

Cloud Service Model

- Service models refer to the different ways in which computing resources are provided to users.
- Cloud computing offers three main service models to meet the diverse needs of users.
- They are following
 1. **Infrastructure as a Service (IaaS)**
 2. **Platform as a Service (PaaS)**
 3. **Software as a Service (SaaS)**

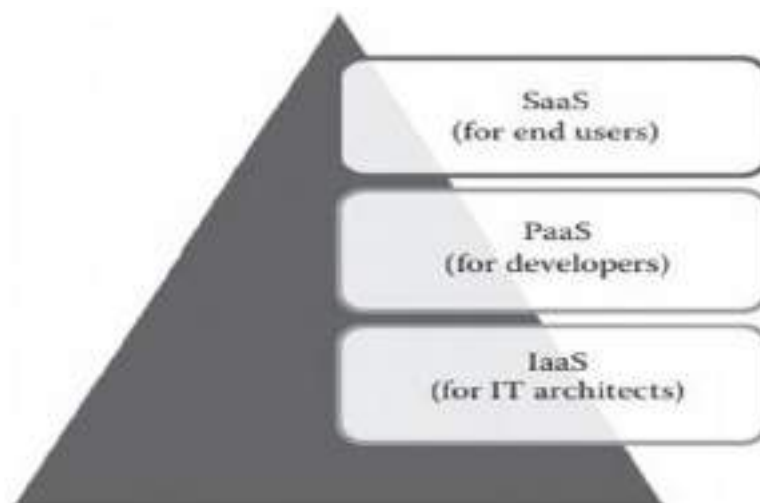


FIGURE 5.1
Basic cloud service models.

1. Infrastructure as a Service (IaaS):

- Infrastructure as a Service (IaaS) is one of the **fundamental service** models in cloud computing, **providing virtualized computing resources** over the internet.
- In an IaaS model, cloud providers **offer a range of infrastructure components**, such as **virtual machines (VMs), storage, and networking resources**, as scalable services.
- Users can rent these resources on a pay-as-you-go basis, allowing for flexibility and cost-efficiency

- IaaS is commonly used for various purposes, **including website hosting, development and testing environments, data backup and recovery, high-performance computing, and running enterprise applications.**
- Popular IaaS providers include **Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP), and IBM Cloud.**

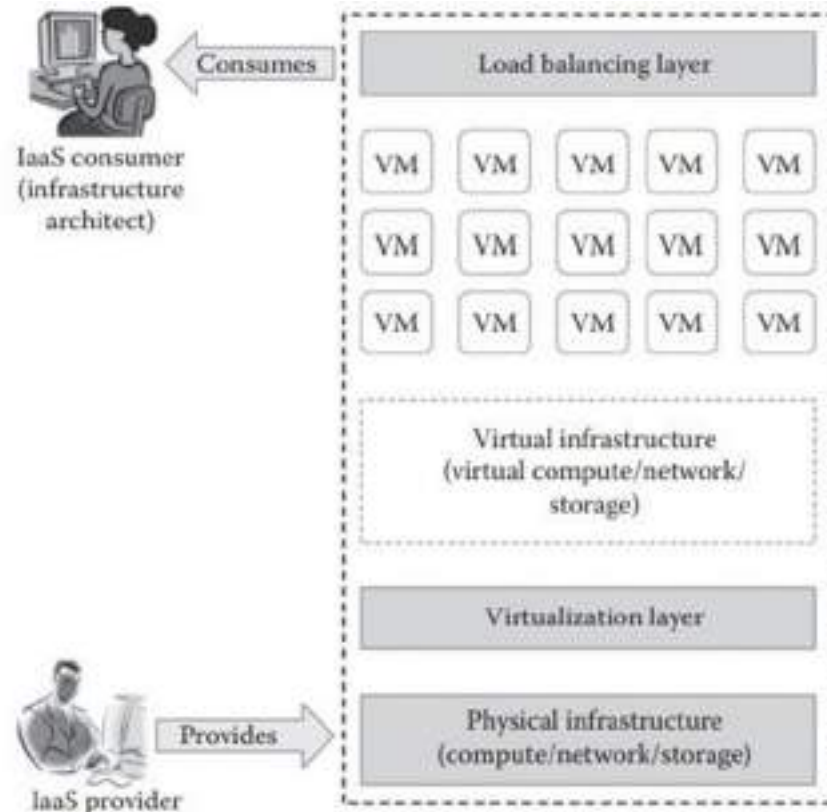


FIGURE 3.4
Overview of IaaS.

A) Overview of IaaS

- IaaS changes the way that the compute, storage, and networking resources are consumed.
- In traditional data centers, the computing power is consumed by having physical access to the infrastructure.
- IaaS changes the computing from a physical infrastructure to a virtual infrastructure.
- IaaS provides virtual computing, storage, and network resources by abstracting the physical resources.
- Technology virtualization is used to provide the virtual resources.
- All the virtual resources are given to the virtual machines (VMs) that are configured by the service provider.

