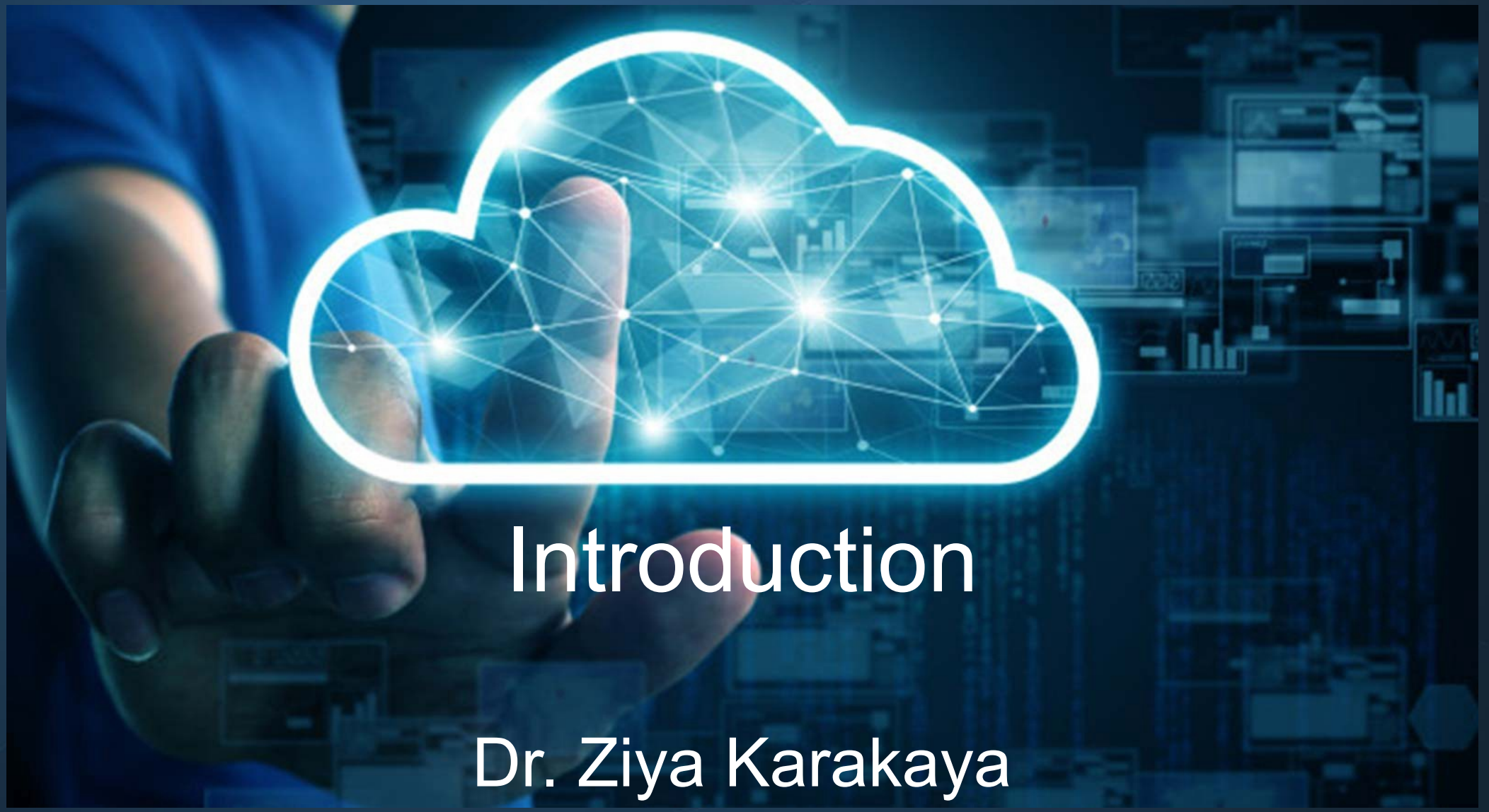
Cloud Computing



Introduction

Dr. Ziya Karakaya

Agenda

- History of Computing Paradigm Shift
- Definition of Cloud Computing
- Fundamental Characteristics
- Service Models
- Deployement Models
- Analogy...

Computing Paradigm Shift

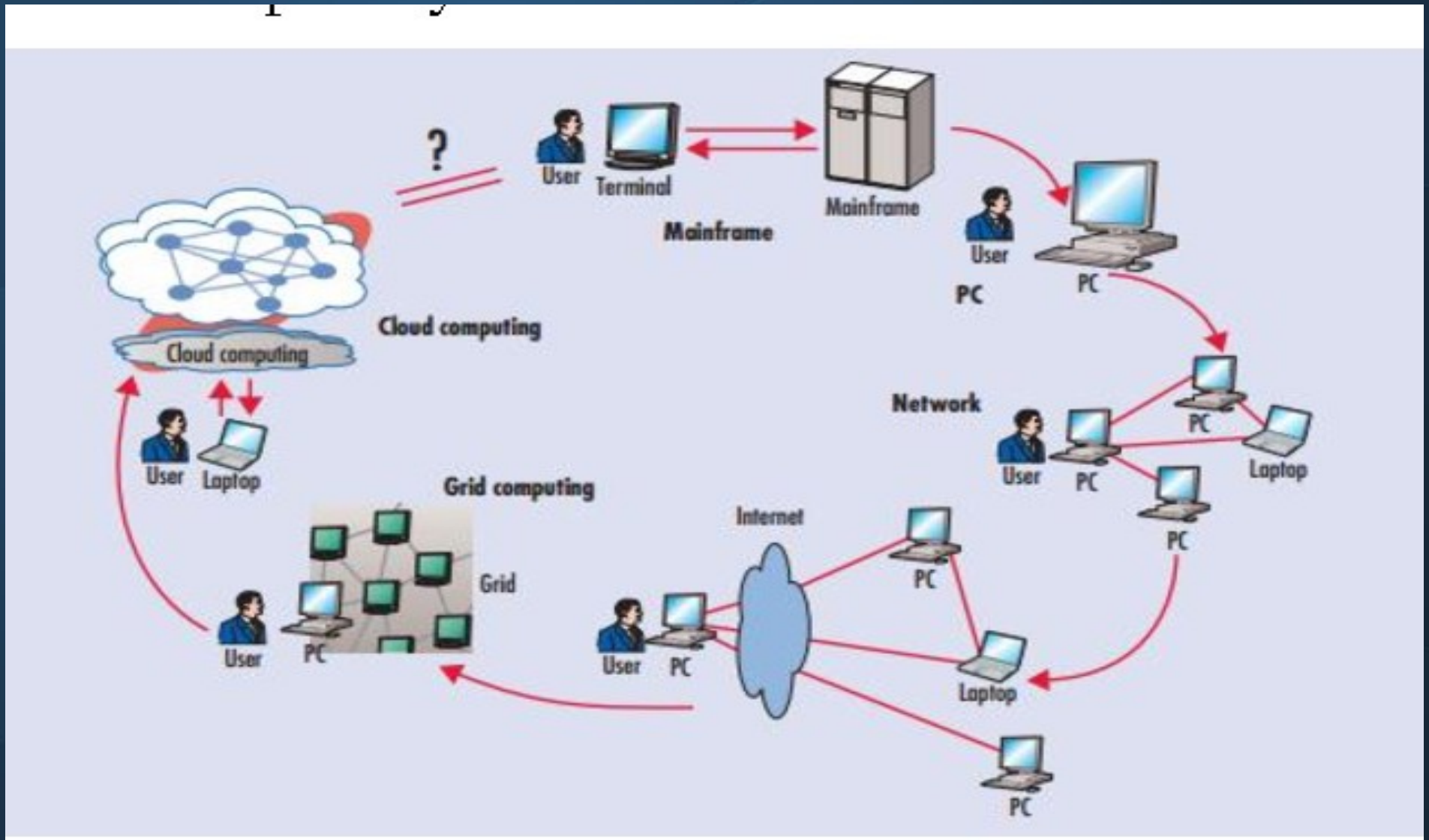


Figure 1. Computing paradigm shift of the last half century [1]

At the beginning, there was Mainframe and Terminals

Users did individual work by connecting to central computer

PC came into our lives

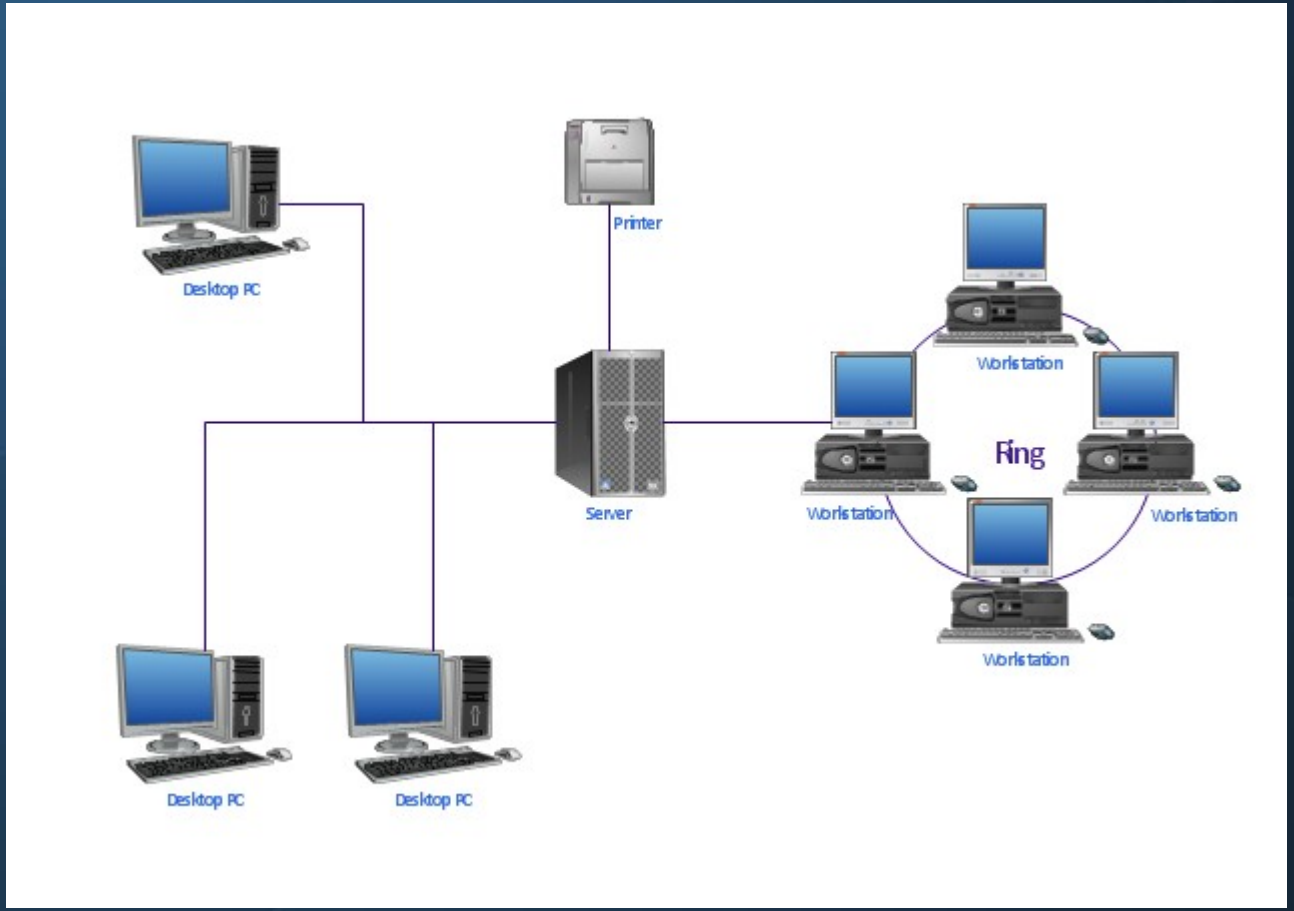
- Users start to do their individual computing on their PC.

Old PC

New PC

PC Network

- We have connected the PCs to share information and resources such as printers.



