

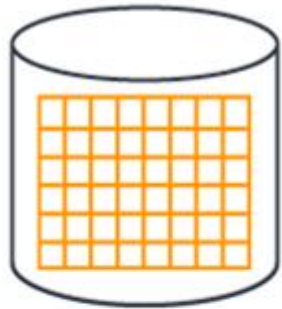


AWS Solutions Architect Associate

Session 1101

Storage: EBS, EFS and Storage Gateway

August/2024



Block Storage

Raw Storage

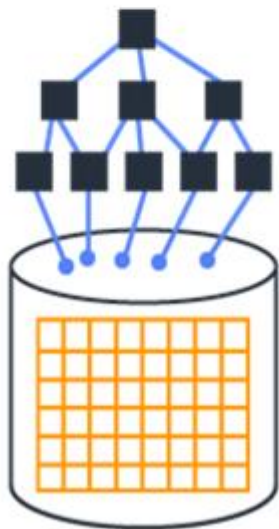
Data organized as an array of unrelated blocks

Host File System places data on disk

E.g.: Microsoft NTFS, Unix ZFS



EBS



File Storage

Unrelated data blocks managed by a file (serving) system

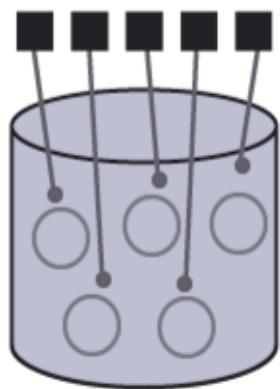
Native file system places data on disk



EFS



FSx

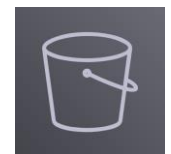


Object Storage

Stores Virtual containers that encapsulate the data, data attributes, metadata and Object ID

API Access to data

Metadata Driven, Policy-based, etc.



S3



Amazon Elastic Block Store



Volume



Snapshot

- Storage Block volume to EC2 instances, so its created on an AZ.
- Virtually unlimited scale. Elasticity as native property (using CLI without detaching).
- Each volume is replicated into AZ to protect against component errors and to offer HA and durability.
- It offers a fixed performance and low latency (<10 ms) to reach any workload, i.e. SQL DB/SAP, No SQL DB, big data/Hadoop.
- Data lifecycle using EBS Snapshots.
- EBS Direct API Calls: To manipulate snapshots (differences, blocks) and resizing volumes.
- Encryption using KMS.

Volume Type ⓘ	Device ⓘ	Snapshot ⓘ	Size (GiB) ⓘ	Volume Type ⓘ	IOPS ⓘ	Throughput (MB/s) ⓘ	Delete on Termination ⓘ	Encryption ⓘ
Root	/dev/xvda	snap-0e1167baa50e9c0ff	8	General Purpose SSD (gp2)	100 / 3000	N/A	<input checked="" type="checkbox"/>	Not Encrypted
EBS	/dev/sdb	snap-0bc7adc70ba6c	8	General Purpose SSD (gp2)	100 / 3000	N/A	<input type="checkbox"/>	Not Encrypted

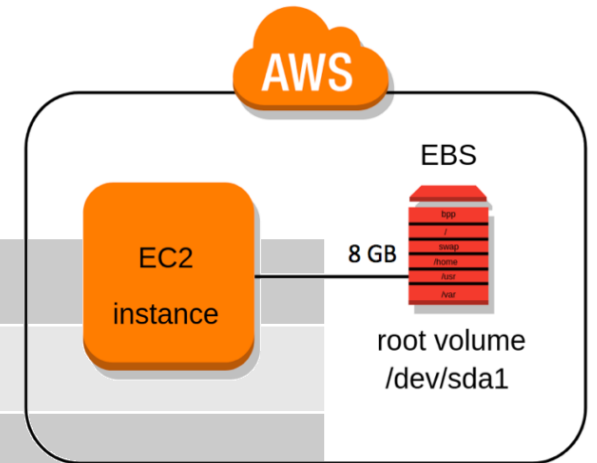
Add New Volume

Filter by attributes

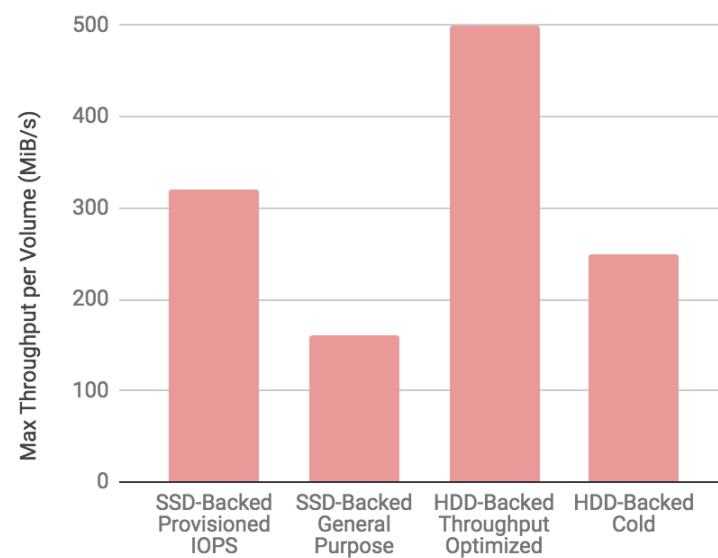
KMS Key Aliases	KMS Key ID
Not Encrypted	
(default) aws/ebs	5a265366-92c0-47f3-954f-71a9701b751a



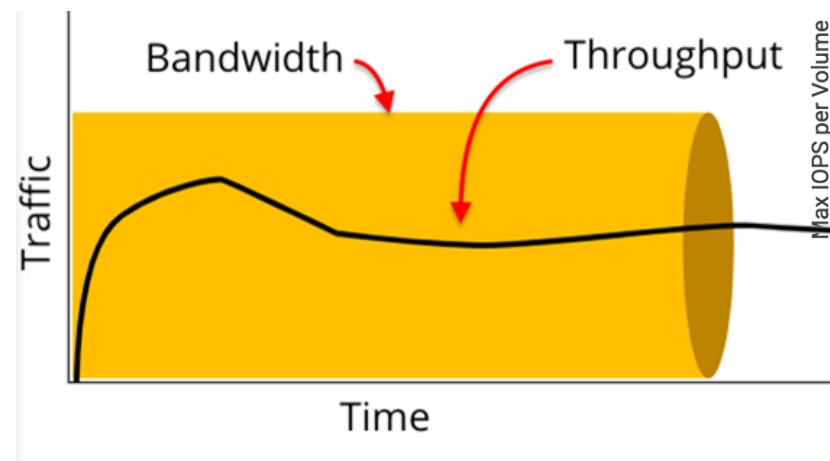
Root volume	Volume to boot an instance.
SSD / HDD	Solid State Disk or Hard Disk Drive
IOPS	I/O Operations per Second (Amount of responses). Important to have fast read and writing outputs in small files.
Throughput	Velocity to transport bytes (MB/s) (Size of the response). Important to get access to big and sequential files.
Old Generations	Magnetic volumes for cold storage.
Delete on termination	Protect to delete content when EC2 instance is terminated.



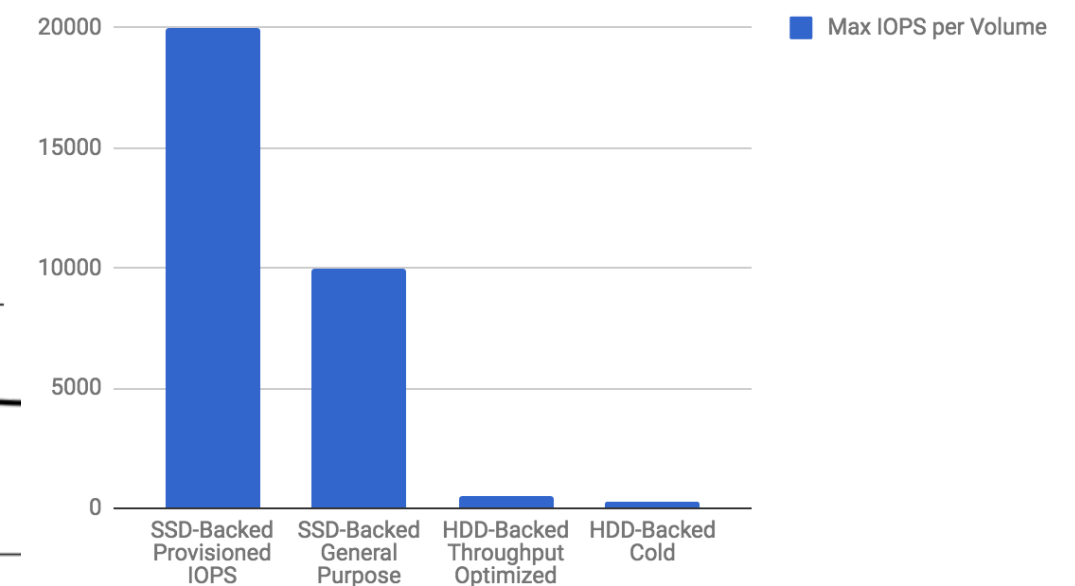
Max Throughput per Volume (MiB/s)



Max Throughput per Volume (MiB/s)



Max IOPS per Volume





	<u>General Purpose SSD volumes</u>		<u>Provisioned IOPS SSD volumes</u>		<u>Throughput Optimized HDD volumes</u>	<u>Cold HDD volumes</u>
Volume type	gp3	gp2	io2 Block Express ³	io1	st1	sc1
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% afr)	99.8% - 99.9% durability (0.1% - 0.2% afr)	99.8% - 99.9% durability (0.1% - 0.2% afr)
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	<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	1 GiB - 16 TiB		4 GiB - 64 TiB ⁴	4 GiB - 16 TiB	125 GiB - 16 TiB	125 GiB - 16 TiB
Max IOPS per volume	16,000 (64 KiB I/O)	16,000 (16 KiB I/O)	256,000 (16 KiB I/O) ⁵	64,000 (16 KiB I/O)	500 (1 MiB I/O)	250 (1 MiB I/O)
Max throughput per volume	1,000 MiB/s	250 MiB/s ¹	4,000 MiB/s	1,000 MiB/s ²	500 MiB/s	250 MiB/s
EBS Multi-attach	Not supported		Supported		Not supported	Not supported
NVMe reservations	Not supported		Supported	Not supported	N/A	
Boot volume	Supported				Not supported	Not supported

