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Jetstream2: Accelerating cloud computing via Jetstream

David Y. Hancock – Indiana University

Director for Advanced Cyberinfrastructure

Jetstream2 Primary Investigator

Deployment of an On-Premise Cloud in a Global Pandemic

HPC•AI Advisory Council – 5 April 2023

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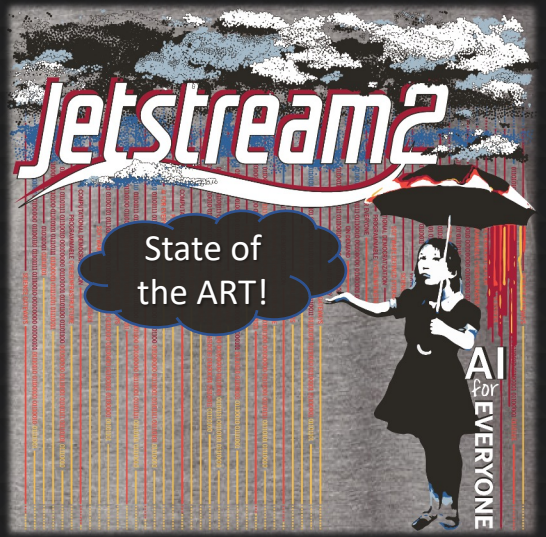
What is “the” Jetstream(2)?

- A US National Science Foundation 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



By Maria Morris: JS2 rear doors (lower) Banksy adaptation [non-commercial] (right)

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

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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)

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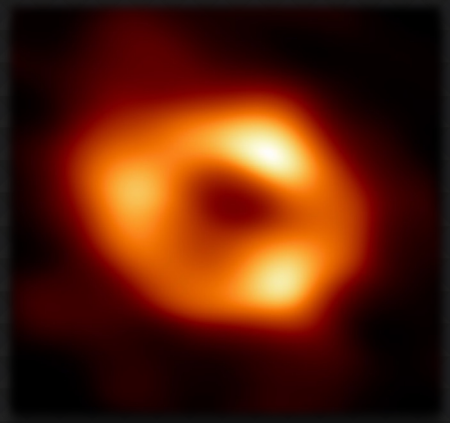
First – Jetstream, a review

- Jetstream began in 2014, production in 2016, retired 2022
- Simultaneous pilot & production
- Services to 18,714 researchers and educators (8,836 students) on 1,220 projects in 69 fields of science for individuals at 399 institutions
- Provided 7x the educational service units as any other XSEDE resource.
- The 63 science gateways that utilized Jetstream indirectly supported over 183,197 people.
- Six year of operations an overall availability of 98.54%, incl. planned and unplanned outages
- An uptime of 99.9967% where the system was operating but at a reduced capacity

Award details: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1445604

Jetstream kick-started the EHT's cloud computing effort
– Chi-kwan Chan



Black hole Sagittarius A
Courtesy https://www.nature.com/articles/d41586-022-01320-y

