Storage on AWS

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Agenda

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

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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
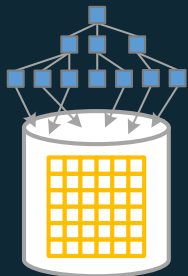
Global Scale

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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
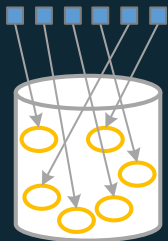
File Storage

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

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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

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More choice for more applications

Block storage

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

Backup

AWS Backup

Re-host

Amazon EC2

Amazon EBS

Re-platform

Amazon EFS

AWS Storage Gateway Family

Amazon FSx for Windows File Server

Amazon FSx for Lustre

Amazon S3

Re-architect
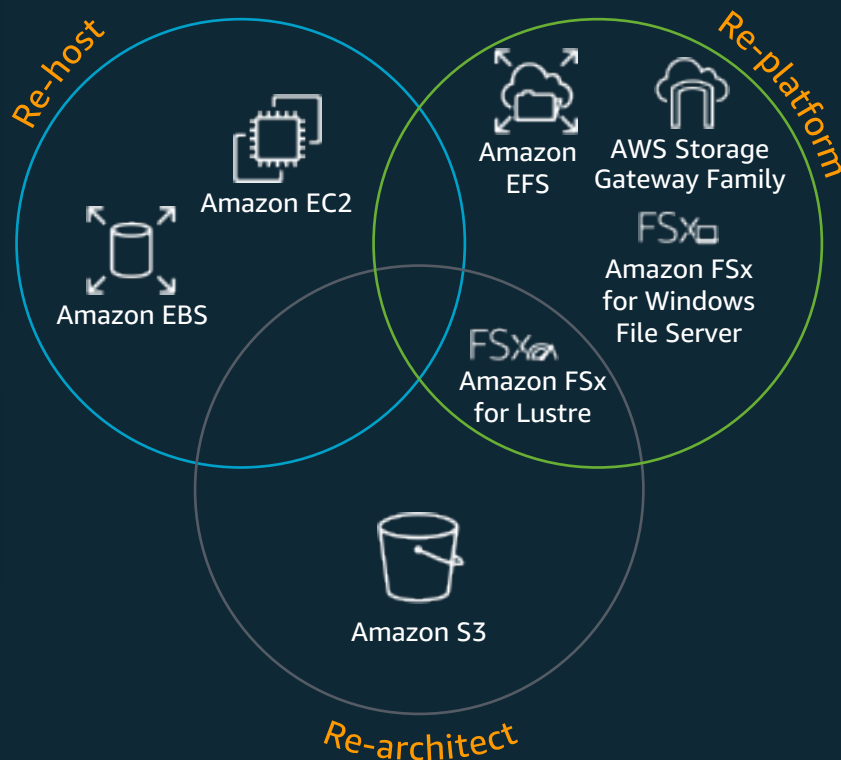
File storage

EFS Standard
EFS Infrequent Access
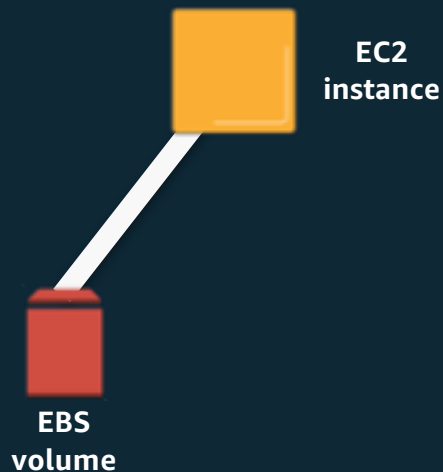FSx for Windows
FSx for Lustre

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?

