

Amazon EC2 - Instance Storage




What's an EBS Volume?

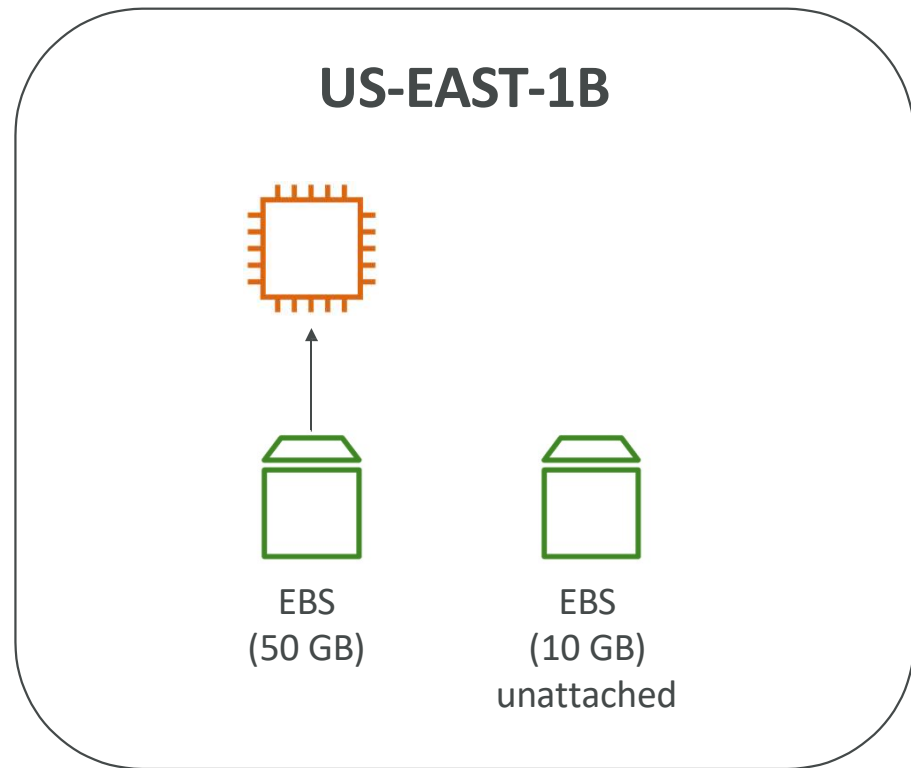
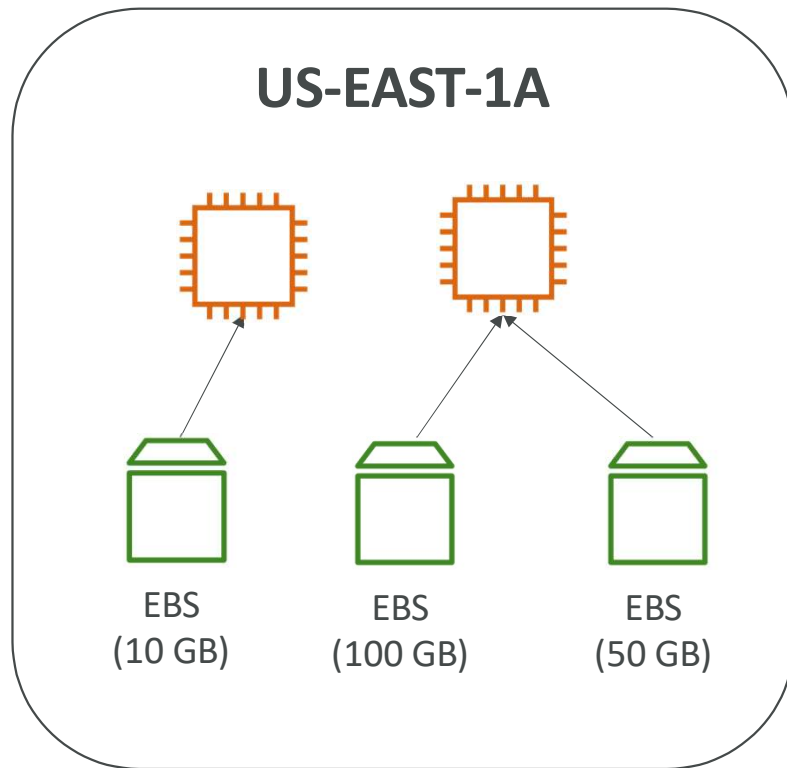


