

MODULE-3 WORKING WITH CLOUD

INTRODUCTION TO INFRASTRUCTURE AS A SERVICE

IaaS (Infrastructure as a Service)

IaaS (Infrastructure As A Service) is one of the fundamental service model of cloud computing alongside PaaS(Platform as a Service). It provides access to computing resources in a virtualized environment “the cloud” on internet. It provides computing infrastructure like virtual server space, network connections, bandwidth, load balancers and IP addresses. The pool of hardware resource is extracted from multiple servers and networks usually distributed across numerous data centers. This provides redundancy and reliability to IaaS.

IaaS(Infrastructure as a service) is a complete package for computing. For small scale businesses who are looking for cutting cost on IT infrastructure, IaaS is one of the solutions. Annually a lot of money is spent in maintenance and buying new components like hard-drives, network connections, external storage device etc. which a business owner could have saved for other expenses by using IaaS.

IaaS is also known as **Hardware as a Service (HaaS)**. It is one of the layers of the cloud computing platform. It allows customers to outsource their IT infrastructures such as servers, networking, processing, storage, virtual machines, and other resources. Customers access these resources on the Internet using a pay-as-per use model.

In traditional hosting services, IT infrastructure was rented out for a specific period of time, with pre-determined hardware configuration. The client paid for the configuration and time, regardless of the actual use. With the help of the IaaS cloud computing platform layer, clients can dynamically scale the configuration to meet changing requirements and are billed only for the services actually used.

IaaS cloud computing platform layer eliminates the need for every organization to maintain the IT infrastructure.

IaaS is offered in three models: public, private, and hybrid cloud. The private cloud implies that the infrastructure resides at the customer-premise. In the case of public cloud, it is located at the cloud computing platform vendor's data center, and the hybrid cloud is a combination of the two in which the customer selects the best of both public cloud or private cloud.

Key Characteristics of Infrastructure-as-a-Service

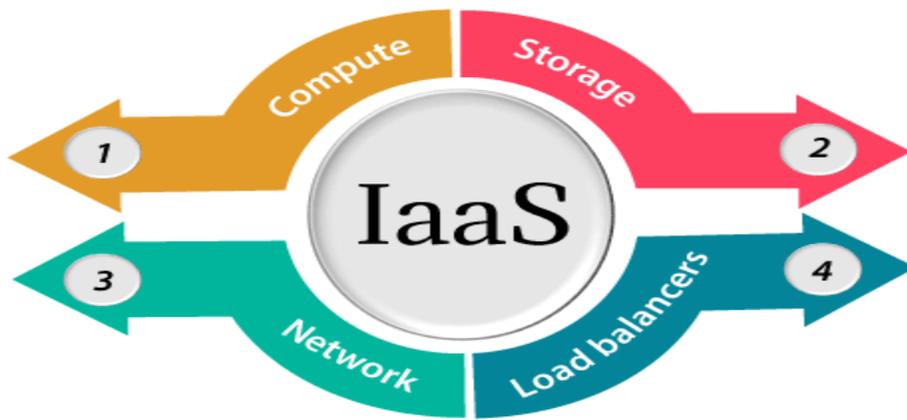
IaaS offers a flexible and dynamic solution for IT organizations or software developers that wish to address their IT infrastructure needs with a cloud-based outsourcing model.

Organizations seeking cloud-based solutions should be aware of these five important characteristics associated with the IaaS outsourcing and pricing model:

- **Resources-as-a-service** - The cloud service model is based on the concept of resources-as-a-service. As an alternative to spending money on the up-front equipment costs associated with creating and managing a server room or data center, the cloud service model allows organizations to access and implement IT infrastructure with a subscription-based payment model that's more affordable.
- **Pay-as-you-go Pricing Model** - IaaS services are provided on an on-demand basis and billed on a pay-as-you-go basis, making them a cost-efficient option for smaller organizations that can only afford to pay for computing resources that they use. An IaaS provider might bill according to the number of virtualization instances that are created, or based on the quantity of data stored. Some cloud service providers may bill extra for specified managerial services.
- **Scalable Services** - The ability to quickly and easily scale service is one of the major benefits of the IaaS model. Cloud service providers maintain data centers with large volumes of servers and data storage available, which can be apportioned to a customer upon request. This significantly cheapens and simplifies the process of scaling up IT infrastructure for subscribers to IaaS services compared to organizations that deploy IT infrastructure in an on-premise data center.
- **Automated Administrative Tasks** - IT organizations that manage data centers and hardware infrastructure in the on-premise model are responsible for routine updates, patches, and maintenance activities that can affect the availability of hardware resources and the software applications that depend on them. In contrast, IaaS service providers handle upgrades and maintenance to their servers without compromising infrastructure availability for customers.
- **Platform Virtualization** - Platform virtualization refers to the creation of a virtual machine that acts as a logical abstraction of a hardware platform. The main purpose of virtualization is to divide the resources of a mainframe computer between different functions and applications and to segment those environments from each other for operational or testing purposes. Platform virtualization enables IaaS subscribers to deploy virtualized computing instances as needed to support software development and other tasks.

IaaS provider provides the following services -

1. **Compute:** Computing as a Service includes virtual central processing units and virtual main memory for the VMs that is provisioned to the end-users.
2. **Storage:** IaaS provider provides back-end storage for storing files.
3. **Network:** Network as a Service (NaaS) provides networking components such as routers, switches, and bridges for the VMs.
4. **Load balancers:** It provides load balancing capability at the infrastructure layer.



