Subject : Technology and Information Systems (SECP1513)
Section : 01
Assignment : Cloud Computing

GROUP NAME / NUMBER : 09

1.		Name : Heong Yi Qing Matric Number : A20EC0043 Phone Number : 016-4161666 Email : heong@graduate.utm.my
2.		Name : Roshini A/P Thavan Nair Matric Number : A20EC0139 Phone Number : 0124754974 Email : roshini01@graduate.utm.my
3.		Name : Sayang Elyiana Amiera binti Helmey Matric Number : A20EC0143 Phone Number : 01140497562 Email : sayangelyianaamiera@graduate.utm.my

Adopting Better Cloud Computing Service Provider

Heong Yi Qing
heong@graduate.utm.my
Roshini A/P Thavan Nair
roshini01@graduate.utm.my
Sayang Elyiana Amiera binti Helmey
sayangelyianaamiera@graduate.utm.my

1. Introduction

Cloud computing is an Internet based computing.Cloud computing corresponds to something that involves offering hosted services over the internet and includes any subscription based or pay-by-use service that expands the current functionality of IT in real time. According to Wikipedia, cloud computing is the on-demand availability of computer system resources, especially data storage (cloud storage) and computing power, without direct active management by the user (Cloud Computing, n.d.). By using conventional desktop computing on our own personal computer (PC) or laptop, we operate various of software programs in one time while doing our works and saved the documents we did on our PC. Even though the documents can be accessed from other computers on the network, but other computers outside the network cannot access them. This is called PC-centric which means by using cloud computing, the software programs that users use are not run from their PC but rather are stored on Internet-accessed servers. If the PC or the windows crashed, the documents which are stored in cloud computing are still available to be used. Instead of using local servers or PC to manage applications, cloud computing is a form of computing that relies on sharing computing resources. In cloud computing, the word cloud itself is used as a metaphor for "the Internet," so the phrase cloud computing means "a type of Internet-based computing," where different services such as servers, storage and applications are delivered to an organization's computers and devices through the Internet (Veerawali Behal, Rydhm Beri, 2016).

2. Background of Cloud Computing

Cloud computing is an availability of on- demand computing services which uses the Internet and the Web to deliver many of the computer activities from the user's computer or from applications to another computer on the Internet (J., I., & A., 2017).Cloud computing covers many services from basics of storage such as cloud back-up of the photos on devices, networking like email and also processing power through natural language processing and artificial intelligence (AI) as well as standard office applications (Roger, 2018).Its efficiency, flexibility, strategic edge cause cloud computing to play an important role in today's society. It allows user to store and access to the multimedia content on the Internet as well as enables users to run software programs without an installation on the devices. The use of cloud computing is growing in a rapid rate and 55% of the organization currently are using multiple public clouds, and 21% said they use more than three according to IDE 2020 Cloud Computing Study (2020 Cloud Computing Study, 2020). "Cloud will increasingly be the default option for software deployment," said Jeffrey Mann, Research Vice President at Gartner.

3. Cloud Models

Cloud computing basically has four kinds of models, which is private cloud, public cloud, community cloud and hybrid cloud. Firstly, public cloud is available to the public which data are created and stores on the third-party server. Public server is usually used for business and have lower privacy concerns (Shaptunova, 2021). Another common uses of public cloud also for applications development and testing, as well as non-mission critical task like file-sharing and email (Rountree & Castrillo, 2014). Public cloud can be used and set up easily (Shaptunova, 2021). Next, the second model is private cloud. It also known as internal or corporate model (Shaptunova, 2021). A specific group of people have access to the information stored in the private cloud which prevents the accessing from general public. The examples of private cloud are Amazon, IBM and Cisco (Shaptunova, 2021). Thirdly, one of the cloud models are hybrid cloud. Hybrid cloud encompasses the best features of the other models, which make use of interconnected private and public clouds. Hybrid cloud is cheaper than private cloud but more costly than a public cloud and it need IT proficiency to handle it. For example, Amazon Web Services (AWS) and Microsoft Azure. Lastly, the community cloud is a cloud model that supports multiple organizations sharing data that are a part of a community. For examples, the universities in cooperating with certain area of research share computing resources (Rountree & Castrillo, 2014).

4. Cloud Services

There are three types of cloud services, which is Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). First of all , IaaS is a form of cloud computing that provide basic compute, network and storage resources to consumers on demand, over the internet and on a pay-as-you-go basis (IBM Cloud Education, 2019). Customer can buy, install, configure and manage any software want to use including

operating system, applications and development tools. Examples of IaaS are Amazon Web Services (AWS), Microsoft Azure and Google Compute Engine (Blair Felter, 2020). The second cloud service is PaaS. This cloud service is a type of cloud computing which offer a service provider delivers a platform to clients, enabling them to develop, run and manage business applications without the need to buid and maintain infrastructure (Bob Violino, 2019). Mosso, Google App Engine and Force.com are the example of PaaS system. (Monitis, 2017). Lastly, SaaS which is known as Software as a Service. SaaS is a cloud based service where downloading software desktop Pc or business network to run and update, instead access an applicatuin through an internet browser (Brian Turner, 2019). Examples of SaaS cloud service providers include Microsoft Office 365, Salesforce, Cisco Webex and Google Apps (Blair Felter, 2020).

