Cloud Computing Fundamentals:
Literature Review on Cloud Computing Service Providers.

Lai Kin Yong[1], Ieskandar Zulqarnain Bin Ghazali[1], Aiman Na'im Bin Ariffin[1],
Syaza Syaurah Binti Mohd Yusran[1], Hibban Kamil Hizbuttahrir[1]

[1] School of Computing, Faculty of Engineering, Universiti Teknologi Malaysia (UTM), Skudai, Johor, Malaysia
{laiyong, ieskandarzulqarnain, aimannaim, syazasyaurah, hibbankamil}@graduate.utm.my

1 Introduction

The provision of science computation needs a growing number of resources and results in a fair time period for increasing issue sizes. While the largest research projects in the last decade had been able to provide costly supercomputers, other projects would have to choose cheaper resources, such as commodity clusters and grids. Cloud infrastructure proposes an approach where services are no longer hosted by the computing facility of the researcher, but only rented from large data centres, if necessary. In specific terms, cloud infrastructure or cloud computing is the collection of facilities that provides on-demand access to computational services which include programme, server, data storage, programming tools, network resources and more (physical servers and virtual server) through internet access while it is hosted by the cloud service provider in a remote data centre (or CSP) (Vennam, S 2020). In this literature review, three cloud computing service providers are chosen to be compared and evaluated.

Table 1. Background of cloud computing service providers.

Providers	Developer	Launch Date	Website
Amazon EC2	Amazon.com	25th August 2006	aws.amazon.com/ec2/
Microsoft Azure	Microsoft	1st February 2010	azure.microsoft.com
Google Cloud Platform	Google	7th April 2008	cloud.google.com

2 Comparative Evaluation

Three cloud computing service providers are evaluated comparatively based on 9 criteria which include service model, virtual machine instance types offered, storage, OS environments offered, security, performance and scalability, pricing model, auto-scaling/elasticity and monitoring tools/service provided. These criteria contribute for the difference in the features and the quality among three cloud computing service providers. With detailed description and explanation regarding these criteria, this literature review manage to determine the most suitable cloud service provider for our software development.

2.1 Service Model

Modern cloud computing services are offered in various service models to suit the different client companies' business requirements. There are three cloud service models which include Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). Nowadays, the primary cloud service providers are able to provide all three service models. However, 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 for its prominence in PaaS such as App Engine which helps in deploying applications, and SaaS since Google is experienced in developing useful softwares like Gmail and Google Drive.

2.2 Virtual Machine

Virtual machine (VM) is one of the services provided in the IaaS. 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 by Amazon EC2 and Microsoft Azure as the instance types while the Cloud network is defined as a system type. Predefined categories of instances are identified by their intended use. The first category is "general purpose" which offers a balanced CPU-to-memory ratio, small to medium databases and low to medium web servers for testing and development. The second category is "compute optimised" and has a high CPU-to-memory ratio and is suitable for medium traffic web servers, network equipment, batch applications, and application servers. Thirdly,' memory optimised' is perfect for relational database servers, medium to large caches, and in-memory analytics, and has a high memory-to-CPU ratio.

2.3 Storage

The storage in this context is referred to cloud storage in which the digital data is stored by the cloud service providers. Amazon EC2 is providing a variety of storage models to the clients in which they could choose the most suitable storage model according to their needs without having to afford extra cost for unwanted features. Besides, Amazon EC2 is mostly favoured by large organisations due to its advantages in storing huge data. Mircrosoft Azure provides a dedicated storage solution called Blob Storage which is reserved for unstructured, REST-based object storage. In other words, storage models of Microsoft Azure aim at storing large-scale data and high-volume workloads. The feature that makes Microsoft Azure stand out in terms of data backup is its unique backup recovery system. On the other hand, Google Cloud Platform has relatively fewer storage choices and limited features for its storage models. However, the storage models of Google Cloud Platform are more unified and targeted which suit the clients who have unique requirement over storage.

2.4 OS Environments

All three cloud computing platform support Windows and Linux OS. Amazon EC2 and Google Cloud Platform can support a few more types of OS which are CentOs, Debian, Fedora CoreOS, SUSE Linux Enterprise Server (SLES), Ubuntu and Red Hat Enterprise Linux (RHEL). The OS environments which are provided exclusively in Amazon EC2 are Amazon Linux, openSUSE Leap, Fedora, Oracle Linux, and FreeBSD. The OS environments that are only provided in Google Cloud Platform include Container-Optimized OS (COS) and SQL Server. 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

The security in every modern cloud infrastructure is based on a model of "shared responsibility" where both customer and cloud providers are obligated to secure the cloud infrastructure but in difference ways. For cloud providers as Amazon (AWS), Google Cloud Platform (GCP) and Microsoft Azure, customers are already given task to do their part for their own security in the cloud. For Amazon EC2 which is categorised as IaaS, it requires the customer to perform all the necessary security configuration and management tasks like managing the guest operating system include updates and security patches, any application software or utilities installed by the customer and the configuration of the AWS-provided firewall.

The wide array of security tools and capabilities gives Microsoft Azure a huge advantage. Azure can control the actions of the clients by providing the configurable security options where we as clients also could customise and meet the desired deployment. The most top is that Azure using the primary-customer controls where the clients themselves could set the level of security to their platform in Azure. Other than that, the Azure platform is controlled by Microsoft where the data centres are monitored and controlled by the staff of Microsoft.

Google Cloud Platform is one of the cloud services that are independent which does not rely on single technology to make it more secure. It have multi-layered of security for its infrastructure which the clients could entrust without any administration on it. Google Cloud Platform build their own infrastructure to make sure the stage of security is top notch .