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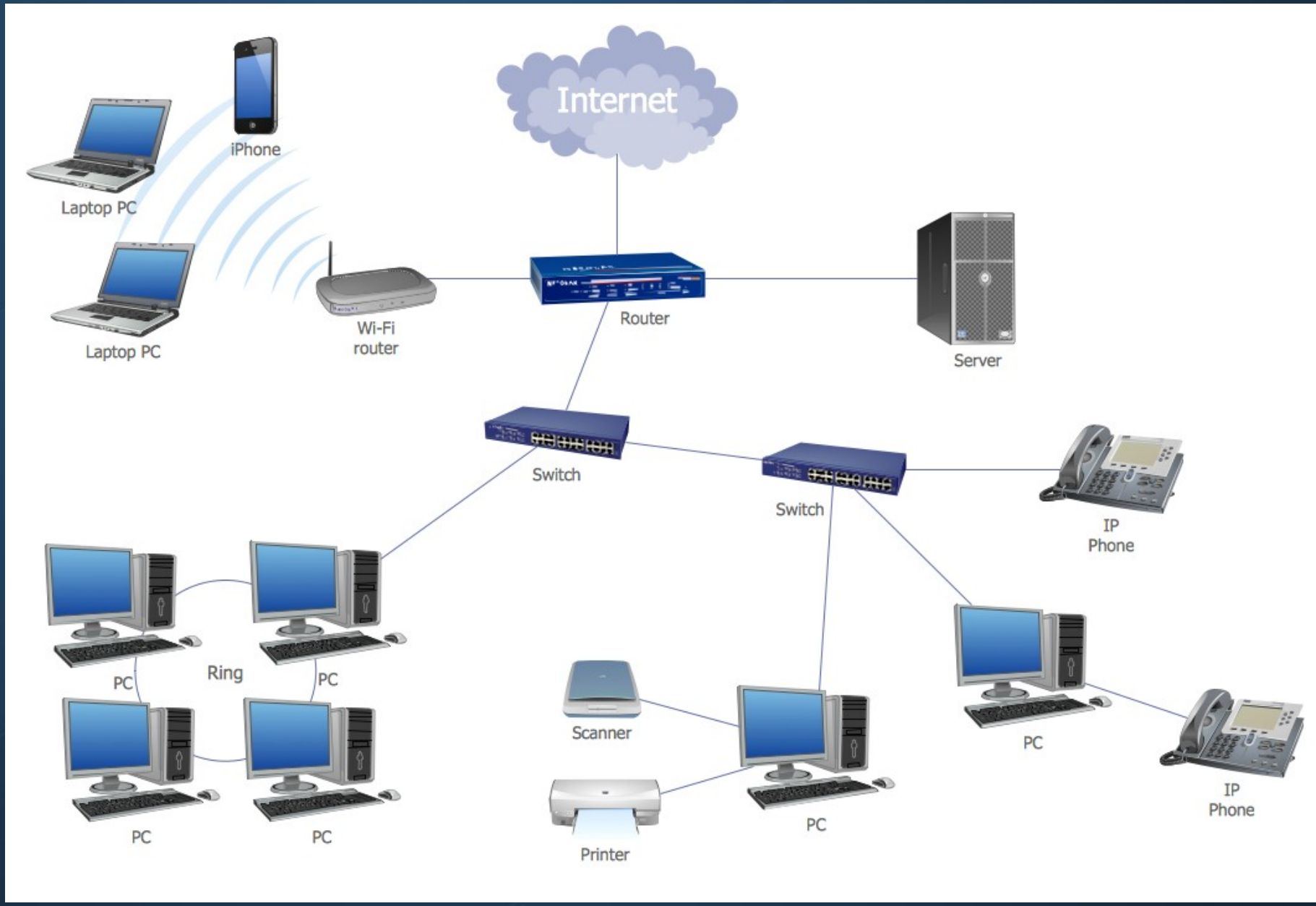
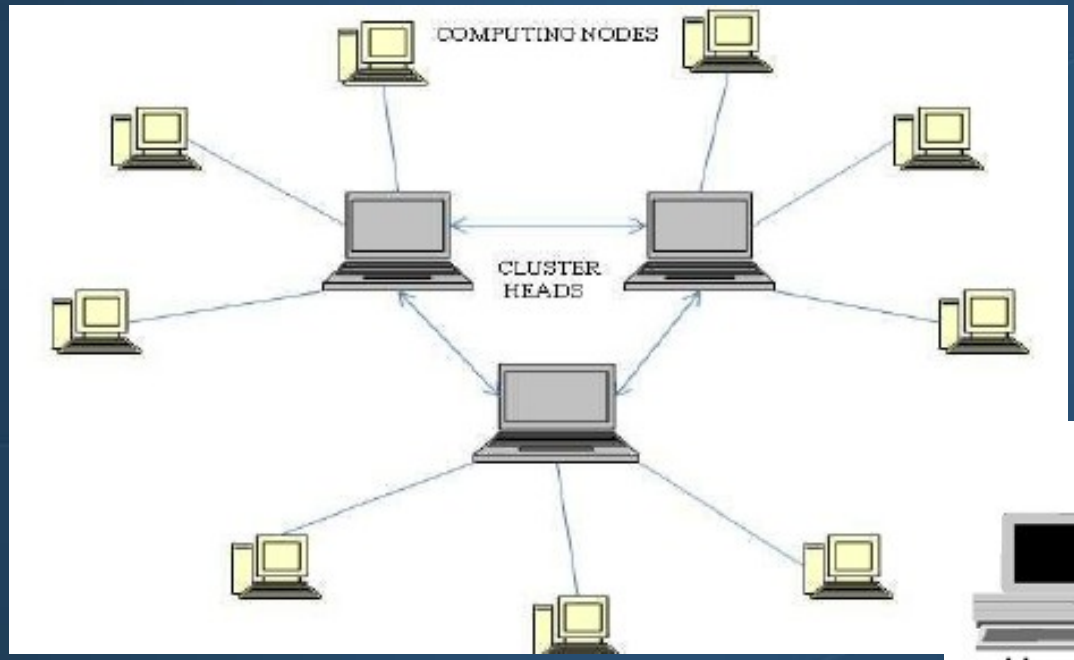
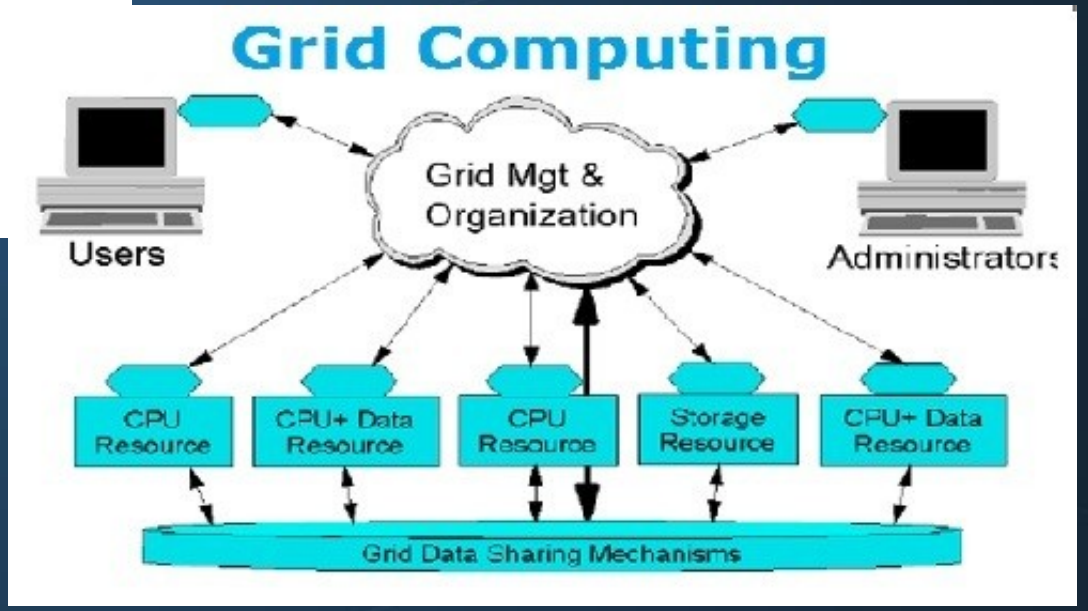


Grid and Cluster Computing





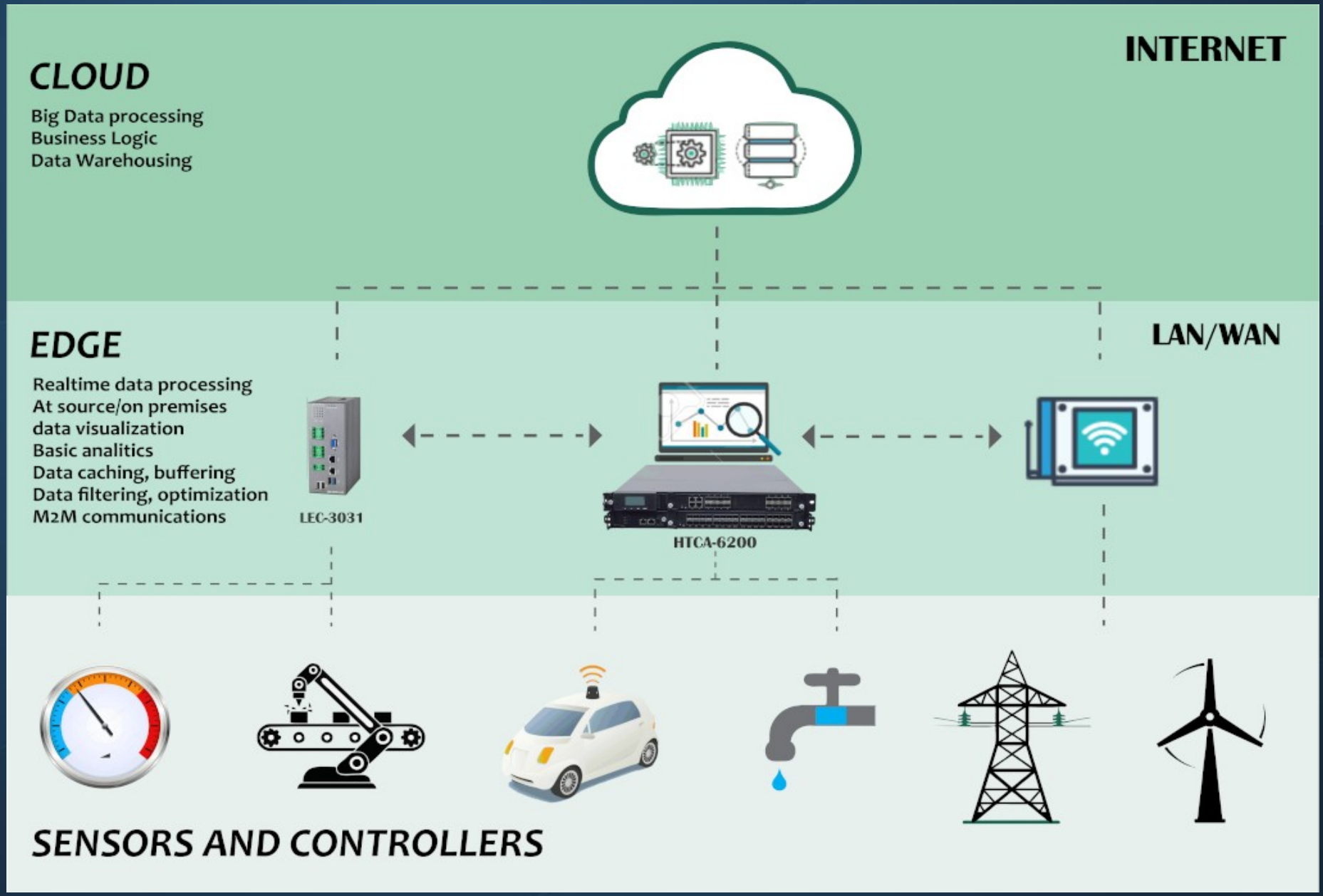
We will talk about the details of and the differences between grid and cluster computing later.

Hello to Cloud Computing

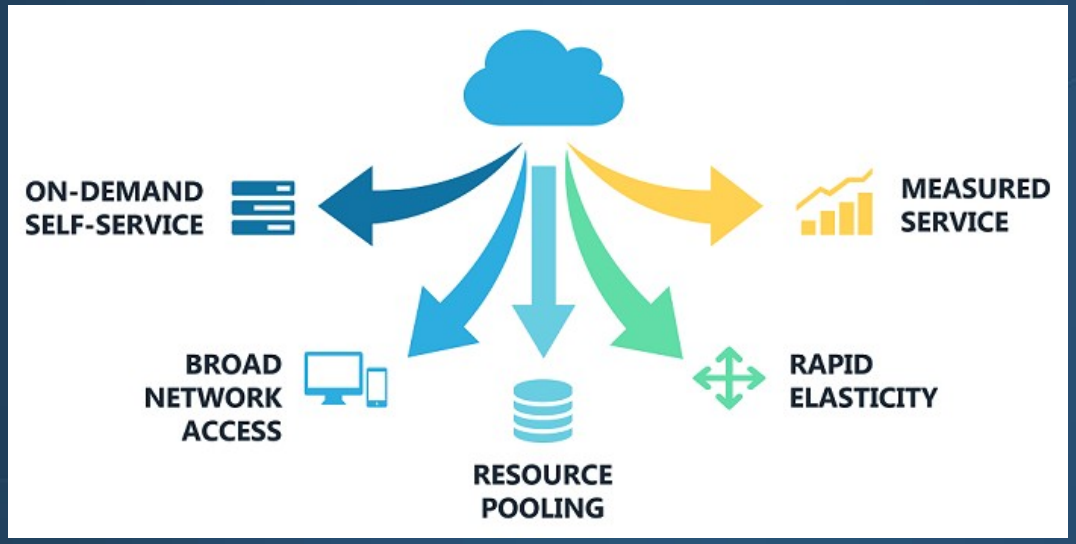
What is next?

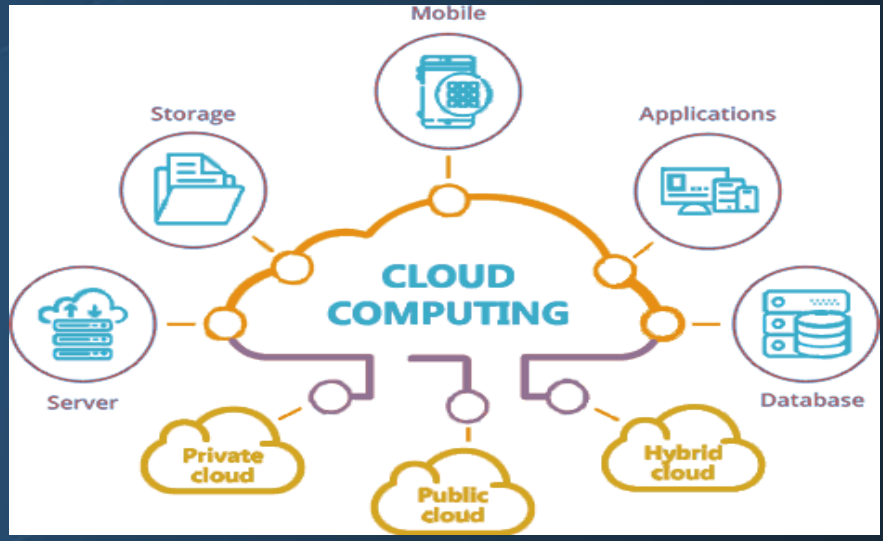
- Multi-cloud computing is the ongoing shift
- Most probably the next is edge or fog computing

Edge Computing



Cloud Definition of NIST



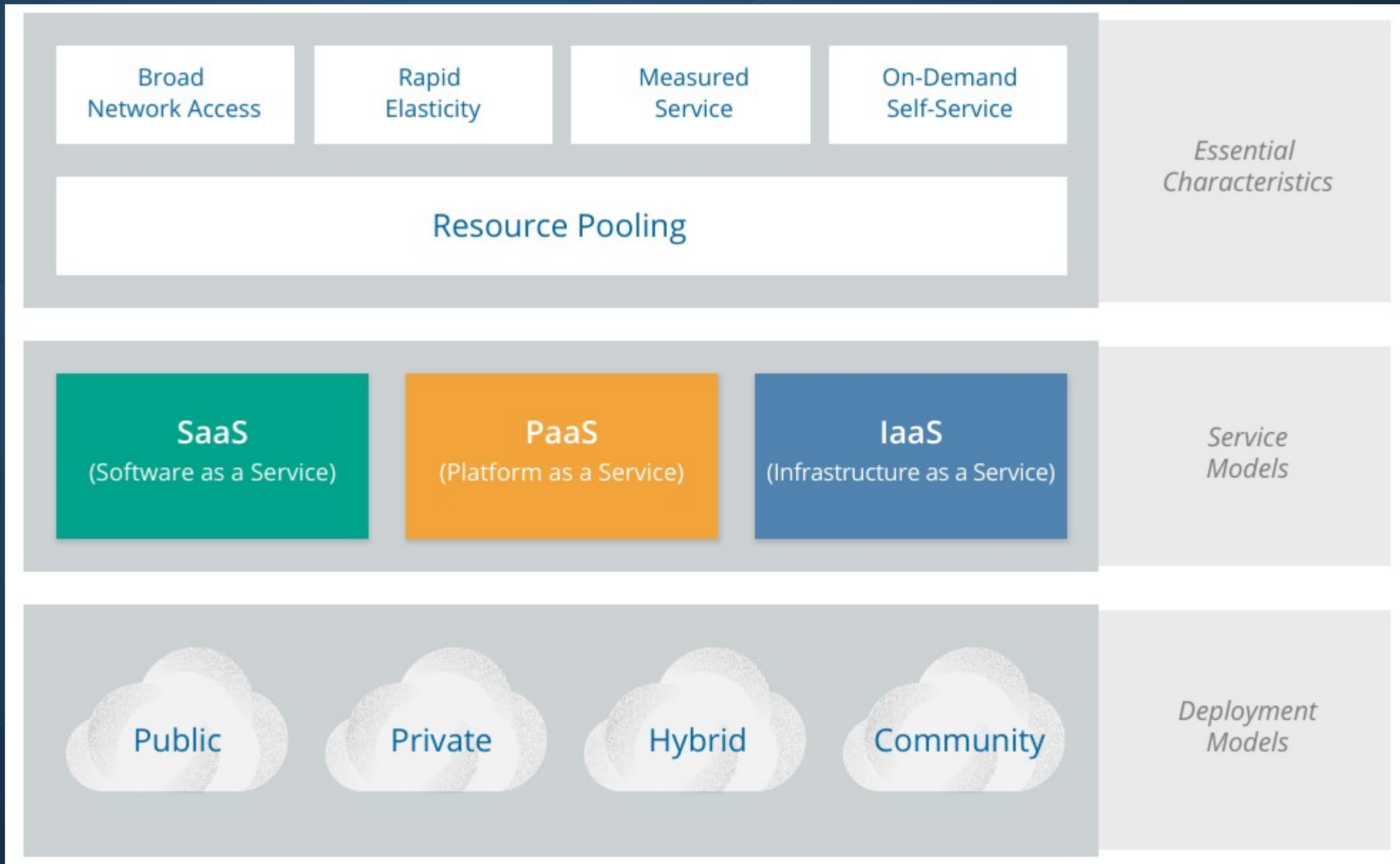


Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models.

