

Cloud Computing Fundamentals: Literature Review on Cloud Computing Service Providers

Vincent Boo Ee Khai ¹, Ong Han Wah ¹, Madihah binti Che Zabri ¹,
Qaisara binti Rohzan ¹, Rishma Fathima binti Basher ¹

¹ Technology and Information Systems (SECP1513-02), School of Computing,
Universiti Teknologi Malaysia (UTM).

1 Introduction

Cloud computing has become an essential tool for humans in the modern day life. It provides people with instant access to a broad range of technologies. With cloud computing, resources from the cloud can be accessed when needed in real time and frees from managing infrastructure and data centers. Today, most organizations use cloud computing for a wide variety of use. For example, big data analytics, data backup, disaster recovery and virtual desktops. These technology services can be accessed from cloud providers such as Google Cloud Platform, Microsoft Azure and Amazon EC2.

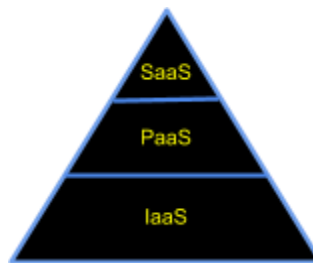


Figure 1

Figure 1 shows three delivery models which are Software as a service (SaaS), Platform as a service (PaaS) and Infrastructure as a service (IaaS). Based on the pyramid, the amount of customer control of the virtualized IT resources increases from top to down. Most cloud computing service providers deliver all three models of services to their clients due to high demands from the industry. Before cloud computing was introduced in the market, service-oriented architecture (SOA) was used to ensure software integrals are capable of being used again by service interfaces. Most organizations tend to change and make use of cloud computing due to its wide range of services. For example, cloud computing eradicates company's capital expenditures of purchasing different software and hardwares.

2 Comparative Evaluation

Below is the table made for comparative analysis. Our group generated this table to ease readers in understanding and differentiating three of the best Cloud computing service providers.

Comparative points	Amazon EC2	Google Cloud Platform	Microsoft Azure
Service model	<ol style="list-style-type: none"> 1.Infrastructure as a service (IaaS) 2.Platform as a service(PaaS) 3.Software as a service (SaaS) 	<ol style="list-style-type: none"> 1.Compute 2.Networking 3.Databases 4.Operation 	<ol style="list-style-type: none"> 1.Infrastructure as a service (IaaS) 2.Platform as a service(PaaS) 3.Software as a service (SaaS)
Virtual Machine (VM) instance types offered	<ul style="list-style-type: none"> • General purpose • Compute optimized • Memory optimized • Accelerated computing • Storage optimized 	<ol style="list-style-type: none"> 1. Standard machines 2. High-memory machines 3. High-CPU machines 4. Mega-memory Machine 	<ul style="list-style-type: none"> • General purpose • Compute optimized • Memory optimized • Storage optimized • GPU • High performance compute
Storage services	<ul style="list-style-type: none"> • Simple Storage Service (S3) • Elastic Block Storage (EBS) • Elastic File System (EFS) • Storage Gateway • Snowball • Snowball Edge • Snowmobile 	<ul style="list-style-type: none"> • Blob Storage • Queue Storage • File Storage • Disk Storage • Data Lake Store 	<ul style="list-style-type: none"> •Cloud Storage • Persistent Disk • Transfer Appliance • Transfer Service
OS environments offered	Amazon Linux, Ubuntu, Windows Server, Red Hat Enterprise Linux, SUSE Linux Enterprise Server, openSUSE Leap, Fedora, Fedora CoreOS, Debian, CentOS, Gentoo Linux, Oracle Linux, and FreeBSD	<ul style="list-style-type: none"> • CentOS • Container-Optimized OS (COS) • Debian • Fedora CoreOS • Red Hat Enterprise Linux (RHEL) • SQL server • SUSE Linux Enterprise Server (SLES) • Ubuntu LTS • Windows client • Windows Server 	<ul style="list-style-type: none"> • CentOS • Flatcar Container Linux • Debian • Red Hat Enterprise Linux (RHEL) • Oracle Linux • SUSE Linux Enterprise Server (SLES) • openSUSE • Ubuntu LTS • Windows Server
Security	<ol style="list-style-type: none"> 1.Controlling network Access to your instances, For example, through configuring your VPC and 	<ol style="list-style-type: none"> 1. Infrastructure security -Rely on a secure-by-design infrastructure with hardening, configuration management, and patch 	<ol style="list-style-type: none"> 1.Azure Security Centre -A cloud workload protection solution that provides security management and advanced threat protection