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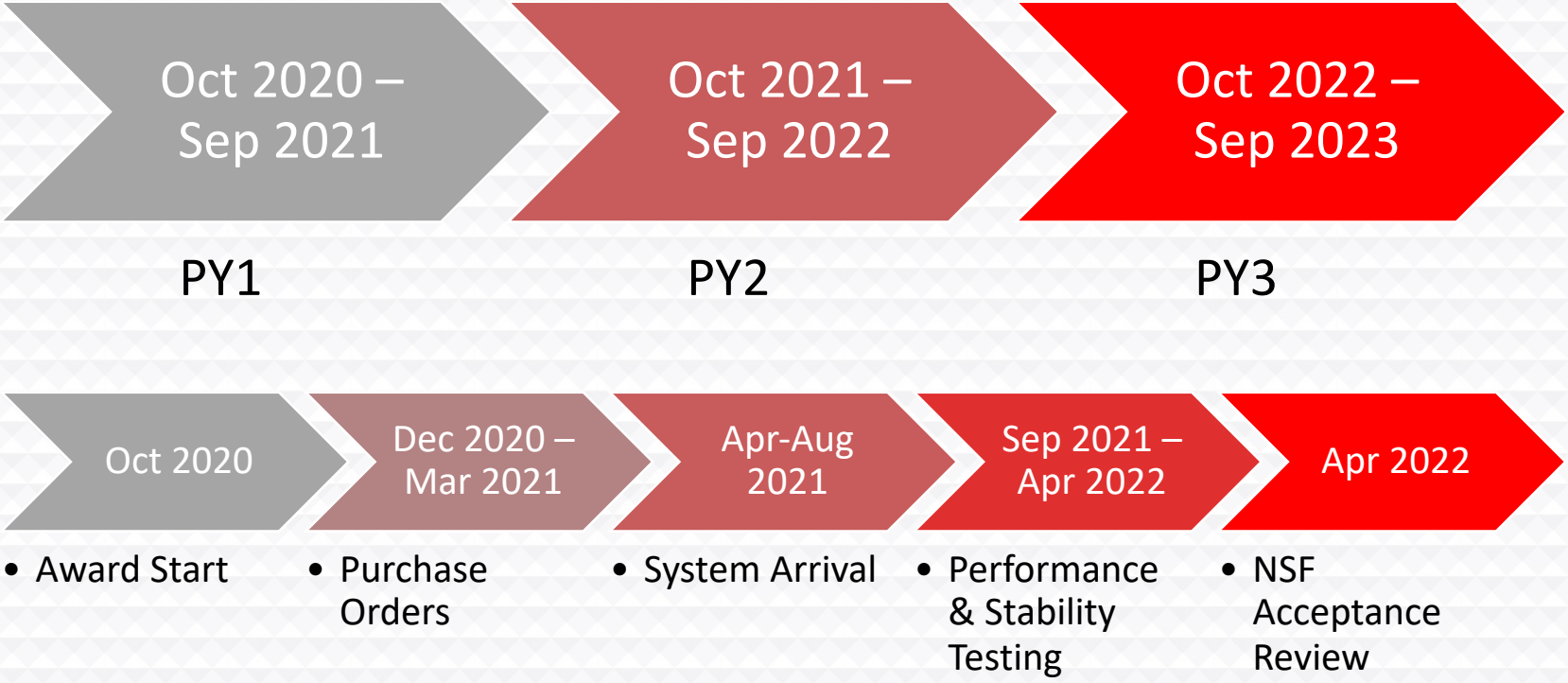
JS2 – Award & Acceptance Timeline



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Early Operations Projects & Activity

- First PI invitations and projects added in February 2022
- Project migrations in May – July 2022
- Q1 2023: 333 projects and 1,882 individuals (499 students)
- >900 unique people have created JS2 instances to date
- Includes multiple science gateways and education/training allocations
- Full production in September 2022 after NSF approval
- Retired Jetstream[1] in July/August 2022

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

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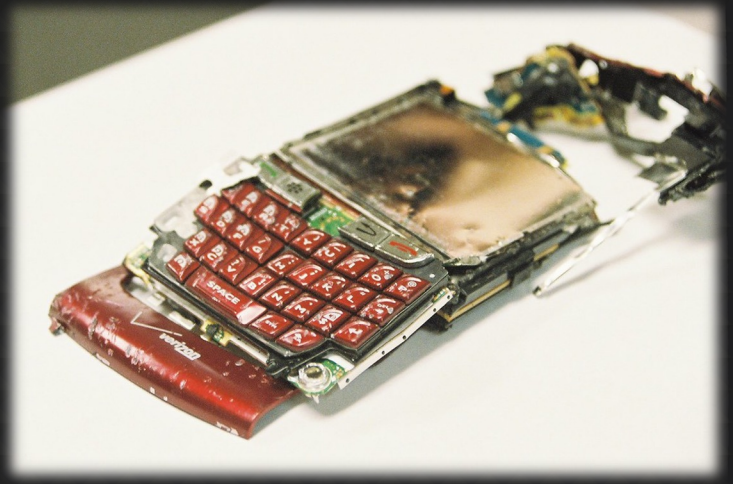
What worked in JS1?

- Allowing API access and full control (root privileges)
- “Indefinite workflows” – allowing instances to run continuously – providing PIs renew their allocations
- Development of trial allocations



Flickr user MattHurst – Broken Blackberry

What didn’t work?

