

## A simplified approach of SPI Service Model in Cloud Computing

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### ABSTRACT

In this paper, SPI model described with its offered services at software, platform and infrastructure level which are more beneficial for the users as well as for small enterprises. Cloud computing narrates a latest companion, storage and distribution model for IT services based on internet protocols. It basically provides dynamically scalable and virtualized resources. To illustrate the purpose of cloud computing is that if we have a lot of stuff like applications, files, videos, music, e-books and we constantly face problem of storage or space to save another stuff in computer. With the help of this reality technique, all the stuff can be store on the internet space of the worldwide web instead of limited space of computer hard drives. Not only that the cloud computing gives the ability to access the data anywhere and anytime because user's information saved at the web server. This type of services can be achieved only by SPI model in the form of IaaS, PaaS and SaaS which are the root services for the entire service model perform intellectual role in real day to day life has been defined. In this paper, new real life example has been taking which has the valuable role to understand the purpose of service model. New techniques has also been shown which are approachable by SPI model easily.

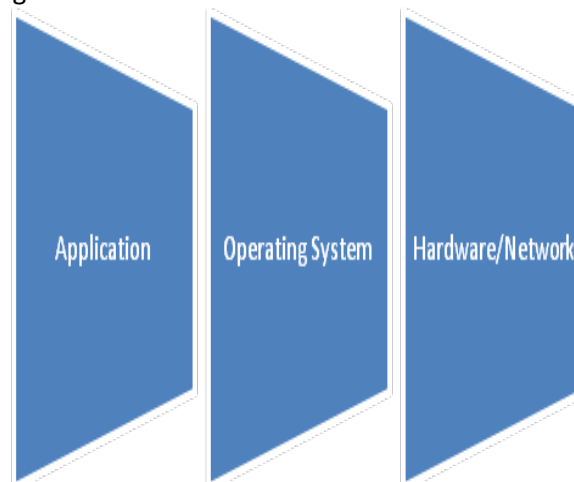
**Keywords:** IaaS, PaaS, SaaS, SPI, Virtual machines, Application performance metrics (APM), Virtual machine (VM).

### 1. INTRODUCTION

Cloud Computing Offers variety of services over the Internet or dedicated network, according to the requirement of the users. Cloud computing services range from full applications and development platforms, to servers, storage, and virtual desktops. User can directly access the software, hardware, or any application online without download it on his/her own computer. Services available for small enterprises and end users to consume internet based services in the cloud environment. SPI is a composition for the most common cloud computing service models as Software as a Service, Platform as a Service and Infrastructure as a Service. Service Models or delivery models provides the services according the need of the consumers and they pay to the service providers according to the use of the resources.

### 2 SPI Model (software, platform and Infrastructure)

Service model represents the different kind of services for the users as shown in the following figure:



**Figure1: List of services**

According the layers of service model; in general the selection of resources can be design as follow: If consumer required:

