

#WWDC19

# What's New in Apple Filesystems

Max Matveev, CoreOS

Jon Becker, CoreOS

Bill Stouder-Studenmund, CoreOS

Protecting system software on macOS

APFS volume replication

External files for iOS

# APFS Refresher

Default filesystem on iOS since 10.3 and macOS since High Sierra

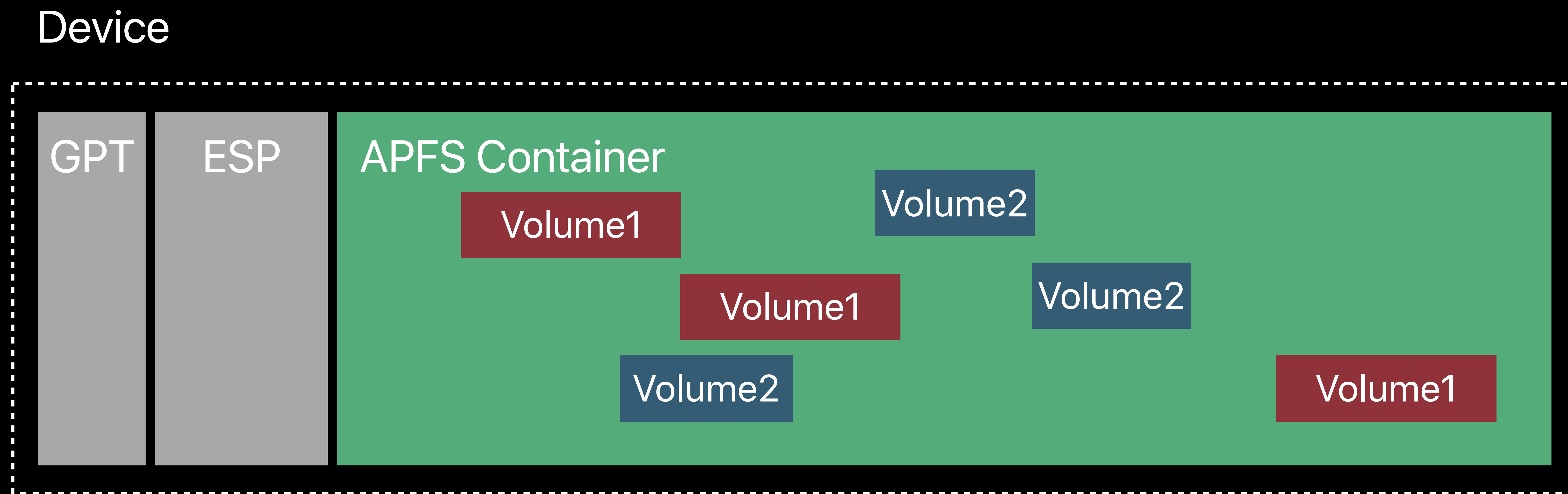
# APFS Refresher

Default filesystem on iOS since 10.3 and macOS since High Sierra



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Default filesystem on iOS since 10.3 and macOS since High Sierra



# Protecting System Software

Max Matveev, CoreOS

# Protecting System Software on macOS

System Integrity Protection is designed to help prevent potentially malicious software from modifying files and folders on your Mac

