

What's New in APFS

Session 715

Pavel Sokolov, File System Manager
Eric Tamura, File System Manager

iOS macOS

APFS on iOS

APFS on Mac

APFS on iOS

APFS on Mac

Default filesystem (iOS 10.3)

Conversion to APFS

Normalization/case-sensitivity (iOS/tvOS/watchOS)

iOS macOS

iOS macOS

Millions

iOS/tvOS/watchOS devices migrated to APFS successfully

iOS 10.3

iOS macOS

iOS 10.3

iOS macOS

APFS became the default filesystem on iOS 10.3

Millions of devices converted successfully

Update frees up storage for end-users

Adds APFS capabilities to iOS/tvOS/watchOS devices

Listening to developer feedback to improve and refine

Conversion to APFS

iOS macOS

Conversion to APFS

iOS macOS

APFS conversion occurs inline during update to iOS 10.3 and beyond

Tracking results during update process

Feedback from iOS conversion yields improvements on macOS

Conversion

iOS macOS



Conversion

iOS macOS



Conversion

iOS macOS



Conversion

iOS macOS



Conversion

iOS macOS



Conversion

iOS macOS



Unicode and APFS

iOS macOS

Unicode NFC vs. NFD

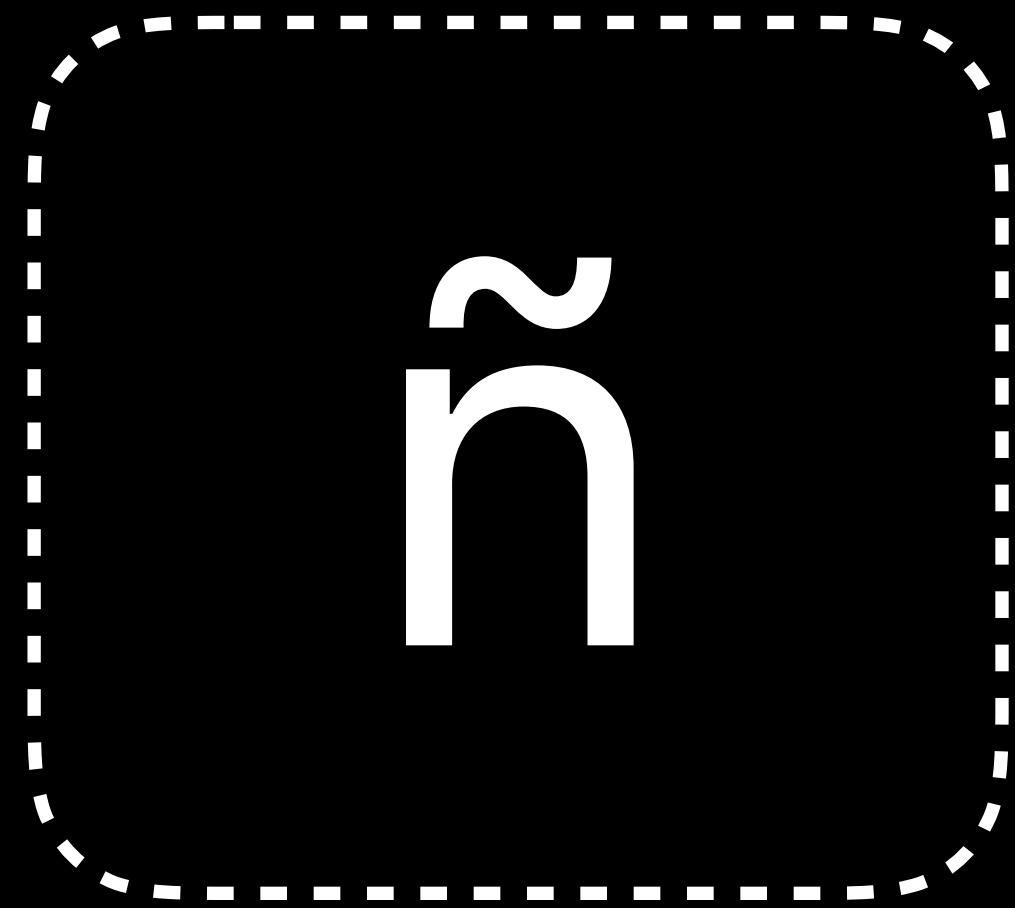
Prior to iOS 11, APFS stored filenames as non-normalized UTF-8

