# Cloud Computing Architecture

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**Abstract**

**The Cloud computing has been a remarkable Transformation and Innovation to store, access and Process unlimited Data with high Reliability, Security, Fault tolerance, Auto Scaling and greater performance with low cost. Several key factors influencing the Cloud computing as emerging technology. The future of cloud Technology plays prominent role and shapes the organizations in coming years. This article briefs about Design and Architecture of Cloud Computing.**

Keywords: Cloud Computing, Hybrid Cloud Computing, Cloud Services, Cloud Architecture

## 1. Introduction

Cloud computing is the on-demand delivery [1] of IT resources over the Internet with pay-as-you-go pricing. Instead of buying, owning, and maintaining physical data centers and servers, we can access technology services, such as computing power, storage, server, software, networking, Intelligence and Data Analytics and databases, on need basis with much lower capital expenses than traditional hosting centers for business applications and services It is massively scalable and globally available on-demand, This allows to deploy your application when needed and highly available and scalable with zero downtime.

Based on the type of services provided by cloud, the cloud service models [2] are categorized as Infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS). These offers a hybrid cloud approach, allowing businesses to seamlessly integrate on-premises and cloud environments.

**Infrastructure as a service (IaaS):** IaaS stands for Infrastructure as a Service. This model provides the necessary infrastructure for cloud computing, eliminating the need to purchase servers, storage devices, or networks Also, the software and applications are managed by the organization.

**Platform as a service (PaaS):** This model offers a flexible, scalable cloud platform to develop, deploy, run, and manage apps. PaaS provides everything developers need for application development without the headaches of updating the operating system and development tools or maintaining hardware. Instead, the entire PaaS environment or platform is delivered by a third-party service provider via the cloud. PaaS helps businesses avoid the hassle and cost of installing hardware or software to develop or host new custom applications. Development teams simply purchase pay-as-you-go access to everything they need to build custom apps, including infrastructure, development tools, operating systems and developers focus on their application code.

