Adapting to the Evolving Research Landscape: Lessons Learned from Deploying OpenStack and Navigating the Challenges of Infrastructure as a Service

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> 900 Research Groups

119 Departments
Supporting the Research Computing Needs of Researchers

- Determine the resources needed to solve the problem
- If we don’t have the resource, recommend someone that does

- NSF HPC Centers
- DOE HPC Centers
- Commercial Cloud
- External software development
Supporting the Research Computing Needs of Researchers

• Determine the resources needed to solve the problem
• If we don’t have the resource, recommend someone that does

• If we don’t have a recommended solution, the researchers WILL find a way. It may include:
  • Unmanaged local & remote hardware
  • Inappropriate use of available resources
Identified Needs

• Bespoke data compliance and other needs that were not met in the existing HPC cluster
• Researcher-controlled persistent services and long-running jobs
• Network isolation, clinical pipelines
• MSI DevOps-maintained applications
  • Public gateways for global collaboration
Timeline

- OpenStack Experimentation 2011
- Internal OpenStack 2013
Local Cloud Computing

Goals
• Offer a lower cost than commercial cloud
• Reduce data movement
• More control over data
• Recover cost

Not Goals
• Scaling to 1000s of VMs
• Expanding free services
Why OpenStack?

**Price**
- Free and OpenSource
- Resellers can support enterprise deployments

**Maturity**
- NASA and Rackspace started the OpenStack project in 2010

**Worldwide Popularity**
- NASA, CERN, Bionimbus PDC (NIH), JetStream (NSF)
- BestBuy, Target, WalMart, Dreamhost, many more

**Versatility**
- OpenStack can run VMs on top most commodity and enterprise hardware
- Reuse infrastructure building blocks like existing HPC nodes
Timeline

• OpenStack Experimentation 2011
• Internal OpenStack 2013
• IaaS for researchers 2017
Stratus

- 7x Control nodes
- 20x Compute Nodes
  - 5 TB RAM
  - 560 Cores
  - Over-subscription rates: 4x CPU; 1.4x RAM
- 200 TB Ceph Block Device Storage
  - Booted VMs, Ephemeral and Persistent Data Volumes, Raw Images
- 512 TB Ceph Object Storage
  - S3 Interface
- 2x 40 GbE Network Switches

Stratus-Dev

- 2x Control nodes
- 2x Compute Nodes
  - 44GB RAM
  - 16 Cores
- 91 TB FrankenCeph Block Device Storage
- 200 TB Ceph Block Device Storage
- 512 TB Ceph Object Storage
- S3 Interface
- 2x 40 GbE Network Switches
Local Cloud Deployment

- OpenStack - Newton
- Ceph Storage
Stratus Features

- Ceph Block Storage
- Ceph S3 Object Storage
- Horizon web interface to manage VMs
- API access
Stratus Features

- Two-factor authentication with University credentials
- MSI-blessed images for common use cases
- Freedom to run user-maintained images
- Subscription model for cost recovery ($165 / month for base subscription)
What Worked?

- Bespoke data compliance and other needs that were not met in the existing HPC cluster
What Worked?

• Bespoke data compliance and other needs that were not met in the existing HPC cluster

• Researcher-controlled persistent services and long-running jobs
Experimental and Persistent User-Controlled Services
What Worked?

- Bespoke data compliance and other needs that were not met in the existing HPC cluster
- Researcher-controlled persistent services and long-running jobs
- MSI DevOps-Controlled Applications
Case Study

GRIDDING GLOBAL AGRICULTURE

We developed the GEMS Grid so you could focus on your data!

Managing the incorporation of multiple geospatial data streams can be a tedious and time-consuming task. We developed a systems protocols grid system that makes it easy and lets you focus on your science.
What Worked in 2017?

• Bespoke data compliance and other needs that were not met in the existing HPC cluster

• Researcher-controlled persistent services and long-running jobs

• MSI DevOps-controlled applications
What is Still Working in 2023?

- Bespoke data compliance and other needs that were not met in the existing HPC cluster
- Researcher-controlled persistent services and long-running jobs
- MSI DevOps-controlled applications
What is Still working in 2023?

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Future Use Cases

- MSI DevOps-controlled applications
  - Rapidly growing number of applications in neuroscience, GIS, and agroinformatics
  - APIs with calculations that run on GPUs
Future Plans

• Deploy similar-size cluster
• Add GPUs
• Focus on collaborative DevOps projects as the primary use case
Lessons Learned

• Like most of Research Computing, IaaS is a moving target.
• Cyberinfrastructure needs require constant reevaluation and communication with researchers.
• Effective use of IaaS generally requires DevOps skills beyond what individual research groups typically maintain.