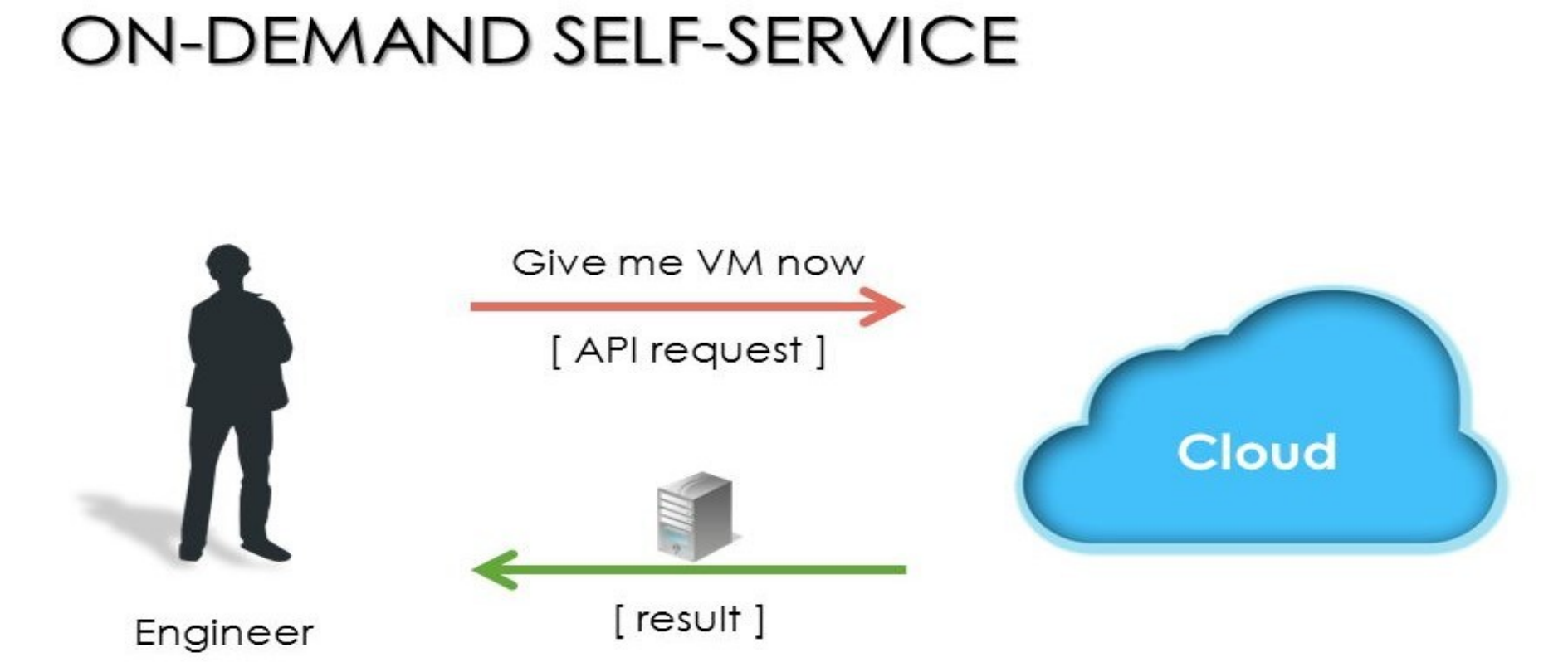
Cloud Computing

- Cloud computing is the on-demand availability of Computing Resources provided by Service Provider, and consumed by clients (persons, organizations, etc.)
- As a utility, it looks like electricty or water services we are consuming in our home or organizations.
- We pay for them depending on our usage level (pay-as-you-go).
- It is an on-demand service
- Relies on sharing of resources (multi-tenant)
- Instead of CapEx we spend for OpEx

All Together



Five Essential Characteristics



1- 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.

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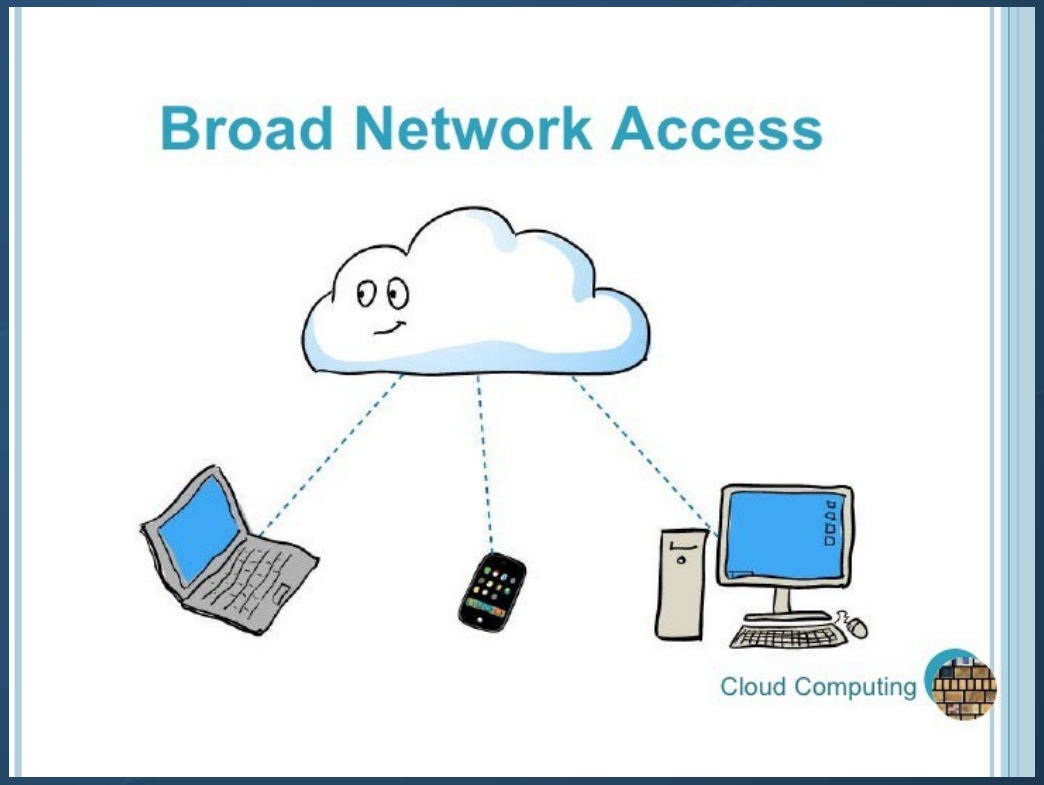

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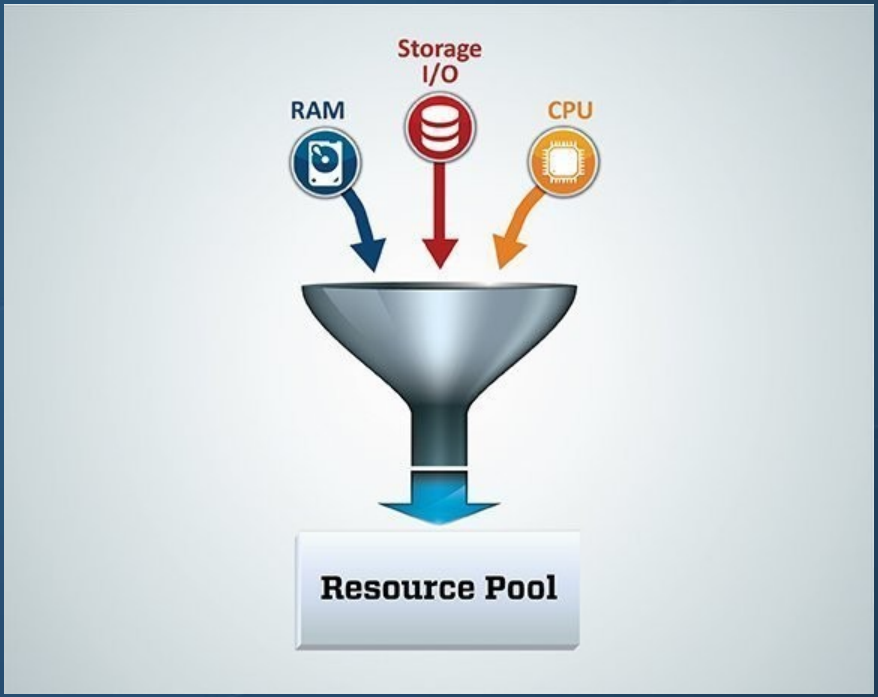

3- Resource pooling: The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally 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 datacenter). Examples of resources include storage, processing, memory, and network bandwidth.

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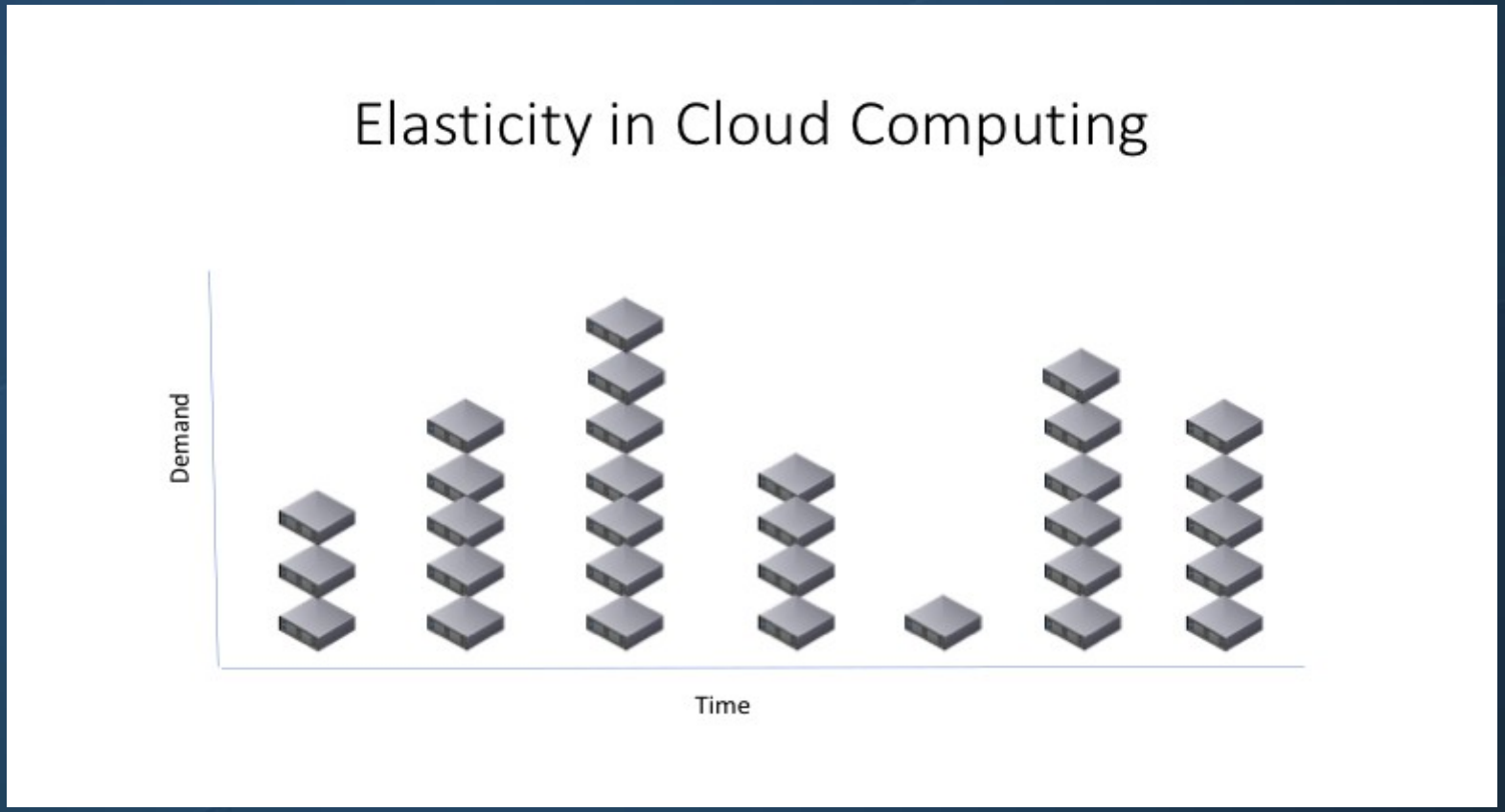
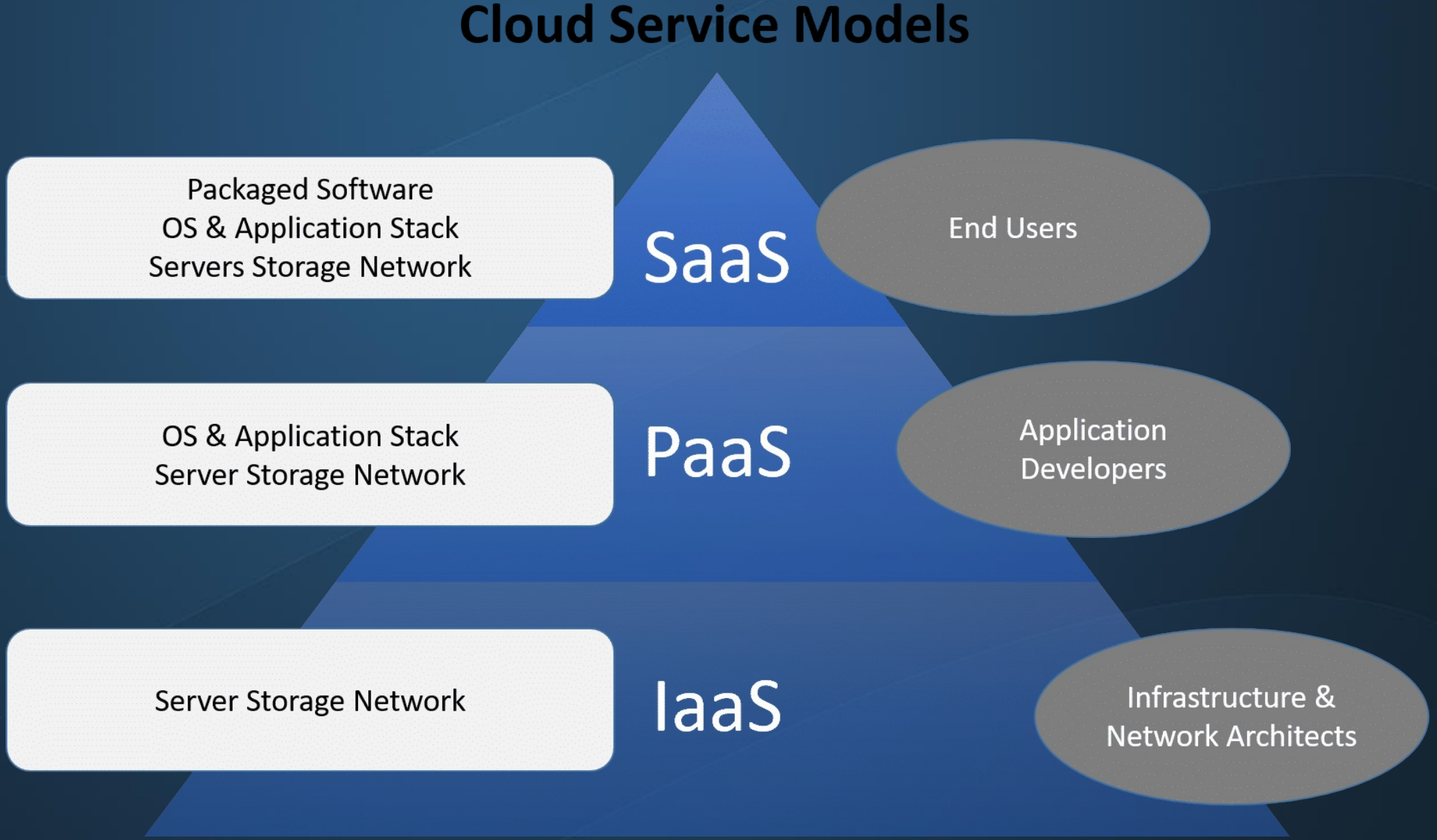


