

What is Cloud Computing?

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cloud com•put•ing

noun

the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.



On-Premise

- You own the servers
- You hire the IT people
- You pay or rent the real-estate
- You take all the risk

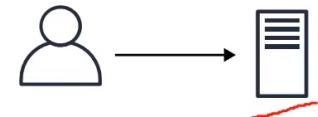
Cloud Providers

- Someone else owns the servers
- Someone else hires the IT people
- Someone else pays or rents the real-estate
- You are responsible for your configuring cloud services and code, someone else takes care of the rest.



The Evolution of Cloud Hosting

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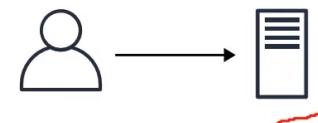


Dedicated Server

One physical machine dedicated to single a business.

Runs a single web-app/site.

Very Expensive, High Maintenance, *High Security



Virtual Private Server (VPS)

One physical machine dedicated to a single business.

The physical machine is virtualized **into sub-machines**

Runs multiple web-apps/sites

Better Utilization and Isolation of Resources

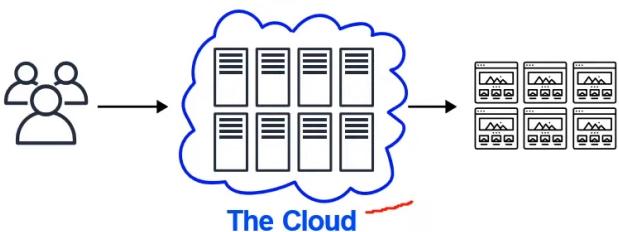


Shared Hosting

One physical machine, shared by hundred of businesses

Relies on most tenants under-utilizing their resources.

Very Cheap, Limited functionality, Poor Isolation



Cloud Hosting

Multiple physical machines that act as one system.

The system is abstracted into multiple **cloud services**

Flexible, Scalable, Secure, Cost-Effective, High Configurability



What is Amazon?

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An American multinational computer technology corporation headquartered in **Seattle, Washington**



Amazon was founded in 1994 by **Jeff Bezos** and the company started as an online store for books and expanded to other products.



@timothyberly on Unsplash



What is Amazon?

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Jeff Bezos **today**

Amazon has expanded beyond just an online e-commerce store into:

- **cloud computing** (Amazon Web Services)
- digital streaming
 - Amazon Prime Video
 - Amazon Prime Music
 - Twitch.tv
- Grocery Stores (Whole Foods Market)
- artificial intelligence
- Low orbit satellites (Kuiper Systems)
- And more!



Andy Jassy is the current CEO of Amazon. Previously the CEO of AWS.

So Jeff Bezos can focus on space travel.



()

What is Amazon Web Services (AWS)?

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Amazon calls their cloud provider service

Amazon Web Services

Commonly referred to just **AWS**



Old Logo



New Logo

AWS was launched in ***2006** is the **leading cloud service provider** in the world.

Cloud Service Providers can be initialized as **CSPs**



What is Amazon Web Services (AWS)?

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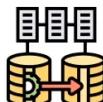
Simple Queue Service (SQS) was the first AWS service launched for public use in 2004



Simple Storage Service (S3) was launched in March of 2006



Elastic Compute Cloud (EC2) was launched in August of 2006



In November 2010, it was reported that all of Amazon.com's retail sites had migrated to AWS



To support industry-wide training and skills standardization, AWS began offering a certification program for computer engineers, on April, 2013



What is Amazon Web Services (AWS)?

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Adam Selipsky

CEO of AWS

Former CTO of Tableau, spent a decade with AWS as VP of Marketing, Sales and Support

Werner Vogels

CTO of AWS

“Everything fails, all the time.”



Jeff Barr

Chief Evangelist

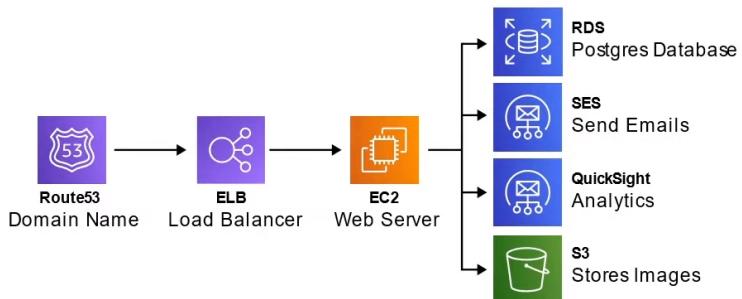


What is a Cloud Service Provider (CSP)?

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A **Cloud Service Provider (CSP)** is a company which

- provides multiple Cloud Services e.g. tens to hundreds of services
- those Cloud Services **can be chained together** to create cloud architectures
- those Cloud Services are accessible **via Single Unified API** eg. AWS API
- those Cloud Services utilized **metered billing** based on usage e.g. per second, per hour
- those Cloud Services have rich monitoring built in eg. AWS CloudTrail
- those Cloud Services have an Infrastructure as a Service (IaaS) offering
- Those Cloud Services offers **automation** via Infrastructure as Code (IaC)



If a company offers multiple cloud services under a single UI but do not meet most of or all of these requirements, it would be referred to as a Cloud Platform e.g. Twilio, HashiCorp, Databricks



Landscape of CSPs

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Tier-1 (Top Tier) – Early to market, wide offering, strong synergies between services, well recognized in the industry



Amazon Web Services (AWS)



Microsoft Azure



Google Cloud Platform (GCP)



Alibaba Cloud

Tier-2 (Mid Tier) – Backed by well-known tech companies, slow to innovate and turned to specialization.



IBM Cloud



Oracle Cloud



Rackspace (OpenStack)

Tier-3 (Light Tier) – Virtual Private Servers (VPS) turned to offer core IaaS offering. Simple, cost-effective



Vultr



Digital Ocean



Linode

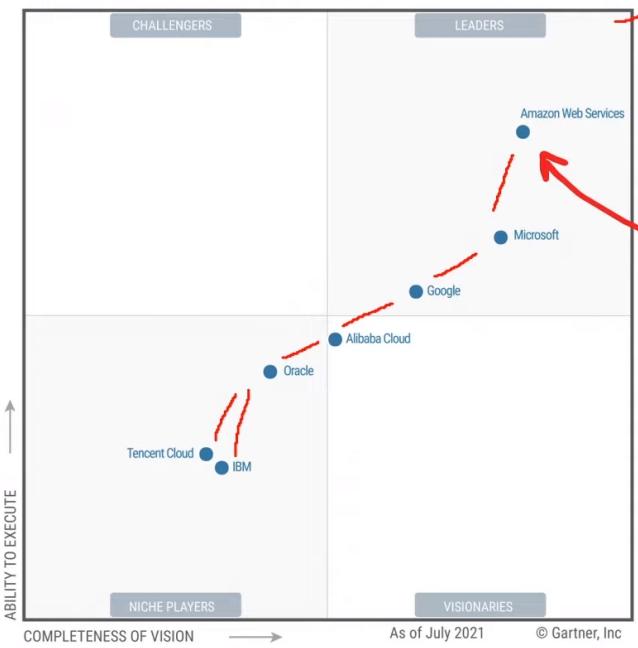


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Gartner Magic Quadrant for Cloud

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Figure 1: Magic Quadrant for Cloud Infrastructure and Platform Services



Source: Gartner (July 2021)



Common Cloud Services

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A cloud service provider **can have hundreds of cloud services** that are grouped into various types of services. The four most common types of cloud services (*the 4 core*) for Infrastructure as a Service (IaaS) would be:



Compute

Imagine having a virtual computer that can run application, programs and code.



Networking

Imagine having virtual network defining internet connections or network isolations between services or outbound to the internet



Storage

Imagine having a virtual hard-drive that can store files



Databases

Imagine a virtual database for storing reporting data or a database for general purpose web-application

AWS has over **200+** cloud services

The term “Cloud Computing” can be used to refer to all categories, even though it has “compute” in the name.



Technology Overview

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Cloud Service Provider (CSPs) that are **Infrastructure as a Service (IaaS)** will always have **4 core cloud service** offerings:



Compute
EC2 Virtual Machines



Storage
EBS Virtual Hard drives



Database
RDS SQL databases



Networking and Content Delivery
VPC Private Cloud Network



Analytics



Application Integration



AR & VR



AWS Cost Management



Blockchain



Business Applications



Containers



Customer Engagement



Developer Tools



End User Computing



Game Tech



Internet of Things



Machine Learning



Management & Governance



Media Services



Migration & Transfer



Mobile



Quantum Technologies



Robotics



Satellites



Security, Identity & Compliance



The Evolution of Computing

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*Dedicated



VMs



Containers



Functions

Wasted Space

App App App

Host Operation System

physical server

- A physical server **wholly utilized by a single customer**.
- You have to guess your capacity
- you'll overpay for an underutilized server
- You can't vertical scale, you need a manual migration
- Replacing a server is very difficult
- You are limited by your Host Operating System
- Multiple apps can result in conflicts in resource sharing
- You have a ***guarantee of security, privacy, and full utility of underlying resources**



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*Dedicated



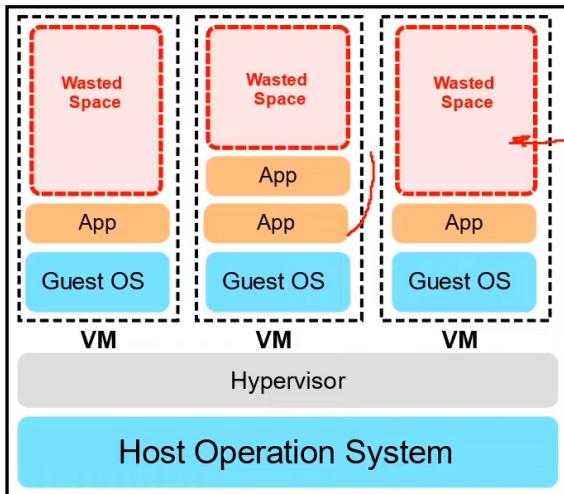
VMs



Containers



Functions



- You can run **multiple Virtual Machines on one machine**.
- **Hypervisor** is the software layer that lets you run the VMs
- A physical server shared by multiple customers
- You are to pay for a fraction of the server
- You'll overpay for an underutilized Virtual Machine
- You are limited by your Guest Operating System
- Multiple apps on a single Virtual Machine can result in conflicts in resource sharing
- Easy to export or import images for migration
- Easy to Vertical or Horizontal scale

physical server



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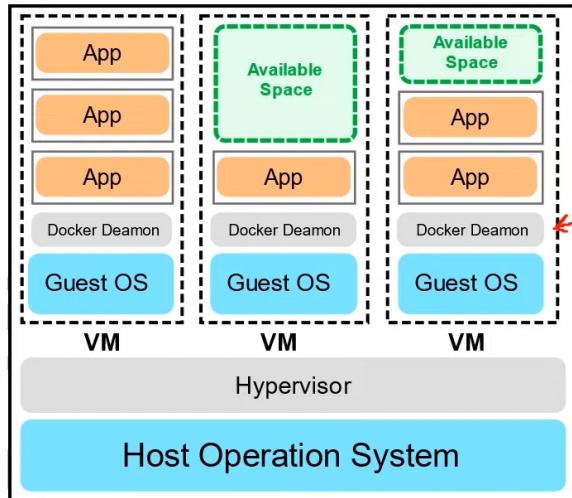
VMs



Containers



Functions



- Virtual Machine running multiple containers
- **Docker Daemon** is the name of the software layer that lets you run multiple containers.
- You can maximize the utilize of the available capacity which is more cost-effective
- Your containers share the same underlying OS so containers are more efficient than multiple VMs
- Multiple apps can run side by side without being limited to the same OS requirements and will not cause conflicts during resource sharing

physical server



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*Dedicated



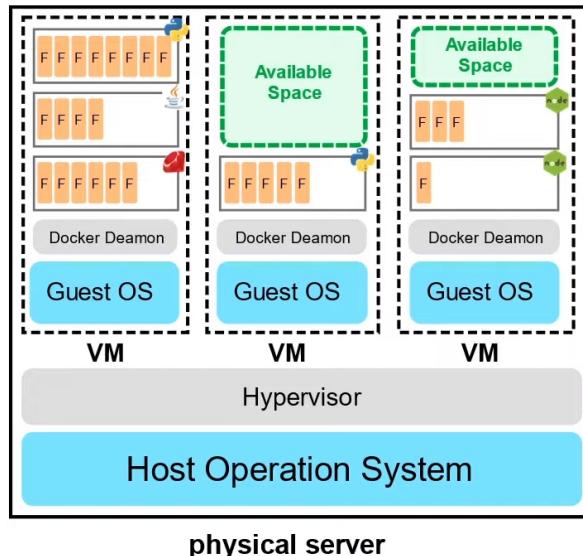
VMs



Containers



Functions



- Are managed VMs running managed containers.
 - Known as **Serverless Compute**
 - You upload a piece of code, choose the amount of memory and duration.
 - Only responsible for code and data, nothing else
 - Very cost-effective, only pay for the time code is running, VMs only run when there is code to be executed
 - Cold Starts is a side-effect of this setup



Types of Cloud Computing

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SaaS Software as a Service For Customers



A product that is run and managed by the service provider

Don't worry about how the service is maintained.

It just works and remains available.

PaaS Platform as a Service For Developers



Focus on the deployment and management of your apps.

Don't worry about, provisioning, configuring or understanding the hardware or OS.

IaaS Infrastructure as a Service For Admins



The basic building blocks for cloud IT. Provides access to networking features, computers and data storage space.

Don't worry about IT staff, data centers and hardware.



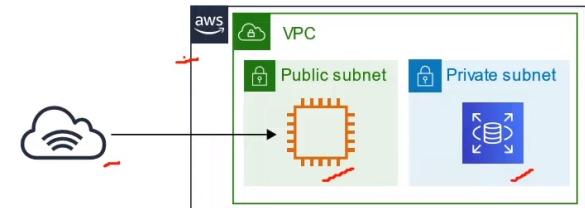
Cloud Computing Deployment Models

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Public Cloud

Everything (the workload or project) is built on the CSP

Also known as: *Cloud-Native or Cloud First

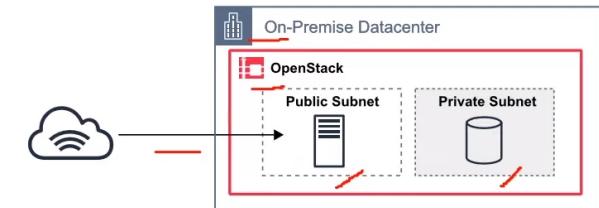


Private Cloud

Everything built on company's datacenters

Also known as **On-Premise**

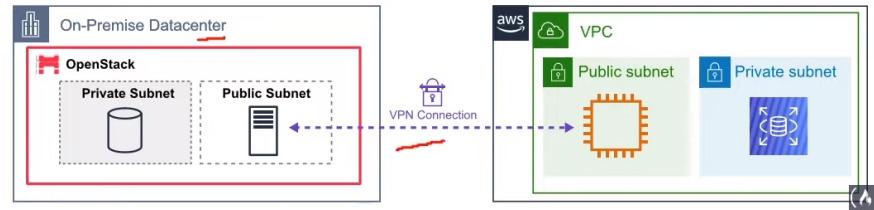
The cloud could be **OpenStack**



Hybrid

Using both **On-Premise** and

A **Cloud Service Provider**



Cloud Computing Deployment Models

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Cross-Cloud

Using **Multiple Cloud Providers**

Aka multi-cloud, "~~hybrid-cloud~~"



Anthos is GCP's offering for a control plane for compute across multiple CSPs and On-premise environments



Cloud Computing Deployment Models

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Cloud

Fully utilizing cloud computing



Companies that are starting out today, or are small enough to make the leap from a VPS to a CSP.

- Startups
- SaaS offerings
- New projects and companies

Hybrid

Using both Cloud and On-Premise



Organizations that started with their own datacenter, can't fully move to cloud due to effort of migration or security compliance

- Banks
- FinTech, Investment Management
- Large Professional Service providers
- Legacy on-premise

On-Premise

Deploying resources on-premises, using virtualization and resource management tools, is sometimes called “private cloud”.



Organizations that cannot run on cloud due to strict regulatory compliance or the sheer size of their organization

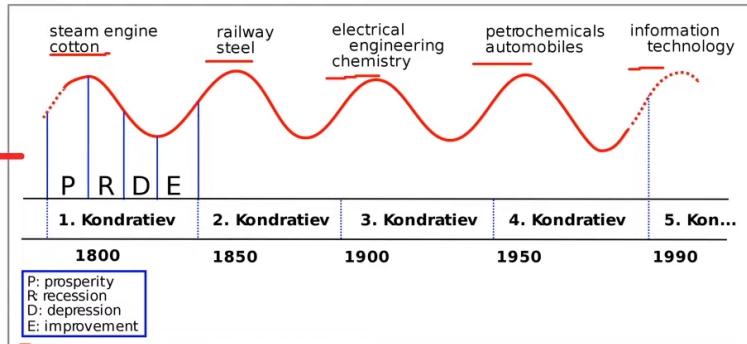
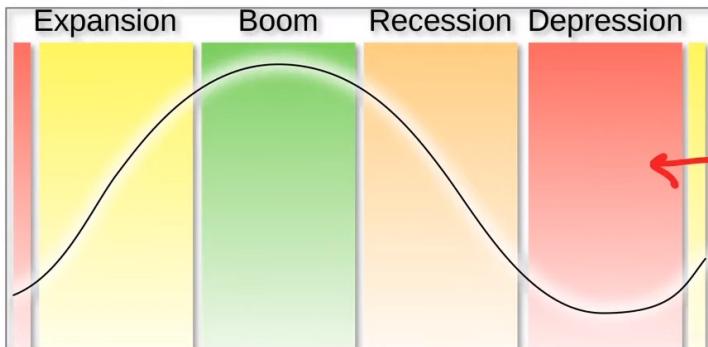
- Public Sector eg. Government
- Super Sensitive Data eg. Hospitals
- Large Enterprise with heavy regulation eg. Insurance Companies

There really isn't reason to be **fully on-premise** 

Innovation Waves

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Kondratiev waves (aka Innovation Waves or K-Waves) are hypothesized cycle-like phenomena in the global world economy.
The phenomenon is closely connected with Technology life cycles.



A common pattern of a wave change of **supply** and **demand**

Each wave irreversibly changes the society on a global scale.
The latest wave is **Cloud Technology**



Burning Platform

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Burning platform is a term used **when a company abandons old technology for new technology** with the uncertainty of success and can be motivated by fear that the organization future survival hinges on its **digital transformation**



Evolution of Computing Power

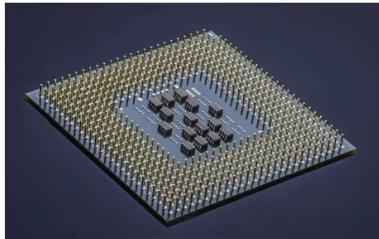
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What is Computing Power?

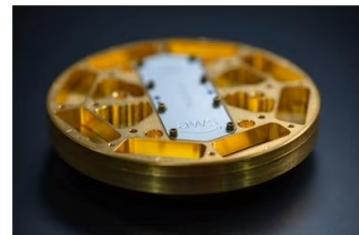
The throughput measured at which a computer can complete a computational task.



General Computing
Xeon CPU Processor



GPU Computing
*50x faster than traditional CPUs



Quantum Computing

- D-Wave 2000Q
- **Rigetti 16Q Aspen-4**
- IonQ linear ion trap
- 100 Million times faster

-- AWS Service Offering -----



Elastic Compute Cloud EC2



AWS Inferentia (Inf1)



AWS Bracket
Via CalTech



The Benefits of Cloud

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The benefits of the cloud is a summary of reasons why an organization would consider adopting or migrating to utilizing public cloud.

- **Agility**
 - Increase speed and agility
- **Pay-as-you go pricing**
 - Trade capital expense for variable expense
- **Economy of scale**
 - Benefit from massive economies of scale
- **Global Reach**
 - Go global in minutes
- **Security**
- **Reliability**
 - Stop spending money on running and maintaining data centers
- **High Availability**
- **Scalability**
 - Benefit from massive economies of scale
- **Elasticity**

Cloud Architecture

Missing:

- Fault Tolerance
- Disaster Recovery



The Benefits of Cloud is a reworking and expansion of the Six Advantages of Cloud



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Six Advantages to Cloud

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1. Trade capital expense for variable expense

You can **Pay On-Demand** meaning there is no upfront-cost and you pay for only what you consume or pay by the hour, minutes or seconds.

Instead of paying for upfront costs of data centers and servers



2. Benefit from massive economies of scale

You are **sharing the cost with other customers** to get unbeatable savings.

Hundreds of thousands of customers utilizing a fraction of a server



3. Stop guessing capacity

Scale up or down to meet the current need. Launch and destroy services whenever instead of paying for idle or underutilized servers.



4. Increase speed and agility

Launch resources within a few clicks in minutes

instead of waiting days or weeks of your IT to implement the solution on-premise



5. Stop spending money on running and maintaining data centers

Focus on your own customers, developing and configuring your applications

Instead of operations such as of racking, stacking, and powering servers



6. Go global in minutes

Deploy your app in multiple regions around the world with a few clicks.

Provide lower latency and a better experience for your customers at minimal cost.



The Six Advantages of Cloud was AWS *original description* of Cloud Benefits



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Seven Advantages to Cloud

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- | | |
|----------------|---|
| Cost-effective | You pay for what you consume , no up-front cost . On-demand pricing or Pay-as-you-go (PAYG) with thousands of customers sharing the cost of the resources |
| Global | Launch workloads anywhere in the world , Just choose a region |
| Secure | Cloud provider takes care of physical security. Cloud services can be secure by default or you have the ability to configure access down to a granular level. |
| Reliable | Data backup, disaster recovery, data replication, and fault tolerance |
| Scalable | Increase or decrease resources and services based on demand |
| Elastic | Automate scaling during spikes and drop in demand |
| Current | The underlying hardware and managed software is patched, upgraded and replaced by the cloud provider without interruption to you. |



AWS Global Infrastructure

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What is the AWS Global Infrastructure?

The AWS Global Infrastructure is **globally distributed hardware and datacenters** that **are physically networked together** to act as one large resource for the end customer.

The AWS Global Infrastructure is made up of the following resources:

- **25** Launched Regions
- **81** Availability Zones
- **108** Direct Connection Locations
- **275+** Points of Presence
- **11** Local Zone
- **17** Wavelength Zones



AWS has **millions** of active customers and **tens of thousands** of partners globally



Global Infrastructure – Regions

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Regions are **geographically distinct locations** consisting of one or more Availability Zones.

Every region is **physically isolated** from and independent of every other region in terms of **location, power, water supply**

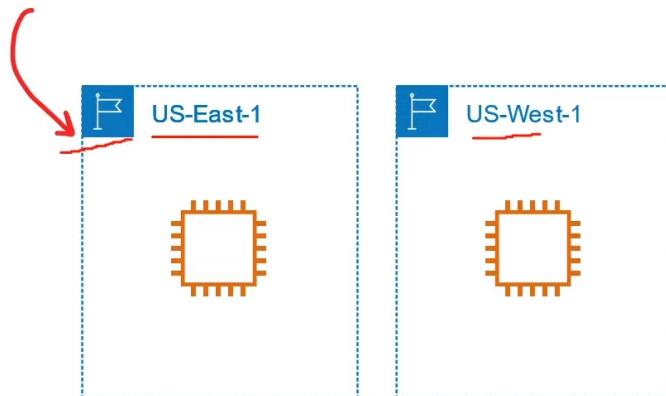
- Launch Regions
- Coming Soon



Global Infrastructure - Regions

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This is what a **region** will look like
represented in an architectural diagram.



Global Infrastructure - Regions

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Each region generally has three Availability Zones

- Some new users are limited to two eg. US-West

New services almost always become available first in **US-EAST**

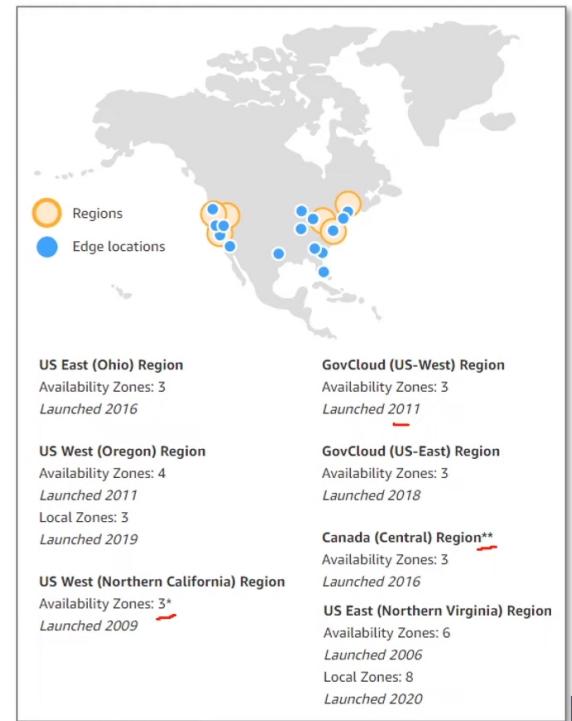
Not all AWS Services are available in all regions

All your billing information appears in **US-EAST-1** (North Virginia)

The cost of AWS services vary per region

When you choose a region there are four factors you need to consider:

1. What Regulatory Compliance does this region meet?
2. What is the cost of AWS services in this region?
3. What AWS services are available in this region?
4. What is the distance or latency to my end-users?



Global Infrastructure – Regional vs Global Services

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Regional Services

AWS **scopes** their AWS Management Console on a selected Region.

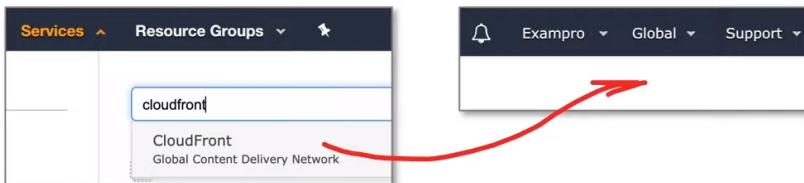
This will determine where an AWS service will be launched and what will be seen within an AWS Service's console.

You generally don't explicitly set the Region for a service at the time of creation.

Global Services

Some AWS Services operate across multiple regions and the region will be fixed to "Global"

E.g. Amazon S3, CloudFront, Route53, IAM



For these global services at the time of creation:

- There is no concept of region. eg. IAM User
- A single region must be explicitly chosen eg. S3 Bucket
- A group of regions are chosen eg. CloudFront Distribution

Region	Endpoint
US East (N. Virginia)	us-east-1
US East (Ohio)	us-east-2
US West (N. California)	us-west-1
US West (Oregon)	us-west-2
Africa (Cape Town)	af-south-1
Asia Pacific (Hong Kong)	ap-east-1
Asia Pacific (Mumbai)	ap-south-1
Asia Pacific (Osaka)	ap-northeast-3
Asia Pacific (Seoul)	ap-northeast-2
Asia Pacific (Singapore)	ap-southeast-1
Asia Pacific (Sydney)	ap-southeast-2
Asia Pacific (Tokyo)	ap-northeast-1
Canada (Central)	ca-central-1
Europe (Frankfurt)	eu-central-1
Europe (Ireland)	eu-west-1
Europe (London)	eu-west-2
Europe (Milan)	eu-south-1
Europe (Paris)	eu-west-3
Europe (Stockholm)	eu-north-1
Middle East (Bahrain)	me-south-1
South America (São Paulo)	sa-east-1

Global Infrastructure – Availability Zones

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An **Availability Zone** (AZ) is physical location made up of one or more datacenter.

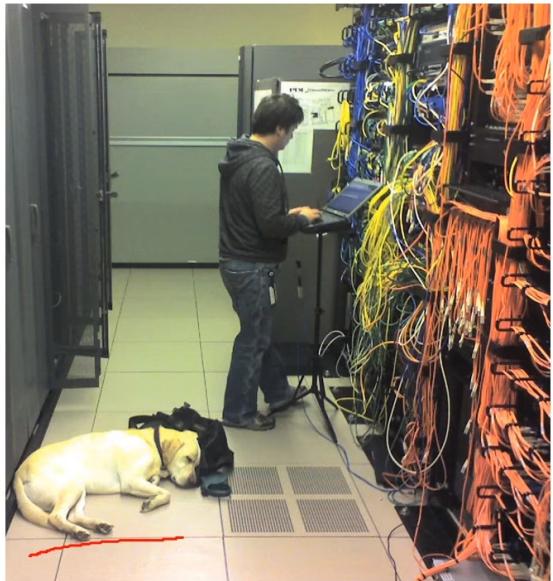
A datacenter is a secured building that contains hundreds of thousands of computers.

A region will ***generally** contain 3 Availability Zones

Datacenters within a region will be isolate from each other (different buildings). But they will be close enough to provide low-latency (< 10ms).

Its common practice to run workloads in at least 3 AZs to ensure services remain available in case one or two datacenters fail. (High Availability)

AZs are represented by a Region Code, followed by a letter identifier eg. us-east-1a



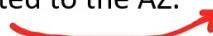
Global Infrastructure – Availability Zones

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A Subnet is associated with an Availability Zone.

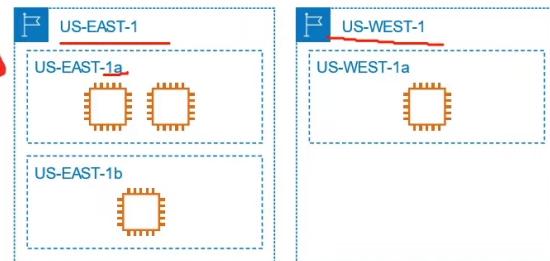
You never choose the AZ when launching resources.

You choose the Subnet which is associated to the AZ.



Subnet		✓ No preference (default subnet in any Availability Zone) subnet-d9de91f7 Default in us-east-1c subnet-d0c28f8c Default in us-east-1a subnet-349fdf53 Default in us-east-1b subnet-a8c2f8a7 Default in us-east-1f subnet-b9db4c87 Default in us-east-1e subnet-13869659 Default in us-east-1d
Public IP		
Ent group		
servation		

Example of an architectural diagram, representing two AZs, the Subnets associated with those AZs, and EC2 instances (Virtual Machines) launched in those subnets



The US-EAST-1 region has 6 AZs
(the most Availability Zones of any region)



Global Infrastructure – Availability Zones

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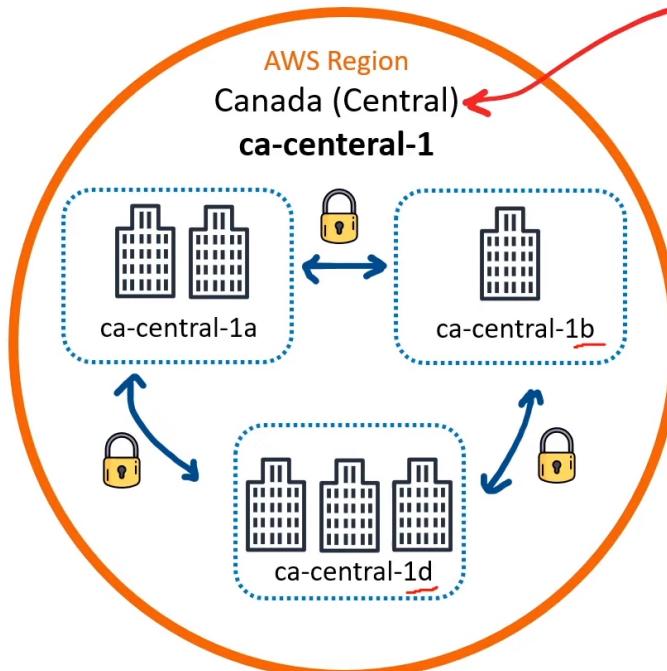
A region has multiple Availability Zones

An Availability Zone is made up of **one or more** datacenters

All AZs in an AWS Region are interconnected with high-bandwidth, low-latency networking, over fully redundant, dedicated metro fiber providing high-throughput, low-latency networking between

All traffic between AZs is encrypted

AZs are within 100 km (60 miles) of each other.



Montreal



@stevenwright Upsplash



Global Infrastructure - Fault Tolerance

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Fault Domain

What is a fault domain?

A fault domain is a section of a network that is vulnerable to damage if a critical device or system fails. The purpose of a fault domain is that if a failure occurs **it will not cascade outside that domain**, limiting the damage possible.

You can have fault domains nested inside fault domains.

What is a fault level?

A fault level is a collection of fault domains.

The scope of a fault domain could be:

- specific servers in a rack
- an entire rack in a datacenter
- an entire room in a datacenter
- the entire data center building

Its up to the Cloud Service Provider (CSPs) to define the boundaries of a domain

An AWS Region would be a **Fault Level** →

Fault Level
us-east-1 (Region)

A Availability Zone would be a **Fault Domain** →

Fault Domain
us-east-1a (AZ)

Fault Domain
us-east-1b (AZ)



Global Infrastructure – Fault Tolerance

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Each Amazon Region is designed to be completely **isolated** from the other Amazon Regions.

- This achieves the greatest possible fault tolerance and stability

Each Availability Zone is **isolated**, but the Availability Zones in a Region are connected through low-latency links

Each Availability Zone is designed as an **independent failure zone**

- A "Failure Zone" is AWS describing a Fault Domain.

Failure Zone

- Availability Zones are physically separated within a typical metropolitan region and are located in lower risk flood plains
- discrete uninterruptible power supply (UPS) and onsite backup generation facilities
- data centers located in different Availability Zones are designed to be supplied by independent substations to reduce the risk of an event on the power grid impacting more than one Availability Zone.
- Availability Zones are all redundantly connected to multiple tier-1 transit providers



* Multi-AZ for High Availability

If an application is partitioned across AZs, companies are better isolated and protected from issues such as **power outages, lightning strikes, tornadoes, earthquakes**, and more.



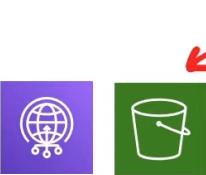
AWS Global Network

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The AWS Global Network represent the **interconnections between AWS Global Infrastructure**.

Commonly referred to as the “The Backbone of AWS”.

Think of it as private expressway, where things can move very fast between datacenters.



Edge Locations can act as **on and off ramps** to the AWS Global Network



AWS Global Accelerator
AWS S3 Transfer Acceleration
Uses Edge Locations as an on-ramp to quickly reach AWS resources in other regions by traversing the fast AWS Global Network



VPC Endpoints

Ensuring your resources stay within the AWS Network and do no traverse over the public Internet.



Global Infrastructure – Point of Presence (PoP)

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Points of Presence (PoP) is an intermediate location between an AWS Region and the end user, and this location could be a datacenter or collection of hardware.

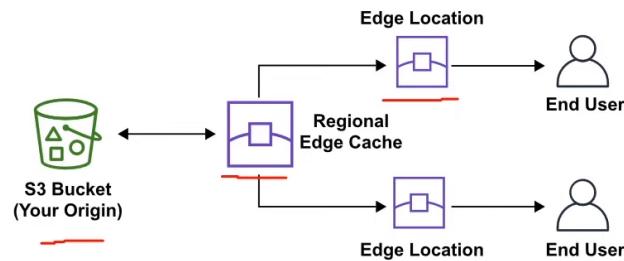
For AWS a Point of Presence is a data center **owned by AWS or a trusted partner** that is utilized by AWS Services related **for content delivery or expedited upload**.

PoP resources are:

- Edge Locations
- Regional Edge Caches

Edge Locations are datacenters that hold cached (copy) on the most popular files (eg. web pages, images and videos) so that the delivery distance to the end users are reduced.

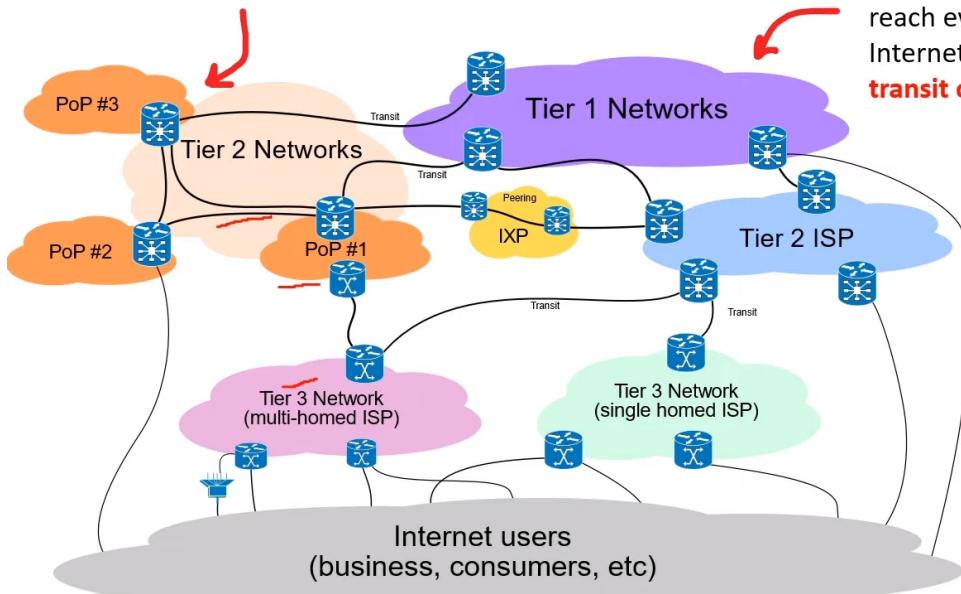
Regional Edge Locations are datacenters that hold much larger caches of less-popular files to reduce a full round trip and also to reduce the cost of transfer fees.



Global Infrastructure – Point of Presence (PoP)

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PoPs live at the edge/**intersection** of two networks



Tier 1 network is a network that can reach every other network on the Internet **without purchasing IP transit or paying for peering**.

AWS Availability Zones are all redundantly connected to multiple **tier-1 transit providers**



Global Infrastructure – Point of Presence (PoP)

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The following AWS Services use PoPs **for content delivery or expedited upload.**



Amazon CloudFront is a **Content Delivery Network (CDN) service** that:

- You point your website to CloudFront so that it will route requests to nearest Edge Location cache
- allows you to choose an **origin** (such as a web-server or storage) that will be source of cached
- caches the contents of what origin would returned to various Edge Locations around the world



Amazon S3 Transfer Acceleration allows you to generate a special URL that can be used by end users to upload files to a nearby Edge Location. Once a file is uploaded to an Edge Location, it can move much faster within the AWS Network to reach S3.



AWS Global Accelerator can find the optimal path from the end user to your web-servers. Global Accelerator are deployed within Edge Locations so you send user traffic to an Edge Location instead of directly to your web-application.



AWS Direct Connect

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



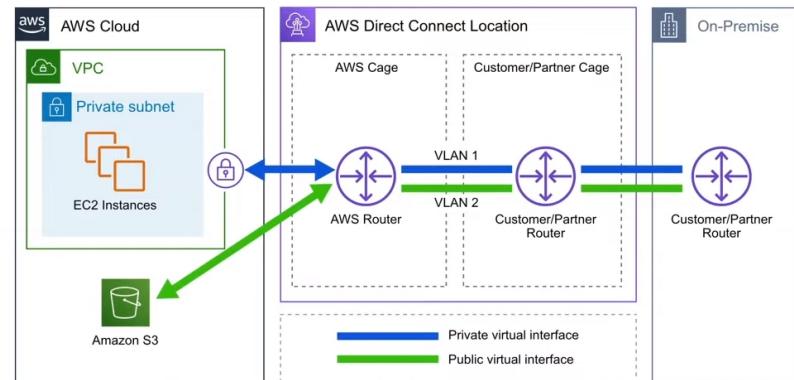
AWS Direct Connect is a **private/dedicated connection between your datacenter, office, co-location and AWS.**

Direct Connect has two **very-fast network** connection options:

1. Lower Bandwidth **50MBps-500MBps**
2. Higher Bandwidth **1GBps or 10GBps**



A co-location (aka carrier-hotel) is a data center where equipment, space, and bandwidth are available for rental to retail customers



Helps **reduce network costs** and **increase bandwidth throughput**. (great for high traffic networks)



Provides a **more consistent network experience** than a typical internet-based connection. (reliable and secure)



Global Infrastructure – Direct Connect Locations

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Direct Connect Locations are **trusted partnered datacenters** that you can establish a dedicated high speed, low-latency connection from your on-premise to AWS.



