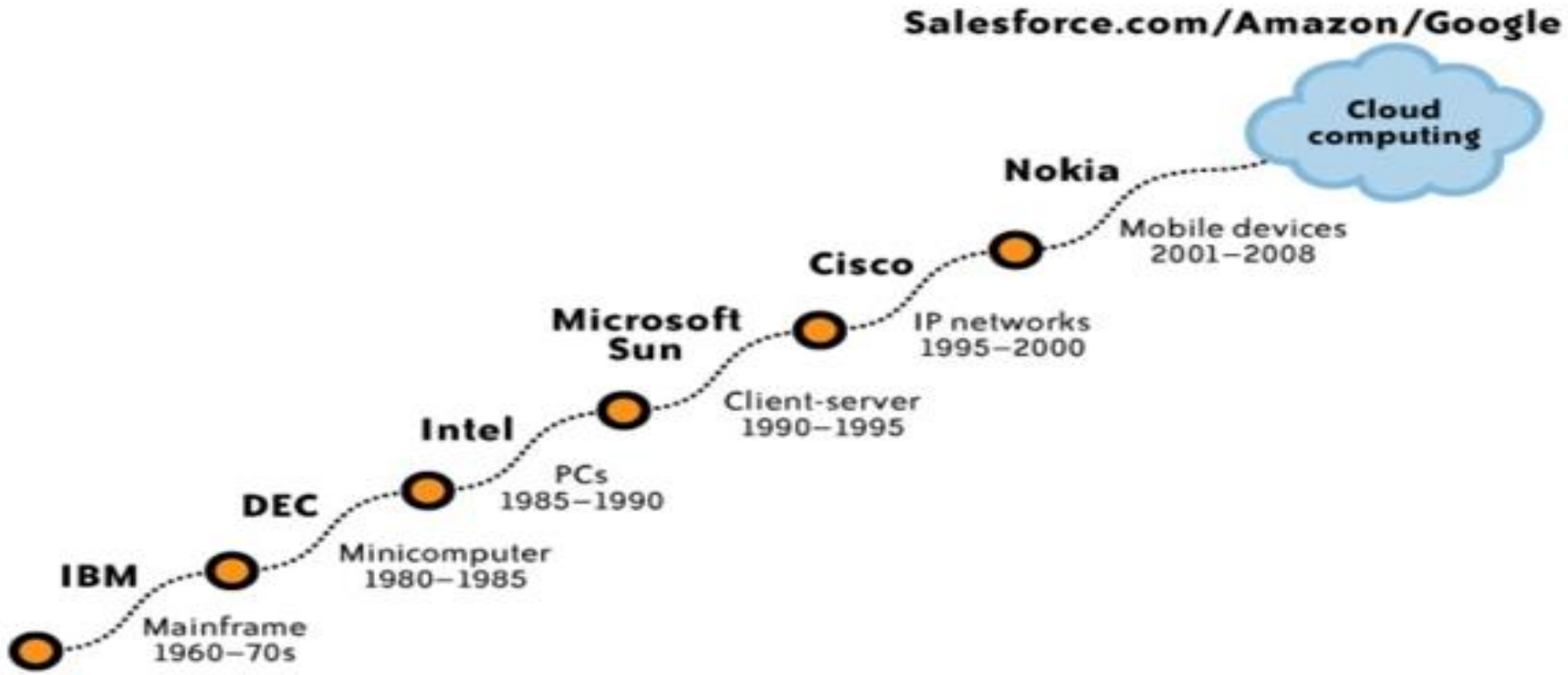
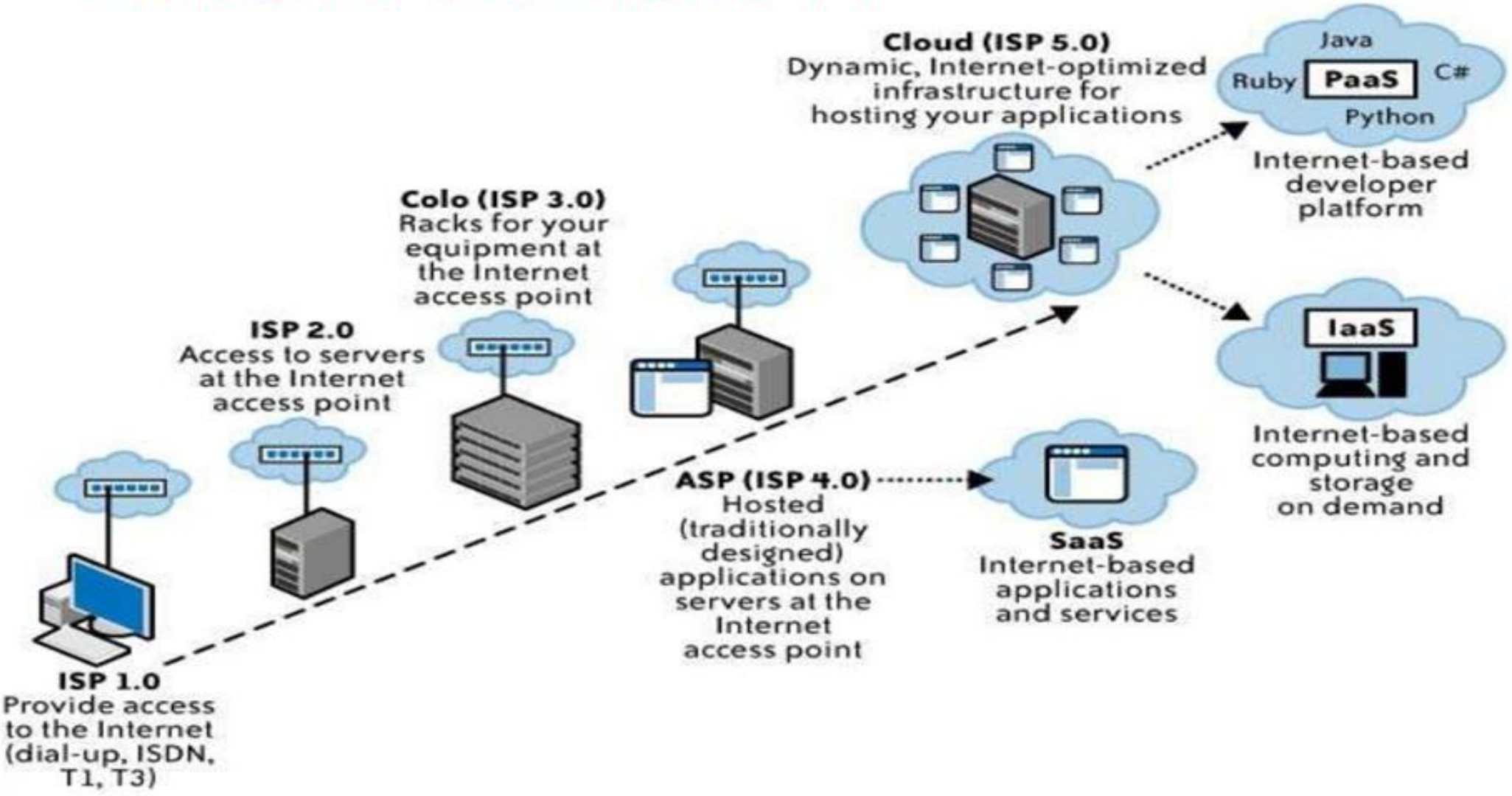
CLOUD COMPUTING
UNIT-1
INTRODUCTION

TECHNOLOGY INNOVATION IN CLOUD COMPUTING

A Brief History



What is the next ??



TECHNOLOGY INNOVATION IN CLOUD COMPUTING

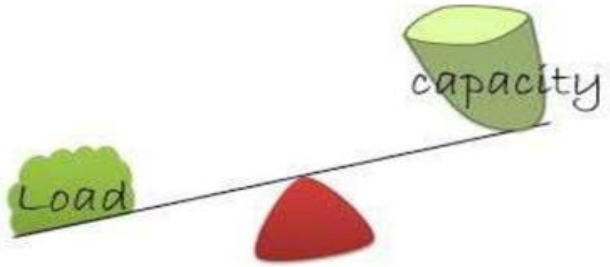
DEFINITION-CLOUD COMPUTING

- *"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.(NIST)*
- *"Cloud computing is a specialized form of distributed computing that introduces utilization models for remotely provisioning scalable and measured resources."(PRECISE)*

Why Cloud Computing?

- **Business Drivers**
  - Capacity Planning
  - Organizational Agility
  - Cost Reduction
- **Technology Innovations**
  - Clustering
  - Grid Computing
  - Virtualization

BUSSINESS DRIVERS



CAPACITY PLANNING

Capacity represents the maximum amount of work that an IT resource is capable of delivering in a given period of time.

Different capacity planning strategies exist

Lead Strategy – adding capacity to an IT resource in anticipation of demand.
Lag Strategy – adding capacity when the IT resource reaches its full capacity.
Match Strategy – adding IT resource capacity in small increments, as demand increases.

ORGANIZATIONAL AGILITY

- Businesses need the ability to adapt and evolve to successfully face change caused by both internal and external factors.
- Organizational agility is the measure of an organization's responsiveness to change.

COST REDUCTION

- The growth of IT environments often corresponds to the assessment of their maximum usage requirements.
- Two costs need to be accounted for:
  - -The cost of acquiring new infrastructure
  - - The cost of its ongoing ownership.

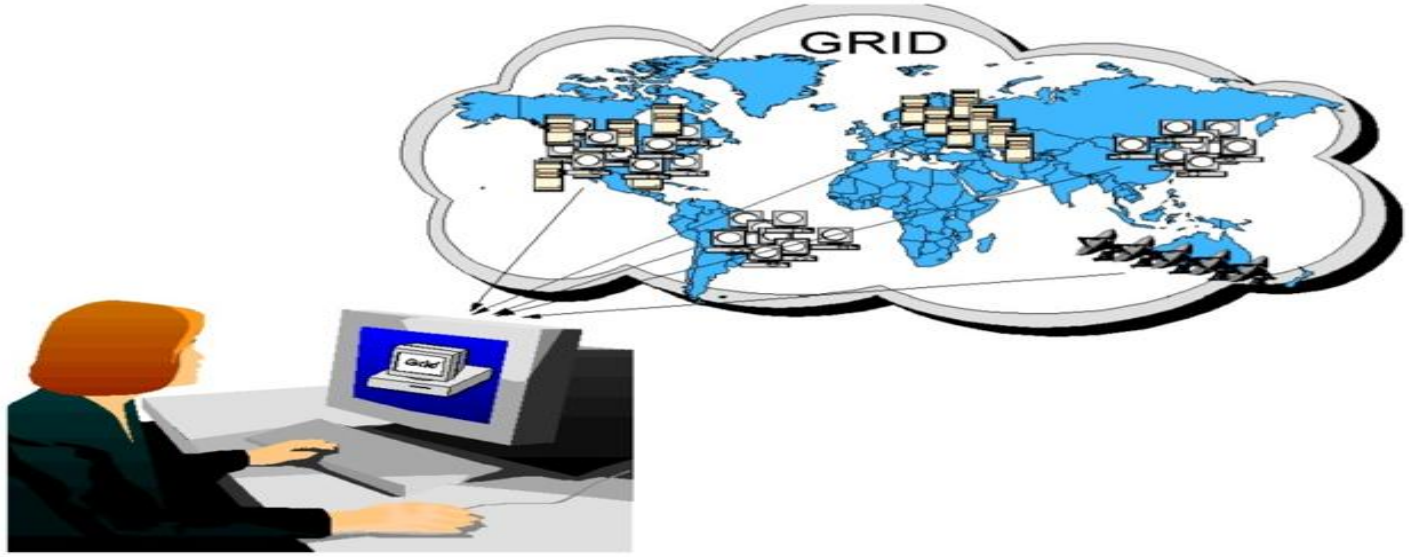
TECHNOLOGY INNOVATION

CLUSTERING

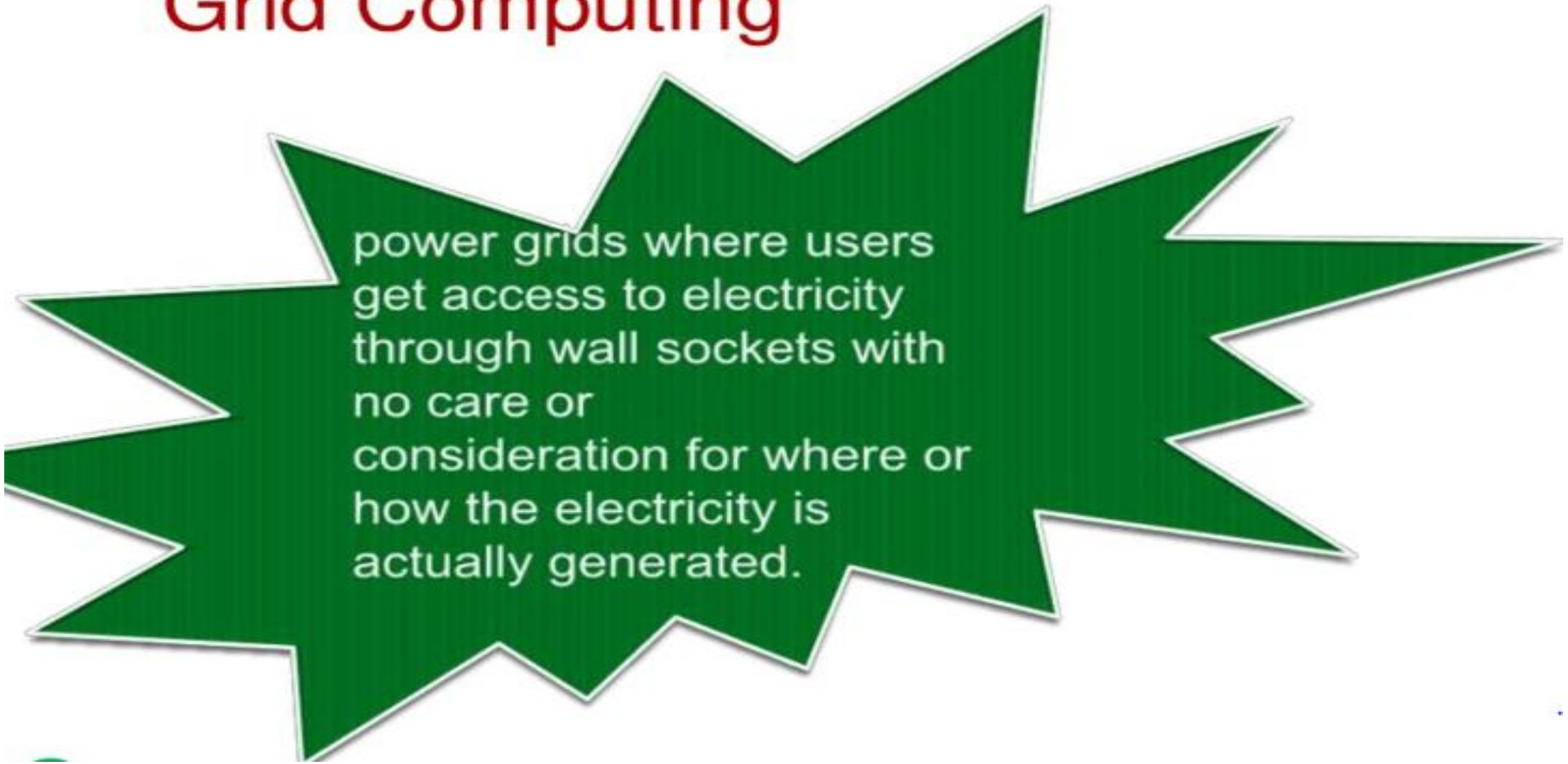
- A cluster is a group of independent IT resources that are interconnected and work as a single system.
- System failure rates are reduced while availability and reliability are increased, since redundancy and failover features are inherent to the cluster.

GRID COMPUTING

- A computing grid (or “computational grid”) provides a platform in which computing resources are organized into one or more logical pools.
- These pools are collectively coordinated to provide a high performance distr er virtual computer.”



