AWS Cloud

-Karan Gupta

Instructor

- 5x AWS Certified
- (AWS Certified Solution Architect Professional)
- Worked with MNCs, Startups, Mid-size
- Published Over 10+ Research Papers
- Corporate Trainer

Course Plan

- Prepare for Market
- Q/A
- Interview Based Prep
- AWS certification POV
- Will give practical based scenarios

Account Creation

- 12 months free – Limited
- Will cost if used excessively

Account Creation

- Practical

Understanding of Physical and Virtual Servers

What is Server?

- Normal computer or device who hosts website can be considered server.
- Including data centers, offices

Problems in Traditional

- **Cost of physical assets**
- **Requirement of power supply, place, cooling, maintenance**
- **Manpower needed**
- 24*7 monitoring
- **Rent of office, data centers**
- **Issue in scaling**
- **Disaster issues**

Rise of Cloud Computing

- **On demand delivery**
- **Pay as u go**
- **Choose your preference of machine**
- Instant
- **Go global**
- **One click**

Some services you already use

- **Gmail**
- **Hotstar**
- **Netflix**
- Dropbox

Types of Cloud

Public

That is available for everyone.

AWS, AZURE, GCP

Private

- Not exposed to everyone
- Complete control in ur hand
- Security specific

Hybrid

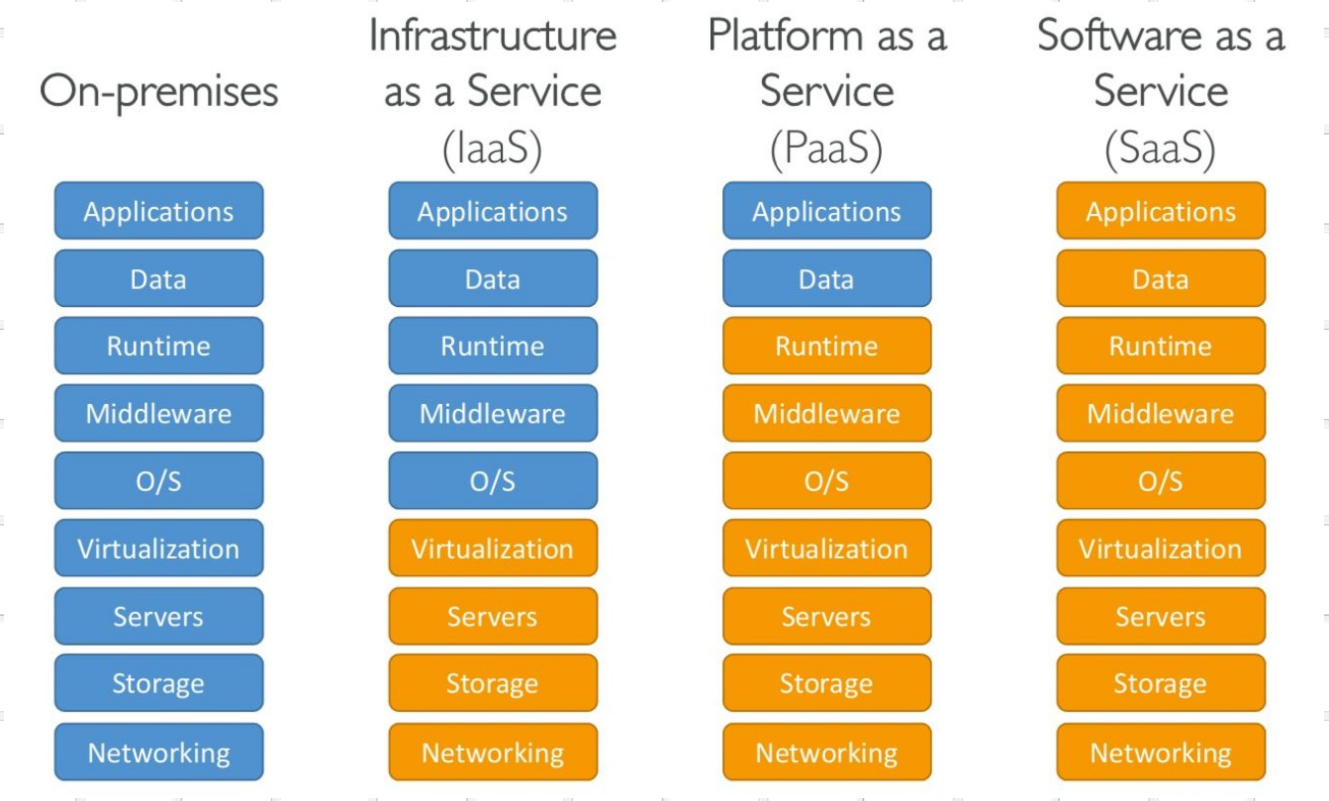
Public + Private

- Sensitive info in private

Need/Benefits of Cloud

- **Flexibility**
- **Scalability**
- **Cost Effective**
- Elasticity
- **High Availability**

Cloud Computing Model



On-premises	Infrastructure as a Service (IaaS)	Platform as a Service (PaaS)	Software as a Service (SaaS)
🟦 Applications	🟦 Applications	🟦 Applications	🟧 Applications
🟦 Data	🟦 Data	🟦 Data	🟧 Data
🟦 Runtime	🟦 Runtime	🟧 Runtime	🟧 Runtime
🟦 Middleware	🟦 Middleware	🟧 Middleware	🟧 Middleware
🟦 O/S	🟦 O/S	🟧 O/S	🟧 O/S
🟦 Virtualization	🟧 Virtualization	🟧 Virtualization	🟧 Virtualization
🟦 Servers	🟧 Servers	🟧 Servers	🟧 Servers
🟦 Storage	🟧 Storage	🟧 Storage	🟧 Storage
🟦 Networking	🟧 Networking	🟧 Networking	🟧 Networking

Examples of Each

- IaaS
  - EC2
- PaaS
  - Elastic Beanstalk
- SaaS
  - DropBox, Gmail

Aws Global Infra

- AWS Regions
- AWS AZ
- AWS Data Centers
- Edge Locations

AWS Region

- What are these
- How to select region

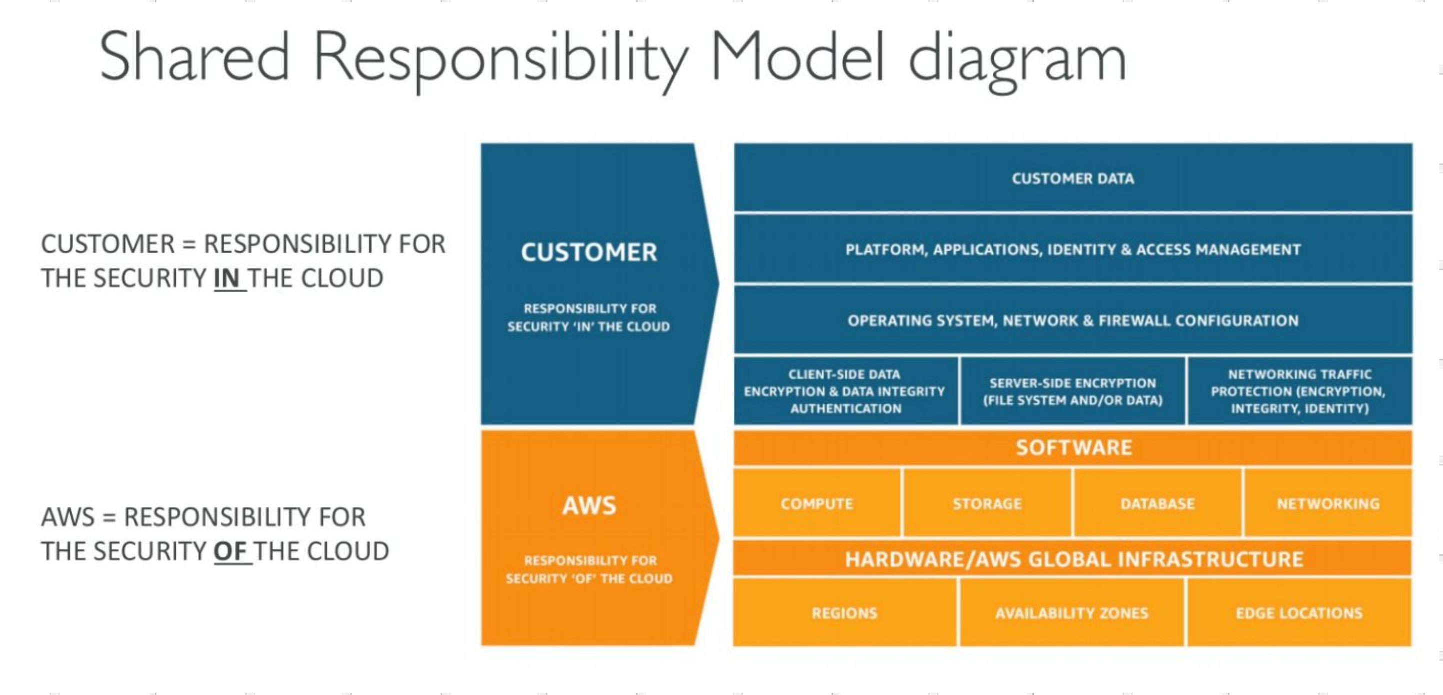
AWS AZ

- **What are AZ**

AWS DC

-

Shared Responsibility Model

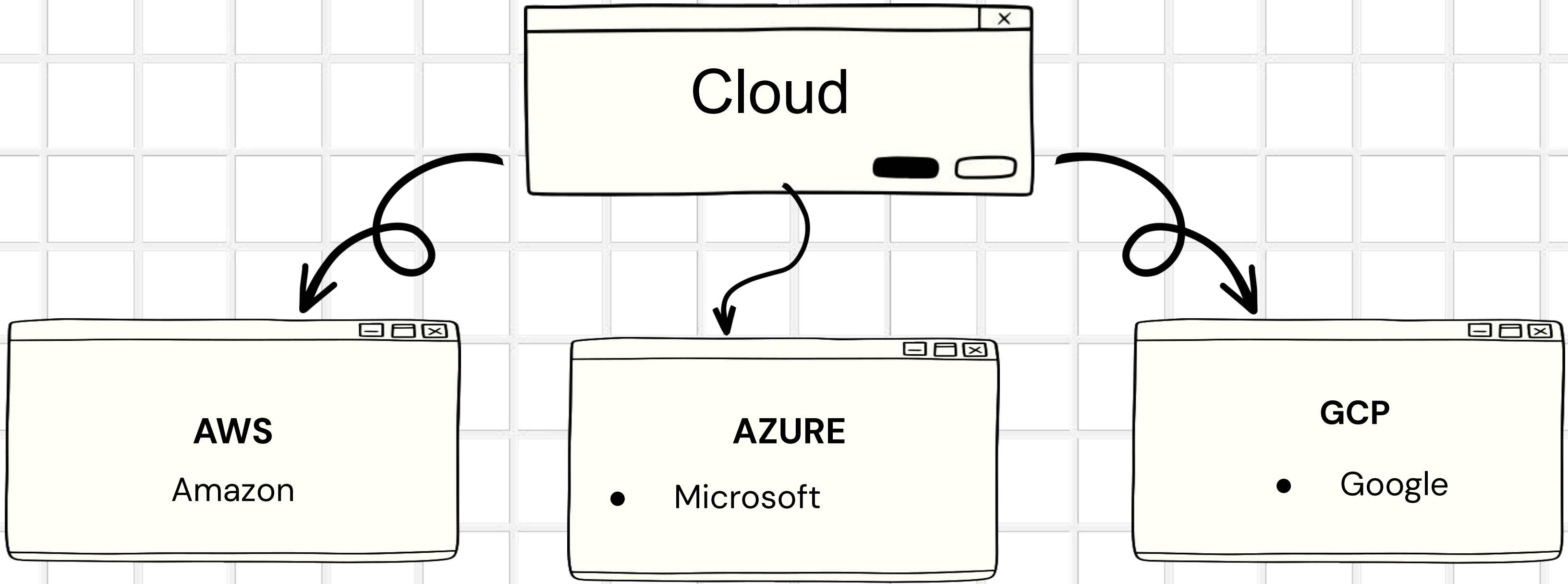

Shared Responsibility Model diagram

CUSTOMER = RESPONSIBILITY FOR THE SECURITY **IN** THE CLOUD

AWS = RESPONSIBILITY FOR THE SECURITY **OF** THE CLOUD

CUSTOMER
RESPONSIBILITY FOR SECURITY 'IN' THE CLOUD
CUSTOMER DATA
PLATFORM, APPLICATIONS, IDENTITY & ACCESS MANAGEMENT
OPERATING SYSTEM, NETWORK & FIREWALL CONFIGURATION
CLIENT-SIDE DATA ENCRYPTION & DATA INTEGRITY AUTHENTICATION
SERVER-SIDE ENCRYPTION (FILE SYSTEM AND/OR DATA)
NETWORKING TRAFFIC PROTECTION (ENCRYPTION, INTEGRITY, IDENTITY)
AWS
RESPONSIBILITY FOR SECURITY 'OF' THE CLOUD
SOFTWARE
COMPUTE
STORAGE
DATABASE
NETWORKING
HARDWARE/AWS GLOBAL INFRASTRUCTURE
REGIONS
AVAILABILITY ZONES
EDGE LOCATIONS

AWS vs Azure vs GCP



AWS vs Azure vs GCP

- https://cloud.google.com/docs/get-started/aws-azure-gcp-service-comparison
- In 2019, AWS - 35$ BILLION revenue
- 47% aws, 22%azure

Pricing

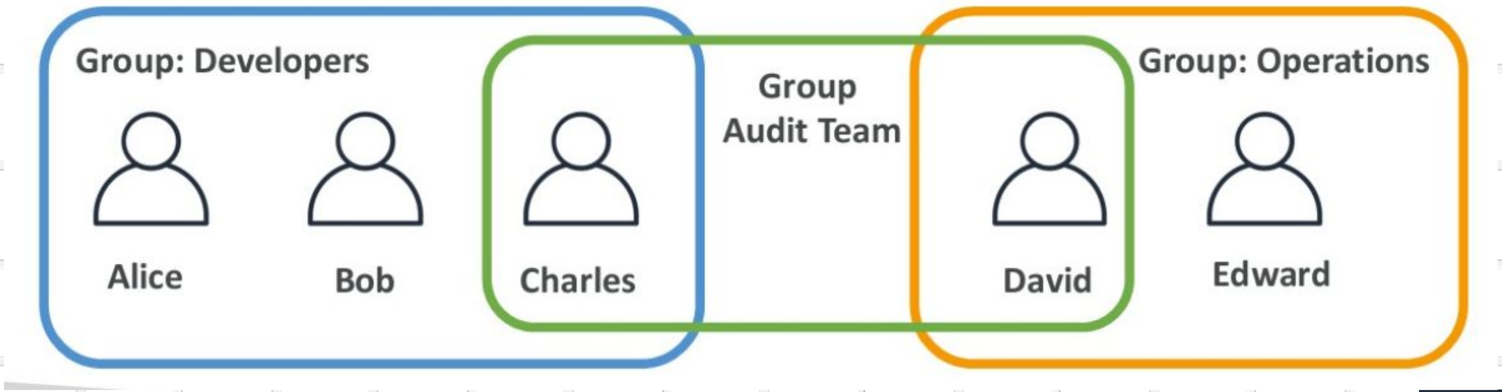
- On aws account
- Cost calculator
- Billing
- budgets
-

Regional vs Global service

- Global –
  - IAM
  - Organisations
  - Route 53
  - ACM
  - Cloudfront

IAM

- **Identity and Access Management**



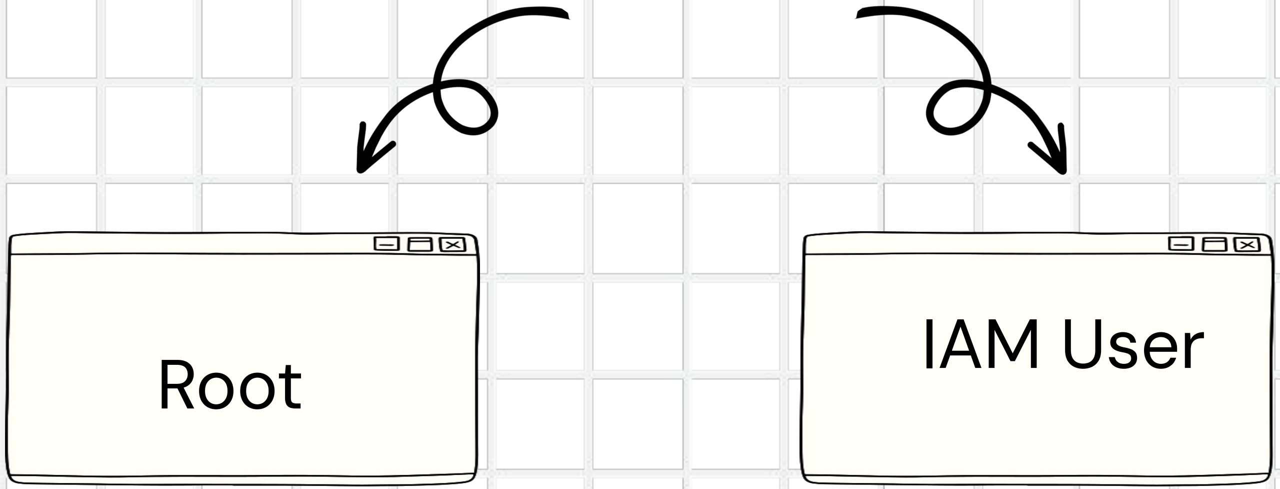
What is IAM

- •Fine-grained control of who can do what
- Eg -user Bob can launch server

IAM Characteristics

- free
- centralized AWS service
- default scope is AWS account
- deny by default

IAM Users



Root User

- Root User
    - the identity used to create AWS account
    - complete access

- Best practices
    - don’t use this account for the everyday
    - setup physical MFA and lock it away
    - don’t use your Amazon.com shopping account

IAM User

- IAM Users
  - an identity with assigned permissions
  - can have username/password access to AWS console
  - can have (secret) key-based access to AWS APIs

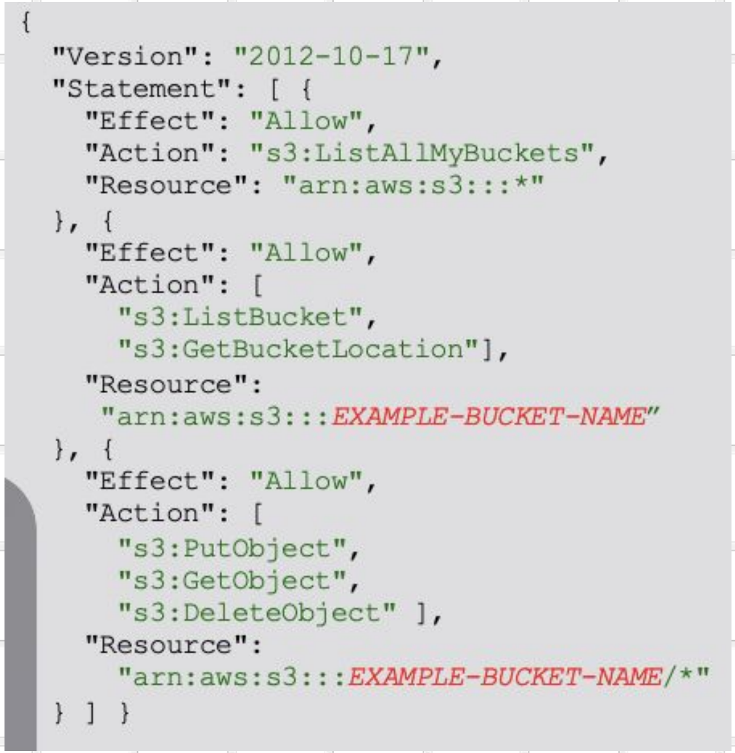
- Best Practices
  - rotate credentials (keys, passwords)
  - MFA
  - password policy

IAM Groups

- collection of IAM users
- operates like you'd think
- Best practices
  - manage permissions with groups
  - i.e., assign policies to groups instead of users

IAM Policies

- set of permissions to be granted or denied
- JSON documents
- can be assigned directly to IAM users



```
{
  "Version": "2012-10-17",
  "Statement": [ {
    "Effect": "Allow",
    "Action": "s3:ListAllMyBuckets",
    "Resource": "arn:aws:s3:::*"
  }, {
    "Effect": "Allow",
    "Action": [
      "s3:ListBucket",
      "s3:GetBucketLocation"],
    "Resource":
     "arn:aws:s3:::EXAMPLE-BUCKET-NAME"
  }, {
    "Effect": "Allow",
    "Action": [
      "s3:PutObject",
      "s3:GetObject",
      "s3:DeleteObject" ],
    "Resource":
      "arn:aws:s3:::EXAMPLE-BUCKET-NAME/*"
  } ] }
```

IAM Role

- a 2nd type of AWS identity
  - also has assigned permissions
  - similar to IAM users
- designed to be temporarily assumed
  - e.g. by an EC2 instance
- no associated credentials
- Instance Profiles
  - assigned to EC2 instance
  - container for one or more IAM roles

Best Practice

- •**Users** – Create individual users.
- •**Permissions** – Grant least privilege.
- •**Groups** – Manage permissions with groups.
- •**Conditions** – Restrict privileged access further with conditions.
- •**Password** – Configure a strong password policy.
- •**Rotate** – Rotate security credentials regularly.
- •**MFA** – Enable MFA for privileged users.
- •**Roles** – Use IAM roles for Amazon EC2 instances.
- •**Root** – Reduce or remove use of root.

