Cloud Computing and Virtualization
(2601602)

Unit 1. Cloud Computing Fundamentals

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Reference:
Buyya, R., Vecchiola, C., & Selvi, S. T. (2013). Mastering cloud computing: foundations and applications programming. McGraw Hill.

A study material for the students of GLS University

Agenda

- Introduction
- History of Cloud Computing
- Characteristics of Cloud
- Cloud Computing Models
- Deployment Model
- Service Model
- Issues and Challenges of Cloud Computing
- Advantages and Disadvantages of Cloud Computing
- Threats to Cloud Computing
- Next Generation of Cloud Computing

Utility Computing

➢ 1969 Leonard Kleinrock one of the chief scientist of ARPANET said…

➢ "As of now computer networks are still in their infancy, but as they grow up and become sophisticated, we will probably see the spread of "computer utilities" which, like present electric and telephone utilities, will service individual homes and offices across the country"

Introduction

➢ Internet is increased day-by-day, and most of peoples are use the Internet-based computing system, this is called the CLOUD COMPUTING.

➢ The software and Hardware resources are available for the users as per his/her demand.

➢ It allows the users to share the storage, computing resources and also provides the infrastructure for the sharing of these resources. This helps to reduce the cost of various applications.

➢ It uses the distributed network to provide different services and application to the users and also support for virtualize resources.

What is Cloud Computing?

Definition:

Cloud Computing is the delivery of computing services like servers, storage, databases, networking, software, over the internet ('the cloud') to offer faster innovation, flexible resources, and economies of scale.

Analogy:

Compare to electricity: "You don't generate your own electricity; you pay for what you use from a provider. Similarly, with the cloud, you pay for IT resources you consume."

Introduction

- CC has two Important features

1) Abstraction

2) Virtualization

Abstraction :-

➢ The CC collects the abstract information from the developers as well as from the end users which includes the details about the implementation of the system.

➢ It is hiding the information about the location of the storage where the data store.

➢ There is not specified that the physical computer systems runs on which the application.

➢ The administrations of the computer system are out-sourced and done by others.

➢ The users can access the application and services at anytime from anywhere.

Introduction

- Virtualization :-

  ➢ In the CC, the sharing and the pooling resources by the application are very important, this is called the virtualization.

  ➢ The centralized infrastructure is used to provide applications and storage space as per demand of the end users.

  ➢ The users have to pay as per the usage and the payment are calculated on a metered basis, the resources are scalable and the multi-tenancy is making possible.

Diffused view of Cloud computing

- I don't care *where* my servers are, *who* manages them, *where* my documents are stored, or *where* my applications are hosted.
- I just *want them always* available and *access* them from *any device* connected *through Internet.*
- And I am *willing to pay* for this service for as long as I need it.

Subscription/Utility Oriented

➤ Whether Cloud Computing service or not can be decided by answering following questions:

➤ Is the service accessible via a Web Browser (non proprietary) or Web Services API?

➤ Does it incur almost ZERO capital expenditure to get started?

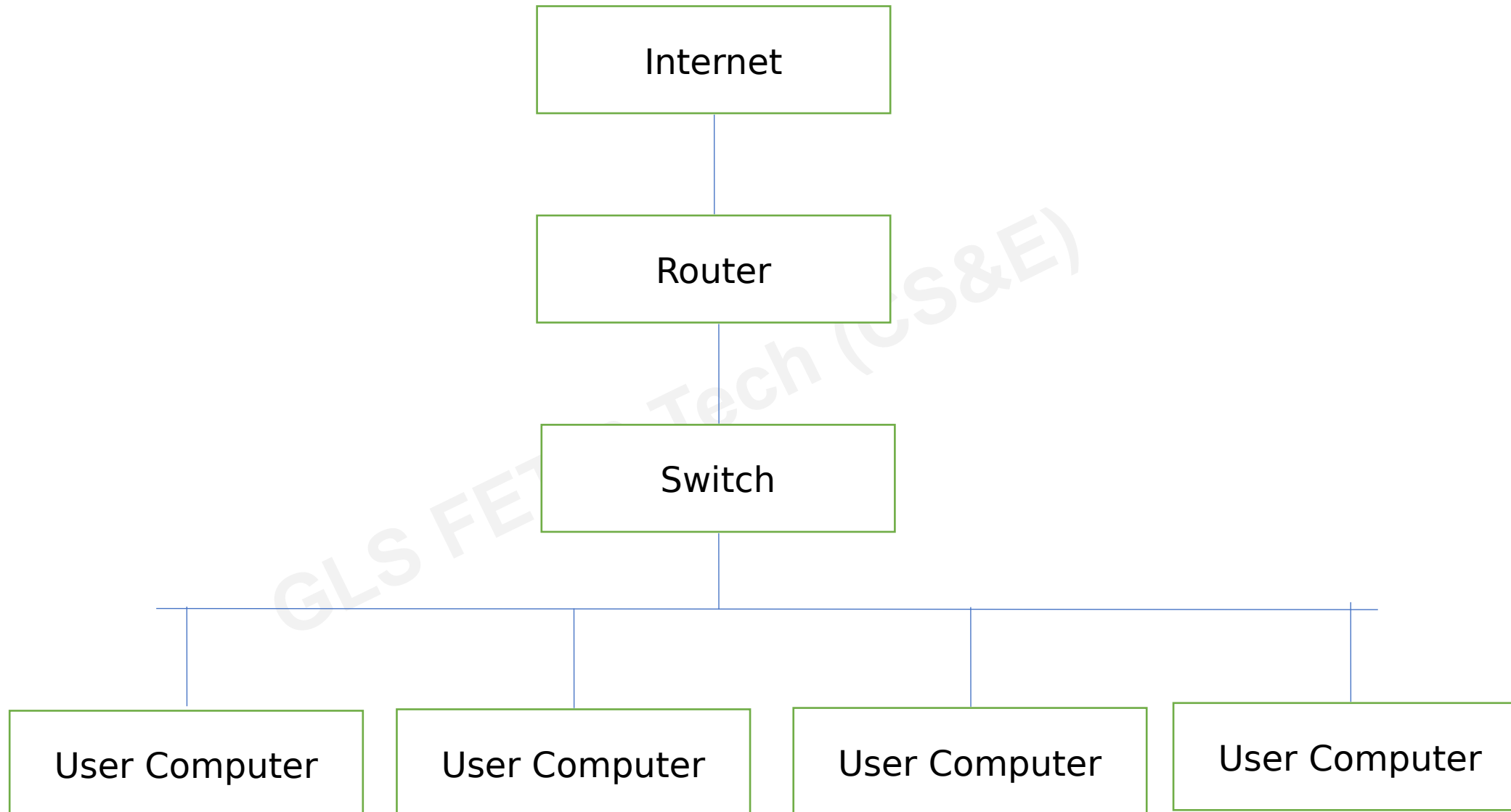➤ Do you pay only for what you use as you use it?

Term Cloud

‣ Initially used in telecommunication industry as an abstraction of network in system diagrams.

‣ Used to define computer networks in Internet Era

‣ Armbrust et al. defined it as

‣ *"Cloud Computing refers to both the applications delivered as services over the Network (Internet), and the hardware and system software in the datacenters that provide those services"*

Introduction

▶ Cloud Computing can be used for the number of Applications. Using Cloud Computing, user can save the operational cost. Here, given below are the applications of CC where the user can:

