Cloud Computing- Unit2

Course code:20CS4701C

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Cloud Computing Architecture

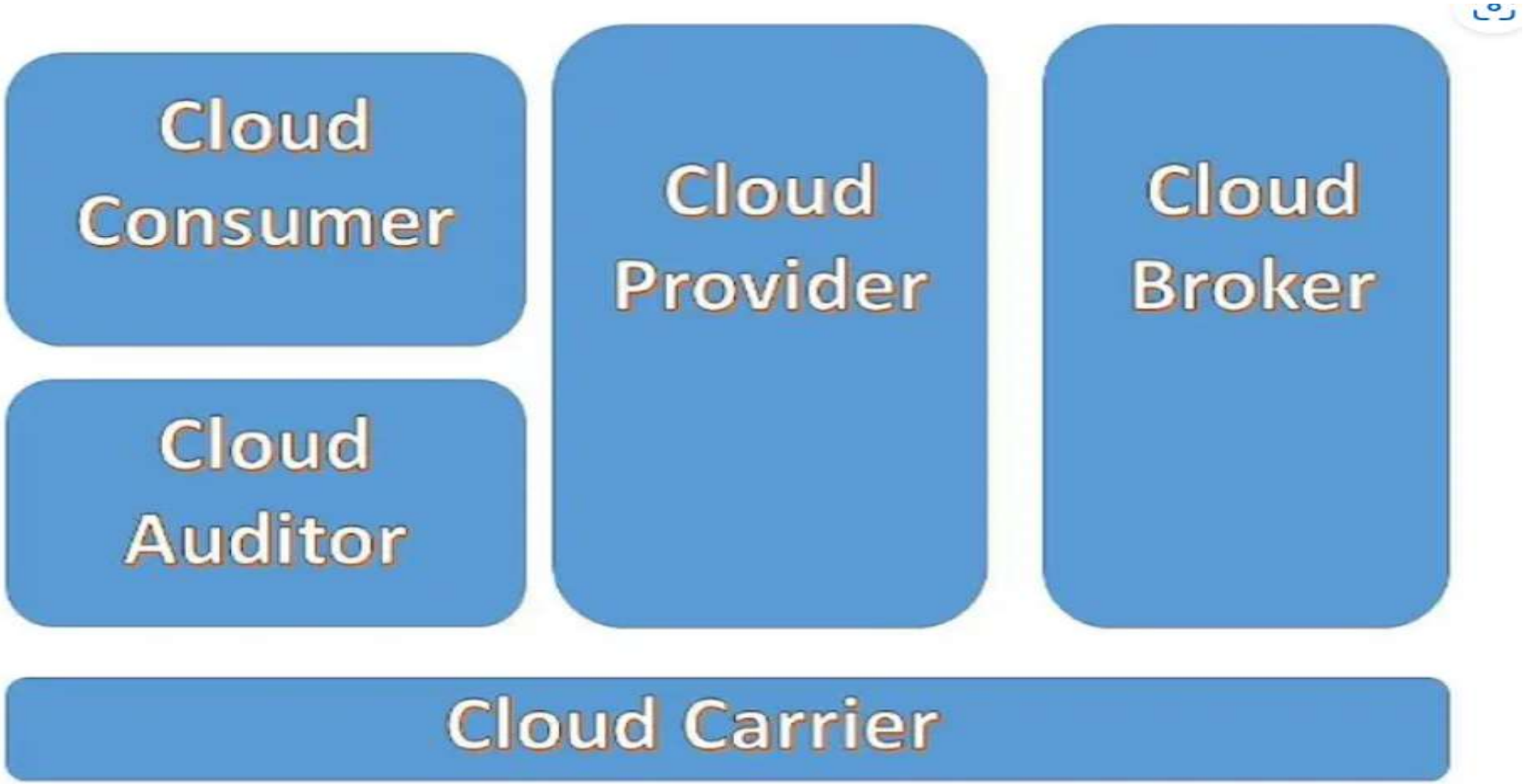
UNIT-2

Cloud Computing Architecture

1. Cloud Reference Model ,
2. Architecture
3. Infrastructure as a Service
4. Platform as a Service
5. Software as a Service
6. **Types of Clouds**

- ❖Public Clouds
- ❖Private Clouds
- ❖Hybrid Clouds
- ❖Community Clouds.

Cloud Reference Model



1.Cloud Reference Model

- Cloud computing reference model is an abstract model that divides a cloud computing environment into abstraction layers and cross-layer.

- This reference model divides cloud computing activities and functions into three cross-layer functions and five logical layers.

- Each of these layers describes different things that might be present in a cloud computing environment, such as computing systems,
- The five layers are the Physical layer, virtual layer, control layer, orchestration layer, and service layer.
- Activities are Interactions Between Actors in Cloud Computing in Cloud Security Reference Model

- Identifies the major actors, their activities and functions in cloud computing.
- The diagram depicts a generic high-level architecture and is intended to facilitate the understanding of the requirements, uses, characteristics and standards of cloud computing.

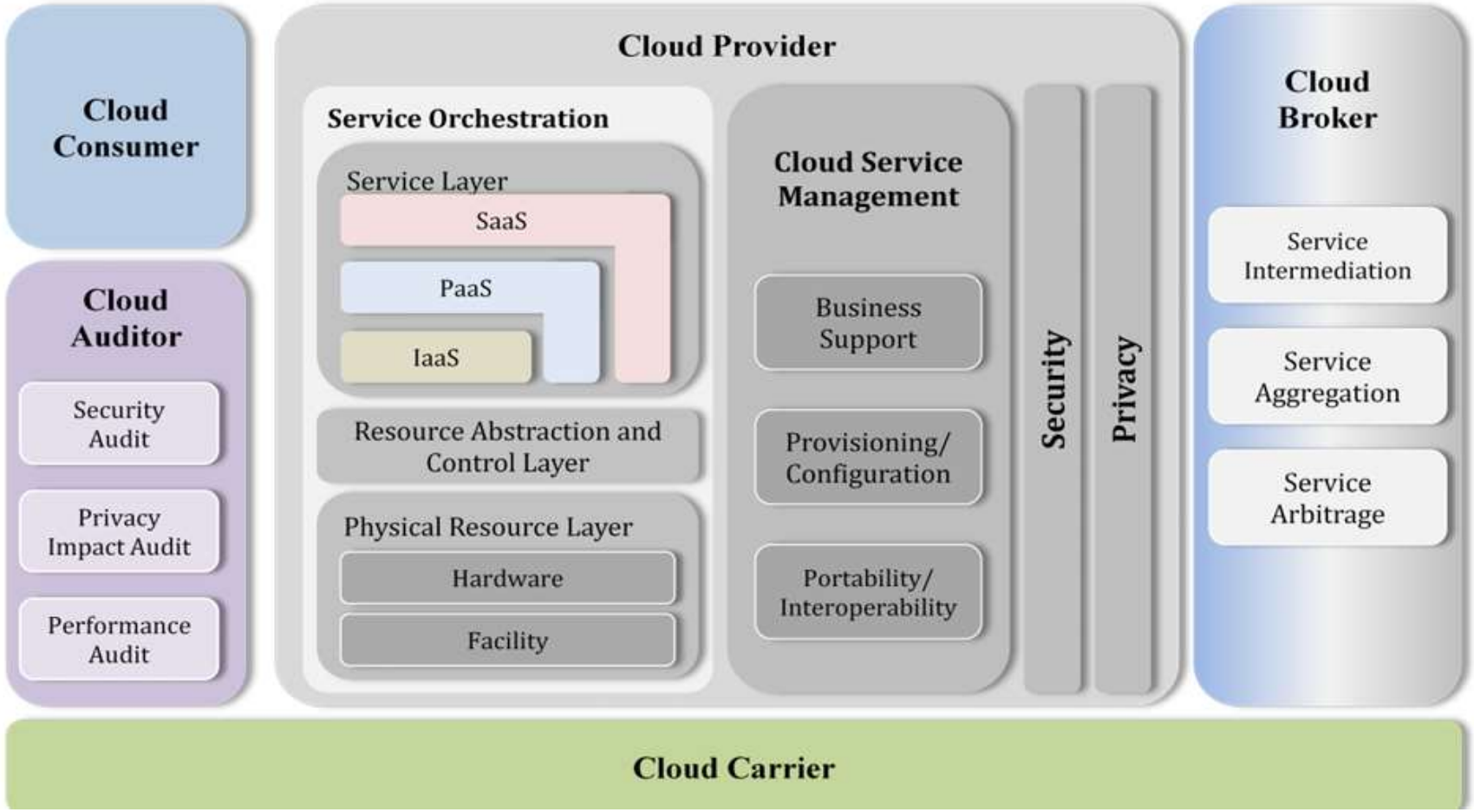


Fig: Cloud Computing Reference Architecture

Table 1 briefly lists the actors defined in the NIST cloud computing reference architecture

Actor	Definition
Cloud Consumer	A person or organization that maintains a business relationship with, and uses service from, *Cloud Providers*.
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*.

Table 1: Actors in Cloud Computing

A cloud consumer may request cloud services from a cloud provider directly or via a cloud broker.

A cloud auditor conducts independent audits and may contact the others to collect necessary information

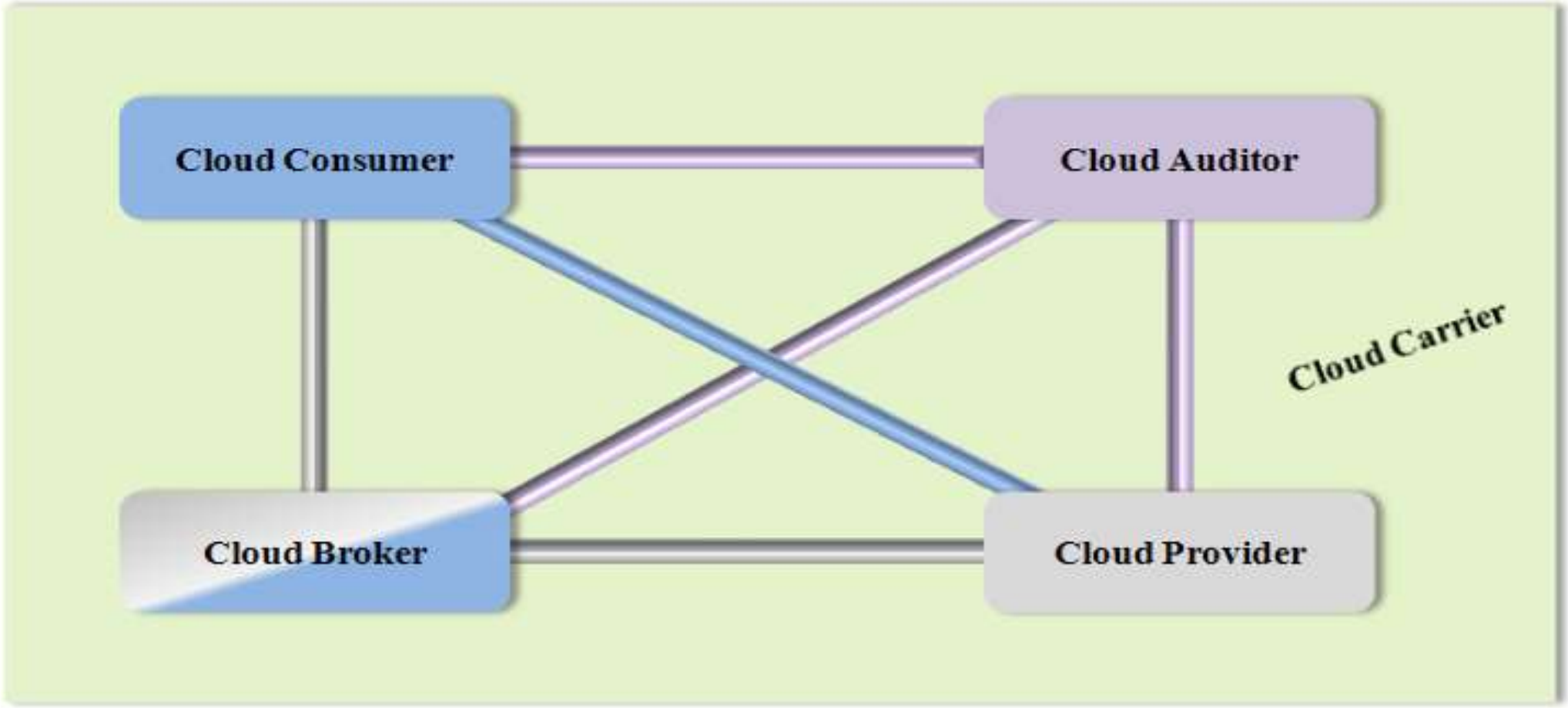


Fig: Interactions between the Actors in Cloud Computing

- A cloud consumer may request service from a cloud broker instead of contacting a cloud provider directly. The cloud broker may create a new service by combining multiple services or by enhancing an existing service.