EC2

Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides resizable compute capacity in the cloud.

Access reliable, scalable infrastructure on demand. Scale capacity within minutes with SLA commitment of 99.99% availability.

Benefits of EC2

* **Scalability:** Easily **scale up or down** resources based on demand.

* **Flexibility:** Choose from various **instance types** optimized for different workloads (compute, memory, GPU).

* **Cost-effectiveness: Pay-as-you-go** pricing model for only the resources you use.

* **Global Availability:** Available in multiple **AWS regions** worldwide.

Different types of EC2

https://aws.amazon.com/ec2/instance-types/

Size n Conf of EC2

- OS
- CPU
- RAM
- Space
- Network Card
- Firewall

Use Cases of EC2

* Hosting websites and applications.

* Running batch jobs.

* Building and deploying cloud-native applications.

* Setting up development, testing, and staging environments.

Key Pair

- AWS uses public-key cryptography to encrypt and decrypt login information.
- AWS only stores the public key, and the user stores the private key.

Generate Key Pair

1. Open the Amazon EC2 console at http://console.aws.amazon.com/ec2/
2. On the navigation bar select region for the key pair
3. Click **Key Pairs** in the navigation pane to display the list of key pairs associated with the account
4. Click **Create Key Pair**
5. Enter a name for the key pair in the **Key Pair Name** field of the dialog box and click **Create**
6. The private key file, with .pem extension, will automatically be downloaded by the browser.

Steps of creating EC2

Step 1: Sign up for Amazon EC2

Step 2: Create a key pair

Step 3: Launch an Amazon EC2 instance

Step 4: Connect to the instance

Step 5: Customize the instance

Step 6: Terminate instance and delete the volume created

Connecting to EC2

- There are several ways to connect to an EC2 instance once it’s launched.
- **Remote Desktop Connection** is the standard way to connect to Windows instances.
- An **SSH client** (standalone or web-based) is used to connect to Linux instances.

Features of EC2

- Virtual Computing Environments, known as instances
- Preconfigured template for your instance is known as AMI
- Various configuration of CPU, memory, storage and network capacity is Instance type
- Secure login information for your instance using Key pairs

More Features of EC2

- Storage volumes for temporary data that's deleted when hardware fails or terminate your instance, known as instance store volumes
- Persistent storage volumes for your data using Amazon Elastic Block Store (Amazon EBS), known as Amazon EBS volumes
- A firewall that enables you to specify the protocols, ports, and source IP ranges that can reach your instances using security groups
- Metadata, known as tags, that you can create and assign to your Amazon EC2 resources

Intro to SG

A security group in the context of Amazon EC2 is essentially a virtual firewall that controls the traffic for one or more instances.

It acts as a virtual firewall for your EC2 instances to control incoming and outgoing traffic.

Key Points – SG

1. Traffic Control
2. Stateful
3. Flexible rule
4. Layer of Defense
5. Only allowed rules

EC2 Purchasing Option

1. On-Demand
2. Reserved
3. Spot
4. Dedicated

EC2 Purchasing Option

<u>On-Demand</u>

- Charged per second or hour of usage, offering maximum flexibility.
- **No upfront commitment:** Ideal for short-term workloads, testing, or unpredictable usage patterns.
- **Scalability:** Easily scale instances up or down based on real-time needs.
- **Availability:** Guaranteed instance availability within your chosen AWS region.

EC2 Purchasing Option

Reserved

- Offer significant discounts (up to 75%) compared to On-Demand pricing through a prepaid reservation for a specific instance type, region, and term (1 or 3 years).
- **Benefits:**
  - **Significant cost savings** for predictable, sustained workloads.
  - **Guaranteed capacity:** Ensures availability of the specified instance type during your reservation term.

EC2 Purchasing Option

Spot:

- Bid on spare EC2 capacity at significantly lower prices (up to 90% discount) compared to On-Demand Instances. The price fluctuates based on supply and demand.
- **Benefits:**
    - **Lowest cost option** for workloads that can tolerate interruptions.

EBS volume

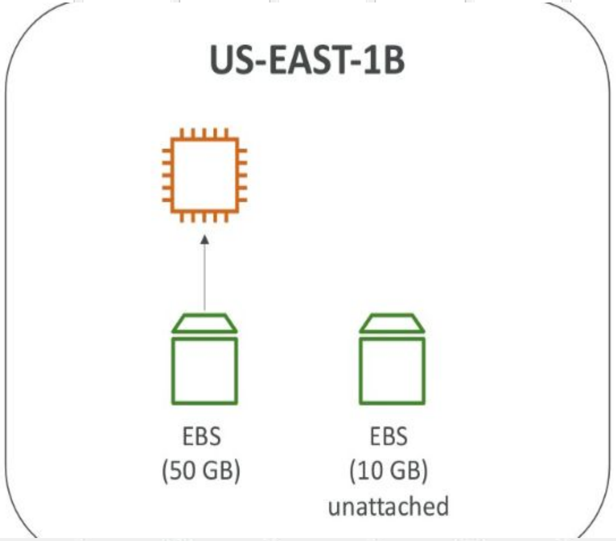
- EBS is drive that you attach when you run the machine/instance.
- Persist even after machine termination
- Can be mounted to one instance at a particular time
- Bound to AZ.

EBS volume– Benefits

- Data Persistence
- Scalability
- Backup and Recovery
- High Availability
- Performance

EBS volume– Key Info

- Restricted to 1 AZ
- It’s a N/W drive
- Costly as compared to other Storage services



EBS volume- Attach

- When you just wanna take the add volume which is available in nature.

EBS volume- Detach

- When you just wanna take the backup of data with volume being available then you can detach the volume.

EBS volume- Size Increase

- You can change size of EBS volume
- Only INCREASE possible
- Not decrease
- 1:1

Types of EBS volumes

Amazon EBS provides the following volume types, which differ in performance characteristics and price.

• SSD-backed volumes optimized for transactional workloads involving frequent read/write operations with small I/O size, where the dominant performance attribute is IOPS

• HDD-backed volumes optimized for large streaming workloads where throughput (measured in MiB/s) is a better performance measure than IOPS

Snapshot

- It acts like a frozen image of your data at a specific moment, allowing you to restore your data or create new EBS volumes from that saved state.
- Make a backup of EBS volume at that point of time
- Can be shared among AZ or Region.

Snapshot – Benefits

- Data Backup and Recovery
- Disaster Recovery
- Data Archiving
- Data Migration

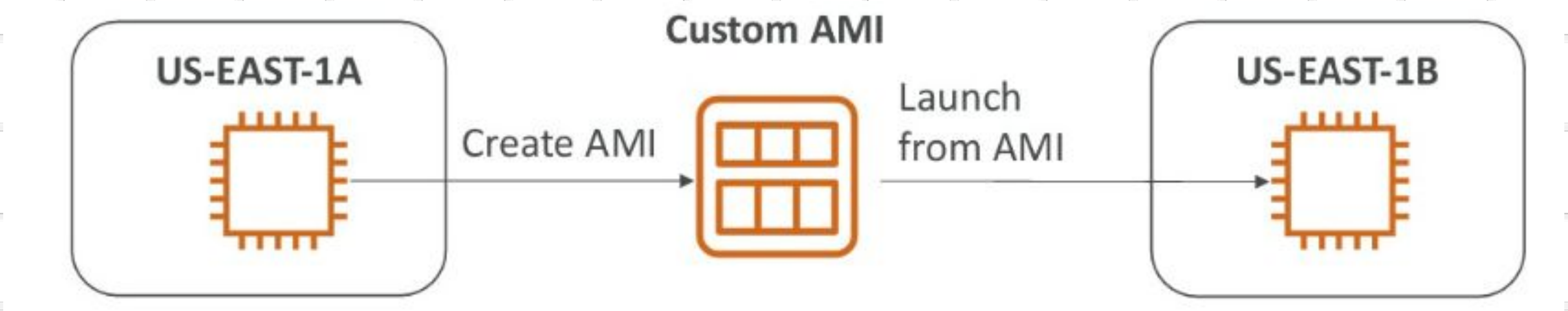
AMI

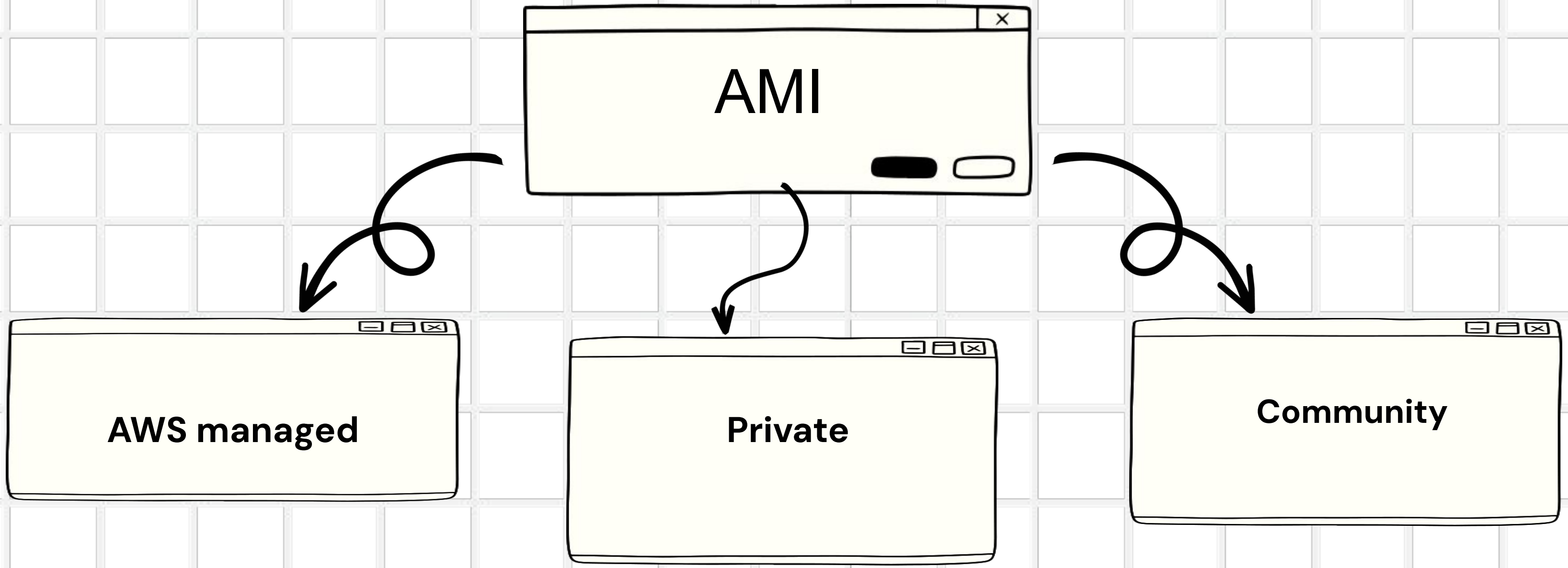
In Amazon Web Services (AWS), an Amazon Machine Image (AMI) acts as a template for creating virtual servers known as EC2 (Elastic Compute Cloud) instances. It essentially encapsulates the configuration of a server, including the operating system, applications, and settings.

Amazon Machine
Image (AMI)

Benefits

- Faster Deployments
- Consistency
- Repeatability
- Improved Manageability




AMI
AWS managed
Private
Community

Finding an Instance type

- Region
- The architecture: 32-bit (i386), 64-bit (x86_64)
- Compute
- Memory
- Storage
- Network performance

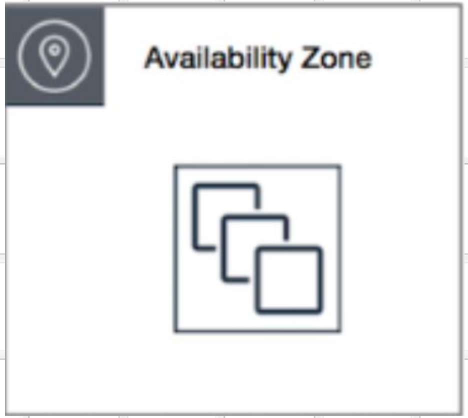
○ Changing the Instance type

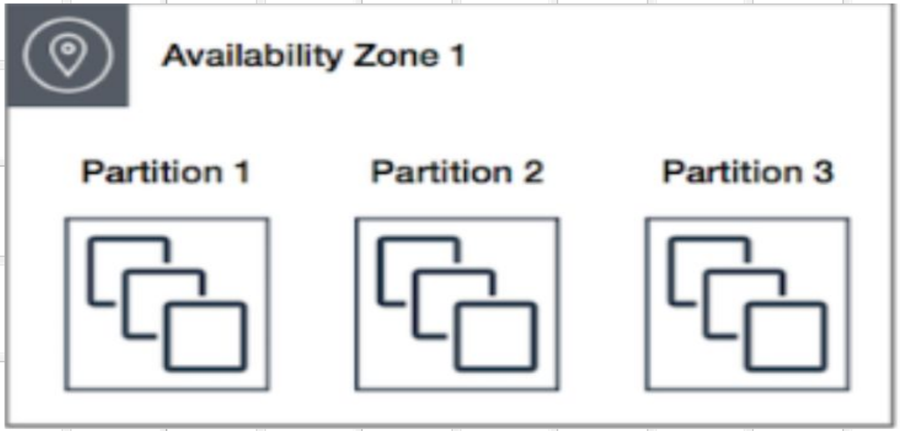
- As your needs change, you might find that your instance is over-utilized or underutilized.
- For example, if your t2.micro instance is too small for its workload, you can change it to another instance type that is appropriate for the workload.
- You might also want to migrate from a previous generation instance type to a current generation instance type to take advantage of some features; for example, support for IPv6.

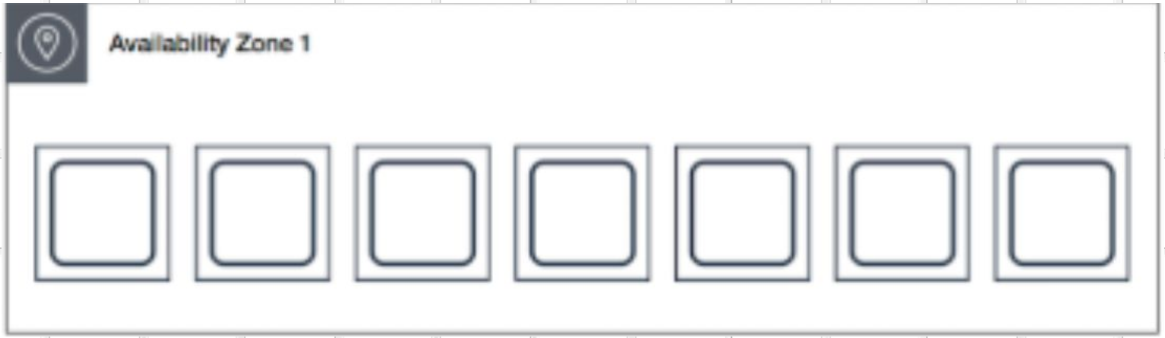
Placement Groups

You can launch or start instances in a placement group, which determines how instances are placed on underlying hardware. When you create a placement group, you can create one of the following strategies for the group:

- Cluster – clusters instances into a low-latency group in a single Availability Zone
- Partition – spreads instances across logical partitions, ensuring that instances in one partition do not share underlying hardware with instances in other partitions
- Spread – spreads instances across distinct underlying hardware

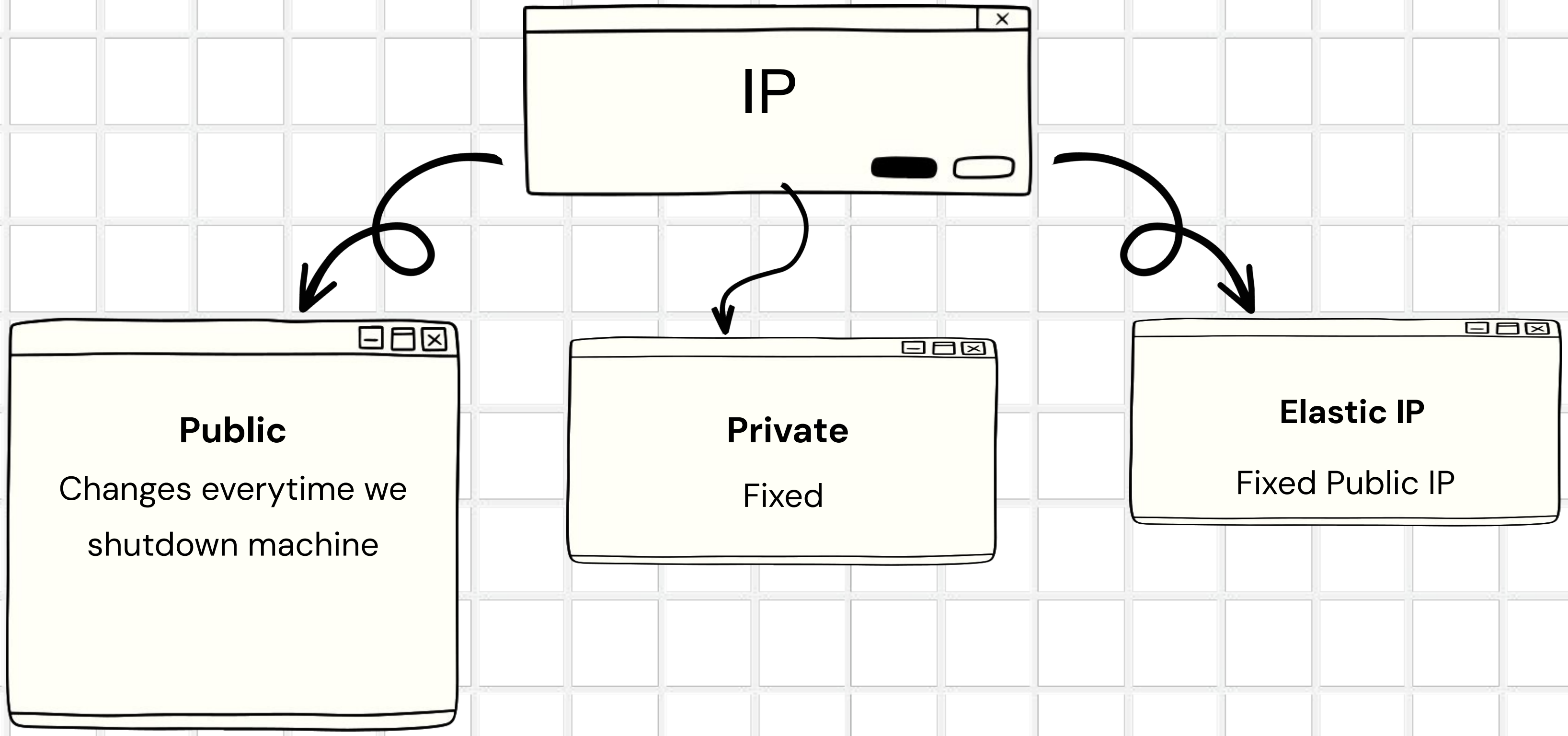

Availability Zone


Availability Zone 1
Partition 1
Partition 2
Partition 3


Availability Zone 1

Other Compute Services

- AWS LAMBDA
- AWS FARGATE


IP
Public
Changes everytime we shutdown machine
Private
Fixed
Elastic IP
Fixed Public IP

Public IP

- A public IP address is an IPv4 address that's reachable from the Internet. You can use public addresses for communication between your instances and the Internet.
- Each instance that receives a public IP address is also given an external DNS hostname; for example,ec2-203-0-113-25.compute-1.amazonaws.com.
- Changes on restart

Private IP

When EC2 instances are launched, the primary IP is
assigned a reserved private IP address
• The private IP address stays assigned to the network interface until it is deleted.
• It is not possible to remove or change the private IP address of the primary network
interface

Elastic IP

An Elastic IP address is a static IPv4 address designed for dynamic cloud computing.