Allied Data Centres
250 Front Street West Toronto



You would use the **AWS Direct Connect** service to order and establish a connection



SUBSCRIBE

Global Infrastructure – Local Zones

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Local Zones are datacenters located very close to a densely populated area to provide single-digit millisecond low latency performance (eg. 7ms) for that area.



- **Los Angeles, California** was the first Local Zone to be deployed
 - It is a logical extension of the US-West Region
 - The Identifier looks like the following: **us-west-2-lax-1a**
- Only specific AWS Services have been made available
 - EC2 Instance Types (T3, C5, R5, R5d, I3en, G4)
 - EBS (io1 and gp2)
 - Amazon FSx
 - Application Load Balancer
 - Amazon VPC

The purpose of Local Zone is the support highly-demanding applications sensitive to latencies:

- Media & Entertainment
- Electronic Design Automation
- Ad-Tech
- Machine Learning

To use Local Zones you need to Opt-In



SUBSCRIBE

Global Infrastructure – Wavelength Zones

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AWS Wavelength Zones allows for **edge-computing on 5G Networks**.

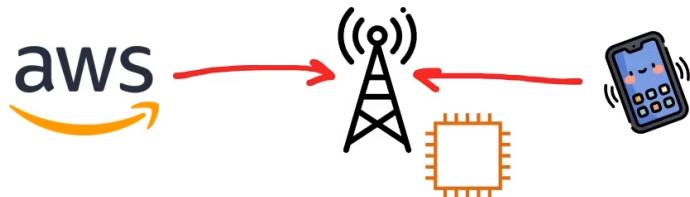
Applications will have **ultra-low latency** being as close as possible to the users

AWS has partnered with various Telecom companies to utilize their 5G networks

verizon ✓ **KDDI**

vodafone

SK telecom



You create a Subnet tied to a Wavelength Zone and then you can launch Virtual Machines (VMs) to the edge of the targeted 5G Networks.



Global Infrastructure – Data Residency

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What is Data Residency?

The physical or geographic location of where an organization or cloud resources reside.

What is Compliance Boundaries?

A regulatory compliance (legal requirement) by a government or organization that describes where data and cloud resources are allowed to reside

What is Data Sovereignty?

Data Sovereignty is the jurisdictional control or legal authority that can be asserted over data because its physical location is within jurisdictional boundaries

For workloads that need to meet compliance boundaries strictly defining the data residency of data and cloud resources in AWS you can use:



AWS Config is a Policy as Code service.

You can create rules to continuously check AWS resources configuration. If they deviate from your expectations you are alerted or AWS Config can in some cases auto-remediate.



IAM Policies can be written explicitly deny access to specific AWS Regions. A **Service Control Policy (SCP)** are permissions applied organization wide.



AWS Outposts is **physical rack of servers** that you can put in your data center. Your data will reside whenever the Outpost Physically resides



Global Infrastructure – AWS for government

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What is Public Sector?

Public sectors include public goods and governmental services such as:

- military
- law enforcement
- infrastructure
- public transit
- public education
- health care
- the government itself

AWS can be utilized by public sector or organizations developing cloud workloads for the public sector.

AWS achieves this by meeting **regulatory compliance programs** along with specific governance and security controls



AWS has special regions for US regulation called **GovCloud**



Global Infrastructure – GovCloud (US)

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Federal Risk and Authorization Management Program (FedRAMP)

a US government-wide program that provides a standardized approach to security assessment, authorization, and continuous monitoring for cloud products and services.

What is GovCloud?

A Cloud Service Provider (CSP) generally will offer an **isolated region** to run FedRAMP workloads.



AWS GovCloud Regions allow customers to host sensitive **Controlled Unclassified Information** and other types of regulated workloads.

- GovCloud Regions are only operated by employees who are U.S. citizens, on U.S. soil.
 - They are **only** accessible to U.S. entities and root account holders who pass a screening process
- Customers can architect secure cloud solutions that comply with:

- FedRAMP High baseline
- DOJ's Criminal Justice Information Systems (CJIS) Security Policy
- U.S. International Traffic in Arms Regulations (ITAR)
- Export Administration Regulations (EAR)
- Department of Defense (DoD) Cloud Computing Security Requirements Guide



Global Infrastructure – AWS in China

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AWS China is the AWS cloud offerings in Mainland China.

AWS China is completely isolate *intentionally* from AWS Global to meet regulatory compliance for Mainland China.

AWS China is on its own domain at: amazonaws.cn

In order to operate in a AWS China Region you need have a Chinese Business License (ICP license)

Not all services are available in china eg. Route53

Running in Mainland China (instead of Singapore) means you would not need to traverse the The Great Firewall.

AWS has two Regions in Mainland China:



Ningxia CN-NorthWest-1
Operated by NSWCF



Beijing CN-North-1
operated by SINNET



Global Infrastructure – Sustainability

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Amazon co-founded the Climate Pledge to achieve Net-Zero Carbon Emissions by 2040 across all of Amazon's business (this includes AWS)
sustainability.aboutamazon.com

AWS Cloud's Sustainability goals are composed of three parts:

1. Renewable Energy

AWS is working towards having their AWS Global Infrastructure powered by 100% renewable energy by 2025.

2. Cloud Efficiency

AWS's infrastructure is 3.6 times more energy efficient than the median of U.S. enterprise data centers surveyed.

3. Water Stewardship

Direct evaporative technology to cool our data center

Use of non-potable water for cooling purposes (recycled water)

On-site water treatment allows us to remove scale-forming minerals and reuse water for more cycles

Water efficiency metrics to determine and monitor optimal water use for each AWS Region

AWS purchases and retires environmental attributes to cover the non-renewable energy for AWS Global Infrastructure:

- Renewable Energy Credits (RECs)
- Guarantees of Origin (GOs)



Global Infrastructure – AWS Ground Station

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



AWS Ground Station is a fully managed service that **lets you control satellite communications**, process data, and scale your operations without having to worry about building or managing your own ground station infrastructure

Use cases for Ground Station: To use Ground Station:

- weather forecasting
 - surface imaging
 - communications
 - video broadcasts
- You schedule a Contact (select satellite, start and end time, and the ground location)
 - use the AWS Ground Station EC2 AMI to launch EC2 instances that will uplink and downlink data during the contact or receive downlinked data in an Amazon S3 bucket.

Use Case:

A company reaches an agreement with a Satellite Imagery Provider to take satellite photos of a specific region. They use AWS Ground Station to communicate that company's Satellite and download the S3 image data.



@isidurumm on Unsplash



Global Infrastructure – AWS Outposts

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



AWS Outposts is a fully managed service that offers the same AWS infrastructure, AWS services, APIs, and tools to virtually any datacenter, co-location space, or on-premises facility for a truly consistent hybrid experience.

AWS Outposts is rack of servers running AWS Infrastructure on your physical location

42U Rack



What is a Server Rack?

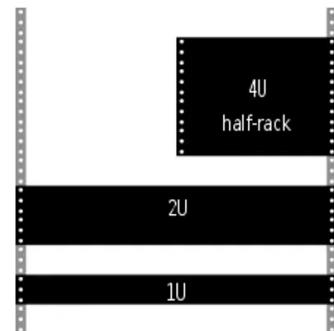
A frame design to hold and organize IT equipment.



Rack Heights

U stands for “rack units” or “U spaces” with is equal to 1.75 inches. The industry standard rack size is 48U (7 Foot Rack)

- full-size rack cage is 42U high
- equipment is typically 1U, 2U, 3U, or 4U high



Global Infrastructure – AWS Outposts

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AWS Outposts comes in 3 form factors: 42U, 1U and 2U

This a full rack of servers provided by AWS

42U



These are servers that you can place into your existing racks:

1U

suitable for 19-inch wide
24-inch deep cabinets
AWS Graviton2 (up to 64 vCPUs)
128 GiB memory
4 TB of local NVMe storage

2U

suitable for 19-inch wide
36-inch deep cabinets,
Intel processor (up to 128 vCPUs)
256 GiB memory
8TB of local NVMe storage

AWS delivers it to your preferred physical site fully assembled and ready to be rolled into final position. It is installed by AWS and the rack needs to be simply plugged into power and network.



Cloud Architecture Terminologies

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What is a Solutions Architect?

A role in a technical organization that architects a technical solution using multiple systems via researching, documentation, experimentation.

What is a Cloud Architect?

A solutions architect that is focused solely on architecting technical solutions using cloud services.

A cloud architect need to understand the following terms and factor them into their designed architecture based on the business requirements.

- **Availability** - Your ability to ensure a service remains available eg. **Highly Available (HA)**
- **Scalability** – Your ability to grow rapidly or unimpeded
- **Elasticity** – Your ability to shrink and grow to meet the demand
- **Fault Tolerance** – Your ability to prevent a failure
- **Disaster Recovery** - Your ability to recover from a failure eg. **Highly Durable (DR)**

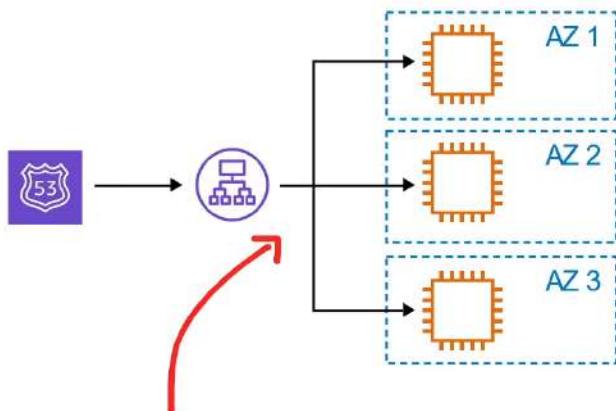
A Solutions Architect needs to always consider the following business factors:

- (Security) How secure is this solution?
- (Cost) How much is this going to cost?

High Availability

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Your ability for your service to **remain available** by ensuring there is
***no single point of failure** and/or ensure a certain level of performance



Elastic Load Balancer

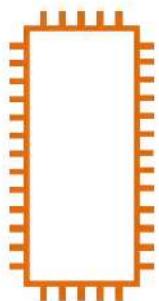
A load balancer allows you to evenly distribute traffic to multiple servers in one or more datacenter. If a datacenter or server becomes unavailable (unhealthy) the load balancer will route the traffic to only available datacenters with servers.

Running your workload across multiple **Availability Zones** ensures that if 1 or 2 **AZs** become unavailable your service / applications remains available.

High Scalability

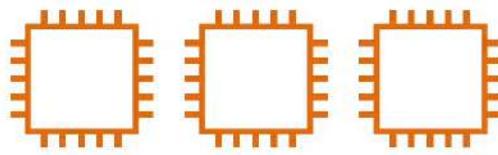
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Your ability to **increase your capacity** based on the increasing demand of traffic, memory and computing power



Vertical Scaling
Scaling **Up**

Upgrade to a bigger server



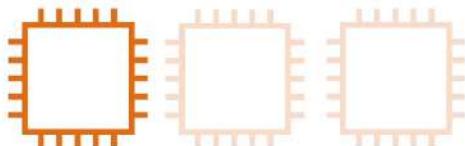
Horizontal Scaling
Scaling **Out**

Add more servers of the same size

High Elasticity

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Your ability to **automatically** increase or decrease your capacity based on the current demand of traffic, memory and computing power



Auto Scaling Groups (ASG) is an AWS feature that will automatically add or remove servers based on scaling rules you define based on metrics

Horizontal Scaling

Scaling **Out** — Add more servers of the same size

Scaling **In** — Removing underutilized servers of the same size

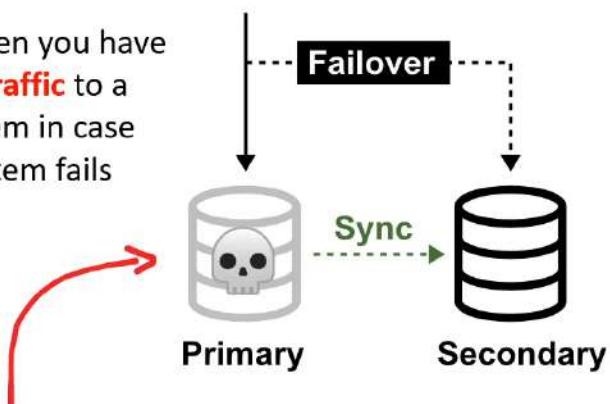
Vertical Scaling is generally hard for traditional architecture so you'll usually only see horizontal scaling described with Elasticity.

Highly Fault Tolerant

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Your ability for your service to ensure there is no
no single point of failure. **Preventing** the chance of failure

Fail-overs is when you have a plan to **shift traffic** to a redundant system in case the primary system fails



 **RDS Multi-AZ** is when you run a duplicate standby database in another Availability Zone in case your primary database fails.

A common example is having a copy (secondary) of your database where all ongoing changes are synced. The secondary system is not in-use until a fail over occurs and it becomes the primary database.

High Durability

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Your ability to **recover** from a disaster and to prevent **the loss** of data
Solutions that recover from a disaster is known as **Disaster Recovery (DR)**

- Do you have a backup?
- How fast can you restore that backup?
- Does your backup still work?
- How do you ensure current live data is not corrupt?



CloudEndure Disaster Recovery continuously replicates your machines into a low-cost staging area in your target AWS account and preferred Region enabling fast and reliable recovery in case of IT data center failures.



Business Continuity Plan (BCP)

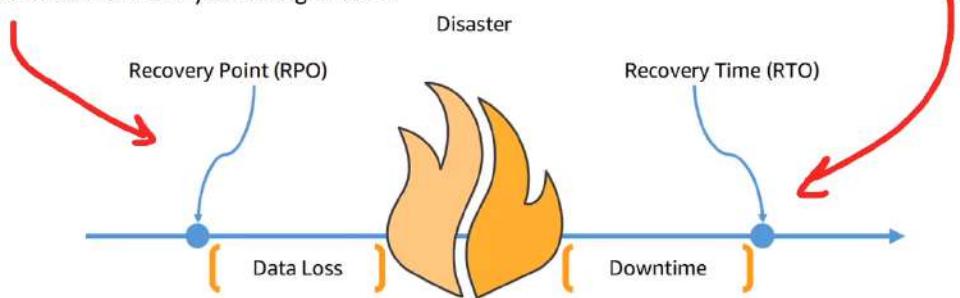
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A **business continuity plan** (BCP) is a document that outlines how a business will continue operating **during an unplanned disruption in services**

Recovery Point Objective (RPO)

the maximum acceptable amount of data loss after an unplanned data-loss incident, expressed as an amount of time

How much data are you willing to lose?



Recovery Time Objective (RTO)

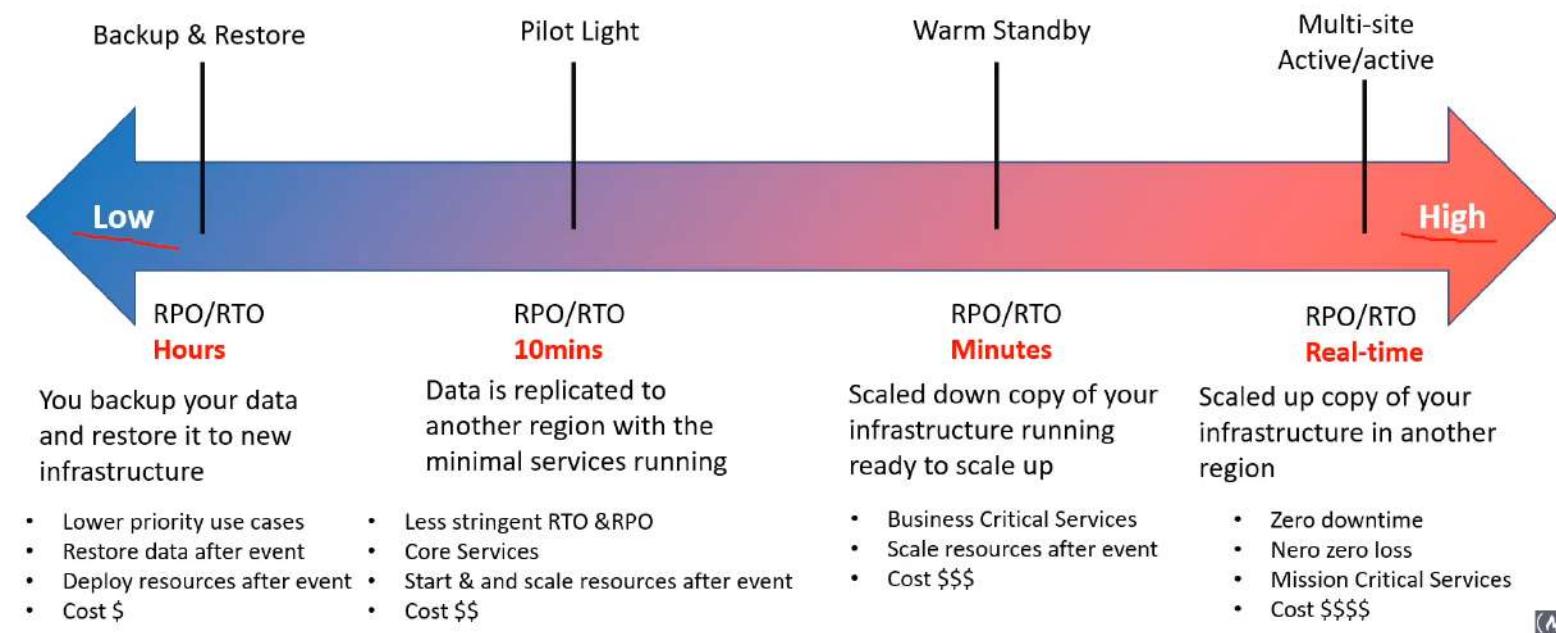
the maximum amount of downtime your business can tolerate without incurring a significant financial loss

How much time are you willing to go down?

Disaster Recovery Options

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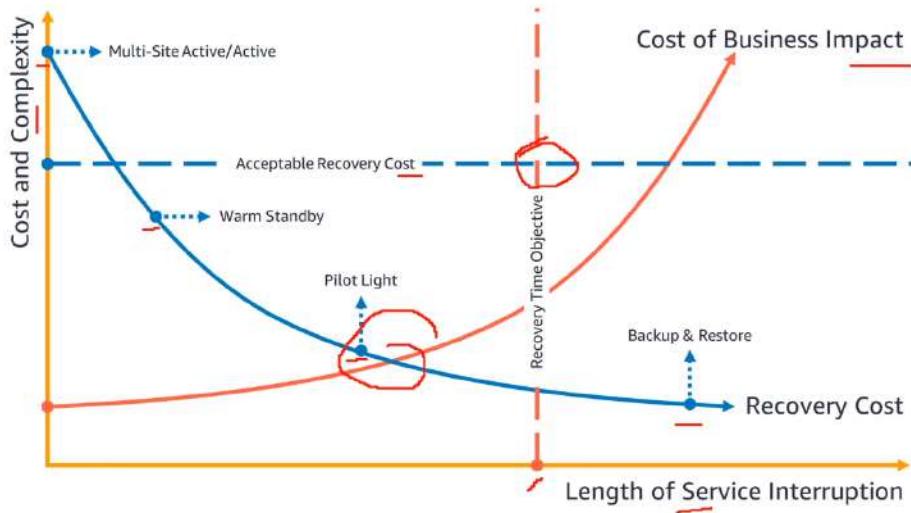
There are multiple options for recovery that trade cost vs time to recover.



RTO

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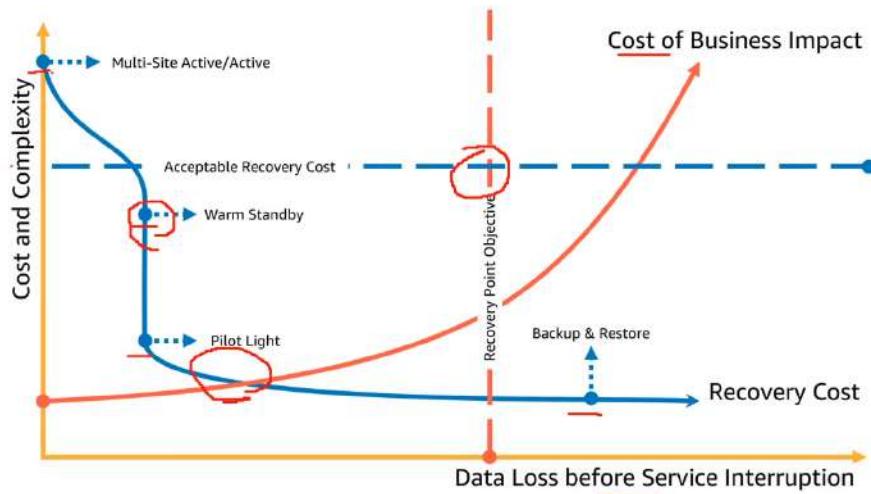
Recovery Time Objective (RTO) is the maximum acceptable delay between the interruption of service and restoration of service. This objective determines what is considered an acceptable time window when service is unavailable and is defined by the organization.



RPO

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Recovery Point Objective (RPO) is the maximum acceptable amount of time since the last data recovery point. This objective determines what is considered an acceptable loss of data between the last recovery point and the interruption of service and is defined by the organization.



AWS Application Programming Interface (API)

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What is an Application Programming Interface (API)?

An API is software that allows two applications/services to talk to each other.
The most common type of API is via HTTP/S requests.

AWS API is an HTTP API and you can interact by sending HTTPS requests,
using an application interacting with APIs like **Postman**.



Each AWS Service has its own **Service Endpoint** which you send requests

```
GET / HTTP/1.1
host: monitoring.us-east-1.amazonaws.com
x-amz-target: GraniteServiceVersion20100801.GetMetricData
x-amz-date: 20180112T092034Z
Authorization: AWS4-HMAC-SHA256 Credential=REDACTEDREDACTED/20180411/.....
Content-Type: application/json
Accept: application/json
Content-Encoding: amz-1.0
Content-Length: 45
Connection: keep-alive
```

To authorize use you will need generate a **signed request**

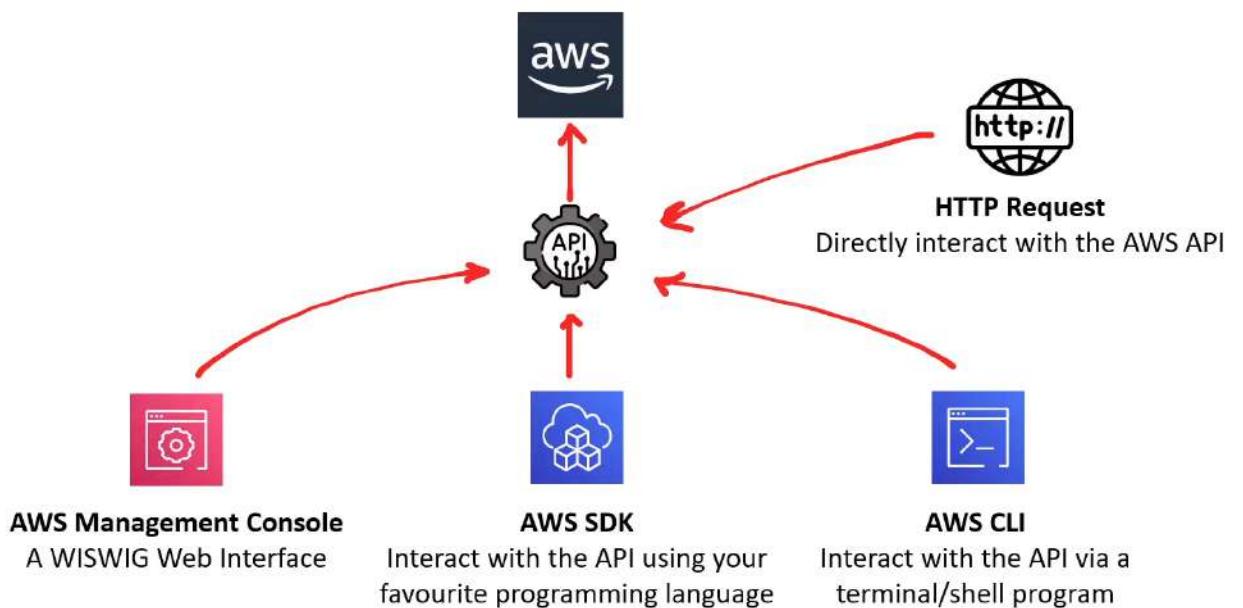
You make a separate request with your AWS credentials and get back a token.

You need to also provide an **ACTION** and accompanying **parameters** as the payload

AWS Application Programming Interface (API)

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Rarely do users directly send HTTP requests directly to the AWS API.
It's much easier to interact with the API via a variety of Developer Tools



AWS Management Console

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The AWS Management Console is a **web-based** unified console

Build, manage, and monitor everything from simple web apps to complex cloud deployments.



The screenshot shows the AWS Management Console interface. On the left, there's a sidebar titled "AWS services" with a "Recently visited services" section containing links to EC2, AWS Cost Explorer, VPC, AWS Outposts, CodePipeline, S3, CloudFront, and Trusted Advisor. Below this is a "All services" link. The main content area has sections for "Stay connected to your AWS resources on-the-go" (mentioning the AWS Console Mobile App supports four additional regions), "Explore AWS" (with a "Free AWS Training" link to Cloud Practitioner Essentials), and "Amazon S3 Multi-Region Access Points" (describing how it accelerates access to replicated data sets). The bottom of the page includes standard footer links for Feedback, English (US), Privacy Policy, Terms of Use, and Cookie preferences.



Point and Click to manually launch and configure AWS resources with limited programming knowledge.

This is known as "**ClickOps**" since you can perform all your system operations via clicks.

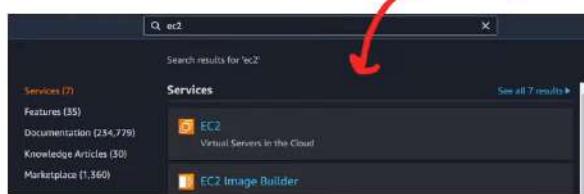
The AWS Management Console is located at: console.aws.amazon.com



AWS Management Console – Service Console

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AWS Service each have their own customized console.
You can access these consoles by **searching** the service name.



The **EC2 Console**

A screenshot of the EC2 Management Console. A red arrow points from the top right corner of the main content area down to the 'Account attributes' sidebar. The main dashboard shows resource counts: Instances (running) 0, Dedicated Hosts 0, Elastic IPs 0, Instances 0, Key pairs 1, Load balancers 0, Placement groups 0, Security groups 4, Snapshots 0, and Volumes 0. Below the dashboard is a 'Launch instance' button and a 'Scheduled events' section. The 'Account attributes' sidebar lists supported platforms (VPC), settings (EBS encryption, Zones, EC2 Serial Console, Default credit specification, Console experiments), and explore options (Get Up to 40% Better Price Performance, Enable Best Price-Performance with AWS Graviton2, Save up to 50% on EC2 with Spot Instances).



Some AWS Services Console will act as an umbrella console containing many AWS Services: eg

- VPC Console
- EC2 Console
- Systems Manager Console
- SageMaker Console
- CloudWatch Console.

AWS Account ID

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Every AWS Account has a unique Account ID.

The **Account ID** can be easily found by dropping down the current user in the Global Navigation

The AWS Account ID is composed of 12 digits eg:

- 123456789012
- 121212121212
- 498241098510

The AWS Account ID is used

- when logging in with a non-root user account.
- Cross-account roles
- Support cases



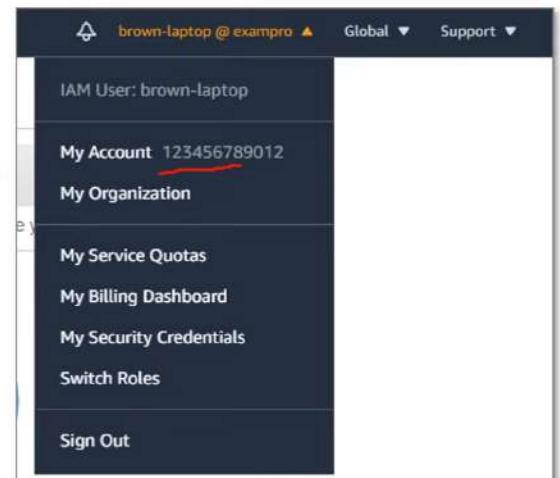
Sign in as IAM user

Account ID (12 digits) or account alias
121212121212

IAM user name

Password

Remember this account



It is generally good to keep your Account ID private as it is one of many components used to identify an account for attack by a malicious actor.

AWS Tools for PowerShell

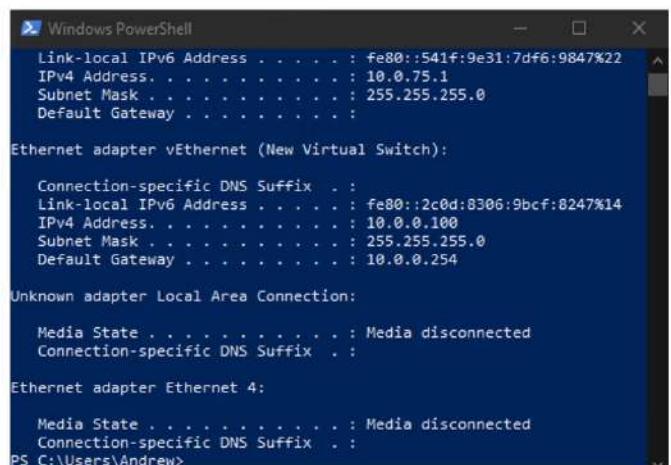
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What is PowerShell?

PowerShell is a task automation and configuration management framework. A **command-line shell** and a **scripting language**.

Unlike most shells, which accept and return text, PowerShell is built on top of the .NET Common Language Runtime (CLR), and accepts and returns .NET objects.



```
Windows PowerShell
Link-local IPv6 Address . . . . . : fe80::541f:9e31:7df6:9847%22
IPv4 Address . . . . . : 10.0.75.1
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . :

Ethernet adapter vEthernet (New Virtual Switch):

Connection-specific DNS Suffix . . .
Link-local IPv6 Address . . . . . : fe80::2c0d:8306:9bcf:8247%14
IPv4 Address . . . . . : 10.0.0.100
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 10.0.0.254

Unknown adapter Local Area Connection:

Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . . .

Ethernet adapter Ethernet 4:

Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . . .
PS C:\Users\Andrew>
```

AWS Tools for PowerShell lets you interact with the AWS API via PowerShell Cmdlets

Cmdlet is a special type of command in PowerShell in the form of capitalized verb-and-noun e.g. *New-S3Bucket*



```
PS > New-S3Bucket -BucketName website-example -Region us-west-2
CreationDate          BucketName
-----              -----
8/16/19 8:45:38 PM  website-example
```

Amazon Resource Name (ARNs)

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Amazon Resource Names (ARNs) uniquely identify AWS resources.

ARNs are required to specify a resource unambiguously across all of AWS

The ARN has the following

format variations

arn:partition:service:region:account-id:resource-id

arn:partition:service:region:account-id:resource-type/resource-id

arn:partition:service:region:account-id:resource-type:resource-id

Partition

- aws - AWS Regions
- aws-cn - China Regions
- aws-us-gov - AWS GovCloud (US) Regions

Resource ID

Could be a number name or path:

- user/Bob
- instance/i-1234567890abcdef0

Service – Identifies the service

- ec2
- s3
- iam

Region – which AWS resource

- us-east-1
- ca-central-1

Account ID

- 121212121212
- 123456789012

In the AWS Management Console its common to be able to copy the ARN to your clipboard



arn:aws:s3:::my-bucket

Name	my-webserver-alb
ARN	arn:aws:elasticloadbalancing:us-east-1:123456789012:loadbalancer/app/my-webserver-alb/31e9d2ce26643cd8

(A) SOURCE

Paths in ARNs

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Resource ARNs can include a path

Paths can include a wildcard character, namely an asterisk (*)

IAM Policy ARN Path

arn:aws:iam::123456789012:user/Development/product_1234/*

S3 ARN Path

arn:aws:s3:::my_corporate_bucket/Development/*



AWS Command Line Interface (CLI)

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What is a CLI?

A Command Line Interface (CLI) **processes commands to a computer program in the form of lines of text.**
Operating systems implement a command-line interface in a shell.

What is a Terminal?

A terminal is a text only interface (input/output environment)

What is a Console?

A console is a physical computer to physically input information into a terminal

What is a Shell?

A shell is the command line program that users interact with to input commands. Popular shell programs:

- **Bash**
- Zsh
- PowerShell

People commonly (erroneously) use **Terminal, Shell or Console** to generally describe interacting with a Shell.



AWS Command Line Interface (CLI)

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AWS Command Line Interface (CLI) allows users to programmatically interact with the AWS API via entering **single or multi-line commands** into a shell or terminal

```
aws ec2 describe-instances \
--filters Name=tag-key,Values=Name \
--query 'Reservations[*].Instances[+].
{Instance:InstanceId,AZ:Placement.AvailabilityZone,Name:Tags[?
Key==`Name`][0].Value}' \
--output table
```

DescribeInstances		
AZ	Instance	Name
us-east-2b	i-057750d42936e468a	my-prod-server
us-east-2a	i-001efd250faaa6ffa	test-server-1
us-east-2a	i-027552a73f021f3bd	test-server-2



The AWS CLI is a Python executable program.

- Python is required to install AWS CLI

The AWS CLI can be installed on Windows, Mac or Linux/Unix

The name of the CLI program is **aws**

AWS Software Development Kit (SDK)

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A Software Development Kit (SDK) is **a collection of software development tools** in **one installable package**.



You can use the **AWS SDK** to programmatically create, modify, delete or interact with AWS resources.

AWS SDK is offered in various programming languages:

- Java
- Python
- Node.js
- **Ruby** 
- Go
- .NET
- PHP
- JavaScript
- C++

```
s3 = Aws::S3::Resource.new({
  region: aws_default_region,
  credentials: Aws::Credentials.new(
    aws_access_key_id,
    aws_secret_access_key
  )
})
bucket = s3.bucket s3_bucket
file = File.open file_path
md5 = Digest::MD5.hexdigest file.read
md5 = Base64.encode64([md5].pack("H*")).strip

attrs = {
  key: data["path"],
  body: IO.read(file),
  content_md5: md5
}
resp = bucket.put_object(attrs)
```

AWS CloudShell

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AWS CloudShell is a **browser-based shell** built into the AWS Management Console.

AWS CloudShell is scoped per region, Same credentials as logged in user. Free Service!

Preinstalled Tools

AWS CLI, Python, Node.js git, make, pip, sudo, tar, tmux, vim, wget, and zip and more

Storage included

1 GB of storage free per AWS region

Saved files and settings

Files saved in your home directory are available in future sessions for the same AWS region

Shell Environments

Seamlessly switch between

- Bash
- PowerShell
- Zsh

AWS CloudShell is available in select regions



Infrastructure as Code (IaC)

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Infrastructure as Code (IaC)

You write a configuration script to **automate creating, updating or destroying** cloud infrastructure.

- IaC is a **blueprint** of your infrastructure.
- IaC allows you to easily **share, version or inventory** your cloud infrastructure.

AWS has two offerings for writing Infrastructure as Code.



AWS CloudFormation (CFN)

CFN is a Declarative IaC tool



AWS Cloud Development Kit (CDK)

CDK is an Imperative IaC tool.

Declarative

- What you see is what you get. **Explicit**
- More verbose, but zero chance of mis-configuration
- Uses scripting languages eg. JSON, YAML, XML

Imperative

- You say what you want, and the rest is filled in. **Implicit**
- Less verbose, you could end up with misconfiguration
- Does more than Declarative
- Uses programming languages eg. Python, Ruby, JavaScript



CloudFormation

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AWS CloudFormation allows you to write Infrastructure as Code (IaC) as either a JSON or **YAML** file.



CloudFormation is simple but it can lead to large files or is limited in some regard to creating dynamic or repeatable infrastructure compared to CDK.

CloudFormation can be easier for DevOps Engineers who do not have a background in web programming languages.

Since CDK generates out CloudFormation its still important to be able to read and understand CloudFormation in order to debug IaC stacks.

```
Ec2Instance:  
  Type: AWS::EC2::Instance  
  Properties:  
    ImageId:  
      Fn::FindInMap:  
        - "RegionMap"  
        - Ref: "AWS::Region"  
        - "AMI"  
    KeyName:  
      Ref: "KeyName"  
    NetworkInterfaces:  
      - AssociatePublicIpAddress: "true"  
        DeviceIndex: "0"  
        GroupSet:  
          - Ref: "myVPCEC2SecurityGroup"  
        SubnetId:  
          Ref: "PublicSubnet"
```

Cloud Development Kit

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AWS CDK allows you to use your favorite programming language to write Infrastructure as Code (IaC)



```
const bucket = new Bucket(this, 'MyBucket');
const result = bucket.addToResourcePolicy(new iam.PolicyStatement({
  actions: ['s3:GetObject'],
  resources: [bucket.arnForObjects('file.txt')],
  principals: [new iam.AccountRootPrincipal()],
}));
```

- CDK is powered by CloudFormation (it generates out CloudFormation templates)
- CDK has a large library of reusable cloud components called CDK Construct <https://constructs.dev>
- CDK comes with its own CLI
- CDK Pipelines to quickly setup CI/CD pipelines for CDK projects
- CDK has a testing framework for Unit and Integration Testing

AWS SDK looks similar, but the key difference is CDK ensures Idempotent of your Infrastructure



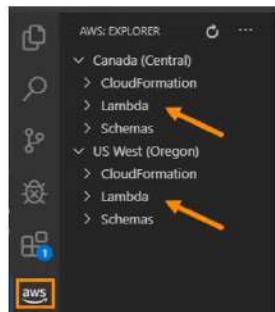
AWS Toolkit for VSCode

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AWS Toolkit is an open-source plugin for VSCode to create, debug, deploy AWS resources

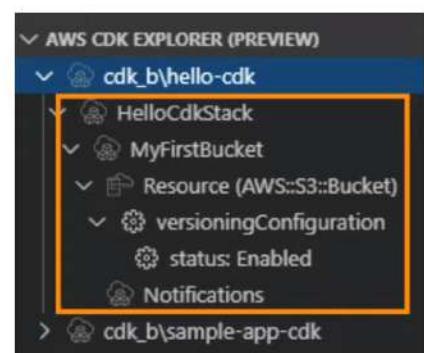
1. AWS Explorer

Explore a wide range of AWS resources to your linked AWS Account



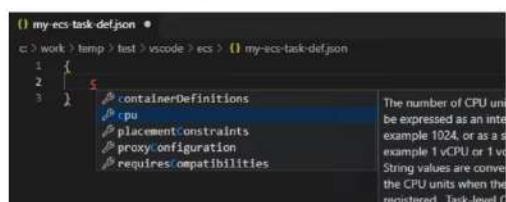
2. AWS CDK Explorer (PREVIEW)

Allows you to explore your stacks defined by CDK.



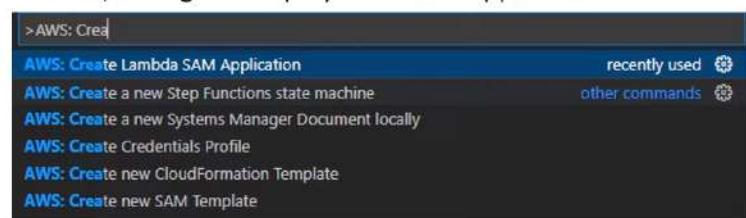
3. Amazon Elastic Container Service

Provides IntelliSense for ECS task-definitions files



4. Serverless Applications

Create, debug and deploy serverless applications via SAM and CFN



Access Keys

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Access Keys is a **key and secret** required to have programmatic access to AWS resources when interacting with the AWS API outside of the AWS Management Console



An Access Key is commonly referred to as **AWS Credentials**

A user must be **granted access** to use Access Keys

Select AWS credential type*	<input checked="" type="checkbox"/> Access key - Programmatic access Enables an access key ID and secret access key for the AWS API, CLI, SDK, and other development tools.
	<input type="checkbox"/> Password - AWS Management Console access Enables a password that allows users to sign-in to the AWS Management Console.

- Never share your access keys
- Never commit access keys to a codebase
- You can have two active Access Keys
- You can deactivate Access Keys
- Access Keys have whatever access a user has to AWS resources.

