Jetstream2:

Unidata’s use and growth with Jetstream

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About Jetstream2

- NSF-funded production cloud environment
- Ease-of-use focus, rapid on-ramp to ACCESS (allocated ONLY via ACCESS)
- On-demand interactive computing and persistent services for science gateways
- Enables configurable environments; *programmable cyberinfrastructure*
- Building on the success of Jetstream1
  - 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
Jetstream2 Features

• Primary Cloud (IU)
  • 400 compute nodes -- AMD EPYC 3rd Generation Milan CPUs – 128 cores per node + 512gb RAM
  • 90 GPU nodes – 4 x NVIDIA A100 40gb per node
  • 32 Large Memory nodes with 1TB of RAM

• Regional Clouds available by invitation/request (Arizona State, Cornell, Hawaii, TACC)

• Shared application store with common applications (NVIDIA HPC Toolkit, multiple compilers, R/Rstudio, Matlab, Anaconda, etc)

• Federated JupyterHubs, Virtual Clusters, and orchestration are all available with features being added and refined

• Commitment to >99% uptime
  • 99.87% availability for 9-7-22 to 3-31-23 (last NSF reporting period)
Some sample use cases

- Science gateways
- Research-supporting infrastructure / Infrastructure as a service
- Education support – compute and desktops for courses, workshops, tutorials
- Domain science interactive compute
- Domain science long running compute
  - Smaller core counts, "pleasingly parallel", etc
- Jupyter notebooks and Hubs
- Research software development
- Machine learning – training and workflow development and data analysis
- [Your use case here]
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.
A few key stats…

3,200
Users using Jetstream2 directly since June 2022

198,000
Users using Jetstream2 via Science Gateway

74
Fields of science represented on Jetstream2
Accessing Jetstream2

Go To https://jetstream-cloud.org/

Before you can use Jetstream2 you must first have an Access ID and be on an active Jetstream2 allocation!
What is Access?

Provides Access to National Advanced Computing Resources

https://access-ci.org/

The NSF’s ACCESS (Advanced Cyberinfrastructure Coordination Ecosystem: Services & Support) program builds upon the successes of the 11-year XSEDE project, while also expanding the ecosystem with capabilities for new modes of research and further democratizing participation.
Applying for an allocation is like applying for a small grant that provides computational resources.

The first level of application “Explore ACCESS” is a single form and only takes a few minutes; approval comes at the longest in a few days. ~$40,000 worth of cloud resources for a few minutes of effort.
How do I access Jetstream2?

https://docs.jetstream-cloud.org/overview/overview-doc/
Using and preserving VMs

- You can install just about anything*
  - But generally limited to Linux**
- Snapshots are fairly simple and easily shared with your allocation
- One general practice is often to pull from Git(hub/lab) or pull a container

* Standard warnings about licensed software here.
** Here there be dragons.
Jetstream2 Allocation/Usage Considerations

- No scheduled downtime for upgrades
  - Upgrades are generally done while the system stays live overall
  - 99.87% availability for 9-7-22 to 3-31-23 (last NSF reporting period)

- Persistent IP addresses (for the life of an allocation if desired)

- No runtime limits – VMs can exist as long as there is an active allocation with SUs available

- No allocation limits for SUs – if you can justify it and we can provide it, we do

- Instance, core, and ram limits are flexible and extendable – if you can justify it and we can provide it, we do

- Storage allocations are reasonably generous – 1TB default up to 50TB in volume, shared, or object storage
Where can I get help?

Jetstream2 docs: https://docs.jetstream-cloud.org/
ACCESS docs: https://support.access-ci.org/
ACCESS Support Form: https://support.access-ci.org/open-a-ticket
A (very) brief history with Unidata on Jetstream1 and 2

- One of the first allocations on Jetstream1 in 2016 early operations
- Ran a combination of API side and Atmosphere instances on Jetstream1
- Evolved into all API side by the end of JS1 with a large auto-scaling JupyterHub deployment based on Dr. Andrea Zonca’s tutorials
- Early operations allocation on Jetstream2 in 2022 under a new allocation
- Continuing the JupyterHub deployment and EDEX operations
- Presently over 100 running instances on JS2 (about 30 labeled test)
DeSouza award