- An Elastic IP address is associated with your AWS account.
- With an Elastic IP address, you can mask the failure of an instance or software by rapidly remapping the address to another instance in your account.
- An Elastic IP address is a public IPv4 address, which is reachable from the internet.

EFS

- Amazon EFS provides a simple, scalable, elastic file system for Linux-based workloads for use with AWS Cloud services and on-premises resources.
- It is built to scale on demand to petabytes without disrupting applications, growing and shrinking automatically as you add and remove files
- It is designed to provide massively parallel shared access to thousands of Amazon EC2 instances
- It is a fully managed service

EFS

- There is a Standard and an Infrequent Access storage class available with Amazon EFS using Lifecycle Management, files not accessed for 30 days will automatically be moved to a cost-optimized Infrequent Access storage class reducing cost up to 85%
- Amazon EFS is a regional service storing data within and across multiple Availability Zones (AZs) for high availability and durability.

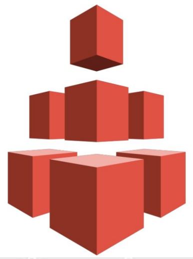
EFS vs EBS

Scalability:

- **EBS**: You can scale EBS volumes by attaching additional volumes to your EC2 instance or using larger volume sizes. However, scaling primarily involves individual instance storage capacity.
- **EFS**: EFS is inherently scalable. You can easily increase or decrease the storage capacity of your file system on demand to accommodate growing data needs.

Availability:

- **EBS**: EBS volumes are designed to be highly available within an Availability Zone. However, they are directly attached to a specific EC2 instance.
- **EFS**: EFS provides higher availability through its distributed architecture across multiple Availability Zones within a region. This ensures that file system access remains available even if a single Availability Zone encounters an outage.



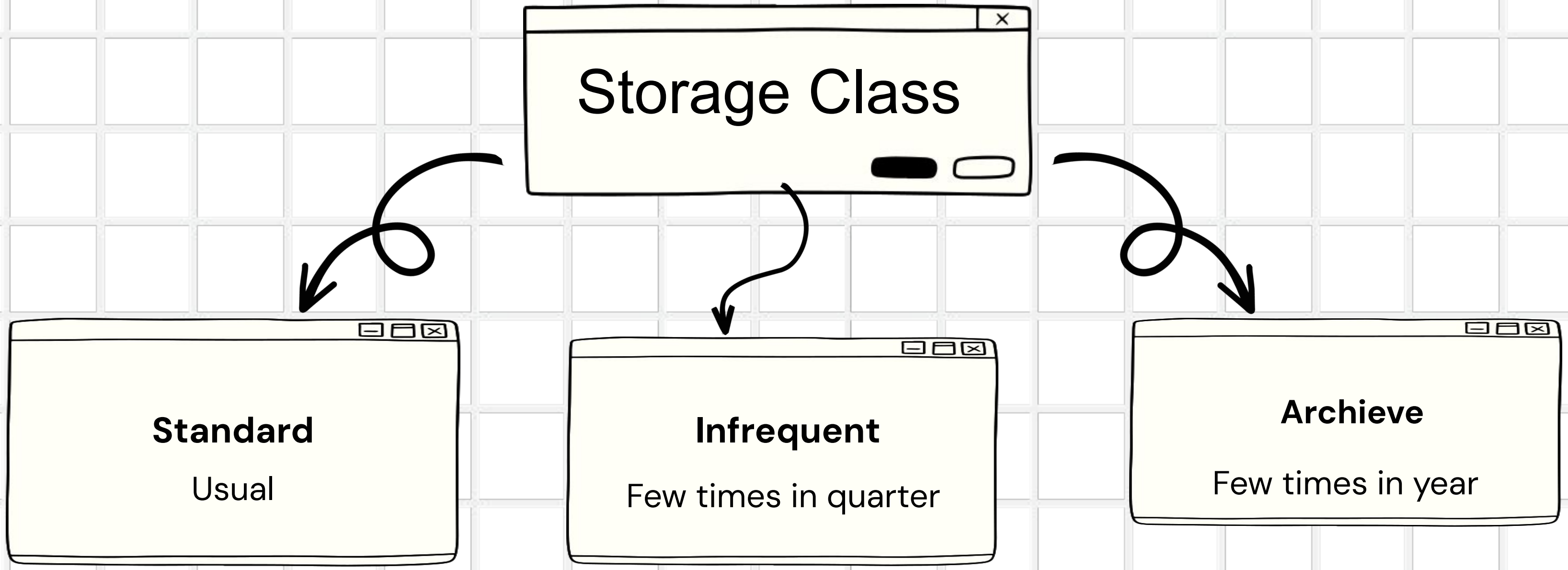
EFS vs EBS

Cost:

- **EBS:** EBS billing is based on the provisioned storage size (per GiB per month) and the type of volume (e.g., magnetic, SSD, NVMe SSD).
- **EFS:** EFS billing is based on the amount of data stored (per GiB per month) and the number of concurrent file operations (IOPS).

Performance:

- **EBS:** EBS offers high performance, making it suitable for applications requiring fast storage access, such as databases or applications working with large datasets.
- **EFS:** While EFS provides good performance, it might not match the raw speed of EBS due to its distributed nature. However, EFS scales well for concurrent access from multiple instances.

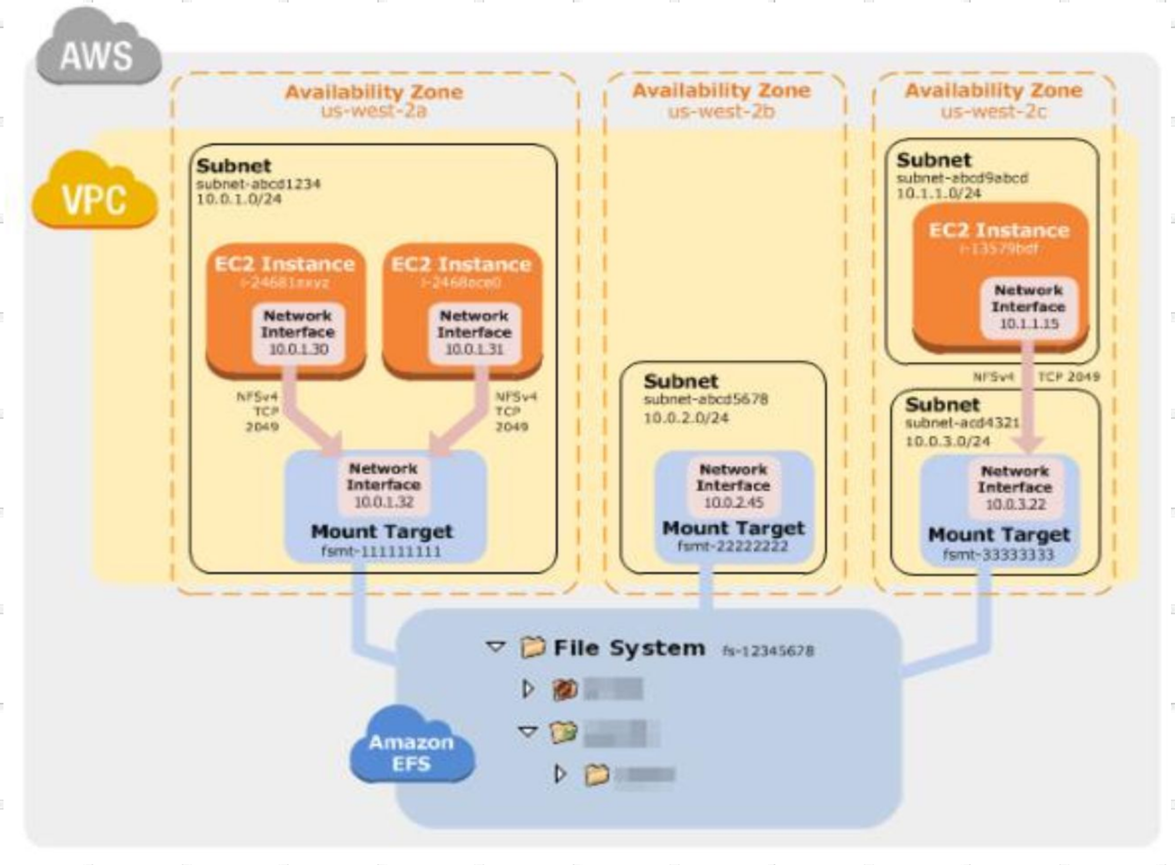

Storage Class
Standard
Usual
Infrequent
Few times in quarter
Archieve
Few times in year

EFS

- **Important**:

  Amazon EFS is not supported on Windows instances.

EFS


AWS
VPC
Availability Zone
us-west-2a
Availability Zone
us-west-2b
Availability Zone
us-west-2c
Subnet
subnet-abcd1234
10.0.1.0/24
EC2 Instance
i-24681axyz
Network Interface
10.0.1.30
EC2 Instance
i-2468ace0
Network Interface
10.0.1.31
NFSv4 TCP 2049
NFSv4 TCP 2049
Network Interface
10.0.1.32
Mount Target
fsmt-11111111
Subnet
subnet-abcd5678
10.0.2.0/24
Network Interface
10.0.2.45
Mount Target
fsmt-22222222
Subnet
subnet-abcd9abcd
10.1.1.0/24
EC2 Instance
i-13579bdf
Network Interface
10.1.1.15
NFSv4 TCP 2049
Subnet
subnet-acd4321
10.0.3.0/24
Network Interface
10.0.3.22
Mount Target
fsmt-33333333
File System fs-12345678
Amazon EFS

EFS–Benefits

- Dynamic elasticity
- Scalable performance
- Shared file storage
- Fully managed
- Cost effective – pay for what you use (no upfront capacity planning)
- Pricing

EFS–Use Cases

Amazon EFS is designed to meet the performance needs of the following use cases.

- Big Data and Analytics
- Media Processing Workflows
- Content Management and Web Serving
- Home Directories

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S3

- Amazon Simple Storage Service is storage for the Internet
- Amazon S3 has a simple web services interface that you can use to store and retrieve any amount of data, at any time, from anywhere on the web.

S3- Advantages

Amazon S3 is intentionally built with a minimal feature set that focuses on simplicity and robustness

- Creating buckets – Create and name a bucket that stores data. Buckets are the fundamental container in Amazon S3 for data storage.
- Storing data – Store an infinite amount of data in a bucket. Upload as many objects as you like into an Amazon S3 bucket. Each object can contain up to 5 TB of data.

S3– Advantages Cont.

- **Downloading data** – Download your data or enable others to do so. Download your data anytime you like, or allow others to do the same.

- **Permissions** – Grant or deny access to others who want to upload or download data into your Amazon S3 bucket.

S3– Use Cases

- Backup and Storage
- Disaster Recovery
- Archive
- Application Hosting
- Static Website

S3- Concepts

Buckets

- To upload your data (photos, videos, documents etc.) to Amazon S3, you must first create an S3 bucket in one of the AWS Regions.
- A bucket is a region specific
- A bucket is a container for objects stored in Amazon S3.

S3– Concepts Cont.

- Every object is contained in a bucket.

- By default, you can create up to 100 buckets in each of your AWS accounts. If you need more buckets, you can increase your account bucket limit to a maximum of 1,000 buckets by submitting a service limit increase.

- For example, if the object named photos/puppy.jpg is stored in the john bucket in the US West (Oregon) Region, then it is addressable using the URL https://john.s3.us-west-2.amazonaws.com/photos/puppy.jpg

S3– Buckets

- For Bucket name to be created, follow the naming guidelines

• Bucket name should be globally unique and the namespace is shared in all accounts. This means that after a bucket is created, the name of that bucket cannot be used by another AWS account in any AWS Region until the bucket is deleted.

• Once created it cannot be changed

S3– Buckets

• Bucket names must be at least 3 and no more than 63 characters long.
• Bucket names must not contain uppercase characters or underscores.
• Bucket names must start with a lowercase letter or number.
• Bucket names must not be formatted as an IP address (for example, 192.168.5.4).
• After you create the bucket, you cannot change the name, so choose wisely.
• Choose a bucket name that reflects the objects in the bucket because the bucket name is visible in the URL that points to the objects that you're going to put in your bucket.

S3– Regions

- You can choose the geographical AWS Region where Amazon S3 will store the buckets that you create.
- You might choose a Region to optimize latency, minimize costs, or address regulatory requirements.
- Objects stored in a Region never leave the Region unless you explicitly transfer them to another Region.
- For example, objects stored in the Europe (Ireland) Region never leave it.

S3- Objects

- Amazon S3 is a simple key, value store designed to store as many objects as you want.
- You store these objects in one or more buckets.
- S3 supports object level storage i.e., it stores the file as a whole and does not divide them
- An object size can be in between 0 KB and 5 TB
- When you upload an object in a bucket, it replicates itself in multiple availability zones in the same region

S3- Objects Cont.

An object consists of the following:

- Key – The name that you assign to an object.
- Version ID – Within a bucket, a key and version ID uniquely identify an object.
- Value – The content that you are storing.
- Metadata – A set of name-value pairs with which you can store information regarding the object.

S3– Objects Versioning

- When you re-upload the same object name in a bucket, it replaces the whole object
- You can use versioning to keep multiple versions of an object in one bucket.
- For example, you could store my-image.jpg (version 1) and my-image.jpg (version 2) in a single bucket.
- Versioning protects you from the consequences of unintended overwrites and deletions.
- You must explicitly enable versioning on your bucket. By default, versioning is disabled.

Objects Versioning Cont.

- Regardless of whether you have enabled versioning, each object in your bucket has a version ID.
- If you have not enabled versioning, Amazon S3 sets the value of the version ID to null. If you have enabled versioning, Amazon S3 assigns a unique version ID value for the object.
- This functionality prevents you from accidentally overwriting or deleting objects and affords you the opportunity to retrieve a previous version of an object.

S3 logs

Server Access Logging

- Server access logging provides detailed records for the requests that are made to a bucket. Server access logs are useful for many applications.
- For example, access log information can be useful in security and access audits.
- Each access log record provides details about a single access request, such as the requester, bucket name, request time, request action, response status, and an error code, if relevant.
- Both the source and target S3 buckets must be owned by the same AWS account, and the S3 buckets must both be in the same Region.

S3 Encryption

Server Side

Client Side

S3 Encryption

Data protection refers to protecting data while in-transit (as it travels to a from Amazon S3) and at rest (while it is stored on disks in Amazon S3 data centers). You have the following options for protecting data at rest in Amazon S3:

- Server-Side Encryption – Request Amazon S3 to encrypt your object before saving it on disks in its data centers and then decrypt it when you download the objects.
- Client-Side Encryption – Encrypt data client-side and upload the encrypted data to Amazon S3. In this case, you manage the encryption process, the encryption keys, and related tools.

S3 Server Side Encryption

Server Side Encryption

- Server-side encryption is the encryption of data at its destination by the application or service that receives it.
- Amazon S3 encrypts your data at the object level as it writes it to disks in its data centers and decrypts it for you when you access it.
- As long as you authenticate your request and you have access permissions, there is no difference in the way you access encrypted or unencrypted objects.

SSE–S3

Server-Side Encryption with Amazon S3-Managed Keys (SSE-S3)

- When you use Server-Side Encryption with Amazon S3-Managed Keys (SSE-S3), each object is encrypted with a unique key.
- As an additional safeguard, it encrypts the key itself with a master key that it regularly rotates.

SSE-KMS

Server-Side Encryption with Customer Master Keys (CMKs) Stored in AWS Key Management Service (SSE-KMS)

- Server-Side Encryption with Customer Master Keys (CMKs) Stored in AWS Key Management Service (SSE-KMS) is similar to SSE-S3, but with some additional benefits and charges for using this service.

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SSE–C

Server-Side Encryption with Customer-Provided Keys (SSE-C)

- With Server-Side Encryption with Customer-Provided Keys (SSE-C), you manage the encryption keys and Amazon S3 manages the encryption, as it writes to disks, and decryption, when you access your objects.

Client Side Encryption

Client-side encryption is the act of encrypting data before sending it to Amazon S3. To enable client-side encryption, you have the following options:

- Use a customer master key (CMK) stored in AWS Key Management Service (AWS KMS).
- Use a master key you store within your application.

Static Website Hosting

- You can host a static website on Amazon S3. On a static website, individual web pages include static content.
- To host a static website, you configure an Amazon S3 bucket for website hosting and then upload your website content to the bucket.
- This bucket must have public read access. It is intentional that everyone in the world will have read access to this bucket.

Static Website Hosting

- Depending on your Region, Amazon S3 website endpoints follow one of these two formats:

- http://bucket-name.s3-website.Region.amazonaws.com
- http://bucket-name.s3-website-Region.amazonaws.com
- This above URL will return the default index document that you configured for the website.

Static Website Hosting

1. Public access to bucket
2. ACL enabled
3. Public access in object

Storage Class

- Each object in Amazon S3 has a storage class associated with it.
- Amazon S3 offers a range of storage classes for the objects that you store.
- You choose a class depending on your use case scenario and performance access requirements. All of these storage classes offer high durability.