2.6 Perfomance and Scalability

Amazon EC2 has a high performance and is highly scalable that supports a fully managed Docker containers registry which allows us to store, manage, and deploy Docker container images. This service also allows us to easily run and scale containerized applications, manage and scale a cluster of VM's, or schedule containers on those VM's. Microsoft Azure is also a highly scalable and high-performance computing, Ai, and ML-based computing container instances and with azure's emphasis on hybrid computing, support for multiple OS's types, Microsoft software, and services. One of it that use to auto-scale our instances is Virtual Machine Scale Sets. Google offer an easy scaling that can spins up instances faster than most of its competition. It also used carbon-neutral infrastructure to run that offers the best value for the buck. The services offers the standard array of features starting from windows and Linux instances, RESTful API's, load balancing, data storage, networking, and CLI and GUI interfaces.

2.7 Pricing Model

The pricing model of Amazon EC2 is particularly inscrutable and it is relatively difficult for clients to calculate the overall expenditure based on those pricing model. Therefore, the clients are encouraged to utilise third-party cost management tools to compute the pricing model of Amazon EC2. Likewise, Azure also offers a complicated pricing model due to its numerous software licensing options and involvement of situation-based discounts. The clients who are interested in using Microsoft Azure are advised to request guidance from individuals with relevant experience to understand its pricing model. In comparison with two previous cloud service providers, Google Cloud Platform provides a customer-friendly pricing model. Besides, Google use deep discounts and flexible contracts which favour the clients who are concerned by their budget.

2.8 Auto-Scaling/Elasticity

Amazon EC2 provides scalable compute capacity in the cloud in which the clients could modify the capacity in minutes and generate thousands of server instances simultaneously. Other than that, Amazon EC2 is integrated with a vast majority of AWS services, providing it a better compatibility and flexibility for auto-scaling. Azure uses VM to virtualise a wide range of computing solutions including development and testing, running applications, and data centre extension. Its open-source software supports a full range of Linux distributions, Windows Server, SQL Server, Oracle, IBM, and SAP. The VM's could be created for both on-premises servers and on the cloud, and can be integrated to provide global load balancing. It's easy to deploy Microsoft enterprise apps on your virtual machines. Google Compute Engine creates virtual machines that run in its data centres and worldwide fibre network. It supports instances with up to 160 virtual CPUs, 3.75 TB of memory, and persistent SSD and HDD disks up to 64 TB in size. Google automatically discounts prices for long-running workloads, and its environmentally friendly global network of data centres consume 50% less energy than the typical data centre.

2.9 Monitoring tools/service

Amazon EC2 provides both automated and manual monitoring tools. The monitoring tools could conduct system status checks to detect any problem with the instances that require repairing. The monitoring tools could also carry out the instance status checks which monitor the software and network configuration of the clients' individual instance. Azure Monitor, the monitoring tool provided by Microsoft Azure helps the clients to maximize the performance of the their services by collecting and analysing the data. The data collected by Azure Monitor includes application monitoring data, guest OS monitoring data and Azure resource monitoring data. Then, the data would be analysed to diagnose the erros without waiting the clients to report them the Application Insights feature of Azure Monitor. Google Cloud Platform offers the cloud monitoring tool which would collect parameters from multicloud and hybrid infrastructure in real time. Like Azure Monitor, Google cloud monitoring tool also visualize the insights upon the errors via dashboards and charts. One amazing feature of Google cloud monitoring tool is that it could collaborate with third-party tools such as Slack for cloud management which provide flexibility to the clients.

3 Opinions

Since we are still students who don't possess much deep knowledge in IT, it is reasonable to choose SaaS for our cloud computing service which is ready-to-use and require less configuration from the clients. We would favour a micro or small VM instance as our software would be developed only for only assignment or small project only which does not involve heavy computation. Likewise, a small, dedicated storage would be great choice for our experimental software development. In our software development, it is safe to assume we won't have much chance to deal with real sensitive data so the security of the cloud service would less likely to concern us. Due to our limited budget, we would look for cloud service provide that has great reputation in performance with reasonable pricing. Besides, elasticity would be a quite important criterion for us to choose the cloud service we could modify the cloud service based on our personal requirement. We also prefer a cloud service that allow us to use external open-source cloud monitoring tools which could save our budgets.

4 Conclusion

In conclusion, we decided to choose Google Cloud Platform because it is reputational in providing SaaS service model, a general purpose machine (f1-micro instance) per month for free to the clients, an unified and targeted storage and it support multiple OS environment. Besides, Google Cloud Platform also offer built-in tool to secure the cloud service, great performance at a reasonable pricing model and feature that allow clients to use external cloud monitoring tools.

5 Reference

1. IBM Cloud Education. (2019, July 12). Learn_iaas. Retrieved January 19, 2021, from https://www.ibm.com/cloud/learn/iaas
2. IBM Cloud Education. (2019, October 29). Paas. Retrieved January 19, 2021, from https://www.ibm.com/cloud/learn/paas
3. AWS Elastic Beanstalk – Deploy Web Applications. (n.d.). Retrieved January 19, 2021, from https://aws.amazon.com/elasticbeanstalk/
4. App Service. (n.d.). Retrieved January 19, 2021, from https://azure.microsoft.com/en-us/services/app-service
5. App Engine Application Platform | Google Cloud. (n.d.). Retrieved January 19, 2021, from https://cloud.google.com/appengine
6. Machine types | Compute Engine Documentation | Google Cloud. (n.d.). Retrieved January 19, 2021, from https://cloud.google.com/compute/docs/machine-types
7. https://www.datamation.com/cloud-computing/aws-vs-azure-vs-google-cloud-comparison.html
8. https://fullscale.io/blog/cloud-computing-comparison-2019-aws-vs-azure-vs-google/
9. https://docs.microsoft.com/en-us/azure/
10. https://cloud.google.com/docs
11. https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/concepts.html