

Università degli Studi di Bologna Facoltà di Ingegneria

Corso di Reti di Calcolatori L-A

Cloud Computing

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What is Cloud computing?



"The architecture and terminology of cloud computing is as clearly and precisely **defined as, well, a cloud**."

Source: www.opencloudmanifesto.org

Cloud Computing Problem Space

"It starts with the premise that the **data services and architecture should be on servers**. We call it **cloud computing** – **they should be in a 'cloud' somewhere**. And that if you have the right kind of browser or the right kind of access, it doesn't matter whether **you have a PC or a Mac or a mobile phone or a BlackBerry or what have you – or new devices still to be developed – you can get access to the cloud**..."

- Dr. Eric Schmidt, Google CEO, August 2006



Cloud computing is...

Main requirements

- Scalability on demand (elastic and highly virtualized resources/images, Service Level Agreements – SLA, …)
- Automated provisioning and ease-of-use (utility computing + infrastructure, platform, and software as a service)
- Cost efficiency (minimized startup costs, energysaving,...)
- Challenges
 - Management (system resources, power-saving, ...)
 - Interoperability and portability (data, applications, and virtualized images)
 - Metering and monitoring (dynamic monitoring of used resources, accounting, ...)
 - Security

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Key Goals - Infrastructure Perspective

- How can we provide flexible compute resources quickly to promote rapid prototyping?
- How do we deploy applications that scale up to meet increasing demands over time?
- How do we manage 100,000's of machines with minimal human intervention?
- How can we make the most efficient use of all the compute resources in a data center?

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What Can You Do With a Cloud?

- Low-barrier prototyping and development
 - Setting up and tearing down VMs is extremely fast
 - Promotes innovation

Scale-out Web 2.0 applications

- Can clone app server VMs in response to user demand
- Scalable transaction processing
 - Support for high end UNIX and mainframe servers enables secure, reliable backend database support

Data intensive applications

- Grid-like computations supported

Cloud computing: reality check

- Amazon Elastic Computing EC2: virtualized images (DB+Software and middleware+OS), Xen, simple SLA console
- **HP/Yahoo/Intel Test Bed:** virtualized images, Xen, simple SLA console
- Research initiatives (*RESERVOIR EU FP7 project*, previous projects on grid computing such as EEGE, ...)
- **Google App Engine** (Software as a Service SAS, Web applications, Google App Engine, sandbox for management and security)
- **IBM Blue Cloud**: virtualized images (DB+Software and middleware+OS), Xen, Tivoli (monitoring and management), simple SLA console

Others ongoing projects: Eucalyptus, 3Tera, ...

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Google App Engine

- Web Application on Google infrastructures
- Application Environment
 - Sandbox: secure environment that distributes Web requests for the application across multiple servers and starts/stops servers to meet traffic demands
 - Python runtime environment
 - Datastore service
 - Google Accounts Integration
- Preview period, only free accounts are available
 - 500 MB and up to 5 million page views a month
 - Up to 3 applications
 - Scalable quotas
- What you need is
 - Google App Engine SDK
 - Google Account
 - Text Editor

Amazon EC2

Features

- AMI Amazon Machine Image
 - Use pre-configured, templated images to get up and running immediately.
 - Create image containing applications, libraries, data and associated configuration settings
 - Restriction: Linux-based
 Images
- Amazon S3 (Simple Storage Service)
 - Providing safe (?), reliable (?) and fast (?) repository to store the AMIs
- Amazon EC2 (Elastic Computing Cloud)
 - Web service that lets the user requisition AMIs

- Price
 - Pay only for the resources that are used
 - Different SLAs
 - Small, Large, Extra Instances
 - Data Transfer Levels
 - Different prices
 - SLAs example
 - Small Instance
 - \$0,10 per instance-hour
 - 1.7 GB of memory
 - 1 EC2 Compute Unit
 - 160 GB of instance storage
 - 32-bit platform

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Amazon EC2

- How does it work?
 - Subscribe account
 - Get Firefox Plug-In
 - Run your image
 - Example

Terminal

- Fedora Core 4
- Apache
- MySQL
- Manage it



Different projects on Cloud Computing

- Configure the number of hosts and their memory and disk
- Specify how much it's willing to pay for the virtualized cluster through a spending rate
- All of these variables can be changed at any point without interrupting running jobs Increasing the spending rate will immediately increase the CPU share on the cluster nodes
- Possible Hadoop Integration



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3Tera

Architecture intended to provide an **open framework** allowing the development of a **Cloud computing environment** that's rigorous enough to take Web or Enterprise application

Configuration options

Resource	Min	Max		
CPU's	2	1024		
RAM, GB	2	2048		
Storage, GB*	750	512,000		
IP addresses	32	1024		

Architecture



- Open-source software infrastructure for implementing Cloud computing on clusters
- Linux systems
- Xen (versions 3.*) for virtualization
- Rocks based (open-source cluster manager)
- Virtual Machines Provisioning

