UNIT II

1. Types of Computing and Cloud

Cluster computing

Cluster computing defines several computers linked on a network and implemented like an individual entity. Each computer that is linked to the network is known as a node. The connected computers execute operations all together thus creating the idea of a single system.

Cluster computing is the process of sharing the computation tasks among multiple computers and those computers or machines form the cluster. It works on the distributed system with the networks.

The clusters are generally connected through fast local area networks (LANs)

Cluster computing provides solutions to solve difficult problems by providing faster computational speed, and enhanced data integrity. The connected computers implement operations all together thus generating the impression like a single system (virtual device). This procedure is defined as the transparency of the system.

Some of the popular implementations of cluster computing are Google search engine, Earthquake Simulation, Petroleum Reservoir Simulation, and Weather Forecasting system.

Types of Cluster computing:

High performance (HP) clusters: This computer networking tactic use supercomputers and Cluster computing to resolve complex and highly advanced computation problems.

High Availability (HA)

These cluster models generate the availability of services and resources in an uninterrupted technique using the system's implicit redundancy. The basic term of Cluster is that if a node declines, then applications and services can be made available to different nodes. These methods of clusters deliver as the element for critical missions, mails, documents, and application servers.

Load Balancing Clusters

This cluster allocates all the incoming traffic/requests for resources from nodes that run the equal programs and machines. In this cluster model, some nodes are answerable for

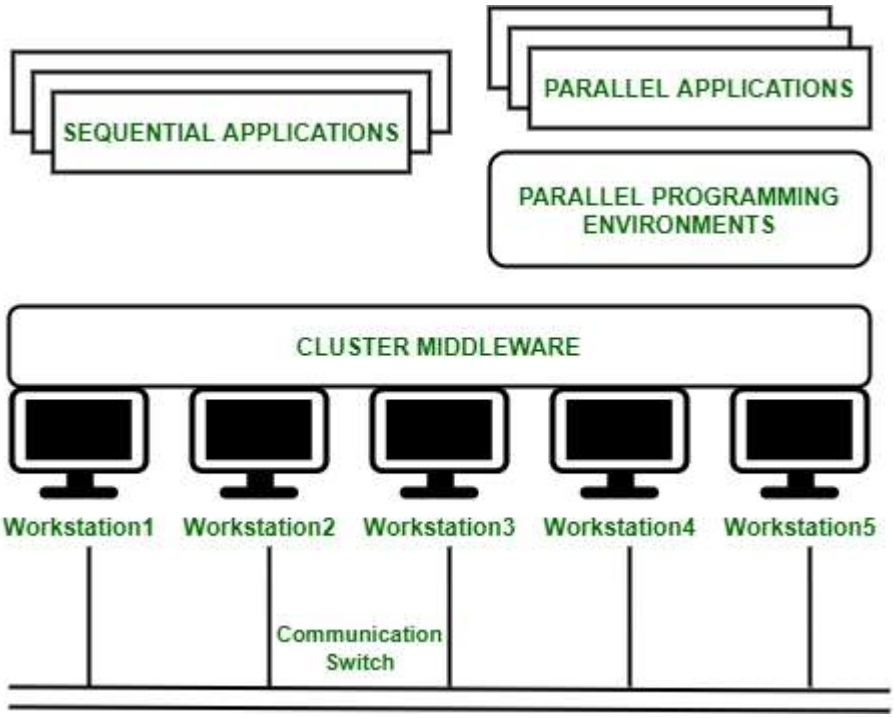
tracking orders, and if a node declines, therefore the requests are distributed amongst all the nodes available. Such a solution is generally used on web server farms.

HA & Load Balancing Clusters

This cluster model associates both cluster features, resulting in boost availability and scalability of services and resources. This kind of cluster is generally used for email, web, news, and FTP servers.

Cluster Computing Architecture:

- It is designed with an array of interconnected individual computers and the computer systems operating collectively as a single standalone system.
- It is a group of workstations or computers working together as a single, integrated computing resource connected via high speed interconnects.
- A node – Either a single or a multiprocessor network having memory, input and output functions and an operating system.
- Two or more nodes are connected on a single line or every node might be connected individually through a LAN connection.



Advantages of Cluster Computing :

1. High Performance:

The systems offer better and enhanced performance than that of mainframe computer networks.

