AWS VS AZURE VS GCP: LEADERS OF THE CLOUD RACE

Nikunj Mani Gupta[*1], Rinkul Singh[*2], Suman Shekhar Das[*3],
Saket Kumar Choudhary[*4]

[*1,2,3]PG Student, School Of Computer Science And Engineering, Galgotias University,
Greater Noida, Uttar Pradesh, India.

[*4]Associate Professor, School Of Computer Science And Engineering, Galgotias University,
Greater Noida, Uttar Pradesh, India.

ABSTRACT

Cloud computing services are being used by an increasing number of businesses and organizations to improve their performance in the competitive business world. Cloud computing is a new technology. But choosing the finest cloud service providers based on the necessary levels of service quality is one of the main difficulties in employing cloud computing services. Leading commercial organizations like Amazon AWS, Microsoft Azure, and Google Cloud offer a variety of cloud services today in the form of specialized, dependable, and affordable web apps. Numerous people and organizations from a variety of fields, including health, business, and education, are drawn to cloud services. We want to expose the most well-known Cloud Service Providers to cloud customers in this article. Additionally, we offer a contrast.

Keywords: Cloud Computing, AWS, AZURE, GCP, Cloud Providers.

I.   INTRODUCTION

Cloud computing:- Cloud computing is the on-demand provisioning of IT resources through the Internet with pay-as-you-go pricing, including servers, storage, databases, networking, software, analytics, and intelligence. This method enables speedier innovation, adaptable resources, and scale economies. Pay for only the cloud services you really use, which will cut your computing expenses, improve the operation and efficiency of your infrastructure, and allow you to scale as your company's needs evolve. Cloud is flexible, highly scalable, dependable, location independent, and reasonably priced because it operates in a distributed environment.

IaaS: In an IaaS paradigm, a cloud service provider hosts the server, storage, networking, and virtualization or hypervisor hardware that was previously present in an on-premises data centre. Additionally, the IaaS provider offers a range of services to transport those infrastructure parts. These include capabilities for storage resilience, such as backup, replication, and recovery, as well as comprehensive billing, monitoring, log access, security, and load-balancing. Customers of IaaS have access to online tools and services, and they can use the cloud provider's services to install the remaining parts of an application stack.

SaaS: SaaS does away with the requirement that businesses set up and run programmes on their servers or in their data centres. This eliminates the cost of purchasing, procuring, and maintaining hardware as well as purchasing, installing, and supporting software. Customers who use SaaS offerings subscribe to them rather than installing the programme or providing additional hardware support for it. They typically pay for this service on a "pay-as-you-go" basis. By converting costs to operating expenses, many large businesses can plan their budgets more accurately and predictably. SaaS users can quit using the services at any moment to stop paying for them.

PaaS: PaaS often does not take the place of a company's whole infrastructure. Instead, a company relies on PaaS suppliers for crucial services like Java development and application hosting. Users can install software in a stable and effective environment provided by a PaaS supplier. Instead of building and maintaining the underlying infrastructure and services, users can focus on creating and operating applications. Software development-related PaaS products are prevalent. These platforms provide storage and computing infrastructure as well as text editing, version control, compiling, and testing services to aid software developers in producing new software more quickly and effectively.

Selecting a cloud service provider (CSP) has evolved into a complex decision. Today, the issue is not which alternative we should choose, but rather how to maximise cost while achieving the best performance and

distributing risk among several vendors. The aforementioned debates suggest that each firm should decide on a CSP based on its IaaS, SaaS, and PaaS capabilities. Any organisation searching for IaaS should focus on CSPs that have a competitive advantage over IaaS.

Amazon Web Services:- It provides scalable, cost-effective cloud computing services and metered pay-as-you-go cloud computing platforms and APIs to individuals, corporations, and governments. With planned plans for 24 additional Availability Zones and 8 additional AWS Regions, the AWS Cloud is currently distributed across 84 geographic regions and 26 countries. It delivers more than 200 fully featured services from data centres around the world and is the most widely used cloud platform in the world.