- The end users or IT architects will use the infrastructure resources in the form of VMs as shown in Figure 5.4.
- The targeted audience of IaaS is the IT architect.
- The IT architect can design virtual infrastructure, network, load balancers, etc., based on their needs.
- The IT architects need not maintain the physical servers as it is maintained by the service providers.
- The physical infrastructure can be maintained by the service providers themselves.
- Thus, it eliminates or hides the complexity of maintaining the physical infrastructure from the IT architects.

B) A typical IaaS provider may provide the following services as shown in Figure below

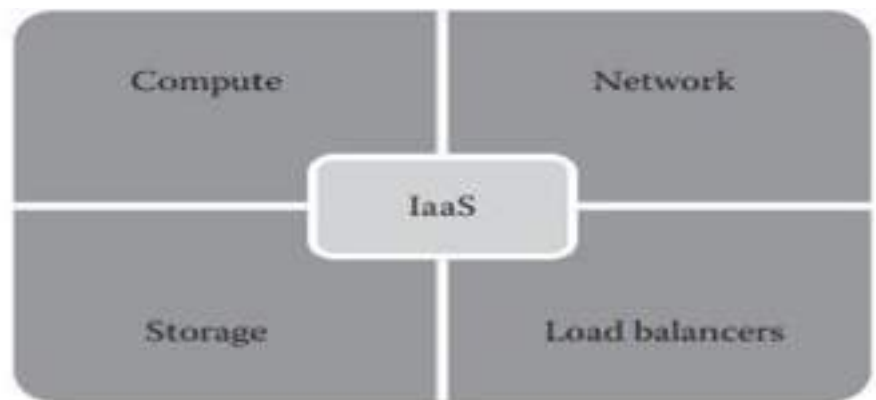


FIGURE 5.5
Services provided by IaaS providers.

1. Compute:

- Computing as a Service includes virtual central processing units (CPUs) and virtual main memory for the VMs that are provisioned to the end users.

2. Storage:

- STaaS provides back-end storage for the VM images. Some of the IaaS providers also provide the back end for storing files.

3. Network:

- Network as a Service (NaaS) provides virtual networking components such as virtual router, switch, and bridge for the VMs.

4. Load balancers:

- Load Balancing as a Service may provide load balancing capability

at the infrastructure layer.

C) Characteristics of IaaS:

- IaaS providers offer virtual computing resources to the consumers on a pay-as-you-go basis.
- IaaS contains the characteristics of cloud computing such as on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service.

IaaS has its own unique characteristics as follows:

1. Web access to the resources:

- The IaaS model enables the IT users to access infrastructure resources over the Internet. When accessing a huge computing power, the IT user need not get physical access to the servers.
- Through any web browsers or management console, the users can access the required infrastructure.

2. Centralized management:

- Even though the physical resources are distributed, the management will be from a single place.
- The resources distributed across different parts can be controlled from any management console.
- This ensures effective resource management and effective resource utilization.

3. Elasticity and dynamic scaling:

- IaaS provides elastic services where the usage of resources can be increased or decreased according to the requirements.
- The infrastructure need depends on the load on the application.
- According to the load, IaaS services can provide the resources.
- The load on any application is dynamic and IaaS services are capable of providing the required services dynamically.

4. Shared infrastructure:

- IaaS follows a one-to-many delivery model and allows multiple IT users to share the same physical infrastructure.
- The different IT users will be given different VMs.
- IaaS ensures high resource utilization.

5. Preconfigured VMs:

- IaaS providers offer preconfigured VMs with operating systems (OSs), network configuration, etc.
- The IT users can select any kind of VMs of their choice. The IT users are free to
- configure VMs from scratch.
- The users can directly start using the VMs as soon as they subscribed to the services

6. Metered services:

- IaaS allows the IT users to rent the computing resources instead of buying it.
- The services consumed by the IT user will be measured, and the users will be charged by the IaaS providers based on the amount of usage.

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B) Suitability of IaaS:

IaaS reduces the total cost of ownership (TCO) and increases the return on investment (ROI) for start-up companies that cannot invest more in buying infrastructure. IaaS can be used in the following situations:

1. Unpredictable spikes in usage:

- When there is a significant spike in usage of computing resources, IaaS is the best option for IT industries.
- When demand is very volatile, we cannot predict the spikes and troughs in terms of demand of the infrastructure.
- In this situation, we cannot add or remove infrastructure immediately according to the demand in a traditional infrastructure.
- If there is an unpredictable demand for infrastructure, then it is recommended to use IaaS services.

2. Limited capital investment:

- New start-up companies cannot invest more on buying infrastructure for their business needs.
- And so by using IaaS, start-up companies can reduce the capital investment on hardware.
- IaaS is the suitable option for start-up companies with less capital investment on hardware.

