



SITA1503

FOG AND CLOUD COMPUTING

Unit 1

Cloud Computing



UNIT 1 UNDERSTANDING CLOUD COMPUTING



- **Basic Concepts and Terminology - Cloud Computing Architectural Framework - Types of Clouds - pros and cons of cloud computing – Cloud Characteristics - difference between web 2.0 and cloud - key challenges in cloud computing - Major Cloud players - Virtualization in Cloud Computing - Parallelization in Cloud Computing - cloud resource management – Cloud Enabling Technology.**

History of Cloud Computing



- Before emerging the cloud computing, there was **Client/Server computing** which is basically a centralized storage in which all the software applications, all the data and all the controls are resided on the server side.
- If a single user wants to access specific data or run a program, he/she need to connect to the server and then gain appropriate access, and then he/she can do his/her business.
- Then after, **distributed computing** came into picture, where all the computers are networked together and share their resources when needed.
- On the basis of above computing, there was emerged of cloud computing concepts that later implemented.

History of Cloud Computing



- At around in 1961, John MacCharty suggested in a speech at MIT that computing can be sold like a utility, just like a water or electricity
- In 1999, Salesforce.com started delivering of applications to users using a simple website. The applications were delivered to enterprises over the Internet, and this way the dream of computing sold as utility were true.

History of Cloud Computing



- In 2002, Amazon started Amazon Web Services, providing services like storage, computation and even human intelligence. However, only starting with the launch of the Elastic Compute Cloud in 2006 a truly commercial service open to everybody existed.

History of Cloud Computing



- In 2009, Google Apps also started to provide cloud computing enterprise applications. Same year Microsoft launched Windows Azure, and companies like Oracle and HP have all joined the game. This proves that today, cloud computing has become mainstream.

EVOLUTION OF COMPUTING

Programming languages	abstract <i>algorithms</i> from machine instructions	1951 A0 SYSTEM 1954 FORTRAN
Operating Systems	abstract <i>software</i> from hardware	1959 GM OS IBM701 1965 OS/360
File Systems	abstract <i>data storage</i> from physical medium	1961 DECTape
Databases	abstract <i>data</i> from physical storage	1960-xIDS,IMS 1970 RDBMS
Networking protocols	abstract <i>communication</i> from network	1969 ARPANet
Virtual machines	abstract <i>application</i> from platform	1995 JVM
Grid Computing	abstract <i>distributed application</i> from distributed platform	1990-2000
Cloud Computing	Abstract <i>application</i> from infrastructure	2000-2009

Cloud Computing

Current Business Challenge



<http://www.slideshare.net/marccaltabiano/ea2009-enterprise-architecture-keynote>

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Cloud Computing

A New Generation of IT Challenges

ea2009

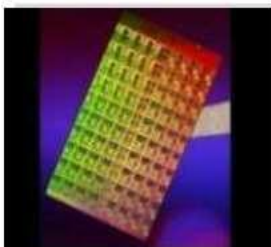
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Data Volumes



Energy Efficiency



Compute Density



Evolving Skills



Globalization



Green Initiatives

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Current Challenge

More Infrastructure ≠ Better Information!

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You need to have actionable information?



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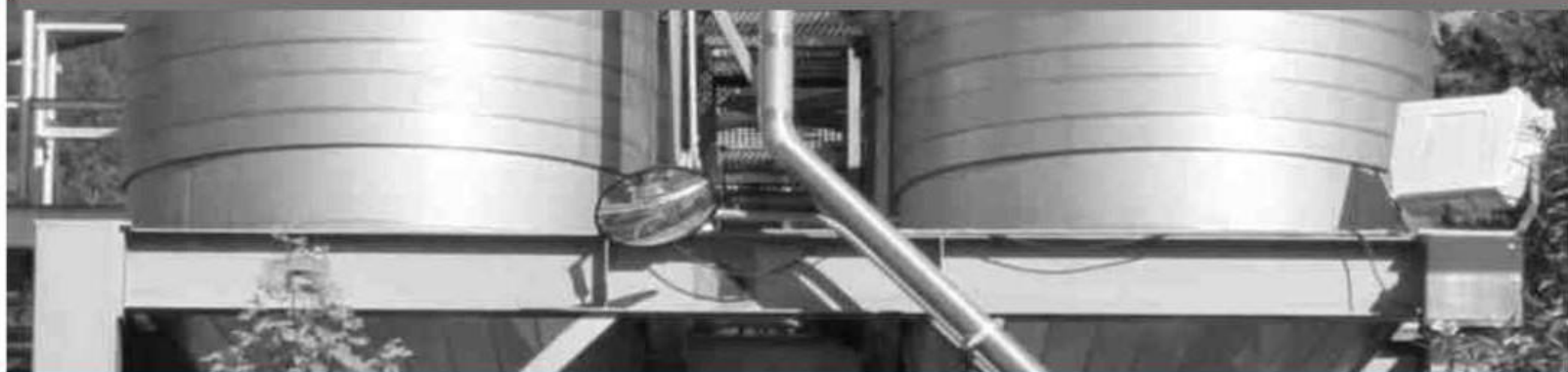
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Current Challenge

Rigid Data Centre - limit innovation



IT Infrastructure silos are expensive, under-utilized and difficult to secure



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What is Cloud?

"A Virtual
Datacenter"

"Automatically
Scalable / Elastic
Compute
Resources"

"Pay for
Computing as
You Use It"

"Computers
For Rent On
The Internet"



"Virtualized
Servers"

"Storage in
The Sky"

What is ?



Cloud computing is a technology that uses the internet and central remote servers to maintain data and applications.

A simple example of cloud computing is Yahoo email or Gmail etc,.