Example 1 the actual cloud providers are invisible to the cloud consumer and the cloud consumer interacts directly with the cloud broker.

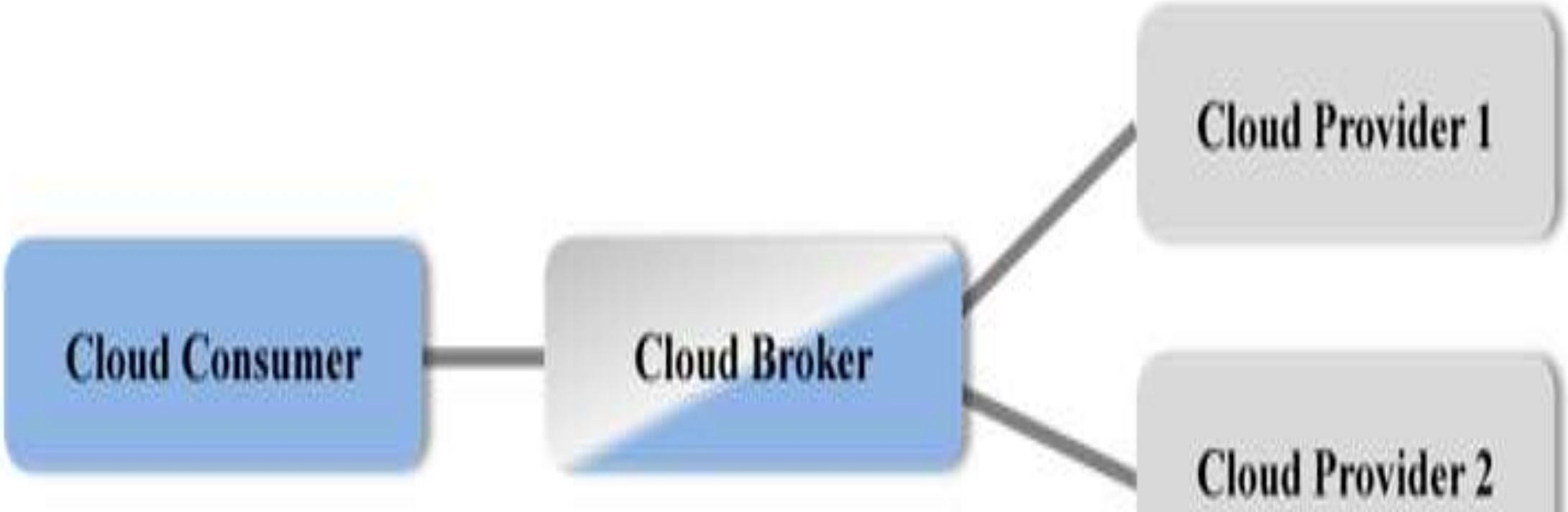


Fig : Usage Scenario for Cloud Brokers

Example 2

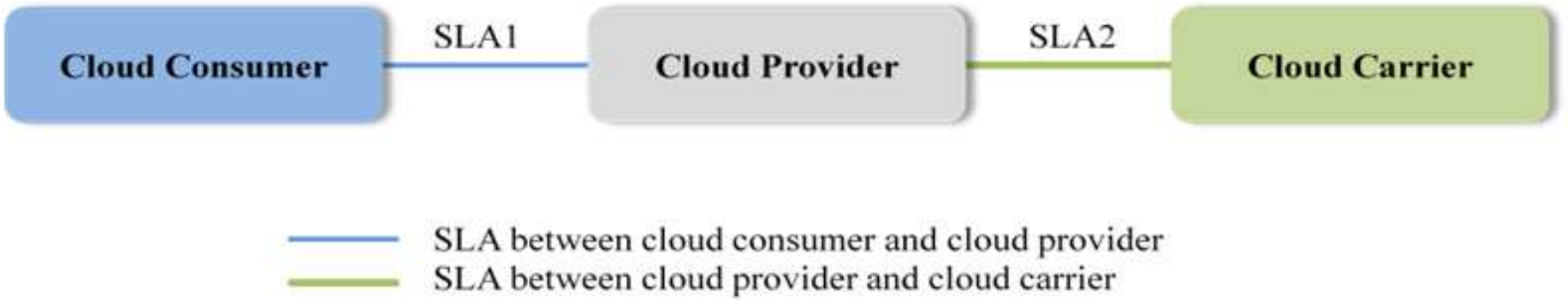


Fig: Usage Scenario for Cloud Carriers

A cloud provider participates in and arranges for two unique service level agreements (SLAs), one with a cloud carrier (e.g. SLA2) and one with a cloud consumer (e.g. SLA1).

A cloud provider arranges service level agreements (SLAs) with a cloud carrier and may request dedicated and encrypted connections to ensure the cloud services are consumed at a consistent level according to the contractual obligations with the cloud consumers.

Example 3

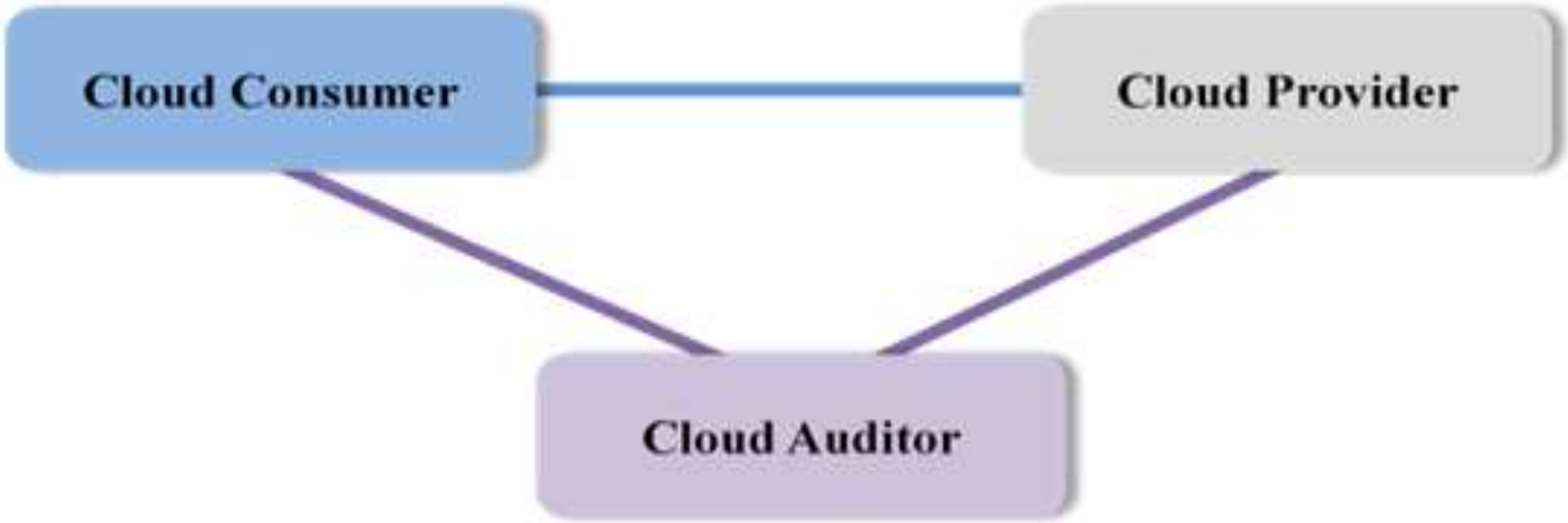


Fig: Usage Scenario for Cloud Auditors

A cloud auditor conducts independent assessments of the operation and security of the cloud service implementation.

The audit may involve interactions with both the Cloud Consumer and the Cloud Provider.

A cloud auditor

- A cloud auditor can assess a cloud provider's services in terms of performance, service level agreement compliance, privacy implications, and security controls.

- An organization called a "Cloud Broker" controls how cloud services are used, performed, and delivered and negotiates contracts between cloud providers and cloud users.

- The integration of cloud services could become too difficult for cloud consumers to handle as cloud computing develops

Cloud Brokers

provide services in three categories:

- **Intermediation:** By enhancing a certain feature and offering cloud consumers value-added services, a cloud broker improves a given service.

- **Aggregation:** Several services are combined and integrated into one or more new services by a cloud broker.

- **Arbitrage:** Like service aggregation, service arbitrage differs in that the services being integrated or aggregated are not fixed.

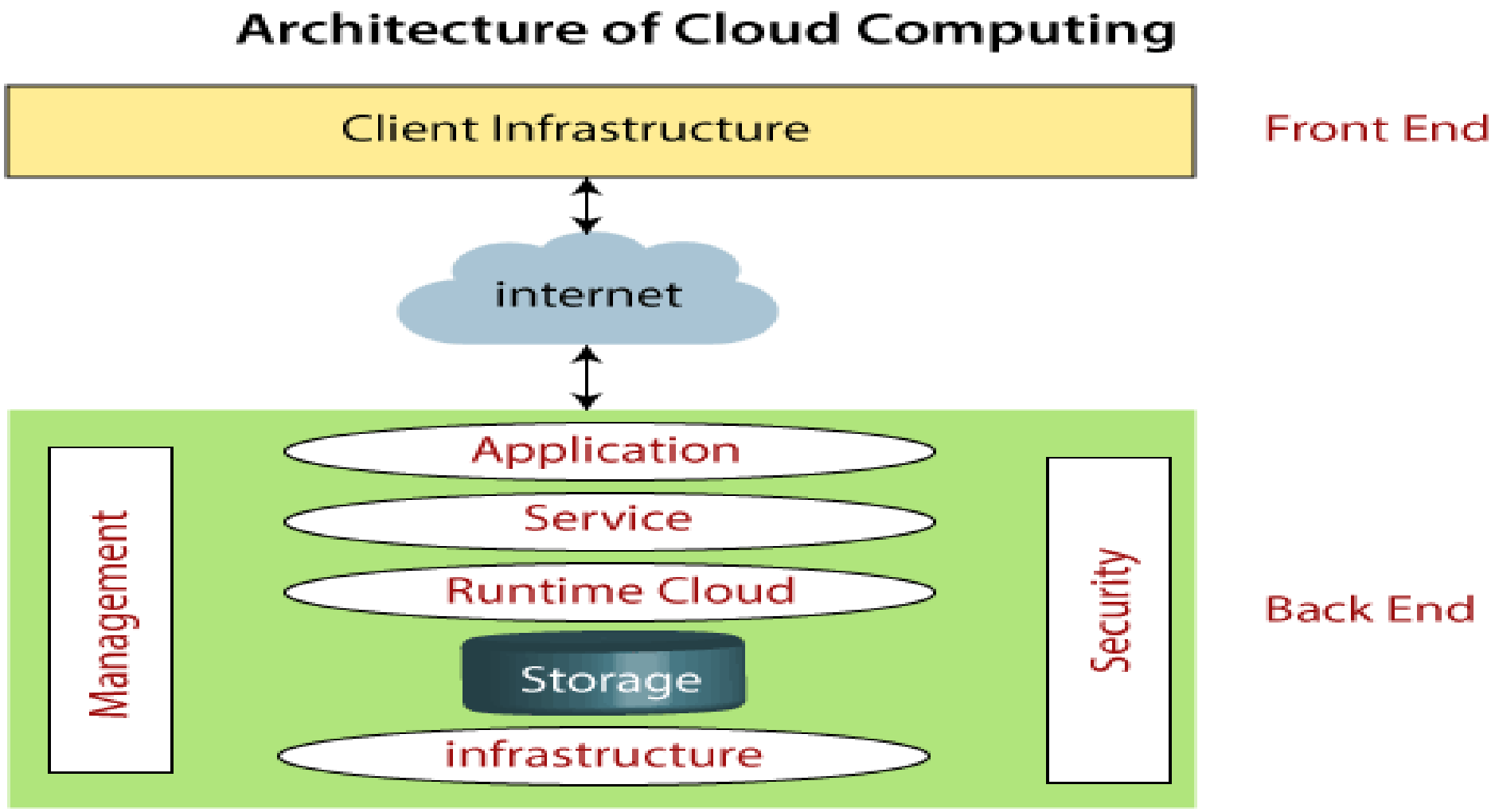
Cloud Computing Architecture

- Architecture of cloud computing is the combination of both SOA (Service Oriented Architecture) and EDA (Event Driven Architecture).

