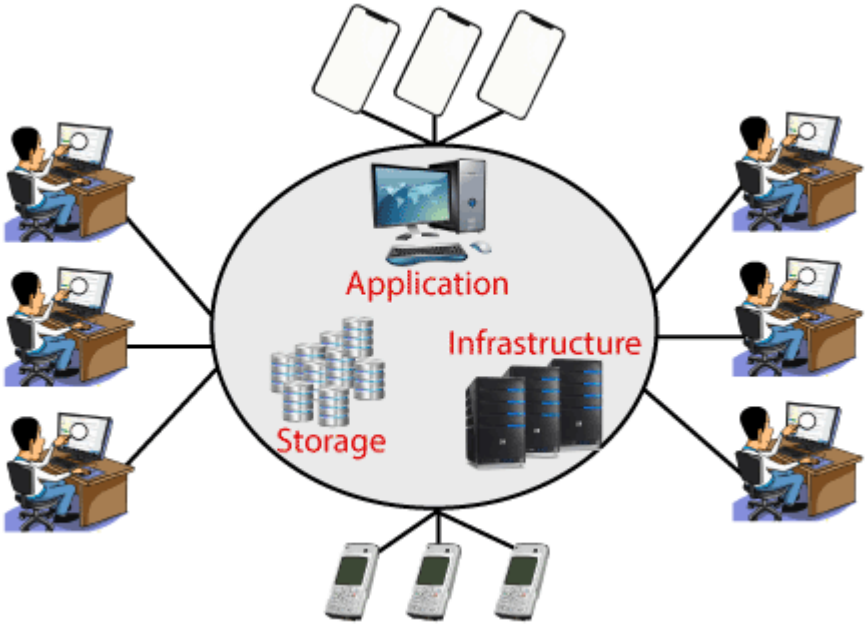
Introduction to Cloud Computing

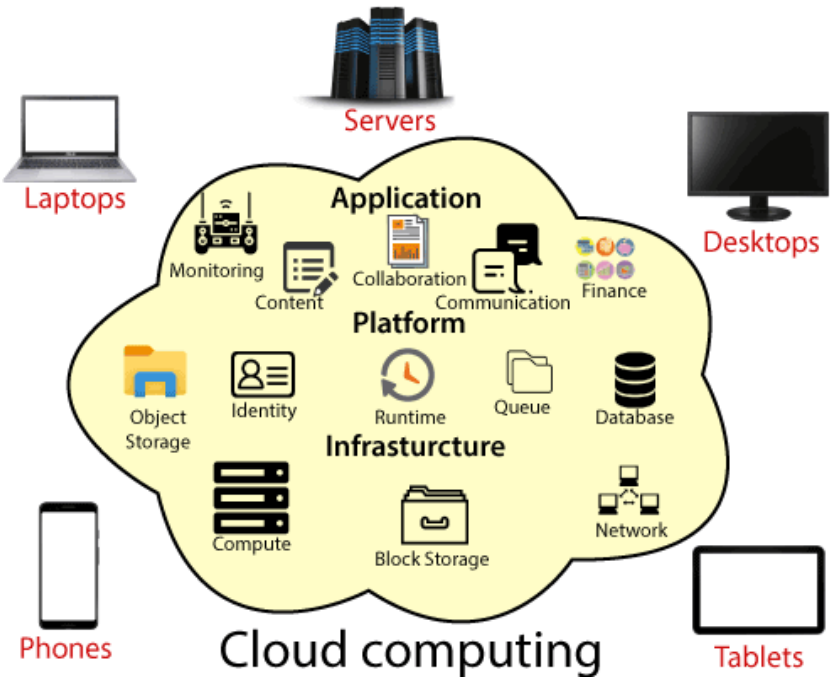
Cloud Computing is the delivery of computing services such as servers, storage, databases, networking, software, analytics, intelligence, and more, over the Cloud (Internet).



Cloud Computing provides an alternative to the on-premises datacentre. With an on-premises datacentre, we have to manage everything, such as purchasing and installing hardware, virtualization, installing the operating system, and any other required applications, setting up the network, configuring the firewall, and setting up storage for data. After doing all the set-up, we become responsible for maintaining it through its entire lifecycle.

But if we choose Cloud Computing, a cloud vendor is responsible for the hardware purchase and maintenance. They also provide a wide variety of software and platform as a service. We can take any required services on rent. The cloud computing services will be charged based on usage.

The cloud environment provides an easily accessible online portal that makes handy for the user to manage the compute, storage, network, and application resources. Some cloud service providers are in the following figure.



Cloud Computing Architecture

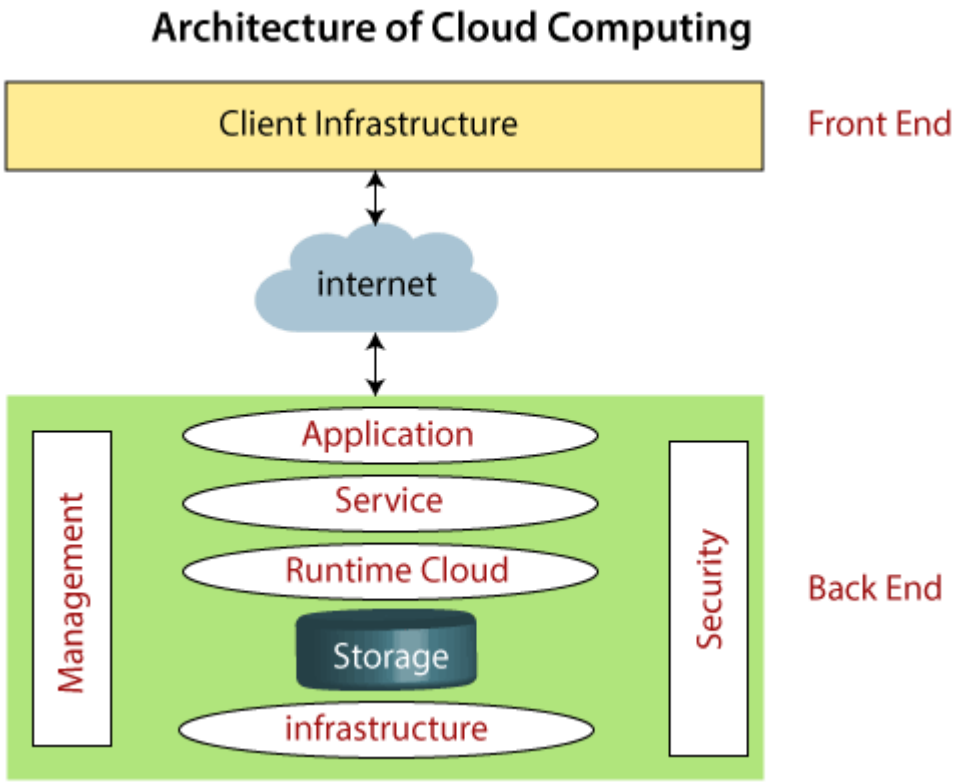
As we know, cloud computing technology is used by both small and large organizations to **store the information** in cloud and **access** it from anywhere at anytime using the internet connection.