Amazon EC2: Amazon EC2, also known as the Amazon Elastic Compute Cloud, offers scalable processing power. By using EC2, you can develop and deploy apps effectively and efficiently without having to make hardware investments. Using Amazon EC2, you may launch as many or as few virtual servers as you require, configure networking and security settings, and manage storage. Instance types refer to various arrangements of your virtual machines' CPU, memory, storage, and networking capabilities.

Amazon RDS: A relational database may be set up, run, and scaled effectively and efficiently with the help of Amazon RDS, which stands for Amazon Relational Database Service. It manages typical workloads and offers relational databases affordable, resizable capacity. The database services MySQL, MariaDB, PostgreSQL, Oracle, and Microsoft SQL Server are all available for use.

Amazon S3: A relational database may be set up, run, and scaled effectively and efficiently with the help of Amazon RDS, which stands for Amazon Relational Database Service. It manages typical workloads and offers relational databases affordable, resizable capacity. The database services MySQL, MariaDB, PostgreSQL, Oracle, and Microsoft SQL Server are all available for use.

AWS IAM: also known as AWS Identity and Access Management, is a service that manages access to all Amazon Web Services. You can specify who has access to which resources and services and under what circumstances using IAM. With IAM, you can control which users and systems have access to what minimal permissions.

Google Cloud Platform is a wholesaler, much like competing public cloud service providers Microsoft Azure and Amazon Web Services (AWS). Through GCP and other cloud wholesalers, clients can use the computing resources housed in Google's data centers throughout the world for free or on a pay-per-use basis. A variety of computing services are available through GCP, including tools for AI and machine learning as well as cost and data management, web and video delivery over the internet, and data management.

App Engine: One of the most important major edge services offered by Google Cloud Platform is App Engine. It is the first primary cloud edge service. Since 2008, it has been GCP's first relief. It is the most simple method for planning and scalability on GCP for your applications. Using pre-configured runtimes, it supports Java,.NET, Node.js, PHP, Python, and Ruby.

Cloud Storage: Cloud storage is a somniferous service that allows you to store and access your data on Google's network. The service combines innovative distribution and security strategies with the capability and scalability of Google's Cloud.

Cloud Bigtable: Cloud storage is a paid service for storing and accessing your data on Google's network. With innovative distribution and security methods, the service combines the capability and scalability of Google's Cloud.

Cloud CDN: Cloud CDN loads stable content close to your clients by caching HTTP(S) and utilising Google's widely dispersed edge points of presence.

Access Transparency: Clients can access access transparency's near real-time logs of manually restricted accesses by Google administrators through the usage of their Cloud Logging accounts.

Microsoft Azure is a cloud computing platform and an internet portal for using Microsoft's resources and services. At the time of writing, Azure has 67 announced and active regions, more than 160 physical data centres, many availability zones, and millions of users worldwide. It is one of the biggest cloud computing platforms, supporting millions of apps, integrations, and clients while providing over 200 services.

Virtual Machines:- With Azure virtual computers, users have the option to quickly and extensively customise Windows or Linux virtual machines.

Virtual Network:- An Azure virtual network allows secure internet connectivity for communication between Azure resources or with other on-premises networks. With this kind of service, users can establish their own private networks, which gives them access to an isolated, highly secure environment for applications.

File Storage:- SMB (server message block) protocol is used to access file-sharing features offered by Azure file storage. SMB 3.0 and HTTPS are used in the Azure file storage service to protect data while managing hardware and operating system deployments. Additionally, it enhances on-premises functionality and performance.

SQL Database:- SQL Azure SQL Database is a general-purpose relational database service built on the most recent stable version of Microsoft SQL Server Database Engine (DBaaS). SQL Database speeds up app development, makes maintenance easier, and reduces costs and time by moving workloads to the cloud. With the aid of adaptive and machine learning technology, performance can be improved.

