# Unit -IV

CLOUD SERVICE MODELS

UNIT-IV

Cloud service models: Infrastructure as service, characteristics of IaaS, Suitability of IaaS, pros and cons of Iaas, summary of Iaas Providers, Platform as a Service with examples of with example of Amazon RDS Amazon DynamoDB, characteristics of PaaS, Suitability of PaaS, pros and cons of PaaS, summary of Paas Providers, software as service, characteristics of SaaS, Suitability of SaaS, pros and cons of Saas, summary of Saas Providers.

INTRODUCTION

➜ Cloud computing is one of the <u>most popular buzzwords </u>used these days.

➜ It is the upcoming technology provisioning resources to the consumers in the form of different services like software, infrastructure, platform, and security.

➜ Services are made available to users on demand via the Internet from a cloud computing provider's servers as opposed to being provided from a company's own on-premise servers.

➜ Cloud services are designed to <u>provide easy, scalable access to applications, resources, and services and are fully managed by a cloud service provider</u>. A cloud service can dynamically scale to meet the needs of its users, and because the service provider supplies the hardware and software necessary for the service, there is no need for a company to provision or deploy its own resources or allocate information technology (IT) staff to manage the service.

➜ Examples of cloud <u>services include online data storage and backup solutions, web-based e-mail services, hosted office suites and document collaboration services, database processing, and managed technical support services.</u>

➜ The National Institute of Standards and Technology (NIST) defines three basic service models, namely, <u>IaaS, PaaS, and SaaS</u>, as shown in Figure 5.1.

SaaS
(for end users)

PaaS
(for developers)

IaaS
(for IT architects)
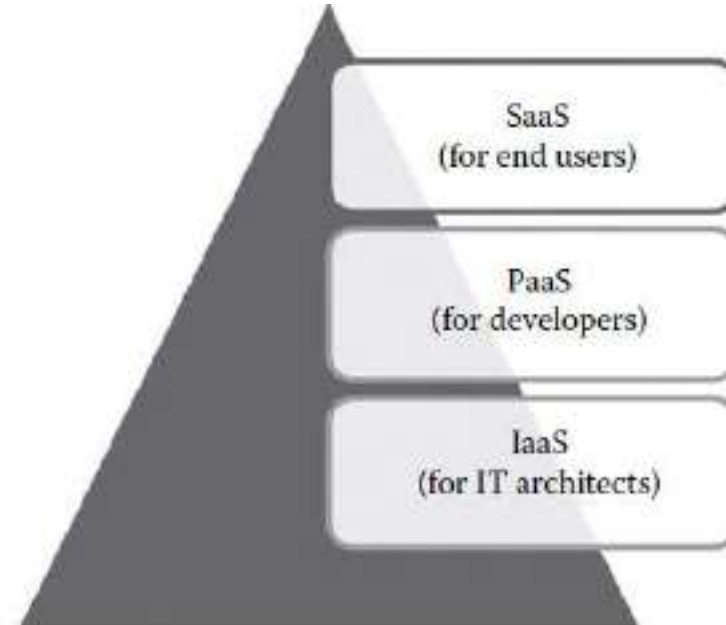
Common examples of PaaS, SaaS, and IaaS

Platform	Examples
PaaS	AWS Elastic Beanstalk, Google App Engine, and Adobe Commerce
SaaS	Gmail, Slack, and Microsoft Office 365
IaaS	Amazon Web Services, Microsoft Azure, and Google Compute Engine

➜ With growing technologies, many more services are emerging in this field, such as

   Security as a Service (SeaaS), Knowledge as a Service, and Data Analytics as a

   Service.

➜ Many companies have come forward to adapt the cloud environment and ensure

   that the users as well as the companies benefit from this. Most popular companies

   providing cloud services are

      Amazon, Microsoft, Google, Yahoo, EMC, Salesforce, Oracle, IBM, and many more

Infrastructure as a service

- IaaS changes the way of 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. All the virtualization 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 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.