Cloud computing architecture is a combination of **service-oriented architecture** and **event-driven architecture**.

Cloud computing architecture is divided into the following two parts -

- Front End
- Back End

The below diagram shows the architecture of cloud computing -



Front End

The front end is used by the client. It contains client-side interfaces and applications that are required to access the cloud computing platforms. The front end includes web servers (including Chrome, Firefox, internet explorer, etc.), thin & fat clients, tablets, and mobile devices.

Back End

The back end is used by the service provider. It manages all the resources that are required to provide cloud computing services. It includes a huge amount of data storage, security mechanism, virtual machines, deploying models, servers, traffic control mechanisms, etc.

Note: Both front end and back end are connected to others through a network, generally using the internet connection.

Components of Cloud Computing Architecture

There are the following components of cloud computing architecture -

1. Client Infrastructure

Client Infrastructure is a Front end component. It provides GUI (Graphical User Interface) to interact with the cloud.

2. Application :- The application may be any software or platform that a client wants to access.

3. Service :- A Cloud Services manages that which type of service you access according to the client's requirement.

Cloud computing offers the following three type of services:

- **Software as a Service (SaaS) –** It is also known as **cloud application services**. Mostly, SaaS applications run directly through the web browser means we do not require to download and install these applications. Some important example of SaaS is given below –

  Example: Google Apps, Salesforce Dropbox, Slack, Hubspot, Cisco WebEx.

- **Platform as a Service (PaaS) –** It is also known as **cloud platform services**. It is quite similar to SaaS, but the difference is that PaaS provides a platform for software creation, but using SaaS, we can access software over the internet without the need of any platform.

  Example: Windows Azure, Force.com, Magento Commerce Cloud, OpenShift.

- **Infrastructure as a Service (IaaS) –** It is also known as **cloud infrastructure services**. It is responsible for managing applications data, middleware, and runtime environments.

  Example:- Amazon Web Services (AWS) EC2, Google Compute Engine (GCE), Cisco Metapod.

4. Runtime Cloud:- Runtime Cloud provides the **execution and runtime environment** to the virtual machines.

5. Storage:- Storage is one of the most important components of cloud computing. It provides a huge amount of storage capacity in the cloud to store and manage data.

6. Infrastructure:- It provides services on the **host level**, **application level**, and **network level**. Cloud infrastructure includes hardware and software components such as servers, storage, network devices, virtualization software, and other storage resources that are needed to support the cloud computing model.

7. Management :- Management is used to manage components such as application, service, runtime cloud, storage, infrastructure, and other security issues in the backend and establish coordination between them.

8. Security :- Security is an in-built back end component of cloud computing. It implements a security mechanism in the back end.

9. Internet

The Internet is medium through which front end and back end can interact and communicate with each other

Service Oriented Architecture (SOA)

A Service-Oriented Architecture or SOA is a design pattern which is designed to build distributed systems that deliver services to other applications through the protocol. It is only a concept and not limited to any programming language or platform.

What is Service?

A service is a well-defined, self-contained function that represents a unit of functionality. A service can exchange information from another service. It is not dependent on the state of another service. It uses a loosely coupled, message-based communication model to communicate with applications and other services.

Advantages of SOA

SOA has the following advantages:

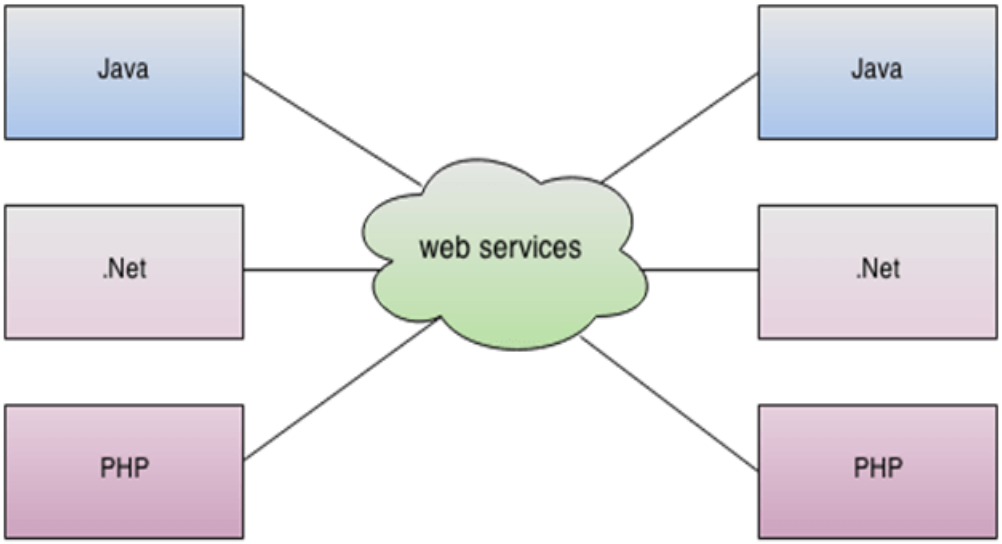
- **Easy to integrate** - In a service-oriented architecture, the integration is a service specification that provides implementation transparency.
- **Manage Complexity** - Due to service specification, the complexities get isolated, and integration becomes more manageable.
- **Platform Independence** - The services are platform-independent as they can communicate with other applications through a common language.
- **Loose coupling** - It facilitates to implement services without impacting other applications or services.
- **Parallel Development** - As SOA follows layer-based architecture, it provides parallel development.
- **Available** - The SOA services are easily available to any requester.
- **Reliable** - As services are small in size, it is easier to test and debug them.

What is Web Service

A **Web Service** is can be defined by following ways:

- It is a client-server application or application component for communication.
- The method of communication between two devices over the network.
- It is a software system for the interoperable machine to machine communication.
- It is a collection of standards or protocols for exchanging information between two devices or application.