- An **EBS (Elastic Block Store) Volume** is a **network** drive you can attach to your instances while they run
- It allows your instances to persist data, even after their termination
- They can only be mounted to one instance at a time (at the CCP level)
- They are bound to a specific availability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

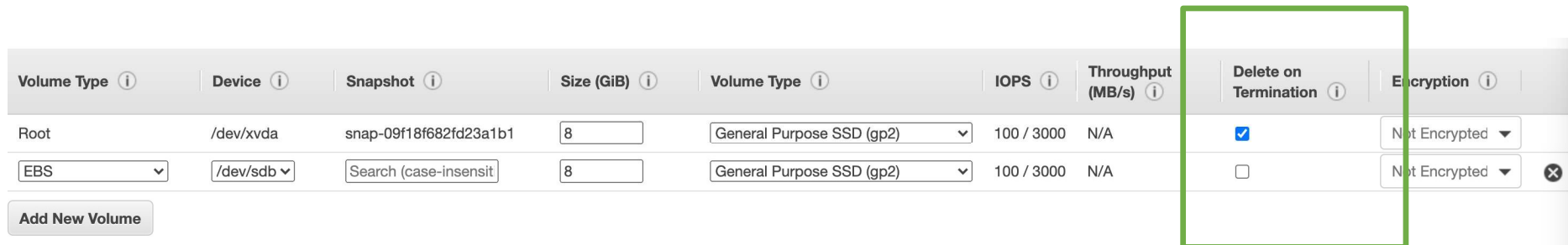
EBS Volume

- 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
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EBS Volume - Example



EBS - Delete on Termination attribute



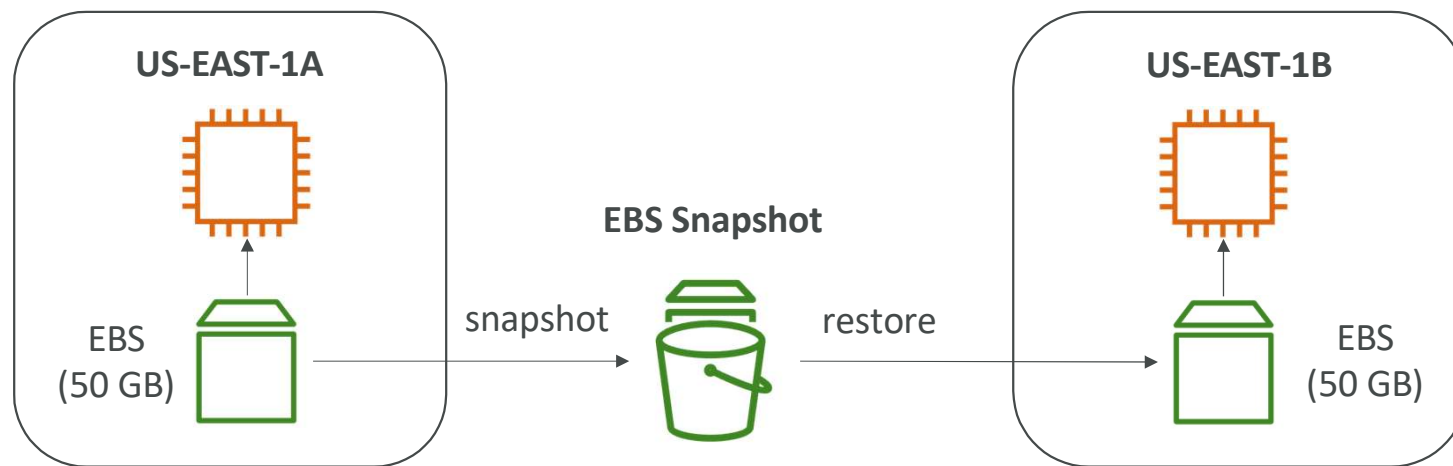
Volume Type ⓘ	Device ⓘ	Snapshot ⓘ	Size (GiB) ⓘ	Volume Type ⓘ	IOPS ⓘ	Throughput (MB/s) ⓘ	Delete on Termination ⓘ	Encryption ⓘ
Root	/dev/xvda	snap-09f18f682fd23a1b1	8	General Purpose SSD (gp2) ▼	100 / 3000	N/A	<input checked="" type="checkbox"/>	Not Encrypted ▼
EBS ▼	/dev/sdb ▼	Search (case-insensit	8	General Purpose SSD (gp2) ▼	100 / 3000	N/A	<input type="checkbox"/>	Not Encrypted ▼ ✕

