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Cloud Computing

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Introduction to cloud

Cloud - Cloud basically means that you could access your files, applications, and services from anywhere in the world. "Cloud refers to servers that are accessed over the Internet, and the software and databases that run on those servers. Cloud servers are located in data centers all over the world. By using cloud computing, users and companies do not have to manage physical servers themselves or run software applications on their own machines.

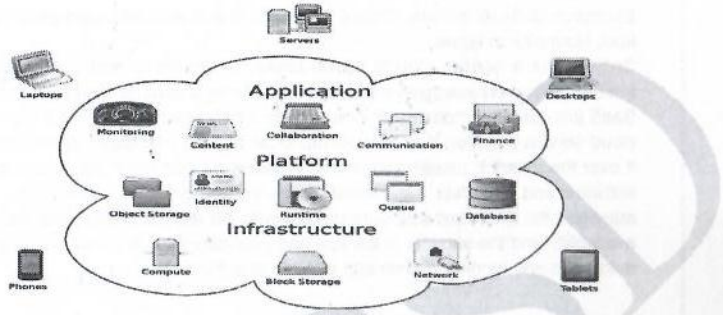


Fig. Cloud computing

Cloud computing consists of three distinct types of computing services delivered remotely to clients via the internet.

1.SAAS – software as a service
2. PAAS –platform as a service
3. IAAS –infrastructure

Clients typically pay a monthly or annual service fee to providers, to gain access to systems that deliver software as a service, platforms as a service and infrastructure as a service to subscribers. Clients who subscribe to cloud computing services can reap a variety of benefits, depending on their business needs at a given point in time. The days of large capital investments in software and IT infrastructure are now a thing of the past for any enterprise that chooses to adopt the cloud computing model for procurement of IT services.

The ability to access powerful IT resources on an incremental basis is leveling the playing field for small and medium sized organizations, providing them with the necessary tools and technology to compete in the global marketplace, without the previously requisite investment in on premise IT resources. Clients who subscribe to computing services delivered via the **cloud** can greatly reduce the IT service expenditures for their organizations; and gain access to more agile and flexible enterprise level computing services, in the process.

SAAS

Saas (Software as a Service) provides clients with the ability to use software applications on a remote basis via an internet web browser. Software as a service is also referred to as **"software on demand"**.

Clients can access SaaS applications from anywhere via the web because service providers host applications and their associated data at their location. The primary benefit of SaaS, is a lower cost of use, since subscriber fees require a much smaller investment than what is typically encountered under the traditional model of software delivery. Licensing fees, installation costs, maintenance fees and support fees that are routinely associated with the traditional model of software delivery can be virtually eliminated by subscribing to the SaaS model of software delivery.

Examples of SaaS include: Google Applications and internet based email applications like Yahoo! Mail, Hotmail and Gmail.

Software as a service (SaaS) allows users to connect to and use cloud-based apps over the Internet. Common examples are email, calendaring and office tools (such as Microsoft Office 365).

SaaS provides a complete software solution which you purchase on a pay-as-you-go basis from a cloud service provider. You rent the use of an app for your organization and your users connect to it over the Internet, usually with a web browser. All the underlying infrastructure, middleware, app software and app data are located in the service provider's data center. The service provider manages the hardware and software and with the appropriate service agreement, will ensure the availability and the security of the app and your data as well. SaaS allows your organization to get quickly up and running with an app at minimal upfront cost.

Common SaaS scenarios

If you have used a web-based email service such as Outlook, Hotmail or Yahoo! Mail, then you have already used a form of SaaS. With these services, you log into your account over the Internet, often from a web browser. The email software is located on the service provider's network and your messages are stored there as well. You can access your email and stored messages from a web browser on any computer or Internet-connected device.

The previous examples are free services for personal use. For organisational use, you can rent productivity apps, such as email, collaboration and calendaring; and sophisticated business applications such as customer relationship management (CRM), enterprise resource planning (ERP) and document management. You pay for the use of these apps by subscription or according to the level of use.

Advantages of SaaS

Gain access to sophisticated applications. To provide SaaS apps to users, you don't need to purchase, install, update or maintain any hardware, middleware or software. SaaS makes even sophisticated enterprise applications, such as ERP and CRM, affordable for organisations that lack the resources to buy, deploy and manage the required infrastructure and software themselves.

Pay only for what you use. You also save money because the SaaS service automatically scales up and down according to the level of usage.

Use free client software. Users can run most SaaS apps directly from their web browser without needing to download and install any software, although some apps require plugins. This means that you don't need to purchase and install special software for your users.

Mobilise your workforce easily. SaaS makes it easy to "mobilise" your workforce because users can access SaaS apps and data from any Internet-connected computer or mobile device. You don't need to worry about developing apps to run on different types of computers and devices because the service provider has already done so. In addition, you don't need to bring special

expertise onboard to manage the security issues inherent in mobile computing. A carefully chosen service provider will ensure the security of your data, regardless of the type of device consuming it.

Access app data from anywhere. With data stored in the cloud, users can access their information from any Internet-connected computer or mobile device. And when app data is stored in the cloud, no data is lost if a user's computer or device fails.