CLOUD COMPUTING:DEFENITION



- Cloud computing means *on demand delivery of IT resources* via the internet with pay-as-you-go pricing. It provides a solution of IT infrastructure in low cost.



- A style of computing where massively scalable (and elastic) IT-related capabilities are provided “as a service” to external customers using Internet technologies.



- The analogy is , '***If you only need milk , would you buy a cow ?***' All the users or consumers need is to get the benefits of using the software or hardware of the computer like sending emails etc. Just to get this benefit (milk) why should a consumer buy a (cow) software /hardware ?



Cloud computing is broken down into three segments:

- "applications,"
- "platforms," and
- "infrastructure."

Cloud Computing Segments



- **Applications: It's all On Demand**
 - On Demand software services
 - **Who is Offering On Demand Software?**
 - [International Business Machines \(IBM\)](#)
 - [Salesforce.com \(CRM\)](#)
 - [EfroTech.com \(HRIS\)](#)
 - [Google \(GOOG\)](#)
 - [NetSuite \(N\)](#)
 - Cordys
 - [Taleo \(TLEO\)](#)
 - [Concur Technologies \(CNQR\)](#)

Cloud Computing Segments



Platforms

- allow users to access applications from centralized servers using the internet.
- **Active platforms -**
 - [International Business Machines \(IBM\)](#) - IBM Cloud - Lotus Live
 - [Google \(GOOG\)](#) - Apps Engine
 - [Amazon.com \(AMZN\)](#) - EC2
 - [Microsoft \(MSFT\)](#) - Windows Azure
 - [Logicworks \(www.logicworks.net\)](#) - infiniCloud
 - [SAVVIS \(SVVS\)](#) - Symphony VPDC
 - [Terremark Worldwide \(TMRK\)](#) - The Enterprise Cloud
 - [Salesforce.com \(CRM\)](#) - Force.com
 - [NetSuite \(N\)](#) - Suiteflex
 - [Rackspace Cloud](#) - cloudservers, cloudsites, cloudfiles
 - [<http://www.metrisoft.com>] Metrisoft

Cloud Computing Segments

Infrastructure

- allow users to build applications
- **Major Infrastructure Vendors**
 - [Google \(GOOG\)](#) - Managed hosting, development environment
 - [International Business Machines \(IBM\)](#) - Managed hosting
 - [SAVVIS \(SVVS\)](#) - Managed hosting & cloud computing
 - [Terremark Worldwide \(TMRK\)](#) - Managed hosting
 - [Amazon.com \(AMZN\)](#) - Cloud storage
 - [Rackspace Hosting \(RAX\)](#) - Managed hosting & cloud computing



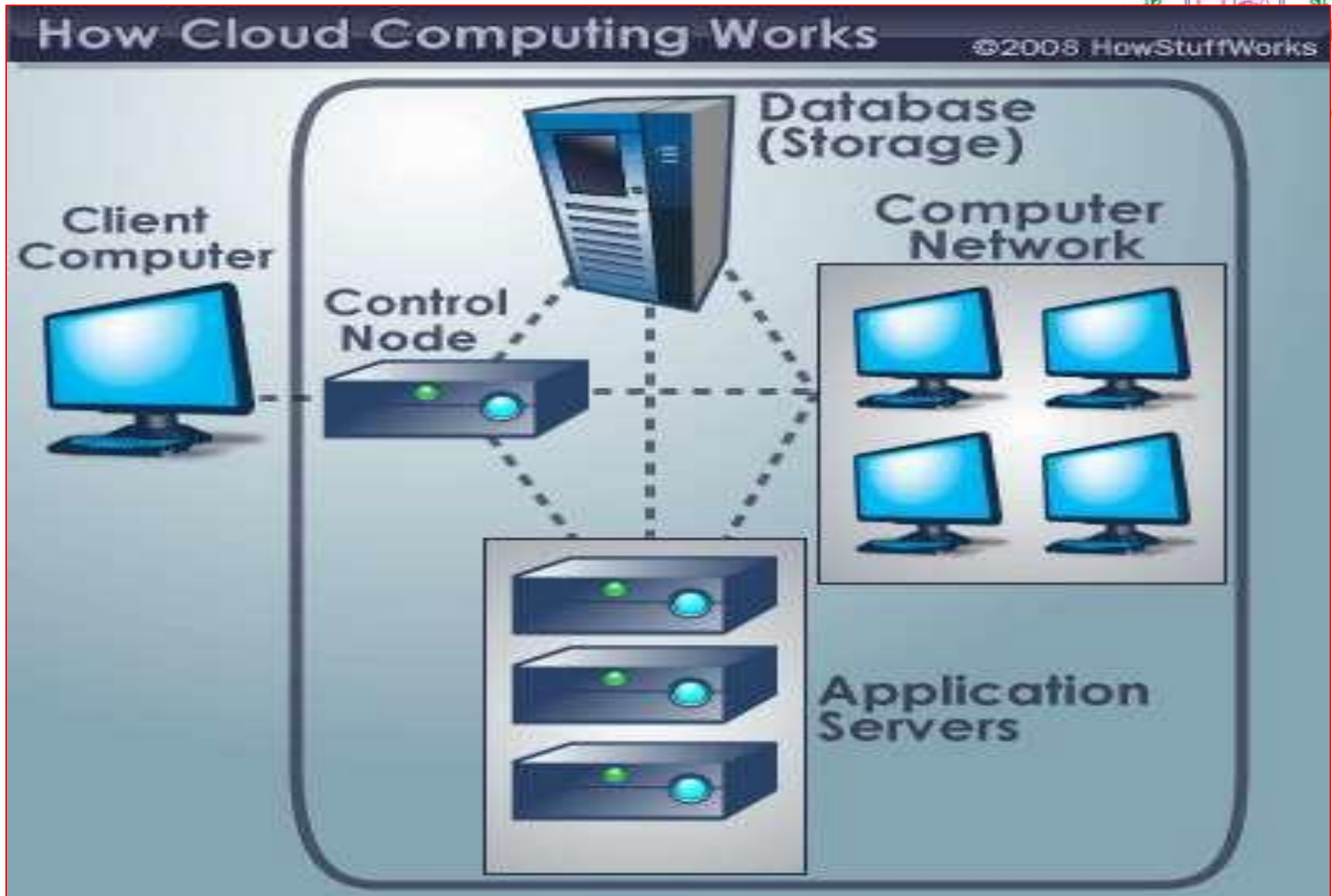
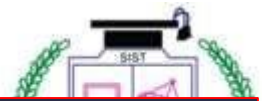
X as a Service



