



Storage on AWS

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Agenda

- Introduction
- Storage Primer
- Block Storage
- Shared File Systems
- Object Store
- On-Premises Storage Integration

Introduction: Why choose AWS for storage

Compelling Economics

Pay as you go

No risky capacity planning

No need to provision for redundancy or overhead

Easy to Use

Self service administration

SDKs for simple integration

No Commitment

Reduce risk

Durable and Secure

Avoid risks of physical media handling

Speed, Agility, Scale

Reduce time to market

Focus on your business, not your infrastructure

Global Scale



Storage Primer

Block vs File vs Object



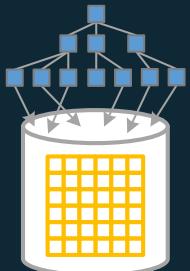
Block Storage

Raw Storage

Data organized as an array of unrelated blocks

Host File System places data on disk

Ex: Hard Disks, Storage Area Network (SAN) Storage Arrays

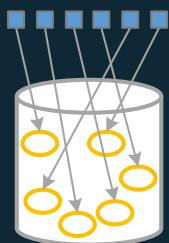


File Storage

Unrelated data blocks managed by a file (serving) system

Native file system places data on disk

Ex: Network Attached Storage (NAS) Appliances, Windows File Servers



Object Storage

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

API Access to data

Metadata Driven, Policy-based, etc.

Ex: Ceph, OpenStack Swift

Storage - Characteristics

Some of the ways we look at storage

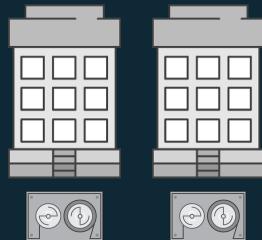
Durability	Availability	Security	Cost	Scalability	Performance	Integration
Measure of expected data loss	Measure of expected downtime	Security measures for at-rest and in-transit data	Amount per storage unit, e.g. \$ / GB	Upward flexibility, storage size, number of users	Performance metrics (bandwidth)	Ability to interact via API or with other services

Understanding Durability



Two copies on one site

designed for
99.99%
durability



Copies on two sites

designed for
99.999%
durability



copies in three AZ

designed for
99.999999999%
durability

Availability vs Durability

%	Availability	Durability
99.999	5 minutes 15 seconds	1 in 100,000
99.9999	31 seconds	1 in 1,000,000
99.99999	3 seconds	1 in 10,000,000
99.999999999	300 uSeconds	1 in 100,000,000,000

More choice for more applications

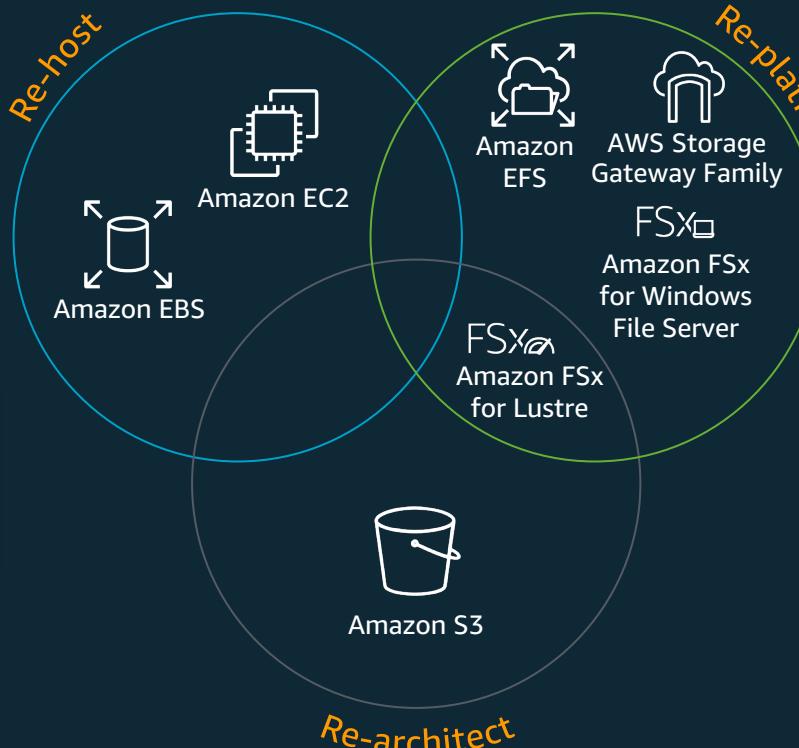
Block storage

- General Purpose SSD
- Provisioned IOPS SSD
- Throughput-Optimized HDD
- Cold HDD



Backup

- AWS Backup



File storage

- EFS Standard
- EFS Infrequent Access
- FSx for Windows
- FSx for Lustre



Object storage

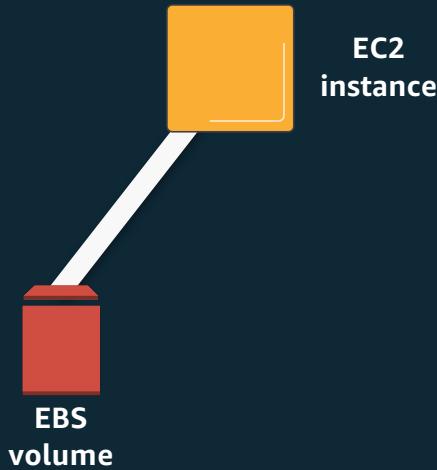
- S3 Standard
- S3 Standard-IA
- S3 One Zone-IA
- S3 Intelligent-Tiering
- S3 Glacier
- S3 Glacier Deep Archive



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Block Storage

What is Amazon EBS?



