Module 1: Cloud Concepts Overview

AWS Academy Cloud Foundations

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Section 1: Introduction to cloud computing

Module 1: Cloud Concepts Overview

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Cloud computing defined

Cloud computing is the **on-demand** delivery of compute power, database, storage, applications, and other IT resources **via the internet** with **pay-as-you-go** pricing.

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Infrastructure as software

Cloud computing enables you to **stop thinking of your infrastructure as hardware**, and instead **think of (and use) it as software.**

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Traditional computing model

- Infrastructure as hardware
- Hardware solutions:
  - Require space, staff, physical security, planning, capital expenditure
  - Have a long hardware procurement cycle
  - Require you to provision capacity by guessing theoretical maximum peaks

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Cloud computing model

- Infrastructure as software
- Software solutions:
  - Are flexible
  - Can change more quickly, easily, and cost-effectively than hardware solutions
  - Eliminate the undifferentiated heavy-lifting tasks

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Cloud service models

IaaS
(infrastructure as a service)

PaaS
(platform as a service)

SaaS
(software as a service)

More control
over IT resources

Less control
over IT resources

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Similarities between AWS and traditional IT

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Section 1 key takeaways

- Cloud computing is the on-demand delivery of IT resources via the internet with pay-as-you-go pricing.
- Cloud computing enables you to think of (and use) your infrastructure as software.
- There are three cloud service models: IaaS, PaaS, and SaaS.
- There are three cloud deployment models: cloud, hybrid, and on-premises or private cloud.
- Almost anything you can implement with traditional IT can also be implemented as an AWS cloud computing service.

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Section 2: Advantages of cloud computing

Module 1: Cloud Concepts Overview

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Trade capital expense for variable expense

Data center investment based on forecast

Pay only for the amount you consume

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Massive economies of scale

Because of aggregate usage from all customers, AWS can achieve higher economies of scale and pass savings on to customers.

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Stop guessing capacity

Overestimated server capacity

Underestimated server capacity

Scaling on demand

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Increase speed and agility

Weeks between wanting resources and having resources

Minutes between wanting resources and having resources

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Stop spending money on running and maintaining data centers

Running data centers

Business and customers

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Go global in minutes

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Section 2 key takeaways

- Trade capital expense for variable expense
- Benefit from massive economies of scale
- Stop guessing capacity
- Increase speed and agility
- Stop spending money on running and maintaining data centers
- Go global in minutes

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Section 3: Introduction to Amazon Web Services (AWS)

Module 1: Cloud Concepts Overview

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What is AWS?

- AWS is a **secure cloud platform** that offers a **broad set of global cloud-based products**.
- AWS provides you with **on-demand access** to compute, storage, network, database, and other IT resources and management tools.
- AWS offers **flexibility**.
- You **pay only for the individual services you need**, for **as long as you use them**.
- AWS services **work together** like building blocks.

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Categories of AWS services

- Analytics
- Application Integration
- AR and VR
- Blockchain
- Business Applications
- Compute
- Cost Management
- Customer Engagement
- Database
- Developer Tools
- End User Computing
- Game Tech
- Internet of Things
- Machine Learning
- Management and Governance
- Media Services
- Migration and Transfer
- Mobile
- Networking and Content Delivery
- Robotics
- Satellite
- Security, Identity, and Compliance
- Storage

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Simple solution example

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Services covered in this course

Compute services –
- Amazon EC2
- AWS Lambda
- AWS Elastic Beanstalk
- Amazon EC2 Auto Scaling
- Amazon ECS
- Amazon EKS
- Amazon ECR
- AWS Fargate

Security, Identity, and Compliance services –
- AWS IAM
- Amazon Cognito
- AWS Shield
- AWS Artifact
- AWS KMS

Storage services –
- Amazon S3
- Amazon S3 Glacier
- Amazon EFS
- Amazon EBS

Database services –
- Amazon RDS
- Amazon DynamoDB
- Amazon Redshift
- Amazon Aurora

Networking and Content Delivery services –
- Amazon VPC
- Amazon Route 53
- Amazon CloudFront
- Elastic Load Balancing

Management and Governance services –
- AWS Trusted Advisor
- AWS CloudWatch
- AWS CloudTrail
- AWS Well-Architected Tool
- AWS Auto Scaling
- AWS Command Line Interface
- AWS Config
- AWS Management Console
- AWS Organizations

AWS Cost Management services –
- AWS Cost & Usage Report
- AWS Budgets
- AWS Cost Explorer

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Three ways to interact with AWS

AWS Management Console

Easy-to-use graphical interface

Command Line Interface (AWS CLI)

Access to services by discrete commands or scripts

Software Development Kits (SDKs)

Access services directly from your code (such as Java, Python, and others)

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Section 3 key takeaways

- AWS is a secure cloud platform that offers a broad set of global cloud-based products called services that are designed to work together.
- There are many categories of AWS services, and each category has many services to choose from.
- Choose a service based on your business goals and technology requirements.
- There are three ways to interact with AWS services.