- "X as a Service" or "Anything as a Service " or "Everything as a Service. “
- XaaS encompasses
 - SaaS (Software as a Service),
 - PaaS (Platform as a Service),
 - IaaS (Infrastructure as a Service),
 - HaaS (Hardware as a Service),
 - MaaS (Management as a Service),
 - CaaS (Communications as a Service) or
 - DaaS (Data or Database or Desktop as a Service).

Unified public + private (on-premises) cloud + Military grade security + full Data Control
+ Breakthrough workforce efficiency (<http://www.xaas.com/>)

A typical cloud computing system



the front end

and

the back end.

Dr. A. Indrakumar, Asso. Prof. of CSE, SST

<http://computer.howstuffworks.com/cloud-computing1.htm>

Cloud Computing

Mosso
Google App Engine
Rails One

Salesforce
Gmail
Gliffy

Joyent
Amazon Web Svcs
Nirvanix
XCalibre
Akamai

PaaS

SaaS

IaaS

Cloud Computing

Utility Computing

Grid Computing

Cluster Computing

Super Computing



NEED OF CLOUD COMPUTING

- Small as well as some large IT companies follows the traditional methods to provide the IT infrastructure
- In their server room, there should be a database server, mail server, networking, firewalls, routers, modem, switches, QPS (Query Per Second means how much queries or load will be handled by the server) , configurable system, high net speed and the maintenance engineers.
- To establish such IT infrastructure, we need to spend lots of money. To overcome all these problems and **to reduce the IT infrastructure cost**, Cloud Computing comes into existence.

Characteristics of Cloud Computing



- **Agility**
 - The cloud works in the distributed computing environment. It shares resources among users and works very fast.
- **High availability and reliability**
 - Availability of servers is high and more reliable, because chances of infrastructure failure are minimal.

Characteristics of Cloud Computing



- **High Scalability**
 - Means "on-demand" provisioning of resources on a large scale, without having engineers for peak loads.
- **Multi-Sharing**
 - With the help of cloud computing, multiple users and applications can work more efficiently with cost reductions by sharing common infrastructure.



Characteristics of Cloud Computing

- **Device and Location Independence**
 - Cloud computing enables the users to access systems using a web browser regardless of their location or what device they use e.g. PC, mobile phone etc. As infrastructure is off-site (typically provided by a third-party) and accessed via the Internet, users can connect from anywhere.

Characteristics of Cloud Computing



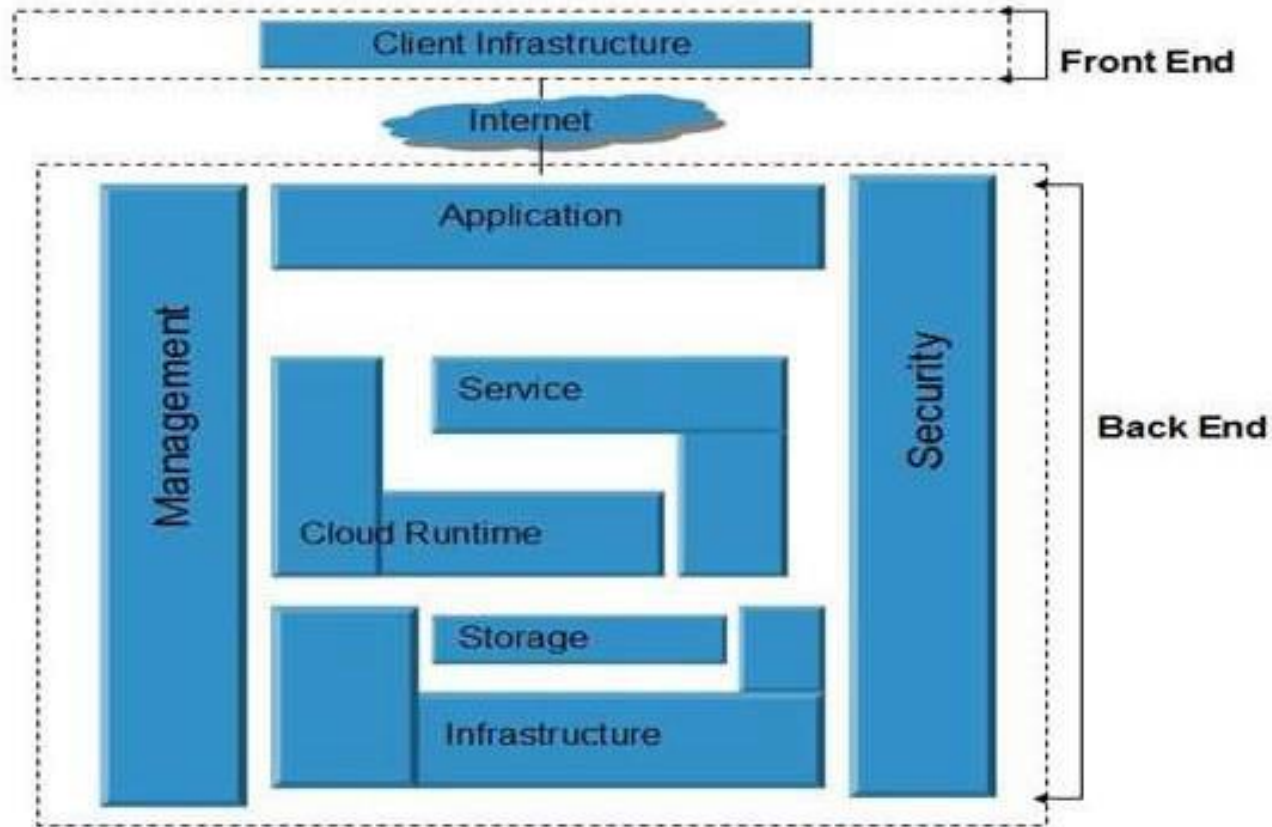
- **Maintenance**
 - Maintenance of cloud computing applications is easier, since they do not need to be installed on each user's computer and can be accessed from different places. So, it reduces the cost also.
- **Low Cost**
 - By using cloud computing, the cost will be reduced because to take the services of cloud computing, IT company need not to set its own infrastructure and pay-as-per usage of resources.

