Amazon EC2 - Instance Storage

What's an EBS Volume?

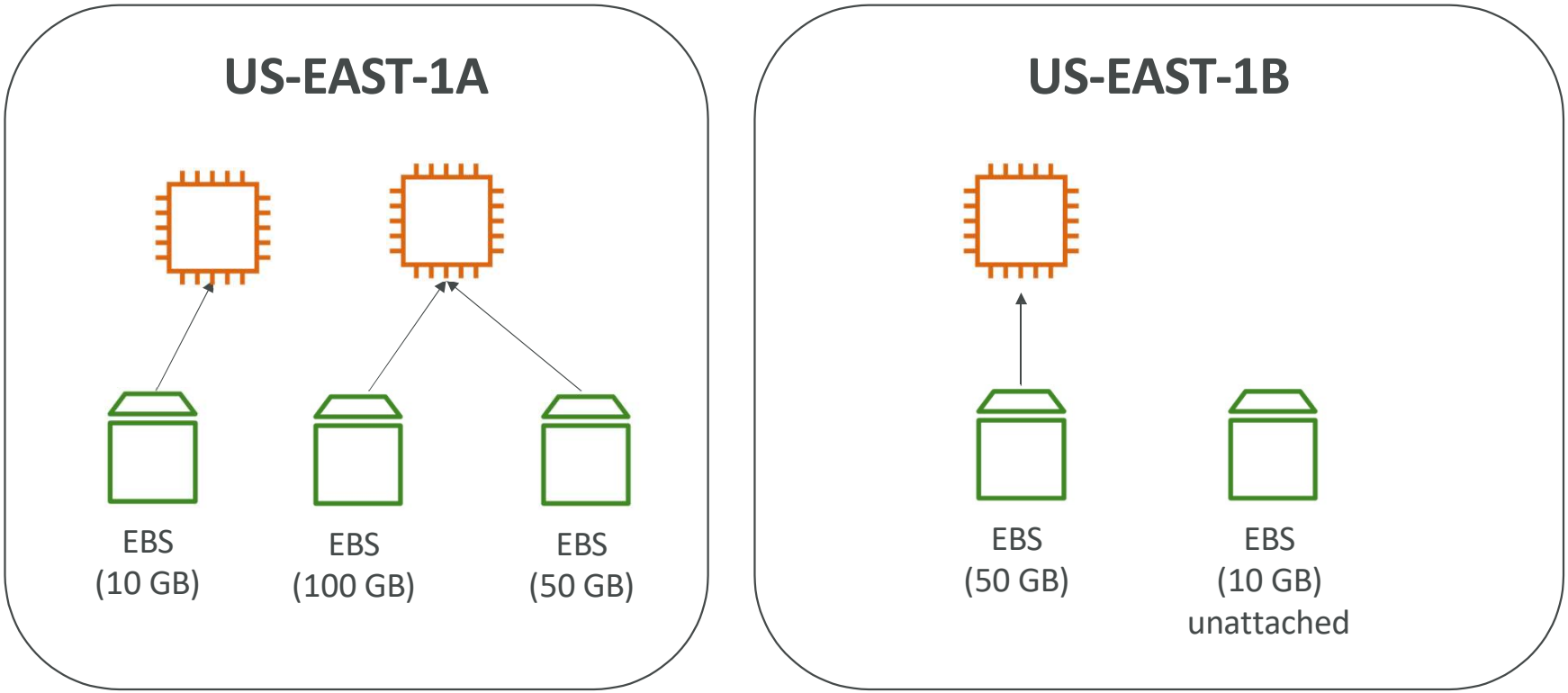
- An EBS (Elastic Block Store) Volume is a network drive you can attach to your instances while they run
- It allows your instances to persist data, even after their termination
- They can only be mounted to one instance at a time (at the CCP level)
- They are bound to a specific availability zone

- Analogy: Think of them as a "network USB stick"
- Free tier: 30 GB of free EBS storage of type General Purpose (SSD) or Magnetic per month

