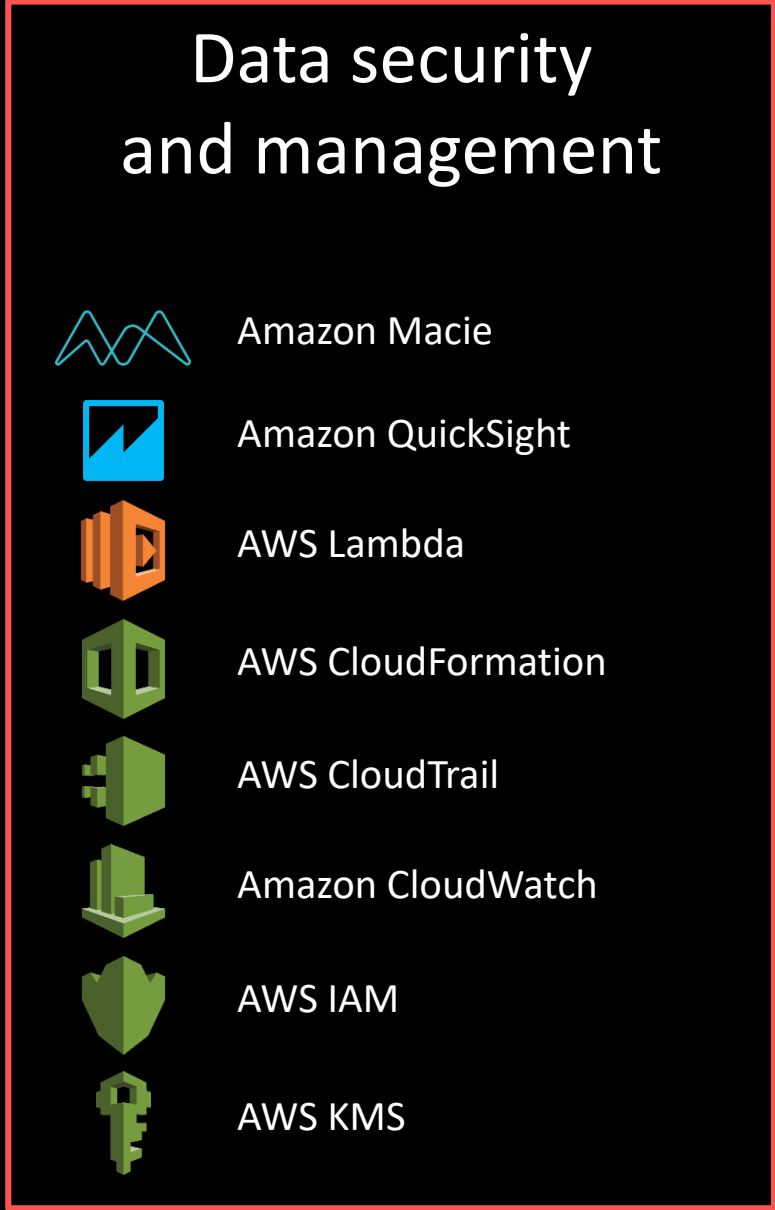
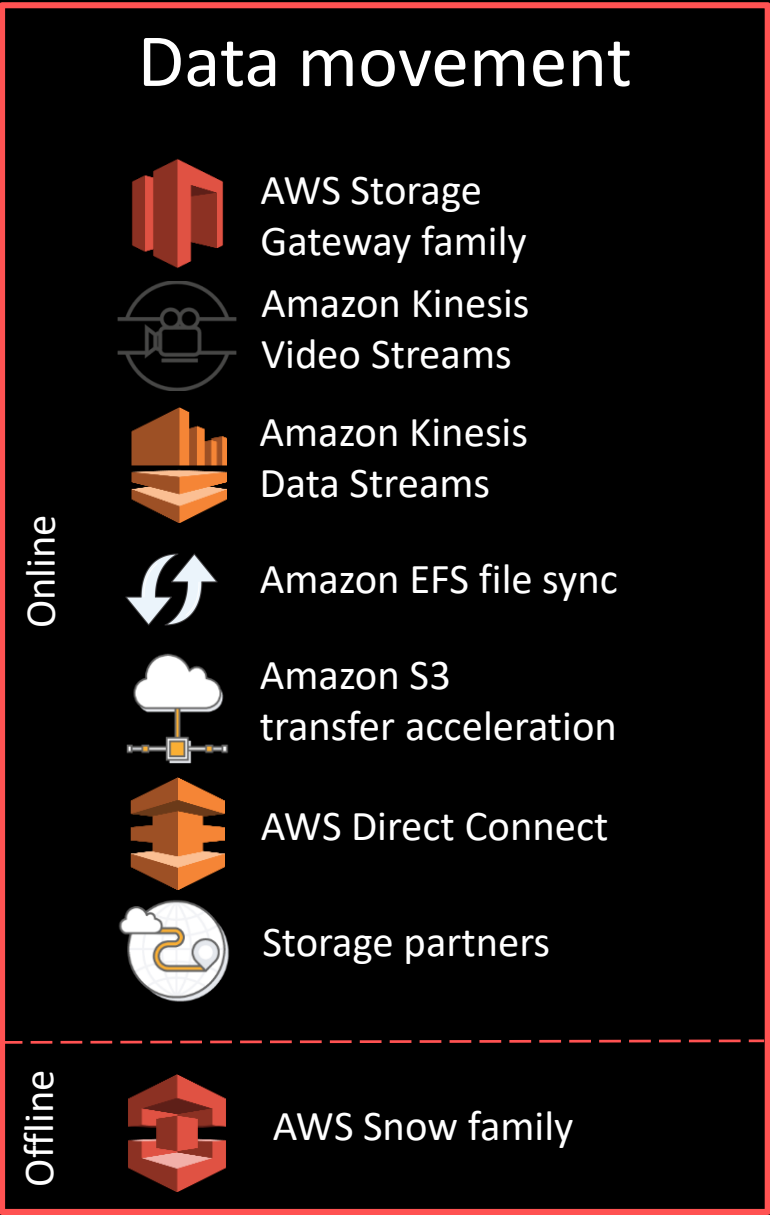


C M P 3 0 1

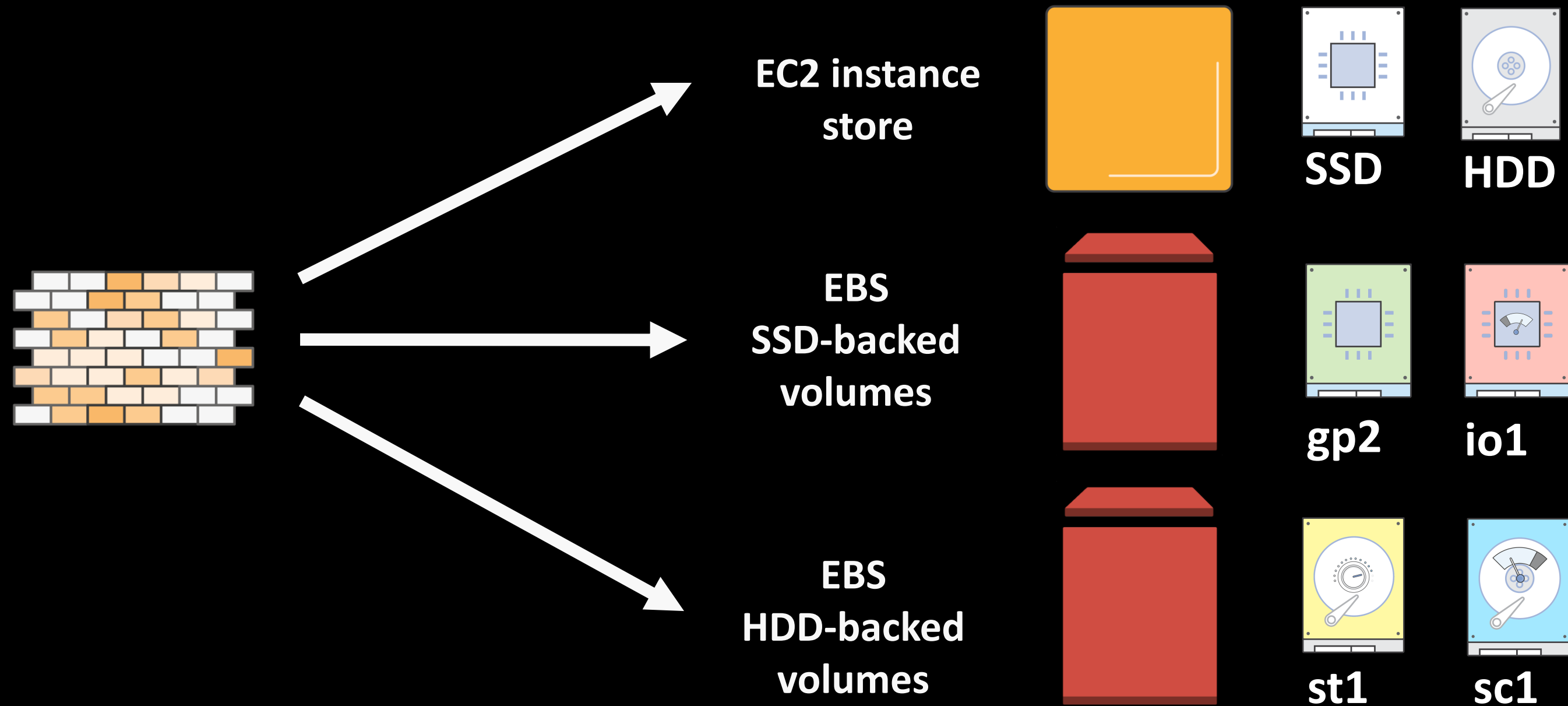
Deep dive on Amazon EBS

Ashish Palekar
Director of Product Management
Amazon Web Services

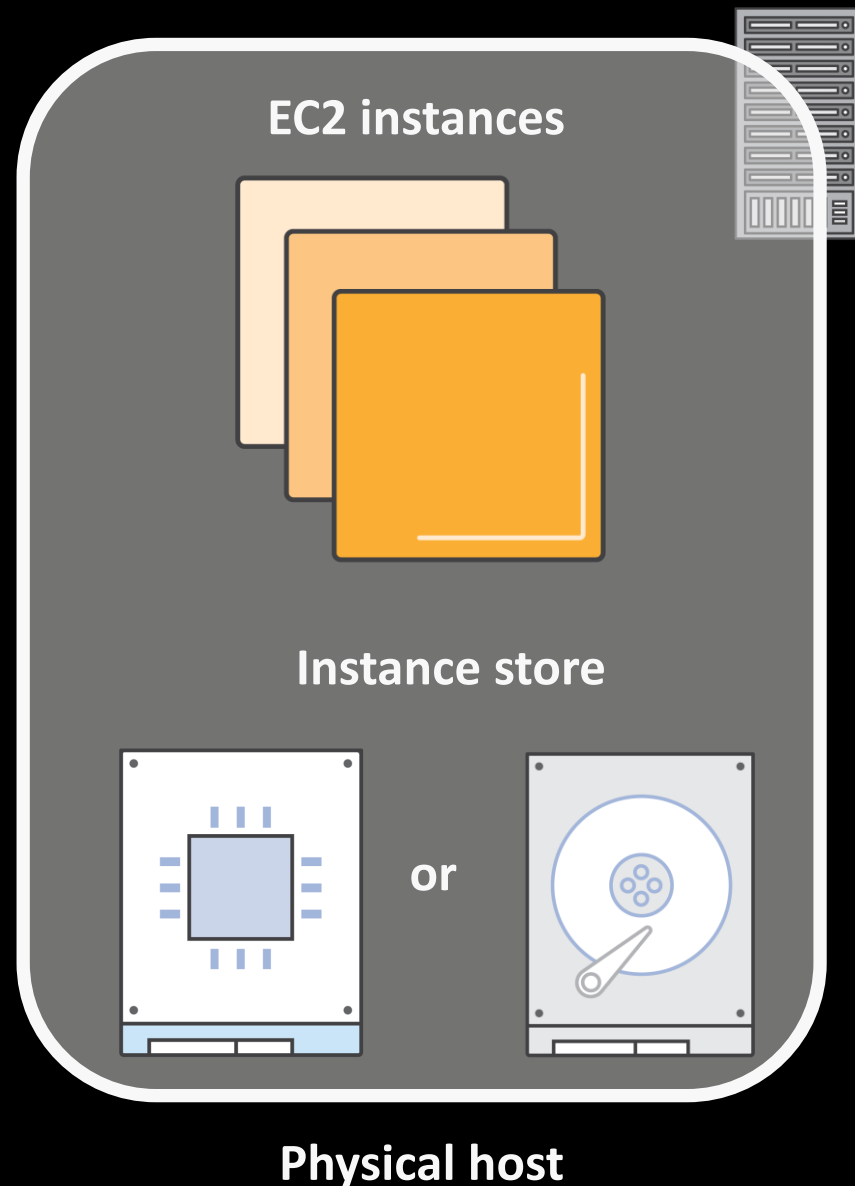
Complete set of data building blocks



AWS block storage offerings

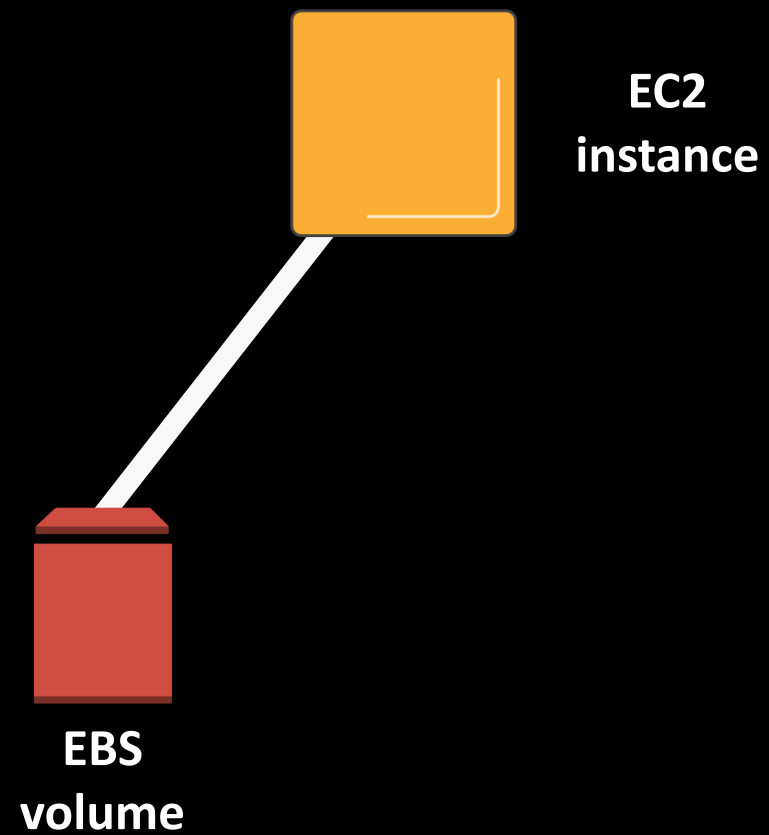


What is Amazon EC2 instance store?



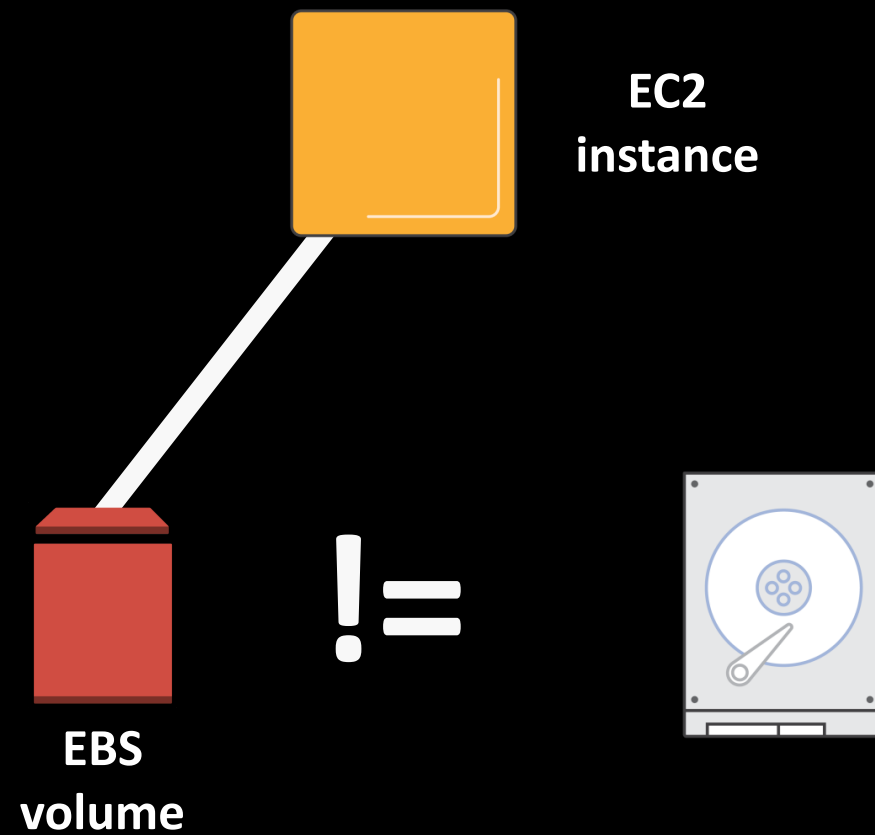
- Local to instance
- Non-persistent data store
- Data not replicated (by default)
- No snapshot support
- Solid state drive (SSD) or hard disk drive (HDD)

What is Amazon EBS?



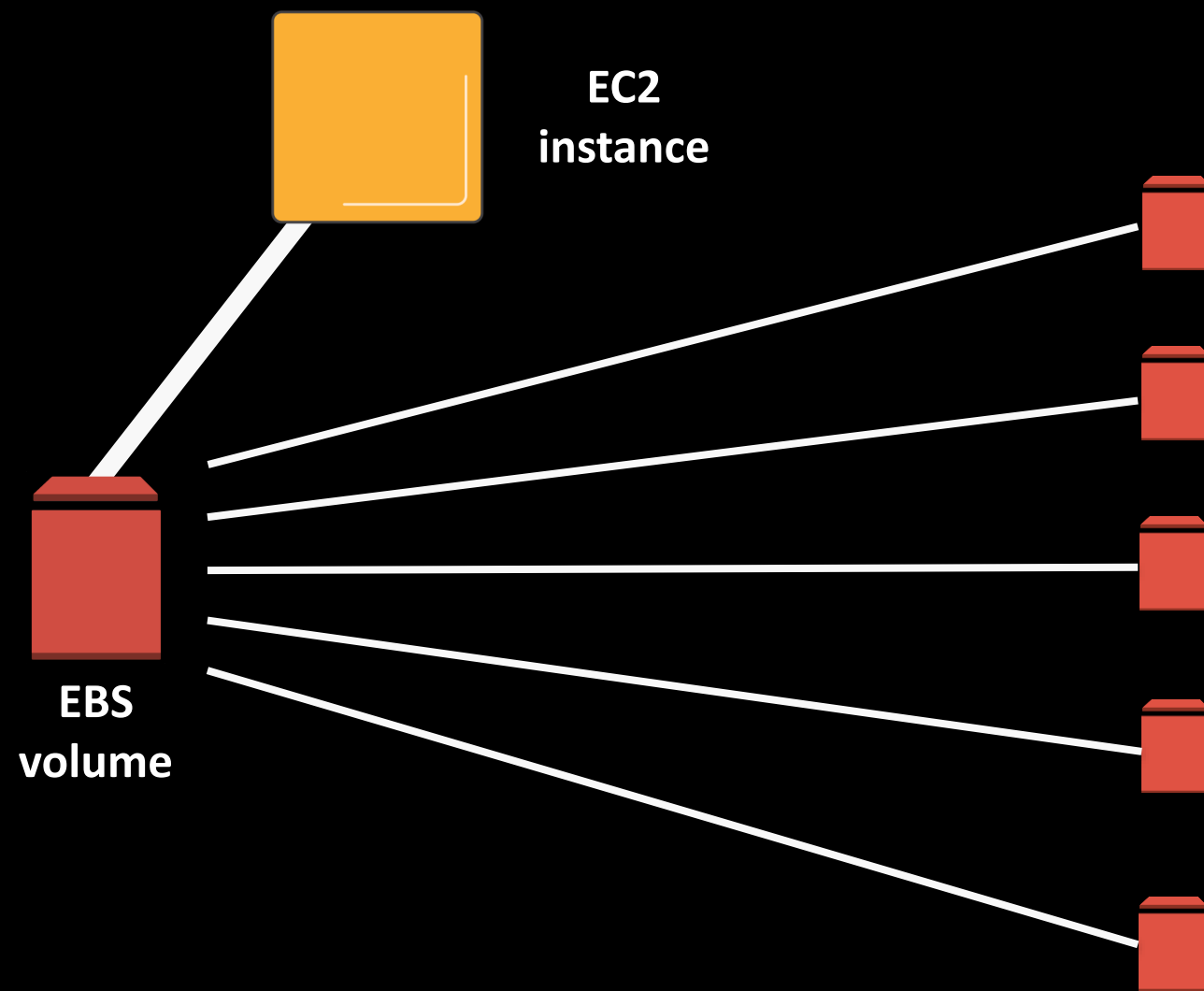
- Block storage as a service
- Create and attach volumes through an API
- Service accessed over the network

What is Amazon EBS?

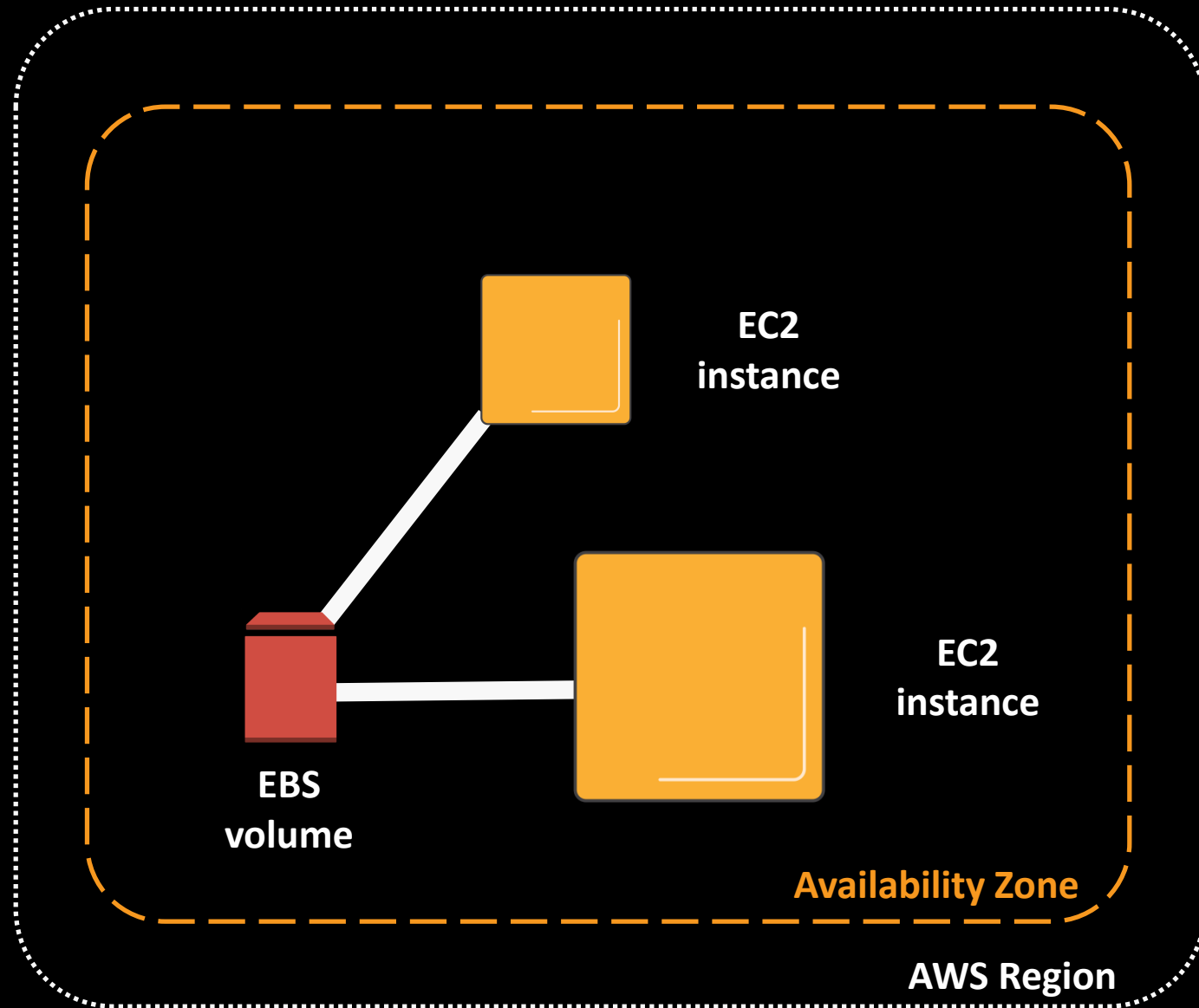


- Block storage as a service
- Create and attach volumes through an API
- Service accessed over the network

What is Amazon EBS?

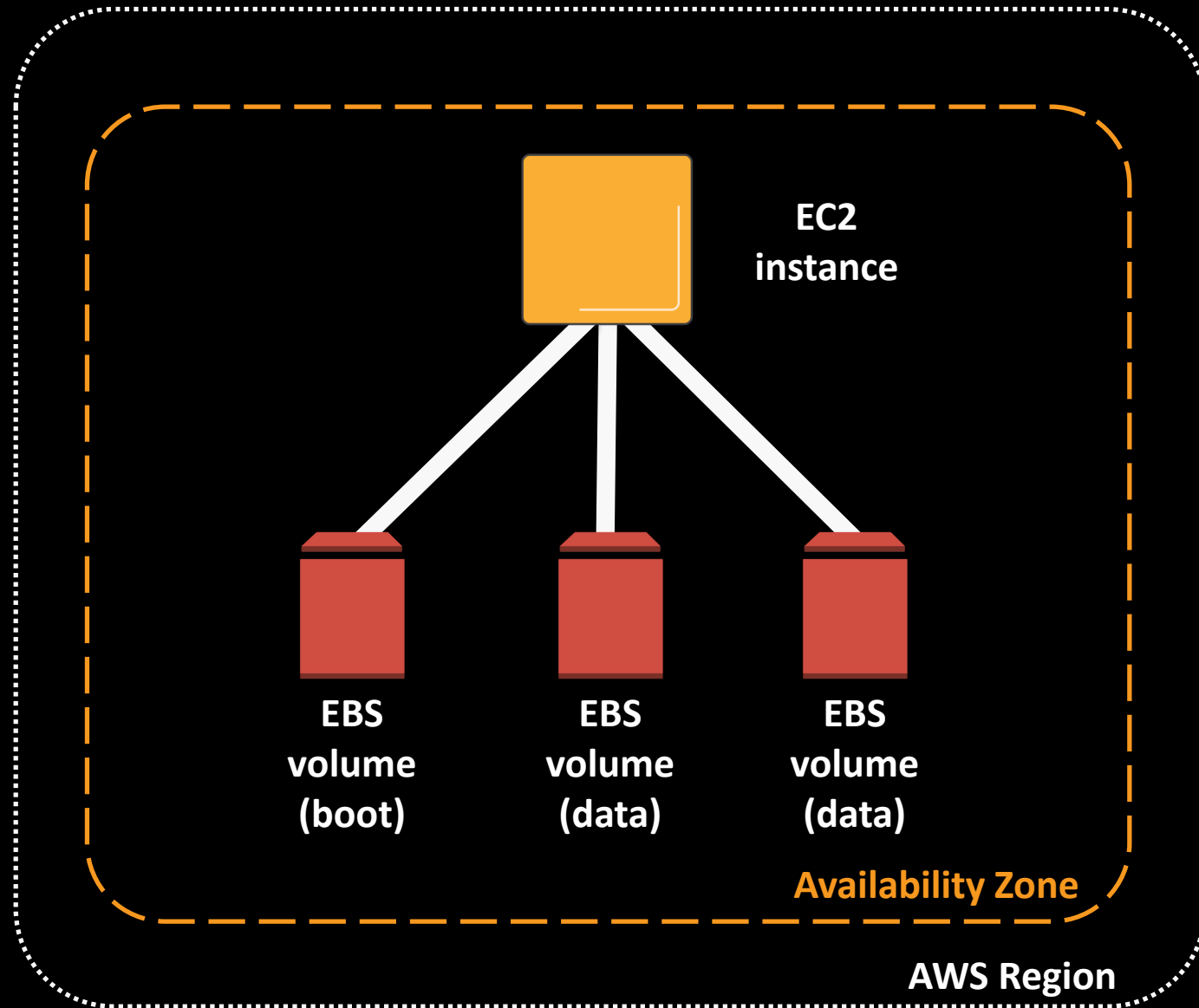


What is Amazon EBS?



- Volumes persist independent of EC2
- Select storage and compute based on your workload
- Detach and attach between instances within the same Availability Zone

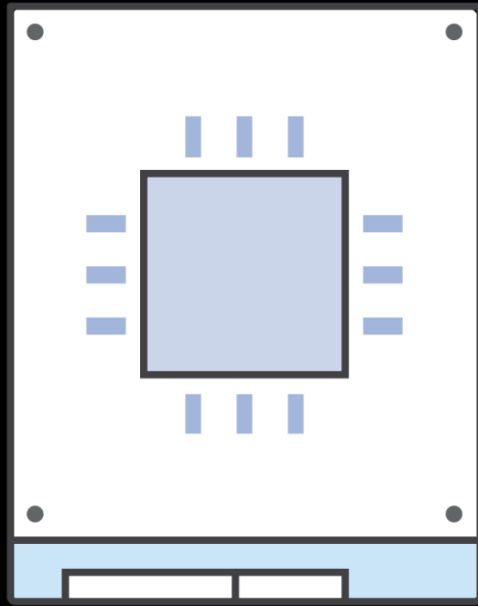
What is Amazon EBS?



