

The Comparison of Cloud Computing services Between Amazon EC2, Google Cloud Platform, and Microsoft Azure

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1. Introduction:

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. It is a way of using computer resources with help of internet. [REF] **Montazerolghaem, Ahmadreza; Yaghmaee, Mohammad Hossein; Leon-Garcia, Alberto (September 2020). "Green Cloud Multimedia Networking: NFV/SDN Based Energy-Efficient Resource Allocation". IEEE Transactions on Green Communications and Networking. 4 (3): 873–889. doi:10.1109/TGCN.2020.2982821. ISSN 2473-2400.** It is basically used to store large amount of data which can be managed without direct user management. It also provides application over the internet through web browsers. With the help of cloud computing the data of a computer is not limited to only one computer. It stays on the server of the service provider and anyone with authorization can access those. Since the invention and use of computer, a huge amount of data is being stored in the storage devices. This resulted in huge amount of data and huge amount of storage devices and question was raised for data storage. Now we do not need to worry about places to store data and information. Now the whole internet is there to store our data. With cloud computing service providers, the work of the customers can be done through the internet remotely. Cloud computing services may be public, private or hybrid. Some cloud computing service providers are Google Cloud services, Microsoft Azure, Heroku, Amazon Web Services etc.

2. Service model (IaaS, PaaS, SaaS), Virtual Machine (VM), & Storage:

- Service model (IaaS, PaaS, SaaS):

IaaS (Infrastructure as a service) is cloud-based services, pay-as-you-go for services such as storage, networking, virtualization, and other computing resources in the cloud.

PaaS (Platform as a service) is hardware and software tools available over the internet. A service provider offers some access to a cloud-based environment in which users can build and deliver some applications. The provider also supplies the underlying infrastructure.

SaaS (Software as a service) is software that's available via a third-party over the internet.

- a. **Amazon EC2** = IaaS (infrastructure as a service)
- b. **Google Cloud Platform** = IaaS (infrastructure as a service)
- c. **Microsoft Azure** = IaaS (infrastructure as a service)

- **Virtual Machine (VM):**

In cloud computing virtual machine is a computer file, typically called an image, which behaves like an actual computer, that is used for virtual representation, or emulation, of a physical computer. In other words, creating a computer within a computer. Each virtual machine provides its own virtual hardware, including CPUs, memory, hard drives, network interfaces and other devices.

- a. **Amazon EC2** = The Virtual Machine in Amazon EC2 is flexible micro, small, and it offers VM based on MAC OS.
- b. **Google Cloud Platform** = The Virtual Machine in Google Cloud Platform is flexible micro, small, and it offers free low-end VM
- c. **Microsoft Azure** = The Virtual Machine in Microsoft Azure is flexible micro, small, and it offers an affordable VM

- **Storage:**

There are 3 types of storage that are the most common cloud storage technologies employed by Amazon EC2, Google Cloud Platform, and Microsoft Azure. They are:

Block storage = a form of persistent disk storage and is used in conjunction with VMs.

There are two forms of block storage: traditional magnetic-based Hard Disk Drives (HDDs) and contemporary Solid-State Disks (SSDs).

Object storage = an elastic and flexible format storage system designed for storing unstructured data within the cloud. There are three forms of object storage: Hot for accessing instantaneous data, Cool for infrequent data and Cold for archival materials in the cloud.

File storage = a relatively nascent cloud storage technology that resembles a traditional Network File System (NFS). With file storage, users can mount files easily to their VMs and read and access their records.

a. **Amazon EC2:**

1. **Block Storage** = Elastic Block Store (EBS). There are 3 forms: Throughput Optimized or Cold HDD, General Purpose SSD, Provisioned Input/Output Operations Per Second (IOPS) SSD.
2. **Object storage** = Simple Storage Service (S3). There are 2 forms of S3: Standard-Infrequent Access (for cool storage) and Glacier (for cold storage)
3. **File storage** = Elastic File System (EFS).

b. Google Cloud Platform:

1. **Block Storage** = Managed Disks. There are 2 forms: Standard (based on magnetic) and Premium (based on SSDs).
2. **Object storage** = Google Cloud Storage (GCS). There are 2 forms of GCS: GCS Nearline (for cool storage) and GCS Coldline (for archival)
3. **File storage** = Lacks a native file storage offering. Uses Filesystem in Userspace (FUSE)

c. Microsoft Azure:

1. **Block Storage** = Persistent Disks (PDs). There are two forms: Standard PDs and SSD-based PDs.
2. **Object storage** = Azure Blob storage. There are 3 categories: Hot (for instantaneous storage access), Cool (for infrequently accessed data), and Archive (for rarely accessed data)
3. **File storage** = Azure File Storage (AFS)

Opinion:

For this comparison, we prefer to use the Amazon EC2 because besides all the advantages that are offered in this 3 cloud computing providers, Amazon EC2 offers us Simple Storage Service (S3) for object storage and Amazon also offers us Virtual Machine MAC OS-based. So, we can use it in windows or Mac OS.

3. OS environments offered, Security, Performance and scalability:

Name	<i>Amazon EC2</i>	<i>Google Cloud Platform</i>	<i>Microsoft Azure</i>
OS environments offered	Amazon EC2 supports multiple operating system that need to pay additional licensing fees. For example, Red Hat Enterprise, SUSE Enterprise, Oracle Enterprise Linux, UNIX, and Windows Server.	Google Cloud Platform supports various operating system for windows and 64-bit Linux such as Window Servers 2012, Window Servers 2012 R2, Window Servers 2016, CentOS 7 and RHEL 7. While the supported windows and Linux for offline migration is Windows Server 2003, Window Server 2003 R2, Windows Server	Microsoft Azure can support a variety list of operating systems. For example, Windows Server 2008 R2, Windows Server 2012, Windows Server 2012 R2, Windows 10, Windows Server 2016, Windows Server 2016 Core and Endorsed Linux operating systems, except CoreOS and Opens SUSE.