3. Infrastructure on demand:

- Some organizations may require large infrastructure for a short period of time.
- For this purpose, an organization cannot afford to buy more on-premise resources.
- Instead, they can rent the required infrastructure for a specific period of time.
- IaaS best suits the organizations that look for infrastructure on demand or for a short time period.

IaaS helps start-up companies limit its capital expenditure. While it is widely used by start-up companies, there are some situations where IaaS may not be the best option. In following situations, **IT users should avoid using the IaaS:**

1. When regulatory compliance does not allow off-premise hosting:

- For some companies, its regulation may not allow the application and data to be hosted on third-party off-premise infrastructure.

2. When usage is minimal:

- When the usage is minimal and the available on-premise infrastructure itself is capable of satisfying their needs.

3. When better performance is required:

- Since the IaaS services are accessed through the Internet, sometimes the performance might be not as expected due to network latency.

4. When there is a need for more control on physical infrastructure:

- Some organizations might require physical control over the underlying infrastructure.
- As the IaaS services are abstracted as virtual resources, it is not possible to have more control on underlying physical infrastructure

C) Pros and Cons of IaaS:

The following are the benefits provided by IaaS:

1. Pay-as-you-use model:

- The IaaS services are provided to the customers on a pay-per-use basis.
- This ensures that the customers are required to pay for what they have used.
- This model eliminates the unnecessary spending on buying hardware.

2. Reduced TCO:

- Since IaaS providers allow the IT users to rent the computing resources, they need not buy physical hardware for running their business.
- The IT users can rent the IT infrastructure rather than buy it by spending large amounts.
- IaaS reduces the need for buying hardware resources and thus reduces the TCO.

3. Elastic resources:

- IaaS provides resources based on the current needs.
- IT users can scale up or scale down the resources whenever they

want.

- This dynamic scaling is done automatically using some load balancers.
- This load balancer transfers the additional resource request to the new server and improves application efficiency.

4. Better resource utilization:

- Resource utilization is the most important criteria to succeed in the IT business.
- The purchased infrastructure should be utilized properly to increase the ROI.
- IaaS ensures better resource utilization and provides high ROI for IaaS providers.

5. Supports Green IT:

- In traditional IT infrastructure, dedicated servers are used for different business needs.
- Since many servers are used, the power consumption will be high.
- This does not result in Green IT.
- In IaaS, the need of buying dedicated servers is eliminated as single infrastructure is shared between multiple customers, thus reducing the number of servers to be purchased and hence the power consumption that results in Green IT.

The following are the drawbacks of IaaS:

1. Security issues:

- Since IaaS uses virtualization as the enabling technology, hypervisors play an important role.
- There are many attacks that target the hypervisors to compromise it.
- If hypervisors get compromised, then any VMs can be attacked easily.
- Most of the IaaS providers are not able to provide 100% security to the VMs and the data stored on the VMs.

2. Interoperability issues:

- There are no common standards followed among the different IaaS providers.
- It is very difficult to migrate any VM from one IaaS provider to the

other.

- Sometimes, the customers might face the vendor lock-in problem.

3. Performance issues:

- IaaS is nothing but the consolidation of available resources from the distributed cloud servers.
- Here, all the distributed servers are connected over the network.
- Latency of the network plays an important role in deciding the performance. Because of latency issues, sometimes the VM contains issues with its performance.

2. PaaS:

- **Platform as a Service" (PaaS)** is a category of cloud computing services that provide a platform allowing customers to **develop, run, and manage applications** without the complexity of building and maintaining the underlying infrastructure typically associated with developing and launching an application.
- In a PaaS model, the **cloud provider** typically **manages the infrastructure** (servers, storage, networking, etc.) and **middleware** (databases, messaging systems, etc.), while the customer focuses on managing the applications and data.
- This **allows developers** to concentrate on **writing code** and **deploying applications** without worrying about the underlying hardware or software infrastructure.
- PaaS offerings often **include features** such as **development tools, database management systems, application hosting, and deployment automation**.
- They **provide a framework** that facilitates the entire **lifecycle of application development**, from coding to testing to deployment and scaling.
- Some of the popular PaaS providers **include Google App Engine, Heroku, Engine Yard, Microsoft Azure App Service, Salesforce App Cloud (formerly Force.com) and Amazon Web Services (AWS) Elastic Beanstalk**

