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Assignment 5

CLOUD COMPUTING

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# **Addressing the given issues via moving to a Cloud Computing platform.**

1. A Physical server AKA ‘bare-metal server, is specific physical server is designated to a single user like only for NextAndCo Company. The resources and components of a physical servers are not shared between multiple users. This physical server should have memory, processor network connection, hard drive, and operating system for running programs and application. Physical server is large due to the powerful processing components that it contains.

The biggest problem is physical server will not survive in worst-case scenarios. Normally there are security problems like,

* + - Inadequate Temperature Control
    - Insufficient Ventilation
    - Imbalanced Moisture Levels
    - Too Much Jostling
    - Clutter and Disarray
    - Power Volatility
    - Acts of Intentional Malice

But in cloud servers there are not any security problems with location. No requirement capital expenses or onsite hardware. This usually suits organisations that outgrow data storage quickly. Data can be backed up in the cloud as regularly as 15-minute intervals, minimizing data losses in disaster situations. Small data set recovery time is improved.

1. Having local servers are not sufficient for larger companies. It is very convenient to use Cloud Computing based services. Cloud computing is a large-scale distributed computing paradigm driven by economies of scale, in which a pool of abstracted, virtualized, dynamically scalable computing resources is delivered on demand as services to external customers over networks. Cloud architecture is developed for high performance, reliability and speed. When the business needs fast updates and seamless changes of features for the business, cloud application can be used for these updates with this not only use adaptation but also security threats can be used. The agility given by cloud technology can make the app robust and more competitive.
2. In here they want some high capacity of voltage for ruining their servers. If the company moves to the cloud platform, usage of electrical power can be decreased. Because cloud platform can create servers inside this cloud storages. Cloud broadband service is better than Physical platform because cloud computing broadband is secure than physical service and it broadcast is better than physical service. Hence company can reduce the cost for Broadband services. Benefits are given for the developers by using these methods. No upfront investment and Redundancy and disaster recovery
3. With the help of cloud storage, you can open and access a document on any of your devices at any location. You need to have internet connection for this to access documents. This slows you to work wherever you want and whenever you want. Those days are gone, when you used to transfer documents through email and must wait long for attachments. With cloud storage, you can transfer files with just a click to the desired location in a much faster and safer manner.
4. It is almost impossible to do a server upgrade without additional downtime. Also, it is worth noting that the future upgrades for a dedicated server should be considered when ordering the server. Otherwise, the upgrades may lead to ordering a completely new server. That will instead lead to an unplanned service migration and thus unplanned service downtime.
5. Traditional disaster recovery approaches entailed off-site duplication of data and infrastructure. So, if something catastrophic were to happen to your primary data centre, you could quickly switch to the backup data centre to get critical applications up and running again.
6. Developers can benefit from the cloud by being able to more easily monitor all the operations and applications that they use. They can see application performance metrics, logs and monitoring tools to identify problems with a server or system before a user reports them.
7. Standard relational databases enable users to manage predefined data relationships across multiple databases. Popular examples of standard relational databases include Microsoft SQL Server, Oracle Database, MySQL and IBM DB2.

Cloud-based relational databases, or database as a service (DBaaS), are also widely used because they enable companies to outsource database maintenance, patching and infrastructure support requirements. Cloud relational databases include Amazon Relational Database Service (RDS), Google Cloud SQL, IBM DB2 on Cloud, SQL Azure and Oracle Cloud.

The advantages of using a relational database in the cloud is that it is a familiar, and popular format - especially for data analytics - while also accelerating the business by leveraging the cloud to bring down cost and increase speed and scalability. This allows businesses to get the most out of existing licenses with, say, Oracle, while also advancing a cloud strategy.

1. The “cloud’ is not one thing. As such, it cannot crash. The cloud is essentially made of three components, each one of these has a level of redundancy. Redundancy means there are copies of everything so a copy can take over if the primary thing fails. These are the three components. Internet, DNS system and Applications

# **Comparison of the three Cloud Services (Google Cloud, AWS & MS Azure) with the Cloud Service solutions of given issues**

## **Currently servers are not available in a secured physical location.**

### **Google - (Storage) Cloud Storage, Persistent Disk, Local SSDS**

* + Cloud Storage

Cloud Storage provides worldwide, highly durable object storage that scales to exabytes of data. You can access data instantly from any storage class, integrate storage into your applications with a single unified API, and easily optimize price and performance.

* + Persistent Disk

Google Persistent Disk is durable and high-performance block storage for Google Cloud Platform. Persistent Disk provides SSD and HDD storage which can be attached to instances running in either Compute Engine or Google Kubernetes Engine. Storage volumes can be transparently resized, quickly backed up, and offer the ability to support simultaneous readers.

* + Local SSDS

Local SSDs are physically attached to the server that hosts your VM instance. This tight coupling offers superior performance, very high input/output operations per second (IOPS), and very low latency compared to other block storage options. Local SSDs are designed for temporary storage use cases such as caches or scratch processing space. Which makes them suitable for workloads like media rendering, data analytics or high-performance computing.

### **AWS - (Storage) Amazon Sample Storage Service (S3), Amazon S3 Glacier, AWS Storage Gateway**

* + Amazon Sample Storage Service (S3)

Amazon Simple Storage Service (Amazon S3) is an object storage service that offers industry-leading scalability, data availability, security, and performance. This means customers of all sizes and industries can use it to store and protect any amount of data for a range of use cases

* + Amazon S3 Glacier

Amazon S3 Glacier and S3 Glacier Deep Archive are a secure, durable, and extremely low-cost Amazon S3 cloud storage classes for data archiving and long-term backup. They are designed to deliver 99.99% durability and provide comprehensive security and compliance capabilities that can help meet even the most stringent regulatory requirements.

