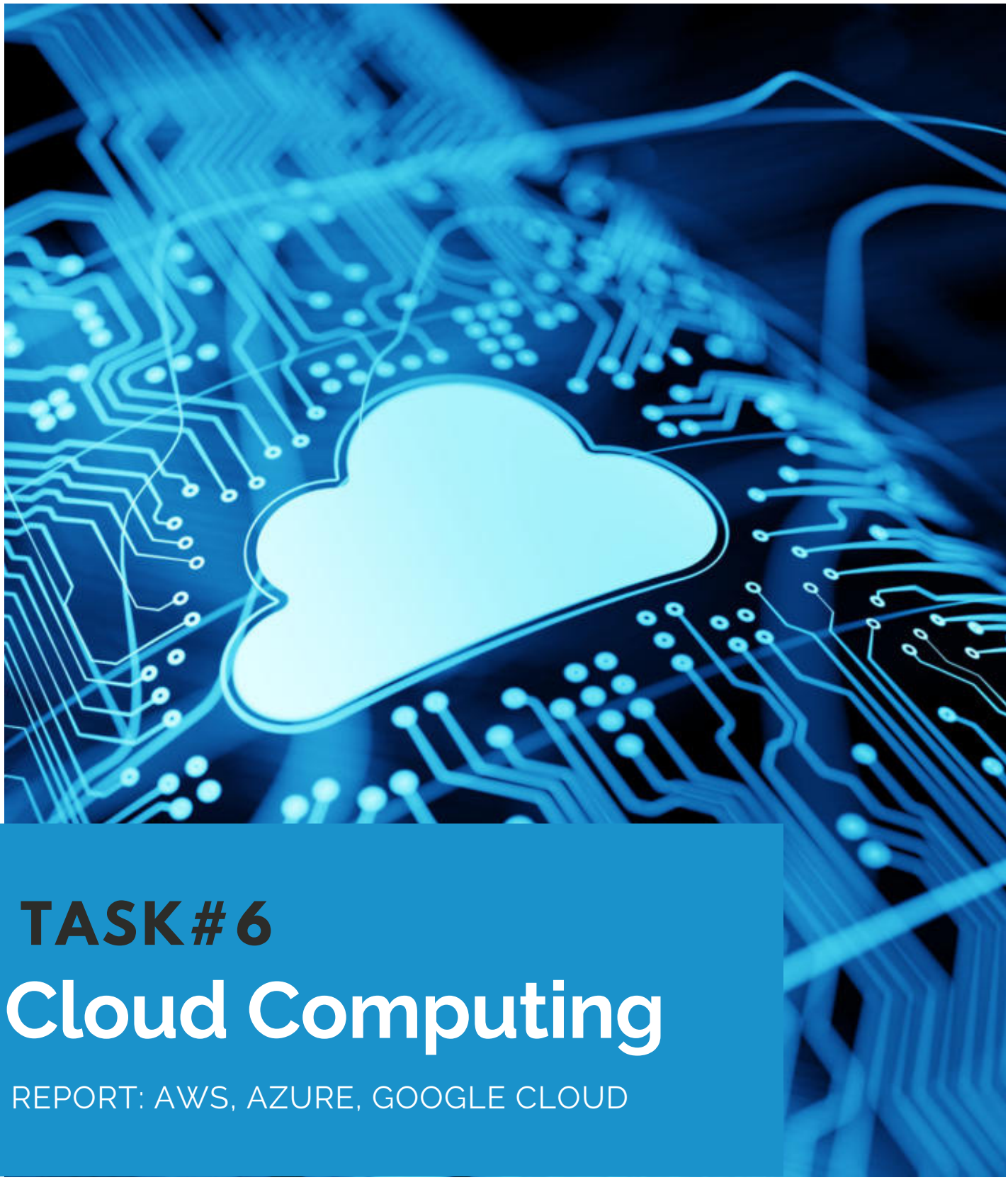

TASK#6

Cloud Computing

REPORT: AWS, AZURE, GOOGLE CLOUD

GRADUATE ROATIONAL
INTERNSHIP PROGRAM

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INTRODUCTION:

The competition for leadership in the public cloud computing is fierce three-way race: AWS vs. Azure vs. Google. Clearly, for infrastructure as a service (IaaS) and platform as a service (PaaS), Amazon Web Services (AWS), Microsoft Azure and Google Cloud Platform (GCP) hold a commanding position among the many cloud companies.
Amazon is particularly dominant. According to a 2020 report from Synergy Research Group, "Amazon growth continued to closely mirror overall market growth so it maintained its 33% share of the worldwide market. Second ranked Microsoft again grew fast than the market and its market share has increased by almost three percentage points in the last four quarters, reaching 18%."
Meanwhile, Microsoft is particularly strong in SaaS, while Google Cloud, with its strength in artificial intelligence, is positioned for aggressive growth as the AI market grows – and is known for offering discounts.

