

## What is Cloud?

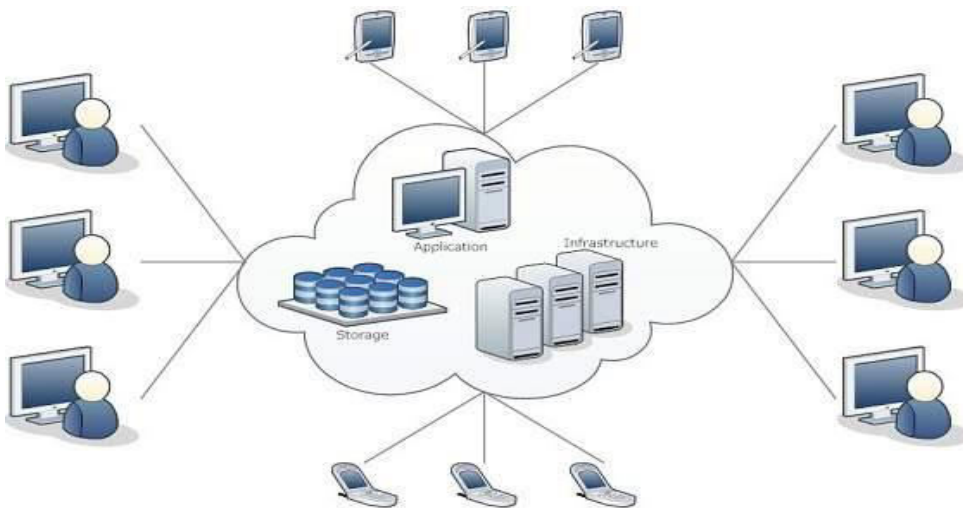
The term **Cloud** refers to a **Network** or **Internet**.

In other words, we can say that Cloud is something, which is present at remote location. Cloud can provide services over public and private networks, i.e., WAN, LAN or VPN.

Applications such as e-mail, web conferencing, customer relationship management (CRM) execute on cloud.

## What is Cloud Computing?

Cloud Computing refers to **manipulating, configuring, and accessing** the hardware and software resources remotely. It offers online data storage, infrastructure, and application.



Cloud computing offers **platform independency**, as the software is not required to be installed locally on the PC. Hence, the Cloud Computing is making our business applications **mobile** and **collaborative**.

Cloud Computing provides us resources of accessing the applications as utilities over the Internet. It allows us to create, configure, and customize the applications online.

## Basic Concepts

There are certain services and models working behind the scene making the cloud computing feasible and accessible to end users.

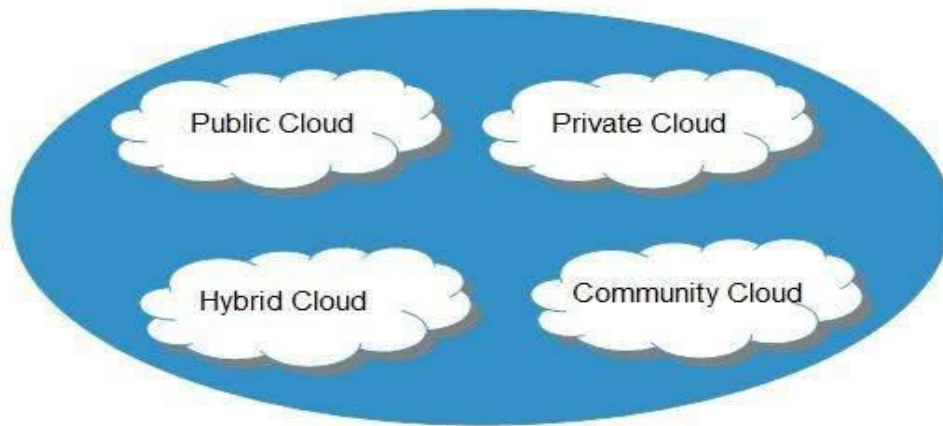
Following **are the working models for cloud computing:**

- **Deployment Models**
- **Service Models**

## Deployment Models:

Deployment models define the type of access to the cloud, i.e., how the cloud is located?

Cloud can have any of the four types of access: **Public, Private, Hybrid, and Community.**



### **Public Cloud:**

The **public cloud** allows systems and services to be easily accessible to the **general public**. Public cloud may be **less secure because of its openness**.

### **Private Cloud:**

The **private cloud** allows systems and services to be accessible **within an organization**. It is **more secured because of its private nature**.

### **Community Cloud:**

The **community cloud** allows systems and services to be accessible **by a group of organizations**.

### **Hybrid Cloud:**

The **hybrid cloud** is a **mixture of public and private cloud**, in which the critical activities are performed using private cloud while the non-critical activities are performed using public cloud.