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

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JS1 Lessons learned

Challenges -> Inspired changes

- Storage capacity -> Larger HDD pool and new flash storage
- Homogeneous hardware -> Inclusion of NVIDIA GPUs (via vGPUs) and memory diversity
- Separate OpenStack domains -> Unification of “Atmosphere” domain

D.Y. Hancock – Castello di Nipozzano 2017

- Virtual networking architecture/maintenance -> Increase offload capabilities via Cumulus Networks software and Mellanox hardware (NAT & simulation)
- Acceptance & integration into national CI ecosystem -> Changes to our metrics/KPIs & accounting processes
- Deployment diversity -> Leverage single technology for config management

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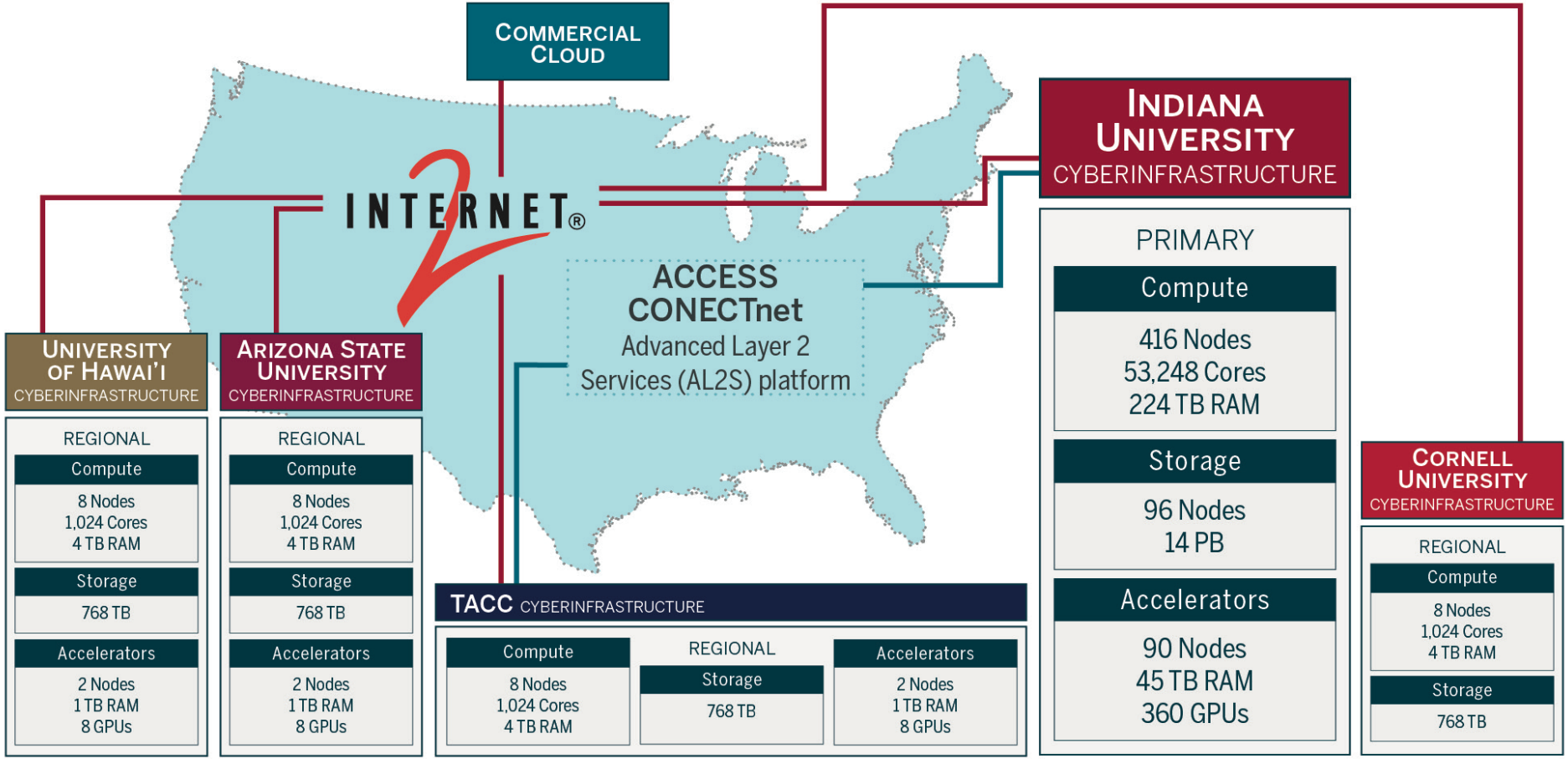
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Storage
96 Nodes
14 PB
Accelerators
90 Nodes
45 TB RAM
360 GPUs
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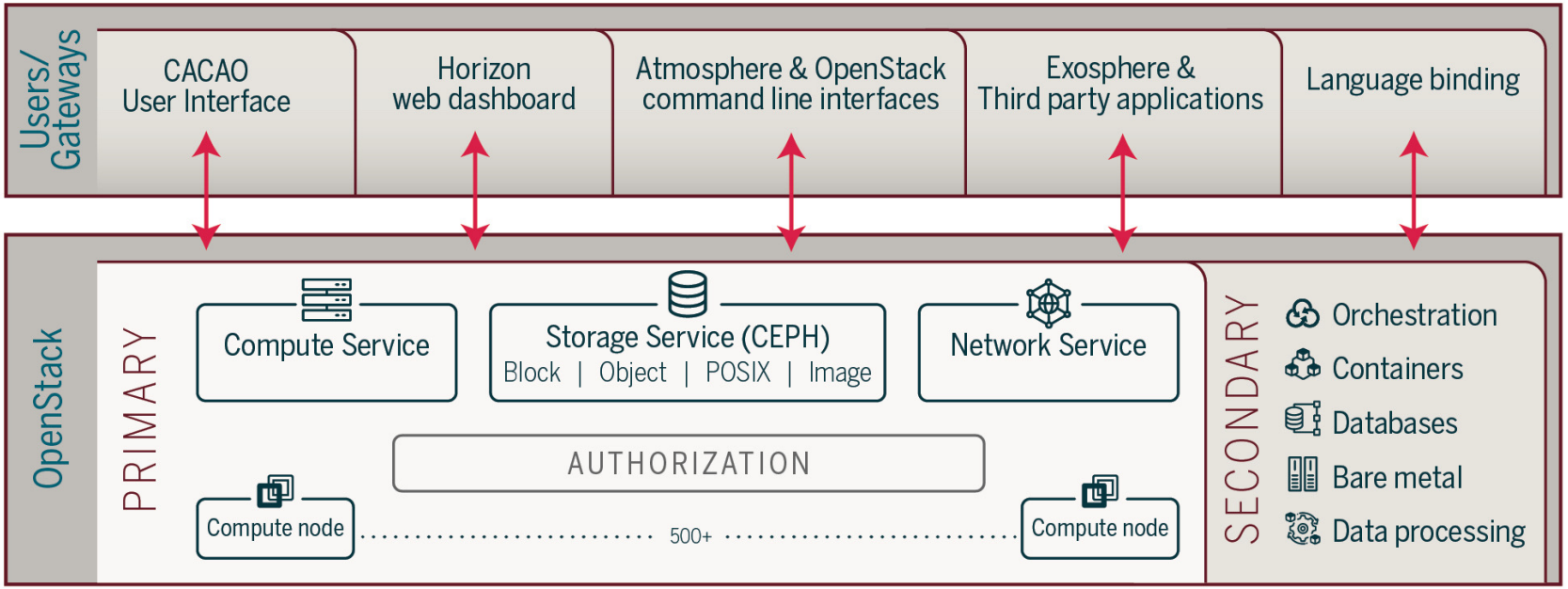
Conceptual Jetstream2 Architecture



