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CLOUD COMPUTING

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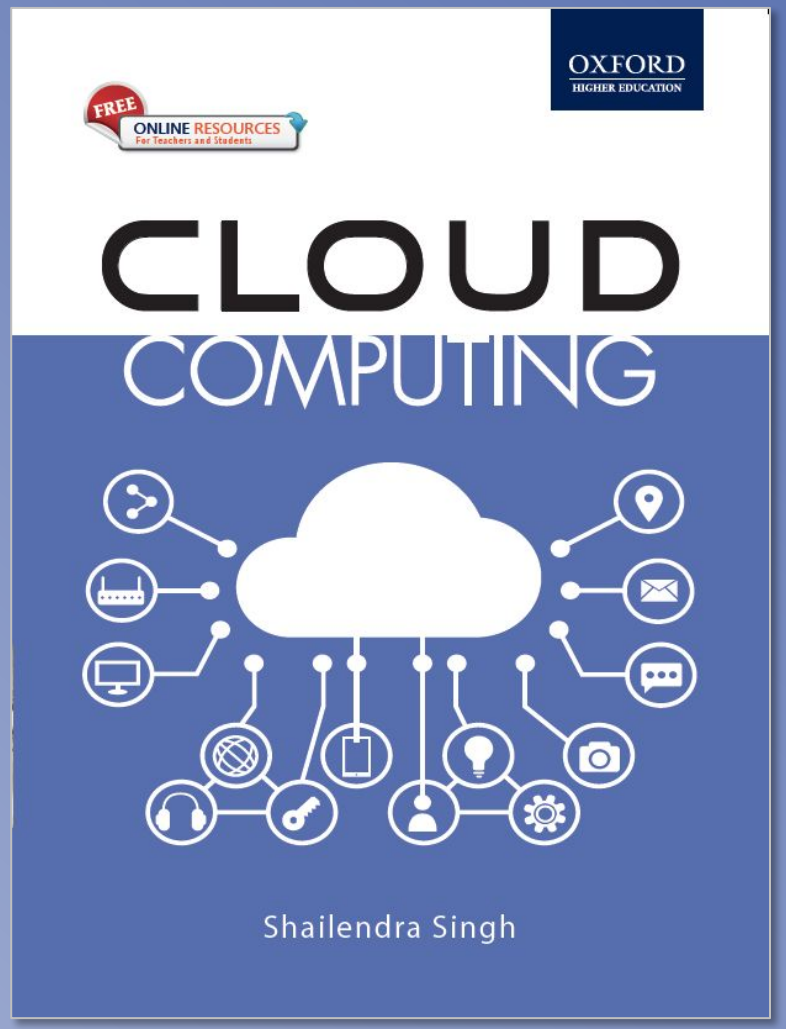

Chapter 1

Overview of Cloud Computing

Learning Outcomes

At the end of the session you will be able to:

- Define cloud computing
- Describe need of cloud computing
- Describe history of cloud computing
- Explain historical evolution of cloud computing
- Describe benefits of cloud computing
- Understand limitations of cloud computing
- Explain elastic computing
- Differentiate various vendors of cloud computing
- Distinguish traditional data center and cloud data center

Introduction

- Cloud computing is a technology which utilizes the Internet and central isolated servers in order to sustain applications and data.
- This technology permits much more proficient computing by consolidating bandwidth, processing, and storage memory.
- Cloud offers robust memory administration, thus there is no necessity to sustain memory on a personal system.

Definition of Cloud Computing

The term ‘cloud’ is defined by NIST [10] as follows:

- *“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. This cloud model is composed of five essential characteristics, three service models, and four deployment models.”*

Basic Structure of Cloud Computing

The basic structure of cloud computing is shown in Fig. 1.1. As given in the figure, facilities and services are offered by cloud providers in a cloud computing environment and different users from various locations and devices can request for specific services that are offered.

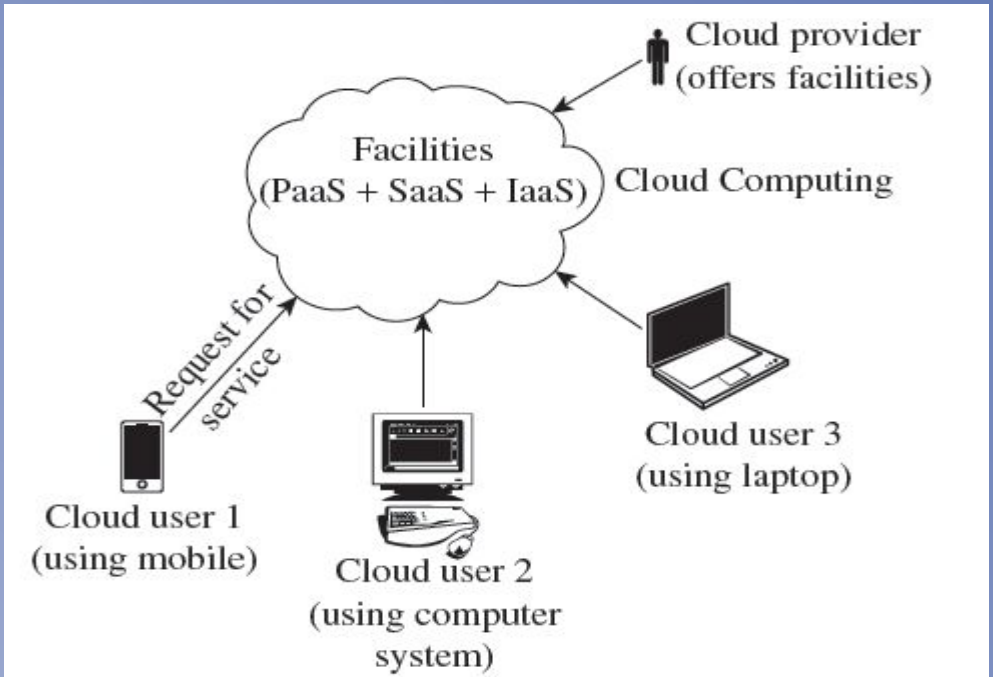

Fig. 1.1 Basic structure of cloud computing

Basic Structure of Cloud Computing

Some of the benefits of cloud computing are given here:

- It improves parallelism and allocation of resources for fast accessing.
- One may acquire software services, networked storage space, computer resources, and various other services at a single place.
- An additional company hosts a set of applications, get software renewals (with no charge), and so on.
- It improves monetary burden such as operational expenses, renewing charge, and capital expenses.

Cloud Resource Management

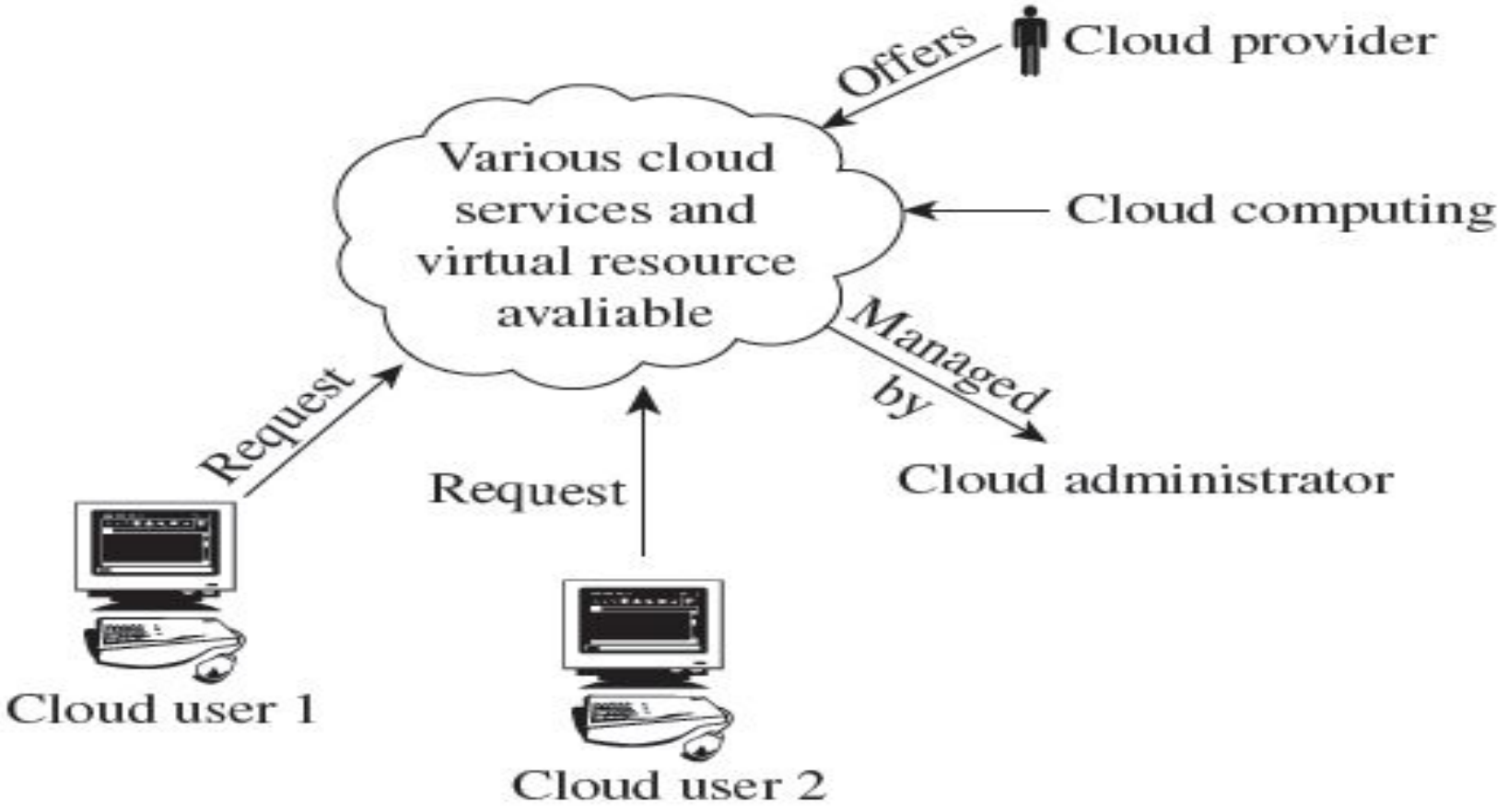

Fig. 1.2 Cloud resource management

Terminology used in Cloud Computing

Cloud consumer	An individual person or organization that sustains a business relationship with cloud providers and avails the services offered by the provider
Cloud provider	An individual person or organization who offers a service and is liable for the services of cloud computing to the parties that demand it
Cloud auditor	A party that conducts evaluation of cloud services, such as performance, operation on various systems, and security, among others
Cloud broker	The management between cloud providers and cloud consumers, like presentation and delivery of various services
Cloud carrier	The mediator responsible for connectivity and transport of cloud services from service providers to cloud consumers

Need of Cloud Computing

Cloud computing is a new trend in computing due to its many benefits:

- Reduced Costs
- Scalability
- Remote Access
- Disaster Relief
- Ease of Implementation
- Skilled Vendors
- Response Time
- Easy to Customize
- Virtual Provisioning
- Fully Automated Storage Tiering—FAST

Scaling Management in Cloud Computing

- One of the biggest advantages of cloud computing is that a business pays only for the services it avails.

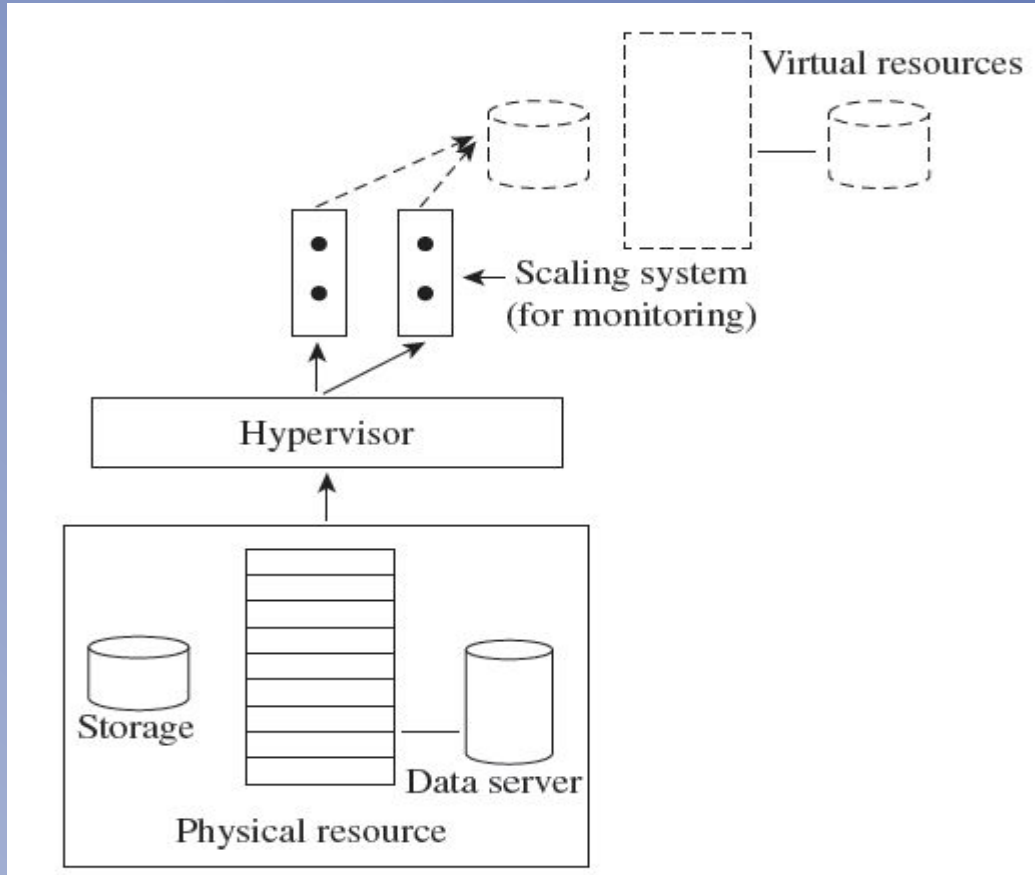

Fig. 1.3 Scaling management in cloud computing

History of Cloud Computing

The historical evolution of Cloud Computing is as follows:

- Client-Server Technology
- Peer-to-Peer Approach
- Distributed Computing
- Evolution of Cloud Computing from Grid Computing
- Autonomic Computing
- Platform Virtualization
- Service Oriented Architecture—SOA
- Utility Computing
- Web 2.0
- Parallel Computing

Client-Server Technology

- Client-Server is the technology behind cloud computing. It is shown in Fig. 1.4. In this, multiple computers perform collectively to augment computing power.
- The server is the prime regulator wherein software kept for access.
- The client is simply a tool which is associated with the user for facilitation.
- Due to inadequate processing power, IT employees neither acquire instant access nor can two users access similar data concurrently in client–server technology.

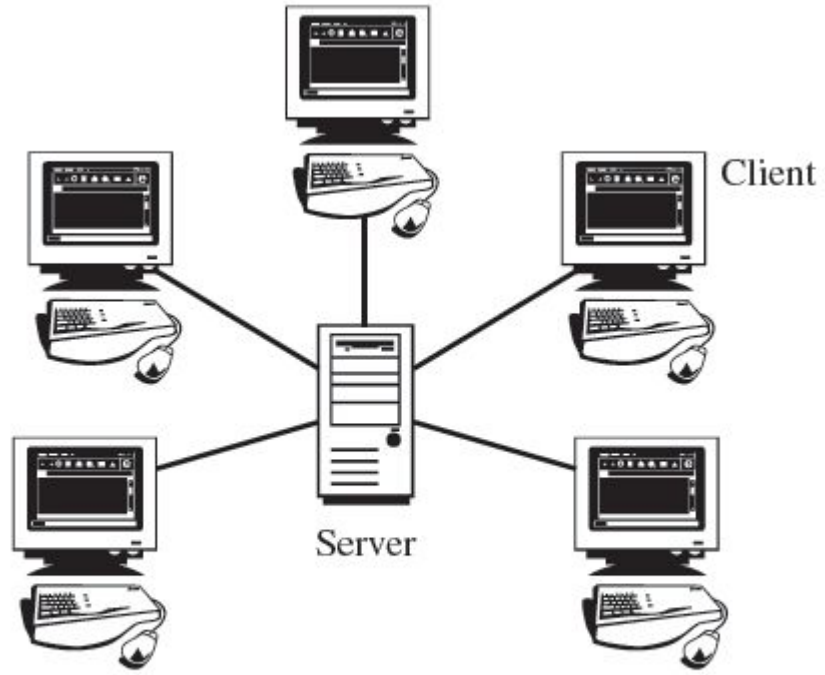

Fig. 1.4 Client-Server technology

Peer to Peer Approach

- Peer-to-Peer (P2P) is a decentralized approach and it encompasses no principal server. It is a design in which every computer has equal responsibilities and facilities.
- P2P facilitates straight swap of services and resources.
- This kind of network is not simple to manage.

Distributed Computing

- Distributed computing utilizes those idle resources that are not utilized for some reason or the other. Figure 1.5 shows distributed computing.

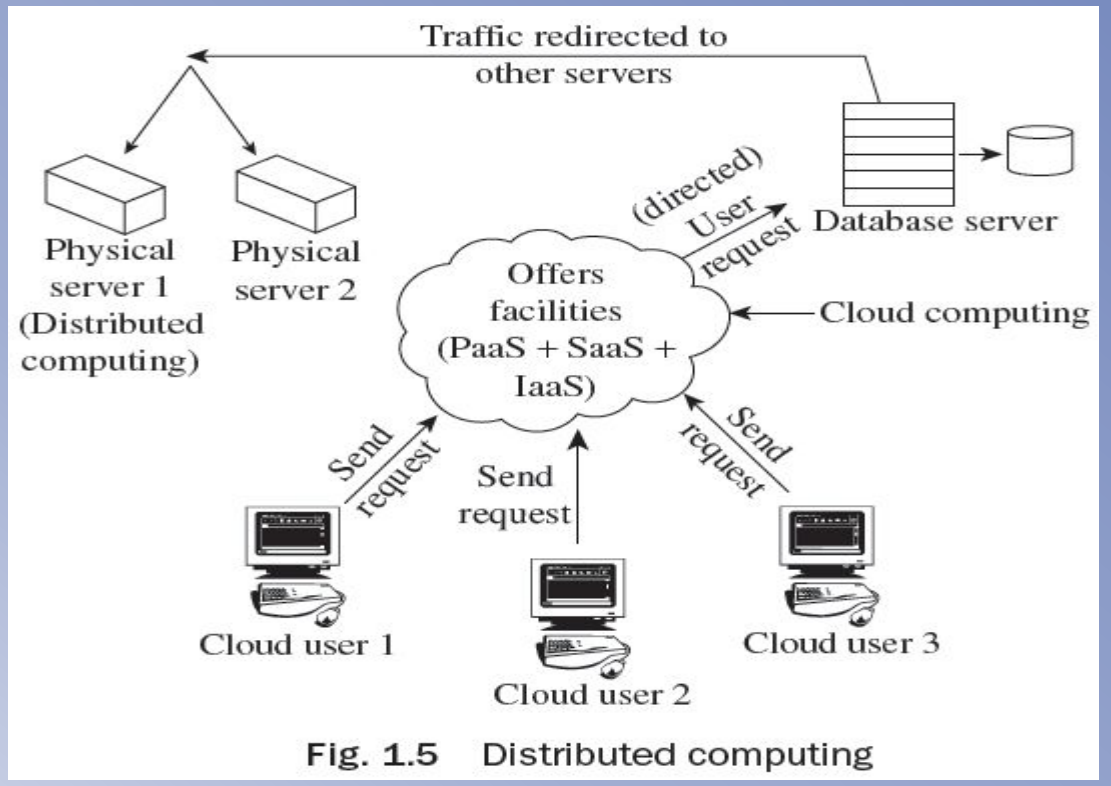

Fig. 1.5 Distributed computing

Evolution of Cloud Computing from Grid Computing

Table 1.2 Evolution of cloud computing from grid computing

Grid computing	Utility computing	Software as a Service	Cloud computing
Big crisis could be resolved with equivalent computing	Provided computing resources as metered services (disburses as per usage)	Beneficial in usage based payments to applications.	An Internet based computing offering services such as IaaS, PaaS, and SaaS.

Web 2.0

- Web 2.0 represents a change in technology in the world of the World Wide Web. It is usually designed to increase data security and customization of application as per the requirement with improved functionality.

The important features of Web 2.0 are as follows:

- Easy to access
- User interaction and participation
- Rich customization features
- Easy communication through video chatting, instant messaging facilities, etc.
- User-friendly writing tools and applications
- Data management and analysis
- Multimedia supporting tools
- Web application and hosting

Parallel Computing

- Parallel computing simultaneously uses various computing resources for solving a computational problem.
- It is based on the principle that a single large problem is divided into small parts and parallely runs different parts on different machines.
- Parallel computing supports applications that require processing of a large problem in a sophisticated way. Some of the examples are Big data problem, Data mining, Search engines, Medical diagnosis, Virtual reality, Multimedia.

Services Provided by Cloud Computing

- Electronic Faxing
- Voice on Clouds
- Commerce on Clouds
- Distributed Hosting on Clouds
- Accounting and Online Banking

News on Cloud Computing

- A mobile phone can be used to access services related to news.
- Google Apps or Gmail is capable of seeking information via e-mail, rapidly from any tool. We can talk and work with partners or consumers without any language barrier.
- Distribution and editing of data with trouble-free collaboration using Google items Docs and Sites. TripIt is a private travel that assists in arranging tours. Data is gathered from consumers and colleagues by using Google types. There is joint work on a general venture.
- Through Force.com, you may construct a scalable business application on the cloud platform. Both Google's cloud and salesforce.com computing platforms are employed to generate business and web applications.
- Using online patterns for presentations, spreadsheets, and records.
- Functioning steady, safe, and quick Web apps.
- Easily and firmly distributing video in apps through Youtube for Google apps.

Benefits of Cloud Computing

Cloud computing offers the following benefits:

- Pay as per use
- Reduced investment and proportional costs
- Accessibility from anywhere
- Increased scalability
- Increased availability and reliability
- Dynamic provisioning

Limitations of Cloud Computing

Some of the limitations of Cloud computing are:

- Availability of Services
- Data Lock-in
- Data Segregation
- Privilege Neglect
- Scaling Resources
- Data Location
- Deletion of Data
- Recovery and Backup
- Offline Clouds
- Unpredictable Performance

How to develop Cloud Computing

For the development of cloud infrastructure, the following are needed:

- Understanding the prevailing conventional data center
- Computing resources that will be virtualized
- Installing service administration devices

Core Components of Traditional Data Centers

- **Application** Program employed to carry out numerous computing functions. It may be an operating system, DBMS, and many more.
- **DBMS** It is an administration system which offers the ability to save or get data from rationally prepared tables.
- **Compute** Resources which work numerous applications using various elements.
- **Storage** This is used to save data for often use.
- **Network** It is the ability to communicate among systems. It assists us to share data and resources.

Vendors of Cloud Computing

- Amazon Web Services—IaaS
- Google—SaaS, PaaS
- Microsoft Azure Service Platform—PaaS
- Rackspace—Cloud Hosting
- Salesforce.com—SaaS, PaaS

Elastic Computing

- Elastic computing is the capability of a cloud service supplier to provision flexible computing strength when and where required.
- In cloud computing, elasticity is described as the level to which a system is capable of adapting to workload variation by offering and taking back resources the autonomic way; at every point in time the accessible resources meet the present need.

