Introduction to Cloud Computing

https://portal.futuregrid.org/contrib/cloud-computing-class
by various contributors
(see last slide)

Request for contributors

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- put your name in the last slide
- write a quick note the next slide concerning what you have modified/added/deleted (since googledocs does not provide this feature, it only says who has modified the presentation and how many slides)

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If you want to became an editor, just send me an email!

Revision history

24/06/11 - M. Canonico - added "ToDo" slide
23/06/11 - M. Canonico - added "request for contributors" slide

ToDO list

- Find a better pic for "Impact of Cloud computing on the Governance structure of IT organization" (it needs a better resolution)
- FInd a better pic for "Community Cloud"
- Fix layout of Virtualization slides
- Find good pics for IaaS, PaaS and SaaS
- In some of the European countries, Government regulations do not allow customer's personal information and other sensitive information to be physically located outside the state or country. Do you know where?
- contributors... what else?

First: do not be scared!

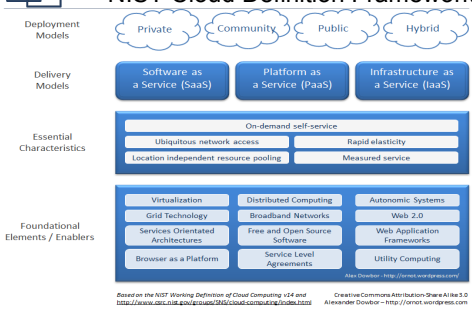
Outline

- Definitions
- Cloud Computing Models
- Public and Private Cloud
- Cloud Computing Benefits
- Cloud Computing Challenges

Definition

- „Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.“ (NIST)
- “Cloud computing is Internet-based computing, whereby shared resources, software and information are provided to computers and other devices on-demand, like electricity” (Wikipedia)

NIST Cloud Definition Framework



„Alternative“ definitions

- The term “Cloud computing” is misleading. As a marketing buzzword, it’s used to suggest that something new and better is going on, when in fact there may be nothing new about it.
- Cloud computing simply increases the number of things that can go wrong. And go wrong they do.
- Cloud Computing is a business concept, not a technological jargon dependent on "as a service model"

In priciple, there were

- Grid computing
- Utility computing
- Virtualization

Grid Computing

Grid computing

- Grid computing (or the use of a computational grid) is applying the resources of many computers in a network to a single problem at the same time - usually to a scientific or technical problem that requires a great number of computer processing cycles or access to large amounts of data.

Utility computing

- Utility computing is the packaging of computing resources, such as computation, storage and services, as a metered service similar to a traditional public utility (such as electricity, water, natural gas, or telephone network). This model has the advantage of a low or no initial cost to acquire computer resources; instead, computational resources are essentially rented - turning what was previously a need to purchase products (hardware, software and network bandwidth) into a service.

Virtualization

- Virtualization is the creation of a virtual (rather than actual) version of something, such as a hardware platform, operating system, a storage device or network resources.

Role of Virtualization

- Virtualization
  - Abstraction layer that decouples computation from physical resource
- Motivations
  - Resource *sharing* with security and isolation
    - Similar to multi-user/multi-programming
  - Ease of management
    - Virtual machines (bits) vs. physical resources (hardware)
    - E.g.: start/stop, clone, migrate, suspend an entire virtual machine

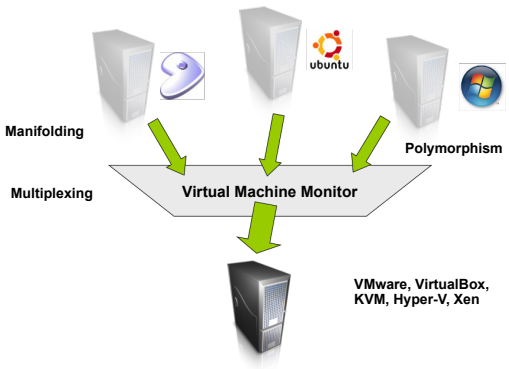
Virtualized Computers

- A definition for "virtual":
  - "Common alternative to *logical*; often used to refer to the artificial objects created by a computer system to help the system control access to shared resources."
    [Free Online Dictionary of Computing]
- Virtual machines (VMs)
  - Key enabling virtualization technology
  - Initial developments in the early 70s
    - Sharing of mainframe computers by multiple legacy O/Ss
  - "Renaissance" when x86 platforms were virtualized
    - VMware; Xen, KVM, VirtualBox, Hyper-V, …