5.   Top/Leading Cloud Computing Providers
Service Model

In 2010 when Microsoft Azure was released, it offers all three types of services for IaaS, PaaS and SaaS. Users can run or combine any service on the cloud with any existing app, data center or infrastructure. This offers a wide variety of solutions appropriate for all forms of industry. It will take into account all your business needs.This lowers the normal costs, such as a support staff for an onsite server. The solution is Linux-compatible as well. Amazon EC2 is a cloud-based platform for the use of integrated web services to build business solutions. It offers an extensive range of services for IaaS and PaaS. Via their secure Web client, Amazon EC2 offers extensive admin controls available. Users can access a lot of features including the creation and auditing of encryption keys and allows users to customize requirements for infrastructure. This costs far less than if we were established on our own premis.Google Cloud allows users to use Google-provided, modular web services to create business solutions. It provides a wide range of services, including IaaS solutions and PaaS solutions. With the multi-layered secure infrastructure of Google Cloud, users can safely assume that it will protect anything you build, create, code or store.

Virtual Machine (VM)

Virtual Machine on cloud service providers act as a virtual computer system with its own CPU, memory, network interface, and storage, created on a physical hardware system (located off- or on-premises).Microsoft Azure provide VM for compute optimized with the size of Fsv2,Fs and F for high CPU—to-memory ratio. And also high memory-to-CPU ratio with the size of Esv3, Ev3, M, GS, G, DSv2, DS, Dv2 and D. Amazon EC2 provides a wide selection of VM types to fit different users' cases. For example, C4 with the size of c4.large, c4.xlarge, c4.4xlarge and c4.8xlarge for the use case optimized compute. Because of many different cases of the users, they provide many types of VM with various of sizes(AWS). Same goes to Google Cloud Performance. They provide E2 VM with the size of e2-micro, e-2small and e-2medium shared-core machine types which have 2 vCPUs available for short periods of bursting (GoogleCloud).

OS environments offered

Operating system is an interface between PC user and hardware.All three Microsoft Azure, Amazon EC2 and Google Cloud Platform are composed of various OS that work together.

Feature	Microsoft Azure	Amazon EC2	Google Cloud Platform
Operating System Types	- Linux - Windows	- Linux -macOS - Windows - Rasbian	- Linux - Windows
Supported Operating Systems	- CentOS - FreeBSD - OpenSUSE Linux - Oracle Enterprise Linux - Ubuntu LTS	- Amazon Linux - Ubuntu LTS - CentOS - Red Hat Enterprise Linux - Debian Server	- CentOS - Container-Optimized OS - Debian Server - Ubuntu LTS - SUSE Enterprise Linux

Security

Feature	Microsoft Azure	Amazon EC2	Google Cloud Platform

Network	Virtual Network, ExpressRoute	Virtual Private Cloud Network	Virtual Private Network
Identity and Access Management	Azure Active Directory B2C	Cognito	Certificate Authority Service (beta)
Authentication and Authorization	Active Directory and Active Directory Premium	Identity and Access Management (IAM)	Identity and Access Management (IAM)
Storage Security	Blob	S3	VPC Firewall
Security Check	Security Center	Trusted Advisor, AWS Inspector	Trusted UEFI firmware

Table 2: Security measure

Performance and Scalability

Performance is the capacity of your task to scale and fulfill the needs positioned by the clients in a productive way.Scalability is the capacity of a framework to deal with expanded burden (Microsoft, 2020).To meet workload, services covered by Azure Autoscale will scale automatically to fit demand. During workload increases, they will scale out to ensure capability and scaling will automatically return to normal when the peak decreases. The benefits of the Amazon EC2 is can be maximized by its auto scaling that tracks the apps. Higher fault tolerance, better availability and better cost control are the advantages. While Google Cloud Performance is the throughput of a system under a given workload for a specific time. In the cloud, the performance is validate by the measurements and testing scalibility (NetworkLessons.com).

Pricing Model

Comparing Azure vs AWS pricing has always been difficult due to the pace at which prices change. Many companies use both to enjoy the exclusive feature set of each cloud.