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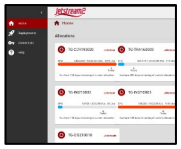
Platform Overview

Horizon

OpenStack CLI



Cacao

Exosphere

Science Gateways

Authentication Service

ACCESS Accounting

OpenStack

Ceph

OpenStack

Jetstream2 Core System

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

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Pandemic Challenges & Lessons

Be early & adaptive

- Changed major items to lessen delays
- Water cooling, CPU configs, order and deployment, benchmarking, integration

Prioritize people

- Cyberinfrastructure[1] includes people
- Highly distributed teams (NY-NZ)

Be patient, have grace

- Capacity to accept or tolerate delay, trouble, or suffering without getting angry or upset
- You control your reaction, not the situation

D.Y. Hancock – Tijuana, MX

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[1]SIGUCCS 2010 - https://doi.org/10.1145/1878335.1878347

Jetstream2 Capabilities

Enhancing IaaS model of Jetstream:

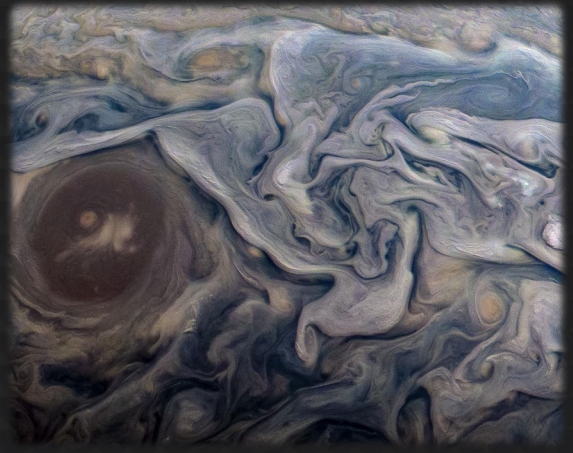
- Improved orchestration support
- Elastic virtual clusters
- Federated JupyterHubs
- Ease storage sharing (CephFS w/Manila)

Commitment to >99% uptime

- Critical for science gateway hosting
- Hybrid-cloud support

Revamped User Interface

- Unified instance management
- Multi-instance launch



Feb 12, 2019 – Jet stream region called "Jet N6"
NASA/JPL-Caltech/SwRI/MSSS/Kevin M. Gill

- >57K cores of next-gen AMD EPYC processors
- >360 NVIDIA A100 GPUs will provide vGPUs via NVIDIA's MIG feature
- >17PB of storage (NVMe and disk hybrid)
- 100GbE Mellanox network

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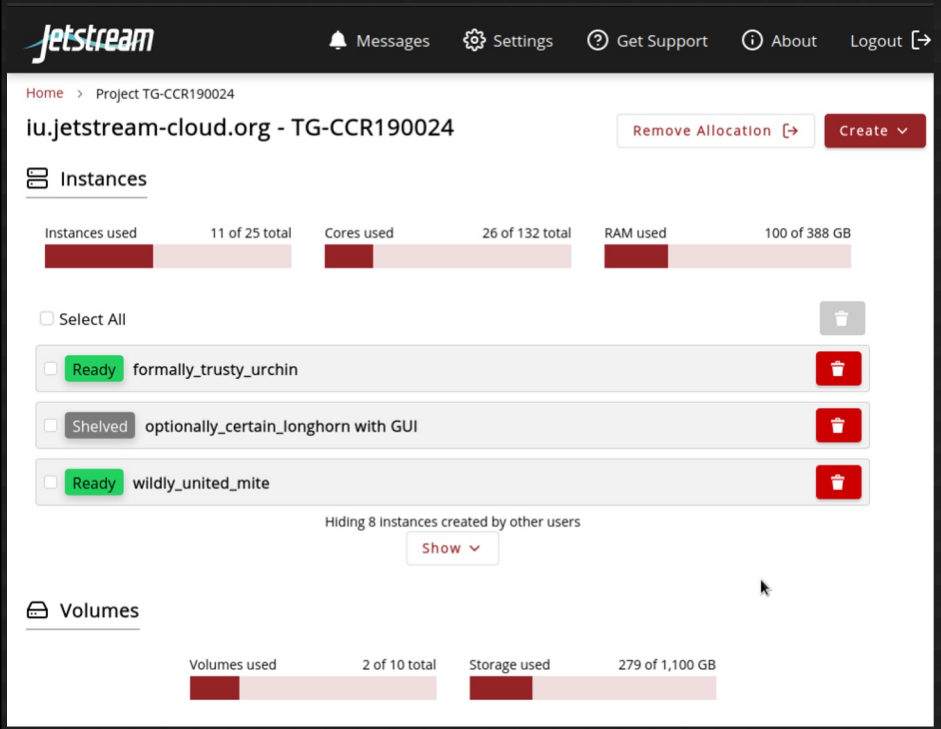
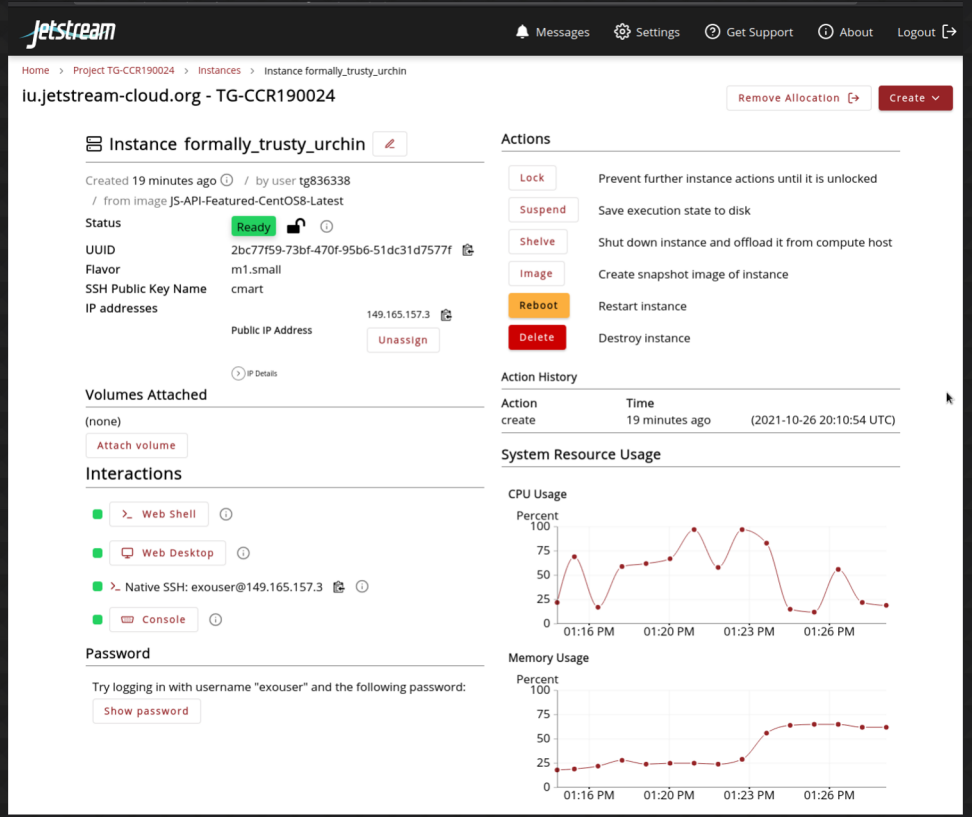
Exosphere





