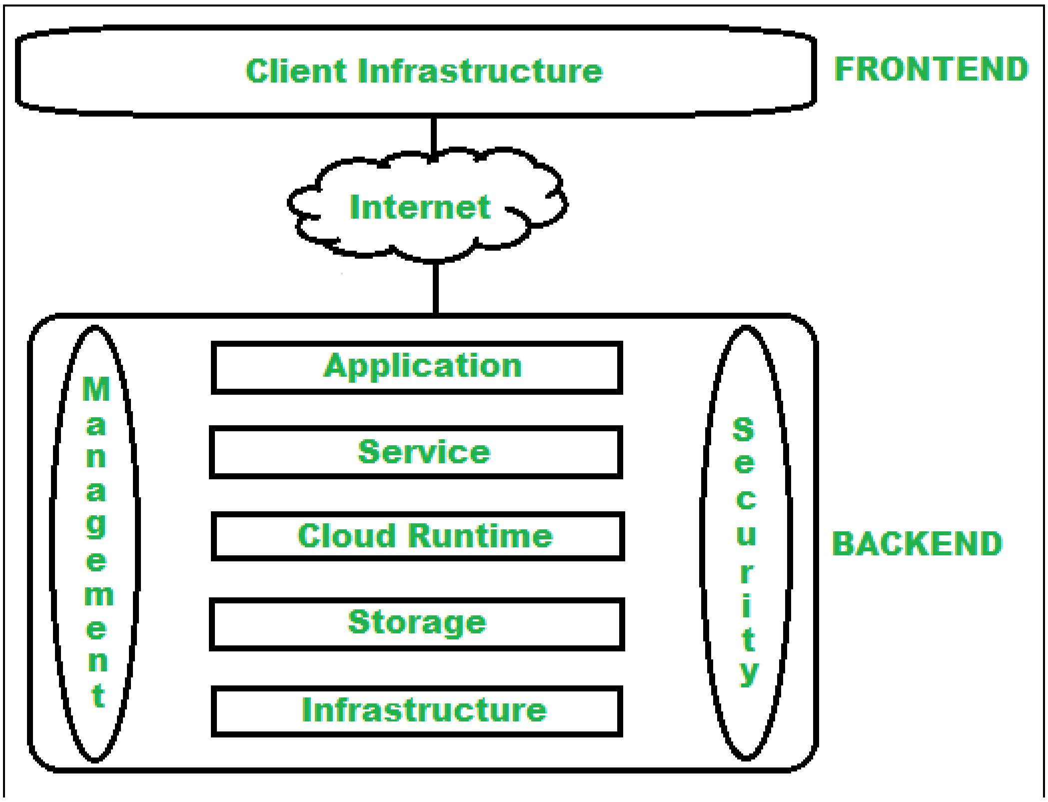
CC MOD 3 NOTES

3.1

Cloud Computing Architecture :

The cloud architecture is divided into 2 parts i.e.

1. Frontend
2. Backend



Architecture of cloud computing is the combination of both SOA (Service Oriented Architecture) and EDA (Event Driven Architecture). Client infrastructure, application, service, runtime cloud, storage, infrastructure, management and security all these are the components of cloud computing architecture.

1. Frontend :

Frontend of the cloud architecture refers to the client side of cloud computing system. Means it contains all the user interfaces and applications which are used by the client to access the cloud computing services/resources. For example, use of a web browser to access the cloud platform.

- **Client Infrastructure** – Client Infrastructure is a part of the frontend component. It contains the applications and user interfaces which are required to access the cloud platform.
- In other words, it provides a GUI(Graphical User Interface) to interact with the cloud.

2. Backend :

Backend refers to the cloud itself which is used by the service provider. It contains the resources as well as manages the resources and provides security mechanisms. Along with this, it includes huge storage, virtual applications, virtual machines, traffic control mechanisms, deployment models, etc.

1. **Application** –
   Application in backend refers to a software or platform to which client accesses. Means it provides the service in backend as per the client requirement.
2. **Service** –
   Service in backend refers to the major three types of cloud based services like SaaS, PaaS and IaaS. Also manages which type of service the user accesses.
3. **Runtime Cloud-**
   Runtime cloud in backend provides the execution and Runtime platform/environment to the Virtual machine.
4. **Storage** –
   Storage in backend provides flexible and scalable storage service and management of stored data.
5. **Infrastructure** –
   Cloud Infrastructure in backend refers to the hardware and software components of cloud like it includes servers, storage, network devices, virtualization software etc.
6. **Management** –
   Management in backend refers to management of backend components like application, service, runtime cloud, storage, infrastructure, and other security mechanisms etc.