**Software as a service (SaaS):** This model host and manages end-user applications. Here, there's no need to deploy applications and software locally. They are delivered and maintained over the internet and usually need a web interface to be accessed. SaaS users subscribe to an application rather than purchasing it once and installing it. Users can log into and use a SaaS application from any compatible device over the Internet. The actual application runs in cloud servers that may be far removed from a user's location.
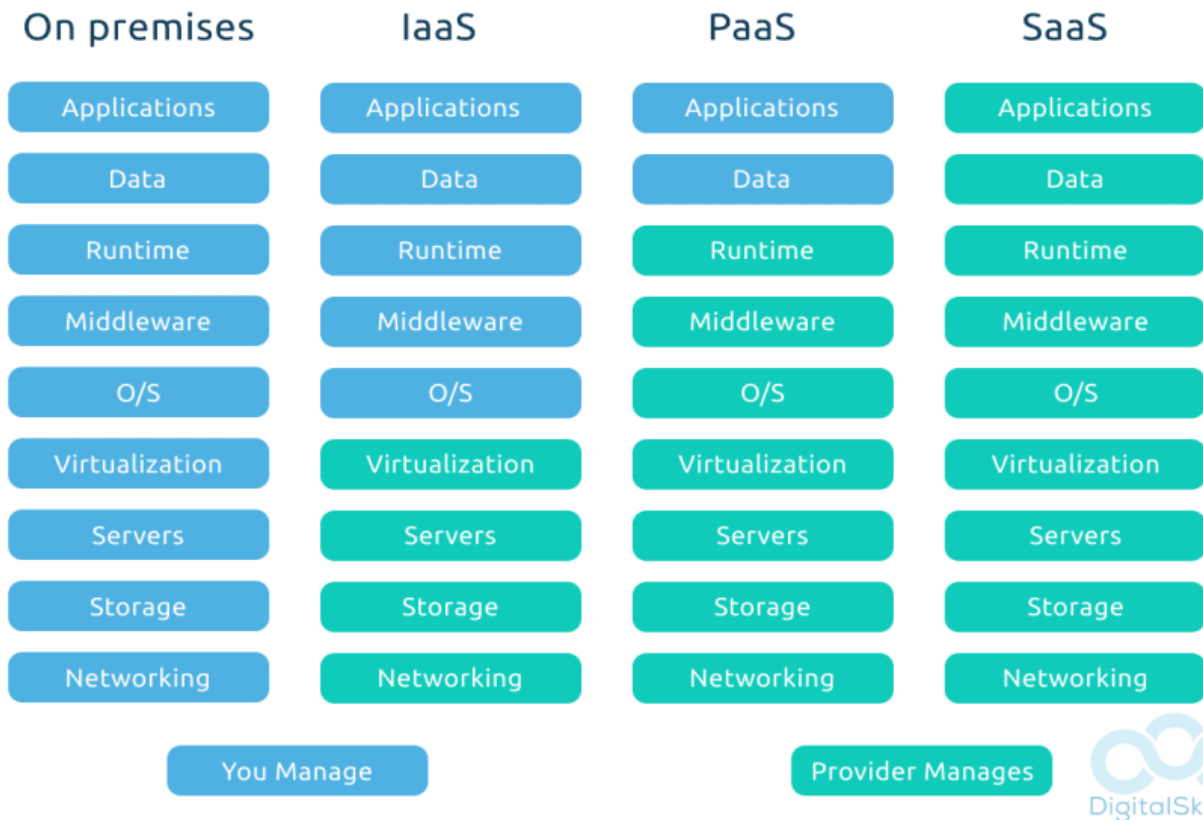
Figure 1: Cloud Service Models
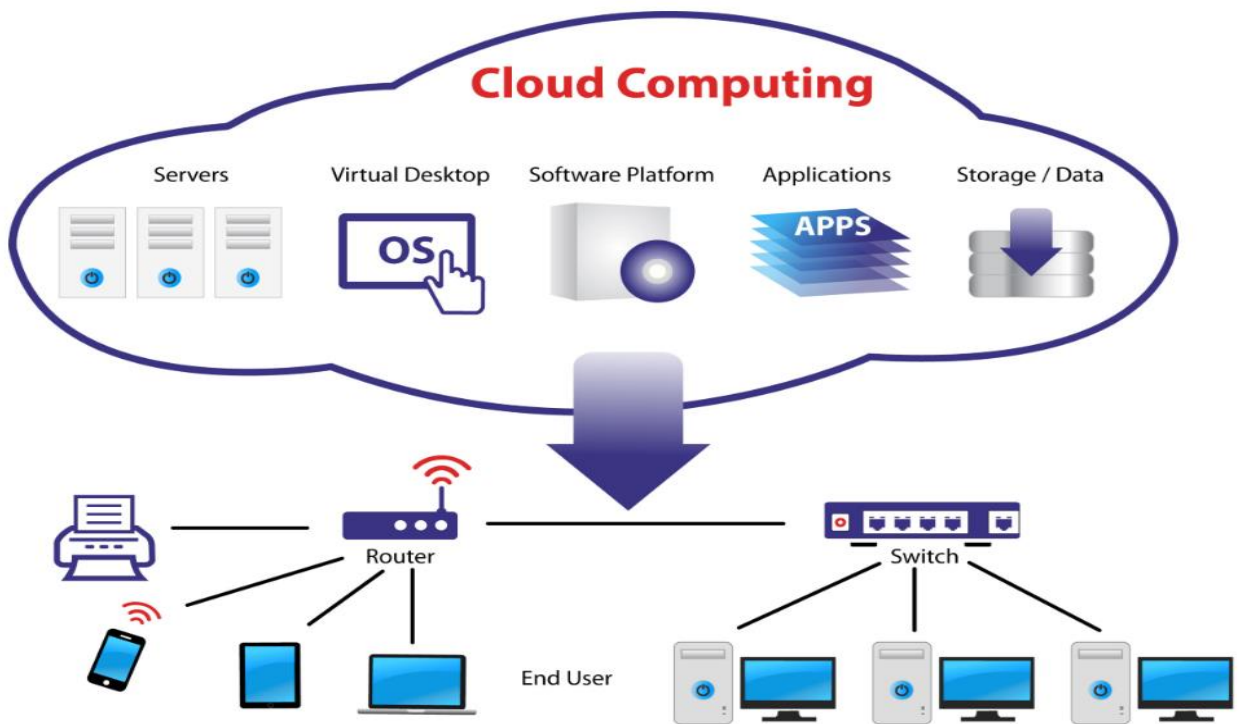