4- Rapid elasticity: Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward in accordance with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity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

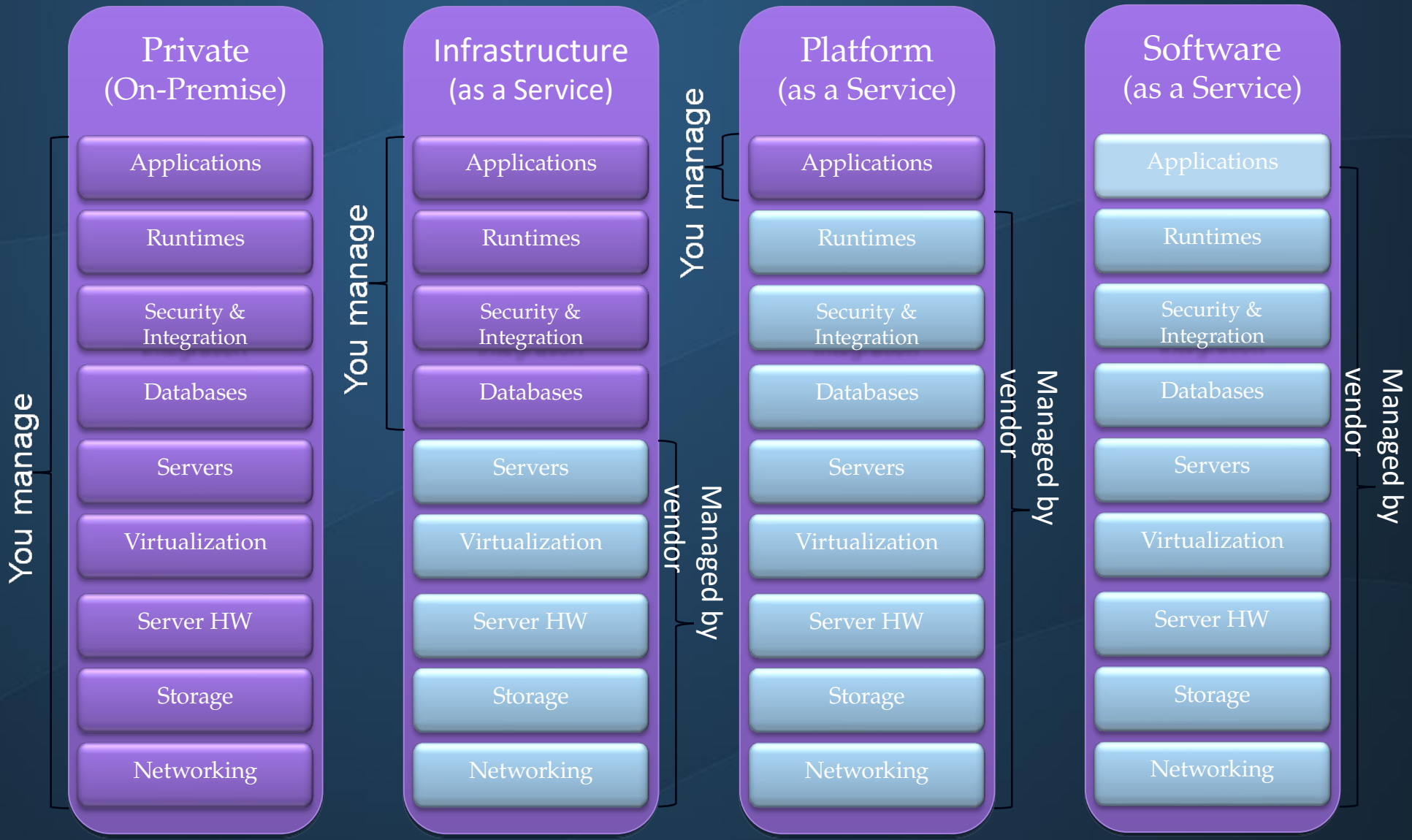
Five Essential Characteristics

5- Measured service: Cloud systems automatically control and optimize resource use by leveraging a metering capability 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.

Cloud Service Models



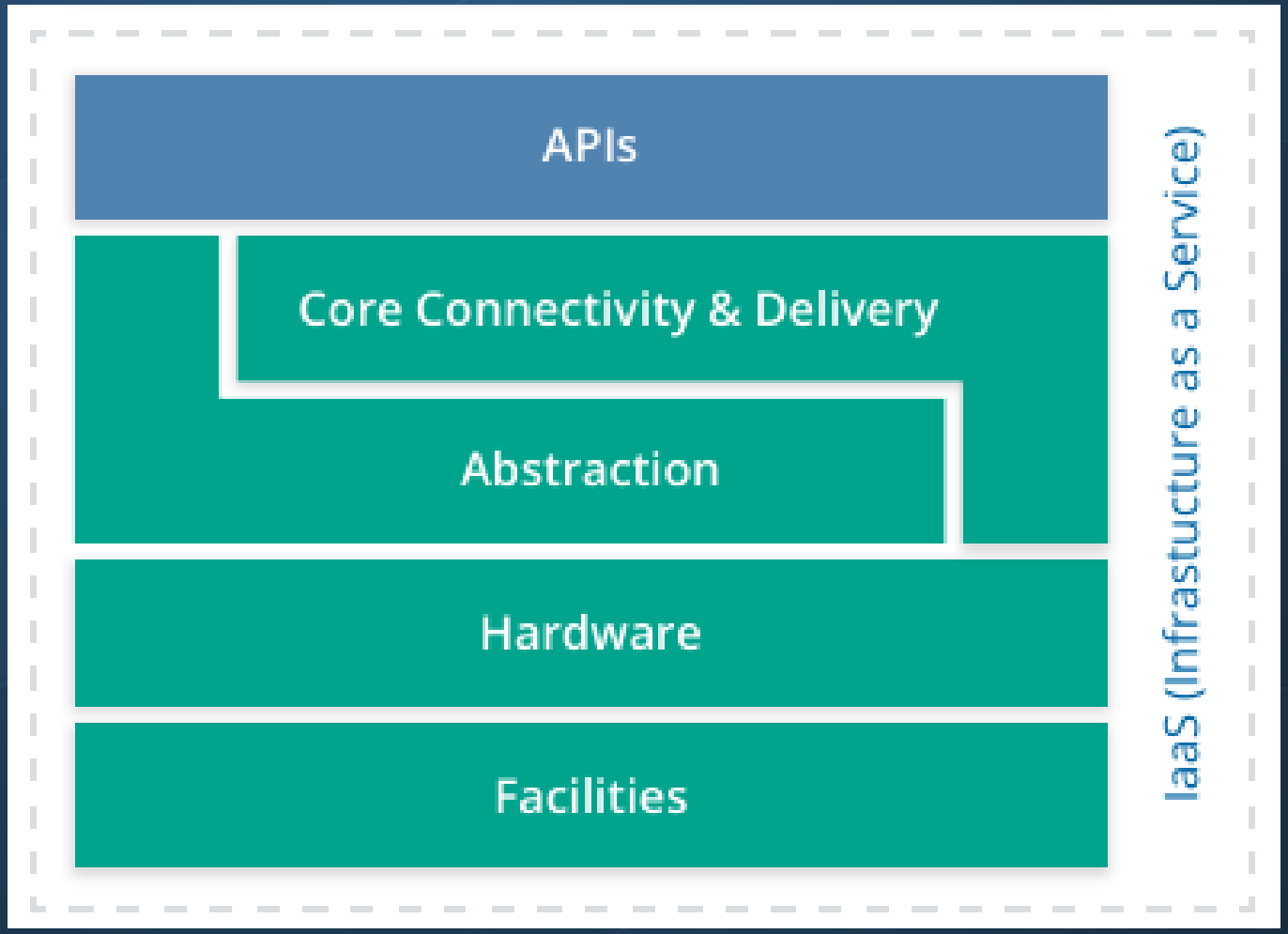
Services


Private
(On-Premise)
Applications
Runtimes
Security & Integration
Databases
Servers
Virtualization
Server HW
Storage
Networking
You manage
Infrastructure
(as a Service)
Applications
Runtimes
Security & Integration
Databases
Servers
Virtualization
Server HW
Storage
Networking
You manage
Managed by vendor
Platform
(as a Service)
Applications
Runtimes
Security & Integration
Databases
Servers
Virtualization
Server HW
Storage
Networking
You manage
Managed by vendor
Software
(as a Service)
Applications
Runtimes
Security & Integration
Databases
Servers
Virtualization
Server HW
Storage
Networking
Managed by vendor

Infrastructure as a Service

- 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).

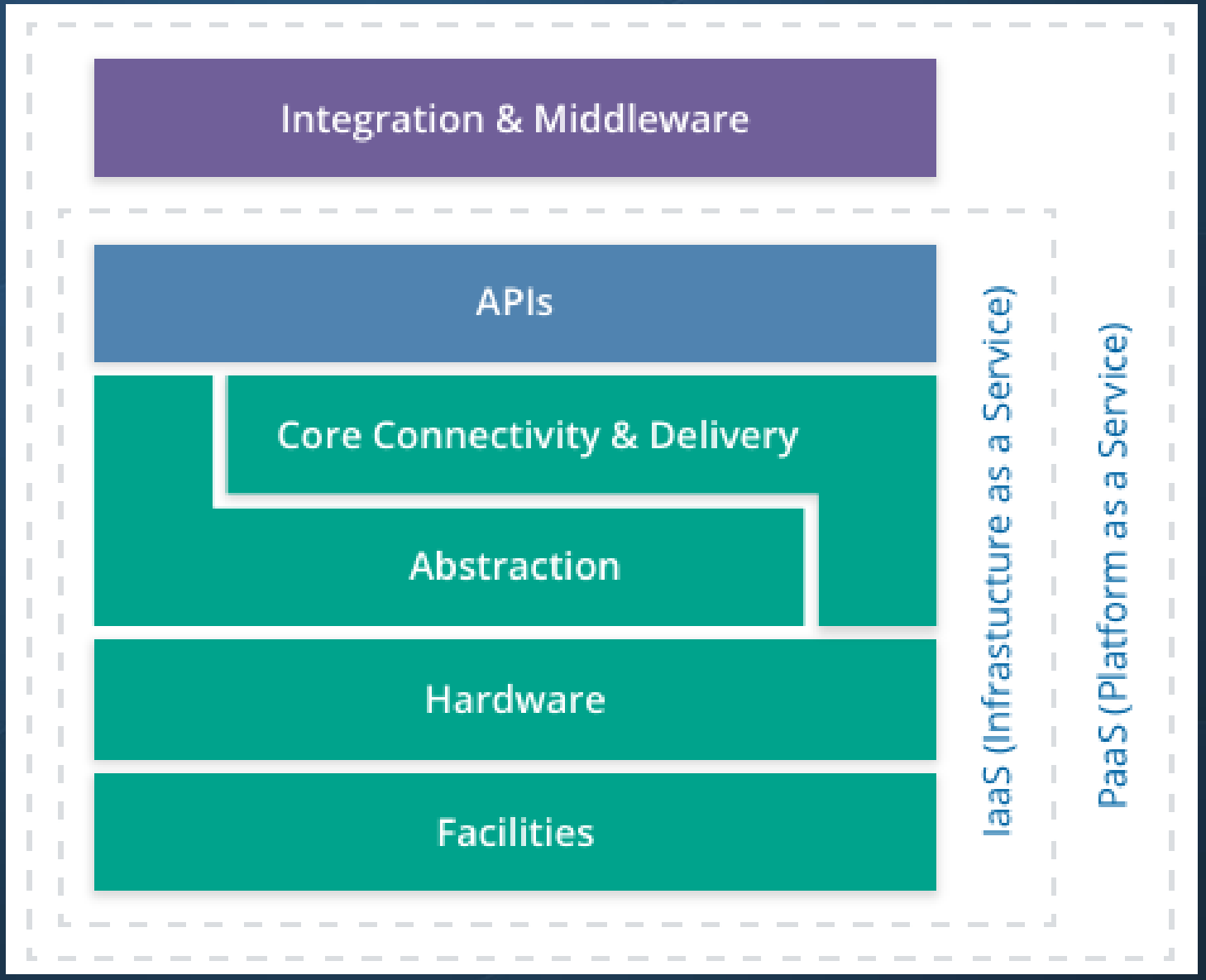
IaaS


APIs
Core Connectivity & Delivery
Abstraction
Hardware
Facilities
IaaS (Infrastucture as a Service)