Read-Only System Volume



# Container Layout

disk1

Macintosh HD

Preboot

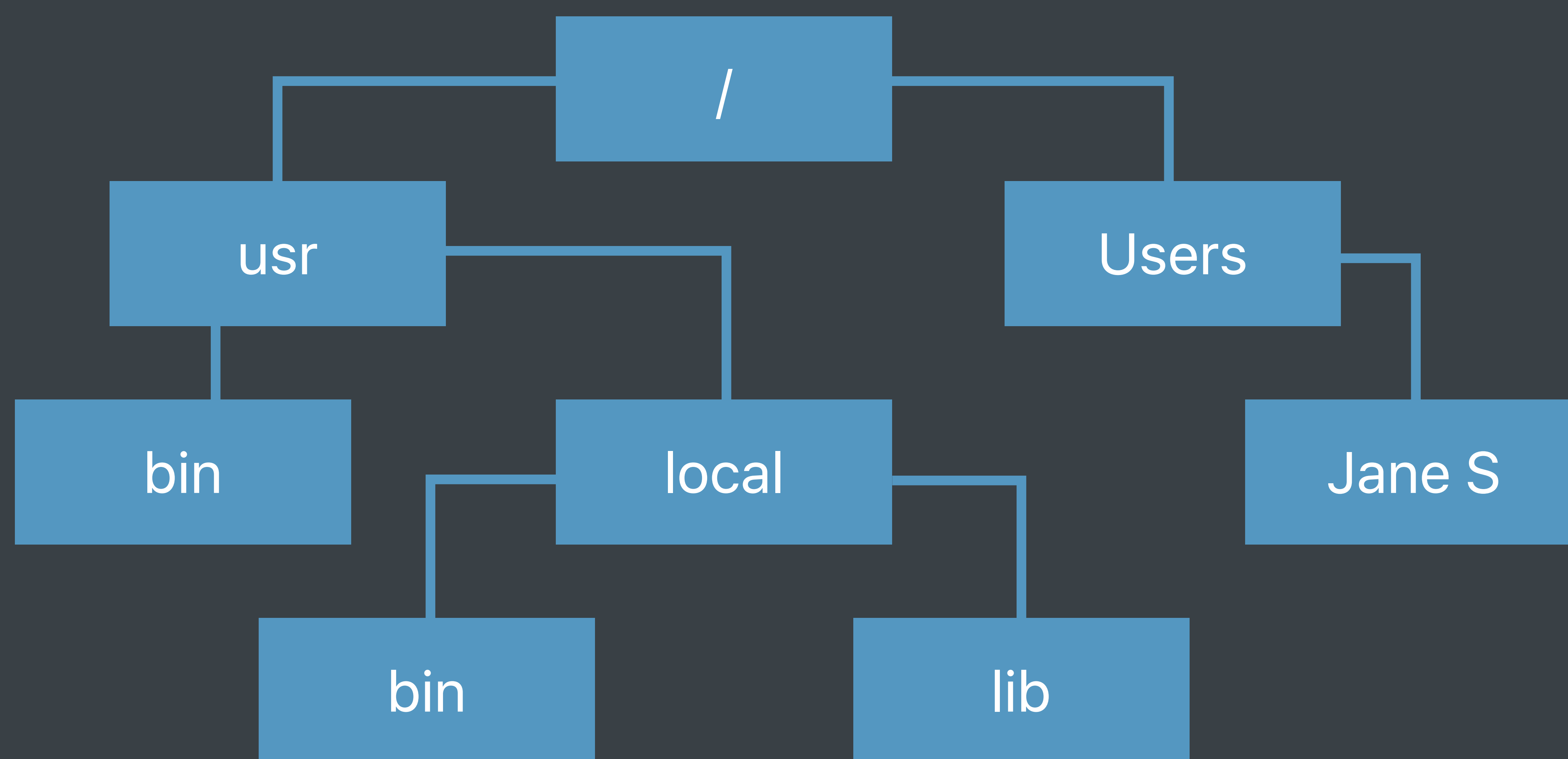
Recovery

VM

# Container Layout

disk1

Macintosh HD



Preboot

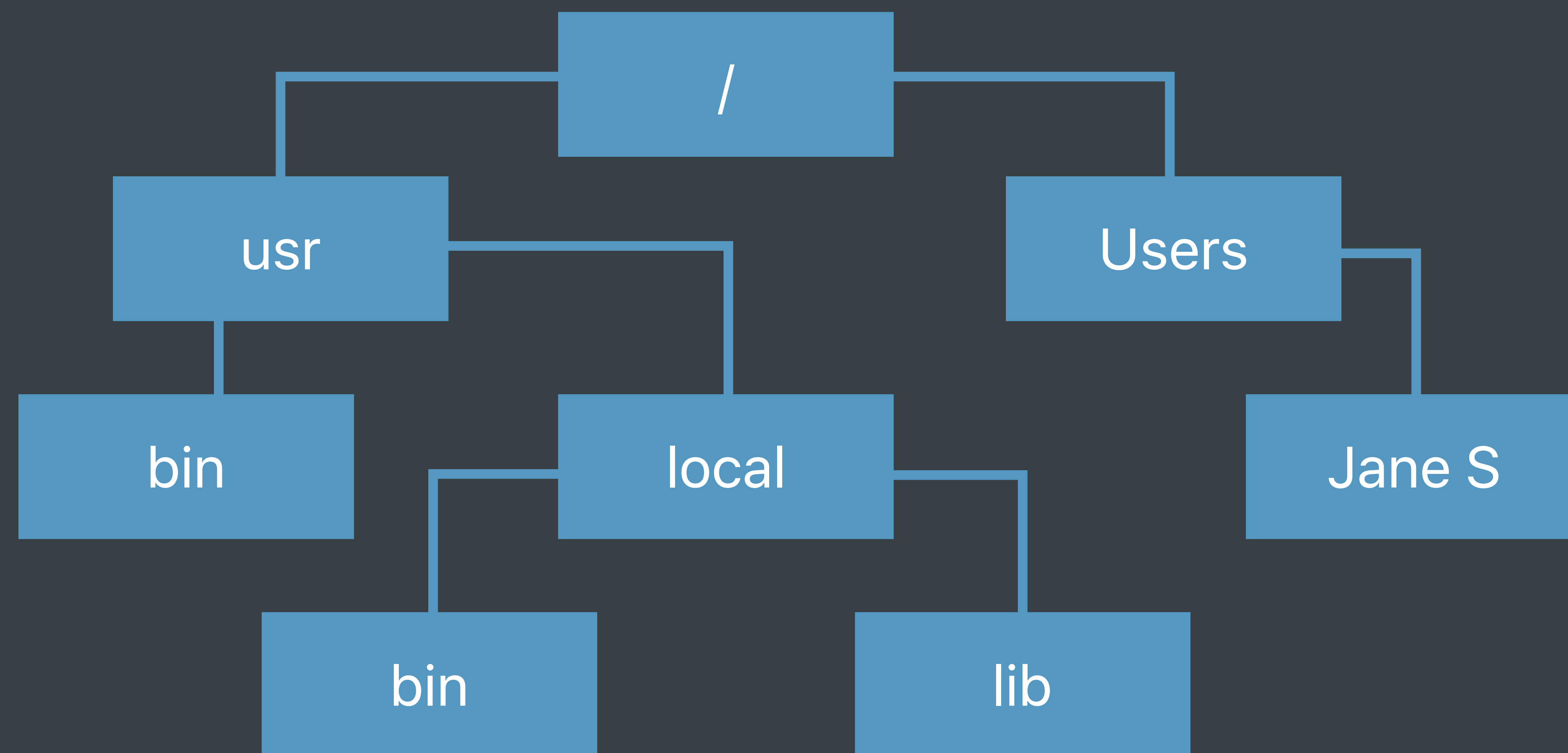
Recovery

VM

# Delete Old System Content

disk1

Macintosh HD — Data



Preboot

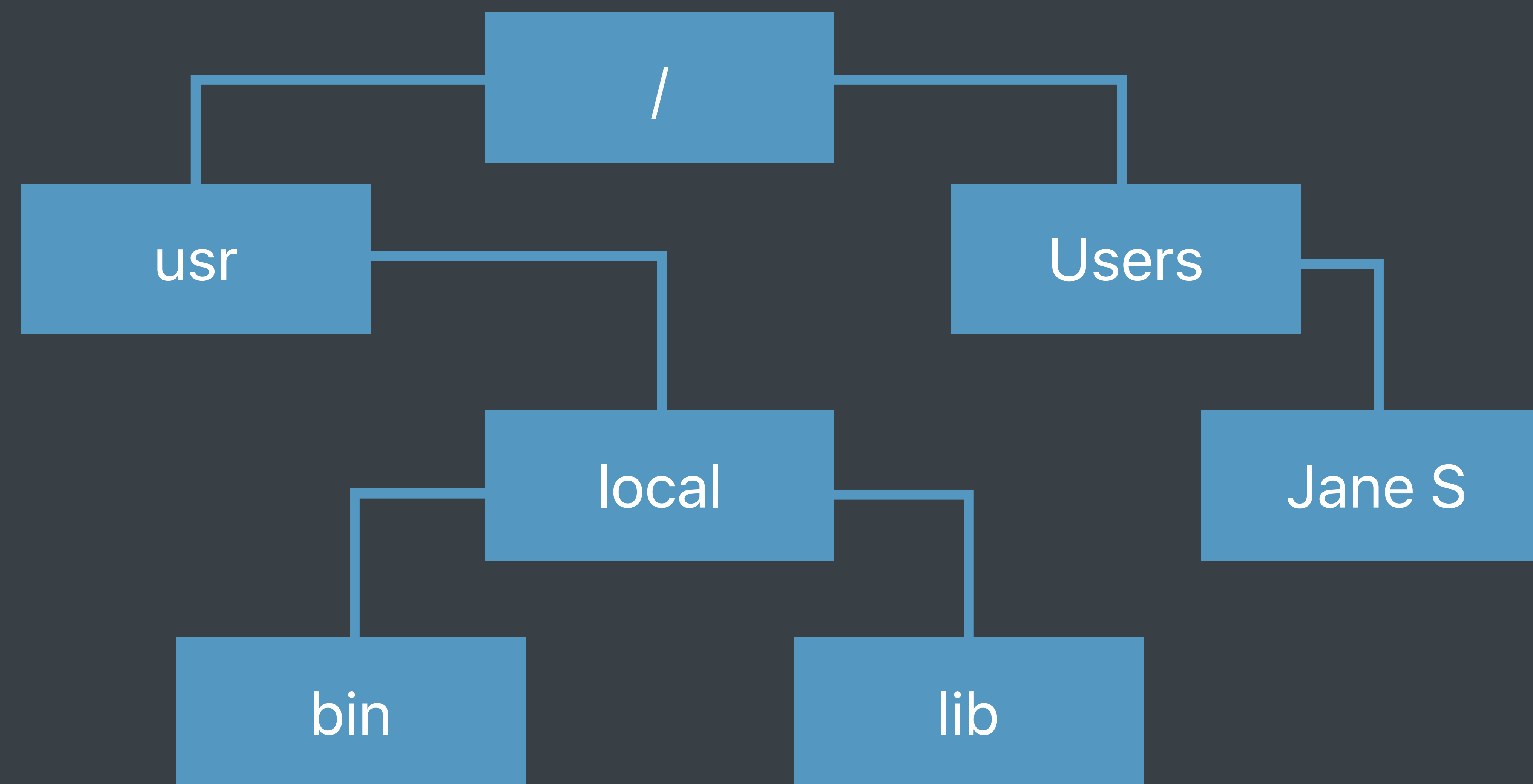
Recovery

VM

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disk1

Macintosh HD — Data



Preboot

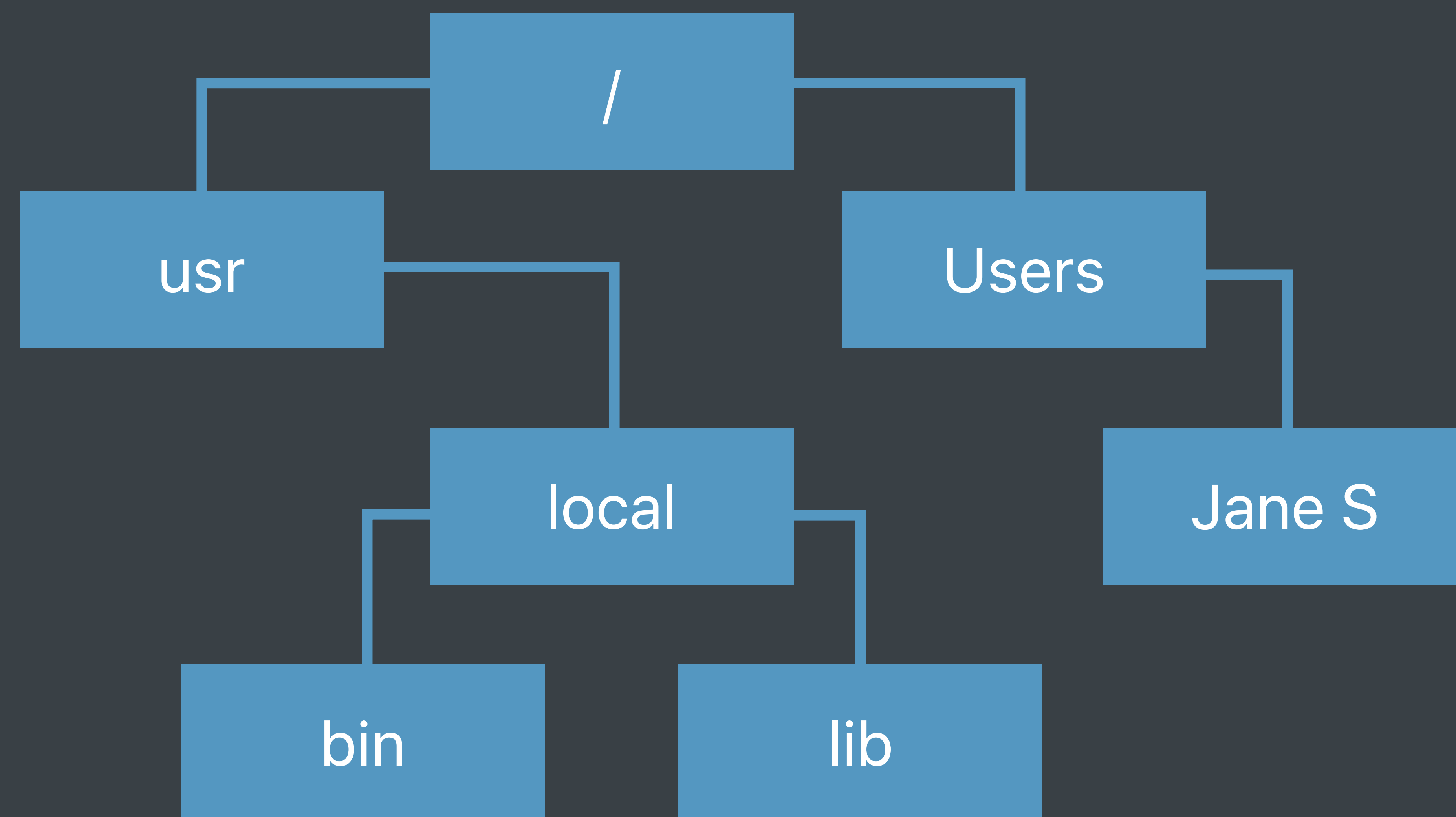
Recovery

VM

# Divide et Impera

disk1

Macintosh HD — Data



Preboot

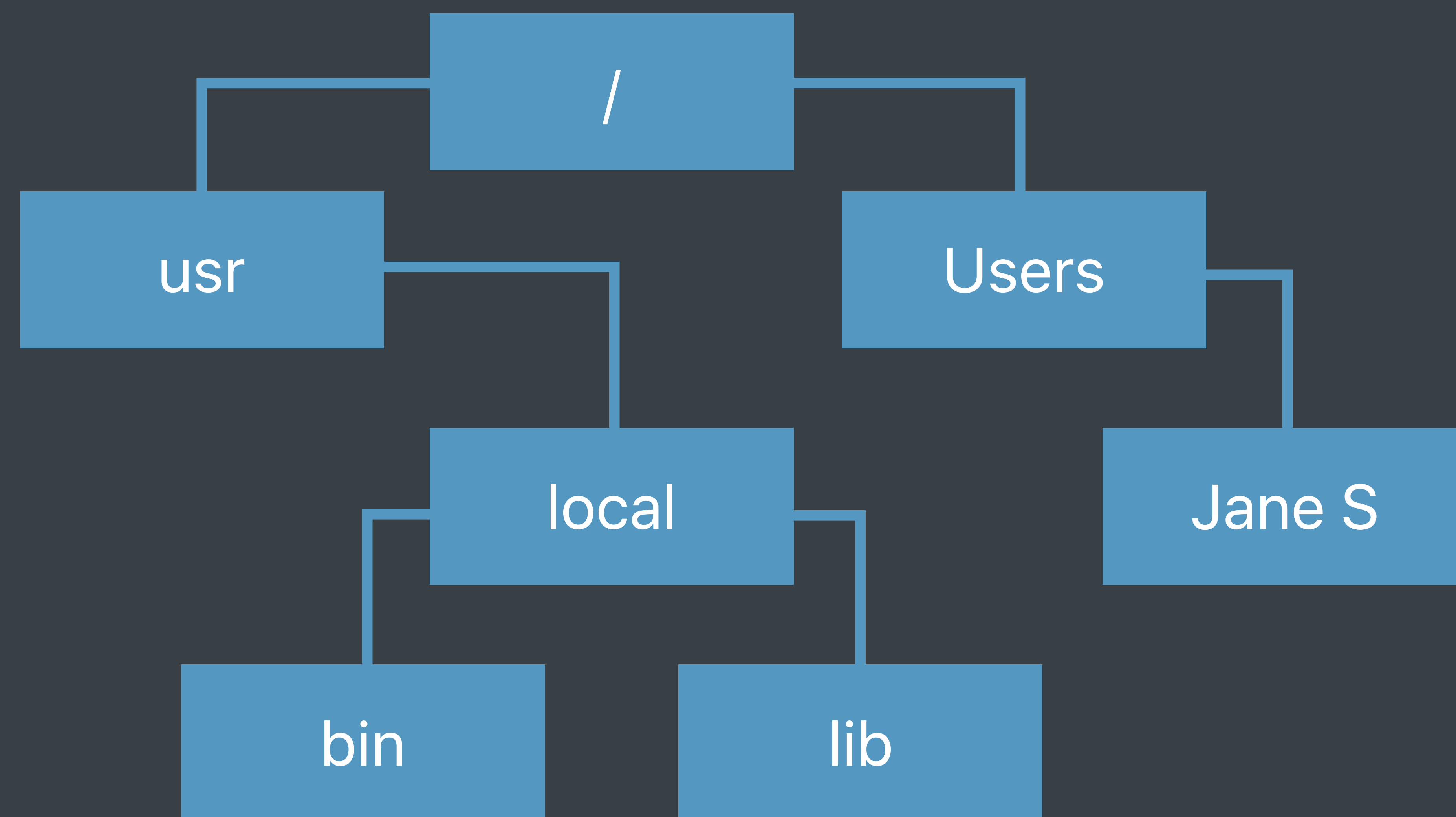
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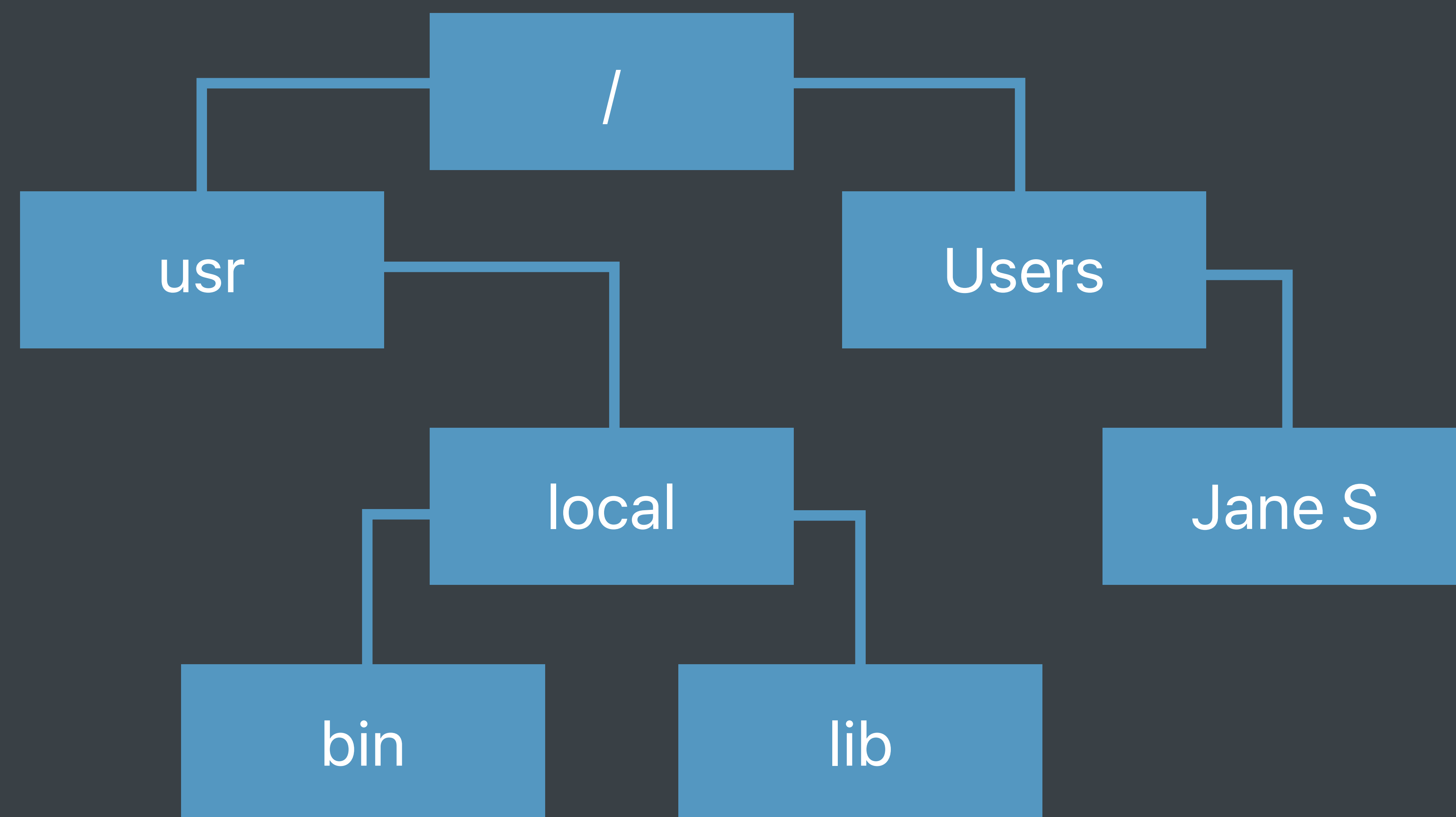
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VM

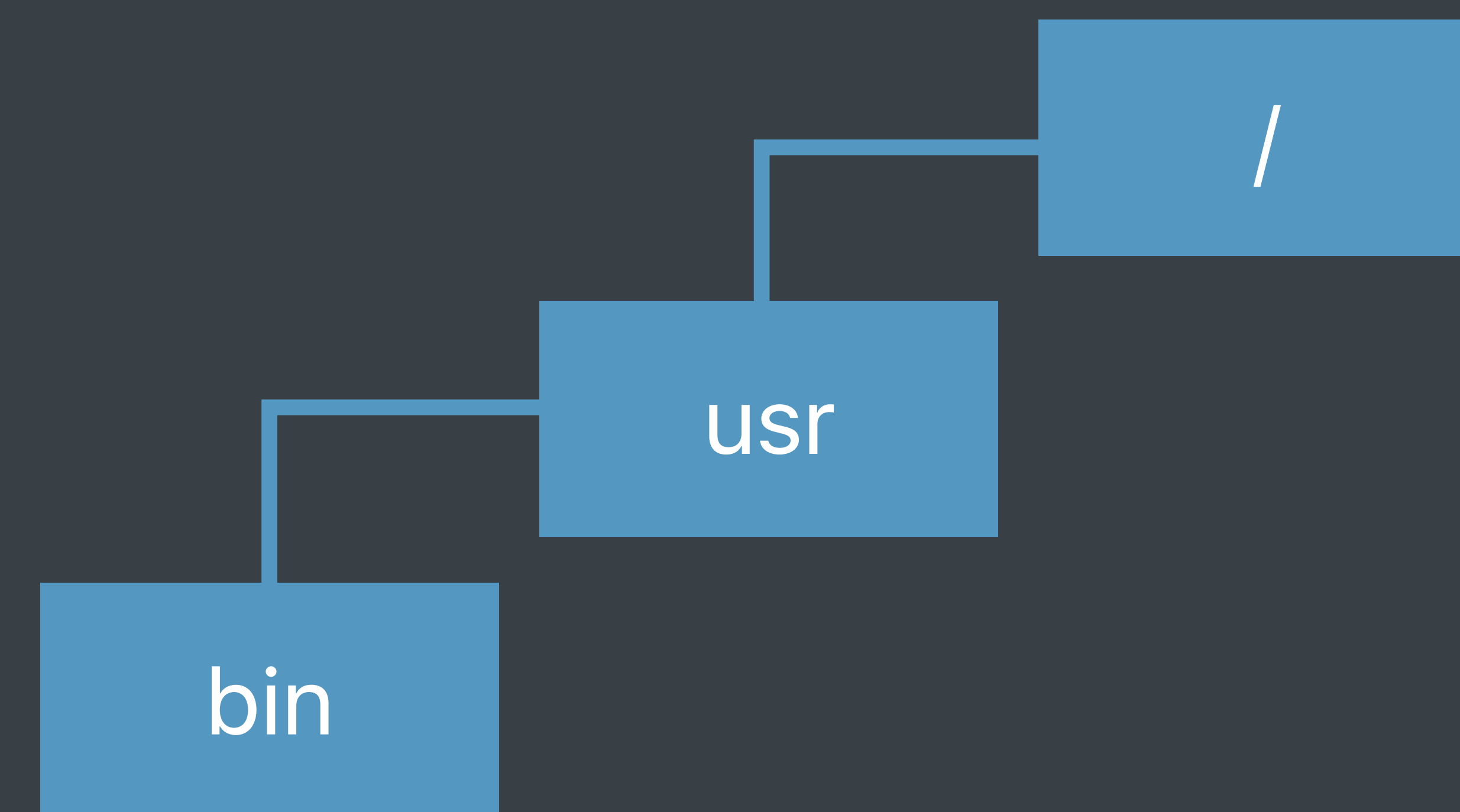
# Divide et Impera

disk1

Macintosh HD — Data



Macintosh HD



Preboot

Recovery

VM

# Firmlinks

Bi-directional wormhole in path traversal



NEW



# Firmlinks

Bi-directional wormhole in path traversal



NEW

New filesystem object, similar to symlink

# Firmlinks

Bi-directional wormhole in path traversal



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New filesystem object, similar to symlink

- Consistent forward and backward traversal of the file name space

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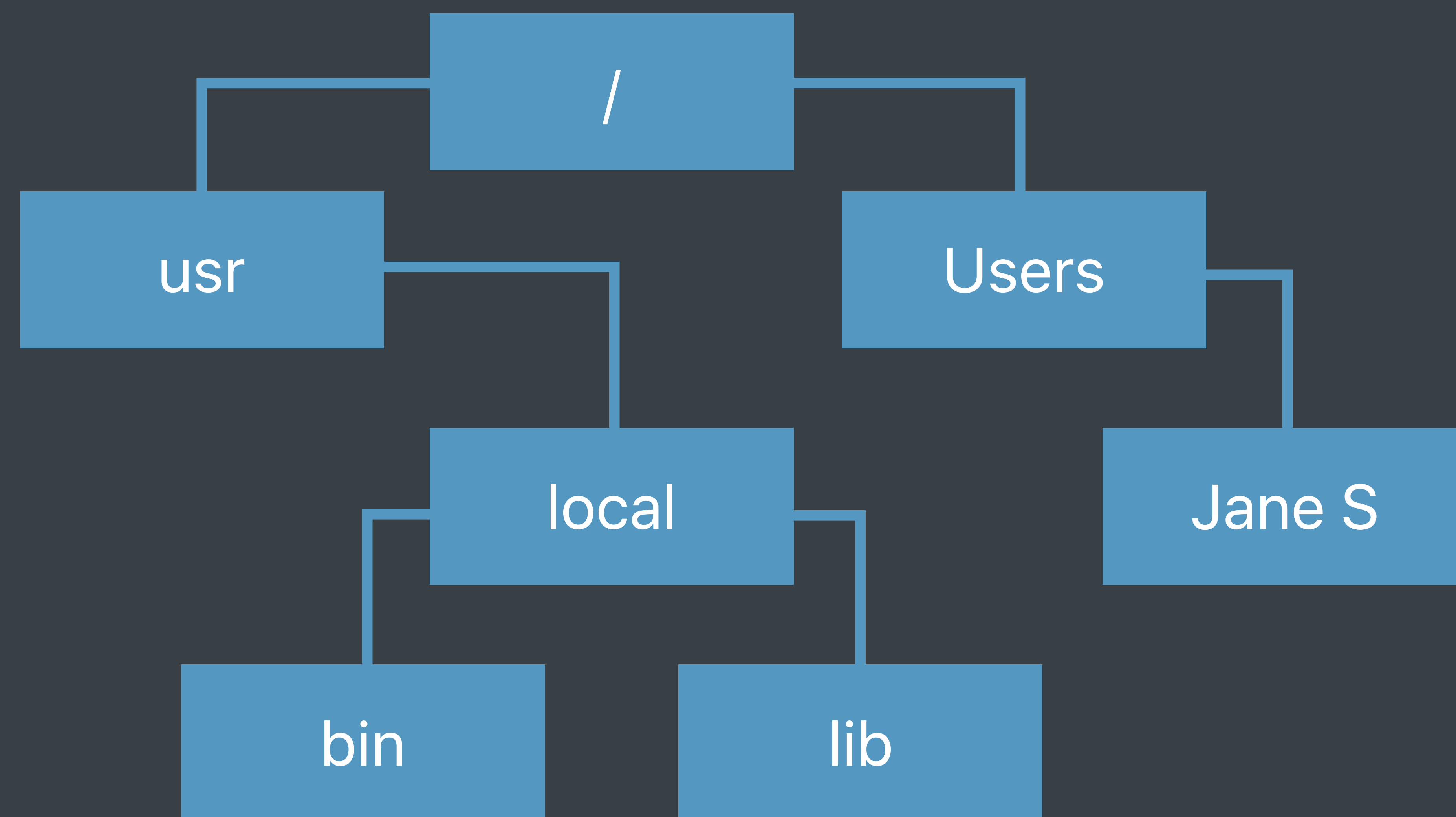
New filesystem object, similar to symlink

- Consistent forward and backward traversal of the file name space
- Only for directories
- Created on the system volume at installation time
- **Not** expected to be noticed by a user or an application

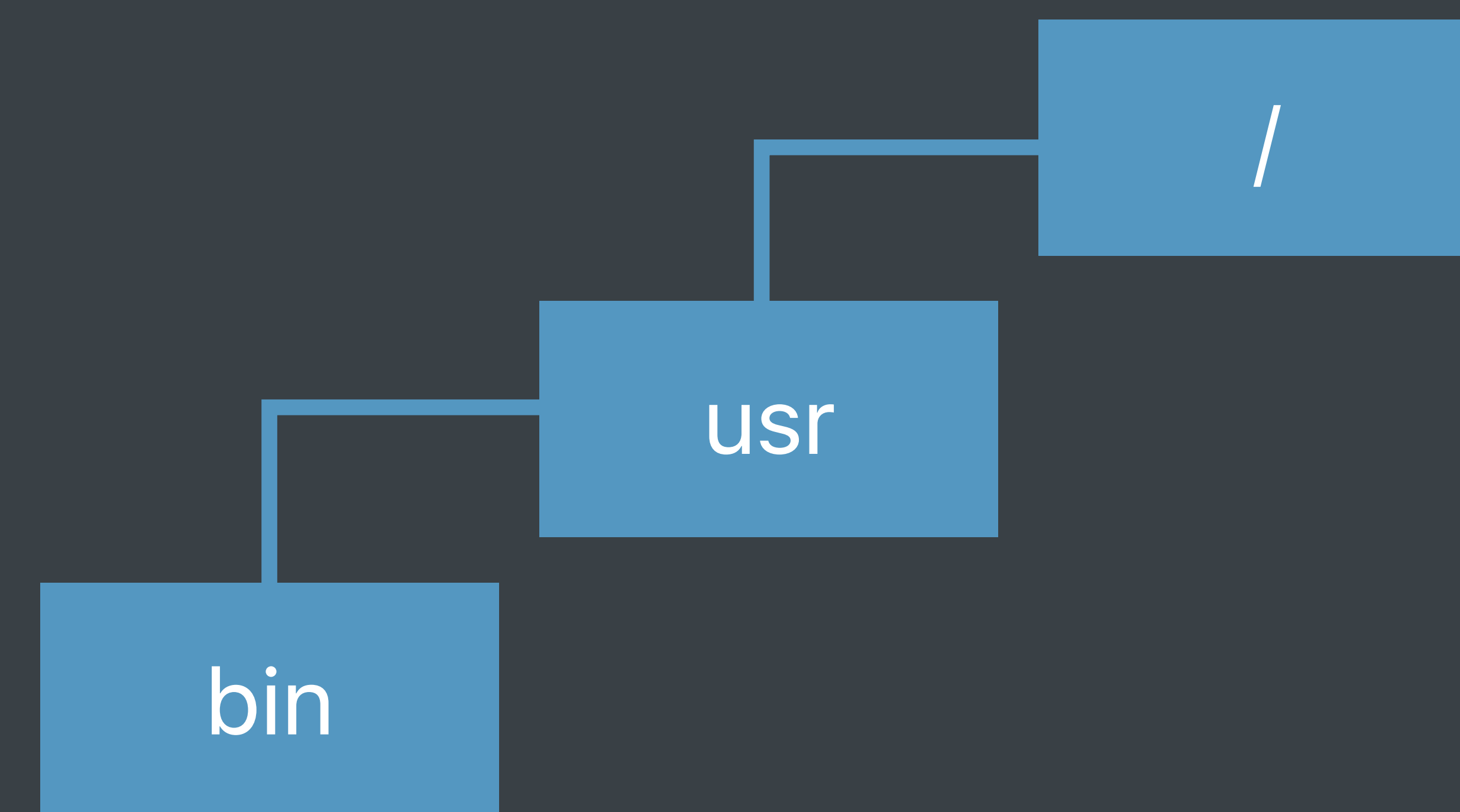
# Stitch It Up

disk1

Macintosh HD — Data



Macintosh HD



Preboot

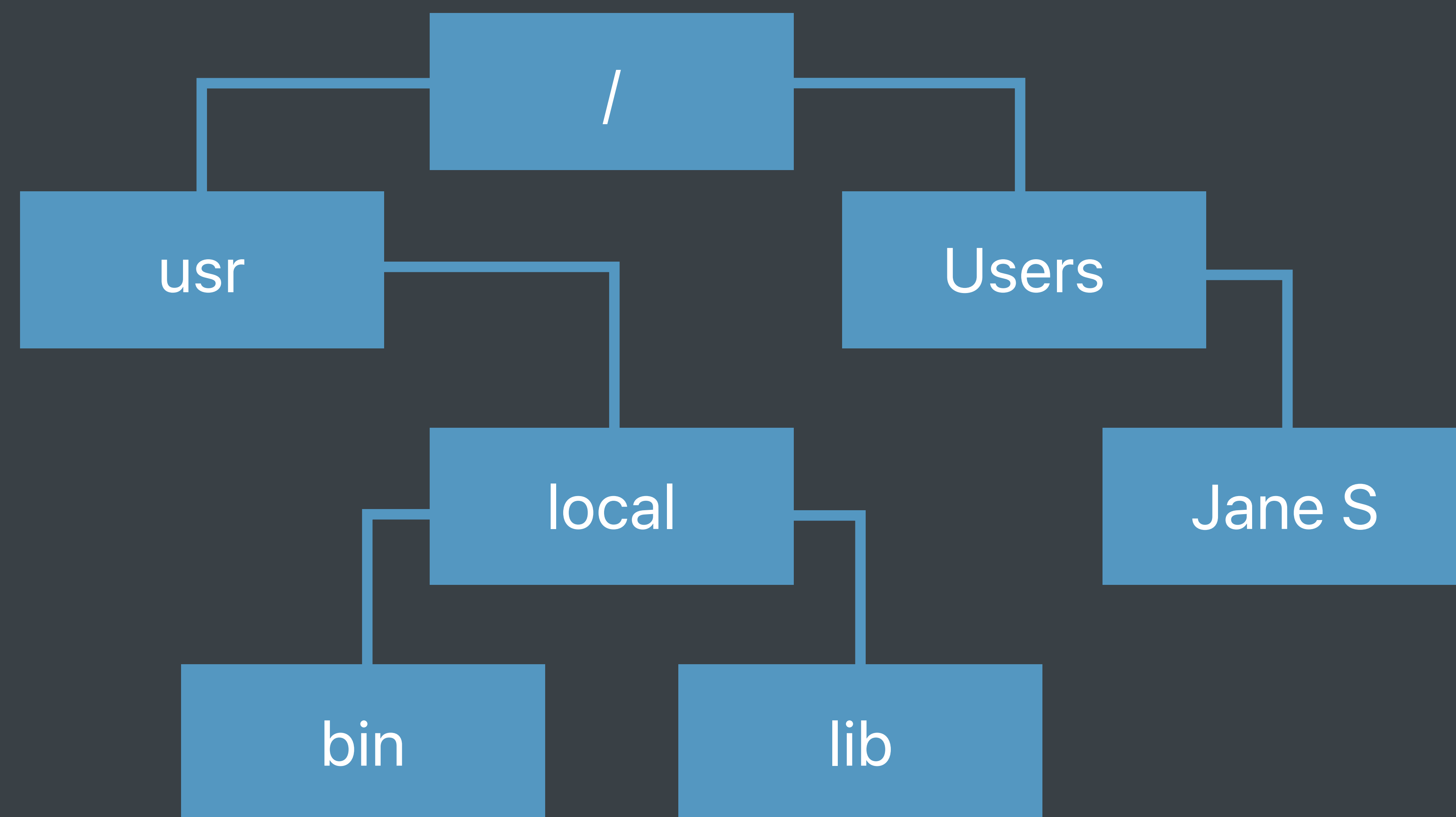
Recovery

VM

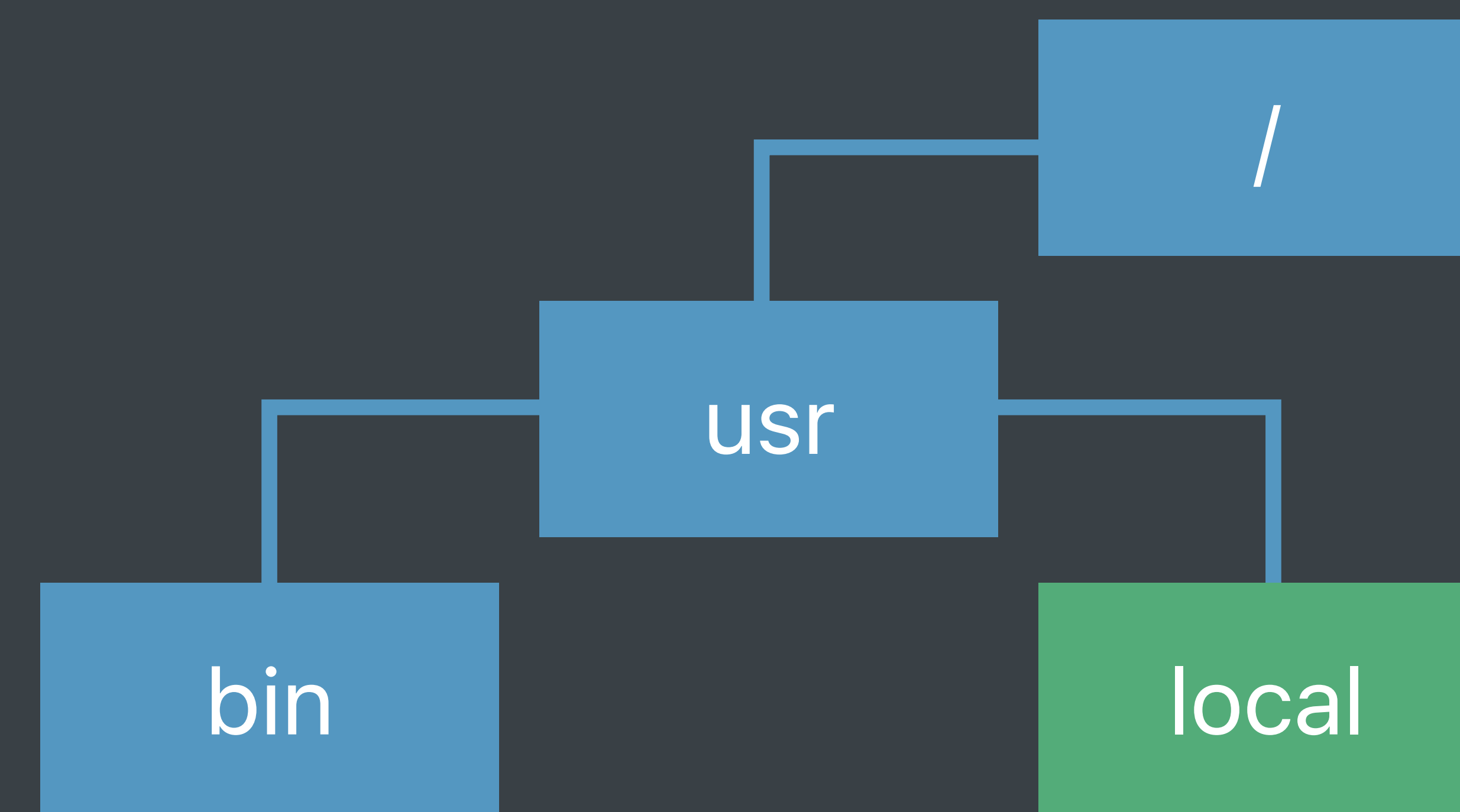
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Macintosh HD



