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A Comparative Analysis of Prominent Cloud Computing Service Providers

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1 Introduction

Every day, technology in this world keep advancing toward the future. It becomes more complex but it also becomes more accessible to the public and not only to military or big enterprise. To develop software, we can build a system on the cloud which is very famous and familiar nowadays. Much small company can start their way to success in the data industry by building a system which helps them in various aspects. Therefore, many cloud computing service provider has been established and they have offered many specifications to their customer that can suit their needs. There are many options of these service provider that have different capabilities and its distinct qualities. Example of the most used cloud computing service providers is Microsoft Azure, Amazon EC2, Google Cloud Platform, Alibaba Cloud, IBM Cloud, Oracle and Salesforce. The main objective of this paper is to explore and compare these cloud computing service providers which will be suitable used in software development. This paper is organized into 5 sections. The first section outline is the background of cloud computing. Section 2.0 describes cloud model that been used by these service providers such as public, private or hybrid. In section 3.0, we research about the cloud services that offered such as IaaS, PaaS and SaaS. In section 4.0, we research the leading cloud providers, describe their advantages and disadvantage and compare them respectively. Finally, in section 5.0, we describe our choice to be a part of our software development and provide arguments about it.

2 Background of Cloud Computing

According to Jake Frankenfield, cloud computing is the delivery of different services through the Internet. Other than that, cloud computing is a general term for anything that involves delivering hosted services over the internet according to Margaret Rouse. Cloud computing is very important nowadays because it can give many benefits to its user. One of the benefits that we can obtain from cloud computing is it can save costs. It takes a lot of money if we use the manual system to maintain all the data and it might also be troublesome to access it. As a solution, cloud computing can cut the cost and easier to manage. Other than that, it also used because of mobility. If we are using the cloud, there's no need to be confined in the office. The cloud increases the efficiency of an organisation by giving staff more mobility. There is also a requirement that needs to be fulfilled if we want to use cloud computing. One of the requirement is Internet access and its bandwidth is enough to support the system. Cloud can consume a lot of data because of uploading and downloading data from it. The next requirement is to consider the specification of the system that we want to build. The cloud can be used to do many things as its service. Therefore, it also important to choose which are suitable for it because it can help in working on it cost-efficient and effectively.

3 Cloud Model

There are 3 types of cloud model which are public, private and hybrid cloud models. The most common type of implementation of cloud computing is public clouds. A third-party cloud service provider owns and manages the cloud services and provides them over the internet. For a public cloud, the cloud provider controls and administers all hardware, applications, and other supporting resources. An example of a public cloud is Microsoft Azure. Private cloud solutions are committed to one entity or organization, and therefore have far more specific security controls than a public cloud. Through meeting requirements and industry-based standards, including medical records, trade secrets, or other classified information, the use of private cloud storage enables them to control highly sensitive data. Example of a private cloud is HP Data Centre. Next, a combination of public and private clouds are hybrid cloud solutions. This is a more complex cloud approach in that various systems must be controlled by the organization and where data is stored must be decided. An example of a hybrid cloud approach is a company that needs to keep proprietary information safe on its private cloud, yet to make public cloud content more general and customer-facing. The most powerful force in the cloud world is Amazon Web Services (AWS). While it is well known for its public cloud platform services, it also provides on-site implementation services for hybrid cloud infrastructure.

4 Cloud Services

A service model is a way or model that followed by the cloud services to suit their services with consumer needs. There is 3 example of service model that we can see from cloud services this day which are IaaS, PaaS and SaaS. First, IaaS which also known as Infrastructure as a Service. IaaS gives the consumer to access resources such as servers, bandwidth, network connections and storage capacity. Next, PaaS is also known as Platform as a Service. PaaS create a complete environment for developing and deploying software quickly. This typically includes databases, file storage and software development tools, as well as the operating system. The cloud provider makes sure all of this keeps running smoothly and securely, letting its users focus on coding, testing and deploying applications. Lastly, SaaS which known as Software as a Service. SaaS sees the cloud provider assume complete responsibility for everything that's needed to deliver an application to your end-user devices. SaaS includes standard applications like Google Workspace.