Azure Active Directory:- Utilizing intelligence-driven access policies, Azure Active Directory assists in managing user identities and protecting resources. Users have access to any application from any location or device thanks to Azure Active Directory, which improves IT productivity and lowers helpdesk expenses. With the help of this service, users may increase security and instantly counter advanced threats.
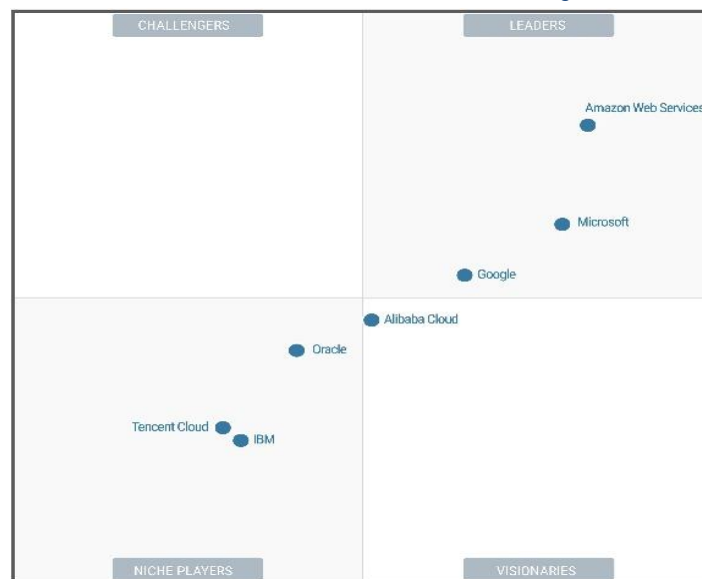
II.   ANALYSIS OF GARTNER MAGIC QUADRANT

Fig 1: Gartner's Magic Quadrant

AWS is a Leader in this Magic Quadrant. A Leader in this Magic Quadrant is **Amazon Web Services**. Being a comprehensive service provider, AWS. Future goals for AWS include trying to acquire ever-larger chunks of the supply chain that is utilised to provide services to customers.

Strengths:

Engineering supply chain: Amazon Web Services is using its engineering expertise to innovate in areas like AWS-designed CPUs, which offer better price/performance in comparison to x86 counterparts for particular applications.

Large financial commitments: Considering the amount and regularity of significant financial commitments made by enterprise companies using the platform, as well as the company's continuous market share dominance, Amazon Web Services continues to perform best in the industry.

Innovation leader: Amazon Web Services is the market leader in innovation, setting the pace that informs the development plans of other CIPS providers. Amazon Web Service is significantly more popular than any other providers among a wide range of customer types since it is the innovation leader.

Cautions:

Challenging renewals: Renewing contracts can be difficult because of unanticipated pressure from Amazon Web Services sales, which have surged over the past year. Many Gartner clients across many locations have observed this pressure and have committed to increasing annual spend by 20%. These consumers frequently depend on the site, so they could believe they have few other options.

Offering complexity: Recognizing the variety of solutions, such as those pertaining to databases, containers, and data management, necessitates technical expertise in order to understand the variations between the offerings and make the best decision. The intricacy necessitates third-party support for many organizations.

Bare-bones offerings: Because these bare-bones offerings have evolved in the public, Amazon Web Services' new services will take some time to be ready for major enterprise adoption. Additionally, Amazon Web Services' dominance in IaaS and dbPaaS has a misleading impact on other products, such as Amazon Web Services Outposts, which has gained only little traction so far.

Google is a Leader in this Magic Quadrant. In this Magic Quadrant, Google is the clear leader: Nearly all use cases can benefit from Google Cloud Platform (GCP), which is also steadily enhancing its frame capabilities. Google keeps making investments to expand its capabilities and the scope of its go-to-market activities in order to become a widely used provider of IaaS and PaaS. Its clients often range from small businesses to very large corporations, and its operations are globally diverse.

Strengths:

Revenue growth: Despite the fact that GCP is currently losing money, its revenue growth over the previous year was excellent. Although the company excels in its core areas of data and analytics, GCP is also gaining footing with more established enterprise workloads like SAP.