Social Networking

- Social networking may be done for business purposes, social purposes, or both.
- Examples of social networking include LinkedIn, Facebook, etc..
- A social networking website is an online podium which permits customers to build a public profile and interact with other users on the website.
- Some social networking websites like LinkedIn are used for creating professional links, whereas sites such as Facebook are on both sides of the line (i.e., professional and private).

Enterprise Cloud Computing

Enterprise cloud computing is the process of using cloud computing for saving cost and for business innovation by getting extraordinary speed and agility, and improved collaboration among customers and business partners. Enterprise cloud computing is important because:

- Cost of accessing data can be reduced to a great extent by linking it directly with the usage. Customers are charged on a pay-per-use basis.
- Start-ups can test out new business ideas risk-free and at low cost, due to enormous scalability. Since there is no upfront capital expense involved, in case a new project takes off, it can be scaled up instantly, and vice versa.

Enterprise Cloud Computing

- Enterprise cloud computing allows a company to create a shared workspace in order to collaborate with its trading partners and work together as a 'virtual enterprise network'. In this way, they can share the information and communication resources, without actually owning it all. This also helps in lowering costs. As shown in Fig. 1.9, an enterprise with *n* numbers of hosts can connect through cloud services and different types of services supported by cloud network such as database, servers, and various applications.

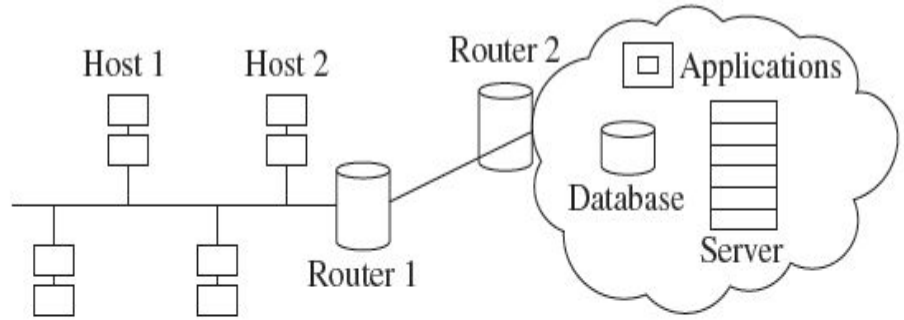

Fig. 1.9 Enterprise cloud computing

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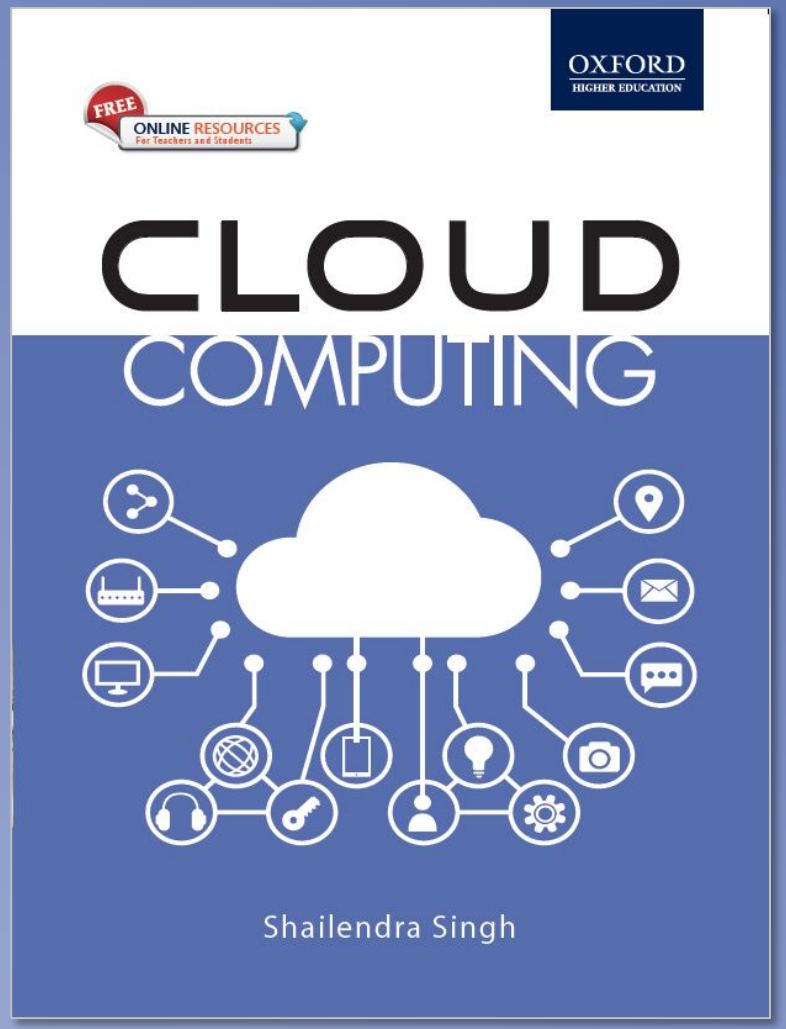

Chapter 2

Factors that Affect Cloud Computing

Learning Outcomes

At the end of the session you will be able to:

- Understand cloud data center requirements
- Describe architectural, technological, and operational influences on cloud computing
- Enlist issues in scalability of cloud architecture and applications
- Understand influences of cloud on various businesses
- Define autonomic computing
- Explain IT service management

Introduction

- Cloud computing is a technology which utilizes the Internet and central isolated servers in order to sustain applications and data.
- This technology permits much more proficient computing by consolidating bandwidth, processing, and storage memory.
- Cloud offers robust memory administration, thus there is no necessity to sustain memory on a personal system.

Cloud Data Center Requirements

A data center comprises the following areas:

- The first distribution area consists of various network equipment such as switches, routers, multiplexers, and firewalls.
- The second distribution area consists of network, storage, etc.
- The third area is that place where the actual rack cabinet is kept for computing and storage.

Architectural Influences of Cloud Computing

Cloud computing has been backed by architectural growth. They are:

- High-performance Computing
- Utility and Enterprise Grid Computing
- Autonomic Computing
- Service Consolidation
- Horizontal Scaling
- Web Services
- High-scalability Architecture

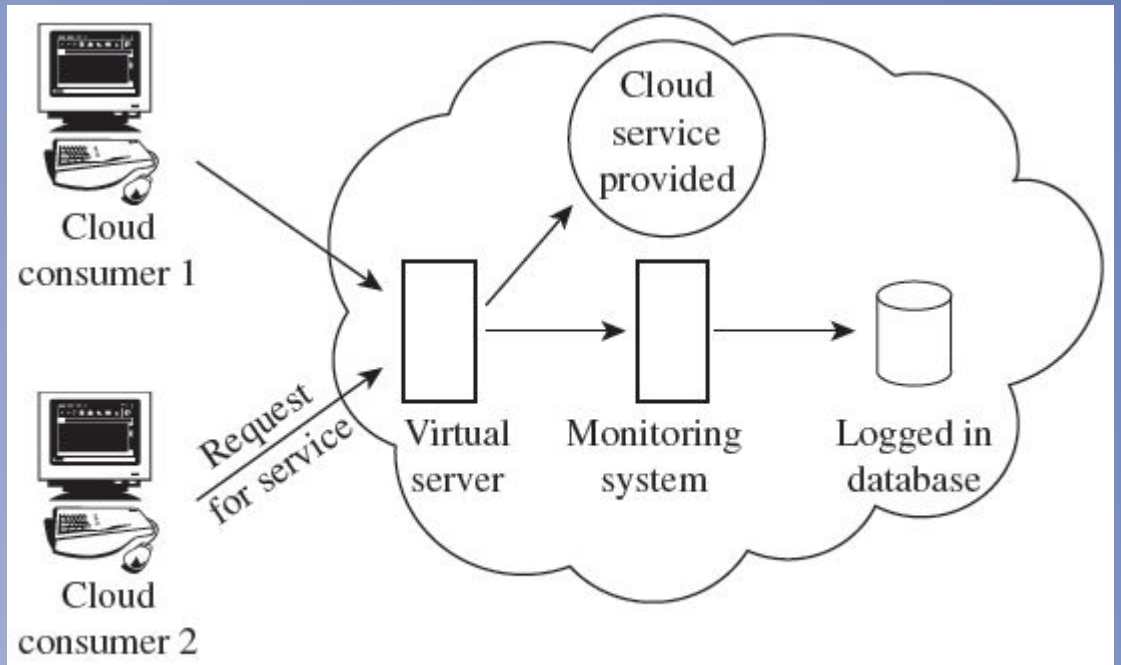

Fig. 2.1 Monitoring system of cloud computing

Horizontal and Vertical Scaling

Differences between horizontal scaling and vertical scaling:

Horizontal scaling	Vertical scaling
Less expensive	More expensive
Does not require extra downtime	More downtime required for replacement
Extra set-up not required	Extra set-up required
Supplementary IT resources required	Supplementary IT resources not required
Not restricted by hardware power	Restricted by hardware power

Horizontal and Vertical Scaling

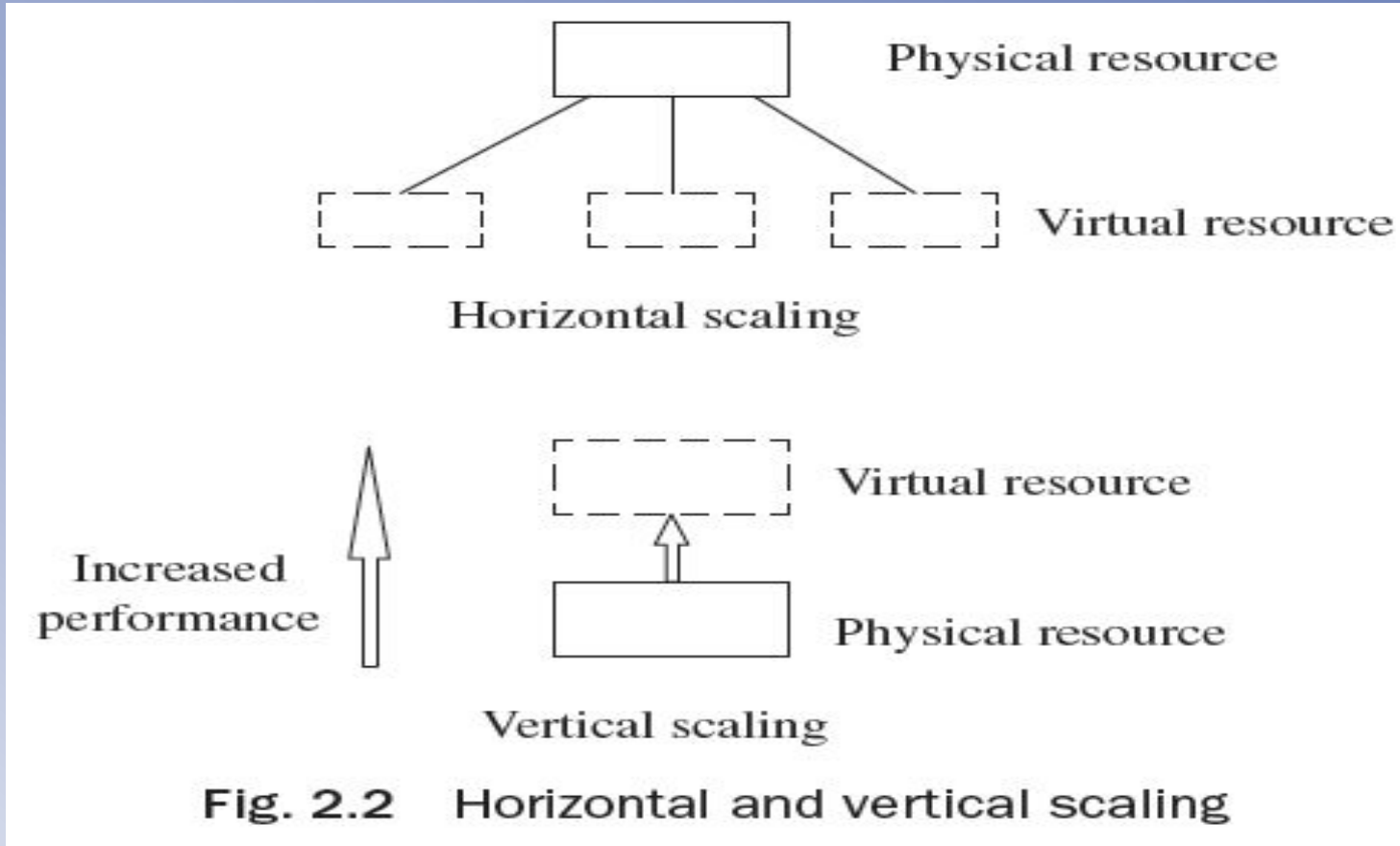

Fig. 2.2 Horizontal and vertical scaling

Challenges faced by an Application Developer in Developing Cloud Applications

- Lack of standardization
- Lack of extra programming support
- Debugging and development kits
- Metrics and best practices

Summary of different cloud service models

Service Model	Provider	Usage Target
SaaS	Google Gmail	Email
	XDrive	Storage
	Salesforce.com	CRM
	Smugmug	Data sharing
	MuxCLoud	Data processing
PaaS	Google App Engine	Web applications
	Azure	Enterprise applications, Web applications
	Heroku	Web applications
	Aneka	.Net Enterprise applications, Web applications
	Force.com	Enterprise applications
IaaS	GoGrid	Compute, Memory, Storage
	Amazon EC2	Compute, Memory, Storage
	Flexiscale	Compute, Memory, Storage
	Rockspace	Compute, Memory, Storage
	Eucaliptus	Compute, Memory, Storage

Design Patterns for Key Issues of Cloud Application Development

- The design patterns include:
  - **Scalability**
  - **Availability**
  - **Multi-Tenacity**
  - **High Performance**
  - **Rapid Elasticity**

Technological Influences of Cloud Computing

- Universal Connectivity
- Commoditization
- Open-source Software
- Virtualization

Operational Influences of Cloud Computing

- Consolidation
- Outsourcing
- Information Technology Service Management
- Automation

Influence of Cloud Computing on Business Companies

- Cloud computing with various advantages and tools affect many companies' working style and is discussed in detail in the following parameters:
  - **Business Alignment**
  - **Governance**

Influence of Cloud Computing on Business Companies

Business Alignment

A business alliance of all IT self-service applications, particularly console applications and enterprise intelligence, is vital for sustaining information quality, and is significant in the modern world of IT self service. The concentration of the IT team of a corporation transfers from running hardware assets and data center functions to handling the following responsibilities:

1. Recognizing enterprise policies, functioning metrics, drivers, market dynamics, purposes, and many more
2. Classifying trade definitions (business unit, department-level, etc.) and trade regulations

Influence of Cloud Computing on Business Companies

3. Forming a value-added information collection which links to the purposes and aims of a corporation
4. Assessing and predicting the realistic advantage of cloud computing applications
5. Recognizing modern challenges of risk administration in on-demand IT self-service

Influence of Cloud Computing on Business Companies

Governance

The following points are important to know how cloud computing affects control and governance on data stored, when you are a cloud user:

1. Process controls and process observation
2. Content secrecy and safety
3. Content consistency and master data management
4. Cloud computing capability maturity model (CMM)
5. Incorporating and running rising cloud computing IT models—SaaS, IaaS, and PaaS

Influence of Cloud Computing on Business Companies

- The cloud maturity module comprises 60 abilities which encapsulate the finest practices. Such abilities offer the feature mandatory to actually assess and direct the development of cloud proposals. There are six spheres in the maturity model:

- **Business and strategy**
- **Architecture**
- **Infrastructure**
- **Information**
- **Projects, portfolios, and services**
- **Operations, administration, and management**

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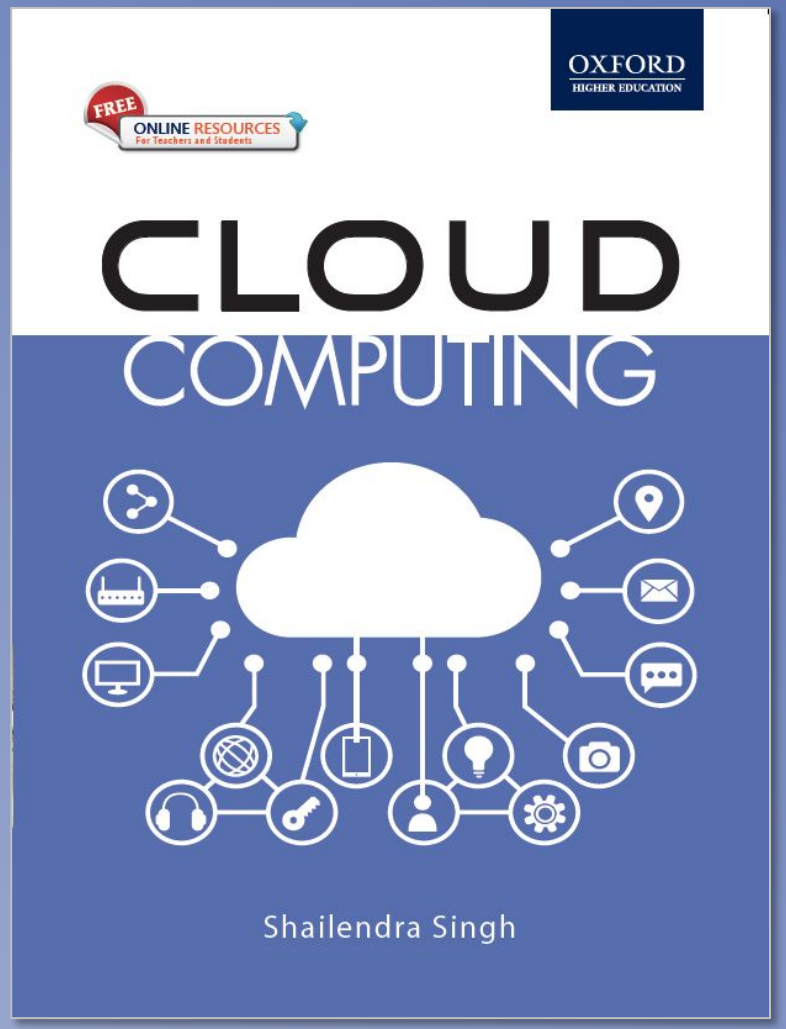

Chapter 3

Cloud Computing Architecture

Learning Outcomes

At the end of the session you will be able to:

- Comprehend characteristics of cloud computing
- Define grid computing
- Explain important features of cloud and grid computing
- Describe grid architecture and cloud computing architecture
- Differentiate between grid and cloud computing

Introduction

- Grid computing is the integration of computer resources for achieving similar objective.
- The grid may be a dispersed system along with non-interactive workloads which comprise a huge number of files.
- Grids are frequently created with middleware software libraries of a common grid.

Grid Framework

- Grids are a type of dispersed computing system, whereas a virtualized super computer is made from various networked.
- Grids focus on two different but associated objectives—supplying isolated access to IT resources and building up processing control.
- The grid is a technology which controls two factors—allocation and trust.
- Grid computing is a versatile technology which has its base in e-science and has progressed from previous expansions in parallel and high-performance computing (HPC).

Grid Framework

The main resources that can be shared in a grid are:

1. Processing and computing power
2. Networked file and data storage systems
3. Bandwidth and communications
4. Application software
5. Tools used for scientific purpose

Grid Framework

The distinct definitions for grid and grid computing are:

- **Grid middleware** is exclusive software that offers the essential functionality needed to facilitate sharing of various resources and setting up of virtual businesses. Grid middleware is exclusive software that is incorporated into the infrastructure of the concerned corporation. Grid middleware offers a unique virtualization and sharing layer which is positioned among the various infrastructures and the particular user applications using it.
- **Grid computing** is fundamentally the installed Grid middleware or the computing permitted by grid middleware based on synchronized, safe, flexible resource sharing among a collection of resources, people, and organizations.

Grid Framework

- **Grid infrastructure** refers to the union of grid middleware and hardware which converts single portions of data resources and hardware into an incorporated virtualized infrastructure that is displayed to the user as the only computer in spite of heterogeneity of the fundamental infrastructure.
- **Utility computing** is a type of computing that provides customized applications of grid and computing as a service. It is based on pay-as-per-utilization business modules.

Grid Architecture

- The grid design offers an outline of the grid constituents, describes the objective and operations of its constituents, and shows how the constituents interrelate with each other. Various layers of the grid architecture are:
  - Fabric layer
  - Connectivity layer
  - Resource layer
  - Collective layer
  - Application layer

Grid Architecture

The key functionalities of a grid middleware are as follows:

1. Integration and virtualization of various independent resources
2. Requirement of information concerning resources and their accessibility
3. Lively and flexible resource administration and allotment
4. Brokerage of resources based on open markets or corporation strategies
5. Safety comprising agreement and confirmation of users and accountability
6. Licenses administration
7. Expense and invoicing
8. Transport of non-insignificant ‘Quality of Service’

Challenges of Grid Computing

- It is not enough to just change the prevailing spread IT infrastructure into a grid. In majority of instances, investments are required for making the existing applications to work on a grid infrastructure.
- Lack of values for grid computing make resources' findings for grid technology difficult and risky.
- Grid computing is a versatile technology and the launching of grid computing in a corporation is characteristically a long-standing plan that needs time until the visibility of first results. The beginning of grid computing could need consistency of physical resources. Even if grids would essentially be capable to handle heterogeneity of resources that are accessible, advanced heterogeneity of resources might need advanced savings in terms of money and time and hence increase the downfall risk.

Cloud Computing Architecture

- In cloud computing environment, physical resources are made available to cloud users with the help of virtualization software in the form of virtual resources.
- Cloud computing architecture is not fixed as other computing architectures, but it is different on the basis of different jobs, resource distribution.