1. Just Infrastructure (only need Hardware or network resources or storage) => IAAS

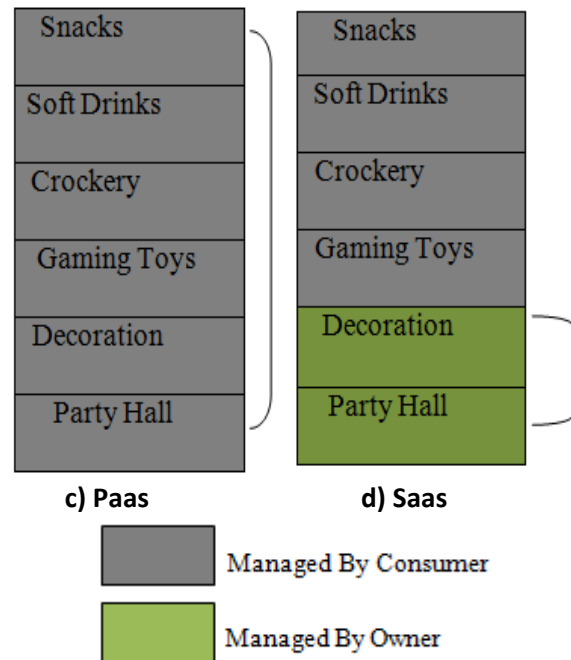
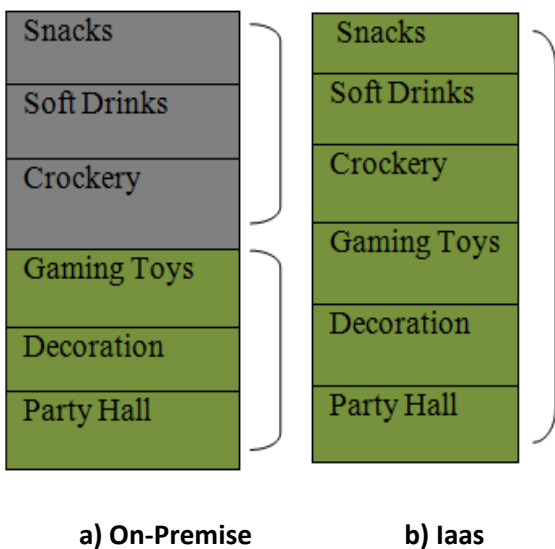
- 2. Infrastructure+Platform => PaaS
- 3. Infrastructure+Platform+Software => SaaS.

**3. Users of cloud computing services**

Government, corporate or end users consume cloud computing services to approach a variety of application and infrastructure needs such as Microsoft office, latest windows, database and data storage. As compare to existing IT environment, where software are implemented on hardware and required updating time to time. So, computing cost increase every year. On the other hand, cloud computing offering service models to access online services to simplify application utilization, store, share, and protect content, and enable access from any web-connected device without implemented on this own platform.

To illustrate this service model, consider a real life example such as a person who wants to arrange a birthday party for his kid. A person can access the resources and pay accordingly to the owner. Similarly, the services from the cloud service stack can be selected by the users or small enterprises according their needs and pay the rent to the service provider according the selection and use of resources.

Now, there may be four situations or cases in which that person can select according the needs and pay accordingly. These situations are shown in the following figures On premise means the home level requirement can be accessed. Cloud computing is internet based computing where services delivered to a computer or an organization’s computer.

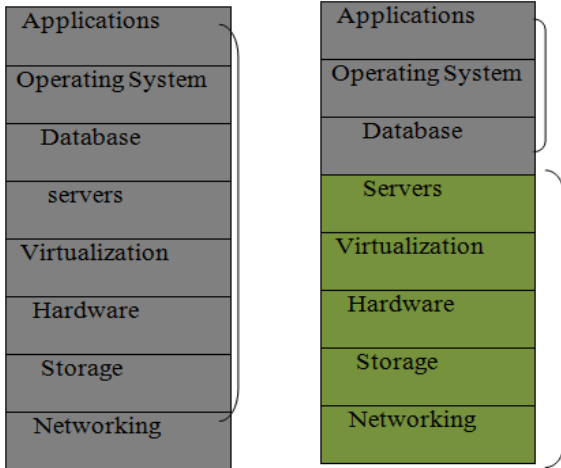


**Figure2: Real example of service model**

According to the above figure; there are four cases for the selection of resources has shown. These are written as follow:

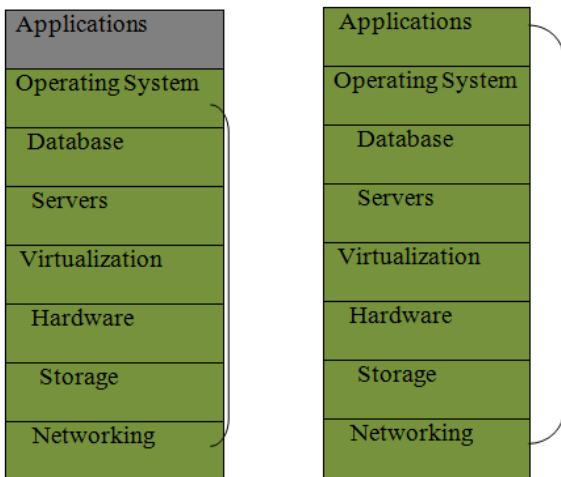
- a) In first case, If person celebrate the birthday party of his kid. The necessity things required for the party such as hall, decoration, toys , eatable things etc. arranged by himself only. He is not talking anything on rent. He will manage all things at his own level. Similarly, when the user of IT do not take any services such as online platform, storage environment or any software from cloud environment then this strategy is to be on on-premise.
- b)In second case; If person demand only hall and decoration but toys ,crockery, soft drinks and snacks managed by him then he pay only for hall and decoration charges. This service is similar as IAAS .In which to access only Hardware, Network, storage, database services required by consumer; other resources like software, applications or operating system manage by consumer himself. So that consumer pays only for infrastructure service.
- c)In Third case, If person demand gaming toys along with hall and decoration services from owner and other rest of the things managed by him then he pay to owner according the selection of resources. This service is similar as PaaS .The consumer pay to cloud service Provider Company for using the Hardware, network, storage and operating system.

d) In fourth case, the person required all facilities such as hall booking, decoration etc from owner .So that person pay for all the resources. This service as SaaS. In this service, it provides all service such as applications, O/S, H/W,N/W, database, security etc. to Consumers in cloud environment. In Saas, end user consume the services as the less knowledge in IT environment. So, all the services by Saas providers to the small companies or end users. So that consumers have no need to install or maintain the resources of their own premise.



a) On-Premise (cloud)

b) IaaS (cloud)



c) PaaS (cloud)

d) SaaS (cloud)

Figure3: SPI Service stack model

Similarly; the above figures has shown the consumption of services by users and distributing service by service provider in SPI cloud service stack. The online consumer can access the resources according the requirements and pay accordingly.

**4. SPI service model characteristics**

SPI service model is the combination of three service model as software, platform and

infrastructure service model. Each model has its own characteristics to define its identity in cloud environment. SPI allows users to consume their required resources online virtual environment without extra cost and without installation on their on home premise computers. The following figure shows the different characteristics with example of SPI model.

**4.1 Infrastructure as a service**

IaaS is the bottom service layer from SPI model. IaaS provides virtual machines, virtual storage, virtual infrastructure, and other hardware assets as resources that clients can provision In this model, consumer can either use server or storage in the cloud. In this model, consumer do not have to purchase and maintain own IT hardware. The IaaS service provider manages the entire infrastructure, while the client is responsible for all other aspects of the deployment. This can include the operating system, applications, and user interactions with the system. Users are given privileges to perform numerous activities to the server, such as: starting and stopping it, customizing it by installing software packages, attaching virtual disks to it, and configuring access permissions and firewalls rules. IaaS allow users to select infrastructure (H/W,N/W)based services according to their needs and pay accordingly their use of resources. The provider makes agreement with consumers to provide facility like equipment and maintains at a level specified in service level agreement (SLA).

In this model, the user can either use servers or storage in the cloud. In this model, user do not have to purchase and maintain own IT hardware. However, user need to install user applications on user cloud based hardware resources. IaaS allow consumers to set up a dedicated server with compute power, storage, and memory and network bandwidth from resources at a provider’s datacenter. Examples of IaaS service providers include:

- 1. Amazon
- 2. Elastic Compute Cloud (EC2)
- 3. Eucalyptus
- 4. GoGrid

All these vendors offer direct access to hardware resources. IaaS example On Amazon EC2. A client would provision a computer in the form of a virtual machine image, provision storage, and then go on to install the operating system and applications onto that virtual system. Amazon has a number of operating systems and some

enterprise applications that they offer on a rental basis to customers in the form of a number of

canned images, but customers are free to install whatever software they want to run.

