UNIT 5

UNIT V	CLOUD COMPUTING	7

Definition of Cloud Computing – Characteristics of Cloud – Cloud Deployment Models – Cloud Service Models – Driving Factors and Challenges of Cloud – Virtualization – Load Balancing – Scalability and Elasticity – Replication – Monitoring – Cloud Services and Platforms: Compute Services – Storage Services – Application Services

Real Life Use Case : I need a bike for a road trip

Own

Rent

4 to 6

What is Cloud Computing?

- Cloud computing is the delivery of different services through the Internet. These resources include tools and applications like data storage, servers, databases, networking, and software.
- Rather than keeping files on a proprietary hard drive or local storage device, cloud-based storage makes it possible to save them to a remote database/server.
- Cloud computing is a popular option for people and businesses for a number of reasons including cost savings, increased productivity, speed and efficiency, performance, and security.


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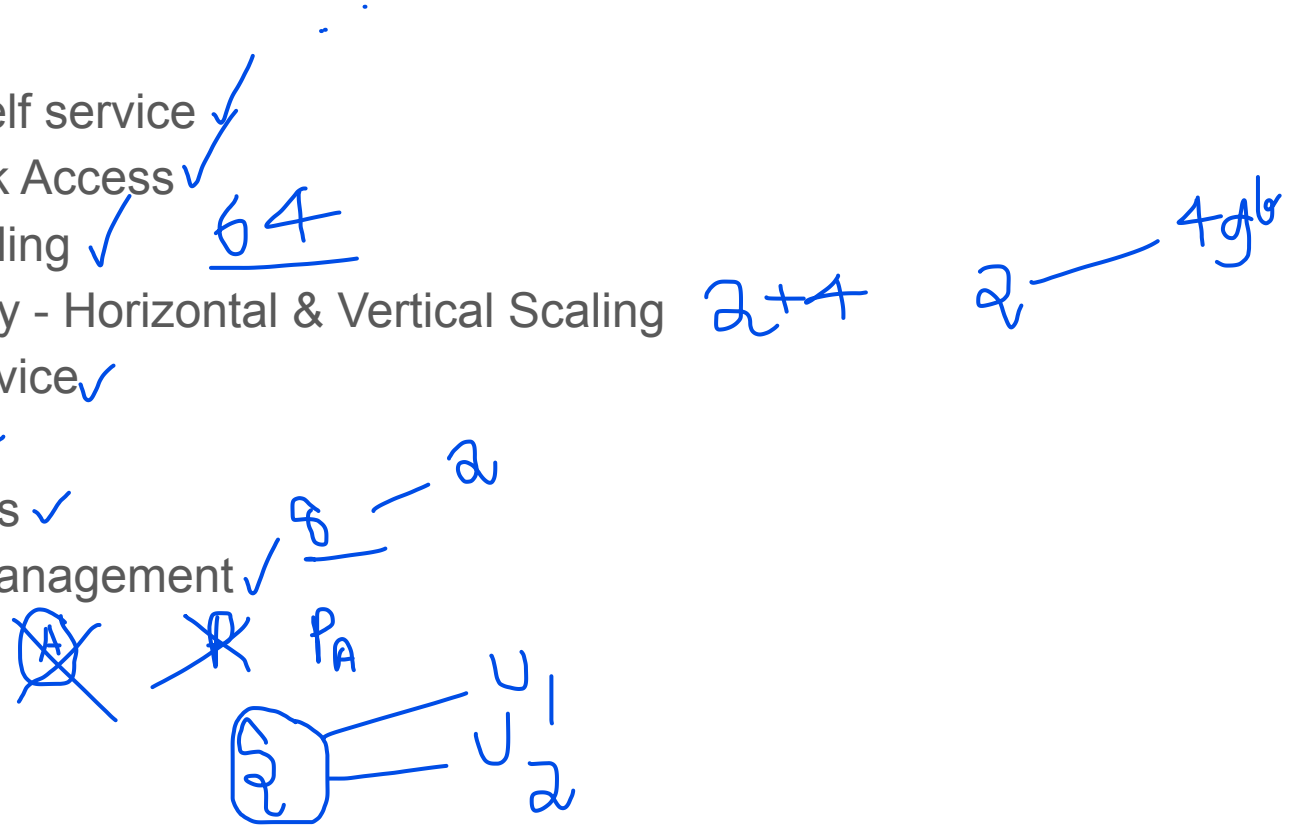
Characteristics of Cloud Computing

1. On demand self service
2. Broad Network Access
3. Resource Pooling
4. Rapid Elasticity - Horizontal & Vertical Scaling
5. Measured Service
6. Performance
7. Reduced Costs
8. Outsourced Management
9. Reliability
10. Multi-tenancy



Key Points

On-demand self service

Cloud computing resources can be provisioned on-demand by the users, without requiring interactions with the cloud service provider. The process of provisioning resources is automated.

