THE SERVICES PROVIDED BY GOOGLE, AMAZON, AZURE

I. GOOGLE

a) Compute

Google Cloud Platform (GCP) offers dozens of IaaS, PaaS, and SaaS services. Computing is one of the key factors at which Google Cloud Services depend upon. Some of the services under Computing are Google Compute Engine, Google App Engine, Google Container Engine and Google Cloud Functions etc. Let's brief all the services in their respective order.

- **Compute Engine** [Virtual Machines, Disks, and Network] An IaaS service that provides virtual machines (VMs) hosted on Google's infrastructure. Competitor services include Amazon Elastic Compute Cloud, and on-premises equivalents such as OpenStack.

- **App Engine** [Managed Application Platform] A PaaS service for building web applications and mobile backends using container instances preconfigured with one of several available runtimes, each of which include a set of standard App Engine libraries. Competitor services include Amazon Elastic Beanstalk and Microsoft Azure Web Sites.

- **Container Engine** [Managed Kubernetes / Containers] Cluster management and orchestration system for coordinating Docker containers. It is based on the open source Kubernetes project.

- **Container Registry** [Private Container Registry & Storage] Private Docker repository hosted on Google's infrastructure.

- **Cloud Functions** [Sever less Microservices] An event-based, asynchronous compute solution that allows you to create microservices (small, single-purpose functions) that respond to cloud events without requiring an explicitly managed

server or a runtime environment. Google Cloud Functions has been in Alpha since February 2016.

➢ **Cloud Pub/Sub** [Distributed Real-time Messaging] A fully-managed real-time messaging service for sending and receiving messages between independent applications.

➢ **Cloud Endpoints Frameworks for App Engine** [Cloud API Gateway] Used to create RESTful services from your code and make them accessible to iOS, Android, and JavaScript clients using App Engine. Formerly Cloud Endpoints.

b)   *Storage and Databases*

➢ **Cloud Storage** [Object & File Storage and Serving] A unified object storage service, offering a spectrum of storage options including geo-redundant (low-latency, high QPS content serving to users distributed across geographic regions), regional (for workloads in a particular region), nearline (for data accessed less than once a month), and coldline (for data accessed less than once a year.) Competitor services include Amazon Simple Storage Service (geo-redundant / regional) and Amazon Glacier (coldline).

➢ **Cloud SQL** [Managed MySQL] A fully-managed MySQL database service for hosting relational MySQL databases on Google's infrastructure.

➢ **Bigtable** [HBase Compatible NoSQL] A high performance NoSQL Big Data database service, designed to support very large workloads at consistent low latency and high throughput rates. Google uses Bigtable internally to power services including Search and Gmail.

➢ **Cloud Datastore** [Distributed Hierarchical Key/Value Storage] A NoSQL schemaless database for storing non-relational data. It's an alternative to Bigtable when ACID transactions are required, or the data stored is highly structured.

- **Cloud Spanner** A managed globally distributed relational database with ACID transactions, strong consistency, SQL semantics, horizontal scaling, and high availability.
- **Persistent Disk** [VM-Attachable Disks] A service that provides SSD and HDD storage that can be attached to instances running in either Compute Engine or Container Engine.
- **Cloud Source Repositories** [Hosted Private Git Repositories] Private Git repositories hosted on GCP; they are currently in beta.

c)*Networking*

- **Google Cloud Virtual Network** [*Software Defined Network*] A set of Google-managed networking capabilities, including granular IP address range selection, routes, firewalls, Virtual Private Network (VPN) and Cloud Router for provisioning your GCP resources, connecting them to each other and isolating them from one another in a Virtual Private Cloud (VPC).
- **Cloud Load Balancing** [*Multi-region Load Distribution*] A service that load-balances and auto-scales GCP compute resources in single or multiple regions behind a single anycast IP.
- **Cloud CDN** [*Content Delivery Network*] Uses Google's globally distributed edge points of presence to cache HTTP(S) load-balanced content close to users.
- **Google Cloud Interconnect** [*Peer with GCP*] Allows GCP customers to connect to Google via higher availability and/or lower latency connections than their existing Internet connections.
- **Cloud DNS** [*Programmable Domain Name Service*] A managed authoritative Domain Name System (DNS) service running on the same infrastructure as Google. Cloud DNS translates requests for domain names into IP addresses and offers a UI, command-line interface, and API for publishing and managing millions of DNS zones and resource records.