PAAS

PaaS (Platform as a Service) provides clients with the ability to develop and publish customized applications in a hosted environment via the web. It represents a new model for software development that is rapidly increasing in its popularity.

An example of PaaS is Salesforce.com. PaaS provides a framework for agile software development, testing, deployment and maintenance in an integrated environment.

Like SaaS, the primary benefit of PaaS, is a lower cost of use, since subscriber fees require a much smaller investment than what is typically encountered when implementing traditional tools for software development, testing and deployment. PaaS providers handle platform maintenance and system upgrades, resulting in a more efficient and cost effective solution for enterprise software development.

Platform as a service (PaaS) is a complete development and deployment environment in the cloud, with resources that enable you to deliver everything from simple cloud-based apps to sophisticated, cloud-enabled enterprise applications. You purchase the resources you need from a cloud service provider on a pay-as-you-go basis and access them over a secure Internet connection.

Like IaaS, PaaS includes infrastructure—servers, storage and networking—but also middleware, development tools, business intelligence (BI) services, database management systems and more. PaaS is designed to support the complete web application lifecycle: building, testing, deploying, managing and updating.

PaaS allows you to avoid the expense and complexity of buying and managing software licenses, the underlying application infrastructure and middleware or the development tools and other resources. You manage the applications and services you develop and the cloud service provider typically manages everything else.

Common PaaS scenarios

Organizations typically use PaaS for these scenarios:

Development framework. PaaS provides a framework that developers can build upon to develop or customize cloud-based applications. Similar to the way you create an Excel macro, PaaS lets developers create applications using built-in software components. Cloud features such as scalability, high-availability and multi-tenant capability are included, reducing the amount of coding that developers must do.

Analytics or business intelligence. Tools provided as a service with PaaS allow organizations to analyze and mine their data, finding insights and patterns and predicting outcomes to improve forecasting, product design decisions, investment returns and other business decisions.

Additional services. PaaS providers may offer other services that enhance applications, such as workflow, directory, security and scheduling.

Advantages of PaaS

By delivering infrastructure as a service, PaaS offers the same advantages as IaaS. But its additional features—middleware, development tools and other business tools—give you more advantages:

Cut coding time. PaaS development tools can cut the time it takes to code new apps with pre-coded application components built into the platform, such as workflow, directory services, security features, search and so on.

Add development capabilities without adding staff. Platform as a Service components can give your development team new capabilities without your needing to add staff having the required skills.

Develop for multiple platforms—including mobile—more easily. Some service providers give you development options for multiple platforms, such as computers, mobile devices and browsers making cross-platform apps quicker and easier to develop.

Use sophisticated tools affordably. A pay-as-you-go model makes it possible for individuals or organizations to use sophisticated development software and business intelligence and analytics tools that they could not afford to purchase outright.

Support geographically distributed development teams. Because the development environment is accessed over the Internet, development teams can work together on projects even when team members are in remote locations.

Efficiently manage the application lifecycle. PaaS provides all of the capabilities that you need to support the complete web application lifecycle: building, testing, deploying, managing and updating within the same integrated environment.

IAAS

IaaS (Infrastructure as a Service) allows clients to remotely use IT hardware and resources on a **"pay-as-you-go"** basis. It is also referred to as HaaS (hardware as a service). Major IaaS players include companies like IBM, Google and Amazon.com.

IaaS employs virtualization, a method of creating and managing infrastructure resources in the "cloud". IaaS provides small start up firms with a major advantage, since it allows them to gradually expand their IT infrastructure without the need for large capital investments in hardware and peripheral systems.

Infrastructure as a service (IaaS) is an instant computing infrastructure, provisioned and managed over the Internet. Quickly scale up and down with demand and pay only for what you use.

IaaS helps you avoid the expense and complexity of buying and managing your own physical servers and other datacenter infrastructure. Each resource is offered as a separate service component and you only need to rent a particular one for as long as you need it. The cloud computing service provider manages the infrastructure, while you purchase, install, configure and manage your own software—operating systems, middleware and applications.

Common IaaS business scenarios

Typical things businesses do with IaaS include:

Test and development. Teams can quickly set up and dismantle test and development environments, bringing new applications to market faster. IaaS makes it quick and economical to scale up dev-test environments up and down.

Website hosting. Running websites using IaaS can be less expensive than traditional web

hosting.

Storage, backup and recovery. Organizations avoid the capital outlay for storage and complexity of storage management, which typically requires a skilled staff to manage data and meet legal and compliance requirements. IaaS is useful for handling unpredictable demand and steadily growing storage needs. It can also simplify planning and management of backup and recovery systems.

Web apps. IaaS provides all the infrastructure to support web apps, including storage, web and application servers and networking resources. Organizations can quickly deploy web apps on IaaS and easily scale infrastructure up and down when demand for the apps is unpredictable.

High-performance computing. High-performance computing (HPC) on supercomputers, computer grids or computer clusters helps solve complex problems involving millions of variables or calculations. Examples include earthquake and protein folding simulations, climate and weather predictions, financial modeling and evaluating product designs.

Big data analysis. Big data is a popular term for massive data sets that contain potentially valuable patterns, trends and associations. Mining data sets to locate or tease out these hidden patterns requires a huge amount of processing power, which IaaS economically provides.

