Course Name :Cloud Computing Lab(CSL803)

Department: Computer Engineering

Semester: VIII

Div: B

Academic Year:2021-2022 (FH 2022)

Name of faculty- Mrs. Reshma Koli

Course Scheme

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in				
		Test 1	Test 2	Avg.						
CSC801	Human Machine Interaction	20	20	20	80	3	-	-	-	100
CSC802	Distributed Computing	20	20	20	80	3	-	-	-	100
CSDLO 801X	Department Level Optional Course -IV	20	20	20	80	3	-	-	-	100
ILO801X	Institute Level Optional Course-II	20	20	20	80	3	-	-	-	100
CSC801	Human Machine Interaction Lab						25	25	-	50
CSL802	Distributed Computing Lab						25	25		50
CSL803	Cloud Computing Lab	-	-	-	-	-	50	--	25	75
CSL804	Computational Lab-II	-	-	-	-	-	50	--	25	75
CSP805	Major Project-II						50	--	50	100
Total		80	80	80	320	--	200	50	100	750

Distribution of marks

- **Term Work: (50 marks)**
- Term work should consist of at least 6 experiments and a mini project.
- Journal must include at least 2 assignments. .
- The distribution of marks for term work shall be as follows:
- **Laboratory work (experiments)(10)+ Quiz(5):** **(15) Marks.**
- **Assignments.....** **(05) Marks**
- **Attendance …….. …..** **(05) Marks**

- **Mini project..... ……. …..** **(10) Marks**
- **Mini Project Presentation ----------** **(05) Marks**
- **Mini Project Report..... ……** **(05) Marks**
- **SalesForces Badges/Honeywell Certification** **(05) Marks**
- **TOTAL: ……** **(50) Marks.**

- **Practical and Oral :(25 marks)**
- **Mini Project demonstration and Oral** examination will be based on Laboratory work, mini project and above syllabus

Course Objectives And Outcomes

- **Lab Objectives:**

The course will help the learners to get familiar with

1. Key concepts of virtualization.

2. Various deployment models such as private, public, hybrid and community.

3. Various service models such as IaaS and PaaS and SaaS.

4. Security and Privacy issues in cloud.

- **Lab Outcomes:**

On completion of the course learners will be able to

1. To understand the architecture and services of cloud computing.

2. To understand and implement different types of virtualization and increase resource utilization.

3. To Demonstrate and Implement various service models (IaaS, PaaS, SaaS)

4. To analyze security issues on cloud and Implement Identity Access Management .

5. To develop real world web applications and deploy on commercial cloud.

6. To understand the concept of Fog Computing in relation with cloud computing.

Course Syllabus

Module No	Detailed Contents	Hrs.
01	**Title:** Study of NIST model of cloud computing. **Objective:** Understand deployment models, service models, advantages of cloud computing	2
02	**Title:** Virtualization. **Objective:** Understand different types of virtualizations, Host and bare metal hypervisors and implement horizontal scalability. **Technology:** XEN/ Vmwares EXSi	2
03	**Title:** Infrastructure as a Service. **Objective:** Implement IaaS using your resources. **Technology:** Open Stack / Eucalyptus	2
04	**Title:** Identity Management in Cloud **Concept:** Simulate identity management in your private cloud. **Technology:** Open Stack	2
05	**Title:** Storage as a Service **Objective:** Explore Storage as a Service for remote file access using web interface. **Technology:** ownCloud	2

Course Syllabus

06	**Title:** Cloud Security **Objective:** Understand security of web server and data directory. **Technology:** ownCloud	2
07	**Title:** Platform as a Service **Objective:** Deploy web applications on commercial cloud. **Technology:** Google appEngine/ Windows Azure	2
08	**Title:** Amazon Web Service **Objective:** To create and access VM instances and demonstrate various components such as EC2, S3, Simple DB, DynamoDB. **Technology:** AWS	2

Course Syllabus

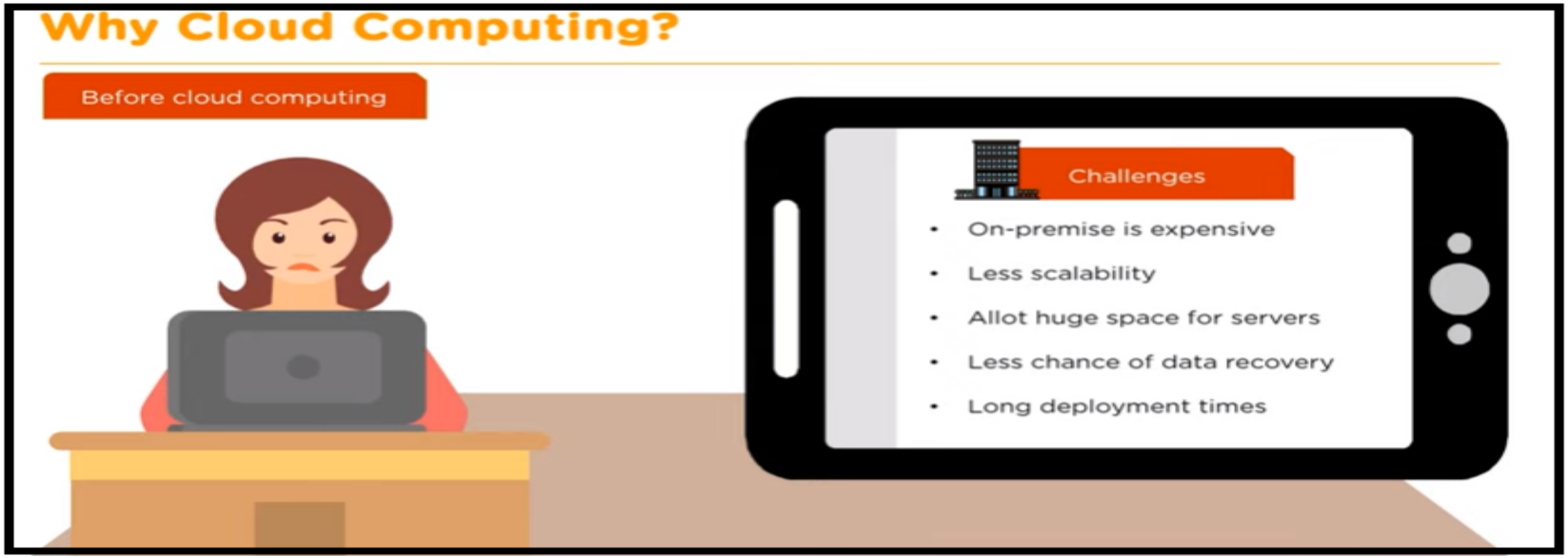
09	**Title:** Software as a Service **Objective:** Understand on demand application delivery and Virtual desktop infrastructure. **Technology:** Ulteo	**2**
10	**Title: Case Study on Fog Computing** **Objective**: To have a basic understanding of implementation/applications of fog computing.	**2**
11	**Title:** Mini Project **Objective:** Using the concepts studied throughout the semester students shall be able to 1. Create their private cloud for the institute using the available resources. 2. Apply security concepts to secure a private cloud. 3. Implement efficient load balancing. 4. Compare various virtualization technologies with given resource. 5. Create cloud applications such as messenger, photo editing website, your own social media etc. **Note:** Evaluators must check if students have used appropriate cloud computing tools for their projects.	**6**
		18

CCL Experiment List

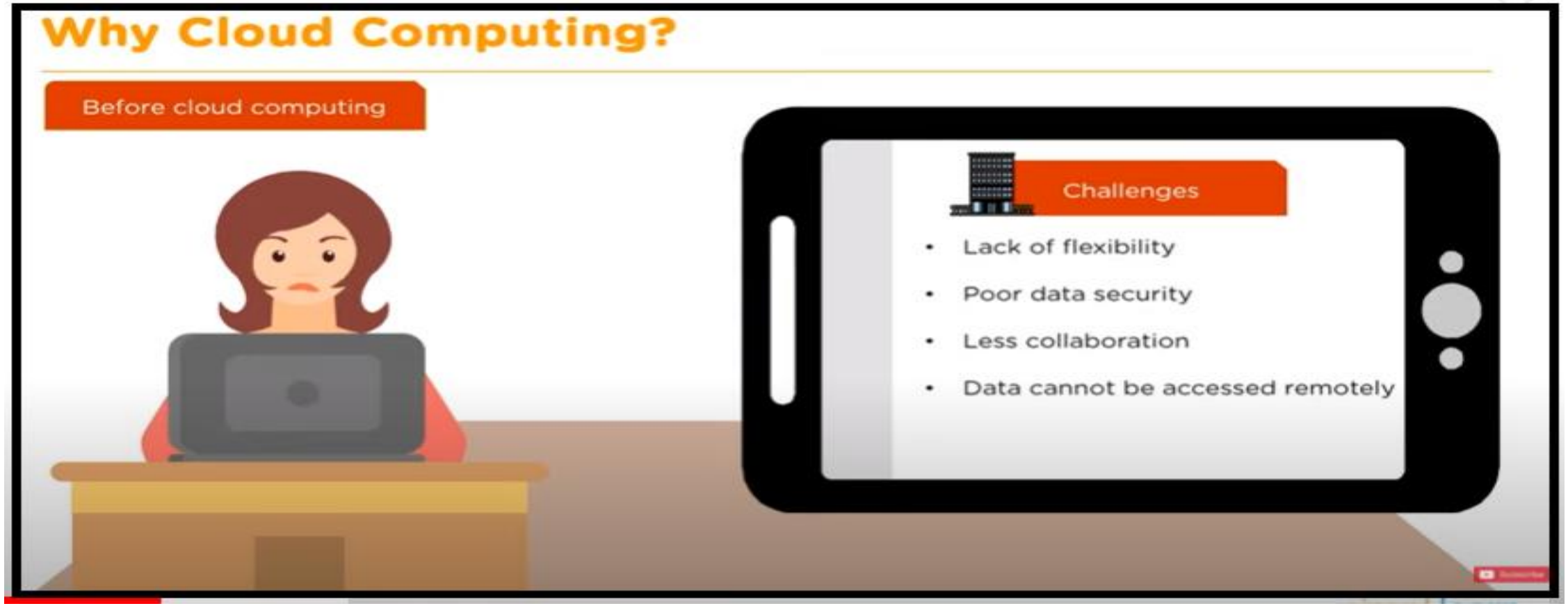
Sr. No.	Title	LO mapping
1	Study of NIST model of cloud computing.	LO1
2A	Implement Virtualization using VM-Ware	LO2
2B	Implement virtualization using Virtual-Box	LO2
3	To demonstrate and implement Infrastructure as a Service (IAAS) using AWS EC2/Open-stack	LO3
4	To demonstrate and implement Storage as a service using AWS S3 Service	LO3
5	To demonstrate and implement Platform As a Service(PASS) using AWS S3 Service	LO3
6	Deploy web applications on commercial cloud (PAAS)(AWS-Light Sail)	LO5
7	Understand Security of Web Server and demonstration of IAM using own cloud/AWS	LO4
8	To have a basic understanding of implementation/applications of fog computing. (Case study)	LO6
9	Mini Project : Implement Cloud Based Application (i.e. integrate cloud services in application)	LO5

Introduction to Cloud Computing

Why Cloud Computing



Why Cloud Computing



Why Cloud Computing

Why Cloud Computing

1. Introduction to Cloud Computing

Why Cloud?