- Block storage as a service
- Create, attach volumes through an API
- Service accessed over the network

AWS EBS Features

Durable

Designed for 99.999 reliability

Redundant storage across multiple devices within an AZ

Secure

Identity and Access Policies

Encryption

Scalable

Capacity when you need it

Easily scale up and down

Performance

Low-latency SSD

Consistent I/O Performance

Stripe multiple volumes for higher I/O performance

Backup

Point-in-time Snapshots

Copy snapshots across AZ and Regions

Amazon EBS

Network attached block device

- Independent data lifecycle
- Multiple volumes per EC2 instance
- **Only one EC2 instance at a time per volume**
- Can be detached from an instance and attached to a different one

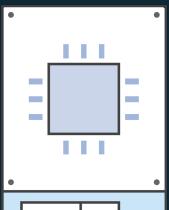
Raw block devices

- Unformatted block devices
- Ideal for databases, filesystems

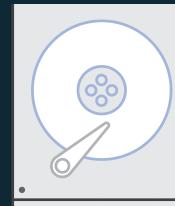
Multiple Drive Types

- SSD (gp2 & io1) and HDD (st1 & sc1)

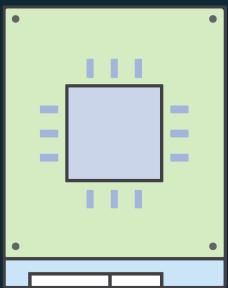
Amazon EBS volume types



SSD

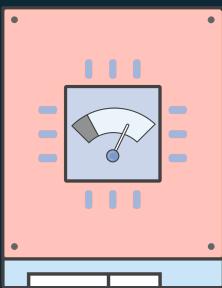


HDD



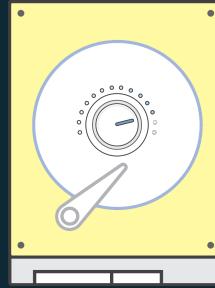
gp2

General Purpose
SSD



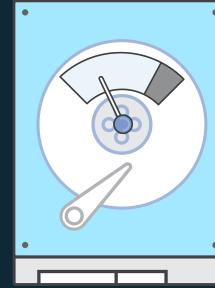
io1

Provisioned IOPS
SSD



st1

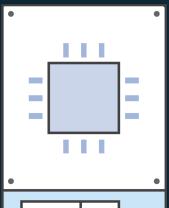
Throughput Optimized HDD



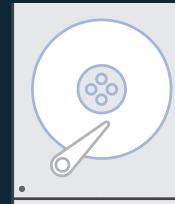
scl

Cold HDD

Amazon EBS use cases



SSD



HDD



Relational Databases

MySQL, SQL Server,
PostgreSQL, SAP,
Oracle



NoSQL Databases

Cassandra, MongoDB,
CouchDB



Big Data , Analytics

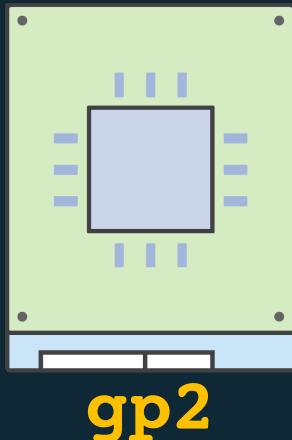
Kafka, Splunk,
Hadoop, Data
Warehousing



File / Media

CIFS/NFS,
Transcoding,
Encoding, Rendering

Amazon EBS volume types: General Purpose SSD



General Purpose SSD

Baseline: 100 to 16,000 IOPS; 3 IOPS per GiB

Burst: 3,000 IOPS (for volumes up to 1,000 GiB)

