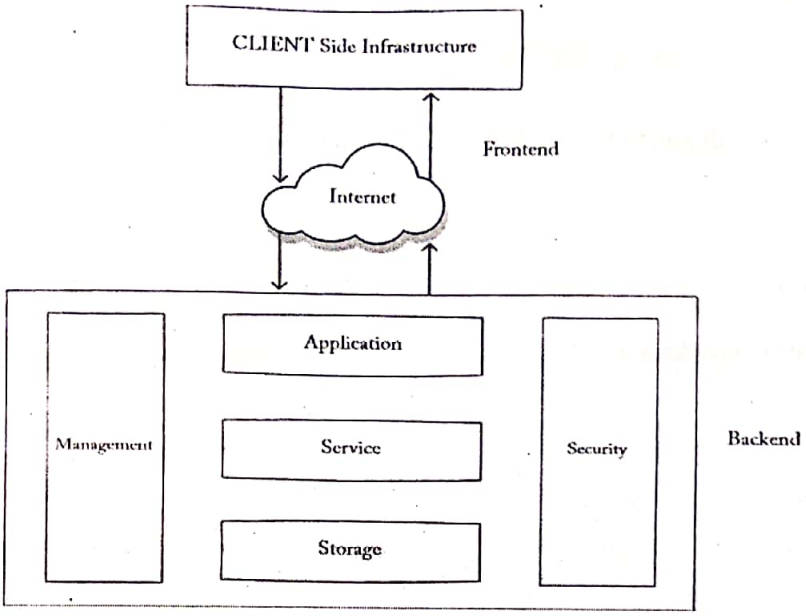
UNIT-3

CLOUD ARCHITECTURE

I) Introduction to Cloud Architecture:



Cloud Computing architecture comprises of many cloud components, which are loosely coupled. We can broadly divide the cloud architecture into two parts:

- Front-end
- Back-end

1) Front End: The **front end** refers to the client part of cloud computing system. It consists of interfaces and applications that are required to access the cloud computing platforms, Example - Web Browser.

2) Back End: The back End refers to the cloud itself. It consists of all the resources required to provide cloud computing services. It comprises of huge data storage, virtual machines, security mechanism, services, deployment models, servers, etc. It is the responsibility of the back end to provide built-in security mechanism, traffic.

The various components of Cloud Architecture are:

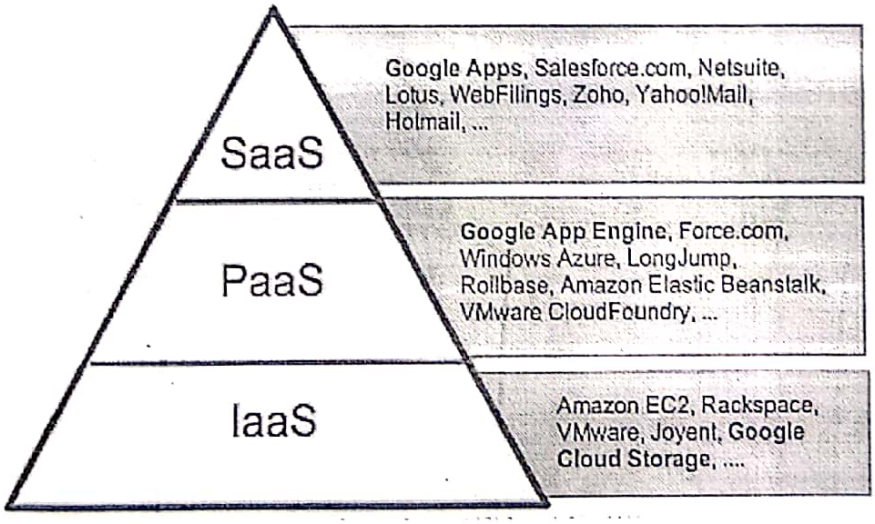
- On premise resources
- Cloud resources
- Software components and services
- Middleware

The entire cloud architecture is aimed at providing the users with high bandwidth, allowing users to have uninterrupted access to data and applications, on-demand agile network with possibility to move quickly and efficiently between servers or even between clouds and most importantly network security.