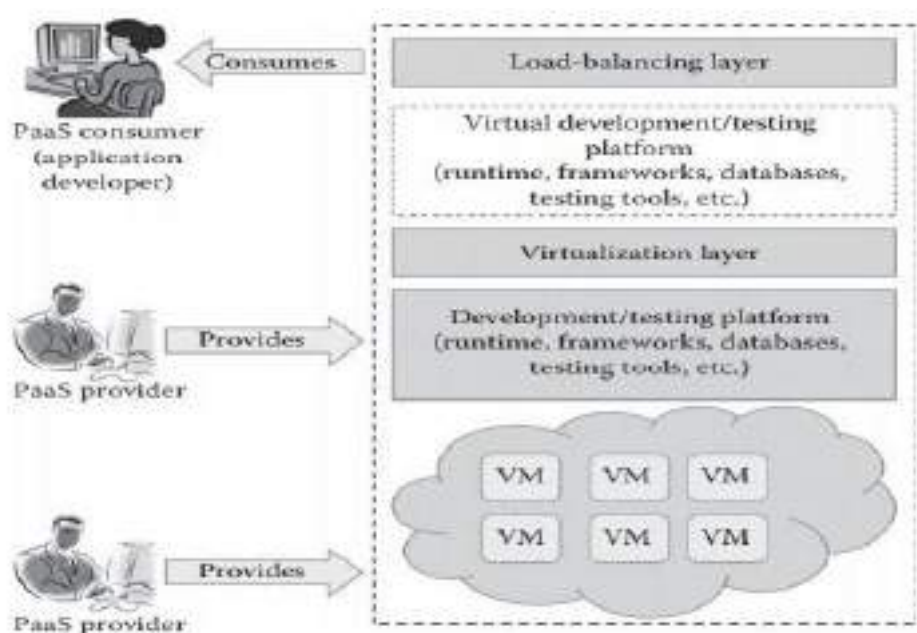


FIGURE 5.6
Overview of PaaS.

A. Overview of Paas

- PaaS changes the way that the software is developed and deployed.
- In traditional application development, the application will be developed locally and will be hosted in the central location.
- In stand-alone application development, the applications will be developed and delivered as executables.
- Most of the applications developed by traditional development platforms result in a licensing-based software, whereas PaaS changes the application development from local machine to online.
- PaaS providers provide the development PaaS from the data center. The developers can consume the services over the Internet as shown in Figure 5.6.
- PaaS allows the developers to develop their application online and also allows them to deploy immediately on the same platform.
- PaaS consumers or developers can consume language runtimes, application frameworks, databases, message queues, testing tools, and deployment tools as a service over the Internet.
- Thus, it reduces the complexity of buying and maintaining different tools for developing an application.

B) Typical PaaS providers may provide programming languages, application frameworks, databases, and testing tools as shown in Figure 5.7

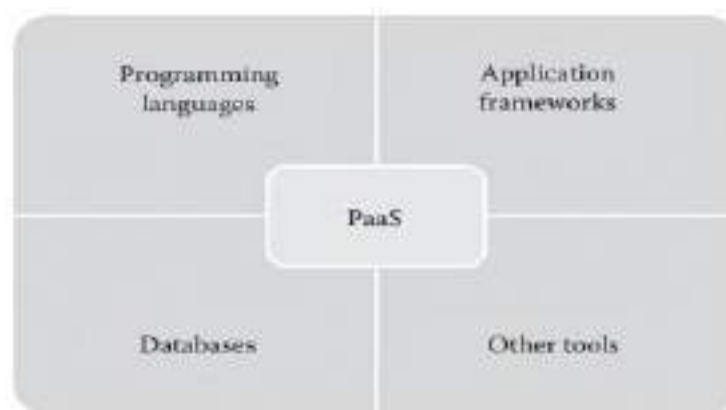


FIGURE 5.7
Services provided by PaaS providers.

Some of the PaaS providers also provide build tools, deployment tools, and software load balancers as a service:

1.Programming languages:

- PaaS providers provide a wide variety of programming languages for the developers to develop applications.
- Some of the popular programming languages provided by PaaS vendors are Java, Perl,PHP, Python, Ruby, Scala, Clojure, and Go.

2.Application frameworks:

- PaaS vendors provide application frameworks that simplify the application development.
- Some of the popular application development frameworks provided by a PaaS provider include Node.js, Rails, Drupal, Joomla, WordPress, Django, EE6, Spring, Play, Sinatra, Rack, and Zend.

3.Database:

- Since every application needs to communicate with the databases, it becomes a must-have tool for every application.
- PaaS providers are providing databases also with their PaaS platforms.
- The popular databases provided by the popular PaaS vendors are ClearDB, PostgreSQL, Cloudant, Membase, MongoDB, and Redis.

4.Other tools:

- PaaS providers provide all the tools that are required to develop, test, and deploy an application

C) Characteristics of PaaS:

PaaS development platforms are different from the traditional application development platforms.

The following are the essential characteristics that make PaaS unique from traditional development platforms:

1.All in one:

- Most of the PaaS providers offer services to develop, test, deploy, host, and maintain applications in the same IDE.
- Additionally, many service providers provide all the programming languages, frameworks, databases, and other development-related services that make developers choose from a wide variety of development platforms.

