Cloud Computing Fundamentals

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1. Introduction

Cloud computing is the delivery of computing services such as servers, storage, database, networking, software, analytics, intelligence, and more, over the cloud (internet).

Cloud computing provides and alternative to the on-premises datacentre. With an on-premises datacentre, we have to manage everything, such as purchasing and installing hardware, virtualization, installing the operating system, and any other required applications, setting up the network, configuring the firewall, and setting up storage for data. After doing all the set-up, we become responsible for maintaining it through it's entire lifecycle.

But if we choose cloud computing, a Cloud vendor is responsible for the hardware purchase and maintenance. They also provide a wide variety of software and platform as a service. We can take any required services on rent. The cloud computing services will be charged based on usage.

The cloud environment provides an easily accessible online portal that makes handy for the user manage the compute, storage, network, and application resources.

2. Evaluation Comparative

2.1. Service model (IaaS, PaaS, SaaS)

Platform Type	Common Examples
SaaS	**Google Workspace, Dropbox, Salesforce, Cisco WebEx, Concur, GoToMeeting.**
PaaS	**AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, OpenShift.**
IaaS	**DigitalOcean, Linode, Rackspace, Amazon Web Services, Cisco Metapod, Microsoft Azure, Google Compute Engine.**

2.2. Virtual Machine (VM) instance types offered

In general, Amazon EC2 leads the other two vendor with over 40 instances types, which are classified into 6 families. Meanwhile, Google Cloud Platform owns 18 instance types which are also divided into several families. In addition, Micorsoft Azure has over 29 instance types which spread over 4 categories.[15]

The figure below show the instance types of the three vendors.

Instance Types\Vendors	Google Cloud Platform	Microsoft Azure	Amazon EC2
General Purpose	E2,N2D,N2,N1	B,Dsv3,Dv3,Dav3,Dasv3,DSv2,Dv2,Av2,DC	Mac,T4g,T3,T3a,T2,M6g,M5,M5a,M5n,M5zn,M4,A1
Compute Optimize	C2	Fsv2	C6g,C6gn,C5,C5a,C5n,C4

Memory Optimize	M2, M1	E2a,E4a,E8a,E16a,E20a, E32a,E48a,E64a,E96a	C6g,C6gn,C5,C5a,C5n, C4
Accelerator Optimized	A2	N/A	P4,P3,P2,Inf1,G4dn,G4ad,G3,F1
Storage Optimizer	N/A	Lsv2	i3i3en,d2,h1
Shared Core	e2, f1, g1	N/A	N/A

Figure 1: Source from internet

2.3. Storage
Many options for storing data are offered by Amazon E2C. E2C types of storage include:
- **Elastic Block Storage (EBS):**
This is persistent block storage, called Elastic Block Store (EBS) network-based storage, which can be linked to running instances or used as a persistent boot medium as well.
- **Instance Storage:**
This is non-persistent local storage and data would be lost after an instance terminates.

Google Cloud Platform has an increasing menu of available storage services. The unified object storage service is Cloud Storage, and it also has a Persistent Disk option. It offers a Transfer Appliance similar to AWS Snowball, and also online transfer services. GCP has the SQL-based Cloud SQL and a relational database called Cloud Spanner that is designed for mission-critical workloads. It also has two NoSQL options which are Cloud Bigtable and Cloud Datastore. It does not have service providers for backup and archive .

Microsoft Azure provides many options for data storage. Microsoft Azure provides many options for storing data such as Blob Storage for REST-based object storage of unstructured data, Queue Storage for large-volume workloads, File Storage and Disk Storage. It also has a Data Lake Store, which is useful for applications using big data. For Extensive Database, it has three SQL-based options which are SQL Database, MySQL Database and PostgreSQL Database. Microsoft Azure also has a Data Warehouse service, as well as Cosmos DB and Table Storage for NoSQL. Redis Cache is its in-memory service and its hybrid storage service, Server Stretch Database, is specifically designed for organisations that use Microsoft SQL Server in their own data centres .

