



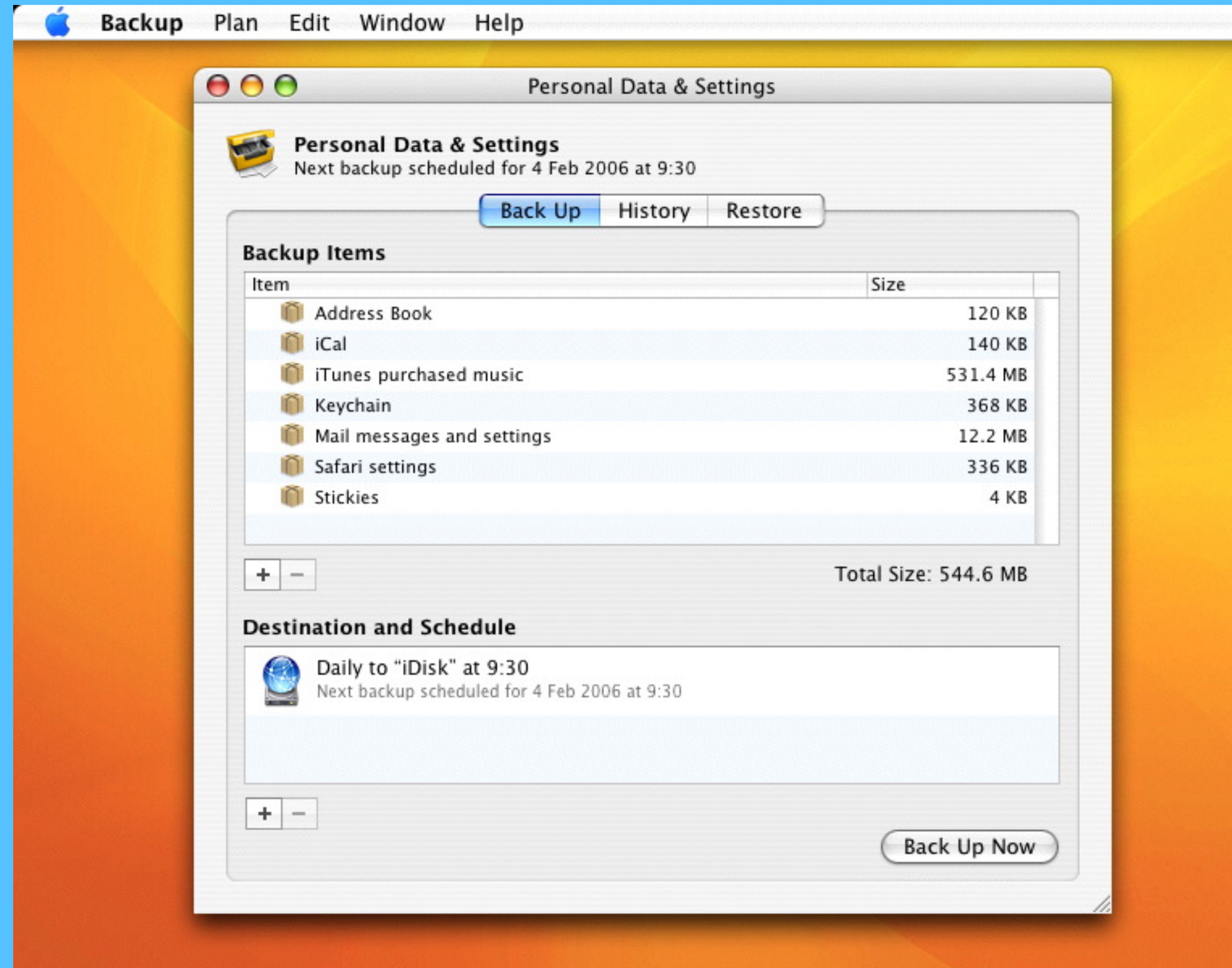
Time Machine to APFS

a 14-year journey

Howard Oakley



Backup early 2007





Time Machine

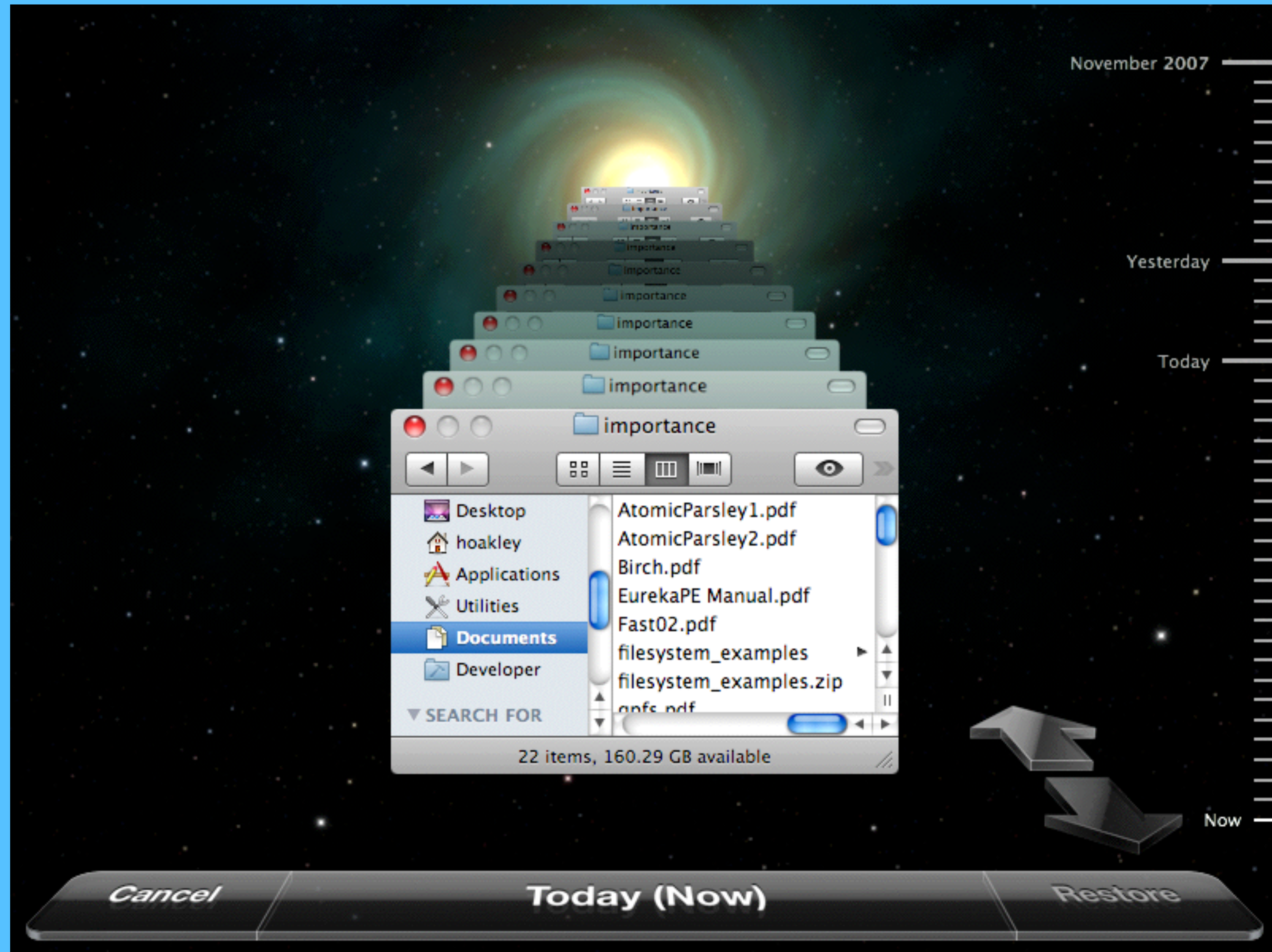