II) CLOUD DELIVERY MODELS:

There are 3 distinct cloud delivery models in Cloud computing:

- Software As a Service
- Platform As a Service
- Infrastructure As a Service



1) **Infrastructure as a Service** is the delivery of computer hardware (servers, networking technology, storage, and data center space) as a service. It may also include the delivery of operating systems and virtualization technology to manage the resources.

2) **Platform as a Service** includes the delivery of more than just infrastructure. It delivers what you might call a solution stack — an integrated set of software that provides everything a developer needs to build an application — for both software development and runtime.

3) **Software as a Service** is the delivery of business applications designed for a specific purpose. Software as a Service comes in two distinct modes:

- **Simple multi-tenancy:** Each customer has its own resources that are segregated from those of other customers. It amounts to a relatively inefficient form of multi-tenancy.
- **Fine-grain multi-tenancy:** This offers the same level of segregation but is far more efficient. All resources are shared, but customer data and access capabilities are segregated within the application.

III) SPI FRAMEWORK:

A commonly used framework for describing cloud computing services goes by the acronym —SPI. This acronym stands for the three major services provided through the cloud: **software-as-a-service (SaaS), platform-as-a-service (PaaS),** and **infrastructure-as-aservice (IaaS).**

1) Infrastructure as a Service - The IaaS model provides the required infrastructure to run the applications. A cloud infrastructure enables on-demand provisioning of servers running several types of operating systems and a customized software stack. The provider is in complete control of the infrastructure. Infrastructure services are considered to be the bottom layer of cloud computing systems. Example IBM, The definition of infrastructure as a service (IaaS) is pretty simple. You rent cloud infrastructure—servers, storage and networking on demand, in a pay-as-you-go model.

Advantages:-

- Tremendous control to use whatever content makes sense.
- Flexibility to secure data to whatever degree necessary
- Physical Independence from infrastructure

Disadvantages:-

- Responsible for all configuration implemented on the server (and in application)
- Responsible for keeping software up to date.
- Multi-tenancy at hypervisor level. Integration of all aspects of application (database, application program, plugin etc.)

2) Platform as a Service - In a platform-as-a-service (PaaS) model, the service provider offers a development environment to application developers, who develop applications and offer those

services through the provider's platform. A cloud platform offers an environment on which developers create and deploy applications and do not necessarily need to know how many processors or how much memory that applications will be using. Example Google App Engine, an example of Platform as a Service, offers a scalable environment for developing and hosting Web applications, which should be written in specific programming languages such as Python or Java.

Advantages:-

a) Reduce complexity because CSP is maintaining the environment.

b) The cloud service provider often uses its API (a benefit to the developer)

Disadvantages:-

a) Still responsible to keep software updated.

b) Multi-tenancy at platform layer.

3. Software as a Service - In a SaaS model, the customer does not purchase software, but rather rents it for use on a subscription or pay-per-use model. Services provided by this layer can be accessed by end users through Web portals. Therefore, consumers are increasingly shifting from locally installed computer programs to on-line software services that offer the same functionally. This model removes the burden of software maintenance for customers and simplifies development and testing for providers. Example Salesforce.com which relies on the SaaS model, offers business productivity applications (CRM) that reside completely on their servers, allowing customers to customize and access applications on demand.

Advantages:-

a) Scaling the environment is not the customer problem.

b) Updates/configuration/security is all managed by the CSP.

Disadvantages:

a) Very little application customization.

b) No control of components.

c) No control over security.

d) Multi-tenancy issue at the application layer

IV) SPI Evolution:

Cloud computing is that which does not compute on local computers but on centralized computers that are handled by another organization or computed by the third party and storage utilities but this is not done in grid computing.

Cloud computing has its roots as far back in 1950s when frame computers came into existence. At that time, several users accessed the central computer via dummy terminals. The only task these dummy terminals could perform was to enable users to access the mainframe computer. The prohibitive costs of this mainframe device did not make them economically feasible for organizations to buy them. That was the time when idea of provision of shared access to a single computer occurred to the companies to save costs.

In 1970s, IBM came out with an operating system named VM. This allowed for simultaneous operation of more than one OS. Guest Operating systems could be run on every VM, with their own memory and other infrastructure, making it possible to share these resources. This caused the concept of Virtualization in computing to gain popularity.