Generate an Access Key and Secret

Access key ID	Secret access key
AKIAZRJIQN2ODG55TBXO	jzXt1gj1PE1f/y9k5JVI2TnvvQ6CSwanzg8aUP3O Hide

Access Keys

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Access Keys are to be stored in `~/.aws/credentials` and follow a TOML file format

Default will be the access key → used when no profile is specified.

You can store multiple access keys by giving the **profile** names.

```
[default]
aws_access_key_id=AKIAIOSFODNN7EXAMPLE
aws_secret_access_key=wJalrXUtnFEMI/K7MDENG/bPxRfCYEXAMPLEKEY
[exampro]
aws_access_key_id=AKIAIOSFODNN7EXAMPLE
aws_secret_access_key=wJalrXUtnFEMI/K7MDENG/bPxRfCYEXAMPLEKEY
region=ca-central-1
```

You can use the **aws configure** → CLI command to populate the credential file.

```
$ aws configure
AWS Access Key ID [None]: AKIAIOSFODNN7EXAMPLE
AWS Secret Access Key [None]: wJalrXUtnFEMI/K7MDENG/bPxRfCYEXAMPLEKEY
Default region name [None]: us-west-2
Default output format [None]: json
```

The AWS SDK will automatically read from these environment variables.

This is the safe way of using an Access Key within your code.

```
$ export AWS_ACCESS_KEY_ID=AKIAIOSFODNN7EXAMPLE
$ export AWS_SECRET_ACCESS_KEY=wJalrXUtnFEMI/K7MDENG/bPxRfCYEXAMPLEKEY
$ export AWS_DEFAULT_REGION=us-west-2
```



AWS Documentation

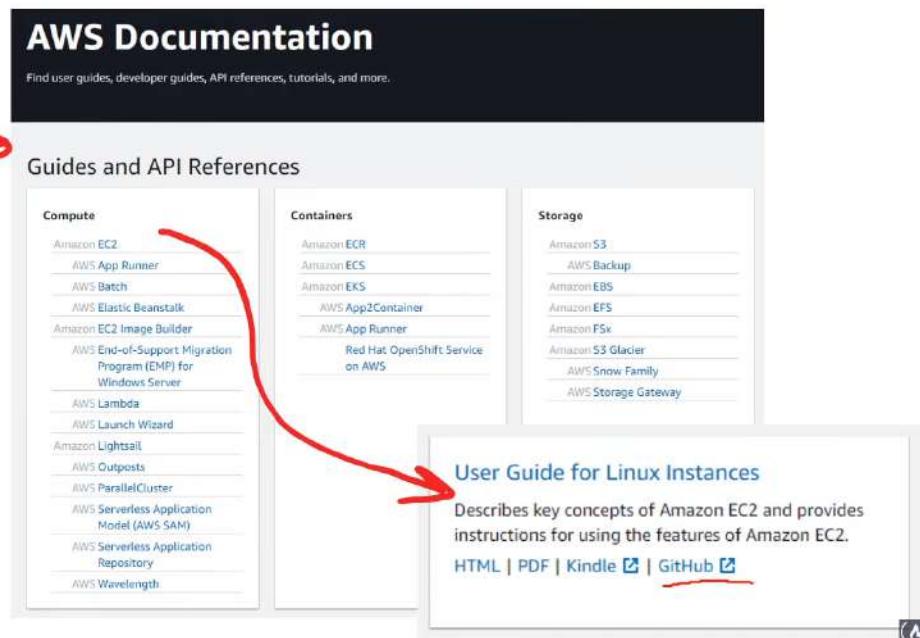
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AWS Documentation is a **large collection of technical documentation** on how to use AWS Services.

docs.aws.amazon.com

AWS is very good about providing detailed information about every AWS service.

The basis of this course and for any AWS Certification will derive mostly from the AWS Documentation



The screenshot shows the AWS Documentation homepage. At the top, it says "AWS Documentation" and "Find user guides, developer guides, API references, tutorials, and more." Below this, there are three main categories: "Compute", "Containers", and "Storage". The "Compute" section lists services like Amazon EC2, AWS App Runner, AWS Batch, AWS Elastic Beanstalk, Amazon EC2 Image Builder, AWS End-of-Support Migration Program (EMP) for Windows Server, AWS Lambda, AWS Launch Wizard, Amazon Lightsail, AWS Outposts, AWS ParallelCluster, AWS Serverless Application Model (AWS SAM), AWS Serverless Application Repository, and AWS Wavelength. The "Containers" section lists Amazon ECR, Amazon ECS, Amazon EKS, AWS App2Container, AWS App Runner, and Red Hat OpenShift Service on AWS. The "Storage" section lists Amazon S3, AWS Backup, Amazon EBS, Amazon EFS, Amazon FSx, Amazon S3 Glacier, AWS Snow Family, and AWS Storage Gateway. In the bottom right corner, there is a callout box for the "User Guide for Linux Instances", which describes key concepts of Amazon EC2 and provides instructions for using the features of Amazon EC2. It includes links for "HTML", "PDF", "Kindle", and "GitHub". A red arrow points from the URL "docs.aws.amazon.com" at the top left to the "Compute" section on the page.

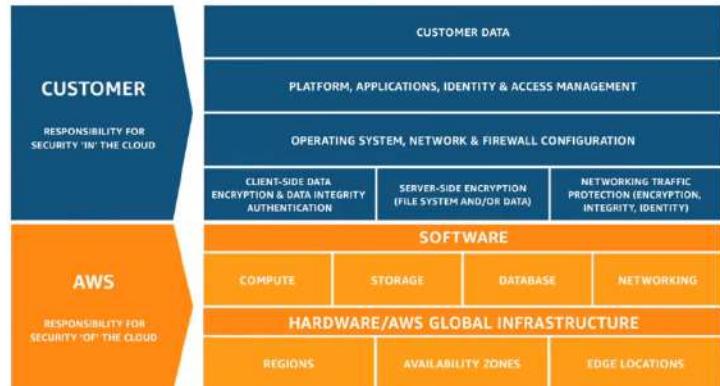
Shared Responsibility Model

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The **Shared Responsibility Model** is a **cloud security framework** that defines the security obligations of the customer versus the Cloud Service Provider (CSP) e.g. AWS.

Each CSP has their own variant of the Shared Responsibility Model but they are all generally the same.

AWS Shared Responsibility Model



The **type of cloud deployment model** and/or the **scope of cloud service category** can result in specialized Shared Responsibility Models.

AWS Shared Responsibility Model

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Customer

Configuration of Managed Services or Third-Party Software

Platforms

Applications

Identity and Access Management (IAM)

Configuration of Virtual Infrastructure and Systems

Operating System

Network

Firewall

Security Configuration of Data

Client-Side Data Encryption

Server-Side Encryption

Networking Traffic Protection

Customer Data

AWS

Software

Compute

Storage

Database

Networking

Hardware / Global Infrastructure

Regions

Availability Zones

Edge Locations

Physical Security



AWS Shared Responsibility Model

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Customers are responsible for Security **in** the Cloud



IN

**Data
Configuration**



OF

**Hardware
Operation of Managed Services
Global Infrastructure**

AWS is responsible for Security **of** the Cloud



Types of Cloud Computing Responsibility

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On-Premise	Infrastructure as a Service	Platform as a Service	Software as a Service
Applications	Applications	Applications	Applications
Data	Data	Data	Data
Runtime	Runtime	Runtime	Runtime
Middleware	Middleware	Middleware	Middleware
OS	OS	OS	OS
Virtualization	Virtualization	Virtualization	Virtualization
Servers	Servers	Servers	Servers
Storage	Storage	Storage	Storage
Networking	Networking	Networking	Networking

Legend:

Customer is Responsible

CSP is Responsible



Shared Responsibility Model - Compute

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Let us take a look at **compute** as a comparison example of the Shared Responsibility Model

Infrastructure as a Service (IaaS)

Bare Metal

EC2 Bare Metal Instance

Customer:

- The Host OS Configuration
- Hypervisor

AWS

- Physical machine

Virtual Machine

Elastic Cloud Compute (EC2)

Customer:

- The Guest OS Configuration
- Container Runtime

AWS

- Hypervisor, Physical machine

Containers

AWS Elastic Container Service(ECS)

Customer:

- Configuration of containers
- Deployment of Containers
- Storage of containers

AWS

- The OS, The Hypervisor, Container Runtime

Platform as a Service (PaaS)

Managed Platform

AWS Elastic Beanstalk

Customer:

- Uploading your code
- Some configuration of environment
- Deployment strategies
- Configuration of associated services

AWS

- Servers, OS, Networking, Storage, Security

Software as a Service (SaaS)

Content Collaboration

Amazon WorkDocs

Customer:

- Contents of documents
- Management of files
- Configuration of sharing access controls

AWS

- Servers, OS, Networking, Storage, Security

Function as a Service (FaaS)

Functions

AWS Lambda

Customer:

- Upload your code

AWS

- Deployment, Container Runtime, Networking, Storage, Security, Physical Machine, (basically everything)



Shared Responsibility Model - Compute

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Bare Metal

EC2 Bare Metal Instance



Dedicated

EC2 Dedicated Instance/Host



Virtual Machines (VM)

Elastic Compute Cloud (EC2)



Containers

Elastic Container Service(ECS)

Elastic Kubernetes Service (EKS)

AWS Fargate*



Functions

AWS Lambda



Code

App Container

Runtime

OS

Virtualization

Customer ←
Responsibility

Level of Control

→ AWS
Responsibility



Shared Responsibility Model

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The **Shared Responsibility Model** is a simple visualization that helps determine what the customer is responsible for and what the CSP is responsible for related to AWS.

The customer is responsible for the data and the **configuration** of access controls that resides in AWS.

The customer is responsible for the **configuration** of cloud services and granting access to users via permissions.

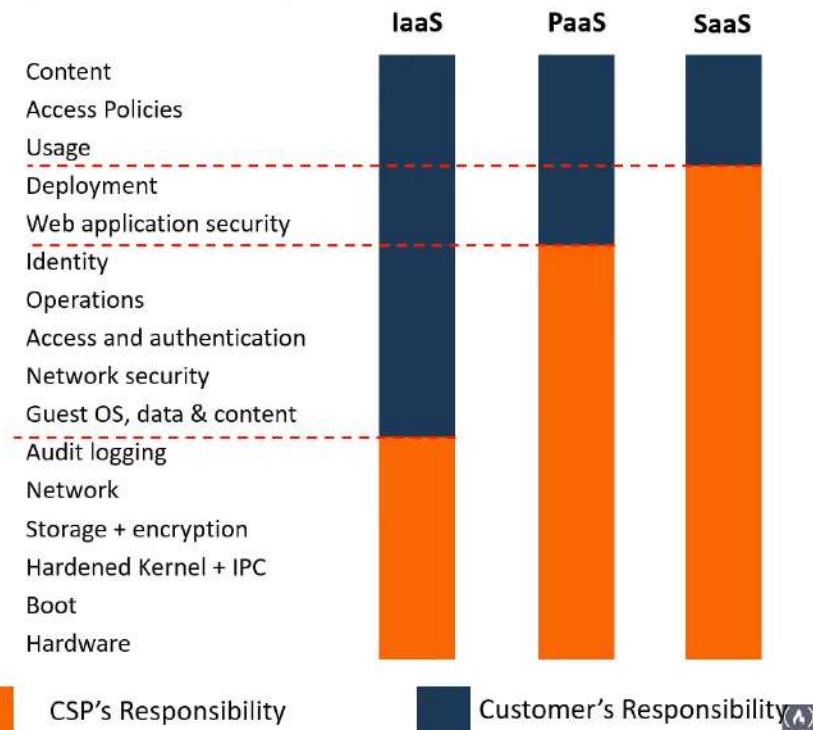
CSP is generally responsible for the underlying Infrastructure.

Responsibility of **in the cloud**

If you can configure or store it then you (the customer) are responsible for it.

Responsibility of **of the cloud**

If you can not configure it then CSP is responsible for it



Shared Responsibility Model - Architecture

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Less Responsibility



Amplify Serverless Framework



Lambda Serverless Architecture



Fargate Serverless Containers



ECS/EKS Containers



Elastic Beanstalk Platform as a Service



EC2 Infrastructure as a Service

Serverless / Functions

No more servers, just worry about data and code

Microservices / Containers

Mix and match languages, better utilization of resources

Traditional / VMs

Global workforce is most familiar with this kind of architecture and lots of documentation, frameworks and support.

More Responsibility



Computing Services

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Elastic Compute Cloud (EC2) allows you to launch **Virtual Machines (VM)**

What is a Virtual Machine?

A Virtual Machine (VM) is an emulation of a physical computer using software.

Server Virtualization allows you to easily **create, copy, resize or migrate** your server.

Multiple VMs can run **on the same physical server** so you can share the cost with other customers.

Imagine if your server or computer was an executable file on your computer

When we launch a Virtual Machine we call it an "**instance**"

EC2 is **highly configurable** where you can choose **AMI** that affects options such as:

- The amount of CPUs
- The amount of Memory (RAM)
- The amount of Network Bandwidth
- The Operation System (OS) eg. Windows 10, Ubuntu, Amazon Linux 2
- Attach multiple virtual hard-drives for storage eg. Elastic Block Store (EBS)



An **Amazon Machine Image (AMI)** is a predefined configuration for a Virtual Machine.



EC2 is also considered **the backbone of AWS** because the majority of AWS services are using EC2 as their underlying servers. eg. S3, RDS, DynamoDB, Lambdas

Computing Services

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Virtual Machines — an emulation of a physical computer using software

 **Amazon LightSail** is the **managed virtual server service**. It is the “friendly” version of EC2 Virtual Machines. *When you need to launch a Linux or Windows server but don’t have much AWS knowledge. eg. Launch a Wordpress*

Containers — virtualizing an Operation System (OS) to run multiple workloads on a single OS instance. Containers are generally used in micro-service architecture (when you divide your application into smaller applications that talk to each other)

 **Elastic Container Service (ECS)** is a **container orchestration service** that support **Docker** containers. Launches a cluster of server(s) on EC2 instances with Docker installed. *When you need Docker as a Service, or you need to run containers.* 

 **Elastic Container Registry (ECR)** is **repository for container images**. In order to launch a containers you need an image. An image just means a saved copy. A repository just means a storage that has version control.

 **ECS Fargate** is **serverless orchestration container service**. It is the same as ECS expect you pay-on-demand per running container (With ECS you have to keep a EC2 server running even if you have no containers running) AWS manages the underlying server, so you don’t have to scale or upgrade the EC2 server.

 **Elastic Kubernetes Service (EKS)** is a **fully managed Kubernetes service**. Kubernetes (K8) is an open-source orchestration software that was created by Google and is generally the standard for managing microservices. *When you need to run Kubernetes as a Service.* 

Serverless — when the underlying servers are managed by AWS. You don’t worry or configure servers.

 **AWS Lambda** is a **serverless functions service**. You can run code without provisioning or managing servers. You upload small pieces of code, choose much memory and how long function is allowed to run before timing out. You are charged based on the runtime of the serverless function rounded to the nearest 100ms. 

Introduction to S3

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What is Object Storage (Object-based Storage)?

data storage architecture that manages data as objects, **as opposed** to other storage architectures:

- **file systems** which manages data as files and file hierarchy, and
- **block storage** which manages data as blocks within sectors and tracks.



S3 provides you with **unlimited storage**.

You don't need to think about the underlying infrastructure

The S3 Console provides an interface for you to upload and access your data



S3 Object

Objects contain your data. They are like files.

Object may consist of:

- **Key** this is the name of the object
- **Value** the data itself made up of a sequence of bytes
- **Version ID** when versioning enabled, the version of object
- **Metadata** additional information attached to the object



S3 Bucket

Buckets hold objects. Buckets can also have folders which in turn hold objects

S3 is a universal namespace so bucket names must be unique (think like having a domain name)

You can store an individual object from **0 Bytes** to **5 Terabytes** in size



AWS Snow Family

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AWS Snow Family are **storage and compute devices used to physically move data in or out the cloud** when moving data over the internet or private connection it to slow, difficult or costly.



Snowcone

Comes in two sizes:

- 8 TB of Storage (HHD)
- 14 TB of Storage (SSD)



Snowball Edge

Comes generally in two type:

- Storage Optimized
 - 80 TB
- Compute Optimized
 - 39.5 TB



Snowmobile

100 PB of storage



Data is delivered to Amazon S3

Types of Storage Services

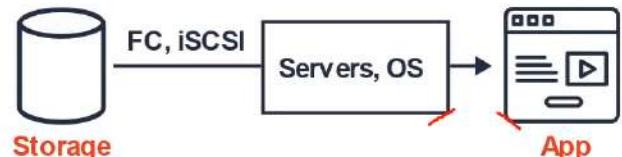
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Elastic Block Store (EBS) - Block

- Data is split into evenly split blocks
- Directly accessed by the Operation System
- Supports only a single write volume

When you need a virtual hard drive attached to a VM



AWS Elastic File Storage (EFS) - File

- File is stored with data and metadata
- Multiple connections via a network share
- Supports multiple reads, writing locks the file.

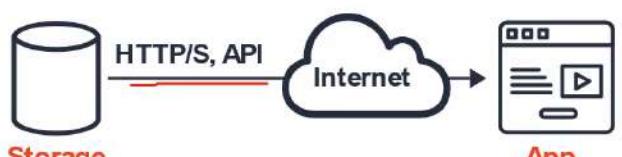
When you need a file-share where multiple users or VMs need to access the same drive



Amazon Simple Storage Service (S3) - Object

- Object is stored with data, metadata and Unique ID
- Scales with limited no file limit or storage limit
- Supports multiple reads and writes (no locks)

When you just want to upload files, and not have to worry about underlying infrastructure. Not intended for high IOPs



S3 Storage Classes

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AWS offers a range of S3 storage classes that *trade Retrieval Time, Accessibility and Durability for Cheaper Storage*

S3 Standard (default)

Fast! 99.99% Availability, 11 9's Durability. Replicated across at least three AZs

S3 Intelligent Tiering

Uses ML to analyze object usage and determine the appropriate storage class.

Data is moved to the most cost-effective access tier, without any performance impact or added overhead.

S3 Standard-IA (Infrequent Access)

Still Fast! Cheaper if you access files less than once a month.

Additional retrieval fee is applied. **50% less** than Standard (reduced availability)

S3 One-Zone-IA

Still Fast! Objects only exist in one AZ. Availability (is 99.5%). but cheaper than Standard IA by 20% less
(Reduce durability) Data could get destroyed. A retrieval fee is applied.

S3 Glacier

For long-term cold storage. Retrieval of data can take minutes to hours but the off is very cheap storage

S3 Glacier Deep Archive

The lowest cost storage class. Data retrieval time is 12 hours.

S3 Outposts has its own storage class. 

Cheaper

Storage Services

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Simple Storage Service (S3) is a **serverless object storage service**. You can upload very large files and an unlimited amount of files. You pay for what you store. You don't worry about the underlying file-system, or upgrading the disk size.



S3 Glacier is a **cold storage service**. It design as a low cost storage solution for **archiving and long-term backup**. It uses previous generation HDD drives to get that low cost. Its highly secure and durable.



Elastic Block Store (EBS) is a **persistent block storage service**. It is a virtual hard drive in the cloud you attach to EC2 instances. You can choose different kinds of hard drives: **SSD, IOPS SSD, Throughput HHD, Cold HHD**



Elastic File Storage (EFS) is a **cloud-native NFS file system service**. File storage you can mount to multiple EC2 instances at the same time. **When you need to share files between multiple servers**



Storage Gateway is a **hybrid cloud storage** service that extends your on-premise storage to cloud



File Gateway extends your local storage to AWS S3



Volume Gateway caches your local drives to S3 so you have a countious backup of local files in the cloud



Tape Gateway stores files onto virtual tapes for backing up your files on very cost effective long term storage.

Storage Services

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AWS Snow Family are **storage devices used to physically migrate large amounts of data** to the cloud.

- **Snowball** and **Snowball Edge** are briefcase size data storage devices. **50-80 Terabytes**
- **Snowmobile** is a cargo container filled with racks of storage and compute that is transported via semi-trailer tractor truck to transfer up to **100PB** of data per trailer.
- **Snowcone** is a very small version of Snowball that can transfer **8TB** of data.



AWS Backup a fully **managed backup service** that makes it easy to centralize and automate the backup of data across multiple AWS services eg. EC2, EBS, RDS, DynamoDB, EFS, Storage Gateway. You create backup plans.



CloudEndure Disaster Recovery continuously replicates your machines into a low-cost staging area in your target AWS account and preferred Region enabling fast and reliable recovery in case of IT data center failures.



Amazon FSx is a **feature rich and highly-performant file system**. That can be used for Windows (SMB) or Linux (Lustre)



Amazon FSx for Window File Server uses the SMB protocol and allows you to mount FSx to Windows servers



Amazon FSx for Lustre uses Linux's Lustre file system and allows you to mount FSx to Linux servers



What is a Database?

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A database is a **data-store that stores semi-structured and structured data.**

A database is more **complex data stores** because it **requires using formal design and modeling techniques**

Databases can be generally categorized as either:

- **Relational databases**
 - Structured data that strongly represents tabular data (tables, rows and columns)
 - Row-oriented or Columnar-oriented
- **Non-relational databases**
 - Semi-structured that may or may not distantly resemble tabular data.

Databases have a rich set of functionality:

- specialized language to query (retrieve data)
- specialized modeling strategies to optimize retrieval for different use cases
- more fine tune control over the transformation of the data into useful data structures or reports



Normally a databases infers someone is using a **relational row-oriented data store**



What is Data Warehouse?

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A relational datastore designed for **analytic workloads**, which is generally **column-oriented data-store**

Companies will have **terabytes and millions of rows of data**, and they need a fast way to be able to produce analytics reports

Data warehouses generally perform **aggregation**

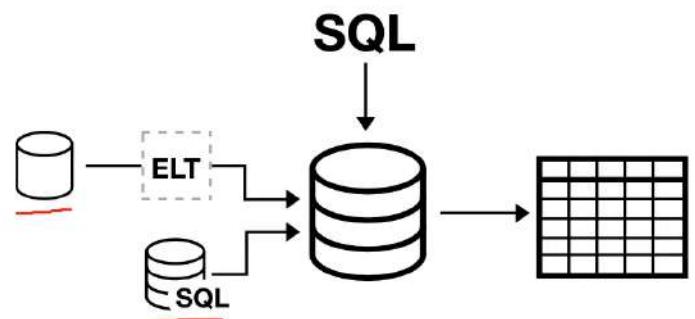
- aggregation is grouping data eg. find a total or average
- Data warehouses are optimized around columns since they need to quickly aggregate column data

Data warehouses are generally designed be HOT

- Hot means they can return queries very fast even though they have vast amounts of data

Data warehouses are infrequently accessed meaning they aren't intended for real-time reporting but maybe once or twice a day or once a week to generate business and user reports.

A data warehouse needs to consume data from a relational databases on a regular basis.



What is a Key / Value store?

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A **key-value database** is a type of non-relational database (NoSQL) that uses a simple key-value method to store data.

A key/value stores a **unique key** alongside a value



Key	Value
Data	1010101000101011001010010101001
Worf	0110101100010101010101011100010
Ro Laren	001010100101011001010101010101010

Key values stores are **dumb and fast**.

They generally lack features like:

- Relationships
- Indexes
- Aggregation

A key/value store can resemble tabular data, it does not have to have the consistent columns per row (hence its schemaless)

Key (Name)	Species	Rank	Affiliation
Data	andriod	Lt commander	
Worf	klingon	Lt commander	
Ro Laren	bajoran		maquis

A simple key/value store will interpret this data resembling a dictionary (aka Associative arrays or hash)

Due to their simple design they can scale well beyond a relational database



What is a Document store?

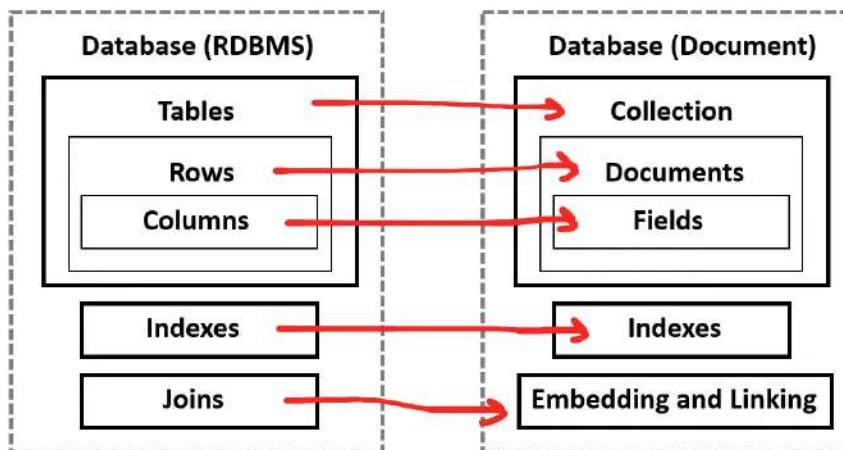
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A **document store** is a NOSQL database that stores **documents** as its primary data structure.

A document could be an XML but more commonly is JSON or JSON-Like

Document stores are sub-class of Key/Value stores

The components of a document store compared to Relational database



NoSQL Database Service

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DynamoDB is a serverless **NoSQL key/value and document database**. It is designed to scale to **billions of records** with guaranteed consistent data return in at least a second. You don't have to worry about managing shards!



DynamoDB is AWS's **flagship database service** meaning whenever we *think* of a database service that just scales, is cost effective and very fast we should think DynamoDB



In **2019**, **Amazon** the online shopping retail shutdown their last Oracle database and completed their migration to DynamoDB. They had 7,500 Oracle Database and 75 petabytes of data. With DynamoDB they reduce costs by 60% and reduce latency by 40%

When we want a massively scalable database



DocumentDB is a NoSQL **document** database that is "MongoDB compatible"

MongoDB is very popular NoSQL among developers. There were open-source licensing issues around using open-source MongoDB, so AWS got around it by just building their own MongoDB database.

When you want a MongoDB database.



Amazon Keyspaces is a fully managed Apache Cassandra database. Cassandra is an open-source NoSQL key/value database similar to DynamoDB in that is columnar store database but has some additional functionality. *When you want to use Apache Casandra.*



Relational Database Services

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Relational Database Service (RDS) is a **relational database service** that supports multiple SQL engines. Relational is synonymous with SQL and Online Transactional Processing (OLTP). Relational database are **the most commonly used type of database** among tech companies and start-ups.



RDS Supports the following SQL Engines:

- **MySQL** – The most popular open-source SQL database that was purchased and now owned by Oracle.
- **MariaDB** – When Oracle bought MySQL, MariaDB made a fork (copy) of MySQL under a different open-source license.
- **Postgres (PSQL)** – Most popular open-source SQL database among developers. Has rich-features over MySQL but at added complexity.
- **Oracle** – Oracle's proprietary SQL database. Well used by Enterprise companies. You have to buy a license to use it.
- **Microsoft SQL Server** – Microsoft's proprietary SQL database. You have to buy a license to use it.
- **Aurora** – Fully managed database.



Aurora is a **fully managed** database of either MySQL (5x faster) and PSQL (3x faster) database.

When you want a highly available, durable, scalable and secure relational database for Postgres or MySQL



Aurora Serverless is the **serverless on-demand version of Aurora**. *When you want “most” of the benefits of Aurora but can trade to have cold-starts or you don't have lots of traffic demand*



RDS on VMware allows you to deploy RDS supported engines to on an-premise data-center. The datacenter must be using VMware for server virtualization. *When you want databases managed by RDS on your own datacenter*



Other Database Services

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Redshift is a **petabyte-size data-warehouse**. Data-warehouses are for Online Analytical Processing (OLAP). Data-warehouses can be expensive because they are keeping data “hot”. Meaning that we can run a very complex query and a large amount of data and get that data back very fast.

When you need to quickly generate analytics or reports from a large amount of data.



ElastiCache is a managed database of the **in-memory** and **caching** open-source databases **Redis** or **Memcached**. *When you need to improve the performance of application by adding a caching layer in-front of web-server or database.*



Neptune is a managed graph database. Data is represented as interconnected nodes.

When you need to understand the connections between data eg. Mapping Fraud Rings or Social Media relationships



Amazon Timestreams is a fully managed time series database. Think of devices that send lots of data that are time-sensitive such as IoT devices. *When you need to measure how things change over time.*



Amazon Quantum Ledger Database is a fully managed ledger database that provides transparent, immutable and cryptographically variable transaction logs.

When you need to record history of financial activities that can be trusted.



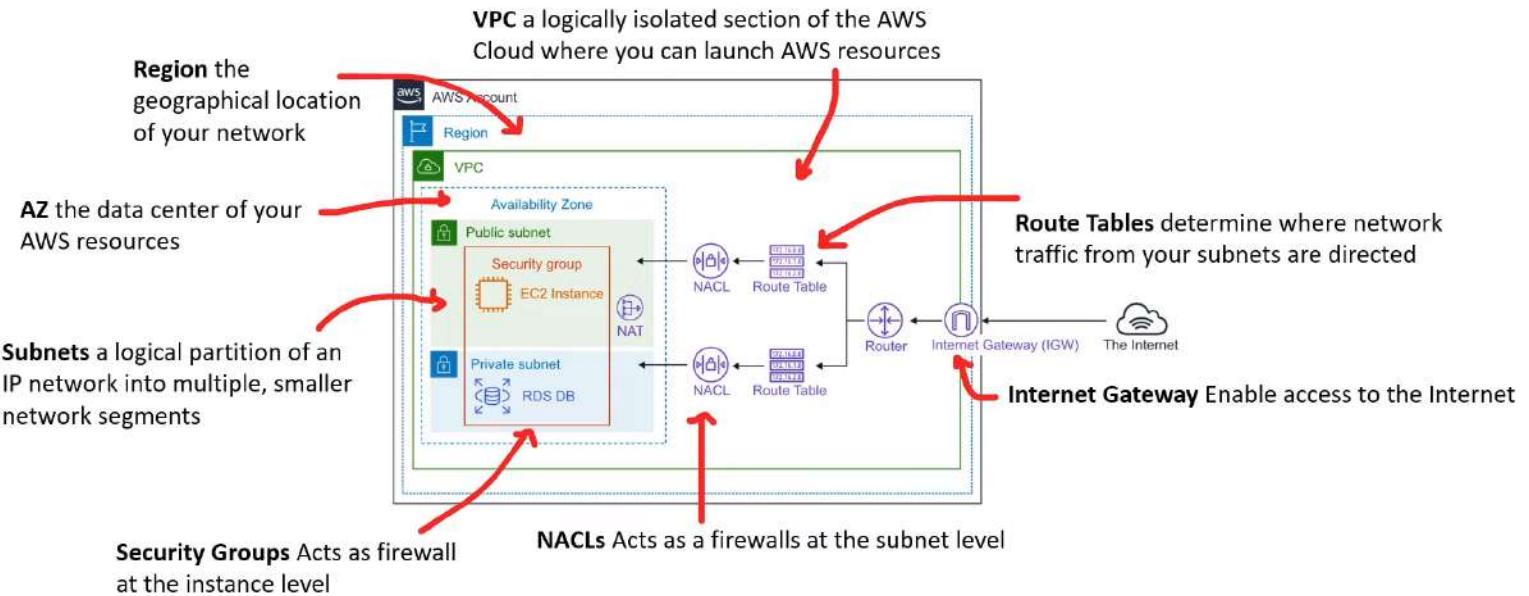
Database Migration Service (DMS) is database migration service. You can migrate from:

- on-premise database to AWS
- from two database in different or same AWS accounts using different SQL engines
- from an SQL to NoSQL database



Cloud-Native Networking Services

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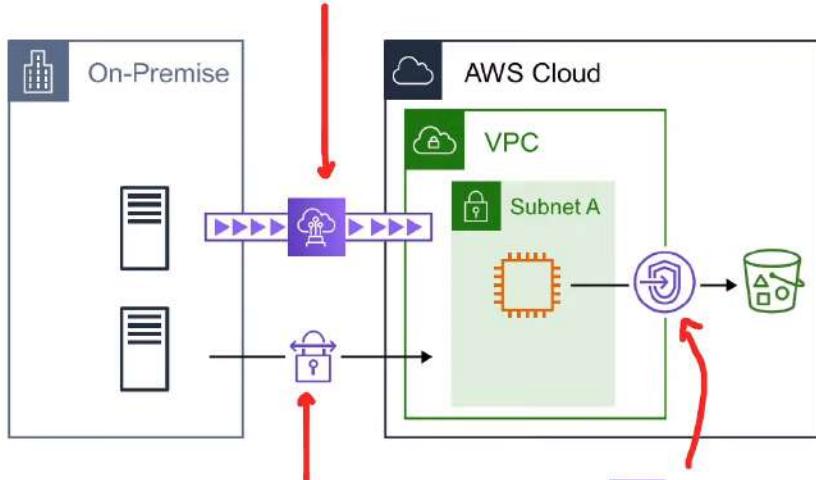


Enterprise/Hybrid Networking

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DirectConnect dedicated gigabit connection from on-premise data-center to AWS (a very fast connection)



AWS Virtual Private Network (VPN) a secure connection between on-premise, remote offices, mobile employees.



PrivateLinks (VPC Interface Endpoints) keeps traffic within the AWS network and not traverse the internet to keep traffic is secure.

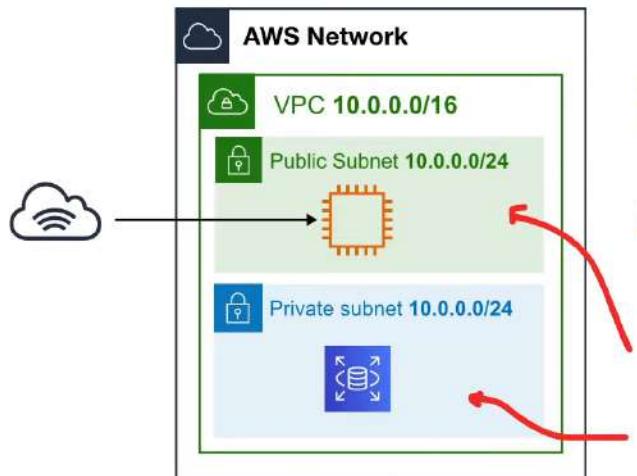


Virtual Private Cloud (VPC) and Subnets

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Virtual Private Cloud (VPC) is a logically isolated section of the AWS Network where you launch your AWS resources. You choose a **range of IPs using CIDR Range**

CIDR Range of **10.0.0.0/16 = 65,536** IP Addresses



Subnets a logical partition of an IP network into multiple smaller network segments. **You are breaking up your IP range for VPC** into smaller networks.

Subnets **need to have a smaller CIDR range than to the VPC** represent their portion.

eg Subnet CIDR Range **10.0.0.0/24 = 256 IP Addresses**

A Public Subnet is one that can reach the internet

A Private Subnet is one that cannot reach the internet

Security Groups vs NACLs

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Network Access Control Lists (NACLs)

Acts as a virtual **firewall at the subnet level**

You create **Allow and Deny rules**.

eg. Block a specific IP address known for abuse

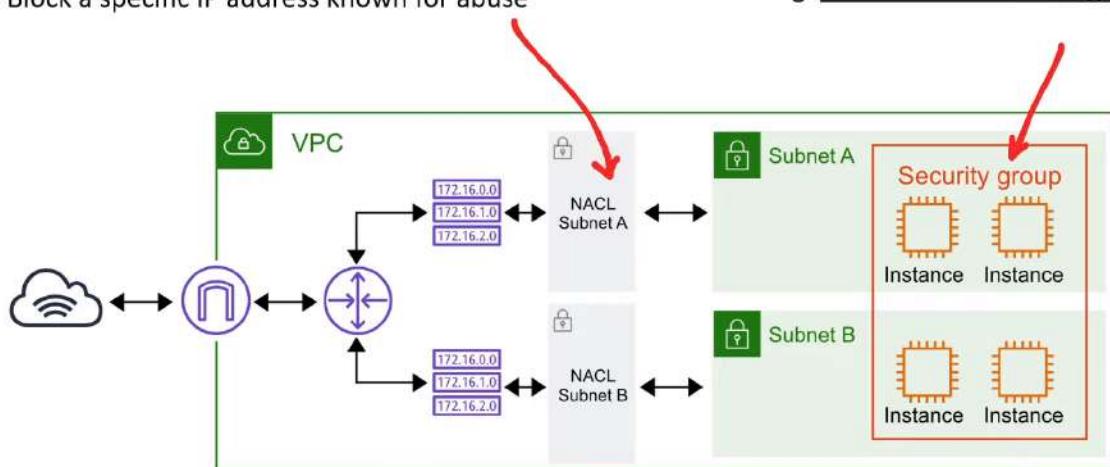
Security Groups

Acts as a virtual **firewall at the instance level**

Implicitly denies all traffic. **You create only Allow rules.**

eg. Allow an EC2 instance access on port 22 for SSH

eg. You cannot block a single IP address.

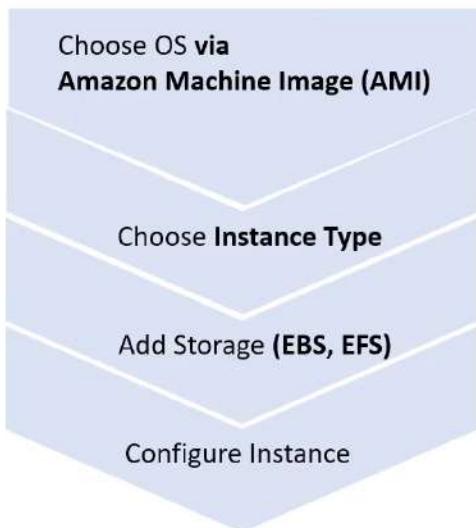


Introduction to EC2

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Elastic Compute Cloud (EC2) is a **highly configurable virtual server**.
EC2 is resizable **compute capacity**. It takes **minutes** to launch new instances.
Anything and everything on AWS uses EC2 Instance underneath.



Red Hat



ubuntu



C4.8xlarge

\$1.591/hour (\$1161.43/month)



Amazon Linux



SUSE

t2.nano

\$0.0065/hour (\$4.75/month)

1 vCPU 0.5GB Mem

SSD

HDD

Virtual Magnetic Tape

Multiple Volumes

Security Groups, Key Pairs, UserData, IAM Roles, Placement Groups



EC2 Instance Families

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What are Instance Families?

Instance families are different combinations of CPU, Memory, Storage and Networking capacity.

Instance families allow you to choose the appropriate combination of capacity to meet your application's unique requirements.

Different instance families are different because of the varying hardware used to give them their unique properties.

Commonly instance families are called "Instance Types" but an instance type is a combination of size and family.

General Purpose

A1 T2 T3 T3a T4g M4 M5 M5a M5n M6zn M6g M6i Mac

balance of compute, memory and networking resources

Use-cases web servers and code repositories

Compute Optimized

C5 C4 Cba C5n C6g C6gn

Ideal for compute bound applications that benefit from high performance processor

Use-cases scientific modeling, dedicated gaming servers and ad server engines

Memory Optimized

R4 R5 R5a R5b R5n X1 X1e High Memory z1d

fast performance for workloads that process large data sets in memory.

Use-cases in-memory caches, in-memory databases, real time big data analytics

Accelerated Optimized

P2 P3 P4 G3 G4ad G4dn F1 Inf1 VT1

hardware accelerators, or co-processors

Use-cases Machine learning, computational finance, seismic analysis, speech recognition

Storage Optimized

I3 I3en D2 D3 D3en H1

high, sequential read and write access to very large data sets on local storage

Use-cases NoSQL, in-memory or transactional databases, data warehousing



EC2 Instance Types

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An instance type is a particular **instance size and instance family**:

A common pattern for instance sizes:

- nano
- micro
- small
- medium
- large
- xlarge
- 2xlarge
- 4xlarge
- 8xlarge
-



Currently selected: t2.micro (- ECUs, 1 vCPUs, 2.5 GHz, -, 1 GiB memory, EBS only)				
	Family	Type	vCPUs	Memory (GiB)
	t2	t2.nano	1	0.5
<input checked="" type="checkbox"/>	t2	<u>t2.micro</u> Free tier eligible	1	1
	t2	<u>t2.small</u>	1	2
	t2	<u>t2.medium</u>	2	4
	t2	<u>t2.large</u>	2	8
	t2	<u>t2.xlarge</u>	4	16

There are many exceptions to this pattern for sizes e.g.

