

Unit-II

- **Syllabus**
- **Cloud Computing Fundamentals:** Motivation for Cloud Computing, The Need for Cloud Computing, Defining Cloud Computing, Definition of Cloud computing, Cloud Computing Is a Service, Cloud Computing Is a Platform, Principles of Cloud computing, Five Essential Characteristics, Four Cloud Deployment Models

Motivation for Cloud Computing

- Let us review the scenario of computing **prior to** the announcement and availability of cloud computing:
 - The users who are in need of computing are expected to **invest money** on computing resources .
 - **Huge expenditure** to the enterprises that require enormous computing power and resources.
- On the other hand, it is easy and handy to get the required computing power and resources from **some provider (or supplier)** as and when it is needed and pay only for that usage.
 - This would cost only a **reasonable investment** or spending, compared to the huge investment when buying the entire computing infrastructure.
 - **Capital expenditure Vs Operational expenditure**

Motivation for Cloud Computing

- Therefore, cloud computing is a mechanism of *bringing—**hiring** or **getting the services of the computing power or infrastructure** to an organizational or individual level to the extent required and paying only for the consumed services.*
- One can compare this situation with the usage of electricity (its services) from its producer-cum-distributor.
- Therefore, cloud computing is needed in getting the services of computing resources.

Motivation for Cloud Computing

- Thus, one can say as a one-line answer to the need for cloud computing that it **eliminates a large computing investment** without compromising the use of computing at the user level at an operational cost. Therefore, cloud computing is needed in getting the services of computing resources.
- **Cloud computing** is **very economical** and **saves a lot of money**. A blind benefit of this computing is that even if we lose our laptop or due to some crisis our personal computer—and the desktop system—gets damaged, still our data and files will stay safe and secured as these are not in our local machine (but remotely located at the provider's place—machine).

Motivation for Cloud Computing

- Figure 1 shows several cloud computing applications. The *cloud* represents the Internet-based computing resources, and the accessibility is through some secure support of connectivity.
- Cloud computing encompasses the subscription-based or pay-per-use service model of offering computing to end users or customers over the Internet and thereby extending the IT's existing capabilities.

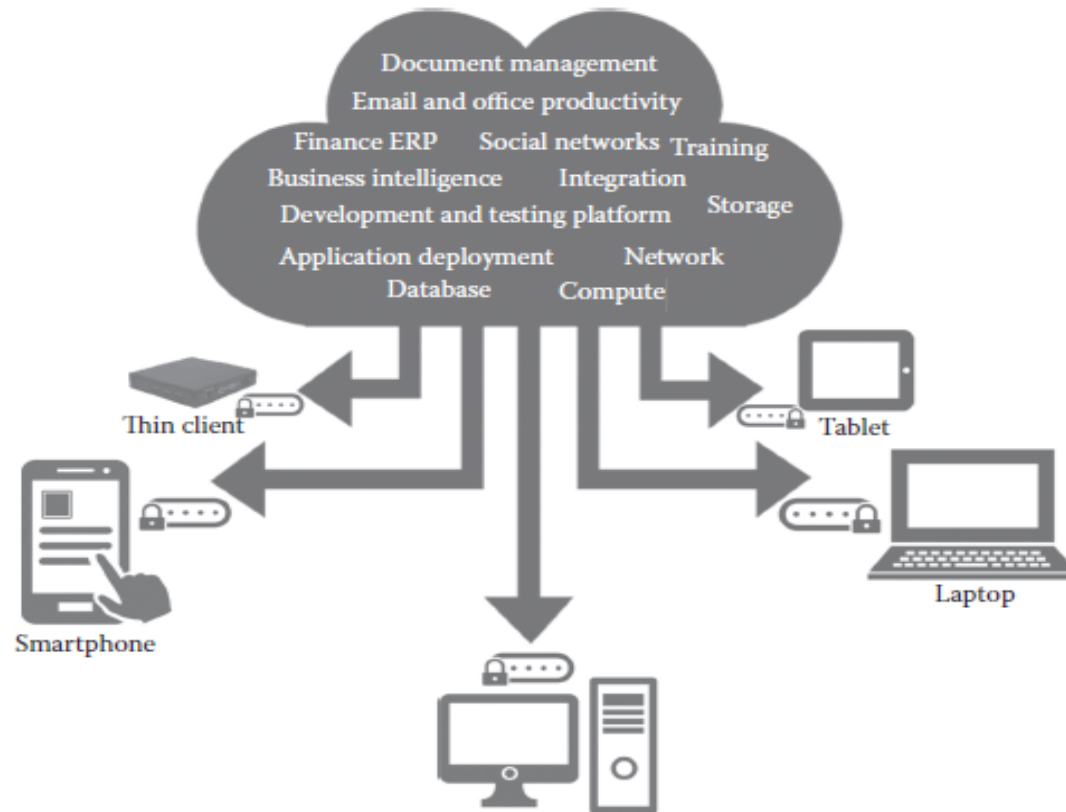


Figure 1: Cloud Computing

The Need for Cloud Computing

- The main reasons for the need and use of cloud computing are **convenience and reliability**.
- **In the past**, if we wanted to bring a file, we would have to save it to a Universal Serial Bus (USB) flash drive, external hard drive, or compact disc (CD) and bring that device to a different place.
- Instead, **saving a file to the cloud** (e.g., use of cloud application Dropbox) ensures that we will be able to access it with any computer that has an Internet connection.
- The cloud also makes it much easier **to share a file** with friends, making it possible to collaborate over the web.

The Need for Cloud Computing

- While using the cloud, losing our data/file is much less likely.
- However, just like anything online, there is always a risk that someone may try to gain access to our personal data, and therefore, it is important to choose an **access control with a strong password** and pay attention to any privacy settings for the cloud service that we are using.

Defining Cloud Computing

- *In the simplest terms*, cloud computing means storing and accessing data and programs over the Internet from a remote location or computer instead of our computer's hard drive.
- This so called *remote location has several properties such as scalability, elasticity etc., which is significantly different from a simple remote machine.*
- The cloud is just a metaphor for the Internet. When we store data on or run a program from the local computer's hard drive, that is called **local storage and computing**.
- For it to be considered *cloud computing*, we need to access our data or programs over the Internet. The end result is the same; however, with an online connection, cloud computing can be done anywhere, anytime, and by any device.

NIST Definition of 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.
- This cloud model is composed of five essential characteristics, three service models, and four deployment models
- It means that the computing resource or infrastructure—be it server hardware, storage, network, or application software—all available from the cloud vendor or provider's site/premises, can be accessible over the Internet from any remote location and by any local computing device.