2.Web access to the development platform:

- A typical development platform uses any IDEs for developing applications.
- Typically, the IDE will be installed in the developer's machines.
- But, PaaS provides web access to the development platform.
- Using web UI, any developer can get access to the development platform.
- The web-based UI helps the developers create, modify, test, and deploy different applications on the same platform.

3.Offline access:

- A developer may not be able to connect to the Internet for a whole day to access the PaaS services.
- When there is no Internet connectivity, the developers should be allowed to work offline.
- To enable offline development, some of the PaaS providers allow the developer to synchronize their local IDE with the PaaS services.
- The developers can develop an application locally and deploy it online whenever they are connected to the Internet.

4.Built-in scalability:

- Scalability is an important requirement for the new generation web or SaaS applications.
- It is very difficult to enable the dynamic scalability for any

application developed using traditional development platforms.

- But, PaaS services provide built-in scalability to an application that is developed using any particular PaaS.
- This ensures that the application is capable of handling varying loads efficiently.

5. Collaborative platform:

- Nowadays, the development team consists of developers who are working from different places.
- There is a need for a common platform where the developers can collaboratively work together on the same project.
- Most of the PaaS services provide support for collaborative development.
- To enable collaboration among developers, most of the PaaS providers provide tools for project planning and communication.

6. Diverse client tools:

- To make the development easier, PaaS providers provide a wide variety of client tools to help the developer.
- The client tools include CLI, web CLI, web UI, REST API, and IDE.
- The developers can choose any tools of their choice.
- These client tools are also capable of handling billing and subscription management.

D)Suitability of PaaS :

Most of the start-up SaaS development companies and independent software vendors (ISVs) widely use PaaS in developing an application. PaaS technology is getting attention from other traditional software development companies also.

PaaS is a suitable option for the following situations:

1.Collaborative development:

- To increase the time to market and development efficiency, there is a need for a common place where the development team and other stakeholders of the application can collaborate with each other.
- Since PaaS services provide a collaborative development environment, it is a suitable option for applications that need collaboration among developers and other third parties to carry out the development process.

2.Automated testing and deployment:

- Automated testing and building of an application are very useful while developing applications at a very short time frame.
- The automated testing tools reduce the time spent in manual testing tools.
- Most of the PaaS services offer automated testing and deployment capabilities.
- The development team needs to concentrate more on development rather than testing and deployment.
- Thus, PaaS services are the best option where there is a need for automated testing and deployment of the applications.

3.Time to market:

- The PaaS services follow the iterative and incremental development methodologies that ensure that the application is in the market as per the time frame given.
- For example, the PaaS services are the best option for application development that uses agile development methodologies.

- If the software vendor wants their application to be in the market as soon as possible, then the PaaS services are the best option for the development.
- PaaS is used widely to accelerate the application development process to ensure the time to market.
- Most of the start-up companies and ISVs started migrating to the PaaS services.

Even though it is used widely, there are some situations where PaaS may not be the best option:

1.Frequent application migration:

- The major problem with PaaS services are vendor lock-in. Since there are no common standards followed among PaaS providers, it is very difficult to migrate the application from one PaaS provider to the other.

2.Customization at the infrastructure level:

- PaaS is an abstracted service, and the PaaS users do not have full control over the underlying infrastructure.
- There are some application development platforms that need some configuration or customization of underlying infrastructure.
 - In these situations, it is not possible to customize the underlying infrastructure with PaaS.
 - If the application development platform needs any configuration at the hardware level, it is not recommended to go for PaaS.

3.Flexibility at the platform level:

- PaaS provides template-based applications where all the different programming languages, databases, and message queues are predefined.
- It is an advantage if the application is a generic application.

4.Integration with on-premise application:

- A company might have used PaaS services for some set of applications. For some set of applications, they might have used on-premise platforms.
- Since many PaaS services use their own proprietary technologies to define the application stack, it may not match with the on-premise application stack.

- This makes the integration of application hosted in on-premise platform and PaaS platform a difficult job.

E) Pros and Cons of PaaS:

PaaS has the following benefits:

1.Quick development and deployment:

- PaaS provides all the required development and testing tools to develop, test, and deploy the software in one place.
- Most of the PaaS services automate the testing and deployment process as soon as the developer completes the development.
- This speeds up application development and deployment than traditional development platforms.

2. Reduces TCO:

- The developers need not buy licensed development and testing tools if PaaS services are selected.
- Most of the traditional development platforms require high-end infrastructure for its working, which increases the TCO of the application development company.
- But, PaaS allows the developers to rent the software, development platforms, and testing tools to develop, build, and deploy the application.
- PaaS does not require high-end infrastructure to develop the application, thus reducing the TCO of the development company.