IaaS Providers



Vendor	Solution	Details
Amazon Web Services	Amazon Elastic Compute Cloud (EC2), Amazon MapReduce, Amazon Virtual Private Cloud, etc.	Amazon is a cloud computing platform pioneer, and Amazon offers auto scaling, cloud monitoring, and load balancing features as part of its portfolio.
Netmagic Solutions	Netmagic IaaS Cloud	Netmagic runs from data centers in Mumbai, Chennai, and Bangalore, and a regional data center in the United States. Plans are underway to extend services to East Asia.
Rackspace	Cloud servers, cloud files, cloud sites, etc.	Rackspace is a cloud computing platform vendor that focuses primarily on enterprise-level managed hosting services.
Reliance Communication	Reliance Internet Data Center	Reliance Cloud supports both traditional hosting and cloud services, with data centers in Mumbai, Bangalore, Hyderabad, and Chennai. The cloud services offered by

		IC include IaaS and SaaS.
Technologies	IaaS	's cloud computing platform is powered by HP's converged infrastructure. The vendor offers all three types of cloud services: IaaS, PaaS, and SaaS.
Tata Communications	InstaCompute	InstaCompute is Tata Communications' IaaS offering. InstaCompute data centers are located in Singapore, with operations in both countries.

Use Cases for Infrastructure-as-a-Service (IaaS)

Software Testing and Development

The availability of virtual machines makes it easy for software development teams to quickly initialize and dismantle test and development environments with desired characteristics. Streamlined testing enables new software development strategies such as continuous delivery and deployment, and helps teams bring their product to market faster.

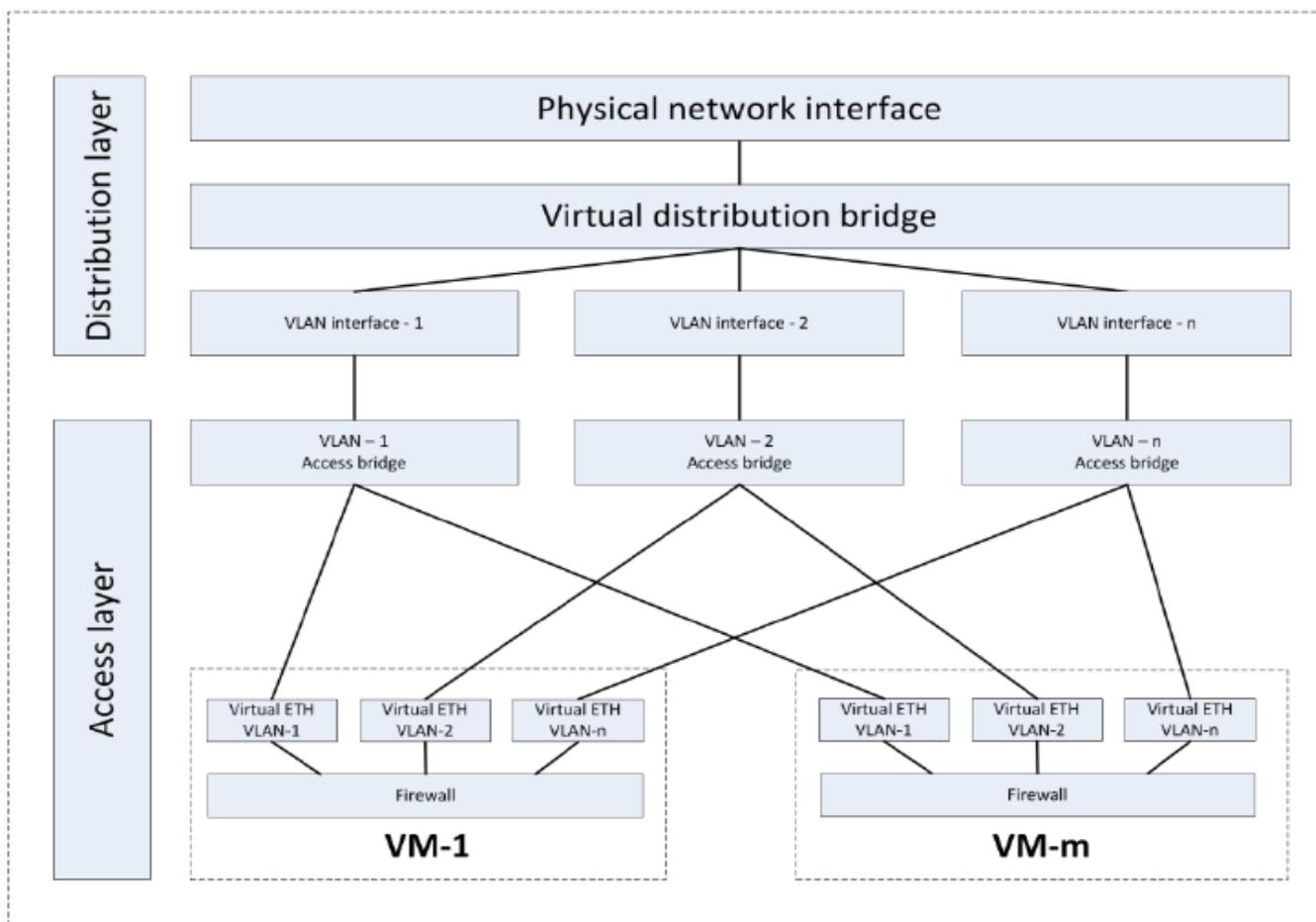
Web-based Application Deployment

IaaS infrastructure is ideal for hosting and supporting web-based applications and includes the capability to increase available resources to support the application during periods of higher-than-normal demand.

Big Data Analysis

Organizations that wish to analyze large data sets require a huge amount of computing power. IaaS provides a budget-friendly option for organizations that need to recruit large volumes of computing power for data mining and analysis purposes.

Conceptual model of infrastructure as a service:-



Designing network and cloud infrastructure

The hierarchical network model is proven to be a good model for designing the network infrastructure for educational clouds. This model divides the network in core, distribution, and access layers, where each layer performs a specific function. The advantages of using the hierarchical model are numerous. The principle of modularity simplifies the process of designing the network. Testing and troubleshooting are easier, as well as network maintenance. More details on the design of hierarchical network model can be found in.