Storage Classes– Frequent

For performance-sensitive use cases (those that require millisecond access time) and frequently accessed data, Amazon S3 provides the following storage class

- **Standard**—The default storage class. If you don't specify the storage class when you upload an object, Amazon S3 assigns the Standard storage class.

Storage Classes- Infrequent

- **The Standard_IA and Onezone_IA** storage classes are designed for long-lived and infrequently accessed data
- Standard_IA and Onezone_IA objects are available for millisecond access (similar to the Standard storage class)
- Amazon S3 charges a retrieval fee for these objects, so they are most suitable for infrequently accessed data.
- The Standard_IA and Onezone_IA storage classes are suitable for objects larger than 128KB that you plan to store for at least 30 days. If an object is less than 128 KB, Amazon S3 charges you for 128 KB.
- Onezone_IA - Amazon S3 stores the object data in only one Availability Zone, which makes it less expensive than Standard_IA

Storage Classes– Archive

-The Glacier and Deep Archive storage classes are designed for low-cost data archiving

Glacier

- Long-term data archiving with retrieval times ranging from minutes to hours
- It has minimum storage duration period of 90 days
- If you have deleted, overwritten, or transitioned to a different storage class an object before the 90-day minimum, you are charged for 90 days.

Storage Classes- Archive

Glacier Deep Archive

- Archiving rarely accessed data with a default retrieval time of 12 hours
- It has minimum storage duration period of 180 days
- If you have deleted, overwritten, or transitioned to a different storage class an object

before the 180-day minimum, you are charged for 180 days.

Storage Classes- Auto Optimizes

- The Intelligent_Tiering storage class is designed to optimize storage costs by automatically moving data to the most cost-effective storage access tier, without performance impact or operational overhead.
- Intelligent_Tiering delivers automatic cost savings by moving data on a granular object level between two access tiers, when access patterns change
- Frequent access tier
- Lower-cost infrequent access tier

Object Lifecycle

- To manage your objects so that they are stored cost effectively throughout their lifecycle, configure their lifecycle.
- A lifecycle configuration is a set of rules that define actions that Amazon S3 applies to a group of objects.

There are two types of actions
Transition actions—Define when objects transition to another storage class.
Expiration actions—Define when objects expire. Amazon S3 deletes expired objects on yourbehalf.

Replication

- Replication enables automatic, asynchronous copying of objects across Amazon S3 buckets.
- Buckets that are configured for object replication can be owned by the same AWS account or by different accounts.
- You can copy objects between different AWS Regions or within the same Region.

Types of Object Replication

You can replicate objects between different AWS Regions or within the same AWS Region.

1. Cross-Region replication (CRR) is used to copy objects across Amazon S3 buckets in different AWS Regions.
2. Same-Region replication (SRR) is used to copy objects across Amazon S3 buckets in the same AWS Region.

S3 Delete Bucket

- You can delete the objects individually. Or you can empty a bucket, which deletes all the objects in the bucket without deleting the bucket.
- You can also delete a bucket and all the objects contained in the bucket.
- If you want to use the same bucket, don't delete the bucket, can empty the bucket and keep it.
- After you delete the bucket, It is available for re-use, but the name might not be available for you to reuse for various reasons. For example, it might take some time before the name can be reused, and some other account could create a bucket with that name before you do.

VPC

VPC

- Amazon Virtual Private Cloud (Amazon VPC) enables you to launch AWS resources into a virtual network that you've defined.
- A virtual private cloud (VPC) is a virtual network dedicated to your AWS account.
- It is logically isolated from other virtual networks in the AWS Cloud.
- You can launch your AWS resources, such as Amazon EC2 instances, into your VPC.

VPC

- You can specify an IP address range for the VPC, add subnets, associate security groups, and configure route tables.
- A VPC spans all the Availability Zones in the region.
- After creating a VPC, you can add one or more subnets in each Availability Zone.
- Each subnet must reside entirely within one Availability Zone and cannot span zones.

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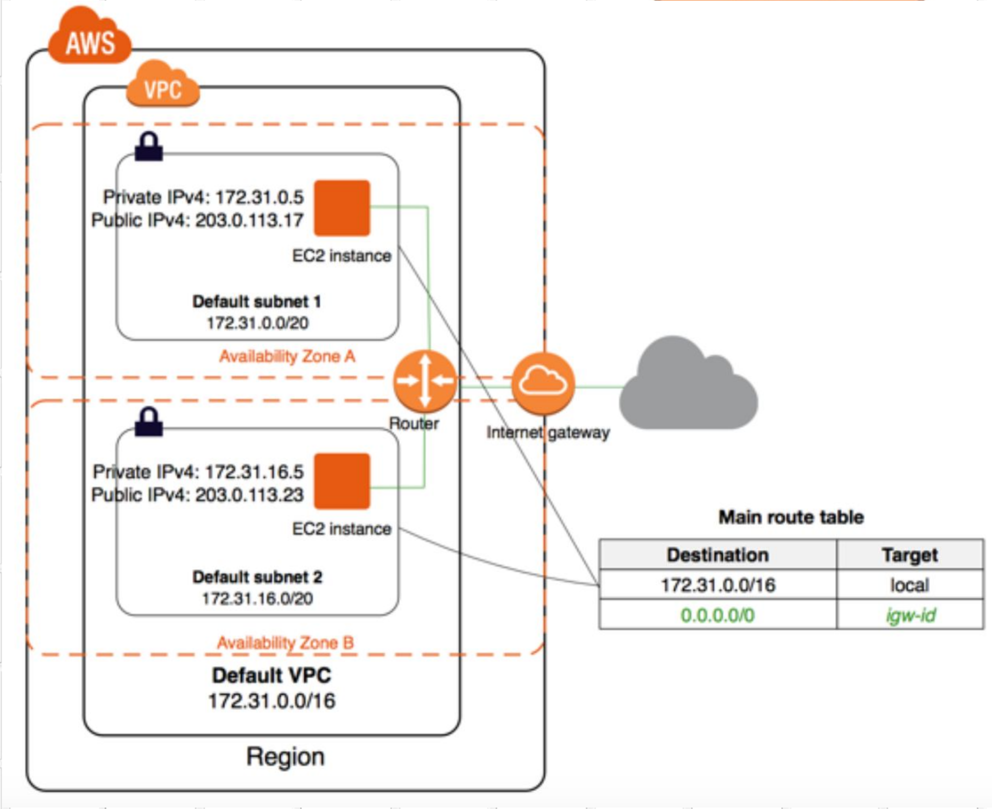
Default vs Custom VPC

- If your account supports the EC2-VPC platform only, it comes with a default VPC that has a default subnet in each Availability Zone.
- A default VPC has the benefits of the advanced features provided by EC2-VPC, and is ready for you to use. If you have a default VPC and don't specify a subnet when you launch an instance, the instance is launched into your default VPC. You can launch instances into your default VPC without needing to know anything about Amazon VPC.
- Regardless of which platforms your account supports, you can create your own VPC, and configure it as you need. This is known as a non-default VPC. Subnets that you create in your non-default VPC and additional subnets that you create in your default VPC are called non-default subnets.

Accessing the Internet

- Your default VPC includes an internet gateway, and each default subnet is a public subnet. Each instance that you launch into a default subnet has a private IPv4 address and a public IPv4 address. These instances can communicate with the internet through the internet gateway.



Destination	Target
172.31.0.0/16	local
0.0.0.0/0	*igw-id*

VPC and Subnet

- When you create a VPC, you must specify an IPv4 CIDR block for the VPC
- The allowed block size is between a /16 netmask (65,536 IP addresses) and /28 netmask (16 IP addresses)

- The CIDR block of a subnet can be the same as the CIDR block for the VPC, or a subset of the CIDR block for the VPC (for multiple subnets)

- The allowed block size for a subnet is between a /28 netmask and /16 netmask. If you create more than one subnet in a VPC, the CIDR blocks of the subnets cannot overlap.

Reserved IPs

- The first four IP addresses and the last IP address in each subnet CIDR block are not available for you to use, and cannot be assigned to an instance.
- For example, in a subnet with CIDR block 10.0.0.0/24, the following five IP addresses are reserved:

10.0.0.0: Network address.
10.0.0.1: Reserved by AWS for the VPC router.
10.0.0.2: Reserved by AWS for the IP address of the DNS server
10.0.0.3: Reserved by AWS for future use.
10.0.0.255: Network broadcast address. We do not support broadcast in a VPC

Public & Private Subnet

The instances in the public subnet can send outbound traffic directly to the Internet, whereas the instances in the private subnet can't. Instead, the instances in the private subnet can access the Internet by using a network address translation (NAT) gateway that resides in the public subnet.

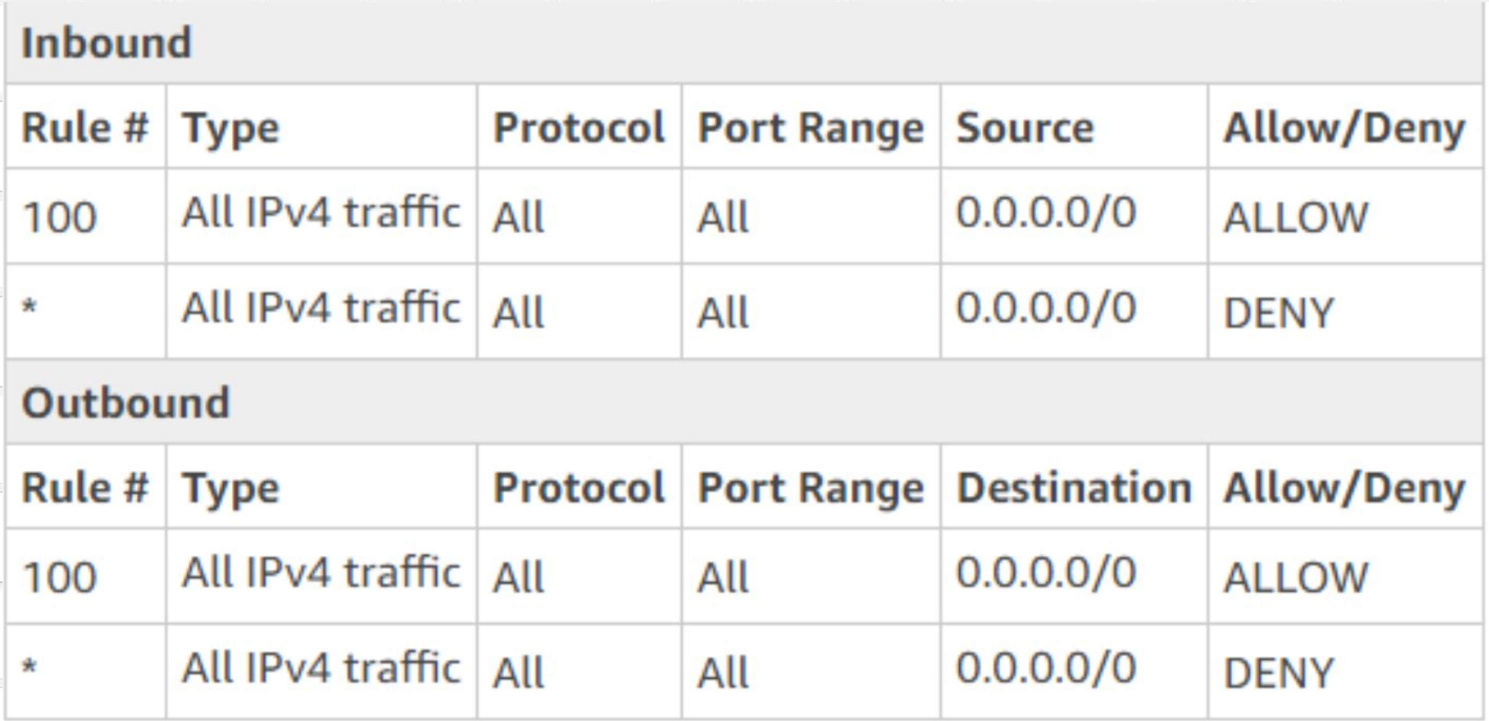
VPC Flow Logs

- VPC Flow Logs is a feature that enables you to capture information about the IP traffic going to and from network interfaces in your VPC.
- Flow log data can be published to Amazon CloudWatch Logs or Amazon S3
- You can create a flow log for a VPC, a subnet

NACl

- A network access control list (ACL) is an optional layer of security for your VPC that acts as a firewall for controlling traffic in and out of one or more subnets
- Each subnet in your VPC must be associated with a network ACL
- You can associate a network ACL with multiple subnets
- A subnet can be associated with only one network ACL at a time
- A network ACL has separate inbound and outbound rules, and each rule can either allow or deny traffic
- Network ACLs are stateless

NACl



Inbound					
Rule #	**Type**	**Protocol**	**Port Range**	**Source**	**Allow/Deny**
100	All IPv4 traffic	All	All	0.0.0.0/0	ALLOW
*	All IPv4 traffic	All	All	0.0.0.0/0	DENY
Outbound					
Rule #	**Type**	**Protocol**	**Port Range**	**Destination**	**Allow/Deny**
100	All IPv4 traffic	All	All	0.0.0.0/0	ALLOW
*	All IPv4 traffic	All	All	0.0.0.0/0	DENY

Route Tables

- A route table contains a set of rules, called routes, that are used to determine where network traffic from your subnet or gateway is directed.
- Main route table—The route table that automatically comes with your VPC. It controls the routing for all subnets that are not explicitly associated with any other route table.
- Custom route table—A route table that you create for your VPC.
- Each subnet in your VPC must be associated with a route table
- A subnet can only be associated with one route table at a time, but you can associate multiple subnets with the same subnet route table

Internet Gateway

- An internet gateway is a horizontally scaled, redundant, and highly available VPC component that allows communication between instances in your VPC and the internet.
- It therefore imposes no availability risks or bandwidth constraints on your network traffic.

NAT

- You can use a NAT device to enable instances in a private subnet to connect to the internet (for example, for software updates) or other AWS services, but prevent the internet from initiating connections with the instances. A NAT device forwards traffic from the instances in the private subnet to the internet or other AWS services, and then sends the response back to the instances.
- AWS offers two kinds of NAT devices
- NAT Gateway : You are charged for creating and using a NAT gateway in your account. NAT gateway hourly usage and data processing rates apply.
- NAT Instance - A NAT instance is launched from a NAT AMI

VPC Peering

- A VPC peering connection is a networking connection between two VPCs that enables you to route traffic between them privately.
- Instances in either VPC can communicate with each other as if they are within the same network.
- You can create a VPC peering connection between your own VPCs, with a VPC in another
AWS account, or with a VPC in a different AWS Region.
- AWS uses the existing infrastructure of a VPC to create a VPC peering connection; it is neither a gateway nor an VPN connection, and does not rely on a separate piece of physical hardware.
- There is no single point of failure for communication or a bandwidth bottleneck.

Direct Connect

- AWS Direct Connect is a cloud service solution that makes it easy to establish a dedicated network connection from your premises to AWS.
- Using AWS Direct Connect, you can establish private connectivity between AWS and your datacenter, which in many cases can reduce your network costs, increase bandwidth throughput, and provide a more consistent network experience than Internet-based connections.

Elastic
Load Balancer

ELB

Elastic
Load Balancer

- Elastic Load Balancing distributes incoming application or network traffic across multiple targets, such as Amazon EC2 instances, containers, and IP addresses, in multiple Availability Zones
- Elastic Load Balancing scales your load balancer as traffic to your application changes over time. It can automatically scale to the vast majority of workloads

ELB – Benefits

Elastic
Load Balancer

- A load balancer distributes workloads across multiple compute resources, such as virtual servers. Using a load balancer increases the availability and fault tolerance of your applications
- You can add and remove compute resources from your load balancer as your needs change, without disrupting the overall flow of requests to your applications
- You can configure health checks, which monitor the health of the compute resources, so that the load balancer sends requests only to the healthy ones

ELB – Need

Elastic
Load Balancer

- To distribute incoming application traffic
- To achieve fault tolerant
- To detect unhealthy instances
- Enable ELB within single and multiple availability zone

ELB – Nodes features

Elastic
Load Balancer

- When you enable an Availability Zone for your load balancer, Elastic Load Balancing creates a load balancer node in the Availability Zone
- Your load balancer is most effective when you ensure that each enabled Availability Zone has at least one registered target
- AWS recommend that you enable multiple Availability Zones
- This configuration helps ensure that the load balancer can continue to route traffic If one Availability Zone becomes unavailable or has no healthy targets, the load balancer can route traffic to the healthy targets in another Availability Zone

Cross-Zone Load Balancing

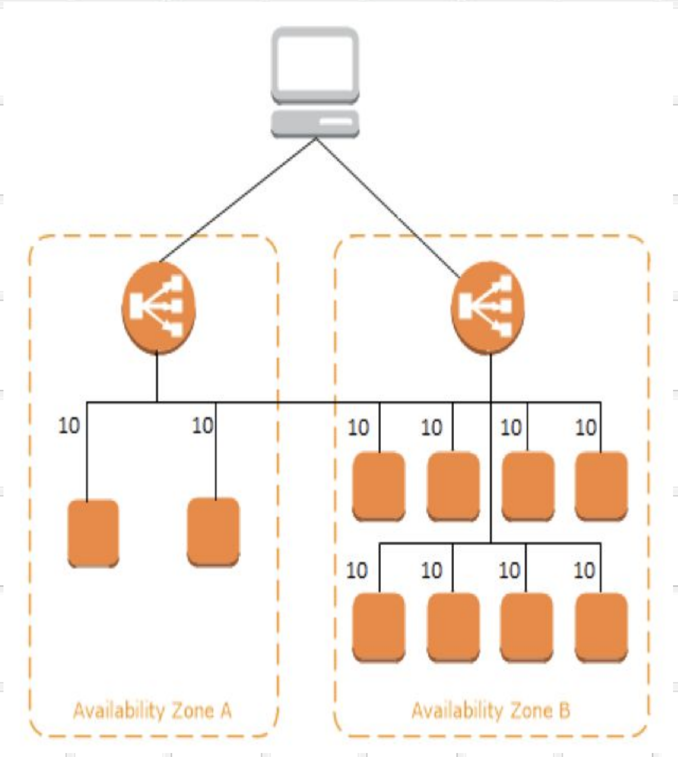
Elastic
Load Balancer

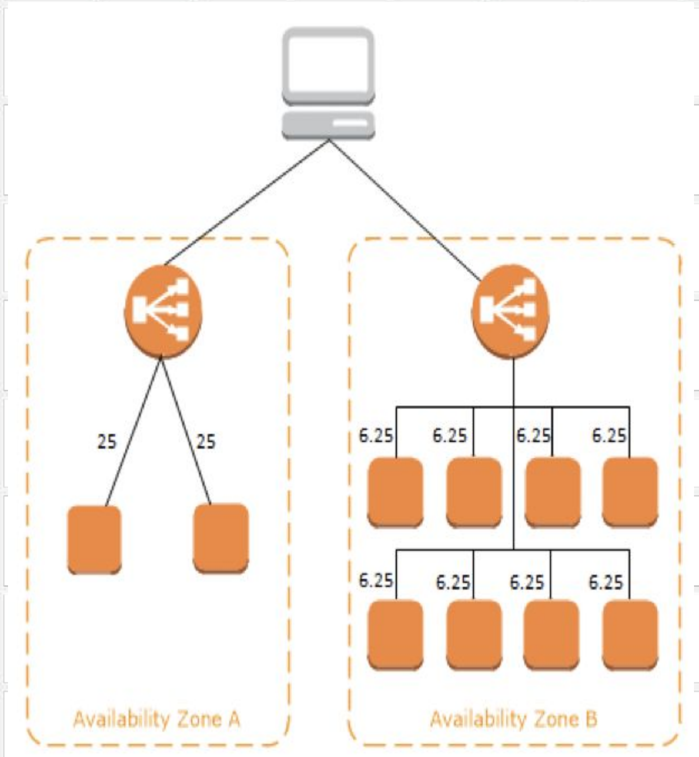
- The nodes for your load balancer distribute requests from clients to registered targets
- When cross-zone load balancing is enabled, each load balancer node distributes traffic across the registered targets in all enabled Availability Zones

- When cross-zone load balancing is disabled, each load balancer node distributes traffic only across the registered targets in its Availability Zone

Cross-Zone Load Balancing

Elastic
Load Balancer





Internet and Internal Load Balancer

Elastic
Load Balancer

When you create a load balancer in a VPC, you must choose whether to make it an internal load balancer or an Internet-facing load balancer.