3.Supports agile software development:

- Nowadays, most of the new-generation applications are developed using agile methodologies.
- Many ISVs and SaaS development companies started adopting agile methodologies for application development.
- PaaS services support agile methodologies that the ISVs and other development companies are looking for.

4.Different teams can work together:

- The traditional development platform does not have extensive support for collaborative development.

- PaaS services support developers from different places to work together on the same project.
- This is possible because of the online common development platform provided by PaaS providers.

5.Ease of use:

- The traditional development platform uses any one of CLI- or IDE-based interfaces for development.
- Some developers may not be familiar with the interfaces provided by the application development platform.
- This makes the development job a little bit difficult.
- But, PaaS provides a wide variety of client tools such as CLI, web CLI, web UI, APIs, and IDEs.
- The developers are free to choose any client tools of their choice.
- Especially, the web UI-based PaaS services increase the usability of the development platform for all types of developers.

6.Less maintenance overhead:

- In on-premise applications, the development company or software vendor is responsible for maintaining the underlying hardware.
- They need to recruit skilled administrators to maintain the servers.
- This overhead is eliminated by the PaaS services as the underlying infrastructure is maintained by the infrastructure providers.
- This gives freedom to developers to work on the application development.

7.Produces scalable applications:

- Most of the applications developed using PaaS services are web application or SaaS application.
- These applications require better scalability on the extra load.
- For handling extra load, the software vendors need to maintain an additional server.
- It is very difficult for a new start-up company to provide extra servers based on the additional load.
- But, PaaS services are providing built-in scalability to the

application that is developed using the PaaS platform.
PAAS contains following drawbacks:

1. Vendor lock-in:

- The major drawback with PaaS providers is vendor lock-in.
- The main reason for vendor lock-in is lack of standards.
- There are no common standards followed among the different PaaS providers.
- The other reason for vendor lock-in is proprietary technologies used by PaaS providers. Most of the PaaS vendors use the proprietary technologies that are not compatible with the other PaaS providers.
- The vendor lock-in problem of PaaS services does not allow the applications to be migrated from one PaaS provider to the other.

2. Security issues:

- Like in the other cloud services, security is one of the major issues in PaaS services.
- Since data is stored in off-premise third-party servers, many developers are afraid to go for PaaS services.
- Of course, many PaaS providers provide mechanisms to protect the user data, and it is not sufficient to feel the safety of on premise deployment.
- When selecting the PaaS provider, the developer should review the regulatory, compliance, and security policies of the PaaS provider with their own security requirements.
- If not properly reviewed, the developers or users are at the risk of data security breach.

3. Less flexibility:

- PaaS providers do not give much freedom for the developers to define their own application stack.
- Most of the PaaS providers provide many programming languages, databases, and other development tools.
- But, it is not extensive and does not satisfy all developer needs.
- Only some of the PaaS providers allow developers to extend the PaaS tools with the custom or new programming

languages.

- Still most of the PaaS providers do not provide flexibility to the developers.

4.Depends on Internet connection:

- Since the PaaS services are delivered over the Internet, the developers should depend on Internet connectivity for developing the application.
- Even though some of the providers allow offline access, most of the PaaS providers do not allow offline access.
- With slow Internet connection, the usability and efficiency of the PaaS platform do not satisfy the developer requirements.

3. Software as a Service(SaaS)

- SaaS (Software as a Service) in AWS refers to a cloud computing model where AWS provides software applications over the internet as a service.
- In this model, users can access the software through a web browser without needing to install or maintain it locally on their own devices.
- The ability given to the end users to access an application over the Internet that is hosted and managed by the service provider.
- Thus, the end users are exempted from managing or controlling an application, the development platform, and the underlying infrastructure.
- AWS offers various services that enable the delivery of SaaS applications, including:
 - Amazon EC2 (Elastic Compute Cloud): Allows companies to run virtual servers in the cloud, providing the infrastructure needed to host and deliver their SaaS applications.
 - Amazon S3 (Simple Storage Service): Provides scalable storage for SaaS applications, allowing companies to store and retrieve data efficiently.

A) Overview of saas

- SaaS changes the way the software is delivered to the customers.
- In the traditional software model, the software is delivered as a license-based product that needs to be installed in the end user device.
- Since SaaS is delivered as an on-demand service over the Internet, there is no need to install the software to the end user's devices.
- SaaS services can be accessed or disconnected at any time based on the end user's needs.
- SaaS services can be accessed from any lightweight web browsers on any devices such as laptops, tablets, and smartphones.
- Some of the SaaS services can be accessed from a thin client that does not contain much storage space and cannot run much software like the traditional desktop PCs.

B) A typical SaaS provider may provide business services, social networks, document management, and mail services as shown in Figure 5.8:



FIGURE 5.8
Services provided by SaaS Providers.

1. Business services:

- Most of the SaaS providers started providing a variety of business services that attract start-up companies.
- The business SaaS services include ERP, CRM, billing, sales, and human resources.