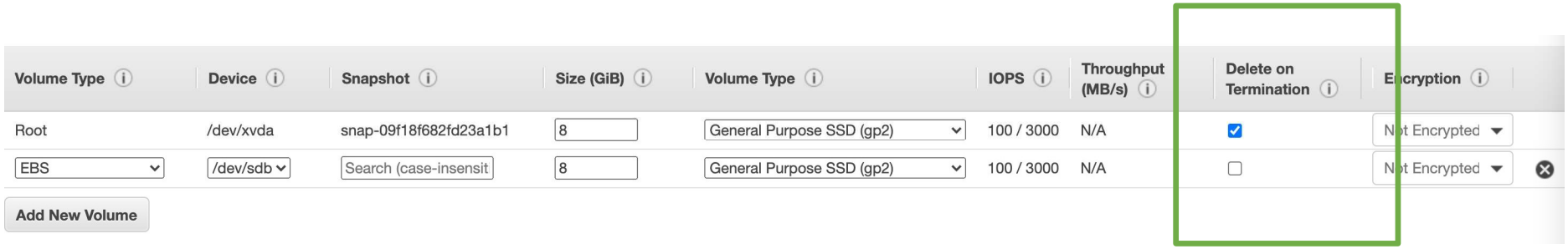
EBS Volume

- It's a network drive (i.e. not a physical drive)
  - It uses the network to communicate the instance, which means there might be a bit of latency
  - It can be detached from an EC2 instance and attached to another one quickly
- It's locked to an Availability Zone (AZ)
  - An EBS Volume in us-east-1a cannot be attached to us-east-1b
  - To move a volume across, you first need to snapshot it
- Have a provisioned capacity (size in GBs, and IOPS)
  - You get billed for all the provisioned capacity
  - You can increase the capacity of the drive over time

EBS Volume - Example



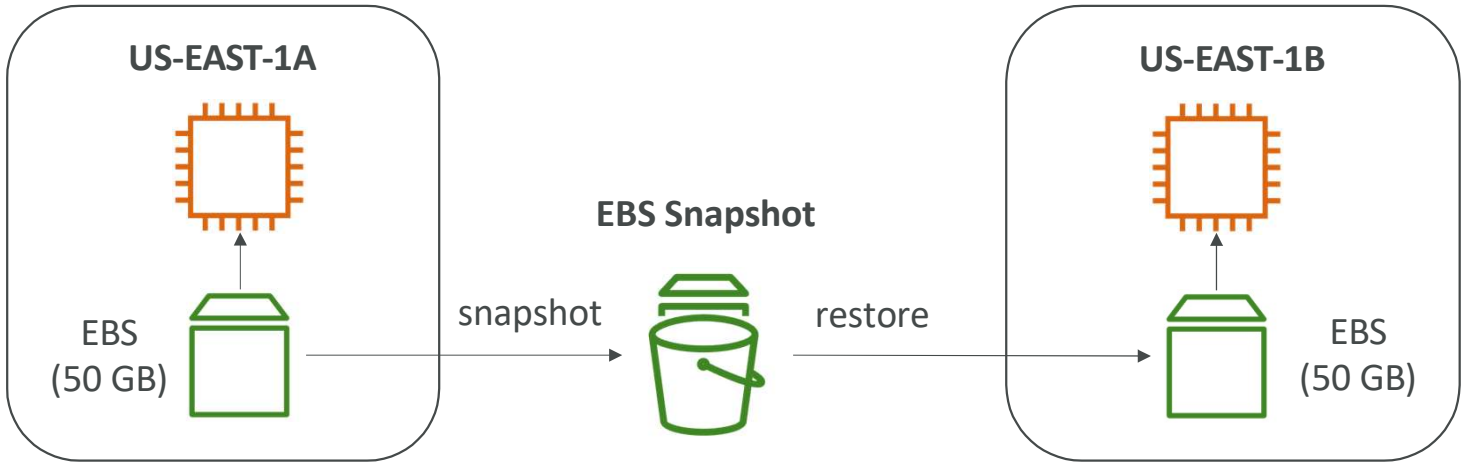
EBS - Delete on Termination attribute



- Controls the EBS behaviour when an EC2 instance terminates
  - By default, the root EBS volume is deleted (attribute enabled)
  - By default, any other attached EBS volume is not deleted (attribute disabled)
- This can be controlled by the AWS console / AWS CLI
- Use case: preserve root volume when instance is terminated