The 1990s witnessed telecom operators begin offering virtualized private network connections, whose quality of service was a good as those of point to point to services at a lesser cost. This is the way for telecom companies to offer many users share access to single physical infrastructure.

The other catalyst were Grid Computing, which allowed major issues to be addresses via Parlell computing: utility Computing facilitated computing resources to be offered as a metered service and SaaS Subscriptions , which were network based , to applications. Cloud computing owes its emergence to all these factors.

The three prominent types of cloud computing for business are software- as-a-Service (SaaS), which requires a company to subscribe to it and access services over the internet. Infrastructure-As-a-Service (IaaS) is a solution where large cloud computing companies deliver virtual infrastructure; and Platform-As-a-service (PaaS) gives the company the freedom to make its own custom applications that will be used by its entire entire workforce.

Some of the popular cloud applications globally are amazon web services, Google Compute Engine, RackSpace, Salesforce.com, IBM cloud managed services, among others. The main benefits of using cloud computing by companies are that they need not buy any infrastructure, thus lowering maintenance costs. They can do away the services used when their business demands have been met. It also gives firms comfort that they have huge resources at beck and call if they suddenly acquire a main project.

V) SPI (cloud computing) VS Traditional Model or Infrastructure:

Feature	Traditional	Cloud
Resilience and Elasticity	Traditional IT systems are not so resilient (flexible) and cannot guarantee a consistently high level of server performance. They have limited capacity and are susceptible to downtime, which can greatly hinder workplace productivity.	The information and applications hosted in the cloud are evenly distributed across all the servers, which are connected to work as one. Therefore, if one server fails, no data is lost and downtime is avoided. The cloud also offers more storage space and server resources, including better computing power
Flexibility and Scalability	With traditional IT infrastructure, you can only use the resources that are already available to you. If you run out of storage space, the only solution is to purchase or rent another server. If you hire more employees, you will need to pay for additional software licences and have these manually uploaded on your office hardware.	Cloud hosting offers an enhanced level of flexibility and scalability in comparison to traditional data centers. The on-demand virtual space of cloud computing has unlimited storage space and more server resources. Cloud servers can scale up or down depending on the level of traffic your website receives, and you will have full control to install any software as and when you need to.
Running Costs	With traditional IT infrastructure, you will need to purchase equipment and additional server space upfront to adapt to business growth. If this slows, you will end up paying for resources you don't use.	Cloud computing is more cost effective than traditional IT infrastructure due to methods of payment for the data storage services. With cloud based services, you only pay for what is used – similarly to how you pay for utilities such as electricity.
Security	With traditional IT infrastructure, you are responsible for the protection of	Cloud computing is an external form of data storage and software delivery,

	your data, and it is easier to ensure that only approved personnel can access stored applications and data. Physically connected to your local network, data centers can be managed by in-house IT departments on a round-the-clock basis.	which can make it seem less secure than local data hosting. Anyone with access to the server can view and use the stored data and applications in the cloud, wherever internet connection is available. Choosing a cloud service provider that is completely transparent in its hosting of cloud platforms and ensures optimum security measures are in place is crucial when transitioning to the cloud.

Software-As-A-Service (SAAS)

I) SaaS Service providers:

There are many cloud service provider for SAAS. One of the popular cloud service providers are **Salesforce.com, Google App Engine,** etc.

i) Salesforce.com:

Salesforce started as Software as a Service (SaaS) CRM company. Salesforce now provides various software solutions and a platform for users and developers to develop and distribute custom software. Salesforce.com is based on multi-tenant architecture. This means that multiple customers share common technology and all run on the latest release.

The following are the services and products that offer salesforce.com:

- **Sales Cloud** – The Sales Cloud is a CRM platform that enables you to manage your organization's sales, marketing and customer support facets. If your company is engaged in business-to-business (B2B) and business-to-customer (B2C), then sales cloud is the service your sales team needs.

- **Marketing Cloud** – The marketing cloud provides you with one of the world's most powerful digital marketing platforms. The marketers in your organization can use it to

manage customer journey, email, mobile, social media, web personalization, content creation, content management and data analytics.

