

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

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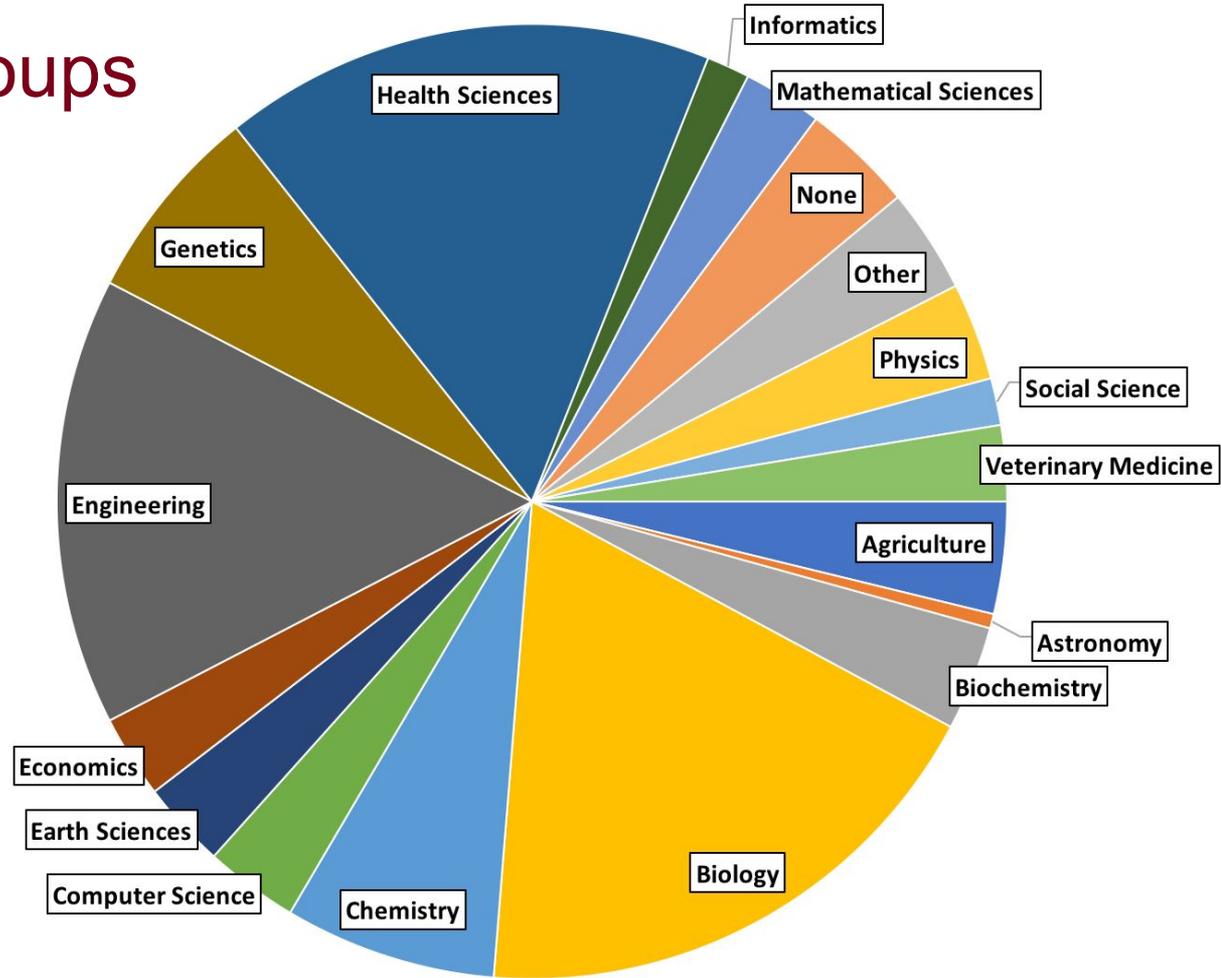
Graham Allan

