



Cloud Computing Architecture

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This research goes through cloud architecture, background, benefits, and applications, it's done as a part of the backend tasks in the backend plan at FTS for summer 2022

I. Abstract

This research paper is made to go through cloud computing and cloud architecture components, its historical background and how it works, the connection between its components mainly the front end and backend sides, the services provided, and the qualities of each one, in addition to the different types of service providers and their features, then it discusses the advantages and disadvantages of using cloud architecture and future improvements.

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1. Introduction:

Cloud Computing is one of the most demanding technology currently that is giving a new shape to every organization by providing on-demand virtualized services/resources.

It refers to storing and accessing data and programs on remote servers instead of local servers or a computer's hard drive, the remote servers are hosted on the internet so users can access the information there, it's called cloud because the access is virtual/ via the internet.

The components and sub-components required for cloud computing present the Cloud Architecture, which refers to:

- Front end(fat client, thin client)
- Back-end platforms(servers, storage)
- Cloud-based delivery and a network (Internet, Intranet, Intercloud)

Cloud Architecture has a lot of advantages and benefits including scalability, reliability, and security, this research will go with more details about these benefits and will show some of the applications and tools that use cloud architecture technology.

2. Cloud Architecture Background:

The cloud architecture presents the components required to operate cloud computing, which is mainly storing and accessing data that is stored on remote servers.

The cloud architecture was used to enable organizations to reduce or eliminate their reliance on an on-premises server, storage, and networking infrastructure.

2.1 History:

The 1960s: The initial concepts of time-sharing became popular via Remote Job Entry which was mostly associated with large vendors such as IBM.

The 1970s: By the early 1970s, full-time sharing was available on Cambridge CTSS and UNIX earliest ports.

The 1990s: Telecommunications companies, which previously offered primarily dedicated point-to-point data circuits, began offering virtual private network (VPN) services with comparable quality of service, but at a lower cost.

By switching traffic as they saw fit to balance server use, they could use overall network bandwidth more effectively.

The architecture of cloud computing is the combination of both **SOA (Service Oriented Architecture)** and **EDA (Event Driven Architecture)**. Client infrastructure, application, service, runtime cloud, storage, infrastructure, management, and security all are the components of cloud computing architecture.

- **SOA:** Service-oriented architecture is a software development model that allows services to communicate across different platforms and languages to form applications.
- **EDA:** Event-driven architecture: is a way of building enterprise IT systems that lets information flow between applications and connected devices in a real-time manner

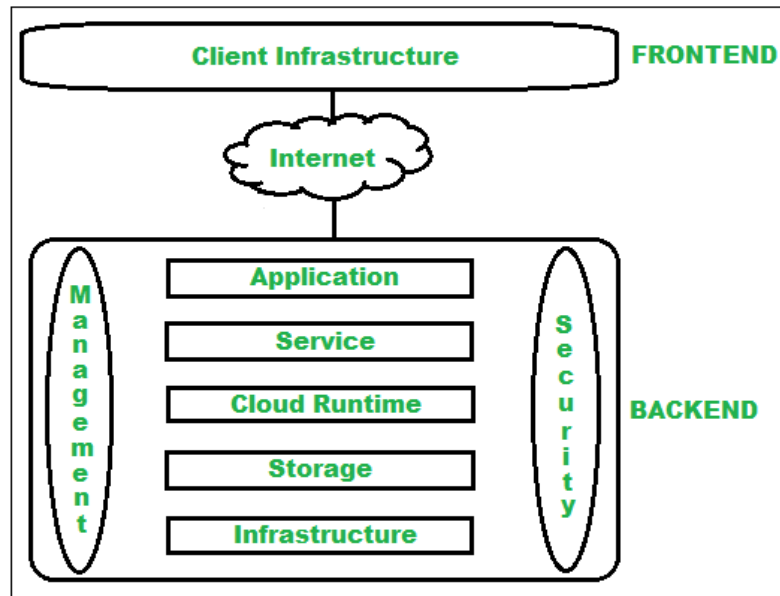


Figure2.1: The architecture of Cloud Computing

The previous figure shows the architecture of cloud computing which is mainly presented on the front and backend sides. The next part will clarify both sides in detail.

2.2 Cloud Architecture Components:

2.2.1 Frontend:

The front end of the cloud architecture contains all the user interfaces and applications that are used by the client in order to access the cloud services/ resources, which presents the client side of the cloud computing system.