Preboot

Recovery

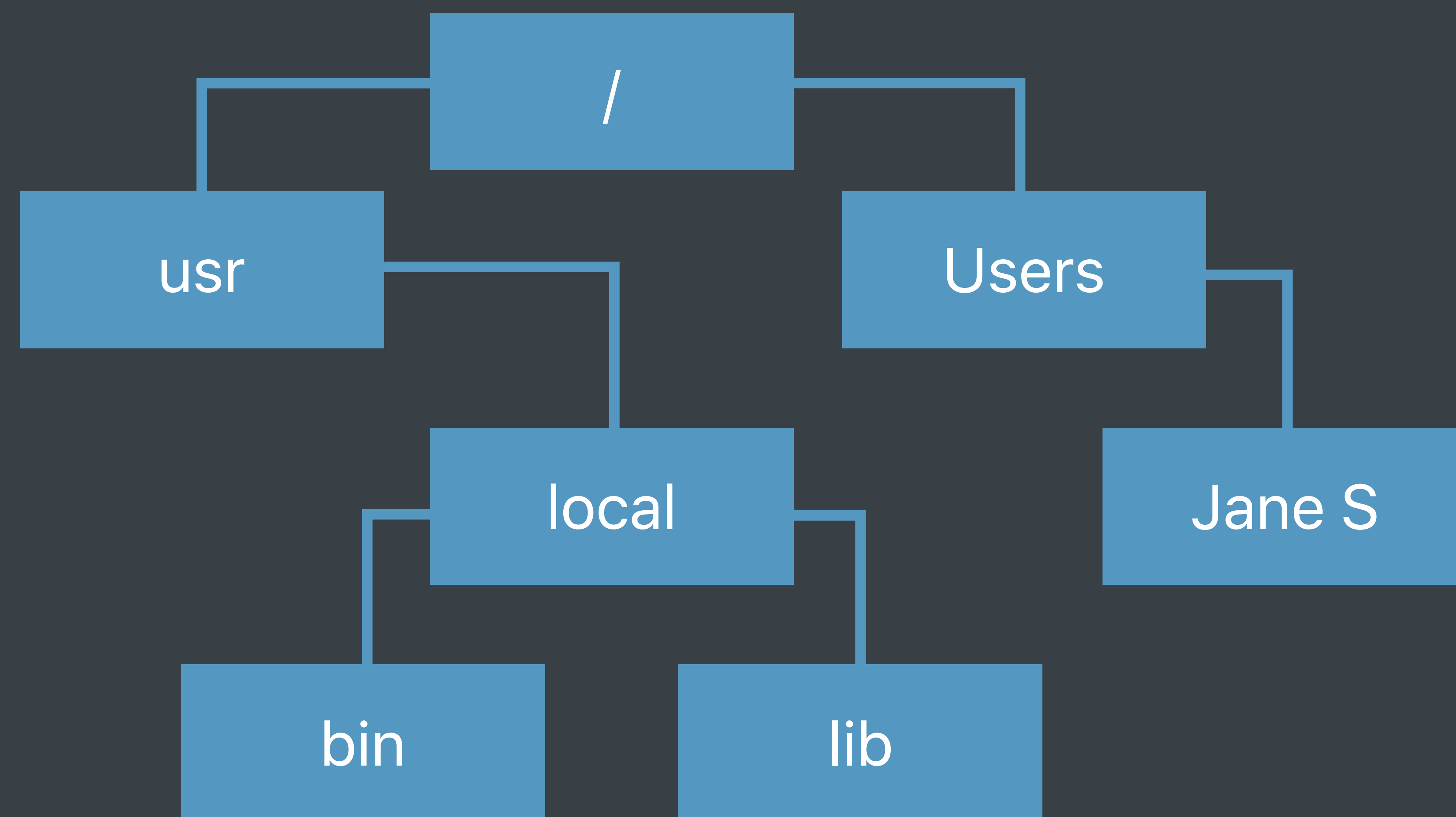
VM



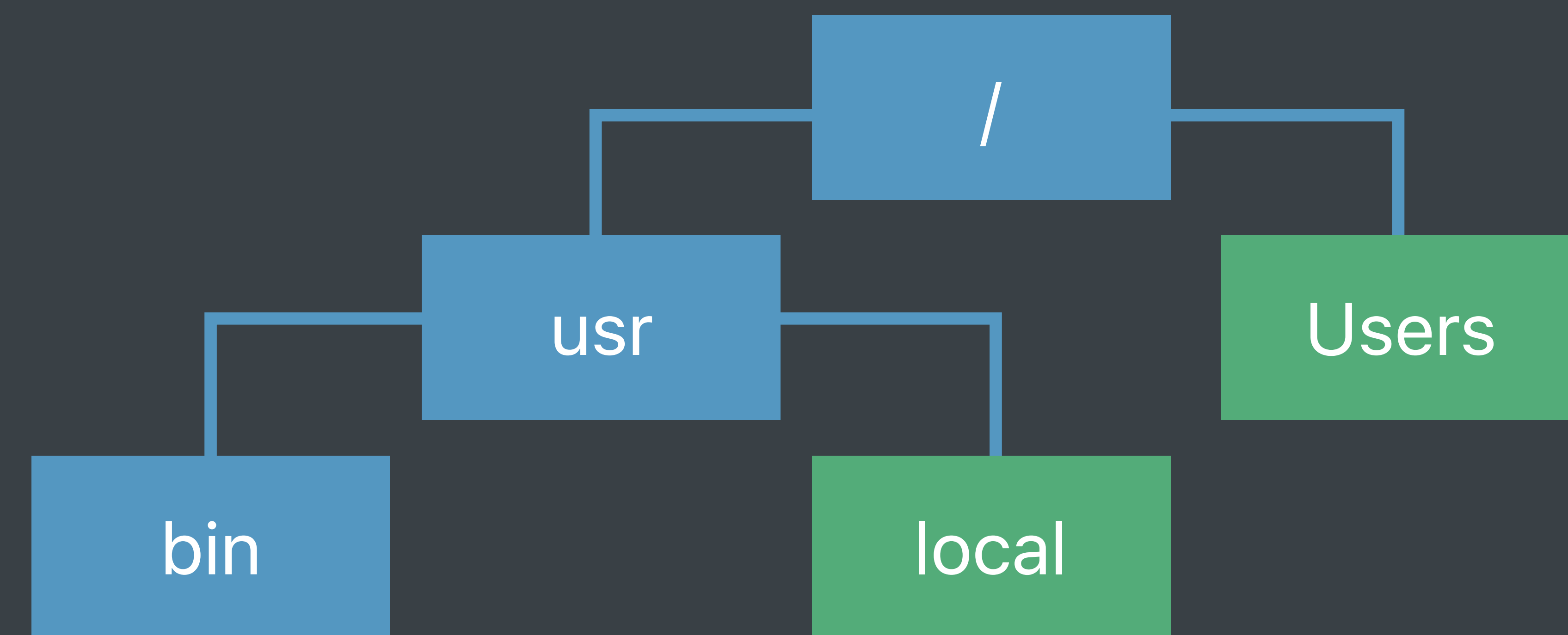
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Macintosh HD — Data



Macintosh HD



Preboot

Recovery

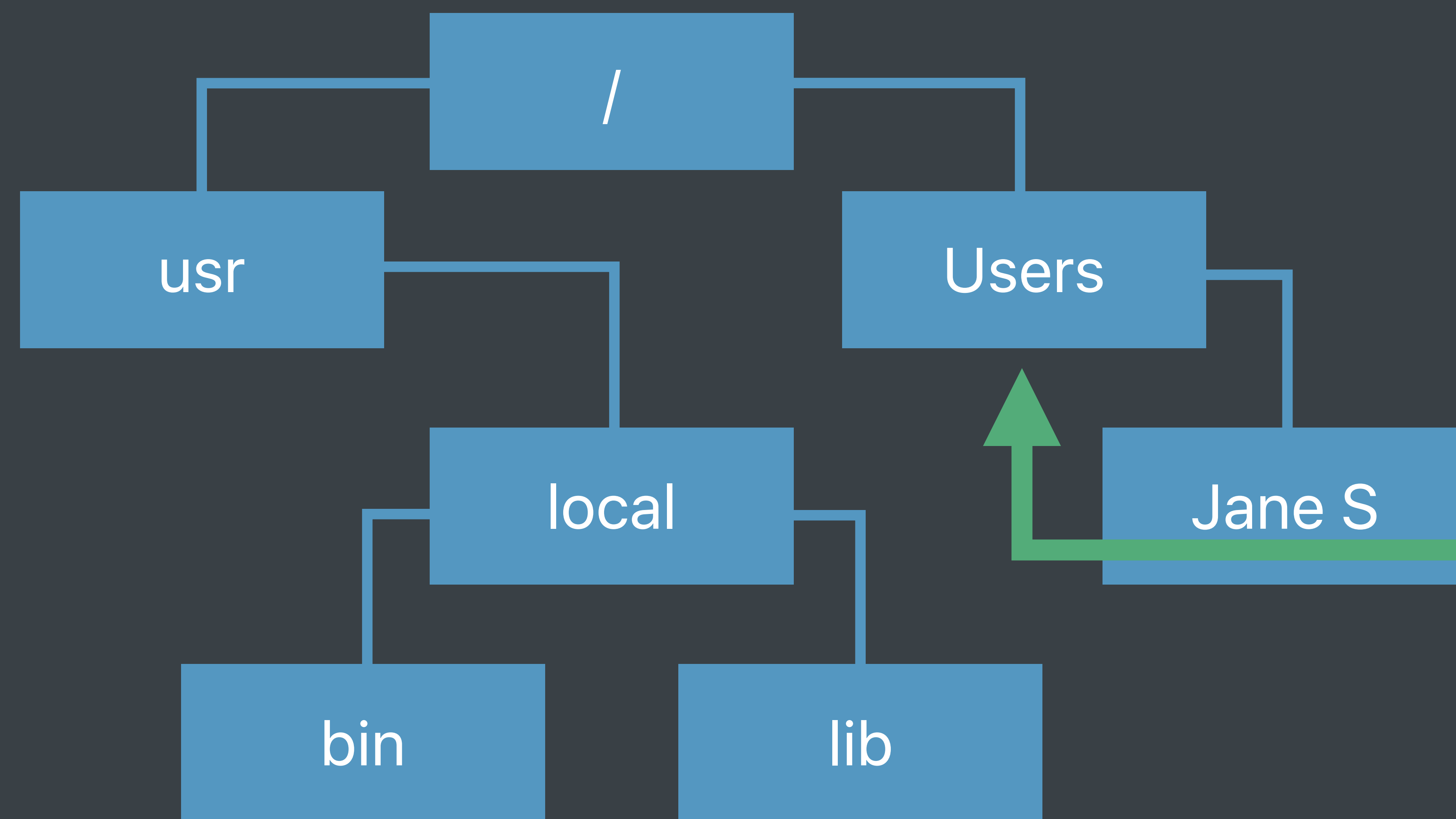
VM



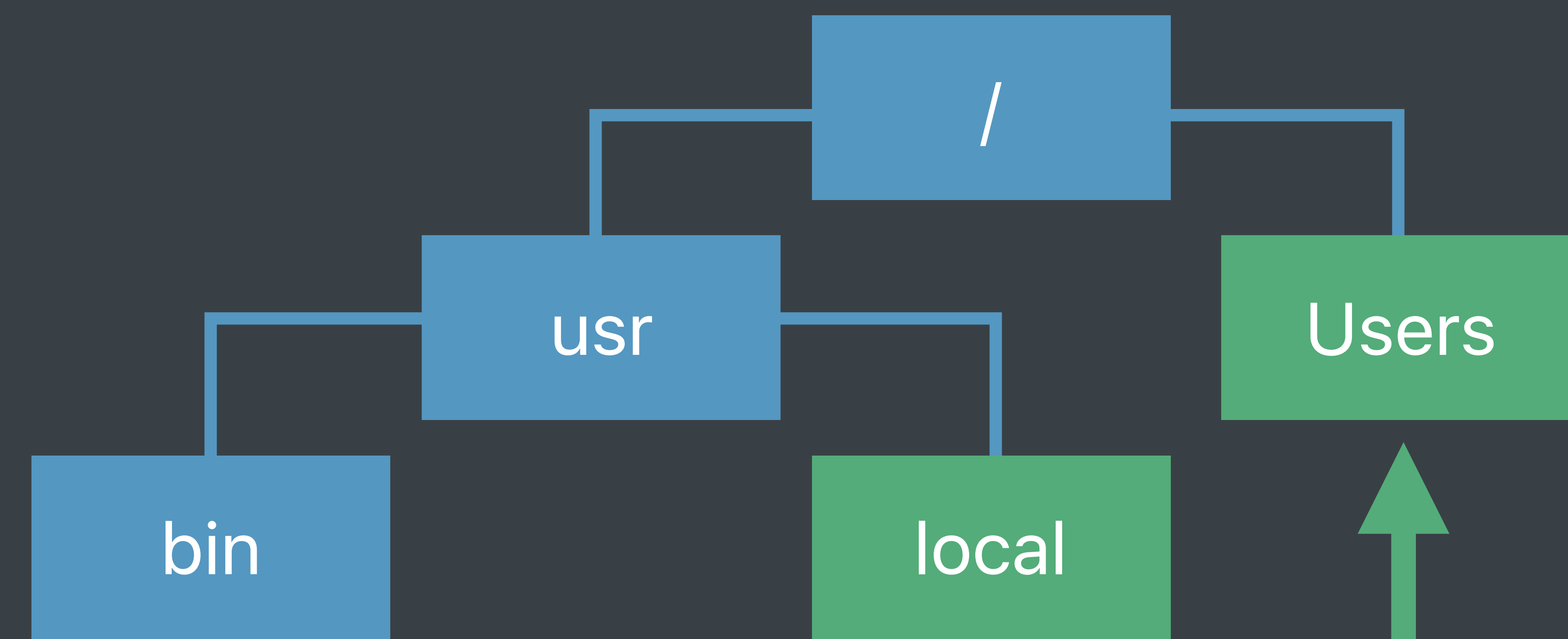
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Macintosh HD — Data



Macintosh HD



Preboot

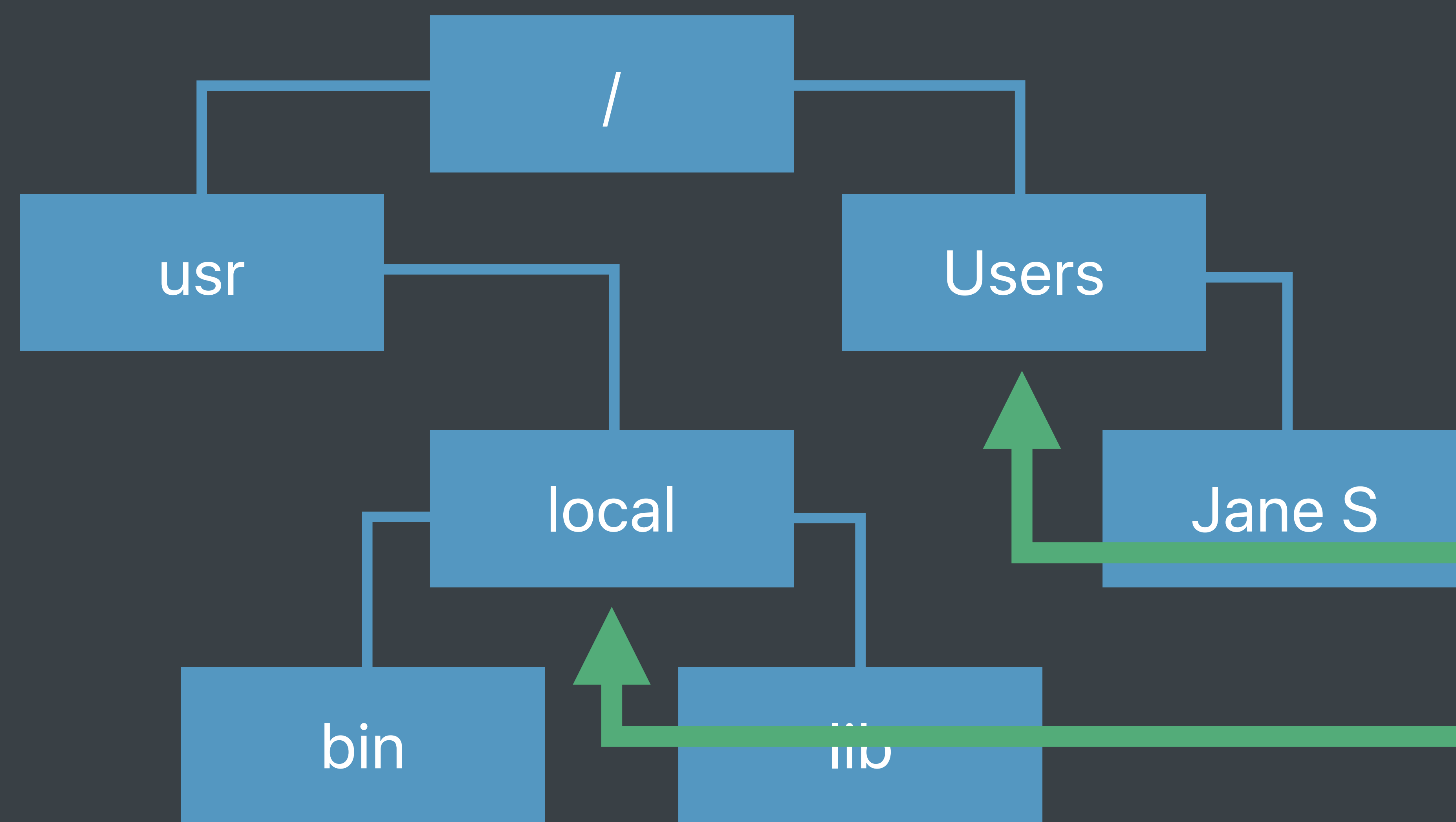
Recovery

VM

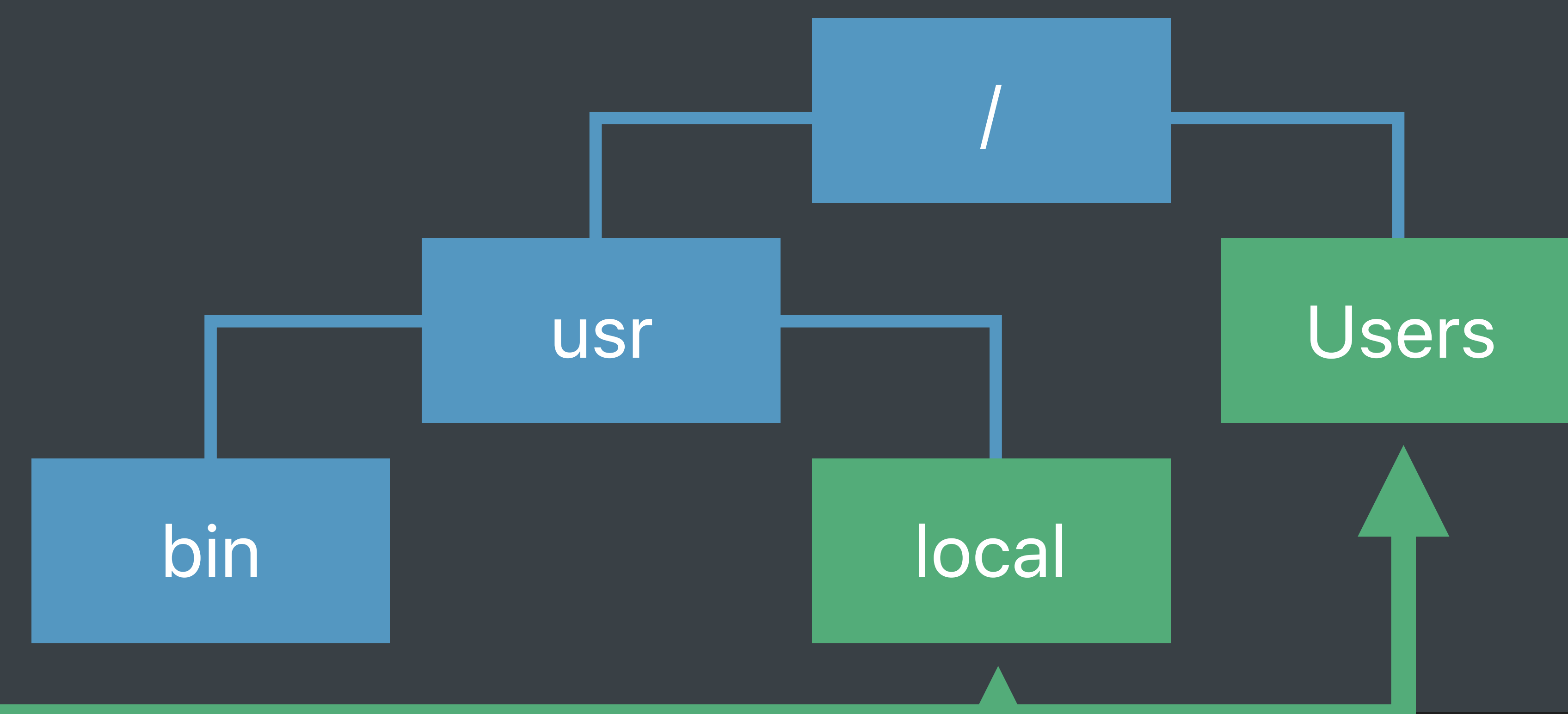
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Preboot