EBS Snapshots

- Make a backup (snapshot) of your EBS volume at a point in time
- Not necessary to detach volume to do snapshot, but recommended
- Can copy snapshots across AZ or Region

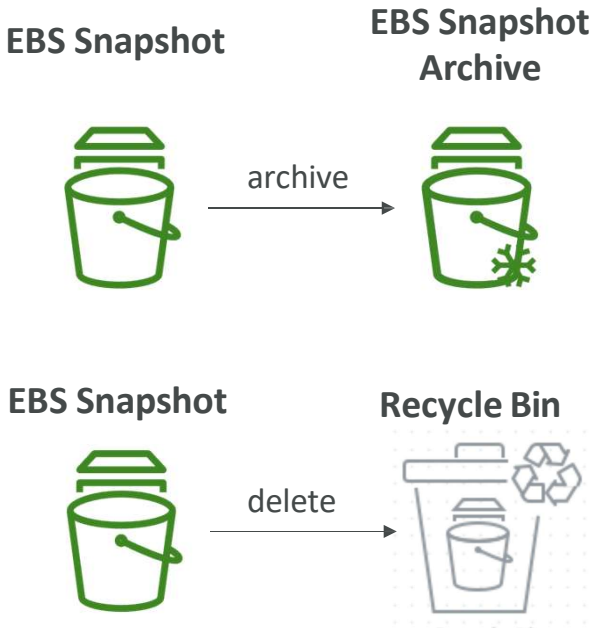


EBS Snapshots Features

- EBS Snapshot Archive
  - Move a Snapshot to an "archive tier" that is 75% cheaper
  - Takes within 24 to 72 hours for restoring the archive

- Recycle Bin for EBS Snapshots
  - Setup rules to retain deleted snapshots so you can recover them after an accidental deletion
  - Specify retention (from 1 day to 1 year)

- Fast Snapshot Restore (FSR)
  - Force full initialization of snapshot to have no latency on the first use ($$$)

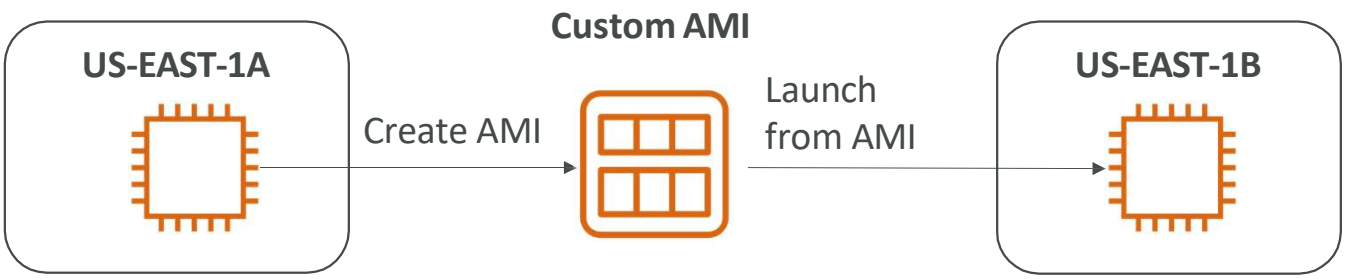


AMI Overview

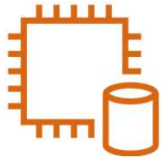
- AMI = Amazon Machine Image
- AMI are a customization of an EC2 instance
  - You add your own software, configuration, operating system, monitoring...
  - Faster boot / configuration time because all your software is pre-packaged
- AMI are built for a specific region (and can be copied across regions)
- You can launch EC2 instances from:
  - A Public AMI: AWS provided
  - Your own AMI: you make and maintain them yourself
  - An AWS Marketplace AMI: an AMI someone else made (and potentially sells)

AMI Process (from an EC2 instance)

- Start an EC2 instance and customize it
- Stop the instance (for data integrity)
- Build an AMI - this will also create EBS snapshots
- Launch instances from other AMIs



