

Cloud Computing Fundamentals (Amazon EC2, Google Cloud Platform, and Microsoft Azure)

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1 Introduction

The world of technology has been evolving every single day and one of the big factors of the Fourth Industrial Revolution (IR 4.0) is cloud computing. Cloud computing is the delivery of different resources through the Internet. These tools or services include servers, databases, networking, and also analytics. Cloud computing can provide organizations with the means and methods needed to ensure financial stability and high quality service. Cloud computing services can interact with each other to forming one comprehensive model of cloud computing and there can offer a business in term of storage and resources pooling (Exin, 2017). This literature review is a comparison and evaluation on the three most popular and prominent cloud providers which are Amazon Elastic Compute Cloud (Amazon EC2), Google Cloud Platform, and Microsoft Azure.

Table 1. Background of the most prominent cloud computing service providers.

Cloud Providers	Developer	Initial Release	Website
Amazon Elastic Compute Cloud (Amazon EC2)	Amazon.com	25 th August 2006	aws.amazon.com/ec2/
Google Cloud Platform	Google	7 th April 2008	cloud.google.com
Microsoft Azure	Microsoft	1 st February 2010	azure.microsoft.com

2 Comparative Evaluation

2.1 Service Model

There are three typical cloud service models which include Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). All three primary cloud service providers have adopted to provide all three service models. Amazon EC2 is primarily known for its IaaS model which provide online computing infrastructure and guarantee that maximum level of flexibility and management control are given to the clients. Microsoft Azure has a balanced advantage over the three service model which causes it to be favoured by the clients who require three service model at the same time. Likewise, Google Cloud Platform also provides all of the service models but it is well known its SaaS which includes the Google Docs Editors Suite. They are also known for their PaaS which helps in deploying applications.

2.2 Virtual Machine

Virtual Machine is often used for testing applications, backing up data and running software designed for other Operating Systems. Amazon, Microsoft and Google provide VM instance forms in a range of predefined instance configurations with specific details of virtual CPU, RAM and network. These configurations are referred as the instances. Amazon EC2 uses EC2 instances while GCP uses instances which is hosted by Google's infrastructure. Microsoft provides Azure VM which also operates the same way as the other two cloud providers but a different platform with having different types of instances such as general purpose, compute optimized, memory optimized and many more.

2.3 Storage

In terms of storage, the data is stored by the cloud service providers. It allows data and files to be saved in the server anytime and anywhere when there is internet connection such as through the public internet or a private network connection. Amazon EC2 has Amazon Simple Storage Service (S3) which provides scalable object storage for data backup, collection and analytics. It is flexible, cost-effective, and easy-to-use data storage options for instances. Each option has a unique combination of performance and durability. While for Google Cloud Platform, it has an unlimited storage with no minimum object size and a worldwide accessibility and storage locations. It also has low latency and high durability. Google has provided an easy transition to lower-cost classes when it meets the criteria users specify, multiple redundancy options which users can customize where and how they store their data, an easy data transfer to Cloud storage and many storage classes for any workload. Meanwhile, Microsoft Azure has more specialized solutions and provides the largest array of databases and offers a dedicated storage option called Blob Storage which is reserved for unstructured REST-based object warehousing.

2.4 OS Environments

All three cloud computing providers supports the common Windows and Linux OS. Amazon EC2 however have support for Amazon Linux, Ubuntu, Windows Server, MacOS, Red Hat Enterprise Linux, SUSE Linux Enterprise Server, Fedora, Debian, CentOS, Gentoo Linux, Oracle Linux, and FreeBSD. The Compute Engine from Google Cloud Platform can support a few more types of OS which Amazon EC2 also supports which are CentOS, Debian, Fedora CoreOS, SUSE Linux Enterprise Server (SLES), Ubuntu and Red Hat Enterprise Linux (RHEL). Lastly, Microsoft Azure offers the least and limited amounts of OS environments. In this case, Amazon EC2 provides the most number of OS environments offered compared to Google Cloud Platform while Microsoft Azure has the least OS environments offered among all of them.

2.5 Security

In Amazon EC2, cloud security is the higher priority. First is the security of the cloud, Amazon is important to protect the infrastructure that runs the service in the AWS Cloud. Amazon EC2 has the security for data protection purposes, identity and access management, compliance validation and infrastructure security. Their system helps to prevent attacks, detect suspicious activities and give a quick respond to the incidents. The Google Cloud Platform uses multiple layers of security. In the Google Cloud security layers, it includes everything from physical security at data centers to some of the most advanced cybersecurity technology and professionals available in the world. Besides, it also gives a chance for customers to make choices either let Google Cloud manage profile key or let them manage by themselves. Microsoft Azure has multi-layered security system. By using this system, it protects the data, apps, and infrastructure very quickly by built-in security services in Azure that include unparalleled security intelligence. By implementing a layered, it provides a deeper and stronger defense across identity, data, hosts and networks. Advanced-encryption standard is one of the more popular security options on Azure.

2.6 Performance and Scalability

In terms of performance and scalability, Amazon EC2 has more than 350 instances types to optimize apps and websites. It can deploy secure, reliable and scalable websites, apps or process for free. Richter F. (2019), stated that Amazon EC2 and AWS is the most successful that is profitable to Amazon that has nothing to do with online shopping. GCP on the other hand has a powerful platform with a vast array of global private networks with equals speed and ease of connectivity and has an impressive selection of AI and data analysis apps. It is also flexible, scalable, and can adjust the resources consumed by an app. Google Cloud Platform also has autoscaling to automatically adjust the number of instances. Microsoft Azure has Azure high-performance computing (HPC) which is a complete set of computing, networking, and storage resources. In Azure high-performance computing, it Maximize the full range of CPU, GPU, FPGA, and fast interconnect capabilities to reduce job completion times. Besides, it has end-to-end workflow agility, production-class platform and incorporating intelligence which is also highly scalable.

