

A Comparative Study of Infrastructure as a Service Provider

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Abstract:

Finding service providers is considerably more difficult in a large firm. It will be easier to choose an infrastructure as a service provider with the assistance of this paper. As a result of this better technology, end consumers have access to numerous services and resources. On the other hand, service provider firms have also experienced tremendous expansion in terms of numbers, increasing rivalry in the market. It investigates how the sector uses its key suppliers and the pricing methods they use. Here, four cloud service providers—AWS, Microsoft Azure, GCP, and Oracle—are contrasted based on CSPs in terms of service, cost, and benefits, highlighting key service aspects. The main factors that influence picking a CSP—such as its suitability for the enterprise, brand recognition, and security considerations—are highlighted.

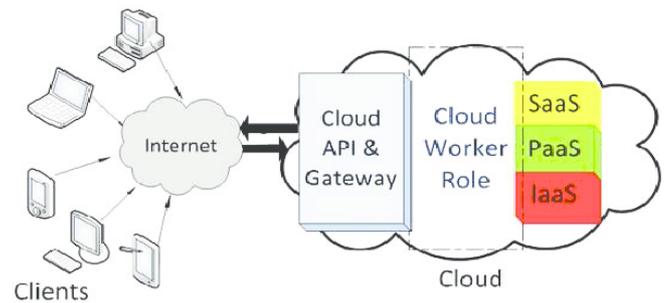
I. INTRODUCTION

A specific kind of cloud computing service known as infrastructure as a service (IaaS) provides basic computation, storage, and networking resources on demand and on a pay-as-you-go basis. IaaS is one of the four categories of cloud services, along with serverless, platform as a service, and software as a service (SaaS). The maintenance can be reduced from on-premises data centres, save money on hardware, and obtain real-time business insights by moving the organization's infrastructure to an IaaS service. IaaS solutions provides the freedom to adjust the amount of IT according to demand. Additionally, they improve the dependability of underlying infrastructure while assisting in quick provisioning of new applications. The way we operate our businesses and serve the general public is being revolutionised by the internet. Most of the time, a client's PC contains all necessary software

and hardware. The client's work and information are thus stored on his or her PC [1]. The concerned department and the user inside the business are responsible for data security as well as maintaining application and system software in accordance with requirements [2]. The Internet is also referred to as "the cloud." The term "computing" refers to a process that makes use of computer technology to carry out a task or accomplish a goal, including the design and development of software and hardware. When the phrase "the cloud" is added to computing, it gives computing a multidimensional meaning. One is from a computer or server and is placed "in the cloud," as opposed to placing away all the data and code [3]. Applications, databases, email, record administrations, computing power, memory, and other services can all be a part of it. The term "cloud computing" refers to a procedure where computer resources are used outside of an organization's firewall, which some analysts and vendors claim is similar to a traditional outsourcing

process [4]. Recent years have seen a sharp rise in the demand for cloud services, which has led to a significant growth in the scalability of cloud platform users. In the modern world, cloud computing has emerged as one of the key technologies. Customers and service providers are directly impacted by the advantages of cloud computing. Companies like Microsoft, Google, Amazon, Verizon, and Rockspace frequently modify their price structures in order to offer services that are more suited to their customers[5]. Platforms for cloud services offer a range of services, including storage, upload, and download. The traditional approach to data management and storage has been replaced by a new cloud approach thanks to cloud computing. Data management is made available through cloud computing at an affordable price. Different forms of SLA certificates are offered by the cloud between the customer and the service provider. Since the cloud offers a variety of price options and advantages to its users. Price is a key factor for the business that offers cloud-based services because it directly influences client needs and business earnings. Prices directly affect the economy, stocks, earnings, and losses. The cloud computing pricing options are quite flexible and is based on the needs of the customer and the service provider's competence. The service provider's main concern is ensuring that clients receive quality of service (QoS)[6]. Even though the IT industry has established corporate frameworks for pricing services, this trend is currently shifting. Newer pricing models have developed in this service field as a result of the newly evolving value chain models adopted by traditional IT services after the emergence of cloud computing [7]. Value Chain, as defined by Michael Porter, is a "system of separate operations, connected by links. There is a link if the manner in which one activity is carried out impacts the price or efficiency of another activity. Links describe how one activity influences another and turns into a source of benefit and added value [8]. Products and services flow through each activity in a sequential manner, gaining value at each stage, therefore this

chain of activities adds some value to the product.



