AWS Certified: Developer Associate

Cheat Sheet

Quick Bytes for you before the exam!

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Compute

AWS EC2

What is AWS EC2?

EC2 (Elastic Compute Cloud) is a scalable virtual machine in the cloud.

- Automatically scales instances based on traffic.
- Eliminates hardware investment.
- Allows launching multiple servers with full control over security, networking, and storage.

Overview of Key Features in Amazon EC2

Feature	Description
Instance Type	Provides a range of instance types for various use cases. Determines the processor and memory configuration of your EC2 instance.
EBS Volume	- Stands for Elastic Block Storage. - Block-level storage assigned to a single EC2 instance. - Persists independently from running EC2 instances. **Types:** - General Purpose (SSD) - Cold Hard Disk Drive - Magnetic - Provisioned IOPS (SSD) - Throughput Optimized Hard Disk Drive
Instance Store	Ephemeral block-level storage for EC2 instances. Used for faster processing and temporary storage of applications.
AMI	- Stands for Amazon Machine Image. - Defines the OS, dependencies, libraries, and data for EC2 instances. - Enables launching multiple instances with the same configuration.
Security Group	- Virtual firewall for EC2 instances. - Controls ports and traffic. - Active at the instance level; Network ACLs operate at the subnet level. - Allows rules only, cannot deny. - Stateful design. - Outbound traffic allowed by default; inbound rules require definition.
Key Pair	- A set of security credentials (public and private keys) for identity verification when connecting to an instance. - Public key attached to the instance; private key remains with the user. - Access is granted when keys match. - Keep the private key secure.
Pricing	Different pricing options: - On-Demand - Reserved Instances - Savings Plan - Spot Instances
Tags	- Key-value pairs assigned to AWS resources. - Help identify and organize resources effectively.

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AWS Lambda

What is AWS Lambda?

AWS Lambda is a **serverless compute service** that runs your code without the need for provisioning servers. It automatically scales with request count and follows a **pay-per-use model**, meaning no charges when the code isn't running. Lambda executes code for any application or backend service, triggered by events like updates in DynamoDB or S3 changes, or HTTP requests via API Gateway.

What is Serverless Computing?

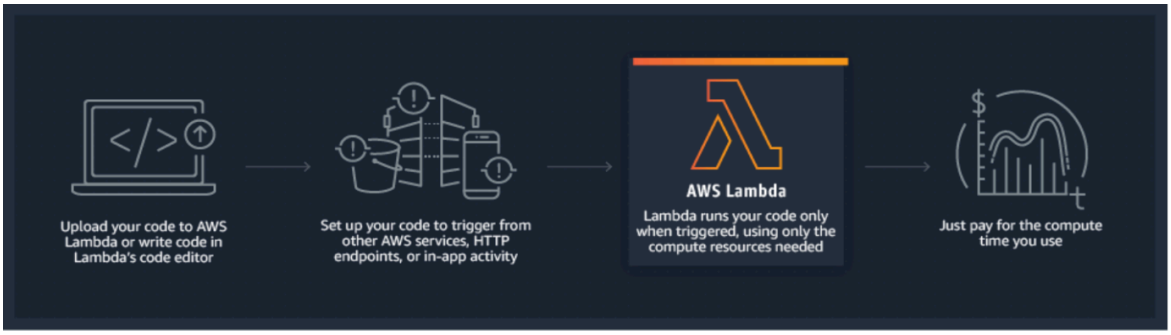
Serverless computing provides backend services on a **pay-per-use basis** without worrying about underlying infrastructure. Servers exist but are managed by the cloud vendor.

When to Use Lambda

- Ideal when you focus solely on your code while AWS manages compute resources like memory, CPU, and network.
- For custom compute management, consider EC2 or Elastic Beanstalk. Lambda abstracts server access and runtime customization.

How AWS Lambda Works

Aspect	Details
Lambda Functions	- Code is uploaded as a zip file or from an S3 bucket. - Functions are monitored via Amazon CloudWatch.
Lambda Layers	- Archive for additional code (e.g., libraries, dependencies, or runtimes). - Allows up to 5 layers per function. - Layers are immutable and can be shared publicly.
Lambda Events	- Entities that trigger functions, such as: - DynamoDB, SQS, SNS, CloudWatch, API Gateway, IoT, Kinesis.
Lambda@Edge	- Runs code closer to users through CloudFront, improving performance and reducing latency.



Supported Languages

- Node.js, Go, Java, Python, Ruby.

Pricing

- Charged based on **number of requests** and **execution duration** (per 100 ms).
- **Free Tier**: 1 million requests/month. 400,000 GB-seconds of compute time/month.

AWS Serverless Application Model

AWS Serverless Application Model (AWS SAM) is an open-source framework used for constructing serverless applications on AWS. It offers a streamlined method for defining the structure of serverless applications, encompassing AWS Lambda functions, Amazon API Gateway APIs, Amazon DynamoDB tables, and various other AWS resources, through a template-driven approach.

Features:

Feature	Details
Simplified Serverless Application Definition	AWS SAM provides a simplified, declarative syntax for defining serverless applications.
Local Development and Testing	AWS SAM CLI allows for local development and testing of serverless applications.
Integration with AWS Services	Serverless applications built with AWS SAM can automatically scale in response to incoming events or requests.
Auto-Scaling and Event-Driven	AWS SAM integrates seamlessly with various AWS services, including AWS Lambda, Amazon API Gateway, Amazon DynamoDB, Amazon S3, Amazon SNS, and others.
Event Sources and Triggers	AWS SAM allows you to define event sources or triggers for Lambda functions, such as AWS API Gateway HTTP endpoints, S3 object uploads, DynamoDB streams, and more.

AWS Elastic Beanstalk

What is AWS Elastic Beanstalk?

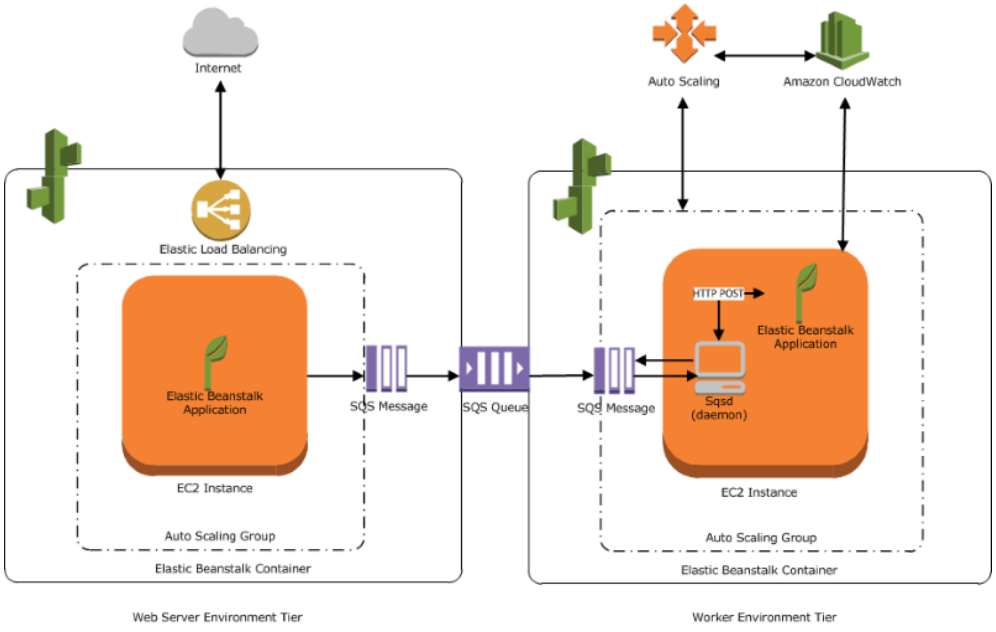
AWS Elastic Beanstalk is a compute service for deploying and scaling applications in popular programming languages. It allows developers to focus on code without managing infrastructure. Beanstalk offers:

- A quick and simple way to deploy applications.
- A user-friendly dashboard for application monitoring.
- Flexibility to select AWS resources like EC2 instances and pricing options based on your needs.

AWS Elastic Beanstalk supports two types of Environment:

Environment Types:

1. **Web Tier:** Handles HTTP/HTTPS requests using ELB and Auto Scaling.
2. **Worker Tier:** Processes background tasks like database cleanup and report generation via a Daemon that pulls tasks from SQS.



Key Components	Description
Elastic Load Balancer (ELB)	Distributes incoming traffic among EC2 instances in the Auto Scaling Group.
Auto Scaling Group	Dynamically adds/removes EC2 instances based on application load.
Host Manager	Manages logs, monitoring, and events on each EC2 instance.

Storage

Amazon S3

What is Amazon S3?

- **Amazon S3 (Simple Storage Service)** is an object storage service that allows users to store any type of data in a scalable, secure, and low-cost environment.

Basics of S3:

- **Object-Based Storage**: Stores files as objects in **buckets**.
- **Buckets**: Folders for objects, with sizes ranging from 0 to 5 TB.
- **Bucket Naming**: Must be globally unique.
- **Upload Success**: Returns HTTP 200 code for successful uploads.
- **Consistency**: Strong consistency for new objects, overwrites, deletes, and list operations.
- **Privacy**: Objects are private by default.

Properties of Amazon S3:

- **Versioning**: Keeps multiple versions of objects within the same bucket.
- **Static Website Hosting**: Hosts static websites without requiring server-side technology.
- **Encryption**: Supports encryption at rest using S3 Managed Keys (SSE-S3) or KMS Managed Keys (SSE-KMS).
- **Object Lock**: Prevents version deletion for a defined period, enabled during bucket creation.
- **Transfer Acceleration**: Speeds up file transfer using Amazon CloudFront's edge locations.

Permissions & Management:

- **Access Control List (ACL)**: Grants read/write permissions to other AWS accounts.
- **Bucket Policy**: JSON-based access policies for advanced permissions.
- **CORS (Cross-Origin Resource Sharing)**: Allows cross-origin access to S3 resources.

