Unit – 1 Introduction to Cloud Computing

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Introduction

- Cloud is nothing but the computer services delivered online over the internet.
- When you store your data, photos online instead of on your own home computer or laptops or use webmail, or social networking site, you are actually using a cloud computing.
- If any organization uses the services which is not handled by itself but by some other third party and use it online, then it is cloud computing.
- Cloud services allow individuals and business to use software and hardware that are managed and handled by someone else at remote locations.

Introduction

- Some examples of cloud services are online file storage, social networking sites, webmail, online business applications.

- The symbols used to represent the internet is always cloud, thus the name is cloud computing.

Cloud Computing

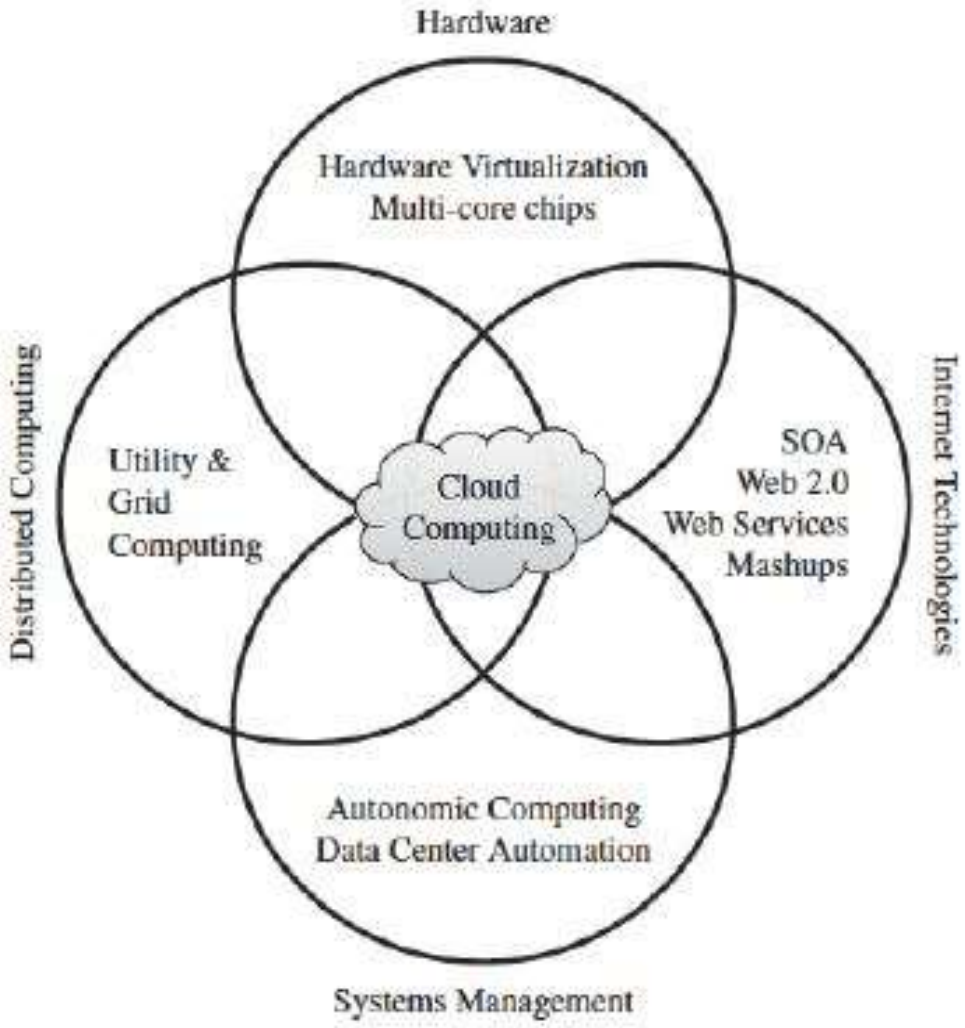
- Cloud computing also refers to the illusion of infinite computer resources.
- Cloud=Grid + Virtualization.
- Amazon, Google and Microsoft provides the cloud services.
- The main principle behind this model is offering computing, storage and software as a “service”.
- And they pay as you go.