II. AMAZON

Amazon Web Services (AWS) is among the widely used cloud-computing platforms today by organizations big and small. The range of services on offer under AWS is astonishing to say the least. AWS offerings include cloud migration, web hosting, and much more. Here's a look at the top 5 AWS services in 2020.

a) Compute

➢ **Amazon Elastic Cloud Compute (EC2):** The Amazon EC2 service comes under the compute domain and it provides services that help to compute workloads. Amazon EC2 web interface is used to reduce the expensive physical servers by creating virtual machines. Also, they help in managing different features of the virtual servers such as security, ports, and storage. Amazon EC2 is highly preferable while creating a virtual server within a few minutes with just a few clicks according to the user's operating system conveniently. It offers resizable compute capacity in the cloud. This helps a lot to focus more on the project rather than the server maintenance.

➢ **Amazon EC2 Auto Scaling:** Amazon EC2 Auto Scaling helps you maintain application availability and allows you to automatically add or remove EC2 instances according to conditions you define. You can use the fleet management features of Amazon EC2 Auto Scaling to maintain the health and availability of your fleet. You can also use the dynamic and predictive scaling features of Amazon EC2 Auto Scaling to add or remove EC2 instances. Dynamic scaling responds to changing demand and predictive scaling automatically schedules the right number of EC2 instances based on predicted demand. Dynamic scaling and predictive scaling can be used together to scale faster.

➢ **Amazon Elastic Container Registry:** Amazon Elastic Container Registry (ECR) is a fully-managed Docker container registry that makes it easy for developers to store, manage, and deploy Docker container images. Amazon ECR is integrated

with Amazon Elastic Container Service (Amazon ECS), simplifying your development to production workflow. Amazon ECR eliminates the need to operate your own container repositories or worry about scaling the underlying infrastructure. Amazon ECR hosts your images in a highly available and scalable architecture, allowing you to reliably deploy containers for your applications. Integration with AWS Identity and Access Management (IAM) provides resource-level control of each repository. With Amazon ECR, there are no upfront fees or commitments. You pay only for the amount of data you store in your repositories and data transferred to the Internet.

➢ **Amazon Elastic Container Service:** Amazon Elastic Container Service (Amazon ECS) is a highly scalable, high-performance container orchestration service that supports Docker containers and allows you to easily run and scale containerized applications on AWS. Amazon ECS eliminates the need for you to install and operate your own container orchestration software, manage and scale a cluster of virtual machines, or schedule containers on those virtual machines. With simple API calls, you can launch and stop Docker-enabled applications, query the complete state of your application, and access many familiar features such as IAM roles, security groups, load balancers, Amazon CloudWatch Events, AWS CloudFormation templates, and AWS CloudTrail logs.

➢ **Amazon Elastic Kubernetes Service:** Amazon Elastic Kubernetes Service (Amazon EKS) makes it easy to deploy, manage, and scale containerized applications using Kubernetes on AWS. Amazon EKS runs the Kubernetes management infrastructure for you across multiple AWS availability zones to eliminate a single point of failure. Amazon EKS is certified Kubernetes conformant so you can use existing tooling and plugins from partners and the Kubernetes community. Applications running on any standard Kubernetes environment are fully compatible and can be easily migrated to Amazon EKS.

➢ **Amazon LightSail:** Amazon LightSail is designed to be the easiest way to launch and manage a virtual private server with AWS. LightSail plans include everything you need to jumpstart your project – a virtual machine, SSD-based storage, data transfer, DNS management, and a static IP address – for a low, predictable price.