Files

music

E-books

Videos

Applications

Podcasts

Introduction to Cloud Computing

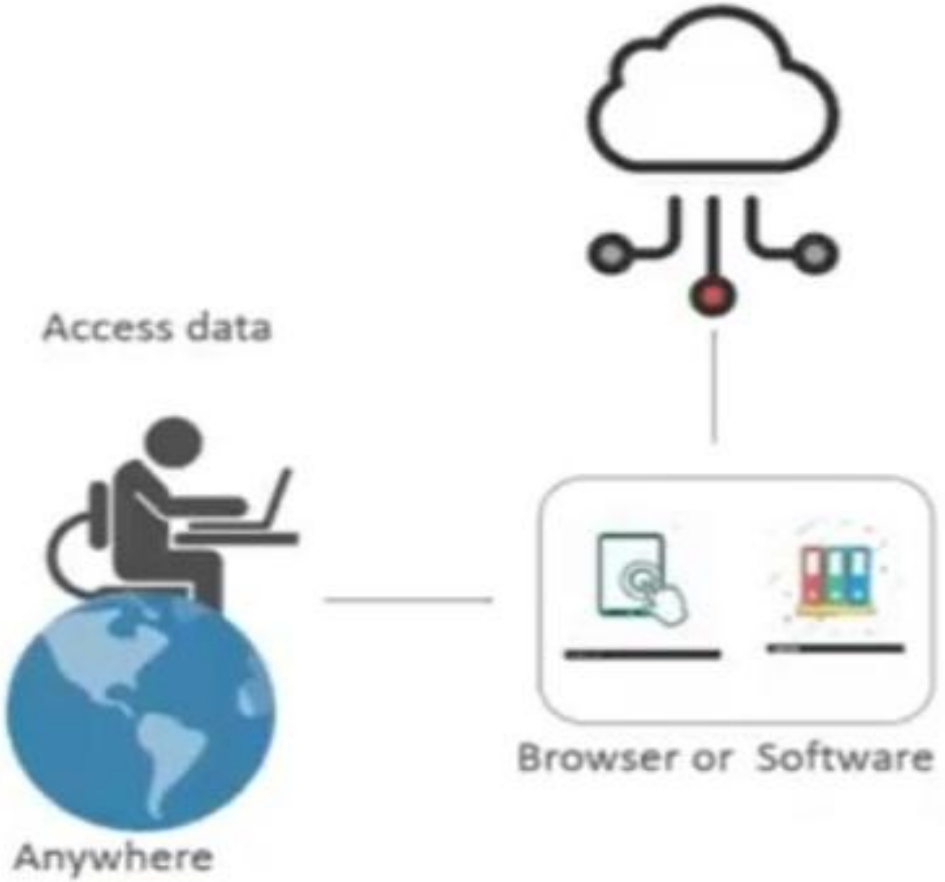
What Is Cloud?

Introduction to Cloud Computing

What Is Cloud Computing?

Cloud computing is:

- Storing data/applications on remote servers
- Processing data/applications from servers
- Accessing data/applications via Internet



Introduction to Cloud Computing

- **Cloud: Huge storage available over the internet, it consist of all networking resources.**
- **Cloud which is a network of multiple devices, computers and servers connected to each other over the Internet.**
- **Cloud computing** is the dynamic delivery of **IT resources (server, databases, software)and capabilities as a Service over the Internet**. Cloud computing encompasses any Subscription-based or pay-per-use service that, in real time over the Internet.
- **cloud computing is the delivery of computing services—including servers, storage, databases, networking, software, analytics, and intelligence**—over the Internet ("the **cloud**")
- **Characteristics:**
- 1. On-Demand Self-Service
- 2. Optimal Resource Utilization
- 3. Minimize licensing new software
- 4. Reduce capital costs
- 5. Improve accessibility
- 6. Resource Pooling
- 7. Rapid Elasticity

NIST Definition of Cloud Computing

- **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.**

NIST Definition of Cloud Computing

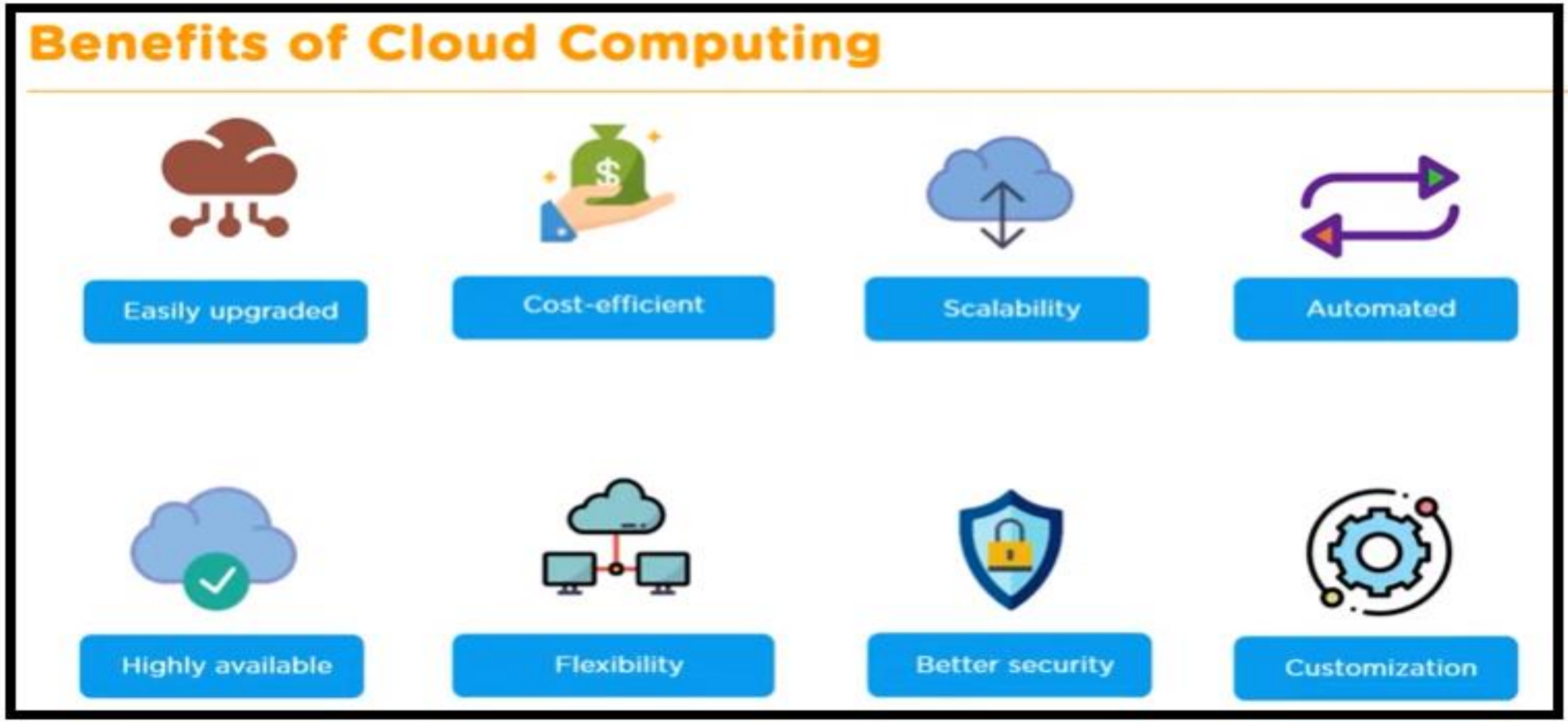
- **Essential Characteristics:**
- **On-demand self-service**. A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.
- **Broad network access.** Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).
- **Resource pooling**. The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or data enter). Examples of resources include storage, processing, memory, and network bandwidth.

NIST Definition of Cloud Computing

- **Rapid elasticity**. Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

- **Measured service.** Cloud systems automatically control and optimize resource use by leveraging a metering capability1 at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service. .

Benefits of Cloud Computing



Types of Cloud (Cloud Deployment Model)

- **Public cloud:**
- The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.

- Public cloud, in general, **is SaaS services offered to users over the internet**.

- It is the most economical option for users in which the service provider bears the expenses of bandwidth and infrastructure.

- It has limited configurations, and the cost is determined by usage capacity.

- **Despite high reliability, lower costs, zero maintenance and on-demand scalability**, the public cloud is **not suitable for organizations operating with sensitive information** as they have to comply with stringent security regulations.

Types of Cloud (Cloud Deployment Model)

- **Private cloud:**
- The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.

- As the name suggests, the private cloud **is used by large organizations to build and manage their own data centers for specific business and IT needs/ operations.**

- The private cloud provides **more control over customizability, scalability and flexibility, while improving security of assets and business operations.**

Types of Cloud(Cloud Deployment Model)

- **Hybrid cloud:**
- The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

- Hybrid cloud is the **combination of a private and public cloud**, **providing for more flexibility to businesses while having control over critical operations and assets**, coupled with improved flexibility and cost efficiency.

- The hybrid cloud architecture **enables companies to take advantage of the public cloud as** and when necessary due to their easy workload migration. For instance**, businesses can use the public cloud for running high-volume applications like emails,** and **utilize private clouds for sensitive assets like financials, data recovery, and during scheduled maintenance and rise in demand.**

Types of Cloud(Cloud Deployment Model)

- **Community cloud:**

- The cloud infrastructure is provisioned for exclusive **use by a specific community of consumers from organizations that have shared concerns** (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.

Popular Cloud Providers

Cloud Providers

2. Cloud Providers

- **There are many Cloud Service providers in the market:**
- **Amazon Web Service (AWS)**
- Microsoft Azure
- Google Cloud Platform
- IBM Cloud Services
- Adobe Creative Cloud
- Kamatera
- VMware
- Rackspace
- Red Hat
- **Salesforce**
- Oracle Cloud
- SAP
- Verizon Cloud
- Navisite
- Dropbox

AWS

- Amazon Web Services (AWS)
- Amazon Web Services is a cloud computing platform which provides services such as **compute power, database storage, content delivery and many other functions which will help to integrate a business**. The Amazon Web Services is flexible, scalable, and reliable and due to this many companies are implementing it in their work. There is no upfront cost and the customer has to pay only for what they have used. It is one of the leading cloud service providers am[illegible]

Microsoft Azure

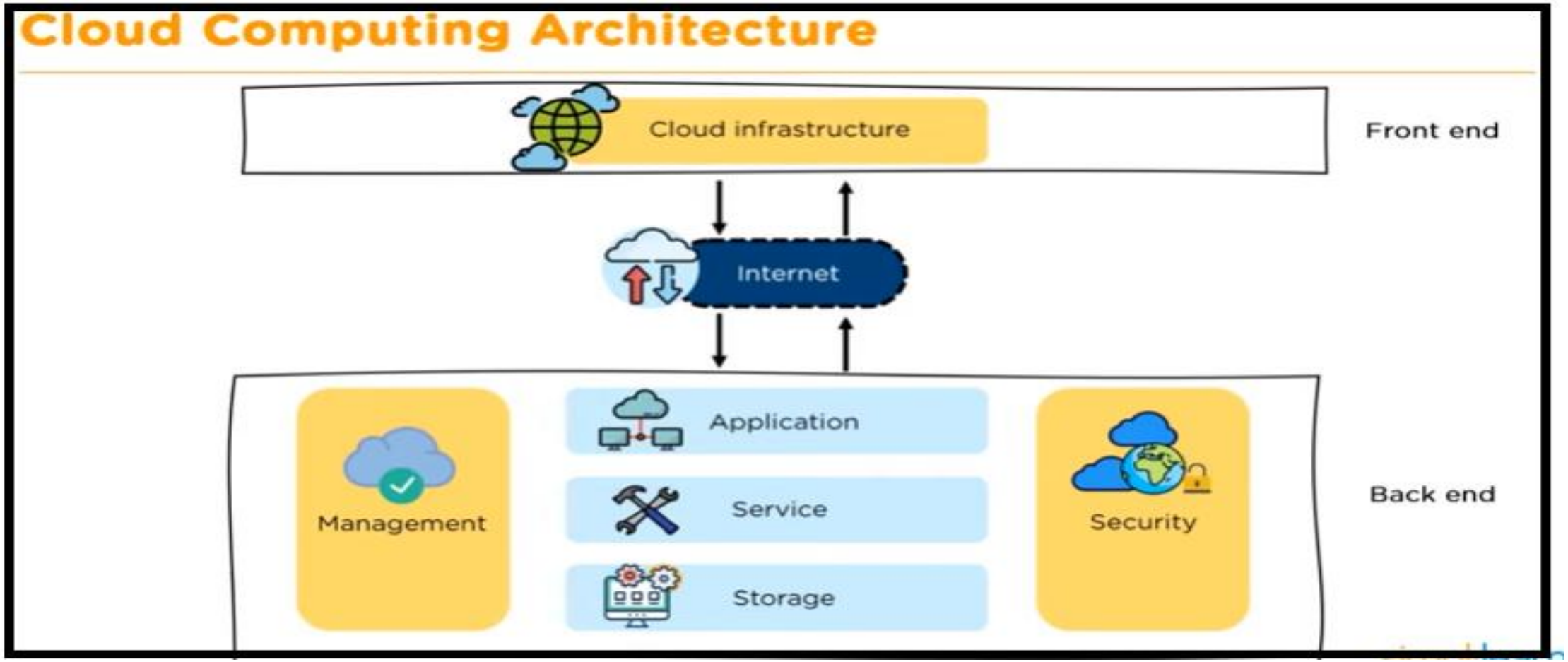
- Microsoft Azure is a cloud computing service which is used for **building, testing, deploying and managing the application.** This process is done in a global network of the Microsoft-managed data centre. It is private as well as a **public cloud** platform.
- It uses virtualization which differentiates the coupling between the operating system and CPU with the help of an abstraction layer known as a hypervisor.
- This hypervisor emulates all the functionality of the physical machine such as hardware and server into a virtual one. There is numerous amount of virtual machine available and each virtual machine can run many operating systems.