- The nodes of an Internet-facing load balancer have public IP addresses
- The DNS name of an Internet-facing load balancer is publicly resolvable to the public IP addresses of the nodes. Therefore, Internet-facing load balancers can route requests from clients over the Internet
- The nodes of an internal load balancer have only private IP addresses

Internet and Internal Load Balancer

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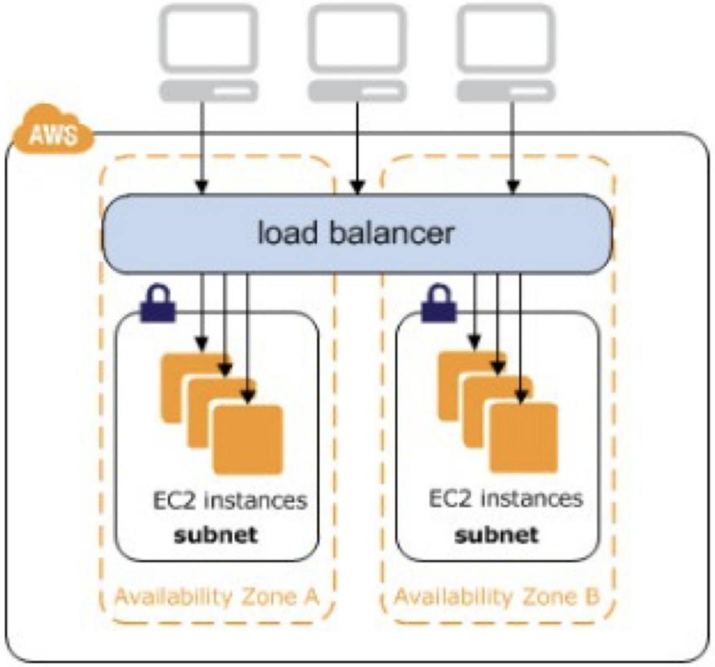
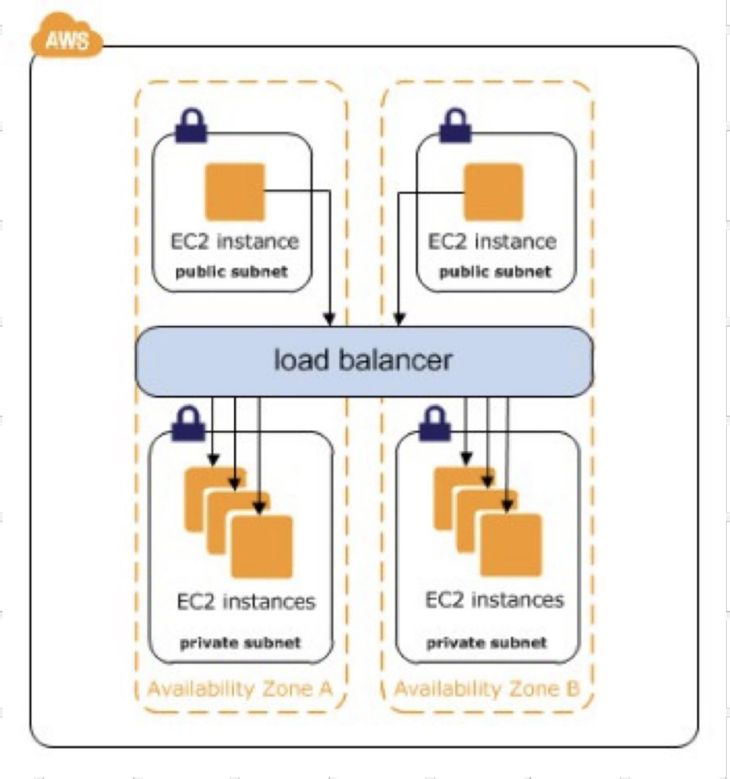
Internet Load Balancer

Elastic
Load Balancer



Internal Load Balancer

Elastic
Load Balancer



ELB – Types

Elastic
Load Balancer

Elastic Load Balancing supports three types of load balancers

- Application Load Balancers
- Network Load Balancers
- Classic Load Balancers
- Gateway Load Balancer

ELB – Classic

Elastic
Load Balancer

- Classic Load Balancer provides basic load balancing across multiple Amazon EC2 instances
- Classic Load Balancer is intended for applications that were built within the EC2-Classic network
- CLB send the requests directly to EC2 instances
- AWS recommend Application Load Balancer for Layer 7 and Network Load Balancer for Layer 4 when using Virtual Private Cloud (VPC)

ELB – Application

Elastic
Load Balancer

- A load balancer serves as the single point of contact for clients
- A listener checks for connection requests from clients, using the protocol and port that you configure, and forwards requests to one or more target groups, based on the rules that you define
- Each rule specifies a target group, condition, and priority. When the condition is met, the traffic is forwarded to the target group.
- An Application Load Balancer functions at the application layer, the seventh layer of the Open Systems Interconnection (OSI) model

ELB – Application

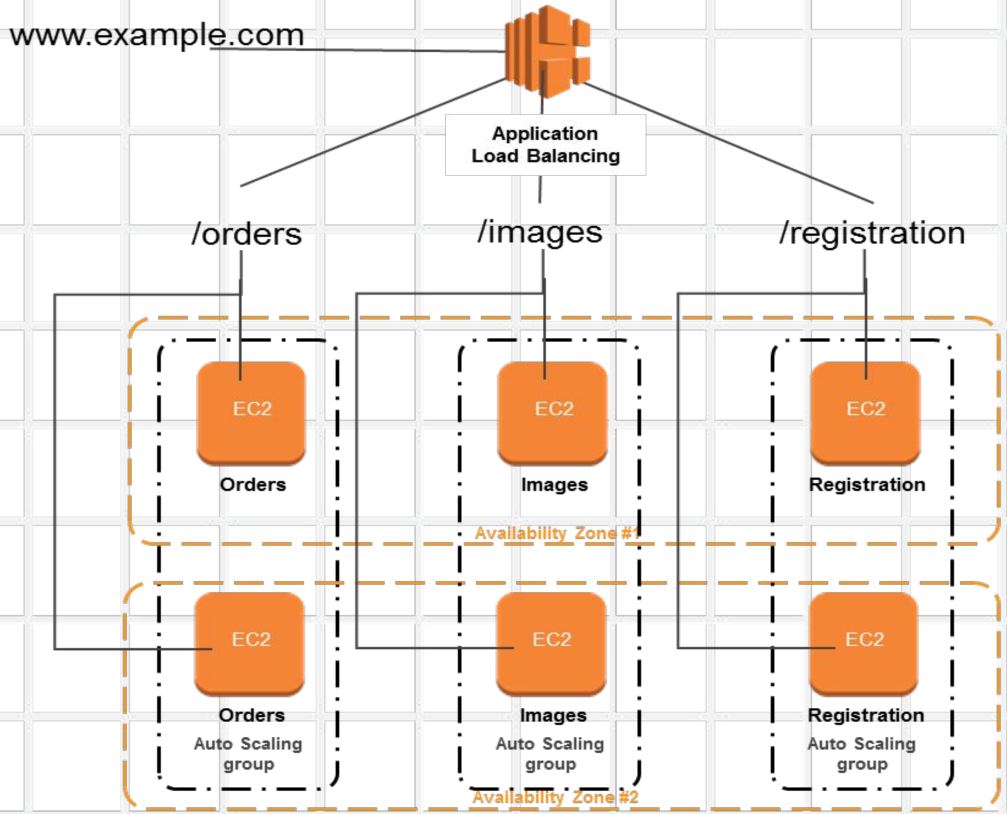
Elastic
Load Balancer

Features

- Content based routing
- Support for container based applications
- Better metrics
- Support for additional Protocols and Workloads

ELB – Application

Elastic
Load Balancer



ELB – Network

Elastic
Load Balancer

- ¯ It is designed to handle tens of millions of requests per second while maintaining high throughput at ultra low latency, with no effort on your part
- ¯ A Network Load Balancer functions at the fourth layer of the Open Systems Interconnection (OSI) model
- ¯ When you enable an Availability Zone for the load balancer, Elastic Load Balancing creates a load balancer node in the Availability Zone

ELB – Network

Elastic
Load Balancer

- ‾ Long-running Connections – NLB handles connections with built-in fault tolerance, and can handle connections that are open for months or years, making them a great fit for IoT, gaming, and messaging applications

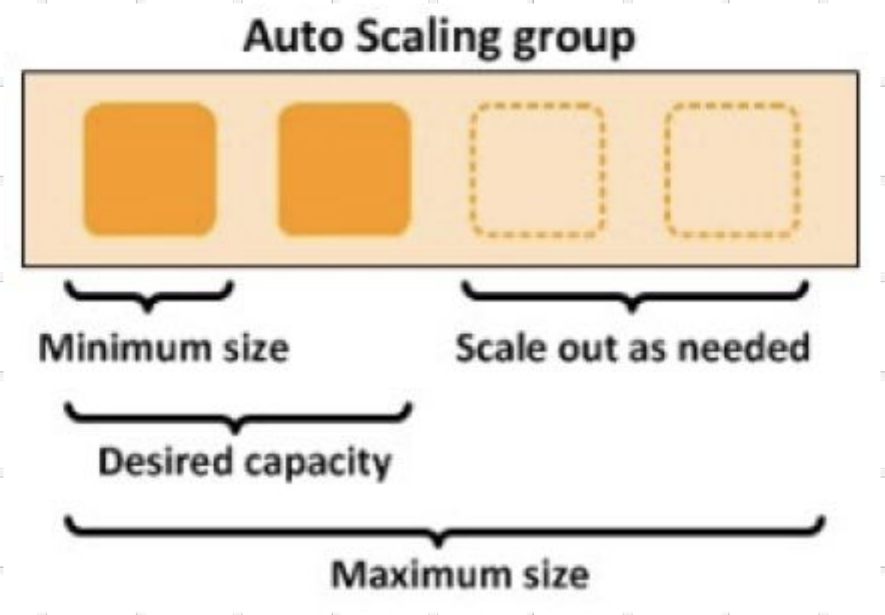
Benefits

- -Ability to handle volatile workloads and scale to millions of requests per second
- -Support for containerized applications
- -Support for monitoring the health of each service independently

Auto Scaling

- ¯ Amazon EC2 Auto Scaling helps you ensure that you have the correct number of Amazon EC2 instances available to handle the load for your application
- ¯ You create collections of EC2 instances, called *Auto Scaling groups*
- ¯ You can specify the minimum number of instances in each Auto Scaling group, and Amazon EC2 Auto Scaling ensures that your group never goes below this size
- ¯ You can specify the maximum number of instances in each Auto Scaling group, and Amazon EC2 Auto Scaling ensures that your group never goes above this size
- ¯ If you specify scaling policies, then Amazon EC2 Auto Scaling can launch or terminate instances as demand on your application increases or decreases

Auto Scaling



Auto Scaling – Benefits

- Setup Scaling quickly
- Make smart Scaling decisions
- Automatically maintain performance
- Pay only for what you need

Auto Scaling – Policies

- Simple Scaling Policy (Desired counts on particular threshold)
- Step Scaling Policy (More granular control)
- Target Scaling Policy (Dynamic in nature)

Launch Config/Template

- A launch configuration is an instance configuration template that an Auto Scaling group uses to launch EC2 instances
- When you create a launch configuration/template, you specify information for the instances which Include the ID of the Amazon Machine Image (AMI), the instance type, a key pair, one or more security groups, and a block device mapping
- If you've launched an EC2 instance before, you specified the same information in order to launch the instance

Launch Config/Template

- You can specify your launch configuration with multiple Auto Scaling groups. However, you can only specify one launch configuration for an Auto Scaling group at a time, and you can't modify a launch configuration after you've created it

- In launch template you can do make changes.

The 5 Pillars of the Framework in AWS

The Five Pillars of the Framework

- Creating a software system is a lot like constructing a building. If the foundation is not solid, structural problems can undermine the integrity and function of the building.
- When architecting technology solutions, if you neglect the five pillars of **operational excellence, security, reliability, performance efficiency, and cost optimization** it can become challenging to build a system that delivers on your expectations and requirements.
- Incorporating these pillars into your architecture will help you produce stable and efficient systems.

1. Operational Excellence

The Operational Excellence pillar includes the ability to run and monitor systems to deliver business value and to continually improve supporting processes and procedures.

The design principles for operational excellence in the cloud

- Perform operations as code
- Annotate documentation
- Make frequent, small, reversible changes
- Refine operations procedures frequently
- Anticipate failure
- Learn from all operational failures

2.Security

The Security pillar includes the ability to protect information, systems, and assets while delivering business value through risk assessments and mitigation strategies.

The design principles for security in the cloud:

- Enable traceability
- Apply security at all layers
- Automate security best practices
- Protect data in transit and at rest
- Prepare for security events

3. Reliability

The Reliability pillar includes the ability of a system to recover from infrastructure or service disruptions, dynamically acquire computing resources to meet demand, and mitigate disruptions such as misconfigurations or transient network issues.

The design principles for reliability in the cloud:

- Automatically recover from failure
- Scale horizontally to increase aggregate system availability
- Manage change in automation

4. Performance Efficiency

The Performance Efficiency pillar includes the ability to use computing resources efficiently to meet system requirements, and to maintain that efficiency as demand changes and technologies evolve.

The design principles for performance efficiency in the cloud:

- Democratize advanced technologies
- Go global in minutes
- Use serverless architectures
- Experiment more often
- Mechanical sympathy

5. Cost Optimization

The Cost Optimization pillar includes the ability to run systems to deliver business value at the lowest price point.

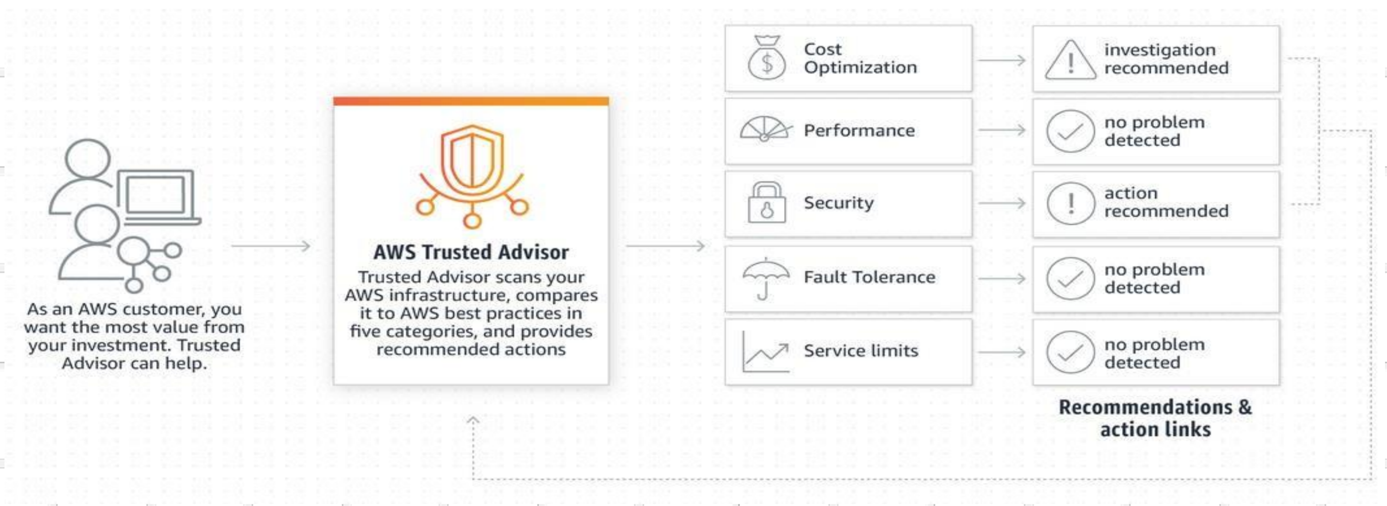
The design principles for cost optimization in the cloud:

- Adopt a consumption model:
- Measure overall efficiency
- Stop spending money on data center operations
- Analyze and attribute expenditure:
- Use managed and application level services to reduce cost of ownership

Trusted Advisor

Trusted Advisor

- AWS Trusted Advisor acts like your customized cloud expert, and it helps you provision your resources by following best practices.
- Trusted Advisor inspects your AWS environment and finds opportunities to save money, improve system performance and reliability, or help close security gaps.


