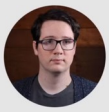
aws certified

Cloud Practitioner

FOUNDATIONAL



Andrew Brown
Cloud Instructor @ ExamPro

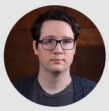
AWS Certified Cloud Practitioner

aws certified Cloud Practitioner

Complete Study Course

made available on
freeCodeCamp

This is a major update from the very popular 2019-2020 AWS Cloud Practitioner course



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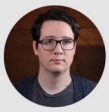
This course is design to help you pass the exam and achieve

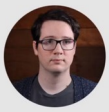
AWS-issued certification



Andrew Brown
Cloud Instructor @ ExamPro

Meet Your Instructor 👋

- Previously CTO of multiple EdTech companies
- 15 years industry experience
- 5 years specializing in cloud
- AWS Community Hero
- Published multiple free cloud courses
- Likes Star Trek and Coconut Water



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- Study Notes
- Flashcards
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- Downloadable Lecture Slides
- Downloadable CheatSheets
- Practice Exams
- Ask Questions, Get Learning Support

What is the Certified Cloud Practitioner?

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

aws certified Cloud Practitioner

The Certified Cloud Practitioner is the **entry-level AWS certification** teaching:

- The cloud fundamentals e.g. Cloud Concepts, Cloud Architecture, Cloud Deployment Models
- A **close look** at the AWS Core Services
- A **quick look** at the vast amount of AWS services
- Identity, Security and Governance of the Cloud
- Billing, Pricing and Support of AWS Services

The course code is **CLF-C01** but its commonly referred to as the **CCP**

AWS is the leading Cloud Service Provider (CSP) in the **world**!
The AWS Certified Cloud Practitioner **is the most common starting point** for people breaking into the cloud industry.

Who is this Certification for?

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

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Consider the AWS Certified Cloud Practitioner if....

- You are **new to cloud** and need to learn the fundamentals
- You are in the **executive, management or sales level** and need to acquire strategic information about cloud for adoption or migration
- You are a Senior Cloud Engineer or Solutions Architect who needs to **reset or refresh** their AWS Knowledge after for working multiple years

What is the value of this Certification?

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AWS Certified Cloud Practitioner provides the most expansive view possible of Cloud Architecture and AWS.

Also known as a **Bird's-eye View**, or **50,000-foot View**

@floregi on Unsplash

The idea is to promote "Big Picture" thinking.
Zooming out, assessing **the Cloud/AWS Landscape** for:

- Changes
- Trends
- Opportunities

Being strategic about the approach and process for our journey

What is the value of this Certification?

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The AWS Certified Cloud Practitioner **is not a difficult exam**,
it will not validate that you can build cloud workloads

For technical implementation roles e.g. Developer, Engineer, DevOps,
it will not be enough to obtain a cloud role but it **can help shortlist your resume for interview**.

The exam covers content not found in other certifications,
It is recommended as an essential study for your AWS journey.

The AWS Certification Roadmap

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

What does it take to pass the exam?

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

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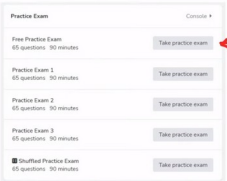
1. **Watch video lecture** and memorize key information
2. **Do hands-on labs** and **follow along** within your own account
3. **Do paid online practice exams** that simulate the real exam.



Exam Pro

Signup and Redeem your **FREE** Practice Exam
No credit card required
https://www.exampro.co/clf-c01

Exam Guide – Content Outline

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

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The exam of questions in **4 domains**.

Each domain has its own weighting, this determines how many questions in a domain that will show up.

- 26% **Domain 1: Cloud Concepts**
  - 13 questions
- 25% **Domain 2: Security and Compliance**
  - 16-17 questions
- **33% Domain 3: Technology**
  - 21-22 questions
- 16% **Domain 4: Billing and Pricing**
  - 10-11 questions

You need to know a wide range of AWS Services.
You need to know core services in more depth.

Exam Guide – Duration

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Duration of **1.5 hours**

You get ~1.5mins per question

Exam Time is: **90mins**
Seat Time is: **120mins**

Seat time refer to the amount of that you should allocate for the exam.
It includes:
- Time to review instructions
- Show online proctor your workspace
- Read and accept NDA
- Complete the exam

Where do you take the exam?

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

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psi

Pearson VUE

At an **in-person test center** or **online from the convenience of your own home**.

"proctor" is a supervisor, or person who monitors students during an examination.

Exam Guide – Valid Until

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Valid for **36 months**

3 years before recertification

Exam Guide – Grading

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Passing Grade is ***700/1000**

You need to get "*around*" 70% to pass

AWS uses Scaled Scoring

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.

Exam Guide – Response Types

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There are **65 Questions**

- 50 Scored Questions
- 15 Unscored Questions

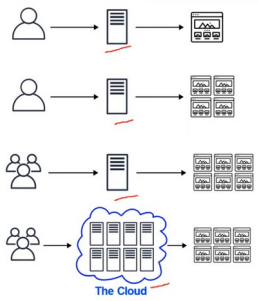
You can afford to get 15 questions wrong

There is **no penalty** for wrong questions

Format of Questions
- Multiple Choice
- Multiple Answer

The Evolution of Cloud Hosting

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



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

Exam Guide – Unscored Questions

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

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15 Questions on the exam are unscored.
- They will not count towards your final score

Why is there unscored questions?
- Unscored questions are used to evaluate the introduction of new questions
- To determine if the exam is too easy and the passing score or question difficult needs to be increased
- To discover users who are attempting to cheat the exam or steal "dump" exam questions

If you encounter questions you never study for that seem really hard, keep your cool and remember they may be unscored questions

What is Amazon?

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

amazon

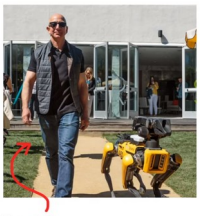
An American multinational computer technology corporation headquartered in **Seattle, Washington**

@timothyeberly on Unsplash

amazon.com

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

What is Amazon?



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 (Kuniper 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)?

Amazon calls their cloud provider service

Amazon Web Services

Commonly referred to just **AWS**

amazon web services™ — **Old Logo**

aws — **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)?

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 a Cloud Service Provider (CSP)?

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

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

Gartner Magic Quadrant for Cloud

Magic Quadrant (MQ) is a series of market research reports published by IT consulting firm Gartner that rely on proprietary qualitative data analysis methods to demonstrate market trends, such as direction, maturity and participants.

aws

Common Cloud Services

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

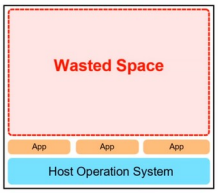
Cloud Service Provider (CSPs) that are **Infrastructure as a Service (IaaS)** will always have **4 core cloud service** offerings:

- **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

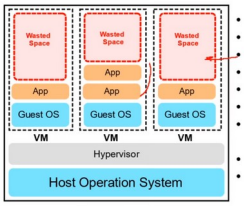
***Dedicated** → VMs → Containers → Functions



- 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**

The Evolution of Computing

*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 Horizonaalty scale

The Evolution of Computing

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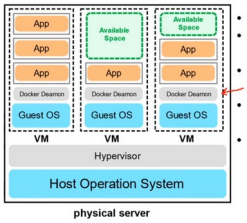
*Dedicated → VMs → **Containers** → Functions



- Virtual Machine running multiple containers
- **Docker Deamon** 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

The Evolution of Computing

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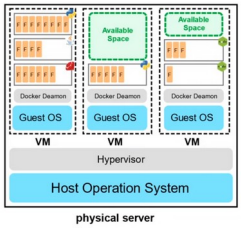
*Dedicated → VMs → Containers → **Functions**



- 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 hardwa

Cloud Computing Deployment Models

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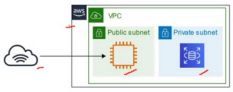
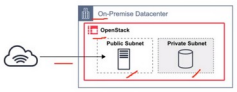
Public Cloud
Everything (the workload or project) is built on the CSP
Also known as: *Cloud-Native or Cloud First



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

Dropbox

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

Deloitte. CIBC CPP INVESTMENT BOARD

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".

AIG Canada

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-prem**

Evolution of Computing Power

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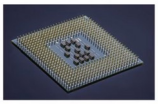
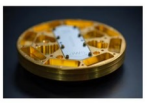
What is Computing Power?
The throughput measured at which a computer can complete a computational task.