Google cloud

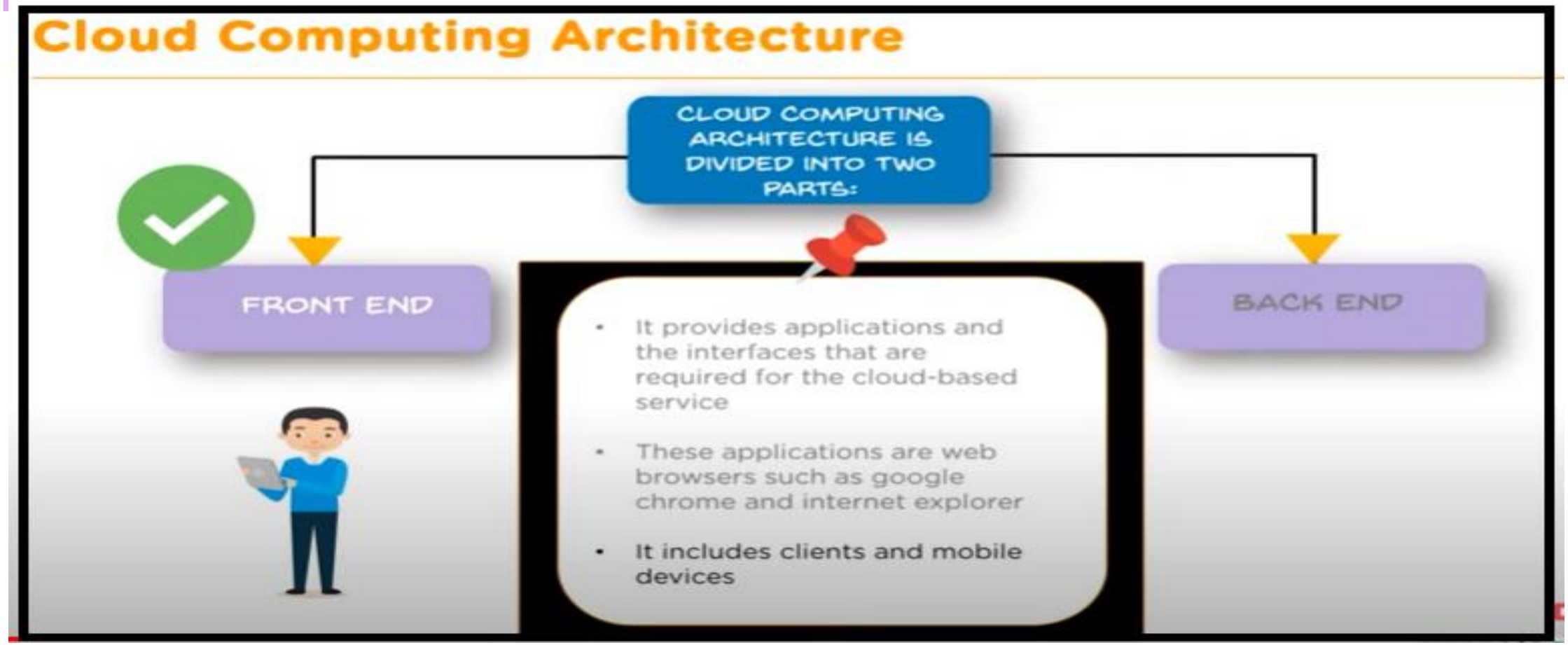
- Google cloud platform is one of the leading Cloud Computing services which are offered by Google and it runs on the same infrastructure that Google uses for its end-user products.
- The Google cloud platform is **basically used for Google search and YouTube**. **There are various services offered by Google Cloud such as data analysis, machine learning, and data storage.**
- The data stored in Google Cloud is secure and can access easily. It offers varieties of services from infrastructure as a service to platform as a service. Google also provides a strong **commitment to security** and stability. With the help of the Google cloud platform, the user is free to think about the code and the feature which are needed to develop without worrying about the operations side.