Figure 2: Cloud Computing

## 2. Design of Cloud Computing

The Cloud computing architecture[3] mainly consists of  components, front end, back end, cloud based delivery and a network. The front end is client architecture and back end is hidden and front end communicates back end through internet connection. The back end plays key role in protecting data security. Cloud delivery model includes the front-end and the back-end systems of the cloud platform. Front-end systems gain access to the cloud environment using the internet or a Virtual Private Network (VPN) link with a mobile app, web browser, or client-based software. The back-end includes the various cloud infrastructure resources, applications, and data.
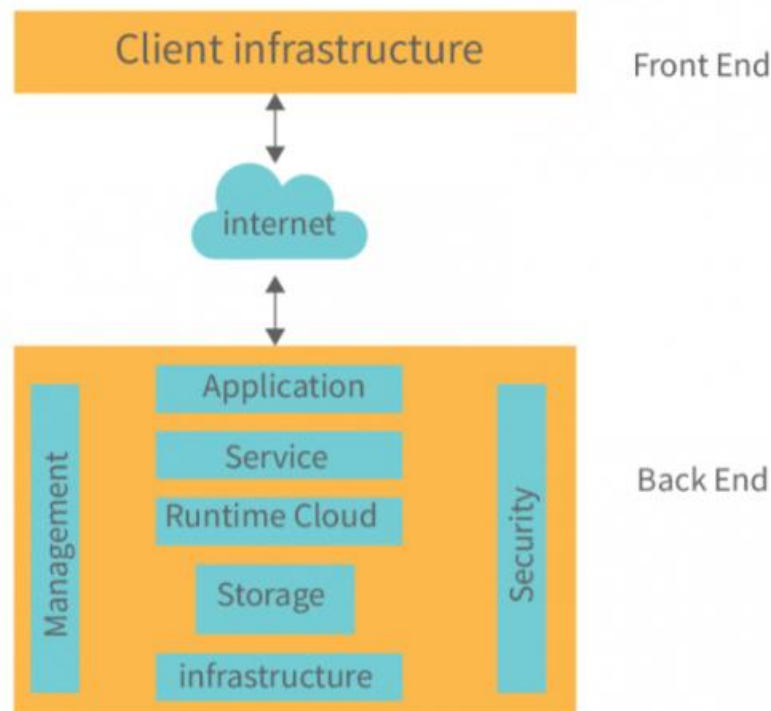


**Figure 3:  Cloud Computing Architecture**

Below is a list of the main back end components:

**Application:** The back end software or application the client is accessing from the front end to coordinate or fulfill client requests and requirements.

**Service:** The service takes care of all the tasks being run on a cloud computing system. It manages which resources you can access, including storage, application development environments, and web applications.

**Runtime cloud:** Runtime cloud provides the environment where services are run, acting as an operating system that handles the execution of service tasks and management. Run times use virtualization technology to create hypervisors that represent all your services, including apps, servers, storage, and networking.

**Storage:** The storage component in the back end is where data to operate applications is stored. While cloud storage options vary by provider, most cloud service providers offer flexible scalable storage services that are designed to store and manage vast amounts of data in the cloud. Storage may include hard drives, solid-state drives, or persistent disks in server bays.

**Infrastructure:** Cloud infrastructure comprises all the major hardware components that power cloud services, including the CPU, graphics processing unit (GPU), network devices, and other hardware components needed for systems to run smoothly. Infrastructure also refers to all the software needed to run and manage everything. Cloud architecture, on the other hand, is the plan that dictates how cloud resources and infrastructure are organized.

