7. THE RELATIONSHIPS OF IAAS, PAAS AND SAAS WITH CLOUD MODELS

The relationships between IaaS, PaaS and SaaS with Private, Community, Public and Hybrid Cloud are examined closely in this chapter.

7.1 Private Cloud

It is a phrase that describes a cloud computing platform which incorporated inside organization and is under the control of the IT departments of the organizations. Quite a few objections which in cloud computing is removed from classical and there are fewer worries about regulatory compliance, database and security. This model provides a secure and distinct environment. The computing power in a private cloud is provided as a service in which the environment is virtualizes. It is accessible by a single client or organization so the applications are organization specific. The features of a private cloud include the ring fencing of the cloud for the organization to be used by the organization and also to provide higher levels of security for the client.

The higher levels of security that is offered by the ring fenced cloud allows the organization to operate in a classified environment, to process, store and carry out sensitive work. The private cloud is quite similar to the traditional model which was individual local access networks, and only it has the benefit of virtualization.

The basic features of the private cloud are:

- **Higher Security and Privacy**
  Using techniques of distinct pool resources with restricted access to connections, it provides an inaccessible environment for the organization to function in.

- **More control**
  It is only accessible by the client organization and therefore, the organization has the control to manage the cloud in line with their private requirements. However, since the hardware management falls under a centralized control economically, it is more expensive than a public cloud.

- **Efficiency of Cost and Energy**
Because of the economies of scale, this model is best suited for organizations as it improves the allocation of resources ensuring the availability of resources to all departments of the organization. The computing resources are more efficiently used, and the unused space economies are minimized, and this adds to the cost savings of the organization.

- **Improved Reliability**

Despite the resources being controlled internally and virtualizes, the environment permits the networks to be more resilient to failures across the physical infrastructure. The virtual partitions in the model pull the resources from the other unaffected servers to withstand any individual failure. Even if the cloud is hosted with a third party, the client organization can still gain from the security cover incorporated into the infrastructure hosted within data centers.

- **Cloud Bursting**

There is good demand to the cloud providers to give the added facility within a private cloud. IT enables the organization to switch some of the non-essential and non-sensitive functions to a public cloud and use the space for more sensitive functions. A private cloud can also be incorporated into a public cloud to form a hybrid cloud and non-essential functions can be allocated to it for better efficiency.

### 7.2 Relationship of IaaS in a Private Cloud

IaaS is the hardware as well as the software that powers the cloud. In a private cloud by itself, the infrastructure is not very useful. It is the platforms that make it functional. It is therefore, a base to deliver cloud computing infrastructure. When this infrastructure is provided to a single client organization that is the only party that can access the system, the IaaS is said to be in a relationship with the private cloud. IaaS has four areas of compliance requirement.

- Resources are distributed as a service
- It allows for dynamic scaling
- It has a variable utility cost model
- Multiple users on a single hardware
7.2.1 Uses of IaaS in a Private Cloud

IaaS is useful in a scenario of volatile demand. When new companies do not have to capital to invest in hardware and infrastructure, IaaS is the best option in a private cloud. When a company is growing in size too quickly, and scaling becomes a problem then the IaaS is the most competent service in such a situation as it allows economies of scale in the private cloud because the cost of a private cloud is more expensive than a public cloud. When an organization is under constraints to cut down on capital expenditure so that it can have resources for operational functions, in a private cloud the IaaS proves to form a very efficient relationship with the requirements. Where any business program is just a pilot program or an experimental unit that is the temporary and yet exclusive use is necessary and also classified secure environment clients of private clouds prefer to use the IaaS.

7.2.2 Negative Impact of IaaS in a Private Cloud

There are a few limitations of IaaS that could be problematic to the provider and the user. The areas of negative impact in a private cloud of IaaS are:

- When outsourcing and storage of data become difficult due to regulatory compliances.
- When the highest levels of performance are required.

The IaaS in a private cloud can be fully managed and be designed and ready to use levels for applications. The managed cloud environment in the private cloud gives the IaaS its exclusive infrastructure that cannot be replicated by any other organization as a copy-cat model.

Considering without the service platforms, it is not of much use by itself. One can say that IaaS in a private cloud dodge these restrictions as the select customer organization uses IaaS in a private cloud, and hence it is designed so that it is compatible to the specific requirements of the client organization only, and the applications can only be used by the specific client organization. IaaS in private cloud is best suited for financial organizations where the storage of data at least for a minimum of seven years is a regulatory compliance that every financial institution must adhere to.
Because of the reluctance of organization to outsource critical missions to a public domain, the private cloud is preferred.