Broad network access

Cloud computing resources can be accessed over the network using standard access mechanisms that provide platform-independent access through the use of heterogeneous client platforms such as workstations, laptops, tablets and smartphones.

Resource pooling

The computing and storage resources provided by cloud service providers are pooled to serve multiple users using multi-tenancy. Multi-tenant aspects of the cloud allow multiple users to be served by the same physical hardware. Users are assigned virtual resources that run on top of the physical resources. Various forms of virtualization approaches such as full virtualization, para-virtualization and hardware virtualization are described in Chapter 2.

Rapid elasticity

Cloud computing resources can be provisioned rapidly and elastically. Cloud resources can be rapidly scaled up or down based on demand. Two types of scaling options exist:

- **Horizontal Scaling (scaling out):** Horizontal scaling or scaling-out involves launching and provisioning additional server resources.

- **Vertical Scaling (scaling up):** Vertical scaling or scaling-up involves changing the computing capacity assigned to the server resources while keeping the number of server resources constant.

Measured service

Cloud computing resources are provided to users on a pay-per-use model. The usage of the cloud resources is measured and the user is charged based on some specific metric. Metrics such as amount of CPU cycles used, amount of storage space used, number of network I/O requests, etc. are used to calculate the usage charges for the cloud resources.

In addition to these five essential characteristics of cloud computing, other characteristics that again highlight savings in cost include:

Performance

Cloud computing provides improved performance for applications since the resources available to the applications can be scaled up or down based on the dynamic application workloads.

Reduced costs

Cloud computing provides cost benefits for applications as only as much computing and storage resources as required can be provisioned dynamically, and upfront investment in purchase of computing assets to cover worst case requirements is avoid. This saves significant cost for organizations and individuals. Applications can experience large variations in the workloads which can be due to seasonal or other factors. For example, e-Commerce applications typically experience higher workloads in holiday seasons. To ensure market readiness of such applications, adequate resources need to be provisioned so that the applications can meet the demands of specified workload levels and at the same time ensure that service level agreements are met.

Outsourced Management

Cloud computing allows the users (individuals, large organizations, small and medium enterprises and governments) to outsource the IT infrastructure requirements to external cloud providers. Thus, the consumers can save large upfront capital expenditures in setting up the IT infrastructure and pay only for the operational expenses for the cloud resources used. The outsourced nature of the cloud services provides a reduction in the IT infrastructure management costs.

Reliability

Applications deployed in cloud computing environments generally have a higher reliability since the underlying IT infrastructure is professionally managed by the cloud service. Cloud service providers specify and guarantee the reliability and availability levels for their cloud resources in the form of service level agreements (SLAs). Most cloud providers promise 99.99% uptime guarantee for the cloud resources, which may often be expensive to achieve with in-house IT infrastructure.

Multi-tenancy

The multi-tenanted approach of the cloud allows multiple users to make use of the same shared resources. Modern applications such as e-Commerce, Business-to-Business, Banking and Financial, Retail and Social Networking applications that are deployed in cloud computing environments are multi-tenanted applications. Multi-tenancy can be of different forms:

- **Virtual multi-tenancy:** In virtual multi-tenancy, computing and storage resources are shared among multiple users. Multiple tenants are served from virtual machines (VMs) that execute concurrently on top of the same computing and storage resources.
- **Organic multi-tenancy:** In organic multi-tenancy every component in the system architecture is shared among multiple tenants, including hardware, OS, database servers, application servers, load balancers, etc. Organic multi-tenancy exists when explicit multi-tenant design patterns are coded into the application.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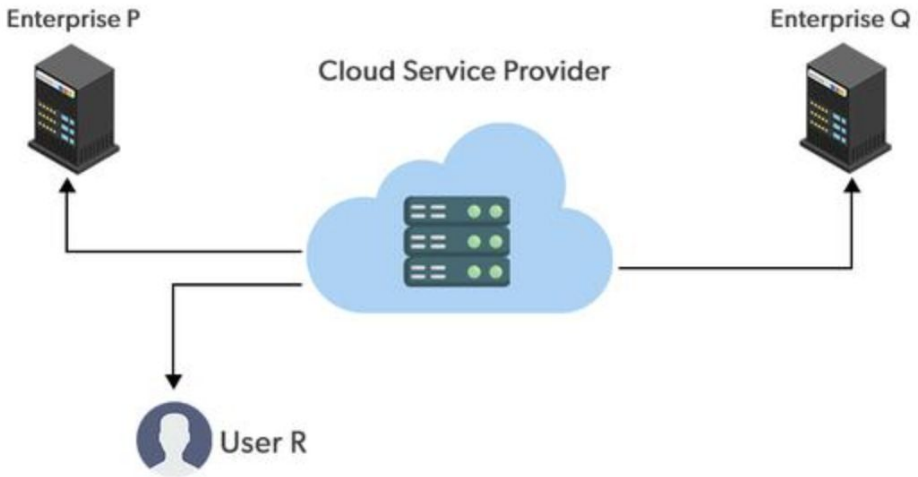
Deployment Models - Public Cloud



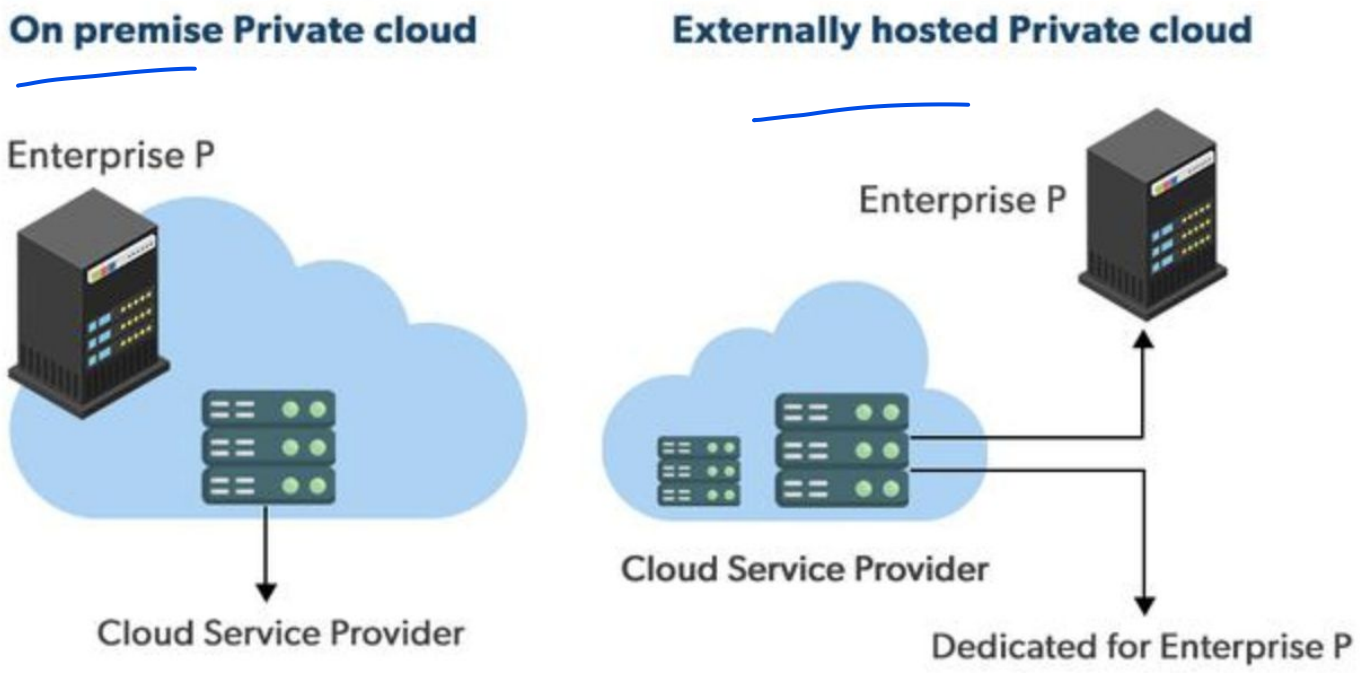
Advantages of the Public Cloud Model

- **Minimal Investment:** Because it is a pay-per-use service, there is no substantial upfront fee, making it excellent for enterprises that require immediate access to resources.
- **No setup cost:** The entire infrastructure is fully subsidized by the cloud service providers, thus there is no need to set up any hardware.
- **Infrastructure Management is not required:** Using the public cloud does not necessitate infrastructure management.
- **No maintenance:** The maintenance work is done by the service provider (not users).
- **Dynamic Scalability:** To fulfill your company's needs, on-demand resources are accessible.

