

Cloud Computing Service Providers: Amazon EC2, Google Cloud Platform, and Microsoft Azure

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1 Introduction

Cloud computing is the distribution of various services including software, storage and database. With cloud computing, user can store the data in the internet instead of computer's hard drive and can access it anywhere as long as the device has internet connection. There are three cloud computing service providers that well known which are Amazon EC2, Google Cloud Platform and also Microsoft Azure. The question is which cloud computing is the most worth to use? We are going to compare the three cloud computing based on Service model (IaaS, PaaS, SaaS), Virtual Machine (VM), Storage, OS environments offered, Security, Performance and scalability, Pricing model, Auto-Scaling/Elasticity and Monitoring tools/service provided.

2 Service Model

For PaaS, AWS Elastic Beanstalk gives the user access to a wide range cloud serviced like content delivery and database storage. Microsoft Azure can deploy various pre-configured and hosted infrastructures through its PaaS solution. It can meet any of your business needs, such as storage, network and web hosting. This utility can fully manage all the platform needs. Google cloud can supporting application development and using built-in hosting services for activities such as email and user management and can be run and managed to monitor, expand and host. For SaaS, AWS provide an easy way to let the customer manage their software like user access, account creation, etc. Azures allow the user to connect and use the cloud-base apps over the internet such as Microsoft Office 365. Google Cloud use the Google Kubernetes Engine to enable the user to easily deploy their product across a network.

3 Virtual Machine

Amazon Web Services EC2, Microsoft Azure, Google cloud provide a lot of type of Virtual Machine (VM) based on memory, storage and compute types such as general-purpose, computer-optimized, memory-optimized, storage optimized, GPU, High-performance computing. For the general-purpose instance, AWS EC2 provide A1, M5, T3 instance while Azure provide B, Dsv3, Dv3 instance and Google Cloud provide E2, N2 to give the customer. For computer-optimized instance, AWS EC2 provide C4, C5 instance while Azure provide Fsv2, Fs, F and Google Cloud provide C2 to give the customer. For the memory-optimized instance, AWS EC2 provide X1e, X1, R5 instance while Azure provide Esv3, Ev3, M instance and Google Cloud provide M2, M1 to give the customer. For the storage optimized, AWS EC2 provide H1, i3, D2 instance while Azure provide Ls instance to give the customer.

4 Storage

Customers can get the flexibility to store, access, monitor and efficiently manage their data with the help of cloud storage services. Block storage is the major type of storage available. The block storage of Amazon's version is Elastic Block Store (EBS). EBS works in alignment with Amazon EC2 for throughout and critical transactional workload. Google Cloud Platform's version of block storage is Persistent Disks (PDs). PDs are suitable for virtual machine disks, virtual machine backups and sharing read-only data. Microsoft Azure's block storage is Managed Disks. It can create up to 1000 VMs in a

single scale set, point-in-time backups, SSD or HDD disks and role-based access control for extra security.

5 OS Environment Offered

AWS EC2 can run in the operating system such as Core OS, Windows, SLES, Cloud Linux, Ubuntu, etc. Microsoft Azure can run in the operating system such as SLES, Windows, CentOS, Oracle Linux, etc. Google provides the operating system which can run in CentOS, Container-Optimized OS (COS), Debian, Fedora Core OS, Red Hat Enterprise Linux (RHEL), SQL Server, SLES, Ubuntu LTS, Windows client.

6 Security

AWS is responsible for protecting the infrastructure that runs AWS services in the AWS Cloud, which includes AWS EC2. AWS EC2 also provides you with services that you can use securely. Third-party auditors regularly test and verify the effectiveness of our security as part of the AWS Compliance Programs. Security in the cloud includes controlling network access to your instances, for example, through configuring your VPC and security groups, managing the credentials used to connect to your instances, and managing the guest operating system and software deployed to the guest operating system, including updates and security patches. Next Google Cloud Platform (GCP) has a global scale technical infrastructure which is designed to offer security through the entire information processing life cycle at Google. According to the Google Infrastructure Security Design Overview Article, this infrastructure is said to provide secure deployment of services, secure storage of data with end-user privacy safeguards, secure communications between services, secure and private communication with customers over the internet, and safe operation by administrators. Meanwhile, for Microsoft Azure, it depends on the cloud service model. This is because there is a variable responsibility for who is responsible for managing the security of the application or service. According to Introduction to Azure security article, The capabilities available in the Azure Platform is designed to assist the user to meet in meeting responsibilities through built-in features. The built-in capabilities are organized in six functional areas, which is operations, applications, storage, networking, compute, and identity.