1. Use the software with the help of internet without installing on his / her own machine

2. Host some Applications

3. Use it for file storage and sharing.

4. Use cloud for website hosting.

5. Use cloud for e-commerce.

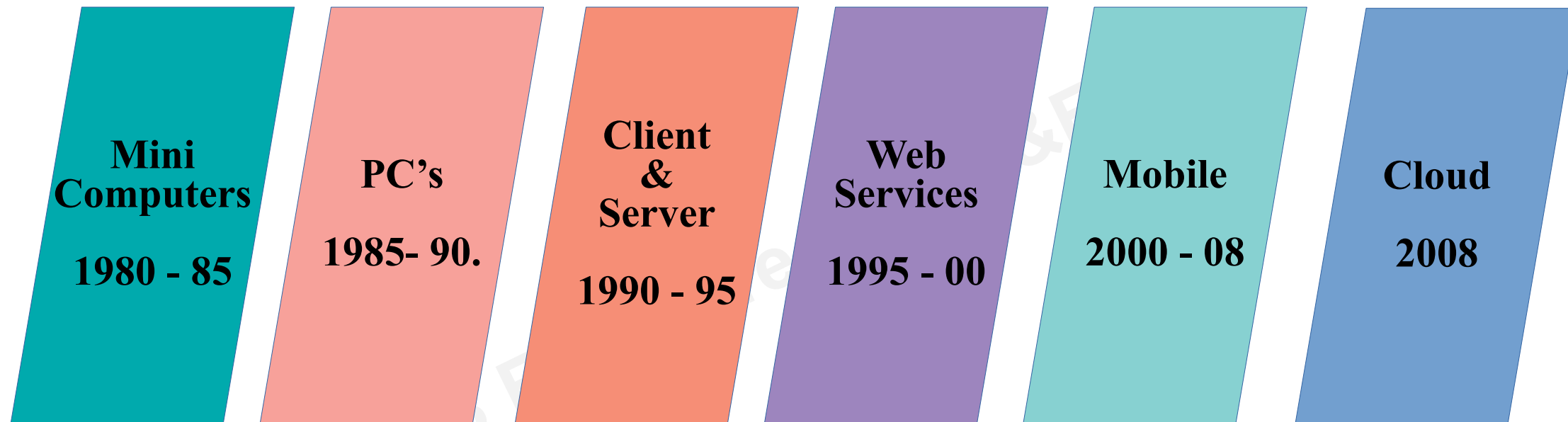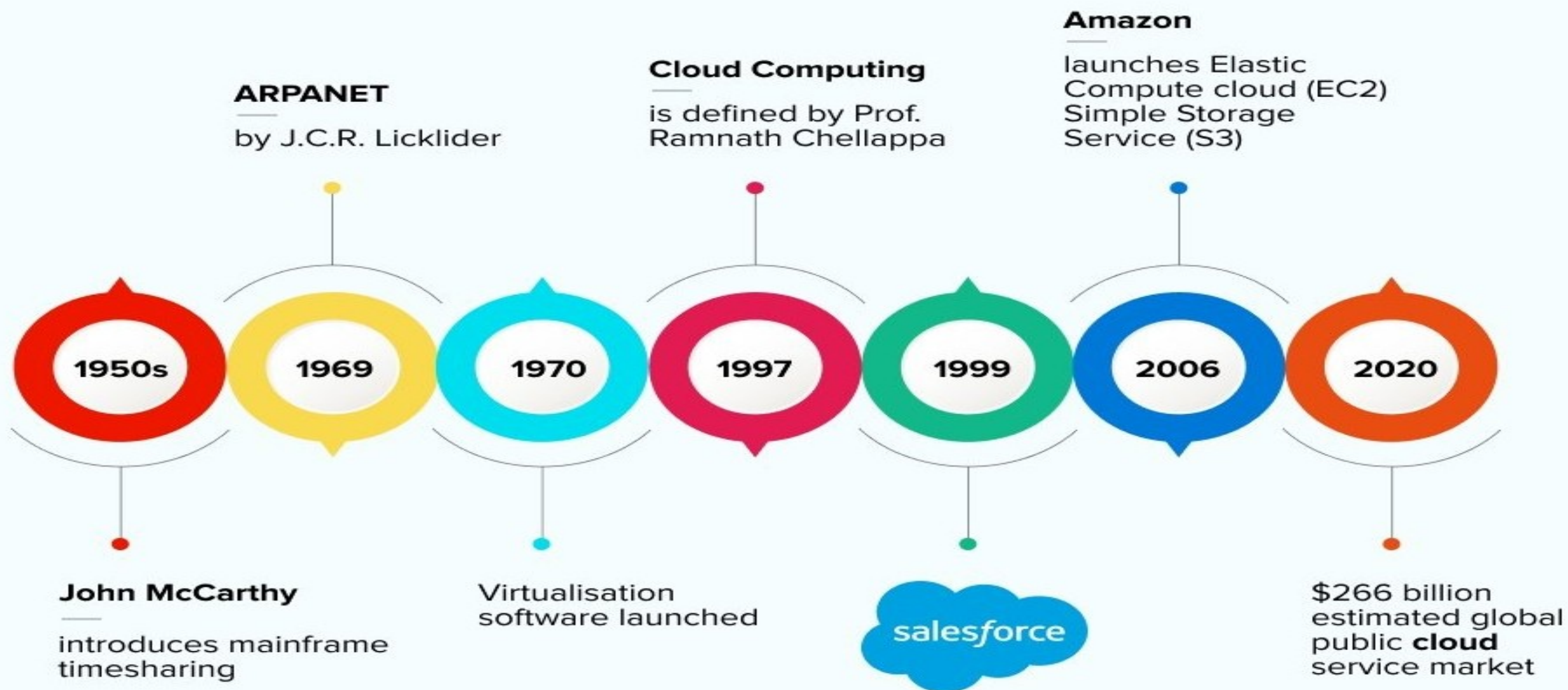6. Use cloud for test and development.