Characteristics of Cloud Computing



- **Services in pay-per-use mode**
- Application Programming Interfaces (APIs) are provided to the users so that they can access services on the cloud by using these APIs and pay the charges as per the usage of services.

Architectural framework:



Components of Cloud Computing Architecture



- A front-end platform that can include fat clients, thin clients, and mobile devices
- Back-end platforms, such as servers and storage
- Cloud-based delivery
- A network (internet, intranet)

Front End and Back End Cloud Computing



At its most basic, cloud architecture can be classified into two sections: front-end and back-end, connected to each other via a virtual network or the internet. There are other parts of cloud architecture including middleware, cloud resources, etc., but for now we'll just review the basics.

- **Front End Cloud Computing**

Front-end is the side that is visible to the client, customer, or user. Front-end pieces include the user interface, and the client's computer system or network that is used for accessing the cloud system. You have probably noticed that different cloud computing systems use different user interfaces—for example, not only can you choose from a variety of web browsers (including Chrome, Safari, Firefox, etc.), but the Google Docs user interface is different than that of Salesforce.

Front End and Back End Cloud Computing



- **Back End Cloud Computing**
- On the other hand, the back-end pieces are on the side used by the service provider. These include various servers, computers, data storage systems, virtual machines, and programs that together constitute the cloud of computing services. The back-end side also is responsible for providing security mechanisms, traffic control and protocols that connect networked computers for communication.
- To briefly summarize: the front-end is the part you see, and the back-end is the computing that happens behind the scenes.

Cloud Services Network



- Cloud services can be delivered publicly or privately using the internet and can also remain within a company's network when delivered over an intranet. Sometimes, organizations make use of a combination of both.
- No matter where the actual “cloud” is—a company's own data center or a service provider's data center, cloud computing uses networking to enable convenient, on-demand access to a shared pool of computing resources like networks, storage, servers, services, and applications. By using virtualization, these assets can be provisioned and released quickly and easily as necessary.

You've Been Virtually Served



- Most of the time, servers don't run at full capacity. That means there's unused processing power going to waste. It's possible to fool a physical server into thinking it's actually multiple servers, each running with its own independent operating system. The technique is called **server virtualization**. By maximizing the output of individual servers, server virtualization reduces the need for more physical machines.

Cloud Computing Applications



- Clients would be able to access their applications and data from anywhere at any time.
- It could bring hardware costs down.
- Corporations that rely on computers have to make sure they have the right software in place to achieve goals.
- Servers and digital storage devices take up space.
- Corporations might save money on IT support.
- If the cloud computing system's back end is a grid computing system, then the client could take advantage of the entire network's processing power.

Cloud Computing Concerns



Perhaps the biggest concerns about cloud computing are **security** and **privacy**.

- **Authentication**, authorization
- **Private Eyes Are Watching You**
 - There are a few standard [hacker](#) tricks that could cause cloud computing companies major headaches. One of those is called **key logging**. A key logging program records keystrokes. If a hacker manages successfully to load a key logging program on a victim's computer, he or she can study the keystrokes to discover user names and passwords. Of course, if the user's computer is just a streamlined terminal, it might be impossible to install the program in the first place.
- **Same As It Ever Was**
 - Cloud computing could turn home computers into simple terminal interfaces. In some ways, this is a step backward. Early computers included hardwired user terminals. Each terminal had a computer monitor and keyboard, but they only served as an interface to the main computer. There was no way to store information locally on a terminal.

Cloud Features & Benefits for Enterprises




- Highly virtualized and standardized infrastructures
- Massive scalability
- Fault tolerant & highly reliable
- Intra- & Inter-cloud load balance
- Instant application deployment
- Simplified, more efficient IT and application management
- Deliver more applications to large number of users
- Excellent service quality
- Higher utilization at reduced cost
- Time-to-market

Cloud Features & Benefits for Users

- Highly virtualized and standardized infrastructures
- Massive scalability
- Fault tolerant & highly reliable
- Intra- & Inter-cloud load balance
- Instant application deployment
- No need to install or update SW or HW; access from any browser
- Unlimited use
- Always on
- Access from anywhere
- Many services to choose from



Cloud Technologies

Technology	Key Feature	What's Missing
Grid Computing	Job scheduling across many machines	Difficult to administer; Lacks broad applicability of cloud computing
Virtualization 	Virtual machines decouple OS from hardware	Fail to fundamentally solve scale and reliability
IaaS Infrastructure-as-a-Service 	Computational infrastructure available for rent	Lacks security , vertical solutions,
SaaS Software-as-a-Service 	Application availability through the cloud	SaaS is an application on the cloud, not a cloud by itself
Utility Computing	Packaged computing, application, and storage sold as a service	Describes a business model, not a technology or architecture

<http://www.slideshare.net/andyandrews/cloud-computing-ppt>

Types of cloud:

- Public Cloud
- Private Cloud
- Hybrid Cloud



Public Cloud



- Public cloud allows the accessibility of systems and services easily to general public.
Eg: Amazon, IBM, Microsoft, Google, Rackspace etc.