➢ **AWS Batch:** AWS Batch enables developers, scientists, and engineers to easily and efficiently run hundreds of thousands of batch computing jobs on AWS. AWS Batch dynamically provisions the optimal quantity and type of compute resources (e.g., CPU or memory-optimized instances) based on the volume and specific resource requirements of the batch jobs submitted. With AWS Batch, there is no need to install and manage batch computing software or server clusters that you use to run your jobs, allowing you to focus on analyzing results and solving problems. AWS Batch plans, schedules, and executes your batch computing workloads across the full range of AWS compute services and features, such as Amazon EC2 and Spot Instances.

b) *Databases*

➢ **Amazon Aurora**: Amazon Aurora is a MySQL and PostgreSQL compatible relational database engine that combines the speed and availability of high-end commercial databases with the simplicity and cost-effectiveness of open source databases. Amazon Aurora is up to five times faster than standard MySQL databases and three times faster than standard PostgreSQL databases. It provides the security, availability, and reliability of commercial databases at 1/10th the cost. Amazon Aurora is fully managed by Amazon Relational Database Service (RDS), which automates time-consuming administration tasks like hardware provisioning, database setup, patching, and backups. Amazon Aurora features a distributed, fault-tolerant, self-healing storage system that auto-scales up to 64TB per database instance. It delivers high performance and availability with up to 15 low-latency read replicas, point-in-

time recovery, continuous backup to Amazon S3, and replication across three Availability Zones (AZs).

➢ **Amazon Relational Database Service:** Amazon Relational Database Service (Amazon RDS) makes it easy to set up, operate, and scale a relational database in the cloud. It provides cost-efficient and resizable capacity while automating time-consuming administration tasks such as hardware provisioning, database setup, patching and backups. It frees you to focus on your applications so you can give them the fast performance, high availability, security and compatibility they need. Amazon RDS is available on several database instance types - optimized for memory, performance or I/O - and provides you with six familiar database engines to choose from, including Amazon Aurora, PostgreSQL, MySQL, MariaDB, Oracle Database, and SQL Server. You can use the AWS Database Migration Service to easily migrate or replicate your existing databases to Amazon RDS.

➢ **Amazon RDS on VMware:** Amazon Relational Database Service (Amazon RDS) on VMware lets you deploy managed databases in on-premises VMware environments using the Amazon RDS technology enjoyed by hundreds of thousands of AWS customers. Amazon RDS provides cost-efficient and resizable capacity while automating time-consuming administration tasks including hardware provisioning, database setup, patching, and backups, freeing you to focus on your applications. RDS on VMware brings these same benefits to your on-premises deployments, making it easy to set up, operate, and scale databases in VMware vSphere private data centers, or to migrate them to AWS. Amazon RDS on VMware allows you to utilize the same simple interface for managing databases in on-premises VMware environments as you would use in AWS. You can easily replicate RDS on VMware databases to RDS instances in AWS, enabling low-cost hybrid deployments for disaster recovery, read replica bursting, and optional long-term backup retention in Amazon Simple Storage Service (Amazon S3).

➤ **Amazon DynamoDB:** Amazon DynamoDB is a key-value and document database that delivers single-digit millisecond performance at any scale. It's a fully managed, multiregional, multimaster database with built-in security, backup and restore, and in-memory caching for internet-scale applications. DynamoDB can handle more than 10 trillion requests per day and support peaks of more than 20 million requests per second. Many of the world's fastest growing businesses such as Lyft, Airbnb, and Redfin as well as enterprises such as Samsung, Toyota, and Capital One depend on the scale and performance of DynamoDB to support their mission-critical workloads. More than 100,000 AWS customers have chosen DynamoDB as their key-value and document database for mobile, web, gaming, ad tech, IoT, and other applications that need low-latency data access at any scale. Create a new table for your application and let DynamoDB handle the rest.

➤ **Amazon Document DB:** Amazon Document DB (with MongoDB compatibility) is a fast, scalable, highly available, and fully managed document database service that supports MongoDB workloads. Amazon Document DB is designed from the ground-up to give you the performance, scalability, and availability you need when operating mission-critical MongoDB workloads at scale. Amazon Document DB implements the Apache 2.0 open source MongoDB 3.6 API by emulating the responses that a MongoDB client expects from a MongoDB server, allowing you to use your existing MongoDB drivers and tools with Amazon Document DB.

