



## Cloud Facility for Scientific Gateways

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funded by the National Science Foundation  
Award #ACI-1445604

# Terms & Definitions



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# What is Jetstream

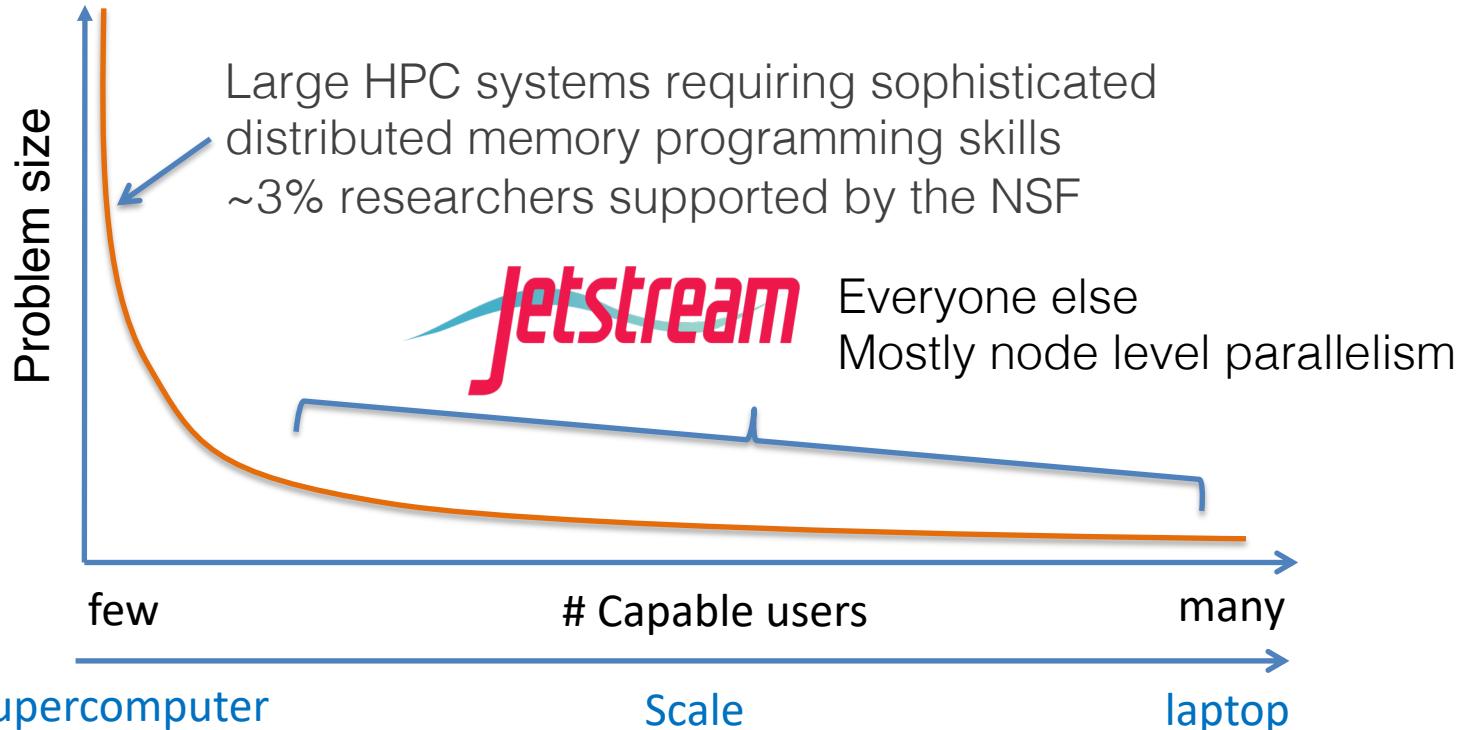


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# What is Jetstream?

- **User-friendly**, widely accessible cloud environment
  - **User-selectable library** of preconfigured virtual machines
    - Interactive computing
    - Software maintained by domain specialist
    - No need for system administration skills
    - The “Atmosphere” side
  - **Programmable cyberinfrastructure**
    - Go beyond batch computing
    - Implement modern cloud computing techniques
    - Common modality for science gateways
    - The “API” side

# “Long tail” of the Science



# What is Jetstream?

- Primary goal is to **expand the user base** of NSF's eXtreme Digital (XD) program resources beyond the current community of users.
- Lowering the hurdle to onboard to XSEDE resources
  - Working to **ease the allocation request** process
  - **Easy-Button**; quick access but limited ability. (Beta)
- **Making Science Easy** for domain researchers, engineers, & educators
  - Domain software installed & maintained by the professionals
  - No sys-admin skills necessary

# What is Jetstream? (Cont.)

- **Creating communities**
  - Domain developers **create, install, and maintain** the software
  - **Encourage collaboration** within the domains
  - **Operating system** level software is professionally **patched and maintained**
- **Repeatability:** store & publish images via IU Scholarworks & create a DOI
- **Science Gateways:**

# What is Jetstream?

- **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
  - **Cows, not pets**:
    - pets have **state**, you name them, you get attached to them, you put forth great amount of care and effort
    - cows **do not have state**, you expect to have high turnover, you do not get attached to them, you give them numbers instead of names

# What is Jetstream?

- **Software layers**
  - **Atmosphere** web interface
    - library of images, generic, domain specific
    - simplify VM administration
  - **OpenStack**: software tools for building and managing cloud computing platforms for public and private clouds.
  - **KVM** hypervisor: what the VMs run on
  - **Ceph**: storage platform that stores data on a single distributed computer cluster, and provides interfaces for **object**-, **block**- and *file-level* storage.
  - **Operating systems**: CentOS, Ubuntu, Windows?
  - **Applications**; e.g. software developed by the domain specialist, gateways, etc.

# 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
- **Slack channel** for collaboration API users of Jetstream

# OpenStack



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# OpenStack Organization

The screenshot shows the official OpenStack website at [www.openstack.org](https://www.openstack.org). The page features a prominent red 3D cube logo and the text "openstack CLOUD SOFTWARE". A mission statement emphasizes the goal of producing a ubiquitous Open Source Cloud Computing platform. Below the logo, there are three main sections: "Get started", "Contribute to OpenStack", and "Join the Community". Each section contains a bulleted list of links. A sidebar on the left lists "Links for ...Contributors", "...Infrastructure & Tools", and "...Others", each with its own set of links. The top navigation bar includes "Main page", "Print/export", "Tools", "Search", "Log in / create account with OpenID", and links for "Home", "Software", "User Stories", "Community", "Profile", "Blog", "Wiki" (which is underlined), and "Documentation".

**The OpenStack Mission:** to produce the ubiquitous Open Source Cloud Computing platform that will meet the needs of public and private clouds regardless of size, by being simple to implement and massively scalable.

OpenStack is [open source](#), [openly designed](#), [openly developed](#) by an [open community](#).

**Get started**

- [Download releases](#) and read release notes
- Read official documentation
- Ask us questions on [Ask OpenStack](#)
- Talk to us on our [IRC channels](#)
- Join the conversation on our [Mailing Lists](#)
- Learn about [Security](#) in OpenStack
- [Get the source code](#)
- Give OpenStack a trial run
- Watch [demo videos](#)
- Go back to main [OpenStack website](#)

**Contribute to OpenStack**

- [How To Contribute](#)
- Learn about [Release Management](#)
- See the [current release cycle schedule](#)
- [How to submit changes](#)
- [Code reviews \(Gerrit\)](#)
- Guidelines for code reviewers
- [Gate system status \(Zuul\)](#)
- How to use Launchpad Bugs and Blueprints

**Join the Community**

- Learn the [OpenStack Way](#)
- [Governance](#) - How OpenStack is governed
- Explore the [Technical Committee documents](#)
- [Online Meetings](#)
- [Design Summits](#)
- [Mid-cycle Sprints](#)
- [OpenStack User Groups](#)
- [OpenStack Blog](#), with [weekly newsletters](#)
- [Planet OpenStack](#) - Blogs about OpenStack

**OpenStack Project Teams** are the building blocks to achieve OpenStack's mission. One can think of Project Teams as teams of people using tools (code repository, bug tracker, etc) and coordinated processes to produce a number of deliverables, in order to achieve a clearly stated objective.

