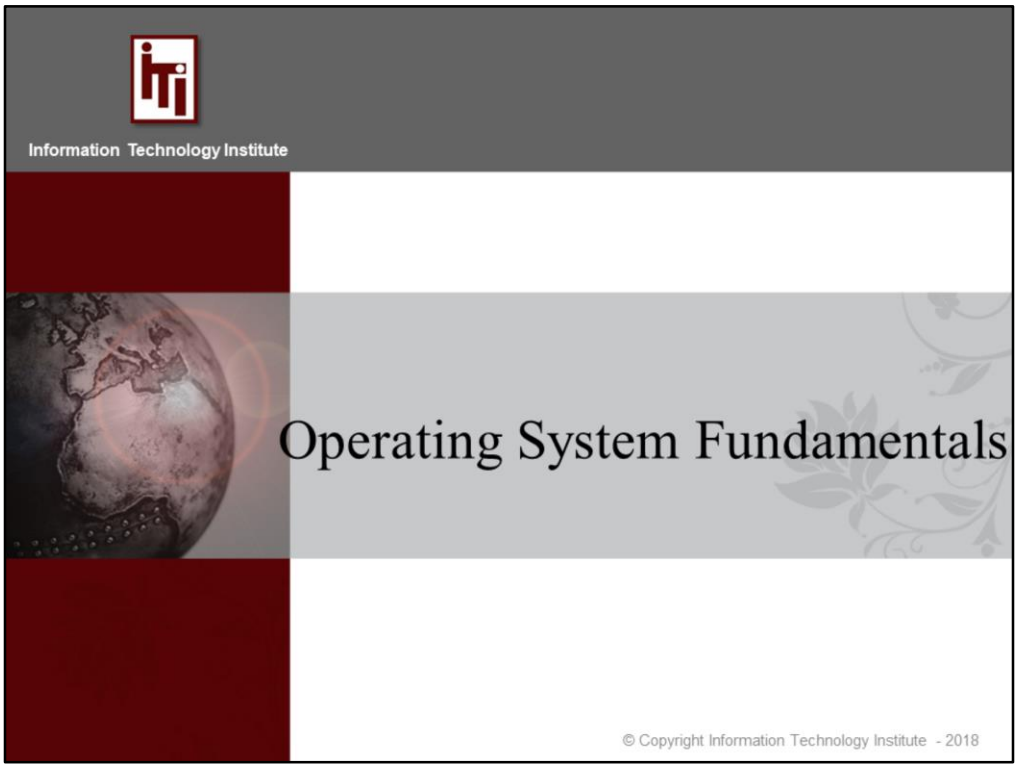
Information Technology Institute
Operating System Fundamentals
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CLOUD COMPUTING OVERVIEW

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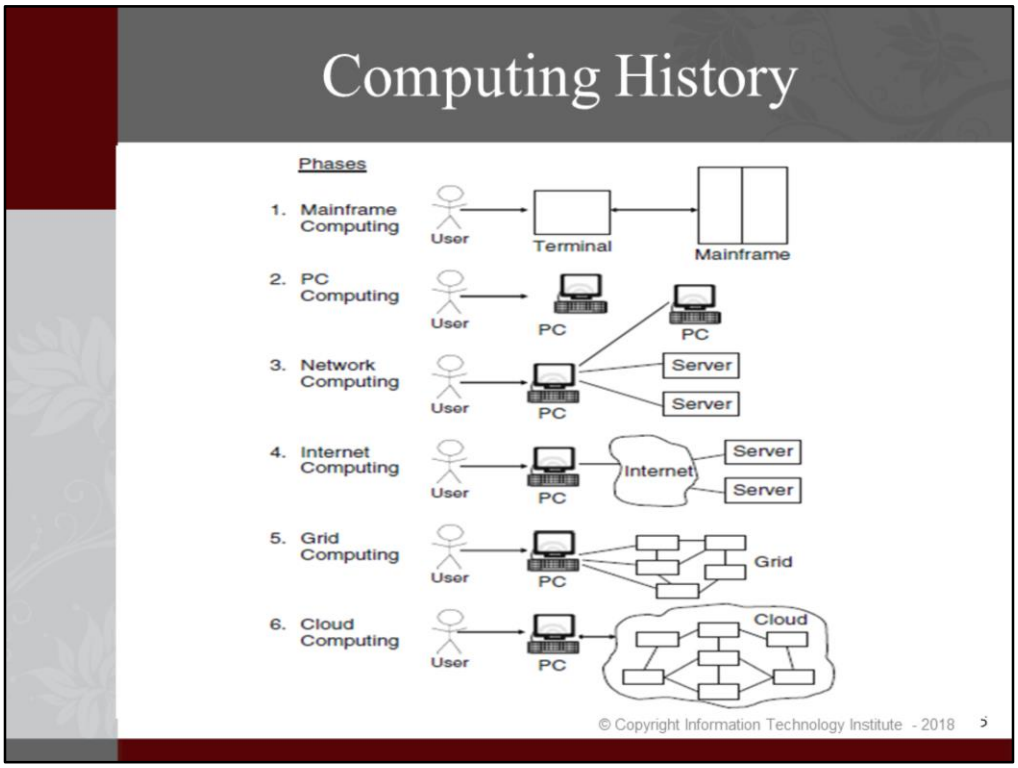
INTRODUCTION



In phase 1, many users shared powerful mainframes using dummy terminals.
In phase 2, stand-alone PCs became powerful enough to meet the majority of users' needs.
In phase 3, PCs, laptops, and servers were connected together through local networks to share resources and increase performance.
In phase 4, local networks were connected to other local networks forming a global network such as the Internet to utilize remote applications and resources.
In phase 5, grid computing provided shared computing power and storage through a distributed computing system.
At its most basic level, **grid computing** is a **computer** network in which each **computer's** resources are shared with every other **computer** in the system. Processing power, memory and data storage are all community resources that authorized users can tap into and leverage for specific tasks.
In other words: **Grid computing** is a **distributed** architecture of large numbers of **computers** connected to solve a complex problem. In the **grid computing** model, servers or personal **computers** run independent tasks and are loosely linked by the Internet or low-speed networks. **Computers** may connect directly or via scheduling systems.

