

CLOD1003- Virtualization Technologies

In Class Assignment 03

Group E-

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Introduction:

Overview of Cloud Computing:

Cloud computing is a technology which enables users to remotely access and manage computing resources such as servers, storage, databases, networking, software, Application, etc. over the internet. Cloud computing is an on-demand IT service.

Significance in the modern technology:

1. **Cost Effectiveness-** It reduces investment needed for building physical infrastructure like datacenters and optimizes hardware costs. It also reduces the cost of upgrading and maintaining the resources.
2. **Impact on Business-** It allows businesses of all sizes to access scalable computing resources without large investment in IT infrastructure which has enabled startups and small businesses to compete with larger enterprises globally. Organizations can rapidly prototype and deploy changes according to the feedback.
3. **Serverless Computing-** It allows the developers to focus on writing code without the need to manage servers. This offers greater scalability, reduced operational overhead, and faster application time-to-market.
4. **Innovation-** It increases productivity and innovation as users can collaborate to the work by remotely accessing the resources and working with real time data from any location.
5. **Scalable Resources-** It gives more flexibility to the businesses. User can scale up or scale down the resources according to the need of business

6. **Accessibility-** Computing resources, data and applications can be accessed easily from any location over the internet.
7. **Environmental Impact-** Efficient use of computing resources can reduce the carbon footprints releasing from traditional data centers. Moreover, it also lowers energy consumption.

Briefly introduce Microsoft Azure, Amazon AWS, and Google GCP, highlighting their roles as major players in the cloud service market.

Microsoft Azure - It offers a wide range of services including virtual machines, databases, AI, and analytics. Any Organization using Microsoft software it is a great choice to use Microsoft azure as it provides good integration with Microsoft products.

Highlights-

1. Integration with Microsoft products like Windows Server, SQL Server, etc.
2. Large network of data centers across the globe which provide low-latency connections and high availability.
3. Broader data analytics services, such as Azure Synapse Analytics and Azure Data Lake.

Amazon Web Services (AWS)- It is cloud services platform that offers compute power, storage, content delivery and other functionality that organizations can use to deploy applications and services. AWS is popular for its scalability, reliability, and wide range of tools that support both startups and large enterprises.

Highlights-

1. 200 fully featured services across a wide range of technologies.
2. Largest global infrastructure, with number of data centers and availability zones.
3. Broadly adopted by enterprises, startups, and government organizations because of its reliability and feature set.

Google Cloud Provider (GCP)- GCP is Google's cloud computing service, which leverages expertise in big data, machine learning, and containerization technologies. It also offers specialized tools for AI and machine learning. It is known for its strong performance in data analytics and open-source technologies.

Highlights-

1. Leading-edge AI and machine learning services, including TensorFlow, AI Platform, etc.

2. Contributors can collaborate with open-source technologies like Kubernetes and TensorFlow.
3. Commitment to sustainability with carbon-neutral data centers and renewable energy initiatives.

1. Microsoft Azure

Microsoft Azure Strengths-

- a. Azure Cloud is Cost effective. Cost Management and Optimization Tools and services provided by azure to monitor, manage, and optimize helps businesses to stay within budget.
- b. Azure has 24/7 technical support which ensures that businesses can get help at whatever time they need.
- c. Azure supports a wide range of programming languages, frameworks, and operating systems, which makes it versatile for different development environments.
- d. Azure cloud offers the most advanced and secure cloud service. It is the most trusted cloud platform recognized by U.S. government institutions.
- e. Unique Selling Point (USP) of Azure is the ability to integrate automation. User can automate updates, manual processes, and configurations.
- f. Azure provides insights on key data through the platform's built-in support and SQL and NoSQL data services.

Azure Services and Offerings:

Azure provides a various services and solutions. Some of them are as mentioned below:

Compute power: Azure offers Virtual Machines, Azure kubernetes services, etc. An Azure virtual machine gives you the ability to virtualize compute resources without actually

buying and maintaining the physical hardwares. This is scalable and can be scaled out or scaled in as per the demand and pay only for the time when resources are used.

Virtual Machines can be used for different purposes like Development and test, Applications in the cloud, etc.