Grid Computing

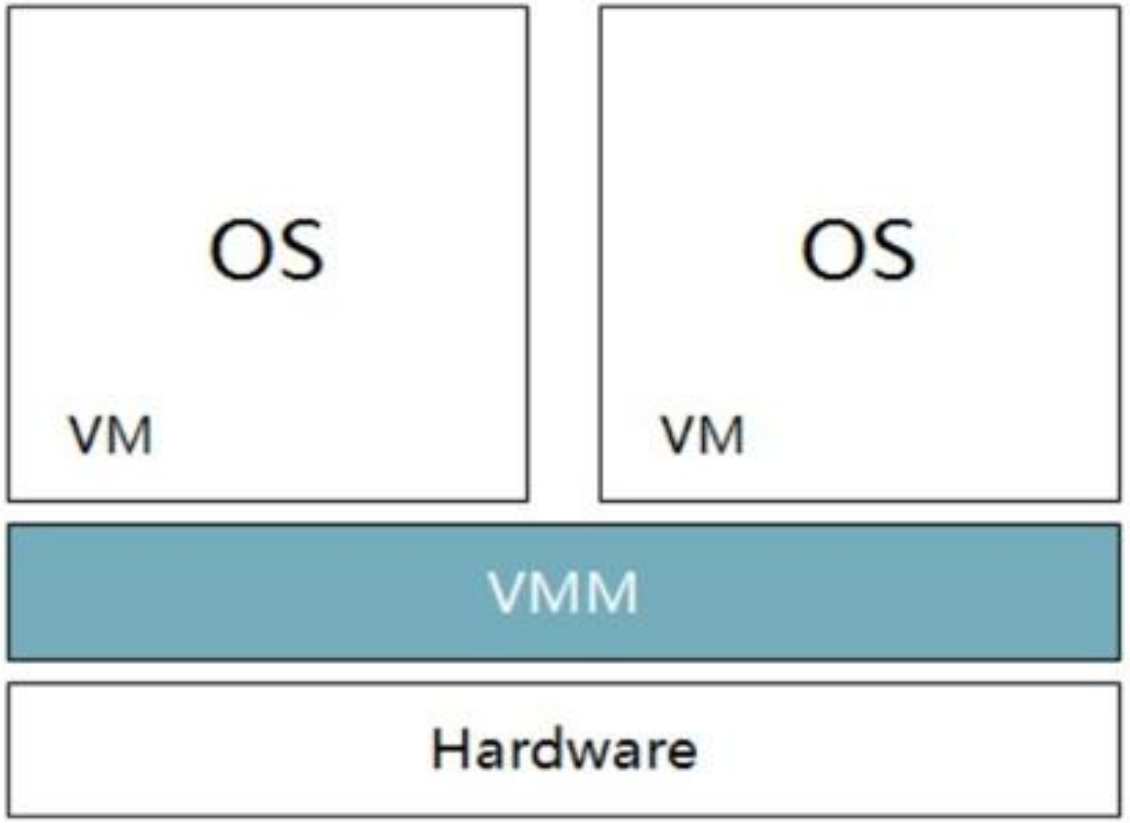


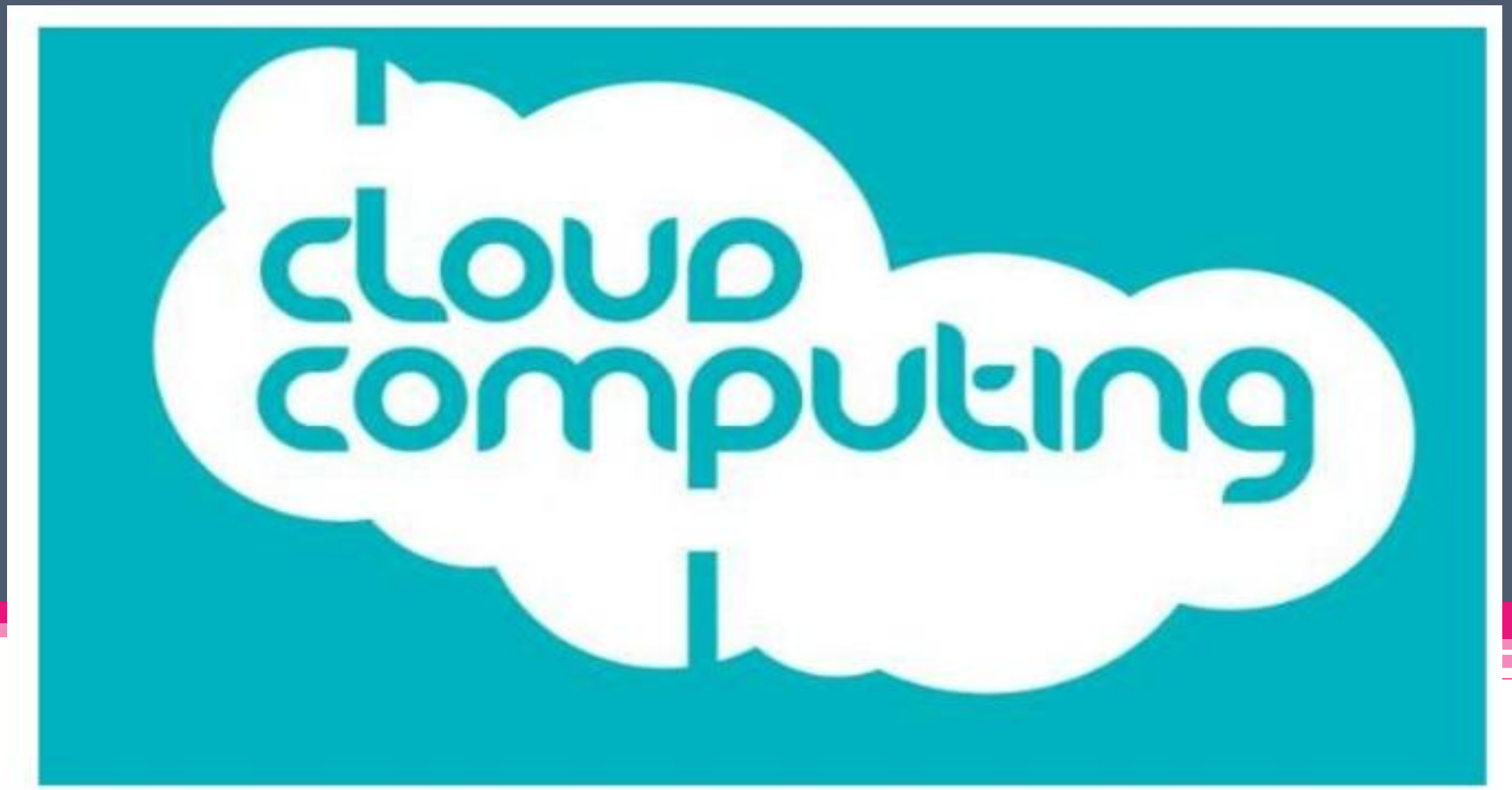
VIRTUALIZATION

- Virtualization represents a technology platform used for the creation of virtual instances of IT resources.
- A layer of virtualization software allows physical IT resources to provide multiple virtual images of themselves so that their underlying processing capabilities can be shared by multiple users.

Virtualization Principles

Server virtualization separates software from hardware. The low-layer virtualization software abstracts a virtual hardware interface by means of space segmentation, time division, and emulation to provide the upper-layer OSs with an expected hardware environment.





CLOUD COMPTING CONCEPTS AND TERMINOLOGY

BASIC CONCEPTS AND TERMINOLOGIES

- **Cloud**
- **IT Resource**
- **On-Premise**
- **Cloud Consumers and Cloud Providers**
- **Scaling**
  - *-Horizontal Scaling*
  - *-Vertical Scaling*
- **Benefits and risk challenges**
- **Roles and boundaries**
- **Additional roles**

Cloud

- A Cloud refers to a distinct IT environment that is designed for the purpose of remotely provisioning scalable and measured **IT resources.**

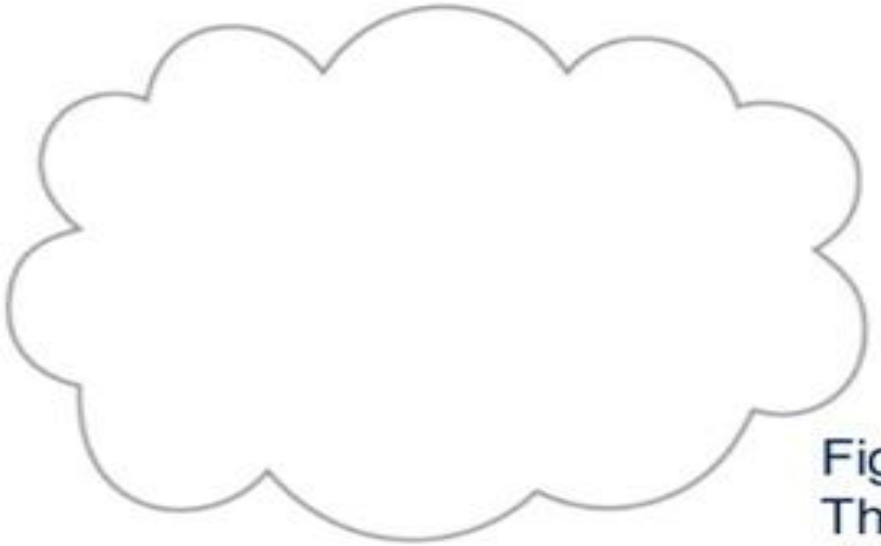


Figure 1.1
The symbol used to denote the boundary of a cloud environment.

IT Resource

- An ***IT resource*** is a physical or virtual IT-related artifact that can be either software based, such as a virtual server or a custom software program, or hardware-based, such as a physical server or a network device (Figure 1.2).

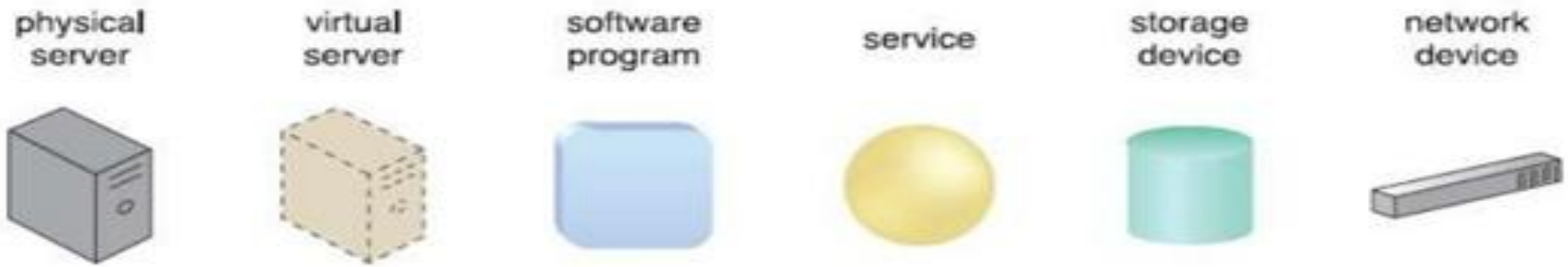


Figure 1.2
Examples of common IT resources and their corresponding symbols.

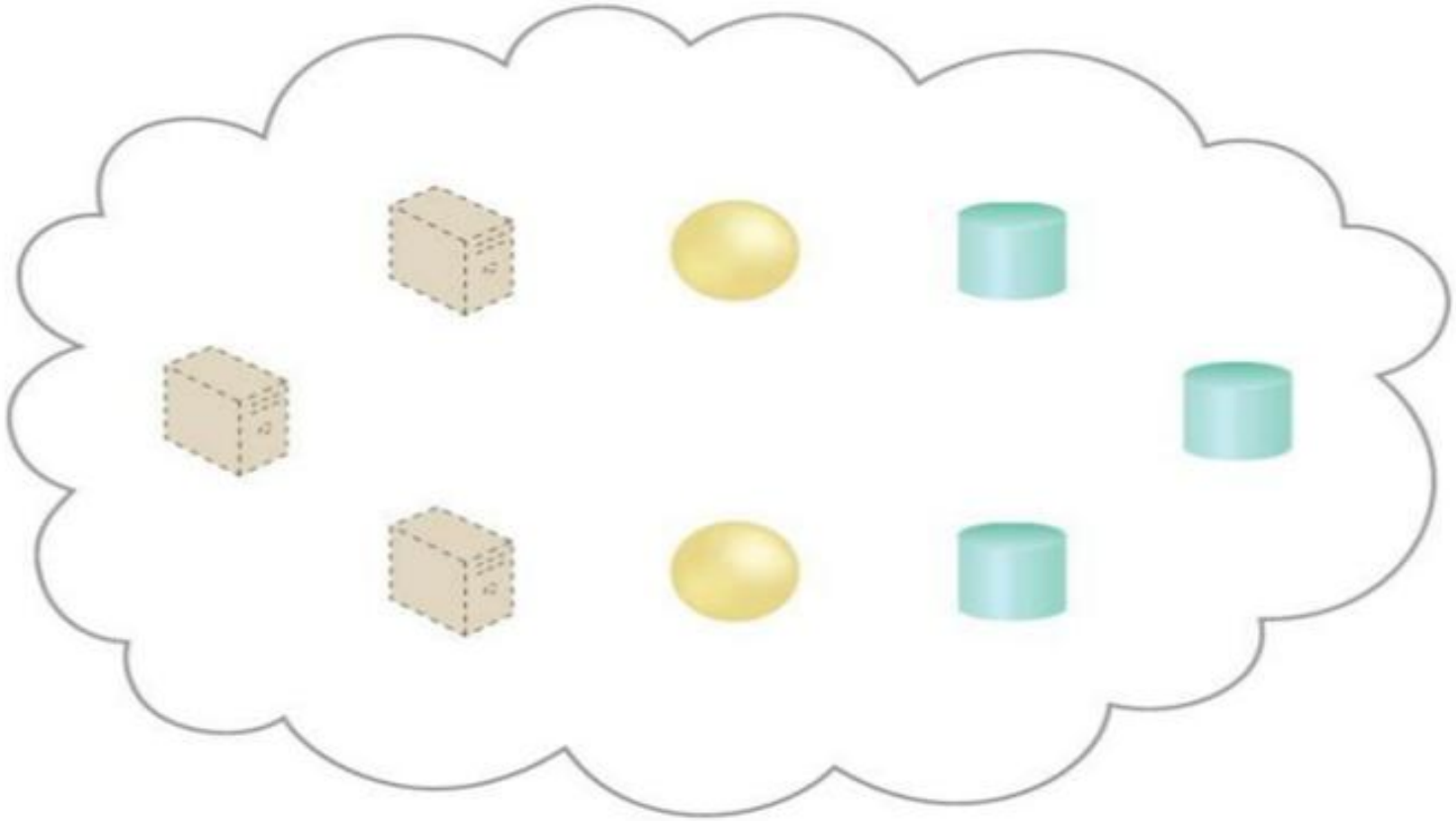


Figure 1.3
A cloud is hosting eight IT resources: three virtual servers, two cloud services, and three storage devices.

On-Premise

- An on-premise IT resource can access and interact with a cloud-based IT resource.
- An on-premise IT resource can be moved to a cloud, thereby changing it to a cloud-based IT resource.
- Redundant deployments of an IT resource can exist in both on-premise and cloud-based environments.

Cloud Consumers and Cloud Providers

- The party that provides cloud-based IT resources is the ***cloud provider.***
- The party that uses cloud-based IT resources is the ***cloud consumer.***
- These terms represent roles usually assumed by organizations in relation to clouds and corresponding cloud provisioning contracts.

Scaling

- Scaling, from an **IT resource** perspective, represents the ability of the IT resource to handle increased or decreased usage demands.
- The following are types of scaling:
  - Horizontal Scaling – **scaling out and scaling in**
  - Vertical Scaling – **scaling up and scaling down**

Horizontal Scaling

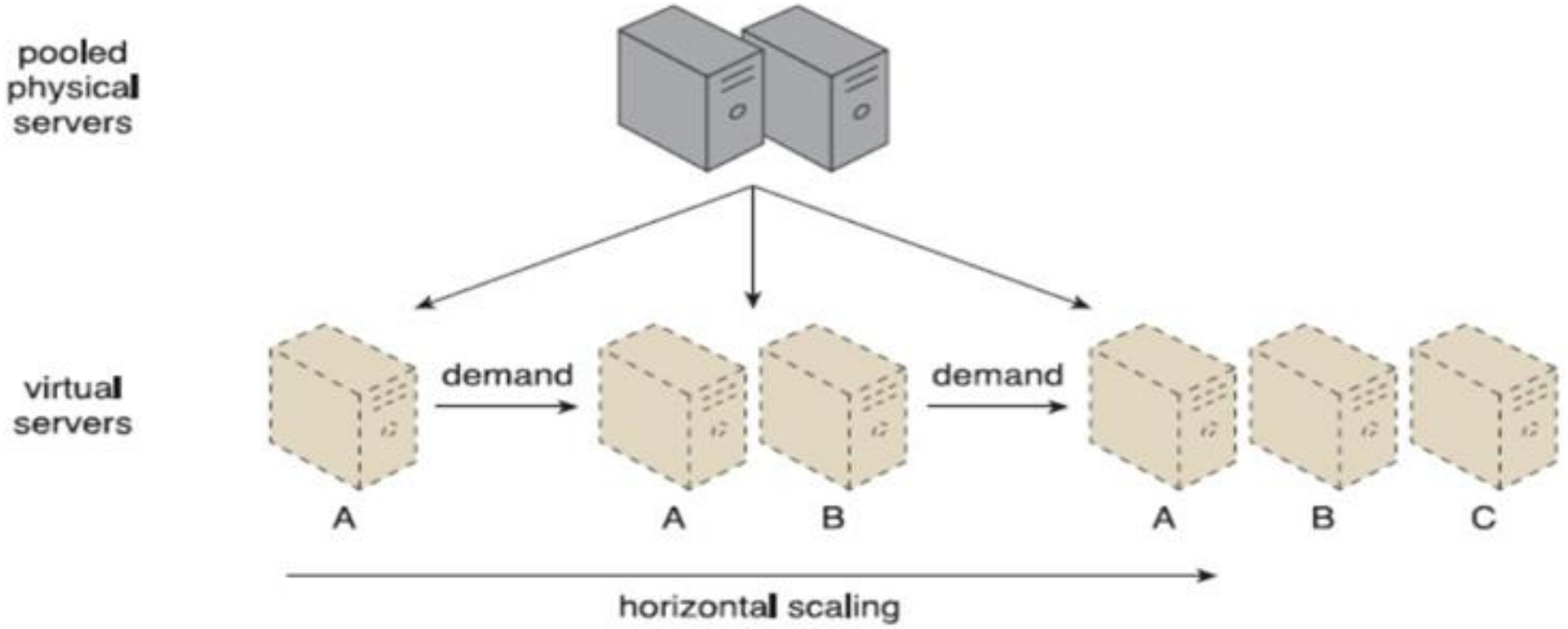


Figure 1.4
An IT resource (Virtual Server A) is scaled out by adding more of the same IT resources (Virtual Servers B and C).

Vertical Scaling

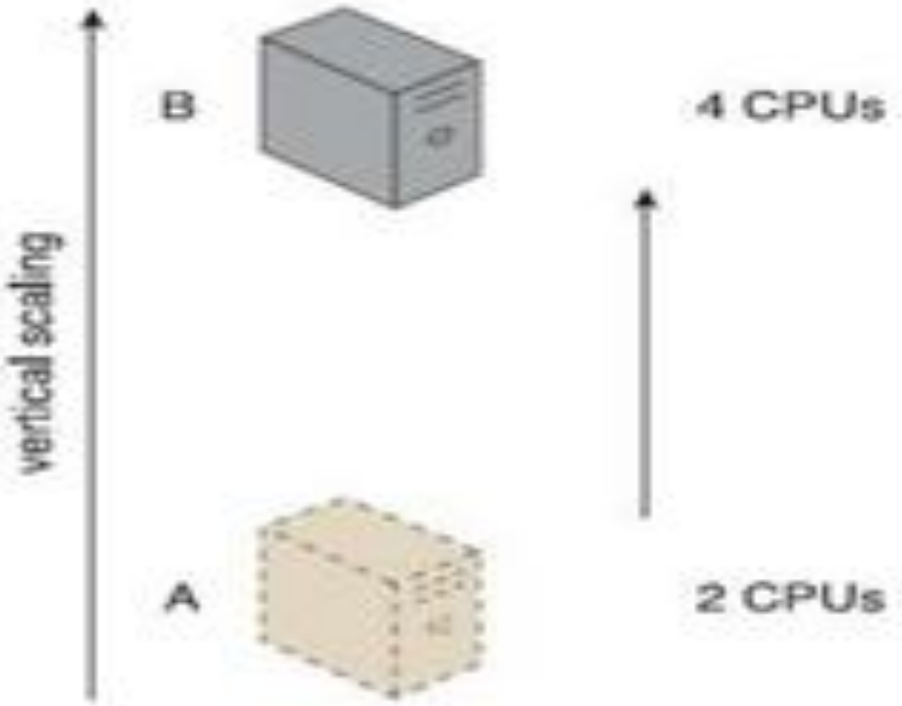


Figure 1.5
An IT resource (a virtual server with two CPUs) is scaled up by replacing it with a more powerful IT resource with increased capacity for data storage (a physical server with four CPUs).