Unicode and APFS

iOS macOS

Unicode NFC vs. NFD

Prior to iOS 11, APFS stored filenames as non-normalized UTF-8



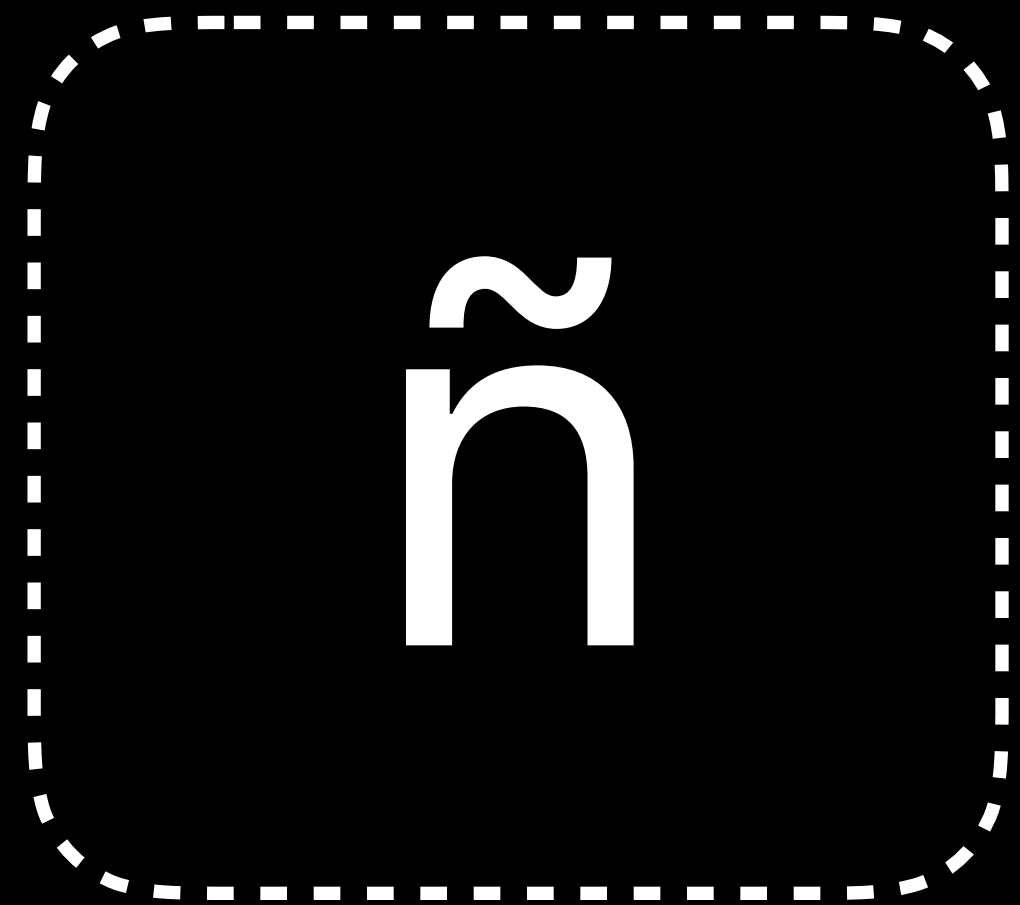
U+00F1

Unicode and APFS

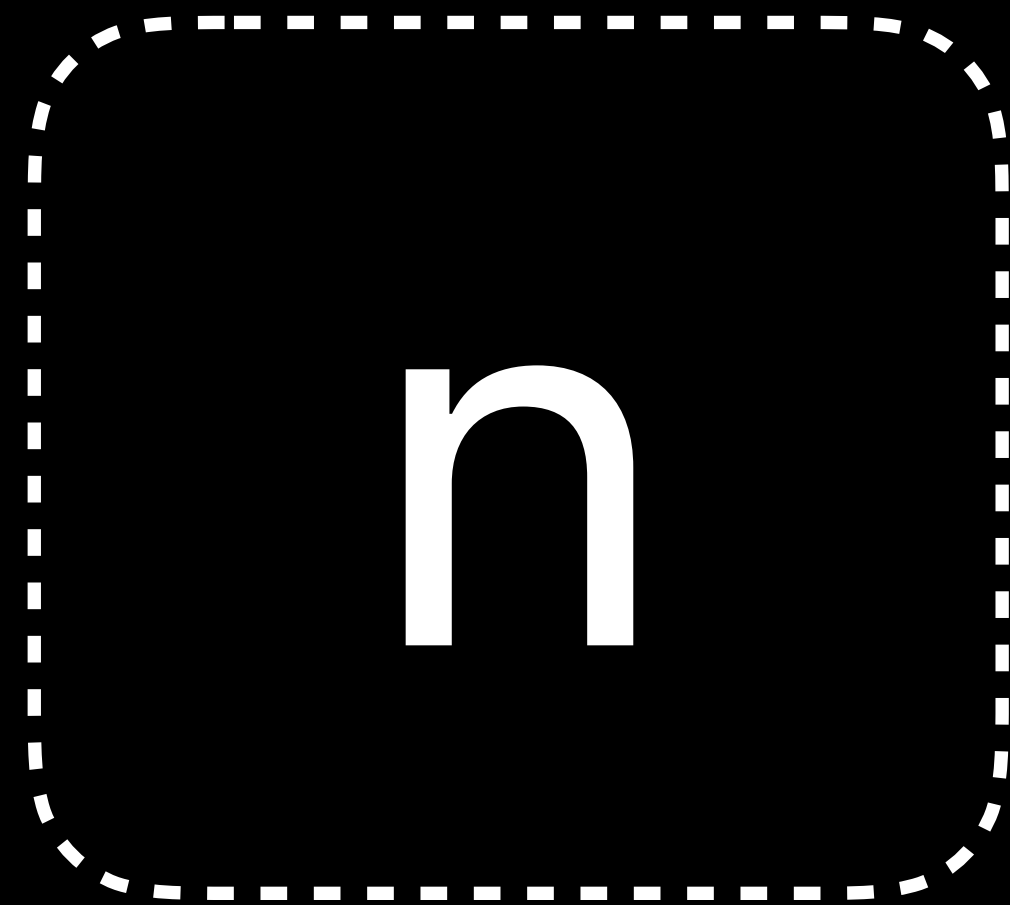
iOS macOS

Unicode NFC vs. NFD

Prior to iOS 11, APFS stored filenames as non-normalized UTF-8

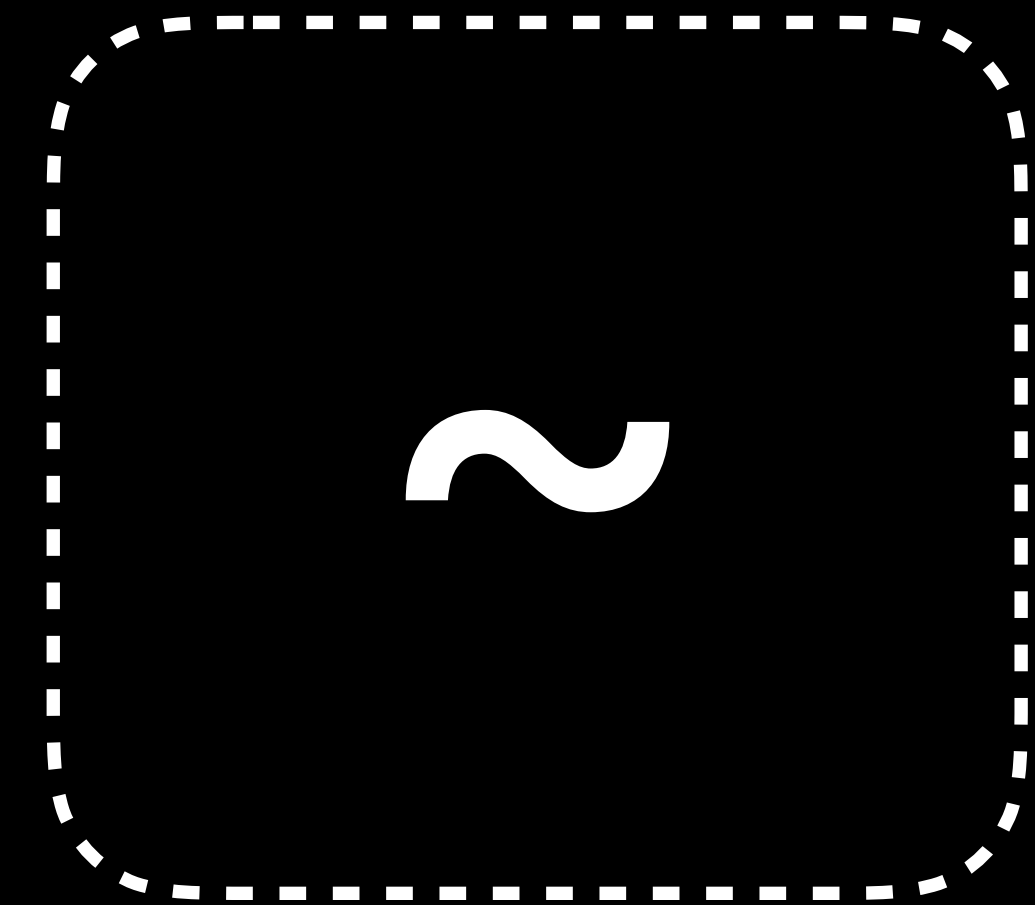


U+00F1



U+006E

+



U+0303

Unicode and APFS

iOS macOS

Unicode and APFS

iOS macOS

Native vs. Runtime normalization

Native normalization available today in macOS Developer Seed (case-sensitive)

Native normalization coming soon for iOS 11 (erase-restore only)