Components of Cloud Computing

- Cloud computing solution is made of several elements:

1) Clients : They are the users who are going to use the services and manage their information using the interface. Like phone, laptop, desktop etc.
2) Data Center : It is the collection of servers where the application which are being used online are placed.
3) Distributed Servers : The servers are distributed at different locations so that failure of one cannot stop one to use cloud from another location.

Roots of Cloud Computing



Roots of Cloud Computing – Internet Technologies

- Service-oriented Architecture
  - SOA = Services + Messages
  - Every computer can run an arbitrary number of services, and each service is built in a way that ensures that the service can exchange information with any other service in the network without human interaction and without the need to make changes to the underlying program itself. Eg: You get a online bank statement.
- Web Services :- Web services can glue together applications running on different messaging product platforms, enabling information from one application to be made available to others, and enabling internal applications to be made available over the Internet.
- Web 2.0:- A tool to use who doesn't posses prog. Skills want to publish their content.
  - Ex. Facebook, Twitter, Blogs
- Mashups:- Combination of APIs
  - In facebook user can access the APIs of Google,Twitter etc.

Roots of Cloud Computing – Grid Computing

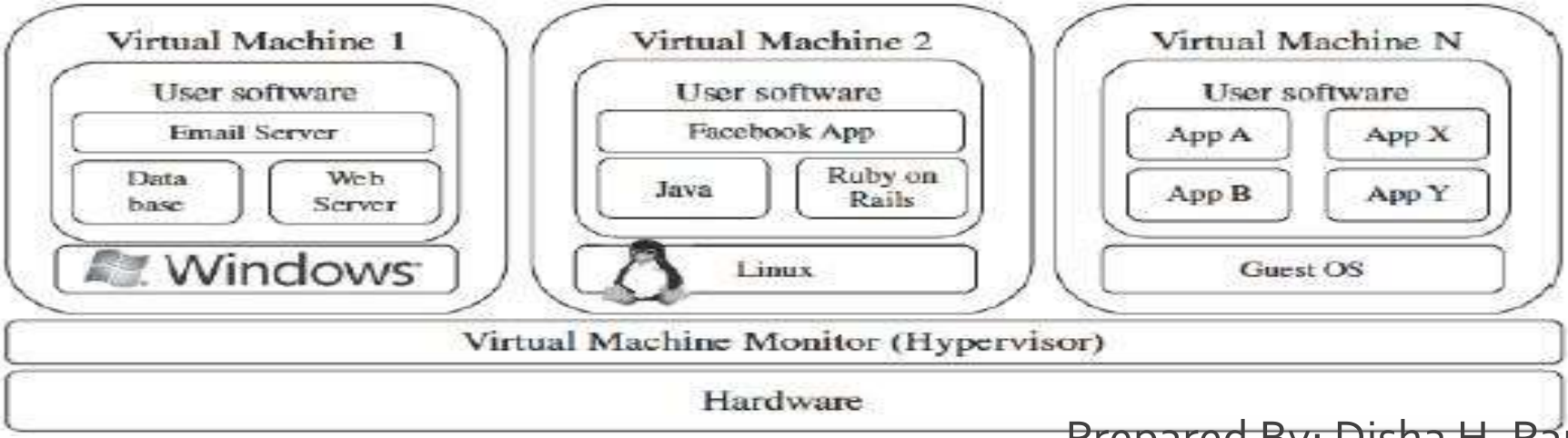
- Grid computing is the collection of computer resources from multiple locations to reach a common goal. The grid can be thought of as a distributed system with non-interactive workloads that involve a large number of files.
- Collection of distributed resources & transparently access to them.
- It is a Application Oriented.
- Globus Toolkit is a middleware that implements several Grid services.
- Parent of Cloud computing.
- Grid can be cloud but cloud cant be grid.
- When one node fails to perform, whole system fails miserably.

Roots of Cloud Computing – Utility Computing

- The utility computing Involves the renting of computer resources such as a hardware, software and network bandwidth on and when required.
- It is given based On demand.
- What we are considering as a product are treated as services in utility computing.
- It is more than business model rather than Technology.
- Example : AT&T, BSNL, Reliance.