Cloud Architecture


```
                    ┌──────────────┐
                    │   Internet   │
                    └──────────────┘
                           │
                    ┌──────────────┐
                    │    Router    │
                    └──────────────┘
                           │
                    ┌──────────────┐
                    │    Switch    │
                    └──────────────┘
                           │
        ┌──────────┬───────┴───────┬──────────┐
 ┌──────────────┐ ┌──────────────┐ ┌──────────────┐ ┌──────────────┐
 │User Computer │ │User Computer │ │User Computer │ │User Computer │
 └──────────────┘ └──────────────┘ └──────────────┘ └──────────────┘
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Everything as Service

> **As per National Institute of Standards and Technology (NIST):**

> Cloud Computing is a model for enabling *ubiquitous, convenient, on demand network access* to a *shared pool (virtualized) of configurable computing resources* that can be *rapidly provisioned* and *released* with *minimal management* effort or service provider *interaction.*

> *As per Gartner:*

> *Cloud computing is a style of computing where massively scalable IT-related capabilities are provided as a service across the Internet to multiple external customers*

Era of Computing

Mini Computers 1980 - 85	PC's 1985- 90.	Client & Server 1990 - 95	Web Services 1995 - 00	Mobile 2000 - 08	Cloud 2008

Subject : Cloud Computing and Virtualization

History of Cloud Computing

ARPANET
by J.C.R. Licklider

Cloud Computing
is defined by Prof. Ramnath Chellappa

Amazon
launches Elastic Compute cloud (EC2) Simple Storage Service (S3)

1950s — 1969 — 1970 — 1997 — 1999 — 2006 — 2020

John McCarthy — introduces mainframe timesharing

Virtualisation software launched

salesforce

$266 billion estimated global public **cloud** service market

Characteristics of Cloud Computing

Characteristics of Cloud Computing

Resource Pooling	Measured Service	Broad Network Access	Multi-Tenancy	Rapid Elasticity	On Demand Self Service

Characteristics of Cloud Computing

1. Resource Pooling:-

➢ Resource Pooling means that users draw the resources from a pool of computing resources which are generally stored in remote data centres.

➢ Service Provider has various computing resources like VM, Storage, e-mail service, processing, software and bandwidth.

➢ These resources are allocated or reallocated among the users.

➢ The resources are shared together so that these can be used by many users at a single and/or at different physical locations.

➢ These services are based according to different conditions such as performance, security and consumer's demand.

➢ The cloud gives a feeling of resource location independent at lower level. Ie server or core, but not at the higher level ie data center or city.

Characteristics of Cloud Computing

2. Measured Service:-

➢ On the cloud Environment, the use of resources can be measured, managed and reported.

➢ This gives transparency to the cloud service providers as well as all the users.

➢ The use of service should be measured and users should pay the bill for the services used.

➢ There is a metering capability in the cloud model which makes it able to optimize and control the use of resources.

➢ This is used for calculating the usage for the user, so that different types of services can have different charges.

➢ This allows optimizing the resources at different levels of abstraction, which are suitable to the services.

Characteristics of Cloud Computing

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3. Broad Network Access:-

➢ Cloud computing offers different services to the users.

➢ Users can access the services through the network.

➢ Internet is the backbone of these capabilities of cloud.

➢ All these services can access by the user of some protocols and standard mechanisms.

4. Multi-Tenacity:-

➢ Multi-tenacity means same resources or application can be used by several users of same or different organizations.

➢ CC has the property of multi-tenacity. It implies the need of requirement for isolation, segmentation, governance, policy-driven enforcement, service level and charge for usages model for users.

➢ Users make use of services, provided by a public cloud provider or from the same company, such as different branch or business office of the same rather than different company which share the infrastructure.

Characteristics of Cloud Computing

5. Rapid Elasticity:

➢ The important chacteristics of CC is elasticity. The resources available on the cloud to users are indefinite.

➢ These resources can be accessible to the end users at any time and in any numbers of times.

➢ These resources can be available without the intervention of the service provider.

➢ These resources can be scaled in and scaled out quickly as per user's requirements in a secure way so that user can get high quality services.
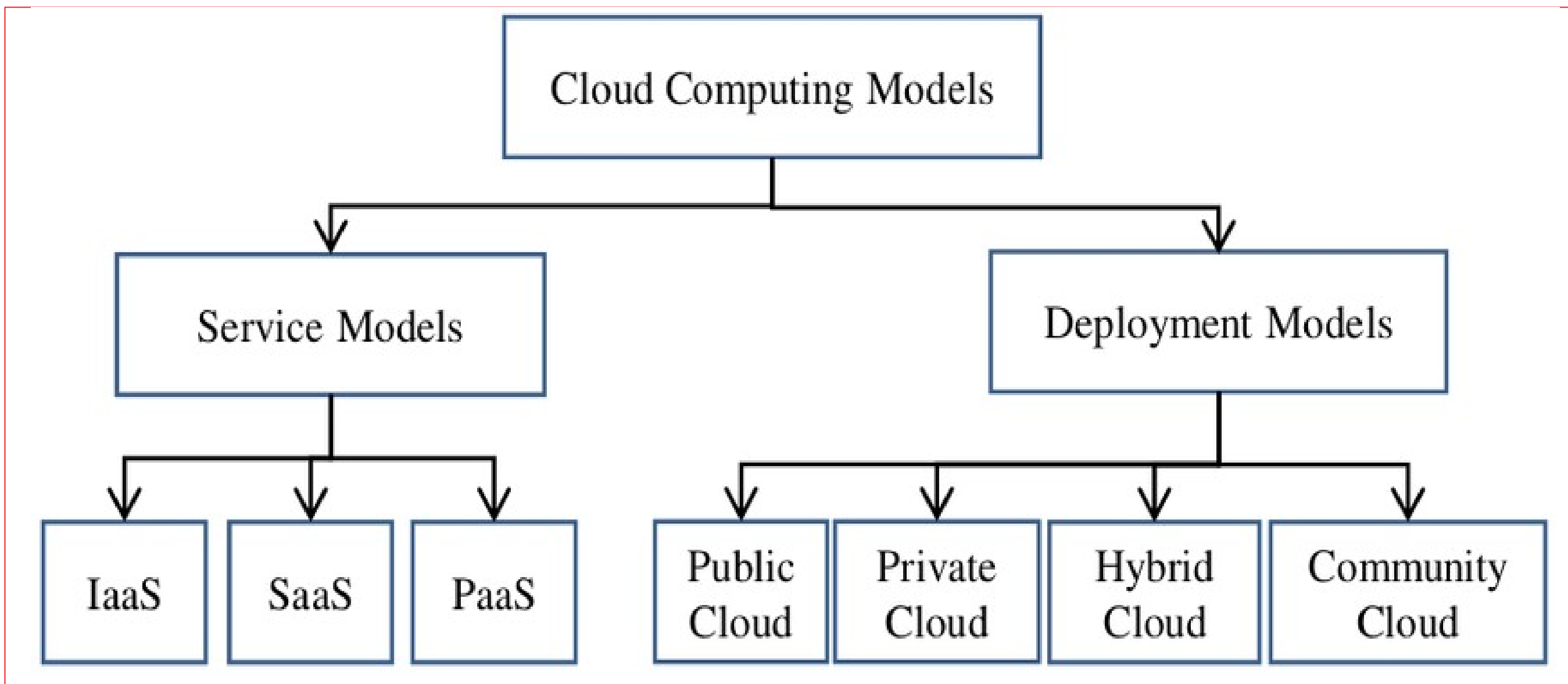
Characteristics of Cloud Computing

6. On-Demand self services:

➢ On-demand self services mean users ask for resources, and also share the resources they have an also provided by cloud service providers.

➢ Different on-demand services include Google, AWS , IBM, salesforce.com , HP and Microsoft.

Cloud Computing Models

Cloud Computing Models

Deployment Model

➢ These models are categorized on the basis of infrastructure, location and availability to the users.

Public Cloud:- When the infrastructures provided by a cloud are owned, controlled and operated by a cloud provider, then that cloud is called public cloud. It is also provide services for business.

➢ Owned and operated by third-party providers.

➢ Resources shared among multiple users (multi-tenancy).

➢ Use Case: Startups and SMEs needing cost-effective solutions.

➢ Examples: AWS, Microsoft Azure, Google Cloud Platform, services are social networking sites or e-mail.

Cloud Computing Models

Deployment Model

Private Cloud:- When the cloud infrastructure are operated exclusively for some particular organization and are controlled and managed by that organization or by third party, than that cloud is called the Private Cloud.

➢ Exclusive use by a single organization.

➢ Offers better security and control.

➢ Examples: VMware, OpenStack.

➢ Use Case: Banks, government agencies.

