computing model are either managed by the user or by the vendor (provider).

In case of the traditional IT model, all the layers or levels are managed by the user because he or she is solely responsible for managing and hosting the applications.

In case of IaaS, the top five layers are managed by the user, while the four lower layers (virtualisation, server hardware, storage and networking) are managed by vendors or providers. So, here, the user will be accountable for managing the operating system via applications and managing databases and security of applications.

The core middleware manages the physical resources and the VMs are deployed on top of them. This deployment will provide the features of pay-per-use services and multi-tenancy. Infrastructure services support cloud development environments and provide capabilities for application development and implementation.

It provides different libraries, models for programming, APIs, editors and so on to support application development. When this deployment is ready for the cloud, they can be used by end-users/ organisations. With this idea, let us further explore the different service models.

Infrastructure as a Service (IaaS)

- Infrastructure-as-a-Service (IaaS) can be defined as the use of servers, storage, computing power, network and virtualization to form utility like services for users.
- It is a cloud service model that provides hardware resources virtualized in the cloud. It provides virtual computing resources to the users through resource pool.
- In IaaS, the CSP owns all equipment, such as servers, storage disks, and network infrastructure.

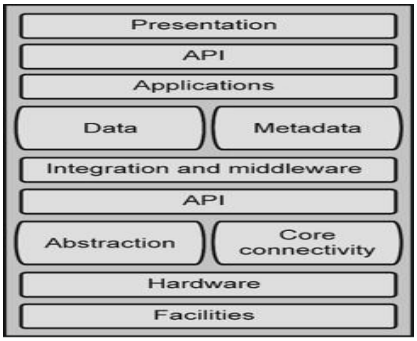
- Developers use the IaaS service model to create virtual hardware on which the applications and/ or services are developed.
- Developers can create virtual private storage, virtual private servers, and virtual private networks by using IaaS.
- The private virtual systems contain software applications to complete the IaaS solution. The infrastructure of IaaS consists of communication networks, physical compute nodes, storage solutions and the pool of virtualized computing resources managed by a service provider.
- IaaS provides users with a web-based service that can be used to create, destroy and manage virtual machines and storage.

- Instead of purchasing extra servers, softwares, datacenter space or network

equipment, IaaS enables on-demand provisioning of computational resources in the form of virtual machines in cloud data center. Some key providers of IaaS are Amazon Web Services (AWS), Microsoft Azure, GoGrid, Joyent, Rackspace etc. and some of the private cloud softwares through which IaaS can be setup are Openstack, Apache Cloud Stack, Eucalyptus, and VMware VSphere etc.

- In IaaS service delivery, workload is the fundamental component of the virtualised client. It simulates the capacity of a physical server to perform work. Hence, the work done is equal to the total number of Transaction Per Minute (TPM).
- In the case of hosted applications, the client runs on a dedicated server inside a server rack. It may also run on a standalone server.
- The user reserves an equivalent machine required to run workloads. The IaaS infrastructure runs the instances of the server in the data centre offering the service.

The resources for this server instance are drawn from a mix of virtualised systems, RAID disks, network and interface capacity. These are physical systems partitioned into logical



Components in IaaS service model (cloud security alliance)

The client in IaaS is allocated with its own private network. For example, Amazon EC2 enables this service to behave such that each server has its own separate network unless the user creates a virtual private cloud. If the EC2 deployment is scaled by adding additional networks on the infrastructure, it is easy to logically scale, but this can create an overhead as traffic gets routed between logical networks.

In IaaS, the customer has controls over the OS, storage and installed applications, but has

limited control over network components. The user cannot control the underlying cloud infrastructure. Services offered by Iaa S include web servers, server hosting, computer hardware, OS, virtual instances, load balancing, web servers and bandwidth provisioning. These services are useful during volatile demands and when there is a computing resource need for a new business launch or when the company may not want to buy hardware or if the organisation wants to expand.

Platform as a Service

- The Platform as a Service can be defined as a computing platform that allows the user to create web applications quickly and easily and without worrying about buying and maintaining the software and infrastructure.
- Platform-as-a-Service provides tools for development, deployment and testing the softwares, middleware solutions, databases, programming languages and APIs for developers to develop custom applications; without installing or configuring the development environment.
- The PaaS provides a platform to run web applications without installing them in a local machine i.e. the applications written by the users can be directly run on the PaaS cloud. It is built on the top of IaaS layer.
- The PaaS realizes many of the unique benefits like utility computing, hardware virtualization, dynamic resource allocation, low investment costs and pre-configured development environment. It has all the application typically required by the client deployed on it. Some key providers of PaaS clouds are Google App Engine, Microsoft Azure, NetSuite, Red hat Open shift etc.

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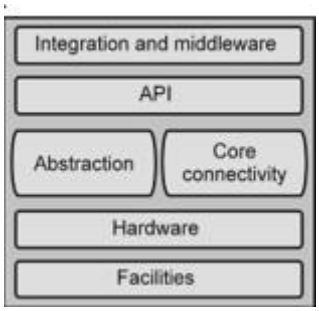
- The PaaS model includes the software environment where the developer can create custom solutions using development tools available with the PaaS platform. The components of a PaaS platform are shown in Fig. 1.13. Platforms can support specific development languages, frameworks for applications and other constructs. Also, PaaS provides tools and development environments to design applications. Usually, a fully Integrated

- Development Environment (IDE) is available as a PaaS service. For PaaS to be a cloud computing service, the platform supports user interface development. It also has many standards such as HTML, JavaScript, rich media and so on.
- In this model, users interact with the software and append and retrieve data, perform an action, obtain results from a process task and perform other actions allowed by the PaaS vendor.
- In this service model, the customer does not own any responsibility to maintain the hardware and software and the development environment.
- The applications created are the only interactions between the customer and the PaaS platform. The PaaS cloud provider owns responsibility for all the operational aspects, such as maintenance, updates, management of resources and product lifecycle.



Components of PaaS

A PaaS customer can control services such as device integration, session management, content management, sandbox, and so on. In addition to these services, customer controls are also possible in Universal Description Discovery and Integration (UDDI), and platform independent Extensible Mark-up Language (XML) registry that allows registration and identification of web service apps.

Let us consider an example of Google app engine.

The platform allows developers to program apps using Google's published APIs. In this platform, Google defines the tools to be used within the development framework, the file system structure and data stores. A similar PaaS offering is given by Force.com, another vendor that is based on the Salesforce.com development platform for the latter's SaaS offerings.Force.com provides an add - on development environment.

In PaaS, note that developers can build an app with Python and Google API. Here, the PaaS vendor is the developer who offers a complete solution to the user.