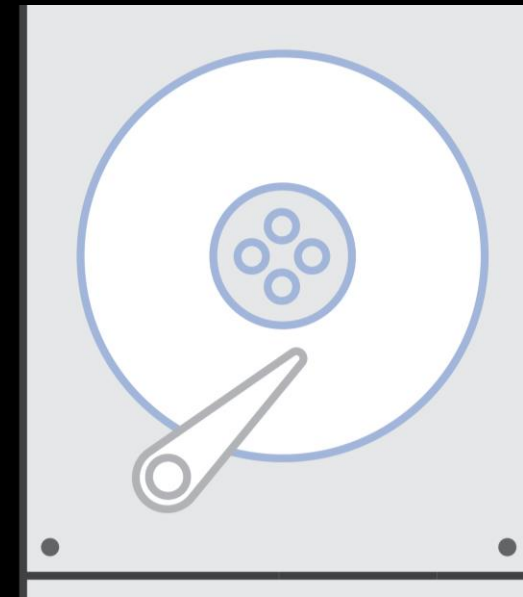
- Volumes attach to one instance
- Many volumes can attach to an instance
- Separate boot and data volumes

Amazon EBS volume types

Amazon EBS volume types

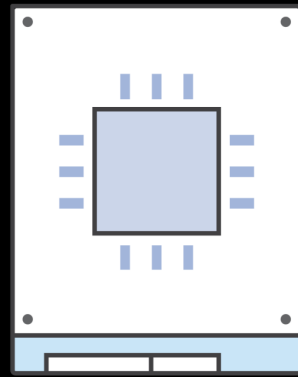


SSD

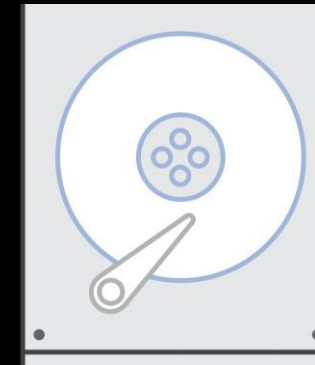


HDD

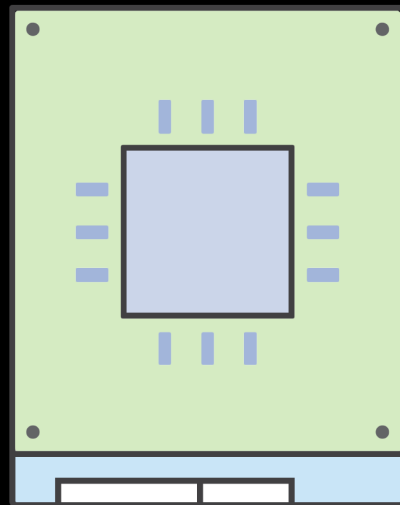
Amazon EBS volume types



SSD

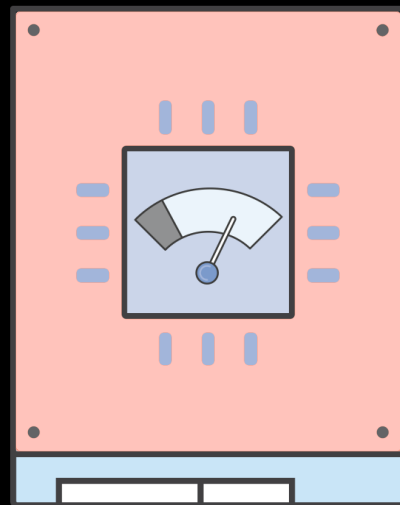


HDD



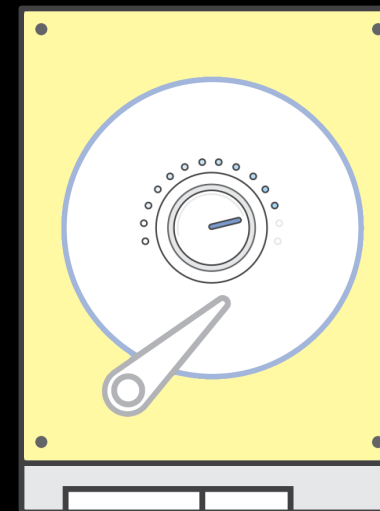
gp2

General Purpose
SSD



io1

Provisioned IOPS
SSD



st1

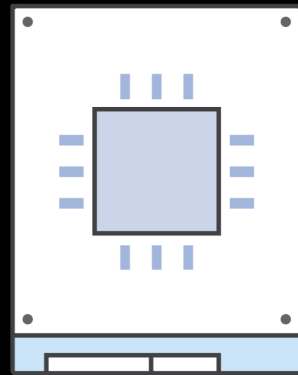
Throughput
Optimized HDD



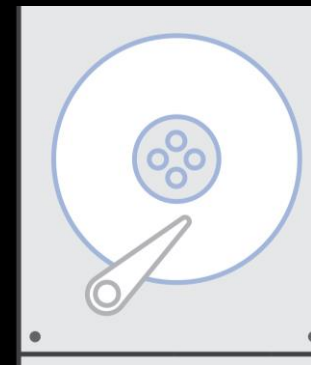
sc1

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

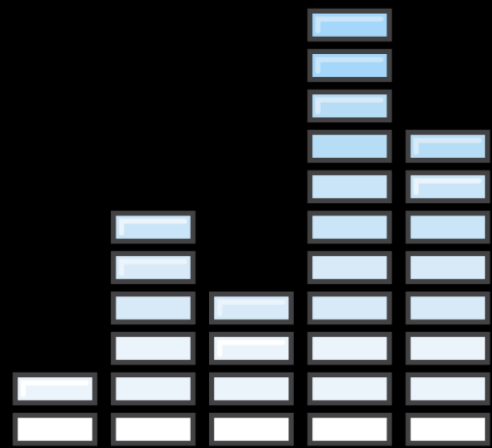


File/media

CIFS/NFS, transcoding,
encoding, rendering

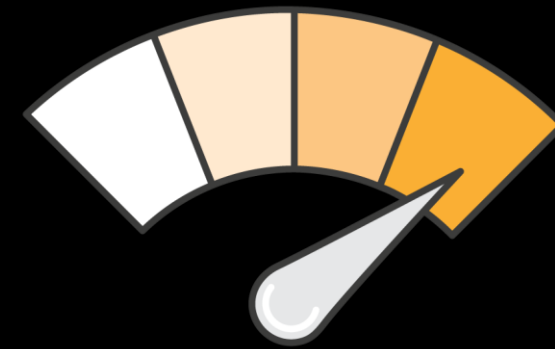
Choosing an Amazon EBS volume type

What is more important to your workload?



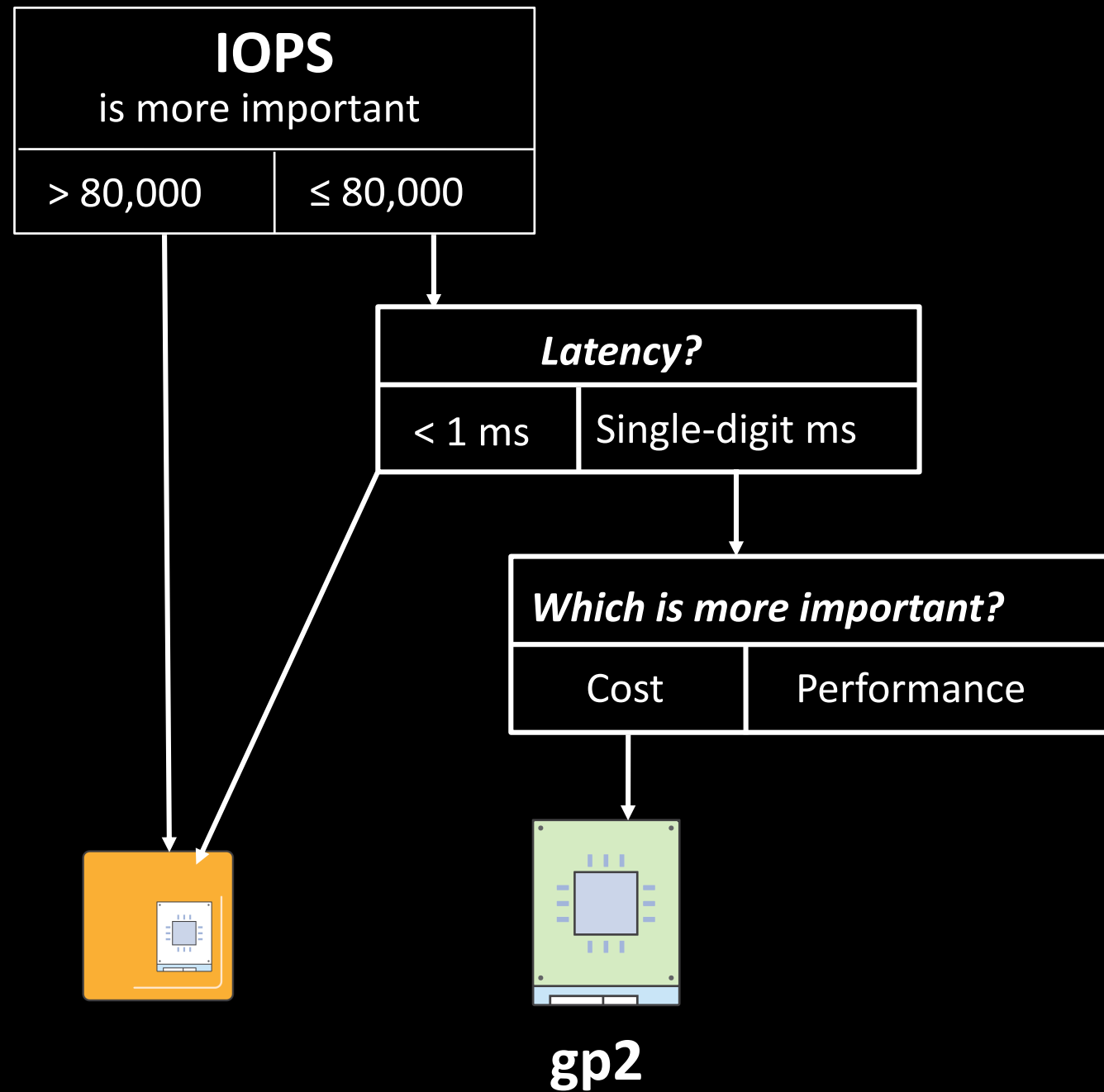
IOPS

or

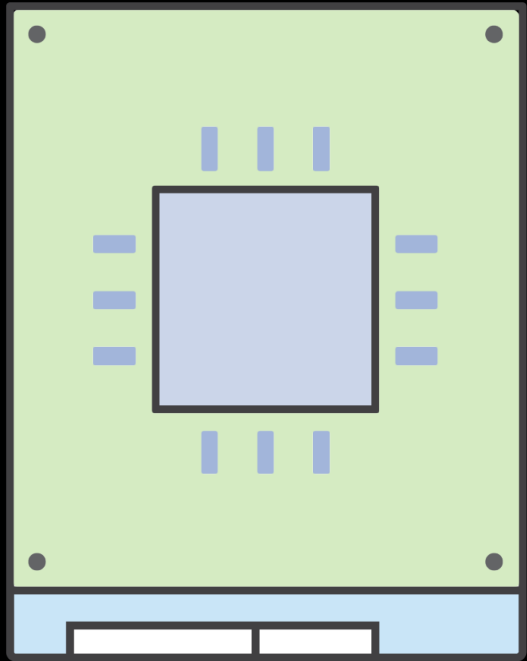


Throughput?

Choosing an Amazon EBS volume type



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)

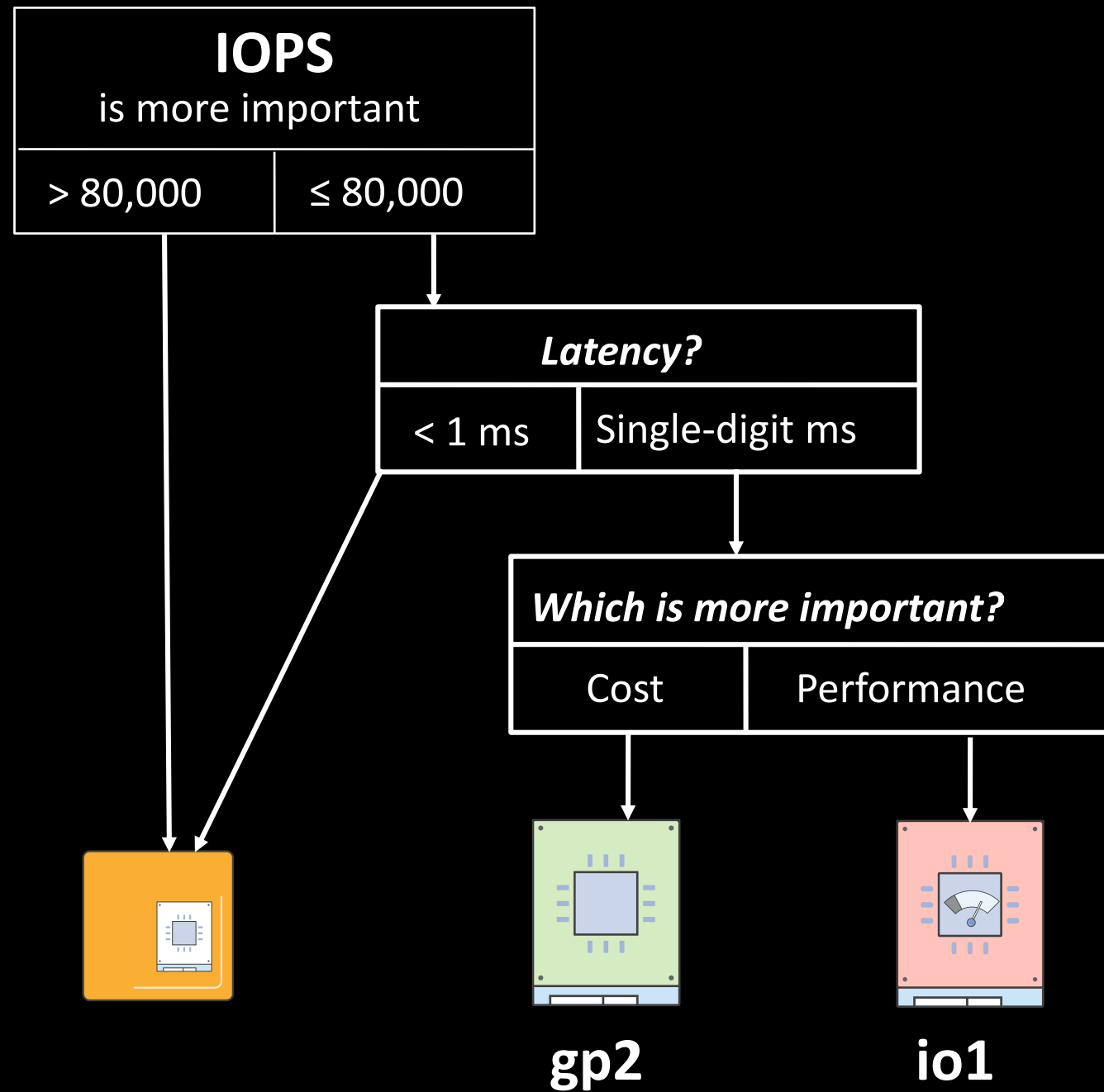
Throughput: Up to 250 MiB/s

Latency: Single-digit ms

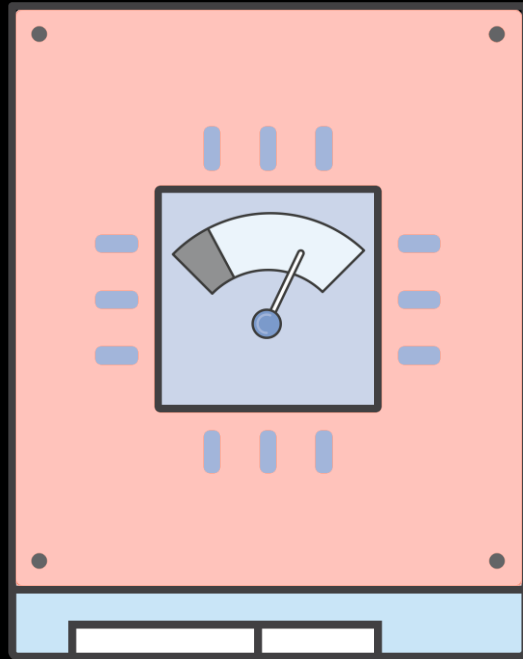
Capacity: 1 GiB to 16 TiB

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

Choosing an Amazon EBS volume type



Amazon EBS volume types: Provisioned IOPS



io1

Provisioned IOPS

Baseline: 100 to 64,000 IOPS

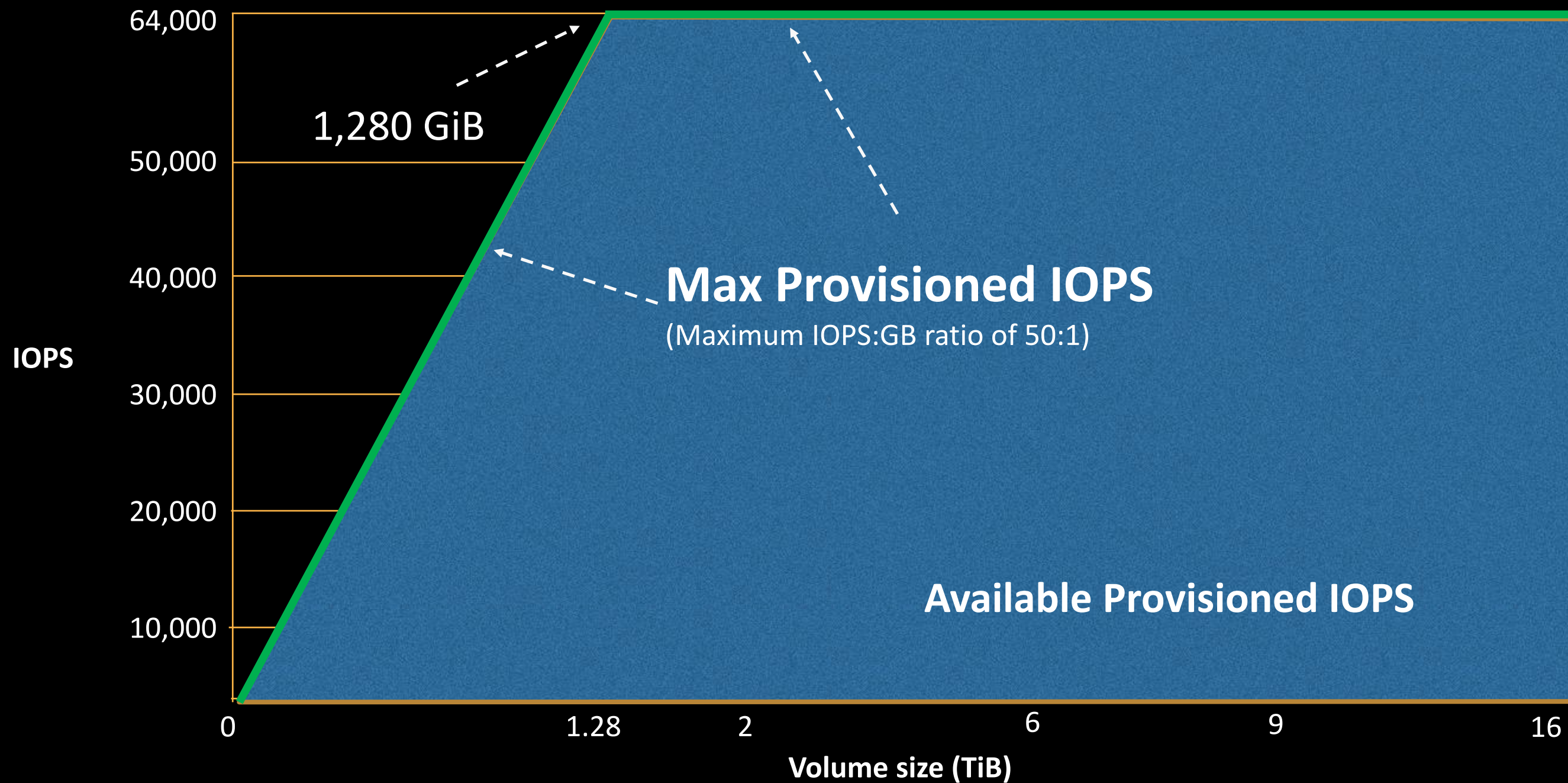
Throughput: Up to 1,000 MiB/s

Latency: Single-digit ms

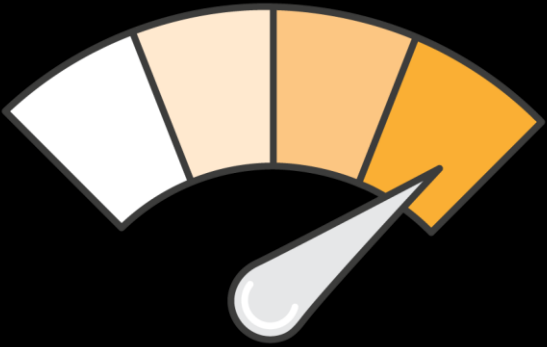
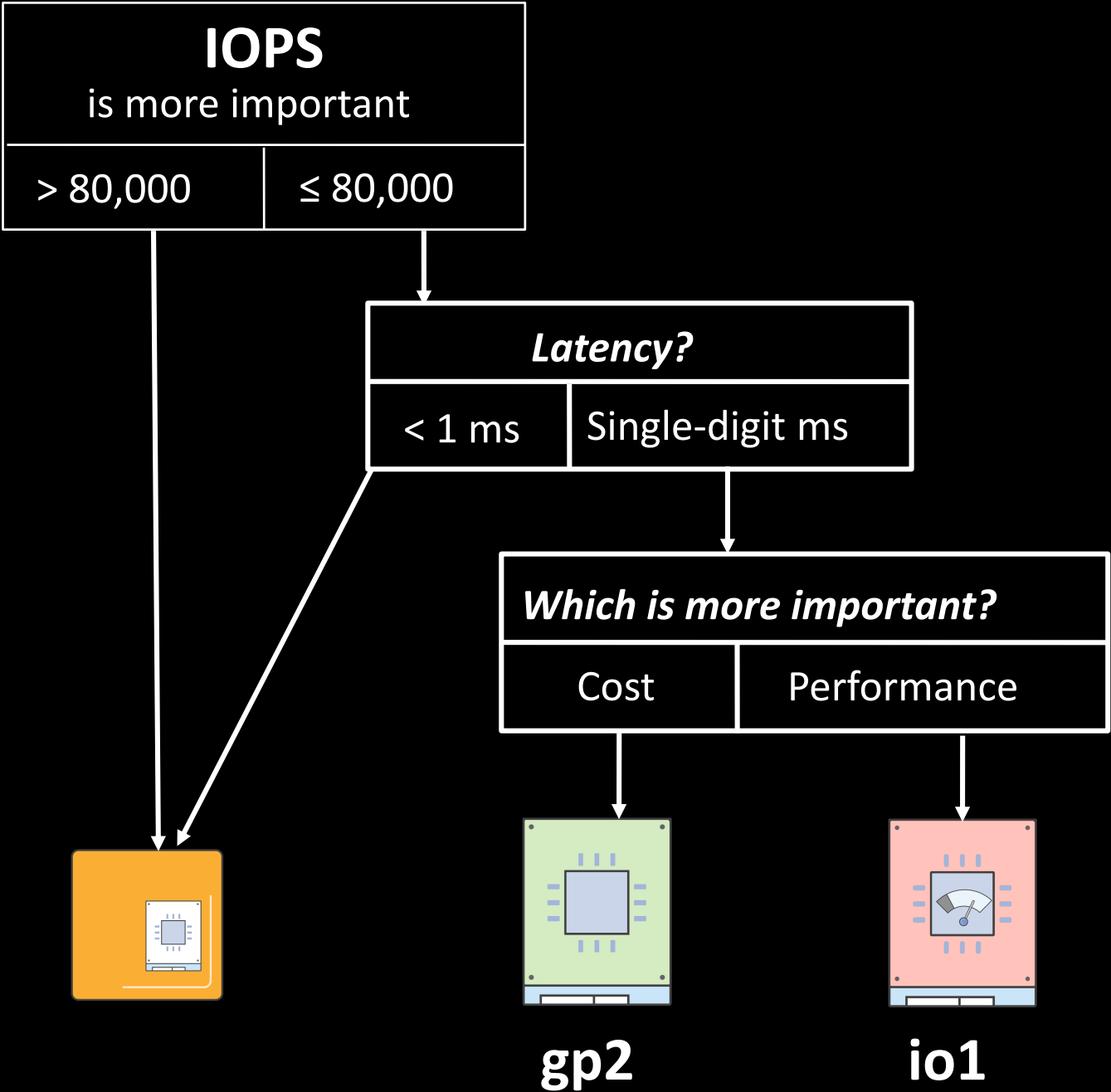
Capacity: 4 GiB to 16 TiB

Ideal for critical applications and databases with sustained IOPS

Scaling Provisioned IOPS SSD (io1)

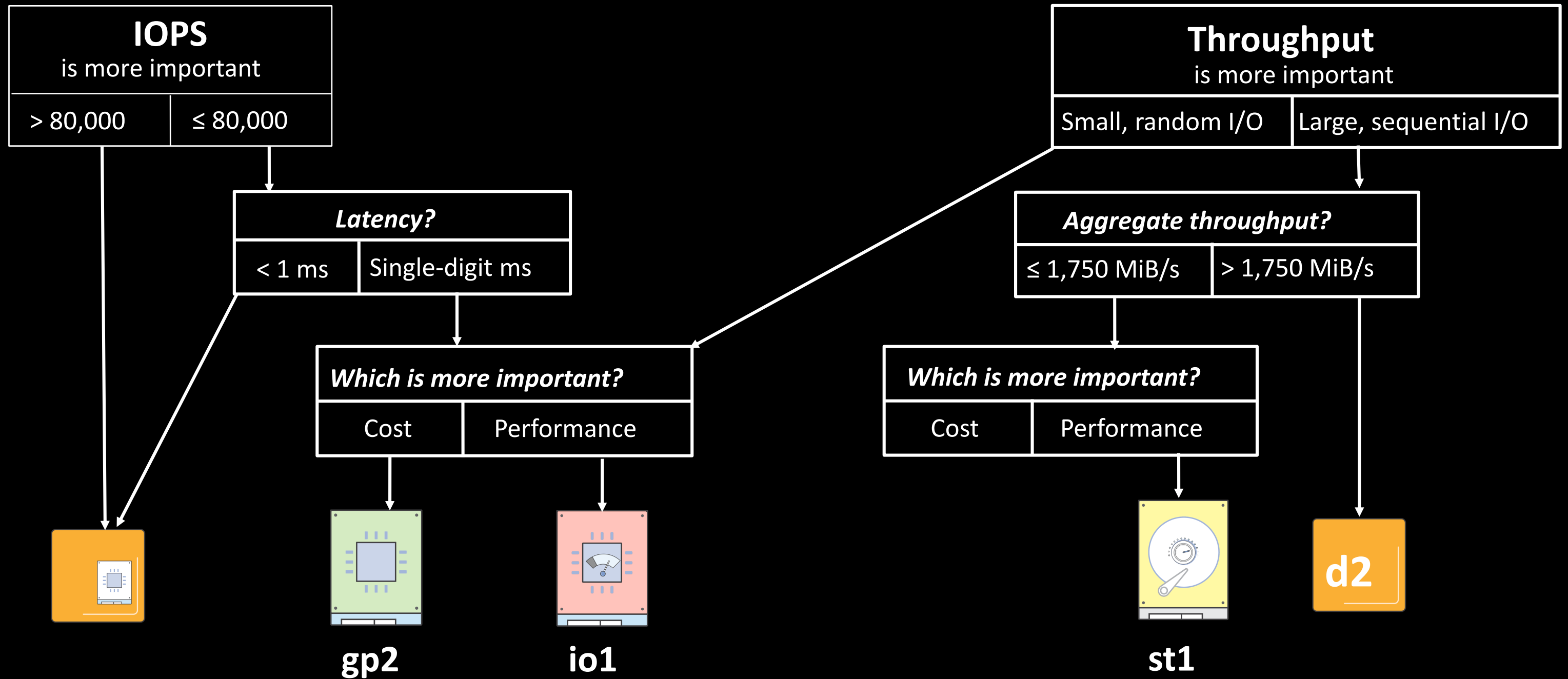


Choosing an Amazon EBS volume type

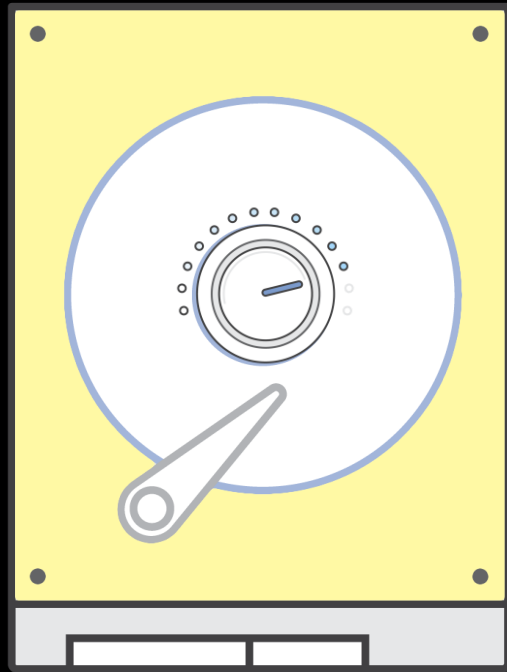


Throughput?