2.7 Pricing Model

Amazon EC2, Google Cloud Platform, and Microsoft Azure have different pricing approach to the users. Thus, these three major cloud providers try to reduce the price of cloud instances by giving up

discounting options, reduce billing increments to per second billing. In this table, it shows the difference between the pricing models of the three cloud services.

Features	aws	vs	Azure	vs	GCP
Pricing/ Discount Options	One-year free trial along with a discount of up to 75% for a 1-3 year commitment		Up to 75% discount for a commitment ranging from one to three years		GCP Credit of \$300 for 12 months apart from a sustained use discount of up to 30%

Source: <https://www.veritis.com/wp-content/uploads/2018/05/infographic-aws-vs-azure-vs-google-cloud-features-veritis.png>

The pricing is based on the machine type that users use, there are smallest instance and largest instance. GCP provides the cheapest rate for a basic instance which contain 2 virtual CPU and 8GB of RAM with a cost of US\$52 per month. While Microsoft Azure has the cheapest rate for a large instance that includes 3.89 TB of RAM and 128 vCPU which costs around US\$6.79per hour, GCP takes the lead here with its largest instance that includes 3.75 TB of RAM and 160 vCPUs. It will cost you around US\$5.32 per hour. It can clearly be seen that the Google Cloud Platform has the best overall value compared to the other two cloud providers. Google states explicitly on its website that it plans to compete not only on performance but also on price. Therefore, organizations should take note and consider all of these factors and pricing before choosing a cloud provider.

2.8 Auto-Scaling/Elasticity

Amazon EC2, Google Cloud Platform and Microsoft Azure all provide Auto-Scaling. Amazon EC2 Auto Scaling helps to maintain application availability and automatically add or remove EC2 instances. Amazon EC2 Auto Scaling help to maintain the health and availability of fleet in fleet management and it has dynamic scaling and predictive scaling which can be used together to scale faster. Other than that, Amazon EC2 is integrated with a vast majority of AWS services, providing it a better compatibility and flexibility for auto-scaling. GCP on the other hand provides auto-scaling capabilities from the Google Compute Engine that automatically add or remove virtual machines (VM) instances from a managed group based on increase or decrease in load. Their auto-scaling helps your apps gracefully handle increases in traffic and reduce costs when the need for resources is low. Like EC2 and GCP, Microsoft Azure has Azure Autoscale that scales automatically to match demand to accommodate workload. Azure Autoscale scale out to ensure capacity during workload peaks and scaling will return to normal automatically when the peak drops. It also dynamically scales apps to meet changes that happens. Azure Autoscale can automatically scale an organization's service any time any day or even by a custom metric that person defines.

2.9 Monitoring tools/service

Amazon EC2 provided developer and management tools which can be used to manage the cloud service easily. AWS also provide machine learning and predictive analytics, machine learning can be used on cloud computing to learn new algorithm to predict analytics. Google Cloud Platform provides Cloud Monitoring that automates out-of-the-box metric collection dashboards. It also facilitates hybrid and multi cloud environment management. GCP also support cloud-native application development which is the ability to build and run applications with Google Cloud. This service reduce risk with open source technology, allows developer to focus on code, not managing infrastructure and build app quickly without sacrificing speed and reliability. Microsoft Azure provide big data and predictive analytics monitoring which can store data in large volume while analyzing the big data to predict business solutions. Azure also provides app and game development service. In game development, Azure offers various tools such as Azure PlayFab, Azure DevOps, Azure Cognitive Services and more to speed up the game development process.

3 Opinions

Cloud Computing Providers	Advantages	Disadvantages
Amazon EC2	• Very scalable • Security, compliance, and disaster recovery • Good support for larger organizations	• Pricing issues • Not user-friendly • Additional technical support fees
Google Cloud Platform	• Many regions available to store data • easy to integrate with other cloud platforms • The best pricings with deep discounts and value	• Lack of important services such as recovery service • Lacks features • Difficult to start at first
Microsoft Azure	• Has a wide range of feature • Has high level privacy and security • Competitive pricing • Has open source support	• High cost (not the best value) • Takes longer time to provision VMs • Lack of integrated backups

Overall, we decided to choose Google Cloud Platform for our software development because it is reputational in providing SaaS service model, its state of the art security system, better and reasonable pricing models with many discounted fees and not to mention its low latency networks. Besides, Google Cloud Platform can also scale and handle hundreds if not thousands of connections at the same time without any bugs or hiccups. Sure, it has its disadvantages like the poor documentations of it, however the GCP stores our data redundantly in at least two regions therefore making it more secure in case of disasters.

4 Conclusion

In conclusion, cloud computing has big potential to give impact one the future of Internet technologies. The 3 major cloud computing services at the moment which are Microsoft Azure, Amazon EC2 and Google Platform each have their strengths and weaknesses and has a lot of room to improve. Cloud computing is known to be one of the fastest growing technologies which can benefit many types of customers from normal consumers, developers, and to large organizations as well. We should pick the computing services based on their need not the branding, we can always compare the difference between these 3 services as well as read the feedback reviews by user to get a better grasp of each cloud computing services. Cloud computing is truly the future.

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