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Module 3: AWS Global Infrastructure Overview

AWS Academy Cloud Foundations

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AWS Global Infrastructure

- The **AWS Global Infrastructure** is designed and built to deliver a **flexible**, **reliable**, **scalable**, and **secure** cloud computing environment with high-quality **global network performance**.
- AWS continually updates its global infrastructure footprint. Visit one of the following web pages for current infrastructure information:
  - AWS Global Infrastructure Map: https://aws.amazon.com/about-aws/global-infrastructure/#AWS_Global_Infrastructure_Map
    Choose a circle on the map to view summary information about the Region represented by the circle.
  - Regions and Availability Zones: https://aws.amazon.com/about-aws/global-infrastructure/regions_az/
    Choose a tab to view a map of the selected geography and a list of Regions, Edge locations, Local zones, and Regional Caches.

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AWS Regions

- An **AWS Region** is a geographical area.
  - Data replication across Regions is controlled by you.
  - Communication between Regions uses AWS backbone network infrastructure.
- Each Region provides full redundancy and connectivity to the network.
- A Region typically consists of two or more **Availability Zones**.

Example: London Region

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Selecting a Region

Determine the right Region for your services, applications, and data based on these factors

- Data governance, legal requirements
- Proximity to customers (latency)
- Services available within the Region
- Costs (vary by Region)

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Availability Zones

- Each **Region** has multiple Availability Zones.
- Each **Availability Zone** is a fully isolated partition of the AWS infrastructure.
  - Availability Zones consist of discrete **data centers**
  - They are designed for fault isolation
  - They are interconnected with other Availability Zones by using high-speed private networking
  - You choose your Availability Zones.
  - **AWS recommends replicating data and resources across Availability Zones** for resiliency.

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AWS data centers

- AWS data centers are designed for security.
- Data centers are where the data resides and data processing occurs.
- Each data center has redundant power, networking, and connectivity, and is housed in a separate facility.
- A data center typically has 50,000 to 80,000 physical servers.

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Points of Presence

- AWS provides a global network of Points of Presence locations
- Consists of **edge locations** and a much smaller number of **Regional edge caches**
- Used with Amazon CloudFront
  - A global Content Delivery Network (CDN), that delivers content to end users with reduced latency
- Regional edge caches used for content with infrequent access.

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AWS infrastructure features

- Elasticity and scalability
  - Elastic infrastructure; dynamic adaption of capacity
  - Scalable infrastructure; adapts to accommodate growth
- Fault-tolerance
  - Continues operating properly in the presence of a failure
  - Built-in redundancy of components
- High availability
  - High level of operational performance
  - Minimized downtime
  - No human intervention

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Key takeaways

- The **AWS Global Infrastructure** consists of Regions and Availability Zones.
- Your choice of a **Region** is typically based on compliance requirements or to reduce latency.
- Each **Availability Zone** is physically separate from other Availability Zones and has redundant power, networking, and connectivity.
- **Edge locations**, and **Regional edge caches** improve performance by caching content closer to users.

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Section 2: AWS services and service category overview

Module 3: AWS Global Infrastructure Overview

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AWS foundational services

Applications

- Virtual desktops
- Collaboration and sharing

Platform Services

Databases	Analytics	Application services	Deployment and management	Mobile Services
Relational	computing	Queuing	Containers	Identity
NoSQL	Real-time	Orchestration	DevOps tools	Sync
Caching	Data warehouse	App Streaming	Resource templates	Mobile Analytics
	Data workflows	Transcoding	Usage tracking	Notifications
		Email	Monitoring and logs	
		Search		

Foundation Services

- Compute (virtual, automatic scaling, and load balancing)
- Networking
- Storage (object, block, and archive)

Infrastructure

- Regions
- Availability Zones
- Edge locations

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AWS categories of services

Analytics

Application Integration

AR and VR

Blockchain

Business Applications

Compute

Cost Management

Customer Engagement

Database

Developer Tools

End User Computing

Game Tech

Internet of Things

Machine Learning

Management and Governance

Media Services

Migration and Transfer

Mobile

Networking and Content Delivery

Robotics

Satellite

Security, Identity, and Compliance

Storage

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Storage service category

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AWS storage services

Amazon Simple Storage Service (Amazon S3)

Amazon Elastic Block Store (Amazon EBS)

Amazon Elastic File System (Amazon EFS)

Amazon Simple Storage Service Glacier

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AWS storage services include the services listed here, and many others.

Amazon Simple Storage Service (Amazon S3) is an object storage service that offers scalability, data availability, security, and performance. Use it to store and protect any amount of data for websites, mobile apps, backup and restore, archive, enterprise applications, Internet of Things (IoT) devices, and big data analytics.

Amazon Elastic Block Store (Amazon EBS) is high-performance block storage that is designed for use with Amazon EC2 for both throughput and transaction intensive workloads. It is used for a broad range of workloads, such as relational and non-relational databases, enterprise applications, containerized applications, big data analytics engines, file systems, and media workflows.

Amazon Elastic File System (Amazon EFS) provides a scalable, fully managed elastic Network File System (NFS) file system for use with AWS Cloud services and on-premises resources. It is built to scale on demand to petabytes, growing and shrinking automatically as you add and remove files. It reduces the need to provision and manage capacity to accommodate growth.

Amazon Simple Storage Service Glacier is a secure, durable, and extremely low-cost Amazon S3 cloud storage class for data archiving and long-term backup. It is designed to deliver 11 9s of durability, and to provide comprehensive security and compliance capabilities to meet stringent regulatory requirements.

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Compute service category

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AWS Compute services

- Amazon EC2
- Amazon EC2 Auto Scaling
- Amazon Elastic Container Service (Amazon ECS)
- Amazon EC2 Container Registry
- AWS Elastic Beanstalk
- AWS Lambda
- Amazon Elastic Kubernetes Service (Amazon EKS)
- AWS Fargate

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Compute service category

AWS compute services include the services listed here, and many others.