Platform as a Service

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

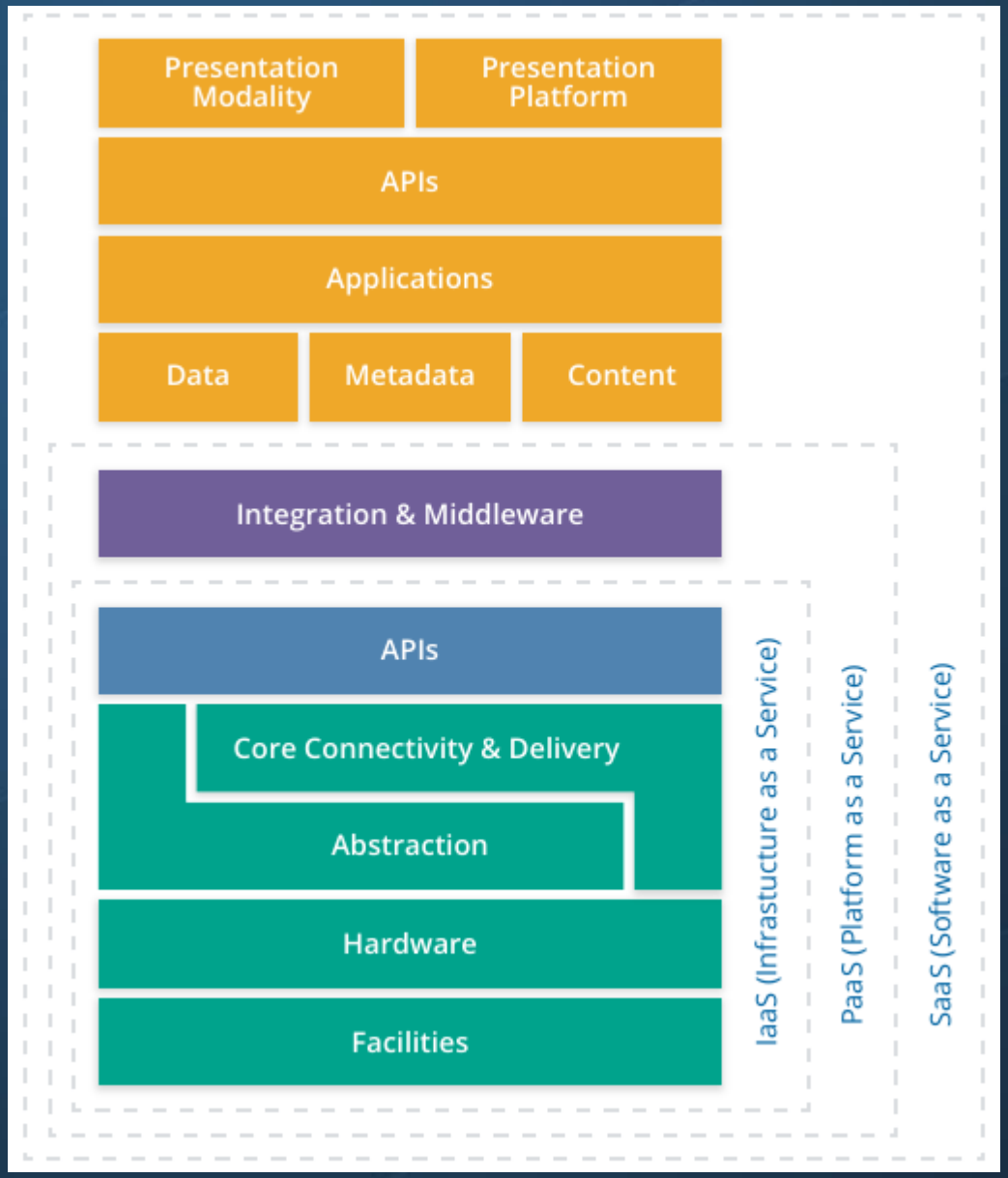
PaaS


Integration & Middleware
APIs
Core Connectivity & Delivery
Abstraction
Hardware
Facilities
IaaS (Infrastucture as a Service)
PaaS (Platform as a Service)

Software as a Service

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

SaaS

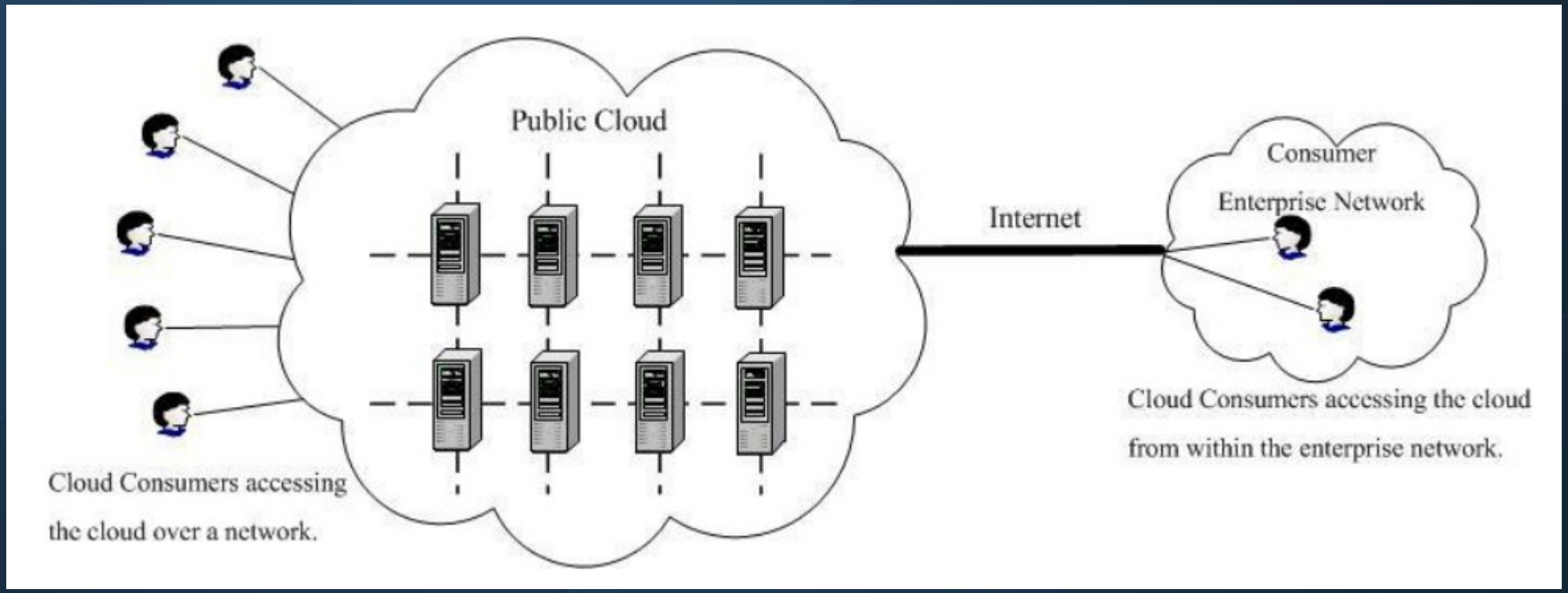

Presentation Modality
Presentation Platform
APIs
Applications
Data
Metadata
Content
Integration & Middleware
APIs
Core Connectivity & Delivery
Abstraction
Hardware
Facilities
IaaS (Infrastucture as a Service)
PaaS (Platform as a Service)
SaaS (Software as a Service)

Deployement Models

- **Private cloud.** The cloud infrastructure is provisioned for exclusive use by a single organizationcomprising 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.
- **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.
- **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.
- **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).

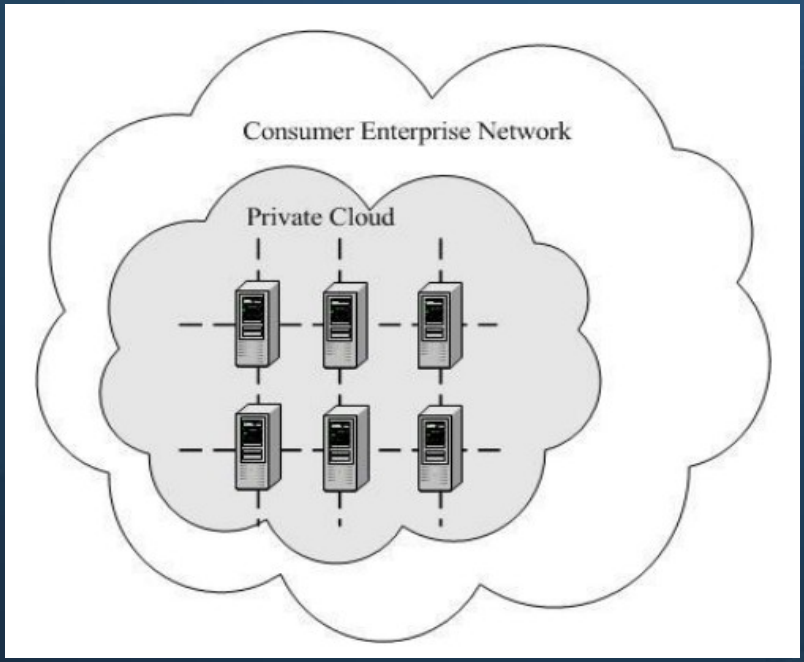
Public Cloud

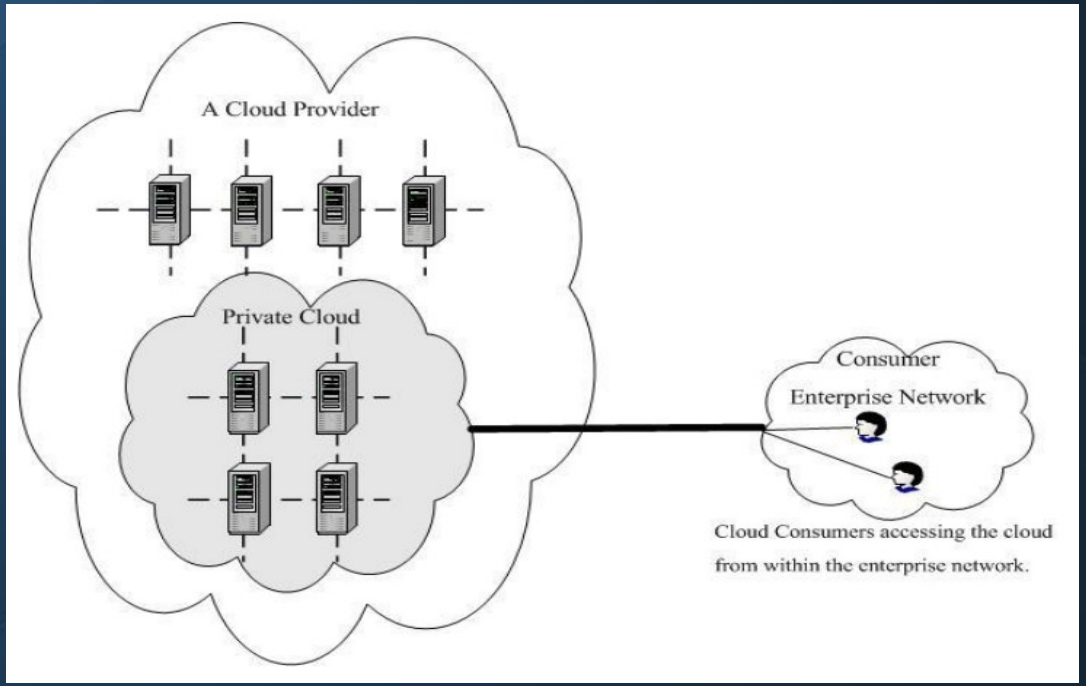
- A public cloud is one in which the cloud infrastructure and computing resources are made available to the general public over a public network.
- A public cloud is owned by an organization selling cloud services, and serves a diverse pool of clients.



Private Cloud

- A private cloud gives a single Cloud Consumer's organization the exclusive access to and usage of the infrastructure and computational resources.
- It may be managed either by the Cloud Consumer organization or by a third party, and may be hosted on the organization's premises (i.e. on-site private clouds) or outsourced to a hosting company (i.e. outsourced private clouds).



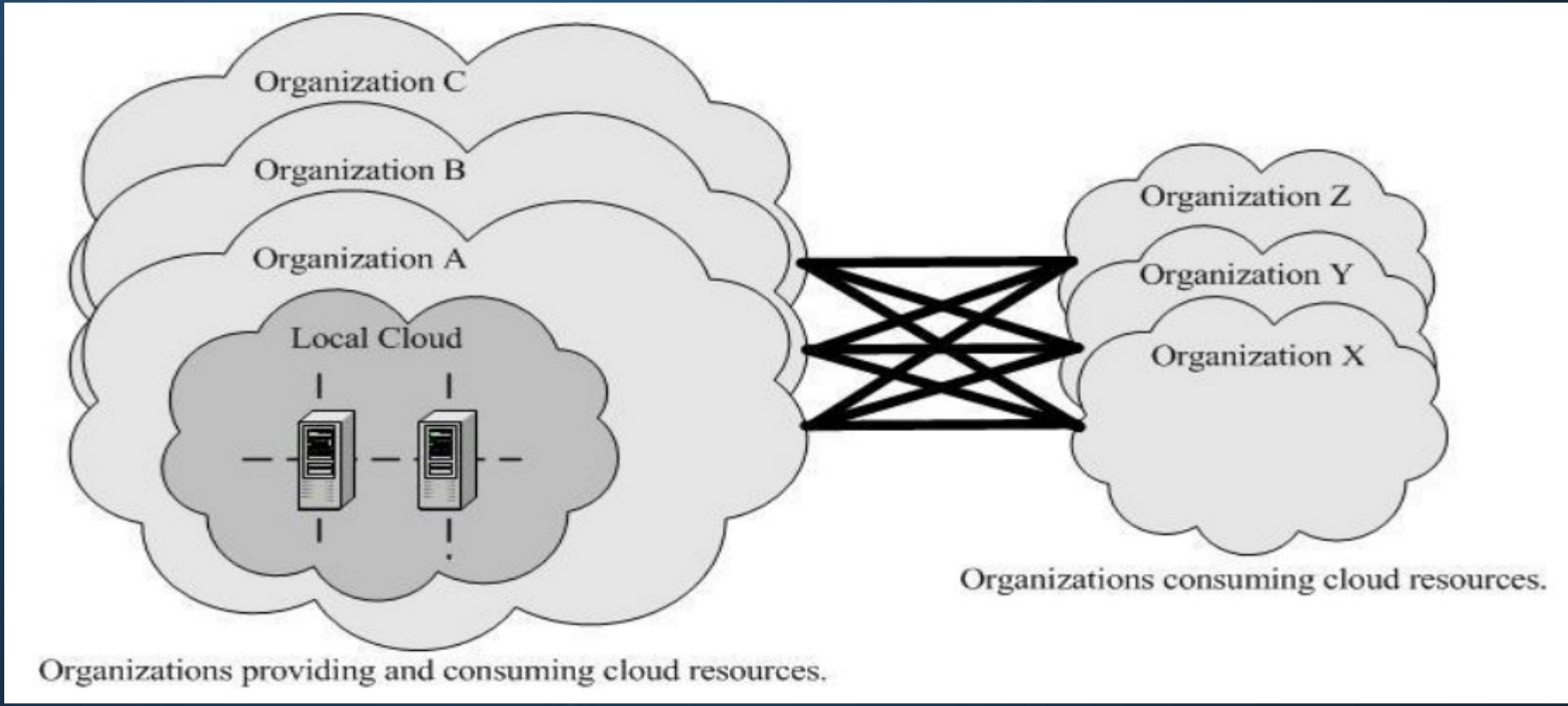


Community Cloud

- A community cloud serves a group of Cloud Consumers which have shared concerns such as mission objectives, security, privacy and compliance policy, rather than serving a single organization as does a private cloud.
- Similar to private clouds, a community cloud may be managed by the organizations or by a third party, and may be implemented on customer premise (i.e. on-site community cloud) or outsourced to a hosting company (i.e. outsourced community cloud).