Azure Storage: Azure offers a different solution for storage. For example, Azure Blob Storage, Azure Files, Azure Table Storage.

Azure Blob Storage is utilized for storing massive amounts of unstructured data, like streaming videos and audios. It can be also used to store data for backup and restore, disaster recovery, and archiving.

Azure Files is fully managed file shares in the cloud. These files can be accessible from Windows, Linux, and macOS clients. The key benefits of using this is Shared access, Easy to use and fully managed, where we do not need to manage hardware or take care of patching OS.

Azure Database: some of the database options available in Azure are Azure SQL Database, Azure Cosmos DB, Azure Database for MySQL, etc. Azure SQL Database is a fully managed relational database service whereas Azure Database for MySQL is a fully managed MySQL database service. It is suitable for a wide range of applications, including web and mobile applications, data warehousing, and analytics.

Pricing tiers of Azure

Standard tier is suitable for developer/test environments whereas Premium tier is suitable for production environments.

2. Amazon Web Service (AWS)

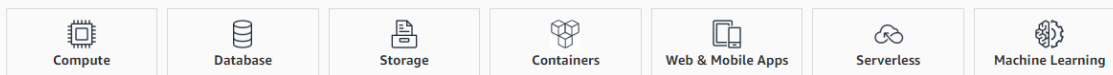
Aws is the world's most comprehensive and broadly accepted cloud provider which has more than 200 data centers available across the globe.

It has millions of customers including the fastest growing startups to the well-established organization which utilizes the services of the AWS at the lower costs and became more agile and innovative.



In this article, we'll cover most of the points such as core services, pricing, security and many more to get a deeper understanding of the AWS platform.

Explore Top Product Categories



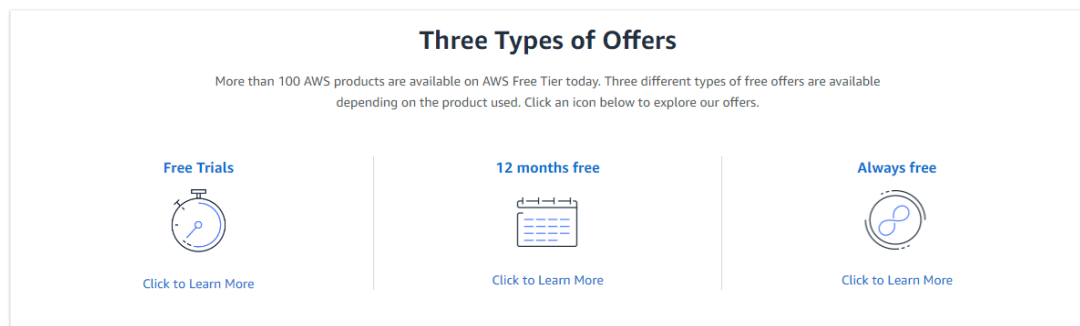
- **Core Service and offering:**

There are bundle of services which are offered by aws to deliver every aspect of cloud computing. Some of them are:

- **Compute:** AWS provides flexible and powerful computing services in form of various compute services such as EC2 instances, amazon lightsail which provides virtual servers. AWS lambda is another good example to handle serverless computing.

- **Database:** Managed database services are provided by AWS in form various storage models such as Amazon RDS (Relational Database Services) for tabular data and Amazon DynamicDB for NoSql Databases.
 - **Storage:** There are multiple storage services provided by AWS to store your structured as well as unstructured data. Amazon S3 Bucket is useful to store object storage and another EBS (elastic block storage) to store the blocks of data.
 - **Networking:** AWS provides various networking services to handle the network needs over the cloud. Amazon Route 53 provides a domain name service which helps in routing the user to an application.
 - **AI/ML:** With the increase in AI/ML technologies, AWS also stepped up with the pace by providing various AI/ML services to compete with the market. For example: Amazon Sagemaker is used for machine learning algorithms by data scientists and developers. Amazon Transcribe is another AI/ML model to convert speech text using the power of artificial intelligence.
- **Pricing Models:**

AWS is mainly based on the pay-as-you-go model and provides flexible pricing options to the user. A user can select any available plans to proceed further according to their requirements.