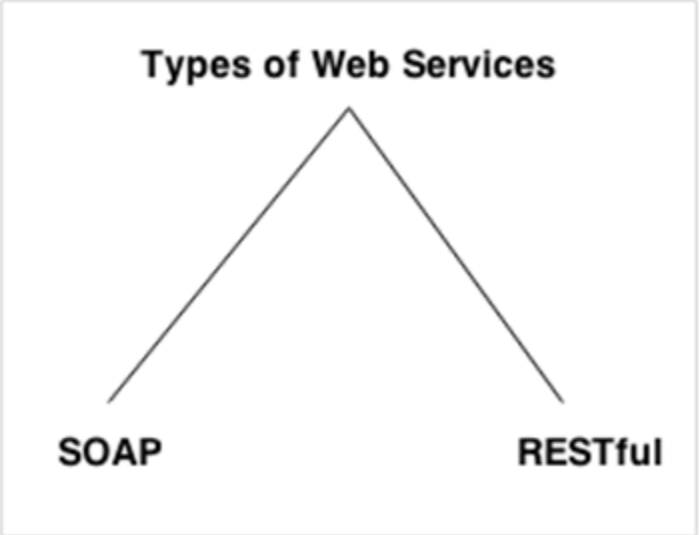
Let's understand it by the figure given below: :- As you can see in the figure, Java, .net, and PHP applications can communicate with other applications through web service over the network. For example, the Java application can interact with Java, .Net, and PHP applications. So web service is a language independent way of communication.



Types of Web Services

There are mainly two types of web services.

1. SOAP web services.
2. RESTful web services.



Web 2.0

Web 2.0 are websites and applications that make use of user-generated content for end-users. Web 2.0 is characterized by greater user interactivity and collaboration, more pervasive network connectivity and enhanced communication channels.

One of the most significant differences between Web 2.0 and the traditional World Wide Web (WWW, retroactively referred to as Web 1.0) is greater collaboration among Internet

users, content providers and enterprises. Originally, data was posted on Web sites, and users simply viewed or downloaded the content. Increasingly, users have more input into the nature and scope of Web content and in some cases exert real-time control over it.

The social nature of Web 2.0 is another major difference between it and the original, static Web. Increasingly, websites enable community-based input, interaction, content-sharing and collaboration. Types of social media sites and applications include forums, microblogging, social networking, Social bookmarking, social curation, and wikis.

Elements of Web 2.0

- **Wikis**: Websites that enable users to contribute, collaborate and edit site content. Wikipedia is one of the oldest and best-known wiki-based sites.
- The increasing prevalence of **Software as a Service** (SaaS), web apps and cloud computing rather than locally-installed programs and services.
- **Mobile computing**, also known as nomadicity, the trend toward users connecting from wherever they may be. That trend is enabled by the proliferation of smartphones, tablets and other mobile devices in conjunction with readily accessible Wi-Fi networks.
- **Mash-ups:** Web pages or applications that integrate complementary elements from two or more sources.
- **Social networking**: The practice of expanding the number of one's business and/or social contacts by making connections through individuals. Social networking sites include Facebook, Twitter, LinkedIn and Google+.
- Collaborative efforts based on the ability to reach large numbers of participants and their collective resources, such as crowdsourcing, crowdfunding and crowdsource testing.
- **User-generated content (UGC):** Writing, images, audio and video content -- among other possibilities -- made freely available online by the individuals who create it.
- **Unified communications (UC):** The integration of multiple forms of call and multimedia/cross-media message-management functions controlled by an individual user for both business and social purposes.
- **Social curation:** The collaborative sharing of content organized around one or more particular themes or topics. Social content curation sites include Reddit, Digg, Pinterest and Instagram.

What is a mashup in web technology.

A Mashup (also known as web application hybrid), is a technique that websites use to provide resources, functionalities, and services from multiple sources. To put it in layman's terms, a mashup works as an aggregator of different services. They mostly use public APIs that are generally free to use and thus, create a new service from existing ones.

Types of Mashups:

1) **Business mashups:** They are the services that power their application and resources with the help of external web services. Thus, they promote collaborative action between businesses and developers. They provide users with a better and interactive user interface and promise users a collection of variegated information.
2) **Consumer mashups:** They are applications that make use of different data from the available public datasets and provide a simple browser user interface that is more easily accessible. Users can use the information in a simple, elegant, and organized way using these types of applications.
3) **Data mashups**: These applications, contrasting to consumer mashups, use the same type of data that is available on different sources, and then combine them to create an entirely new source that has all the information that cannot be found at a single source.

Architectural Levels:

There are three levels that define the architecture of a mashup:

1) **Presentation or User Interaction Layer**: This is the user interface of the mashup. Technologies: HTML, CSS, AJAX, JavaScript and XML.
2) **Web Services**: Accessing products functionality with API services. Tools: XMLHTTPRequest and SOAP.
3) **Data**: Data handling like sending, storing, and receiving of data. Technologies: JSON, XML.

Examples:

Google Maps is one of the most popular services that is used by a lot of other companies/services. Applications that provide information about road conditions, using maps to show social media friends' location, providing ratings of different cities, etc. are some services that combine Google's data and use it in their own application.

Amazon e-commerce is another one of the most popular services that some mashup websites use. Their API can be used in applications such as viewing product availability over different websites, cost comparison of a particular product over different websites, etc.

Advantages:

Using mashups has become an important and popular part of the web. It has several benefits described below:

- Providing aggregated content in one place so that users don't have to browse through different services.
- A more rich, interactive user interface.
- The development cycle is generally faster, due to the reason that developers require less code to build them.
- Promoting greater collaborations between companies/services.
- The cost of developing a mashup website is comparatively lower because of the reduced effort in application development.

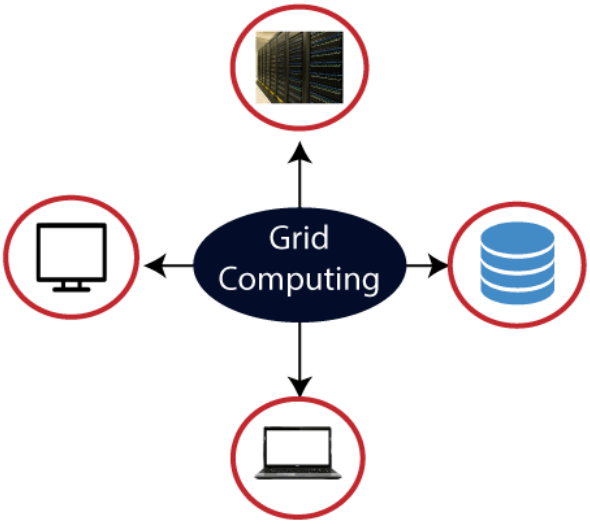
Disadvantages:

- Although mashups seem to be a great option, it has some disadvantages as discussed below:
- The features of the mashup website are completely dependent on other developers, i.e. they can implement the features that are defined in the API of other websites and cannot be flexible about them.
- If the API/service of a website gets discontinued, it directly affects the mashup website.
- Contents that are being used in the mashup website are not completely secure.
- Lack of scalability is a major concern since it is unpredictable that the service used by the mashup website will be able to handle large traffic.

Grid Computing

Grid computing is also called as "**distributed computing**." It links multiple computing resources (PC's, workstations, servers, and storage elements) together and provides a mechanism to access them.