Cloud Service Providers – Google Cloud Platform

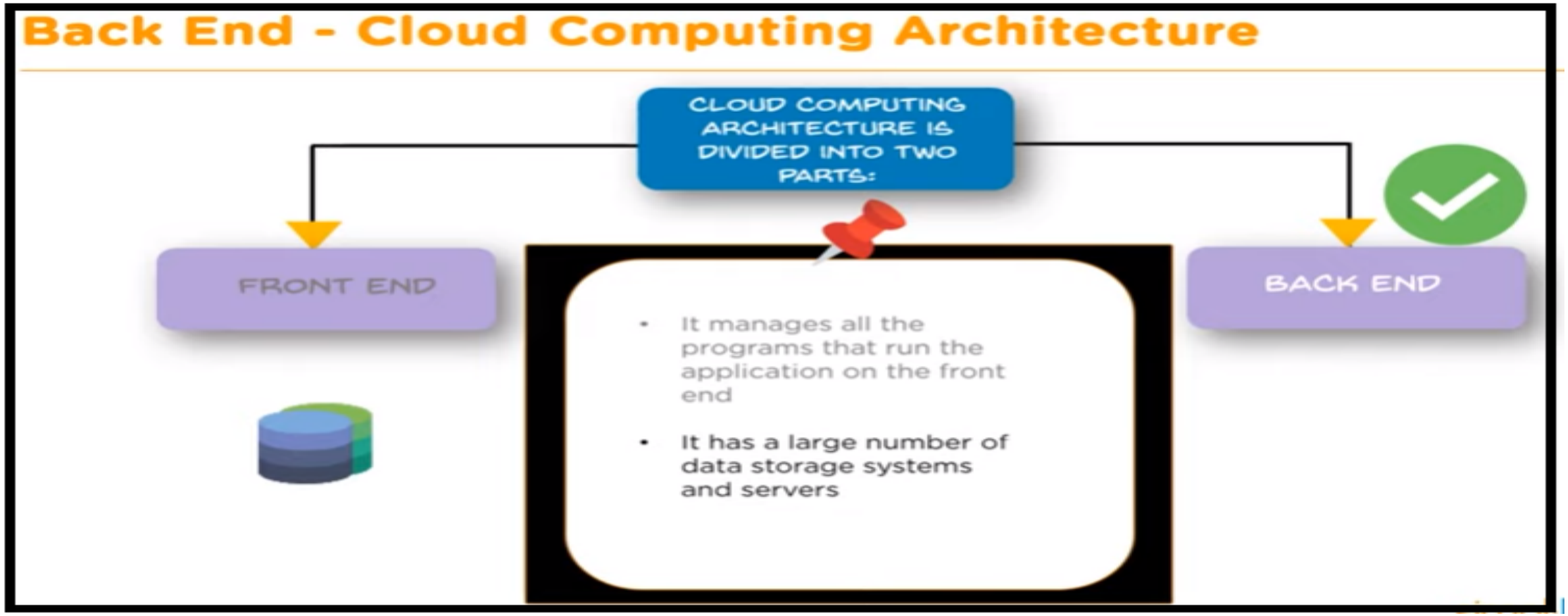
3. Cloud Computing Architecture



Cloud Computing Architecture



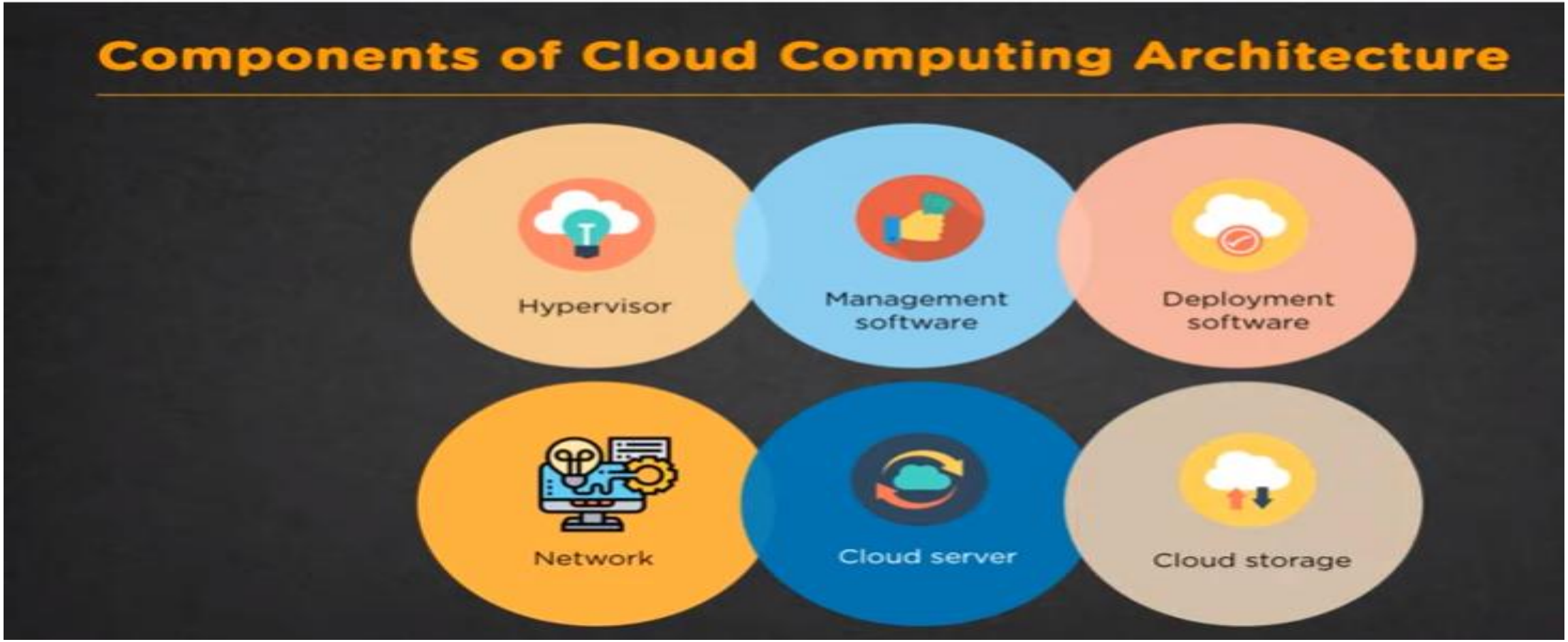
Cloud Computing Architecture



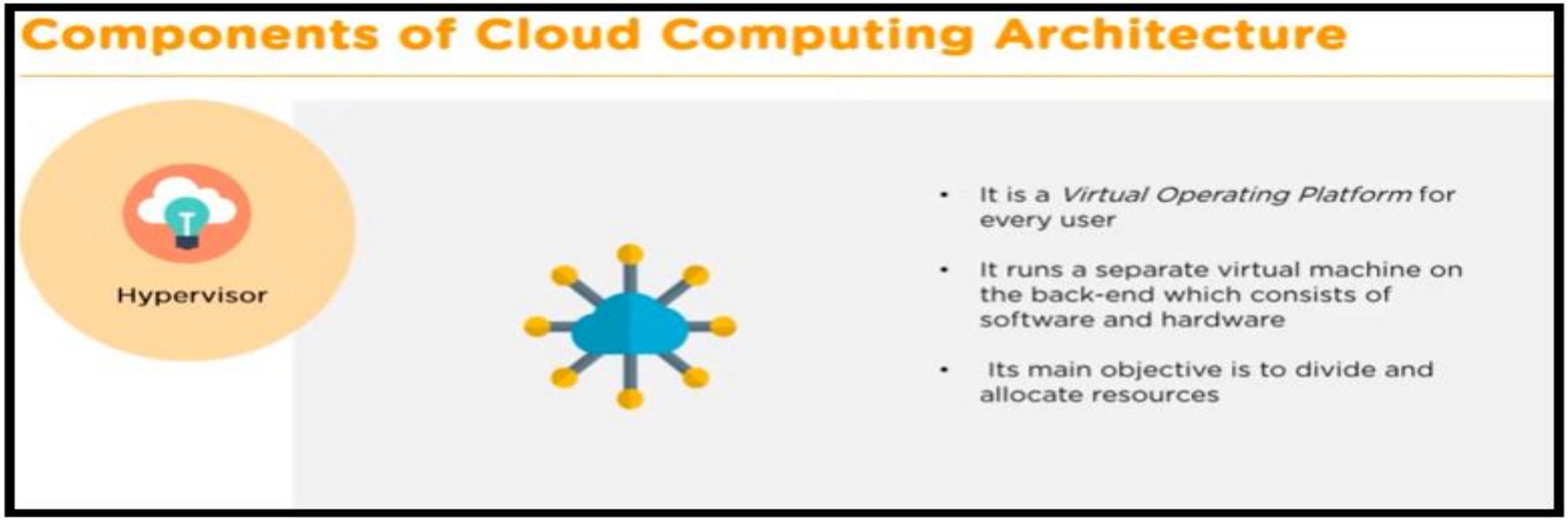
Cloud Computing Architecture (back-end)

- It can also be a software or a platform
- Based on the requirement, the application provides output to the end-user (with resources) in the back end

4. Components of Cloud Computing



Components of Cloud Computing



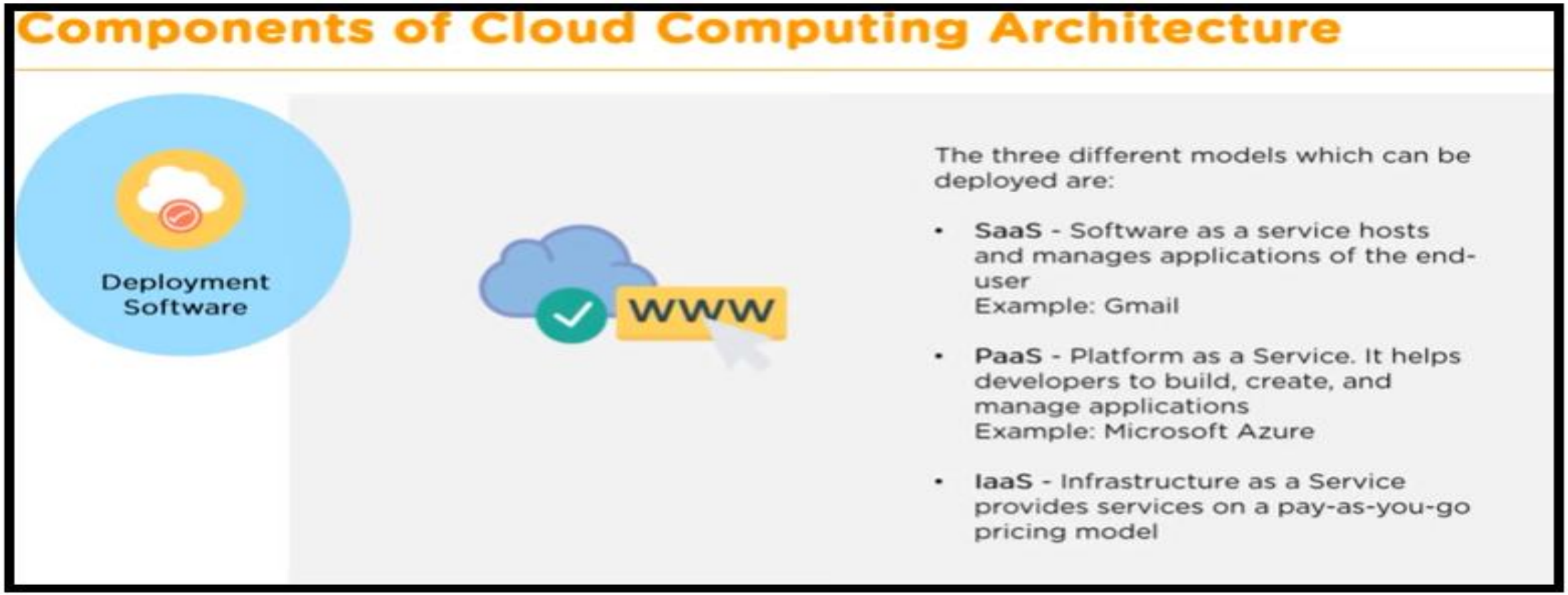
Components of Cloud Computing

Components of Cloud Computing Architecture

- Its responsibility is to manage and monitor cloud operations
- It helps in improving the performance of the cloud
- For example high security, flexibility, full-time access, etc.

Components of Cloud Computing

Components of Cloud Computing



Components of Cloud Computing

Components of Cloud Computing Architecture

Network

- It connects the front end and back end. Also, allows every user to access cloud resources
- It helps users to connect and customize the route and protocol

Components of Cloud Computing

Components of Cloud Computing Architecture

- Here, every data is stored and accessed by a user from anywhere over the internet
- It is scalable at run-time and is automatically accessed
- Data can be modified and retrieved from cloud storage over the web

5. Cloud Service Models

1. **Software-as-a-service (SaaS):** The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure2. 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

Saas is a cloud service provided by the cloud company. In SaaS, a cloud providers provides software which can be either for a particular amount of time or for the lifetime.

SaaS utilizes the internet and delivers the application to the customer. Most of the SaaS application does not require any downloads as they can use directly through the web browser.

Example: G-Mail

Cloud Service Models

2. **Platform-as-a-service (PaaS):** 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.3 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 .

It is a **development environment** where **a customer can create and develop applications** on a provider's computing environment.

Paas is a framework for the developer where they can create an application for customizing the previously built application. This service also provided through the means of internet and here all the management is done by the enterprise or any third party provider.

Example: Google App Engine

Cloud Service Models

3. **Infrastructure e-as-a-service (SaaS):** 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) .Where infrastructure is provided to you , you can create your own applications. i.e. underlying architecture is available where you can choose kind of technology , applications you want.**

Example: AWS EC2 service

Saas , Paas, Iaas Examples

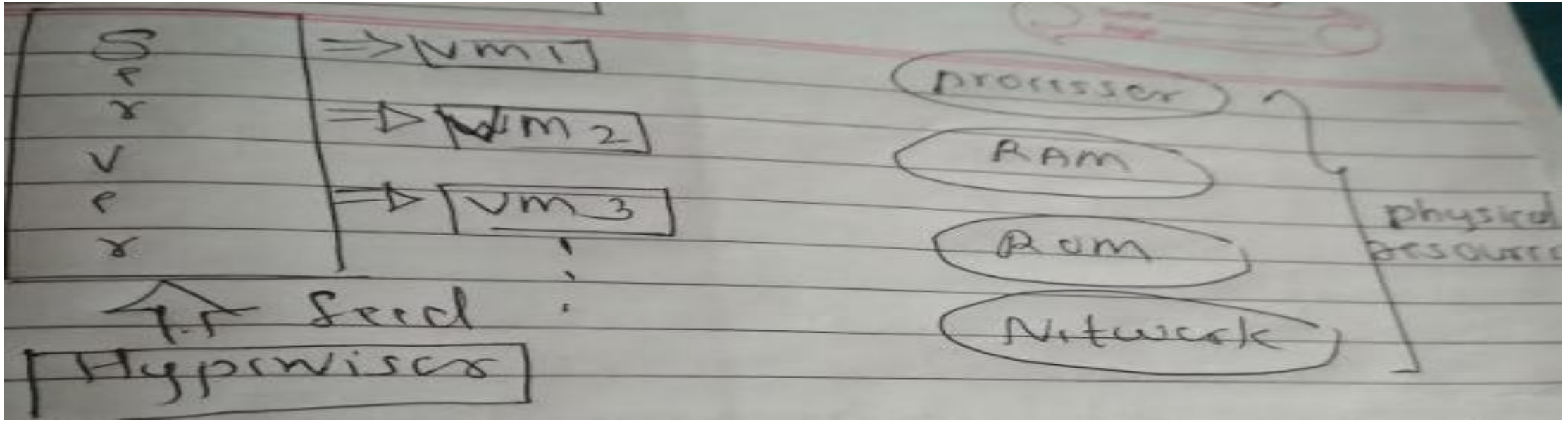
Platform Type	Common Examples
SaaS	Google Apps, Dropbox, Salesforce, Cisco WebEx, Concur, GoToMeeting
PaaS	AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, OpenShift
IaaS	DigitalOcean, Linode, Rackspace, Amazon Web Services (AWS), Cisco Metapod, Microsoft Azure, Google Compute Engine (GCE)

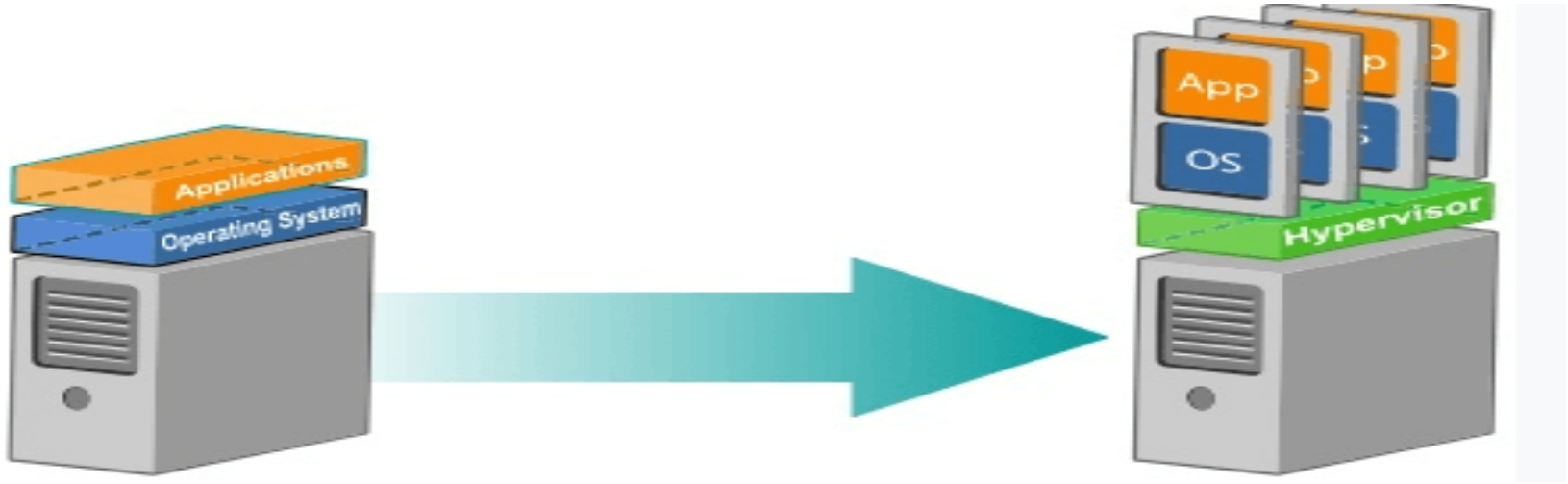
Services Provided by Cloud Providers

Name of Company	IaaS	Paas	SaaS
AWS	Amazon EC2	Amazon Web Services	Amazon Web Services
Microsoft	Microsoft Private Cloud	Microsoft Azure	Microsoft Office 365
Google	–	Google App Engine (Python, Java and many)	Google Applications
IBM	Smart Cloud Enterprise	Smart Cloud Application Services	SaaS Products
Adobe	–	Adobe Creative Cloud	Acrobat, Flashplayer, etc.

