A STUDY ON CLOUD COMPUTING ARCHITECTURE

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ABSTRACT: Cloud Computing means storing and accessing the data and programs on remote servers that are hosted on the internet instead of the computer's hard drive or local server. Client infrastructure, application, service, runtime cloud, storage, infrastructure, management and security all these are the components of cloud computing architecture.it Makes overall cloud computing system simpler This technology has recognized service-oriented idea and has formed a new system in the computing world with its influence and benefits. The capabilities of Cloud computing have been able to move IT industry one step forward.

KEYWORDS: cloud computing, service, infrastructure.

I. INTRODUCTION

Cloud computing is a revolutionary technology transforming how we store, access, and process data. It simply refers to delivering computing resources, such as servers, storage, databases, software, and applications, over the Internet. Cloud computing uses a network of remote computer systems housed on the net to save and process data rather than relying on physical infrastructure.

Cloud service companies use advanced security techniques, which include encryption, firewalls, and access restrictions, to secure your data from unauthorized access. Moreover, because your information is saved in the cloud, it is secure even if your nearby devices are damaged, misplaced, or stolen. Redundancy and cloud backups guarantee that your data may be restored promptly and effectively in case of any unexpected situations.

According to Gartner's list, Cloud computing is on the top of the ten most disruptive technologies of the next coming years . It stand for the long-held dream of visualizing computing as a service where the economy of scale principles help to drive the cost of computing infrastructure effectively down. Big players such as Sun Microsystems,Google, IBM, Amazon and Microsoft have initiated to establish new data centers for hosting Cloud computing applications in different locations around the world to provide redundancy and make sure consistency due to site collapse or failure.

II. HISTORY OF CLOUD COMPUTING

Before emerging the cloud computing, there was Client/Server computing which is basically a centralized storage in which all the software applications, all the data and all the controls are resided on the server side. If a single user wants to access specific data or run a program, he/she need to connect to the server and then gain appropriate access, and then he/she can do his/her business .Then after, distributed computing came into picture, where all the computers are networked together and share

their resources when needed. On the basis of above computing, there was emerged of cloud computing concepts that later implemented. At around in 1961, John Mac Charty suggested in a speech at MIT that computing can be sold like a utility, just like a water or electricity. It was a brilliant idea, but like all brilliant ideas, it was ahead if its time, as for the next few decades, despite interest in the model, the technology simply was not ready for it. *In 1999,* **Salesforce.com** started delivering of applications to users using a simple website. The applications were delivered to enterprises over the Internet, and this way the dream of computing sold as utility were true. *In 2002,* **Amazon** started Amazon Web Services, providing services like storage, computation and even human intelligence. However, only starting with the launch of the Elastic Compute Cloud in 2006 a truly commercial service open to everybody existed. *In 2009,* **Google Apps** also started to provide cloud computing enterprise applications. In 2009, **Microsoft** launched Windows Azure, and companies like Oracle and HP have all joined the game. This proves that today, cloud computing has become mainstream.

III. TYPES OF CLOUD COMPUTING

i. PUBLIC CLOUD

Public cloud is open to all to store and access information via the Internet using the pay-per-usage method.In public cloud, computing resources are managed and operated by the Cloud Service Provider (CSP). The CSP looks after the supporting infrastructure and ensures that the resources are accessible to and scalable for the users.Due to its open architecture, anyone with an internet connection may use the public cloud, regardless of location or company size. Users can use the CSP's numerous services, store their data, and run apps. By using a pay-per-usage strategy, customers can be assured that they will only be charged for the resources they actually use, which is a smart financial choice.

Example: Amazon elastic compute cloud (EC2), IBM SmartCloud Enterprise, Microsoft, Google App Engine, Windows Azure Services Platform.

ii. PRIVATE CLOUD

Private cloud is also known as an **internal cloud** or **corporate cloud**. It is used by organizations to build and manage their own data centers internally or by the third party. It can be deployed using Opensource tools such as Openstack and Eucalyptus.