2. Easy to manage:
Cluster Computing is manageable and easy to implement.

3. Scalable:
Resources can be added to the clusters accordingly.

4. Expandability:
Computer clusters can be expanded easily by adding additional computers to the network. Cluster computing is capable of combining several additional resources or the networks to the existing computer system.

5. Availability:
The other nodes will be active when one node gets failed and will function as a proxy for the failed node. This makes sure for enhanced availability.

6. Flexibility:
It can be upgraded to the superior specification or additional nodes can be added.

Disadvantages of Cluster Computing :

1. High cost:
It is not so much cost-effective due to its high hardware and its design.

2. Problem in finding fault:
It is difficult to find which component has a fault.

3. More space is needed:
Infrastructure may increase as more servers are needed to manage and monitor.

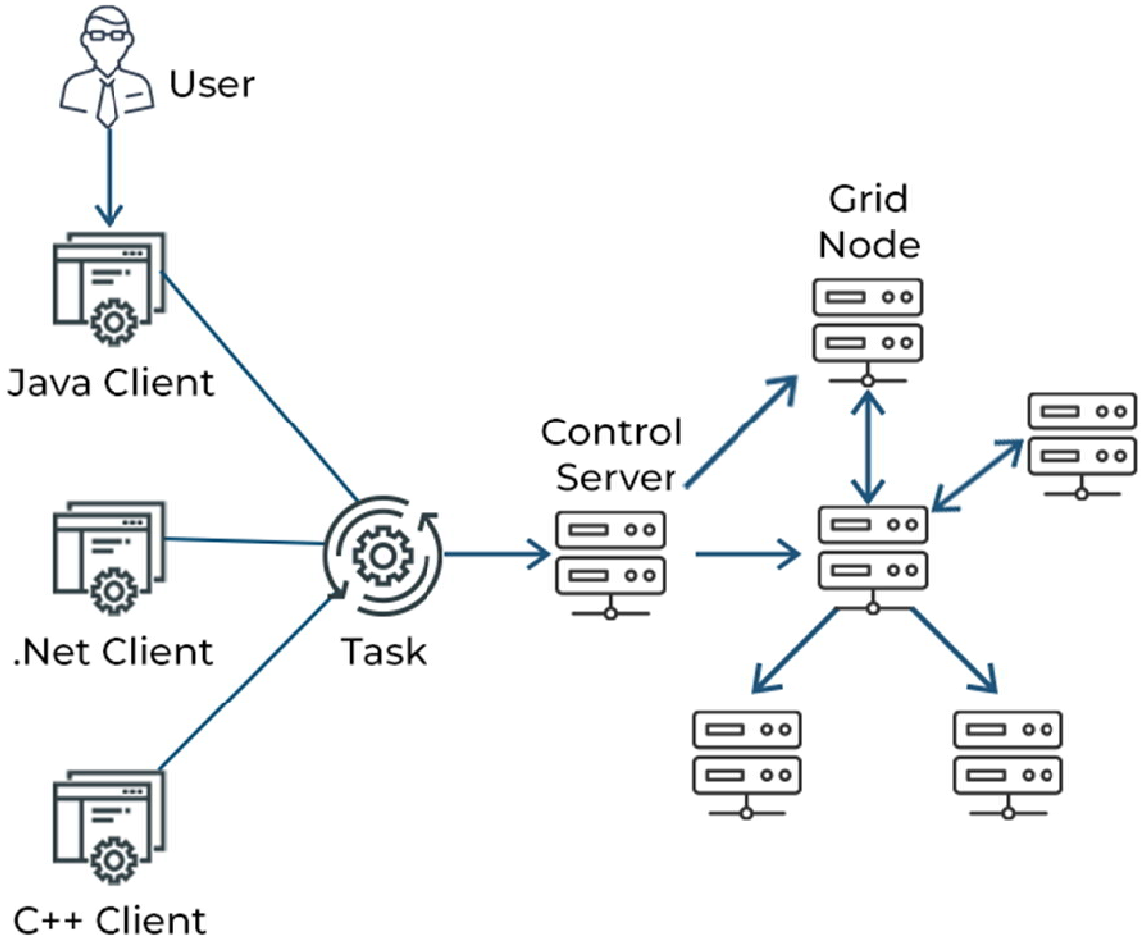
Applications of Cluster Computing:

- Various complex computational problems can be solved.
- It can be used in the applications of aerodynamics, astrophysics and in data mining.
- Weather forecasting.
- Image Rendering.
- Various e-commerce applications.
- Earthquake Simulation.
- Petroleum reservoir simulation.