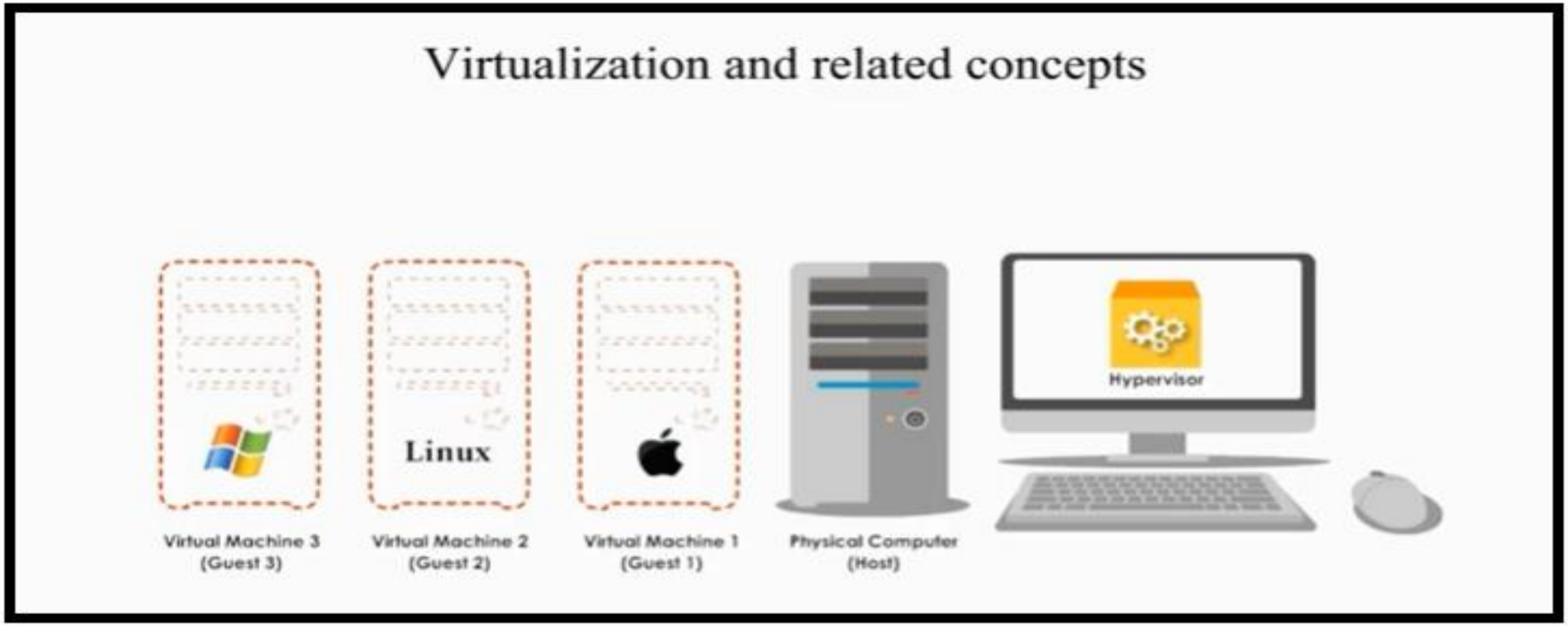
Introduction to Virtualization

6. Virtualization

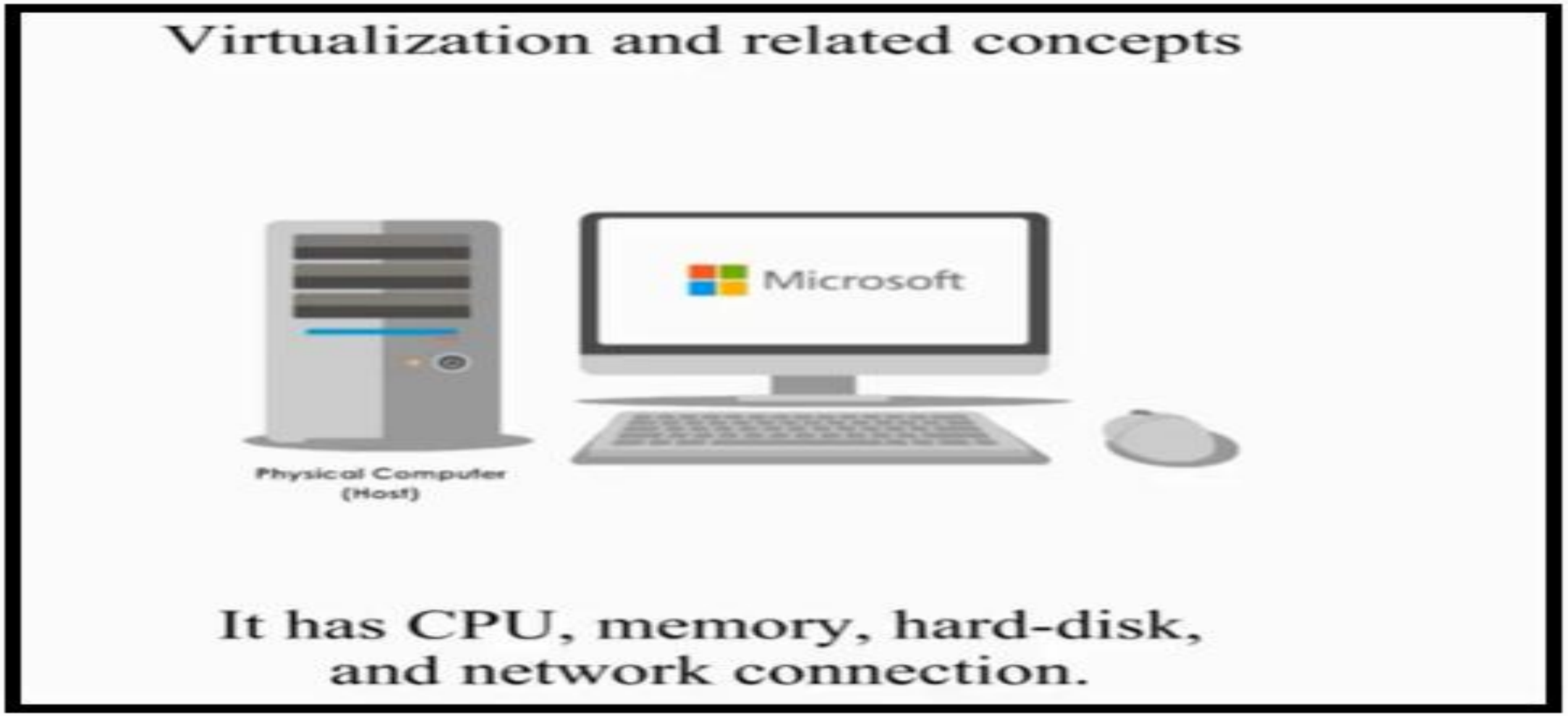




Virtualization



Virtualization



Virtualization

Virtualization is the process of using special software on a physical machine– to create virtual machines.

1. We can create and run as many virtual machines as we like

as long as their host's CPU, RAM, and other resources allow.

RAM is almost always the main limiting factor.

Together, all the virtual machines share the same resources of the host.

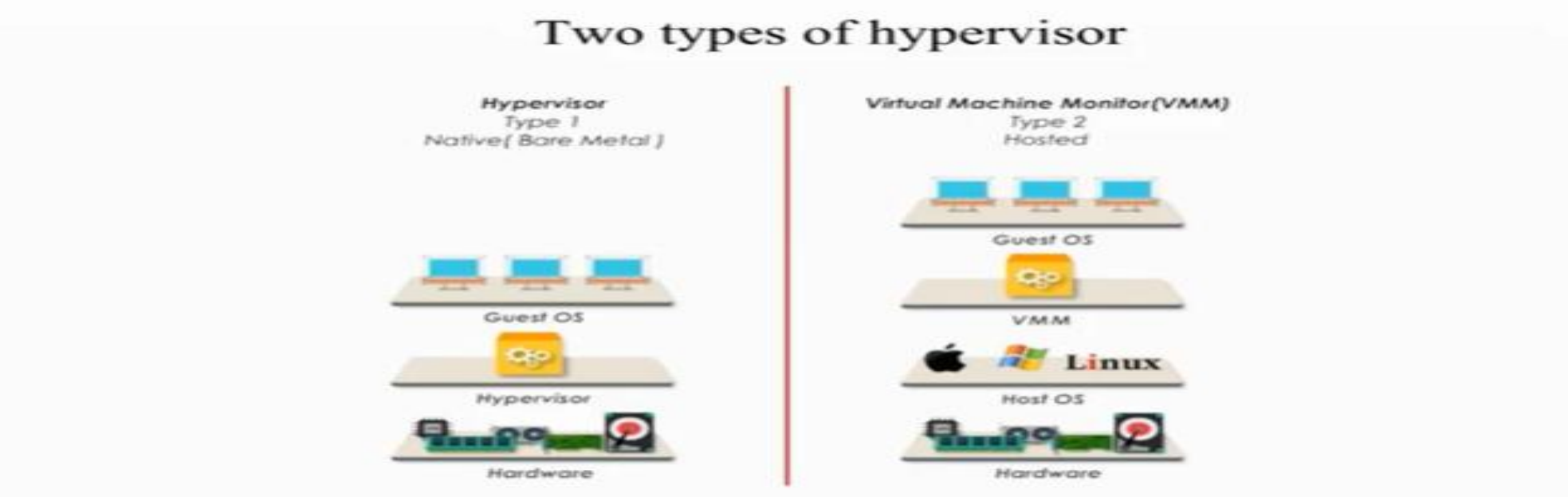
Yet, each virtual machine works independently.

but to users, a virtual machine appears and acts no differently from a physical computer.

A virtual machine can be configured to use not only a different operating system,

but also a different type of CPU, storage drive, or NIC than its host.

Virtualization



They control the hardware and manage virtual machines.

Xen, VMware's ESXi, Microsoft's Hyper-V, or KVM, just name a few.

A Type-2 hosted hypervisor, most frequently referred to as Virtual Machine Monitor(VMM),

is like an application program running on top of a conventional operating system,

such as Windows, Linux, or MacOS.

Virtual machines are created and managed by both Virtual Machine Monitor

through the host's operating system.