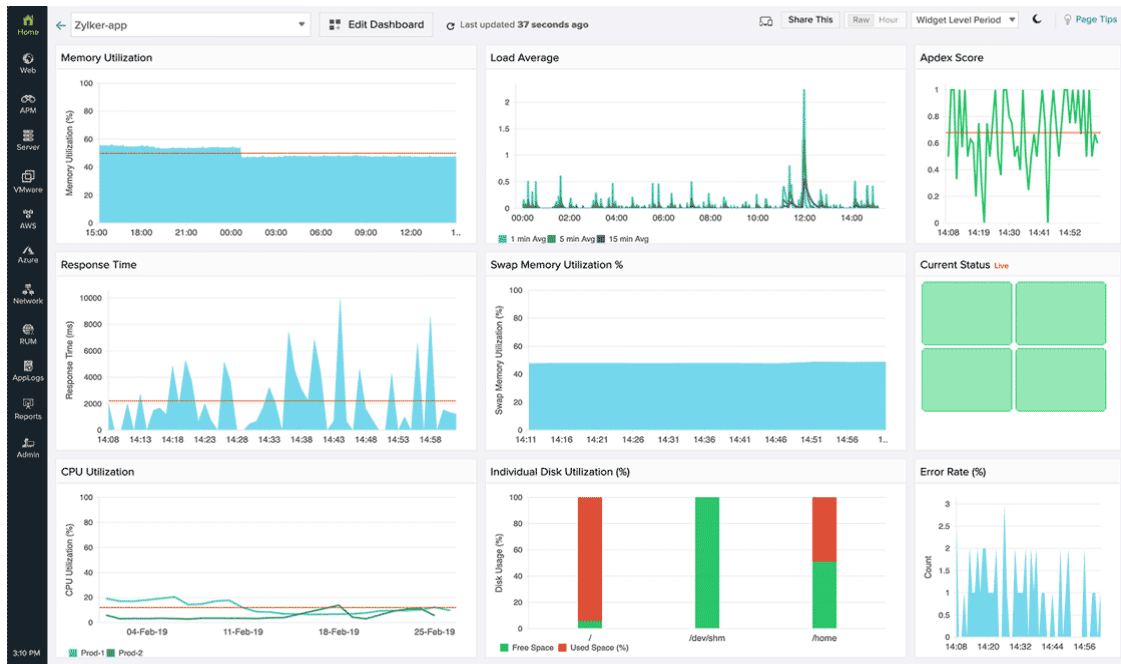


There are 3 different types of pricing models available in the AWS:

1. **Free trial:** There are some services which are available freely for a defined number of periods and going to be charged after that. Once the trial is expired you can just continue with the pay as you go model.

2. **12 months free:** This plan is available for the new user only to play with the cloud services and use them as per their requirement. Once this tier is over again it reverts to standard, pay as you model.
3. **Always free:** The services which are free for the entire period come under this category.

Moreover, AWS provides a price calculate which helps user to determine the total cost of resources that they going to use in their application.



Security and Compliance of AWS

- **Performance Metrics:**

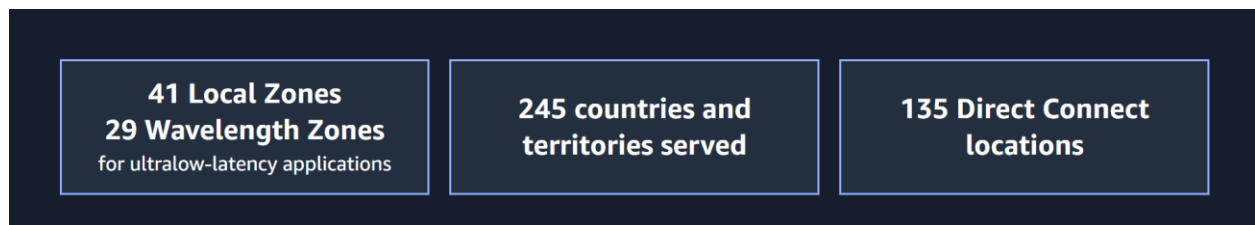
AWS performance is the key factor which makes it most trusted all over the world.