Browse the [official list of OpenStack project teams](#).

**Links for ...Contributors**

- [git.openstack.org](#) - Git repositories browser
- [review.openstack.org](#) - Code reviews
- [lists.openstack.org](#) - Mailing-lists
- [eavesdrop.openstack.org](#) - IRC logs and meetings
- [translate.openstack.org](#) - Contribute translations
- [specs.openstack.org](#) - OpenStack specs browser
- [codesearch.openstack.org](#) - Code search

**...Infrastructure & Tools**

- [stackalytics.openstack.org](#) - Contribution analytics
- [status.openstack.org](#) - Infrastructure status
- [grafana.openstack.org](#) - Infrastructure dashboards
- [graphite.openstack.org](#) - Infra metrics & graphs
- [logstash.openstack.org](#) - Search test logs with Kibana
- [etherpad.openstack.org](#) - Collaborative text editor
- [paste.openstack.org](#) - Pastebin

**...Others**

- [www.openstack.org](#) - OpenStack Foundation site
- [governance.openstack.org](#) - Technical Committee docs
- [security.openstack.org](#) - Security advisories & policies
- [docs.openstack.org](#) - Documentation
- [groups.openstack.org](#) - Find user groups
- [ask.openstack.org](#) - Q&A website
- [planet.openstack.org](#) - Blog aggregator
- [refstack.openstack.org](#) - Interoperability testing
- [apps.openstack.org](#) - App catalog

# OpenStack : the Project Navigator

The screenshot shows the OpenStack Project Navigator interface. At the top, there's a navigation bar with links for Overview, Project Navigator (which is active), Sample Configurations, Get Started, Roadmap, Latest Release, and Source Code. Below this is a search bar with placeholder text "Enter a keyword". The main content area is titled "Browse All OpenStack Projects" and includes a sub-section header "Core Services (6 Results)". It lists six projects: NOVA, NEUTRON, SWIFT, CINDER, KEYSTONE, and GLANCE. Each project card includes a brief description, adoption and maturity metrics (e.g., 93% Adoption, 8 or 8 Maturity), and a "MORE DETAILS" button.

Project	Description	Adoption	Maturity
NOVA	Compute	93 %	8 or 8
NEUTRON	Networking	84 %	8 or 8
SWIFT	Object Storage	52 %	7 or 8
CINDER	Block Storage	84 %	8 or 8
KEYSTONE	Identity	84 %	8 or 8
GLANCE	Image Service	64 %	6 or 6

<http://www.openstack.org/software/project-navigator/>

# Openstack Projects ...the core services

Service	Name	Adoption	Maturity	Age
Identity	Keystone	96%	7/8	5 yrs
Images	Glance	95%	6/8	7 yrs
Block device	Cinder	88%	7/8	5 yrs
Networking	Neutron	93%	7/8	5 yrs
Compute	Nova	95%	8/8	7 yrs
Object device	Swift	52%	7/8	7 yrs

<https://www.openstack.org/software/project-navigator/>

# Openstack Projects ...some other services

Service	Name	Adoption	Maturity	Age
Dashboard	Horizon	87%	6/8	5 yrs
Telemetry	Ceilometer	55%	1/8	4 yrs
Orchestration	Heat	67%	6/8	4 yrs
Containers	Magnum	11%	2/8	2 yrs
Map/Reduce	Sahara	10%	3/8	3 yrs

<https://www.openstack.org/software/project-navigator/>

# Openstack Projects ...some other services

Service	Name	Adoption	Maturity	Age
Shared Filesystems	Manila	14%	5/8	3 yrs
Workflow	Mistral	5%	1/7	1 yr
Load Balancing as a Service	Octavia	>0%	1/7	1 yr

<https://www.openstack.org/software/project-navigator/>

# Hardware & Infrastructure

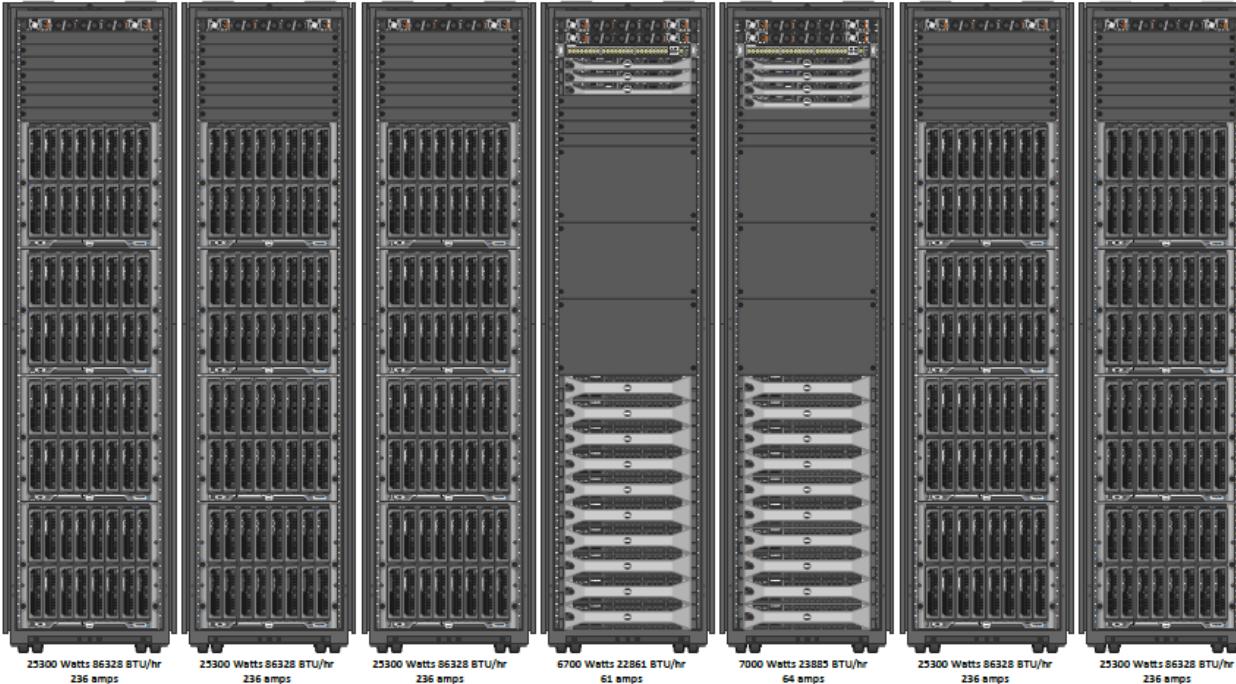


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# Production Cloud Hardware (per site)