Cloud Computing Models

Community Cloud:- A community cloud is a cloud infrastructure that allows multiple organizations to share systems, services, and information. It can be owned, managed, and operated by one or more organizations in the community, a third party, or a combination of them.

➢ When the service and infrastructure are used by many organizations and are accessible only to those organizations, then that cloud is called community cloud.

➢ In Community cloud , the infrastructure may be changed , controlled and operated by a cloud service provider or by the organizations.

➢ Shared infrastructure for a specific community with shared concerns.

➢ Example: Government departments sharing a cloud.

➢ Use Case: Research institutions or collaborative projects.
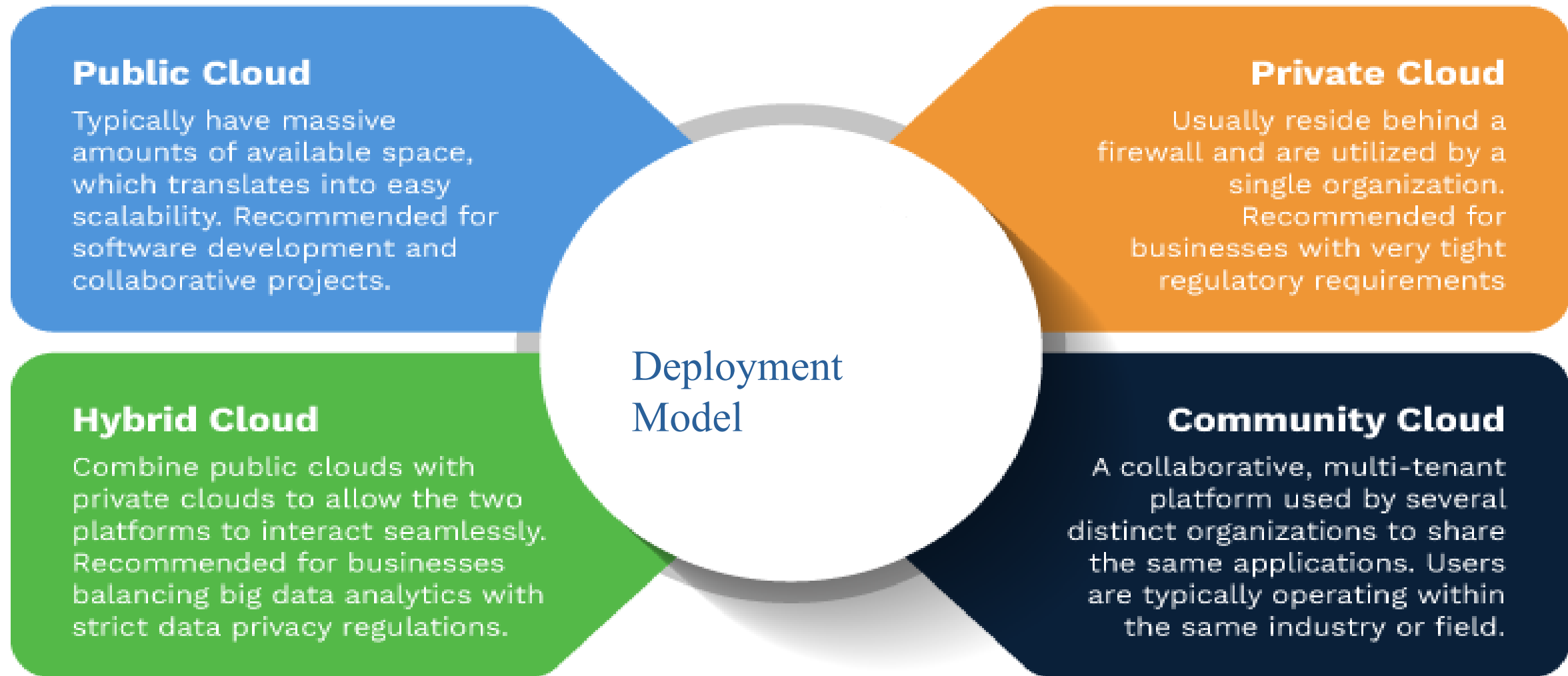
Cloud Computing Models

Hybrid Cloud:-

➢ When there is a grouping of different clouds(combination of private and public cloud services,), then that cloud is called Hybrid Cloud.

➢ It demands more functionality, which should be considered while software systems designing.

➢ These functionalities are specific and support the execution of applications in hybrid and dynamic environments.

➢ Hybrid clouds are developed heterogeneously using resources such as private or public virtual infrastructure, clusters and computers.

➢ There is constantly change in demands or SLA (Service Level Agreement) and also there is a change in architecture which allows for easy plugging of additional components.

➢ Hybrid cloud supports all these changes dynamically and also supports for basic supports for monitoring the workload in distributed middleware.

➢ Example: Microsoft Azure Hybrid Cloud.

➢ Use Case: Organizations needing scalability and control.

Cloud Computing Models

GLS UNIVERSITY
Promoted By Gujarat Law Society Since 1927

Deployment Model

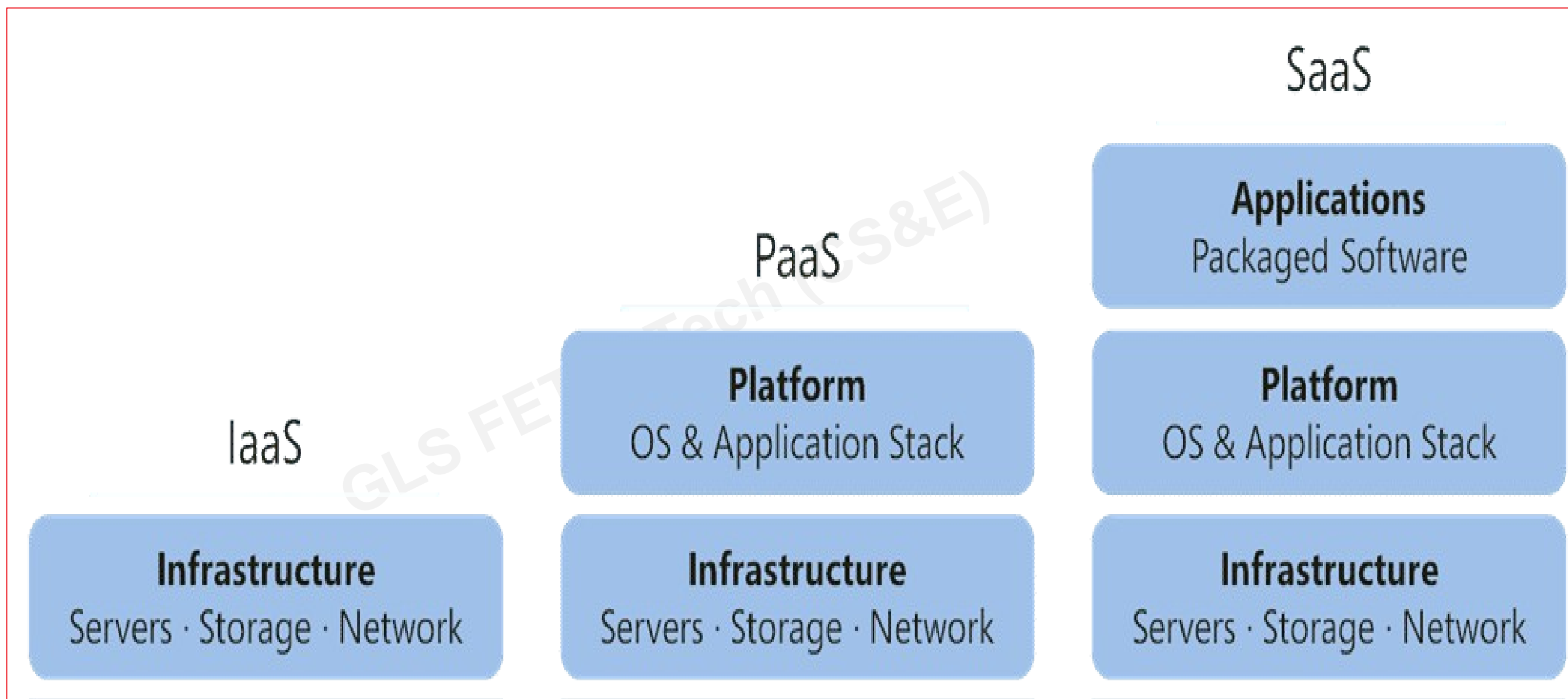| Private Cloud	Hybrid Cloud	Community Cloud	Public Cloud
Exclusive	Cloud Paradigm		**Shared**
• CapEx & OpEx Model • Higher Investment • In-house Services • Total Control and Security • Multiple Business Units Sharing Resources	• CapEx & OpEx Model • Balanced Costs, Overhead, Control, Security, Services, and Tenancy • Cloudbursting • B2B Integration	• CapEx & OpEx Model • Shared Investment • Communal Services • Limited Control and Security • Multiple Tenants Sharing Resources	• OpEx Model • Fast & Inexpensive to Start • Outsourced Services • Limited Control and Security • Multiple Tenants Sharing Resources

➢ CapEx refers to large, long-term investments in tangible assets(property), such as buildings, equipment, or land.

➢ OpEx refers to ongoing, recurring costs associated with the day-to-day operations of a business, such as rent, utilities, salaries, and office supplies

Cloud Computing Models

Public Cloud
Typically have massive amounts of available space, which translates into easy scalability. Recommended for software development and collaborative projects.

Private Cloud
Usually reside behind a firewall and are utilized by a single organization. Recommended for businesses with very tight regulatory requirements

Deployment Model

Hybrid Cloud
Combine public clouds with private clouds to allow the two platforms to interact seamlessly. Recommended for businesses balancing big data analytics with strict data privacy regulations.

Community Cloud
A collaborative, multi-tenant platform used by several distinct organizations to share the same applications. Users are typically operating within the same industry or field.

Generic Service Model

SaaS

PaaS

IaaS

Applications
Packaged Software

Platform
OS & Application Stack

Platform
OS & Application Stack

Infrastructure
Servers · Storage · Network

Infrastructure
Servers · Storage · Network

Infrastructure
Servers · Storage · Network

Generic Service Model

Software as a Service (SaaS):-

➢ It as a Service model is a total Operating environment with interface, application and management.

➢ In this model, a web browser is used to provide the access to the application to the user.

➢ The user is accountable only for enter and manage his/her data.

➢ The vendor is responsible for everything from the downloading of the application to providing the infrastructure.

Eg. Google , Docs,Dropbox,Salesforce

Generic Service Model

Platform as a Service (PaaS):-

➢ PAAS model provides operating system, virtual machines, services , applications , framework for the development , control structure and transaction.

➢ In this model, users can deploy their applications on the infrastructure available in the cloud environment. And also allows the user to use those applications that are developed using tools supported by the CSP.

➢ In this model, cloud infrastructure, the OS and the software are managed by the service provider.

➢ Whereas, users are responsible for install and control the application.

➢ Eg. Google App Engine, Microsoft Azure.

Generic Service Model

Infrastructure as a Service (IaaS):-

➢ IAAS model offers hardware and minimum software support for the users to develop an application eg. virtual machines, virtual storage and virtual infrastructure.

➢ All infrastructure are managed by the cloud service provider.

➢ Users are responsible for install and control of applications, OS and interactions.

➢ Eg. AWS EC2, Google Compute Engine, Rackspace.

Hardware as a Service (HaaS):-

➢ This model offers access to devoted(dedicated) firmware through the internet.

Firmware is a form of microcode or program embedded into hardware devices to help them operate effectively

Issues and Challenges of Cloud Computing

Interoperability & Portability

Scalabilty & Elasticity

Energy Consumption

Security & Privacy

Availability & Reliability

Virtualization

What to Migrate

Performance

Service Delivery & Billing

Bandwidth Cost
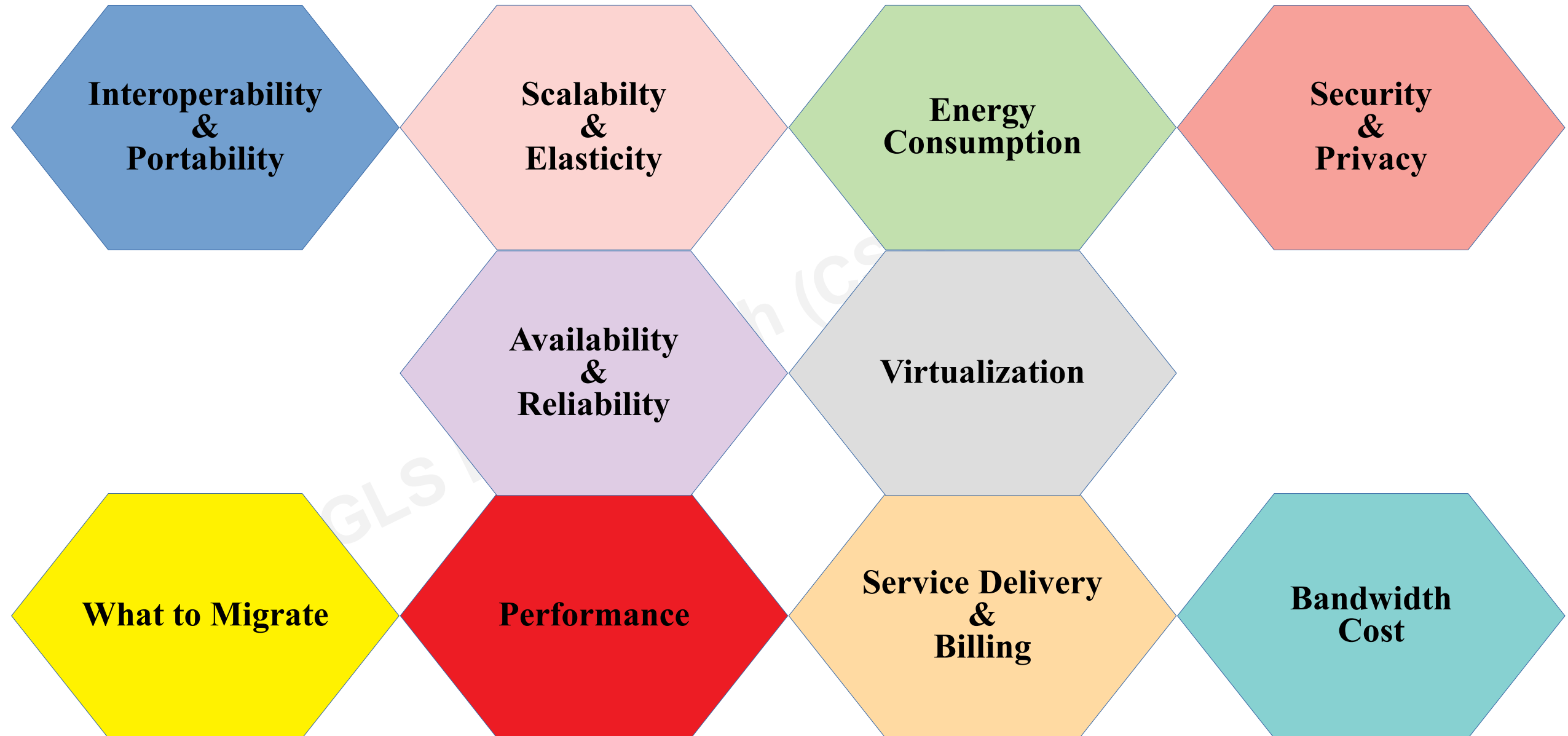
Issues and Challenges of Cloud Computing

- ➢ The building block of the cloud computing are software-oriented architecture, distributed computing etc., these building block or paradigms have numerous issues related with them.
- ➢ These issues include issues related to availability and management of resources, protection and security of infrastructure and data storage, management of power etc.