NIST Definition of Cloud Computing

- In addition, the usage or accessibility is to cost only to the level of usage to the customers based on their needs and demands, also known as the *pay-as-you-go* or *pay-as-per-use* model. *If the need is more, more quantum computing resources are made available (provisioning with elasticity) by the provider.*
- *Minimal management effort implies that at the customer's side, the maintenance of computing systems is very minimal as they will have to look at these tasks only for their local computing devices used for accessing cloud-based resources, not for those computing resources managed at the provider's side.*

Cloud Computing Is a Service

- The simplest thing that any computer does is allow us to store and retrieve information.
- We can store our family photographs, our favorite songs, or even save movies on it, which is also the most basic service offered by cloud computing.
- Let us look at the example of a popular application called *Flickr* to illustrate the meaning of this section.
- Flickr started with an emphasis on sharing photos and images, it has emerged as a great place to store those images.
 - First, Flickr allows us to easily access our images no matter where we are or what type of device we are using.
 - Second, Flickr lets us share the images.
 - Third, Flickr provides data security

Cloud Computing Is a Platform

- The World Wide Web (WWW) can be considered as the operating system for all our Internet-based applications. However, one has to understand that we will always need a local operating system in our computer to access web-based applications.
- The basic meaning of the term *platform* is that it is the support on which applications run or give results to the users. For example, Microsoft Windows is a platform. But, a platform does not have to be an operating system. Java is a platform even though it is not an operating system.

Cloud Computing Is a Platform

- Through cloud computing, the web is becoming a platform. With trends (applications) such as Office 2.0, more and more applications that were originally available on desktop computers are now being converted into web–cloud applications
- Word processors like Buzzword and office suites like Google Docs are now available in the cloud as their desktop counterparts. All these kinds of trends in providing applications via the cloud are turning cloud computing into a platform or to act as a platform.

Cloud Computing :Advantages

Consolidated set of points briefing the benefits of cloud computing can be as follows:

1. *Achieve economies of scale:* We can increase the volume output or productivity with fewer systems and thereby reduce the cost per unit of a project or product.
2. *Reduce spending on technology infrastructure:* It is easy to access data and information with minimal upfront spending in a pay-as-you-go approach, in the sense that the usage and payment are similar to an electricity meter reading in the house, which is based on demand.
3. *Globalize the workforce:* People worldwide can access the cloud with Internet connection.
4. *Streamline business processes:* It is possible to get more work done in less time with less resource.
5. *Reduce capital costs:* There is no need to spend huge money on hardware, software, or licensing fees.

Cloud Computing :Advantages

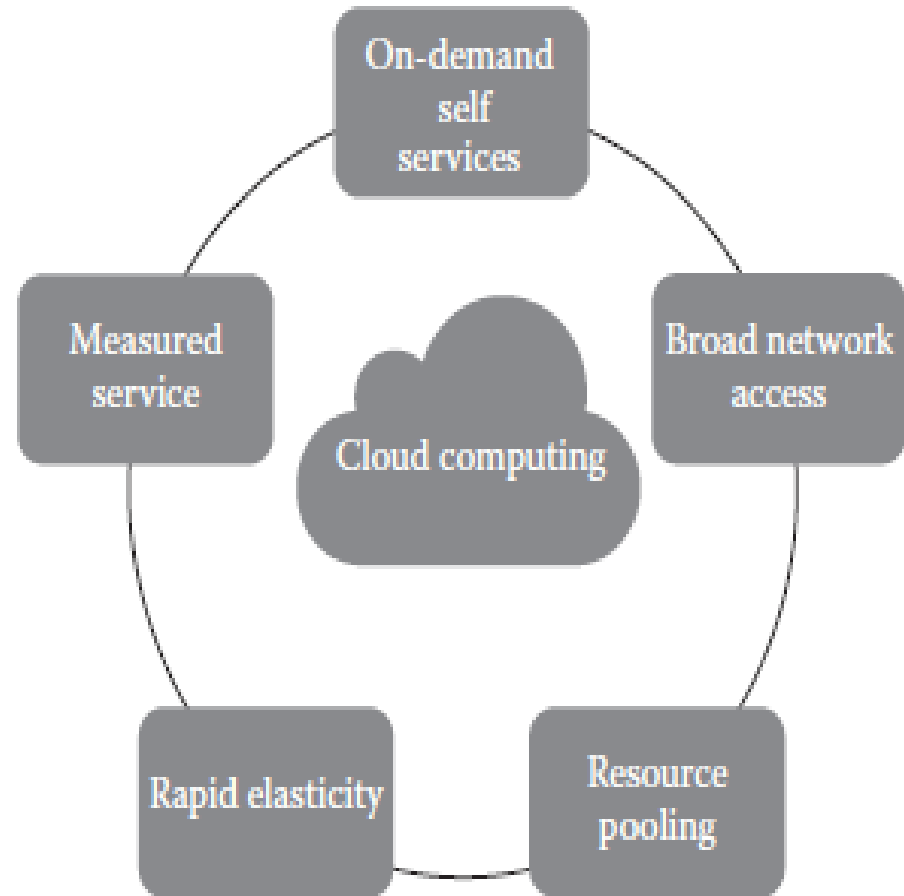
6. *Pervasive accessibility:* Data and applications can be accessed anytime, anywhere, using any smart computing device, making our life so much easier.
7. *Monitor projects more effectively:* It is possible to confine within budgetary allocations and can be ahead of completion cycle times.
8. *Less personnel training is needed:* It takes fewer people to do more work on a cloud, with a minimal learning curve on hardware and software issues.
9. *Minimize maintenance and licensing software:* As there is no too much of on-premise computing resources, maintenance becomes simple and updates and renewals of software systems rely on the cloud vendor or provider.
10. *Improved flexibility:* It is possible to make fast changes in our work environment without serious issues at stake.

Principles of Cloud computing

- The 5-4-3 principles put forth by NIST describe
 - (a) The **five essential characteristic** features that promote cloud computing,
 - (b) The **four deployment models** that are used to narrate the cloud computing opportunities for customers while looking at architectural models, and
 - (c) The **three important and basic service** offering models of cloud computing.

Five Essential Characteristics

1. *On-demand self-service:*
2. *Broad network access:*
3. *Resource pooling:*
4. *Rapid elasticity:*
5. *Measured service:*



Five Essential Characteristics

1. *On-demand self-service:*

The Cloud computing services does not require any human administrators, user themselves are able to **provision, monitor and manage computing resources as needed**.

2. *Broad network access:*

The Computing services are generally provided over **standard networks and heterogeneous devices**.

