# Storage in AWS

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Agenda

- Local Disks – RAID
- Data Storage Options Supported by Amazon EC2
- Amazon Elastic Block Store (EBS), EBS Benefits and Use Cases
- Amazon EC2 Instance Store
- Amazon Elastic File System (EFS), EFS Benefits and Use Cases
- Amazon Simple Storage Service (S3), S3 Storage Classes
- Amazon FSx
- Amazon Snow
- AWS Storage Gateway

Local Disks - RAID
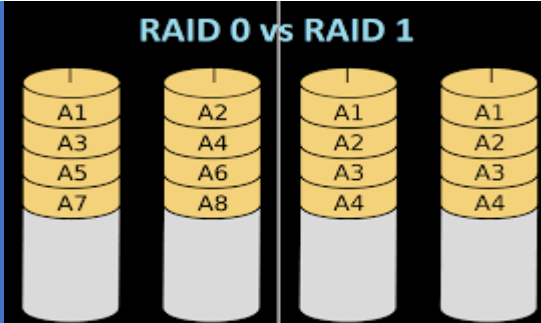
RAID stands for Redundant Array of Independent Disk, is the technique used for disk organization for reliability and performance.

RAID 0	RAID 1
Disk Striping	Disk Mirroring
Use RAID 0 when I/O performance is more important than fault tolerance	Use RAID 1 when fault tolerance is more important than I/O performance
No Overhead	Data redundancy as data is replicated across two or more disks
Low Cost	Expensive compared to RAID 0
Easy to Implement	No real-time swapping of faulty disks
No Parity, hence no fault tolerance	Reduced storage capacity
Unsuitable for critical data	Most-suited for mission-critical applications

Data storage options supported by Amazon EC2

❑ Amazon Elastic Block Store (EBS)

❑ Amazon EC2 Instance store

❑ Amazon Elastic File System (EFS)

❑ Amazon Simple Storage Service (Amazon S3)
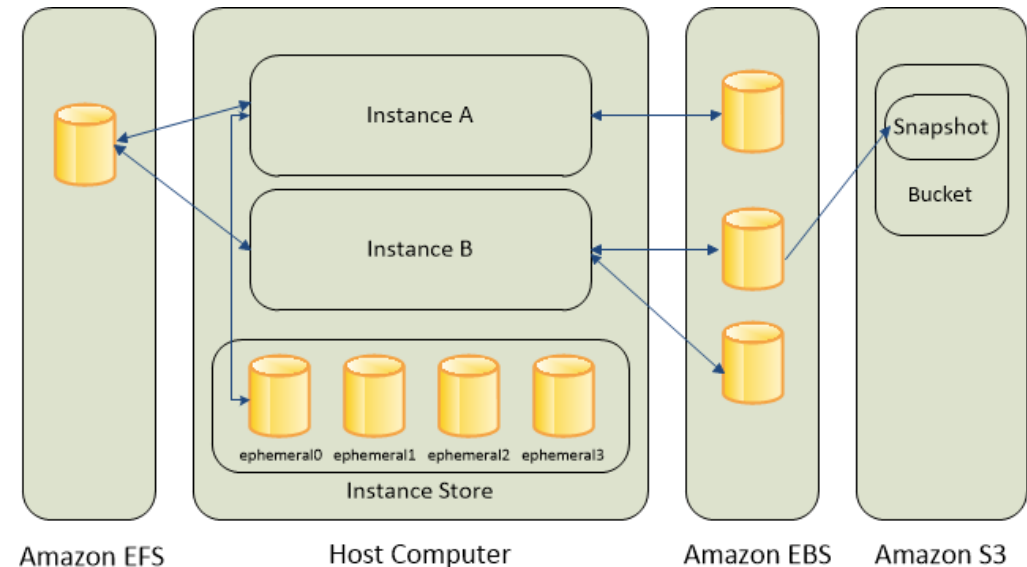
Amazon Elastic Block Store (EBS)

- Amazon EBS provides durable, block-level storage volumes that can be attached to a running instance.
- Use Amazon EBS as a primary storage device for data that requires frequent and granular updates.
- For example, Amazon EBS is the recommended storage option if database is run on an instance.
- An EBS volume behaves like a raw, unformatted, external block device that can be attached to a single instance.
- The volume persists independently from the running life of an instance. It stores data on a file system which is retained after the EC2 instance is shut down.
- EBS volumes can also be created as encrypted volumes using the Amazon EBS encryption feature.
- To keep a backup copy of data, create a snapshot of an EBS volume, which is stored in Amazon S3.
- After an EBS volume is attached to an instance, we can use it like any other physical hard drive.
- Multiple volumes can be attached to an instance.
- Can also detach an EBS volume from one instance and attach it to another instance.
- Can dynamically change the configuration of a volume attached to an instance.
- Can create an EBS volume from a snapshot and attach it to another instance.

