Lecture 6

Learning outcomes:

- *Cloud Computing and Virtualization.*

Cloud Computing

- Cloud Computing is a technology that allows you to store and access data and applications over the internet instead of using your computer's hard drive or a local server.
- In cloud computing, you can store different types of data such as files, images, videos, and documents on remote servers, and access them anytime from any device connected to the internet.

- **Infrastructure:** Cloud computing depends on remote network servers hosted on the Internet to store, manage, and process data.
- **On-Demand Access:** Users can access cloud services and resources on demand, scaling up or down without having to invest in physical hardware.
- **Types of Services:** Cloud computing offers various benefits such as cost saving, scalability, reliability, and accessibility. It reduces capital expenditures, and improves efficiency.

Architecture Of Cloud Computing

- Cloud computing architecture refers to the components and sub-components required for cloud computing.
- These components typically refer to:

1. Front end (Fat client, Thin client)
2. Back-end platforms (Servers, Storage)
3. Cloud-based delivery and a network (Internet, Intranet, Intercloud)

1. Front End (User Interaction Enhancement)

- The User Interface of Cloud Computing consists of 2 sections of clients. The Thin clients are the ones that use web browsers facilitating portable and lightweight accessibilities and others are known as Fat Clients that use many functionalities for offering a strong user experience.
- A thin client relies heavily on a central server for processing, with the local device acting more as a terminal for input and output, requiring a continuous network connection.
- A fat client (or thick client) performs most of its processing on the local device, which has significant memory, storage, and computing power, allowing it to operate more independently.

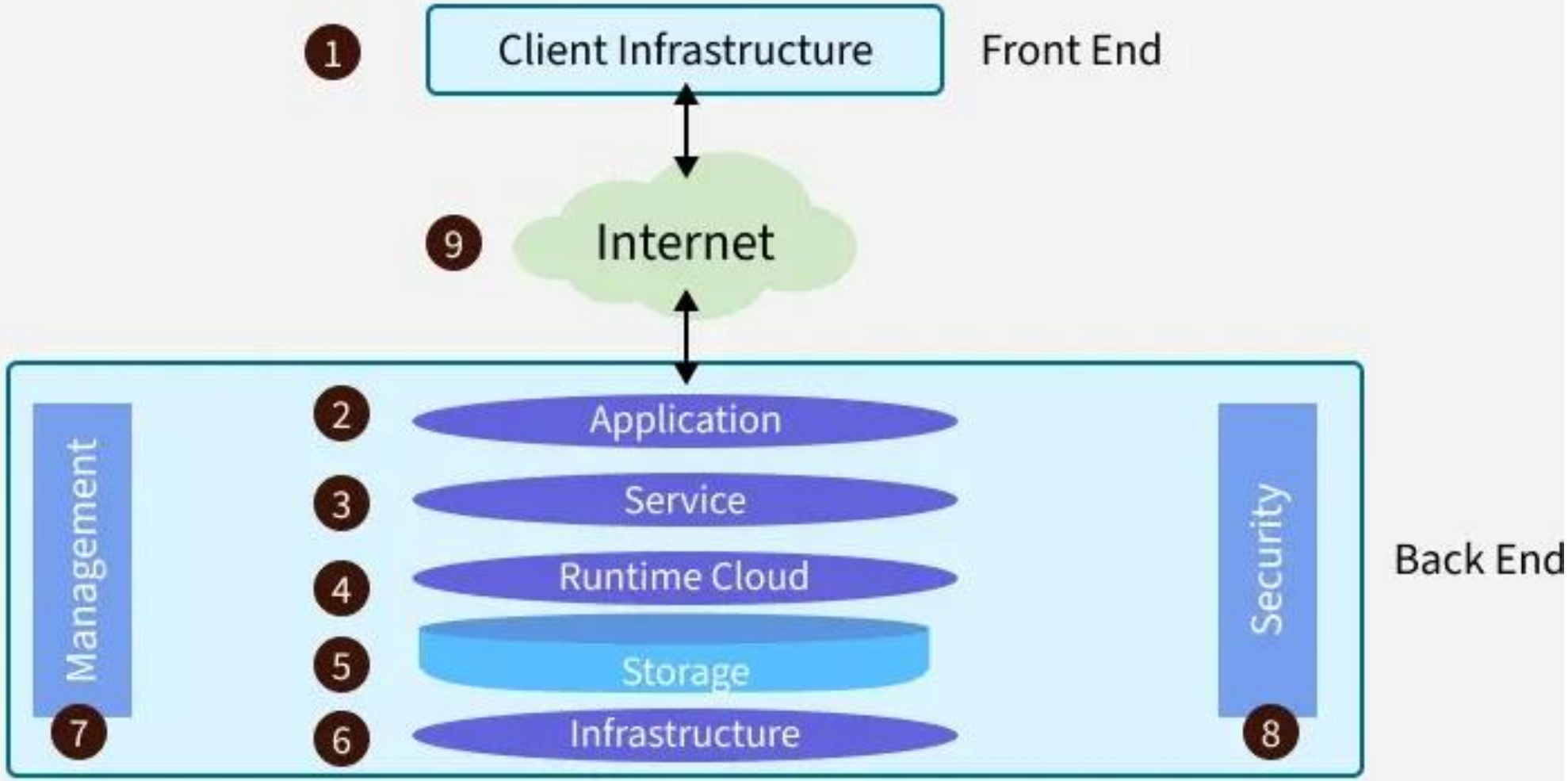
2. Back-end Platforms (Cloud Computing Engine)