- Thus, it eliminates or hides the complexity of maintaining the physical infrastructure from the IT architects.
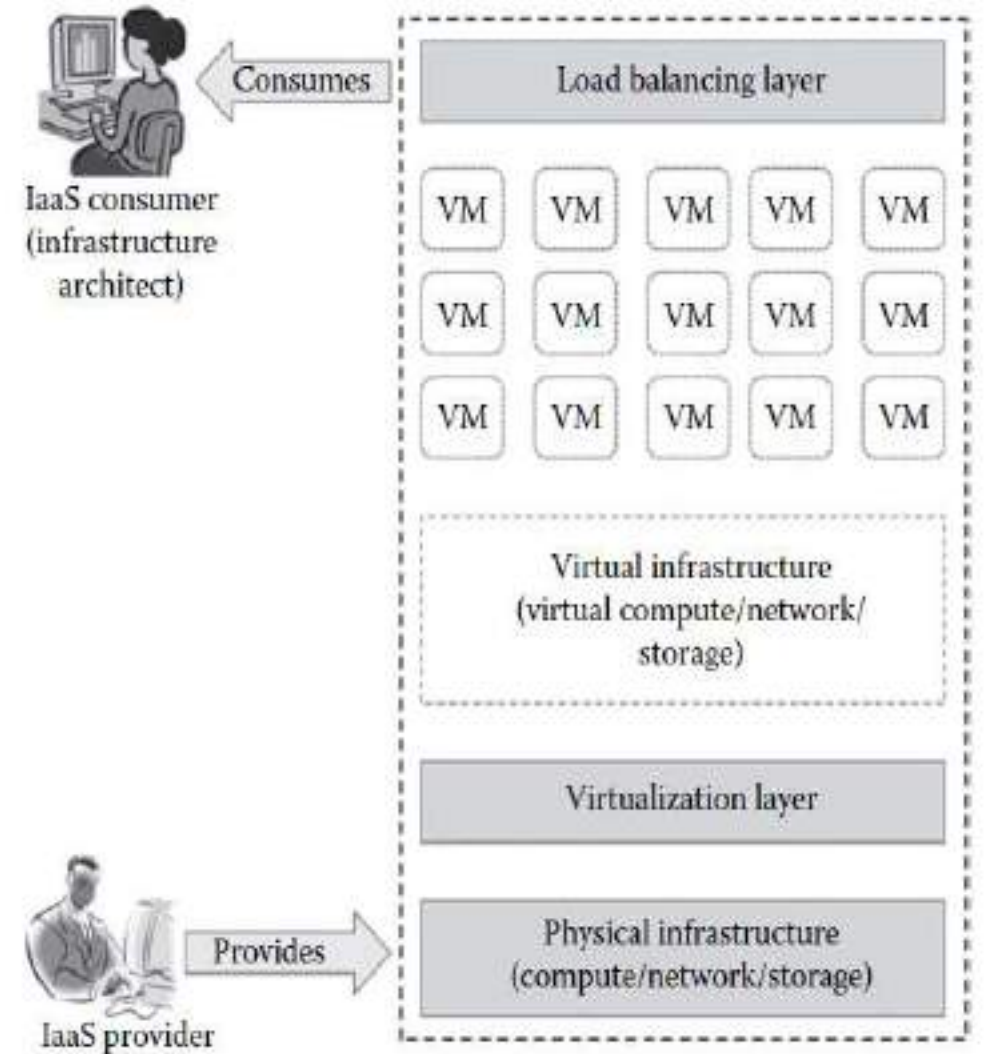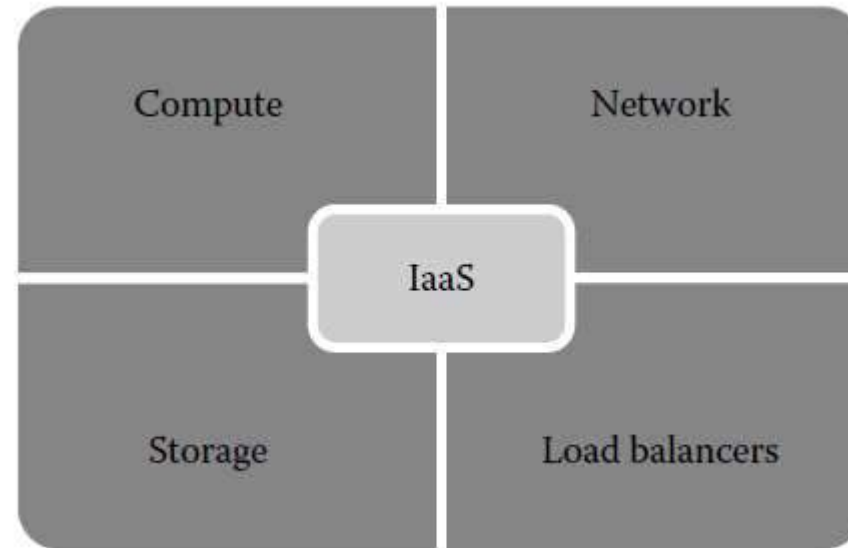

FIGURE 5.4
Overview of IaaS.

A typical <u>IaaS provider</u> may provide the following <u>services</u> as shown in Figure

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.

A typical IaaS provider may provide the following services as shown in Figure(Contd..)

- **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.

Characteristics Of IaaS

IaaS providers offer virtual computing resources to the consumers on a pay-as-you-go basis.

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 by IaaS easily..

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.

Characteristics Of IaaS(Contd..)

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 proving 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.

Characteristics Of IaaS(Contd..)

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.

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 of infrastructure, then it is recommended to use IaaS services.

Suitability of IaaS(Contd..)

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.

Pros and Cons of IaaS

Being one of the important service models of cloud computing, IaaS provides lot of benefits to the IT users. 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 amount. 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.

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.

Summary Of IaaS Providers

- There are many public and private IaaS providers in the market who provides infrastructure services to the end users. Table 5 provides the summary of popular infrastructure providers.

- In the table, the popular IaaS providers are classified based on the license, deployment model, and supported host OS, guest OS, and hypervisors. The end user may choose any IaaS provider that matches their needs.

- Generally, public IaaS consumers need not consider the host OS as it is maintained by the service provider.