7. **Security** –
   Security in backend refers to implementation of different security mechanisms in the backend for secure cloud resources, systems, files, and infrastructure to end-users.
8. **Internet** –
   Internet connection acts as the medium or a bridge between frontend and backend and establishes the interaction and communication between frontend and backend.
9. **Database**– Database in backend refers to provide database for storing structured data, such as SQL and NOSQL databases. Example of Databases services include Amazon RDS, Microsoft Azure SQL database and Google CLoud SQL.
10. **Networking**– Networking in backend services that provide networking infrastructure for application in the cloud, such as load balancing, DNS and virtual private networks.
11. **Analytics**– Analytics in backend service that provides analytics capabillities for data in the cloud, such as warehousing, bussness intellegence and machine learning.

Features:

The cloud architecture is different from the traditional hosting in many ways.
1. In cloud architecture, the server hardware is provided and maintenance to it is done by the service provider.
2. Users can draw the services they require over the internet eliminating the need to purchase any new hardware.
3. Users pay for the services they use. It does away the need to pay any fixed monthly plan fee as in traditional hosting. It also ensures users do not have to buy resources they do not require and leave them un-utilized.
4. Cloud architecture is scalable on demand. Users can increase or decrease their resources depending on their business needs with just a few clicks without the need of any physical effort as in traditional hosting.
5. Cloud hosting is capable of handling workloads seamlessly without any possibility of failure. Since it functions as a network, even if there is a failure in one of the components, the services are available from the other active components.

6. Cloud offers better data security and recovery from any natural disasters and human errors as it backs up data over multiple locations.
7. According to the need, cloud architecture fulfills the hardware demands.
8. Cloud architecture can be easily scaled to the resource as per the demands.
9. Cloud architecture is able to handle and manage dynamic workloads without any failure.

Introduction to Eucalyptus:

Eucalyptus (Elastic Utility Computing Architecture for Linking Your Programs to Useful Systems) is a Linux-based open-source software architecture for cloud computing and also a storage platform that implements Infrastructure a Service (IaaS). It provides quick and efficient computing services. Eucalyptus was designed to provide services compatible with Amazon's EC2 cloud and Simple Storage Service(S3).

Operation Modes Of Eucalyptus

- **Managed Mode**: Numerous security groups to users as the network is large. Each security group is assigned a set or a subset of IP addresses. Ingress rules are applied through the security groups specified by the user. The network is isolated by VLAN between Cluster Controller and Node Controller. Assigns two IP addresses on each virtual machine.
- **Managed (No VLAN) Node:** The root user on the virtual machine can snoop into other virtual machines running on the same network layer. It does not provide VM network isolation.
- **System Mode:** Simplest of all modes, least number of features. A MAC address is assigned to a virtual machine instance and attached to Node Controller's bridge Ethernet device.
- **Static Mode**: Similar to system mode but has more control over the assignment of IP address. MAC address/IP address pair is mapped to static entry within the DHCP server. The next set of MAC/IP addresses is mapped.

Open Stack:

Modes of operation :

open stack can mainly operate in two modes i.e. single host mode and multi host mode. the operation is called multi host mode ,if a copy of the network is run on each of the compute nodes and the nodes areused as the internet gateway by the instances that are running on individual node.

A single node installation installs all components like nova, keystone, cinder, etc. in one single node. Multinode installation installs diferent components along various node. For example keystone and cinder in one node, neutron in another and 2 novas in 2 diferent servers. Generally speaking a single node setup of OpenStack is used for testing ,purposes. It is not designed for production and thus most would strongly discourage such implementation. environment.

A multi-node setup on the other hand is what most (if not all) production environments run on. Given the various components of OpenStack having all components on one node can significantly affect performance as you are limited to whatever resources that one node may have. Multi-Node not only provides a solution for this, but it is also highly scalable in the sense that if you require more compute power all you have to do is add more compute nodes (same with swift for storage, etc.). Additionally, having various nodes for various components can offer a failover in the case of one of your nodes suffers downtime.