Advantages of IaaS

Eliminates capital expense and reduces ongoing cost. IaaS sidesteps the upfront expense of setting up and managing an on-site datacenter, making it an economical option for start-ups and businesses testing new ideas.

Improves business continuity and disaster recovery. Achieving high availability, business continuity and disaster recovery is expensive, since it requires a significant amount of technology and staff. But with the right service level agreement (SLA) in place, IaaS can reduce this cost and access applications and data as usual during a disaster or outage.

Innovate rapidly. As soon as you have decided to launch a new product or initiative, the necessary computing infrastructure can be ready in minutes or hours, rather than the days or weeks—and sometimes months—it could take to set up internally.

Respond quicker to shifting business conditions. IaaS enables you to quickly scale up resources to accommodate spikes in demand for your application— during the holidays, for example—then scale resources back down again when activity decreases to save money.

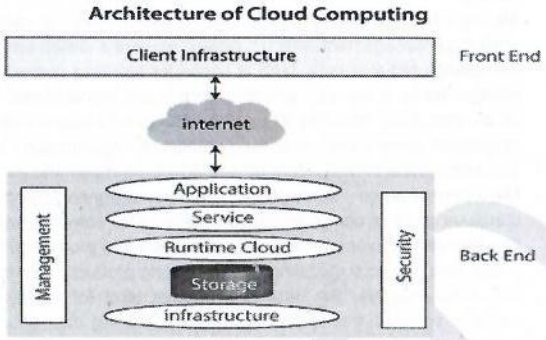
Focus on your core business. IaaS frees up your team to focus on your organization's core business rather than on IT infrastructure.

Increase stability, reliability and supportability. With IaaS there is no need to maintain and upgrade software and hardware or troubleshoot equipment problems. With the appropriate agreement in place, the service provider assures that your infrastructure is reliable and meets SLAs.

Better security. With the appropriate service agreement, a cloud service provider can provide security for your applications and data that may be better than what you can attain in-house.

Gets new apps to users faster. Because you don't need to first set up the infrastructure before you can develop and deliver apps, you can get them to users faster with IaaS.

Cloud Architecture



Important Components of Cloud Computing Architecture

Here are some important components of Cloud computing architecture:

1. Client Infrastructure:

Client Infrastructure is a front-end component that provides a GUI. It helps users to interact with the Cloud.

2. Application:

The application can be any software or platform which a client wants to access.

3. Service:

The service component manages which type of service you can access according to the client's requirements.

Three Cloud computing services are:

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

4. Runtime Cloud:

Runtime cloud offers the execution and runtime environment to the virtual machines.

5. Storage:

Storage is another important Cloud computing architecture component. It provides a **large amount of storage capacity in the Cloud to store and manage data.**

6. Infrastructure:

It offers services on the host level, network level, and application level. Cloud infrastructure includes hardware and software components like servers, storage, network devices, virtualization software, and various other storage resources that are needed to support the cloud computing model.

7. Management:

This component manages components like application, service, runtime cloud, storage, infrastructure, and other security matters in the backend. It also establishes coordination between them.

8. Security:

Security in the backend refers to implementing different security mechanisms for secure **Cloud systems, resources, files, and infrastructure to the end-user.**

9. Internet:

Internet connection acts as the bridge or medium between frontend and backend. It allows you to establish the interaction and communication between the frontend and backend.

Types of cloud deployments: public, private, hybrid

Not all clouds are the same. There are three different ways to deploy cloud computing resources: **public cloud**, **private cloud** and **hybrid cloud**.

Public cloud

Public clouds are owned and operated by a third-party cloud service provider, which deliver their computing resources like servers and storage over the Internet. Microsoft Azure, AWS, Google Cloud are an example of a public cloud. With a public cloud, all hardware, software and other supporting infrastructure is owned and managed by the cloud provider. You access these services and manage your account using a web browser.

Private cloud

A private cloud refers to cloud computing resources used exclusively by a single business or organization. A private cloud can be physically located on the company's on-site datacenter. Some companies also pay third-party service providers to host their private cloud. A private cloud is one in which the services and infrastructure are maintained on a private network.

Hybrid cloud

Hybrid clouds combine public and private clouds, bound together by technology that allows data and applications to be shared between them. By allowing data and applications to move between private and public clouds, hybrid cloud gives businesses greater flexibility and more deployment options.

Virtualization

Virtualization is the process of creating multiple virtual machines /operating system from one physical hardware.

This is called type -2 hypervisor

a. VMware Workstation/Fusion/Player
b. Oracle VM VirtualBox

Virtual Box hypervisor technology provides reasonable performance and features if you want to virtualize on a budget. Despite being a free, hosted product with a very small footprint, Virtual Box shares many features with VMware vSphere and Microsoft Hyper-V.

Introduction Virtual Private Cloud (VPC)
Amazon Virtual Private Cloud (Amazon VPC) enables you to launch AWS resources into a virtual network that you've defined. This virtual network closely resembles a traditional network that you'd operate in your own data center, with the benefits of using the scalable infrastructure of AWS.