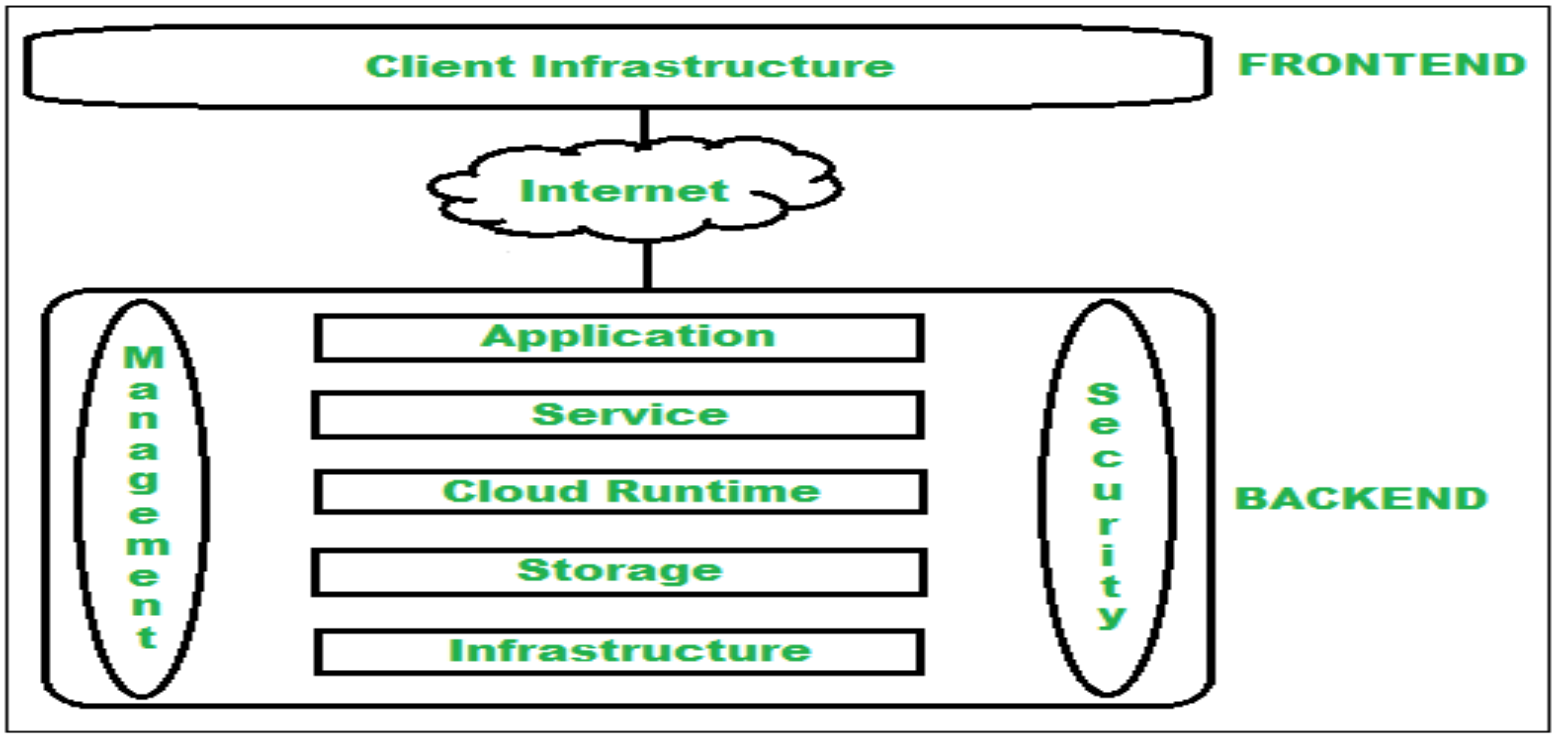
The components of cloud computing architecture are **Client infrastructure, application, service, runtime cloud, storage, infrastructure, management and security.**

- The cloud architecture is divided into 2 parts,
- Frontend
- Backend

Cntd.


Architecture of Cloud Computing
Client Infrastructure
Front End
internet
Application
Service
Runtime Cloud
Storage
infrastructure
Management
Security
Back End

Cntd.


Client Infrastructure
FRONTEND
Internet
Application
Service
Cloud Runtime
Storage
Infrastructure
Management
Security
BACKEND

Cntd.

- **1. Frontend**
- Frontend of the cloud architecture **refers to the client side of cloud computing system.** Means **it contains all the user interfaces and applications which are used by the client to access the cloud computing services/resources**.
- For example, **use of a web browser to access the cloud platform**.
- **2. Backend**
- Backend **refers to the cloud itself which is used by the service provider.**
- It contains the **resources** as well as **manages the resources and provides security mechanisms**.
- Along with this, it **includes huge storage, virtual applications, virtual machines, traffic control mechanisms, deployment models**, etc.

Components of Cloud Computing Architecture

- **Client Infrastructure –** It is a part of the frontend component. It contains the applications and user interfaces which are required to access the cloud platform. In other words, it provides a GUI(Graphical User Interface) to interact with the cloud.
- **Application** :It is a part of backend component that refers to a software or platform to which client accesses. Means it provides the service in backend as per the client requirement.
- **Service**: in backend It refers to the major three types of cloud based services like SaaS, PaaS and IaaS. Also manages which type of service the user accesses.
- **Runtime Cloud**: in backend It provides the execution and Runtime platform/environment to the Virtual machine.
- **Storage:** in backend It provides flexible and scalable storage service and management of stored data.
- **Infrastructure:** Cloud Infrastructure in backend refers to the hardware and software components of cloud like it includes servers, storage, network devices, virtualization software etc

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- **Management:** in backend It refers to management of backend components like application, service, runtime cloud, storage, infrastructure, and other security mechanisms etc.
- **Security:** It refers to implementation of different security mechanisms in the backend for secure cloud resources, systems, files, and infrastructure to end-users.
- **Internet:** It acts as the medium or a bridge between frontend and backend and establishes the interaction and communication between frontend and backend.
- **Database:** In backend It refers to provide database for storing structured data, such as SQL and NOSQL databases. Example of Databases services include Amazon RDS, Microsoft Azure SQL database and Google CLoud SQL.
- **Networking:** in backend services that provide networking infrastructure for application in the cloud, such as load balancing, DNS and virtual private networks.
- **Analytics:** in backend service that provides analytics capabilities for data in the cloud, such as warehousing, business intelligence and machine learning.

Benefits of Cloud Computing Architecture

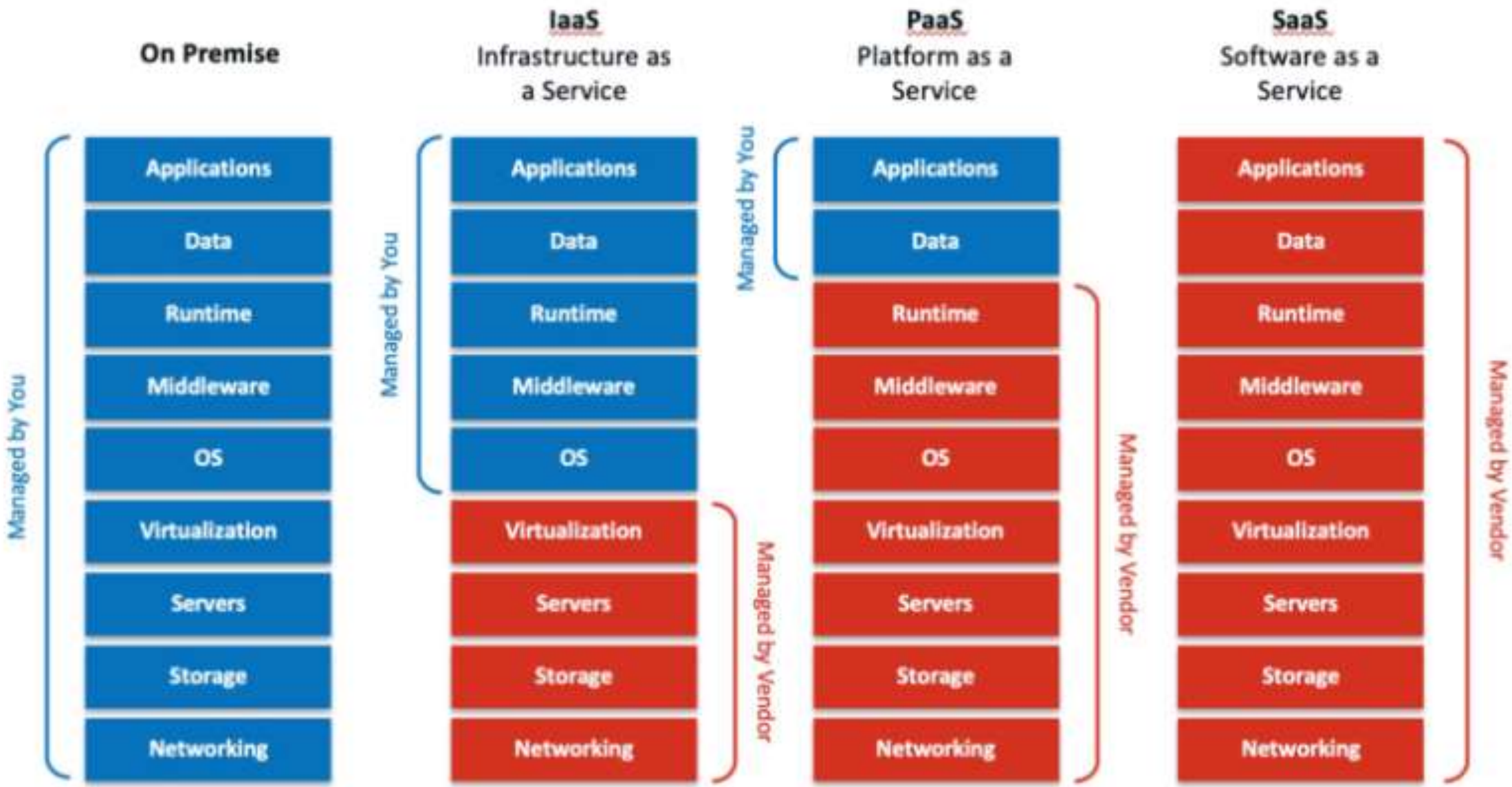
- Makes overall cloud computing system simpler.
- **Improves data processing requirements.**
- Helps in providing high security.
- **Makes it more modularized**.
- Results in better disaster recovery.
- **Gives good user accessibility.**
- Reduces IT operating costs.
- **Provides high level reliability.**
- Scalability.

