Eucalyptus: an Open-Source Infrastructure for Cloud Computing

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The Eucalyptus Project
Exciting Weather Forecasts
Commercial Cloud Formation

Amazon Elastic Compute Cloud (Amazon EC2) - Beta

POWER OF NETWORK.COM

Microsoft

VERIO

Engine Yard

Eucalyptus
What is a Cloud?
Public Clouds (Now)

- Large scale infrastructure available on a rental basis
  - Operating System virtualization (e.g. Xen) provides CPU isolation
  - “Roll-your-own” network provisioning provides network isolation
  - Locally specific storage abstractions

- Fully customer self-service
  - Service Level Agreements (SLAs) are advertised
  - Requests are accepted and resources granted via web services
  - Customers access resources remotely via the Internet

- Accountability is e-commerce based
  - Web-based transaction
  - “Pay-as-you-go” and flat-rate subscription
  - Customer service, refunds, etc.
How do they work?

• Public clouds are opaque
  — What applications will work well in a cloud?

• Many of the advantages offered by Public Clouds appear useful for “on premise” science IT
  — Self-service provisioning
  — Legacy support
  — Flexible resource allocation

• What extensions or modifications are required to support a wider variety of services and applications?
  — Scientific applications
  — Data assimilation
  — Multiplayer gaming
  — Mobile devices
Open Source Cloud Infrastructure

• Simple
  – Transparent => need to “see” into the cloud
  – Scalable => complexity often limits scalability

• Extensible
  – New application classes and service classes may require new features
  – Clouds are new => need to extend while retaining useful features

• Commodity-based
  – Must leverage extensive catalog of open source software offerings
  – New, unstable, and unsupported infrastructure design is a barrier to uptake, experimentation, and adoption

• Easy
  – To install => system administration time is expensive
  – To maintain => system administration time is really expensive
On a Clear Day...

- **Globus/Nimbus**
  - Client-side cloud-computing interface to Globus-enabled TeraPort cluster at U of C
  - Based on GT4 and the Globus Virtual Workspace Service
  - Shares upsides and downsides of Globus-based grid technologies

- **Enomalism (now called ECP)**
  - Start-up company distributing open source
  - REST APIs

- **Reservoir**
  - European open cloud project
  - Many layers of cloud services and tools
  - Ambitious and wide-reaching but not yet accessible as an implementation
• Elastic Utility Computing Architecture Linking Your Programs To Useful Systems

• Web services based implementation of elastic/utility/cloud computing infrastructure
  — Linux image hosting ala Amazon

• *How do we know if it is a cloud?*
  — Try and emulate an existing cloud: Amazon AWS

• Functions as a software overlay
  — Existing installation should not be violated (too much)

• Focus on installation and maintenance
  — “System Administrators are people too.”
Goals for Eucalyptus

- Foster greater understanding and uptake of cloud computing
  - Provide a vehicle for extending what is known about the utility model of computing
- Experimentation vehicle prior to buying commercial services
  - Provide development, debugging, and “tech preview” platform for Public Clouds
- Homogenize local IT environment with Public Clouds
  - AWS functionality locally makes moving using Amazon AWS easier, cheaper, and more sustainable
- Provide a basic software development platform for the open source community
  - E.g. the “Linux Experience”
- Not a designed as a replacement technology for AWS or any other Public Cloud service
Open Source Cloud Anatomy

• Extensibility
  – Simple architecture and open internal APIs

• Client-side interface
  – Amazon’s AWS interface and functionality (familiar and testable)

• Networking
  – Virtual private network per cloud
  – Must function as an overlay => cannot supplant local networking

• Security
  – Must be compatible with local security policies

• Packaging, installation, maintenance
  – System administration staff is an important constituency for uptake
Cloud Mythologies

• Cloud computing infrastructure is just a web service interface to operating system virtualization.
  —“I’m running Xen in my data center - I’m running a private cloud.”

• Cloud computing imposes a significant performance penalty over “bare metal” provisioning.
  —“I won’t be able to run a private cloud because my users will not tolerate the performance hit.”

• Clouds and Grids are equivalent
  —“In the mid 1990s, the term grid was coined to describe technologies that would allow consumers to obtain computing power on demand.”
Cloud Speed

- Extensive performance study using HPC applications and benchmarks
- Two questions:
  - What is the performance impact of virtualization?
  - What is the performance impact of cloud infrastructure?
- Tested Xen, Eucalyptus, and AWS (small SLA)
- Many answers:
  - Random access disk is slower with Xen
  - CPU bound can be faster with Xen -> depends on configuration
  - Kernel version is far more important
  - Eucalyptus imposes no statistically detectable overhead
  - AWS small appears to throttle network bandwidth and (maybe) disk bandwidth -> $0.10 / CPU hour
Comparing TCP Performance between EC2 and EPC

TCP Throughput mb/s

EC2 1 Zone
EC2 2 Zones
EPC 1 Zone
EPC 2 Zones
Clouds Versus Grids

- Rich's assertion: Clouds and Grids are distinct
- **Cloud**
  - Full private cluster is provisioned
  - Individual user can only get a tiny fraction of the total resource pool
  - No support for cloud federation except through the client interface
  - Opaque with respect to resources
- **Grid**
  - Built so that individual users can get most, if not all of the resources in a single request
  - Middleware approach takes federation as a first principle
  - Resources are exposed, often as bare metal
- These differences mandate different architectures for each
Open Source Cloud Ecosystem

• AppScale
  – Google App Engine inside EC2/Eucalyptus
  – Multiple scalable database back ends
    - [http://appscale.cs.ucsb.edu](http://appscale.cs.ucsb.edu)

• Rightscale
  – Local enterprise focused on providing client tools as SaaS hosed in AWS
  – “Turing Test” for Eucalyptus
    - Can Rightscale “tell” that it isn’t talking to EC2?
  – Uses the REST interface
  – Available for EPC
    - [http://eucalyptus.rightscale.com](http://eucalyptus.rightscale.com)
  – Next release any Eucalyptus cloud will be able to register with a free RightScale image
Our Roadmap

• 5/28/08 – Release 1.0 shipped
• 8/28/08 – EC2 API and initial installation model in V1.3
  — Completes overlay version
• 12/16/08 – Security groups, Elastic IPs, AMI, S3 in V1.4
• 4/01/09 – EBS, Metadata service in V1.5
• 4/23/09 – Ubuntu release
• 5/15/09 – Final feature release as V1.6
  — Completes AWS specification as of 1/9/2009
• 6/15/09 – Final bug-fix release
  — “core” opens for community contributions
Thanks and More Information

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