- ➢ The implementation and use of cloud computing, create number of challenges and issues related to business risk and largest hurdle in the spread of Cloud computing and also to provide high quality services to the customers.
- ➢ There are many challenges with CC, some of them are as follows:

1. Interoperability and portability
2. Scalability and elasticity
3. Energy Consumption
4. Security and Privacy
5. Availability and reliability
6. Virtualization
7. What to migrate
8. Performance
9. Service Delivery and billing
10. Bandwidth Cost

Issues and Challenges of Cloud Computing

1. **Interoperability and portability:-**

➢ Different platforms are used by different service providers. Same tools or applications can be used on all these different platforms, this property is called the interoperability.

➢ It can be defined at different level such as service level, application level, data level and management level.

➢ The users can migrate from one cloud to another cloud as per his/her wish. But there is lack of open standard, APIs and Interfaces for virtual machine formats.

➢ Portability means the solution for one cloud will be work with other clouds having different platforms.

Issues and Challenges of Cloud Computing

2. Scalability and Elasticity:-

➢ The unique features of CC are scalability and elasticity, that allow the customers to use cloud resources as per their requirements.

➢ For traditional database system, most of the cloud database system offer easier scalability to the users.

➢ Scalability of the system means its ability to give better performance even when the resources have been scaled up.

➢ Elasticity of the system means its ability to scale resources as and when required. It allows the dynamic integration and pulling out of physical resources to the infrastructure.

➢ In cloud computing, elasticity enables scalability in both vertical and horizontal directions by allowing resources to be automatically adjusted to meet demand.

➢ Vertical scaling Also known as "scaling up", this involves increasing the power of existing resources. For example, you can add more RAM or a more powerful CPU to a server.

➢ Horizontal scaling Also known as "scaling out", this involves adding more resources to meet demand. For example, you can add more servers or virtual machines.

Continue…

- ➢ In **Horizontal**, the resources allocated or released are the same type as **Scaling-Out** and **Scaling-In.**

- ➢ **Scaling-Out** means allocations of resources and **Scaling-In** means releasing of resources.

- ➢ In Horizontal scalability, this involves adding more resources to meet demand to the existing system of service provider.. For example, you can add more servers or virtual machines.

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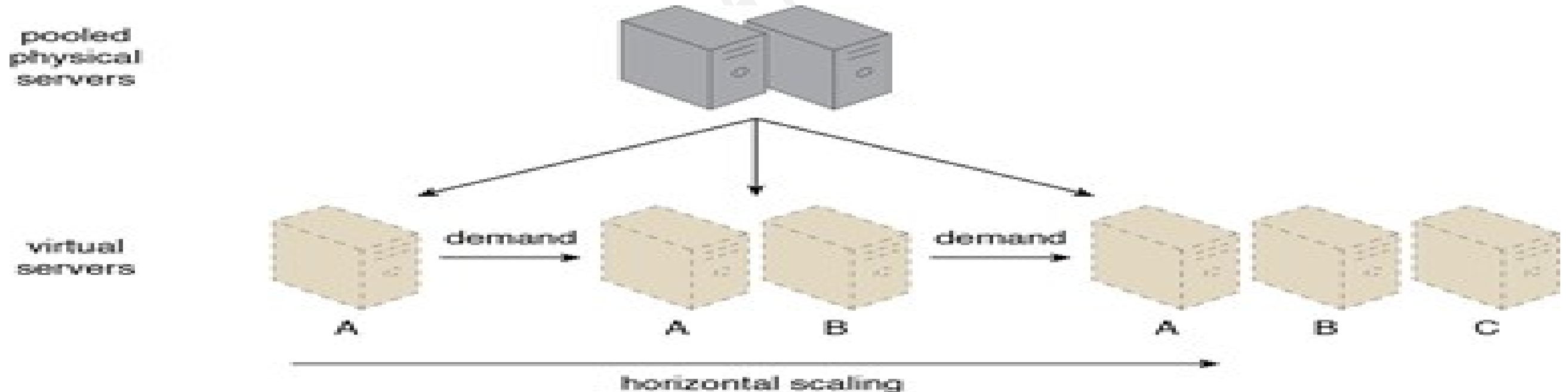
- ➢ In **Vertical scaling**, the existing resources are replaced by lower or higher capacity resources.
- ➢ When the resources are replaced by higher capacity resources, then it is called **scaling up** whereas when the resources are replaced by lower capacity resources, then it is called the **scaling down**.
- ➢ In this, new resources are added to a single node in the existing system.eg, adding extra Memory or Processor to a single computer.
- ➢

VERTICAL SCALING

Increase size of instance
(RAM, CPU etc.)

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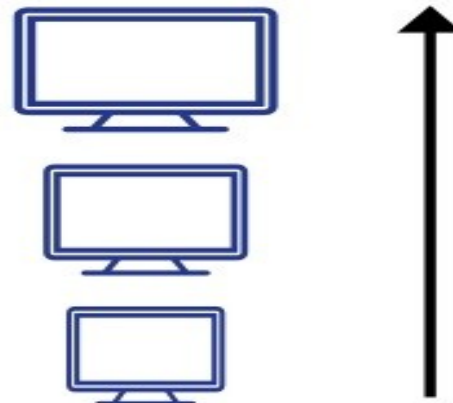
3. Energy Consumption:-

➤ Cloud Computing infrastructure consumes large power / energy. Amazon conducted a survey for energy consumption by the cloud computing model.

4. Security and Privacy:-

➤ Security and Privacy are the major components of network security. International Data Corporation(IDC) conducted the survey related to the security of the cloud computing.

➤ There are identified three major issues in cloud computing: **Security**, **Performance** and **Availability**.

➤ Data and application are portable on the networks, the resources are heterogeneous in nature; there is no control of the organization on the data.

➤ The significant challenge is how it addresses security and privacy issues as there is no control of an organization on processing, storage and movement of data.

➤ This increases the risk and make it easy for the attackers to make an attack.

➤ The risk may be as two types: 1. **Internal Risk** and 2. **External Risk**.

Continue…

1. **Internal Risk**: It is posed by employees of the organization, contractors, people who use organization's servers, data and other infrastructure.

2. **External Risk**: It is posed by persons outside the organization. There is no direct access to these persons to the cloud.

➢ Privacy is another major issues which is related to the data because the data is stored on the server which is under the control of the service provider. It can access the data , change or delete the data or remove the data. This is causes serious business trust and legal consequences.

➢ Attack on any one website on the cloud may affect numbers of users. To protect the data and reduce the risk, different techniques can be used. These techniques include encryption of the data , use of data loss software etc.

➢

Continue…

➢ **Availability and Reliability:-**

➢ The Availability and reliability of the resources are directly related to the substantial benefits of the business. These are the most important factors required for the success of any business as well as technology.

➢ The **Availability** is the measures to which a system or information is accessible and usable upon request by an authorized person at any particular time. Eg. the access to a system or information should not be prevented to the legitimate users.

➢ The **Reliability** means how often the system or resources are available at any particular instant without interruption.

➢ Most of the cloud computing are suffers by DoS (Denial of Service) attack, natural disasters or decrease in the performance.

➢ To provide effective service to the customer, availability and reliability of the resources should be considered as a serious issues during the installation of the cloud computing.

Continue…

6. Virtualization:-

➢ The Virtualization allows sharing physical instance of resource or an application by number of the users or organizations. The virtual resources are OS, a server, network resources and storage devices.