As an AWS customer, you want the most value from your investment. Trusted Advisor can help.
AWS Trusted Advisor
Trusted Advisor scans your AWS infrastructure, compares it to AWS best practices in five categories, and provides recommended actions
Cost Optimization
Performance
Security
Fault Tolerance
Service limits
investigation recommended
no problem detected
action recommended
no problem detected
no problem detected
Recommendations & action links

Cost Optimization checks

- ✔ Low Utilization Amazon EC2 Instances : Checks the Amazon Elastic Compute Cloud (Amazon EC2) instances that were running at any time during the last 14 days and alerts you if the daily CPU utilization was 10% or less and network I/O was 5 MB or less on 4 or more days
- ✔ Underutilized Amazon EBS Volumes: Checks Amazon Elastic Block Store (Amazon EBS) volume configurations and warns when volumes appear to be underused
- ✔ Unassociated Elastic IP Addresses: Checks for Elastic IP addresses (EIPs) that are not associated with a running Amazon Elastic Compute Cloud (Amazon EC2) instance
- ✔ Amazon RDS Idle DB Instances: Checks the configuration of your Amazon Relational Database Service (Amazon RDS) for any DB instances that appear to be idle. If a DB instance has not had a connection for a prolonged period of time, you can delete the instance to reduce costs

Performance Checks

- ✔ High Utilization Amazon EC2 Instances: Checks the Amazon Elastic Compute Cloud (Amazon EC2) instances that were running at any time during the last 14 days and alerts you if the daily CPU utilization was more than 90% on 4 or more days

- ✔ Large Number of Rules in an EC2 Security Group: Checks each Amazon Elastic Compute Cloud (EC2) security group for an excessive number of rules. If a security group has a large number of rules, performance can be degraded

- ✔ Over utilized Amazon EBS Magnetic Volumes: Checks for Amazon Elastic Block Store (EBS) Magnetic volumes that are potentially over utilized and might benefit from a more efficient configuration

Security Checks

- ✔ Security Groups - Specific Ports Unrestricted: Checks security groups for rules that allow unrestricted access (0.0.0.0/0) to specific ports
- ✔ Amazon EBS Public Snapshots: Checks the permission settings for your Amazon Elastic Block Store (Amazon EBS) volume snapshots and alerts you if any snapshots are marked as public
- ✔ AWS CloudTrail Logging: Checks for your use of AWS CloudTrail. CloudTrail provides increased visibility into activity in your AWS account by recording information about AWS API calls made on the account

Fault Tolerance Checks

- ✔ Amazon EBS Snapshots: Checks the age of the snapshots for your Amazon Elastic Block Store (Amazon EBS) volumes (available or in-use)

- ✔ Amazon EC2 Availability Zone Balance: Checks the distribution of Amazon Elastic Compute Cloud (Amazon EC2) instances across Availability Zones in a region

- ✔ Amazon RDS Backups: Checks for automated backups of Amazon RDS DB instances

- ✔ Amazon RDS Multi-AZ: Checks for DB instances that are deployed in a single Availability Zone

- ✔ Amazon S3 Bucket Logging: Checks the logging configuration of Amazon Simple Storage Service (Amazon S3) buckets

Service Limit Checks

- ✔ EBS Active Snapshots: Checks for usage that is more than 80% of the EBS Active Snapshots Limit
- ✔ EC2 Elastic IP Addresses: Checks for usage that is more than 80% of the EC2 Elastic IP Addresses Limit
- ✔ RDS DB Instances: Checks for usage that is more than 80% of the RDS DB Instances Limit
- ✔ VPC: Checks for usage that is more than 80% of the VPC Limit
- ✔ VPC Internet Gateways: Checks for usage that is more than 80% of the VPC Internet Gateways Limit

Amazon
CloudTrail

Introduction to Cloud Trail

- AWS CloudTrail is an AWS service that helps you enable governance, compliance, and operational and risk auditing of your AWS account
- Actions taken by a user, role, or an AWS service are recorded as events in CloudTrail
- CloudTrail is enabled on your AWS account when you create it
- **<u>You can identify</u>**
  - who or what took which action
  - what resources were acted upon
  - when the event occurred
  - other details to help you analyze and respond to activity in your AWS account
- Can create 5 Trails per region (cannot be increased)

CloudTrail Concepts

CloudTrail Events

- An event in CloudTrail is the record of an activity in an AWS account
- This activity can be an action taken by a user, role, or service that is monitorable by CloudTrail
- There are two types of events that can be logged in CloudTrail
    - Management Events
    - Data Events
- By default, trails log management events, but not data events
- CloudTrail does not log all AWS services. Some AWS services do not enable logging of all APIs and events

Management Events

Management events provide information about management operations that are performed on resources in your AWS account. These are also known as control plane operations

- Example
    - Registering devices
    - Configuring rules for routing data

Data Events

Data events provide information about the resource operations performed on or in a resource. These are also known as data plane operations. Data events are often high-volume activities

- Example
    - Amazon S3 object-level API activity Data events are disabled by default when you create a trail. To record CloudTrail data events, you must explicitly add to a trail the supported resources or resource types for which you want to collect activity

Insights Events

CloudTrail Insights events capture unusual activity in your AWS account. If you have Insights events enabled, and CloudTrail detects unusual activity, Insights events are logged to a different folder or prefix in the destination S3 bucket for your trail

CloudTrail Event History

CloudTrail event history provides a viewable, searchable, and downloadable record of the past 90 days of CloudTrail events. You can use this history to gain visibility into actions taken in your AWS account in the AWS Management Console, AWS SDKs, command line tools, and other AWS services

Encryption

- By default, AWS CloudTrail encrypts all log files delivered to your specified Amazon S3 bucket using Amazon S3 server-side encryption (SSE)
- Optionally, can add a layer of security to your CloudTrail log files by encrypting the log files with your AWS Key Management Service (AWS KMS) key

Cloudwatch

Introduction to Cloud Watch

- Amazon Cloudwatch monitors your Amazon Web Services (AWS) resources and the applications you run on AWS in real time
- The Cloudwatch home page automatically displays metrics about every AWS service you use
- You can additionally create custom dashboards to display metrics about your custom applications by installing the CloudWatch agent on the instance/server

Introduction to Cloud Watch

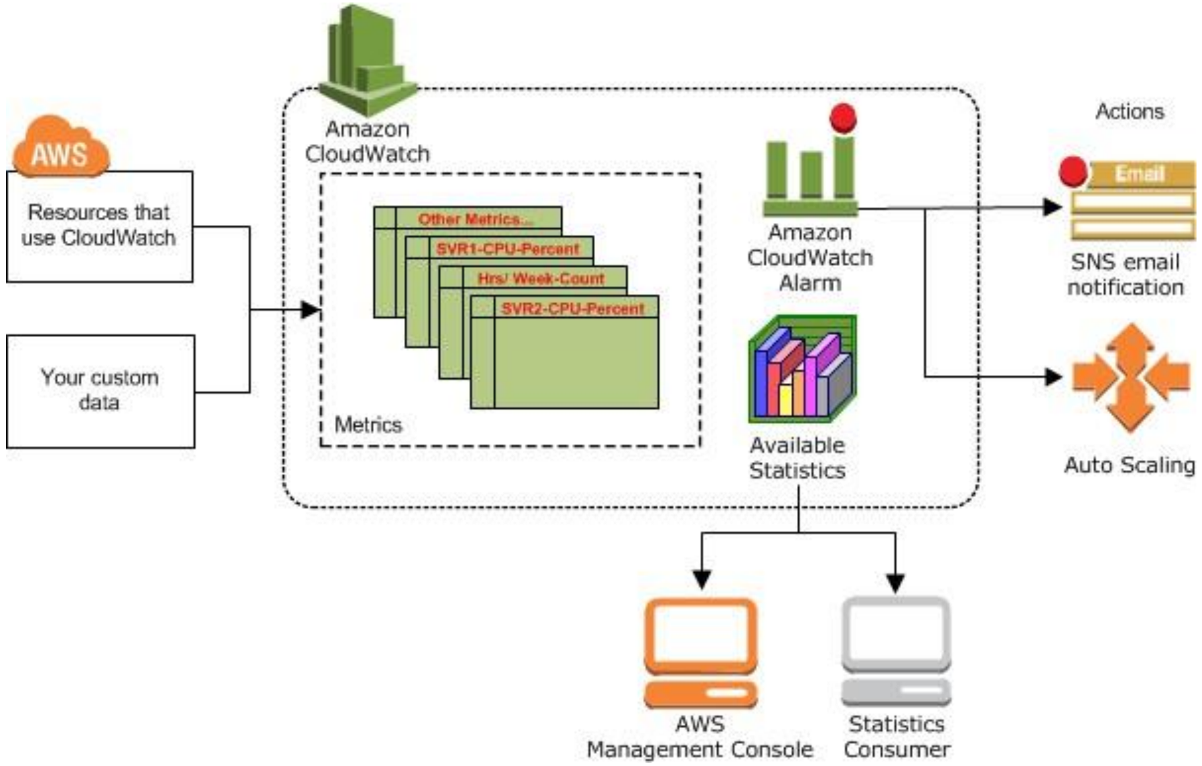
- You can create alarms which watch metrics and send notifications or automatically make changes to the resources you are monitoring when a threshold is breached
    - For example, you can monitor the CPU usage and disk reads and writes of your Amazon EC2 instances and then use this data to determine whether you should launch additional instances to handle increased load. You can also use this data to stop under-used instances to save money
- With Cloudwatch, you gain system-wide visibility into resource utilization, application performance, and operational health

AWS Services which are integrated with Cloud watch

- Amazon Simple Notification Service (Amazon SNS)
- Amazon EC2 Auto Scaling
- AWS CloudTrail
- AWS Identity and Access Management (IAM)

How Amazon Cloudwatch Works

- Amazon Cloudwatch is basically a metrics repository
- An AWS service—such as Amazon EC2—puts metrics into the repository, and you retrieve statistics based on those metrics
- If you put your own custom metrics into the repository, you can retrieve statistics on these metrics as well
- You can use metrics to calculate statistics and then present the data graphically in the Cloudwatch console
- You can configure alarm actions to stop, start, or terminate an Amazon EC2 instance when certain criteria are met
    - In addition, you can create alarms that initiate Amazon EC2 Auto Scaling and Amazon Simple Notification Service (Amazon SNS) actions on your behalf


AWS
Resources that use CloudWatch
Your custom data
Amazon CloudWatch
Other Metrics...
SVR1-CPU-Percent
Hrs/ Week-Count
SVR2-CPU-Percent
Metrics
Amazon CloudWatch Alarm
Available Statistics
Actions
Email
SNS email notification
Auto Scaling
AWS Management Console
Statistics Consumer

Cloudwatch Concepts

Metric

- *Metrics* are the fundamental concept in Cloudwatch
- A metric represents a time-ordered set of data points that are published to Cloudwatch
- Think of a metric as a variable to monitor, and the data points as representing the values of that variable over time
- For example, the CPU usage of a particular EC2 instance is one metric provided by Amazon EC2. The data points themselves can come from any application or business activity from which you collect data
- By default, several services provide free metrics for resources (such as Amazon EC2 instances, Amazon EBS volumes, and Amazon RDS DB instances). You can also enable detailed monitoring for some resources

Alarm

- You can create a CloudWatch alarm that watches a single CloudWatch metric
- The alarm performs one or more actions based on the value of the metric or expression relative to a threshold over a number of time periods.
- The action can be an Amazon EC2 action, an Amazon EC2 Auto Scaling action, or a notification sent to an Amazon SNS topic.
- You can also add alarms to CloudWatch dashboards and monitor them visually.
- When an alarm is on a dashboard, it turns red when it is in the ALARM state, making it easier for you to monitor its status proactively.
- After an alarm invokes an action due to a change in state, its subsequent behavior depends on the type of action that you have associated with the alarm.

An alarm has the following possible 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, or not enough data is available for the metric to determine the alarm state.

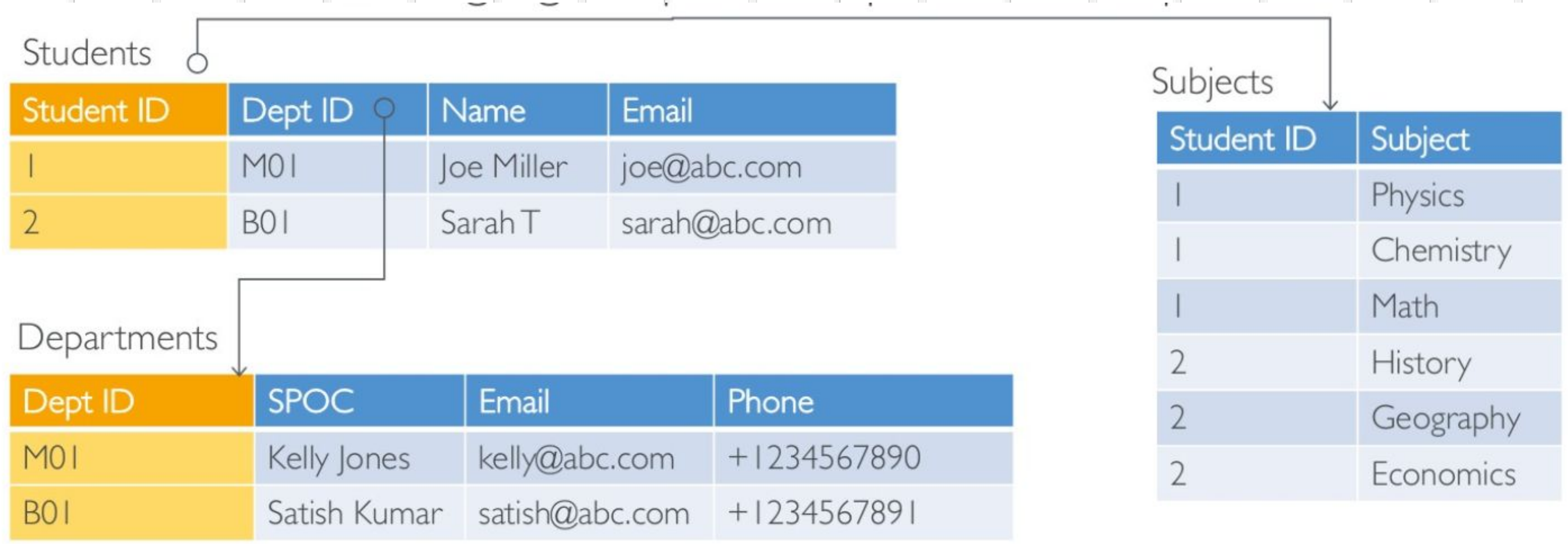
DATABASE
BIG DATA
VOLUME
SETS
SOCIAL
TECHNOLOGY
VIRTUAL
NAS
SAN
INTERNET
SEARCH
LARGE
STORAGE
INFORMATION
PETABYTES
ANALYSIS
MILLION
FUTURE
SOFTWARE
MANAGEMENT
TECHNOLOGIES
RESEARCH
SCIENCE
NEW
WORLD
EXABYTES
DEVELOPMENT
GOVERNMENT
PROCESS
SIZE

Database services of AWS

1. **Relational**

Used for: Traditional applications, ERP, CRM, and e-commerce.

AWS Offerings
Amazon RDS
Aurora
Amazon Redshift



Students

Student ID	Dept ID	Name	Email
1	M01	Joe Miller	joe@abc.com
2	B01	Sarah T	sarah@abc.com

Subjects

Student ID	Subject
1	Physics
1	Chemistry
1	Math
2	History
2	Geography
2	Economics

Departments

Dept ID	SPOC	Email	Phone
M01	Kelly Jones	kelly@abc.com	+1234567890
B01	Satish Kumar	satish@abc.com	+1234567891

Amazon
RDS

Relational Database Services

Introduction to Amazon RDS

- Easy to set up, operate, and scale a relational database in the cloud.
- Provides cost-efficient and resizable capacity while automating time-consuming administration tasks such as hardware provisioning, database setup, patching and backups.
- Makes to focus on your applications so you can give them the fast performance, high availability, security and compatibility they need.
- Primary use case is a transactional database (rather than analytical)

Why Managed RDS vs On Servers

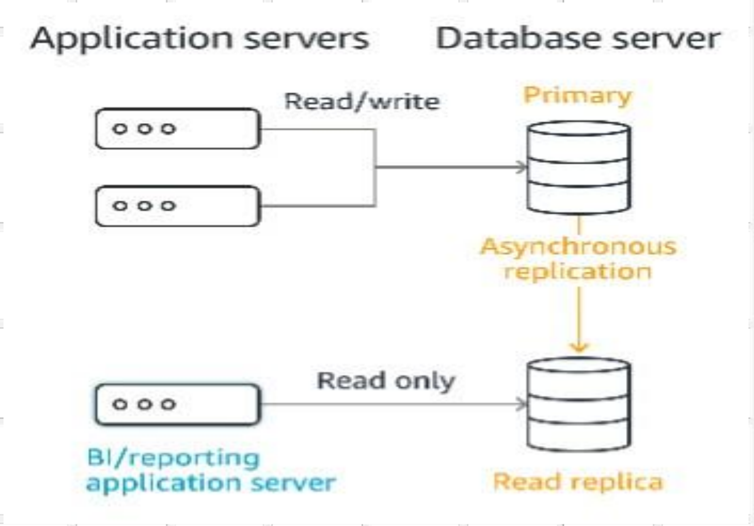
- Automated Scaling
- Easy to administer
- Highly scalable
- Available and durable
- Fast
- Secure
- Inexpensive
- Automated and Manuals Backups

Different types of database engines supported in AWS RDS

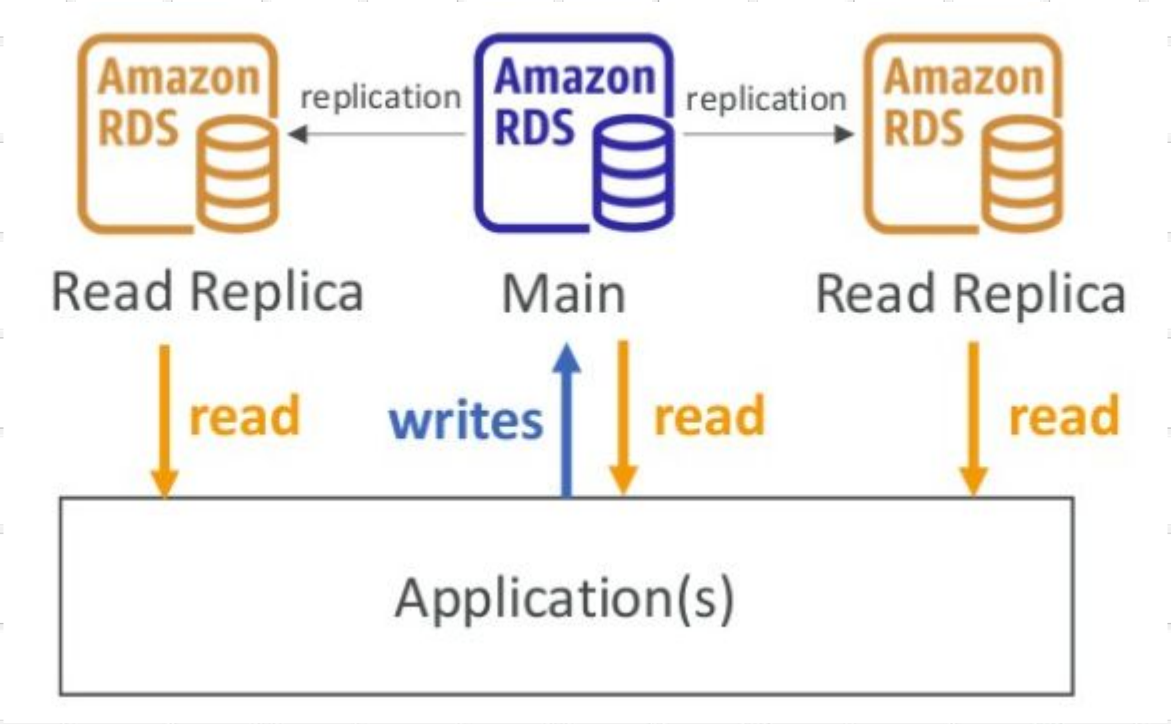
- MySQL
- Maria DB
- PostgreSQL
- Oracle
- Microsoft SQL Server DB engines
- Amazon Aurora