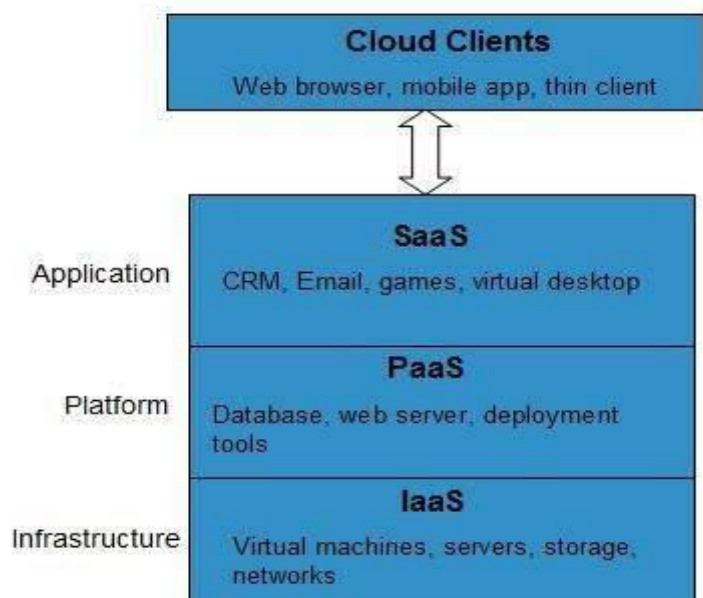
## Service Models:

Cloud computing is based on service models. These are categorized into three basic service models:-

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

**Anything-as-a-Service (XaaS)** is yet another service model, which includes Network-as-a-Service, Business-as-a-Service, Identity-as-a-Service, Database-as-a-Service or Strategy-as-a-Service.

The **Infrastructure-as-a-Service (IaaS)** is the most basic level of service. Each of the service models inherit the security and management mechanism from the underlying model, as shown in the following diagram:



#### Infrastructure-as-a-Service (IaaS):

**IaaS** provides access to fundamental resources such as physical machines, virtual machines, virtual storage, etc.

#### Platform-as-a-Service (PaaS):

**PaaS** provides the runtime environment for applications, development and deployment tools, etc.

#### Software-as-a-Service (SaaS):

**SaaS** model allows to use software applications as a service to end-users.

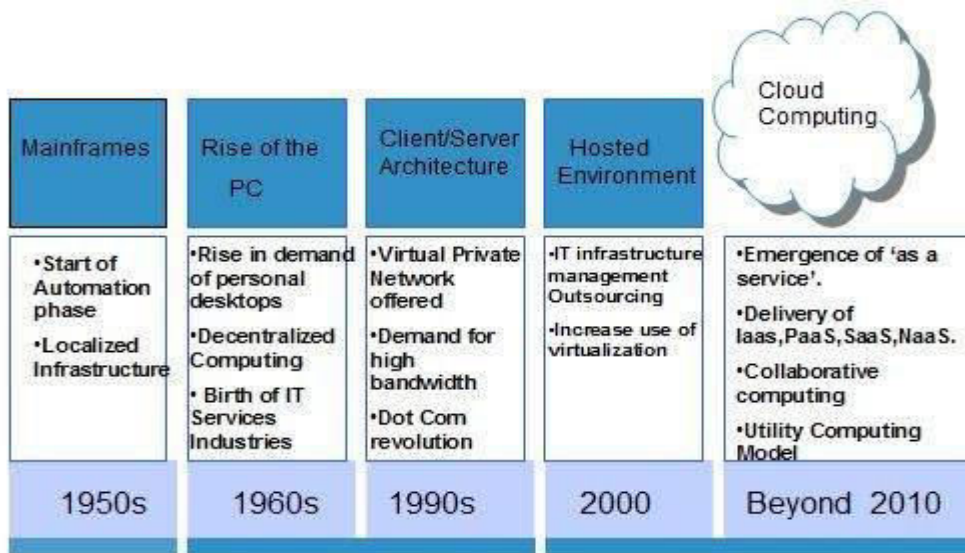
### History of Cloud Computing

The concept of **Cloud Computing** came into existence in the year 1950 with implementation of mainframe computers, accessible via **thin/static clients**.

Since then, cloud computing has been evolved from static clients to dynamic ones and from software to services.

[A **thin client** is a computer that runs from resources stored on a central server instead of a localized hard drive. **Thin clients** work by connecting remotely to a server-based computing environment where most applications, sensitive data, and memory, are stored.]