The main advantages of grid computing are that it increases user productivity by providing transparent access to resources, and work can be completed more quickly.



Advantages of Grid Computing:

1) It is not centralized, as there are no servers required, except the control node which is just used for controlling and not for processing.
2) Multiple heterogeneous machines i.e. machines with different Operating Systems can use a single grid computing network.
3) Tasks can be performed parallelly across various physical locations and the users don't have to pay for them (with money).

Disadvantages of Grid Computing :

The software of the grid is still in the involution stage.

Cloud Computing	Grid Computing
Cloud Computing follows client-server computing architecture.	Grid computing follows a distributed computing architecture.
Scalability is high.	Scalability is normal.
Cloud Computing is more flexible than grid computing.	Grid Computing is less flexible than cloud computing.
Cloud operates as a centralized management system.	Grid operates as a decentralized management system.
In cloud computing, cloud servers are owned by infrastructure providers.	In Grid computing, grids are owned and managed by the organization.
Cloud computing uses services like Iaas, PaaS, and SaaS.	Grid computing uses systems like distributed computing, distributed information, and distributed pervasive.
Cloud Computing is Service-oriented.	Grid Computing is Application-oriented.
It is accessible through standard web protocols.	It is accessible through grid middleware.

1) A super fast interconnect between computer resources is the need of hour.
2) Licensing across many servers may make it prohibitive for some applications.
3) Many groups are reluctant with sharing resources .
4) Let's understand the difference between cloud computing and grid computing.

Utility Computing :

Utility Computing, as name suggests, is a type of computing that provide services and computing resources to customers. It is basically a facility that is being provided to users on their demand and charge them for specific usage. It is similar to cloud computing and therefore requires cloud-like infrastructure.

- It is process architecture that provide on-demand computing resources and infrastructure on basis of pay per use method.
- It allows organization to allocate and segregate computing resources and infrastructure to various users on basis of their requirements.
- It simply reduces IT costs, easier to manage, provide greater flexibility, compatibility, provide more convenience, etc.
- It mainly focuses on acquiring computing resources.
- It is of two type i.e., Internal and external utility.

- It is used in large organizations such as Amazon, Google, etc., where they establish their own utility services for computing storage and applications.

- Its main purpose is to make computing resources and infrastructure management available to customer as per their need, and charge them for specific usage rather than flat rate.
- Its characteristics include scalability, demand pricing, standardized utility computing services, automation, etc

Hardware Virtualization

Previously, there was *"one to one relationship"* between physical servers and operating system. Low capacity of CPU, memory, and networking requirements were available. So, by using this model, the costs of doing business increased. The physical space, amount of power, and hardware required meant that costs were adding up.

The **hypervisor** *manages shared the physical resources of the hardware between the guest operating systems and host operating system*. The physical resources become abstracted versions in standard formats regardless of the hardware platform. The abstracted hardware is represented as actual hardware. Then the virtualized operating system looks into these resources as they are physical entities.

Virtualization means abstraction. Hardware virtualization is accomplished by abstracting the physical hardware layer by use of a hypervisor or VMM (Virtual Machine Monitor).

When the virtual machine software or virtual machine manager (VMM) or hypervisor software is directly installed on the hardware system is known as hardware virtualization.

The main **job of hypervisor** is to control and monitoring the processor, memory and other hardware resources.

After virtualization of hardware system we can install different operating system on it and run different applications on those OS.

Usage of Hardware Virtualization

Hardware virtualization is mainly done for the server platforms, because controlling virtual machines is much easier than controlling a physical server.

Advantages of Hardware Virtualization

The main benefits of hardware virtualization are more efficient resource utilization, lower overall costs as well as increased uptime and IT flexibility.

1) More Efficient Resource Utilization:

Physical resources can be shared among virtual machines. Although the unused resources can be allocated to a virtual machine and that can be used by other virtual machines if the need exists.

2) Lower Overall Costs Because Of Server Consolidation:

Now it is possible for multiple operating systems can co-exist on a single hardware platform, so that the number of servers, rack space, and power consumption drops significantly.

3) Increased Uptime Because Of Advanced Hardware Virtualization Features:

The modern hypervisors provide highly orchestrated operations that maximize the abstraction of the hardware and help to ensure the maximum uptime. These functions help to migrate a running virtual machine from one host to another dynamically, as well as maintain a running copy of virtual machine on another physical host in case the primary host fails.

4) Increased IT Flexibility:

Hardware virtualization helps for quick deployment of server resources in a managed and consistent ways. That results in IT being able to adapt quickly and provide the business with resources needed in good time.

Characteristics of Cloud Computing

On-demand self-service

Cloud computing delivers on-demand service. It provides the feature of monitoring server uptime with computing capabilities to the end-users. Cloud computing provides pre-defined network storage that enables the end-users to monitor their computing capabilities. Cloud computing works on a self-service model. They help end-users to make better decisions as they know how to use cloud computing services.

Multi-tenancy and resource pooling

One of the most important features of cloud technology is multi-tenancy. It can be defined as the software architecture that enables the single program instance to provide services to multiple end-users. This feature enables the usage of the same computing resources by multiple customers.

Broad network access

Cloud computing is achieved through standard computing mechanisms, and this feature helps promote heterogeneous thick and thin client platforms.

Examples of such platforms comprise mobile phones, laptops, dedicated workstations, and tablets. The capabilities are delivered across multiple networks. Cloud computing, therefore, helps break barriers and boundaries as they function across multiple geographies.

Rapid elasticity and scalability

The cloud computing capabilities can be released elastically. It enables you to scale the cloud computing services inward and outward, and it helps to be commensurate with the dynamic demand posted by the end-users.

Resource pooling

Cloud computing delivers affordable resource pooling solutions. With resource pooling, organizations can reduce substantial computing costs, and it helps in the dynamic pooling of resources that enable them to deliver computing services to several consumers.

Measured and reporting service

Cloud systems offer the metering capability to monitor, control, and optimize the usage of cloud resources. This feature can be defined as a measured service. The metering capability is placed at some level of the abstraction of applicable services. Therefore, this feature enables transparency for both the provider of service and the consumer.

Automation

Through automation, IT teams and developers maintain and modify cloud services. When cloud infrastructure is in place, it ensures minimum interaction from humans. All the configurations are installed to ensure the monitoring and maintenance of cloud computing services, and such configurations are mostly automated. Therefore, automation in cloud computing facilitates the faster expansion of cloud services.

Resilience

Cloud computing delivers continuous server uptime, and hence it offers resilient services. It offers the capability to recover from any service interruption. The cloud service provider also develops strategies that boost disaster management, achieved by maintaining backup cloud nodes.