Choosing an Amazon EBS volume type



Amazon EBS volume types: Throughput provisioned



st1

Throughput Optimized HDD

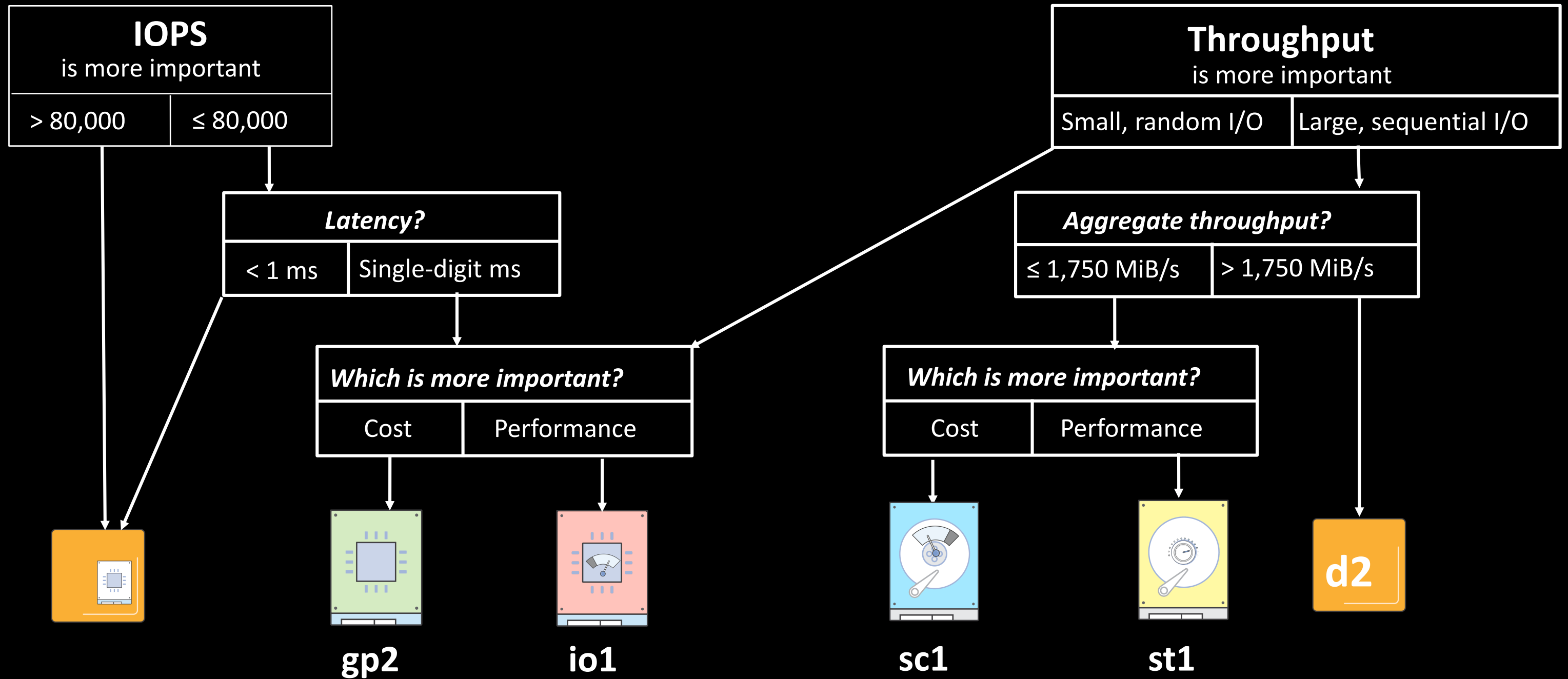
Baseline: 40 MiB/s per TiB up to 500 MiB/s

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

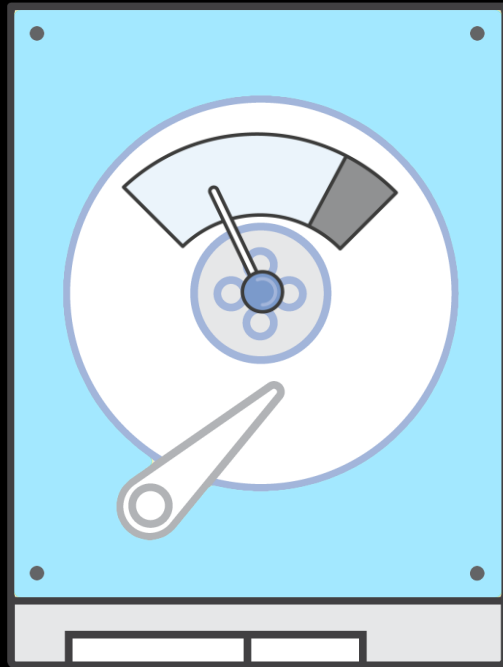
Capacity: 500 GiB to 16 TiB

Ideal for large-block, high-throughput sequential workloads

Choosing an Amazon EBS volume type



Amazon EBS volume types: Throughput provisioned



sc1

Cold HDD

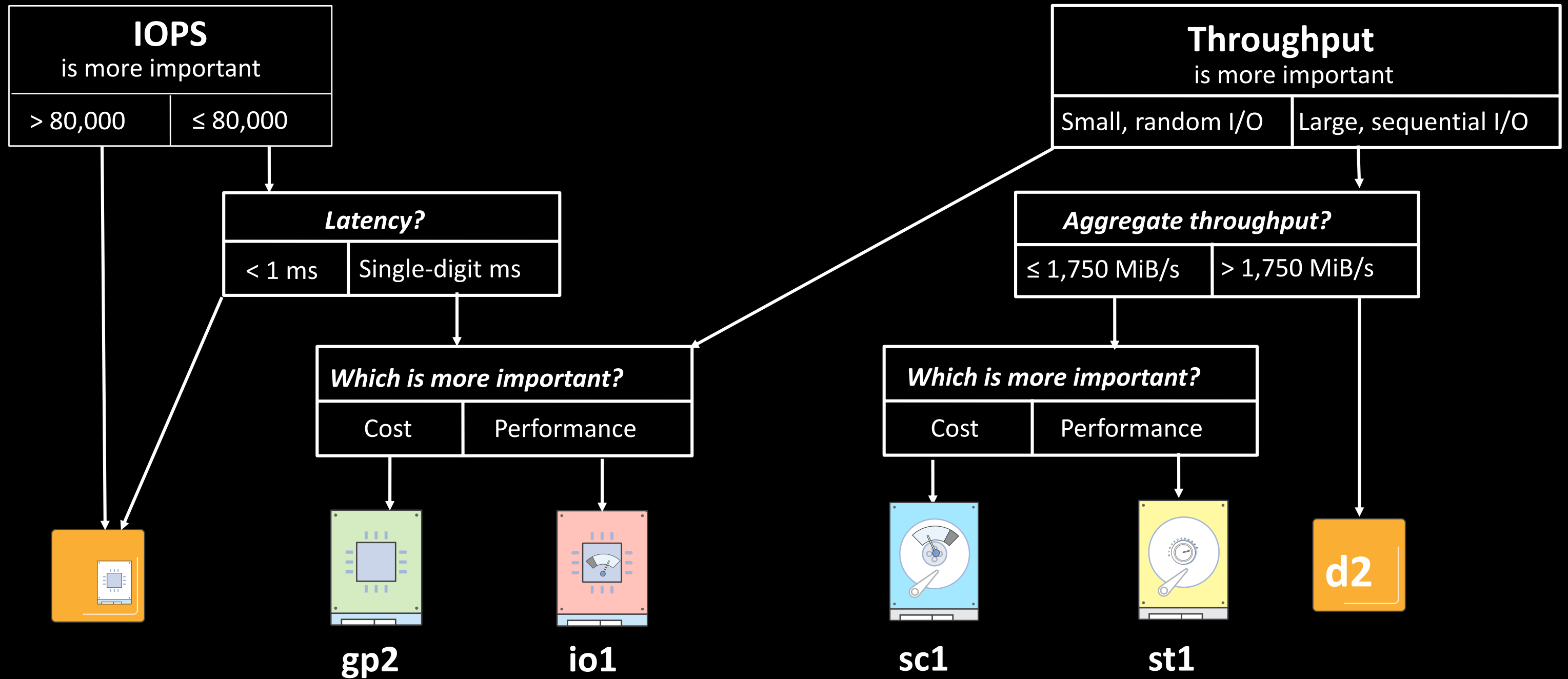
Baseline: 12 MiB/s per TB up to 192 MiB/s

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

Capacity: 500 GiB to 16 TiB

Ideal for sequential throughput workloads, such as logging and backup

Choosing an Amazon EBS volume type



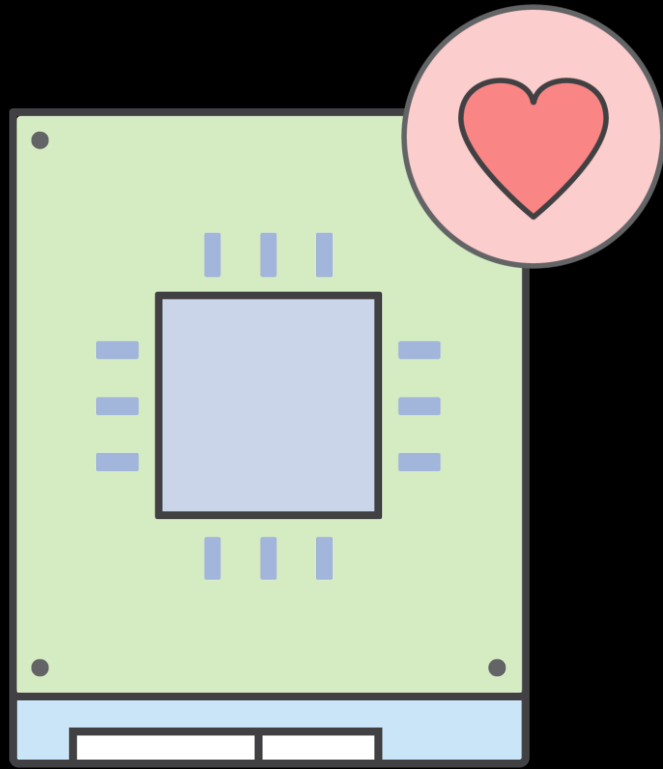
Choosing an Amazon EBS volume type

**Don't know
your workload**

yet?



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)

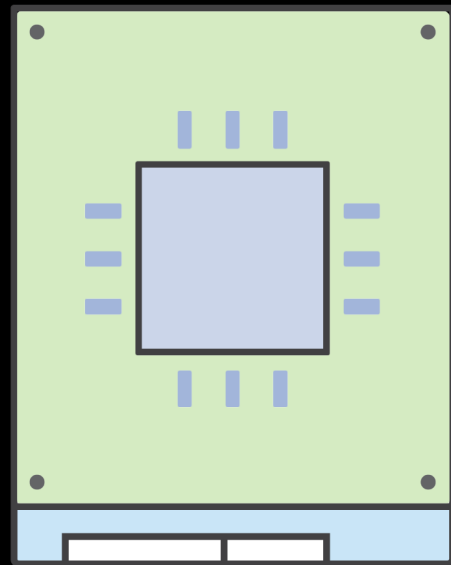
Throughput: Up to 250 MiB/s

Latency: Single-digit ms

Capacity: 1 GiB to 16 TiB

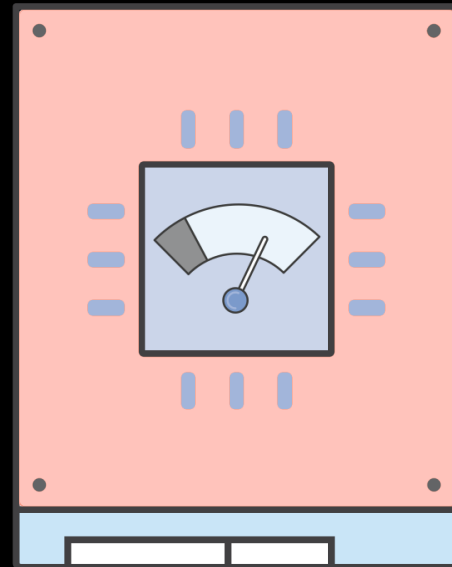
Great for boot volumes, low-latency applications, and bursty databases

I/O provisioned volumes



gp2

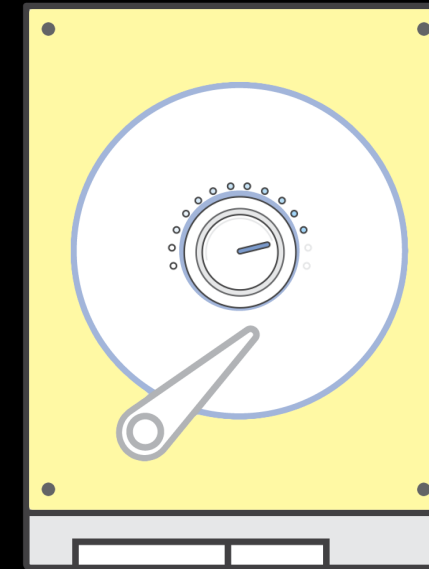
\$0.10 per GiB



io1

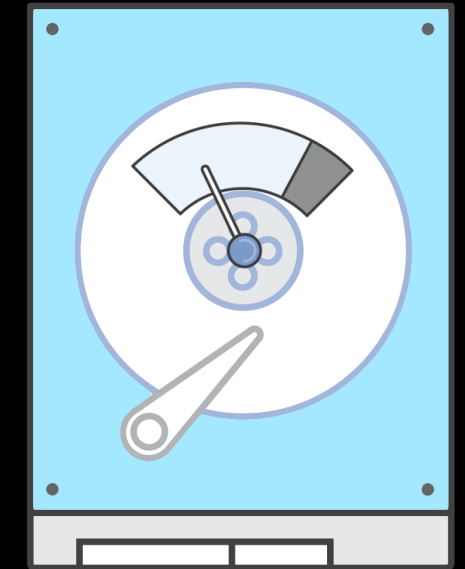
\$0.125 per GiB
\$0.065 per PIOPS

Throughput provisioned volumes



st1

\$0.045 per GiB



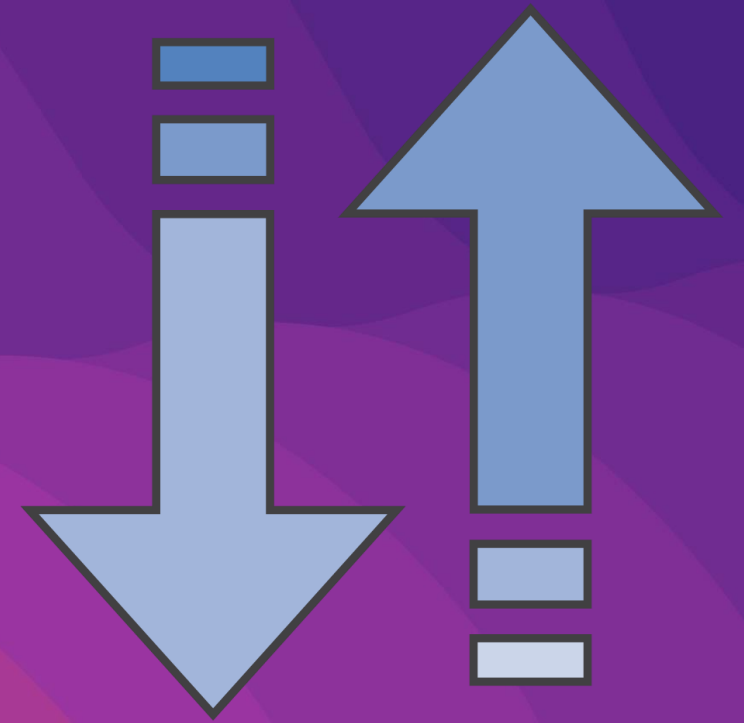
sc1

\$0.025 per GiB

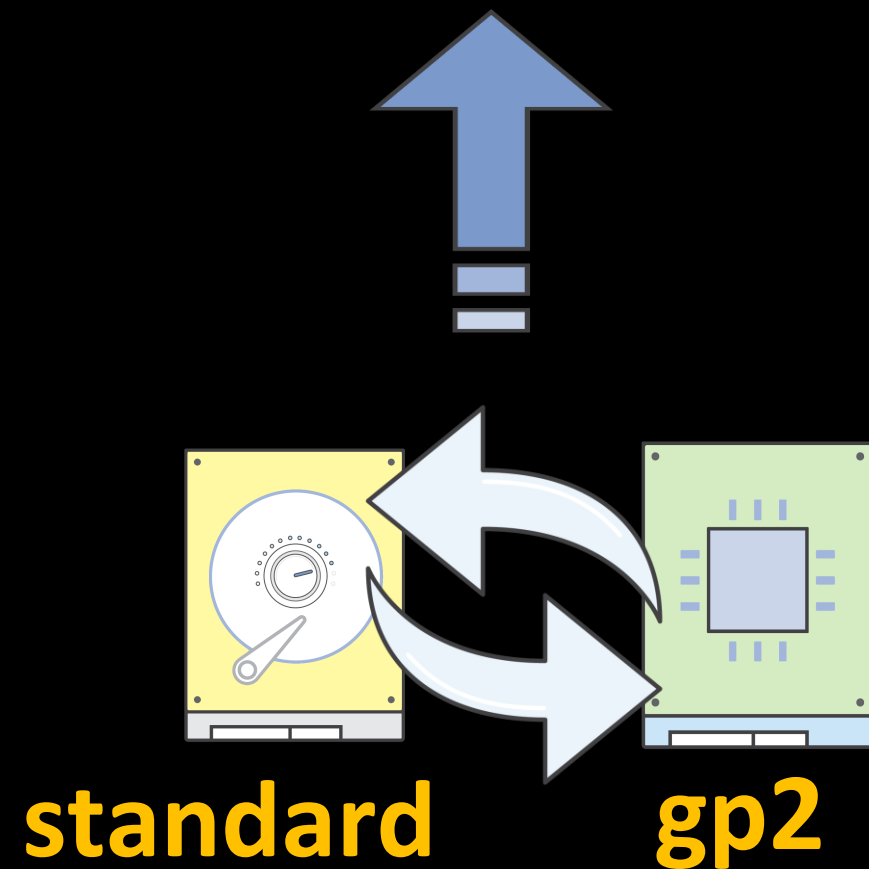
Snapshot storage for all volume types is \$0.05 per GiB per month

All prices are per month, prorated to the second, and are from the us-west-2 Region as of April 2018

Amazon EBS Elastic Volumes



Elastic Volumes: Features

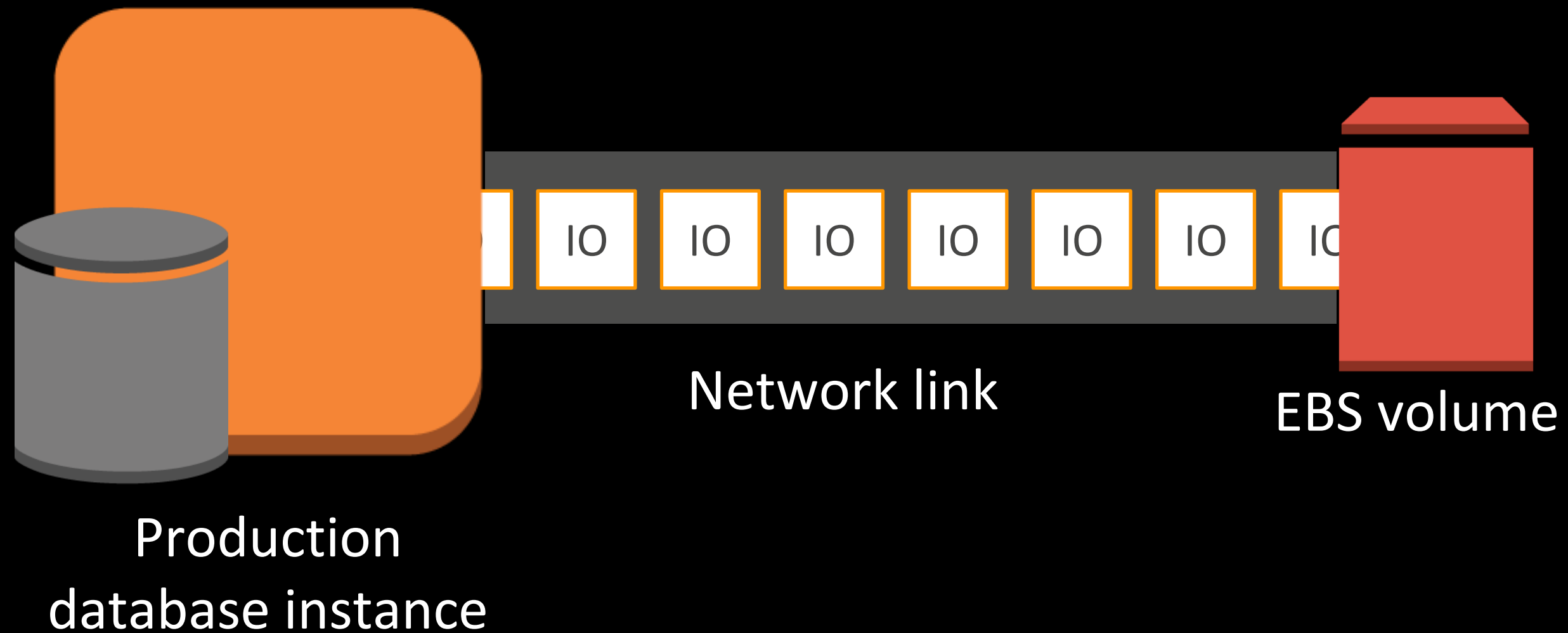


Increase volume size

Change volume type

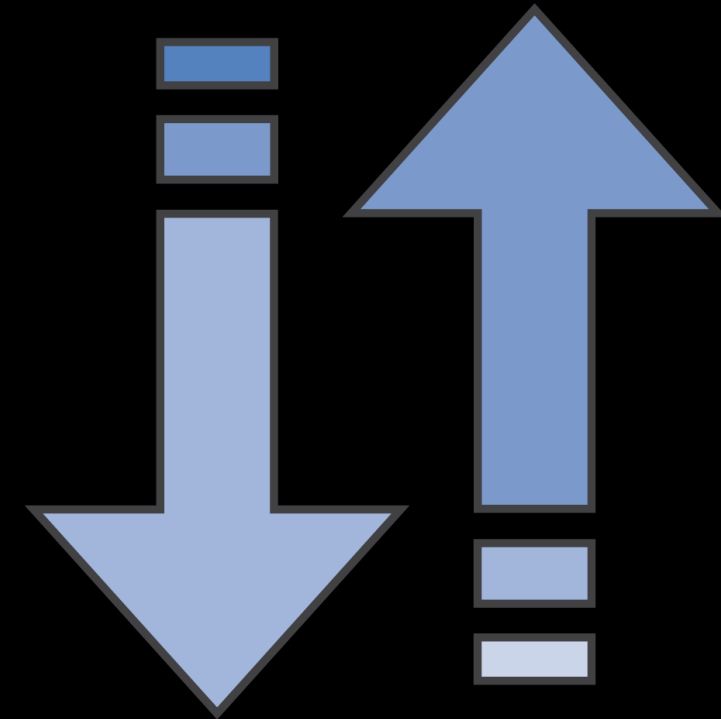
Increase/decrease provisioned IOPS

Elastic Volumes: Overview



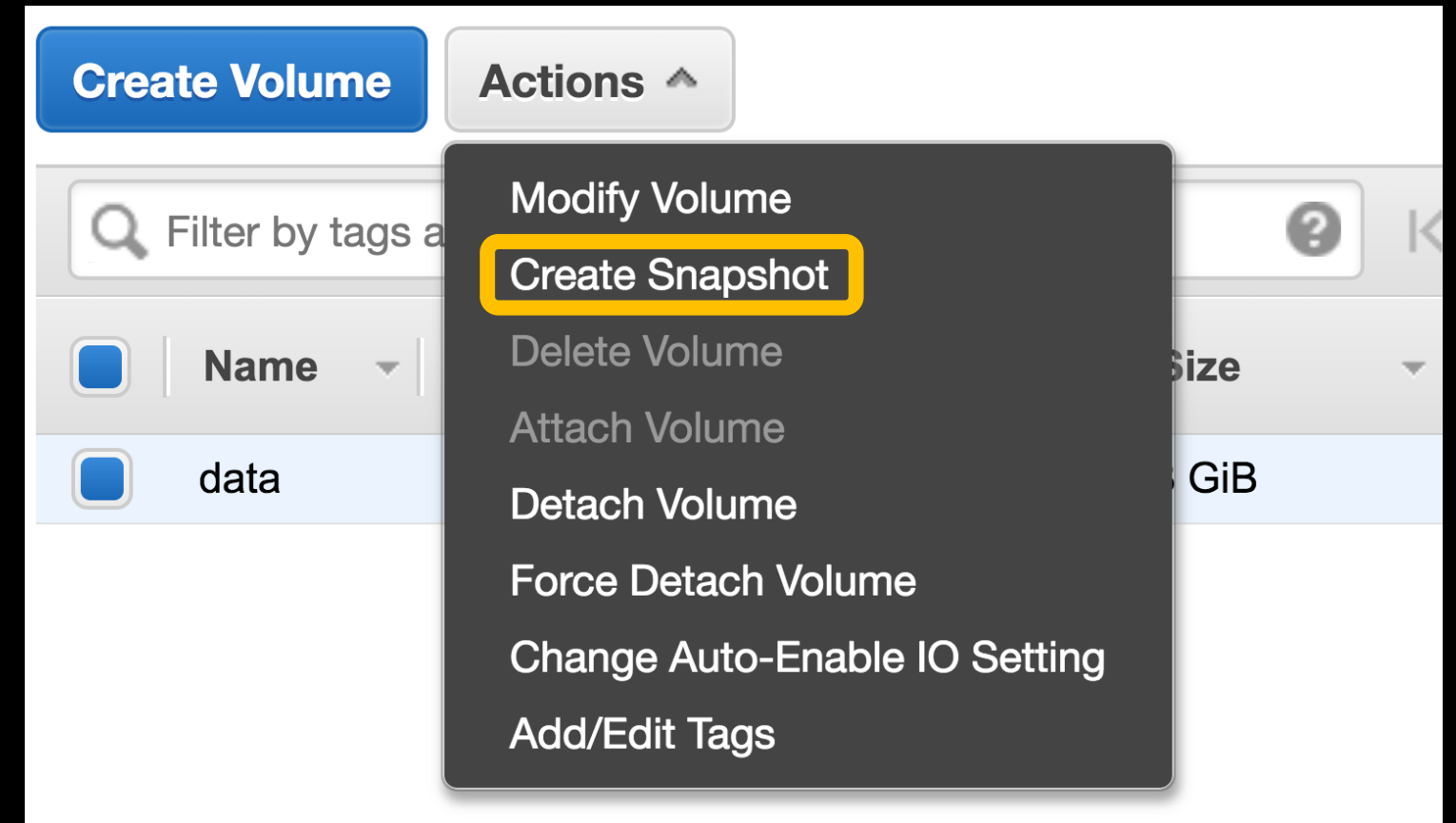
How to modify

1. Snapshot volume
2. Modify volume
3. Monitor modification
4. Extend file system (if necessary)



Step 1: Snapshot volume

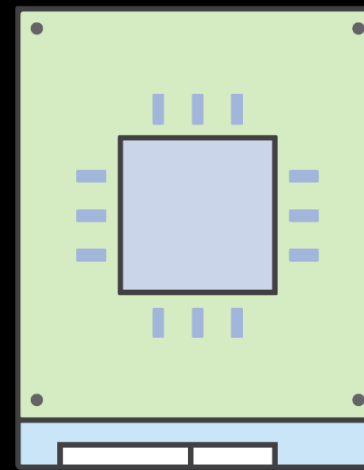
```
aws ec2 create-snapshot  
  --volume-id vol-00077cd243d4af642  
  --description "data before resize"
```



Step 2: Modify volume

```
aws ec2 modify-volume  
  --volume-id vol-00077cd243d4af642  
  --size 5000  
  --volume-type io1  
  --iops 32000
```

Original volume

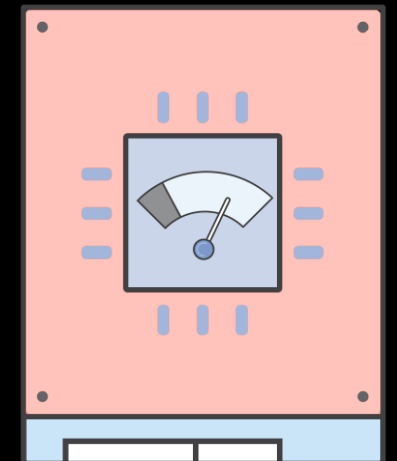


Type: gp2

IOPS: 3,000

Size: 1 TiB

Modified volume



Type: io1

IOPS: 32,000

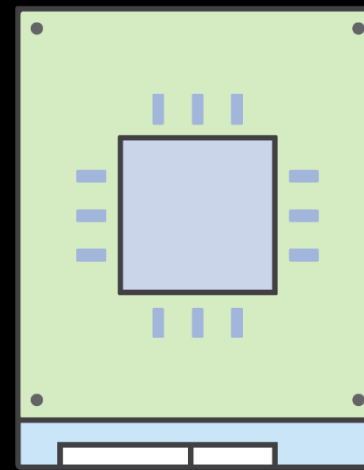
Size: 5 TiB

Step 3: Monitor volume

```
aws ec2 describe-volumes-modifications  
--volume-id vol-00077cd243d4af642
```

```
{  
  "VolumesModifications": [  
    {  
      "TargetSize": 5000,  
      "TargetVolumeType": "io1",  
      "ModificationState": "optimizing",  
      "VolumeId": "vol-00077cd243d4af642",  
      "TargetIops": 32000,  
      "StartTime": "2018-03-30T17:09:18.486Z",  
      "Progress": 99,  
      "OriginalVolumeType": "gp2",  
      "OriginalIops": 3000,  
      "OriginalSize": 1000  
    }  
  ]  
}
```

Original volume

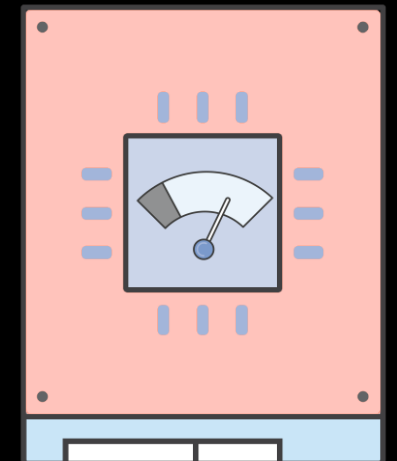


Type: gp2

IOPS: 3,000

Size: 1 TiB

Modified volume



Type: io1

IOPS: 32,000

Size: 5 TiB

Step 3: Monitor volume (EC2 console)

Create Volume

Actions

Volume ID : vol-00077cd243d4af642

Add filter

1 to 1 of 1

	Name	Environment	Volume ID	Size	Volume Type	IOPS	State	Alarm Status
	Data Volume	prod	vol-00077cd2...	1000 GiB	gp2	3000	in-use - modifying (0%)	None

Volumes: vol-00077cd243d4af642 (Data Volume)

Description

Status Checks

Monitoring

Tags

Volume ID

Size

Created

State

Attachment information

Volume type

Product codes

IOPS

vol-00077cd243d4af642

1000 GiB

March 30, 2018 at 10:03:39 AM UTC-7

in-use - modifying (0%)

[i-0395ece7b05c94ce3 \(Data Processing\)](#) :/dev/sdj (attached)

gp2

marketplace:

3000

Alarm status

Snapshot

Availability Zone

Encrypted

KMS Key ID

KMS Key Aliases

KMS Key ARN

None

-

us-west-2a

Not Encrypted

Step 3: Monitor volume (EC2 console)

Create Volume

Actions

Volume ID : vol-00077cd243d4af642

Add filter

1 to 1 of 1

	Name	Environment	Volume ID	Size	Volume Type	IOPS	State	Alarm Status
☒	Data Volume	prod	vol-00077cd2...	5000 GiB	io1	32000	in-use - optimizing (99%)	None

Volumes: vol-00077cd243d4af642 (Data Volume)

Description

Status Checks

Monitoring

Tags

Volume ID

Size

Created

State

Attachment information

Volume type

Product codes

IOPS

vol-00077cd243d4af642

5000 GiB

March 30, 2018 at 10:03:39 AM UTC-7

in-use - optimizing (99%)

[i-0395ece7b05c94ce3 \(Data Processing\)](#) :/dev/sdj (attached)

io1

marketplace:

32000

Alarm status

Snapshot

Availability Zone

Encrypted

KMS Key ID

KMS Key Aliases

KMS Key ARN

None

-

us-west-2a

Not Encrypted

Step 4: Extending the file system (Linux)

- Determine your file system

```
[ec2-user ~]$ sudo file -s /dev/xvd*  
/dev/xvda1: Linux rev 1.0 ext4 filesystem data ...  
/dev/xvdf: SGI XFS filesystem data ...
```

- Compare block device size to file system disk usage

```
[ec2-user ~]$ lsblk  
[ec2-user ~]$ df -h
```

- Extend the file system (if needed)

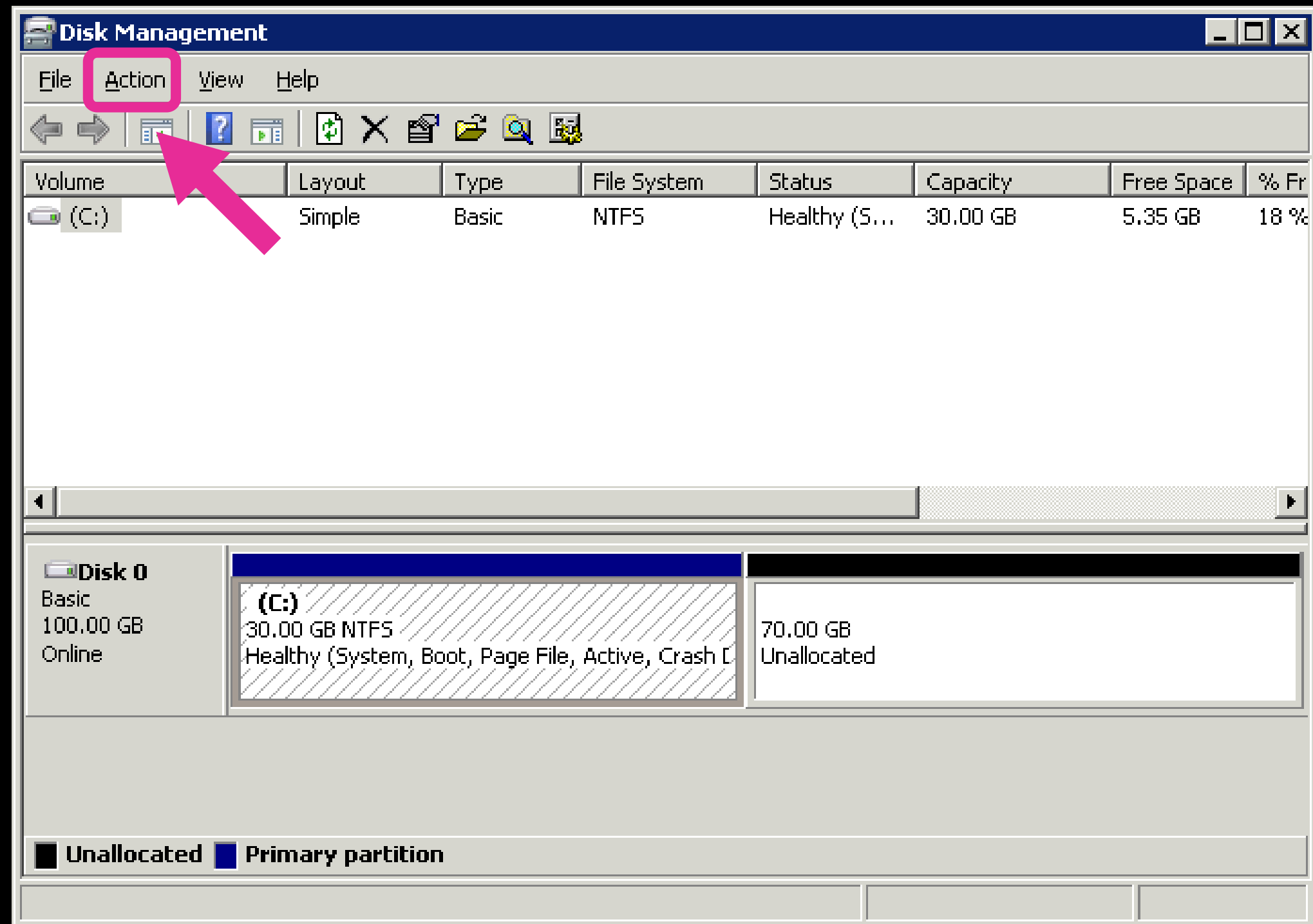
```
EXT:  
[ec2-user ~]$ sudo resize2fs device_name
```