There are different metrics which are considered while maintaining the performance of the AWS.

- **Uptime:** AWS provides SLA(service level agreement) with a 99.99% uptime where they guarantee in a year they have only 52.56 minutes downtime.

Availability %	Downtime per year
99.8%	17.52 hours
99.9% ("three nines")	8.76 hours
99.95%	4.38 hours
99.99% ("four nines")	52.56 minutes
99.999% ("five nines")	5.26 minutes

- **Latency:** With a global data center availability, AWS ensures low latency for application. In the above diagram, AWS is available across 33 regions globally.
- **Global Data Centers:** AWS operates in multiple geographical areas, which allows the application of multiple cloud concepts such as Load Balancer to be available.



- **Security at AWS:**
 - **Flexibility and Agility:** AWS offers flexible and agile security controls, like on-premises data centers, without physical hardware.
 - **Shared Responsibility Model:** AWS secures the cloud infrastructure, while customers manage security within the cloud.
 - **Guidance and Tools:** AWS provides tools and features for network security, access control, and data encryption.
 - **Audits and Certifications:** Regular audits ensure high security standards; automated tools help with asset management and access reporting.

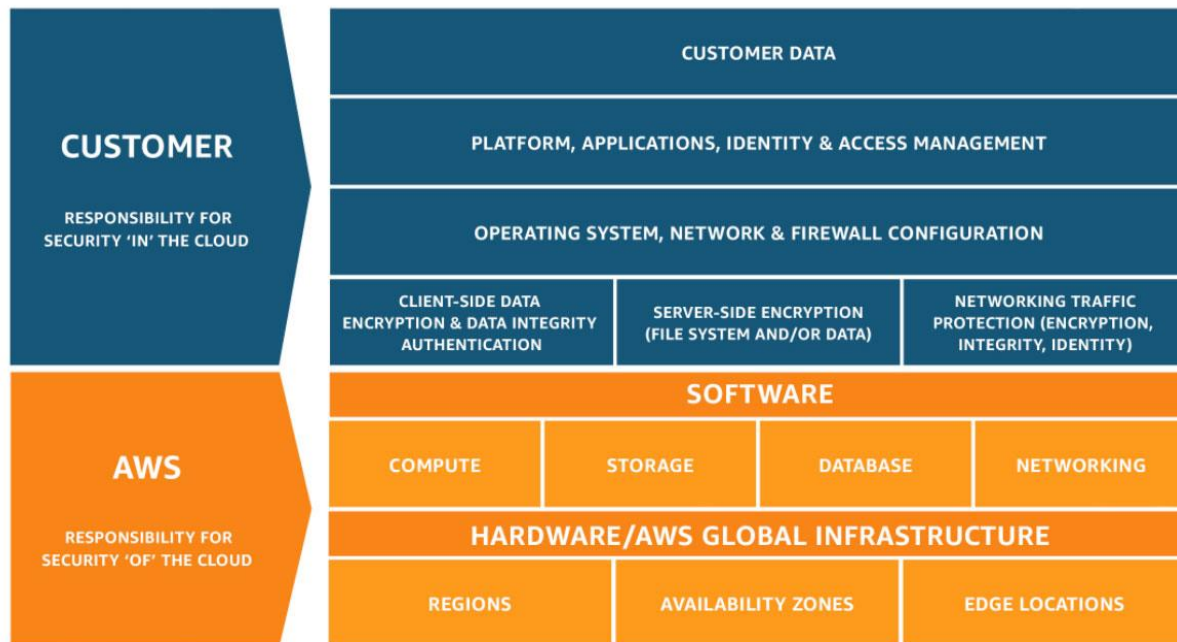
Benefits of AWS Security:

Data Safety: Strong safeguards protect data in secure AWS data centers.

Compliance: AWS manages multiple compliance programs.

Cost Savings: Utilize AWS data centers to cut costs.

Scalability: Security scales with AWS Cloud usage.