Add New Volume

- 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

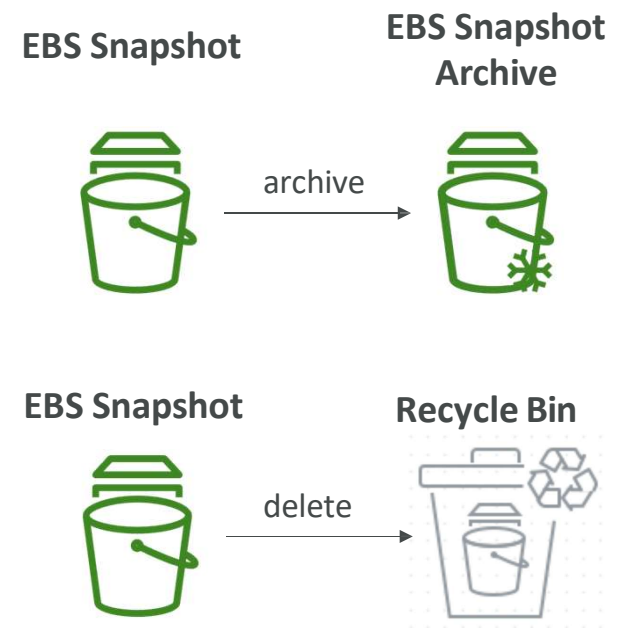
EBS Snapshots

- 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 (\$\$\$)



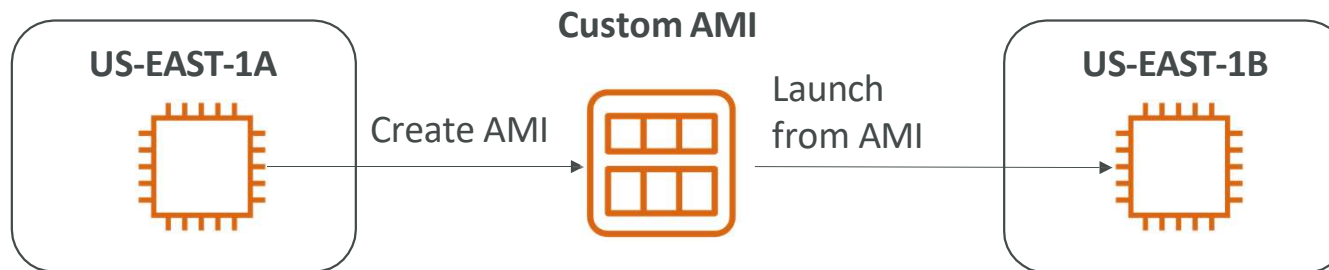
AMI Overview



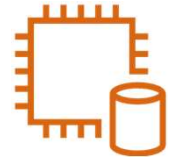
- AMI = Amazon Machine Image
- AMI are a customization of an EC2 instance
 - You add your own software, configuration, operating system, monitoring...
 - Faster boot / configuration time because all your software is pre-packaged
- AMI are built for a specific region (and can be copied across regions)
- 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
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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
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EBS - Volume Types Summary