Types of Hypervisors

Type 1: Bare metal

✓ Run directly on the top of the host hardware, they control hardware and manage virtual machines

Type 2: Hosted Hypervisor

✓ Referred as VMM, it is an application program running on the top of the OS

✓ Virtual machines are created and managed by VMM through host OS

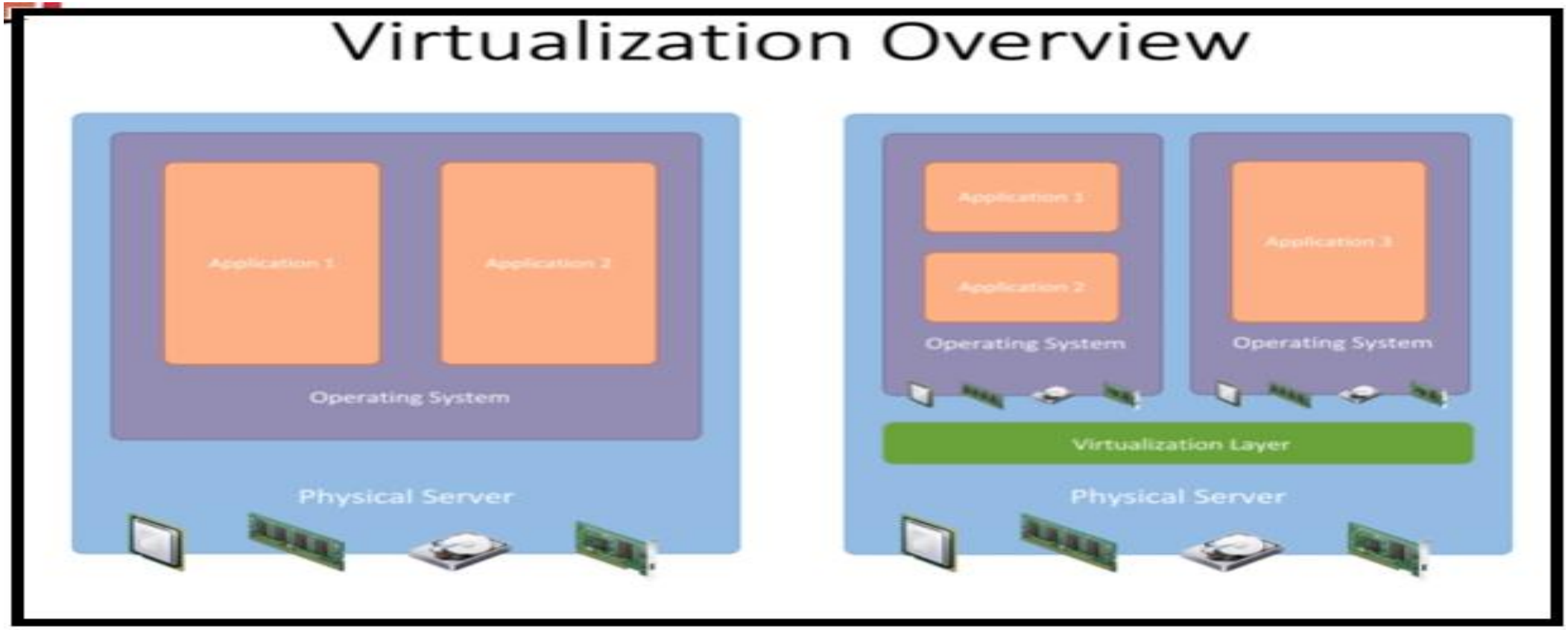
Virtualization

- **Example of Hosted Hypervisor**

VMware Workstation, VMware Player,

VirtualBox, or Parallels Desktop for Mac.

Virtualization



Virtualization

- Physical server has physical devices

✓CPU

✓Memory

✓Disc

✓NIC

- On the Top of physical server there is OS , on which multiple applications are running

Virtualization

- **Virtualization:** v**irtualization in cloud computing** is **making a virtual image of the storage devices ,servers or network resources** so that they can be used on multiple machines at the same time. There are many positive and negative effects of **virtualization** technology on the environment as well as the business and IT field.

- In technology virtualization means, virtual version of something is created and used regardless of the original version. This could be anything from operating systems, servers, storage devices and networks. One such example is partitioning a hard drive.

- **Virtualization** is the "creation of a virtual (rather than actual) version of something, such as a server, a desktop, a storage device, an operating system or network resources".

- We can define Virtualization as a technology that provides the capability to logically separate the physical resources of a server and use them as different isolated machines, called Virtual Machines.

- **Previously, there were computers that ran an Operating System (OS) and application on top of the OS, but now, with the help of virtualization software like Hypervisor, one can create multiple Virtual Machines (VMs) on a single computer and install OS on them and run all of them at the same time.**

Virtualization

- **Advantages of Virtualization:**

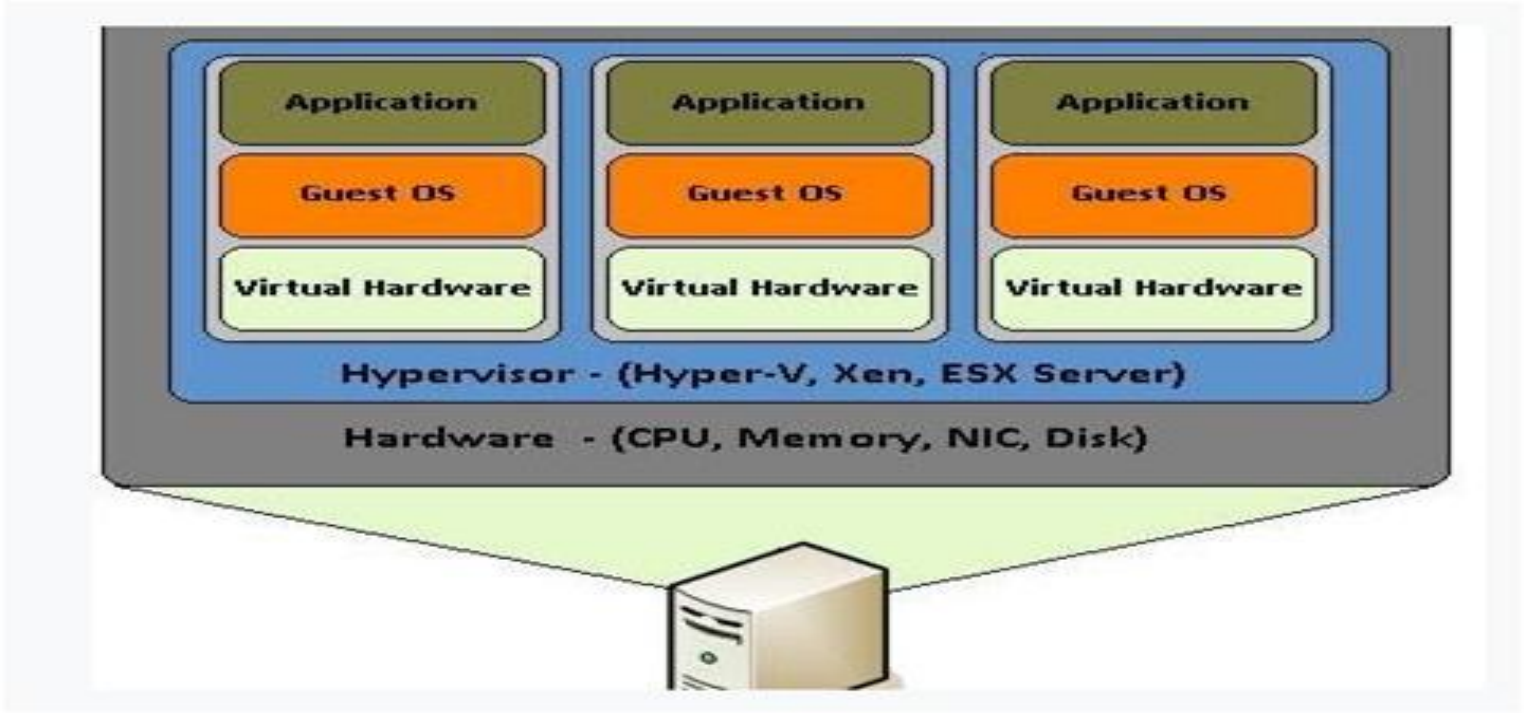
- **Virtualization in Cloud Computing**, save the cost for a physical system such as hardware and servers. It stores all the data in the **virtual** server, which are quite economical. It reduces the wastage, decreases the electricity bills along with the maintenance cost.
- Reduced capital and operating costs.
- Minimized or eliminated downtime.
- Increased IT productivity, efficiency, agility and responsiveness.
- Faster provisioning of applications and resources.
- Greater business continuity and disaster recovery.
- Simplified data center management.

Virtualization

- **Disadvantages of Virtualization**

- It can have a high cost of implementation. ...
- It still has limitations. ...
- It creates a security risk. ...
- It creates an availability issue. ...
- It creates a scalability issue. ...
- It requires several links in a chain that must work together cohesively. ...
- It takes time.
- Software licensing costs.
- The necessity to train IT, staff, in virtualization.

Virtualization



Virtualization

Hardware	Network	Storage	Memory	Software	Data	Desktop
• Full • Bare-Metal • Hosted • Partial • Para	• Internal Network Virtualization • External Network Virtualization	• Block Virtualization • File Virtualization	• Application Level Integration • OS Level Integration	• OS Level • Application • Service	• Database	• Virtual desktop infrastructure • Hosted Virtual Desktop

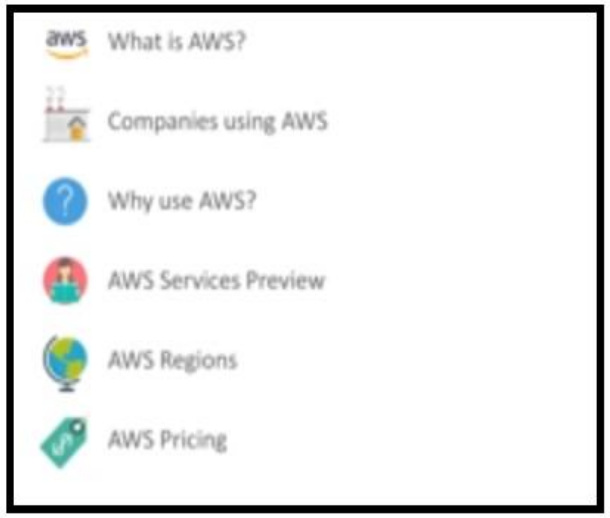
Virtualization

Hypervisor

The machine on which the virtual machine is created is known as host machine and virtual machine is referred as a guest machine. This virtual machine is managed by a software or firmware, which is known as hypervisor.

AWS

7. AWS



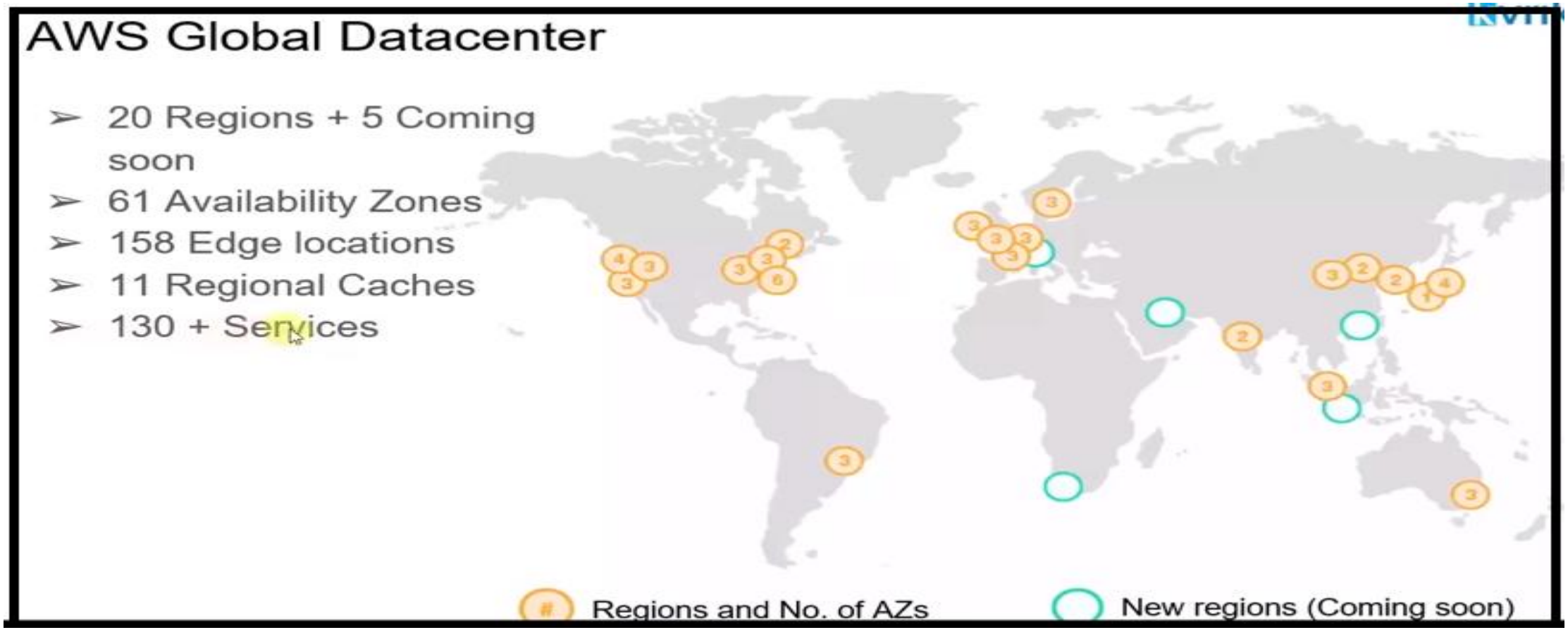
What is AWS?