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 2 to 1 Fat Tree topology

# Jetstream Production Hardware



25300 Watts; 86328 BTU/hr  
236 amps

25300 Watts; 86328 BTU/hr  
236 amps

25300 Watts; 86328 BTU/hr  
236 amps

6700 Watts; 22861 BTU/hr  
61 amps

7000 Watts; 23885 BTU/hr  
64 amps

25300 Watts; 86328 BTU/hr  
236 amps

25300 Watts; 86328 BTU/hr  
236 amps

# Jetstream's Cooling Doors

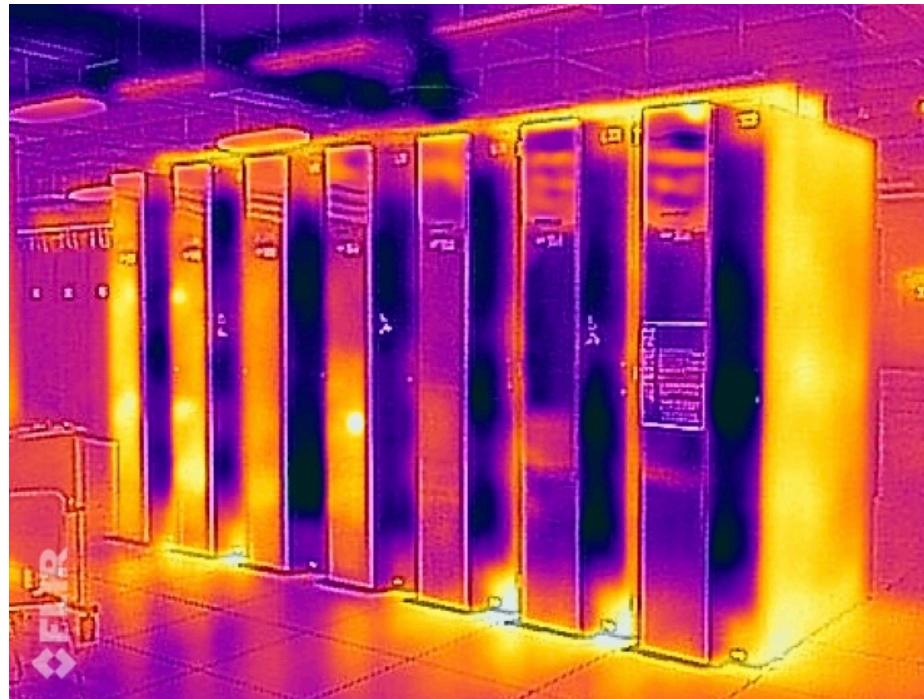


$\frac{1}{2}$  the heat generated via Jetstream is removed via the cooling doors and  $\frac{1}{2}$  is removed via traditional CRACs

Colour related to health of the cooling system

# Infrared image of Jetstream

Note yellow doors on left side: this is hot air blowing from the Wrangler Storage cluster onto the cooling doors



**ChilledDoor**  
Rack Cooling System  
*motivair*

Yellow: hot  
Blue: cold

# Benchmarks – single node



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# HPCC results : VM vs BareMetal Comparison

Benchmark	VM/ BareMetal	Units	What's tested
HPL	97%	FLOPS	floating point execution rate for solving a system of linear equations
DGEMM	98%	FLOPS	floating point execution rate for double precision real matrix-matrix multiplication
Bandwidth	88%	B/s	bytes/unit_time it takes to transmit a 2MB message from one node to another
Latency	97%	s	time required to send an 8-byte message from one node to another

# HPCC results : VM vs BareMetal Comparison (Cont.)

Benchmark	VM/ BareMetal	Units	What's tested
Random	80%	up/s	rate of random updates of memory
Stream	77%	B/s	sustained memory bandwidth
MPI-FFT	67%	FLOPS	floating point rate of execution of double precision complex one-dimensional Discrete Fourier Transform
Ptrans	64%	B/s	rate of transfer for large arrays of data from multiprocessor's memory

# Jetstream System Details



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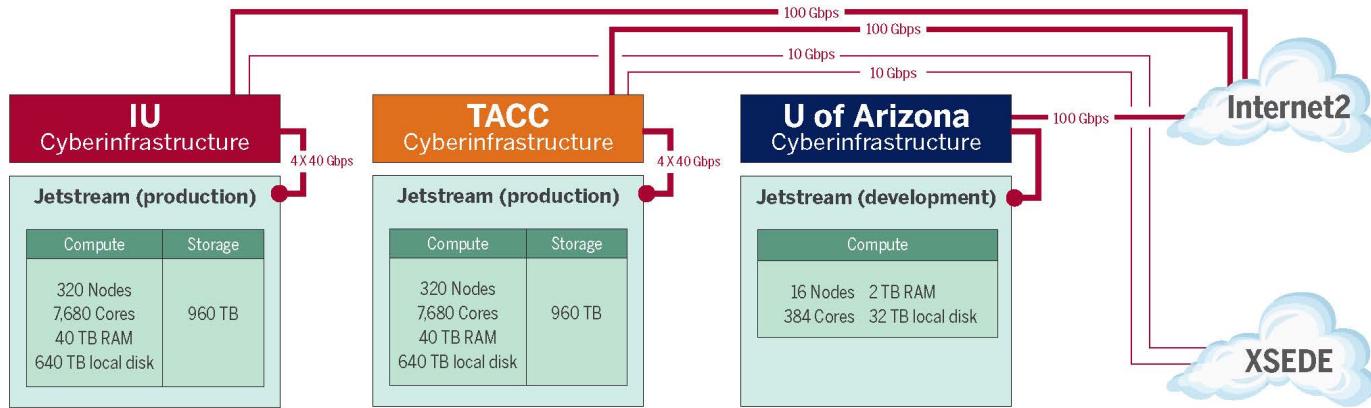
# VM Instance Sizes (Flavors)

Instance Type	vCPUs	RAM(GB)	Storage(GB)	Instances/Node
Tiny	1	2	8	46
Small	2	4	20	23
Medium	6	16	60	7
Large	10	30	120/60*	4
X-Large	22	60	240/60*	2
XX-Large	44	120	480/60*	1

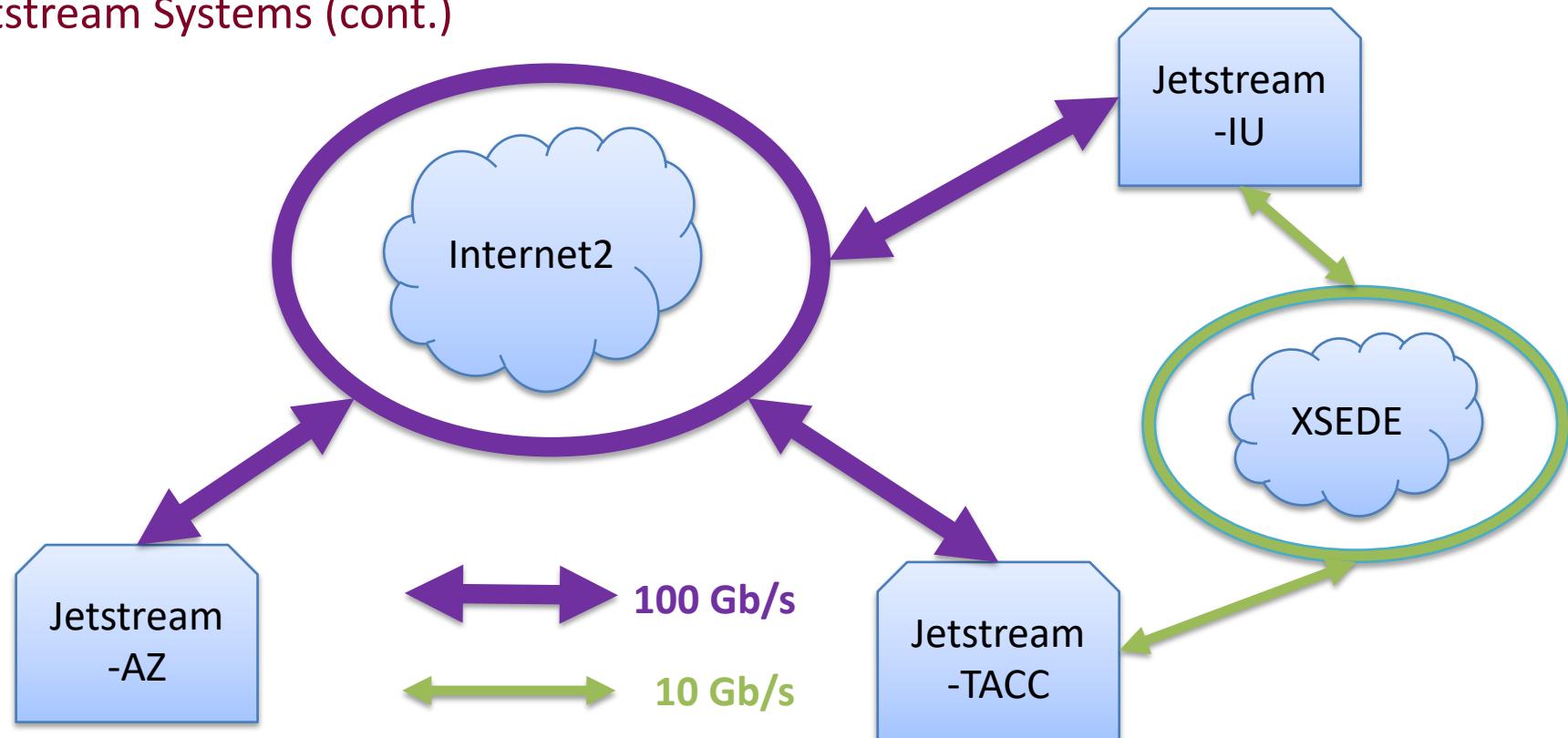
Node config: dual Intel E-2680v3 “Haswell”, 24 physical cores/node @ 2.5 GHz, 128 GB RAM, dual 1 TB local disks.