- The core of cloud computing is made at back-end platforms with several servers for storage and processing computing.
- Management of Applications logic is managed through servers and effective data handling is provided by storage.
- The combination of these platforms at the backend offers the processing power, and capacity to manage and store data behind the cloud.

3. Cloud-Based Delivery and Network

- On-demand access to the computer and resources is provided over the Internet, Intranet, and Intercloud.
- The Internet comes with global accessibility, the Intranet helps in internal communications of the services within the organization and the Intercloud enables interoperability across various cloud services.
- This dynamic network connectivity ensures an essential component of cloud computing architecture on guaranteeing easy access and data transfer.

Cloud Computing Architecture



Types of Cloud Computing Services

❑ The following are the types of Cloud Computing:

1. Infrastructure as a Service (IaaS)
2. Platform as a Service (PaaS)
3. Software as a Service (SaaS)
4. Function as a Service (FaaS)

1. Infrastructure as a Service (IaaS)

- Infrastructure as a Service (IaaS) is a type of cloud computing that gives people access to IT tools like virtual computers, storage, and networks through the internet. You don't need to buy or manage physical hardware. Instead, you pay only for what you use.
- Here are some key benefits of using IaaS:

- **Flexibility and Control:** IaaS comes up with providing virtualized computing resources such as VMs, Storage, and networks facilitating users with control over the Operating system and applications.
- **Reducing Expenses of Hardware**: IaaS provides business cost savings with the elimination of physical infrastructure investments making it cost-effective.
- **Scalability of Resources:** The cloud provides in scaling of hardware resources up or down as per demand facilitating optimal performance with cost efficiency.

2. Platform as a Service (PaaS)

- Platform as a Service (PaaS) is a cloud computing model where a third-party provider offers the software and hardware tools needed to develop, test, and run applications. This allows users to focus on building their applications without worrying about managing servers or infrastructure.
- **For example,** AWS Elastic Beanstalk is a PaaS offered by Amazon Web Services that helps developers quickly deploy and manage applications.

❑Here are some key benefits of using PaaS:

- **Simplifying the Development:** Platform as a Service offers application development by keeping the underlying Infrastructure as an Abstraction. It helps the developers to completely focus on application logic (Code) and background operations are completely managed by the AWS platform.
- **Enhancing Efficiency and Productivity:** PaaS lowers the Management of Infrastructure complexity, speeding up the Execution time and bringing the updates quickly to market by streamlining the development process.
- **Automation of Scaling:** Management of resource scaling, guaranteeing the program's workload efficiency is ensured by PaaS.