Runtime normalization will be available in iOS 10.3.3 and iOS 11

Future update will convert all devices to new native normalization

iOS macOS

APFS on iOS

APFS on Mac

APFS on macOS

Features

iOS macOS

Features

iOS macOS

Next-generation file system designed for iOS, tvOS, watchOS, macOS

Cloning

Copy-on-write

Snapshots

Natively supported encryption

Space sharing

Defragmentation

Forward Migration

iOS macOS

Forward Migration

iOS macOS

System volume is converted by installer

Manual conversion for other volumes

Multiple containers do not share space

Forward Migration

iOS macOS

Forward Migration

iOS macOS

HFS+

Forward Migration

iOS macOS

HFS+

CoreStorage

Forward Migration

iOS macOS

Fusion

HFS+

CoreStorage

Forward Migration

iOS macOS

Fusion

HFS+

CoreStorage

FileVault

Forward Migration

iOS macOS

Fusion

HFS+

APFS

CoreStorage

FileVault

Forward Migration

iOS macOS

APFS

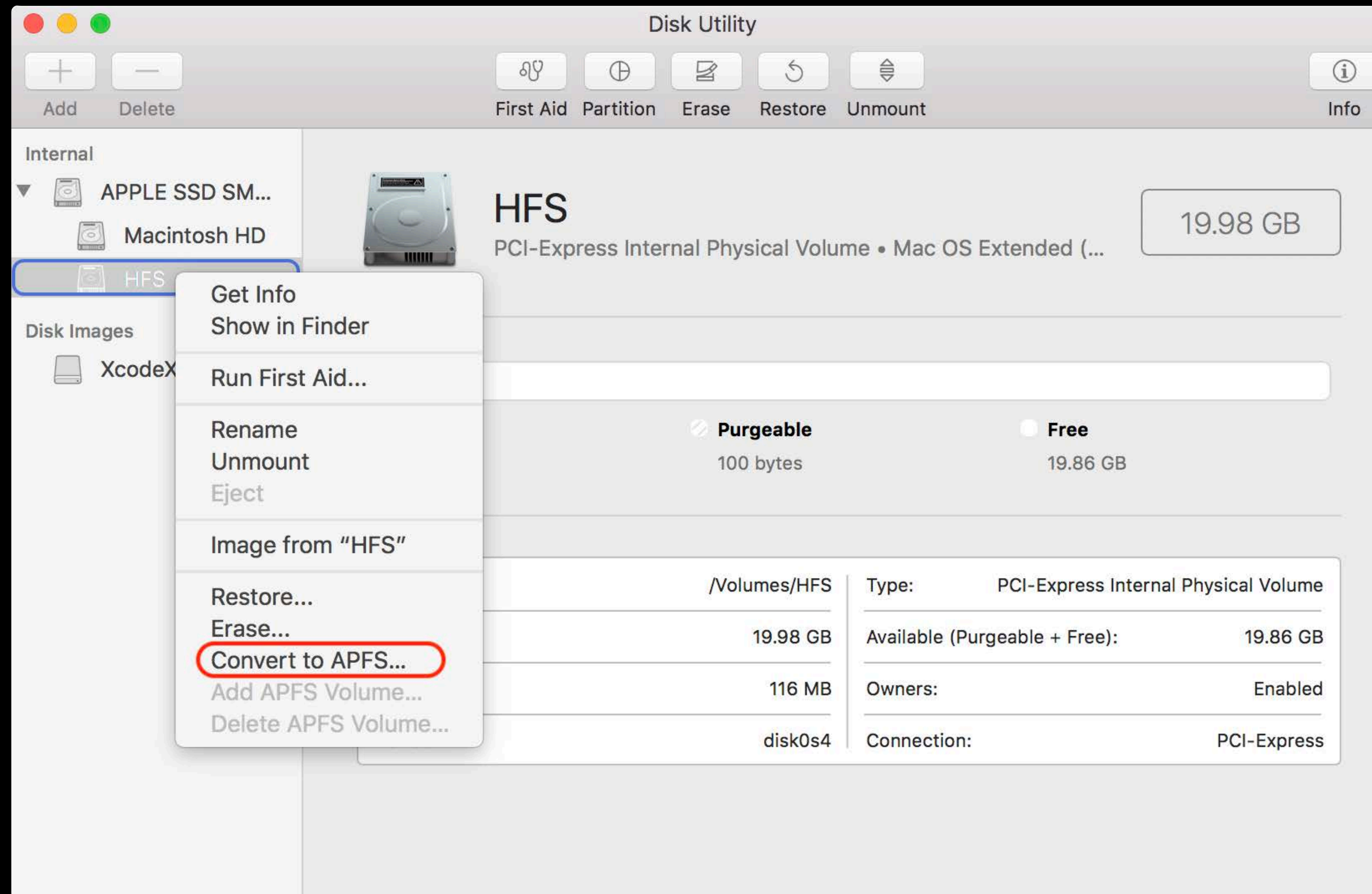
Forward Migration

iOS macOS

APFS

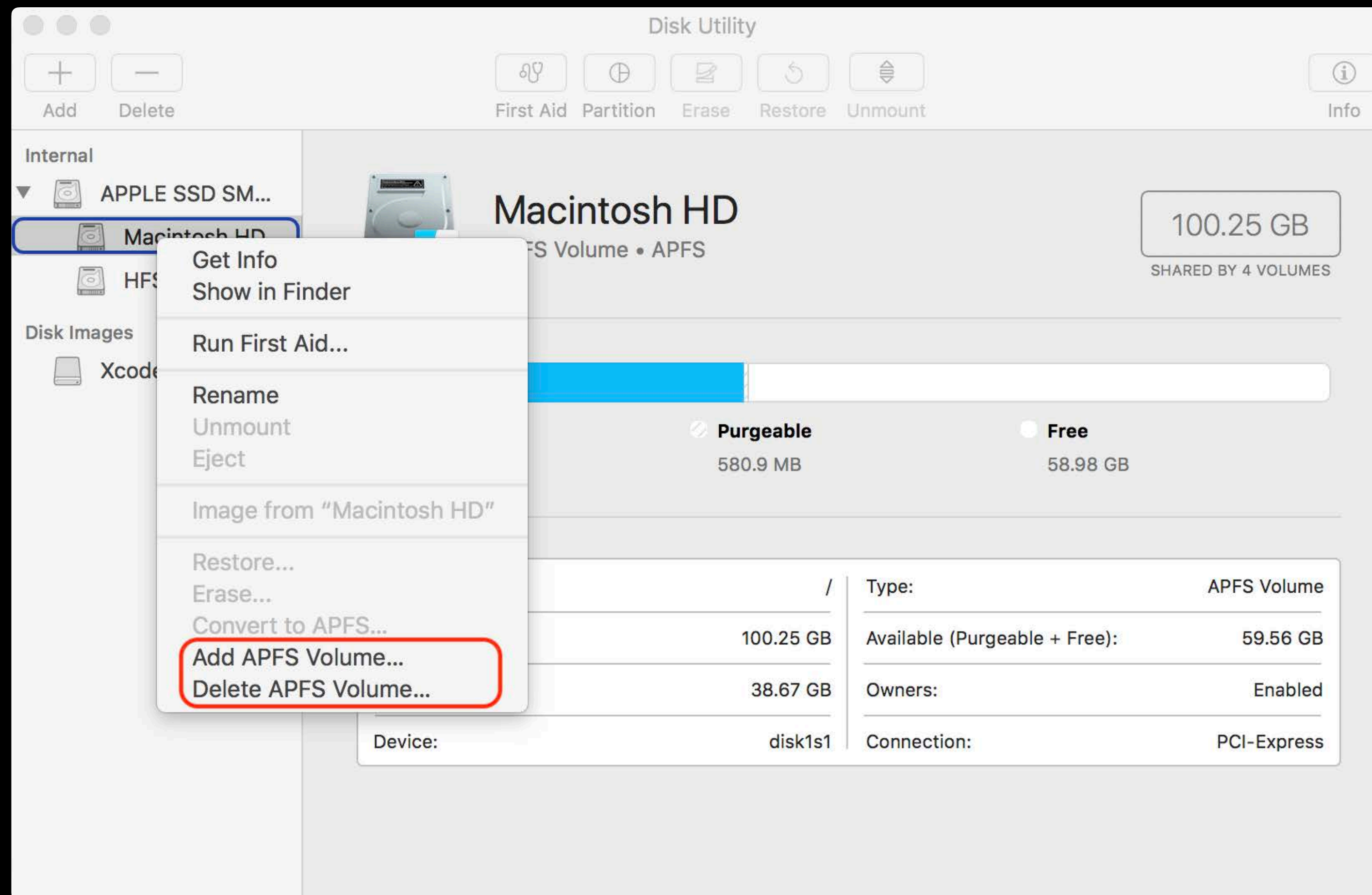
Forward Migration

iOS macOS



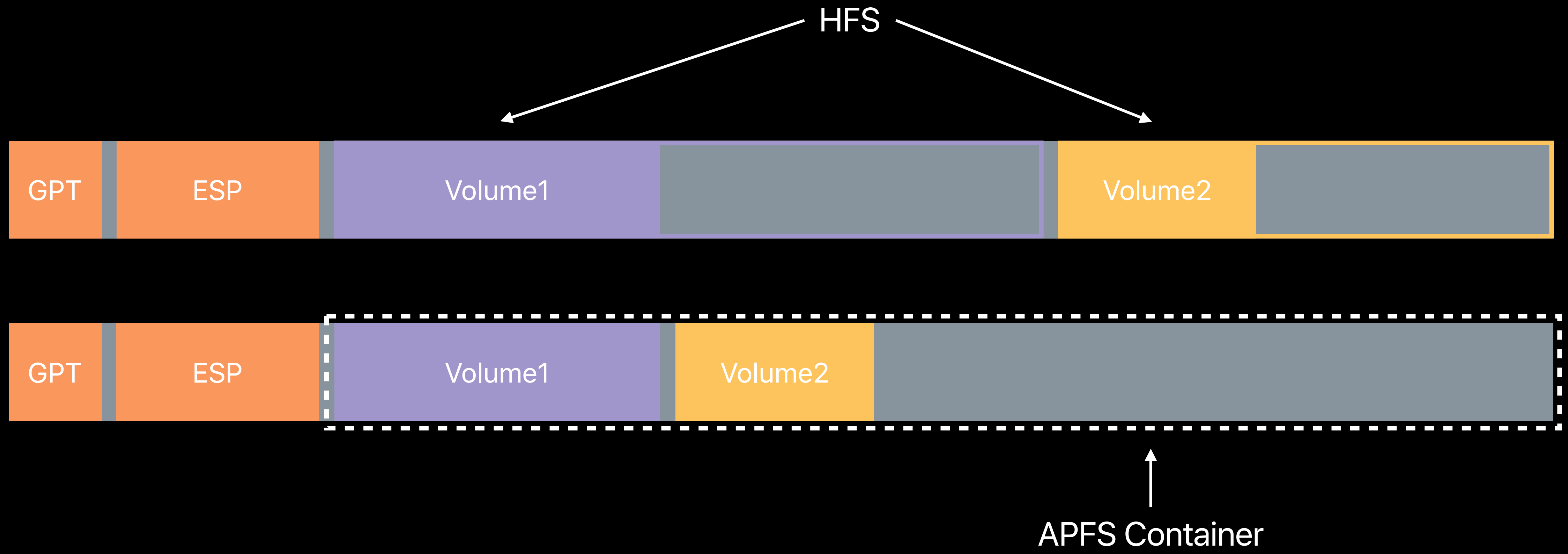
Forward Migration

iOS macOS



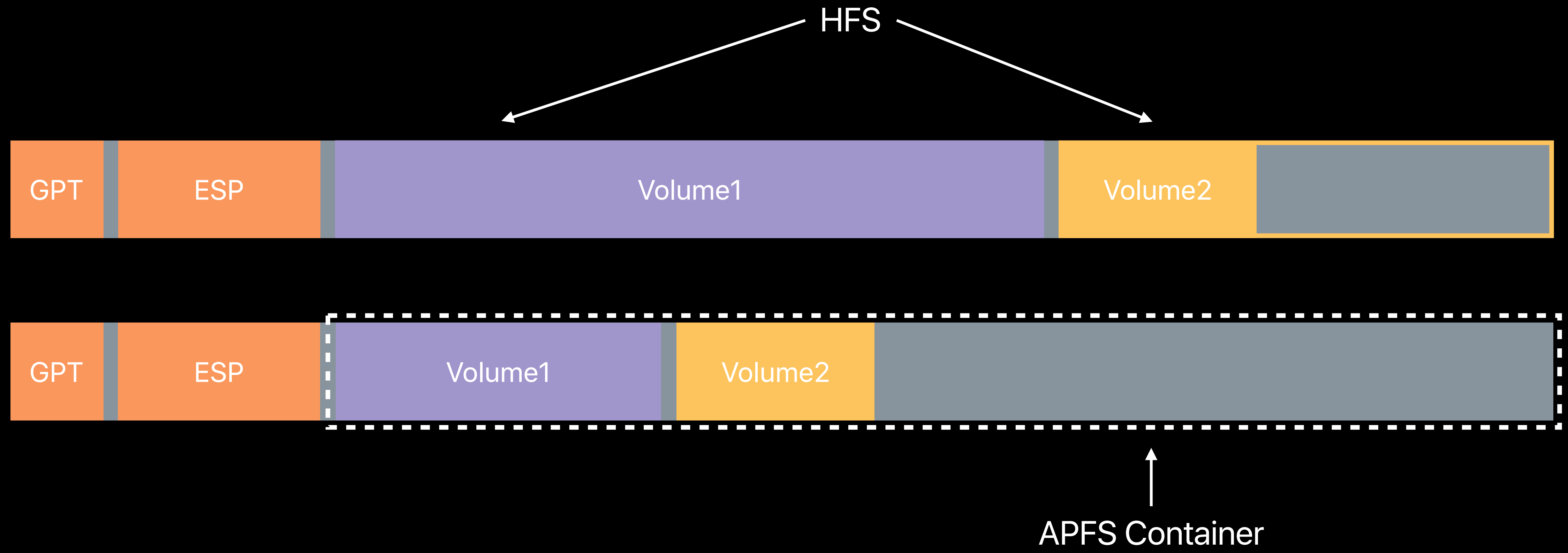
Space Sharing

iOS macOS



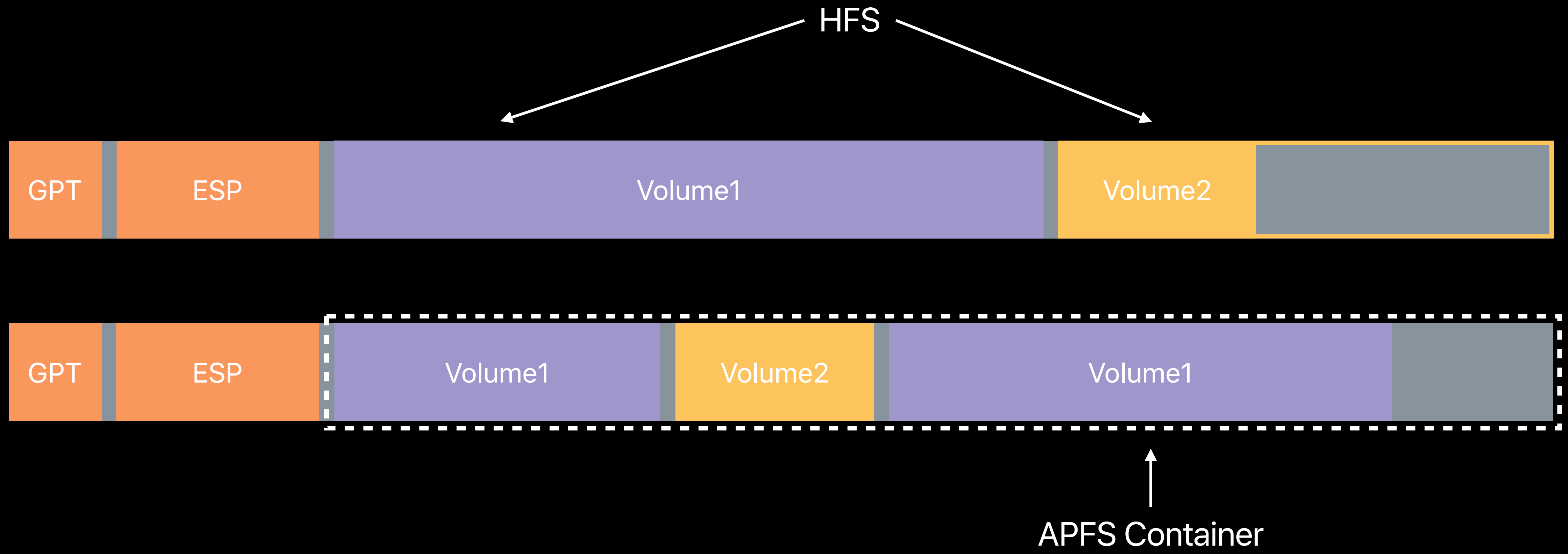
Space Sharing

iOS macOS



Space Sharing

iOS macOS



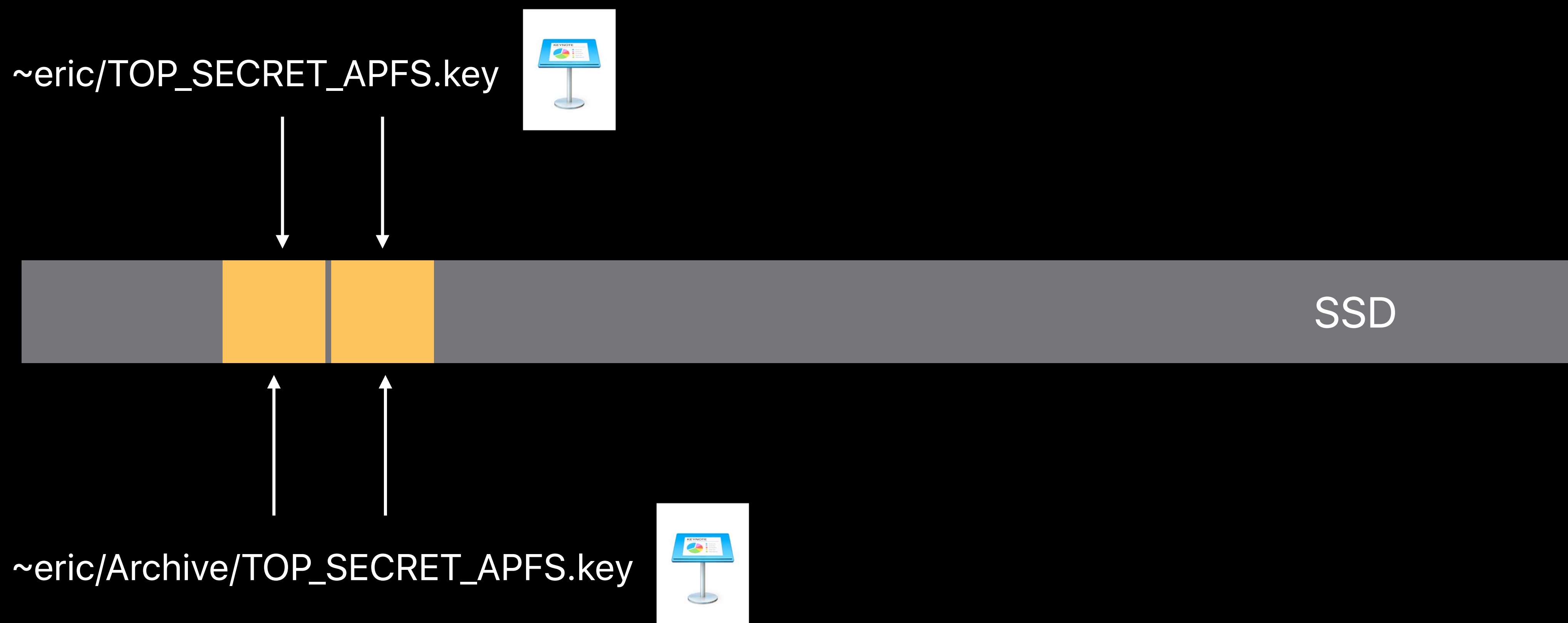
Cloning Files and Directories