Cloud Computing Architecture

Basic cloud computing environment is shown in the Fig. 3.1 in which various services such as available servers, virtual desktop, system software, application software, database, etc. are available for cloud users. Users can avail the services using any device such as desktop system, laptop, mobile, tablet, etc.,

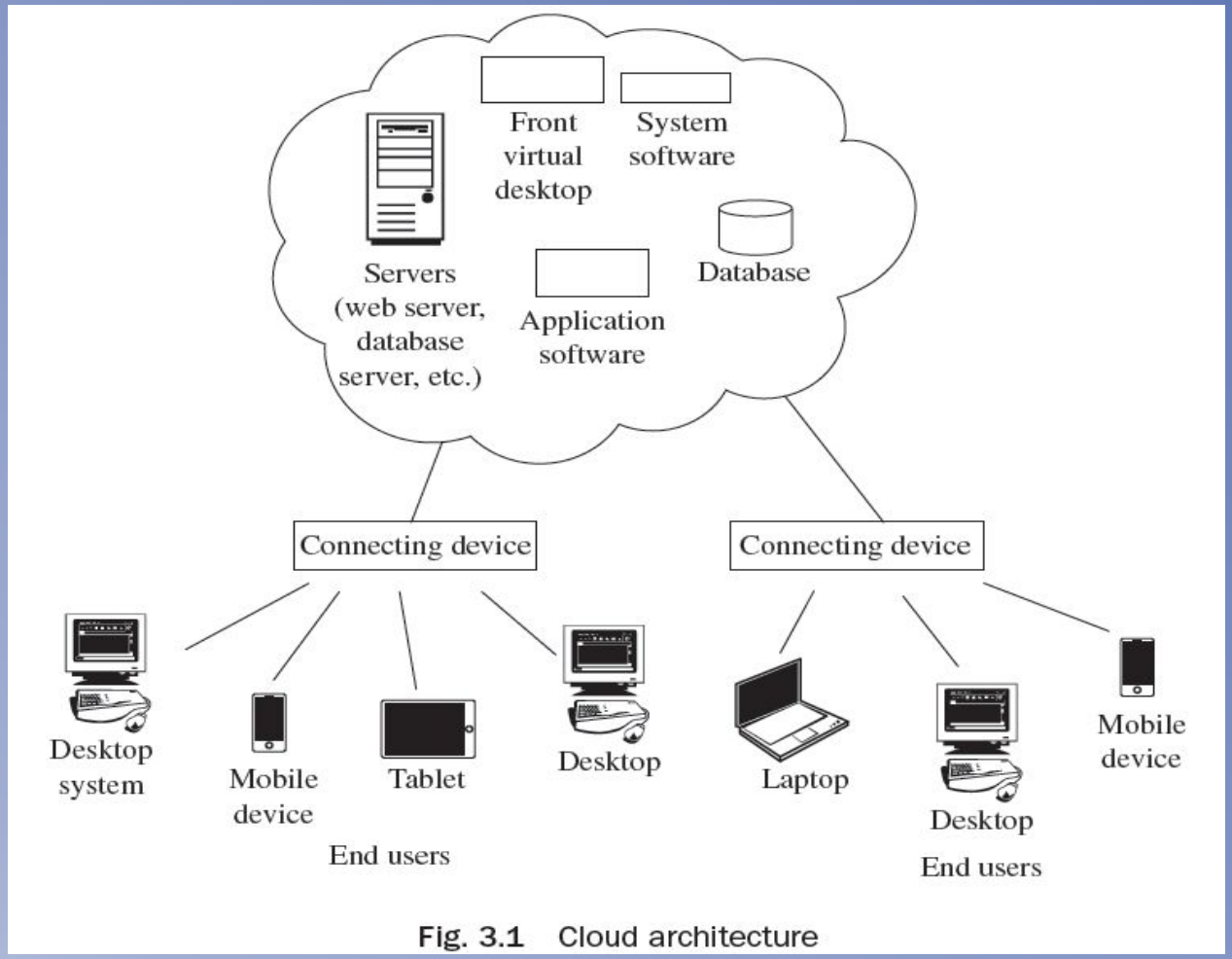

Fig. 3.1 Cloud architecture

Cloud Computing Architecture

The Cloud Computing architecture is discussed based on different criteria:

- On the Basis of Load Balancing
- On the Basis of Disk Provisioning
- On the Basis of Storage Management
- On the Basis of Hypervisor Installed
- On the Basis of Migration
- On the Basis of Service Relocation
- On the Basis of Cloud Balancing
- On the Basis of Virtual Switches Load Balancing
- On the Basis of Failure Detection and Recovery

Key Design Aspects of Cloud Architecture, Cloud Services and Cloud Applications

- Cloud computing has various issues related to its architecture:
- **Issues at Design Level**
  - **Issues of Architectural of Cloud Computing**
  - **Platform Related Issues**
- **Issues Related to the Implementation**
  - **Issues related to Business**
  - **Technical Issues**

Similarities and Differences between Grid and Cloud Computing

Similarities:

- Grid computing and cloud computing are scalable.
- Grid and cloud computing offer service-level agreements (SLAs) for uptime accessibility of around 99 per cent. If the service slides below the definite uptime service level, the service credit for receiving data to the customer gets delayed.

Differences:

- Cloud computing offers SaaS applications, whereas grid computing is used when the processing authority of service or an application is distributed across multiple systems.
- With cloud computing, the corporation acquires feasibility and expense savings, whereas with grid computing the corporation acquires suppleness and authority.

Features of Cloud Computing

- On-demand self service
- Broad network access
- Resource pooling
- Rapid elasticity
- Measured service
- Multi-persistence
- Dynamic Computing Infrastructure
- Elasticity and scalability
- IT service-centric approach
- Standardized Interfaces

Cloud and Dynamic Infrastructure

- Cloud service characteristics include reduced cost, high scalability, pay-as-you-grow facility, guaranteed data center and network uptime, better resource utilization, and lesser implementation time since resources are available on demand.
- Cloud services are exclusive as they permit to see, amend and share files saved on the cloud. At the same time, as no two cloud services are alike, all of the services offer almost similar basic functionality and features.
- The finest cloud computing services are those which permit to store and upload any sort of file one would keep on his/her local hard drive, from word documents to music files. Security issues can be solved by file encryption, and password sharing is restricted to protect the data.

Cloud and Dynamic Infrastructure

- Points to consider while selecting a cloud provider as per the requirement are given below:
  - Ease of use
  - Help and support
  - Packaged software
  - Shared software
  - Tool management
  - Mobile access
  - Line of business services
  - Customer-oriented services

Impediments to Cloud Adoption

- Businesses must vigilantly think about five chief barriers for prosperous implementation of cloud computing. These are as follows:
  - Security
  - Privacy
  - Irresponsibility of vendors
  - Risk improvement
  - Inheritance of applications

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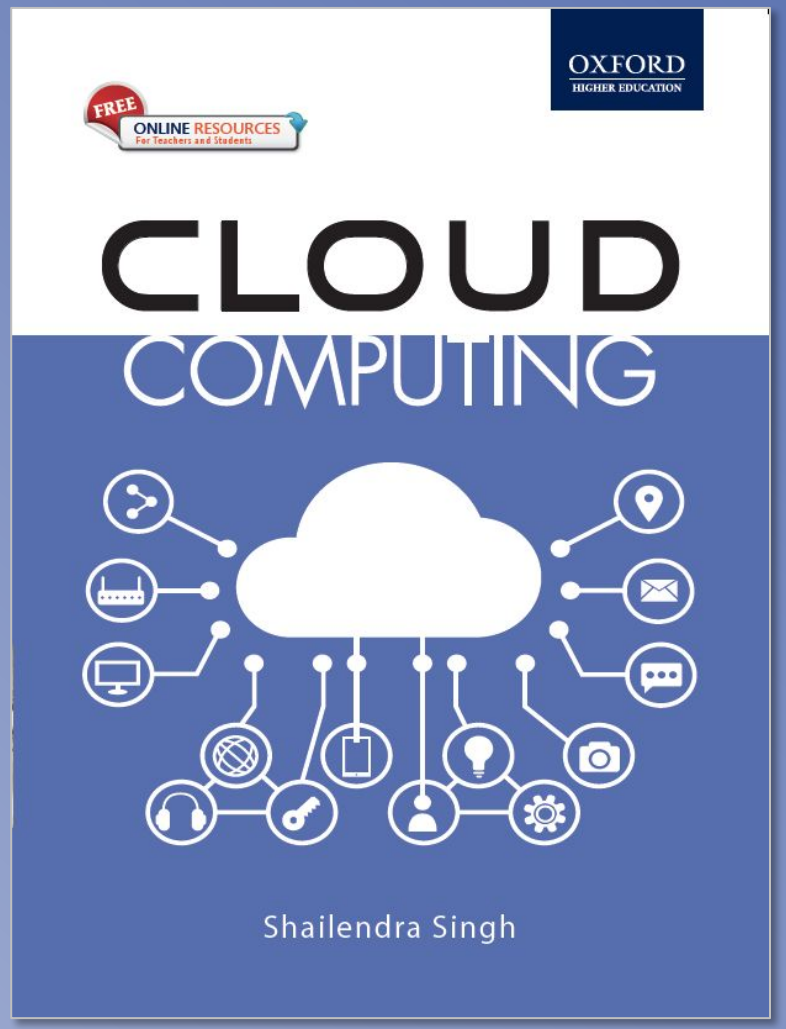


Chapter 4

Models of Cloud Computing

Learning Outcomes

At the end of the session you will be able to:

- Comprehend service models of cloud computing
- Describe cloud services provided by SaaS, IaaS, and PaaS
- Describe cloud stack and cloud storage
- Differentiate various deployment models
- List the benefits of service models

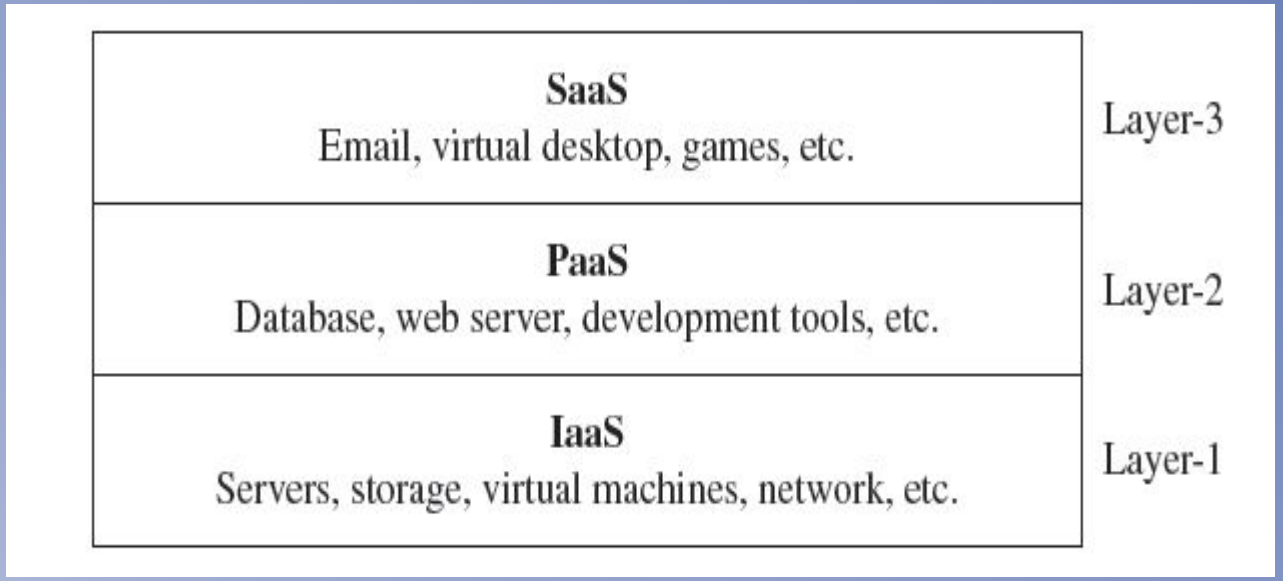
Introduction

- The cloud computing system is composed of a set of layers upon which distributed applications are built. These layers include *infrastructure, platform,* and *software*. Based on these three layers, we can devise three cloud computing models are devised.
- **Infrastructure as a Service (IaaS)** model provides infrastructure-related services and is responsible for handling hardware-related issues, power, and cool management in data centers.
- **Platform as a Service (PaaS)** model takes the responsibilities of operating system, database management, server, and programming language.
- **Software as a Service (SaaS)** model handles software-related issues and provides amenities to the cloud users.

Cloud Service Models

- On the basis of allocation of resources, cloud computing offers their services.

1. **Bottom layer (layer-1)—**IaaS—accommodates memory, CPU, and additional hardware resources
2. **Middle layer (layer-2)—**PaaS—accommodates diverse settings for consumer-particular services
3. **Top layer (layer-3)—**SaaS—cloud service accessing occurs via web browsers and web services



Software as a Service

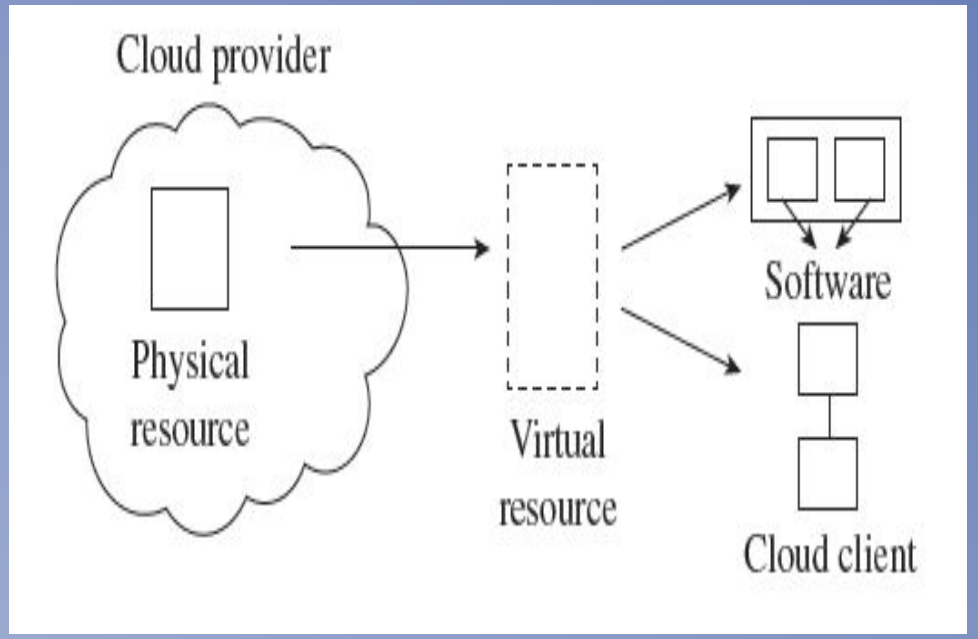
- **Software as a Service (SaaS)** is a software distribution model in which applications are hosted by a vendor or service provider and made available to customers over the Internet.
- **National Institute of Standards and Technologies (NIST) defines cloud SaaS as follows:**

"The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings".

Software as a Service

Some of the applications of SaaS are:

- Complaint resolution system
- Employee management system
- Attendance resolutions system
- E-police, E-court
- Municipal maintenance
- Water board, billing, payment systems
- District management solutions
- Service desk



Importance of SaaS

 The following are some of the reasons SaaS services are required:

1. Straightforward expenses are nil.

2. You only need a web browser to access the application. It doesn't require other hardware purchase or software installation.

3. It provides quick operation service.

4. SaaS is extremely scalable.

5. Since the source code is the same for each customer, it is a multi-tenant design that makes it extremely proficient.

6. SaaS can endure every demand, because of easy arrangement; this is usually not simple with conventional applications.

7. Any noble technical modernization is effortlessly incorporated by the supplier that is accessible to all subscribers because, usually, all the consumers use a similar code base.

Platform as a Service

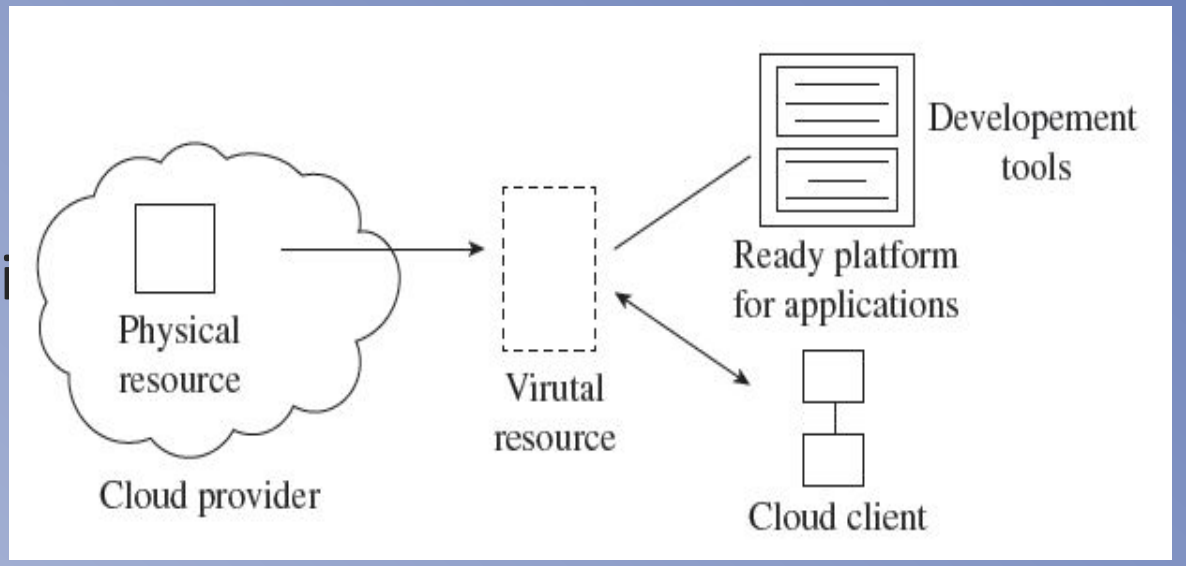
- **The Platform as a Service (PaaS)** model makes all of the facilities required to support the complete life cycle of building and delivering web applications and services available from the Internet.
- **National Institute of Standards and Technologies (NIST) defines cloud PaaS as follows:**

"The capability provided to the consumer is to deploy onto the cloud infrastructure consumer created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment".

Platform as a Service

The following has to be performed in the PaaS:

- Attain and install the server.
- Organize the operating system, operate time settings, and source manage depository and other middleware to work efficiently.
- Organize the operating system, operating time settings, warehouse, and supplementary middleware.
- Copy data for further reference.
- The best way to comprehend PaaS is to split i separately into its major constituents— service and platform.



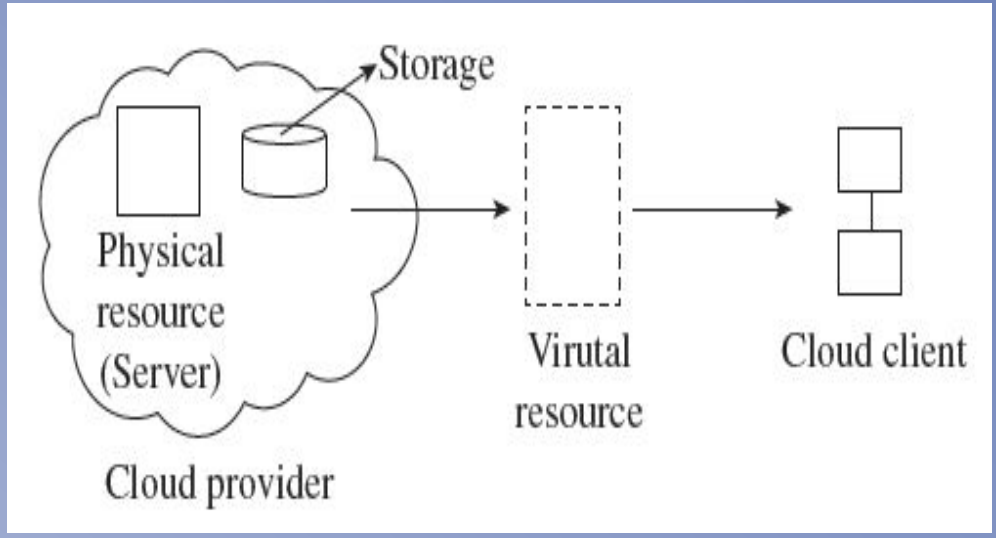
Platform as a Service

- Various Service Providers of PaaS
  - Terremark
  - Engine Yard
  - AT & T
  - Atlassian
  - PivotalLab
  - AppScale
  - Engine Yard
  - Flexiscale

Infrastructure as a Service

- **Infrastructure as a Service (IaaS)** is the delivery of computer infrastructure as a service.
- **National Institute of Standards and Technologies (NIST) defines cloud IaaS as follows:**

"The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls)".



Infrastructure as a Service

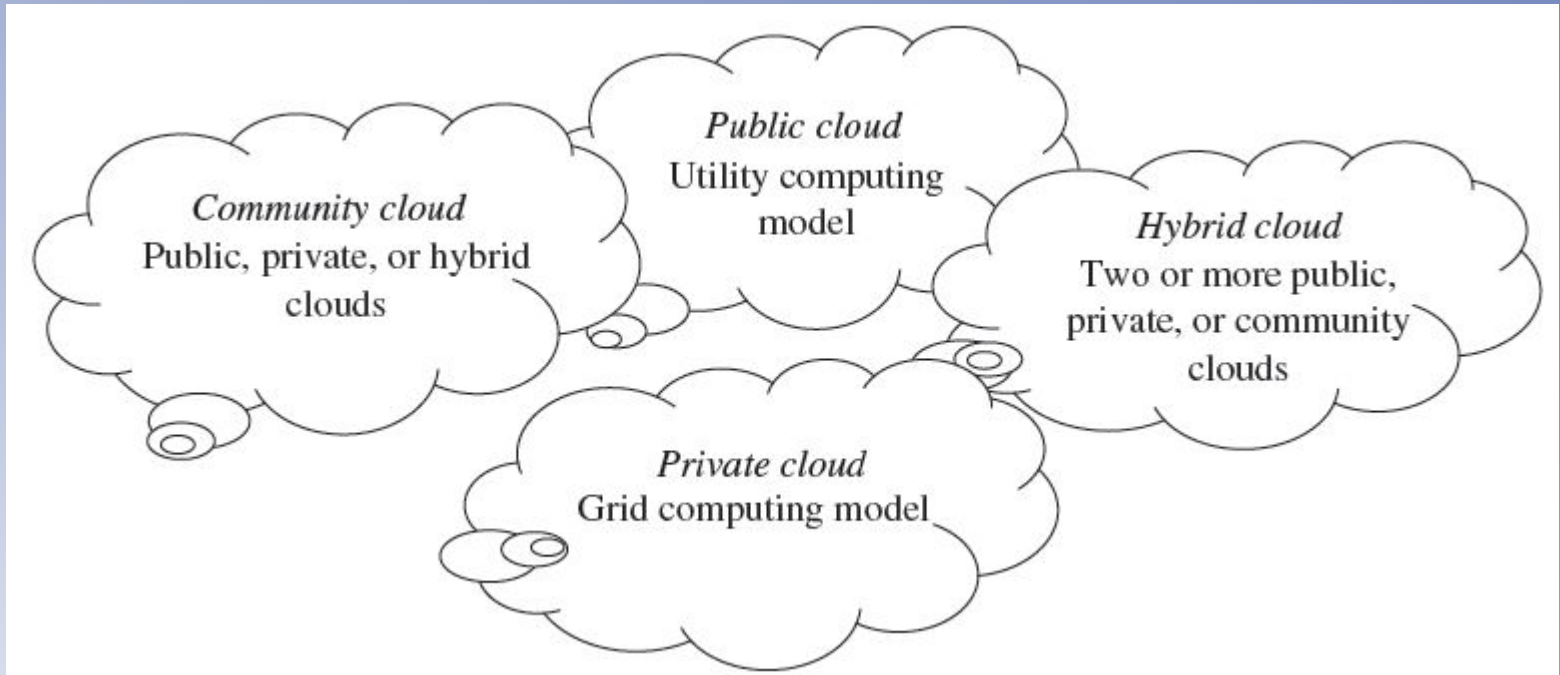
- Amazon is the pioneer of IaaS. In India, IaaS providers include NetMagicSolutions and InstaCompute (from Tata Communications). The other leading providers are:
  - Rackspace
  - Joyent
  - Rightscale
  - Terremark
  - GoGrid
  - Elastic Hosts
  - Symetriq

Cloud Computing Sub Service Models

- Everything as a Service (XaaS)
- Compliance as a Service
- Identity as a Service (IdaaS)
- IaaS: DataBase as a Service (DBaaS)
- Paas: Storage as a Service (STaaS)
- Communications as a Service (CaaS)
- SaaS: Security as a Service (SECaaS)
- SaaS: Monitoring as a Service (MaaS)
- PaaS: Desktop as a Service (DTaaS)
- IaaS: Compute Capacity as a Service (CCaaS)

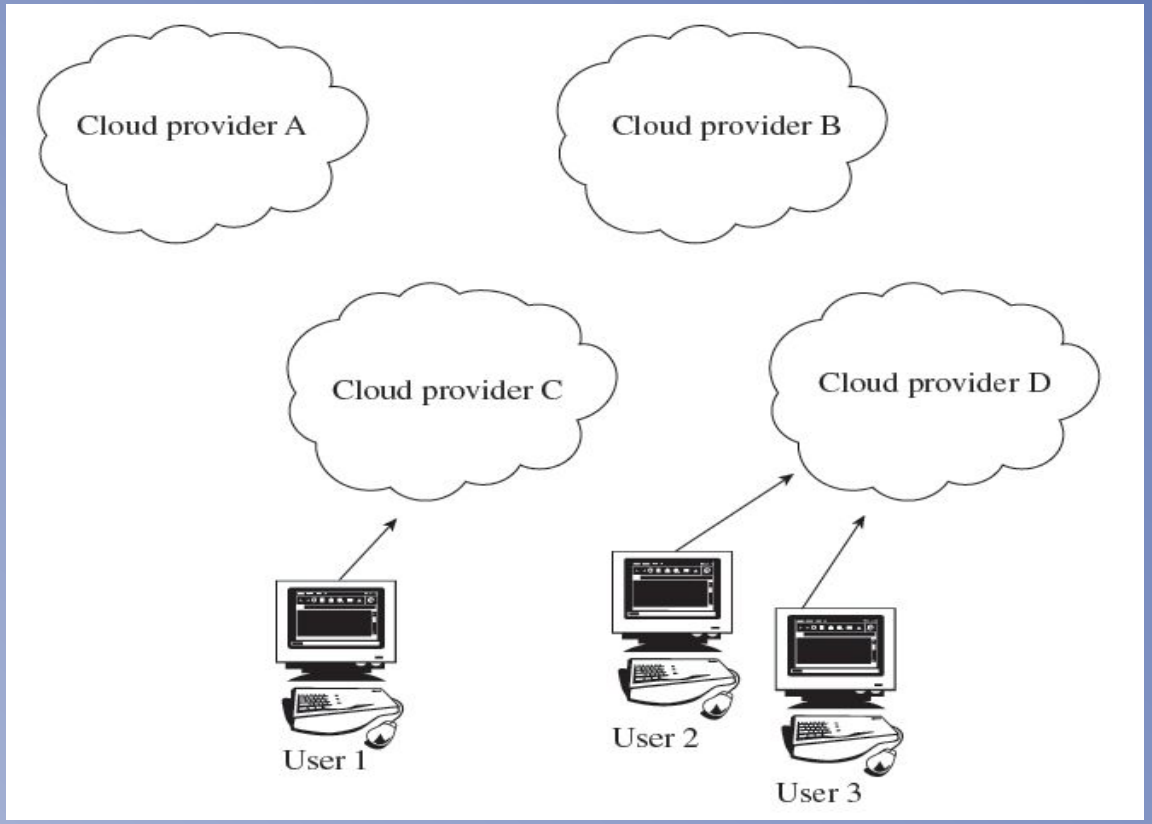
Cloud Deployment Models

- The cloud model is invented with four deployment models—public cloud, private cloud, hybrid cloud, and community cloud.)