2. Social networks:

- Since social networking sites are extensively used by the general public, many social networking service providers adopted SaaS for their sustainability.
- Since the number of users of the social networking sites is increasing exponentially, cloudcomputing is the perfect match for handling the variable load.

3. Document management:

- Since most of the enterprises extensively use electronic documents, most of the SaaS providers started providing services that are used to create, manage, and track electronic documents.

4. Mail services:

- E-mail services are currently used by many people. The future growth in e-mail usage is unpredictable.
- To handle the unpredictable number of users and the load on e-mail services, most of the e-mail providers started offering their services as SaaS services.

C) Characteristics of SaaS:

- SaaS services are different and give more benefits to end users than the traditional software.
- The following are the essential characteristics of SaaS services that make it unique from traditional software:

1. One to many:

- SaaS services are delivered as a one-to-many model where a single instance of the application can be shared by multiple tenants or customers.

2. Web access:

- SaaS services provide web access to the software.
- It allows the end user to access the application from any location if the device is connected to the Internet.

3. Centralized management:

- Since SaaS services are hosted and managed from the central location, management of the SaaS application becomes easier.
- Normally, the SaaS providers will perform the automatic updates that ensure that each tenant is accessing the most recent version of the application without any user-side updates.

4. Multi Device support:

- SaaS services can be accessed from any end user devices such as desktops, laptops, tablets, smartphones, and thin clients.

5. Better scalability:

- Since most of the SaaS services leverage PaaS and IaaS for its development and deployment, it ensures a better scalability than the traditional software.
- The dynamic scaling of underlying cloud resources makes SaaS applications work efficiently even with varying loads.

6. High availability:

- SaaS services ensure the 99.99% availability of user data as proper backup and recovery mechanisms are implemented at the back end.

7. API integration:

- SaaS services have the capability of integrating with other software or service through standard APIs.

B) Suitability of SaaS:

- SaaS is popular among individuals and start-up companies because of the benefits it provides.
- Most of the traditional software users are looking for SaaS versions of the software as SaaS has several advantages over traditional applications

SaaS applications are the best option for the following:

1. On-demand software:

- The licensing-based software model requires buying full packaged software and increases the spending on buying software.
- Some of the occasionally used software does not give any ROI.
- Because of this, many end users are looking for a software that they can use as and when they needed.
- If the end users are looking for on-demand software rather than the licensing-based full-term software, then the SaaS model is the best option.

2. Software for start-up companies:

- When using any traditional software, the end user should buy devices with minimum requirements specified by the software vendor.
- This increases the investment on buying hardware for start-up companies.
- Since SaaS services do not require high-end infrastructure for accessing, it is a suitable option for start-up companies that can reduce the initial expenditure on buying high-end hardware.

3. Software compatible with multiple devices:

- Some of the applications like word processors or mail services need better accessibility from different devices.
- The SaaS applications are adaptable with almost all the devices.

4. Software with varying loads:

- We cannot predict the load on popular applications such as social networking sites.
- The user may connect or disconnect from applications anytime.
- It is very difficult to handle varying loads with the traditional infrastructure.

- With the dynamic scaling capabilities, SaaS applications can handle varying loadsefficiently without disrupting the normal behavior of the application.

Most of the traditional software vendors moved to SaaS business as it is an emerging software delivery model that attracts end users.

But still many traditional applications do not have its SaaS versions.

This implies that SaaS applications may not be the best option for all types of software.

The SaaS delivery model is not the best option for the applications mentioned in the following:

1. Real-time applications:

- Since SaaS applications depend on Internet connectivity, it may not work better with low Internet speed.
- If data is stored far away from the end user, the latency issues may delay the data retrieval timings.
- Real-time applications require fast processing of data that may not be possible with the SaaS applications because of the dependency on high-speed Internet connectivity and latency issues.

2. Applications with confidential data:

- Data security, data governance, and data compliance are always issues with SaaS applications.
- Since data is stored with third-party service providers, there is no surety that our data will be safe.
- If the stored confidential data get lost, it will make a serious loss to the organization.
- It is not recommended to go for SaaS for applications that handle confidential data.

3. Better on-premise application:

- Some of the on-premise applications might fulfill all the requirements of the organization.
- In such situations, migrating to the SaaS model may not be the best option.

C) Pros and Cons of SaaS:

SaaS services provide the following benefits:

1. No client-side installation:

- SaaS services do not require client-side installation of the software.
- The end users can access the services directly from the service provider data center without any installation.
- There is no need for high-end hardware to consume SaaS services.
- It can be accessed from thin clients or any handheld devices, thus reducing the initial expenditure on buying high-end hardware.