- In managing the private cloud, the users should see the supported host OS. However, most of the private IaaS supports popular guest OS, fully depending on the hypervisor that the

TABLE 5.1

Summary of Popular IaaS Providers

Provider	License	Deployment Model	Host OS	Guest OS	Supported Hypervisor(s)
Amazon Web Services	Proprietary	Public	Not available	Red Hat Linux, Windows Server, SuSE Linux, Ubuntu, Fedora, Debian, CentOS, Gentoo Linux, Oracle Linux, and FreeBSD	Xen
Google Compute Engine	Proprietary	Public	Not available	Debian 7 Wheezy, CentOS 6, Red Hat Enterprise Linux, SUSE, Windows Server, CoreOS, FreeBSD, and SELinux	KVM
Microsoft Windows Azure	Proprietary	Public	Not available	Windows Server, CentOS, FreeBSD, openSUSE Linux, and Oracle Enterprise Linux	Windows Azure hypervisor
Eucalyptus	GPLv3	Private and hybrid	Linux	Linux and Windows	Xen, KVM, VMware
Apache CloudStack	Apache 2	Private	Linux	Windows, Linux, and various versions of BSD	KVM, vSphere, XenServer / XCP
OpenNebula	Apache 2	Private, public, and hybrid	CentOS, Debian, and openSUSE	Microsoft Windows and Linux	Xen, KVM, VMware
OpenStack	Apache 2	Private and public	CentOS, Debian, Fedora, RHEL, openSUSE, and Ubuntu	CentOS, Ubuntu, Microsoft Windows, and FreeBSD	libvirt, Hyper-V, VMware, XenServer 6.2, baremetal, docker, Xen, LXC via libvirt

Platform as a Service(PaaS)

- PaaS changes the way that the software is <u>developed and deployed</u>. In <u>traditional application </u>development, the application will be <u>developed locally </u>and will be <u>hosted in the central location</u>.

- Most of the applications developed by traditional development platforms result in a licensing-based software, whereas PaaS changes the <u>application development from local machine to</u>

- PaaS allows the developers to <u>develop their application online </u>and also allows them to <u>deploy</u> immediately on the <u>online</u> 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
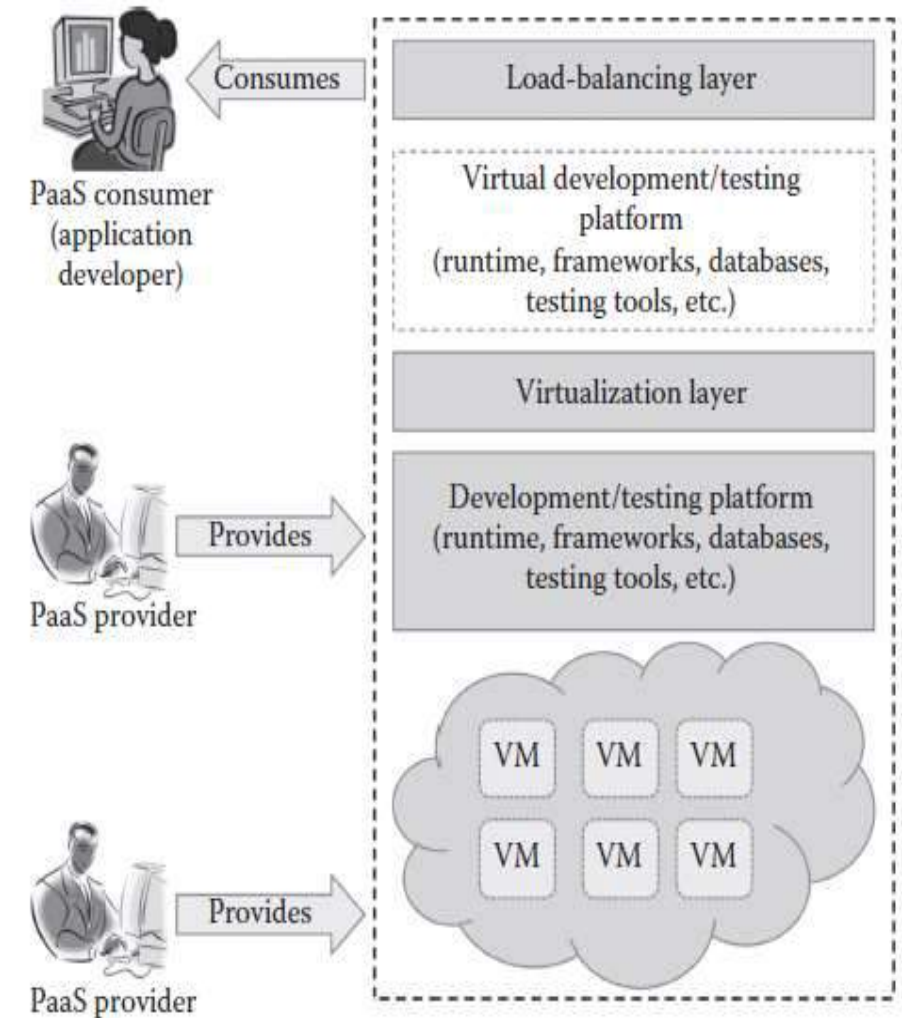
FIGURE 5.6
Overview of PaaS.

