

# A Comparative Study of Cloud Providers Based on Services and Cost

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**Abstract:** *Cloud Computing means a place where we can store our valuable information of data and access the computing and networking services following the pay-as-you-go method without a physical environment. In the present day, cloud computing offers us powerful computing and storage, high availability and security, instant accessibility and adaptation, guaranteed scalability and interoperability, and cost and time effectiveness. Cloud computing has three platforms (IaaS, PaaS, SaaS) with exclusive features which assure to make easy their work for a client, Organization or Trade to build up any kind of IT business. In this paper, I managed a comparison of cloud service features based on the platforms based on service providers claiming the cost for their services to consumers where services providers are IBM, Microsoft Azure, Google cloud, Amazone. Using the result of this survey to not only find the similarities and differences based on the services and their cost between various elements of cloud computing but also to propose some topics to investigate for further research.*

**Keywords:** *Cloud Computing, IaaS, PaaS, SaaS, IBM, Amazone, Google cloud, Microsoft Azure.*

## I. INTRODUCTION

The next-generation change known as "cloud computing" is being hailed for fusing the internet and computing, allowing software, materials, and data to be stored on remote servers that are accessible via the web from anywhere in the globe via computers, phones, and other devices like televisions. It goes without saying that cloud computing is not a replacement concept. Indeed, John McCarthy, a pioneer in computing, foresaw that count would someday be set up as a public-service organisation and went on to speculate in how it may happen in 1961. With time, we have developed a brand-new need to examine massive amounts of data, which has considerably raised demand for computing. In recent years, the field of cloud computing has experienced tremendous expansion, leading to the emergence of numerous cloud providers.

With services like CPU, storage, databases, and networking available to customers, several providers have focused on the computational aspects of their offerings. The cost of using resources or services in the cloud is determined by how much and for how long they are used. Numerous cloud-based services are available thanks to cloud computing. Each cloud has unique characteristics, storage capabilities, pricing structures, and ways of delivering services from other clouds. Different types of service models are supported, including Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). All the strategies had flaws, like expensive infrastructure or ineffective resource use. People have better options thanks to cloud computing. It is made up of large data centres and several closely coupled resources. Resources that are dynamically regulated satisfy the needs of the end user. Consumers have access to a wide range of computing resources, much like with traditional utilities.

The current issue is that people appear to be unaware of which cloud is appropriate and consistent with their needs, making it difficult for them to quickly select the best cloud for their needs among the various clouds handled by various cloud providers. Over time, several cloud computing service providers have appeared. Significant study has been done on cloud computing over the past few years, and a variety of issues have been discussed. Among the issues being discussed are security, privacy, energy management, virtualization, and data management. These suppliers offer different deployment strategies and repair approaches. This research report offers a comparative analysis of the current top cloud computing providers considering this problem. Then, a comparison of different service providers is given.

## II. CLOUD COMPUTING SERVICE PROVIDERS (CLOUD\_1)

### 1. AMAZON Web Services:

Amazon began operating as a store with computing infrastructure in 2003. In addition to Platform-as-a-Service, Amazon also offers Infrastructure-as-a-Service [2]. In 2006, Amazon starts providing web services for IT infrastructure, a method now known as cloud computing. Hundreds of thousands of enterprises are currently supported by AWS's

scalable, dependable, and inexpensive infrastructure across 190 different countries [8]. Amazon primarily sells items in the following four categories: computing, storage, databases, and networking.

#### ***Compute:***

Amazon Elastic Compute Cloud (EC2) is a web service computing technology that provides secure, dynamically scaled compute power. EC2 provides a web service interface to deploy and manage instances running on servers with the Microsoft and Linux operating systems [4]. Essential components of Amazon EC2 are Amazon Machine Images (AMI), which comprise an image of EC2 instances, their software, and configuration to produce a boot disc for user instances [5]. Thanks to EC2, new server instances may be purchased and booted in minutes as opposed to hours [4].

#### ***Storage:***

The two types of storage available through an Amazon S3 storage service are objects and buckets. In buckets, data can be stored and accessed as objects that can be obtained in any quantity from any location. A single object can store up to 5GB of data, with a minimum of 1 byte.

#### ***Database:***

Commercial databases claim that the MySQL and PostgreSQL relational database Amazon Aurora provides exceptional speed and availability. In terms of security, availability, and dependability for commercial databases, Amazon Aurora offers up to five times better performance than MySQL.

#### ***Network and content delivery:***

A customer of AWS can use the Amazon VPC region of the AWS Cloud to install AWS resources in a virtual private network. The customer has complete control over the virtual networking environment, including the selection of an IP address range, the establishment of subnets, and the configuration of routing tables and network gateways [2], [7].