Note: If the drive is partitioned, first grow the partitions

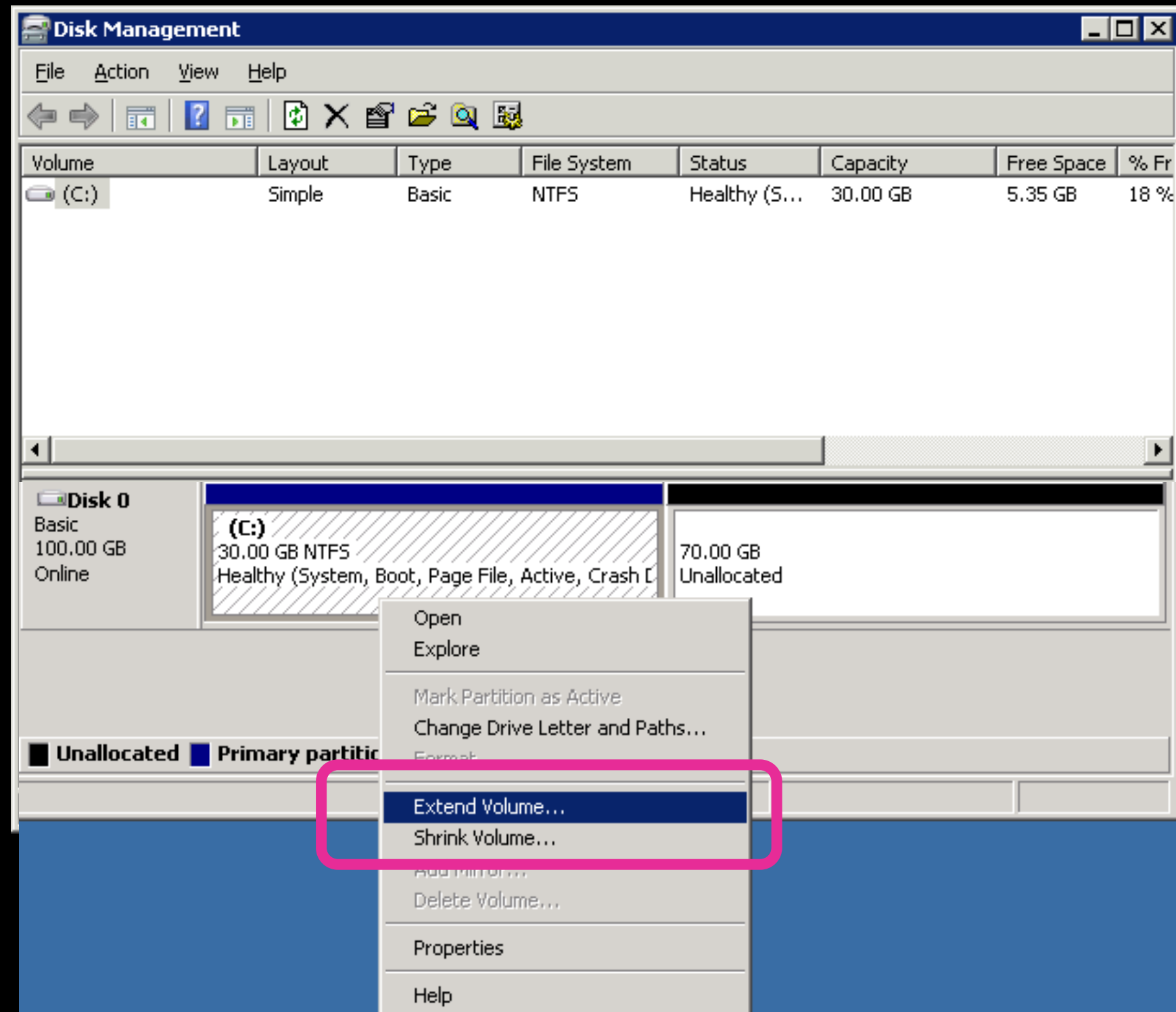
```
XFS:  
[ec2-user ~]$ sudo xfs_growfs -d mount_point
```

<https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/recognize-expanded-volume-linux.html>

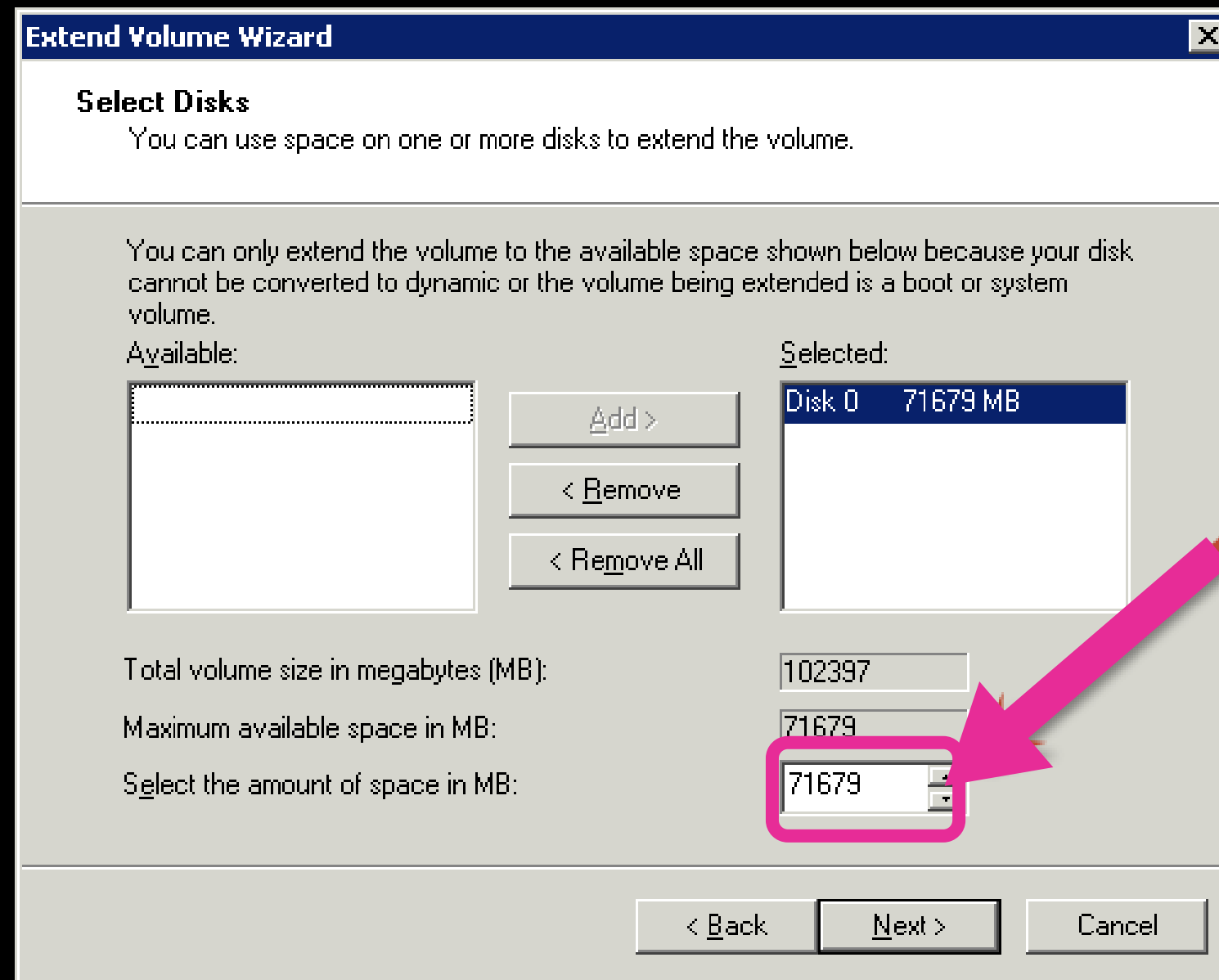
Step 4: Extending the file system (Windows)



Step 4: Extending the file system (Windows)



Step 4: Extending the file system (Windows)



Extend Volume Wizard

Select Disks
You can use space on one or more disks to extend the volume.

You can only extend the volume to the available space shown below because your disk cannot be converted to dynamic or the volume being extended is a boot or system volume.

Available:

Selected:

Disk 0 71679 MB

Total volume size in megabytes (MB): 102397

Maximum available space in MB: 71679

Select the amount of space in MB: 71679

< Back Next > Cancel

Resize partition with PowerShell:

<https://docs.microsoft.com/en-us/powershell/module/storage/resize-partition?view=win10-ps>

Volume modification tips

- Modification must fit within volume specs (**1 GiB gp2 != 1 GiB st1**)
- Can modify volumes once every 6 hours
- Current generation instances do not need a stop/start or attach/detach
- Volumes created before 11/1/2016 require a stop/start or attach/detach

Amazon EBS deep dive

How do volumes attach?

Amazon EBS volume attachment

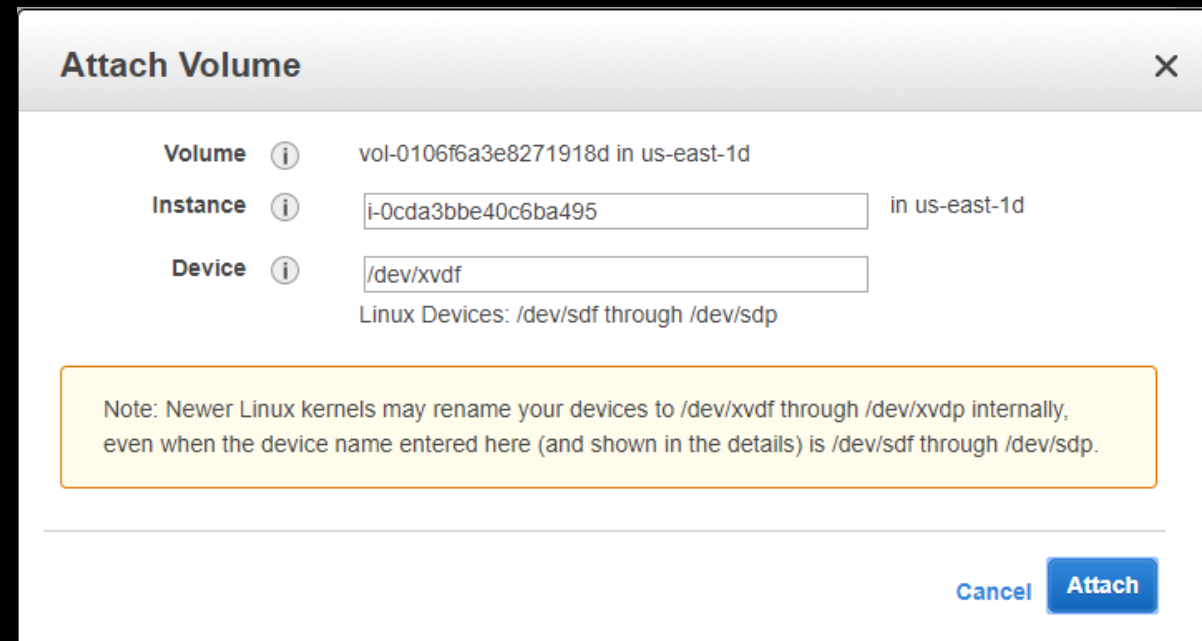
API

AttachVolume

CLI

```
aws ec2 attach-volume --instance-id i-0cda3bbe40c6ba495  
--volume-id vol-01324f611e2463981 --device /dev/xvdf
```

Console



The screenshot shows the 'Attach Volume' dialog box in the AWS Management Console. It has a title bar with 'Attach Volume' and a close button. The dialog contains three fields: 'Volume' with the value 'vol-0106f6a3e8271918d in us-east-1d', 'Instance' with the value 'i-0cda3bbe40c6ba495 in us-east-1d', and 'Device' with the value '/dev/xvdf'. Below the 'Device' field, it says 'Linux Devices: /dev/sdf through /dev/sdp'. A yellow note box at the bottom states: 'Note: Newer Linux kernels may rename your devices to /dev/xvdf through /dev/xvdp internally, even when the device name entered here (and shown in the details) is /dev/sdf through /dev/sdp.' At the bottom right, there are 'Cancel' and 'Attach' buttons.

Amazon EBS volume attachment: Xen

```
[ec2-user@ip-10-0-22-96 ~]$ lsblk
```

NAME	MAJ:MIN	RM	SIZE	RO	TYPE	MOUNTPOINT
xvda	202:0	0	8G	0	disk	
└─xvda1	202:1	0	8G	0	part	/
xvdf	202:80	0	1G	0	disk	

Amazon EBS volume attachment: Nitro Hypervisor

```
[ec2-user@ip-10-0-12-183 ~]$ lsblk
```

NAME	MAJ:MIN	RM	SIZE	RO	TYPE	MOUNTPOINT
nvme1n1	259:1	0	1G	0	disk	
nvme0n1	259:0	0	8G	0	disk	
└─nvme0n1p1	259:2	0	8G	0	part	/
└─nvme0n1p128	259:3	0	1M	0	part	

```
[ec2-user@ip-10-0-12-183 ~]$ sudo nvme id-ctrl -v /dev/nvme1n1 | egrep "mn|sn|^00[01]0"
```

```
sn      : vo101324f611e2463981
```

```
mn      : Amazon Elastic Block Store
```

```
0000: 2f 64 65 76 2f 78 76 64 66 20 20 20 20 20 20 20 20 "/dev/xvdf....."
```

```
0010: 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 "....."
```

Amazon EBS volume attachment: Nitro Hypervisor

```
[ec2-user@ip-10-0-12-183 ~]$ lsblk
NAME                MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
nvme1n1              259:1    0   1G  0 disk
nvme0n1              259:0    0   8G  0 disk
└─nvme0n1p1          259:2    0   8G  0 part /
└─nvme0n1p128        259:3    0    1M  0 part
```

With ec2-utils

```
[ec2-user@ip-10-0-12-183 ~]$ sudo /sbin/ebsnvme-id /dev/nvme1n1
EBS volume ID: vol-01324f611e2463981
Block device : /dev/xvdf
```

```
[ec2-user@ip-10-0-12-183 ~]$ ls -la /dev/xvdf
lrwxrwxrwx 1 root root 7 Oct 12 02:55 /dev/xvdf -> nvme1n1
```

```
[ec2-user@ip-10-0-12-183 ~]$ ls -la /dev/disk/by-id/nvme-Amazon_Elastic_Block_Store_vol01324f611e2463981-ns-1
lrwxrwxrwx 1 root root 13 Oct 12 02:55 /dev/disk/by-id/nvme-Amazon_Elastic_Block_Store_vol01324f611e2463981-ns-1 -> ../../nvme1n1
```

Amazon EBS best practices

Amazon EBS best practices

Security



Best practice: Encryption



Amazon EBS encryption: Data volumes

Create Volume

Volume Type

Throughput Optimized HDD (ST1)

Size (GiB)

500

(Min: 500 GiB, Max: 16384 GiB)

IOPS

Not Applicable

Throughput

20/123

(Baseline of 40 MB/sec per TiB up to 500 MB/sec)

Availability Zone

us-west-2a

Snapshot ID

Search (case-insensitive)

Encryption

☒ Encrypt this volume

Master Key

(default) aws/ebs

Key Details

Description

Default master key that protects my EBS volumes when no other key is defined

Account

This account ()

KMS Key ID

KMS Key ARN

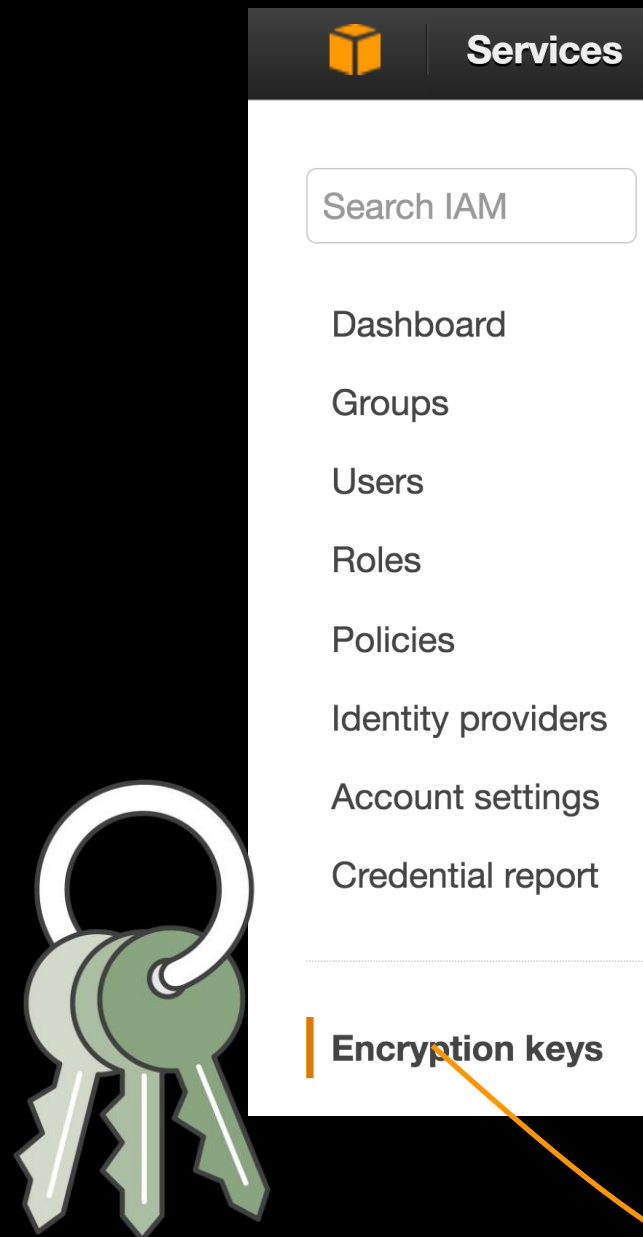
arn:aws:kms:us-west-2: :key/

Cancel

Create

Best practice: Encryption

Create a new AWS KMS master key for Amazon EBS



Create Alias and Description

Provide an alias and a description for this key. These properties of the key can be changed later. [Learn more.](#)

Alias (required)

ebs-master

Description

Master EBS Encryption Key

- Define key rotation policy
- Enable AWS CloudTrail auditing
- Control who can use key
- Control who can administer key

Best practice: Encryption



Amazon EBS encryption: Data volumes

Create Volume [X]

Volume Type ⓘ Throughput Optimized HDD (ST1) [v]

Size (GiB) ⓘ 500 (Min: 500 GiB, Max: 16384 GiB)

IOPS ⓘ Not Applicable

Throughput ⓘ 20/123 (Baseline of 40 MB/sec per TiB up to 500 MB/sec)

Availability Zone ⓘ us-west-2a [v]

Snapshot ID ⓘ Search (case-insensitive)

Encryption ⓘ ☒ Encrypt this volume

Master Key ⓘ ebs-master [v]

Key Details

Description	Master EBS Encryption Key
Account	This account (██████████)
KMS Key ID	██████████
KMS Key ARN	arn:aws:kms:us-west-2:██████████:key/██████████

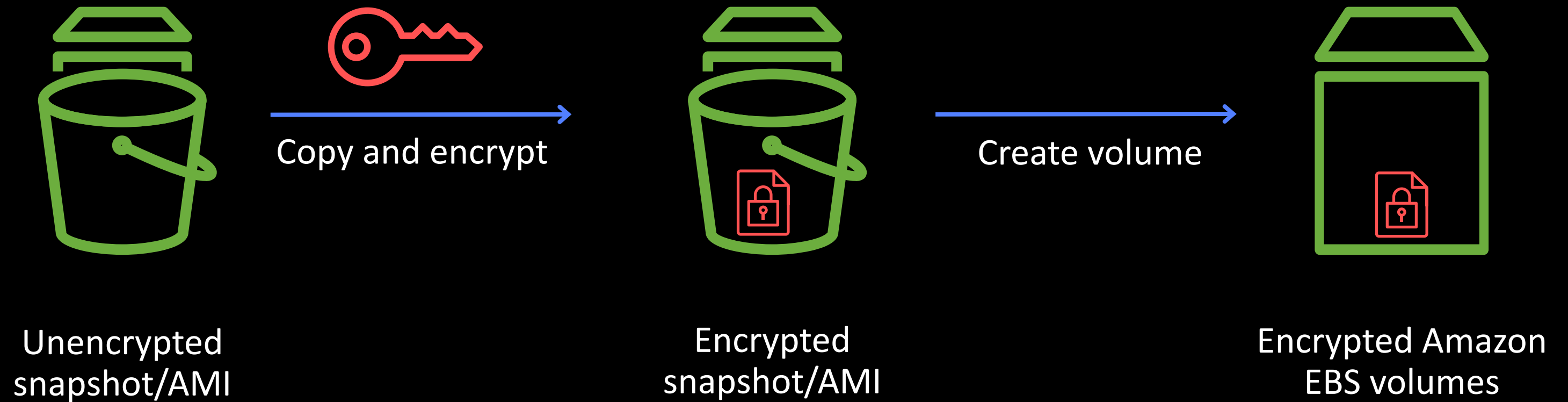
Cancel **Create**

Three new features to make encryption easier

- Launch encrypted volumes from unencrypted snapshots/AMIs
 - Launch volumes encrypted with different CMKs from encrypted snapshots/AMIs
- Share snapshots encrypted with custom CMKs across accounts
- Encryption by default for Amazon EBS for an account in a Region with a single setting

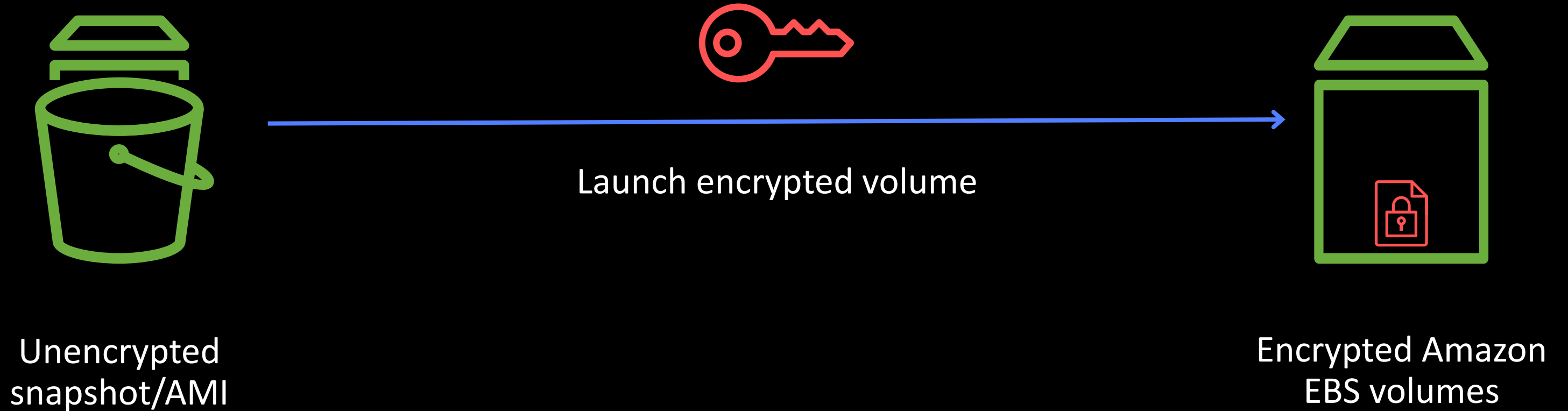
Feature: Encrypted volumes from unencrypted snapshots or AMIs

Previously...



Similar steps if you need to change encryption on a snapshot/AMI

Now...



Similar steps if you need to change encryption on a snapshot/AMI

How to do this

Create Snapshot Actions

Owned By Me Filter by tags and attributes or search by keyword 1 to 8 of 8

	Name	Snapshot ID	Size	Description	Status	Started	Progress	Encryption
☒		abc6be...	100 GiB	multi-volume snapshots	completed	June 20, 2019 at 11:09:24 A...	available (100%)	Not Encrypted
☐		c43a9a...	100 GiB	multi-volume snapshots	completed	June 20, 2019 at 11:09:24 A...	available (100%)	Not Encrypted
☐		a0028ff...	100 GiB	multi-volume snapshots	completed	June 20, 2019 at 11:09:24 A...	available (100%)	Not Encrypted
☐		e92b23...	100 GiB	multi-volume snapshots	completed	June 20, 2019 at 11:09:24 A...	available (100%)	Not Encrypted
☐		a7a78a...	100 GiB	multi-volume snapshots	completed	June 20, 2019 at 11:09:24 A...	available (100%)	Not Encrypted
☐		snap-0566ad0ea2e...	100 GiB	multi-volume snapshots	completed	June 20, 2019 at 11:09:24 A...	available (100%)	Not Encrypted
☐		snap-0dd67735547c...	100 GiB	multi-volume snapshots	completed	June 20, 2019 at 11:09:24 A...	available (100%)	Not Encrypted
☐		snap-0ea6182c417d...	100 GiB	multi-volume snapshots	completed	June 20, 2019 at 11:09:24 A...	available (100%)	Not Encrypted

- Delete
- Create Volume
- Create Image
- Copy
- Modify Permissions
- Add/Edit Tags

How to do this

[Snapshots](#) > Create Volume

Create Volume

Snapshot ID `snap-041d54e92b23119db`

Volume Type General Purpose SSD (gp2) ⓘ

Size (GiB) (Min: 1 GiB, Max: 16384 GiB) ⓘ

IOPS `300 / 3000` (Baseline of 3 IOPS per GiB with a minimum of 100 IOPS, burstable to 3000 IOPS) ⓘ

Availability Zone* us-west-2a ⓘ

Throughput (MB/s) Not applicable ⓘ

Encryption ☒ Encrypt this volume

Master Key (default) aws/ebs ⓘ

KMS Key Description Default master key that protects my EBS volumes when no other key is defined

KMS Key Account This account (415031010107)

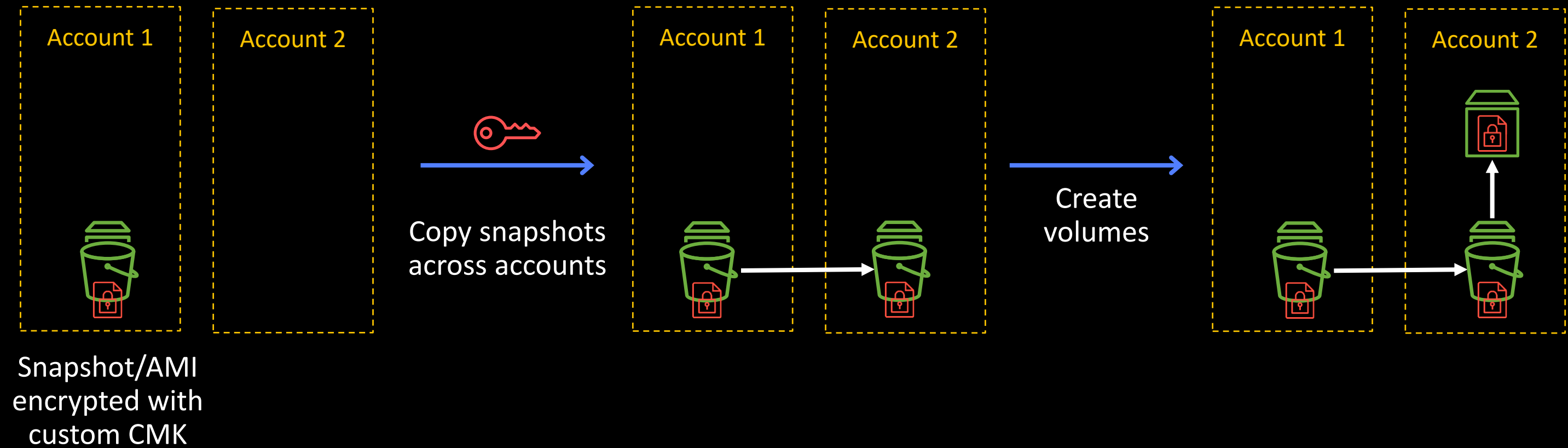
KMS Key ID `arn:aws:kms:us-west-2:415031010107:key/12345678-9012-3456-7890-123456789012`

KMS Key ARN `arn:aws:kms:us-west-2:415031010107:key/12345678-9012-3456-7890-123456789012`

```
aws ec2 create-volume --snapshot-id snap-010bb9c48a9a4c237 --availability-zone us-west-2a --encrypted --volume-type gp2
```

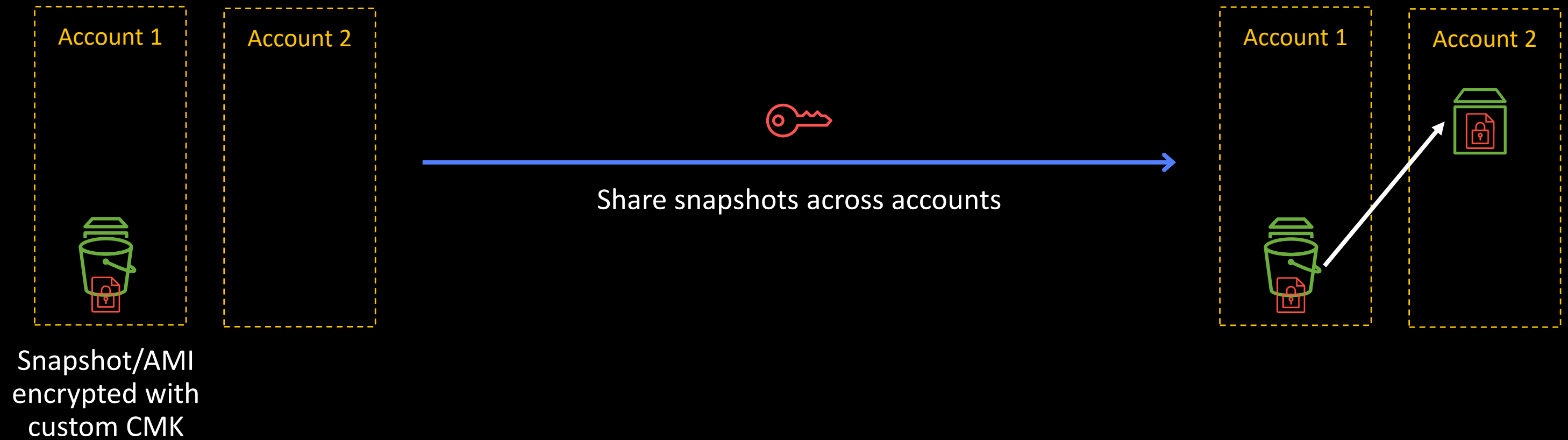
Feature: Share encrypted snapshots/AMIs across accounts

Previously...