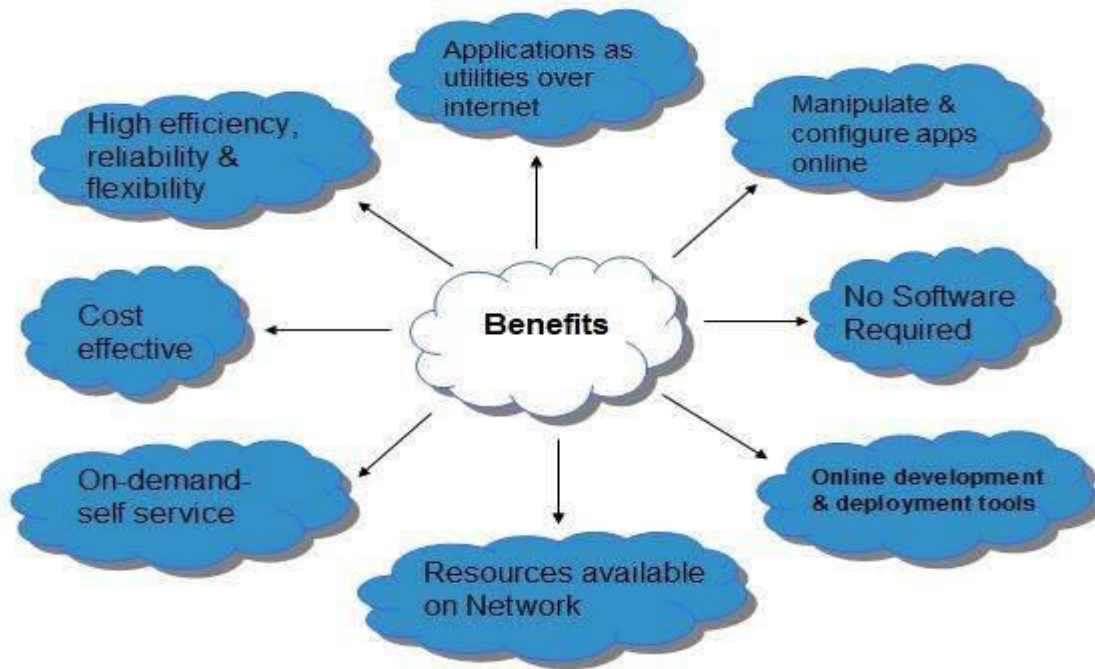
The following diagram explains the evolution of cloud computing:



## Benefits

Cloud Computing has numerous advantages. Some of them are listed below -

- One can **access applications as utilities**, over the Internet.
- One can **manipulate** and **configure** the applications **online at any time**.
- It does not require to install a software to access or manipulate cloud application.
- Cloud Computing offers online development and deployment tools, programming runtime environment through **PaaS model**.
- Cloud resources are available over the network in a manner that provide platform independent access to any type of clients.
- Cloud Computing offers **on-demand self-service**. The resources can be used without interaction with cloud service provider.
- Cloud Computing is highly cost effective because it operates at high efficiency with optimum utilization. It just requires an Internet connection
- Cloud Computing offers load balancing that makes it more reliable.



### Risks related to Cloud Computing:

Although cloud Computing is a promising innovation with various benefits in the world of computing, it comes with risks as below:

#### Security and Privacy:

It is the biggest concern about cloud computing. Since data management and infrastructure management in cloud is provided by third-party, it is always a risk to handover the sensitive information to cloud service providers.

Although the cloud computing vendors ensure highly secured password protected accounts, any sign of security breach may result in loss of customers and businesses.

#### Lock In:

It is very difficult for the customers to switch from one **Cloud Service Provider (CSP)** to another. It results in dependency on a particular CSP for service.

#### Isolation Failure:

This risk involves the failure of isolation mechanism that separates storage, memory, and routing between the different occupiers.