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 Inferentiare (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

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 comsume 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

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

AWS First Region *2006*
US-East 1 (Northern Virginia)

Global Infrastructure – Regions

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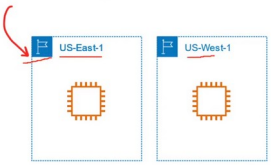
This is what a **region** will look like represented in an architectural diagram.



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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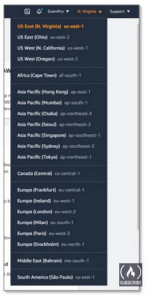
Regional Services
AWS **scopes** their AWS Management Console on a selected Region.
This will determine where an AWS service will be launched and what will be seen within an AWS Service's console.
You generally don't explicitly set the Region for a service at the time of creation.

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



Global Infrastructure – Availability Zones

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

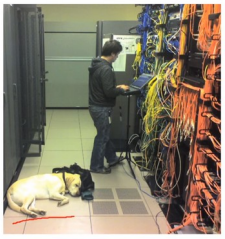
A datacenter is a secured building that contains hundreds of thousands of computers.

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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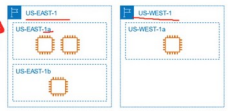
A Subnet is associated with an Availability Zone.

You never choose the AZ when launching resources.
You choose the Subnet which is associated to the AZ.

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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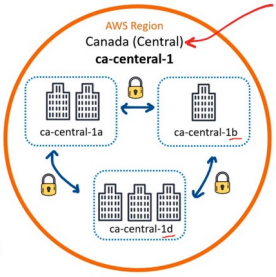
A region has multiple Availability Zones

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

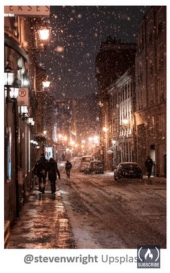
All AZs in an AWS Region are interconnected with high-bandwidth, low-latency networking, over fully redundant, dedicated metro fiber providing high-throughput, low-latency networking between

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

Amazon CloudFront (CDN)
Uses Edge Locations as an off-ramp, to provide at the Edge storage and compute near the end user.

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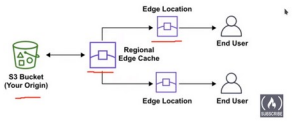
Points of Presence (PoP) is an intermediate location between an AWS Region and the end user, and this location could be a datacenter or collection of hardware.

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 expediated 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 of distance to the end users are reduce

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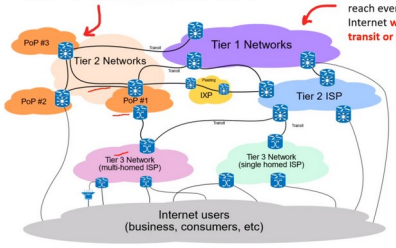
PoPs live at the edge/**intersection** of two networks

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 expediated 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

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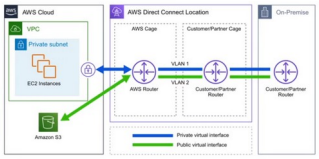
AWS Direct Connect is a **private/dedicated connection between your datacenter, office, co-location and AWS**.

Direct Connect has two **very-fast network** connection options:
1. Lower Bandwidth **50MBps-500MBps**
2. Higher Bandwidth **1GBps** or **10GBps**

HOTEL 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.**

A partnered datacenter in Toronto

Allied Data Centres
250 Front Street West Toronto

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

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

Global Infrastructure – Wavelength Zones

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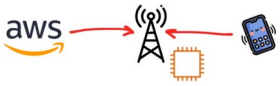
AWS Wavelength Zones allows for **edge-computing on 5G Networks**.
Applications will have **ultra-low latency** being as close as possible to the users

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 it's 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 continuous 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

HIPAA FedRAMP FIPS

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

Global Infrastructure – GovCloud (US)

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

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

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.

AWS purchases and retires environmental attributes to cover the non-renewable energy for AWS Global Infrastructure:
- Renewable Energy Credits (RECs)
- Guarantees of Origin (GOs)

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

Global Infrastructure – AWS Ground Station

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:
- weather forecasting
- surface imaging
- communications
- video broadcasts

To use Ground Station:
- 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

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.

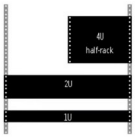
AWS Outposts is rack of servers running AWS Infrastructure on your physical location

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

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

This a full rack of servers provided by AWS

42U

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.

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

Cloud Architecture Terminologies

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.

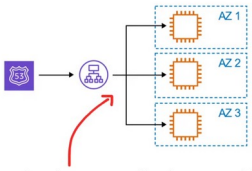
A cloud architect need to understand the following terms and factor them into their designed architecture based on the business requirements.

- **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

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

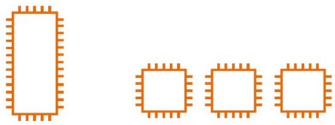


Elastic Load Balancer
A load balancer allows you to evenly distribute traffic to multiple servers in one or more datacenter. If a datacenter or server becomes unavailable (unhealthy) the load balancer will route the traffic to only available datacenters with servers.

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

High Scalability

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

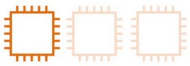


Vertical Scaling
Scaling **Up**
Upgrade to a bigger server

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

High Elasticity

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

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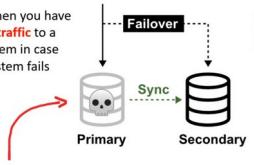
Your ability for your service to ensure there is no **no single point of failure. Preventing the chance of failure**

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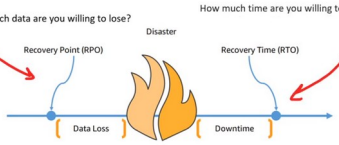
A **business continuity plan** (BCP) is a document that outlines how a business will continue operating **during an unplanned disruption in services**

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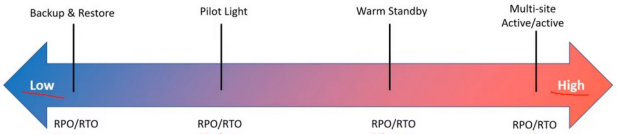
There are multiple options for recovery that trade cost vs time to recover.



RPO/RTO Hours
You backup your data and restore it to new infrastructure
- Lower priority use cases
- Restore data after event
- Deploy resources after event
- Cost $

RPO/RTO 10mins
Data is replicated to another region with the minimal services running
- Less stringent RTO &RPO
- Core Services
- Start & and scale resources after event
- Cost $$

RPO/RTO Minutes
Scaled down copy of your infrastructure running ready to scale up
- Business Critical Services
- Scale resources after event
- Cost $$$

RPO/RTO Real-time
Scaled up copy of your infrastructure in another region
- Zero downtime
- Nero zero loss
- Mission Critical Services
- Cost $$$$

RTO

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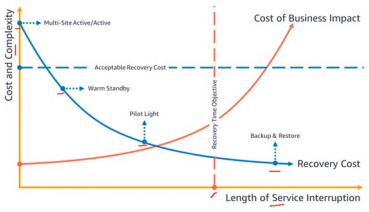
Recovery Time Objective (RTO) is the maximum acceptable delay between the interruption of service and restoration of service. This objective determines what is considered an acceptable time window when service is unavailable and is defined by the organization.



RPO

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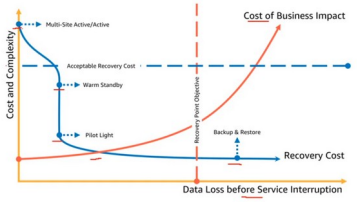
Recovery Point Objective (RPO) is the maximum acceptable amount of time since the last data recovery point. This objective determines what is considered an acceptable loss of data between the last recovery point and the interruption of service and is defined by the organization.



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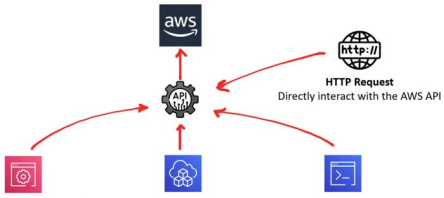
Rarely do users directly send HTTP requests directly to the AWS API.
Its much easier to interact with the API via a variety of Developer Tools



AWS Management Console
A WISWIG Web Interface

AWS SDK
Interact with the API using your favourite programming language

AWS CLI
Interact with the API via a terminal/shell program

AWS Management Console

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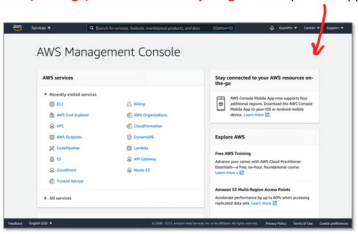
The AWS Management Console is a **web-based** unified console
Build, manage, and monitor everything from simple web apps to complex cloud deployments.