Encrypted snapshots could only be copied across accounts

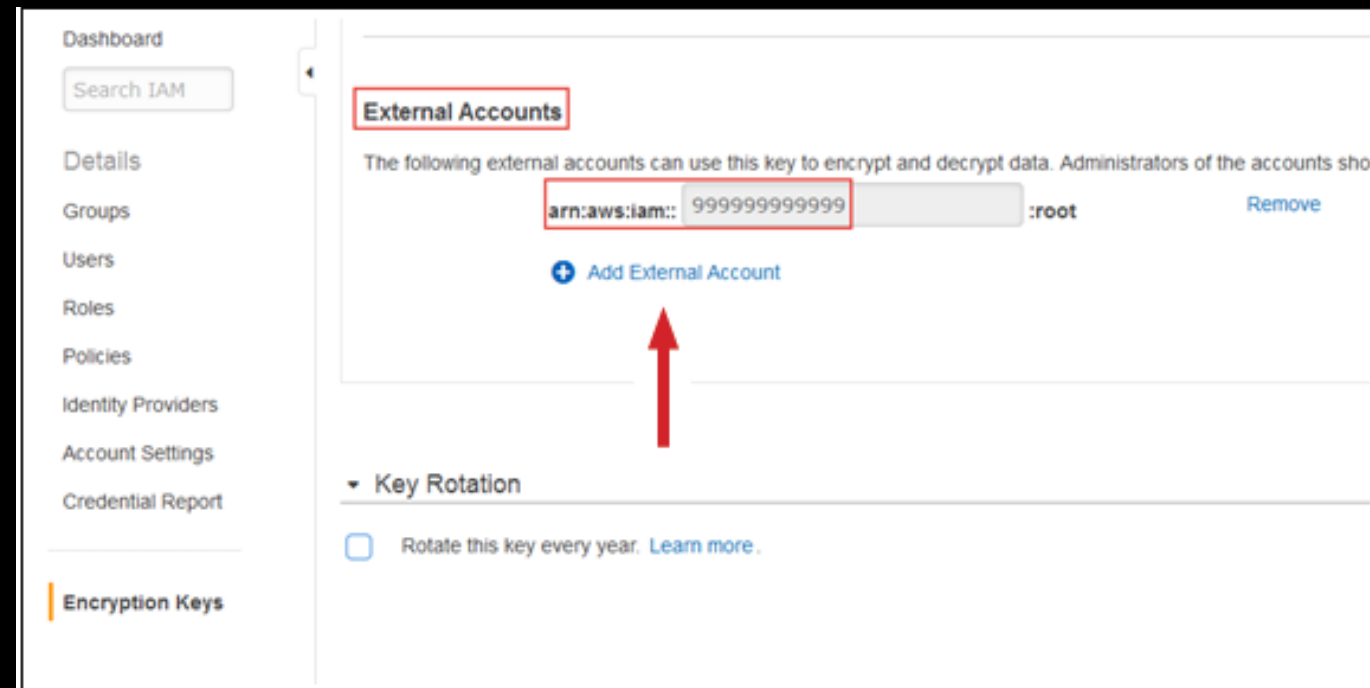
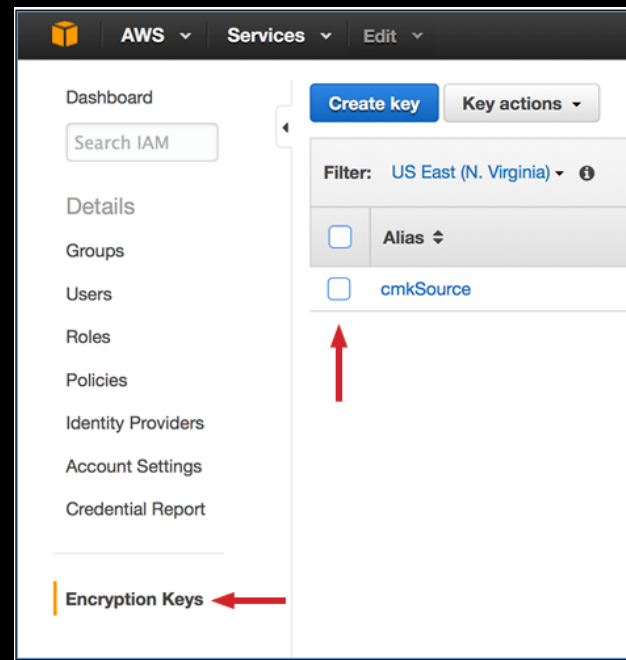
Now...



Share snapshots/AMIs encrypted with custom CMKs across accounts

Note: Snapshots/AMIs encrypted with default CMKs cannot be shared across accounts

How to do this



```
{
  "version": "2012-10-17",
  "statement": [
    {
      "effect": "Allow",
      "action": [
        "kms:DescribeKey",
        "kms:ReEncrypt*",
        "kms:CreateGrant",
        "kms:Decrypt"
      ],
      "resource": [
        "arn:aws:kms:us-east-1:<111111111111>:key/<key-id of cmkSource>"
      ]
    }
  ]
}
```

How to do this

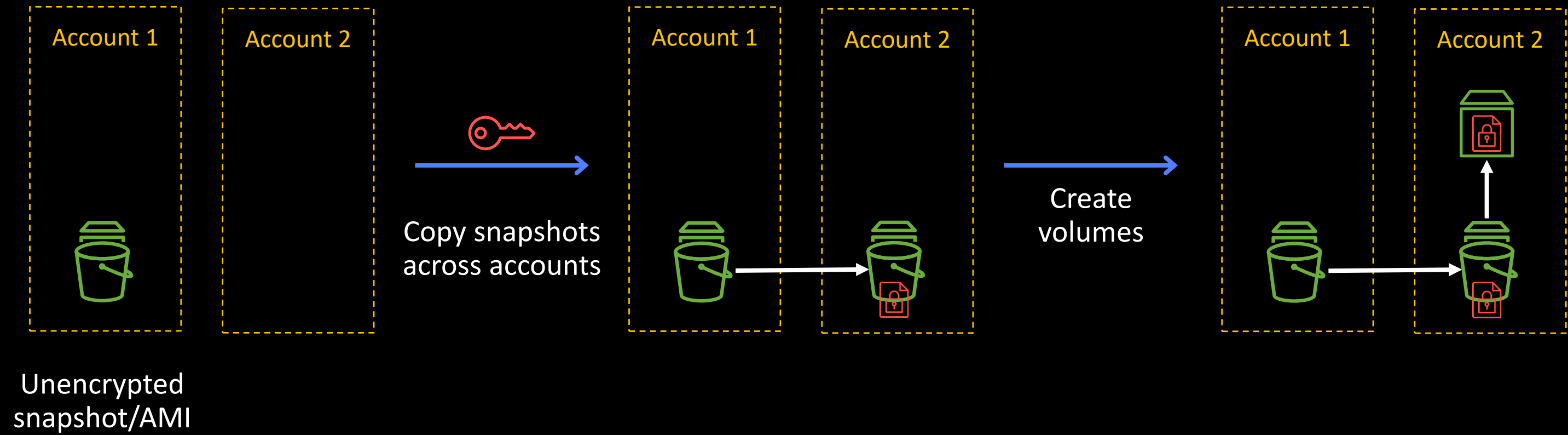
```
$> aws ec2 run-instances
    --image-id ami-XXXXX
    --count 1
    --instance-type m4.large
    --region us-east-1
    --subnet-id subnet-aec2fc86
    --key-name 2016KeyPair
    --security-group-ids sg-f7dbc78e
    subnet-id subnet-aec2fc86
    --block-device-mappings
    file://mapping.json
```

mapping.json

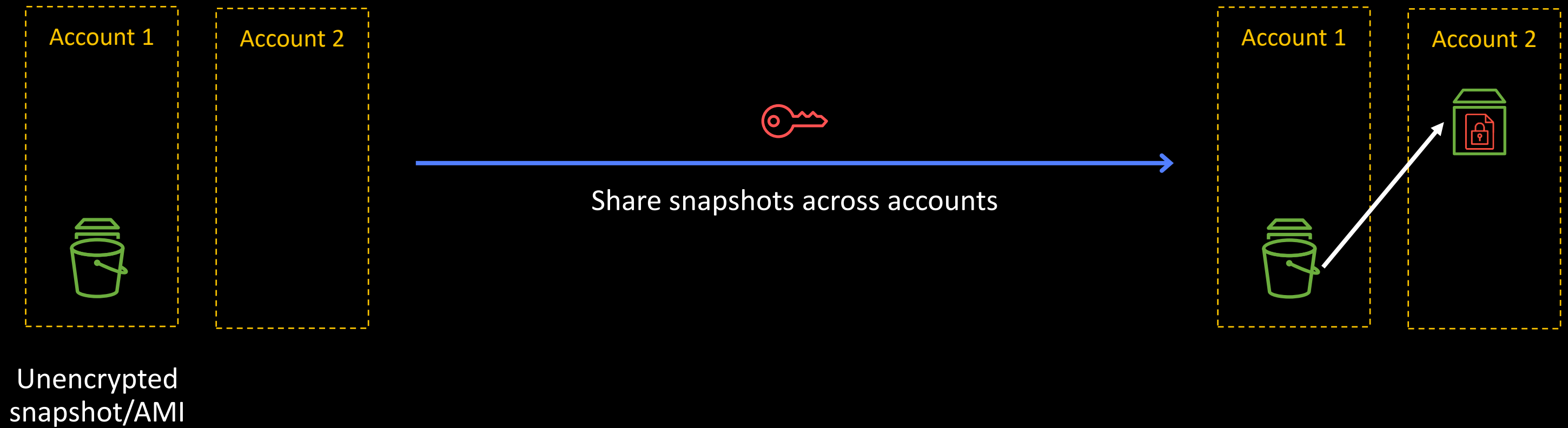
```
[
  {
    "DeviceName": "/dev/xvda",
    "Ebs": {
      "Encrypted": true,
      "KmsKeyId":
        "arn:aws:kms:us-east-
        1:<99999999999999>:key/<abcd1234-a123-
        456a-a12b-a123b4cd56ef>"
    }
  }
]
```

Combining the two features

Previously...



Now...

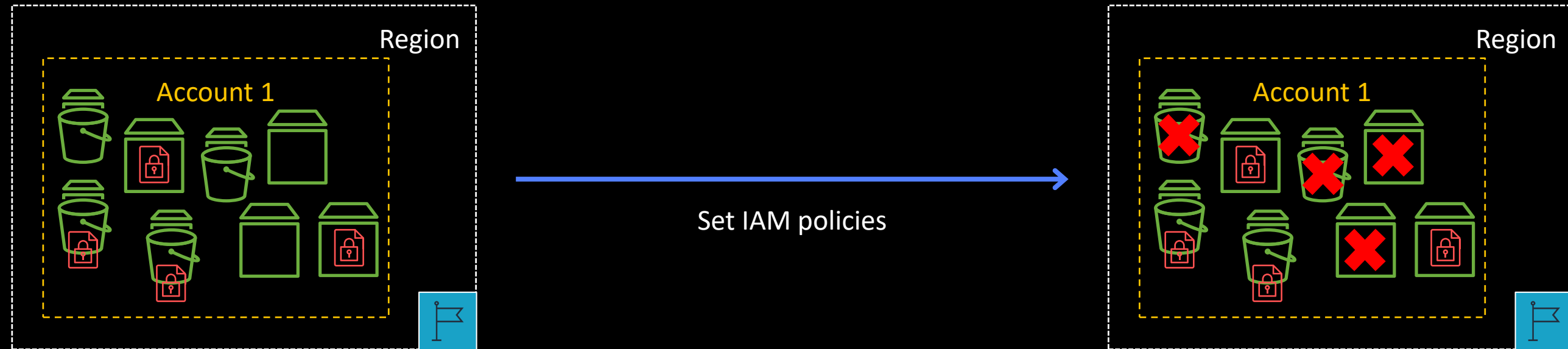


Launch encrypted volumes across accounts from unencrypted snapshots/AMIs

Note: Snapshots/AMIs encrypted with default CMKs cannot be shared across accounts

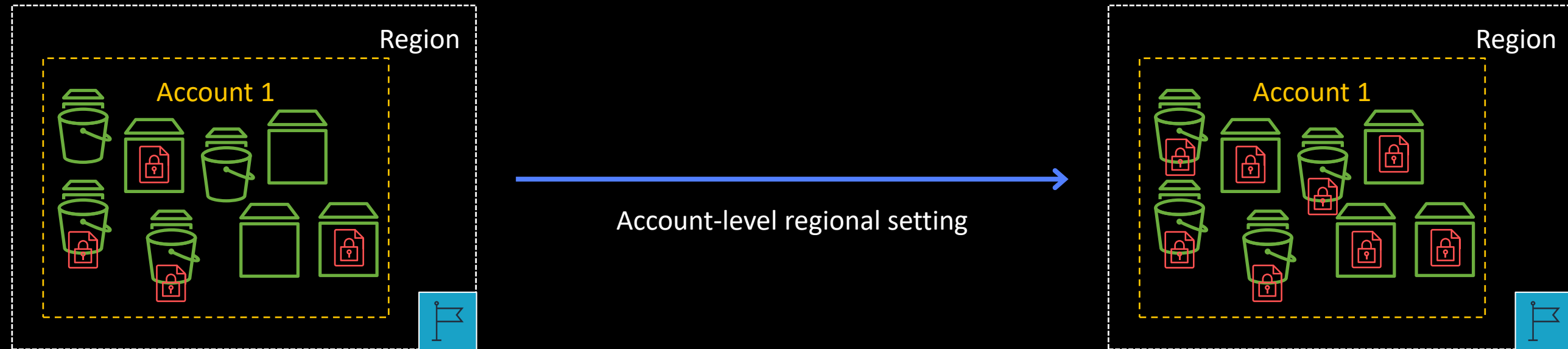
Feature: Enable Amazon EBS account-level encryption by default

Previously...



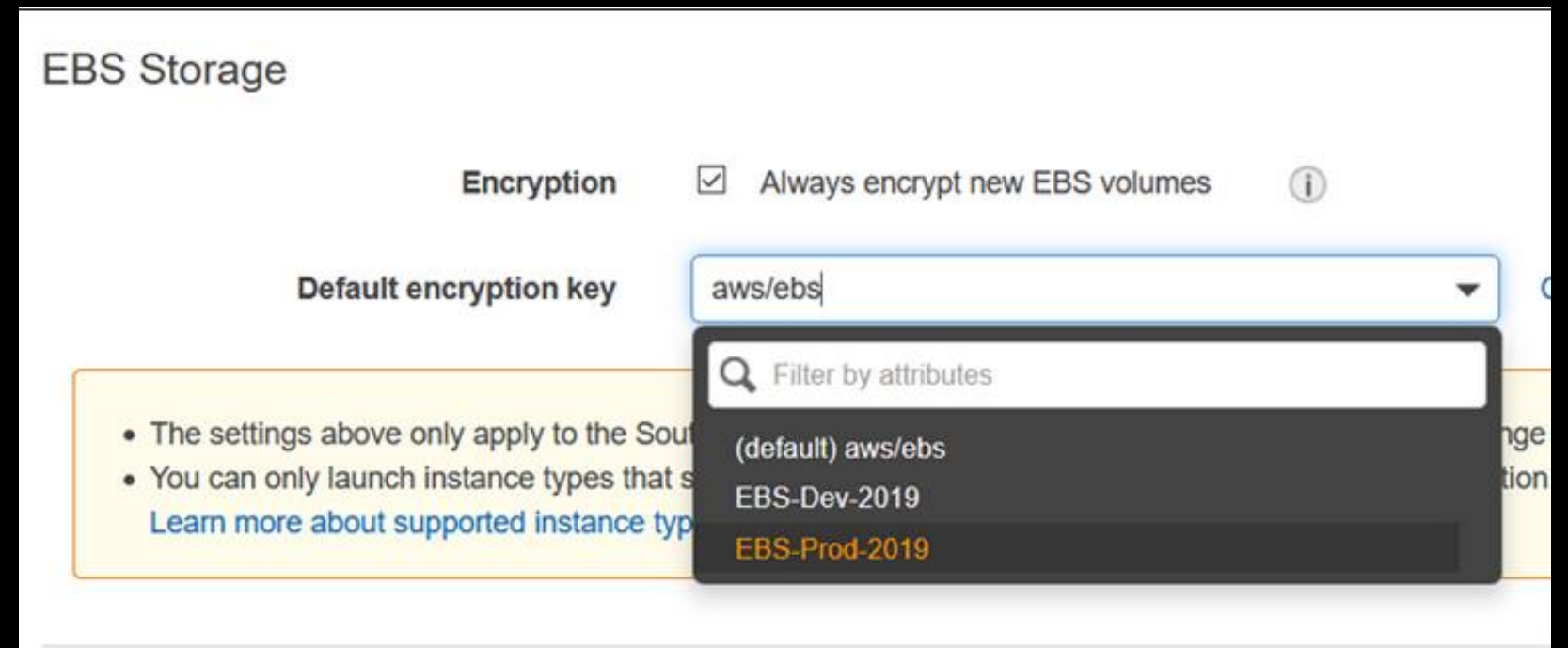
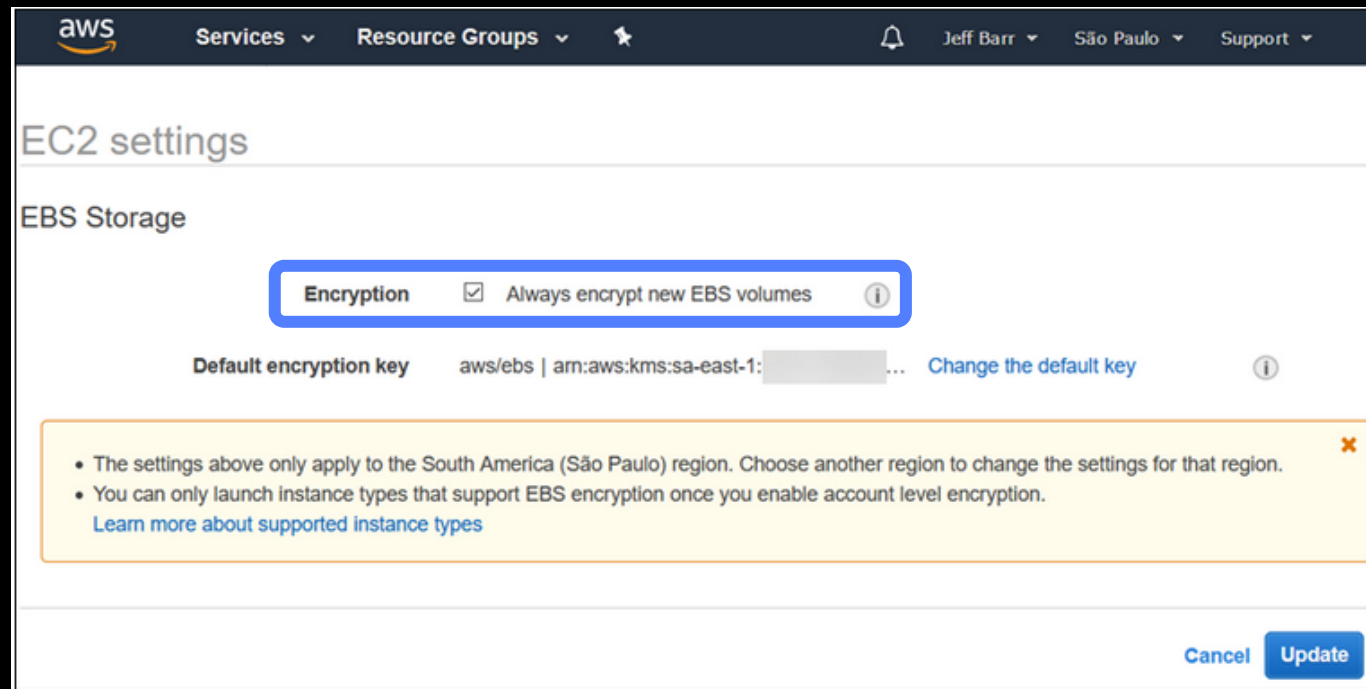
With AWS Identity and Access Management (IAM) policies,
you can prevent unencrypted volumes from launching

Now...



Without change to workflows, newly launched volumes + snapshots are encrypted

How to do this



And that's it!

Amazon EBS best practices

Security

Reliability



Amazon EBS is designed for

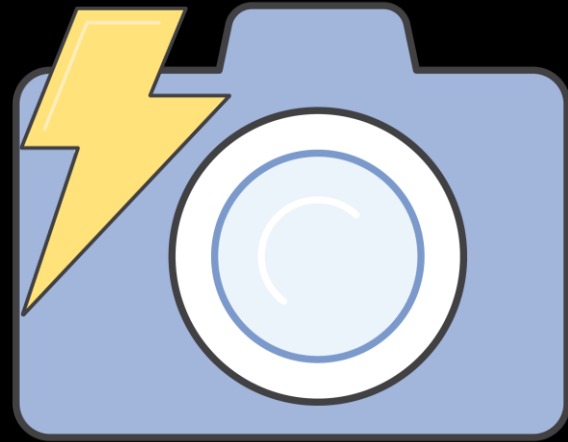


99.999% service availability

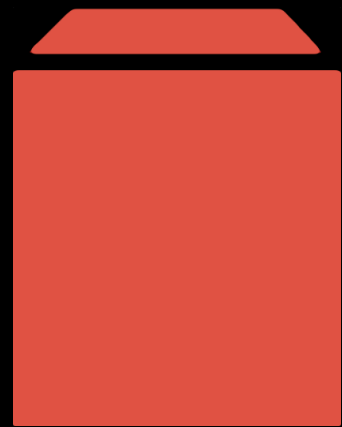


0.1–0.2% annual failure rate (AFR)

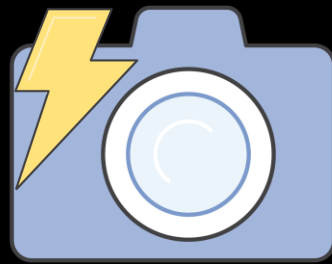
Snapshots



How does an Amazon EBS snapshot work?



EBS
volume

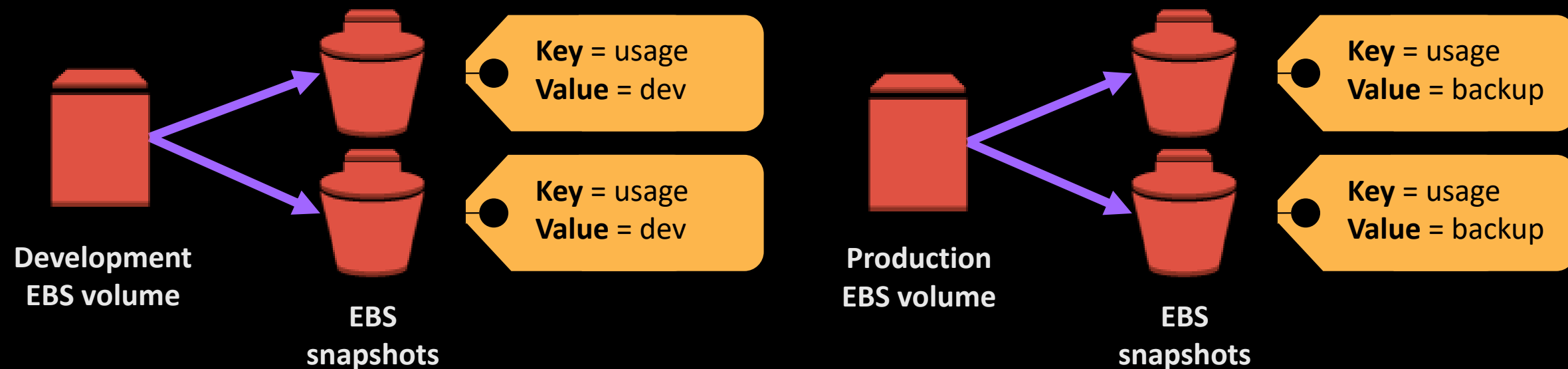


EBS
snapshot

- Point-in-time backup of **modified volume blocks**
- **Stored in Amazon S3**, accessed via Amazon EBS APIs
- Subsequent snapshots are **incremental**
- Deleting snapshot only removes data **exclusive** to that snapshot
- **Crash consistent**

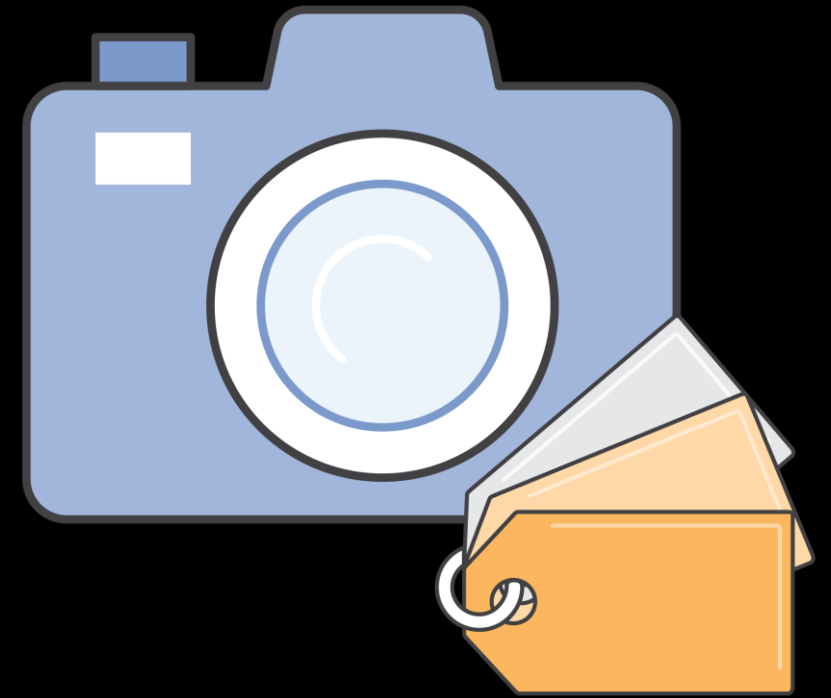
Tracking snapshots and costs (custom tagging)

- Tags provide the ability to assign key/value pairs to AWS resources
- Snapshots support tags for identification and management
- Snapshot tags can be activated as “cost allocation” tags allowing for greater visibility into snapshot storage costs



Amazon EBS snapshot tagging upon creation

```
aws ec2 create-snapshot  
--volume-id vol-03f3c34ded2e3398f  
--tag-specifications  
  'ResourceType=snapshot,  
  Tags=[{Key=CostCenter,Value=115},  
  {Key=IsProd,Value=Yes}]'
```



Amazon EBS snapshot tagging upon creation

Specify tags for Amazon EBS snapshots as part of the API call that creates the resource or via the Amazon EC2 console when creating an Amazon EBS snapshot

Volumes > Create Snapshot

Create Snapshot

Are you sure you want to perform this action?

Volume vol-0ecee4895fc7186a4 ⓘ

Description ⓘ

Encrypted Encrypted ⓘ

Tags ☒ Add tags to your snapshot

Key (127 characters maximum)	Value (255 characters maximum)	
CostCenter	115	✕
IsProd	Yes	✕

(Up to 50 tags maximum)

Tracking snapshots and costs (Cost Explorer)

First, activate customer tag for cost allocation

User-Defined Cost Allocation Tags

✓ Finished loading tags.

Activating tags for cost allocation tells AWS that the associated cost data for these tags should be made available throughout the billing period. Once activated, cost allocation tags can be used as a dimension of grouping and filtering in Cost Explorer, as well as for refining AWS budget creation.

Clicking the Refresh button will prioritize your account for updates, so that tags from your linked accounts are visible to you sooner. Please note that the Refresh operation can only be triggered once every 24 hours.

Activate Deactivate Undo

Filter: All tags Tags per page

☒	Tag key
☒	usage

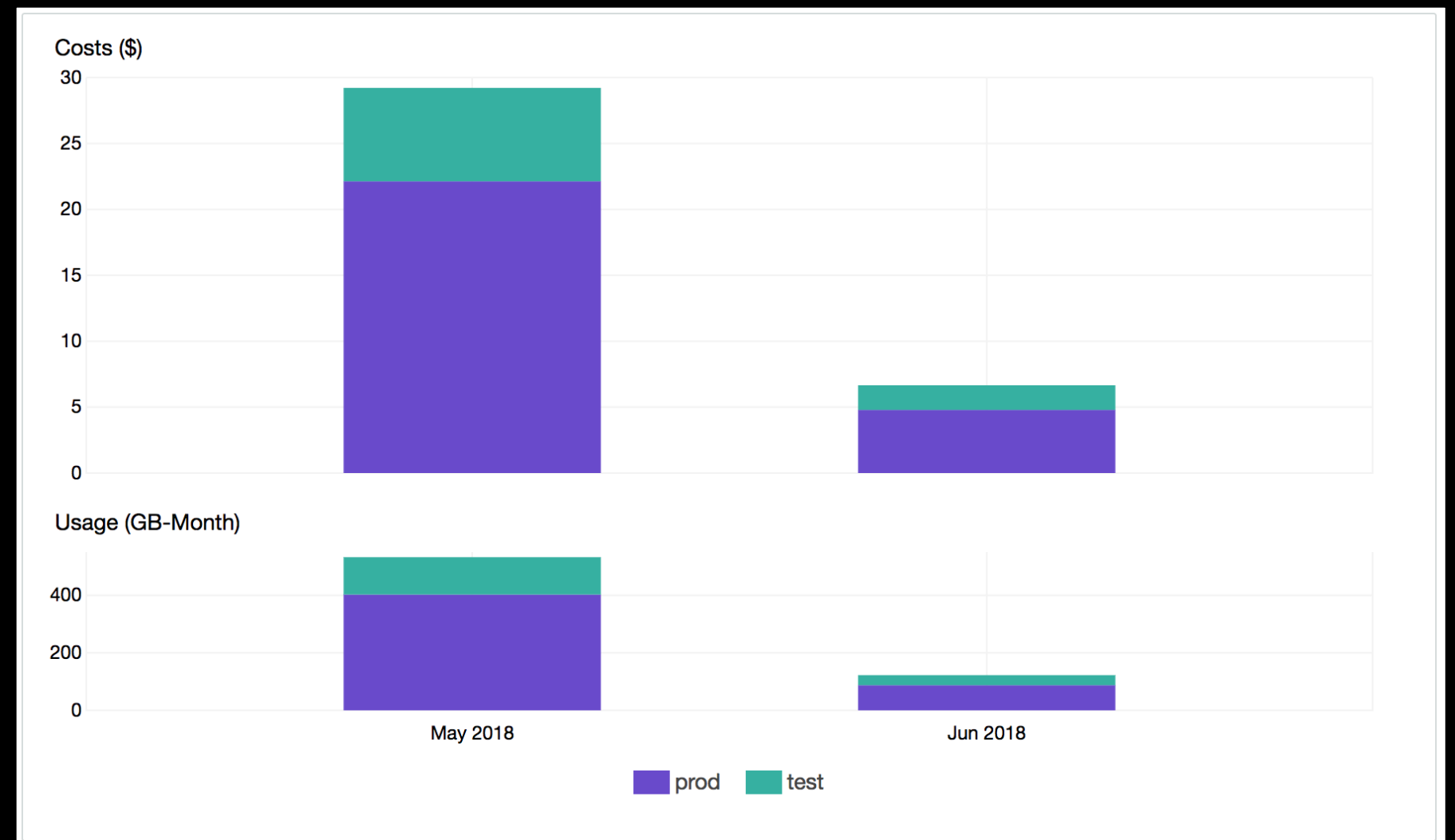
Generate reports with...