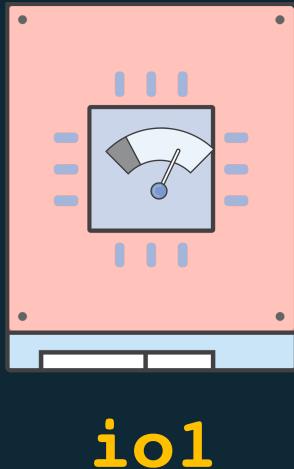
Throughput: Up to 250 MiB/s

Latency: Single-digit ms

Capacity: 1 GiB to 16 TiB

Great for boot volumes, low-latency applications, and bursty databases

Amazon EBS volume types: Provisioned IOPS



Provisioned IOPS

Baseline: 100–64,000 IOPS

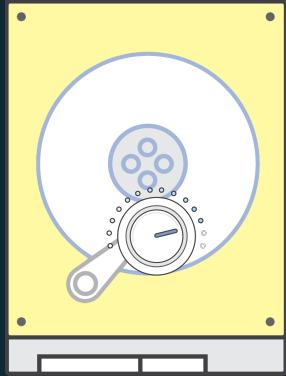
Throughput: Up to 1,000 MiB/s

Latency: Single-digit ms

Capacity: 4 GiB to 16 TiB

Ideal for critical applications and databases with sustained IOPS

Amazon EBS volume types: Throughput Provisioned



Baseline: 40 MiB/s per TiB up to 500 MiB/s

Burst: 250 MiB/s per TiB up to 500 MiB/s

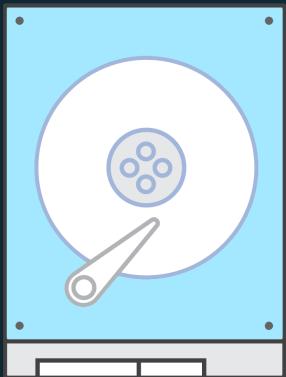
Capacity: 500 GiB to 16 TiB

Ideal for large-block, high-throughput sequential workloads

st1

Throughput Optimized HDD

Amazon EBS volume types: Cold HDD



Baseline: 12 MiB/s per TiB up to 192 MiB/s

Burst: 80 MiB/s per TiB up to 250 MiB/s

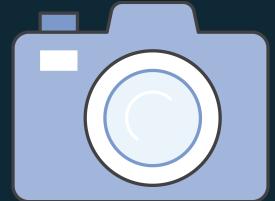
Capacity: 500 GiB to 16 TiB

Ideal for sequential throughput workloads, such as logging and backup

sc1

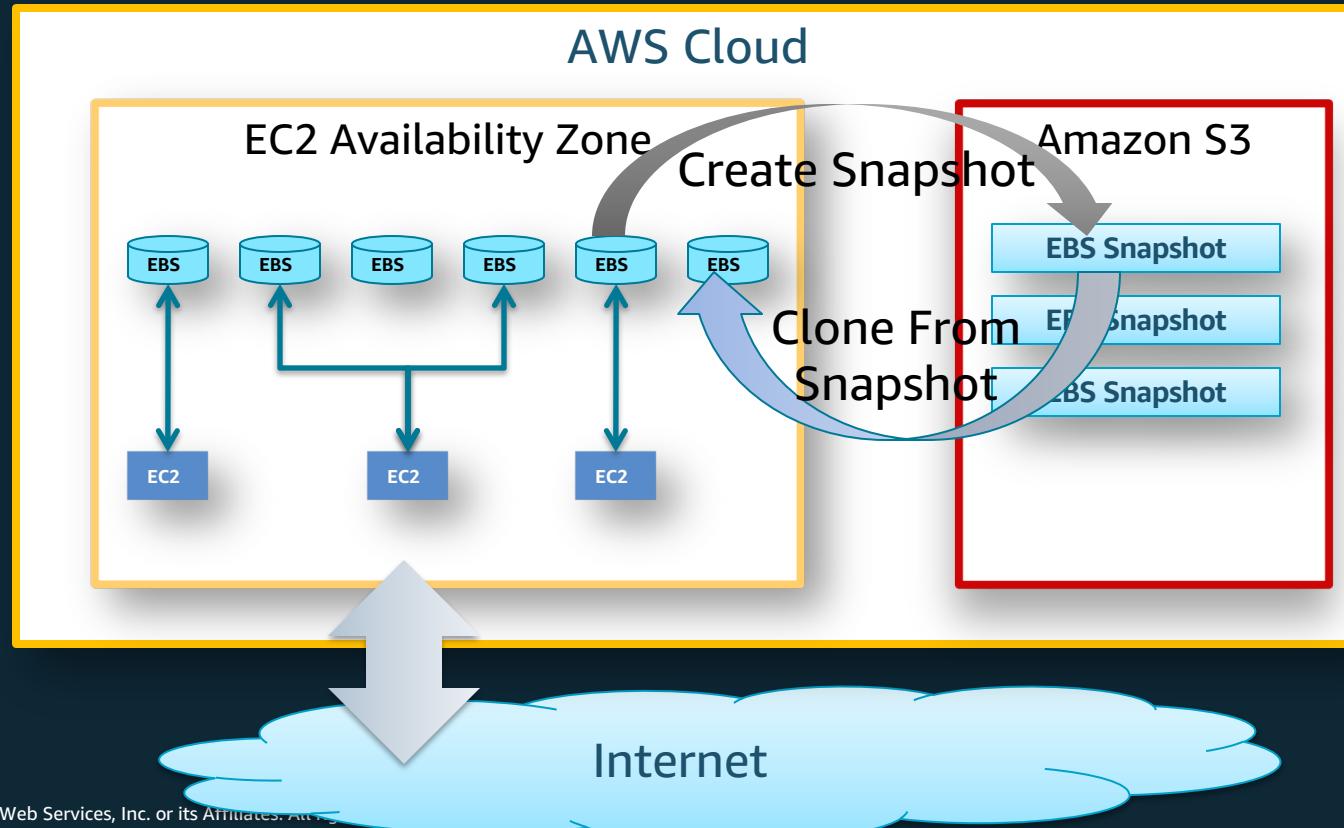
Cold HDD

EBS Snapshots

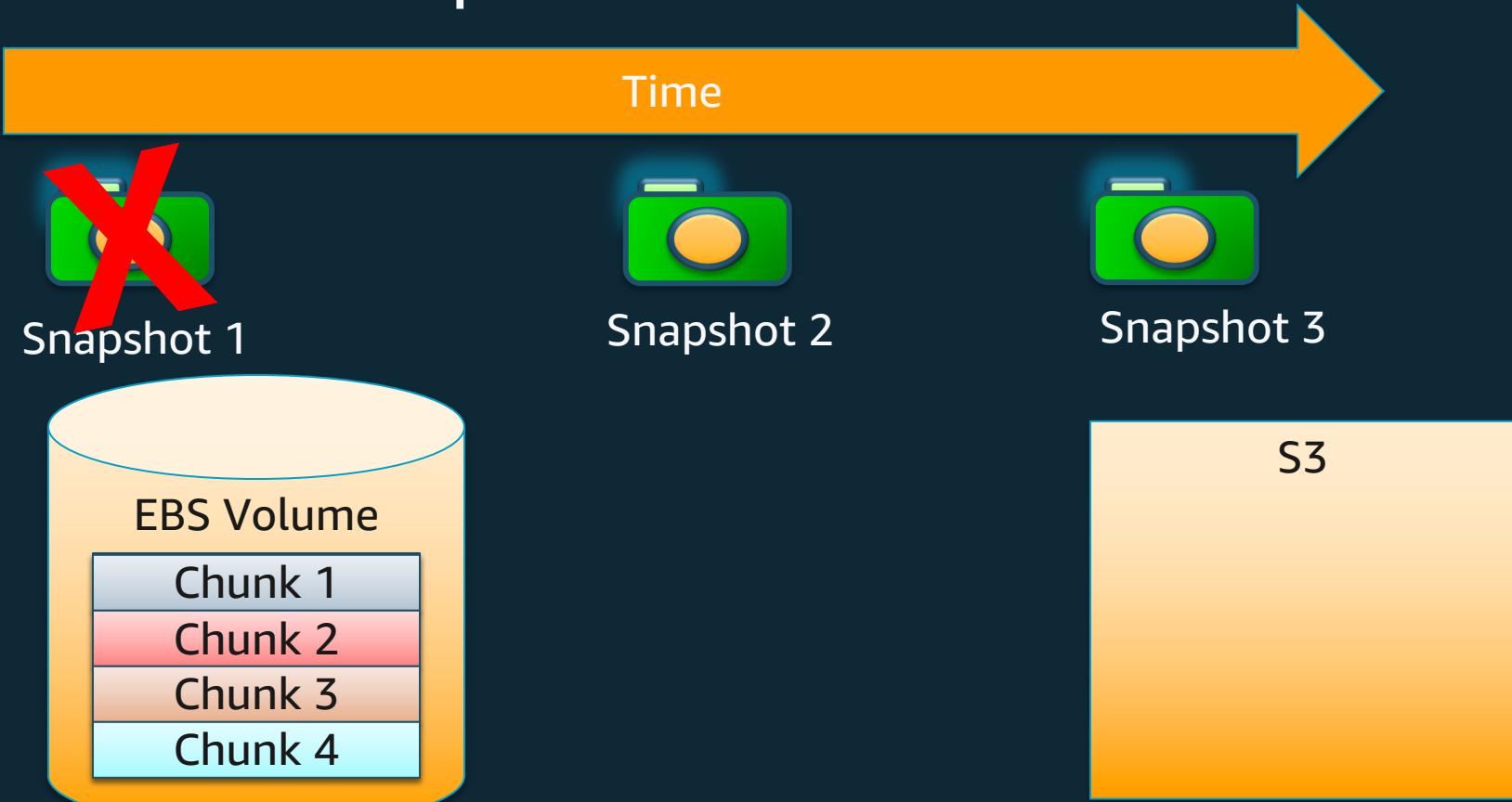