7.3 Relationship of PaaS in Private Cloud

PaaS in a private cloud is an accelerating facilitator. In business today, speed is the key element and motivator. In such a situation, it is imperative for large businesses to have rapid operational functions to beat their competition in a secure cloud environment. It is therefore, the most logical decision to use PaaS in the private cloud computing of business organizations and enterprise. It helps to extend the usage and there by supporting private cloud companies with the right technology. Internal IT organizations are looking to PaaS in private cloud because of the flexibility that it ensures and the security that it provides.

Business organizations and enterprise require speedy functions and the capability of deployment anywhere without outsiders and to access the database and for the critical functions to be performed in a secure environment. This is where PaaS is favored and the fact is that it allows rapid processing, makes it even more popular. The cost of a private cloud may be higher than the cost of a public cloud but PaaS being cheaper than the other platform services to make up and compensate for the pricing.

PaaS provides a secure environment whereby outsiders cannot access the information in a private cloud base. This is the addition to the private cloud security features. One can say that it is a double security system for the client organization of the private cloud.

It can allow the specific applications to be processed that have been given. At any intrusion to the specifications, it will automatically use the modes of security in the platform to divert, warn the client and shut down the container to avoid access by an intruding third party.

Most organizations have a business critical requirement. These applications are deployed horizontally and laterally across their businesses and shared by multiple community users. Long running financial algorithms for ERP to CRM, these applications are built using a variety of languages, databases, technological methods and frame works. As these functions consume IT resources, all organizations want to
move to on demand better infrastructure, which is flexible and secure and also is economically a cost saving process.

### 7.3.1 Process of Private PaaS

- The first step is to conduct a viability test.
- Using the cloud provider’s tools, set and dashboard, the configurations must be installed.
- A small multiple nodes private PaaS cluster is the input. It consists of a cloud controller node, one services node and two dead nodes. A multi node cluster is used to run the testing and scaling tests to ensure that the private PaaS is fully functional.

The internal organizations are looking for private PaaS to run their own data centers. Instead of just allowing people to use a shared infrastructure, a PaaS platform has all the tools, and services needed to develop and deploy applications on multi-tenant architecture. This is of benefit to IT internal organizations, mainly because instead of putting together various cloud computing applications and trying to hawk it as a complete platform, the PaaS provides an all-inclusive path to cloud computing.

Private PaaS makes the journey to cloud computing that is much easier. Private PaaS is even more attractive now than before even though the IaaS has closed the gap in pricing because of the immense flexibility and the security levels that is provided. The access is immediate without delay. The issue of holding customers from fully using PaaS in private or in any cloud, computing is that the pricing of PaaS is still a grey area with three-dimensional factors involved.

### 7.4 Relationship of SaaS in Private Cloud

The business model which provides software as a kind of service is known as SaaS. In the hierarchy level of stack, one has IaaS then PaaS and then SaaS. The popular demand for SaaS deployment is in private cloud computing because of the requirements of tailor made software to handle the business operations that are critical to the organization. One of the main reasons that is why client organizations use private cloud computing essentially so that they can run their business confidentially even though a private clouds is more expensive than the public cloud or the hybrid cloud.
7.4.1 Process of SaaS Deployment in Private Cloud

The providers install and operate application software in the private cloud, and the client organization accesses the software for the private cloud.

The cloud users do not manage the infrastructure or platform where the applications run, is in the hands of the provider. It is therefore simplifies the process for the client user as they do not have to install or run the application on their own computers, which make the process time less than half. The cloud servers give the availability of access very fast and there are no delays or intervals.

Cloud applications are different from other applications because of their scalability. This is achieved by cloning multiple tasks on a virtual machine, and then the load balancers distribute it evenly when the work load demands increase.

7.4.2 Pricing Model of SaaS in Private Cloud

The pricing of the SaaS model applications are based on a flat monthly fee or a yearly fee, but this is a little different in a private cloud as there is no singular costing it is clubbed with the turnkey price of the private cloud for the client user.

The benefit that organizations see in using this service is that their IT costs are taken away from the maintenance and support of IT infrastructure and hence there are no expenses towards hardware, software, infrastructure or personnel. So reallocating the IT expenses to a cloud provider in the form of a cost for the private cloud still falls much cheaper than an in-house infrastructure. With all these benefits, the one drawback that is exposed in this service is that the entire database storage is in the hands of the cloud provider. This raises the possibility of unauthorized intrusions into the database, but companies are using third party key management to secure their data, which means there is a solution to the drawback, and it is not a draw back as of now.