EC2 Instance Store



- EBS volumes are network drives with good but "limited" performance
- If you need a high-performance hardware disk, use EC2 Instance Store

- Better I/O performance
- EC2 Instance Store lose their storage if they're stopped (ephemeral)
- Good for buffer / cache / scratch data / temporary content
- Risk of data loss if hardware fails
- Backups and Replication are your responsibility

Local EC2 Instance Store

Very high IOPS

Instance Size	100% Random Read IOPS	Write IOPS
i3.large *	100,125	35,000
i3.xlarge *	206,250	70,000
i3.2xlarge	412,500	180,000
i3.4xlarge	825,000	360,000
i3.8xlarge	1.65 million	720,000
i3.16xlarge	3.3 million	1.4 million
i3.metal	3.3 million	1.4 million
i3en.large *	42,500	32,500
i3en.xlarge *	85,000	65,000
i3en.2xlarge *	170,000	130,000
i3en.3xlarge	250,000	200,000
i3en.6xlarge	500,000	400,000
i3en.12xlarge	1 million	800,000
i3en.24xlarge	2 million	1.6 million
i3en.metal	2 million	1.6 million

EBS Volume Types

- EBS Volumes come in 6 types
  - gp2 / gp3 (SSD): General purpose SSD volume that balances price and performance for a wide variety of workloads
  - io1 / io2 Block Express (SSD): Highest-performance SSD volume for mission-critical low-latency or high-throughput workloads
  - st1 (HDD): Low cost HDD volume designed for frequently accessed, throughput-intensive workloads
  - sc1 (HDD): Lowest cost HDD volume designed for less frequently accessed workloads
- EBS Volumes are characterized in Size | Throughput | IOPS (I/O Ops Per Sec)
- When in doubt always consult the AWS documentation – it's good!
- Only gp2/gp3 and io1/io2 Block Express can be used as boot volumes

EBS Volume Types Use cases

General Purpose SSD

- Cost effective storage, low-latency
- System boot volumes, Virtual desktops, Development and test environments
- 1 GiB - 16 TiB
- gp3:
  - Baseline of 3,000 IOPS and throughput of 125 MiB/s
  - Can increase IOPS up to 16,000 and throughput up to 1000 MiB/s independently
- gp2:
  - Small gp2 volumes can burst IOPS to 3,000
  - Size of the volume and IOPS are linked, max IOPS is 16,000
  - 3 IOPS per GB, means at 5,334 GB we are at the max IOPS

EBS Volume Types Use cases

Provisioned IOPS (PIOPS) SSD

- Critical business applications with sustained IOPS performance
- Or applications that need more than 16,000 IOPS
- Great for databases workloads (sensitive to storage perf and consistency)
- io1 (4 GiB - 16 TiB):
  - Max PIOPS: 64,000 for Nitro EC2 instances & 32,000 for other
  - Can increase PIOPS independently from storage size
- io2 Block Express (4 GiB - 64 TiB):
  - Sub-millisecond latency
  - Max PIOPS: 256,000 with an IOPS:GiB ratio of 1,000:1
- Supports EBS Multi-attach

EBS Volume Types Use cases

Hard Disk Drives (HDD)

- Cannot be a boot volume
- 125 GiB to 16 TiB
- Throughput Optimized HDD (st1)
  - Big Data, Data Warehouses, Log Processing
  - Max throughput 500 MiB/s – max IOPS 500
- Cold HDD (sc1):
  - For data that is infrequently accessed
  - Scenarios where lowest cost is important
  - Max throughput 250 MiB/s – max IOPS 250