2. Grid computing

Grid computing is a group of networked computers which work together as a virtual supercomputer to perform large tasks, such as analyzing huge sets of data or weather modeling.

Grid computing is a distributed architecture of multiple computers connected by networks to accomplish a joint task. These tasks are compute-intensive and difficult for a single machine to handle. Several machines on a network collaborate under a common protocol and work as a single virtual supercomputer to get complex tasks done. This offers powerful virtualization by creating a single system image that grants users and applications seamless access to IT capabilities.



A typical grid computing network consists of three machine types:

- **Control node/server:** A control node is a server or a group of servers that administers the entire network and maintains the record for resources in a network pool.
- **Provider/grid node:** A provider or grid node is a computer that contributes its resources to the network resource pool.
- **User:** A user refers to the computer that uses the resources on the network to complete the task.

3. Grid Computing Versus Cloud Computing

Cloud Computing	Grid Computing
Cloud computing is a Client-server computing architecture.	While it is a Distributed computing architecture.
Cloud computing is a centralized executive.	While grid computing is a decentralized executive.
In cloud computing, resources are used in centralized pattern.	While in grid computing, resources are used in collaborative pattern.
It is more flexible than grid computing.	While it is less flexible than cloud computing.
In cloud computing, the users pay for the use.	While in grid computing, the users do not pay for use.
Cloud computing is a high accessible service.	While grid computing is a low accessible service.
It is highly scalable as compared to	While grid computing is low scalable in

Cloud Computing	Grid Computing
grid computing.	comparison to cloud computing.
It can be accessed through standard web protocols.	While it is accessible through grid middleware.

4. Key Characteristics of Cloud Computing

1. RESOURCES POOLING

Resource pooling is one of the essential characteristics of Cloud Computing. Resource pooling means that a cloud service provider can share resources among several clients, providing everyone with a different set of services as per their requirements. It is a multi-client strategy that can be applied to data storage services, processing services, and bandwidth provided services. The administration process of allocating resources in real-time doesn't conflict with the client's experience.

2. ON-DEMAND SELF-SERVICE

It is one of the significant and essential features of Cloud Computing. It enables the client to constantly monitor the server uptime, abilities, and allotted network storage. This is a fundamental characteristic of Cloud Computing, and a client can likewise control the computing abilities as per his needs.

3. EASY MAINTENANCE

This is one of the best cloud characteristics. The servers are effortlessly maintained, and the downtime remains low or absolutely zero sometimes. Cloud Computing powered resources undergo several updates frequently to optimize their capabilities and potential. The updates are more viable with the devices and perform quicker than the previous versions.

4. SCALABILITY AND RAPID ELASTICITY

A key characteristic and benefit of cloud computing is its rapid scalability. This cloud characteristic enables cost-effective running of workloads that require a vast number of

servers but only for a short period. Many clients have such workloads, which can be run very cost-effectively because of the rapid scalability of Cloud Computing.

5. ECONOMICAL

This cloud characteristic helps in reducing the IT expenditure of the organizations. In Cloud Computing, the client needs to pay the administration for the space they have used. There is no covered up or additional charge which needs to be paid. The administration is economical, and more often than not, some space is allotted for free.

6. MEASURED AND REPORTING SERVICE

Reporting services are one of the many cloud characteristics that make it the best choice for organizations. Measuring & reporting service is helpful for both cloud providers and their clients. It enables both the provider and the client to monitor and report what services have been used and for what purpose. This helps in monitoring billing and ensuring the optimum usage of resources.

7. SECURITY

Data security is one of the best characteristics of Cloud Computing. Cloud services create a copy of the data that is stored to prevent any form of data loss. If one server loses the data by any chance, the copy version is restored from the other server. This feature comes handy when several users work on a particular file in real-time and a file suddenly gets corrupted.