For example, the use of a web browser to access the cloud platform.

The main part of the frontend component is presented by the **Client Infrastructure**, which contains the Graphical User Interface (**GUI**) that includes the applications and user interfaces that are required to interact with the cloud.

2.2.2 Backend:

The Backend refers to the cloud itself which is used by the service provider. It contains the resources, manages the resources, and provides security mechanisms.

It also includes huge storage, virtual applications, virtual machines, traffic control mechanisms, and deployment models.

The next points will show the different parts that form the component in cloud architecture.

1. **Application:** Application in the backend refers to software or platform that the client accesses. This means it provides the service in the backend according to the client's requirements.
2. **Service:** Service in the backend is an essential component in the cloud architecture and refers to the major three types of cloud-based services and which type the user accesses, mainly [SaaS, PaaS and IaaS](#).
3. **Runtime Cloud:** The runtime cloud in the backend provides the execution and Runtime platform/environment to the Virtual machine.
4. **Storage:** Storage in the backend provides flexible and scalable storage service and management of stored data like files, videos, and documents.
5. **Infrastructure:** It is the hardware and software components of the cloud like it includes servers, storage, network devices, virtualization software etc.
6. **Management:** Management refers to the management of backend components like application, service, runtime cloud, storage, infrastructure, and other security mechanisms, Its responsibility is to manage and monitor cloud operations with various strategies to increase the performance of the cloud

7. **Security:** Security refers to the implementation of different security mechanisms in the backend for securing cloud resources, systems, files, and infrastructure to end-users.
8. **Internet(Network):** Internet connection acts as the medium or a bridge between frontend and backend, it allows every user to access cloud resources, It also helps users to connect and customize the route and protocol It is a virtual server which is hosted on the cloud computing platform It is highly flexible, secure, and cost-effective
9. **Hypervisor:** It is a virtual machine monitor which provides Virtual Operating Platforms to every user It also manages guest operating systems in the cloud It runs a separate virtual machine on the back end which consists of software and hardware Its main objective is to divide and allocate resource.



Figure2.4.1: Cloud Architecture Components

3. Cloud Based Services:

As mentioned before, cloud computing is the usage of network and remote servers hosted on the Internet to store, manage, and process data. Companies offering such kinds of cloud computing services are called cloud providers and typically charge for cloud computing services based on usage.

Most cloud computing services fall into five broad categories:

1. Software as a service (SaaS)
2. Platform as a service (PaaS)
3. Infrastructure as a service (IaaS)
4. Anything/Everything as a service (XaaS)
5. Function as a Service (FaaS)

Knowing what each of the previous categories of services does and how they are different, makes it easier **to choose which one to use.**

They are sometimes called the cloud computing stack because they are built on top of one another. These abstraction layers can also be viewed as a layered architecture where services of a higher layer can be composed of services of the underlying layer i.e, SaaS can provide Infrastructure.

3.1 Software-as-a-Service (SaaS):

Is a way of delivering services and applications over the Internet. Instead of installing and maintaining software, we simply access it via the Internet.

The SaaS applications are sometimes called Web-based software, on-demand software, or hosted software and most of them can be run directly from the web browser.

It removes the need to install and run applications on our own computers or in the data centers eliminating the expenses of hardware as well as software maintenance.

Advantages of SaaS

1. **Cost-Effective:** This means that you pay only for what you use.
2. **Reduced time:** Since users don't need to install or configure SaaS apps, and they can run most SaaS apps directly from their web browser, this reduces the time spent in installation and configuration and can reduce the issues that can get in the way of the software deployment.
3. **Accessibility:** App data can be accessed from anywhere.
4. **Automatic updates:** Rather than purchasing new software, customers rely on a SaaS provider to automatically perform the updates.
5. **Scalability:** Users can access the services and features on demand.

3.2 Platform as a Service

This category of cloud computing provides a platform and environment to allow developers to build applications and services over the internet.

PaaS services are hosted in the cloud and accessed by users simply via their web browser.

A PaaS provider hosts the hardware and software on its own infrastructure. As a result, PaaS frees users from having to install in-house hardware and software to develop or run a new application.

