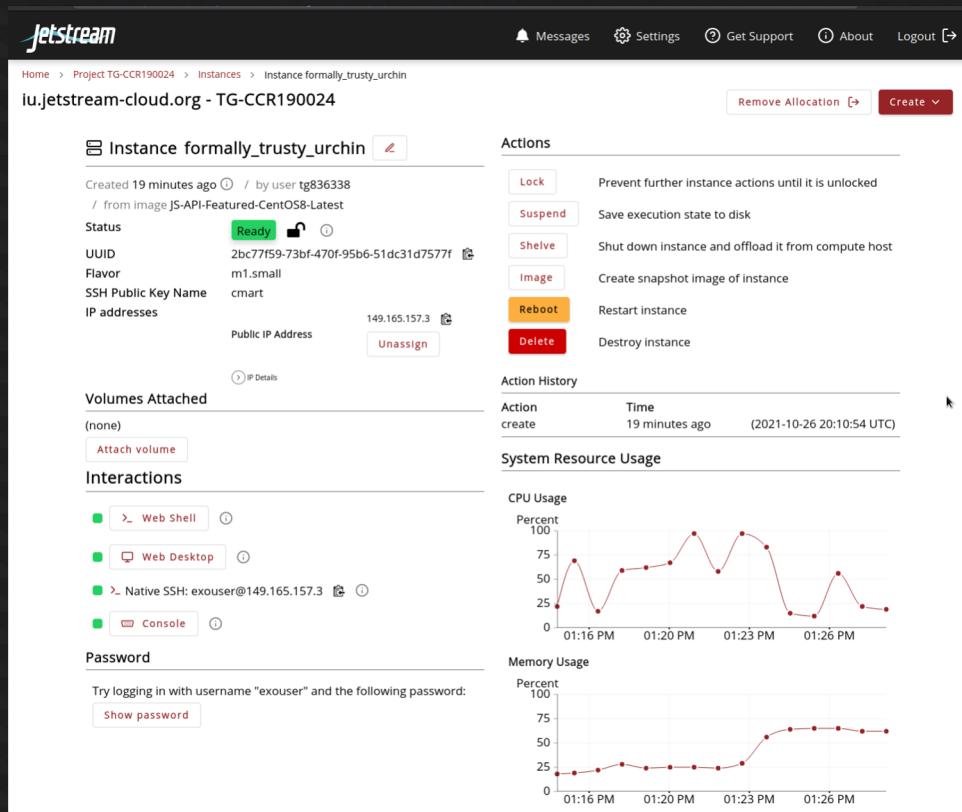
➔ Native SSH: exouser@149.165.157.3 ⓘ ⓘ

📺 Console ⓘ

System Resource Usage

CPU Usage
Percent 100
75
50
25
0
01:16 PM 01:20 PM 01:23 PM 01:26 PM

Memory Usage
Percent 100
75
50
25
0
01:16 PM 01:20 PM 01:23 PM 01:26 PM



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<https://exosphere.Jetstream-cloud.org> or <try.exosphere.app>

Differences from Jetstream[1] GUI

- Co-exists with other OpenStack interfaces, other research clouds
- Much easier collaboration between users on same allocation
- Choose an operating system instead of browsing a list of images
- Multi-instance create and delete
- Volume-backed instances → large, persistent root disks
- Live instance load graphs (CPU, GPU, RAM, storage)
- Live instance resize
- Push-button virtual clusters with elastic scaling
- Reproducible workbenches with Binder-compatible repositories

CACAO

The screenshot shows the CACAO web interface. At the top left is the Jetstream2 logo. The main navigation bar includes links for Home, Deployments, Credentials, and Help. The Home page features a large banner for the "Jetstream2 Alpha Release" with the CACAO logo and a DNA helix graphic. Below the banner are sections for "Allocations" and "Featured Learning". The "Allocations" section displays three projects: TRA220028 (Jetstream2 Affiliated Development Projects), TRA160003 (Jetstream Staff Test Allocation), and CIS220046 (Deep Learning Tutorial for Translational AI Center at Iowa State University). Each project card shows resource usage (CPU, GPU, Large Memory) and remaining allocation days. The "Featured Learning" section contains three cards: "Continuous Analysis 101", "Jetstream2 Basics", and "Manage Resources", each with a brief description and a "Learn more" link.

