Cloud Computing

Cloud computing:

A model of data processing in which high scalability IT solutions are delivered to multiple users:
- *as a service,*
- *on a mass scale,*
- *on the Internet.*

Network services offering:
- *computing power*
- *flexible, shared infrastructure*
- *storage space*

with payments collected for actual use of resources.

Cloud Computing: moving software to the Internet

What is a cloud?

Cloud:

Approach to building IT services using increasing **performance** of computers and **virtualization** techniques allowing for consolidation of servers

(a single physical computer can host multiple virtual machines).

Cloud – data processing in a decentralized environment
(**computation performed by multiple remote servers**).

Software installed on **remote servers**

(**users only have access to interfaces**).

Multiple services from multiple vendors

User's computers are also part of the cloud, as they are the user's access points.

(**data not stored locally on these units**).

Public cloud

Public cloud:

Shared infrastructure provided by third parties and paid for depending on actual use.

Properties:
- accessibility,
- multiuser access provided using virtual environments,
- accessed through on-line portals with self-service options.

Limitations:
- scalability
- security

Private cloud

Private cloud:

Mimics the public cloud service model but entirely under control of a single organization.

Properties:
- located entirely **inside a protected corporate network,**
- access limited to users from the corporation,
- highly virtualized, consolidating a diverse infrastructure in one or more easily managed groups of logical resources,
- accessed through on-line portals with self-service options and cost accounting.

Advantages: **efficiency** and **standarization**.

Interest: mainly large corporations.

Between public and private...

Community cloud:

Cloud built by cooperating organizations or by a community and restricted to its users.

Advantages: some distribution of costs and load sharing – improves scalability over the limits of a single organization. Fairness problems, potentially difficult management and accounting.

Hybrid cloud:

Mix of private and public cloud.

Examples:
- burst outsourcing – normal load handled by a private cloud; in case of an activity burst depleting resources some tasks offloaded to a public cloud.
- surplus sharing – offloading tasks from public or community cloud to private cloud if resources available (difficult, rare).

Cloud Computing Technologies

SaaS (Software as a Service)

Software available only as an online service.

SpS (Software plus Services)

Software can be installed on a private computer, but is tied to additional online services.

Business rationale:
Service vs. software, sold license vs. subscription: solves the "buy once upgrade never" problem of large software vendors with mature products.

Cloud service provision models (1)

IaaS **(Infrastructure as a Service***)*

Service providing IT infrastructure (hardware, software, support).

User may provide his own software to be installed on the rented hardware.

Example: user rents servers, storage, computing power...[1]

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[1] Virtualized!!! Otherwise it's not a cloud, it's just hosting!

Cloud service provision models (2)

PaaS (Platform as a Service)

Service providing **a preset, often customizable set of applications.**
Software is installed in the provider's servers.
The client software (often a web browser) provides a uniform interface.
Access from any computer with an Internet connection.

SaaS (Software as a Service)

Service providing **specific tools and applications**, not necessarily
with a uniform interface.
Software installed at the provider's servers, accessed on demand – no
need to purchase a license, pay per use.

Cloud Computing architecture

Multilayer architecture
(5 layers used in software development)

1. Hardware
2. Virtualization
3. Infrastructure
4. Platform
5. Application

Layer 3: Cloud Computing infrastructure middleware

Management software and services for:

- computing power (*Infrastructure as a Service*)
- storage space (*Data-Storage as a Service*)
- communication (*Communication as a Service*)
- and others

Set of ready-to-use tools for the users.

Layer 4: Cloud Computing APIs
(*Platform as a Service*)

A platform for building applications in the cloud, using layers 1-3.

Dedicated for programmers and software vendors.

Layer 5: Cloud Computing applications
(*Software as a Service*)

Dedicated for end-users, interested only in using a cloud-based application.

Advantages of Cloud Computing (1)

Flexibility

Adapting IT solutions to actual current needs without investing in new hardware or software.

Adaptability

Dynamic allocation of necessary resources (e.g. computing power) to the users' needs. Load balancing. Eliminated cost of deployment of software to all client computers.

Hardware and location independent

Data can be accessed from any computer with Internet access.

Massive sharing of resources

Efficient use of resources, distribution of upkeep costs among users, many ways of cost rationalization and many work models.

Advantages of Cloud Computing (2)

Fault tolerance and high accessibility

Data remains safe in case of client computer failure. Redundancy.

Data security

Secure access protocols, data protection software.

Outsourced backup, processing and storage

Cost reduction

No additional investment if work model changes. Upgrade cost moved to the provider. Upkeep cost reduced and easy to monitor.

Energy conservation

Limitations of Cloud Computing

No physical control over data
(privacy, safety and accessibility concerns)

Risk of data loss or inaccessibility

Fast internet access required

Vendor lock-in

Third party dependence in business critical applications
(note the similarity to *supply chain security*)

Legal problems
- unclear responsibility
- data privacy and restricted/confidential data problems

Cloud Computing applications

Some well-known Cloud Computing providers:
Google, **Yahoo**, **Microsoft, Amazon**...

Example: **Google Apps** (Gmail, Google Talk, Google Calendar, Google Docs...)

Drive towards cloud computing in client-installed software:
- Microsoft
- Adobe
- Mobile operating systems and applications
- ...