The hierarchical network model allows realization of a part of the network infrastructure within a private cloud. The cloud network infrastructure includes parts of distribution and access layers. The concept of virtual local area networks (VLAN) is used, since within the cloud infrastructure it is important to isolate network traffic for each tenant. All servers are connected to access ports within the same VLAN, so the communication between servers and virtual instances flows within the same network. The usage of VLANs enables a simple, flexible, and inexpensive way to administer the network; it provides a segmentation of virtual servers, and secures isolated network traffic between instances. In addition, multiple VLANs can be created for each instance. This approach allows flexibility in the development of cloud e-learning services, because students can be provided with network, infrastructure, development platforms, and software as a service, according to the specifics of each course. The organization of the network segment of the cloud infrastructure is shown in Figure. After setting up the network infrastructure, the main issue is to enable an efficient and comprehensive management of the network resources. Considering the heterogeneity of e-

learning systems' components and a need for delivering resources and services on demand, the idea was to find and customize a tool that fulfils all the mentioned requirements. OpenStack is an open source cloud computing platform for public and private clouds primarily focused on Infrastructure as a service . It provides software, control panels, and APIs required to orchestrate a cloud, including running instances, managing networks, and controlling access. The communication of OpenStack services is realized through public APIs. The main features of the OpenStack include: multi-tenancy, massive scalability, multiple network models, pluggable authentication, block storage support, control panel, hypervisor support.

OpenStack Networking adds a layer of virtualized network services. This gives tenants the capability for designing their own, virtual networks. Neutron, OpenStack project that provides networking as a service, allows users to create multiple tenant networks . A single open-switch bridge can be utilized by multiple tenant networks using different VLAN IDs, allowing instances to communicate with other instances across the environment. Neutron has an API extension to allow administrators and tenants to create routers that connect to L2 networks. Neutron uses the Linux IP stack and iptables to perform L3 forwarding and NAT. In order to support multiple routers with potentially overlapping IP addresses, the Linux network namespaces are used to provide isolated forwarding contexts. Like the DHCP namespaces that exist for every network defined in Neutron, each router has its own namespace with a name based on its UUID. Giving each application its own virtual infrastructure, including its own network, leads to simplified security configurations, and gives developers additional flexibility. Application owners in this case do not use the shared infrastructure, but instead each has their own end-to-end infrastructure, isolated from the others, and with few or no interaction points. The flexibility and automation that comes with virtualization of the network allows both network administrators and application owners to respond more quickly to educational needs. For instance, in periods of high usage of the e-learning system (during labs, tests, upload of assignment, etc.) using OpenStack, an IT administrator can easily reserve additional computing resources on the infrastructure and add new instances of the needed server. At the same time, when a new course opens, services and applications tailored to the course' requirements can be delivered in real time. In the periods of the reduced activities, some server instances can easily be removed.

Advantages of IaaS cloud computing layer

There are the following advantages of IaaS computing layer -

1. Shared infrastructure

IaaS allows multiple users to share the same physical infrastructure.

2. Web access to the resources

IaaS allows IT users to access resources over the internet.

3. Pay-as-per-use model

IaaS providers provide services based on the pay-as-per-use basis. The users are required to pay for what they have used.

4. Focus on the core business

IaaS providers focus on the organization's core business rather than on IT infrastructure.

5. On-demand scalability

On-demand scalability is one of the biggest advantages of IaaS. Using IaaS, users do not worry about to upgrade software and troubleshoot the issues related to hardware components.

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Reduced Costs and Up-front IT Infrastructure Investment

IT organizations can reduce their up-front expenditures on IT infrastructure by choosing a cloud-based delivery model such as IaaS. Cloud service providers make it easy for organizations to access business-critical IT infrastructure and scale their operations as needed based on the current level of demand.

Improved Availability and Continuity

Imagine that your business purchases a server to host a critical business application. When you need to perform server maintenance, the server has to be taken offline and the application is made unavailable. In the IaaS model, your cloud service provider can simply host your application on a separate server while conducting maintenance and your application can be re-deployed on another server or virtual machine if the current one fails. Cloud service providers can also mirror your data on additional servers, creating redundancies to prevent data loss and ensure optimized service availability and business continuity for your organization.

Reduced IT Labor Overhead

IaaS services reduce the amount of labor and knowledge that organizations need to maintain their IT infrastructure. In the IaaS model, the cloud service provider manages and updates the data centers, servers, and other hardware, leaving subscribers free to focus on their core business activities rather than the never-ending maintenance tasks associated with managing a data center.

Disadvantages of IaaS cloud computing layer

1. Security

Security is one of the biggest issues in IaaS. Most of the IaaS providers are not able to provide 100% security.

2. Maintenance & Upgrade

Although IaaS service providers maintain the software, but they do not upgrade the software for some organizations.

3. Interoperability issues

It is difficult to migrate VM from one IaaS provider to the other, so the customers might face problem related to vendor lock-in.

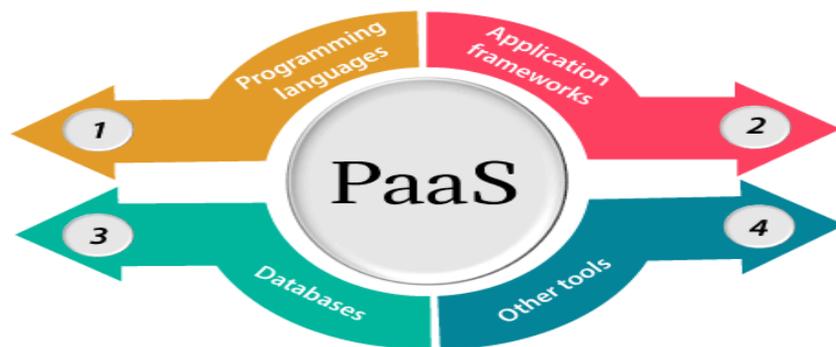
PLATFORM AS A SERVICE | PAAS

Platform as a Service (PaaS) provides a runtime environment. It allows programmers to easily create, test, run, and deploy web applications. You can purchase these applications from a cloud service provider on a pay-as-per use basis and access them using the Internet connection. In PaaS, back end scalability is managed by the cloud service provider, so end-users do not need to worry about managing the infrastructure.

PaaS includes infrastructure (servers, storage, and networking) and platform (middleware, development tools, database management systems, business intelligence, and more) to support the web application life cycle.