➤ **Amazon Neptune:** Amazon Neptune is a fast, reliable, fully-managed graph database service that makes it easy to build and run applications that work with highly connected datasets. The core of Amazon Neptune is a purpose-built, high-performance graph database engine optimized for storing billions of relationships and querying the graph with milliseconds latency. Amazon Neptune supports popular graph models Property Graph and W3C's RDF, and their respective query languages Apache TinkerPop Gremlin and SPARQL, allowing you to easily build queries that efficiently navigate highly connected datasets. Neptune powers graph use cases such

as recommendation engines, fraud detection, knowledge graphs, drug discovery, and network security.

c) *Storage*

➢ **Amazon 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, such as websites, mobile applications, backup and restore, archive, enterprise applications, IoT devices, and big data analytics. Amazon S3 provides easy-to-use management features so you can organize your data and configure finely-tuned access controls to meet your specific business, organizational, and compliance requirements. Amazon S3 is designed for 99.999999999% (11 9's) of durability, and stores data for millions of applications for companies all around the world.

➢ **Amazon Elastic Block Store:** Amazon Elastic Block Store (Amazon EBS) provides persistent block storage volumes for use with Amazon EC2 instances in the AWS Cloud. Each Amazon EBS volume is automatically replicated within its Availability Zone to protect you from component failure, offering high availability and durability. Amazon EBS volumes offer the consistent and low-latency performance needed to run your workloads. With Amazon EBS, you can scale your usage up or down within minutes—all while paying a low price for only what you provision.

➢ **Amazon Elastic File System:** Amazon Elastic File System (Amazon EFS) provides a simple, scalable, elastic file system for Linux-based workloads for use with AWS Cloud services and on-premises resources. It is built to scale on demand to petabytes without disrupting applications, growing and shrinking automatically as you add and remove files, so your applications have the storage they need – when they

need it. It is designed to provide massively parallel shared access to thousands of Amazon EC2 instances, enabling your applications to achieve high levels of aggregate throughput and IOPS with consistent low latencies. Amazon EFS is a fully managed service that requires no changes to your existing applications and tools, providing access through a standard file system interface for seamless integration. Amazon EFS is a regional service storing data within and across multiple Availability Zones (AZs) for high availability and durability. You can access your file systems across AZs and regions and share files between thousands of Amazon EC2 instances and on-premises servers via AWS Direct Connect or AWS VPN.

➢ **Amazon FSx for Lustre:** Amazon FSx for Lustre is a fully managed file system that is optimized for compute-intensive workloads, such as high-performance computing, machine learning, and media data processing workflows. Many of these applications require the high-performance and low latencies of scale-out, parallel file systems. Operating these file systems typically requires specialized expertise and administrative overhead, requiring you to provision storage servers and tune complex performance parameters. With Amazon FSx, you can launch and run a Lustre file system that can process massive data sets at up to hundreds of gigabytes per second of throughput, millions of IOPS, and sub-millisecond latencies.

➢ **Amazon FSx for Windows File Server:**Amazon FSx for Windows File Server provides a fully managed native Microsoft Windows file system so you can easily move your Windows-based applications that require file storage to AWS. Built on Windows Server, Amazon FSx provides shared file storage with the compatibility and features that your Windows-based applications rely on, including full support for the SMB protocol and Windows NTFS, Active Directory (AD) integration, and Distributed File System (DFS). Amazon FSx uses SSD storage to provide the fast performance your Windows applications and users expect, with high levels of throughput and IOPS, and consistent sub-millisecond latencies. This compatibility and performance is

particularly important when moving workloads that require Windows shared file storage, like CRM, ERP, and .NET applications, as well as home directories.