Features

The following features help you configure a VPC to provide the connectivity that your applications need:

Virtual private clouds (VPC)
A VPC is a virtual network that closely resembles a traditional network that you'd operate in your own data center. After you create a VPC, you can add subnets.
Subnets
A subnet is a range of IP addresses in your VPC. A subnet must reside in a single Availability Zone. After you add subnets, you can deploy AWS resources in your VPC.
IP addressing
You can assign IP addresses, both IPv4 and IPv6, to your VPCs and subnets. You can also bring your public IPv4 and IPv6 GUA addresses to AWS and allocate them to resources in your VPC, such as EC2 instances, NAT gateways, and Network Load Balancers.
Routing
Use route tables to determine where network traffic from your subnet or gateway is directed.
Gateways and endpoints
A gateway connects your VPC to another network. For example, use an internet gateway to connect your VPC to the internet. Use a VPC endpoint to connect to AWS services privately, without the use of an internet gateway or NAT device.
Peering connections
Use a VPC peering connection to route traffic between the resources in two VPCs.
Traffic Mirroring
Copy network traffic from network interfaces and send it to security and monitoring appliances for deep packet inspection.
Transit gateways

Use a transit gateway, which acts as a central hub, to route traffic between your VPCs, VPN connections, and AWS Direct Connect connections.
VPC Flow Logs
A flow log captures information about the IP traffic going to and from network interfaces in your VPC.
VPN connections
Connect your VPCs to your on-premises networks using AWS Virtual Private Network (AWS VPN).

VM Provisioning Process
The common and normal steps of provisioning a virtual server are as follows:
• Firstly, you need to select a server from a pool of available servers (physical servers with enough capacity) along with the appropriate OS template you need to provision the virtual machine.
• Secondly, you need to load the appropriate software (operating System you selected in the previous step, device drivers, middleware, and the needed applications for the service required).
• Thirdly, you need to customize and configure the machine (e.g., IP address, Gateway) to configure an associated network and storage resources.
• Finally, the virtual server is ready to start with its newly loaded software

To summarize, server provisioning is defining server's configuration based on the organization requirements, a hardware, and software component (processor, RAM, storage, networking, operating system, applications, etc.).
Normally, virtual machines can be provisioned by manually installing an operating system, by using a preconfigured VM template, by cloning an existing VM, or by importing a physical server or a virtual server from another hosting platform. Physical servers can also be virtualized and provisioned using P2V (Physical to Virtual) tools and techniques (e.g., virt- p2v).
After creating a virtual machine by virtualizing a physical server, or by building a new virtual server in the virtual environment, a template can be created out of it.
Most virtualization management vendors (VMware, XenServer, etc.) provide the data center's administration with the ability to do such tasks in an easy way.
VM For Cloud Infrastructures
There are many commercial IaaS cloud providers in the market, such as those cited earlier, and all of them share five characteristics:
(i) They provide on-demand provisioning of computational

resources;
(ii) They use virtualization technologies to lease these resources;
(iii) They provide public and simple remote interfaces to manage those resources;
(iv)They use a pay-as-you-go cost model, typically charging by the hour;
(v) They operate data centers large enough to provide a seemingly unlimited amount of resources to their clients (usually touted as —infinite capacityǁ or —unlimited elasticityǁ). Private and hybrid clouds share these same characteristics, but instead of selling capacity over publicly accessible interfaces, focus on providing capacity to an organization's internal users

Benefits of Virtualization

1. **Resource Optimization** -You can create multiple virtual on the unused and utilized hardware without need to buy new hardware
2. **Consolidation**-If an organization have multiple application running on multiple hardware, we can consolidate into one single machine and creating multiple virtual machines to host that application. This results in less physical space, A/C resources, and other data center resources.

3. **Maximize Uptime**- With virtualization, we can spin off virtual machine easily.
Reconfiguration of computer resources without impacting users.
Guaranteed uptime of server and applications
4. **Easily Migrate workload** - We can move virtual machine from one physical box to another box regardless of difference in hardware configuration. So it increases reliability and availability

virtualization Software:

Microsoft virtual PC
Oracle virtual Box,
VMware exi
Citrix ,etc

(file formats for virtualized images)- .vhdx, .vdi, .vmdk

AWS

Amazon Web Services (AWS) is the world's most comprehensive and broadly adopted cloud platform, offering over 200 fully featured services from data centers globally.
AWS (Amazon Web Services) is a comprehensive, evolving cloud computing platform provided by Amazon that includes a mixture of infrastructure as a service (IaaS), platform as a service (PaaS) and packaged software as a service (SaaS) offerings.

AWS launched in 2006 from the internal infrastructure that Amazon.com built to handle its online retail operations. AWS was one of the first companies to introduce a pay-as-you-go cloud computing model that scales to provide users with compute, storage or throughput as needed.

AWS offers many different tools and solutions for enterprises and software developers that can be used in data centers in up to 190 countries. Groups such as government agencies, education institutions, nonprofits and private organizations can use AWS services.