Amazon Elastic Block Store (EBS)
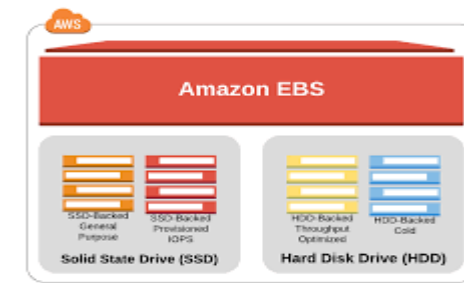
Summary of performance and use cases for each volume type.

- **General Purpose SSD volumes** (gp2 and gp3) balance price and performance for a wide variety of transactional workloads. These volumes are ideal for use cases such as boot volumes, medium-size single instance databases, and development and test environments.

- **Provisioned IOPS SSD volumes** (io1 and io2) support up to 64,000 IOPS and 1,000 MiB/s of throughput. This enables us to predictably scale to tens of thousands of IOPS per EC2 instance.

- **Throughput Optimized HDD volumes** (st1) provide low-cost magnetic storage that defines performance in terms of throughput rather than IOPS. These volumes are ideal for large, sequential workloads such as Amazon EMR, ETL, data warehouses, and log processing.

- **Cold HDD volumes** (sc1) provide low-cost magnetic storage that defines performance in terms of throughput rather than IOPS. These volumes are ideal for large, sequential, cold-data workloads. If we require infrequent access to our data and are looking to save costs, these volumes provides inexpensive block storage.

Amazon Elastic Block Store (EBS)

- We can create our EBS volumes as encrypted volumes, in order to meet a wide range of data-at-rest encryption requirements for regulated/audited data and applications. When we create an encrypted EBS volume and attach it to a supported instance type, data stored at rest on the volume, disk I/O, and snapshots created from the volume are all encrypted. The encryption occurs on the servers that host EC2 instances, providing encryption of data-in-transit from EC2 instances to EBS storage.

- We can create point-in-time snapshots of EBS volumes, which are persisted to Amazon S3. Snapshots protect data for long-term durability, and they can be used as the starting point for new EBS volumes. The same snapshot can be used to instantiate as many volumes as we wish. These snapshots can be copied across AWS Regions.

- Performance metrics, such as bandwidth, throughput, latency, and average queue length, are available through the AWS Management Console. These metrics, provided by Amazon CloudWatch, allow us to monitor the performance of our volumes to make sure that we are providing enough performance for our applications without paying for resources we don't need.

Amazon EBS Benefits

- **Performance optimization:** Increase throughput by devoting network capacity and minimizing the network contention between our instances and EBS.

- **Low-latency performance:** By using SSD EBS volumes, it offers reliable I/O performance scaled to meet our workload needs.

- **Highly available and secure storage:** EBS volumes offer redundancy within its Availability Zones while access control and encryption bolster security.

- **Geographic interchangeability:** With EBS, we can duplicate snapshots throughout AWS regions and place resources and data in multiple locations. This makes disaster recovery, data center migration, and geographical expansion simple.

- **Easy data backup and restoration:** Point-in-time volume snapshots safeguard data.

- **Rapid up- or down-scaling:** EBS can quickly scale volumes, ensuring we get the right performance and capacity for changing computing needs.

Amazon EBS Use Cases

- **Testing and development:** We can scale, archive, duplicate or provision our testing, development, or production environments.

- **NoSQL databases:** EBS offers NoSQL databases the low-latency performance and dependability they need for peak performance.

- **Relational databases:** EBS scales to meet our changing storage needs. This makes it a great choice for deploying databases, including PostgreSQL, MySQL, Oracle, or Microsoft SQL Server.

- **Business consistency:** Copy EBS Snapshots and Amazon Machine Images (AMIs) to run applications in different AWS regions. This reduces data loss and speeds recovery time by backing up log files and data regularly, across geographies.

- **Enterprise-wide applications:** It can meet a variety of enterprise computing needs through powerful block storage that can support our most important applications, such as Microsoft Exchange, Oracle, or Microsoft SharePoint.