Large Network Access

Cloud computing is so versatile that it enables its users to access cloud services. These fundamental characteristics of Cloud Computing also enable them to upload data to the cloud from anywhere. For this, you need to have a decent internet connection and a robust device that helps make a connection to the cloud.

Work from any location

Cloud computing promotes the feature of remote working. It helps the end-user function, work, or deliver remote services from any location. Users are therefore able to access company data even on their smartphones or through laptops. It also enables users to connect with one another quickly.

Comfortable payment structure

Cloud computing offers a flexible payment structure that plays an important role in the cost-cutting of organizations. Pricing varies based on the features and functionalities chosen by a customer.

The payment options provided by the cloud service providers to the end-users are very simple and streamlined, which aides them in saving on substantial costs and time.

Service Excellence

Cloud computing delivers end-users with a wide range of services. The cloud service providers share end users' service level agreements with their clients.

It also provides documentation on how they would achieve continuous availability and bandwidth of their clients' services.

Easy maintenance

Easy maintenance is one of the critical features of cloud computing. The client is never involved in maintenance-related services. Its managed by the cloud computing provider. The maintenance services are so well planned that the downtime remains significantly low. Moreover, the cloud undergoes regular updates that help in capability optimization.

Flexibility

The end-users benefit from the flexibility offered by the cloud services when they host data in the dedicated cloud. This ensures that the end-users can do away from traditional hosting techniques wherein they had to change or switch the service providers more frequently.

Economical and Security

This feature is one of the key aspects of cloud computing. It helps the big organizations to save a substantial amount on IT-related expenditure. You need to pay a small fee to the third-party providers to ensure that the cloud space is adequately administered and maintained. This also helps in boosting security in exchange for a nominal fee.

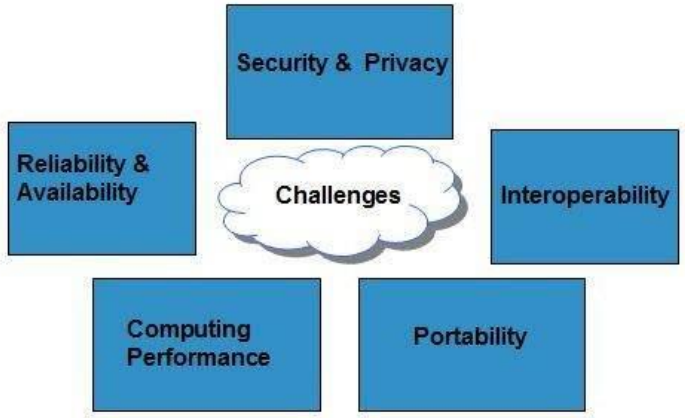
Availability

Cloud computing offers highly resilient services, and the cloud services are available for 24 x7 duration if the cloud resource faces downtime, the system recovers and starts within no time.

While the cloud service makes a recovery, information stored in servers, networks, and databases remains to be secured. Since cloud services can be accessed from any geographical location, their services remain available most of the time

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.

Economics of Cloud Computing

Economics of Cloud Computing is based on the PAY AS YOU GO method. Users/Customers must have to pay only for their way of the usage of the cloud services. It is definitely beneficial for the users. So the Cloud is economically very convenient for all. Another side is to eliminate some indirect costs which is generated by assets such as license of the software and their support. In the cloud, users can use software applications on a subscription basis without any cost because the property of the software providing service remains to the cloud provider.

Economical background of the cloud is more useful for developers in the following ways:

- Pay as you go model offered by cloud providers.
- Scalable and Simple.

Cloud Computing Allows:

- Reduces the capital costs of infrastructure.
- Removes the maintenance cost.
- Removes the administrative cost.

What is Capital Cost?

It is cost occurred in the purchasing infrastructure or the assets that is important in the production of goods. It takes a long time to generate profit.

In the case of start-ups, there is no extra budget for the infrastructure and its maintenance. So cloud can minimizes expenses of any small organization in terms of economy. It leads to the developers can only focus on the development logic and not on the maintenance of the infrastructure.

There are three different Pricing Strategies that are introduced by Cloud Computing: Tiered Pricing, Per-unit Pricing, and Subscription-based Pricing. These are explained as following below.

- **Tiered Pricing:** Cloud Services are offered in the various tiers. Each tier offers to fix service agreements at a specific cost. Amazon EC2 uses this kind of pricing.
- **Per-unit Pricing:** The model is based upon the unit-specific service concept. Data transfer and memory allocation include in this model for specific units. GoGrid uses this kind of pricing in terms of RAM/hour.
- **Subscription-based Pricing: In** this model, users are paying periodic subscription fees for the usage of the software.

Role of Networks in Cloud Computing

Cloud Networking is service or science in which company's networking procedure is hosted on public or private cloud. Cloud Computing is source manage in which more than one computing resources share identical platform and customers are additionally enabled to get entry to these resources to specific extent. Cloud networking in similar fashion shares networking however it gives greater superior features and network features in cloud with interconnected servers set up under cyberspace.

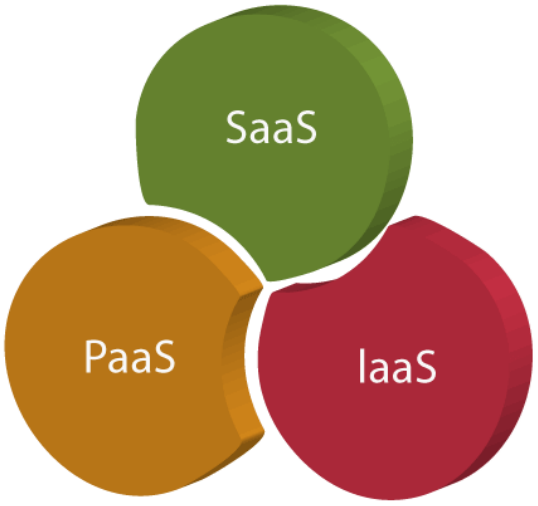
Why cloud networking is required and in-demand?

- It is in demand by many companies for their speedy and impervious delivery, fast processing, dependable transmission of information without any loss, pocket-friendly set-up. Benefited corporations who select Cloud Networking consist of internet service providers, e-commerce, cloud service providers, community operators, cloud service providers.
- It permits users to boost their networks in accordance with necessities in cloud-based services. An actual cloud network provides high-end monitoring to globally positioned servers, controls site visitors flow between interconnected servers, protects structures with superior network safety, and offers visibility to user by means of its centralized management. The web access can be expanded and made greater reliable bandwidth to promote couple of network features into cloud.
- It ensures overall performance and safety in multi-cloud surrounding so that Information technology receives greater visibility by means of supplying end-users with necessities and experience they need. Workloads are shared between cloud surroundings using software program as provider application. Safety is given to user to get entry to web page and infrastructure by means of transferring functions to the cloud with standard security model. The gateway offers contextual access code and multi-layer firewall. Applications and offerings are given to allotted data centers in cloud environment.
- Software-Defined Wide Area Network is technology that makes use of bunch of networking switches and routers to virtually get entry to machine from hardware to software program deployed on white box. Confidential units and information are set up on primary branch workplace or consumer region and given unique access to administrator to get admission to its superior networking functions, cloud optimization software, and firewalls. It is massive range of array with network features deployed in cloud platform.
- Software-defined Wide range community offers standard load balancing approach and combines all stages of network to user experience. It offers greater visuality with assist of intelligent analytics. Giving options to every cloud user may be challenging however leverage of all offerings and supplying them special answer by means of SD-WAN from ceasing to cease applications.

