Comparison between Three Cloud Services: Amazon EC2, Microsoft Azure and Google Cloud

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1 Introduction

Cloud computing is combination of new and existing technologies which distributing computing services through connected computers and virtualized machine using internet resulting unified computing resources can be provided [1]. Cloud computing technology using virtualization technology to enable the usage hardware and software resources such as CPU, RAM, and bandwidth in virtual environment [1]. Cloud computing provides advantages such as saving costs and high mobility resulting the usage of cloud computing becoming popular in the recent years. The examples of cloud services are Amazon EC2, Microsoft Azure and Google Cloud.

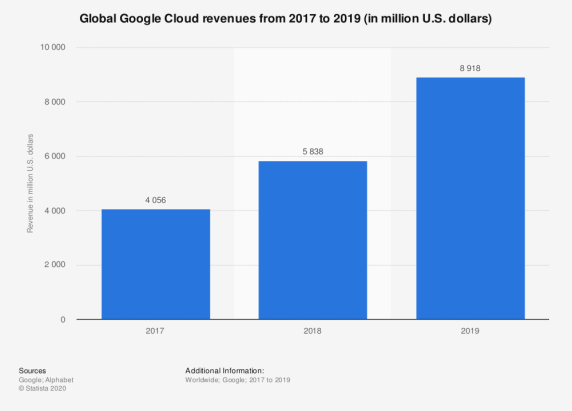

Fig. 1. According to statistic from Statista, the revenues of Google Cloud in global was doubled from 4,056 million USD in 2017 to 8,918 million USD in 2019 within 2 years [10].

2 Comparative Evaluation

Amazon EC2 is an IaaS. App Engine is Google Cloud's PaaS. With the App Engine, Google takes a large part in managing resources for user necessary. While Microsoft Azure is a PaaS which is like Google App Engine and an IaaS that helps and offers the development of compute, application, and storage services [2].

Table 1. Usefulness of various service models [3]

Service Model	**Software-as-a-Service (SaaS)**					
		Platform-as-a-Service (PaaS) *Google Cloud, Microsoft Azure*				
				Infrastructure-as-a-Service (IaaS) *AWS, Microsoft Azure*		
Utility	Hosted applications	Development tools, database management, business analytics	Operating systems	Storage and servers	Security/networking firewalls	Datacenter physical plant

Microsoft Azure offers enhanced security, integrated support for Microsoft software, and hybrid cloud capabilities. It has variety of instances including GPU and high-performance compute options, optimization for machine learning like AWS. Google's Compute Engine also offers one f1-micro instance [4].

Table 2. Comparison of instances / VMs [5]

Instance type	**AWS Instances**	**AWS RAM (GiB)**	**Azure VMs**	**Azure RAM (GiB)**	**Google VMs**	**Google RAM (GiB)**
General purpose	m5.xlarge	16	B4MS	16	n1-standard-4	15
Compute optimized	c5.xlarge	8	F4s v2	8	n1-highcpu-4	3.6
Memory optimized	r5.xlarge	32	E4 v3	32	n1-highmem-4	26
GPU	g3s.4xlarge	30.5	NC 6	56	NVIDIA@Tesla@P4	64

Table 3. The three most common cloud storage options provided [6]

Cloud Storage	**Block Storage**	**Object Storage**	**File Storage**
AWS	Elastic Block Store (Throughput Optimized HHD, General Purpose SSD, Provisioned IOPS SSD)	Simple Storage Service (Infrequent Access and Glacier)	Elastic File Storage.
Google Cloud	Persistent Disk (Standard or SSD)	Google Cloud Storage (GCS Nearline, GCS coldline)	Open-source FUSE adapter.
MS Azure	Managed Disk (Standard and Premium with SSD)	Hot & Cool with Azure Hot and Storage Blob.	Azure File Storage

AWS uses a version of Linux which is adapted to CentOS/RHEL and has minor adjustments to local requirements. As for Azure, it is not a single operating

system, but consists of several different OS working together [11]. While Google Cloud has a Debian 10+ OS.

Amazon has Fortinet which provides security features to Virtual Private Cloud in zones at will. As for Microsoft Azure, Fortinet provides optimized security and removes security outputs during migration. FortiGate provides security and firewalls for Google Cloud Platform [7].

Table 4. Comparison of security provided.

Services	AWS	Azure	Google
Authentication & authorization	Identity & management	Active Directory	Cloud Identity & management, Cloud Identity-Aware Proxy
Firewall	Web Application Firewall	Application Gateway	
Protection Cloud Services	Shield	DDoS Protection Service	
Identity Management	Cognito	Active Directory B2C	
Protection with Data Encryption	Key Management Service	Storage Service Encryption	

Table 5. Comparison of scalability.

Performance	AWS	Google Cloud	Microsoft Azure
Scalability	Highly scalable, high-performance container orchestration service allows to scale applications, group of VMs, or schedule containers on the VMs.	Features from Windows and Linux instances, RESTful APIs, load balancing, data storage and networking, CLI and GUI interfaces and easy scaling.	Highly scalable computing solution with different optimizations with Azure emphasis on hybrid computing, support many OS, Microsoft software and services.