3. *Resource pooling:*

The IT resource (e.g., **networks, servers, storage, applications, and services**) present are shared across multiple applications and occupant in an uncommitted manner. Multiple clients are provided service from a same physical resource.

4. *Rapid elasticity:*

The Computing services should have IT resources that are able **to scale out and in quickly** and on as needed basis. Whenever the user require services it is provided to him and it is scale out as soon as its requirement gets over.

5. *Measured service:*

The resource utilization is tracked for each application and occupant, it will provide both the user and the resource provider with an account of what has been used. This is done for various reasons like **monitoring billing** and effective use of resource.

1. On-demand self-service:

- Cloud Computing services are available on-demand and do not require much human interaction.
- The user himself can **provision, manage, and monitor the resources** as per his requirement. This is done through a web-based self-service management console.
- The customer can create the service on his own, like creating a new mailbox or adding additional disk space to a virtual machine, etc.
- For example, for booking a ticket on a travel portal, a passenger gets the flexibility to **book his ticket by himself without any human interaction**. Right from choosing the flight to preference class, the process is **entirely automated** and does not require any salesperson in between.

2. *Broad network access:*

- Cloud computing is accessible from a network, generally **over the internet**.
- Similarly, private cloud services can be accessed from anywhere within the enterprise.
- The services are provided over **heterogeneous devices such as mobile phones, laptops, tablets, office computers, etc.**
- The user can access **the existing data on a cloud platform or upload new data on the cloud from anywhere** using a device and internet connection.
- In the above example, the passenger can book his ticket via the internet **from any device** like a smartphone, laptop, tablet, etc., which has access to a network.

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3. Resource pooling and Multi-tenancy

- Computing resources like networks, servers, storage, applications, and service can be pooled to serve multiple consumers by securely separating the resources on a logical level.
- This is done using a multi-tenant model, which allows multiple customers to share the same application or physical infrastructure while retaining data security and privacy.
- It is the same as an apartment building where many people share the same building infrastructure but still have the privacy of their apartment.
- If we take the same example of the travel portal, the flights can carry several passengers in a single trip. These passengers travel to the same destination, board the same flight, and are allotted separate seats as per the demand and requirement.

4. *Rapid elasticity:*

- Resource capabilities can be elastically provisioned and released to meet immediate requirements. Similarly, they can be removed or scaled-down when not required.
- In many cases, this can even happen automatically in response to business demands. This makes sure that the application has the capacity it needs at any point in time.
- Scalability adds a cost-effectiveness aspect to cloud technology. When the demand or workload is high, more servers can be added for that particular period.
- For example, to meet the demand of the increasing number of passengers, an airline can increase the number of flights for a particular time and stop the flights when the demand goes down.

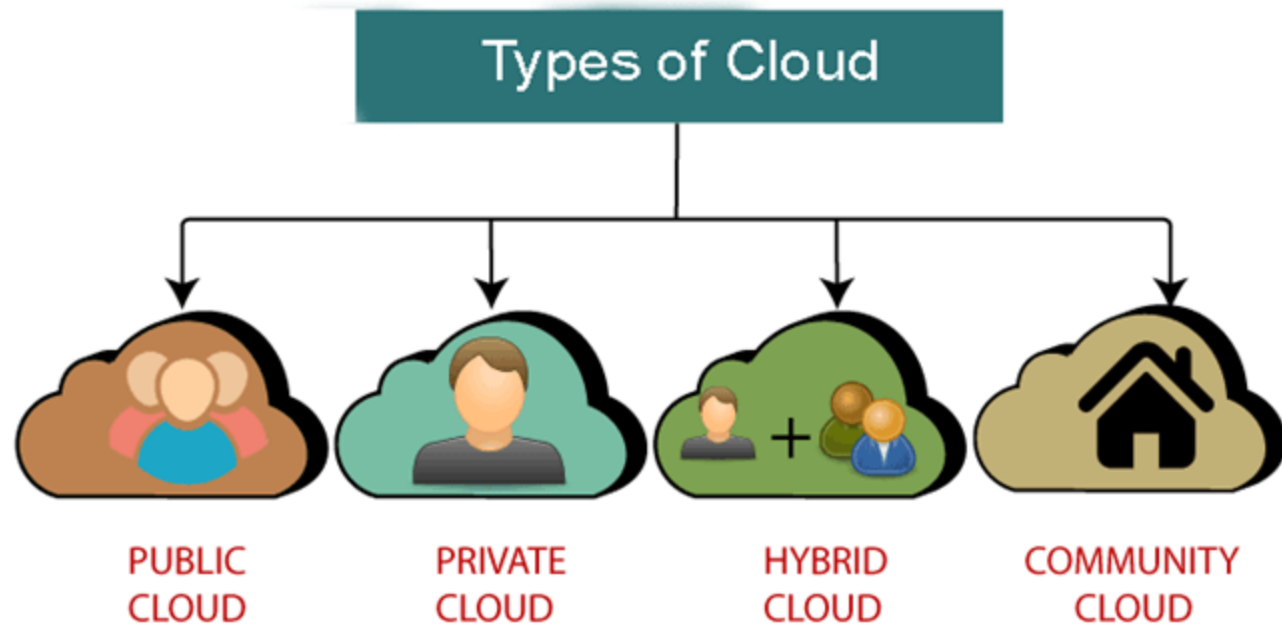
5. Measured Service:

- The utilization of resources is tracked, monitored, controlled, and reported for each occupant. This gives transparency to both the service provider and the consumer.
- The cloud system has a metering capability, which is leveraged to monitor billing, use of resources, and pay only for what has been used.
- When a passenger is traveling by train, he has to pay only for the distance traveled by him and not for the entire journey that the train takes.