Amazon Web Services is a subsidiary of Amazon.com that provides on-demand cloud computing platforms to individuals, companies and governments, **on a paid subscription basis** with a free-tier option available for 12 months.

Companies Using AWS

Kellogg's NETFLIX GE Adobe amazon airbnb

AWS


AWS Global Datacenter
➢ 20 Regions + 5 Coming soon
➢ 61 Availability Zones
➢ 158 Edge locations
➢ 11 Regional Caches
➢ 130 + Services
Regions and No. of AZs
New regions (Coming soon)

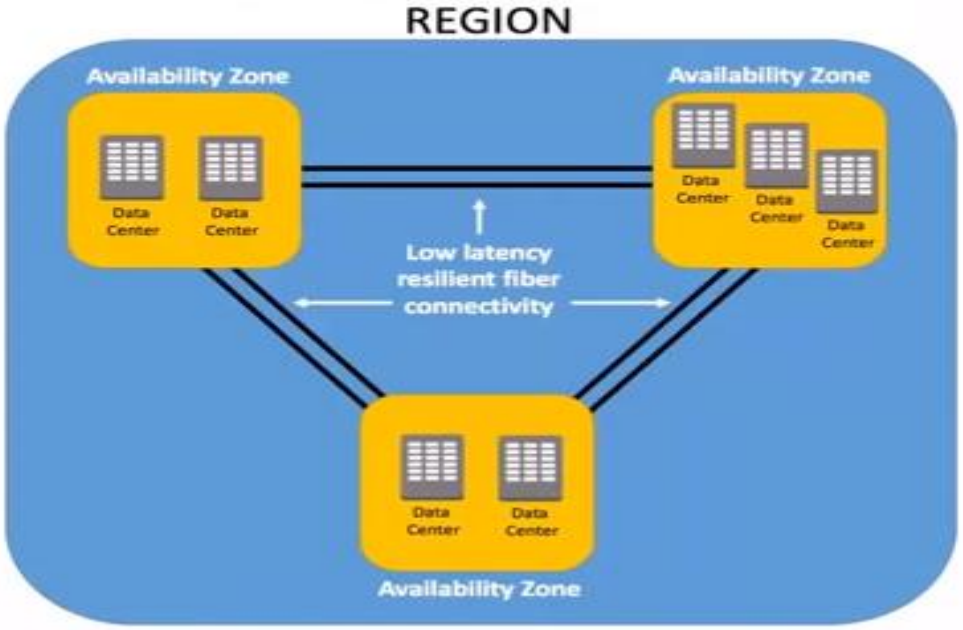
AWS

Region and Availability Zones

Region = Independent Geographic Area

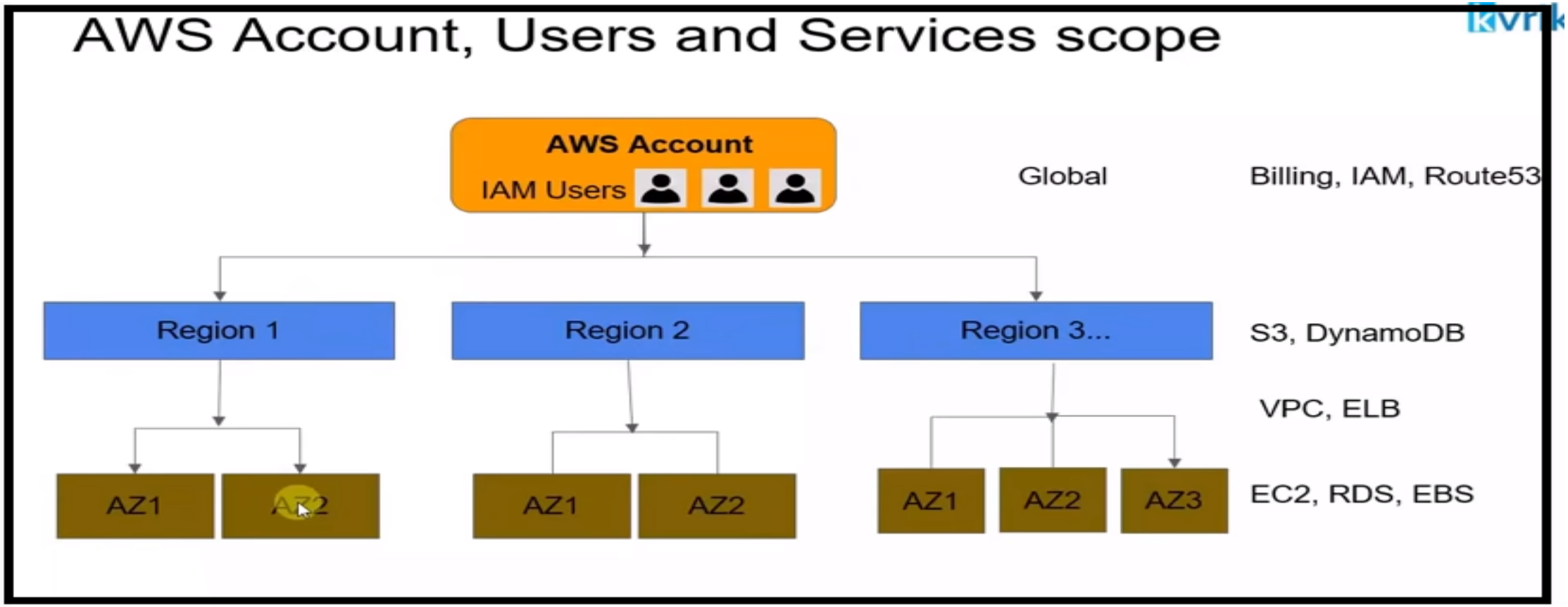
Availability Zone = Multiple isolated locations / data centers within a region

**Region contains at least 2 AZs (except for Osaka region)*



US West - California (us-west-1)

AWS



Once you have an AWS account , you can deploy your infrastructure on any region

AWS

AWS Account: Once you have an AWS account , you can deploy your infrastructure on any region.

Billing Service: Works at account level and at the end of the month you will get bill

IAM (Identity Access Management) : Works at account level , you can create different users and that users can use AWS services

S3 and DynamoDB Service: Works at region level

EC2(Elastic Compute Cloud):

RDS : (Database)

EBS : (Elastic Block storage)

AWS SERVICES

AWS Compute and Analytics Services

EC2
Elastic Compute Cloud

Auto Scaling
EC2 Horizontal scaling

Lambda
Serverless Computing

ELB
Elastic Load Balancer

ECS
Elastic Container Service

EMR
Elastic Mapreduce

Kinesis
Real time data/video streaming

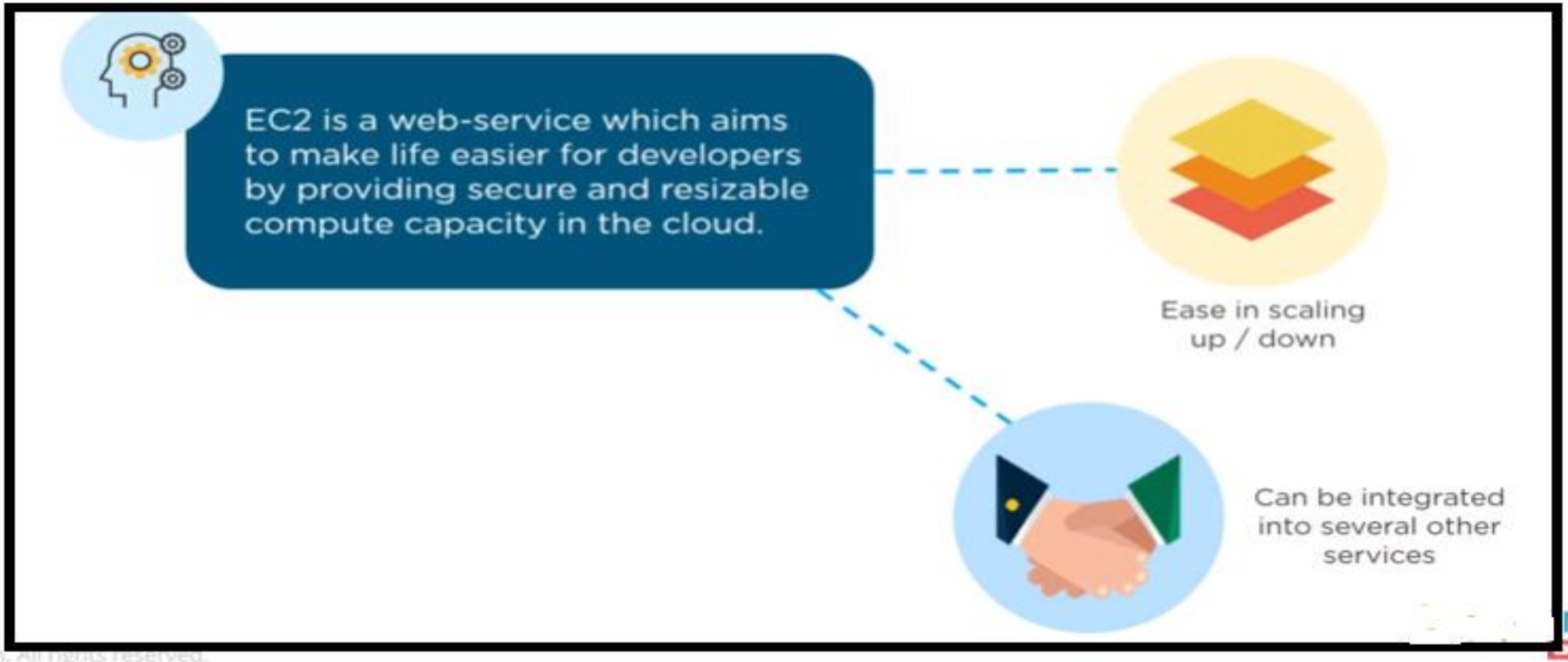
Athena
Interactive Query Engine

QuickSight
Business Intelligence

Glue

AWS SERVICES

AWS SERVICES



8. Ulteo

- It is **Open Virtual Desktop** (OVD) was an **open**-source Application Delivery and **Virtual Desktop** infrastructure project that could deliver **applications or a desktop hosted on a Linux or Windows server to end users.**

9. AWS Identity and Access Management (IAM)

- **AWS Identity and Access Management (IAM) is a web service that helps you securely control access to AWS resources.**
- You use IAM **to control who is authenticated (signed in) and authorized** (has permissions) to use resources.
- When **you first create an AWS account**, you begin with a **single sign-in identity that has complete access to all AWS services and resources in the account**. **This identity is called the AWS account root user** and is accessed by signing in with the email address and password that you used to create the account.
- We strongly recommend that you do not use the root user for your everyday tasks, even the administrative ones. Instead, adhere to the best practice of using the root user only to create your first IAM user. Then securely lock away the root user credentials and use them to perform only a few account and service management tasks.
- You **can grant other people permission to administer and use resources** in your AWS account without having to share your password or access key.