Disadvantages of the Public Cloud Model

- **Less secure:** Public cloud is less secure as resources are public so there is no guarantee of high-level security.
- **Low customization:** It is accessed by many public so it can't be customized according to personal requirements.

Deployment Models - Private Cloud



Private Cloud

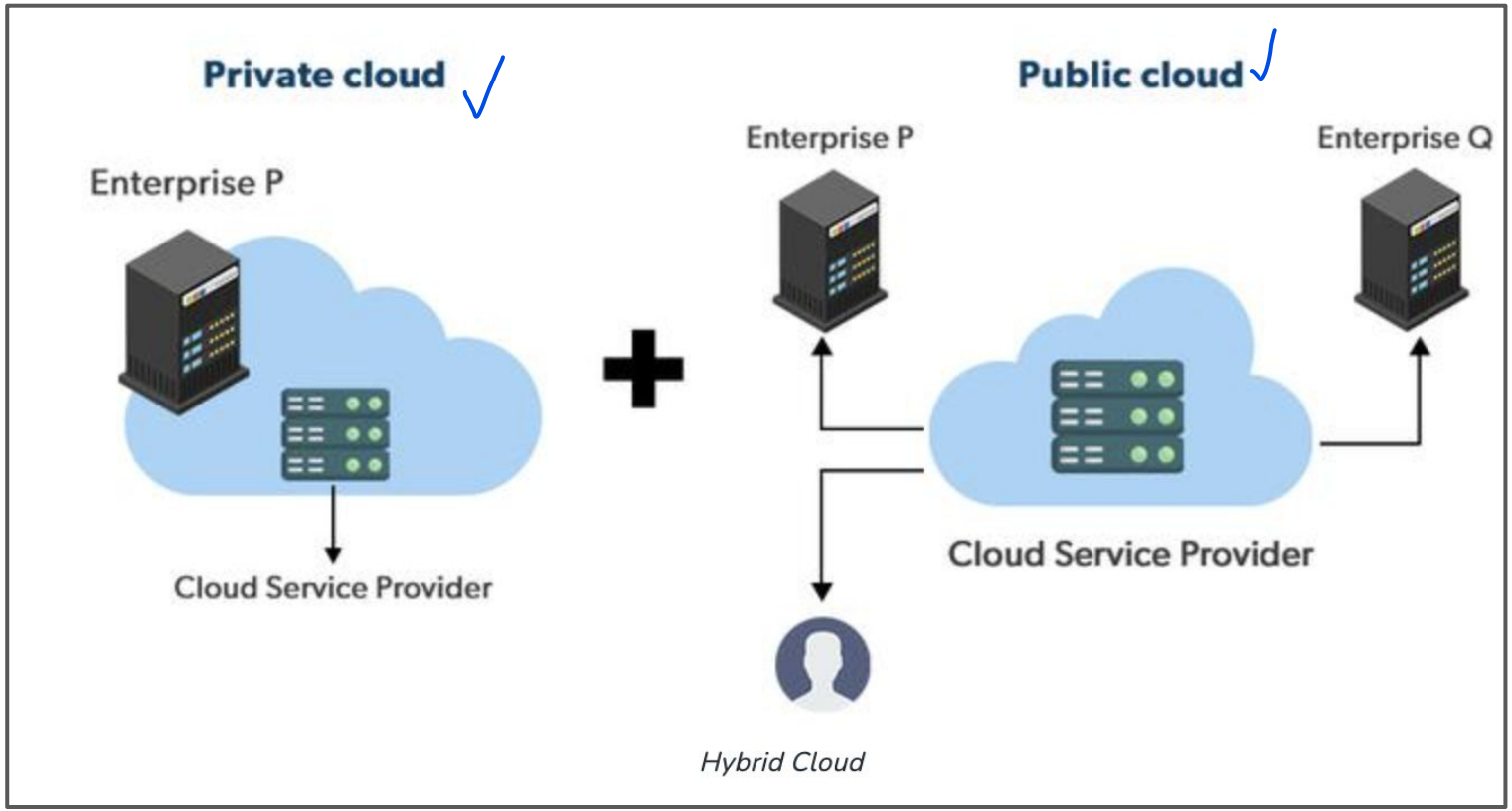
Advantages of the Private Cloud Model

- **Better Control:** You are the sole owner of the property. You gain complete command over service integration, IT operations, policies, and user behavior.
- **Data Security and Privacy:** It's suitable for storing corporate information to which only authorized staff have access. By segmenting resources within the same infrastructure, improved access and security can be achieved.
- **Supports Legacy Systems:** This approach is designed to work with legacy systems that are unable to access the public cloud.
- **Customization:** Unlike a public cloud deployment, a private cloud allows a company to tailor its solution to meet its specific needs.

Disadvantages of the Private Cloud Model

- **Less scalable:** Private clouds are scaled within a certain range as there is less number of clients.
- **Costly:** Private clouds are more costly as they provide personalized facilities.

Deployment Models - Hybrid Cloud



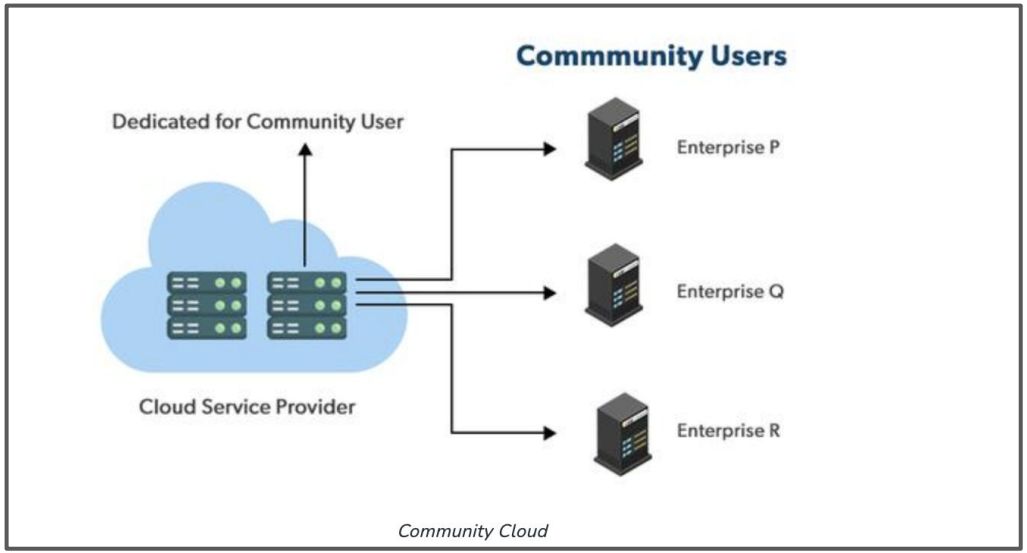
Advantages of the Hybrid Cloud Model

- **Flexibility and control:** Businesses with more flexibility can design personalized solutions that meet their particular needs.
- **Cost:** Because public clouds provide scalability, you'll only be responsible for paying for the extra capacity if you require it.
- **Security:** Because data is properly separated, the chances of data theft by attackers are considerably reduced.

Disadvantages of the Hybrid Cloud Model

- **Difficult to manage:** Hybrid clouds are difficult to manage as it is a combination of both public and private cloud. So, it is complex.
- **Slow data transmission:** Data transmission in the hybrid cloud takes place through the public cloud so latency occurs.

Deployment Models - Community Cloud



Advantages of the Community Cloud Model

- **Cost Effective:** It is cost-effective because the cloud is shared by multiple organizations or communities.
- **Security:** Community cloud provides better security.
- **Shared resources:** It allows you to share resources, infrastructure, etc. with multiple organizations.
- **Collaboration and data sharing:** It is suitable for both collaboration and data sharing.

Disadvantages of the Community Cloud Model

- **Limited Scalability:** Community cloud is relatively less scalable as many organizations share the same resources according to their collaborative interests.
- **Rigid in customization:** As the data and resources are shared among different organizations according to their mutual interests if an organization wants some changes according to their needs they cannot do so because it will have an impact on other organizations.