iOS macOS



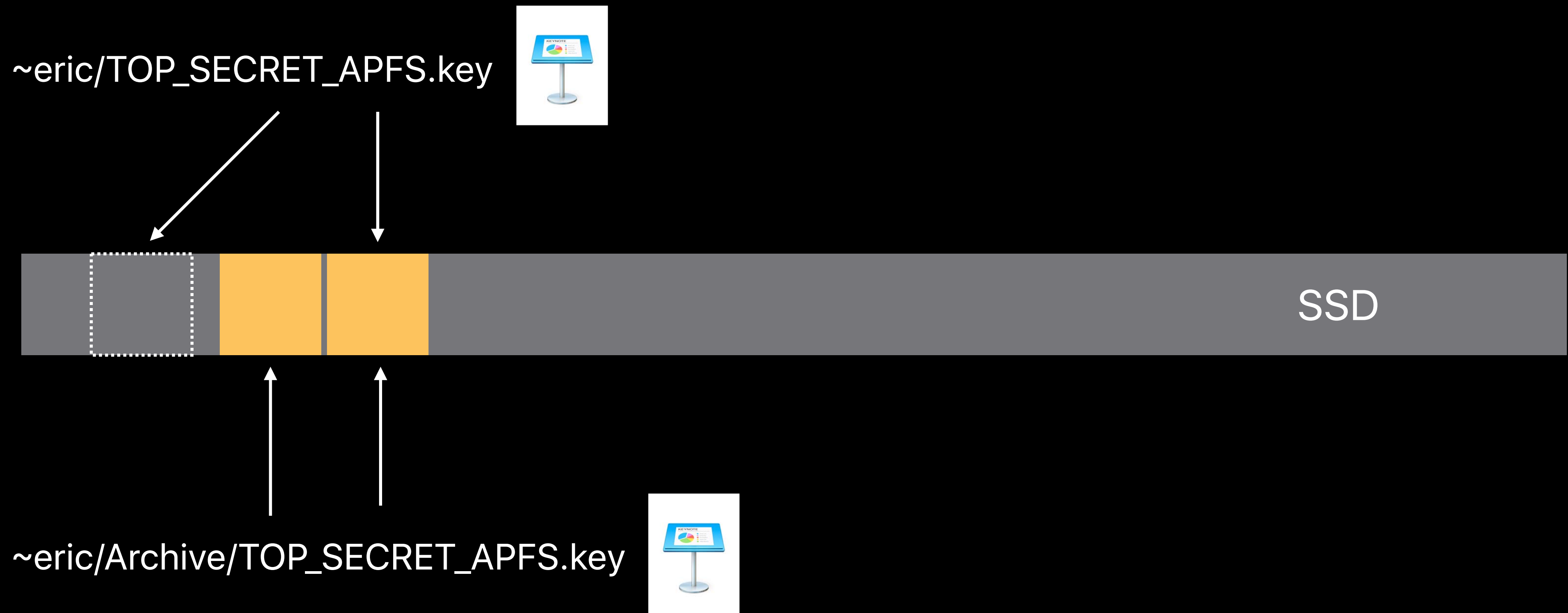
Cloning Files and Directories

iOS macOS



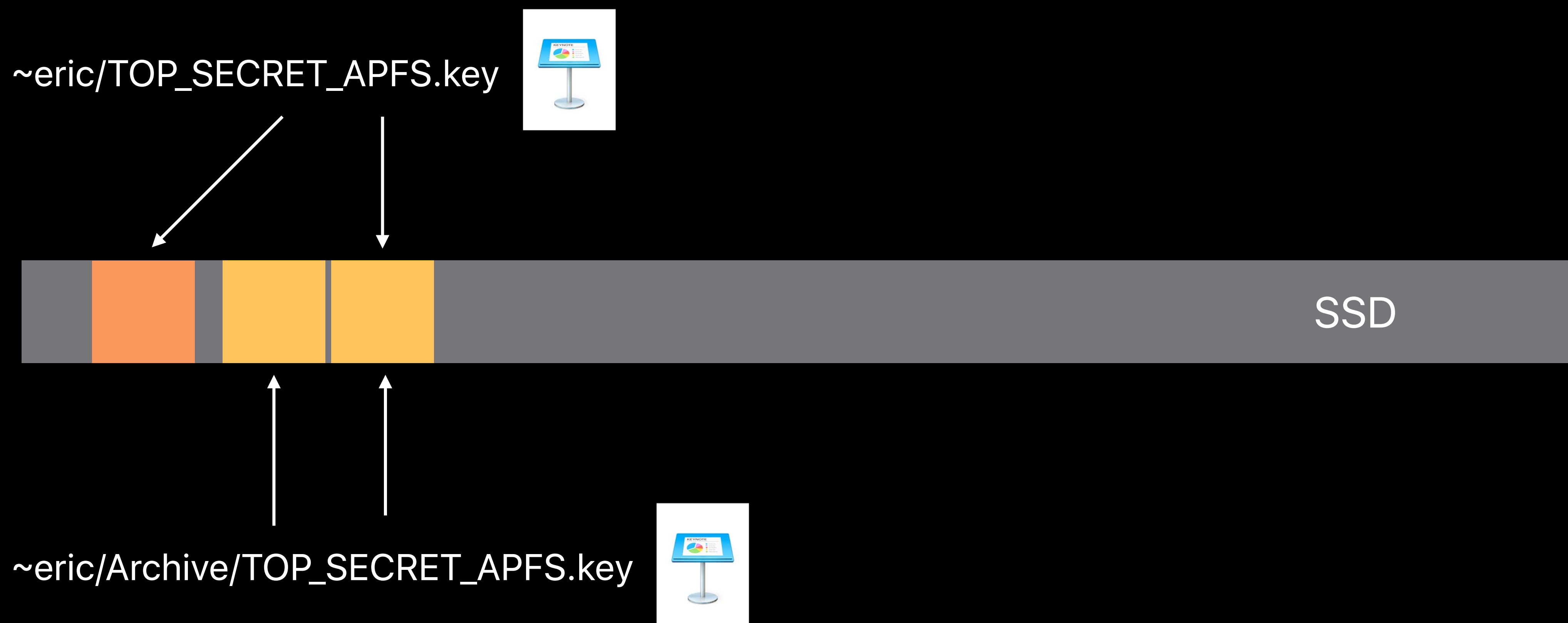
Cloning Files and Directories

iOS macOS



Cloning Files and Directories

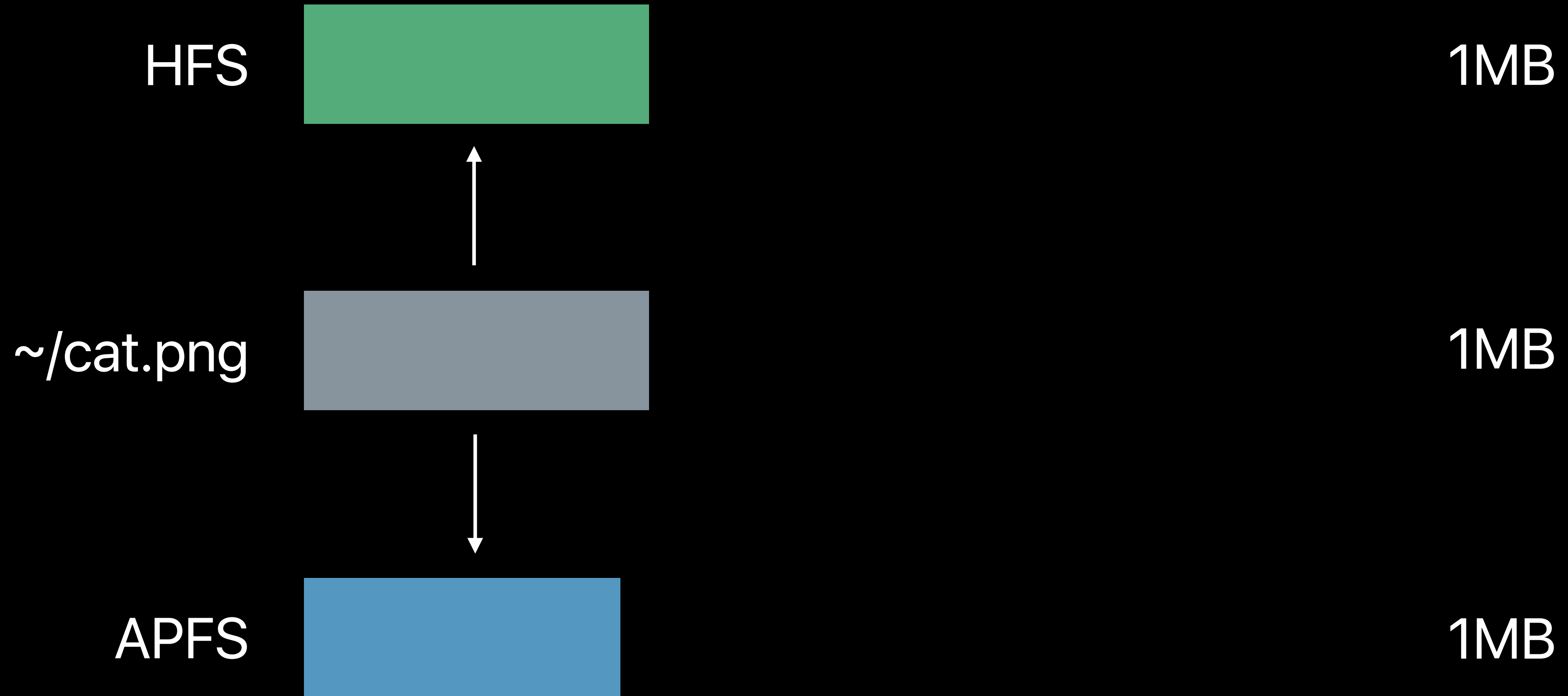
iOS macOS





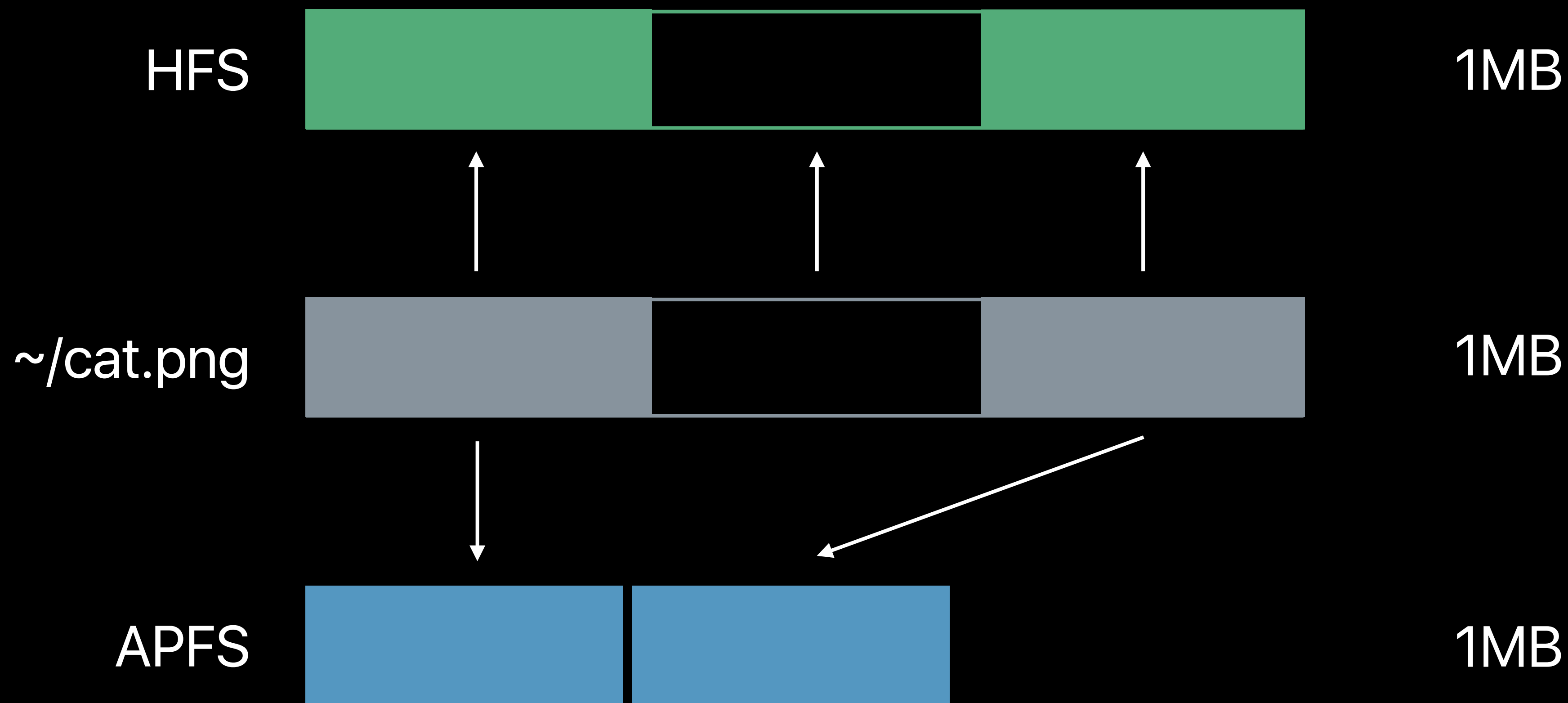
Sparse Files

iOS macOS



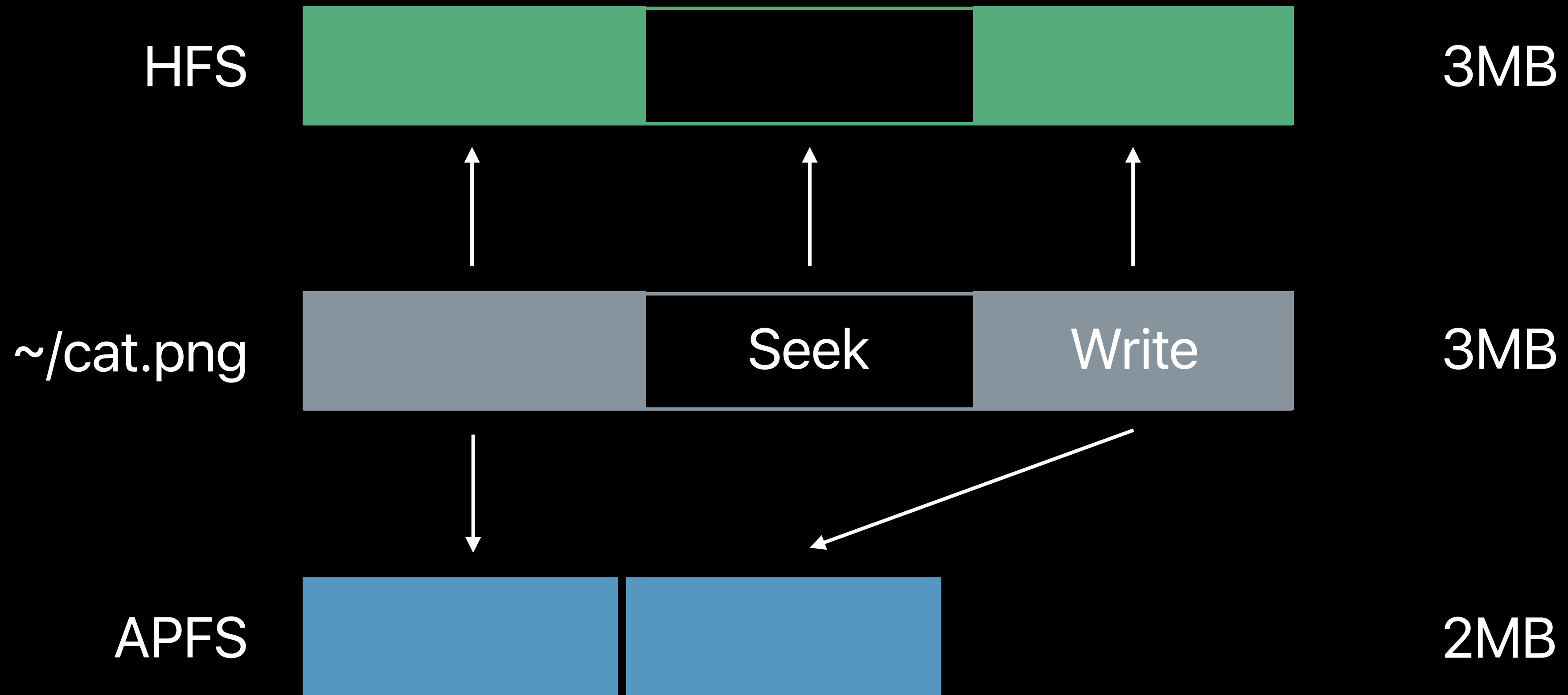
Sparse Files

iOS macOS



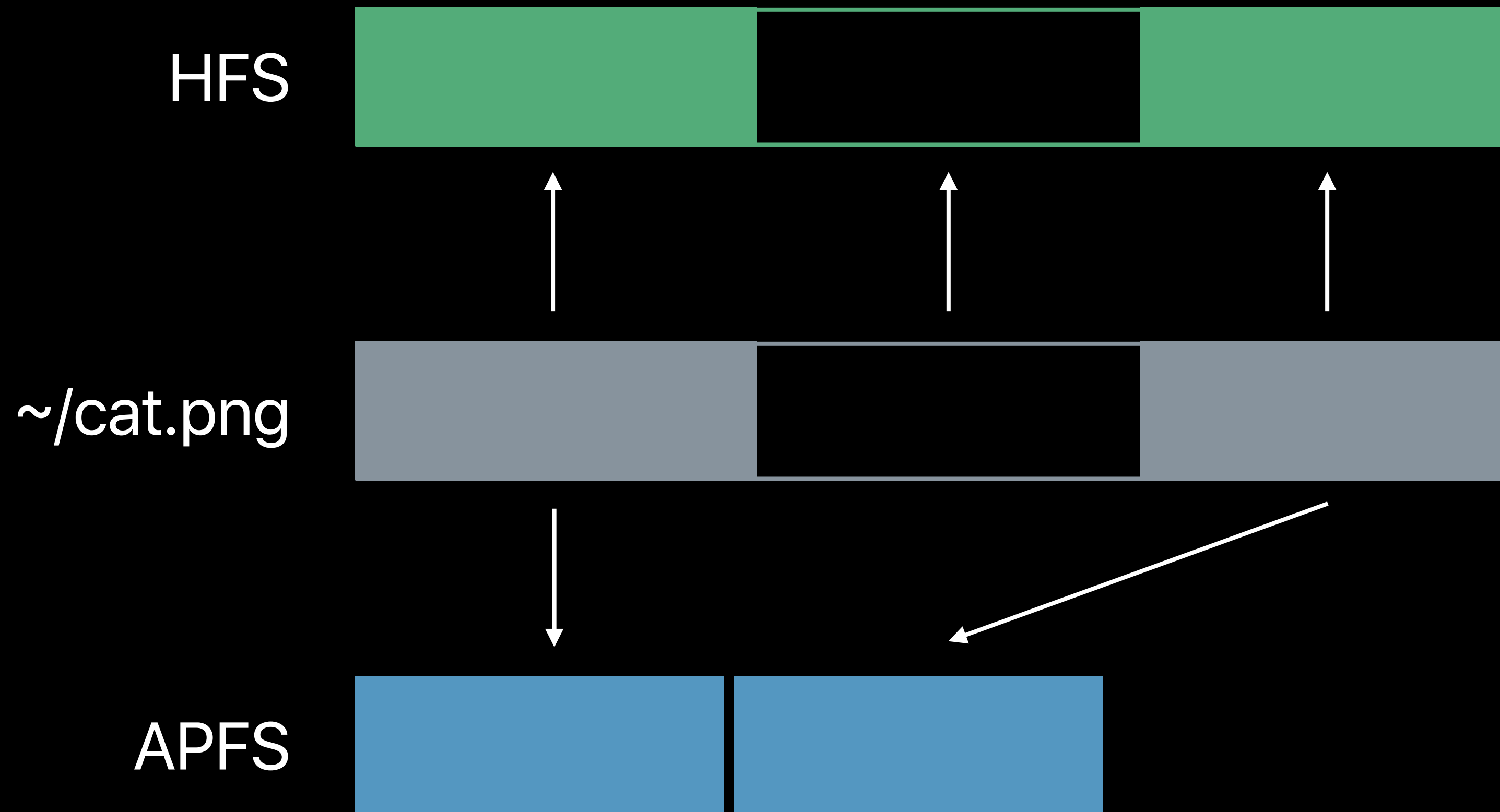
Sparse Files

iOS macOS



Sparse Files

iOS macOS



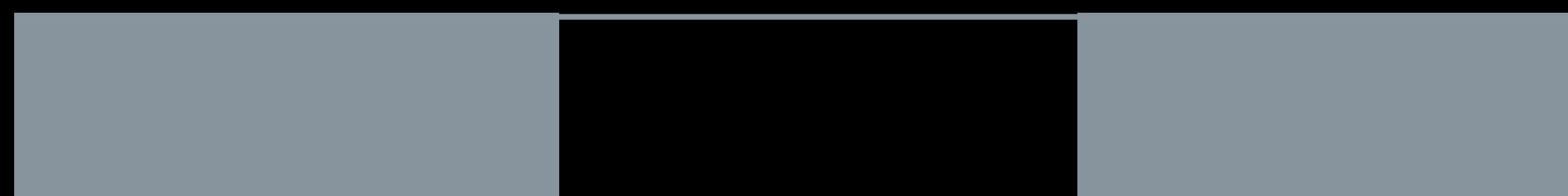
Sparse Files

iOS macOS

HFS



~/cat.png



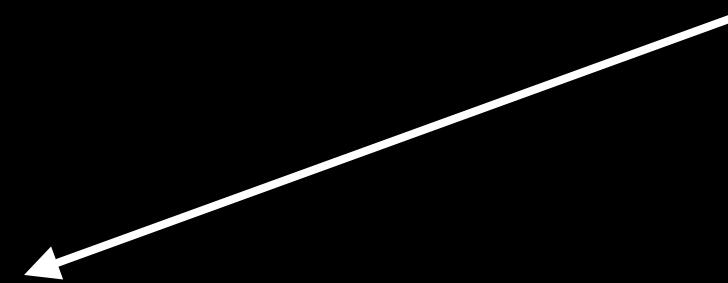
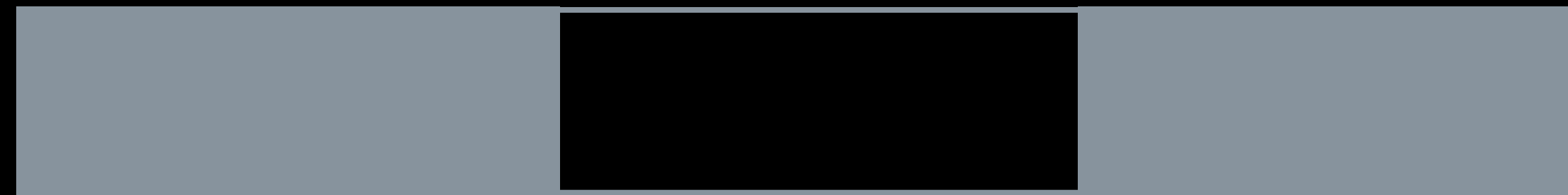
APFS