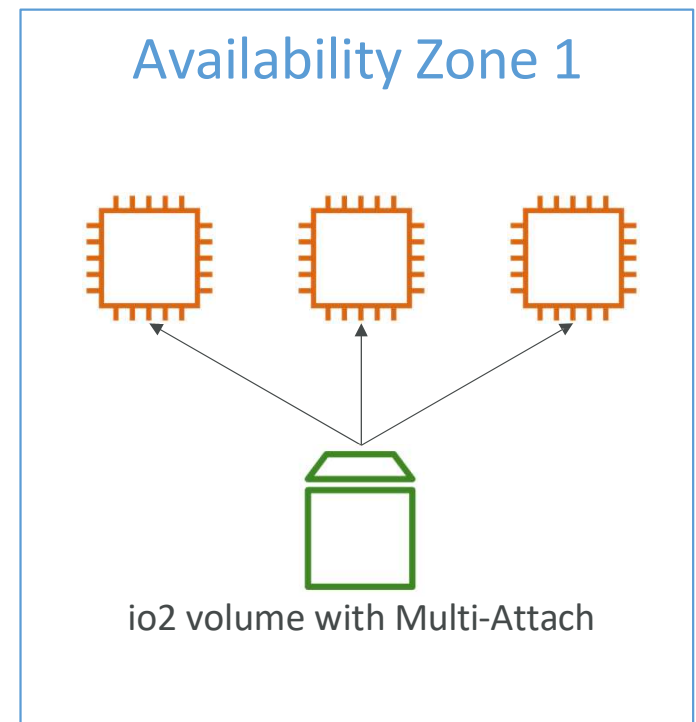
	General Purpose SSD volumes		Provisioned IOPS SSD volumes	
Volume type	gp3	gp2	io2 Block Express ³	io1
Durability	99.8% - 99.9% durability (0.1% - 0.2% annual failure rate)		99.999% durability (0.001% annual failure rate)	99.8% - 99.9% durability (0.1% - 0.2% annual failure rate)
Use cases	<ul style="list-style-type: none"> Transactional workloads Virtual desktops Medium-sized, single-instance databases Low-latency interactive applications Boot volumes Development and test environments 		Workloads that require: <ul style="list-style-type: none"> Sub-millisecond latency Sustained IOPS performance More than 64,000 IOPS or 1,000 MiB/s of throughput 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Big data Data warehouses Log processing 	<ul style="list-style-type: none"> 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

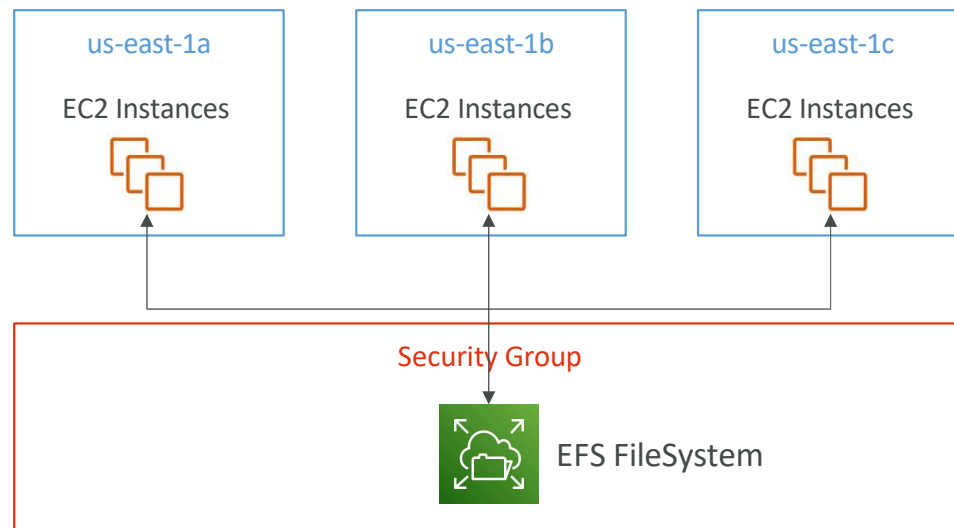
- When you create an encrypted EBS volume, you get the following:
 - Data at rest is encrypted inside the volume
 - All the data in flight moving between the instance and the volume is encrypted
 - All snapshots are encrypted
 - All volumes created from the snapshot
 - Encryption and decryption are handled 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
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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
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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