In phase 6, cloud computing further provides shared resources on the Internet in a scalable and simple way.

Comparing these six computing paradigms, it looks like that cloud computing is a return to the original mainframe computing paradigm. However, these two paradigms have several important differences. Mainframe computing offers finite computing power, while cloud computing provides almost infinite power and capacity. In addition, in mainframe computing dummy terminals acted as user interface devices, while in cloud computing powerful PCs can provide local computing power and cashing support.

Cloud Computing History

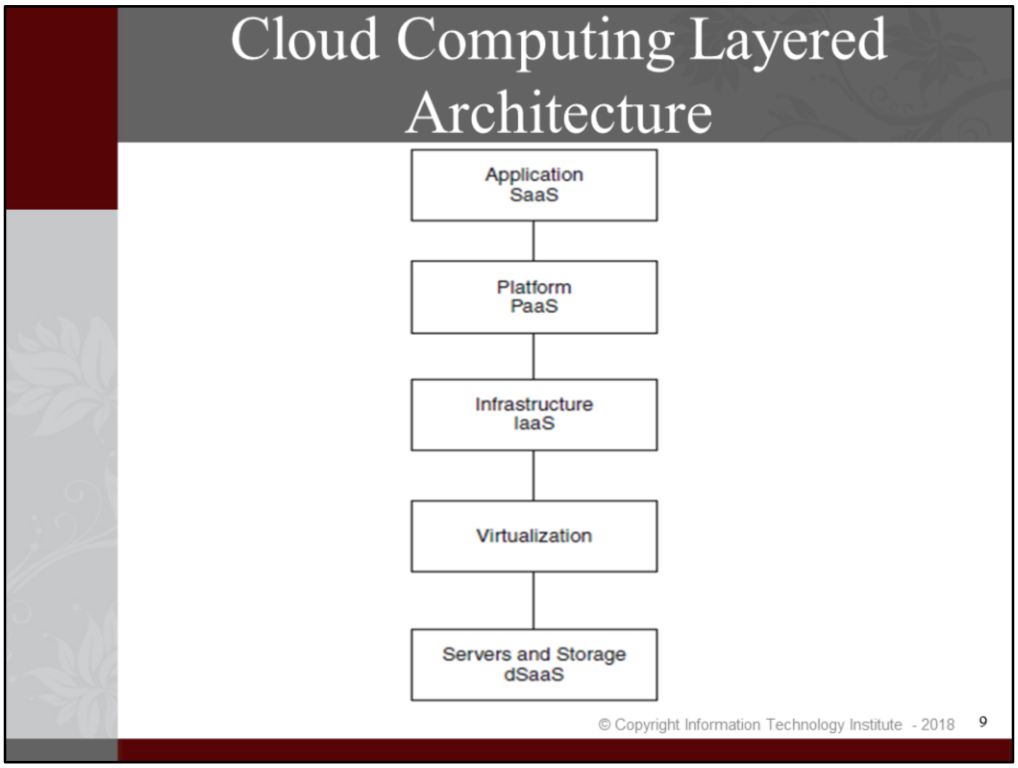
- Concept evaluated in 1950(IBM) called RJE (Remote Job Entry Process).
- In 2006 Amazon provided first public cloud AWS (Amazon Web Service).

What is Cloud?

- The term cloud refers to Network or Internet. Something that is present in at remote location.
- Cloud can provide
  - Services over network (on Public networks or on Private networks).
  - Applications such as email, web conferencing, customer relationship management (CRM)

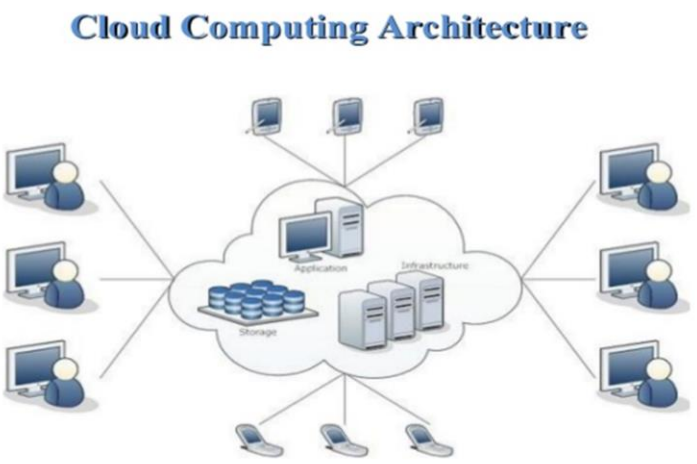
What is Cloud Computing?