2.4. OS environments offered

Features	AMAZON E2C	GOOGLE CLOUD PLATFORM	MICROSOFT AZURE
Server OS Types	● Linux ● Windows	● Linux ● Windows	● Linux ● Windows
Preconfigured Operating System	● Amazon Linux ● Cent OS ● Debian ● Oracle Linux ● Red Hat Linux ● Ubuntu ● Windows Server	● Cent OS ● Debian ● Ubuntu ● Red Hat Linux ● Windows Server	● Cent OS ● FreeBSD ● OpenSUSE Linux ● Oracle Linux ● Ubuntu ● Windows server

2.5. Security
Google Cloud Platform has a security that covers Infrastructure, Security products, for example Access Transparency, and Binary Authorization. Transparency & privacy and also a Security solutions for your industry, such as Education, Media & entertainment, Retail, Government, Financial services, ect. And for AMAZON AWSS EC2, thre are Security of the cloud, so AWS is responsible for protecting the infrastructure that runs AWS services in the AWS Cloud. Also provides you with services that you can use securely. Also there is Security in the cloud, Controlling network access to your instances, for example, through configuring your VPC and security groups.

The last is Microsoft Azure. First of all, Microsoft Azure have a Assess and visualize the security state of your resources in Azure, on-premises, and in other clouds with Azure Secure Score, secondly Simplify enterprise compliance and view your compliance against regulatory requirements, third, they Protect all your hybrid cloud workloads with Azure Defender, which is integrated with Security Center, the last Microsoft Azure Use AI and automation to cut through false alarms, quickly identify threats, and streamline threat investigation.

2.6. Performance and scalability

Performance and scalability varies by vendor. We are starting to look at its performance for the Google Cloud Platform which is divided into two, namely the PerfKit Benchmarker or referred to as a benchmarking tool used to measure and compare cloud provider services, and PerfKit Explorer or a visualization tool that provides rich functionality in creating and editing dashboards. whereas in AMAZON AWSS EC2, they focus more on New metrics that give customers visibility when their instances exceed the network allowance defined by AWS. This visibility aims to help customers proactively resolve application performance issues and the right size instance fleet based on desired network performance, and finally Microsoft Azure with four important goals. first there is optimized performance with cost control, second is the end-to-end agility workflow, third is production class platform, and lastly is Combining intelligence

Scalability has an important role in cloud computing. First we can see from the Google Cloud Platform which has many products including Compute Engine virtual machines and integrated Google Kubernetes Engine (GKE) clusters, Google Cloud serverless platforms providing managed computing, databases and other services, Database products such as BigQuery, Cloud Spanner, and Bigtable Cloud, Cloud Monitoring, and Google Cloud provide tools and services. Second is AMAZON AWS EC2 with the advantages of Increasing Fault Tolerance, Increasing Available Applications, and Lowering Costs. How it works, first there is Fleet Management, second is Scheduled Scaling, third is Dynamic Scaling, and finally is Predictive Scaling. and the last vendor is Microsoft Azure which has the Scaling function is the ability to adapt the system to changes in the amount of workload or traffic to web applications, free and shared service packages, and in standard and premium packages

2.7. Pricing model

There are many types of pricing model offered by the three vendors. Three of the vendors had freemium for their customer with a limited of time. Meanwhile,GCP and AWS EC2 also offer certain always-free package. Moreover, GCP offers Commited Use Discounts, which are similar to AWS Reserved Innstances and Azure Reserve VM Instances. However, three of the models are differentiate with discount offered. In addition, GCP, AWS EC2 and Microsoft Azure has the common model which is on demand model. However, the values for each vendor differ.On the other hand,GCP provides Preemptible VM instances , which are almost same with Spot Instances offered by AWS EC2.[17]

In general, Microsoft Azure introduces Price Discrimination model which different types of group will receive different offers. This model has some similarity with Dedicated Hosts by AWS EC2, which the company can receive discounts if they reserve instance. Meanwhile, GCP also ntroduces Sustained Use Discounts which gives discounts to their customer who keep subscribing the same instances.[17]

2.8. Auto-Scaling/Elasticity

Google Cloud Platform provides an auto-scaling tool to their customer, which is Compute Engine. However, auto-scaling only works with zonal and regional managed instance group (MIGs).Its auto-scaling abilities allows the user to edit their instances easily because it works automatically. Hence, the user can manage their works better as auto-scaler can help them to save cost whenever the need of resources is lower. In addition, it performs automatic scaling based on the load [2].