Growing enterprise mind share: In terms of mind split with businesses, GCP is advancing. When infrastructure leaders are questioned about their strategic cloud provider pick in the coming years, the company consistently sees increased adoption and tops poll findings.

Innovation velocity: In terms of CIPS capabilities, Google continues to make amazing year over year advancements that have allowed GCP to catch up to and in some cases surpass AWS and Microsoft Azure. For instance, GCP offers the most feature-rich Kubernetes service of any vendor in this space

Cautions:

Post sales satisfaction: Following their commitment to use the platform, some Gartner clients have had terrible experiences with GCP's commerce. This is mostly due to the organizational immaturity that emerges from GCP's rapid growth.

Limited incentives: Google is now luring users with ruthless pricing compared to its rivals, but the discounts are likely to eventually stop as the business continues to develop in terms of revenue and customers.

Financial losses: The only CIPS supplier with a sizable market share that is currently operating at a loss is GCP. Additionally, the success of GCP reduces Google's otherwise healthy gross margins, and the cloud business generates a relatively small portion of the parent company's total revenue.

Microsoft is a Leader in this Magic Quadrant. Microsoft Azure is reliable for all use cases, including edge computing and extended clouds. Azure is mostly well suited for businesses that focus on Microsoft. The Azure platform's architectural enhancements and the provision of a wide range of enterprise-focused services are Microsoft's investment priorities. Its clients are often midrange and large businesses, and its operations are globally diverse.

Strengths:

Broadly appealing: Microsoft has the broadest variety of capabilities of any vendor in this market, encompassing every aspect of commercial IT requirements from SaaS to PaaS to IaaS. Strong IaaS and PaaS capabilities from developer tools like Visual Studio and GitHub to public cloud services are a strength of Microsoft.

Enterprise relationships: Because of the long-standing trust that businesses have had in Microsoft, they frequently select Azure. Azure benefits from such a strategic partnership with Microsoft in practically every industry vertical.

Data services adoption: Over the past year, Microsoft Azure's forays into big data solutions and operational databases have been remarkably successful. Regarding customer uptake, Azure's Cosmos DB and its collaborative effort with Databricks stand out

Cautions:

Resiliency: Microsoft has worked hard to strengthen resilience with risky services like Azure Active Directory, but many Gartner clients are still concerned about the effects in the real world when such essential services are down. Furthermore, Microsoft keeps responding slowly to the implementation of AZs, increasing the probability that some regions would never have such resilient infrastructure. There are still occasional outages with services like the Azure Kubernetes Service (AKS), usually related to updates and maintenance activities.

Commercial complexity: Microsoft has a complicated account management structure, very complicated licencing and contracting, and sporadic cloud expertise. Additionally, Microsoft is unable to use Azure to successfully reduce a customer's overall Microsoft expenditures due to sales efforts to increase overall account income.

Novel innovations: In comparison to its competitors, Azure's unique advancements in the market for IaaS and PaaS over the last year were far less compelling. Furthermore, despite Microsoft Azure's early days as an application PaaS provider, Azure's product execution and adoption in this market have been uneven.

III.   COMPARISION BETWEEN AWS, GCP AND AZURE

Table 1: Comparison between AWS, GCP and AZURE

Parameter	Amazon Web Services	Google Cloud Platform	Microsoft Azure
Starting year	2006	2011	2010
Available Region	26	24	54
Computing types provided	Iaas, Paas, and Saas with major contributions in Iaas	Iaas, Paas, and Saas with major contributions in Paas	Iaas, Paas, and Saas with major contributions in Paas
IDE Support	SDK support for Eclipse	Direct support in Cloud9 IDE	SDK support for Eclipse & Visual Studio
Virtualization Technology	XEN Virtualization Technology	KVM Hypervisor Virtualization technology	Hyper-V Hypervisor Virtualization technology
Pricing types	On-Demand, per-second billing	Pay as you go, on-demand per second billing	Pay as you go pricing
Compute Services	Elastic Compute Cloud	Compute Engine	Virtual Machine
			Virtual Machine Scale sets
PaaS	Elastic Beanstalk	App Engine Standard	Cloud Services
		App Engine Flexible	
VPS	LightSail		Virtual Machine Images