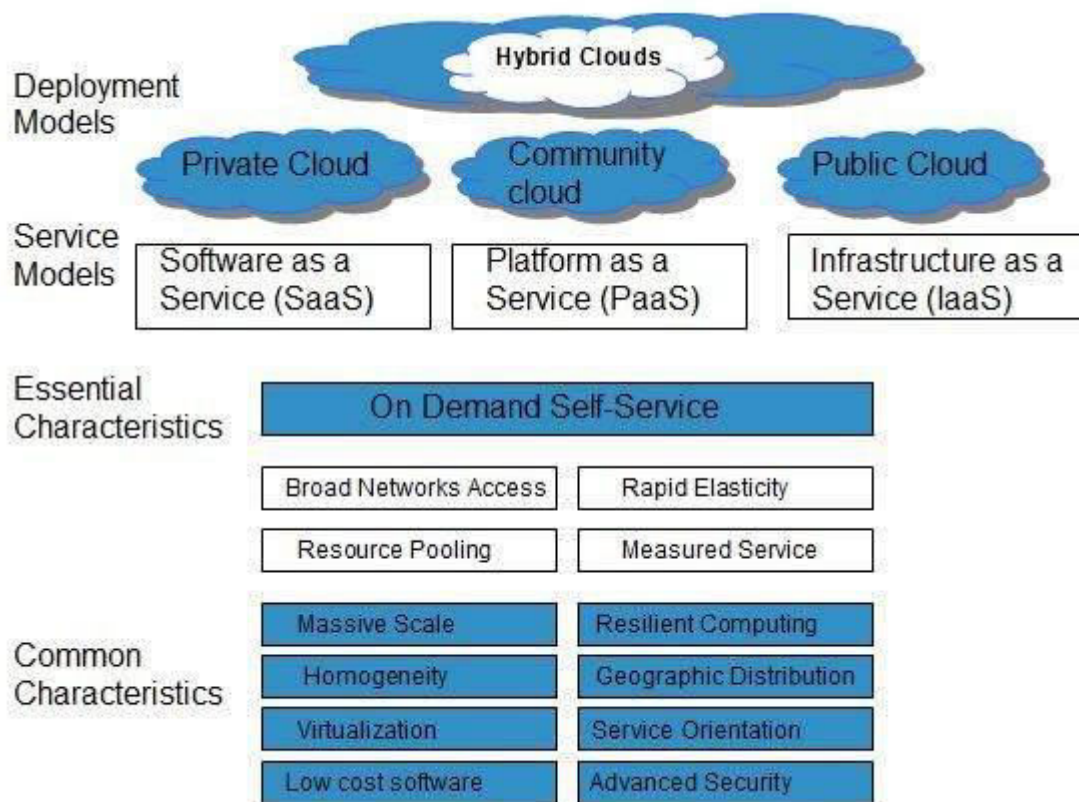
#### Management Interface Compromise:

In case of public cloud provider, the customer management interfaces are accessible through the Internet.

**Insecure or Incomplete Data Deletion:**

It is possible that the data requested for deletion may not get deleted. It happens because either of the following reasons

- Extra copies of data are stored but are not available at the time of deletion
- Disk that stores data of multiple occupiers is destroyed.

**Characteristics of Cloud Computing:**

Following are the **essential characteristics** of Cloud Computing:

**On Demand Self Service:**

Cloud Computing allows the users to use web services and resources on demand. One can logon to a website at any time and use them.

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



**Broad Network Access:**

Since cloud computing is completely web based, it can be accessed from anywhere and at any time.

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

**Resource Pooling:**

Cloud computing allows multiple residents to share a pool of resources. One can share single physical instance of hardware, database and basic infrastructure.

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.

**Rapid Elasticity:**

It is very easy to scale the resources vertically or horizontally at any time. Scaling of resources means the ability of resources to deal with increasing or decreasing demand.

The resources being used by customers at any given point of time are automatically monitored.

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

**Measured Service:**

In this service cloud provider controls and monitors all the aspects of cloud service. Resource optimization, billing, and capacity planning etc. depend on it.

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

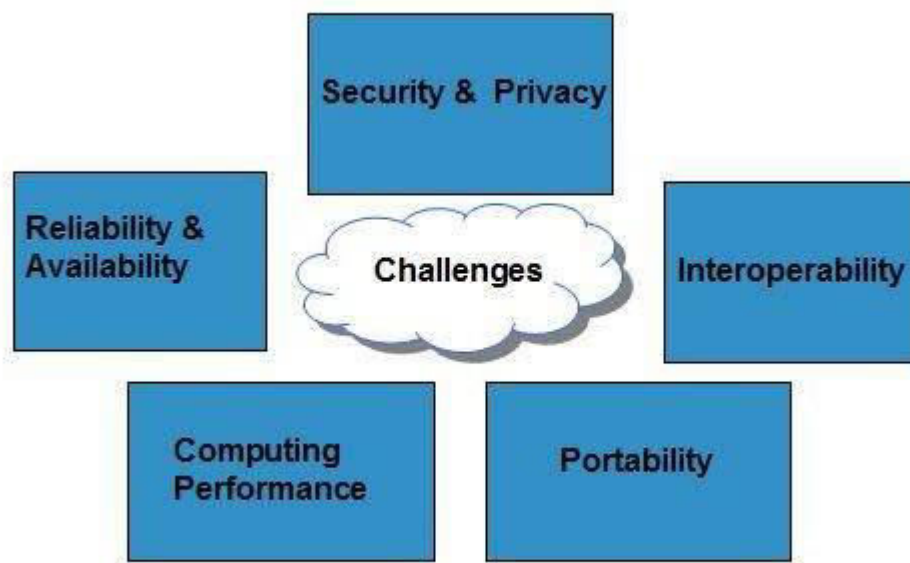
**Cloud Vulnerability**

**Vulnerability** is a cyber-security term that refers to a flaw in a system that can leave it open to attack. A **vulnerability** may also refer to any type of weakness in a computer system itself, in a set of procedures, or in anything that leaves information security exposed to a threat.