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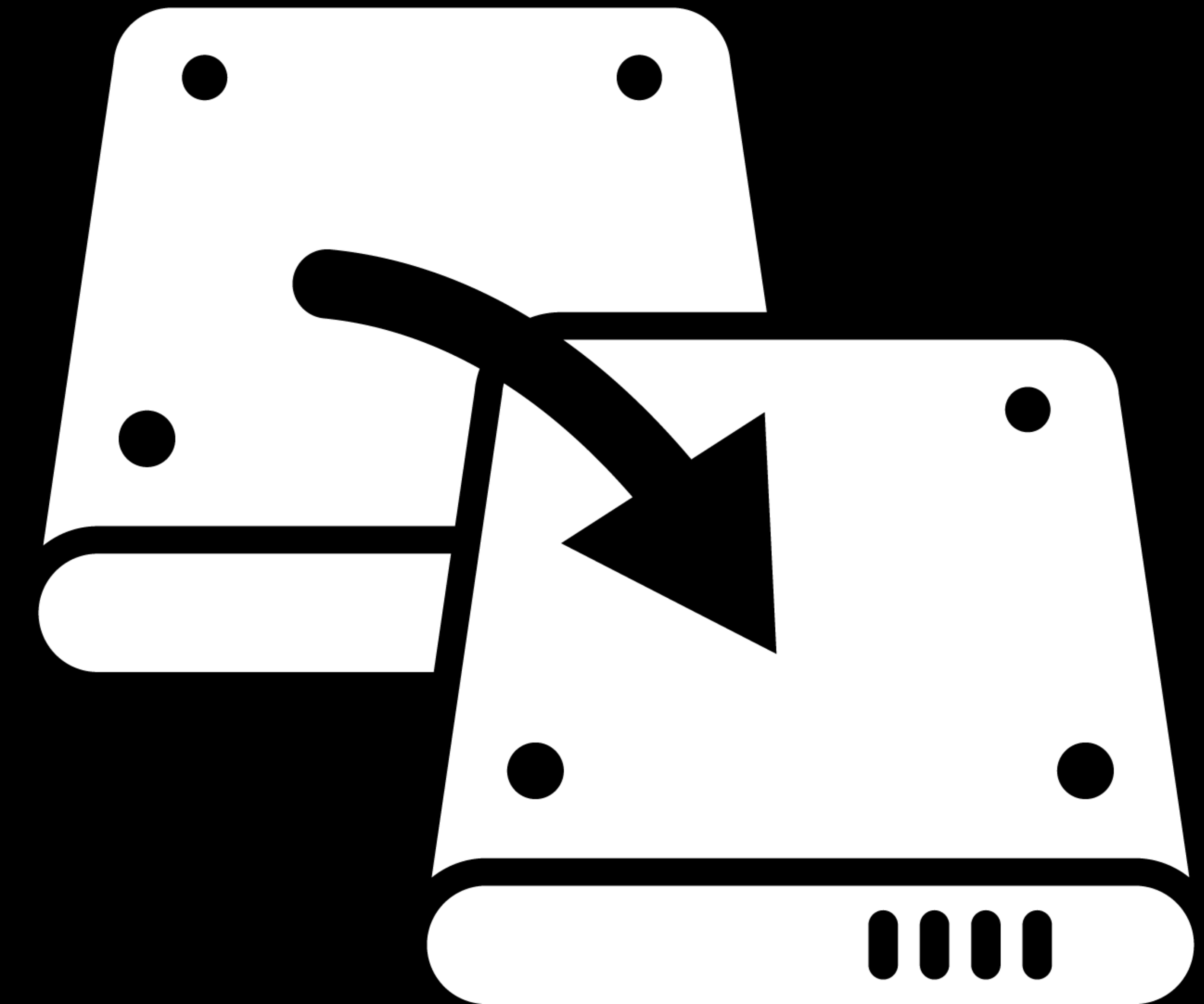
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Test your applications

# ASR, Volume Replication, and Snapshots

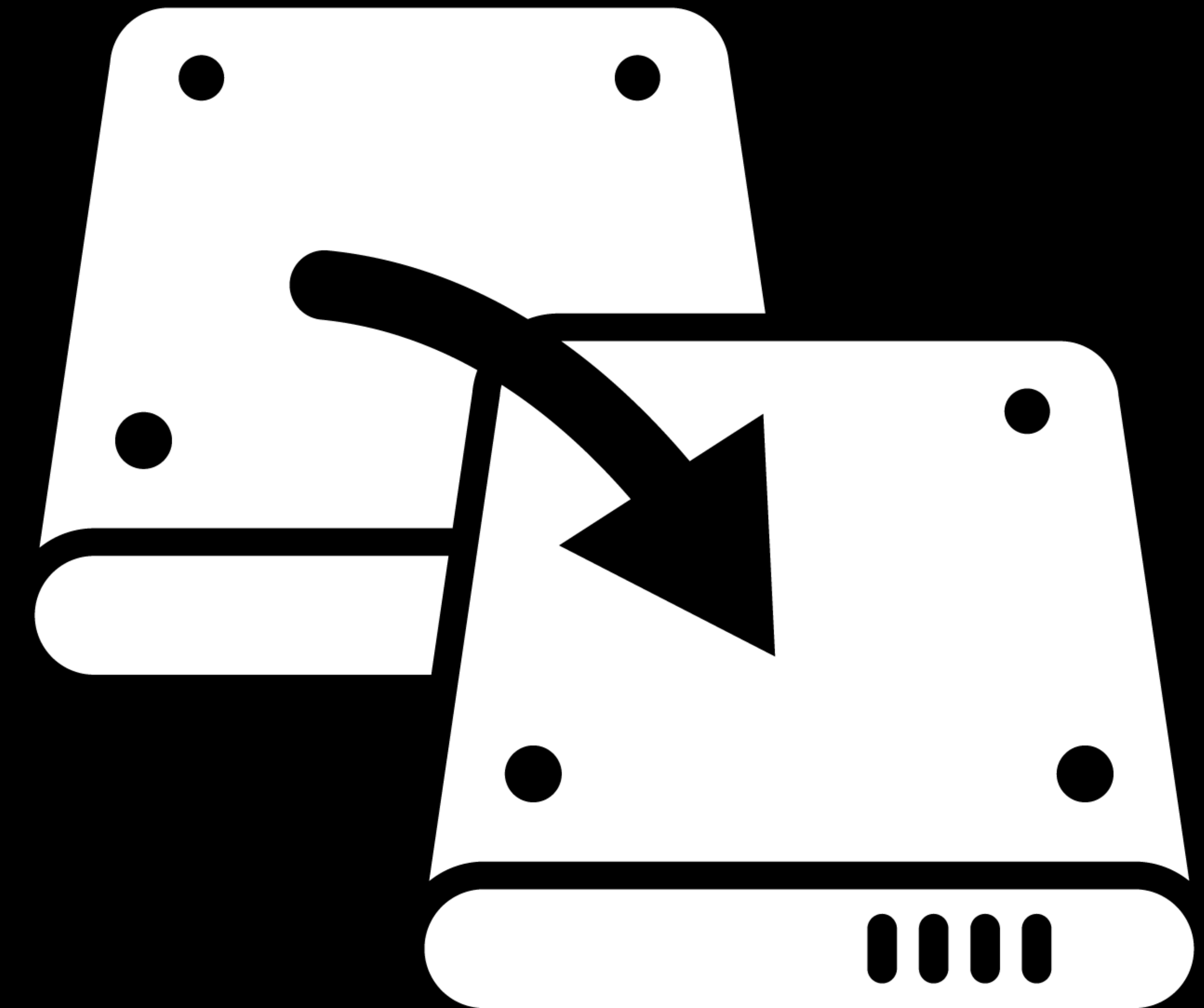
Jon Becker, CoreOS

# What is Volume Replication?



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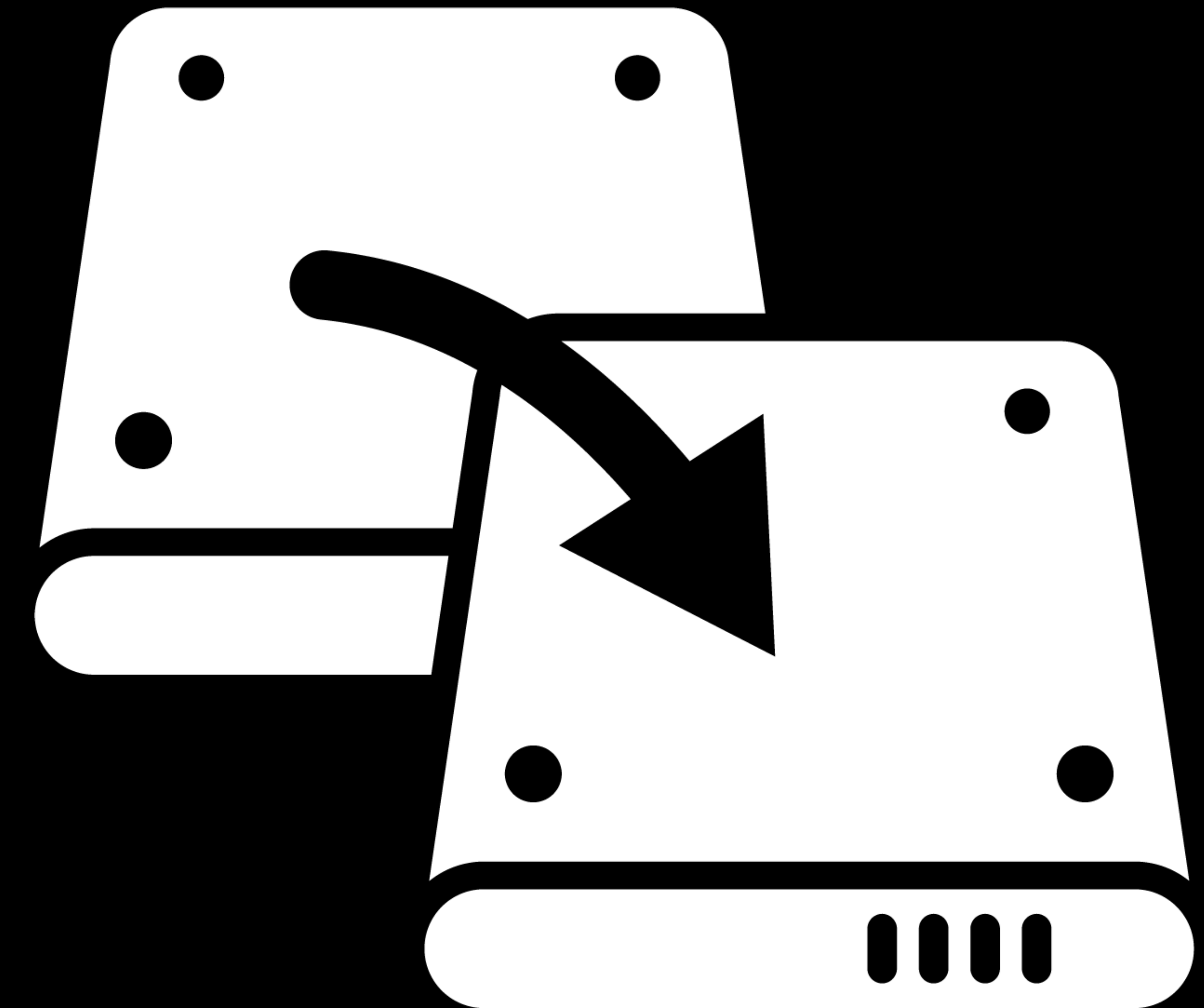
Copying volume content



# What is Volume Replication?

Copying volume content

Superior to file copies

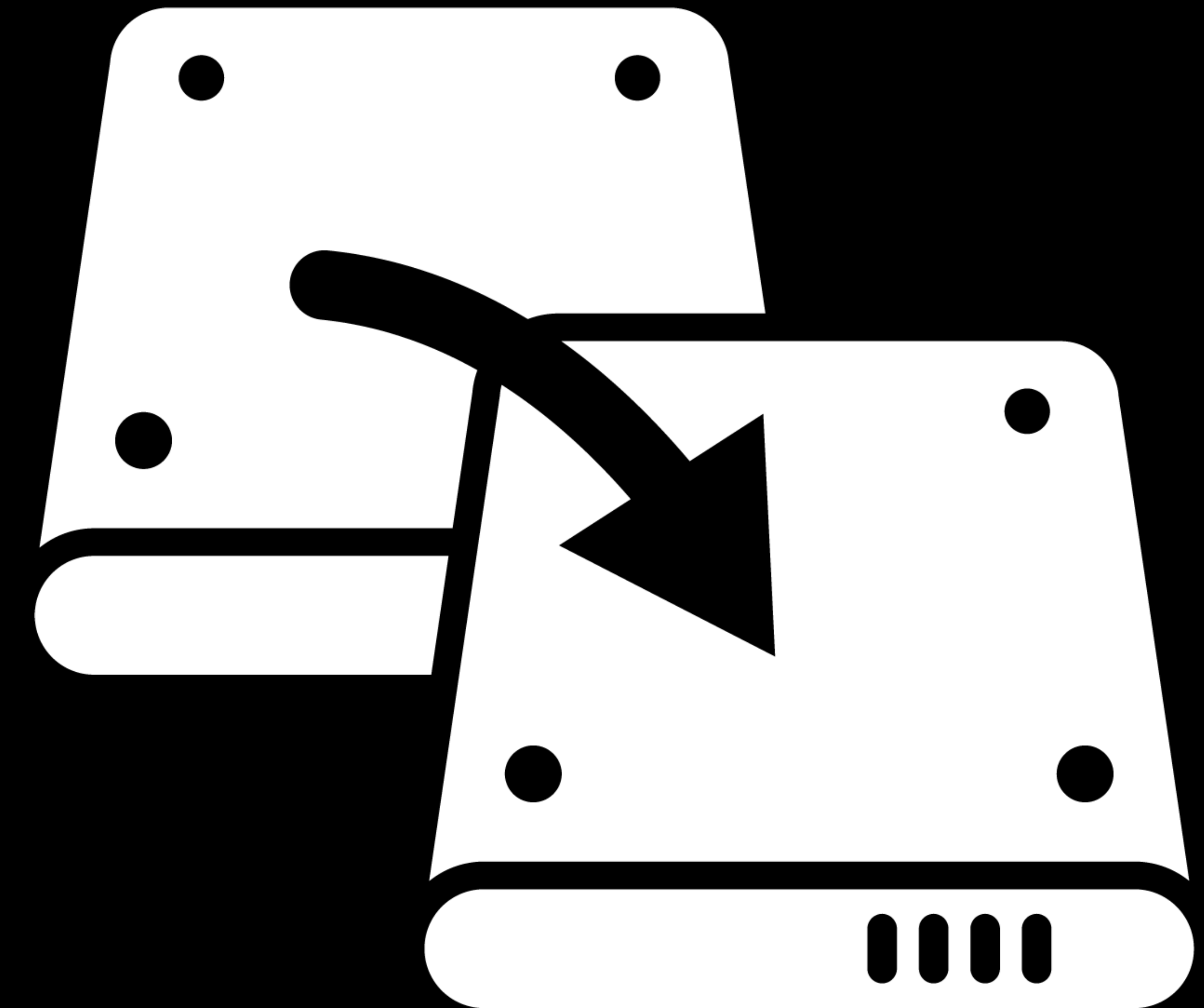


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All volume data, metadata



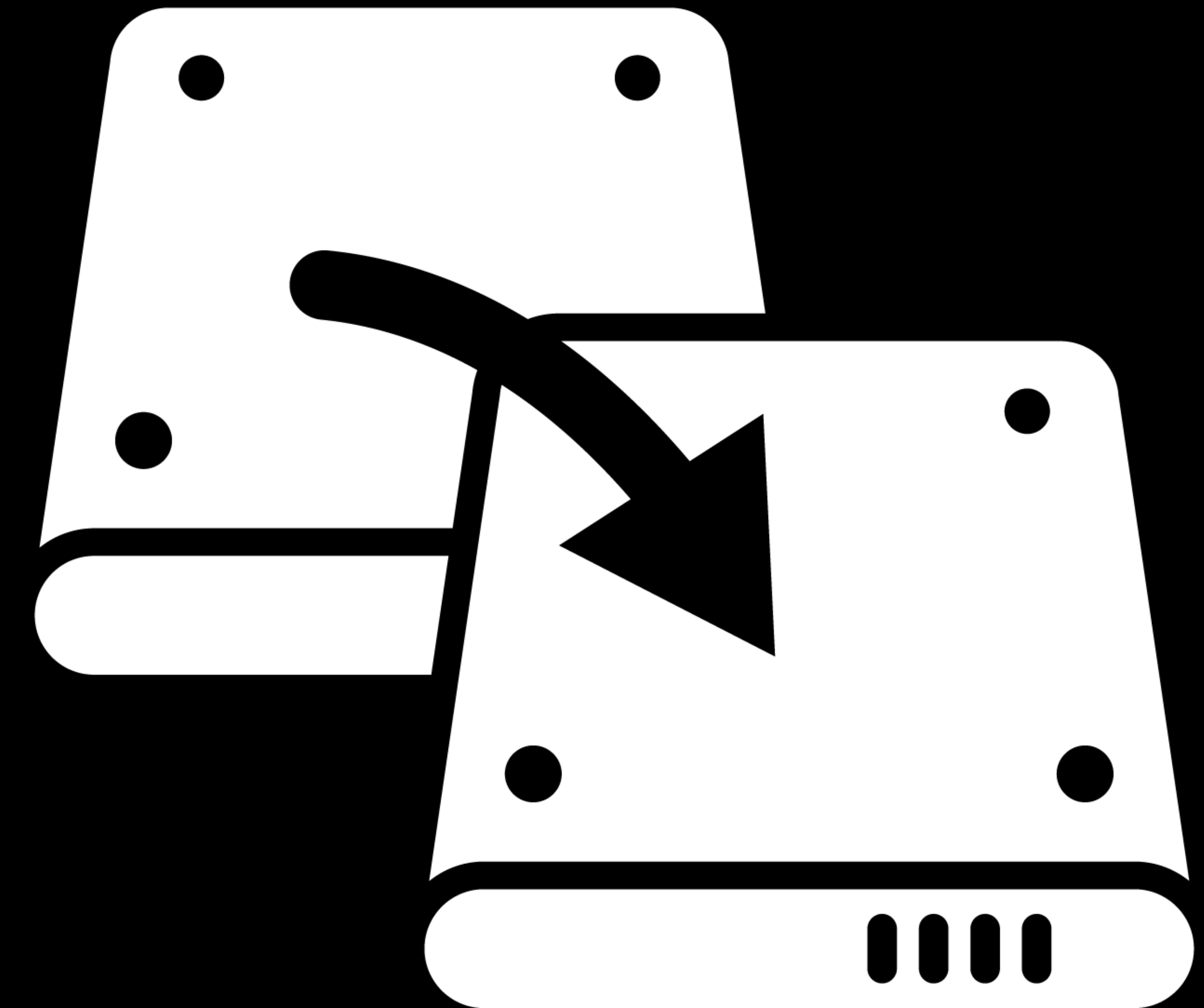
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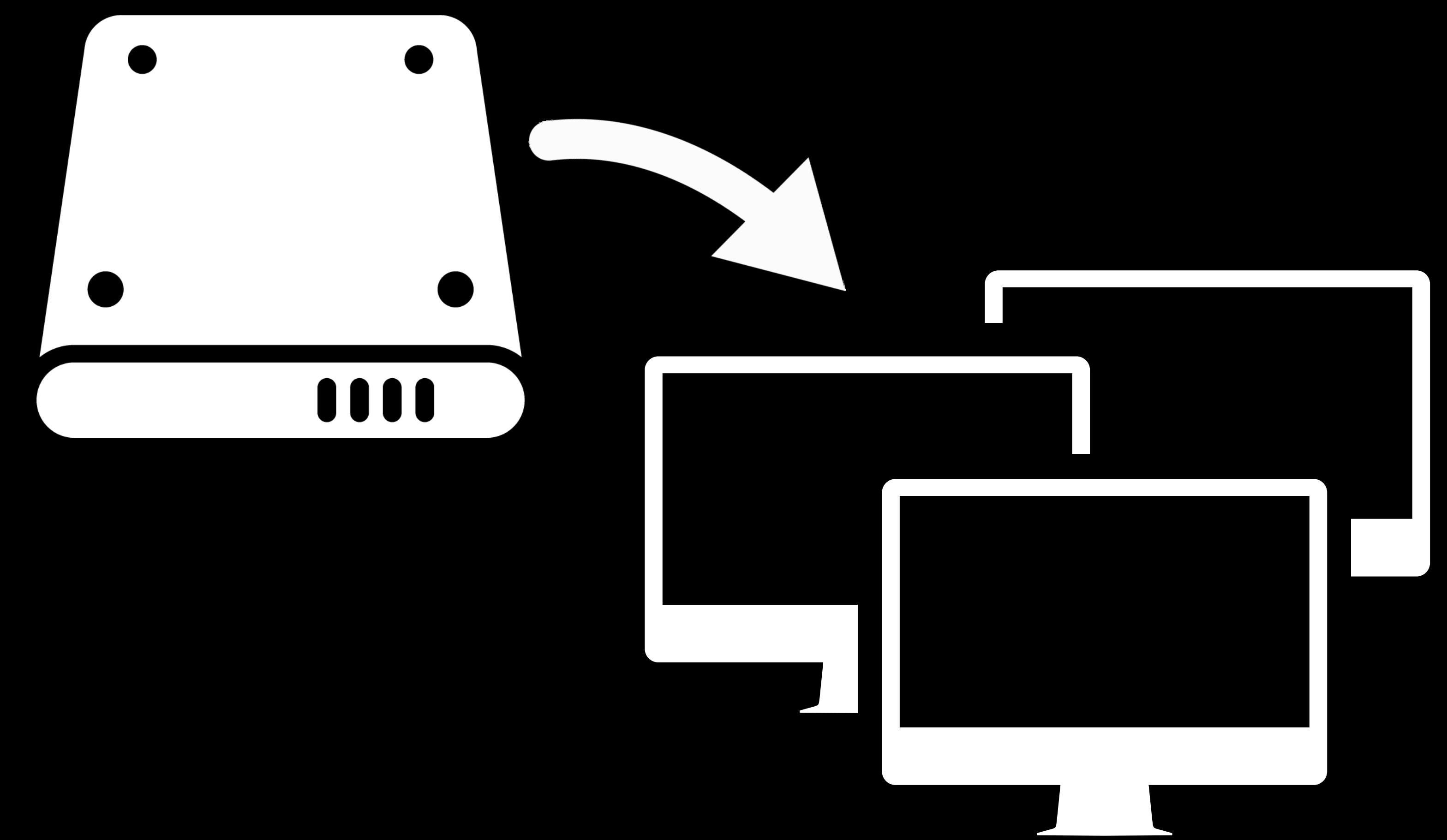
Apple Software Restore (ASR)