October 2007





Time Machine

October 2007





Time Machine

October 2007

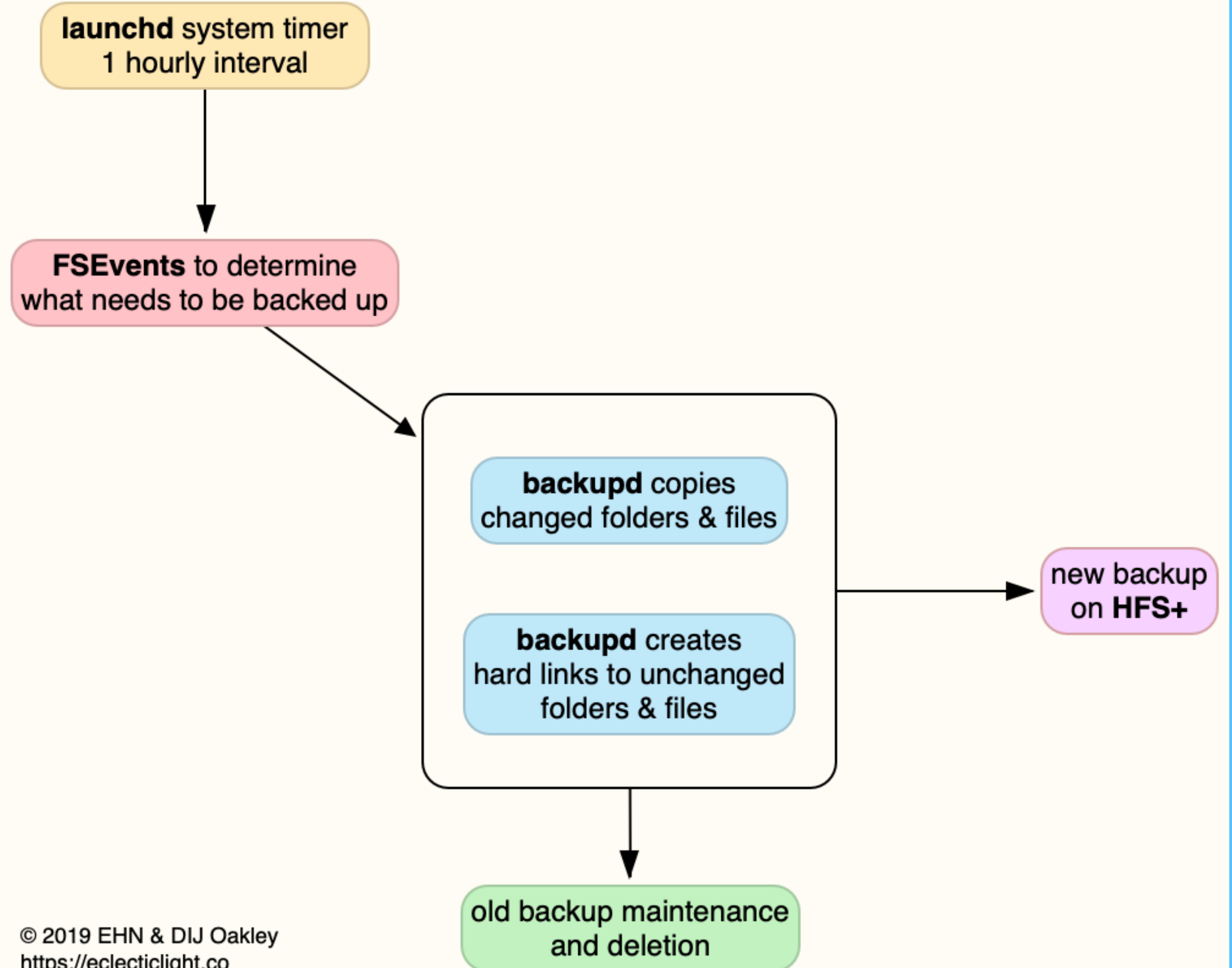
- hourly backups via launchd
- FSEvents scan to discover changed files
- exclusion list
- whole changed files copied
- unchanged directories and files use hard links
- backup tree to create illusion
- all stored in a single HFS+ file system