- Typical PaaS providers may provide programming languages, application frameworks, databases, and testing tools as shown in Figure 5.7.
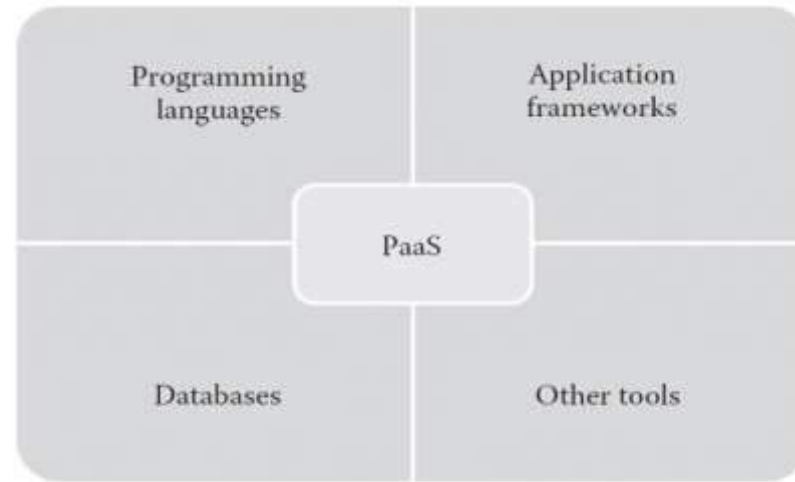
FIGURE 5.7
Services provided by PaaS providers.

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 so on.

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 <u>Node.js, Rails, Drupal, Joomla, WordPress, Django, EE6, Spring, Play, Sinatra, Rack, and Zend.</u>

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 <u>ClearDB,</u>

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 :

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 <u>programming languages, frameworks, databases, and other development-related services</u> that make developers choose from a wide variety of development platforms.

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 <u>developer to synchronize their local IDE with the PaaS services</u>. 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

5. **Collaborative platform:** Nowadays, the development team consists of developers who are working from <u>different places.</u> There is a need for a common platform where the developers can <u>collaboratively work together on the same project</u>. 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

Suitability of PaaS

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.

2. **Automated testing and deployment:** Automated testing and building of an application are very useful while developing applications at a very short time frame. 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.

Pros and Cons of PaaS

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 requires 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.

- 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:** 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

Drawbacks of PaaS

- PaaS provides a lot of benefits to developers when compared to the traditional development environment. On the other hand, it contains drawbacks, which are described in the following:

- 1. **Vendor lock-in:** The major drawback with PaaS providers are 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

- 2. **Security issues:** Like in the other cloud services, security is one of the major issues in PaaS services. Since data are 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

- 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

Summary of PaaS Providers

- **PaaS providers are more in the IT market for public as well as the private clouds. Table 5 gives a summary of popular private and public PaaS providers.**

TABLE 5.2

Summary of Popular PaaS Providers

Provider	License	Deployment Model	Supported Languages	Supported Frameworks	Supported Databases	Client Tools
Cloud Foundry	Open source and proprietary	Public	Python, PHP, Java, Groovy, Scala, and Ruby	Spring, Grails, Play, Node.js, Lift, Rails, Sinatra, and Rack	MySQL, PostgreSQL, MongoDB, and Redis	cf. CLI, IDEs, and build tools
Google App Engine	Proprietary	Public	Python, Java, Groovy, JRuby, Scala, Clojure, Go, and PHP	Django, CherryPy, Pyramid, Flask, web2py, and webapp2.	Google Cloud SQL, Datastore, BigTable, and Blobstore	APIs
Heroku	Proprietary	Public	Ruby, Java, Scala, Clojure and Python, PHP, and Perl	Rails, Play, Django, and Node.js.	ClearDB, PostgreSQL, Cloudant, Membase, MongoDB, and Redis	CLI and RESTful API
Microsoft Windows Azure	Proprietary	Public	.Net, PHP, Python, Ruby, and Java	Django, Rails, Drupal, Joomla, WordPress, DotNetNuke, and Node.js.	SQL Azure, MySQL, MongoDB, and CouchDB	RESTful API and IDEs

Red Hat OpenShift Online	Proprietary	Public	Java, Ruby, Python, PHP, and Perl	Node.js, Rails, Drupal, Joomla, WordPress, Django, EE6, Spring, Play, Sinatra, Rack, and Zend.	MySQL, PostgreSQL, and MongoDB	Web UI, APIs, CLI, and IDEs
ActiveState Stackato	Proprietary	Private	Java, Perl, PHP, Python, Ruby, Scala, Clojure, and Go	Spring, Node.js, Drupal, Joomla, WordPress, Django, Rails, and Sinatra.	MySQL, PostgreSQL, MongoDB, and Redis	CLI and IDE
Apprenda	Proprietary	Private	.Net and Java	Most of the frameworks form .Net.	SQL Server	REST APIs
CloudBees	Proprietary	Private	Java, Groovy, and Scala	Spring, JRails, JRuby, and Grails.	MySQL, PostgreSQL, MongoDB, and CouchDB	API, SDK, and IDEs
Cumulogic	Proprietary	Private	Java, PHP, and Python	Spring and Grails.	MySQL, MongoDB, and Couchbase	RESTful API
Gigaspaces Cloudify	Open source	Private	Any programming language specified by recipe	Rails, Play, and others.	MySQL, MongoDB, Couchbase, Cassandra, and others	CLI, web UI, and REST API

Amazon RDS

- Amazon RDS (Relational Database Service) is a managed database service provided by Amazon Web Services (AWS).

- It allows users to create and manage relational databases in the cloud, without needing to worry about the underlying infrastructure.

- Amazon RDS supports an array of database engines to store and organize data. It also helps in relational database management tasks like data migration, backup, recovery and patching.