2. Cost savings:

- Since SaaS services follow the utility-based billing or pay-as-you-go billing, it demands the end users to pay for what they have used.
- Most of the SaaS providers offer different subscription plans to benefit different customers.
- Sometimes, the generic SaaS services such as word processors are given for free to the end users.

3. Less maintenance:

- SaaS services eliminate the additional overhead of maintaining the software from the client side.
- For example, in the traditional software, the end user is responsible for performing bulk updates.
- But in SaaS, the service provider itself maintains the automatic updates, monitoring, and other maintenance activities of the applications.

4. Ease of access:

- SaaS services can be accessed from any devices if it is connected to the Internet.
- Accessibility of SaaS services is not restricted to any particular devices.
- It is adaptable to all the devices as it uses the responsive web UI.

5. Dynamic scaling:

- SaaS services are popularly known for elastic dynamic scaling.
- It is very difficult for on-premise software to provide dynamic scaling capability as it requires additional hardware.
- Since the SaaS services leverage elastic resources provided by cloud computing, it can handle any type of varying loads

without disrupting the normal behavior of the application.

6. Disaster recovery:

- With proper backup and recovery mechanisms, replicas are maintained for every SaaS services.
- The replicas are distributed across many servers.
- If any server fails, the end user can access the SaaS from other servers.
- It eliminates the problem of single point of failure. It also ensures the high availability of the application.

7. Multitenancy:

- Multitenancy is the ability given to the end users to share a single instance of the application.
- Multitenancy increases resource utilization from the service provider side.

The following are the major problems with SaaS services:

1. Security:

- Security is the major concern in migrating to SaaS applications
- Since the SaaS application is shared between many end users, there is a possibility of data leakage.
- Here, the data is stored in the service provider data center.
- We cannot simply trust some third-party service provider to store our company-sensitive and confidential data.
- The end user should be careful while selecting the SaaS provider to avoid unnecessary data loss.

2. Connectivity requirements:

- SaaS applications require Internet connectivity for accessing it.
- Sometimes, the end user's Internet connectivity might be very slow.
- In such situations, the user cannot access the services with ease.
- The dependency on high-speed Internet connection is a major problem in SaaS applications.

3. Loss of control:

- Since the data are stored in a third-party and off premise location, the end user does not have any control over the data.
- The degree of control over the SaaS application and data is

lesser than the on-premise application.

What is Amazon DynamoDB?

- Amazon DynamoDB is a fully managed NoSQL database service that provides fast and predictable performance with seamless scalability.
- DynamoDB lets you offload the administrative burdens of operating and scaling a distributed database so that you don't have to worry about hardware provisioning, setup and configuration, replication, software patching, or cluster scaling.
- DynamoDB also offers encryption at rest, which eliminates the operational burden and complexity involved in protecting sensitive data.
- With DynamoDB, you can create database tables that can store and retrieve any amount of data and serve any level of request traffic.
- You can scale up or scale down your tables' throughput capacity without downtime or performance degradation.
- You can use the AWS Management Console to monitor resource utilization and performance metrics.
- DynamoDB allows you to delete expired items from tables automatically to help you reduce storage usage and the cost of storing data that is no longer relevant.

Step 1: Create a table

In this step, you create a Employee table in Amazon DynamoDB. The table has the following details:

- Partition key — eid
- Sort key —deptno

To create a new Employee table using the DynamoDB console:

1. Sign in to the AWS Management Console and open the DynamoDB console
2. In the left navigation pane, choose Tables.
3. Choose Create table
4. Enter the Table details as follows:
 - a. For Table name, enter Employee.
 - b. For Partition key, enter eid.
 - c. For Sort key, enter deptno.
5. For Table settings, keep the default selection of Default settings.
6. Choose Create table to create the table

Step 2: Write data to a table using the console

- In this step, you insert several items into the Employee table that you created in Step 1: Create a table.

Follow these steps to write data to the Music table using the DynamoDB console.

1. Open the DynamoDB console
 2. In the left navigation pane, choose Tables.
 3. On the Tables page, choose the Employee table.
 4. Choose Explore table items.
 5. In the Items returned section, choose Create item.
 6. On the Create item page, do the following to add items to your table:
 - a. Choose Add new attribute called name, and then choose String.
 - b. Enter the following values for your item:
 - i. For eid enter 1.
 - ii. For deptno enter 101.
 - iii. For name, enter Sam.
- Do this one more time to create another item with the same Employee as the previous step, but different values for the other attributes

Step 3: Read data from a table

- In this step, you'll read back one of the items that you created in Step 2: Write data to a table using the console.
- You can use the DynamoDB console to read an item from the Employee table

AWS Management Console

Follow these steps to read data from the Music table using the DynamoDB console.

1. Open the DynamoDB console
2. In the left navigation pane, choose Tables.
3. On the Tables page, choose the Employee table.
4. Choose Explore table items.
5. On the Items returned section, view the list of items stored in the table, sorted by eid