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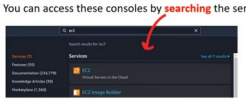
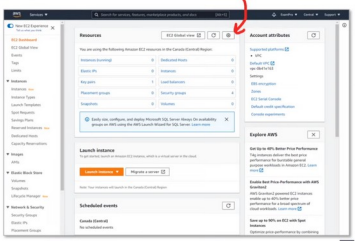
AWS Service each have their own customized console.
You can access these consoles by **searching** the service name.

The **EC2 Console**

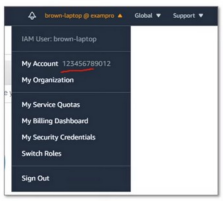




Some AWS Services Console will act as an umbrella console containing many AWS Services: eg
- VPC Console
- EC2 Console
- Systems Manager Console
- SageMaker Console
- CloudWatch Console.

AWS Account ID

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

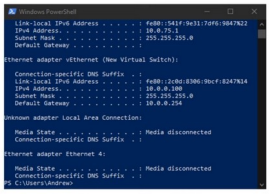
- when logging in with a non-root user account.
- Cross-account roles
- Support cases

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

AWS Tools for PowerShell

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.



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)

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

Service – Identifies the service

- ec2
- s3
- iam

Region – which AWS resource

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

Account ID

- 121212121212
- 123456789012

Resource ID
Could be a number name or path:

- user/Bob
- instance/i-1234567890abcdef0

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

arn:aws:s3:::my-bucket

Paths in ARNs

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)

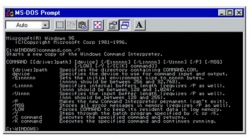
What is a CLI?
A Command Line Interface (CLI) **processes commands to a computer program in the form of lines of text**.
Operating systems implement a command-line interface in a shell.

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)

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-05759b42936e468a   |  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)

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 programing 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

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!

Click the **shell icon**

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

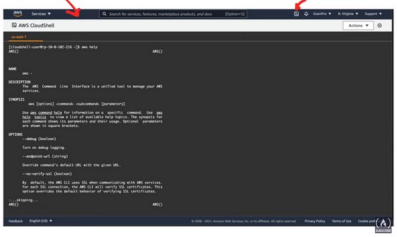
Storage included
1 GB of storage free per AWS region

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)

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

Declarative

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

AWS Cloud Development Kit (CDK)
CDK is an Imperative IaC tool.

Imperative

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

CloudFormation

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

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

TypeScript | NodeJS | Python | Java | ASP.NET

```
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 Infrastructrue

AWS Toolkit for VSCode

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
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

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*
- **Access key - Programmatic access** — Enables an **access key ID** and **secret access key** for the AWS API, CLI, SDK, and other development tools.
- **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/y9k5JVt2TnwvQ6CSwanzg8aUP3O Hide

Access Keys

Access Keys are to be store 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/bPxRfiCYEXAMPLEKEY
[exampro]
aws_access_key_id=AKIAIOSFODNN7EXAMPLE
aws_secret_access_key=wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY
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/bPxRfiCYEXAMPLEKEY
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/bPxRfiCYEXAMPLEKEY
$ export AWS_DEFAULT_REGION=us-west-2
```

AWS Documentation

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

AWS Documentation
Find user guides, developer guides, API references, tutorials, and more.

Guides and API References

Compute | Containers | Storage

User Guide for Linux Instances
Describes key concepts of Amazon EC2 and provides instructions for using the features of Amazon EC2.
HTML | PDF | Kindle | GitHub

Shared Responsibility Model

The **Shared Responsibility Model** is a **cloud security framework** that defines the security obligations of the customer versa 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

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

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

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

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

	IaaS	PaaS	SaaS
Content	Customer	Customer	CSP
Access Policies	Customer	Customer	CSP
Usage	Customer	Customer	CSP
Deployment	Customer	CSP	CSP
Web application security	Customer	CSP	CSP
Identity	Customer	CSP	CSP
Operations	Customer	CSP	CSP
Access and authentication	Customer	CSP	CSP
Network security	Customer	CSP	CSP
Guest OS, data & content	Customer	CSP	CSP
Audit logging	CSP	CSP	CSP
Network	CSP	CSP	CSP
Storage + encryption	CSP	CSP	CSP
Hardened Kernel + IPC	CSP	CSP	CSP
Boot	CSP	CSP	CSP
Hardware	CSP	CSP	CSP

CSP's Responsibility | Customer's Responsibility

Shared Responsibility Model – Architecture

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Less Responsibility

Amplify Serverless Framework
Lambda Serverless Architecture

Serverless / Functions
No more servers, just worry about data and code

Fargate Serverless Containers
ECS/EKS Containers

Microservices / Containers
Mix and match languages, better utilization of resources

Elastic Beanstalk Platform as a Service
EC2 Infrastructure as a Service

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 server** 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 a charged based on the runtime of the serverless function rounded to the nearest 100ms.

Higher Performance Computing Services

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The Nitro System A combination of **dedicated hardware and lightweight hypervisor** enabling faster innovation and enhanced security. All new EC2 instance types use the Nitro System.

- Nitro Cards — specialized cards for VPC, EBS and Instance Storage and controller card
- Nitro Security Chips — Integrated into motherboard. Protects hardware resources.
- Nitro Hypervisor — lightweight hypervisor Memory and CPU allocation Bare Metal-like performance

Bare Metal Instance You can launch EC2 instance that have no hypervisor so you can run workloads directly on the hardware for maximum performance and control. The **M5 and R5** EC2 instances run are bare metal.

Bottlerocket is a Linux-based open-source operation system that is purpose-built by AWS for running containers on Virtual Machines or bare metal hosts

What is High Performance Computing (HPC)?
A cluster of hundreds of thousands of servers with fast connections between each of them with the purpose of boosting computing capacity.
When you need a supercomputer to perform computational problems too large to run on a standard computers or would take to long.

AWS ParallelCluster is an **AWS-supported open source cluster management tool** that makes it easy for you to deploy and manage High Performance Computing (HPC) clusters on AWS.

Edge and Hybrid Computing Services

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What is Edge Computing?
When you push your computing workloads outside of your networks to run close to the destination location. eg. Pushing computing to run on phones, IoT Devices, or external servers not within your cloud network.

What is Hybrid Computing?
When you're able to run workloads on both your on-premise datacenter and AWS Virtual Private Cloud (VPC)

AWS Outposts is **physical rack of servers** that you can put in your data center. AWS Outposts allows you to use AWS API and Services such as EC2 right in your datacenter.

AWS Wavelength allows you **to build and launch your applications in a telecom datacenter**. By doing this your applications with have ultra-low latency since they will be pushed over a the **5G network** and be closest as possible to the end user.

VMWare Cloud on AWS allows you to **manage on-premise virtual machines using VMWare** as EC2 instances. The data-center must being using VMWare for Virtualization.

AWS Local Zones are **edge datacenters located outside of an AWS region** so you can use AWS closer to end destination.
When you need faster computing, storage and databases in populated areas that are outside of an AWS Region

Cost and Capacity Management Computing Services

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Cost Management How do we save money?
Capacity Management How do we meet the demand of traffic and usages though adding or upgrading servers?

EC2 Spot Instances, Reserved Instanced and Savings Plan
Ways to save on computing, by paying up in full or partially, by committing to a yearly contracts or by being flexible about availability and interruption to computing service.

AWS Batch plans, schedules, and executes **your batch computing workloads** across the full range of AWS compute services, can utilize Spot Instance to save money.

AWS Compute Optimizer suggests how to **reduce costs and improve performance** by using machine learning to analyze you previous usage history

EC2 Autoscaling Groups (ASGs)
Automatically adds or remove EC2 servers to meet the current demand of traffic. Will save you money and meet capacity since you only run the amount of servers you need.