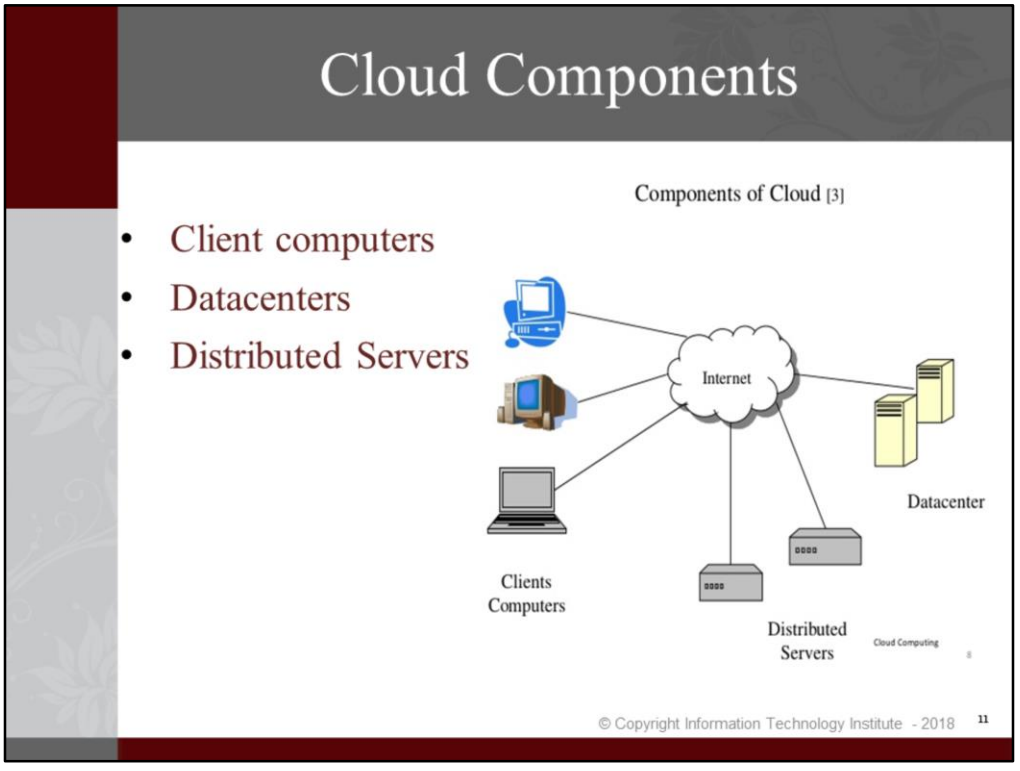
- Cloud computing can be defined as a new style of computing in which dynamically scalable and often virtualized resources are provided as a services over the Internet.
- Cloud computing refers to manipulating, configuring, and accessing the application online. It offers online data storage, infrastructure and application.
- Cloud computing is both combination of software and hardware based computing resources delivered as a network service.



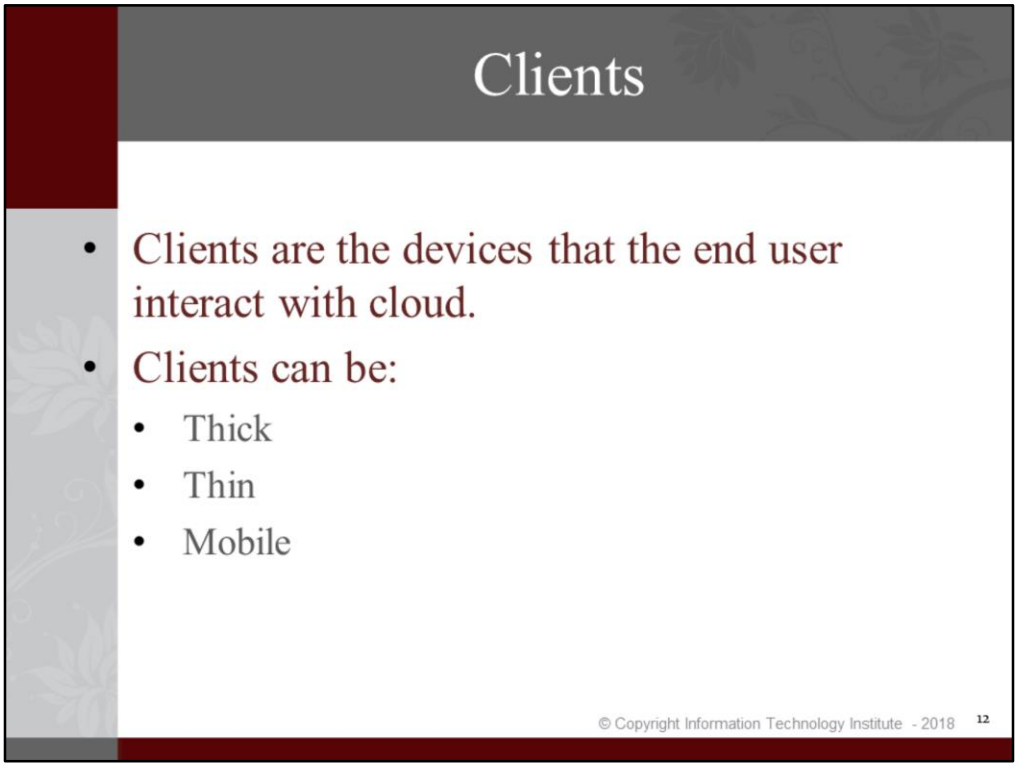
SaaS (Software-as-a-Service), which is shown on top of the stack. SaaS allows users to run applications remotely from the cloud.
Infrastructure-as-a-service (IaaS) refers to computing resources as a service. This includes virtualized computers with guaranteed processing power and reserved bandwidth for storage and Internet access.
Platform-as-a-Service (PaaS) is similar to IaaS, but also includes operating systems and required services for a particular application. In other words, PaaS is IaaS with a custom software stack for the given application.
The data-Storage-as-a-Service (dSaaS) provides storage that the consumer is used including bandwidth requirements for the storage.