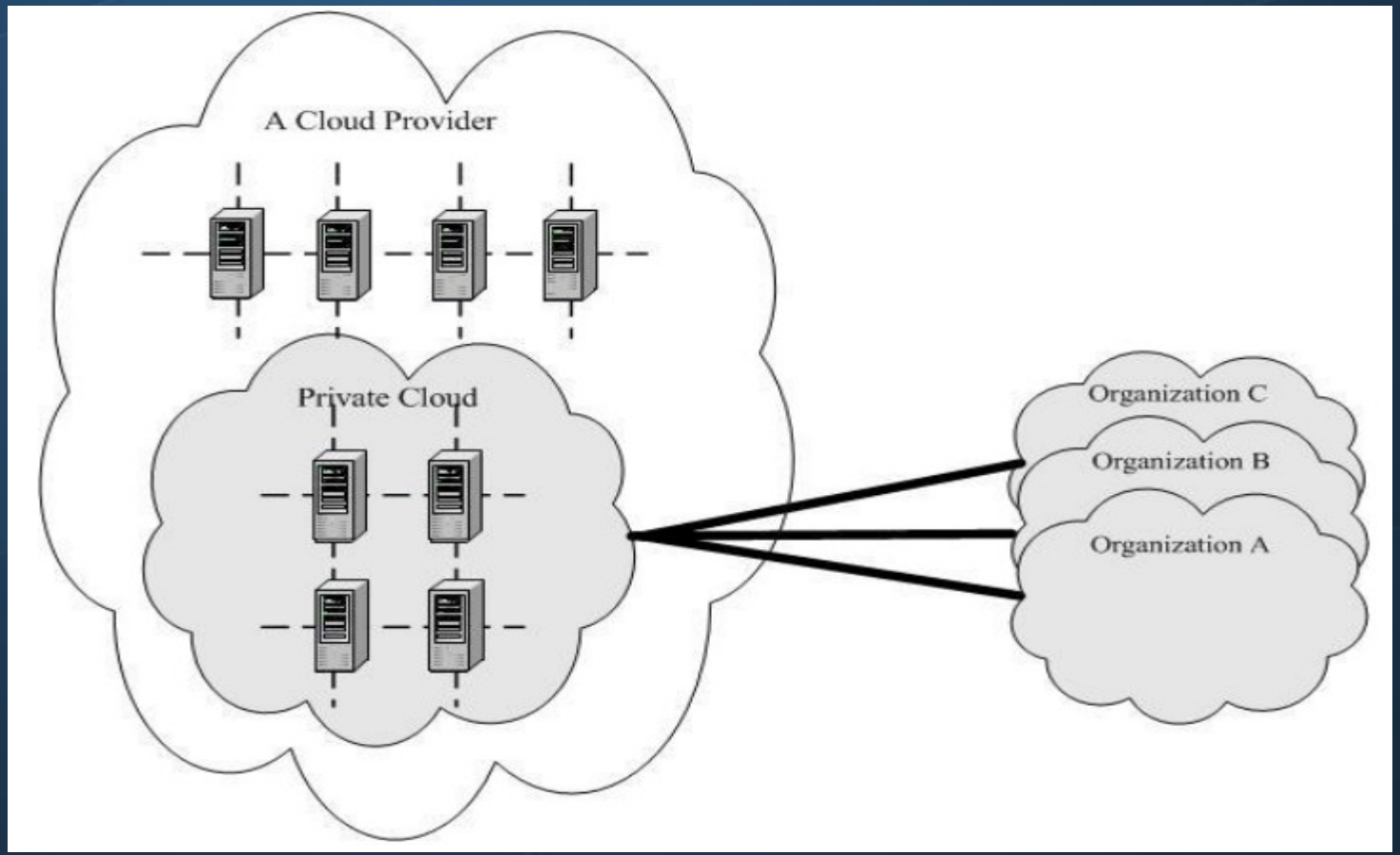
On-site Community Cloud

- An on-site community cloud comprised of a number of participant organizations. A cloud consumer can access the local cloud resources, and also the resources of other participating organizations through the connections between the associated organizations.



Outsourced Community Cloud

- Where the server side is outsourced to a hosting company. In this case, an outsourced community cloud builds its infrastructure off premise, and serves a set of organizations that request and consume cloud services.



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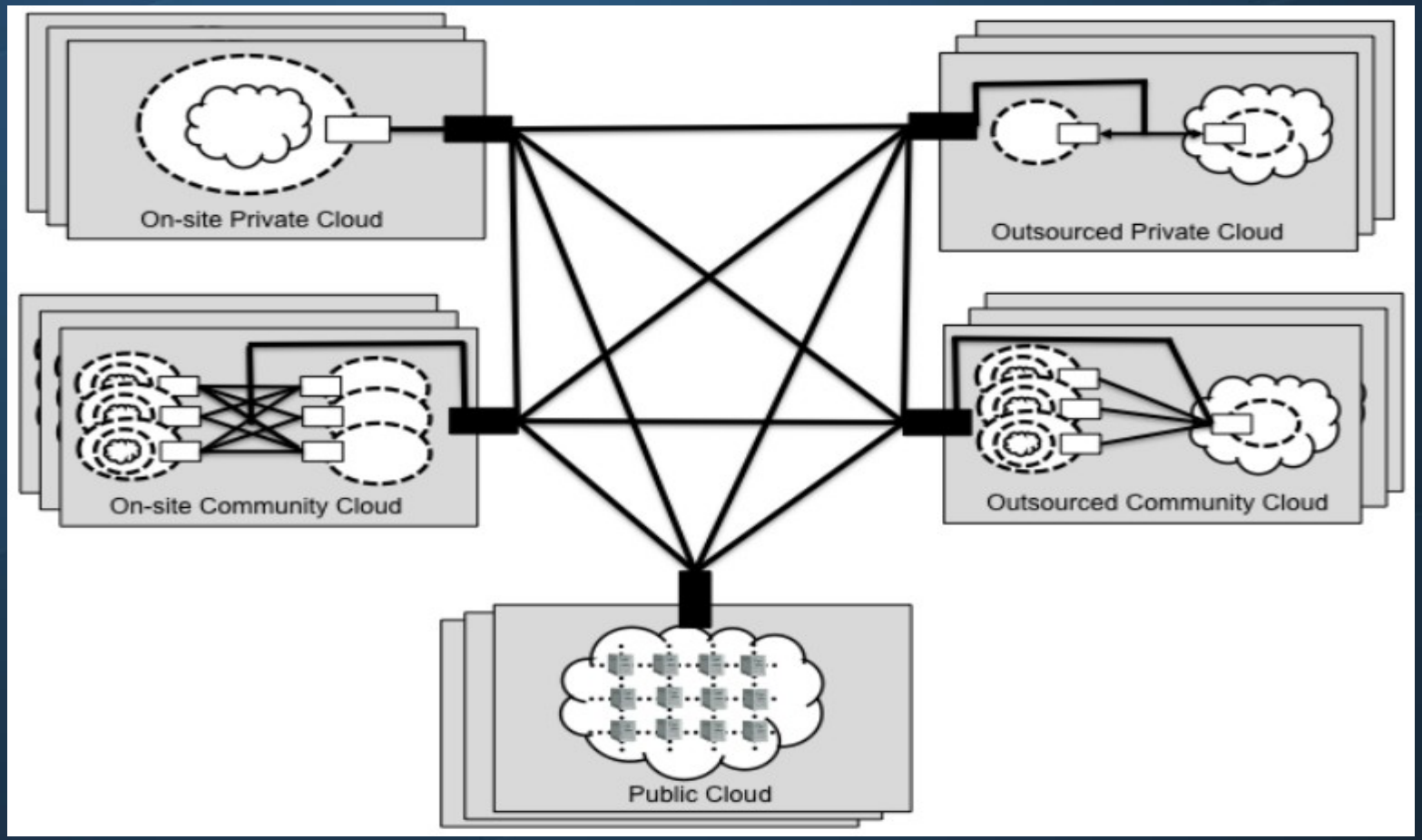
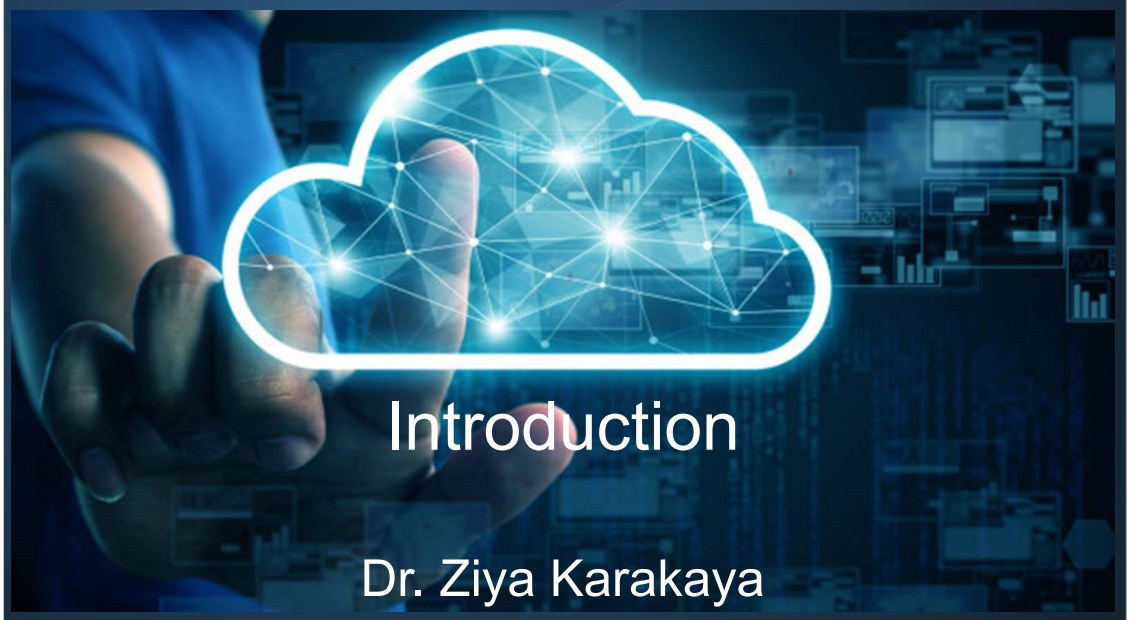


Thank you
for you participation

Cloud Computing



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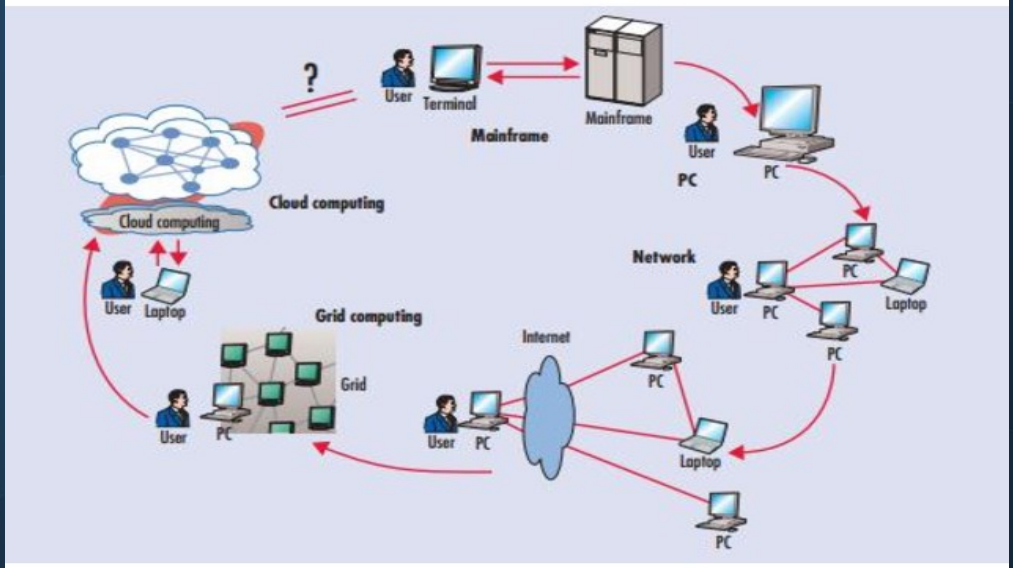

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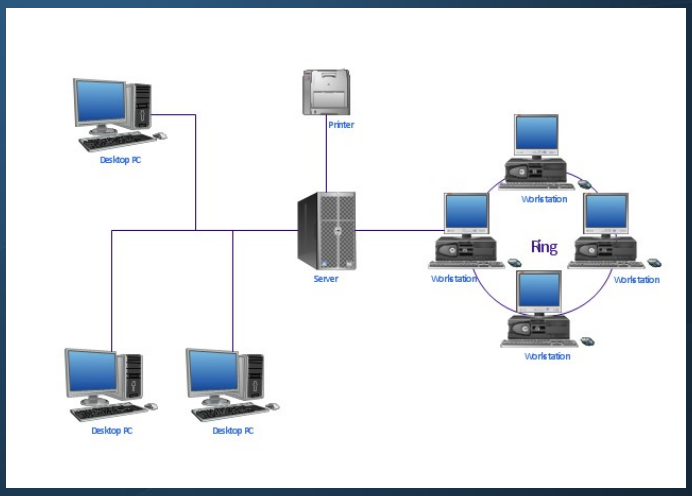

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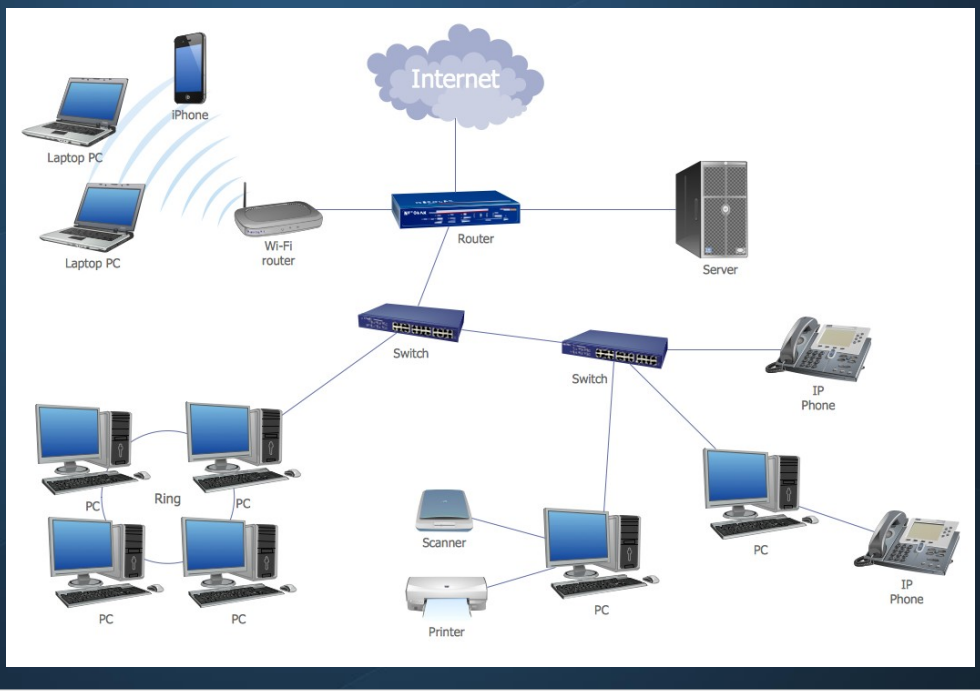