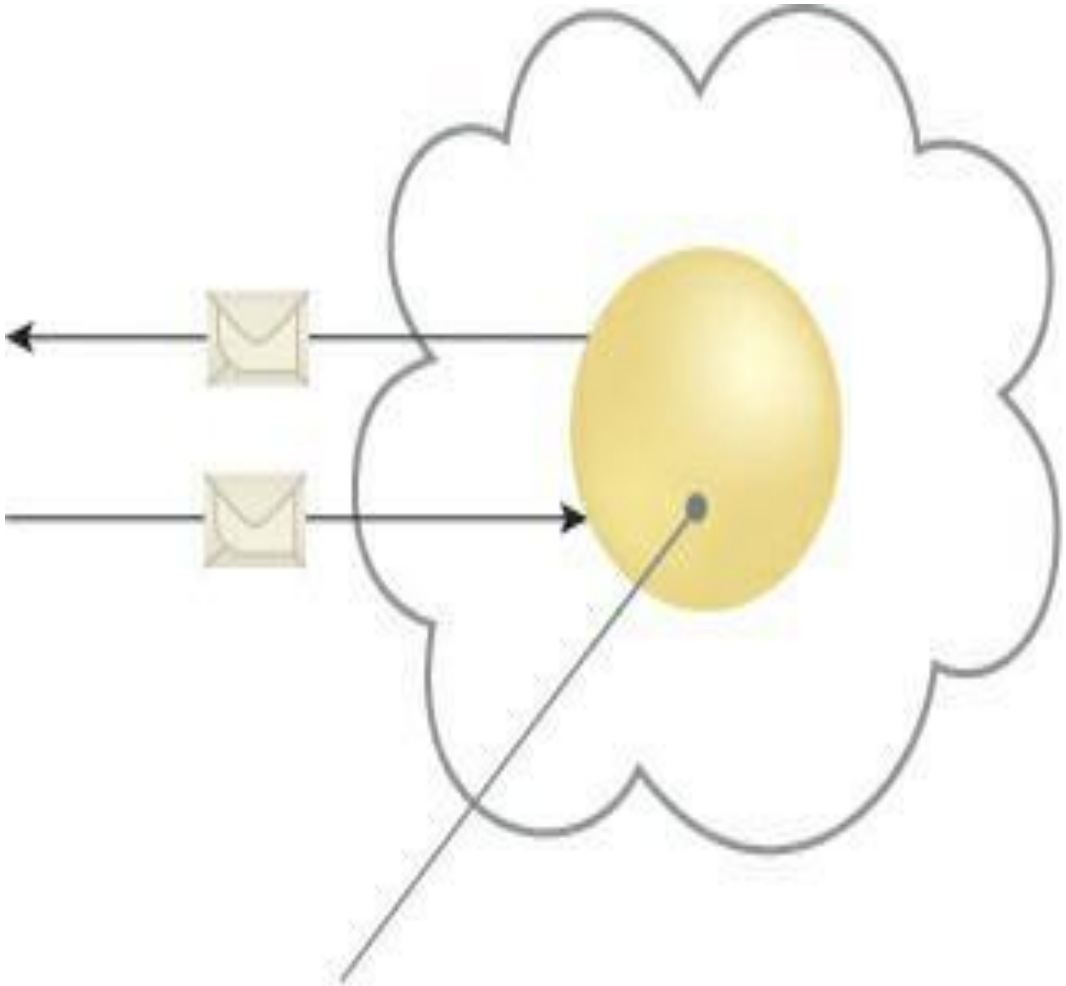
HS & VS comparison

Horizontal Scaling	Vertical Scaling
less expensive (through commodity hardware components)	more expensive (specialized servers)
IT resources instantly available	IT resources normally instantly available
resource replication and automated scaling	additional setup is normally needed
additional IT resources needed	no additional IT resources needed
not limited by hardware capacity	limited by maximum hardware capacity

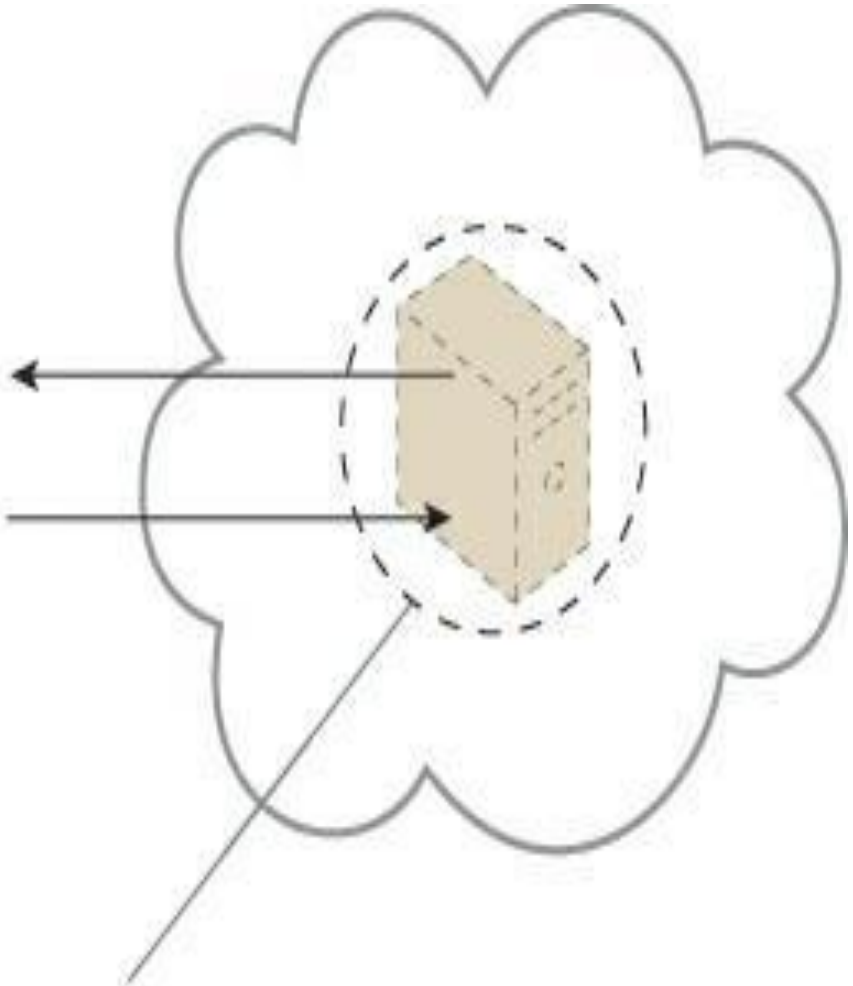
Cloud Service

- **A cloud service** is any IT resource that is made remotely accessible via a cloud.

- Unlike other IT fields that fall under the service technology umbrella—such as service- oriented architecture—the term “service” within the context of cloud computing is especially broad.



remotely accessed Web service
acting as a cloud service



remotely accessed virtual server
acting as a cloud service

Cloud Service Consumer

- The *cloud service consumer* is a temporary runtime role assumed by a software program when it accesses a cloud service.

Benefits

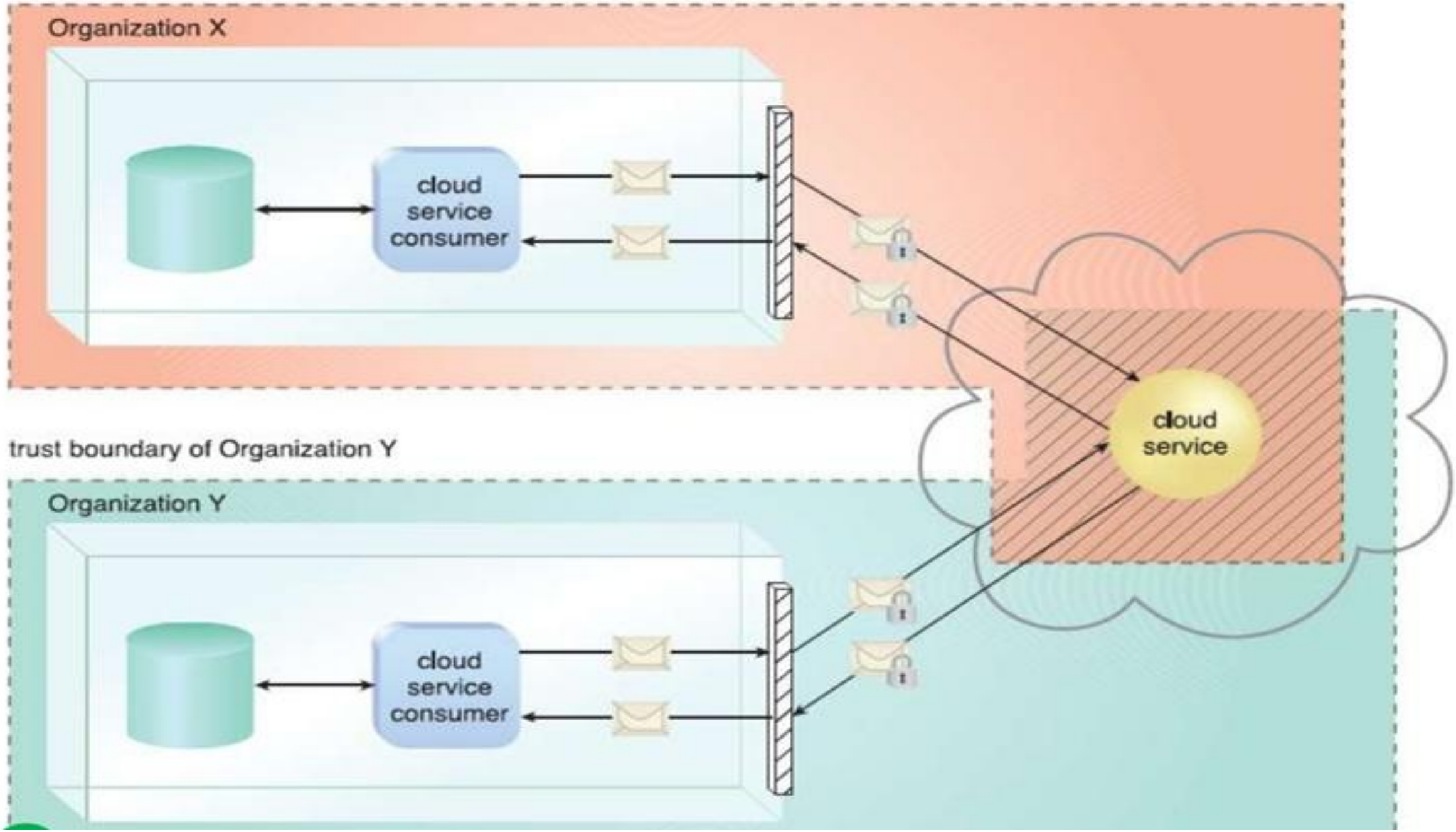
- Reduced Investments and Proportional Costs
- Increased Scalability
- Increased Availability and Reliability

Risks and Challenges

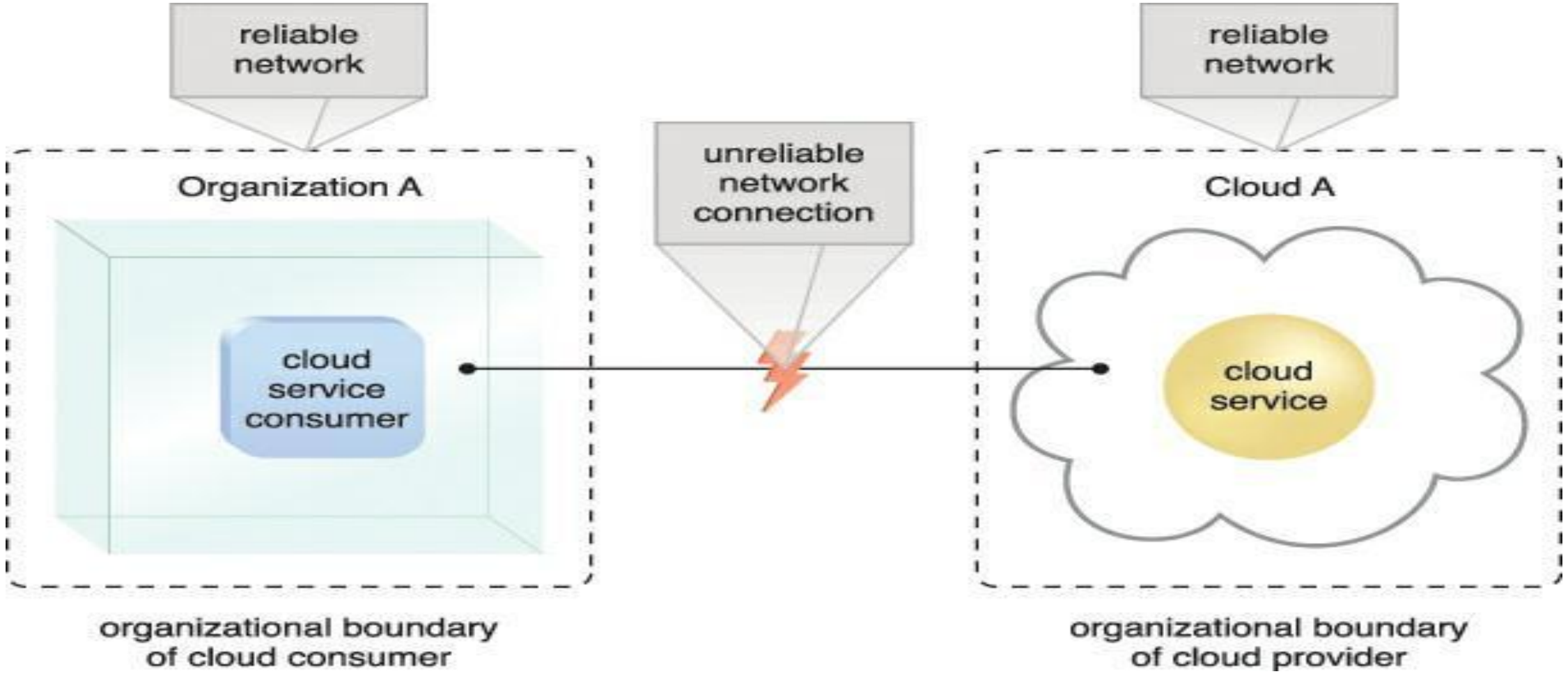
- Increased Security Vulnerabilities
- Reduced Operational Governance Control
- Limited Portability Between Cloud Providers
- Multi-Regional Compliance and Legal Issue

Increased Security Vulnerabilities

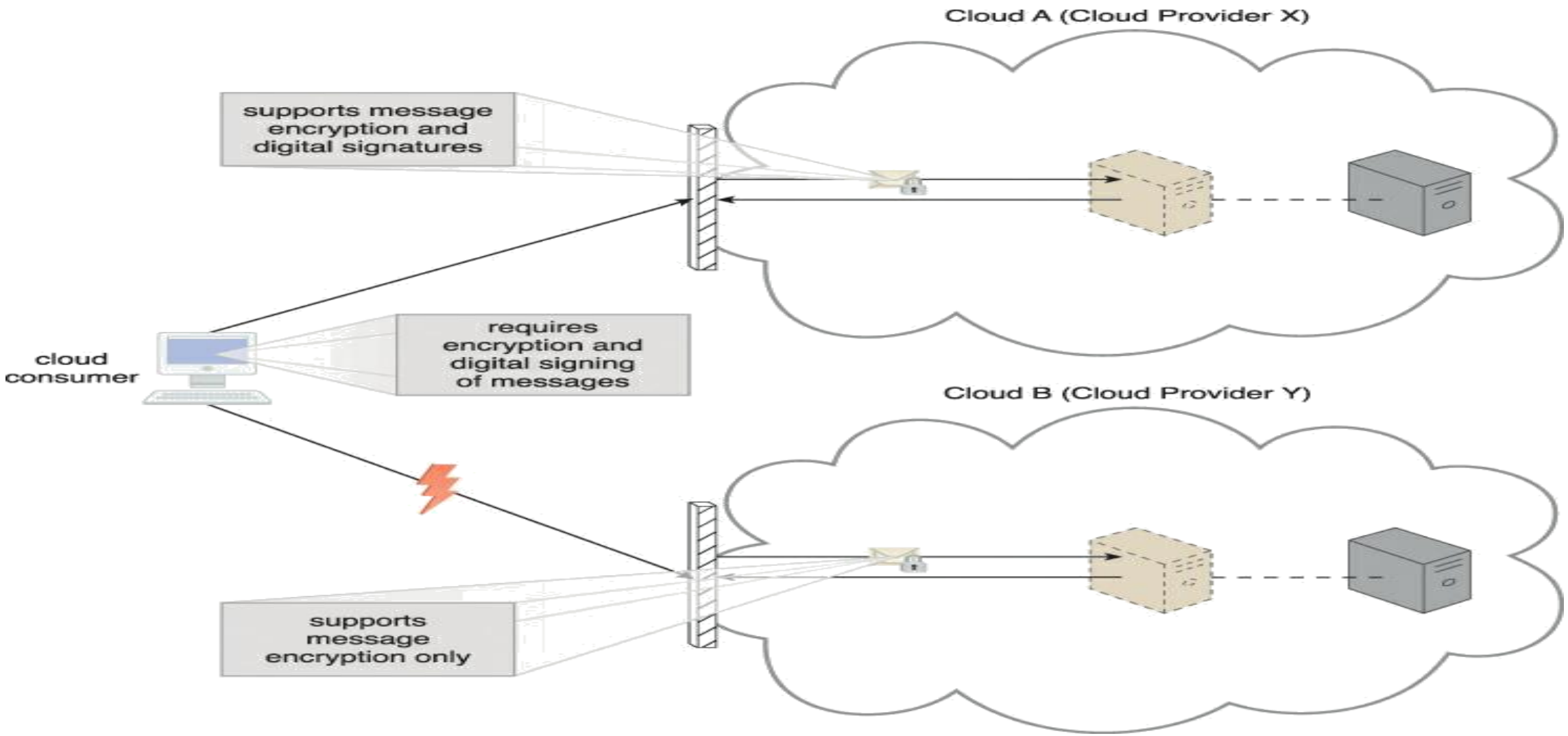
- The moving of business data to the cloud means that the responsibility over data security becomes shared with the cloud provider. The remote usage of IT resources requires an expansion of trust boundaries by the cloud consumer to include the external cloud.