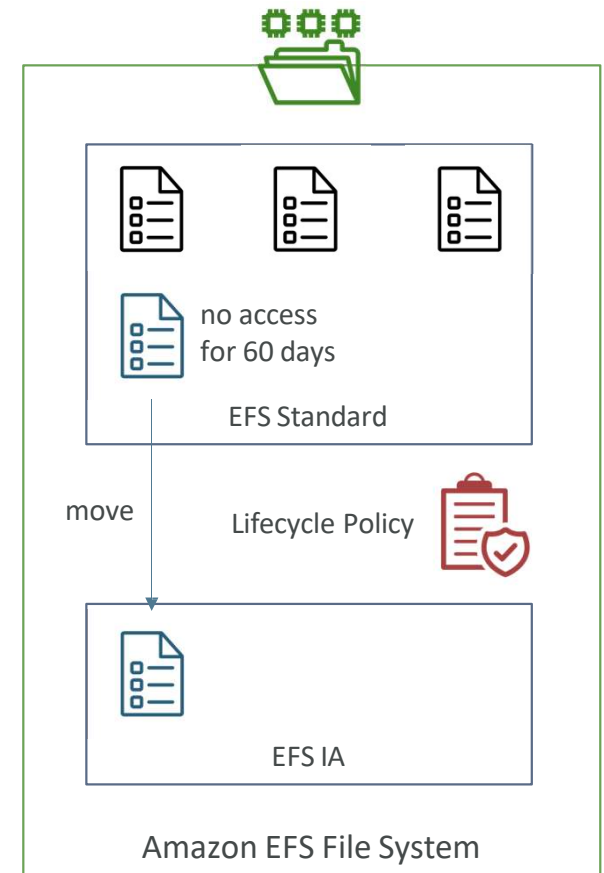
- Use cases: content management, web serving, data sharing, Wordpress
 - Uses NFSv4.1 protocol
 - Uses security group to control access to EFS
 - Compatible with Linux based AMI (not Windows)
 - Encryption at rest using KMS
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- POSIX file system (~Linux) that has a standard file API
 - File system scales automatically, pay-per-use, no capacity planning!
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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

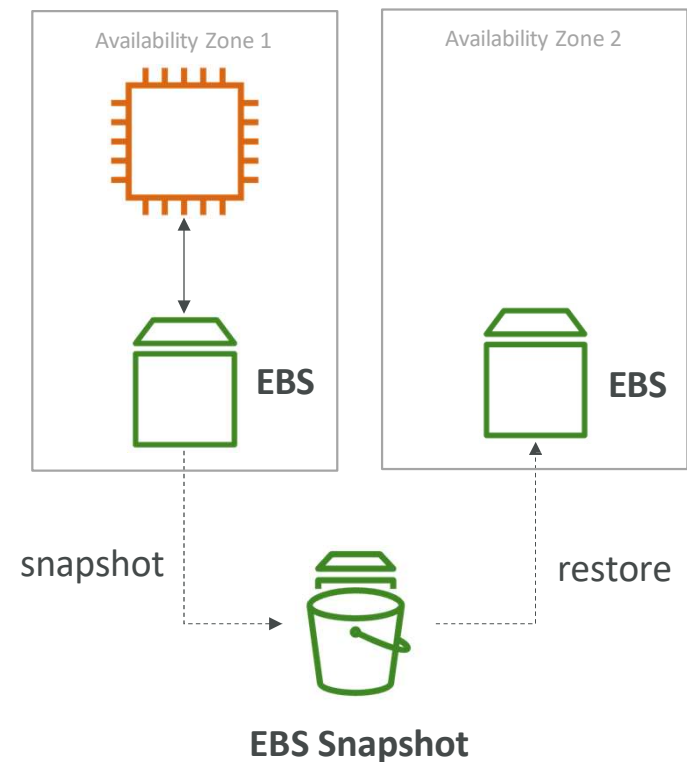
EFS - Storage Classes

- 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