The screenshot shows a "New Deployment" dialog box. At the top right is the text "JETSTREAM 2 / BIO220047" and "IN PROGRESS". The main area is titled "Deployments (1)". It asks to "Select a template that best describes what you want to do:" with four options: "simple launch of one or more vms" (selected, highlighted in orange), "launch a multi-vm zero-to-jupyterhub", "launch a multi-vm kubernetes cluster (k3s)", and "launch instances for a workshop". A "GO" button is at the bottom right of the dialog.

Jetstream2

<https://cacao.jetstream-cloud.org>

Deep dive into DL

- First-of-a-kind workshop to apply DL techniques to agricultural data sets in April 2022
- AIIRA, AI Institute for Resilient Agriculture, intends to distribute the digital twin built on JS2 for community re-use
- Allows community training and inference
- Provided via Terraform templates and customized UI through CACAO



...we were able to easily provide so many students with a GPU-enabled container so quickly. Normally, getting GPU resources on an HPC scheduler, like OnDemand, takes time, and the high demand for GPUs makes finding 40 or more unoccupied resources an impossibility.

– Tyson Swetnam, CyVerse Co-PI and workshop instructor

Gateways use JS2 in several ways



Gateway web hosting



Datasets and
Database hosting



Gateway Security
Services

Integrated JupyterHub



Interactive
Computing



Elastic Virtual Clusters

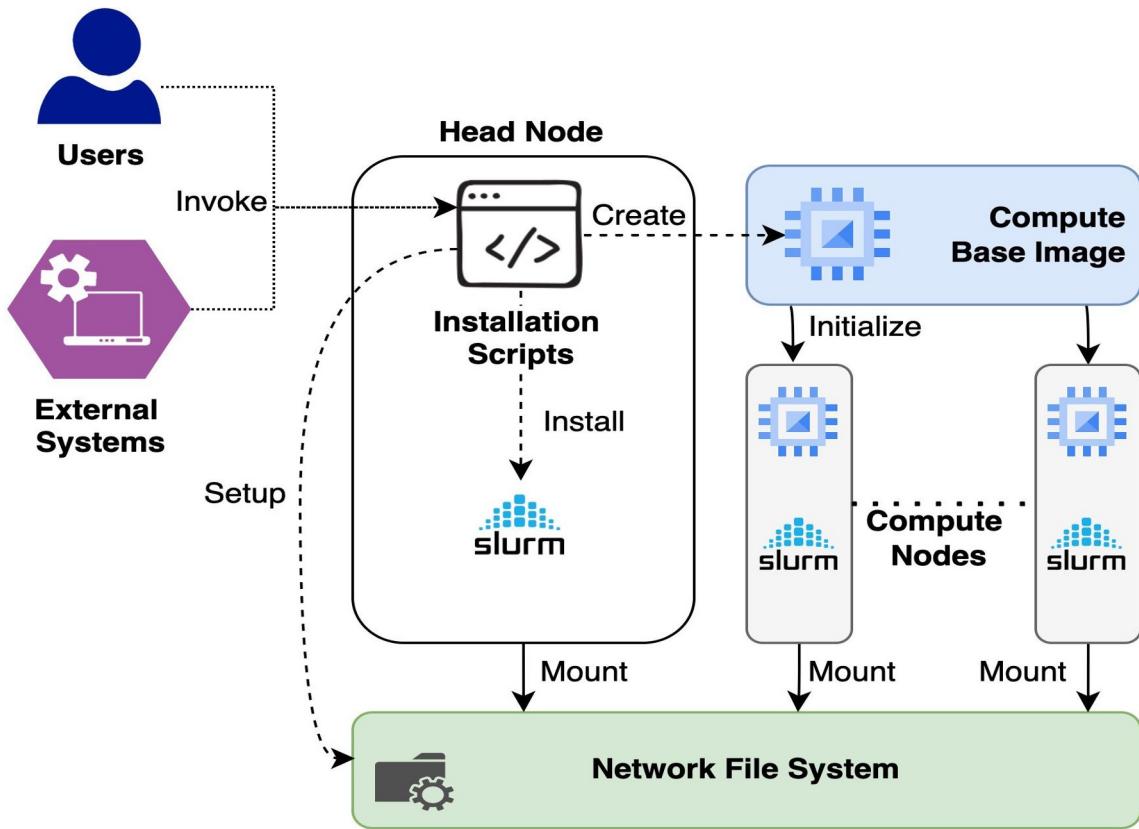


Elastic Virtual Clusters

- One Click OnDemand Cluster Augmenting the cloud Capabilities
 - Bundled lightweight HPC Stack, including SLURM.
 - Users deploy scientific software with complete OS control.
 - Dedicated and Responsive scheduler for rapid testing and development like workloads.
 - Mounted persistent storage.