**Management:** Cloud service models require that resources be managed in real time according to user requirements. It is essential to use management software, also known as middleware, to coordinate communication between the back end and front end cloud architecture components and allocate resources for specific tasks. Beyond middleware, management software will also include capabilities for usage monitoring, data integration application deployment, and disaster recovery.

**Security:** As more organizations continue to adopt cloud computing, implementing cloud security features and tools is critical to securing data, applications, and platforms. It's essential to plan and design data security and network security to provide visibility, prevent data loss and downtime, and ensure redundancy. This may include regular backups, debugging, and virtual firewalls.

## 3. Evaluation of Cloud Computing Benefits

**Scalability:** Cloud computing offers unparalleled scalability. Vertical and horizontal scalability based on the workloads allowing businesses to quickly adjust their computing resources based on demand and by achieving operational excellence.

**Serverless Computing:** The Serverless Computing in Cloud is proven to be cost efficient and less maintenance for Application users by eliminating the burden of managing Server Infrastructure. Server less platforms become more advanced and established, businesses are in a position to take advantage of them to create and deploy flexible, cloud-based applications.

**Security:** Advancements in cloud security measures have made it increasingly safe for businesses to store and process sensitive data in the cloud by enabling the Data Encryption and cryptographic methodologies such as cloud managed and customer managed keys on server side and client side platforms on data at rest and in transit.

**High Availability:** Applications run and managed on cloud architectures benefit from high-performance computing resources that ensure continuous availability, regardless of fluctuating loads.

**Innovation:** Leveraging cloud-based development platforms and services, businesses can quickly experiment, develop and deploy new applications, products and services to meet evolving customer demands. Cloud-based collaboration tools also facilitate real-time collaboration among teams, fostering creativity, efficiency, and knowledge sharing.

**Cost Efficiency:** IT infrastructure requires significant investments in hardware, software, and maintenance. By migrating on prem Applications to Cloud computing eliminates these expenses by offering pay for use pricing models, allowing businesses to access computing resources on demand and by providing sustained use discounts based on the usage and workloads and by using storage object life cycle management and using the respective cloud resources based on the business needs.

**Data Analytics:** Cloud-based analytics tools allows businesses by providing advanced Data analytical capabilities, such as machine learning and AI, that can help businesses gain valuable insights from their vast amounts of data and make more informed decisions of customer behavior, risk management, and fraud

detection by improving operational efficiency.