EC2 instance

EBS volume

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

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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

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Amazon EBS

Network attached block device

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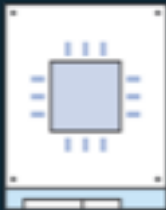- Can be detached from an instance and attached to a different one

Raw block devices

- Unformatted block devices
- Ideal for databases, filesystems

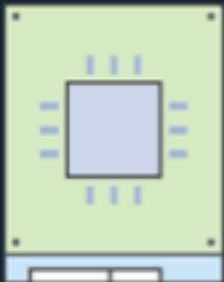## Multiple Drive Types

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

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Amazon EBS volume types

SSD

HDD

gp2
General Purpose
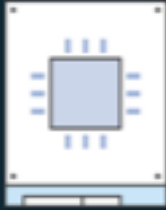SSD

io1
Provisioned IOPS
SSD

st1
Throughput Optimized HDD

sc1
Cold HDD

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Amazon EBS use cases

SSD

HDD

Relational Databases

MySQL, SQL Server, PostgreSQL, SAP, Oracle

NoSQL Databases

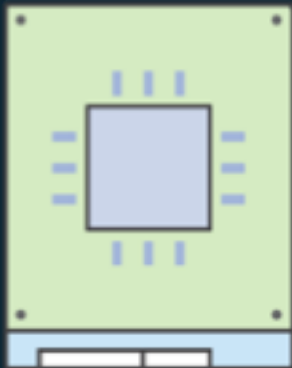Cassandra, MongoDB, CouchDB

Big Data , Analytics

Kafka, Splunk, Hadoop, Data Warehousing

File / Media

CIFS/NFS, Transcoding, Encoding, Rendering

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Amazon EBS volume types: General Purpose SSD

gp2
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

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Amazon EBS volume types: Provisioned IOPS

io1
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

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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

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Amazon EBS volume types: Cold HDD

sc1
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

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EBS Volume Types Comparison

|	Magnetic	General Purpose (SSD)	Provisioned IOPS (SSD)
Performance	Lowest Cost	Burstable	Predictable
Use Cases	Infrequent Data Access	Boot volumes Small to Medium DBs Dev & Test	I/O Intensive Relational & NoSQL
Media	Magnetic (HDD)	SSD	SSD
Max IOPS	100 on average with the ability to burst to hundreds of IOPS	Baseline 3 IOPS/GB Burstable to 16,000 IOPS	Consistently performed at provisioned level, up to 64,000 IOPS
Price	$.045/GB (st1) $.025/GB (sc1)	$.10/GB/Month (gp2)	$.125/GB/Month (io1) $.065/provisioned IOPS