		2008 R1 64-bit and Ubuntu 12.x.	
Security	Amazon EC2 allow the users to completely control the visibility of their AWS account. This security systems allow the users can specify the groups with which other groups may communicate and also groups with which IP subnets.	Google uses several layers of encryption to protect the user's data. Google Cloud Platform will encrypt customer content stored using one or many encryption mechanisms without any action required from the users.	Microsoft Azure able to identify threats and respond it to the cloud security threats. It can also manage others sensitive assets and the encryption keys.
Performance and scalability	Amazon EC2 can increase or decrease its capacity within minutes, hours or days. The Amazon EC2 is recognized by the Gartner Research to be able to run high availability enterprise applications.	Google Cloud Platform deliver services to the users with speed and reliability. Google Cloud Platform has powerful data analytics ability to manage, process, capture, and visualize data.	Microsoft Azure can increase or decrease workload based on demand of the users. Microsoft Azure also allow users to deliver software more faster using end-to-end DevOps solutions.

The operating system environments are defined as the unique installation of both physical and virtual Windows Server. First, we will be looking at the operating system environments of the Amazon Elastic Compute Cloud (Amazon EC2). Amazon EC2 supports the used of Red Hat Enterprise, SUSE Enterprise, Oracle Enterprise Linux, UNIX, and Windows Serve that require its user to pay additional licensing fees. While the Google Cloud Platform only available to supports operating system for Windows server and 64-bit Linux. The Microsoft Azure support a variety list of operating systems for the Windows server and Endorsed Linux operating systems except CoreOS and OpenSUSE.

For the security, Amazon EC2 allow the users to completely manage their Amazon Web Services account visibility. This security system allows the users can specify which other groups may communicate and also group with. Google Cloud Platform provide its users several layers of encryption mechanisms to protect the user's data without any action required from the users. While Microsoft Azure can identify threats from its users account and respond it to the cloud security threats, manage others sensitive assets and the encryption keys.

Performance is the indication of the responsiveness of the system to execute in a short time. While scalability is the ability of the system to handle increasing load without impact on its performance. Amazon EC2 can increase or decrease its capacity within minutes, hours or days which is important to run high availability enterprise applications. Google Cloud Platform deliver services to the users with speed and reliability as well as having powerful data analytics ability to help its users to manage, process, capture, and visualize data more easily. Microsoft Azure has the ability to allow its user to increase or decrease workload and to deliver software more rapidly using end-to-end DevOps solutions.

4. Pricing model, Auto-Scaling/Elasticity, Monitoring tools/service provided:

Amazon

Pricing models: There are four pricing models for Amazon EC2 instances: On-Demand Instances, Reserved Instances, Spot Instances, and Dedicated Hosts.

Elasticity: Allows you to match the supply of resources—which cost money—to demand. Matching needs to utilization is critical for cost optimization. Demand includes external usage (number of customers who visit the website) and internal usage (application team using development and test environments). There are two types: Time-based elasticity (turning off resources when they are not being used) and Volume-based elasticity (matching scale to the intensity of demand)

Monitoring tools: There are SolarWinds® AppOptics™, SolarWinds Papertrail™, Zenoss ZenPack, Zabbix, and Weave Scope.

Azure

Pricing Model: When using Azure under a capacity reservation contract, companies can save up to 60% on service cost depending on the capacity reservation specified compared to pay-as-you go contracts. Pricing for capacity reservations is also based on their specific location across the US or overseas. Pricing starts at \$ 100 per 100GB per day for sites and goes up to \$ 200 per 100GB per day for sites in southern Brazil.

Auto scaling / Elasticity : Auto scale is a built-in feature of Cloud Services, Mobile Services, Virtual Machines, and Websites that helps applications perform their best when demand changes.

Monitoring Tools/Service Provided: Azure Monitor helps you maximize the availability and performance of your applications and services. It delivers a comprehensive solution for collecting, analysing, and acting on telemetry from your cloud and on-premises environments.

Google computing

Pricing Models: Google cloud has many pricing models, such as Free, Subscription-based pricing, Usage-based pricing, Combined pricing.

Elasticity: Managed instance groups (MIG) offer autoscaling capabilities that let GCP's clients automatically add or delete virtual machine instances from a MIG based on increases or decreases in load. Autoscaling helps their apps gracefully handle increases in traffic and reduce costs when the need for resources is lower.

Monitoring tool: Cloud Monitoring provides endpoint checks to web applications and other internet-accessible services running in the user's cloud environment. Users can configure uptime checks associated with URLs, groups or resources, such as instances and load balancers.

Opinion:

We prefer Microsoft Azure for this comparison because it supports a wide range of programming languages, frameworks, operating systems, databases, and devices.

5. Conclusion:

Various improvements have taken place in the field of technology and information systems. With the passage of time new discoveries made the world easier. Cloud computing is one of those technologies, which made peoples' life easier. The industries have to store a large amount of data and has to access to a lot of information. Through cloud computing they can excess it from anywhere. This also reduces the costs because the number of resources required is less than usual. An industry or an individual can select cloud computing packages according to his needs. Moreover, the highest security is guaranteed by the service providers which is improved through regular software updates. For this reason, nowadays, the industries and big companies are moving towards cloud computing services.

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