Advantages of Public Cloud Model



- Low Cost
- Reliable
- Flexible
- Location Independent
- High Scalability

Disadvantages of Public Cloud Model



- Low security

In public cloud model, data is present off-site and resources are shared publicly. Hence it does not ensure the high level security.

- Less customizable

It is less customizable than private cloud.

Private Cloud



- The Private cloud allows the accessibility of systems and services within the organization. Private cloud is operated only within a particular organization. But it will be managed internally or by third party.

Advantages of Private Cloud Model



- **High security and privacy**
 - Private cloud resources are shared from distinct pool of resources and hence highly secured.
- **More Control**
 - Private clouds have more control on its resources and hardware than public cloud because it is accessed only within the boundary of an organization.

Disadvantages of Private Cloud Model



- **Restriction**
 - Private cloud is only accessible locally and it is very difficult to deploy globally.
- **More Cost**
 - Private cloud is having more cost than public clouds.
- **Inflexible price**
 - In order to fulfill demands, purchasing new hardware is very costly.
- **Less Scalability**
 - Private clouds are scaled only within capacity of internal hosted resources.

Hybrid Cloud



The Hybrid cloud is the mixture of public and private cloud. Non-critical activities are performed by public cloud while critical activities are performed by private cloud.

Advantages of Hybrid Cloud Model



- **Scalable**

- It provides both the features of public and private cloud scalability.

- **Flexible and secure**

- It provides secure resources because of private cloud and scalable resources because of public cloud.

Advantages of Hybrid Cloud Model



- Cost effective
- It is having less cost as compared to private cloud.

Disadvantages of Hybrid Cloud Model



- **Networking issues**

Networking becomes complex because of private and public cloud.

- **Security Compliance**

It is necessary to ensure that cloud services are compliant with the security policies of an organization.

PROS AND CONS OF CLOUD COMPUTING:



- **Advantages of Cloud Computing**

There are various advantages of cloud computing technology. The important advantages of cloud computing are given below.

- **Lower cost computer for users**
- **Lower IT infrastructure cost**
- **Fewer maintenance cost**
- **Lower Software Cost**
- **Instant software updates**
- **Increased computing Power**
- **Unlimited storage capacity**

PROS AND CONS OF CLOUD COMPUTING:



- **Disadvantages of Cloud Computing**

There are various disadvantages of cloud computing technology. The important disadvantages of cloud computing are given below.

- **Require a constant Internet Connection**
- **Require High Speed Internet connection**
- **Stored Data Might Not Be Secure**

Difference: Cloud and Web 2.0



Cloud Computing	Web 2.0
It is more specific and definite	Programming and business models
It is a way of searching through data.	It is sharing entire pieces of data between <u>different websites</u> .
Cloud computing is about computers.	Web 2.0 is about people.
The internet as a computing platform	Attempt to explore and explain the business rules of that platform
Google apps are considered in Cloud <u>computing</u> .	A web-based application is considered in Web 2.0.
It is a business model for hosting these <u>services</u> .	It is a technology which allows <u>webpages</u> to act as more responsive applications



Key challenges in cloud computing

- There are also many challenges involved in cloud computing, and if you're not prepared to deal with them, you won't realize the benefits. Here are six common challenges you must consider before implementing cloud computing technology.



Key challenges in cloud computing

- **Cost**
- **Service Provider Reliability**
- **Downtime**
- **Password Security**
- **Data privacy**
- **Vendor lock-in**



Key challenges in cloud computing

Cost

- Cloud computing itself is affordable, but tuning the platform according to the company's needs can be expensive. Furthermore, the expense of transferring the data to public clouds can prove to be a problem for short-lived and small-scale projects.
- Companies can save some money on system maintenance, management, and acquisitions. But they also have to invest in additional bandwidth, and the absence of routine control in an infinitely scalable computing platform can increase costs.



Key challenges in cloud computing

Service Provider Reliability

- The capacity and capability of a technical service provider are as important as price. The service provider must be available when you need them. The main concern should be the service provider's sustainability and reputation. Make sure you comprehend the techniques via which a provider observes its services and defends dependability claims.



Key challenges in cloud computing

Downtime

- Downtime is a significant shortcoming of cloud technology. No seller can promise a platform that is free of possible downtime. Cloud technology makes small companies reliant on their connectivity, so companies with an untrustworthy internet connection probably want to think twice before adopting cloud computing.



Key challenges in cloud computing

Password Security

- Industrious password supervision plays a vital role in cloud security. However, the more people you have accessing your cloud account, the less secure it is. Anybody aware of your passwords will be able to access the information you store there.
- Businesses should employ multi-factor authentication and make sure that passwords are protected and altered regularly, particularly when staff members leave. Access rights related to passwords and usernames should only be allocated to those who require them.



Key challenges in cloud computing

Data privacy

- Sensitive and personal information that is kept in the cloud should be defined as being for internal use only, not to be shared with third parties. Businesses must have a plan to securely and efficiently manage the data they gather.



