**Comparative Study of Cloud Services Offered by Amazon, Microsoft & Google**

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**ABSTRACT**

With the accelerated development in processing and storage technologies and the boom of the Internet, IT Hardware have become inexpensive, more potent and highly available than ever before. This has triggered the commencement of a new computing model called cloud computing, in which IT-Resources are catered as general utilities that can be hired and released by users through the Internet in an on-demand fashion. According to Gartner Survey Report, The marketplace for public-cloud is predicted to reach from ‘$260 billion’ in 2017 to around ‘$411 billion in 2020’. As more and more IT systems are externalized, it is getting more imminent for us to choose the right cloud service provider for long term success. However, the challenge is to choose the best cloud service provider from the vast number of options like AWS, Azure and GCP to the smaller CSP’s. As per Market share the Top 3 Global leaders are AWS, Azure and GCP. In this paper, we will try to make analysis of between the three market leaders in cloud services namely Amazon, Microsoft & Google. We will also compare and contrast what AWS, Azure, and GCP offer in terms of storage, compute, management tools etc.

**KEYWORDS:** Cloud Service Provider (CSP), Amazon Web Service (AWS), Microsoft Azure, Google Cloud Platform (GCP)

1. **INTRODUCTION**

Before an organization finds the best Cloud Service Provider, it should freeze its exact requirement. Sometimes organizations need Software as a Service and end up hiring Infrastructure as a Service. Hence an Organization should know its exact requirements with context to IaaS, SaaS & PaaS.

IaaS - In an IaaS model, a CSP hosts the hardware components originally present in an on-premises data center, including servers, storage and networking hardware, as well as the virtualization or hypervisor layer. The IaaS provider also provides a range of services to convey those infrastructure components. These can include detailed-billing, monitoring, log-access, security, load-balancing and clustering, as well as storage-resiliency, such as backup, replication and recovery. IaaS customers access resources and services through a (WAN), such as the internet, and can use the cloud provider’s services to install the remaining elements of an application stack.

SaaS - SaaS eliminates the need for organizations to install and run applications on their own servers or in their own data-centers. This eliminates the expense of hardware procurement, provisioning and maintenance, as well as software-licensing, installation and support. Rather than procuring software to install, or additional hardware to support it, customers subscribe to a SaaS offering. Generally, they pay for this service on a monthly/hourly basis using a ‘pay-as-you-go’ model. Transitioning costs to a periodic operating expense allows many big-business to exercise better and more foreseeable budgeting. Users can also terminate SaaS offerings at any time to stop those periodic costs.

PaaS - PaaS does not normally replace a business’s entire IT-Infra. Instead, a business trusts on PaaS providers for key-services, such as application hosting or Java development. A PaaS provider forms and supplies a strong and optimized environment on which users can install applications and data-sets. Users can emphasis on making and running applications rather than constructing and maintaining the underlying infrastructure and services. Many PaaS products are geared toward software-development. These platforms offer compute and storage infra, as well as text editing, version-management, compiling and testing services that help software-engineers create new software more quickly and efficiently. A PaaS product can also enable development teams to join forces and work together, regardless of their physical-work-location.

Finding a cloud service provider (CSP) has become an intricate judgement. Nowadays it’s not a question of which
option we should work with, but rather, how to achieve the right performance and dispense risk across multiple vendors—while optimizing the cost.

In view of the above discussions, it can be envisaged that every organization should finalize CSP based on its Capabilities in IaaS, SaaS & PaaS. If any Organization is looking for Iaas then it should look for those CSP’s which are having an edge on Iaas.

II. Major Cloud Computing Service-Providers
There are several cloud-computing service-providers available in industry. Few leading companies are listed below as per Gartner's Magic Quadrant:

1. Amazon Web Services – Launched in 2006
2. Microsoft Azure - Launched in 2010
3. Google Cloud Platform - Launched in 2008
4. Alibaba Cloud - Launched in 2009
5. Oracle Cloud- Launched in 2012
6. IBM Cloud- Launched in 2011