➢ The virtualization partitions the physical resource into number of environments. It hides the physical features of the resources.

➢ Hardware virtualization means creating a VM over present hardware and OS and it is logically divided from the hardware.

➢ The machine on which the virtual machine is produced is known as **Host Machine.**

➢ This virtual machine is known as **Guest machine.**

➢ The virtual machine is controlled by software or firmware, called **Hypervisors.**

➢ There are two types of Hypervisors,   **1. Type-1 Hypervisors**
   2. Type-2 Hypervisors

Continue...

1. **Type-1 Hypervisor:-** It is run on bare system. They do not have any host OS and are installed on a bare system.

2. Bare system means a computer that runs instructions directly on the hardware without an operating system (OS)

Eg. RTS hypervisor, Sun xVm Server, LynxSecure, Oracle VM and VirtualLogic VLX

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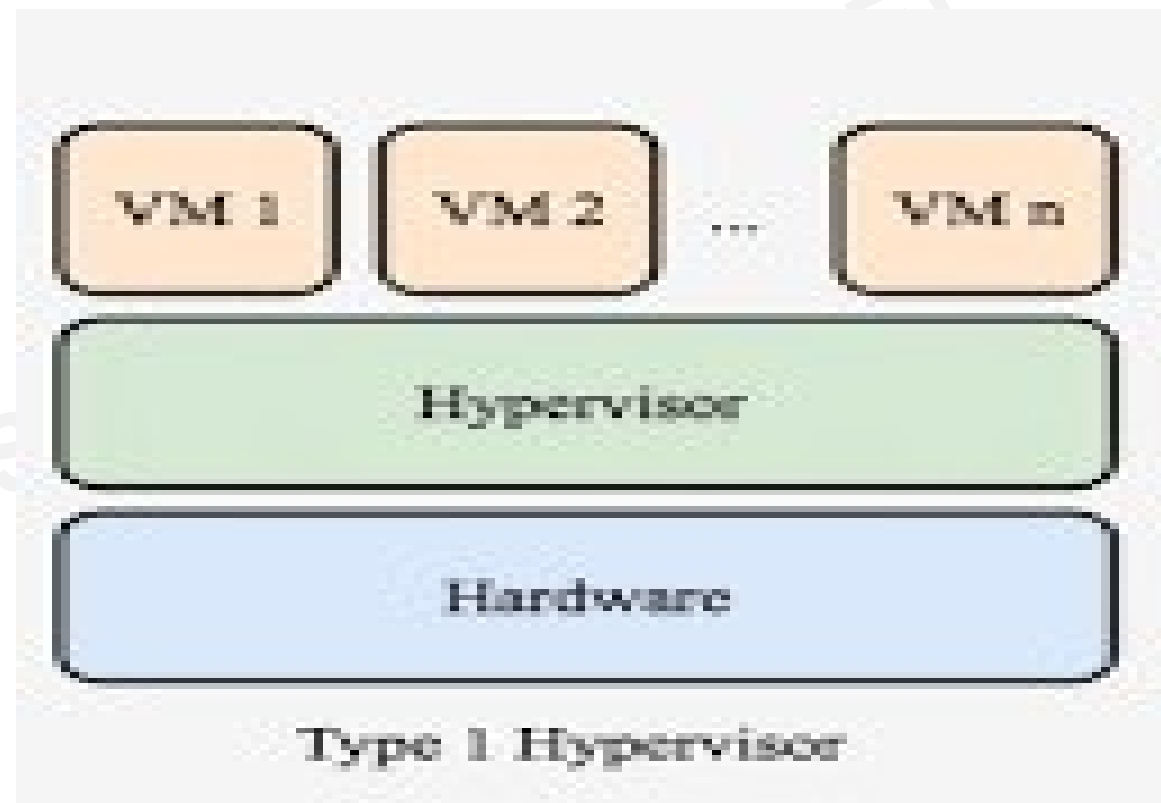
2. Type-2 Hypervisor:- It is software interface. Eg. VMware Fusion, Windows Virtual PC, Microsoft Hyper V, Containers, Virtual Server 2005 R2, VMware workstation 6.0 and KVM

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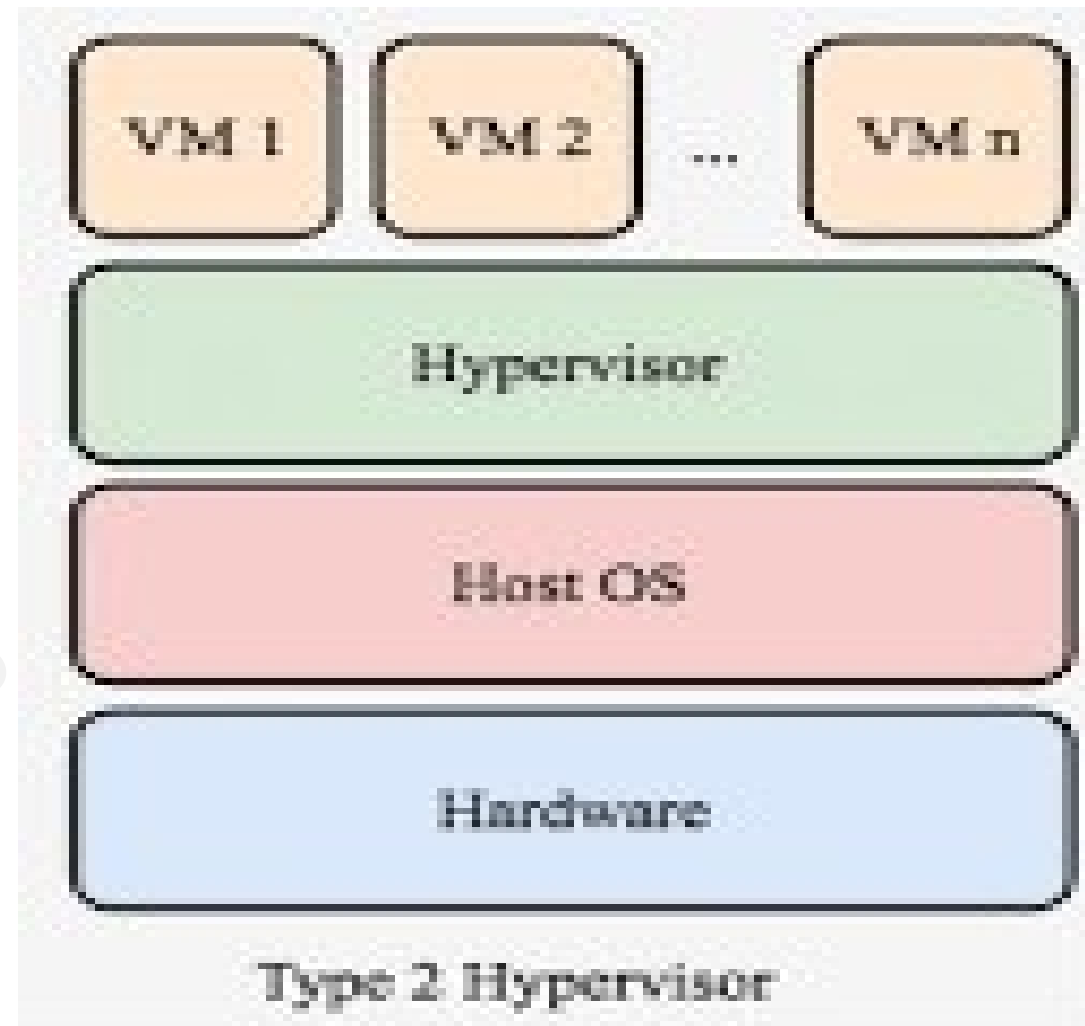
➤ The Virtualization enables customers to migrate their data to a remote location to improve the performance and it also provides the scalability, elasticity, benefits such as customizations , cost-effectiveness, infrastructure independency, location independence, simplified access interface etc.

➤ It is also provides the benefits for challenges such as virtual machine collapse, workload characterization of virtual machines, various security issues in hypervisor-based cloud computing etc.

7. **What a migrate:-** To the migration of the business and companies on the cloud, some information technology application have been migrate to the cloud, while many organizations are not ready / prepared to adopt cloud due to the different security issues.

8. **Performance:-** It is measured by potential of applications running in the system. It is depend on the space available on the hard disk, bandwidth, CPU speed, size of memory and n/w infrastructure.

➤ Some applications are located on Public cloud whereas some of applications are located on Private cloud, it is more challenging to provide the proper service to the users.

Continue…

9. Service Delivery and Billing:-

➢ CC provides different services to the users as per their demand, it is very difficult to calculate the cost of actual use by each user.

➢ The users expect proper cost for the services they use on the cloud computing.

➢ For the cost of services, the service provider should use some benchmarks.

10. Bandwidth Cost:- The backbone of any cloud is the speed of communication.

➢ Sufficient bandwidth is required for delivering intensive data applications over the cloud, without high bandwidth, it is not possible to provide the services through the cloud computing.

Advantages of Cloud Computing

Lower Cost	Ease Of Use	QoS	Availability	Reliability

Outsourced IT Management	Simplified Maintenance & Upgrade	Flexibility	RoI	Environment Friendly Computing

Continue…

- Cloud Computing provides many benefits to the users / organizations. Users can use application on the cloud at anytime and from anywhere.

- Some of the advantage of cloud computing are as follows:-

1. **Lower Costs:-** As CC is used to work at higher efficiencies and with greater use, the cost is reduced significantly.

- This allows the user to pay less for the use of applications on the cloud.

- CC reduces the up-front investment, Ownership and operational cost.

- It is minimize the business risk.

2. **Ease of utilization:-** User can implement his / her services on cloud without any hardware and software licences.

3. **Quality of Services:-** User can get better QoS by the use of cloud. It offers on-demand , scalable and adaptable service to the user.

4. **Availability:-** Cloud provides consistent service to the use.

5. **Reliability:-** Cloud computing is more reliable.

6. **Outsourced IT management:-** A CC offers outsource of infrastructure management. This help to minimize the cost of staffing.

Continue...

7. **Simplified maintenance and upgrade:** Due to centralization , it is easy to add patches and upgradation of the system is easy. So, user can always get latest version of the software.

➢ Cloud computing also offers advantages like automatic software updates, documents format compatibility and compatibility among different OS.

8. **Flexibility:-** It also offers flexibility so that user can work on the same project globally.

9. **Return on Investment:-** It offered increased return on investment of existing assts.

10. **Environment-Friendly computing:-** CC only uses the server space required by the application, this reduce the carbon footprints.

Disadvantages of Cloud Computing
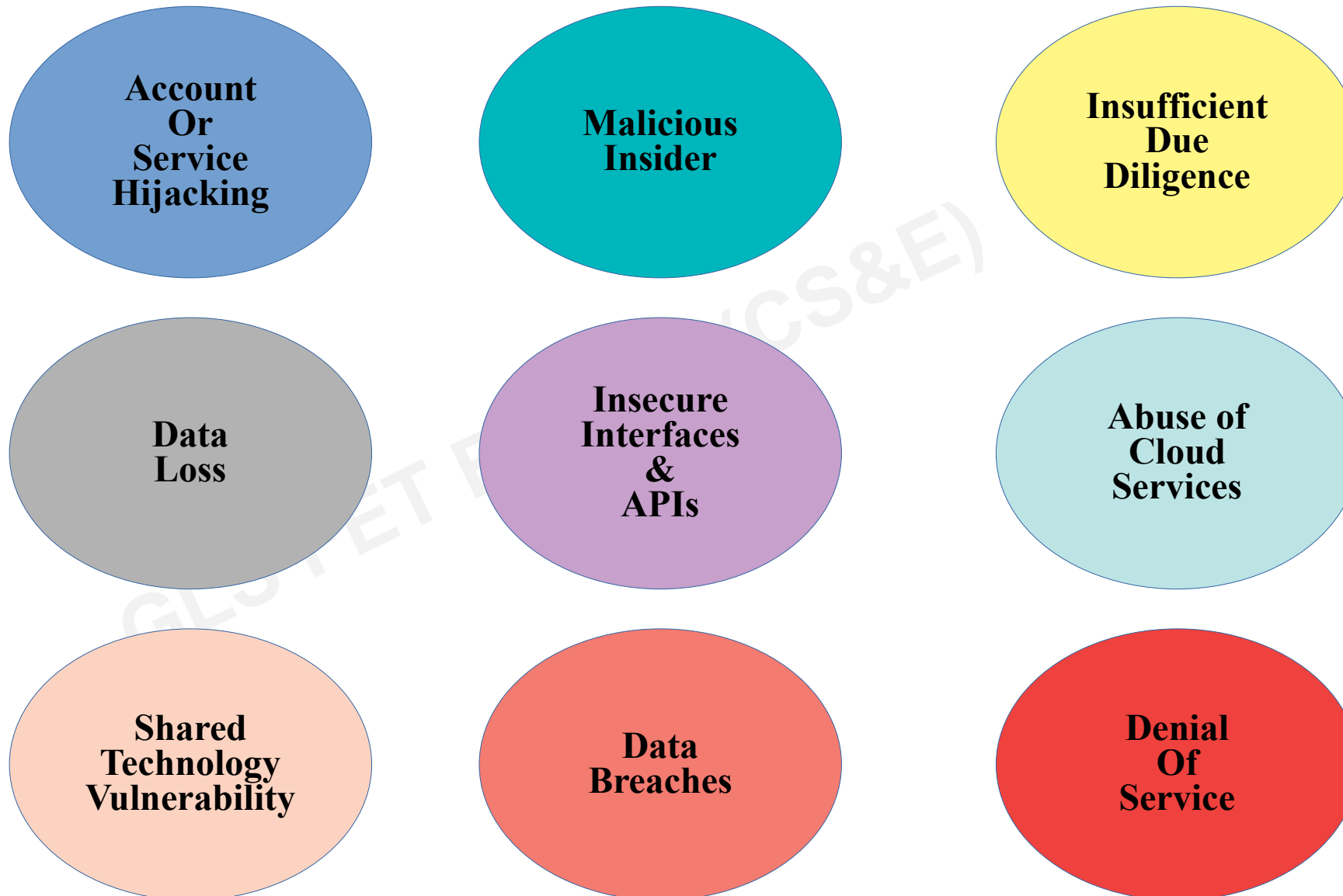
Bandwidth Requirement	Privacy & Security	Recovery Of Data	Dependency	Service Level Agreements

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1. **Bandwidth Requirement:-** CC requires large bandwidth for speedy application and Internet connectivity constantly.

2. **Privacy and Security:-** The security and Privacy of the user's data is not maintained on cloud. The data stored on the cloud might not be secured.

3. **Recovery of Data:-** If the data is lost on cloud, it is not always possible to recover the data .

4. **Dependency:-** User have to depend on external party for critical applications.

5. **Agreements:-** Users of cloud require constantly monitoring and enforcement of Service Level Agreements (SLAs)

Threats to Cloud Computing

Account Or Service Hijacking

Malicious Insider

Insufficient Due Diligence

Data Loss

Insecure Interfaces & APIs

Abuse of Cloud Services

Shared Technology Vulnerability

Data Breaches

Denial Of Service

Prepared by : Dr. Tejas Bhatt

Subject : Cloud Computing and Virtualization

Continue…

- CC is vey popular due to it easy availability and accessibility using any device with web browser.
- The organizations can scale their software application and infrastructure as when needed using cloud computing. CC has its risk or threats.