Charges: **Factors Affecting Charges**:

- Storage
- Requests
- Storage Management (Lifecycle Policies)
- Transfer Acceleration
- Data Transfer

Miscellaneous Topics:

- **Access Points**: Makes S3 accessible over the internet.
- **Lifecycle Policies**: Transition objects between storage classes based on lifecycle configuration.
- **Replication**: Replicates data across buckets, either within the same region or across different regions.

Storage class	Suitable for	Durability	Availability	Availability Zones	Min. storage days
S3 Standard	accessed data frequently	100%	99.99%	>= 3	None
S3 Standard-IA	accessed data infrequently	100%	99.90%	>= 3	30 days
S3 Intelligent-Tiering	Storage for unknown access patterns	100%	99.90%	>= 3	30 days
S3 One Zone-IA	Non-critical data	100%	99.50%	1	30 days
S3 Glacier	For long term Data Archival. e.g., 3 years – 5 years	100%	99.99%	>= 3	90 days
S3 Glacier Deep Archive	For long term Data Archival. e.g., 3 years – 5 years	100%	99.99%	>= 3	180 days
RRS (Reduced Redundancy Storage)	Frequently accessed for non-critical data but not recommended	99%	99.99%	>= 3	NA

AWS Backup

What is AWS Backup?

AWS Backup is a secure service that automates and manages data backup for AWS cloud resources and on-premises environments.

Features:

Feature	Description
Backup Management	Offers a backup console, APIs, and AWS CLI to manage backups for AWS resources (e.g., instances, databases).
Policy-Based Backup	Automates backup based on policies, tags, and resources.
Scheduled Backup Plans	Automates backups across AWS accounts and regions with customizable policies.
Incremental Backups	Reduces storage costs by performing full backups initially, followed by incremental backups.
Backup Retention Plans	Automatically retains and expires backups to optimize storage costs.
Backup Monitoring	Provides a dashboard in the AWS Backup console to track backup and restore activities.
Encryption	Supports separate encryption keys for multiple AWS resources.
Lifecycle Policies	Automates the transition of backups from Amazon EFS to cold storage.
Cross-Account Backup	Supports backup and restore across AWS accounts and organizations.
Cross-Region Backup	Enables backup and restore to different regions for disaster recovery and business continuity.
Monitoring & Auditing	Integrates with CloudWatch, CloudTrail, and SNS for monitoring, auditing, and notifications.

Use Cases

- **Hybrid Storage Backup**:
  - Uses AWS Storage Gateway volumes for secure, hybrid storage backup, compatible with Amazon EBS for restoring volumes.

Pricing

- **Charges**: Based on backup storage used and the amount of backup data restored.

Amazon EBS - Elastic Block Store

What is Amazon EBS?

Amazon Elastic Block Store (EBS) is a persistent block-level storage service for Amazon EC2 instances. It is AZ-specific, automatically replicated within its AZ for high availability and durability.

Types of EBS:

SSD-backed volumes (Solid State Drive)	**Optimized for transactional workloads** (small and frequent I/O) - IOPS	
Types SSD	**General Purpose SSD- gp2** (1 GiB — 16 TiB) IOPS : 3000 to 20000 Max / Volume	Boot volumes Development /Test Low-latency Apps Virtual Desktops
	Provisioned IOPS SSD (io1) low-latency or high-throughput Consistent IOPS (16,000+ IOPS) Transactional workloads	MongoDB / NoSQL MySQL / RDS Latency Critical Apps
HDD-backed volumes: (Magnetic Drive)	**Low-Cost throughput-intensive workloads** (Not Suitable for Low Latency(IOPS) -- i.e. booting)	
Types HDD	**Throughput Optimized HDD (st1)** Low Cost - Frequently accessed, throughput-intensive & Large-Sequential O/I -- 500 MB/s	Stream Processing Big Data Processing Data Warehouse
	Cold HDD (sc1) Lowest Cost - less frequently accessed data Throughput : 250 MiB/s	Colder Data requires fewer scans per day.

Features:

- **High Performance:** Single-digit millisecond latency.
- **Highly Scalable:** Scales to petabytes.
- **High Availability & Durability:** 99.999% uptime guarantee.
- **Encryption:** Seamless data encryption with AWS KMS.
- **Automated Backups:** Backups via EBS snapshots to S3 using lifecycle policies.
- **Quick Detach/Attach:** Easily detach from one EC2 instance and attach to another.

Pricing: Charges apply for provisioned capacity, snapshots, and data transfer between AZs/Regions.

EBS vs Instance Store:

- **Instance Store:** Ephemeral, temporary storage with high IOPS, data lost on instance stop/crash. Cannot create snapshots.
- **EBS:** Persistent, reliable storage that can be detached/reattached, boots faster, and supports snapshots.

Amazon EFS - Elastic File Storage

What is Amazon EFS?

Amazon Elastic File System (EFS) is a scalable, fully managed file system based on NFS. It offers persistent storage, scales up to petabytes, and supports parallel access from thousands of EC2 instances. EFS is a regional service, automatically replicated across multiple Availability Zones for high availability and durability.

Types of EFS Storage Classes:

Standard Storage	For frequently accessed files.
Infrequent Access Storage (EFS-IA)	For files not accessed every day Cost-Optimized (costs only $0.025/GB-month) Use EFS Lifecycle Management to move the file to EFS IA

EFS Access and Performance Modes:

- **Performance Modes:**
  - *General Purpose:* Low latency, lower throughput.
  - *Max I/O:* High throughput, higher latency.
- **Throughput Modes:**
  - *Bursting (default):* Throughput grows with file system size.
  - *Provisioned:* Fixed throughput capacity.

Features:

- Fully managed, scalable, and durable NFSv4-based system.
- High availability, low latency (SSD-based).
- POSIX compliant.
- Access across AZs, regions, VPCs, and on-premises via Direct Connect/VPN.
- Lifecycle management for better cost-performance.
- Integrated with AWS DataSync, CloudWatch, CloudTrail.
- Supports encryption in transit (TLS) and at rest (KMS).
- Not suitable for boot volumes or highly transactional databases.

Use Cases:

- Mission-critical apps, microservices, containers, media storage, database backups, analytics, and machine learning.

Best Practices:

- Monitor with CloudWatch, track with CloudTrail.
- Leverage IAM for security, separate latency-sensitive workloads.

Pricing: Pay for storage, access mode, and backup storage used.

Amazon S3 Glacier

Category	Description
Purpose	Long-term data archiving and backup.
Cost & Durability	Cheapest S3 storage class with 99.999999999% durability.
Data Types	Stores unlimited data (photos, videos, documents, TAR/ZIP files, data lakes, analytics, IoT, ML, compliance data).
Storage Distribution	Automatically distributes data across Availability Zones in a region.
Retrieval Options	Expedited: 1–5 minutes Standard: 3–5 hours Bulk: 5–12 hours

Features:

- **IAM Integration**: Grants user permissions for vault access.
- **CloudTrail Logging**: Tracks API call activities for auditing.
- **Vaults**: Store archives with options to create, delete, lock, list, retrieve, tag, and configure.
- **Access Policies**: Users can set policies for enhanced security.
- **Retrieval Jobs**: Uses **Amazon SNS** for job completion notifications.
- **S3 Glacier Select**: Queries specific archive objects instead of full retrievals.
- **Supported Format**: Works with **uncompressed CSV**, outputting results to S3.
- **SQL Support**: Uses **SELECT, FROM, WHERE** for queries.
- **Encryption**: Supports **SSE-KMS** and **SSE-S3**.
- **No Real-Time Retrieval**: Archives are not instantly accessible.

Use Cases:

- It helps to store and archive media data that can increase up to the petabyte level.
- Organizations that generate, analyze, and archive large data can make use of Amazon S3 Glacier and S3 Glacier Deep Archive storage classes.
- Amazon S3 Glacier replaces tape libraries for storage because it does not require high upfront cost and maintenance.

Price details:

- Free Usage Tier - Users can retrieve with standard retrieval up to 10 GB of archive data per month for free.
- Data transfer out from S3 Glacier in the same region is free.

Database

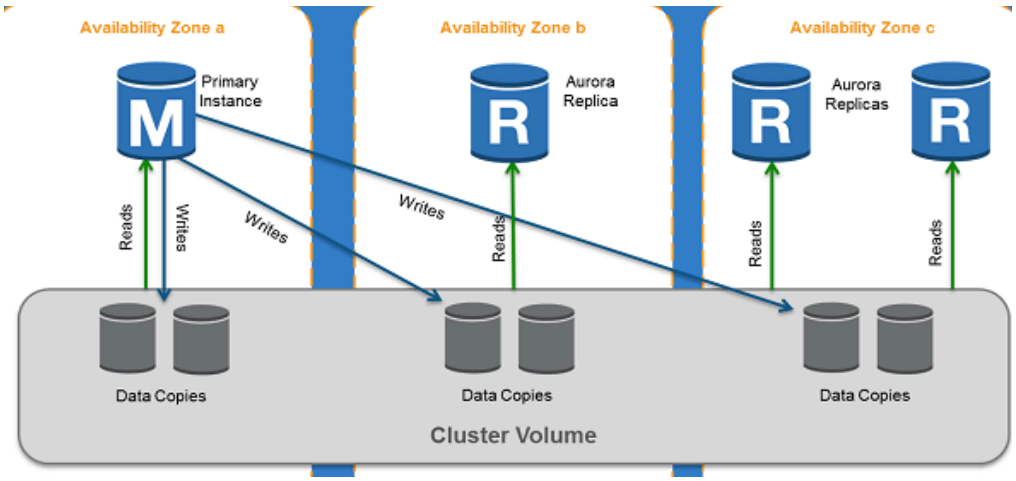
Amazon Aurora

What is Amazon Aurora?

Aurora is the fully managed RDS services offered by AWS**. It's only compatible with PostgreSQL/MySQL.** As per AWS, Aurora provides 5 times throughput to traditional MySQL and 3 times throughput to PostgreSQL.

