



Introduction to Storage on AWS

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Solutions Architect, Higher Education

Agenda

- Introduction
- Storage Primer
- Block Storage
- Shared File Systems
- Object Store
- Data Transfer and Edge Processing
- Backup
- Elastic Disaster Recovery Service



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



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Block vs File vs Object



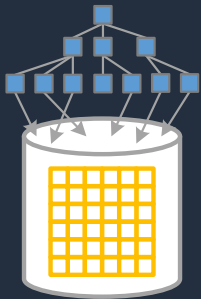
Block Storage

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

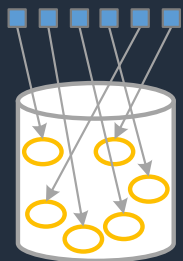


File Storage

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, NetApp OnTap



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

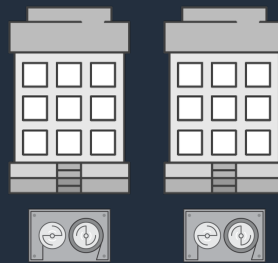
Durability	Availability	Security	Cost	Scalability	Performance	Integration
Measure of expected data loss	Measure of expected downtime	Security measures for at-rest and in-transit data	Amount per storage unit, e.g. \$ / GB	Upward flexibility, storage size, number of users	Performance metrics (bandwidth	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
99.9999%
durability



copies in three AZ

designed for
99.9999999999%
durability

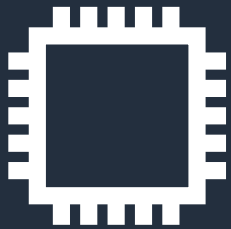
Availability vs Durability

%	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

Block Storage

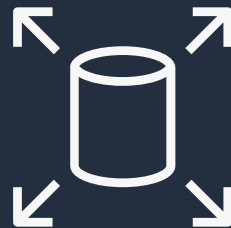


Block storage portfolio



Instance storage

Temporary block-level storage attached to host hardware that is ideal for storage of information that frequently changes or is replicated across multiple instances



Amazon EBS

Easy to use, high performance block storage service designed for use with Amazon Elastic Compute Cloud (EC2) for both throughput and transaction intensive workloads



Snapshots

Incremental, point-in-time copies of your EBS data that can be used to restore new volumes, expand the size of a volume, or move volumes across Availability Zones

EBS is designed for a wide range of workloads on EC2

Enterprise applications



SAP ERP, Oracle ERP,
Microsoft
SharePoint,
Microsoft Exchange

Relational databases



MySQL, PostgreSQL,
SQL Server, Oracle DB,
SAP HANA

Non-relational/ NoSQL databases



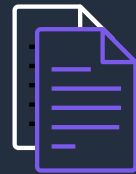
Cassandra,
MongoDB, CouchDB

Big data analytics



Kafka, Splunk, Hadoop,
Data warehousing

File/media



CIFS/NFS, transcoding,
encoding, rendering

LOW LATENCY AND CONSISTENT, HIGH IOPS AND THROUGHPUT

SCALABLE WITHOUT DISRUPTION TO YOUR WORKLOAD

ANNUAL FAILURE RATE (AFR) BETWEEN 0.1%–0.2%



Easy to use, high performance block storage at virtually any scale



Performance for any workload

Up to 256,000 IOPS, single digit millisecond latency, 4,000 MiB/s Throughput



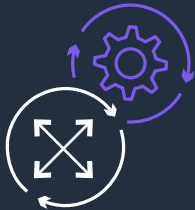
Easy to use

Easily add/remove capacity, or change volume types with Elastic Volumes



High reliability

99.8%-99.9% availability and annual failure rate of between 0.1%-0.2%



Virtually unlimited scale

Use a single gigabyte or less, or scale up to petabytes of data



Secure

Encrypt all new volumes and data for a region by default with a single setting

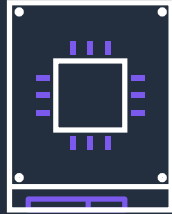


Cost-effective

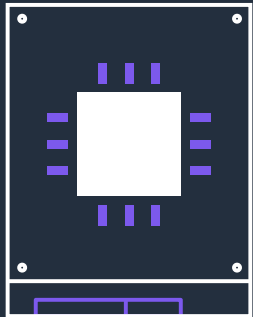
Pay as low as \$0.015/GB-month for highly cost-effective dollar per gigabyte block storage



Amazon EBS Volume Types

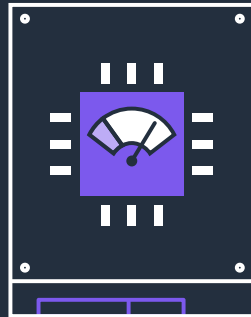


SSD



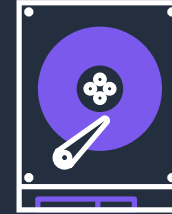
gp3

General Purpose
SSD

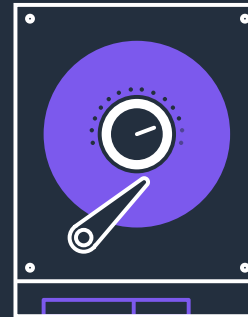


io2

Block Express



HDD



st1

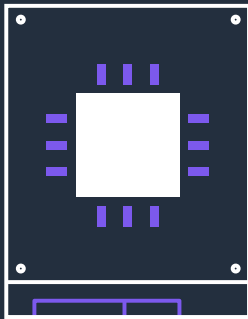
Throughput
Optimized HDD



sc1

Cold
HDD

General Purpose SSD gp3



gp3

General Purpose SSD

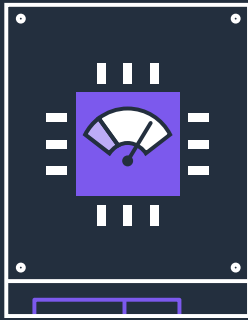
- **Use cases:** Latest generation general-purpose SSD-based EBS volumes. Provision performance independent of storage capacity, while providing up to 20% lower pricing per GB than existing gp2 volumes.
- **Volume size:** 1 GiB–16 TiB
- **Durability:** 99.8% - 99.9%
- **IOPS/volume:** 16,000
- **Throughput/volume*:** 1,000 MiB/s
- **Pricing**:** \$0.08 per GB-month of provisioned storage, 3,000 IOPS free and \$0.005/provisioned IOPS-month over 3,000