Amazon Elastic Compute Cloud (Amazon EC2) provides resizable compute capacity as virtual machines in the cloud.

Amazon EC2 Auto Scaling enables you to automatically add or remove EC2 instances according to conditions that you define.

Amazon Elastic Container Service (Amazon ECS) is a highly scalable, high-performance container orchestration service that supports Docker containers.

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

AWS Elastic Beanstalk is a service for deploying and scaling web applications and services on familiar servers such as Apache and Microsoft Internet Information Services (IIS).

AWS Lambda enables you to run code without provisioning or managing servers. You pay only for the compute time that you consume. There is no charge when your code is not running.

Amazon Elastic Kubernetes Service (Amazon EKS) makes it easy to deploy, manage, and scale containerized applications that use Kubernetes on AWS.

AWS Fargate is a compute engine for Amazon ECS that allows you to run containers without having to manage servers or clusters.

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Database service category

Photo from https://aws.amazon.com/compliance/data-center/data-centers/

AWS Database services

Amazon Relational Database Service

Amazon Aurora

Amazon Redshift

Amazon DynamoDB

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Database service category

AWS database services include the services listed here, and many others.

Amazon Relational Database Service (Amazon RDS) makes it easy to set up, operate, and scale a relational database in the cloud. It provides resizable capacity while automating time-consuming administration tasks such as hardware provisioning, database setup, patching, and backups.

Amazon Aurora is a MySQL and PostgreSQL-compatible relational database. It is up to five times faster than standard MySQL databases and three times faster than standard PostgreSQL databases.

Amazon Redshift enables you to run analytic queries against petabytes of data that is stored locally in Amazon Redshift, and directly against exabytes of data that are stored in Amazon S3. It delivers fast performance at any scale.

Amazon DynamoDB is a key-value and document database that delivers single-digit millisecond performance at any scale, with built-in security, backup and restore, and in-memory caching.

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Networking and content delivery service category

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AWS networking and content delivery services

- Amazon VPC
- Elastic Load Balancing
- Amazon CloudFront
- AWS Transit Gateway
- Amazon Route 53
- AWS Direct Connect
- AWS VPN

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Networking and content delivery service category

AWS networking and content delivery services include the services listed here, and many others.

Amazon Virtual Private Cloud (Amazon VPC) enables you to provision logically isolated sections of the AWS Cloud.

Elastic Load Balancing automatically distributes incoming application traffic across multiple targets, such as Amazon EC2 instances, containers, IP addresses, and Lambda functions.

Amazon CloudFront is a fast content delivery network (CDN) service that securely delivers data, videos, applications, and application programming interfaces (APIs) to customers globally, with low latency and high transfer speeds.

AWS Transit Gateway is a service that enables customers to connect their Amazon Virtual Private Clouds (VPCs) and their on-premises networks to a single gateway.

Amazon Route 53 is a scalable cloud Domain Name System (DNS) web service designed to give you a reliable way to route end users to internet applications. It translates names (like www.example.com) into the numeric IP addresses (like 192.0.2.1) that computers use to connect to each other.

AWS Direct Connect provides a way to establish a dedicated private network connection from your data center or office to AWS, which can reduce network costs and increase bandwidth throughput.

AWS VPN provides a secure private tunnel from your network or device to the AWS global network.

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Security, identity, and compliance service category

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AWS security, identity, and compliance services

- AWS Identity and Access Management (IAM)
- AWS Organizations
- Amazon Cognito
- AWS Artifact
- AWS Key Management Service
- AWS Shield

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Security, identity, and compliance service category

AWS security, identity, and compliance services include the services listed here, and many others.

AWS Identity and Access Management (IAM) enables you to manage access to AWS services and resources securely. By using IAM, you can create and manage AWS users and groups. You can use IAM permissions to allow and deny user and group access to AWS resources.

AWS Organizations allows you to restrict what services and actions are allowed in your accounts.

Amazon Cognito lets you add user sign-up, sign-in, and access control to your web and mobile apps.

AWS Artifact provides on-demand access to AWS security and compliance reports and select online agreements.

AWS Key Management Service (AWS KMS) enables you to create and manage keys. You can use AWS KMS to control the use of encryption across a wide range of AWS services and in your applications.

AWS Shield is a managed Distributed Denial of Service (DDoS) protection service that safeguards applications running on AWS.

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AWS cost management service category

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AWS cost management services

AWS Cost and Usage Report

AWS Budgets

AWS Cost Explorer

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Activity: AWS Management Console clickthrough

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Hands-on activity: AWS Management Console clickthrough

1. Launch the Sandbox hands-on environment and connect to the AWS Management Console.
2. Explore the AWS Management Console.
   A. Click the **Services** menu.
   B. Notice how services are grouped into service categories. For example, the **EC2** service appears in the **Compute** service category.

      Question #1: Under which service category does the **IAM** service appear?

      Question #2: Under which service category does the **Amazon VPC** service appear?
   C. Click the **Amazon VPC** service. Notice that the dropdown menu in the top-right corner displays an AWS Region (for example, it might display *N. Virginia*).
   D. Click the Region menu and switch to a different Region. For example, choose **EU (London)**.
   E. Click **Subnets** (on the left side of the screen). The Region has three subnets in it. Click the box next to one of the subnets. Notice that the bottom half of the screen now displays details about this subnet.