7 Performance and Scalability

According to Marwan Al Shawi, the AWS EC2 accommodate to current scale needs as well as the anticipated growth of the solution. Besides, modularity encourages separation of concerns by having well-defined boundaries among the various components of the architecture. As a result, each component can be managed, secured, and scaled independently. On the other hand, GCP ensures the user that it can focus on your business, instead of servers that are running out of disk space or slow response time. The GCP products and services are designed to handle large amounts of data and have scalability that adapts to your needs. Meanwhile, the services covered by Azure Autoscale can scale automatically to match demand to accommodate the workload. They will scale out to ensure capacity during workload peaks and scaling will return to normal automatically when the peak drops.

8 Pricing Model

Pricing can be a huge attraction to the customers to consider. The pricing models can be compare based on the machine type offered, that is the smallest instance and largest instance. For the smallest instance, Google Cloud Platform gives better pricing options. This is because it contains 2 virtual CPUs and 8 GB of RAM at a 25 percent cheaper rate. It costs around US\$52/month. Amazon EC2 costs around US\$69/month and Microsoft Azure costs around US\$70/month. For the largest instance, Amazon EC2 offers the best pricing, includes 3.84 TB of RAM and 128 vCPUs costs around US\$3.97/hour. Microsoft Azure costs around US\$6.79/hour and Google Cloud Platform costs around US\$5.32/hour.

Table 1. Pricing models of AWS, Azure and GCP based on the machine type:

Machine Type	AWS	Azure	GCP
Smallest Instance	2 virtual CPUs and 8 GB of RAM will cost around US\$69 per month.	2 vCPUs and 8 GB of RAM will cost around US\$70/month.	2 virtual CPUs and 8 GB of RAM cost around US\$52/month.
Largest Instance	3.84 TB of RAM and 128 vCPUs will cost around US\$3.97/hour.	3.89 TB of RAM and 128 vCPUs. It costs around US\$6.79/hour.	3.75 TB of RAM and 160 vCPUs. It will cost around US\$5.32/hour.

9 Auto – Scaling/Elasticity

AWS Auto-Scaling supervisors the user's applications and automatically adjusts capacity to maintain steady, predictable performance at the lowest possible cost. AWS Auto Scaling provides a simple, powerful user interface. For Google Cloud Platform (GCP), the managed instance groups (MIGs) provides auto-scaling capabilities that let the user to automatically add or delete virtual machine (VM) instances from a MIG based on increases or decreases in load. GCP auto-scaling helps the user's apps gracefully handle traffic increases and reduce costs when the need for resources is lower and it lets the user have the right amount of resources running to handle the load on your application. On the other hand, Microsoft Azure's auto-scale profile is a mixture of a capacity setting (indicates the minimum, maximum, and default values for the number of instances), set of rules (each includes a trigger time or metric and a scale action up or down), and lastly recurrence (indicates when auto-scale should put this profile into effect).

10 Monitoring tools/Service Provided

They share the common elements of a public cloud. For instance, auto scaling, self-service and instant provisioning, compliance and identify management features and others. Amazon EC2 provides secure, resizable compute capacity in the cloud. The developers can make web-scale cloud computing easily and obtain, configure capacity with minimal friction. Google Cloud Platform offers a one-stop-shop AI platform to help machine learning engineers build and deploy models based on its popular open-source Tensor Flow deep learning library. Microsoft Azure lets developers write, test and deploy algorithms, as well as a marketplace for off-the-shelf APIs.