Cloud Computing Architecture





The leading vendors of cloud computing components:
Computer hardware: Dell, HP, IBM, Sun
Storage: Sun, EMC, IBM
Infrastructure: Cisco, Juniper Networks, Brocade Communication
Computer software: 3tera. Eucalyptus. G-Eclipse. Hadoop
Operating systems: Solaris, AIX, Linux (Red Hat, Ubuntu)
Platform virtualization: Citrix, VMWare, IBM, Xen, Linux KVM, Microsoft, Sun xVM



A **fat client** (also called heavy, rich or **thick client**) is a computer (**client**) in **client**–server architecture or networks that typically provides rich functionality independent of the central server.

A **thin client** is a lightweight computer that is purpose-built for remoting into a server (typically cloud or desktop virtualization environments). It depends heavily on another computer (its server) to fulfill its computational roles.

Datacenter & Distributed Servers

- Datacenter is a collection of servers where applications is placed and is accessed via internet.
- Distributed Servers are in different places geographically, but they are working as if they are next to each other.

Central Server

- It administrates the system such as monitoring traffic, clients requests to ensure everything runs smoothly.
- It uses a special type of software called middleware.
- Middleware software allows computers to communicate with each other.

Models for Cloud Computing

- Deployment models
- Service models

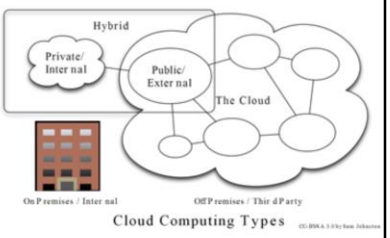
Deployment Models

- Deployment models define the type of access to the cloud.
- There are four types of access
  - Public
  - Private
  - Hybrid
  - Community

Deployment Models cont'd

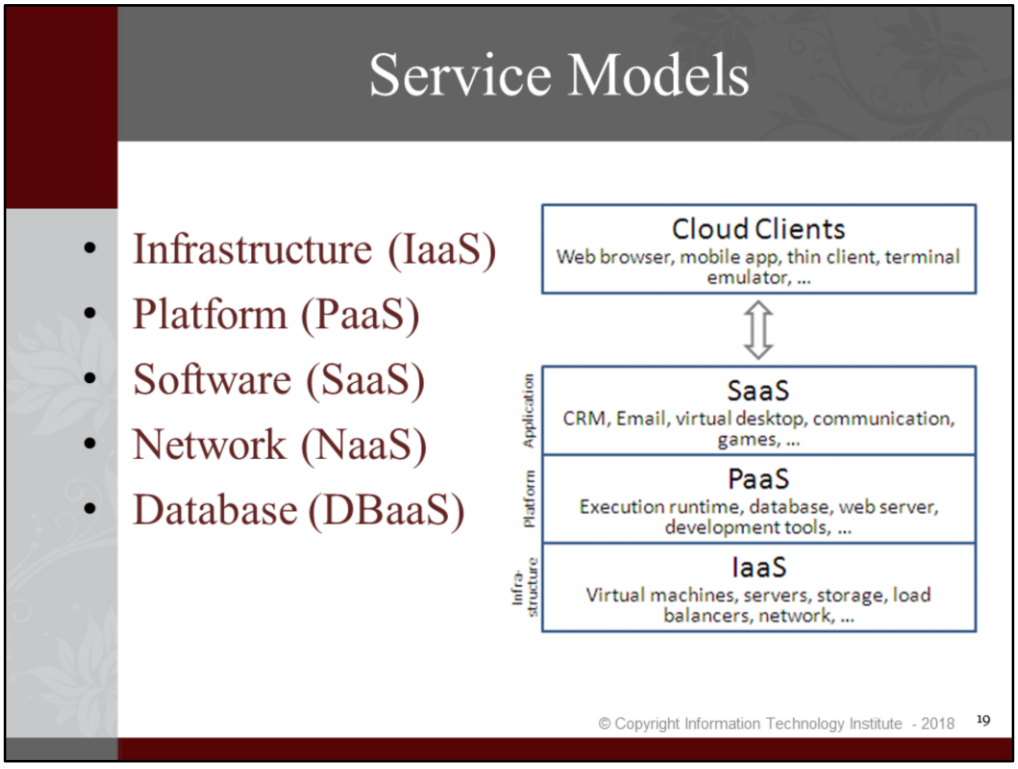
- Public cloud
  - It allows systems and services to be accessible to the general public.
  - It may be less secure due to its openness (email).
- Private cloud
  - It allows systems and services to be accessible within an organization
  - It is more secure due to its private nature

Deployment Models cont'd



Cloud Computing Types

- Hybrid cloud
  - It is a mixture of public and private cloud.
  - The critical activities are performed using private cloud while non critical activities are performed using public cloud.
- Community cloud
  - It allows systems and services to be accessible by a group of organizations



While many in the industry can debate the components, there are 11 major categories or patterns of cloud computing technology:
Storage-as-a-service
Database-as-a-service
Information-as-a-service
Process-as-a-service
Application-as-a-service
Platform-as-a-service
Integration-as-a-service
Security-as-a-service
Management/governance-as-a-service
Testing-as-a-service
Infrastructure-as-a-service

Storage-as-a-service (also known as disk space on demand), as you may expect, is the ability to leverage storage that physically exists at a remote site but is logically a local storage resource to any application that requires storage. This is the most primitive component of cloud computing and is a component or pattern that is leveraged by most of the other cloud computing components.
Database-as-a-service (DaaS) provides the ability to leverage the services of a remotely hosted database, sharing it with other users and having it logically

function as if the database were local. Different models are offered by different providers, but the power is to leverage database technology that would typically cost thousands of dollars in hardware and software licenses.