Key Points from Book

Public cloud

In the public cloud deployment model, cloud services are available to the general public or a large group of companies. The cloud resources are shared among different users (individuals, large organizations, small and medium enterprises and governments). The cloud services are provided by a third-party cloud provider. Public clouds are best suited for users who want to use cloud infrastructure for development and testing of applications and host applications in the cloud to serve large workloads, without upfront investments in IT infrastructure.

Private cloud

In the private cloud deployment model, cloud infrastructure is operated for exclusive use of a single organization. Private cloud services are dedicated for a single organization. Cloud infrastructure can be setup on premise or off-premise and may be managed internally or by a third-party. Private clouds are best suited for applications where security is very important and organizations that want to have very tight control over their data.

Hybrid cloud

The hybrid cloud deployment model combines the services of multiple clouds (private or public). The individual clouds retain their unique identities but are bound by standardized or proprietary technology that enables data and application portability. Hybrid clouds are best suited for organizations that want to take advantage of secured application and data hosting on a private cloud, and at the same time benefit from cost savings by hosting shared applications and data in public clouds.

Community cloud

In the community cloud deployment model, the cloud services are shared by several organizations that have the same policy and compliance considerations. Community clouds are best suited for organizations that want access to the same applications and data, and want the cloud costs to be shared with the larger group.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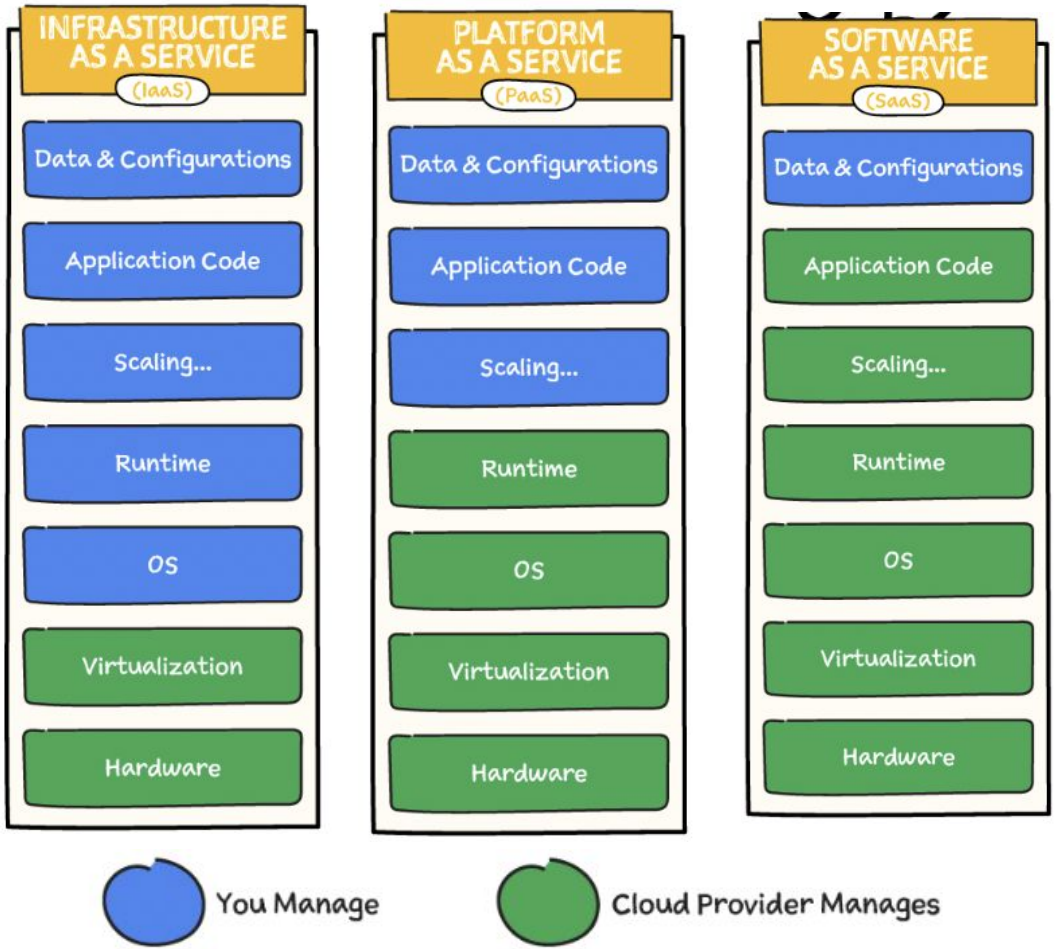
Service Models of Cloud