AWS Cost and Usage Reports

Create report Delete

☐		Report name	S3 bucket	Time unit	Last modified
☐	▶	DailySnapshotUsage	jbarr-billing	Daily	2018-05-01 10:00:00
☐	▶	MyReport	jbarr-bcm	Hourly	2018-05-01 10:00:00
☐	▶	MyReportDaily	jbarr-bcm	Daily	2018-05-01 10:00:00

View usage and costs broken down by “usage” tag value
(Example: Metrics, dev, backup)



VSS support via Amazon EC2 SSM

- Use Policy Generator to create IAM policy for AWS service, AWS Systems Manager
- *Actions: DescribeInstances, CreateTags, and CreateSnapshot*
- *Create Amazon EC2 type IAM role and attach to Windows instances*

The screenshot shows the 'Create policy' page in the AWS IAM console. It features a 'Visual editor' tab and a 'JSON' tab. The 'Visual editor' is active, showing a policy for the 'EC2' service. The 'Actions' section is expanded, showing 'List' (DescribeInstances) and 'Write' (CreateSnapshot, CreateTags). The 'Resources' section is set to 'Select resources to restrict access'. The 'Request conditions' section is set to 'Specify request conditions (optional)'. There are buttons for 'Clone', 'Remove', 'Add additional permissions', 'Cancel', and 'Review policy'.

Create policy

A policy defines the AWS permissions that you can assign to a user, group, or role. You can create and edit a policy in the visual editor and using JSON. [Learn more](#)

Visual editor JSON Import managed policy

Expand all Collapse all

EC2 (3 actions) Clone Remove

Service EC2

Actions List

DescribeInstances

Write

CreateSnapshot

CreateTags

Resources Select resources to restrict access

Request conditions Specify request conditions (optional)

+ Add additional permissions

Cancel Review policy

SSM VSS included in Microsoft Windows Server AMI version 2017.11.21 and up

Resource-level permissions

IAM policies can mandate the use of specific tags when taking actions on Amazon EBS snapshots

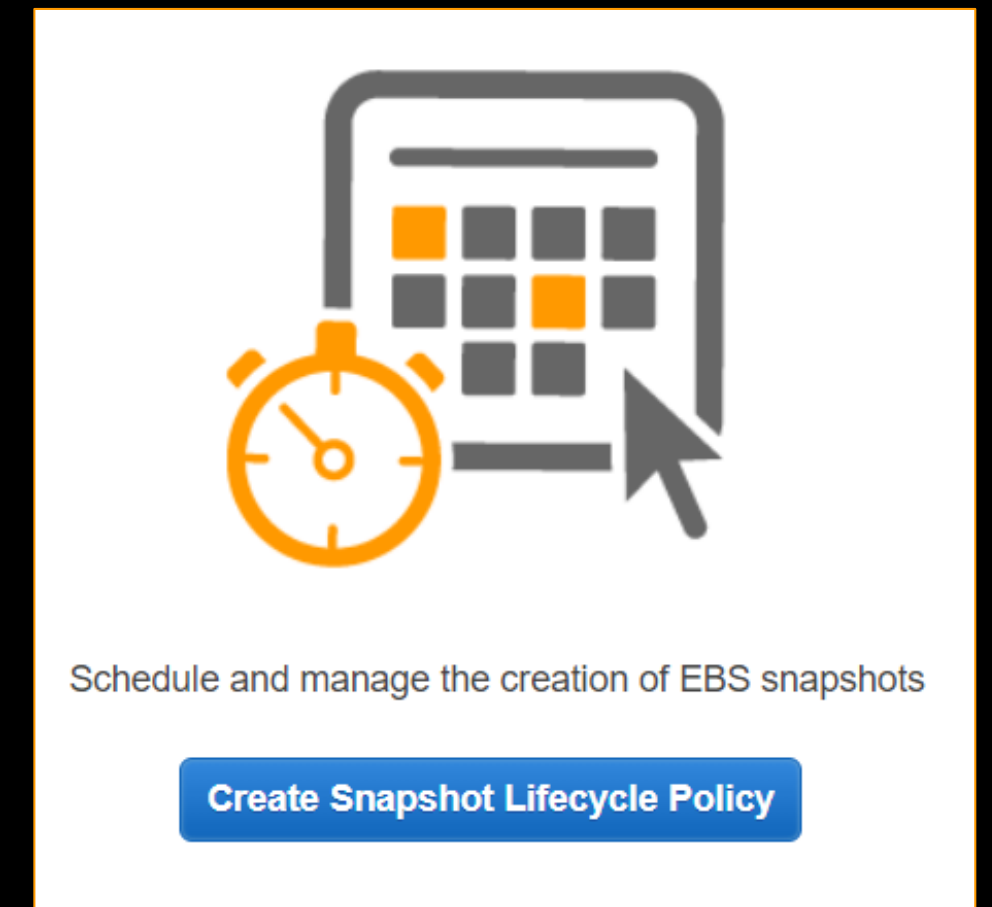
Ideas

- Require use of specific tags
- Specify which users could take snapshots for a given set of volumes
- Restrict access to DeleteSnapshot

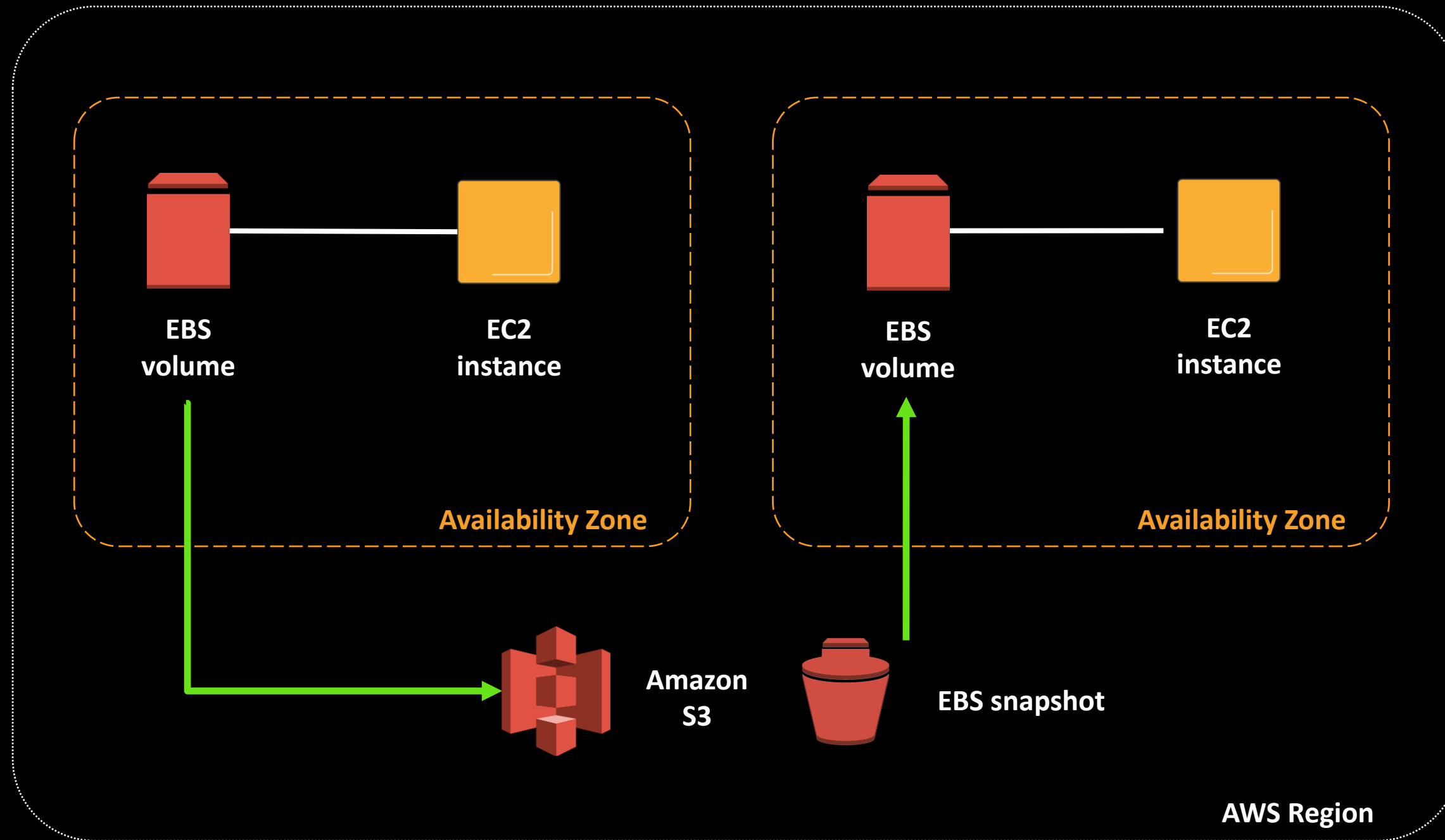
Amazon Data Lifecycle Manager

Simple, automated way to back up data stored on Amazon EBS volumes by ensuring that Amazon EBS snapshots are created and deleted on a custom schedule

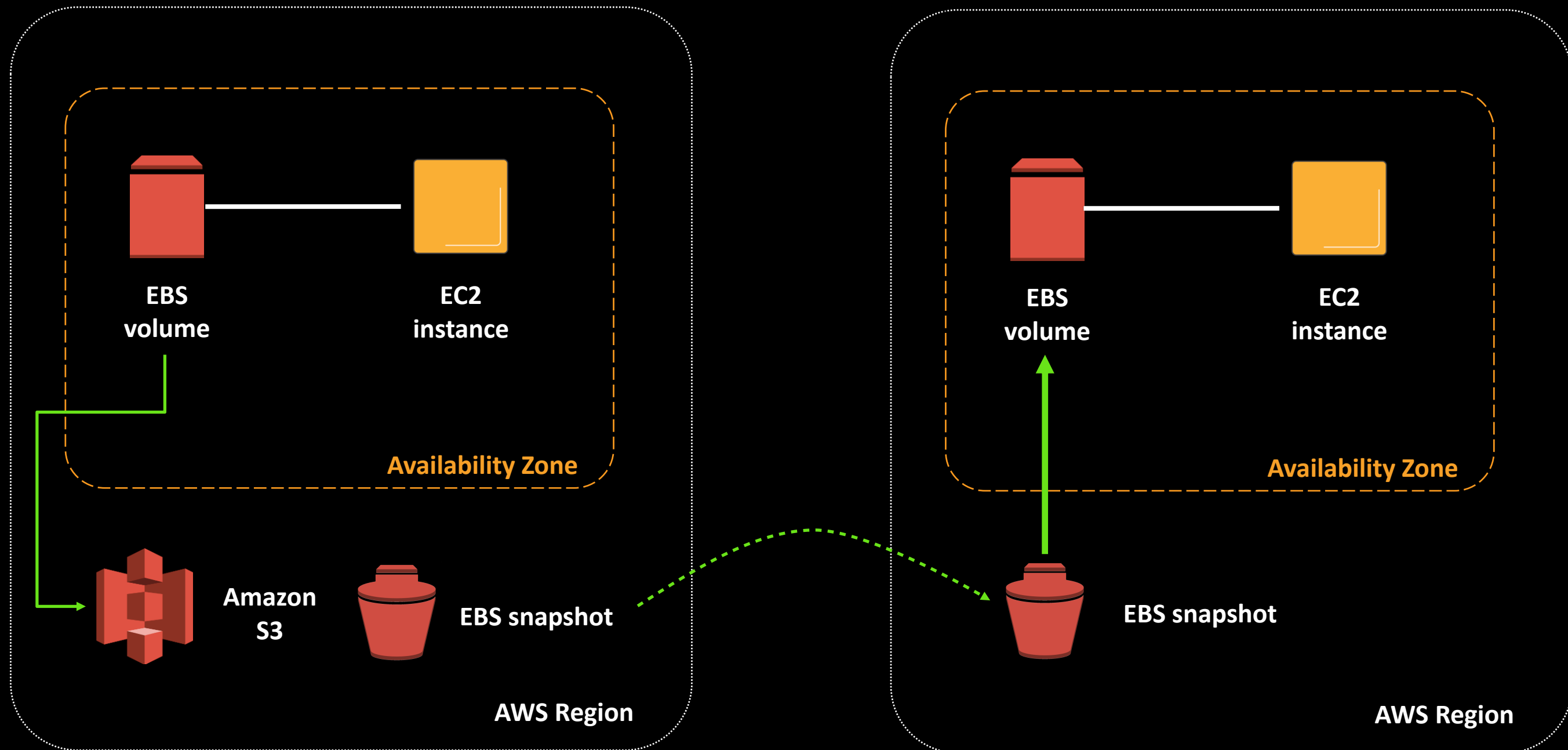
- Use policies to enforce **regular backup schedules**
- Policies **use tags** to identify volumes to back up
- **Retain backups** for compliance/audit purposes
- **Control snapshot costs** by automatically deleting old backups
- Use IAM to control policy access
- **No cost** to use



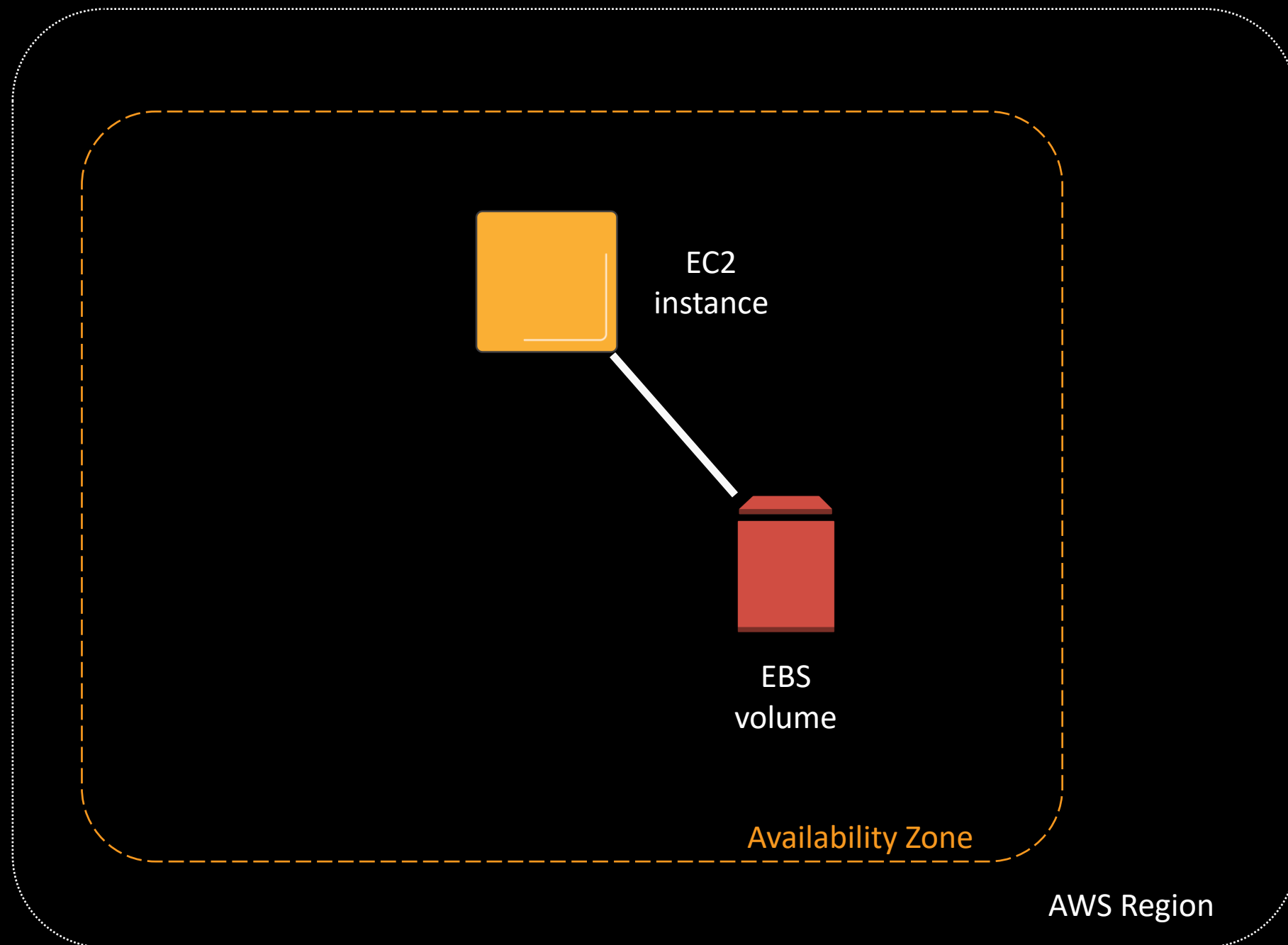
What can you do with a snapshot?



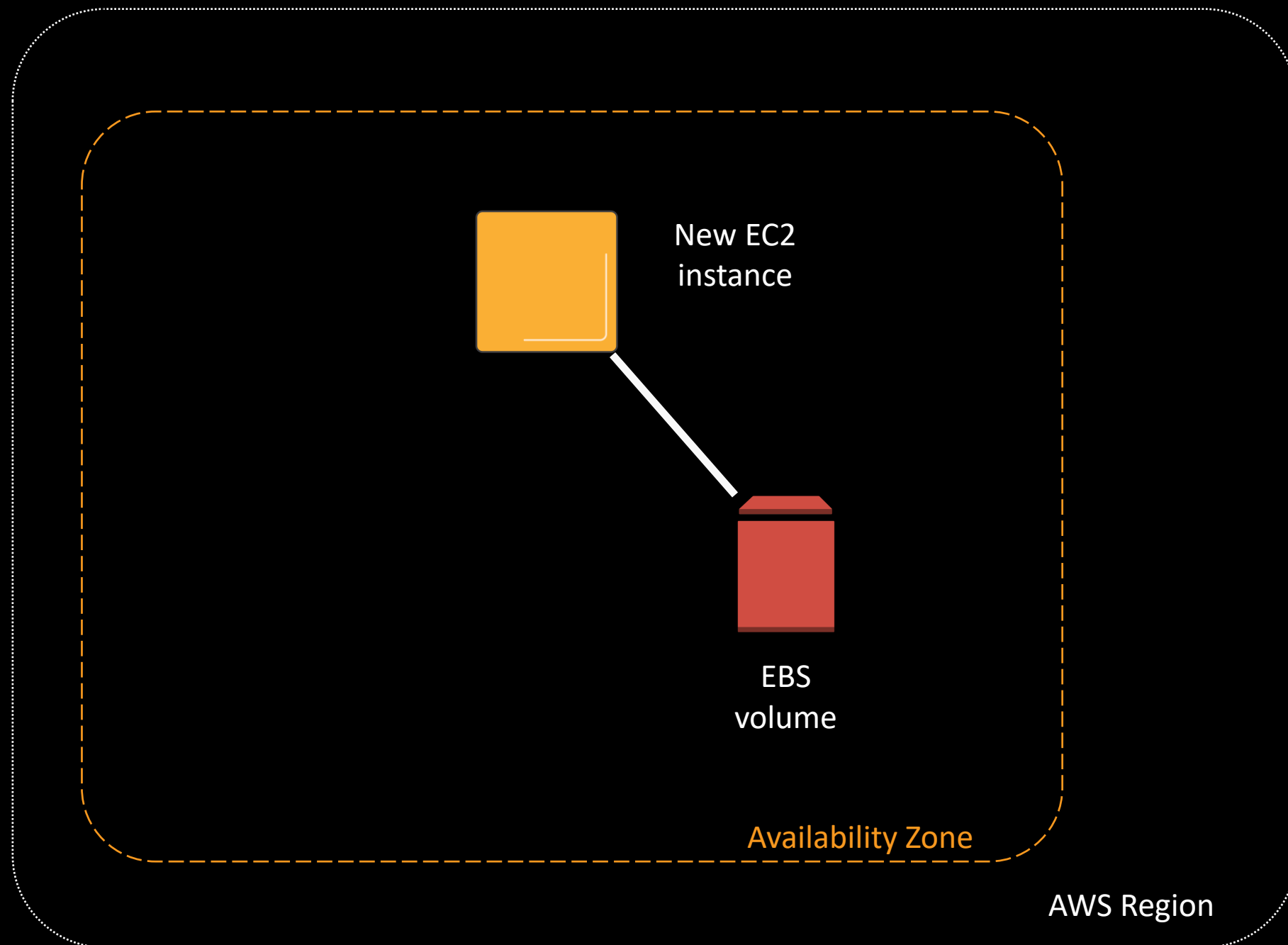
What can you do with a snapshot?



What about EC2 instance failure?



What about EC2 instance failure?



Amazon EBS enables EC2 instance recovery

 Amazon CloudWatch
per-instance metric alarm
`StatusCheckFailed_System`

When alarm triggers?
RECOVER instance

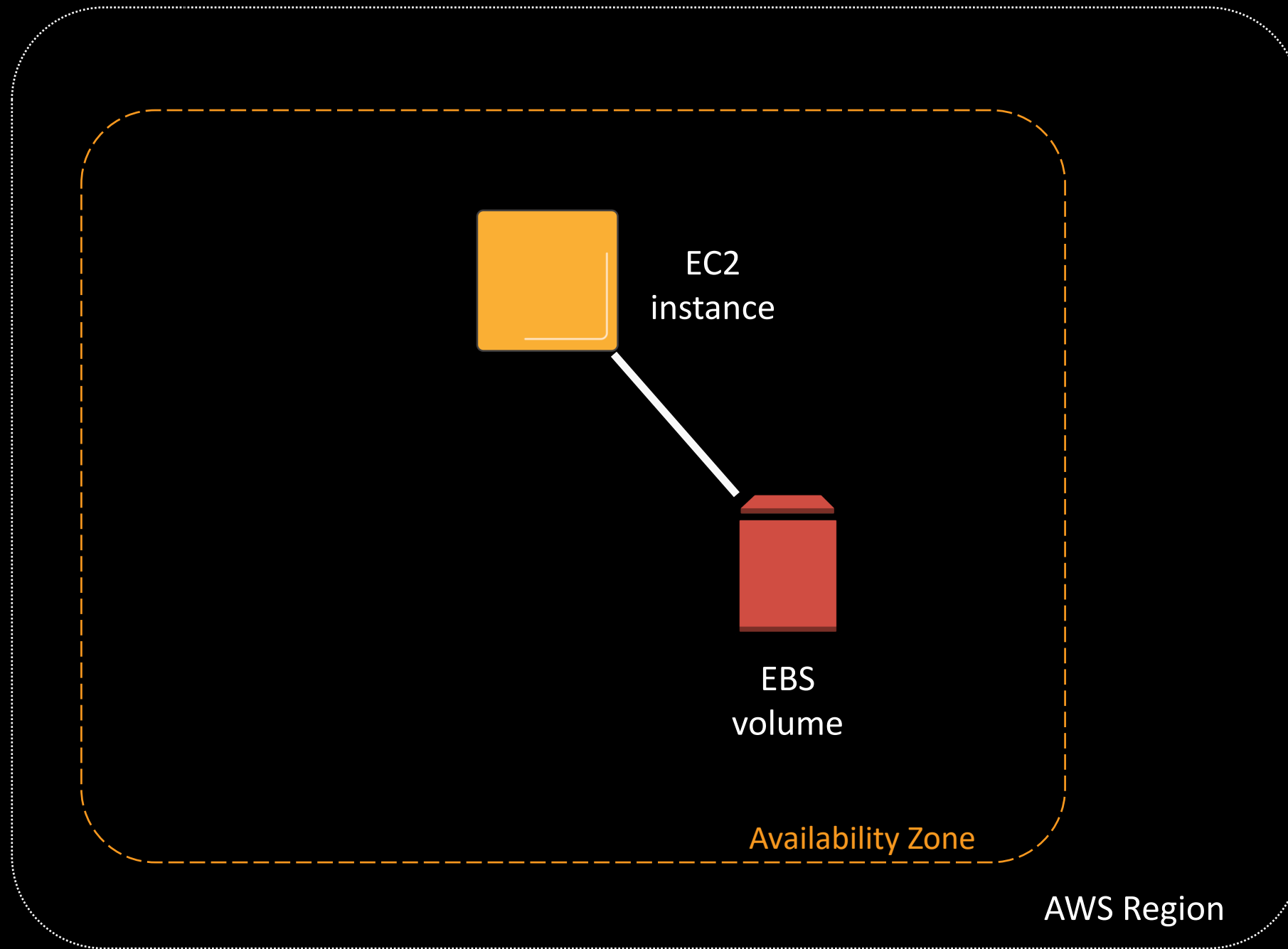


Instance retains

- ✓ Instance ID
- ✓ Instance metadata
- ✓ Private IP addresses
- ✓ Elastic IP addresses
- ✓ EBS volume attachments

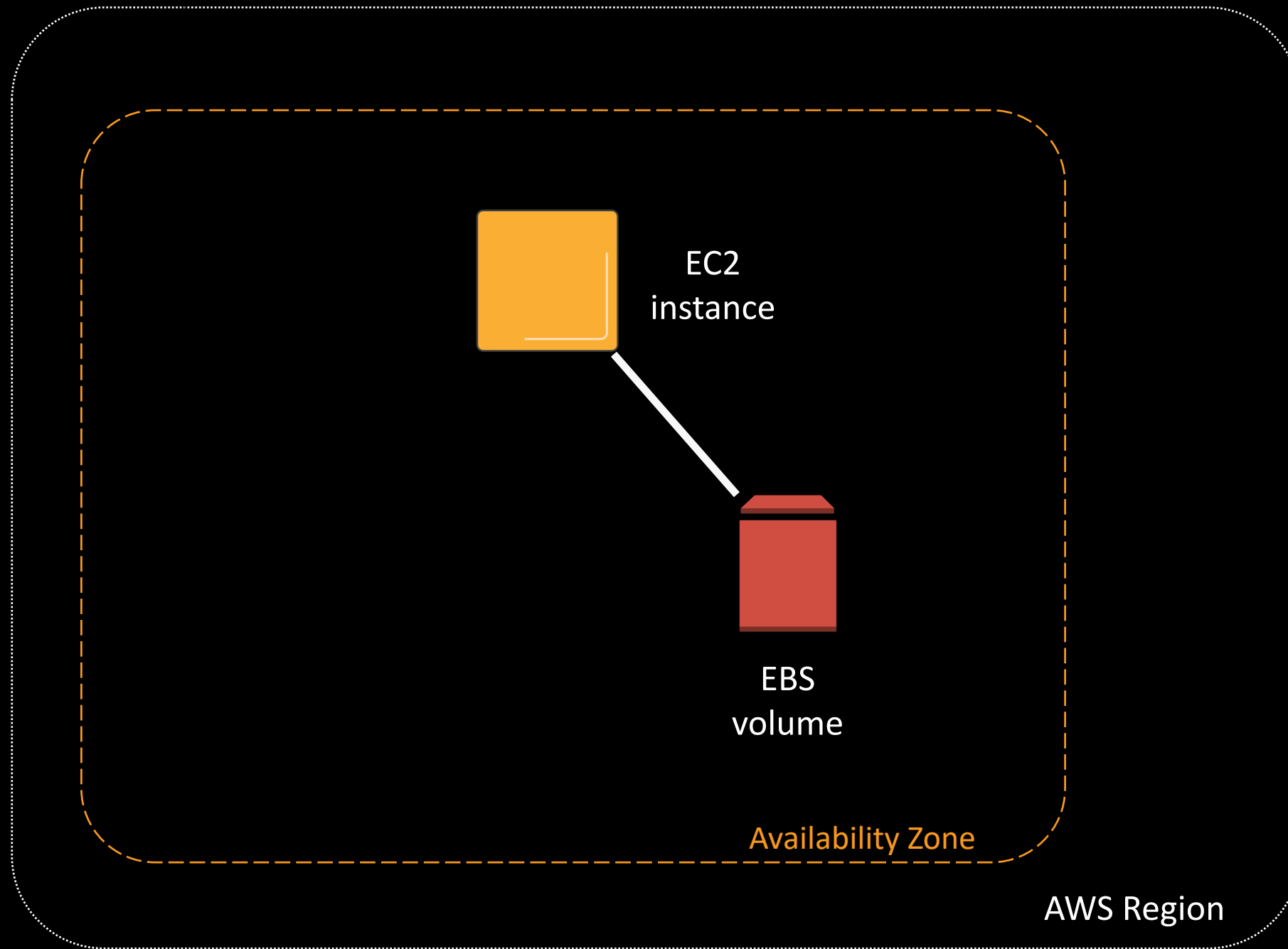
Supported on C3, C4, C5, M3, M4, M5, R3, R4, T2, and X1 instance types within a VPC and with EBS-only storage

What about EC2 instance termination?



`DeleteOnTermination = False`

What about EC2 instance termination?



DeleteOnTermination = **True**

Amazon EBS best practices

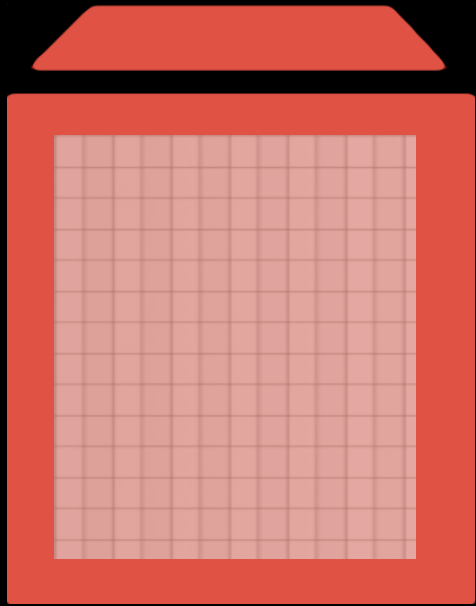
Security

Reliability

Performance

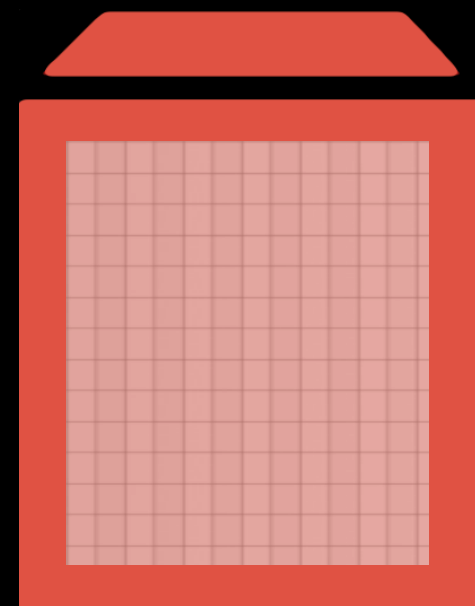


EBS volume initialization



New EBS volume?

Attach and it's ready to go



New EBS volume from snapshot?

- Initialize for best performance
- Random read across volume



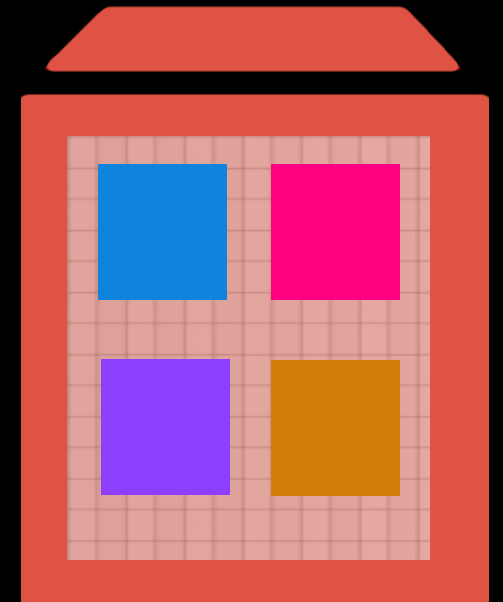
<https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/ebs-initialize.html>

Best practice: EBS volume initialization

Fio-based example:

```
$ sudo yum install -y fio
```

```
$ sudo fio --filename=/dev/xvdf --rw=randread --bs=128k --iodepth=32  
--ioengine=libaio --direct=1 --name=volume-initialize
```



<https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/ebs-initialize.html>

How do we count I/Os?