- **Amazon Web Services** – With a vast tool set that continues to grow exponentially, Amazon's capabilities are unmatched. Yet its cost structure can be confusing, and its singular focus on public cloud rather than hybrid cloud or private cloud means that interoperating with your data center isn't AWS's top priority.

- **Microsoft Azure** – A close competitor to AWS with an exceptionally capable cloud infrastructure. If you're an enterprise customer, Azure speaks your language – few companies have the enterprise background (and Windows support) as Microsoft. Azure knows you still run a data center, and the Azure platform works hard to interoperate with data centers; hybrid cloud is a true strength.

- **Google Cloud** – A well-funded underdog in the competition, Google entered the cloud market later and doesn't have the enterprise focus that helps draw corporate customers. But its technical expertise is profound, and its industry-leading tools in deep learning and artificial intelligence, machine learning and data analytics are significant advantages.

AWS VS. AZURE VS. GOOGLE: OVERALL PROS AND CONS

Many experts recommend that enterprises evaluate their public cloud needs on a case-by-case basis and match specific applications and workloads with the vendor that offers the best fit for their needs. Each of the leading vendors has particular strengths and weaknesses that make them a good choice for certain projects.

AWS PROS AND CONS:

Amazon's biggest strength is its dominance of the public cloud market. In its Magic Quadrant for Cloud Infrastructure as a Service, Worldwide, Gartner noted, "AWS has been the market share leader in cloud IaaS for over 10 years."Part of the reason for its popularity is undoubtedly the massive scope of its operations. AWS has a huge and growing array of available services, as well as the most comprehensive network of worldwide data centers. The Gartner report summed it up, saying, "AWS is the most mature, enterprise-ready provider, with the deepest capabilities for governing a large number of users and resources."Amazon's big weakness relates to cost. While AWS regularly lowers its prices, many enterprises find it difficult to understand the company's cost structure and to manage those costs effectively when running a high volume of workloads on the service.In general, however, these cons are more than outweighed by Amazon's strengths, and organizations of all sizes continue to use AWS for a wide variety of workloads.

MICROSOFT AZURE PROS AND CONS:

Microsoft came late to the cloud market but gave itself a jump start by essentially taking its on-premises software – Windows Server, Office, SQL Server, Sharepoint, Dynamics Active Directory, .Net, and others – and repurposing it for the cloud.

A big reason for Azure’s success: so many enterprises deploy Windows and other Microsoft software. Because Azure is tightly integrated with these other applications, enterprises that use a lot of Microsoft software often find that it also makes sense for them to use Azure. This builds loyalty for existing Microsoft customers. Also, if you are already an existing Microsoft enterprise customer, expect significant discounts off service contracts.

On the con side, Gartner finds fault with some of the platform's imperfections. "While Microsoft Azure is an enterprise-ready platform, Gartner clients report that the service experience feels less enterprise-ready than they expected, given Microsoft's long history as an enterprise vendor," it said. "Customers cite issues with technical support, documentation, training and breadth of the ISV partner ecosystem."

GOOGLE CLOUD PLATFORM PROS AND CONS

Google has a strong offering in containers, since Google developed the Kubernetes standard that AWS and Azure now offer. GCP specializes in high compute offerings like Big Data, analytics and machine learning. It also offers considerable scale and load balancing – Google knows data centers and fast response time.On the downside, Google is a distant third in market share, perhaps because it doesn't offer as many different services and features as AWS and Azure. It also doesn't have as many global data centers as AWS or Azure, although it is quickly expanding.Gartner said that its "clients typically choose GCP as a secondary provider rather than a strategic provider, though GCP is increasingly chosen as a strategic alternative to AWS by customers whose businesses compete with Amazon, and that are more open-source-centric or DevOps-centric, and thus are less well-aligned to Microsoft Azure."