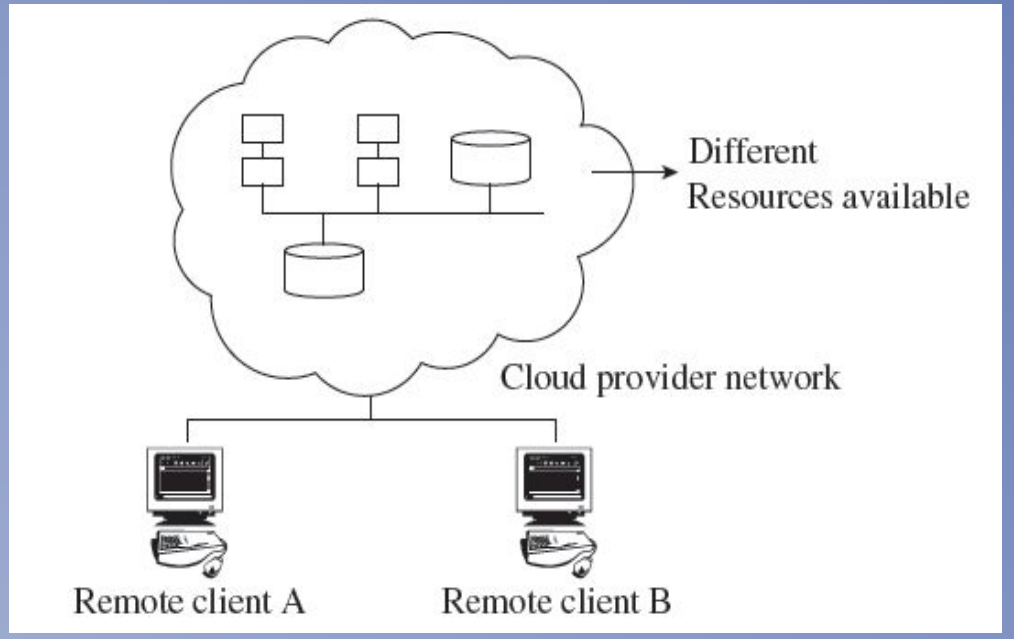
Public Clouds

- The public cloud is the first deployment model. In this model, users have many options to opt for and decide on any service provider as per requirement.
- Examples of public cloud vendors include Google, Amazon Elastic Compute Cloud, Windows Azure Services Platform, Microsoft, etc.
- This model assists in the reduction of capital expenses and removes equipped IT expenses.



Private Clouds

- The private cloud offers several advantages of an open cloud computing setting that comprises its service support and flexibility.
- Private clouds allow infrastructure to be accessed only by the members of the organization and granted by third parties.
- Examples of private cloud include Eucalyptus cloud computing infrastructure with Ubuntu Server, Elastra private-cloud, Vmware, Microsoft, etc.

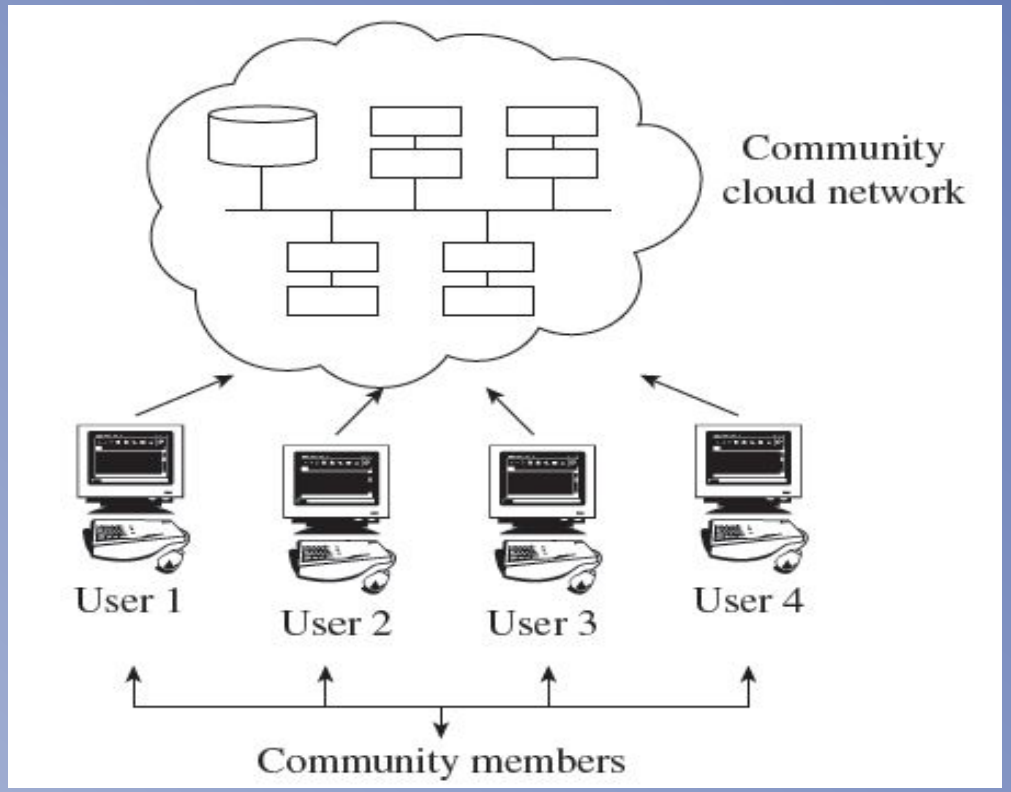


Community Clouds

- A community cloud falls between public and private clouds category.
- The drawback related to a community cloud is that of having costs higher than a public cloud.
- Examples of community cloud include

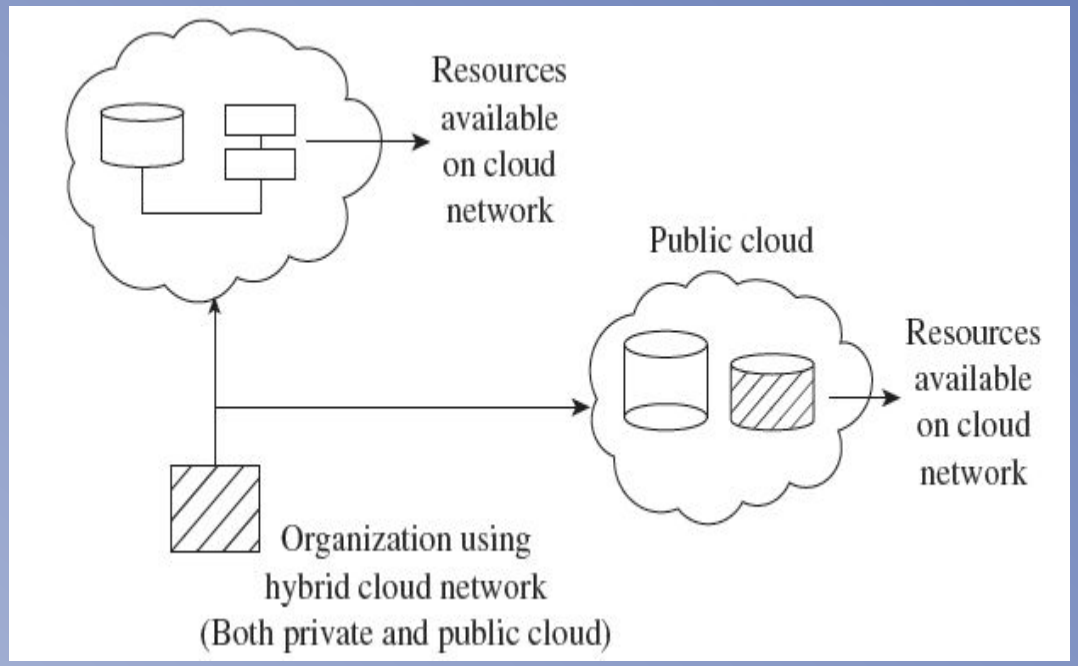
  Google's 'Gov Cloud', NASA Nebula cloud,

  etc.



Hybrid Clouds

- The hybrid cloud is a combination of a private and public cloud which is mutually dependent on one another.
- In this model, cloud users are supplied with information on the public cloud, in spite of the reality that the cloud supplier has to maintain the company-significant services and information in a few instructions.



Alternative Deployment Models

Linthicum Model

- 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 as a Service
- Testing as a Service

Jericho Cloud Cube Model

- Internal or external
- Proprietary or open
- Perimeterized or de-perimeterized architectures
- Outsourced or insourced

CloudStack

- CloudStack is cloud software which assists users to alter the cloud according to their requirements.
- It controls and supports the network, storage, and compute joints in a cloud infrastructure.
- It is used to arrange, control, and systematize situations in cloud computing.
- With CloudStack, you are capable of the following:

1. Establishing an on-command, flexible cloud computing service. Service suppliers may offer self service virtual machines, networking arrangements, and storage sizes over the Internet.

2. CloudStack may be used to construct an on-command cloud computing service along with flexibility. Service supplier provides storage and virtual machines, and much more on the Internet.

3. An organization or worker could establish an on-premise private cloud along with CloudStack.

Cloud Storage

- Cloud storage is a service model wherein data is maintained, controlled, and backed up distantly and made accessible to users over a network (characteristically the Internet).

There are three major cloud storage models which are as follows:

1. Public cloud storage services, like Amazon's Simple Storage Service (S3), offers a multi-occupant storage appropriate for data.

2. Private cloud storage services offer a dedicated storage restricted behind the firewall of a corporation. Private clouds are suitable for users who require customization and more power on their data.

3. Hybrid cloud storage is an amalgamation of the other two models, which comprise no less than a single public cloud and a single private cloud infrastructure. A corporation could, for instance, collect forcefully used and prepared data on a private cloud and sharable data on a public cloud.

Cloud Storage

- Cloud storage is a module of networked online storage in which data is saved in virtualized groups of storage that are normally hosted by third parties.
- Cloud storage services can be accessed via a web service application programming interface (API), or via a web-based user interface.

Thank You!

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CLOUD COMPUTING

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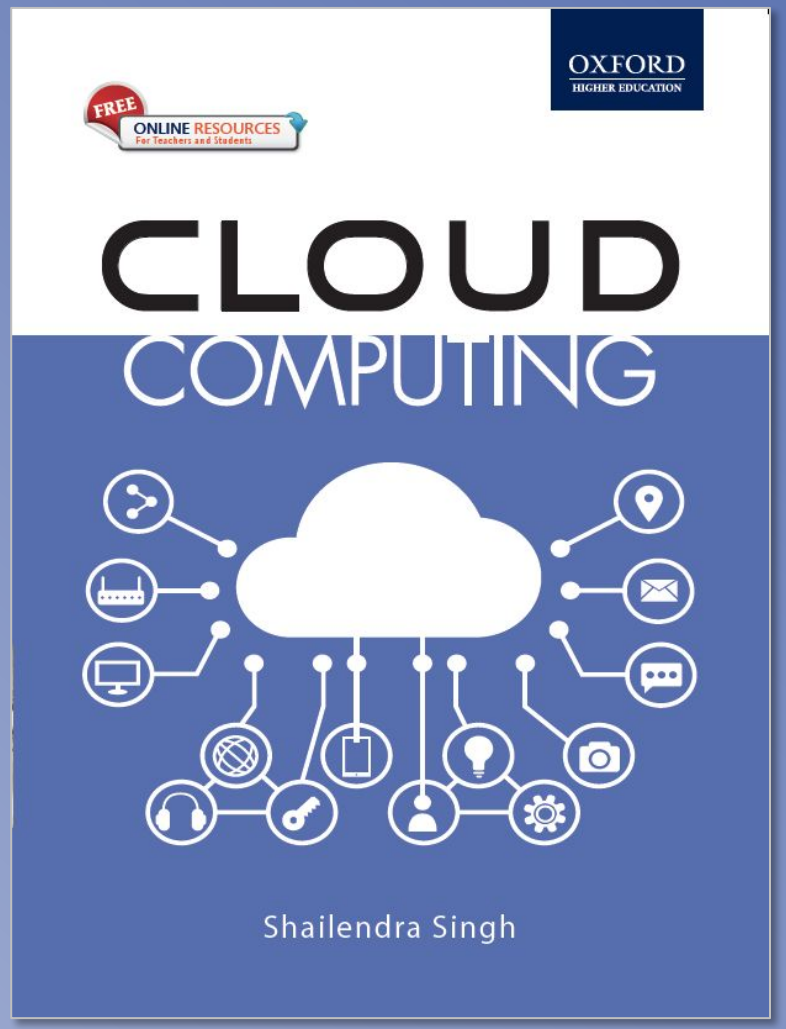

Chapter 5

Cloud Data Center

Learning Outcomes

At the end of the session you will be able to:

- Comprehend the core elements of cloud data center
- Describe the different storage options
- Describe RAID technology and its advantages
- Understand database and its management
- Understand the various technologies of backup and recovery
- Discuss replication technologies
- Describe life cycle management
- Describe cloud analytics
- Understand traditional data center management

Cloud Data Center Core Elements

- The important cloud elements are as follows:

1. Clients (i.e., mobile, thin, or thick)
2. Data center (i.e., collection of servers, IT, and non-IT equipment)
3. Distributed servers (geographically distributed)
4. Storage

Cloud Data Center Core Elements

The principal components of a cloud data center (CDC) comprise:

1. **Application:** It is a computer program which has the ability of computing operations. Applications can use a DBMS that uses operating system services in order to work on, retrieve, and store functions on storage tools.
2. **DBMS:** It offers planned means to save data in rationally prepared tables which are unified. DBMS optimizes the retrieval and storage of data.
3. **Compute:** It is a physical computing machine which controls applications, databases, and operating systems.

Cloud Data Center Core Elements

4. Storage: It refers to a tool which constantly saves data for subsequent use. The distinct necessities of storage are dependent on the sum of data to be saved and for the period it is to be saved.

Storage devices/Drives	Functions/Features
Tape drive	• Low-cost solution for long-term data storage • Sequential data access, physical wear and tear, and storage and retrieval overheads
Optical disk	• Write once and read many times • Limited in capacity and speed • Popular in small, single-user environments
Disk drive	• Random read and write access • Uses mechanical parts for data access • Most popular storage device with large storage capacity
Solid state drive	• Provides ultra-high performance required by mission- critical applications • Very low latency per input output, low power requirements, and very high throughput drive

5. Network: It is a connecting path which allows communication among compute systems and customers or among storage and compute systems.

Types of RAID and Definition of various RAID levels

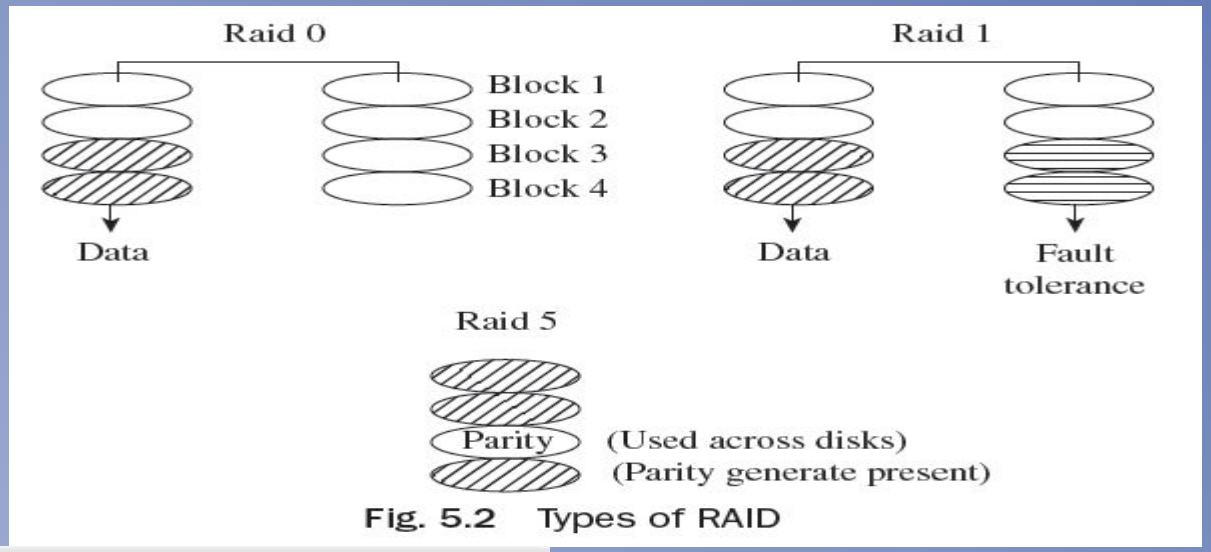

Fig. 5.2 Types of RAID

Raid levels	Definition
RAID 0	Striping with no fault tolerance
RAID 1	Disk mirroring
Nested	Combinations of RAID levels
RAID 3	Parity RAID with dedicated parity disk
RAID 5	Parity RAID with distributed parity across all the disks in the set
RAID 6	Distributed parity RAID with dual parity

Components of Fibre Channel SAN

- The following are the components of a Fibre Channel SAN:
  - Node ports
  - Cables
  - Connectors
  - Interconnecting devices
  - Storage arrays
  - SAN management software

Object-based Storage Technologies

- Object-based storage merges data with rich metadata in order to create an ‘object’.
- Object-based storage saves data in a flat address space.
- Every object in object storage is recognized through a distinctive ID known as object ID.
- Simple object access protocol (SOAP) is a means of switching messages between associates on a disseminated network, like the Internet. SOAP offers an array of XML aspects and components that are utilized to build a ‘SOAP’ message.
- Object-based storage has an even address space that fulfils the want for controlling RAID and LUN groups.
- Rather than RAID systems used for backup strengthening, storage managers can force object-based storage to simply generate multiple copies, as required, with every copy recognized with a similar object storage ID.

Unified Storage

- Unified storage merges SAN-based, object-based, and NAS-based access inside a single amalgamated platform.
- It supports NAS protocols (i.e., NFS for UNIX or Linux and CIFS for Windows) fibre channel, iSCSI, REST, SOAP, and FCoE protocols.
- The capability to assist multiple protocols from a similar storage system aids to liberally merge and counterpart workloads to really enhance consumption.
- Possessing a one-data model and toolset for amalgamated storage facilitates a reliable administration structure athwart various workloads and applications.
- Amalgamated storage has been offered by storage consolidation.

Business Continuity

- Business continuity (BC) is a significant procedure for classifying and executing.
- BC involves arranging for, responding to, and improving from a system outage which unfavorably influences corporation functions.
- It is a procedure of reinstating or recommencing corporation operations from a reliable replica of the data.
- **Hot site:** It is a site where functions of businesses may be stimulated, in the event of a catastrophe.
- **Cold site** It is a site where functions of businesses may be stimulated, in the event of a catastrophe.
- **Cluster** A set of servers and other essential resources are united to function as a solo system.

Cloud Backup

- Backup is a replica of the manufactured data, generated and maintained for the only intention of improving corrupted or deleted data.
- Backup technologies, maintenance, and revival necessities for applications and data are a vital step to guarantee successful execution of the revival and backup solution.
- Backups are carried out for three key reasons—documentation, operational restores, and disaster recovery.
- Based on necessities, corporations use diverse backup approaches for catastrophe recovery. Data in the construction situation alters with each industry deal and function.
- The backup replicas are used for reinstating data at an alternating location when the primary location is harmed because of a catastrophe.

Cloud Backup

- The majority of corporations use an amalgamation of these three kinds of backup to meet the backup and recovery necessities.
- The backup metadata has been obtained by the backup server from the backup consumers to carry out its actions.
- The metadata is saved either locally inside the backup server or outwardly in a storage range.
- The storage joint is accountable for writing data to the backup tool. Characteristically, the storage joint is incorporated through the backup server and both are hosted on a similar physical platform.

Cloud and Disaster Recovery

- The backup server synchronizes the backup procedure with all the constituents in a backup arrangement.
- The backup server recovers the backup-concerned information from the backup list and, on the basis of this information, initiates a suitable storage joint to put in the backup media into the backup tools.
- The backup consumer transmits the data to the storage joint, and the storage joint inscribes the data to the storage tool.
- The backup server recognizes the backup media needed for the reinstate and informs the storage joint to put in the backup media. Then, the data is interpreted and transmitted to the consumer which has been recognized to obtain the reinstated data.

Cloud and Disaster Recovery

- Backing up disk storage systems proposes lucid benefits, owing to their essential random access and RAID security facilities.
- Several types of backup permit for backup descriptions to remain on the disk for a period of time even after they have been staged.
- As for backup software, both physical tape library and virtual tape library are the same. Virtual tape uses disks for backup. A virtual tape can span multiple LUNs, if required.
- Virtual tape supports instantaneous support, which is distinct from physical tape library, and has mechanical delays.