How AWS works

AWS is separated into different services; each can be configured in different ways based on the user's needs. Users should be able to see configuration options and individual server maps for an AWS service.
More than 100 services comprise the Amazon Web Services portfolio, including those for compute, databases, infrastructure management, application development and security. These services, by category, include:

- Compute
- Storage databases
- Data management
- Migration
- Hybrid cloud
- Networking
- Development tools
- Management
- Monitoring
- Security
- Governance
- Big data management
- Analytics
- Artificial intelligence (AI)
- Mobile development
- Messages and notification

Availability

Amazon Web Services provides services from dozens of data centers spread across availability zones (AZs) in regions across the world. An AZ is a location that contains multiple physical data centers. A region is a collection of AZs in geographic proximity connected by low-latency network links.

A business will choose one or multiple availability zones for a variety of reasons, such as compliance and proximity to end customers. For example, an AWS customer can spin up virtual machines (VMs) and replicate data in different AZs to achieve a highly reliable infrastructure that is resistant to failures of individual servers or an entire data center.

Amazon Elastic Compute Cloud (EC2) is a service that provides virtual servers -- called EC2 instances -- for compute capacity. The EC2 service offers dozens of instance types with varying capacities and sizes, tailored to specific workload types and applications, such as memory-

intensive and accelerated-computing jobs. AWS also provides an Auto Scaling tool to dynamically scale capacity to maintain instance health and performance.

Storage

Amazon Simple Storage Service (S3) provides scalable object storage for data backup, collection and analytics. An IT professional stores data and files as S3 objects -- which can range up to 5 gigabytes (GB) -- inside S3 buckets to keep them organized. A business can save money with S3 through its Infrequent Access storage tier or by using Amazon Glacier for long-term cold storage. Amazon Elastic Block Store provides block-level storage volumes for persistent data storage when using EC2 instances. Amazon Elastic File System offers managed cloud-based file storage.

Networking

An Amazon Virtual Private Cloud (Amazon VPC) gives an administrator control over a virtual network to use an isolated section of the AWS cloud. AWS automatically provisions new resources within a VPC for extra protection.

Admins can balance network traffic with the Elastic Load Balancing (ELB) service, which includes the Application Load Balancer and Network Load Balancer. AWS also provides a domain name system called Amazon Route 53 that routes end users to applications.

An IT professional can establish a dedicated connection from an on-premises data center to the AWS cloud via AWS Direct Connect.

Acquisitions

Over time, AWS has acquired multiple organizations, increasing its focus on technologies it wants to further incorporate. Recently AWS' acquisitions haven't concentrated on larger well-established companies, but instead on organizations that could bolster and overall improve the cloud vendor's existing offerings. These acquisitions don't add to AWS, but rather enhance its core services. For example, AWS has acquired TSO Logic, Sqrrl and CloudEndure.

Amazon Elastic Compute Cloud features-

AWS EC2 is a cloud service that's easy to use and easy to set up if companies understand its many facets and features.

Amazon Elastic Compute Cloud (Amazon EC2) provides scalable computing capacity in the Amazon Web Services (AWS) Cloud. Using Amazon EC2 eliminates your need to invest in hardware up front, so you can develop and deploy applications faster. You can use Amazon EC2 to launch as many or as few virtual servers as you need, configure security and networking, and manage storage. Amazon EC2 enables you to scale up or down to handle changes in requirements or spikes in popularity, reducing your need to forecast traffic.

Amazon EC2 provides the following features:

Virtual computing environments, known as instances
Preconfigured templates for your instances, known as Amazon Machine Images (AMIs), that package the bits you need for your server (including the operating system and additional software)
Various configurations of CPU, memory, storage, and networking capacity for your instances, known as instance types
Secure login information for your instances using key pairs (AWS stores the public key, and you store the private key in a secure place)
Storage volumes for temporary data that's deleted when you stop, hibernate, or terminate your instance, known as instance store volumes
Persistent storage volumes for your data using Amazon Elastic Block Store (Amazon EBS), known as Amazon EBS volumes

Multiple physical locations for your resources, such as instances and Amazon EBS volumes, known as Regions and Availability Zones
A firewall that enables you to specify the protocols, ports, and source IP ranges that can reach your instances using security groups
Static IPv4 addresses for dynamic cloud computing, known as Elastic IP addresses
Metadata, known as tags, that you can create and assign to your Amazon EC2 resources
Virtual networks you can create that are logically isolated from the rest of the AWS Cloud, and that you can optionally connect to your own network, known as virtual private clouds (VPCs)
How to get started with Amazon EC2?

first, you need to get set up to use Amazon EC2. After you are set up, you are ready to complete the Get Started tutorial for Amazon EC2. Whenever you need more information about an Amazon EC2 feature, you can read the technical documentation.

You can provision Amazon EC2 resources, such as instances and volumes, directly using Amazon EC2. You can also provision Amazon EC2 resources using other services in AWS.

To automatically distribute incoming application traffic across multiple instances, use Elastic Load Balancing.

Amazon EC2 provides a web-based user interface, the Amazon EC2 console. If you've signed up for an AWS account, you can access the Amazon EC2 console by signing into the AWS Management Console and selecting EC2 from the console home page.

On-Demand Instances
Pay for the instances that you use by the second, with a minimum of 60 seconds, with no long-term commitments or upfront payments.