Database Read replicas

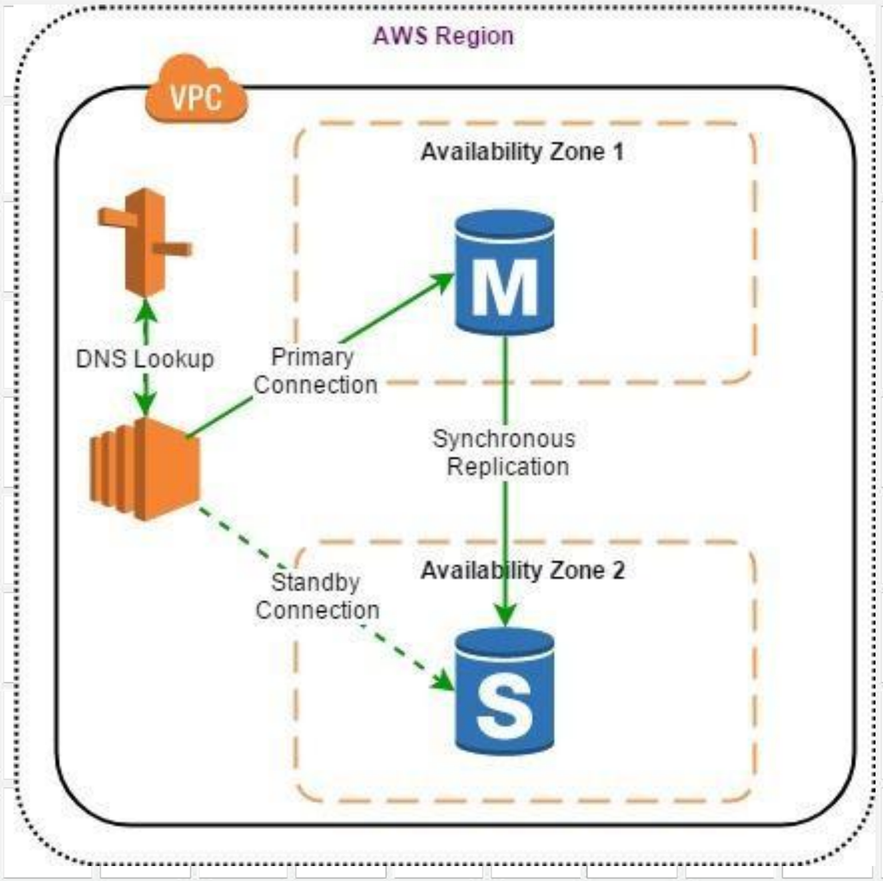
- When the required read I/O capacity is reached but still more I/O capacity is required for heavy/intensive read applications, RDS read replicas can be helpful
- A read replica is a replica of the primary database that can be used only for read actions



Read Replicas



Multi-AZ Deployment

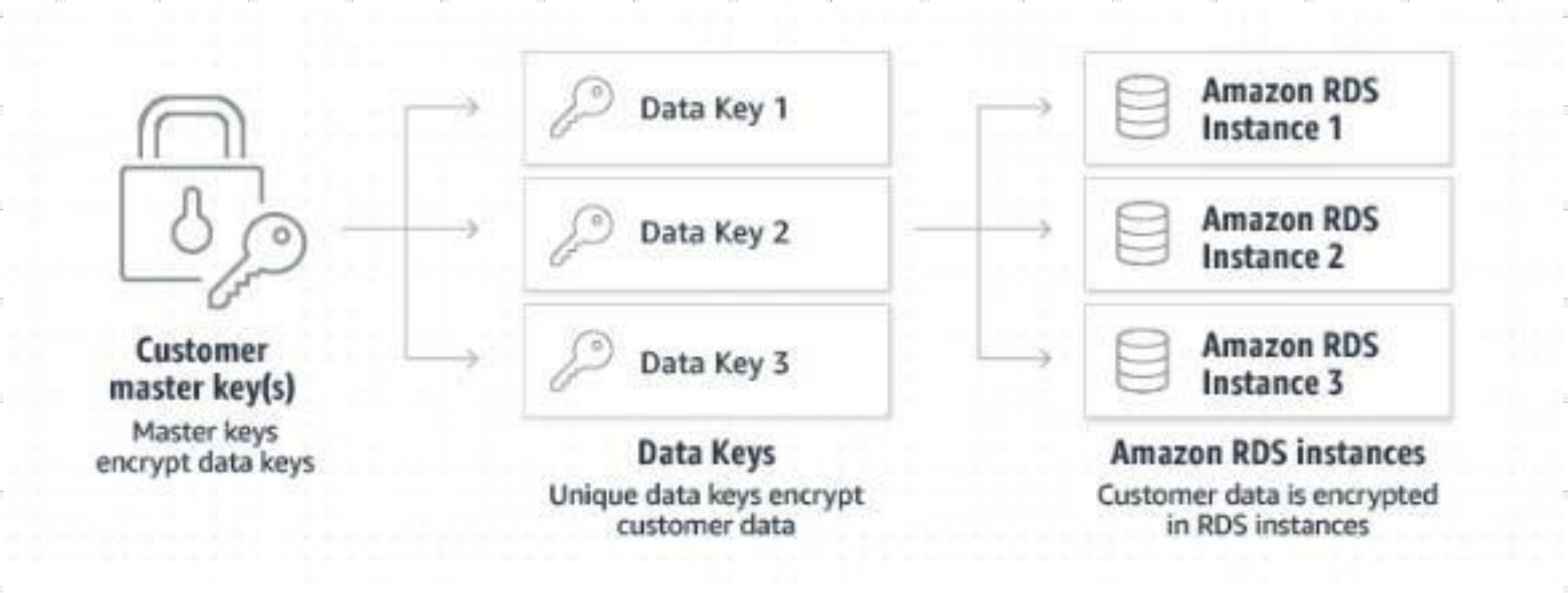


Multi-AZ Deployment

- Multi-AZ for RDS provides high availability, data durability, and fault tolerance for DB instances
- You can select the Multi-AZ option during RDS DB instance launch or modify an existing stand alone RDS instance
- AWS creates a secondary database in different availability zone in the same region for high availability
- Not possible to Insert/Update/Select the data to the Secondary (stand-by) RDS database
- OS patching, System upgrades and DB scaling are done on standby DB first and then on primary

Encrypting Amazon RDS Resources

- You can encrypt your Amazon RDS DB instances and snapshots at rest by enabling the encryption option for your Amazon RDS DB instances.
- You can't disable encryption on an encrypted DB
- You can not enable encryption for an existing, un-encrypted database instance, but there is an alternate way
    - Create a snapshot of the DB
    - Copy the snapshot and choose to encrypt it during the copy process
    - Restore the encrypted copy into a New DB


Customer master key(s)
Master keys encrypt data keys
Data Key 1
Data Key 2
Data Key 3
Data Keys
Unique data keys encrypt customer data
Amazon RDS Instance 1
Amazon RDS Instance 2
Amazon RDS Instance 3
Amazon RDS instances
Customer data is encrypted in RDS instances

Alternative to Amazon RDS

If your use case isn’t supported on RDS, you can run databases on Amazon EC2.

Consider the following points when considering a DB on EC2:

- You can run any database you like with full control and ultimate flexibility.
- You must manage everything like backups, redundancy, patching and scaling.
- Good option if you require a database not yet supported by RDS, such as SAP HANA.
- Good option if it is not feasible to migrate to AWS-managed database.

2. In-memory (Cache)

In-memory databases are used for applications that require real time access to data. By storing data directly in memory, these databases provide microsecond latency where millisecond latency is not enough.

Used for: Caching, gaming leaderboards, and real-time analytics.

In-memory

AWS Offerings:

- Amazon ElastiCache for Redis
- Amazon ElastiCache for Memcached

ElastiCache

Introduction to ElastiCache

- Amazon ElastiCache allows you to seamlessly set up, run, and scale popular open-Source compatible in-memory data stores in the cloud
- Build data-intensive apps or boost the performance of your existing databases by retrieving data from high throughput and low latency in-memory data stores
- Elasticache can be used if data stores have areas of data that are frequently accessed but seldom updated
    - Additionally, querying a database will always be slower and more expensive than locating a key in a key-value pair cache.

Uses cases

- ✔ Session Stores
- ✔ Gaming
- ✔ Real-Time Analytics
- ✔ Queuing

Features

- Extreme performance by allowing for the retrieval of information from a fast, managed, in- memory system (instead of reading from the DB itself)
- Improves response times for user transactions and queries
- It offloads the read workload from the main DB instances (less I/O load on the DB)
  - It does this by storing the results of frequently accessed pieces of data (or computationally intensive calculations) in-memory
- Fully managed
- Scalable

Supports two caching engines

- Memcached (is not a Data store [DB], only a cache)
- Redis can be used as a DB (data store)

Amazon Elasticache for Memcached

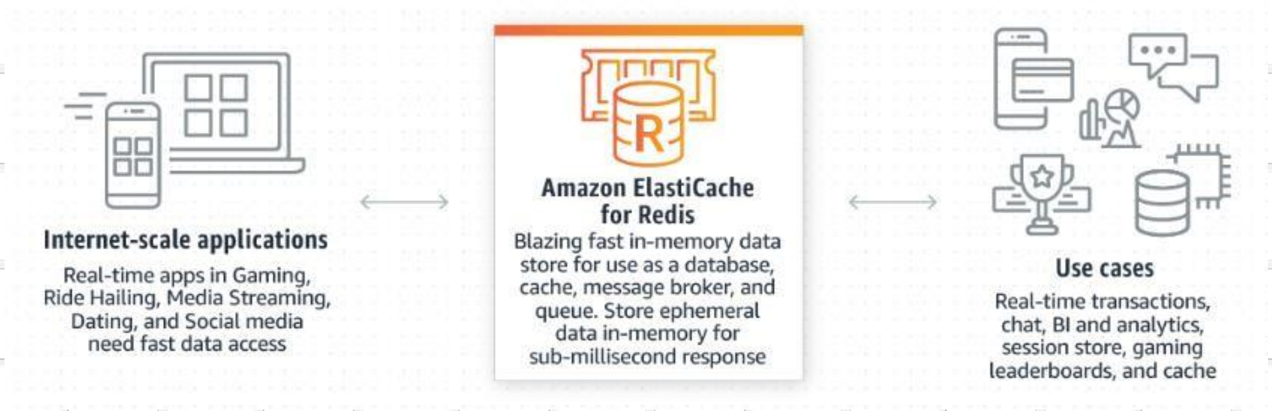
- Is not persistent
- Can not be used as a data store
- If the node fails, the cached data (in the node) is lost
- Ideal front-end for data stores (RDS, DynamoDB…etc)
- Does not support Multi-AZ failover, replication, nor does it support Snapshots for backup/restore
    - Node failure means data loss
- You can, however, place your Memcached nodes in different AZs to minimize the impact of an AZ failure and to contain the data loss in such an incident

Use cases

- Cache contents of a DB
- Cache data from dynamically generated webpages

Amazon Elasticache for Redis

- Is persistent, using the snapshot feature
- At any time, you can restore your data by creating a new Redis cluster and populating it with data from a backup
- Supports Redis master/slave replication
- Supports snapshots (automatic and manual) to S3 (managed by AWS)
    - The back up can be used to restore a cluster or to seed a new cluster
    - The back up includes cluster metadata and all data in the cluster


Internet-scale applications
Real-time apps in Gaming, Ride Hailing, Media Streaming, Dating, and Social media need fast data access
Amazon ElastiCache for Redis
Blazing fast in-memory data store for use as a database, cache, message broker, and queue. Store ephemeral data in-memory for sub-millisecond response
Use cases
Real-time transactions, chat, BI and analytics, session store, gaming leaderboards, and cache

3. Nosql Database

Key-value databases are optimized to store and retrieve key-value pairs in large volumes and in milliseconds, without the performance overhead and scale limitations of relational databases.

Used for: Internet-scale applications, real-time bidding, shopping carts, and customer preferences.

AWS Offerings

- Amazon DynamoDB

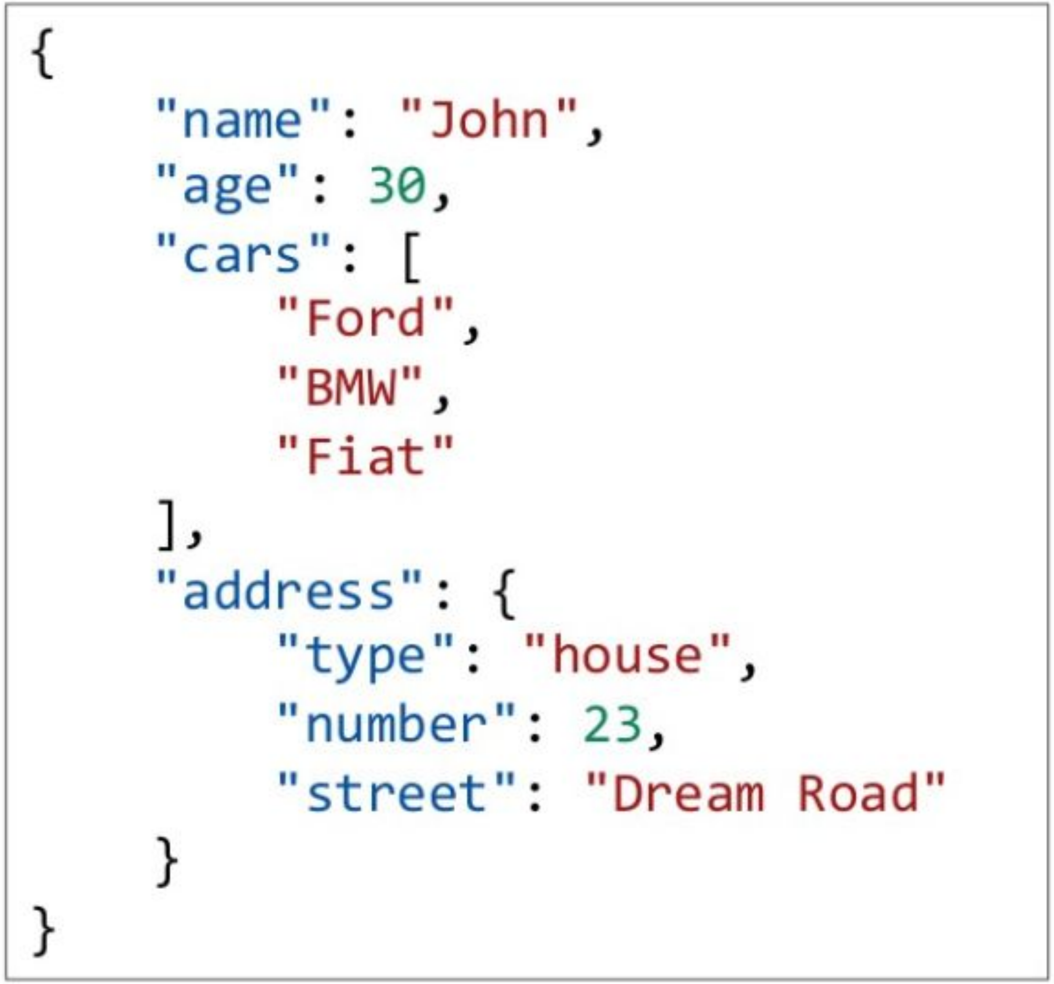
Key-value

Nosql Database

- Document databases are designed to store semi-structured data as documents and are intuitive for developers to use because the data is typically represented as a readable document.

- Used for: Content management, personalization, and mobile applications.

- *AWS Offerings*
- Amazon DocumentDB (with MongoDB compatibility)



```json
{
    "name": "John",
    "age": 30,
    "cars": [
        "Ford",
        "BMW",
        "Fiat"
    ],
    "address": {
        "type": "house",
        "number": 23,
        "street": "Dream Road"
    }
}
```

Amazon DynamoDB

Introduction to Dynamodb

- It is a key-value and document database that delivers single-digit millisecond performance at any scale
- It's a fully managed, multi-region, multi-master database with built-in security, backup and restore, and in-memory caching for internet-scale applications
- Can handle more than 10 trillion requests per day and support peaks of more than 20 million requests per second
- Many of the world's fastest growing businesses such as Lyft, Airbnb, and Redfin as well as enterprises such as Samsung, Toyota, and Capital One depend on the scale and performance of DynamoDB to support their mission-critical workloads

Introduction to Dynamodb

Benefits

- Performance at scale: DynamoDB supports some of the world’s largest scale applications by providing consistent, single-digit millisecond response times at any scale
- Serverless: there are no servers to provision, patch, or manage and no software to install, maintain, or operate

Use cases

- Serverless Web Applications
- Microservices Data Store
- Mobile Back ends
- Gaming
- IOT

Customers

- Nike
- Samsung
- Netflix

Tables

- Dynamo DB tables are schema less
  - Which means that neither the attributes nor their data types need to be defined before hand
  - Each item can have its own distinct attributes
- Dynamo DB does not support
  - Complex relations DB querying or joins
  - Does not support complex transactions

Durability and performance

- Dynamo DB automatically keep data across three facilities(Datacenters) in a region for High availability and data durability
    - It also partitions your DB over sufficient number of servers according to reads/write capacity
    - Performs automatic failover in case of any failure
- Dynamo DB runs exclusively on SSD volumes which provides
    - Low latency
    - Predictable performance
    - High I/O’s

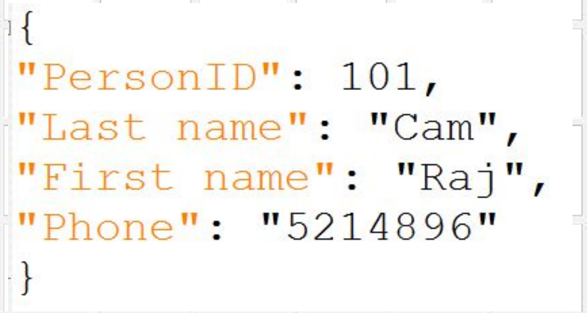
Dynamo DB basic Components

Tables

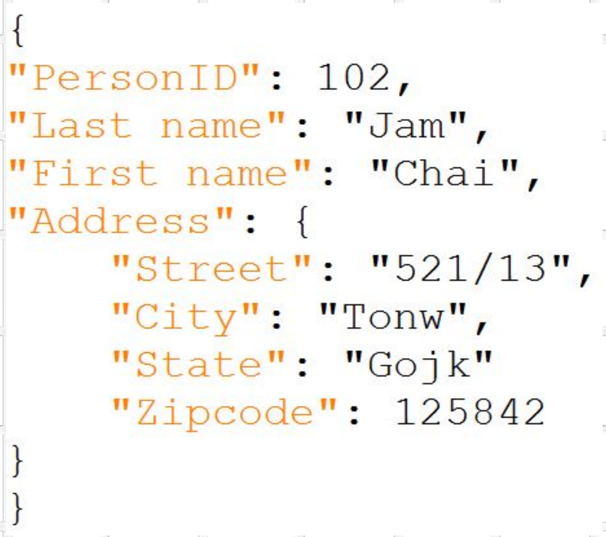
- Like all other DBs, Dynamo DB stores data in tables
- A table is a collection of data items
- Each table can have an infinite number of data items

Items

- Each table contains multiple data items
- An data item consists of a primary or composite key and a flexible number of attributes
- There is no limit to the number of items you can store in a table



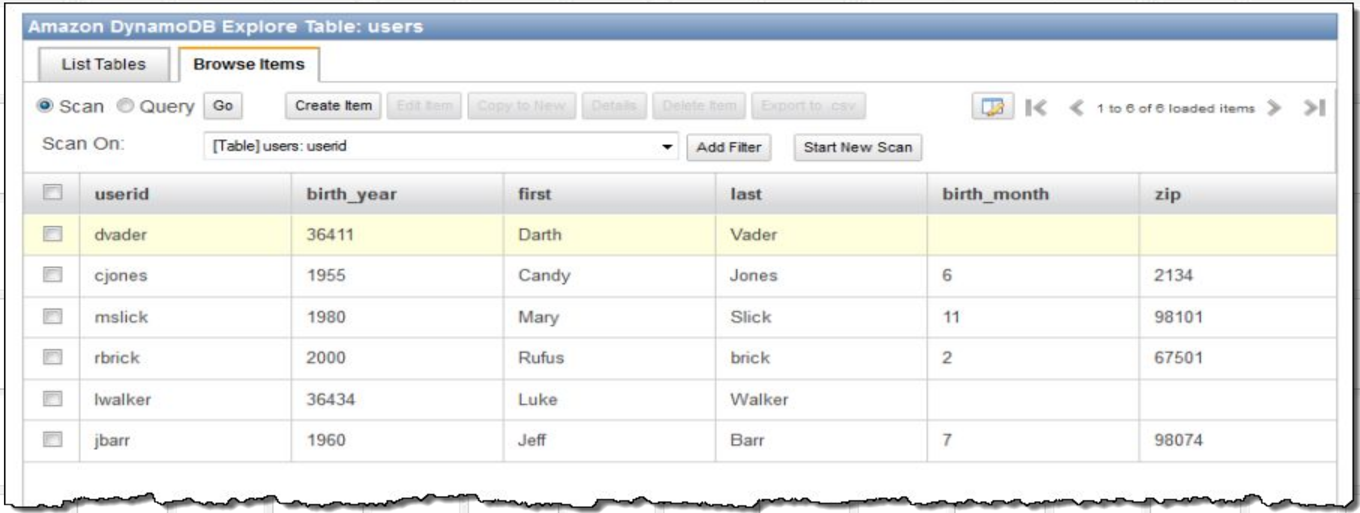
```
{
"PersonID": 101,
"Last name": "Cam",
"First name": "Raj",
"Phone": "5214896"
}
```



```
{
"PersonID": 102,
"Last name": "Jam",
"First name": "Chai",
"Address": {
     "Street": "521/13",
     "City": "Tonw",
     "State": "Gojk"
     "Zipcode": 125842
}
}
```

Attributes

- Each item is composed of one or more attributes
- An attribute consists of the attribute name and a value or a set of values
- An attribute is a fundamental data element
- Attributes in Dynamo DB are similar into fields or columns in other database systems



userid	birth_year	first	last	birth_month	zip
dvader	36411	Darth	Vader		
cjones	1955	Candy	Jones	6	2134
mslick	1980	Mary	Slick	11	98101
rbrick	2000	Rufus	brick	2	67501
lwalker	36434	Luke	Walker		
jbarr	1960	Jeff	Barr	7	98074

Read Capacity Units

- One read capacity unit represents one strongly consistent read per second, or two eventually consistent reads per second for an item up to 4KB in size
- If you need to read an item that is larger than 4 KB, Dynamo DB will need to consume additional read capacity units
- The total number of read capacity units required depends on the item size, and whether you want an eventually consistent or strongly consistent read.