Four Cloud Deployment Models

Four deployment models are usually distinguished, namely,

1. Public,
2. Private,
3. Hybrid, and
4. Community cloud



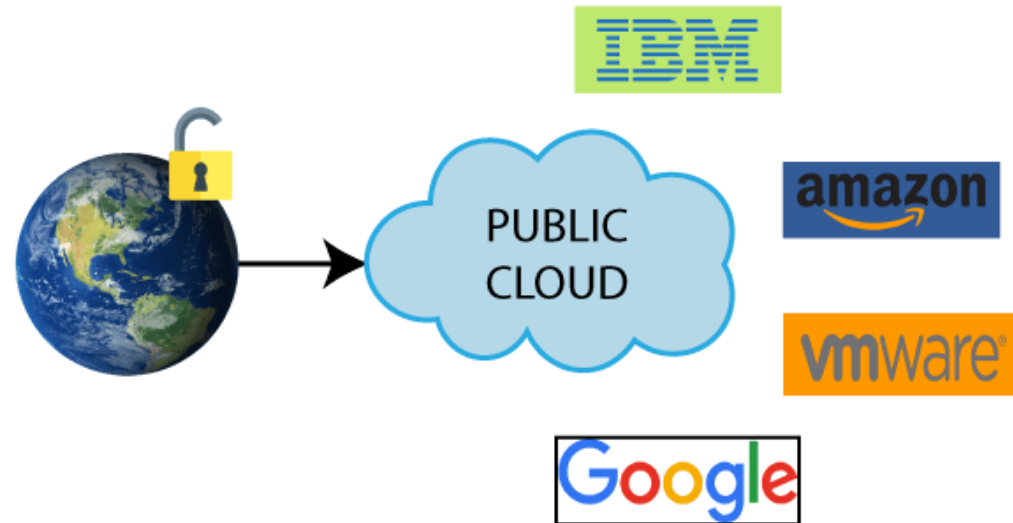
1. Public Cloud

- The public cloud makes it possible for **anybody to access systems** and services.
- The public cloud may be **less secure** as it is open for everyone.
- Public Cloud provides a **shared platform** that is accessible to the **general public** through an Internet connection.
- Public cloud operated on the **pay-as-per-use model** and administrated by the **third party**, i.e., Cloud service provider.
- In the Public cloud, the **same storage** is being **used by multiple users** at the same time.
- Public cloud is **owned, managed, and operated** by businesses, universities, government organizations, or a combination of them.
- Amazon Elastic Compute Cloud (EC2), Microsoft Azure, IBM's Blue Cloud, Sun Cloud, and Google Cloud are examples of the public cloud.

1. Public Cloud

Advantages:

- Low Cost
- Location Independent
- Save Time
- Quickly and easily set up
- Scalability and reliability



Disadvantages:

- Low Security
- Performance: Depends upon the speed of internet connectivity
- Less customizable

2. Private Cloud

- The private cloud allows systems and services to be accessible **within an organization**. It is **more secured** because of its private nature.
- Private cloud is also known as an **internal cloud or corporate cloud**.
- Private cloud provides computing services to a **private internal network (within the organization)** and **selected users** instead of the general public.
- Private cloud provides a **high level of security** and **privacy** to data **through firewalls** and internal hosting.
- It also ensures that operational and sensitive data are **not accessible to third-party providers**.
- HP Data Centers, Microsoft, Elastra-private cloud, and Ubuntu are the **example of a private cloud**.

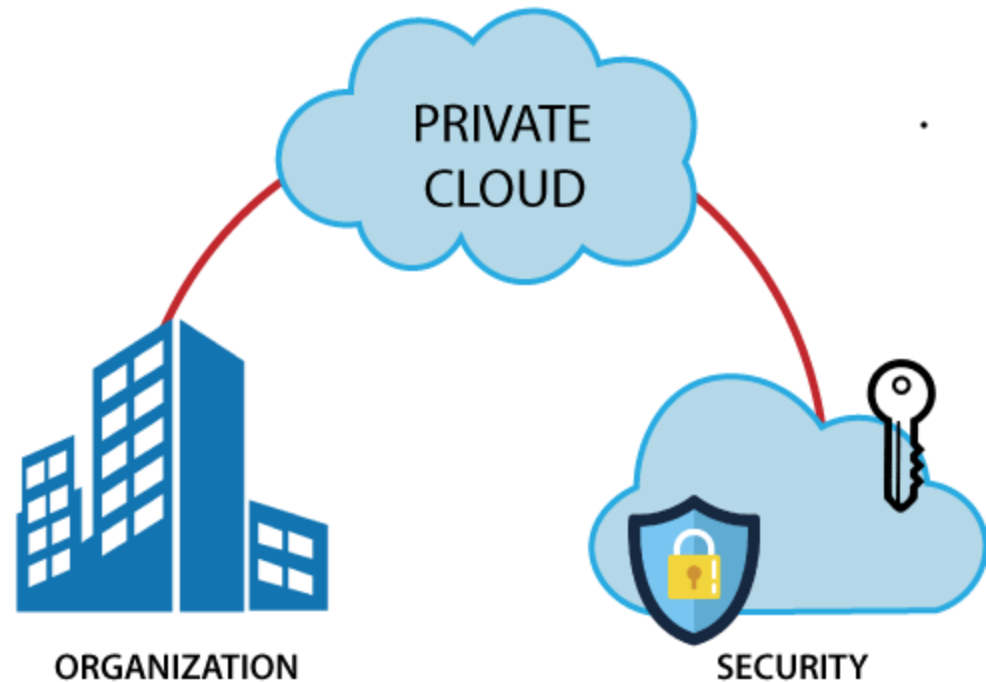
2. Private Cloud

Advantages:

- More Control
- Security & Privacy
- Improved Performance

Disadvantages:

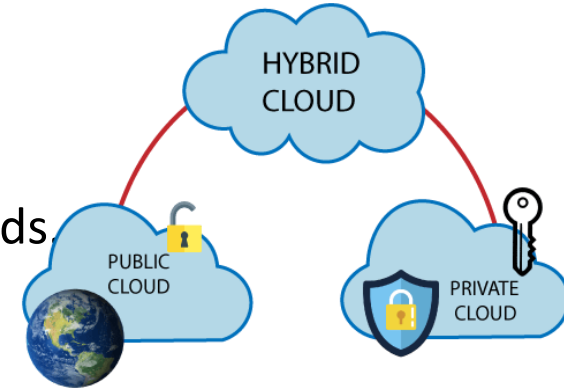
- High Cost
- Limited Scalability
- No Skilled people



3. Hybrid Cloud

- Hybrid cloud is a combination of **public and private** clouds

Hybrid cloud = public cloud + private cloud



- The main aim to combine these cloud (Public and Private) is **to create a unified, automated, and well-managed computing** environment.
- In the Hybrid cloud, **non-critical activities** are performed by the **public cloud** and **critical activities** are performed by the **private cloud**.
- Mainly, a hybrid cloud is used in finance, healthcare, and Universities.
- The best hybrid cloud provider companies are **Amazon, Microsoft, Google, Cisco, and NetApp**.

3. Hybrid Cloud

- Advantages
- **Flexible and secure**
 - It provides flexible resources because of the public cloud and secure resources because of the private cloud.
- **Cost effective**
 - Hybrid cloud costs less than the private cloud. It helps organizations to save costs for both infrastructure and application support.
- **Security**
 - Hybrid cloud is secure because critical activities are performed by the private cloud.
- **Risk Management**
 - Hybrid cloud provides an excellent way for companies to manage the risk.