* + AWS Storage Gateway

AWS Storage Gateway is a hybrid cloud storage service that gives you on-premises access to virtually unlimited cloud storage. Customers use Storage Gateway to simplify storage management and reduce costs for key hybrid cloud storage use cases.

### **Azure- (Storage) Archive Storage, Azure NetApp Files, Disk Storage**

* + Archive Storage

Azure storage offers different access tiers, which allow you to store blob object data in the most cost-effective manner. The available access tiers include

Hot - Optimized for storing data that is accessed frequently.

Cool - Optimized for storing data that is infrequently accessed and stored for at least 30 days.

Archive - Optimized for storing data that is rarely accessed and stored for at least 180 days with flexible latency requirements (on the order of hours).

* + Azure NetApp Files

The Azure NetApp Files service is an enterprise-class, high-performance, metered file storage service. Azure NetApp Files supports any workload type and is highly available by default. You can select service and performance levels and set up snapshots through the service.

* + Disk Storage

Azure managed disks are block-level storage volumes that are managed by Azure and used with Azure Virtual Machines. Managed disks are like a physical disk in an on-premises server but virtualized.

## **At peak times of the business, the capacity and the performance of the servers are not enough.**

### **Google Cloud Storage - (Storage) Filestore ,(Operations) Application Performance**

### **Management, Cloud Profiler**

* + Filestore

Cloud Filestore is a managed file storage service for applications that require a filesystem interface and a shared filesystem for data. Filestore gives users a simple, native experience for standing up managed Network Attached Storage (NAS) with their Google Compute Engine and Kubernetes Engine instances.

* + Application Performance Management

[Cloud Trace](https://cloud.google.com/trace), [Cloud Debugger](https://cloud.google.com/debugger), and [Cloud Profiler](https://cloud.google.com/profiler) use some of the same tools Google’s own [Site Reliability Engineering (SRE)](http://landing.google.com/sre/interview/ben-treynor.html) team uses, to give you insights into how your code runs, and let you take action to fix problems, whatever cloud you’re using.

* + Cloud Profiler

Cloud Profiler presents the call hierarchy and resource consumption of the relevant function in an interactive flame graph that helps developers understand which paths consume the most resources and the different ways in which their code is called.

### **AWS Cloud Storage - (Storage) Amazon FSx for Lustre, (Containers), Amazon Elastic**

### **Container Service, (Analytics) Amazon Quick Site**

* + Amazon FSx for Lustre

Amazon FSx for Lustre makes it easy and cost effective to launch and run the world’s most popular high-performance file system. Use it for workloads where speed matters, such as machine learning, high performance computing (HPC), video processing, and financial modeling.

* + Amazon Elastic Container Service

Amazon Elastic Container Service (Amazon ECS) is a fully managed container orchestration service. Customers such as Duolingo, Samsung, GE, and Cook Pad use ECS to run their most sensitive and mission critical applications because of its security, reliability, and scalability.

* + Amazon Quick Site

Amazon QuickSight is a fast, cloud-powered business intelligence service that makes it easy to deliver insights to everyone in your organization. As a fully managed service, QuickSight lets you easily create and publish interactive dashboards that include ML Insights. Dashboards can then be accessed from any device, and embedded into your applications, portals, and websites.

### **Azure Cloud Storage - (Storage) Azure Data Lake Storage, Avere vFXT for Azure,**

### **(Analytics) Azure Data Explorer**

* + Azure Data Lake Storage

Azure Data Lake Storage Gen2 is a highly scalable and cost-effective data lake solution for big data analytics. It combines the power of a high-performance file system with massive scale and economy to help you spend your time to insight

* + Avere vFXT for Azure

Avere vFXT for Azure lets you protect your infrastructure investment while easily managing new demands. Run your NFS and SMB workloads without latency and scale them to your needs using an intelligent cache to keep your data placement efficient, flexible, and cost-effective.

* + Azure Data Explorer

Azure Data Explorer is a fast, fully managed data analytics service for real-time analysis on large volumes of data streaming from applications, websites, IoT devices, and more.

## **Cost for the electricity, broadband and dev-ops teams are increasing and higher.**

### **Google- (API Management) Cloud Endpoints, API Monetization**

* + Cloud Endpoints

Endpoints is an API management system that helps you secure, monitor, analyze, and set quotas on your APIs using the same infrastructure Google uses for its own APIs. After you deploy your API to Endpoints, you can use the Cloud Endpoints Portal to create a developer portal, a website that users of your API can access to view documentation and interact with your API.

* + API Monetization

Apigee API Monetization is a powerful, comprehensive and flexible solution that helps enterprises leverage their digital assets into new revenue streams and business models. More than 60 enterprises across multiple industries leverage Apigee’s API Monetization capabilities to capture additional value in the digital value chain. API Monetization can also help companies manage records for chargebacks within internal corporate units.

### **AWS - (API Management) Amazon DevOps**

* + Amazon DevOps

AWS provides a set of flexible services designed to enable companies to more rapidly and reliably build and deliver products using AWS and DevOps practices. These services simplify provisioning and managing infrastructure, deploying application code, automating software release processes, and monitoring your application and infrastructure performance.

### **Azure - (API Management) API Apps**

* + API Apps

Azure App Service enables you to build and host web apps, mobile back ends, and RESTful APIs in the programming language of your choice without managing infrastructure. It offers auto scaling and high availability, supports both Windows and Linux, and enables automated deployments from GitHub, Azure DevOps, or any GIT repo. Learn how to use Azure App Service with our quick starts, tutorials, and samples.