- Cloud Security Alliance (CSA) conducted a survey about the greatest vulnerabilities within cloud computing, as per the survey there are following nine(9) threats to cloud computing.

1. Account or Service hijacking
2. Malicious Insiders
3. Shared technology vulnerability
4. Data breaches
5. Denial of service
6. Insufficient due diligence
7. Data Loss
8. Insecure interface and APIs
9. Abuse of cloud service.

Continue...

1. Account or Service hijacking:-

➤ Attackers use different methods for hijacking the user account or service provided by the cloud.

➤ These methods include phishing, fraud, and exploitation of software vulnerabilities.

➤ If the attackers is able to access sensitive information related to the user, then he eavesdrops user activities and manipulated the information and redirects the user on the cloud to illegitimate sites.

2. Malicious insiders:-

➤ Most of the security threats are done by the insiders of the network.

➤ If the cloud is improperly designed, then a system administrator having malicious intention can access the potentially sensitive information of the users.

3. Insufficient due diligence (analysis):-

➤ Without knowledge of the cloud environment and necessary security mechanisms available with cloud, user does not know what to do for incident response, use of the encryption and security monitoring.

➤ This adds risk to the organizations.

Continue…

4. Data loss:-

➢ There may be different reasons for the data loss on the data stored in cloud other than malicious attackers.

➢ The data loss may happen due to an accidental deletion of data by the service provider.

➢ The natural disaster like earthquake and fire may damage the cloud infrastructure. This may effect on storage system and ultimately this leads to data loss permanently.

➢ To prevent the data loss, the service provider uses appropriate measure to take the backup of the data.

5. Insecure interface and APIs:-

➢ The availability and security services are based on the security of the interfaces and APIs.

➢ The interfaces are designed in such a way that they protect the user information against both malicious and accidental attempts.

➢ Many times organizations and third parties build the interfaces for offering value-added service to the users.

➢ This introduces the complexity to API, which in turn increases the risk of attacks.

Continue…

6. Abuse of Cloud Services:-

➢ Cloud computing provides vase computing power to any organization irrespective of small or large organizations.

➢ The attackers are crack the key for encryption and create Distributed Denial if Service (DDoS) attack or they distribute pirate the software using cloud. This threat is a serious issue for the service providers than users of cloud.

7. Shared technology vulnerability:-

➢ The cloud services are delivering to the users in a scalable form by sharing applications, platform and infrastructure.

➢ A single vulnerability or mis-configuration in any of the service model can lead to a compromise across the cloud. This vulnerability can damage the whole cloud at a time. Therefor, it is very harmful to cloud computing.

8. Denial of service:-

➢ In DoS attacks, the legitimate users are prevented from accessing the applications or data on the cloud.

➢ DoS attack consumes the cloud resources such as memory, processor, bandwidth or disk space. This cause the system shutdown and affects the services accessed by legitimate users of the cloud.

Continue…

9. Data breaches:-

➢ In Cloud computing, attackers attempt to attack the cloud, and able to capture the sensitive data of any organization, who uses the cloud.

➢ Leakage or loss of data is the serious threats to cloud computing. The action to protect the data from one of these threats can affect the other.

➢ To protect data, the most common security technique is encryption. But if the users loses the encryption key, then user loses the data.

➢ To prevent the data loss on cloud, the replication of copies of data and taken are stored at multiple places / servers. But the excess copies of the data may allow more attempts to attack the data.

Next Generation of Cloud Computing

Intercloud

Cloud of Cloud

OpenStack
Implementation

BigData
As
Service
(BDaaS)

Graphics As
Service
(GaaS)

Hybrid cloud
Adoption

Cloud As
An Innovation
(CaaI)

IoT

BYOD
&
Personal
Cloud

Identity
Management

Software
Defined
Hardware

Continue...

- The cloud administrator is taking care and providing response to the real opportunities which the cloud offers to develop new models.

- Instead of the cost and efficiency, the cloud model is now emerged as an innovation powerhouse.

- The next generation cloud will provide better services using automation of everything from development to configuration. This will be applicable for scaling the stack in up and down and also for the infrastructure. To achieve these objectives for the next generation cloud computing, some platforms are required which support as

- ✓ High degree of service flexibility

- ✓ Multiple constituencies (one which elects more than one)

- ✓ Loosely coupled (reduce the interdependencies)

- ✓ An intelligent machine.

Continue…

1. **Cloud of clouds or Intercloud:-**

➢ If different clouds are combined into a faultless mass, then this new cloud model is termed as cloud of clouds.

➢ This combination or grouping of cloud models is based in on-demand operations.

➢ If the single cloud uses the resources beyond its reach, then it is termed as intercloud.

➢ This can be achieved by using established contacts of a service provider of an individual cloud with other service providers.

2. **Open Stack Implementation:-**

➢ The Open stack software is an open source IaaS. It is useful to get a scalable cloud operating system and advantage of its flexibility and versatility.

➢ Open Stack software is useful for the creation and management of large groups of virtual private servers.

➢ The main objective of OpenStack initiative is to support inter-operability among the different services provided by the cloud.

➢ It allows the user organizations to build cloud services in their own organization.

Continue...

3. **Big Data as a Service:-**

➢ The service which allow the analysis of complex and large data using services such as SaaS and IaaS, hosted by the cloud are called the Big data as a Service.