Organization X
cloud service consumer
cloud service
trust boundary of Organization Y
Organization Y
cloud service consumer

Reduced Operational Governance Control



Limited Portability Between Cloud Providers



Multi-Regional Compliance and Legal Issues

- Third-party cloud providers will frequently establish data centers in affordable or convenient geographical locations. Cloud consumers will often not be aware of the physical location of their IT resources and data when hosted by public clouds.
- For some organizations, this can pose serious legal concerns pertaining to industry or government regulations that specify data privacy and storage policies.
- For example, some UK laws require personal data belonging to UK citizens to be kept within the United Kingdom.

Legal Issues

- Another potential legal issue pertains to the accessibility and disclosure of data.
- Countries have laws that require some types of data to be disclosed to certain government agencies or to the subject of the data.
- For example, a European cloud consumer's data that is located in the U.S. can be more easily accessed by government agencies (due to the U.S. Patriot Act) when compared to data located in many European Union countries.

Roles and Boundaries

- **Cloud Provider**

  The organization that provides cloud-based IT resources is the *cloud provider*.

- **Cloud Consumer**

  A *cloud consumer* is an organization (or a human) that has a formal contract or arrangement with a cloud provider to use IT resources made available by the cloud provider.

- **Cloud Service Owner**

  The person or organization that legally owns a cloud service is called a *cloud service owner*.

- **Cloud Resource Administrator**

A *cloud resource administrator* is the person or organization responsible for administering a cloud-based IT resource (including cloud services).

- **Organizational Boundary**

An *organizational boundary* represents the physical perimeter that surrounds a set of IT resources that are owned and governed by an organization.

- **Trust Boundary**

When an organization assumes the role of cloud consumer to access cloud-based IT resources, it needs to extend its trust beyond the physical boundary of the organization to include parts of the cloud environment.

Additional Roles

- The NIST Cloud Computing Reference Architecture defines the following supplementary roles:

- **Cloud Auditor** – A third-party (often accredited) that conducts independent assessments of cloud environments assumes the role of the cloud auditor. The typical responsibilities associated with this role include the evaluation of security controls, privacy impacts, and performance. The main purpose of the cloud auditor role is to provide an unbiased assessment (and possible endorsement) of a cloud environment to help strengthen the trust relationship between cloud consumers and cloud providers.

- **Cloud Broker** – This role is assumed by a party that assumes the responsibility of managing and negotiating the usage of cloud services between cloud consumers and cloud providers. Mediation services provided by cloud brokers include service intermediation, aggregation, and arbitrage.

- **Cloud Carrier** – The party responsible for providing the wire-level connectivity between cloud consumers and cloud providers assumes the role of the cloud carrier. This role is often assumed by network and telecommunication providers.


CLOUD
COMPUTING

Agenda

- Introduction to Cloud Computing
- Cloud Architecture
- Characteristics of Cloud Computing
- Cloud Deployment Model
- Cloud Services Model
- NIST Cloud Architecture

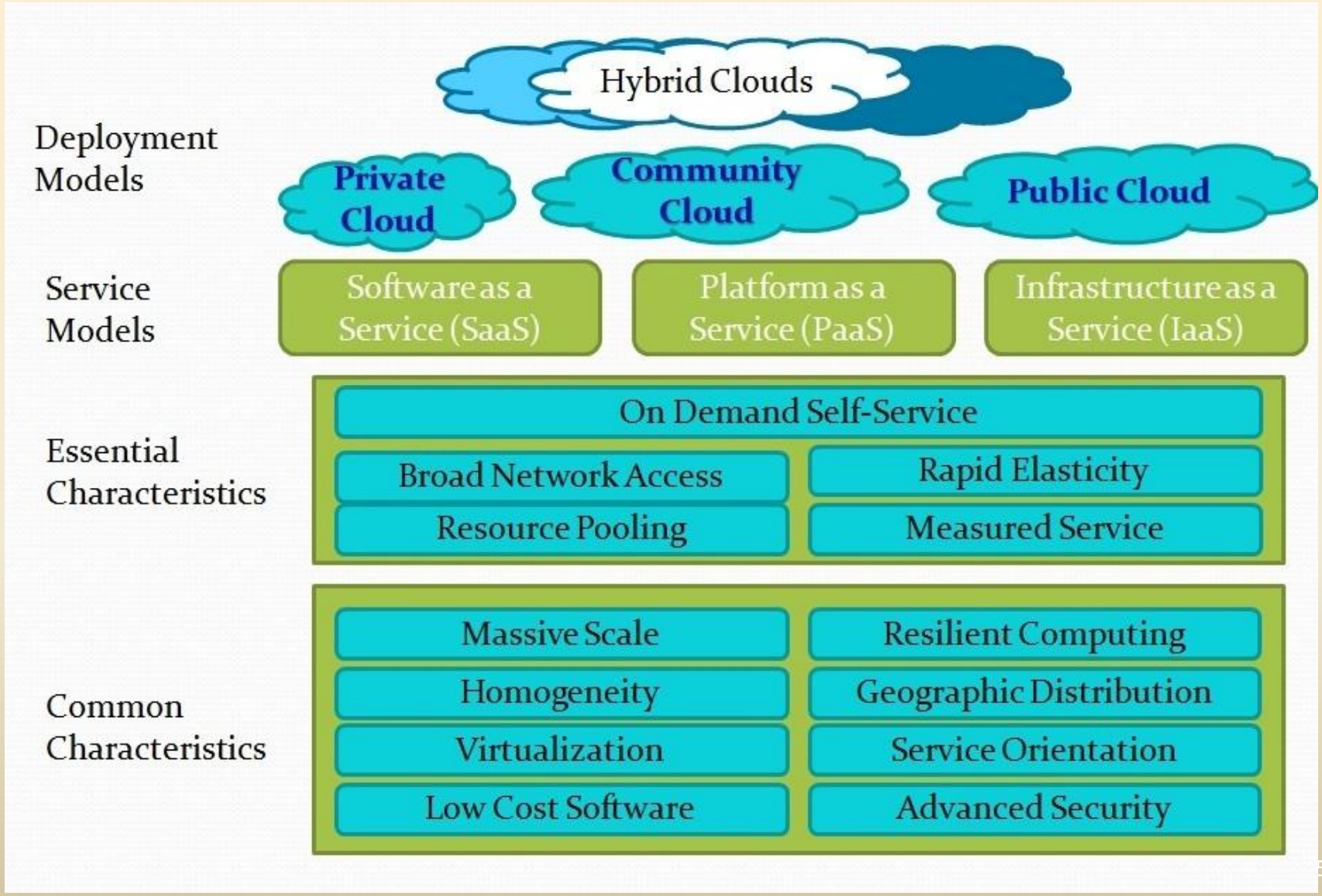
Cloud Computing Definition

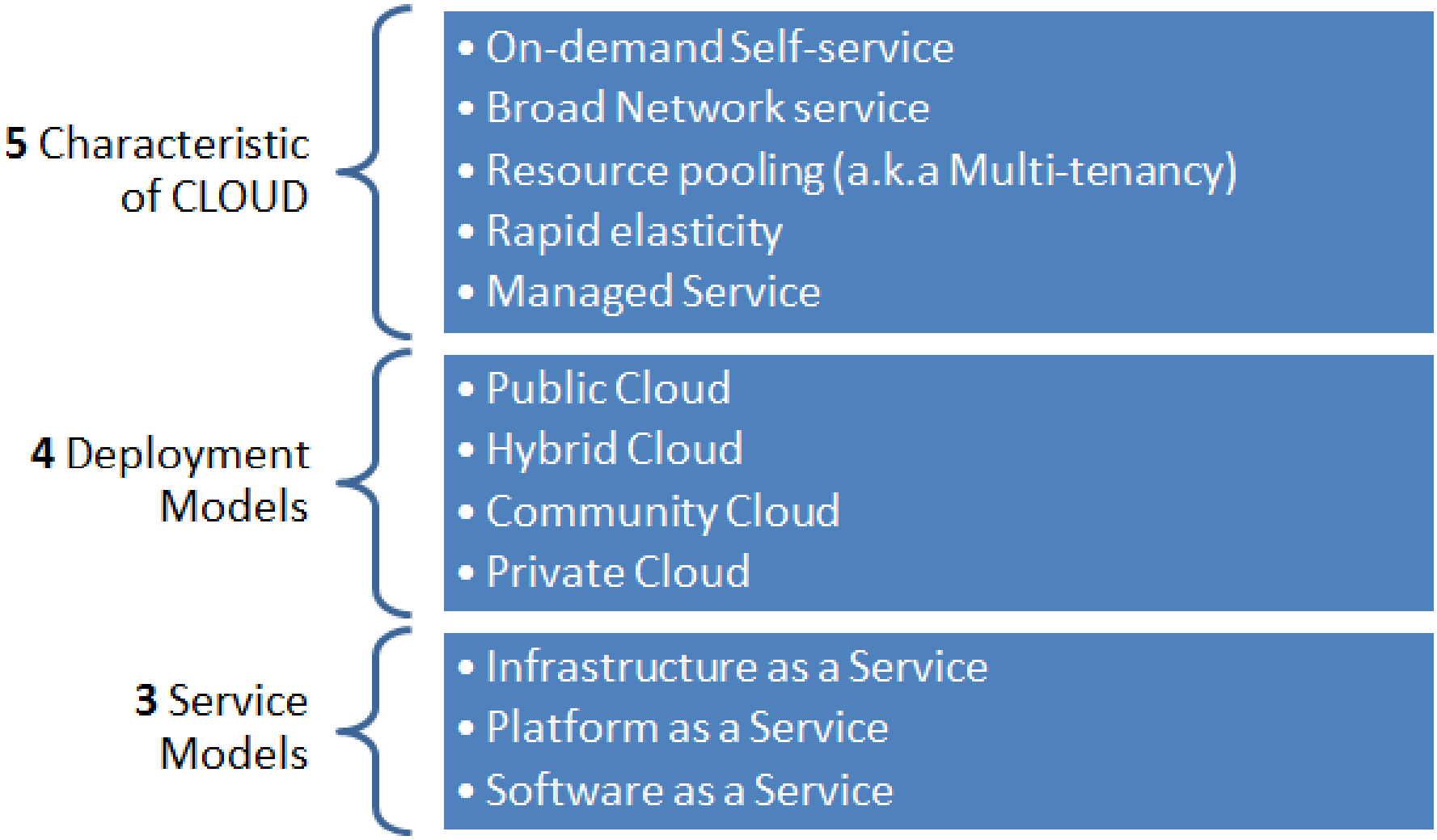
- Cloud is a parallel and distributed computing system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements (SLA) established through negotiation between the service provider and consumers.”

Cloud Computing Definition

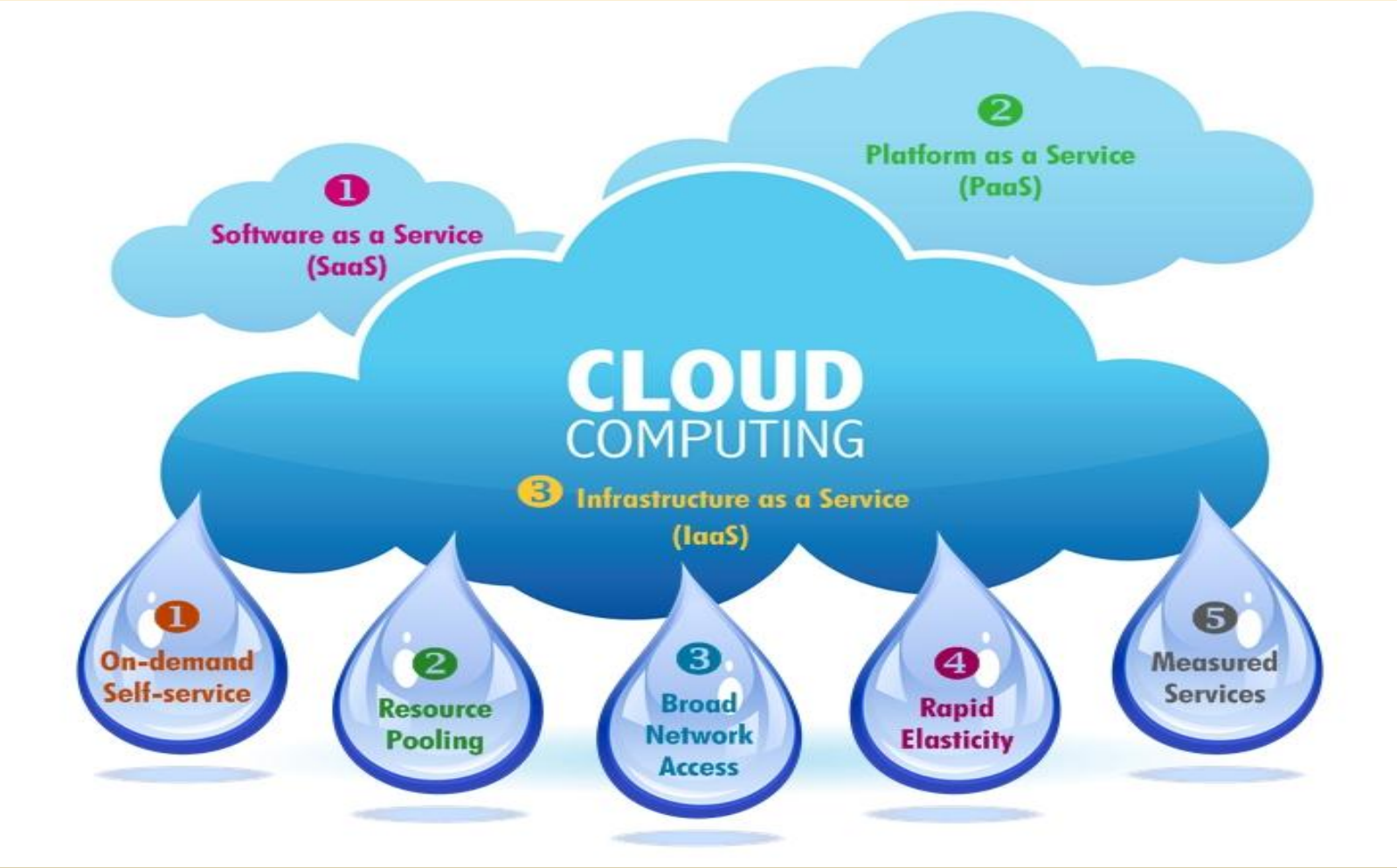
- Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization.
- This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized Service Level Agreements.”

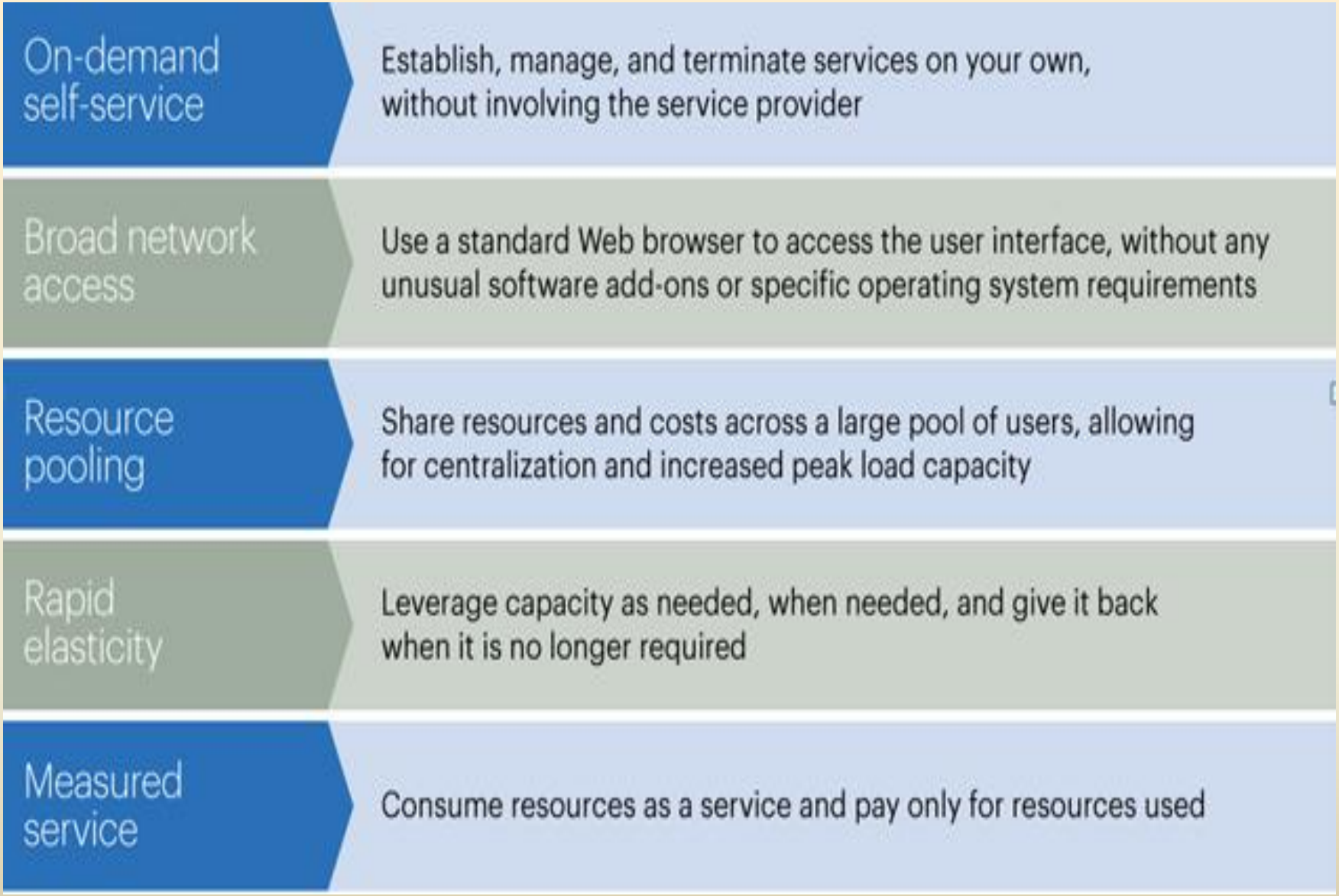
Cloud Architecture




5 Characteristic of CLOUD
• On-demand Self-service
• Broad Network service
• Resource pooling (a.k.a Multi-tenancy)
• Rapid elasticity
• Managed Service
4 Deployment Models
• Public Cloud
• Hybrid Cloud
• Community Cloud
• Private Cloud
3 Service Models
• Infrastructure as a Service
• Platform as a Service
• Software as a Service