Savings Plans
You can reduce your Amazon EC2 costs by making a commitment to a consistent amount of usage, in USD per hour, for a term of 1 or 3 years.

Reserved Instances
You can reduce your Amazon EC2 costs by making a commitment to a specific instance configuration, including instance type and Region, for a term of 1 or 3 years.

Spot Instances
Request unused EC2 instances, which can reduce your Amazon EC2 costs significantly.

To see your bill, go to the Billing and Cost Management Dashboard in the AWS Billing and Cost Management console. Your bill contains links to usage reports that provide details about your bill.

Services provided by AWS: EC2, Lambda, AWS storage services S3 –
Amazon EC2 is one of the most widely-used services offered by Amazon. It hosts configurable virtual machines in the AWS cloud, which can be configured individually to suit the end user's needs. The service allows users to configure a computer with the required amount of CPU, GPU, RAM, and storage, and be able to access it within minutes.
Amazon RDS is used for building a relational database service in the cloud. Just like other AWS products, Amazon RDS also allows the provisioning of large amounts of storage in an accessible format.
AWS storage services S3-Storage was one of the first infrastructural options offered over the cloud and remains one of AWS' most used services to date. It is worth noting that S3 is different from Amazon RDS, as the latter is a way to create a database, while the former simply stores all kinds of objects.
Amazon Lambda allows users to focus squarely on developing and not provisioning infrastructure. Built on the elastic nature of other AWS offerings
Lambda allows for serverless compute. With serverless compute, an individual does not need to provision resources individually. The service provider takes care of all the infrastructural requirements.
Mannual steps for Application Deployment on AWS :

1.Create Node JS Folder
2.Add public folder to store web pages.
3.Add images folder inside public folder to store images for web site.
3.Add server.js to create and listen web server.
4.define package.json file to list down library dependency for Web Application
5.install required libraries needed for Webserver to host Web site.
6.Run node JS Application.
7.Test Web site by invoking using url http://localhost:9000.
8.Push it to github in repository.
9.Commit all those changes to repository.
10.Add collaborators so that other team members can clone repository to their machines
Deploy, Configure and run on aws cloud subscription available (mumbai data Center)
11.Loging to aws console using id and password.
12.Create EC2 instance to host above web appliation which tested and run on physical machine of developer.
13.Clone code repository from github account to EC2 instance.

14.Update necessary linux packages using sudo apt update command.
15.Install node js runtime.
16.Configure security Group to allow traffic from anywhere.
17.Run Node js process for weberver.js to listen web application on port 9000.
18.Test Web appliation with default url using ipaddress of ec2 instnace with port 9000

Docker
In the IT world, Docker has now established itself as a de facto standard and is enormously important due to its functionality in the modern development environment. It is free software developed by Docker, Inc. Docker is based on Linux containers in which individual services are isolated. So it is a platform for packaging, distributing and executing applications. This is simplified by features such as operating system independence for data transport.

Why should we talk about Platform-as-a-Service (PaaS) in this context? A PaaS service simplifies the productive operation of applications such as critical database systems and increases security because the cloud provider takes care of the smooth operation. The combination of Docker and PaaS has many good reasons, which I would like to show you below.

Docker Platform

Many companies are always looking for the best solutions to save time, costs and above all resources.
This is exactly where Docker comes in, as this technology offers a convenient solution for many demanding processes in the development process.

Docker Workflow
Docker is an open source software and uses the so-called container technology.
It separates different levels from each other by running software components separately and independently on a single container.
For example, database and web server would run in different containers.

The isolation is achieved by the mechanisms of the Linux kernel such as Linux namespace and control groups (Linux-Cgroups). Linux namespace personalize the resources such as files, processes, network interfaces, hostname, etc. on the system. Linux groups have the task of restricting the amount of resources such as CPU, memory, network bandwidth, etc. in participating processes.

Isolation makes it easier to move and replicate services, since settings no longer need to be configured manually. Once a Docker image and the runtime environment are stored, this environment can be shared with other people without the need to set up the environment again. The further steps can simply build on this.

As already indicated, Docker is a good alternative to virtualization by using container technologies. Docker containers have their own file system and share the operating system kernel on the Docker host. This means that processes running on containers are displayed on process tables of the

operating system. The containers are managed by the so-called Docker daemon.

When a Docker container starts, the first version is created by the file system, the Docker image. The Docker image opens a further layer, into which the container writes its own data. Docker images consist of programs, libraries and data. From the Docker image, any number of containers can be created.

The file system contains the so-called Docker file. The Dockerfile is a shell script that installs the required software from e.g. Docker-Hub. It describes how a Docker image – also called base image – can be created. A special advantage of Dockerfile is the simplicity of its creation, so that you can create it with a few commands (FROM, RUN, CMD, COPY, EXPOSE). Afterwards, the Docker image can be exported and saved to a Docker registry.

What are Containers?

Containers are packages of software that contain all of the necessary elements to run in any environment.
In this way, containers virtualize the operating system and run anywhere, from a private data center to the public cloud or even on a developer's personal laptop.
From Gmail to YouTube to Search, everything at Google runs in containers.
Containerization allows our development teams to move fast, deploy software efficiently, and operate at an unprecedented scale.