Elastic Load Balancer (ELB)
Distributes traffic to multiple instance, can re-route traffic from unhealthy instance to healthy instances. can route traffic to EC2 instances running in different Availability Zones

AWS Elastic Beanstalk (EB) is for easily deploying web-applications without developers having to worry about setting up and understanding the underlying AWS Services. Similar to **Heroku**.

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

Storage —FC, iSCSI— Servers, OS → App

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

Storage —NFS, SMB— NAS Exports → App

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

Storage —HTTP/S, API— Internet → App

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 a files and fire 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

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.

Cheaper

S3 Outposts has its own storage class.

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

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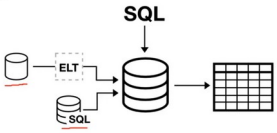
A relational datastore designed for **analytic workloads**, which is generally **column-oriented data-store**

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 aggerate 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 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	011010110001010101010111100010
Ro Laren	001010100101011001010101010101

Key values stores are **dumb and fast.** They generally lack features like:
- Relationships
- Indexes
- Aggregation

Key	Value
Data	{species: android, rank: 'lt commander' }
Worf	{species: klingon, rank: 'lt commander' }
Ro Laren	{species: bajoran, affiliation: 'maquis'}

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

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

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

What is a Document store?

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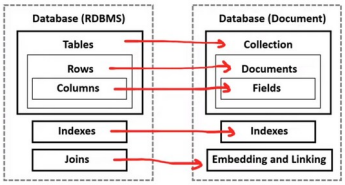
A document store is a NOSQL database that stores **documents** as its primary data structure.
A document could be an XML but more commonly is JSON or JSON-Like
Document stores are sub-class of Key/Value stores

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 was made 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 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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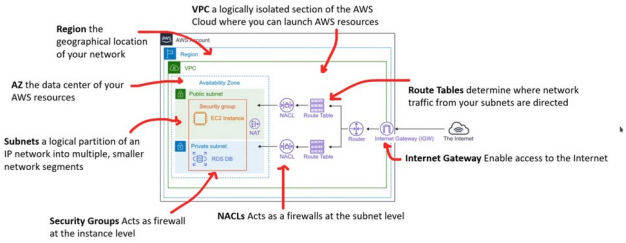

Enterprise/Hybrid Networking

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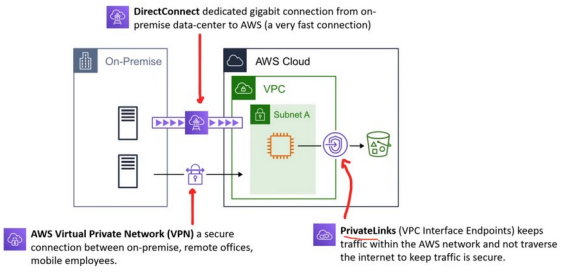

Virtual Private Cloud (VPC) and Subnets

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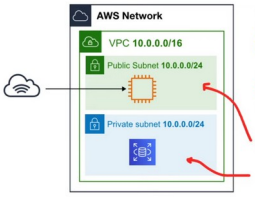
Virtual Private Cloud (VPC) is a logically isolated section of the AWS Network where you launch your AWS resources. You choose a **range of IPs using CIDR Range**

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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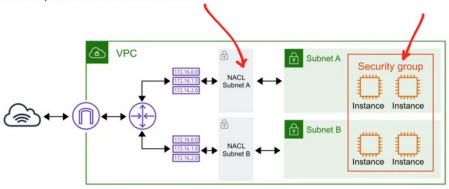
Network Access Control Lists (NACLs)
Acts as a virtual **firewall at the subnet level**
You create **Allow and Deny rules.**

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.



CIDR.xyz
AN INTERACTIVE IP ADDRESS AND CIDR RANGE VISUALIZER

CIDR is a notation for describing blocks of IP addresses and is used heavily in various networking configurations. IP addresses contain 4 octets, each consisting of 8 bits giving values between 0 and 255. The decimal value that comes after the slash is the number of bits consisting of the routing prefix. This in turn can be translated into a netmask, and also designates how many available addresses are in the block.

10 . 88 . 135 . 144 / 32

255.255.255.255	10.88.135.144	10.88.135.144	1
NETMASK	FIRST USABLE IP	LAST USABLE IP	COUNT

* For routing mask values <= 30, first and last IPs are base and broadcast addresses and are unusable.

Created by Yuval Adam. Source available on Github.

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.

Choose OS **via Amazon Machine Image (AMI)**

Choose **Instance Type**

Add Storage **(EBS, EFS)**

Configure Instance

Red Hat, ubuntu, Amazon Linux, SUSE

t2.nano
$0.0065/hour ($4.75/month)
1 vCPU 0.5GB Mem

C4.8xlarge
$1.591/hour ($1161.43/month)
36 vCPU 60GB Mem 10 Gigabit performance

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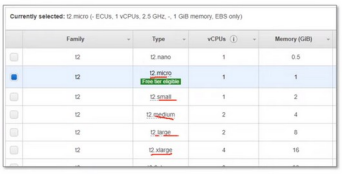
An instance type is a particular **instance size and instance family**:

A common pattern for instance sizes:
- nano
- micro
- small
- medium
- large
- xlarge
- 2xlarge
- 4xlarge
- 8xlarge
- ....



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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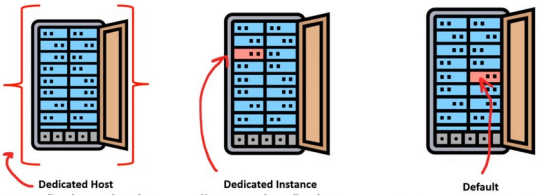
EC2 has three levels of tenancy:



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**

On-Demand is for applications where the workload is for **short-term**, **spikey** 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 the 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 great 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

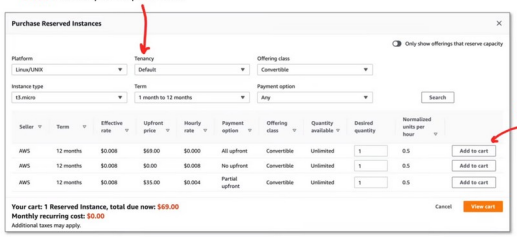
No Upfront
You are billed a discounted hourly rate for every hour within the term, regardless of whether the Reserved Instance is being used

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

Reserved Instances (RI)

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

Filter base on your requirements



Add to cart

Reserved Instances (RI) – RI Attributes

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

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	**Zonal RI**: purchase for an Availability Zone
does *not* reserve capacity.	reserves capacity in the specified Availability Zone.
RI discount applies to instance usage in any AZ in the Region.	RI discount applies to instance in the selected AZ (No AZ Flexibility)
RI discount applies to instance usage within the instance family, regardless of size. Only supported on Amazon Linux/Unix Reserved Instances with default tenancy.	No instance size flexibility RI discounts discount applies to instance usage for the specified instance type and size only.
You can queue purchases for regional RI	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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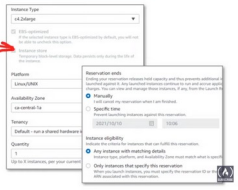
EC2 instances are backed by different kind of hardware, and so there is a **finite amount of servers** available within an Availability Zone per instance type or family.

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



Standard vs Convertible RI

There are some key difference between Standard and Convertible

Standard RI	Convertible 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	RI attributes can't be modified (you perform an exchange)
Can't be exchanged	Can be exchanged during the term for another Convertible RI with new RI attributes, including: • instance family • instance type • platform • scope • tenancy
Can be bought or sold in the RI Marketplace	Can't be bought or sold in the RI Marketplace

RI Marketplace

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

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

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

Single Tenant
think of everyone having their own house

Multi-Tenant

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)

Tenancy
- Shared - Run a shared hardware instance
- Shared - Run a shared hardware instance
- Dedicated - Run a Dedicated instance
- Dedicated host - Launch this instance on 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

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, regardless of region, instance family, size, tenancy, and operating system. Learn more
- EC2 Instance Savings Plans — Applies to instance usage within the selected 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 Pl
$0.092

Payment option
- All Upfront
- Partial Upfront
- No Upfront

You choose an hourly commitment

AWS Savings Plan

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

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 Unspla

Zero Trust on AWS

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

AWS Identity and Access Management (IAM)
- IAM Policies
- Permission Boundaries
- Service Control Policies (Organization-wide Policies)
- IAM Policy Conditions
  - aws:SourceIp – 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

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

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.