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

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EBS Snapshots – Delta Block Changes
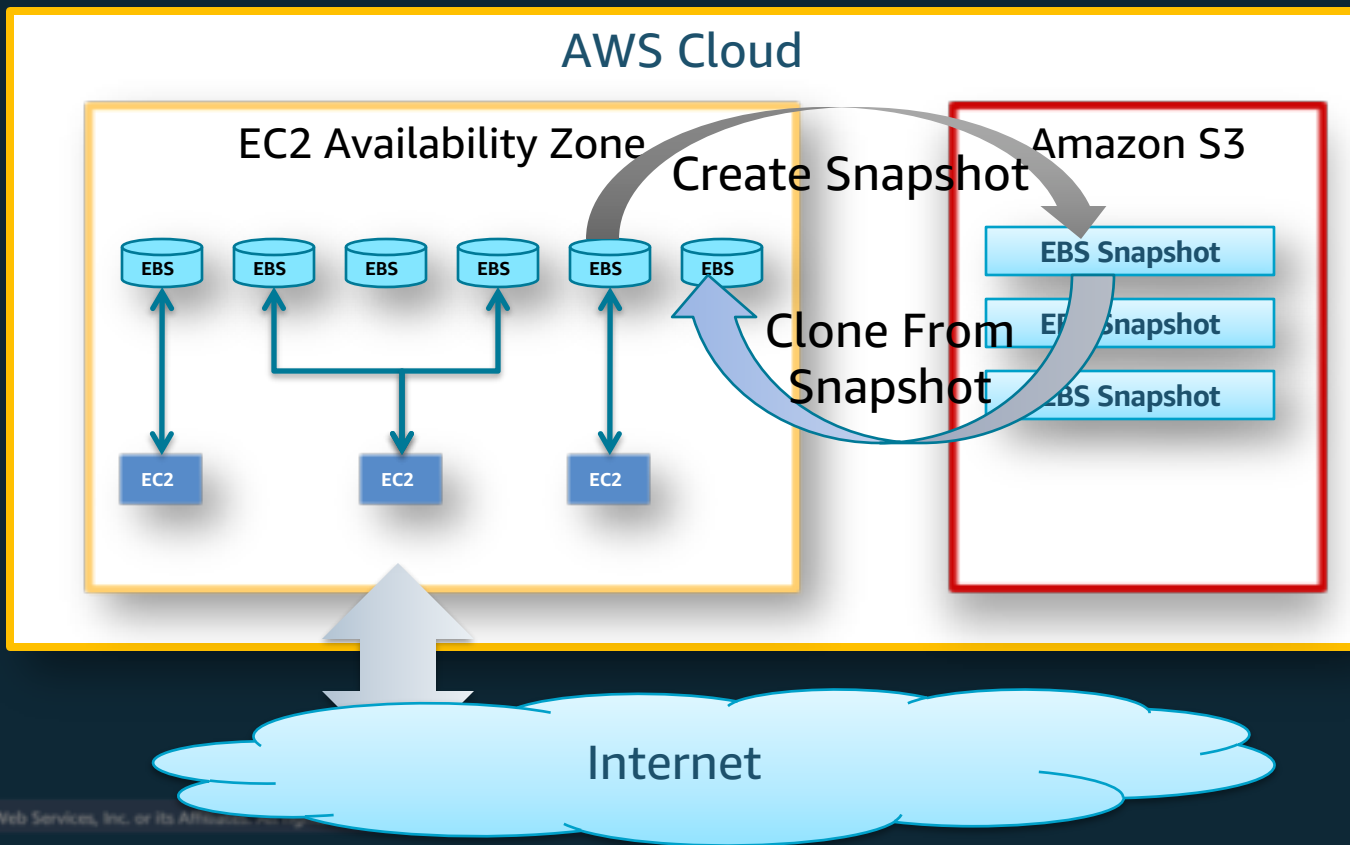
How Do EBS Snapshots Work?
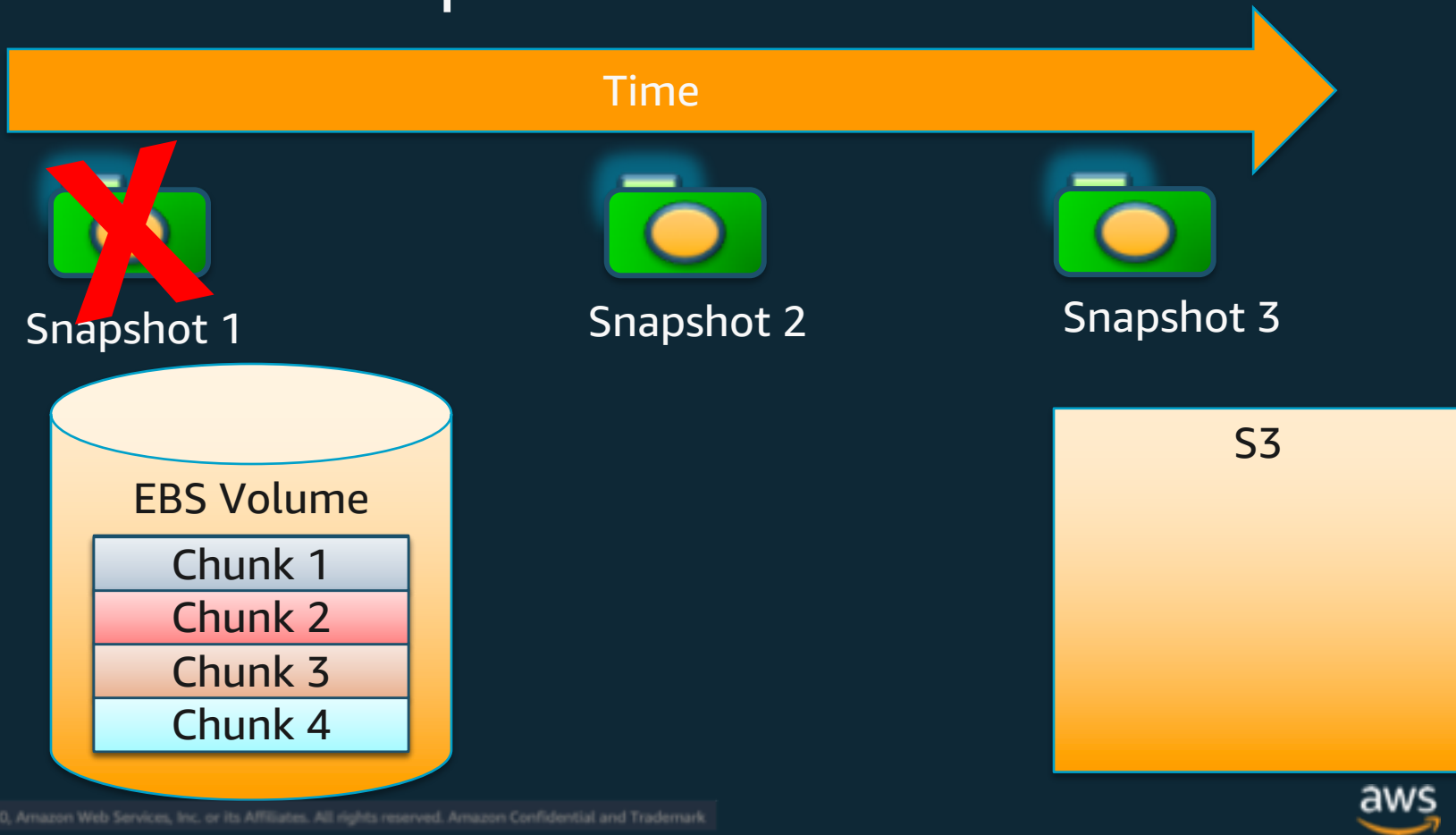
What is Amazon EC2 instance store?

