

Introduction to Cloud Computing

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Introduction to Cloud Computing

Outline

- 1 Introduction
- 2 Main Characteristics
- 3 What are Clouds used for?
- 4 Support Paper

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Today: Distributed Services are everywhere

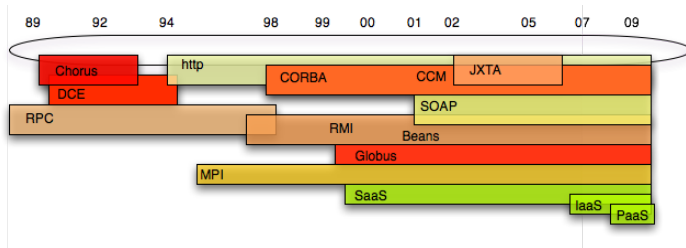
Storage and Computing



Technologies for Distributed Systems

- Extremely fast evolution of DS since 1985.
- Distributed System design adapts to hardware technology evolution.

A Time-line of technologies



Cloud Computing

Cloud Computing: A definition

General Definition: The ability to compute or store data at *some* location and retrieve them from ubiquitous and various devices.

- Notes

- ▶ Tablets, smartphones, and not only desktops and laptops
- ▶ Note: *Why cloud computing even for data storage?* Maybe because, computations take place near the data.

Enabling Technologies

Enabling Technologies

- Web 2.0 (REST design)
- Distributed Storage (originates in P2P file-systems)
- Virtualization
- Network bandwidth and latency
- Asymmetric ciphering (RSA, then PGP)

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Clouds' Characteristics

Cloud Computing can be characterized by:

- Types of Services: SaaS, IaaS, PaaS
- A new business model
- Elasticity

Software as a Service

- users have only access to the service (hosted *somewhere*)
- long standing form of cloud computing (before the name existed)
- e.g Gmail, Hotmail, Dropbox, ...

Infrastructure as a Service

- users are granted a total control over machines they can start/stop
- machines are totally controlled by the user (e.g through ssh)
- e.g Amazon EC2 and S3, Google Compute Engine, recently Microsoft Azure

Platform as a Service

- users are given a library or a framework to develop their applications
- the application is deployed over a cloud by the provider
- e.g Google App Engine, Microsoft Azure

Business Model

- Clients
 - ▶ *pay-as-you-go* model, almost always per-hour
- Provider
 - ▶ consolidation of VMs onto PMs
 - ▶ investment in hardware and software are amortized in large data-centers *price in medium (1K-server) data center is 5 to 7 times the one in large datacenters (50K)*

Amazon's EC2 illustration

On-demand instance, Linux, USA-West. Partial list (on 04/25/2013)

Instance	price (\$/hour)	CPU	RAM (GB)
m1.small	0.06	1 Vcore	1.7
m1.medium	0.12	1 Vcore x2	3.75
m1.large	0.24	2 Vcore x2	7.5
m1.xlarge	0.48	4 Vcore x2	15
m2.xlarge	0.41	4 Vcore x3.25	17.1
m2.2xlarge	0.82	8 Vcore x3.25	34.2
c1.medium	0.145	2 Vcore x2.5	1.7
c1.xlarge	0.580	8 Vcore x2.5	7
cc2.8.xlarge	2.40	2x8Vcore x5.5	60.5

Elasticity

- *pay-as-you-go* model encourages elastic provisioning
- VM starts in a couple of minutes
- Manual or automatic scaling (e.g. **RightScale**)

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Web applications and contents

- Scalable delivery of contents e.g Amazon CloudFront

Data storage

- Scalable data storage
- e.g. GoogleDrive, Dropbox, iCloud
- Use of distributed storage systems, generally NoSQL systems
- e.g. Cassandra, Dynamo, CouchDB

Analytics

- Batch jobs for parameter sweep computations
- Parallel jobs (e.g Map-Reduce for PageRank)

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Above the Clouds: A Berkeley View of Cloud Computing

- a paper from feb 2009 (Amazon **announced** EC2 Beta opening in 2006)
- defines cloud computing (Section 3)
- explains the reasons why Cloud Computing succeeds (Section 4)
- browses the offers of Utility Computing (Section 5)
- describes the economics behind cloud computing (Section 6)
- list obstacles and opportunities (Section 7)

Concepts

- DataCenter Economics
- VM – Virtualization
- Pricing model
- Lock-In and Availability Issues
- Data Storage
- Parallel jobs