Amazon EC2 also provides a good platform to their users with auto-scaling. Amazon EC2 Auto Scaling is built to help the user to maintain their application availability. At the same time, the users are also able to add or delete their instances based on the demand. There are a lot of features in Amazon EC2 Auto Scaling which allow their user to maintain the health and availability of their application. Hence, the users can identified so that they can take immediate action. In addition, Microsoft Azure also helps their users to save cost as they can optimize their performance by using Amazon EC2 Auto Scaling. Luckily, the auto-scaler is available at no additional charge whenever the user purchases AWS resource needed [4].

Microsoft Azure will provide a better working environment to their users with more elastic tools. Autoscale provided is flexible because it is a built-feature of Cloud service, Mobile Services, Virtual Machines, and websites. It can help any application used to perform well according to the demand. At the same time,

autoscale also helps the user to reduce the traffic by handle all the loads. Moreover, the user also can save cost because the user will only pay whenever they use the cloud. The user also can always monitor their cloud service by setting alert whenever the autoscale is triggered [3].

2.9. Monitoring tools/service provided

Monitoring as a service (MaaS) is one of many cloud computing delivery models under anything as a service (XaaS). It is a framework that facilitates the deployment of monitoring functionalities for various other services and applications within the cloud. The most common application for MaaS is online state monitoring, which continuously tracks certain states of applications, networks, systems, instances or any element that may be deployable within the cloud.

3. Opinion

Advantages of Amazon E2C:

- EC2 is cheaper. You can get an EC2 windows 2008 R2 Server instance up and running for about $40 per month.
- EC2 is familiar. The pleasant issue approximately EC2 is it's like having your personal home windows Server without buying the hardware. We can do whatever we need to it; we simply need to remote desktop into it.
- EC2's biggest strength: it's conceptually simple. There's no learning curve, simply instant gratification

Advantages of Google Cloud Platform:

- Google Cloud features come out as the cheapest provider for serverless computing because of its very low compute price compared to AWS and Azure.
- GCP gives better productivity because of quick access to Innovation, Google's systems can deliver updates effectively and on a weekly basis.
- Control and flexibility available to customers: they have managed over technology and feature ownership over their statistics in Google apps. If they decide to no longer use the service anymore, they could get their data out of Google cloud [14].

Advantages of Microsoft Azure:

- The cost may be cheaper than E2C. You simply install your application and Microsoft takes care of the software, patches, and backups.
- Scalability is extremely good in windows Azure. If it fulfill these capabilities home windows Azure is as easy as changing a value in the configuration file.
- Azure is absolutely integrated with visual Studio. as soon as installation, deploying changes from visual Studio to home windows Azure is only a couple clicks.

Disadvantages:

Amazon E2C	Google Cloud Platform	Microsoft Azure
The price structure is a bit intricate.	GCP does not provide as many services as Amazon or Azure.	Azure is lacking in the area of DevOps.
Amazon does not have a particular "hybrid cloud" solution.	GCP is the newest out of the three providers, that means it's the least mature in terms of kind of services.	Azure's support for other operating systems is very limited, only supporting a limited varieties of Linux [15].

Based on the analysis of advantages and disadvantages of the three cloud service providers (Amazon E2C, Google cloud Platform, Microsoft Azure), we choose Microsoft Azure because the cost may be cheaper than E2C and have better services than GCP. Azure is a zero maintenance solution. You simply install your application and Microsoft takes care of the software, patches, and backups. There's a cost to maintenance that needs to be taken under consideration when using EC2 compared to Azure. The problem is that cost is a bit difficult to calculate. Scalability is extremely good in windows Azure. If it fulfills these capabilities windows Azure is as easy as changing a value in the configuration file.

4. Conclusion

Cloud Computing can be said to be a paradigm where information is permanently stored on internet servers and temporarily stored on user computers (client) including desktops, tablet computers, notebooks, wall computers, handhelds, sensors, monitors and others. -other. In this article, we've covered a lot about cloud computing architectures. Some of the examples presented and case studies of cloud service implementation on Microsoft Azure, Amazon E2C, and Google Cloud Platform demonstrate the many benefits that can be obtained.

We can also find various advantages of the three cloud computing. Comparative Evaluation can be seen from Service Model (IaaS, PaaS, SaaS), Virtual Machine (VM) instance types offered, Storage, OS environment offered, Security, Performance and scalability, Pricing Model, Auto Scaling / Elasticity, and Tools / Monitoring services provided

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