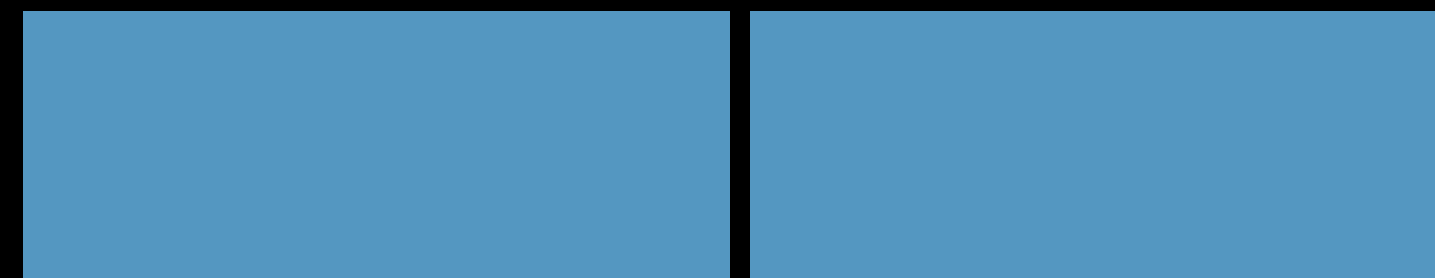
Sparse Files

iOS macOS

~/cat.png

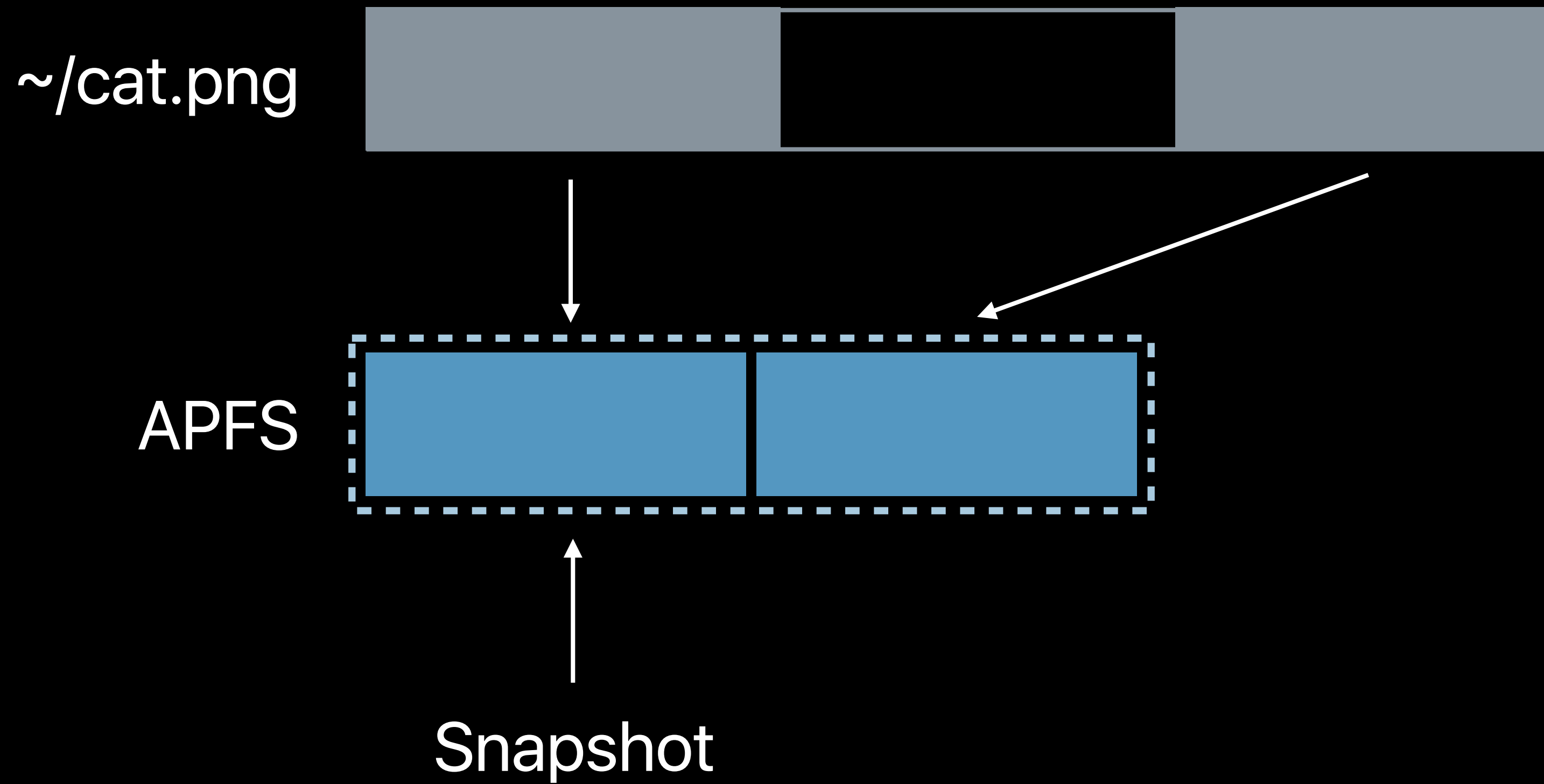


APFS



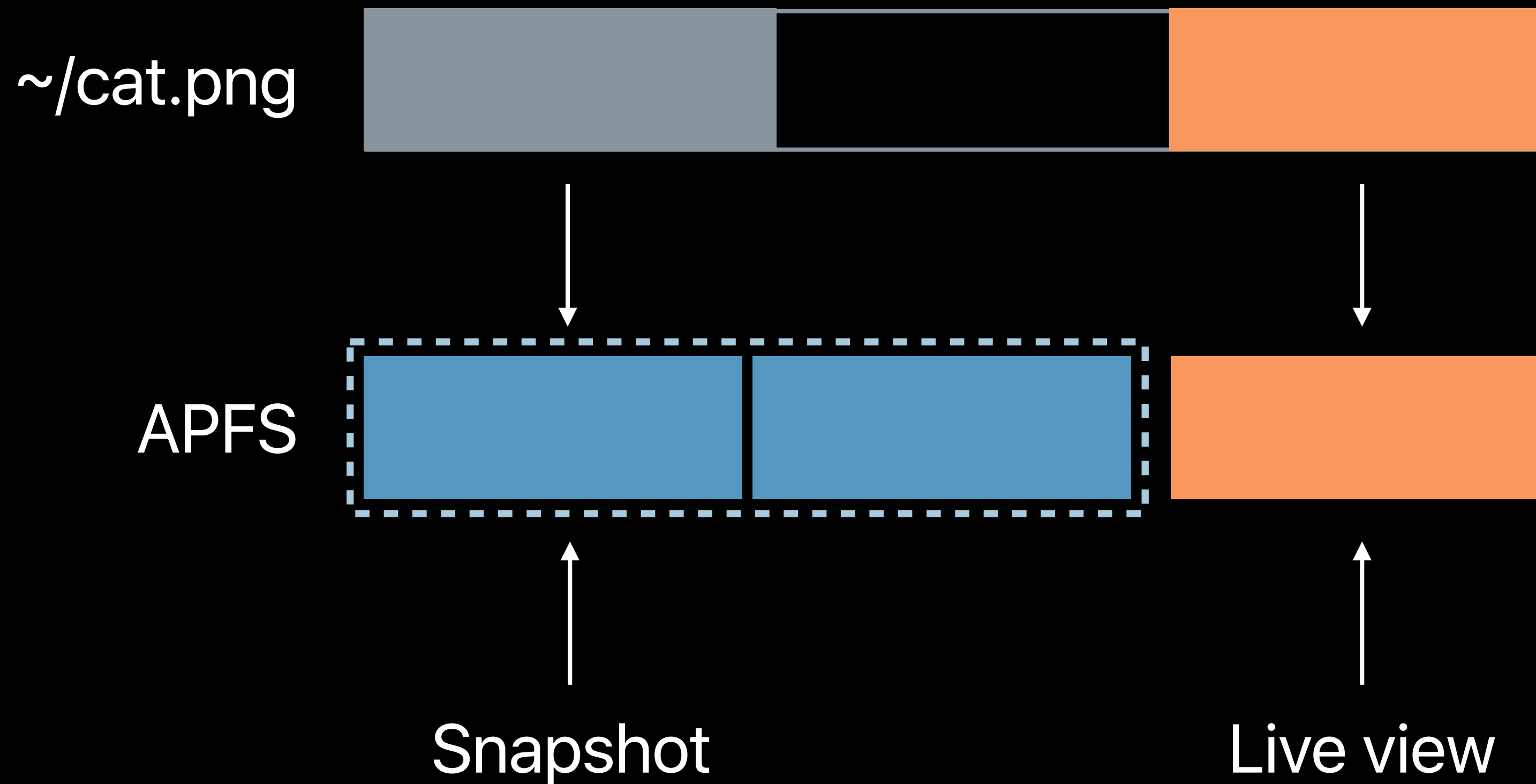
How Big is My File?

iOS macOS



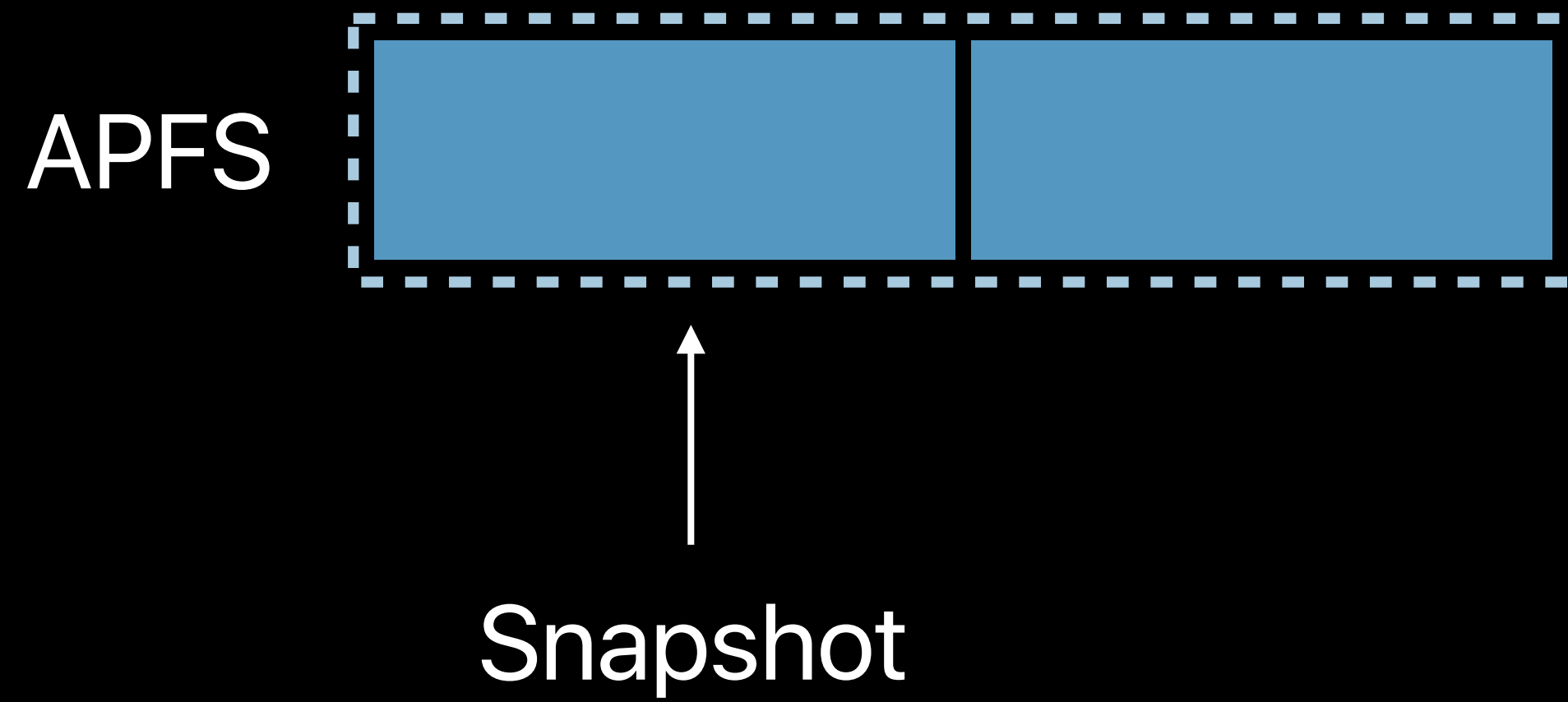
How Big is My File?

iOS macOS



How Big is My File?