      Question #3: Does the subnet you selected exist at the level of the Region or at the level of the Availability Zone?
   F. Click **Your VPCs**. An existing VPC is already selected.

      Question #4: Does the VPC exist at the level of the Region or the level of the Availability Zone?

      Question #5: Which services are global instead of Regional? Check Amazon EC2, IAM, Lambda, and Route 53.

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Activity answer key

- Question #1: Under which service category does the **IAM** service appear?
  - **Answer**: **Security, Identity, & Compliance**.
- Question #2: Under which service category does the **Amazon VPC** service appear?
  - **Answer**: **Networking & Content Delivery**
- Question #3: Does the subnet that you selected exist at the level of the Region or the level of the Availability Zone?
  - **Answer**: Subnets exist at the **level of the Availability Zone.**
- Question #4: Does the VPC exist at the level of the Region or the level of the Availability Zone?
  - **Answer**: VPCs exist at the **Region level.**
- Question #5: Which of the following services are global instead of Regional? Check Amazon EC2, IAM, Lambda, and Route 53.
  - **Answer: IAM and Route 53 are global**. Amazon EC2 and Lambda are Regional.

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Module 4: AWS Cloud Security

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Section 1: AWS shared responsibility model

Module 4: AWS Cloud Security

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AWS shared responsibility model

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AWS responsibility: Security *of* the cloud

AWS responsibilities:

- Physical security of data centers
  - Controlled, need-based access
- Hardware and software infrastructure
  - Storage decommissioning, host operating system (OS) access logging, and auditing
- Network infrastructure
  - Intrusion detection

- Virtualization infrastructure
  - Instance isolation

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Customer responsibility: Security *in* the cloud

Customer responsibilities:

- Amazon Elastic Compute Cloud (Amazon EC2) instance operating system
  - Including patching, maintenance
- Applications
  - Passwords, role-based access, etc.
- Security group configuration
- OS or host-based firewalls
  - Including intrusion detection or prevention systems
- Network configurations
- Account management
  - Login and permission settings for each user

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Service characteristics and security responsibility (1 of 2)

Example services managed by the customer

Amazon EC2

Amazon Elastic Block Store (Amazon EBS)

Amazon Virtual Private Cloud (Amazon VPC)

Example services managed by AWS

AWS Lambda

Amazon Relational Database Service (Amazon RDS)

AWS Elastic Beanstalk

Infrastructure as a service (IaaS)

- Customer has more flexibility over configuring networking and storage settings
- Customer is responsible for managing more aspects of the security
- Customer configures the access controls

Platform as a service (PaaS)

- Customer does not need to manage the underlying infrastructure
- AWS handles the operating system, database patching, firewall configuration, and disaster recovery
- Customer can focus on managing code or data

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Service characteristics and security responsibility (2 of 2)

SaaS examples

AWS Trusted Advisor

AWS Shield

Amazon Chime

Software as a service (SaaS)

- Software is centrally hosted
- Licensed on a subscription model or pay-as-you-go basis.
- Services are typically accessed via web browser, mobile app, or application programming interface (API)
- Customers do not need to manage the infrastructure that supports the service

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Section 2: AWS Identity and Access Management (IAM)

Module 4: AWS Cloud Security

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AWS Identity and Access Management (IAM)

- Use **IAM** to manage access to **AWS resources** –
  - A resource is an entity in an AWS account that you can work with
  - Example resources; An Amazon EC2 instance or an Amazon S3 bucket

- *Example* – Control who can terminate Amazon EC2 instances

- Define fine-grained access rights –
  - **Who** can access the resource
  - **Which** resources can be accessed and what can the user do to the resource
  - **How** resources can be accessed

- IAM is a no-cost AWS account feature

AWS Identity and Access Management (IAM)

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IAM: Essential components

IAM user

A **person** *or* **application** that can authenticate with an AWS account.

IAM group

A **collection of IAM users** that are granted identical authorization.

IAM policy

The document that defines **which resources can be accessed** and the **level of access** to each resource.

IAM role

Useful mechanism to grant a set of permissions for making AWS service requests.

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Authenticate as an IAM user to gain access

When you define an **IAM user**, you select what ***types of access*** the user is permitted to use.

Programmatic access

- Authenticate using:
  - Access key ID
  - Secret access key
- Provides AWS CLI and AWS SDK access

AWS CLI

AWS Tools and SDKs

AWS Management Console access

- Authenticate using:
  - 12-digit Account ID *or* alias
  - IAM user name
  - IAM password
- If enabled, **multi-factor authentication (MFA)** prompts for an authentication code.

AWS Management Console

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Authorization: What actions are permitted

After the user or application is connected to the AWS account, what are they allowed to do?

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IAM: Authorization

- Assign permissions by creating an IAM policy.
- Permissions determine **which resources and operations** are allowed:
  - All permissions are implicitly denied by default.
  - If something is explicitly denied, it is never allowed.

Best practice: Follow the **principle of least privilege**.

IAM permissions

Note: The scope of IAM service configurations is **global**. Settings apply across all AWS Regions.

