Acknowledgement

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Overview

- Cloud computing
- Research Computing Environment (RCE)
- RCE in the cloud
- Challenges in the cloud
- RCE Batch in the cloud
- Consolidating cloud resources
Cloud principles

- The cloud is a set of resources managed remotely by a third party.
- Cloud providers support administrator ratios as high as 1:1000 systems.
- There are several types of cloud services
  - Software as a Service (SaaS)
    - A vendor provides software for a specific function and the vendor stores data such that no data needs to be stored locally.
  - Platform as a Service (PaaS)
    - A vendor provides a framework to develop new applications and part of the framework involves storing state or performing certain functions for your application.
  - Infrastructure as a Service (IaaS)
    - A vendor provides basic compute, storage, and network infrastructure, leaving it up to the customer to manage those resources as if they were local resources.
Cloud vendor options

• Microsoft Azure
  – Current RCE user base and apps are Linux-based
  – More of a platform for building Windows applications

• Google Apps
  – Currently intended for specific apps (mail, calendar, etc.)

• Amazon
  – Very similar to current work environment for RCE
  – Uses Amazon Machine Image (AMI), essentially an OS image
  – Leverages existing vendors (Red Hat, VMware)

• Other similar IaaS infrastructure offerings:
  – Rightscale
  – Rackspace Cloud
  – ElasticHosts
The RCE

- A remote virtual desktop (GNOME)
Running a job on a Compute-on-Demand (COD) node

- Run software on higher memory nodes
Running a job on a Compute-on-Demand (COD) node
RCE in detail

• RCE = Research Computing Environment, remote infrastructure and scalable computing power for research analysis

• Used to run common statistical applications
  – R, GAUSS, Mathematica, MATLAB, Octave, SAS, S-PLUS, Stata

• RCE has three types of nodes
  – Login nodes
    • User logs in via NX (similar to VNC) and gets a desktop session
    • User can launch an application directly from the desktop
  – Compute-on-demand nodes
    • 25 compute cores on 9 nodes
    • User has special “RCE Powered Applications” menu to launch applications on machines with large memory resources (up to 64GB)
  – Batch nodes
    • 572 compute cores on 79 nodes
    • Used typically for non-interactive, long-running, scalable jobs
    • Most jobs use R
RCE architecture and configuration

Key Applications

- R
- GAUSS
- Mathematica
- MATLAB
- Octave
- SAS (COD only)
- S-PLUS
- Stata (SE and MP)

Interactive nodes

Login nodes

Batch nodes

Secure login via NX

Allocate and manage resources

Request remote job

Local

Remote

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The case for RCE and the cloud

• To advance research computing technologies, we need to focus less on commodity services.
• External vendors manage large commodity clusters more efficiently than our in-house operation.
• Embarrassingly parallel queries, the bulk of social science data analysis, are ideal research to benefit from the cloud resources.
• The RCE’s structure allows a gradual transition and hybrid infrastructure.
• Clouds will expand the range of hardware and platform support for all researchers.
The hybrid model: RCE and the cloud

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Cloud advantages

• Elasticity
  – Avoids over- and under-resourcing
  – Eliminates need to pay for resources not in use
  – Accesses much larger set of resources when needed

• Increased research computing focus
  – Offloads hardware maintenance to the “experts”
  – Focuses local staff on working with researchers to develop the next generation of social science computing tools

• Customized user environments
  – Sets up each cloud OS image with only the software needed

• More direct accounting of usage
  – Reduces divisional upfront commitment
  – Charges project for specific time / resources used
Cloud challenges

• Security
  – Restricting / controlling access to RCE cloud nodes
  – Dealing with confidential data

• Data hosting
  – Proximity to executing hosts
  – Latency and bandwidth
  – Backups
  – Availability

• Licensing
  – Variable underlying hardware

• Accounting
  – Setting individual and global limits
  – Monitoring limits
Moving exclusively to the cloud

Challenges
1. Managing number of nodes in cluster
2. Securing communication between local and remote resources
3. Syncing local and remote data
4. Managing cost for high-memory nodes
5. License management and connection issues for interactive apps

Resource Manager

User

Secure login via NX

Allocate and manage resources

Request remote job

Local

Remote

Interactive

Login nodes

Batch nodes

Interactive

Login nodes
What we store

• Data volumes are allocated for specific types of data:
  • Murray Research Archive
  • Web server files
    – Dataverse Network (DVN)
    – CGA WorldMap / AfricaMap
  • RCE storage
    – Home directories
    – Project directories (backed up and not backed up)
  • FTP mirrors of open-source files
  • Tools data
    – e.g., source (code) control data (CVS)
Where we store data

User (applications)

Server
Internal drives

Server
Internal drives

...

NetApp filer

Head 1
Head 2

DR site (60 Ox)

Tape drive

NetApp filer

Head 3

Harvard University IT Summit – Research Computing in the Cloud
How we store data

User (applications)

Server

Internal drives

Server

Internal drives

HTTP

SFTP

NetVault

NFS

NetVault

HTTP

SFTP

Tape drive

HTTP

SFTP

NDMP

SnapMirror

DR site (60 Ox)

NetApp filer

Head 1

Head 2

Head 3

NetVault

NFS

NetVault
RCE Batch in the Cloud

- As an initial phase, limit the scope of cloud migration
- Batch nodes form a majority of the cluster
- R is predominantly used for batch computing in social sciences
- Goals
  - Developing a repeatable, shareable infrastructure
  - Leveraging open source software
  - Sharing any new software developed as open source
Batch nodes and R

Totals of RCE stat apps on Batch Cluster - by year

- R (GNU S) Cur: 0.00 Min: 0.00 Avg: 77.47 Max: 643.89
- SAS Cur: 0.00 Min: 0.00 Avg: 0.00 Max: 0.00
- SPSS (PASW) Cur: 0.00 Min: 0.00 Avg: 0.00 Max: 0.00
- Matlab Cur: 0.00 Min: 0.00 Avg: 1.67 Max: 73.00
- Mathematica Cur: 0.00 Min: 0.00 Avg: 0.00 Max: 0.00
- Stata Cur: 0.00 Min: 0.00 Avg: 59.96m Max: 20.70

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Getting to RCE Batch in the Cloud

• Steps to get to RCE Batch in the cloud
  • Develop system and configuration management infrastructure to spin up cloud instances on-demand
    – Considered ROCKS and starcluster, chose Puppet
  • Reserve Amazon instances for expected workload
    – Use non-reserved instances for elastic expansion on-demand
  • Stop buying new cluster hardware as warranties expire
    – Three-year cycle
Expanding the cloud resource pool

• Increase resource pool available to researchers by leveraging system management infrastructure and integrating other cloud types into hybrid cluster
  • Local Harvard resources (Odyssey, other clusters)
  • NSF Teragrid clusters
  • Other vendor cloud options
    – e.g., Rightscale, Rackspace, ElasticHosts

• Challenges
  • Keeping backend resources transparent from the user
  • Interacting with other clusters via consistent interfaces
  • Architecting for pluggable components
  • Developing software that matches requirements to resources