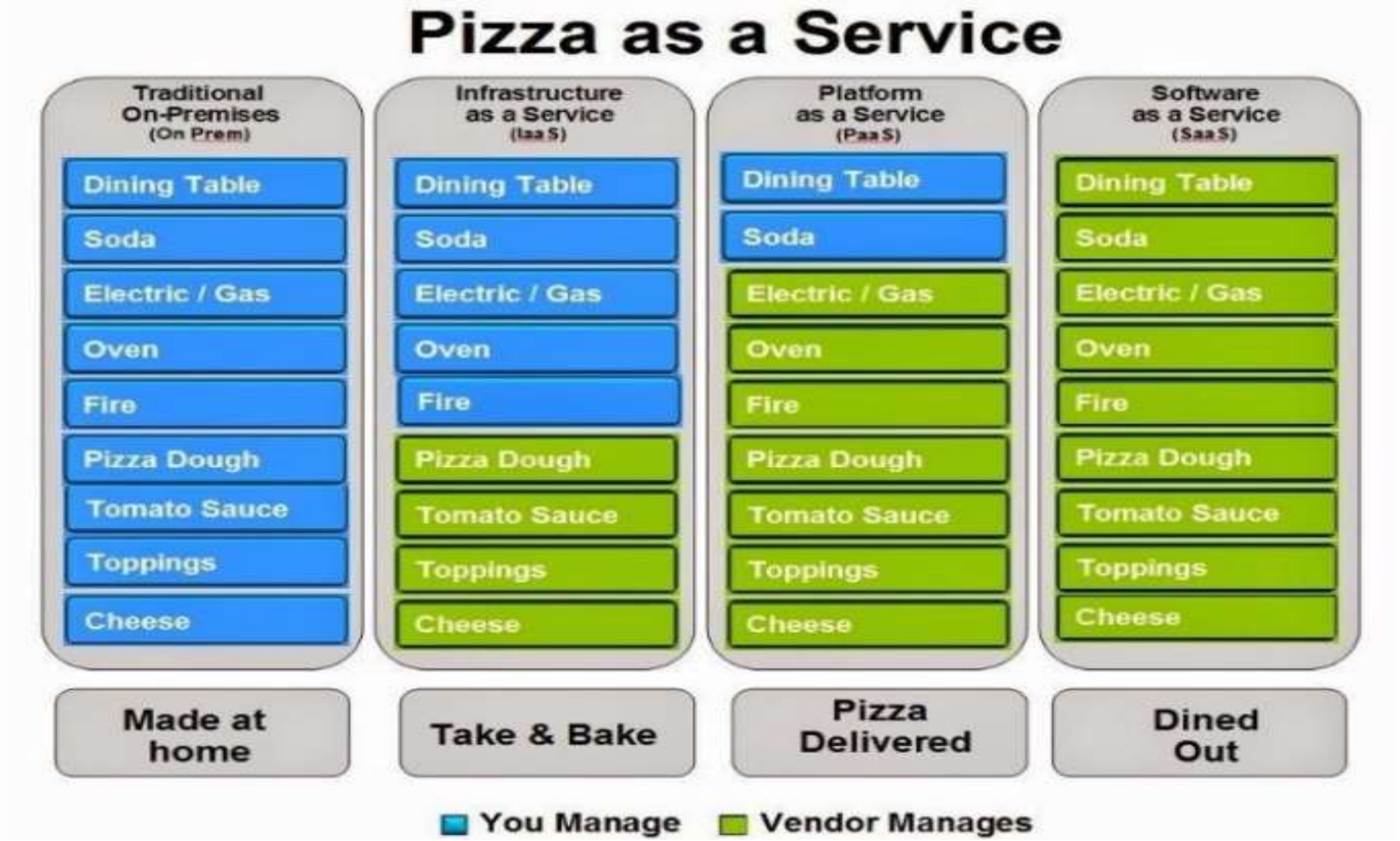
DELIVERY MODELS

1.Software As a Service

2.Platform As a Service

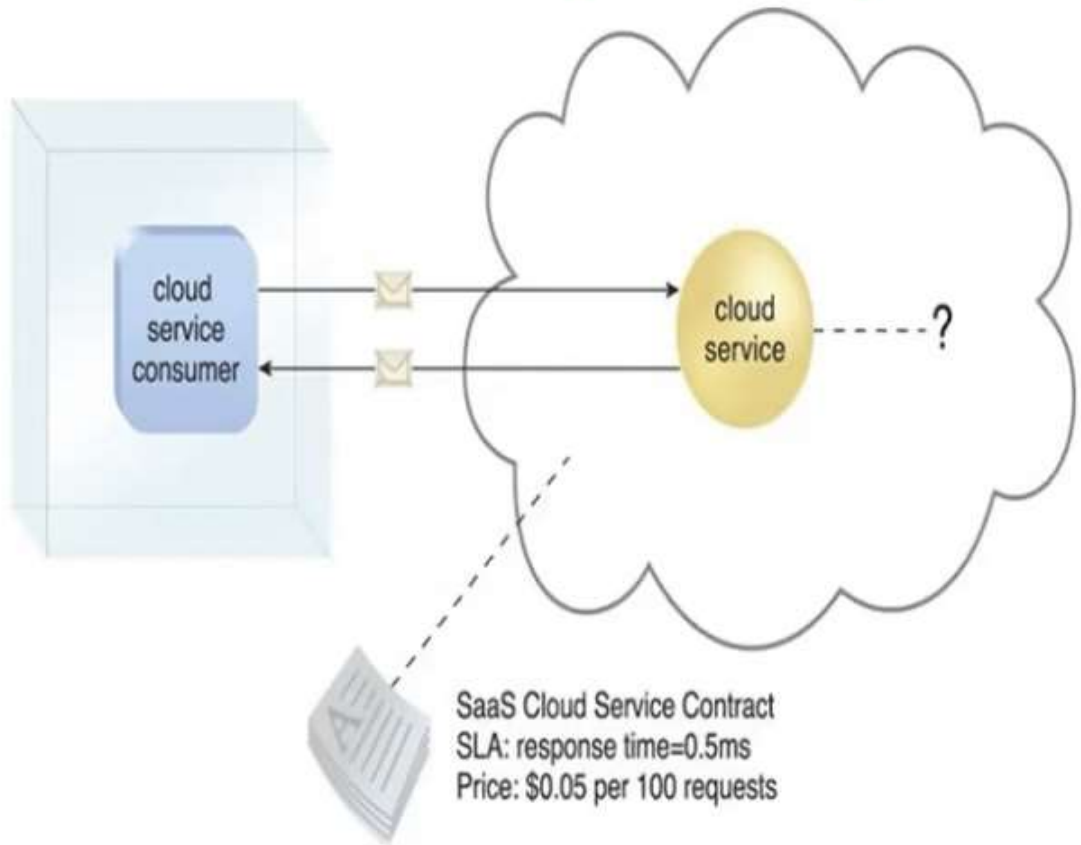
3.Infrastructure As a Service

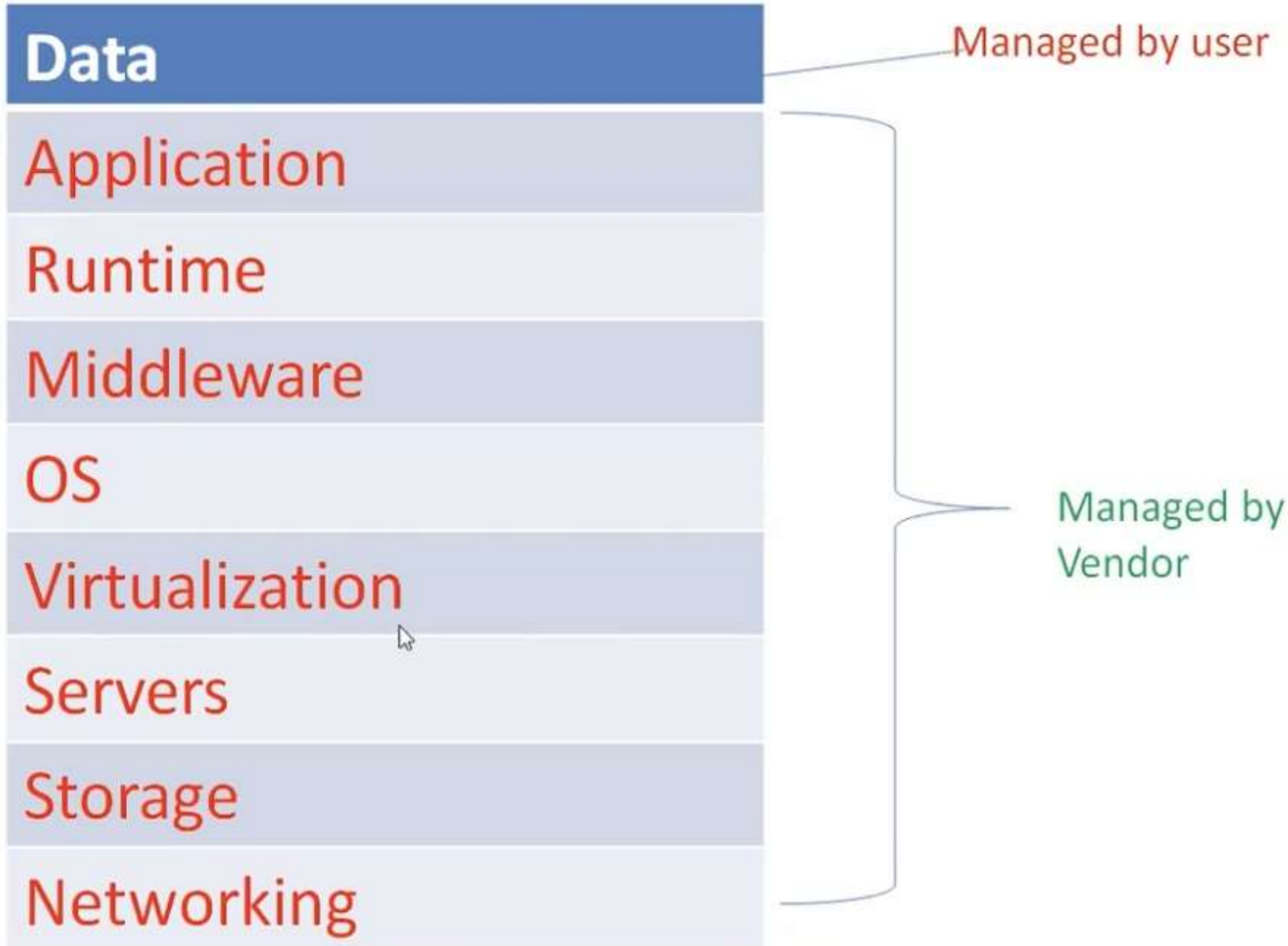

On Premise
IaaS
Infrastructure as a Service
PaaS
Platform as a Service
SaaS
Software as a Service
Applications
Data
Runtime
Middleware
OS
Virtualization
Servers
Storage
Networking
Managed by You
Managed by Vendor


Pizza as a Service
Traditional On-Premises (On Prem)
Infrastructure as a Service (IaaS)
Platform as a Service (PaaS)
Software as a Service (SaaS)
Dining Table
Soda
Electric / Gas
Oven
Fire
Pizza Dough
Tomato Sauce
Toppings
Cheese
Made at home
Take & Bake
Pizza Delivered
Dined Out
You Manage
Vendor Manages

Software-as-a-Service (SaaS)

- The cloud service consumer is given access the cloud service contract, but not to any underlying IT resources or implementation details.