Roots of Cloud Computing – Hardware Virtualization

- Virtualization of computer system resources, including processors and memory and IO devices, or OS.
- It hides physical attributes of computer from users and showing another abstract of computing platform.
- A software that control virtualization is called VMM(Virtual Machine Monitors)
- Guest Software.



Roots of Cloud Computing – Hardware Virtualization

- Hardware virtualization has following benefits:
  - Cost.
  - Reducing energy Consumption.
  - It is easily controlled and monitor.
  - Easy to Relocate.
  - Improvement in Security.
  - Better Reliability.
  - Better Performance.

Roots of Cloud Computing – Hardware Virtualization

- Hardware Virtualization is achieved thru VMM, and there are many VMM platforms. Most notably are:
  - VMWare ESXi – VMWare is pioneered in the virtualization market. Its ecosystem of tools ranges from server and desktop virtualization to high level management tools. ESXi is a VMM from VMWare. It is a bare-metal hypervisor, meaning that it installs directly on the physical server, whereas others may require a host operating system. It provides advanced virtualization techniques of processor, memory and I/O.
  - Xen – The Xen hypervisor started as an open-source project and has served as a base to other virtualization products both commercial and open-source. It has pioneered the para-virtualization concept, on which the guest operating system, by means of a specialized kernel, can interact with the hypervisor, thus significantly improving performance. In addition to an open-source distribution, Xen currently forms the base of commercial hypervisors of a number of vendors, most notably, Citrix XenServer and Oracle VM.
  - KVM – The Kernel-based Virtual Machine is a Linux virtualization subsystem. Is has been part of the mainline Linux Kernel since version 2.6.20, thus being natively supported by several distributions. In addition, activities such as memory management and scheduling are carried out by existing kernel features, thus making KVM simpler and smaller than hypervisors that take control of the entire machine.

Roots of Cloud Computing – Autonomic Computing

- Research Area.
- Where system improved by itself.
- No need of human involvement.
- Self managing ➔ Autonomic Computing.
- IBM's Autonomic Computing Initiative has contributed to define the four properties of autonomic systems:
  - Self configuration.
  - Self Optimization.
  - Self healing.
  - Self protection.
    - Egs: Sensors

Layers of Cloud

Web 2.0 Interfaces

Software as a Service

End user applications

Scientific applications

Office automation, Photo editing,

CRM, and Social Networking

Examples: Google Documents, Facebook, Flickr, Salesforce

Platform as a Service

Runtime Environment for Applications

Development and Data Processing Platforms

Examples: Windows Azure, Hadoop, Google AppEngine, Aneka

Infrastructure as a Service

Virtualized Servers

Storage and Networking

Examples: Amazon EC2, S3, Rightscale, vCloud

Layers of Cloud

- **Saas**
  - Software As A Service.
  - It is on the top of Cloud Stack, Service provided by this layer can be accessed by end user through web portals.
  - This reduces the burden of software maintenance and simplifies the development.
  - Advantages

    Simplicity of integration.

    Cost.

    Scalability.