Advantages of PaaS:

1. **Simple and convenient for users:** Users can access its services anywhere, it provides much of the infrastructure and other IT services.
2. **Cost-Effective:** Same as SaaS, it charges for the services provided on a per-use basis

3. **Efficiently managing the lifecycle:** It is designed to support the complete web application lifecycle: building, testing, deploying, managing, and updating.
4. **Efficiency:** The overall development of the application is more effective since PaaS allows for higher-level programming with reduced complexity.

3.3 Infrastructure as a Service

Infrastructure as a service (IaaS) is a service model that delivers computer infrastructure as outsourcing to enterprises such as networking equipment, devices, database, and web servers.

It's provided as an outsourced basis to support various operations.

It is also known as **Hardware as a Service (HaaS)**. It simply provides the underlying operating systems, security, networking, and servers for developing such applications, and services, and deploying development tools, databases, etc.

Advantages of IaaS:

1. **Cost-Effective:** IaaS customers pay on a per-user basis, typically by the hour, week, or month. Some providers also charge customers based on the amount of virtual machine space they use.
2. **Website hosting:** Running websites using IaaS can be less expensive than traditional web hosting.
3. **Security:** The IaaS Cloud Provider may provide better security than the existing software.
4. **Maintenance:** maintenance is handled by the IaaS Cloud Provider, so there is no need to manage the underlying data center or the introduction of new releases of the development or underlying software.

3.4 Function as a Service :

This category provides a platform for its users to develop, compute, run and deploy the code or entire application as functions. It allows the user to entirely develop the code and update it at any time without worrying about the maintenance of the underlying infrastructure. The developed code can be executed in response to a specific event. It is also as same as PaaS.

FaaS is an event-driven execution model. It is implemented in the serverless container. When the application is developed completely, the user will now trigger the event to execute the code. Now, the triggered event makes a response and activates the servers to execute it.

Advantages of FaaS :

- **Highly Scalable:** Auto scaling is done by the provider depending upon the demand.
- **Cost-Effective:** Pay only for the number of events executed.
- **Code Simplification:** FaaS allows the users to upload the entire application all at once. It allows you to write code for independent functions or similar to those functions.
- **Maintenance:** no need to worry about the servers.
- Functions can be written in any programming language.
- Less control over the system

3.5 Anything as a Service

It is also known as Everything as a Service. Most of the cloud service providers nowadays offer anything as a service that is a compilation of all of the above services including some additional services.

Advantages of XaaS: As this is a combined service, so it has all the advantages of every type of cloud service.

4. Cloud Architecture Service Providers

In this part, various cloud service providers will be mentioned, to better clarification about how cloud computing has changed the commercial deployment of the system.

- **Amazon Web Services(AWS):** One of the most successful cloud-based businesses, which is an Infrastructure as a Service(Iaas) offering that pays rent for virtual computers on Amazon's infrastructure.
 - Main Features:
 - AWS offers **175 fully-featured services** to meet any kind of business requirements. These services are database storage, computing power, networking, and many more
 - You can virtually host any application, including networks like firewall, DNS, Load balancing, or even you can have your virtual private cloud.
 - AWS applications are scalable, flexible, reliable, secure, and trustworthy.
 - Easy sign-up and fast deployment.
 - There is no upfront cost and you pay for what you use. It also offers a FREE tier for some of its popular services.
- **Microsoft Azure Platform:** Microsoft is creating the Azure platform which enables the .NET Framework Application to run over the internet as an alternative platform for Microsoft developers. It supports various operating systems, databases, tools, programming languages, and frameworks. It's categorized under the classic Platform as a Service(PaaS).
 - Main Features:
 - Microsoft Azure is available with public or private cloud service or hybrid cloud service consisting of both private and public.
 - Scalability, consistency, security, flexibility, and cost-effectiveness.
 - It's easier for users to move their application or framework without any bother and recoding them again.

- **Google:** Google has built a worldwide network of data centers to service its search engine. From this service, Google has captured the world's advertising revenue. By using that revenue, Google offers free software to users based on infrastructure. This is called Software as a Service(SaaS).
 - Main Features:
 - Security, stability, flexibility, scalability, and trustworthiness.
 - GCP offers the cheapest cloud services in the market. It offers \$300 in credit to be used in 60 days as a free trial.
 - Flexible payment plans based on Pay-As-You-Go (PAYG). Also, the cost only applies if the codes given by a user run accurately if not, it doesn't cost any amount.
 - Easy migration of data without touching or rewriting any codes.
 - Machine learning and the use of API are very easy.