iOS macOS



Unicode and Normalization

iOS macOS

Unicode and Normalization

iOS macOS

APFS

HFS

Case-insensitive and normalization-insensitive by default

Case-insensitive and normalizing by default

Unicode 9.0

Unicode 3.2

Forward compatible

Not forward compatible

Unassigned code points are not allowed

Unassigned code points are allowed

Hash based comparison

Lexicographic comparison

Canonical folding

Simplified folding

Unicode 9.0

iOS macOS

Unicode 9.0

iOS macOS

Truly global

Unicode 9.0

iOS macOS

Truly global

Latest emojis

Unicode 9.0

iOS macOS

Truly global

Latest emojis

Unicode 9.0

iOS macOS

Truly global

Latest emojis

Correctness

Boot Support

iOS macOS

Boot Support

iOS macOS

Embedded EFI driver

Future proof

Encrypted and Fusion volumes are supported

More secure

Encryption

iOS macOS

Encryption

iOS macOS

FileVault model

Converter for existing FileVault

Passwords and recovery keys are preserved

Snapshots are encrypted

Fusion

iOS

macOS

Fusion

iOS macOS

All metadata is on SSD

Write back cache

Read cache

Defragmentation

iOS macOS

Defragmentation

iOS macOS

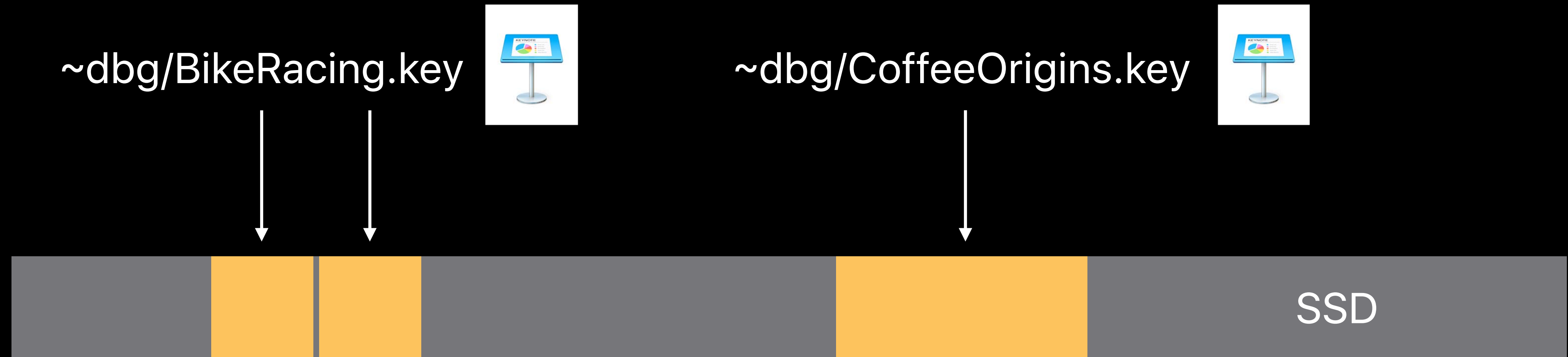
Intelligent defragmenter

Defragments on HDD only

Active when your machine is idle

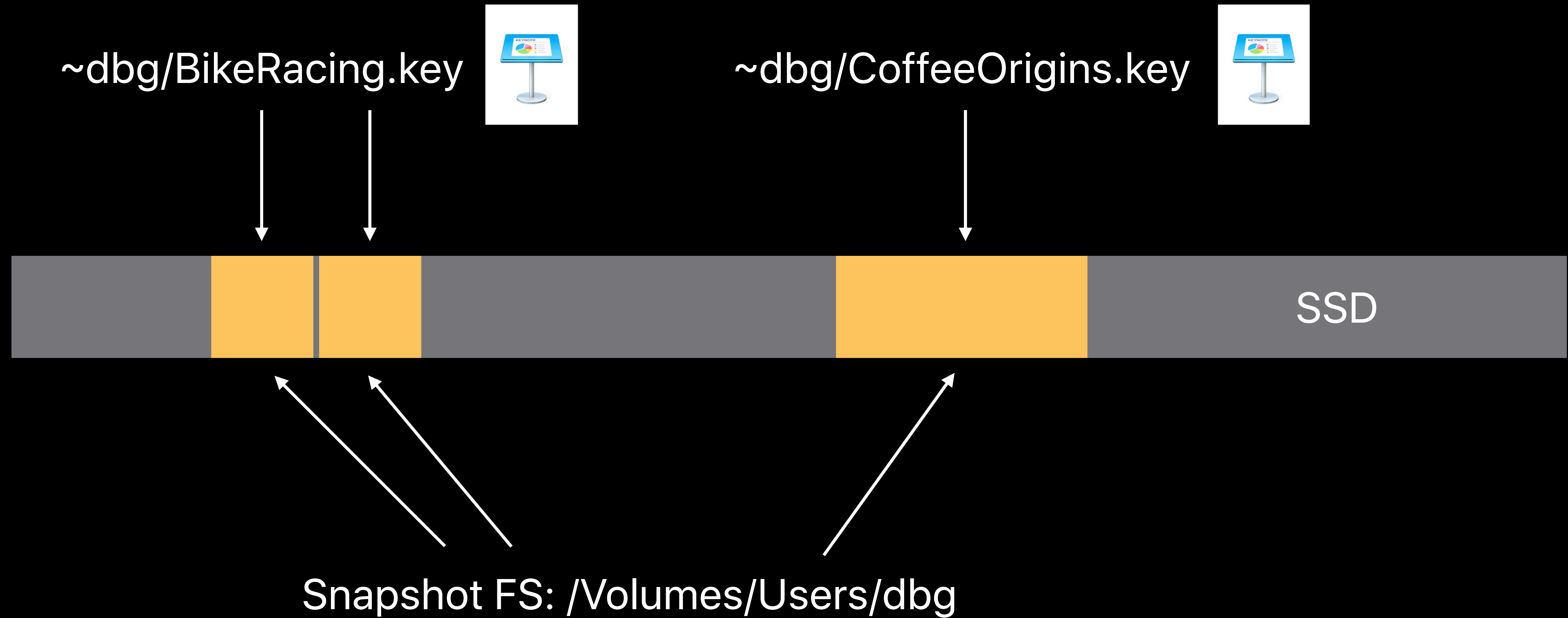
File System Snapshots

iOS macOS



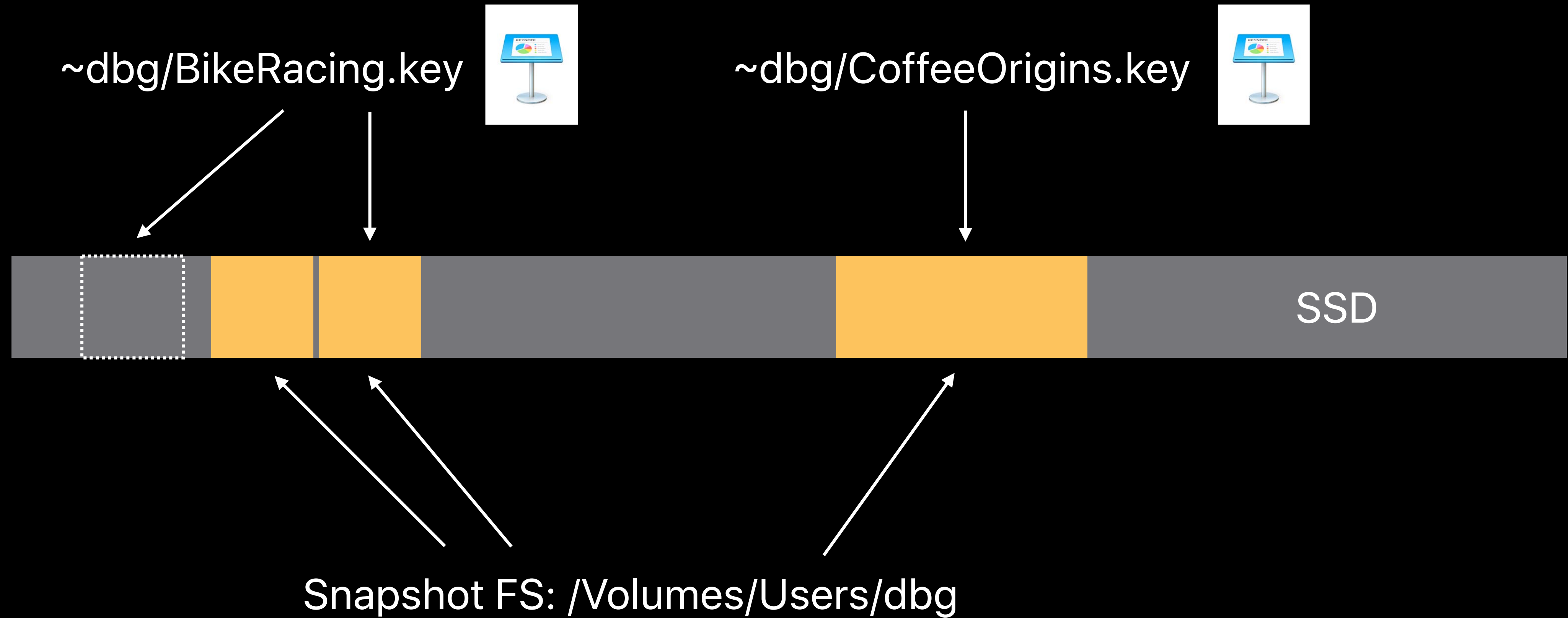
File System Snapshots

iOS macOS



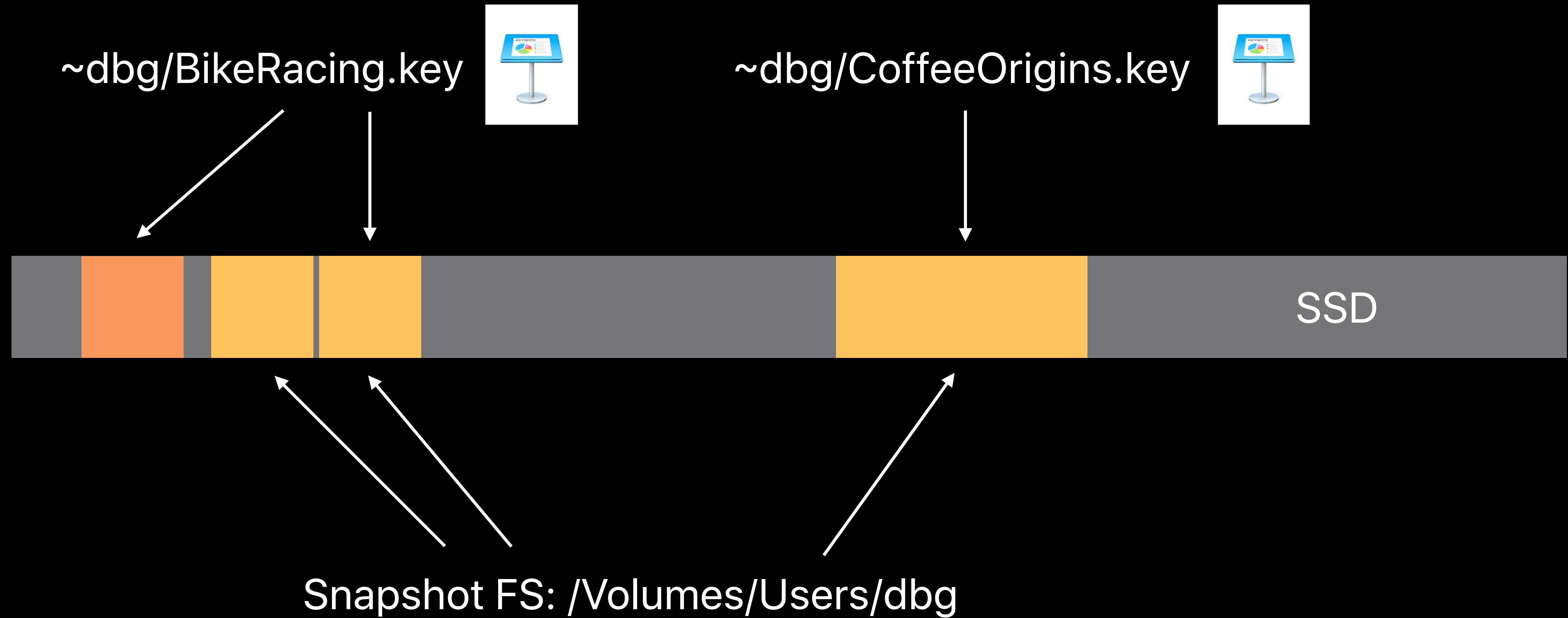
File System Snapshots

iOS macOS



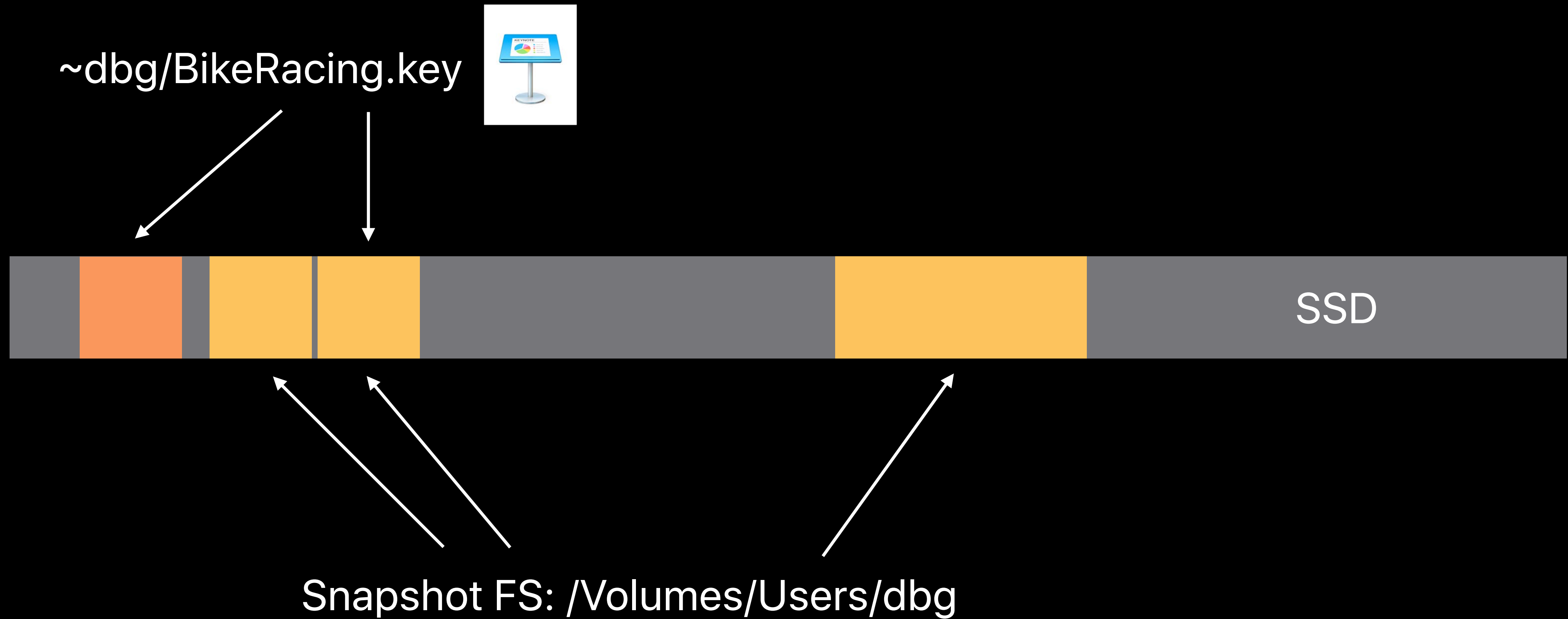
File System Snapshots

iOS macOS