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Eucalyptus

- Eucalyptus Features (1.2 and 1.3)
 - Installation
 - · Rocks-based "almost-one-button" binary install
 - Experts-only "you-are-on-your-own" source install
 - RPM packages for "non-Rocks" RPM based systems
 - Administration
 - Adding/approving/disabling/deleting users (via the Web interface)
 - Adding/listing/disabling images (Web interface with command line use)
 - Adding/deleting nodes and clusters (via edit of configuration files)
 - Amazon's EC2 compatibility:
 - · In terms of command-line tools





ROCKS

Xcerion

🔤 icloud

- Xcerion is an Internet service providing a virtual desktop and OS for free
- Technology
 - XIOS/3 XML Internet Operating System
 - XML Virtual Machine executes the applications locally instead of in the cloud
 - Cloud used for data persistence, storing the users files



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Basic Cloud Computing Architecture



MapReduce Programming Model

- Functional programming that is easily parallelizable
- Split into two phases:
 - Map Perform custom function on all items in an array
 - Reduce Collate map results using custom function
- Scales well computation separated from processing dataflow
- Illustrative example
 - Map that squares the value of numbers in an array
 - {1, 2, 3, 4} -> {1, 4, 9, 16}
 - Reduce that sums the squares : 30



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Our experience with the Cloud

We currently work with the Cloud Computing Center at Dublin

- Virtual machine (VM) consolidation for power-saving
- Significant for **pervasive computing environment with a high number of VMs**, e.g., one proxy-VM for each node...



The fog has gone...



... and the Clouds are disclosed into the sky!

> Thanks for your attention!

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Resources and links

- Introductive YouTube video on Cloud Computing: http://www.youtube.com/watch?v= XdBd14rjcs0
- Introductive YouTube video on Cloud Computing

3Tera

👌 mygrid2 - 3Tera Appl	ogic - Mozilla	Firefox			
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Dashboard Applications	Support				
					mygrid2
Status					
Account	mygrid2		CPU Cores	10.35 (8.00 free)	
AppLogic Version	2.4.2 BETA		Memory	18.38GB total (14.73G	B free)
System Status	Running		Storage	1.89TB total (1.68TB fi	ree)
System Uptime	10 days, 3 hour	s and 44 minutes	Bandwidth	3.91Gbps total (3.73G	ops free)
High Availability	ok				
Applications	2 running				
	🗖 Grid Shell				
Messages					
	There are no m	essages at this ti			
Account Info					
Public Network					
Application IP Range		Netmask	Gateway	DNS Servers	
192.168.123.60 - 192.	168.123.70	255.255.255.0	192. 168. 123. 253	192, 168, 123, 16	
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3Tera



3Tera

bhoard Applications Supp	ort				
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Application Name 🔻	State	Description	CPU	Mem	BV
ackupHelper_r1 (template)	Stopped	Helper Application for the BCK appliance (v1.2.0-1)	0.30	320M	501
amp_r2 (template)	Stopped	LAMP Application (v1.1.1-1)	1.10	1.63G	1.250
ampCluster_r5 (template)	Stopped	Scalable LAMP Cluster Application (v1.3.1-1)	2.05	3.56G	1.80
ampX4_r2 (template)	Stopped	Scalable LAMP Application (v1.1.1-1)	2.80	3.13G	1.6
ligHelper (template)	Stopped	Helper Application for the MIG appliance (v1.3.0-1)	0.30	320M	41
iugarCRM_r1 (template)	Stopped	Fully featured, scalable CRM Application, based on SugarCRM's Sugar Open Source 4.0.1 (v4.0.1d-8)	1.65	2.25G	2.05
ys_Filer_Linux (template) 🔒	Stopped	Linux Filer Application (v1.1.2-1)	0.05	512M	1000
ys_Filer_Solaris (template) 🔒	Stopped	Solaris Filer Application (v1.0.2-1)	0.05	512M	1000
iys_Filer_Windows (template) 🔒	Stopped	Windows Filer Application (v1.0.0-1)	0.05	512M	1000
Wiki_r1 (template)	Stopped	TWiki 4.0.2 collaboration platform (v4.0.2-6)	1.05	896M	9000
DS_CentOS50_r2 (template)	Stopped	Virtual Dedicated Server - Based on CentOS 5 (v1.0.1-1)	0.25	256M	250
DS_CentOS51_r2 (template)	Stopped	Virtual Dedicated Server - Based on CentOS 5.1 (v1.0.1-1)	0.25	256M	250
DS64_CentOS50_r2 (template)	Stopped	Virtual Dedicated Server - Based on 64 bit CentOS 5 (v1.0.1-1)	0.25	256M	250
DS64_OSOL_r1 (template)	Stopped	Virtual Dedicated Server - based on OpenSolaris build 2008.05 (v1.0.0-1)	0.50	512M	250
ng	Stopped		0.05	128M	100
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