7.4.3 Application Deployment

SaaS like any other cloud computing service facilitates the installation of applications in a computing platform. To enable SaaS be deployed properly so that the full benefit of the service can be experienced, it is necessary to ensure that it provide automated deployment and configuration.
7.5 What is Public Cloud?

It is a situated of machines or machine system assets focused around the standard distributed computing model where the administration supplier makes assets, for example, application and capacity and makes it accessible to the overall population for utilization. The cloud administrations are given in a virtualization built by utilizing pooled assets that are imparted and made accessible to the overall population. Open mists give administrations to different customer clients utilizing the same imparted framework. Open cloud offer benefits for the most part to people who needn't bother with an abnormal state of security and foundation to the private cloud clients.

7.5.1 Features of the Public Cloud

- **Ultimate Scalability:** Cloud resources are available on demand. The vast pools of resources in the public cloud enable applications to run smoothly, effortlessly and respond fluidly to fluctuations and interruptions.

- **Cost Effectiveness:** Since it brings together large resources, it is more cost effective per individual.

- **Utility Style Costing:** This is a pay when you use and pay how you use the model. So there is now stage and specific resources can be used for specific periods, and the charges are for that and no more.

- **Reliability:** The absolute number of the servers and the networks involved in public cloud computing as well as the redundancy configurations mean that if one component breaks down, there are many other components from where the resources will be drawn so that there is no collapse in a public cloud.

- **Flexibility:** The flexibility of the model is in the fact that through any Internet device, a public cloud can be accessed. Private clouds can be integrated with public clouds to make it more cost effective or for sustained performance and the scale at which a public cloud operates ensures that it is less likely to break down at intervals, which reduce any interruptions and the loss of data for that reason.

- **Location Independence:** The cloud service can be provided to a client anywhere where there is a remote IT infrastructure or an Internet device. Being location independent, one can work and function from any location without any hindrance.
7.5.2 Relationship of IaaS in Public Cloud

With the IaaS deployment, the applications run faster. It also has stability and independent scalability, which is necessary for a public domain. The storage facilities are massive so the amount of data that can be stored is immense.

In a public Cloud, the IaaS is deployed at very low prices and is cost-effective for the users. Maintaining business continuity is the most important factor for an organization.

Also,

- IaaS in a public cloud is a certified virtual private data center
- It has a 99.999% guarantee in uptime
- Exceptionally low I/O latency
- Services are deployable, with good backup when there are location/ failure scenarios
- Multi-site redundancy
- Dual power feeds
- Automatic regulatory compliance

These are some of the reasons why managed service providers are shifting to a public infrastructure as public IaaS providers. According to a survey conducted by Nixu Software, the market of IaaS deployment in cloud computing is growing rapidly.

Another key finding is that after the spy scandal, cyberspace customers are moving to provide a shield for their database and as a counter measure.

Other findings are as follows:

- Changing to the IaaS cloud is gaining momentum.
- The U. S. based IaaS cloud is now matched from outside incumbents as challengers to the US cloud as well as a counter measure for their unprovoked attacks.
- Due to competition getting tougher, the companies are reducing their data center footprints by buying CPU, memory, storage, and networking from IaaS clouds.
According to the survey in March 2013, 84% participants said they were considering IaaS clouds. The percentage has since come down to 59% in November 2013. The survey included responses from 189 MSP’s and carriers during November 2013.

### 7.5.3 Relationship of PaaS in Public Cloud

In the public domain, PaaS is a platform for development, deployment and the management of cloud application with it’s ability to understand any language that is written. The scaling ability, the flexibility and the security that it provides make it the right platform for a public cloud.

The pre-installed framework and the language stack to reduce the deployment and the development time considerably. It has a dynamic load balancing ability, and the monitoring ability optimizes the allocation of resources. One can choose the framework, and the language that PaaS provides. The secure container based security measures in the PaaS make it cost-effective and reliable even in a public domain as the instructions of a single user will be available only to that single user.

Public cloud PaaS is the most highly productive application platform service that a user can hope to get. The speed at which the PaaS operates is hard to imagine, and yet it is a virtual reality. Supported by the sheer number of the servers and components of a public cloud, it is veritably unmatched by any other service where the reliability, cost and the capability of the PaaS in a public cloud is concerned. PaaS on the public cloud has been installed in twenty four countries across twenty two industries in about 36000 installations. What makes PaaS so formidable in a public cloud is that it can read any language even those that others write.