Example: Google App Engine, Force.com, Joyent, Azure.

PaaS providers provide the Programming languages, Application frameworks, Databases, and Other tools:



1. Programming languages

PaaS providers provide various programming languages for the developers to develop the applications. Some popular programming languages provided by PaaS providers are Java, PHP, Ruby, Perl, and Go.

2. Application frameworks

PaaS providers provide application frameworks to easily understand the application development. Some popular application frameworks provided by PaaS providers are Node.js, Drupal, Joomla, WordPress, Spring, Play, Rack, and Zend.

3. Databases

PaaS providers provide various databases such as ClearDB, PostgreSQL, MongoDB, and Redis to communicate with the applications.

4. Other tools

PaaS providers provide various other tools that are required to develop, test, and deploy the applications.

PaaS architecture

PaaS does not typically replace a business's entire IT infrastructure. Instead, it tends to incorporate various underlying cloud infrastructure components, such as operating systems, servers, databases, middleware, networking equipment and storage services. Each of these functions is owned, operated, configured and maintained by the service provider. PaaS also provides additional resources, including database management systems, programming languages, libraries and various development tools.

A PaaS provider builds and supplies a resilient and optimized environment on which users can install applications and data sets. Users can focus on creating and running applications rather than constructing and maintaining the underlying infrastructure and services.

Many PaaS products are geared toward software development. These platforms offer compute and storage infrastructures, as well as text editing, version management, compiling and testing services that help developers create new software more quickly and efficiently. A PaaS product can also enable development teams to collaborate and work together, regardless of their physical location.

PaaS architectures keep their underlying infrastructure hidden from developers and other users. As a result, the model is similar to serverless computing and function-as-a-

service architectures where the cloud service provider manages and runs the server and controls the distribution of resources.

How PaaS works

As mentioned above, PaaS does not replace a company's entire IT infrastructure for software development. It is provided through a cloud service provider's hosted infrastructure with users most frequently accessing the offerings through a web browser. PaaS can be delivered through public, private and hybrid clouds to deliver services such as application hosting and Java development.

A common issue for modern businesses is scaling to the global economy. Businesses and individuals that develop and maintain applications are often hit with this problem. The cloud computing industry has developed many solutions, and platform as a service (PaaS) offerings are one of the most commonly leveraged tools. They are highly scalable application development and hosting solutions that diminish infrastructural burden on small and growing businesses.

PaaS solutions supply and power an application's back end, which usually includes facets such as databases, web servers, operating systems, and storage. Service providers give developers the tools required to build atop this pre-developed back end. They are presented in a web-based or cloud-synced platform for developers to access anywhere, at any time. These tools can be filled with existing company data and instantly sync with your application.

With back-end development out of the way, for the most part, developers can focus on front-end design and user experience. These PaaS solutions provide either a web-based or downloadable interface. The development environments also have plentiful integrations to sync external data and provide additional functionality. In the end, the PaaS supplies a platform that allows design, development, and delivery to the end user.

Cost saving and planning burdens can be significantly reduced using PaaS solutions. The reduced need for infrastructure simplifies hardware and personnel requirements, giving more time for development and application management. The level of abstraction between hardware and software allows for increased resource control. As resource needs increase, no

pressure is put on the business. Pricing reflects the amount of information transferred and number of users allows for rapid scaling and predictable prices.

Other PaaS services include:

- Development team collaboration
- Application design and development
- Application testing and deployment
- Web service integration
- Information security
- Database integration

Users pay for PaaS on a per-use basis. However, some providers charge a flat monthly fee for access to the platform and its applications.

PAAS BUSINESS USE CASES

A few of the most common use cases of PaaS are in SaaS applications, cloud migrations, and mobile PaaS backends.

1. SaaS applications

One of the most common use cases of PaaS is the development of SaaS applications. These SaaS deliverables can range from an e-commerce payment gateway to a cloud-based **backup software** solution. PaaS provides the tools to facilitate cloud application development from brainstorming and organizing to development and deployment.

All companies that plan to iterate quickly, alter data, update applications, and scale accessibility should consider investing in a PaaS solution. They are highly flexible and reasonably affordable solutions that provide companies with more bandwidth, storage, and development tools during the most crucial stages of software development.

2. Cloud migration

Companies with existing legacy applications or on-premise infrastructure are continuing to adopt PaaS as their cloud-based solution for the future. Companies choose to migrate their company data and applications from on-premise hardware, because it's cheaper in general and less expensive to maintain. On-premise hardware requires dedicated staff to operate and maintain. Outsourcing that can cut down on staffing needs and hardware costs. The data hosted in the cloud will also be accessible to virtually any permitted user with an internet connection.

Another common migration use case is moving legacy applications from local infrastructure to the cloud. These applications become more scalable and easier to distribute, monitor, and maintain. The PaaS vendor typically offers cloud services in addition to PaaS. These tools can be used to beef up security, add functionality, or improve monitoring. There are a significant number of additional features companies can add once they've moved their applications into the cloud.

Advantages of PaaS

There are the following advantages of PaaS -

1) Simplified Development

PaaS allows developers to focus on development and innovation without worrying about infrastructure management.

2) Lower risk

No need for up-front investment in hardware and software. Developers only need a PC and an internet connection to start building applications.

3) Prebuilt business functionality

Some PaaS vendors also provide already defined business functionality so that users can avoid building everything from very scratch and hence can directly start the projects only.

4) Instant community

PaaS vendors frequently provide online communities where the developer can get the ideas to share experiences and seek advice from others.

5) Scalability

Applications deployed can scale from one to thousands of users without any changes to the applications.

Disadvantages of PaaS cloud computing layer

1) Vendor lock-in

One has to write the applications according to the platform provided by the PaaS vendor, so the migration of an application to another PaaS vendor would be a problem.

2) Data Privacy

Corporate data, whether it can be critical or not, will be private, so if it is not located within the walls of the company, there can be a risk in terms of privacy of data.

3) Integration with the rest of the systems applications

It may happen that some applications are local, and some are in the cloud. So there will be chances of increased complexity when we want to use data which in the cloud with the local data.