**Pricing is for US East (N. Virginia) Region



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Provisioned IOPS SSD io1



io1

Provisioned IOPS SSD

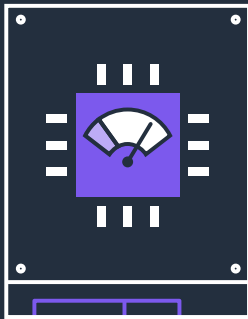
- **Use cases:** Large database workloads, mission-critical business applications requiring sustained high performance – Supports Multi-Attach
- **Volume size:** 4 GiB–16 TiB
- **Durability:** 99.8% - 99.9%
- **Max IOPS/volume*:** 64,000
- **Max throughput/volume*:** 1,000 MiB/s
- **Pricing**:** \$0.125 per GB-month of provisioned storage
\$0.065 per provisioned IOPS-month

**Pricing is for US East (N. Virginia) Region



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Provisioned IOPS SSD io2 Block Express



io2 Block Express
Provisioned IOPS SSD

- **Use cases:** io2 Block Express offers the highest performance block storage in the cloud with 4x higher throughput, IOPS, and capacity than io2 volumes, along with sub-millisecond latency. Block Express is the next generation of Amazon EBS storage server architecture purpose-built to meet the performance and latency requirements of the most demanding applications.
- **Volume size:** 4 GiB–64 TiB
- **Durability:** 99.999%
- **Max IOPS/volume*:** 256,000
- **Max throughput/volume*:** 4,000 MiB/s
- **Pricing*:** \$0.125 per GB-month of provisioned storage
\$0.065 per provisioned IOPS-month up to 32,000 IOPS,
\$0.046 per provisioned IOPS-month up to 64,000 IOPS,
\$0.032 per provisioned IOPS-month greater than 64,000 IOPS

*Pricing is for US East (N. Virginia) Region



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Throughput Optimized HDD for frequently accessed, throughput-intensive workloads



st1

Throughput Optimized HDD

- **Use cases:** st1 is backed by hard disk drives (HDDs) and is ideal for frequently accessed, throughput-intensive workloads with large datasets and large I/O sizes, such as MapReduce, Kafka, log processing, data warehouse, and ETL workloads.
- **Volume size:** 125 GiB–16 TiB
- **Durability:** 99.8% - 99.9%
- **Max IOPS/volume*:** 500
- **Max throughput/volume*:** 500 MiB/s
- **Pricing**:** \$0.045 per GB-month of provisioned storage

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Cold HDD for infrequently accessed workloads



sc1

Cold HDD

- **Use cases:** sc1 is backed by hard disk drives (HDDs) and provides the lowest cost per GB of all EBS volume types. It is ideal for less frequently accessed workloads with large, cold datasets.
- **Volume size:** 125 GiB–16 TiB
- **Durability:** 99.8% - 99.9%
- **Max IOPS/volume*:** 250
- **Max throughput/volume*:** 250 MiB/s
- **Pricing**:** \$0.015 per GB-month of provisioned storage

**Pricing is for US East (N. Virginia) Region



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Fully managed backup with EBS Snapshots