**4.1.1 Features of IaaS**

**Table1: Various features of IaaS**

1.Charges as per use	Consumer pay according to the use of services. It offers utility style costing. The services can be accessed on demand and clients only pay for the resources which they actually use.
2.Scalability	There is no wastage of resources. It offers the resources according to the need of the consumer. It has large scale to offer resources as when the clients needs.
3.No extra cost in Hardware	In this IaaS service model, company can refer hardware or network related resources from host cloud companies. They just need to manage software design and operating system needs by themselves. On the other hands, H/W and N/W resources directly refer by host companies without giving extra cost. They pay according their needs of resources.
4.Mobility Access	IaaS,also offers feature as location independent. The service can usually be accessed from any location as long as there is internet connection on.
5.No Failure	If one server or network switch were to fail, the broader server would be unaffected the remaining multitude of hardware resources and duplicity configuration.

**4.1.2. Layer Architecture of IaaS**

Layer architecture divided in three categories as follow:

4.3.1. Web based Management Interface Layer

4.3.2. Infrastructure Management Software Layer

4.3.3. Physical Infrastructure Layer

**4.1.2.1 Top Layer-Web Base Management Interface Layer** At the top layer provides access to the services exposed by the software management infrastructure .This Interface is generally based on web 2.0 technologies as web services, APIs, Portals. These Technologies allows either applications or final users to access the services exposed by underlying infrastructure .Web services allow program to interact with the services without human intervention, thus providing complete integration within a software system.

**4.1.2.2 Middle Layer-Infrastructure management Software Layer** The core feature of an IaaS solution is implemented in middle layer of IaaS. To manage the functionality of virtual machines are easily performed in this layer. A central Role is played by the scheduler, which is in-charge of allocation the execution of virtual machine instances. The scheduler interacts with other components performing different tasks. The components of middle layer perform the following tasks:

**Pricing/Billing Component** The pricing/billing component takes care of the cost of executing each virtual machine instance and maintains data that will be used to charge the bill to the user according their needs or requirements of the resources.

**Monitoring Components** It tracks the execution of each virtual machine instance and maintains data required for reporting and analyzing the performance of the system.

**The reservation Component** This component stores the information of all the virtual machine instances that have been executed or that will be executed in the future.

**QOS/SLA Management** This component support quality of service/service level agreement functionality. It maintains a repository of all the service level agreement made with users and together with the monitoring component is used to ensure that a given virtual machine instance is executed with desired quality of service.

**VM (Virtual Machine) Image Repository** This component provides a catalog of virtual machine images that users can use to create virtual instances. Some implementation also allows the users to upload their specific virtual machine image.

**4.1.2.3 Bottom Layer-Physical Infrastructure Layer** This bottom layer operates by the top management layer. Any type of infrastructure and any specific use of the infrastructure can perform by user. All different requirement of different

infrastructure can be handled by this layer. The components of this layers are as follow:

**Data Center** In this component, a service provider uses a massive datacenters containing hundreds or thousands of nodes to handle huge data storage from multiple users. Datacenters give you specific servers, network, storage, power. In other Words, a data center is a facility composed of networked computers and storage that businesses or other organizations use to organize, process, store and disseminate large amounts of data.

**Cluster** A cloud infrastructure developed in a small or medium enterprises or complete system will most likely cluster. A cluster is a system comprising two or more computers or systems (**called nodes**) which work together to execute applications or perform other tasks, so that users who use them, have the impression that only a single system responds to them, thus creating an illusion of a single resource (**virtual machine**). This concept is called transparency of the system.

**Desktop/Heterogeneous Resources** In this component, It is possible to consider a heterogeneous environment where different types of resources can be aggregated such as pcs, workstations and clusters. This represent the desktop grids where any available computing resources provide a huge compute power .This layer also include the virtual resources that are rented from external IaaS providers.