AWS (Amazon Web Services) offers extensive compliance programs, certifications, and frameworks to ensure that its services meet various regulatory and industry requirements. Here's a detailed overview of AWS's compliance offerings:

Regulatory and Industry Certifications

- **ISO/IEC 27001, 27017, 27018:**
 - **ISO/IEC 27001:** International standard for information security management systems (ISMS).
 - **ISO/IEC 27017:** Cloud-specific controls for information security.

- **ISO/IEC 27018:** Standards for protecting personal data in the cloud.
- **SOC 1, SOC 2, SOC 3:**
 - **SOC 1:** Controls relevant to financial reporting.
 - **SOC 2:** Controls related to security, availability, processing integrity, confidentiality, and privacy.
 - **SOC 3:** General use report covering the same controls as SOC 2 but intended for a broader audience.
- **Ease of Use and Management of AWS**
 - **Ease of Use:**

AWS Management Console: User-friendly interface for accessing AWS services.

Well-Documented APIs: Simplifies platform access and eliminates on-site servers.
 - **Management Tools:**
 - **AWS Management Console:** Web-based access to AWS services.
 - **Developer Tools:** SDKs, AWS Cloud9, AWS CodeStar.
 - **Administrator Tools:** AWS CLI, Amazon CloudWatch, AWS IAM.
 - **Business Tools:** AWS Cost Explorer, Amazon QuickSight.
- **Tool Options:**
 - **AWS Well-Architected Tool:** Evaluates workloads.
 - **AWS Organizations:** Manages accounts and resources.
 - **Provisioning Tools:** AWS CloudFormation, AWS OpsWorks.
 - **Operating Tools:** Amazon CloudWatch, AWS CloudTrail.
- **AWS Support and Community**

AWS Support:

- **Customer Service:** 24x7 access to support, documentation, and whitepapers.
- **AWS Trusted Advisor:** Guidance for best practices.
- **AWS Health:** Personalized service health view and alerts.

Community:

- **User Groups:** Over 400 AWS-focused groups worldwide.
- **AWS Community Day:** Community-led conferences.
- **AWS Summits:** Events for learning and collaboration.

The screenshot shows the AWS Developer Center Community page. The navigation bar includes links for Developer Center, Learning, Programming Languages, Events, Tools, Community, and More Resources. A search bar at the top contains the text 'canada'. On the left, there are filters for Location and Category. The Location filter has checkboxes for Asia Pacific, Australia & New Zealand, Europe, Middle East, & Africa, Greater China Region, Japan, Latin America, and North America (which is checked). The Category filter has checkboxes for AI/ML, Analytics, and AWS Startups. The main content area displays a grid of 10 user groups, sorted by Group Name (A-Z). The groups listed are: AWS Ontario Virtual User Group, Calgary AWS User Group, Kitchener Waterloo AWS User Group, Montréal AWS User Group, Ottawa AWS User Group, Québec City AWS User Group, Toronto AWS User Group, Vancouver AWS User Group, and Vancouver Amazon Web Services User Group. A URL bar at the bottom shows 'https://www.meetup.com/aws-ontario-virtual-user-group/'.

Developer Center Learning Programming Languages Events Tools Community More Resources

Clear all filters

Q canada

Location

- ☐ Asia Pacific
- ☐ Australia & New Zealand
- ☐ Europe, Middle East, & Africa
- ☐ Greater China Region
- ☐ Japan
- ☐ Latin America
- ☒ North America

Category

- ☐ AI/ML
- ☐ Analytics
- ☐ AWS Startups

Sort by: Group Name (A-Z)

1-10 (10)

- AWS Ontario Virtual User Group**
Toronto, Ontario, Canada
- Calgary AWS User Group**
Calgary, Alberta, Canada
- Kitchener Waterloo AWS User Group**
Waterloo, Canada
- Montréal AWS User Group**
Montréal, Canada
- Ottawa AWS User Group**
Ottawa, Ontario, Canada
- Québec City AWS User Group**
Québec City, Québec, Canada
- Toronto AWS User Group**
Toronto, Ontario, Canada
- Vancouver AWS User Group**
Vancouver, Canada
- Vancouver AWS User Group**
Canada, Vancouver
- Vancouver Amazon Web Services User Group**

<https://www.meetup.com/aws-ontario-virtual-user-group/>

Get to Know the AWS Community

Connecting with a builder community gives you the support to grow your career and skills in the cloud.