8. AUTOMATION

Automation is an essential characteristic of cloud computing. The ability of cloud computing to automatically install, configure, and maintain a cloud service is known as automation in cloud computing. In simple terms, it is the process of making the most of technology and reducing manual effort. However, to achieve automation in the cloud ecosystem is not so easy. It requires the installation and deployment of virtual machines, servers, and large storage. Upon successful deployment, these resources require constant maintenance as well.

9. RESILIENCE

Resilience in cloud computing means the ability of the service to quickly recover from any disruption. A cloud's resilience is measured by how fast its servers, databases, and network system restarts and recovers from any kind of harm or damage. Availability is

another major characteristic of cloud computing. Since cloud services can be accessed remotely, there is no geographic restriction or limitation when it comes to utilizing cloud resources.

10. LARGE NETWORK ACCESS

A big part of the cloud characteristics is its ubiquity. The client can access the cloud data or transfer the data to the cloud from any place just with a device and internet connection. These capacities are accessible everywhere in the organization and get to with the help of the internet. Cloud providers save that large network access by monitoring and guaranteeing different measurements that reflect how clients access cloud resources and data: latency, access time, data throughput, etc.

11. WORK FROM ANY LOCATION

Remote working is one of the primary **features of cloud computing. It** enables users to work remotely or from any location on the planet. Users will be able to access corporate data via mobile devices such as laptops and smartphones. It also ensures that every user can connect quickly. Employees that work remotely or live in another location can communicate with one another and do their jobs.

12. MULTI-TENANCY

One of the best **characteristics of Cloud Computing** is its Multi-Tenancy. Multi-Tenancy is a software architecture that allows a single program instance to serve several user groups. It signifies that numerous cloud provider customers are sharing the same computing resources. Although they share the same computing resources, each Cloud customer's data is kept completely separate and safe.

13. FLEXIBILITY

The company must scale as the competition develops. Users that use the traditional hosting technique will have to switch service providers. Users benefit from greater freedom when they host their data in the cloud. Scaling does not require the server to be restarted and can be done anytime. There are a variety of payment alternatives also

available for the users. This implies businesses won't have to spend too much on resources they don't need.

14. SERVICE EXCELLENCE

Cloud computing ensures that users receive the highest level of service possible. The benefits outlined in Service Level Agreements must include continuous availability and comprehensive resources, performance, and bandwidth. Any compromise on these services will result in a loss of clients and a decrease in popularity.

15. COMFORTABLE PAYMENT STRUCTURE

The payment structure is critical since it aids in the cost-cutting process. Because of the additional functionality, cloud computing choices come with a range of prices. Users find the payment option to be simple to use, and it allows them to save time when making payments regularly.

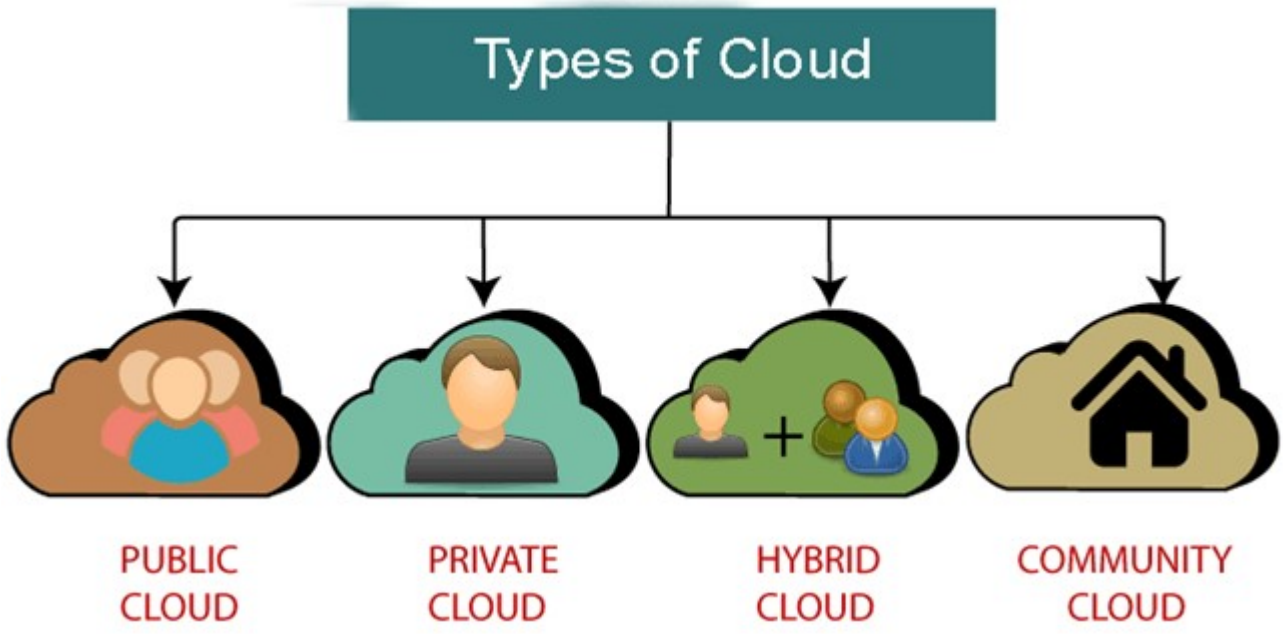
5. Difference between Cluster and Grid Computing