Feature	Microsoft Azure	Amazon EC2	Google Cloud Platform
Pricing Model	Pay as you go	Pay as you go Save when you reserve Pay less using more	Pay as you go
Free Trial	12 months	12 months	12 months
Subscription	$200 credits for 30 days	-	$300 free credits
Cost Calculator	Provided	Provided	Provided

Table 2: Security measure

Auto-Scaling/Elasticity

Azure elasticity as a service relates to a cloud service that allows Azure hosted services to be automatically scalable to meet demand and configured parameters. This gives Azure Administrators the ability to automatically scale the infrastructure and resources of Azure as and when required. With Amazon EC2, users can automate both volume-based and time-based elasticity, which can provide significant savings. Companies that shut down, for instance, Instances of EC2 outside a 10-hour workday will save 70% in comparison to running Instances like that 24 hours a day.For Google Cloud Performance, auto-scaling is supported by the Compute Engine to automatically add or delete VM instances from a managed instance category based on load increases or decreases. Autoscaling helps the apps to handle changes in traffic gracefully and when the demand for resources is smaller, it lowers costs.

Monitoring Tools / Service Provided

Monitoring tools are used to monitor and track any software if there is any problem or failure so that the problem can be fixed before it gets worse.There are some tools that can monitor all these providers.Microsoft Azure provides auto-discovery, continuous dependency mapping and instant answers to automate monitoring of Azure cloud services including App Service, Database Performance, AKS, HDInsight, and many more. The AI technology implemented will continuously baselines the performance and adapts as environment (Azure monitoring, n.d.). Amazon EC2 provides CPU utilization, network utilization, disk performance by using DiskReadOps and DiskWriteOps, memory utilization and many more (Monitor Amazon EC2, n.d.). Google Cloud

Performance provides monitor Cpu and memory details, keep tabs on disk utilization, achieve maximum network efficiency, effectively track firewall metrics, track quota metrics with ease, and plan ahead with insightful reports.

ADOPTING BETTER CLOUD COMPUTING SERVICE PROVIDERS

Cloud services have revolutionized computing, not least through IaaS, PaaS, and especially SaaS, which have allowed businesses to develop virtualized IT infrastructure and deliver software through the cloud, independent of a user's operating system. With many useful applications and services offered by cloud computing service providers, we need to decide if we are satisfied using all the shelf standard solutions provided by the shared cloud service providers whether they have secured system that should be hosted on cloud infrastructure for private users. There are few factors and aspects that we should focus on while choosing cloud computing service providers which can help us make a better decision on which cloud providers suit us the best.

Advantages and Disadvantages of Cloud Computing Service Providers

	Microsoft Azure	Amazon EC2	Google Cloud Platform
Advantages	- Ability to scale on demand - Flexible : allows users to customize the cloud as needed - Cost competitive - Customer support - Hybrid capability - Big Data insights	- CentOS - FreeBSD - OpenSUSE Linux - Oracle Enterprise Linux - SUSE Enterprise Linux - Ubuntu LTS - Windows Server	- Better pricing than competitors - Private global fiber network - Live migration of virtual machines - State of the art security - Redundant backups
Disadvantages	- Lack of Hyper-V Snapshot Support - Inability to Upload Custom Images - Provisioning Virtual Machines in the Cloud Takes Longer than On-Premise	- Service is a little complex - Takes too long to create images of EC2 instances - Limitations of Amazon EC2 - Security Limitations - Technical support fee	- Support fee is quite hefty - It has a complex pricing schema - Downloading data from GCS is expensive

Table 5: Advantages and Disadvantages of Cloud Computing Service Providers

6. Selected Cloud Service Providers

Based on the comparative evaluation of the two cloud service providers, we have made the decision to choose Microsoft Azure as our cloud service provider for our software development. There are few characteristics of why we chose Microsoft Azure with opinions supported and strong argument based on the Figure – above. Microsoft Azure offers a strong security profile which follows the DADSC (detect, assess, diagnose, stabilize, close). This is very important to protect our data from information theft.There are also several features that help Microsoft Azure reduce the risk by using multi-factor authentication besides having built-in mechanisms to avoid distributed denial-of-service (DDoS) attacks.Microsoft Azure has multiple redundancies in place to maintain data access as they have access to a broader range of global data centers than any other cloud provider.The physical component of Azure consists of 160+ physical data centers that are arranged into regions. This is really helpful for us whenever one of the data centers are having problems or under maintenance, we do not have to worry because there are other data centers that are accessible at the fingertips.Lastly, Microsoft Azure is highly known for their scalability options. They are designed to provide the best performance as they are massively scalable to meet the data storage from the end-user (Brandon Lee, 2019). Azure offers many great capabilities related to scaling such as scaling up and down, scaling in and out and autoscaling. We could benefit so much with the Azure cloud environment as they are not forced to purchase any data packets and just pay only for what we have used.