- Point-in-time snapshots of volume blocks
- Stored in Amazon S3 and accessed via EBS APIs
- Key Features:
 - Immediate access to EBS volume data
 - Resizing EBS volumes
 - Sharing EBS Snapshots
 - Copying EBS Snapshots across AWS regions

EBS Snapshots – Delta Block Changes



How Do EBS Snapshots Work?



What is Amazon EC2 instance store?



- Local to instance
- Non-persistent data store
- Available on certain EC2 families
 - Ex: d2, i3, r5d, m5d
- Data is not replicated (by default)
- No snapshot support
- SSD or HDD



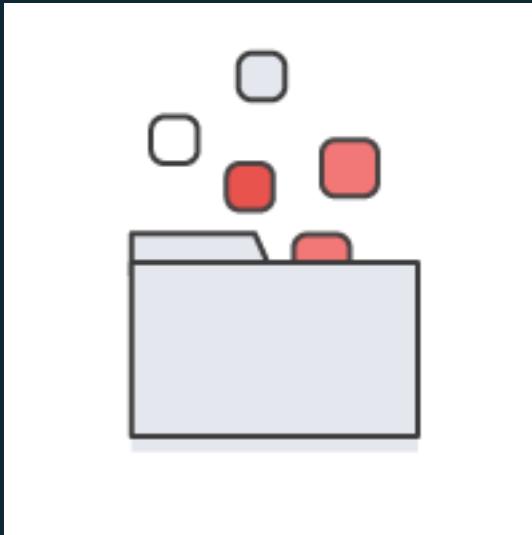
Shared file system

Elastic File System (EFS)

- Fully managed file system for EC2 instances
- Provides standard file system semantics
- Works with standard operating system APIs
- Sharable across thousands of instances
- Elastically grows to petabyte scale
- Delivers performance for a wide variety of workloads
- Highly available and durable
- NFS v4-based
- Accessible from on-premise servers



Amazon EFS is Simple



Fully managed

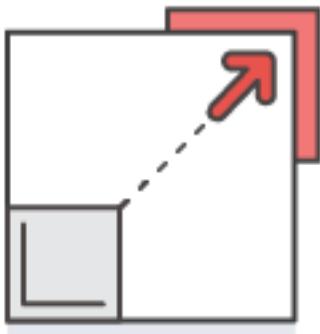
- No hardware, network, file layer
- Create a scalable file system in seconds!