Features:

- **Availability & Durability:**
  - Supported in regions with at least 3 AZs.
  - 99.99% availability with 6 copies of data (2 per AZ).
  - Up to 15 Read Replicas (RDS allows only 5).
  - Scales up to 128 TB per instance.
- **Aurora DB Cluster:**
  - **Primary DB Instance** – Handles read/write operations.
  - **Aurora Replica** – Read-only, auto-failover with <100 ms lag.
- **Security & Fault Tolerance:**
  - Data resides in VPC with AWS KMS encryption (at rest) and SSL (in transit).
  - **Fault tolerance:** Handles loss of 2 copies (write unaffected) and 3 copies (read unaffected).
  - **Self-healing storage:** Auto-detects and repairs disk errors.
- **Aurora Features:**
  - **Aurora Global Database** – Spans multiple regions for low-latency access and disaster recovery.
  - **Aurora Multi-Master** (MySQL only) – Enables write scaling across AZs, eliminating single points of failure.
  - **Aurora Serverless** – Auto-scales based on load, ideal for intermittent workloads.



Pricing: No upfront fees. On-demand costs more than reserved. Free backups (<1 day retention) and intra-AZ/inbound transfers. Outbound internet transfer is chargeable beyond 1 GB/month.

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Amazon DynamoDB

DynamoDB is a **serverless** NoSQL **key-value** and **document** database with **single-digit millisecond latency**. It handles **20M requests/sec** and **10T requests/day** while automatically managing data traffic across servers.

Key Features:

- **Scalability:** Supports automatic scaling and multi-region replication.
- **Flexible Schema:** Stores multi-valued attributes dynamically.
- **Primary Key Types:**
  - **Partition Key:** Unique identifier (e.g., Student_ID).
  - **Partition + Sort Key:** Composite key for better organization.
- **Indexes:**
  - **Global Secondary Index (GSI):** Different partition/sort key from the table.
  - **Local Secondary Index (LSI):** Same partition key, different sort key.

Performance & Acceleration:

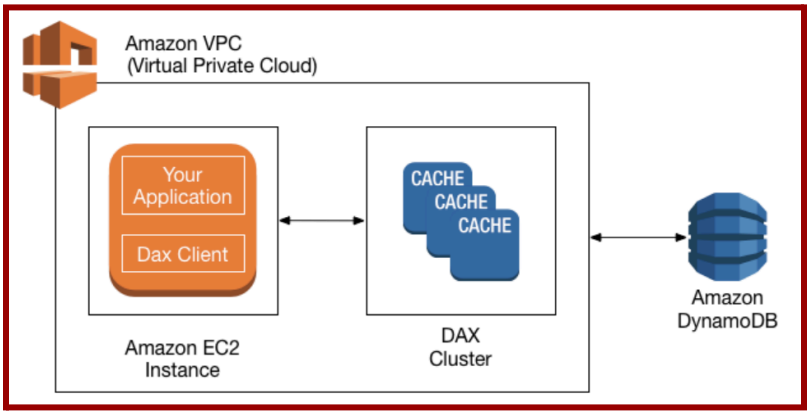
- **DynamoDB Accelerator (DAX):** In-memory caching for 10x performance boost (microseconds latency).
- Supports **horizontal scaling** (read replicas) and **vertical scaling** (node type changes).

Data Access & Operations:

- **Scan:** Retrieves multiple items but is slower than queries (up to **1MB** per operation).
- **Query:** Searches based on **primary key**, with optional **sort key** for filtering.
- **Streams:** Captures real-time item changes, retained for **24 hours**, accessed via **Lambda** or **KCL**.
- **Transactions:** ACID-compliant, supporting **up to 4MB** and **25 unique items** per transaction.

Consistency & Throughput Models:

- **Consistency:**
  - **Eventual Reads:** May return stale data but scales better.
  - **Strong Reads:** Always returns the latest data but has higher latency.
- **Throughput:**
  - **Read Capacity Unit (RCU):** 1 strong or 2 eventual reads (per 4KB).
  - **Write Capacity Unit (WCU):** 1 write per second (1KB).
  - **Provisioned Mode:** Pre-defined capacity for predictable workloads.
  - **On-Demand Mode:** Auto-scales for unpredictable workloads.



Pricing: **Pay-as-you-go** for disk space, data transfer, and provisioned throughput. Charges apply for **reserved capacity** and **on-demand usage**.

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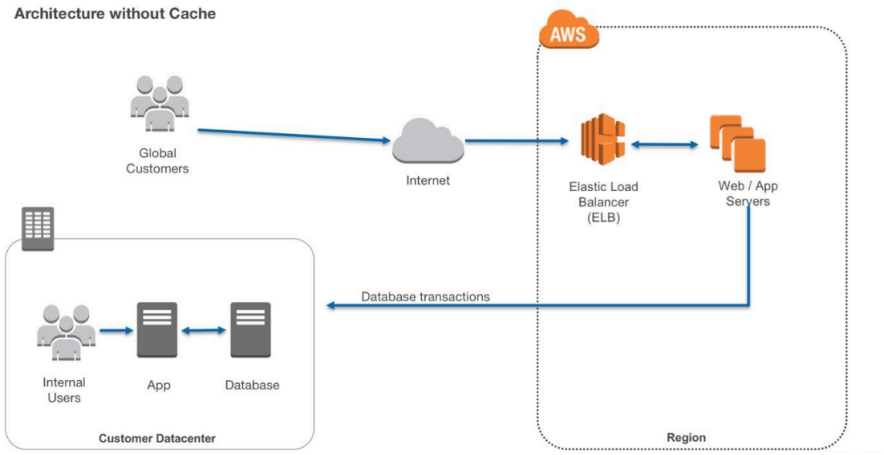
Amazon ElastiCache

ElastiCache is a **fully managed in-memory data store** that boosts **read-heavy workloads** by reducing latency. It supports **Redis** and **Memcached** engines, offering faster performance than disk-based databases.

Key Features:

- **High Availability:** Ensures data access even during maintenance or outages.
- **Key-Value Storage:** Unlike databases, data is retrieved via key-value pairs.
- **Automatic Node Replacement:** Failed nodes are replaced automatically.



Memcached vs. Redis:

Feature	Memcached	Redis
Data Persistence	Volatile	Non-volatile
Data Types	Simple	Complex (strings, hashes, geospatial)
Multi-Threading	Yes	No
Scaling	Add/remove nodes	Add shards (primary + replicas)
Multi-AZ	Not supported	Supported via read replicas
Failover	Not supported	Auto-switch to replica

Best Practices:

- Session Storage: Use Redis for web sessions to ensure data persistence.
- Database Caching: Use Memcached with RDS for faster query performance.
- Live Polling & Gaming: Cache frequently accessed data in Memcached.
- Hybrid Approach: Combine RDS with ElastiCache for backend optimization.

Pricing:

- Charged per node hour (partial hours billed as full).
- Free data exchange within the same AZ.
- Available as on-demand or reserved nodes.

Amazon RDS

Amazon RDS Overview

Amazon RDS is a managed relational database service that simplifies operation, management, and scaling in the cloud. It automates tasks like patching, backups, and provisioning, offering cost-efficient scalability.

Supported Engines:

- MySQL, MariaDB, PostgreSQL – Open-source databases with easy AWS provisioning.
- MS SQL, Oracle – Commercial databases with provisioning and licensing options.
- Amazon Aurora – AWS-native MySQL/PostgreSQL-compatible engine, 5x faster than MySQL, 3x faster than PostgreSQL, supports 15 read replicas.

Instance Classes:

Type	Examples	Use Case
Standard	db.m6g, db.m5, db.m4	General-purpose workloads
Burstable	db.t3, db.t2	Baseline CPU with burst capability
Memory-Optimized	db.z1d, db.x1e, db.r5	Large datasets with high memory needs

High Availability & Performance:

Feature	Multi-AZ Deployment	Read Replicas
Replication	Synchronous	Asynchronous
Purpose	Disaster Recovery	Performance Enhancement
Scope	Two AZs in a region	Cross-AZ or cross-region
Failover	Automatic	Manual promotion

Storage Types:

- General Purpose (SSD): Baseline 3 IOPS/GiB, bursts up to 3,000 IOPS.
- Provisioned IOPS (SSD): High-performance storage, supports 1,000–30,000 IOPS.

Monitoring & Backups:

- Enhanced Monitoring: Disabled by default, incurs extra charges.
- Backups: Default retention 7 days (Console), 1 day (CLI/API), max 35 days.
- Manual Snapshots: 100 per region.

Pricing Factors:

- Active instances, storage, requests, backups, enhanced monitoring, cross-region replication.

Security, Identity, & Compliance

AWS IAM

Identity and Access Management (IAM)

IAM is an AWS service that **securely controls access** to AWS resources by managing **users, groups, roles, and policies**.

Key Components:

Principals

- **Root User** – Created with an AWS account, has full access.
- **IAM User** – Represents a person/service with assigned permissions.
- **IAM Group** – Collection of users with shared permissions.
- **IAM Role** – Temporary identity with policies, used by federated users or AWS services.

Policies

- **Identity-Based Policies** – Define access for users, groups, and roles.
    - **AWS Managed** – Predefined by AWS.
    - **Customer Managed** – Created by users for fine-grained control.
    - **Inline** – Directly attached to a user, group, or role.
- **Resource-Based Policies** – Control access at the resource level (e.g., S3 bucket).

Best Practices:

✔ Grant **least privilege access**.
✔ Enable **MFA** for users.
✔ Monitor with **AWS CloudTrail**.
✔ Enforce **strong password policies**.
✔ **Use policy conditions for security.**

Pricing:

IAM is **free**; charges apply only for AWS services used by IAM users.

AWS Directory Service

AWS Directory Service (AWS Managed Microsoft AD) enables **Microsoft Active Directory (AD) integration** with AWS services, supporting **authentication, schema extensions, and AD-dependent applications** like SharePoint and SQL Server.