\* Effective 29-Mar-2017

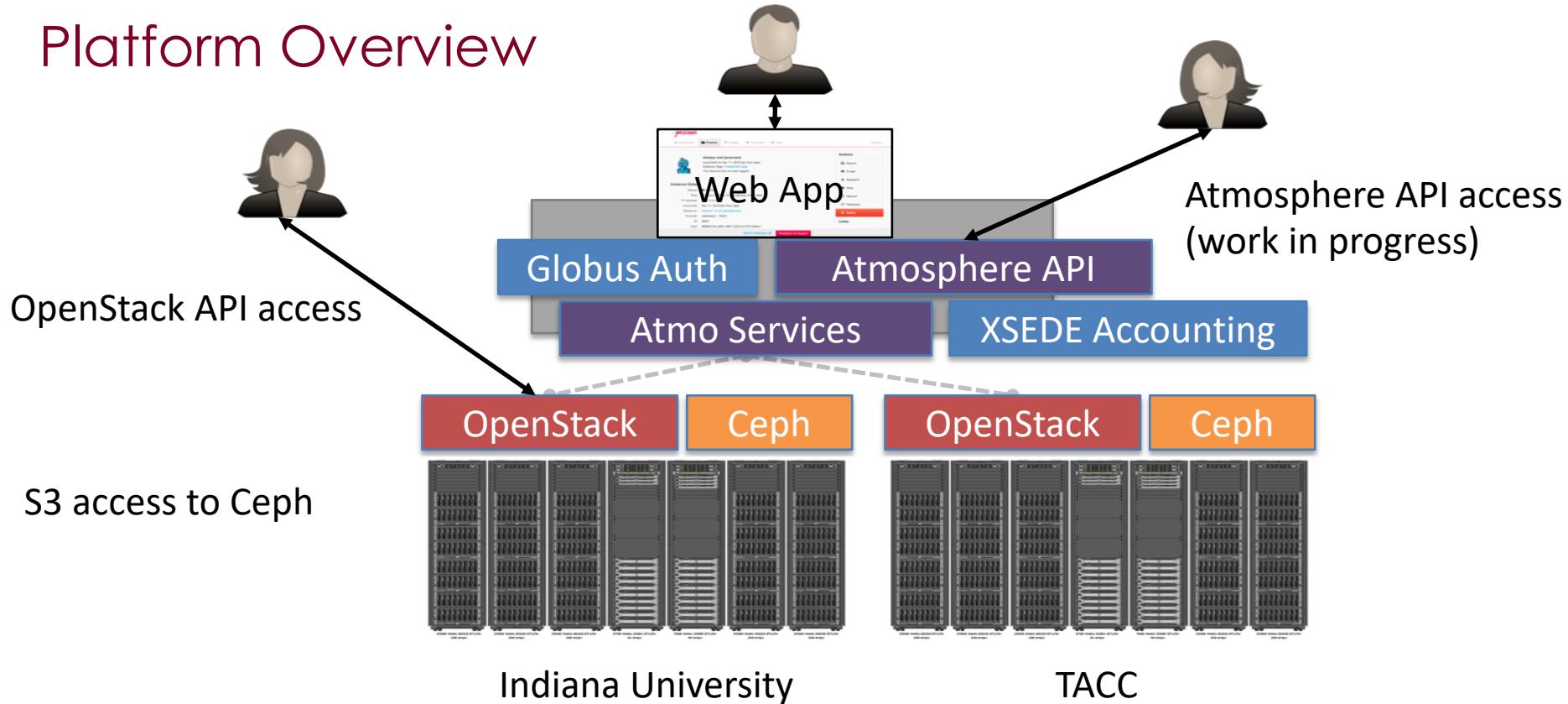
# Jetstream Systems



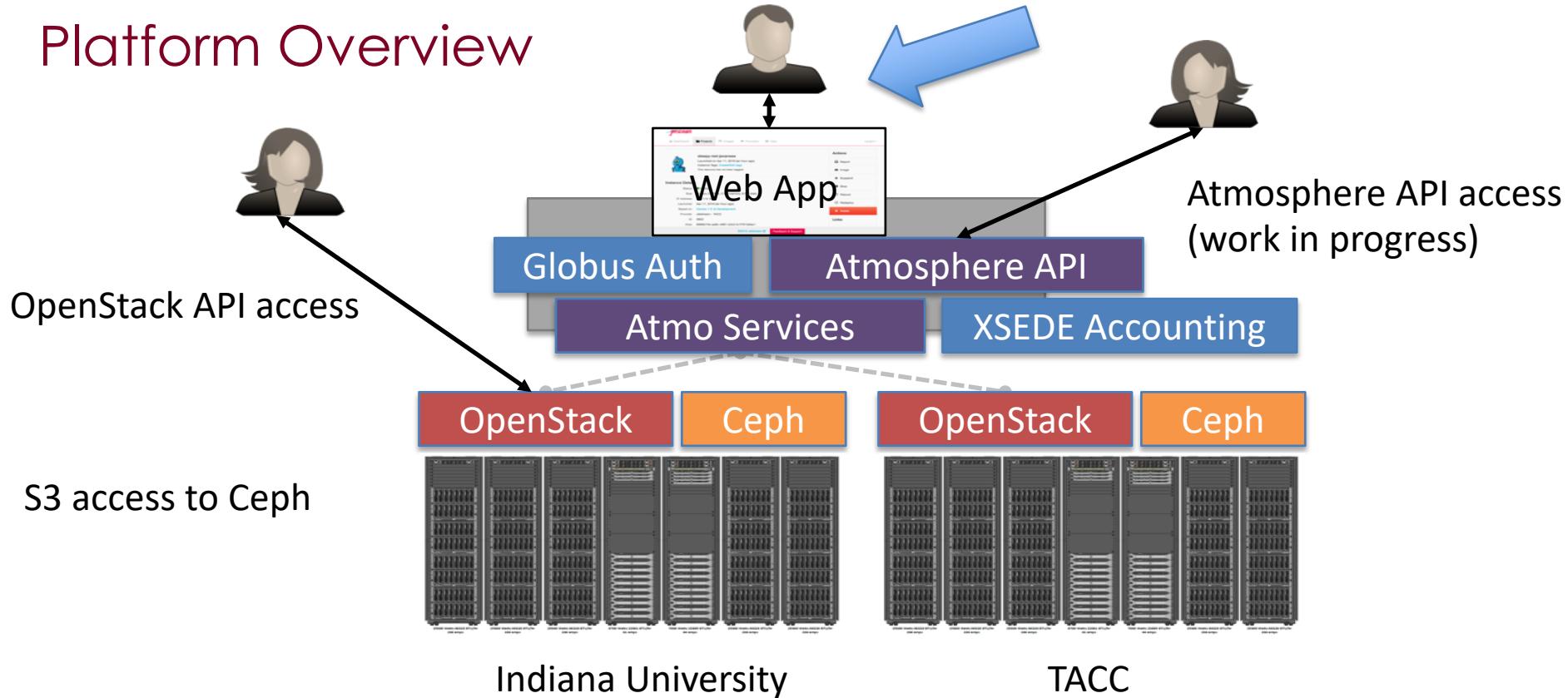
## Jetstream Systems (cont.)