Seamless integration with existing tools and apps

- NFS v4.1—widespread, open
- Standard file system access semantics
- Works with standard OS file system APIs

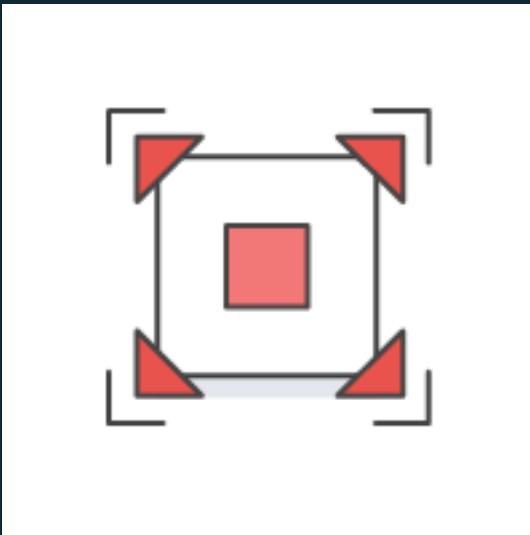
Simple pricing = simple forecasting

Amazon EFS is Elastic



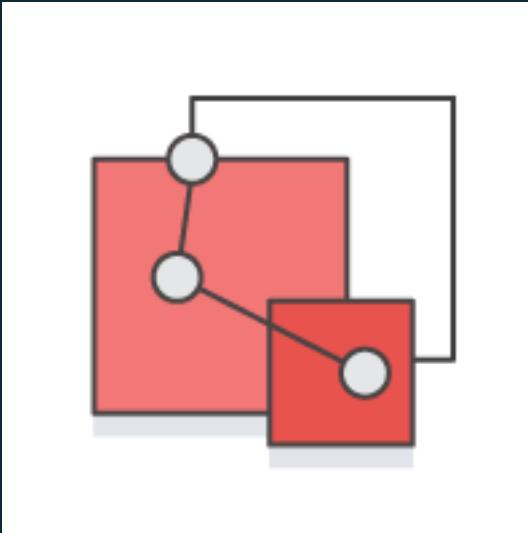
- File systems grow and shrink automatically as you add and remove files
- No need to provision storage capacity or performance
- You pay only for the storage space you use, with no minimum fee

Amazon EFS is Scalable



- File systems can grow to petabyte scale
- Throughput and IOPS scale automatically as file systems grow
- Consistent low latencies regardless of file system size
- Support for thousands of concurrent NFS connections

Highly Durable and Highly Available



- Designed to sustain AZ offline conditions
- Resources aggregated across multiple AZ's
- Superior to traditional NAS availability models
- Appropriate for Production / Tier 0 applications

Example use cases

Big Data Analytics

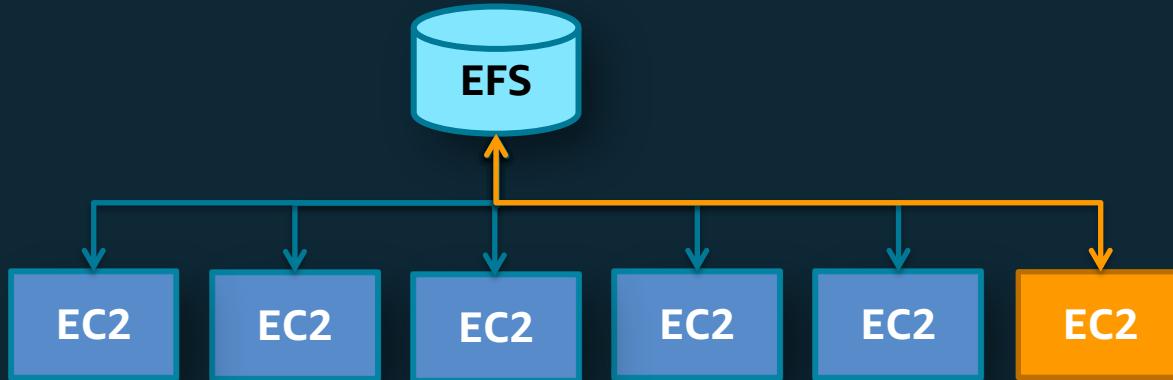
Media Workflow Processing

Web Serving

Content Management

Home Directories

EFS – Mounting



EFS DNS Name

availability-zone.file-system-id.efs.aws-region.amazonaws.com

Mount on machine

```
sudo mount -t nfs4 mount-target-DNS:/ ~efs-mount-point
```

EFS Lifecycle Management

- EFS offers both Standard and Infrequent Access (IA) storage classes
- With Lifecycle Management enabled, EFS automatically moves files not accessed for 30 days from the Standard storage class to the EFS IA storage class

FSx for Windows



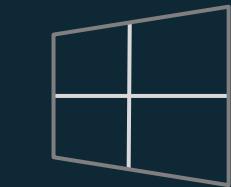
Fully managed Windows
file systems ...