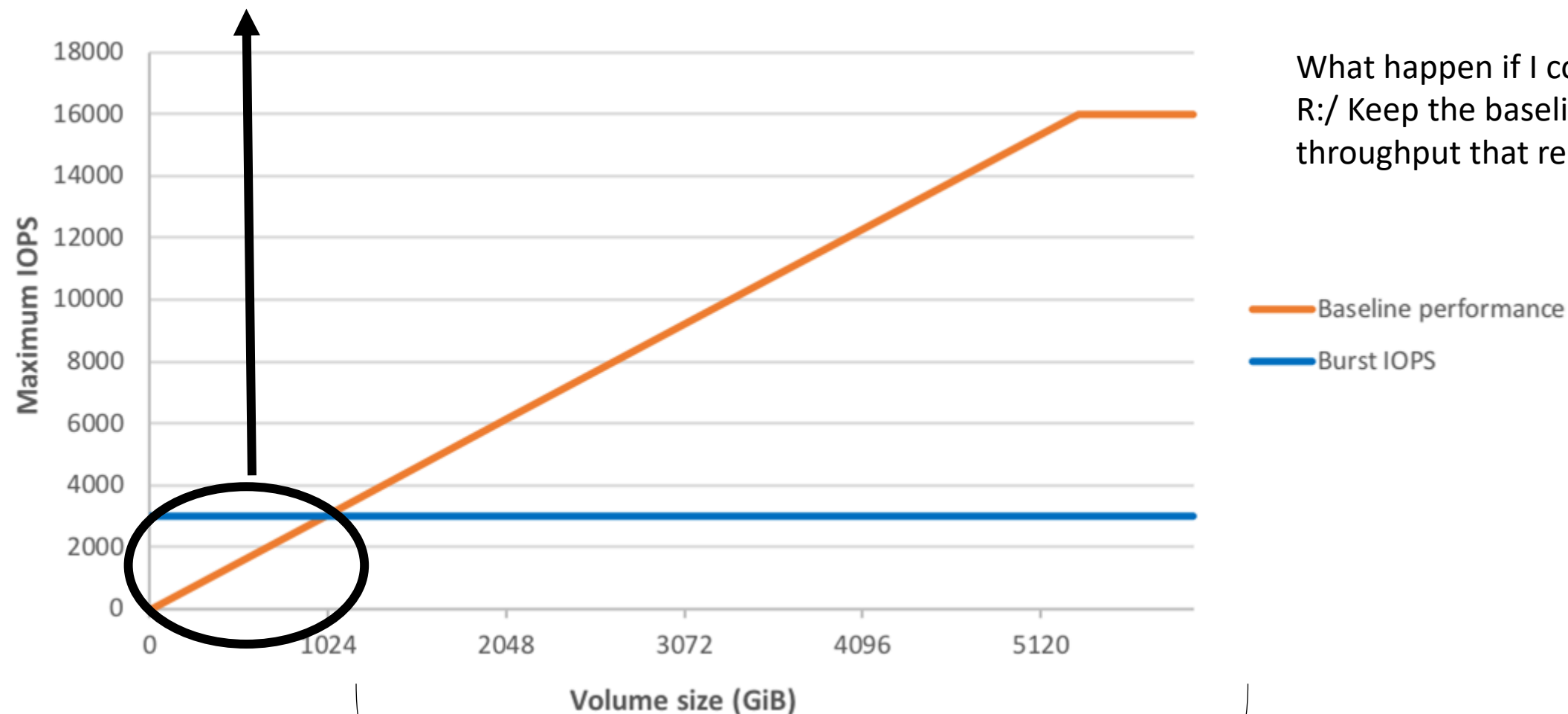
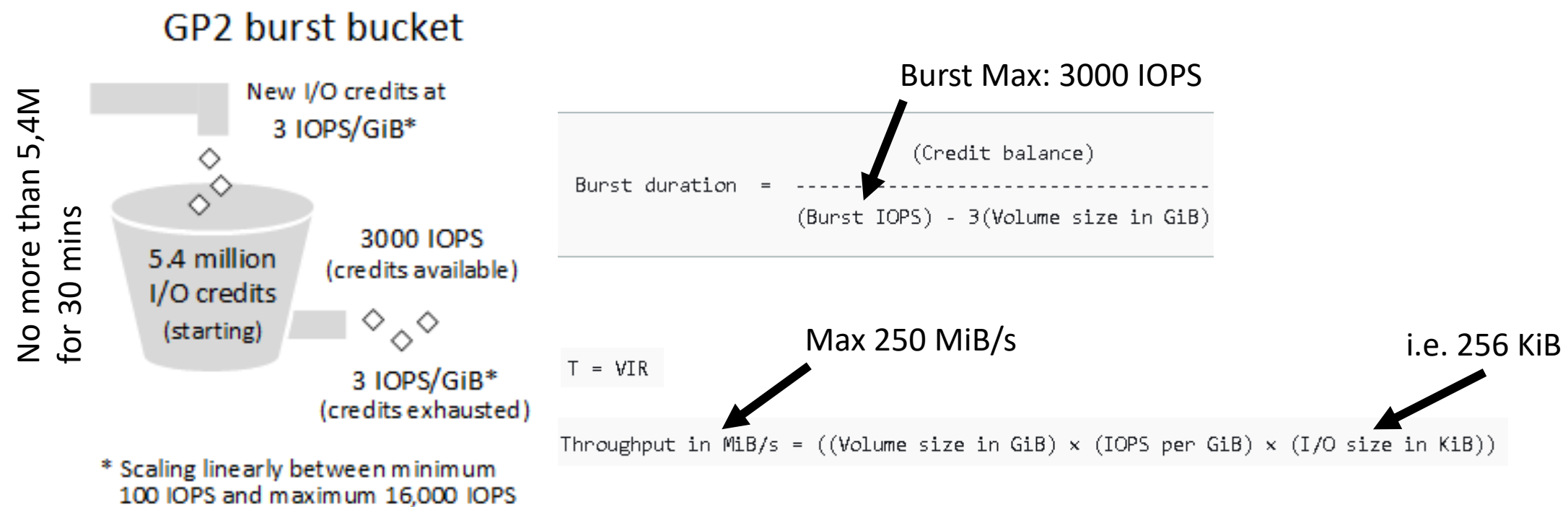
Note: It has a deprecated volume type: magnetic, the cheapest storage and its similar to sc1.



GP3

Latest generation for SSD, 20% cheaper than GP2.
Doesn't offer burst performance, 3k IOPS as base with 500 IOPS/Gb upto 16k IOPS per volume.
Throughput base is 125MiB/s with 0.25 MiB per provisioned IOPS upto 1000 MiB/s (4k IOPS)

GP2



What happen if I consume the IO credits?
R:/ Keep the baseline IOPS therefore limit the max throughput that reach.