The reference Architecture applies to IaaS implementation which provides computing resources especially for scheduling components. The role of infrastructure software of IaaS is not only to track and managing the execution of virtual machines but to provide access to large infrastructure and implement storage virtualization solution on top of the physical layers. All the vendors such as Amazon, Gogrid, Joyent, Right scale, Rackspace has own large datacenters and give access to their computing infrastructure by using an IaaS approach.

#### 4.1.3 Advantages of IaaS

- **Easy service Provider**– Each infrastructure component is provided as a service. For example: hardware ,server, computing, storage, as-a -service. This adds lot of flexibility to anyone looking for only specific services. This is also important as not all client requirements are same. Some require more computing power and others

more storage. So, IaaS handle required services very easily.

- **Cost savings:** An obvious benefit of moving to the IaaS model is lower infrastructure costs. No longer do organizations have the responsibility of ensuring uptime, maintaining hardware and networking equipment, or replacing old equipment. IaaS also saves enterprises from having to buy more capacity to deal with sudden business spikes. Organizations with a smaller IT infrastructure generally require a smaller IT staff as well. The IaaS model demands no upfront charges, bandwidth utilization fees or minimum term commitments.

- **Dynamic Scalability and flexibility:** One of the greatest benefits of IaaS is the ability to scale up and down quickly in response to an enterprise's requirements. IaaS providers generally have the latest, most powerful storage, servers and networking technology to accommodate the needs of their customers. This on-demand scalability provides added flexibility and greater ability to respond to changing opportunities and requirements. Scales up and down of Infrastructure services based on the application usage.

- **Faster time to market:** Competition is strong in every sector, and time to market is one of the best ways to beat the competition. Because IaaS provides elasticity and scalability, organizations can ramp up and get the job done (and the product or service to market) more rapidly.

- **Focus on business growth:** Time, money and energy spent making technology decisions and hiring staff to manage and maintain the technology takes extra time and make the growth of the business slow and expensive.

- **Utility Service** – IaaS follows a utility service model – pay per use / pay per go subscription based model. Availability of ready to go IaaS offerings with limited time for implementation and customization.

- **Investment Cap** – More beneficial for companies with limited capital to invest in hardware and infrastructure. Most Small and Medium businesses cannot afford the upfront cost of their IT infrastructure as they want to focus more on their product offering / core business.

- **Metered Service** – IaaS usage is metered and priced on the basis of units (or instances)

consumed. Pay for what you use and when you use. Thus if your usage is low so will be your bill.

**4.1.4 Disadvantages of IaaS**

- Companies or consumers are responsible for the versioning/upgrades of software developed because IAAS just provide hardware or network infrastructure .Other development of application and software resources is handled by user level.
- The maintenance and upgrades of tools, database systems, etc. and the underlying infrastructure is your responsibility or the responsibility of your organization
- There may be a problem when it is mandatory that the underlying hardware be of a specific type or the underlying software be modified to support the deployed application.
- Security features of the IaaS Cloud Provider may not adequate for your needs.
- IaaS cloud computing platform model is dependent on internet availability.
- It is also dependent on the availability of virtualization services.
- IaaS cloud computing platform can limit the user privacy and customization options.

**4.2 PLATFORM-AS-A-SERVICE** A PaaS provides the tools and development environment to deploy applications on another vendor’s application. Often a PaaS tool is a fully integrated development environment. To be useful as a cloud computing offering, PaaS systems must offer a way to create user interfaces, and thus support standards such as HTML, JavaScript, or other rich media technologies. PaaS describes a software environment in which a developer or user can create customized solutions within the context of the development tools that the platform provides. Platforms can be based on the specific types of development language, application frameworks on the other constructs.