... built on Windows
Server



Integrated with
AWS

Native Windows compatibility and features



Native Windows compatibility



NTFS



Native SMB
2.0 to 3.1.1



Integrates with
Microsoft AD
and supports
Windows ACLs



DFS
Namespaces
and
DFS Replication



Windows Server



Object Stores

Amazon S3 (Simple Storage Service)

- Web accessible object store (through API or HTTPS)
- Highly durable (99.99999999% design)
- Limitlessly scalable
- Multiple Tiers to match your workload
- Data Lifecycle Rules
- Static Website Hosting
- Security, Compliance, and Audit capabilities
- Standard Storage Pricing (us-east-1) - \$0.023 per GB



Your choice of object storage classes



S3 Standard



S3 Intelligent-Tiering



S3 Standard-IA



S3 One Zone-IA



S3 Glacier



S3 Glacier
Deep Archive

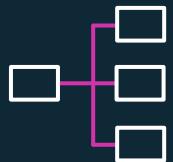
Frequent

Access Frequency

Infrequent

- | | | | | | |
|------------------------------------|--------------------------------------|------------------------------|------------------------------------|---------------------------|-------------------------|
| • Active, frequently accessed data | • Data with changing access patterns | • Infrequently accessed data | • Re-creatable, less accessed data | • Archive data | • Archive data |
| • Milliseconds access | • Milliseconds access | • Milliseconds access | • Milliseconds access | • Select minutes or hours | • Select 12 or 48 hours |
| • ≥ 3 AZ | • ≥ 3 AZ | • ≥ 3 AZ | • 1 AZ | • ≥ 3 AZ | • ≥ 3 AZ |
| • \$0.0210/GB | • \$0.0210 to \$0.0125/GB | • \$0.0125/GB | • \$0.0100/GB | • \$0.0040/GB | • \$0.00099/GB |
| | • Monitoring fee per Obj. | • Retrieval fee per GB | • Retrieval fee per GB | • Retrieval fee per GB | • Retrieval fee per GB |
| | • Min storage duration | • Min storage duration | • Min storage duration | • Min storage duration | • Min storage duration |
| | • Min object size | | • Min object size | • Min object size | • Min object size |

S3 Management Features



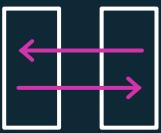
Organize

S3 Tagging
S3 Prefixes
S3 Versioning



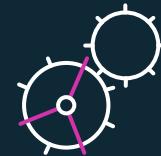
Monitor

CloudWatch
CloudTrail
S3 Event Notifications
S3 Inventory
S3 Glacier Restore
Notifications



Replicate & Tier

S3 Lifecycle
S3 Storage Class
Analysis
S3 Intelligent-Tiering
Cross-Region
Replication



Modify

S3 Event Notifications +
Lambda
S3 Batch Operations
S3 Object Lock



S3 Access Management & Security

- Deep integration with AWS Identity and Access Management (IAM)
- Access Control Lists (ACLs) & S3 bucket policies
- Query String Authentication
- Audit Logs
- S3 supports both server-side & client-side encryption
 - S3 Inventory to check the encryption status of S3 objects
- S3 Block Public Access to ensure S3 buckets and objects do not have public access
- Amazon Macie to discover, classify, and protect sensitive data stored in Amazon S3



4

On-Premises Storage Integration

Many Options for Data Transfer



AWS
Direct Connect



Amazon
Kinesis
Firehose



Amazon
Kinesis
Data Streams



Amazon Kinesis
Video Streams



Amazon S3
Transfer
Acceleration



AWS
Storage
Gateway



AWS
Database
Migration
Service



AWS
Snowball



AWS
Snowball Edge



AWS
Snowmobile



AWS
DataSync



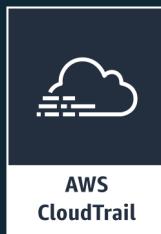
AWS
Transfer
for SFTP

Storage Gateway hybrid storage solutions

Enables using standard storage protocols to access AWS storage services



Amazon
CloudWatch



AWS
CloudTrail



AWS Identity
and Access
Management



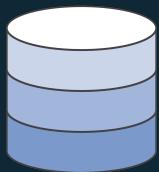
AWS Key
Management
Service

Storage Gateway – Files, volumes, and tapes



File gateway NFS (v3 and v4.1) interface

On-premises file storage backed by Amazon S3 objects



Volume gateway iSCSI block interface

On-premises block storage backed by S3 with EBS snapshots



Tape gateway iSCSI virtual tape library interface

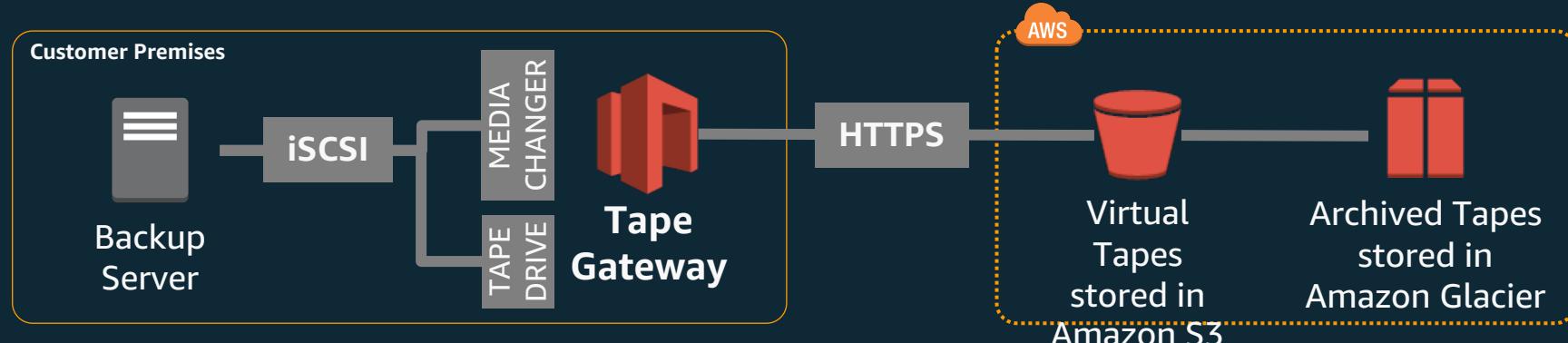
Virtual tape storage in Amazon S3 and Glacier with VTL management