### ***2. Microsoft Azure:***

Microsoft Azure, the centrepiece of the infrastructure-as-a-service concept from Microsoft, was unveiled in June 2012. As a tool for hypervisors, it makes use of Hyper-V. In addition to a programming model designed to enable scalable applications, the Windows Azure Platform provides ways to increase and decrease the computational capacity of apps and services [9]. Microsoft Azure, the cloud services operating system, powers the development, hosting, and administrative environments for the Azure Services Platform. Windows Azure provides on-demand compute and storage to developers in Microsoft data centres for hosting, scaling, and managing web applications and services on the internet [10]. Connect, Storage, Content Delivery Network, Fabric Controller, and Compute are the five components that make up Microsoft.

#### ***Compute:***

Using Microsoft Azure Compute Services, the programme is operated in the cloud. It provides a way to run programmes on Windows servers located in Microsoft data centres as well as in the cloud [10]. Azure applications use roles, which are computing containers, to access computing resources [9]. Web, worker, and virtual machine roles are the three primary types of roles used by Windows Azure. This software was created using the .NET framework in addition to C# and Visual Basic [9] and other programming languages.

#### ***Storage:***

Windows Azure's storage features are designed to be incredibly simple and scalable. They provide the fundamental functions of BLOB storage, queue storage, and simple table storage. We interface with these services using a simple REST API based on HTTP requests, and we modify data in the storage services using customary POST, PUT, and DELETE requests as well as retrieve data from the storage services using simply GET requests [6]. Storage services can handle both organised and unstructured data. Storage components ensure integrity because each storage account has two account keys that are used to control access to all the data in that storage account [9]. Full control over the linked data is granted with access to the storage keys.

### *Content Delivery Network:*

Content delivery networks (CDNs) guarantee good speed and high bandwidth for service delivery by caching content at locations close to customers. A few of the resources that can be given via content delivery are Windows software and compute roles. Thanks to CDN [1], anyone anywhere in the world can easily access high-quality frequently visited data.

### *Connect:*

Using Windows Azure Connect's user interface, computers and virtual machines on a company network can be connected through IPsec [09], [10].

### *3. Google Cloud:*

One of Google's completely integrated offerings is the Google App Engine platform. The entire package is used by developers to write, link, and execute code for both common web applications and mobile applications. Services, SDKs, development environments, and other elements fall under this category. Google App Engine is also available online as a PaaS solution with high availability. By using this strategy, the management strain caused by virtual machines during periods of high utilisation is reduced. Later, Google decided to enter the IaaS industry and offered a range of cloud options to all cloud customers. Users of the Google Cloud have access to hardware-based control over cloud-running virtual machines. Google also offers price reductions and various pricing options. Google's Compute Engine has an edge over the other cloud providers in terms of price/performance thanks to all these characteristics [03].

Google offers a sizable number of services, each with a few special features. This is the cause of the ongoing global expansion of Google Cloud Platform. Among GCP's noteworthy services are the following:

- Compute Services
- Networking
- Storage Services
- Big Data
- Security and Identity Management
- Management Tools
- Cloud AI
- IoT (Internet of Things)

### *4. IBM Cloud*

<https://www.datamation.com/cloud/ibm-cloud/>

By acquiring SoftLayer cloud in 2013, IBM (International Business Machines Corporation), the multinational technology giant that created one of the first PC computers, created history once more in the era of cloud computing. In 2005, SoftLayer was established and was the first major provider company to offer bare-metal compute services.

Since it is very challenging to discuss every significant cloud computing provider in-depth in a single post, I will do my best to summarise the key elements. Most importantly, I want to stress that, contrary to popular belief, the cloud offers a variety of services beyond only storage. While reading this essay, keep in mind that IBM Cloud is a vast universe that dwarfs any sizable programme, operating system, or hosting service you have ever heard of. This manual will serve as a useful starting point for comprehending that "world" and its many developer-oriented products. IBM offers the following services.

- **Compute Infrastructure** — includes its virtual servers, GPU computing, bare metal servers (single-tenant, highly customised servers), POWER servers (based on IBM's POWER architecture), and server software.
- **Compute Services** — includes the Cloud Foundry runtimes, containers, and serverless computing with OpenWhisk
- **Storage** — has server backup capabilities as well as object, block, and file storage.
- **Network** — covers domain services, Direct Link private secure connections, network appliances, and load balancing.