Backup



Restore



Low cost

Incremental backups do not duplicate data and reduce storage costs

Protection

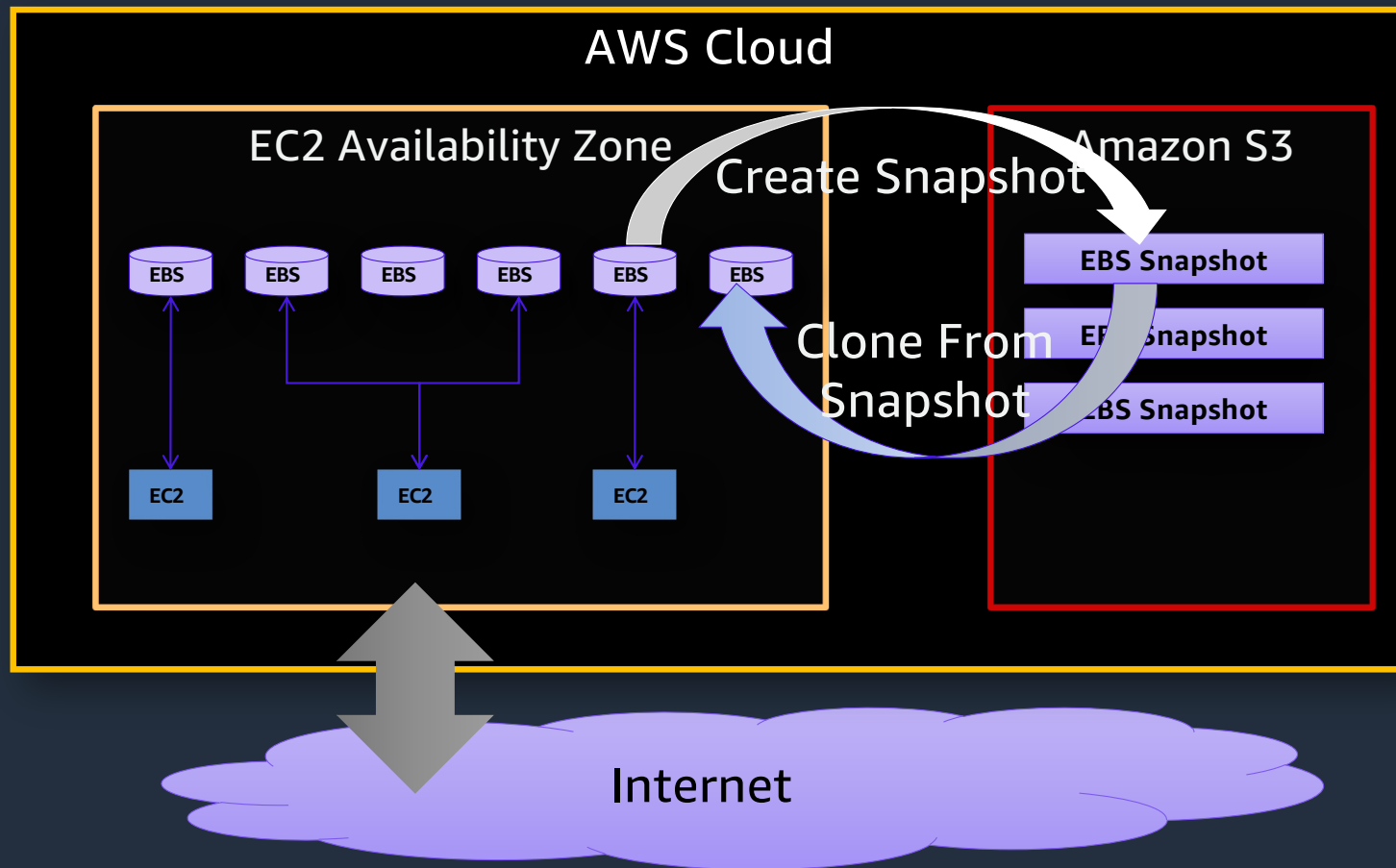
Snapshots are stored in Amazon S3

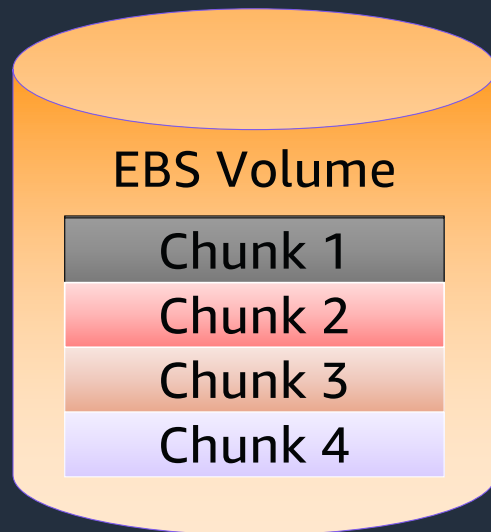
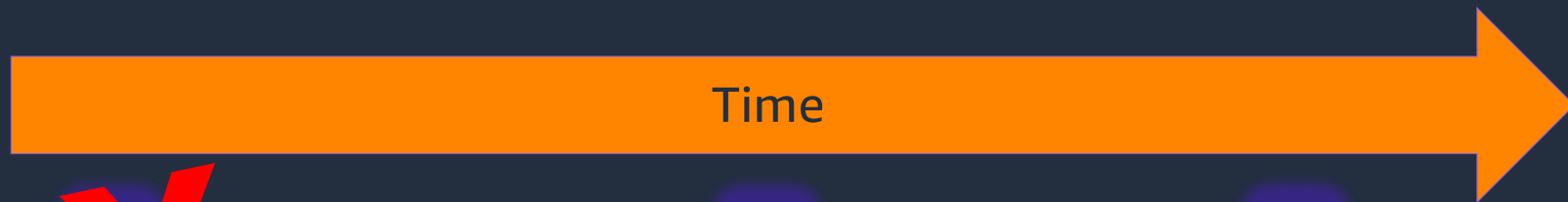
Agility

Quickly restore volumes across Availability Zones within a region



EBS Snapshots – Delta Block Changes





EBS Snapshots Archive Tier



Long-term snapshot retention

- 90-day minimum retention period

Full, point-in-time backups

Retrieve snapshot before use

- Retrieval time of hours

75% lower storage costs at 1.25c/GB-month

- 3c/GB additional retrieval charges

EBS Snapshots Archive Tier provides low storage cost for long-term retention of rarely accessed EBS Snapshots



Recycle Bin for EBS Snapshots and EBS-backed AMIs

QUICK RECOVERY OF DELETED SNAPSHOTS



Automatically retain deleted snapshots for a retention period you specify

Use Retention Rules to specify retention periods for all or some tagged snapshots in your account

Recover deleted snapshots before retention time expiry

Pay EBS Snapshot price for snapshots in Recycle Bin

Automatically retain deregistered EBS-backed AMIs



What is Amazon EC2 instance store?



- Local to instance
- Non-persistent data store
- Available on several EC2 families
- Data is not replicated (by default)
- No snapshot support
- SSD or NVMe
- Pricing is included in instance cost

Shared file system



Amazon Elastic File System



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Amazon
EFS

Designed to scale with and for your data

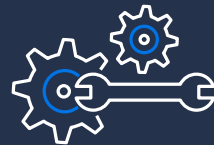
Built from the ground up to deliver super-simple, virtually bottomless file storage that **“just works”**



Amazon
EFS

Amazon Elastic File System (Amazon EFS)

Serverless, fully elastic file storage



Configuration-free



Fully elastic, no
provisioning



Accessible from
anywhere



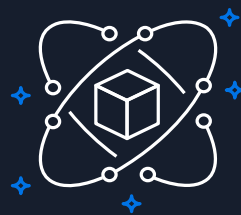
Cost optimized
without any effort

Use cases for Amazon EFS



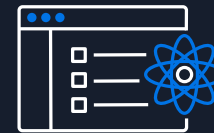
SaaS applications

Multi-tenant SaaS applications deployed with EC2, Containers, or Serverless based compute where filesystem performance enhances user experience



Modern applications

Containers, AWS Lambda workloads where multiple clients can recall the same data, incurring data accesses per access



Data science & analytics

ML training and analysis where analysis results age over time but can become hot again periodically

Automatic cost optimization for workloads with unpredictable access patterns

No need to think about provisioning infrastructure



**Fully elastic
storage**

Virtually bottomless capacity that automatically scales up and down to fit your changing needs



**Fully elastic
performance**

“Just works” performance for throughput-intensive applications, without any planning or provisioning