Honorees of this award are exemplars of an inclusive community that promotes the sharing of data, software, and ideas through computing and networking technology. While direct involvement in the Unidata community is one avenue by which such contributions may be made, this is not a requirement — the distinguishing ethos of awardees is their contribution and dedication to accessible and reproducible science and education within the geosciences.
PyAOS JupyterHubs - slide from Julien Chastang

- 1,400 Users for semester classes and workshops since 2020
- 19 Universities
- 22 Workshops
- ~ 90 Hubs launched
- Tailored to objectives of instructor / professor
Deploy Kubernetes and JupyterHub

- On Jetstream 2 Openstack deployment
- Kubernetes for orchestration/networking/logging/resiliency
- JupyterHub runs a pod for each user across the cluster

https://docs.jetstream-cloud.org/general/k8skubespray/
https://zonca.dev/2022/03/jetstream2-jupyterhub.html
Deploy Dask Gateway

- Give more computational resources to users
- Use dask for high-level distributed computing

https://www.zonca.dev/posts/2023-09-28-dask-gateway-jupyterhub
Laptop user 1

Jetstream VM Main

Kubernetes

JupyterHub

Jetstream VM Worker

Notebook+Kernels user 1

Dask gateway API

Dask gateway Proxy

Jetstream VM Worker

Jetstream VM Worker
Parallel data storage with Object Store and Zarr

- Read/write data in parallel to Object Store with dask in Zarr format
- Zarr is a cloud-native file format for chunked/compressed/multi-dimensional arrays

https://www.zonca.dev/posts/2022-04-04-zarr_jetstream2
Deploy on GPU nodes

- Make GPUs available to containers running in Kubernetes
- Ideal for ML/AI applications

https://docs.jetstream-cloud.org/general/k8sgpu/
Share volume across all JupyterHub users

- In case object storage is not suitable for a specific use-case
- Set read-only or read-write permissions by folder
- NFS service provided by Jetstream 2 via Manila
  https://www.zonca.dev/posts/2022-12-05-jetstream2-kubernetes-manila

- Runs as a container in Kubernetes
- Saves data to persistent volume
- Expose SSH port externally for terminal access
  https://www.zonca.dev/posts/2023-02-06-nfs-server-kubernetes-jetstream
Shared persistent dask cluster

- Alternative to Dask Gateway
- 1 persistent cluster
- Multiple users accessing the same cluster

Load software stack from CVMFS

- CernVM File System software distribution service
- Used in High Energy Physics
- Runs in docker container managed by Kubernetes
- Caches software in a persistent volume
- Mounted through NFS in all users' JupyterHub containers
- Provides Jupyter Kernels

https://www.zonca.dev/posts/2020-02-26-kubernetes_cvmfs
Deploy MariaDB database

- Runs as a container in Kubernetes
- Run separate pod for terminal access, e.g. ingest/dump data
- Either accessible from the web or just internally within the Kubernetes deployment

https://www.zonca.dev/posts/2022-06-06-mariadb
Deploy BinderHub

- Instead of JupyterHub, deploy BinderHub
- No persistent user data
- Builds containers on the fly based on Github repo

Nightly backup of user data

- Automated volume backup system
- Saves offsite to Open Science Network object store
- Notifies admin if backup fails to notify completion

Experimental autoscaling

- Adds and removes Virtual Machines based on load
- Runs as a service inside Kubernetes

https://www.zonca.dev/posts/2021-01-20-autoscaling_script_kubespray_jupyterhub
In progress: Run Singularity containers inside Kubernetes

- Tutorial I'm currently working on
- Execute Singularity containers commands inside Docker
- Use Singularity containers as kernel providers for Jupyter
In progress: Load balancer for High Availability Kubernetes

- Single point of failure in current setup is we the master node
- Use a load balancer provided by Jetstream 2
- Support multiple master nodes
Conclusion

Interest in deploying services on Jetstream 2? Contact us

See the in-depth tutorial video about Distributed Computing with Dask on Jetstream 2 at the Gateways 2023 conference:

zonca.dev/posts/gw23
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