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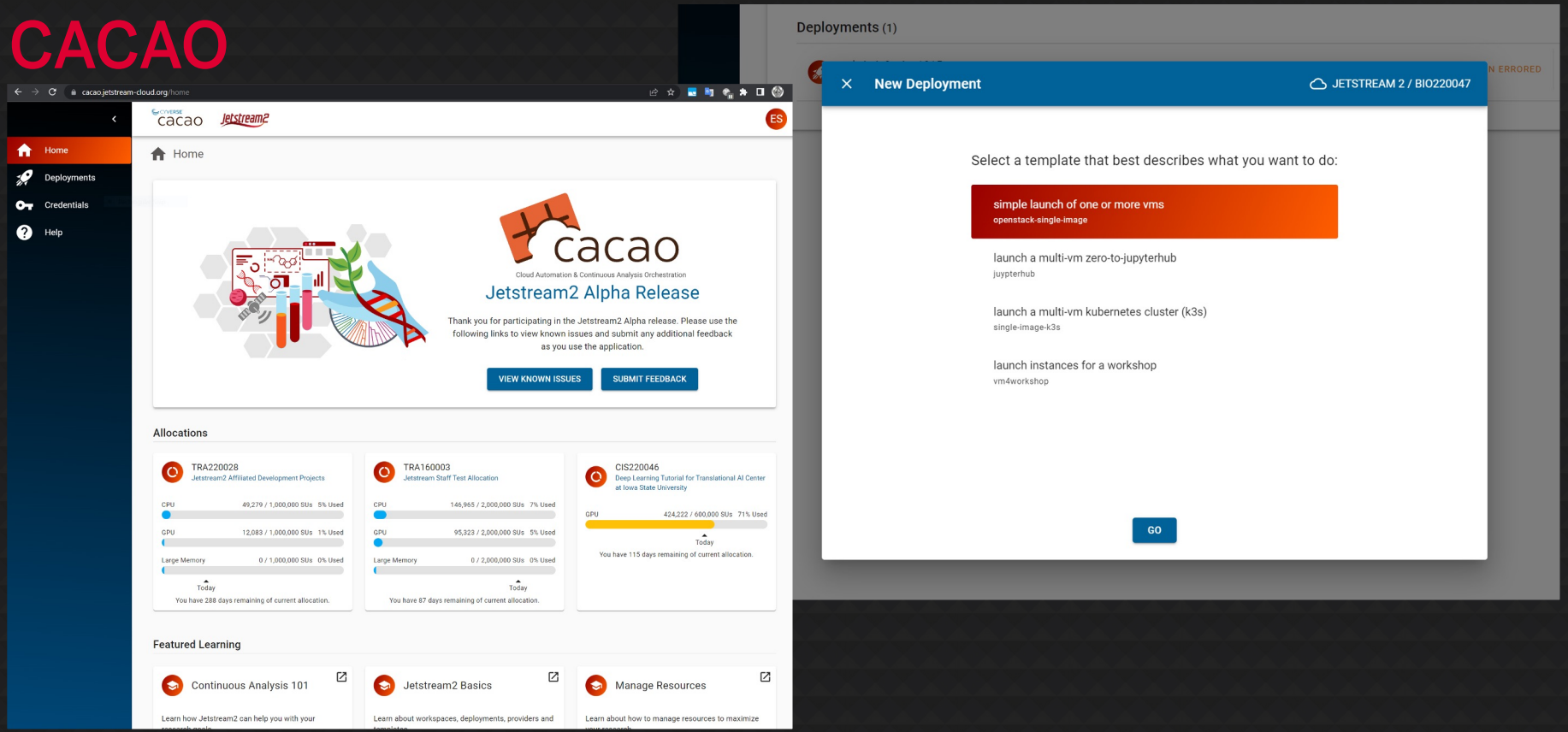
https://exosphere.Jetstream-cloud.org or try.exosphere.app