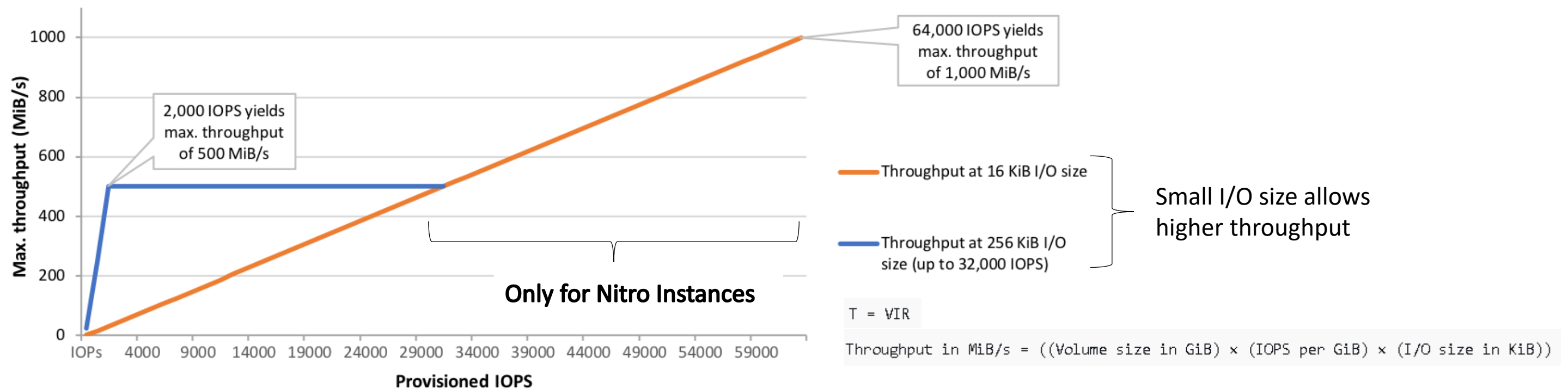
Never used I/O credits



IO1

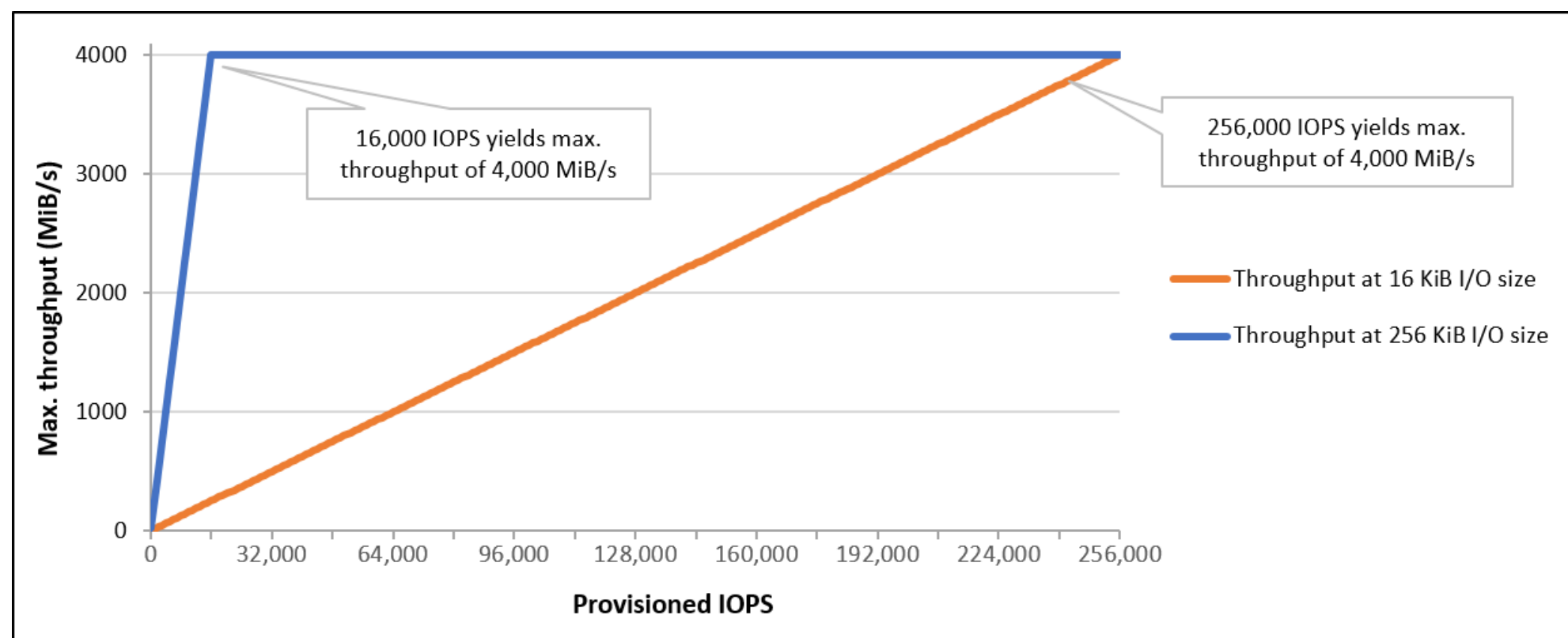
The max IOPS ratio is 50 (in GiB):1, i.e. Volume of 100 GiB provide max 5000 IOPS, in comparison with baseline IOPS performance of GP2 which is 3.

The max IOPS are 64k for Nitro Instances (the volume size is 1280 GiB), otherwise 32k.



IO2 Express

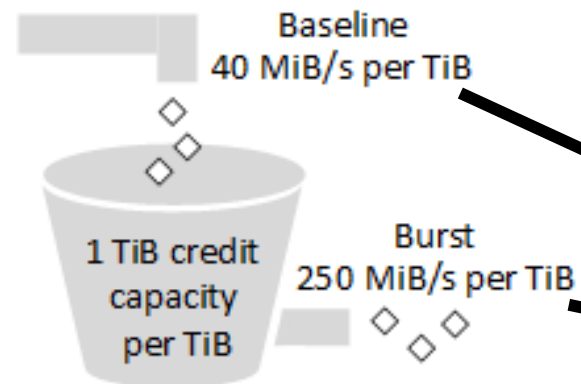
The max IOPS ratio is 1000 (in GiB):1. The max IOPS are 256k for Nitro Instances (volume size is 256 GiB), otherwise 32k.



Taken from
<https://docs.aws.amazon.com/ebs/latest/userguide/provisioned-iops.html> (20/07/2024)



ST1 burst bucket

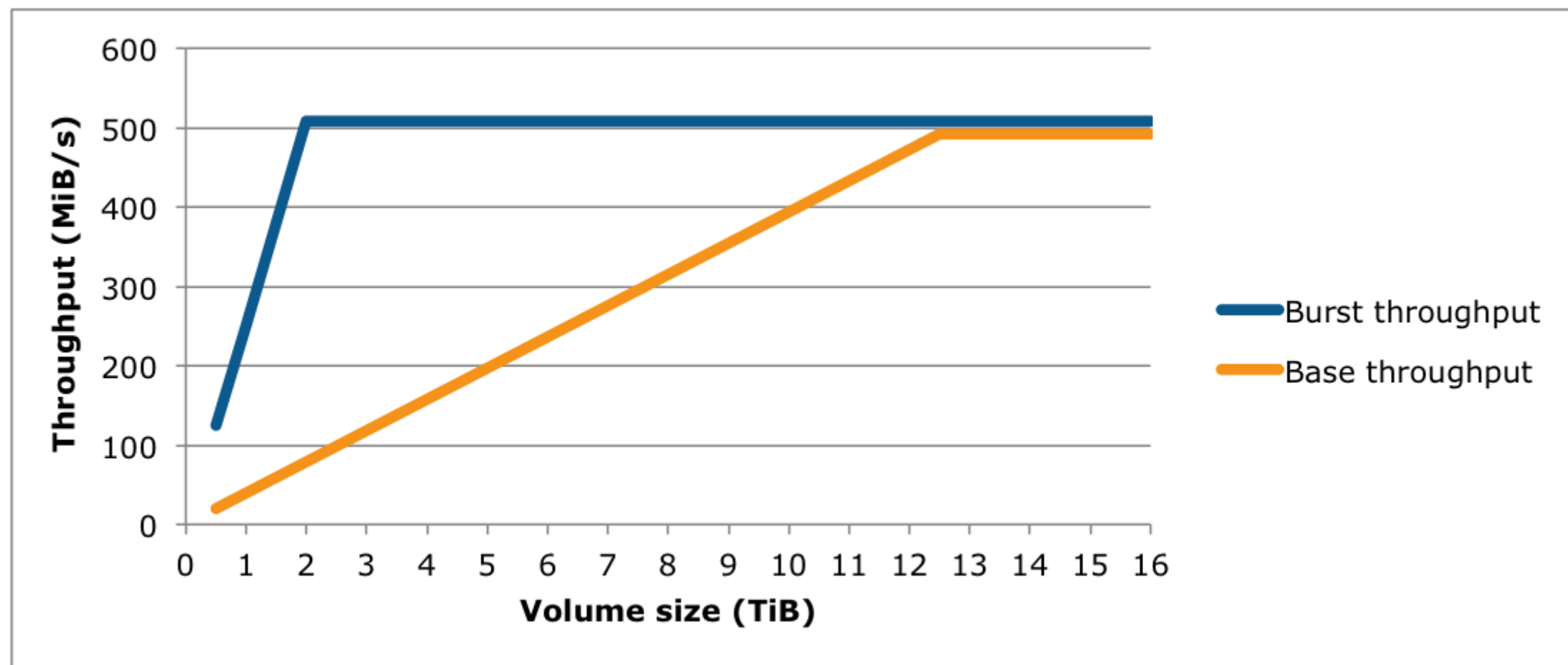


Max. Throughput = 500 MiB/s

You have a baseline of 40MiB/s per TiB which don't use credit capacity.

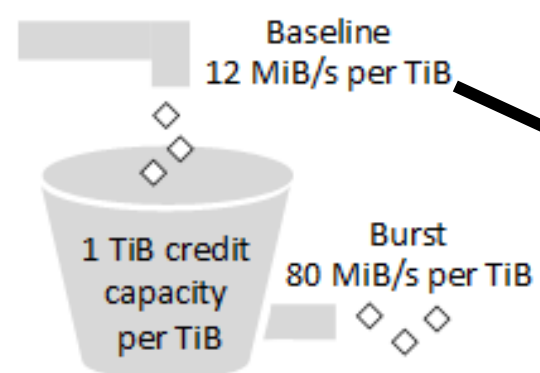
When you need to deliver a spike of data, you use burst capacity in a range of 250 MiB/s per TiB.

$$(\text{Volume size}) \times (\text{Credit accumulation rate per TiB}) = \text{Throughput}$$





SC1 burst bucket



$$(\text{Volume size}) \times (\text{Credit accumulation rate per TiB}) = \text{Throughput}$$

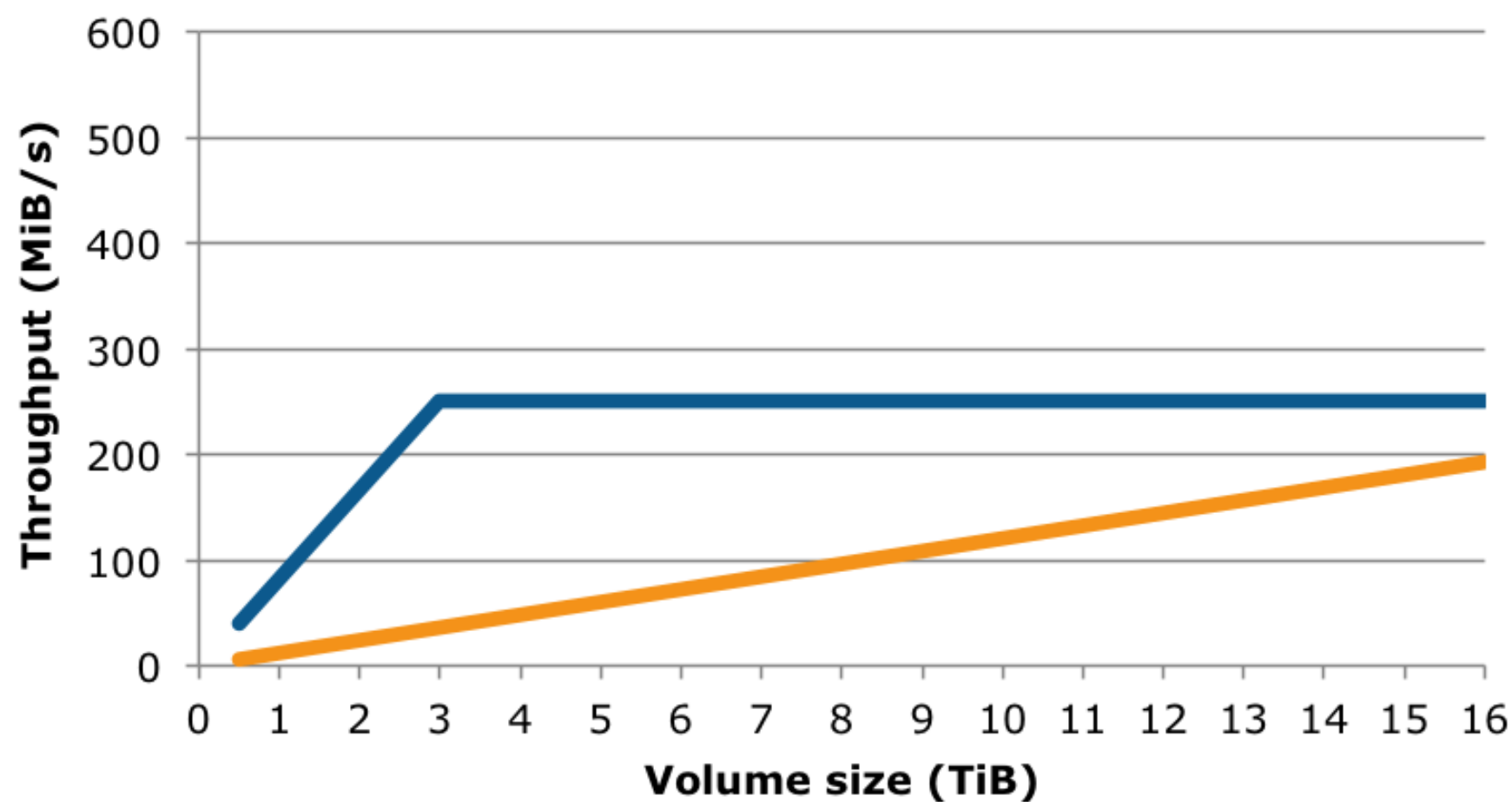
For ST1 and SC1,

$$\frac{\text{Volume size}}{\text{Throughput}} = \text{Scan time}$$

$$\text{Minimum time} = \text{Scan time} / ((\text{burst \%}) (\text{time \%}))$$