Vendor	Strengths	Weaknesses
AWS	• Dominant market position • Extensive, mature offerings • Support for large organizations • Extensive training • Global reach	• Difficult to use • Cost management • Overwhelming options
Microsoft Azure	•Second largest provider • Integration with Microsoft tools and software • Broad feature set • Hybrid cloud • Support for open source	•Issues with documentation • Incomplete management tooling
Google	• Designed for cloud-native businesses • Commitment to open source and portability • Deep discounts and flexible contracts • DevOps expertise	• Late entrant to IaaS market • Fewer features and services • Historically not as enterprise focused

AWS VS. AZURE VS. GOOGLE: COMPUTE

AWS COMPUTE:

- **Elastic Compute Cloud:** Amazon's flagship compute service is Elastic Compute Cloud, or EC2. Amazon describes EC2 as "a web service that provides secure, resizable compute capacity in the cloud." EC2 offers a wide variety of options, including a huge assortment of instances, support for both Windows and Linux, bare metal instances, GPU instances, high-performance computing, auto scaling and more. AWS also offers a free tier for EC2 that includes 750 hours per month for up to twelve months.
- **Container services:** Within the compute category, Amazon's various container services are increasing in popularity, and it has options that support Docker, Kubernetes, and its own Fargate service that automates server and cluster management when using containers. It also offers a virtual private cloud option known as Lightsail, Batch for batch computing jobs, Elastic Beanstalk for running and scaling Web applications, as well as a few other services.

MICROSOFT COMPUTE:

- **Virtual Machines:** Microsoft's primary compute service is known simply as Virtual Machines. It boasts support for Linux, Windows Server, SQL Server, Oracle, IBM, and SAP, as well as enhanced security, hybrid cloud capabilities and integrated support for Microsoft software. Like AWS, it has an extremely large catalog of available instances, including GPU and high-performance computing options, as well as instances optimized for artificial intelligence and machine learning. It also has a free tier with 750 hours per month of Windows or Linux B1S virtual machines for a year.
- **Additional Services:** Azure's version of Auto Scaling is known as Virtual Machine Scale Sets. And it has two container services: Azure Container Service is based on Kubernetes, and Container Services uses Docker Hub and Azure Container Registry for management. It has a Batch service, and Cloud Services for scalable Web applications is similar to AWS Elastic Beanstalk. It also has a unique offering called Service Fabric that is specifically designed for applications with microservices architecture.

Google Compute:

- **Compute Engine:** By comparison, Google's catalog of compute services is somewhat shorter than its competitors'. Its primary service is called Compute Engine, which boasts both custom and predefined machine types, per-second billing, Linux and Windows support, automatic discounts and carbon-neutral infrastructure that uses half the energy of typical data centers. It offers a free tier that includes one f1-micro instance per month for up to 12 months.
- **Focus on Kubernetes**: Google also offers a Kubernetes Engine for organizations interested in deploying containers. Like all of the leading cloud vendors, it's set up to offer containers and microservices. And it's worth noting that Google has been heavily involved in the Kubernetes project, giving it extra expertise in this area.

Vendor	Compute Services
AWS	• EC2 • Elastic Container Service • Elastic Container Service for Kubernetes • Elastic Container Registry • Lightsail • Batch • Elastic Beanstalk • Fargate • Auto Scaling • Elastic Load Balancing • VMware Cloud on AWS
Microsoft Azure	• Virtual Machines • Virtual Machine Scale Sets • Azure Container Service (AKS) • Container Instances • Batch • Service Fabric • Cloud Services
Google Cloud	• Compute Engine • Kubernetes • Functions • Container Security • Graphics Processing Unit (GPU) • App Engine • Knative

AWS VS. AZURE VS. GOOGLE: STORAGE

AWS STORAGE:

- **SSS to EFS:** AWS offers a long list of storage services that includes its Simple Storage Service (S3) for object storage, Elastic Block Storage (EBS) for persistent block storage for use with EC2, and Elastic File System (EFS) for file storage. Some of its more innovative storage products include the Storage Gateway, which enables a hybrid storage environment, and Snowball, which is a physical hardware device that organizations can use to transfer petabytes of data in situations where Internet transfer isn't practical.
- **Database and archiving** On the database side, Amazon has a SQL-compatible database called Aurora, Relational Database Service (RDS), DynamoDB NoSQL database, ElastiCache in-memory data store, Redshift data warehouse, Neptune graph database and a Database Migration Service. Amazon offers Glacier, which is designed for long-term archival storage at very low rates. In addition, its Storage Gateway can be used to easily set up backup and archive processes.