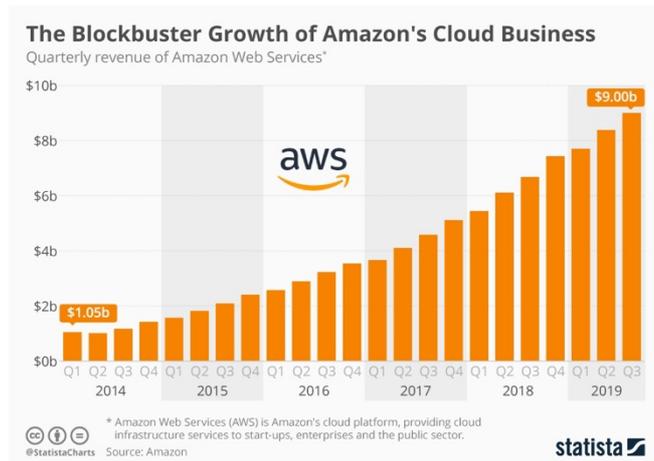
II. CLOUD SERVICE PROVIDERS

A. Amazon Web Services(AWS)

AWS can be purchased by an individual or an organisation (public, corporate, or government) in the form of on-demand computing resources using a pay-as-you-go payment model. Cloud-based web administrations provide a variety of distinct, targeted frameworks as well as the right tools and building blocks for processing requirements [9]. With the help of the Internet, Amazon's Elastic Compute Cloud makes it possible for customers to access a virtual network of PCs continuously. In this mode, the client receives features similar to those of owning high-quality PC hardware, including hardware (CPU and GPU for processing needs, RAM for memory requirements, hard drive, SSD for information storage), a choice of operating frameworks, setting up, and pre-stacked application programme design, such as CRM, databases, servers to host websites, etc.[10] The Amazon backup mechanism keeps AWS servers updated across the globe [11].

The price of hiring them depends on several factors, including the use of tools, operating system, program design, organizing features selected by the sponsor, needed level of approachability, security, and tools configured for administrative chores. A client can pay for a dedicated physical PC, a dedicated virtual AWS PC, or a mix of both. The crucial component of the membership agreement

from Amazon protects the client's structure. AWS is dispersed throughout numerous geological regions of the globe [12]. Across 2017, AWS completed approximately 90 administrations in a variety of industries, including information database management, storage, application administration, engineering equipment, Internet of Things (IoT)-related equipment, and analysis [13].



B. Microsoft Azure

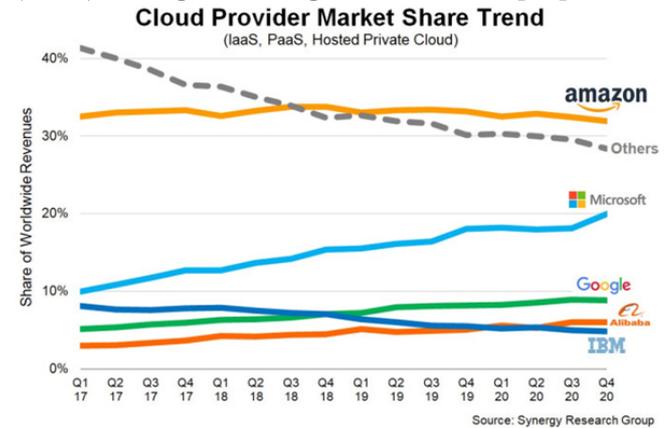
A public cloud platform called Microsoft Azure enables users to create and deploy web apps while storing their data in Microsoft Datacenters. The following categories apply to the services offered: Applications for the Cloud, Identity and access control, networking, and data management Integration & Messaging. The Azure platform allows for multilingual development and can connect cloud apps into existing IT infrastructures.

Organizations have the option to use a single authentication method with synced data already existent at the corporate office thanks to Windows Azure. The solution also offers the capability to instantly produce security reports.