- Amazon RDS is available on multiple database and gives you six familiar database engines to choose from, including Amazon Aurora, PostgreSQL, MySQL, MariaDB, Oracle Database and

How does Amazon RDS work?

- Administrators control Amazon RDS with the AWS Management Console, Amazon RDS API calls, or the AWS command-line interface. They use these interfaces to deploy database instances to which users can apply specific settings.

- Amazon provides several instance types with different resources, such as CPU, memory, storage options, and networking capability. Each type comes in a variety of sizes to suit the needs of different workloads.

Amazon RDS(Cont..)

Some key features of Amazon RDS include:

- Compatibility: Amazon RDS supports popular relational database engines such as MySQL, PostgreSQL, Oracle, and Microsoft SQL Server, making it easy to migrate existing applications to the cloud.

- Scalability: Amazon RDS can scale up or down in response to changes in traffic or data volume, allowing users to easily add or remove capacity as needed.

- Availability: Amazon RDS is designed to be highly available and fault-tolerant, with automatic failover and multi-AZ deployment options.

- Security: Amazon RDS provides several security features

Amazon RDS(Cont..)

- Monitoring: Amazon RDS provides extensive monitoring capabilities, including real-time performance metrics and automated backups, to help users optimize database performance and ensure data durability.

   Amazon RDS is used by a wide range of companies and organizations, including Airbnb, Netflix, and Expedia. It is well-suited for use cases such as web applications, e-commerce, and gaming, where relational databases are essential for storing and retrieving data. By using Amazon RDS, businesses can focus on their applications, while

Step by Step Procedure to create Amazon RDS

1. In the Amazon services, search for RDS.

2. Choose **Create database**.

3. On the **Create database** page, choose **Standard create**.For **Engine options**, choose **MySQL**.

4. For **Templates**, choose **Free tier ,**Your DB instance configuration should look similar to the

   following image

5. In the **Availability and durability** section, keep the defaults.

6. In the **Settings** section, set these values:

- **DB instance identifier** – Type tutorial-db-instance.

- **Master username** – Type tutorial_user.

- **Auto generate a password** – Leave the option turned off.

- **Master password** – Type a password.

- **Confirm password** – Retype the password.

7. In the **Instance configuration** section, set these values:

- **Burstable classes (includes t classes)**
- **db.t3.micro**

8. In the **Storage** section, keep the defaults.

9. In the **Connectivity** section, set these values and keep the other values as their defaults:

- For **Compute resource**, choose **Connect to an EC2 compute resource**.
- For **EC2 instance**, choose the EC2 instance you created previously, such as **tutorial-ec2-instance-web-server**.

Connectivity Info ⟳

Compute resource
Choose whether to set up a connection to a compute resource for this database. Setting up a connection will automatically change connectivity settings so that the compute resource can connect to this database.

○ **Don't connect to an EC2 compute resource**
Don't set up a connection to a compute resource for this database. You can manually set up a connection to a compute resource later.

● **Connect to an EC2 compute resource**
Set up a connection to an EC2 compute resource for this database.

EC2 instance Info
Choose the EC2 instance to add as the compute resource for this database. A VPC security group is added to this EC2 instance. A VPC security group is also added to the database with an inbound rule that allows the EC2 instance to access the database.

i-1234567890abcdef0
tutorial-ec2-instance-web-server ▼

ⓘ **Some VPC settings can't be changed when a compute resource is added**
Adding an EC2 compute resource automatically selects the VPC, DB subnet group, and public access settings for this database. To allow the EC2 instance to access the database, a VPC security group rds-ec2-X is added to the database and another called ec2-rds-X to the EC2 instance. You can remove the new security group for the database only by removing the compute resource.

10. In the **Database authentication** section, make sure **Password authentication** is selected.

    -Open the **Additional configuration** section, and enter sample for **Initial database name**. Keep the default settings for the other options.

11. Choose **Create database**.Your new DB instance appears in the **Databases** list with the status **Creating**.

12. Wait for the **Status** of your new DB instance to show as **Available**. Then choose the DB instance name to show its details.

DynamoDB

- Amazon DynamoDB is a fully managed NoSQL database service provided by Amazon Web Services (AWS). It is designed to provide high performance and scalability for applications that require low-latency access to data.

- Amazon DynamoDB is a fully managed NoSQL database service that provides fast and predictable performance with seamless scalability.

- 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

DynamoDB (Cont)

Some key features of DynamoDB include:

- Performance: DynamoDB is designed to provide fast and predictable performance, even at scale. It can handle millions of requests per second, making it ideal for applications with high read and write loads.

- Scalability: DynamoDB is a fully managed service that automatically scales to meet the demands of your application. It can handle petabyte-scale datasets and is designed to be highly available and durable.

- NoSQL: DynamoDB is a NoSQL database, meaning it does not

DynamoDB (Cont)

- Security: DynamoDB provides several security features, including encryption at rest and in transit, fine-grained access control, and integration with AWS Identity and Access Management (IAM).

- Integration: DynamoDB integrates with other AWS services, such as AWS Lambda, Amazon S3, and Amazon EMR, allowing you to build end-to-end applications with minimal coding.

DynamoDB is used by a wide range of companies and organizations, including Lyft, Samsung, and Airbnb. It is well-

Step by Step Procedure for DynamoDB

1. In the AWS services search for Dynamo DB

2. On the right side of the console, choose **Create Table**.

Create a table

Create an Amazon DynamoDB table for fast and predictable database performance at any scale.