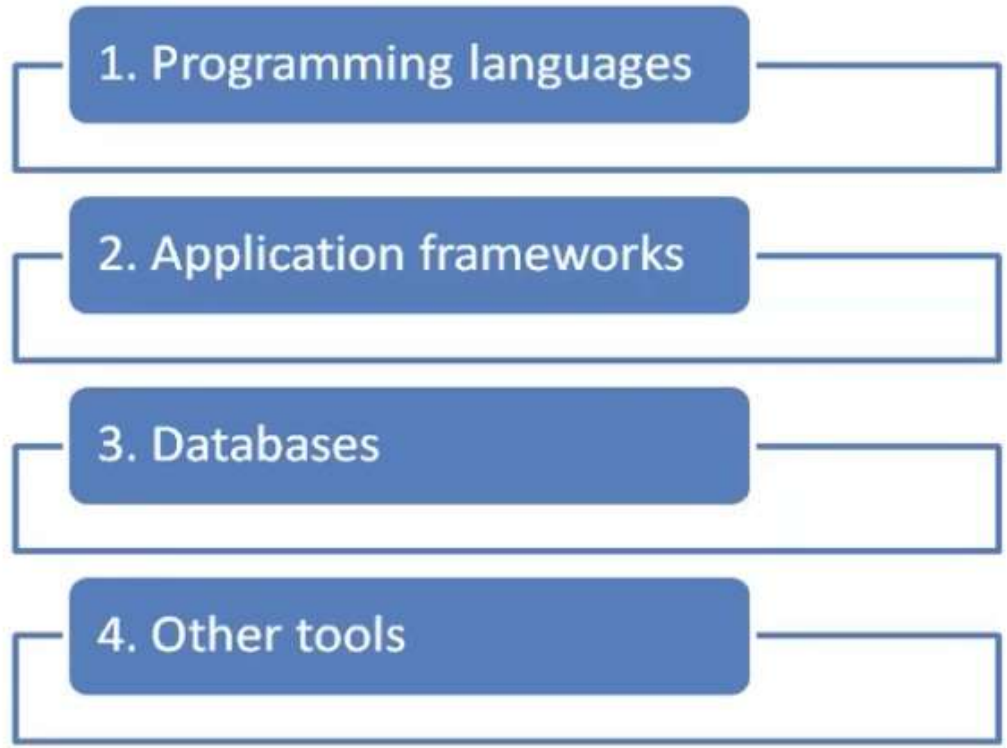

Data
Application
Runtime
Middleware
OS
Virtualization
Servers
Storage
Networking
Managed by user
Managed by Vendor

Platform-as-a-Service (PaaS)

PaaS providers provide the Programming languages, Application frameworks, Databases, and Other tools:

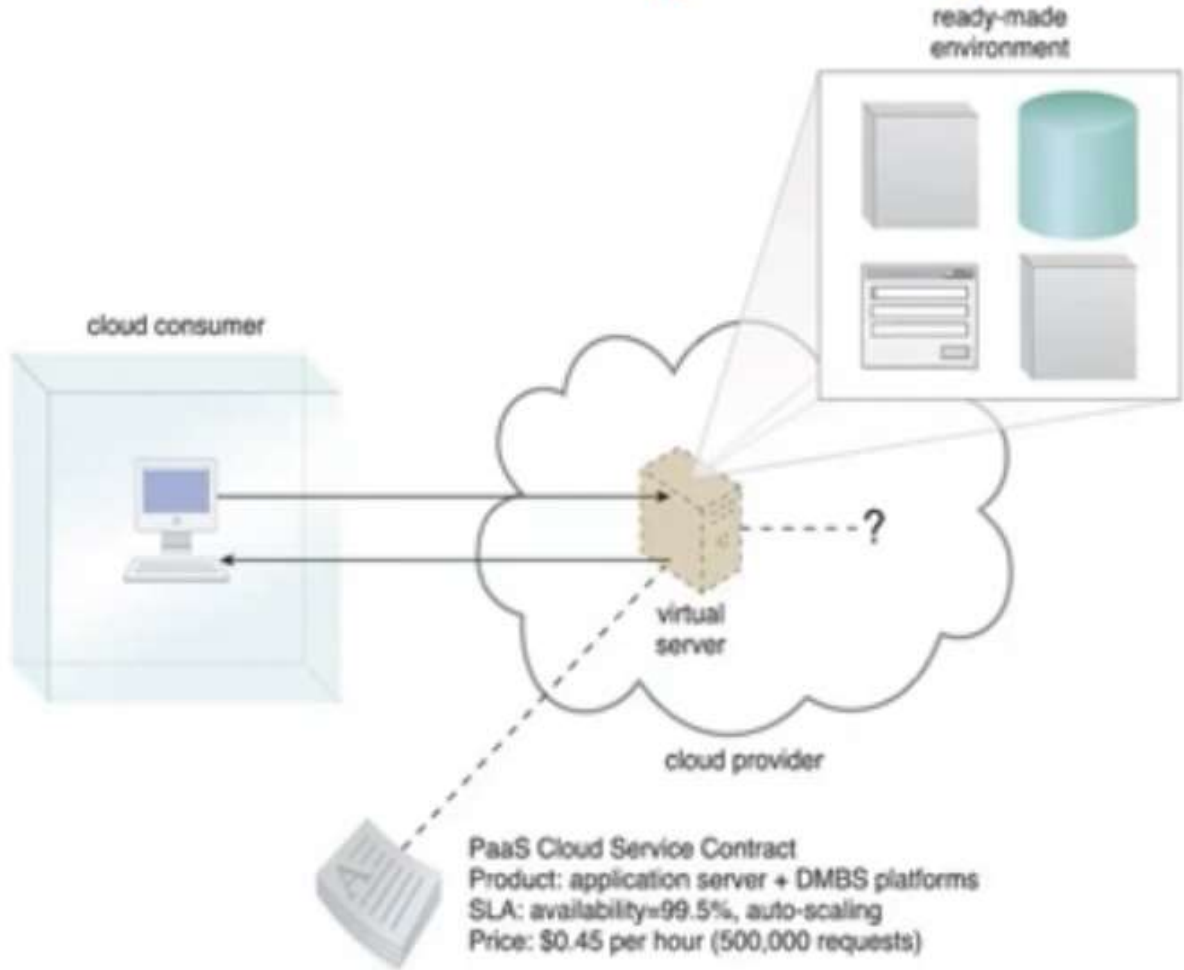
1. Programming languages

- PaaS providers provide various programming languages for the developers to develop the applications.
- Some popular programming languages provided by PaaS providers are Java, PHP, Ruby, Perl, and Go.



Platform-as-a-Service (PaaS)

- A cloud consumer is accessing a ready-made PaaS environment.
- The question mark indicates that the cloud consumer is intentionally shielded from the implementation details of the platform.

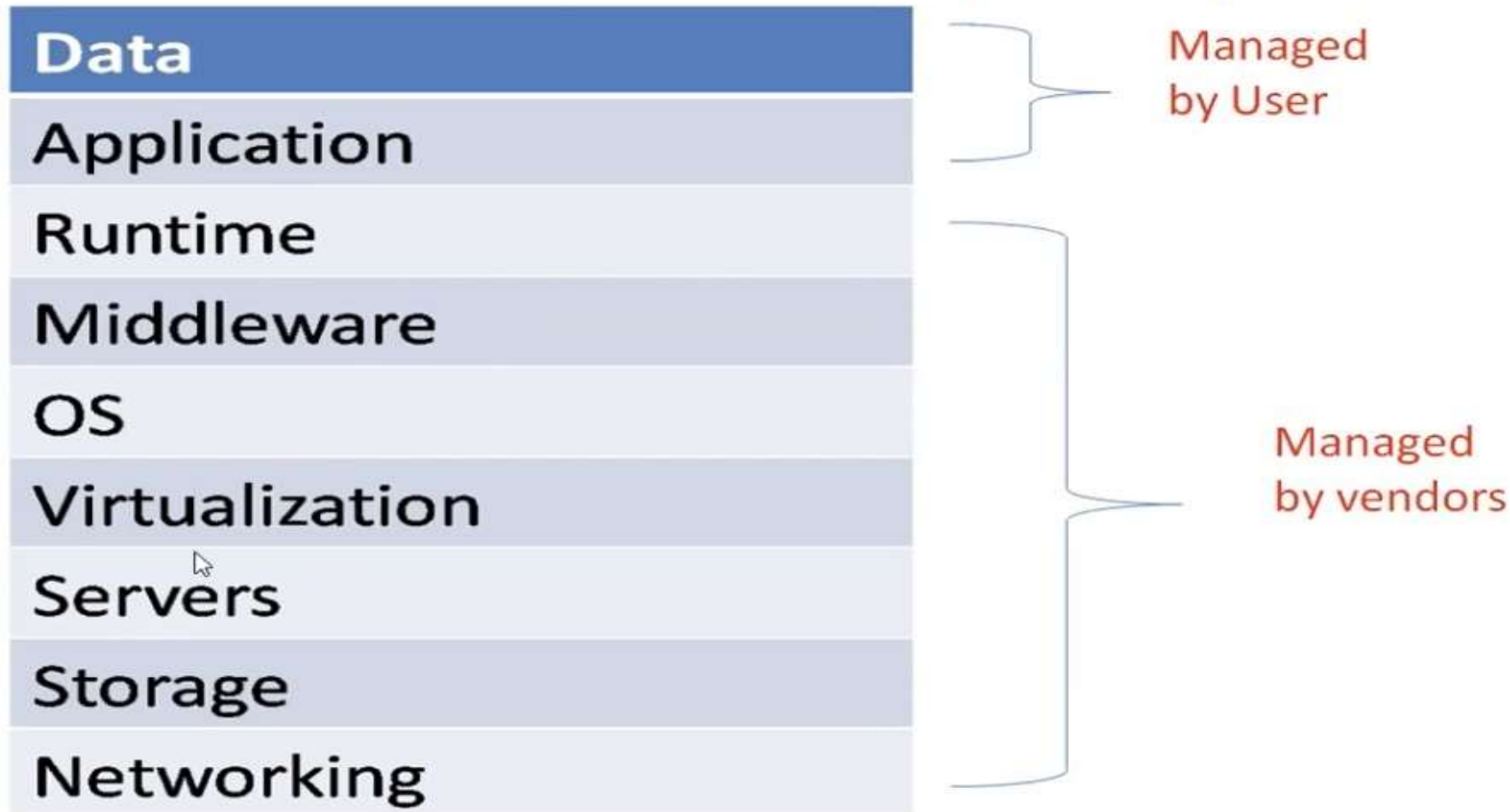


Platform-as-a-Service (PaaS)

Advantages of PaaS

1. **Simple and convenient for users :** It provides much of the infrastructure and other IT services, which users can access anywhere via a web browser.
2. **Cost Effective :** It charges for the services provided on a per-use basis thus eliminating the expenses one may have for on-premises hardware and software.
3. **Efficiently managing the lifecycle :** It is designed to support the complete web application lifecycle: building, testing, deploying, managing and updating.