**Hybrid Cloud Technologies:** The era of one-size-fits-all cloud solutions is giving way to a more tailored and dynamic approach that combines public and private clouds. This approach consists of on-premises infrastructure plus anything else in the cloud, and provides unparalleled flexibility. Businesses can now select the optimal cloud resources for specific workloads to ensure redundancy and embrace vendor-agnostic solutions.
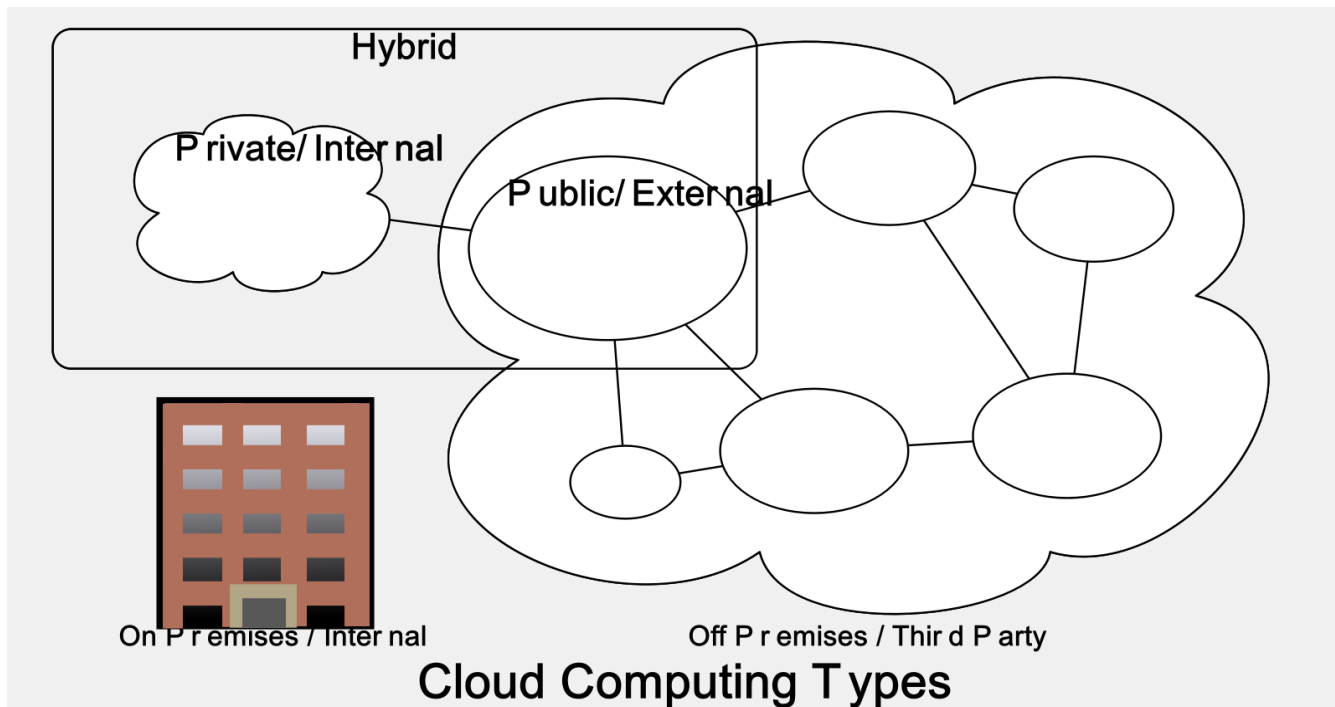


**Figure 4:  Cloud Computing Types**

**Edge Computing:** Cloud edge computing promises real-time data processing at the edge, reducing latency for IoT applications and other latency-sensitive workloads. Cloud providers serves the global content with low latency.

**Orchestration:** Container orchestration predominantly Kubernetes and Docker are among the trending and evolving technologies in cloud computing. They are an open-source platform that manages services and workloads from a single location while running applications from a single source. They provide scalability and efficiency to many large-scale deployments. As the use of cloud computing services is increasing, Kubernets and  Docker play major role in managing cloud deployments of cloud users and organizations.

**Data Storage and Backup:** Cloud computing offers reliable and secure data storage and backup solutions. Instead of relying on local storage devices susceptible to physical damage or loss, businesses can securely store their data in the cloud, mitigating risks and ensuring data resilience. Cloud-based backup solutions provide automated and efficient data recovery options, reducing the impact of potential data loss incidents.

The convergence of these factors has made cloud computing an increasingly essential and disruptive technology across industries. As more businesses recognize the benefits and potential of cloud services, the adoption of cloud computing continues to accelerate, solidifying its status as an emerging technology.

There are several popular cloud computing providers and among them, below are the list of major providers. These have been in use by major IT companies and clients based on the cost and the business requirements. All these offers similar  range of services, including computing power, storage, databases, networking, Data

analytical, and artificial intelligence. These offers scalability, flexibility, and reliability for businesses of all sizes.

- Amazon Web Services (AWS)

- Google Cloud Platform (GCP)

- Microsoft Azure

- IBM Cloud

- Oracle Cloud Infrastructure (OCI)

## 4. Challenges:

Despite being the major strength of some businesses, cloud computing also has some issues. And in some rare circumstances, this can cause some serious problems as well. These issues or challenges [4] are real-life ghosts of cloud computing.

**Security of Data:** In terms of security concerns of cloud technology, website hacking and virus attacks are the biggest security challenges in cloud computing data security.
Before utilizing cloud computing technology for a business, entrepreneurs should think about these things. Once you transfer important data of your organization to a third party, you should make sure you have a cloud security and management system. Cybersecurity experts are more aware of cloud security than any other IT professional.