Azure Active Directory

Google BeyondCorp

JumpCloud

AWS Single Sign On (SSO)

Your AWS Resources

Third-Party Identity solutions
- Azure Active Directory (Azure AD)
- Google BeyondCorp
- JumpCloud

all have more intelligent security controls for real-time detection.

Directory Service

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

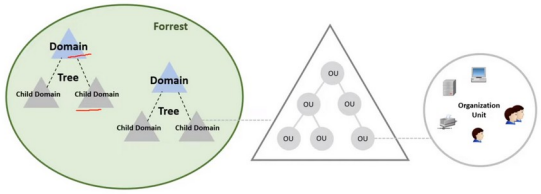
Client Client Client

Directory Service

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

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)

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

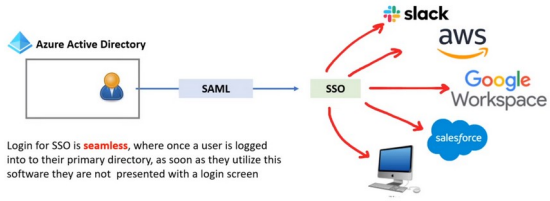
OAuth2.0
industry-standard protocol for authorization OAuth doesn't share password data but instead uses authorization tokens to prove an identity between consumers and service providers.
Oauth is about granting access to functionality

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

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.



Login for SSO is **seamless**, where once a user is logged into to their primary directory, as soon as they utilize this software they are not presented with a login screen

LDAP

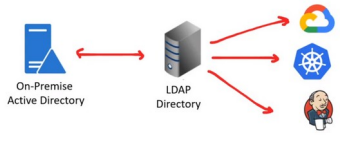
Lightweight Directory Access Protocol (LDAP) is an open, vendor-neutral, industry standard **application protocol for accessing and maintaining distributed directory information services** over an Internet Protocol (IP) network.

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

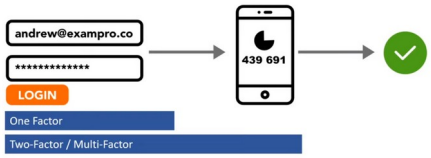


Multi-Factor Authentication

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

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 popular brand of security key is an Yubikey

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.

- 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)

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

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)

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

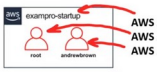
ConsoleMe is an open-source Netflix project to self-serve short-lived IAM policies so an end user can access AWS resources while enforcing JEA and JIT

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



AWS Account – the account which holds all your AWS resources
AWS Account - Root User – a special account with full access that cannot be deleted
AWS Account – User – a user for common tasks that is assigned permissions

AWS Account Root User is a special user who is created at the time of AWS account creation:

- The Root User account uses an Email and Password to login
  - A regular user has to provide the Account ID / Alias, Username and Password
- The Root User account can not be deleted
- The Root User account has full permissions to the account and its permissions ***cannot be limited**.
  - You cannot use IAM policies to explicitly deny the root user access to resources.
  - You can only use an AWS Organizations service control policy (SCP) to limit the permissions of the root user
- There can only be one Root user per AWS account
- The root user is instead for very specific and specialized tasks that are infrequently or rarely performed
  - An AWS Root Account should not be used for daily or common tasks
- Its strongly recommended to never use Root User Access Keys
- Its strongly recommended to turn on MFA for the Root User

AWS Account Root User

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

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.

AWS SSO Use Cases

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

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.

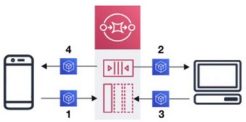
The common systems or design patterns utilized for Application Integration generally are:
- Queueing
- Streaming
- Pub/Sub
- API Gateways
- State Machine
- Event Bus

Queueing

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 **queuing 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

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

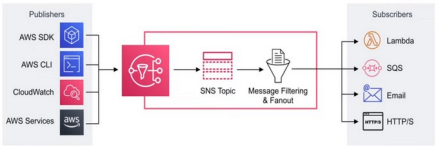
What is Pub/Sub?
Publish–subscribe pattern commonly implemented in **messaging systems**.
In a pub/sub system the sender of messages (**publishers**) do not send their messages directly to receivers.
They instead send their messages to an **event bus**. The event bus categorizes their messages into groups.
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

- Publisher 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

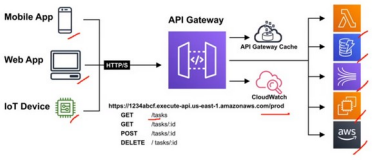
Simple Notification Service (SNS) is a highly available, durable, secure, fully managed **pub/sub messaging** service that enables you to **decouple** microservices, distributed systems, and serverless applications.



API Gateway

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

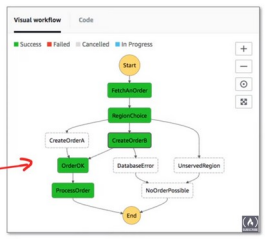
Amazon API Gateway is a solution for **creating secure APIs** in your cloud environment at **any scale**.
Create APIs that act as a front door for applications to access data, business logic, or functionality from back-end services.



State Machines

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.**

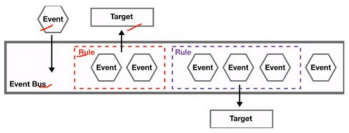
What is AWS Step Functions?
- Coordinate multiple AWS Services into a serverless workflow
- A graphical console to visualize the components of your application as a series of steps.
- Automatically triggers and tracks each step, and retries when there are errors, so your application executes in order 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

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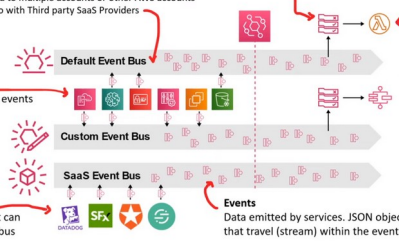
Event Bus
Holds event data, define rules on an event bus to react to events.
Default Event Bus — An AWS account has a default event bus
Custom Event Bus — Scoped to multiple accounts or other AWS accounts
SaaS Event Bus — Scoped to with Third party SaaS Providers

Rules
Determines what events to capture and pass to targets. (100 Rules per bus)

Targets
AWS Services that consume events
(5 targets per rule)

Producers
AWS Services that emit events



Partner Sources
Are third-party apps that can emit events to an event bus

Events
Data emitted by services. JSON objects that travel (stream) within the event bus.

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

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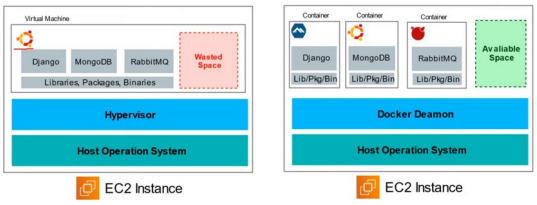
VMs **do not** make best use of space.
Apps are not isolated which. Could cause **config conflicts**, **security problems** or **resource hogging**.

Containers allow you to run multiple apps which are virtually isolated from each other.
Launch new containers and configure OS Dependencies per container.



What are Microservices

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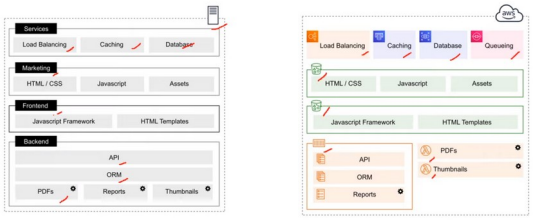
Monolithic Architecture
One app which is responsible for everything
Functionality is tightly coupled

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.

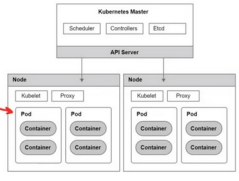
Originally created by Google and now maintained by the **Cloud Native Computing Foundation (CNCF)**

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 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

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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

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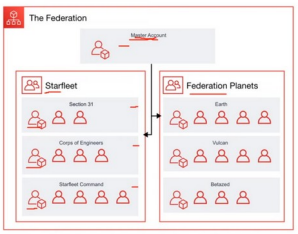
AWS Organizations allow the creation of new AWS accounts. Centrally manage billing, control access, compliance, security, and share resources across your AWS accounts.