Key Features:

✔ **Trust relationships** – Extend on-premises AD authentication to AWS.
✔ **Patching without downtime** – Ensures high availability.
✔ **Supports Windows & Linux** domain-joining for EC2 instances.
✔ **Single Sign-On (SSO)** – Integrate AWS Managed AD with on-premises AD.

Limitations:

❌ No **MFA**, **trust relationships**, **LDAPS communication**, or **PowerShell AD cmdlets**.

Additional Components:

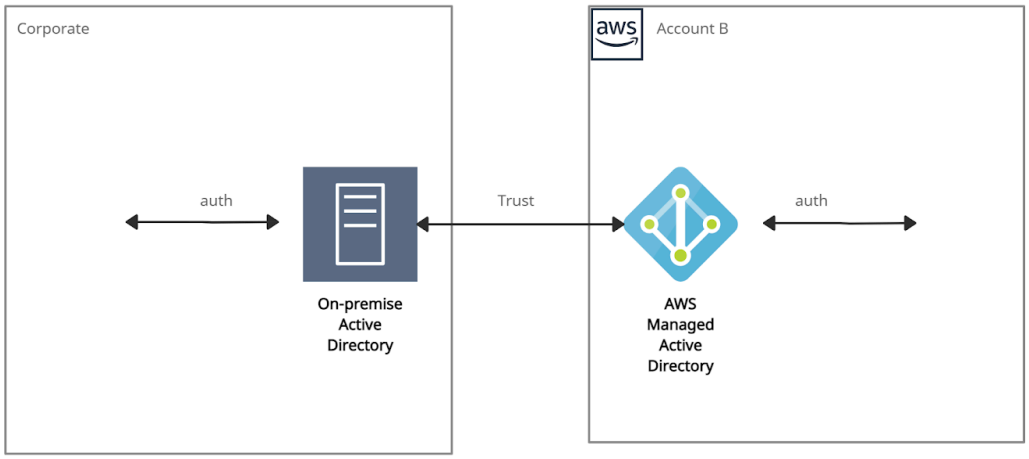
✔ **Amazon Cognito** – Provides **user authentication** via Cognito User Pools, supports **SAML-based federation** for external identities.
✔ **AD Connector** – Acts as a **gateway** redirecting directory requests to **on-premises AD**. Requires **VPN or Direct Connect**. Supports **MFA via RADIUS**.

Use Cases:

✔ Sign in to AWS Cloud services with **AD credentials**.
✔ Provide **directory services** to AD-aware workloads.
✔ Enable **SSO** for Office 365 and cloud applications.
✔ Extend **on-premises AD to AWS** via **AD trusts**.

Pricing:

✔ Varies by **region**.
✔ **Hourly charges** for shared directories.
✔ **Data transfer charges** for cross-region directory sharing.



AWS Managed AD

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AWS Secrets Manager

AWS Secrets Manager securely stores, rotates, and retrieves sensitive credentials like database passwords, API keys, and OAuth tokens, replacing hardcoded secrets with API calls. It ensures encryption in transit and integrates with AWS KMS for encryption at rest.

Key Features:

✔ Automated secret rotation for AWS databases (RDS, Aurora, Redshift, DocumentDB).
✔ Custom secret rotation via AWS Lambda for non-AWS services.
✔ Secure access control using IAM and resource-based policies.
✔ Monitoring & auditing with AWS CloudTrail and CloudWatch.

Access Methods:

✔ AWS Console, CLI, SDKs, PowerShell, HTTPS API.

Use Cases:

✔ Store encrypted secrets in SecretString/SecretBinary.
✔ Cache secrets using an open-source client for efficient access.
✔ Monitor changes with AWS Config.

Pricing:

✔ Pay per stored secret and API calls.
✔ Additional charges for AWS KMS encryption keys.

AWS Security Hub

AWS Security Hub provides a **centralized view of security alerts and compliance status** across AWS accounts and services, helping organizations adhere to **security best practices**.

Key Features:

✔ **Aggregates security alerts** from AWS services like:

- Amazon GuardDuty
- Amazon Inspector
- Amazon Macie
- AWS IAM Access Analyzer
- AWS Firewall Manager

✔ **Integrates with AWS Partner security solutions**.

✔ **Automated compliance checks** against:

- **PCI DSS** (Payment Card Industry Data Security Standard)
- **CIS AWS Foundations Benchmark** (43 best practices, e.g., IAM password policies).

✔ **Prioritizes findings** and suggests **remediation steps**.

Enabling Security Hub:

✔ **AWS Management Console**
✔ **AWS CLI**
✔ **Infrastructure-as-Code tools (Terraform, etc.)**
✔ **Multi-region setup required** for full coverage.

Benefits:

- It collects data using a standard findings format and reduces the need for time-consuming data conversion efforts.
- Integrated dashboards are provided to show the current security and compliance status.

Price details:

- Charges applied for usage of other services that Security Hub interacts with, such as AWS Config items, but not for AWS Config rules that are enabled by Security Hub security standards.
- Using the Master account's Security Hub, the monthly cost includes the costs associated with all of the member accounts.
- Using a Member account's Security Hub, the monthly cost is only for the member account.
- Charges are applied only for the current Region, not for all Regions in which Security Hub is enabled.

AWS Key Management Service

AWS KMS is a **secure service** for creating and managing encryption keys, integrated with AWS services like Amazon S3 and EBS for **data encryption at rest**.

Key Concepts:

✔ **Regional Keys** – Keys cannot be shared across regions.
✔ **Customer Master Keys (CMKs)** – Stores key metadata and is used for encryption.
✔ **Types of CMKs:**

- **Symmetric CMKs** – Single 256-bit key for encryption/decryption.
- **Asymmetric CMKs** – RSA/ECC key pairs for encryption/decryption or signing/verification.

CMK Management:

✔ **Customer-Managed CMKs** – Fully controlled by users, visible in AWS KMS console.
✔ **AWS-Managed CMKs** – Created and managed by AWS, used by AWS services.

Envelope Encryption:

✔ Encrypts plaintext with a **data key**, then encrypts the data key with a **master key**.
✔ Benefits:

- Protects data keys.
- Supports multiple master keys.
- Enhances security with multiple algorithms.

Features:

✔ **Automatic key rotation** (yearly) without re-encryption.
✔ **AWS CloudTrail logging** for auditing.
✔ **Auto-scaling** to support encryption growth.
✔ **High availability** with multiple encrypted key copies.

Pricing:

✔ **Free Tier** – 20,000 requests/month.
✔ **Customer-Managed CMKs** – $1/month per key.
✔ **AWS-Managed CMKs** – Free but limited to AWS service use.

AWS Certificate Manager (ACM)

AWS ACM provides, manages, renews, and deploys **SSL/TLS X.509 certificates** for secure web communications. Users can issue ACM certificates or import third-party certificates.

SSL Server Certificates:

✔ **X.509 certificates** authenticate HTTPS transactions.
✔ Issued by a **Certificate Authority (CA)** and include server name, validity period, and public key.

Types of SSL Certificates:

✔ **EV SSL** – Highest security, most expensive.
✔ **OV SSL** – Validates business credibility.
✔ **DV SSL** – Basic encryption.
✔ **Wildcard SSL** – Secures base domain + subdomains.
✔ **Multi-Domain SSL (MDC)** – Secures multiple domains/subdomains.
✔ **UCC** – Secures multiple domain names in one certificate.

Deployment Options:

✔ **AWS Certificate Manager (ACM)** – Used for public certificates, deploys via **API Gateway, ELB, CloudFront**.
✔ **ACM Private CA** – Creates internal **PKI** to issue private certificates for internal authentication.

ACM-Integrated Services:

✔ **Elastic Load Balancing, CloudFront, API Gateway, Elastic Beanstalk, AWS Nitro Enclaves, CloudFormation**.

Benefits:

✔ **Automated creation & renewal** of SSL/TLS certificates.
✔ Simplifies **certificate issuance** and management.
✔ Ensures **data-in-transit security** and site authentication.

Pricing:

✔ **Public ACM certificates** – Free when used with ACM-integrated services.
✔ **ACM Private CA** – Monthly charges for private CA operation and issued certificates.

AWS STS

AWS STS stands for "AWS Security Token Service." It is a web service provided by Amazon Web Services (AWS) that enables you to request temporary, limited-privilege credentials for accessing AWS resources. STS is a crucial component of AWS identity and access management (IAM) services and is designed to enhance the security of your AWS environment.

Features	Key Points
Cross-Account Access	Allows one AWS account to securely access resources in another account using temporary credentials.
Fine-Grained Permissions	Enables precise control over what actions and resources can be accessed during temporary sessions.
Temporary Session Tokens	Issues short-lived credentials (access key, secret key, session token) that are valid for a specified duration, reducing long-term credential exposure.
Multi-Factor Authentication	Can be combined with MFA to add an extra layer of security when requesting temporary credentials.
CLI & SDK Integration	Built-in support in the AWS CLI and SDKs allows programmatic requests and use of temporary credentials.
Identity Federation	Integrates with external identity providers (e.g., Active Directory, SAML-based providers) to grant temporary AWS access.
AssumeRole	Lets an IAM user or AWS service temporarily assume a different role with distinct permissions, providing flexible and secure access management.

AWS WAF

AWS WAF is a web application firewall that helps protect web applications from common web exploits and attacks.

It acts as a protective shield for your web applications, helping you safeguard them from threats like SQL injection, cross-site scripting (XSS), and other malicious activities.

Features:

- **Web Traffic Filtering:** AWS WAF allows you to filter and inspect web traffic coming to your applications. You can set up rules to allow, block, or monitor traffic based on various criteria, such as IP addresses, HTTP headers, request methods, and query strings.
- **Protection Against Common Attacks:** It protects a wide range of common web attacks, including SQL injection, XSS, and cross-site request forgery (CSRF).
- **Custom Rules:** You can create custom rules to address specific security requirements and business logic.
- **AWS WAF Managed Rules for AWS Organizations:** This feature allows you to centrally manage and deploy WAF rules across multiple AWS accounts within an AWS Organization.