Amazon EC2 Instance Store

- Many instances can access storage from disks that are physically attached to the host computer. This disk storage is referred to as instance store.

- Instance store provides temporary block-level storage for instances.

- This storage is located on disks that are physically attached to the host computer. Instance store is ideal for temporary storage of information that changes frequently, such as buffers, caches, scratch data, and other temporary content, or for data that is replicated across a fleet of instances, such as a load-balanced pool of web servers.

- We can specify instance store volumes for an instance only when we launch it. We can't detach an instance store volume from one instance and attach it to a different instance.

- The data on an instance store volume persists only during the life of the associated instance; if we stop, hibernate, or terminate an instance, any data on instance store volumes is lost.

- Do not rely on instance store for valuable, long-term data. Instead, use more durable data storage, such as Amazon S3, Amazon EBS, or Amazon EFS.

Amazon Elastic File System (EFS)

- Amazon Elastic File System (Amazon EFS) provides a simple, serverless, set-and-forget elastic file system 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 we add and remove files, eliminating the need to provision and manage capacity to accommodate growth. The service manages all the file storage infrastructure for us, meaning that we can avoid the complexity of deploying, patching, and maintaining complex file system configurations. EFS supports Portable Operating System Interface (POSIX).

- Amazon EFS supports the Network File System version 4 (NFSv4.1 and NFSv4.0) protocol, so the applications and tools that we use today work seamlessly with Amazon EFS. Multiple compute instances, including Amazon EC2, Amazon ECS, and AWS Lambda, can access an Amazon EFS file system at the same time, providing a common data source for workloads and applications running on more than one compute instance or server.

Amazon Elastic File System (EFS)

- Amazon EFS provides scalable file storage for use with Amazon EC2.

- We can create an EFS file system and configure our instances to mount the file system.

- We can use an EFS file system as a common data source for workloads and applications running on multiple instances.

- Using an EFS file system, we may configure instances to mount the file system. The main differences between EBS and EFS is that EBS is only accessible from a single EC2 instance in a particular AWS region, while EFS allows us to mount the file system across multiple regions and instances.

- EFS is the best choice for running any application that has a high workload, requires scalable storage, and must produce output quickly.

- It scales automatically, even to meet the most abrupt workload spikes. After the period of high-volume storage demand has passed, EFS will automatically scale back down.

- EFS can be mounted to different AWS services and accessed from all our virtual machines. Use it for running shared volumes, or for big data analysis. We'll always pay for the storage we use, rather than provisioning storage in advance that's ultimately wasted.

Amazon EFS Benefits

- **Performance that scales to support any workload**: EFS offers the throughput changing workloads need. It can provide higher throughput in spurts that match sudden file system growth, even for workloads up to 500,000 IOPS or 10 GB per second.

- **Energetic elasticity**: Automatically scale our file system storage up or down. Remove or add files and never disturb applications. Once we make our EFS file system we can add files without worrying about storage provisioning.

- **Accessible file storage**: On-premises servers and EC2 instances can access shared file systems concurrently. EC2 instances can also access EFS file systems located in other AWS regions through VPC peering.

- **Comprehensive managed service**: EFS is a complete managed service, meaning we will never have to patch, deploy, or maintain our file system.

- **Cost savings**: The only storage we'll pay for is exactly what we use, as there's no advance provisioning, up-front fees, or commitments. Moreover, we can use Lifecycle Management to transfer files that have been unused for a month to a more cost-effective storage class, which can lower expenses up to 85%.

- **Tighter security and compliance**: We can securely access the file system with our current security solution, or control access to EFS file systems using AWS Identity and Access Management (IAM), Amazon Virtual Private Cloud (Amazon VPC), or POSIX permissions. And, EFS can encrypt our data, whether it's in transit or at rest. This gives us dependable security and makes regulatory compliance easier.

Amazon EFS Use Cases

- **Lift-and-shift application support**: EFS is elastic, available, and scalable, and enables us to move enterprise applications easily and quickly without needing to re-architect them.

- **Analytics for big data**: It has the ability to run big data applications, which demand significant node throughput, low-latency file access, and read-after-write operations.

- **Content management system and web server support**: EFS is a robust throughput file system capable of enabling content management systems and web serving applications, such as archives, websites, or blogs.

- **Application development and testing**: Only EFS provides a shared file system needed to share code and files, across multiple compute resources to facilitate auto-scaling workloads.

Amazon Simple Storage Service (Amazon S3)

- Amazon S3 provides access to reliable and inexpensive data storage infrastructure.