Write Capacity Units

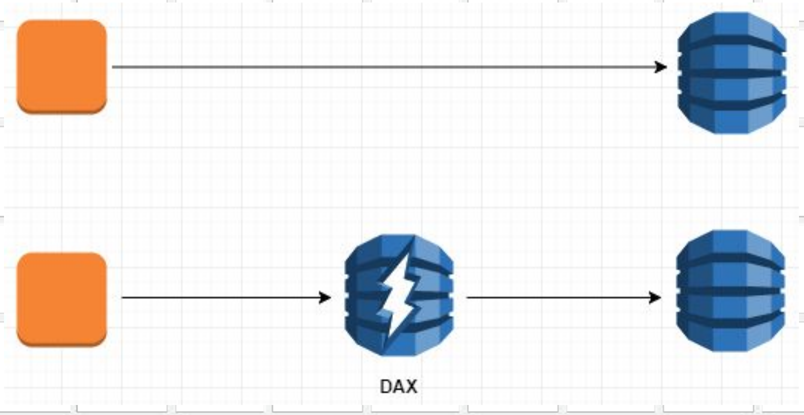
- One write capacity unit represents one write per second for an item up to 1 KB in size
- If you need to write an item that is larger than 1 KB, Dynamo DB will need to consume additional write capacity units
- The total number of write capacity units required depends on the item size.

Scalability

- It provides for a push button scaling on AWS where you can increase the read/write throughput and AWS will go a head and scale it for you (up or down) without downtime or performance degradations
- You can scale the provisioned capacity of your Dynamo DB table any time you want
- There is no limit to the number of items(data) you can store in a Dynamo DB table
- There is no limit on how much data you can store per Dynamo DB table

Dynamo DB Accelerator

- Amazon Dynamo DB Accelerator (DAX) is a fully managed, highly available, in-memory cache for Dynamo DB that delivers up to a 10x performance improvement – from milliseconds to microseconds – even at millions of requests per second
- Now you can focus on building great applications for your customers without worrying about performance at scale
- You can enable DAX with just a few clicks



Redshift

Introduction to Redshift

- Redshift, is an AWS fully managed, petabyte scale data warehouse service in the cloud
    - A data warehouse is a relational database that is designed for query and analysis rather than for transaction processing
    - It usually contains historical data derived from transaction data, but it can include data from other sources
    - To perform analytics you need a data warehouse not a regular database
    - OLAP (On-line Analytical Processing) is characterized by relatively low volume of transactions
        - Queries are often very complex and involve aggregations (group the data)
    - RDS (MySQL.. Etc.) is an OLTP database, where there is detailed and current data, and a schema used to store transactional data

Data Security (Exam View)

At Rest

- Supports encryption of data “at rest” using hardware accelerated AES-256bits (Advanced Encryption Standard)
- By default, AWS Redshift takes care of encryption key management
- You can choose to manage your own keys through HSM (Hardware Security Modules), or AWS KMS (Key Management Service)

In-Transit

- Supports SSL Encryption, in-transit, between client applications and Redshift data warehouse cluster

- You can’t have direct access to your AWS Redshift cluster nodes, however, you can through the applications themselves

Redshift Cluster

- No upfront commitment, you can start small and grow as required
  - You can start with a single, 160GB, Redshift data warehouse node
- For a multi-node deployment (Cluster), you need a leader node and compute node(s)
  - The leader node manages client connections and receives queries
  - The compute nodes store data and perform queries and computations
  - You can have up to 128 compute nodes in a cluster

Back-Up Retention

- Amazon Redshift automatically patches and backs up (Snapshots) your data warehouse, storing the backups for a user-defined retention period in AWS S3
    - It keeps the backup by default for one day (24hours) but you can configure it from 0 to 35days
    - Automatic backups are stopped if you choose retention period of 0
    - You have access to these automated snapshots during the retention period

- If you delete the cluster
    - You can choose to have a final snapshot to use later
    - Manual backups are not deleted automatically, if you do not manually delete them, you will be charged standard S3 storage rates
- AWS Redshift currently supports only one AZ (no Multi-AZ option)
- You can restore from your backup to a new Redshift cluster in the same or a different AZ
    - This is helpful in case the AZ hosting your cluster fails

Availability and Durability

- Redshift automatically replicates all your data within your data warehouse cluster
- Redshift always keeps three copies of your data
    - The original one
    - A replica on compute nodes (within the cluster)
    - A backup copy on S3

- Cross Region Replication

  - Redshift can asynchronously replicate your snapshots to S3 in another region for DR

- Amazon Redshift automatically detect and replace a failure node in your data warehouse cluster
  - The data warehouse cluster will be unavailable for the queries and updates until a replacement node is provided and added to the DB
  - Amazon Redshift makes your replacement node available immediately and loads the most frequently accessed data from S3 first to allow you to resume querying your data as quickly as possible

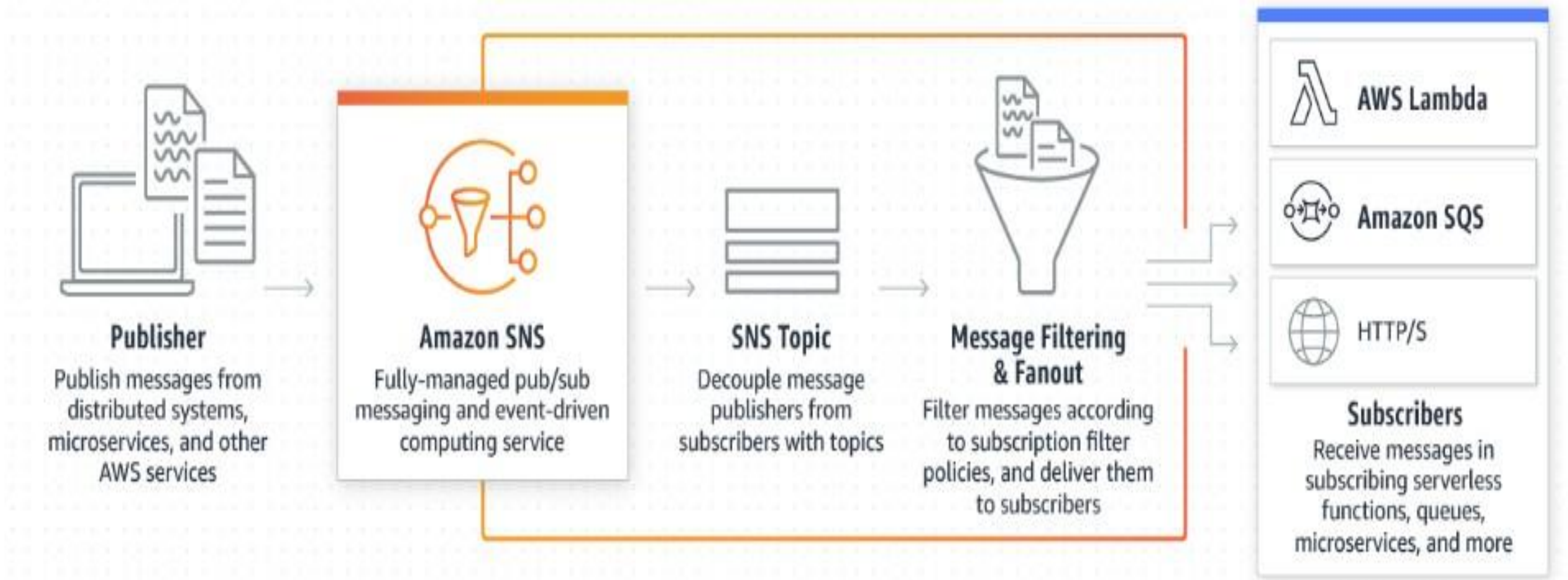
Amazon
SNS

Introduction to Simple Notification Services

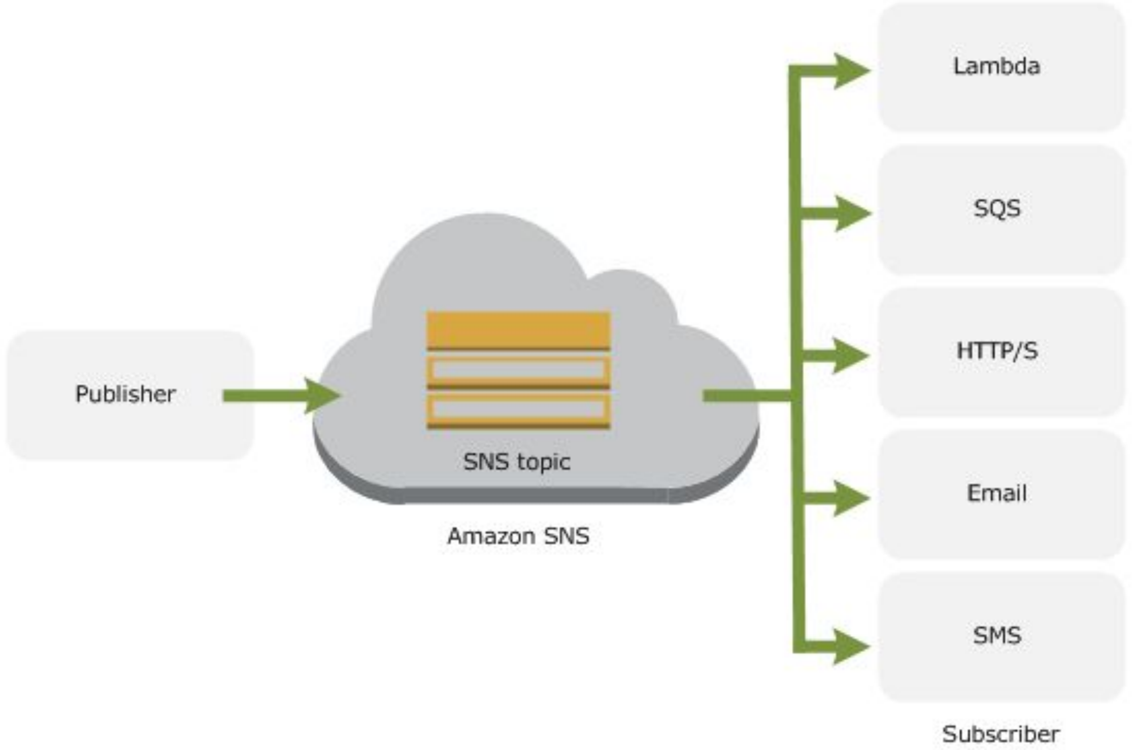
- Amazon Simple Notification Service (SNS) is a highly available, durable, secure, fully managed pub/sub messaging service that enables you to decouple micro services, distributed systems, and serverless applications
- Amazon SNS provides topics for high-throughput, push-based, many-to-many messaging.
- Using Amazon SNS topics, your publisher systems can fan out messages to a large number of subscriber endpoints for parallel processing, including Amazon SQS queues, AWS Lambda functions, and HTTP/S web hooks
- Additionally, SNS can be used to fan out notifications to end users using mobile push, SMS, and email.

Benefits

- Reliably deliver messages with durability
- Automatically scale your workload
- Simplify your architecture with Message Filtering
- Keep messages private and secure


Publisher
Publish messages from distributed systems, microservices, and other AWS services
Amazon SNS
Fully-managed pub/sub messaging and event-driven computing service
SNS Topic
Decouple message publishers from subscribers with topics
Message Filtering & Fanout
Filter messages according to subscription filter policies, and deliver them to subscribers
AWS Lambda
Amazon SQS
HTTP/S
Subscribers
Receive messages in subscribing serverless functions, queues, microservices, and more

- In Amazon SNS, there are two types of clients—publishers and subscribers—also referred to as producers and consumers
- Publishers communicate asynchronously with subscribers by producing and sending a message to a topic, which is a logical access point and communication channel
- Subscribers (i.e., web servers, email addresses, Amazon SQS queues, AWS Lambda functions) consume or receive the message or notification over one of the supported protocols (i.e., Amazon SQS, HTTP/S, email, SMS, Lambda) when they are subscribed to the topic


Publisher
SNS topic
Amazon SNS
Lambda
SQS
HTTP/S
Email
SMS
Subscriber

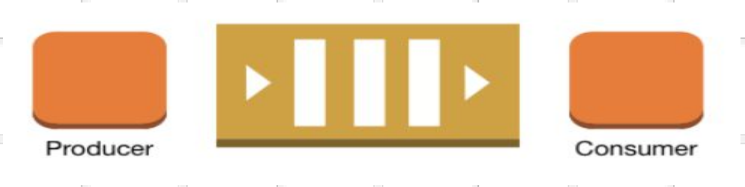
Simple Queue Service

Introduction to SQS

- Amazon Simple Queue Service (Amazon SQS) offers a secure, durable, and available hosted queue that lets you integrate and decouple distributed software systems and components
- Fully managed Queuing service
- Eliminates the complexity and overhead associated with managing and operating message oriented middleware
- Can send, store, and receive messages between software components at any volume, without losing messages or requiring other services to be available

Lifecycle of an Amazon SQS message in Distributed Queues

- There are three main parts in a distributed messaging system: the components of your distributed system, your queue (distributed on Amazon SQS servers), and the messages in the queue
- Your system has several *producers* (components that send messages to the queue) and *consumers* (components that receive messages from the queue). The queue redundantly stores the messages across multiple Amazon SQS servers



Step 1

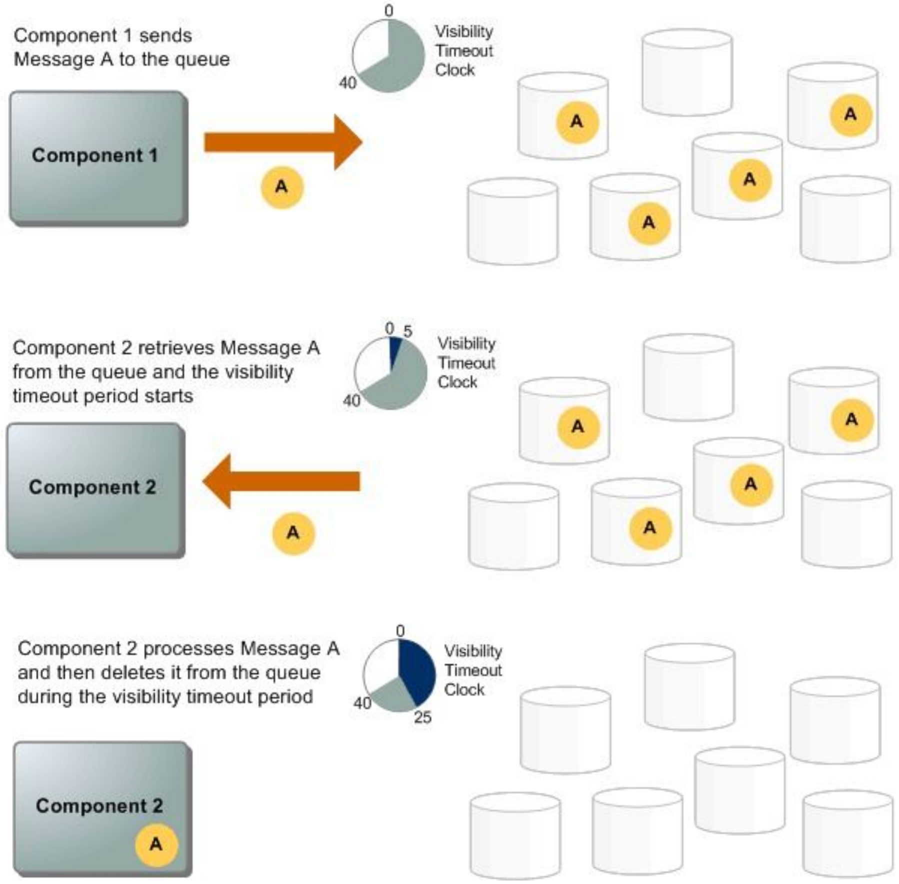
A producer (component 1) sends message A to a queue, and the message is distributed across the Amazon SQS servers redundantly

Step 2

When a consumer (component 2) is ready to process messages, it consumes messages from the queue, and message A is returned

Step 3

The consumer (component 2) deletes message A from the queue to prevent the message from being received and processed again when the visibility timeout expires


Component 1 sends Message A to the queue

Component 2 retrieves Message A from the queue and the visibility timeout period starts

Component 2 processes Message A and then deletes it from the queue during the visibility timeout period

Use Case

SQS : Decoupling 2 applications and allowing parallel asynchronous processing

SNS : Fan-out - Processing the same message in multiple ways

Persistence

SQS : Messages are persisted for some (configurable) duration if no consumer is available

SNS : No persistence. Whichever consumer is present at the time of message arrival gets the message and the message is deleted. If no consumers are available then the message is lost.

SQS : Queue
SNS : Topic (Pub/Sub system)

Message consumption

SQS : Pull Mechanism - Consumers poll and pull messages from SQS

- SQS is distributed queuing system
    - Messages are NOT pushed to receivers
    - Receivers have to poll or pull messages from SQS

SNS : Push Mechanism - SNS Pushes messages to consumers

- SNS is a distributed publish-subscribe system

SQS:

- Messages can't be received by multiple receivers at the same time
- Polling inherently introduces some latency in message delivery in SQS unlike SNS where messages are immediately pushed to subscribers.

SNS :

- Messages are pushed to subscribers as and when they are sent by publishers to SNS
- SNS supports several end points such as email, sms, http end point and SQS