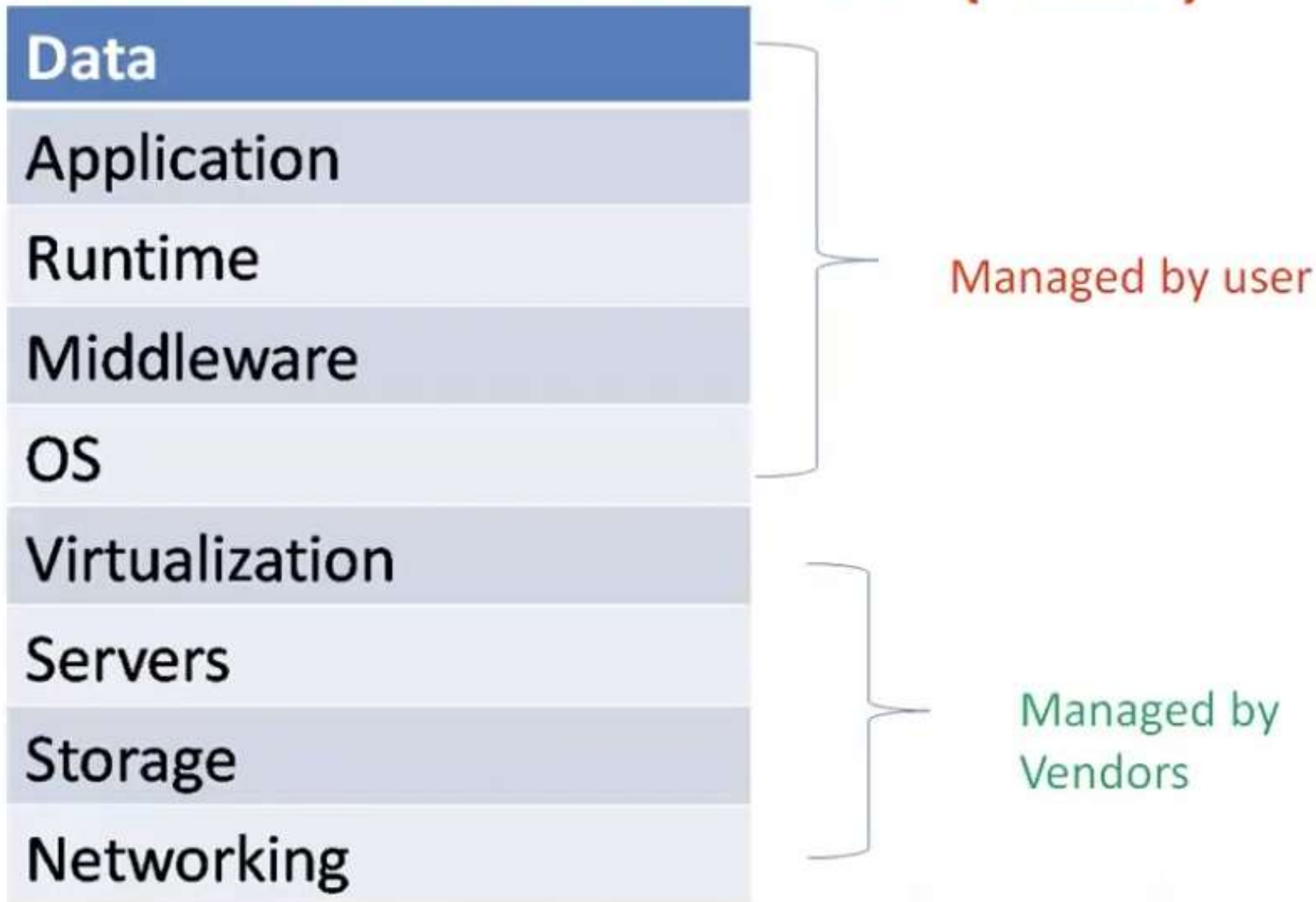
Platform-as-a-Service (PaaS)



Infrastructure-as-a-Service (IaaS)

- IaaS environments are generally offered as freshly initialized virtual instances.
- A central and primary IT resource within a typical IaaS environment is the virtual server.
- Virtual servers are leased by specifying server hardware requirements, such as processor capacity, memory, and local storage space.

Infrastructure-as-a-Service (IaaS)



Cloud Computing Service Layers

	Services	Description
Application Focused	Services	Services – Complete business services such as PayPal, OpenID, OAuth, Google Maps, Alexa
	Application	Application – Cloud based software that eliminates the need for local installation such as Google Apps, Microsoft Online
	Development	Development – Software development platforms used to build custom cloud based applications (PAAS & SAAS) such as SalesForce
Infrastructure Focused	Platform	Platform – Cloud based platforms, typically provided using virtualization, such as Amazon ECC, Sun Grid
	Storage	Storage – Data storage or cloud based NAS such as CTERA, iDisk, CloudNAS
	Hosting	Hosting – Physical data centers such as those run by IBM, HP, NaviSite, etc.

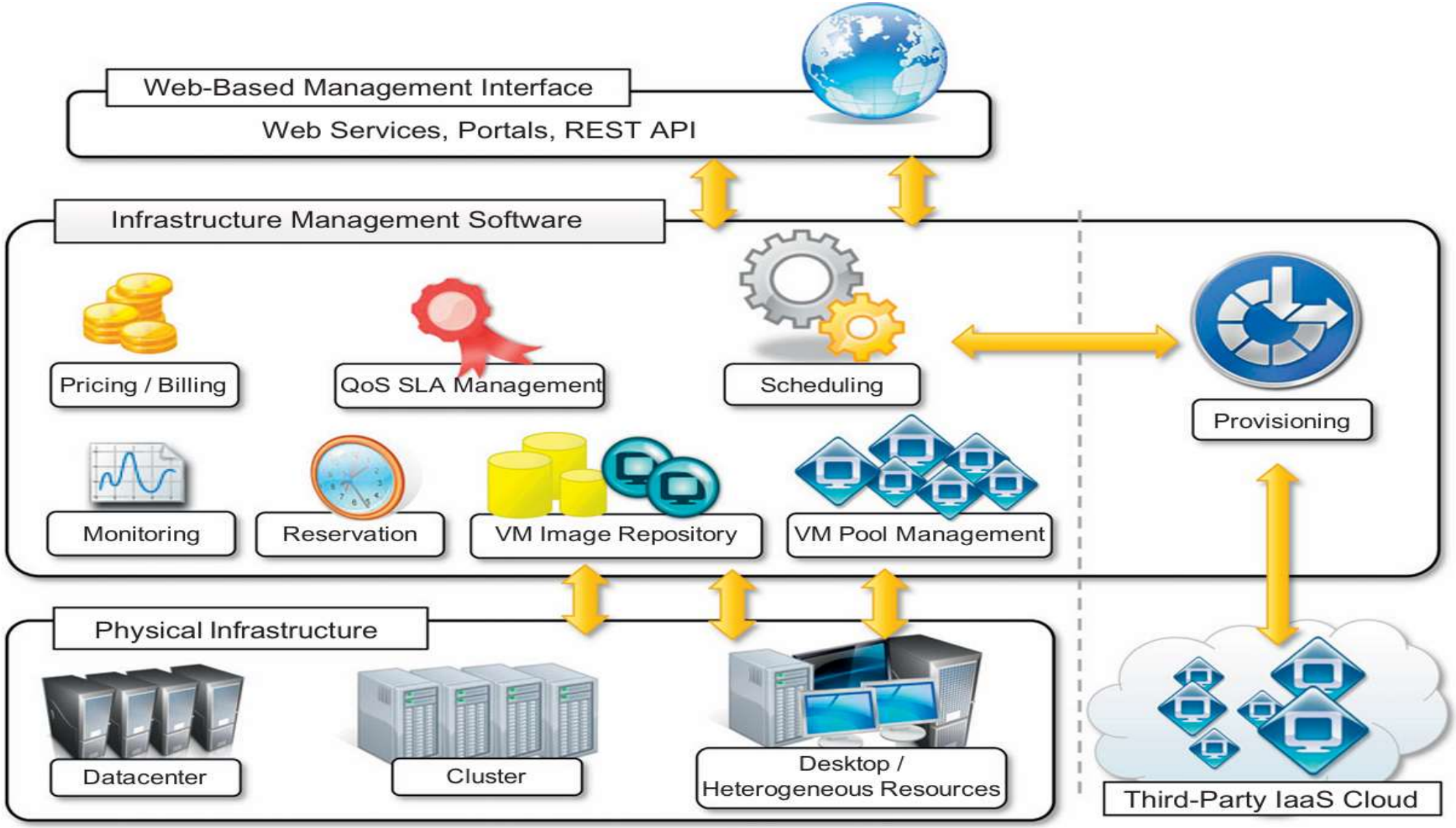
Cloud Computing Services Classification

Category	Characteristics	Product Type	Vendors and Products
SaaS	Customers are provided with applications that are accessible anytime and from anywhere.	Web applications and services (Web 2.0)	SalesForce.com (CRM) Clarizen.com (project management) Google Apps
PaaS	Customers are provided with a platform for developing applications hosted in the cloud.	Programming APIs and frameworks Deployment systems	Google AppEngine Microsoft Azure Manjrasoft Aneka Data Synapse
IaaS/HaaS	Customers are provided with virtualized hardware and storage on top of which they can build their infrastructure.	Virtual machine management infrastructure Storage management Network management	Amazon EC2 and S3 GoGrid Nirvanix

1.Infrastructure as service

- IT infrastructure and provides a more secure environment where executing third party applications.
- From the perspective of the customer, it reduces the administration and maintenance cost as well as the capital costs allocated to purchase hardware.
- At the same time, users can take advantage of the full customization offered by virtualization to deploy their infrastructure in the cloud and virtual machines come with only the selected operating system installed

Infrastructure-as-a-Service reference implementation



Infrastructure-as-a-Service reference implementation

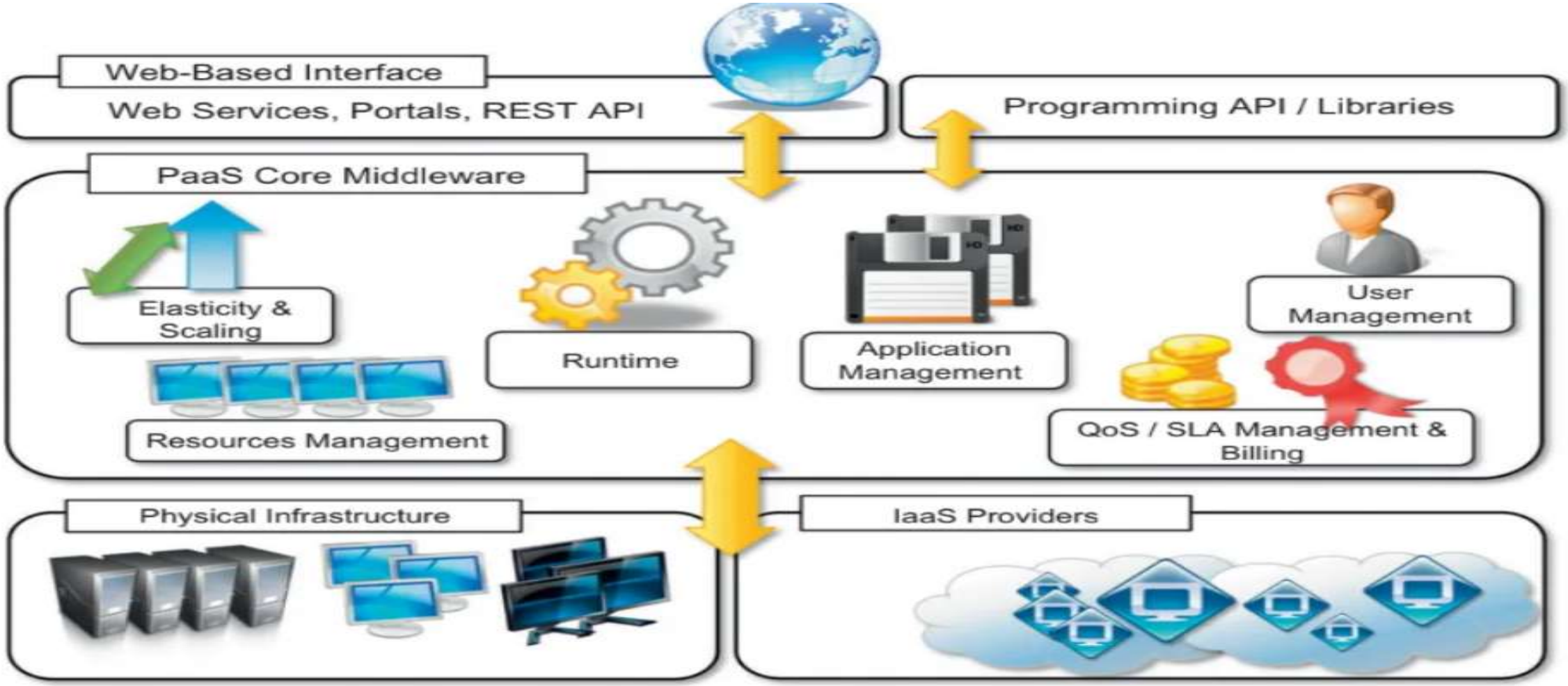
- illustrated in Figure above have three primary layers: the physical infrastructure, the software management infrastructure, and the user interface.
- The user interface, often based on Web 2.0 technologies, grants access to services exposed by the underlying infrastructure.