➢ **Amazon S3 Glacier:** Amazon S3 Glacier is a secure, durable, and extremely low-cost storage service for data archiving and long-term backup. It is designed to deliver 99.999999999% durability, and provides comprehensive security and compliance capabilities that can help meet even the most stringent regulatory requirements. Amazon S3 Glacier provides query-in-place functionality, allowing you to run powerful analytics directly on your archive data at rest. You can store data for as little as $0.004 per gigabyte per month, a significant savings compared to on-premises solutions. To keep costs low yet suitable for varying retrieval needs, Amazon S3 Glacier provides three options for access to archives, from a few minutes to several hours.

➢ **AWS Storage Gateway:** The AWS Storage Gateway is a hybrid storage service that enables your on-premises applications to seamlessly use AWS cloud storage. You can use the service for backup and archiving, disaster recovery, cloud data processing, storage tiering, and migration. Your applications connect to the service through a virtual machine or hardware gateway appliance using standard storage protocols, such as NFS, SMB and iSCSI. The gateway connects to AWS storage services, such as Amazon S3, S3 Glacier, and Amazon EBS, providing storage for files, volumes, and virtual tapes in AWS. The service includes a highly-optimized data transfer mechanism, with bandwidth management, automated network resilience, and efficient data transfer, along with a local cache for low-latency on-premises access to your most active data.

d) Networking.

➢ **Amazon VPC:** Amazon Virtual Private Cloud (Amazon VPC) lets you provision a logically isolated section of the AWS Cloud where you can launch AWS resources in a virtual network that you define. You have complete control over your virtual

networking environment, including selection of your own IP address range, creation of subnets, and configuration of route tables and network gateways. You can use both IPv4 and IPv6 in your VPC for secure and easy access to resources and applications. You can easily customize the network configuration for your VPC. For example, you can create a public-facing subnet for your web servers that has access to the Internet, and place your backend systems, such as databases or application servers, in a private-facing subnet with no Internet access. You can leverage multiple layers of security (including security groups and network access control lists) to help control access to EC2 instances in each subnet. Additionally, you can create a hardware virtual private network (VPN) connection between your corporate data center and your VPC and leverage the AWS Cloud as an extension of your corporate data center.

➢ **Amazon CloudFront:** Amazon CloudFront is a fast content delivery network (CDN) service that securely delivers data, videos, applications, and APIs to customers globally with low latency, high transfer speeds, all within a developer-friendly environment. CloudFront is integrated with AWS – both physical locations that are directly connected to the AWS global infrastructure, as well as other AWS services. CloudFront works seamlessly with services including AWS Shield for DDoS mitigation, Amazon S3, Elastic Load Balancing or Amazon EC2 as origins for your applications, and Lambda@Edge to run custom code closer to customers' users and to customize the user experience.You can get started with the Content Delivery Network in minutes, using the same AWS tools that you're already familiar with: APIs, AWS Management Console, AWS CloudFormation, CLIs, and SDKs. Amazon's CDN offers a simple, pay-as-you-go pricing model with no upfront fees or required long-term contracts, and support for the CDN is included in your existing AWS Support subscription.

➢ **Amazon Route 53:** Amazon Route 53 is a highly available and scalable cloud Domain Name System (DNS) web service. It is designed to give developers and businesses an extremely reliable and cost-effective way to route end users to Internet applications by translating human readable names, such as www.example.com, into the numeric IP addresses, such as 192.0.2.1, that computers use to connect to each other. Amazon Route 53 is fully compliant with IPv6 as well.

➢ **AWS PrivateLink:** AWS Private Link simplifies the security of data shared with cloud-based applications by eliminating the exposure of data to the public Internet. AWS Private Link provides private connectivity between VPCs, AWS services, and on-premises applications, securely on the Amazon network. AWS Private Link makes it easy to connect services across different accounts and VPCs to significantly simplify the network architecture.

➢ **AWS Direct Connect**: AWS Direct Connect makes it easy to establish a dedicated network connection from your premises to AWS. Using AWS Direct Connect, you can establish private connectivity between AWS and your data center, office, or co-location environment, which in many cases can reduce your network costs, increase bandwidth throughput, and provide a more consistent network experience than Internet-based connections.