Learn more

Create table

3.Enter the table details as follows:

For the table name, enter **Music**.

For the partition key, enter **Artist**.

Enter **SongTitle** as the sort key.

Leave **Default settings** selected

4.In the table list, choose the **Music** table.
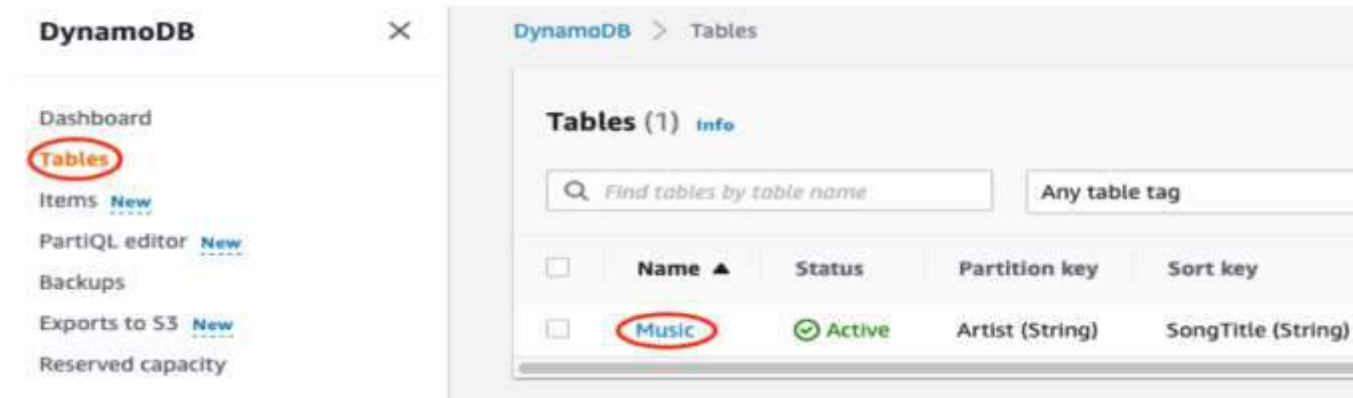
5. Select **Explore Table Items**.

6. In the **Items** view, choose **Create item**.

7. Choose **Add new attribute**, and then choose **Number**. Name the field **Award**

8.Repeat this process and create another item with the following values:
    1.For **Artist**, enter **Acme Band**.
    2.For **SongTitle** enter **Happy Day**.
    3.For **AlbumTitle**, enter **Songs About Life**.
    4.For **Awards**, enter **10**.
9. The table created.
10. To check the table items , go to the navigation pane on the left side of the console, choose **Tables**.
11. Choose the **Music** table from the table list.
12. Select the **Explore table items**.
13.On the **Items** tab, view the list of items stored in the table

	Artist		SongTitle		AlbumTitle	Awards	
☐	Acme Band		Happy Day		Songs Abou...	10	
☐	No One You...		Call Me Today		Somewhat ...	1	

Items returned (2)   Actions ▼   Create Item

Q Find Items   < 1 > ◉ ⛶

14.To Update the data in tables
    - Choose the **Music** table from the table list.
        - Choose **View items**.
        - Choose the item whose ₐᵣₜᵢₛₜ value is **Acme Band** and ₛₒₙₜᵢₜₗₑ value is **Happy Day**.
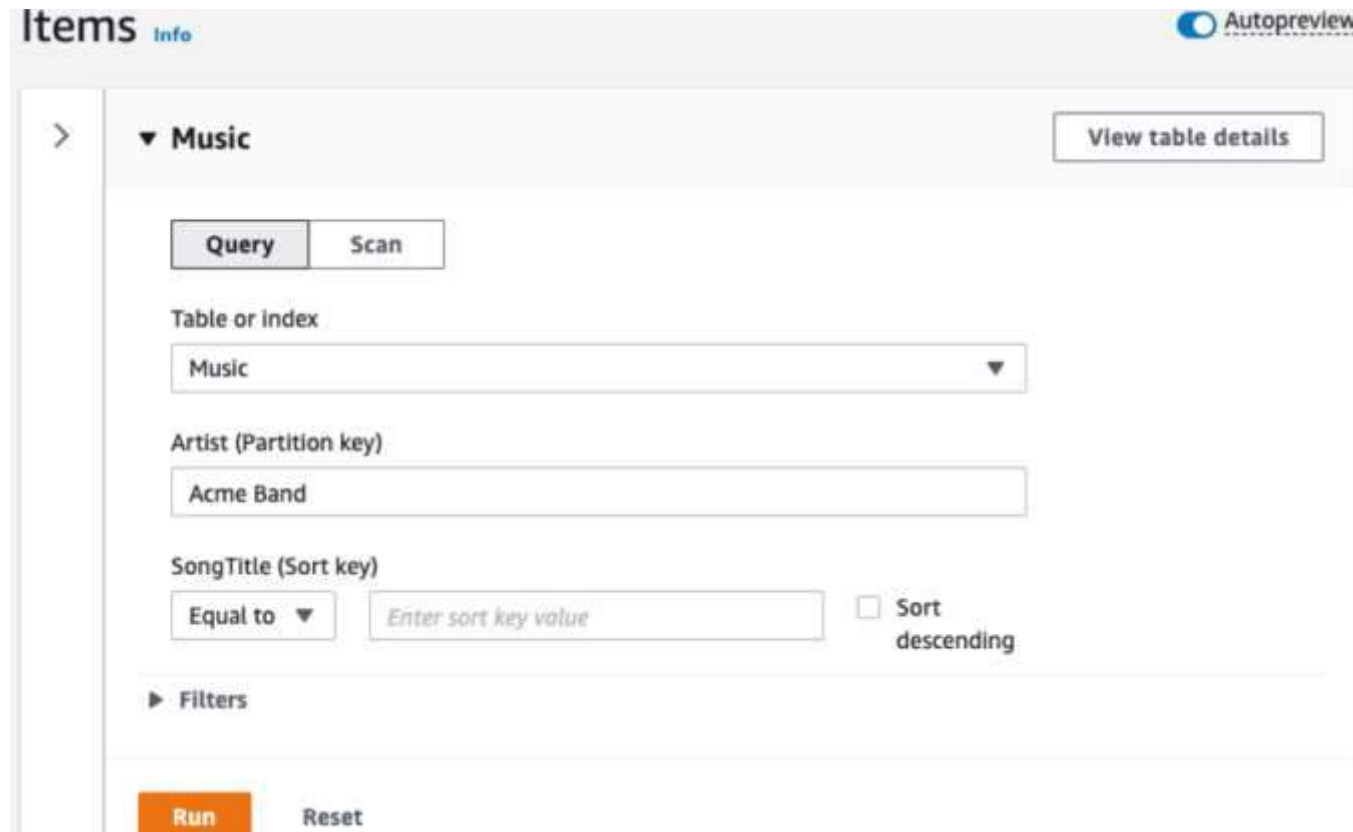   - Update the **AlbumTitle** value to Updated Album Title, and then choc