Benefits of PaaS

Developers and businesses use platform as a service (PaaS) solutions to develop, test, and deploy cloud-based and web applications. Developers are given tools like text editors, development environments, testing capabilities, and other necessary features to write, build, configure, deploy, and maintain modern applications. They provide the middle layer on which software as a service (SaaS) solutions are built. In addition, they typically provide some level of infrastructure beyond development and deployment capabilities.

1. Increase development speed

PaaS solutions allow for rapid prototyping and development by providing prebuilt backend infrastructure. Instead of building large databases and managing backend requirements, developers can focus on features, performance, and usability. Data can be hosted atop an

existing backend and synced through APIs for live updates and integration with external applications.

PaaS solutions also typically provide development, staging, and testing environments. These tools centralize developer resources for increased productivity and reduced costs. Many PaaS offerings provide tools to automate builds and tests to save time and eliminate bugs. Once development has ceased, applications can quickly be hosted through the PaaS solution.

2. Reduced costs and commitment

Companies launching an application for the first time may not have the financial means to purchase the hardware and software necessary to build and deploy an application. PaaS solutions are designed for startup accessibility with scalable costs. This means new companies can opt in and develop an application quickly and begin creating revenue. As demand grows, they can increase spending periodically to maintain their application without a large upfront investment.

Companies looking to reduce their current operating costs could see PaaS solutions as a viable option. These are typically large companies with various existing applications. They may be running on in-house infrastructure or an IaaS solution. But consolidating infrastructure management with development and maintenance can both simplify and reduce your current infrastructure spending.

3. Reducing infrastructural burden

Aside from prebuilt backend and development infrastructure, most PaaS solutions reduce security risk by providing a stable network infrastructure on which applications can run. In-house or on-premise infrastructure can be very expensive and require additional staff for implementation, operation, and maintenance. PaaS solutions allow users to deploy information and code directly to a public, private, or hybrid cloud.

With PaaS solutions, users are able to manage objects, resources, and databases remotely and simultaneously. They do not have to maintain servers or update hardware as needs change.

Some companies use PaaS solutions atop existing infrastructure, but files, data, and resources can be easily deployed into cloud storage.

4. Improve scalability and reliability

The pay-as-you-go model also enables worry-free scaling. Costs will increase, but performance should not be affected by increased traffic and usage. Databases can also be scaled as the information within them multiplies. As performance is maintained through reliable cloud servers, security is often cited as an additional level of reliability. With proper configuration, data can be tightly secured, ensuring safety for company and customer information.

5. Other benefits of PaaS

Companies can benefit from easier application reuse, increased resource allocation, and improved customer support, among other things. And that's in addition to lower costs, quicker development, and increased security. Application multi-tenancy can allow developers working on different projects to utilize the same core service and isolate instances for each application. That improves speed, performance, and security. Resource allocation can be simplified through shared resources across applications. Each application can allocate and share resources while properly documenting each KPI and recording historical performance trends. For the business, this means reduced overhead, lower headcount requirements, reduced failover frequency, and quicker deployments.

6. Simplified integrations

A PaaS solution will have to integrate with numerous other tools in your organization, and the complexity of these integrations ties directly into the time and effort needed to implement the platform. In addition to having to integrate with the infrastructure as a service (IaaS), a PaaS will likely need to integrate with other development tools that are already in place, such as version control systems, build automation tools, software testing products, or integrated development environments (**IDEs**).

Some PaaS tools provide for continuous deployment and integration. This allows companies to apply updates and change functionality without limiting public access to applications. Virtual machines can also be extremely helpful for computing, storage, and simulation.

Element libraries, pre-configured integrations, and programming language variety also contribute to the development process.

Disadvantages of PaaS

1. Vendor lock-in

Affordable development tool kits and reasonable host pricing are readily available for businesses. In most cases, companies won't have to invest in costly servers or other infrastructure because it's handled by the provider. When demand increases, the payment model will continue to reflect usage. Hopefully, as user bases grow, revenue follows, allowing for simpler expense forecasting. Still, some users disapprove of some potential vendor lock-in when using PaaS offerings. Since your company's entire application is built on the platform, it can be difficult to change providers without affecting functionality.

Changing PaaS providers would involve a significant workload and expense increase. All of the application's code and data will need to be migrated. All of the network monitoring and configuration management operations will need to be restructured. Contracts will also need to be renegotiated. It is possible to switch PaaS providers, but it can be time consuming, labor intensive, and expensive.

2. Lack of control

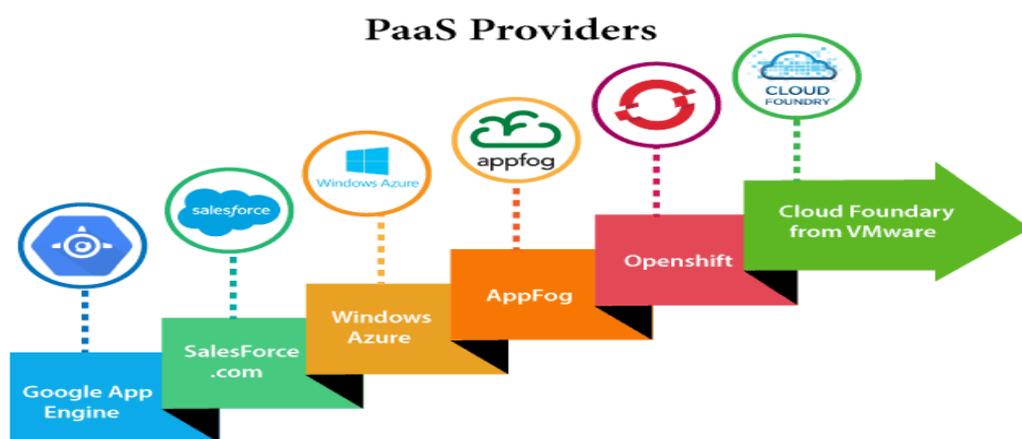
One downside of relying on a PaaS provider is that the product is vulnerable to downtime during which users cannot access the system. Downtime is a necessary evil needed to improve and maintain the platform, but if it occurs too frequently or at unannounced times, developers could be left in the dark, basking in their frustration. Having a reliable system is key to launching an application quickly and efficiently, so make sure you ask what the service uptime is and urge providers to give advance notice whenever possible.