CACAO



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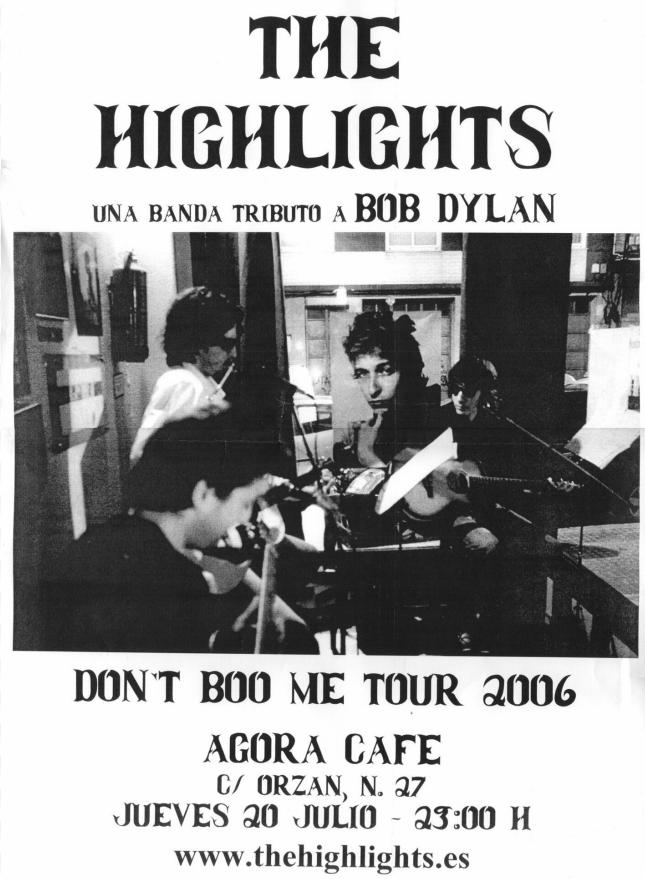
https://cacao.jetstream-cloud.org

Operations highlights

- OpenStack upgrades Wallaby -> Zed
- Shared storage availability (Manila)
- Using CI/CD for image build pipeline
  - Weekly updates (vs periodic)
  - Allows more distros (currently 7)
  - Allows reuse of our pipeline for others

  https://gitlab.com/jetstream-cloud/
- Launched a ”software store” using CephFS and LMOD



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

Dynamic Connections

Importance of leveraging other projects

- XSEDE -> ACCESS
- Exosphere
- CyVerse – CACAO
- Globus
- Custos / CI Logon
- Open Source (KVM, Ceph, Salt ...)

Monterey Bay Aquarium – D. Y. Hancock

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Demo? Watch this...

"You can't recycle wasted time..." by H M Cotterill
Flickr CC BY-NC-ND 2.0

Generated with stable diffusion on a Jetstream2 instance with NVIDIA A100 vGPUs

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What's next?

- Nearing end of YR 1 operations
- Prepare for panel review (April 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
Flickr CC0 1.0

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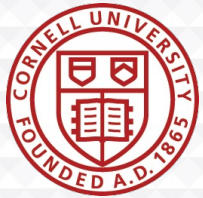
Jetstream2 partners



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