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

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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**

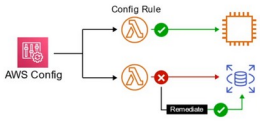
AWS Config

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 as is **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

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

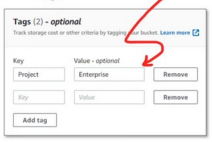
Reduce hundreds of manual procedures into just a few steps

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

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

Tagging

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



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**

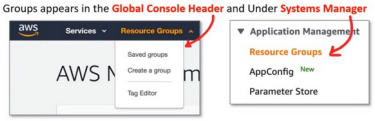
Resource Groups

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**



Business Centric Services

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 it 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 preform 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

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 provisiong 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

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

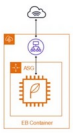
AWS Cloud Development Kit (CDK)
An Infrastructure as Code (IaC) tool. Allows you to use your favourite programming language. Generates out CloudFormation templates as the means for IaC.

AWS Elastic Beanstalk

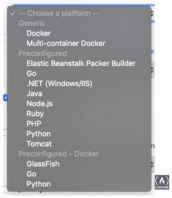
What is Platform as a Service? (PaaS)
a PasS allows customers to develop, run, and manage applications without the complexity of building and maintaining the infrastructure typically associated with developing and launching an app

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

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 a 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?

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

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 a 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

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 then 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 License 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)

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

Logging Services

CloudTrail - logs all **API calls** (SDK, CLI) between **AWS services** (who can we blame)
Who created this bucket?
Who spun up that expensive EC2 instance?
Who launched this SageMaker Notebook?
- Detect developer misconfiguration
- Detect malicious actors
- Automate responses

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

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

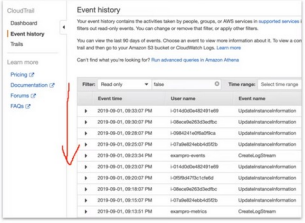

```
{"Records": [{
    "eventVersion": "1.0",
    "userIdentity": {
        "type": "IAMUser",
        "principalId": "EX_PRINCIPAL_ID",
        "arn": "arn:aws:iam::123456789012:user/Worf",
        "accountId": "123456789012",
        "accessKeyId": "EXAMPLE_KEY_ID",
        "userName": "Worf"
    },
    "eventTime": "2014-03-24T21:11:59Z",
    "eventSource": "iam.amazonaws.com",
    "eventName": "CreateUser",
    "awsRegion": "us-east-1",
    "sourceIPAddress": "127.0.0.1",
    "userAgent": "aws-cli/1.3.2 Python/2.7.5 Windows/10",
    "requestParameters": {"userName": "LaForge"},
    "responseElements": {"User": {
        "createDate": "Mar 24, 2014 9:11:59 PM",
        "userName": "LaForge",
        "arn": "arn:aws:iam::123456789012:user/LaForge",
        "path": "/",
        "userId": "EXAMPLEUSERID"
    }}
}]}
```


AWS CloudTrail

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**.



CloudWatch Alarms

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

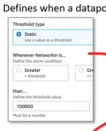
When alarm breaches (goes outside the defined threshold) than it changes **state.**

When it changes state we can define what **action it should trigger.**
- Notification
- Auto Scaling Group
- EC2 Action

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

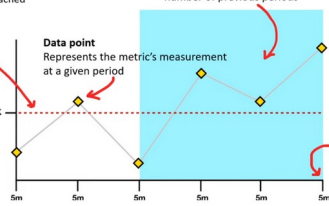
CloudWatch Alarms — Anatomy of an Alarm

Threshold Condition
Defines when a datapoint is breached



Evaluation Periods
number of previous periods

Data point
Represents the metric's measurement at a given period



Period
How often it checks to evaluate the Alarm

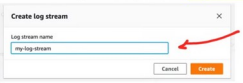
Metric
The actual data we are measuring

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

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

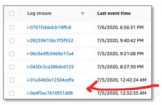
CloudWatch Logs — Log Streams

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

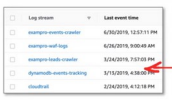


You can create Log Streams manually but generally this is automatically done by the service you are using

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



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**

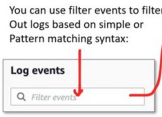


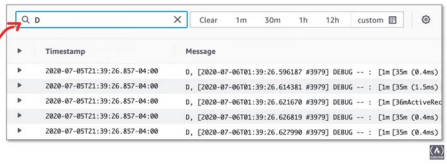
Here is a Log Group for **AWS Glue**.
You can see here the Log Streams are named after the **Glue Jobs.**

CloudWatch Logs — Log Events

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

You can use filter events to filter Out logs based on simple or Pattern matching syntax:





CloudWatch Logs — Log Insights

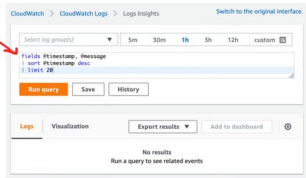
CloudWatch Logs Insights enables you to **interactively search and analyze your CloudWatch log data** and has the following advantages:
- more robust filtering then using the simple Filter events in a Log Stream
- Less burdensome then having to export logs to S3 and analyze them via Athena.

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.

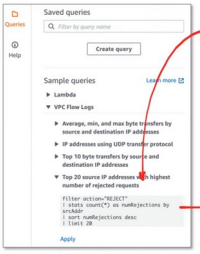
CloudWatch Insights has its own language called:
- CloudWatch Logs Insights **Query Syntax**

```
filter action="REJECT"
| stats count(*) as numRejections by srcAddr
| sort numRejections desc
| limit 20
```

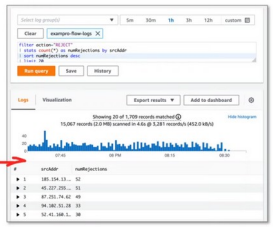


- A single request can query up to **20 log groups**.
- Queries **time out after 15 minutes**, if they have not completed.
- Query results are **available for 7 days.**

CloudWatch Logs – Log Insights



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.



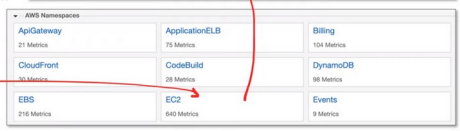
You can create and save your own queries to make future repetitive tasks easier.

CloudWatch Metrics

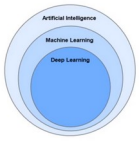
A CloudWatch Metric represents a **time-ordered set of data points**
Its a **variable** that is **monitored over time**.

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



Machine Learning and AI Services



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

Amazon CodeGuru is **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

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

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

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 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 connect and ingest to many different types of databases

AWS Data Pipeline **automates the movement of data**. You can reliably move data between compute and storage services.

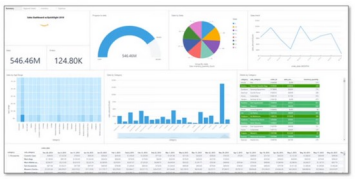
AWS Glue is an **Extract, Transform, Load (ETL) service**. Moving data from one location to another and where you need to perform transformations before the final destination. Similar to Database Migration Service (DMS) but more robust

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

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

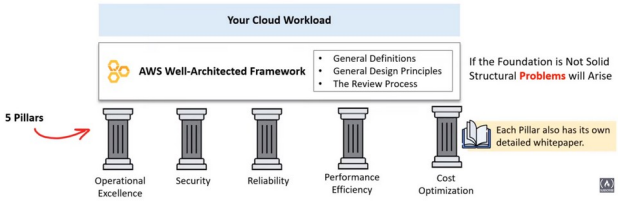
Amazon QuickSight ML Insights – Detect Anomalies, Perform accurate forecasting, Generate Natural Language Narratives.
Amazon QuickSight Q - Ask question using natural language, on all your data, and receive answers in seconds.

AWS Well-Architected Framework

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

*Business Value

Operational Excellent Pillar — Run and monitor systems
Security Pillar — Protect data and systems, mitigate risk
Reliability Pillar — Mitigate and recover from disruptions
Performance Efficiency Pillar — Use computing resources effectively
Cost Optimization Pillar — Get the lowest price

*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

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 distrubted 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

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

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

- Performance Efficiency
  - Design Principles
  - Definition
  - Best Practices
  - Resources

Performance Efficiency

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

AWS Well-Architected – Design Principles

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 serves 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

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

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

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

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

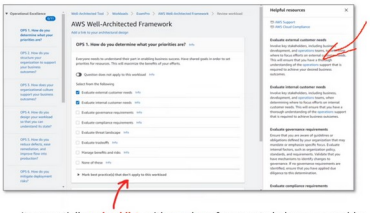
Measure overall efficiency
Measure the business output of the workload and the costs associated with delivering it.
Use this measure to know the gains you make from increasing output and reducing costs.