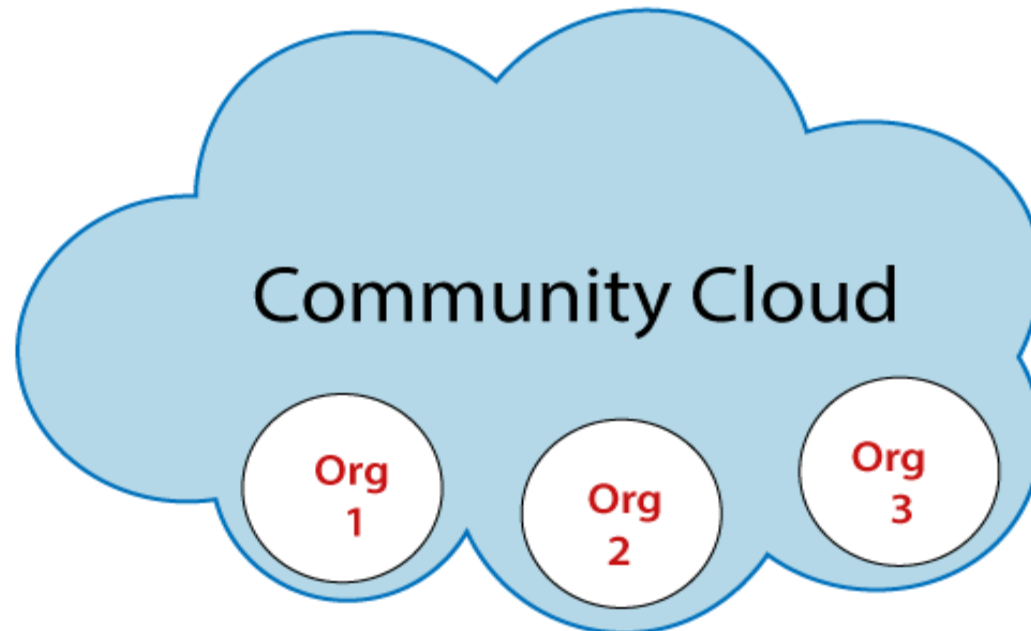
3. Hybrid Cloud

Disadvantages

- **Networking issues**
 - In the Hybrid Cloud, networking becomes complex because of the private and the public cloud.
- **Infrastructure Compatibility**
 - Infrastructure compatibility is the major issue in a hybrid cloud.
 - With dual-levels of infrastructure, a private cloud controls the company, and a public cloud does not, so there is a possibility that they are running in separate stacks.
- **Reliability**
 - The reliability of the services depends on cloud service providers.

4.Community Cloud

- Community cloud is a cloud infrastructure that allows systems and services to be accessible by a group of several organizations to share the information.
- It is owned, managed, and operated by one or more organizations in the community, a third party, or a combination of them.



Example:

Our government organization within India may share computing infrastructure in the cloud to manage data.

4.Community Cloud

Advantages:

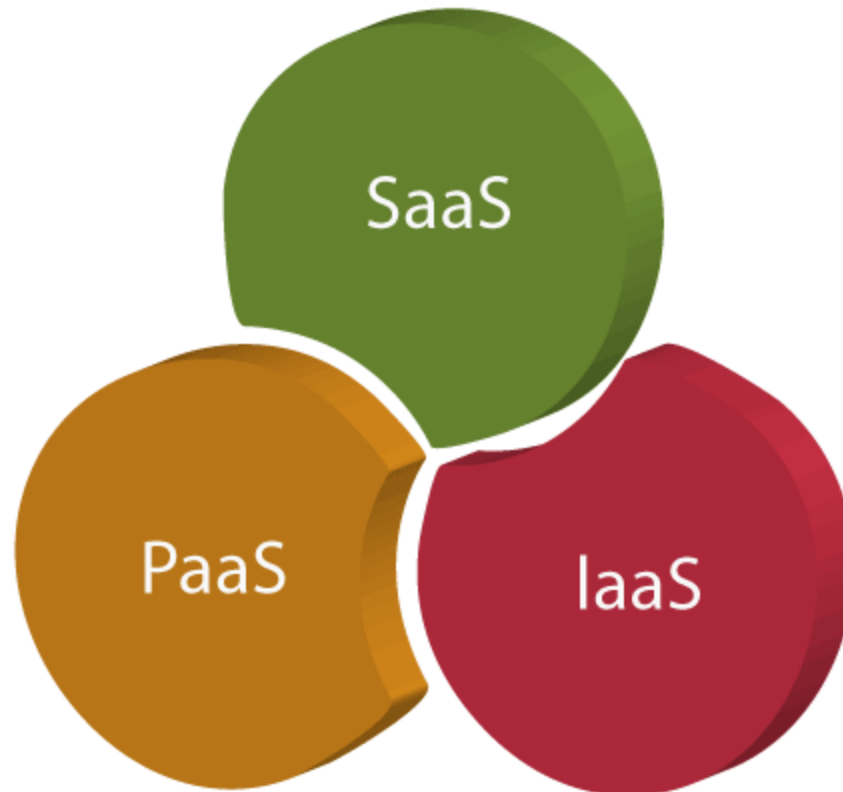
- **Cost effective(without costing a lot of money)**
 - Community cloud is cost effective because the whole cloud is shared between several organizations or a community.
- **Flexible and Scalable**
 - The community cloud is flexible and scalable because it is compatible with every user. It allows the users to modify the documents as per their needs and requirement.
- **Security**
 - Community cloud is more secure than the public cloud but less secure than the private cloud.
- **Sharing infrastructure**
 - Community cloud allows us to share cloud resources, infrastructure, and other capabilities among various organizations.

4.Community Cloud

- Disadvantages of Community Cloud
 - Community cloud is not a good choice for every organization.
 - Slow adoption to data
 - The **fixed amount of data storage and bandwidth** is shared among all community members.
 - Community Cloud is costly than the public cloud.
 - Sharing responsibilities among organizations is difficult.