EC2 instances

Instance Store

or

Physical Host

- 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

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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

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① Amazon EFS is Simple
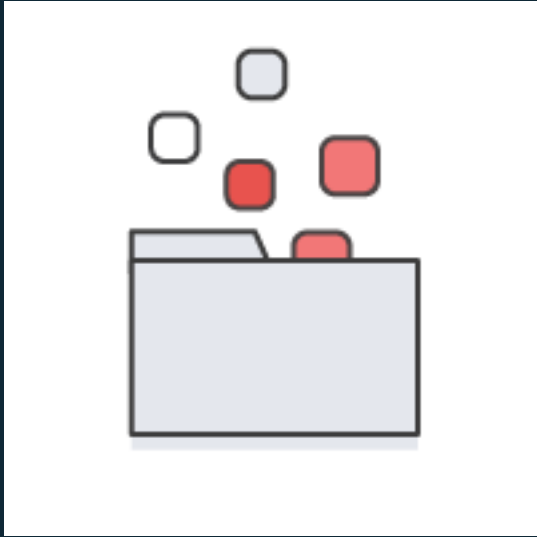
Fully managed

- 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
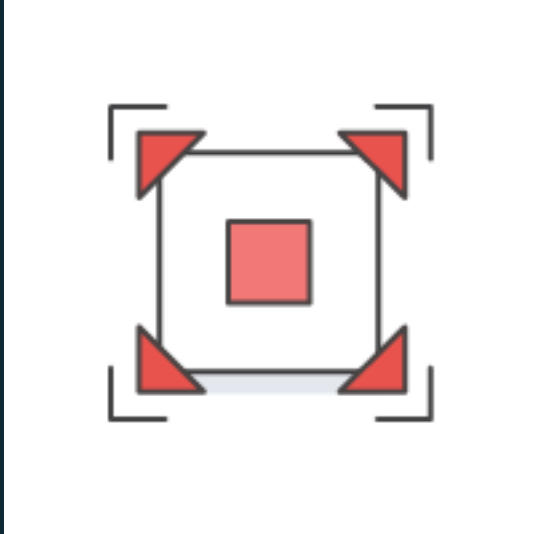- Works with standard OS file system APIs

Simple pricing = simple forecasting

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② 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

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③ 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

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Highly Durable and Highly Available
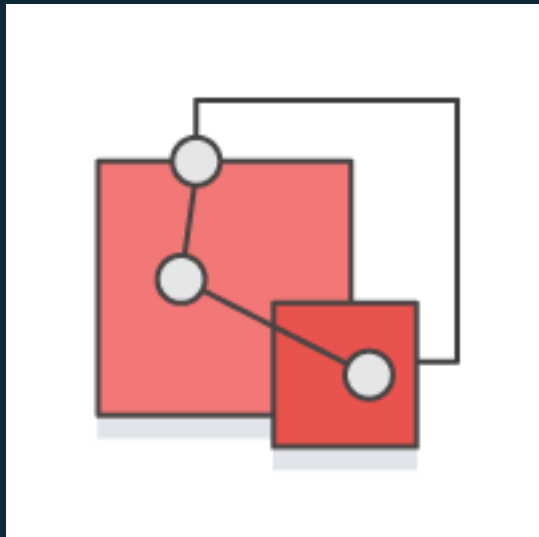
- Designed to sustain AZ offline conditions