Characteristics Of Cloud Computing




On-demand self-service
Establish, manage, and terminate services on your own, without involving the service provider
Broad network access
Use a standard Web browser to access the user interface, without any unusual software add-ons or specific operating system requirements
Resource pooling
Share resources and costs across a large pool of users, allowing for centralization and increased peak load capacity
Rapid elasticity
Leverage capacity as needed, when needed, and give it back when it is no longer required
Measured service
Consume resources as a service and pay only for resources used

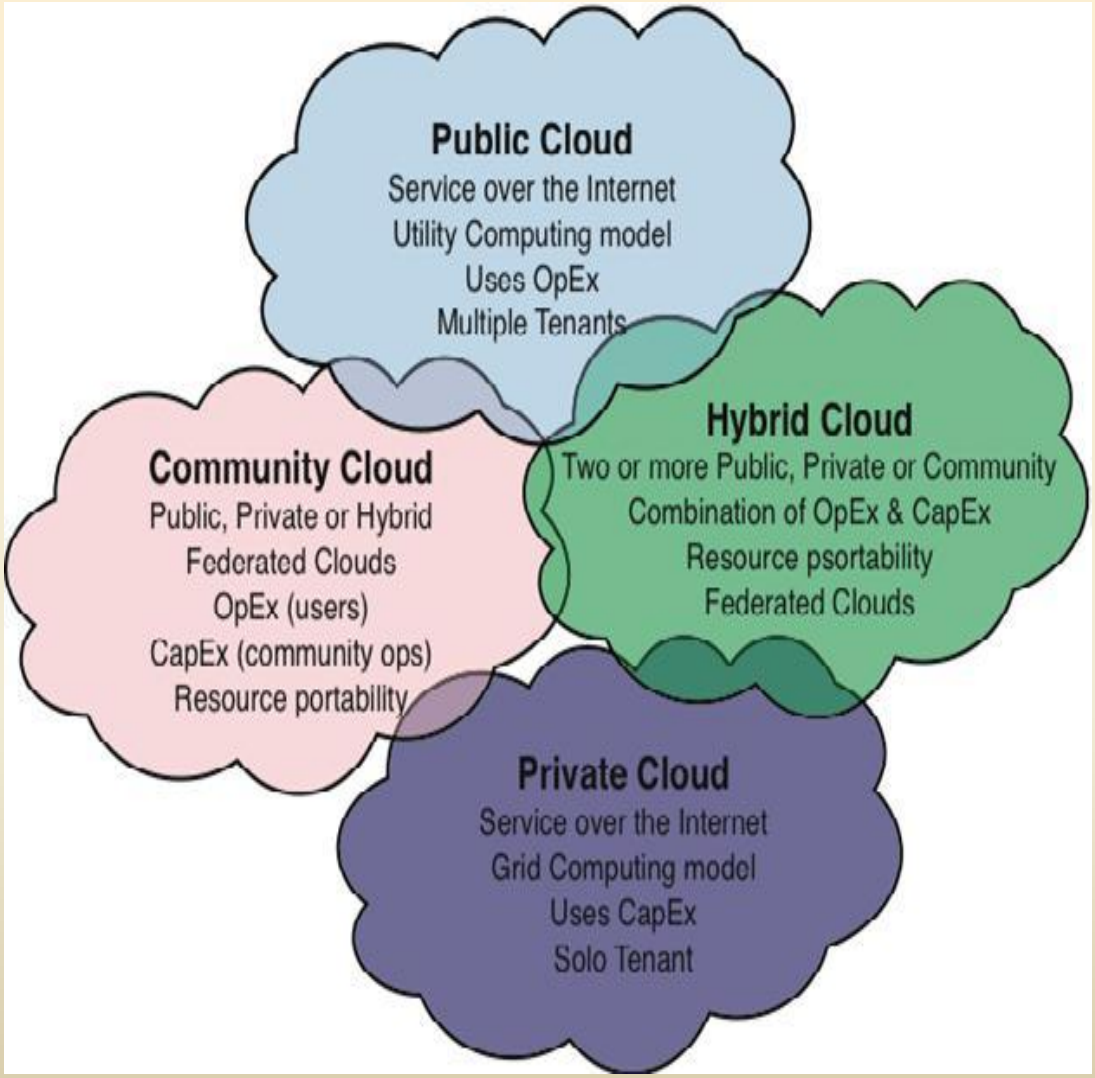
Cloud Deployment models

- The concept of cloud computing has evolved from cluster, grid and utility computing.
- Cluster and grid computing leverage the use of many computers in parallel to solve problems of any size.
- Utility and Software as a Service (SaaS) provide computing resource as a service with notation of pay per use.
- Cloud computing is a high throughput computing (HTC) paradigm whereby the infrastructure provides the service through a large data centre or server farms.
- The cloud computing model enables users to share to resources from anywhere at any time through their connected devices.
- All computations in cloud applications are distributed to servers in a data centre, cloud platforms are systems distributed through virtualization.

Cloud Deployment Models

The major cloud deployment models are

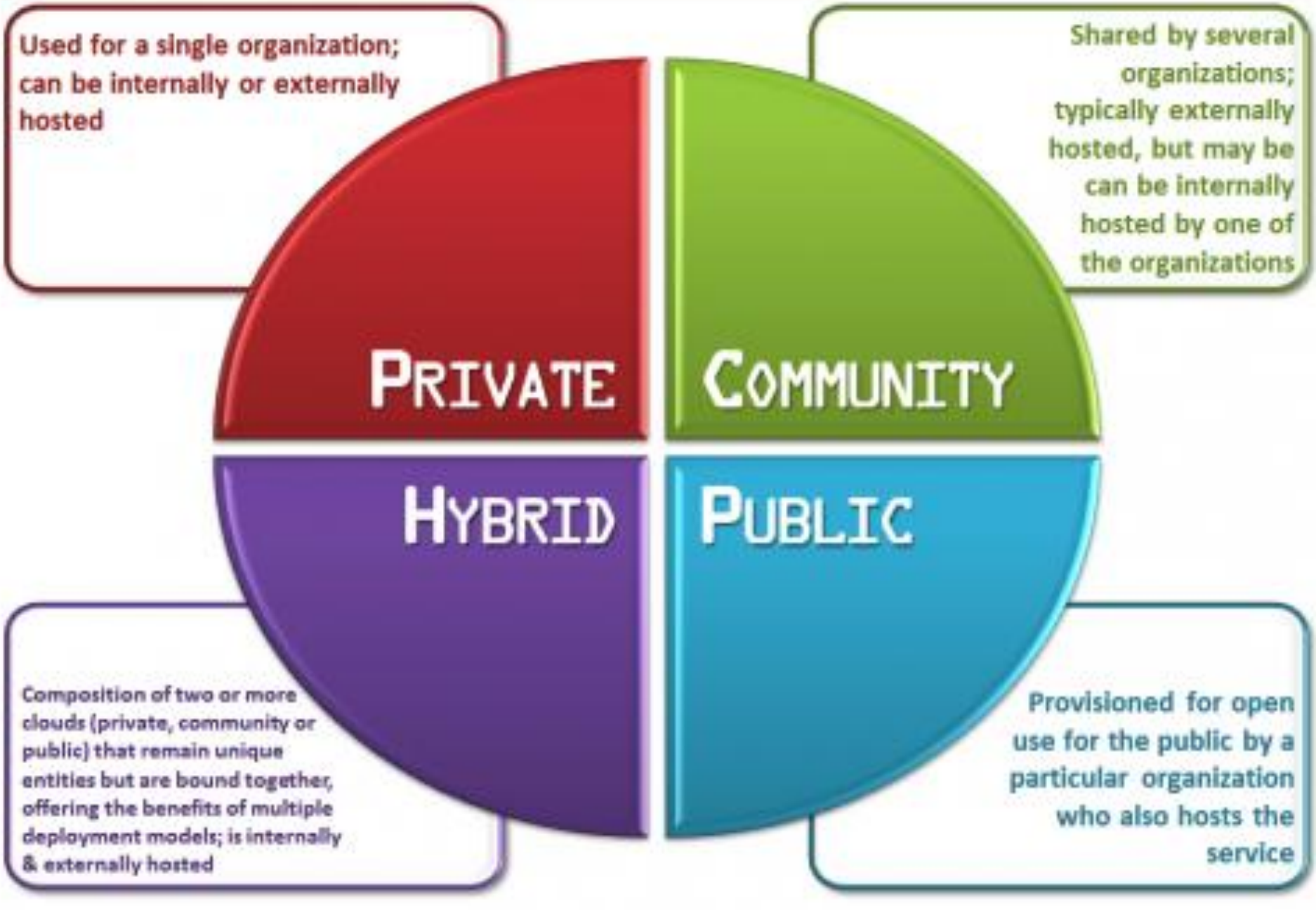
1. Public Cloud
2. Private Cloud,
3. Hybrid Cloud
4. Community Cloud

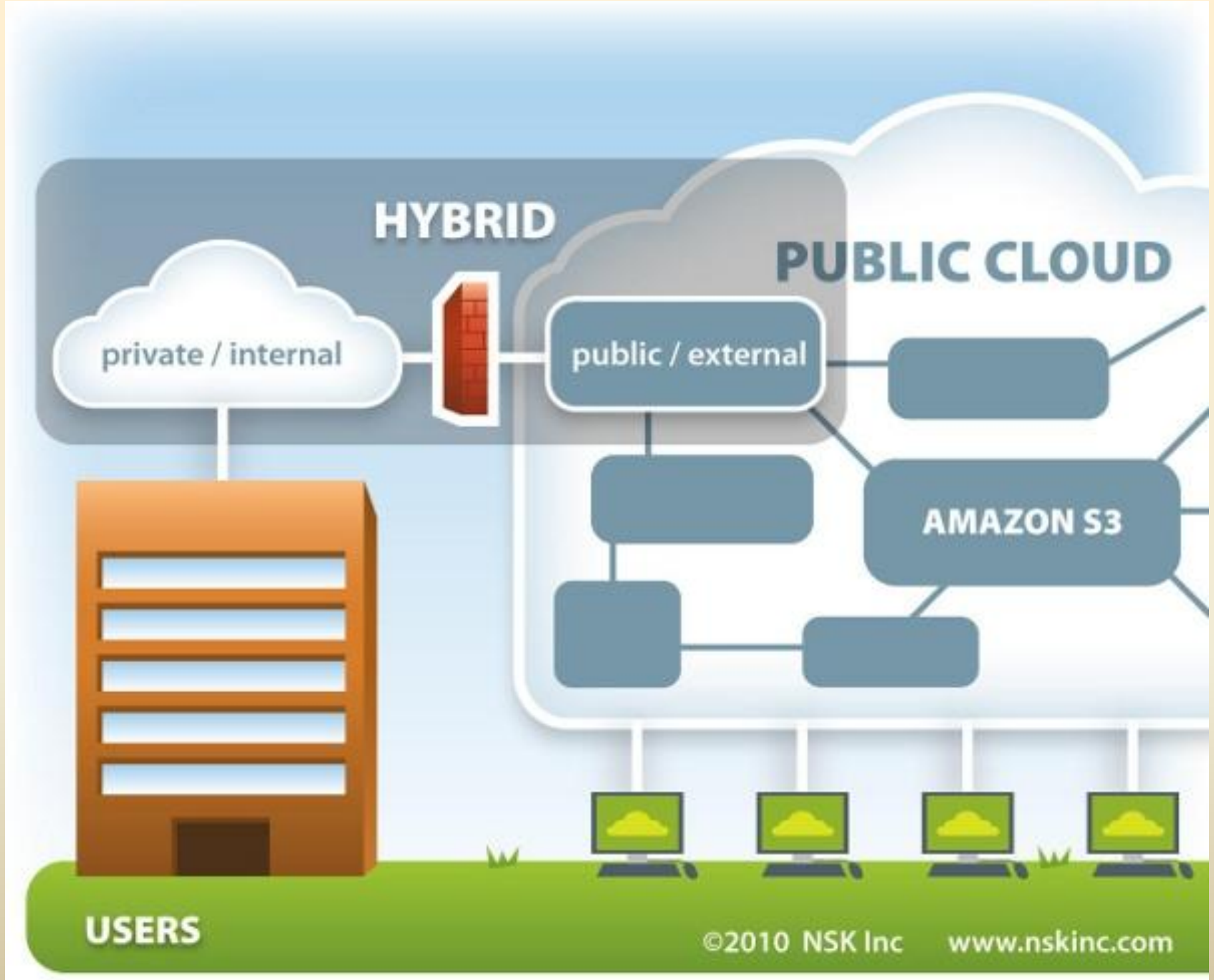


Deployment Models

- **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.
- **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).


Used for a single organization; can be internally or externally hosted
PRIVATE
Shared by several organizations; typically externally hosted, but may be can be internally hosted by one of the organizations
COMMUNITY
HYBRID
Composition of two or more clouds (private, community or public) that remain unique entities but are bound together, offering the benefits of multiple deployment models; is internally & externally hosted
PUBLIC
Provisioned for open use for the public by a particular organization who also hosts the service


HYBRID
PUBLIC CLOUD
private / internal
public / external
AMAZON S3
USERS
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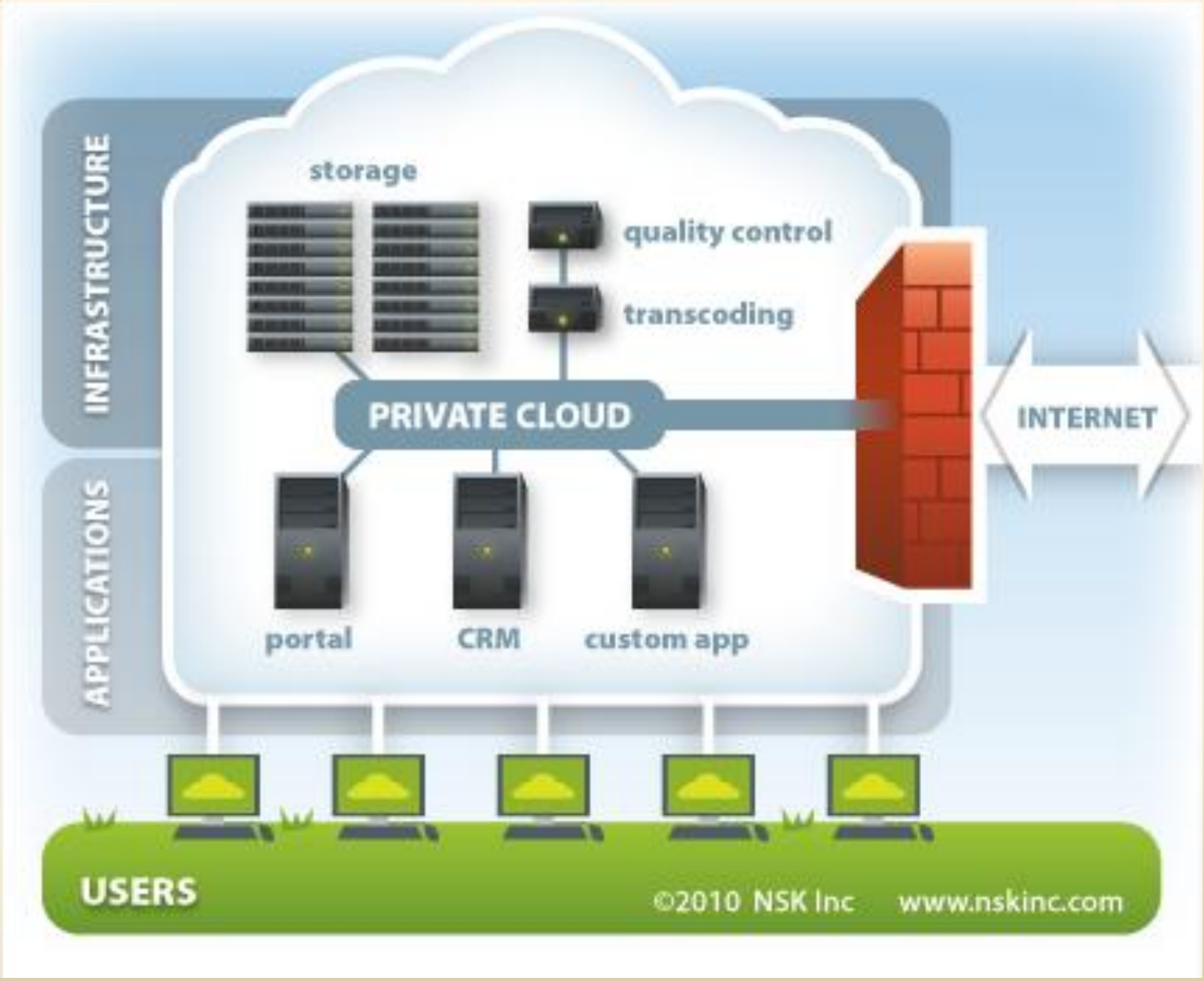
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	Managed* By	Owned By	Located*	Accessible and Consumed By
Public	Third Party Provider	Third Party Provider	External Internal	Trusted or Untrusted
Private	Organization	Organization Third Party Provider	Internal External	Trusted
Hybrid	Organization or Third Party Provider	Organization or Third Party Provider	External and Internal	Trusted or Untrusted

**Management includes: operations, security, compliance, etc...*
Location is both physical and relative to and Organization's management umbrella