- **Mobile** — contains IBM's MobileFirst Starter package for setting up a mobile app, its Swift tools for developing iOS apps, and its Mobile Foundation app back-end services.
- **Watson** — contains IBM's so-called “cognitive computing,” or artificial intelligence and machine learning, services, such as Discovery search and content analytics, Conversation natural language services, and speech-to-text.
- **Data and analytics** — covers hosting for big data, cloud computing, mongo database, and riak as well as data services, analytics, and hosting.
- **Security** — contains security software, SSL certificates, hardware security modules (physical devices with key management capabilities), Intel Trusted Execution Technology, a firewall, and other technologies for protecting cloud environments.
- **Integration** — includes tools for building virtual bridges for hybrid cloud and multi-cloud environments, such as API Connect and Secure Gateway

### III. COMPUTE SERVICE COMPARISON OF AWS, AZURE, GOOGLE CLOUD, IBM CLOUD

Service	AWS	AZURE	GOOGLE	IBM
Shared Web hosting	AWS Amplify	Web Apps	Firebase	Web hosting services
Virtual Server	Amazon EC2	Azure Virtual Machine	Compute Engine	Classic Virtual Server Virtual Server for VPC Power Systems Virtual Servers Hyper Protect Virtual Server Quantum Services
Bare Metal Server	Amazon EC2 Bare Metal Instance	Azure Bare Metal Servers	Bare Metal Solution	Bare Metal Servers
VMware	VMC on AWS	Azure VMware Solution	Google Cloud VMware Engine	VMware Solutions
Virtual Dedicated Host	Amazon EC2, AWS Nitro Enclaves	Azure Dedicated Host	Sole Tenant Node	Dedicated Virtual Servers Infrastructure (VSi)

### IV. STORAGE SERVICE COMPARISON OF AWS, AZURE, GOOGLE CLOUD, IBM CLOUD

Service	AWS	AZURE	GOOGLE	IBM
Object Storage	Amazon Simple Storage Service (S3)	Azure Blob Storage	Cloud Storage	Cloud Object Storage
Virtual Machine Disk Storage	Amazon Elastic Block Storage (EBS)	Azure Page Blobs / Premium Storage	Persistent Disk	Block Storage
File Storage (SMB Compatible)	Amazon Elastic File System (EFS)	Azure NetApp Files	File Store	File Storage



Long Term Cold Storage	Amazon S3 Glacier	Azure Archive Storage	Cloud Storage	Object Storage-ColdVault
Hybrid Storage/Storage Gateway	AWS Storage Gateway	Azure StorSimple	–	–

## V. DATABASE SERVICE COMPARISON OF AWS, AZURE, GOOGLE CLOUD, IBM CLOUD

Service	AWS	AZURE	GOOGLE	IBM
Non-Relational Database Management Service	Amazon DynamoDB Amazon DynamoDB Accelerator (DAX)	Azure CosmosDB Table Storage	Cloud Datastore Cloud Firestore	Cloudant NoSQL DB
Timeseries Database	Amazon Timestream	Azure Time Series Insights	Cloud Bigtable	Informix
Graph Database	Amazon Neptune	–	–	IBM Graph
Data Warehousing	Amazon Redshift	Azure Synapse Analytics	BigQuery	Db2 Warehouse

## VI. PRICING COMPARISON OF AWS, AZURE, GOOGLE CLOUD, IBM CLOUD

Parameters	AWS	AZURE	GOOGLE	IBM
Types of cloud services	IaaS, PaaS	IaaS, PaaS	PaaS, SaaS	IaaS, PaaS, SaaS
(1 vCPU, RAM 2 GiB)	0.0225	0.0214	0.0125	0.013
(2 vCPU, RAM 4 GiB)	0.041	0.057	0.046	0.060
(4 vCPU, RAM 8 GiB)	0.98	0.92	0.95	0.86
(8 vCPU, RAM 16 GiB)	0.125	0.128	0.132	0.122
(16 vCPU, RAM 32 GiB)	0.310	0.298	0.318	0.278

## VII. CONCLUSION:

This paper provides an overview of the cloud functionalities provided by major service providers. I compare the most popular cloud providers, including Amazon, Azure, Google, and IBM. This document explains the many sorts of disparities between these providers in terms of various attributes. This study focuses on the primary services provided by various cloud providers, such as storage, computation, and network services. The study also shows the pricing comparison of these service providers where some point of view IBM gives the lowest pricing then other and in some point of view Azure. So, as per users' requirement all service providers give benefits to users. In recent years, any commercial organization has shifted its operations to the cloud, which has shown to be profitable and attracted the interest of many others. The information gathered in this research paper will help cloud customers choose the significant cloud provider according to their needs as well as the services provided by the selected cloud provider and its price.

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