- The software management layer, crucial for IaaS functionality, includes components for virtual machine management, pricing, billing, monitoring, reservation, SLA management, VM repository, and VM pool management.
- .

2. Platform as a service

- Platform-as-a-Service (PaaS) is a pivotal layer in cloud computing, focusing on application management.
- PaaS implementations furnish developers with runtime environments, automating the deployment, configuration, and scaling of applications without exposing the underlying infrastructure.
- User interfaces, presented through web-based interfaces or APIs, facilitate programming and application deployment.
- Including web-based interfaces, visual programming, and programming language-based approaches like Java, .NET, Python, or Ruby.
- Some PaaS providers deliver integrated development environments, while others offer object models or programming language-based frameworks.

Platform as a service



Platform-as-a-Service reference model

Category	Description	Product Type	Vendors and Products
PaaS-I	Runtime environment with Web-hosted application development platform. Rapid application prototyping.	Middleware + Infrastructure Middleware + Infrastructure	Force.com Longjump
PaaS-II	Runtime environment for scaling Web applications. The runtime could be enhanced by additional components that provide scaling capabilities.	Middleware + Infrastructure Middleware Middleware + Infrastructure Middleware + Infrastructure Middleware + Infrastructure Middleware	Google AppEngine AppScale Heroku Engine Yard Joyent Smart Platform GigaSpaces XAP
PaaS-III	Middleware and programming model for developing distributed applications in the cloud.	Middleware + Infrastructure Middleware Middleware Middleware Middleware Middleware	Microsoft Azure DataSynapse Cloud IQ Manjrasof Aneka Apprenda SaaSGrid GigaSpaces DataGrid

Software-as-a-service (SaaS) is a software delivery model that revolutionizes

Cond…

- In above table PaaS-I, PaaS-II, and PaaS-III. The first category identifies PaaS implementations that completely follow the cloud computing style for application development and deployment.
- Google AppEngine is the most popular product in this category, in this case developers design and create their applications with the traditional methods.
- It helps management reduce the risk of ever-changing technologies by offloading the cost of upgrading the technology to the PaaS provider.
- PaaS solutions reduce costs across development, deployment and management.

3.Software as a service

- The SaaS model is appealing for applications serving a wide range of users and that can be adapted to specific needs with little further customization.

- This requirement characterizes SaaS as a “one-to-many” software delivery model, whereby an application is shared across multiple users. This is the case of CRM3 and ERP4 applications.
- The SaaS approach introduces a more flexible way of delivering application ser vices that are fully customizable by the user
- SaaS applications comprises social networking applications such as Facebook and professional networking sites such as LinkedIn.
- providing the basic features of networking, they allow incorporating and extending their capabilities by integrating third-party applications

Software as a Service (SaaS)

Platform as a Service (PaaS)

Infrastructure as a Service (IaaS)

SalesForce CRM
LotusLive

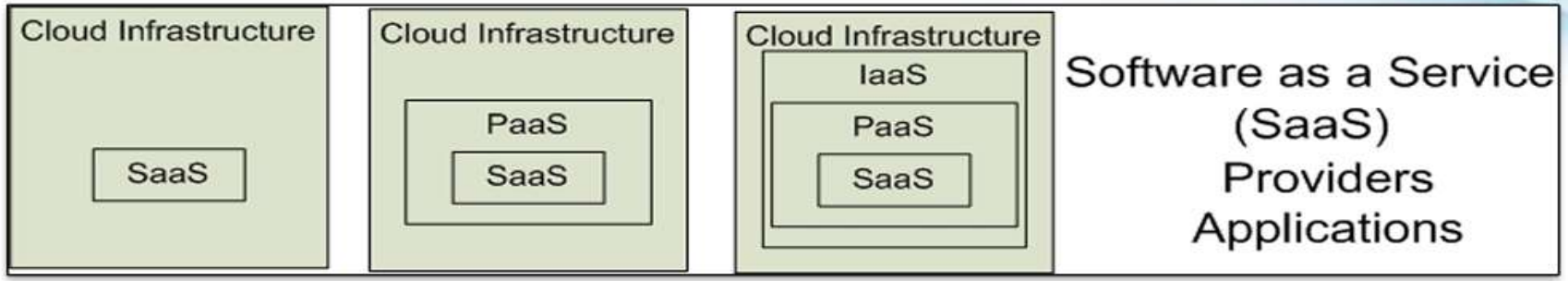


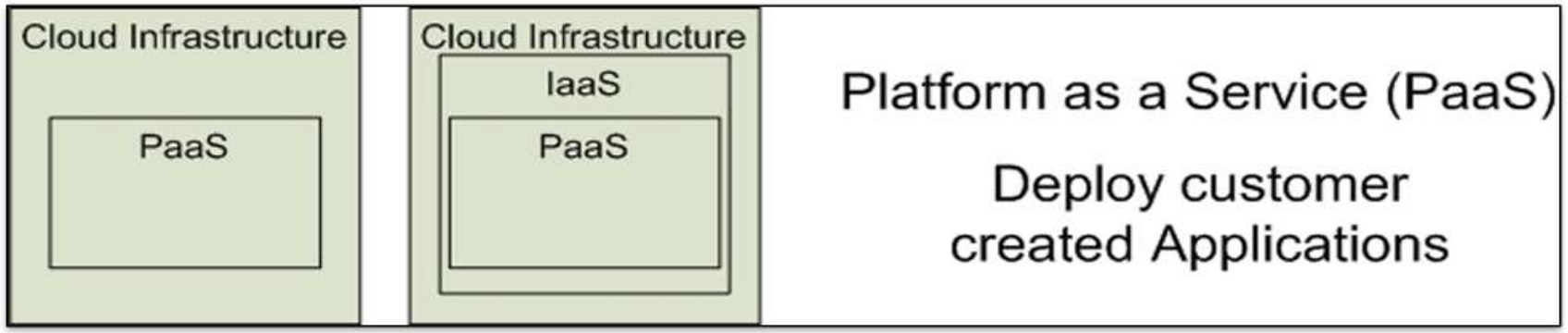
Google App Engine

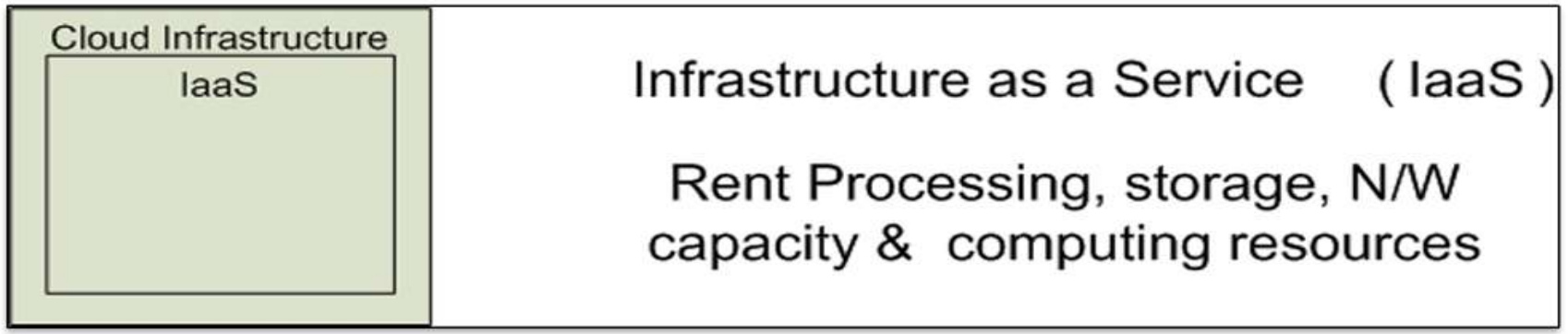
Windows Azure
The Future Made Familiar

amazon web services™

rackspace HOSTING



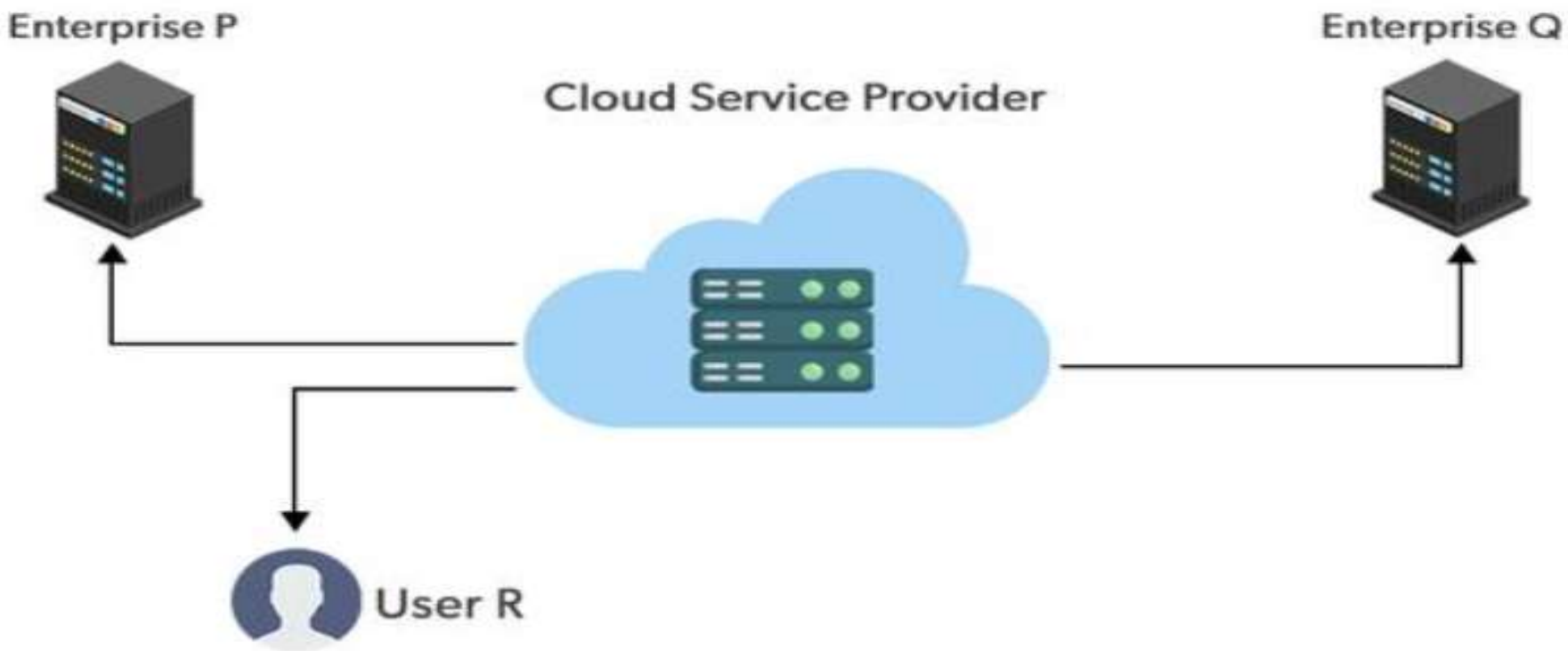




5.Types of cloud /Deployment Models

- Public cloud
- Private cloud
- Hybrid cloud
- Community cloud

Public cloud



Public Cloud

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Public clouds are owned by cloud service providers who charge for the use of cloud resources.