Information-as-a-service is the ability to consume any type of information, remotely hosted, through a well-defined interface such as an API. Examples include stock price information, address validation, and credit reporting.

Process-as-a-service is remote resource that can bind many resources together, such as services and data, either hosted within the same cloud computing resource or remotely, to create business processes. You can think of a business process as a meta-application that spans systems, leveraging key services and information that are combined into a sequence to form a process. These processes are typically easier to change than are applications and thus provide agility to those who leverage these process engines that are delivered on demand.

Application-as-a-service (AaaS), also known as software-as-a-service (SaaS), is any application that is delivered over the platform of the Web to an end user, typically leveraging the application through a browser. While many people associate application-as-a-service with enterprise applications such as Salesforce SFA, office automation applications are indeed applications-as-a-service as well, including Google Docs, Gmail, and Google Calendar.

Platform-as-a-service (PaaS) is a complete platform, including application development, interface development, database development, storage, testing, and so on, delivered through a remotely hosted platform to subscribers. Based on the traditional time-sharing model, modern platform-as-a-service providers provide the ability to create enterprise-class applications for use locally or on demand for a small subscription price or for free.

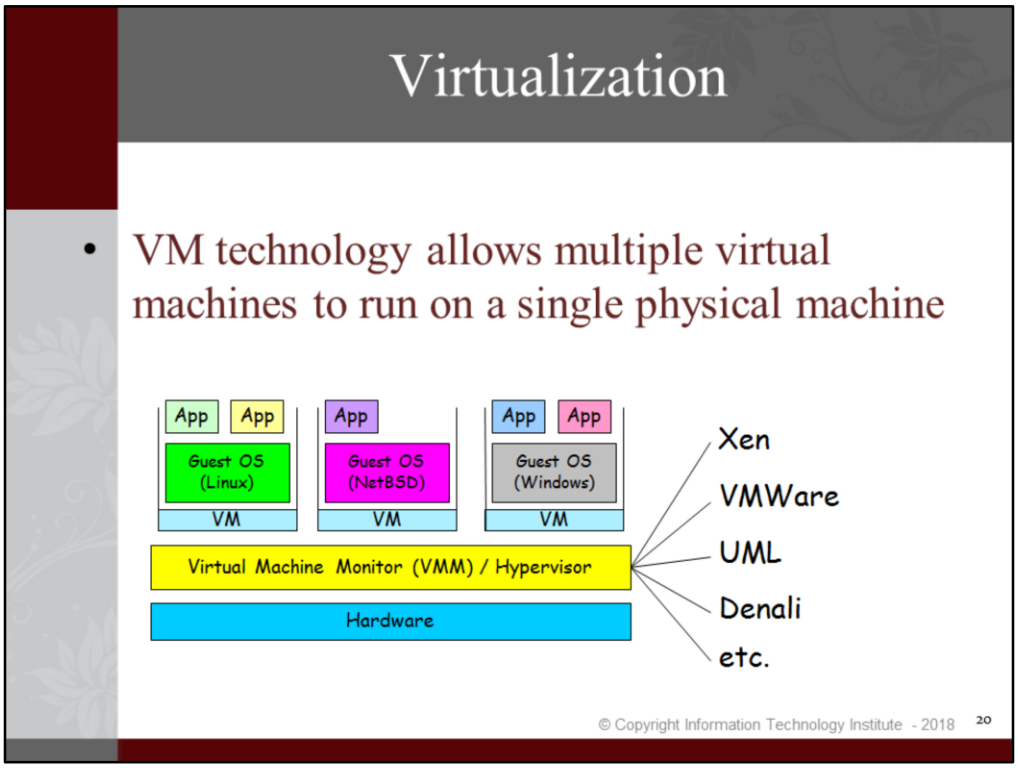
Integration-as-a-service is the ability to deliver a complete integration stack from the cloud, including interfacing with applications, semantic mediation, flow control, integration design, and so on. In essence, integration-as-a-service includes most of the features and functions found within traditional enterprise application integration (EAI) technology but delivered as a service.

Security-as-a-service, as you may have guessed, is the ability to deliver core security services remotely over the Internet. While the typical security services provided are rudimentary, more sophisticated services such as identity management are becoming available.