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

The Well-Architected Tool is **an auditing tool** to be used to asset your cloud workloads for alignment with the AWS Well Architected Framework.

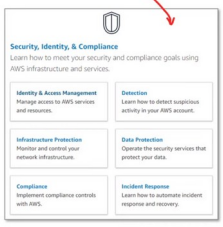


Its essentially **a checklist**, with nearby references to help you assemble a report to share with executives and key stake-holders

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



Total Cost of Ownership (TCO)

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

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.

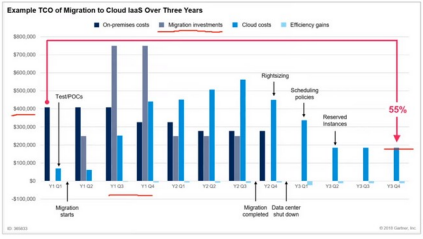
Creating a TCO report is useful when your company **is looking to migrate from on-premise to cloud.**

Total Cost of Ownership (TCO)

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

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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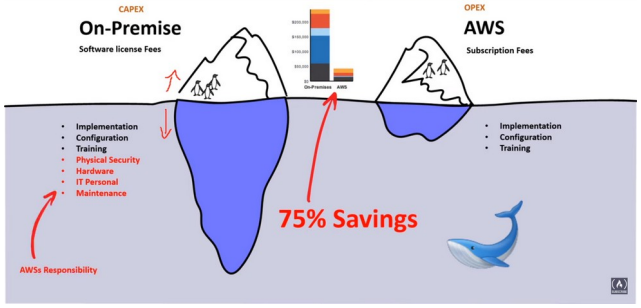


Capital vs Operational Expenditure

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

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

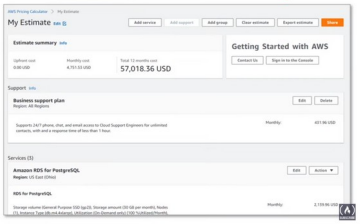
The **AWS Pricing Calculator** is a **free cost estimate tool** that can be used within your **web-browser** without the need for an AWS Account to estimate the cost of a various AWS services.

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.

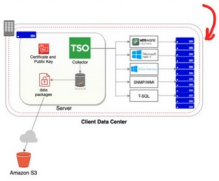


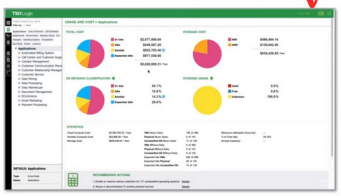
Migration Evaluator

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

AWS Migration Evaluator (formally 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

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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)

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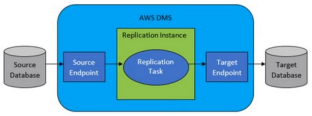
AWS Database Migration Service (DMS) allows you to quickly and securely migrate one database to another. DMS can be used to migrate your on-premise database to AWS.

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)

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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**.

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 Marketplace

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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

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

- **IAM - Identity Access Management**
- **Amazon VPC**
- **Auto Scaling**
- **CloudFormation**
- **Elastic Beanstalk**
- Opsworks
- Amplify
- AppSync
- CodeStar
- Organizations & Consolidated Billing
- AWS Cost Explorer

Consolidated Billing

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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

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		
	No third party support	Tech Support via **Chat, Phone** Anytime 24/7	
	General Guidance < 24 hrs		
	System Impaired < 12 hrs		
		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

Consolidated Billing – Volume Discounts

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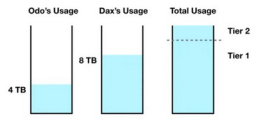
AWS has **Volume Discounts** for many services
The more you use, the more you save.
Consolidated Billing lets you take advantage of Volume Discounts
Consolidate Billing is a feature of AWS Organizations



Data Transfer	
First 10 TB	$0.17 per GB
Next 40 TB	$0.13 per GB

Odo	(4*1024)*0.17	= $696.32	1 TB = 1024 GB
Dax	(8*1024)*0.17	= $1392.64	
Unconsolidated	696.32+1392.64	= **$2088.96**	
Consolidated	((10*1024)*0.17)+((2*1024)*0.13)	= **$2007.04**	

AWS Support Plans

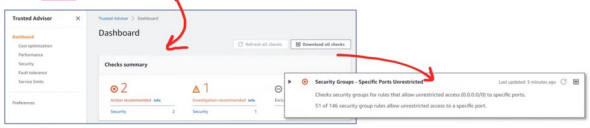
Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

Developer	Business	Enterprise
***$29 USD** /month or 3% of monthly AWS usage *whichever is greater*	***$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 *whichever is greater*	***$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 *whichever is greater*
eg. **Monthly Spend is $500** 3% of 500 = $15 USD ($29) **Monthly Spend is $1000** 3% of 1000 = $30 USD	eg. **Monthly Spend is $1000** 10% of 1000 = $100 USD **Monthly Spend is $5000** 10% of 5000 = $500 USD **Monthly Spend is $12,000** 10% of 10,000 = $1000 USD 7% of 2,000 = 140 USD $1140 USD	

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.



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?

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 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 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

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%
- 99.999999999% (commonly called **Nine nines**)
- 99.99999999999% (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
Global Tables SLA	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%
Standard SLA	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
Region-Level SLA	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%
Instance-Level SLA	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 Heath Dashboard

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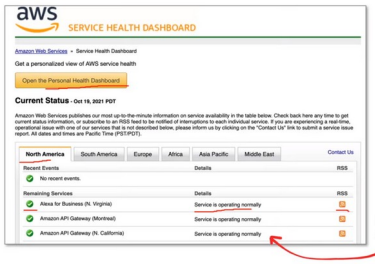
The **Service Health Dashboard** shows the general status of AWS services,



An **icon** and **details** will indicate the status of each AWS Service

AWS Personal Heath Dashboard

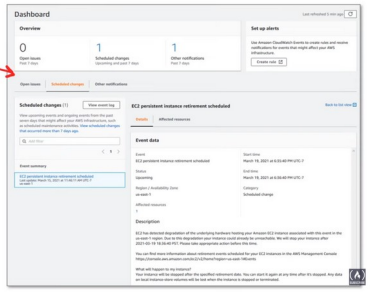
Cheat sheets, Practice Exams and Flash cards www.exampro.co/clf-c01

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.



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

The Best Deals

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

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

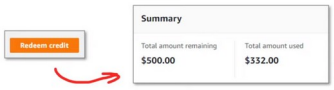
AWS CodeBuild Building Code
100 build minutes per month forever

AWS Lambda Serverless Compute
1M free request per month
3.2M seconds of compute time per month

AWS Credits

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
- ...



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)

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

AWS Budgets give you the ability to setup alerts if you **exceed** or are **approaching** your defined budget

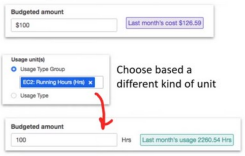
Create **Cost**, **Usage** or **Reservation** Budgets

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 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

Choose your budget amount in $$$

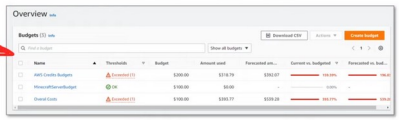


Choose based a different kind of unit

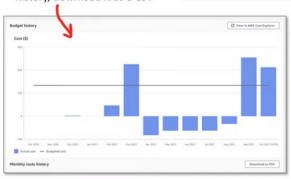
Budget based on a fixed cost or plan your upfront based on your chosen level
Can be easily manage from the **AWS Budgets** dashboard or via the **Budgets API**.
Get Notified by providing an email or **Chatbot** and threshold how close to the current or forecasted budget

AWS Budgets

You have a list of budgets:



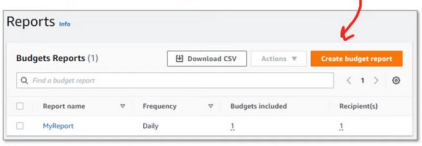
You can see your budget history, download it as a CSV



- **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

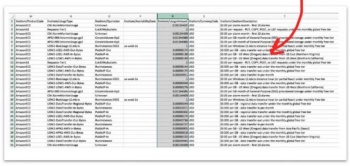
AWS Budget Report is used alongside AWS Budgets to create and send daily, weekly, or monthly reports to monitor the performance of your AWS Budget that will be emailed to specific emails.