The screenshot shows the 'Get to Know the AWS Community' section. It features four cards with orange headers and blue text. The first card is 'Connect with an AWS Hero', the second is 'Learn about AWS Community Builders', the third is 'Join an AWS User Group', and the fourth is 'Start an AWS Cloud Club'. Each card contains a brief description and a link to learn more or join. On the right side, there is a vertical toolbar with icons for like, dislike, and comment, and a circular orange button with a speech bubble icon.

- Connect with an AWS Hero**
AWS Heroes are technical experts whose enthusiasm for knowledge-sharing has a real impact within the community.
[Connect with a Hero today »](#)
- Learn about AWS Community Builders**
AWS Community Builders are enthusiasts creating technical resources and a powerful network.
[Learn more or apply to join »](#)
- Join an AWS User Group**
AWS User Groups are community-led meetups for all levels to learn with your peers.
[Join a AWS User Group near you »](#)
- Start an AWS Cloud Club**
AWS Cloud Clubs are User Groups just for students.
[Find or start a Cloud Club »](#)

3.Google cloud platform

Google Cloud Platform (GCP) offers a range of strengths, weaknesses, and unique features that make it distinct among cloud service providers. Here's a breakdown:

Strengths

Data Analytics and Machine Learning:

- **Big Query:** GCP's fully managed, serverless data warehouse allows for real-time analytics on large datasets with impressive speed.
- **TensorFlow:** Developed by Google, TensorFlow is a leading machine learning framework, and GCP provides robust support and integration for it.

Infrastructure and Networking:

- **Global Network:** Google's infrastructure is backed by its extensive global network, which ensures high performance, reliability, and low latency.
- **Compute Engine:** Offers high-performance virtual machines with custom configurations and extensive options for scalability.

Kubernetes and Containerization:

- **Google Kubernetes Engine (GKE):** Highly regarded for its ease of use and integration with Kubernetes, GKE is one of the most advanced managed Kubernetes services.

Open Source and Integration:

- **Strong Open Source Support:** GCP has a strong commitment to open source technologies and integrates well with many popular open-source tools and projects.

Security and Compliance:

- **Security Infrastructure:** Google has a robust security framework with strong data encryption practices and compliance with various standards and certifications.

Innovative Tools:

- **Cloud AI and Machine Learning Tools:** Tools like AutoML and pre-trained APIs for natural language processing, vision, and translation are powerful and easy to use.

Weaknesses

Market Penetration:

- **Smaller Market Share:** Compared to AWS and Azure, GCP has a smaller market share, which can sometimes lead to less community support and fewer third-party integrations.

Complex Pricing Model:

- **Pricing Complexity:** GCP's pricing model can be complex and difficult to predict, which may pose challenges for budgeting and cost management.

Support and Documentation:

- **Support Quality:** While Google offers support, some users report that it can be less responsive or detailed compared to AWS and Azure.
- **Documentation Gaps:** There can be inconsistencies or gaps in documentation that may pose challenges for users, particularly those new to GCP.

Enterprise Adoption:

- **Enterprise Features:** Although GCP has been making strides, it is sometimes perceived as less mature in terms of enterprise features and support compared to AWS and Azure.

Unique Features

Big Data and AI Integration:

- **Big Query:** Real-time analytics on large data sets with a highly efficient and easy-to-use query engine.
- **AI Platform:** Seamless integration with various AI tools and frameworks for building and deploying machine learning models.

Custom Machine Types:

- **Custom Machine Types:** GCP offers the flexibility to create virtual machines with custom configurations, optimizing performance and cost.

Global Load Balancing:

- **Global Load Balancer:** GCP's global load balancing distributes traffic across multiple regions, enhancing availability and performance.

Preemptible VMs:

- **Preemptible VMs:** Cost-effective, short-lived VMs that are ideal for batch processing and other transient workloads.

Anthos:

- **Hybrid and Multi-cloud:** Anthos provides a unified management platform for hybrid and multi-cloud environments, allowing users to manage workloads across different cloud providers.