## **As per the dev ops teams, the software’s running on servers are legacy and requires manual upgrade.**

### **Google - (Compute) App Engine**

* + App Engine

App Engine enables developers to stay more productive and agile by supporting popular development languages and a wide range of developer tools.

### **AWS - (Compute)AWS Lambda**

* + AWS Lambda

With Lambda, can run code for virtually any type of application or backend service - all with zero administration. Just upload your code and Lambda takes care of everything required to run and scale your code with high availability. Can set up code to automatically trigger from other AWS services or call it directly from any web or mobile app.

### **Azure - (Compute) Azure Cycle Cloud, Azure VMware Solution, Azure Spring Cloud**

* + Azure Cycle Cloud

Deploy full clusters and other resources, including scheduler, compute VMs, storage, networking, and cache.

* + Azure VMware Solution

Run native VMware environments at any scale with unified management of Azure and VMware resources, Azure networking services, and security tools. Reduce costs with innovative savings programs that are only available on Azure.

* + Azure Spring Cloud

Use Spring Cloud to bring modern microservice patterns to Spring Boot apps, eliminating boilerplate code to quickly develop robust Java apps. Easily deploy, operate, and scale your apps in a fully managed environment.

## **Developers are complaining, its unable to upgrade with latest technologies due to infrastructure limitations.**

### **Google- (AI and Machine Learning) Text-to-Speech, AutoML, Cloud Natural Language**

* + Text-to-Speech

Google Cloud Text-to-Speech converts text into human-like speech in more than 180 voices across 30+ languages and variants. It applies groundbreaking research in speech synthesis (WaveNet) and Google's powerful neural networks to deliver high-fidelity audio. With this easy-to-use API, you can create lifelike interactions with your users that transform customer service, device interaction, and other applications.

* + AutoML

Cloud AutoML is a suite of machine learning products that enables developers with limited machine learning expertise to train high-quality models specific to their business needs. It relies on Google’s state-of-the-art transfer learning and neural architecture search technology.

* + Cloud Natural Language

Natural Language uses machine learning to reveal the structure and meaning of text. You can extract information about people, places, and events, and better understand social media sentiment and customer conversations. Natural Language enables you to analyze text and integrate it with your document storage on Cloud Storage.

### **AWS - (Machine Learning) Amazon Forecast, Amazon Personalize, Amazon Polly,**

### **Amazon Lex**

* + Amazon Forecast

Amazon Forecast is a fully managed service that uses machine learning to deliver highly accurate forecasts. Companies today use everything from simple spreadsheets to complex financial planning software to attempt to accurately forecast future business outcomes such as product demand, resource needs, or financial performance. These tools build forecasts by looking at a historical series of data, which is called time series data.

* + Amazon Personalize

Amazon Personalize is a machine learning service that makes it easy for developers to create individualized recommendations for customers using their applications. Machine learning is being increasingly used to improve customer engagement by powering personalized product and content recommendations, tailored search results, and targeted marketing promotions. However, developing the machine-learning capabilities necessary to produce these sophisticated recommendation systems has been beyond the reach of most organizations today due to the complexity. Amazon Personalize allows developers with no prior machine learning experience to easily build sophisticated personalization capabilities into their applications, using machine learning technology perfected from years of use on Amazon.com.

* + Amazon Polly

Amazon Polly is a service that turns text into lifelike speech, allowing you to create applications that talk, and build entirely new categories of speech-enabled products. Polly's Text-to-Speech (TTS) service uses advanced deep learning technologies to synthesize natural sounding human speech. With dozens of lifelike voices across a broad set of languages, you can build speech-enabled applications that work in many different countries.

* + Amazon Lex

Amazon Lex is a service for building conversational interfaces into any application using voice and text. Amazon Lex provides the advanced deep learning functionalities of automatic speech recognition (ASR) for converting speech to text, and natural language understanding (NLU) to recognize the intent of the text, to enable you to build applications with highly engaging user experiences and lifelike conversational interactions

### **Azure - (AI + Machine Learning) Azure Cognitive Search, Azure Machine Learning, Azure Open Datasets**

* + Azure Cognitive Search

Azure Cognitive Search is the only cloud search service with built-in AI capabilities that enrich all types of information to easily identify and explore relevant content at scale.

* + Azure Machine Learning

Empower developers and data scientists with a wide range of productive experiences for building, training, and deploying machine learning models faster. Accelerate time to market and foster team collaboration with industry-leading MLOps—DevOps for machine learning. Innovate on a secure, trusted platform, designed for responsible AI.

* + Azure Open Datasets

Azure Open Datasets are curated public datasets that you can use to add scenario-specific features to machine learning solutions for more accurate models.

## **Network engineers are complaining that server is crashing frequently and there is no disaster recovery plan.**

### **Google- (Networking) Cloud Armor, Security Command Center**

* + Cloud Armor

Cloud Armor is a distributed service which is supported with Global HTTP(S) Load Balancer to provide built-in defenses against infrastructure DDoS attacks. It will also scale up based on your traffic.

* + Security Command Center

Cloud Security Command Center (Cloud SCC) is the canonical security and risk database for Google Cloud Platform (GCP). Cloud SCC is an intuitive, intelligent risk dashboard and analytics system for surfacing, understanding, and remediating GCP security and data risks across an organization.

### **AWS- (Security, Identity & Compliance) Amazon GuardDuty, AWS Shield**

* + Amazon GuardDuty

Amazon GuardDuty is a threat detection service that continuously monitors for malicious activity and unauthorized behavior to protect your AWS accounts and workloads.

* + AWS Shield

AWS Shield is a managed Distributed Denial of Service (DDoS) protection service that safeguards applications running on AWS. AWS Shield provides always-on detection and automatic inline mitigations that minimize application downtime and latency, so there is no need to engage AWS Support to benefit from DDoS protection.