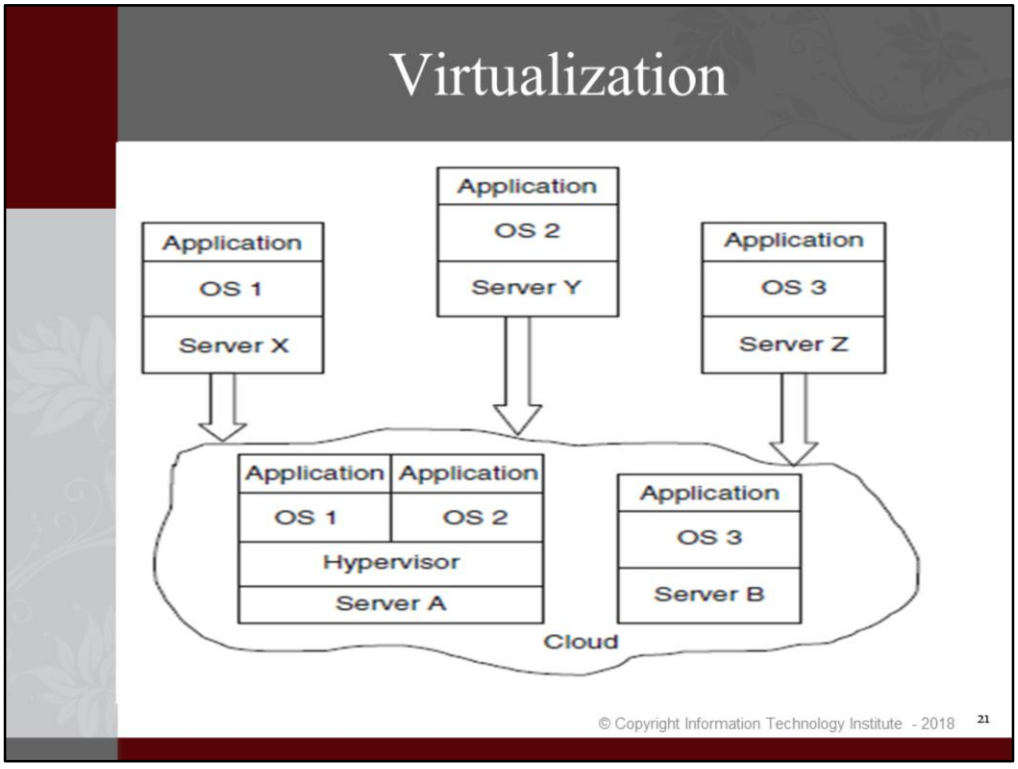
Management/governance-as-a-service (MaaS and GaaS) is any on-demand service that provides the ability to manage one or more cloud services. These are typically simple things such topology, resource utilization, virtualization, and uptime management. Governance systems are becoming available as well, offering, for instance, the ability to enforce defined policies on data and services.

Testing-as-a-service (TaaS) is the ability to test local or cloud-delivered systems using testing software and services that are remotely hosted. It should be noted that while

a cloud service requires testing unto itself, testing-as-a-service systems have the ability to test other cloud applications, Web sites, and internal enterprise systems, and they do not require a hardware or software footprint within the enterprise. ***Infrastructure-as-a-service (IaaS)*** is actually data center-as-a-service, or the ability to remotely access computing resources. In essence, you lease a physical server that is yours to do with as you will and, for all practical purposes, is your data center, or at least part of a data center. The difference with this approach versus more mainstream cloud computing is that instead of using an interface and a metered service, you have access to the entire machine and the software on that machine. In short, it is less packaged.

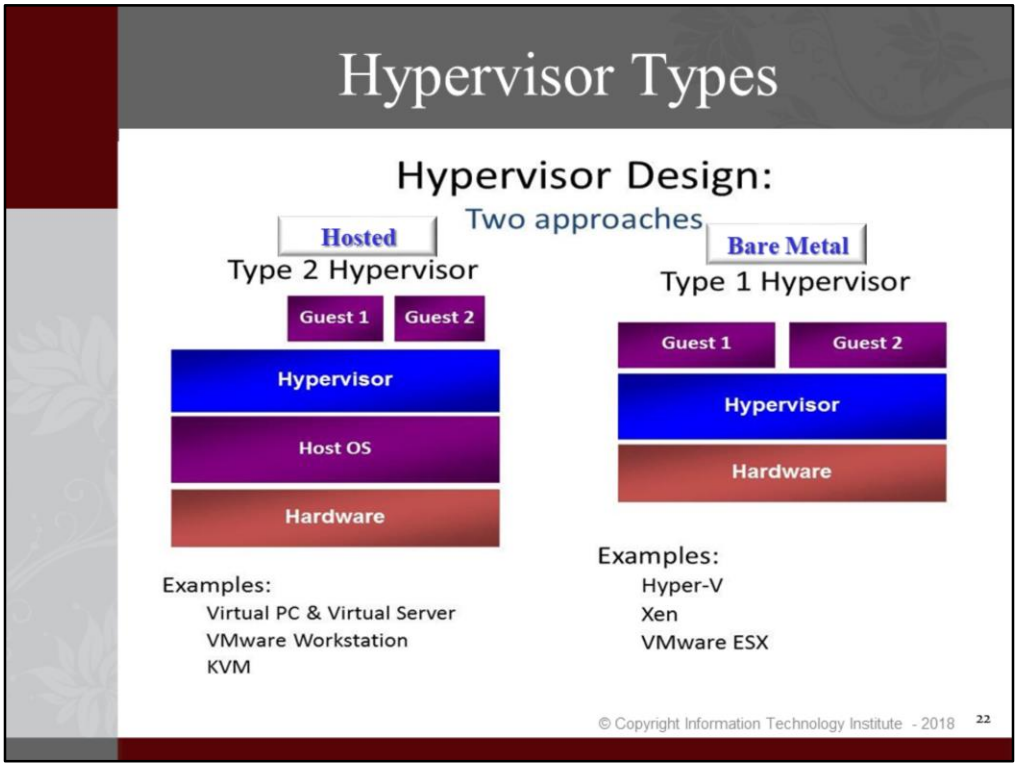


A **hypervisor** or virtual machine monitor (VMM) is a piece of computer software, firmware or hardware that creates and runs virtual machines. A computer on which a **hypervisor** runs one or more virtual machines is called a host machine, and each virtual machine is called a guest machine.