3. Hardware and software dependencies

Companies migrating a legacy application may have difficulty pairing their existing hardware to their new provider's hardware. Some applications require specific kinds of servers, data storage systems, and networking components. Some cloud service providers will be able to accommodate these needs at little to no cost. Some may not be able to meet your hardware needs, while others may be able to accommodate your hardware requirements at an additional price point.

Programming languages and existing development software setups should be considered when adopting a PaaS. One of the first steps you need to take when selecting a PaaS provider is to choose which programming language you will use. Every PaaS platform supports a different set of programming languages, so ensuring that the one you choose is compatible with your language of choice is a crucial step in your decision process.

Popular PaaS Providers



The below table shows some popular PaaS providers and services that are provided by them -

Providers	Services
Google App Engine (GAE)	App Identity, URL Fetch, Cloud storage client library, Logservice
Salesforce.com	Faster implementation, Rapid scalability, CRM Services, Sales cloud, Mobile connectivity, Chatter.

Windows Azure	Compute, security, IoT, Data Storage.
AppFog	Justcloud.com, SkyDrive, GoogleDocs
Openshift	RedHat, Microsoft Azure.
Cloud Foundry from VMware	Data, Messaging, and other services.

Best PaaS Providers in 2019

1. AWS

Amazon Web Services has a wide range of cloud service offerings that range from PaaS and IaaS solutions to analytics and security solutions. Their flagship offering is **AWS EC2**, which offers a variety of IaaS and PaaS tools. It gives users complete control over their computing infrastructure and lets them scale usage to meet their demands. It was one of their first publicly available cloud computing offerings and it has remained a core part of AWS since 2006. (It's even hosted Amazon.com since 2010.)

AWS Elastic Beanstalk and **AWS Lambda** are AWS' most popular pure-play PaaS offerings. Elastic Beanstalk is a scalable platform for developing applications written in **Java**, .NET, PHP, Node.js, Python, Ruby, and Go. It also supports Docker applications and common application servers including Apache, Nginx, Passenger, and IIS.

AWS Lambda is a **serverless computing platform**. It allows users to execute code without actually managing any server infrastructure. The product is designed to run applications on any endpoint device and scale continuously by only running when requests are triggered.

2. Microsoft Azure

The Azure platform is **Microsoft's** flagship cloud computing service offering. It was launched in 2008 and provides PaaS, IaaS, and SaaS solutions. Today, Azure offers a wide array of computing, development, networking, and integration services.

There are a few ways to utilize PaaS through Azure's plug-and-play service model. But **Azure Web Apps** and **Azure App Service** are two of their most commonly used pure-play PaaS offerings. Web Apps is pretty straightforward. It's a managed platform that supports Windows and Linux applications.

Azure App Service takes a more modern approach to PaaS, offering complete infrastructure control and a development platform for web apps, mobile apps, and APIs. Users can integrate existing frameworks to speed up development time and integrate **continuous delivery** tools to build out DevOps processes.

Azure Functions is noteworthy; it operates much like AWS Lambda through its serverless computing model. The event-driven code execution model is designed to accelerate development time, optimize resource usage, and simplify operational processes.

3. Google Cloud

The **Google Cloud Platform** offers a laundry list of cloud computing services, much like AWS and Azure. Most industry experts rank them as the fourth-largest vendor in the entire cloud computing space, behind AWS, Microsoft, and IBM. In July, the company **announced** a number of offerings including improved security, and new edge computing capabilities.

Its main PaaS tool is **Google App Engine**, a decade-old cloud platform for building and hosting web applications. It operates on a managed serverless platform that supports a variety of popular programming languages. It also comes with built-in tools for monitoring, versioning, and application security management.

Google Cloud Functions is has comparable event-driven functionality to that of Lambda and Azure Functions. Most companies use Cloud Functions as a serverless backend, but it can also support real-time data processing and intelligent applications.

What is SaaS ?

Software as a Service (SaaS) – If you are new to the concept of SaaS, then this article is meant for you. You will know what is SaaS, what it can do for you, how SaaS is different and more about Software as a Service applications.

Software as a Service is a software delivery method that allows software and its functions to be accessed from any device with an internet connection and a browser. The applications are hosted in the cloud and can be used for a variety of tasks to be performed by both individuals and organizations.

In short form Software as a Service means a provider hosts an application centrally and provides access to multiple users across various locations through the internet for a fee.

Software as a Service applications are called Web based software or hosted software. SaaS runs on a SaaS provider's servers.

Utilising Software as a Service (SaaS) is similar to renting software rather than buying it. Previously you would purchase a software and install it in your computer. Through Software as a Service you just subscribe to a software on a term basis usually monthly basis.

Software as a Service has become a widespread software delivery model as the web services have become more popular with its improved technologies and developmental approaches. Due to the increasingly available broadband services we are able to easily access different areas of the world.

Understanding Software as a Service (SaaS)

Software as a Service is often compared with Application Service Providers (ASP) and on demand computing software models. Earlier these applications had a lot of things in common with traditional on-premise applications. But now Software as a Service applications has developed a lot in its architecture and licensing.

Today, Software as a Service applications are centralized with a multi tenant architecture to provide comparatively best experience than on-premise applications.

On-premise software uses a one-time licensing model whereas SaaS uses a subscription model where access to the software is frequently sold either directly by the provider or an agent called an aggregator.

The cost of SaaS varies from application to application. Some SaaS providers charge a fixed price for access to all the application's features, while some providers charge a varied price based on the usage of the application.

You can customize the SaaS applications like the data schema, workflow and other aspects as per your business need.

Software as a Service providers also provide a high security mechanism to protect the data of the customers while transmission and storage.