### **Azure- (Security, Migration) Azure DDoS Protection, Azure Site Recovery**

* + Azure DDoS Protection

Azure DDoS Protection service is integrated with Virtual Networks and provides protection for Azure applications from the impacts of DDoS attacks. It enables additional application specific tuning, alerting and telemetry features beyond the basic DDoS Protection which is included automatically in the Azure platform.

* + Azure Site Recovery

Azure Site Recovery helps ensure business continuity by keeping business apps and workloads running during outages. Site Recovery replicates workloads running on physical and virtual machines (VMs) from a primary site to a secondary location.

## **Management is required a dashboard view of all the resource usage and application usage.**

### **Google - (API Management) Apigee API Platform, API Analytics**

* + Apigee API Platform

Apigee is a full lifecycle API platform that accelerates the pace of digital business and empowers organizations to securely deliver and manage all APIs. Apigee sits in-line with runtime API traffic and enforces a set of out-of-the-box API policies, including key validation, quota management, transformation, authorization, and access control

* + API Analytics

The Google Analytics Reporting API v4 is the most advanced programmatic method to access report data in Google Analytics. With the Google Analytics Reporting API, you can: ... Automate complex reporting tasks to save time. Integrate your Google Analytics data with other business applications.

### **AWS - (API Management) Amazon API Gateway**

* + Amazon API Gateway

Amazon API Gateway is an AWS service for creating, publishing, maintaining, monitoring, and securing REST, HTTP, and WebSocket APIs at any scale. API developers can create APIs that access AWS or other web services, as well as data stored in the AWS Cloud.

### **Azure - (Integration) API Management**

* + API Management

A new Azure API Management feature allows you to expose apps deployed in Azure App Service to manage, protect, and secure APIs. It's now easier to publish apps to API Management from the App Service extension in the Azure portal.

## **Their existing database is relational, Management is looking for a solution to move all their existing data to non-relational database. Leadership is more worried about the data loss, support and hiring developers who can do the needful.**

### **Google- (Database) Cloud Spanner, Cloud Bigtable**

* + Cloud Spanner

Cloud Spanner is the first scalable, enterprise grade, globally distributed, and strongly consistent database service built for the cloud specifically to combine the benefits of relational database structure with non-relational horizontal scale.

* + Cloud Bigtable

Cloud Bigtable is Google's NoSQL Big Data database service. It's the same database that powers many core Google services, including Search, Analytics, Maps, and Gmail.

### **AWS- (Database)Amazon DynamoDB, Amazon Aurora**

* + Amazon DynamoDB

Amazon DynamoDB is a fully managed NoSQL database service that provides fast and predictable performance with seamless scalability. DynamoDB lets you offload the administrative burdens of operating and scaling a distributed database so that you don't have to worry about hardware provisioning, setup and configuration, replication, software patching, or cluster scaling.

* + Amazon Aurora

Amazon Aurora is a MySQL and PostgreSQL-compatible relational database built for the cloud, that combines the performance and availability of traditional enterprise databases with the simplicity and cost-effectiveness of open source databases.

### **Azure- (Databases)Azure Database migration service, Table storage**

* + Azure Database Migration Service

Azure Database Migration Service is a fully managed service designed to enable seamless migrations from multiple database sources to Azure data platforms with minimal downtime (online migrations).

* + Table Storage

Azure Table storage is a service that stores structured NoSQL data in the cloud, providing a key/attribute store with a schema less design. Because Table storage is schema less, it's easy to adapt your data as the needs of your application evolve. Access to Table storage data is fast and cost-effective for many types of applications and is typically lower in cost than traditional SQL for similar volumes of data

## **One of their functionalities in the main application is to send bulk emails. When sending bulk emails, servers are taking too much time and sometimes the email server crashes. Network engineers has suggested to upgrade servers to solve the issue which is expensive.**

### **Google - (Migration) Migrate for Compute Engine, Transfer Appliance**

* + Migrate for Compute Engine

Migrate for Compute Engine provides an agentless cloud migration solution that allows users to efficiently migrate VMs to Google Cloud Platform in minutes.

* + Transfer Appliance

Google Transfer Appliance is a high-capacity storage server that enables enterprises to transport large volumes of data to Google Cloud Storage

### **AWS- (Migration)AWS Database Migration Service, AWS Server Migration Service**

* + AWS Database Migration Service

AWS Database Migration Service (AWS DMS) is a cloud service that makes it easy to migrate relational databases, data warehouses, NoSQL databases, and other types of data stores.

* + AWS Server Migration Service

AWS Server Migration Service (SMS) is an agentless service which makes it easier and faster for user to migrate thousands of on-premises workloads to AWS.

### **Azure- (Migration)Azure Migrate, Azure Database migration Service**

* + Azure Migrate

Azure Migrate provides a centralized hub to assess and migrate to Azure on-premises servers, infrastructure, applications, and data.

* + Azure Database migration Service

Azure Database Migration Service is a fully managed service designed to enable seamless migrations from multiple database sources to Azure data platforms with minimal downtime (online migrations).