Cloud Service Models

There are the following three types of cloud service models -

1. Infrastructure as a Service (IaaS)
2. Platform as a Service (PaaS)
3. Software as a Service (SaaS)



Infrastructure as a Service (IaaS)

IaaS is also known as **Hardware as a Service (HaaS)**. It is a computing infrastructure managed over the internet. The main advantage of using IaaS is that it helps users to avoid the cost and complexity of purchasing and managing the physical servers.

Characteristics of IaaS

There are the following characteristics of IaaS -

- Resources are available as a service
- Services are highly scalable
- Dynamic and flexible
- GUI and API-based access
- Automated administrative tasks

Example: DigitalOcean, Linode, Amazon Web Services (AWS), Microsoft Azure, Google Compute Engine (GCE), Rackspace, and Cisco Metacloud.

Platform as a Service (PaaS)

PaaS cloud computing platform is created for the programmer to develop, test, run, and manage the applications.

Characteristics of PaaS

There are the following characteristics of PaaS -

- Accessible to various users via the same development application.
- Integrates with web services and databases.
- Builds on virtualization technology, so resources can easily be scaled up or down as per the organization's need.

- Support multiple languages and frameworks.
- Provides an ability to "**Auto-scale**".

Example: AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, Magento Commerce Cloud, and OpenShift.

Software as a Service (SaaS)

SaaS is also known as "**on-demand software**". It is a software in which the applications are hosted by a cloud service provider. Users can access these applications with the help of internet connection and web browser.

Characteristics of SaaS

There are the following characteristics of SaaS -

- Managed from a central location
- Hosted on a remote server
- Accessible over the internet
- Users are not responsible for hardware and software updates. Updates are applied automatically.
- The services are purchased on the pay-as-per-use basis

Example: BigCommerce, Google Apps, Salesforce, Dropbox, ZenDesk, Cisco WebEx, ZenDesk, Slack, and GoToMeeting.

Cloud services brokerage (CSB)

Cloud services brokerage (CSB) is an IT role and business model in which a company or other entity adds value to one or more (public or private) cloud services on behalf of one or more consumers of that service via three primary roles including aggregation, integration and customization brokerage.

Cloud service brokerage provides the intermediary between cloud providers and cloud consumer that assist companies in choosing the services and offerings that best suits their needs. They may also assist in the deployment and integration of apps across multiple clouds or provide a choice and possible cost saving function which include multiple competing services from a catalog.

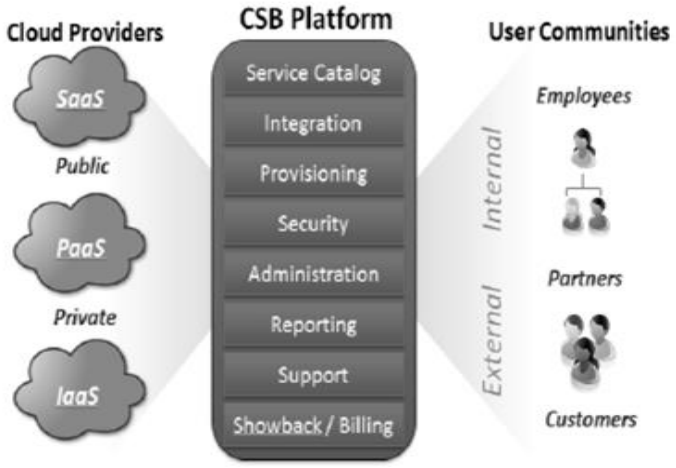
Value added services like migration, VM portability, and API management and normalization from cloud brokerage platforms like ComputeNext also allow end users freedom to move between platforms and keep options available at a variety of cloud vendors.

There are three primary areas a cloud service broker can address in accelerating the adoption of the cloud:

1. **Aggregation** – enabling the consumption of cloud by end users via a cloud application marketplace approved by the company
2. **Integration** – ensuring cloud applications exchange data with each other and with on-premise applications to orchestrate business processes
3. **Customization** – augmenting cloud services with changes to data schema or enhanced security and compliance

The challenge for IT is that the cloud is relatively immature compared to on-premise enterprise software. By adding customized capabilities on top of cloud services, the enterprise can realize the benefits of cloud, while also meeting its other business objectives including data security and compliance. In particular, organizations are looking to augment the cloud and achieve the following:

1. Reduce risk with more robust security and compliance capabilities
2. Add value and visibility with analytics
3. Centralize functionality for audit trails and policy enforcement
4. Streamline the selection process of cloud services



Advantages of CSB:

1) Broader Technical Expertise

2) Lower Total Cost of Ownership – Financial Returns

3) Operational efficiencies

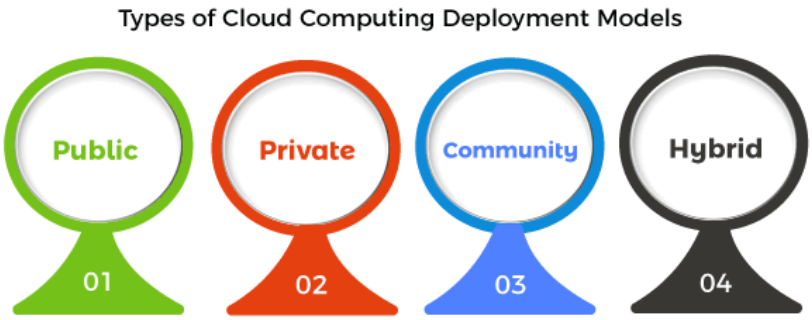
4) Better options in dealing with risk, compliance and governance

Cloud Deployment Model

It works as your virtual computing environment with a choice of deployment model depending on how much data you want to store and who has access to the Infrastructure.

Different Types Of Cloud Computing Deployment Models

Most cloud hubs have tens of thousands of servers and storage devices to enable fast loading. It is often possible to choose a geographic area to put the data "closer" to users. Thus, deployment models for cloud computing are categorized based on their location. To know which model would best fit the requirements of your organization, let us first learn about the various types.