# Who Wants This?

Enterprise / Education IT, setting up labs

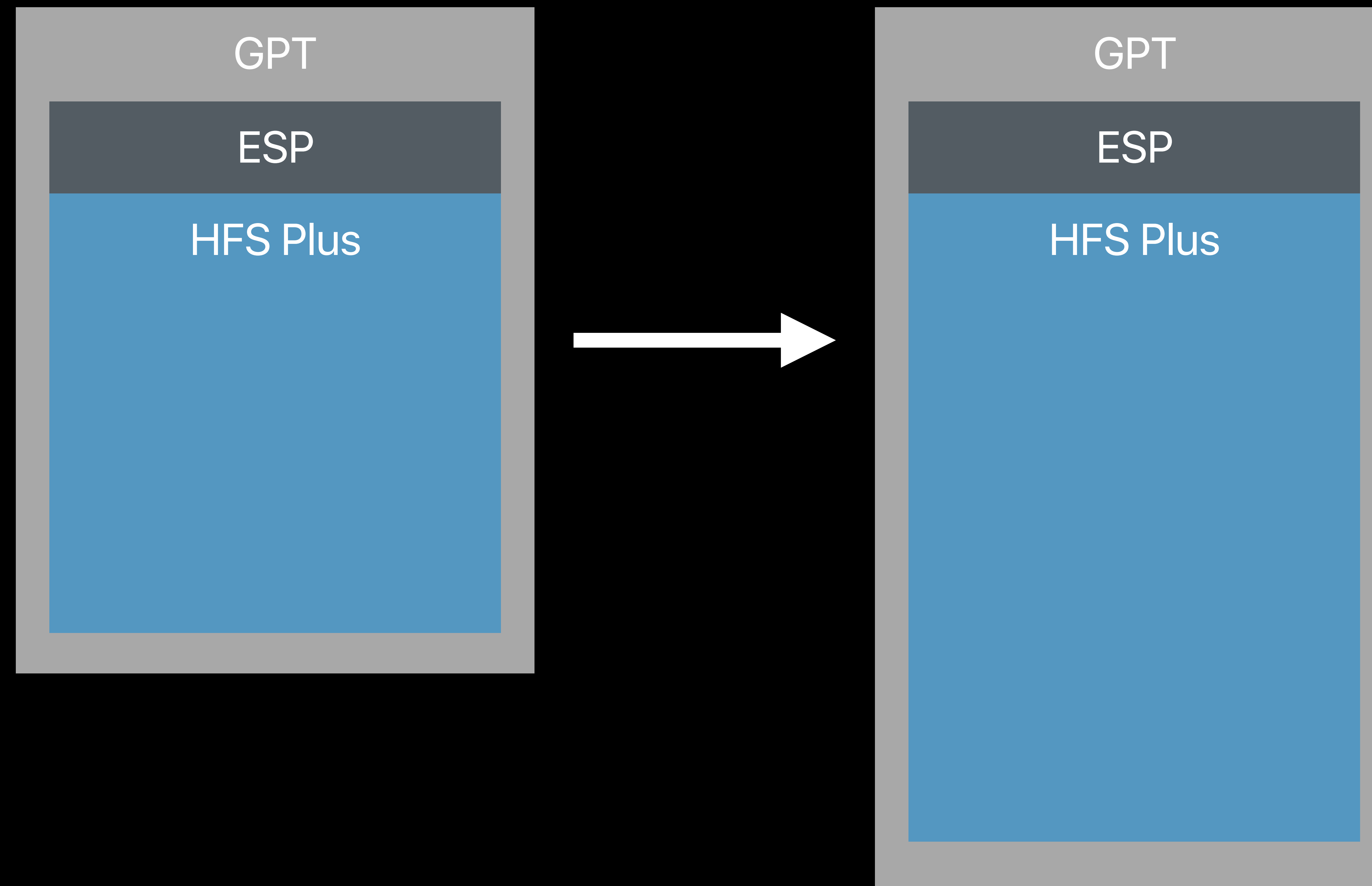
Backup utilities





# Traditional Model (HFS Plus)

Partitions and volumes in one-to-one relationship



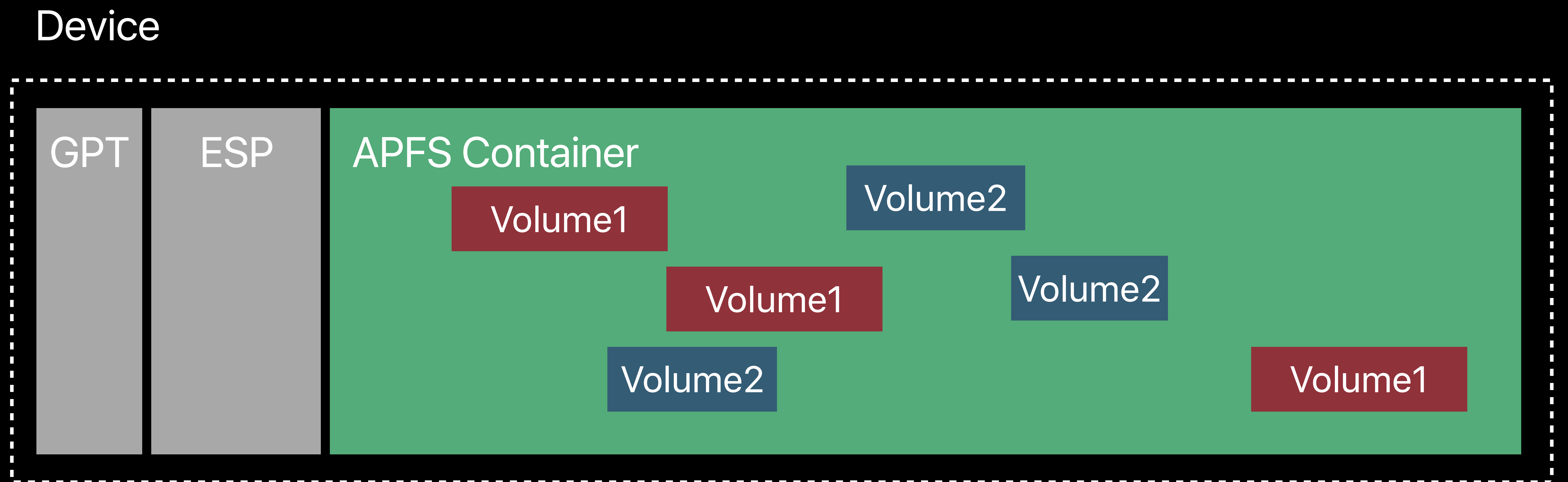
# APFS

Great features

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## Great features

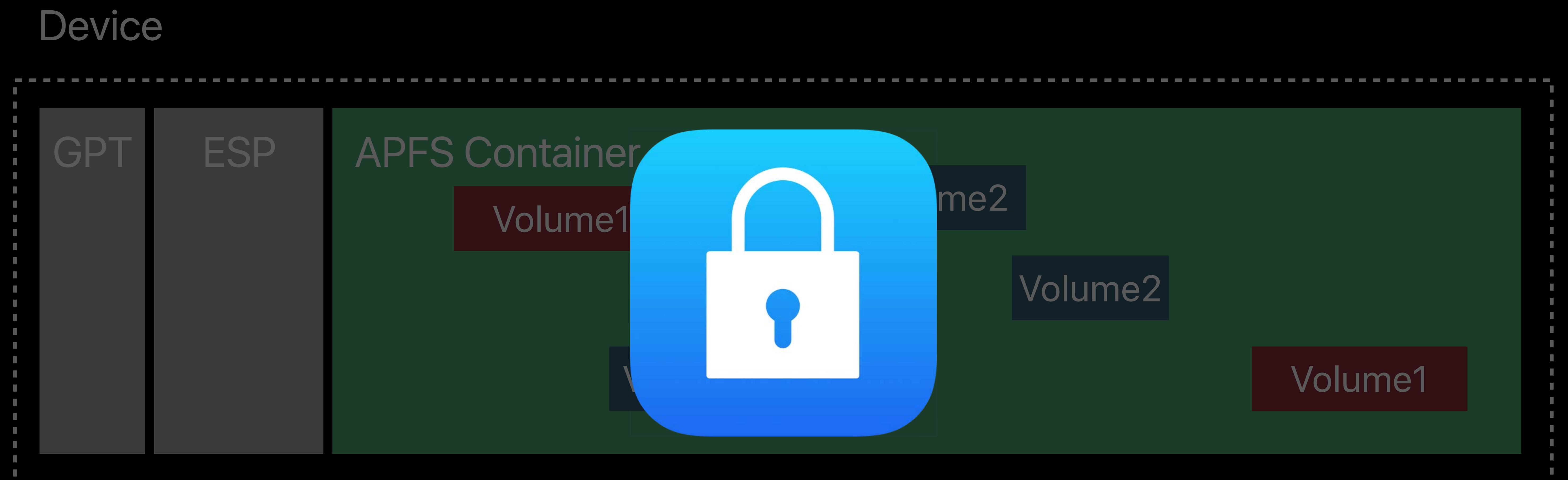
- Volume management, space sharing



# APFS

## Great features

- Volume management, space sharing
- Encryption

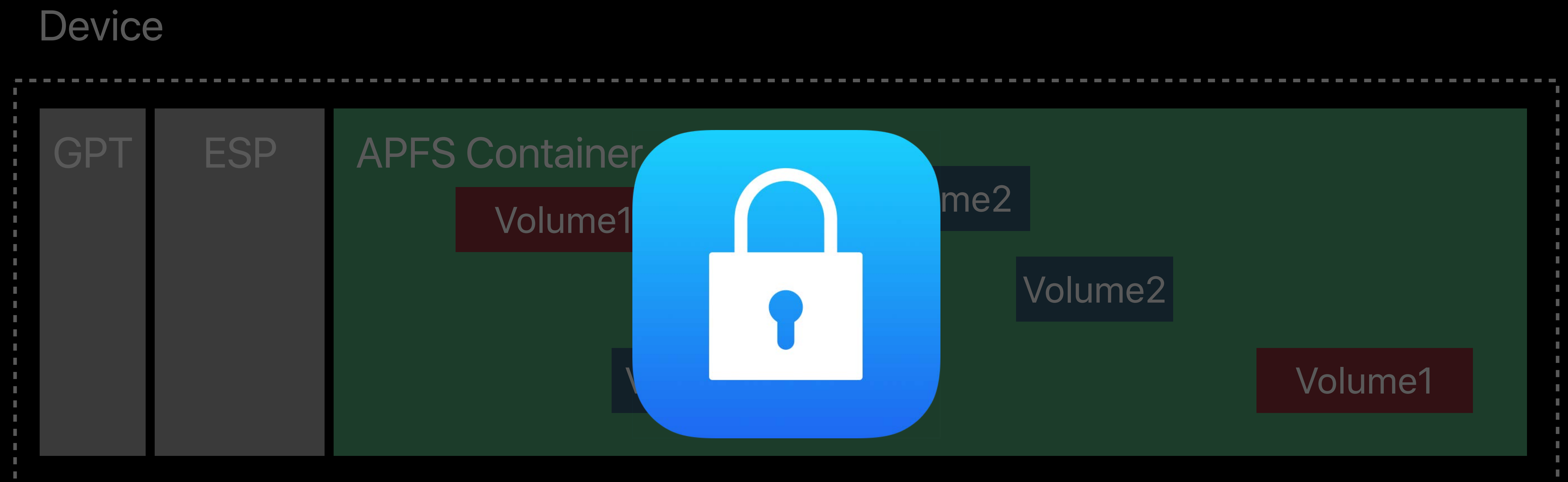


# APFS

## Great features

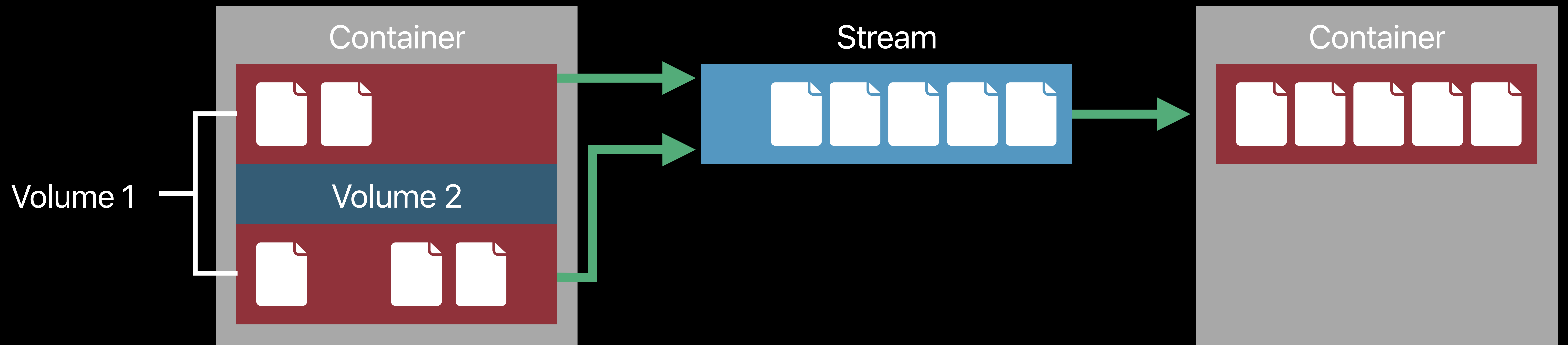
- Volume management, space sharing
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Block copies not possible with APFS volumes



# APFS Volume Replication with ASR

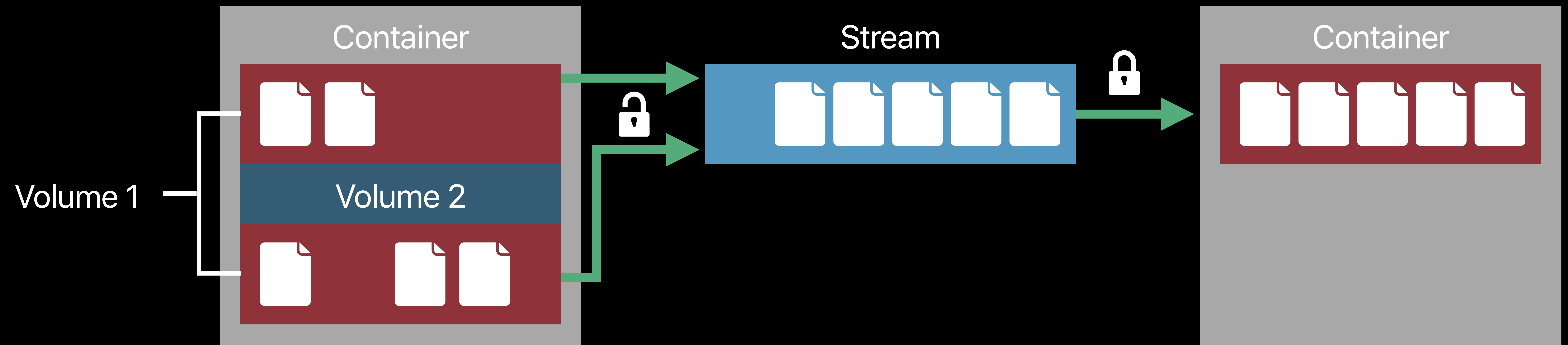
NEW



# APFS Volume Replication with ASR

NEW

Decryption / encryption part of generation / restore

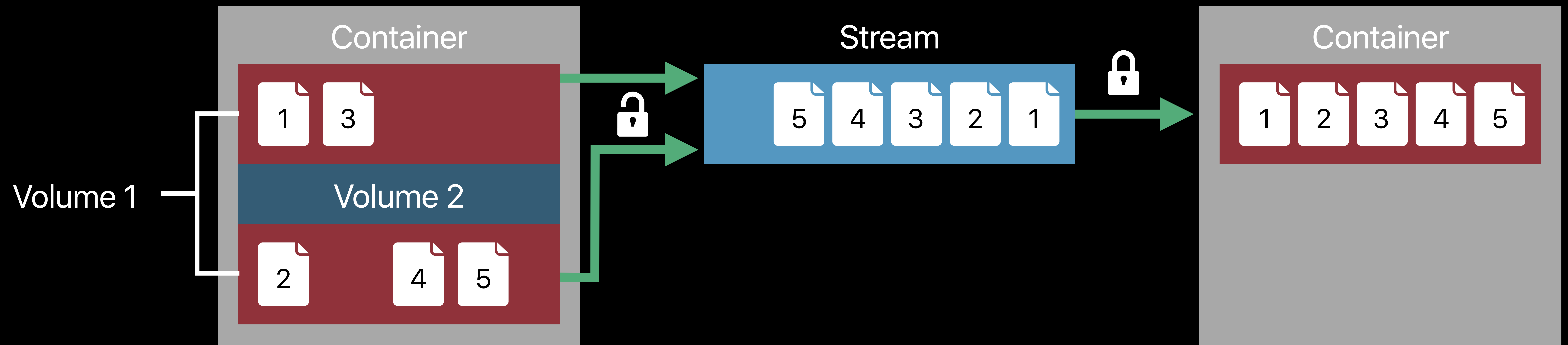


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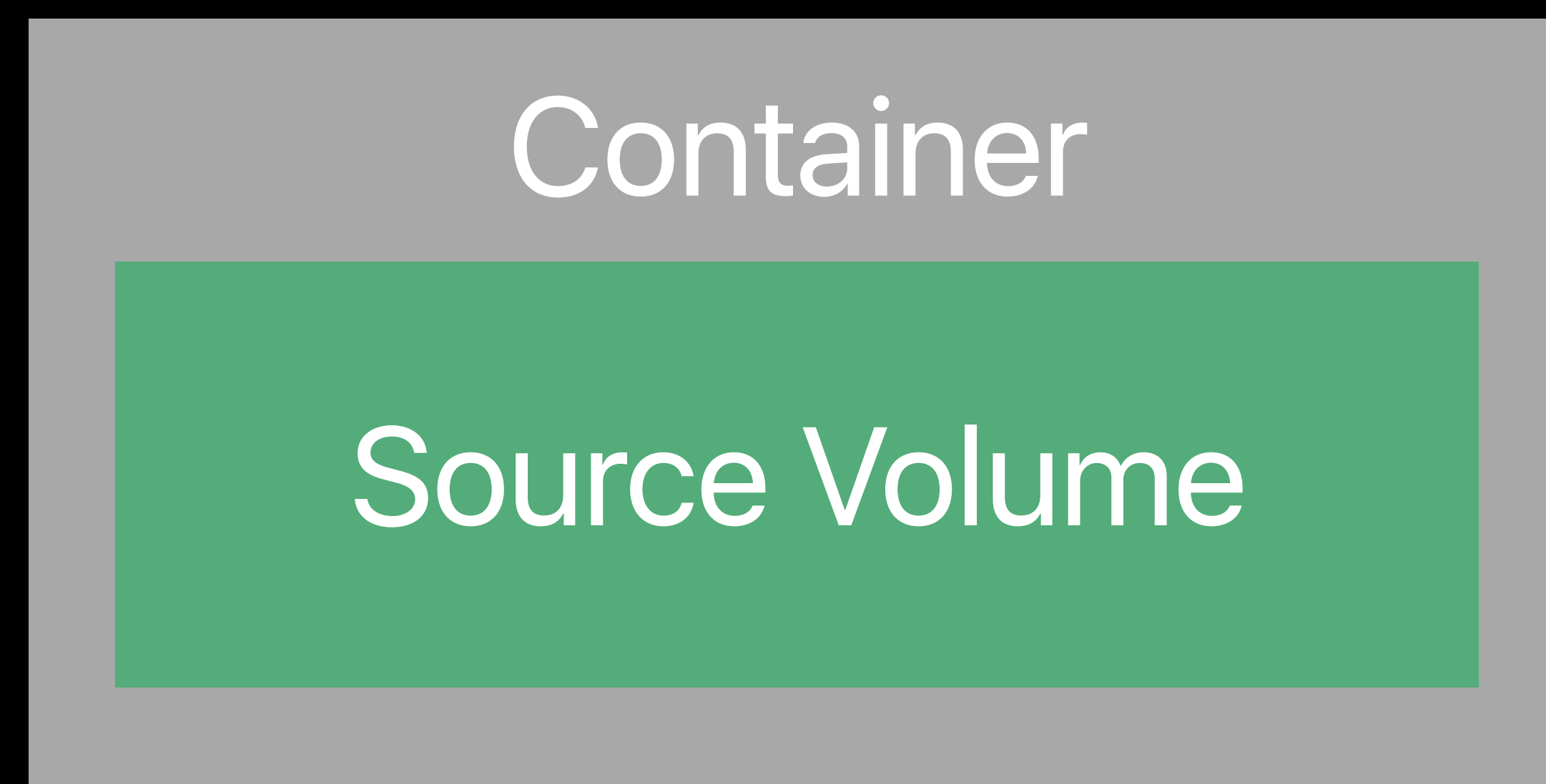
Volume is defragmented as stream is generated





