Eucalyptus: an Open-Source Infrastructure for Cloud Computing

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The Eucalyptus Project

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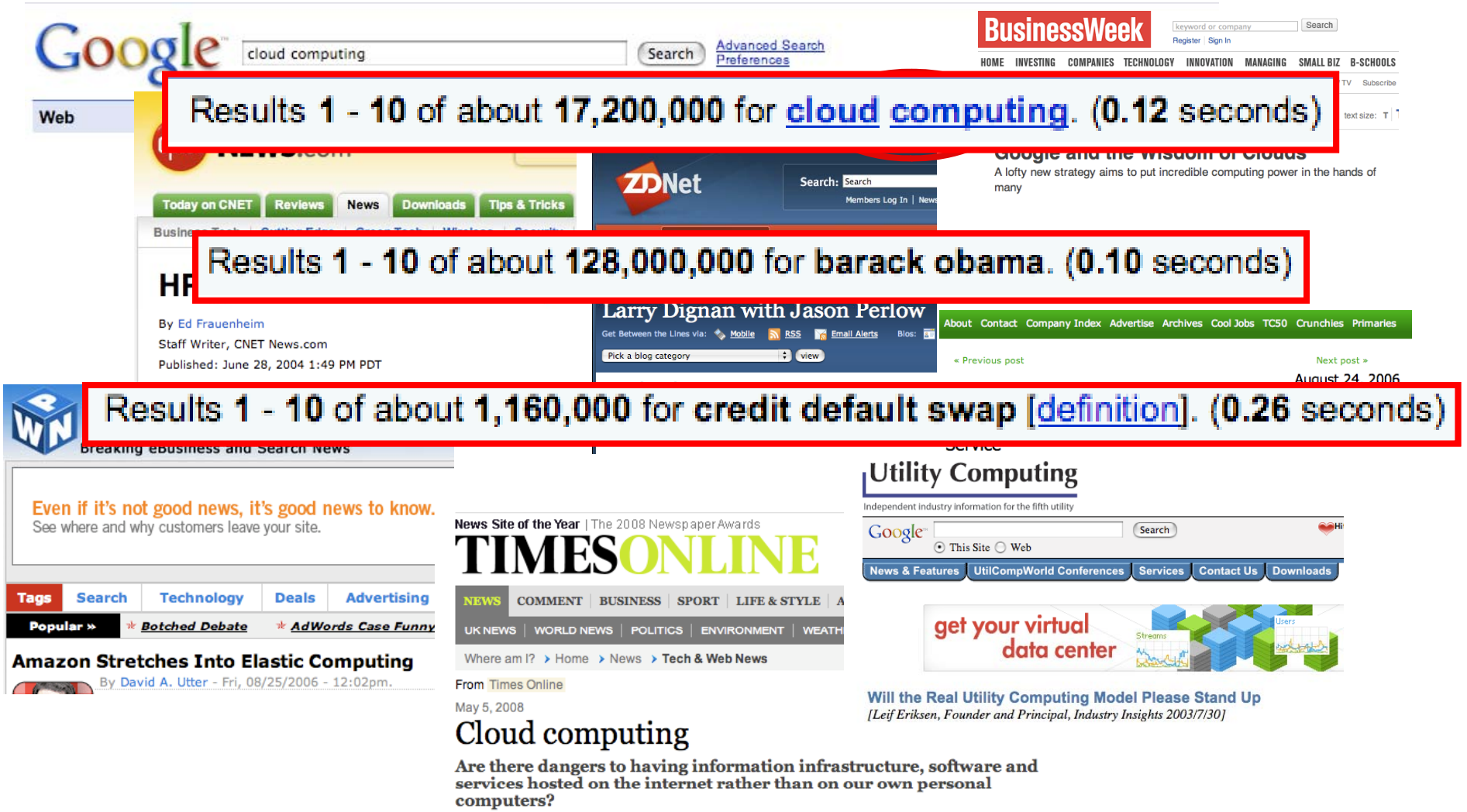
Exciting Weather Forecasts



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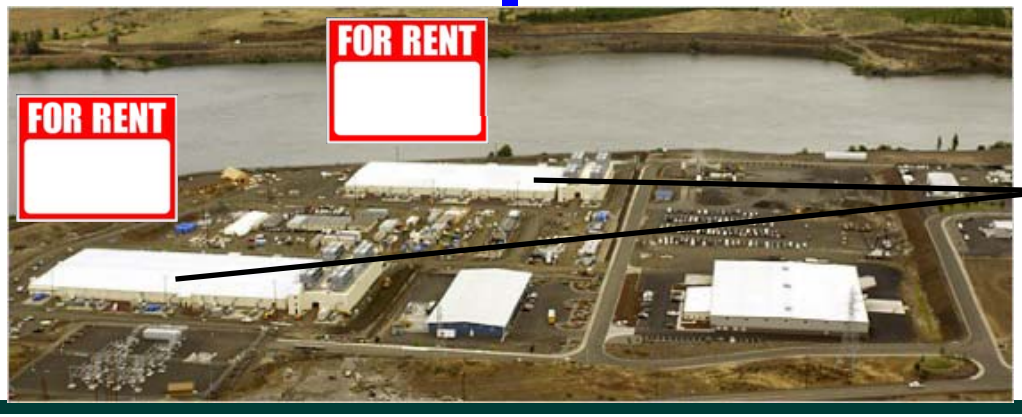
Commercial Cloud Formation

What is a Cloud?