A good example of Software as a Service model is a bank. It protects the privacy of the customer while at the same time provide more reliable service to them. All the customers of the bank use the same technology without the fear of anyone accessing their personal information without proper authentication.

Objective of SaaS

- Reduce the investment in server hardware by sharing end user licenses
- Reduce hiring costs of software

Models of SaaS

There are two models of Software as a Service

- Hosted Application Management Model
- Software On demand Model

In the hosted application management model the provider hosts the readily available software for the customers and delivers it through net.

In the software on demand model the provider gives web based access to its customers only to a specific section of the application created explicitly for SaaS distribution

Benefits of SaaS model

There are a number of reasons why SaaS is more useful for individuals and businesses of all sizes and types. Here's what is driving customers to use Software as a Service

- No initial setup costs – The applications once subscribed by you it is ready to use
- Time management – SaaS applications needs only less time to be spent in installation and configuration
- Reduces the work of IT department – SaaS applications are handled by the hoster and thus it helps the IT department to concentrate more on the activities that helps in attaining the goals of the business
- Lower costs – SaaS is operated in a shared environment where the hardware and software license costs are low when compared to other software models
- Low maintenance costs – If you want to improve the storage capacity it can be done without installing any new hardware or software
- Scalability – SaaS resides in a cloud environment that is scalable.
- Seamless Integration – SaaS can be integrated with a number of devices such as tablets, laptop, desktop and other internet enabled phones. SaaS can be customized to meet the needs of a particular customer
- New Upgrades – If the SaaS providers upgrades the software then it is available online to you with free of cost. Even if it is available for cost it will be lower than the traditional model up gradation cost

- Easy accessibility – SaaS applications can be accessed from anywhere and from any device that uses internet

SaaS characteristics

Software as a Service has several characteristics that makes it unique from other services. Few of the important characteristics are listed below

- **Configurability**

SaaS offers various configuration options like Social site extensions, blog interface, network content access and custom tool modules. These options can be used by the user at any time as per their need for the site.

- **Multi-Tenant Efficiency**

In SaaS all the users share a common infrastructure and code which is centrally maintained by the provider. Through this way users can save their server space, cost and maintenance. Updates are automatically notified to the users and made at no cost or sometimes with less cost. This will also save a lot of time for you.

- **Easy Customization**

SaaS applications can be easily customized to fit your business purpose without affecting your common infrastructure. Software as a Service is designed in such a way that the customizations are made unique to each company or individual. Updates are also made with less cost and less risk.

- **Scalability**

Software as a Service has a multi tier structure that implements a load balancer. Without modifying the entire structure of your software the capacity of your system can be adjusted by adding servers as per your demand

- **Easy access**

You can access to the data easily from any device that uses internet. This will help you to manage your data and make sure that everyone sees the same information at the same time.

SaaS and On-premise Application

Software as a Service application and On-premise application are differentiated using three major dimensions – Licensing, Location and Management

- **Licensing**

On-premise applications are licensed with a single cost for each user or site

SaaS applications are licensed based on two models – Usage based transaction model and time based subscription model. In usage based model the user is billed for the number of service transactions used. In the second model the user pays for a particular period of time for which he has subscribed.

- **Location**

On-premise applications are hosted in the users IT environment. The application provider also provides a hardware or software part called 'black box' which will be installed in the users location.

SaaS applications are hosted in the provider's server. No hardware or software is installed in the users place.

- **Management**

In On premise applications the entire responsibility lies with the IT department of the company. The IT people should be familiar with the network, server and application functions. They should also be able to troubleshoot the problems and take care of the reliability and security of the application. This was a big deal and some companies even outsourced this work to a third party who specialize in IT.

While with SaaS, the application is completely handled by the SaaS provider or vendor. Service Level Agreements rule the support and service to be provided by the vendor to the user.

Considerations for embracing SaaS

There are few things that should be taken into account before using Software as a Service application in an organization. Here are four major factors that affect SaaS

- **Political**

Some important people in the organization will feel that certain functionality of the business should remain under the support and control of IT department. In such situations Software as a Service and other applications are considered unimportant. If a test application is deployed in the organization by the provider then there are chances of the managers to approve such applications.

- **Technical**

SaaS provides customization option to its users but there are few limitations in it. If a particular technical knowledge is required to operate a SaaS application and if it cannot be afforded by the Software as a Service provider then it becomes difficult for the user to run the SaaS application.

Another important factor is the amount and type of data transmitted to and fro the application. The data transmitted between the servers should be done quickly. So the companies always prefer a SaaS solution that takes network latency into account.

- **Financial**

SaaS application is usually considered lower than the On premise application. But the long term cost of SaaS application is not sure. The things that affect the cost of SaaS application includes the number of licensed users, amount of customization which need to be done for your business and your data centres' economy of scale.

- **Legal**

Some industries are subject to law in different parts of the world. They need to maintain various reports and records. Software as a Service application will not be able to satisfy all such needs of the customer. SaaS providers should also meet your internal standards regarding your data security and privacy in order to avoid any legal problems.

SaaS application should meet the rules and regulation of the jurisdiction in which the organization operates.

Is SaaS suitable for your organization ?

SaaS is not suitable for all the organization nor do all the applications can lend themselves to SaaS delivery model. There are few criteria's to be considered while deciding about SaaS application for your business. The important factors are listed below

- The type of process for which you are going to use SaaS application
- The amount of customizations to be done
- The integration of SaaS application with other systems in your company which includes both internal and external
- The term of the application

SaaS application is usually best suited for processes which are simple, standard and not too much dependent on other functions and systems of your business.

SaaS also works best for the functions which are automated for the first time as there will be few changes to be made.

A function which is related to the core of your business like ERP and others do not lend themselves to Software as a Service so for such functions you need to go with other onsite solution. This will help you to manage the application as it runs.

If you need to customize a SaaS product then it will take more time for implementation. Customization will shoot up the SaaS vendor's cost and it also involves a lot of complexity. As a result many vendors refuse to do customizations and even if they do they do it for a high cost.

So if you are going to do a customization to your SaaS product be aware about the charge for it and whether it is affordable for you.