Examples: VMware vSphere, OpenStack, Microsoft Azure Stack, Oracle Cloud at Customer, and IBM Cloud Private.

iii. HYBRID CLOUD

Hybrid Cloud is a combination of the public cloud and the private cloud. we can say:

Hybrid Cloud = Public Cloud + Private Cloud

Hybrid cloud is partially secure because the services which are running on the public cloud can be accessed by anyone, while the services which are running on a private cloud can be accessed only by the organization's users. In a hybrid cloud setup, organizations can leverage the benefits of both public and private clouds to create a flexible and scalable computing environment. The public cloud portion allows using cloud services provided by third-party providers, accessible over the Internet.

Example: Google Application Suite (Gmail, Google Apps, and Google Drive), Office 365 (MS Office on the Web and One Drive), Amazon Web Services.

iv. COMMUNITY CLOUD

Community cloud allows systems and services to be accessible by a group of several organizations to share the information between the organization and a specific community. It is owned, managed, and operated by one or more organizations in the community, a third party, or a combination of them.In a community cloud setup, the participating organizations, which can be from the same industry, government sector, or any other community, collaborate to establish a shared cloud infrastructure. This infrastructure allows them to access shared services, applications, and data relevant to their community.

Example: Health Care community cloud

v. MULTI-CLOUD

Multi-cloud is a strategy in cloud computing where companies utilize more than one cloud service provider or platform to meet their computing needs. It involves distributing workloads, applications, and statistics throughout numerous cloud environments consisting of public, private, and hybrid clouds. Adopting a multi-cloud approach allows businesses to have the ability to select and leverage the most appropriate cloud services from different providers based on their specific necessities. This allows them to harness each provider's distinctive capabilities and services, mitigating the risk of relying solely on one vendor while benefiting from competitive pricing models. '

Examples: Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP).

IV. ARCHITECTURE

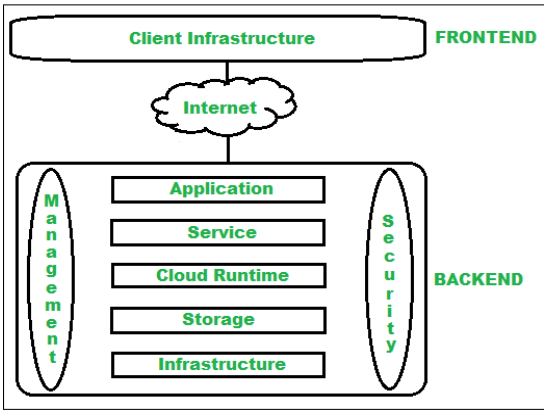
cloud computing technology is used by both small and large organizations to store the information in cloud and access it from anywhere at anytime using the internet connection. Cloud computing architecture is a combination of **service –oriented architecture** and **event - driven architecture** .Cloud computing architecture is divided into the two parts.

i. FRONT END

The front end is used by the client. It contains client-side interfaces and applications that are required to access the cloud computing platforms. The front end includes web servers (including Chrome, Firefox, internet explorer, etc.), thin & fat clients, tablets, and mobile devices.

ii. BACK END

The back end is used by the service provider. It manages all the resources that are required to provide cloud computing services. It includes a huge amount of data storage, security mechanism, virtual machines, deploying models, servers, traffic control mechanisms, etc.



V. COMPONENTS OF CLOUD COMPUTING ARCHITECTURE

i. CLIENT INFRASTRUCTURE

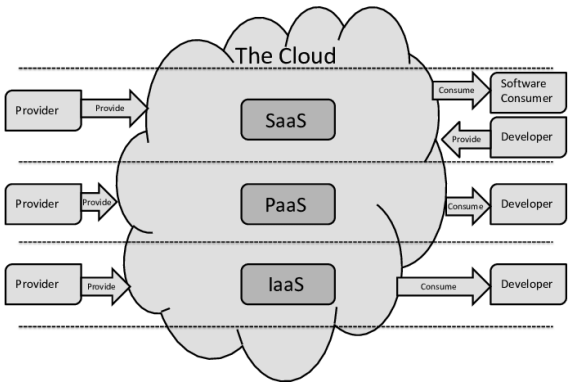
Client Infrastructure is a part of the frontend component. It contains the applications and user interfaces which are required to access the cloud platform.In other words, it provides a GUI(Graphical User Interface) to interact with the cloud.