Virtual Machine is a completely separate individual operating system installation on your usual operating system. It is implemented by software emulation and hardware virtualization.

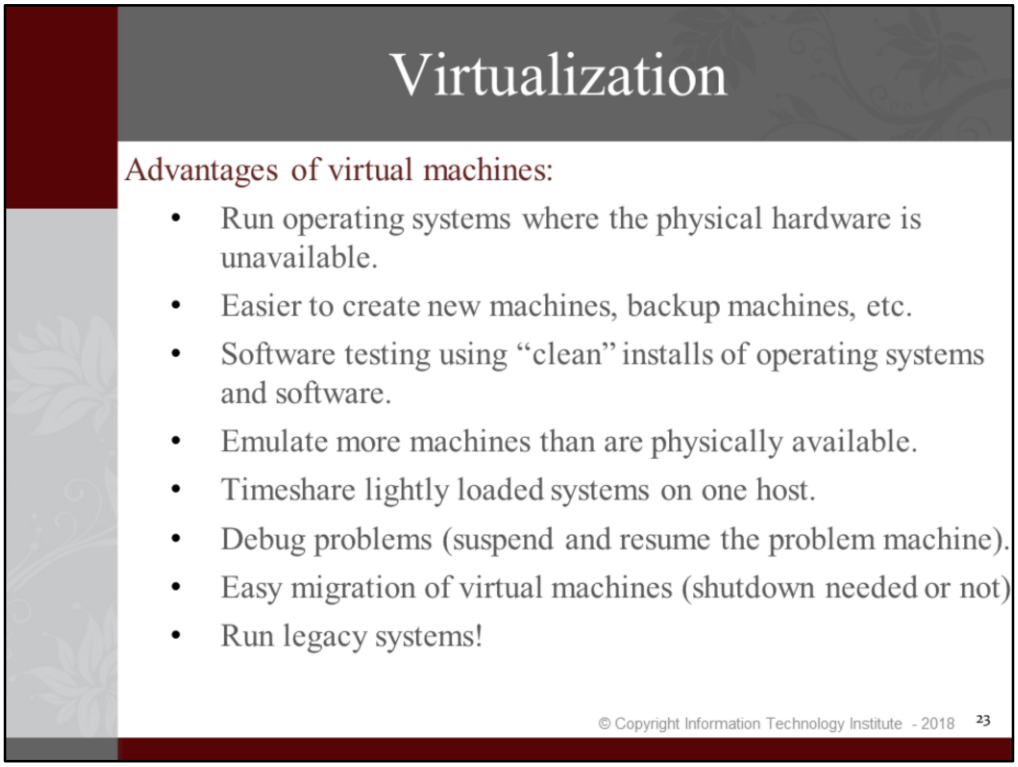
Virtual machine is a software implementation of a physical machine - computer - that works and executes analogically to it. Virtual machines are divided in two categories based on their use and correspondence to real machine: system virtual machines and process virtual machines. First category provides a complete system platform that executes complete operating system, second one will run a single program.



In a virtualization hypervisor comparison, the place to start is to understand the two types of hypervisors on the market, which are:

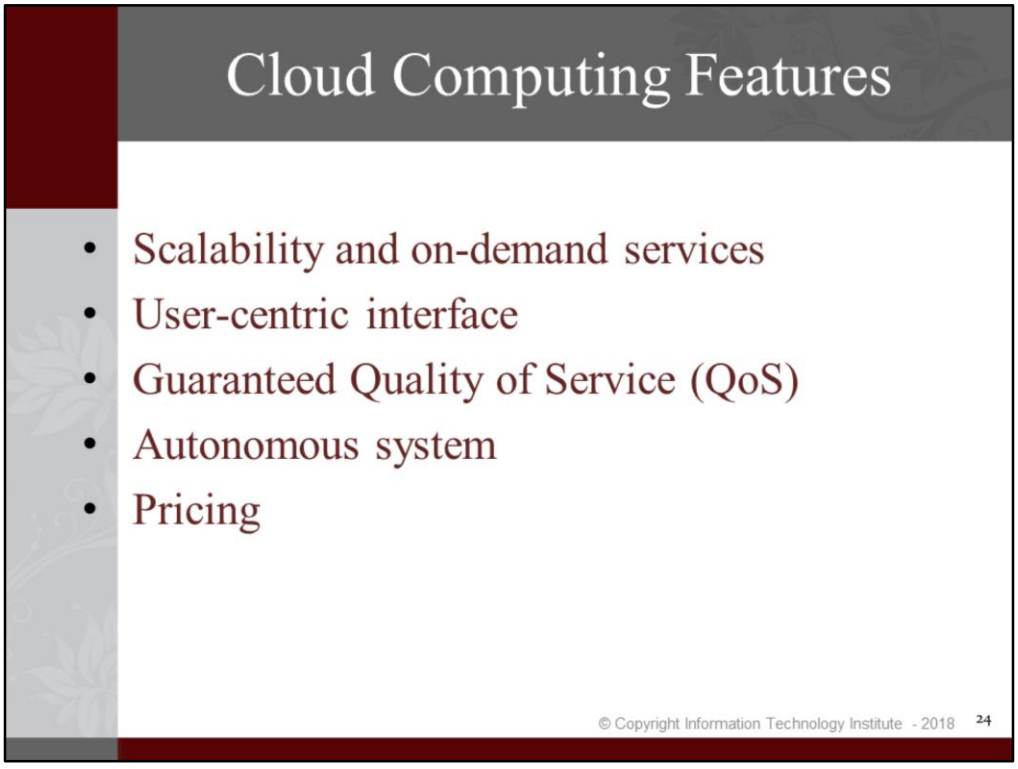
Type 1, which is considered a bare-metal hypervisor and runs directly on top of hardware.