# Restore Options

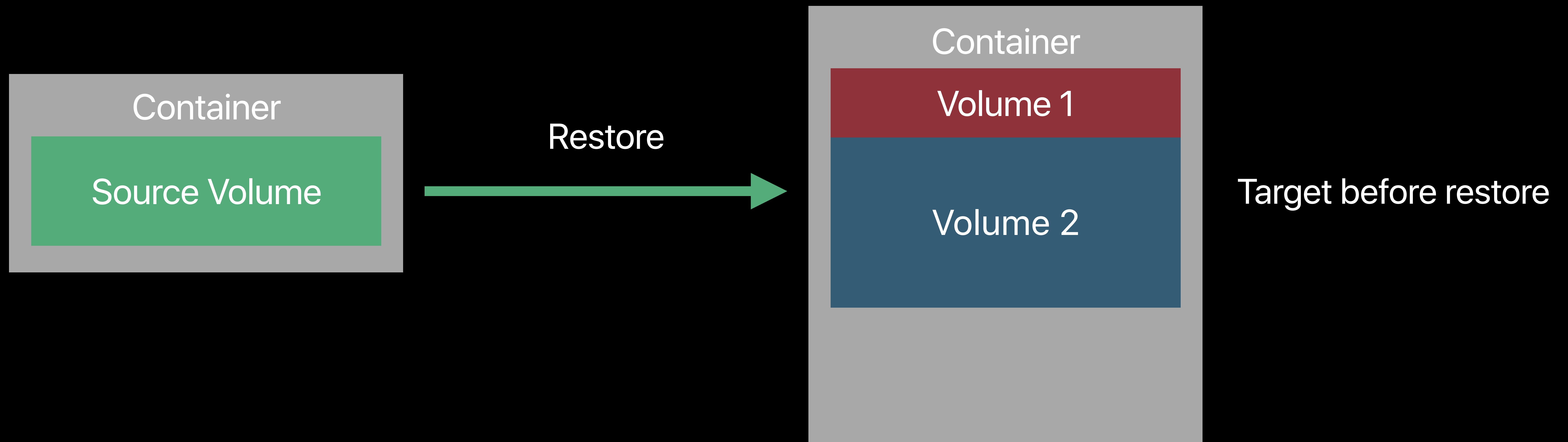
Restoring to an existing target volume (erasing prior content)



Target before restore

# Restore Options

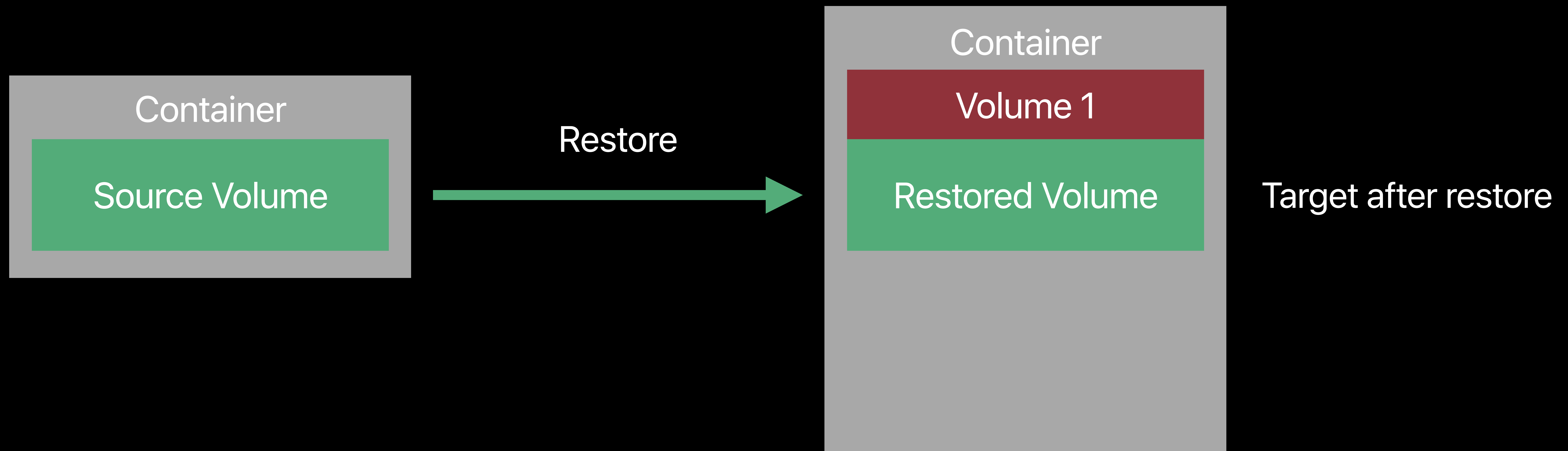
Restoring to an existing target volume (erasing prior content)



```
# Restore, erasing a target volume  
% sudo asr restore --source file.dmg --target /Volumes/Volume2 --erase
```

# Restore Options

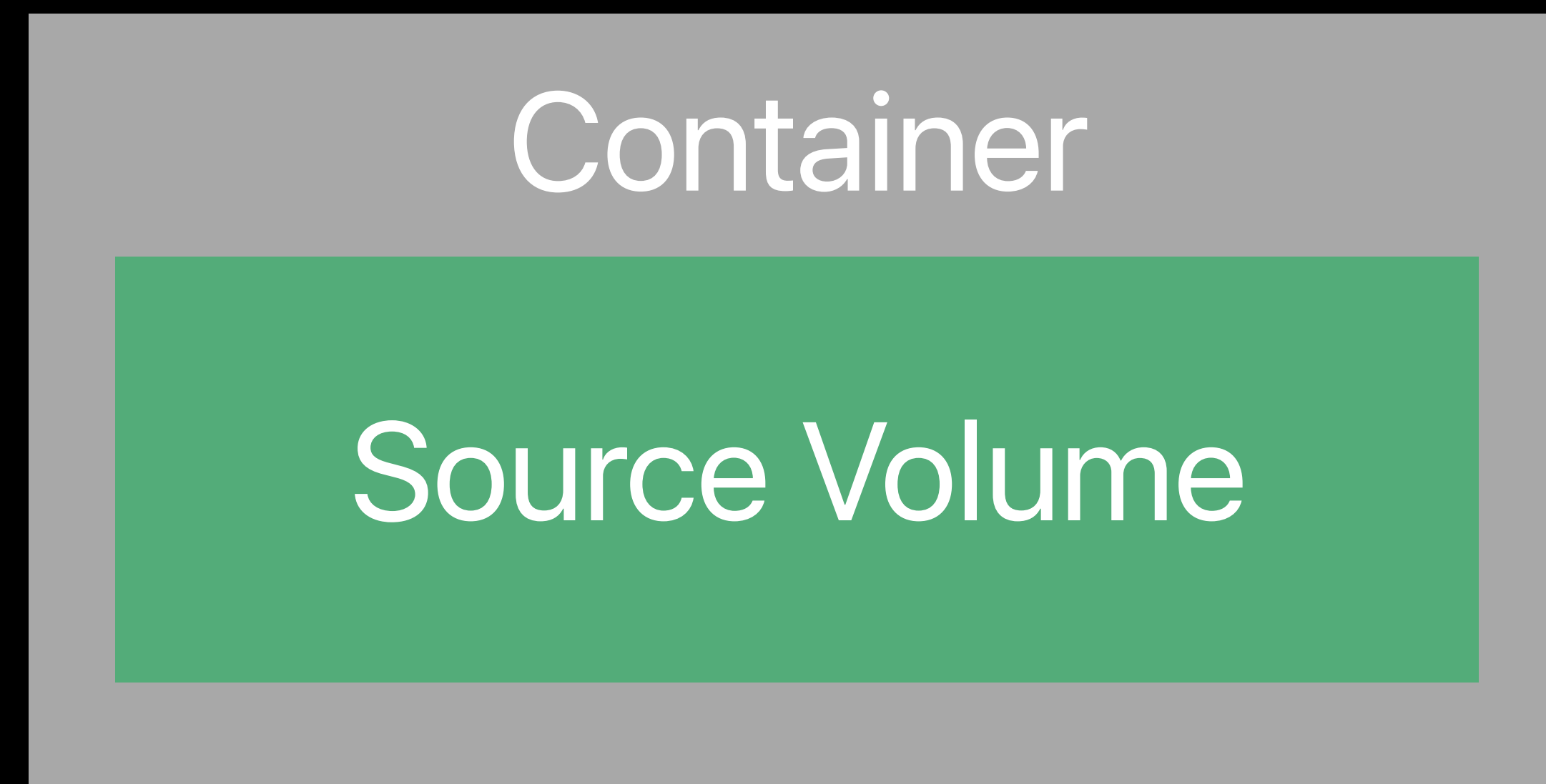
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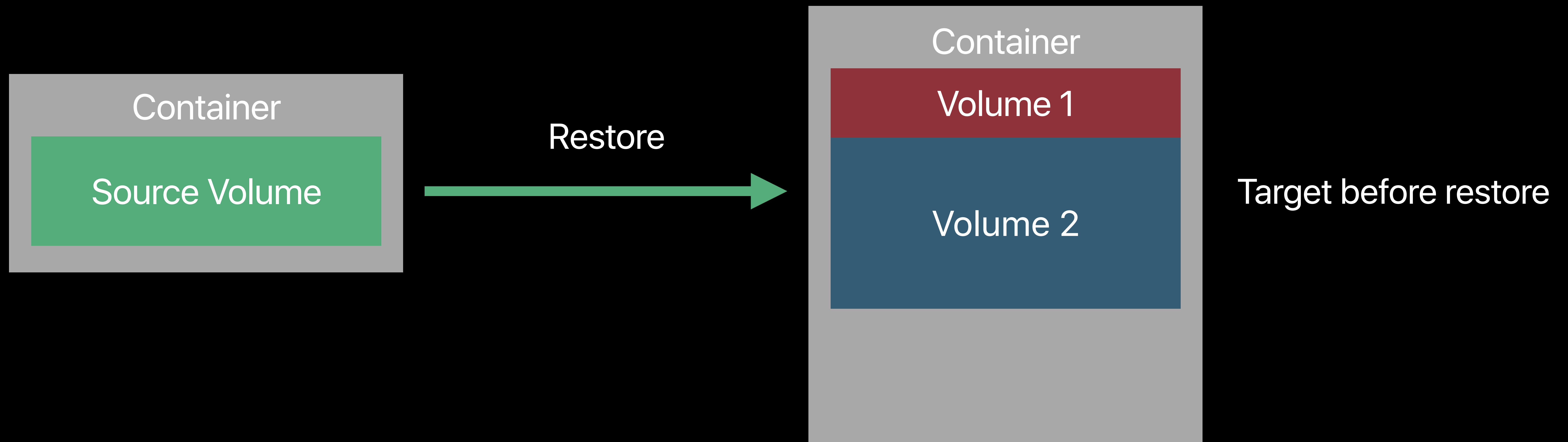
Restoring to a newly created target volume



Target before restore

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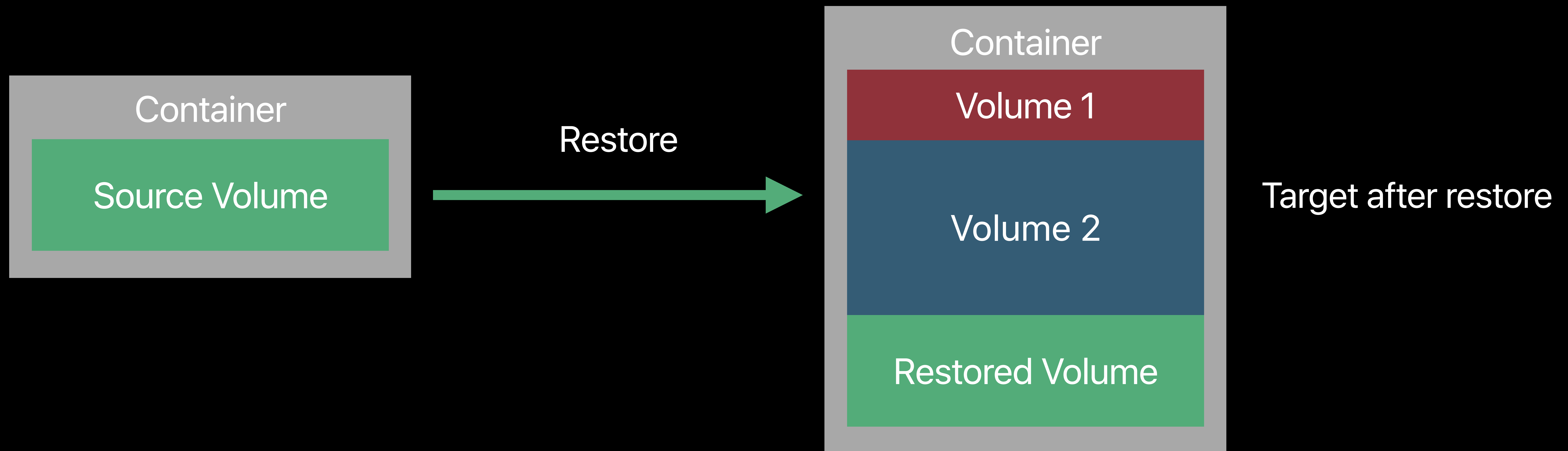
Restoring to a newly created target volume



```
# Creates a new volume during restore  
% sudo asr restore --source file.dmg --target /dev/disk1
```

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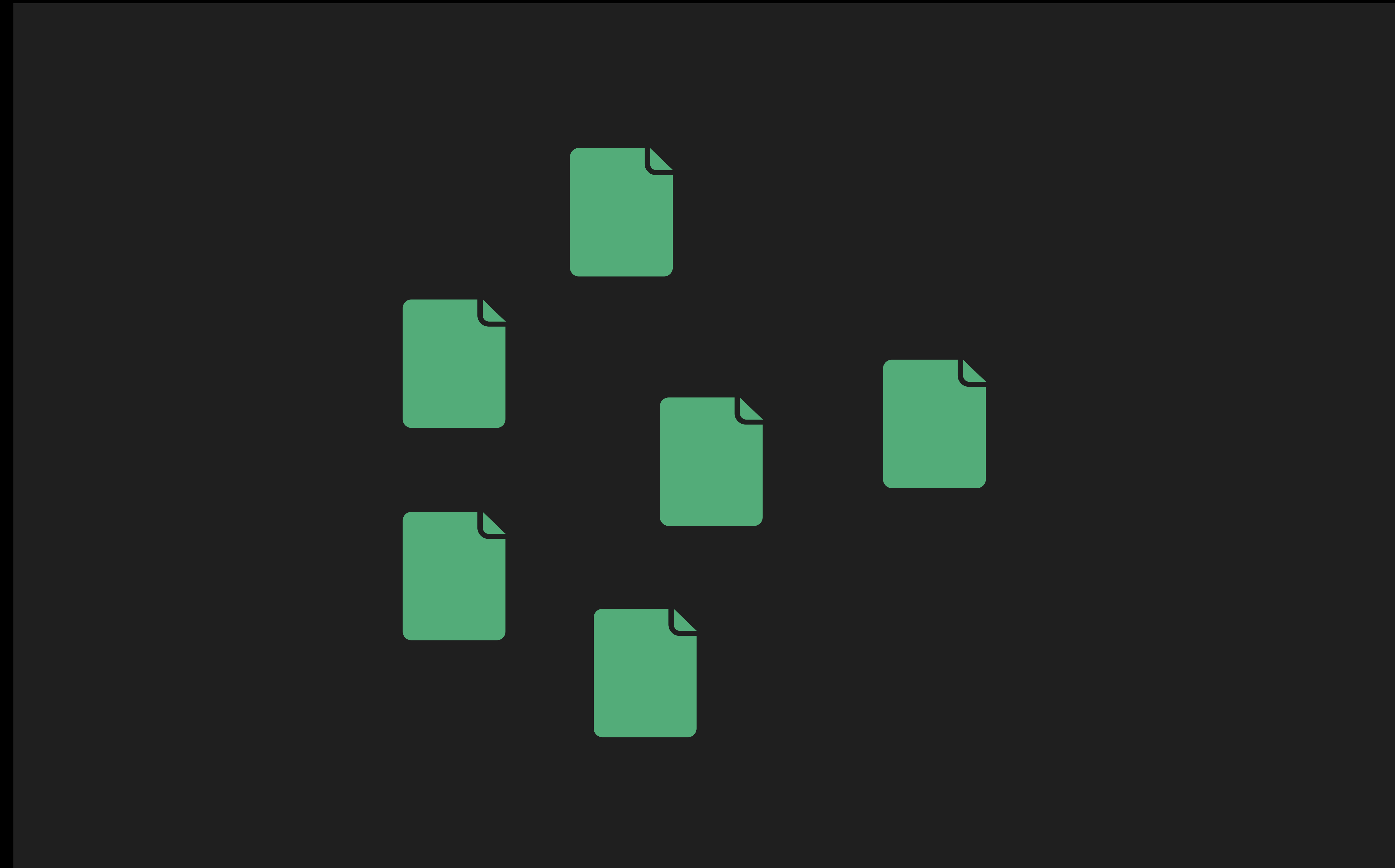
# Snapshots