III. Comparison of Compute Services : AWS vs AZURE vs GCP

| Service             | Amazon Web Services | Google Cloud Platform | Microsoft Azure |
|---------------------|---------------------|-----------------------|-----------------|
| Compute Services    | Elastic Compute Cloud (EC2) | Compute Engine | Virtual Machines |
| PaaS                | Elastic Beanstalk   | App Engine Standard Environment | Virtual Machine Scale Sets |
| VPS                 | Lightsail           | App Engine Flexible Environment | Cloud Services |
| Docker / Kubernetes containers | EC2 Container Service | Kubernetes Engine | Container Service |
| Integrate systems and run backend logic processes | Lambda | Cloud Functions (Beta) | Functions |
| Automatically scale Instances | Auto Scaling | Instance Groups | Virtual Machine Scale Sets |

IV. Comparison of Storage Services: AWS vs AZURE vs GCP

| Vendor | Storage Services | Database Services | Backup Services |
|--------|------------------|-------------------|-----------------|
| AWS    | Simple Storage Service (S3) | Aurora | Glacier |
|        | Elastic Block Storage (EBS) | RDS | |
|        | Elastic File System (EFS) | DynamoDB | |
|        | Storage Gateway | ElastiCache | |
|        | Snowball | Redshift | |
|        | Snowball Edge | Neptune | |
|        | Snowmobile | Database migration service | |
| Azure  | Blob Storage | SQL Database | Archive Storage |
|        | Queue Storage | Database for MySQL | Backup |
|        | File Storage | Database for PostgreSQL | Site Recovery |
|        | Disk Storage | Data Warehouse | |
|        | Data Lake Store | Server Stretch Database | |
|        | | Cosmos DB | |
|        | | Table Storage | |
|        | | Redis Cache | |
|        | | Data Factory | |
| GCP    | Cloud Storage | Cloud SQL | None |
|        | Persistent Disk | Cloud Bigtable | |
|        | Transfer Appliance | Cloud Spanner | |
|        | Transfer Service | Cloud Datastore | |

Table -1

Table -2
V. Key Cloud Tools

| Key Cloud Tools                      |
|-------------------------------------|
| AWS                                 |
| Athena, QuickSight, SageMaker, Lex, GreenGrass IoT, AWS Lambda & Deep Lens |
| Azure                               |
| HDInsight, Azure DataFactory, Azure ML Studio, Azure Boot Service, Cognitive Service, IoT Hub, Functions |
| GCP                                 |
| BigQuery, Cloud DataFlow, Cloud ML Engine, Cloud IoT Core, Cloud Functions |

Table – 3

VI. Comparison of Database Services: AWS vs AZURE vs GCP

| Service                          | Amazon Web Services | Google Cloud Platform | Microsoft Azure |
|----------------------------------|---------------------|-----------------------|-----------------|
| Managed relational database-as-a-service | RDS                 | Cloud SQL             | SQL Database    |
| NoSQL (indexed)                  | DynamoDB            | Cloud Datastore       | Database for MySQL |
| NoSQL (Key-value)                | DynamoDB            | Cloud Bigtable        | Cosmos DB       |
| Application or Memory Caching    | ElastiCache         | Mem Cache             | Redis Cache     |
| Database migration               | Database Migration Service | Database Migration Service |
| Managed data warehouse           | Redshift            | Big Query             | SQL Data Warehouse |

Table – 4

VII. Comparison of Networking Services: AWS vs AZURE vs GCP

| Service                          | Amazon Web Services | Google Cloud Platform | Microsoft Azure |
|----------------------------------|---------------------|-----------------------|-----------------|
| Isolated, private cloud private networking | Virtual Private Cloud | Virtual Private Cloud | Virtual Network |
| Cross-premises connectivity      | API Gateway         | Cloud VPN             | VPN Gateway     |
| Manage DNS names and records     | Route 53            | Google Cloud DNS      | Azure DNS       |
| Global content delivery networks | CloudFront          | Cloud Interconnect    | Traffic Manager |
| Dedicated, private network connection | Direct Connect     | Cloud Interconnect    | ExpressRoute    |
| Load balancing configuration     | Elastic Load Balancing | Cloud Load Balancing | Load Balancer   |