Replication Technologies

- The procedure of generating an accurate/similar replica of data is known as replication.
- The main aim of replication is to allow users to have the chosen data at the correct place, in a condition suitable to the needs of revival.
- Replicas may be used to address a number of business permanence performances, such as those given here:
  1. Offering an alternating source for backup to enhance the effect on construction
  2. Offering a source for rapid revival

Replication Technologies

3. Facilitating judgment support actions, like reporting

4. Mounting and analysing projected modification to an application or an operating situation

5. Reviving an application from the copy in the occurrence of a malfunction in the source level

 Replicas may be continuous or point-in-time (PIT).

- Continuous replica: The data on the replica is matched with the manufacture data during the entire period.
- PIT: The data on the replica is a copied picture of the manufacture at a certain timestamp.

Replication Technologies

- For every business function, the replica may be accessed by an alternating server.
- Storage group-based regional replication may be classified as follows:
  - Pointer-based virtual replication
  - Pointer-based complete degree replication
  - Complete degree mirroring
- Replication might be synchronous or asynchronous. SAN-based isolated replication permits the data replication among assorted dealer storage groups.
- There is no effect on the manufacturer servers or the LAN as replication is made by the group and the data is moved over the SAN.

Traditional Data Center Management

- The chief administration actions in a conventional or traditional data center are as follows:

1. Vigilance and scrutinizing
2. Reporting
3. Accessibility administration
4. Capability administration
5. Functioning administration
6. Safety administration

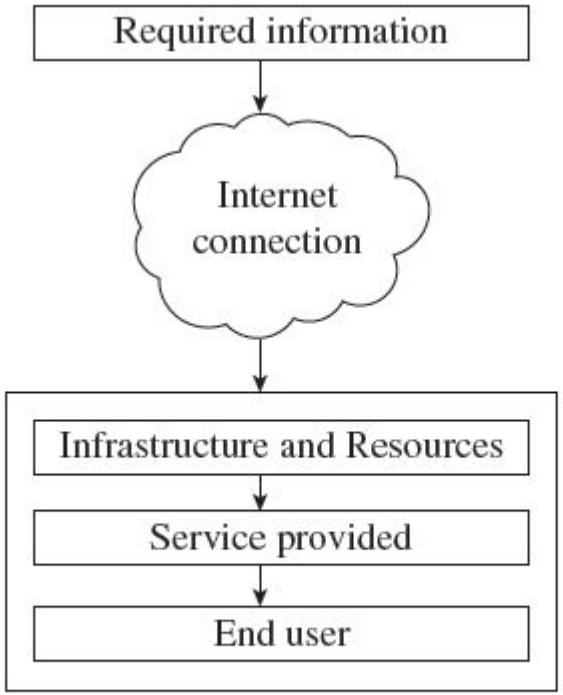

Fig. 5.3 Services provided by traditional data center

Services provided by Cloud Data Center

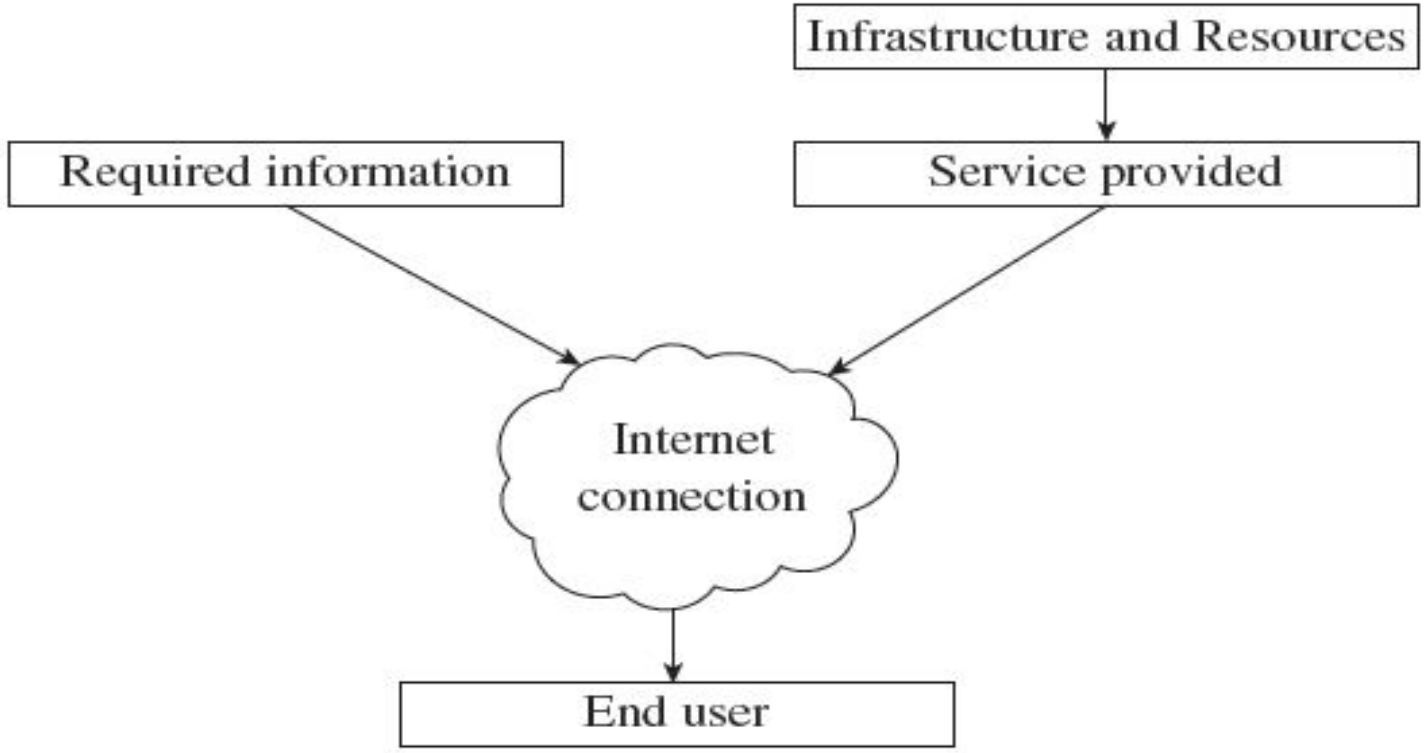

Fig. 5.4 Services provided by cloud data center

Information Life Cycle Management

- Information life cycle management (ILM) is a procedure for organizing information via its life cycle, from beginning to its clearance. The key assessments required to be made as division of the ILM strategy for the business are as follows:
  - When is it important to record the business data from live or transactional databases to archived databases?
  - Up to what phase will the data be saved in the operational databases before they may be set out forever?

Information Life Cycle Management

The vital features are as follows:

1. Insignificant or surplus information slows application functioning and augments the time needed to advance applications and backup databases.

2. In-house features will principally be determined during negotiations, which refers to how valuable the information will be to the corporation in its business dealings.

3. Peripheral aspects will be principally directed by authorized and inflexible necessities; inparticular, the least sum of time information enclosed by that legislation must be reserved.

Information Life Cycle Management

An ILM policy must comprise the following features:

- Business-centric
- Centrally managed
- Policy-based
- Heterogeneous
- Optimized
- Tiered storage

Cloud Analytics

- Cloud analytics is a sort of cloud service module where exploration of data and associated services are carried out on a private or public cloud.
- Cloud analytics is chiefly a cloud-facilitated resolution which permits a corporation or person to work intelligence measures or business studies.
- Cloud analytics is a service module wherein constituents of the data investigative procedure are offered via a private or public cloud.
- Cloud analytics services and applications are characteristically proposed underneath a contribution-based or utility (pay per use) costing model.

Cloud Analytics

- Cloud-based social media analytics involves the isolated provisioning of devices which comprise applications for choosing social media sites which serve your intentions, divide applications for gathering data, data investigative software, and storage services.
- Spending on cloud analytics may be rewarding for a corporation but appropriate preparation is necessary to make sure that all six investigative components are concealed.

Computing on Demand

- On-demand computing (ODC) is a model of computing at enterprise level. In this technology, resources are offered on a pay-per-use basis.
- ODC is recognized as utility computing or on-demand computing too.
- The main benefit of ODC is its low basic price, since computational resources are substantially hired when they are needed.
- On-request computing goods are swiftly becoming common in the market. HP, Microsoft, Computer Associates, Sun Microsystems, and IBM are among the more famous on-request sellers. These companies mention to their on-request services and goods by various names. IBM names it as ‘OnDemand Computing’.

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CLOUD COMPUTING

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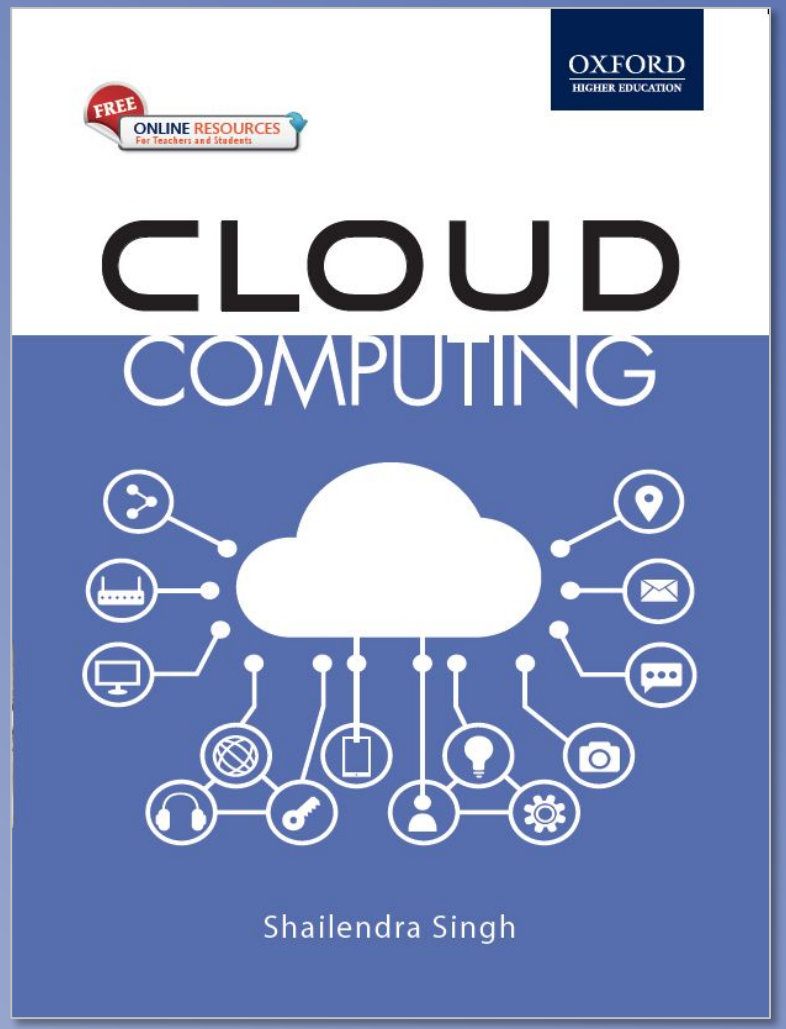


Chapter 6

Virtualization Technology (At Server)

Learning Outcomes

At the end of the session you will be able to:

- Comprehend virtualization
- Explain need of compute virtualization
- Understand virtual clusters
- Apply various techniques used for computing virtualization
- Describe various resource management tools
- Describe application of virtual machine
- Describe hypervisor taxonomy
- Appreciate the concept of virtual machine
- Explain data center virtualization

Introduction

- Virtualization refers to a technology that is used to make physical resources available as virtual resources.
- Cloud computing technologies use a set of techniques to create virtual servers, virtual storage, virtual networks, and perhaps virtual applications as well.
- Virtualization software is used to make a physical server like a virtual server.
- Operating system-level virtualization can be achieved by installing virtualization software on already installed operating systems.

Virtualization Reference Model

- The virtualization model consists of a host or physical resources in the first layer, virtualization tool in the second layer, and a guest in the third layer (application as well as virtual image) as shown in Fig. 6.1.

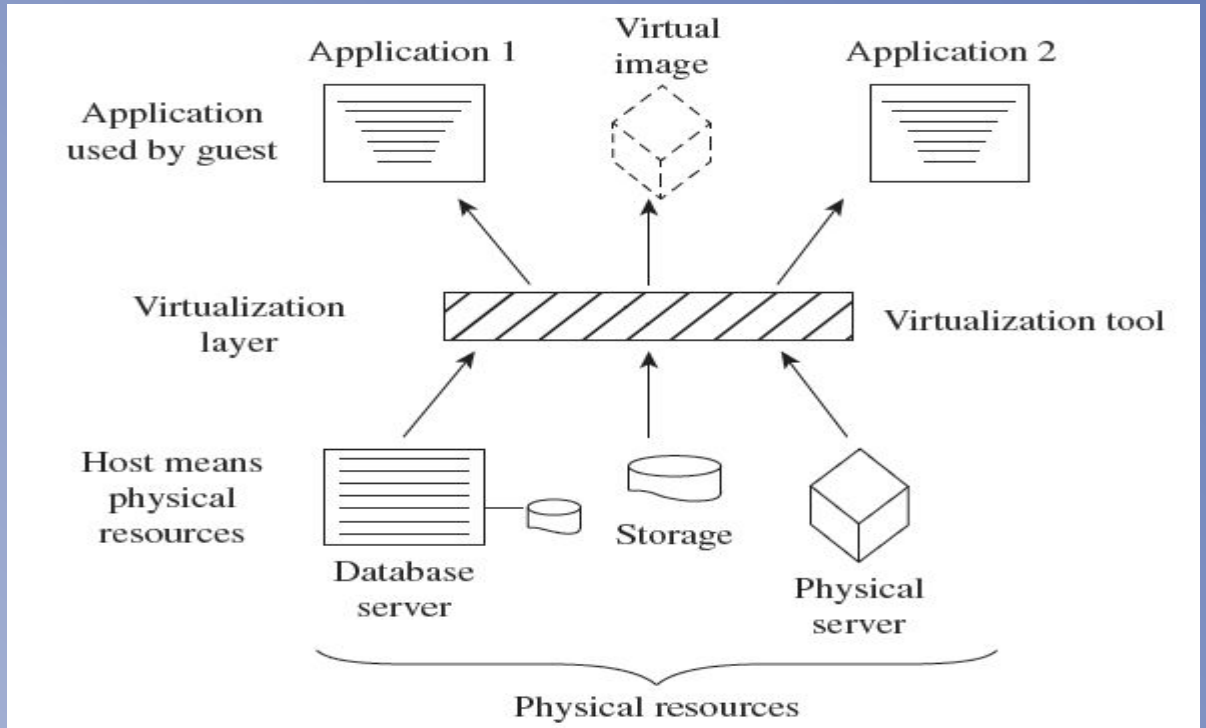


Fig. 6.1 Virtualization reference model

Advantages of Virtualization

The advantages of virtualization include the following:

- It allows any network-enabled device to access any network application over any network.
- It maintains isolation of one workload from another application to enhance security in the environment.
- Virtualization of an application allows users to be comfortable with different versions of the operating system.
- It can support and allow application with multiple instances to run on various machines concurrently.
- It optimizes the use of a single system.
- It enhances the reliability or availability of an application through redundancy.

Server/Compute Virtualization

- Server/Compute virtualization in cloud computing refers to making a virtual edition of a device or resource, such as a server, storage device, network, or an operating system where the structure splits the resources as one or more environments for execution.
- The following are the advantages of server/compute virtualization:

1. Consistency
2. Energy efficiency
3. Enhanced disaster recovery
4. Cost savings

- A virtual machine is a reasonable computing system like a physical machine which governs an application and operating system (OS). Some of the virtual components used in a virtual machine are as follows:

Server/Compute Virtualization

A virtual machine (VM) can be configured with the following virtual components:

- Virtual central processing unit (vCPU)
- Virtual random access memory (vRAM)
- Virtual disk
- Virtual network adaptor (vNIC)
- Virtual DVD/CD-ROM and floppy drives
- Virtual SCSI (Small Computer System Interface) controller
- Virtual USB controllers
- Virtual machine console

Server/Compute Virtualization

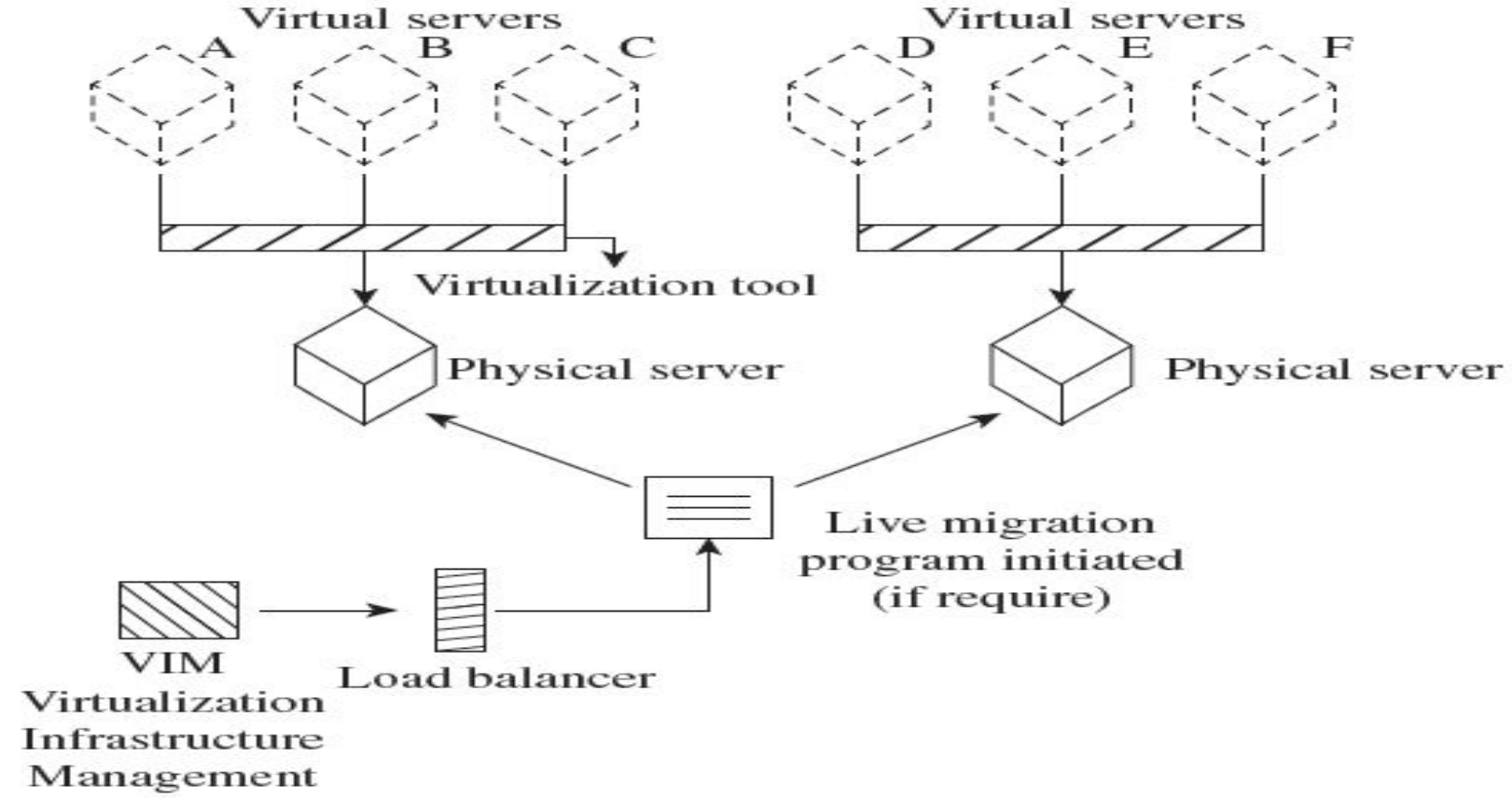


Fig. 6.2 Compute virtualization

Server/Compute Components

The logical components of a server/compute system comprise the following:

- File system
- Operating system
- Volume manager
- Device drivers

Need of Server/Compute Virtualization

- Compute virtualization facilitates and permits various applications and operating systems to function on a physical machine.
- This method considerably minimizes charge and enhanced consumption. Resource management is the allotment of a physical machine or clustered physical machines to VMs.
- Every physical machine and group has a parent resource pool which provides the resources of that physical machine or group.
- Each child resource pool possesses a few of the resources of their parents. A parent resource pool may include virtual machines, child resource pools, or both.

Need of Server/Compute Virtualization

- Present CPUs are prepared with hyper-threading characteristics and multiple cores per CPU. A multicore CPU is an incorporated circuit with which two or more processing units have been connected for improved functioning and more effective, synchronized processing of multiple resources.
- A hypervisor augments and supports the CPU resources by use of modern CPU aspects such as hyper-threading and multicore. It also helps in the following ways:
  1. Server consolidation
  2. Improved security
  3. Increased hardware consumption
  4. Hardware independence and support portability
  5. Decreased provisioning timing

Virtual Clusters

- There are common agreements for most applications or users, such as user-level or OS programming libraries.
- The VMs (guest systems) and physical machines (host systems) may operate with different OSes.
- The virtual environment design should be able to function quickly. In this case, deployment should be to build and allocate software stacks (i.e., applications, OS, and libraries) to a physical node within clusters as quick as possible and to instantly switch run time environments from one virtual cluster of user to another.
- Live moving VMs permit one to deliver workloads from one node to other one.
- One more advantage for clustering carried by virtualization is load-balancing applications in a virtual cluster.

Advantages of Server/Compute Virtualization

Compute virtualization offers the following advantages:

- Server consolidation
- Segregation
- Encapsulation
- Non-dependence on hardware
- Reduction in cost

Techniques of Server/Compute Virtualization

The three methods which manage confidential commands to virtualize the CPU are:

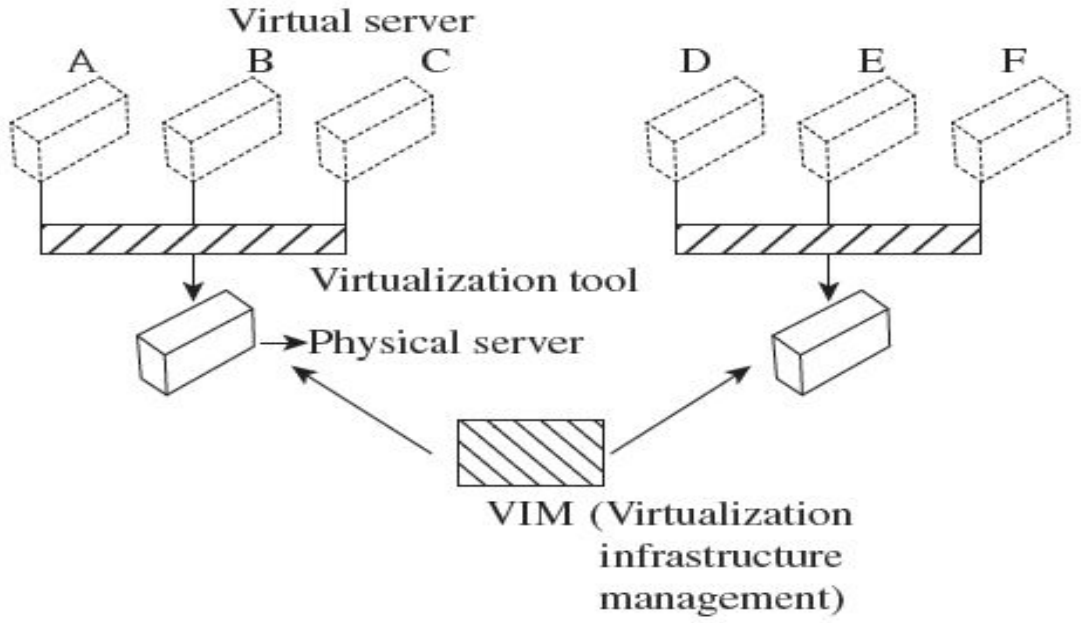
- Full Virtualization
- Para Virtualization
- Hardware Assisted Virtualization

Virtual Machine and Hardware Components

- A VM is a rational compute system similar to a physical machine which operates an application and an OS.
- An operating system which works within a virtual machine is known as a guest operating system.
- Network file system (NFS) and virtual machine file system (VMFS) are the file systems sustained by the hypervisor.
- The VMFS is a group of file systems augmented to preserve files of a virtual machine.
- In a virtualization environment, if any of the physical servers does not work properly, virtual infrastructure management (VIM) is initiated to divert traffic to a new selected physical server.