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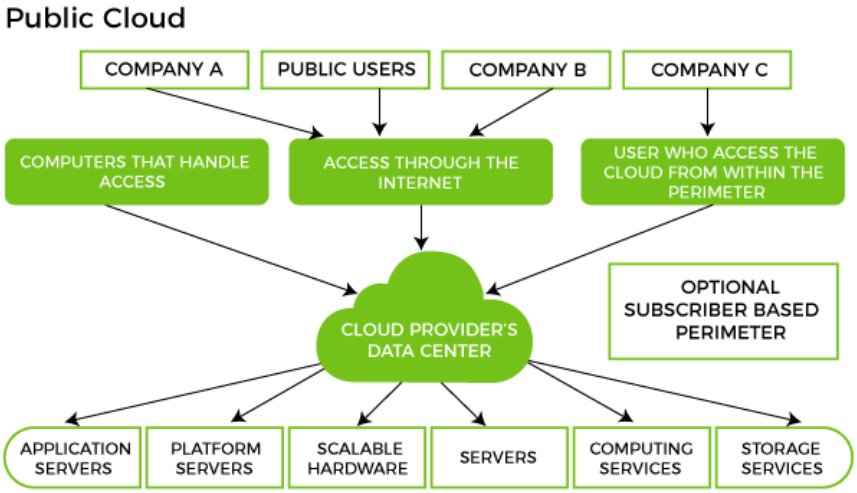
Public Cloud

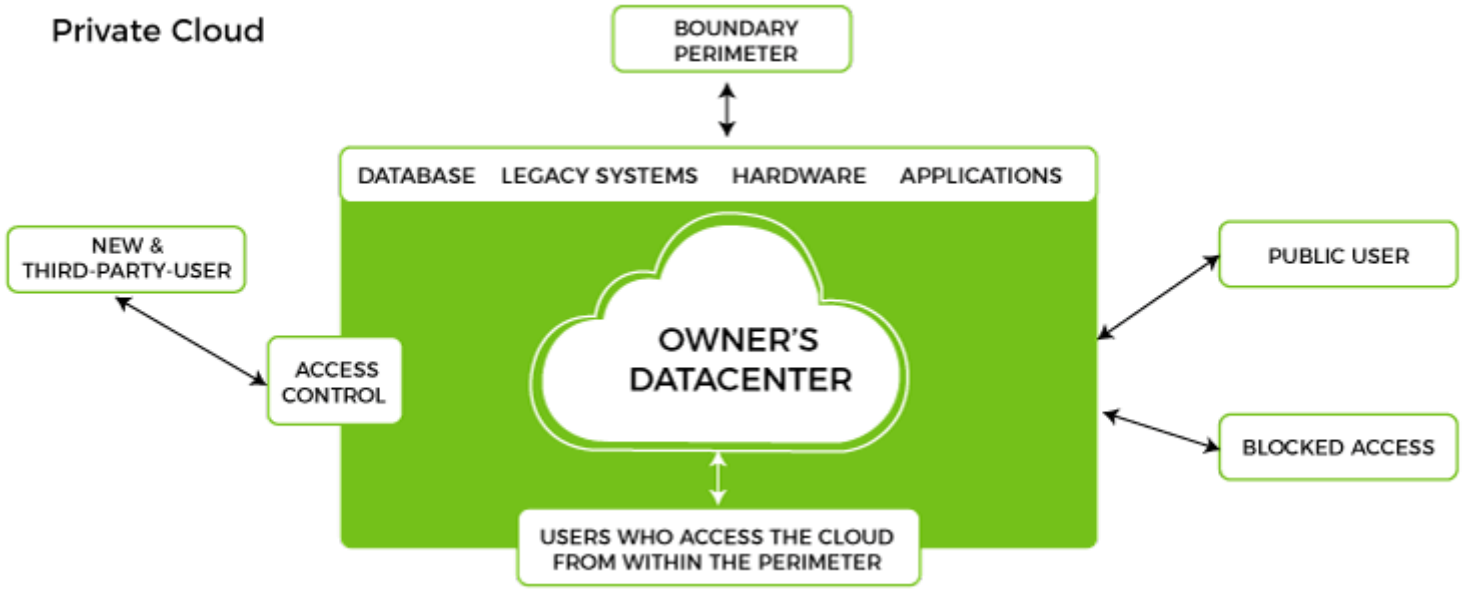
The name says it all. It is accessible to the public. Public deployment models in the cloud are perfect for organizations with growing and fluctuating demands. It also makes a great choice for companies with low-security concerns. Thus, you pay a cloud service provider for networking services, compute virtualization & storage available on the public internet. It is also a great delivery model for the teams with development and testing. Its configuration and deployment are quick and easy, making it an ideal choice for test environments.



Private Cloud

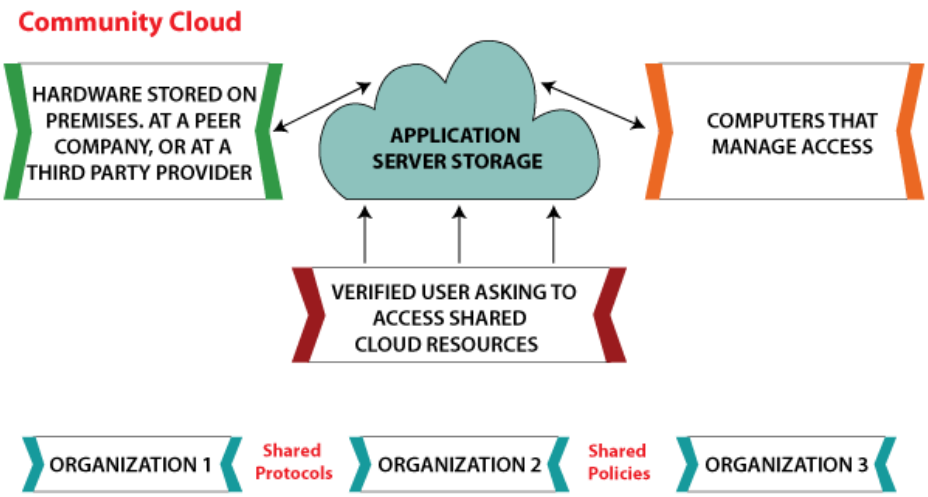
Now that you understand what the public cloud could offer you, of course, you are keen to know what a private cloud can do. Companies that look for cost efficiency and greater control over data & resources will find the private cloud a more suitable choice.

It means that it will be integrated with your data center and managed by your IT team. Alternatively, you can also choose to host it externally. The private cloud offers bigger opportunities that help meet specific organizations' requirements when it comes to customization. It's also a wise choice for mission-critical processes that may have frequently changing requirements.