Cluster Computing	Grid Computing
Nodes must be homogeneous i.e. they should have same type of hardware and operating system.	Nodes may have different Operating systems and hardwares. Machines can be homogeneous or heterogeneous.
Computers in a cluster are dedicated to the same work and perform no other task.	Computers in a grid contribute their unused processing resources to the grid computing network.
Computers are located close to each other.	Computers may be located at a huge distance from one another.
Computers are connected by a high speed local area network bus.	Computers are connected using a low speed bus or the internet.
Computers are connected in a centralized network topology.	Computers are connected in a distributed or de-centralized network topology.
Scheduling is controlled by a central server.	It may have servers, but mostly each node behaves independently.
Whole system has a centralized resource manager.	Every node manages it's resources independently.

Whole system functions as a single system.	Every node is autonomous, and anyone can opt out anytime.

6. Types of Cloud

There are the following 4 types of cloud that you can deploy according to the organization's needs-



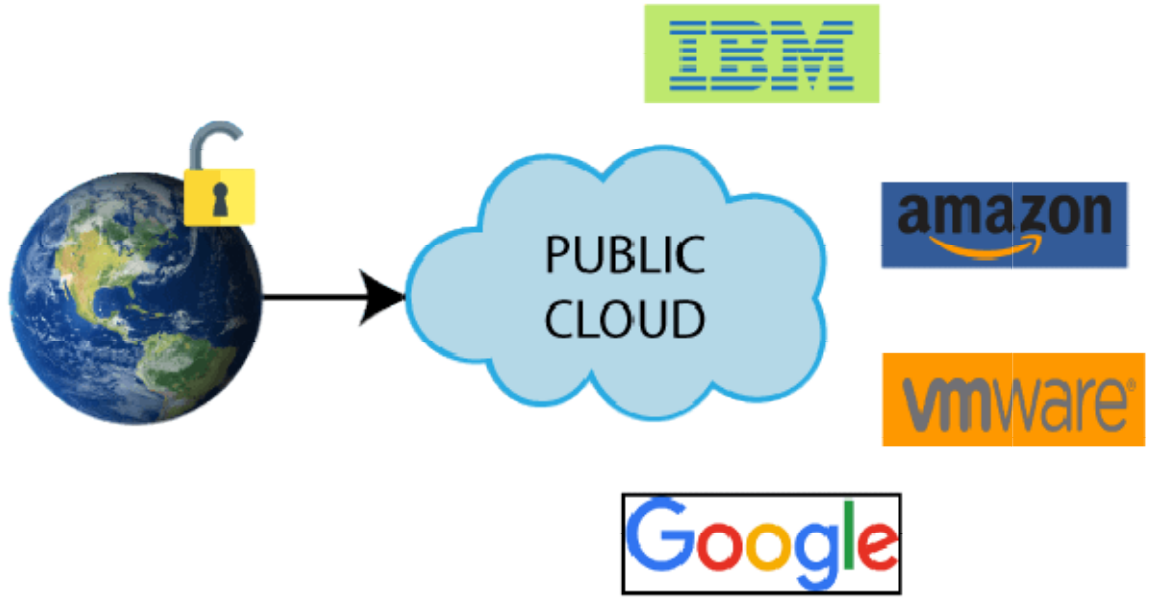
- Public Cloud
- Private Cloud
- Hybrid Cloud
- Community Cloud

Public Cloud

Public cloud is **open to all** to store and access information via the Internet using the pay-per-usage method.