Virtual Machine and Hardware Components

- In Fig. Virtual machine management systems, if E, F, and G virtual instances are not working, then live migration of these E, F, and G into a new destination will be carried out.



VIM selects and diverts traffic to a new selected physical server after accessing capacity of other available hypervisor. E, F, and G virtual servers are live migrated to a new destination.

Fig. 6.5 Virtual machine management systems

Hypervisor Taxonomy

- A hypervisor, also known as a virtual machine manager, is a program that permits multiple operating systems to share one hardware host.
- Hypervisor is compute virtualization software which facilitates manifold operating systems to operate on physical machines simultaneously.
- The hypervisor is the main constituent of the data center consolidation.
- Hypervisor has two main constituents—virtual machine monitor (VMM) and kernel.

Hypervisor Taxonomy

- Hypervisors are categorized into two types:
  - Type 1 (Bare-metal hypervisor)
  - Type 2 (Hosted hypervisor)

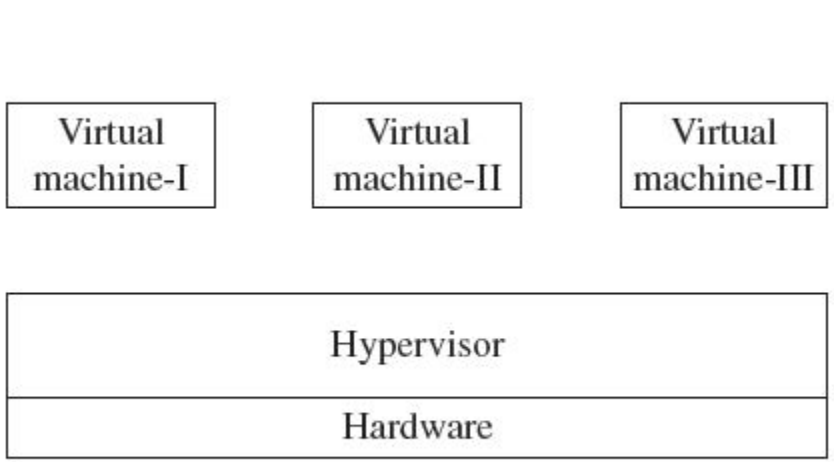


Fig. 6.6 Hypervisor Type 1

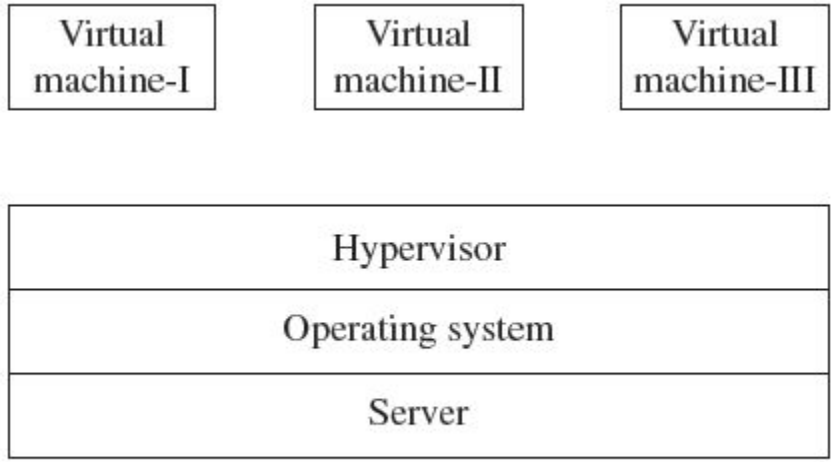


Fig. 6.7 Hypervisor Type 2

Resource Management and Tools

- Cloud resource management needs versatile judgments and policies for multi-objective optimization.
- The policies for cloud resource management associated with the three cloud delivery models, Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) vary from each other.
- In cloud computing, where alterations are common and spontaneous, centralized control is not believable to offer a persistent service and performance assurances.
- Resource management policies frequently mutually target power utilization and performance.

Resource Management and Tools

- Resource management is the allotment of a physical machine or clustered physical machines to virtual machines.
- Unused memory allocated by a virtual machine to CPU can be accessed and used by other virtual machines without disturbing other resources.
- Some virtual machines can enclose the same user data, administer the same guest operating system, or have the same applications.
- A hypervisor recognizes surplus pages copied by their contents.
- Virtual machines may securely alter the shared pages without disturbing other virtual machines which are sharing that memory.

Physical Machine to Virtual Machine (P2v) Conversion

- A VM maintains a relationship between various virtual machines, and between a hypervisor and a VM in a grouped server environment.
- Physical to VM exchange is a procedure via which a physical machine is transformed into a virtual machine. When transforming a physical machine, the 'converter application' (Converter) copies data on the hard disk of the source machine and shifts that data to the target virtual disk.
- Advantages of P2V converters are:

1. Runs migration among heterogeneous hardware
2. Minimizes time required to set up a new virtual machine
3. Permits migration of machines to a new hardware without re-launching the application or operating system

Physical Machine to Virtual Machine (P2v) Conversion

- The P2V ‘converter application’ comprises three constituents—converter server, converter agent, and converter boot CD.
- There are two means to shift from physical machine to virtual machine (VM). These are cold migration and hot migration.

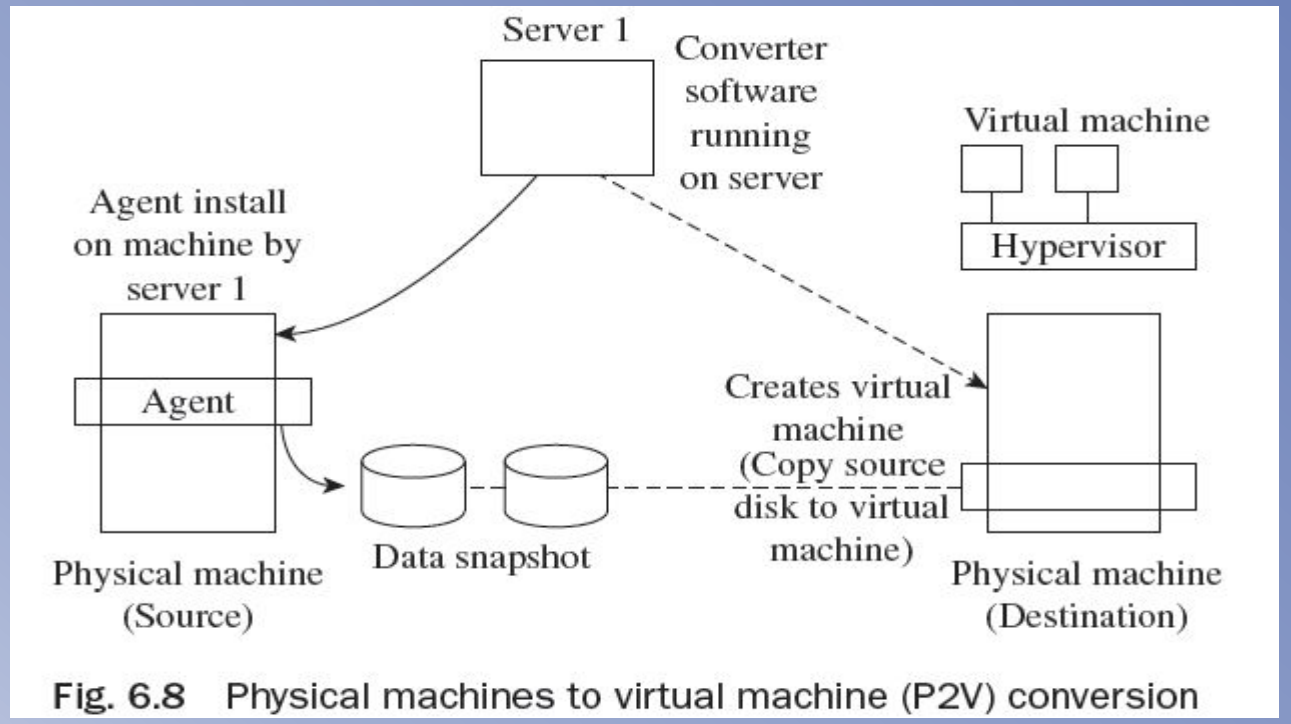


Fig. 6.8 Physical machines to virtual machine (P2V) conversion

- The movement of VMs from one resource to another, such as from one physical host to another physical host, or data store to data store, is known as VM migration. There are two types of VM migration: cold and live. **Cold migration** occurs when the VM is shut down. **Live migration** occurs while the VM is actually running.

- **Cold migration** is the **migration** of powered off or suspended virtual machines between hosts across clusters, data centers, and vCenter Server instances. **Migrating** a suspended virtual machine is considered a **cold migration** because although the virtual machine is powered on, it is not running.

Types of Virtualization

- Different types of virtualization are :
  - Data Center Virtualization
  - Server Virtualization
  - Storage Virtualization
  - Sensor Virtualization

- You can use cold migration to have the target host checked against fewer requirements than when you use vMotion. For example, if you use cold migration when a virtual machine contains a complex application setup, the compatibility checks during vMotion might prevent the virtual machine from moving to another host.
- You must power off or suspend the virtual machines before you begin the **cold migration** process. **Migrating** a suspended virtual machine is considered a **cold migration** because although the virtual machine is powered on, it is not running. You cannot implement a **cold migration** across different subnets.
- When you migrate a suspended virtual machine, the new host for the virtual machine must meet CPU compatibility requirements. This requirement allows the virtual machine to resume execution on the new host.

Storage Area Network

- Storage area network (SAN) refers to the LAN design for managing huge amounts of data transfer.
- It uses interconnection technology for supporting data storage, retrieval, and replication. NAS works on TCP/IP, whereas SAN for disk blocks transformation works on low-level network protocols.
- Storage area networks are actually designed for data management. It is a rapid storage device network and can be connected with servers.
- SAN is helpful for transferring data from one storage device to another without disturbing other devices.
- SAN also supports fast backup as CPU cycles of server are not involved in the backup process. At the time of recovery, SAN plays an important role.

Storage Area Network

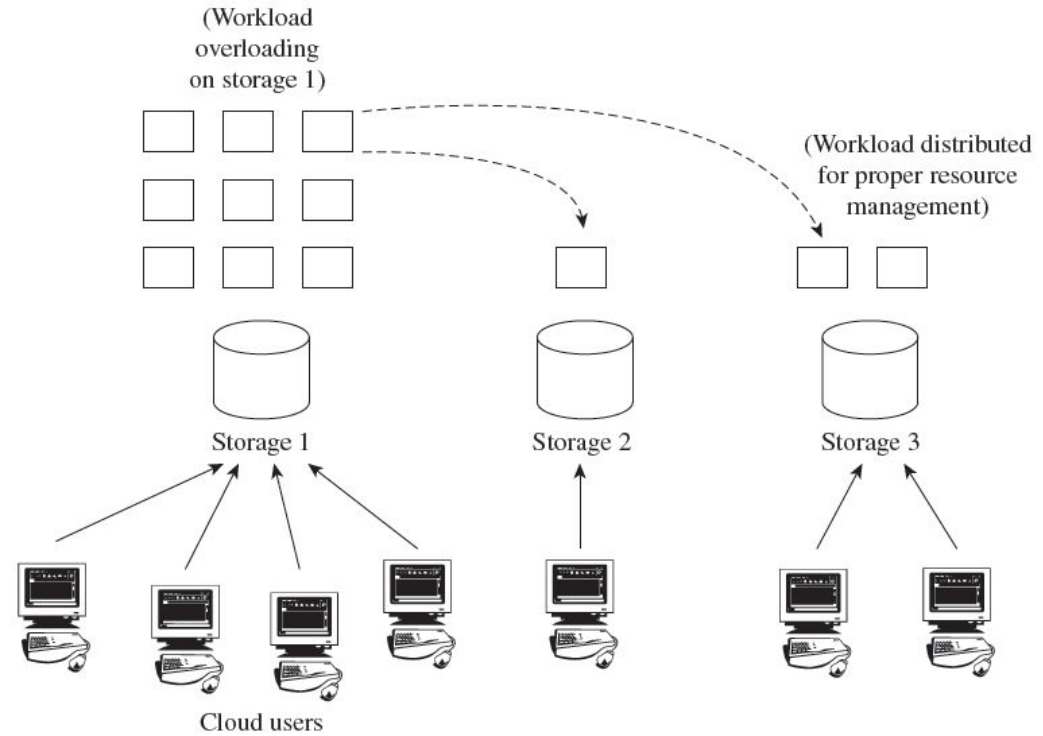


Fig. 6.10 Storage area network—SAN

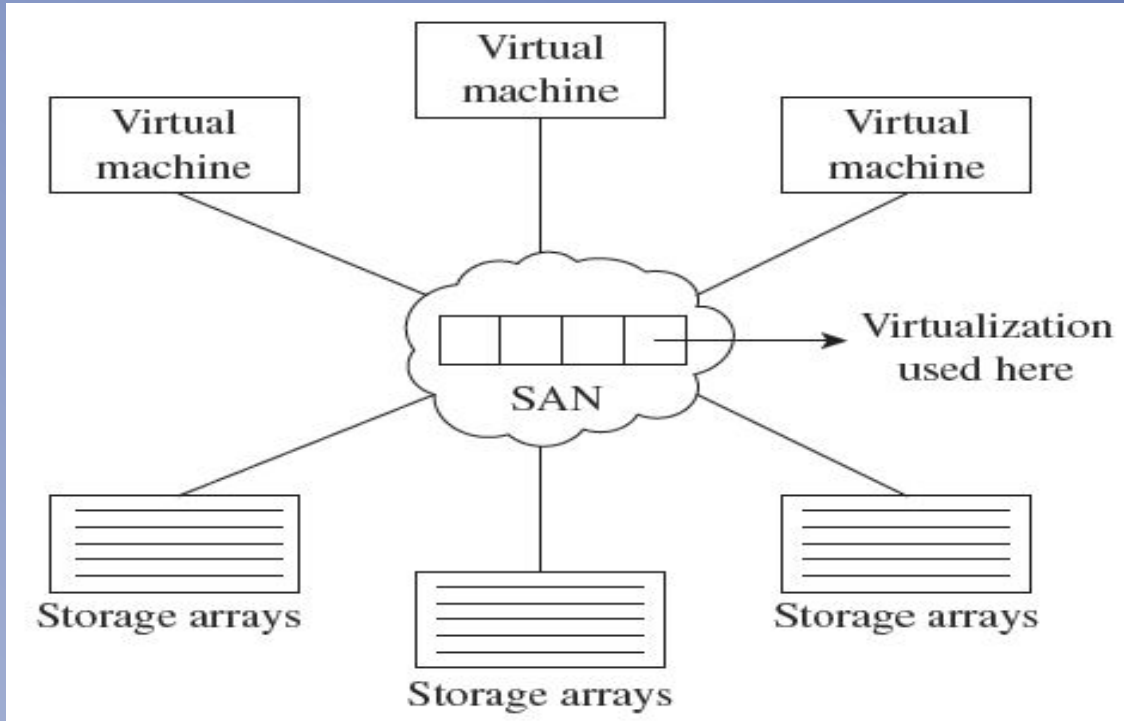


Fig. 6.11 Block-level storage virtualization

Network Attached Storage

- Network-attached storage (NAS) is actually a dedicated file storage device for providing local area network nodes with file-based shared storage using a standard ethernet connection.
- NAS has its own IP address and each NAS exists on the LAN as an independent network node.
- Some examples of NAS devices include Seagate Central, Seagate Business Storage NAS, and 8-Bay Rackmounts. All NAS products provide a secure and centralized location for the files.
- Accessing of NAS system storage data is easy—it can be accessed from anywhere, whether one is in own house, on another computer, or through mobile, Wi-fi technology, etc.

Network Attached Storage

- NAS has the following benefits:
  - Broad access to information
  - Better efficiency
  - Better flexibility
  - Centralized storage
  - Simplified management
  - Scalability
  - High availability
  - Security

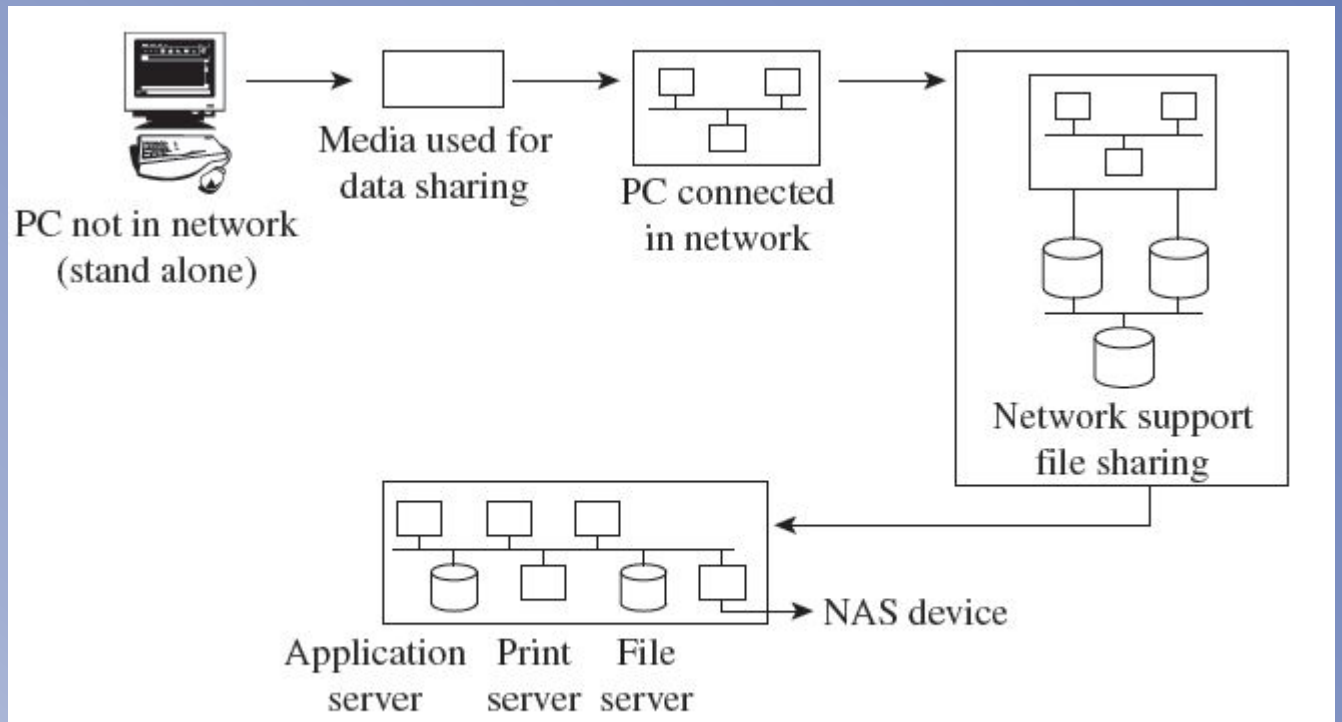


Fig. 6.12 File sharing technology using NAS

Network Attached Storage

- NAS has the following components:
  - NAS head (CPU and memory)
  - Network interface cards (NICs) for providing connectivity
  - Operating system for handling NAS functionality
  - Network file system (NFS) and common Internet file system (CIFS) protocols for file sharing. NFS mainly supports UNIX-based operating environments, whereas CIFS is supported by Microsoft Windows-based operating environments. Supported file sharing protocols facilitate users to share files with different operating platforms.
  - Storage protocols to connect and manage physical disk resources
  - Storage array

Network Attached Storage

- **Comparison between SAN and NAS:**
  - Storage area network (SAN) supports networking, whereas network-attached storage (NAS) is a storage device, in a network.
  - Operating systems consider SAN as a disk, whereas a NAS device is a file server.
  - SAN supports block-level storage for servers, whereas NAS devices support file-level storage. For saving files such as word documents or MS Excel spreadsheets, NAS is generally used.