IaaS (Infrastructure as a Service)	AWS Azure GCP
PaaS (Platform as a Service)	Google App Engine - Web App AWS Elastic Beanstalk for application hosting.
SaaS (Software as a Service)	Google Meet Google Sheets


INFRASTRUCTURE AS A SERVICE
(IaaS)
Data & Configurations
Application Code
Scaling...
Runtime
OS
Virtualization
Hardware
PLATFORM AS A SERVICE
(PaaS)
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OS
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Hardware
SOFTWARE AS A SERVICE
(SaaS)
Data & Configurations
Application Code
Scaling...
Runtime
OS
Virtualization
Hardware
You Manage
Cloud Provider Manages

IaaS pros

- Highest level of control over infrastructure
- On-demand scalability
- No single point of failure for higher reliability
- Reduced upfront capital expenditures (for example, pay-as-you-go pricing)
- Fewer provisioning delays and wasted resources
- Accelerated development and time to market

IaaS cons

- Responsible for your own data security and recovery
- Requires hands-on configuration and maintenance
- Difficulties securing legacy applications on cloud-based infrastructure

PaaS pros

- Instant access to a complete, easy-to-use development platform
- Cloud service provider is responsible for maintenance and securing infrastructure
- Available over any internet connection on any device
- On-demand scalability

PaaS cons

- Application stack can be limited to the most relevant compo
- Vendor lock-in may be an issue depending on the cloud serv provider
- Less control over operations and the overall infrastructure
- More limited customizations

SaaS pros	SaaS cons
• Easy to set up and start using • The provider manages and maintains everything, from hardware to software • Software is accessible over any internet connection on any device	• No control over any of the infrastructure or security controls • Integration issues with your existing tools and applications • Vendor lock-in may be an issue depending on the cloud servic provider • Little to no customization

Basis Of	IAAS	PAAS	SAAS
Stands for	Infrastructure as a service.	Platform as a service.	Software as a service.
Uses	IAAS is used by network architects.	PAAS is used by developers.	SAAS is used by the end user.
Access	IAAS gives access to the resources like virtual machines and virtual storage.	PAAS gives access to run time environment to deployment and development tools for application.	SAAS gives access to the end user.
Model	It is a service model that provides virtualized computing resources over the internet.	It is a cloud computing model that delivers tools that are used for the development of applications.	It is a service model in cloud computing that hosts software to make it available to clients.
Technical understanding.	It requires technical knowledge.	Some knowledge is required for the basic setup.	There is no requirement about technicalities company handles everything.

Key Points from Book

Infrastructure-as-a-Service (IaaS)

IaaS provides the users the capability to provision computing and storage resources. These resources are provided to the users as virtual machine instances and virtual storage. Users can start, stop, configure and manage the virtual machine instances and virtual storage. Users can deploy operating systems and applications of their choice on the virtual resources provisioned in the cloud. The cloud service provider manages the underlying infrastructure. Virtual resources provisioned by the users are billed based on a pay-per-use paradigm. Common metering metrics used are the number of virtual machine hours used and/or the amount of storage space provisioned.

Platform-as-a-Service (PaaS)

PaaS provides the users the capability to develop and deploy application in the cloud using the development tools, application programming interfaces (APIs), software libraries and services provided by the cloud service provider. The cloud service provider manages the underlying cloud infrastructure including servers, network, operating systems and storage. The users, themselves, are responsible for developing, deploying, configuring and managing applications on the cloud infrastructure.

Software-as-a-Service (SaaS)

SaaS provides the users a complete software application or the user interface to the the application itself. The cloud service provider manages the underlying cloud infrastructure including servers, network, operating systems, storage and application software, and the user is unaware of the underlying architecture of the cloud. Applications are provided to the user through a thin client interface (e.g., a browser). SaaS applications are platform independent and can be accessed from various client devices such as workstations, laptop, tablets and smartphones, running different operating systems. Since the cloud service provider manages both the application and data, the users are able to access the applications from anywhere.


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