Type 2, which operates as an application on top of an existing operating system.



Primary advantages of server virtualization
Reduce number of servers.
Reduce TCO.
Improve availability and business continuity.
Increase efficiency for development and test environments.
Improve availability of your virtual environment.
Assume a mixed virtual environment.

The main advantages of virtual machines:
Multiple OS environments can exist simultaneously on the same machine, isolated from each other;
Virtual machine can offer an instruction set architecture that differs from real computer's;
Easy maintenance, application provisioning, availability and convenient recovery.



• Scalability and on-demand services

Cloud computing provides resources and services for users on demand. The resources are scalable over several data centers.

• User-centric interface

Cloud interfaces are location independent and can be accesses by well established interfaces such as Web services and Internet browsers.

• Guaranteed Quality of Service (QoS)

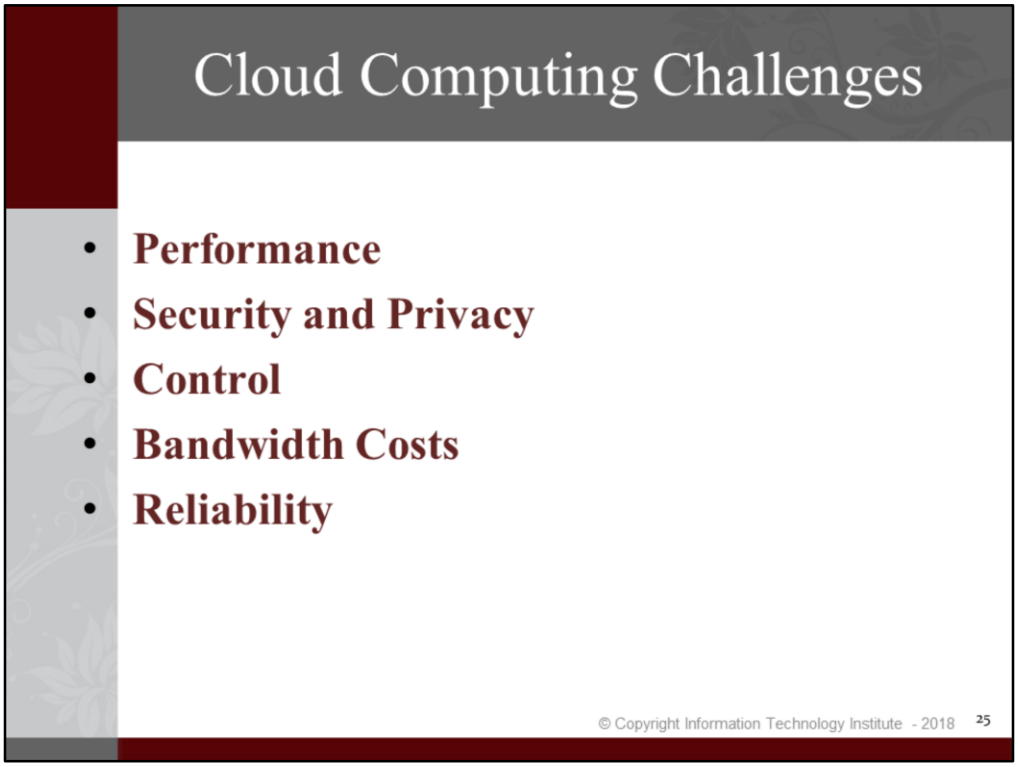
Cloud computed can guarantee QoS for users in terms of hardware/CPU performance, bandwidth, and memory capacity.

• Autonomous system

The cloud computing systems are autonomous systems managed transparently to users. However, software and data inside clouds can be automatically reconfigured and consolidated to a simple platform depending on user's needs.

• Pricing

Cloud computing does not require up-from investment. No capital expenditure is required. Users pay for services and capacity as they need them.



Performance:

The major issue in performance can be for some intensive transaction-oriented and other data-intensive applications, in which cloud computing may lack adequate performance. Also, users who are at a long distance from cloud providers may experience high latency and delays.

Security and Privacy:

Companies are still concerned about security when using cloud computing. Customers are worried about the vulnerability to attacks, when information and critical IT resources are outside the firewall. The solution for security assumes that that cloud computing providers follow standard security practices

Control:

Some IT departments are concerned because cloud computing providers have a full control of the platforms. Cloud computing providers typically do not design platforms for specific companies and their business practices.

Bandwidth Costs:

With cloud computing, companies can save money on hardware and software; however they could incur higher network bandwidth charges. Bandwidth cost may be low for smaller Internet-based applications, which are not data intensive, but could significantly grow for data-intensive applications.

Reliability:

There were cases where cloud computing services suffered a few-hours outages. In

the future, we can expect more cloud computing providers, richer services, established standards, and best practices.

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