Pricing:

- **Pricing Factors for AWS WAF:**
    - Number of web access control lists (web ACLs) you create.
    - Number of rules within each web ACL.
    - Volume of incoming web requests.
- **No Upfront Commitments:**
    - There are no prior commitments or contracts required for AWS WAF.
- **Separate Charges:**
    - AWS WAF costs are independent and do not include charges for services like Amazon CloudFront, AWS Cognito, Application Load Balancer (ALB), Amazon API Gateway, or AWS AppSync.

Management & Governance

AWS CloudFormation

AWS CloudFormation automates resource provisioning and management using **templates** to create, update, and delete stacks as a **single unit**. It integrates with **IAM for security** and **CloudTrail for API event tracking**.

Key Concepts:

✔ **Templates** – JSON/YAML files for defining AWS resources.
✔ **Stack** – A collection of resources managed together.
✔ **Change Sets** – Preview changes before applying them.
✔ **Stack Updates** – Update only modified resources.
✔ **StackSets** – Manage stacks across multiple accounts/regions.
✔ **Nested Stacks** – Reuse common components within stacks.
✔ **CloudFormation Registry** – Supports third-party resource provisioning.

Pricing:

✔ **Free for AWS resources**; charges apply for the services used.
✔ Supports *AWS::*, Alexa::*, and Custom:: namespaces**; others incur costs.
✔ **Free tier:** 1000 handler operations/month.
✔ **Paid operations:** $0.0009 per handler operation.

Example: EC2 Instance Template:

```
EC2Instance:
  Type: AWS::EC2::Instance
  Properties:
    ImageId: 1234xyz
    KeyName: aws-keypair
    InstanceType: t2.micro
    SecurityGroups:
      - !Ref EC2SecurityGroup
    BlockDeviceMappings:
      - DeviceName: /dev/sda1
        Ebs:
          VolumeSize: 50
```

AWS CloudTrail

AWS CloudTrail enables operational and risk auditing by tracking account activity across AWS services. It records actions as events from users, roles, and AWS services via the Console, CLI, SDKs, and APIs.

Integrations:

✔ Amazon S3 – Stores and retrieves log files.
✔ Amazon SNS & SQS – Notifies on log file delivery.
✔ Amazon CloudWatch & IAM – For monitoring and security.
✔ CloudTrail Insights – Detects unusual API activity.
✔ Log Retention – Past 90 days of events can be viewed/downloaded.

Event Types:

✔ Management Events (e.g., CreateSubnet, CreateDefaultVpc)
✔ Data Events (e.g., GetObject, DeleteObject, PutObject)
✔ Insights Events (e.g., deleteBucket, AuthorizeSecurityGroupIngress)

CloudTrail vs. CloudWatch:

✔ CloudTrail – Logs all AWS actions for auditing.
✔ CloudWatch – Monitors AWS services for performance & health.

Pricing

✔ First copy of management events per region is free.
✔ Additional copies: $2.00 per 100,000 events.
✔ Data events: $0.10 per 100,000 events.
✔ Insights events: $0.35 per 100,000 analyzed events.

Amazon CloudWatch

Amazon CloudWatch monitors and manages AWS applications and infrastructure by collecting logs, metrics, and events. It supports **EC2, RDS, DynamoDB, and custom log files**.

Access Methods:

✔ **CloudWatch Console**

✔ **AWS CLI, API, SDKs**

Integrations:

✔ **Amazon SNS** – Sends notifications

✔ **EC2 Auto Scaling** – Adjusts resources

✔ **AWS CloudTrail & IAM** – Security & auditing

Key Features:

✔ **Custom Dashboards** – Visualize metrics

✔ **Alarms** – Trigger actions on threshold breaches

✔ **Cross-Account Visibility** – Unified monitoring across AWS accounts

✔ **Container Insights** – Monitors ECS, EKS, Kubernetes

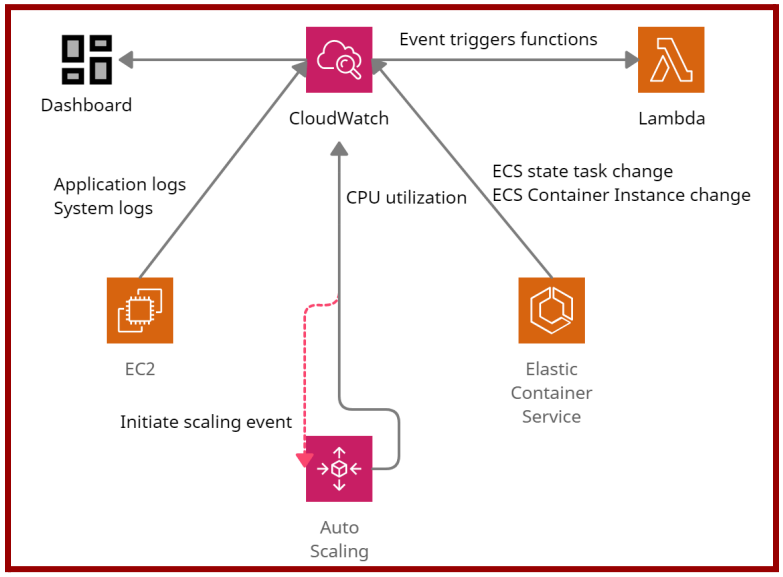
✔ **Lambda Insights** – Tracks CPU, memory, disk, and network usage

CloudWatch Agent:

✔ Collects **system-level metrics** from EC2/on-prem servers.

✔ Supports **StatsD (Linux/Windows)** and **collectd (Linux)** for custom metrics.

✔ Default namespace: **CWAgent** (configurable).



Amazon CloudWatch in action

AWS Config

AWS Config **monitors, evaluates, and records** AWS resource configurations, tracking changes over time.

Key Features

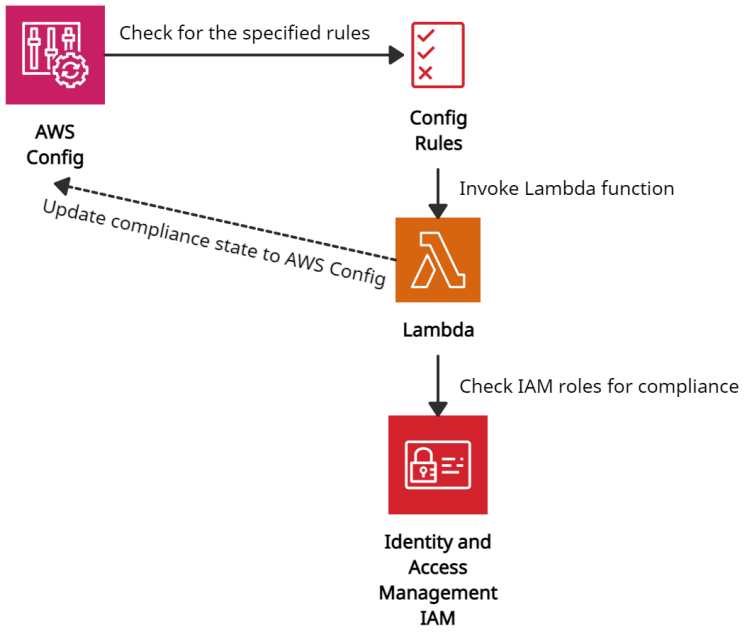
✔ **Configuration Snapshots** – Provides a complete resource inventory.
✔ **Change Tracking** – Records modifications and sends notifications.
✔ **Compliance Checks** – Uses **Managed** & **Custom Config Rules** (150 per region).
✔ **Integration** – Works with **IAM, S3, SNS, and CloudTrail** for auditing and alerts.
✔ **Aggregators** – Collects compliance data across multiple **accounts, regions, or AWS Organizations**.

Use Cases

✔ **Automates compliance checks** using Lambda-based custom rules.
✔ **Identifies security risks** and tracks historical configurations for analysis.

Pricing

✔ **$0.003 per configuration item recorded per region**.
✔ **Charges for Config rule evaluations** and **integrations with AWS services**.



AWS Config in action

AWS License Manager

AWS License Manager **manages software licenses** for AWS and on-premises environments, supporting **Bring-Your-Own-License (BYOL)** for vendors like Microsoft, SAP, Oracle, and IBM.

Key Features

✔ **Custom Licensing Rules** – Prevents violations with **hard (blocks) & soft (alerts) limits**.
✔ **Dashboard Control** – Provides visibility and enforcement of license usage.
✔ **Dedicated Host Management** – Optimizes allocation & capacity utilization.
✔ **Managed Entitlements** – Controls license assignments for users/workloads.
✔ **Cross-Account Management** – Uses **AWS Organizations** for license sharing.
✔ **Integration** – Works with **EC2, RDS, Systems Manager, IAM, Marketplace, CloudFormation, X-Ray**.

Pricing

✔ No additional charges; **AWS resources follow standard pricing**.

AWS Organizations

AWS Organizations **manages multiple AWS accounts**, enforcing security, governance, and cost tracking.

Access Methods

✔ **Console, CLI, SDKs, API, PowerShell**

Key Features

✔ **Security Boundaries** – Uses multiple member accounts.
✔ **Organizational Units (OUs)** – Groups accounts for better management.
✔ **Service Control Policies (SCPs)** – Enforces security & governance.
✔ **Cost Allocation Tags** – Tracks AWS costs per account.

Integration with AWS Services

✔ **CloudTrail** – Auditing & logging
✔ **Backup** – Backup monitoring
✔ **Control Tower** – Cross-account security & policy view
✔ **GuardDuty** – Threat detection
✔ **Resource Access Manager (RAM)** – Resource sharing

Member Account Migration

1️⃣ Remove from old Organization
2️⃣ Send invitation from new Organization
3️⃣ Accept invitation from member account

Pricing

✔ **Free service**; standard charges apply for AWS resources.
✔ **Consolidated billing** ensures volume discounts across accounts.

AWS Systems Manager

AWS Systems Manager **manages EC2 and on-premises systems at scale**, detects infrastructure issues, and automates patching for compliance. Works with **Windows & Linux**.