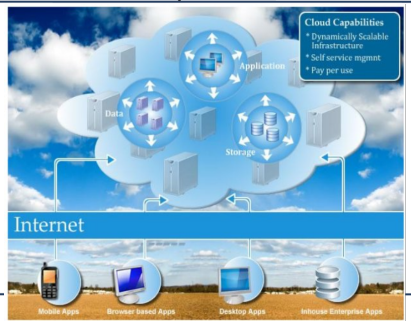
"Classic" VMs defined

- "A virtual machine is taken to be an *efficient*, *isolated*, *duplicate* copy of the real machine" [2]
  - "A statistically dominant subset of the virtual processor's instructions is executed directly by the real processor"[2]
  - "…transforms the single machine interface into the illusion of many"[3]
  - "Any program run under the VM has an effect identical with that demonstrated if the program had been run in the original machine directly"[2]
- Bottom line: near-native performance for many applications; time/space sharing with strong isolation; runs unmodified O/Ss and applications

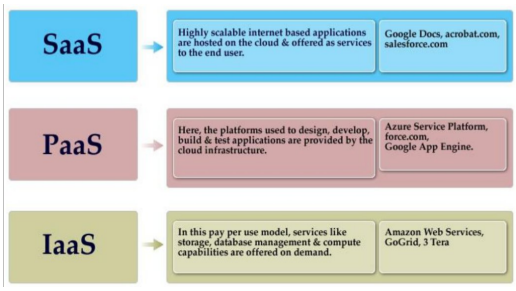
Virtual Machines



Conceptual view



Models



SaaS

- A complete application is offered to the customer, as a service on demand
- A single instance of the service runs on the cloud and multiple end users are serviced
- *Customers' side*: **no** need for upfront investment in servers or software licenses
- *Providers' side*: the costs are lowered, since only a single application needs to be hosted and maintained
- SaaS offered by Google, Salesforce, Microsoft, Zoho, etc.

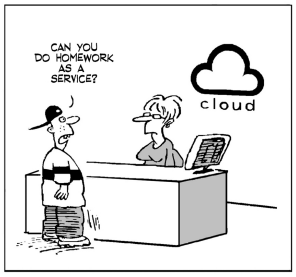
PaaS

- A layer of software, or development environment is encapsulated and offered as a service
- The customer has the freedom to build his own applications, which run on the provider's infrastructure
- PaaS providers offer a predefined combination of OS and application servers, such as LAMP platform, restricted J2EE, Ruby etc.
- PaaS example: Google's App Engine, Force.com

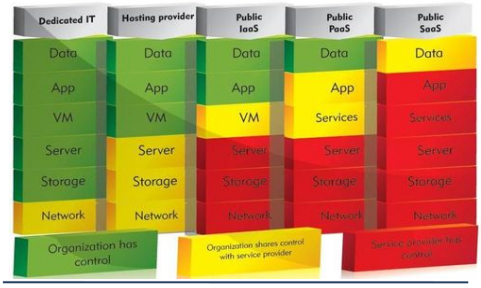
IaaS

- IaaS provides basic storage and computing capabilities as standardized services over the network
- Servers, storage systems, networking equipment, data centre space etc. are pooled and made available to handle workloads
- The customer would typically deploy his own software on the infrastructure.
- IaaS examples: Amazon, GoGrid, 3 Tera, etc.

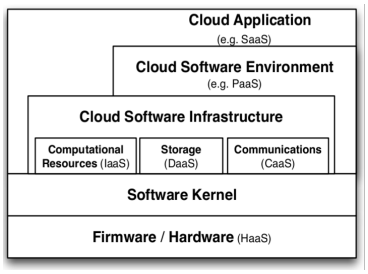
*aaS



Impact of Cloud computing on the Governance structure of IT organization



Cloud computing ontology



form Youseff et al,2008

Public, Private or Hybrid cloud

- Enterprises can choose to deploy applications on Public, Private or Hybrid clouds.