# **Compare the costing on each service**

## **Hosting**

1. **AWS - AWS Lambda: The price for Duration depends on the amount of memory you allocate to your function.**

|  |  |
| --- | --- |
|  | Price |
| Requests | $0.20 per 1M request |
| Duration | $0.0000166667 for every GB-second |

One Execution per 100ms:

|  |  |
| --- | --- |
| Memory | Price (per-100ms) |
| 128MB | $0.0000002083 |
| 152MB | $0.0000008333 |
| 1024MB | $0.0000016667 |
| 1536MB | $0.0000025000 |
| 2048MB | $0.0000033333 |
| 3008 MB | $0.0000048958 |

Ex:

Memory – 512MB, Execution – 3milion, Duration- 1month, ran – 1s, compute price - $0.00001667 and free tier - 400,000GB-s, monthly request - $0.20 per 1 million requests and free tier - 1M

Monthly compute charges:

1. Total compute (seconds) = 3M \* (1s) = 3,000,000 seconds
2. Total compute (GB-s) = 3,000,000 \* 512MB/1024 = 1,500,000 GB-s
3. Total compute – Free tier compute = Monthly billable compute GB- s

1,500,000 GB-s – 400,000 free tier GB-s = 1,100,000 GB-s

1. Monthly compute charges = 1,100,000 \* $0.00001667 = $18.34

Monthly request charges

1. Total requests – Free tier requests = Monthly billable requests

3M requests – 1M free tier requests = 2M Monthly billable requests

1. Monthly request charges = 2M \* $0.2/M = $0.40

Total monthly charges

Total charges = Compute charges + Request charges

$18.34 + $0.40 = $18.74 per month

1. **Azure - Azure App Service:**

|  |  |  |  |
| --- | --- | --- | --- |
| Memory | API call | Maximum instances | Price (per-h) |
| 1GB | 100 | - | $0.013 |
| 10 GB | Unlimited | Up to 3 | $0.075 |
| 50 GB | Unlimited | Up to 10 | $0.10 |
| 250 GB | Unlimited | Up to 30 | $0.20 |
| 1 TB | Unlimited | Up to 100 | $0.30 |

1. **Google: App Engine:**

|  |  |  |  |
| --- | --- | --- | --- |
| Instance Class | Memory Limit | CPU Limit | Price |
| F1 (default) | 256 MB | 600 MHz | $0.05 |
| F2 | 512 MB | 1.2 GHz | $0.10 |
| F4 | 1024 MB | 2.4 GHz | $0.20 |
| F4\_1G | 2048 MB | 2.4 GHz | $0.30 |
| B1 | 256 MB | 600 MHz | $0.05 |
| B2 (default) | 512 MB | 1.2 GHz | $0.10 |
| B4 | 1024 MB | 2.4 GHz | $0.20 |
| B4\_1G | 2048 MB | 2.4 GHz | $0.30 |
| B8 | 2048 MB | 4.8 GHz | $0.40 |

## 

## **Cloud Storage**

1. **Cloud Storage for Firebase:**

|  |  |
| --- | --- |
| service | price |
| Authentication | $0.06 |
| Stored data | $0.18 |
| Document writes | $0.18 |
| Document reads | $0.06 |
| Document deletes | $0.02 |
| Invocations | $0.4 |
| GB-seconds | $0.12 |
| CPU-seconds | $0.026 |
| Outbound networking | $0.15 |
| Realtime Database | $6 |
| Storage | $0.2 |
| Test Lab | $5 |

1. **Amazon A3 Storage:**

* S3 Standard - General purpose storage for any type of data, typically used for frequently accessed data
* First 50 TB / Month $0.023 per GB
* Next 450 TB / Month $0.022 per GB
* Over 500 TB / Month $0.021 per GB
* S3 Intelligent - Tiering \* - Automatic cost savings for data with unknown or changing access patterns
* Frequent Access Tier, First 50 TB / Month $0.023 per GB
* Frequent Access Tier, Next 450 TB / Month $0.022 per GB
* Frequent Access Tier, Over 500 TB / Month $0.021 per GB
* Infrequent Access Tier
  + - All Storage / Month -: $0.0125 per GB
* Monitoring and Automation
  + - All Storage / Month -: $0.0025 per 1,000 objects
* S3 Standard - Infrequent Access \* - For long lived but infrequently accessed data that needs millisecond access
  + - All Storage / Month -: $0.0125 per GB
* S3 One Zone - Infrequent Access \* - For re-createable infrequently accessed data that needs millisecond access
  + - All Storage / Month -: $0.01 per GB
* S3 Glacier \*\* - For long-term backups and archives with retrieval option from 1 minute to 12 hours
  + - All Storage / Month -: $0.004 per GB
* S3 Glacier Deep Archive \*\* - For long-term data archiving that is accessed once or twice in a year and can be restored within 12 hours
  + - All Storage / Month -: $0.00099 per GB

1. **Azure Data Lake Storage:**

|  |  |
| --- | --- |
| USAGE | PRICE/MONTH |
| First 100 TB | $0.039 per GB |
| Next 100 TB to 1,000 TB | $0.038 per GB |
| Next 1,000 TB to 5,000 TB | $0.037 per GB |
| Over 5,000 TB | Contact server |

## **Cloud Storage**

1. **Google: $25**
2. **Amazon Elastic Block Store:** 
   1. General Purpose SSD (gp2) Volumes : $0.10 per GB-month of provisioned

storage

* 1. Provisioned IOPS SSD (io1) Volumes : $0.125 per GB-month of provisioned

storage

$0.065 per provisioned IOPS-month

* 1. Throughput Optimized HDD (st1) Volumes: $0.045 per GB-month of provisioned

storage

* 1. Cold HDD (sc1) Volumes: $0.025 per GB-month of provisioned storage
  2. EBS Snapshots: $0.05 per GB-month of data stored
  3. Fast Snapshot Restore: $0.75 per 1 DSU hour in each AZ it is enabled
  4. ListChangedBlocks and ListSnapshotBlocks: $0.0006 per thousand requests
  5. GetSnapshotBlock : $0.003 per thousand SnapshotAPIUnits