Basic characteristics:- Homogeneous infrastructure, Common policies- Shared resources and multi-tenancy- Leased or rented infrastructure- Economies of scale

- AWS/EC2 (Amazon)
- Azure (Microsoft)
- Google Cloud Platform.
- Rackspace.

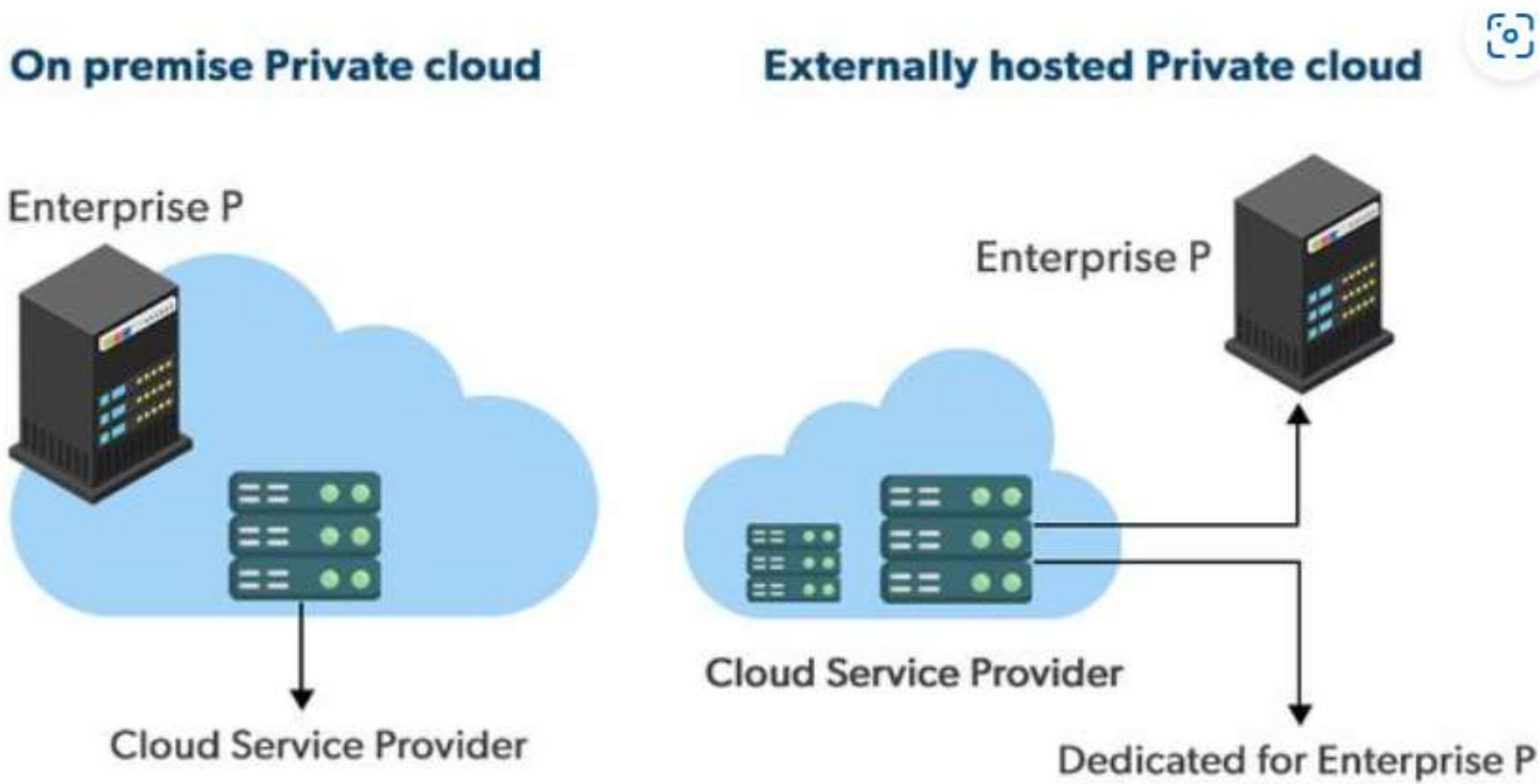
Advantages of the Public Cloud Model

- **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.

Private cloud

- The private cloud deployment model is the exact opposite of the public cloud deployment model. It's a one-on-one environment for a single user (customer).
- There is no need to share your hardware with anyone else.
- The distinction between private and public clouds is in how you handle all of the hardware. It is also called the "internal cloud" & it refers to the ability to access systems and services within a given border or organization.

- The cloud platform is implemented in a cloud-based secure environment that is protected by powerful firewalls and under the supervision of an organization's IT department



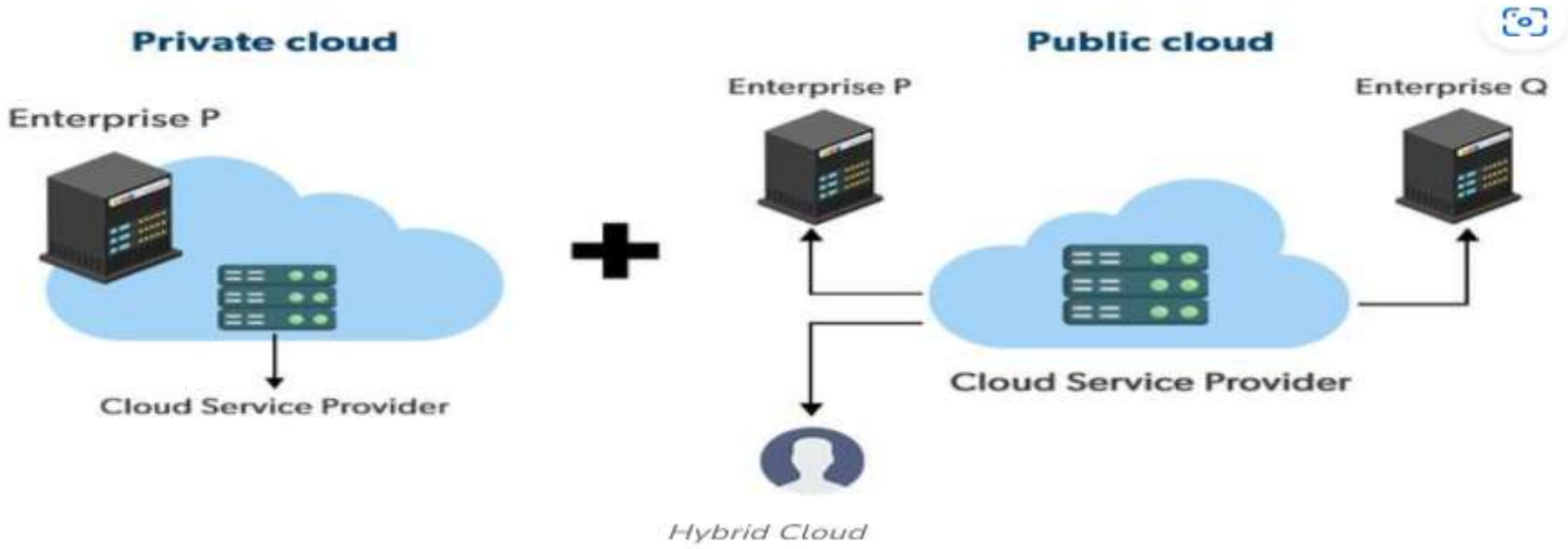
Private Cloud

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.

Hybrid cloud

- bridging the public and private worlds with a layer of proprietary software, hybrid cloud computing gives the best of both worlds.
- With a hybrid solution, you may host the app in a safe environment while taking advantage of the public cloud's cost saving
- It is a heterogeneous distributed system resulting from a private cloud that integrates additional services or resources from one or more public clouds. For this reason they are also called heterogeneous clouds.

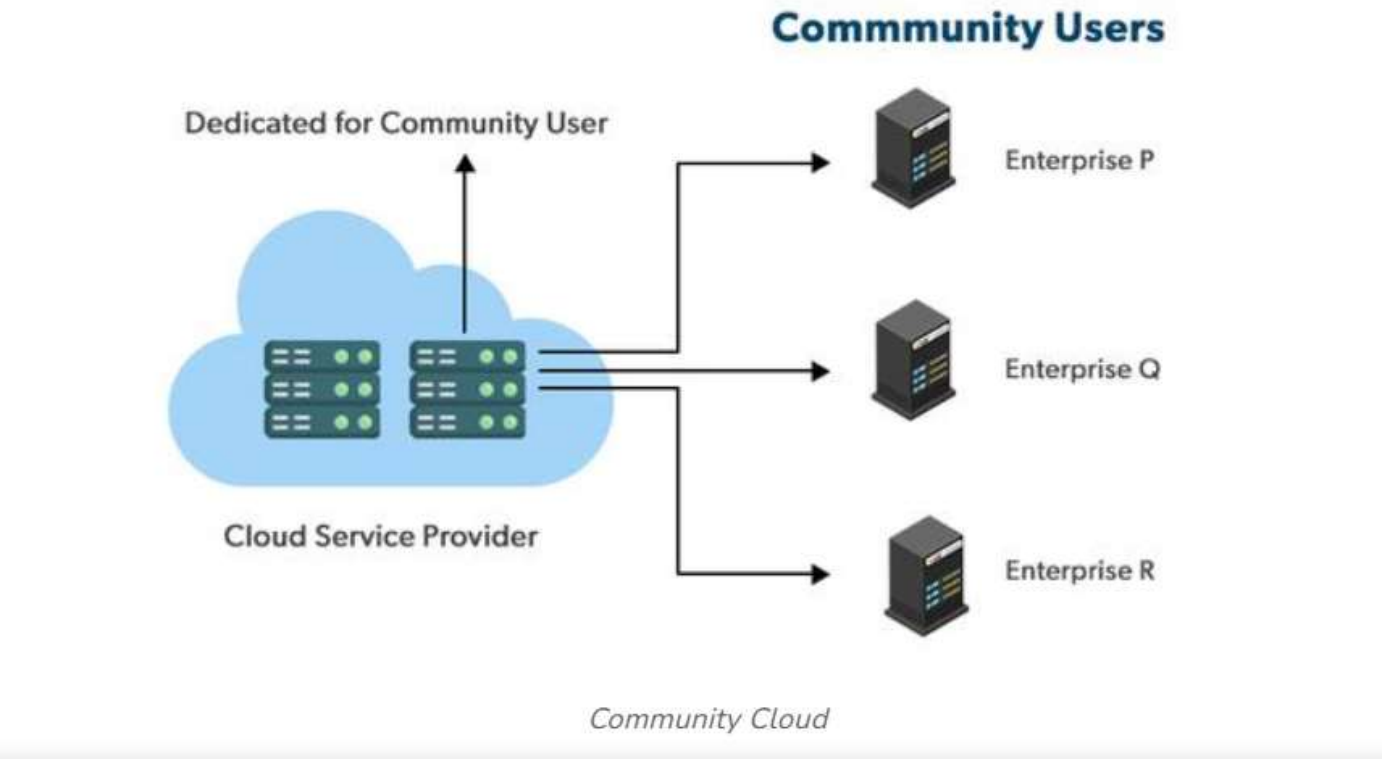


Advantages of the Hybrid Cloud Model

- **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.

Community cloud

- It allows systems and services to be accessible by a group of organizations.
- It is a distributed system that is created by integrating the services of different clouds to address the specific needs of a community, industry, or business.
- The infrastructure of the community could be shared between the organization which has shared concerns



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


Thank
You!