Time Machine

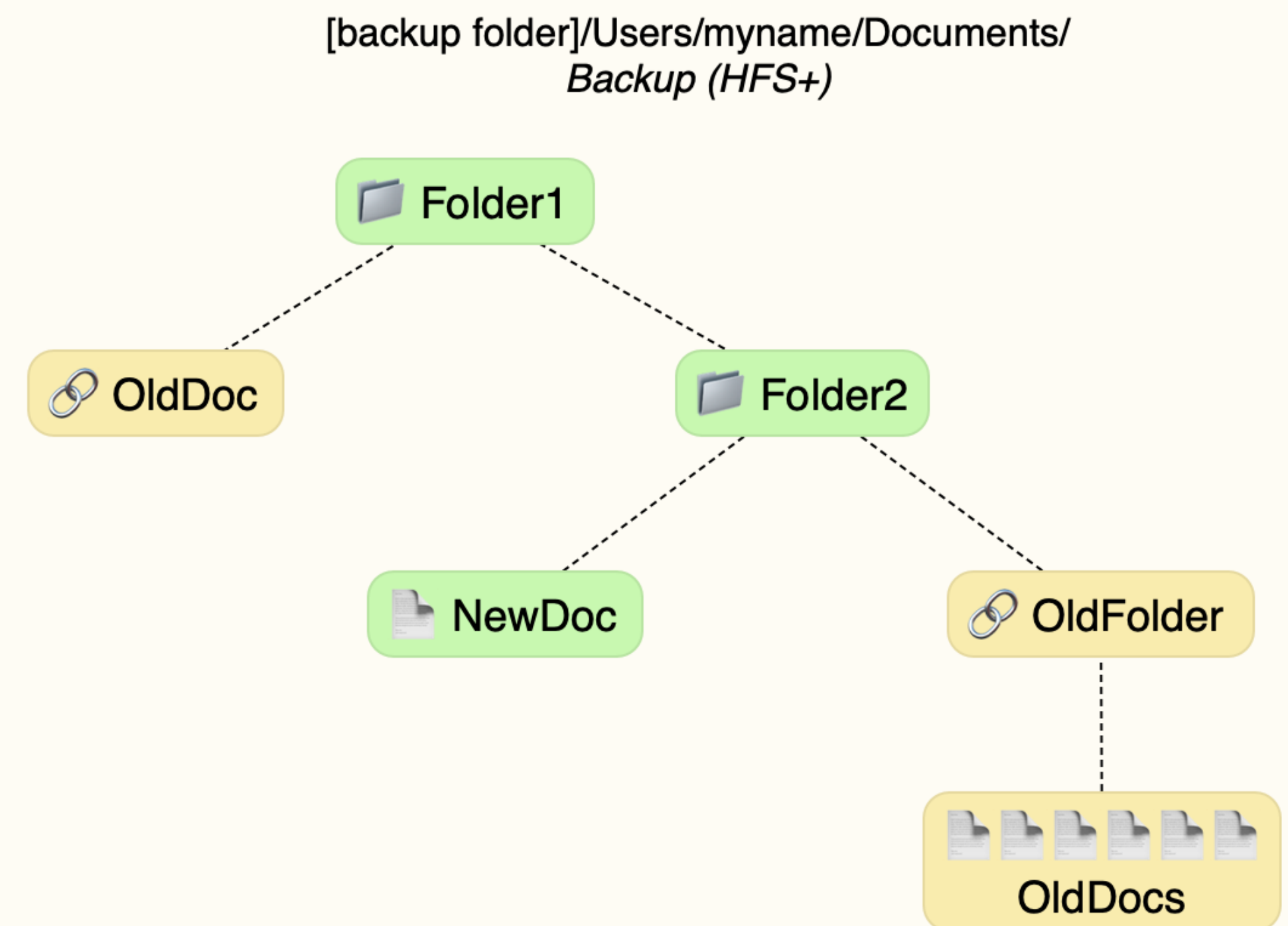