In other words; PaaS provides virtual machines, operating systems, applications, services, development frameworks, transactions, and control structures. The client can deploy its applications on the cloud infrastructure or use applications that were programmed using languages and tools that are supported by the PaaS service provider. The service provider manages the cloud infrastructure, the operating systems, and the enabling software. The client is responsible for installing and managing the application that it is deploying. As a result, PaaS frees users from having to install in-house hardware and software to develop or run a new application. Example that is most quoted as a PaaS offering is Google’s App Engine platform. Developers program against the App Engine using Google’s published APIs.

Platform as a service (PaaS) or application platform as a service (APaaS) is a category of cloud computing services that provides a platform allowing customers to develop, run, and manage applications without the complexity of building and maintaining the infrastructure typically associated with developing and launching an app. PaaS can be delivered in two ways: as a public cloud service from a provider, where the consumer controls software deployment with minimal configuration options, and the provider provides the networks, servers, storage, operating services.

**4.2.1 Features Of PaaS**

PaaS offer easy way for configure and maintain the O/S , messaging queues, activity logs, security and O/S updates. The PaaS provides an application infrastructure where the provider managed the cloud stack’s second layer which offer operating system related services.

**Table2: List of feature of PaaS**

1.Integrated Development Environment(IDE)	It provides same environment for all phases. PaaS model has IDE for developing, testing, debugging.
2.Virtual Machines, storage, Databases	Paas Providers offered the infrastructure to meet all requirement of users regarding storage, databases or servers.Force.com is the example of PaaS .
3. Caching	A PaaS environment that support caching for cloud resources will boost application performance. Developer would need an API to put an object or resources in the cache.
4.Easy Access and Quick Development	All the resources as hardware, network, operating system applications can be easily accessible in PaaS.
5.Integeration	Integration with external databases and web services and their compatibility is ensure with leading cloud providers such as google apps engine, Amazon, Microsoft Azure.

## 4.2.2 Layer Architecture of PaaS

**4.2.2.1. Web based Interface Layer** Web based interface hosted in the cloud offering different services such as web services ,portals, APIs. It is possible to find integrated development environment based on visual programming concepts where applications are built by assembling mash-ups and user defined components and successively customized. On the other hand; object model for representing an application and provide a programming language offer by PaaS. Developer have full power to use java, .NET,Python.

**4.2.2.2. PaaS Core Middleware layer** In this layer of PaaS, it offer a middleware for developing applications together with the infrastructure. The middleware constitute the core value of the offering. It is also possible to have vendors that deliver both middleware and infrastructure for private installations.

**Application Management:** It is the core functionality of the middleware. PaaS implementation provides applications with the runtime environment and do not expose any service for managing the infrastructure. Developer designs their system in term of applications and is not concerned with hardware, operating system and other level services.

**Elasticity and Scaling:** The core middleware is in-charge of managing the resources and scaling applications on-demand or automatically, according to the commitment made with the user.

**User Management:** From a user point of view, the core middleware managed the requirement of users. It expose interfaces that allow programming and deploying applications on the cloud. These can be in the form of programming APIs or web based interface.

**Run time Environment:** A local runtime environment that simulates the conditions of the cloud is given to users for testing their applications before deployment. This environment can be restricted in terms of features and not optimized for scaling.

**4.2.2.3Physical Infrastructure:** Paas offers set of datacenters and collection of platform devices offer the use of operating system and applications. PaaS environment deliver a platform for developing applications which exposes a well defined set of APIs. In most cases. It binds the

application to the specific runtime of the PaaS providers.

## 4.2.3 Advantages of PaaS

Paas Service model introduces various advantages that are written as follow:

**No need for Investment on Physical Infrastructure:** Application developers or consumers do not have to invest in physical infrastructure being able to 'rent' virtual infrastructure has both cost benefits and physical benefits. They do not need to purchase hardware themselves or employ the expertise to manage it. Client juts need to rent the resources which they need rather than to pay for the whole fixed and unused resources.