    The   em on the console.

Item editor			Form	JSON

Attributes

⊞ Attribute name	Value		Type	
Artist - Partition key	Acme Band	New	String	
SongTitle - Sort key	Happy Day	New	String	
AlbumTitle	Updated Album Title		String	Remove
Awards	10		Number	Remove

Add new attribute ▼				

Cancel   **Save changes**

15. To Search/Query the data in Tables Choose the **Music** table from the table list.
      - Choose **View items**.
      - Choose **Query**.
     - For **Partition key**, enter **Acme Band**, and then choose **Run**.

Software as a Service(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.

• The important benefits of using thin clients for accessing the SaaS

- SaaS provider may provide business services, social networks, document management, and mail services as shown in Figure 5.8:
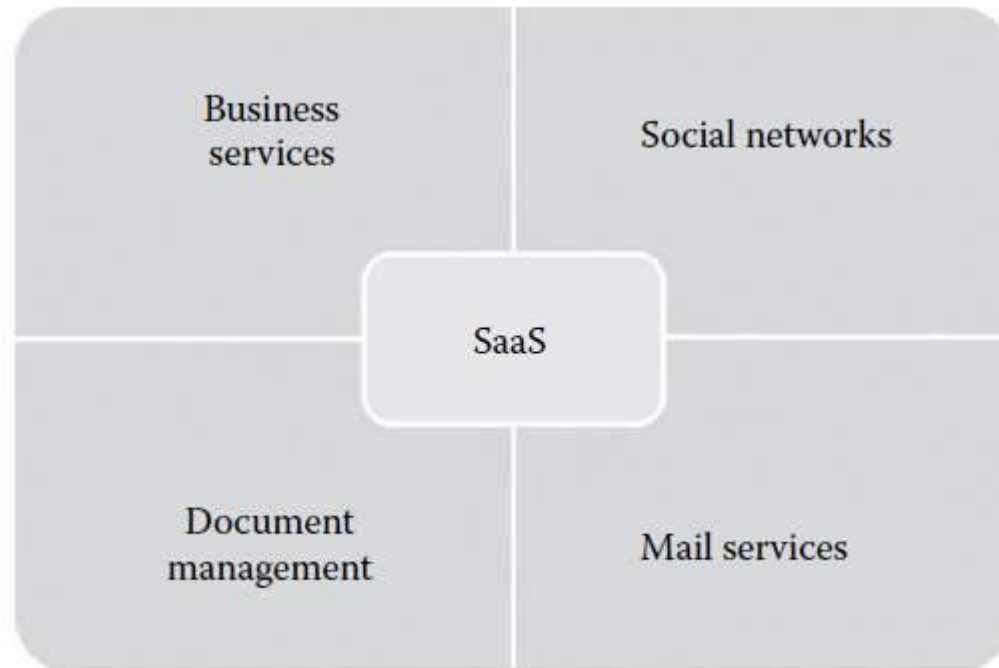
1. **Business services:** Most of the SaaS providers started providing a variety of business services that attract start-up companies. The business SaaS services include ERP, CRM, billing, sales, and human resources.

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, cloud computing 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

Characteristics of SaaS:

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. **Multidevice 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.

Suitability of SaaS

- SaaS is popular among individuals and start-up companies because of the benefits it provides. 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,then the SaaS model is the best option.

- **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

Pros and Cons of SaaS

- SaaS applications are used by a wide range of individuals and start-up industries for its cost-related benefits. Apart from the cost-related benefits, 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 of 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.