Point-in-time capture of volume state



# Snapshots

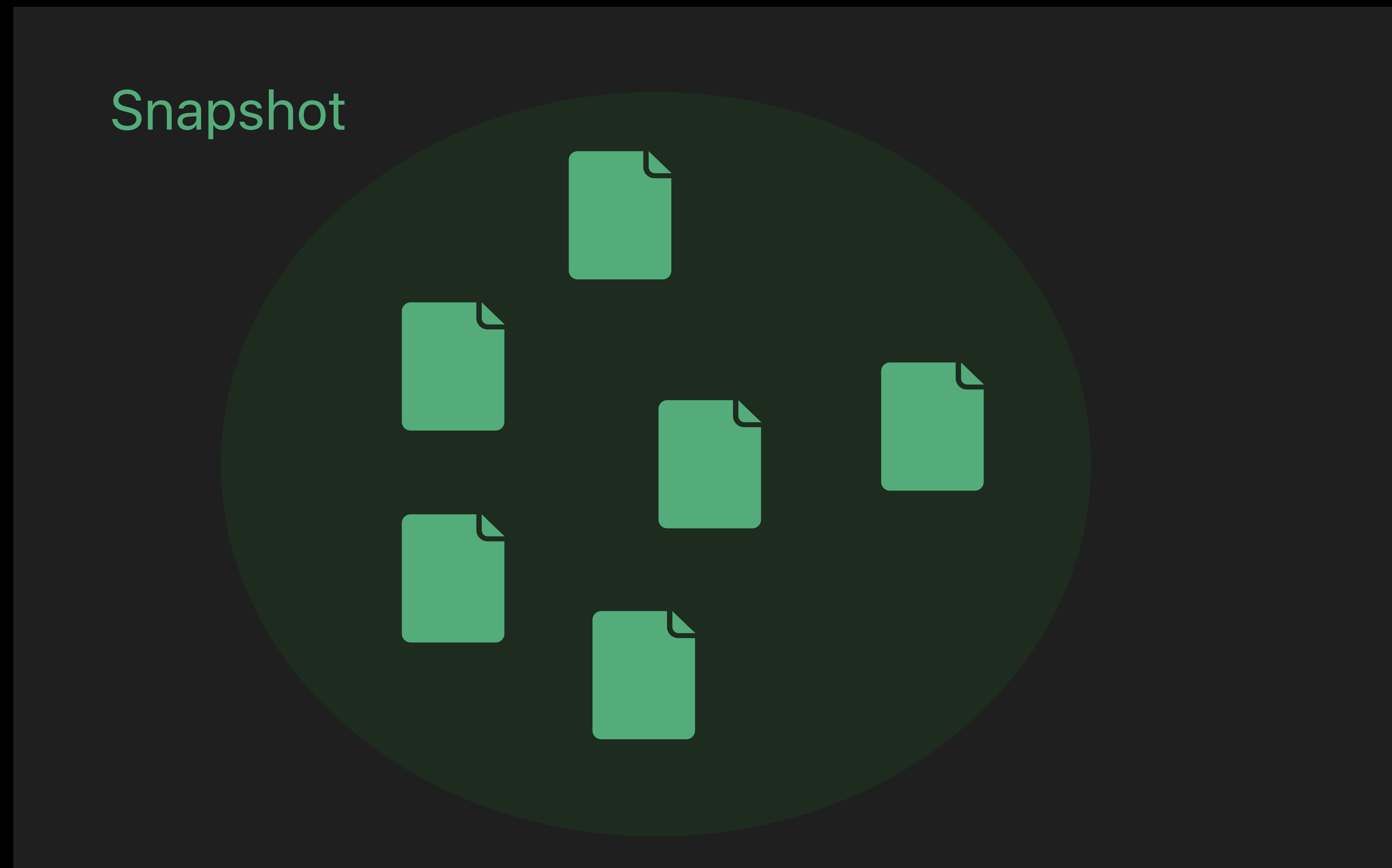
Point-in-time capture of volume state





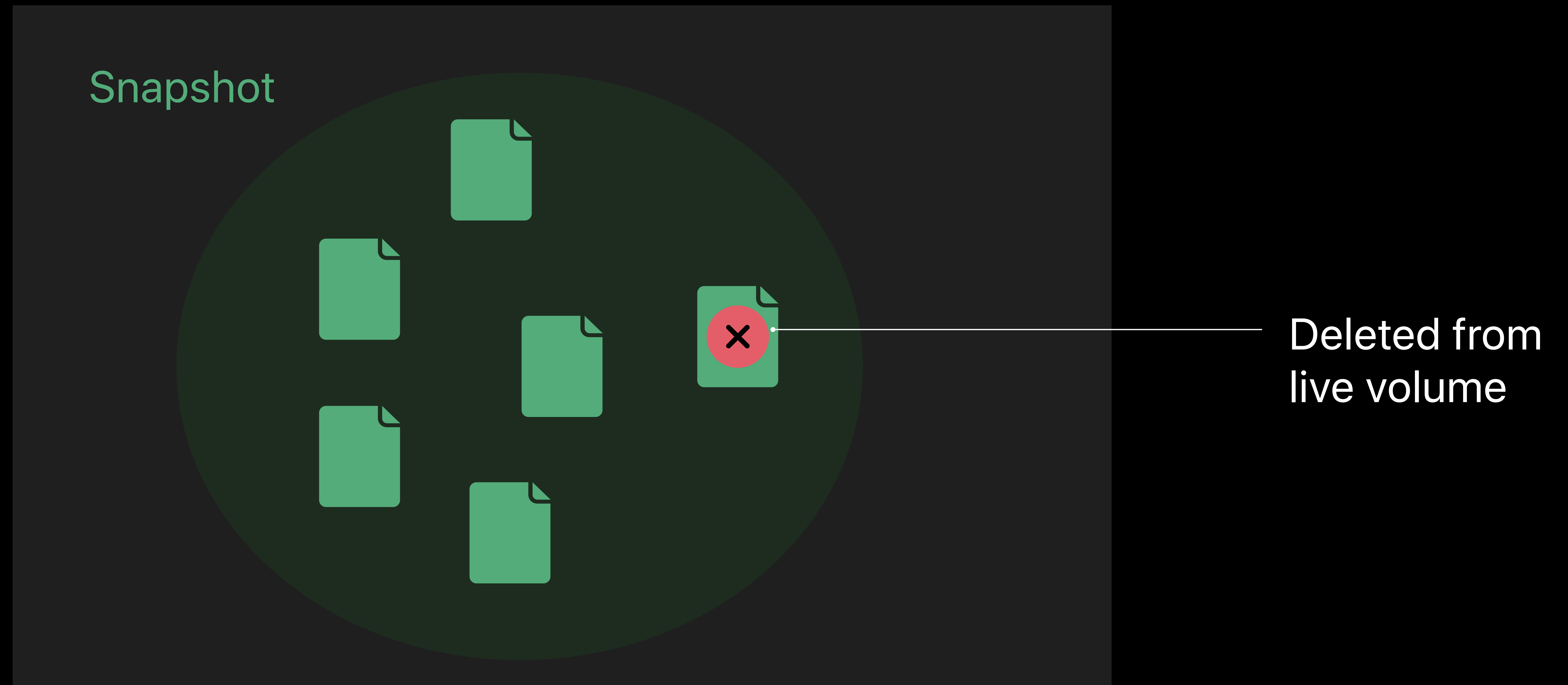
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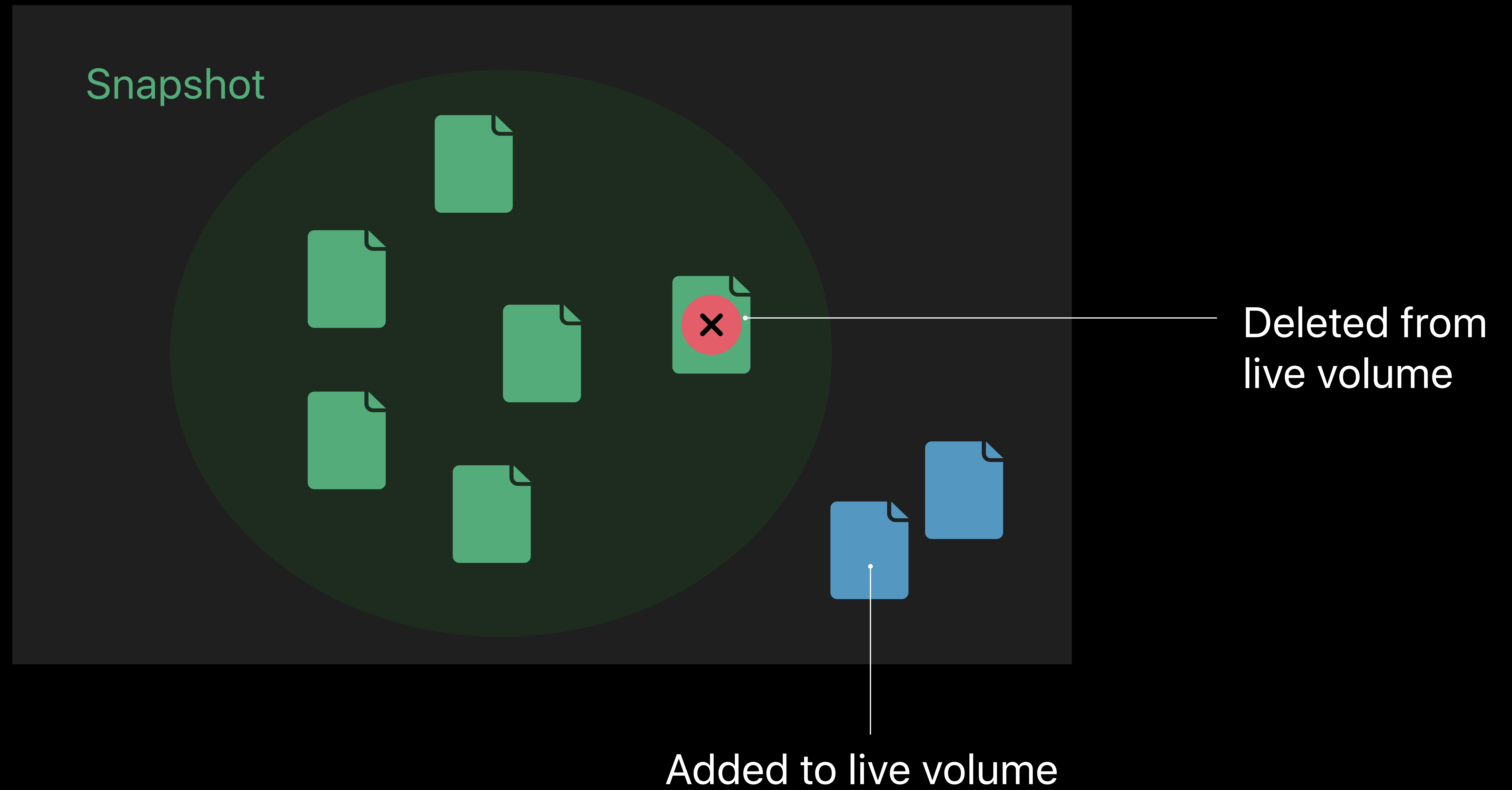
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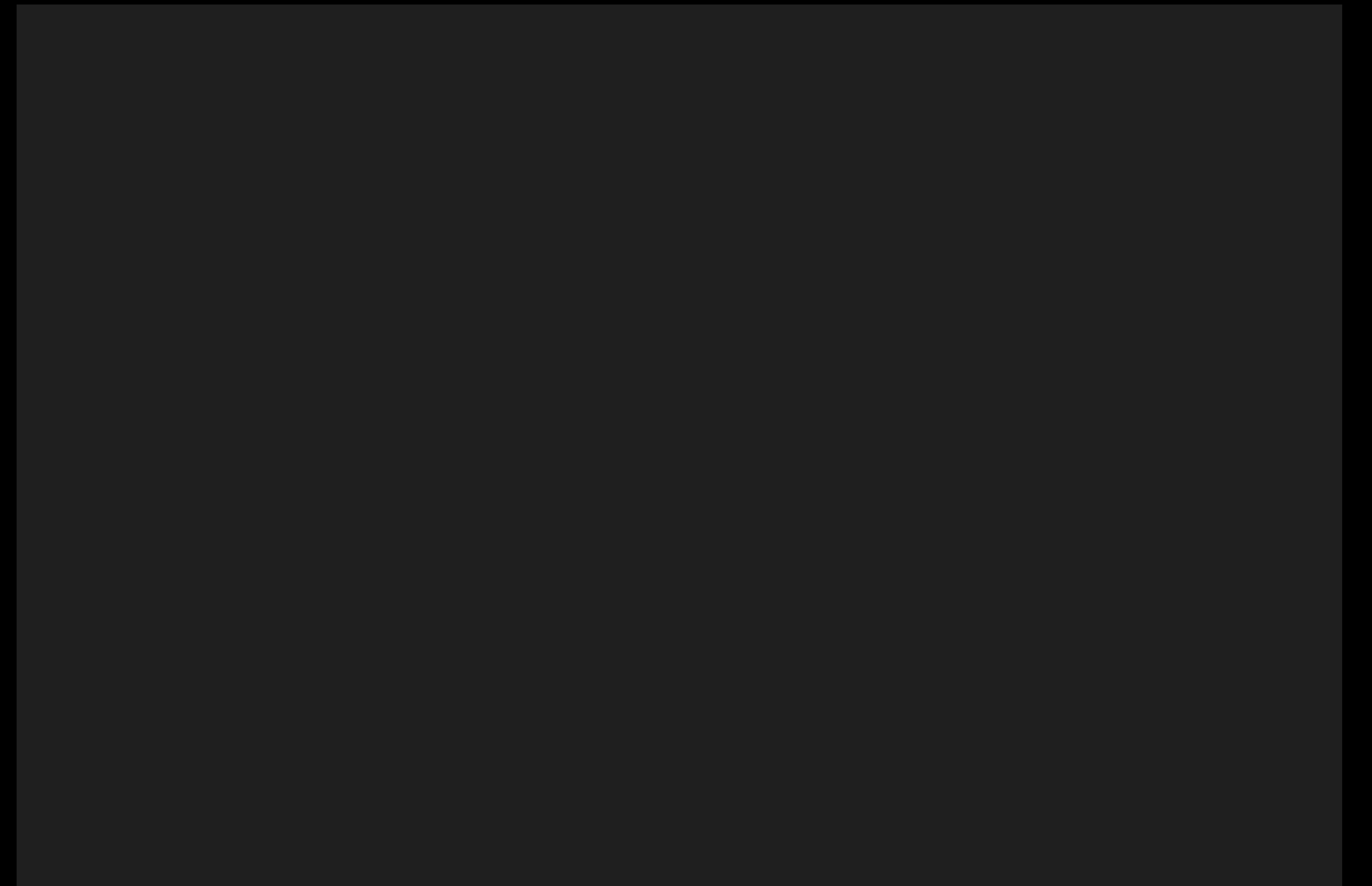
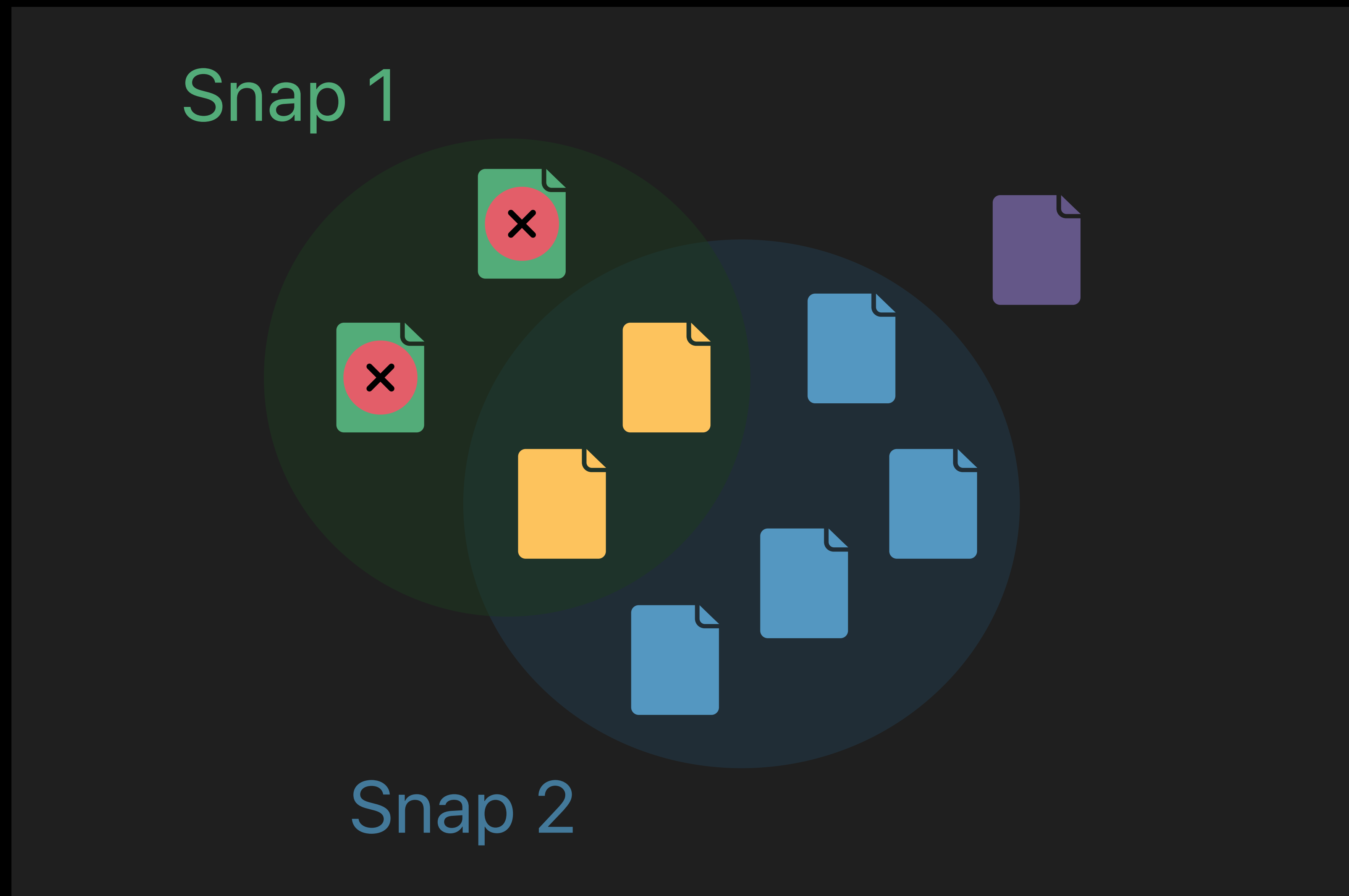


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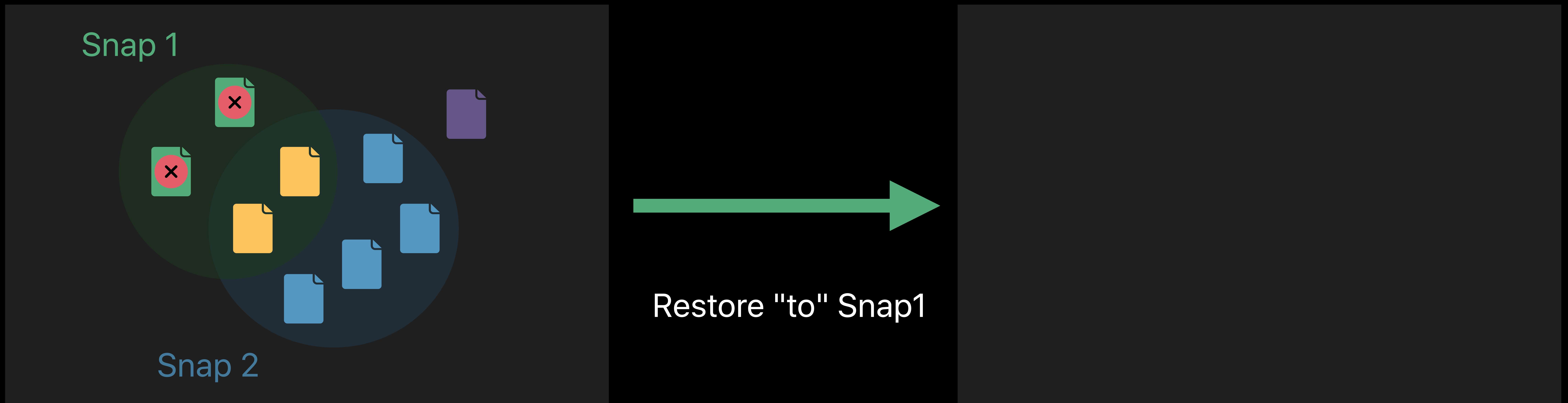
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# Restoring with Snapshots



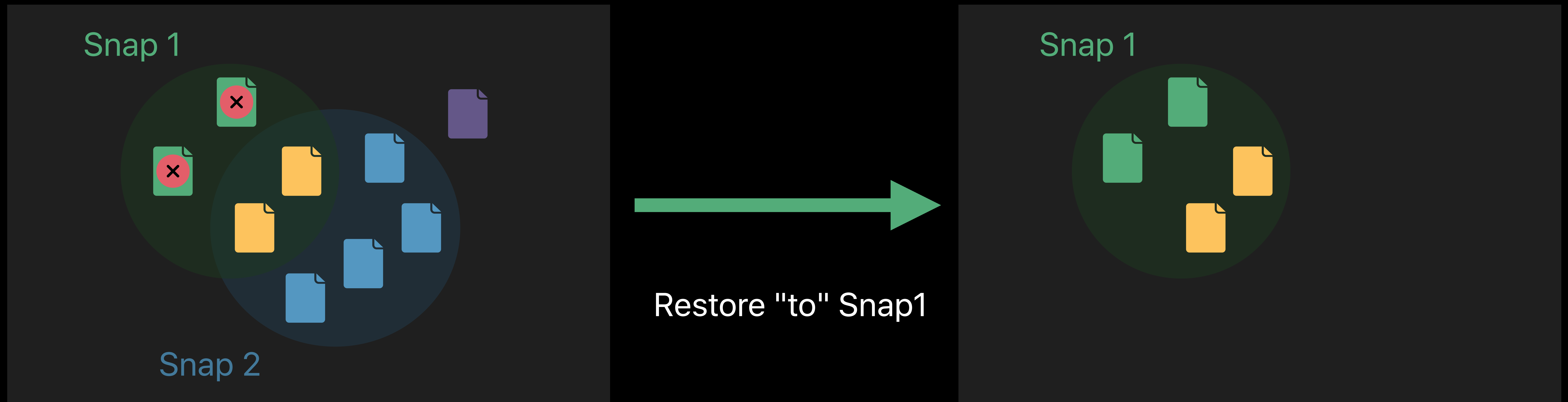
# Restoring with Snapshots



```
# Restore a snapshot
```

```
% sudo asr restore --source file.dmg --target /Volumes/Target --toSnapshot Snap1
```