Kubernetess/Docker containers		Kubernetes(EKS)	Container Engine	Container Services(AKS)
		EC2 Container Services	Kubernetes Engine	
Integrate systems and run backend logic process		Lambda	Cloud Functions	Functions
				Event Grid
Key tools		Athena, Quick sight, SageMaker, Kex, Greengrass IoT, Lambda, Deeplens	BIgQuery, Cloud Dataflow, MLengine, IOT core, Functions	HDinsight, DataFactory, ML Studio, Azure Boot, Cognitive, IOT hub
Storage Service	Object Storage	Amazon Simple Storage Service	Google Cloud Storage	Blob Storage
	Virtual Server Disks	Amazon Elastic Block Store	Google Compute Engine Persistent Disks	Managed Disks
	Cold Storage	Amazon Glacier	Google Cloud Storage Nearline	Archive Blob Storage
	File Storage	Amazon Elastic File System	ZFS/Avere	Azure File Storage
Database service	RDBMS	Amazon RDS	Cloud SQL	SQL database
	NoSQL: Key–Value	Amazon DynamoDB	Cloud DataStore Cloud Bigtable	Table Storage
	NoSQL: Indexed	Amazon Simple DB	Google Cloud Datastore	Cosmos DB
Networking Service	Virtual Network	Amazon Virtual Private Cloud(VPC)	Virtual Private Cloud	Virtual Networks
	Elastic Load Balancer	Elastic Load Balancer	Google Cloud Load Balancing	Azure Load Balancers
	Peering	Direct Connect	Google Cloud Interconnect	ExpressRoute
	DNS	Amazon Route 53	Google Cloud DNS	Azure DNS
Pre-configured OS		1. Amazon Linux 2. Cent OS 3. Debian 4. Oracle Linux 5. Red Hat Linux 6. Ubuntu 7. Windows Server	1. Cent OS 2. Debian 3. Ubuntu 4. Red Hat Linux 5. Windows Server	1. Cent OS 2. FreeBSD 3. OpenSUSE Linux 4. Oracle Linux 5. Ubuntu 6. Windows server
Hybrid and Multi Cloud		AWS Snowball AWS Snowcone AWS Outposts AWS Local Zones VMware Cloud on AWS	Anthos Traffic Director Looker Cloud Build Operations	Azure Arc Azure Backup Azure Active Directory Azure Security Center Azure Blob Storage

	AWS Wavelength Amazon ECS Anywhere Amazon EKS Anywhere	Cloud Run for Anthos	Azure Stack Azure Centinel
Available runtimes	1. .NET 2. JAVA 3. PHP 4. Python 5. Ruby	1. Python 2. JAVA 3. Node 4. PHP 5. Ruby 6. GO	1. .NET 2. JAVA 3. Node 4. PHP 5. Python 6. Ruby
Machine Learning Frameworks Supported	1. Apache 2. MXNet (With Gluon API) 3. TensorFlow 4. Caffe framework	1. TensorFlow 2. DistBelief 3. Many in-built API's to support development	1. PyTorch 2. TensorFlow 3. Scikit-learn 4. MXNet 5. Chainer 6. Keras
Benefits	Breadth and depth of its services Developer functionality Economic benefits for customers Gold standard for reliability and security Control market position Sizeable , develop fully offerings Help for huge organizations Worldwide reach	Deep expertise technology Adjustable pricing model Advance costing than Competitors Live Migration of Virtual Machines Delegation to Continued	Adjustable billing Accuracy and expandable. High level availability Price-effective differentiate to the competition Integrated public and private cloud Help for open source
Limitations	Cost prohibitive Usage is not facile Stewardship of price Overcoming Technical support fee	Safety and privacy Bounded control and flexibility Vendor pin- down Insufficient characters or services Historically not as enterprise focused	Consequences with documentation Imperfect management devices Comparatively hard to use Expensive Data transfer cost Require platform expertise

IV.   ANALYSIS REPORT

- AWS has a five-year head start.
- There are numerous regions and availability zones in AWS.
- About one-third of the market is held by AWS.
- The growth rate of GCP is almost 100%.
- Premium clients utilizing all three cloud platforms
- There are numerous services offered by AWS.