AZURE STORAGE:

- **Storage Services:** Microsoft Azure's basic storage services include Blob Storage for REST-based object storage of unstructured data, Queue Storage for large-volume workloads, File Storage and Disk Storage. It also has a Data Lake Store, which is useful for big data applications.
- **Extensive Database:** Azure's database options are particularly extensive. It has three SQL-based options: SQL Database, Database for MySQL and Database for PostgreSQL. It also has a Data Warehouse service, as well as Cosmos DB and Table Storage for NoSQL. Redis Cache is its in-memory service and the Server Stretch Database is its hybrid storage service designed specifically for organizations that use Microsoft SQL Server in their own data centers. Unlike AWS, Microsoft does offer an actual Backup service, as well as Site Recovery service and Archive Storage.

GOOGLE STORAGE:

- **Unified Storage and more:** As with compute, GCP has a smaller menu of storage services available. Cloud Storage is its unified object storage service, and it also has a Persistent Disk option. It offers a Transfer Appliance similar to AWS Snowball, as well as online transfer services.

- **SQL and NoSQL** When it comes to databases, GCP has the SQL-based Cloud SQL and a relational database called Cloud Spanner that is designed for mission-critical workloads. It also has two NoSQL options: Cloud Bigtable and Cloud Datastore. It does not have backup and archive services .See Full Table

Vendor	Storage Services	Database Services	Backup Services
AWS	• Simple Storage Service (S3) • Elastic Block Storage (EBS) • Elastic File System (EFS) • Storage Gateway • Snowball • Snowball Edge • Snowmobile	• Aurora • RDS • DynamoDB • ElastiCache • Redshift • Neptune • Database migration service	· Glacier
Azure	• Blob Storage • Queue Storage • File Storage • Disk Storage • Data Lake Store	•SQL Database • Database for MySQL • Database for PostgreSQL • Data Warehouse • Server Stretch Database • Cosmos DB • Table Storage • Redis Cache • Data Factory	• Archive Storage • Backup • Site Recovery
GCP	•Cloud Storage • Persistent Disk • Transfer Appliance • Transfer Service	•Cloud SQL • Cloud Bigtable • Cloud Spanner • Cloud Datastore	· None

AWS vs. Azure vs. Google: Key Cloud Tools

Looking ahead, experts say that emerging technologies like artificial intelligence, machine learning, the Internet of Things (IoT) and serverless computing will become key points of differentiation for the cloud vendors. All three leading vendors have begun experimenting with offerings in these areas and are likely to expand their services in the coming year.

AWS Key Tools:

- **Pagemaker to Serverless**: As in other areas, AWS has the longest lists of services in each of these areas. Highlights include its SageMaker service for training and deploying machine learning models, the Lex conversational interface that also powers its Alexa services, its Greengrass IoT messaging service and the Lambda serverless computing service.

- **AI and ML:** Among its many AI-oriented services, AWS offers DeepLens, an AI powered camera for for developing and deploying machine learning algorithms to use with things like optical character recognition and image and object recognition. AWS has announced Gluon, an open source deep learning library designed to make it easy for developers and non-developers alike to build and quickly train neural networks without having to know AI programming.

AZURE KEY TOOLS:

- **Cognitive Services:** Microsoft has also invested heavily in artificial intelligence, and it offers a machine learning service and a bot service on Azure. It also has Cognitive Services that include a Bing Web Search API, Text Analytics API, Face API, Computer Vision API and Custom Vision Service. For IoT, it has several management and analytics services, and its serverless computing service is known as Functions.
- Supporting MSFT Software Not surprisingly, many of Azure's top tools are geared around supporting on-premises Microsoft software. Azure Backup is a service that links Windows Server Backup in Windows Server 2012 R2 and Windows Server 2016. Visual Studio Team Services hosts Visual Studio projects on Azure.

GOOGLE KEY TOOLS:

- **Big on AI:** For Google Cloud Platform, AI and machine learning are big areas of focus. Google is a leader in AI development thanks to TensorFlow, an open source software library for building machine learning applications. The TensoreFlow library is popular and well regarded. A testament to its popularity is that AWS recently added support for TensorFlow.
- **IoT to Serverless:** Google Cloud has strong offerings in APIs for natural language, speech, translation and more. Additionally, it offers IoT and serverless services, but both are still in beta previews.