The more the integration the longer the SaaS implementation. So SaaS providers pay attention to things that ease the integration process.

SaaS can work best if you are purchasing a new application from a vendor who is going to frequently update the application for its enhancement.

Popular SaaS Providers



The below table shows some popular SaaS providers and services that are provided by them -

Provider	Services
Salseforce.com	On-demand CRM solutions
Microsoft Office 365	Online office suite

Google Apps	Gmail, Google Calendar, Docs, and sites
NetSuite	ERP, accounting, order management, CRM, Professionals Services Automation (PSA), and e-commerce applications.
GoToMeeting	Online meeting and video-conferencing software
Constant Contact	E-mail marketing, online survey, and event marketing
Oracle CRM	CRM applications
Workday, Inc	Human capital management, payroll, and financial management.

ADVANTAGES AND DISADVANTAGES OF SAAS

Advantages of SaaS

Although SaaS is a major departure from the established method of purchasing and installing software, but it still manages to provide distinguished advantages in a typical business environment. We have listed some pros of SaaS development here -

1. Cost Reduction

Cost benefits are one of the well-known and most obvious advantages of using software as a service for businesses. The expense of buying and installing the entire software and IT infrastructure in-house is negated when the software is rented from a third-party service provider. The payment is done on a subscription basis which depends on the usage of the infrastructure.

2. Ease of Accessibility

A software as a service application is easily accessible. A computer and a stable internet connection is all that is required to access and use the cloud-hosted software. Using this method, the application can be easily made available on any remote desktop or mobile phone and used at anytime from anywhere.

3. Effortless Scalability

Whenever your business grows and you feel the need of adding new users, there is no need to buy additional software licenses or server space for the new users. All you have to do is to upgrade your existing plan or subscription for the SaaS application to accommodate the new users. This also holds in good stead if your business has strong off-seasonal trends, allowing you to cut down on subscription costs.

4. Trouble-free Upgradation

It is a cumbersome task to upgrade your existing software and hardware to the newer versions. In many cases, businesses do not have the budget or the IT manpower to upgrade software every subsequent year. This in turn leaves the software vulnerable to external threats. On the other hand, when you opt for a SaaS application, this is one burden less for you to bear and removes a significant workload from your in-house IT department. The extra human bandwidth can be used for other tasks such as integration with in-house applications.

5. Highly Resilient

Since the IT infrastructure and your data is installed and stored in the cloud storage provided by the service provider in a remote location, any damage or disaster of any form to your business premises can be quickly sorted out. The business can be back up and running from any other location which has access to an internet connection easily.

Disadvantages of SaaS

Though using software as a service looks to be a very viable option for most of the businesses, there are some downsides too which need to be considered. We have listed some of the cons of SaaS development here -

1. Insufficient Data Security

This is one of the top concerns for companies who are looking to opt for a SaaS-based application model. Issues such as identity and access management need to be addressed before trusting any third party service provide with your company's sensitive data. Particularly in the case of accessibility from a mobile device, strict measures need to be taken before any kind of sensitive data is divulged to the service provider.

2. Difficulty with Regulations Compliance

When your business critical data is stored in the service provider's data center, it is difficult to comply with the government's data protection regulations. Your company will need to learn which rules apply to your business, ask the right questions from your service provider, and address any kind of inconsistencies in the process.

3. Cumbersome Data Mobility

The software as service market is filled with startups, and many of them do not have enough experience to survive in a highly competitive atmosphere. In case of a failure or in an event where you want to change your service provider, it becomes a cumbersome task to transfer your company's critical data from one service provider to another. Therefore, you need to be prepared for such an event with a planned exit strategy.

4. Low Performance

A browser-based application running on a remote data center may lack in performance when compared to a similar application running from your employee's desktop. Companies

therefore need to invest in a fast and reliable internet connection to negate this factor and also use tools for application performance management to know how their SaaS apps are performing over time.

5. Troublesome Software Integration

When working with an external SaaS service provider to host multiple apps, there might be an integration problem with the existing in-house software. The in-house APIs and data structures might not integrate properly with the external software. As a result, you should always perform compatibility checks with all SaaS applications for better results.

Trends in Cloud-Computing :

The present availability of high-capacity networks, low-cost computers and storage devices as well as the widespread adoption of hardware virtualization, service-oriented architecture, and autonomic and utility computing have led to a growth in cloud computing .

A. Open Source / Open Stack Cloud Computing

- With the help of open standards, different technology firms have started powerful cloud services.
- Many open source cloud computing platforms with unique set of characteristics are available which meets different kinds of user requirements
- One of the prominent examples is the creation and development of Hadoop Framework. The framework divides the application into different clusters and assigns to various independent nodes to carry out the work .
- According to Open Stack, its goal is to produce an ubiquitous open source cloud computing platform that will meet the needs of public and private clouds regardless of size, by being simple to implement and massively scalable.
- Predominantly acting as an infrastructure as a service (IaaS) platform, it is free and open-source software released under the terms of the Apache License.

B. Mobile cloud computing

- Mobile cloud computing is the combination of both cloud computing and mobile networks to bring benefits for mobile users, network operators, as well as cloud computing providers].
- The main goal of MCC is to enable execution of rich mobile applications on mobile devices, with a rich user experience .

- In the recent years, cloud computing has cultivated the outsourcing of computing resources like IT infrastructures, service platforms, and software.
- With the emergence of ultra-fast 4G mobile networks and highly-featured smartphones and tablets, the prerequisites are now met for bringing cloud computing to the mobile domain.
- Cloud technologies and opportunities in mobile working will allow organisations to innovate in new ways. These trends can help business leaders to develop strategies to improve competitiveness, increase productivity and efficiency, and get closer to customers.

C. BYOD

- Bring your own device (BYOD) mobile strategies allow companies to make greater use of the cloud while at the same time satisfying employees demand in being able to use their own gadgets to do their work.
- Bring Your Own Device and cloud computing are changing the way we use technology in the workplace.
- Bring your own device goes beyond employees conveying their personal smartphones to work or accessing business email from home on their tablet PC.