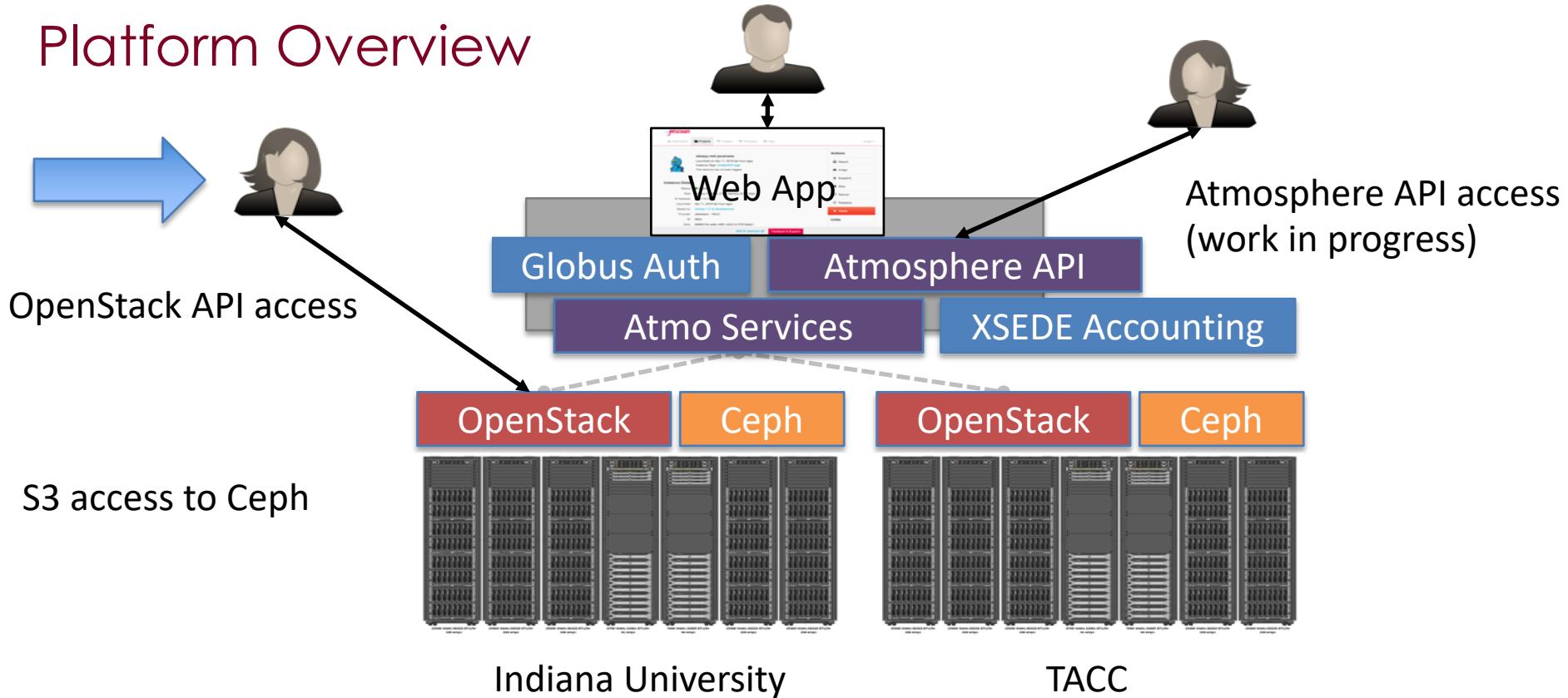
# Platform Overview

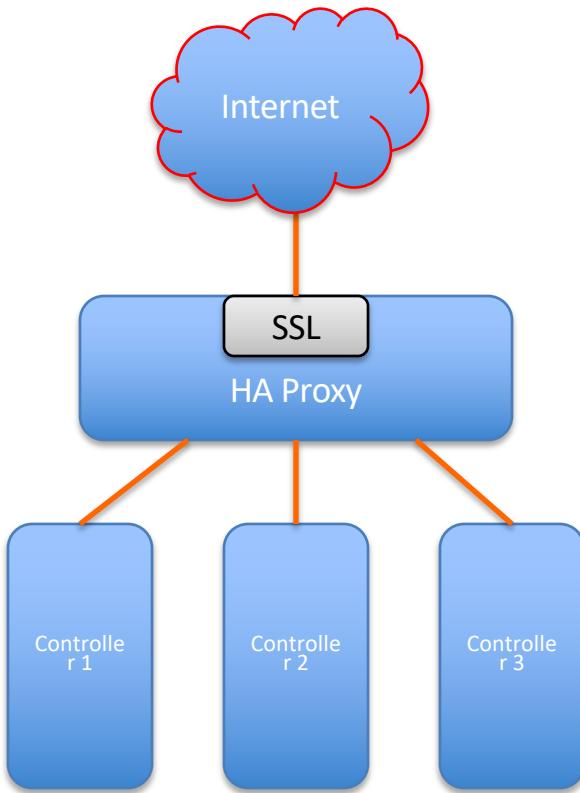


# Platform Overview



# Platform Overview





Load Balancer  
1

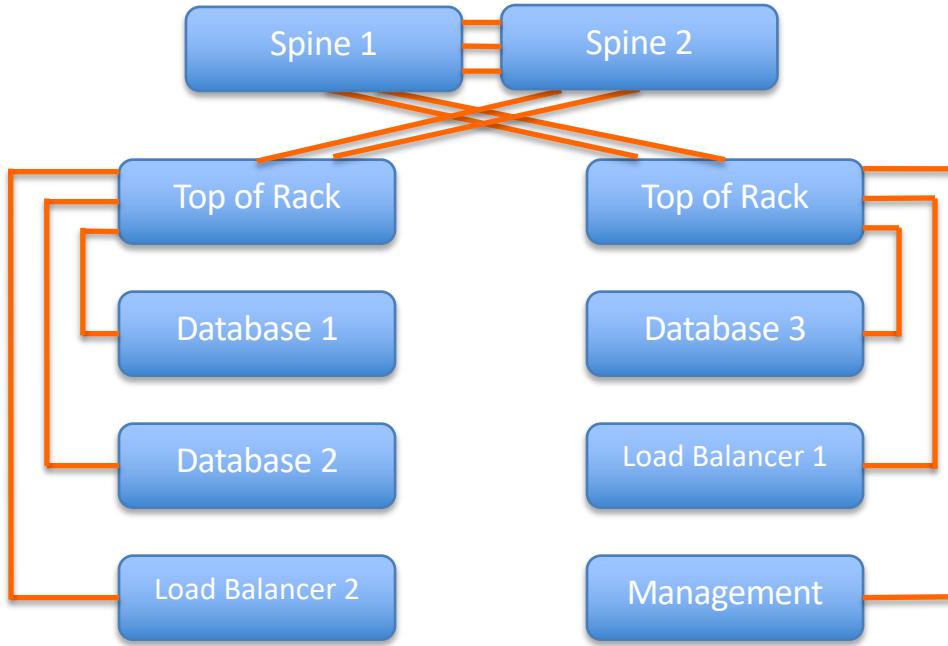


Load Balancer  
2

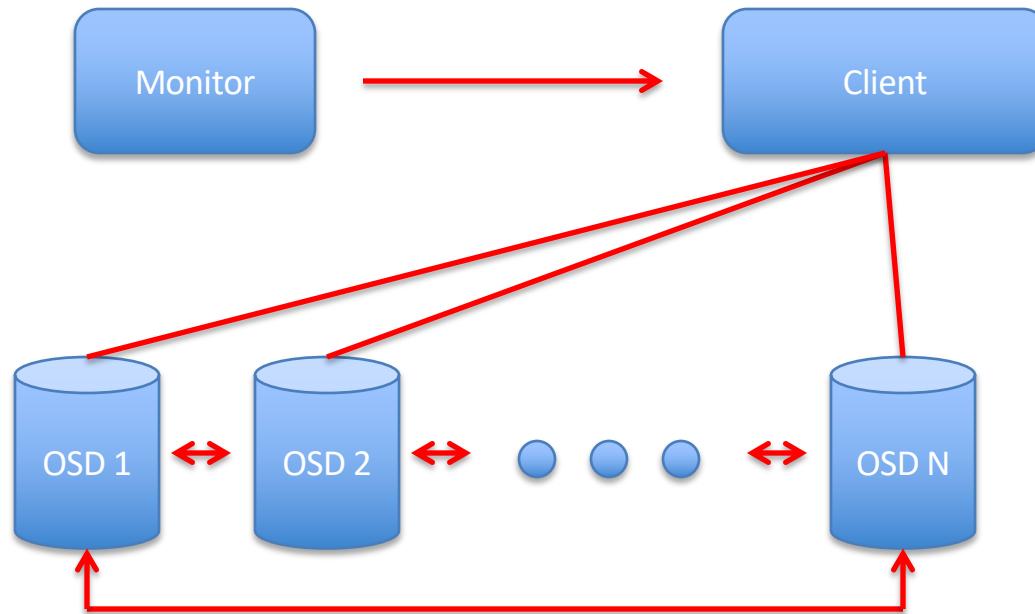
Keep Alive

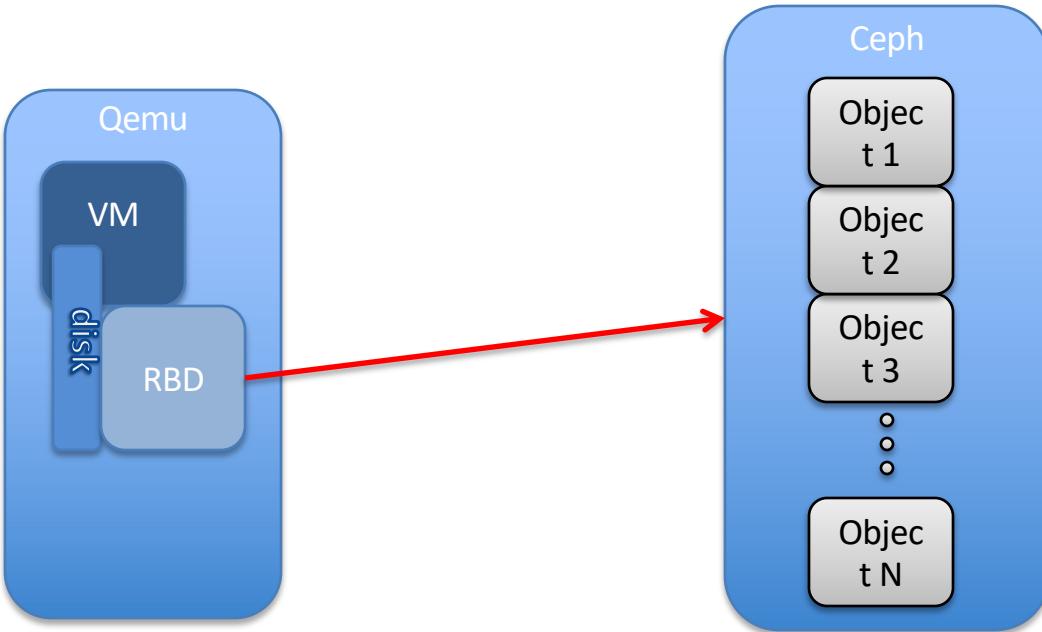
DNS Round Robin  
IP1 – IP2

## High Availability layout for the databases

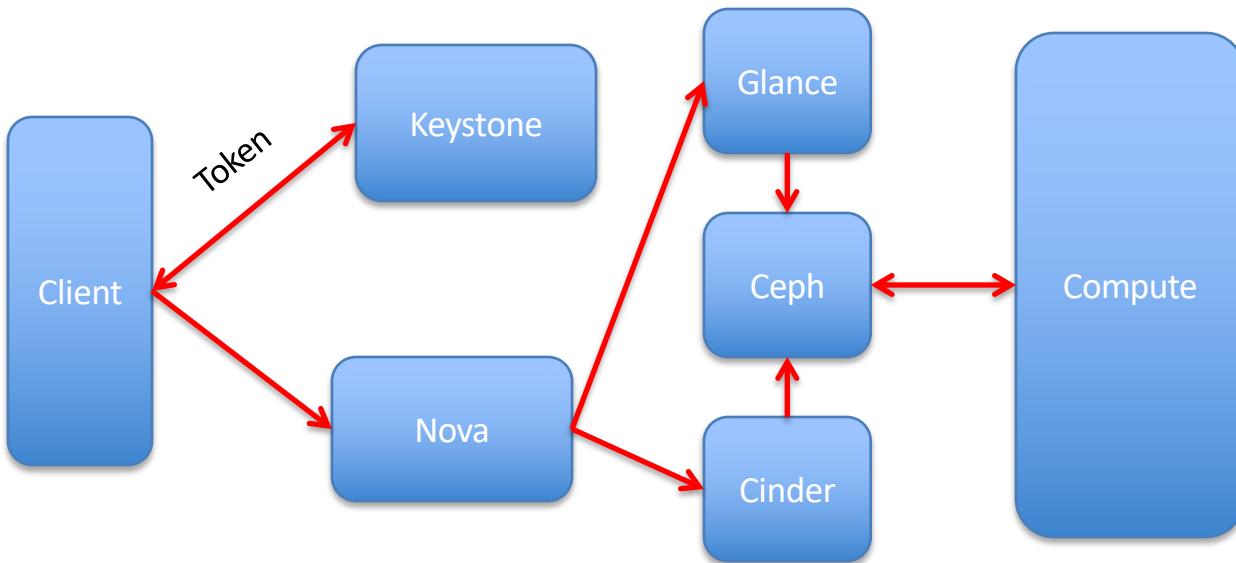


# Glance - Cinder - Ceph

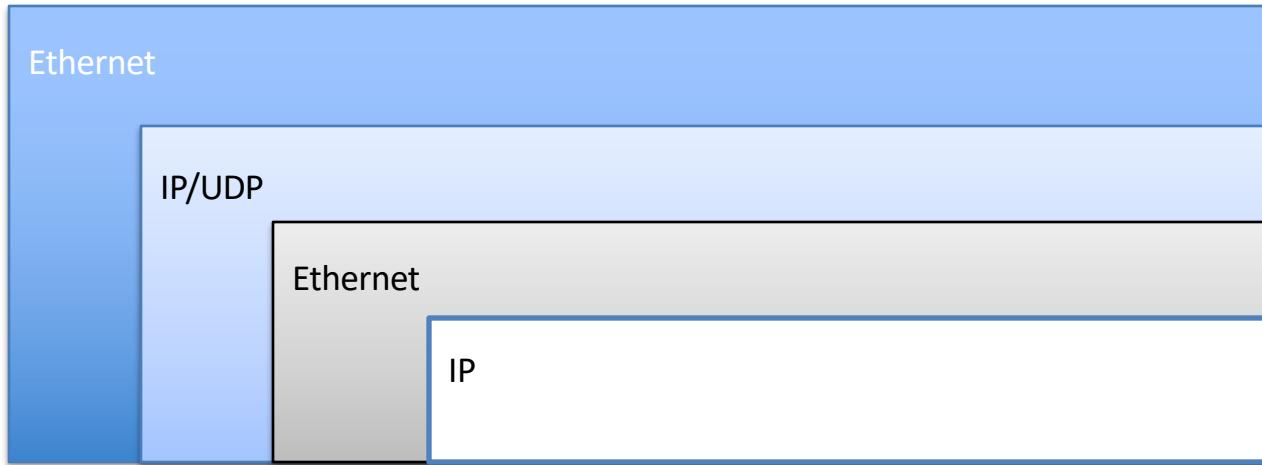




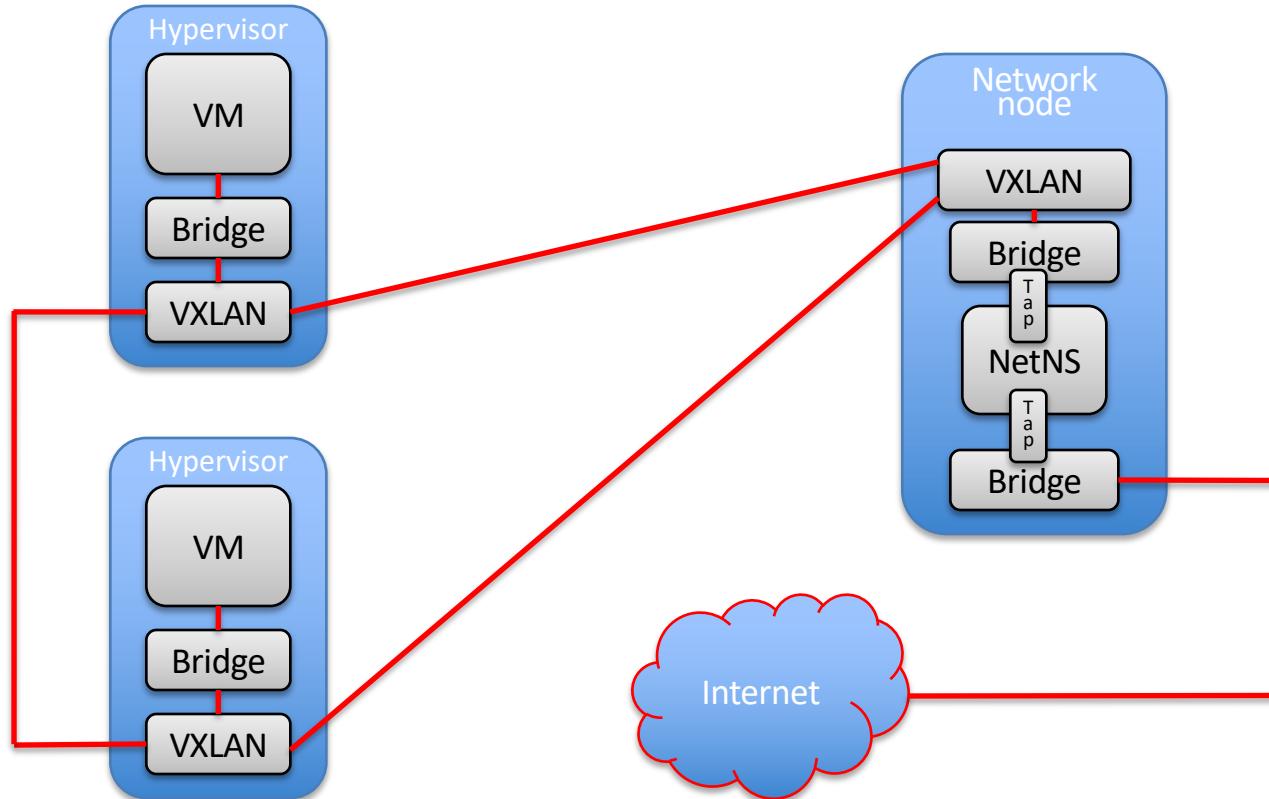
# OpenStack Overview



# VXLAN Packet



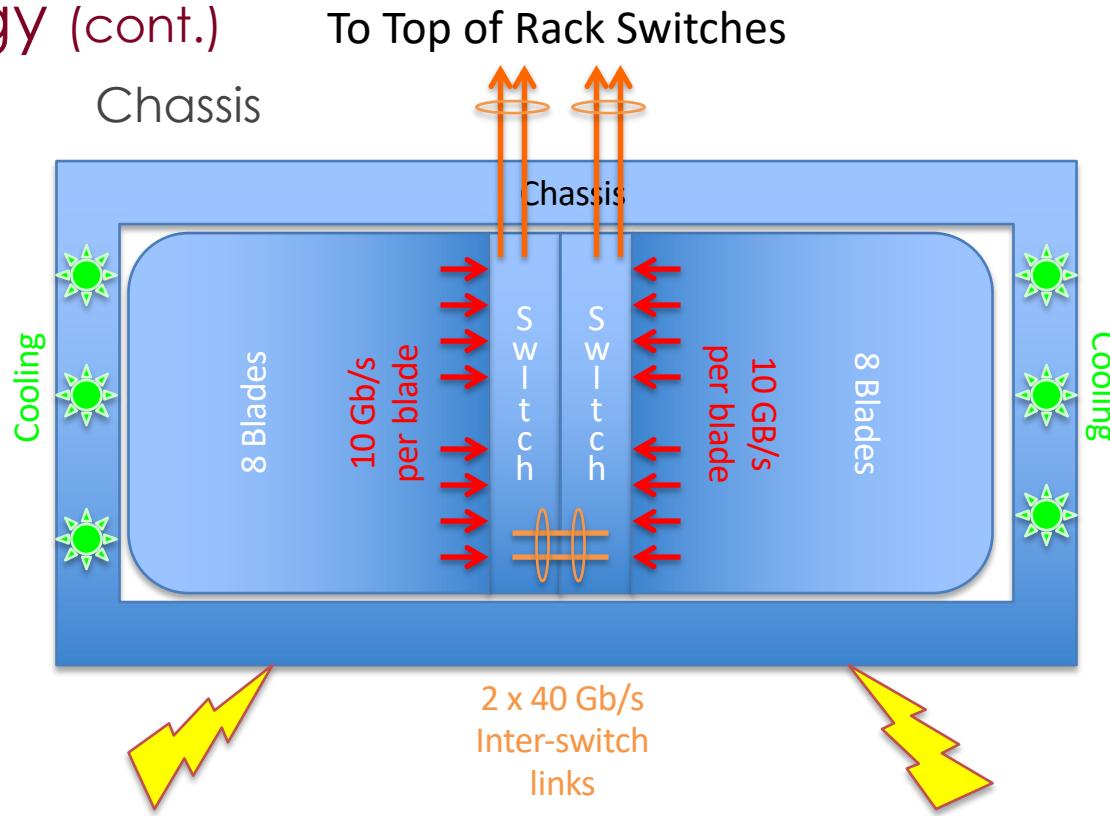
# Neutron Networking



# Network Topology (cont.)

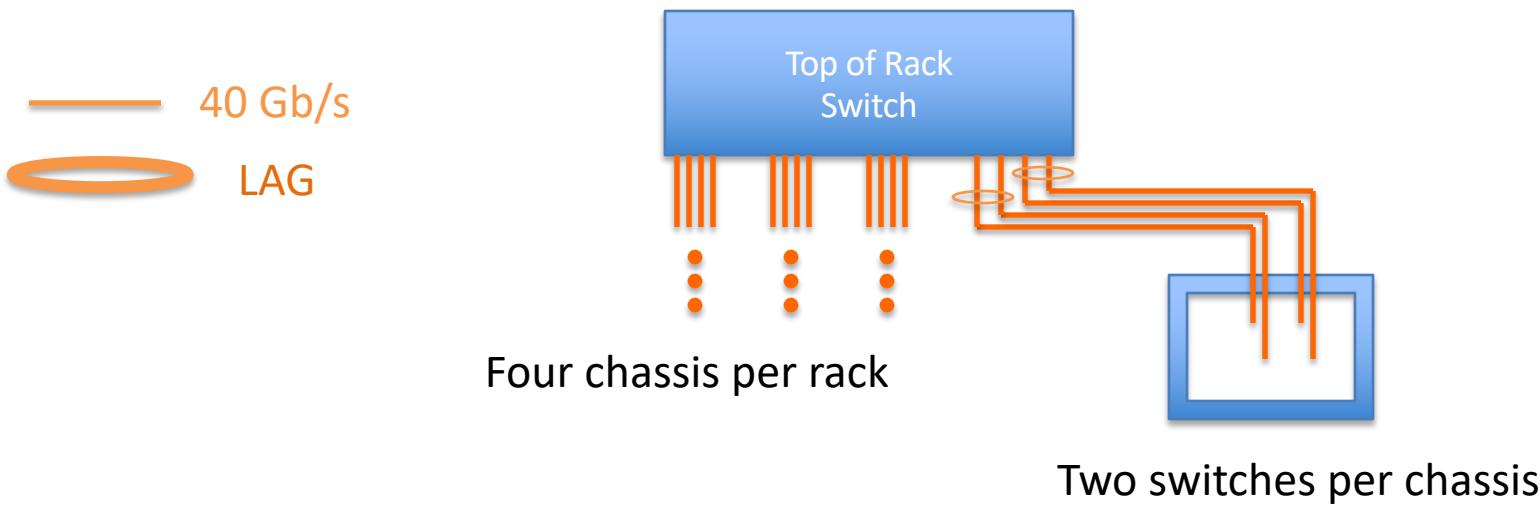
Sixteen blades per chassis  
Two switches per chassis

- 10 Gb/s
- 40 Gb/s
- LAG

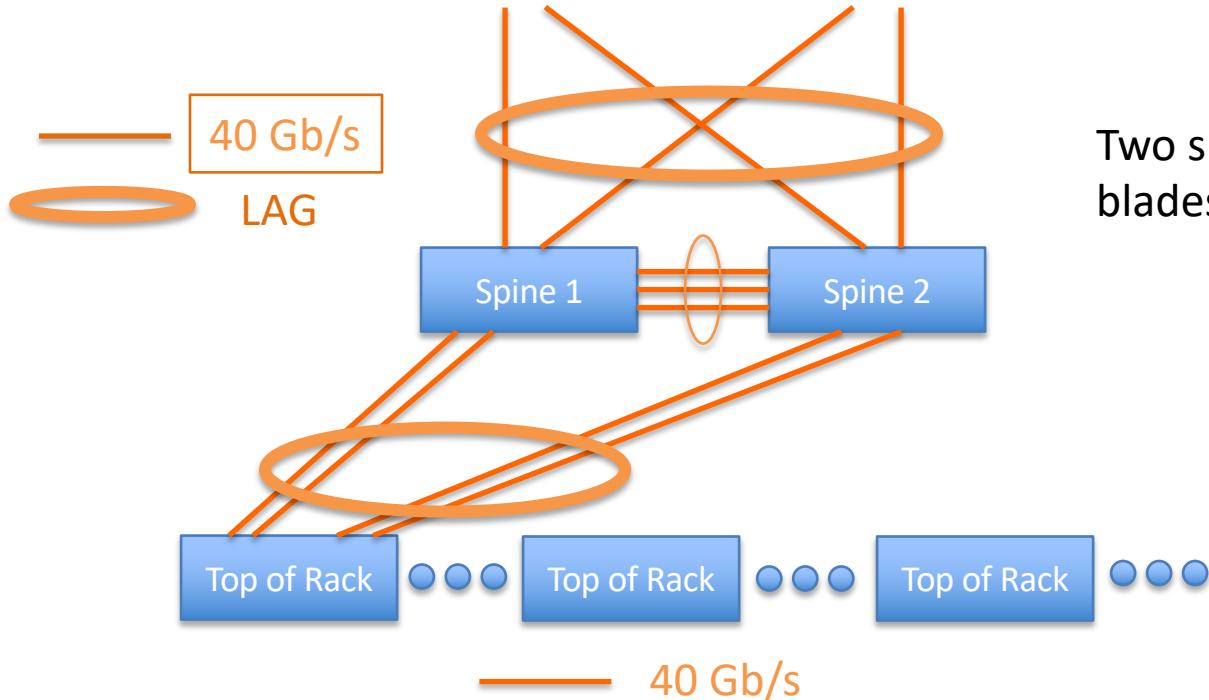