Key challenges in cloud computing

Vendor lock-in

- Entering a cloud computing agreement is easier than leaving it. “Vendor lock-in” happens when altering providers is either excessively expensive or just not possible. It could be that the service is nonstandard or that there is no viable vendor substitute.
- It comes down to buyer carefulness. Guarantee the services you involve are typical and transportable to other providers, and above all, understand the requirements.
- Cloud computing is a good solution for many businesses, but it’s important to know what you’re getting into. Having plans to address these six prominent challenges first will help ensure a successful experience.

Cloud players



- Top 5 cloud players
- **#1 Microsoft**
- **#2 Amazon**
- **#3 IBM**
- **#4 Salesforce.com**
- **#5 SAP**

Deployment Models



- **Public Cloud**
- **Private Cloud**
- **Hybrid Cloud**
- **Community Cloud**

Public Cloud



- **Public Cloud** is a type of cloud hosting that allows the accessibility of systems & its services to its clients/users easily. Some of the examples of those companies which provide public cloud facilities are IBM, Google, Amazon, Microsoft, etc
- Public cloud is better suited for business purposes for managing the load. This type of cloud is economical due to the decrease in capital overheads.

The advantages of the Public cloud are:



- Flexible
- Reliable
- High Scalable
- Low cost
- Place independence

Some Disadvantages

- Less Secured
- Poor Customizable





Private Cloud

- **Private Cloud** also termed as 'Internal Cloud'; which allows the accessibility of systems and services within a specific boundary or organization. The cloud platform is implemented in a cloud-based secure environment that is guarded by advanced firewalls under the surveillance of the IT department that belongs to a particular organization. Private clouds permit only authorized users, providing the organizations greater control over data and its security. Business organizations that have dynamic, critical, secured, management demand based requirement should adopt Private Cloud.

The advantages of using private cloud are



- **Highly private and secured** - Private cloud resource sharing is highly secured.
- **Control Oriented-** Private clouds provide more control over its resources than public cloud as it can be accessed within the organization's boundary.



Disadvantages

- **Poor scalability** - Private type of clouds is scaled within internal limited hosted resources.
- **Costly** - As it provides secured and more features, so it's more expensive than a public cloud.
- **Pricing** - is inflexible; i.e., purchasing new hardware for up-gradation is more costly.
- **Restriction** - It can be accessed locally within an organization and is difficult to expose globally.



Hybrid Cloud

- **Hybrid Cloud** is another cloud computing type, which is integrated, i.e., it can be a combination of two or more cloud servers, i.e., private, public or community combined as one architecture, but remain individual entities
- Non-critical tasks such as development and test workloads can be done using public cloud whereas critical tasks that are sensitive such as organization data handling are done using a private cloud. Benefits of both deployment models, as well as community deployment model, are possible in a hybrid cloud hosting

Advantages of Hybrid Cloud Computing are:



- Flexible
- Secure
- Cost Effective
- Rich Scalable

Disadvantages of Hybrid Cloud are:



- Complex networking problem
- Organization's security Compliance

Community Cloud



- It is another type of cloud computing in which the setup of the cloud is shared manually among different organizations that belong to the same community or area. Example of such a community is where organizations/firms are there along with the financial institutions/banks. A multi-tenant setup developed using cloud among different organizations that belong to a particular community or group having similar computing concern.

Virtualization



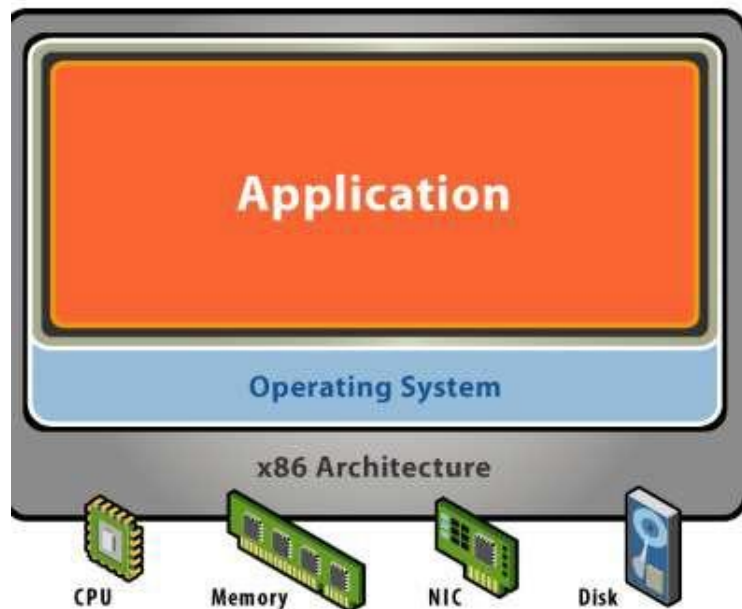
- The term '**Virtualization**' can be used in many respect of computer. It is the process of creating a virtual environment of something which may include hardware platforms, storage devices, OS, network resources, etc.
- Virtualization is the ability which allows sharing the physical instance of a single application or resource among multiple organizations or users. This technique is done by assigning a name logically to all those physical resources & provides a pointer to those physical resources based on demand.
- Over an existing operating system & hardware, we generally create a virtual machine which and above it we run other operating systems or applications. This is called Hardware Virtualization. The virtual machine provides a separate environment that is logically distinct from its underlying hardware. Here, the system or the machine is the host & virtual machine is the guest machine. This virtual environment is managed by a firmware which is termed as a **hypervisor**.



