Cloud Computing Fundamentals – Literature Review on Cloud Computing Service Providers

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1 Introduction

There is a study shown that the global spending on cloud services has reached $260bn in 2020, which is more than a third of all IT spending and it is predicted to continue growing in the future years. The concept of cloud computing is basically " the delivery of on-demand computing services -- from applications to storage and processing power -- typically over the internet and on a pay-as-you-go basis." [9]. In other words, cloud computing is providing computing infrastructure for many companies, they can rent access to many things from a cloud service provider to storage without worrying about building their own infrastructure and maintaining it.

2 Comparative Evaluations

Table 1. Overview of Amazon EC2 [1], Google Cloud [2], Microsoft Azure [3]

	Amazon EC2	Google Cloud	Microsoft Azure
Service Model	IaaS, PaaS	IaaS, PaaS	IaaS, PaaS
VM instances	medium	medium	large
Storage	Amazon Elastic Block Store, Amazon EC2 instance store, Amazon EFS, Amazon S3	cloud storage	block blobs, azure data lake storage, managed disks, files
OS environments offered	Amazon Linux, Windows Server, Debian, CentOS, macOS	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	Linux, Microsoft Windows

Security	Network isolation, isolation on physical hosts, controlling network traffic	Multi-layered security (Operational & device security, internet communication, identity, storage services, service deployment, hardware infrastructure)	Security Center, Key Vault, Azure DDoS Protection, Azure Information Protection, Application Gateway, Microsoft Azure Attestation
Performance and scalability	- High Performance Computing - 24 regions and 77 availability zones globally	- High Performance Computing - 24 regions and 73 zones available	- High Performance Computing - 60+ regions available
Pricing model	On-Demand, Savings Plans, Reserved Instances, and Spot Instances	Pay-as-you-go pricing, New customers get $300 in free credits, 20+ free products	Pay-as-you-go pricing, available prepaid with discount
Auto-Scaling/Elasticity	- Fleet Management, Scheduled Scaling, Dynamic Scaling, Predictive Scaling - Time-based/ volume-based elasticity	- Scaling based on CPU utilization, the serving capacity, Cloud Monitoring metrics, schedules	- Host-based metrics, Azure diagnostics extension, App Insights, Scheduled autoscale - Azure Elasticity
Monitoring tools/service provided	Automated monitoring tools, manual monitoring tools (Amazon CloudTrail, Amazon CloudWatch)	Cloud Console, Stackdriver Monitoring, Stackdriver Logging	Azure Operational Insights, Azure Application Insights

There are three types of service model in cloud computing which are IaaS, PaaS, and SaaS. According to our research, we found that Amazon EC2, Google Cloud, Microsoft Azure all provide IaaS and PaaS service.

Virtual machines (VM) are on-demand scalable computing resources. This could operate multiple computing environments (OS). There are various virtual machine (VM) instance types offered from three cloud computing services. Most cloud computing services provide general purpose, compute optimized, memory optimized, accelerated computing, and storage optimized VMs. Additionally, Amazon EC2 has instance features, measuring instance performance VMs. Google Cloud has E2 shared-core, N1 shared-core VMs. Lastly, Microsoft Azure have entry-level economical VMs for dev/test, economical burstable VMs, optimized for in-memory hyper-threaded applications, high performance computing virtual machines, GPU enabled virtual machines VMs. Hence, we could conclude that Microsoft Azure has the largest VM instance types compared to other services.

Storage in cloud computing is the essential part that stores data on the internet. It has storage services and databases. Google Cloud only has cloud storage that can store all the data in one storage. However, Amazon EC2 and Microsoft Azure have more storage types to store data.

The OS environment is needed to manage and support cloud computing services. All of cloud computing (Amazon EC2, Google Cloud, Microsoft Azure) offered Linux and Microsoft Windows. Additionally, Amazon EC2 and Google Cloud offer more various OS environments.

Security is important for cloud computing. Amazon EC2 provides a security-sensitive organized data center and network architecture. Google Cloud has

multi-layered security that delivers true defense in depth. Microsoft Azure protec data, apps, and infrastructure with built-in security services in Azure. We assume that Google Cloud has the most secure services, since it has 6 layered security to protect the cloud computing.

In view of performance and scalability, three of all cloud computing systems have high performance computing (HPC). We claimed that Microsoft Azure has the widest range of scalability which is available in 60+ regions.

Three of all cloud computing services have an on-demand pricing model. However, they offer different discounts. We conclude that Amazon EC2 offers various plans for discount and lower the price from saving plans, reserved instances, and spot instances.

Auto Scaling is a process that scales up or down the number of resources to be allocated on applications needed. All of three cloud computing services provided various types of auto scaling. Elasticity provides the ability to auto scale infrastructure and resources. We assumed that Amazon EC2 has the best offer because it has two types of elasticity.

Monitoring tools are needed to monitor and manage the cloud computing services. All of three cloud computing services provide various monitoring tools/services.

3 Challenges and Opinions

Microsoft Azure allows the users to integrate with other Microsoft products and this is one big advantage, because most of the people including the enterprises are using Microsoft technology. It is easy to use when it comes to testing software [4]. Besides, Azure Pipelines helps the developers in both building and testing the code by implementing Continuous Integration (CI) and Continuous Delivery (CD) [5]. However, its capabilities seem to be limited within its own environment only. Despite the integration provided, it is still hard for the users to integrate with other products. Furthermore, it gains less preference compared to the other Cloud Service Provider (CSP) especially regarding the reliability due to outages instances [6].

Google Cloud Platform (GCP), on the other hand, is relatively new, but it is known for Big Data, analytics and so on [7]. The efficiency and effectiveness of data integration is said to be up to the mark, providing convenience to its users from time to time. Plus, its processing capability is very good as it can analyse massive data quickly. It also enables the users to write, debug and run the code quickly in the cloud itself [2]. Nevertheless, GCP provides fewer services compared to Microsoft Azure and Amazon EC2. GCP's users also claim that they are easily confused by the web interface.

Customised services are offered by Amazon EC2 to different type of businesses and purposes, no matter whether they are big or small. Hence, it possesses the ability to handle high workload [6]. Also, it might be the best CSP for software development and it is highly recommended by a lot of the developers for its efficiency, scalability, elasticity, and reliability. It is user-friendly and most of the users have gained satisfaction from its auto-scaling feature as it allows the programmers or developers to focus better on their tasks. Software deployment is automated rapidly, where the

service is scaled to the user's interface. Furthermore, the users can track the deployment status and to get a detailed report about it, which is extremely convenient. The application health during the deployment process is also tracked and the process will stop and roll back should any problem occur [8]. Nonetheless, the challenge faced by its users is the confusing cost structure from Amazon EC2, which makes a company difficult to gauge or to estimate the cost needs to be spent.

4 Conclusion

In this article, we have discussed a few types of currently existing cloud computing services. For example, Amazon EC2 [1], Google Cloud [2], Microsoft Azure [3]. We compare and contrast the pros and cons of these services in terms of security, storage, and etc. Also, we conclude that the best choice is Amazon EC2 for users.

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