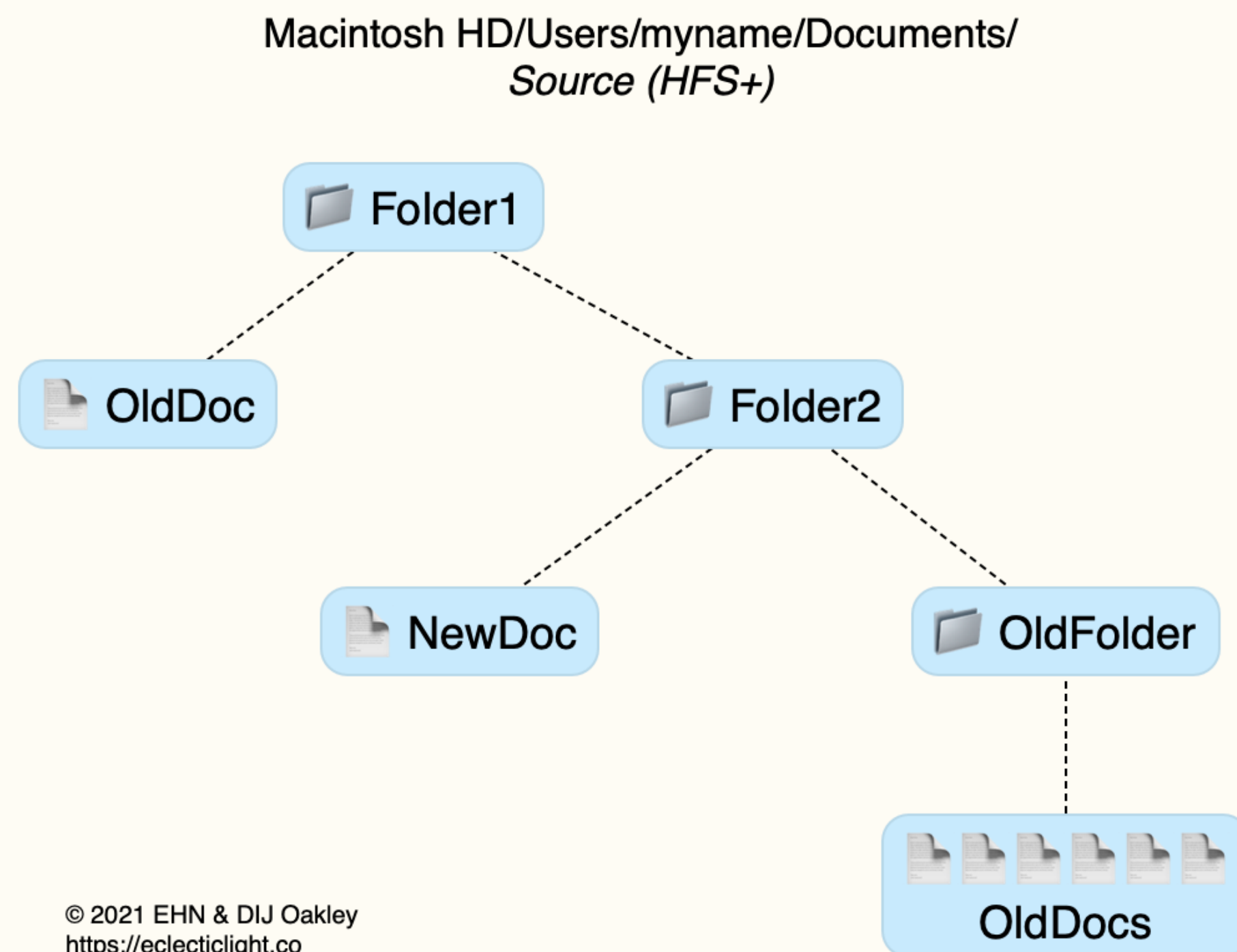
October 2007