Microsoft Azure is a versatile cloud platform that enables rapid application development, testing, and iteration as well as ongoing management via a network of Microsoft data centres [14]. Applications can be created using any tool, programming language, or framework that is already in use. Additionally, it is possible to

integrate public cloud applications with the current IT ecosystem.

Azure subscriptions require the usage of a payment card and a few Microsoft Live accounts (Live, Hotmail, Outlook). The user can buy the required cloud resources after finishing the registration process. It is possible to choose from a list of available settings while creating virtual machines (VMs) through a management console.[15]



c. Google Cloud Provider

As the name implies, GCP is a collection of cloud computing administrations offered by Google. It utilises the same platform that Google uses to operate its end-client services, including YouTube and Google Search [16]. Through the platform, the client may quickly carry out numerous cloud administration duties, including information gathering, information analysis, data analysis, and machine learning. The registration process requires a charge card or ledger detail [17]. The foundation receives a management platform and serverless registration requirements from GCP. [18]. In April 2008, Google unveiled App Engine, a platform for building and facilitating online applications on server farms under Google's management. Administration of distributed computing was the key topic. It was discovered to be widely used in November 2011 as a result of its expanding popularity, and as a result, Google began to introduce several cloud administrations at this time [19]. A division of Google, Google Cloud Platform combines the GCP open cloud framework, G Suite,

commercial Android and Chrome OS versions, as well as application programming interfaces (APIs) for artificial intelligence (AI) and undertaking mapping administrations [20].

d. Oracle

As a virtual cloud data centre that provides totally managed resources with the highest level of security for people and businesses, Oracle built their Oracle Cloud Infrastructure. Oracle servers run on software that has been around for a decade, such as database solutions, in their data centres. The regular virtual machines and bare metal compute instances are just two of the many cloud computing instances that Oracle provides. Aside from instances, there are numerous more services available, including managed load balancing services, remote block storage, high-performance managed databases, access and identity management, and software defined virtual cloud networks (VCNs). Oracle With up to 52 cores per machine, bare metal instances offer better performance metrics and virtually no virtualization overhead. Budgets that are spent each month on Oracle cloud computing are managed using Universal Credits. The Bring Your Own License (BYOL) paradigm enables Oracle cloud users to install their on-premises licences that they previously purchased from Oracle.

III. LITERATURE SURVEY

This section provides a summary of earlier work that examines the chosen cloud service providers from the viewpoint of users. On their respective websites, these suppliers let their clients know about their most recent offering. While comparing these cloud providers, this work makes use of information released by the original sources. Comparative research comparing these providers were scarce. We reviewed some earlier research on the subject that was done when comparing some of these suppliers in this part. An introductory study was conducted in [22] that compared SunNetwork.com and GRIDS Lab Aneka clusters

with Amazon EC2, Google Compute Engine, and Microsoft Azure clouds from a variety of general perspectives, including: focus on service delivery, virtualization techniques, and programming frameworks. At that time, the authors counselled the cloud provider to enhance their product to satisfy customer demands for QoS and reliability. [23] compares the capabilities, features, and applications provided by Google Compute Engine, Microsoft Azure, and Amazon EC2. This study suggested avoiding relying solely on one service provider to meet organisational objectives.

The computing engine clouds from Amazon EC2, Microsoft Azure, and Google were evaluated in [24] from a variety of performance and cost-related angles. They discovered that there was no interoperability standard that supported cloud purchases from various cloud providers. These guidelines may make it easier to roll out new cloud services while lowering the risk associated with doing so.

The Amazon EC2, Microsoft Azure, Google Compute Engine, and Rackspace clouds were compared by the authors of [25] from a variety of architectural angles, including computing, network, and storage performance. Numerous VMs from these providers were evaluated through experiments utilising various benchmarks. Variations in performance readings were noticed. Additionally, research published in [20] included cost analyses of numerous services provided by various cloud providers; these clouds included Amazon EC2, Rackspace, GoGrid, CloudSigma, ElasticHosts, and Joyent. They compared the operation costs of each virtual type using the standard instance from each supplier. Depending on the type of virtual machine used, the job preferred and suggested certain suppliers over others.