- **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

- **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

Drawbacks of SaaS

- 1. **Security:** Security is the major concern in migrating to SaaS application. Since the SaaS application is shared between many end users, there is a possibility of data leakage. Here, the data are stored in the service provider data center.

- 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

Summary of SaaS Providers

- There are many SaaS providers who provide SaaS services such as ERP, CRM, billing, document management, and mail services. Table 5.3 gives a summary of popular SaaS vendors in the market

Summary of Popular SaaS Providers

Provider	Services Provided
Salseforce.com	On-demand CRM solutions
Google Apps	Gmail, Google Calendar, Talk, Docs, and Sites
Microsoft Office 356	Online office suite, software, plus services
NetSuite	ERP, accounting, order management, inventory, CRM, professional services automation (PSA), and e-commerce applications
Concur	Integrated travel and expense management solutions
GoToMeeting	Online meeting, desktop sharing, and video-conferencing software
Constant Contact	E-mail marketing, social-media marketing, online survey, event marketing, digital storefronts, and local deals tools
Workday, Inc.	Human capital management, payroll, and financial management
Oracle CRM	CRM applications
Intacct	Financial management and accounting software solutions

Other Cloud Service Models

- The basic cloud services such as IaaS, PaaS, and SaaS are widely used by many individual and start-up companies.

- Now, the end users' expectation changed, and they are expecting the individual services to be offered by service providers.

- This makes most of the service providers to think about the separate services that meet end user requirements. Many service providers already started offering separate services such

NaaS(Network as a Service)

- NaaS is an ability given to the end users to access virtual network services that are provided by the service provider. In on-premise data center, the IT industries spent a lot of money to buy network hardware to manage in-house networks. But, cloud computing changes networking services into a utility-based service.

- NaaS allows network architects to create virtual networks, virtual network interface cards (NICs), virtual routers, virtual switches, and other networking components.

- Additionally, it allows the network architect to deploy custom routing protocols and enables the design of efficient in-network services, such as data aggregation, stream processing, and caching.

- Some of the popular services provided by NaaS include virtual private network (VPN), bandwidth on demand (BoD), and mobile network virtualization.

DEaaS(Desktop as a Service):

- It is an ability given to the end users to use desktop virtualization without buying and managing their own infrastructure.

- DEaaS is a pay-per-use cloud service delivery model in which the service provider manages the back-end responsibilities of data storage, backup, security, and upgrades.

- The end users are responsible for managing their own desktop images, applications, and security. Accessing the virtual desktop provided by the DEaaS provider is device, location, and network independent.

- DEaaS services are simple to deploy, are highly secure, and produce better experience on almost all devices.

STaaS (Storage as a Service):

It is an ability given to the end users to store the data on the storage services provided by the service provider. STaaS allows the end users to access the files at any time from any place. The STaaS provider provides the virtual storage that is abstracted from the physical storage of any cloud data center. STaaS is also a cloud business model that is delivered as a utility. Here, the customers can rent the storage from the STaaS provider. STaaS is

DBaaS(Database as a Service)

It is an ability given to the end users to access the database service without the need to install and maintain it. The service provider is responsible for installing and maintaining the databases. The end users can directly access the services and can pay according to their usage. DBaaS automates the database administration process. The end users can access the database services through any API or web UIs provided by the service provider. The DBaaS eases the database administration process. Popular examples of DBaaS include SimpleDB, DynamoDB, MongoDB as a Service, GAE datastore, and ScaleDB.

Data as a Service (DaaS)

- It is an ability given to the end users to access the data that are provided by the service provider over the Internet. DaaS provides data on demand. The data may include text, images, sounds, and videos. DaaS is closely related to other cloud service models such as SaaS and STaaS. DaaS can be easily integrated with SaaS or STaaS for providing the composite service. DaaS is highly used in geography data services and financial data services. The advantages of DaaS include agility,

SECaaS(Security as a Service)

- It is an ability given to the end user to access the security service provided by the service provider on a pay-per-use basis. In SECaaS, the service provider integrates their security services to benefit the end users. Generally, the SECaaS includes authentication, antivirus, antimalware/spyware, intrusion detection, and security event management. The security services provided by the SECaaS providers are typically used for securing the on-premise or in-house infrastructure and applications. Some of the SECaaS providers include Cisco, McAfee, Panda Software, Symantec, Trend Micro, and VeriSign.

- Now, cloud computing moves to the scenario where everything can be given as a service. This can be termed as Everything as a Service (XaaS). In the future, we expect many new service models to achieve the goal of XaaS. XaaS may include

    - Backup as a Service (BaaS),

    - Communication as a Service (CaaS),

    - Hadoop as a Service (HaaS),

    - Disaster Recovery as a Service (DRaaS),

    - Testing as a Service (TaaS),

    - Firewall as a Service (FWaaS),

    - Virtual Private Network as a Service (VPNaaS),

    - Load Balancers as a Service (LBaaS),

    - Message Queue as a Service (MQaaS),

    - Monitoring as a Service (MaaS).

- ## **SUMMARY:**

- Cloud computing composes of three basic service models The service models include IaaS, PaaS, and SaaS

- Cloud services cannot be used when the application uses more sensitive and confidential data. The general benefits of cloud services are cost savings, elastic and dynamic scaling, and centralized management.

- The general drawbacks include security issues, interoperability issues, and performance issues. Apart from the basic service

Thank you!