**Lack of Expertise:** The inadequacy of resources and expertise is one of the cloud migration challenges this year. Although many IT employees are taking different initiatives to improve their expertise in cloud computing future predictions, employers still find it challenging to find employees with the expertise that they require.
Some organizations are also expecting to win over the challenges of shifting to cloud computing by employing more workers with certifications or skills in cloud computing. Industry professionals also suggest providing training of present employees to make them more productive and speedier using the trendiest technology.

**Complete Governance over IT Services:** IT always doesn't have full control over provisioning, infrastructure delivery, and operation in this cloud-based world. This has raised the complicity of IT to offer important compliance, governance, data quality, and risk management.
To eradicate different uncertainties and difficulties in shifting to the cloud, IT should embrace the conventional control and IT management procedures to incorporate the cloud. Ultimately, basic IT teams' role in the cloud has emerged over the last few years.

Alongside the business unites, core IT plays an increasing role in the mediation, preference, and control over cloud services. Moreover, third-party cloud computing or management providers are gradually offering best practices and government support.

**Cost Management:** The Right Scale report revealed that for a few companies, handling cloud spending has passed security as the biggest cloud computing challenge. Some companies find themselves hindered by the hidden cloud costing packages that provide numerous discounts that they might not be using.

Using cloud spending management challenges, several tech solutions can help organizations. For instance, automation, cloud spending management solutions, serverless services, containers, auto scaling features, and numerous management tools provided by the cloud vendors may help lower the possibility of the issue. Furthermore, some companies have been succeeded by building a core cloud team for handling usage and costs.

**Compliance:** Compliance is also one of the challenges faced by cloud computing in 2023. For everyone using cloud storage or backup services, this is a problem. Whenever an organization transfers data from its internal storage to the cloud, it experiences compliance with the laws and regulations of the industry.

An interesting law aspect of General Data Protection Regulation (GDPR) is that it will expedite compliance in the future. Many organizations require employing a data protection professional who can anticipate data security and privacy according to the needs of the law.

Considering these professionals are aware of the compliance needs of the organizations they are employed, concentrating on the duties for compliance will help organizations fulfill every legal responsibility.

**Cloud Migration:** Although releasing a new app in the cloud is a very simple procedure, transferring an existing application to a cloud computing environment is tougher.Especially, some organizations migrating their apps to the cloud reported downtime during migration, issues syncing data before cutover, the problem having migration tools to work well, slow data migration, configuring security issues, and time-consuming troubleshooting.

And to solve over these issues,  IT experts said they wished they had increased their budgets, and wished to have employed an in-house professional, wanted to set a longer project duration performed more pre-migration testing.

**Cloud Integration:** Finally, several companies, especially those with hybrid cloud environments report issues associated with having their on-premise apps and tools and public cloud for working together. Integration of legacy systems while utilizing the Cloud  as their biggest challenge in multi-cloud.

This particular challenge, like the other ones discussed in this blog, will not possibly disappear any time in the future. Combining new cloud-based apps and legacy systems needs resources, expertise, and time. But several companies are considering that the perks of cloud computing dominate the backlogs of this technology.

## 5. Conclusion:

Cloud computing will stay around for long stretches of time. Its universal impact on our lives today has already let us know that the benefits offered by it  in terms of storing data, saving it, backing up files, sharing information with people all over the world etc. are undeniable and thus cannot be stopped from leading us into a much newer era of technological advancement.

Cloud computing has been around for approximately two decades and despite the data pointing to the business efficiencies, cost-benefits, and competitive advantages it holds, a large portion of the business

community continues to operate without it. According to a study by the International Data Group, businesses are already using cloud technology in one capacity or another, At the same time, companies that invest in big data, cloud, mobility, and security enjoy faster revenue growth than their competitors. As this data shows, an increasing number of tech-savvy businesses and industry leaders are recognizing the many benefits of the cloud-computing trend. But more than that, they are using this technology to more efficiently run their organizations, better serve their customers, and dramatically increase their overall profit margins.

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