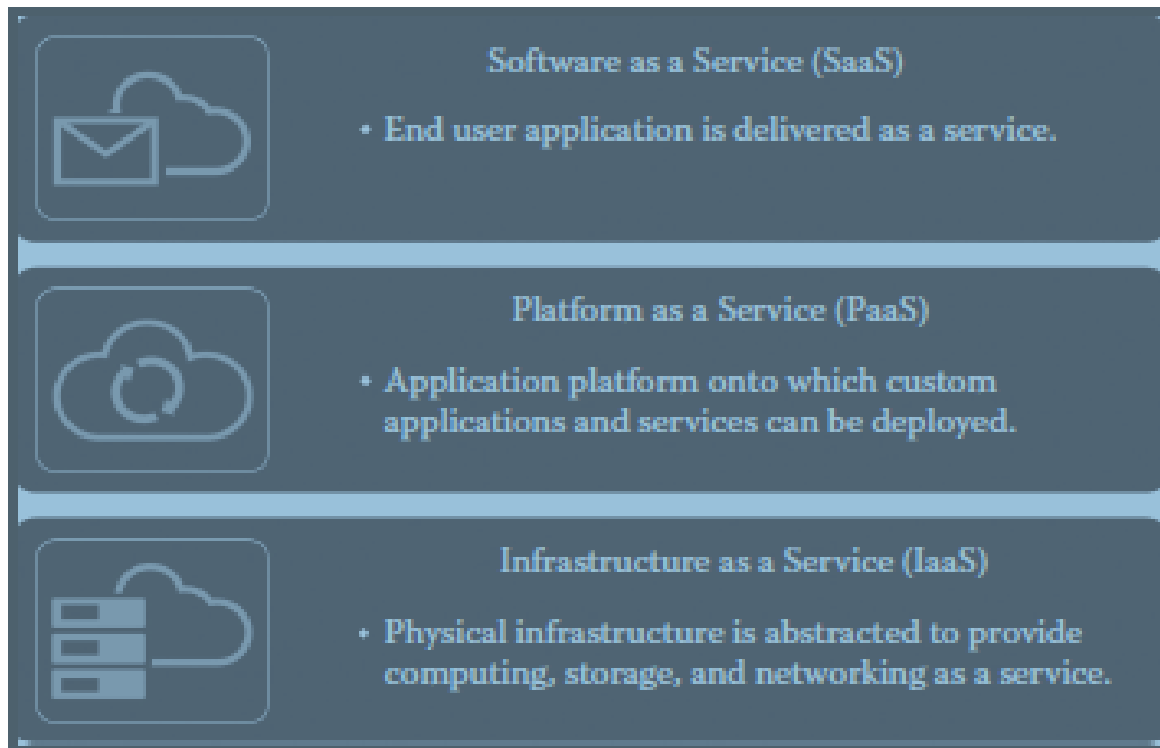
Three Service Models

- Three types of cloud service models -
 - [Software as a Service \(SaaS\)](#)
 - [Platform as a Service \(PaaS\)](#)
 - [Infrastructure as a Service \(IaaS\)](#)



Three Service Models

- The three kinds of services with which the cloud-based computing resources are available to end customers are as follows: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).
- It is also known as the service–platform–infrastructure (SPI) model of the cloud and is shown in figure



Three Service Models

- **SaaS** is a software distribution model in which applications (software, which is one of the most important computing resources) are hosted by a vendor or service provider and made available to customers over a network, typically the Internet.
- **PaaS** is a paradigm for delivering operating systems and associated services (e.g., computer aided software engineering [CASE] tools, integrated development environments [IDEs] for developing software solutions) over the Internet without downloads or installation.
- **IaaS** involves outsourcing the equipment used to support operations, including storage, hardware, servers, and networking components.

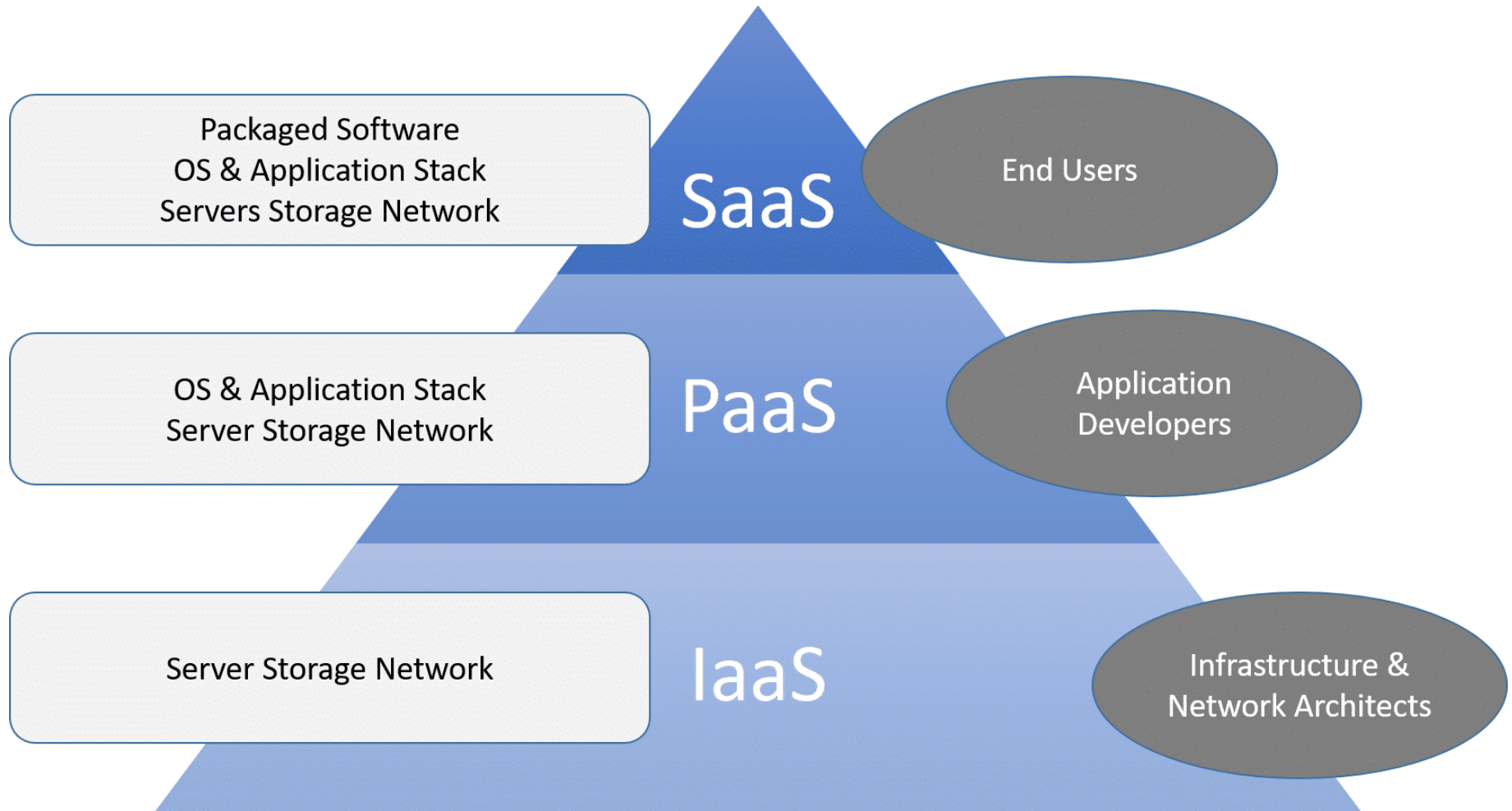
Three Service Models

Common examples of SaaS, PaaS, & IaaS

Platform Type	Common Examples
SaaS	Google Workspace, Dropbox, Salesforce, Cisco WebEx, Concur, GoToMeeting
PaaS	AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, OpenShift
IaaS	DigitalOcean, Linode, Rackspace, Amazon Web Services (AWS), Cisco Metapod, Microsoft Azure, Google Compute Engine (GCE)