In public cloud, computing resources are managed and operated by the Cloud Service Provider (CSP).

Example: Amazon elastic compute cloud (EC2), IBM SmartCloud Enterprise, Microsoft, Google App Engine, Windows Azure Services Platform.



Advantages of Public Cloud

There are the following advantages of Public Cloud -

- Public cloud is owned at a lower cost than the private and hybrid cloud.
- Public cloud is maintained by the cloud service provider, so do not need to worry about the maintenance.
- Public cloud is easier to integrate. Hence it offers a better flexibility approach to consumers.
- Public cloud is location independent because its services are delivered through the internet.
- Public cloud is highly scalable as per the requirement of computing resources.
- It is accessible by the general public, so there is no limit to the number of users.

Disadvantages of Public Cloud

- Public Cloud is less secure because resources are shared publicly.
- Performance depends upon the high-speed internet network link to the cloud provider.

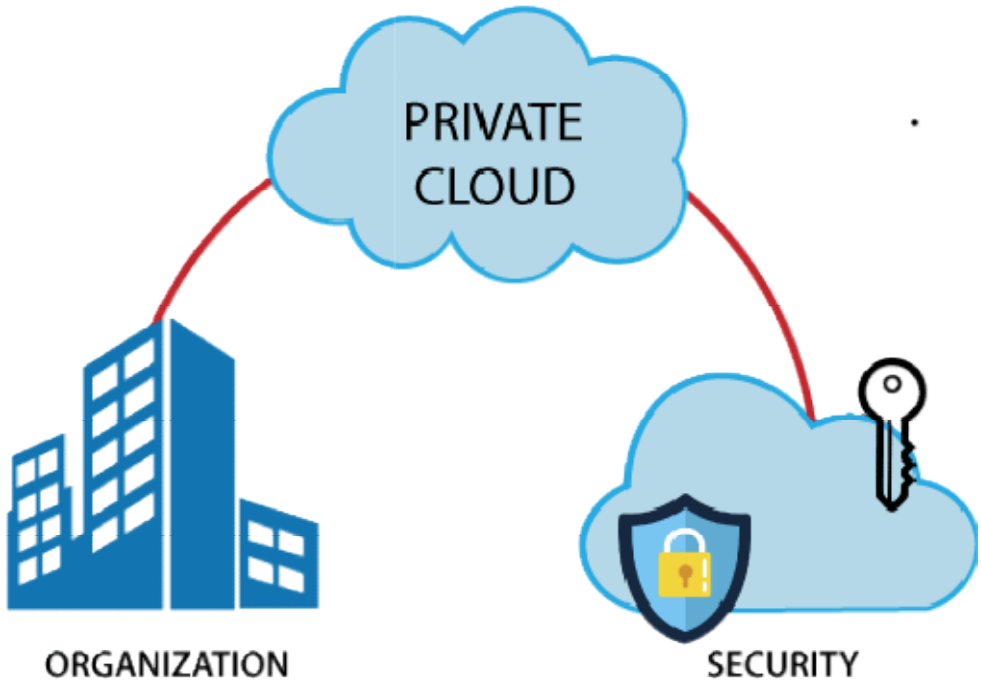
- The Client has no control of data.

Private Cloud

Private cloud is also known as an **internal cloud** or **corporate cloud**. It is used by organizations to build and manage their own data centers internally or by the third party. It can be deployed using Opensource tools such as Openstack and Eucalyptus.

Based on the location and management, National Institute of Standards and Technology (NIST) divide private cloud into the following two parts-

- On-premise private cloud
- Outsourced private cloud



Advantages of Private Cloud

There are the following advantages of the Private Cloud -

- Private cloud provides a high level of security and privacy to the users.
- Private cloud offers better performance with improved speed and space capacity.
- It allows the IT team to quickly allocate and deliver on-demand IT resources.
- The organization has full control over the cloud because it is managed by the organization itself. So, there is no need for the organization to depends on anybody.
- It is suitable for organizations that require a separate cloud for their personal use and data security is the first priority.