When possible, we **logically** merge sequential I/Os

...to *minimize* I/O charges on io1,
and *maximize* burst on gp2, sc1, and st1

io1 and gp2: Up to 256 KiB

st1 and sc1: Up to 1 MiB

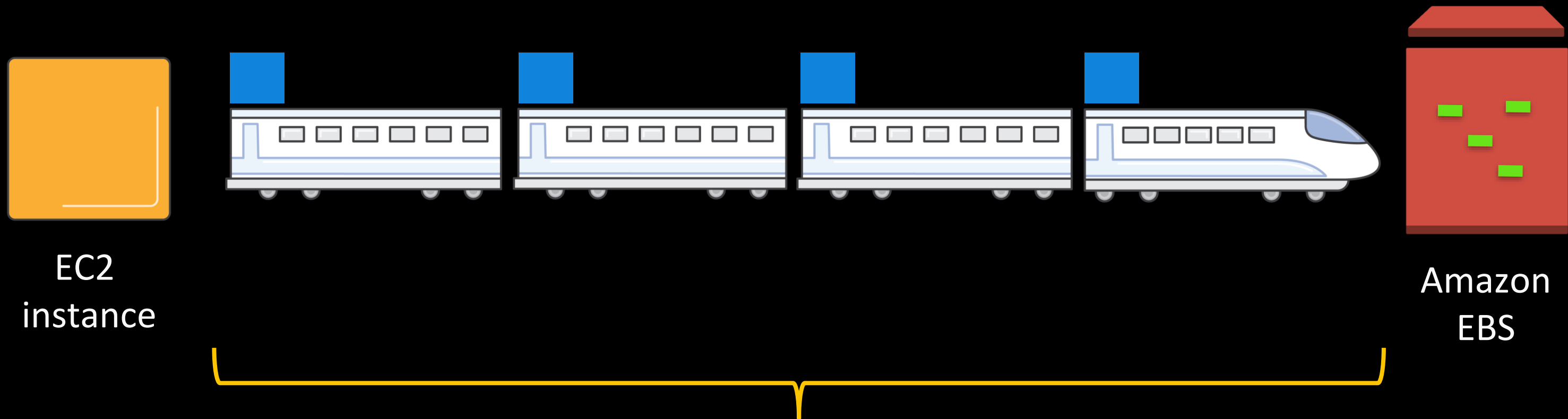
How do we count I/Os?

- Example 1: Random I/Os
- Example 2: Sequential I/O (SSD and HDD)
- Example 3: Large I/O
- Example 4: Mixed I/O

How do we count I/Os?

Example 1: Random I/Os

- 4 random I/Os (i.e., non-sequential I/Os)
- Each I/O **64 KiB**

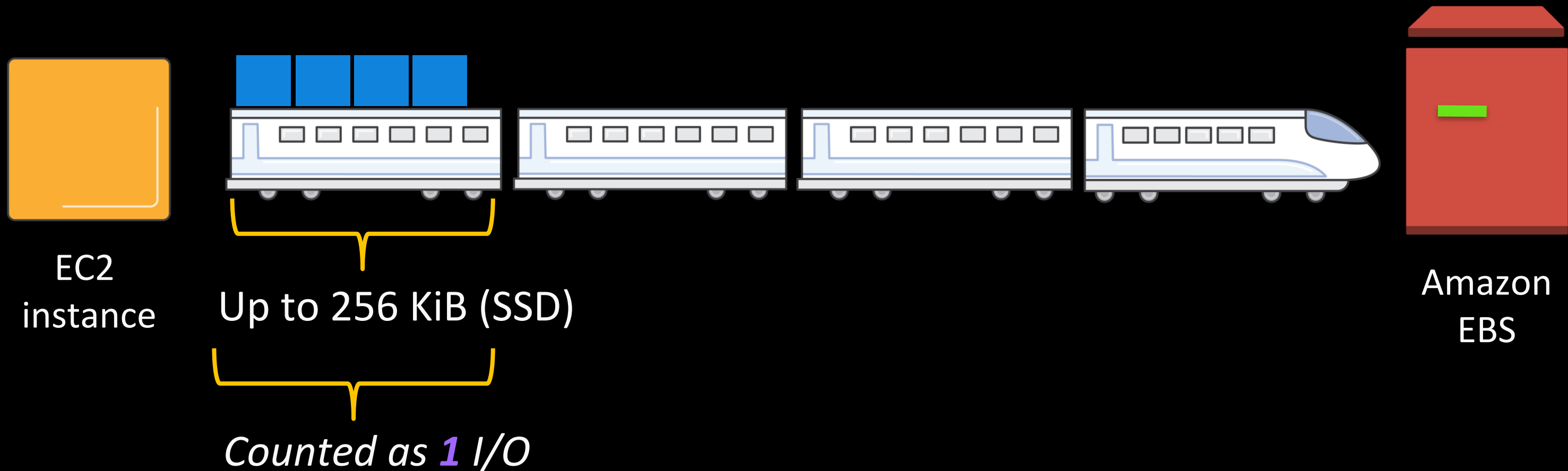


Counted as 4 I/Os

How do we count I/Os?

Example 2: Sequential I/O

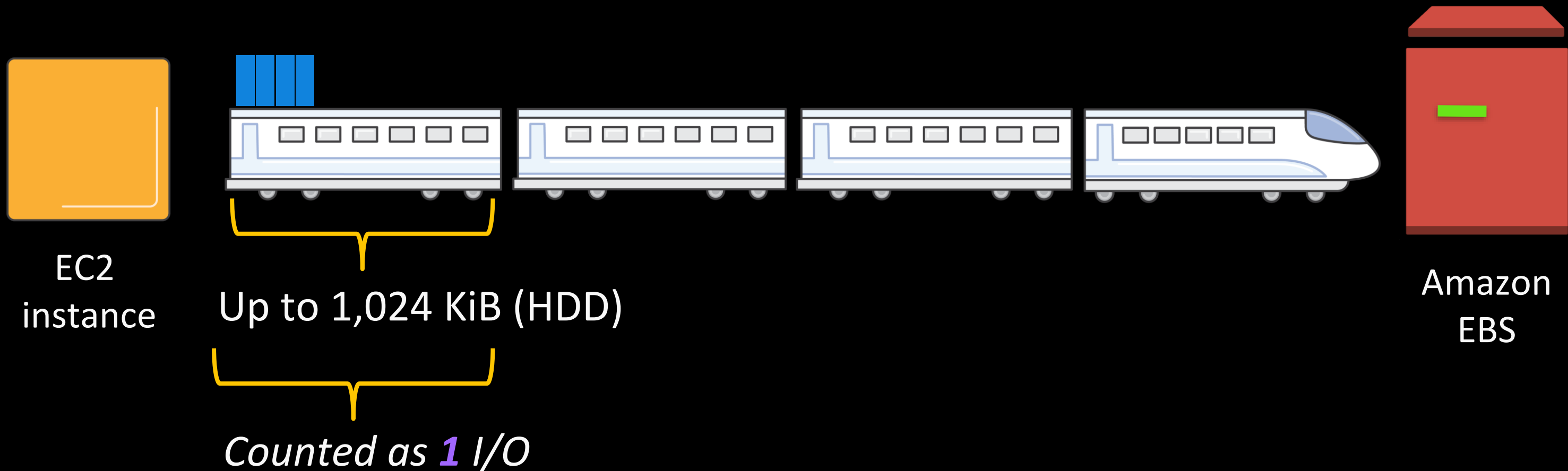
- 4 sequential I/Os
- Each I/O **64 KiB**



How do we count I/Os?

Example 2: Sequential I/O

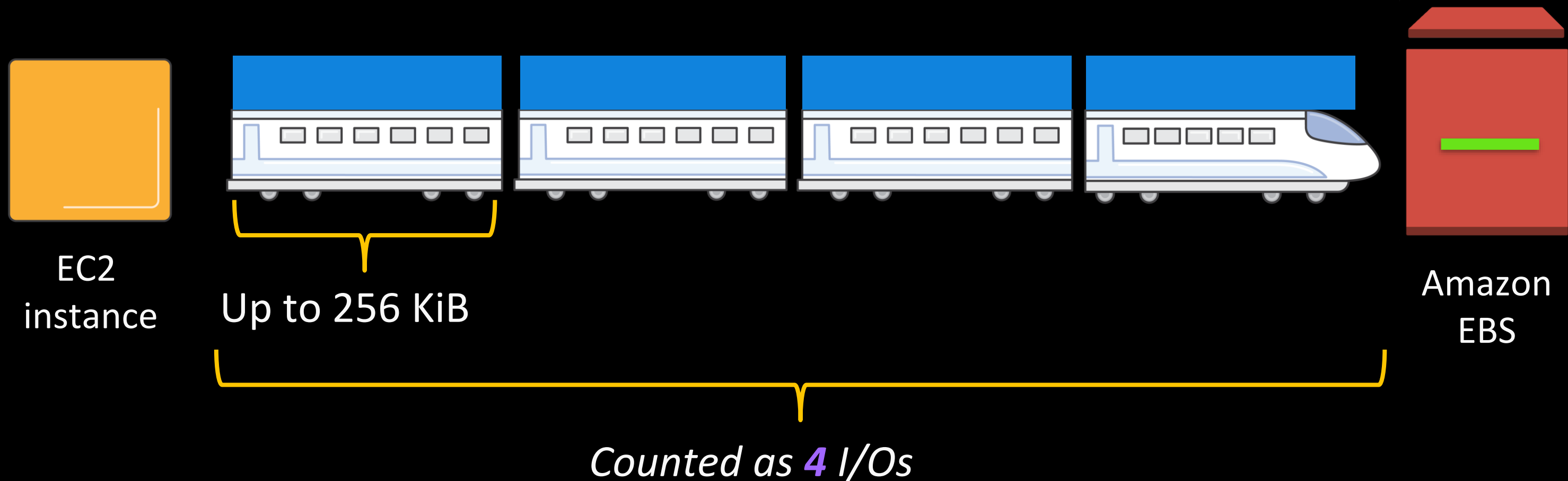
- 4 sequential I/Os
- Each I/O **64 KiB**



How do we count I/Os for gp2 and io1?

Example 3: Large I/O

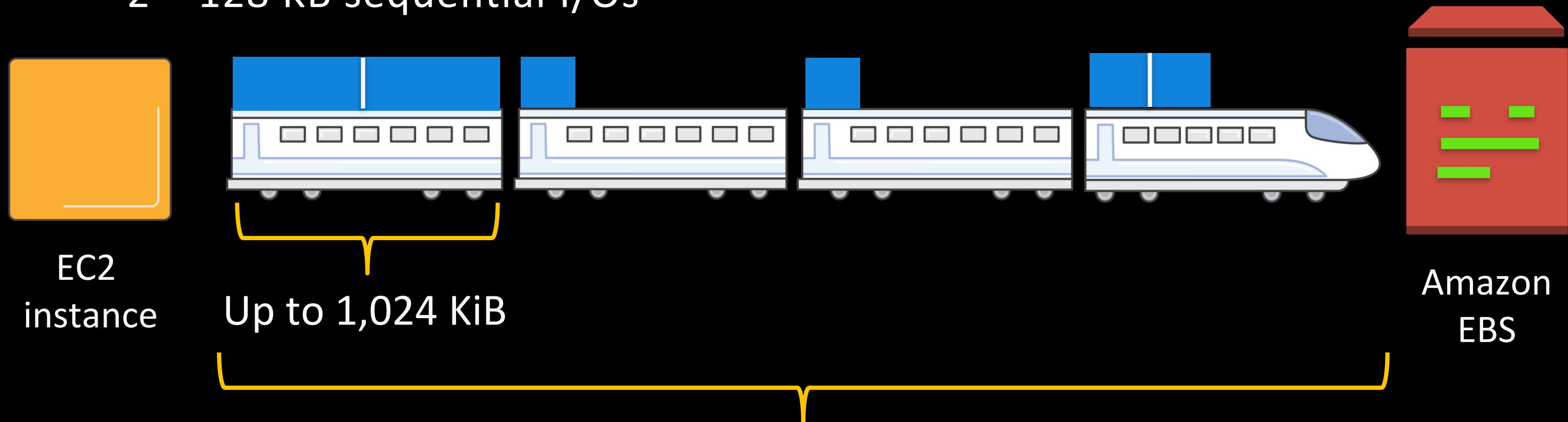
- 1 I/O
- 1,024 KiB



How do we count I/Os for ST1 and SC1?

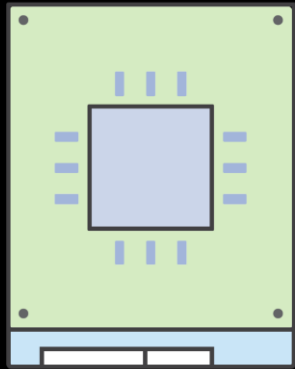
Example 4: Mixed I/O

- 2 * 512 KB sequential I/Os
- 2 * 64 KB random I/Os
- 2 * 128 KB sequential I/Os



Counted as 4 I/Os or 4 MiB/s of burst (but only ~1.4 MiB of data transferred)

Burst bucket: gp2



gp2

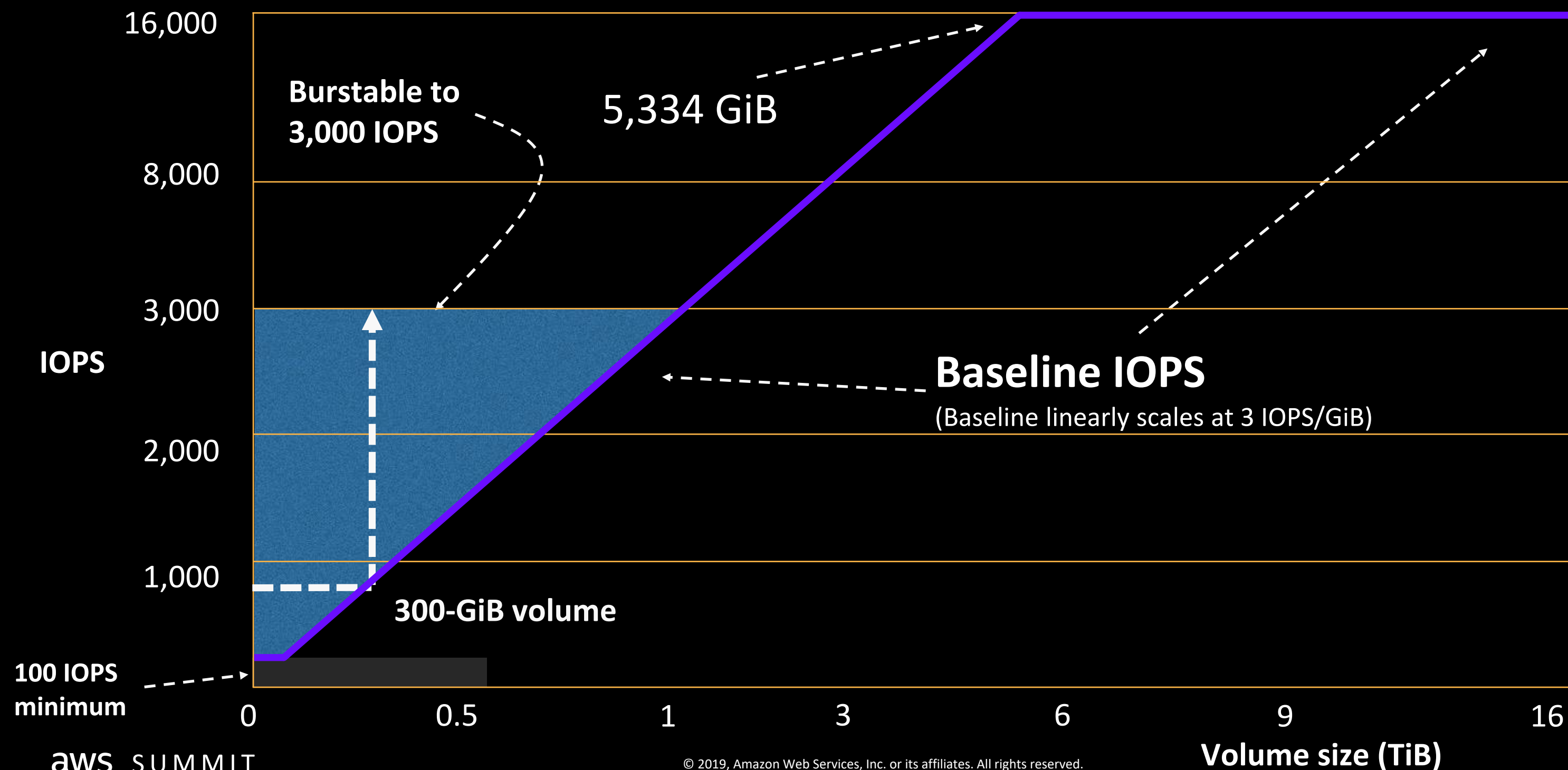


Baseline performance
Always accumulating
3 IOPS per GiB per second

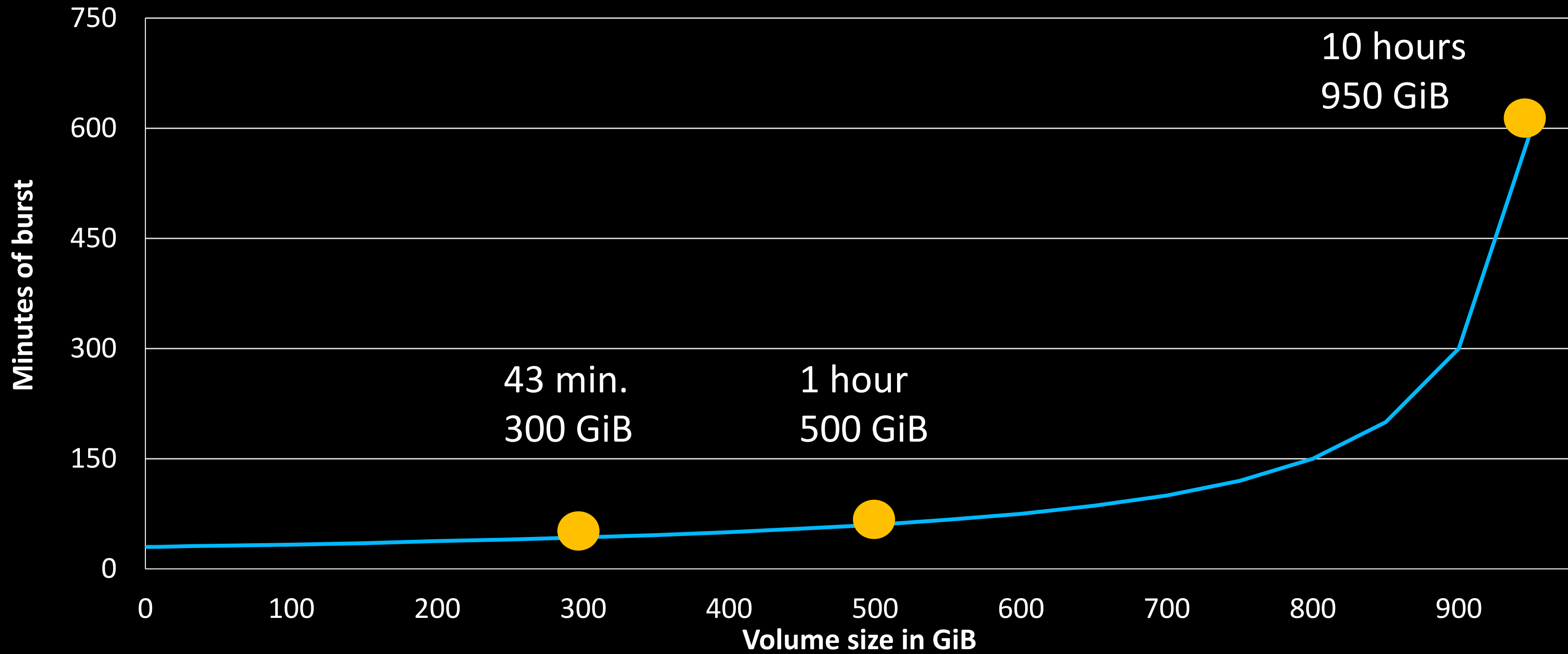
Max I/O credit per bucket is 5.4M

Burst performance
You can spend up to 3,000
credits per second

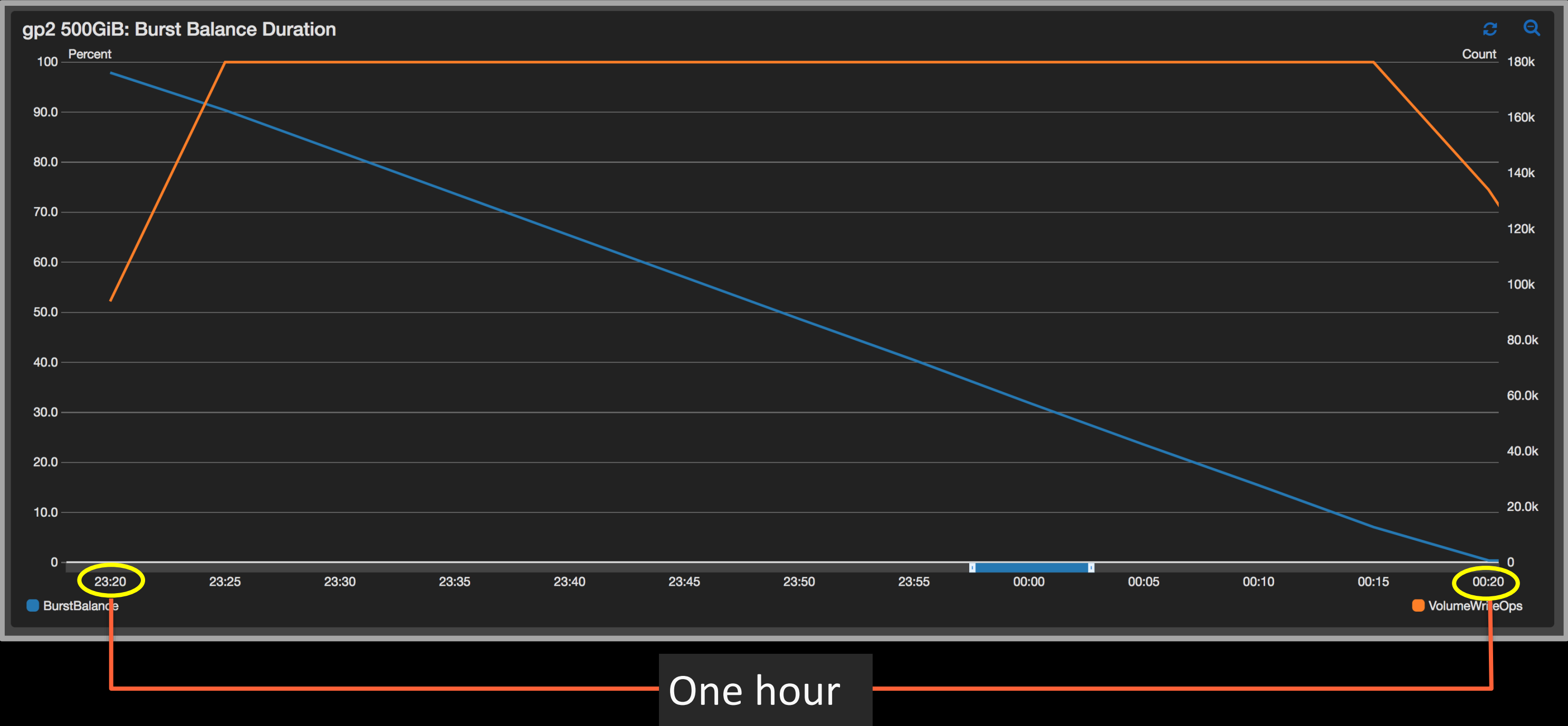
Burst and baseline: gp2



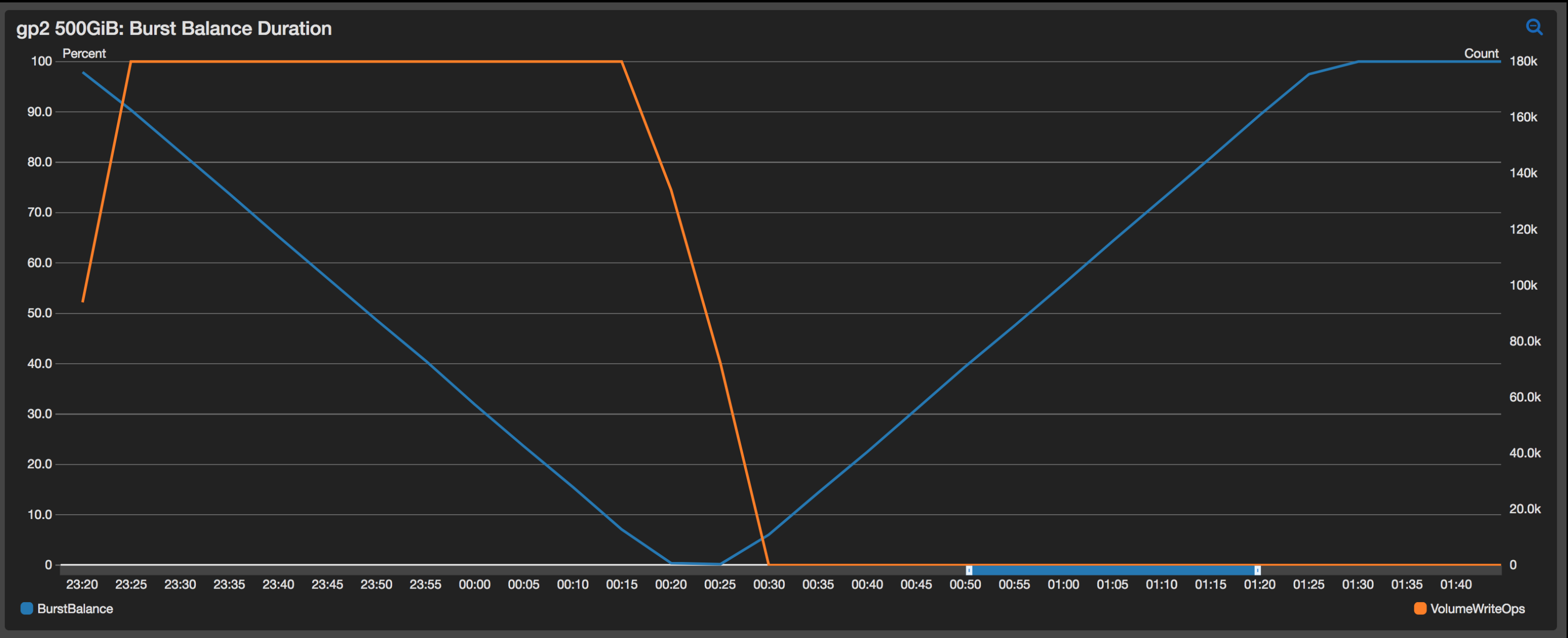
How long can I burst on gp2?



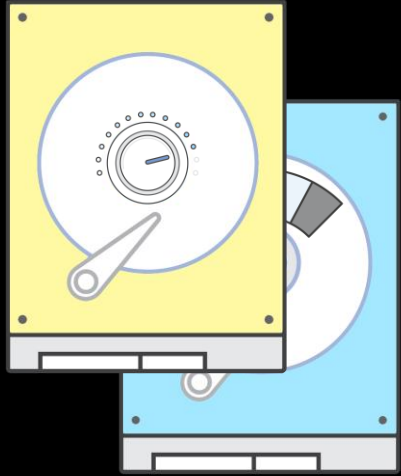
How do I monitor my burst balance?



How do I monitor my burst balance?