Fully elastic performance

LATENCY

2x

lower latencies

0.25ms reads

1.6ms writes

THROUGHPUT

3x

higher throughput

20 GB/s reads

5 GB/s writes

IOPS

4.5x

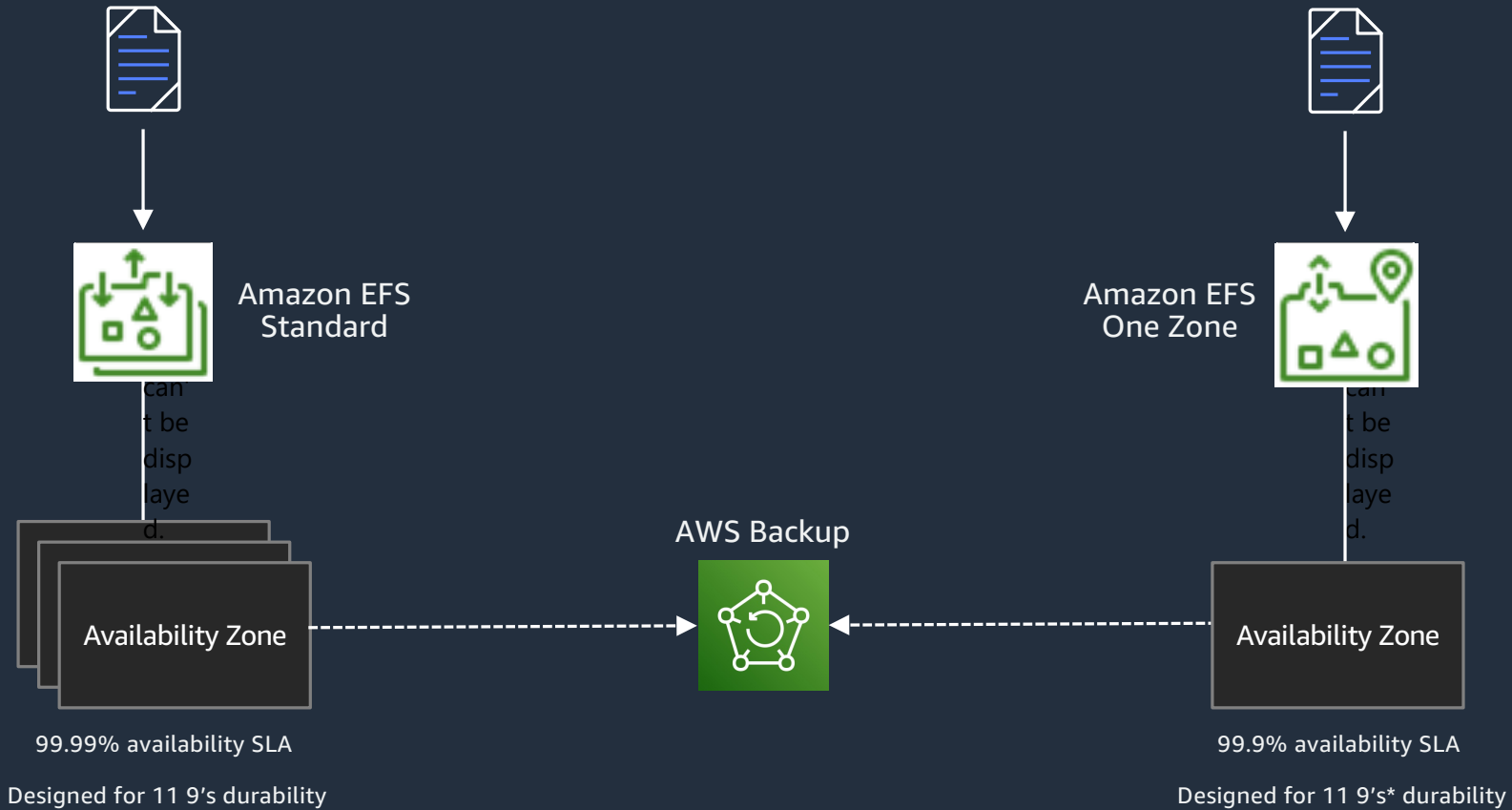
higher IOPS

250K read IOPS

50K write IOPS

Build and deploy with confidence

Highly available and durable

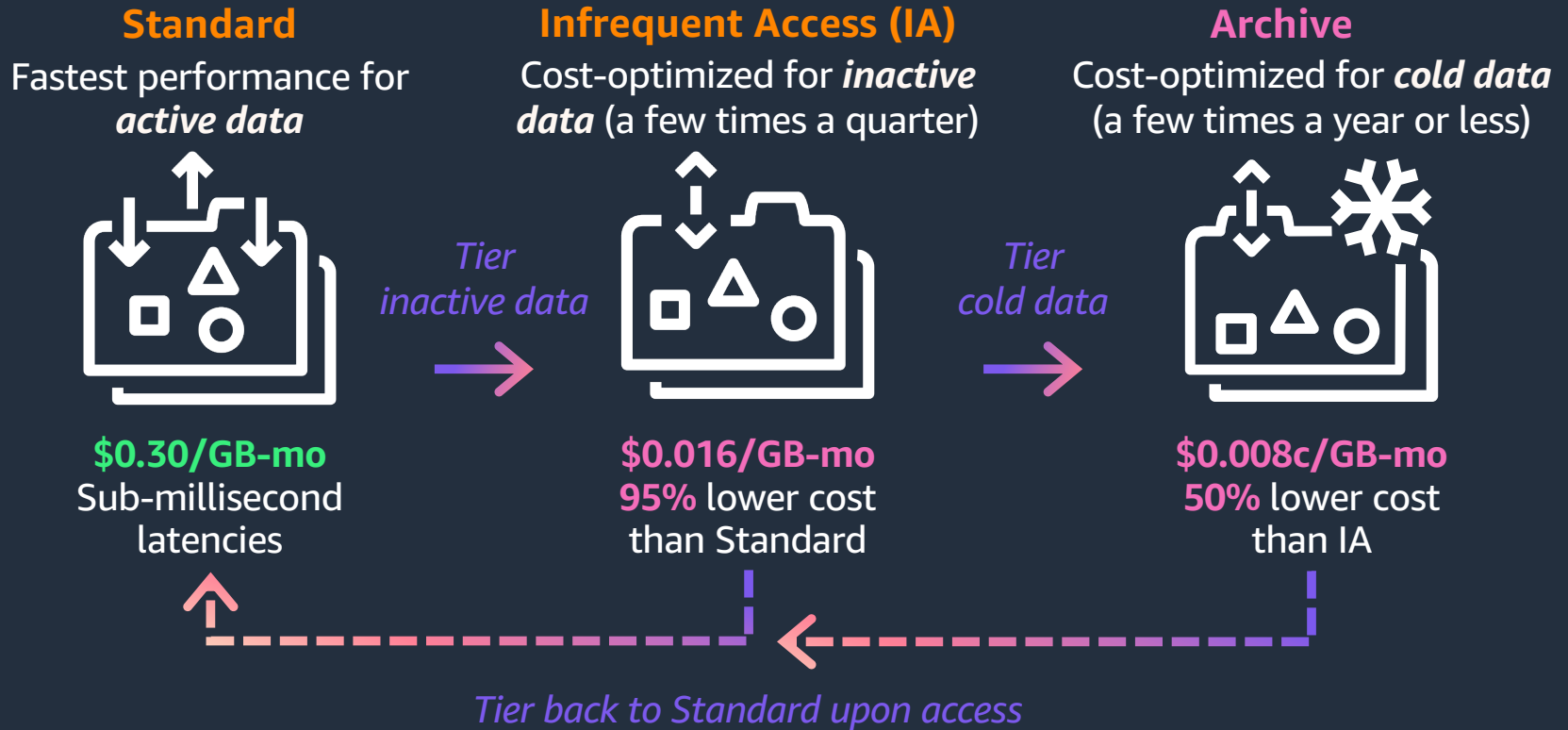


* Data stored in these storage classes may be lost in the event of a disaster or other fault that affects all copies of the data within the Availability Zone (AZ), or in the event of AZ destruction.



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EFS Storage Classes



Performance that scales with your application

Amazon EFS can scale up to 10s of GB/s of throughput and unlimited IOPS



Performance Modes

General Purpose

Up to 35K read and 7K write IOPS

Max I/O

Unlimited IOPS (at the file system)



Throughput Modes

Bursting Throughput

Auto-scale throughput based on storage

Provisioned Throughput

User-defined throughput independent of storage.
Additional charges apply.