- **Community Cloud** – If you need a social platform for your organization to connect and facilitate communication among your employees, partners and customers then Salesforce Community Cloud is the service you need. You can use this platform to exchange data and images in real time.

- **Analytics Cloud** – The Analytics Cloud provides a business intelligence platform for your organization to work with large data files, create graphs, charts and other pictorial representations of data.

- **App Cloud** – To develop custom apps that will run on the Salesforce platform, you can use the Salesforce App Cloud. It provides you with a collection of development tools that you can utilize to create custom applications.

II) Google App Engine:

Google App Engine (GAE) is a web framework and cloud computing platform for developing and hosting web applications in Google-managed datacenters.

GAE quickly build and deploy applications using many of the popular languages like Java, PHP, Node.js, Python, C#, .Net, Ruby and Go or bring your own language runtimes and frameworks if you choose. Traditional databases such as MySQL are supported, as well as next-generation NoSQL datastores and big data distributions such as MongoDB and Hadoop, respectively.

The following are the features of Google App engine:

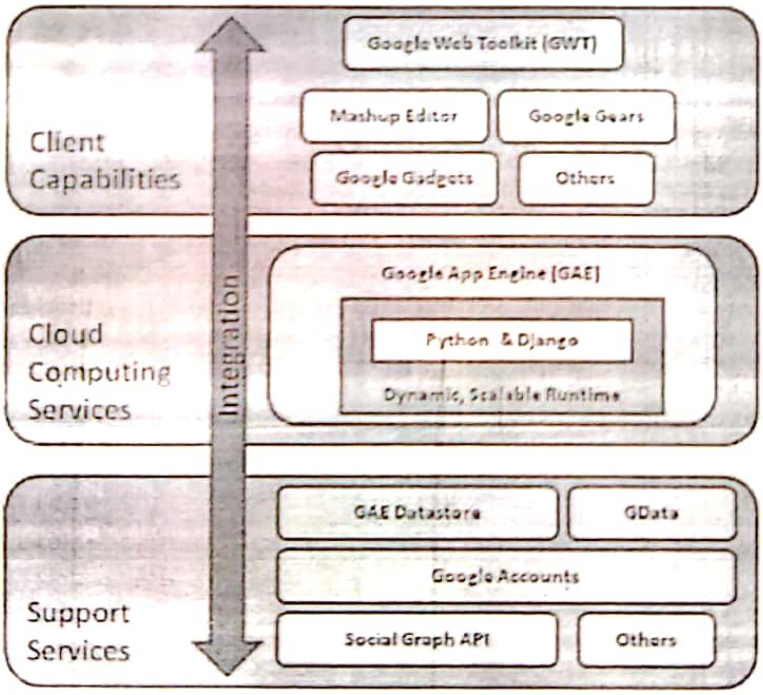
- **Popular Languages**: Build your application in Node.js, Java, Ruby, C#, Go, Python, or PHP, etc.

- **Open & Flexible:** Custom runtimes allow you to bring any library and framework to App Engine.

- **Fully Managed:** A fully managed environment lets you focus on code while App Engine manages infrastructure concerns.

- **Monitoring, Logging & Diagnostics: Google** Stackdriver gives you powerful application diagnostics to debug and monitor the health and performance of your app.
- **Application Versioning:** Easily host different versions of your app, easily create development, test, staging, and production environments.
- **Traffic Splitting:** Route incoming requests to different app versions, A/B test and do incremental feature rollouts.
- **Application Security:** Help safeguard your application by defining access rules with App Engine firewall and leverage managed SSL/TLS certificates.