### 7.5.4 Relationship of SaaS in Public Cloud

Being software as a service when it is deployed in a public cloud, it becomes an insecure proposition because of the levels of access in a public cloud. The ability intruder in the public cloud SaaS is necessary but is an insecure service in a public cloud.

Considering the deployment over the open Internet, it is not private and should be mindfully used in a public domain. SaaS applications are designed for end users and delivered over the web or other public domains. Interceptions by social media sites
are very common. Despite the change password setting, authorizations and security questions, every check has been opened by intruders and interceptors who are making communication over a public cloud for important issues.

7.5.4.1 Process of SaaS in the public cloud

A provider licenses an application to the client either as a service on demand or the pay-as-you-go service.

The revenue is generated from advertisements and the sales of the users’ lists.

As per the statistics, it appears that the SaaS growth is going to be in double digits soon.

7.5.4.2 Characteristics of SaaS in a public cloud

- It is a quickly becoming system for engineering.
- It gives web access to business programming.
- The programming is overseen from a focal area.
- Software conveyance is a one to a lot of people' model.
- Users are not needed to handle overhauls and patches.
- Application programming interfaces are took into consideration reconciliation between diverse bits of programming.
- In an open cloud SaaS, just bodes well when the arrangement is undifferentiated. A decent illustration of this would be the email.
- Applications where there is the huge interface between the outside world and general society area.
- Applications that have a huge requirement for web or versatile access.
- Applications and programming those are needed for a makeshift period.
- SaaS is not the best administration. Then again, where the applications needed is to be quick and fast to process ongoing information.
- It is additionally not the best alternative in situations where the applications are managed. The regulations don't permit the private information to be facilitated unreservedly.
7.6 What is Community Cloud?

The definition of a community cloud is a collaborative effort in which infrastructure is shared between many organizations from a specific community with common concerns, whether managed internally or by a third party.

It is a cloud service model that provides a cloud computing solution to a group of individuals or a group of organizations that are governed, managed and secured by all the participating organizations or a third party managed service provider.

They are a hybrid form of private clouds that are built and operated specifically for that group of organizations or individuals. These communities or groups have similar requirements, and their ultimate goal is to work together to achieve the collective business objectives.

They are mostly designed for businesses and organizations working in a research team, joint applications and joint projects where a common central cloud computing facility is required for building, managing and executing.

7.6.1 Relationship of IaaS in a Community Cloud

IT infrastructures like storage, networks and the fundamental computing resources by the entire group as a service. It helps in saving expenses and also focuses the entire community toward its common goal.

In this:

- The infrastructure for the entire group is common and only one set is sufficient to meet the requirements of the entire community.
- The objectives and the goals being similar, the applications are just one type of applications made available to multiple users.
- The design and the architecture is based on the common specifications so again for many usage just one set of applications is used making IaaS economical.
- There are fewer likelihoods of loss of data or requirement for backups as everyone will be able to access the data as licensed by the provider.
- The rest of the processes costing, issue's features and characteristics are that of the regular IaaS. The only difference is that it is hosted on a community cloud.
7.6.2 Relationship of PaaS in a Community Cloud

The value of the community PaaS is there but not as much as it is on a public cloud. The speed and the facilities ensure that the community cloud users do not access other member accounts and data, and any attempt would immediately give the details of the trespasser.

The PaaS essential element here is that it provides a platform for a community of the common objective application but the functions, and the characteristics of the PaaS do not change in dimension in a community cloud as it does in a public cloud.

Again where pricing is concerned with the three dimensions involved, it is difficult to quantify the exact price for the service, but a justifiable sum is added to the total cost of the community cloud.

Being location independent, the platform can provide for an internal transfer of data within the community to bypass certain regulations in a country which is not favorable to the company’s business objectives.

The legal stance for the community PaaS, users would be that as a group because of the different locations, the community cloud users did not violate any regulatory compliance.

7.6.3 Relationship of SaaS in a Community Cloud

As already mentioned, the functions and features of SaaS in a community cloud are like that of the SaaS functions and features of the SaaS in a public cloud, and then again, the community cloud is in itself similar to the public cloud.

The cost of the service comes down considerably because of the duplication process of the application for multiple users. SaaS in community provides an increased agility for the users as, we all rapid migration of data. The energy consumption is also reduced and is a green computing environment.