Community Cloud

The community cloud operates in a way that is similar to the public cloud. There's just one difference - it allows access to only a specific set of users who share common objectives and use cases. This type of deployment model of cloud computing is managed and hosted internally or by a third-party vendor. However, you can also choose a combination of all three.



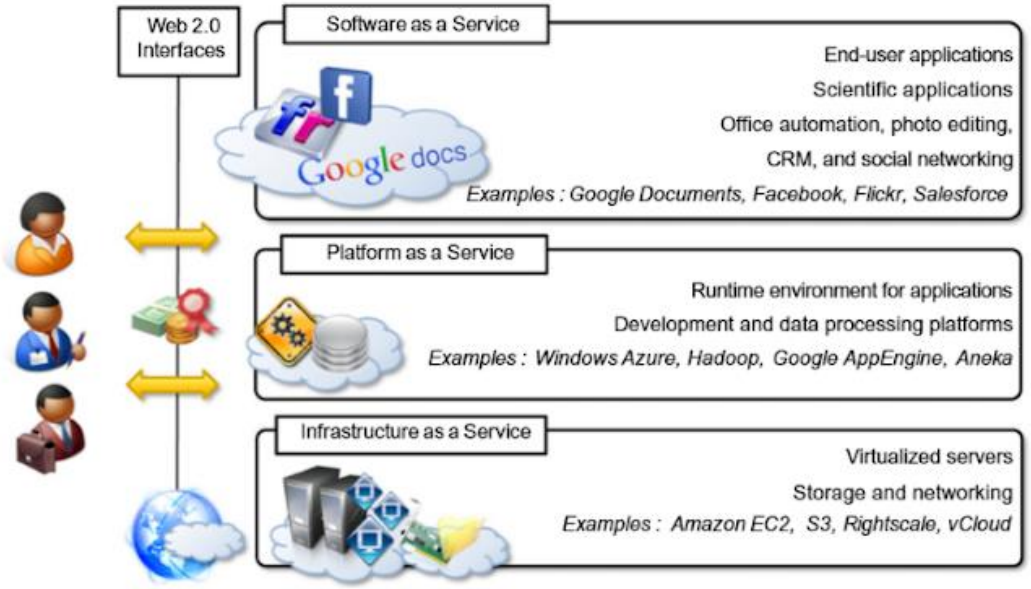
Hybrid Cloud

As the name suggests, a hybrid cloud is a combination of two or more cloud architectures. While each model in the hybrid cloud functions differently, it is all part of the same architecture. Further, as part of this deployment of the cloud computing model, the internal or external providers can offer resources.

Let's understand the hybrid model better. A company with critical data will prefer storing on a private cloud, while less sensitive data can be stored on a public cloud. The hybrid cloud is also frequently used for 'cloud bursting'. It means, supposes an organization runs an application on-premises, but due to heavy load, it can burst into the public cloud.

Cloud Computing reference model

The reference model for cloud computing is an abstract model that characterizes and standardizes a Cloud computing environment by partitioning it into abstraction layers and cross-layer functions.



If we look in to the reference model as seen in above image we will find classification of Cloud Computing services:

1. Infrastructure-as-a-Service (IaaS),
2. Platform-as-a-Service (PaaS), and
3. Software-as-a-Service (SaaS).
4. Web 2.0

1. Infrastructure as a service (IaaS)

Infrastructure as a service (IaaS) is a cloud computing offering in which a vendor provides users access to computing resources such as servers, storage and networking.

2. Platform as a service (PaaS)

Platform as a service (PaaS) is a cloud computing offering that provides users with a cloud environment in which they can develop, manage and deliver applications.

3. Software as a service (SaaS)

Software as a service (SaaS) is a cloud computing offering that provides users with access to a vendor's cloud-based software. Users do not install applications on their local devices. Instead, the applications reside on a remote cloud network accessed through the web or an API. Through the application, users can store and analyze data and collaborate on projects.

4. Web 2.0

Web 2.0 is the term used to describe a variety of web sites and applications that allow anyone to create and share online information or material they have created. A key element of the technology is that it allows people to create, share, collaborate & communicate.

With software becoming one of the fastest and most dynamic industries, it requires developers to use appropriate software development tools and methodologies in order to develop products that meet the growing demands of modern businesses. Greenfield and Brownfield software development are two approaches to developing cutting-edge software. So, what are these approaches? How are they different? Is Greenfield development better for you, or should you consider a Brownfield project? Keep reading to find out the major differences between Brownfield and Greenfield projects.

The Greenfield And Brownfield Deployment Options.

What is Greenfield Software Development?

Greenfield development refers to developing a system for a totally new environment and requires development from a clean slate – no legacy code around. It is an approach used when you're starting fresh and with no restrictions or dependencies.

A pure Greenfield project is quite rare these days, you frequently end up interacting or updating some amount of existing code or enabling integrations. Some examples of Greenfield software development include: building a website or app from scratch, setting up a new data center, or even implementing a new rules engine.

The Advantages of Greenfield Development

Some of the greatest advantages of Greenfield development include:

- Gives an opportunity to implement a state-of-the-art technology solution from scratch
- Provides a clean slate for software development
- No compulsion to work within the constraints of existing systems or infrastructure
- No dependencies or ties to existing software, preconceived notions, or existing business processes

The Disadvantages of Greenfield Software Development

As with anything, there can be cons to taking on a Greenfield project. Greenfield development disadvantages include:

- With no clear direction, the degree of risk is comparatively higher
- Since all aspects of the new system need to be defined, it can be quite time consuming
- With so many possible development options, there may be no clear understanding of the approach to take
- It may be hard to get everyone involved to make critical decisions in a decent time frame

What is Brownfield Software Development?

Brownfield software development refers to the development and deployment of a new software system in the presence of existing or legacy software systems. Brownfield development usually happens when you want to develop or improve upon an existing application, and compels you to work with previously created code.

Therefore, any new software architecture must consider and coexist with systems already in place – so as to enhance existing functionality or capability. Examples of Brownfield development include: adding a new module to an existing enterprise system, integrating a new feature to software that was developed earlier, or upgrading code to enhance the functionality of an app.

The Advantages of Brownfield Software Development

Some of the largest advantages of Brownfield development include:

- Offers a place to start with a predetermined direction
- Gives a chance to add improvements to existing technology solutions
- Supports working with defined business processes and technology solutions
- Allows existing code to be reused to add new features

The Disadvantages of Brownfield Software Development

Brownfield projects do also have their own set of disadvantages. These include:

- Requires thorough knowledge of existing systems, services, and data on which the new system needs to be built
- There may be a need to re-engineer a large portion of the existing complex environment so that they make operational sense to the new business requirement
- Requires detailed and precise understanding of the constraints of the existing business and IT, so the new project does not fail
- Dealing with legacy code can not only slow down the development process but also add to overall development costs