- Resources aggregated across multiple AZ's

- Appropriate for Production / Tier 0 applications

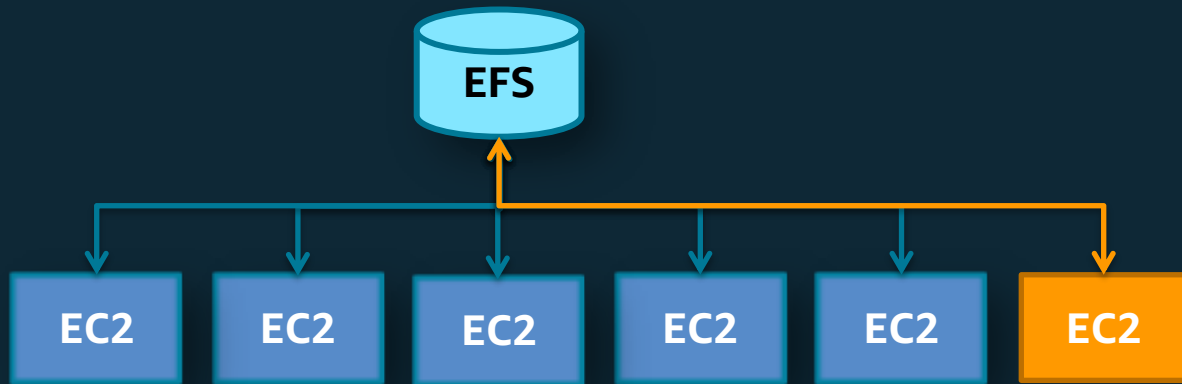aws

Example use cases

Big Data Analytics

Media Workflow Processing

Web Serving

Content Management

Home Directories

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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

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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

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FSx for Windows

Fully managed Windows
file systems …

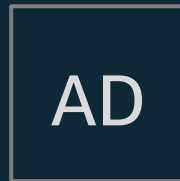… built on Windows
Server

Integrated with
AWS

Native Windows compatibility and features

Native Windows compatibility

NTFS

SMB

Native SMB 2.0 to 3.1.1

AD

Integrates with Microsoft AD and supports Windows ACLs

DFS Namespaces and DFS Replication

Windows Server

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3

Object Stores

Amazon S3 (Simple Storage Service)

- Web accessible object store (through API or HTTPS)
- Highly durable (99.999999999% 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

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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*

| S3 Standard	S3 Intelligent-Tiering	S3 Standard-IA	S3 One Zone-IA	S3 Glacier	S3 Glacier Deep Archive
• Active, frequently accessed data • Milliseconds access • > 3 AZ • $0.0210/GB	• Data with changing access patterns • Milliseconds access • > 3 AZ • $0.0210 to $0.0125/GB • Monitoring fee per Obj. • Min storage duration	• Infrequently accessed data • Milliseconds access • > 3 AZ • $0.0125/GB • Retrieval fee per GB • Min storage duration • Min object size	• Re-creatable, less accessed data • Milliseconds access • 1 AZ • $0.0100/GB • Retrieval fee per GB • Min storage duration • Min object size	• Archive data • Select minutes or hours • > 3 AZ • $0.0040/GB • Retrieval fee per GB • Min storage duration • Min object size	• Archive data • Select 12 or 48 hours • > 3 AZ • $0.00099/GB • Retrieval fee per GB • Min storage duration • Min object size

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S3 Management Features
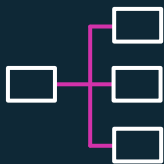
Organize

S3 Tagging
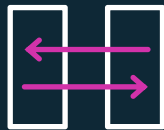
S3 Prefixes

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

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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

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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