Amazon FSx



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Amazon FSx for Windows File Server

FULLY MANAGED, HIGHLY RELIABLE AND SCALABLE FILE STORAGE BUILT ON WINDOWS SERVER



Home
directory



Content
management



Virtual
desktops



HA SQL Server
databases

Fully managed, and built on **Windows Server**

- No need to manage hardware infrastructure
- Windows-native SMB access

Flexible **price** and **performance** options

- SSD or HDD
- Single-AZ or Multi-AZ
- Scale throughput and storage independently
- Data deduplication

Easy **migration** to AWS

- SMB to SMB with AWS DataSync
- No need to replatform or rearchitect



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Fully managed Windows file storage means you no longer have to ...



Managed hardware

- Plan capacity
- Procure and purchase hardware
- Set up storage servers and volumes
- Detect and address hardware failures
- Incur high upfront costs



Managed software

- Install and configure server software
- Set up and configure file systems
- Apply Windows updates
- Manage software licenses
- Manage backups
- Monitor security

Deeply integrated with AWS

Security



Amazon
VPC



Amazon
IAM

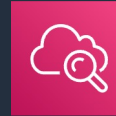


Amazon
KMS

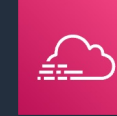


AWS Directory
Service

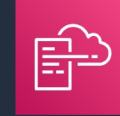
Monitoring and automation



Amazon
CloudWatch



AWS
CloudTrail



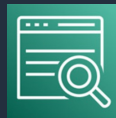
AWS
CloudFormation



Amazon
ECS



Amazon
EKS



Amazon
Kendra



Amazon
File Gateway



Amazon
EC2



VMware Cloud on
AWS

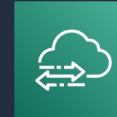


Amazon
AppStream 2.0



Amazon
WorkSpaces

Compute instances



AWS
DataSync



AWS
Backup

Data management



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Flexible price and performance options

- Storage type flexibility (SSD / HDD)
- Deployment type flexibility (Single-AZ / Multi-AZ)
- Select throughput and storage independently
- Choice of in-line snapshots and backups stored in S3
- Data deduplication and compression

Object Stores



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Amazon S3



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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



Amazon S3 storage class choice matters at scale

PURPOSE-BUILT TO DELIVER THE MOST COST-EFFECTIVE STORAGE FOR VARIOUS ACCESS PATTERNS AND PERFORMANCE REQUIREMENTS

S3 Express
One Zone



Most
frequently
accessed data

Single-digit
millisecond access

S3 Intelligent-
Tiering



Changing
access
patterns

S3
Standard



Frequently
accessed
data

S3
Standard-IA



Infrequently
accessed
data

S3 One
Zone-IA



Re-creatable,
less accessed
data

S3 Glacier
Instant Retrieval



Rarely
accessed
data

S3 Glacier
Flexible Retrieval



Archive
data

S3 Glacier
Deep Archive



Long-term
archive data

Milliseconds access

Minutes to hours



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Amazon S3 Storage Classes

S3 Intelligent-Tiering



Changing access patterns

S3 Standard



Frequently accessed data

S3 Standard-IA



Infrequently accessed data

S3 Glacier Instant Retrieval



Rarely accessed data

S3 Glacier Flexible Retrieval



Archive data

S3 Glacier Deep Archive



Long-term archive data

AWS Region $\geq$ 3 Availability Zones

Changing access patterns

- Milliseconds access
- No retrieval charge
- Archive Instant Access tier

Frequently accessed data

- Milliseconds access
- No retrieval charge

Infrequently accessed data

- Milliseconds access
- Per-GB retrieval charge

Rarely accessed data

- Milliseconds access
- Per-GB retrieval charge

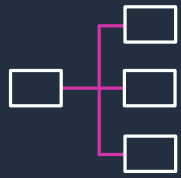
Archive data

- Retrieval options from minutes to hours
- Free bulk retrievals

Long term archive data

- Retrieval in hours

S3 Management Features



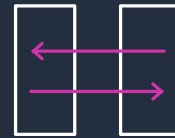
Organize

S3 Tagging
S3 Prefixes
S3 Versioning



Monitor

CloudWatch
CloudTrail
S3 Event Notifications
S3 Inventory
S3 Glacier Restore Notifications
S3 Storage Lens
AWS Config



Replicate & Tier

S3 Lifecycle
S3 Storage Class Analysis
S3 Intelligent-Tiering
Cross-Region Replication
Replication Time Control (RTC)



Modify

S3 Event Notifications + Lambda
S3 Batch Operations
S3 Object Lock
S3 Object Lambda

S3 Access Management & Security

- Deep integration with AWS Identity and Access Management (IAM)
- Access Control Lists (ACLs), S3 bucket policies, and S3 Access Points
- Query String Authentication
- Audit Logs
- S3 supports both server-side & client-side encryption
- 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
- Access Analyzer for S3
- Amazon S3 Object Lock
- AWS PrivateLink for S3
- Amazon GuardDuty for S3

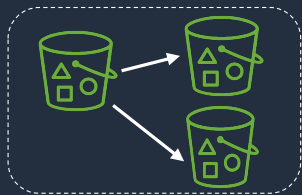


New S3 Features

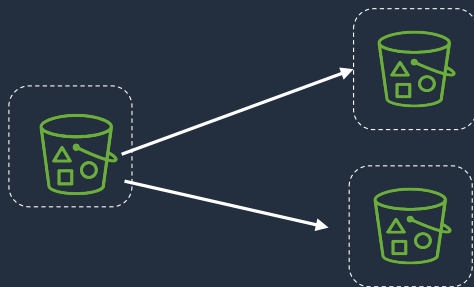
- S3 Mountpoint
- Object Replication Status Visibility
- Data Exchange for S3
- Automatic Encryption of New Objects
- VPC Interface Endpoints for S3
- Automatic enabling of S3 Block Public Access on new Buckets
- Automatic disabling of S3 Access Control Lists (ACL's) on new Buckets

S3 Replication

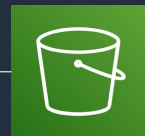
Replicate to 1 or more buckets within the **same AWS Region**



Replicate to one or more bucket in **different AWS Regions**



Amazon Simple Storage Service



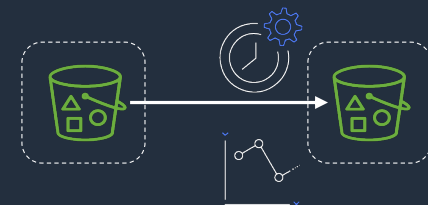
Bi-Directional Replication (in the same or different AWS Region)



Replicate to a bucket with **retention controls** (in the same or different AWS Region)



Replicate faster to a different AWS Region, **backed by an SLA + replication metrics**



AWS Transfer Family



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Managed file transfer – what is it?