Virtual Clusters Architecture

- All these steps are bundled into the Ansible orchestration.
- The entire system is a single click invoked from Exosphere.



Early Operations Projects & Activity

- First PI invitations and projects added in February 2022
 - Remaining project migrations in May – July
- Retired Jetstream[1] in July/August 2022
- Full production in September 2022 after NSF approval
- Dec 2022: 357 projects and 1753 individuals (565 students)
- Approximately 900 unique people have created JS2 instances to date via Exosphere
- Includes multiple science gateways and education/training allocations



"Bike Exchange - 2009 IU Women's Little 500" by Indiana Public Media Flickr CC BY-NC 2.0

Production & Pilot

Vision for Jetstream2 is that it functions as a **production** system yet does not cede our **pilot** roots.

- Obsolescence vs Maturity & graceful aging
- Carry new lessons into the future

Imitation is the sincerest form of flattery

- Influenced design of many other systems
- Distinct utility, focus, and inclusion
- Reflecting on Why?



"Metamorphosis" by h.koppdelaney
Flickr CC BY-ND 2.0

Dynamic Connections

Importance of leveraging other projects

- XSEDE -> ACCESS
- Exosphere
- CyVerse – CACAO
- Globus
- Custos / CI Logon
- Open Source

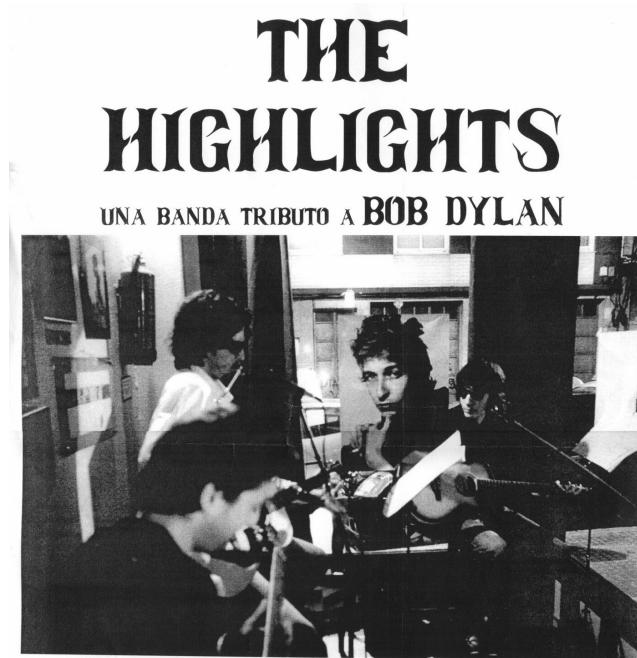


Monterey Bay Aquarium – D. Y. Hancock

Operations highlights

- OpenStack upgrades x4 Wallaby -> Zed
- Shared storage availability (Manila)
- DNSaaS for instances (Designate)
- Only 17.2 hrs downtime (<0.2%) 4Q22
- 96.4% of instances started in <5 min
- Using CI/CD for image build pipeline
 - Weekly updates (vs periodic)
 - Allows more flavors (currently 7)
 - Allows reuse of our pipeline for others

Jetstream2



DON'T BOO ME TOUR 2006

AGORA CAFE
C/ ORZAN, N. 27
JUEVES 20 JULIO - 23:00 H
www.thehighlights.es

"The Highlights" by Modesto del Río
Flickr CC BY 2.0

Developments to come

- LBaaS (load balancing)
- Secret storage
- Managed Kubernetes (via OpenStack)
- IPV6
- Addition of a new partner
- Continued/evolving outreach
- Increased Cacao use / features

Exosphere specific

- Shared storage integration
- GPU-accelerated desktops
- Education / workshop features



"Work in progress" by Alexander Baxevanis
Flickr CC BY 2.0

What's next?

- Midway into YR 1 operations
- Prepare for panel review (~March 2023)
- Integrate new partners
- Survey JS2 community
- Grow the community, focus on new tools and approaches
- Support hybrid science gateways
- Upgrade, share, and evolve



"Look Ahead!" by brenkee
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- Vendors, particularly Dell and NVIDIA, also deserve recognition for their efforts



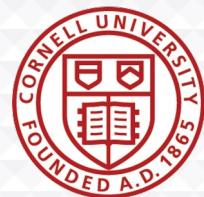
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<http://jetstream-cloud.org/>
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