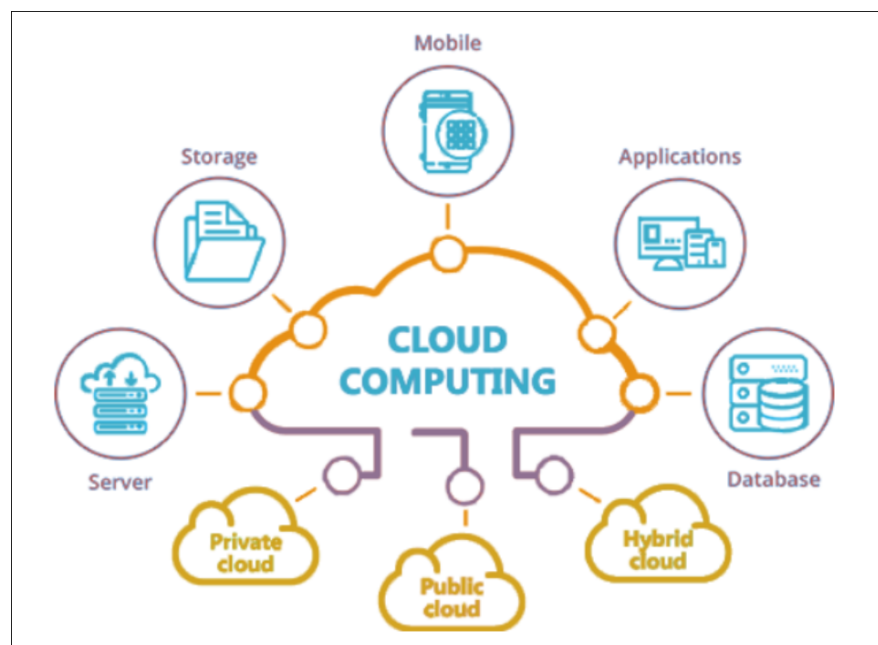


Figure 4.1: Cloud Computing Services

5. Advantages and disadvantages

In spite of its many benefits, as mentioned above, cloud computing also has its disadvantages. Businesses, especially smaller ones, need to be aware of these cons before going in for this technology.

5.1 Advantages of Cloud Computing services:

- **Scalability:** With Cloud hosting, it is easy to grow and shrink the number and size of servers based on the need. This is done by either increasing or decreasing the resources in the cloud.
- **Instant:** Whatever you want is instantly available in the cloud, and you can access data directly and easily.
- **Save Money:** An advantage of cloud computing is the reduction in hardware costs. Instead of purchasing in-house equipment, and taking responsibility for repairing and replacing equipment, this all left to the vendors, in addition, it's cost effective since you pay for what you use, and then you upgrade if needed.
- **Reliability:** If one server goes offline it will have no effect on availability, as the virtual servers will continue to pull resources from the remaining network of servers.
- **Physical Security:** The underlying physical servers are still housed and secured within data centers
- **Outsource Management:** No need to worry about managing the infrastructure or upgrading the service
- **Almost Unlimited Storage**
- **Quick Deployment:** Once you opt for this method of functioning, your entire system can be fully functional in a matter of a few minutes.

5.2 Disadvantages of Cloud Computing

- **Technical Issues**

Though it is true that information and data on the cloud can be accessed anytime and from anywhere at all, there are times when this system can have some serious dysfunction.

- **Security in the Cloud**

Since the company's data will be submitted to a third-party cloud service provider, companies should make sure to choose the most reliable service provider that will keep the information secure and safe.

- **Prone to Attack**

Storing information in the cloud could make the company vulnerable to external hack attacks and threats.

6. Conclusion

Cloud Computing has changed the way IT solutions are delivered and consumed by the end-users.

Earlier people were using hard drives to store their data on a computer but now Cloud Computing services have replaced such hard drive technology.

Cloud computing provides services such as storage, databases, servers, processing, memory, networking, and software through the Internet. When you update your Facebook status, you are using cloud computing. When you use net banking, again you are into the cloud.

There are so many companies offering cloud services but the best one depends on your **business needs** or application. However, there are some factors you should consider such as your level of expertise, location, cost, reliability, flexibility, security, and of course things that you want to accomplish.

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