Usually,
burst time % = 0.99
time % = 0.9

$$\text{Minimum time} = \text{Scan time} * 1.12$$



Max. Throughput = 250 MiB/s

— Burst throughput
— Base throughput



Resource	Default Limit
Number of EBS volumes	5,000
Number of EBS snapshots	10,000
Total volume storage of General Purpose SSD (gp2) volumes	20 TiB
Total volume storage of Provisioned IOPS SSD (io1) volumes	20 TiB
Total volume storage of Throughput Optimized HDD (st1)	20 TiB
Total volume storage of Cold HDD (sc1)	20 TiB
Total volume storage of Magnetic volumes	20 TiB
Total provisioned IOPS	40,000

Resource	Default
Number of EBS snapshots per Region	100,000
Concurrent snapshot copies to a single destination Region	20
Number of EBS snapshots enabled for fast snapshot restore	50

General Purpose SSD (gp2) volumes	
Resource	Default
Concurrent snapshots for a single volume	5
Total volume storage	300 TiB
Maximum modifying storage	100 TiB

Provisioned IOPS SSD (io1) volumes	
Resource	Default
Concurrent snapshots for a single volume	5
Total volume storage	300 TiB
Total provisioned IOPS	300,000
Maximum modifying storage	100 TiB
	100,000

2019

2020

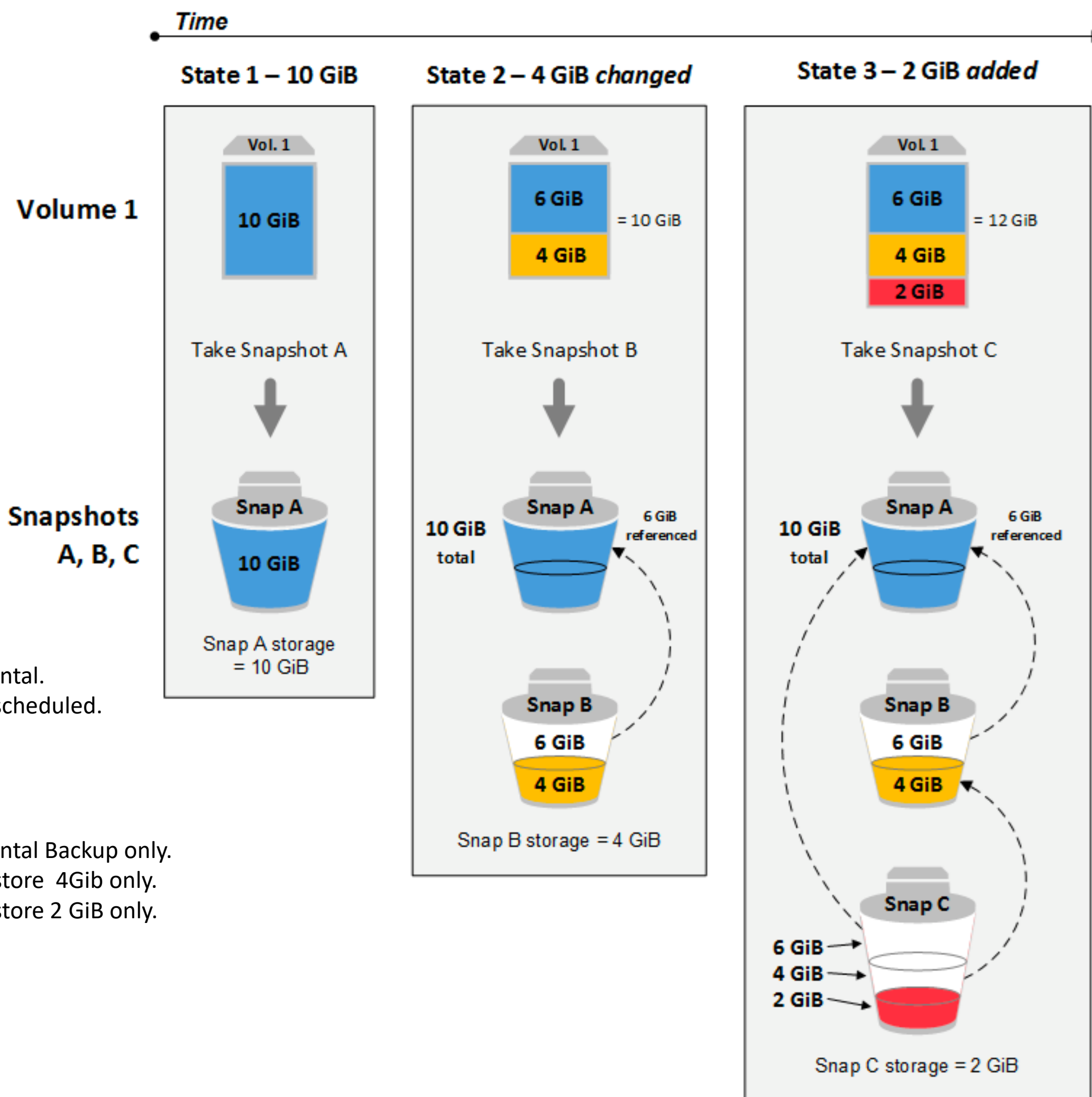
Cold HDD (sc1) volumes	
Resource	Default
Concurrent snapshots for a single volume	1
Total volume storage	300 TiB
Maximum modifying storage	100 TiB

Throughput Optimized HDD (st1) volumes	
Resource	Default
Concurrent snapshots for a single volume	1
Total volume storage	300 TiB
Maximum modifying storage	100 TiB

Provisioned IOPS SSD (io2) volumes	
Resource	Default
Concurrent snapshots for a single volume	5
Total volume storage	20 TiB
Total provisioned IOPS	100,000
Maximum modifying storage	20 TiB
Maximum modifying IOPS	100,000



EBS – Snapshots

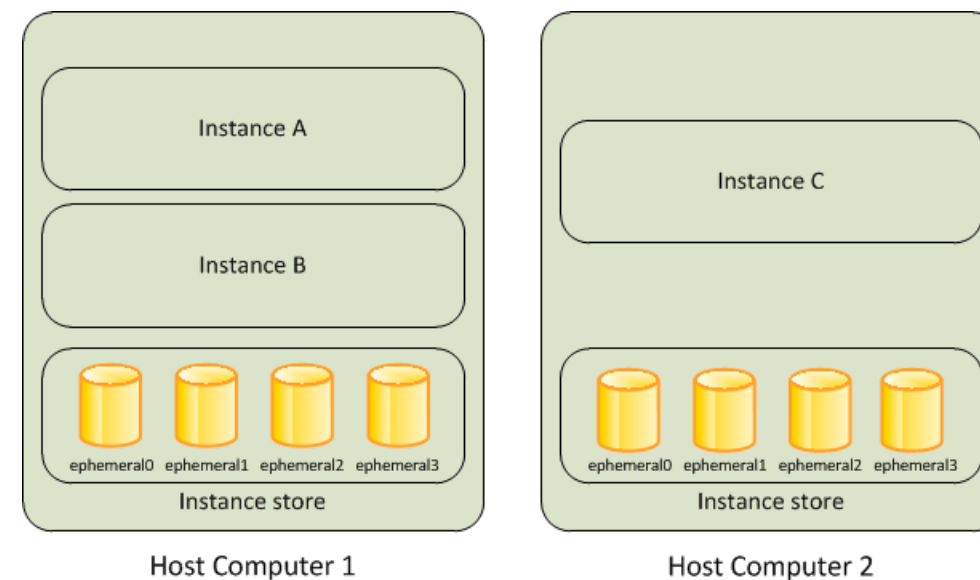


Incremental.
Can be scheduled.
Any OS.

Incremental Backup only.
State 2 store 4Gib only.
State 3 store 2 GiB only.



- Use case: replicated volumes/sharing, move between AZ, resizing volume and backup.
- Scope: Regional. Due to regulatory laws, you can make additional procedure to move.
- You can use to create AMI on the same region.
- Copy snapshot to another regions to have geo expansion, datacenter migration or DRP.
- You used when it have completed status.
- Keep the encrypted option (from and to volume). In addition, you can encrypted an unencrypted volume. All options using KMS.
- You can used to create AMI.
- Fast Snapshot Restore (FSR): No better performance, Additional pricing.



- An ephemeral block storage (similar to EBS) which provide startup storage to EC2 Instance (Max 10 GB). Can use Linux AMI for boot up using this storage.
- Ideal for frequent and temp access: buffers, cache (swap for Linux); because those store are physical attached to the instance (low latency).
- You can create AMI from an instance however the AMI don't get any information about that storage, therefore its recommend using EBS Snapshots.



- Span on instance lifetime only.
- Don't store important information.
- If there are reasons that you lost data from instance storage:
 - Stop/Terminate (no apply for Reboot).
 - Hard disk fail.

“Some instance types use NVMe or SATA-based solid state drives (SSD) to deliver high random I/O performance. This is a good option when you need storage with very low latency, but you don't need the data to persist when the instance terminates or you can take advantage of fault-tolerant architectures.”

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 4: Add Storage

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. [Learn more](#) about storage options in Amazon EC2.