Nimbus

Nimbus is another open-source toolkit that was initially aimed at providing IaaS capabilities specifically for the scientific community. It enables users to turn clusters into Infrastructure-as-a-Service (IaaS) clouds. Historically, Nimbus was more focused on the needs of scientific users who required cloud capabilities for computation and data-intensive applications but has less prominence today compared to Eucalyptus and OpenStack.

Modes of Operation:

- Science Clouds: Particularly suited for scientific computing, Nimbus is often used in academic or research settings where custom cloud capabilities are needed for specific projects.
- Toolkit for Cloud Computing: Nimbus provides tools that enable users to turn existing clusters into clouds that can run different jobs and applications, catering primarily to a niche of users with specialized needs.

3.2

Closed architectures in cloud computing refer to environments where the infrastructure and platform services are managed by single vendors and are not openly customizable by the users. Prominent examples include Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (including Google App Engine). These platforms offer powerful, scalable, and reliable cloud services but come with their specific sets of advantages and disadvantages.

Advantages of Closed Cloud Architectures

1. **Scalability and Elasticity:**
   - These platforms provide immense scalability and elasticity, allowing users to easily scale resources up or down based on demand without needing to manage the underlying hardware.
2. **Reliability and Availability:**
   - Major cloud providers invest heavily in infrastructure redundancy and robust failover systems, which translates to higher uptime and reliability for their customers.
3. **Advanced Services:**
   - Services like AI, machine learning, analytics, and database management are deeply integrated and constantly upgraded, providing businesses with cutting-edge tools.
4. **Global Network:**
   - AWS, Azure, and Google have a global presence with multiple regions and availability zones, reducing latency and improving performance for geographically distributed users.

5. **Security and Compliance:**
    - These platforms adhere to rigorous security standards and are compliant with a myriad of international and industry-specific regulations, reducing the compliance burden on businesses.

Disadvantages of Closed Cloud Architectures

1. **Vendor Lock-in:**
    - Committing to a single cloud provider can lead to dependency, making it difficult and potentially expensive to switch providers due to proprietary technologies and platform-specific services.
2. **Cost Predictability:**
    - Pricing structures can be complex and difficult to predict. Sudden increases in usage can lead to unexpectedly high charges, especially if not properly monitored.
3. **Customization Limits:**
    - While these platforms are highly configurable, there are inherent limitations in how much you can customize the underlying infrastructure compared to open architectures.
4. **Complexity:**
    - The sheer breadth of services and options available can be overwhelming and may require specialized skills to manage effectively.

Comparison: AWS, Azure, and Google Cloud

- **Amazon Web Services (AWS):**
    - **Strengths:** Broadest service offering, mature ecosystem, extensive marketplace with third-party services, and deep capabilities in enterprise IT integration.
    - **Weaknesses:** Can be complex to navigate due to the vast array of options and services; sometimes considered more expensive for certain services.
- **Microsoft Azure:**
    - **Strengths:** Strong integration with Microsoft software and services (like Windows Server, SQL Server, and Active Directory); preferred by enterprises deeply embedded in Microsoft technologies.
    - **Weaknesses:** Historically, perceived as less open for non-Microsoft and Linux-based technologies, although this has significantly improved.
- **Google Cloud Platform (Google App Engine):**
    - **Strengths:** Deep data analytics integration and machine learning services; highly optimized for performance and modern application architectures; strong security.
    - **Weaknesses:** Smaller market share and enterprise focus compared to AWS and Azure; perceived as less enterprise-friendly, although this perception is changing.

3.3

IOT AND CC

Cloud computing enables users to perform computing tasks using services provided over the Internet. IoT in the cloud means storing and processing the massive amounts of data generated by these interconnected devices in the cloud, rather than on local servers or in traditional data centers.benefits. In combination, it will be possible to use powerful processing of sensory data streams and new monitoring services. As an example, sensor data can be uploaded and saved using cloud computing for later use as intelligent monitoring and activation using other devices. The goal is to transform data into insights and thus drive cost-effective and productive action.