- c6g.metal – is a bare metal machine.
- C5.9xlarge – Is not a power of 2 or even number size

EC2 Instance Sizes

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EC2 Instance Sizes **generally double** in price and key attributes

Name	vCPU	RAM (GiB)	On-Demand per hour	On-Demand per month
t2.small	1	12	\$0.023	\$16.79
t2.medium	2	24	\$0.0464	\$33.87
t2.large	2	36	\$0.0928	\$67.74
t2.xlarge	4	54	\$0.1856	\$135.48

EC2 – Dedicated Host

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Dedicated Hosts are single-tenant EC2 instances designed to let you Bring-Your-Own-License (BYOL) based on **machine characteristics**

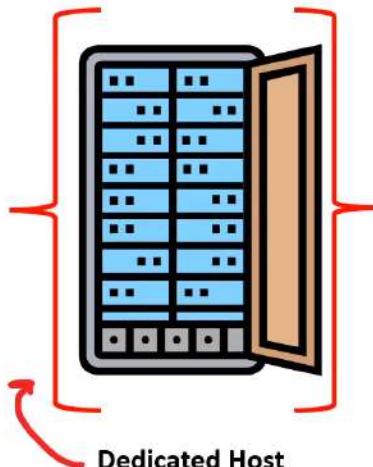
	Dedicated Instance	Dedicated Hosts
Isolation	Instance Isolation	Physical Server Isolation
Billing	Per instance billing (+\$2 per region fee)	Per host billing
Visibility of Physical characteristics	No Visibilities	Sockets, cores, host ID
Affinity between a host and instance	No Affinity	Consistency deploy to the same instances to the same physical server
Targeted instance placement	No control	Additional control over instance placement on physical server
Automatic instance placement	Yes	Yes
Add capacity using an allocation request	No	Yes



EC2 Tenancy

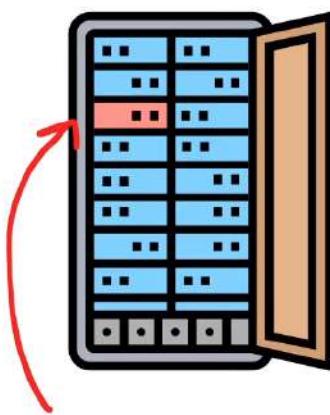
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EC2 has three levels of tenancy:



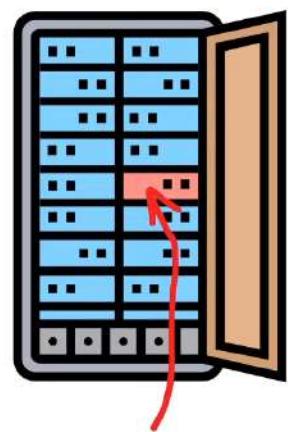
Dedicated Host

Your server lives here and you have control of the physical attributes



Dedicated Instance

Your server always lives here



Default

You instance live here *until reboot*

EC2 Pricing Models

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There are 5 different ways to pay for EC2 (Virtual Machines)

On-Demand

Least Commitment

- low cost and flexible
- only pay per hour or the *second
- short-term, spiky, unpredictable workloads
- cannot be interrupted
- For first time apps

Spot up to 90%

Biggest Savings

- request spare computing capacity
- flexible start and end times
- Can handle interruptions (server randomly stopping and starting)
- For non-critical background jobs

Reserved up to 75% off

Best Long-term

- steady state or predictable usage
- commit to EC2 over a 1 or 3 year term
- Can resell unused reserved instances

Dedicated

Most Expensive

- Dedicated servers
- Can be on-demand or reserved or spot
- When you need a guarantee of isolate hardware (enterprise requirements)

AWS Savings Plan is another way to save but can be used for more than just EC2.



On-Demand

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On-Demand is a **Pay-As-You-Go (PAYG) model**, where you consume compute and then you pay.

When you **launch** an EC2 instance it **is by default** using **On-Demand Pricing** 

Launch instances

On-demand has **no up-front payment** and **no long-term commitment**

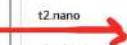
You are charged by the **second (minimum of 60 seconds)** or the **hour**

per-second for:

Linux, Windows, Windows with SQL
Enterprise, Windows with SQL Standard,
and Windows with SQL Web Instances
that do not have a separate hourly charge

per-hour:

full hour for all other instance types.

When looking up pricing it will always
show EC2 pricing is the **hourly rate** 

Viewing 363 of 363 available instances						
Instance name	On-Demand hourly rate	vCPU	Memory	Storage	Network performance	
t2.nano	\$0.0058	1	0.5 GiB	EBS Only	Low	
t2.micro	\$0.0116	1	1 GiB	EBS Only	Low to Moderate	

On-Demand is for applications where the workload is for **short-term, spiky** or **unpredictable**.

When you have a **new app** for development or you want to run experiment.



Reserved Instances (RI)

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Designed for applications that have a **steady-state, predictable usage**, or require **reserved capacity**.

Reduced Pricing is based on **Term x Class Offering x RI Attributes x Payment Option**

Term — The longer the term the greater savings.

You commit to a **1 Year** or **3 Year** contract.

Reserved Instances do not renew automatically

When they expire your instance will use On-Demand with no interruption to service

Class — The less flexible the greater the savings

Standard Up to **75%** reduced pricing compared to on-demand. You can modify **RI Attributes**.

Convertible Up to **54%** reduced pricing compared to on-demand. You can exchange RI based on **RI Attributes** if greater or equal in value.

Scheduled AWS no longer offers Scheduled RI

Payment Options — The greater upfront the greater the savings

All Upfront

Full payment is made at the start of the term

Partial Upfront

A portion of the cost must be paid upfront and the remaining hours in the term are billed at a discounted hourly rate

No Upfront

You are **billed** a discounted hourly rate for every hour within the term, regardless of whether the Reserved Instance is being used

RIs can be **shared between multiple accounts within an AWS Organization**
Unused RIs can be sold in the **Reserved Instance Marketplace**



Reserved Instances (RI)

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Filter base on your requirements

Purchase Reserved Instances

Platform: Linux/UNIX | Tenancy: Default | Offering class: Convertible

Instance type: t3.micro | Term: 1 month to 12 months | Payment option: Any

Only show offerings that reserve capacity

Seller	Term	Effective rate	Upfront price	Hourly rate	Payment option	Offering class	Quantity available	Desired quantity	Normalized units per hour	Add to cart
AWS	12 months	\$0.008	\$69.00	\$0.000	All upfront	Convertible	Unlimited	1	0.5	<input type="button" value="Add to cart"/>
AWS	12 months	\$0.008	\$0.00	\$0.008	No upfront	Convertible	Unlimited	1	0.5	<input type="button" value="Add to cart"/>
AWS	12 months	\$0.008	\$35.00	\$0.004	Partial upfront	Convertible	Unlimited	1	0.5	<input type="button" value="Add to cart"/>

Your cart: 1 Reserved Instance, total due now: \$69.00

Monthly recurring cost: \$0.00

Additional taxes may apply.

(A) SOURCE

Reserved Instances (RI) – RI Attributes

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RI Attributes (aka Instance Attributes) are limited based on Class Offering and can affect the final price of an RI instance. There are 4 RI Attributes:



1. Instance type: For example, m4.large. This is composed of the instance family (for example, m4) and the instance size (for example, large).



2. Region: The Region in which the Reserved Instance is purchased.



3. Tenancy: Whether your instance runs on shared (default) or single-tenant (dedicated) hardware.



4. Platform: The operating system eg. Windows or Linux/Unix.

Regional and Zonal RI

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When you purchase a RI, you determine **the scope** of the Reserved Instance.
The scope **does not affect the price**.

Regional RI: purchase for a Region

does *not* reserve capacity.

RI discount applies to instance usage in any AZ in the Region.

RI discount applies to instance usage within the instance family, regardless of size. Only supported on Amazon Linux/Unix Reserved Instances with default tenancy.

You can queue purchases for regional RI

Zonal RI: purchase for an Availability Zone

reserves capacity in the specified Availability Zone.

RI discount applies to instance in the selected AZ (No AZ Flexibility)

No instance size flexibility
RI discounts apply to instance usage for the specified instance type and size only.

You can't queue purchases for zonal RI



RI Limits

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There is a limit to the number of Reserved Instances that you can purchase per month.

Per month you can purchase

- **20** Regional Reserved Instances *per Region*
- **20** Zonal Reserved Instances *per AZ*

Regional Limits

You cannot exceed your running On-Demand Instance limit by purchasing regional Reserved Instances.

The default On-Demand Instance limit is 20.

Before purchasing RI ensure your On-Demand limit is equal to or greater than your RI you intend to purchase

Zonal Limits

You can exceed your running On-Demand Instance limit by purchasing zonal Reserved Instances

If you already have 20 running On-Demand Instances, and you purchase 20 zonal Reserved Instances, you can launch a further 20 On-Demand Instances that match the specifications of your zonal Reserved Instances



Capacity Reservations

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EC2 instances are backed by different kind of hardware, and so there is a **finite amount of servers** available within an Availability Zone per instance type or family.



You go to launch a specific type of EC2 instance but AWS has ran out of that server!

Capacity Reservation is a service of EC2 that allows you to **request a reserve of EC2 instance type** for a specific Region and AZ

The reserved capacity is charged at the selected instance type's On-Demand rate whether an instance is running in it or not.

You can also use your regional reserved instances with your Capacity Reservations to benefit from billing discounts

The screenshot shows the 'Create New Capacity Reservation' form. It includes fields for Instance Type (c4.2xlarge), Platform (Linux/UNIX), Availability Zone (ca-central-1a), Tenancy (Default - run a shared hardware instance), Quantity (1), and EBS-optimized (checked). A red arrow points from the text 'request a reserve of EC2 instance type' to the 'Instance Type' dropdown. The 'Reservation ends' section shows a date and time of 2021/10/10 10:06. The 'Instance eligibility' section contains two options: 'Any instance with matching details' (selected) and 'Only instances that specify this reservation'.

Standard vs Convertible RI

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There are some key difference between Standard and Convertible

Standard RI

RI attributes can be modified

- Change the AZ within same Region
- Change the scope of the Zonal RI to Regional RI or visa versa
- Change the instance size (Linux/Unix only, default tenancy)
- Change network from Ec2-Classic to VPC and visa-versa

Can't be exchanged

Can be bought or sold in the RI Marketplace

Convertible RI

RI attributes can't be modified (you perform an exchange)

Can be exchanged during the term for another Convertible RI with new RI attributes, including:

- instance family
- instance type
- platform
- scope
- tenancy

Can't be bought or sold in the RI Marketplace



RI Marketplace

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EC2 Reserved Instance Marketplace allows you to **sell your unused Standard RI** to recoup your RI spend for RI you do not intend or cannot use.

- Reserved Instances can be sold after they have been active for at least 30 days and once AWS has received the upfront payment (if applicable).
- You must have a US bank account to sell Reserved Instances on the Reserved Instance Marketplace.
- There must be at least one month remaining in the term of the Reserved Instance you are listing.
- You will retain the pricing and capacity benefit of your reservation until it's sold and the transaction is complete.
- Your company name (and address upon request) will be shared with the buyer for tax purposes.
- A seller can set only the upfront price for a Reserved Instance. The usage price and other configuration (e.g., instance type, Availability Zone, platform) will remain the same as when the Reserved Instance was initially purchased.
- The term length will be rounded down to the nearest month. For example, a reservation with 9 months and 15 days remaining will appear as 9 months on the Reserved Instance Marketplace.
- You can sell up to \$20,000 in Reserved Instances per year. If you need to sell more Reserved Instances.
- Reserved Instances in the GovCloud region cannot be sold on the Reserved Instance Marketplace.



Spot Instances

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AWS has **unused compute capacity** that they want to maximize the utility of their idle servers.



It's like when a hotel offers booking discounts to fill vacant suites or planes offer discount to fill vacant seats

Spot Instances provide a discount of **90%** compared to On-Demand Pricing
Spot Instances can be terminated if the computing capacity is needed by other On-Demand customers

Designed for applications that have flexible start and end times or applications that are only feasible at **very low** compute costs.

Load balancing workloads
Launch instances of the same size, in any Availability Zone.
Good for running web services.

Flexible workloads
Launch instances of any size, in any Availability Zone. Good for running batch and CI/CD jobs.

Big data workloads
Launch instances of any size, in a single Availability Zone.
Good for MapReduce jobs.



AWS Batch is an easy and convenient way to use Spot Pricing

Termination Conditions

Instances can be terminated by AWS **at anytime**

If your instance is **terminated by AWS**, **you don't get charged** for a partial hour of usage.

If **you terminate** an instance **you will still be charged** for any hour that it ran.



Dedicated Instances

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Dedicated Instances is designed to meet regulatory requirements.

When you have strict **server-bound licensing** that won't support multi-tenancy or cloud deployments you use **Dedicated Hosts**.



Multi-Tenant

think of everyone living in an apartment



Multi-Tenant



Single Tenant

think of everyone having their own house



Single-Tenant



Single-Tenant



Single-Tenant

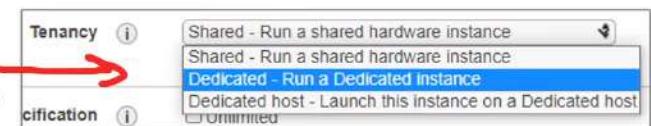
When multiple customers are running workloads on the same hardware. **Virtual Isolation** is what separate customers

When a single customer has dedicated hardware. **Physical Isolation** is what separates customers

Dedicated can be offered for:

- **On-demand**
- **Reserved (up to 60% savings)**
- **Spot (up to 90% savings)**

You choose tenancy when you **launch** your EC2
(Notice there is a Dedicated Host)



Enterprises and Large Organizations may have security concerns or obligations about against sharing the same hardware with other AWS Customers.

AWS Savings Plan

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Savings Plans offer you the similar discounts as Reserved Instances (RI) but **simplifies the purchasing process**

There are 3 types of Savings Plans:

- **Compute Savings Plans**
- **EC2 Instance Savings Plans**
- **SageMaker Savings Plan**

You can choose two different terms

- 1 Year
- 3 Year

Term

1-year

3-year

Savings Plan type

Compute Savings Plans
Applies to EC2 Instance usage, AWS Fargate, and AWS Lambda service usage, regardless of region, instance family, size, tenancy, and operating system.
[Learn more](#)

EC2 Instance Savings Plans
Applies to instance usage within the committed EC2 family and region, regardless of size, tenancy, and operating system.
[Learn more](#)

SageMaker Savings Plans
Applies to SageMaker service usage, regardless of region, instance family, and component.
[Learn more](#)

You choose the following Payment Options:

- All Upfront
- Partial Upfront
- No Upfront

Hourly commitment

Your hourly commitment at Savings Plan

\$0.092

Payment option

All Upfront

Partial Upfront

No Upfront

You choose an hourly commitment



AWS Savings Plan

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AWS Savings Plan has 3 different savings types:

Compute

 Compute Savings Plans provide the most flexibility and help to reduce your costs by up to 66%. These plans automatically apply to EC2 instance usage, AWS Fargate, and AWS Lambda service usage regardless of instance family, size, AZ, region, OS, or tenancy.

EC2 Instances

 provide the lowest prices, offering savings up to 72% in exchange for commitment to usage of individual instance families in a region.
automatically reduces your cost on the selected instance family in that region regardless of AZ, size, OS or tenancy.
give you the flexibility to change your usage between instances within a family in that region.

SageMaker

 Helps you reduce SageMaker costs by up to 64%.
automatically apply to SageMaker usage regardless of instance family, size, component, or AWS region.



Zero Trust Model

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The Zero Trust model operates on the principle of
"trust no one, verify everything."

Malicious actors being able to by-pass conventional **access controls**
demonstrates traditional security measures are no longer sufficient

In the Zero Trust Model **Identity** becomes the primary security perimeter.

What is the Primary Security Perimeter?

The primary or new security perimeter defines the first line of defense and its security controls that protect a company's cloud resources and assets

Network-Centric: (Old-Way)

traditional security focused on firewalls and VPNs since there were few employees or workstations outside the office or they were in specific remote offices.

Identity-Centric: (New-Way)

Bring-your-own-device, remote workstations is much more common , we can't trust if the employee is in a secure location, we have identity based security controls like MFA, or providing provisional access based on the level of risk from where, when and what a user wants to access.

Identity-Centric does not replace but **augments** Network-Centric Security



@Sigmund on Unsplash 

Zero Trust on AWS

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Identity Security Controls you can implement on AWS to meet the Zero Trust Model



- IAM Policies
- Permission Boundaries
- Service Control Policies (Organization-wide Policies)
- IAM Policy Conditions
 - aws:Sourcelp – Restrict on IP Address
 - aws:RequestedRegion – Restrict on Region
 - aws:MultiFactorAuthPresent – Restrict if MFA is turned off
 - aws:CurrentTime – Restrict access based on time of day

AWS Identity and Access Management (IAM)



Your AWS Resources



AWS does not have a ready-to-use identity controls are intelligent, which is why AWS is considered to not have a true Zero Trust offering for customers, and third-party services need to be used.

A collection of AWS Services can be setup to intelligent-ish detection of identity concerns but requires expert knowledge



AWS CloudTrail
Tracks all API calls



Amazon GuardDuty
Detects suspicious or malicious activity based on CloudTrail and other logs



Amazon Detective
Used to analyze, investigate and quickly identify security issues (can ingest findings from Guard Duty)



Zero Trust on AWS with Third Parties

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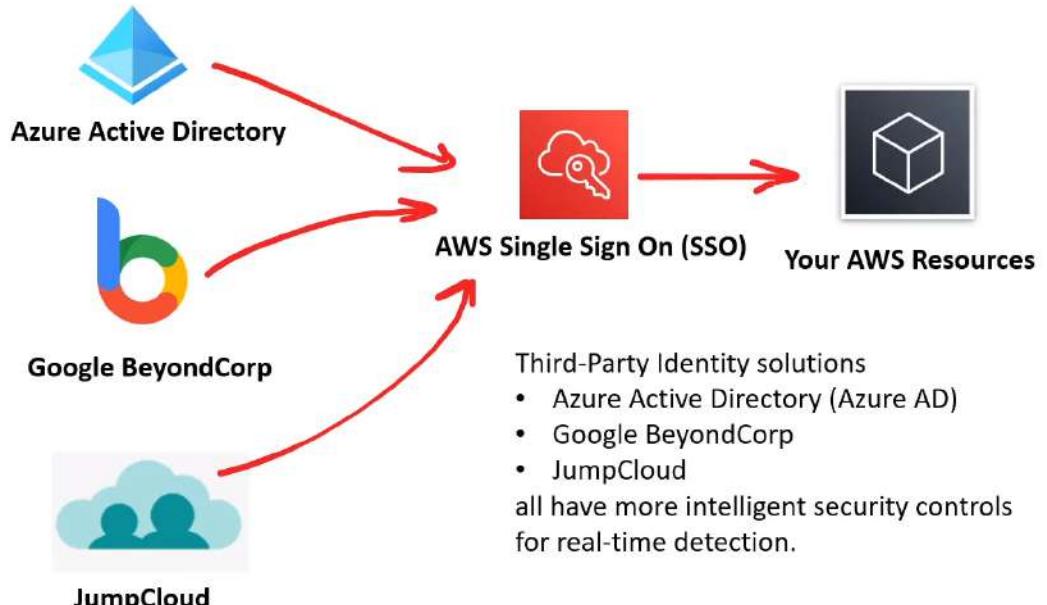
AWS does technically implement a Zero Trust Model but does not allow for intelligent identity security controls.

For example:

Azure Active Directory has Real-time and calculated risk detection based more data points than AWS eg:

- Device and Application
- Time of Day
- Location
- MFA turned on
- What is being accessed

And the security controls, verifications or logic restriction is much more robust.



Directory Service

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What is a directory service?

A directory service maps the **names of network resources to their network addresses.**

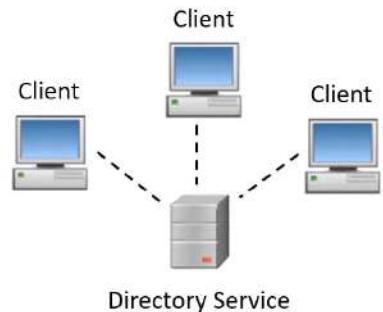
A directory service is shared information infrastructure for **locating, managing, administering and organizing** resources:

- Volumes
- Folders
- Files
- Printers
- Users
- Groups
- Devices
- Telephone numbers
- other objects

A directory service is a critical component of a network operating system

A directory server (name server) is a server which provides a directory service

Each resource on the network is considered an object by the directory server. Information about a particular resource is stored as a collection of attributes associated with that resource or object



Well known directory services:

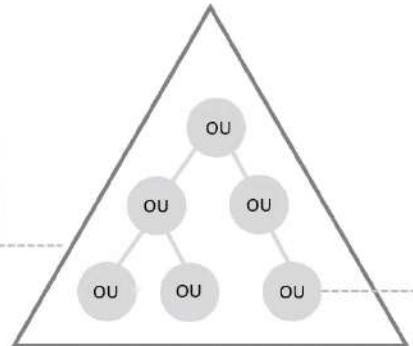
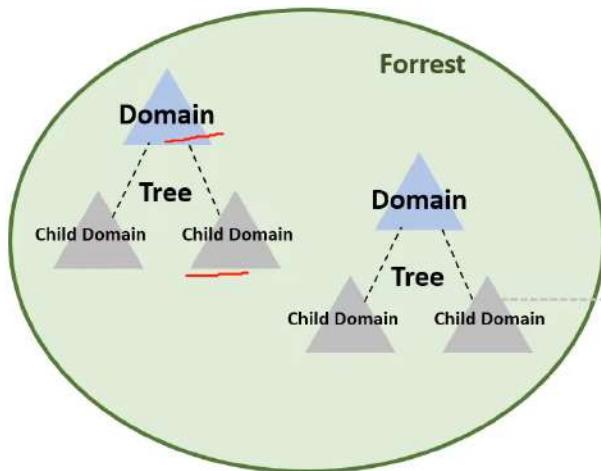
- Domain Name Service (DNS)
 - the directory service for **the internet**
- **Microsoft Active Directory**
 - Azure Active Directory
- Apache Directory Server
- Oracle Internet Directory (OID)
- OpenLDAP
- Cloud Identity
- JumpCloud

Active Directory

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Microsoft introduced **Active Directory** Domain Services in **Windows 2000** to give organizations the ability to manage multiple on-premises infrastructure components and systems using a single identity per user.



Identity Providers (IdPs)

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Identity Provider (IdP) a system entity that creates, maintains, and manages identity information for principals and also provides authentication services to applications within a **federation** or distributed network. A trusted provider of your user identity that lets you use authenticate to access other services.
Identity Providers could be: **Facebook, Amazon, Google, Twitter, Github, LinkedIn**

Federated identity is a method of linking a user's identity across multiple separate identity management systems



OpenID

open standard and decentralized authentication protocol. Eg be able to login into a different social media platform using a Google or Facebook account

OpenID is about providing who are you



OAuth2.0

industry-standard protocol for authorization OAuth doesn't share password data but instead uses authorization tokens to prove an identity between consumers and service providers.

Oauth is about granting access to functionality

SAML

Security Assertion Markup Language is an open standard for exchanging authentication and authorization between an identity provider and a service provider.

An important use case for SAML is **Single-Sign-On via web browser**.

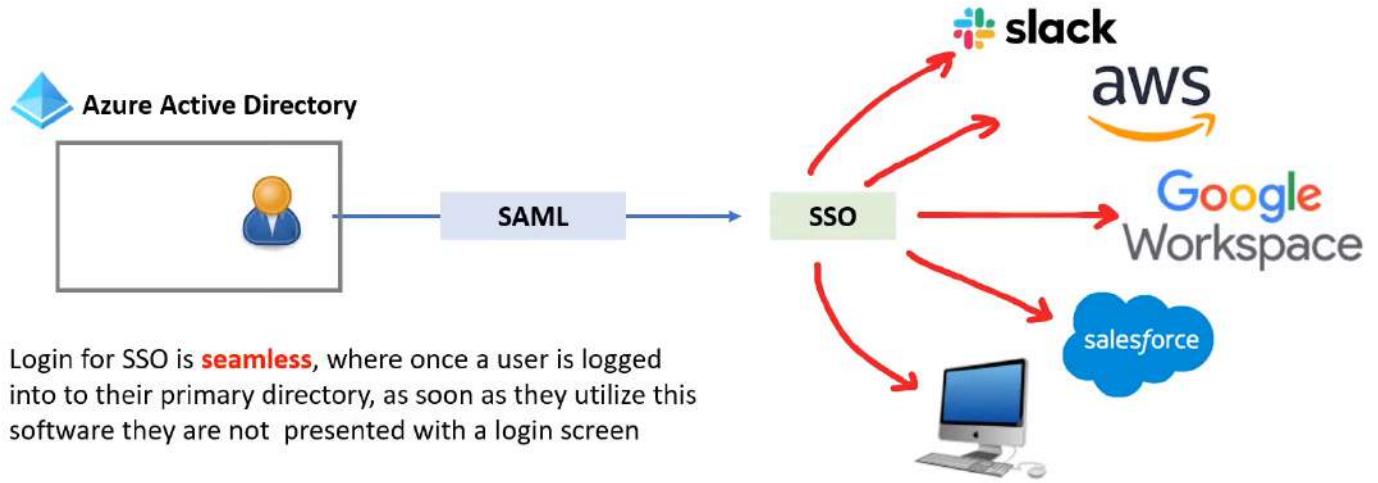


Single-Sign-On

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Single sign-on (SSO) is an authentication scheme that **allows a user to log in with a single ID and password to different systems and software.**

SSO allows IT departments to administrator a single identity that can access many machines and cloud services.



LDAP

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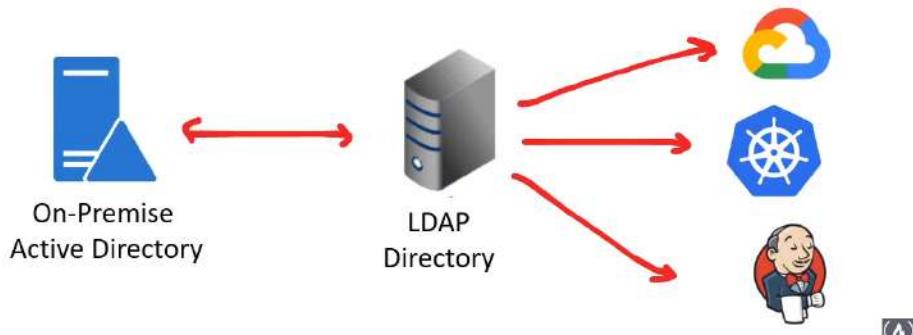
Lightweight Directory Access Protocol (LDAP) is an open, vendor-neutral, industry standard **application protocol for accessing and maintaining distributed directory information services** over an Internet Protocol (IP) network.

A common use of LDAP is to provide a central place to store usernames and passwords

LDAP enables for **same-sign on**. Same sign-on allows users to single ID and password, but they have to enter it in every time they want to login.

Why use LDAP when SSO is more convenient?

Most SSO systems are using LDAP.
LDAP was not designed natively to work with web-applications.
Some systems only support integration with LDAP and not SSO



Multi-Factor Authentication

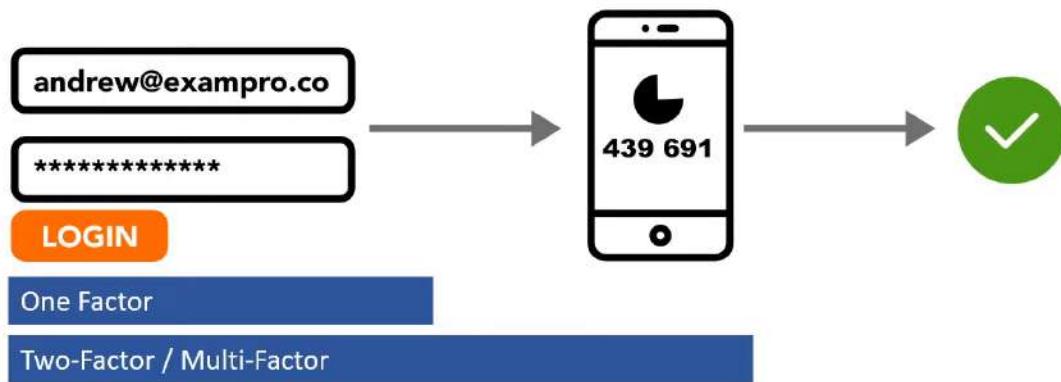
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What is Multi-Factor Authentication (MFA)?

A security control where after you fill in your username/email and password **you have to use a second device** such as a phone to confirm that its you logging in.

MFA **protects** against people who have stolen your password.

MFA is an option in most cloud providers and even social media websites such as Facebook.



Security Keys

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What is a Security Key?

A secondary device used as second step in authentication process to gain access to a device, workstation or application.

A security key can resemble a memory stick. When your finger makes contact with a button of exposed metal on the device it will generate And autofill a security token.

Manage MFA device

Choose the type of MFA device to assign:

Virtual MFA device
Authenticator app installed on your mobile device

U2F security key
YubiKey or any other compliant U2F device

Other hardware MFA device
Gemalto token

A popular brand of security key is an Yubikey



- Works out of the box with Gmail, Facebook, and hundreds more
- Supports **FIDO2**/WebAuthn, U2F
- Waterproof and crush resistant
- USB-A and NFC dual connectors on a single key

AWS Identity and Access Management (IAM)

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AWS Identity and Access Management (IAM) you can create and manage AWS users and groups, and use permissions to allow and deny their access to AWS resources.



IAM Policies JSON documents which grant permissions for a specific user, group, or role to access services. Policies are attached to **IAM Identities**

IAM Permission The API actions that can or cannot be performed.
They are represented in the IAM Policy document

IAM Identities



IAM Users End users who log into the console or interact with AWS resources programmatically or via clicking UI interfaces



IAM Groups Group up your Users so they all share permission levels of the group
eg. Administrators, Developers, Auditors



IAM Roles Roles grant AWS resources permissions to specific AWS API actions
Associate policies to a Role and then assign it to an AWS resource



Anatomy of an IAM Policy

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IAM Policies are written in JSON, and contain the permissions which determine what API actions are allowed or denied.

Version policy language version.
2012-10-17 is the latest version.

Statement container for the policy element you are allowed to have multiples

Sid (optional) a way of labeling your statements.

Effect Set whether the policy will Allow or Deny

Action list of actions that the policy allows or denies

Principal account, user, role, or federated user to which you would like to allow or deny access

Resource the resource to which the action(s) applies

Condition (optional) circumstances under which the policy grants permission

```
{  
  "Version": "2012-10-17",  
  "Statement": [  
    {  
      "Sid": "Deny-Barclay-S3-Access",  
      "Effect": "Deny",  
      "Action": "s3:*",  
      "Principal": {"AWS": ["arn:aws:iam:123456789012:barclay"]},  
      "Resource": "arn:aws:s3:::my-bucket"  
    },  
    {  
      "Effect": "Allow",  
      "Action": "iam:CreateServiceLinkedRole",  
      "Resource": "*",  
      "Condition": {  
        "StringLike": {  
          "iam:AWSServiceName": [  
            "rds.amazonaws.com",  
            "rds.application-autoscaling.amazonaws.com"  
          ]  
        }  
      }  
    }  
  ]  
}
```

Principle of Least Privilege (PoLP)

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Principle of Least Privilege (PoLP) is the computer security concept of providing a user, role, or application the least amount of permissions to perform a operation or action.

Just-Enough-Access (JEA)

Permitting only the exact actions for the identity to perform a task

Just-In-Time (JIT)

Permitting the smallest length of duration an identity can use permissions



ConsoleMe is an open-source Netflix project to self-serve short-lived IAM policies so an end user can access AWS resources while enforcing JEA and JIT

<https://github.com/Netflix/consoleme>

Risk-based adaptive policies

Each attempt to access a resource generates a risk score of how likely the request is to be from a compromised source. The risk score could be based on many factors e.g. device, user location, IP address what service is being accessed and when.



AWS at the time of this recording does not have Risk-based adaptative policies built into IAM



AWS Account Root User

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Administrative Tasks **that only the Root User can perform:**

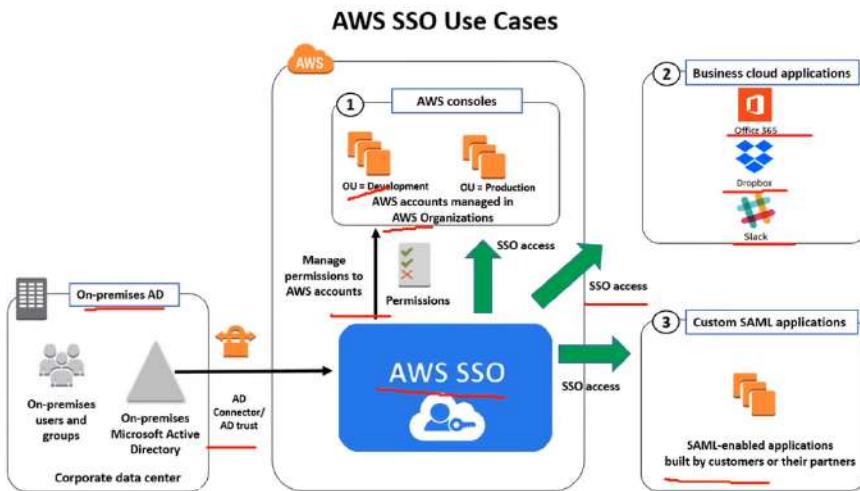
- **Change your account settings.**
 - includes the account name, email address, root user password, and root user access keys.
 - Other account settings, such as contact information, payment currency preference, and Regions, do not require root user credentials.
- Restore IAM user permissions.
 - If the only IAM administrator accidentally revokes their own permissions, you can sign in as the root user to edit policies and restore those permissions.
- Activate IAM access to the Billing and Cost Management console.
- View certain tax invoices
- **Close your AWS account.**
- **Change or Cancel AWS Support plan**
 - Register as a seller in the Reserved Instance Marketplace.
 - Enable MFA Delete on an S3 Bucket.
 - Edit or delete an Amazon S3 bucket policy that includes an invalid VPC ID or VPC endpoint ID.
 - Sign up for GovCloud.

AWS Single-Sign On

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AWS Single Sign-On (AWS SSO) is where you create, or connect, your workforce identities in AWS **once** and manage access centrally across your AWS organization.



Choose your Identity Source

- AWS SSO
- Active Directory
- SAML 2.0 IdP

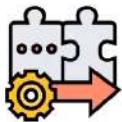
Managed User Permissions Centrally

- AWS Account
- AWS Applications
- SAML Applications

Uses get Single Click Access

Application Integration

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What is Application Integration?

Application Integration is the process of letting two independent applications to communicate and work with each other, commonly facilitated by an intermediate system.



Cloud workloads encourage systems and services to be loosely coupled and so AWS has many service for the specific purpose of application integration.

The common systems or design patterns utilized for Application Integration generally are:

- Queueing
- Streaming
- Pub/Sub
- API Gateways
- State Machine
- Event Bus

Queueing

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What is a Messaging System?

Used to provide asynchronous communication and decouple processes via messages / events
From a sender and receiver (producer and consumer)

What is a Queueing System?

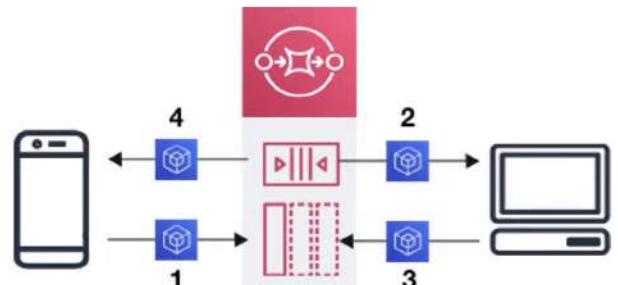
A Queueing system is a messaging system that generally will delete messages once they are consumed.
Simple communication. **Not Real-time.** Have to pull. Not reactive.



Simple Queueing Service (SQS)

Fully managed **queueing service** that enables you to decouple and scale microservices, distributed systems, and serverless applications

Use Case: You need to queue up transaction emails to be sent e.g. Signup, Reset Password.



Streaming

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What is streaming?

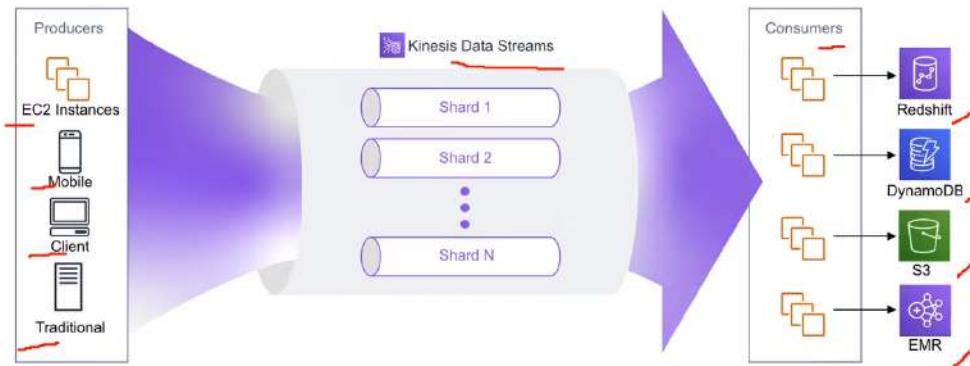
Multiple consumers can **react** to events (messages)

Events live in the stream for long periods of time, so complex operations can be applied. **Real-time**



Amazon Kinesis

Amazon Kinesis is the AWS fully managed solution for collecting, processing, and analyzing streaming data in the cloud.



Pub/Sub

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What is Pub/Sub?

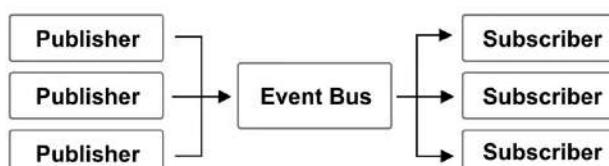
Publish–subscribe pattern commonly implemented in **messaging systems**.

In a pub/sub system the sender of messages (**publishers**) do not send their messages directly to receivers.

They instead send their messages to an **event bus**. The event bus categorizes their messages into groups.

Then receivers of messages (**subscribers**) subscribe to these groups.

Whenever new messages appear within their subscription the messages are immediately delivered to them.



Use Case: a real-time chat system. A web-hook system

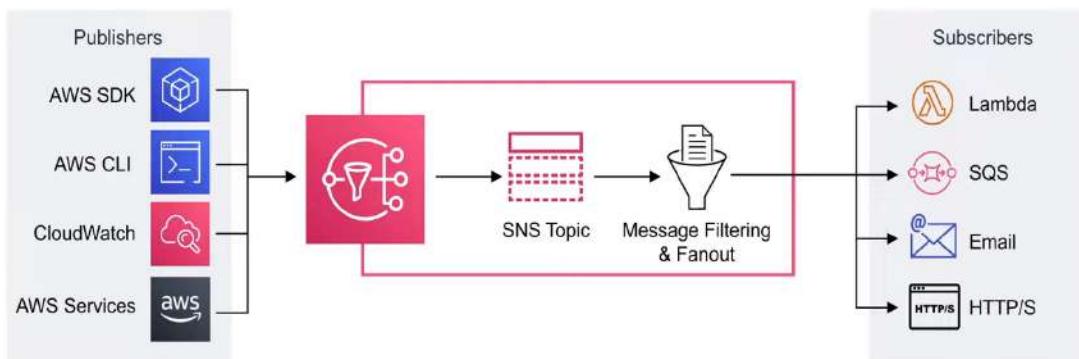
- Publishers have no knowledge of who their subscribers are.
- Subscribers do **not pull** for messages.
- Messages are instead automatically and immediately **pushed** to subscribers.
- Messages and events are interchangeable terms in pub/sub

Pub/Sub

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Simple Notification Service (SNS) is a highly available, durable, secure, fully managed **pub/sub messaging** service that enables you to **decouple** microservices, distributed systems, and serverless applications.