Virtualization

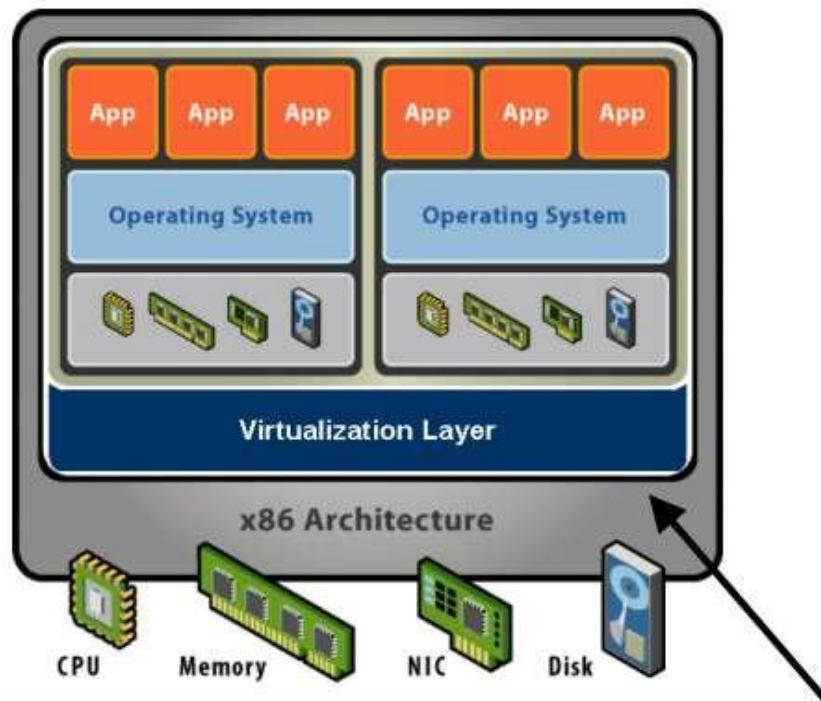
“a technique for hiding the physical characteristics of computing resources from the way in which other systems, applications, or end users interact with those resources. This includes making a single physical resource appear to function as multiple logical resources; or it can include making multiple physical resources appear as a single logical resource”

Starting Point: A Physical Machine



- Physical Hardware
 - Processors, memory, chipset, I/O devices, etc.
 - Resources often grossly underutilized
- Software
 - Tightly coupled to physical hardware
 - Single active OS instance
 - OS controls hardware

What is a Virtual Machine?



- Software Abstraction
 - Behaves like hardware
 - Encapsulates all OS and application state
- Virtualization Layer
 - Extra level of indirection
 - Decouples hardware, OS
 - Enforces isolation
 - Multiplexes physical hardware across VMs

Approaches or ways to virtualizes cloud servers.



- Grid Approach
- OS - Level Virtualization
- Hypervisor-based Virtualization
- Software virtualization
- Hardware virtualization
- Server virtualization

Virtualization



- **Grid Approach** - where the processing workloads are distributed among different physical servers, and their results are then collected as one.
- **OS - Level Virtualization** -Here, multiple instances of an application can run in an isolated form on a single OS
- **Hypervisor-based Virtualization**-With hypervisor's virtualization, there are various sub-approaches to fulfill the goal to run multiple applications & other loads on a single physical host

Virtualization



- **Hardware Virtualization** -It is the abstraction of computing resources from the software that uses cloud resources. It involves embedding virtual machine software into the server's hardware components. That software is called the hypervisor.

Virtualization



Three types of **hardware virtualizations**

- **Full Virtualization** - Here the hardware architecture is completely simulated. Guest software doesn't need any modification to run any applications
- **Emulation Virtualization** - Here the virtual machine simulates the hardware & is independent. Furthermore, the guest OS doesn't require any modification
- **Para-Virtualization** - Here, the hardware is not simulated; instead the guest software runs its isolated system

Software virtualization



- It is also called application virtualization
- Software virtualization is similar to that of virtualization except that it is capable to abstract the software installation procedure and create virtual software installation. Many applications & their distributions became typical tasks for IT firms and departments. The mechanism for installing an application differs.
- So virtualized software is **introduced in which an application that will be installed into its self-contained unit and provide software virtualization**. Some of the examples are **Virtual Box, VMware, etc**
- Benefits are **Ease of Client Deployment , Software Migration, Easy to Manage**

Server virtualization:



- In this process, the server resources are kept hidden from the user. This partitioning of physical server into several virtual environments; result in the dedication of one server to perform a single application or task.
- This technique is mainly used in web-servers which reduces the cost of web-hosting services. Instead of having separate system for each web-server, multiple virtual servers can run on the same system/computer.

Primary uses of server virtualization are:



- To centralize the server administration
- Improve the availability of server
- Helps in disaster recovery
- Ease in development & testing
- Make efficient use of server resources.

Cloud resource management



- **Critical function** of any man-made system.

It affects the **three basic criteria** for the evaluation of a system like:

- Functionality.
- Performance.
- Cost.



Scheduling

- **Scheduling** in a computing system deciding how to allocate resources of a system, such as CPU cycles, memory, secondary storage space, I/O and network bandwidth, between users and tasks.

Policies and mechanisms for resource allocation.

- Policy: principles guiding decisions.
- Mechanisms: the means to implement policies

Cloud resource management (CRM) policies



- 1. **Admission control:** prevent the system from accepting workload in violation of high-level system policies.
- 2. **Capacity allocation:** allocate resources for individual activations of a service.
- 3. **Load balancing:** distribute the workload evenly among the servers
- 4. **Energy optimization:** minimization of energy consumption
- 5. **Quality of service (QoS) guarantees:** ability to satisfy timing or other conditions specified by a Service Level Agreement

Dynamic resource allocation



- Cloud Computing environment can supply of computing resources on the basis of demand and when needed
- Managing the customer demand creates the challenges of on-demand resource allocation.
- Effective and dynamic utilization of the resources in cloud can help to balance the load and avoid situations like slow run of systems.
- Cloud computing allows business outcomes to scale up and down their resources based on needs.
- Virtual Machines are allocated to the user based on their job in order to reduce the number of physical servers in the cloud environment
- If the VM is available then job is allowed to run on the VM.
- If the VM is not available then the algorithm finds a low priority job taking into account the job's lease type.