Key Features

✔ **Integration** – Works with CloudWatch & AWS Config
✔ **Software Discovery** – Audits installed software
✔ **Compliance Management** – Monitors patch levels & configurations
✔ **Resource Grouping** – Over 100 resource types into applications & units
✔ **Automated Workflows** – Reduces errors with centralized parameters
✔ **Security & Patching** – Runs commands & scheduled patching
✔ **Software Distribution** – Manages multiple versions safely

How it Works

- **SSM Agent** must be installed on controlled systems.
- **IAM Role** required for EC2 instances to allow SSM actions.

Pricing

✔ **App Config** – $0.2 per 1M API calls, $0.0008 per config received
✔ **Parameter Store** – Standard (Free), Advanced ($0.05/param/month)
✔ **Change Manager** – $0.296 per change request, $0.039 per 1K API calls

Networking & Content Delivery

Amazon API Gateway

Category	Description
Overview	Amazon API Gateway creates, publishes, monitors, and secures APIs at any scale, powering both serverless and microservices architectures.
API Types	**REST APIs:** HTTP-based, stateless communication with standard methods (GET, POST, PUT, PATCH, DELETE). **WebSocket APIs:** Stateful, full-duplex communication.
Endpoint Types	**Edge-Optimized:** Global low latency with CloudFront. **Regional:** Optimized for same-region requests with CDN/WAF. **Private:** Restricted to VPC access.
Security	Secured using resource policies, IAM, Lambda authorizers, and Cognito user pools.
Integrations	Works with EC2, Lambda, CloudTrail, CloudWatch, AWS WAF, and X-Ray.
Pricing	Charges apply for API caching; auth failures, missing API keys, and throttled requests are free.

Amazon CloudFront

Category	Description
Overview	Amazon CloudFront is a CDN that securely delivers content worldwide with low latency and high transfer speeds by caching data at edge locations.
Integrations	Works with AWS services such as S3, EC2, ELB, Route 53, and Elemental Media Services.
Origins	Retrieves content from Amazon S3, EC2, ELB, or custom HTTP origins.
Edge Computing	Supports Lambda@Edge for custom code execution, dynamic load-balancing, and enhanced security at the edge.
Security	Provides HTTPS encryption (including field-level), AWS Shield Standard for DDoS protection, AWS WAF, and Origin Access Identity (OAI) to secure S3 content.
Access Controls	Uses signed URLs, signed cookies, and geo-restrictions to control access to content.
Pricing	Charged for data transfer out, HTTP/HTTPS requests, custom SSL certificates, field-level encryption, and Lambda@Edge execution. Free for inter-region transfers, ACM, and shared certificates.

AWS Elastic Load Balancer

Distributes incoming traffic across multiple targets (EC2, containers, Lambda, IPs) across one or more Availability Zones for high availability, scalability, and security.

Types:

- **Application Load Balancer:** Ideal for web apps; routes traffic based on request content.
- **Network Load Balancer:** Suited for high-performance apps; supports TCP, UDP, and TLS protocols.
- **Gateway Load Balancer:** Designed for third-party appliances (e.g., security, analytics).
- **Classic Load Balancer:** Legacy option for EC2; AWS recommends using ALB or NLB.

Key Components:

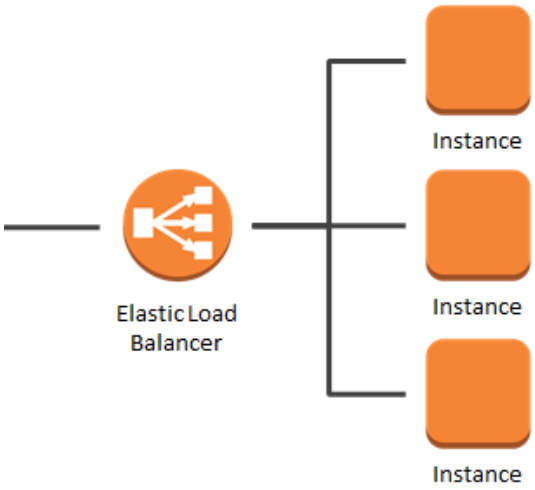
- **Listeners:** Monitor incoming requests on specified protocols/ports (HTTP, HTTPS).
- **Target Groups:** Define the destination for traffic (instances, IPs, Lambda functions).
- **Health Checks:** Regularly monitor target health and remove unhealthy targets.

Use Cases:

- Balancing traffic across multiple servers for web applications.
- Building hybrid cloud solutions by load balancing across AWS and on-premises resources.
- Supporting AWS migrations with auto-scaling and dynamic capacity management.

Pricing:

Billed hourly (or partial hour) plus based on Load Balancer Units (LCUs).



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Amazon Route 53

- Managed DNS service that routes users to servers via domain names.
- Acts as a domain name registrar and DNS server.

Hosted Zones:

- **Public Hosted Zone:** Routes traffic on the Internet.
- **Private Hosted Zone:** Routes traffic within a VPC.

Record Types:

- Common: A (IPv4), AAAA (IPv6), CNAME, Alias.
- Others: CAA, MX, NAPTR, NS, PTR, SOA, SPF, SRV, TXT.

Routing Policies:

- **Simple:** Single resource routing (no health checks).
- **Weighted:** Routes based on assigned weights; supports health checks.
- **Failover:** Routes to secondary resource if primary fails.
- **Geo-location/Geo-proximity:** Routes based on geographic location.
- **Latency-based:** Routes to lowest-latency destination.
- **Multi-value Answer:** Distributes responses across multiple IPs.

Use Cases:

- Domain registration and DNS hosting.
- Managing public and private DNS zones.
- Routing based on performance, location, and health.

Pricing:

- No long-term contracts; annual fees for registered domains.
- Charges vary for different query types (standard, latency, geo, etc.).

Route53 CNAME vs. Alias

CNAME	Alias
• It points a hostname to any other hostname. • (app.mything.com -> abc.anything.com) • It works only for the non-root domains. • (abcxyz.maindomain.com) • Route 53 charges for CNAME queries. • It points to any DNS record that is hosted anywhere.	• It points a hostname to an AWS Resource. • (app.mything.com ->abc.amazonaws.com) • It works for the root domain and non-root domain. (maindomain.com) • Route 53 doesn't charge for Alias queries. • It points to an ELB, CloudFront distribution, Elastic Beanstalk environment, S3 bucket as a static website, or another record in the same hosted zone.

AWS VPC

A dedicated virtual network in AWS where you can launch and manage resources in an isolated environment.

Security:

- **Security Groups:**
  - *Default:* Allow all inbound/outbound traffic.
  - *Custom:* Block inbound by default, allow outbound.
- **Network ACLs:**
  - *Default:* Allow all traffic.
  - *Custom:* Deny all traffic by default.

Core Components:

- **Subnets:**
  - Logical IP address divisions.
  - *Public Subnet:* Has internet access via an Internet Gateway.
  - *Private Subnet:* No direct internet access; requires NAT for outbound connectivity.
- **Route Tables:**
  - Direct network traffic.
  - Public subnets use routes to an Internet Gateway; private subnets use NAT.
- **NAT Devices:**
  - **NAT Instance:** EC2 instance deployed in a public subnet for outbound IPv4 traffic.
  - **NAT Gateway:** Managed by AWS for scalable outbound connectivity.
- **DHCP Options Set:**
  - Automatically configures network parameters like domain name and DNS servers.
- **PrivateLink & Endpoints:**
  - Provide secure, private connectivity to AWS services without using the public internet.
- **Egress-Only Internet Gateway:**
  - Enables outbound-only IPv6 traffic.
- **VPC Peering:**
  - Connects two VPCs (within or across regions) for seamless resource communication.
- **VPN Connections:**
  - **AWS Site-to-Site VPN:** Securely connects on-premises networks to your VPC.
  - **AWS Client VPN:** Provides remote user connectivity to AWS resources.

Use Cases:

- Hosting public websites and multi-tier applications.
- Disaster recovery.
- Hybrid cloud setups and secure communication between different networks.

Pricing:

- VPC creation is free.
- Charges apply for NAT Gateway usage, data processing, and traffic mirroring.

Application Integration

Amazon EventBridge

Amazon EventBridge is a serverless event bus service that connects applications with data from multiple sources.

Functions of Amazon EventBridge:

Loosely Coupled, Event-Driven Architecture

- Facilitates the creation of distributed systems where components interact via events without being tightly integrated.

Seamless Event Delivery

- Connects applications and transmits events without requiring custom code, streamlining integration between services.

Real-Time Data Streaming

- Delivers live data streams from SaaS applications or AWS services to various targets such as EC2 instances, ECS tasks, or CodeBuild projects.

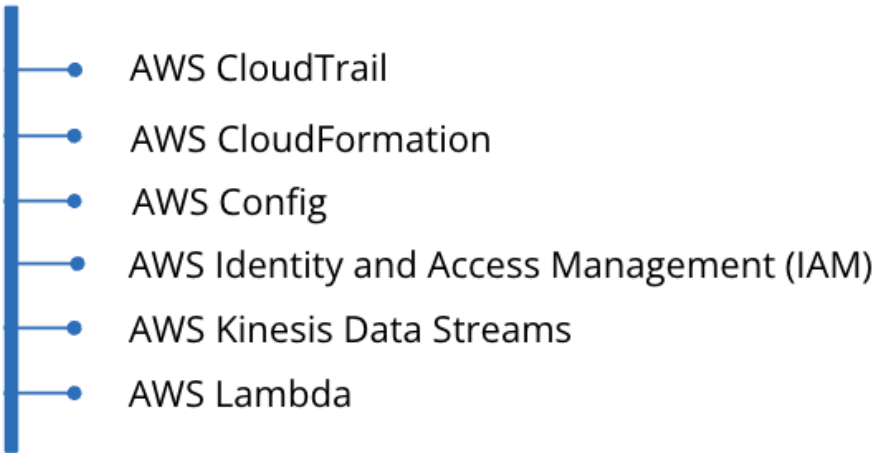
Routing Rules Configuration

- Allows you to define rules that determine how events are routed to appropriate targets, enabling reactive application architectures.

