3.1 Cloud Architecture Design

The cloud architecture design is the important aspect while designing a cloud. The simplicity in cloud services attract cloud users to use it which makes positive business impact. Therefore, to design such a simple and user - friendly services, the cloud architecture design plays an important role to develop that. Every cloud platform is intended to provide four essential design goals like scalability, reliability, efficiency and virtualization. To achieve this goal, certain requirements has to be considered. The basic requirements for cloud architecture design are given as follows :

- The cloud architecture design must provide automated delivery of cloud services along with automated management.
- It must support latest web standards like Web 2.0 or higher and REST or RESTful APIs.
- It must support very large - scale HPC infrastructure with both physical and virtual machines.
- The architecture of cloud must be loosely coupled.
- It should provide easy access to cloud services through a self - service web portal.
- Cloud management software must be efficient to receive the user request, finds the correct resources and then calls the provisioning services which invoke the resources in the cloud.
- It must provide enhanced security for shared access to the resources from data centers.
- It must use cluster architecture for getting the system scalability.
- The cloud architecture design must be reliable and flexible.
- It must provide efficient performance and faster speed of access.

Today's clouds are built to support lots of tenants (cloud devices) over the resource pools and large data volumes. So, the hardware and software plays an important role to achieve that. The rapid development in multicore CPUs, memory chips, and disk arrays in the hardware field has made it possible to create data centers with large volumes of storage space instantly. While development in software standards like web 2.0 and SOA have immensely helped to developed a cloud services. The Service - Oriented Architecture (SOA) is also a crucial component which is used in the delivery of SaaS. The web service software detects the status of the joining and leaving of each node server and performs appropriate tasks accordingly. The virtualization of infrastructure allows for quick cloud delivery and recovery from disasters. In recent cloud platforms, resources are

built into the data centers which are typically owned and operated by a third - party provider. The next section explains the layered architecture design for cloud platform.

3.1.1 Layered Cloud Architecture Design

The layered architecture of a cloud is composed of three basic layers called infrastructure, platform and application. These three levels of architecture are implemented with virtualization and standardization of cloud - provided hardware and software resources. This architectural design facilitates public, private and hybrid cloud services that are conveyed to users through networking support over the internet and the intranets. The layered cloud architecture design is shown in Fig. 3.1.1.

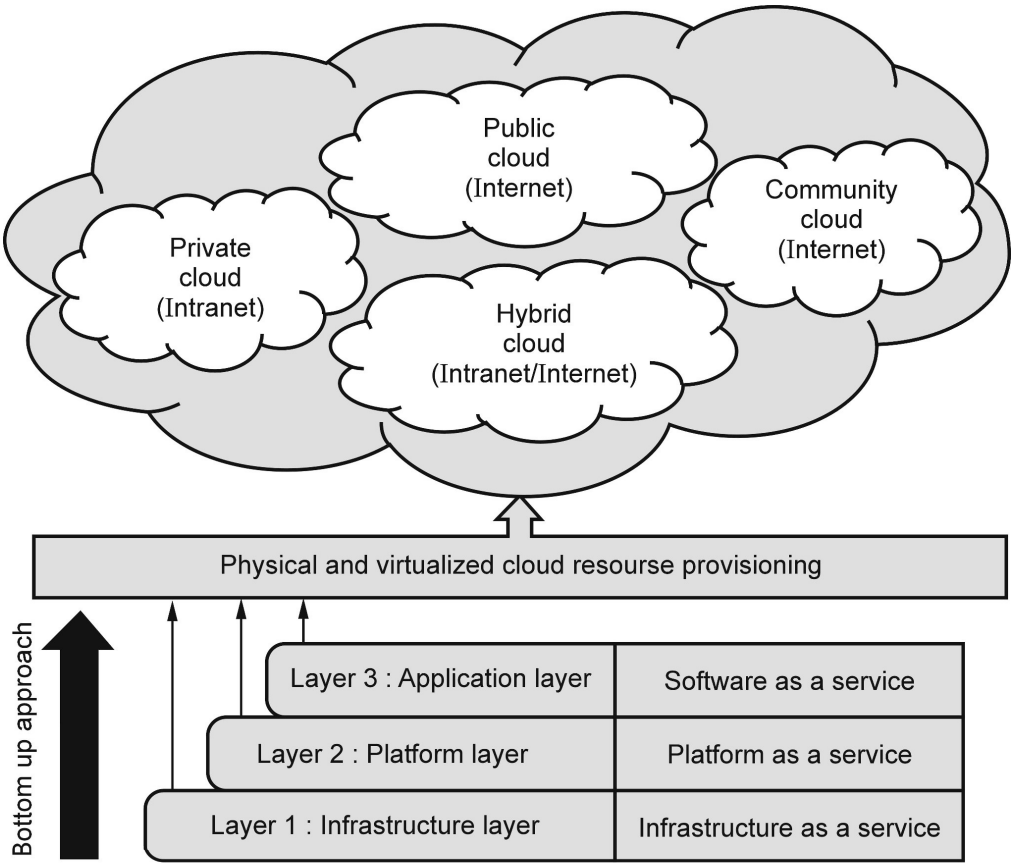

Fig. 3.1.1 : Layered cloud architecture design

In layered architecture, the foundation layer is infrastructure which is responsible for providing different Infrastructure as a Service (IaaS) components and related services. It is the first layer to be deployed before platform and application to get IaaS services and to run other two layers. The infrastructure layer consists of virtualized services for computing, storage and networking. It is responsible for provisioning infrastructure components like compute (CPU and memory), storage, network and IO resources to run

virtual machines or virtual servers along with virtual storages. The abstraction of these hardware resources is intended to provide the flexibility to the users. Internally, virtualization performs automated resource provisioning and optimizes the process of managing resources. The infrastructure layer act as a foundation for building the second layer called platform layer for supporting PaaS services.

The platform layer is responsible for providing readily available development and deployment platform for web applications to the cloud users without needing them to install in a local device. The platform layer has collection of software tools for development, deployment and testing the software applications. This layer provides an environment for users to create their applications, test operation flows, track the performance and monitor execution results. The platform must be ensuring to provide scalability, reliability and security. In this layer, virtualized cloud platform, acts as an "application middleware" between the cloud infrastructure and application layer of cloud. The platform layer is the foundation for application layer.

A collection of all software modules required for SaaS applications forms the application layer. This layer is mainly responsible for making on demand application delivery. In this layer, software applications include day-to-day office management softwares used for information collection, document processing, calendar and authentication. Enterprises also use the application layer extensively in business marketing, sales, Customer Relationship Management (CRM), financial transactions and Supply Chain Management (SCM). It is important to remember that not all cloud services are limited to a single layer. Many applications can require mixed - layers resources. After all, with a relation of dependency, the three layers are constructed from the bottom up approach. From the perspective of the user, the services at various levels need specific amounts of vendor support and resource management for functionality. In general, SaaS needs the provider to do much more work, PaaS is in the middle and IaaS requests the least. The best example of application layer is the Salesforce.com's CRM service where not only the hardware at the bottom layer and the software at the top layer is supplied by the vendor, but also the platform and software tools for user application development and monitoring.

3.2 NIST Cloud Computing Reference Architecture

In this section, we will examine and discuss the reference architecture model given by the National Institute of Standards and Technology (NIST). The model offers approaches for secure cloud adoption while contributing to cloud computing guidelines and standards.