There are three types

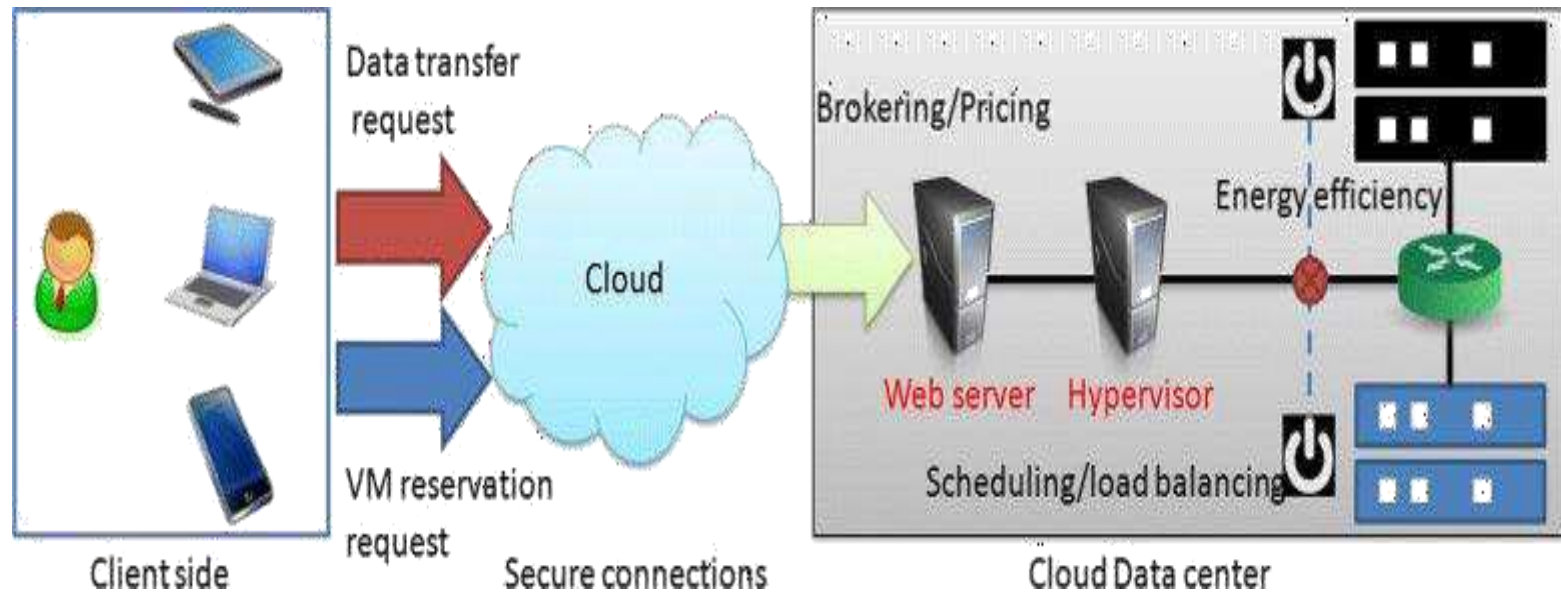
- Cancellable: These requests can be scheduled at any time after their arrival time
- Suspendable: Suspendable leases are flexible in start time and can be scheduled at any time after their ready time
- Non-Preemptable: The leases associated with such requests cannot be pre-empted at all.

Optimal allocation of cloud models



- The optimal allocation of computing resources is a core part for implementing cloud computing.
- High heterogeneity, high dynamism, and virtualization make the optimal allocation problem more complex than the traditional scheduling problems in grid system or cloud computing system.

Optimal allocation of cloud models



Quiz



- <https://forms.gle/yCP92iUP4D2nFjaK6>

UNIT II



- **CLOUD SERVICE MODELS**

UNIT 2 CLOUD SERVICE MODELS :



- Software as a Service (SaaS) - Infrastructure as a Service (IaaS)- Platform as a Service (PaaS)- Service Oriented Architecture (SoA) - Elastic Computing - On Demand Computing.

Software-as-a-Service (SaaS)



- Software-as-a-Service (SaaS) model allows to provide software application as a service to the end users. It refers to a software that is deployed on a host service and is accessible via Internet. There are several SaaS applications listed below:
- Billing and invoicing system
- Customer Relationship Management (CRM) applications
- Help desk applications
- Human Resource (HR) solutions

Characteristics



Here are the characteristics of SaaS service model:

- SaaS makes the software available over the Internet.
- The software applications are maintained by the vendor.
- The license to the software may be subscription based or usage based. And it is billed on recurring basis.
- SaaS applications are cost-effective since they do not require any maintenance at end user side.
- They are available on demand.
- They can be scaled up or down on demand.
- They are automatically upgraded and updated.
- SaaS offers shared data model. Therefore, multiple users can share single instance of infrastructure. It is not required to hard code the functionality for individual users.
- All users run the same version of the software.

Benefits of SaaS



Using SaaS has proved to be beneficial in terms of scalability, efficiency and performance.

Some of the benefits are listed below:

- Modest software tools
- Efficient use of software licenses
- Centralized management and data
- Platform responsibilities managed by provider
- Multitenant solutions