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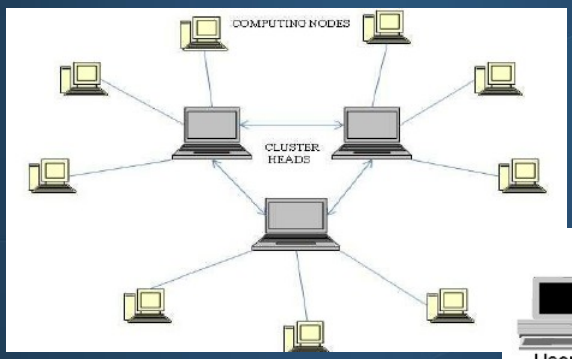

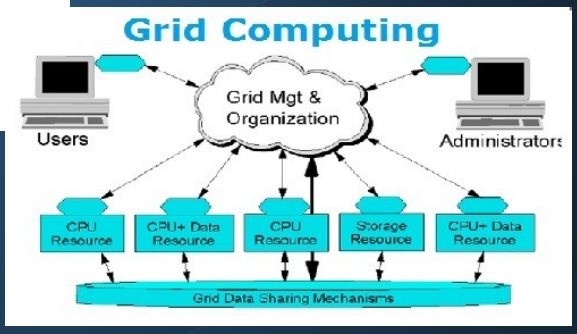

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Hello to Cloud Computing
Mobile
Storage
Applications
CLOUD
COMPUTING
Server
Database
Private cloud
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Hybrid cloud

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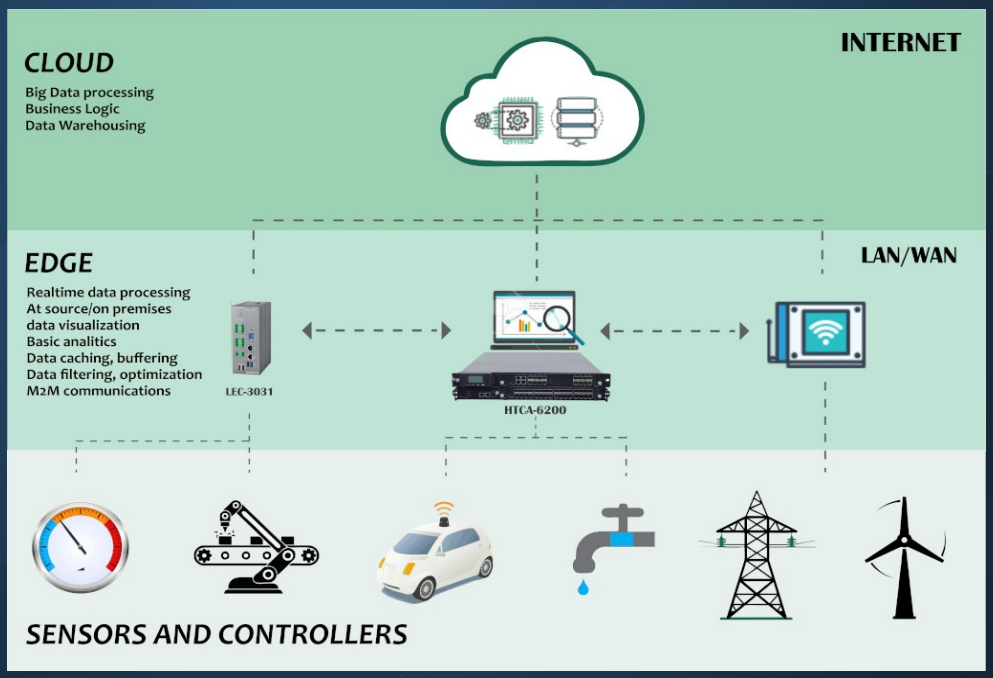
Edge Computing



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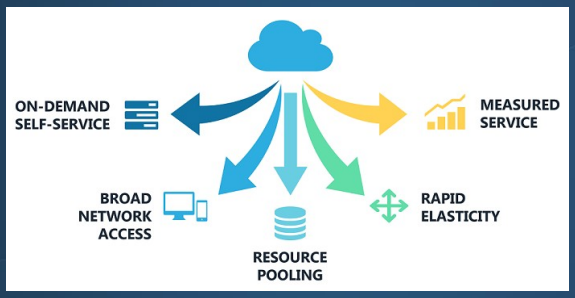

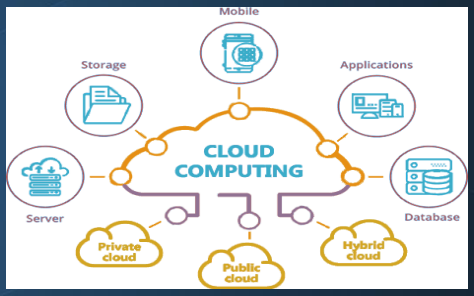

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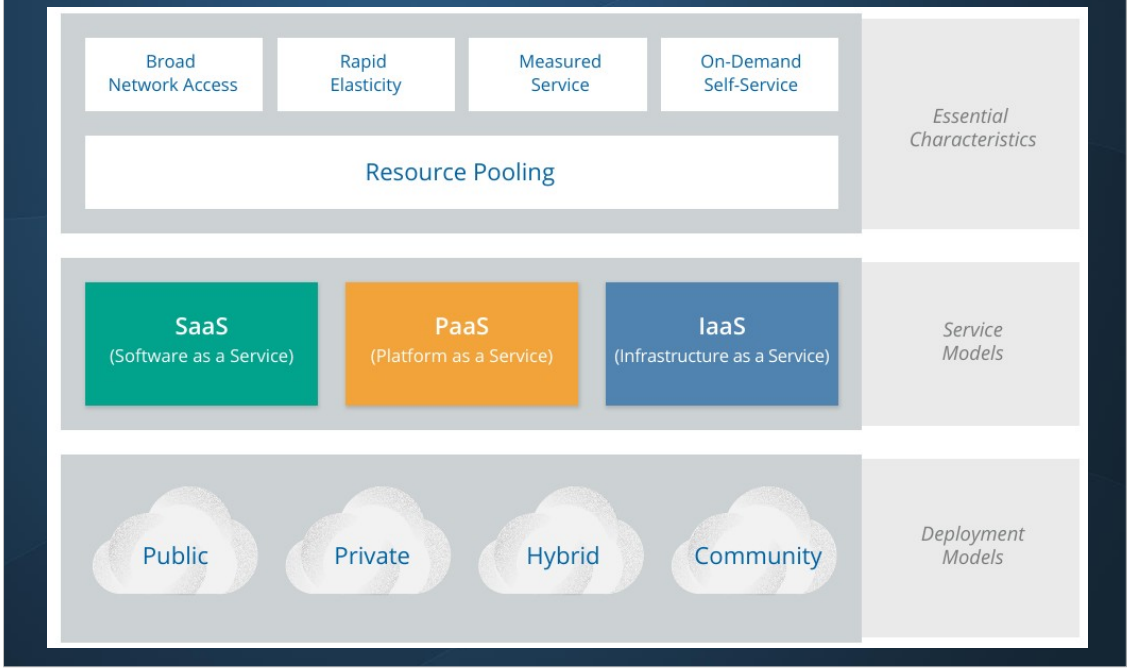

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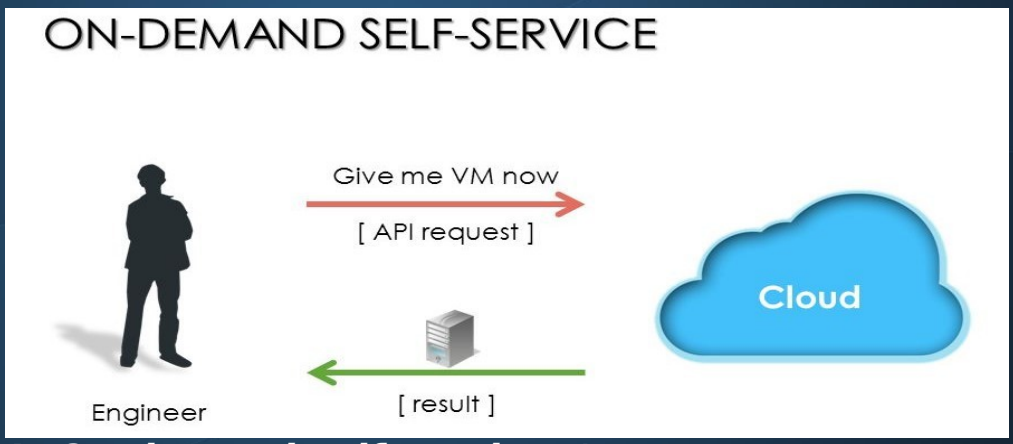

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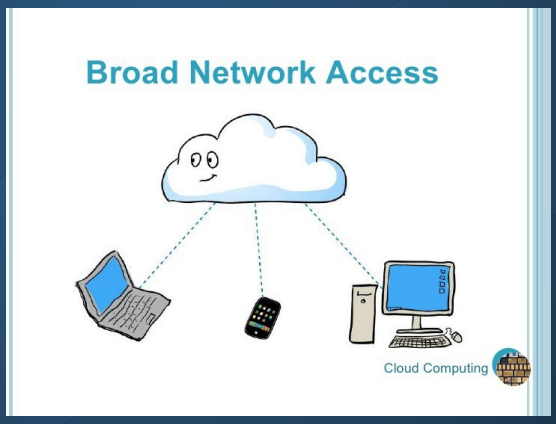

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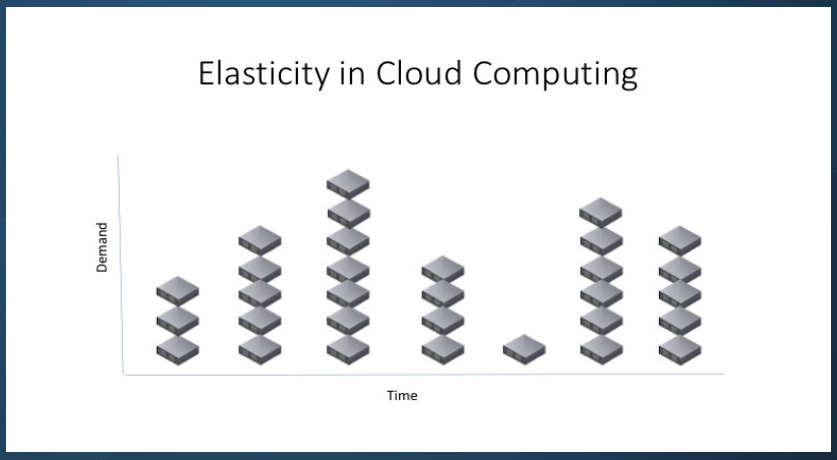

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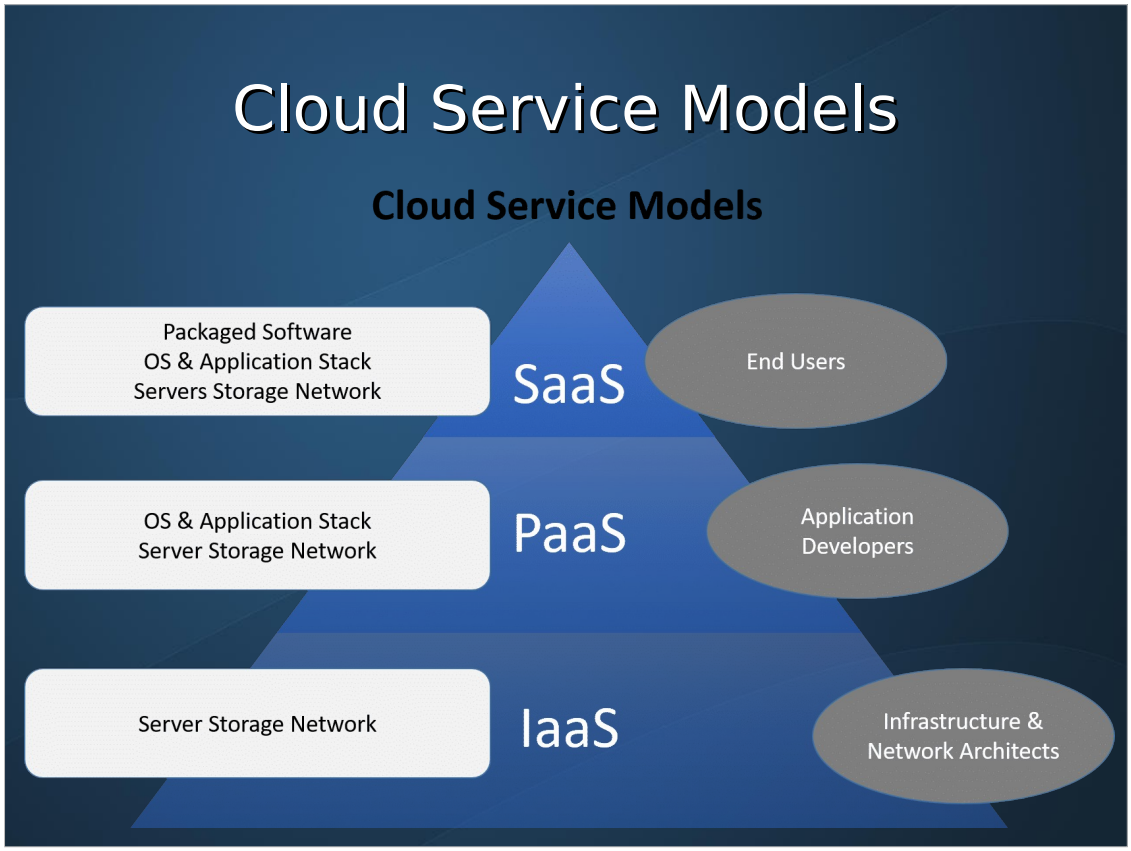
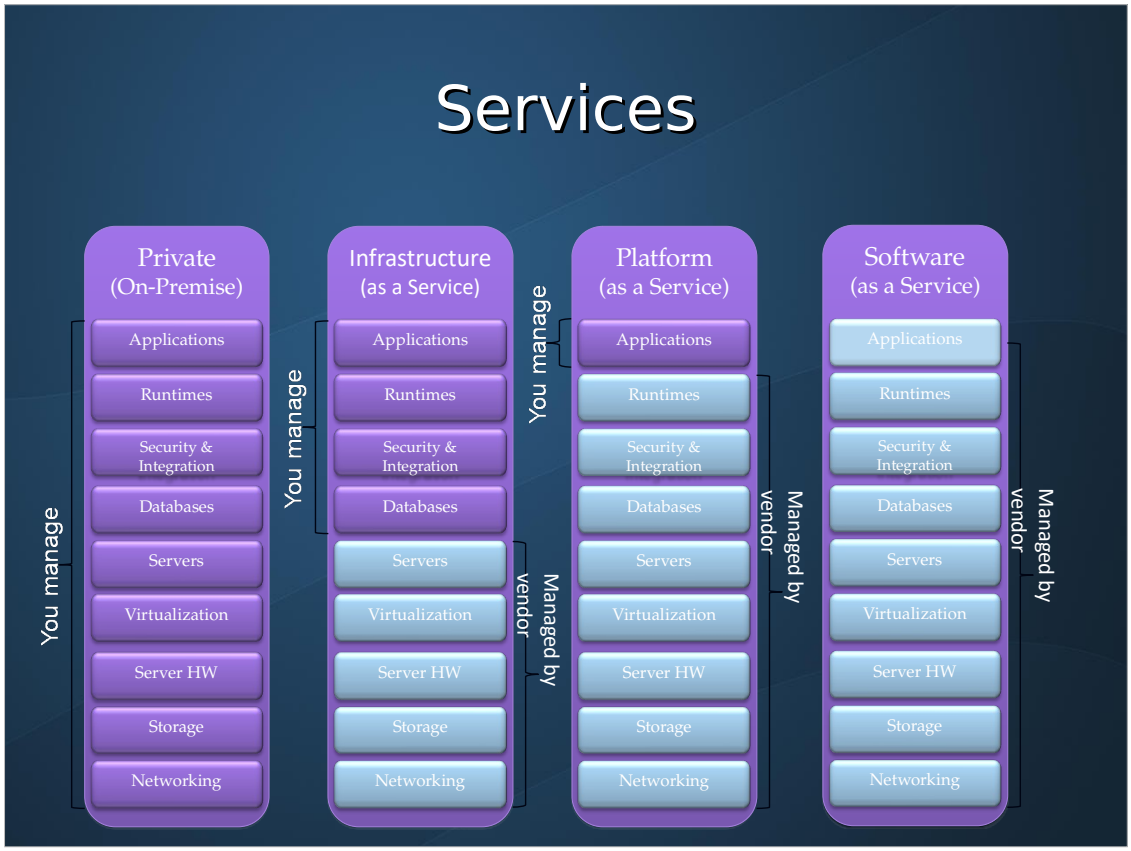
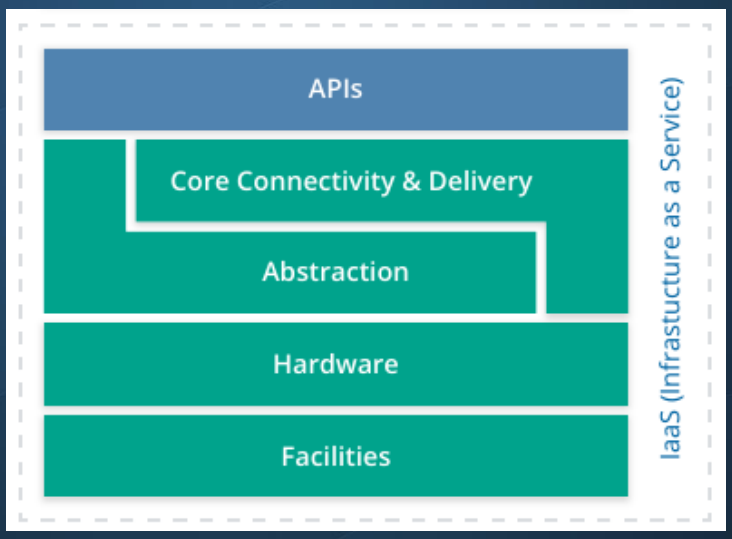