AWS IAM Features

1. **Shared access to your AWS account:**

You can grant other people permission to administer and use resources in your AWS account without having to share your password or access key. (by creating user name and password)

2. **Granular permissions (Read only/Read write/etc permission)**

You can grant different permissions to different people for different resources.
For example, you might allow some users complete access to Amazon Elastic Compute Cloud (Amazon EC2), Amazon Simple Storage Service (Amazon S3), Amazon Dynamo, Amazon Red-shift, and other AWS services.
For other users, you can allow read-only access to just some S3 buckets, or permission to administer just some EC2 instances, or to access your billing information but nothing else.

3. **Secure access to AWS resources for applications that run on Amazon EC2**

You can use IAM features to securely provide credentials for applications that run on EC2 instances. These credentials provide permissions for your application to access other AWS resources.

AWS IAM Features

4. Multi-factor authentication (MFA)

You can add two-factor authentication to your account and to individual users for extra security. With MFA you or your users must provide not only a password or access key to work with your account, but also a code from a specially configured device.

5. Identity federation

You can allow users, who already have passwords elsewhere (like face-book or elsewhere can use that account and login)— for example, in your corporate network or with an internet identity provider—**to get temporary access to your AWS account. (Trust between company ids (or face book id, Gmail id) and AWS)**

6. Identity information for assurance

If you use AWS Cloud-Trail, **you receive log records that include information about those who made requests for resources in your account.** That information is based on IAM identities.

AWS IAM Features

7. PCI DSS Compliance

IAM supports the processing, storage, and transmission of credit card data by a merchant or service provider, and has been validated as being compliant with Payment Card Industry (PCI) Data Security Standard (DSS). For more information about PCI DSS, including how to request a copy of the AWS PCI Compliance Package, see PCI DSS Level 1.

8. Integrated with many AWS services

For a list of AWS services that work with IAM, see AWS Services That Work with IAM (p. 502).

9. Eventually Consistent

IAM, like many other AWS services, is eventually consistent (IAS work is replicated like multiple zones). IAM achieves high availability by replicating data across multiple servers within Amazon's data centres around the world.

If a request to change some data is successful, the change is committed and safely stored. However, the change must be replicated across IAM, which can take some time. Such changes include creating or updating users, groups, roles, or policies. We recommend that you do not include such IAM changes in the critical, high-availability code paths of your application. Instead, make IAM changes in a separate initialization or setup routine that you

AWS IAM Features

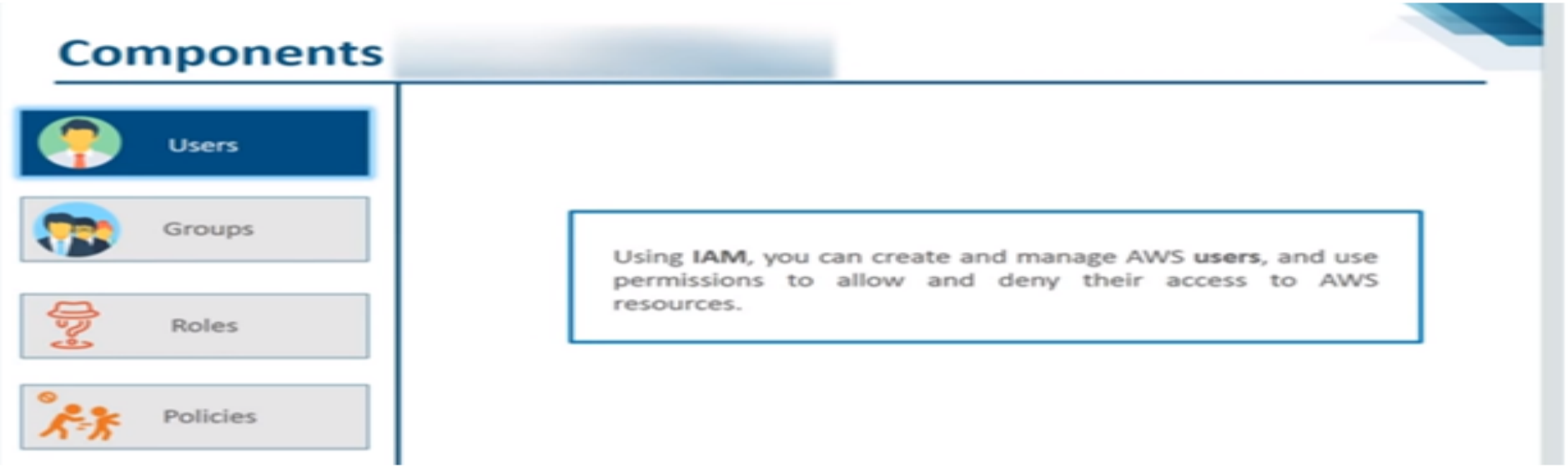
run less frequently. Also, be sure to verify that the changes have been propagated before production workflows depend on them. For more information, see Changes that I make are not always immediately visible (p. 466).

10. Free to use

AWS Identity and Access Management (IAM) and AWS Security Token Service (AWS STS) are features of your AWS account offered at no additional charge. You are charged only when you access other AWS services using your IAM users or AWS STS temporary security credentials. For information about the pricing of other AWS products, see the Amazon Web Services pricing page.

AWS IAM Components

1. **Users**
2. **Groups**
3. **Roles**
4. **Policies**

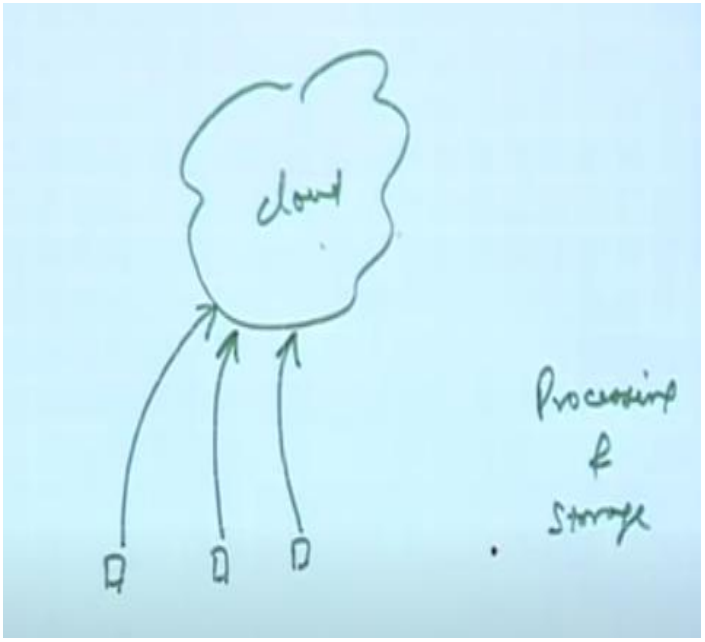


AWS IAM Components

The users created, can also be divided among **groups**, and then the **rules** and **policies** that apply on the **group**, apply on the user level as well.

An IAM **role** is an IAM entity that defines a set of permissions for making **AWS** service requests. IAM **roles** are not associated with a specific user or group. Instead, trusted entities assume **roles**, such as IAM users, applications, or **AWS** services such as EC2

10. Fog Computing(Distributed computing)



In IOT multiple devices are connected to each other and generating huge data, if we send this data on cloud for storage or analysis then it will cost very huge (that is huge data is send to cloud unnecessarily). Hence data is send to the intermediate devices present over the network for analysis, communication. That is in **fog computing data is stored ,analysed at local level** (having computing power). Bandwidth is saved because data is computed at local level.

Fog Computing(Distributed computing)

Introduction

- ✓ Fog computing or fogging is a term coined by CISCO.
- ✓ The idea of fog computing is to extend the cloud nearer to the IoT devices.
- ✓ The primary aim: solve the problems faced by cloud computing during IoT data processing.
- ✓ an intermediate layer between cloud and devices.

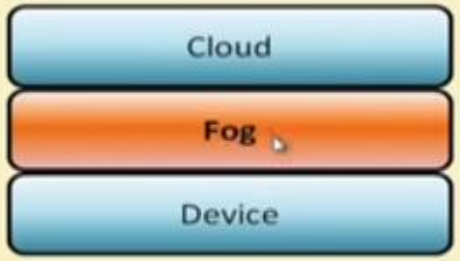


Fig. Fog as intermediate layer between cloud and device

Fog computing is designed to be deployed in a distributed manner where edge de-vices do the processing.

In contrast, **cloud computing is a more centralized concept.**
In Fog, processing and storage devices are located in close proximity compared to the cloud and **this is the reason why Fog is more capable to serve latency aware services** through **access points, smart phones, base stations, switches, servers, and routers.**

Devices are IOT devices and data send to fog devices ; where they do some processing and then it sends to cloud.

Fog Computing(Distributed computing)

Why Fog Computing

- ✓ The ability of the current cloud model is insufficient to handle the requirements of IoT.
- ✓ Issues are:
  - ✓ Volume
  - ✓ Latency
  - ✓ Bandwidth

Fog Computing

- The main **difference between fog computing and cloud computing** is that **cloud is a centralized system**, while the **fog** is a **distributed decentralized infrastructur**e.
- **Fog computing** is a mediator **between** hardware and remote servers.
- **cloud** and **fog computing both offer end users data, storage, computation and application services**, but **fog computing** is in much closer proximity to end users and better supports mobility.
- **To be clear, fog computing will** not **replace cloud computing** altogether; rather, it's a supplement to the **cloud**.
- Fog and cloud computing are interconnected. **In nature, fog is closer to the earth than clouds; in the technological world, it is just the same, fog is closer to end-users, bringing cloud capabilities down to the ground.**

11. Conclusion

- **Cloud Computing** is helping a lot in business whether it is a small or large.

- **These Cloud Service Providers companies provide storage, database server, networking and the software through which the business can increase.**

- So a customer can choose the company which is most suitable for their business and their requirement.

CCL Mini Project Guidelines

- **To prepare CCL mini project report, use same format as per your final year project report format**
- **Prepare 5 mins video of project demonstration**
- **Prepare ppt of CCL project and upload on Google classroom**
- **Upload soft copy of report on Google classroom**

Google App Engine

- Google App Engine is An example of Platform as a Service (PaaS).
- Google App Engine provides Web app developers and enterprises with access to Google's scalable hosting and tier 1 Internet service.
- The Google App Engine supports applications which are written in Java or Python.
- Applications in Google app engine stores data in Google BigTable.
- Application in Google app engine uses Google query language.

Google App Engine

- **Google App Engine** (often referred to as GAE or simply App Engine) is a Platform as a Service (**PaaS**) cloud computing platform for **developing** and **hosting web applications** in Google-managed data centres.

- Applications are **sandboxed** and run across multiple servers. App Engine offers **automatic scaling** for web applications as the number of **requests increases** for an application, App Engine automatically **allocates** more **resources** for the web application to handle the additional demand.

Google App Engine

- Google App Engine is **free up** to a **certain** level of consumed resources. **Fees** are charged for **additional storage, bandwidth**, or instance hours required by the application.
- The **App Engine** requires that apps be
  - Written in **Java** or **Python**
  - Store data in **Google** BigTable and use the **Google** query language.

Note:

- Google App Engine primarily supports

Go, PHP, Java, Python, Node.js, .NET, and Ruby applications.

Google App Engine

COST OF GOOGLE APP ENGINE:

- Google app engine provides limited resource usage as free of cost.
- After free resource usage limit users can per day or per minute basis.