Disadvantages of Private Cloud

- Skilled people are required to manage and operate cloud services.
- Private cloud is accessible within the organization, so the area of operations is limited.
- Private cloud is not suitable for organizations that have a high user base, and organizations that do not have the prebuilt infrastructure, sufficient manpower to maintain and manage the cloud.

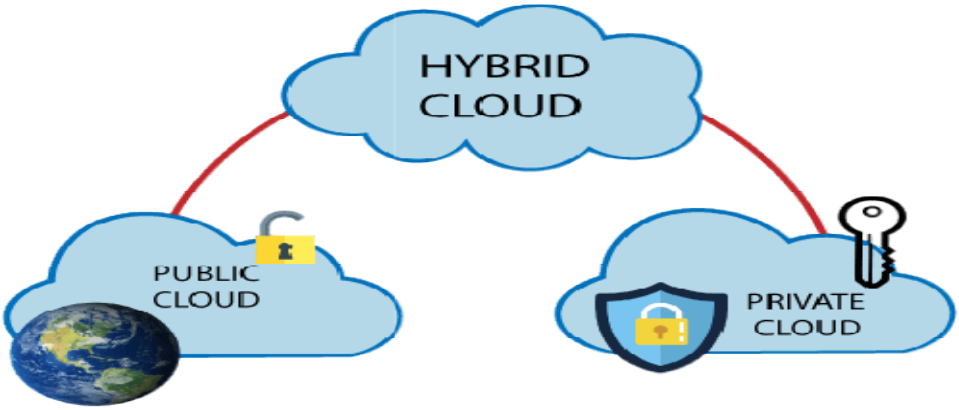
Hybrid Cloud

Hybrid Cloud is a combination of the public cloud and the private cloud. we can say:

Hybrid Cloud = Public Cloud + Private Cloud

Hybrid cloud is partially secure because the services which are running on the public cloud can be accessed by anyone, while the services which are running on a private cloud can be accessed only by the organization's users.

Example: Google Application Suite (Gmail, Google Apps, and Google Drive), Office 365 (MS Office on the Web and One Drive), Amazon Web Services.



Advantages of Hybrid Cloud

There are the following advantages of Hybrid Cloud -

- Hybrid cloud is suitable for organizations that require more security than the public cloud.
- Hybrid cloud helps you to deliver new products and services more quickly.
- Hybrid cloud provides an excellent way to reduce the risk.
- Hybrid cloud offers flexible resources because of the public cloud and secure resources because of the private cloud.

Disadvantages of Hybrid Cloud

- In Hybrid Cloud, security feature is not as good as the private cloud.
- Managing a hybrid cloud is complex because it is difficult to manage more than one type of deployment model.
- In the hybrid cloud, the reliability of the services depends on cloud service providers.

7. Shared Private Cloud

The shared cloud is designed to provide individuals and small businesses that have fairly simple requirements with an affordable way in which they can enter the cloud. With the shared cloud you can specify the resources of your individual virtual machines so that each VM is designed to meet its usage precisely; the eNlight platform from ESDS encourages this by providing you with a control panel that allows you to specify precise resource units during the VM creation process so that you will only ever

be paying for the resources that you want or are using and nothing more. Resource wastage can be a big issue for businesses when they have to choose pre-defined cloud hosting plans because more often than not there will be certain resources that they aren't using to their full potential; for web hosting companies resource wastage can represent a failure to assist their customers in having their needs met in full and by offering to allow customers to choose what they'd like to see from their cloud virtual machines, hosting companies can guarantee that businesses have a platform on which their needs can be met in full.

Although the shared cloud hosts many users, most cloud platforms can guarantee up to 100% uptime because the design of the cloud ensures that hardware and network failure can't impact on the performance or operation of the cloud as a whole. Even though individual servers in the cluster can fail, virtual machines are often hosted across several servers in the cloud so that additional resources can be located on other hosting nodes if one of the servers that a VM rely on crashes. Storage responsibilities are taken care of by central SAN (Storage Area Network) arrays to provide the highest level of data security possible and if any issues occur here, data is backed up across several hard drives so that data loss is pretty much impossible.