Volume Type ⓘ	Device ⓘ	Snapshot ⓘ	Size (GiB) ⓘ	Volume Type ⓘ	IOPS ⓘ	Throughput (MB/s) ⓘ	Delete on Termination ⓘ	Encryption ⓘ
Root	/dev/xvda	snap-08be832481aebc7df	8	General Purpose SSD (gp2) ▼	100 / 3000	N/A	<input checked="" type="checkbox"/>	Not Encrypted ▼
ephemeral0	/dev/nvme0n1	N/A	75	NVMe SSD	N/A	N/A	N/A	Hardware Encrypted

Add New Volume

Free tier eligible customers can get up to 30 GB of EBS General Purpose (SSD) or Magnetic storage. [Learn more](#) about free usage tier eligibility and usage restrictions.

More info at <https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/InstanceStorage.html> and <https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/instance-store-lifetime.html> (20/07/2024)



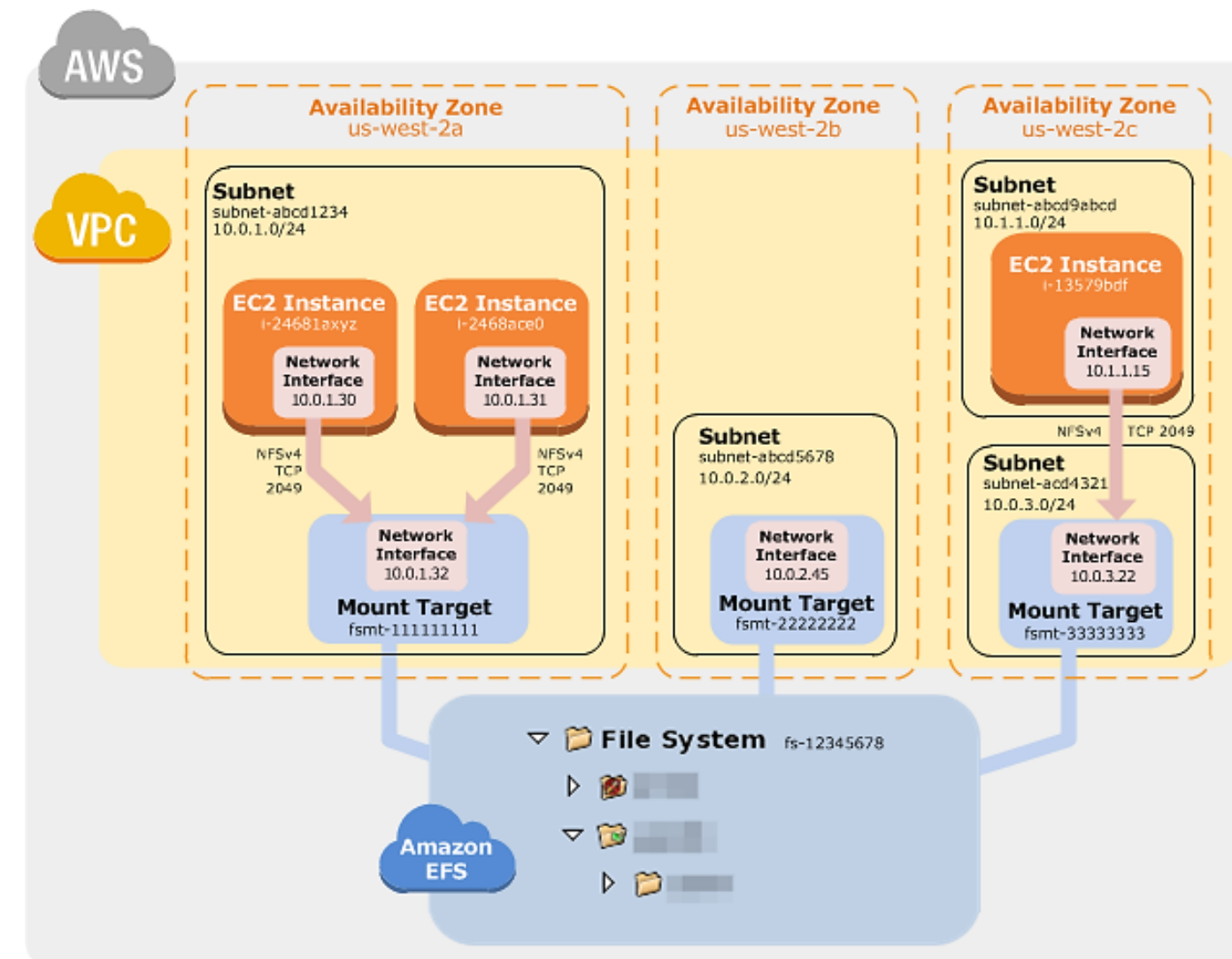
Amazon Elastic File System

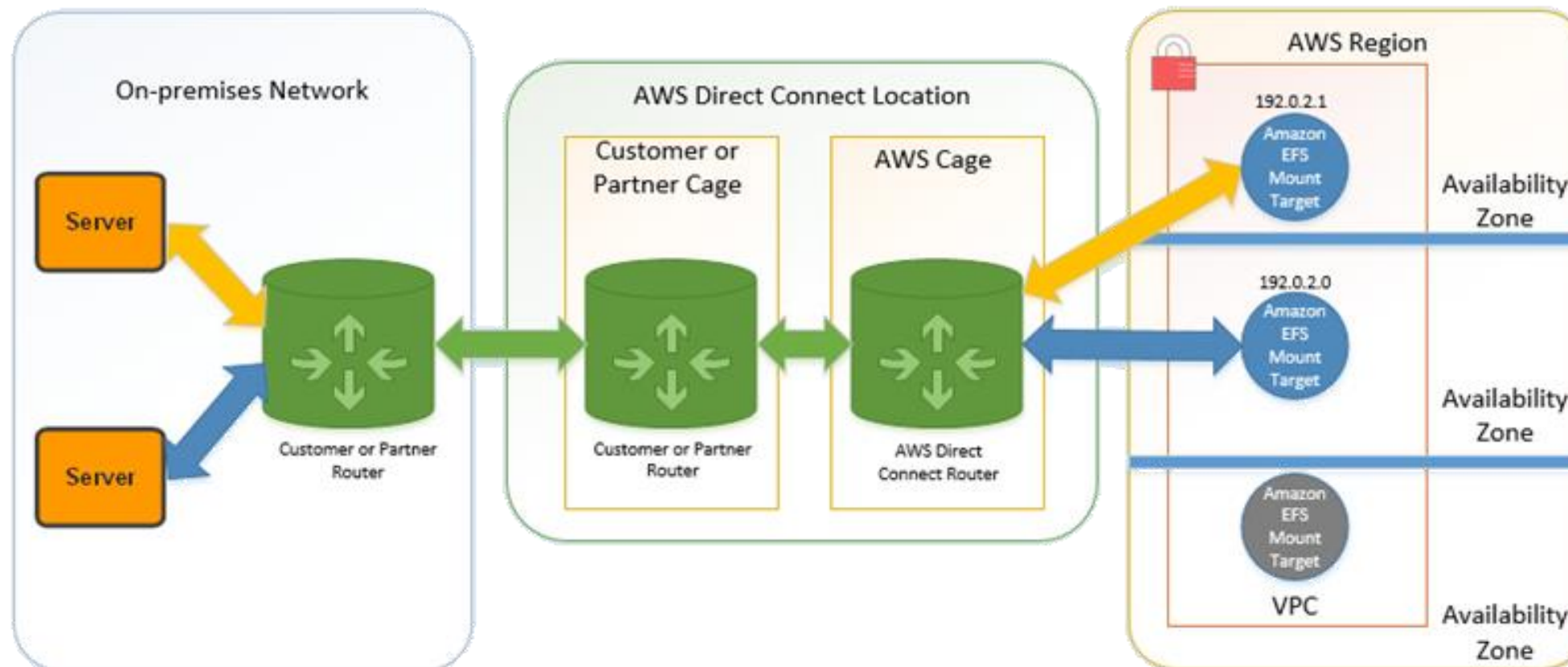
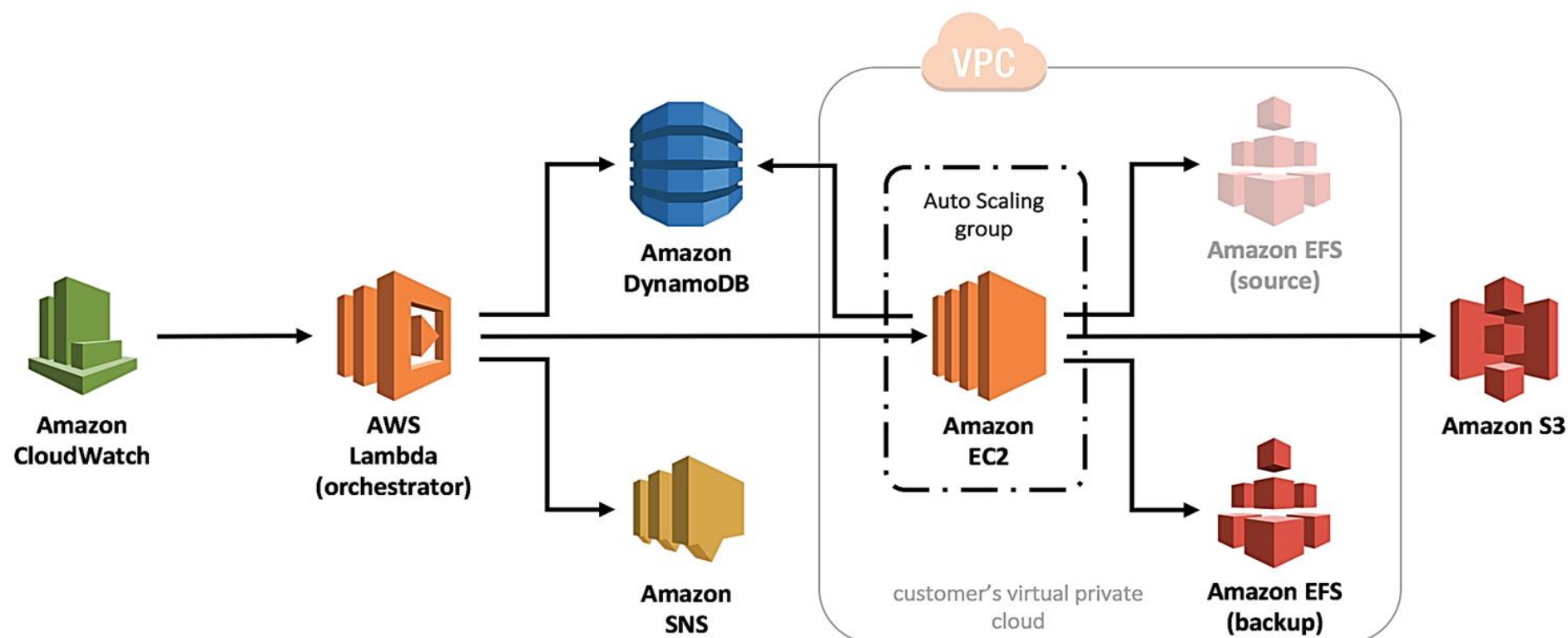