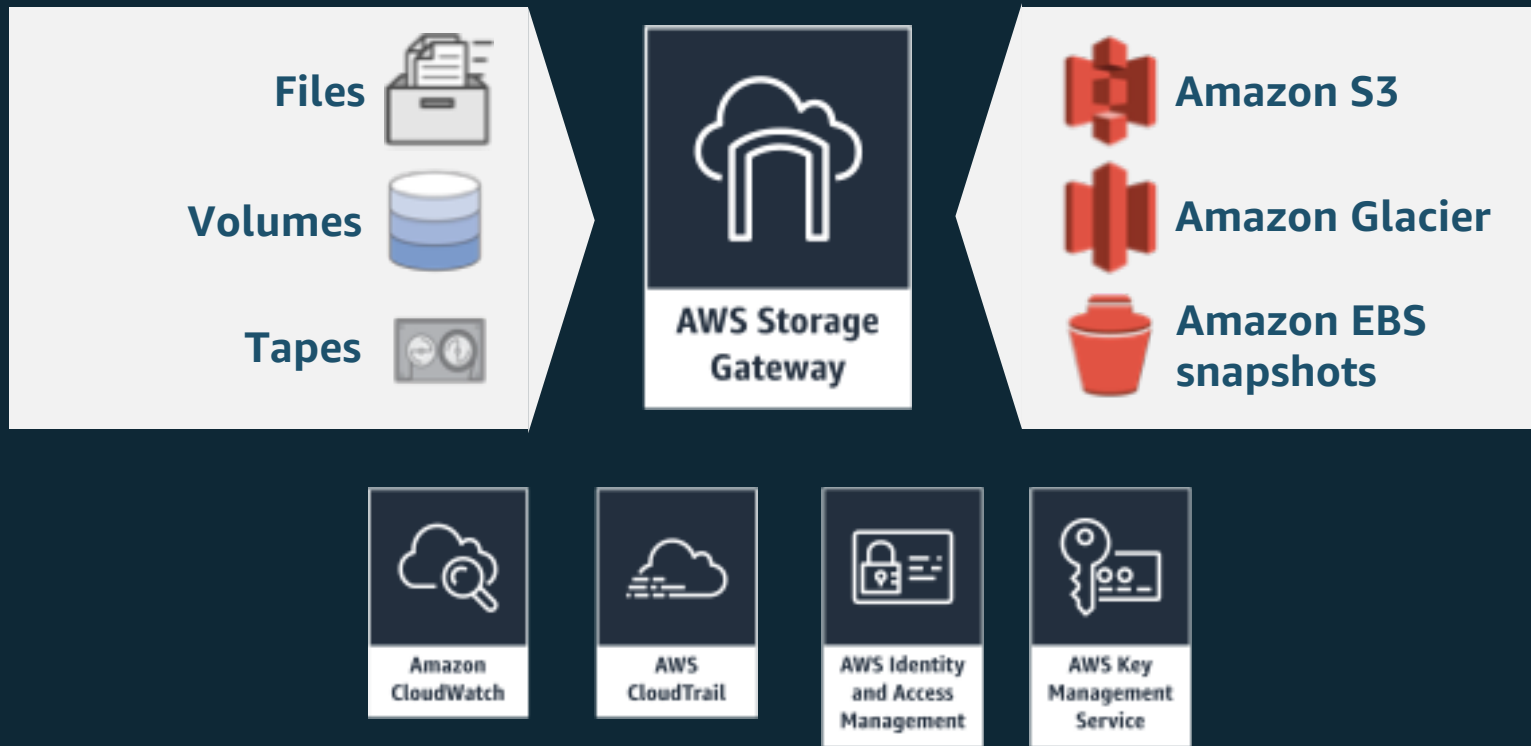**AWS Snowball Edge**

AWS Snowmobile

AWS DataSync

AWS Transfer for SFTP

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Storage Gateway hybrid storage solutions

Enables using standard storage protocols to access AWS storage services

Files	AWS Storage Gateway	Amazon S3
Volumes		Amazon Glacier
Tapes		Amazon EBS snapshots

Amazon CloudWatch

AWS CloudTrail

AWS Identity and Access Management

AWS Key Management Service

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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