API Gateway

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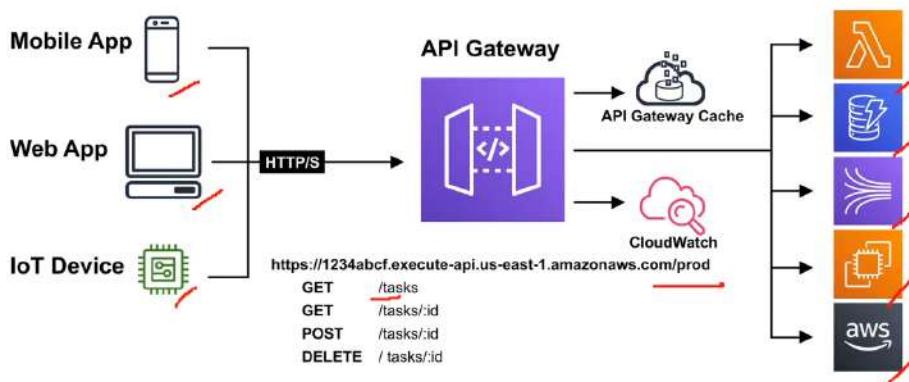
What is an API Gateway?

An API Gateway is a program that sits between a single-entry point and multiple backends.
API Gateway allows for throttling, logging, routing logic or formatting of the request and response



Amazon API Gateway is a solution for **creating secure APIs** in your cloud environment at **any scale**.

Create APIs that act as a front door for applications to access data, business logic, or functionality from back-end services.



State Machines

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What is a state machine?

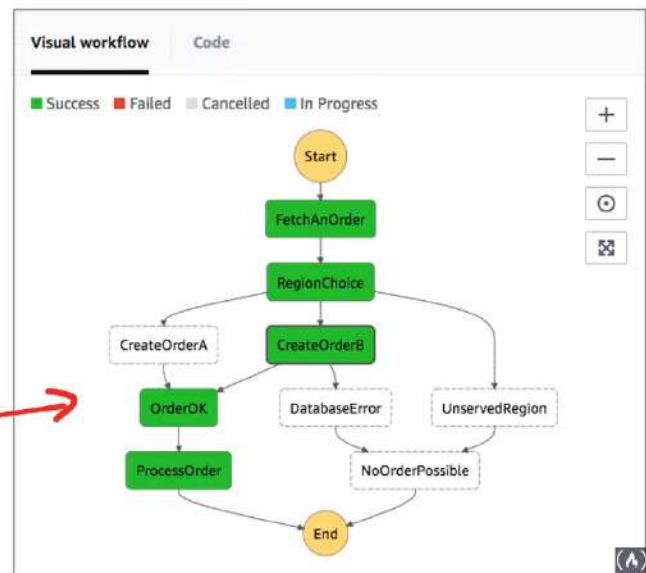
A state machine is an abstract model which decides how one state moves to another based on a series of conditions. **Think of a state machine like a flow chart.**



What is AWS Step Functions?

- Coordinate multiple AWS Services into a serverless workflow
- A graphical console to visualize the components of your application as a series of steps.
- Automatically triggers and tracks each step, and retries when there are errors, so your application executes in order and as expected, every time
- logs the state of each step, so when things go wrong, you can diagnose and debug problems quickly

Any one of these steps could be using an AWS Service

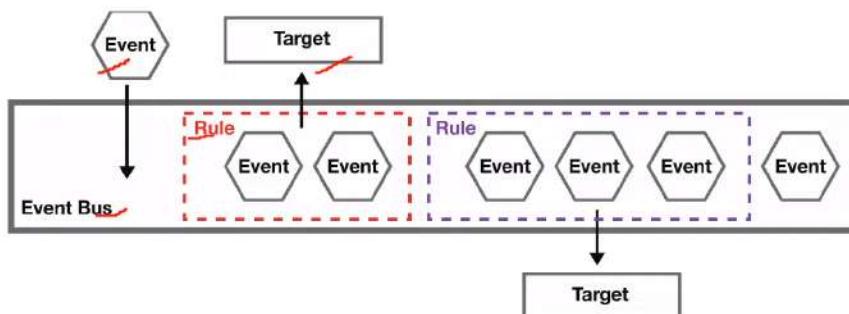


Event Bus

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What is an Event Bus?

An event bus **receives events** from a **source** and **routes events** to a **target** based on **rules**



EventBridge is a **serverless** event bus service that is used for application integration by **streaming real-time** data to your applications

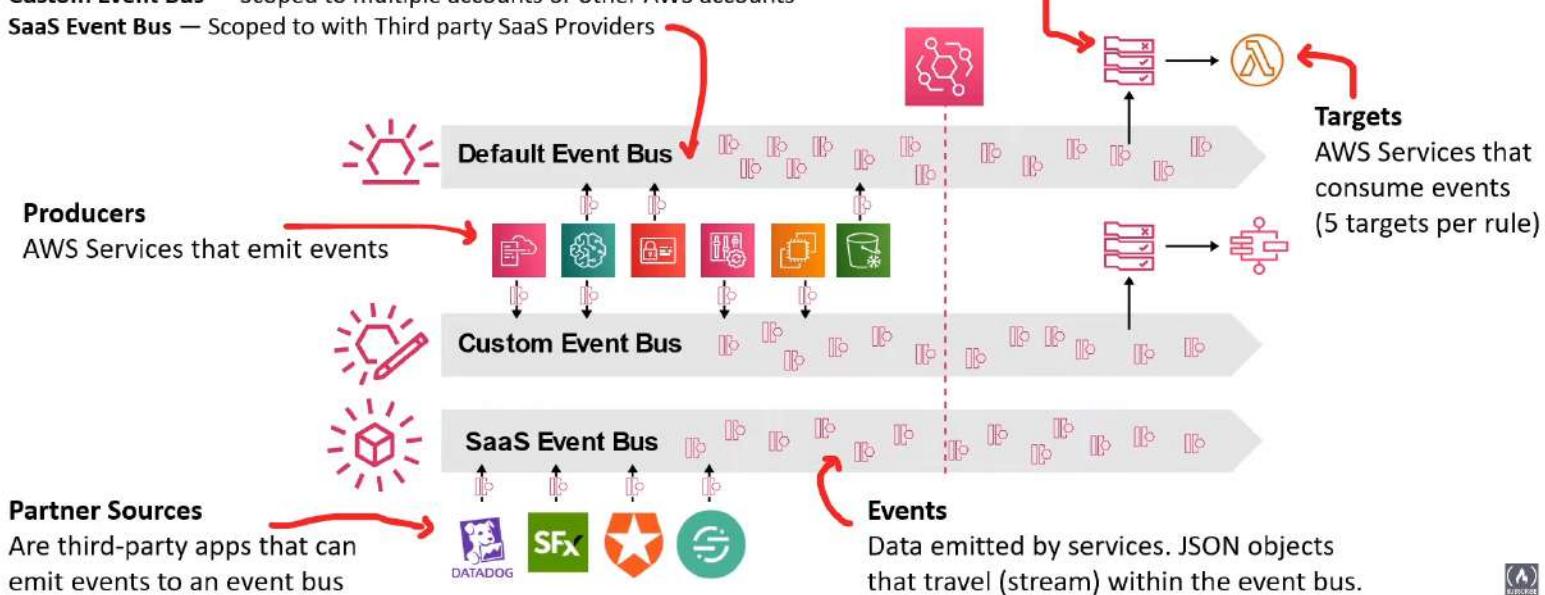
EventBridge was formerly called **Amazon CloudWatch Events**.

Amazon Event Bridge

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Event Bus

Holds event data, define rules on an event bus to react to events.
Default Event Bus — An AWS account has a default event bus
Custom Event Bus — Scoped to multiple accounts or other AWS accounts
SaaS Event Bus — Scoped to with Third party SaaS Providers



Application Integration Services

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Simple Notification Service (SNS) - a **pub-sub messaging system**. Sends notifications via various formats such as Plain-text **Email**, HTTP/s (**webhooks**) SMS (**text messages**), **SQS** and **Lambda**. Push messages which then are sent to subscribers



Simple Queue Service (SQS) is a **queueing messaging service**. Send events to a queue. Other applications pull the queue for messages. Commonly used for background jobs.



Step Functions is a **state machine service**. It coordinate multiple AWS services into serverless workflows. Easily share data among Lambdas. Have a group of lambdas wait for each other. Create logical steps. Also works with Fargate Tasks.



EventBridge (CloudWatch Events) is a **serverless event bus** that makes it easy to connect applications together from your own application, third-party services and AWS services.



Kinesis is a **real-time streaming data service**. Create **Producers** which send data to a stream. **Multiple Consumers** can consume data within a stream. Use for real-time analytics, click streams, ingesting data from a fleet of IOT Devices



Amazon MQ is a **managed message broker service** that uses **Apache ActiveMQ**



Managed Kafka Service (MSK) a **fully managed Apache Kafka service**. Kafka is an open-source platform for building real-time streaming data pipelines and applications. Similar to Kinesis but more robust



API Gateway is a fully-managed service for developers to create, publish, maintain, monitor, and secure APIs. You can create API endpoints and route them to AWS services.



AppSync is a **fully managed GraphQL service**. GraphQL is an open-source agnostic query adaptor that allows you to query data from many different data sources.



VMs vs Containers

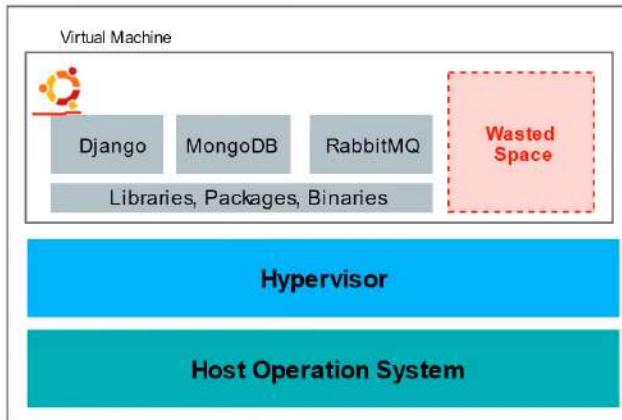
Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

VMs **do not** make best use of space.

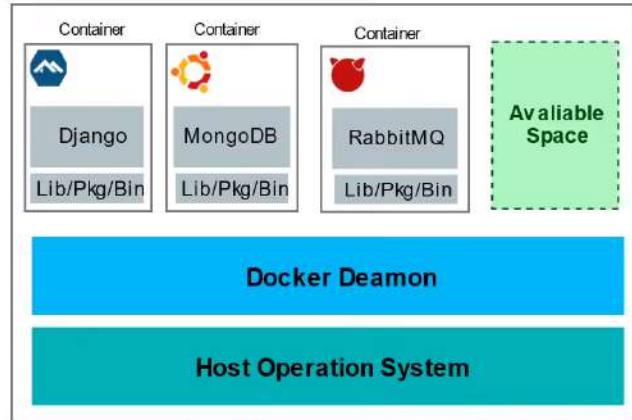
Apps are not isolated which. Could cause
config conflicts, security problems
or **resource hogging**.

Containers allow you to run multiple apps which
are virtually isolated from each other.

Launch new containers and configure OS
Dependencies per container.



 EC2 Instance



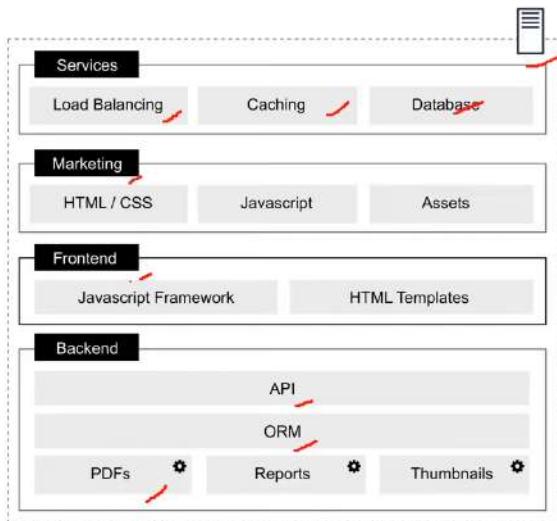
 EC2 Instance

What are Microservices

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Monolithic Architecture

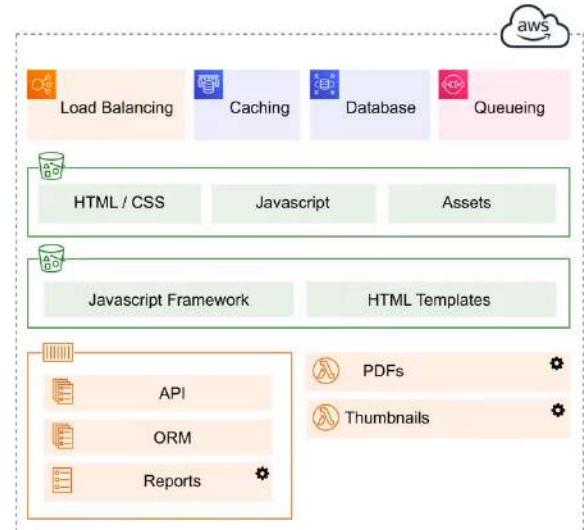
One app which is responsible for everything
Functionality is tightly coupled



VS

Microservices Architecture

Multiple apps which are each responsible for one thing
Functionality is isolate and stateless



Kubernetes

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Kubernetes is an **open-source container orchestration system** for automating **deployment, scaling and management** of containers.



Originally created by Google and now maintained by the **Cloud Native Computing Foundation (CNCF)**

Kubernetes is commonly called **K8**

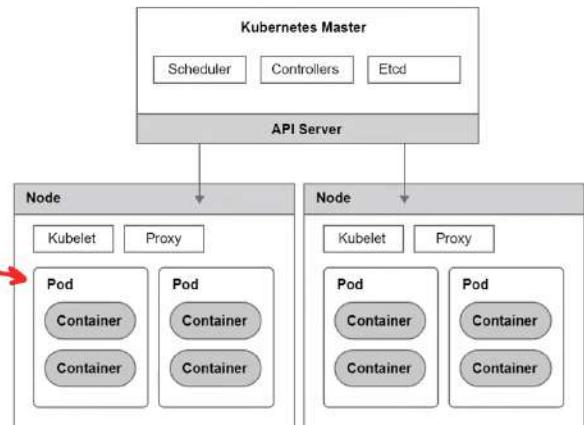
- The 8 represent the remaining letters “ubernete”

The advantage of Kubernetes over Docker is the ability to run containers distributed across multiple VMs

A unique component of Kubernetes are **Pods**.

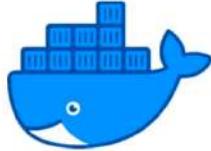
A pod is a group of one or more containers with shared storage, network resources and other shared settings.

Kubernetes is ideally for micro-service architectures where a company has tens to hundreds of services they need to manage



Docker

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Docker is a set of Platform as a Service (PaaS) products that use OS-level virtualization to deliver software in packages called containers.

Docker was the earliest popularized open-source container platform.
When people think of containers, they think of Docker.

```
FROM python:3.8-alpine3.12
COPY . /app
WORKDIR /app
RUN pip install -r requirements.txt
CMD ["python3", "app.py"]
```

Docker CLI – CLI commands to download, upload, build run and debug containers

Dockerfile – a configuration file on how to provision a container

Docker Compose – is a tool and configuration file when working with multiple containers

Docker Swarm – An orchestration tool for managing deployed multi-containers architectures

Dockerhub – a public online repository for containers published by the community for download



The Open Container Initiative (OCI) is an open governance structure for creating open industry standards around container formats and runtime.
Docker established the OCI and it is now maintained by the Linux Foundation.

Docker has been losing favor with developers due to their handling of introducing a paid open-source model and alternative like Podman are growing.



Podman, Buildah and Skopeo

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



Podman is a container engine that is OCI-compliant and is a drop-in replacement for Docker.

- Podman is daemon-less where Docker uses a containerd deamon
- Podman allows you to create pods like K8, Docker does not have pods
- Podman only replaces one part of Docker. Podman is to be used alongside Buildah and Skopeo



Buildah is a tool used to build OCI Images



Skopeo a tool for moving container images between different types of container storages

Container Services

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Primary Services



Elastic Container Service (ECS)

No Cold Starts
Self-Managed EC2



AWS Fargate

More Robust Than Lambda
Scale to Zero Cost
AWS-Managed EC2



Elastic Kubernetes Services (EKS)

Open Source
Avoid Vendor Lock-In



AWS Lambda

Only think about code
Short running tasks
Can deploy custom containers

Provisioning and Deployment



Elastic Beanstalk (EB)

ECS on training wheels
Platform as a Service



App Runner

Platform as a Service
specifically for containers



AWS Copilot CLI

build, release and operate production ready
containerized applications on AWS App
Runner, Amazon ECS, and AWS Fargate

Supporting Services



Elastic Container Registry (ECR)

Repos for your Docker Images



X-Ray

Analyze and debug between
microservices



Step Functions

Stitch together Lambdas and ECS tasks



Organizations and Accounts

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



AWS Organizations allow the creation of new AWS accounts. Centrally manage billing, control access, compliance, security, and share resources across your AWS accounts.

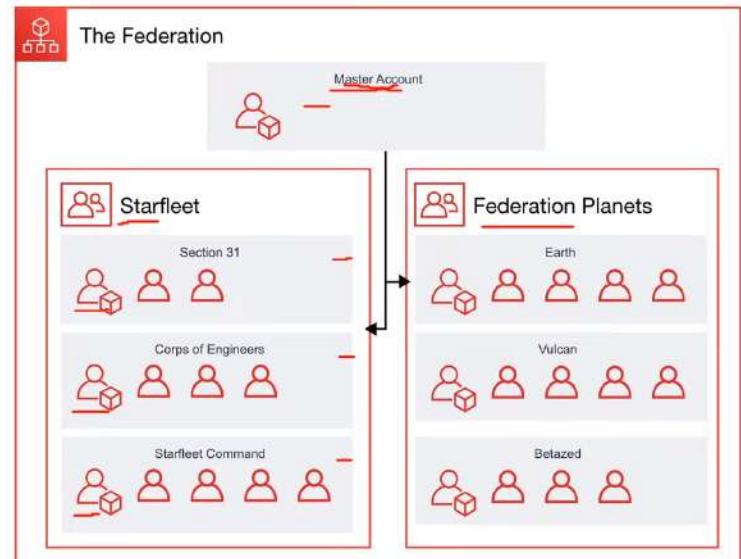


Root Account User is a single sign-in identity that has complete access to all AWS services and resources in an account. Each account has a Root Account User



Organization Units are a group of AWS accounts within an organization which can also contain other organizational units - creating a hierarchy

Service Control Policies give central control over the allowed permissions for all accounts in your organization, helping to ensure your accounts stay within your organization's guidelines.



AWS Organizations must be turned on, once turned it cannot be turned off.

You can create as many AWS Accounts as you like, one account will be the Master/Root Account

AWS Account is not the same as a **User Account**



AWS Control Tower

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



AWS Control Tower helps **Enterprises** quickly set-up a secure, **AWS multi-account** Provides you with a **baseline environment** to get started with a **multi-account architecture**



Landing Zone

A landing zone is a baseline environment following well-architected and best practices to start launching production ready workloads.

- AWS SSO enabled, Centralized logging for AWS CloudTrail, cross-account security auditing



Account Factory

- automates provisioning of new accounts in your organization
- standardize the provisioning of new accounts with pre-approved account configurations
- configure your account factory with pre-approved network configuration and region selections
- enable self-service for your builders to configure and provision new accounts using AWS Service Catalog



Guardrails

pre-packaged governance rules for security, operations, and compliance that customers can select and apply enterprise-wide or to specific groups of accounts

AWS Control Tower is the *replacement* for retired **AWS Landing Zones**



AWS Config

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

What is Change management?

- Change management in the context of Cloud Infrastructure is when we have **formal process** to:
- monitor changes
 - enforce changes
 - Remediate changes

What is Compliance-as-code (CaC)?

Compliance as code is when we utilize programming to automate the monitoring, enforcing and remediating changes to stay compliant with a compliance programs or expected configuration.

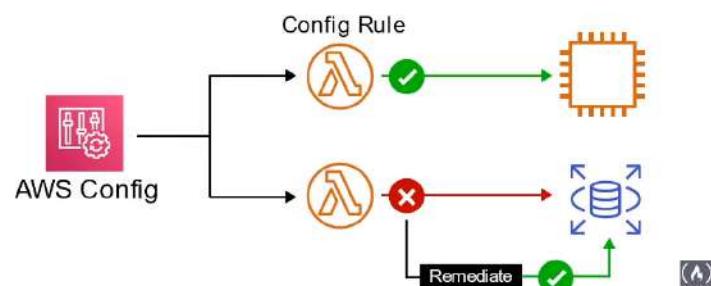


What is AWS Config?

AWS Config is a **Compliance-as-Code framework** that allows us to **manage change** in your AWS accounts on a **per region basis**.

When should you use AWS Config?

- I want this **resource** to stay **configured** a **specific way** for **compliance**.
- I want to **keep track** of configuration **changes** to resources.
- I want a **list of all resources** within a region.
- I want to use **analyze potential security** weaknesses, you need detailed historical information.



AWS Quick Starts

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



AWS Quick Starts are **Prebuilt templates** by AWS and AWS Partners to **help deploy wide range of stacks**

Reduce hundreds of manual procedures into just a few steps

A Quick Start is composed of **3** parts

1. A reference architecture for the deployment
2. AWS CloudFormation templates that automate and configure the deployment
3. A deployment guide explaining the architecture and implementation in detail

MACHINE LEARNING UPDATED

AWS QnABot
Built by AWS

Deploy a multi-channel, multi-language conversational interface (chatbot) that responds to your customer's questions, answers, and feedback.

Last update
October 2021



Most Quick Start reference deployments enable you to spin up a fully functional architecture in less than an hour!



Tagging

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



A tag is a **key and value pair** that you can assign to AWS resources.

Tags (2) - optional
Track storage cost or other criteria by tagging your bucket. [Learn more](#)

Key	Value - optional	Remove
Project	Enterprise	Remove
Key	Value	Remove

Add tag

Tag Examples

Dept = Finance

Status = Approved

Team = Compliance

Environment = Production

Project = Enterprise

Location = Canada

Tags allow you to organize your resources in the following ways:

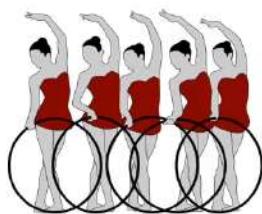
- **Resource management**
 - specific workloads, environments eg. Developer Environments
- **Cost management and optimization**
 - Cost tracking, Budgets, Alerts
- **Operations management**
 - Business commitments and SLA operations eg. Mission-Critical Services
- **Security**
 - Classification of data and security impact
- **Governance and regulatory compliance**
- **Automation**
- **Workload optimization**



Resource Groups

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

Resource Groups are a collection of resources that share one or more **tags**



Helps you organize and consolidate information based on your project and the resources that you use.

Resource Groups can display details about a group of resource based on

- Metrics
- Alarms
- Configuration Settings

At any time you can modify the settings of your resource groups to change what resources appear.

Resource Groups appears in the **Global Console Header** and Under **Systems Manager**

The screenshot shows the AWS Global Console Header with 'Services' and 'Resource Groups' selected. Below it, the 'Systems Manager' interface is shown with 'Application Management' expanded, revealing 'Resource Groups'.



Business Centric Services

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



Amazon Connect is a **virtual call center service**. You can create workflow to route callers. You can record phone calls. Manage a queue of callers. Based on the same proven system used by the Amazon customer service teams.



WorkSpaces is **virtual remote desktop service** Secure managed service for provisioning either Windows or Linux desktops in just a few minutes which quickly scales up to thousands of desktops



WorkDocs is a **shared collaboration service**. A centralized storage to share content and files. It is similar to Microsoft SharePoint. Think of it as a shared folder where the company has ownership



Chime is **video-conference service**. It is similar to Zoom or Skype. You can screenshare, have multiple people on the call. It is secure by default and it can show you a calendar of your upcoming calls.



WorkMail is a **managed business email, contacts, and calendar service** with support for existing desktop and mobile email client applications. (IMAP). Similar to Gmail or Exchange.



Pinpoint is a **marketing campaign management service**. Pinpoint is for **sending targeted email** via SMS, push notifications, and voice messages. You can perform A/B testing or create Journeys (complex email response workflows)



Simple Email Service (SES) is a **transactional email service**. You **can integrate SES into your application to send emails**. You can create common template, track open-rates, keep track of your reputation.



QuickSight is a **Business Intelligence (BI) service**. Connect multiple data sources and quickly visualize data in the form of graphs with little to no programming knowledge.

Provisioning Services

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

What is provisioning?

The allocation or creation of resources and services to a customer.

AWS Provisioning Services are responsible for setting up and then managing those AWS Services



Elastic Beanstalk (EB) is a **Platform as a Service (PaaS) to easily deploy web-applications**. EB will provision various AWS services, including EC2, S3, Simple Notification Service (SNS), CloudWatch, EC2 Auto Scaling Groups, and Elastic Load Balancers. If you have ever used **Heroku** it the AWS equivalent



AWS OpsWorks is a **configuration management service** that also provides managed instances of the open-source configuration managed software **Chef** and **Puppet**.



CloudFormation is a **infrastructure modeling and provisioning service**. Automate the provisioning of AWS Services by writing CloudFormation templates in either **JSON** or **YAML files**. This is known as **Infrastructure as Code (IaC)**



AWS QuickStarts are pre-made packages that can launch and configure your AWS compute, network, storage, and other services required to deploy a workload on AWS



AWS Marketplace - a **digital catalogue** of **thousands** of software listings from independent software vendors you can use to find, buy, test, and deploy software.



AWS Amplify is a **mobile and web-application framework**, that will provision multiple AWS services as your backend.



Provisioning Services

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



AWS App Runner

A fully managed service that makes it easy for developers to quickly deploy containerized web applications and APIs, at scale and with no prior infrastructure experience required



AWS Copilot

AWS Copilot is a command line interface (CLI) that enables customers to quickly launch and easily manage containerized applications on AWS.



AWS CodeStar

provides a unified user interface, enabling you to easily manage your software development activities in one place. Easily launch common types of stacks eg. LAMP



AWS Cloud Development Kit (CDK)

An Infrastructure as Code (IaC) tool. Allows you to use your favourite programming language. Generates out CloudFormation templates as the means for IaC.

AWS Elastic Beanstalk

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

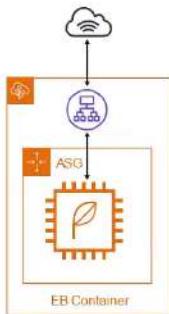
What is Platform as a Service? (PaaS)

a PaaS allows customers to develop, run, and manage applications without the complexity of building and maintaining the infrastructure typically associated with developing and launching an app



Elastic Beanstalk is a PaaS for deploying web-applications with little-to-no knowledge of the underlying infrastructure so you can focus on writing application code instead of setting up an automated deployment pipeline and DevOps tasks. Choose a platform, upload your code and it runs with little knowledge of the infrastructure.

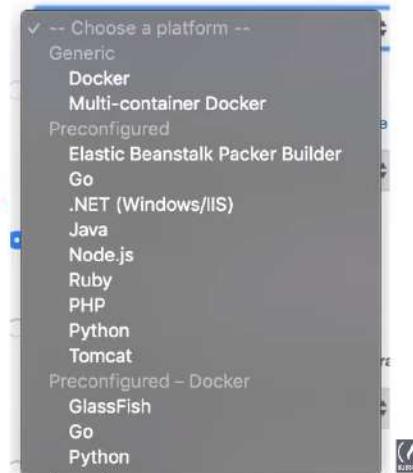
Not Recommended for “Production” applications



AWS is talking about enterprise, large companies.

Elastic Beanstalk is powered by a CloudFormation template **setups** for you:

- Elastic Load Balancer
- Autoscaling Groups
- RDS Database
- EC2 Instance preconfigured (or custom) platforms
- Monitoring (CloudWatch, SNS)
- In-Place and Blue/Green deployment methodologies
- Security (Rotates passwords)
- Can run **Dockerized** environments



Serverless Services

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

What is Serverless?

When the underlying servers, infrastructure and Operating System (OS) is taken care of by the Cloud Service Provider (CSP). Serverless is generally by default highly available, scalable and cost-effective. You pay for what you use.

-  **DynamoDB** is a serverless **NoSQL key/value and document database**. It is designed to scale to **billions of records** with guaranteed consistent data return in at least a second. You don't have to worry about managing shards!
-  **Simple Storage Service (S3)** is a **serverless object storage service**. You can upload very large and an unlimited amount of files. You pay for what you store. You don't worry about the underlying file-system, or upgrading the disk size.
-  **ECS Fargate** is **serverless orchestration container service**. It is the same as ECS expect you pay-on-demand per running container (With ECS you have to keep a EC2 server running even if you have no containers running) AWS manages the underlying server, so you don't have to scale or upgrade the EC2 server.
-  **AWS Lambda** is a **serverless functions service**. You can run code without provisioning or managing servers. You upload small pieces of code, choose much memory and how long function is allowed to run before timing out. You are charged based on the runtime of the serverless function rounded to the nearest 100ms.
-  **Step Functions** is a **state machine service**. It coordinate multiple AWS services into serverless workflows. Easily share data among Lambdas. Have a group of lambdas wait for each other. Create logical steps. Also works with Fargate Tasks.
-  **Aurora Serverless** is the **serverless on-demand version of Aurora**. *When you want "most" of the benefits of Aurora but can trade to have cold-starts or you don't have lots of traffic demand*

What is Serverless?

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

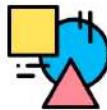
What is Serverless?

Serverless architecture generally describe fully managed cloud services. The classification of a cloud service being serverless is not a Boolean answer (yes or no), but a answer on a scale where a cloud service has a degree of serverless.

A serverless service could have all or most of the following characteristics:



- Highly elastic and scalable
- highly available
- Highly durable
- Secure by default

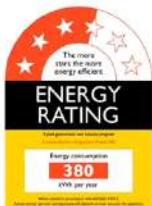


Abstracts away the underlying infrastructure and are billed based on the execution of your business task.



Serverless can **Scale-to-Zero** meaning when not in use the serverless resources cost nothing.

Pay-for-Value (you don't pay for idle servers).



An analogy of serverless could be similar to an energy rating labels which allows consumers to compare the energy efficiency of a product. Some services are more serverless than others.



Windows on AWS

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AWS has multiple cloud services and tools to make it easy for you run Windows workloads on AWS.



Windows Servers on EC2

You can select from a number of Windows Server versions including the latest version, Windows Server 2019



SQL Server on RDS

You can select from a number of SQL Server database versions



AWS Directory Service

lets you run **Microsoft Active Directory (AD) as a managed service**



AWS License Manager

makes it easier to manage your software licenses from software vendors such as Microsoft.



Amazon FSx for Windows File Server

is a **fully managed scalable storage** built for Windows.



AWS Software Development Kit (SDK)

allows you to write code in your favorite language to interact with AWS API.

The SDK supports **.NET** a language favorite for Windows Developers



Amazon WorkSpaces

allows you to run a virtual desktop. You can launch a **Windows 10 desktop** to provide secure and durable workstation that is accessible from wherever you have an internet connection.



AWS Lambdas

supports **PowerShell** as a programming language to write your serverless functions!

AWS Migration Acceleration Program (MAP) for Windows is a migration methodology from moving large enterprise.

AWS has Amazon Partners that specialize in providing professional services for MAP.



AWS License Manager

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

What is Bring-Your-Own-License? (BYOL)

The process of reusing an existing software license to run vendor software on a cloud vendor's computing service. BYOL allows companies to save money since they may have purchased the license in bulk or at a time that provided a greater discount than if purchased again.

eg. **License Mobility** is Microsoft Volume Licensing customers with eligible server applications covered by active Microsoft Software Assurance (SA)



AWS License Manager is a service that makes it easier for you to manage your software licenses from software vendors centrally across AWS and your on-premises environments.

AWS Licence Manager software that is licensed based on **virtual cores (vCPUs), physical cores, sockets, or number of machines**. This includes a variety of software products from  Microsoft, IBM, SAP, Oracle, and other vendors

AWS License Manager works with:

- EC2 – Dedicated Instances, Dedicated Hosts, Spot Instances
- RDS – (Only for Oracle databases)

License type
The counting model used for the license. This may not track the terms of your agreement with your licensor for vCPUs.

vCPUs
vCPUs
Cores
Sockets
Instances

Enforce license limit
Helps prevent usage after available license types are exhausted, e.g. an instance launch requiring new prevent overuse. Not supported for RDS.

For **Microsoft Windows Server** and **Microsoft SQL Server** license you generally need to use a **Dedicated Host**



Logging Services

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



CloudTrail - logs all **API calls** (SDK, CLI) between **AWS services** (who can we blame)

Who created this bucket?

- Detect developer misconfiguration
- Detect malicious actors
- Automate responses

Who spun up that expensive EC2 instance?

Who launched this SageMaker Notebook?



CloudWatch is a collection of multiple services

- CloudWatch **Logs** A centralized place to store your cloud services log data or application logs.
- CloudWatch **Metrics** Represents a time-ordered set of data points. A variable to monitor
- CloudWatch **Events (EventBridge)** trigger an event based on a condition eg. ever hour take snapshot of server
- CloudWatch **Alarms** triggers notifications based on metrics
- CloudWatch **Dashboard** create visualizations based on metrics



AWS X-Ray is a **distributed tracing system**. You can use it to pinpoint issues with your microservices.

See how data moves from one app to another, how long it took to move, and if it failed to move forward.



AWS CloudTrail

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



AWS CloudTrail is a service that enables governance, compliance, operational auditing, and risk auditing of your AWS account.

AWS CloudTrail is used to monitor API calls and Actions made on an AWS account.

Easily identify which users and accounts made the call to AWS eg.

- **Where** — Source IP Address
- **When** — EventTime
- **Who** — User, UserAgent
- **What** — Region, Resource, Action

```
1 {"Records": [
2     "eventVersion": "1.0",
3     "userIdentity": {
4         "type": "IAMUser",
5         "principalId": "EX_PRINCIPAL_ID",
6         "arn": "arn:aws:iam::123456789012:user/Worf",
7         "accountId": "123456789012",
8         "accessKeyId": "EXAMPLE_KEY_ID",
9         "userName": "Worf"
10    },
11    "eventTime": "2014-03-24T21:11:59Z",
12    "eventSource": "iam.amazonaws.com",
13    "eventName": "CreateUser",
14    "awsRegion": "us-east-1",
15    "sourceIPAddress": "127.0.0.1",
16    "userAgent": "aws-cli/1.3.2 Python/2.7.5 Windows/10",
17    "requestParameters": {"userName": "LaForge"},
18    "responseElements": {"user": {
19        "createDate": "Mar 24, 2014 9:11:59 PM",
20        "userName": "LaForge",
21        "arn": "arn:aws:iam::123456789012:user/LaForge",
22        "path": "/",
23        "userId": "EXAMPLEUSERID"
24    }}
25 ]}]
```

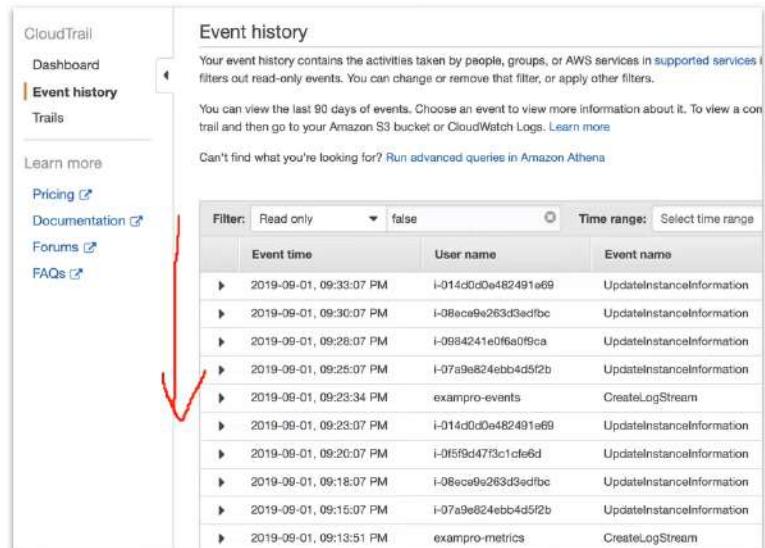
AWS CloudTrail

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

CloudTrail is already logging by default and will collect logs for **last 90 days** via **Event History**

If you need more than 90 days you need to create a **Trail**

Trails are output to S3 and do not have GUI like Event History. To analyze a Trail you'd have to use **Amazon Athena.** 



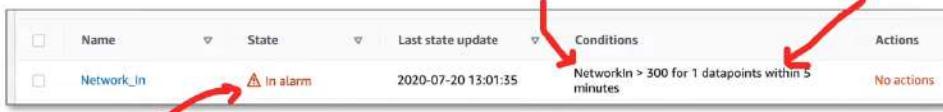
The screenshot shows the AWS CloudTrail console. On the left, there's a sidebar with links: CloudTrail, Dashboard, Event history (which is selected and highlighted in orange), Trails, Learn more, Pricing, Documentation, Forums, and FAQs. The main content area is titled 'Event history'. It contains a brief description: 'Your event history contains the activities taken by people, groups, or AWS services in supported services. It filters out read-only events. You can change or remove that filter, or apply other filters.' Below this is a note: 'You can view the last 90 days of events. Choose an event to view more information about it. To view a trail and then go to your Amazon S3 bucket or CloudWatch Logs.' There's also a link to 'Learn more' and a search bar. At the bottom, there's a table with columns: Event time, User name, and Event name. The table lists several log entries from September 1, 2019, such as 'UpdateInstanceInformation' and 'CreateLogStream' events. The table has a header row and 10 data rows.

Event time	User name	Event name
2019-09-01, 09:33:07 PM	i-014cd0d0e482491a69	UpdateInstanceInformation
2019-09-01, 09:30:07 PM	i-08ec09e263d3edfbcc	UpdateInstanceInformation
2019-09-01, 09:28:07 PM	i-0984241e0f6a0f9ca	UpdateInstanceInformation
2019-09-01, 09:26:07 PM	i-07a9e824ebb4d5f2b	UpdateInstanceInformation
2019-09-01, 09:23:34 PM	exampro-events	CreateLogStream
2019-09-01, 09:23:07 PM	i-014cd0d0e482491a69	UpdateInstanceInformation
2019-09-01, 09:20:07 PM	i-0f59d47f3c1cf6d	UpdateInstanceInformation
2019-09-01, 09:18:07 PM	i-08ec09e263d3edfbcc	UpdateInstanceInformation
2019-09-01, 09:15:07 PM	i-07a9e824ebb4d5f2b	UpdateInstanceInformation
2019-09-01, 09:13:51 PM	exampro-metrics	CreateLogStream

CloudWatch Alarms

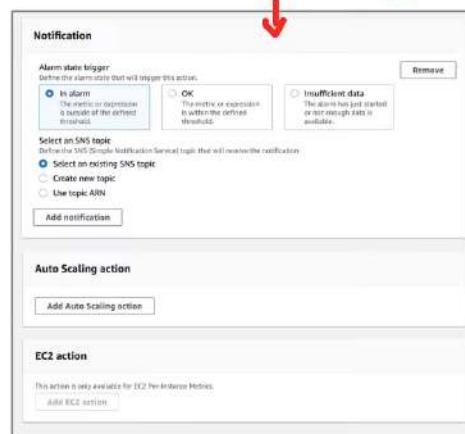
Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

A CloudWatch Alarm monitors a **CloudWatch Metric** based on a **defined threshold**.



When alarm breaches (goes outside the defined threshold) than it changes **state**.

When it changes state we can define what **action it should trigger**.



Metric Alarm States

- **OK** The metric or expression is **within** the defined threshold
- **ALARM** The metric or expression is **outside** of the defined threshold
- **INSUFFICIENT_DATA**
 - The alarm has **just started**
 - the metric is **not available**
 - **Not enough data** is available

- Notification
- Auto Scaling Group
- EC2 Action

CloudWatch Alarms – Anatomy of an Alarm

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Threshold Condition

Defines when a datapoint is breached

Threshold type

Static
Use a value as a threshold

Whenever NetworkIn is...
Define the alarm condition.