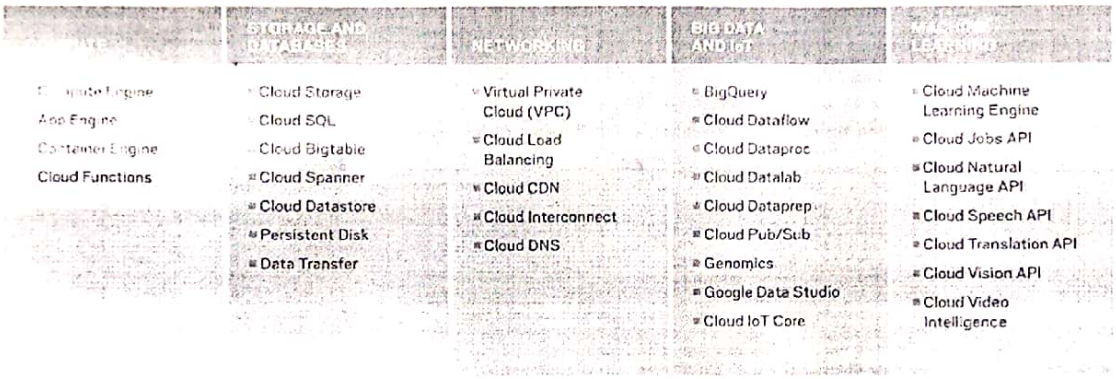
The following fig shows the architecture of Google App Engine:



III) Google Cloud platform:

Google Cloud Platform offers four main kinds of services: Compute, Storage, Big Data, and Machine Learning.

Google Cloud Platform services



i) Compute services:

- **Compute engine:** Google Compute Engine enables users to launch virtual machines (VMs) on demand. VMs can be launched from the standard images or custom images created by users.
- **Google App Engine,** which is a platform-as-a-service (PaaS) offering that gives software developers access to Google's scalable hosting. Developers can also use a software developer kit (SDK) to develop software products that run on App Engine.

ii) Storage and databases:

- **Google Cloud Storage,** which is a cloud storage platform designed to store large, unstructured data sets. Google also offers database storage options, including Cloud Datastore for NoSQL non-relational storage.
- **Cloud SQL** is a fully-managed database service that makes it easy to set up, maintain, manage, and administer your relational PostgreSQL and MySQL databases in the cloud. Cloud SQL offers high performance, scalability, and convenience.

iii) Networking:

- A **virtual private cloud** (VPC) is an on-demand configurable pool of shared computing resources allocated within a public **cloud** environment, providing a certain level of isolation between the different organizations using the resources.
- Google Cloud CDN (Content Delivery Network) uses Google's globally distributed edge points of presence to cache HTTP(S) load balanced content close to your users. Caching content at the edges of Google's network provides faster delivery of content to your users while reducing serving costs.

iv) Machine learning:

- **Cloud ML Engine** to train your machine learning models at scale, to host your trained model in the cloud, and to use your model to make predictions about new data.
- **Google Cloud Jobs API**, our latest machine learning service that provides the necessary job opportunities between the job seeker and employer job postings in order to improve the hiring process.
- Google **Cloud Speech-to-Text** enables developers to convert audio to text by applying powerful neural network models in an easy-to-use **API**. ... It can process real-time streaming or prerecorded audio, using Google's machine learning technology.

IV) Google Platform Operational Benefits:

1. Better Pricing than Competitors: Google gives in minute-level increments, so you only pay for the compute time you use. Which give you discounted prices for long-running workloads with no up-front commitment required. To start off, instances are simply lower in cost on Google Cloud Platform; Compute Engine alone is typically between 40% – 50% cheaper than AWS and Azure.

2. Private Global Fiber + Tiered Network: The Power is in the Network." The other thing – it has a private distributed backbone between all the data centers. You are talking over Google's backbone, not over the Internet."

3. Live Migration of Virtual Machines : Another huge advantage for Google Cloud Hosting, is live migrations of Virtual Machines. Benefits of live migrations allow for the engineers at Google to better address issues such as patching, repairing, and updating the software and hardware, without the need for you to worry about machine reboots.

4. State of the Art Security: Another big advantage is security. Choosing Google Cloud Platform means you get the benefit of a security model that has been built upon currently secures products and services like Gmail, Search, etc.

5. Dedication to Continued Expansion : Google has continued to rapidly build out their infrastructure for Google Cloud Platform. On September 29th, 2016 they announced the locations of new strategically placed Google Cloud Regions.

6. **Redundant Backups:** Google Cloud Storage is designed for 99.999999999% durability and has 4 different types of storage: Coldline storage, nearline, regional storage, and multi-regional storage. It stores data redundantly, with automatic checksums to ensure data integrity.