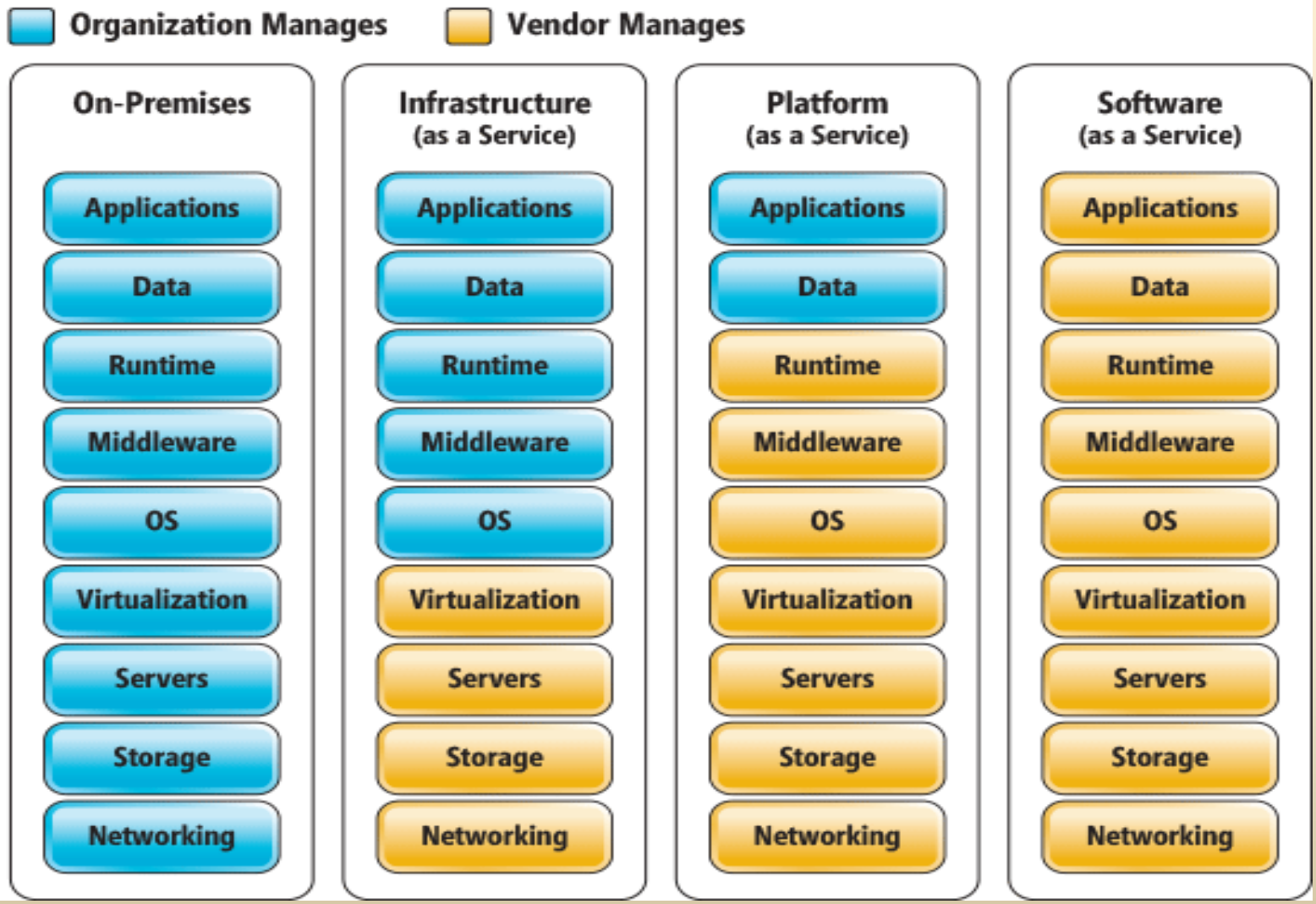
PUBLIC vs. PRIVATE vs. HYBRID
CLOUD STORAGE

Characteristic	Public cloud storage	Private cloud storage	Hybrid cloud storage
Scalability	Very high	Limited	Very high
Security	Good, but depends on the security measures of the service provider	Most secure, as all storage is on-premise	Very secure; integration options add an additional layer of security
Performance	Low to medium	Very good	Good, as active content is cached on-premise
Reliability	Medium; depends on Internet connectivity and service provider availability	High, as all equipment is on premise	Medium to high, as cached content is kept on-premise, but also depends on connectivity and service provider availability
Cost	Very good; pay-as-you-go model and no need for on-premise storage infrastructure	Good, but requires on-premise resources, such as data center space, electricity and cooling	Improved, since it allows moving some storage resources to a pay-as-you-go model

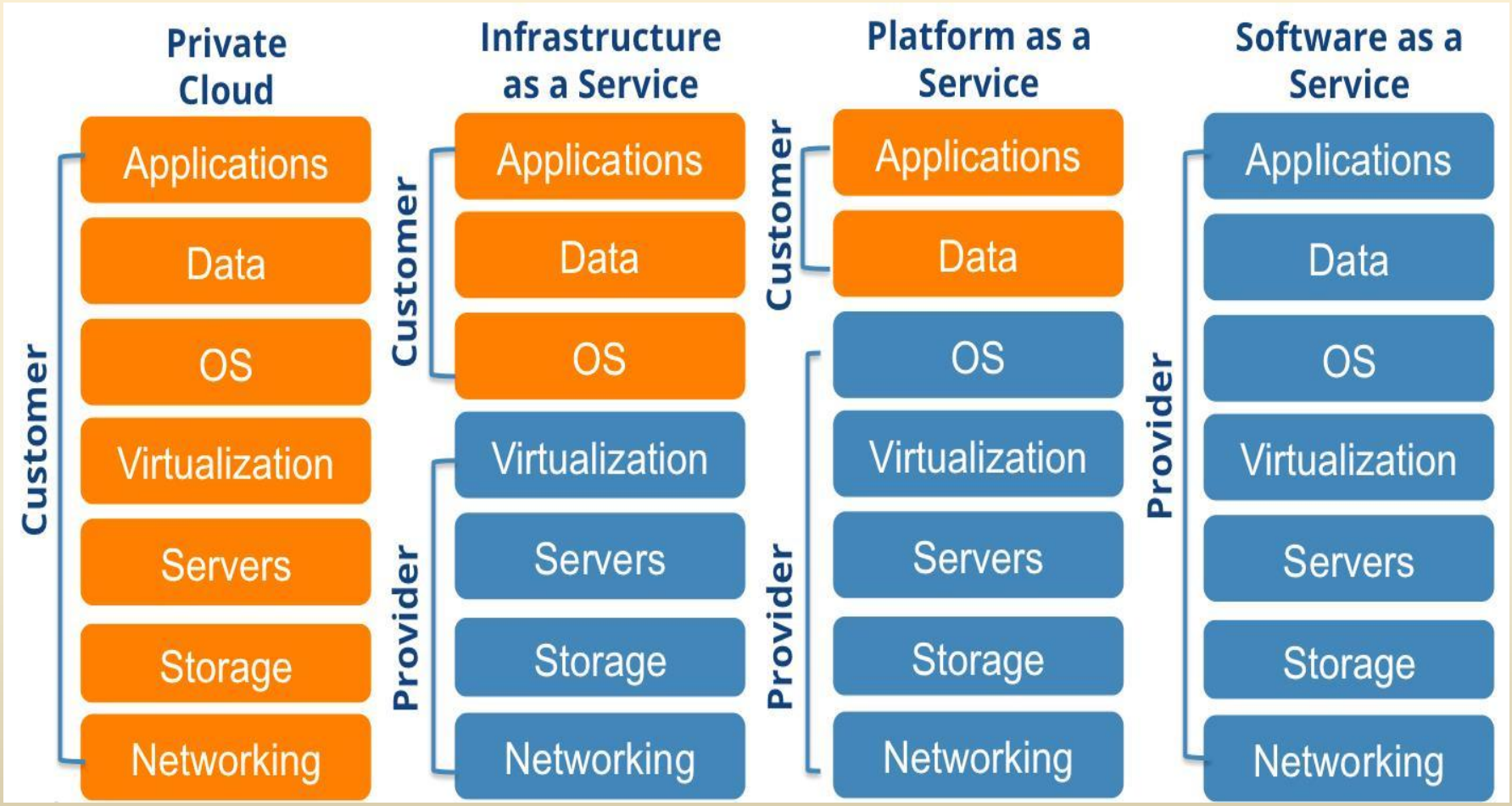
Service Models

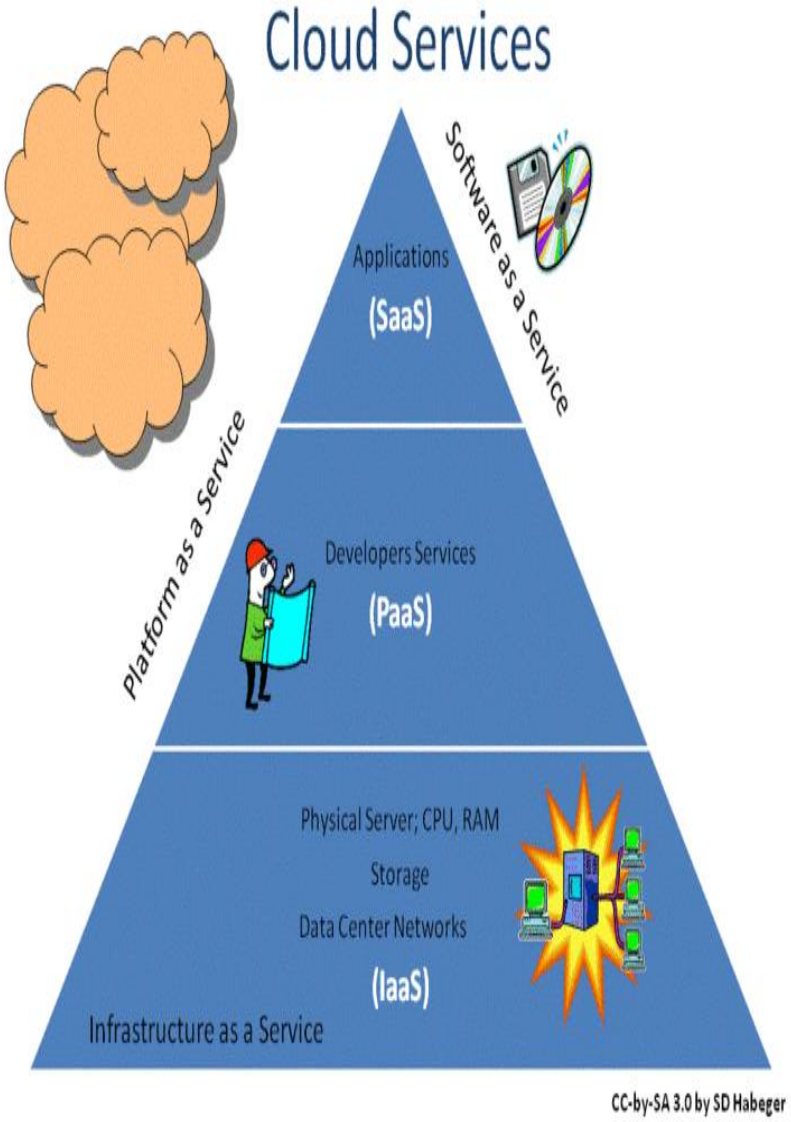
- Software as a Service (SaaS).
- Platform as a Service (PaaS).
- Infrastructure as a Service (IaaS).

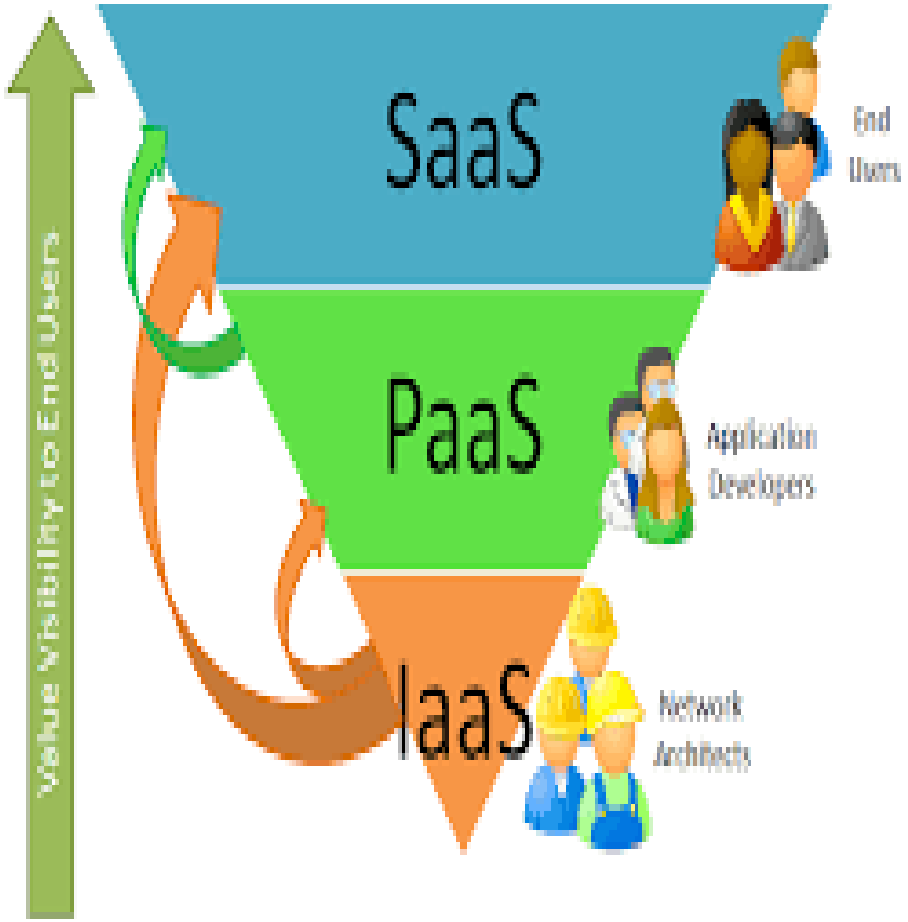
Cloud service models offer customers varying levels of control over assets and services, which presents performance visibility challenges.



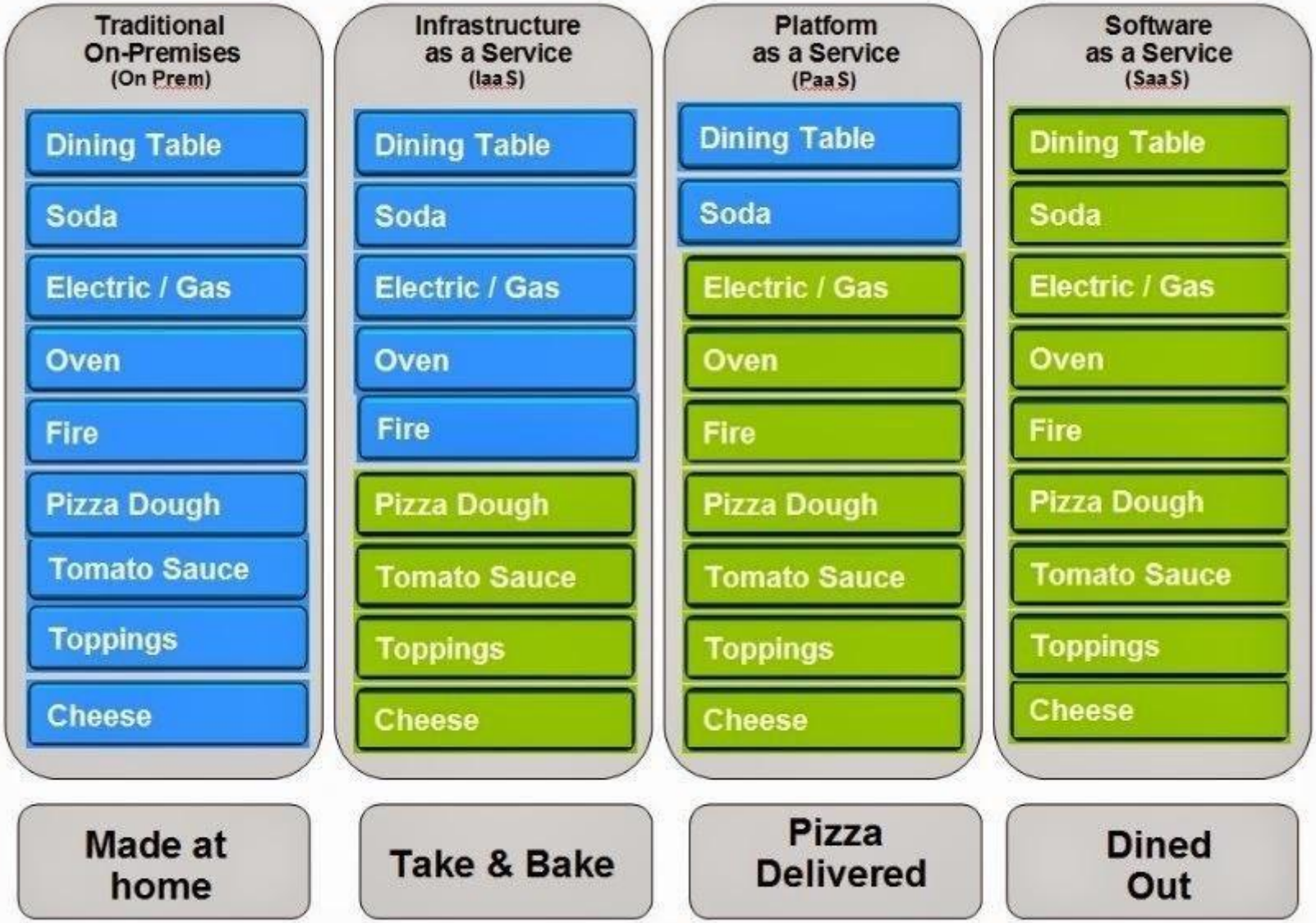
The platform and ecosystem views of cloud computing represent a new paradigm, and promote a new way of computing.