Managed file transfer (MFT) provides **secure and reliable transfer of data** between systems through a network (e.g., the Internet), enabling exchange of data to meet business critical needs

Attributes

- Focused on secure and flexible file transfers
- Support 3rd party integrations and connectors
- Provide pre-processing for data filtering and encryption
- Supports additional protocols (AS2/HTTPS)

AWS Transfer Family benefits



Reduce
Costs



Scales with
business



Operational
Visibility



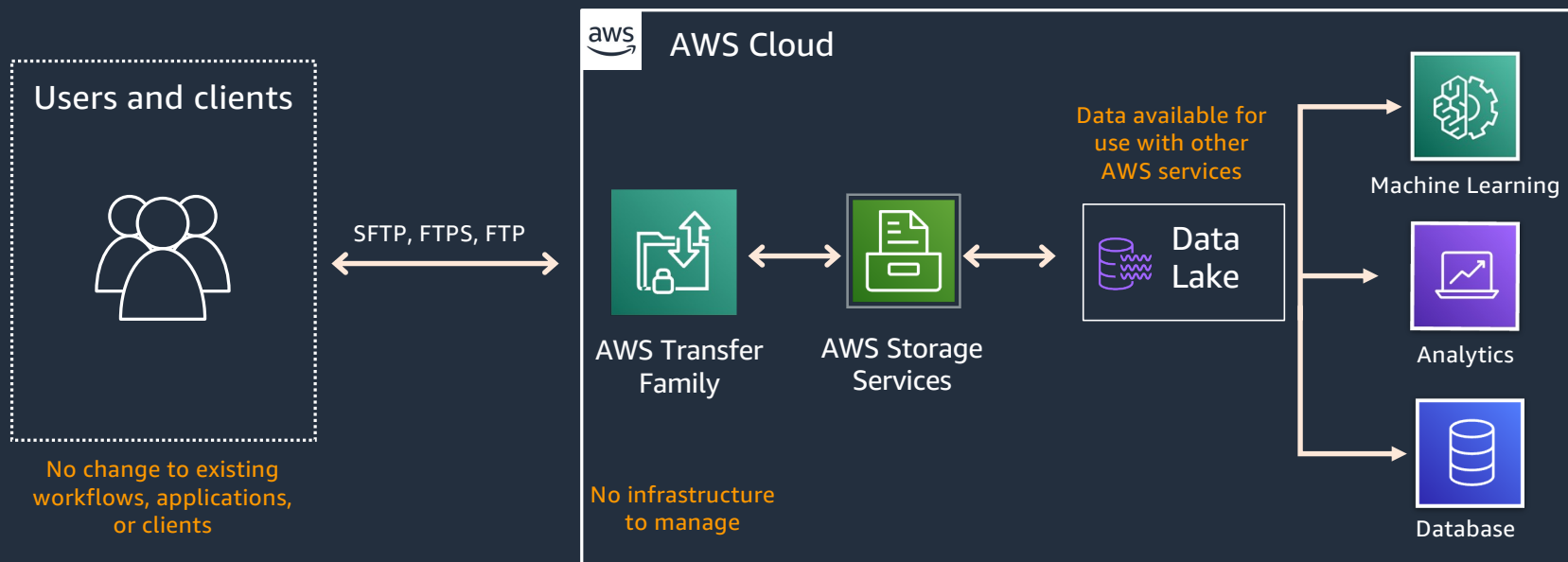
Secure and
Compliant



AWS
Integrated

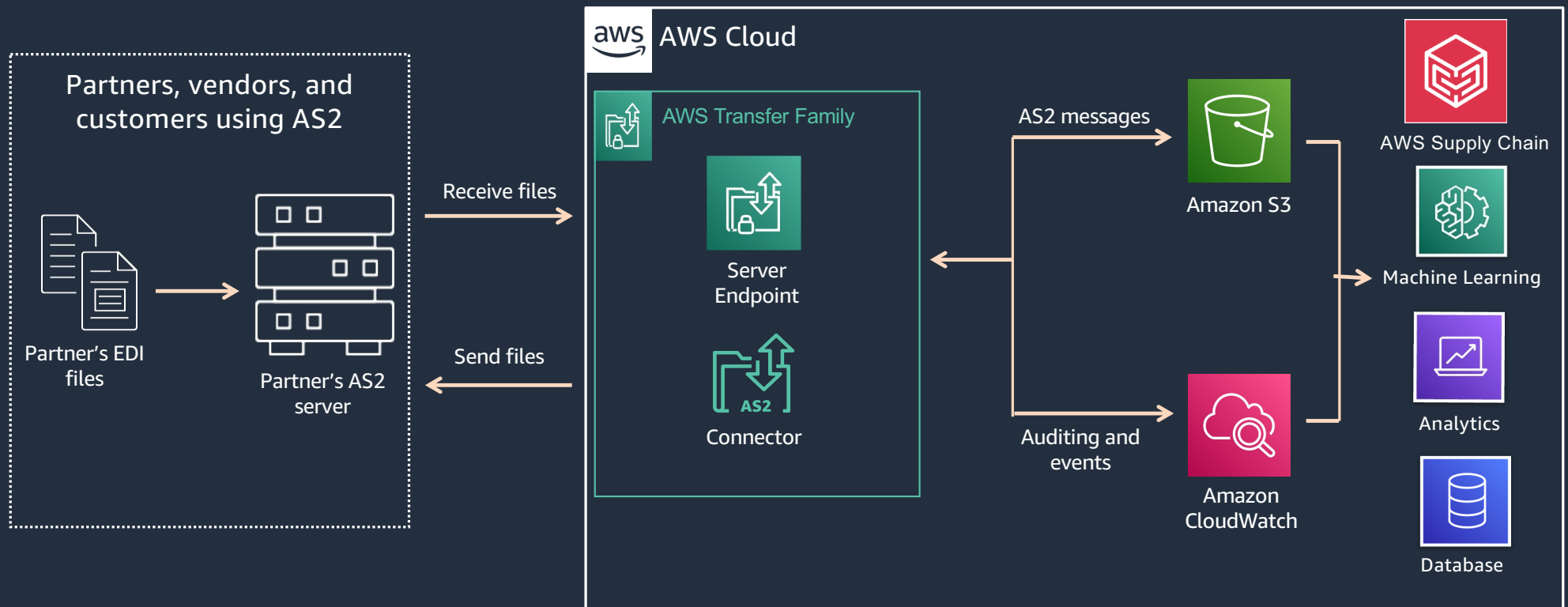
AWS Transfer Family (SFTP/FTPS/FTP)

Seamlessly migrate without impacting your workflows



AWS Transfer Family (AS2)