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IAM policies

- **An IAM policy is a document that defines permissions**
  - Enables fine-grained access control
- Two types of policies – *identity-based* and *resource-based*
- **Identity-based** policies –
  - Attach a policy to any IAM entity
    - An IAM user, an IAM group, or an IAM role
  - Policies specify:
    - Actions that ***may*** be performed by the entity
    - Actions that ***may not*** be performed by the entity
  - A single *policy* can be attached to multiple *entities*
  - A single *entity* can have multiple *policies* attached to it
- **Resource-based** policies
  - Attached to a resource (such as an S3 bucket)

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IAM policy example

```
{
  "Version": "2012-10-17",
  "Statement":[{
    "Effect":"Allow",
    "Action":["DynamoDB:*","s3:*"],
    "Resource":[
      "arn:aws:dynamodb:region:account-number-without-hyphens:table/table-name",
      "arn:aws:s3:::bucket-name",
      "arn:aws:s3:::bucket-name/*"]
    },
    {
    "Effect":"Deny",
    "Action":["dynamodb:*","s3:*"],
    "NotResource":["arn:aws:dynamodb:region:account-number-without-hyphens:table/table-name”,
      "arn:aws:s3:::bucket-name",
      "arn:aws:s3:::bucket-name/*"]
    }
  ]
}
```

Explicit allow gives users access to a specific DynamoDB table and…

…Amazon S3 buckets.

Explicit deny ensures that the users cannot use any other AWS actions or resources other than that table and those buckets.

An explicit deny statement **takes precedence** over an allow statement.

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Resource-based policies

- *Identity-based policies* are attached to a user, group, or role
- **Resource-based policies** are attached to a resource (*not* to a user, group or role)
- Characteristics of resource-based policies –
  - Specifies who has access to the resource and what actions they can perform on it
  - The policies are *inline* only, not managed
- Resource-based policies are supported only by some AWS services

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IAM permissions

How IAM determines permissions:

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IAM groups

- An **IAM group** is a collection of IAM users
- A group is used to grant the same permissions to multiple users
  - Permissions granted by attaching IAM *policy* or policies to the group
- A user can belong to multiple groups
- There is no default group
- Groups cannot be nested

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IAM roles

- An **IAM role** is an IAM identity with specific permissions
- Similar to an IAM user
  - Attach permissions policies to it
- Different from an IAM user
  - Not uniquely associated with one person
  - Intended to be *assumable* by a **person**, **application**, or **service**
- Role provides *temporary* security credentials
- Examples of how IAM roles are used to **delegate** access –
  - Used by an IAM user in the same AWS account as the role
  - Used by an AWS service—such as Amazon EC2—in the same account as the role
  - Used by an IAM user in a different AWS account than the role

IAM role

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Example use of an IAM role

Scenario:

- An application that runs on an EC2 instance needs access to an S3 bucket

Solution:

- Define an IAM policy that grants access to the S3 bucket.
- Attach the policy to a role
- Allow the EC2 instance to assume the role

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Section 2 key takeaways

- **IAM policies** are constructed with JavaScript Object Notation (JSON) and define permissions.
  - IAM policies can be attached to any **IAM entity**.
  - Entities are IAM users, IAM groups, and IAM roles.
- An **IAM user** provides a way for a person, application, or service to authenticate to AWS.
- An **IAM group** is a simple way to attach the same policies to multiple users.
- An **IAM role** can have permissions policies attached to it and can be used to delegate temporary access to users or applications.

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Module 6: Compute

AWS Academy Cloud Foundations

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Categorizing compute services

Services	Key Concepts	Characteristics	Ease of Use
• Amazon EC2	• Infrastructure as a service (IaaS) • Instance-based • **Virtual machines**	• Provision virtual machines that you can manage as you choose	A familiar concept to many IT professionals.
• AWS Lambda	• **Serverless** computing • Function-based • Low-cost	• Write and deploy code that runs on a schedule or that can be triggered by events • Use when possible (architect for the cloud)	A relatively new concept for many IT staff members, but easy to use after you learn how.
• Amazon ECS • Amazon EKS • AWS Fargate • Amazon ECR	• **Container-based** computing • Instance-based	• Spin up and run jobs more quickly	AWS Fargate reduces administrative overhead, but you can use options that give you more control.
• AWS Elastic Beanstalk	• Platform as a service (PaaS) • For **web applications**	• Focus on your code (building your application) • Can easily tie into other services—databases, Domain Name System (DNS), etc.	Fast and easy to get started.

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Choosing the optimal compute service

- The optimal compute service or services that you use will depend on your use case
- Some aspects to consider –
  - What is your application design?
  - What are your usage patterns?
  - Which configuration settings will you want to manage?
- Selecting the wrong compute solution for an architecture can lead to lower performance efficiency
  - A good starting place—Understand the available compute options

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Amazon Elastic Compute Cloud (Amazon EC2)

Photo by Taylor Vick on Unsplash

On-premises servers

Example uses of Amazon EC2 instances

- ✓ Application server
- ✓ Web server
- ✓ Database server
- ✓ Game server
- ✓ Mail server
- ✓ Media server
- ✓ Catalog server
- ✓ File server
- ✓ Computing server
- ✓ Proxy server

Amazon EC2 instances

Photo by panumas nikhomkhai from Pexels

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Amazon EC2 overview

- **Amazon Elastic Compute Cloud (Amazon EC2)**
  - Provides virtual machines—referred to as EC2 instances—in the cloud.
  - Gives you *full control* over the guest operating system (Windows or Linux) on each instance.
- You can launch instances of any size into an Availability Zone anywhere in the world.
  - Launch instances from **Amazon Machine Images (AMIs)**.
  - Launch instances with a few clicks or a line of code, and they are ready in minutes.
- You can control traffic to and from instances.