Denial of Service (DoS) and Distributed Denial of Service (DDoS) attacks are **cloud** security **vulnerabilities** that make servers inaccessible for users by flooding the network's traffic. Data Loss.

## Cloud Computing Challenges

Cloud computing, an emergent technology, has placed many challenges in different aspects of data and information handling. Some of these are shown in the following diagram:



### Security and Privacy:

Security and Privacy of information is the biggest challenge to cloud computing. Security and privacy issues can be overcome by employing encryption, security hardware and security applications.

### Portability:

This is another challenge to cloud computing that applications should easily be migrated from one cloud provider to another. There must not be vendor lock-in. However, it is not yet made possible because each of the cloud provider uses different standard languages for their platforms.

### Interoperability:

It means the application on one platform should be able to incorporate services from the other platforms. It is made possible via web services, but developing such web services is very complex.



**Computing Performance:**

Data intensive applications on cloud requires high network bandwidth, which results in high cost. Low bandwidth does not meet the desired computing performance of cloud application.

**Reliability and Availability:**

It is necessary for cloud systems to be reliable and robust because most of the businesses are now becoming dependent on services provided by third-party.

**Cloud Migration**

Cloud migration is the process of moving data, applications or other business elements to a cloud computing environment. ... However, a cloud migration could also involve moving data and applications from one cloud platform or provider to another -- a model known as cloud-to-cloud migration.

There are various types of cloud migrations an enterprise can perform. One common model is the transfer of data and applications from a local, on-premises data center to the public cloud.

The most important part of any cloud migration is making sure the migration gets your company where it needs to be. The four types of cloud migration are called lift and shift, shift to Software-as-a-Service (SaaS), application refactoring, and replatforming.

**Lift and Shift:**

**The** lift and shift approach is for organizations looking to get out of the data center and stop managing hardware.

Lift and shift provides the same software that your company used in the data center, but now in the cloud. There isn't any learning curve for the cloud applications, since they work exactly the same as before. This is the fastest method for migrating applications to the cloud, and the one that causes the least disruption. It only requires the involvement of the infrastructure and security teams, leaving everyone else free to pursue their work uninterrupted.

It's also the option with the least upfront cost. Moving the application to the cloud allows it to handle peak performance, without your company having to pay for it.

Lift and shift comes with its drawbacks, however. This cloud migration can't take full advantage of the speed and versatility the cloud can provide.

Since the process doesn't change the application – it just moves the code to a new location – the shifted version of the application doesn't usually have better performance than the original.

It's also unlikely to lead to long-term savings. This model is best suited to companies with a regular peak schedule and slow, predictable changes in the market.

Food delivery companies with their regular peaks on Monday, Saturday, and Sunday are a good example of the former.

Tax companies are a good example of the latter, since tax rules change on a yearly basis and new rules are released a year in advance, giving the companies plenty of time to prepare.

Lift and shift cloud migration involves copying, bit by bit, the workloads, tasks, and applications housed within an organization's virtual machines, and storing the replicated version in a cloud-based location. Because the data is simply a replication, no code is modified and no costly, time-consuming redesign is required during migration.

The method is certainly less complex than other migration techniques, IT teams and their cloud provider will want to be sure data sets are properly matched with handling systems in the new environment. Additionally, they need to ensure that all applications have the resources needed to operate effectively and efficiently.

### **Shift to SaaS: Save Time and Trouble:**

Companies that want to stop allocating time and resources to applications outside their core business should think about shifting to SaaS.

Shifting to SaaS means outsourcing one or more applications to a cloud services company that specializes in managing those applications. Companies do this on an application by application basis and only shift the applications they need to. Static applications can remain on-premises.

Shifting to SaaS frees employees up to focus on core competencies and the things that make a business unique and competitive.

It's extremely important when shifting an application to SaaS that you pick the right service.

The main drawback of shifting to SaaS, while you can personalize it, is that customizing it can lead to problems.

Shifting to SaaS should only be used for routine functions – not for anything that needs to be unique.

Email is a good example of a routine business function that can be shifted to SaaS. For example, we worked with a manufacturing company that built engine components. The company was sick of managing its own email. While it needed to have email for all its employees, the customers didn't care what the email service looked like – so long as it worked. We helped them find a hosting service that freed the company of needing to worry about their email so it could focus on manufacturing.

### **Application Refactoring: App Modernization:**

App modernization is a preferred approach for organizations that have specific applications which could benefit from the cloud.