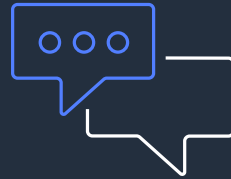
Seamlessly migrate without impacting your workflows



Common use cases



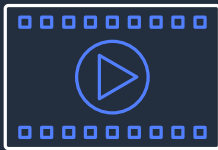
Data lakes and analytics platforms



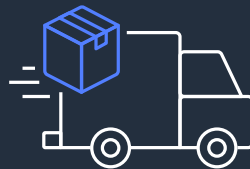
Customer relationship management applications



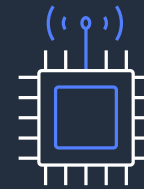
Subscription based data products



Digital media content aggregation and distribution



Enterprise resource planning and electronic data interchange for supply chain logistics



IoT services used in remote locations for monitoring



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Get started with AWS Transfer Family

1 Launch a server endpoint



2 Select your target S3 bucket(s) or EFS file share(s)



3 Configure your users



SFTP/FTPS/FTP Pricing

Server endpoint time: \$0.30/protocol/hour
Data uploads and downloads: \$0.04/GB

AS2 (only available for S3) Pricing

Server endpoint time: \$0.30/protocol/hour
Cost per message sent/received: \$0.01/per message

SFTP/FTPS/FTP Examples:

20 end users download data from S3 over SFTP at 1 GB/day

- Monthly estimate: \$217.20

or

1000 end users, upload 100 GB/day of data and download 50 GB/day over SFTP, and upload 200 GB/day of data and download 100 GB/day over FTPS

- Monthly estimate: \$972

AS2 Pricing

At \$0.01/messages, your 30 day charge for receiving 500 messages over AS2

- Monthly estimate added to above SFTP/FTPS/FTP costs: \$150



Learn more: aws.amazon.com/aws-transfer-family/pricing/

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Backup



AWS Backup



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AWS Backup – meeting the challenges