File system

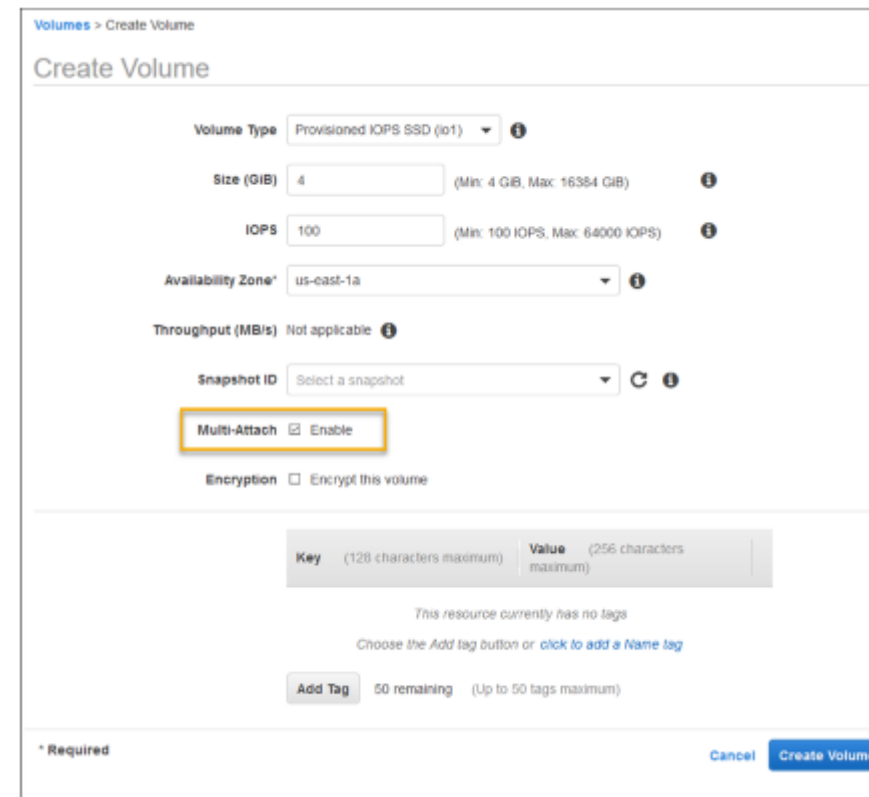
- Full managed service to provide simple and scalable storage to use on EC2.
- Elastic capacity due to file usage to avoid disruption.
- Simple GUI service to configure FS, quickly and simple.
- NFSv4 (4 and 4.1) Compatibility.
- Designed to share storage simultaneously on cloud or On Premise using Direct Connect.
- Pay only for real usage storage (By used GB, not per provisioning).
- Think it like a cloud SAN.

- Lifecycle Management: EFS Standard, EFS Infrequent Access, and EFS Archive.
- The expected performance for your Amazon EFS file system depends on its specific configuration (for instance, storage class and throughput mode) and the specific file system operation type (read or write).
- Throughput Mode: Elastic, Provisioned and Bursting; i.e. 500k IOPS and 10 Gb/s.
- Encryption in-transit and in-rest: TLS and KMS.

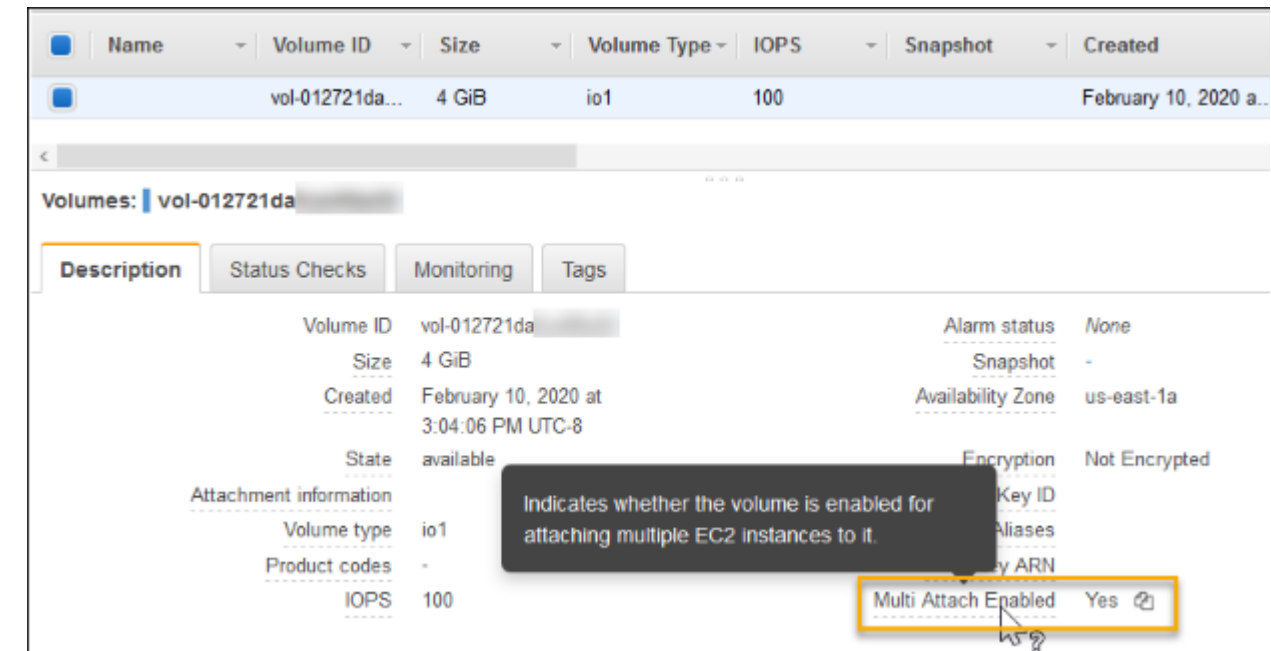




- IO1 or IO2 Storage Type (Lin/Win Limits).
- Up to 16 Nitro Systems.
- I/O Fencing.
- Some regions (3 for IO1 and every where IO2 run).
- No boot volume.
- FS no recommended = Remounted to see changes (Lab9)



The screenshot shows the 'Create Volume' page in the AWS Management Console. The 'Volume Type' is set to 'Provisioned IOPS SSD (io1)'. The 'Size (GiB)' is 4, and 'IOPS' is 100. The 'Availability Zone' is 'us-east-1a'. The 'Multi-Attach' checkbox is checked and highlighted with a yellow box. The 'Encryption' checkbox is unchecked.



The screenshot shows the 'Volumes' console page for volume 'vol-012721da'. The 'Multi Attach Enabled' checkbox is highlighted with a yellow box. A tooltip indicates that this checkbox 'Indicates whether the volume is enabled for attaching multiple EC2 instances to it.'

Name	Volume ID	Size	Volume Type	IOPS	Snapshot	Created
	vol-012721da...	4 GiB	io1	100		February 10, 2020 a..

Description		Status Checks	Monitoring	Tags
Volume ID	vol-012721da	Alarm status	None	
Size	4 GiB	Snapshot	-	
Created	February 10, 2020 at 3:04:06 PM UTC-8	Availability Zone	us-east-1a	
State	available	Encryption	Not Encrypted	
Attachment information		Key ID		
Volume type	io1	Aliases		
Product codes	-	ARN		
IOPS	100	Multi Attach Enabled	Yes	

Comparing Amazon Cloud Storage

aws.amazon.com/efs/when-to-choose-efs/

The table below compares performance and storage characteristics for Amazon's highest performing file, object, and block cloud storage offerings.

		File Amazon EFS	Object Amazon S3	Block Amazon EBS
Performance	Per-operation latency	Low, consistent	Low, for mixed request types, and integration with CloudFront	Lowest, consistent
	Throughput scale	Multiple GBs per second	Multiple GBs per second	Single GB per second
Characteristics	Data Availability/Durability	Stored redundantly across multiple AZs	Stored redundantly across multiple AZs	Stored redundantly in a single AZ
	Access	One to thousands of EC2 instances or on-premises servers, from multiple AZs, concurrently	One to millions of connections over the web	Single EC2 instance in a single AZ
	Use Cases	Web serving and content management, enterprise applications, media and entertainment, home directories, database backups, developer tools, container storage, big data analytics	Web serving and content management, media and entertainment, backups, big data analytics, data lake	Boot volumes, transactional and NoSQL databases, data warehousing & ETL