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Amazon EC2 console view of a running EC2 instance

Instances | EC2 Management C

https://console.aws.amazon.com/ec2/home?region=us-east-1#Instances:se

110% Search

aws Services Resource Groups voclabs/user341951=davemoh... N. Virginia Support

EC2 Dashboard
Events
Tags
Reports
Limits

INSTANCES
Instances
Launch Templates
Spot Requests
Reserved Instances
Dedicated Hosts
Scheduled Instances
Capacity Reservations

IMAGES
AMIs
Bundle Tasks

ELASTIC BLOCK STORE
Volumes
Snapshots

Launch Instance | Connect | Actions

search : i-092b6f3efba959a53 Add filter

1 to 1 of 1

Name	Instance ID	Instance Type	Instance State	Status Checks	Public DNS (IPv4)	IPv4 Public IP
	i-092b6f3efba959a53	t2.micro	running	Initializing	ec2-54-159-171-63.co...	54.159.171.63

Instance: i-092b6f3efba959a53 Public DNS: ec2-54-159-171-63.compute-1.amazonaws.com

Description | Status Checks | Monitoring | Tags

Instance ID	i-092b6f3efba959a53	Public DNS (IPv4)	ec2-54-159-171-63.compute-1.amazonaws.com
Instance state	running	IPv4 Public IP	54.159.171.63
Instance type	t2.micro	IPv6 IPs	-
Elastic IPs		Private DNS	ip-172-31-82-44.ec2.internal
Availability zone	us-east-1c	Private IPs	172.31.82.44
Security groups	launch-wizard-1. view inbound rules. view outbound rules	Secondary private IPs	
Scheduled events	No scheduled events	VPC ID	vpc-e4e9859e
AMI ID	amzn2-ami-hvm-2.0.20190823.1-x86_64-gp2 (ami-0b69ea66ff7391e80)	Subnet ID	subnet-d22779fc
Platform	-	Network interfaces	eth0

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Amazon CloudWatch for monitoring

- Use **Amazon CloudWatch** to monitor EC2 instances
  - Provides near-real-time metrics
  - Provides charts in the Amazon EC2 console **Monitoring** tab that you can view
  - Maintains 15 months of historical data

- **Basic monitoring**
  - Default, no additional cost
  - Metric data sent to CloudWatch every 5 minutes

- **Detailed monitoring**
  - Fixed monthly rate for seven pre-selected metrics
  - Metric data delivered every 1 minute

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Section 2 key takeaways

- **Amazon EC2** enables you to run Windows and Linux **virtual machines** in the cloud.
- You launch **EC2 instances** from an **AMI** template into a VPC in your account.
- You can choose from many **instance types**. Each instance type offers different combinations of CPU, RAM, storage, and networking capabilities.
- You can configure **security groups** to control access to instances (specify allowed ports and source).
- **User data** enables you to specify a script to run the first time that an instance launches.
- Only **instances that are backed by Amazon EBS can be stopped.**
- You can use **Amazon CloudWatch** to capture and review metrics on EC2 instances.

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Section 4: Container services

Module 6: Compute

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Container basics

- **Containers** are a method of operating system virtualization.

- Benefits –
  - Repeatable.
  - Self-contained environments.
  - Software runs the same in different environments.
    - Developer's laptop, test, production.
  - Faster to launch and stop or terminate than virtual machines

Your Container

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What is Docker?

- **Docker** is a software platform that enables you to build, test, and deploy applications quickly.
- You run containers on Docker.
  - Containers are created from a template called an *image*.
- A **container** has everything a software application needs to run.

Container

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Containers versus virtual machines

Example

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Amazon Elastic Container Service (Amazon ECS)

- Amazon Elastic Container Service (**Amazon ECS**) –
  - A highly scalable, fast, container management service

Amazon Elastic Container Service

- Key benefits –
  - Orchestrates the running of Docker containers
  - Maintains and scales the fleet of nodes that run your containers
  - Removes the complexity of standing up the infrastructure

- Integrated with features that are familiar to Amazon EC2 service users –
  - Elastic Load Balancing
  - Amazon EC2 security groups
  - Amazon EBS volumes
  - IAM roles

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Amazon ECS orchestrates containers

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Amazon ECS cluster options

- **Key question**: Do ***you*** want to manage the Amazon ECS cluster that runs the containers?
  - If **yes**, create an **Amazon ECS cluster backed by Amazon EC2** (provides more granular control over infrastructure)
  - If no, create an Amazon ECS cluster backed by AWS Fargate (easier to maintain, focus on your applications)

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What is Kubernetes?

- Kubernetes is open source software for container orchestration.
  - Deploy and **manage containerized applications** *at scale*.
  - The same toolset can be used on premises and in the cloud.
- Complements Docker.
  - Docker enables you to run multiple containers on a single OS host.
  - Kubernetes **orchestrates** multiple Docker hosts (nodes).
- Automates –
  - Container provisioning.
  - Networking.
  - Load distribution.
  - Scaling.