1. **Azure Disk Storage**

|  |  |  |  |
| --- | --- | --- | --- |
|  | disk size | price per month | 1-year reserved price per month |
| P1 - Preview\* | 4 GiB | $0.33 | N/A |
| P2 - Preview\* | 8 GiB | $0.66 | N/A |
| P3 - Preview\* | 16 GiB | $1.32 | N/A |
| P4 | 32 GiB | $5.28 | N/A |
| P6 | 64 GiB | $10.21 | N/A |
| P10 | 128 GiB | $19.71 | N/A |
| P15 | 256 GiB | $38.02 | N/A |
| P20 | 512 GiB | $73.22 | N/A |
| P30 | 1 TiB | $135.17 | $128.4167 |
| P40 | 2 TiB | $259.05 | $246.0834 |
| P50 | 4 TiB | $495.57 | $470.8334 |
| P60 | 8 TiB | $946.08 | $898.75 |
| P70 | 16 TiB | $1,802.06 | $1,712 |
| P80 | 32 TiB (32767 GiB) | $3,604.11 | $3,423.9167 |

## **Database**

1. **Google: Cloud Spanner:**

|  |  |  |
| --- | --- | --- |
| Multi-region configuration | Description | Storage per GB per month |
| nam3 | North America | $0.50 |
| nam6 | North America | $0.70 |
| nam-eur-asia1 | North America, Europe, and Asia | $0.90 |
| eur3 | Europe | $0.50 |

1. **Amazon: Amazon DynamoDB**
   * read and write: $0.00065 per WCU / $0.00013 per RCU
   * storage: 25 GB free thereafter $0.25 per GB
   * Backup: $0.20 per GB-Month
   * Restoring table: $0.15 per GB
   * R4.16xlarge / vCPU 64 / Memory / 448GiB: $8.59 per hour
   * Data Transfer 150TB/Month: $0.05 per GB
2. **Azure: SQL Database, All options come with minimal Included Storage of 250GB**

|  |  |  |  |
| --- | --- | --- | --- |
| Instance Type | DTUs | Maximum Storage Allowed | Price for DTUs and Included Storage |
| S0 | 10 | 250 GB | $0.0202 |
| S1 | 20 | 250 GB | $0.0404 |
| S2 | 50 | 250 GB | $0.1009 |
| S3 | 100 | 1 TB | $0.2017 |
| S4 | 200 | 1 TB | $0.4033 |
| S6 | 400 | 1 TB | $0.8066 |
| S7 | 800 | 1 TB | $1.6130 |
| S9 | 1,600 | 1 TB | $3.2260 |
| S12 | 3,000 | 1 TB | $6.0488 |

## **Operations / Analytics**

1. **Google Cloud:**

|  |  |  |
| --- | --- | --- |
| Feature Service | Price | Free allotment per month |
| Logging | $0.50/GiB | First 50 GiB per project |
| Non-chargeable metrics | Free | Unlimited |
| Chargeable metrics | $0.2580/MiB: 150–100,000 MiB $0.1510/MiB: 100,000–250,000 MiB $0.0610/MiB: > 250,000 MiB | First 150 MiB per billing account |
| API usage (read) | $0.01/1,000 API calls | First 1 million API calls per project |
| API usage (write) | Free | Unlimited |

## 

1. **AWS:**

(Analytics) Amazon Quick Site - This query would cost: $1.67.

There is a 3x savings from compression and 3x savings for reading only one column.  
(File size = 3TB/3 = 1 TB. Data scanned when reading a single column = 1TB/3 = 0.33 TB. Price for 0.33 TB = 0.33 \* $5/TB = $1.67)

1. **AZURE:**

(Analytics) Azure Data Explorer -

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Instance | Cores | RAM | Temporory Storage | Price |
| A0 | 1 | 0.75 | 20GB | $0.02/hour |
| A1 | 1 | 1.75 | 225GB | $0.08/hour |
| A2 | 2 | 3.50 | 490GB | $0.16/hour |

## **API Management**

1. **Google:**

* Apigee API platform

1. Enterprise plan Apigee API platform: Develop, secure, deploy, and monitor your APIs everywhere.
2. Apigee Healthcare APIx: Accelerate building new FHIR API-based digital services.
3. Developer Portal: Enable developers and API teams with a turnkey self-service platform.
4. Apigee Open Banking APIx: Accelerate open banking and PSD2 compliance.
   * Contact the vendor for pricing
   * 10 organization/environment combinations
   * 10 billion calls per year
   * 12 months of analytics reports
   * Less than 10 minutes P1 response time with callback telephone support and escalation
   * Up to 99.9% runtime SLA
5. Cloud Endpoints: Develop, deploy, and manage APIs on Google Cloud.

|  |  |
| --- | --- |
| API calls per month per billing account | Cost per million API calls |
| 0-2M | $0.00 |
| 2M-1B | $3.00 |
| 1B+ | $1.50 |

1. **Amazon**
2. Amazon API Gateway
3. HTTP APIs: HTTP APIs are metered in 512 KB increments.

|  |  |
| --- | --- |
| Number of Requests (per month) | Price (per million) |
| First 300 million | $1.00 |
| 300+ million | $0.90 |

1. REST APIs:

|  |  |
| --- | --- |
| Number of Requests (per month) | Price (per million) |
| First 333 million | $3.50 |
| Next 667 million | $2.80 |
| Next 19 billion | $2.38 |
| Over 20 billion | $1.51 |

1. Caching:

|  |  |
| --- | --- |
| Cache Memory Size (GB) | Price per Hour |
| 0.5 | $0.02 |
| 1.6 | $0.038 |
| 6.1 | $0.20 |
| 13.5 | $0.25 |
| 28.4 | $0.50 |
| 58.2 | $1.00 |
| 118.0 | $1.90 |
| 237.0 | $3.80 |