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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
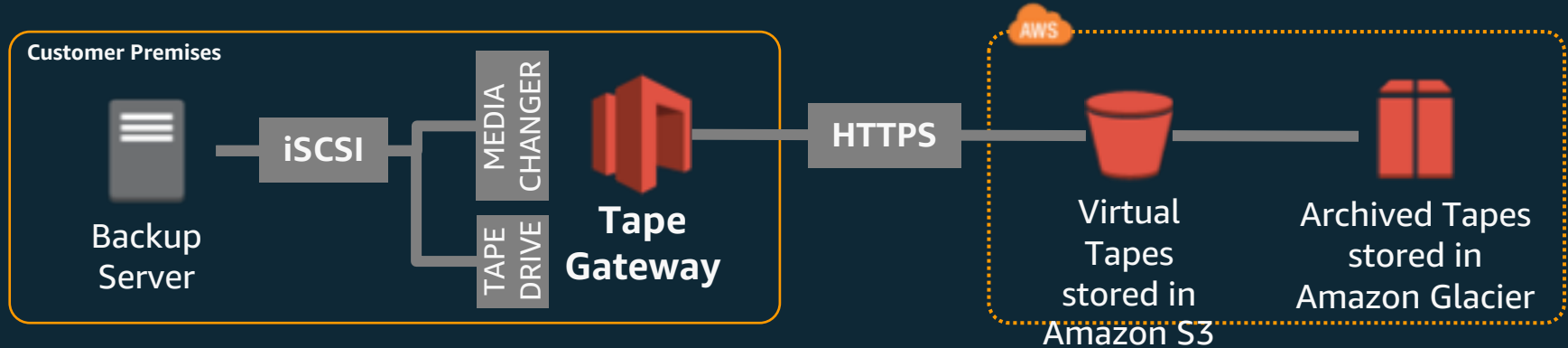
Native data storage in AWS

Stateless virtual appliance for resiliency

Integrated with AWS management and security

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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:

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File gateway
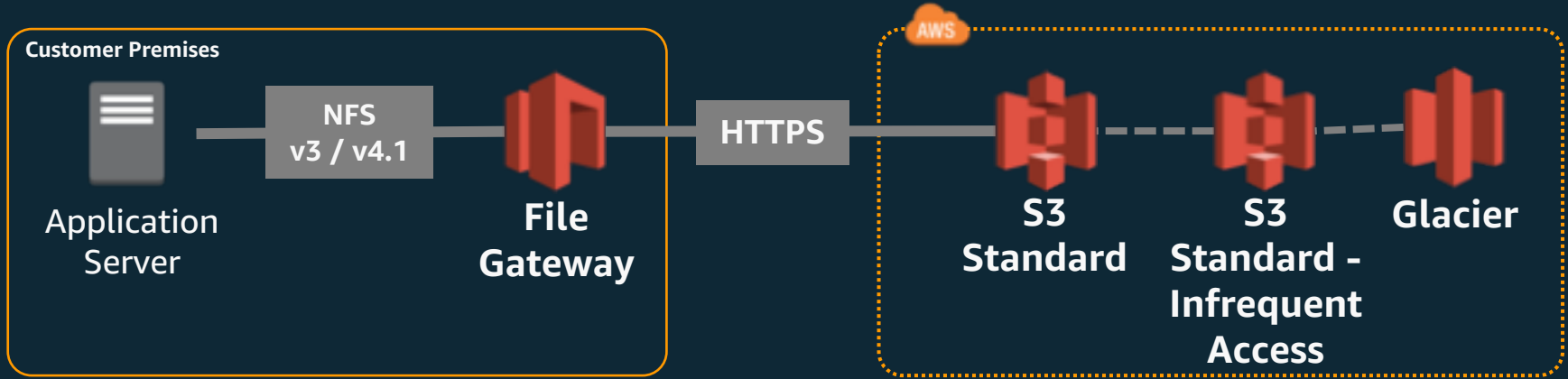*On-premises file storage maintained as objects in Amazon S3*