Three Service Models

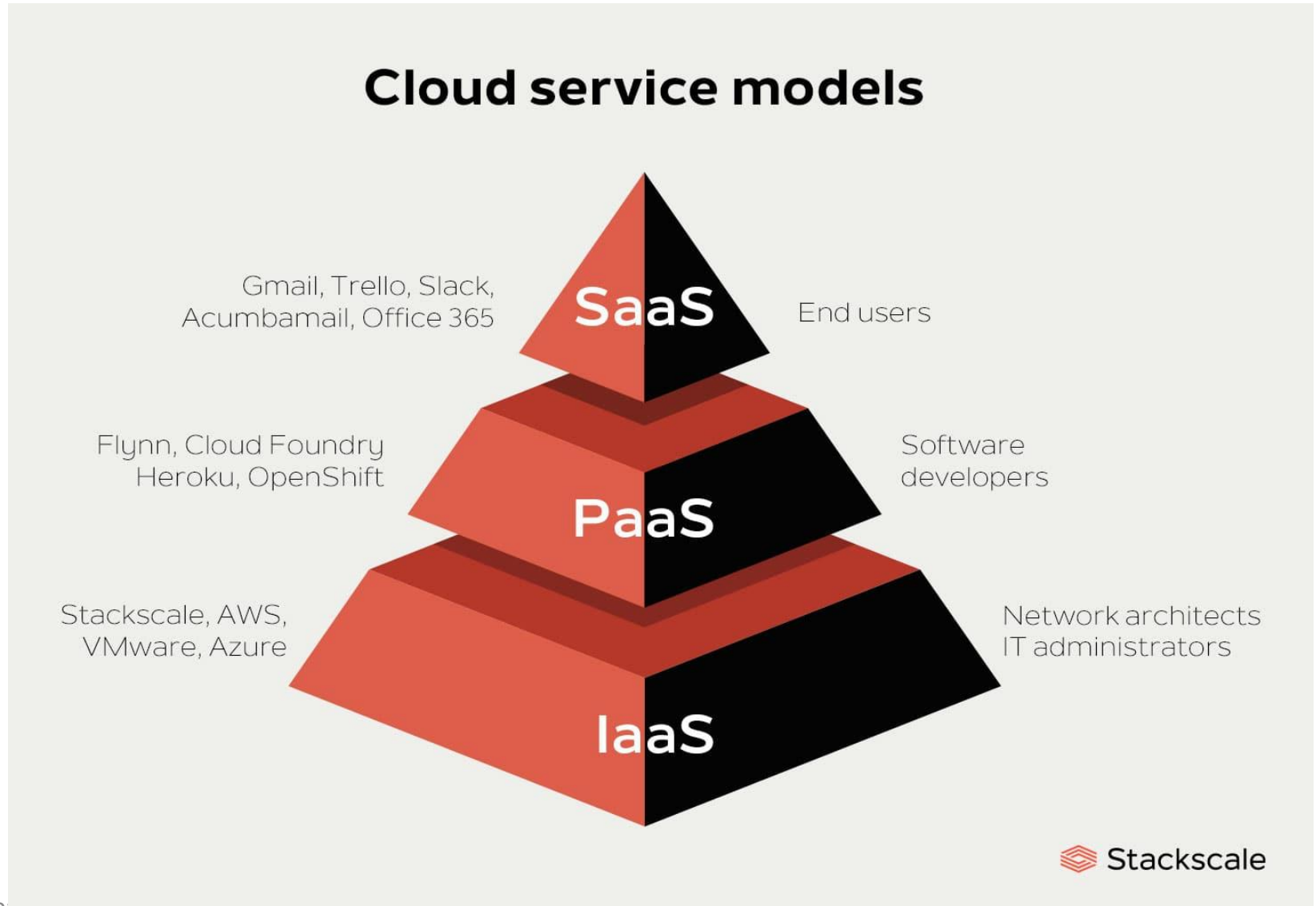
Cloud Service Models



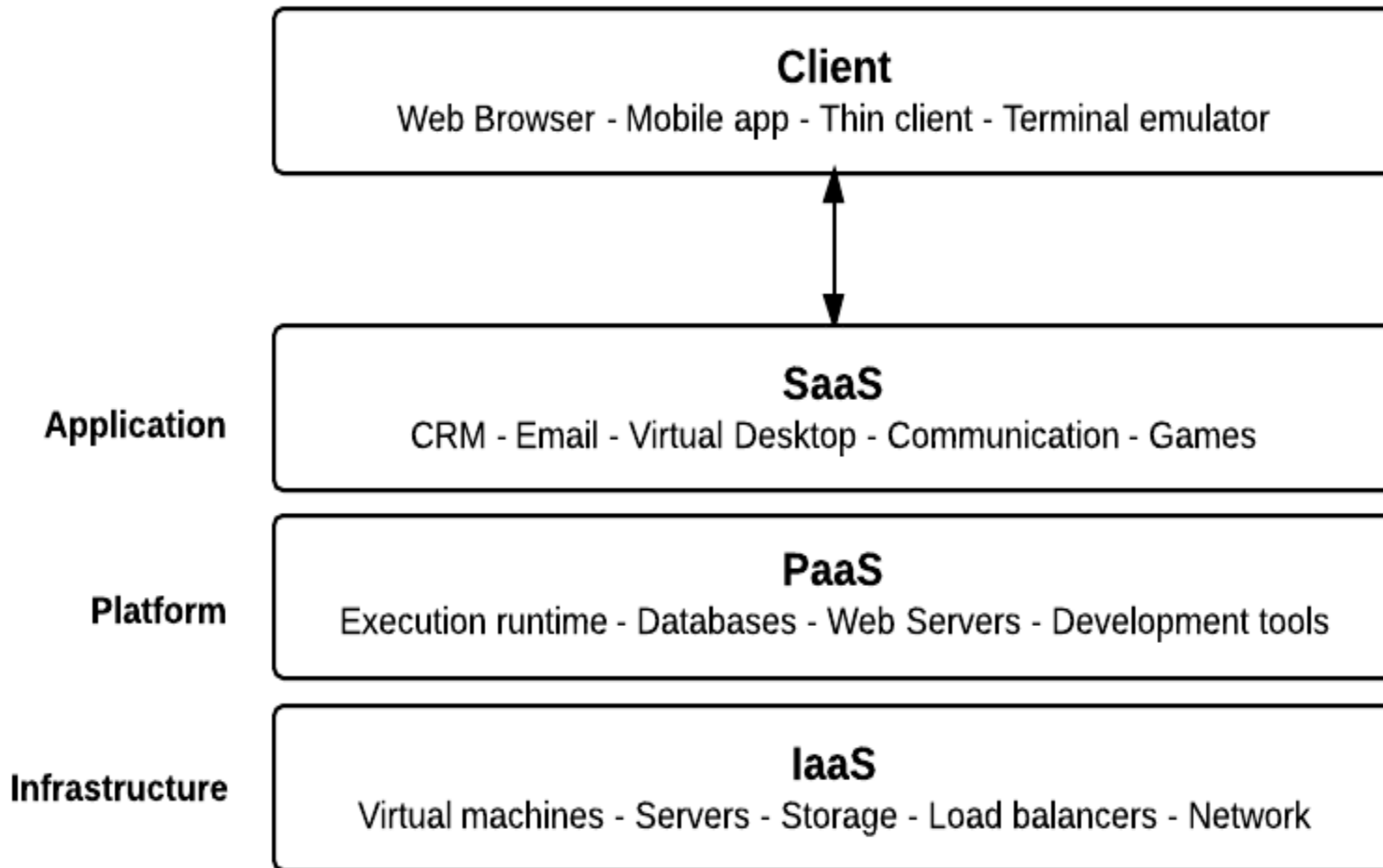
Three Service Models

IaaS	Paas	SaaS
It provides a virtual data center to store information and create platforms for app development, testing, and deployment.	It provides virtual platforms and tools to create, test, and deploy apps.	It provides web software and apps to complete business tasks.