# Network Topology (cont.)

## Chassis to Top of Rack



# Network Topology (cont.)



100 Gb/s uplink to Internet2

Two spines tie into two network blades in the datacenter switch

Seven racks tie into the two spine switches

# How do we onboard users onto Jetstream?

- An XSEDE User Portal (XUP) account is required. They are free! Get one at <https://portal.xsede.org>
- Work with your XSEDE Campus Champion.
- Submit an allocations request
  - Read the Allocations Overview - <https://portal.xsede.org/allocations-overview>
  - Writeup an allocation request – *start with a Startup or Education request* - <https://portal.xsede.org/successful-requests>
- Easy Button: instant access to small, limited instances while the allocation request is processed and the user is vetted.

# Jetstream Information Sources

- Twitter: @jetstream-cloud
- Jetstream's web interface: <https://use.jetstream-cloud.org/>  
No login required to browse image library
- XSEDE User Portal account is required to actually login:  
<https://portal.xsede.org> Create account in seconds.
- Jetstream Home page: <https://jetstream-cloud.org/>
- Jetstream's public documentation: <https://wiki.jetstream-cloud.org>

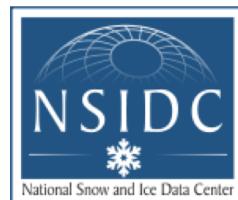
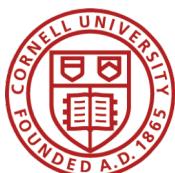
# Jetstream Information Sources (Cont.)

- Paper describing Jetstream [Jetstream: A self-provisioned, scalable science and engineering cloud environment](#)
- Configuration management: <https://github.com/jetstream-cloud/Jetstream-Salt-States>

For questions, comments, etc. of any manner

[help@jetstream-cloud.org](mailto:help@jetstream-cloud.org)

# Jetstream Partners



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# Questions?

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

Project email: [jethelp@iu.edu](mailto:jethelp@iu.edu)

Direct email: [jomlowe@iu.edu](mailto:jomlowe@iu.edu), [turnerg@iu.edu](mailto:turnerg@iu.edu)

## License Terms

- Lowe, J.M., Turner G.W. 2017. Jetstream: Cloud Facility for Scientific Gateways: CSCI0B 649, Topics in Systems, Science Gateway Architectures; Computer Science, School of Informatics and Computing, Indiana University. Also available at: <http://jetstream-cloud.org/publications.php>
- Jetstream is supported by NSF award 1445604 (Craig Stewart, IU, PI)
- XSEDE is supported by NSF award 1053575 (John Towns, UIUC, PI)
- This research was supported in part by the Indiana University Pervasive Technology Institute, which was established with the assistance of a major award from the Lilly Endowment, Inc. Opinions presented here are those of the author(s) and do not necessarily represent the views of the NSF, IUPTI, IU, or the Lilly Endowment, Inc.
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