- 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

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Volume gateway

On-premises volume storage backed by Amazon S3 with EBS snapshots
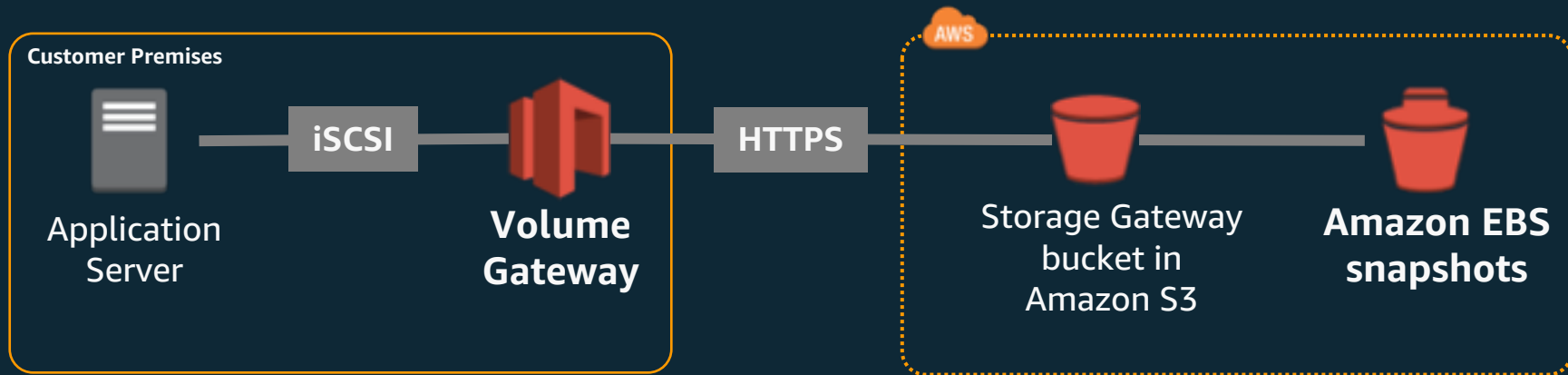
Block storage in S3 accessed via the volume gateway

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

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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

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How AWS DataSync works
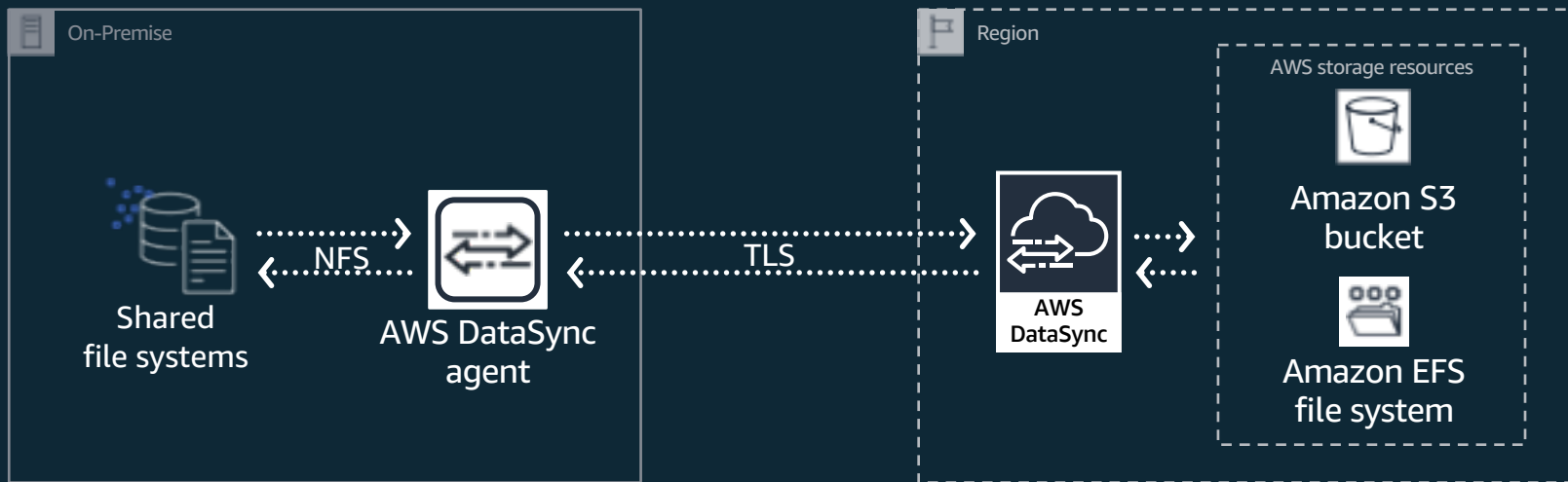
Deploy on-premises agent for fast access to local storage

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

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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

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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 <u>days</u> 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

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Amazon Snowmobile

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

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Any Questions?

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