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Amazon Elastic Kubernetes Service (Amazon EKS)

- Amazon Elastic Kubernetes Service (**Amazon EKS**)
  - Enables you to run Kubernetes on AWS
  - Certified Kubernetes conformant (supports easy migration)
  - Supports Linux and Windows containers
  - Compatible with Kubernetes community tools and supports popular Kubernetes add-ons

Amazon Elastic Kubernetes Service

- Use Amazon EKS to –
  - Manage clusters of Amazon EC2 compute instances
  - Run containers that are orchestrated by Kubernetes on those instances

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Amazon Elastic Container Registry (Amazon ECR)

Amazon ECR is a fully managed Docker container registry that makes it easy for developers to store, manage, and deploy Docker container images.

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Section 4 key takeaways

- **Containers** can hold everything that an application needs to run.
- **Docker** is a software platform that packages software into containers.
  - A single application can span multiple containers.
- Amazon Elastic Container Service (**Amazon ECS**) orchestrates the running of Docker containers.
- **Kubernetes** is open source software for container orchestration.
- Amazon Elastic Kubernetes Service (**Amazon EKS**) enables you to run Kubernetes on AWS
- Amazon Elastic Container Registry (**Amazon ECR**) enables you to store, manage, and deploy your Docker containers.

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Section 5: Introduction to AWS Lambda

Module 6: Compute

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AWS Lambda: Run code without servers

AWS Lambda is a **serverless** compute service.

Upload your code

The code you run
is a **Lambda function**

Run your code on a ***schedule***
*or in response to **events***

Your code
runs only when it is
triggered

Pay only for the
compute time that
you use

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Benefits of Lambda

AWS Lambda

- It supports multiple programming languages
- Completely automated administration
- Built-in fault tolerance
- It supports the orchestration of multiple functions
- Pay-per-use pricing

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AWS Lambda event sources

Event sources

Configure other AWS services as **event sources** to invoke your function as shown here.

Alternatively, invoke a Lambda function from the Lambda console, AWS SDK, or AWS CLI.

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AWS Lambda function configuration

Lambda function configuration

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Schedule-based Lambda function example: Start and stop EC2 instances

Stop instances example

Start instances example

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Event-based Lambda function example: Create thumbnail images

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AWS Lambda quotas

Soft limits per Region:

- Concurrent executions = 1,000
- Function and layer storage = 75 GB

Hard limits for individual functions:

- Maximum function memory allocation = 10,240 MB
- Function timeout = 15 minutes
- Deployment package size = 250 MB unzipped, including layers
- Container image code package size = 10 GB

Additional limits also exist. Details are in the AWS Lambda quotas documentation at https://docs.aws.amazon.com/lambda/latest/dg/gettingstarted-limits.html.

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Section 5 key takeaways

- **Serverless computing** enables you to build and run applications and services without provisioning or managing servers.
- **AWS Lambda is a serverless compute service** that provides built-in fault tolerance and automatic scaling.
- An **event source** is an AWS service or developer-created application that triggers a Lambda function to run.
- The maximum memory allocation for a single Lambda function is 10,240 MB.
- The maximum run time for a Lambda function is 15 minutes.

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Section 6: Introduction to AWS Elastic Beanstalk

Module 6: Compute

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AWS Elastic Beanstalk

AWS Elastic Beanstalk

- An easy way to get **web applications** up and running
- A **managed service** that automatically handles –
  - Infrastructure provisioning and configuration
  - Deployment
  - Load balancing
  - Automatic scaling
  - Health monitoring
  - Analysis and debugging
  - Logging
- No additional charge for Elastic Beanstalk
  - Pay only for the underlying resources that are used

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AWS Elastic Beanstalk deployments

- It supports web applications written for common platforms
  - **Java**, **.NET**, **PHP**, **Node.js**, **Python**, **Ruby**, **Go**, and **Docker**
- You upload your code
  - Elastic Beanstalk automatically handles the deployment
  - Deploys on servers such as Apache, NGINX, Passenger, Puma, and Microsoft Internet Information Services (IIS)

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Benefits of Elastic Beanstalk

Fast and simple to start using

Developer productivity

Difficult to outgrow

Complete resource control

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Amazon AWS Service

Amazon Web Services (AWS) offers a wide range of big data services and applications designed to help organizations store, process, and analyze large datasets. Here are some key AWS services and apps related to big data:

1. Amazon S3 (Simple Storage Service)

Amazon S3 provides scalable object storage with industry-leading durability, availability, and performance. It is often used as a data lake to store vast amounts of unstructured data.

2. Amazon Redshift

Amazon Redshift is a fully managed data warehouse service that makes it simple and cost-effective to analyze all your data using standard SQL and existing Business Intelligence (BI) tools. It can handle petabyte-scale data and is optimized for complex queries.

3. Amazon EMR (Elastic MapReduce)

Amazon EMR is a cloud big data platform for processing large amounts of data using open-source tools such as Apache Hadoop, Apache Spark, and Apache HBase. It allows you to run and scale big data frameworks easily.

4. AWS Glue

AWS Glue is a fully managed ETL (extract, transform, load) service that makes it easy to prepare and load your data for analytics. It can handle data discovery, schema inference, and job scheduling.

5. Amazon Kinesis

Amazon Kinesis is a platform for real-time data processing. It offers multiple services:

- **Kinesis Data Streams:** Collect and process large streams of data records in real-time.
- **Kinesis Data Firehose:** Load streaming data into data lakes, data stores, and analytics services.
- **Kinesis Data Analytics:** Analyze streaming data using standard SQL.