- Amazon S3 provides object storage. Each object has its own unique identifier or key, for access through web requests from any location. S3 also supports static web content hosting that can be accessed from the S3 bucket or from AWS CloudFront. And S3 is notably secure, providing. "eleven nines" - 99.999999999 of data durability.

- Amazon S3 stores data objects redundantly on multiple devices across multiple facilities and allows concurrent read or write access to these data objects by many separate clients or application threads. We can use the redundant data stored in Amazon S3 to recover quickly and reliably from instance or application failures.

- S3 Storage Classes
  - S3 Standard
  - S3 Intelligent-Tiering
  - S3 Standard-Infrequent Access (IA), S3 One Zone-Infrequent Access (IA)
 - S3 Glacier, S3 Glacier Deep Archive

Amazon Simple Storage Service (Amazon S3)

Types of Storage Classes
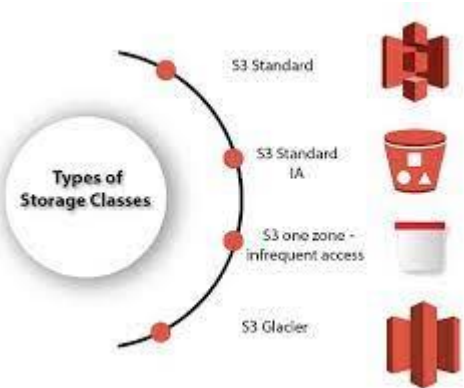
- **Amazon S3 Standard (S3 Standard)** offers high durability, availability, and performance object storage for frequently accessed data. Because it delivers low latency and high throughput, S3 Standard is appropriate for a wide variety of use cases, including cloud applications, dynamic websites, content distribution, mobile and gaming applications, and big data analytics. S3 Storage Classes can be configured at the object level and a single bucket can contain objects stored across S3 Standard, S3 Intelligent-Tiering, S3 Standard-IA, and S3 One Zone-IA. We can also use S3 Lifecycle policies to automatically transition objects between storage classes without any application changes.

- **Amazon S3 Intelligent-Tiering (S3 Intelligent-Tiering)** is the only cloud storage class that delivers automatic cost savings by moving objects between four access tiers when access patterns change. The S3 Intelligent-Tiering storage class is designed to optimize costs by automatically moving data to the most cost-effective access tier, without operational overhead.

Amazon Simple Storage Service (Amazon S3)

Types of Storage Classes
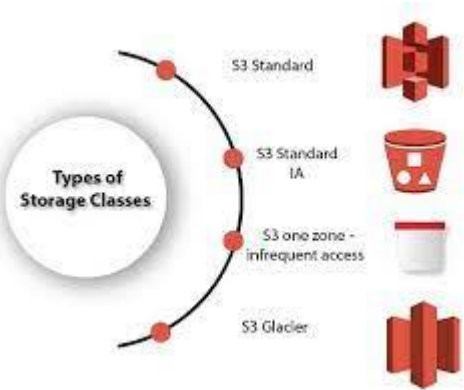
- **S3 Standard-IA** is for data that is accessed less frequently but requires rapid access when needed. S3 Standard-IA offers the high durability, high throughput, and low latency of S3 Standard, with a low per GB storage price and per GB retrieval fee. This combination of low cost and high performance make S3 Standard-IA ideal for long-term storage, backups, and as a data store for disaster recovery files.

- **S3 One Zone-IA** is for data that is accessed less frequently but requires rapid access when needed. Unlike other S3 Storage Classes which store data in a minimum of three Availability Zones (AZs), S3 One Zone-IA stores data in a single AZ and costs 20% less than S3 Standard-IA. S3 One Zone-IA is ideal for customers who want a lower-cost option for infrequently accessed data but do not require availability and resilience of S3 Standard or S3 Standard-IA.

Amazon Simple Storage Service (Amazon S3)

Archive Storage Class
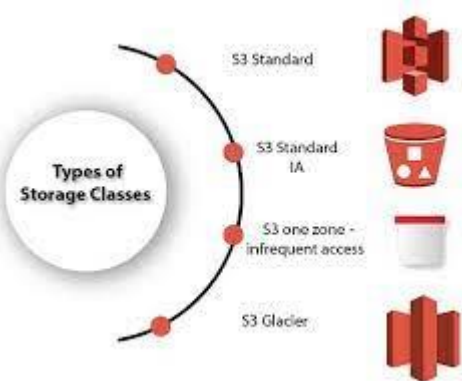
- **Amazon S3 Glacier (S3 Glacier)** is a secure, durable, and low-cost storage class for data archiving. We can reliably store any amount of data at costs that are competitive with or cheaper than on-premises solutions. To keep costs low yet suitable for varying needs, S3 Glacier provides three retrieval options that range from a few minutes to hours. We can upload objects directly to S3 Glacier or use S3 Lifecycle policies to transfer data between any of the S3 Storage Classes for active data (S3 Standard, S3 Intelligent-Tiering, S3 Standard-IA, and S3 One Zone-IA) and S3 Glacier.