  Disadvantages

    Security

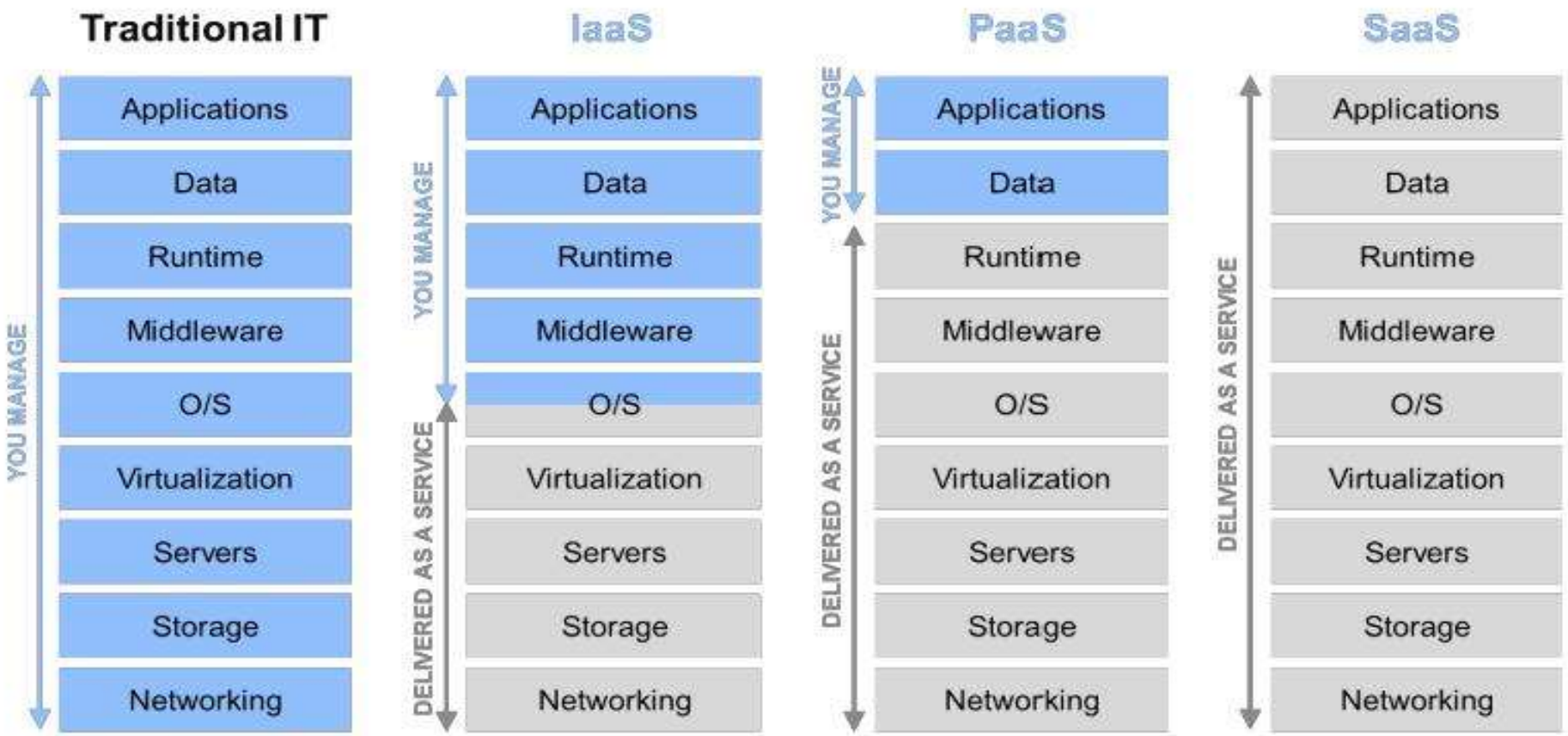
Layers of Cloud

- **Iaas**
  - Infrastructure As A Service
- Offering virtualized resources (computation, storage, and communication) on demand is known as Infrastructure as a Service (IaaS)
- It is considered to be at the bottom layer of the cloud computing systems.
- It provide servers, cloud based data storage etc.
  - But, a developers must install their own OS, Database software, Support Software.
  - Admin must manage both hardware & software.
  - Amazon AWS (Amazon Web Services) provides Iaas.

Layers of Cloud

- **PaaS**
- Platform as a service (PaaS) is a category of cloud computing services that provides a computing platform and a solution stack as a service.
- The provider provides the networks, servers, storage, and other services that are required to host the consumer's application service.
- Google AppEngine is the example of PaaS. It offers environment for developing and hosting web applications.

Layers of Cloud



Source: Microsoft.

Layers of Cloud

- All Saas, Paas, Iaas allow users to run applications & store data online.