Backup operations unified across AWS services



Complexity

Simple & Performant



Policy- and tag-based backup solution



Automated backup scheduling



Compliance

Reliable & Secure



Centralized backup activity monitoring and logs



Backup encryption



Backup access policies



Cost

Cost Effective



Automated backup retention management



No added cost for orchestration

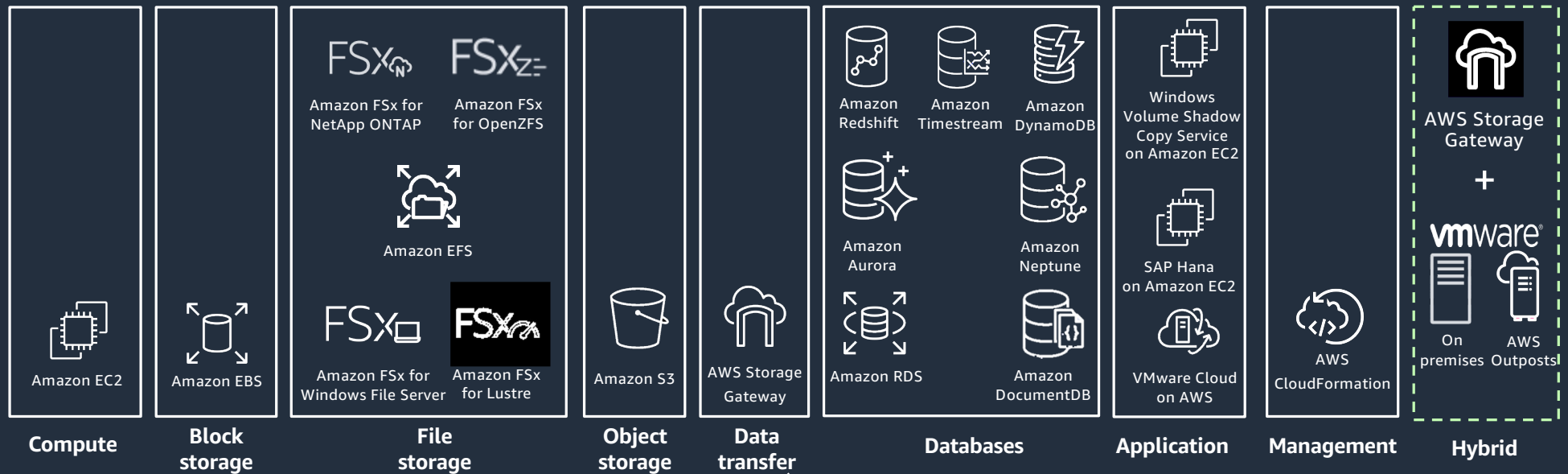


Overview of AWS Backup

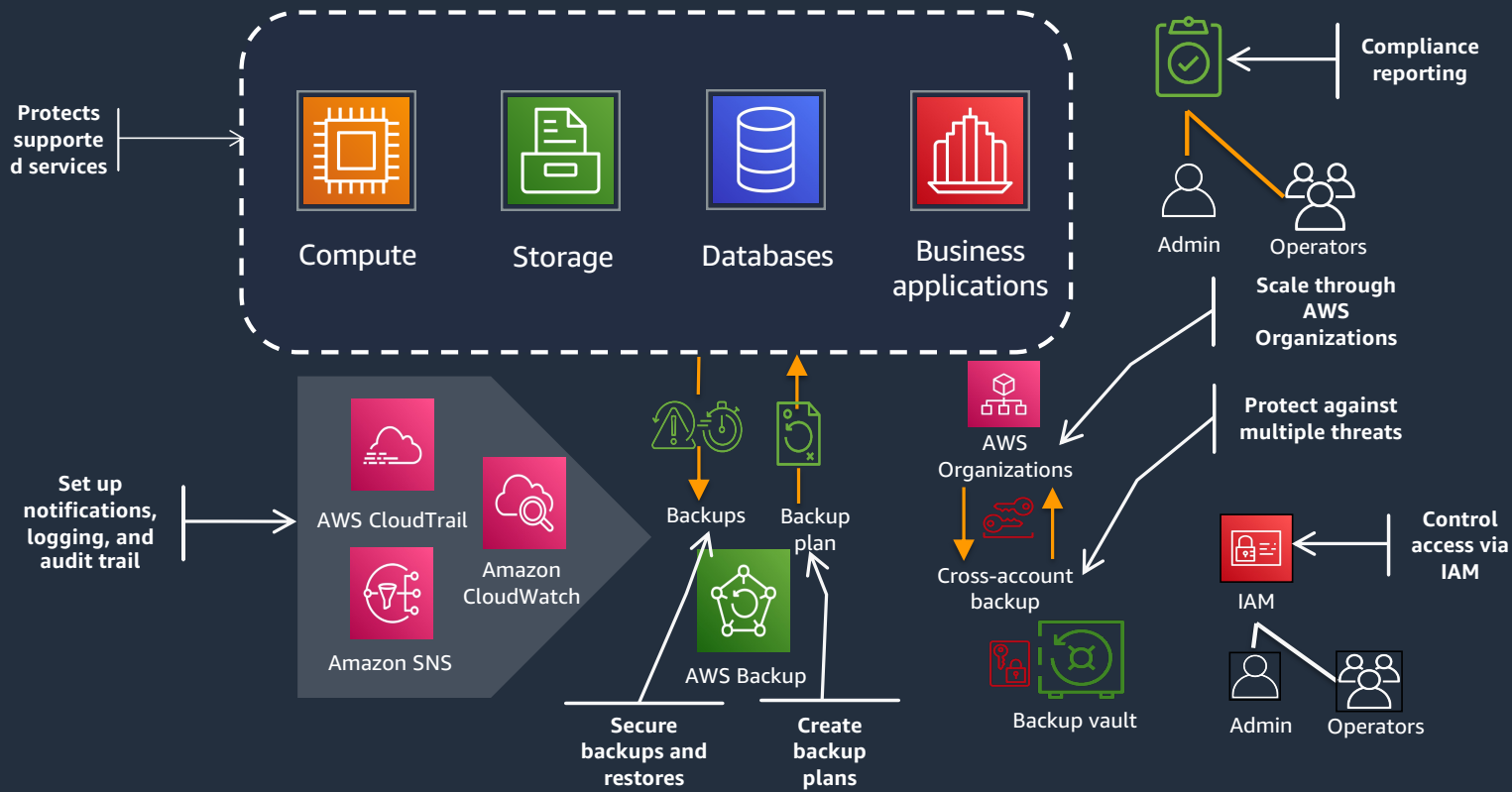


AWS Backup

A fully **managed**, **policy-based** service that **centralizes and automates** data protection across multiple **AWS services and hybrid workloads** with data protection **compliance analytics and insights**



How AWS Backup works



DR & Ransomware Recovery with AWS Backup



- Vault characteristics:
 - Backups are highly efficient incremental forever
 - Backup copies cannot be changed or encrypted
 - Manage with vault specific CMK/KMS best practices
 - Air-gapped backups using vault access policies
 - Prescriptive guidance for vault account access provided
- Recovery options:
 - Supports 1-to-many, many-to-many, many-to-1, etc.
 - Recover from same account locally or from across region
 - Recover from cross-account locally or across region
 - Recover from RPOs that are hours, days, weeks or months old
 - Simple workflow to apply any forensic analysis

Notable Recent AWS Backup launches

Cloud native and hybrid support

Support for Amazon Aurora continuous backups

Support for SAP HANA on EC2

Scalability and performance improvements for S3 backup

VMware vSphere 8 support and multiple vNIC support

Compliance and governance support

Backup Audit Manager support for delegated administrator

Logical Air Gapped Vault

Platform improvements

Tag on restore

Support for local time zone selection

Automated Restore Testing

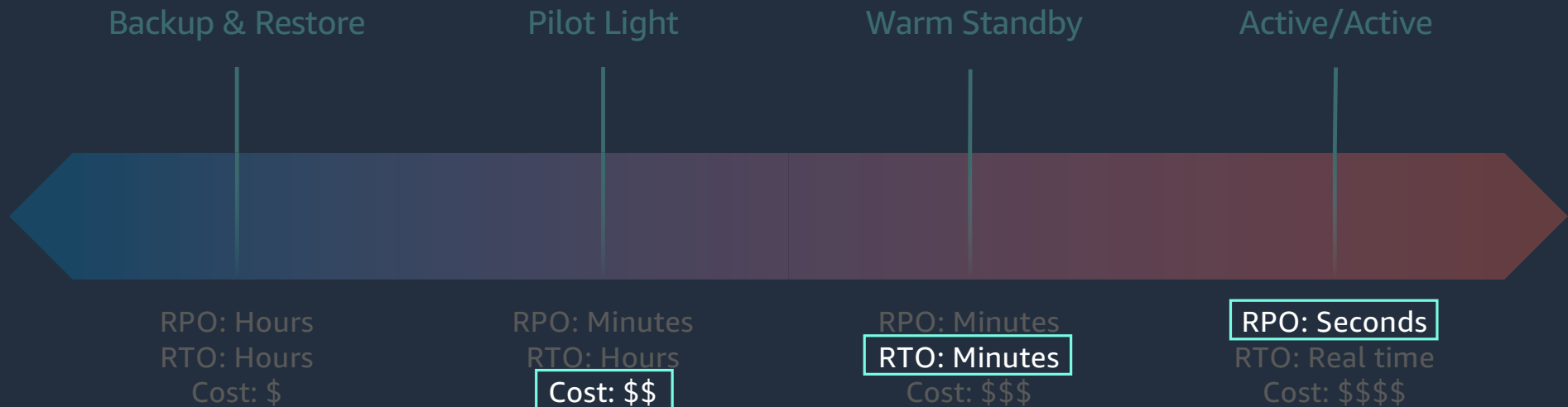
AWS Elastic Disaster Recovery



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AWS Elastic Disaster Recovery

Get the RPOs of Active/Active and the RTOs of Warm Standby at the cost of Pilot Light



AWS Elastic Disaster Recovery

High-performance, cost-effective application recovery



AWS Elastic Disaster Recovery selected as the DRaaS market leader for both innovation and growth in Frost & Sullivan's 2022 *Frost Radar: Disaster Recovery as a Service*.

AWS Elastic Disaster Recovery key benefits



Faster recovery

Recovery time objectives (RTOs) of minutes



Lower costs

No need to pay for idle recovery site resources



Data protection

Recovery point objectives (RPOs) of seconds



Easy testing

Conduct non-disruptive drills to verify readiness



Ransomware recovery

Launch unlocked and unencrypted versions of your applications

Ransomware mitigation

Use AWS Elastic Disaster Recovery for ransomware protection, detection, response, and recovery



Account isolation

Protect your workloads by isolating your staging account from your production and recovery accounts.



Immutable snapshots

Keep your data safe with immutable snapshots that can't be altered or overwritten.



Endpoint detection and response (EDR)

Detect and eliminate threats using integrated solutions from AWS Partners CrowdStrike and SentinelOne.



Point-in-time recovery

Recover your servers by using unlocked and unencrypted point-in-time snapshots.

Elastic Disaster Recovery deployment patterns



On-premises to AWS



Other cloud to AWS



AWS Region to AWS Region



AWS Availability Zone to
AWS Availability Zone

Q&A





Thank you!