EventBridge Schema Registry

- Stores a collection of event schemas.
- Provides the ability to download code for these schemas, allowing developers to represent events as objects within their IDE for easier integration and use.

Amazon EventBridge integrates with the following services:

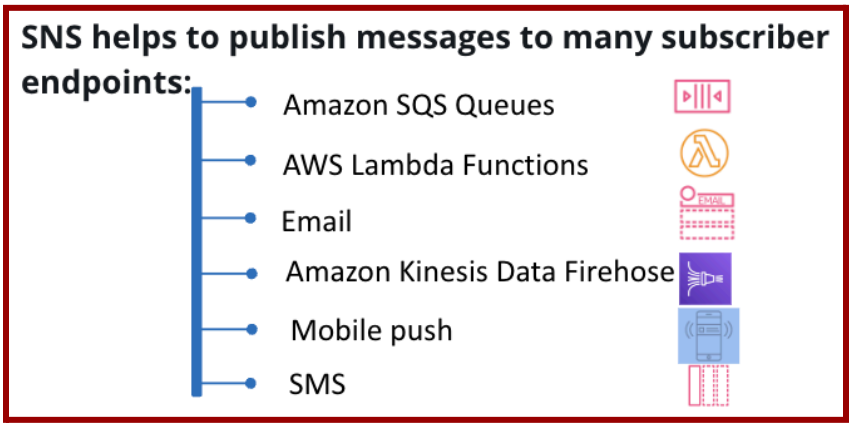


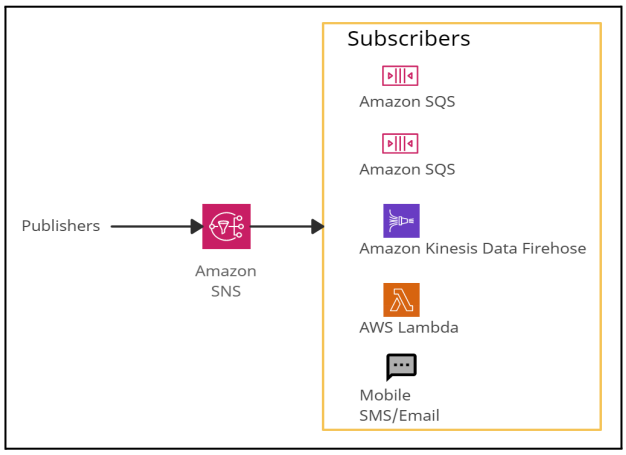
Amazon SNS

- Amazon Simple Notification Service (Amazon SNS) is a serverless notificationservice that offers message delivery from publishers to subscribers.

Features

- **Asynchronous Communication:** Enables asynchronous messaging between publishers and subscribers via topics.
- **Application-to-Application Integration:** Supports application-to-application subscriptions using services like Amazon SQS and other AWS offerings.
- **Application-to-Person Notifications:** Facilitates application-to-person notifications through subscriptions such as Mobile SMS and Email.
- **One-to-Many Communication:** The producer sends one message to one SNS topic.
- **Fan-out Delivery:** Multiple receivers (subscribers) listen for notifications on that SNS topic.
- **Guaranteed Delivery:** All subscribers will receive all messages published to the topic.
- **Scalability:** A single message can be efficiently delivered to a large number of subscribers (e.g., 1 message, 1 topic, 10 subscribers results in the message being delivered to all 10 subscribers).





Source: AWS Documentation

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Amazon Simple Queue Service (SQS)

Amazon Simple Queue Service (SQS) is a serverless service used to decouple (loose couple) serverless applications and components.

SQS Queue Types:

Queue Type	Key Features
Standard Queue	- Supports unlimited transactions per second. - Delivers messages in a non-deterministic order. - May deliver messages more than once (at-least-once delivery).
FIFO Queue	- Handles up to 300 messages per second (or 3000 messages per second with batching). - Supports batches of 10 messages per operation. - Guarantees exactly-once message consumption in order.
Delay Queue	- Allows postponement of message delivery by a specified duration. - Messages can be delayed from 0 seconds (default) up to a maximum of 15 minutes.
Dead-Letter Queue	- Captures messages that fail to be consumed successfully. - Helps manage and troubleshoot message processing failures.
Visibility Timeout	- Determines the time period during which a message is hidden from other consumers once retrieved. - Default: 30 seconds; Minimum: 0 seconds; Maximum: 12 hours.

General SQS Characteristics:

- Serves as a temporary repository between producers and consumers.
- Scales to manage between 1 to 10,000 messages per second.
- Default message retention is 4 days, extendable up to 14 days.
- Automatically deletes messages once consumed.
- Each message can be up to 256KB in size.

Service	Description	Key Features / Use Cases
AWS AppSync	Simplifies app development by creating secure, real-time GraphQL APIs connecting clients to backend data.	GraphQL schema, resolvers, real-time subscriptions, offline access, caching, conflict resolution.
AWS Step Functions	Orchestrates serverless workflows by coordinating AWS services into state machines.	Standard and Express workflows, built-in retries, error handling, GUI monitoring, integration with Lambda, ECS, SQS, and more.

Developer Tools

AWS CodeBuild

Feature	Details
Description	Fully managed CI service for efficient builds & tests.
Benefits	No build queue waiting, auto-scaling, pay-as-you-go pricing.
Features	Easy setup, integrates with Jenkins/Git, automated builds.
Pricing	First 100 minutes free, charges based on usage.

AWS CodeDeploy

Feature	Details
Description	Automates deployments to EC2, Lambda, on-premises, ECS.
Deployment	Code, Lambda, web files, executables, scripts.
How It Works	Define revision → Configure YAML → Deploy.
Features	Rapid releases, zero-downtime deployment, status tracking.
Pricing	Free for EC2/Lambda, $0.02 per on-prem deployment.

AWS CodePipeline

Feature	Details
Pipeline Structure	Defines stages (source, build, test, deploy) that automate the CI/CD process from code commit to production.
Source Stage	Connects to code repositories (e.g., CodeCommit, GitHub, S3) to trigger the pipeline on code changes.
Build Stage	Uses tools like CodeBuild to compile code, run tests, and generate deployable artifacts.
Test & Deployment	Integrates testing tools and deploys applications to various environments (e.g., Elastic Beanstalk, Lambda, ECS).
Approval & Notifications	Supports manual approvals and sends notifications (via SNS) for pipeline events.
Service Integrations	Seamlessly works with AWS CodeBuild, CodeDeploy, CodeCommit, Elastic Beanstalk, and Lambda.

AWS CloudShell

Feature	Details
Pre-configured Environment	Comes with a built-in set of common tools and utilities, eliminating local setup.
AWS CLI Integration	Includes the AWS CLI for direct interaction with AWS services from a browser-based shell.
Persistent Storage	Provides a home directory with persistent storage to retain files and scripts across sessions.
Secure & Browser-Based	Hosted within AWS, integrated with IAM for security, and accessible via the AWS Management Console or mobile apps.

AWS Cloud9

Feature	Details
Cloud-Based IDE	Fully hosted IDE accessible from any device with an internet connection—no local installation required.
Real-Time Collaboration	Enables multiple developers to work concurrently on the same codebase.
Integrated Editor & Terminal	Features a built-in code editor (with syntax highlighting, autocompletion) and terminal access for command-line operations.
Version Control & Debugging	Integrates with Git and provides debugging tools to streamline development workflows.
Customizable & Serverless	Supports plugins for customization and is optimized for developing serverless applications (e.g., AWS Lambda).

AWS CodeArtifact

Feature	Details
Centralized Repository	Provides a central location for storing and managing software artifacts (libraries, packages, dependencies).
Multi-Package Support	Supports various package formats like npm, Maven, and PyPI.
Security & Access Control	Integrates with IAM for fine-grained control over who can access and publish artifacts.
Dependency Management	Facilitates consistent dependency resolution across projects and teams.
CI/CD Integration	Seamlessly integrates with AWS CodePipeline, CodeBuild, and CodeDeploy.

AWS CodeStar

Feature	Details
Project Templates	Offers pre-configured templates for various languages and application types to jumpstart development projects.
Integrated Development Tools	Integrates with AWS Cloud9, Visual Studio Code, and others, providing a unified development environment.
CI/CD Automation	Automates build, test, and deployment processes via integration with CodePipeline, CodeBuild, and CodeDeploy.
Centralized Management	Provides a dashboard to manage projects, monitor progress, and facilitate team collaboration.
Limitations	Customization may be limited compared to more flexible, self-managed setups, and it relies heavily on other AWS services like CodeCommit, CodeBuild, and CodeDeploy.

Amazon CodeWhisperer

Feature	Details
Real-Time Code Generation	Uses machine learning to provide code recommendations, completions, and refactoring suggestions as you type.
Security Scanning	Scans code for vulnerabilities in languages such as Java, JavaScript, and Python.
IDE Integration	Supports integration with popular IDEs like AWS Cloud9, SageMaker Studio, PyCharm, Visual Studio, and JupyterLab.
Limitations	Code quality and security may vary; supports only a limited set of languages and IDEs.

AWS X-Ray

Feature	Details
Description	Debugs & analyzes distributed applications.
Components	Daemon, Segments, Traces, Sampling, Service Graph.
Features	Supports multiple languages, AWS integrations, performance insights.
Pricing	$0.50 per 1M requests (beyond free tier).

Containers

AWS Fargate

What is AWS Fargate?

AWS Fargate is a serverless compute service for containers used with Amazon ECS and EKS. It simplifies running containers by eliminating the need to manage virtual machines like EC2.

Key Features	Description
Serverless Containers	Runs containers by specifying CPU, memory, and IAM policies.
Isolation	Fargate tasks have dedicated kernels, memory, CPU, and ENI, ensuring task isolation.
Task Limitations	Supports only specific ECS task definition parameters with some restrictions.
Kubernetes Integration	Schedules Kubernetes pods on Fargate using controllers. Security groups for EKS pods are unsupported.
Storage Support	- Amazon EFS for persistent storage. - Ephemeral storage for nonpersistent needs.