With refactoring, organizations can copy their inheritance applications whole and unbroken onto a cloud platform.

What makes it low risk is that inheritance applications can run in parallel while new applications are constructed, with the immediate benefits of quickness and speed to market. This approach focuses on the applications that benefit the most from a cloud platform.

Refactoring is about prioritization; it provides lots of opportunities to save over time by minimizing spending on things you won't need once you're in the cloud.

You can save money on the platform itself as well by switching to cloud native services that cost less than the ones you use on-premises.

Refactoring is not just about cutting costs. It also allows you to make changes to your enterprise very quickly, which means that you can keep up with your customers.

Refactoring lets you respond faster and prioritize updates. One big box store we worked with started out with its applications so hard coded that it took months to do simple things like changing the font or background color. Refactoring got them moving.

Refactoring usually requires outside help. We worked with a company that wanted to refactor its entire application suite into modern technology. The project would have taken four years for the company working on their own, but we were able to cut that time down to eighteen months. We provided the company making the migration with its unique model for retraining.

When introducing the new technology, we rotate through everyone who needs training. Slowly, over time, we dial back how many consultants they have helping until the local IT people are able to handle everything on their own. This means that the IT staff learns by doing, so there is no awkward learning curve. At every point in the process, there is someone trained to handle difficulties on-site.

### **Replatforming: Develop Applications in the Cloud:**

Replatforming is for companies looking to hold benefits of the cloud, enterprise-wide.

These companies want their core capabilities to be scalable, flexible, robust, redundant, and available.

This is the hardest option to implement, requires the most planning for the future, and comes with the most upfront cost, but it's the only option that lets you utilize the full strength and flexibility of the cloud.

Replatforming is replacing the application at the code level to make it cloud native. This is a complete reimagination of the application and usually requires a complete rewrite.

When considering replatforming, think about how fast your company can change. Then think about how fast it needs to change to keep up with customers and the market.

By making applications truly cloud native, they can be updated and those updates pushed out at the speed of the cloud. This boosts the speed to change across the board for all aspects of the business.

Replatformed applications can also be designed to be more modular and thus easier to maintain.

Refactoring the application can save development time, since modules of code from your first refactored application can be used to extend the capabilities of new applications.

Unlike refactored applications, refactored platforms can work across multiple cloud providers. This makes it easier to port from one mobile platform to another, which positions replatforming as the ideal strategy for those looking to develop mobile applications.

We worked with a healthcare company building a net-new mobile application for patient management, which included sending push notifications on appointments and subscriptions. The company wanted to build this application as a cloud-native company. However, they already had internal patient managing applications for the nurses and doctors that complemented the new applications. The company used replatforming to get their inheritance patient management application to the cloud, so the application would be ready and waiting while it developed its net-new mobile application.

#### **Determine your goals before you select your cloud migration model:**

Each of the four primary methods we identified comes with its share of advantages, but also with its disadvantages. Finding the method that matches your organizations goals and needs is the first step to a successful migration.

### **Cloud Service Provider**

A cloud provider is a company that delivers cloud computing based services and solutions to businesses and/or individuals. This service organization may provide rented and provider-managed virtual hardware, software, infrastructure and other related services.

#### **Amazon Web Services:**

AWS is Amazon's cloud web hosting platform which offers fast, flexible, reliable and cost-effective solutions. It offers a service in the form of building block which can be used to create and deploy any kind of application in the cloud. It is the most popular as it was the first to enter the cloud computing space.

#### **Cloudways:**

Cloudways provides managed cloud hosting to agencies, stores, etc.

The platform has partnered with top cloud providers including AWS, Google Cloud, DigitalOcean, etc.

Experience the freedom to build, deploy and manage applications including PHP, WordPress, etc without requiring any knowledge of cloud server management.

Cloudways users can focus on business growth without worrying about the technical complexities of server management, security, and maintenance.

#### **DigitalOcean:**

Digitalocean's droplet is a scalable computer service. It is more than just virtual machines.

This cloud platform offers add-on storage, security, and monitoring capabilities to run production applications easily.

#### **Rackspace**

Rackspace is another useful cloud computer service tool. It offers services like hosting web applications, cloud files, cloud backup, database, and cloud server, etc.

#### **Alibaba Cloud:**

Alibaba is the largest Chinese cloud computing company. It is a new platform which created a global footprint with over 1500 Nodes worldwide of 19 regions and 56 availability zones across more than 200 countries.

[A content delivery network (**CDN**) is a system of distributed servers (network) that deliver pages and other web content to a user, based on the geographic **locations** of the user, the origin of the webpage and the content delivery server. ... CDNs also provide protection from large flows in traffic.]