Service Class	Main Access & Management Tool	Service content
 SaaS	Web Browser	**Cloud Applications** Social networks, Office suites, CRM, Video processing
 PaaS	Cloud Development Environment	**Cloud Platform** Programming languages, Frameworks, Mashups editors, Structured data
 IaaS	Virtual Infrastructure Manager	**Cloud Infrastructure** Compute Servers, Data Storage, Firewall, Load Balancer

Types of Cloud

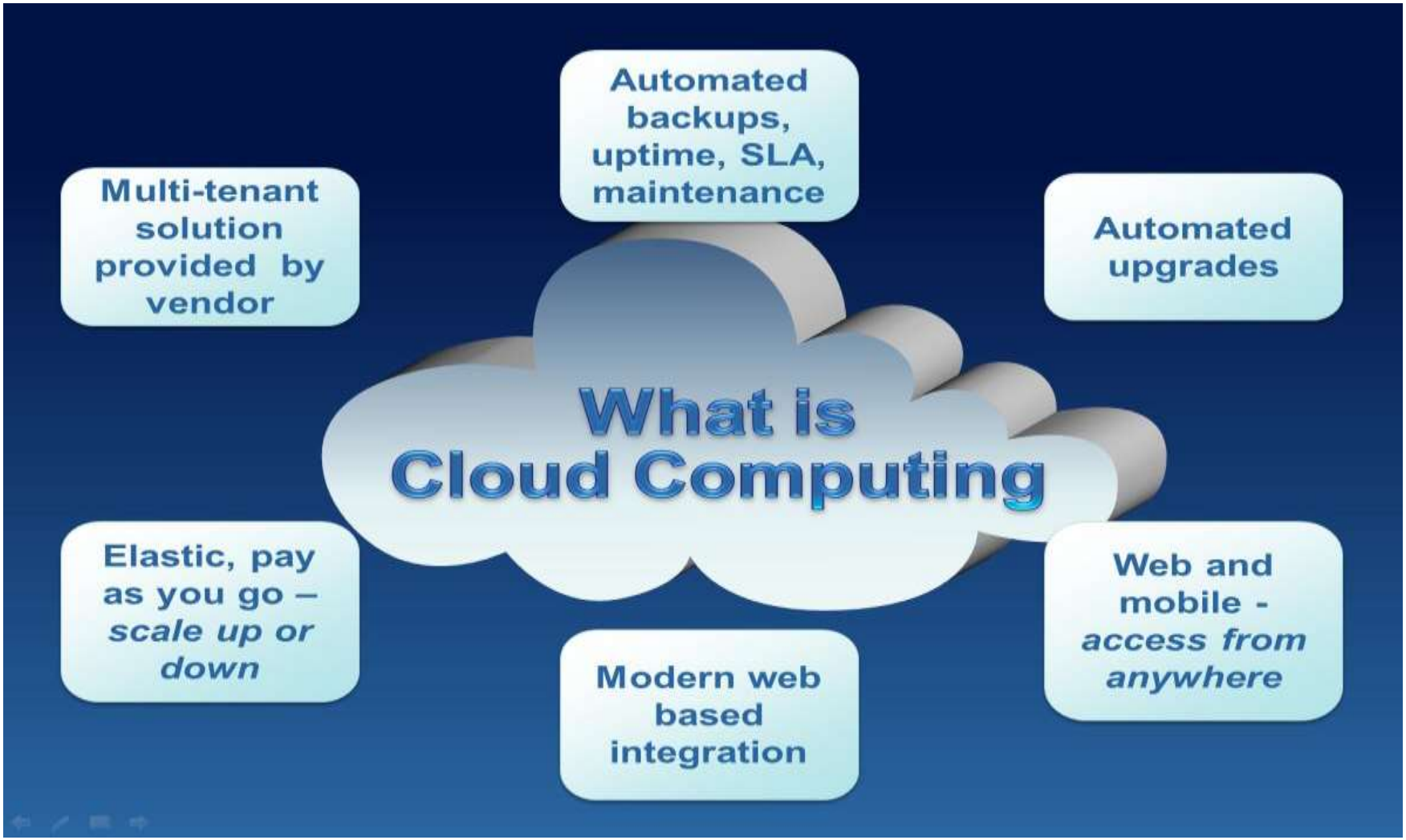
- *Public* : A public cloud is a model in which services such as application and storage are available for general use over the internet. They are offered on a pay-per-usage mode or other purchasing models.
- The infrastructure is hosted by the vendor at its premises and customer has no visibility or control.
  - Eg: Blue cloud bye IBM.
- *Private* : A private cloud is a virtualized data center that operates within the firewall. They are privately owned and managed. The infrastructure is dedicated to particular organization and not shared. They are more expensive and secure.