**Offer Development for non-Expert:** With some PaaS offering anyone can develop an application. They can simply do this through their web browser utilizing one click functionality.

**Flexibility:** Customers can have control over the tools that are installed within their platforms and create platform according to the requirement.

**Security:** Security is provided including data security and backup security. Various security algorithm used to provide security over the user's resources.

**Application development** A PaaS platform either provides the means to use programs the user create in a supported language or offers a visual development environment that writes the code for the user.

**Collaboration:** Many PaaS systems are set up to allow multiple individuals to work on the same projects. More than one developer can share resources as operating system ,networks and databases.

**Data management:** Tools are provided for accessing and using data in a data store.Tools are available for measuring user's applications and optimizing their performance.

**Storage:** Data can be stored in either the PaaS vendor's service or accessed from a third party storage service.

**Cost Effective:** It is Still cost effective in comparison to IaaS, as you are still essentially leasing the software platform not a resource.

**Minimal management:** User has to do minimum efforts to manage the resources of the VM, as this is still handled by the provider. PaaS provides

support to the users to accessing the software and the processing even with minimum knowledge of working of Virtual Machine.

**4.2.4 Disadvantages of PaaS**

- Lack of visibility
- Portability with applications on another cloud
- security concern
- Security for development code
- No Control over the VM or processing of data, this is a big security risk as you don't know what's happening with your data.
- Possibly no control over platform depending on Cloud provider.
- Platform is most likely a shared platform, for example there could be other customers running different websites on the same platform.
- Not as cost effective as SaaS and not as much control over VM as IaaS.

**4.3 Software as a Service** SaaS is the most complete cloud computing service model is one in which the computing hardware and software as well as the solution itself are provided by vendor as a complete service offering. This service resides on the top of the cloud stack. The

service offered by this model can be accessed by the end users. Therefore, consumers are increasingly shifting from locally installed computer program to online software services that offer the same functionality. In SaaS, It offers operating environment with applications, management, and the user interface. SaaS is a software delivery model providing access to applications through the internet as a web based services. It free the users from complex hardware and software management by off loading such tasks to third parties who build applications accessible to multiple users through a web browser.

In this service model, customers neither need to install anything on their home premises nor have to pay considerable upfront cost to purchased the software and the required licenses. They simply access the application website , enter their credential and billing details. On the provider's side ,the specific details and features of each customer's application are maintained in the infrastructure and made available on demand.

**4.3.1. Features of SaaS**

Table 3:

Ownership	It has the ownership feature and offers all the services such as O/S,N/W, storage, applications, software sharing etc .It is multitenant application hosted with regular updates directly from the developer.
Infrastructure	On the infrastructure point of view, It is shared , virtualized server, network and storage system from a resource pool. Server and storage are shared with other services.
Web Based Features	Build to be web based and used over the public internet.
Cloud Backup Services	It can replicate its data to a provider's data center and configure servers for use in the event of a disaster.
Evault Services	It enables the user to efficiently backup your physical or virtual systems and data.It allows to extend IT infrastructure to the cloud.
Service Availability	It offers multisite facilities and infrastructure to mitigate disasters. They have a secure disk solutions that is an online, disk based service for rapid backups, increased reliability and shorter recovery time objective(RTO).

**4.4 CONCLUSION**

Cloud computing narrates a latest companion, storage and distribution model for IT services based on internet protocols. It basically provides dynamically scalable and virtualized resources .In cloud computing the resources are pooled and is distributed on the basis of requirement of the users.SPI model represent the readymade option for users by provide online software, platform, networking and sharing, storage facility without download or install it on their own on-premise.

With the help of this model, the small enterprises can save their capital cost and utilize their resources without applying much man power. So, SPI model extends more service model from this combinatorial model to provide more services to users such as online database related service model, desktop related service model which provides the facility online without downloading which is the great achievement in cloud environment.



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