
Building Clouds using Commodity, Open-Source Software Components

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Cloud computing
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[Leif Eriksen, Founder and Principal, Industry Insights 2003/7/30]

Commercial Cloud Formation



Amazon Elastic Compute Cloud (Amazon EC2) - Beta



What is a Cloud?



SLAs



Web Services



Virtualization

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 advertized
 - 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” IT
 - Self-service provisioning
 - Legacy support
 - Flexible resource allocation
- What extensions or modifications are required to support a wider variety of services and 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

RESERVOIR

-
- 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

Notes from the Open Source Cloud

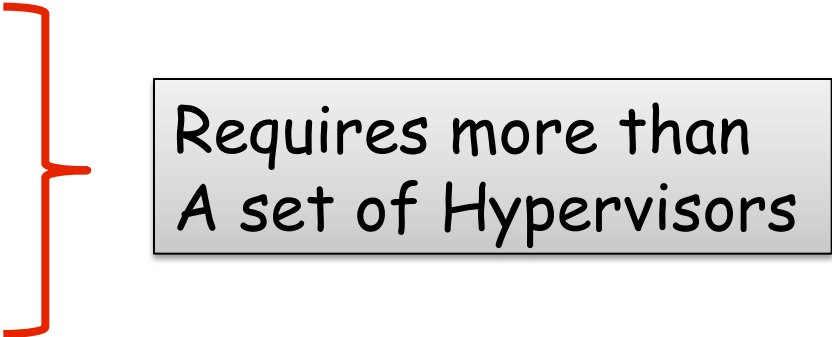
- Private clouds are really hybrid clouds
 - Users want private clouds to export the same APIs as the public clouds
- In the Enterprise, the storage model is key
 - Scalable “blob” storage doesn't quite fit the notion of “data file.”
- Cloud Federation is a policy mediation problem
 - No good way to translate SLAs in a cloud allocation chain
 - “Cloud Bursting” will only work if SLAs are congruent
- Customer SLAs allow applications to consider cost as first-class principle
 - Buy the computational, network, and storage capabilities that are required

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.”

Clouds and Virtualization

- Operating System virtualization (Xen, KVM, VMWare, HyperV) is only apparent for IaaS
 - AppEngine = BigTable + MapReduce
- Hypervisors virtualize CPU, Memory, and local device access as a single virtual machine (VM)
- IaaS Cloud allocation is
 - Set of VMs
 - Set of storage resources
 - Private network
- Allocation is atomic



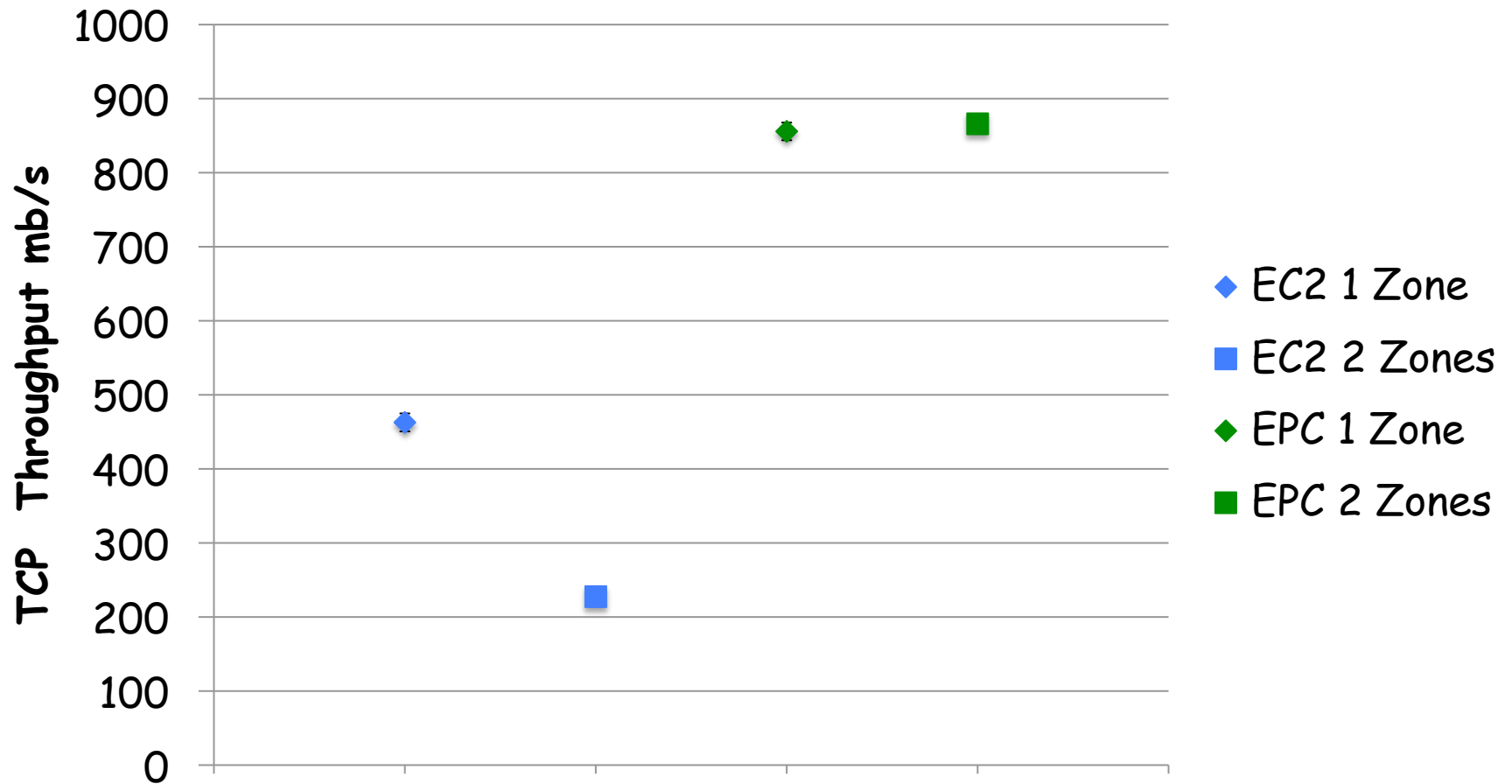
Requires more than
A set of Hypervisors

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*

Gratuitous Performance Slide

Comparing TCP Performance between EC2 and EPC and 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>




- Rightscale

- Local enterprise focused on providing client tools as SaaS hosted 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>
- 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

- National Science Foundation
 - VGrADS Project
- SDSC, CNSI, IU, Rice University
- RightScale.com
- The Eucalyptus Development Team at UCSB is
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