Containers are lightweight packages of your application code together with dependencies such as specific versions of programming language runtimes and libraries required to run your software services.

Containers make it easy to share CPU, memory, storage, and network resources at the operating systems level and offer a logical packaging mechanism in which applications can be abstracted from the environment in which they actually run.

What are the benefits of containers?

Separation of responsibility
Containerization provides a clear separation of responsibility, as developers focus on application logic and dependencies, while IT operations teams can focus on deployment and management instead of application details such as specific software versions and configurations.

Workload portability
Containers can run virtually anywhere, greatly easing development and deployment: on Linux, Windows, and Mac operating systems; on virtual machines or on physical servers; on a developer's machine or in data centers on-premises; and of course, in the public cloud.
Application isolation
Containers virtualize CPU, memory, storage, and network resources at the operating system level,

providing developers with a view of the OS logically isolated from other applications.

Google Cloud Platform

Google Cloud Platform

Google Cloud Platform is a set of cloud computing services that Google offers, which runs on the same infrastructure that Google uses for its end-user products, such as YouTube, Gmail, and more. Google Cloud Platform offers a variety of services, including:

- Compute
- Network
- Machine learning and AI
- Big data processing

Google Cloud Platform Components

Several components and services are an important feature of Google Cloud Platform; let's dive into each one individually and learn more about what they provide.

1. Compute

The compute service enables compute and hosting the cloud. The various services under this are as follows:

- App Engine
- Compute Engine
- Kubernetes Engine
- Cloud Functions
- Cloud Run

2. Storage and Database

The storage and database service enables the application to store media files, backups, or other file-like objects. The services include:

- Cloud Storage
- Cloud SQL

- Cloud Bigtable
- Cloud Spanner
- Cloud Datastore

3. Networking

The networking service enables us to load-balance traffic across resources, create DNS records, and much more. Some of the services include:

- VPC
- Cloud Load Balancing
- Cloud Armor
- Cloud CDN
- Cloud Interconnect
- Cloud DNS
- Network Service Tiers

4. Big Data

The big data service enables us to process and query big data in the cloud. A few of the included services are the following::

- BigQuery
- Cloud Dataproc
- Cloud Datalab
- Cloud Data Studio

5. Developer Tools

The developer tools service includes tools that enable software and application development.

- Artifact Registry (beta)
- Cloud SDK
- Cloud Code

- CloudBuild
- Cloud Scheduler
- Cloud Tasks

6. Identity and Security

This service deals with security and authentication:

- Cloud Identity
- Cloud IAM
- Cloud Data Loss Prevention API
- Security Key Enforcement

7. Internet of Things(IoT)

You can leverage GCP to create IoT environments with the following tools:

- Cloud IoT Core
- Edge TPU
- Cloud IoT

8. Cloud AI

Cloud AI comprises services related to machine learning, which also encompasses:

- Cloud AutoML
- Cloud Natural Language
- Cloud Speech-to-Text
- Cloud Text-to-Speech
- Cloud Translation API
- Cloud Vision API
- Cloud Video Intelligence

9. Management Tools

This domain includes services related to management and monitoring. The services under this are as follows:

- Cloud Deployment Manager
- Cloud Console
- Cloud Shell
- Cloud APIs

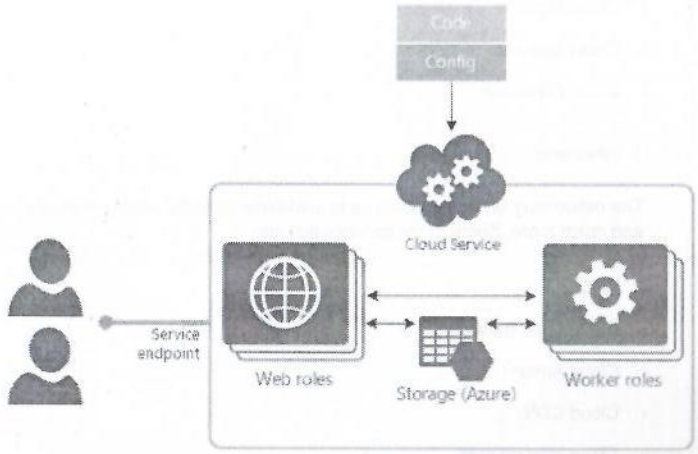
10. API Platform

The few services under this are as follows:

- Maps Platform
- Developer Portal
- API Analytics
- Apigee Sense
- Cloud Endpoints

Azure Cloud Services

Azure Cloud Services is an example of a platform as a service (PaaS). Like Azure App Service, this technology is designed to support applications that are scalable, reliable, and inexpensive to operate. In the same way that App Service is hosted on virtual machines (VMs), so too is Azure Cloud Services. However, you have more control over the VMs. You can install your own software on VMs that use Azure Cloud Services, and you can access them remotely.



More control also means less ease of use. Unless you need the additional control options, it's typically quicker and easier to get a web application up and running in the Web Apps feature of App Service compared to Azure Cloud Services.

There are two types of Azure Cloud Services roles. The only difference between the two is how your role is hosted on the VMs:

- **Web role**: Automatically deploys and hosts your app through IIS.
- **Worker role**: Does not use IIS, and runs your app standalone.