Benefits And Functions of IoT Cloud:

Bnenfits:

- IoT Cloud Computing provides many connectivity options, implying large network access. People use a wide range of devices to gain access to cloud computing resources: mobile devices, tablets, laptops. This is convenient for users but creates the problem of the need for network access points.
- **Greater scalability:** Cloud-based IoT platforms offer immense scalability. The cloud's elastic nature allows organizations to add or remove IoT devices without worrying about the infrastructure's capability to handle the increased or decreased load.
- **Speed and efficiency:** Cloud platforms have robust processing capabilities that allow data to be processed in near real-time. IoT devices constantly generate large amounts of data that need to be processed quickly to make timely decisions. With cloud computing, this high-speed data processing becomes possible, increasing efficiency and the speed at which actions can be taken.
- **Reduced operational costs:** With the cloud, businesses don't need to invest heavily in setting up physical infrastructure or worry about its maintenance. The pay-as-you-go model allows organizations to pay for only what they use, leading to considerable cost savings.

- **Data redundancy and recovery:** Cloud-based platforms usually have excellent data redundancy and recovery protocols in place. Data is often backed up in multiple locations, which ensures that in the event of any failure or loss of data, a backup is readily available.
- **Global accessibility:** One of the key features of cloud services is the ability to access the system from anywhere in the world, as long as you have an internet connection. This allows for remote monitoring and control of IoT devices, enabling real-time responses regardless of geographical location.
- **Improved interoperability:** Cloud-based IoT platforms tend to support a wide range of protocols and standards, making it easier to integrate different types of IoT devices and applications. This improved interoperability can lead to more effective IoT solutions.

Functions:

Here are some of the key functions of cloud-based IoT platforms:

- **Data storage and management:** IoT devices generate a staggering amount of data. This data needs to be stored, managed, and processed efficiently. Cloud storage provides a scalable, cost-effective solution for storing and managing IoT data.
- **Scalability and flexibility:** As the number of IoT devices increases, so does the need for storage and processing power. Cloud computing provides a scalable, flexible solution that can easily adapt to these changing needs.
- **Real-time processing and analytics:** IoT devices often need to process and analyze data in real-time to provide valuable insights and make informed decisions. Cloud computing provides the necessary infrastructure and processing power to carry out these real-time operations.

Internet of Things vs. Cloud Computing: Comparison Chart

Internet of things	Cloud Computing
Iot is a network of interconnected devices that are capable of exchanging data over a network.	Cloud computing is the on-demand delivery of IT resources and application via the internet.
The main purpose is to create an ecosystem of interconnected things and give them the ability to sense, touch, control, and communicate.	The purpose is to allow access to large amounts of computing power virtually, and offering a single system view.
The role of IoT is to generate massive amounts of data.	Cloud computing provides a way to store IoT data and provides tools to create IoT applications.

Role of cloud computing in IOT:

The cloud is an excellent IoT enabler that satisfies the data-driven requirements of the company. Cloud also offers technology framework. Using that framework, we can develop better IoT devices. Speed and scale are two essential aspects of cloud computing, and they work in unmatched harmony with IoT networking and mobility. So, user can benefit more by combine use of cloud computing and IoT. Some roles CC plays:

- ### IoT Data is More Secure And Private as a Result of Cloud Computing.

  IoT involves significant data generation. And when you work with data, the data security and data privacy become issue. IoT also makes use of mobility. Cloud uses advance encryption algorithms and authentication. Which enable cloud to provide its user high security.

- ## No Requirement For Hosting on-premises

For IoT devices, plug-and-play hosting services are necessary. This will become quite expensive due to plug-and-play hosting services. This will cost more to organizations. This type of hosting services needs hardware system. Due to the combined power of cloud computing and IoT, you do not need to depend on substantial machinery. As cloud computing infrastructure make it ready to use without having hardware storage device set-up offline. This makes it easy for IoT hosting organizations.

- ## Improved Device-To-Device Communication

We can use cloud technology for the communication using the IoT. Smart device can easily connect with each other using IoT APIs. It also makes internal communication between devices fast and easy

- ## Less Cost of Ownership

While preventing enterprises from putting up the infrastructure, cloud technology also provides many resources. As a result, it saves lot of money on infrastructure construction. Additionally, because there is no idea of local systems, hardware, and software in the cloud, the IT teams are abler to concentrate on their regular tasks.

- **Pay-as-you-go:** Internet Cloud Computing infrastructures help IoT to give meaning to the greater amount of data generated. Users have no worry of buying greater or less storage. They can easily scale the storage as the data generated increases and pay for the amount of storage they consume with Internet Cloud Computing.