Table 6. Comparison of pricing models [8]

Machine Type	AWS	Azure	Google Cloud Platform
Smallest Instance (2 vCPUs and 8 GB RAM)	US$69/month	US$70/month	US$52/month
Largest Instance	3.84 TB RAM 128 vCPUs US$3.97/hour	3.89 TB RAM 128 vCPUs US$6.79/hour	3.75 TB of RAM 160 vCPUs US$5.32/hour

AWS and Azure offer pay per minute billing while Google Cloud offers pay-per-second billing models. Google also offers discounts in certain condition.

Table 7. Comparison of auto-scaling provided.

Auto-Scaling	AWS	Google Cloud	Microsoft Azure
Elasticity	AWS Auto Scaling automatically creates all the scaling policies based on scaling plans and demands.	Compute Engine provides automatic scaling to add or remove VM instances based on demands.	Cloud service that enables Azure hosted resources to be automatically scaled according to demand and set parameters.

Table 8. Comparison of monitoring tools provided [9]

SERVICES	AWS	AZURE	GOOGLE
Burstable VM Types	*t4g*	*B*	*f1/g1*
General Purpose VM types	*m6g*	*Dv4/Dsv4*	*n2d-standard*
Regular Memory Optimized VM types	*r6g*	*Ev4/Esv4*	*n2d-highmem*
Super Memory Optimized VM types	*x1/z1d*	*Mv2*	*m1-ultramem*
Compute Optimized VM types	*c6g*	*Fsv2*	*c2-standard*
High Performance Compute VM types	*p3/g4/f1*	*HBv2/HC*	*clusters*
Storage Optimized VM types	*h1/i3/d2*	*Lsv2*	*n/a*
Container services	*ECS*	*ACI*	*Compute Engine*
Kubernetes services	*EKS*	*AKS*	*Kubernetes Engine*
Serverless containers	*Fargate*	*ACI*	*Cloud Run*
Serverless computing	*Lambda*	*Functions*	*Cloud Functions*

The Lambda service of AWS supports programming language with its Runtime API, which integrates with dozens of AWS services, or with other tools via AWS Lambda Extensions [9].

3 Opinions

One of the advantages of the Amazon EC2 is its ease of use as it provides user-friendly interface. It also provides speed and agility. Amazon EC2 can offers hiring of server in a few minutes only. It can greatly reduce the time taken to complete tasks with tools such as Auto Scaling, AWS Tools and Elastic Load Balancing. Its disadvantage is its networking is not flexible enough compared to other cloud platform resulting cross region communication difficult to setup.

For Microsoft Azure, it provides high data security make it becomes the leader in IaaS security. It allows companies to launch their clients' application in the cloud to save infrastructure and maintenance costs. The cons of this platform are it needs experts to fully utilize the platform. Experts are required to ensure all functions

work correctly. Many mistakes will occur, and costs will be wasted if no expert managing the platform.

Meanwhile, Google Cloud Platform (GCP) provides faster networking speed compared to other cloud platforms as its network using fiber optic cable. GCP costs less as pay-per-second billing model provided, and it also offers discounts to their clients. Unfortunately, GCP still has its limitation at compute services provided and only has Compute engine and Kubernetes engine.

Amazon EC2 is preferred because it is the leading platform in cloud services and provides variety of services tool such as management, web designing and mobile application tools. These tools increase efficiency in software development due to ease of using and greatly reduce the time required. Although Amazon EC2 costs more than the other two, it is still preferred to ensure the quality of software even it costs more.

4 Conclusion

This paper evaluates the comparisons between three major cloud services, Amazon EC2, Microsoft Azure and Google Cloud. These three services have their own advantages and disadvantages over each other, making them preferred by users. However, Amazon EC2 is the best for software development due to its superior quality and efficiency.

References

1. Swathi, T., Srikanth, K., Reddy, S.R.: Virtualization in Cloud Computing, International Journal of Computer Science and Mobile Computing (IJCSMC), Vol. 3, Issue. 5 (2014) 540-546
2. Azure IaaS. Retrieved from https://www.bitscape.com/it-services/managed services/azure-iaas/
3. What is IaaS? Retrieved from https://azure.microsoft.com/en-in/overview/what-is-iaas/
4. Harvey, C., Patrizio, A.: AWS vs. Azure vs. Google: 2021 Cloud Comparison. Retrieved from https://www.datamation.com/cloud-computing/aws-vs-azure-vs-google-cloud-comparison.html
5. AWS vs Azure vs Google Cloud: Pricing Comparison of Virtual Machines. Retrieved from https://www.simform.com/compute-pricing-comparison-aws-azure-googlecloud/
6. Yudi, W.: Pilihan Cloud Storage AWS vs Azure vs Google Cloud. Retrieved from https://cloudhostingindonesia.com/pilihan-cloud-storage-aws-vs-azure-vs-google-cloud/
7. AWS Vs Azure Vs Google Cloud- What is the best cloud platform for your business. Retrieved from https://embee.co.in/blog/aws-vs-azure-vs-google-cloud/
8. Laatikainen, G. & Ojala, A. & Mazhelis, O. (2013) Cloud Services Pricing Models. ICSOB 2013. LNBIP. 150.
9. A Cloud Services Comparison of the Top Three IaaS Providers. Retrieved from https://www.cloudhealthtech.com/blog/cloud-services-comparison
10. Global Google Cloud revenues from 2017 to 2019. Retrieved from https://www.statista.com/statistics/478176/google-public-cloud-revenue/
11. The Operating Systems of Windows Azure. Retrieved from https://www.red-gate.com/simple-talk/cloud/cloud-development/the-operating-systems-of-windows-azure/