#### **Microsoft Azure:**

Azure is a cloud computing platform which is launched by Microsoft in February 2010. This open source and flexible cloud platform which helps in development, data storage, service management & hosting solutions.

#### **Google Cloud Platform:**

Google Cloud is a set of solution and products which includes GCP & G suite. It helps you to solve all kind of business challenges with ease.

#### **Oracle Cloud:**

Oracle Cloud offers innovative and integrated cloud services. It helps you to build, deploy, and manage workloads in the cloud or on premises. Oracle Cloud also helps companies to transform their business and reduce complexity.

**IBM Cloud:**

IBM cloud is a full stack cloud platform which spans public, private and hybrid environments. It is built with a robust suite of advanced and AI tools.

**Roles and Responsibilities:**

There is a important growth of cloud adoption across small as well as large enterprises. This has resulted in a large spectrum of cloud offerings including cloud delivery models and a variety of cloud computing services that are being provided by cloud hosting companies.

**Improved accessibility and security:**

Cloud adoption not only helps improve business processes and enhances the efficiency of IT infrastructures but also brings down costs of running, upgrading, and maintaining on-site IT facilities.

Your business-critical data is armed with added security in the cloud environment. In reality, the data is not actually being placed up in the cloud but is distributed to a number of remote data center facilities that are owned and operated by third-party service providers. These establishments consist of climate-controlled rooms to house enterprise-grade servers for seamless protection and easy accessibility for maintaining business continuity in spite of any tragic event that may impact the main office of your enterprise.

The cloud data centers are designed to house a multitude of servers for storing data under strict security controls. The arrangement is aimed at enabling uninterrupted connectivity among vast networks comprising of millions of machines. Cloud computing is controled by end users as well as cloud hosting companies for the enhancement of their services.

**Understanding the cloud's role in businesses:**

In order to understand the precise reasons for increased cloud adoption in enterprise setups, we should have in-depth knowledge about of cloud's attributes that boost business processes.

Cloud services are designed to set your IT staff free from boring(ordinary) and time-consuming tasks of maintaining, repairing, and upgrading hardware equipment such as servers. On-site IT infrastructure in enterprises will be thinner after moving workloads to cloud data center. In the majority of cases, there will be no need to allocate separate space for housing servers and other IT equipment.

The direct benefit of cloud computing is associated with reduced capital expenditure as companies need not invest funds in purchasing costly hardware equipment. improvement of hardware costs is also backed by freedom from maintenance and repair costs of web servers. There is a definite reduction in upfront costs of ownership of cost-intensive software as well as hardware.

**Performance with a promise of security:**

In comparison with a physical server, a cloud hosting delivers better performance. This is because established web hosting service providers are in a better position to afford enterprise-grade cloud servers as against small or medium-sized enterprises.

Cloud hosting providers attach great importance to the security of customers' digital assets by spending a significant amount of financial and manpower resources. These providers harden the defences by the implementation of strict measures such as firewalls, anti-malware and anti-virus deployments. In addition to this, the host data centers are armed with barrier-like security for safeguarding physical as well as networking assets.

**Greater affordability:**

By provisioning top of the line hardware and software resources to customers at affordable prices, cloud hosting service providers help business enterprises reduce their capital as well as operating costs without impacting performance.

Cloud services go all out by investing huge sums of money to offer world-class resources to customers at economical prices. Their efficient staffs are well equipped to look after the routine tasks as well as technical problems irrespective of the time of the day for all weekdays.

**Demand-oriented resource provisioning:**

Users of cloud services are allowed to access the optimum amount of resources in response to resource requirements. This not only assures guaranteed resource availability but also helps businesses achieve resource optimization for reduction of operating costs.

Cloud-based infrastructure also enables users to access a variety of resources such as applications or platforms via any internet enabled device, from any location. These services are always available on round the clock basis for improved efficiency of enterprises. Employees can use a number of devices including smart-phones, tablets, and laptops to get their hands on a huge number of files and folders without the need to make a trip to the office. Cloud-based solutions are inherently flexible and accessible and businesses can easily keep their employees well-connected with each other for greater efficiency.

**Freedom from maintenance:**

On-site IT infrastructures are resource intensive and need to be regularly upgraded and maintained. In contrast, cloud service providers shoulder the entire responsibility of looking after the performance of servers, bandwidth, network, and software applications. This also includes periodic upgrades and security patching of operating systems and other business-critical applications.

This kind of infrastructure management requires large teams of software professionals to be available for 24 hours a day for 365 days in a year. Majority of companies that adopt cloud are



driven by the need to have consistently available, flexible, secure, and well managed IT infrastructure in the absence of any on-premise facility.

These are some of the valuable benefits of cloud computing that signify the role of cloud service providers. Therefore, the future of faultless data management is secure in the hands of established cloud service providers.