Public Cloud

- Owned and operated by third parties
- Give to each individual client an attractive low-cost, "Pay-as-you-go" model
- All customers share the same infrastructure pool with
  - limited configuration, security protections, and availability variances
- May be larger than an enterprises cloud
  - scale seamlessly on demand

Private Clouds

- Are built exclusively for a single enterprise
- Aim to address concerns on data security and offer greater control
- There are two variations:
  - On-premise Private Cloud
  - Externally hosted Private Cloud

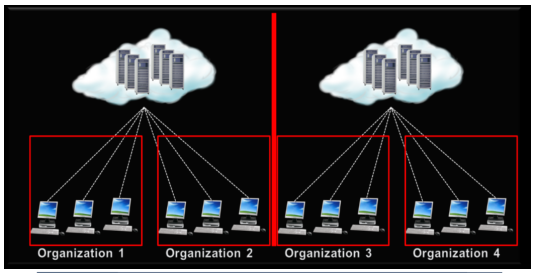
On-premise Private Clouds

- Also known as internal clouds since are hosted within one own data centre
  - Pros:
    - more standardized process and protection
    - best suited for applications which require complete control and configurability of the infrastructure and security
  - Cons:
    - limited in aspects of size and scalability
    - need to incur the capital and operational costs for the physical resources

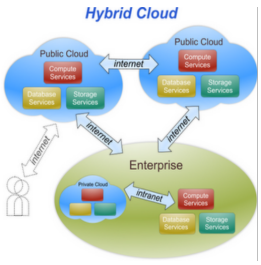
Externally hosted Private Cloud

- Hosted externally with a cloud provider
- The provider facilitates an exclusive cloud environment with full guarantee of privacy
- Best suited for enterprises that don't prefer a public cloud due to sharing of physical resources

Community Cloud



Hybrid cloud



Hybrid Clouds

- Combine both public and private cloud models
- Service providers can utilize 3rd party Cloud Providers in a full or partial manner thus increasing the flexibility of computing
- The ability to augment a private cloud with the resources of a public cloud can be used to manage any unexpected surges in workload

Cloud Computing benefits

- Some of the typical benefits are listed below:
  - Reduced cost
  - Increased storage
  - Flexibility

Reduced cost

- The billing model is pay as per usage
- The infrastructure is not purchased thus lowering maintenance
- Initial expense and recurring expenses are much lower than traditional computing.

Increased storage

- With the massive infrastructure that is offered by Cloud providers today, storage and maintenance of large volumes of data is achievable
- Sudden workload spikes are also managed effectively and efficiently, since the cloud can scale dynamically

Flexibility

- With enterprises having to adapt, even more rapidly, to changing business conditions, speed to deliver is critical
- Cloud computing stresses on getting applications to market very quickly, by using the most appropriate building blocks necessary for deployment

Cloud Computing Challenges

- Despite its growing influence, concerns regarding cloud computing still remain.
- Some common challenges are:
  - Data Protection
  - Data Recovery and Availability
  - Management Capabilities
  - Regulatory and Compliance Restrictions

Data protection

- Data Security is a crucial element that warrants scrutiny
- Enterprises fear losing data to competition and the data confidentiality of consumers
- Moreover, the actual storage location is not disclosed, adding onto the security concerns of enterprises
- Service providers are responsible for maintaining data security and enterprises would have to rely on them

Data Recovery and Availability

- All business applications have Service level agreements (SLA) that are stringently followed
- Cloud providers must serve
  - Appropriate clustering and Fail over
  - Data Replication
  - System monitoring
  - Maintenance
  - Disaster recovery
  - Capacity and performance management

Management Capabilities

- Despite there being multiple cloud providers, the management of platform and infrastructure is still in its infancy
- Features like „auto-scaling" for example, are a crucial requirement for many enterprises
- There is huge potential to improve on the scalability and load balancing features provided today

Regulatory and Compliance Restrictions

- In some of the European countries, Government regulations do not allow customer's personal information and other sensitive information to be physically located outside the state or country
- In order to meet such requirements, cloud providers need to setup a data center or a storage site exclusively within the country to comply with regulations.
- Having such an infrastructure may not always be feasible and is a big challenge for cloud providers

Conclusions

- With cloud computing, the action moves to the interface
  - that is, to the interface between service suppliers and multiple groups of service consumers
- Cloud services will demand expertise in distributed services, procurement, risk assessment and service negotiation
  - areas that many enterprises are only modestly equipped to handle

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- Cloud Computing Use Cases, v. 4 (http://www.opencloudmanifesto.org/)
- [1] "Formal Requirements for Virtualizable Third-Generation Architectures", G. Popek and R. Goldberg, Communications of the ACM, 17(7), July 1974
- [2] "Survey of Virtual Machine Research", R. Goldberg, IEEE Computer, June 1974

Contributors

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