EBS - Volume Types Summary

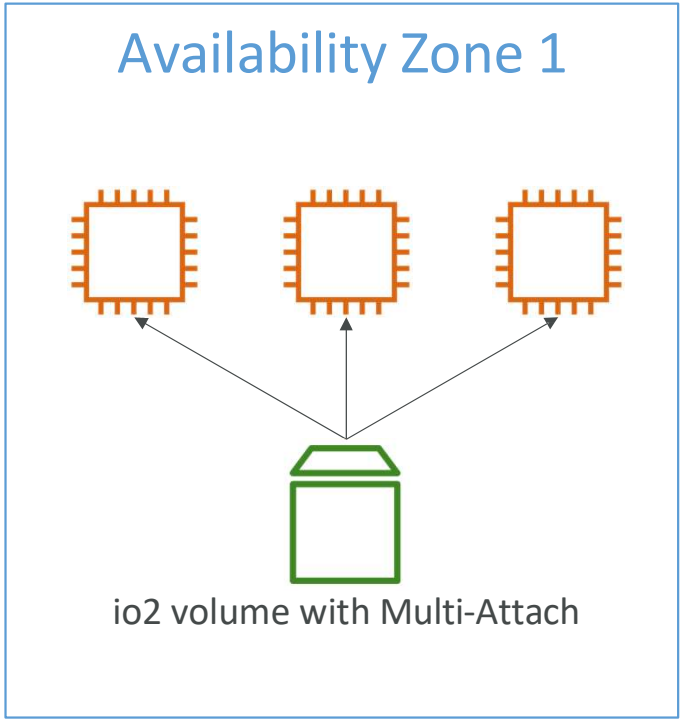
	General Purpose SSD volumes		Provisioned IOPS SSD volumes	
Volume type	gp3	gp2	io2 Block Express [3]	io1
Durability	99.8% - 99.9% durability (0.1% - 0.2% annual failure rate)		99.999% durability (0.001% annual failure rate)	99.8% - 99.9% durability (0.1% - 0.2% annual failure rate)
Use cases	• Transactional workloads • Virtual desktops • Medium-sized, single-instance databases • Low-latency interactive applications • Boot volumes • Development and test environments		Workloads that require: • Sub-millisecond latency • Sustained IOPS performance • More than 64,000 IOPS or 1,000 MiB/s of throughput	• Workloads that require sustained IOPS performance or more than 16,000 IOPS • I/O-intensive database workloads
Volume size	1 GiB - 16 TiB		4 GiB - 64 TiB [4]	4 GiB - 16 TiB
Max IOPS per volume (16 KiB I/O)	16,000		256,000 [5]	64,000
Max throughput per volume	1,000 MiB/s	250 MiB/s [1]	4,000 MiB/s	1,000 MiB/s [2]
Amazon EBS Multi-attach	Not supported		Supported	
NVMe reservations	Not supported		Supported	Not supported
Boot volume	Supported			

	Throughput Optimized HDD volumes	Cold HDD volumes
Volume type	st1	sc1
Durability	99.8% - 99.9% durability (0.1% - 0.2% annual failure rate)	
Use cases	• Big data • Data warehouses • Log processing	• Throughput-oriented storage for data that is infrequently accessed • Scenarios where the lowest storage cost is important
Volume size	125 GiB - 16 TiB	
Max IOPS per volume (1 MiB I/O)	500	250
Max throughput per volume	500 MiB/s	250 MiB/s
Amazon EBS Multi-attach	Not supported	
Boot volume	Not supported	

https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/ebs-volume-types.html#solid-state-drives

EBS Multi-Attach – io1/io2 family

- Attach the same EBS volume to multiple EC2 instances in the same AZ
- Each instance has full read & write permissions to the high-performance volume
- Use case:
  - Achieve higher application availability in clustered Linux applications (ex:Teradata)
  - Applications must manage concurrent write operations
- Up to 16 EC2 Instances at a time
- Must use a file system that's cluster-aware (not XFS, EXT4, etc...)