Using the ESDS eNlight platform as an example, you can expect to see the following benefits when using a shared cloud solution:

- If you are upgrading from a form of shared web hosting then you can expect to see a cloud virtual machine offer you an improved level of uptime as well as an improved web hosting environment that can offer a higher level of security
- Compared to a dedicated server, the shared cloud can offer you a more affordable web hosting experience that can meet your requirements in the same or similar ways
- You will have full root access to your virtual machine, but eNlight servers and resources can also be managed through our web-based control panel so that you can adjust the settings of your VMs on the move to ensure that they remain stable.

8. Dedicated Cloud

A dedicated cloud is a single-tenant cloud infrastructure, which essentially acts as an isolated, single-tenant public cloud. Dedicated clouds are set as an infrastructure as a service (IaaS) and are made to reduce an organizations downtime and cost while promoting flexibility and performance. Dedicated clouds work especially well for resource-intensive workloads.

Dedicated clouds may appeal to many regulated businesses because the servers each customer uses is isolated. With this isolation, users can have more control and customization options when it comes to features such as bandwidth and storage. Organizations can use a dedicated cloud for developing or extending on-premise applications in the cloud with included management tools, without needing to worry about the scalability of their infrastructure.

An example of a dedicated cloud is VMware's dedicated cloud option included in VMware vCloud Air (formerly known as vCHS), called Dedicated Cloud. VMware's Dedicated Cloud is designed for large-scale cloud projects. IT organizations can migrate existing workloads such as testing and development environments to the Dedicate Cloud service, or develop new applications. Other dedicated cloud services include options from Netsource and OVH.

Dedicated cloud features

Features found in dedicated clouds may include:

- Security provided by the service provider.
- Existing development tools provided by the service provider.
- Licensing cost (typically) by month.
- Ease of access to, or customization of:
  - Compute resources.
  - Storage.
  - Bandwidth.
  - Level of subscription by license.
  - Support levels.

For example, customers of VMware's Dedicated Cloud can have complete control over CPU resources and memory and reserve storage for specific virtual machines (VMs). Dedicated Cloud can also provide multiple gateways to the Internet, which allows each virtual data center created to have its own network and firewall configurations.

Dedicated cloud vs private cloud, public cloud and hybrid cloud

Private cloud, public cloud and hybrid clouds are types of cloud architectures which can be easily confused with dedicated clouds.

In a public cloud, a service provider will make resources, such as VMs, applications or storage, available to the public over the internet. While a dedicated cloud is essentially a single-tenant isolated public cloud, a public cloud has a multi-tenant architecture, which enables users to share computing resources.

In a private cloud, a service provider will deliver its services dedicated to the needs of a single organization. Private clouds have similar advantages to a public cloud but through a proprietary architecture.

A hybrid cloud is the combination of private and public clouds, where a private cloud will connect to a public cloud infrastructure. In a hybrid cloud, data and applications are shared between public and private environments.

9. Dynamic Cloud

Dynamic cloud is the ability for software and services to grow with your business. Sometimes that means automatically adjusting itself to adjust to changes in demand or workloads.

Dynamic cloud allows business to be more agile in how it responds to changes in the market. It allows a business to quickly develop through composing new applications using prebuilt components.

Dynamic cloud gives companies what they need, where they need it and how and when they want it. Dynamic cloud is the foundation of the composable business; it allows relentless innovation at the speed of business.

The dynamic cloud is characterized by applications that use only the resources they need at that given moment in time. They dynamically allocate and de-allocate the resources on the fly, and the allocation and de-allocation of those resources is an integral part of the application architecture. Resources are allocated, they’re consumed, then they’re de-allocated, all under the control of the application and the application environment.

The dynamic cloud makes it faster and easier to build applications that can scale as needed. Container and serverless technologies like Docker, Amazon EC2, and AWS Lambda are great examples of dynamic cloud technologies. Lambda functions, for example, are a highly scalable way of processing data, in which the compute function is allocated on demand from a common pool of resources, and you don't have to worry about it. That kind of freedom is what the dynamic cloud is all about.

The dynamic cloud also lets you build applications faster and make and deploy changes faster. The dynamic cloud makes it easy to launch an application using a new set of resources and terminate the old one when it's done. Using the dynamic cloud, you can very easily create staging environments and development environments, all of which can help you build applications faster and result in higher availability for your applications.