ii. APPLICATION

Application in backend refers to a software or platform to which client accesses. Means it provides the service in backend as per the client requirement.

iii. SERVICE

A Cloud Services manages that which type of service you access according to the client's requirement.Cloud computing offers the three type of services:



a. Software as a Service (SaaS)

It is also known as cloud application services. Mostly, SaaS applications run directly through the web browser means we do not require to download and install these applications. Some important example of SaaS is given below

Example: Google Apps, Salesforce Dropbox, Slack, Hubspot, Cisco WebEx.

b. Platform as a Service (PaaS)

It is also known as cloud platform services. It is quite similar to SaaS, but the difference is that PaaS provides a platform for software creation, but using SaaS, we can access software over the internet without the need of any platform.

Example: Windows Azure, Force.com, Magento Commerce Cloud, OpenShift.

c. Infrastructure as a Service (IaaS)

It is also known as cloud infrastructure services. It is responsible for managing applications data, middleware, and runtime environments.

Example: Amazon Web Services (AWS) EC2, Google Compute Engine (GCE), Cisco Metapod.

iv. RUNTIME CLOUD

Runtime Cloud provides the execution and runtime environment to the virtual machines. Runtimes on Cloud Functions include an operating system, software required to build and execute code written for a specific programming language, and software to support your functions.

v. STORAGE

Storage is one of the most important components of cloud computing. It provides a huge amount of storage capacity in the cloud to store and manage data. Cloud storage is a virtual locker where we can remotely stash any data. When we upload a file to a cloud-based server like Google Drive, OneDrive, or iCloud that file gets copied over the Internet into a data server that is **cloud-based** actual physical space where companies store files on multiple hard drives. Most companies have hundreds of the else servers known as 'server farms' spanning across multiple locations. So, if our data gets somehow lost we will not lose our data because it will be backed up by another location. This is known as redundancy which keeps our data safe from being lost. There are 3 types of storage systems in the Cloud .

a. Block-Based Storage System

Hard drives are block-based storage systems. Your operating system like Windows or Linux actually sees a hard disk drive. So, it sees a drive on which you can create a volume, and then you can partition that volume and format them. For example, If a system has 1000 GB of volume, then we can partition it into 800 GB and 200 GB for local C and local D drives respectively

b. File-Based Storage System

In this, you are actually connecting through a Network Interface Card (NIC). You are going over a network, and then you can access the network-attached storage server (NAS). NAS devices are file-based storage systems. This storage server is another computing device that has another disk in it. It is already created a file system so that it's already formatted its partitions, and it will share its file systems over the network. Here, you can actually map the drive to its network location.

c. Object-Based Storage System

In this, a user uploads objects using a web browser and uploads an object to a container i.e., Object Storage Container. This uses the HTTP Protocols with the rest of the APIs (for example: GET, PUT, POST, SELECT, DELETE).

vi. INFRASTRUCTURE

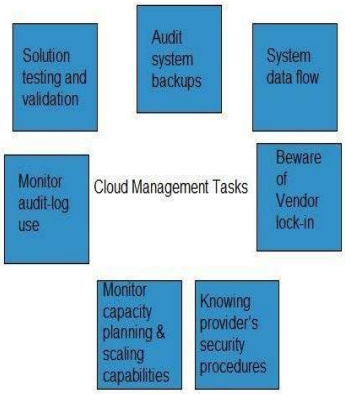
It provides services on the **host level**, **application level**, and **network level**. Cloud infrastructure includes hardware and software components such as servers, storage, network devices, virtualization software, and other storage resources that are needed to support the cloud computing model.