Vendor	AI/ML	IoT	Serverless
AWS	•SageMaker •Comprehend • Lex • Polly •Rekognition •Machine Learning • Translate •Transcribe •DeepLens • Deep Learning AMIs • Apache MXNet on AWS • TensorFlow on AWS	• oT Core •FreeRTOS •Greengrass • IoT 1-Click • IoT Analytics • IoT Button • IoT Device Defender • IoT Device Management	• Lambda • Serverless Application Repository
Azure	• Machine Learning • Azure Bot Service • Cognitive Services	• IoT Hub • IoT Edge • Stream Analytics • Time Series Insights	· Functions
GCP	•Cloud Machine Learning Engine • Dialogflow Enterprise Edition • Cloud Natural Language • Cloud Speech API • Cloud Translation API • Cloud Video Intelligence • Cloud Job Discovery (Private Beta)	· Cloud IoT Core (Beta)	· Cloud Functions (Beta)

AWS VS. AZURE VS. GOOGLE: PRICING

When comparing the three cloud leaders, pricing is sometimes the trickiest area of all. Yet it is possible to make some generalizations.

- **AWS Pricing:** Amazon's pricing is particularly inscrutable. While it does offer a cost calculator, the many number of variables involved make it difficult to get accurate estimates. Gartner advised, "[Amazon's] granular pricing structure is complex; use of third-party cost management tools is highly recommended."
- **Azure Pricing:** Microsoft Azure doesn't make things any simpler. Because of Microsoft's complicated software licensing options and use of situation-based discounts, its pricing structure can difficult to understand without outside help and/or considerable experience.
- **Google Pricing:** By contrast, Google uses its pricing as a point of differentiation. It aims to offer "customer-friendly" prices that beat the list prices of the other providers. Gartner noted, "Google uses deep discounts and exceptionally flexible contracts to try to win projects from customers that are currently spending significant sums of money with cloud competitors."

	 Amazon Web Services	 Microsoft Azure	 Google Cloud Platform
Regions	Global Infrastructure	Regions	Regions and Zones
Pricing	Cloud Services Pricing	Pricing	Pricing
Basic Compute	EC2	Virtual Machines	Compute Engine
Containers	ECS EKS	AKS Container Instances	Kubernetes Engine
Serverless	Lambda	Functions	Cloud Functions
App Hosting	Elastic Beanstalk	App Service Service Fabric Cloud Services	App Engine
Batch Processing	Batch	Batch	N/A
Object Storage	S3	Blob Storage	Cloud Storage
Block Storage	EBS	N/A	Persistent Disk
File Storage	EFS	File Storage	N/A

			
Hybrid Storage	Storage Gateway	StorSimple	N/A
Offline Data Transfer	Snowball Snowball Edge Snowmobile	N/A	Transfer Appliance
Relational/SQL Database	RDS Aurora	SQL Database Database for MySQL Database for PostgreSQL	Cloud SQL Cloud Spanner
NoSQL Database	DynamoDB	Cosmos DB Table Storage	Cloud Bigtable Cloud Datastore
In-Memory Database	Elasticache	Redis Cache	N/A
Archive/Backup	Glacier	Backup	N/A
Disaster Recovery	N/A	Site Recovery	N/A
Machine Learning	SageMaker AML Apache MXNet on AWS TensorFlow on AWS	Machine Learning	Cloud Machine Learning Engine

			
Cognitive Services	Comprehend Lex Polly Rekognition Translate Transcribe	Cognitive Services	Cloud Natural Language Cloud Speech API Cloud Translation API Cloud Video Intelligence
IoT	IoT Core	IoT Hub IoT Edge	Cloud IoT Core
Networking	Direct Connect	Virtual Network	Cloud Interconnect Network Service Tiers
Content Delivery	CloudFront	CDN	Cloud CDN
Big Data Analytics	Athena EMR Kinesis	HDInsight Stream Analytics Data Lake Analytics Analysis Services	Cloud Dataflow Cloud Dataproc
Authentication and Access Management	IAM Directory Service Organizations Single Sign-On	Active Directory Multi-Factor Authentication	Cloud IAM Cloud IAP

			
Security	GuardDuty Macie Shield WAF	Security Center	Cloud DLP Cloud Security Scanner
Application Lifecycle Management	CodeStar CodePipeline	Visual Studio Team Services Visual Studio App Center	N/A
Cloud Monitoring	CloudWatch CloudTrail	Monitor Log Analytics	Stackdriver
Cloud Management	Systems Manager Management Console	Portal Policy Cost Management	Stackdriver
AR & VR	Sumerian	N/A	N/A
Virtual Private Cloud	VPC	N/A	Virtual Private Cloud
Training	Training and Certification	Training	Training Programs
Support	Support	Support	Support
3rd Party Software and Services	Marketplace	Marketplace	Cloud Launcher Partner Directory