7. Conclusion

In this era of technology, almost every important innovation depend on cloud computing as it is continuously increase in the market. The networking speed and storage capacity attracted each person to explore and use it. In our point of we, we think that the cloud computing will provide proper security in the future because the data which is stored in the cloud is secure but not fully. In addition, we hope that the storage capacity will be increase for the upcoming generations to enable store more data since data is generating in a high volume and difficult to store it with security. In the future cloud computing will be one of the crucial thing in all the field and will provide benefits to the customers.

References :

2020 Cloud Computing Study. (2020, 08 06). Retrieved from IDE: https://www.idg.com/tools-for-marketers/2020-cloud-computing-study/

J., T., I., L., & A., D. (2017). *Computing Essentials 2017*. New York: McGraw-Hill Education.

Roger, S. (2018, December 13). *What is cloud computing? Everything you need to know about the cloud explained*. Retrieved from ZD Net: https://www.zdnet.com/article/what-is-cloud-computing-everything-you-need-to-know-about-the-cloud/

Rountree, D., & Castrillo, I. (2014). *Cloud Deployment Model* . Retrieved from ScienceDirect : https://www.sciencedirect.com/topics/computer-science/cloud-deployment-model

Shaptunova, Y. (2021). *4 Best Cloud Deployment Models Overview*. Retrieved from Sam Solutions: https://www.sam-solutions.com/blog/four-best-cloud-deployment-models-you-need-to-know/

Citrix. Retrieved from : https://www.citrix.com/en-my/glossary/what-is-a-cloud-service.html#:~:text=The%20term%20%22cloud%20services%22%20refers,for%20internal%20infrastructure%20or%20hardware.

IBM Cloud Education (2019). *IaaS (Infrastructure as a Service*. Retrieved from : https://www.ibm.com/cloud/learn/iaas

Blair Felter (2020). *The Different Types of Cloud Computing and How They Differ*. Retrieved from: https://www.vxchnge.com/blog/different-types-of-cloud-computing.

Bob Violino (2019). *What is PaaS?*. retrived from: https://www.infoworld.com/article/3223434/what-is-paas-software-development-in-the-cloud.html

Monitis (2017). *3 Types of Cloud Computing Services*. retrived from : https://www.monitis.com/blog/3-types-of-cloud-computing-services/

Brian Turner (2019). What is SaaS? Everything You Need to Know about Software as a Service. Retrieved from: https://www.techradar.com/sg/news/what-is-saas

AWS . retrieved from :https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/instance-types.html

GoogleCloud.Machine types. retrieved from : https://cloud.google.com/compute/docs/machine-types

NetworkLessons.com. Cloud Performance, Scalability and High Availability. Retrieve from : https://networklessons.com/cisco/evolving-technologies/cloud-performance-scalability-and-high-availability

Arumugam, N. (2020, April 15). *Microsoft Azure - Virtual Machine Types*. Retrieved from vembu: https://www.vembu.com/blog/microsoft-azure-virtual-machine

Azure monitoring. (n.d.). Retrieved from dynatrace: https://www.dynatrace.com/monitoring/technologies/azure-monitoring/?utm_source=google&utm_medium=cpc&utm_term=%2Bmicrosoft%20%2Bazure%20%2Bmonitoring&utm_campaign=my-azure-monitoring&utm_content=none&gclid=Cj0KCQiA3Y-ABhCnARIsAKYDH7v1BGK4pHlZdwI0HXGXJTyaS

Cloud Computing. (n.d.). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Cloud_computing

Microsoft. (2020, October 23). *Overview of the perfomance efficiency pillar*. Retrieved from Microsoft: https://docs.microsoft.com/en-us/azure/architecture/framework/scalability/overview

Microsoft. (n.d.). *Azure Actice Directory IDaaS in Security Operations*. Retrieved from Microsoft: https://docs.microsoft.com/en-us/azure/architecture/example-scenario/aadsec/azure-ad-security

Microsoft Azure Explained : What It Is and Why It Matters. (n.d.). Retrieved from ccb Technology: https://ccbtechnology.com/what-microsoft-azure-is-and-why

Microsoft. (n.d.). *Azure pricing*. Retrieved from Microsoft Azure: https://azure.microsoft.com/en-us/pricing/

Monitor Amazon EC2. (n.d.). Retrieved from aws: https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/monitoring_ec2.html

Nate Drake, Brian Turner. (2020, November 27). *Best cloud computing services of 2021 : for Digital Transformation*. Retrieved from techradar.pro: https://www.techradar.com/sg/best/best-cloud-computing-services

Veerawali Behal, Rydhm Beri. (2016). Cloud Computing : A Survey on Service Providers. *International Jouranl for Innovative Research in Science and Technology*.

What is a Virtual Machine (VM)? (2021). Retrieved from Red Hat: https://www.redhat.com/en/topics/virtualization/what-is-a-virtual-machine