EBS Encryption

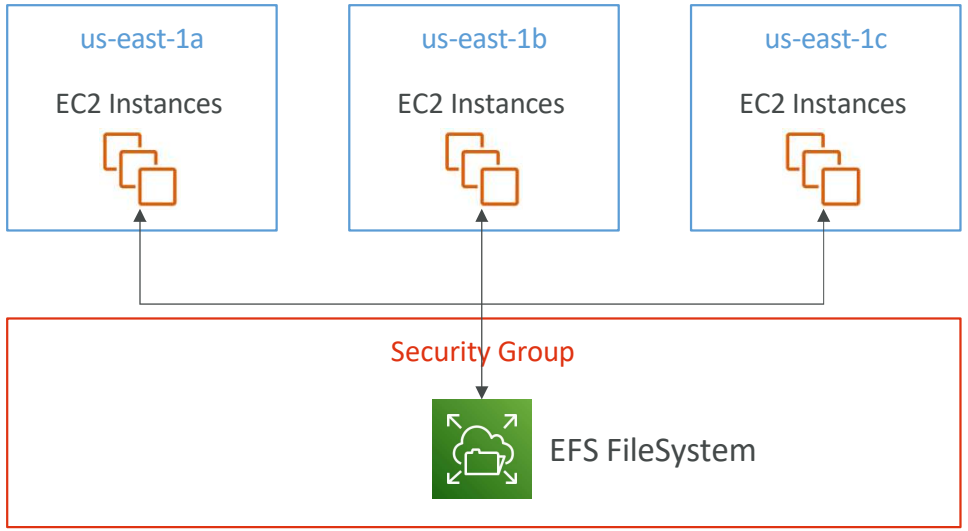
- When you create an encrypted EBS volume, you get the following:
  - Data at rest is encrypted inside the volume
  - All the data in flight moving between the instance and the volume is encrypted
  - All snapshots are encrypted
  - All volumes created from the snapshot
- Encryption and decryption are handled transparently (you have nothing to do)
- Encryption has a minimal impact on latency
- EBS Encryption leverages keys from KMS (AES-256)
- Copying an unencrypted snapshot allows encryption
- Snapshots of encrypted volumes are encrypted

Encryption: encrypt an unencrypted EBS volume

- Create an EBS snapshot of the volume
- Encrypt the EBS snapshot (using copy)
- Create new ebs volume from the snapshot (the volume will also be encrypted)
- Now you can attach the encrypted volume to the original instance

Amazon EFS - Elastic File System

- Managed NFS (network file system) that can be mounted on many EC2
- EFS works with EC2 instances in multi-AZ
- Highly available, scalable, expensive (3x gp2), pay per use



Amazon EFS - Elastic File System

- Use cases: content management, web serving, data sharing, Wordpress
- Uses NFSv4.1 protocol
- Uses security group to control access to EFS
- Compatible with Linux based AMI (not Windows)
- Encryption at rest using KMS

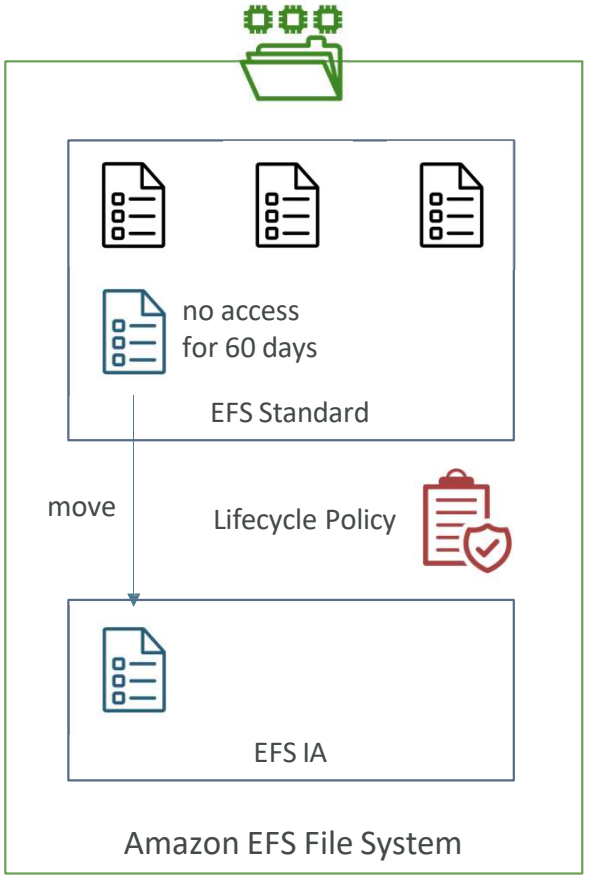
- POSIX file system (~Linux) that has a standard file API
- File system scales automatically, pay-per-use, no capacity planning!