3. Software as a Service (SaaS)

- Software as a Service (SaaS) is a way of using software over the internet instead of installing it on your computer. The software is hosted by a company, and you can use it just by logging in through a web browser. You don’t need to worry about updates, maintenance, or storage the provider takes care of all that.
- A common example is Google Docs. You can write and share documents online without downloading any software.

❑Here are some key benefits of using SaaS:

- **Collaboration And Accessibility:** Software as a Service (SaaS) helps users to easily access applications without having the requirement of local installations. It is fully managed by the AWS Software working as a service over the internet encouraging effortless cooperation and ease of access.
- **Automation of Updates:** SaaS providers manage the handling of software maintenance with automatic latest updates ensuring users gain experience with the latest features and security patches.
- **Cost Efficiency:** SaaS acts as a cost-effective solution by reducing the overhead of IT support by eliminating the need for individual software licenses.

4. Function as a Service (FaaS)

- Function as a service (FaaS) is a cloud-computing service that allows customers to run code in response to events, without managing the complex infrastructure. You just write the code, upload it and the cloud provider runs it only when it's needed. You pay only for the time your code runs.
- **For example,** with AWS Lambda, you can write a function that resizes images whenever someone uploads a photo to your website. You don’t need to keep a server running all the time AWS runs your function only when a photo is uploaded.

❑Here are some key benefits of using SaaS:

- **Event-Driven Execution:** FaaS helps in the maintenance of servers and infrastructure making users worry about it. FaaS facilitates the developers to run code as a response to the events.
- **Cost Efficiency:** FaaS facilitates cost efficiency by coming up with the principle "Pay as per you Run" for the computing resources used.
- **Scalability and Agility:** Serverless Architectures scale effortlessly in handing the workloads promoting agility in development and deployment.

Cloud Deployment Models

❑The following are the Cloud Deployment Models:

1. Private Cloud

- It provides an enhancement in protection and customization by cloud resource utilization as per particular specified requirements.
- It is perfect for companies which looking for security and compliance needs.

2. Public Cloud

- It comes with offering a pay-as-you-go principle for scalability and accessibility of cloud resources for numerous users. it ensures cost-effectiveness by providing enterprise-needed services.

3. Hybrid Cloud

- It comes up with a combination of elements of both private and public clouds providing seamless data and application processing in between environments. It offers flexibility in optimizing resources such as sensitive data in private clouds and important scalable applications in the public cloud.

Top Leading Cloud Computing Companies

- The following tables show the top leading cloud computing companies along with key details about their cloud services:

Company	Cloud Service Name	Key Offerings
1. Amazon	AWS (Amazon Web Services)	Compute, Storage, AI/ML, Databases, Networking
2. Microsoft	Azure	Cloud computing, AI, Analytics, Hybrid Cloud
3. Google	Google Cloud Platform (GCP)	AI/ML, Big Data, Kubernetes, Cloud Storage
4. Alibaba	Alibaba Cloud	IaaS, AI, Big Data, Cloud Security, CDN
5. Oracle	Oracle Cloud	Enterprise Cloud, Databases, SaaS, PaaS
6. IBM	IBM Cloud	AI, Quantum Computing, Hybrid Cloud, Security
7. Salesforce	Salesforce Cloud	CRM, SaaS, AI, Analytics
8. Tencent	Tencent Cloud	AI, Gaming Cloud, IoT, Big Data

Cloud Storage?

- **Cloud storage** is a method to **save data on the internet** instead of your computer or hard drive. It allows you to store files (like documents, images, videos, backups, and more) on **remote servers** that are managed by cloud service providers. You can access your files **anytime and from anywhere** using the internet. When we upload a file to a cloud-based server like Google Drive, OneDrive, or iCloud, that file gets copied over the Internet into a data server that is **cloud-based** actual physical space where companies store files on multiple hard drives. Most companies have hundreds of these servers known as 'server farms' spanning across multiple locations.
- So, if our data gets somehow lost we will not lose our data because it will be backed up by another location. This is known as redundancy which keeps our data safe from being lost.