James Wilgenbusch



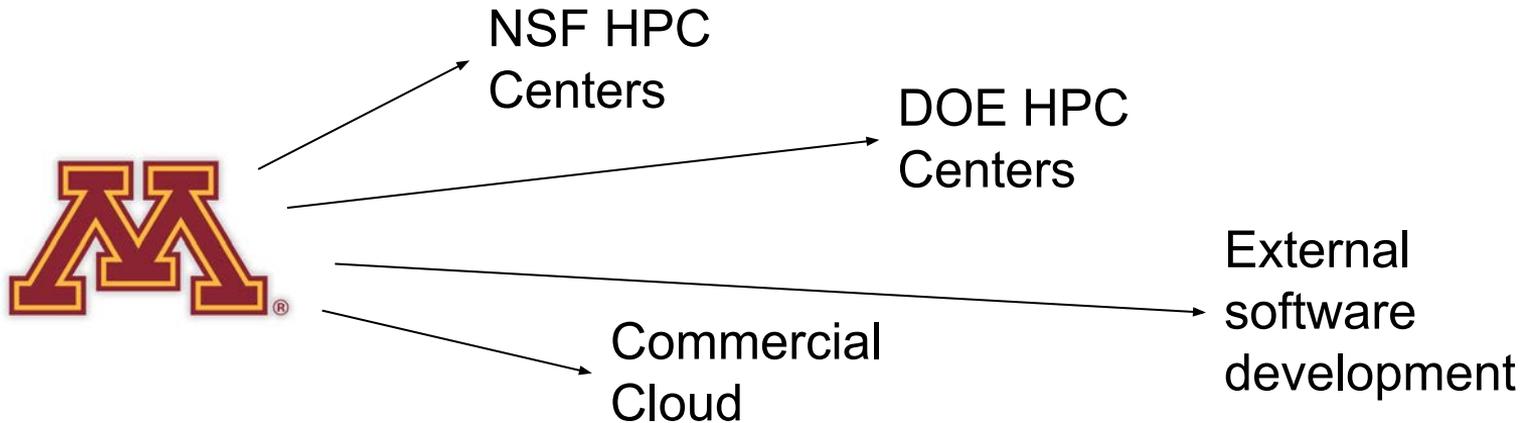
> 900 Research Groups

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



# 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

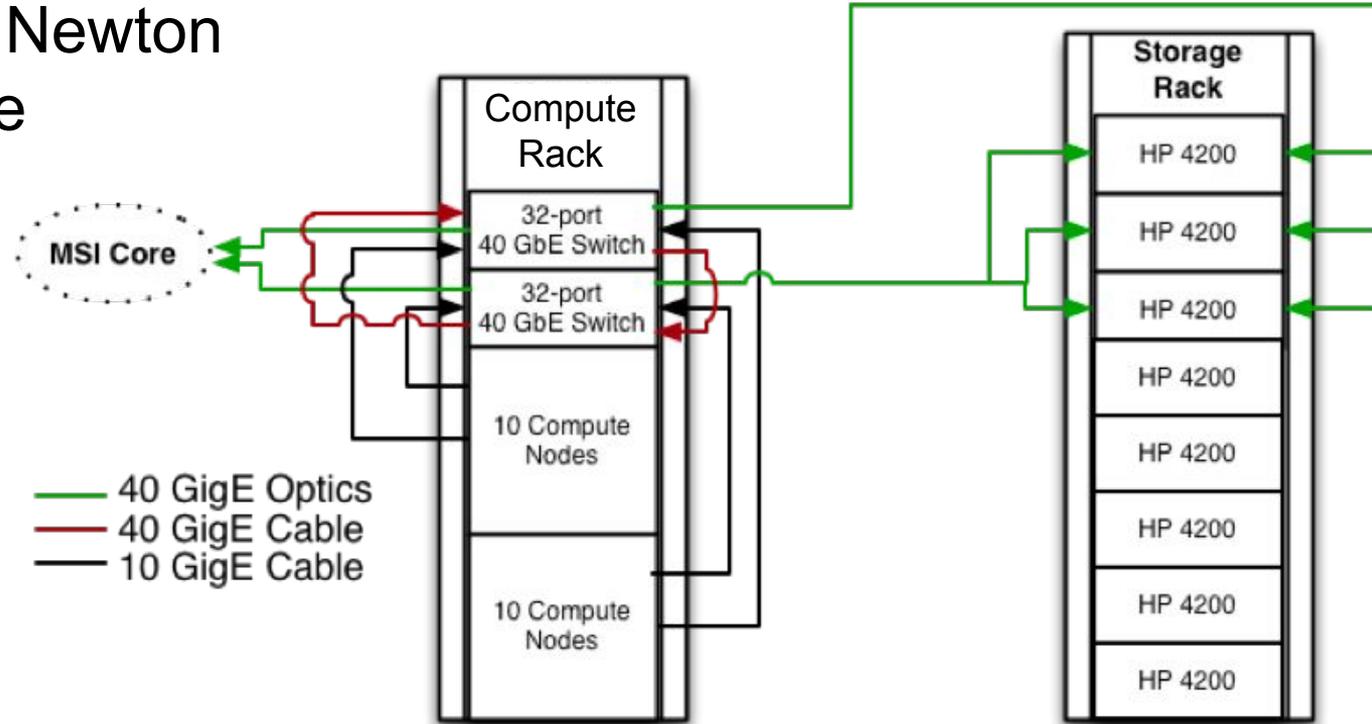
# Stratus-Dev

- 2x Control nodes
- 2x Compute Nodes
  - 44GB RAM
  - 16 Cores
- 91 TB FrankenCeph Block Device Storage
- 1 GbE Networking



# 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



The screenshot shows the dbGaP website interface. At the top, there is a search bar with the text 'ncicp' and a search button. Below the search bar, there is a navigation menu with 'Links' and 'Advanced' options. The main content area features a header with the dbGaP logo and a description: 'The database of Genotypes and Phenotypes (dbGaP) was developed to archive and distribute the data and results from studies that have investigated the interaction of genotype and phenotype in humans.' Below this, there are three columns of links: 'Access dbGaP Data', 'Resources', and 'Important Links'. The 'Access dbGaP Data' column includes links for 'Advanced Search', 'Controlled Access Data', 'Public FTP Download', 'Collections', and 'Summary Statistics'. The 'Resources' column includes links for 'dbGaP Data Browser', 'Phenotype Genotype Integrator', 'dbGaP RSS Feed', 'Subsites', and 'dbGaP Tutorial'. The 'Important Links' column includes links for 'How to Submit', 'FAQ', 'Guidelines', 'Security Procedures', and 'Contact Us'. Below these columns, there is a section titled 'Latest Studies' which contains a table of study information.