7.7 What is Hybrid Cloud?

A hybrid cloud is a composition of two or more cloud models. It is normally a combination for a private cloud and a public cloud but there are occasions when the hybrid is that of a community cloud and a public cloud or a private cloud with a community cloud.
• **Properties**

The properties of the hybrid cloud are a combination of the type of clouds that are integrated. The importance of hybrid clouds is growing as businesses and enterprises are trying to get the best features and combine it for their business requirements.

On the off chance that an organization utilizes an open advancement stage which sends information to a private cloud or a server farm based application, then it is a cross breed cloud.

At the point when an organization influences various Saas applications and moves information between, and server farm assets then it is regarded to be a mixture cloud likewise.

At the point when a business procedure is outlined as an issue with the goal that it can unite with different situations as one environment then it is a half breed cloud.

**7.7.1 Relationship of IaaS in Hybrid Cloud**

In this:

- All the services not just IaaS can provide, control security and flexibility in a hybrid cloud.
- Dedicating hosting provides private computing and storage at fixed prices.
- Virtualization provides a private cloud environment.
- The combination with the public cloud provides the dynamic and immense scalability.
- All the services not just IaaS when in relations with a hybrid cloud, provide elastic public scaling.
- Match service to the dedicated cloud infrastructure according to the profile performance.

The rests of the features of IaaS are identical in every way except the results when it is integrated with other clouds.

**7.7.2 Relationship of PaaS in Hybrid Cloud**

Cloud computing, especially hybrid cloud computing has gained popularity because of the complexities that have solutions provided in hybrid clouds.
We can say about PaaS Hybrid Cloud that:

- A very correct platform for hybrid clouds is the PaaS. It provides a platform for the developers to create and deploy their applications with ease.
- Because of the combination of a private cloud with a public cloud, the full extent of the PaaS can be utilized on a scale that is head spinning because of the combined capability of the private cloud along with that of the public cloud facilities.
- The projected use of PaaS in the year of 2012 was only 3% and the effective prediction of PaaS in a hybrid cloud by the year of 2015 is 43%!
- The projected size of the global PaaS hybrid in the market is 1.8 billion dollars by the year of 2015.
- The annual growth rate of hybrid PaaS in the market through the year of 2014 is 26%.
- It has speed and agility because of the hybrid combination. It can deliver on demand services. It has an auto scaling capacity and pay per use facility. The specialty of hybrid PaaS is that it focuses on the applications and the languages as well as the codes rather than the infrastructure.
- Infrastructure is more efficiently driven. It enables faster time to market and also reduces costs.

The hybrid PaaS allows for migration and portability as well as recognition of the languages written. The platform lock-in provides unusual security, which helps the enterprises but leaves the regulators very unhappy. A hybrid cloud can be locally managed also and yet give the impression of being in another country perhaps because of the lack of topographical identification unless specified by the provider or regulator and that too is something that can be dodged.

### 7.7.3 Relationship of SaaS in a Hybrid Cloud

There are three types of SaaS in hybrid SaaS.

i. **Traditional Hybrid SaaS model:**

   It is where the customer may deploy the SaaS as a service or on premise solutions with the ability to switch from to another. The hybrid SaaS allows the companies to move SaaS in the house if necessary.


ii. **Homebrew hybrid SaaS model:**

In this, the customer uses functionality for both the clouds via SaaS and combines it with an on premise solution. In hybrid SaaS, both solutions are operational at the same time. The main benefit of this type of solutions is that a large amount of data can be removed before it reaches the premises of the user reducing hardware and band width requirements. However, this means that it has two management’s consoles to monitor and configure as well as two sets of license costs and subscription costs.

iii. **The Next-Generation Hybrid SaaS model:**

The Home Brew is extended to include inter operating solutions situated both in the customer premise as well as the cloud, therefore, building on strengths and reducing the drawbacks.

Three services when in hybrid cloud take more progressive roles and it is because of the features of both the private and the public cloud. The popularity is increasing because of the abilities of the hybrid PaaS get magnified in a hybrid cloud, and this gives the SaaS hybrid, the flexibility and the manageability required to align the application to the customer and also allow the inter transfer and the migration of data without detection if needed.

All functions clearly become more magnified as the PaaS in its full hybrid potential when it comes to the SaaS hybrid applications. The compounded integration qualities of the hybrid give to sit a complex yet simple system of potential speed and power.