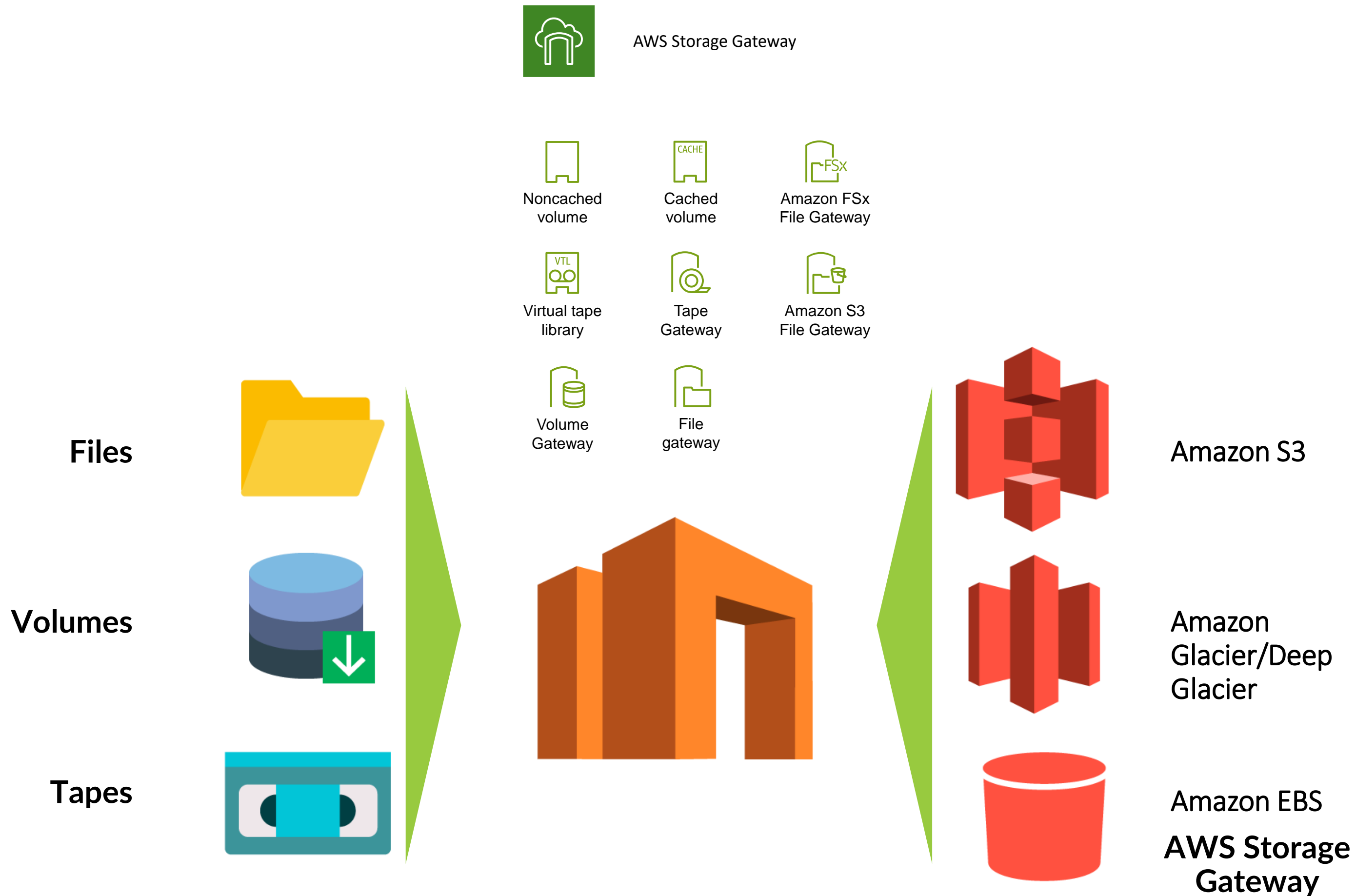
COVID-19 Initiatives Services Industries Products

Taken from <https://www.powerupcloud.com/amazon-ebs-multi-attach-now-available-on-provisioned-iops-io1-volumes/> (16/05/2020)

Definition	Amazon EBS is the block storage offered on AWS. An Amazon EBS volume is a persistent storage device that can be used as a file system for databases, application hosting and storage, and plug and play devices.	Amazon EFS is an NFS file system service offered by AWS. An Amazon EFS file system is excellent as a managed network file system that can be shared across different Amazon EC2 instances and works like NAS devices.
Accessibility	Accessible via single EC2 instance(updated to multiple provisioned instances)	Accessible from multiple availability zones in the same region
Performance	Manually scale the size of the volumes without stopping instance.Baseline performance of 3 IOPS per GB for General Purpose volume.Use Provisioned IOPS for increased performance	Highly Scalable Managed Service.Supports up to 7000 file system operations per second
Scalability	Manual Scale up	Scalable
Availability	99.99 Percent	No Publicly available SLA(Service level agreement)
Access Control	Security group.Use-based authentication(IAM)	IAM user-based authentication.Security groups



Hybrid Storage

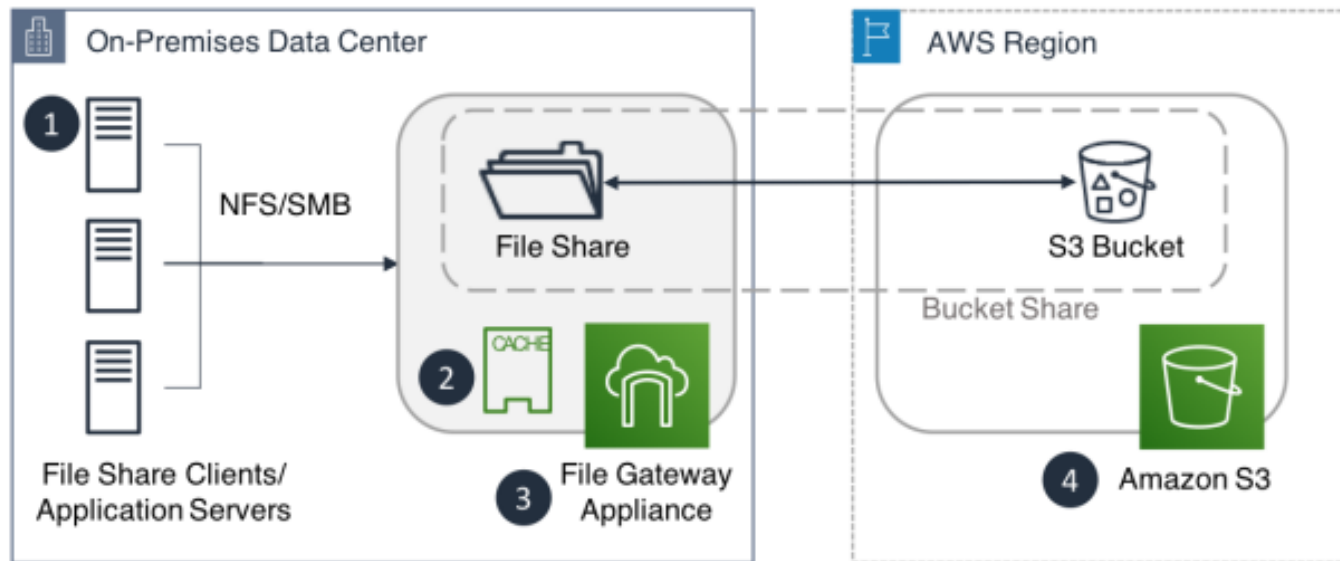




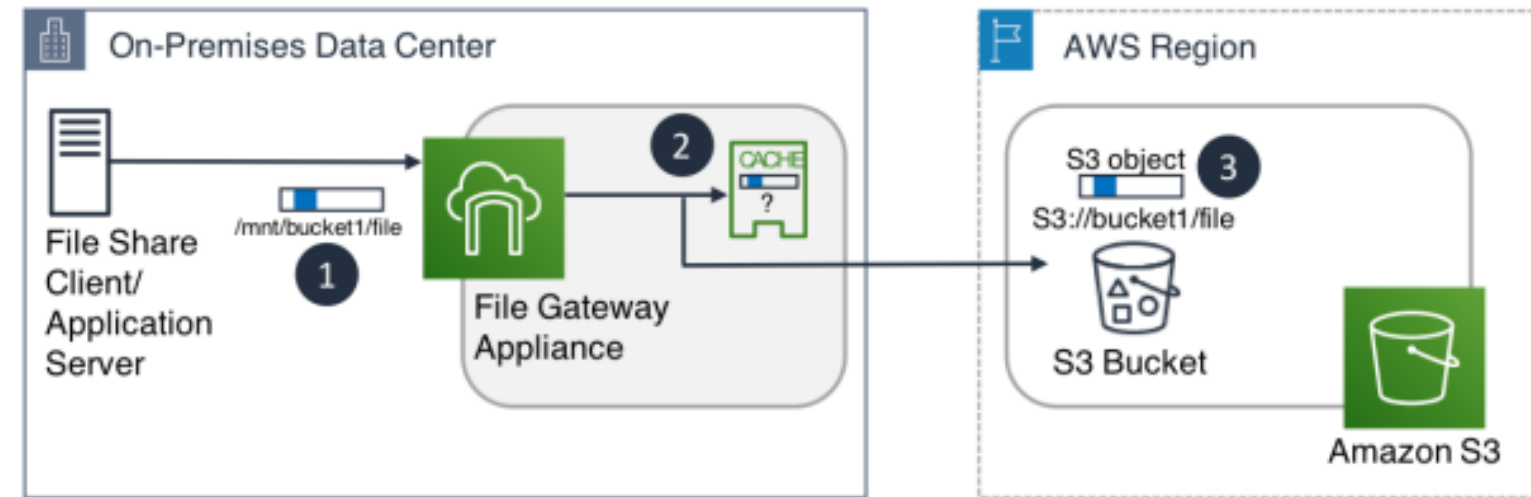
Definition	a hybrid storage service that connects on-premises with cloud-based storage
Use Case	Backup, archiving, disaster recovery and cloud data processing.
Protocols	NFS, SMB and iSCSI.
Integration with	S3, EBS, Glacier, Glacier Deep Archive.
Steps	Download an VM, configure and use it.
Security	by default, uploads data using SSL and provides data encryption-at-rest when stored in S3 or Glacier using AES-256 (SSE-S3). Even, when you use File GW, you can use SSE-KMS for each file.