Storage Gateway – Common capabilities

-  **Standard storage protocols** integrate with on-premises applications
-  **Local caching** for low-latency access to frequently used data
-  **Efficient data transfer** with buffering and bandwidth management
-  **Native data storage** in AWS
-  **Stateless virtual appliance** for resiliency
-  **Integrated with AWS** management and security

Tape gateway

Virtual tape storage in Amazon S3 and Glacier with VTL management



Virtual tape storage in S3 and Glacier accessed via tape gateway

Data compressed in-transit and at-rest

Unlimited virtual tape storage, with up to 1PB of tapes active in library

Supports leading backup applications:

VERITAS™

DELL EMC

VEEAM

Hewlett Packard
Enterprise

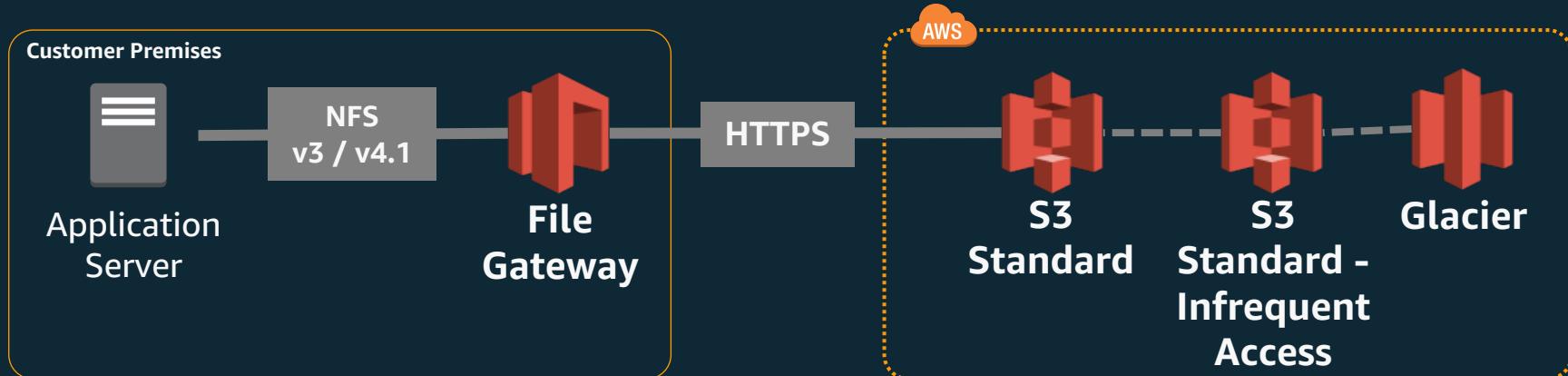
Microsoft®
System Center
Data Protection Manager 2012

arcserve



File gateway

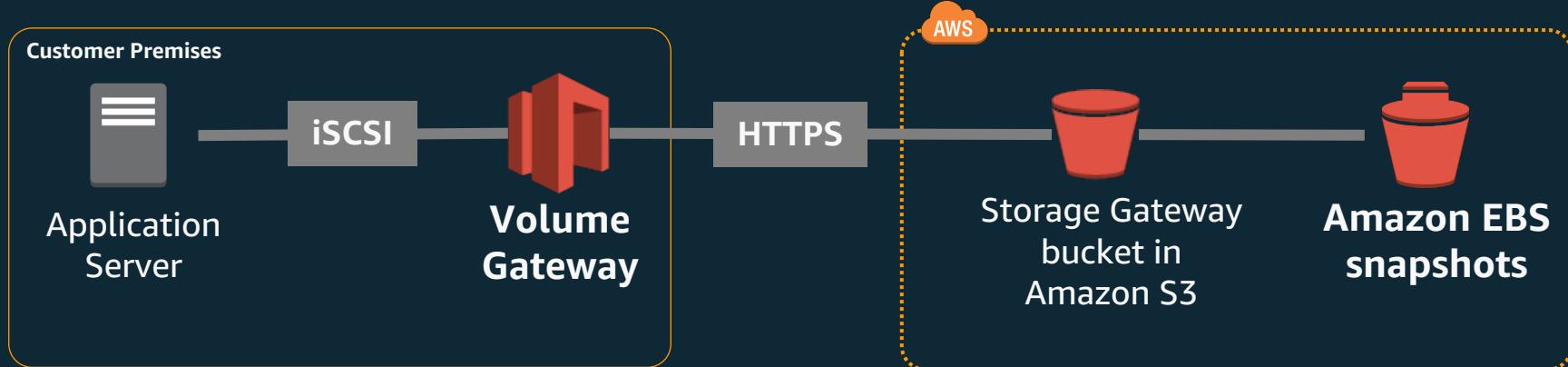
On-premises file storage maintained as objects in Amazon S3