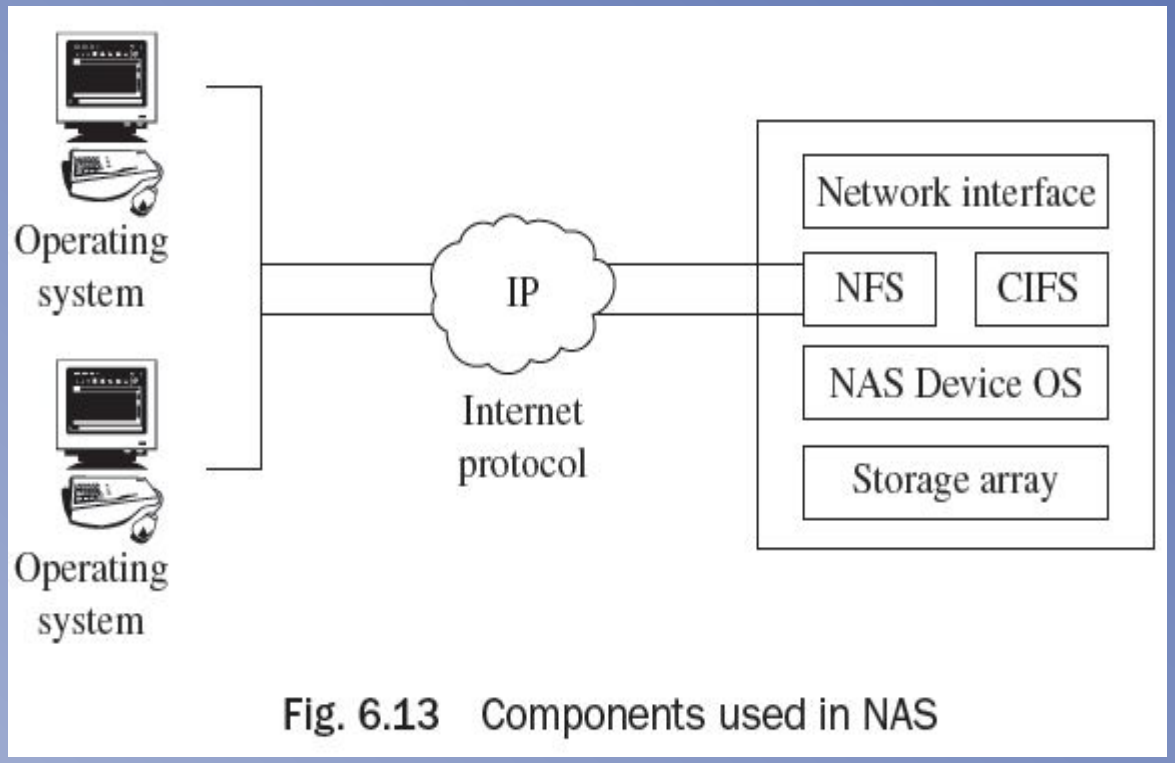


Fig. 6.13 Components used in NAS

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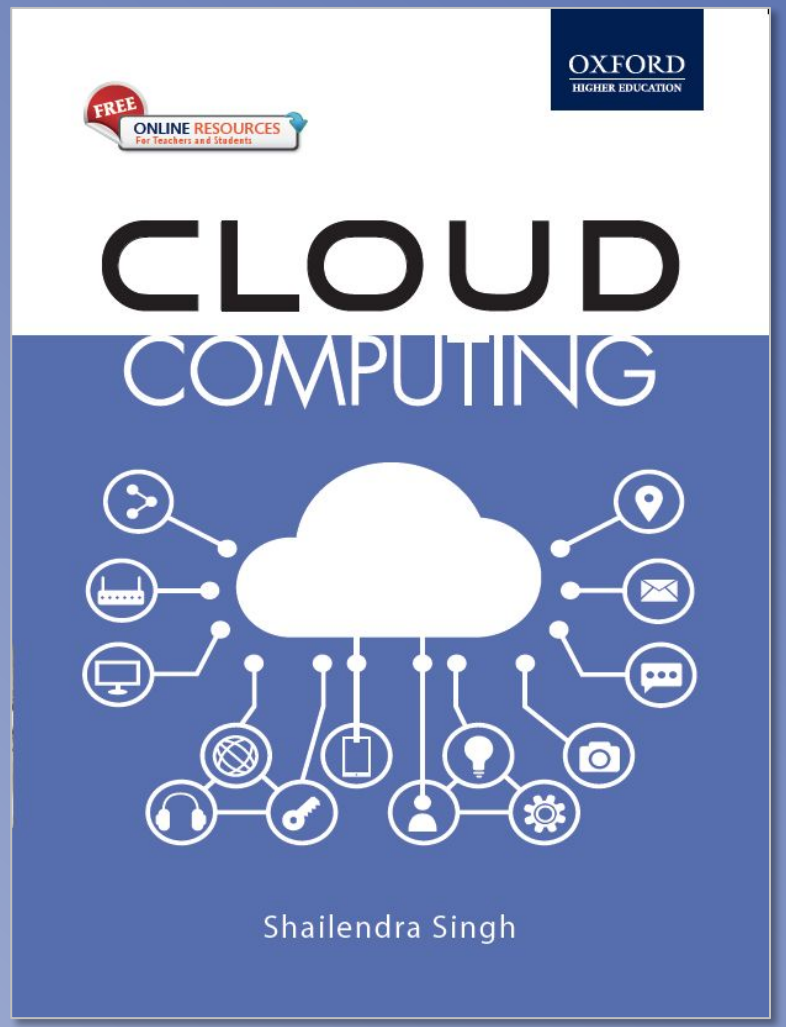

Chapter 7

Virtualization Technology (At Network)

Learning Outcomes

- Comprehend network virtualization
- List the benefits of network virtualization
- Explain the benefits of virtualization
- Describe various network components
- Understand traffic management techniques
- Understand virtual machine migration services

Exploring Network Virtualization

- In network virtualization, multiple virtual networks run with the help of a physical network as shown in Fig. 7.1.
- Network virtualization comprises rationally grouping and segmenting physical network (s) into distinct rational units known as 'virtual network(s)' and forming them to act as one or multiple separate network(s).
- It permits multiple virtual networks to share network resources.

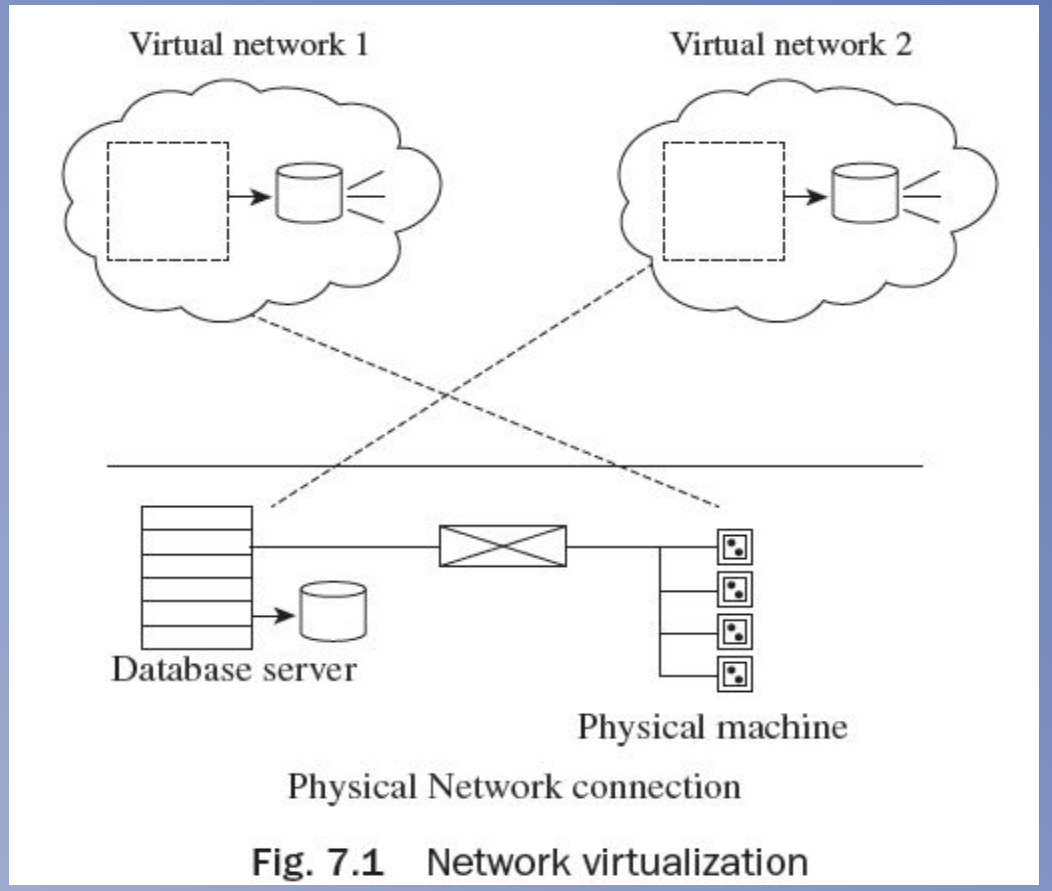

Fig. 7.1 Network virtualization

Exploring Network Virtualization

- In virtual data center (VDC), network virtualization comprises virtualization of both VM and physical networks.
- The physical network may consist of network routers, hubs, switches, repeaters, adapters, and bridges.
- A VM network exists within a physical server.
- 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.
- Network virtualization permits a manager to construct multiple virtual networks in the data center (DC).
- A virtual network offers alignment of all the nodes which belong to a similar working unit in an enterprise.

Benefits of Network Virtualization

- Reduction of hardware expense
- Energy expenses
- Recoverability
- Disaster recuperation

Features of Network Components

- Virtual Switches
- Virtual LAN

Virtual Switches:

- Virtual switches act as an interface between virtual ethernet and the physical ethernet. Virtual switches develop VM network and support the ethernet protocol as shown in Fig. 7.2.
- They manage storage, administration, and VM migration traffic to and from the hypervisor kernel.
- A virtual switch can have multiple port groups.

Features of Network Components

- The IBM system Networking Distributed Virtual Switch 5000V is a superior, feature rich distributed virtual switch for VMware environments along with policy-based VM associatively. The IBM Distributed Virtual Switch (DVS) 5000V allows network managers accustomed with IBM System.

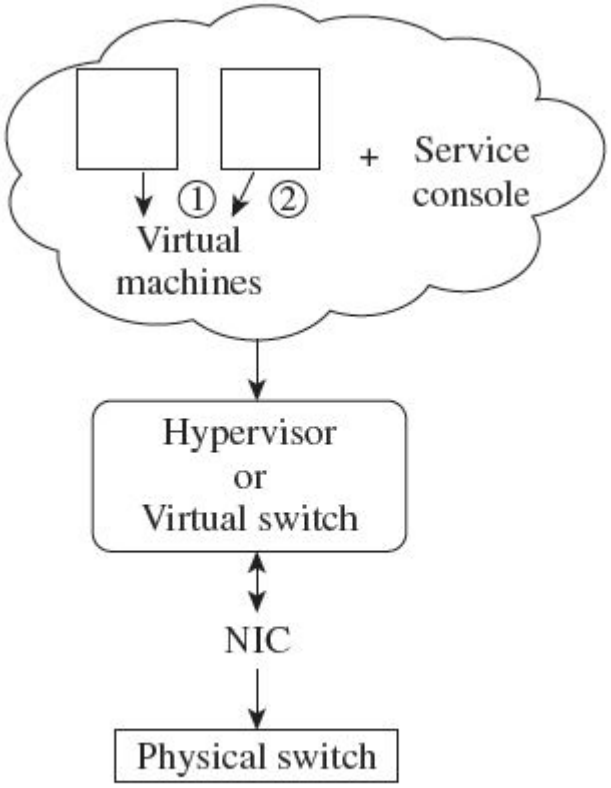

Fig. 7.2 Virtual switch

Features of Network Components

- Virtual LAN allows one to have separate LANs among ports on the same switch.
- VLAN trunking allows traffic from multiple VLANs to tr
  connection.
- VLAN membership can be defined in several ways:

(a) Port-based

(b) Protocol-based

(c) MAC-layer grouping

(d) Network-layer grouping

(e) Multicast grouping

(f) Policy grouping

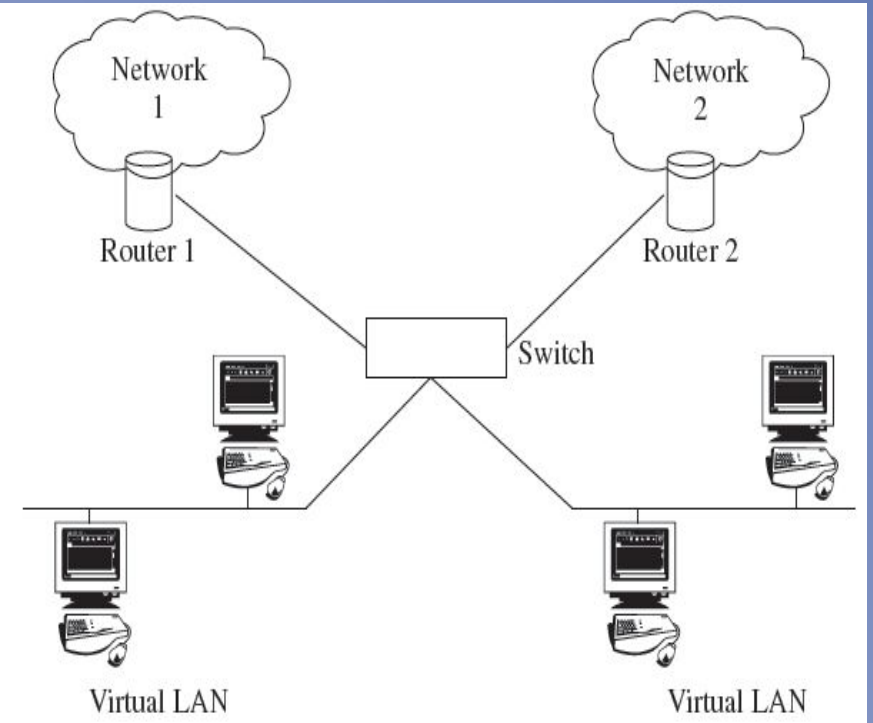

Fig. 7.3 Virtual LAN

Traffic Management and its Techniques

- Resource management of various resource instances between various users in a cloud computing environment as per user requirement is called traffic management.
- Cloud computing is generally based on adaptive traffic management and control techniques.
- In VDC, network managers have a suitable policy for allocation of network traffic across network connections and VMs.
- Load balancing is one of the key matters in cloud computing. It is a procedure which allocates the extra dynamic regional workload consistently across all the nodes. It also assists in facilitating scalability, executing fail-over, and minimizing the response period preventing blockage and over-provisioning, and many more.

Traffic Management and its Techniques

The network governing skills are as follows:

1. Technique 1: Balancing client workload—hardware
2. Technique 2: Balancing client workload—software
3. Technique 3: Storm control
4. Technique 4: NIC teaming
5. Technique 5: Limit and share
6. Technique 6: Traffic shapping

Load Balancing in Cloud Computing

Load balancing that is presently prevalent in clouds is as follows:

- Decentralized content alert load balancing
- Server-based load balancing for Internet allocated services
- Join–Idle–Queue
- A lock-free multiprocessing for load balancing (LB)
- Scheduling scheme on load balancing of virtual machine resources
- Central load balancing policy for virtual machines (CLBVM)
- Load balancing scheme for virtual storage (LBVS)
- Task scheduling algorithm based on load balancing
- Honeybee foraging behaviour

Load Balancing in Cloud Computing

- Biased random sampling
- Active clustering
- Load balancing procedure based on ant colony and complex network theory (ACCLB)
- Two-phase load balancing algorithm
- Event-driven
- Carton
- Compare and balance
- Overheads associated
- Throughput
- VectorDot

Virtual Machine Migration Services

- VM migration is one of the vital strategies in the field of physical machine virtualization that permits applications to be clearly moved with their implementation settings across physical machines.
- Virtual machine migration is required for server consolidation (power saving), resource scheduling, and load balancing. For successful migration, interruption and migration time should be minimized.
- The various virtual machine migration methods are :
  - Fault Tolerant Migration
  - Load Balancing Migration
  - Energy Efficient Migration
    - ✔ Pre-copy-based migration
    - ✔ Post-copy-based migration

Virtual Machine Migration Services

- ***Post-copy-based migration***

The steps included in the post-copy technique are as follows:

1. The virtual machine is on the source machine.
2. The execution state of the virtual machine is transferred before memory is transferred and if the page generates page fault then the requested page is transferred.
3. The virtual machine is activated on the target machine, later.

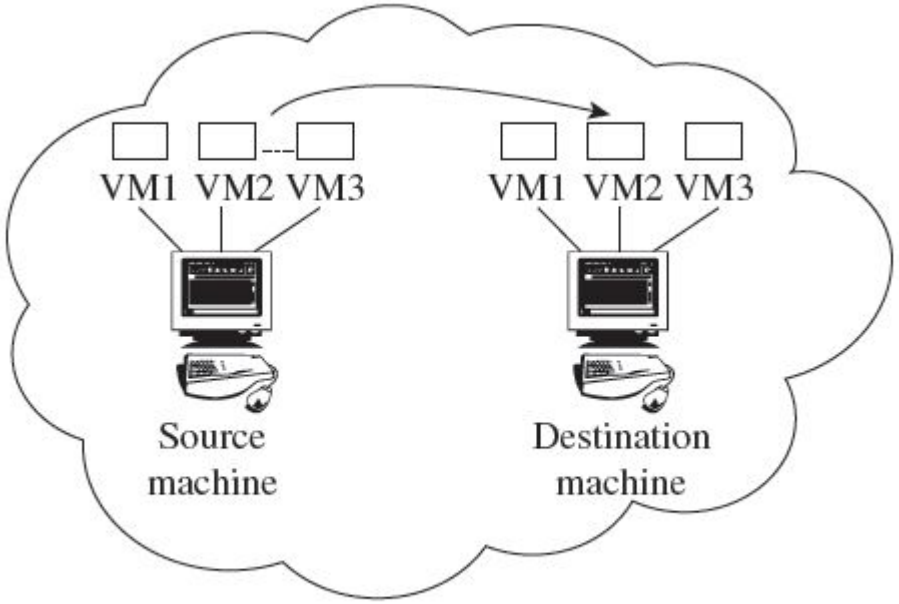

Fig. 7.7 Post-copy migration

Virtual Machine Migration Services

Pre-copy-based migration

- Pre-copy technique is usually employed for live migration. In the beginning, it shifts each of the memory pages to the target machine. Then, iteratively, copies of pages are altered in the last round as shown in Fig. 7.8.1.

The steps included in pre-copy migration are as follows:

1. Send all the memory pages to the target machine
2. Transfer the modified pages
3. Virtual machines activate the target machine

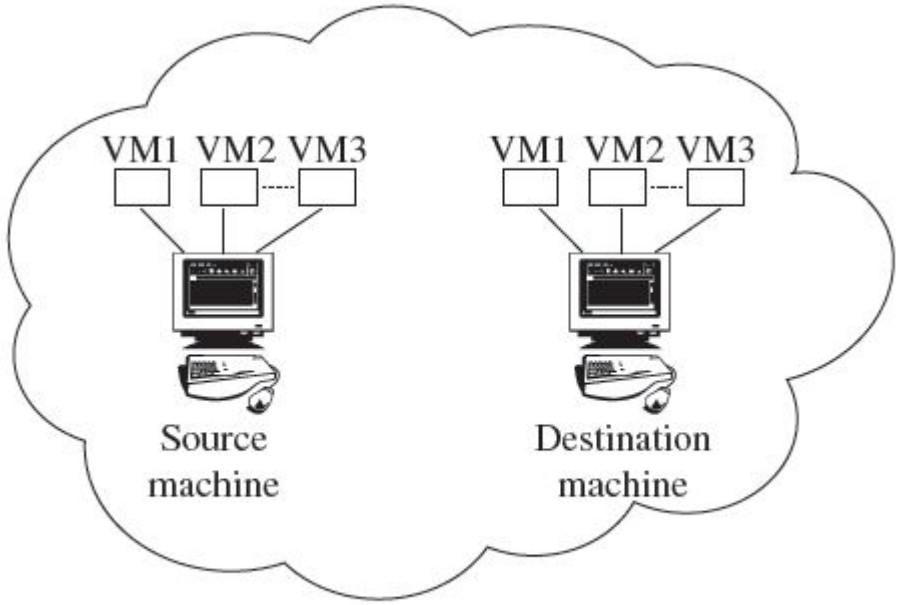

Fig. 7.8 Pre-copy migration

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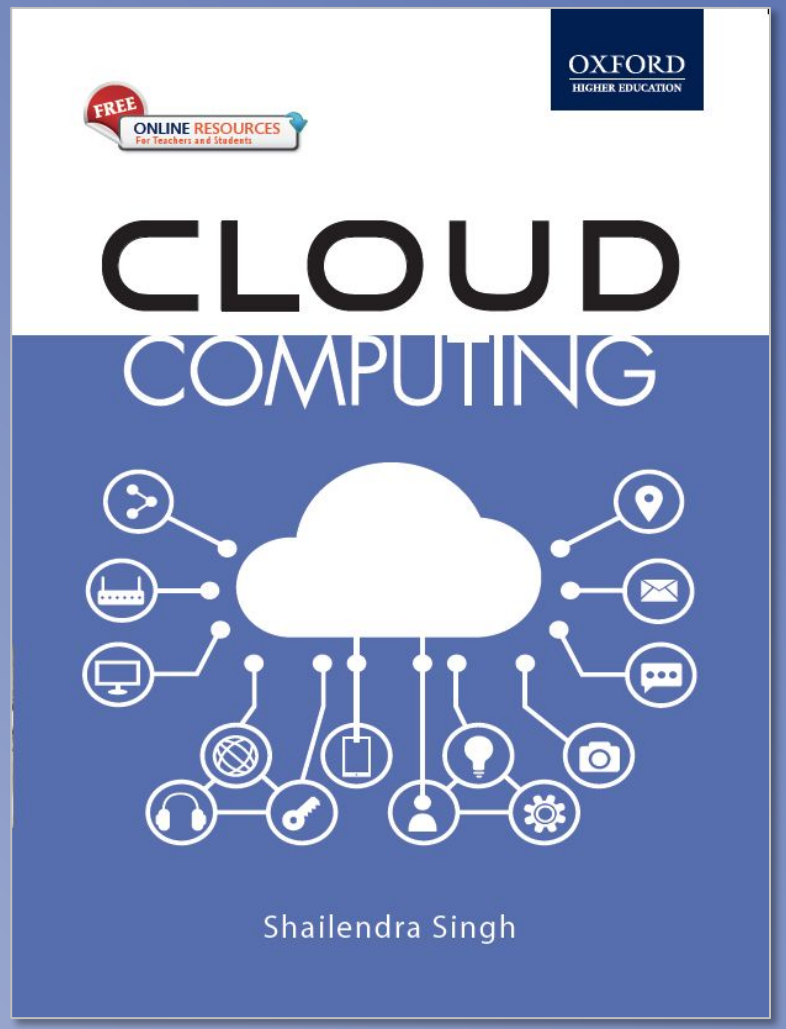

Chapter 8

Virtualization Technology (At Desktop and Application)

Learning Outcomes

- Comprehend desktop virtualization
- Describe techniques used for desktop virtualization
- Illustrate remote desktop services
- Explain hardware virtual machine
- Understand infrastructure of desktop virtualization
- Describe components of desktop virtualization
- Describe machine imaging
- Describe VM migration services management

Introduction

- Desktop virtualization is actually a type of illusion provided to the user using different techniques.
- It involves encapsulating and delivering either access to an entire information system environment or the environment itself to a remote client device.
- For IT organizations, desktop administration is expensive, manual, and time-consuming.
- As compared to desktop virtualization, server virtualization makes datacenters more quick and effective by advanced levels of accessibility, quicker application delivery, and enhanced utilization.

Desktop Virtualization

- Desktop virtualization is a type of software technology used to separate the desktop and its connected application software from the physical device used by the client.
- Remote desktop virtualization works in a manner similar to client–server model in which applications can be executed on any remote desktop with different operating systems and with the help of the protocol of remote display, a user can interact with the application as shown in Fig. 8.1.
- In a virtualized desktop, virtualization breaks the connection between hardware and the elements facilitate the IT staff to alter, update, and organize these elements independently for greater business quickness and improved response time.