- Azure offers the ability to integrate with open-source and on-premises systems, like MS tools, which are largely utilized in businesses.
- GCP offers more affable pricing and discount schemes.

Amazon Web Services is easily analyzed as being at the top of all the major cloud providers in today's cloud battle between Microsoft Azure, Amazon AWS, and Google Cloud. Given Microsoft Azure and Google Cloud Platform are consistently moving up the list of the top cloud leaders, it is difficult to anticipate how long Amazon Web Services will reign as the top cloud provider. While Azure and Google Cloud Platform also have benefits, Amazon AWS has the unique benefit of being the first of its kind. Many businesses that utilise Microsoft tools find that using the Azure cloud platform makes more sense because it makes it simple to employ MS tools. The only reason clients should choose Google Cloud Platform is because it has the best pricing structure for the services, including YouTube and Google Search. Taking the analysis report into account, it would be preferable to argue that choosing the best cloud service provider for your needs is more important than choosing the greatest cloud service provider overall.

V. CONCLUSION

High speed data processing and large scale storage solutions are critical given the constant appearance of new start-ups and the heavy reliance on data by consumers. The cloud platforms' use of virtualization, or the creation of numerous virtual machines on a single physical machine, offers a solution for these problems. As a result, the processor is more effective and spends less time idle. The three cloud computing platforms discussed above are each good in their own unique ways due to their respective characteristics. Even while AWS EC2 is the most established and supports the greatest number of operating systems that come pre-configured, it falls behind in terms of accessibility and support. We get to the conclusion that the choice of cloud platform is greatly influenced by the customer's requirements, which vary from user to user.

VI. REFERENCES

[1] AMAZON WEB SERVICES Amazon, http://aws.amazon.com

[2] Microsoft Azure, https://portal.azure.com

[3] GCP Console, https://console.cloud.google.com

[4] AWS Security Best Practices – By Dob Todorovadn Yinal Ozkan.

[5] Advanced Web Services - Springer – By Athman Bouguettaya, Auan Z. Sheng and Florian Daniel.

[6] S. Srinivas, Microsoft Azure v/s Amazon AWS Cloud Services: An Appropriative Study, International Journal of Engineering Science Invention ISSN: 2319 – 6734, ISSN: 2319 – 6726 www.ijesi.org - Volume 6 Issue 12 - December 2017 - PP. 16-2

[7] T. Erl, Z. Mahmood and R. Puttini "Cloud Computing: Concepts, Technology & Architecture" - Prentice Hall - JCS&T - vol. 13, no. 3 – 2013 - pp. 63-72

[8] Nikunj Mani Gupta "An Eye on Amazon AWS – International Research Journal of Engineering and Technology (IRJET) - e-ISSN: 2395-0056- p-ISSN: 2395-0072 - Volume: 09 Issue: 07 | July 2022- PNo. 1475-1480

[9] Pranay Dutta and Prashant Dutta – "Comparative Study of Cloud Services Offered by Amazon, Microso_ and Google" International Journal of Trend in Scientific Research and Development (IJTSRD)- Volume: 3 | Issue: 3 | Mar-Apr 2019 - e-ISSN: 2456 – 6470

[10] Pallavi Wankhede*, Minaiy Talati and Rutuja Chinchamalatpure - "COMPARATIVE STUDY OF CLOUD PLATFORMS –MICROSOFT AZURE, GOOGLE CLOUD PLATFORM AND AMAZON EC2" - International Journal of Research in Engineering and Applied Sciences - Vol. 05, Issue 02, April 2020- ISSN (Online): 2456-6403