Advantages of Cloud Computing

❑The following are some of the benefits of using cloud computing:

- It is easier to get backup in cloud.
- It allows us easy and quick access stored information anywhere and anytime.
- It allows us to access data via mobile.
- It reduces both hardware and software cost, and it is easily maintainable.
- One of the biggest advantage of Cloud Computing is Database Security.

Disadvantages of Cloud Computing

- The following are some of disadvantages you will face while using cloud computing:

- It requires good internet connection.
- User have limited control on the data

Virtualization in Cloud Computing and Types

- Virtualization is a way to use one computer as if it were many. Before virtualization, most computers were only doing one job at a time, and a lot of their power was wasted. Virtualization lets you run several virtual computers on one real computer, so you can use its full power and do more tasks at once.

- In cloud computing, this idea is taken further. Cloud providers use virtualization to split one big server into many smaller virtual ones, so businesses can use just what they need, no extra hardware, no extra cost.

❑Let us understand virtualization by taking a real-world example:

➢Suppose there is a company that requires servers for four different purposes:

- Store customer data securely
- Host an online shopping website
- Process employee payroll systems
- Run Social media campaign software for marketing

➢All these tasks require different things:

- The customer data server requires a lot of space and a Windows operating system.
- The online shopping website requires a high-traffic server and needs a Linux operating system.
- The payroll system requires greater internal memory (RAM) and must use a certain version of the operating system.

➢In order to fulfill these requirements, the company initially configures **four individual physical servers**, each for a different purpose. This implies that the company needs to purchase four servers, keep them running, and upgrade them individually, which is very expensive.

- Now, by utilizing **virtualization**, the company can run these four applications on a few physical servers through multiple virtual machines (VMs).

- Each VM will behave as an independent server, possessing its own operating system and resources.

- Through this means, the company can cut down on expenses, conserve resources, and manage everything from a single location with ease.

❑Working of Virtualization

- ➢Virtualizations uses special software known as hypervisor, to create many virtual computers (cloud instances) on one physical computer. The Virtual Machines behave like actual computers but use the same physical machine.
- ➢**Virtual Machines (Cloud Instances)**

- After installing virtualization software, you can create one or more virtual machines on your computer.
- Virtual machines (VMs) behave like regular applications on your system.
- The real physical computer is called the **Host**, while the virtual machines are called **Guests**.
- A single host can run multiple guest virtual machines.
- Each guest can have its own operating system, which may be the same or different from the host operating system.
- Every virtual machine functions like a standalone computer, with its own settings, programs, and configuration.
- VMs access system resources such as **CPU, RAM, and storage**, but they work as if they are using their own hardware.

Hypervisors

- A hypervisor is the software that gets virtualization to work. It serves as an intermediary between the physical computer and the virtual machines. The hypervisor controls the virtual machines' use of the physical resources (such as the CPU and memory) of the host computer.

- For instance, if one virtual machine wants additional computing capability, it requests it from the hypervisor. The hypervisor ensures the request is forwarded to the physical hardware, and it's accomplished.