EFS - Performance & Storage Classes

- EFS Scale
  - 1000s of concurrent NFS clients, 10 GB+ /s throughput
  - Grow to Petabyte-scale network file system, automatically
- Performance Mode (set at EFS creation time)
  - General Purpose (default) - latency-sensitive use cases (web server, CMS, etc...)
  - Max I/O - higher latency, throughput, highly parallel (big data, media processing)
- Throughput Mode
  - Bursting - 1 TB = 50MiB/s + burst of up to 100MiB/s
  - Provisioned - set your throughput regardless of storage size, ex: 1 GiB/s for 1 TB storage
  - Elastic - automatically scales throughput up or down based on your workloads
    - Up to 3GiB/s for reads and 1GiB/s for writes
    - Used for unpredictable workloads

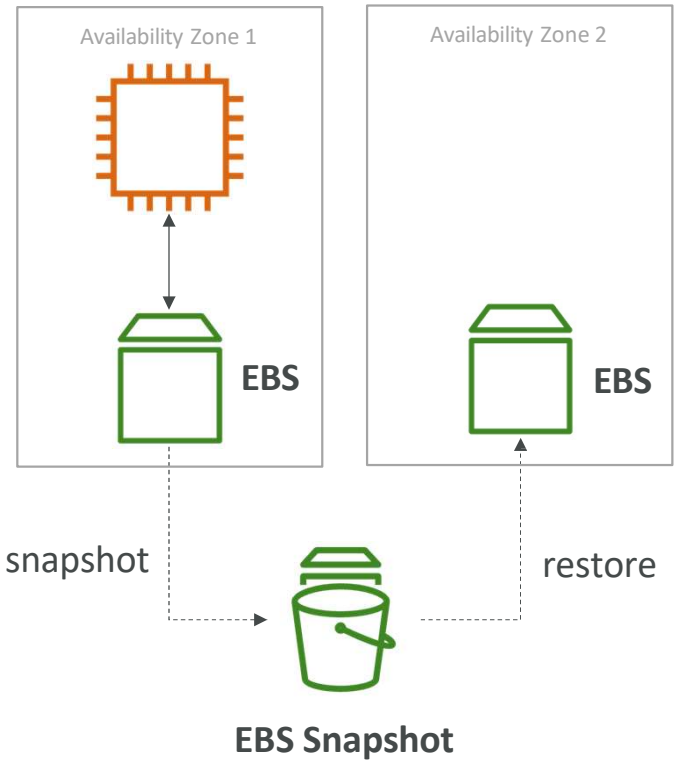
EFS - Storage Classes

- Storage Tiers (lifecycle management feature - move file after N days)
  - Standard: for frequently accessed files
  - Infrequent access (EFS-IA): cost to retrieve files, lower price to store.
  - Archive: rarely accessed data (few times each year), 50% cheaper
  - Implement lifecycle policies to move files between storage tiers
- Availability and durability
  - Standard: Multi-AZ, great for prod
  - One Zone: One AZ, great for dev, backup enabled by default, compatible with IA (EFS One Zone-IA)
- Over 90% in cost savings



EBS vs EFS - Elastic Block Storage

- EBS volumes...
  - one instance (except multi-attach io1/io2)
  - are locked at the Availability Zone (AZ) level
  - gp2: IO increases if the disk size increases
  - gp3 & io1: can increase IO independently
- To migrate an EBS volume across AZ
  - Take a snapshot
  - Restore the snapshot to another AZ
  - EBS backups use IO and you shouldn't run them while your application is handling a lot of traffic
- Root EBS Volumes of instances get terminated by default if the EC2 instance gets terminated. (you can disable that)



EBS vs EFS - Elastic File System

- Mounting 100s of instances across AZ
- EFS share website files (WordPress)
- Only for Linux Instances (POSIX)

- EFS has a higher price point than EBS
- Can leverage Storage Tiers for cost savings

- Remember: EFS vs EBS vs Instance Store