- **Amazon S3 Glacier Deep Archive (S3 Glacier Deep Archive)** is Amazon S3's lowest-cost storage class and supports long-term retention and digital preservation for data that may be accessed once or twice in a year. It is designed for customers — particularly those in highly-regulated industries, such as the Financial Services, Healthcare, and Public Sectors — that retain data sets for 7-10 years or longer to meet regulatory compliance requirements. S3 Glacier Deep Archive can also be used for backup and disaster recovery use cases and is a cost-effective and easy-to-manage alternative to magnetic tape systems, whether they are on-premises libraries or off-premises services.

Amazon S3 Storage Classes

	S3 Standard	S3 Intelligent-Tiering*	S3 Standard-IA	S3 One Zone-IA†	S3 Glacier	S3 Glacier Deep Archive
Designed for durability	100.00% (11 9's)	100.00% (11 9's)	100.00% (11 9's)	100.00% (11 9's)	100.00% (11 9's)	100.00% (11 9's)
Designed for availability	99.99%	99.90%	99.90%	99.50%	99.99%	99.99%
Availability SLA	99.90%	99%	99%	99%	99.90%	99.90%
Availability Zones	≥3	≥3	≥3	1	≥3	≥3
Minimum capacity charge per object	N/A	N/A	128KB	128KB	40KB	40KB
Minimum storage duration charge	N/A	30 days	30 days	30 days	90 days	180 days
Retrieval fee	N/A	N/A	per GB retrieved	per GB retrieved	per GB retrieved	per GB retrieved
First byte latency	milliseconds	milliseconds	milliseconds	milliseconds	select minutes or hours	select hours
Storage type	Object	Object	Object	Object	Object	Object
Lifecycle transitions	Yes	Yes	Yes	Yes	Yes	Yes

Amazon FSx

Amazon FSx provides fully managed third-party file systems with the native compatibility and feature sets for workloads such as Microsoft Windows–based storage, high-performance computing, machine learning, and electronic design automation. Amazon FSx supports two file system types: Lustre and Windows File Server.

- **Amazon FSx for Windows File Server** provides fully managed Microsoft Windows file servers, backed by a fully native Windows file system. Amazon FSx for Windows File Server has the features, performance, and compatibility to easily lift and shift enterprise applications to the AWS Cloud. Amazon FSx has native support for Windows file system features and for the industry-standard Server Message Block (SMB) protocol to access file storage over a network.

- **Amazon FSx for Lustre** is (POSIX-compliant) and makes it easy and cost-effective to launch and run the popular, high-performance Lustre file system. We use Lustre for workloads where speed matters, such as machine learning, high performance computing (HPC), video processing, and financial modeling. Lustre was built to solve the problem of quickly and cheaply processing the world's ever-growing datasets. It's a widely used file system designed for the fastest computers in the world. It provides sub-millisecond latencies, up to hundreds of GBps of throughput, and up to millions of IOPS.

Amazon Snow

The AWS Snow Family is a service that helps customers who need to run operations in austere, non-data center environments, and in locations where there's no consistent network connectivity. We can use these devices to locally and cost-effectively access the storage and compute power of the AWS Cloud in places where an internet connection might not be an option.

AWS Snowball service uses physical storage devices to transfer large amounts of data between Amazon S3 and our onsite data storage location at faster-than-internet speeds. By working with AWS Snowball, we can save time and money. Snowball provides powerful interfaces that we can use to create jobs, track data, and track the status of our jobs through to completion. Snowball devices are physically rugged devices that are protected by the AWS Key Management Service (AWS KMS). They secure and protect our data in transit. Regional shipping carriers transport Snowballs between Amazon S3 and our onsite data storage location. Snowball is intended for transferring large amounts of data. Not an economical choice for data less than 10 TB.

The first-generation 80 TB Snowball device is no longer available. Use the Snowball Edge storage optimized devices for all data transfer jobs.