Types of Cloud

- *Hybrid* : It is a mix of public and private clouds. Organization host critical important applications at private and less secured concerns on public cloud.

- Community : It is a model or an infrastructure shared by a several organizations which support a specific community.
  - Eg: government organization within any state may share computing infrastructure on cloud to manage data related to citizens of the state

Desired Features



Cloud Infrastructure Management

- A key challenge IaaS providers face when building a cloud infrastructure is managing physical and virtual resources, namely servers, storage, and networks, in a holistic fashion
- Virtual Resource management is a issue in Iaas.
- Software toolkit for management of resources is called VIM(Virtual Infrastructure manager).
- This type of software resembles a traditional operating system—but instead of dealing with a single computer, it aggregates resources from multiple computers, presenting a uniform view to user and applications.
- These aggregate resources from multiple computers, present a uniform view to user.
- Two categories for managing clouds.
  - Cloud toolkits:-creating, controlling & monitoring virtual resources.
  - VIMs:-load balancing and server consolidation.

Cloud Infrastructure Management – Features of VIMs

- Virtualization support
  - Virtualized resources (CPUs, memory, etc.) can be sized and resized with certain flexibility. These features make hardware virtualization, the ideal technology to create a virtual infrastructure that partitions a data center among multiple tenants..
- Self service, On demand resource provisioning
  - This feature enables users to directly obtain services from clouds, such as spawning the creation of a server and tailoring its software, configurations, and security policies, without interacting with a human system administrator
- Multiple backend Hypervisors (VMM)
  - Different virtualization models & tools offer different benefits, drawbacks & limitations.

Cloud Infrastructure Management – Features of VIMs

- Storage virtualization
  - Virtualizing storage means abstracting logical storage from physical storage. By consolidating all available storage devices in a data center, it allows creating virtual disks independent from device and location.
- Virtual Networking
  - Virtual networks allow creating an isolated network on top of a physical infrastructure independently from physical topology and locations
- Dynamic Resource Allocation
  - Dynamically remapping VMs to physical machines at regular intervals.

Cloud Infrastructure Management – Features of VIMs

- Virtual clusters
  - Several VI managers can holistically manage groups of VMs. This feature is useful for provisioning and computing virtual clusters on demand, and interconnected VMs for multi-tier Internet applications
- Reservation & negotiation mechanism
  - When users request computational resources to be available at a specific time, requests are termed advance reservations (AR).
- High availability and data recovery
  - Minimize application downtime & preventing business disruption.

Challenges and Risks

- Security, Privacy and Trust
- Data Lock-In and standardization
  - They do not interoperate and user data are not portable.
- Availability, Fault-Tolerance, and Disaster Recovery (included in SLA)
- Resource Management and Energy-Efficiency
  - challenges such as detecting when to initiate a migration, which VM to migrate, and where to migrate.
  - Energy consumption is high.

Elastic Computing

- Elastic computing is nothing but a concept in cloud computing in which computing resources can be scaled up and down easily by the cloud service provider.
- Cloud service provider gives you provision to flexible computing power when and wherever required.
- The elasticity of these resources depends upon the following factors such as processing power, storage, bandwidth, etc.

Types of Elastic Computing

- Rather than various types, elastic computing have only one type i.e. Elasticity, or fully-automated scalability which removes manual labor for increasing or decreasing resources as everything is controlled by triggers by the system monitoring tools

Elasticity and Scalability Difference

- Scalability refers to the ability of system to accommodate larger loads just by adding resources either making hardware stronger (scale up) or adding additional nodes (scale out).
- Elasticity refers the ability to fit the resources needed to cope with loads, so that when load increase you scale up by adding more resources and when demand diminishes you shrink back and remove unneeded resources.