For example, a simple application might use just a single web role, serving a website. A more complex application might use a web role to handle incoming requests from users, and then pass those requests on to a worker role for processing. (This communication might use Azure Service Bus or Azure Queue storage.)

As the preceding figure suggests, all the VMs in a single application run in the same cloud service. Users access the application through a single public IP address, with requests automatically load balanced across the application's VMs. The platform scales and deploys the VMs in an Azure Cloud Services application in a way that avoids a single point of hardware failure.

Even though applications run in VMs, it's important to understand that Azure Cloud Services provides PaaS, not infrastructure as a service (IaaS). Here's one way to think about it. With IaaS, such as Azure Virtual Machines, you first create and configure the environment your application runs in. Then you deploy your application into this environment. You're responsible for managing much of this world, by doing things such as deploying new patched versions of the operating system in each VM. In PaaS, by contrast, it's as if the environment already exists. All you have to

do is deploy your application. Management of the platform it runs on, including deploying new versions of the operating system, is handled for you.

Scaling and management

With Azure Cloud Services, you don't create virtual machines. Instead, you provide a configuration file that tells Azure how many of each you'd like, such as "three web role instances" and "two worker role instances." The platform then creates them for you. You still choose what size those backing VMs should be, but you don't explicitly create them yourself. If your application needs to handle a greater load, you can ask for more VMs, and Azure creates those instances. If the load decreases, you can shut down those instances and stop paying for them.

An Azure Cloud Services application is typically made available to users via a two-step process. A developer first uploads the application to the platform's staging area. When the developer is ready to make the application live, they use the Azure portal to swap staging with production. This switch between staging and production can be done with no downtime, which lets a running application be upgraded to a new version without disturbing its users.

Monitoring

Azure Cloud Services also provides monitoring. Like Virtual Machines, it detects a failed physical server and restarts the VMs that were running on that server on a new machine. But Azure Cloud Services also detects failed VMs and applications, not just hardware failures. Unlike Virtual Machines, it has an agent inside each web and worker role, and so it's able to start new VMs and application instances when failures occur.

IaaS vs PaaS vs SaaS: Comparison

Basis	IaaS	PaaS	SaaS
Abbreviation	Infrastructure as a Service	Platform as a Service	Software as a Service
Uses	Provide cloud-based services	Hardware and Software tools available over the internet	Available via a third-party over the internet
Used by	Used by network architects	Used by developers	Used by end-users
Access	Access to virtual storage and virtual machines	Access to run time environment to deployment and development tools for application	SAAS provides access to end-user
Model	Provides visualized computing resources over the internet	Deliver tools that are used for the development of application	Service model in cloud computing that host software makes available

Basis	IaaS	PaaS	SaaS
			for client
Technical understanding	Technical Knowledge is required	Knowledge of subject to understand the basic setup	No requirement about technicalities
Cloud Services	Cloud express, sun, amazon web services, Azure	Facebook and Google search engine	Facebook, google apps, and M.S office
Popularity	Popular between developers and researchers	Popular among developers who focus on the development of apps and scripts	Popular between consumer and company
Enterprise services	AWS virtual private cloud	Microsoft azure	AWS Terremark

Introduction to Heroku

The Heroku Platform

The Heroku network runs the customer's apps in virtual containers which execute on a reliable runtime environment. Heroku calls these containers "Dynos". These Dynos can run code written in Node, Ruby, PHP, Go, Scala, Python, Java, or Clojure. Heroku also provides custom buildpacks with which the developer can deploy apps in any other language. Heroku lets the developer scale the app instantly just by either increasing the number of dynos or by changing the type of dyno the app runs in.

Heroku Postgres

Heroku Postgres is the Cloud database (DBaaS) service for Heroku based on PostgreSQL. Heroku Postgres provides features like continuous protection, rollback, and high availability; also forks, followers, and dataclips.

Heroku Redis

Heroku Redis is the customized Redis from Heroku to provide a better developer experience. It is fully managed and is provided as a service by Heroku. It helps in managing instances with a CLI, associate data with Postgres to gain business insights using SQL tools, and lets customer gain performance visibility.

Heroku Teams

Heroku Teams is a team management tool which provides collaboration and controls to bring a customer's developers, processes, and tools together in order to build better software. With Heroku Teams, teams can self-organize, add, and manage members, get fine-grained control with app-level permissions and also use collaboration tools like Heroku Pipelines. It also provides delegated administration and centralized billing.

Heroku Enterprise

Heroku Enterprise provides services to large companies which help them to improve collaboration among different teams. It provides a set of features like fine-grained access controls, identity federation, and private spaces to manage their enterprise application development process, resources, and users.

Heroku Connect

Heroku Connect lets users create Heroku apps that can easily integrate with Salesforce deployments at scale. This is done by having a seamless data synchronization between Heroku Postgres databases and Salesforce organizations.

Heroku Elements

Heroku Elements provides users with Add-ons (tools and services for developing, extending, and operating the app), Buildpacks (which automate the build processes for the preferred languages and frameworks) and Buttons (a tool for the one-click provisioning, configuring, and deployment of third party components, libraries and patterns).