AWS Snowball Edge is a type of Snowball device with on-board storage and compute power for select AWS capabilities. Snowball Edge can do local processing and edge-computing workloads in addition to transferring data between our local environment and the AWS Cloud. Each Snowball Edge device can transport data at speeds faster than the internet. This transport is done by shipping the data in the appliances through a regional carrier. The appliances are rugged, complete with E Ink shipping labels. Snowball Edge devices have three options for device configurations—Storage Optimized, Compute Optimized, and Compute Optimized with GPU.

Amazon Snow

AWS Snowcone is a portable, rugged, and secure device for edge computing and data transfer. We can use Snowcone to collect, process, and move data to AWS, either offline by shipping the device to AWS, or online by using AWS DataSync. With two CPUs and 8 TB of storage, Snowcone can run edge computing workloads that use Amazon EC2 instances and store data securely. The Snowcone device is small (8.94" x 5.85" x 3.25" / 227 mm x 148.6 mm x 82.65 mm), so it can be placed next to machinery in a factory to collect, format, and transport data back to AWS for storage and analysis. Snowcone weighs about 4.5 lbs. (2 kg), so we can carry one in a backpack, use it with battery-based operation, and use the Wi-Fi interface to gather sensor data. Snowcone supports a file interface with NFS support. The Snowcone device supports data transfer from on-premises Windows, Linux, and macOS servers and file-based applications through the NFS interface.

AWS Snowmobile is an Exabyte-scale data transfer service used to move extremely large amounts of data to AWS. We can transfer up to 100PB per Snowmobile, a 45-foot long ruggedized shipping container, pulled by a semi-trailer truck. Snowmobile makes it easy to move massive volumes of data to the cloud, including video libraries, image repositories, or even a complete data center migration. Transferring data with Snowmobile is more secure, fast and cost effective. Snowmobile uses multiple layers of security to help protect our data including dedicated security personnel, GPS tracking, alarm monitoring, 24/7 video surveillance, and an optional escort security vehicle while in transit. All data is encrypted with 256-bit encryption keys we manage through the AWS Key Management Service (KMS) and designed for security and full chain-of-custody of our data.

AWS Storage Gateway

AWS Storage Gateway is a service that connects an on-premises software appliance with cloud-based storage to provide seamless and secure integration between our on-premises IT environment and the AWS storage infrastructure in the cloud.

File Gateway supports a file interface into Amazon S3 and combines a service and a virtual software appliance. By using this combination, we can store and retrieve objects in Amazon S3 using industry-standard file protocols such as Network File System (NFS) and Server Message Block (SMB). The software appliance, or gateway, is deployed into our on-premises environment as a virtual machine (VM) running on VMware ESXi, Microsoft Hyper-V, or Linux Kernel-based Virtual Machine (KVM) hypervisor. The gateway provides access to objects in S3 as files or file share mount points. With a file gateway, we can do the following:

- We can manage our S3 data using lifecycle policies, cross-region replication, and versioning. We can think of a file gateway as a file system mount on S3.

- We can store and retrieve files directly using the NFS version 3 or 4.1 protocol.

- We can store and retrieve files directly using the SMB file system version, 2 and 3 protocol.

- We can access our data directly in Amazon S3 from any AWS Cloud application or service.

AWS Storage Gateway

Volume Gateway provides cloud-backed storage volumes that we can mount as Internet Small Computer System Interface (iSCSI) devices from our on-premises application servers. It is deployed into our on-premises environment as a VM running on VMware ESXi, KVM, or Microsoft Hyper-V hypervisor.

The gateway supports the following volume configurations:

- **Cached volumes** – You store your data in Amazon Simple Storage Service (Amazon S3) and retain a copy of frequently accessed data subsets locally. Cached volumes offer a substantial cost savings on primary storage and minimize the need to scale your storage on-premises. You also retain low-latency access to your frequently accessed data.

- **Stored volumes** – If you need low-latency access to your entire dataset, first configure your on-premises gateway to store all your data locally. Then asynchronously back up point-in-time snapshots of this data to Amazon S3. This configuration provides durable and inexpensive offsite backups that you can recover to your local data center or Amazon Elastic Compute Cloud (Amazon EC2). For example, if you need replacement capacity for disaster recovery, you can recover the backups to Amazon EC2.

Tape Gateway – A tape gateway provides cloud-backed virtual tape storage. The tape gateway is deployed into your on-premises environment as a VM running on VMware ESXi, KVM, or Microsoft Hyper-V hypervisor.

Thank You!

If any questions please contact

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#hyperscalers-guild-aws-solution-architect