➢ **AWS Global Accelerator:** AWS Global Accelerator is a networking service that improves the availability and performance of the applications that you offer to your global users. Today, if you deliver applications to your global users over the public internet, your users might face inconsistent availability and performance as they traverse through multiple public networks to reach your application. These public networks are often congested and each hop can introduce availability and performance risk. AWS Global Accelerator uses the highly available and congestion-free AWS global network to direct internet traffic from your users to your applications on AWS, making your users' experience more consistent.

III. AZURE

Microsoft Azure, commonly referred to as Azure (/ˈæʒər/), is a cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services through Microsoft-managed data centers. It provides software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS) and supports many different programming languages, tools, and frameworks, including both Microsoft-specific and third-party software and systems.

Compute

Whether you are building new applications or deploying existing ones, Azure compute provides the infrastructure you need to run your apps. Tap in to compute capacity in the cloud and scale on demand. containerize your applications, deploy Windows and Linux virtual machines (VMs) and take advantage of flexible options for migrating VMs to Azure. With comprehensive support for hybrid environments, deploy how and where you want to. Azure compute also includes a full-fledged identity solution, so you gain managed end-point protection and Active Directory support which helps secure access to on-premises and cloud apps.

➢ **API Apps:** Easily build and consume Cloud APIs.
➢ **Azure Cycle Cloud:** Create, manage, operate and optimize HPC and big compute clusters of any scale.
➢ **App Service:** Quickly create powerful cloud apps for web and mobile.
➢ **Azure Kubernetes Service (AKS):** Simplify the deployment, management and operations of Kubernetes.
➢ **Virtual Machine Scale Sets:** Manage and scale up to thousands of Linux and Windows virtual machines.

- **Windows Virtual Desktop:** The best virtual desktop experience, delivered on Azure.

Databases

Azure offers a choice of fully managed relational, NoSQL and in-memory databases, spanning proprietary and open-source engines, to fit the needs of modern app developers. Infrastructure management—including scalability, availability and security—is automated, saving you time and money. Focus on building applications while Azure managed databases make your job simpler by surfacing performance insights through embedded intelligence, scaling without limits and managing security threats.

- **Azure Cosmos DB**: Fast NoSQL database with open APIs for any scale.
- **Azure Database for MySQL:** Managed MySQL database service for app developers.
- **Azure Database for MariaDB:** Managed MariaDB database service for app developers.
- **Azure Database for PostgreSQL:** Managed PostgreSQL database service for app developers.
- **Azure SQL:** Modern SQL family for migration and app modernization.
- **Table Storage:** NoSQL key-value store using semi-structured datasets.

Storage

- **Archive Storage**: Industry leading price point for storing rarely accessed data.
- **Avere vFXT for Azure**: Run high-performance, file-based workloads in the cloud.
- **Azure Backup:** Simplify data protection and protect against ransomware.
- **Azure Data Lake Storage:** Massively scalable, secure data lake functionality built on Azure Blob Storage

- **Azure Data Share:** A simple and safe service for sharing big data with external organizations.
- **File Storage:** File shares that use the standard SMB 3.0 protocol.
- **Azure FXT Edge Filer:** Hybrid storage optimization solution for HPC environments.
- **Azure HPC Cache:** File caching for high-performance computing (HPC).

Networking

- **Application Gateway:** Build secure, scalable and highly available web front ends in Azure.
- **Azure Bastion**: Private and fully managed RDP and SSH access to your virtual machines.
- **Azure DDoS Protection**: Protect your applications from Distributed Denial of Service (DDoS) attacks.
- **Azure DNS:** Host your DNS domain in Azure.
- **Azure ExpressRoute:** Dedicated private network fiber connections to Azure.
- **Azure Firewall:** Native firewalling capabilities with built-in high availability, unrestricted cloud scalability and zero maintenance.
- **Azure ExpressRoute:** Dedicated private network fiber connections to Azure.
- **Azure Firewall Manager:** Central network security policy and route management for globally distributed, software-defined perimeters.
- **Azure Front Door**: Scalable, security-enhanced delivery point for global, microservice-based web applications.