	<p>security groups.</p> <p>2.Managing the credentials used to connect to your instances.</p> <p>3.Managing the guest operating system and software deployed to the guest operating system, including updates and security patches.</p> <p>Configuring the IAM roles that are attached to the instance and the permissions associated with those roles.</p>	<p>and vulnerability management.</p> <p>2. Network security Help secure the network with products that define and enforce your perimeter and allow for network segmentation, remote access, and DoS defense.</p> <p>3. Endpoint security -Help secure endpoints and prevent compromise with device hardening, device management, and patch and vulnerability management.</p> <p>4. Data security -Make sensitive data more secure with data discovery, data governance, and controls to prevent loss, leakage, and exfiltration.</p> <p>5. Application security -Protect and manage your business applications with application testing, scanning, and API security features.</p> <p>6. Security monitoring and operation -Monitor for malicious activity, handle security incidents, and support operational processes that prevent, detect, and respond to threats.</p>	<p>across hybrid cloud workloads.</p> <p>2. Azure Key Vault -A secure secrets store for the passwords, connection strings, and other information you need to keep your apps working.</p> <p>3. Azure Monitor logs -A monitoring service that collects telemetry and other data, and provides a query language and analytics engine to deliver operational insights for your apps and resources. Can be used alone or with other services such as Security Center.</p> <p>4. Azure Dev -A service that helps developers and testers quickly create environments in Azure while minimizing waste and controlling cost.</p>
Performance and scalability	Monitors the applications and automatically adjusts capacity to maintain steady, predictable performance. It is also easy to set up application scaling for multiple resources across multiple services in minutes.	Provide more performance stability compared to Amazon	Provide more performance stability compared to Amazon
Pricing model	<p>1.On-Demand</p> <p>2.Per-second billing</p>	<p>1.Pay as you go</p> <p>2.On-demand per second billing</p>	Pay as you go pricing

Auto-Scaling/Elasticity	Allow automatically add or remove EC2 instances according to demand or conditions defined	Serves automatic healing and built-in load balancing	Allows us to scale automatically using a wide variety of metrics
Monitoring tools/service provided	<ul style="list-style-type: none"> • Amazon CloudWatch 	<ul style="list-style-type: none"> • Cloud Monitoring 	<ul style="list-style-type: none"> • Microsoft Azure Monitor • Azure Advisor • Azure Automation • Azure Cost Management plus Billing • Azure Service Health • Azure Network Watcher • Azure Resource Health

3 Opinion

Cloud platforms	Advantages	Disadvantages
Amazon EC2	<ol style="list-style-type: none"> 1. Deliver new services 2. Easier scale of services 3. Almost unlimited storage 	Expensive cost
Google Cloud Platform	<ol style="list-style-type: none"> 1. Easy to access to information 2. Backup and recovery 3. Cost efficiency 	<ol style="list-style-type: none"> 1. Technical issue 2. Possible downtime
Microsoft Azure	<ol style="list-style-type: none"> 1. Automatic software integration 2. Easier scale of services 3. Almost unlimited storage 	Expensive cost

After going through thorough research and discussions, our group chose Microsoft Azure as our preferred cloud computing service provider. From a client perspective, Microsoft Azure provides more services as compared to Amazon EC2 (AWS) and Google Cloud Platform (GCP). In terms of financial astutes, Microsoft Azure extends a better and affordable 'Pay as you go' service in spite of its captivating 12 months of complimentary popular service with an addition of credit worth \$200 to explore any Microsoft Azure service within 30 days trial. On top of that, Azure also offers a wide free of charge range of services which spans over 25 functional services. As a university student with zero working income, we would definitely subscribe to Microsoft Azure as it provides more comprehensive services and offers for less. Amazon EC2 (AWS) on the other hand is priced 5 times more than Azure.

Besides that, Microsoft Azure also promotes a serverless working environment in which no solid servers are needed for the application to operate. This will surely benefit all kinds of organizations by reducing the cost on hardware expenditure and on-site server maintenance team. In the prospects of Machine Learning, all three cloud

service providers are equally strong in this field. If looking into the cloud computing performance and scalability, Microsoft Azure tops off Amazon EC2 with their undeniably high computing performance.

4 CONCLUSION

In conclusion, cloud computing is the new technological development and it keeps being on-demand especially during the Covid-19 pandemic in which most people conduct their work via online platforms. Therefore, it is proved that cloud computing has given a great impact on the world. For example, we can say that almost all of the organizations use cloud computing as they can spend less on maintenance and software upgrades resulting in less operational cost. In this globalised era, all computing fundamentals are digitised to ease a man's way of life. Nowadays, we can simply store, restore and back up data with the click of a button and with the help of cloud computing. No solid devices such as compact discs (CDs), USB thumb drives and hard disks are needed in today's modern way of living. Cloud computing in general has positively impacted the society by reducing computing architectural expenses, increases mobility and scalability and many more.

5 REFERENCES

Tajadod, G., Batten, L. and Govinda, K., 2012, December. Microsoft and Amazon: A comparison of approaches to cloud security. In *4th IEEE International Conference on Cloud Computing Technology and Science Proceedings* (pp. 539-544). IEEE.

Aljamal, R., El-Mousa, A. and Jubair, F., 2018, April. A comparative review of high-performance computing major cloud service providers. In *2018 9th International Conference on Information and Communication Systems (ICICS)* (pp. 181-186). IEEE.

Wankhede, P., Talati, M. and Chinchamalature, R., COMPARATIVE STUDY OF CLOUD PLATFORMS-MICROSOFT AZURE, GOOGLE CLOUD PLATFORM AND AMAZON EC2.

Gandhi, V.A. and Kumbharana, C.K., 2014. Comparative study of Amazon EC2 and Microsoft Azure cloud architecture. *International Journal of Advanced Networking & Applications*, pp.117-123.