- Data stored and retrieved from your S3 buckets
- One-to-one mapping from files-to-objects
- File metadata stored in object metadata
- Bucket access managed by IAM role you own and manage
- Use S3 Lifecycle Policies, versioning, or CRR to manage data

Volume gateway

On-premises volume storage backed by Amazon S3 with EBS snapshots



Block storage in S3 accessed via the volume gateway

Data compressed in-transit and at-rest

Backup on-premises volumes to EBS snapshots

Create on-premises volumes from EBS snapshots

Up to 1PB of total volume storage per gateway

Hybrid storage use cases with Storage Gateway



Enabling cloud workloads

Move data to AWS storage for Big Data, cloud bursting, or migration



Backup, archive, and disaster recovery

Cost effective storage in AWS with local or cloud restore



Tiered cloud storage

Easily add AWS storage to your on-premises environment

AWS DataSync

Online transfer service that simplifies, automates, and accelerates moving data between on-premises storage and AWS



Fast data
transfer



Easy to use



Secure and
reliable



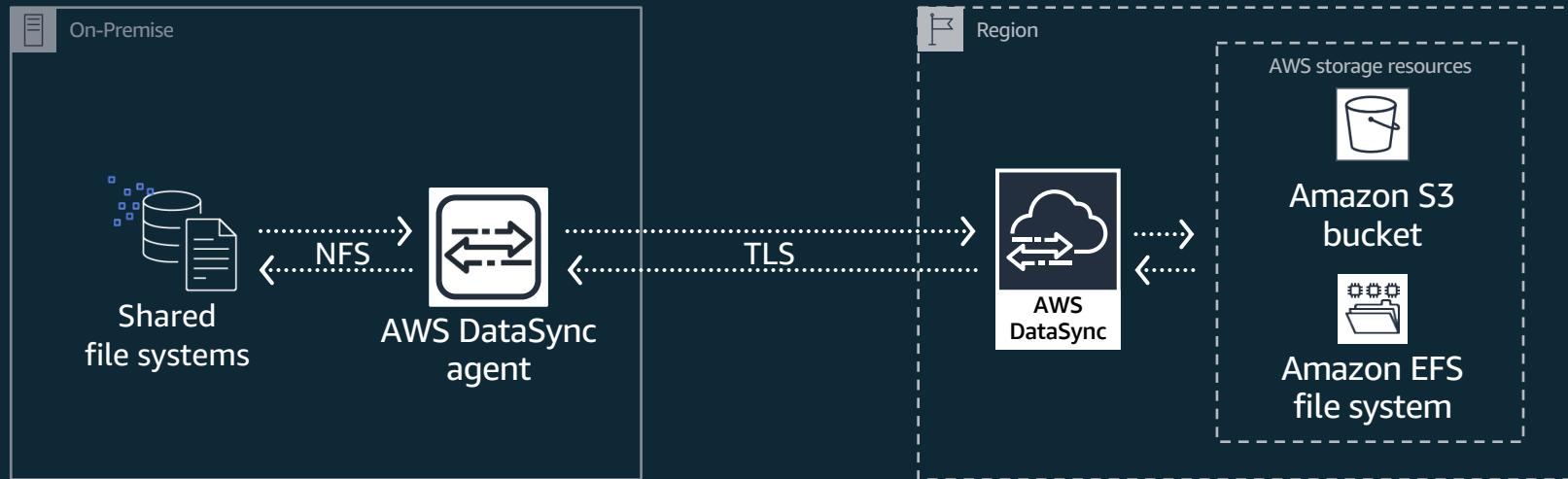
Cloud
integrated



Cost-
effective

Combines the speed and reliability of *network acceleration* software with the cost-effectiveness of *open source tools*

How AWS DataSync works



Deploy on-premises agent for fast access to local storage



Data transfer over the WAN using purpose-built protocol



Service in AWS writes or reads data from AWS storage services



Managed from AWS Console or Command Line Interface (CLI)

Amazon Snowball & Snowball Edge

- Terabyte scale data transport
- Uses secure appliances
- Faster than Internet for significant data sets
- Import into S3
- HIPAA Compliant



What is Snowball?

Terabyte scale data transport



Ruggedized
case
“8.5G Impact”

E-ink shipping
label



80 TB
10G network



Rain & dust
resistant

Tamper-resistant
case & electronics

All data encrypted
end-to-end



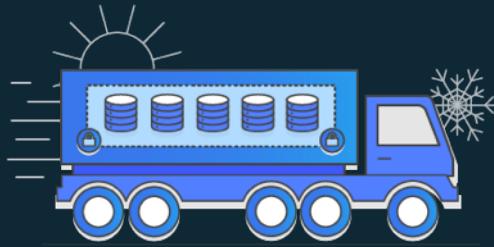
How fast is Snowball?

- Less than 1 day to transfer 250TB via 5x10G connections with 5 Snowballs, less than 1 week including shipping
- Number of days to transfer 250TB via the Internet at typical utilizations

	Internet Connection Speed			
Utilization	1Gbps	500Mbps	300Mbps	150Mbps
25%	95	190	316	632
50%	47	95	158	316
75%	32	63	105	211

Amazon Snowmobile

<https://www.youtube.com/watch?v=8vQmTZTq7nw>



Any Questions?