AWS Elastic Compute Service or EC2 is IaaS (Infrastructure as a Service). This is because Amazon takes the responsibility of networking, storage, server and virtualization and the user is responsible for managing the Operating System, middleware, runtime, data and application. Amazon EC2 provides a true virtual computing environment, which allow its consumer to use web service interfaces to launch instances with a variety of operating systems, load them with custom application environment, manage network's access permissions, and run your image using as many or few systems as you desire.

Google Cloud Platform offers all of these three service models which are IaaS, PaaS and SaaS. Google Compute Engine is also known as GCE is one of Google's IaaS. With GCE you can freely create Virtual Machines, allocating CPU and memory, kind of Storage and the amount of storage. Google also offer SaaS with its Google Kubernetes Engine also known as GKE. It allows customers to easily run their Docker containers in a fully managed Kubernetes environment. For those not familiar with containers, Containers help modularize services/applications, so different containers can hold different services. Google App Engine (GAE) also known as GAE is Google's dedicated PaaS. This ensures customers that use GAE do not have to deal with the underlying hardware/middleware, all they need to do is provide the necessary code required to run it.

Microsoft Azure is a Cloud provider which offer many computing, storage and application services. Azure services contain Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). In an IaaS deployment, Azure's fundamental unit, compute resources in the virtual machine. Users of Azure also can spin up general-purpose Windows or Linux VMs as well as machine images for applications such as SQL Server or Oracle. With Azure IaaS, developers get complete control of the stack at the design time but the deployment still needs to consider the systematic qualities of the application influenced by the storage.

5 Comparative Analysis of Cloud Computing Service Providers and Discussions

Among the many Cloud services, 3 major ones are Amazon EC2, Microsoft Azure and Google Cloud. Amazon EC2 is known as one of the oldest cloud providers and with the most experience, it is known as a resizable compute capacity in the cloud, variety of choices such as the instances types as well as a secure cloud provider. Microsoft Azure is known for its capabilities in cloud infrastructure. Azure is common among enterprising companies. Google Cloud Platform has technical expertise along with industry-leading tools on artificial intelligence, machine learning and data analytics makes it a major cloud provider.

Table 5.1: Comparative analysis of Cloud Computing Service Providers

Providers	Amazon EC2	Microsoft Azure	Google Cloud Platform
Similarities	per-second billing, speed, scalability, security and agility		
Virtual Machine (VM) instance types	• Nano • Micro • Small • Metal • Medium • Large.	In series : • A, Bs, D, DC, E, F, G, H, Ls, M and N • range from entry level VM to largest memory optimized VM.	• Micro • Small • Medium • Standard
Storage	• Simple Storage Service(S3) • Elastic Block Storage(EBS) • Elastic File System(EFS) • Storage Gateway • Snowball • Snowball Edge • Snowmobile	• Blob Storage • Queue Storage • File Storage • Disk Storage • Data Lake Storage	• Cloud storage, Persistent disk • Transfer appliance • Transfer service
OS environments offered	Windows Server, Ubuntu, Red Hat Enterprise Linux(RHEL), Debian, and CentOS are commonly using by all the three platforms		
	• Amazon Linux • SUSE Linux Enterprise Server • Fedora • Gentoo Linux • Oracle Linux • FreeBSD	• Windows	• Container-Optimized OS(COS) • Fedora CoreOS • SQL Server • SUSE Linux Enterprise Server(SLES) • Ubuntu LTS • Windows Client
Security	Some security tools : • AWS Config • CloudWatch • CloudTrail • GuardDuty • Macie • Security Hub	• Integrated in hardware and firmware components • more than 3,500 cybersecurity experts • Uses AI and automation to quickly identify threats, streamline threat investigation, and help automate remediation	• Cloud DLP • Cloud Security Scanner • Kubernetes support - more secure implementation than any other cloud provider
Performance and scalability	• instance-level metrics that measure CPU, disk, and network performance • Fleet and Spot Fleet simplify the provisioning of EC2 capacity across different EC2 instance types, Availability Zones, and purchase models	• scale automatically to meet the demand of • high-performance computing (HPC) is a complete set of computing, networking, and storage resources integrated with workload orchestration services	• Compute Engine virtual machines and Google Kubernetes Engine (GKE) clusters integrate with autoscales • metrics through the applications and networks help users make data-driven scaling decisions
Pricing model	5 ways : • On- demand • Savings Plan • Reserved Instances • Spot Instances • Dedicated Hosts : provide EC2 instance capacity on physical servers	• Substantial savings compared to other clouds • Transparent and competitive pricing • Free enterprise grade cost management tools	• Pay-as-you-go structure • No up-front fees / termination charges • Varies by product and usage • Discounts : automatic savings
Auto - Scaling/ Elasticity	• Dynamic scaling and predictive scaling can be used together for faster scaling • the fleet management features of EC2 Auto Scaling • to ensure the protection and availability of your fleet	• Azure elasticity : Azure's hosted resources to be automatically scaled to meet demand and configured parameters	• to automatically add or delete VM instances from a managed instance category • After user have established the autoscaling policy, the autoscaler performs automatic scaling based on the calculated load
Monitoring tools/service provided	• Some tools require manual intervention • Automated monitoring tools : System status, Instance status checks, Amazon CloudWatch alarms, CloudWatch agent, AWS Management Pack for Microsoft System Centre Operations Manager	• Serverless360: provides features like Azure service bus, Azure event hub, Azure event grid, Azure SQL database, Azure Functions, and Azure Logic Apps all in one platform • Monitoring tool conducts end-to-end monitoring and identifies application infrastructure problems	• use Opsview Monitor's GCP Opspack : convenient to monitor performance metrics for Compute Engine Instance, Cloud Storage Buckets and Cloud SQL Database Instance