Greater
 \geq

Greater or equal
 \geq

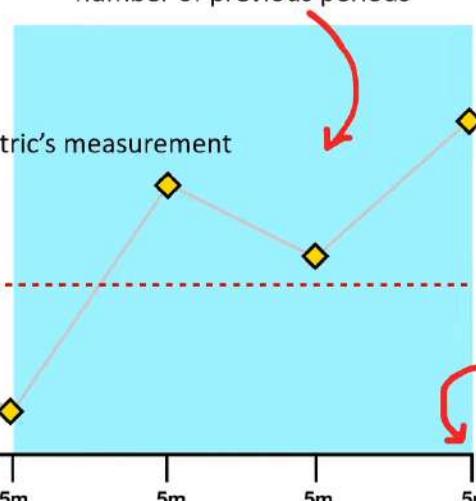
than...
Define the threshold value:
100000
Must be a number

Metric
The actual data we are measuring

NetworkIn
The volume of incoming network traffic.
measured in Bytes. When using 5min monitoring divide by 300 to get Bytes/second

Evaluation Periods

number of previous periods



Period

How often it checks to evaluate the Alarm

Period

5 minutes

Datapoints to alarm

1 data point is breached in an evaluation period going back 4 periods.
This is what triggers the alarm

Datapoints to alarm

Define the number of datapoints within the evaluation period that must be breaching to cause the alarm to go to ALARM state.

1 out of 4

CloudWatch Logs – Log Streams

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Log Streams

A log stream represents a **sequence of events** from a **application or instance being monitored**.

Create log stream

Log stream name
my-log-stream

Cancel Create

You can create Log Streams manually but generally this is automatically done by the service you are using

Here is a Log Group for a **Lambda function**
You can see here the Log Streams are named after the **running instance**. Lambdas frequency run on new instances so the stream streams contain timestamps

Log stream	Last event time
2020/07/06/[LATEST]ebca38579fac4842b531b260d5c35e0e	7/6/2020, 7:41:24 PM
2020/07/06/[LATEST]7679ba0f37b14a3da994cd243963ca60	7/6/2020, 6:14:42 PM
2020/07/06/[LATEST]bb7edeb95cb345b48dd151a79367a5d6	7/6/2020, 3:52:56 PM
2020/07/06/[LATEST]e1544efd95a4492585b9c8d27ddaea4b	7/6/2020, 1:30:09 PM
2020/07/06/[LATEST]86a8cc4dcff740628effaeb82b41e1cc	7/6/2020, 12:28:00 PM
2020/07/06/[LATEST]a06263c73f8242e5a0e35b366b3bbdf9	7/6/2020, 10:08:43 AM

Log stream	Last event time
i-0761fcbbdb19ffc8	7/6/2020, 6:56:31 PM
i-09239615bc7f3f52	7/5/2020, 9:40:42 PM
i-06c9e4fb3469e17a4	7/5/2020, 9:21:08 PM
i-0450c5ca38bddcd125	7/5/2020, 8:27:30 PM
i-01a34b0a12504edfa	7/5/2020, 12:42:24 AM
i-0ef5ec7610f21d08	7/5/2020, 12:32:35 AM

Here is a Log Group for an **application logs running on EC2** You can see here the Log Streams are named after the **running instance's Instance ID**

Log stream	Last event time
exampro-events-crawler	6/30/2019, 12:57:11 PM
exampro-waf-logs	6/26/2019, 9:00:49 AM
exampro-leads-crawler	3/24/2019, 7:57:03 PM
dynamodb-events-tracking	3/13/2019, 4:38:00 PM
cloudtrail	2/24/2019, 4:12:18 PM

Here is a Log Group for **AWS Glue**. You can see here the Log Streams are named after the **Glue Jobs**.



CloudWatch Logs – Log Events

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Log Events

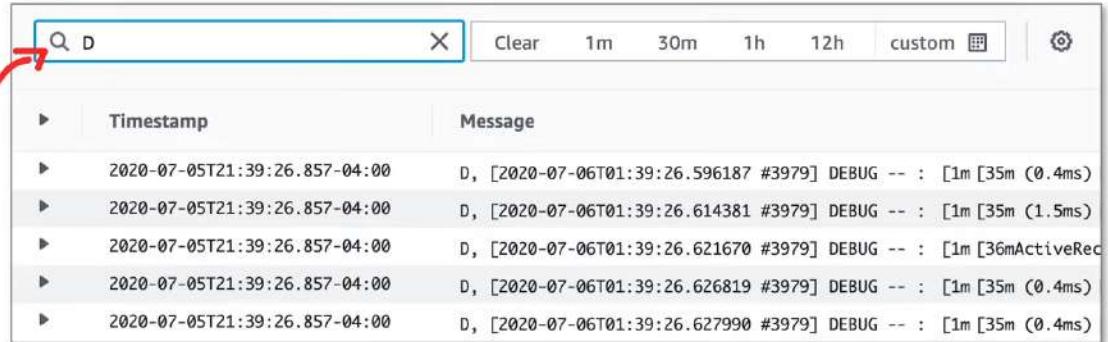
Represents a single event in a log file. Log events can be seen within a Log Stream.

▶ 2020-07-06T20:12:18.079-04:00	START RequestId: e4b5bd10-5d88-4d7b-870c-daf793159b88 Version: \$LATEST
▶ 2020-07-06T20:12:18.082-04:00	{"records_size":1}
▶ 2020-07-06T20:12:18.093-04:00	{"failed_put_count":0}
▶ 2020-07-06T20:12:18.127-04:00	END RequestId: e4b5bd10-5d88-4d7b-870c-daf793159b88
▶ 2020-07-06T20:12:18.127-04:00	REPORT RequestId: e4b5bd10-5d88-4d7b-870c-daf793159b88 Duration: 45.32 ms Billed Duration: 100 ms Memory Size: 128

You can use filter events to filter out logs based on simple or pattern matching syntax:



A screenshot of the AWS CloudWatch Logs console. On the left, there's a sidebar with the heading "Log events". Below it is a search bar with the placeholder "Filter events". A red arrow points from the text "Filter events" in the first paragraph to this search bar.



A screenshot of the AWS CloudWatch Logs console showing a filtered log stream. The interface includes a search bar at the top with the text "Q D" and a dropdown menu with options like "Clear", "1m", "30m", "1h", "12h", "custom", and a refresh icon. Below the search bar is a table with two columns: "Timestamp" and "Message". The table lists six log entries, each starting with a timestamp like "2020-07-05T21:39:26.857-04:00" followed by a log message. A red arrow points from the text "Filter events" in the sidebar to the search bar at the top of this screenshot.

Timestamp	Message
2020-07-05T21:39:26.857-04:00	D, [2020-07-06T01:39:26.596187 #3979] DEBUG -- : [1m [35m (0.4ms)
2020-07-05T21:39:26.857-04:00	D, [2020-07-06T01:39:26.614381 #3979] DEBUG -- : [1m [35m (1.5ms)
2020-07-05T21:39:26.857-04:00	D, [2020-07-06T01:39:26.621670 #3979] DEBUG -- : [1m [36mActiveRec
2020-07-05T21:39:26.857-04:00	D, [2020-07-06T01:39:26.626819 #3979] DEBUG -- : [1m [35m (0.4ms)
2020-07-05T21:39:26.857-04:00	D, [2020-07-06T01:39:26.627990 #3979] DEBUG -- : [1m [35m (0.4ms)

CloudWatch Logs – Log Insights

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

CloudWatch Logs Insights enables you to **interactively search and analyze your CloudWatch log data** and has the following advantages:

- more robust filtering than using the simple Filter events in a Log Stream
- Less burdensome than having to export logs to S3 and analyze them via Athena.

CloudWatch Logs Insights supports all types of logs.

CloudWatch Logs Insights is commonly used via the console to do ad-hoc queries against logs groups.

CloudWatch Insights has its own language called:

- CloudWatch Logs Insights **Query Syntax**

```
filter action="REJECT"  
| stats count(*) as numRejections by srcAddr  
| sort numRejections desc  
| limit 20
```

The screenshot shows the CloudWatch Logs Insights interface. At the top, there are navigation links: CloudWatch > CloudWatch Logs > Logs Insights. To the right, a link says "Switch to the original interface". Below the navigation is a search bar labeled "Select log group(s)" with a dropdown arrow, and time range buttons for 5m, 30m, 1h (which is highlighted in blue), 3h, 12h, and custom. A code editor window contains the following CloudWatch Logs Insights query:
`fields @timestamp, @message
| sort @timestamp desc
| limit 20`

Below the code editor are three buttons: "Run query" (orange), "Save", and "History". Underneath these buttons is a tabs section with "Logs" (which is selected and highlighted in blue) and "Visualization". To the right of the tabs are "Export results" (with a dropdown arrow), "Add to dashboard", and a settings icon. The main content area displays the message "No results" and "Run a query to see related events".

- A single request can query up to **20 log groups**.
- Queries **time out after 15 minutes**, if they have not completed.
- Query results are **available for 7 days**.



CloudWatch Logs – Log Insights

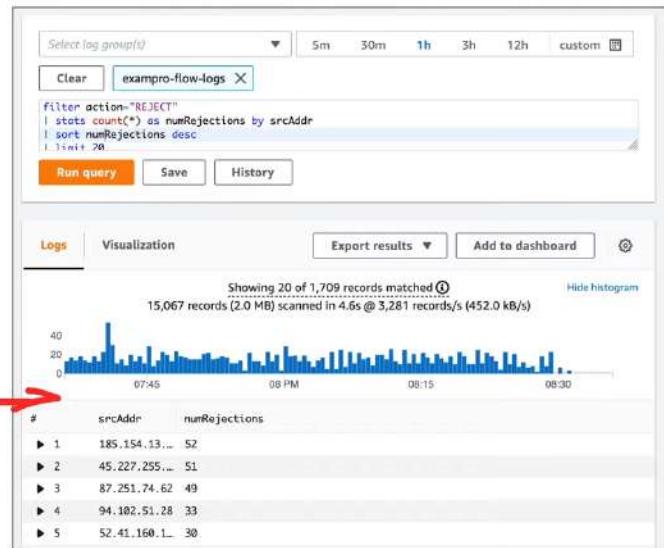
Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

The screenshot shows the AWS CloudWatch Log Insights interface. On the left, there's a sidebar with 'Queries' and 'Help' buttons. Below them is a 'Saved queries' section with a search bar and a 'Create query' button. Under 'Sample queries', there are sections for 'Lambda' and 'VPC Flow Logs'. The 'VPC Flow Logs' section is expanded, showing four items: 'Average, min, and max byte transfers by source and destination IP addresses', 'IP addresses using UDP transfer protocol', 'Top 10 byte transfers by source and destination IP addresses', and 'Top 20 source IP addresses with highest number of rejected requests'. The last item is selected, and its query code is displayed in a text area at the bottom:

```
filter action="REJECT"
| stats count(*) as numRejections by srcAddr
| sort numRejections desc
| limit 20
```

An 'Apply' button is at the bottom right of this area. A red arrow points from the 'Top 20 source IP addresses with highest number of rejected requests' link in the sidebar to the selected query code.

AWS provides sample queries that can get you started for common tasks, And to ease learning the Query Syntax. A good example is filtering VPC Flow Logs.



You can create and save your own queries to make future repetitive tasks easier.



CloudWatch Metrics

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A CloudWatch Metric represents a **time-ordered set of data points**
Its a **variable** that is **monitored over time**.

CloudWatch comes with many **predefined** metrics that are generally name spaced by AWS Service.



EC2 Per-Instance Metrics

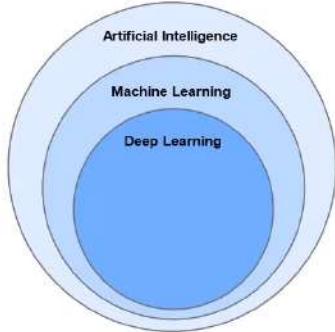
- CPUUtilization
- DiskReadOps
- DiskWriteOps
- DiskReadBytes
- DiskWriteBytes
- **NetworkIn**
- NetworkOut
- NetworkPacketsIn
- NetworkPacketsOut



AWS Namespaces		
ApiGateway	21 Metrics	ApplicationELB
CloudFront	30 Metrics	CodeBuild
EBS	216 Metrics	DynamoDB
		Events
		9 Metrics
		(A) SOURCE

Machine Learning and AI Services

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What is Artificial Intelligence (AI)?

Machines that perform jobs that mimic human behavior

What is Machine Learning (ML)?

Machines that get better at a task without explicit programming

What is Deep Learning (DL)?

Machines that have an artificial neural network inspired by the human brain to solve complex problems.

 **Amazon SageMaker** is a fully managed service to **build, train, and deploy machine learning models** at scale

- **Apache MXNet on AWS**, open-source deep learning framework
- **TensorFlow on AWS** open-source machine intelligence library
- **PyTorch on AWS** open-source machine learning framework

 **Amazon SageMaker Ground Truth** is **data-labeling service**. Have humans label a dataset that will be used to train machine learning models

 **Amazon Augmented AI** human-intervention review service. When SageMaker's uses machine Learning to make a prediction is not confident it has the right answer queue up the predication for human review.



Machine Learning and AI Services

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Amazon CodeGuru is a **machine-learning code analysis service**. CodeGuru performs code-reviews and will suggest changes to improve the quality of code. It can show visual code profiles (show the internals of your code) to pinpoint performance.



Amazon Lex is a **conversion interface service**. With Lex you can build **voice and text chatbots**



Amazon Personalize is a **real-time recommendations** service. Same technology used to make product recommendations to customers shopping on the Amazon platform



Amazon Polly is a **text-to-speech** service. Upload your text and an audio file spoken by synthesized voice is generated.



Amazon Rekognition is **image and video recognition service**. Analyze images and videos to detect and label objects, people, celebrities.



Amazon Transcribe is a **speech-to-text service**. Upload your audio file and it is converted



Amazon Textract and **OCR (extract text from scanned documents) service**. When you have paper forms and you want to digitally extract the data.



Amazon Translate **neural machine learning translation service**. Uses deep learning models to deliver more accurate and natural sounding translations.



Amazon Comprehend is a **Natural Language Processor (NLP) service**. Find relationships between text to produce insights. Looks at data such as Customer emails, support tickets, social media and makes predictions.



Machine Learning and AI Services

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Amazon Forecast is a **time-series forecasting service**. Forecast business outcomes such as product demand, resource needs or financial performance.



AWS Deep Learning AMIs Amazon EC2 instances **pre-installed with popular deep learning frameworks** and interfaces such as TensorFlow, PyTorch, Apache MXNet, Chainer, Gluon, Horovod, and Keras



AWS Deep Learning Containers Docker images instances pre-install with popular deep learning frameworks and interfaces such as TensorFlow, PyTorch, and Apache MXNet.



AWS DeepComposer is **machine-learning enabled musical keyboard**



AWS DeepLens is a **video-camera that uses deep-learning**.



AWS DeepRacer a **toy race car** that can be powered with machine-learning to perform **autonomous driving**.



Amazon Elastic Inference allows you to attach low-cost GPU-powered acceleration to EC2 instances to reduce the cost of running deep learning inference by up to 75%.



Amazon Fraud Detector is a **fully managed fraud detection a service**. identify potentially fraudulent online activities such as online payment fraud and the creation of fake accounts.



Amazon Kendra **enterprise machine learning search engine service**. Uses natural language to suggest answers to question instead of just simple keyword matching



Big Data and Analytics Services

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

What is BigData?

A term used to describe **massive volumes of structured/unstructured data** that is so large it is difficult to **move and process** using traditional database and software techniques.

-  **Amazon Athena** is a **serverless interactive query service**. It can take a bunch of CSV or JSON files in a S3 Bucket and load them into temporary SQL tables so you can run SQL queries. *When you want to query CSV or JSON files*
-  **Amazon CloudSearch** is a fully managed **full-text search service**. *When you want add search to your website*
-  **Amazon Elasticsearch Service (ES)** is a **managed Elasticsearch cluster**. Elasticsearch is a open-source full-text search engine. It is more robust than CloudSearch but requires more server and operational maintaince.
-  **Amazon Elastic MapReduce (EMR)** is for data processing and analysis. Its can be used for creating reports just like Redshift, but is more suited when you need to transform unstructured data into structured data on the fly.
-  **Kinesis Data Streams** is a **real-time streaming data service**. Create **Producers** which send data to a stream. **Multiple Consumers** can consume data within a stream. Use for real-time analytics, click streams, ingesting data from a fleet of IOT Devices
-  **Kinesis Firehose** is serverless and a simpler version of Data Streams, You pay-on-demand based on how much data is consumed through the stream and you don't worry about the underlying servers.
-  **Amazon Kinesis Data Analytics** allows you to run queries against data that is flowing through your real-time stream so you can create reports and analysis on emerging data.
-  **Amazon Kinesis Video Streams** allows you to analyze or apply processing on real-time streaming video.

Big Data and Analytics Services

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Managed Kafka Service (MSK) a **fully managed Apache Kafka service**. Kafka is an open-source platform for building real-time streaming data pipelines and applications. It is similar to Kinesis but with more robust functionalities



Redshift is a **petabyte-size data-warehouse**. Data-warehouses are for Online Analytical Processing (OLAP). Data-warehouses can be expensive because they are keeping data "hot". Meaning that we can run a very complex query and a large amount of data and get that data back very fast.

When you need to quickly generate analytics or reports from a large amount of data.



Amazon QuickSight is **business intelligence (BI) dashboard**. You can use it to create business dashboards to power business decisions. It requires little to no programming knowledge and connects to many different types of databases



AWS Data Pipeline **automates the movement of data**. You can reliably move data between compute and storage services.



AWS Glue is an **Extract, Transform, Load (ETL) service**. Moving data from one location to another and where you need to perform transformations before the final destination. Similar to Database Migration Service (DMS) but more robust



AWS Lake Formation is as a **centralized, curated, and secured repository that stores all your data**.

A **data lake** is a storage repository that holds a vast amount of raw **data** in its native format until it is needed.

AWS Data Exchange is a catalogue of third-party datasets. You can download for free, subscribe or purchase datasets. Eg. COVID-19 Foot Traffic Data, IMDB TV and Movie data, Historical Weather Data

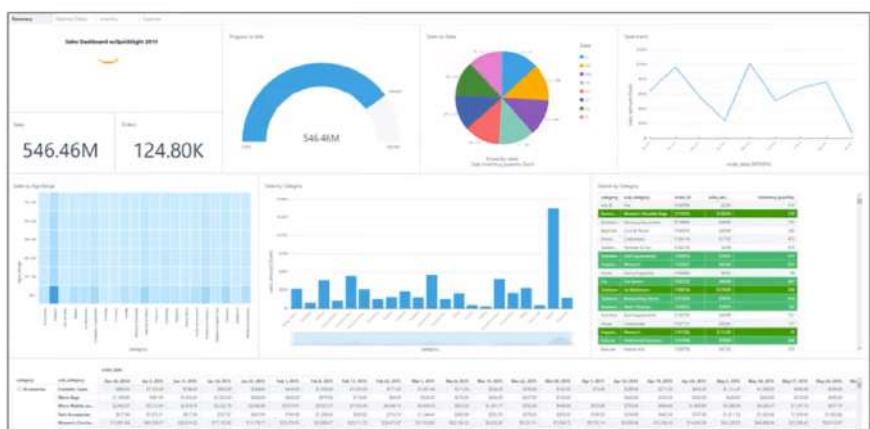


Amazon QuickSight

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Amazon QuickSight is a **Business Intelligence (BI) Dashboard** that allows you to ingest data from various AWS storage or database services to **quickly visualize business data** with minimal programming or data formula knowledge.



QuickSight uses **SPICE** (super-fast, parallel, in-memory, calculation engine) to achieve blazing fast performance at scale

Amazon QuickSight ML Insights – Detect Anomalies, Perform accurate forecasting, Generate Natural Language Narratives.
Amazon QuickSight Q - Ask question using natural language, on all your data, and receive answers in seconds.



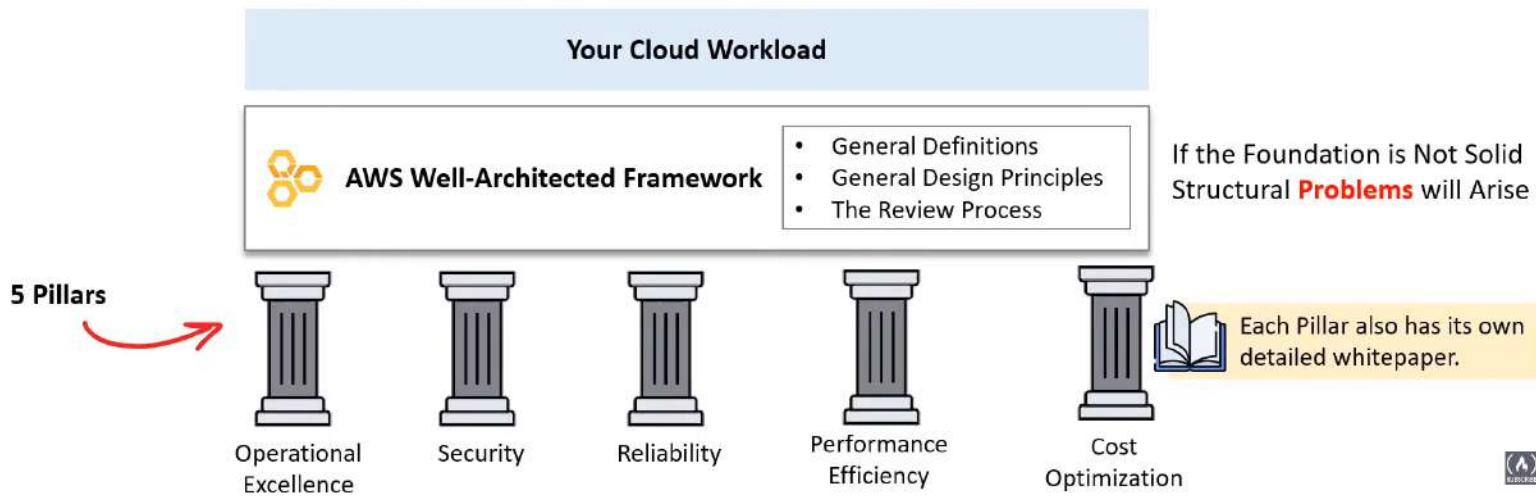
AWS Well-Architected Framework

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The AWS Well-Architected Framework is a Whitepaper created by AWS to help customers build using best-practices defined by AWS.

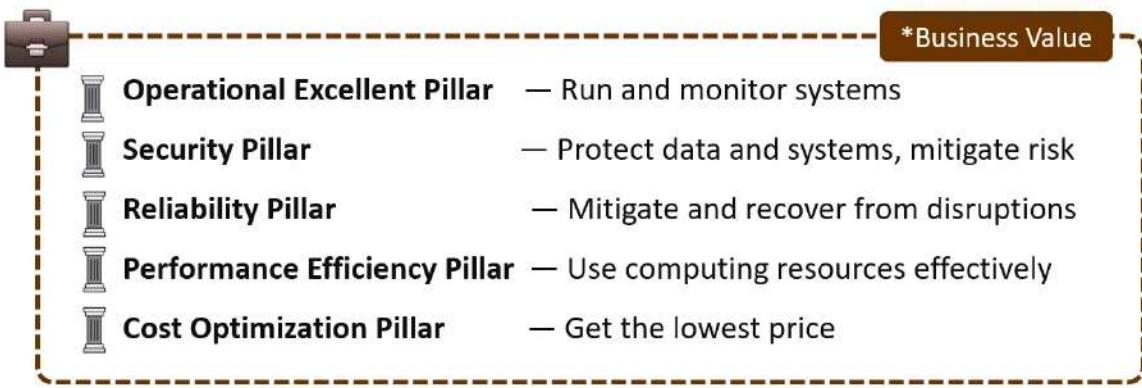
aws.amazon.com/architecture/well-architected

The framework is divided into 5 sections called pillars which address different aspects or "lenses" that can be applied to a cloud workload.



AWS Well-Architected – General Definitions

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*Trade-Off Pillars Based on Business Context

General Definitions

- Component** — Code, Configuration and AWS Resource against a requirement
- Workload** — A set of components that work together to deliver business value
- Milestones** — Key changes of your architecture through product life cycle
- Architecture** — How components work together **in a workload**
- Technology Portfolio** — A collection of workloads required for the business to operate

AWS Well-Architected – On Architecture

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The AWS Well-Architected Framework is designed around a different kind of team structure.
Enterprises generally have centralized teams with specific roles where AWS has distributed teams with flexible roles.
Distributed teams can come with new risks, AWS mitigates these with Practices, Mechanisms and Leadership Principles



On-Premise Enterprise

VS



Amazon Web Services

Centralized team consisting of:

- Technical Architect (infrastructure)
- Solution Architect (software)
- Data Architect
- Networking Architect
- Security Architect

Managed by either **TOGAF** or **Zachman Framework**

Distributed teams consisting of:

- Practices
 - Team Experts (Raise the Bar)
- Mechanisms
 - Automated Checks for Standards
- *Amazon Leadership Principle

Supported by a virtual community of **SMEs, Principle Engineers**
eg. lunchtime talks - recycled into onboarding material



Amazon Leadership Principles

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The Amazon Leadership Principles are a set of principles used during the company decision-making, problem-solving, simple brainstorming, and hiring.

1. Customer Obsession
2. Ownership
3. Invent and Simplify
4. Are Right, A Lot
5. Learn and Be Curious
6. Hire and Develop the Best
7. Insist on the Highest Standards
8. Think Big
9. Bias for Action
10. Frugality
11. Earn Trust
12. Dive Deep
13. Have Backbone; Disagree and Commit
14. Deliver Results
15. Strive to be Earth's Best Employer
16. Success and Scale Bring Broad Responsibility



You can read in detail about all 16 here:
<https://www.amazon.jobs/en/principles>

AWS Well-Architected – General Design Principles

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Stop guessing your capacity needs

eg. Cloud computing you use as little or much based **on demand**.

Test systems at production scale

eg. Clone production env to testing, Tear down testing not in use to save money.

Automate to make architectural experimentation easier

eg. Using CloudFormation with ChangeSets, StackUpdate and Drift Detection

Allow for evolutionary architectures

eg. CI/CD, rapid or nightly releases, Lambdas deprecating run-times forcing you to evolve

Drive architectures using data

eg. CloudWatch, Cloud Trail automatically turned on collecting data

Improve through game days

eg. simulate traffic on production or purposely kill EC2 instances to see test recovery



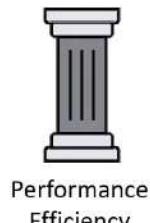
AWS Well-Architected - Anatomy of a Pillar

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A Pillar of the Well-Architected Framework is **structured** as follows:

- Design Principles
 - A list of design principles that need to be considered during implementation
- Definition
 - overview of the best practice categories
- Best Practices
 - detailed information about each best practice with AWS Services
- Resources
 - Additional documentation, whitepapers and videos to implement this pillar



Performance
Efficiency

AWS Well-Architected - Design Principles

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Operational Excellence Design Principles

Perform operations as code

Apply the same engineering discipline you would to application code to your cloud infrastructure.

By treating your operations as code you can limit human error and enable consistent responses to events.

eg. Infrastructure as Code

Make frequent, small, reversible changes

Design workloads to allow components to be updated regularly.

eg. rollbacks, incremental changes, Blue/Green, CI/CD

Refine operations procedures frequently

Look for continuous opportunities to improve your operations

eg. Use game days to simulate traffic or event failure on your production workloads

Anticipate failure

Perform post-mortems on system failures to better improve, write test code, kill production servers to test recovery

Learn from all operational failures

share lessons learned in a knowledge base for operational events and failures across your entire organization

AWS Well-Architected - Design Principles

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Security Design Principles

Implement a strong identity foundation

Implement Principle of Least Privilege (PoLP). Use Centralized identity. Avoid Long-lived credentials

Enable traceability

Monitor alert and audit actions and changes to your environment in real-time

Integrate log and metric collection and automate investigation and remediation

Apply security at all layers

Take Defense in depth approach with multiple security controls for everything eg. Edge Network, VPC, Load Balancing Instances, OS, Application Code

Automate security best practices

Protect data in transit and at rest

Keep people away from data

Prepare for security events

Incident management systems and investigation policy and processes. Tools to detect, investigate and recover from incidences



AWS Well-Architected - Design Principles

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



Reliability Design Principles

Automatically recover from failure

Monitor Key Performance Indicators (KPIs) and trigger automation when threshold is breached.

Test recovery procedures

Test how your workload fails, and you validate your recovery procedures.

You can use automation to simulate different failures or to recreate scenarios that led to failures before.

Scale horizontally to increase aggregate system availability

Replace one large resource with multiple small resources to reduce the impact of a single failure on the overall workload.

Distribute requests across multiple, smaller resources to ensure that they don't share a common point of failure.

Stop guessing capacity

In on-premise it takes a lot of guess work to determine the elasticity of your workload demands.

With Cloud you don't need to guess how much you need because you can request the right size of resources on-demand.

Manage change in automation

Making changes via Infrastructure as Code, will allow for a formal process to track and review infrastructure



AWS Well-Architected - Design Principles

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Performance Efficiency Design Principles

Democratize advanced technologies:

Focus on product development rather than procurement, provisioning and management of services.

Take advantage of advanced technology specialized and optimized for your use-case with on-demand cloud services.

Go global in minutes

Deploying your workload in multiple AWS Regions around the world allows you to provide lower latency and a better experience for your customers at minimal cost.

Use serverless architectures:

Serverless architectures remove the need for you to run and maintain physical servers for traditional compute activities.

Removes the operational burden of managing physical servers, and can lower transactional costs because managed services operate at cloud scale.

Experiment more often:

With virtual and automatable resources, you can quickly carry out comparative testing using different types of instances, storage, or configurations.

Consider mechanical sympathy

Understand how cloud services are consumed and always use the technology approach that aligns best with your workload goals. For example, consider data access patterns when you select database or storage approaches.



AWS Well-Architected - Design Principles

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Cost Optimization Design Principles

Implement Cloud Financial Management:

Dedicate time and resources to build capability Cloud Financial Management and Cost Optimization tooling.

Adopt a consumption model

Pay only for the computing resources that you require and increase or decrease usage depending on business requirements

Measure overall efficiency

Measure the business output of the workload and the costs associated with delivering it.

Use this measure to know the gains you make from increasing output and reducing costs.

Stop spending money on undifferentiated heavy lifting

AWS does the heavy lifting of data center operations like racking, stacking, and powering servers.

It also removes the operational burden of managing operating systems and applications with managed services.

This allows you to focus on your customers and business projects rather than on IT infrastructure.

Analyze and attribute expenditure

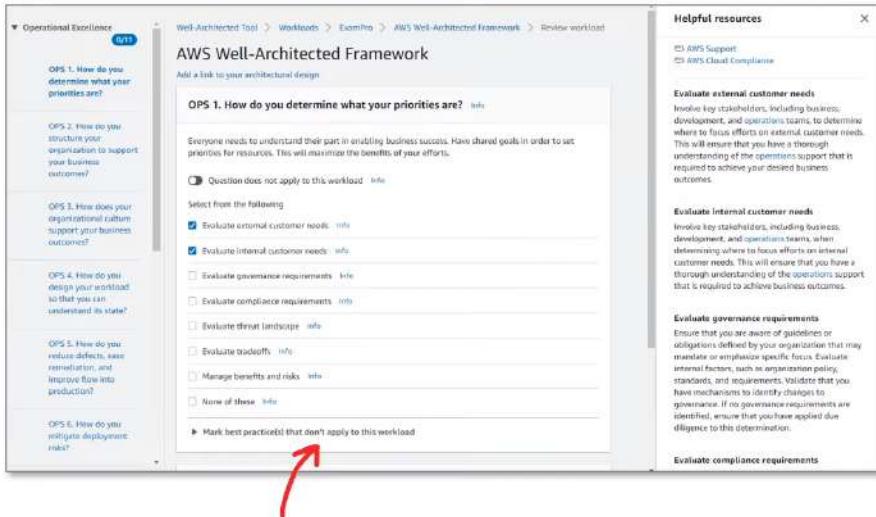
The cloud makes it easier to accurately identify the usage and cost of systems, which then allows transparent attribution of IT costs to individual workload owners. This helps measure return on investment (ROI) and gives workload owners an opportunity to optimize their resources and reduce costs.



AWS Well-Architected Tool

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The Well-Architected Tool is **an auditing tool** to be used to asset your cloud workloads for alignment with the AWS Well Architected Framework.



The screenshot shows the AWS Well-Architected Framework review interface. On the left, there's a sidebar with navigation links for Operational Excellence, Workloads, Examples, and AWS Well-Architected Framework. The main content area is titled "AWS Well-Architected Framework" and contains a question: "OPS 1. How do you determine what your priorities are?". Below the question is a note: "Everyone needs to understand their part in enabling business success. Have shared goals in order to set priorities for resources. This will maximize the benefits of your efforts." A red arrow points from the text "Its essentially a checklist" to the "Question does not apply to this workload" checkbox. To the right, there's a "Helpful resources" panel with sections for "Evaluate external customer needs", "Evaluate internal customer needs", "Evaluate governance requirements", and "Evaluate compliance requirements".

Its essentially a **checklist**, with nearby references to help you assemble a report to share with executives and key stake-holders



AWS Architecture Center

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

The AWS Architecture Center is a web-portal that contains
best practices and reference architectures
for a variety of different workloads.
aws.amazon.com/architecture

Security, Identity, & Compliance
Learn how to meet your security and compliance goals using AWS infrastructure and services.

Identity & Access Management
Manage access to AWS services and resources.

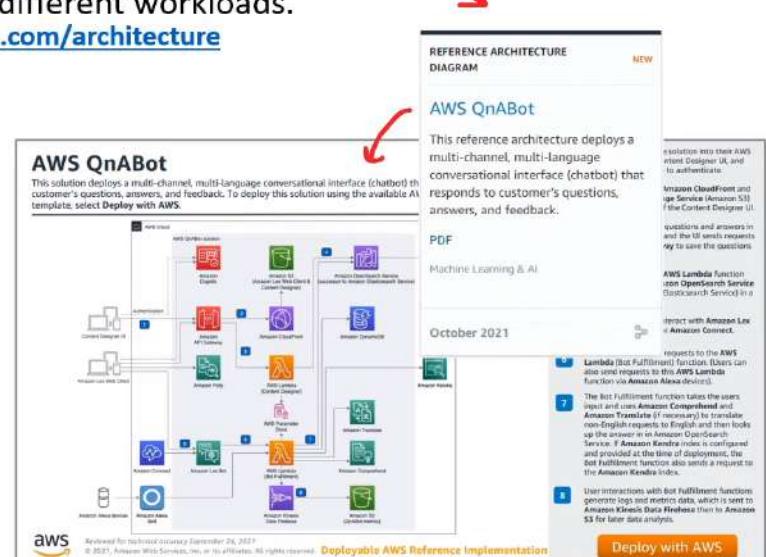
Detection
Learn how to detect suspicious activity in your AWS account.

Infrastructure Protection
Monitor and control your network infrastructure.

Data Protection
Operate the security services that protect your data.

Compliance
Implement compliance controls with AWS.

Incident Response
Learn how to automate incident response and recovery.



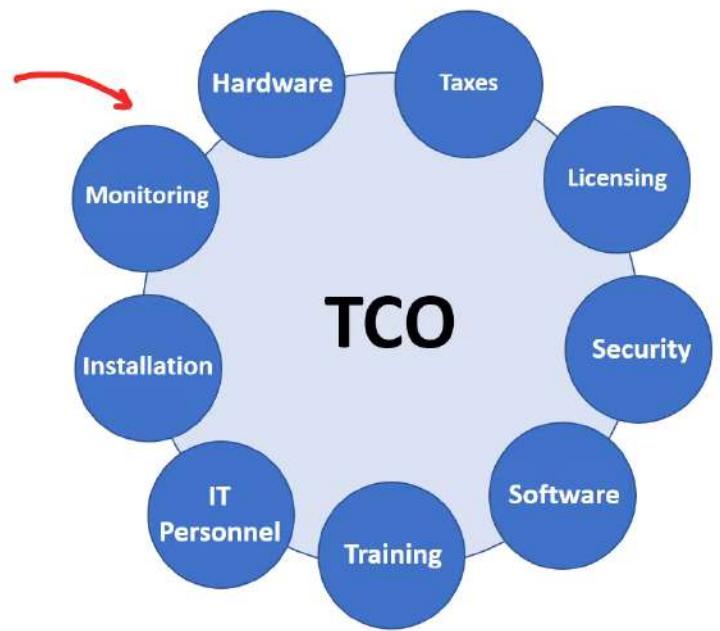
Total Cost of Ownership (TCO)

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What is the Total Cost of Ownership? (TCO)?

TCO is a **financial estimate** intended to help buyers and owners determine the direct and indirect costs of a product or service.

Creating a TCO report is useful when your company
is looking to migrate from on-premise to cloud.



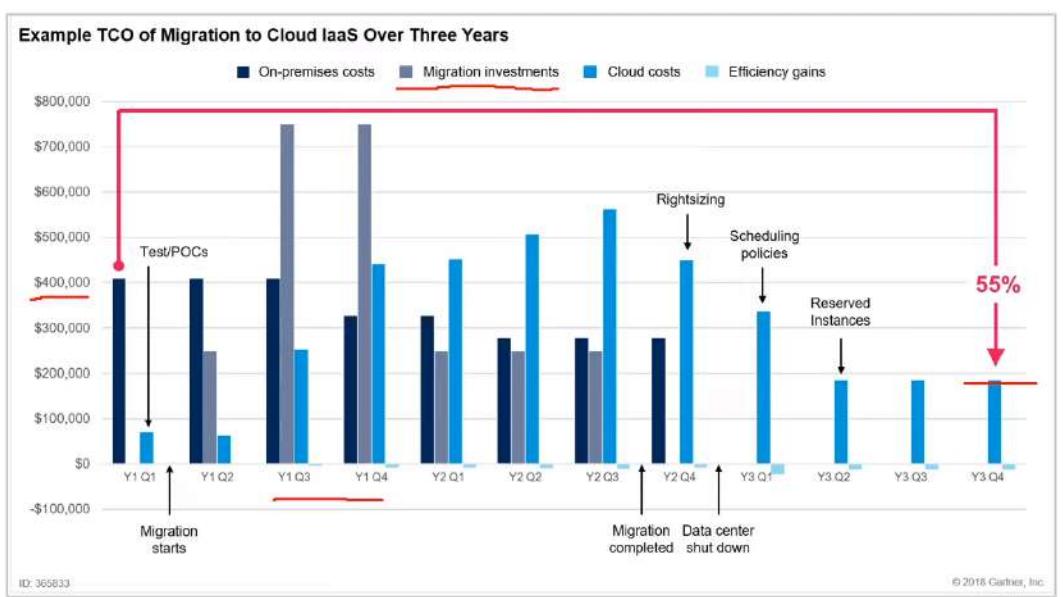
Total Cost of Ownership (TCO)

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According to research stated by Garter:

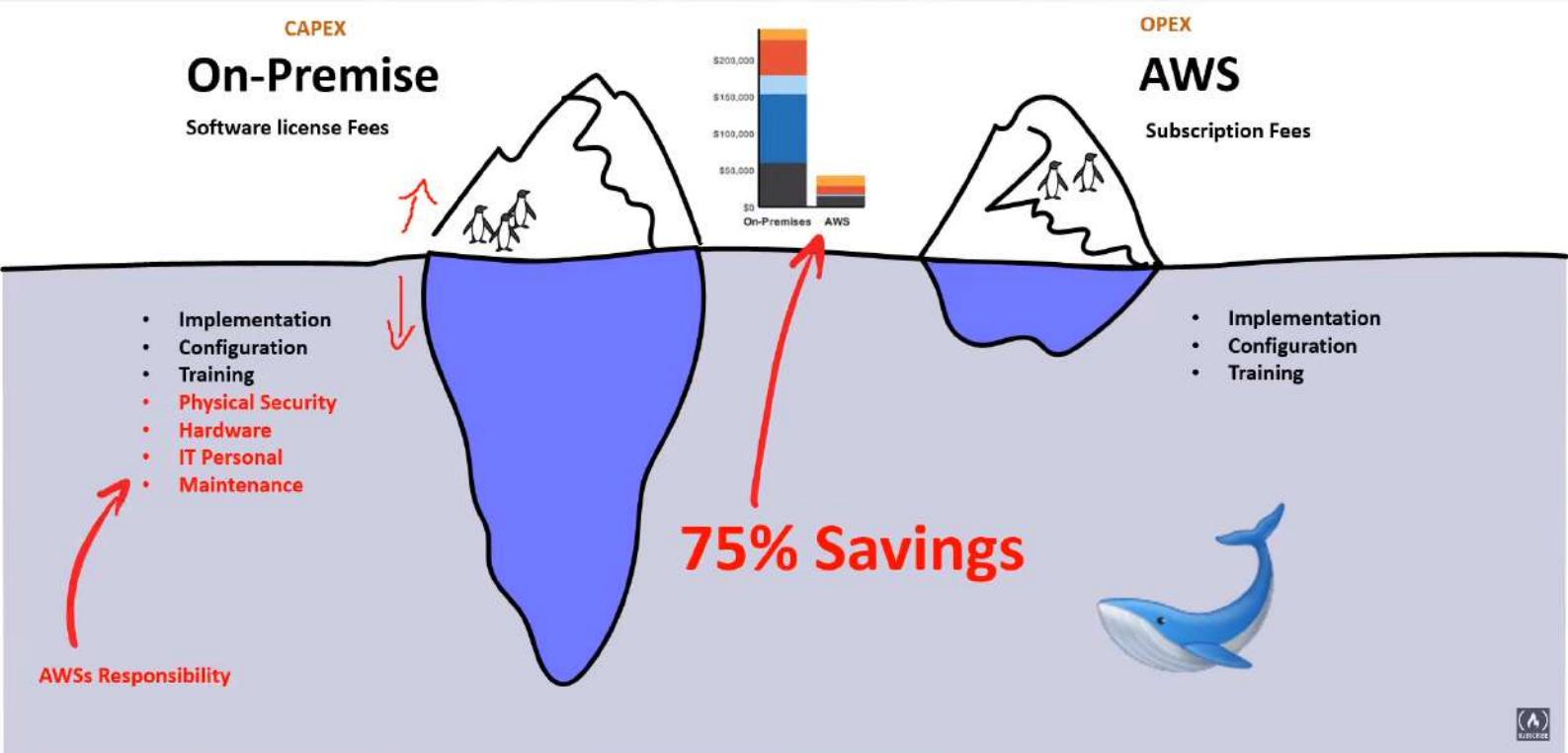
"cloud services can initially be more expensive than running on-premises data centers. [However, it also proves that] cloud services can become cost-effective over time if organizations learn to use and operate them more efficiently"

Example of a 2,500
Virtual Machines (VMs)
moved to Amazon EC2



Total Cost of Ownership (TCO)

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Capital vs Operational Expenditure

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Capital Expenditure (CAPEX)

Spending money upfront on **physical infrastructure**

Deducting that expense from your tax bill over time.