It provides access to resources such as virtual machines, virtual storage, etc.	It provides runtime environments and deployment tools for applications.	It provides software as a service to the end-users.
It is used by network architects.	It is used by developers.	It is used by end users.
IaaS provides only Infrastructure.	PaaS provides Infrastructure+Platform.	SaaS provides Infrastructure+Platform +Software.

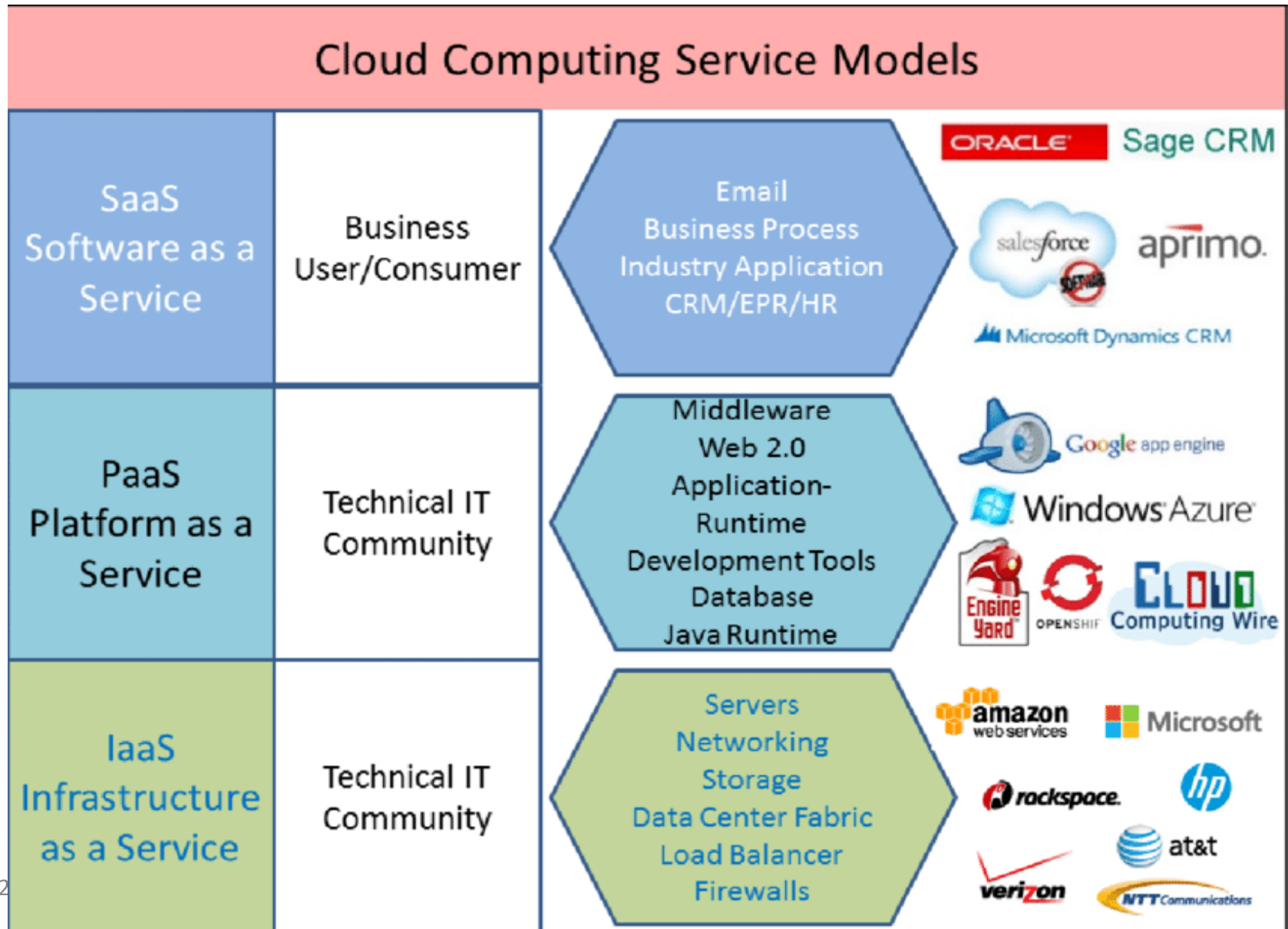
Three Service Models



Three Service Models



Three Service Models



Three Service Models