- Hypervisor is a firmware or low-level program that acts as a Virtual Machine Manager. It allows to share the single physical instance of cloud resources between several tenants
- Management Software helps to maintain and configure the infrastructure.
- Deployment Software helps to deploy and integrate the application on the cloud.
- Network is the key component of cloud infrastructure. It allows to connect cloud services over the Internet. It is also possible to deliver network as a utility over the Internet, which means, the customer can customize the network route and protocol.
- The server helps to compute the resource sharing and offers other services such as resource allocation and de-allocation, monitoring the resources, providing security etc.
- Cloud keeps multiple replicas of storage. If one of the storage resources fails, then it can be extracted from another one, which makes cloud computing more reliable.

vii. MANAGEMENT

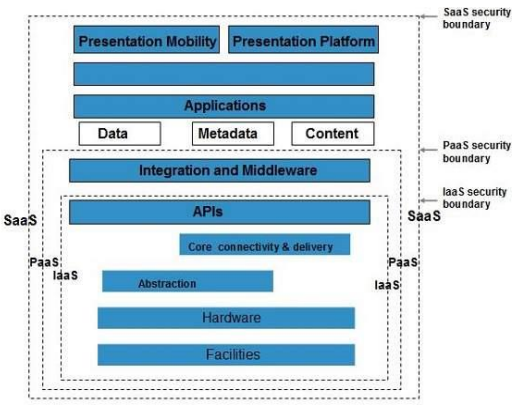
Management is used to manage components such as application, service, runtime cloud, storage, infrastructure, and other security issues in the backend and establish coordination between them. Cloud computing management is maintaining and controlling the cloud services and resources be it public, private or hybrid. Some of its aspects include load balancing, performance, storage, backups, capacity, deployment etc. To do so a cloud managing personnel needs full access to all the functionality of resources in the cloud. Different software products and technologies are combined to provide a cohesive cloud management strategy and process. A cloud management platform is a software solution that has a robust and extensive set of APIs that allow it to pull data from every corner of the IT infrastructure. A CMP allows an IT organization to establish a structured approach to security and IT governance that can be implemented across the organization's entire cloud environment. The different cloud management tasks :

- Auditing System Backups
- Flow of data in the system
- Vendor Lock-In –
- Knowing provider's security procedures
- Monitoring the Capacity, Planning and Scaling abilities
- Monitoring audit log
- Solution Testing and Validation



viii. SECURITY

Security is an in-built back end component of cloud computing. It implements a security mechanism in the back end. The mega data center in the cloud should be securely architected. Also the control node, an entry point in mega data center, also needs to be secure.A particular service model defines the boundary between the responsibilities of service provider and customer. **Cloud Security Alliance (CSA)** stack model defines the boundaries between each service model and shows how different functional units relate to each other.



Key Points to Cloud Security Alliance Model

- Each of the service inherits capabilities and security concerns of the model beneath.
- IaaS provides the infrastructure, PaaS provides platform development environment, and SaaS provides operating environment.
- IaaS has the least level of integrated functionalities and integrated security while SaaS has the most.
- This model describes the security boundaries at which cloud service provider's responsibilities end and the customer's responsibilities begin.
- Any security mechanism below the security boundary must be built into the system and should be maintained by the customer.

Although each service model has security mechanism, the security needs also depend upon where these services are located, in private, public, hybrid or community cloud . In Data Security all the data is transferred using Internet, data security is of major concern in the cloud. All of the service models should incorporate security mechanism operating in all areas for protecting data.

- Access Control
- Auditing
- Authentication
- Authorization

ix. INTERNET

Internet connection acts as the medium or a bridge between frontend and backend and establishes the interaction and communication between frontend and backend.

VI. BENEFITS OF CLOUD COMPUTING ARCHITECTURE

- Makes overall cloud computing system simpler.
- Improves data processing requirements.
- Helps in providing high security.
- Makes it more modularized.
- Results in better disaster recovery.
- Gives good user accessibility.
- Reduces IT operating costs.
- Provides high level reliability.
- Scalability.

VII. CONCLUSION

Cloud computing architecture plays a pivotal role in shaping the modern IT landscape offering scalability, flexibility and cost-efficiency . the layered structure of infrastructure as service, platform as service, software as service provides a versatile framework. Challenges such as security and data privacy persist but are addressed through evolving technologies. As cloud computing continues to advance ,it is crucial to consider architectural principles to harness its full potential for organization and individuals

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