## **Cloud Service Consumer**

A cloud consumer represents a person or organization that maintains a business relationship with, and uses the service from a cloud provider.

A cloud consumer browses the service catalog from a cloud provider, requests the appropriate service, sets up service contracts with the cloud provider, and uses the service.

The main expectation of cloud service consumer is to have a reliable service.

To satisfy consumer's expectation several Data centres are established all over the world and each Data centre contain thousands of servers.

The idle servers and resources in data center wastes huge amount of energy.

An appealing customer experience is essential for consumer business. If you can't manage expectations for consumer fast enough, they too may go elsewhere.

### **1. Flexibility:**

Change is the only constant in the digital economy. A hybrid cloud model gives you the flexibility to adjust and grow.

This flexibility allows you to go after the big opportunities knowing that the location of your company's data won't be an obstacle.

The value is in more than just cost and speed, though these remain key principle for the public cloud.

The hybrid model also enables you to realize new insights across your entire ecosystem and quickly move priorities and resources to meet opportunities.

### **2. Freedom to choose:**

Never forget you have options. You need to be able to easily change where an application runs based on your business needs. Which cloud helps you realize the most value: public, private?

What if that changes? If you're locked in with a public vendor, for example, moving data without disturbance can be very costly and time-consuming.

Look for solutions that give you the freedom to choose, with easy application portability regardless of your architectural environment across any cloud.

Solutions like IBM WebSphere Application Server Version 9 are built to put clients in control, not cloud providers.

### 3. Cognitive insights:

We're living in the cognitive era, inseparable from cloud innovation.

Cognitive is the way to outthink the competition and make sense of information. What can your data do? Bring new customer experiences, new applications and even new business models, for starters.

IBM Cloud offers a host of accessible cognitive capabilities which you can build into your applications.

You can rapidly infuse apps with cognitive capabilities to gain operational insights and dazzle your customers. Use these cognitive capabilities to breathe new life into your existing investments and extend their value while still putting the customer first.

## Service level agreements in Cloud computing

A **Service Level Agreement (SLA)** is the bond for performance negotiated between the cloud services provider and the client.

Earlier, in cloud computing all Service Level Agreements were negotiated between a client and the service consumer. Nowadays, with the initiation of large utility-like cloud computing providers, most Service Level Agreements are standardized until a client becomes a large consumer of cloud services.

Service level agreements are also defined at **different levels** which are mentioned below:

- Customer-based SLA
- Service-based SLA
- Multilevel SLA

Few Service Level Agreements are enforceable as contracts, but mostly are agreements or contracts which are more along the lines of an Operating Level Agreement (OLA) and may not have the restriction of law.

It is fine to have an advocate review the documents before making a major agreement to the cloud service provider.

Service Level Agreements usually specify **some parameters** which are mentioned below:

1. Availability of the Service
2. Latency or the response time
3. Service components reliability
4. Each party accountability
5. Warranties

In any case, if a cloud service provider fails to meet the stated targets of minimums then the provider has to pay the penalty to the cloud service consumer as per the agreement. So, Service Level Agreements are like insurance policies in which the corporation has to pay as per the agreements if any casualty occurs.

Microsoft publishes the Service Level Agreements linked with the Windows Azure Platform components, which is demonstrative of industry practice for cloud service vendors.

Each individual component has its own Service Level Agreements.

Below are two **major Service Level Agreements (SLA)** described:

1. **Windows Azure SLA –**

Windows Azure has different SLA's for compute and storage. For compute, there is a guarantee that when a client deploys two or more role instances in separate fault and upgrade domains, client's internet facing roles will have external connectivity minimum 99.95% of the time. Moreover, all of the role instances of the client are monitored and there is guarantee of detection 99.9% of the time when a role instance's process is not runs and initiates properly.

2. **SQL Azure SLA –**

SQL Azure clients will have connectivity between the database and internet gateway of SQL Azure. SQL Azure will handle a "Monthly Availability" of 99.9% within a month. Monthly Availability Proportion for a particular tenant database is the ratio of the time the database was available to customers to the total time in a month. Time is measured in some intervals of minutes in a 30-day monthly cycle. Availability is always remunerated for a complete month. A portion of time is marked as unavailable if the customer's attempts to connect to a database are denied by the SQL Azure gateway.

Service Level Agreements are based on the usage model. Frequently, cloud providers charge their pay-as-per-use resources at a premium and deploy standards Service Level Agreements only for that purpose.

Clients can also subscribe at different levels that guarantees access to a particular amount of purchased resources.

The Service Level Agreements (SLAs) attached to a subscription many times offer various terms and conditions. If client requires access to a particular level of resources, then the client need to subscribe to a service.