A study has been done to show that mobile cloud computing can be optimised to utilise less resource by applying patterns seen in mainstream cloud computing. There are many strategies to employ for optimization in cloud computing because it uses resources to provide services to the consumer but does so with fewer resources and more services to

consumers. Through their workshop conference papers, a number of researchers have emphasised the advantages of R&D in the cloud computing field. Examples include software engineering challenges in cloud-based applications, the advantages of using cloud computing in the distribution of oceanographic data on a global scale, and software engineering towards developing applications for the broking of cloud storage services [26]. According to a study conducted by researchers, the popularity of cloud computing has led to a rapid expansion in the number of CSPs in the market. These services have also been compared based on a number of different criteria. Many CSPs have been compared in order to determine which CSP offers the better services. Every CSP has some benefits as well as some drawbacks in terms of everything from cost to computation to infrastructure to storage [27].

IV. COMPARISION

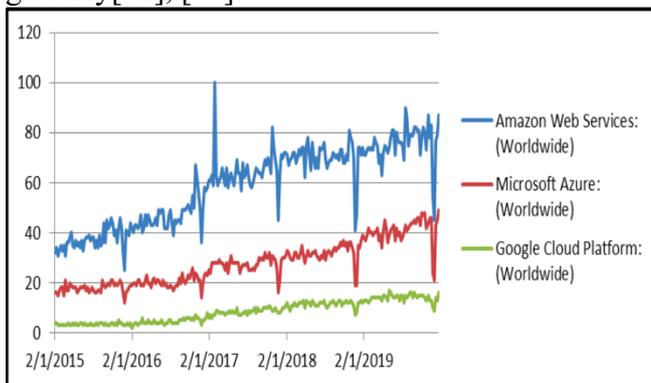
Cloud computing is a speedier technology that allows users to use IT abilities wherever they are needed or required by their employers . Amazon is a significant open cloud service provider and a market leader in distributed computing .In terms of distributed computing, Amazon AWS offers almost everything. Numerous areas of interest, including design and monitoring, are dominated by AWS .AWS is favoured in the industry for the most part due to its wide-ranging and significant contributions, project-helpful administrations, global reach, and open and adaptable characteristics. AWS and Azure both provide a wide range of services and solutions for individuals and organisations with relation to foundation, processing power, storing, organising, and other related issues. The strength of Microsoft Azure is its registration capacity .Microsoft provides the ability to send and manage virtual machines as a scale that can quickly adjust to any limit requirement. It offers something different from Amazon and Google. Microsoft Azure also offers open-source support, half-breed cloud advantages,

and the ability to integrate with Microsoft tools successfully .The importance of Google's specialised knowledge and its industry-leading innovations in computational reasoning, deep learning, and information research cannot be overstated. For engineers, Google Cloud provides a selection of cloud administrations. Open source support, shifting flexibility, savings, and flexible contracts are all provided by Google Cloud [28]. The DevOps expertise of Google Cloud is specifically geared toward cloud-based enterprises .Google has an analytical foundation, and GCP offers greater features and adaptability to research and scientific tools. Oracle offers a wide range of cloud services and products, including: Business analytics, including Business Intelligence (BI) solutions, Big Data, data visualisation, autonomous analytics, and more. Oracle does this by mixing IaaS, PaaS, SaaS, and DaaS solutions.development of applications for mobile, the Internet of Things (IoT), blockchain, databases, and other platforms,installation and upkeep of cloud infrastructure,administration and integration of data,business integration,Cloud-based systems for Customer Relationship,Management (CRM) are available,management of content and user experience, Security solutions that prioritised compliance and safety.

The experience is an unavoidable benefit of Amazon. The world's best and most seasoned developers and architects work for Amazon, which has been in the cloud computing business for roughly 14 years. AWS exists as a result of numerous advancements in these technologies. Amazon Web services give its rivals fierce competition. However, it can be difficult to understand the cost of AWS's infrastructure. [29]. Due to its experience, Amazon is the most open-ended cloud specialist co-op, allowing anyone to use AWS with ease . The quickest cloud solution currently available is Microsoft Azure. It is appropriate for large business development since it has a high computing capacity and is integrated with other Microsoft features to provide greater power. Microsoft Azure is a strong rival to AWS.