- Server Costs (computers)
- Storage Costs (hard drives)
- Network Costs (Routers, Cables, Switches)
- Backup and Archive Costs
- Disaster Recovery Costs
- Datacenter Costs (Rent, Cooling, Physical Security)
- Technical Personal

With Capital Expenses **you have to guess upfront** what you plan to spend

Operational Expenditure (OPEX)

The costs associated with an on-premises datacenter that has shifted the cost to the service provider. The customer only has to be concerned with **non-physical costs**.

- Leasing Software and Customizing features
- Training Employees in Cloud Services
- Paying for Cloud Support
- Billing based on cloud metrics eg.
 - compute usage
 - storage usage

With Operation Expenses you can try a product or service **without investing in equipment**



Does Cloud Make IT Personnel Redundant?

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

A company is considering migrating their workloads from on-premise to the cloud to take advantage of the savings. There is a concern among the staff that there will be mass layoffs. Does cloud make IT Personnel redundant?



Shifting your IT Team

- A company needs IT personnel during the migration phase
- A company can transition some roles to new cloud roles:
 - Networking to Cloud Networking
- A company may decide to take a Hybrid approach so they'll always need to have a traditional IT team and a Cloud IT Team
- A company can change employees activities from **Managing Infrastructure to Revenue Generating**



AWS Pricing Calculator

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

The AWS Pricing Calculator is a **free cost estimate tool** that can be used within your **web-browser** without the need for an AWS Account to estimate the cost of a various AWS services.

[calculator.aws](#)



The AWS Pricing Calculator contains 100+ services that you can configure for cost estimate.

To calculate Total Cost of Ownership an organization needs to compare their existing cost against the AWS costs and so the AWS Pricing Calculator can be used to determine that cost.



You can export your final estimate to a CSV.

The screenshot shows the AWS Pricing Calculator interface. At the top, there's a navigation bar with links like 'AWS Pricing Calculator', 'My Estimate', 'Add service', 'Add support', 'Add group', 'Clear estimate', 'Export estimate', and 'Share'. Below the navigation, there's a 'My Estimate' section with a 'Edit' button. It displays the following summary:

Upfront cost	Monthly cost	Total 12 months cost
0.00 USD	4,751.53 USD	57,018.36 USD

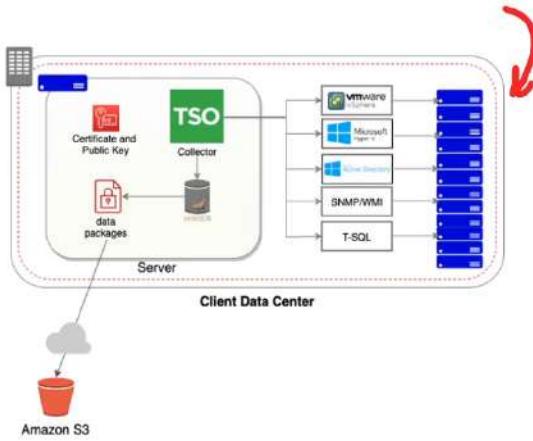
Below the summary, there's a 'Getting Started with AWS' section with 'Contact Us' and 'Sign in to the Console' buttons. The main content area has sections for 'Support' (Business support plan, Region: All Regions) and 'Services' (Amazon RDS for PostgreSQL, RDS for PostgreSQL). The 'Amazon RDS for PostgreSQL' section includes a note about storage volume and instance type.

Migration Evaluator

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

AWS Migration Evaluator (formerly known as TSO Logic) is an **estimate tool** used to determine an organization existing on-premise cost so it can compare it against AWS Costs for planned cloud migration

Migration Evaluator uses an **Agentless Collector** to collect data from your on-premise infrastructure to extract your on-premise costs



EC2 VM Import/Export

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



VM Import/Export allows users **to import Virtual Machine images into EC2.**

AWS has import instructions for:

- VMWare
- Citrix
- Microsoft Hyper-V
- Windows VHD from Azure
- Linux VHD from Azure



Prepare your Virtual Image for Upload



Upload your Virtual Image to S3



Use the AWS CLI to Import your Image
It will generate an Amazon Machine Image (AMI)

```
aws ec2 import-image \
--disk-containers Format=ova,UserBucket="{S3Bucket=my-vm,S3Key=vm.ova}"
```

Database Migration Service (DMS)

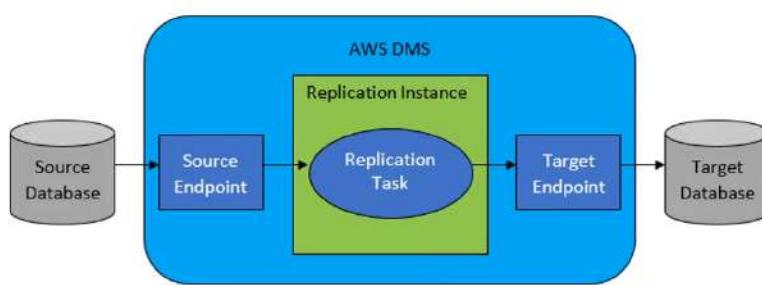
Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



AWS Database Migration Service (DMS) allows you to quickly and securely migrate one database to another. DMS can be used to migrate your on-premise database to AWS.

Possible Sources:

- Oracle Database
- Microsoft SQL
- MySQL
- MariaDB
- PostgreSQL
- MongoDB
- SAP ASE
- IMDB Db2
- Azure SQL Database
- Amazon RDS
- Amazon S3 (database dumps)
- Amazon Aurora
- Amazon DocumentDB



AWS Schema Conversion Tool is used in many cases to automatically convert a source database schema to a target database schema.

Each migration path requires a bit of research since not all combination of sources and targets are possible.

Possible Targets:

- Oracle Database
- Microsoft SQL
- MySQL
- MariaDB
- PostgreSQL
- Redis
- SAP ASE
- Amazon Redshift
- Amazon RDS
- Amazon DynamoDB
- Amazon S3
- Amazon Aurora
- Amazon OpenSearch Service
- Amazon ElastiCache for Redis
- Amazon DocumentDB
- Amazon Neptune
- Apache Kafka



AWS Cloud Adoption Framework (CAF)

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

The AWS Cloud Adoption Framework is a whitepaper to help you plan your migration from on-premise to AWS.

At the highest level, the AWS CAF organizes guidance into **six focus areas**.

 BUSINESS	 PLATFORM
 PEOPLE	 SECURITY
 GOVERNANCE	 OPERATIONS

1 Business Perspective e.g. Business Managers, Finance Managers, Budget Owners, and Strategy Stakeholders.

How to update the staff skills and organizational processes to optimize business value as they move ops to the cloud

2 People Perspective e.g. Human Resources, Staffing, People Managers,

how to update the staff skills and organizational processes to optimize and maintain their workforce, and ensure competencies are in place at the appropriate time.

3 Governance Perspective e.g. CIO, Program Managers, Project Managers, Enterprise Architects, Business Analysts

how to update the staff skills and organizational processes that are necessary to ensure business governance in the cloud, and manage and measure cloud investments to evaluate their business outcomes.

4 Platform Perspective e.g. CTO, IT Managers, Solution Architects.

how to update the staff skills and organizational processes that are necessary to deliver and optimize cloud solutions and services.

5 Security Perspective e.g. CISO, IT Security Managers, IT Security Analysts.

how to update the staff skills and organizational processes that are necessary to ensure that the architecture deployed in the cloud aligns to the organization's security control requirements, resiliency, and compliance requirements.

6 Operations Perspective e.g. IT Operations Managers, IT Support Managers.

how to update the staff skills and organizational processes that are necessary to ensure system health and reliability during the move of operations to the cloud and then to operate using agile, ongoing, cloud computing best practices.



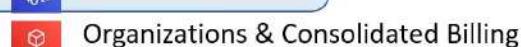
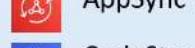
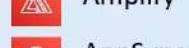
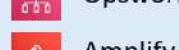
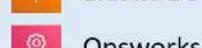
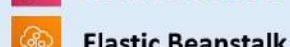
AWS Free Services

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

AWS Free services are free forever, unlike the “free-tier” that are up to a point of usage or time



The AWS services are also free, however these AWS Services provision other services which may cost money



AWS Support Plans

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Basic	Developer	Business	Enterprise
Email Support only For Billing and Account	Tech Support via Email ~24 hours until reply	Tech Support via Chat, Phone Anytime 24/7	
	No third party support		< 24 hrs
	General Guidance		< 12 hrs
	System Impaired	Production System Impaired	< 4 hrs
		Production System DOWN!	< 1 hrs
			Business-Critical System DOWN! < 15m
			 Personal Concierge
			 TAM
7 Trusted Advisor Checks		All Trusted Advisor Checks	
\$0 USD /month	*\$29 USD /month	*\$100 USD / month	*\$15,000 USD / month



AWS Support Plans

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Developer	Business	Enterprise
<p>*\$29 USD /month or 3% of monthly AWS usage <i>whichever is greater</i></p> <p>eg. Monthly Spend is \$500 3% of 500 = \$15 USD (\$29)</p> <p>Monthly Spend is \$1000 3% of 1000 = \$30 USD</p>	<p>*\$100 USD / month or 10% of monthly AWS usage for the first \$0–\$10K 7% of monthly AWS usage from \$10K–\$80K 5% of monthly AWS usage from \$80K–\$250K 3% of monthly AWS usage over \$250K <i>whichever is greater</i></p> <p>eg. Monthly Spend is \$1000 10% of 1000 = \$100 USD</p> <p>Monthly Spend is \$5000 10% of 5000 = \$500 USD</p> <p>Monthly Spend is \$12,000 10% of 10,000 = \$1000 USD 7% of 2,000 = 140 USD \$1140 USD</p>	<p>*\$15,000 USD / month or 10% of monthly AWS usage for the first \$0–\$150K 7% of monthly AWS usage from \$150K–\$500K 5% of monthly AWS usage from \$500K–\$1M 3% of monthly AWS usage over \$1M <i>whichever is greater</i></p>
		

Technical Account Manager (TAM)

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



A Technical Account Manager? (TAM) provides both **proactive guidance** and **reactive support** to help you succeed with your AWS journey

What does a TAM do? (Straight from an AWS Job Posting)

- Build solutions, provide technical guidance and advocate for the customer
- Ensure AWS environments remain operationally healthy whilst reducing cost and complexity
- Develop trusting relationships with customers, understanding their business needs and technical challenges
- Using your technical acumen and customer obsession, you'll drive technical discussions regarding incidents, trade-offs, and risk management
- Consult with a range of partners from developers through to C-suite executives
- Collaborates with AWS Solutions Architects, Business Developers, Professional Services Consultants, and Sales Account Managers
- Proactively find opportunities for customers to gain additional value from AWS
- Provide detailed reviews of service disruptions, metrics, detailed prelaunch planning
- Being part of a wider Enterprise Support team providing post-sales, consultative expertise
- Solve a variety of problems across different customers as they migrate their workloads to the cloud
- Uplift customer capabilities by running workshops, brown bag sessions, etc.



TAMs follow the Amazon Leadership Principles
Especially about being Customer Obsessed!



TAMs are only available at the Enterprise Support tier.

AWS Marketplace

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

AWS Marketplace is a curated digital catalogue with **thousands** of software listings from independent software vendors.

Easily find, buy, test, and deploy software that already runs on AWS.

The product can be **free** to use or can have an **associated charge**. The charge becomes part of your AWS bill, and once you pay, AWS Marketplace pays the provider.

The sales channel for ISVs and Consulting Partners allows you to **sell your solutions** to other AWS customers.



Products can be offered as

- Amazon Machine Images (AMIs)
- AWS CloudFormation templates
- Software as a service (SaaS) offerings
- Web ACL
- AWS WAF rules

Consolidated Billing

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Consolidated Billing is a feature of AWS Organizations that allows you to pay for multiple AWS accounts with **one bill**.

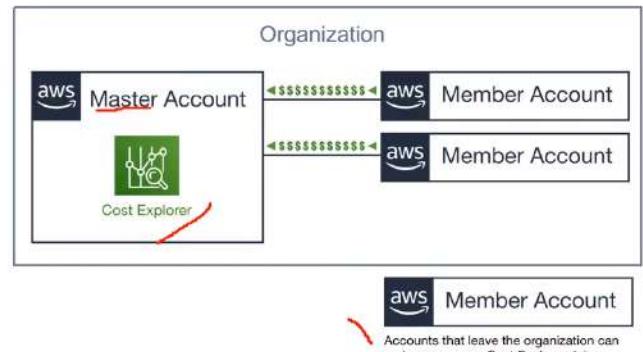
For billing AWS treats all the accounts in an organization as if they were one account.

You can designate one **master account that pays the charges** of all the other **member accounts**.

Consolidated billing is offered at no additional cost!

Use **Cost Explorer** to visualize usage for consolidated billing

You can combine the usage across all accounts in the organization to share the volume pricing discounts



Consolidated Billing – Volume Discounts

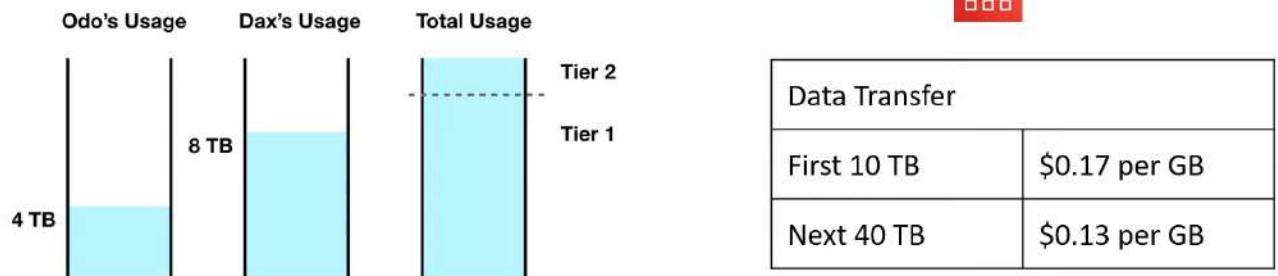
Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

AWS has **Volume Discounts** for many services

The more you use, the more you save.

Consolidated Billing lets you take advantage of Volume Discounts

Consolidate Billing is a feature of AWS Organizations



$$\text{Odo} \quad (4 * 1024) * 0.17 = \$696.32 \quad 1 \text{ TB} = 1024 \text{ GB}$$

$$\text{Dax} \quad (8 * 1024) * 0.17 = \$1392.64$$

$$\text{Unconsolidated} \quad 696.32 + 1392.64 = \$2088.96$$

$$\text{Consolidated} \quad ((10 * 1024) * 0.17) + ((2 * 1024) * 0.13) = \$2007.04$$

AWS Trusted Advisor

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



AWS Trusted Advisor is a **recommendation tool** which automatically and actively monitors your AWS account to provide **actional recommendations** across a series of categories.

The screenshot shows the AWS Trusted Advisor dashboard. On the left, there's a sidebar with 'Dashboard' selected, followed by 'Cost optimization', 'Performance', 'Security', 'Fault tolerance', and 'Service limits'. Below that is a 'Preferences' section. The main area is titled 'Dashboard' and has a 'Checks summary' section. It shows 2 'Action recommended' items under 'Security' and 1 'Investigation recommended' item under 'Security'. A red arrow points from the top of the page down to the 'Checks summary' section. Another red arrow points from the 'Checks summary' section to a detailed view of a specific recommendation: 'Security Groups - Specific Ports Unrestricted'. This detail view includes a description: 'Checks security groups for rules that allow unrestricted access (0.0.0.0/0) to specific ports.', a note: '51 of 146 security group rules allow unrestricted access to a specific port.', and update information: 'Last updated: 3 minutes ago'.



Think of AWS Trusted Advisor like an **automated checklist of best practices on AWS**

The 5 categories of AWS Trusted Advisor

- Cost Optimization – How can we save money?
- Performance – How can improve performance?
- Security – How we can improve security?
- Fault Tolerance – How can we prevent a disaster or data loss?
- Service Limits – Are we are going to hit the maximum limit for a service?



AWS Trusted Advisor

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

AWS Trusted Advisor providers different level of checks based on your AWS Support Plan

Basic

Developer

Business

Enterprise

7 Trusted Advisor Checks

All Trusted Advisor Checks

AWS providers the following checks for free:

1. MFA on Root Account
2. Security Groups – Specific Ports of Unrestricted
3. Amazon S3 Bucket Permissions
4. Amazon EBS Public Snapshots
5. Amazon RDS Public Snapshots
6. IAM Use - discourage the use of root access
7. Service Limits (All Service limits checks are free)

 Six security checks



AWS Trusted Advisor

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Cost Optimization

Amazon EC2 Reserved Instances Optimization
Low Utilization Amazon EC2 Instances
Underutilized Amazon EBS Volumes
Amazon EC2 Reserved Instance Lease Expiration
Amazon RDS Idle DB Instances
Amazon Route 53 Latency Resource Record Sets
Idle Load Balancers
Unassociated Elastic IP Addresses
Underutilized Amazon Redshift Clusters

Performance

CloudFront Alternate Domain Names
Amazon EBS Provisioned IOPS (SSD) Volume Attachment Configuration
Amazon EC2 to EBS Throughput Optimization
Amazon Route 53 Alias Resource Record Sets
CloudFront Content Delivery Optimization
CloudFront Header Forwarding and Cache Hit Ratio
High Utilization Amazon EC2 Instances
Large Number of EC2 Security Group Rules Applied to an Instance
Large Number of Rules in an EC2 Security Group
Overutilized Amazon EBS Magnetic Volumes

Security

AWS CloudTrail Logging
IAM Password Policy
MFA on Root Account
Security Groups - Specific Ports Unrestricted
Security Groups - Unrestricted Access
Amazon S3 Bucket Permissions
IAM Access Key Rotation
Amazon EBS Public Snapshots
Amazon RDS Public Snapshots
Amazon RDS Security Group Access Risk
Amazon Route 53 MX Resource Record Sets and Sender Policy Framework
CloudFront Custom SSL Certificates in the IAM Certificate Store
CloudFront SSL Certificate on the Origin Server
ELB Listener Security
ELB Security Groups
Exposed Access Keys
IAM Use

AWS Trusted Advisor

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



Fault Tolerance

- Amazon EBS Snapshots
- Amazon RDS Multi-AZ
- Amazon S3 Bucket Logging
- Amazon S3 Bucket Versioning
- Amazon Aurora DB Instance Accessibility
- Amazon EC2 Availability Zone Balance
- Amazon RDS Backups**
- Amazon Route 53 Deleted Health Checks
- Amazon Route 53 Failover Resource Record Sets
- Amazon Route 53 High TTL Resource Record Sets
- Amazon Route 53 Name Server Delegations
- Auto Scaling Group Health Check
- Auto Scaling Group Resources
- ELB Connection Draining
- ELB Cross-Zone Load Balancing
- Load Balancer Optimization
- VPN Tunnel Redundancy
- AWS Direct Connect Connection Redundancy
- AWS Direct Connect Location Redundancy
- AWS Direct Connect Virtual Interface Redundancy
- EC2Config Service for EC2 Windows Instances
- ENA Driver Version for EC2 Windows Instances
- NVMe Driver Version for EC2 Windows Instances
- PV Driver Version for EC2 Windows Instances



Service Limits

- Auto Scaling Groups
- Auto Scaling Launch Configurations
- CloudFormation Stacks
- DynamoDB Read Capacity
- DynamoDB Write Capacity
- EBS Active Snapshots
- EBS Active Volumes
- EBS Cold HDD (sc1) Volume Storage
- EBS General Purpose SSD (gp2) Volume Storage
- EBS Magnetic (standard) Volume Storage
- EBS Provisioned IOPS (SSD) Volume Aggregate IOPS
- EBS Provisioned IOPS SSD (io1) Volume Storage
- EBS Throughput Optimized HDD (st1) Volume Storage
- EC2 Elastic IP Addresses
- EC2 On-Demand Instances
- EC2 Reserved Instance Leases
- ELB Active Load Balancers
- IAM Group
- IAM Instance Profiles
- IAM Policies
- IAM Roles
- IAM Server Certificates
- IAM Users
- Kinesis Shards per Region

- RDS Cluster Parameter Groups
- RDS Cluster Roles
- RDS Clusters
- RDS DB Instances
- RDS DB Parameter Groups
- RDS DB Security Groups
- RDS DB Snapshots Per User
- RDS Event Subscriptions
- RDS Max Auths per Security Group
- RDS Option Groups
- RDS Read Replicas per Master
- RDS Reserved Instances
- RDS Subnet Groups
- RDS Subnets per Subnet Group
- RDS Total Storage Quota
- Route 53 Hosted Zones
- Route 53 Max Health Checks
- Route 53 Reusable Delegation Sets
- Route 53 Traffic Policies
- Route 53 Traffic Policy Instances
- SES Daily Sending Quota
- VPC**
- VPC Elastic IP Address
- VPC Internet Gateways



Service Level Agreements

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

What is a Service Level Agreement (SLA)?

A SLA is a **formal commitment** about the **expected level of service** between a customer and provider.

When a service level is not met and if Customer meets its obligations under the SLA, Customer will be eligible to receive the compensation eg. **Financial or Service Credits**

What is a Service Level Indicator (SLI)?

A **metric/measurement** that indicates what measure of performance a customer is receiving at a given time

A SLI metric could be uptime, performance, availability, throughput, latency, error rate, durability, correctness

What is a Service Level Objective (SLO)?

The objective that the provider has agreed to meet

SLOs are represented as a specific **target percentage** over a period of time.

Availability SLA of **99.99%** in a period of **3 months**

Target percentages

- 99.95%
- 99.99%
- 99.99999999% (commonly called **Nine nines**)
- 99.9999999999% (commonly called **Nine elevens**)

AWS Service Level Agreements

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

DynamoDB SLA

AWS will use commercially reasonable efforts to make DynamoDB available with a Monthly Uptime Percentage for each AWS region, during any monthly billing cycle, of (a) at least 99.999% if the Global Tables SLA applies, or (b) at least 99.99% if the Standard SLA applies

In the event DynamoDB does not meet the Service Commitment, you will be eligible to receive a Service Credit as described below

	Monthly Uptime Percentage	Service Credit Percentage
<i>Global Tables SLA</i>	Less than 99.999% but equal to or greater than 99.0%	10%
	Less than 99.0% but equal to or greater than 95.0%	25%
	Less than 95.0%	100%
<i>Standard SLA</i>	Less than 99.99% but equal to or greater than 99.0%	10%
	Less than 99.0% but equal to or greater than 95.0%	25%
	Less than 95.0%	100%



AWS Service Level Agreements

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Compute SLAs

- Amazon Elastic Compute Cloud (Amazon EC2)*
- Amazon Elastic Block Store (Amazon EBS)
- Amazon Elastic Container Service (Amazon ECS)
- AWS Fargate for Amazon ECS and Amazon EKS

AWS makes two SLA commitments for the Included Services:

1. a Region-Level SLA that governs Included Services deployed across multiple AZs or regions, and
2. an Instance-Level SLA that governs Amazon EC2 instances individually.

	Monthly Uptime Percentage	Service Credit Percentage
<i>Region-Level SLA</i>	Less than 99.99% but equal to or greater than 99.0%	10%
	Less than 99.0% but equal to or greater than 95.0%	30%
	Less than 95.0%	100%
<i>Instance-Level SLA</i>	Less than 99.5% but equal to or greater than 99.0%	10%
	Less than 99.0% but equal to or greater than 95.0%	30%
	Less than 95.0%	100%



AWS Service Level Agreements

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RDS SLA

AWS will use commercially reasonable efforts to make Multi-AZ instances available with a Monthly Uptime Percentage of at least 99.95% during any monthly billing cycle

In the event Amazon RDS does not meet the Monthly Uptime Percentage commitment, you will be eligible to receive a Service Credit as described below.

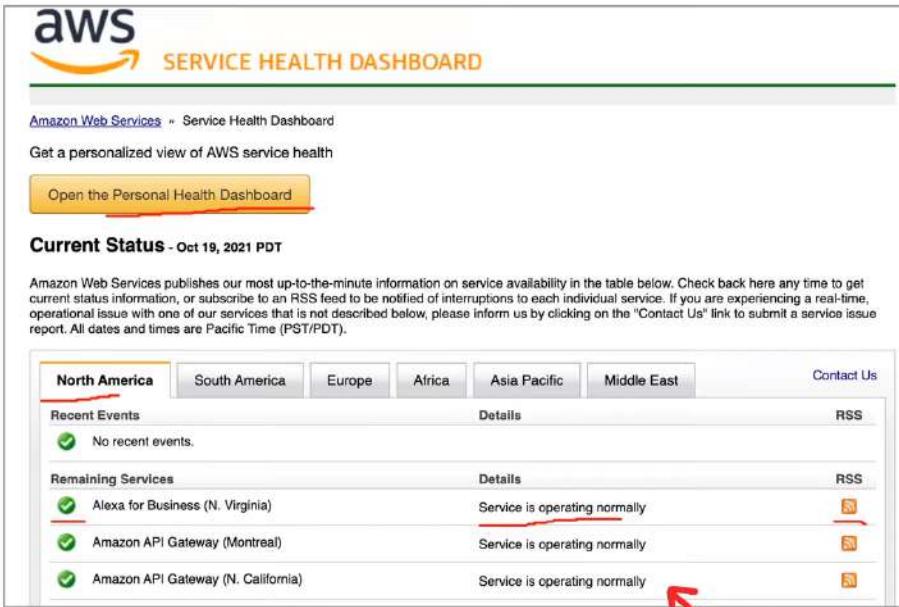
Monthly Uptime Percentage	Service Credit Percentage
Less than 99.95% but equal to or greater than 99.0%	10%
Less than 99.0% but equal to or greater than 95.0%	25%
Less than 95.0%	100%



Service Health Dashboard

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

The **Service Health Dashboard** shows the general status of AWS services,



The screenshot shows the AWS Service Health Dashboard. At the top, there's a navigation bar with the AWS logo and a "SERVICE HEALTH DASHBOARD" button. Below the navigation, it says "Amazon Web Services » Service Health Dashboard" and "Get a personalized view of AWS service health". A yellow button labeled "Open the Personal Health Dashboard" is highlighted with a red arrow. The main section is titled "Current Status - Oct 19, 2021 PDT". It includes a note about staying updated on service availability and contacting support. Below this, there are two tabs: "North America" (which is selected and highlighted with a red arrow) and "South America", "Europe", "Africa", "Asia Pacific", and "Middle East". To the right of the tabs are "Contact Us" and "RSS" links. The "Recent Events" section shows "No recent events". The "Remaining Services" section lists three services:

Service	Status	RSS
Alexa for Business (N. Virginia)	Service is operating normally	
Amazon API Gateway (Montreal)	Service is operating normally	
Amazon API Gateway (N. California)	Service is operating normally	

An **icon** and **details** will indicate the status of each AWS Service



AWS Personal Health Dashboard

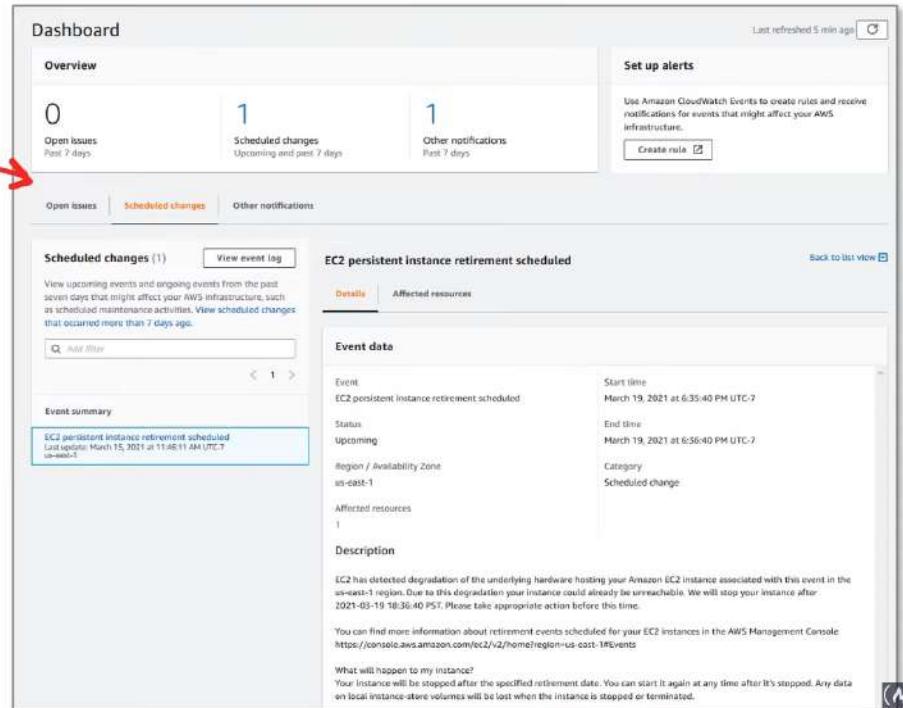
Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

AWS Personal Health Dashboard provides **alerts and guidance** for AWS events that might affect your environment.

All AWS customers can access the Personal Health Dashboard.

The Personal Health Dashboard shows recent events to help you manage active events, and shows proactive notifications so that you can plan for scheduled activities

Use these alerts to get notified about changes that can affect your AWS resources, and then follow the guidance to diagnose and resolve issues.



The screenshot shows the AWS Personal Health Dashboard interface. At the top, there's a summary section with three metrics: 'Open issues' (0), 'Scheduled changes' (1), and 'Other notifications' (1). Below this is a navigation bar with tabs: 'Open issues', 'Scheduled changes' (which is highlighted in orange), and 'Other notifications'. The main content area is titled 'Scheduled changes (1)' and contains a single event entry:

EC2 persistent instance retirement scheduled

Event details | **Affected resources**

Event data

Event	Start time
EC2 persistent instance retirement scheduled	March 19, 2021 at 6:35:40 PM UTC-2

Status: Upcoming
Region / Availability Zone: us-east-1
Affected resources: 1

Description

EC2 has detected degradation of the underlying hardware hosting your Amazon EC2 instance associated with this event in the us-east-1 region. Due to this degradation your instance could already be unreachable. We will stop your instance after 2021-03-19 18:36:40 PST. Please take appropriate action before this time.

You can find more information about retirement events scheduled for your EC2 instances in the AWS Management Console: <https://console.aws.amazon.com/ec2/v2/home?region=us-east-1#Events>

What will happen to my instance?
Your instance will be stopped after the specified retirement date. You can start it again at any time after it's stopped. Any data on local instance store volumes will be lost when the instance is stopped or terminated.

AWS Abuse

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

AWS Trust & Safety is a team that specifically deals with abuses occurring on the AWS platform for the following issues:

Spam

You are receiving unwanted emails from an AWS-owned IP address, or AWS resources are used to spam websites or forums.

Port scanning

Your logs show that one or more AWS-owned IP addresses are sending packets to multiple ports on your server. You also believe this is an attempt to discover unsecured ports.

Denial-of-service (DoS) attacks

Your logs show that one or more AWS-owned IP addresses are used to flood ports on your resources with packets. You also believe that this is an attempt to overwhelm or crash your server or the software running on your server.

Intrusion attempts:

Your logs show that one or more AWS-owned IP addresses are used to attempt to log in to your resources.

Hosting prohibited content:

You have evidence that AWS resources are used to host or distribute prohibited content, such as illegal content or copyrighted content without the consent of the copyright holder.

Distributing malware

You have evidence that AWS resources are used to distribute software that was knowingly created to compromise or cause harm to computers or machines that it's installed on.



AWS Support does not deal with Abuse tickets. You need to contact abuse@amazonaws.com or fill out the Report Amazon AWS abuse form.



AWS Free-Tier

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

AWS has a free-tier which allows you to use AWS at no cost

- for the first 12 months of signup
- Or free usage up to a certain monthly limit forever



EC2 Web Server

t2.micro 750 hours per month for 1 year



RDS Database (MySQL or Postgres)

t2.db.micro 750 hours per month for 1 year



ELB Load Balancer

750 hours per month for 1 year

The Best Deals

Amazon CloudFront Homepage Video

50 GB data-transfer out in total for 1 year

Amazon Connect Toll Free Number

90 minutes of call-time per month for 1 year

Amazon ElastiCache Caching

cache.t3.micro 750 hours per month for 1 year

Amazon ElasticSearch Service Full Text Search

750 hours per month for 1 year

PinPoint Campaign / Marketing Emails

5,000 targeted users per month for 1 year

SES Emails sent by your web-application

62,000 emails per month forever

AWS CodePipeline CI/CD

1 Pipeline free

AWS CodeBuild Building Code

100 build minutes per month forever

AWS Lambda Serverless Compute

1M free request per month

3.2M seconds of compute time per month

AWS Credits

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AWS Promotional Credits (or AWS Credits for short) are the equivalent to USD dollars on the AWS platform. AWS Credits can be earned several ways:

- Joining the AWS Activate startup program
- Winning Hackathons
- Participating in Surveys
- ...

Summary

Total amount remaining	Total amount used
\$500.00	\$332.00

Redeem credit



AWS Credits generally have an expiry date attached to them.

AWS Credits can be used for most services but there are exceptions where AWS Credits cannot be used eg. Purchasing a domain via Route53

AWS Partner Network (APN)

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The AWS Partner Network (APN) is a global partner program for AWS. Joining the APN will open your organization up to business opportunities and allows exclusives trainings and marketing events



When joining the APN you can either be a:

Consulting Partner – you help companies utilize AWS

Technology Partner – you build technology ontop of AWS as a service offering

- A partner belongs to a specific Tier: Select, Advanced or Premier
- Different tiers have different Annual fee commitments
- Different tiers have different Knowledge requirements
 - AWS Certification
 - AWS APN-Exclusive Certifications
- You can get back Promotional AWS Credits
- You can have unique speaking opportunities in the official AWS marketing channels. Eg blogs, webinars
- Being part of the APN is a requirement to be a Sponsor with a vendor booth at AWS Events

AWS Budgets

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



AWS Budgets give you the ability to setup alerts if you **exceed** or are **approaching** your defined budget

Create Cost, Usage or Reservation Budgets

It can be tracked at the **monthly**, **quarterly**, or **yearly** levels, with customizable start and end dates

Alerts support **EC2**, **RDS**, **Redshift**, and **ElastiCache** reservations.



AWS Budgets can be used to Forecast costs but is limited compared to Cost Explorer or doing your analysis with AWS Cost and Usage Reports along with a Business Intelligence tool

Budget based on a fixed cost or plan your upfront based on your chosen level
Can be easily managed from the **AWS Budgets** dashboard or via the **Budgets API**.

Get Notified by providing an email or **Chatbot** and threshold how close to the current or forecasted budget

Choose your budget amount in \$\$\$

Budgeted amount	\$100	Last month's cost \$126.59
-----------------	-------	----------------------------

Usage unit(s)

Usage Type Group
EC2: Running Hours (Hrs) 
 Usage Type

Choose based a different kind of unit

Budgeted amount	100	Hrs	Last month's usage 2260.54 Hrs
-----------------	-----	-----	--------------------------------



AWS Budgets

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You have a list of budgets:



Overview Info

Budgets (3) Info

Name	Thresholds	Budget	Amount used	Forecasted am...	Current vs. budgeted	Forecasted vs. bud...
AWS Credits Budgets	Exceeded (1)	\$200.00	\$318.79	\$392.07	-159.39%	\$196.00
MinecraftServerBudget	OK	\$100.00	\$0.00	-	0.00%	-
Overall Costs	Exceeded (1)	\$100.00	\$393.77	\$559.28	-395.77%	\$539.21

[Download CSV](#) [Actions](#) [Create budget](#)

You can see your budget history, download it as a CSV

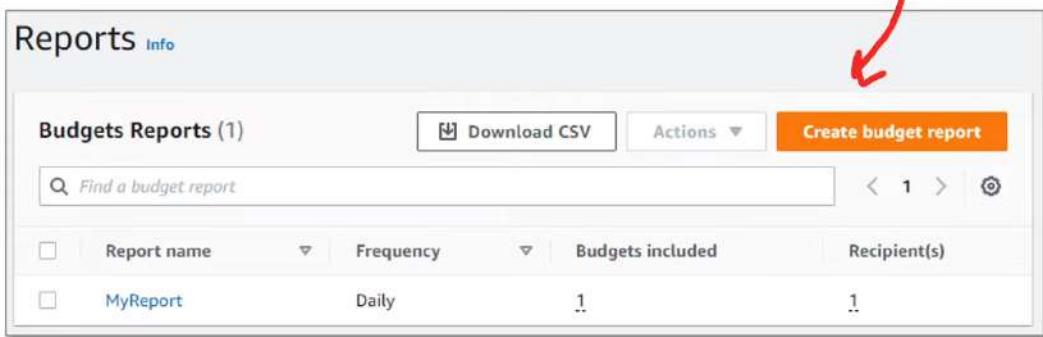


- **first two budgets are free of charge**
- Each budget is **\$0.02 per day ~\$0.60 USD / month**
- **20,000 budgets limit**

AWS Budget Reports

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

AWS Budget Report is used alongside AWS Budgets to create and send daily, weekly, or monthly reports to monitor the performance of your AWS Budget that will be emailed to specific emails.



The screenshot shows the AWS Budget Reports interface. At the top, there's a header with the title 'Reports' and an 'Info' link. Below the header, a button bar includes 'Download CSV', 'Actions', and a prominent orange 'Create budget report' button. A red arrow points from the text above to this button. The main area displays a table titled 'Budgets Reports (1)'. The table has columns for 'Report name', 'Frequency', 'Budgets included', and 'Recipient(s)'. One row is visible, showing 'MyReport' under 'Report name', 'Daily' under 'Frequency', '1' under 'Budgets included', and '1' under 'Recipient(s)'. A search bar at the top of the table area contains the placeholder 'Find a budget report'.