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Amazon AWS

6. Amazon Athena

Amazon Athena is an interactive query service that makes it easy to analyze data in Amazon S3 using standard SQL. Athena is serverless, so there's no infrastructure to manage.

7. Amazon QuickSight

Amazon QuickSight is a fast, cloud-powered business intelligence service that makes it easy to deliver insights to everyone in your organization. It allows you to create and publish interactive dashboards.

8. Amazon RDS (Relational Database Service)

Amazon RDS makes it easy to set up, operate, and scale a relational database in the cloud. It supports several database engines, including Amazon Aurora, PostgreSQL, MySQL, MariaDB, Oracle, and Microsoft SQL Server.

9. AWS Data Pipeline

AWS Data Pipeline is a web service that helps you reliably process and move data between different AWS compute and storage services as well as on-premises data sources.

10. AWS Lambda

AWS Lambda lets you run code without provisioning or managing servers. You can use Lambda to process data in real-time, such as processing logs or analyzing data streams.

11. Amazon Elasticsearch Service (Amazon OpenSearch Service)

Amazon OpenSearch Service is a fully managed service that makes it easy to deploy, operate, and scale OpenSearch for log analytics, full-text search, application monitoring, and more.

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Amazon AWS

12. Amazon MSK (Managed Streaming for Apache Kafka)

Amazon MSK is a fully managed service that makes it easy to build and run applications that use Apache Kafka to process streaming data.

13. AWS Lake Formation

AWS Lake Formation makes it easy to set up a secure data lake in days. A data lake is a centralized, curated, and secured repository that stores all your data, both in its original form and prepared for analysis.

14. Amazon SageMaker

Amazon SageMaker provides every developer and data scientist with the ability to build, train, and deploy machine learning (ML) models quickly. SageMaker is a fully managed service that covers the entire machine learning workflow.

Key Benefits of AWS Big Data Services

- **Scalability:** AWS services can scale up and down based on your workload demands.
- **Cost-Effectiveness:** Pay-as-you-go pricing models and various cost management tools.
- **Security:** Comprehensive security and compliance capabilities.
- **Integration:** Seamless integration with other AWS services and third-party tools.
- **Managed Services:** Many AWS services are fully managed, reducing the operational burden.

These services collectively provide a robust ecosystem for handling diverse big data needs, from storage and processing to analytics and machine learning.

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Some of the Main Big Data Providers on the Cloud

Feature/Service Category	Amazon AWS	Google Cloud Platform	Microsoft Azure	Cloudera Data Platform (CDP)
Object Storage	Amazon S3	Google Cloud Storage	Azure Blob Storage	Cloudera Data Lake Storage (S3, ADLS, GCS)
Data Warehouse	Amazon Redshift	BigQuery	Azure Synapse Analytics (SQL Data Warehouse)	Cloudera Data Warehouse (Impala, Hive LLAP)
Batch Data Processing	Amazon EMR	Google Cloud Dataproc	Azure HDInsight	Cloudera Data Engineering (Apache Spark)
Stream Data Processing	Amazon Kinesis	Google Cloud Dataflow	Azure Stream Analytics	Cloudera Streams Messaging (Apache Kafka)
ETL/Data Integration	AWS Glue	Google Cloud Data Fusion	Azure Data Factory	Cloudera DataFlow (Apache NiFi)
Real-time Messaging	Amazon Kinesis Data Streams	Google Cloud Pub/Sub	Azure Event Hubs	Cloudera Streams Messaging (Apache Kafka)
Serverless Query Service	Amazon Athena	Google BigQuery	Azure Synapse Analytics (Serverless)	Cloudera Data Warehouse (Impala, Hive LLAP)
Data Lake Storage	Amazon S3 (with AWS Lake Formation)	Google Cloud Storage (with Dataproc)	Azure Data Lake Storage	Cloudera Data Lake Storage (S3, ADLS, GCS)
Big Data Analytics	AWS Glue/Athena	Google Cloud Dataflow/BigQuery	Azure Synapse Analytics/HDInsight	Cloudera Data Engineering, Data Science Workbench
Managed Apache Spark	Amazon EMR	Google Cloud Dataproc	Azure Databricks	Cloudera Data Engineering
NoSQL Database	Amazon DynamoDB	Google Cloud Bigtable	Azure Cosmos DB	Cloudera Operational Database (HBase, Kudu)
Machine Learning	Amazon SageMaker	Google AI Platform	Azure Machine Learning	Cloudera Machine Learning (CDSW)
Interactive Analysis	Amazon QuickSight	Looker	Power BI	Cloudera Data Warehouse, Hue
Data Exploration	Amazon Elasticsearch Service (OpenSearch)	Google Cloud Dataflow/Data Studio	Azure Data Explorer	Cloudera Data Science Workbench
Workflow Orchestration	AWS Step Functions	Google Cloud Composer	Azure Data Factory	Cloudera DataFlow (Apache NiFi)
Serverless Computing	AWS Lambda	Google Cloud Functions	Azure Functions	Cloudera Data Engineering (serverless Spark)
Managed Database	Amazon RDS	Google Cloud SQL	Azure SQL Database	Cloudera Operational Database (HBase, Kudu)
Pre-built AI Services	AWS AI Services (Rekognition, Polly, etc.)	Google Cloud AI (Vision, Speech, etc.)	Azure Cognitive Services	Cloudera Machine Learning (CDSW)

Thank you

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