SLAs

Web Services



Virtualization

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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" 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

RESERVOIR

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- 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

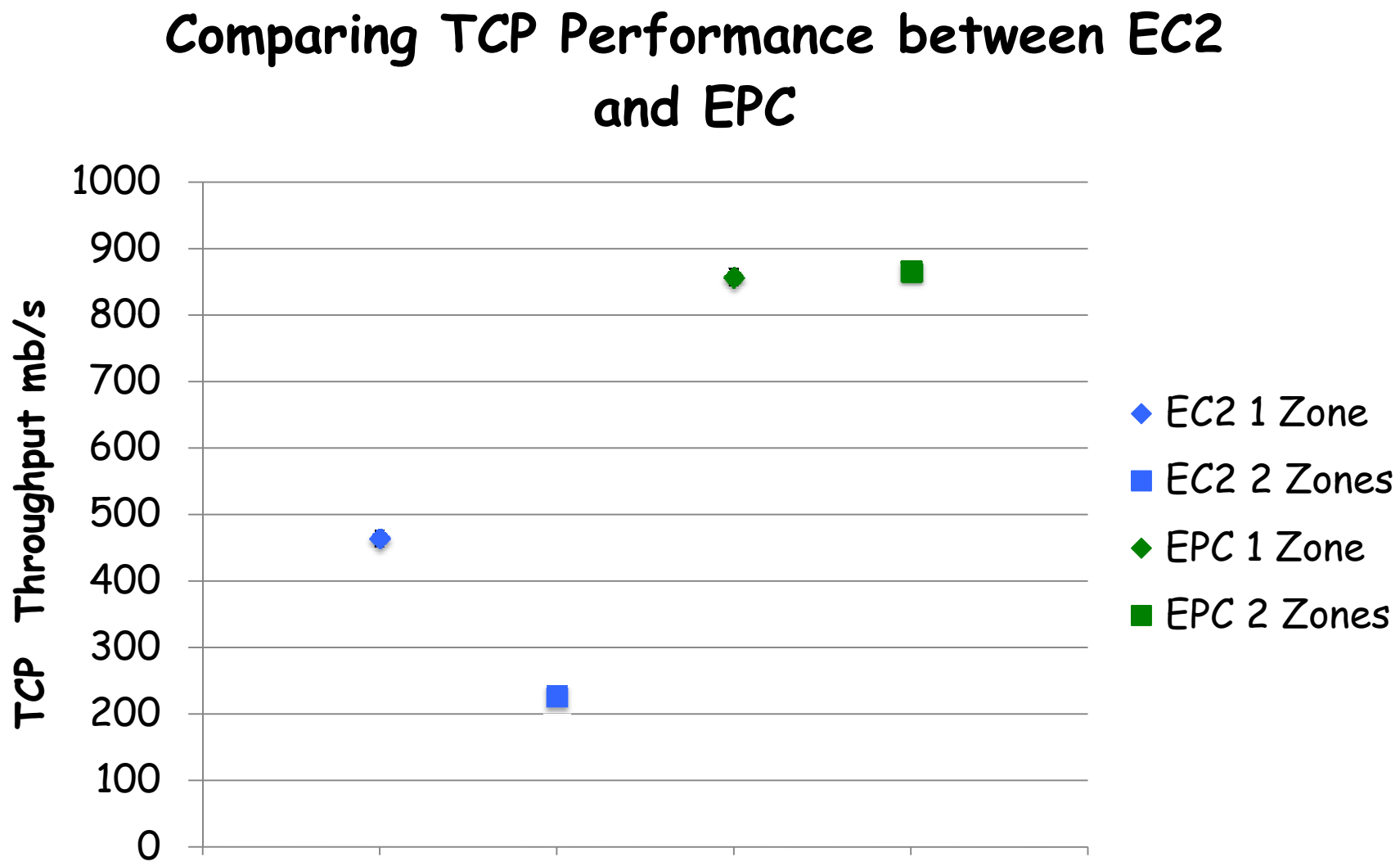
Cloud Mythologies

- 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*

Gratuitous Performance Slide



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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 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
  - Next release any Eucalyptus cloud will be able to register with a free RightScale image

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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

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Thanks and More Information

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