11 Opinions

In my opinion, I will choose AWS EC2 as my service provider based on their compute, storage, database, establishment, availability zone and pricing. Amazon EC2 provide secure, sizeable and compute capacity. Besides, it also designed to make web-scale computing easier for developers. AWS is the experienced cloud provider and it has established a larger amount of user base, and it give the customer bigger truth. Although AWS is not the lowest price among three but it also not too expensive compare with the other. AWS have the larger availability zone than the other two which is 66 availability zone with 12 on the anvil. This is the reason why it will choose AWS as my service provider. (Lim Zeng Kai)

The advantages of AWS are it is the best cloud computing service since 2006 and offers undoubtedly the massive scope of its operation and the disadvantage is its cost. It is not quite cost-effective for many enterprises when running a high volume of workloads on the service. The pro of Azure is Azure is tightly integrated with Windows and other Microsoft software. Thus, many enterprises are continuing to use Azure as they built loyalty for existing Microsoft customers. On the cons side, its functions provided are limited compared to AWS and need enterprise management from customers. The advantages of GCP are it has a flexible pricing model and it specializes in high compute offerings like Big Data, analytics and machine learning. On the downside, it is not focused on supporting large, enterprise projects and a range of functions is lacking innovation. In my opinion, the best of the cloud service provider for my software development is GCP. This is because it offers the most cost-effective services for start-up and small

businesses. Besides, I can execute all computing operations by using the powerful hardware utilized by Google for its web services such as Gmail. (Joey Chai Wan Yi)

I would like to choose Microsoft Azure because I want to develop web application that can give benefits to others. Microsoft Azure is ideal for a developer because it's very easy and simple to connect the Visual Studio with Azure. Microsoft also provided two software for basic web application which are Web App and Web App with SQL. For operating system to create the web app, we can choose either Windows or Linux. I also can save my money because Azure is working on a pay-as-you-go model, which eliminates the upfront costs for small companies, and an extra company discount can be offered to those who sign a contract. (Azlinah Herman)

I would prefer Google Cloud Platform. Firstly, I strongly believe that Google priorities its security as Google invests heavily in safeguarding its infrastructure by having hundreds of engineers devoted to security and privacy distributed across all of Google. According to the Google Infrastructure Security Design Overview Article, Google utilizes this infrastructure to build its internet services, including both consumer services, for instance Search, Gmail, and Photos, and business services such as G Suite and Google Cloud. Secondly, based on the performance and scalability, GCP is able to minimize the IT costs and create a more flexible management, operations, and development platform. Thirdly, based on the Auto-Scaling, GCP can guarantee that usage information collected from the instance group is stable, prevent behavior where an auto-scale continuously adds or removes instances at an excessive rate and lastly, GCP safely eliminates instances by determining that the smaller group size is sufficient to support top load from the last 10 minutes. (Sharteswary A/ P Bojarajoo)

12 Conclusion

As a conclusion, every cloud providers have their own benefits. It is up to the company or user which cloud providers suitable with their career, works and budget. They probably choose Microsoft Azure if they use Windows and many Microsoft Software because it's easy to connect Azure with Microsoft Software while Google Cloud is suitable with new entrepreneur wishing to develop rapidly. AWS would be right for the user if they searching for the cloud provider with the largest collection of resources and global scope.

References

1. "AWS vs Azure vs Google - Detailed Cloud Comparison." *Intellipaat Blog*, 17 Oct. 2020, Retrieved from: [AWS vs Azure vs Google - Detailed Cloud Comparison \(intellipaat.com\)](https://www.intellipaat.com/blog/aws-vs-azure-vs-google-detailed-cloud-comparison/)
2. "AWS vs Azure vs Google Cloud: Which Cloud Service Suits Your Needs?" *Insights - Web and Mobile Development Services and Solutions*, 21 Dec. 2020, Retrieved from: www.netsolutions.com/insights/aws-vs-azure-vs-google-cloud-comparison/.
3. Vishal Padghan, et al. "Comparing Cloud Computing Services AWS, Microsoft Azure, Google Cloud." *GreatLearning*, 17 July 2020, Retrieved from: www.mygreatlearning.com/blog/comparison-of-amazon-web-services-microsoft-azure-and-google-cloud-platform-learnability-best-opportunities-versatility/#servicecomparison.
4. Marwan Al Shawi. Architecting for Reliable Scalability (3/11/2020) <https://aws.amazon.com/blogs/architecture/architecting-for-reliable-scalability/>
5. Overview of autoscale in Microsoft Azure.(24/09/2018).<https://docs.microsoft.com/en-us/azure/azure-monitor/platform/autoscale-overview>
6. Introduction to Azure security. (18/10/2019) <https://docs.microsoft.com/en-us/azure/security/fundamentals/overview>
7. Overview of the performance efficiency pillar (23/10/2020) <https://docs.microsoft.com/en-us/azure/architecture/framework/scalability/overview>