Desktop Virtualization

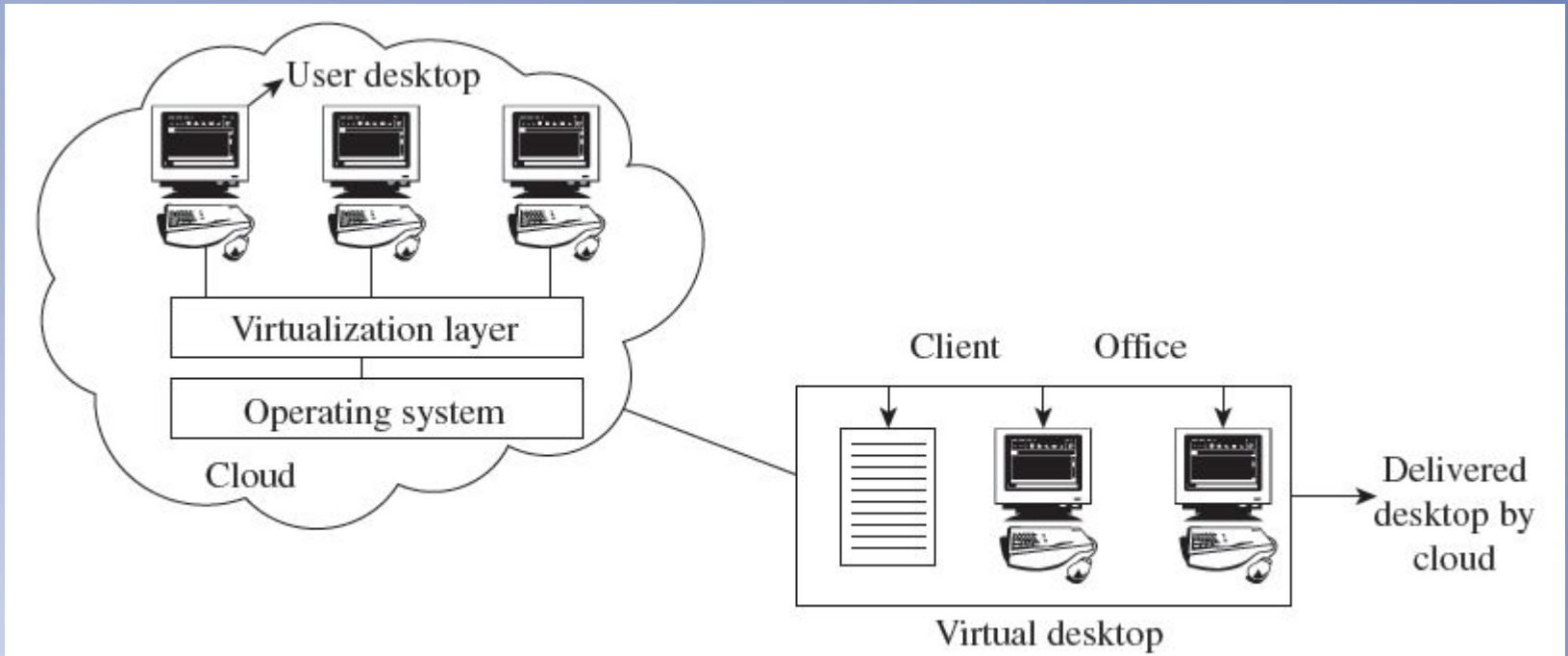

Fig. 8.1 Desktop virtualization

Advantages of Desktop Virtualization

- Simpler provisioning of new desktops
- Installation of new applications at cheap rates
- Desktop image-management capabilities
- Increased data security
- Longer time given for customer desktop infrastructure
- Protected reserved access to a business' desktop settings

Advantages of Desktop Virtualization

- Facilitation of thin clients
- Improved security
- Better business continuity and disaster recovery
- Abridged PC repairs
- Suppleness of access
- Improved deployment and management

Features of Desktop Virtualization Drivers

- Reduction in cost of desktops
- Reduction in management cost of desktop
- Easy setting of desktops
- Reduced cost to refresh desktops

Techniques used for Desktop Virtualization

- The two desktop virtualization techniques basically used for providing services to users are as follows:
  - Remote desktop services (RDS)
  - Virtual desktop infrastructure (VDI)

VDI and RDS are designed for providing services to users as per their requirement.

Differences between RDS and VDI

RDS	VDI
Separate virtual machines are not provided to the user	Separate virtual machines are provided to the users
Multiple operating systems' instances need not be managed	Multiple operating systems' instances need to be managed
Various users share the same virtual machines and operating systems	Same resources need not be shared
Full administration is not provided to the users because many instances of the same resources are shared by many users	User gets full administration over resources
Less resource utilization of CPU, memory elements, etc.	More resource utilization

Remote Desktop Services

- Remote desktop services (RDS) is customarily called terminal services. It is a blanket term for characteristics of Microsoft Windows server which permits consumers to distantly access Windows applications and graphical desktops.
- The advantages of RDS are as follows:
  - Data recovery in tragedy
  - Operation from anyplace
  - Economical

Remote Desktop Services

- The disadvantages of RDS are as follows:
  - Requirement of powerful RDS
  - Requirement of RDS monitoring
  - Requirement of reliable network
  - Requirement of right adjustment in network
  - Knowledgeable administrator

Virtual Desktop Infrastructure

- Virtual desktop infrastructure (VDI) refers to the hosting of a desktop OS running in a VM on a server in the virtual data center (VDC).
- VDI allows a user to access a remote desktop environment from an endpoint device via a remote desktop delivery protocol.
- The VDI architecture consists of several components that work together to provide an end-to-end solution.

Virtual Desktop Infrastructure

- Advantages of VDI are:
  - Low price in buying desktop computers
  - Centralized client operating system management
  - Swift client implementation
  - Reduction in the costs of desktop
  - Reduction in the cost of electricity
  - Enhanced security of data
  - Protected remote access
  - Lesser applications compatibility troubles

Virtual Desktop Infrastructure

- Disadvantages of VDI are:
  - Printing normally involves third-party appends
  - Scanning is natively unsupported
  - Bi-directional audio is natively unsupported
  - Exhibit protocols are unsuitable for graphic design
  - Needs low-latency association between the virtual infrastructure and customer
  - Needs enterprise class server hardware and storage areas network for VMs permanently delivered to particular users
  - Needs trained IT staff

Components for Desktop Virtualization

- The VDI architecture consists of several components that work together to provide an end-to-end solution. The main components are:
  - Endpoint devices
  - A connection broker
  - VM hosting

Application Virtualization

- Application Virtualization technology offers skills to install applications without altering or making any variation to the file system, underlying OS, or registry of the computing platform in which they are installed as shown in Fig. 8.2.

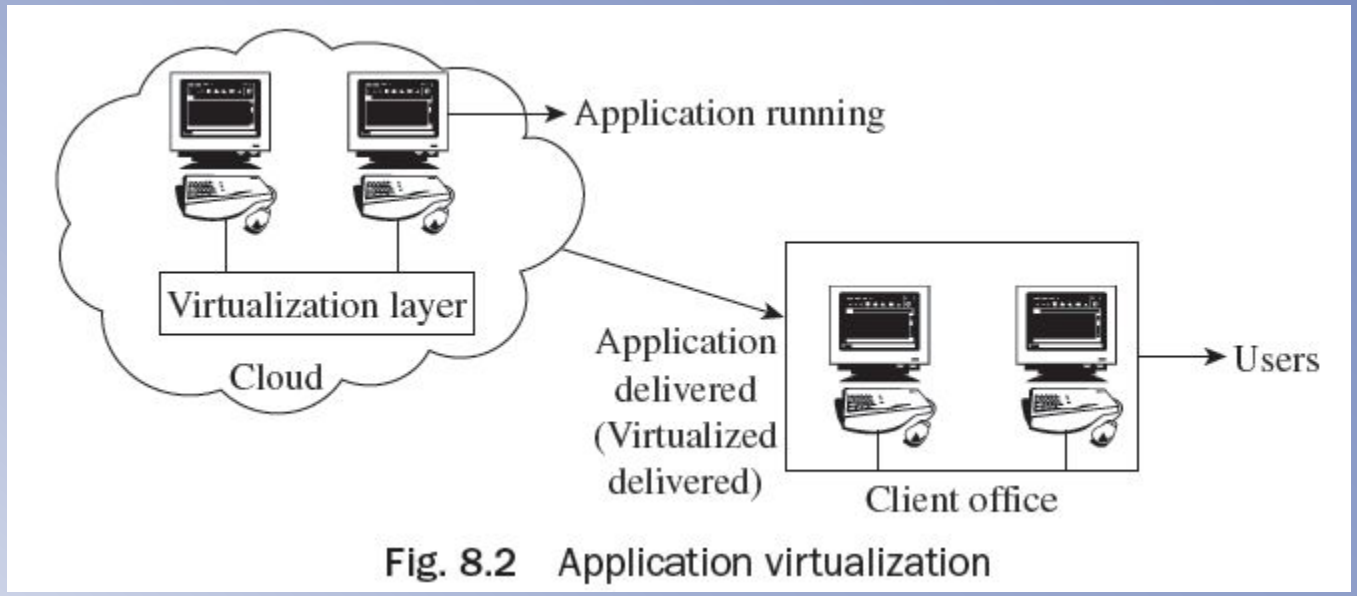

Fig. 8.2 Application virtualization

Application Virtualization

- Technology categories that fall under application virtualization include the following:

- **Streaming of application**: Before startup, rather than delivering the whole application, portions of the application's code, settings, and data are delivered according to their requirement.

- **VDI or desktop virtualization**: The application is introduced in blade PC or VM which also comprises the operating system (OS). This makes management of infrastructure and formation of virtual desktops easy to grant access of virtual desktops. VDI may normally fill up the gaps wherever applications' streaming fails.

Application Virtualization

Advantages of Application Virtualization:

- Improved workload management
- Reduced hardware cost
- Increased flexibility for working remotely
- Simplified application deployment: Applications are never installed on to an operating System; hence the deployment of the applications is greatly simplified. Furthermore, complete removal of all application bits from a PC during retirement is assured.

Application Virtualization

- Simplified operating system image management: Since applications are completely different from the OS, managing OS images is simpler, especially during OS patches and upgrades. It helps to create a more dynamic desktop environment, in which the desktop is an aggregation of separately managed components.
- Elimination of resource conflicts: Since each application has its own virtual OS resources, resource and application conflict issues are eliminated.

Application Virtualization

Limitations of Application Virtualization:

- All software cannot be virtualized. For example, applications that require a device driver or 16-bit applications that require shared memory space cannot be virtualized.
- Some types of software cannot be virtualized, such as anti-virus packages and applications that require heavy OS integration.

Tools used for Application Virtualization

- The tools for application virtualization include:
  - Microsoft Application Virtualization (App-V)
  - VMWare ThinApp
  - Flexera Software Supporting Application Virtualization

Hardware Virtual Machine

- Hardware virtualization technique is used to make a physical machine a virtual machine.
- Hardware virtualization is a developing technology which can turn out to be foremost, particularly for server platforms.
- Virtual machines, along with hardware editions earlier than edition 8, may work on ESXi 5.0 hosts but do not encompass all the facilities accessible in hardware edition 8.
- A VM is described as a physical machine by software which has its individual array of virtual hardware on which an application and operating system may be overloaded.

Porting Application

- Porting is a method of making software adaptive to every situation for which it was not initially written or planned to perform.
- It is also compatible with different hardware configurations.
- The three favored platforms are those from UNIX, Apple, and Microsoft, making it simpler to build software that is transferable.
- Customer requirements and platforms are generally different from each other, but for availing services of the cloud environment, customers have to interact with the cloud services provided by the cloud providers.

Virtual Machine Migration Services Management

- Virtual machine migration is mostly done for dynamic resource administration.
- Its chief aims are:
  - Load balancing
  - server consolidation
  - coldspot and hotspot mitigation.

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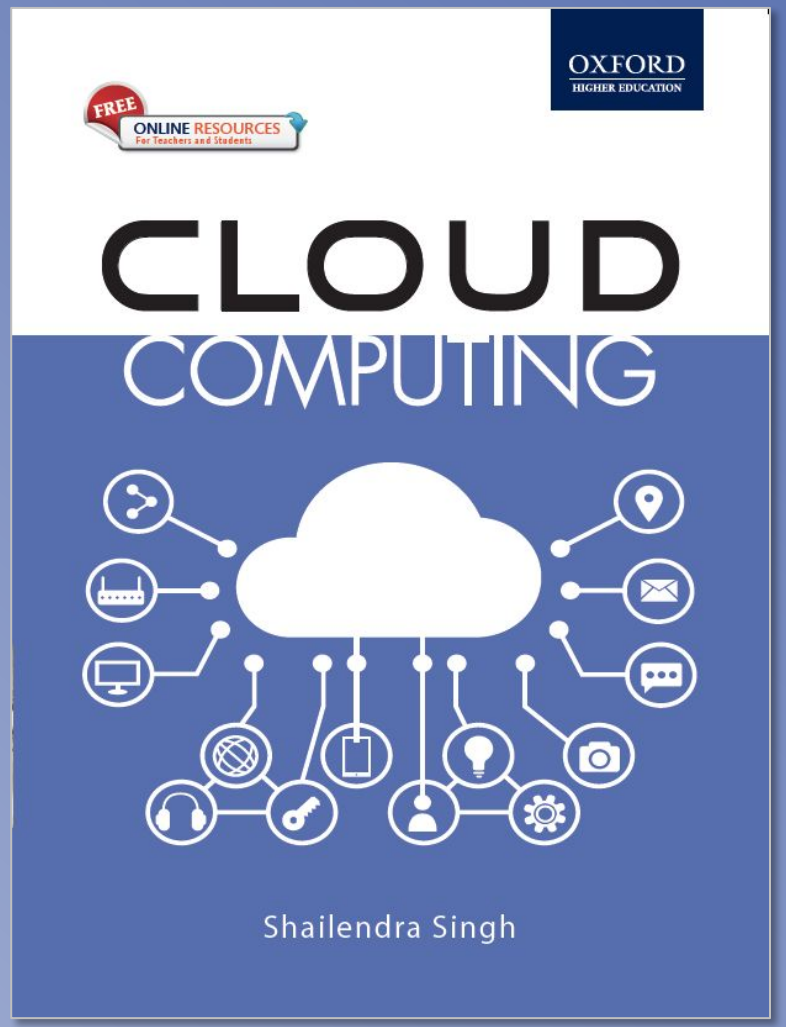

Chapter 9

Cloud Infrastructure Management and Migration

Learning Outcomes

- Comprehend various service creation tools
- Describe the web application programming interface
- Describe the unified management software
- Understand cloud service management
- Describe the way to access cloud
- Understand cloud migration
- Describe banking on cloud

Introduction

- Virtualization is a key feature that supports cloud computing.
- A cloud with a more virtualized infrastructure has higher resource utilization.

Administrating Clouds

- Various suppliers possess products structured for cloud computing management, such as OpenQRM, Managed Methods, VMware, and Cloud Kick, together with established names such as CA, BMC, IBM, Tivoli, and HP.
- The main features are provided by the main cloud substructure managing products which are as follows:

1. Almost all of these assist in designing and furnishing new items and in eliminating useless items.
2. Almost all offer a common set of reports on status such as response time, used quota, uptime, etc.
3. Almost all of these assist distinct clouds forms (often stated as hybrid clouds).

Administrating Clouds

- Few suppliers present comprehensive means in handling metrics and managing provisioning in hybrid environments and they are Zeus, Morph, RightScale Kaavo, and Scalr.
- Cloud suppliers offer certain options to meet the first and second standard, like CloudWatch by Web Services of Amazon.
- HP company Open View, also known as Operating Manager, can administer cloud-based servers, but in the same way as administered by some other server.

Cloud Management Products

- The framework of cloud infrastructure is made up of the following components:
  - Physical infrastructure
  - Virtual infrastructure
  - Applications and platform software
  - Cloud infrastructure management and service creation tools

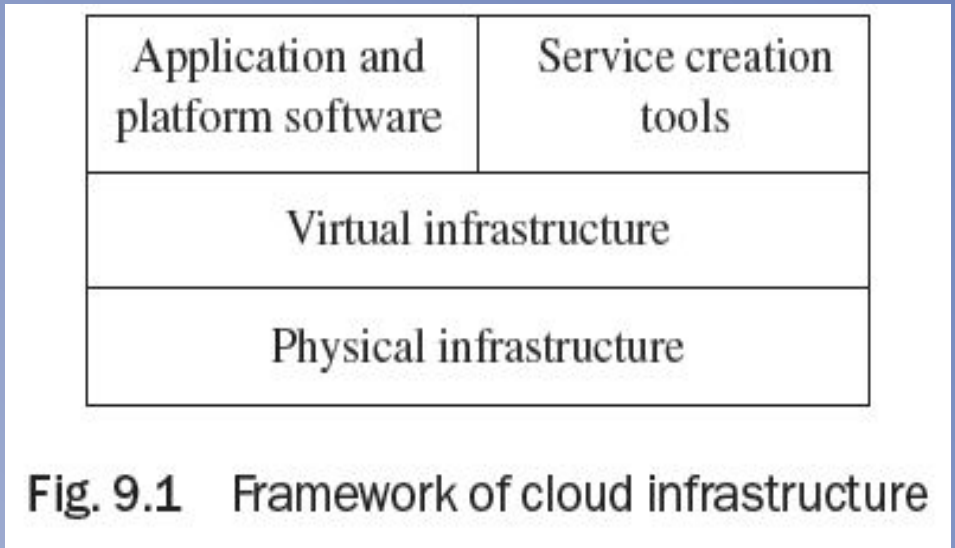

Fig. 9.1 Framework of cloud infrastructure

Unified Management Software

- Unified management software interrelates with all individual virtual infrastructure management software and gathers data on the accessible virtual and physical infrastructure patterns, connectivity, and consumption.
- The vital purpose of unified management software is to generate cloud services.
- Unified management software assists in classifying cloud services. It permits a manager to roll all the services together with their service traits.
- Unified management software facilitates generating a variety of cloud services along with varied service traits.

Unified Management Software

 Unified management comprises the following:

- Automation of IT sequence with incorporation into accessible IT systems' management tactics
- Self-service portal and service catalog for IT resources along with on-demand provisioning
- On-demand provisioning offered along with self-service portal and service catalog for IT resources
- Resource management for efficient operation of hardware infrastructure groups
- Automatic workload for carrying effectual batch and event-driven project business measures

Unified Management Software

- Automatic workload for carrying effectual batch and event-driven project business measures
- Life cycle management from request to retirement
- Strategy-based administration destined for improved handling and governance
- Virtual and physical assets administration
- Automatic network provisioning
- Automation and setting up for huge data and business enterprise aptitude workloads

Unified Management Software

- Resource allocation comprises generating service cases and assigning resources from bundles to service cases when customers ask for services. At the occasion of generating service cases, VMs are built and incorporated with virtual volumes (virtual disks) and VLANs. Platform software and application can be deployed on the VMs. The service cases get storage, network, and compute capacity from suitable bundles. The allotment of aptitude and software deployment pursues traits described for the service.

Processes in Cloud Service Management

- Cloud service management procedures perform in the environment to make certain all the service tasks are carried out as committed. Processes included in cloud service management are:

- Service benefit and configuration administration
- Capacity administration
- Performance administration
- Incident administration
- Problem administration
- Availability administration
- Service catalog administration
- Financial administration
- Compliance administration

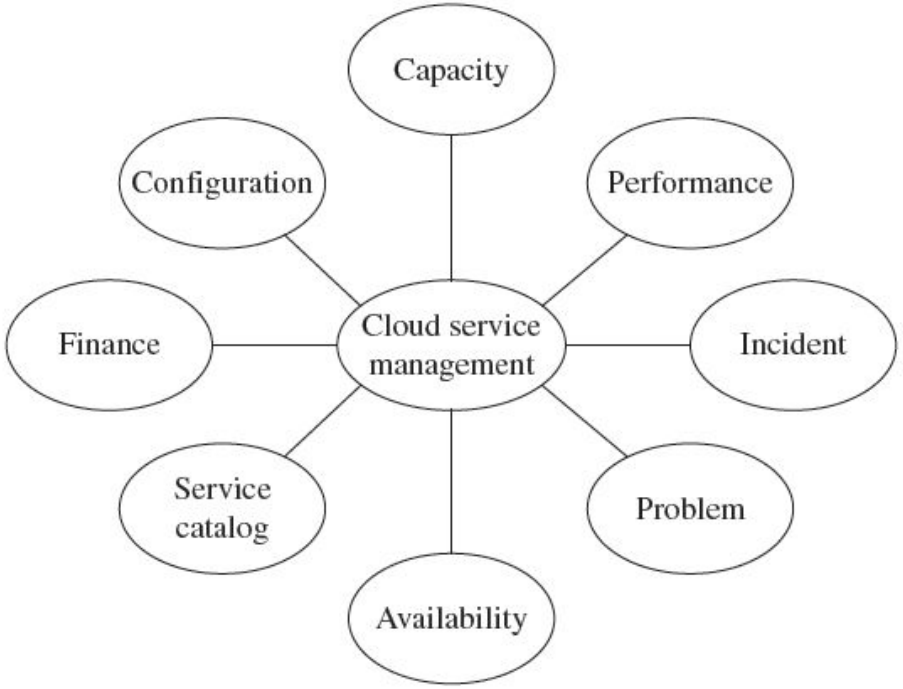

Fig. 9.2 Process administration involved in cloud service management

Differences between Traditional IT Services and Cloud Services

	Traditional IT services	Cloud services
Data	If there is a requirement for higher bandwidth or storage, you should upgrade your package. These packages are generally deployed on a monthly or yearly subscription.	According to your requirement, cloud services permit you to alter the bandwidth and storage. When you are not using bandwidth, you need not pay for it.
Performance	When any issues occur, you need to be worried	A backup facility is provided by cloud services that gets activated during issues in the main server. The data is retrieved as well as saved within a secure period.
Security	Less secure	More secure

How to access the Cloud

- For accessing the cloud, an Internet connection is required.
- Every provider offers a certain function so that users can manage their clouds according to their form.
- One can buy additional storage space at any time from the respective cloud provider according to technological requirements, thus the cloud provider will offer services on a pay-as-you-use method.
- The tools required for accessing cloud services and tools are Platforms, Web Applications, Web Application Programming Interface, Web Browsers.

Migrating to Cloud

- A corporation's aim of migrating to the cloud must be a clear perceptive of what the cloud may and may not do it.
- A well-formed cloud policy needs thorough deliberation of every cloud service kind, installation module and access alternative considered against specific application characteristics of the company.
- A full-grown immigration policy will be expected in various objects, but among these, three are the most vital—organizational customs, IT governance, and virtualization.

Advantages of Clouds

- **Scalable**—Nearly all cloud-computing services are payable as per a monthly charge. Therefore, if your business expands, you may order additional server space.
- **Nearly zero provisioning cost**—Along with the cloud, you need not establish a server and waste the man-hours it takes to get one, up and working.
- **Money can be saved for other means**—It lessens the expenses involved in setting up a novel infrastructure.
- **Fewer IT infrastructure staff to administer**—Along with cloud computing, you need not employ a technical group to administer and scrutinize the cloud.

Disadvantages of Clouds

- **Scarcity of control**—Servers might not be directly administrated by you, but even now you are accountable for your data. Before deciding on a cloud service, you must inquire about the backup system, safety, and upholding policies. Decide what happens to your data if the company modifies hands or moves out of business, and understand that your company even possesses the information and may get it from the cloud whenever you need it.
- **Integrating systems**—It is impossible for everybody to shift a corporation totally to the cloud due to the systems it has constructed already.

Disadvantages of Clouds

- **Speed**—Along with the data transfer speed, cloud-based services sometimes do not communicate among themselves during low-speed connectivity.
- **Cost**—As there is no up-front assets' investment associated with cloud services, the technology is yet to have long-standing expenses' investments. The expenses linked with downtime, renewing of native computers to access the system, and unavoidable unpredicted faults are all drawbacks for drifting to the cloud.

Challenges in Migration to and from the Cloud

- Successful cloud migrations need adequate resources and time.
- The three main dealers—Google, Microsoft, and Amazon,—control the cloud market, whereas most businesses use multiple dealers' apps instead of asking employees to follow one set of devices.
- With the lack of third-party support, controlling cloud apps might be a budget buster.
- Safety remains the biggest obstacle to cloud adoption.
- Although various businesses have made the jump to the cloud, almost one quarter is still uncertain to migrate—mainly because of concerns over safety.

Banking on Cloud Economics

- The cloud computing module is a modern conception of computation which offers a number of advantages for its adopters, for example, that of the same physical infrastructure being easily shared by many users with virtualized infrastructure.
- Such an online computing module has been broadly used in the western world and assumed to have some trade and financial effects.
- For predicting the effects of the cloud computing acceptance, various models are built. Several strategy executions comprise the support of the cloud computing adoption in banks and universities for comprehending the advantage of efficient usage and scalability of computing resources.

Thank You!