Table – 5

VIII. Comparison of Management Services: AWS vs AZURE vs GCP

| Service                          | Amazon Web Services | Google Cloud Platform | Microsoft Azure |
|----------------------------------|---------------------|-----------------------|-----------------|
| Cloud advisor                    | Trusted Advisor     | Cloud Platform Security | Advisor         |
| DevOps deployment                | OpsWorks (Chef-based) | Cloud Deployment Manager | Automation     |
| Management & monitoring          | CloudWatch          | Stackdriver Monitoring | Portal          |
| Administration                   | Application Discovery Service | Cloud Console         | Log Analytics   |
| Billing                          | Billing API         | Cloud Billing API     | Billing API     |

Table – 6
IX. Comparison of Security Services: AWS vs AZURE vs GCP

| Service                      | Amazon Web Services | Google Cloud Platform | Microsoft Azure          |
|------------------------------|---------------------|-----------------------|--------------------------|
| Authentication and authorization | Identity and Access Management (IAM) | Cloud IAM              | Active Directory          |
|                              | Organizations       | Cloud Identity-Aware Proxy | Active Directory Premium |
| Protect and safeguard with data encryption | Key Management Service | Storage Service Encryption | Storage Service Encryption |
| Hardware-based security modules | CloudHSM            | Cloud Key Management Service | Key Vault                |
| Firewall                     | Web Application Firewall | Application Gateway | Application Gateway       |
| Directory services           | AWS Directory Service | Active Directory Domain Services |
| Identity management          | Cognito             | Active Directory B2C   |                          |
| Cloud services with protection | Shield              | DDoS Protection Service |                          |

Table – 7

X. Market Share and Usages
Amazon Web Services holds 33 percent of the cloud infrastructure market, according to data published by Synergy Research Group. Microsoft’s stake of the market hopped to 13 percent from 10 percent a year before. Google improved to six percent from five percent. AWS market-share chopped by a percentage point.

![Cloud Infrastructure Services - Market Share Trend](image)

Source: Synergy Research Group

Figure- 2

XI. Pricing Models: AWS vs AZURE vs GCP

|        | Pricing                                      | Models                                      |
|--------|----------------------------------------------|---------------------------------------------|
| AWS    | Per hour – rounded up                        | On demand, reserved, spot                   |
| GCP    | Per minute – rounded up (minimum 10 minutes) | On demand – sustained use                    |
| Azure  | Per minute – rounded up commitments (pre-paid or monthly) | On demand – short term commitments (pre-paid or monthly) |

Table – 8
XII. Key Benefits of AWS, AZURE & GCP

| S. NO | AWS | AZURE | GCP |
|-------|-----|-------|-----|
| 1     | Dominates cloud domain with features such as configuration, monitoring, security, auto-scaling etc. | More reliable when comes to integrating with Microsoft tools | Expertise in DevOps |
| 2     | Better Offering | Better Development and testing tools | Flexible discounts & contracts |
| 3     | More Experience, enterprise friendly services | Also provide Hybrid cloud | Specifically designed for cloud-based businesses |
| 4     | More open source tools integration | | |
| 5     | Global Reach | | |

Table – 9

XIII. Drawbacks of AWS, AZURE & GCP

| S. NO | AWS | AZURE | GCP |
|-------|-----|-------|-----|
| 1     | The price structure is a bit intricate | Azure is lacking in the area of DevOps | GCP does not offer as many services as AWS or Azure. |
| 2     | AWS doesn’t have a specific "hybrid cloud" solution | Azure’s support for other operating systems is very limited, only supporting a limited varieties of Linux. | GCP is the newest out of the three providers, that means it’s the least mature in terms of variety of offerings |

Table – 10

XIV. Conclusion

Although AWS leads in public cloud market share, but it would be incorrect to claim it provides the top solutions. Microsoft Azure and Google Cloud Platform sure have their added advantages if you’re looking for easy business solutions or foolproof security. The idea is - there’s no universal best when it comes to Cloud Service Provider, it all derives down to what best suits your requirements.

XV. Recommendations

In order to distribute Risk, the Organizations should go for Multi-Vendor CSPs. The SaaS should be delegated to the CSP having better SaaS features, similarly the PaaS should be delegated to the CSP having better PaaS features and The IaaS should be delegated to the CSP having better IaaS features. The Major role in this aspect will be of the Managed Service Provider (MSP) who will ensure to provide multiple CSPs.

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