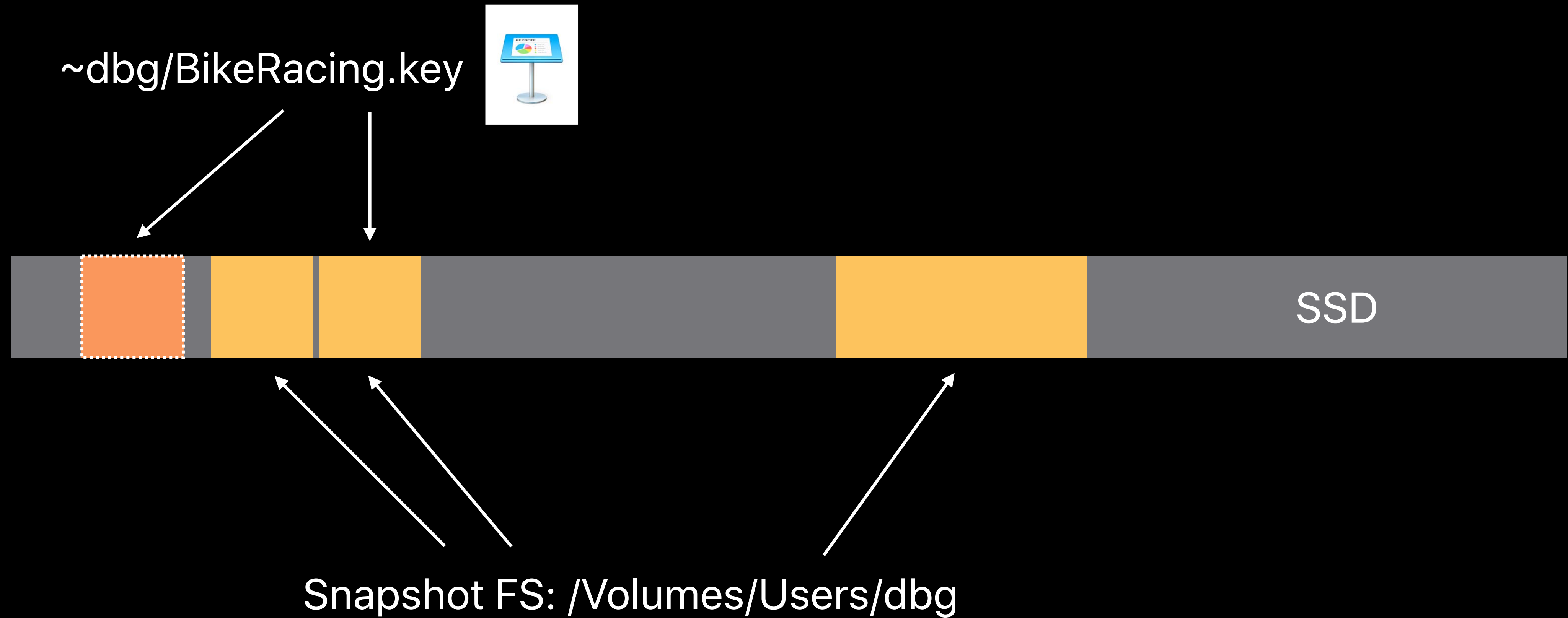
File System Snapshots

iOS macOS



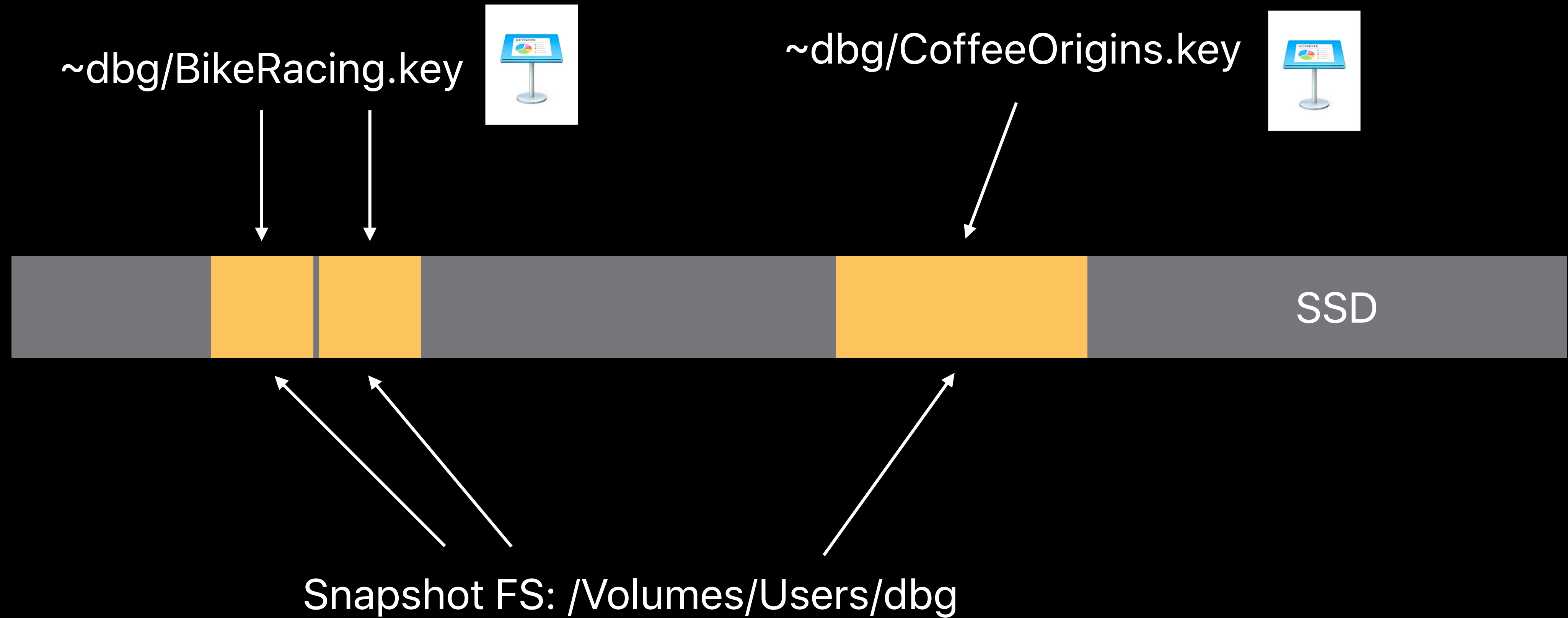
Reverting to a Snapshot

iOS macOS



Reverting to a Snapshot

iOS macOS



Snapshots

iOS macOS

Snapshots

iOS macOS

Snapshots are fast to take

Snapshots occupy space

Creating snapshots requires entitlements

Please talk to us if you want to use snapshots

iOS macOS

Demo

Pavel Císler, Manager, Finder and Time Machine

```
// Swift APIs
```

```
import Foundation
```

```
open class FileManager : NSObject {
```

```
    open func copyItem(at srcURL: URL, to dstURL: URL) throws
```

```
    open func replaceItem(at originalItemURL: URL, withItemAt newItemURL: URL, backupItemName: String?, options: FileManager.ItemReplacementOptions = [], resultingItemURL resultingURL: AutoreleasingUnsafeMutablePointer<NSURL?>?) throws
```

```
}
```


Guidelines

iOS macOS

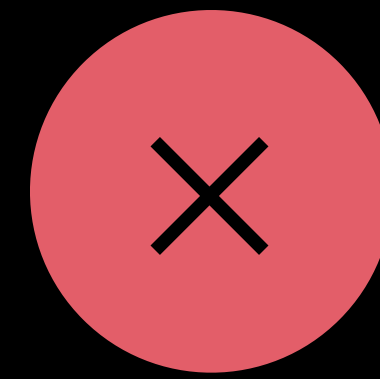


Recommended

```
renamex_np()
```

Foundation APIs

```
copyfile() + COPYFILE_CLONE
```



Deprecated

```
exchangedata()
```

Carbon APIs

Caveats for WWDC Preview

iOS macOS

HDD-based systems are not automatically converted

We are working on performance improvements

Bootable APFS requires running installer

Summary

APFS is coming to macOS!

Fusion drives, encryption, space sharing, cloning, and snapshots

Please test your apps for compatibility with APFS installations

Please report any bugs you encounter with APFS

More Information

<https://developer.apple.com/wwdc17/715>

Labs

Apple File System Lab

Technology Lab D

Fri 10:00AM–12:00PM