Elastic Cloud Computing - Advantages

- Cost Efficiency
- Convenience and Continuous Availability
- Backup and Recovery
- Cloud is environment friendly
- Scalability and Performance
- Increased Storage Capacity

Elastic Cloud Computing - Disadvantages

- Security and Privacy in the cloud
- Limited Control
- Dependency and Vendor Lock-in
- Increased Vulnerability

Utility Computing

- Utility computing is the process of providing computing service through an on-demand, pay-per-use billing method. Utility computing is a computing business model in which the provider owns, operates and manages the computing infrastructure and resources, and the subscribers accesses it as and when required on a rental or metered basis.

Utility Computing

- Utility computing is one of the most popular IT service models, primarily because of the flexibility and economy it provides.
- This model is based on that used by conventional utilities such as telephone services, electricity and gas.
- The principle behind utility computing is simple. The consumer has access to a virtually unlimited supply of computing solutions over the Internet or a virtual private network, which can be sourced and used whenever it's required.
- The back-end infrastructure and computing resources management and delivery is governed by the provider.

IaaS Providers – Amazon EC2

- Amazon Elastic Compute Cloud (Amazon EC2) provides scalable computing capacity in the Amazon Web Services (AWS) cloud.
- Using Amazon EC2 eliminates your need to invest in hardware up front, so you can develop and deploy applications faster.
- You can use Amazon EC2 to launch as many or as few virtual servers as you need, configure security and networking, and manage storage.
- Amazon EC2 enables you to scale up or down to handle changes in requirements or spikes in popularity, reducing your need to forecast traffic.

IaaS Providers – Amazon EC2 - Features

- Amazon EC2 provides the following features:
  - Virtual computing environments, known as instances
  - Preconfigured templates for your instances, known as Amazon Machine Images (AMIs), that package the bits you need for your server (including the operating system and additional software)
  - Various configurations of CPU, memory, storage, and networking capacity for your instances, known as instance types
  - Secure login information for your instances using key pairs (AWS stores the public key, and you store the private key in a secure place)
  - Storage volumes for temporary data that's deleted when you stop or terminate your instance, known as instance store volumes

IaaS Providers – Amazon EC2 - Features

- Persistent storage volumes for your data using Amazon Elastic Block Store (Amazon EBS), known as Amazon EBS volumes
- Multiple physical locations for your resources, such as instances and Amazon EBS volumes, known as regions and Availability Zones.
- A firewall that enables you to specify the protocols, ports, and source IP ranges that can reach your instances using security groups
- Static IPv4 addresses for dynamic cloud computing, known as Elastic IP addresses.
- Metadata, known as tags, that you can create and assign to your Amazon EC2 resources.
- Virtual networks you can create that are logically isolated from the rest of the AWS cloud, and that you can optionally connect to your own network, known as Virtual Private Clouds (VPCs).

PaaS Providers – Google App Engine

- Google App Engine (often referred to as GAE or simply App Engine) is a web framework and cloud computing platform for developing and hosting web applications in Google-managed data centers. Applications are sandboxed and run across multiple servers.[1] App Engine offers automatic scaling for web applications—as the number of requests increases for an application, App Engine automatically allocates more resources for the web application to handle the additional demand.

PaaS Providers – Google App Engine

- Google App Engine is free up to a certain level of consumed resources and only in standard environment but not in flexible environment.
- Fees are charged for additional storage, bandwidth, or instance hours required by the application.
- It was first released as a preview version in April 2008 and came out of preview in September 2011.

PaaS Providers – Google App Engine - Features

- Runtimes and Framework
- Reliability and Support
- Bulk Downloading
- Restrictions

PaaS Providers – Microsoft Azure

- Microsoft is a cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services through a global network of Microsoft-managed data centers.
- It provides software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS) and supports many different programming languages, tools and frameworks, including both Microsoft-specific and third-party software and systems.

PaaS Providers – Microsoft Azure

- Azure was announced in October 2008, started with codename "Project Red Dog", and released in February 1, 2010 as "Windows Azure" before being renamed "Microsoft Azure" on March 25, 2014

PaaS Providers – Microsoft Azure - Services

- Compute
- Mobile Services
- Storage Services
- Data Management
- Messaging
- Media Services