Burst bucket: Throughput



st1/sc1



Baseline performance

Always accumulating

st1: 40 MiB/s per TiB

sc1: 12 MiB/s per TiB

Max I/O bucket credit is 1 TiB of credit per TiB in volume

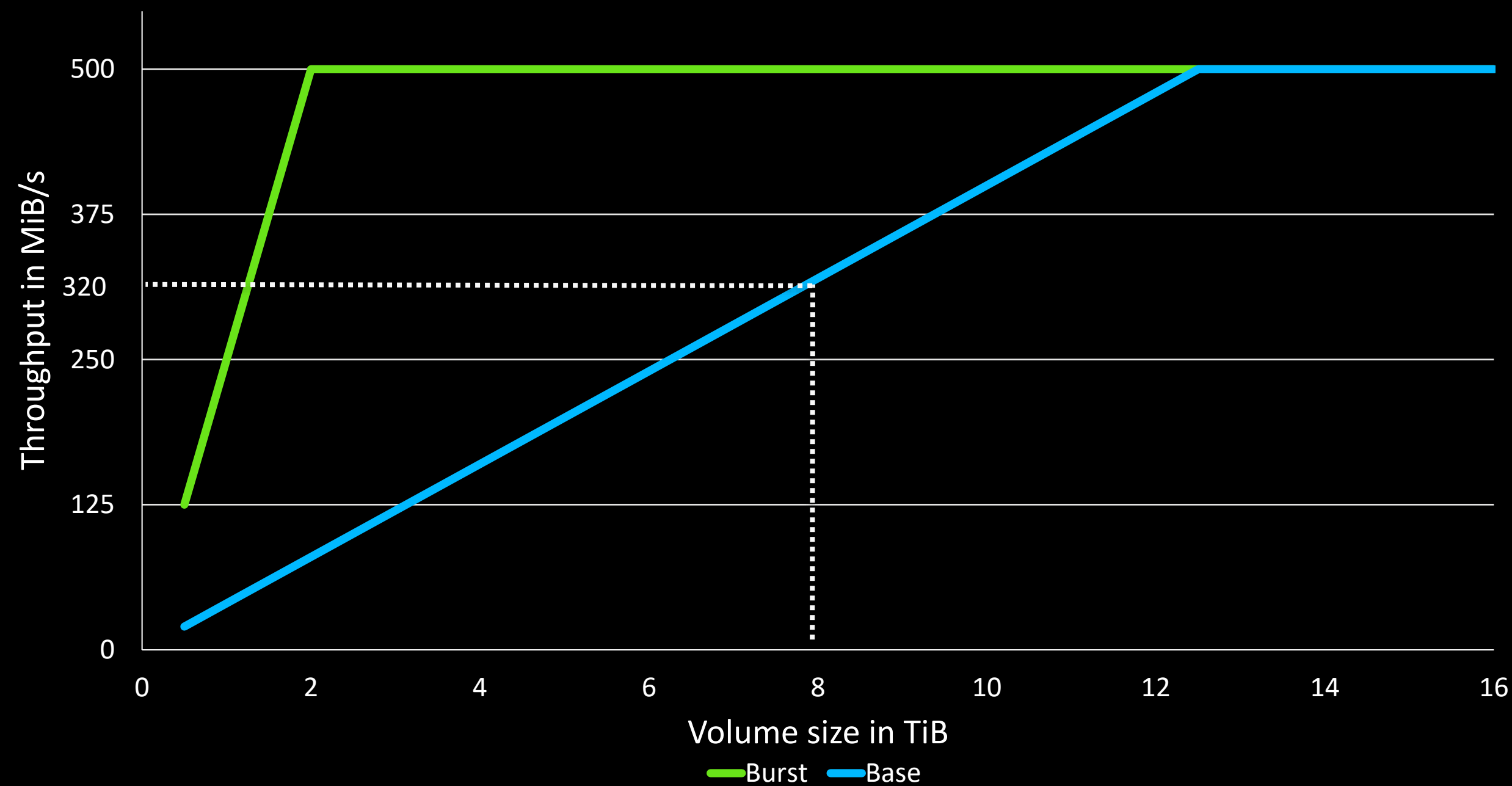
Burst performance

Spend up to

st1: 500 MiB/s

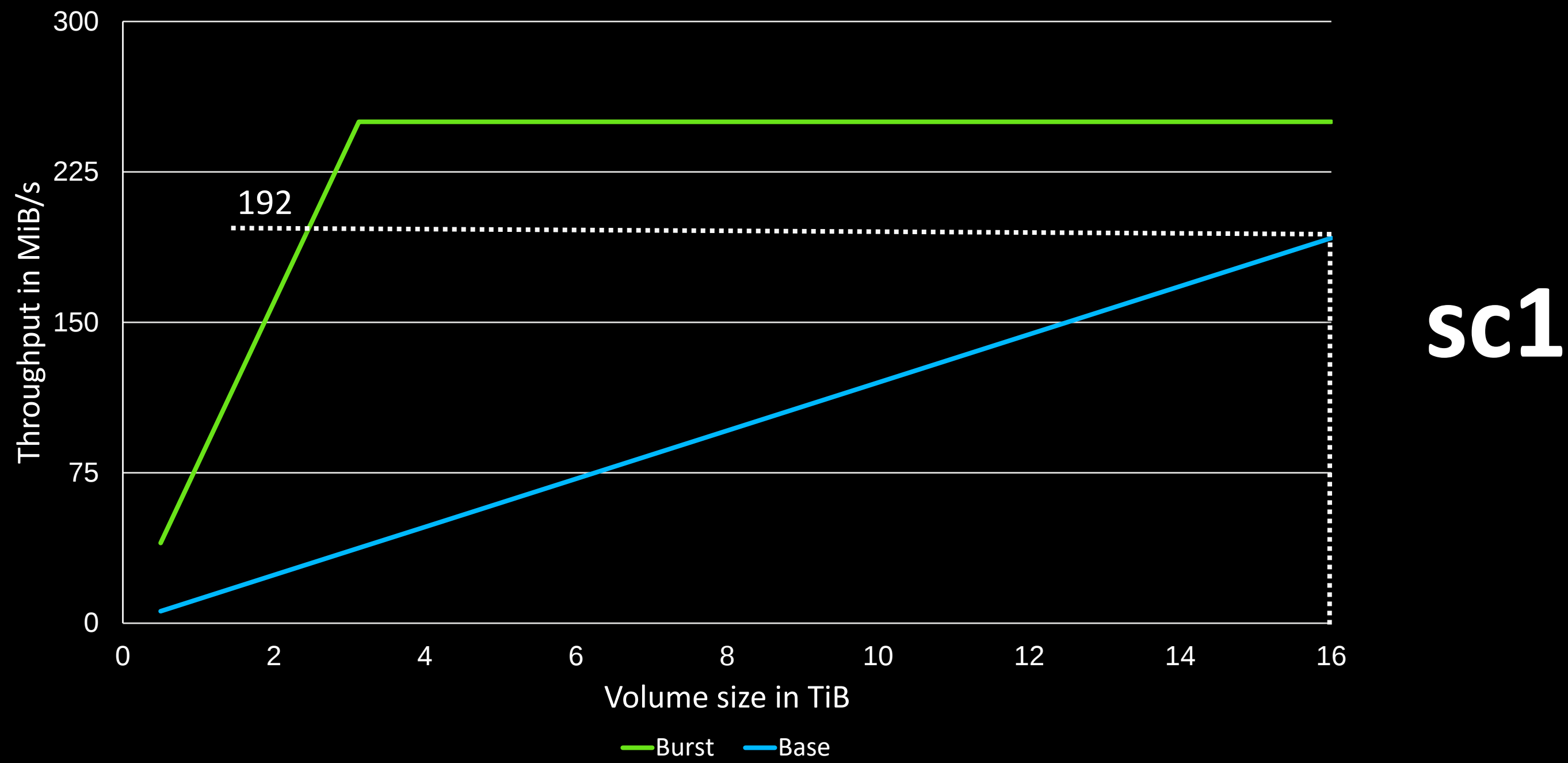
sc1: 250 MiB/s

Burst and baseline: st1

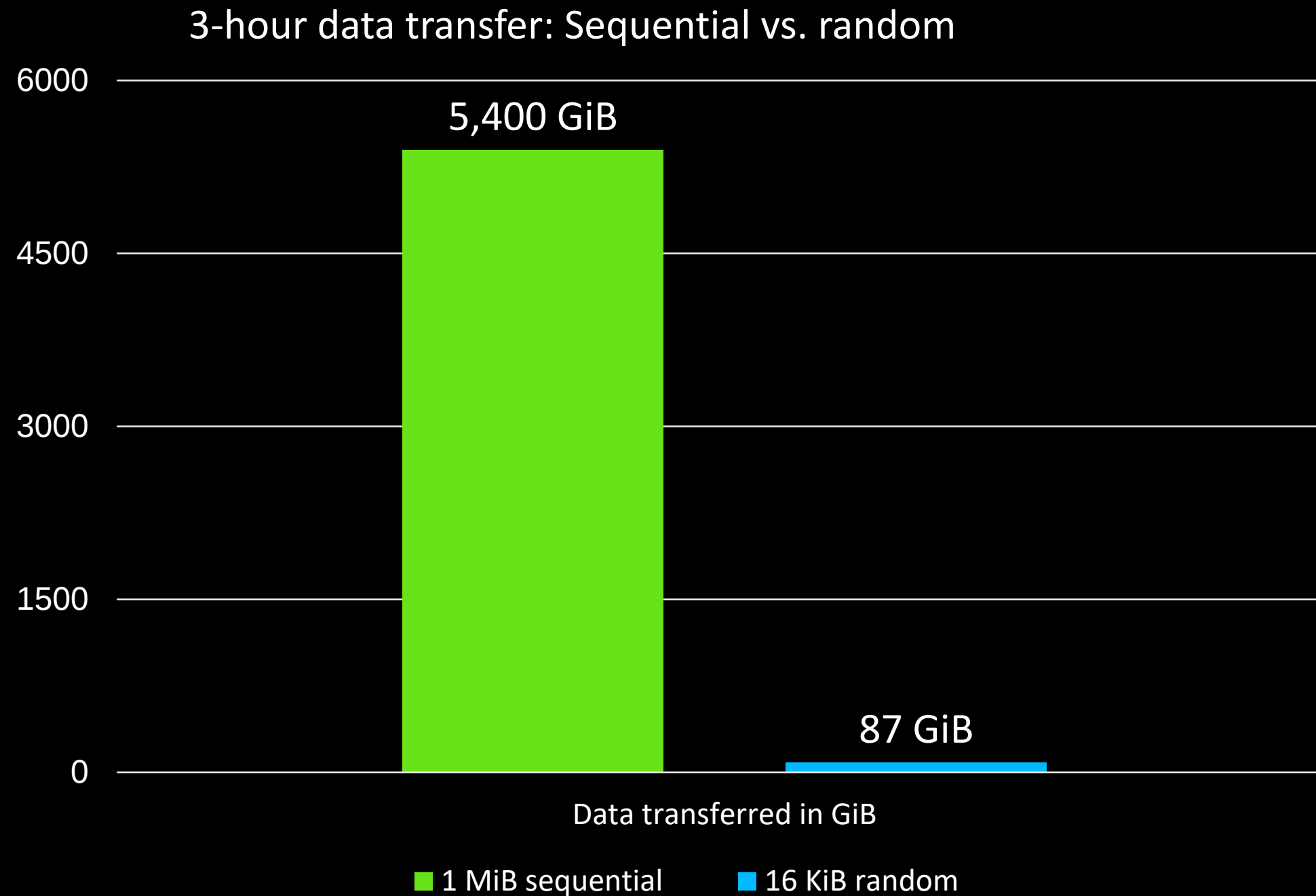


st1

Burst and baseline: sc1



Burst balance for st1 and sc1



4 TiB st1 column

1 MiB sequential:
5.4 TiB transferred

16 KiB random:
87 GiB transferred

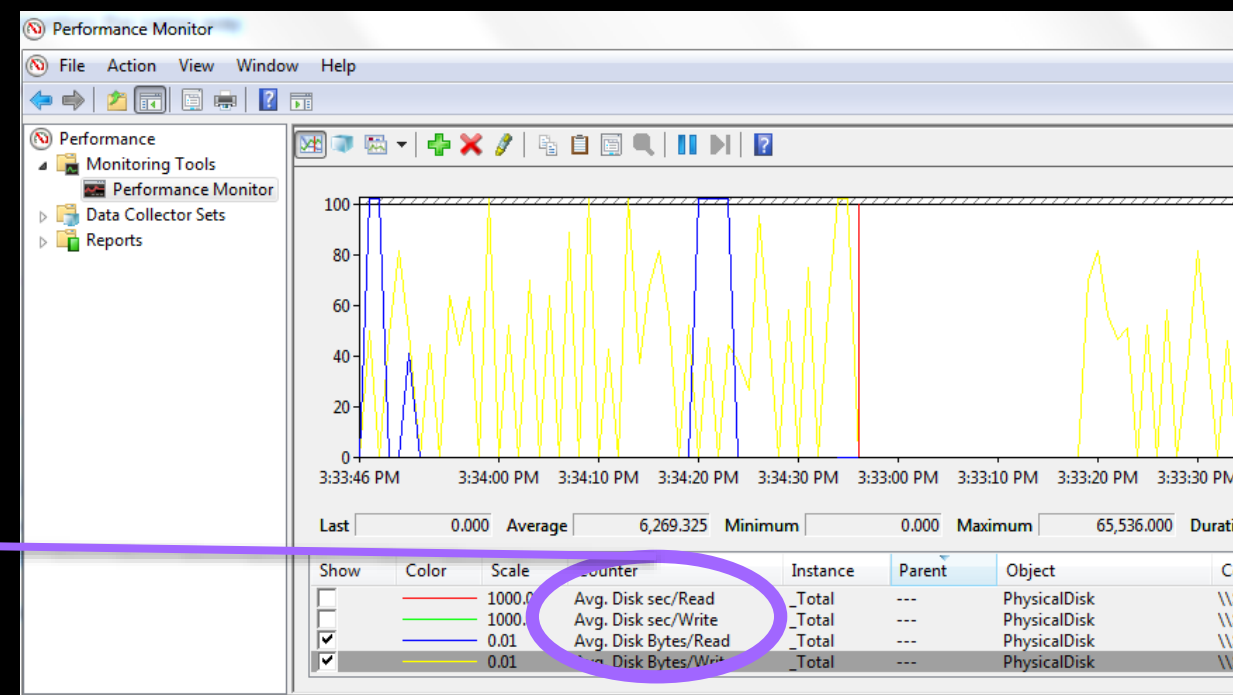
Verify workload I/O patterns

iostat for Linux

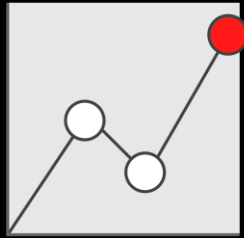
```
$ iostat -xm
Device: rrqm/s   wrqm/s   r/s     w/s     rMB/s    wMB/s   avgrq-sz  avgqu-sz   await    svctm    %util
xvdf      0.00     0.20    0.00    523.40   0.00    523.00   2046.44    3.99      7.62     1.61    100.00
```

2,046 sectors * 512 bytes/sector = ~1,024 KiB

Perfmon for Windows

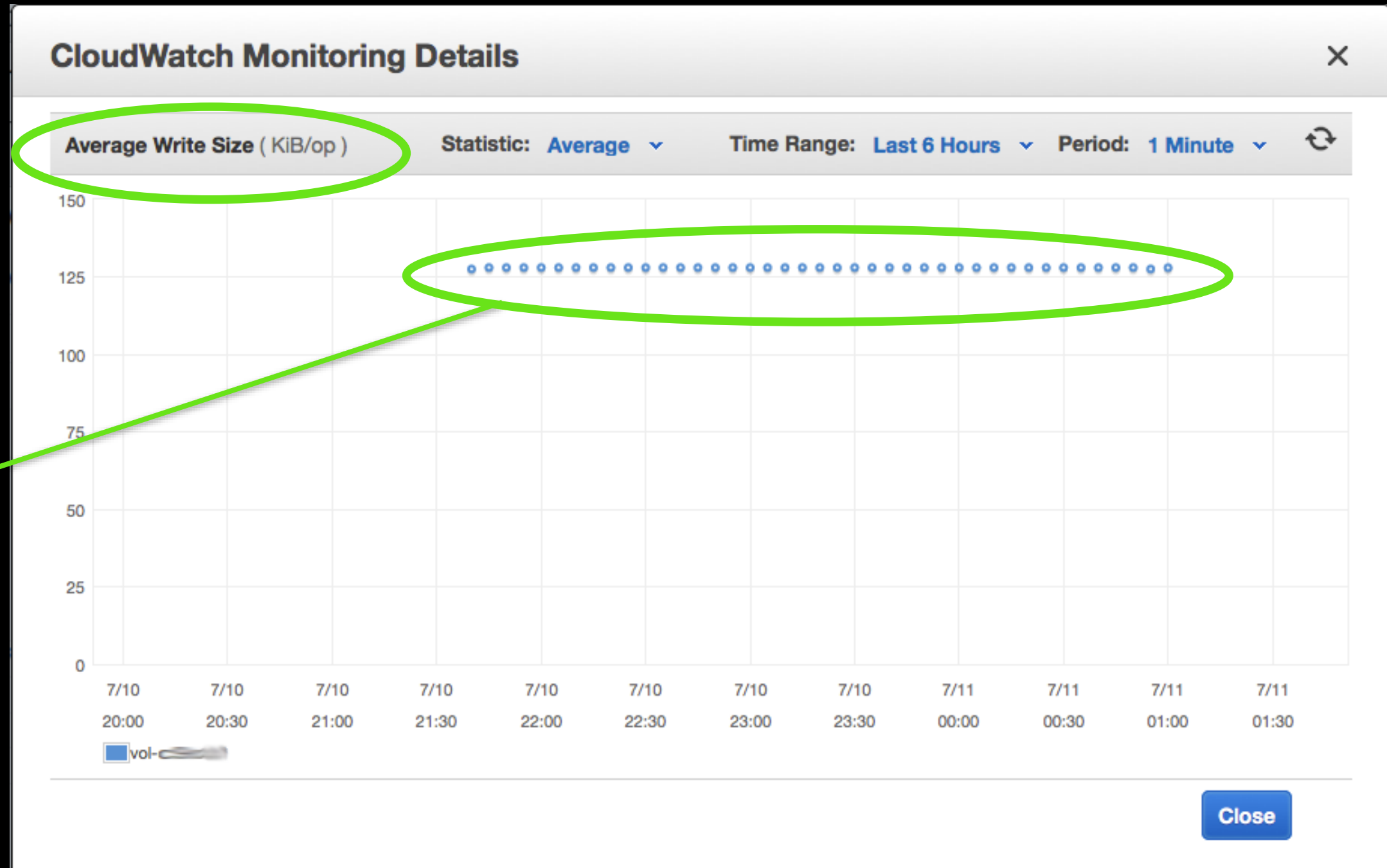


Verify st1 and sc1 workloads

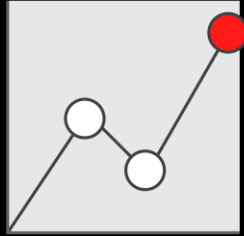


Amazon
CloudWatch
Console

128 KiB



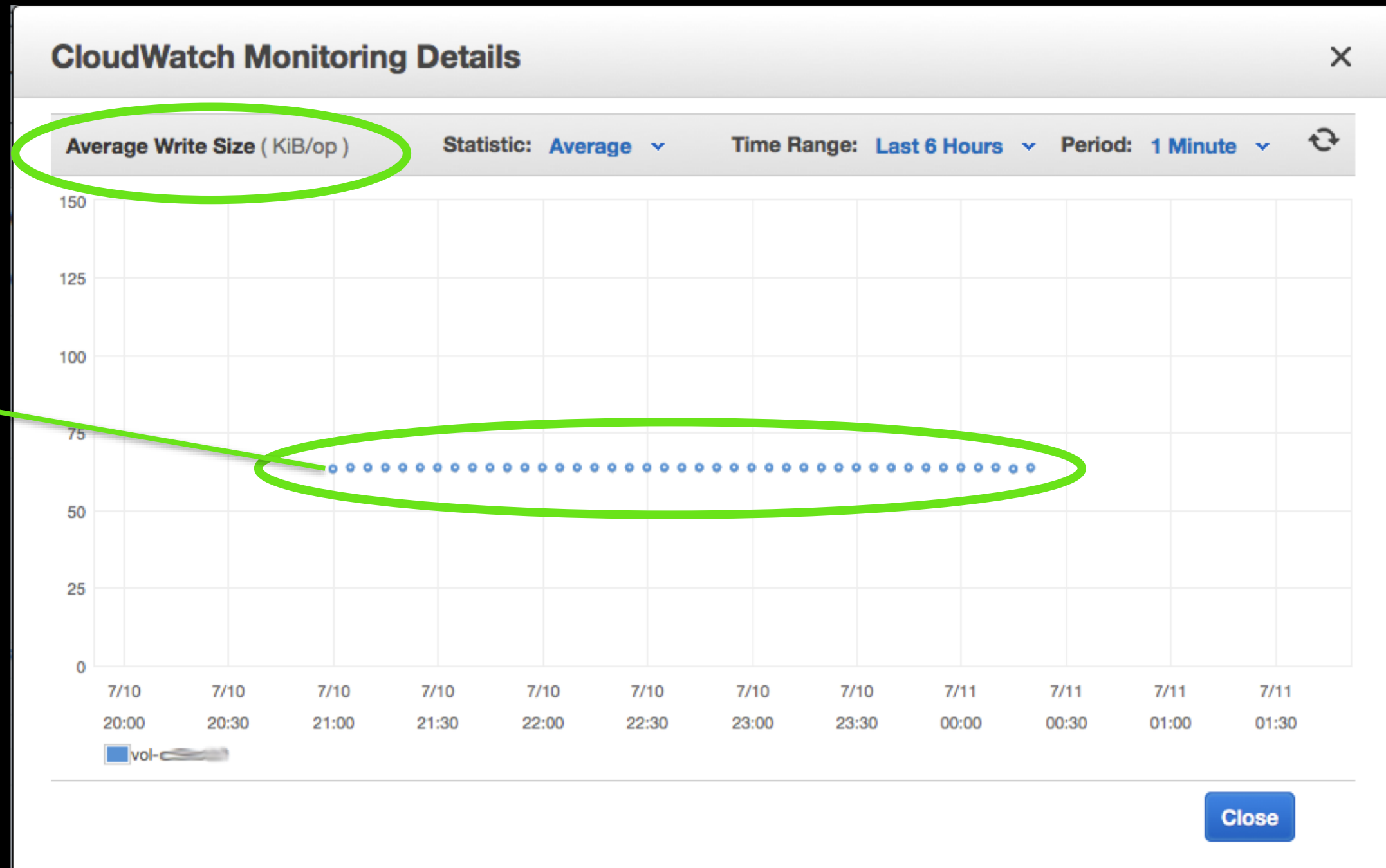
Verify st1 and sc1 workloads



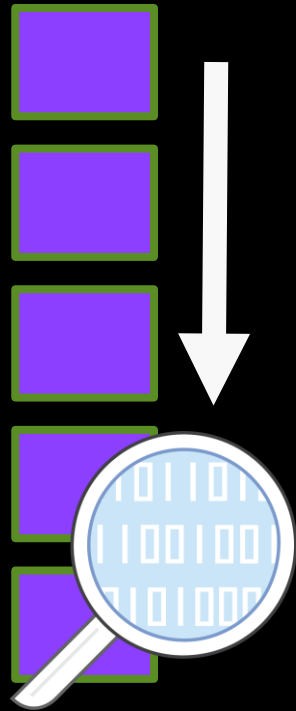
Amazon
CloudWatch
Console

Under
64 KiB?

Small or random
IOPS likely



Linux performance tuning: st1 and sc1



Increase read-ahead buffer

- Recommended for high-throughput read workloads
- Per-volume configuration
- Default is 128 KiB (256 sectors) for Amazon Linux
- Smaller or random I/O will degrade performance

Increase read-ahead:

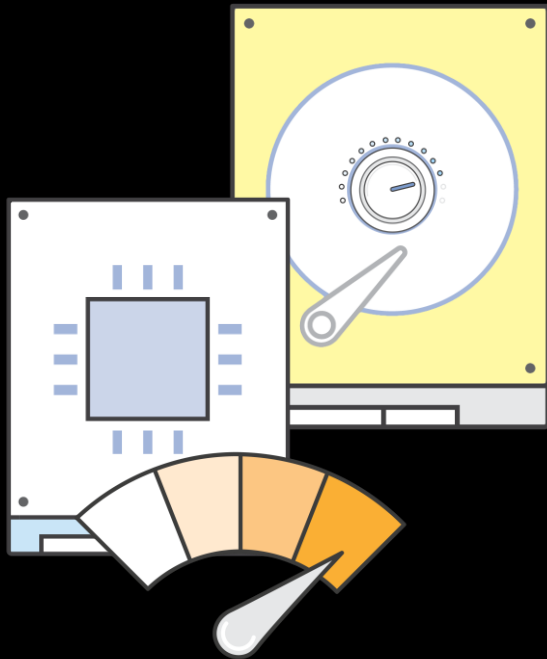
```
$ sudo blockdev --setra 2048 /dev/<device>
```

Examine current value:

```
$ sudo blockdev --getra 2048 /dev/<device>
```

<https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/EBSPerformance.html>

What is an EBS-optimized instance?



- Dedicated network bandwidth for Amazon EBS I/O
- Enabled by default on all current generation instance types
- Can be enabled at instance launch or on a running instance
- Not an option on some 10-Gbps instance types (c3.8xlarge, r3.8xlarge, i2.8xlarge)

More details:

<https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/EBSOptimized.html>

Performance: EBS-optimized



c4.large

Dedicated to EBS

500 Mbps ~ 62.5 MiB/s
4,000 16K IOPS



2 TiB GP2 volume:
6,000 IOPS
250 MiB/s max throughput



c4.2xlarge

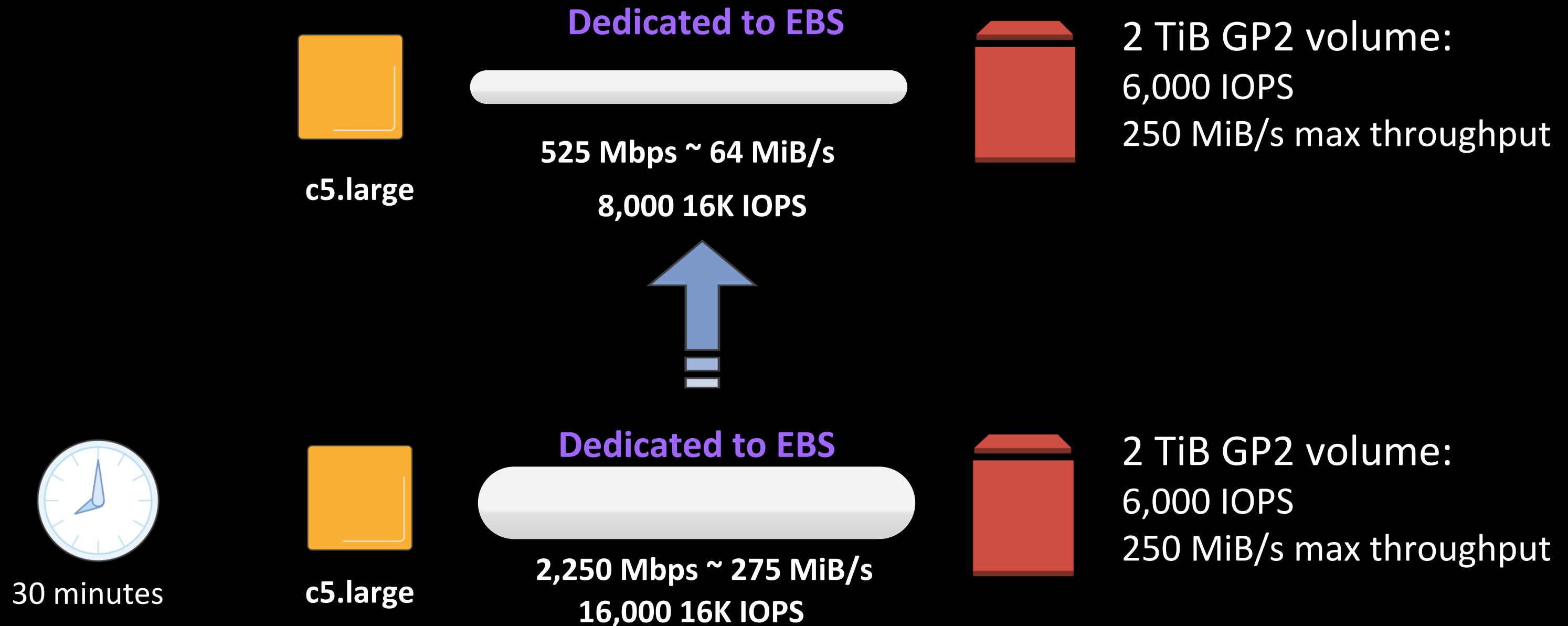
Dedicated to EBS

1 Gbps ~ 125 MiB/s
8,000 16K IOPS

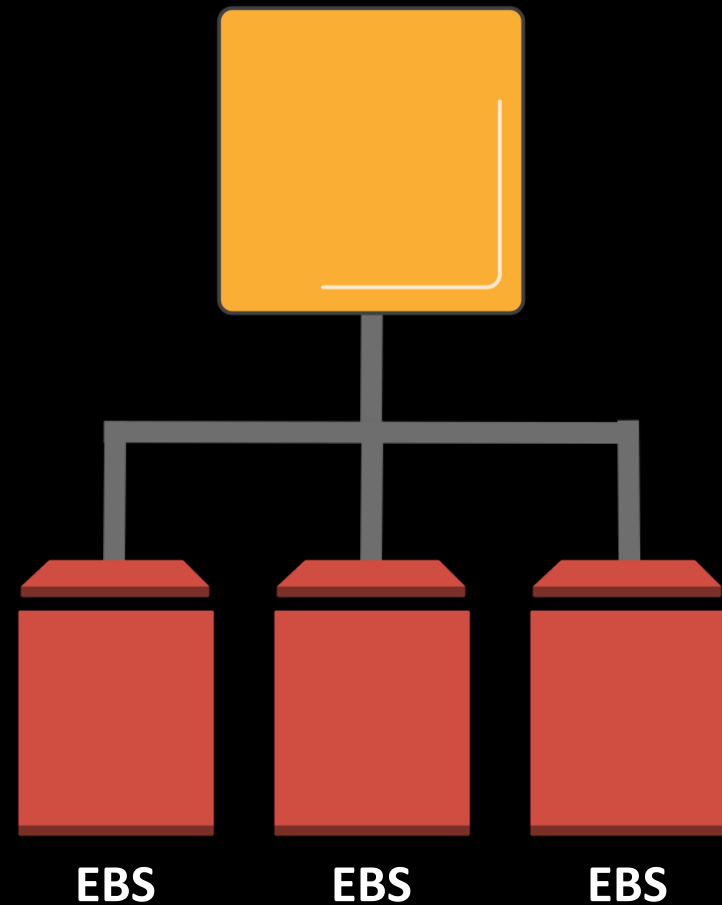


2 TiB GP2 volume:
6,000 IOPS
250 MiB/s max throughput

Performance: EBS-optimized burst



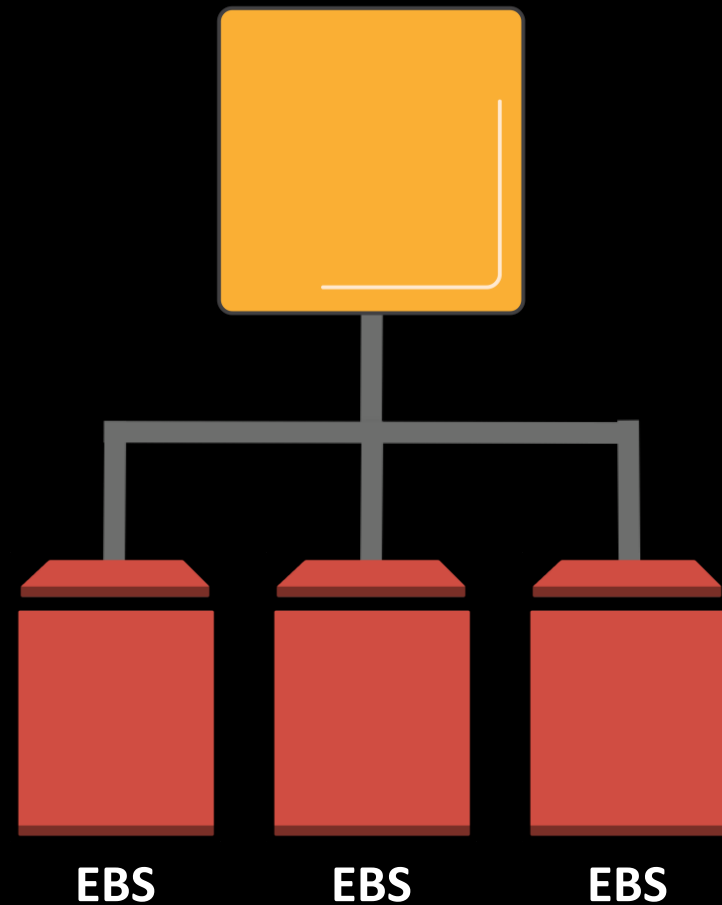
Best practice: RAID



When to use RAID?

- Storage requirement >16 TiB
- Throughput requirement > 1,000 MiB/s
- IOPS requirement > 64,000 @ 16K

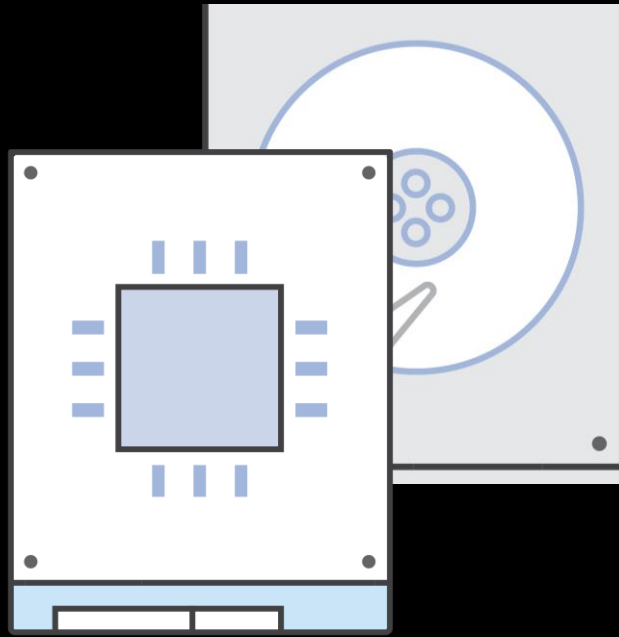
Best practice: RAID



Avoid RAID for redundancy

- EBS data is already replicated
- RAID1 halves available EBS bandwidth
- RAID5/6 loses 20% to 30% of usable I/O to parity

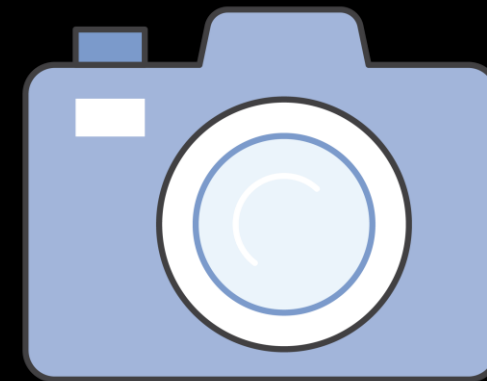
Summary



Select the right volume for
your workload



Select the right instance
for your workload



Take snapshots,
tag snapshots



Use
encryption

Thank you!

Ashish Palekar
@logicalblock