There is an endeavour basis for Microsoft Azure (supporting Windows). It tries to work with them in a way that is interoperable. [30]. One of the top cloud security services is provided by GCP . More than 500 security engineers are working on it, and it offers a different aspect of cloud security than the rest of its competitors. GCP will be the greatest option for high security activities, such as banking, finance, and defence applications [31].

IBM, Google, Amazon, and Microsoft are competing to offer their customers the best cloud services. Amazon and Microsoft are considered the top tech companies in the world since they control the US and UK markets. There is a lengthy list of businesses that offer cloud services. Small tech companies today have begun to invest in the cloud sector. Comparing Amazon Web Services (AWS) to Microsoft Azure and Google Cloud Platform, AWS has the most market share (GCP). Figure 6's graph shows the development of three cloud service platforms during the previous five years. It is evident that during the past five years, Amazon Web Services (AWS) has been more popular than Google Cloud Platform (GCP) and Microsoft Azure globally[32], [33].



V. RESULTS

Every consumer has different priorities, and each CSP offers a different set of services. With so many features, it can be quite challenging for customers to understand what services Azure is providing from a storage viewpoint. AWS capabilities from a

compute standpoint are likewise tough to identify, as are Google features from an infrastructure perspective. All of the properties listed in tables 1, 2, and 3 have been gathered and categorised into categories related to compute, storage, and infrastructure based on a review of numerous research articles. It has been really difficult to go through each aspect of the table individually and recommend the CSP, which has excellent service features. As a result, some conclusions have been offered based on the analysis of numerous studies, to the best of our knowledge and comprehension.

AWS offers more and better features than Azure and Google, and it dominates the IaaS market more than both of them. However, AWS is slightly more expensive than Google and Azure, and its security isn't all that great either.

Additionally, it has beneficial advantages, particularly for all services. Compared to AWS, Microsoft Azure is a little less expensive. Microsoft has a stronghold in SaaS and PaaS, and its service characteristics are superior to AWS'. People are familiar with Google and Microsoft, yet few people are familiar with AWS. Because of its affordable price and high level of security, it is a solid rival to AWS and Microsoft Azure. When compared to AWS and Microsoft Azure, Google dominates the PaaS market. Google is also growing in SaaS. As was previously mentioned, AWS, Microsoft Azure, and GCP all provide excellent services across various industries. All cloud services, such as SaaS, PaaS, and IaaS, primarily use the same domain. Storage, compute, and infrastructure are used by all three services, which is why feature tables are created from the domain's perspective rather than the service perspective. The CSP service attributes that companies or organisations take into account are highlighted.

When comparing cloud services like AWS vs. Google Cloud vs. Microsoft Azure vs. Oracle Cloud, there isn't just one winner in the end. They all invest billions of dollars annually to improve their services, which should undoubtedly lead to innovations year after year. The end users and businesses with high

demands for speed and space in the cloud environment win out with this.

VI. CONCLUSION

The choices of vendors are determined by the technical and business needs of a specific enterprise. It was discovered throughout the survey that some firms require a specific cloud service provider, while others require assistance in selecting the best vendor for their industry or to offer services to clients. The results are as follows for AWS, Azure, and GCP: AWS is Wider more Stable, Reliable number of Services: It has large number of Products. It has More Global reach and it has many Data Centers. It is useful when You work for a larger organisation: Its pricing strategies are geared toward enterprise-level businesses that require pricey, flexible solutions. Oracle makes the biggest investments in bare, dedicated virtual machines with many of cores. Google joined the market with its user-custom virtual machines, which customers may purchase regardless of their compute and memory needs without having to pay anything up front.

The majority of applications/solutions are based on Microsoft/Windows. Azure is the first migration to the cloud.

They require hybrid deployment strategies or solutions. GCP is concentrating on the container-based paradigm (containers are programming kinds that can virtually share the OS Kernel without the requirement for virtual machines) and web-based applications. It has a modular price, when you already have a digital organisation, you're developing and deploying cloud-based software and applications. As a result, AWS is the best option if you're looking for a platform with a wide range of dependable and stable services, and pricing isn't a big problem. However, if your company's servers run Windows, Azure is the best option because it offers services that are integrated with the Windows platform. GCP is perfect for start-up and medium-sized businesses that are fast expanding and have a big number of user data, innovations, and resources.

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