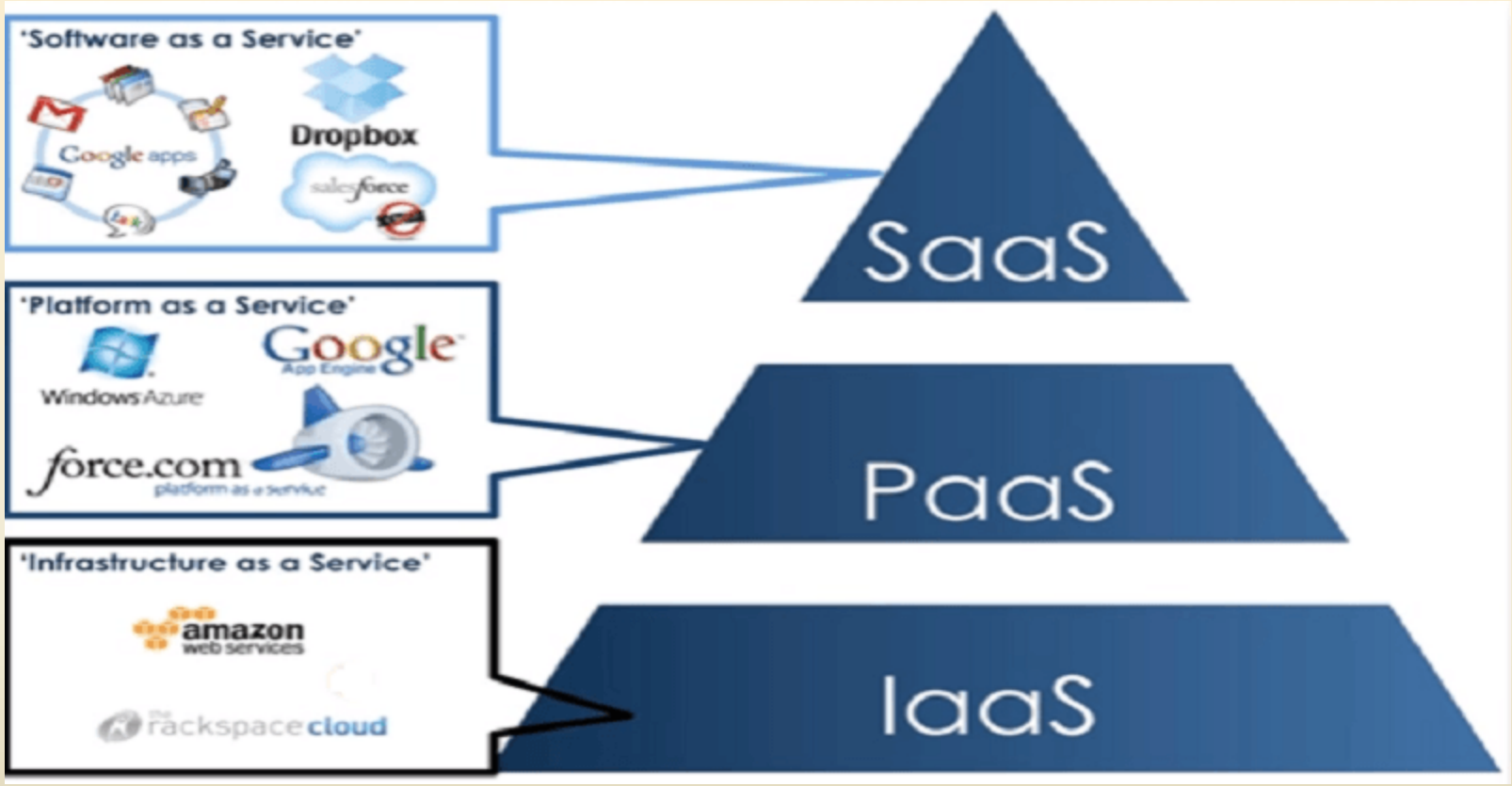



Cloud Services
Applications
(SaaS)
Software as a Service
Platform as a Service
Developers Services
(PaaS)
Physical Server; CPU, RAM
Storage
Data Center Networks
(IaaS)
Infrastructure as a Service
CC-by-SA 3.0 by SD Habeger


Value Visibility to End Users
SaaS
End Users
PaaS
Application Developers
IaaS
Network Architects

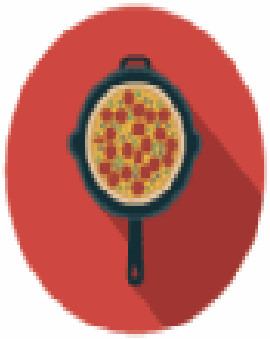
Pizza as a Service




'Software as a Service'
Google apps
Dropbox
salesforce
'Platform as a Service'
Windows Azure
Google
App Engine
force.com
platform as a service
'Infrastructure as a Service'
amazon
web services
rackspace cloud
SaaS
PaaS
IaaS

Pizza as a service

The variety of cloud services can obfuscate the level of an organization's ownership of the stack. Albert Barron, executive software client architect at IBM, uses this analogy to provide clarity:



ON-PREMISES MANAGEMENT

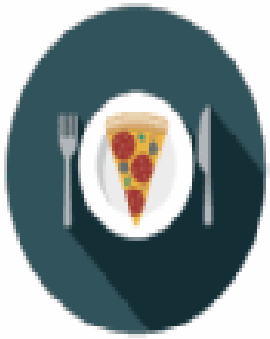
Making a pizza at home

IAAS

Take-and-bake service

PAAS

Delivery



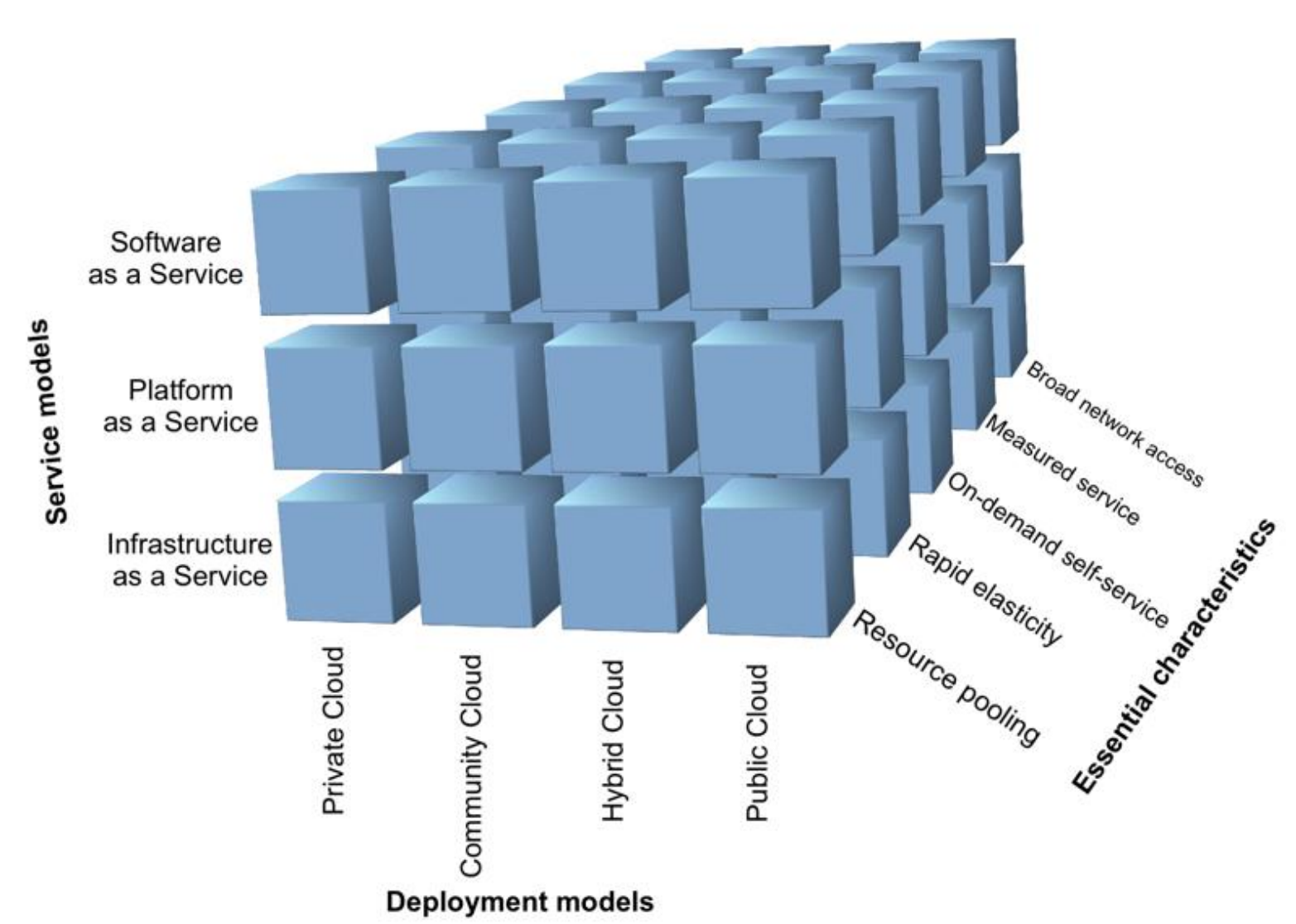
SAAS

Eat-in restaurant

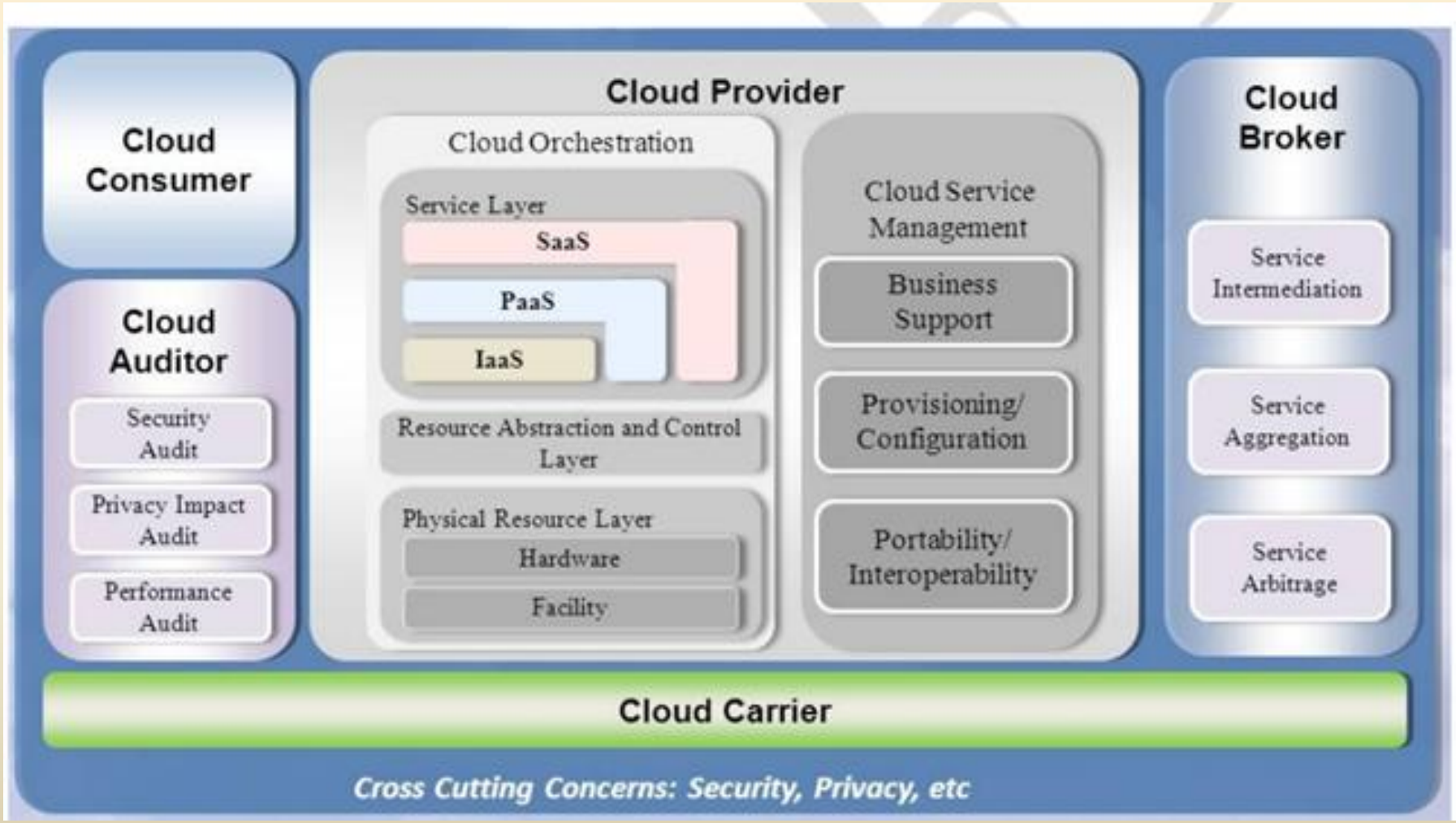
NIST DEFINITOIN

- 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.

NIST Cloud Model



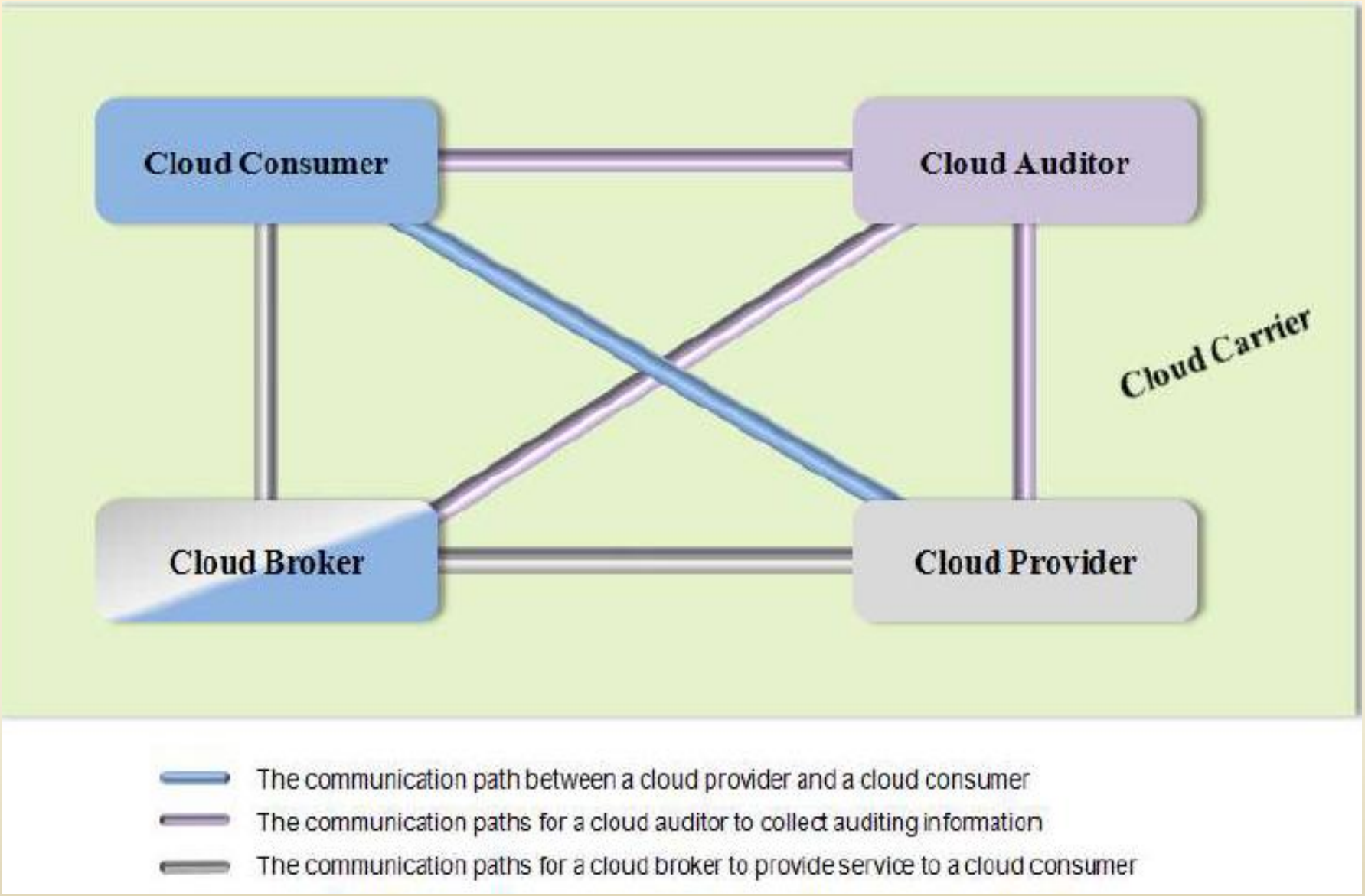
Cloud Computing Architecture



The Conceptual Reference Model

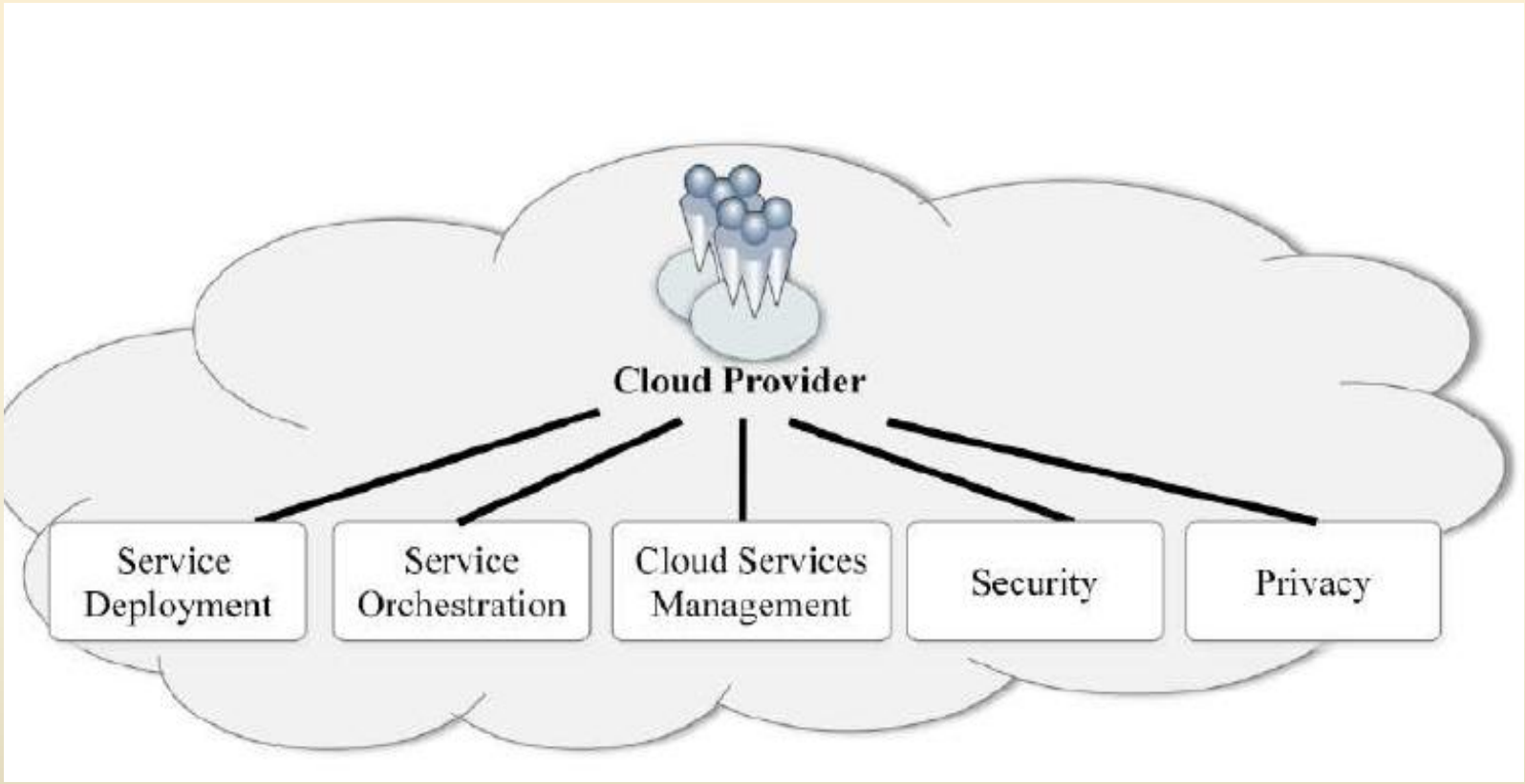
NIST Cloud Agents

- **Cloud Consumer** A person or organization that maintains a business relationship with, and uses service from, Cloud Provider
- **Cloud Provider** A person, organization, or entity responsible for making a service available to interested parties.
- **Cloud Auditor** A party that can conduct independent assessment of cloud services, information system operations, performance and security of the cloud implementation.
- **Cloud Broker** An entity that manages the use, performance and delivery of cloud services, and negotiates relationships between Cloud Providers and Cloud Consumers.
- **Cloud Carrier** An intermediary that provides connectivity and transport of cloud services from Cloud Providers to Cloud Consumers.