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)

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

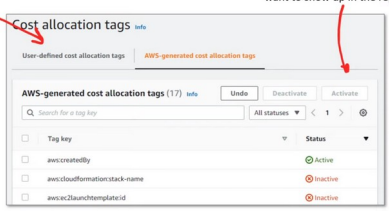
Cost Allocation Tags

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:

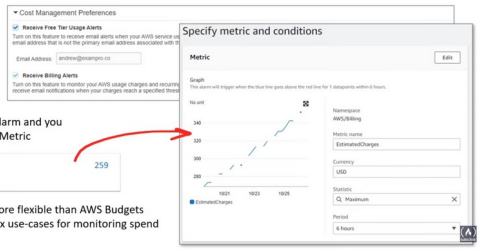
- User-Defined
  - Eg Project
- AWS Generated
  - E.g. aws:createdBy



Billing Alerts/Alarms

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**



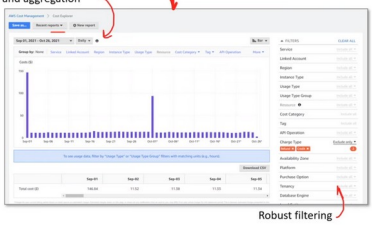
Go create a CloudWatch Alarm and you can choose Billing as your Metric

Billing Alarms are much more flexible than AWS Budgets and ideal for more complex use-cases for monitoring spend and usage

AWS Cost Explorer

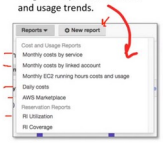
AWS Cost Explorer lets you **visualize, understand, and manage** your AWS costs and usage **over time.**

Specific type range and aggregation

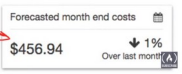


Robust filtering

Default reports help you gain insight into your cost drivers and usage trends.



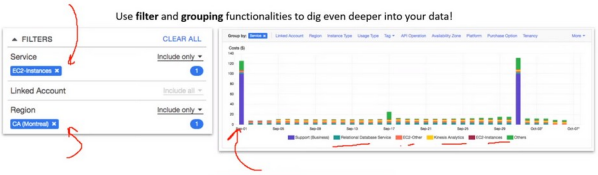
Use **forecasting** to get an idea of future costs



AWS Cost Explorer

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!



Cost Explorer shows up in **US-East-1**

AWS Pricing API

With AWS you can programmatically access pricing information to get the latest price offering for services.

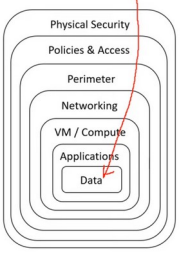
There are two versions of this API:

- 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



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)

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 be 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

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

OWASP

Allowing Domains or Accounts to Expire
Buffer Overflow
Business logic vulnerability
CRLF Injection
CSV Injection
Catch NullPointerException
Covert storage channel
Deserialization of untrusted data
Directory Restriction Error
Doubly freeing memory
Empty String Password
Expression Language Injection
Full Trust CLR Verification issue
Heartbleed Bug
Improper Data Validation
Improper pointer subtraction
Information exposure through query strings
Injection problem
Insecure Compiler Optimization
Insecure Randomness
Insecure Temporary File
Insecure Third Party Domain Access
Insecure Transport
Insufficient Entropy
Insufficient Session-ID Length
Least Privilege Violation
Memory leak
Missing Error Handling
Missing XML Validation
Multiple admin levels
Null Dereference
OWASP .NET Vulnerability Research
Overly Permissive Regular Expression
PHP File Inclusion
PHP Object Injection
PRNG Seed Error
Password Management Hardcoded Password
Password Plaintext Storage
Poor Logging Practice
Portability Flaw
Privacy Violation
Process Control
Return Inside Finally Block
Session Variable Overloading
String Termination Error
Unchecked Error Condition
Unchecked Return Value Missing Check against Null
Undefined Behavior
Unreleased Resource
Unrestricted File Upload
Unsafe JNI
Unsafe Mobile Code
Unsafe function call from a signal handler
Unsafe use of Reflection
Use of Obsolete Methods
Use of hard-coded password
Using a broken or risky cryptographic algorithm
Using freed memory
Vulnerability template
XML External Entity (XXE) Processing

Encryption

What is cryptography?
The practice and study of techniques for secure communication in the presence of third parties called adversaries

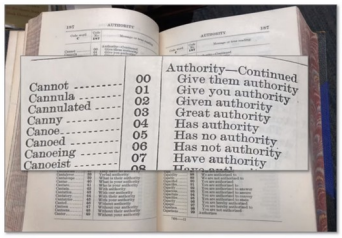
What is encryption?
The process of encoding (scrabbling) information **using a key** and a **cypher** to store sensitive data in an unintelligible format as a means of protection. An encryption takes in plaintext and produces **ciphertext**.

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.

Cyphers

What is a cypher?
An algorithm that performs encryption or decryption. Cipher is synonymous with "code"

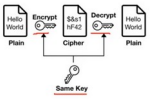
What is ciphertext
Ciphertext is the result of encryption performed on plaintext via an algorithm



A **codebook** is a type of document used for gathering and storing cryptography codes

Cryptographic Keys

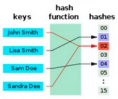
What is a cryptographic key?
A key is a variable used in conjunction with an encryption algorithm in order to encrypt or decrypt data.



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



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.

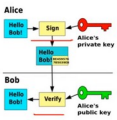
Hashing Passwords
Hashing functions are used to store passwords in database so that a password does not reside in a plaintext format.

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 knowns 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



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

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

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

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

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

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

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

AWS Artifact is a self-serve portal for on-demand access to **AWS compliance reports**

Choose you report

View the PDF

Download the Excel

AWS Inspector

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

- 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)

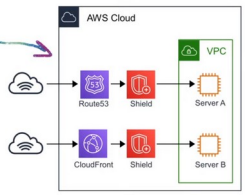
What is a DDoS (Distributed Denial of Service) Attack?
A malicious attempt to disrupt normal traffic by flooding a website with large amounts of fake traffic.

AWS Shield

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

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 EC1 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

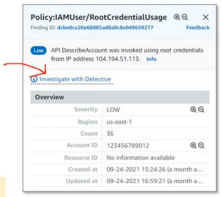
Both plans integrate with AWS Web Application Firewall (WAF) to give you Layer 7 (Application) protection

Amazon Guard Duty

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.

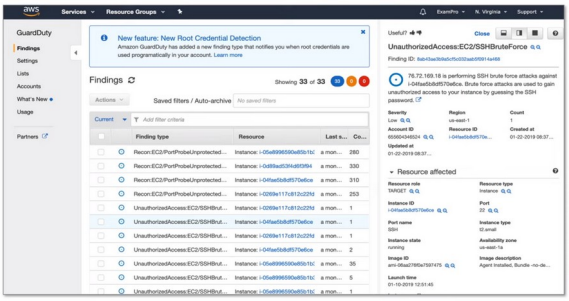
Guard Duty is a **threat detection service** that continuously monitors for malicious, suspicious activity and unauthorized behavior. It uses Machine Learning to analyze the following AWS logs:

- 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

Amazon Guard Duty



Amazon Macie

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)

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)

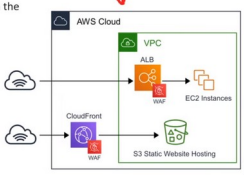
AWS WAF

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)

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

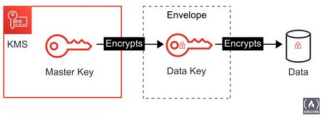
AWS Key Management Service

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.

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

CloudHSM is a single-tenant HSM as a service that automates hardware provisioning, software patching, high availability and backups.

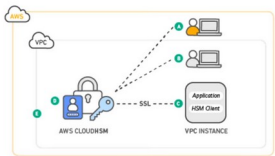
AWS CloudHSM enables you to generate and use your encryption keys on a FIPS 140-2 Level 3 validated hardware.

Built on Open HSM industry standards to integrate with:

- PKCS#11
- Java Cryptogrpahy Extensions (JCE)
- Microsoft CryptoNG (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

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

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 automat 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

PUSHER 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

RabbitMQ Sidekiq

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

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Both are security tools and they both perform audits

Amazon Inspector

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

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

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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.

Its 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 preform various operations during transcoding.

- Transcodes videos to streaming formats
- Overlays images
- Insert videos 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