Cloud Service Models
Cloud Service Models
Packaged Software
OS & Application Stack
Servers Storage Network
SaaS
End Users
OS & Application Stack
Server Storage Network
PaaS
Application
Developers
Server Storage Network
IaaS
Infrastructure &
Network Architects


Services
Private (On-Premise)
Infrastructure (as a Service)
Platform (as a Service)
Software (as a Service)
Applications
Runtimes
Security & Integration
Databases
Servers
Virtualization
Server HW
Storage
Networking
You manage
You manage
You manage
Managed by vendor
Managed by vendor

Infrastructure as a Service

- 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).

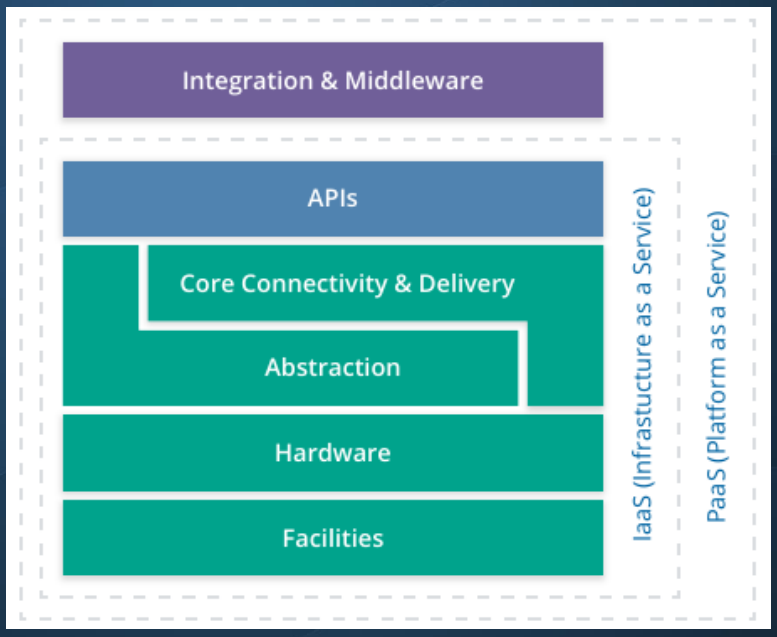
IaaS


APIs
Core Connectivity & Delivery
Abstraction
Hardware
Facilities
IaaS (Infrastucture as a Service)

Platform as a Service

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

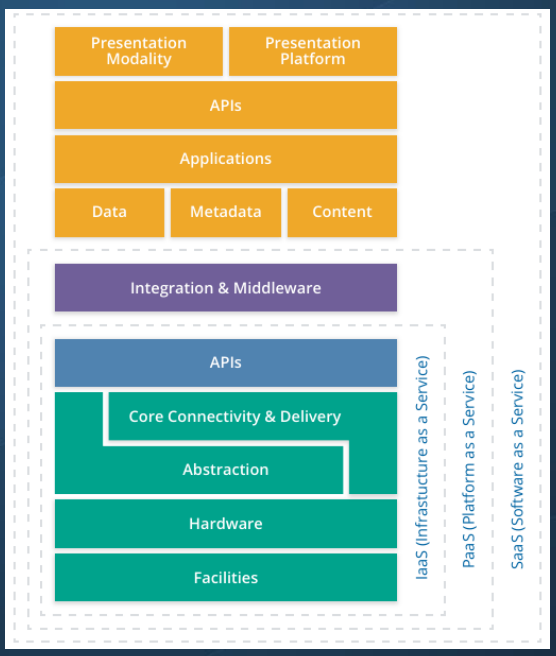
PaaS


Integration & Middleware
APIs
Core Connectivity & Delivery
Abstraction
Hardware
Facilities
IaaS (Infrastucture as a Service)
PaaS (Platform as a Service)

Software as a Service

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

SaaS

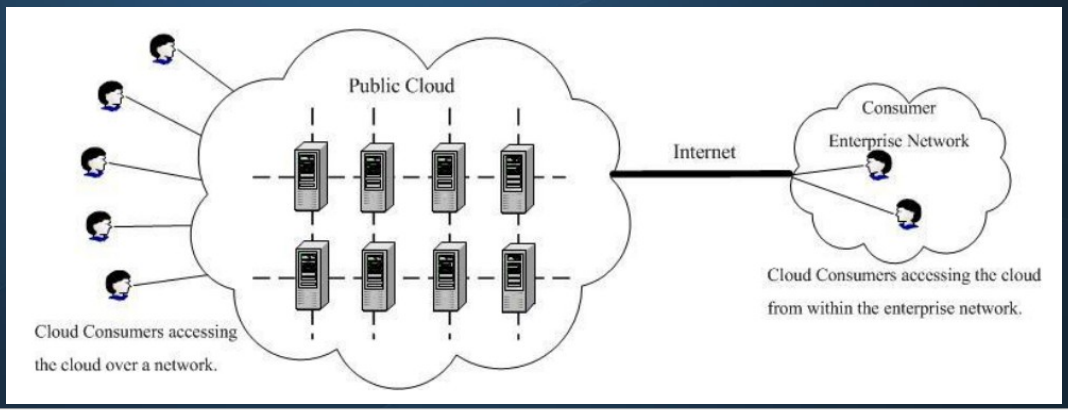

Presentation Modality
Presentation Platform
APIs
Applications
Data
Metadata
Content
Integration & Middleware
APIs
Core Connectivity & Delivery
Abstraction
Hardware
Facilities
IaaS (Infrastucture as a Service)
PaaS (Platform as a Service)
SaaS (Software as a Service)

Deployement Models

- **Private cloud.** The cloud infrastructure is provisioned for exclusive use by a single organizationcomprising 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.
- **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.
- **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.
- **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).

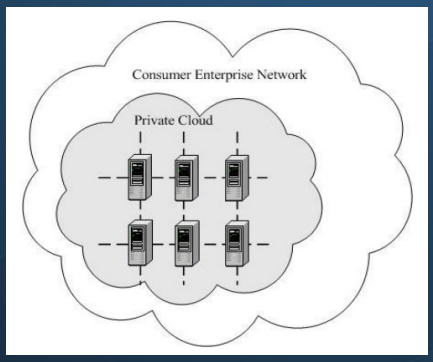
Public Cloud

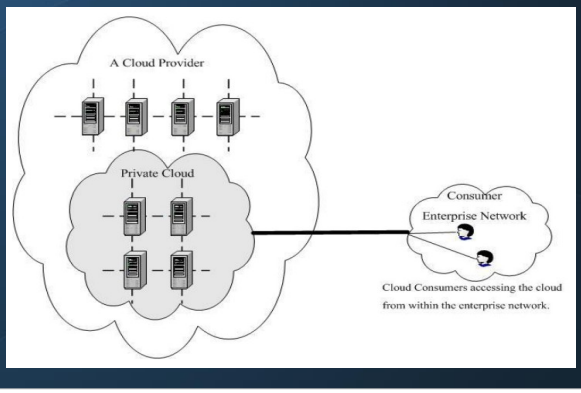
- A public cloud is one in which the cloud infrastructure and computing resources are made available to the general public over a public network.
- A public cloud is owned by an organization selling cloud services, and serves a diverse pool of clients.



Private Cloud

- A private cloud gives a single Cloud Consumer's organization the exclusive access to and usage of the infrastructure and computational resources.
- It may be managed either by the Cloud Consumer organization or by a third party, and may be hosted on the organization's premises (i.e. on-site private clouds) or outsourced to a hosting company (i.e. outsourced private clouds).



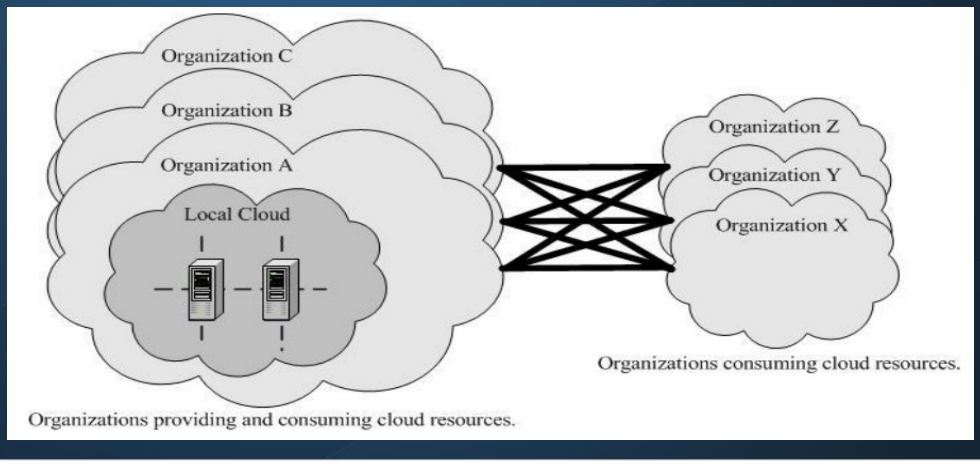


Community Cloud

- A community cloud serves a group of Cloud Consumers which have shared concerns such as mission objectives, security, privacy and compliance policy, rather than serving a single organization as does a private cloud.
- Similar to private clouds, a community cloud may be managed by the organizations or by a third party, and may be implemented on customer premise (i.e. on-site community cloud) or outsourced to a hosting company (i.e. outsourced community cloud).

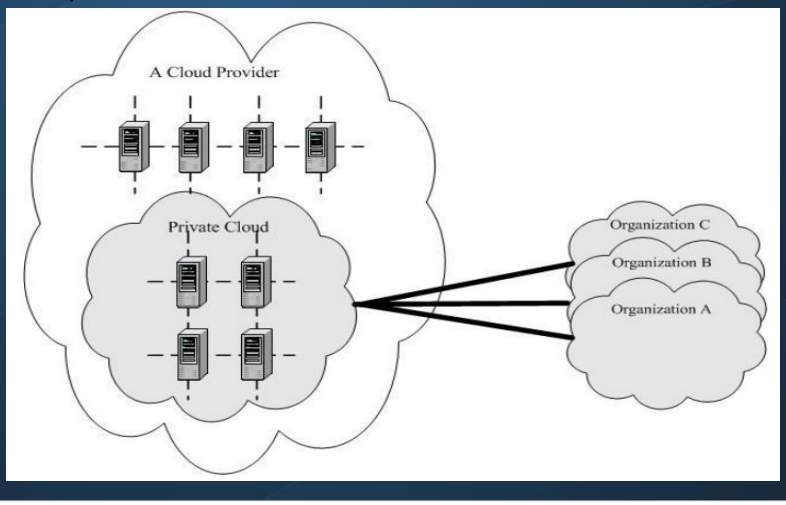
On-site Community Cloud

- An on-site community cloud comprised of a number of participant organizations. A cloud consumer can access the local cloud resources, and also the resources of other participating organizations through the connections between the associated organizations.



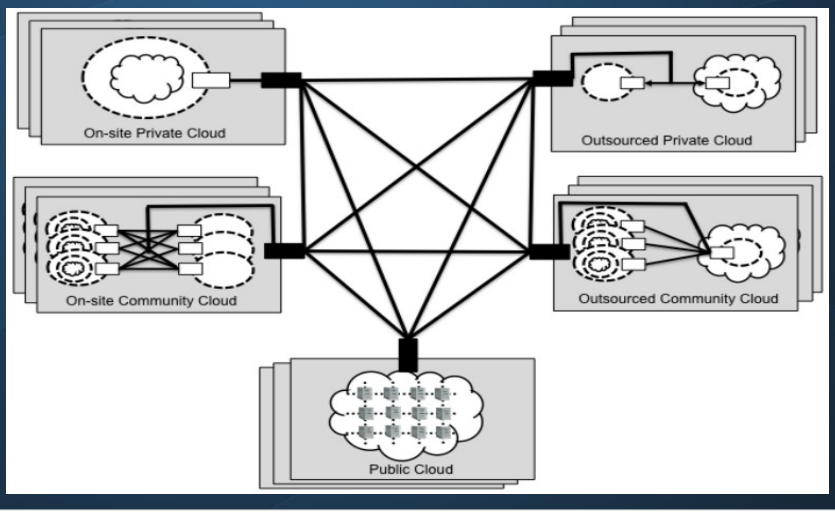
Outsourced Community Cloud

- Where the server side is outsourced to a hosting company. In this case, an outsourced community cloud builds its infrastructure off premise, and serves a set of organizations that request and consume cloud services.



Hybrid Cloud

A hybrid cloud is a composition of two or more clouds (on-site private, on-site community, off-site private, off-site community or public) that remain as distinct entities but are bound together by standardized or proprietary technology that enables data and application portability.



Thank you
for you participation