Cloud Spanner:

- **Scalable Database:** A globally distributed database service that offers horizontal scaling and strong consistency, combining the best of SQL and NoSQL databases.

Case study on Spotify, that is a leading company in music entertainment industry who uses google cloud services.

Challenge: Spotify needed a scalable and reliable infrastructure to handle its massive and growing amount of data and deliver seamless music streaming experiences to its global user base.

Solution: Spotify migrated from on-premises data centers to GCP to take advantage of its high-performance computing capabilities and global network. The company uses GCP's **Big Query** for analytics, **Cloud Pub/Sub** for real-time messaging, and **Compute Engine** for scalable compute resources.

Outcome: By leveraging GCP, Spotify improved its ability to scale efficiently and manage massive data workloads. The move also facilitated enhanced real-time analytics, allowing Spotify to deliver more personalized music recommendations and better user experiences.

Comparison Between AWS, Azure and GCP

AWS	AZURE	GCP
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In AWS pricing is calculated per second pricing with a 60-second minimum.	In Azure, the pricing is per-minute basis.	In GCP, the pricing is per-minute basis.
EC2 (Elastic Compute Cloud) provides all the computing administration. The program oversees virtual machines, which can either be designed by the owner or have pre-configured settings for convenience.	With Microsoft Azure, you can create virtual machines and scale sets for virtual machines.	As part of GCP (Google Cloud Platform), GCE (Google Compute Engine) does a similar function.
AWS provides apportioned, transient (brief) stockpiling storage.	Azure uses ID drives (transient capacity), and Page Blobs VM-based volumes are stored in Block Storage (Microsoft's choice).	Comparatively, Google's Cloud Platform offers both brief stockpiling and constant circles. For Object stockpiling, GCP has Google Cloud Storage.
AWS provides a vast array of computing resources, including Amazon EC2 (Elastic Compute Cloud), which offers scalable virtual private cloud for a wide range of use cases.	Azure offers similar computing resources with its Virtual Machines (VMs) service, providing scalable and flexible virtualized computing environments.	GCP's computing resources are available through Google Compute Engine, offering customizable VM instances.
AWS operates a vast global network of over 200 data centers spread across multiple geographic regions, covering North America, Europe, Asia, Australia.	Azure cloud has an extensive network of data centers worldwide, offering services in more regions compared to AWS and GCP.	GCP's data centers are strategically located across multiple regions globally, covering North America, Europe, Asia, Australia, and South America.

Scenario

A company is planning to develop real-time analytics system to process and analyze data from thousands of IoT devices. This system needs to handle high data ingestion rates, perform real-time analytics, store large volumes of time-series data, and ensure low-latency responses. Additionally, the platform should be cost-effective, secure, and easily scalable.

In this case I would suggest GCP cloud service as it offers real-time data streams, scalable storage, cost efficiency, and integration with analytics tools.

Conclusion

Based on the above point that we discussed as a group each cloud service has its own strength.

- **AWS:** Known for its extensive range of services, scalability, reliability, and global infrastructure. It's highly adopted by enterprises and startups due to its feature set and strong support.
- **Microsoft Azure:** Integrates with Microsoft products which makes it best for organizations using Microsoft software. It offers support, cost management tools, and advanced analytics services.
- **GCP:** Excels in data analytics, machine learning, and open-source technologies. It boasts strong performance, security, and innovative tools like Big Query and TensorFlow.

References:

AWS

[What is AWS? - Cloud Computing with AWS - Amazon Web Services](#)

<https://aws.amazon.com/free>

<https://aws.amazon.com/about-aws/global-infrastructure/>

[AWS Pricing Calculator](#)

[https://aws.amazon.com/legal/service-level-agreements.](https://aws.amazon.com/legal/service-level-agreements)

Azure

<https://azure.microsoft.com/en-ca/solutions/ai/>

<https://azure.microsoft.com/en-ca/pricing/>

<https://azure.microsoft.com/en-ca/explore/global-infrastructure/>

GCP

<https://cloud.google.com/customers/spotify#:~:text=By%20employing%20automated%2C>

[%20developer%2Dfriendly,operational%20complexity%20from%20our%20ecosystem.](#)
<https://cloud.google.com/>