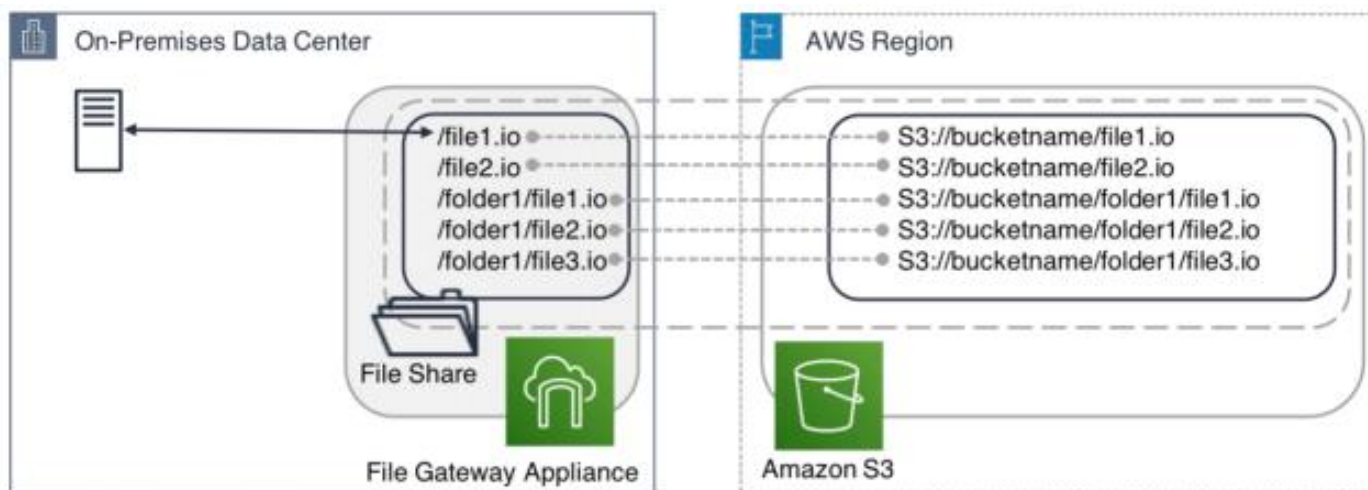
- Mount a VMware appliance on your local LAN, and it provided an NFS/SMB Server (NFS v3, 4.1 or SMB v1,2) as cache.
- It has a mapped with a S3 bucket.
- Take account on S3 features: multi load part, CRR, KMS.



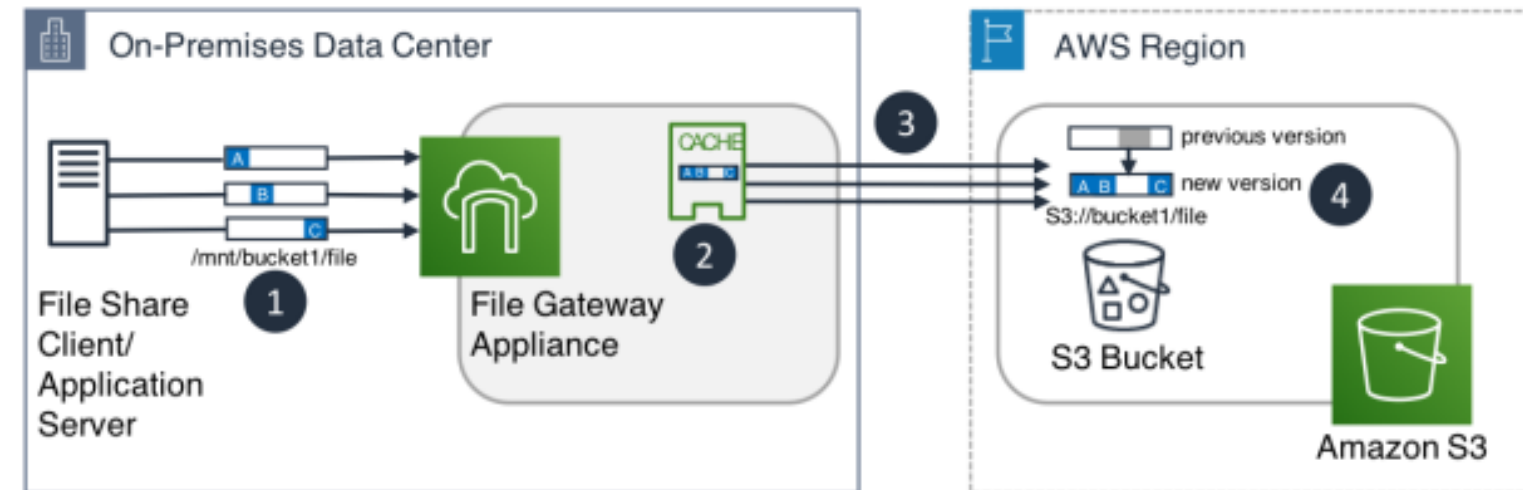
Normal operation



Read Operation



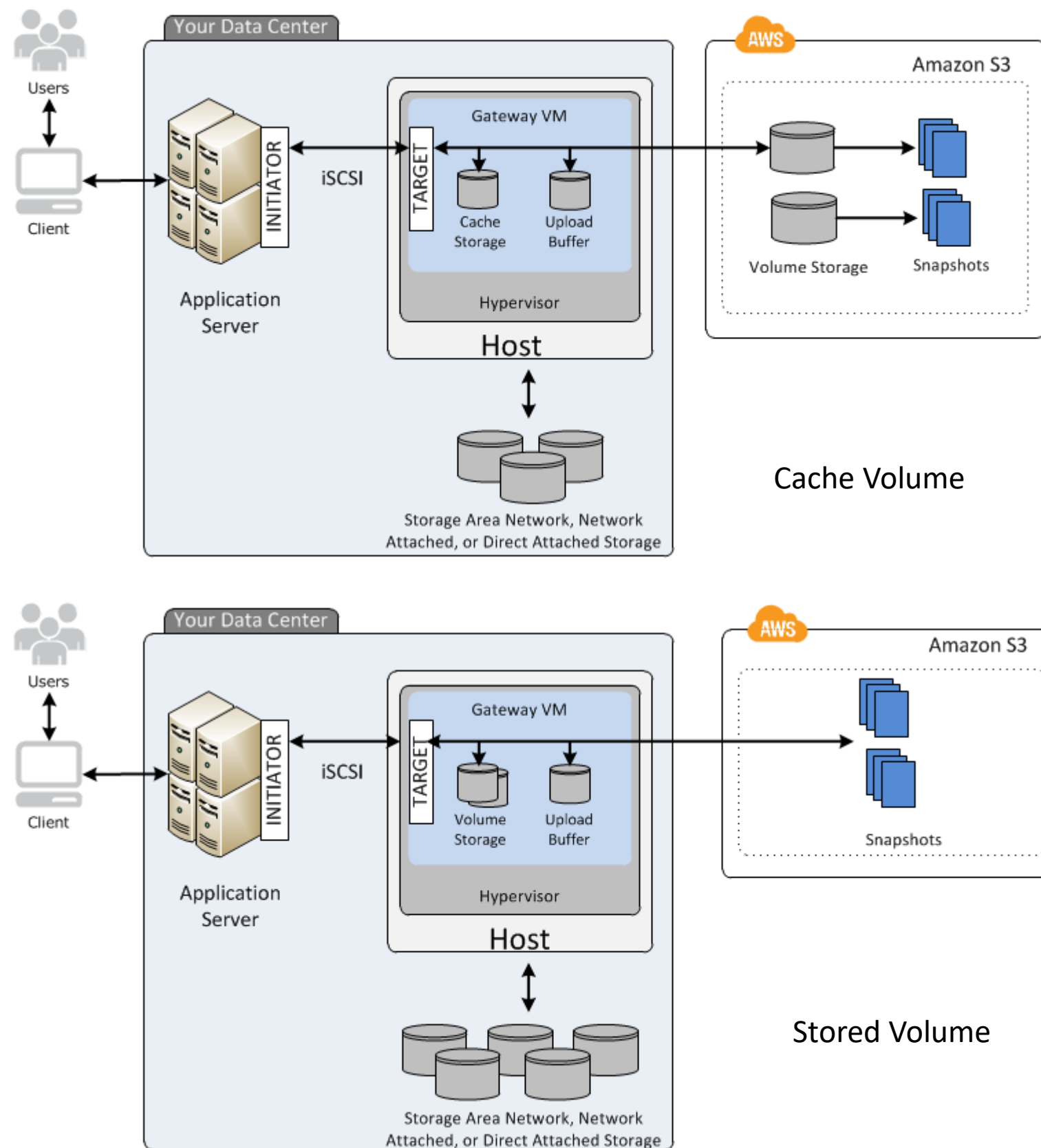
Mapped one-to-one with S3



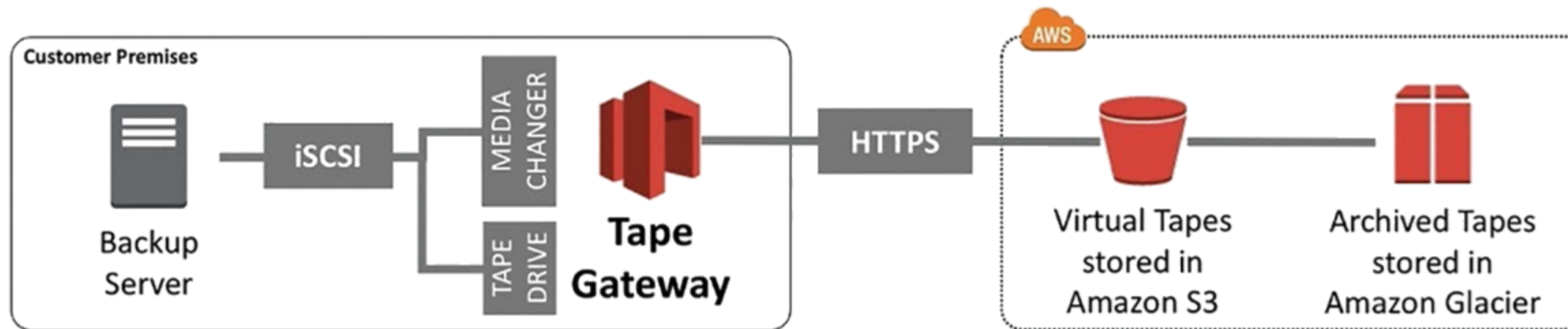
Write Operation using multipart upload / incremental writing



Volume Gateway



- It shows as iSCSI Volume locally.
- It has 2 options: Cache volume and Store volume.
- **Cache Volume:** Primary data storage on S3. Additional frequented access files on cache to improved latency, and async upload to Volumes Store (after snapshot). Volume up to 32TB/Up to 32 Volume GW → 1PB.
- **Stored volume:** Primary data storage locally using DAS/SAN. Async to EBS Snapshot. It is used as DRP or backup. Volume up to 16TB/Up to 32 Volume GW → 512TB.



Supports leading backup applications:

- Virtual Tape Library - VTL

VERITAS

DELL EMC

VEEAM

Hewlett Packard
Enterprise

Microsoft
System Center
Data Protection Manager 2012

arcserve

- Replace tape backup using the cloud.
- Current tapes can be migrated to the cloud.
- Concepts:
- Virtual Tape, VTL (Media Changer, Tape Drive), Archive, Archiving Tapes, Retrieving Tapes.



Storage Gateway - MindMap