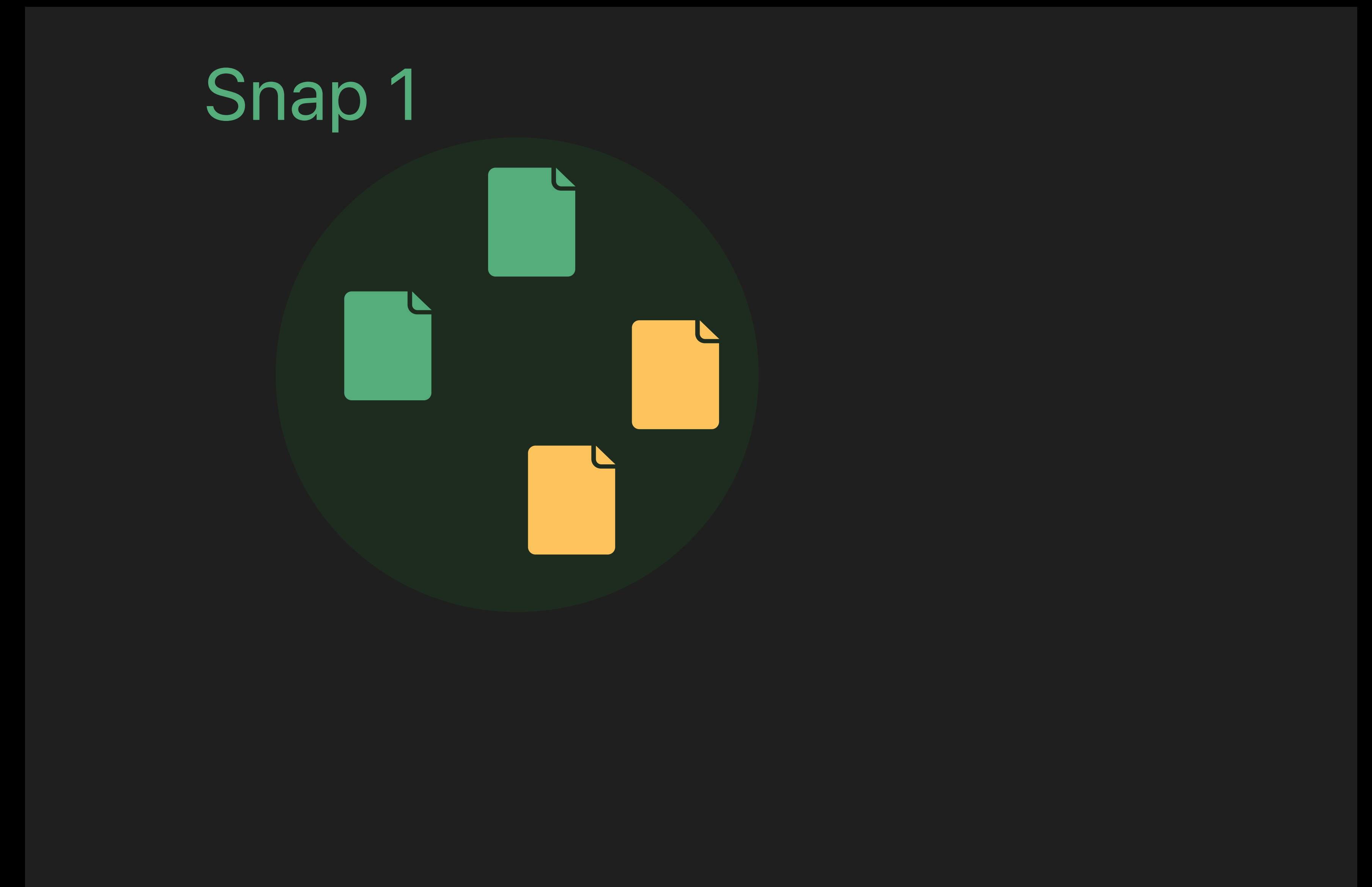
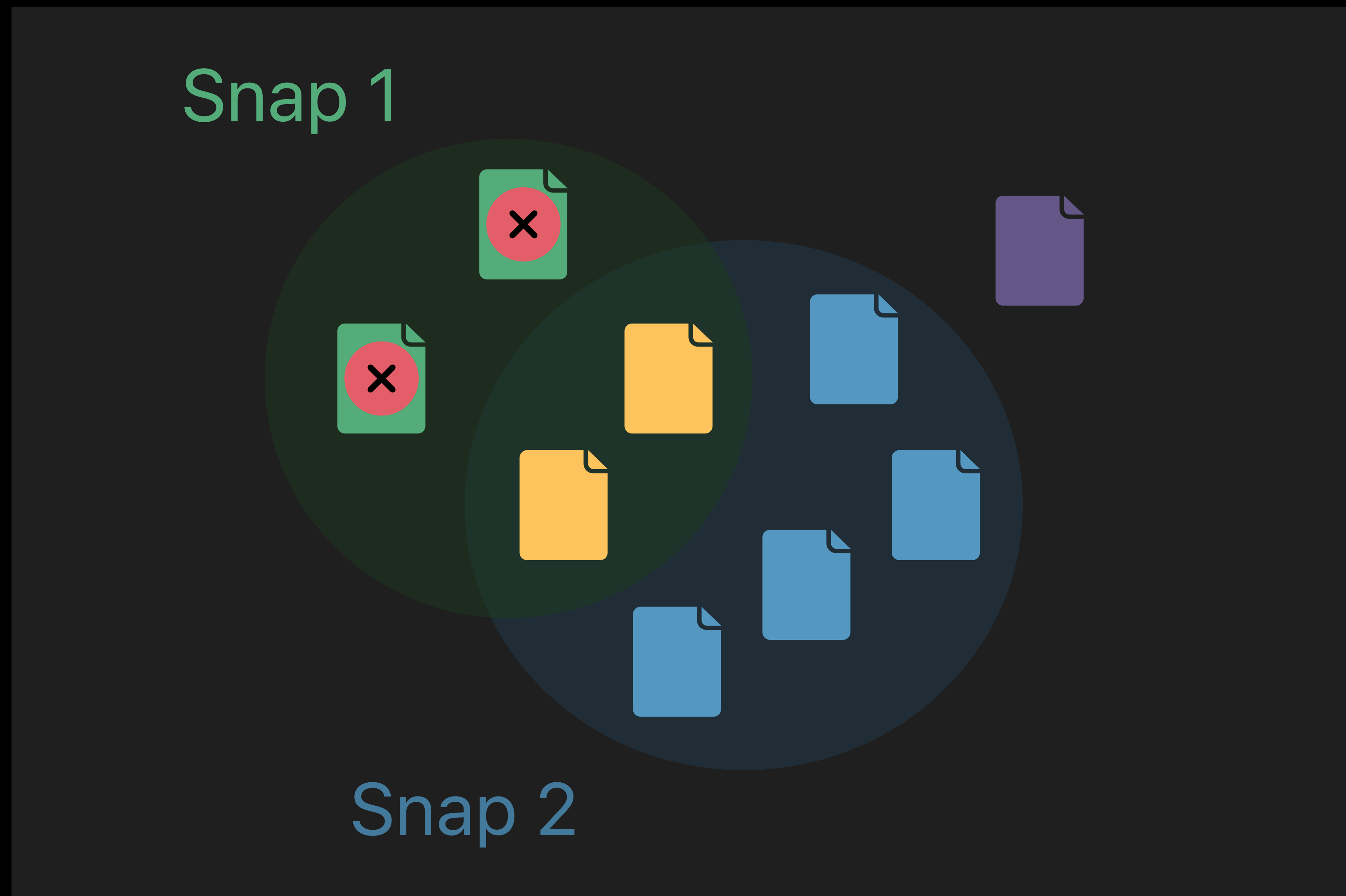
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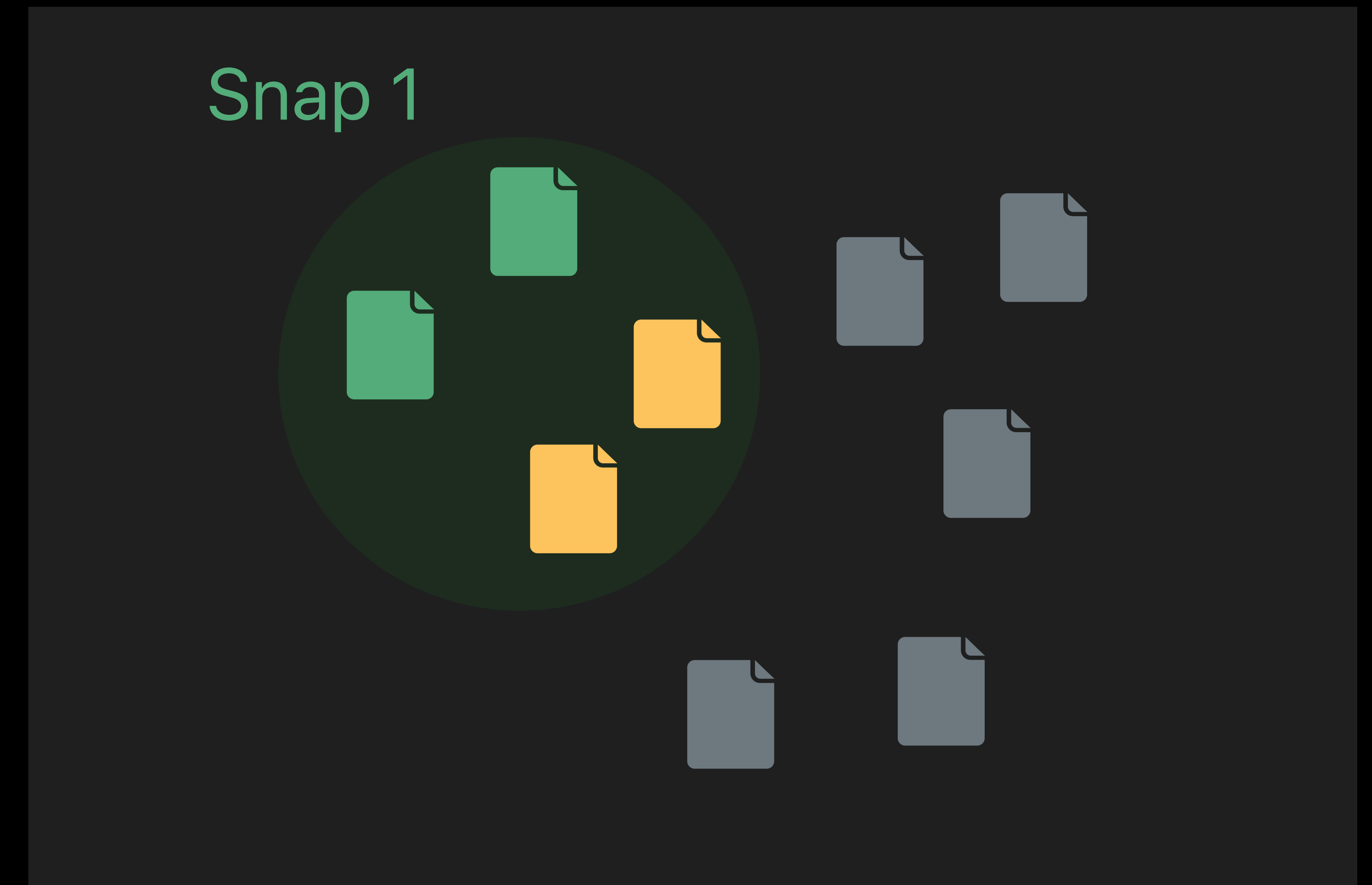
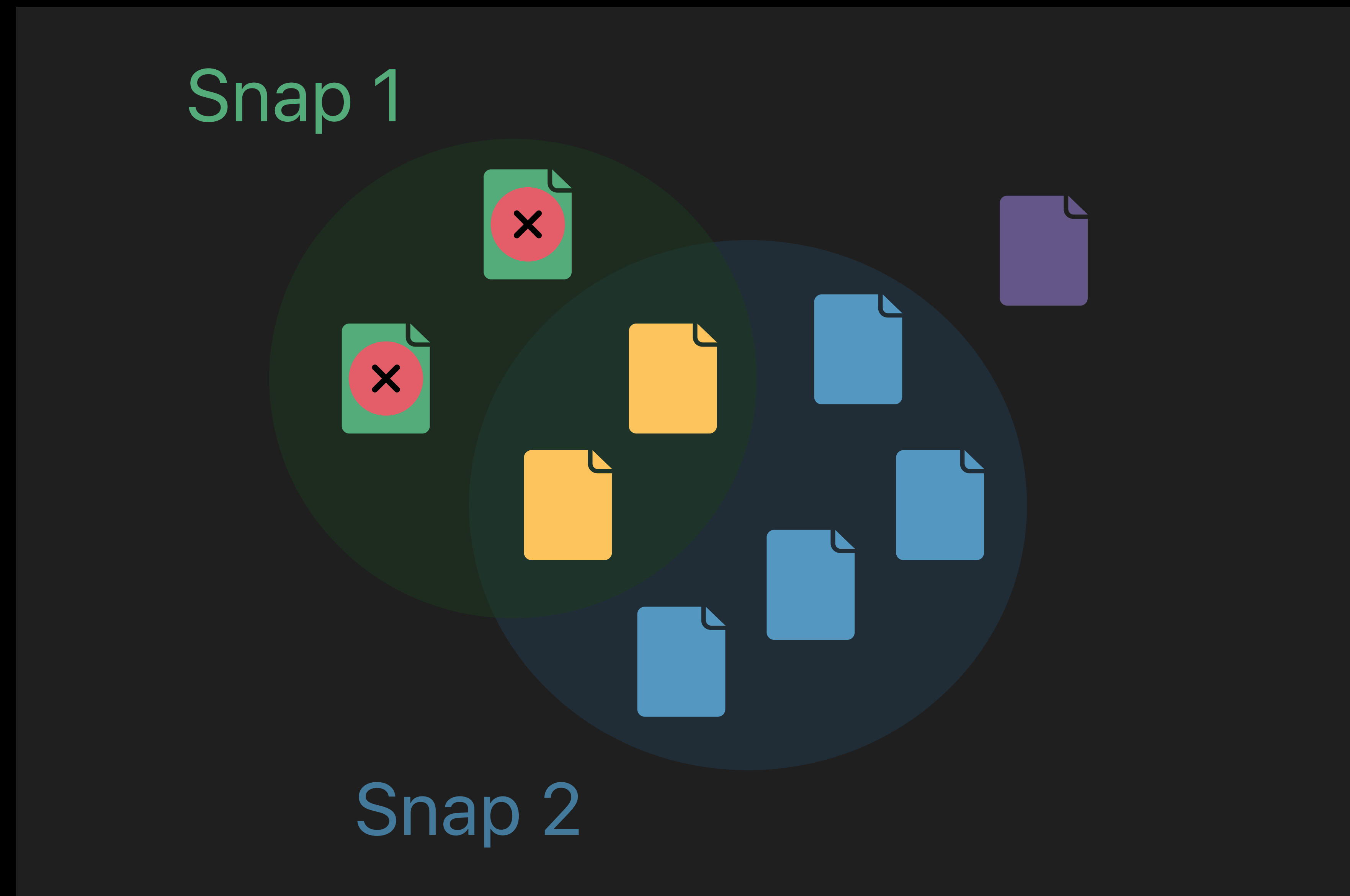
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```

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# Restoring with Snapshots

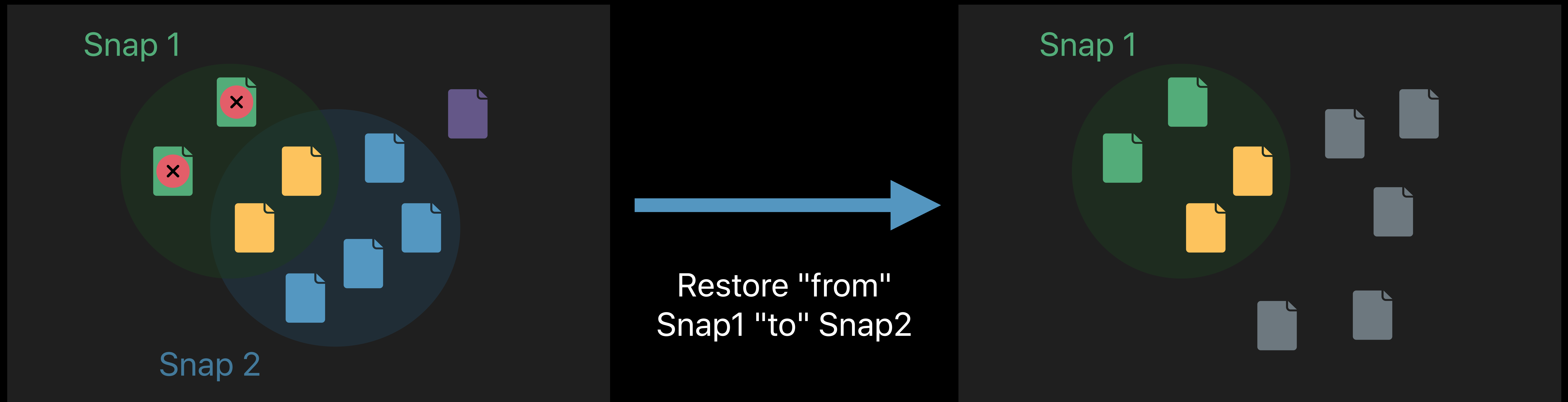


# Restoring with Snapshots



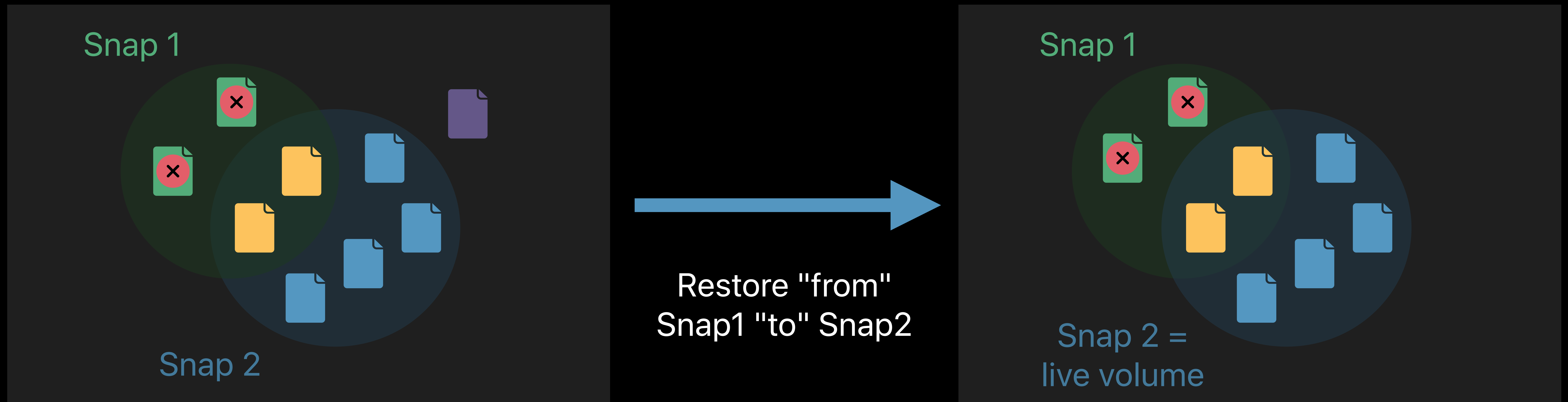


# Restoring with Snapshots



```
# Restore a snapshot delta
% sudo asr restore --source file.dmg --target /Volumes/Target --fromSnapshot Snap1 \
  --toSnapshot Snap2
```

# Restoring with Snapshots



Only items in blue need to be copied

```
# Restore a snapshot delta
% sudo asr restore --source file.dmg --target /Volumes/Target --fromSnapshot Snap1 \
  --toSnapshot Snap2
```

# Replication Summary

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New features in APFS require new models of replication

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# Replication Summary

New features in APFS require new models of replication

APFS Volume replication best done with ASR

- Gives highest fidelity
- Handles encryption

ASR can restore snapshots, snapshot deltas



# External File Access for iOS

Bill Stouder-Studenmund, CoreOS



# Browse

## Locations

iCloud Drive

On My iPad

Recently Deleted

## Tags

Red

Orange

Yellow

Green

Blue

Purple

Gray

Work

Home

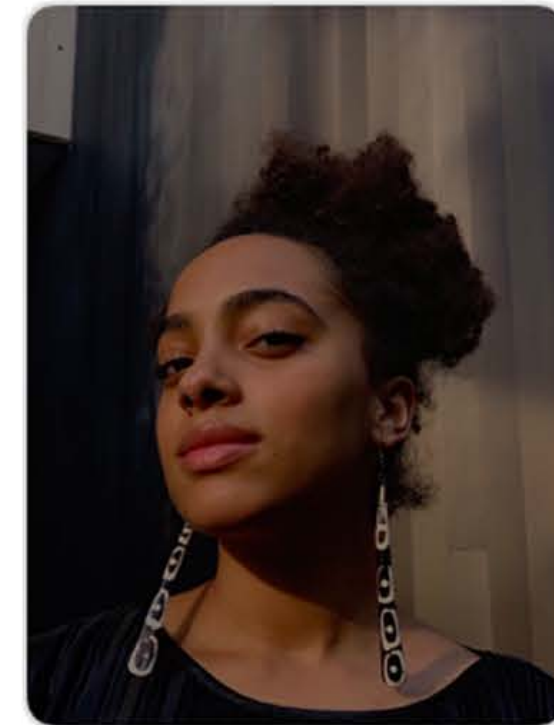
Important

Test Documents

Media

Select

Search



19\_i062990

May 28, 2019 at 2:23 PM  
4.2 MB



190116\_i041922

May 28, 2019 at 2:23 PM  
3.5 MB



190116\_i091151

May 28, 2019 at 2:23 PM  
2.9 MB



Fun With Charts

May 28, 2019 at 12:58 PM  
210 KB



i021770

May 28, 2019 at 2:23 PM  
4.1 MB



i022452

May 28, 2019 at 2:23 PM  
4.3 MB



i062141

May 28, 2019 at 2:23 PM  
3.7 MB



iE041586

May 28, 2019 at 2:23 PM  
1.8 MB



iE090764

May 28, 2019 at 2:23 PM  
2.2 MB



iE100473

May 28, 2019 at 2:23 PM  
1.7 MB



Loans- which is worth it?

May 28, 2019 at 4:37 PM  
151 KB



Oranges

May 28, 2019 at 2:23 PM  
2.7 MB













# USB Storage





# USB Storage

Unencrypted APFS



# USB Storage

Unencrypted APFS

Unencrypted HFS Plus





# USB Storage

Unencrypted APFS

Unencrypted HFS Plus

FAT, ExFAT



# Network Shares



# Network Shares

Supports SMB 3.0





# Network Shares

Supports SMB 3.0

Connect over WiFi, Cellular, and Ethernet



# Network Shares

Supports SMB 3.0

Connect over WiFi, Cellular, and Ethernet

Search using Windows Search Protocol





# Network Shares

Supports SMB 3.0

Connect over WiFi, Cellular, and Ethernet

Search using Windows Search Protocol

And we've added Windows Search to macOS Catalina's SMB server





***Demo***



# What This Means for You

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Enabled by default for apps linked on or after iOS 13

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Pay attention to volume capability attributes

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NSURL.resourceValues(forKey:)
```

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```
fileManager.url(for: .itemReplacementDirectory,  
                in: .userDomainMask,  
                appropriateFor: yourFile,  
                create: true)
```

# What This Means for You



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External devices can suddenly go away

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- For best results, keep multiple large operations in-flight at once

# Summary

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We are making the root volume read-only for enhanced security

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You can use ASR to perform volume replication, including snapshot deltas



# Summary

We are making the root volume read-only for enhanced security

You can use ASR to perform volume replication, including snapshot deltas

We now support accessing external files on USB Storage and Network Shares

# More Information

[developer.apple.com/wwdc19/710](https://developer.apple.com/wwdc19/710)

---

Filesystem Lab

Wednesday, 5:00

---

Introducing Combine and Advances in Foundation

Thursday, 10:00

---

What's New in File Management and Quick Look

WWDC App

---

 WWDC19