5.1 Advantages

Amazon EC2 main advantage is its dominance in the market. Since it has been the oldest cloud storage, it has the advantage of extensive mature offerings and the support for large organizations. Besides, it is faster and easier on getting help and supported tools as the platform has overall maturity and scope. Amazon EC2 is also best in privacy as services cannot access other services and accounts in Amazon EC2 are isolated from each other unless access is enabled explicitly. Moreover, the security groups (firewalls) are implemented exceptionally.

The main and obvious advantage is Microsoft Azure is integrated with Microsoft tools and software. Also, open-source is supported along with the usage of hybrid cloud. Most authentication and permissions are managed from a single directory using Azure. Azure Security Center covers the entire tenant but with the right licensing and can be scoped to allow subscription-level access.

Google Cloud Platform better centralized and with its cloud-native design, it can high commit to open source along with portability. Within users, accounts on projects are isolated unless connected to services. Google Cloud Platform also offers organization-wide logging, various discounts along with flexible contracts for organizations. GCP also have exceptional built-in tools. Among them are The Cloud Security Command Center and Stackdriver Logging. In addition to that, GCP is specialized in high compute offerings like Big Data, analytics and machine learning

5.2 Disadvantages

One of Amazon EC2 advantage also comes with disadvantages. That is isolation which makes the management complicated as even small data is hard to collect and managed across regions. Amazon EC2 Security Hub is limited to certain regions only. In addition, IAM is also tough to manage when more permissions and access are given.

Many customers complain that Azure has poor documentation, lack of consistency as well as availability. Besides, a lot of the services have defaulted to a less secure configuration. Also, the ports are exposed to the Internet. Azure also has an issue with lacking in transparency and assessment limitations.

Google Cloud Platform lacks in the storage solution aspects mainly in the backup section. Furthermore, fewer security experts with in-depth GCP experience and robust community as well as tooling. However, it is common among new providers with less experience.

6 Our First Choice

In our opinion, we choose Amazon EC2 as the best among the three platforms. This is because it has 6 virtual machines instance types that are Nano, Micro, Small, Metal, Medium and Large. Comparing all together, Amazon EC2 has more experience in cloud storage which makes its features more reliable than the others. It is also having the most complete security systems. Beside those common Operating systems, Amazon EC2 also supporting operating systems like Amazon Linux, SUSE Linux Enterprise, Server, Fedora, Gentoo Linux, Oracle Linux and FreeBSD. Not only that, but we also choose Amazon EC2 because of its performance and scalability. Amazon EC2 has instance-level metrics that measure CPU, disks and network performance. Its Fleet and Spot Fleet simplify the provisioning of EC2 capacity across different EC2 instance types, Availability Zones and purchase models. It is also using dynamic scaling and predictive scaling that can be used together for faster scaling as well as the fleet management features.

7 Conclusion

In conclusion, the three-cloud computing software has each own merits and advantages. We can consider our needs and their provided advantages to select the most suitable for us. We predict that in future, this software will keep improving and launch more advance useful features for their users to ensure they can survive among numerous competitors.

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