Report name	Frequency	Budgets included	Recipient(s)
MyReport	Daily	1	1

AWS Budget Reports serve as a more convenient way of staying on top of reports since they are delivered to your email instead of logging into the AWS Management Console



AWS Cost and Usage Reports (CUR)

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



Generate a **detailed spreadsheet**, enabling you to **better analyze and understand your AWS costs**

choose the granularity of your data by selecting hourly, daily or monthly

The report will contain Cost Allocation Tags

CUR data is stored in a CSV (GZIP) or Parquet format in your selected S3 bucket



Places the reports into S3



Use Athena to turn the report into a queryable database



Use QuickSight to visualize your billing data as graphs

Cost Allocation Tags

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

Cost Allocation Tags are optional metadata that can be attached to AWS resource so when you generate out a Cost and Usage Report you can use that data to better analyze your data.

You have to **activate** the tags you want to show up in the report

There are **two types** of tags:

- User-Defined
 - Eg Project
- AWS Generated
 - E.g. aws:createdBy

Cost allocation tags Info

User-defined cost allocation tags | **AWS-generated cost allocation tags**

AWS-generated cost allocation tags (17) Info Undo Deactivate Activate

Search for a tag key All statuses ▾ 1 Status ▾

Tag key	Status
aws:createdBy	Active
aws:cloudformation:stack-name	Inactive
aws:ec2launchtemplate:id	Inactive

Billing Alerts/Alarms

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



You can create your own Alarms in CloudWatch Alarms to monitor spend. They are commonly called “Billing Alarms”

You first need to turn on **Billing Alerts**



Cost Management Preferences

Receive Free Tier Usage Alerts

Turn on this feature to receive email alerts when your AWS service usage exceeds the free tier limit.

Email Address:

Receive Billing Alerts

Turn on this feature to monitor your AWS usage charges and recurring bills. You will receive email notifications when your charges reach a specified threshold.

Go create a CloudWatch Alarm and you can choose Billing as your Metric

Billing

259



Billing Alarms are much more flexible than AWS Budgets and ideal for more complex use-cases for monitoring spend and usage

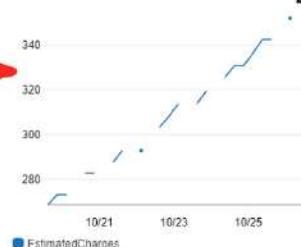
Specify metric and conditions

Metric

Graph

This alarm will trigger when the blue line goes above the red line for 1 datapoint within 6 hours.

No unit



Namespace
AWS/Billing

Metric name

Currency
USD

Statistic
 Maximum

Period
6 hours

AWS Cost Explorer

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

The screenshot illustrates the AWS Cost Explorer interface with several annotations:

- Specific type range and aggregation:** Points to the date range selector ("Sep 01, 2021 - Oct 26, 2021") and the "Group by" dropdown menu.
- AWS Cost Explorer lets you visualize, understand, and manage your AWS costs and usage over time.** A yellow box highlights the main purpose of the tool, with a red arrow pointing from the text to the bar chart.
- Default reports help you gain insight into your cost drivers and usage trends.** A red arrow points from the text to the "Reports" section on the right.
- Robust filtering:** Points to the extensive filter sidebar on the right, which includes filters for Service, Linked Account, Region, Instance Type, Usage Type, Resource, Cost Category, Tag, API Operation, Charge Type, Availability Zone, Platform, Purchase Option, Tenancy, and Database Engine.
- Use forecasting to get an idea of future costs**: Points to the "Forecasted month end costs" section, which shows a total of \$456.94 with a 1% decrease over the last month.

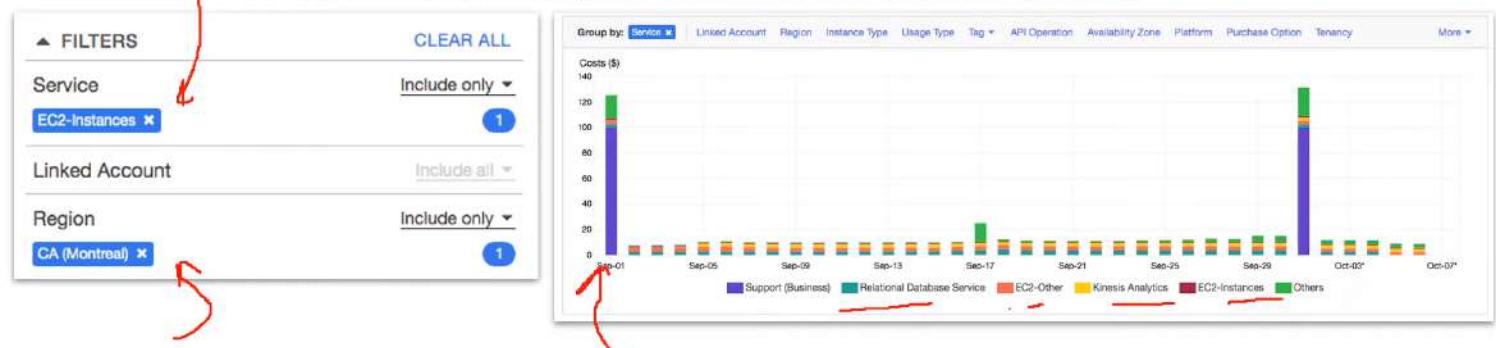
AWS Cost Explorer

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Choose if you want to view your data at a
monthly or daily level of granularity



Use **filter** and **grouping** functionalities to dig even deeper into your data!



AWS Pricing API

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



With AWS you can programmatically access pricing information to get the latest price offering for services.

There are two versions of this API:

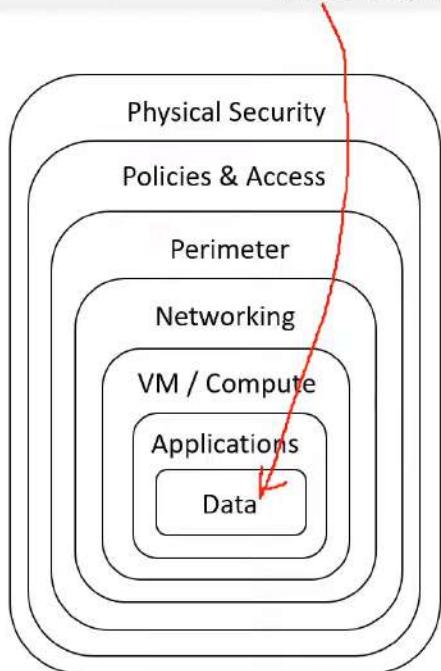
- Query API – The Pricing Service API via **JSON**
 - <https://api.pricing.us-east-1.amazonaws.com>
- Batch API – The Price List API via **HTML**
 - <https://pricing.us-east-1.amazonaws.com/offers/v1.0/aws/index.json>

You can also subscribe to Amazon Simple Notification Service (Amazon SNS) notifications to get alerts when prices for the services change.

AWS prices change periodically, such as when AWS cuts prices, when new instance types are launched, or when new services are introduced

Defense in Depth

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



The 7 Layers of Security

1. Data

access to business and customer data, and encryption to protect data.

2. Application

applications are secure and free of security vulnerabilities.

3. Compute

Access to virtual machines (ports, on-premise, cloud)

4. Network

limit communication between resources using segmentation and access controls.

5. Perimeter

distributed denial of service (DDoS) protection to filter large-scale attacks before they can cause a denial of service for users.

6. Identity and access

controlling access to infrastructure and change control.

7. Physical

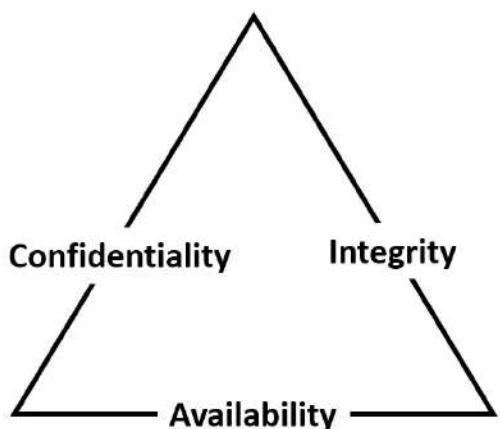
limiting access to a datacenter to only authorized personnel.



Confidentiality, Integrity, Availability (CIA)

Cheat sheets, Practice Exams and Flash cards www.exampro.co/cif-c01

Confidentiality, Integrity, and Availability (CIA) triad is a model describing the foundation to security principles and their trade-off relationship.



Confidentiality

confidentiality is a component of privacy that implements to protect our data from unauthorized viewers. In practice this can be using cryptographic keys to encrypt our data, and using keys to encrypt our keys (envelope encryption)

Integrity

maintaining and assuring the accuracy and completeness of data over its entire lifecycle. In Practice utilizing ACID compliant databases for valid transactions. Utilizing tamper-evident or tamper proof Hardware security modules. (HSM)

Availability

information needs to be made available when needed
In Practice: High Availability, Mitigating DDoS, Decryption access

The CIA triad was first mentioned in a **NIST publication from 1977**.

There have been efforts to expand and modernize or suggest alternatives to CIA triad:

- (1998) Six Atomic Elements of Information eg. confidentiality, possession, integrity, authenticity, availability, and utility
- (2004) NIST Engineering Principles for Information Technology Security — 33 security principles



Vulnerabilities

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

What is a vulnerability?

a hole or a weakness in the application, which can be a design flaw or an implementation bug, that allows an attacker to cause harm to the stakeholders of an application



Allowing Domains or Accounts to Expire	Insecure Temporary File	Privacy Violation
Buffer Overflow	Insecure Third Party Domain Access	Process Control
Business logic vulnerability	Insecure Transport	Return Inside Finally Block
CRLF Injection	Insufficient Entropy	Session Variable Overloading
CSV Injection	Insufficient Session-ID Length	String Termination Error
Catch NullPointerException	Least Privilege Violation	Unchecked Error Condition
Covert storage channel	Memory leak	Unchecked Return Value Missing Check against Null
Deserialization of untrusted data	Missing Error Handling	Undefined Behavior
Directory Restriction Error	Missing XML Validation	Unreleased Resource
Doubly freeing memory	Multiple admin levels	Unrestricted File Upload
Empty String Password	Null Dereference	Unsafe JNI
Expression Language Injection	OWASP .NET Vulnerability Research	Unsafe Mobile Code
Full Trust CLR Verification issue	Overly Permissive Regular Expression	Unsafe function call from a signal handler
Heartbleed Bug	PHP File Inclusion	Unsafe use of Reflection
Improper Data Validation	PHP Object Injection	Use of Obsolete Methods
Improper pointer subtraction	PRNG Seed Error	Use of hard-coded password
Information exposure through query strings	Password Management Hardcoded Password	Using a broken or risky cryptographic algorithm
Injection problem	Password Plaintext Storage	Using freed memory
Insecure Compiler Optimization	Poor Logging Practice	Vulnerability template
Insecure Randomness	Portability Flaw	XML External Entity (XXE) Processing



Encryption

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What is cryptography?

The practice and study of techniques for secure communication in the presence of third parties called adversaries

What is encryption?

The process of encoding (scrabbling) information **using a key** and a **cypher** to store sensitive data in an unintelligible format as a means of protection. An encryption takes in plaintext and produces **ciphertext**.



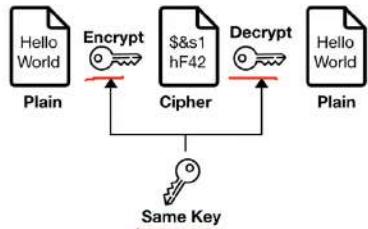
The **enigma machine** was used during WW2. A different key for each day was used to set the position of the rotors. It relied on simple cypher substitution.

Cryptographic Keys

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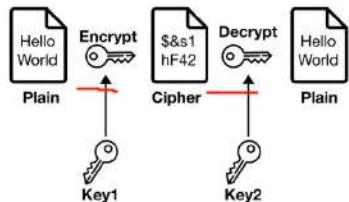
What is a cryptographic key?

A key is a variable used in conjunction with an encryption algorithm in order to encrypt or decrypt data.



What is symmetric encryption?

The same key is used for encoding and decoding.
eg **Advanced Encryption Standard (AES)**

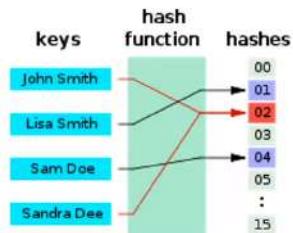


What is asymmetric encryption?

Two keys are used. One to encode and one to decode eg. **Rivest–Shamir–Adleman (RSA)**

Hashing and Salting

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



What is hashing function?

A function that accepts arbitrary size value and maps it to a fixed-size data structure. Hashing can reduce the size of the store value.

Hashing is a **one-way process** and is **deterministic**

A deterministic function always returns the same output for the same input.

Hashing Passwords

Hashing functions are used to store passwords in database so that a password does not reside in a plaintext format.

To authenticate a user, when a user inputs their password, it is hashed, and the hash is compared to the store hashed. If they match then the user has successful logged in.

Popular hashing functions are **MD5, SHA256 and Bcrypt**

If an attacker knows what function you are using and stole your database, they could enumerate a dictionary of password to determine the password.

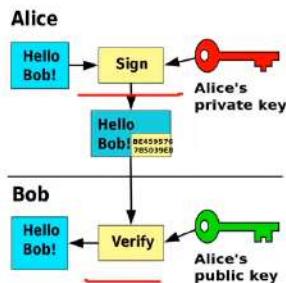
Salting Passwords

A salt is a random string not known to the attacker that the hash function accepts to mitigate the deterministic nature of hashing functions



Digital Signatures and Signing

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



What is a digital signature

A mathematical scheme for verifying the authenticity of digital messages or documents.

A Digital signature gives us **tamper-evidence**.

- Did someone mess (modify) the data?
- Is this data is not from the expected sender?

There are three algorithms to digital signatures:

- **Key generation** – generates a public and private key.
- **Signing** - the process of generating a digital signature with a **private key** and inputted message
- **Signing verification** – verify the authenticity of the message with a **public key**

```
ssh-keygen -t rsa
```

SSH uses a public and private key to authorize remote access into a remote machine e.g. Virtual Machine. It is common to use RSA
ssh-keygen is a **well known command** to generate a public and private key

What is Code Signing?

When you use a digital signature to ensure **computer code** has not been tampered



In-Transit vs At-Rest Encryption

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Encryption In-Transit

Data that is secure when moving between locations

Algorithms: **TLS, SSL**

Encryption At-Rest

Data that is secure when residing on storage or within a database

Algorithms: **AES, RSA**

Transport Layer Security (TLS)

An encryption protocol for data integrity between two or more communicating computer application.

TLS 1.0, 1.1 are deprecated. TLS 1.2 and 1.3 is the current best practice

Secure Sockets Layers (SSL)

An encryption protocol for data integrity between two or more communicating computer application

SSL 1.0, 2.0 and 3.0 are deprecated



Common Compliance Programs

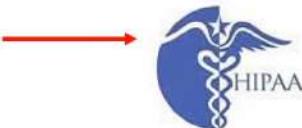
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Compliance Programs

A set of internal policies and procedures of a company to comply with laws, rules, and regulations or to uphold business reputation.

Health Insurance

Portability and Accountability Act of 1996) is United States legislation that provides data privacy and security provisions for safeguarding medical information.



The Payment Card Industry Data Security Standard (PCI DSS)



When you want to sell things online and you need to handle credit card information.



Common Compliance Programs

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International Organization for Standardization (ISO) / International Electrotechnical Commission

ISO/IEC 27001 — control implementation guidance

ISO/IEC 27017 — enhanced focus on cloud security

ISO/IEC 27018 — protection of personal data in the cloud. eg. PII

ISO/IEC 27701 — Privacy Information Management System (PIMS) framework

- outlines controls and processes to manage data privacy and protect PII.



System and Organization Controls (SOC)

SOC 1 — 18 standard and report on the effectiveness of internal controls (SSAE) at a service organization

- relevant to their client's internal control over financial reporting (ICFR).

SOC 2 — evaluates internal controls, policies, and procedures that directly relate to the security of a system at a service organization

SOC 3 — A report based on the Trust Services Criteria that can be freely distributed



Payment Card Industry Data Security Standard (PCI DSS)

a set of security standards designed to ensure that ALL companies that accept, process, store or transmit credit card information maintain a secure environment.



Federal Information Processing Standard (FIPS) 140-2

US and Canadian government standard that specifies the security requirements for cryptographic modules that protect sensitive information.

Common Compliance Programs

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Personal Health Information Protection Act (PHIPA)

An Ontario provincial law (Canada) that regulates patient Protected Health Information



Health Insurance Portability and Accountability Act (HIPAA).

US federal law that regulates patient Protected Health Information



Cloud Security Alliance (CSA) STAR Certification

Independent third-party assessment of a cloud provider's security posture



Common Compliance Programs

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Federal Risk and Authorization Management Program (FedRAMP)
US government standardized approach to security authorizations
for Cloud Service Offerings



Criminal Justice Information Services (CJIS)

Any US state or local agency that wants to access the FBI's CJIS database is required to adhere to the CJIS Security Policy.



General Data Protection Regulation (GDPR)

A European privacy law. Imposes new rules on companies, government agencies, non-profits, and other organizations that offer goods and services to people in the European Union (EU), or that collect and analyze data tied to EU residents.

Penetration Testing

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What is PenTesting?

An authorized simulated cyberattack on a computer system, performed to evaluate the security of the system.



Pen Testing is allowed to be performed on AWS!

Permitted Services

- Amazon EC2 instances
- NAT Gateways
- Elastic Load Balancers
- Amazon RDS
- Amazon CloudFront
- Amazon Aurora
- Amazon API Gateways
- AWS Lambda and Lambda Edge functions
- Amazon Lightsail resources
- Amazon Elastic Beanstalk environments

Prohibited Activities

- DNS zone walking via Amazon Route 53 Hosted Zones
- *Subject to the **DDoS Simulation Testing policy**
 - Denial of Service (DoS)
 - Distributed Denial of Service (DDoS)
 - Simulated DoS, Simulated DDoS
- Port flooding
- Protocol flooding
- Request flooding (login request flooding, API request flooding)

For **Other Simulated Events** you will need to submit a request to AWS. A reply could take up to 7 days.



AWS Artifact

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



AWS Artifact is a self-serve portal for on-demand access to **AWS compliance reports**



Choose your report



Reports Info

Reports (82)

Q: canada X 1 match

Title Reporting period Category Description

Government of Canada (GC) Partner Package	August 25, 2017 to current	Alignment Documents	The Government of Canada (GC) Partner Package is intended for use by partners and customers when building applications and solutions on AWS that need to meet the GC requirements based on the Protected B/Medium Integrity/Medium Availability (PBMM) profile. The documents available in this package include: Partner Package Playbook, Controls Implementation Summary (CIS)/Customer Responsibility Matrix (CRM), and Government of Canada PBMM Security Assessment and Letter of Attestation.
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View the PDF



Download the Excel



AWS Inspector

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

What is Hardening?

The act of eliminating as many **security** risks as possible. Hardening is common for Virtual Machines where you run a collection of security checks known as a security benchmark



AWS Inspector runs a **security benchmark** against specific EC2 instances.

You can run a variety of security benchmarks.

Can perform both **Network** and **Host** Assessments

Assessment Setup

You can use the options below to get the following assessments on all of your EC2 Instances in this AWS region. Click **Run weekly** for the assessment to **once** for a one-time assessment, or **Advanced setup** for custom assessments.

Network Assessments (Inspector Agent is not required)

- Assessments performed: Network configuration analysis to checks for ports reachable from outside the VPC. Learn more
- Optional Agent: If the Inspector Agent is installed on your EC2 instances, the assessment also finds processes reachable on port. Learn more about
- Pricing: Pricing for **network assessments** is based on the monthly volume of instance-assessments, where an instance-assessment denotes a single example; for 100 instances assessed weekly, the monthly cost would be around \$61/month. Learn more

Host Assessments (Inspector Agent is required)

- Assessments performed: Vulnerable software (CVE), host hardening (CIS benchmarks), and security best practices. Learn more
- Agent Deployment: Inspector assessments require an agent to be installed on your EC2 instances. We will automatically install the agent for Instance Command. Learn more about Inspector Agent and how to manually install agent.
- Pricing: Pricing for **host assessments** is based on the monthly volume of agent-assessments, where an agent-assessment denotes a successful 100 instances assessed weekly, the monthly cost would be around \$120/month. Learn more

Run weekly (recommended)

- Install the AWS agent on your EC2 instances.
- Run an assessment for your assessment target.
- Review your findings and remediate security issues.

One very popular benchmark you can run is by CIS which has **699 checks!**

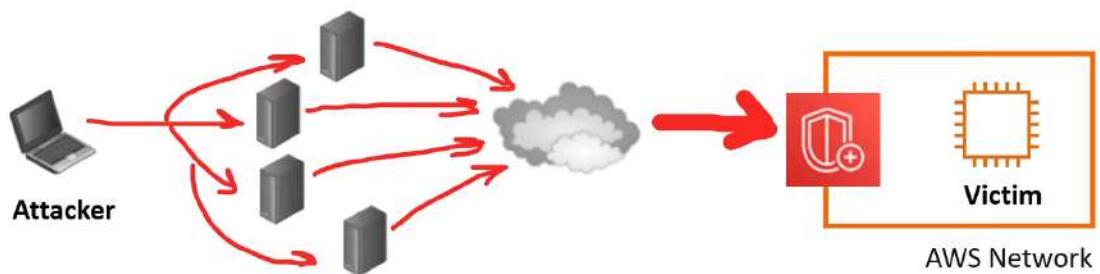


Distributed Denial of Service (DDoS)

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clif-c01

What is a DDoS (Distributed Denial of Service) Attack?

A malicious attempt to disrupt normal traffic by flooding a website with large amounts of fake traffic.



AWS Shield

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

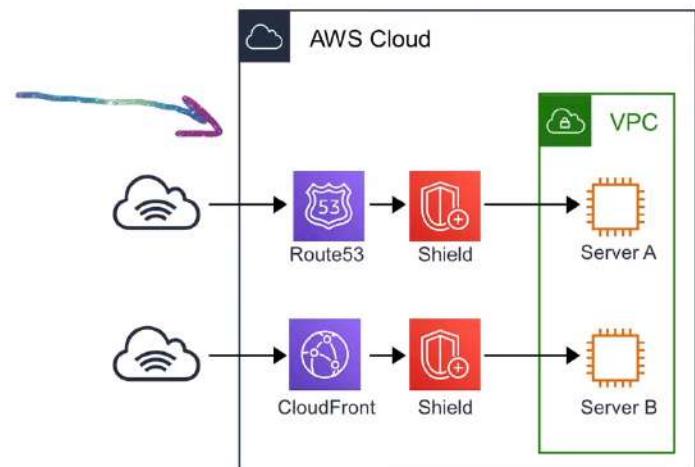


AWS Shield is a **managed** DDoS (Distributed Denial of Service) protection service that safeguards applications running on AWS

When you route your traffic through **Route53** or **CloudFront** you are using **AWS Shield Standard**

Protects you against **Layer 3, 4 and 7** attacks

- 7 Application
- 4 Transport
- 3 Network



AWS Shield

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Shield Standard FREE

protection against most common DDoS attacks

- access to tools and best practices to build a DDoS resilient architecture.
- Automatically available on all AWS services.

Shield Advanced *3000 USD / Year

additional protection against larger and more sophisticated attacks

Available On

- Amazon Route 53
- Amazon CloudFront
- Elastic Load Balancing
- AWS Global Accelerator
- Elastic IP (Amazon EC2 and Network Load Balancer)

Notable Features

- Visibility and Reporting on Layer 3,4 and 7
- Access to Team and Support (with Business or Enterprise Support)
- DDoS Cost Protection
- Comes with SLA



Both plans integrate with AWS Web Application Firewall (WAF) to give you Layer 7 (Application) protection



Amazon Guard Duty

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

What is IDS/IPS?

Intrusion Detection System and Intrusion Protection System.

A device or software application that monitors a network or systems for malicious activity or policy violations.



Guard Duty is a **threat detection service** that continuously monitors for malicious, suspicious activity and unauthorized behavior. It uses Machine Learning to analyze the following AWS logs:

- CloudTrail Logs
- VPC Flow Logs
- DNS logs

It will alert you of **Findings** which you can automate a incident response via CloudWatch Events or with 3rd Party Services

The screenshot shows a finding titled "Policy: IAMUser/RootCredentialUsage". The finding ID is "dcbe0ca20e68085ad8a0c8e049659217". The finding details indicate a "Low" priority event where "API DescribeAccount was invoked using root credentials from IP address 104.194.51.113." A red arrow points to the "Investigate with Detective" button. The "Overview" section shows the following details:

Severity	LOW
Region	us-east-1
Count	36
Account ID	123456789012
Resource ID	No information available
Created at	09-24-2021 15:24:26 (a month a...)
Updated at	09-24-2021 16:59:21 (a month a...)





Amazon Guard Duty

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

AWS Services Resource Groups

GuardDuty

Findings

Settings

Lists

Accounts

What's New

Usage

Partners

New feature: New Root Credential Detection

Amazon GuardDuty has added a new finding type that notifies you when root credentials are used programmatically in your account. [Learn more](#)

Findings Showing 33 of 33

Actions Saved filters / Auto-archive No saved filters

Current Add filter criteria

	Finding type	Resource	Last s...	Co...
<input type="checkbox"/>	Recon:EC2/PortProbeUnprotected...	Instance: i-05e8996590e85b1b	a mon...	280
<input type="checkbox"/>	Recon:EC2/PortProbeUnprotected...	Instance: i-0d89ad53f4d6f3f94	a mon...	330
<input type="checkbox"/>	Recon:EC2/PortProbeUnprotected...	Instance: i-04fae5b8df570e6ce	a mon...	310
<input type="checkbox"/>	Recon:EC2/PortProbeUnprotected...	Instance: i-0269e117c812c22fd	a mon...	253
<input type="checkbox"/>	UnauthorizedAccess:EC2/SSHBrut...	Instance: i-0269e117c812c22fd	a mon...	1
<input type="checkbox"/>	UnauthorizedAccess:EC2/SSHBrut...	Instance: i-04fae5b8df570e6ce	a mon...	1
<input type="checkbox"/>	UnauthorizedAccess:EC2/SSHBrut...	Instance: i-0269e117c812c22fd	a mon...	1
<input type="checkbox"/>	UnauthorizedAccess:EC2/SSHBrut...	Instance: i-04fae5b8df570e6ce	a mon...	2
<input type="checkbox"/>	UnauthorizedAccess:EC2/SSHBrut...	Instance: i-05e8996590e85b1b	a mon...	35
<input type="checkbox"/>	UnauthorizedAccess:EC2/SSHBrut...	Instance: i-05e8996590e85b1b	a mon...	5
<input type="checkbox"/>	UnauthorizedAccess:EC2/SSHBrut...	Instance: i-05e8996590e85b1b	a mon...	1

Useful? Close

UnauthorizedAccess:EC2/SSHBruteForce

Finding ID: 8ab43ae3b9a5cf5c032aab5f0914a468

76.72.169.18 is performing SSH brute force attacks against i-04fae5b8df570e6ce. Brute force attacks are used to gain unauthorized access to your instance by guessing the SSH password.

Severity	Region	Count
Low	us-east-1	1

Account ID: 655604346524 Resource ID: i-04fae5b8df570e6ce Created at: 01-22-2019 08:37... Updated at: 01-22-2019 08:37...

Resource affected

Resource role	Resource type
TARGET	Instance

Instance ID: i-04fae5b8df570e6ce Port: 22

Port name: SSH Instance type: t2.small

Instance state: running Availability zone: us-east-1a

Image ID: ami-06aa276f0e7597475 Image description: Agent Installed, Bundle -no-de...

Launch time: 01-10-2019 12:51:45

Amazon Macie

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01



Macie is a fully managed service that continuously monitors **S3 data access** activity for anomalies, and generates detailed alerts when it detects risk of unauthorized access or inadvertent data leaks.

Macie works by uses Machine Learning to Analyze your CloudTrail logs

Macie has a variety of alerts

- Anonymized Access
- Config Compliance
- Credential Loss
- Data Compliance
- File Hosting
- Identity Enumeration
- Information Loss
- Location Anomaly
- Open Permissions
- Privilege Escalation
- Ransomware
- Service Disruption
- Suspicious Access

Macie's will identify your most at-risk users which could lead to a compromise



AWS Virtual Private Network (VPN)

Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01



AWS VPN lets you establish a **secure** and **private tunnel** from your network or device to the AWS global network

AWS Site-to-Site VPN

securely connect on-premises network or branch office site to VPC

AWS Client VPN

securely connect users to AWS or on-premises networks

What is IPSec?

Internet Protocol Security (IPsec) is a secure network protocol suite that authenticates and encrypts the packets of data to provide secure encrypted communication between two computers over an Internet Protocol network. It is used in virtual private networks (VPNs)



AWS WAF

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AWS Web Application Firewall (WAF) protect your web applications from common web exploits

Write your own **rules** to ALLOW or DENY traffic based on the contents of an HTTP requests

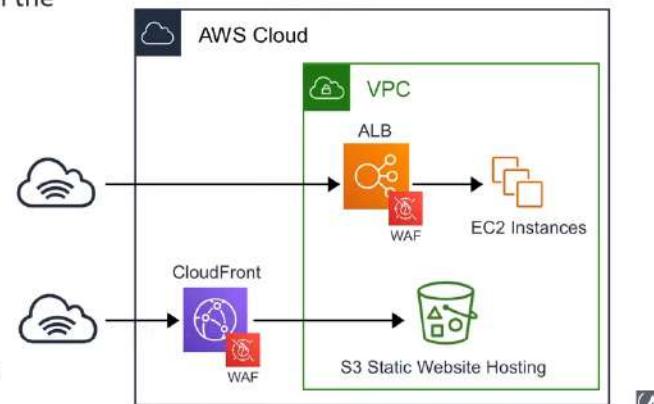
Use a **ruleset** from a trusted AWS Security Partner in the AWS WAF Rules Marketplace

WAF can be attached to either **CloudFront** or an **Application Load Balancer**

Protect web applications from attacks covered in the

OWASP Top 10 most dangerous attacks:

1. Injection
2. Broken Authentication
3. Sensitive data exposure
4. XML External Entities (XXE)
5. Broken Access control
6. Security misconfigurations
7. Cross Site Scripting (XSS)
8. Insecure Deserialization
9. Using Components with known vulnerabilities
10. Insufficient logging and monitoring

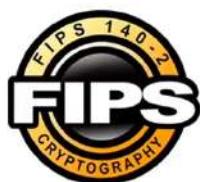


Hardware Security Module (HSM)

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A Hardware Security Module (HSM).

Its a piece of hardware designed to store encryption keys.
HSM hold keys in memory and never write them to disk.



Federal Information Processing Standard (FIPS)

US and Canadian government standard that specifies the security requirements for cryptographic modules that protect sensitive information.

HSM's that are **multi-tenant** are **FIPS 140-2 Level 2 Compliant**
(multiple customers virtually isolated on an HSM)



eg. AWS KMS

HSM's that are **single-tenant** are **FIPS 140-2 Level 3 Compliant**
(single customer on a dedicated HSM)



eg. AWS CloudHSM

AWS Key Management Service

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AWS Key Management Service (KMS) is a managed service that makes it easy for you to create and control the encryption keys used to encrypt your data.

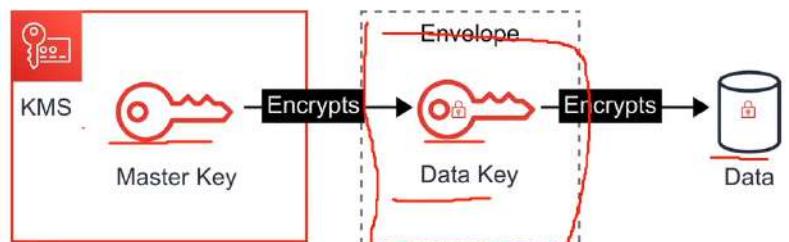
- KMS is a multi-tenant HSM (hardware security module)
- Many AWS services are integrated to use KMS to encrypt your data with a simple checkbox
- KMS uses Envelope Encryption.

The screenshot shows the 'Encryption' section of the AWS KMS console. It includes a checkbox for 'Enable Encryption' which is checked, with a note below explaining that it chooses to encrypt the given instance. A dropdown menu for 'Master key' is open, showing '(default) aws/rds'.

Envelope Encryption

When you encrypt your data, your data is protected, but you have to protect your encryption key.

When you encrypt your data key with a master key as an additional layer of security.



CloudHSM

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CloudHSM is a single-tenant HSM as a service that automates hardware provisioning, software patching, high availability and backups.

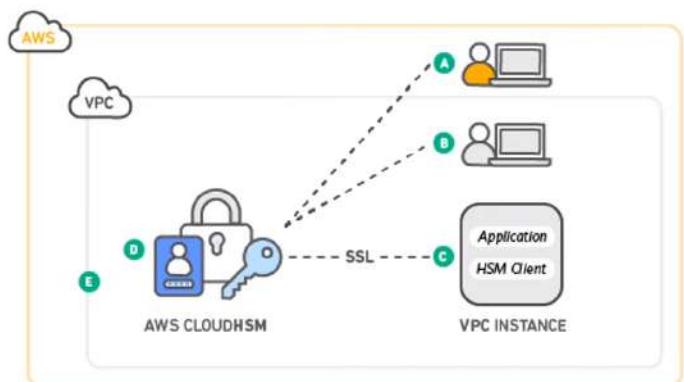
AWS CloudHSM enables you to generate and use your encryption keys on a FIPS 140-2 Level 3 validated hardware.

Built on Open HSM industry standards to integrate with:

- PKCS#11
- Java Cryptography Extensions (JCE)
- Microsoft CryptoAPI (CNG) libraries

You can also transfer your keys to other commercial HSM solutions to make it easy for you to migrate keys on or off of AWS.

Configure AWS KMS to use AWS CloudHSM cluster as a custom key store rather than the default KMS key store.



Know Your Initialisms

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IAM Identity and Access Management

S3 Simple Storage Service

SWF Simple Workflow Service

SNS Simple Notification Service

SQS Simple Queue Service

SES Simple Email Service

SSM Simple Systems Manager

RDS Relational Database Service

VPC Virtual Private Cloud

VPN Virtual Private Network

CFN CloudFormation

WAF Web Application Firewall

MQ Amazon ActiveMQ

ASG Auto Scaling Groups

TAM Technical Account Manager

ELB Elastic Load Balancer

ALB Application Load Balancer

NLB Network Load Balancer

GWLB Gateway Load Balancer

CLB Classic Load Balancer

EC2 Elastic Cloud Compute

ECS Elastic Container Service

ECR Elastic Container Repository

EBS Elastic Block Storage

EFS Elastic File Storage

EMR Elastic MapReduce

EB Elastic Beanstalk

ES Elasticsearch

EKS Elastic **Kubernetes** Service

MSK Managed **Kafka** Service

RAM AWS Resource Manager

ACM Amazon Certificate Manager

PoLP Principle of Least Privilege

IoT Internet of Things

RI Reserved Instances



AWS Config vs AWS AppConfig

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AWS Config

AWS Config is a governance tool for Compliance as Code (CoC).

You can create rules that will check to see if resources are configured the way you expect them to be.

If a resource drifts from the expected configuration you are notified or AWS Config can auto-remediate (correct) the configuration back to the expected state



AWS AppConfig

AWS App Config is used to automate the process of deploying application configuration variable changes to your web-application(s).

You can write a validator to ensure the changed variable will not break your web-app

You can monitor deployments and automate integrations to catch errors or rollback.

SNS vs SQS

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The Both **Connect Apps via Messages**



Simple Notifications Service

Pass Alongs Messages eg. PubSub

Send notifications to **subscribers of topics** via multiple protocol. eg, HTTP, Email, SQS, SMS

SNS is generally used for sending **plain text emails** which is triggered via other AWS Services. The best example of this is billing alarms.

Can retry sending in case of failure for **HTTPS**

Really good for webhooks, simple internal emails, triggering lambda functions



PubNub



Simple Queue Service

Queue Up Messages, Guaranteed Delivery

Places messages into a **queue**. Applications pull queue using **AWS SDK**

Can retain a message for up to 14 days
Can send them in sequential order or in parallel
Can ensure only one message is sent
Can ensure messages are delivered at least once

Really good for delayed tasks, queueing up emails





SNS vs SES vs PinPoint vs Workmail

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They All Send Emails



Simple Notifications Service Practical and Internal Emails

Send notifications to **subscribers of topics** via multiple protocol. eg, HTTP, Email, SQS, SMS

SNS is generally used for sending **plain text emails** which is triggered via other AWS Services. The best example of this is billing alarms.

Most exam questions are going to be talking about SNS because lots of services can trigger SNS for notifications.

You Need to Know what are **Topics** and **Subscriptions** regarding SNS



Simple Email Service Transactional Emails

Emails that should be triggered based on in-app actions: Signup, Reset Password, Invoices...

- A cloud based email service. eg. [SendGrid](#)
- SES sends [html emails](#), SNS cannot.
- SES can receives inbound emails
- SES can create Email Templates
- Custom domain name email
- Monitor your email reputation



Amazon PinPoint Promotional Emails

Emails for marketing

- Create email campaigns
- Segment your contacts
- Create customer journeys via emails
- A/B emailing testing



Amazon Workmail Email Web Client

Similar to Gmail and Outlook. Create company emails, read, write and send emails from a Web Client within AWS Management Console



Amazon Inspector vs AWS Trusted Advisor

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Both are **security tools** and they both perform audits



Amazon Inspector



Trusted Advisor

Audits **a single EC2 instance** that you've selected

Generates a report from a long list of security checks i.e 699 checks.

Trusted Advisor **doesn't generate out a PDF report**.

Gives you a **holistic view** of recommendations across multiple services and best practices

eg.

You have open ports on these security groups

You should enable MFA on your root account when using trusted advisor.

Connect Names Services

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They all have “**Connect**” in the name but they are not related or similar in functionality

Direct Connect

- A Dedicated Fiber Optics Connection from your DataCenter to AWS
- Intended for large enterprises with their own datacenter and they need an insanely fast and *private* connection directly AWS.
- If you need a **secure connection** you need apply a AWS VPN connection on-top of Direct Connect

Amazon Connect

- Call Center as a Service
- Get a toll free number, accept inbound and outbound calls, setup automated phone systems.
- Interactive Voice System (IVS)

Media Connect

- New Version of Elastic Transcoder, Converts Videos to Different Video Types
- You have 1000 of videos you and you need to transcode them into different videos format, maybe you need to apply watermarks, or insert introduction video in front of every video

Elastic Transcoder vs MediaConvert

Cheat sheets, Practice Exams and Flash cards  www.exampro.co/clf-c01

Both services **transcodes videos**



Elastic Transcoder The Old Way

Elastic Transcoder was the original transcoding service. It may have programmatic APIs or workflows not available in MediaConvert.

It exists due to legacy customers still using the platform

- Transcodes videos to streaming formats



AWS Elemental MediaConvert The New Way

MediaConvert is a more robust transcoding service that can perform various operations during transcoding.

- Transcodes videos to streaming formats
- Overlays images
- Insert video clips
- Extracts captions data
- Robust UI



AWS Artifact vs Amazon Inspector

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Both Artifact and Inspector **compile out PDFs**



AWS Artifact

Why should an enterprise trust AWS?

Generates a security report that's based on **global compliance frameworks** such as:

- Service Organization Control (SOC)
- Payment Card Industry (PCI)



Amazon Inspector

How do we know this EC2 instance is Secure? Prove It?

Runs a script that analyzes your EC2 instance, then generates a PDF report telling you which security checks passed.

Audit tool for security of EC2 instances

ELB vs ALB vs NLB vs GWLB vs CLB

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Elastic Load Balancer (ELB) has 4 different types of possible load balancers.



Application Load Balancer (ALB)

Layer 7 - HTTP/S

Routing Rules

- create rules to change routing based on information found in a HTTP/S request

Can attach an AWS WAF



Network Load Balancer (NLB)

Layer 3 and 4 – TCP and UDP

Where extreme performance is required for **TCP and TLS traffic**

Capable of handling millions of requests per second while maintaining **ultra-low latencies**

Optimized for **sudden and volatile traffic** patterns while using a single static IP address per Availability Zone



Gateway Load Balancer (GWLB)

When you need to deploy a fleet of third-party virtual appliances that support GENEVE



Classic Load Balancer (CLB)

Layer 3,4 and 7

Intended for applications that were built within the **EC2-Classic network**

Doesn't use Target Groups

Retires on Aug 15, 2022