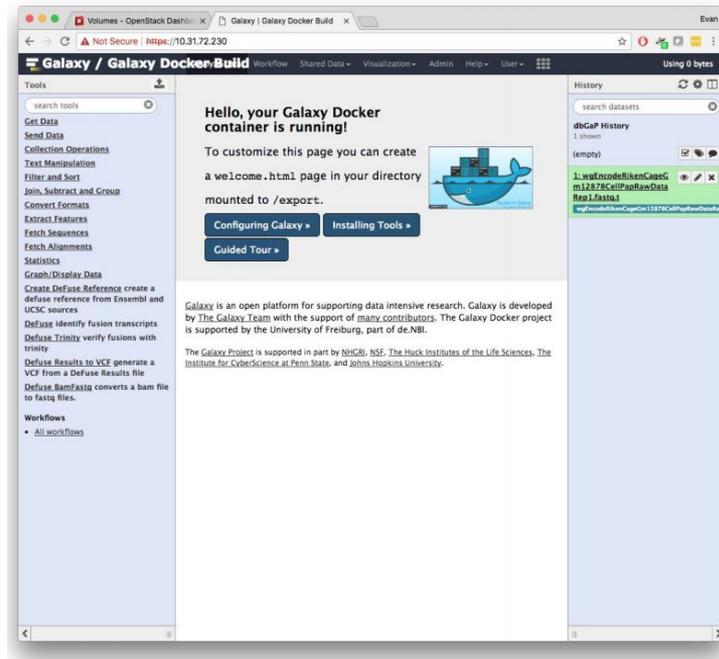
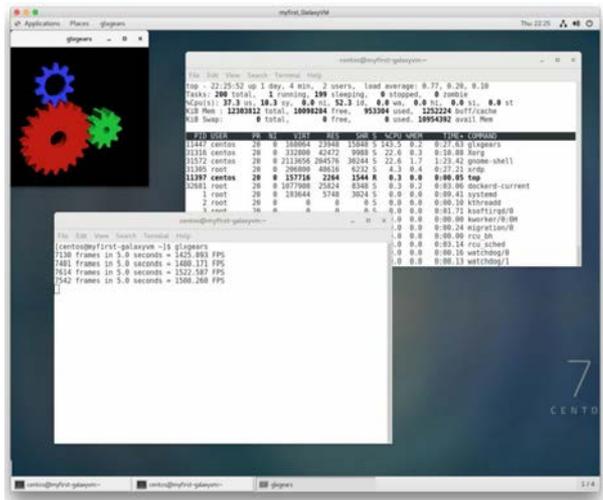
Study	Ensembl Release	Details	Participants	Type of Study	Links	Platform
ph001256.v1.g1 Chromosome 1q11.2 Banding Study	Version 1: passed ensembl Version 2:		66	Case-Control		illumina Illumina HiSeq 2500 Human Exome Library v1.0 HT-Seq
ph000338.v1.g1 Protein Architecture using Genomic and Exonchip (PAGE)	Version 1: passed ensembl Version 2:		0	Cross-Sectional, Longitudinal, Nested Case- Control	Links	
ph001343.v1.g1 Biopsychosocial Insights from the personal Sequences of Human Embryonic Stem Cell Lines	Version 1: passed ensembl		125	Control Set	Links	illumina Illumina HiSeq 2500
ph001126.v1.g1				Case-Control, Family		illumina Illumina HiSeq 2500 Human Exome Library v1.0 HT-Seq

# 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?

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- Researcher-controlled persistent services and long-running jobs
- MSI DevOps-Controlled Applications



# MSI DevOps-Controlled Applications

GEMS Informatics

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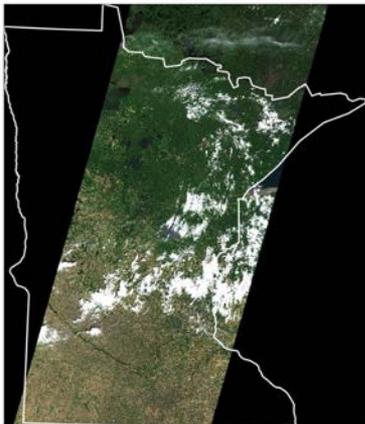
## Case Study

### GRIDDING GLOBAL AGRICULTURE



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

Cognizant that interoperating multiple geospatial data streams can be a tedious and time-consuming task, we developed a discrete global gridding system that makes it easy and lets you focus on your science.



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## Informatics



**Informatics Hub:** Advancing our understanding of brain development by harmonizing data across different species, studies, and modalities

Jump to: [How We Engage](#) | [Team](#) | [Engagement Examples](#) | [Contact Us](#)

# 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?

- 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 

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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.