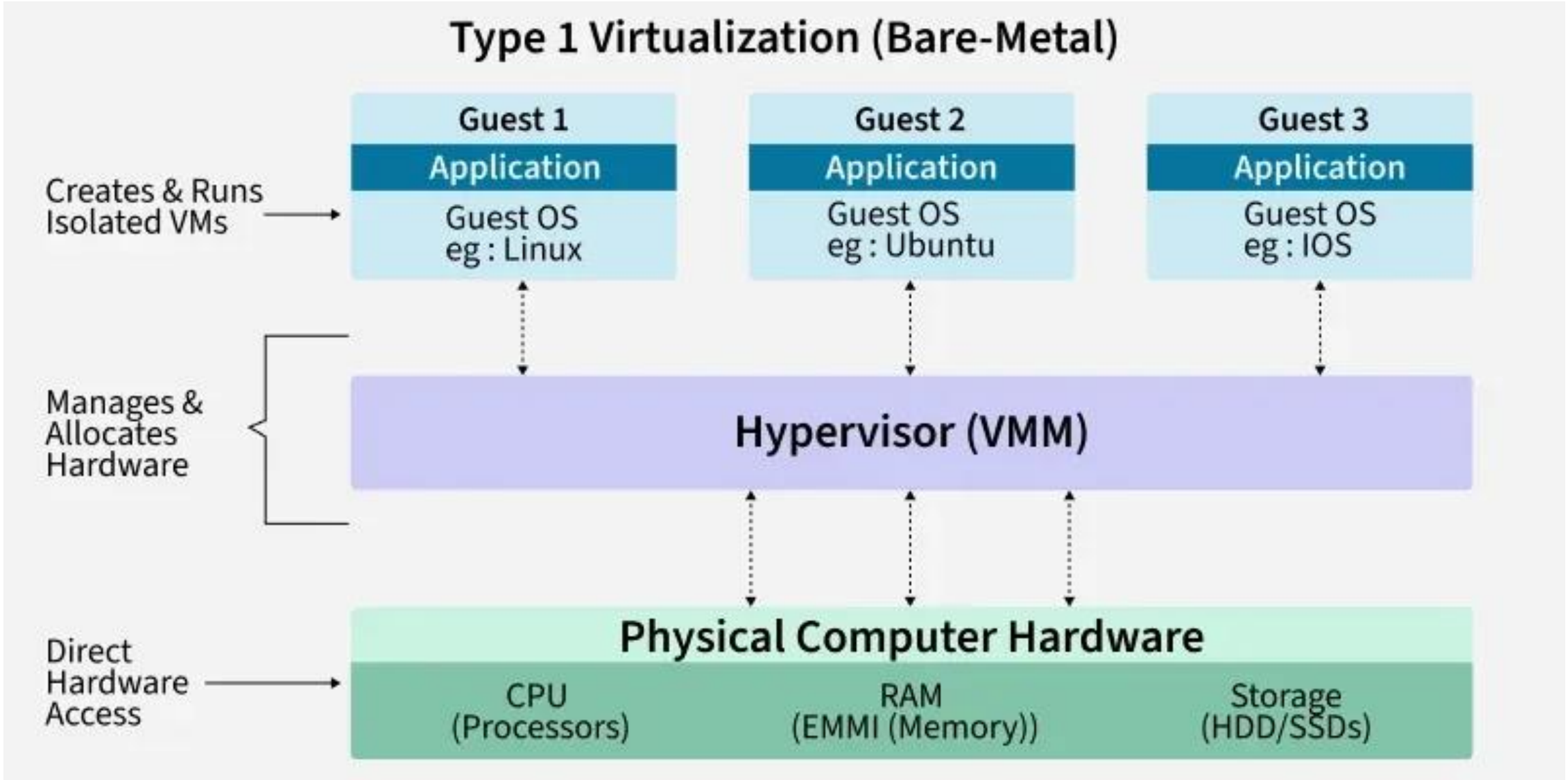
❖There exist two categories of hypervisors:

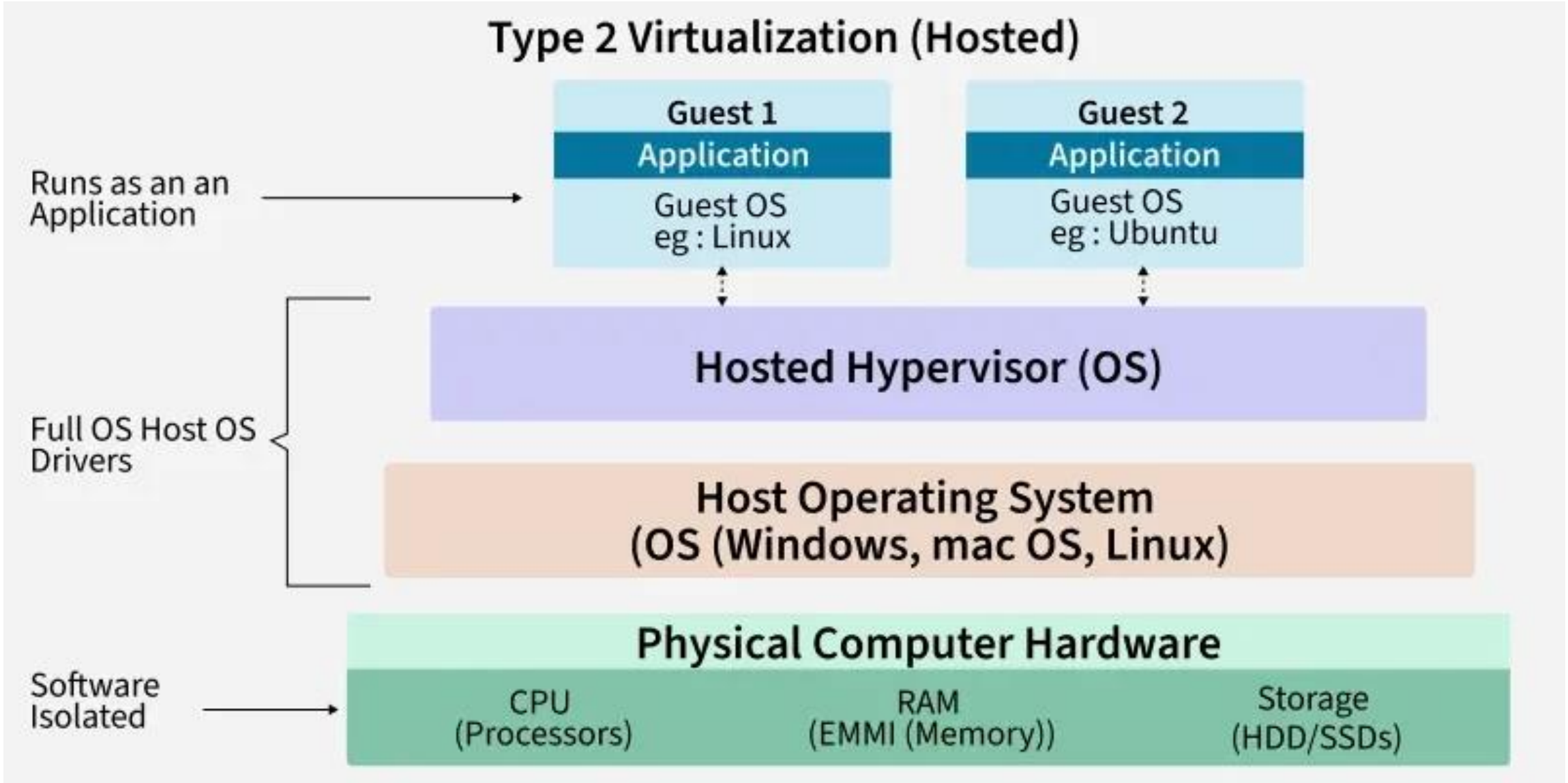
❑*Type 1 Hypervisor (Bare-Metal Hypervisor):*

- The hypervisor is installed directly onto the computer hardware, without an operating system sitting in between.
- It is highly efficient as it has a direct access to the resources of the computer.

❑*Type 2 Hypervisor:*

- It is run over an installed operating system (such as Windows or macOS).
- It's employed when you need to execute more than one operating system on one machine.


Type 1 Virtualization (Bare-Metal)
Guest 1
Application
Guest OS
eg : Linux
Guest 2
Application
Guest OS
eg : Ubuntu
Guest 3
Application
Guest OS
eg : IOS
Creates & Runs
Isolated VMs
Manages &
Allocates
Hardware
Hypervisor (VMM)
Direct
Hardware
Access
Physical Computer Hardware
CPU
(Processors)
RAM
(EMMI (Memory))
Storage
(HDD/SSDs)


Type 2 Virtualization (Hosted)
Guest 1
Application
Guest OS
eg : Linux
Guest 2
Application
Guest OS
eg : Ubuntu
Runs as an an Application
Hosted Hypervisor (OS)
Full OS Host OS Drivers
Host Operating System
(OS (Windows, mac OS, Linux)
Physical Computer Hardware
Software Isolated
CPU
(Processors)
RAM
(EMMI (Memory))
Storage
(HDD/SSDs)