Benefits of AWS Fargate:

- **Focus on Application Development**: Fargate enables users to focus on building and operating applications rather than managing servers, security, scaling, and patching.
- **Automatic Scaling**: It automatically adjusts the compute environment to meet the container's resource requirements.
- **Built-in Integrations**: Fargate integrates seamlessly with other AWS services, including Amazon CloudWatch Container Insights for monitoring.

Pricing Details:

- **Cost Based on vCPU and Memory Usage**: Charges are incurred based on the amount of vCPU and memory consumed by the containerized applications.
- **Savings Plans**: Fargate's Savings Plans offer up to 50% savings in exchange for a one- or three-year long-term commitment.
- **Additional Charges**: Extra charges may apply if containers are used in conjunction with other AWS services.

Amazon Elastic Kubernetes Service(EKS)

What is Amazon Elastic Kubernetes Service (EKS)?

Amazon EKS is a fully managed service that allows users to deploy, manage, and scale Kubernetes applications on AWS or on-premises. It supports standard Kubernetes applications without the need for code modification.

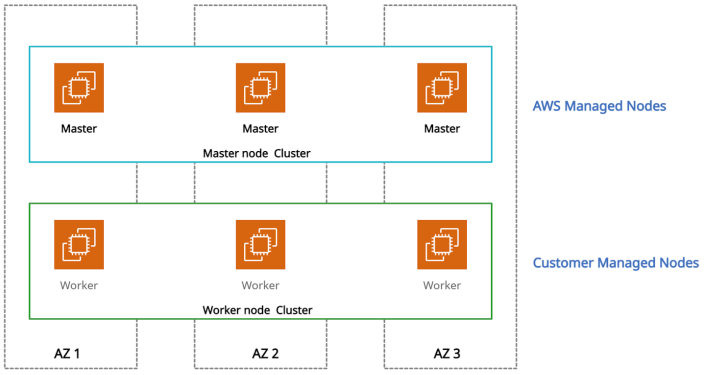
Key Components	
Amazon EKS Control Plane	Runs Kubernetes software (API server, etcd) with high availability across multiple AZs.
Amazon EKS Nodes	Worker nodes where Kubernetes pods run.
Cluster Creation Methods	
eksctl	Command-line tool for creating and managing clusters.
AWS Management Console & AWS CLI	Alternative methods for cluster creation.
Node Scheduling Methods	
Self-managed nodes	EC2 instances in Auto Scaling groups.
Amazon EKS Managed Node Groups	Automates node provisioning and lifecycle management.
AWS Fargate	Runs Kubernetes pods on Fargate without managing servers.
AWS Service Integrations	
Images	Amazon ECR for container images.
Load Balancing	AWS ELB for load balancing.
Authentication	AWS IAM for authentication.
Networking	Amazon VPC for networking and isolation.

Use Cases:

- **Hybrid Environments**: Manage Kubernetes clusters across on-premises and AWS.
- **Machine Learning**: Use Kubeflow with EC2 GPU instances for ML workflows.
- **Batch Workloads**: Execute Kubernetes jobs across EC2, Fargate, and Spot Instances.

Pricing:

- **EKS Cluster**: $0.10 per hour per cluster.
- **With EC2**: Charges for EC2 resources (e.g., instances, EBS volumes).
- **With Fargate**: Charges for CPU and memory from image download to pod termination.



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Amazon Elastic Container Service

What is Amazon Elastic Container Service (Amazon ECS)?

- A regional container orchestration service to execute, stop, and manage containers on a cluster.
- Allows containers to run smoothly across environments by combining code, dependencies, and system libraries.
- Containers are created from Docker images defined by a Dockerfile.
- Task definitions (in JSON format) specify which container images should run across clusters.

Key Concepts

- **ECS Cluster**: A combination of tasks or services running on EC2 instances or AWS Fargate.
- **Task Definition**: Defines the container images and configurations for tasks.
- **Service**: Maintains multiple tasks running simultaneously within a cluster.
- **Task**: Represents a single unit of work based on a task definition.
- **Container Agent**: Runs on ECS instances, manages tasks, and reports resource utilization.

ECS Integrations:

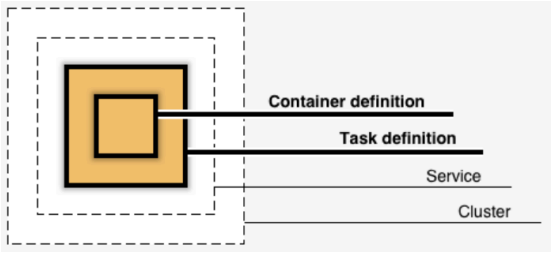
- AWS Identity and Access Management (IAM)
- Amazon EC2 Auto Scaling
- Elastic Load Balancing
- Amazon Elastic Container Registry (ECR)
- AWS CloudFormation
- AWS App Mesh (for traffic control, security, and observability)

Use Cases

- **Microservices**: Decomposes complex applications into smaller, independent services.
- **Batch Jobs**: Docker containers are ideal for processing short-lived, packaged jobs.

Pricing Details

- **Fargate Launch Type Model**: Pay for vCPU and memory resources used.
- **EC2 Launch Type Model**: Pay for AWS resources (EC2 instances, storage) to store and run applications.



ECS Cluster

Amazon Elastic Container Registry

What is Amazon Elastic Container Registry (ECR)?

- A managed service for storing, managing, sharing, and deploying container images and artifacts.
- Integrated with Amazon Elastic Container Service (ECS), Amazon Elastic Kubernetes Service (EKS), AWS Lambda, and AWS Fargate for simplified deployments.

Features

- **Container Storage**: Stores both user-created containers and container software from AWS Marketplace.
- **Integration**: Works seamlessly with ECS, EKS, Lambda, and Fargate for easy deployment.
- **IAM Integration**: AWS Identity and Access Management (IAM) allows resource-level access control for each repository.
- **Public and Private Repositories**: Supports both private (organization-specific) and public container image repositories.
- **Amazon ECR Public Gallery**: A separate portal for accessing all public repositories hosted on Amazon ECR Public.
- **Durability**: Stores images in Amazon S3, offering 99.999999999% (11 9's) data durability.
- **Cross-region and Cross-account Replication**: Supports replication for high availability applications.
- **Encryption**: Images are encrypted at rest using Amazon S3 server-side encryption or customer-managed AWS KMS keys. Data transfers are encrypted via HTTPS.
- **CI/CD Integration**: Works with continuous integration and delivery tools and third-party developer tools.
- **Lifecycle Policies**: Manages container image lifecycles efficiently.

Pricing Details

- **Free Tier**:
  - 500 MB-month of storage for private repositories for the first year.
  - 50 GB-month of storage for public repositories for the first year.
- **Public Repository Data Transfer**:
  - 500 GB per month can be transferred to the internet for free without sign-up.
  - 5 TB per month for free with AWS account sign-up or authentication to ECR.

AWS Copilot

AWS Copilot is used to simplify the process of building, deploying, and managing containerized applications on AWS infrastructure.

It is designed to streamline the development workflow for container-based applications, making it easier for developers to work with container services like AWS Fargate and Amazon Elastic Container Service (ECS).

AWS Copilot Features

Feature	Description
Application & Service Management	Manage applications and services using simple YAML configurations.
Deployment Automation	Automates container builds and deployments (ECR, ECS/Fargate, load balancers, networking).
Local Development	Provides tools to run and test containers locally.
CI/CD Integration	Seamlessly integrates with CI/CD tools like AWS CodePipeline and AWS CodeBuild for automated pipelines.

AWS Copilot CLI Commands

Command	Function
copilot init	Initialize a new Copilot application and service.
copilot env init	Create a new environment (e.g., development, staging, production).
copilot app	Display application details and deployment status.
copilot service	Manage services: create, view, and deploy them.
copilot logs	Stream logs from deployed services.

Analytics

Amazon Athena

- **What:** Serverless interactive SQL query service for analyzing data stored in S3.
- **Key Features:**
  - Runs ANSI SQL queries on various formats (CSV, JSON, ORC, Avro, Parquet).
  - Integrates with Amazon QuickSight.
- **Pricing:** Billed per data scanned; DDL commands are free; costs reduced via compression, partitioning, and columnar formats.

Amazon Kinesis Data Streams

- **What:** Real-time data streaming service to collect, process, and analyze streaming data.
- **Key Features:**
  - Scalable shards (default retention 1 day, extendable to 7 days).
  - Captures data from sources like websites, events, and social media.
  - Each shard offers 1MB/sec input and 2MB/sec output capacity.

Comparison of Amazon Data Firehose & Amazon Kinesis Data Streams

Category	Amazon Data Firehose	Amazon Kinesis Data Streams
Purpose	Ingests, transforms, and delivers data to AWS destinations.	Collects and processes streaming data for custom applications.
Management	Fully managed; auto-buffers and delivers data.	Requires manual management of shards and consumers.
Latency	Near real-time (min 60 sec or on size threshold).	Low latency; processes data immediately.
Use Cases	Simple ingestion and loading into S3, Redshift, etc.	Real-time analytics and custom stream processing.
Data Retention	Temporary buffering only.	Configurable retention (24 hours to 7 days).
Integration	Directly integrates with AWS storage/analytics services.	Integrates with custom consumers via APIs and Kinesis Client Library.
Overhead	Minimal operational overhead.	Higher operational management required.

Amazon OpenSearch Service

- **What:** Managed service to deploy, operate, and scale Elasticsearch/OpenSearch clusters.
- **Key Features:**
  - Direct access to Elasticsearch APIs.
  - Integrated with Kibana (visualization) and Logstash (log ingestion).
  - Auto-scales and auto-replaces failed nodes.
- **Pricing:** Billed per EC2 instance hour and attached storage; free data transfer within AZs.