➢ In SaaS and IaaS, specific big data as a service options are used to handle big Data or sophisticated aggregated data sets in the IT business.

4. **Platform as a Service(PaaS):-**

➢ It allows organizations to lower the hardware costs and also gives the momentum to the application development with the use of efficient testing and deployment.

5. **Graphics as a Service(GaaS)**

➢ For high quality graphics applications, the massive hardware infrastructure is required.

➢ In CC based graphics technology, this infrastructure requirement is nullified. For the execution of such graphics application, only a web browser is required.

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Continue…

6. Hybrid Cloud Adoption:-

➢ In hybrid cloud, there is a combination of private and public cloud. It allows the use of on-premises and cloud-based infrastructure. This help to reduce the cost of extra hardware and also useful for disaster data recovery.

7. Cloud as an Innovation(CaaL):-

➢ Due to cloud technology, it is possible to provide a common platform for different applications related to mobile devices, social networking and big data. .

8. Internet of Things (IoT)

➢ IoT, nowadays in the user applications, analysis of big data and intelligent machines are combined to provide the solutions in the cloud environment.

➢ CC platform will play a major role in the creation of next generation of intelligent and software-defined machines, which can be controlled and operated centrally from the remote place.

Continue...

9. BYOD and the personal cloud:-

➢ The BYOD(Bring Your Own Device) is a rapidly spreading enterprise environment and it may also continue to expand beyond 2014. Generally, the users use personal cloud services for syncing , streaming and storage their data.

➢ Therefore , the organizations are searching for techniques , which can incorporates these cloud services on their environment.

10. Identity Management:-

➢ The service in cloud environment are easily accessible, redundancy etc. But now, there is a need to think about the security policies. The identity management for the new paradigm of security to the cloud will be coming soon.

11. Software – defined software:-

➢ Nowadays, there is a trend, in which applications themselves can assume the whole infrastructure will be scaled, virtualize and controlled centrally or it may be software-defined.

Real-World Applications

Cloud Computing Applications

- 01 Hybrid Cloud
- 02 Testing and Development
- 03 Recovery
- 04 Backup
- 05 Image Editing Applications
- 06 Antivirus Applications
- 07 URL Conversion Applications
- 08 Social Media Applications
- 09 Accounting Application
- 10 Management Application

Continue...

> **Entertainment:** Netflix and Spotify use cloud for content delivery.

> **E-commerce:** Amazon and Flipkart leverage cloud for scalability and personalization.

> **Healthcare:** Cloud enables telemedicine and centralized patient data.

> **Education:** Platforms like Coursera and Google Classroom rely on cloud infrastructure.

> **Agriculture:** Smart farming with IoT sensors and cloud data analytics.

Cloud Service Providers

- ➢ **Amazon Web Services (AWS):**
- ➢ The leader with 32% of the market share.
- ➢ AWS's size and global presence help it provide high-quality service.
- ➢ Services: EC2, S3, RDS, Lambda.
- ➢ Strength: Comprehensive services and global reach.

- ➢ **Microsoft Azure:**
- ➢ The second-largest CSP with 23% of the market share.
- ➢ Azure is known for its hybrid cloud capabilities and ability to sell to large customers.
- ➢ Services: Virtual Machines, Azure AI, Azure DevOps.
- ➢ Strength: Integration with Microsoft tools (e.g., Office 365).

- ➢ **Google Cloud Platform (GCP):**
- ➢ Services: Compute Engine, BigQuery, TensorFlow.
- ➢ Strength: Data analytics and machine learning capabilities.

Why Netflix Migrated to the Cloud: A Case Study

- Netflix is a global leader in the streaming industry, with millions of subscribers worldwide.
- Over 230 million global subscribers as of 2024.
- Presence in more than 190 countries.
- Streams 10 billion hours of video monthly.
- Its migration to the cloud is a prime example of a successful transition that showcases the power of cloud computing.

Why Netflix Migrated to the Cloud: A Case Study

Timeline:

➢ The migration process spanned over eight years, from 2008 to 2016.

➢ **Challenges with On-Premises Infrastructure:**

➢ Presence in more than 190 countries.

➢ Frequent hardware failures and scaling limitations.

➢ Inability to handle peak traffic, especially during popular show releases.

➢ Maintenance and operational complexities.

➢ **Objectives:**

➢ Enhance scalability and availability.

➢ Reduce downtime and improve reliability.

➢ Accelerate innovation by focusing on core business instead of infrastructure management.

Why Netflix Migrated to the Cloud: A Case Study

Migration Process

Initial Assessment:

➤ Netflix evaluated its IT needs and chose Amazon Web Services (AWS) for its robust scalability and global presence.

➤ Focused on transitioning incrementally to minimize risks.

➤ **Phased Migration:**

➤ Rehosting: Lift-and-shift of existing applications and data.

➤ Refactoring: Optimized applications to utilize cloud-native features like elasticity.

➤ Rebuilding: Some legacy systems were rebuilt from scratch to better align with the cloud environment.

➤ **Data Migration:**

➤ Transferred vast amounts of user data, ensuring security and compliance.

➤ Used AWS services like S3 for storage and DynamoDB for database management.

Why Netflix Migrated to the Cloud: A Case Study

Testing and Validation:

➢ Conducted rigorous testing to ensure seamless user experience.

➢ Addressed performance issues proactively during the transition.

Scalability:

➢ Netflix can now handle millions of concurrent streams, even during peak hours.

➢ Auto-scaling features of AWS allow the platform to dynamically adjust resources based on demand.

Reliability:

➢ Achieved near-zero downtime, enhancing user satisfaction.

➢ Multi-region deployments ensured high availability.

Cost Efficiency:

➢ Reduced operational costs by paying only for resources used.

➢ Freed internal teams to focus on content and innovation.

Global Reach:

➢ Leveraged AWS's global network to serve content to users worldwide with low latency.

THANK YOU