1. WebSocket APIs

|  |  |
| --- | --- |
| Number of Requests (per month) | Price (per million) |
| First 1 billion | $1.0 |
| Over 1 billion | $0.80 |

1. **Azure:**
2. Azure - (Integration) API Management: (Premium)
   * Purpose: High-volume or Enterprise production use cases
   * Price (per unit) : $3.83/hour
   * Cache (per unit):5 GB
   * Scale-out (units):10 per region
   * (call support to add more)
   * SLA: 99.95%
   * Azure Active Directory integration: Yes
   * Virtual Network support: Yes
   * Multi-region deployment: Yes
   * Self-hosted gateway: Yes
   * Estimated Maximum Throughput
   * (per unit): Yes
   * Self-hosted gateway: $1.37 per hour per gateway deployment

## **Compute**

1. **Google:** App Engine
2. vCPU: $0.0526 per core hour
3. Memory: $0.0071 per GB hour
4. Instance class F4\_1G - $0.30
5. Outgoing network traffic: $0.12 per GB
6. Incoming network traffic: Free
7. Blobstore stored data: $0.026 Gigabytes per month
8. Dedicated Memcache: $0.06Gigabytes per hour
9. Logs API: $0.12 Gigabytes
10. Search API Total storage (documents and indexes): $0.18 per GB per month
11. Search API Queries: $0.50 per 10K queries
12. Search API Indexing searchable documents: $2.00 per GB
13. Sending an email, shared, cron, APIs (Task Queues, Image, Files, Users): No Additional Charge
14. **AWS:** AWS Lambda
15. Requests: $0.20 per 1M requests
16. Duration: $0.0000166667 for every GB-second
17. **Azure:**
18. Azure Cycle Cloud

* Type: D4SV3
* Used : General Purpose
* Core: 4
* RAM: 16GB
* Disk: 32GB
* Drive Type: SSD
* Price: US$0.22
* Software Cost: BYOL

1. Azure VMware Solution

* Type: CS36
* Core: 36
* RAM: 512 GB
* Flash store: 11.25 TB
* NVME cashes: 3.2 TB
* Price: $6,720/month

## **AI – Machine Learning**

1. **Google:**
   1. Speech to Text: Each request is rounded up to the nearest increment of 15 seconds.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Feature | Standard models (all models except enhanced video and phone call) | | Enhanced models (video, phone call) | |
|  | 0-60 Minutes | Over 60 Mins up to 1 Million Mins | 0-60 Minutes | Over 60 Mins up to 1 Million Mins |
| Speech Recognition (without Data Logging - default) | Free | $0.006 / 15 seconds \*\* | Free | $0.009 / 15 seconds \*\* |
| Speech Recognition (with Data Logging opt-in) | Free | $0.004 / 15 seconds \*\* | Free | $0.006 / 15 seconds \*\* |

* 1. AutoML Tables
* Training (6 hours of free one-time use (per billing account) ): $19.32 per hour (92 n1-standard-4 equivalent machines used in parallel)
* Batch prediction (6 hours of free one-time use (per billing account)\*): $1.16 per hour (5.5 n1-standard-4 equivalent machines used in parallel)
* Online prediction: $0.21 per hour
* (1 n1-standard-4 equivalent machine)
* Deployment: $0.005 per GiB-hour x 9 machines(model replicated to 9 machines for low latency serving purposes)
  1. Text to speech:

|  |  |  |
| --- | --- | --- |
| Feature | Monthly free tier | Paid usage |
| Standard (non-WaveNet) voices | 0 to 4 million characters | $4.00 USD / 1 million characters |
| WaveNet voices | 0 to 1 million characters | $16.00 USD / 1 million characters |

* 1. Natural Language:
* Natural Language API:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Feature | 0 - 5K | 5K+ - 1M | 1M+ - 5M | 5M+ - 20M |
| Entity Analysis | Free | $1.00 | $0.50 | $0.25 |
| Sentiment Analysis | Free | $1.00 | $0.50 | $0.25 |
| Syntax Analysis | Free | $0.50 | $0.25 | $0.125 |
| Entity Sentiment Analysis | Free | $2.00 | $1.00 | $0.50 |
| Feature | 0 - 30K | 30K+ - 250K | 250K+ - 5M | 5M+ |
| Content Classification | Free | $2.00 | $0.50 | $0.10 |

* AutoML Natural Language:

|  |  |
| --- | --- |
| Activity | Cost |
| Data upload (PDF only) | First 1,000 pages free each month $1.50 per 1,000 pages $0.60 per 1,000 pages over 5,000,000 |
| Training | $3.00 per hour |
| Prediction | $5.00 per 1,000 text records $25.00 per 1,000 document pages |
| Deployment | $0.05 per hour, billed at per second granularity |

1. **AWS**
2. Amazon Forecast

|  |  |
| --- | --- |
| Cost Type | Pricing |
| Generated forecasts | $0.60 per 1,000 forecasts |
| Data storage | $0.088 per GB |
| Training hours | $0.24 per hour |

1. Amazon Personalize:

|  |  |
| --- | --- |
| Data Ingestion | $0.05 per GB |
| Training | $0.24 per training hour |
| Recommendations (Inference)  Real time |  |
| First 20K TPS-hour per month | $0.20 per TPS-hour for real-time recommendations |
| Next 180K TPS-hour per month | $0.10 per TPS-hour for real-time recommendations |
| Over 200K TPS-hour per month | $0.05 per TPS-hour for real-time recommendations |
| Batch recommendations |  |
| First 20 million recommendations per month | $0.067/ 1000 recommendations |
| Next 180 million recommendations per month | $0.058/1000 recommendations |
| Over 200 million recommendations per month | $0.050/1000 recommendations |

1. Amazon Polly:

You are billed monthly for the number of characters of text that you processed. Amazon Polly’s Standard voices are priced at $4.00 per 1 million characters for speech or Speech Marks requests (when outside the free tier). Amazon Polly’s Neural voices are priced at $16.00 per 1 million characters for speech or Speech Marks requested (when outside the free tier).