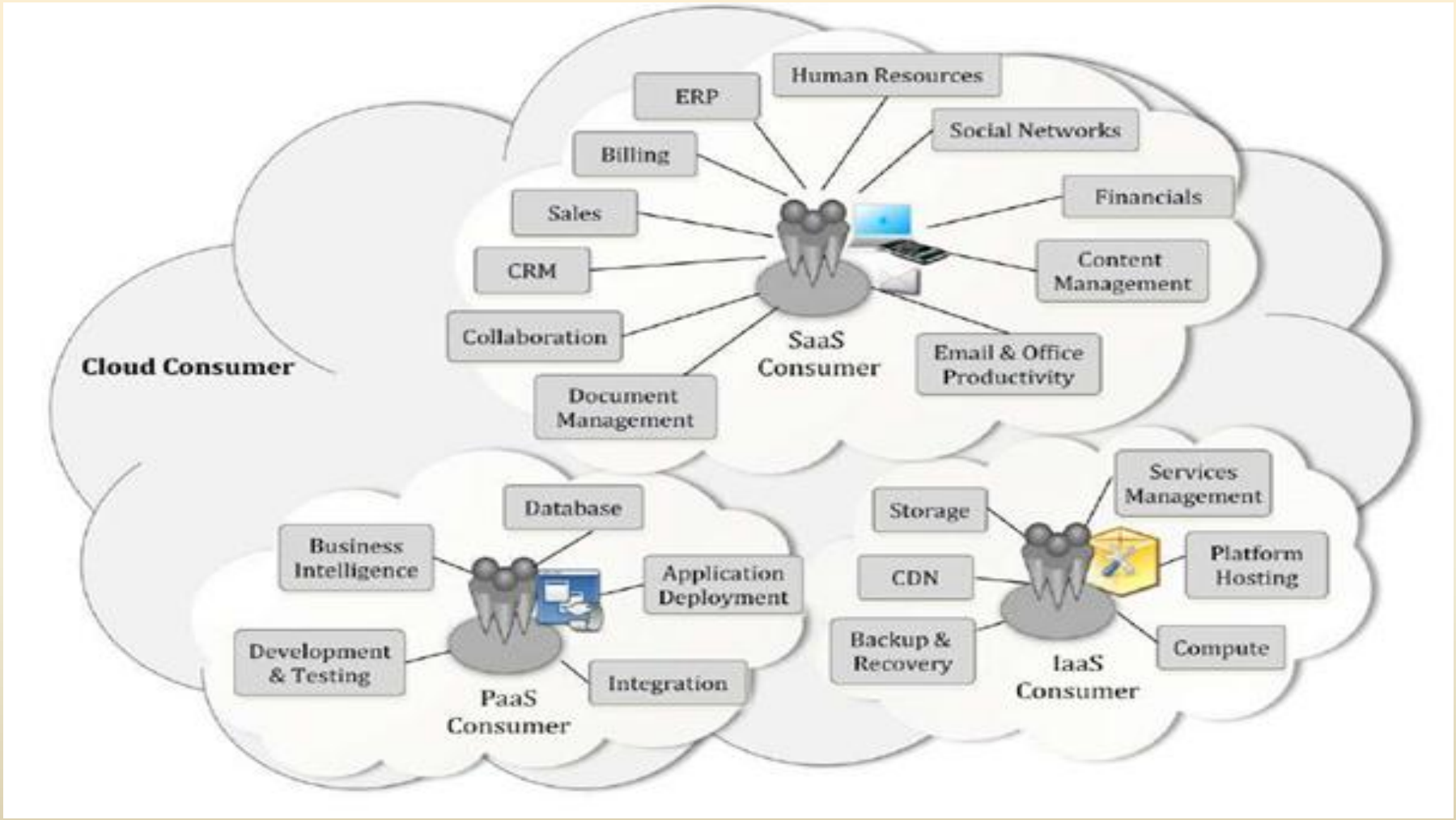


Interactions between the Actors in Cloud Computing

CLOUD PROVIDER

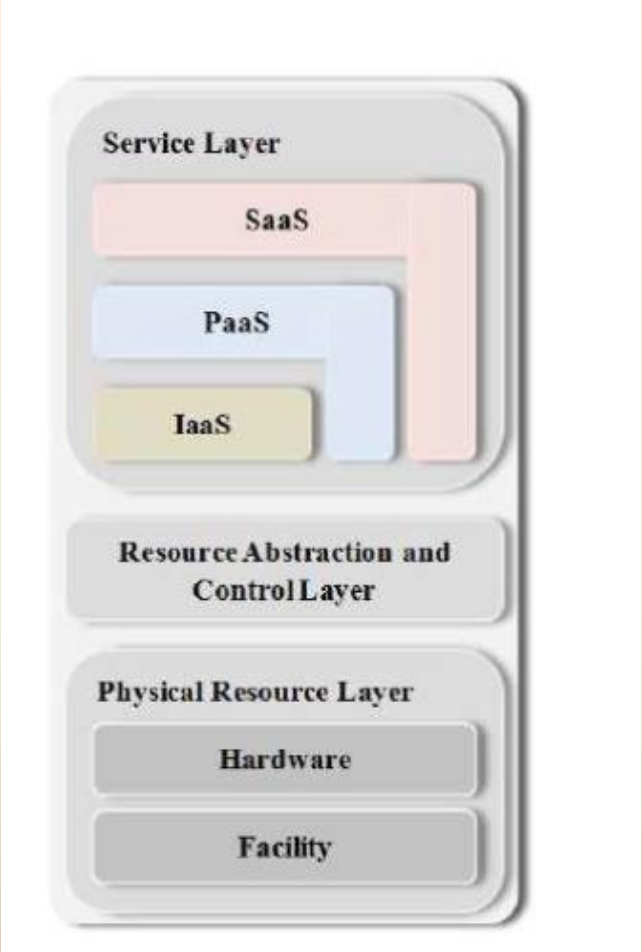


CLOUD CONSUMER

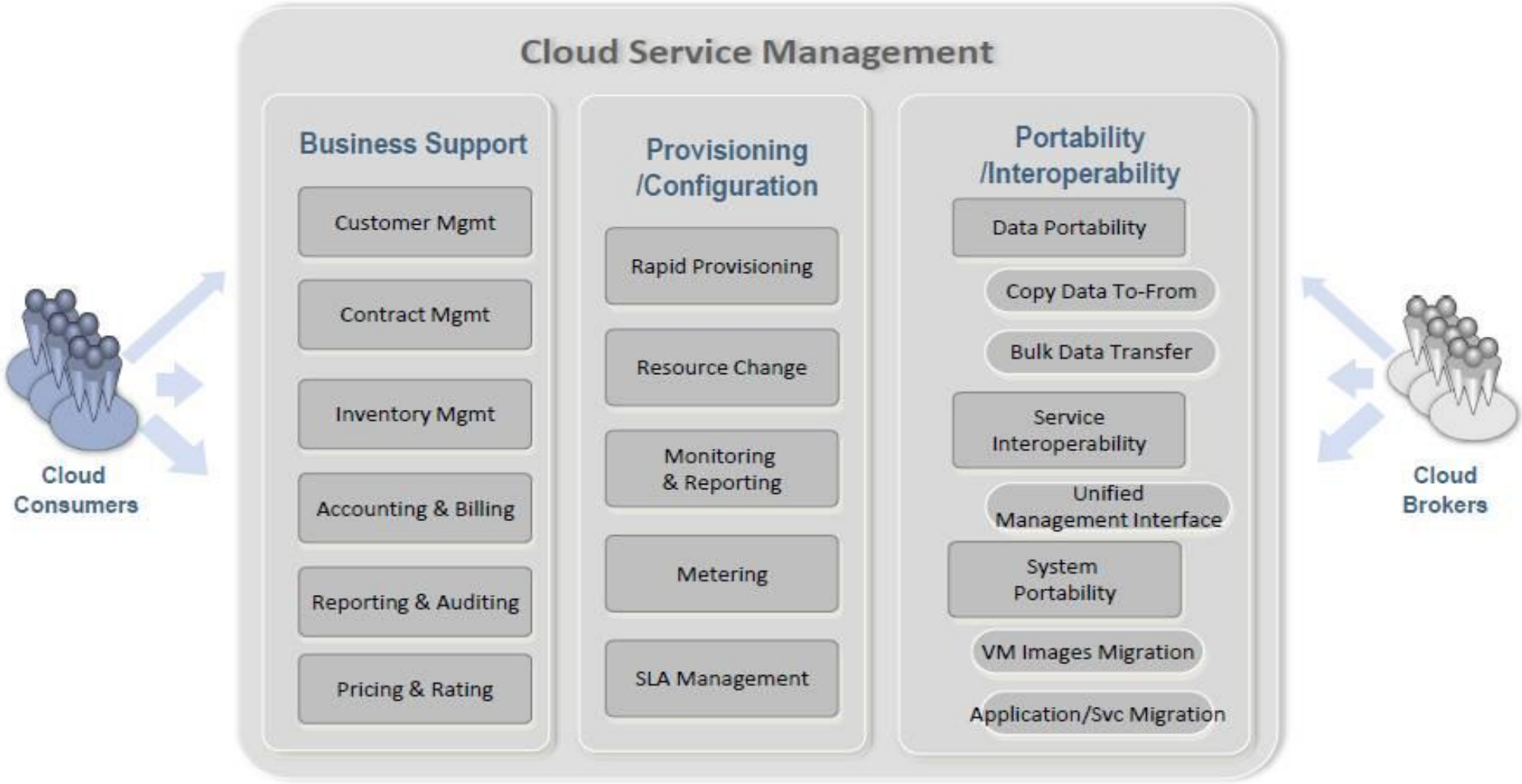


Example Service Available to a Cloud Consumer

Cloud Provider
Service Orchestration

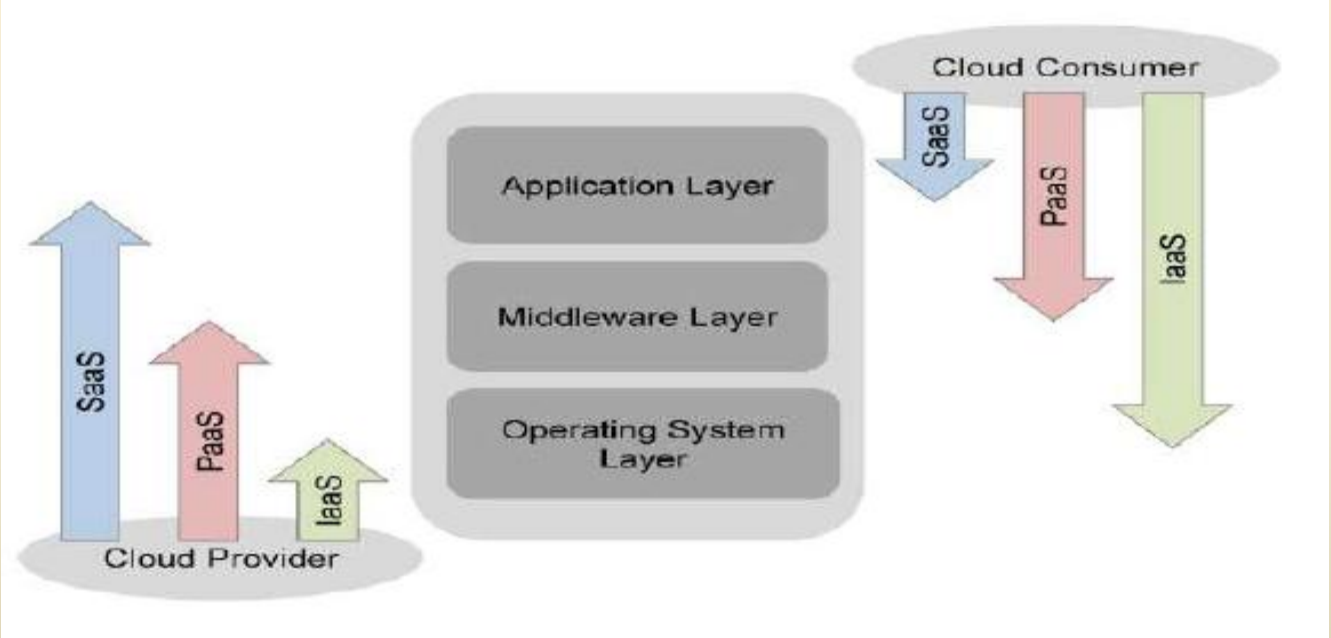


Cloud Provider
Cloud Service Management



Cloud Carrier

- provides connectivity and transport of cloud services between cloud consumers and cloud
- providers (network, telecommunication, access devices)



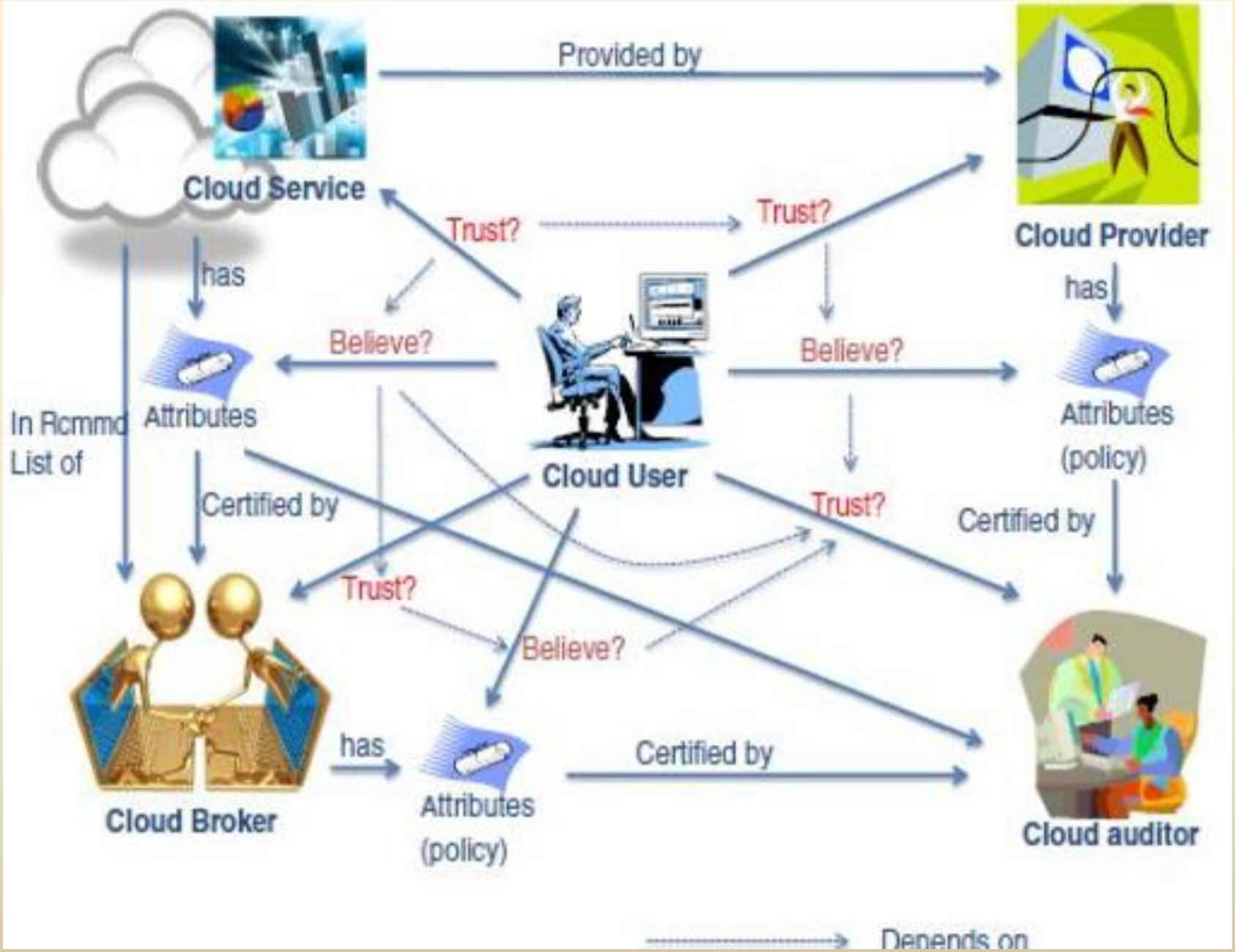
Scope Of Control between Provider and Consumer

Cloud Auditor

=>Security controls, Privacy impact, Performance

Cloud Broker

=> Intermediation, Aggregation, Arbitrage


Provided by
Cloud Service
Cloud Provider
Trust?
Trust?
has
has
Believe?
Believe?
Attributes
Attributes
(policy)
In Rcmmd
List of
Cloud User
Certified by
Certified by
Trust?
Trust?
Believe?
has
Certified by
Cloud Broker
Attributes
(policy)
Cloud auditor
Depends on

THANK YOU