1. Amazon Lex:

With Amazon Lex, you pay only for what you use. You are charged based on the number of text or voice requests processed by your bot, at $0.004 per voice request, and $0.00075 per text request. For example, the cost for 1,000 speech requests would be $4.00, and 1,000 text requests would cost $0.75. Your usage is measured in "requests processed", which are added up at the end of the month to generate your monthly charges.

You can try Amazon Lex for free. From the date you get started with Amazon Lex, you can process up to 10,000 text requests and 5,000 speech requests per month for free for the first year.

1. **Azure**
2. Azure Cognitive Search

* Storage: 2 TB(max 24 TB per service
* Max indexes per service: 10
* Scale out limits: Up to 36 units per service (max 12 partition; max 12 replicas) up to 12 replicas in high density1 mode
* Document Cracking: Image Extraction: (price per 1,000 images)
* 0-1M images - $1
* 1M-5M images - $0.80
* 5M+ images - $0.65
* Private Endpoints Related Charges: Additional charges may apply2
* Price per unit: $7.677/hour

1. Azure Machine Learning:

* Instance: B20MS
* VCPU: 20
* RAM: 80 GiB
* Linux VN Price: $1.056/hour
* Machine learning Service surcharge: $0/hour
* Total price: $1.056/hou

1. Azure Open Datasets:

Microsoft pays for the storage costs associated with hosting Azure Open Datasets. While storage will always remain free, egress costs associated with reading large datasets can be charged to the Azure subscription accessing the data Most datasets will be free to access. Egress charges, if applicable, will be mentioned on the Open Datasets overview page.

## **Networking and Security**

1. **Google:**
2. Cloud Armor:

* Per Policy Charge: $5 per Google Cloud Armor security policy per month
* Per Rule Charge: $1 per rule per month, pro-rated to the day
* Incoming Requests Charge: $0.75 per million HTTP(S) request

1. Security Command Center:

|  |  |
| --- | --- |
| Data transferred per day | Price per GB |
| Up to 1GB | Free |
| Over 1GB | $0.30 |

1. **AWS:**
2. Amazon GuardDuty:

|  |  |
| --- | --- |
| First 500 GB / month | $1 per GB |
| Next 2000 GB / month | $0.5 GB |
| Next 7500 GB / month | $0.25 GB |
| Over 10000 GB / month | $0.15 GB |
| Per 1 million events / month | $4.00 per 1 million events |

1. AWS Shield:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Amazon CloudFront | Elastic Load Balancing (ELB) | AWS Elastic IP (EC2 and Network Load Balancer) | AWS Global Accelerator | Amazon Route 53 |
| First 100 TB | $0.025 | $0.05 | $0.05 | $0.05 | No additional cost |
| Next 400 TB | $0.02 | $0.04 | $0.04 | $0.04 | No additional cost |
| Next 500 TB | $0.015 | $0.03 | $0.03 | $0.03 | No additional cost |
| Next 4 PB | $0.01 | Contact Us | Contact Us | Contact Us | No additional cost |
| Above 5 PB | Contact Us | Contact Us | Contact Us | Contact Us | No additional cost |

1. **Azure:**
   1. Azure DDoS Protection:

|  |  |
| --- | --- |
| 0 - 100 TB | $0.05 |
| 100 TB - 500 TB | $0.04 |
| 500 TB - 1 PB | $0.03 |
| Over 1 PB | Contact Us |

* 1. Azure Site Recovery:

|  |  |  |
| --- | --- | --- |
|  | Price for first 31 days | Price after 31 days |
| Azure Site Recovery to customer owned sites | Free | $16/month per instance protected |
| Azure Site Recovery to Azure | Free | $25/month per instance protected |

## **Migration**

1. **Google:**
2. Transfer Appliance

|  |  |  |
| --- | --- | --- |
| Fees | 100 Terabyte Transfer Appliance | 480 Terabyte Transfer Appliance |
| Use fee | $300 | $1800 |
| Free days | 10 | 25 |
| Late fee | $30 per day | $90 per day |
| Shipping fee | May vary based on delivery to and from your location, and carrier rates. Freight shipping typically starts around $500. | May vary based on delivery to and from your location, and carrier rates. Freight shipping typically starts around $700. |

1. Migrate for Compute Engine: Customers migrating to Google Cloud may use Migrate for Compute Engine software at no additional cost. However, Google Cloud charges for resources like Compute Engine instances, Cloud Storage, Cloud Monitoring, Cloud Logging, and networking bandwidth used during your migration.
2. **AWS:**
3. AWS Database Migration Service:

* Instance: r4.8xlarge
* Price per hours (Single-AZ): $3.30
* Price per hours (Multi-AZ): $6.60

1. AWS Server Migration Service:

* You can use the AWS Server Migration Service to migrate your on-premises workloads to AWS at no charge.

1. **Azure:**
2. Azure Migrate: Azure Migrate is available at no additional charge, however, you may incur charges depending on the tools (first-party or ISV) you decide to use for assessment and migration.
3. Azure Database migration Service:

* Compute: Compute is provisioned in virtual cores (vCores). A vCore represents a logical CPU.
* vCores: 4
* Price: $0.426/hour