Time Machine: Mac OS X 10.5





Traditional HFS+ Backup





Time Capsule

February 2008





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eclecticlight.co

APPLICATION

CTS

DAS

Waiting

DAS rescoring of activities

DAS assessment
DAS CurrentScore > ThresholdScore
DAS DecisionToRun:0

DAS rescoring of activities

DAS assessment
DAS CurrentScore > ThresholdScore
DAS DecisionToRun:1

Running

CTS runs activity
DAS told us to run com.apple.backupd-auto
evaluating activities
com.apple.backupd-auto state change 1 -> 2
Initiating XPC Activity: com.apple.backupd-auto
taking power assertion: com.apple.backupd-auto: 35264

Runs backupd-auto
which then runs backupd to perform backup

Activity completes
com.apple.backupd-auto state change 2 -> 5
Completed XPC Activity: com.apple.backupd-auto
Completing DASActivity: 0:com.apple.backupd-auto

Activity rescheduled
Rescheduling XPC Activity: com.apple.backupd-auto
Submitting DASActivity: <_DASActivity: "0:com.apple.backupd-auto", Utility, 60s, [12/05/2017, 10:01:23 - 12/05/2017, 10:03:23], Plugin Required, Dark-Wake Eligible>
releasing power assertion: 35264

Updated in DAS activities



High Sierra: APFS

September 2017

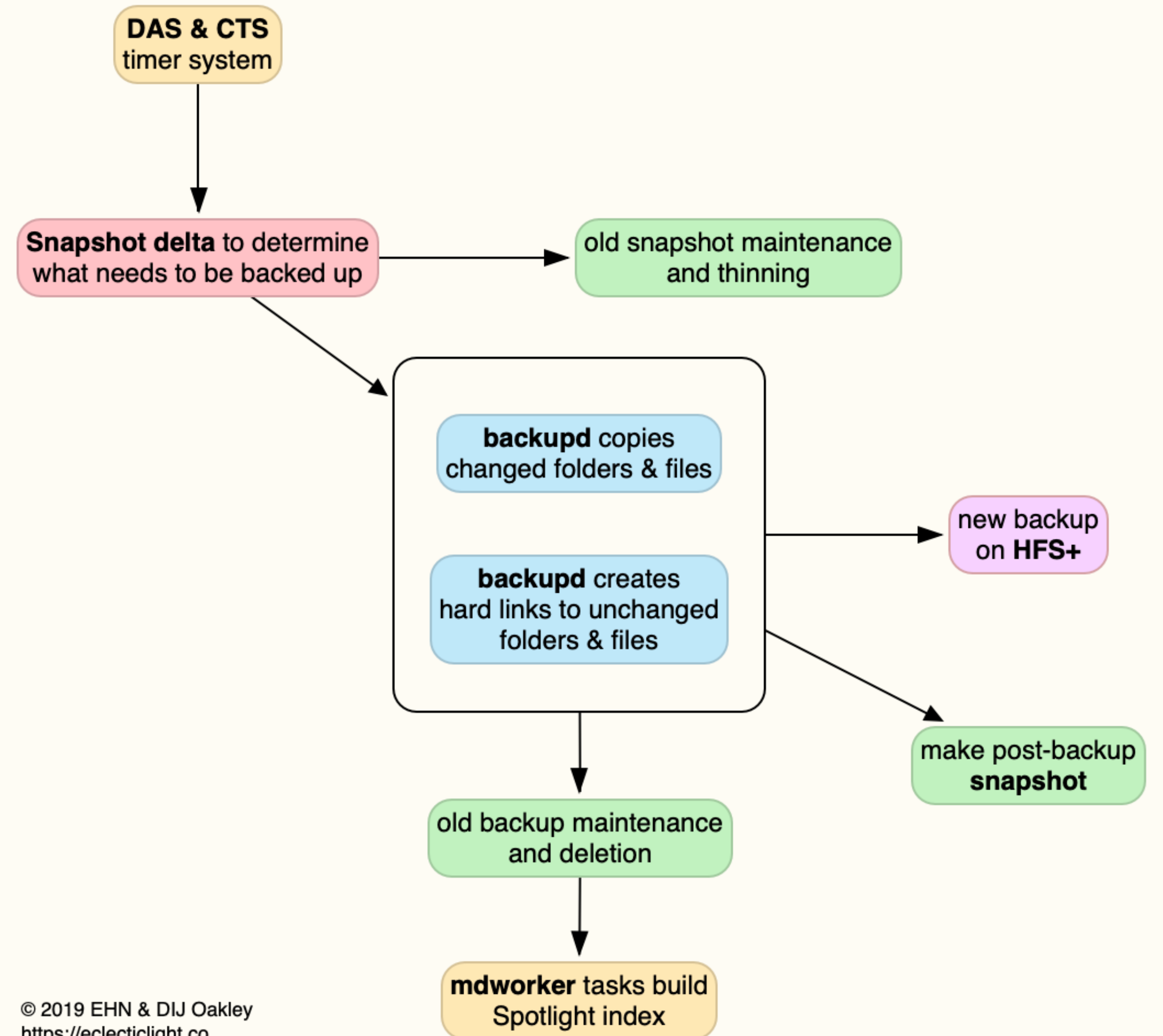
- modern file system
- copy on write for reliability
- snapshots; previous Mobile Time Machine was $> 10,000$ lines of code
- no directory hard links
- clone files
- sparse files



macOS Mojave

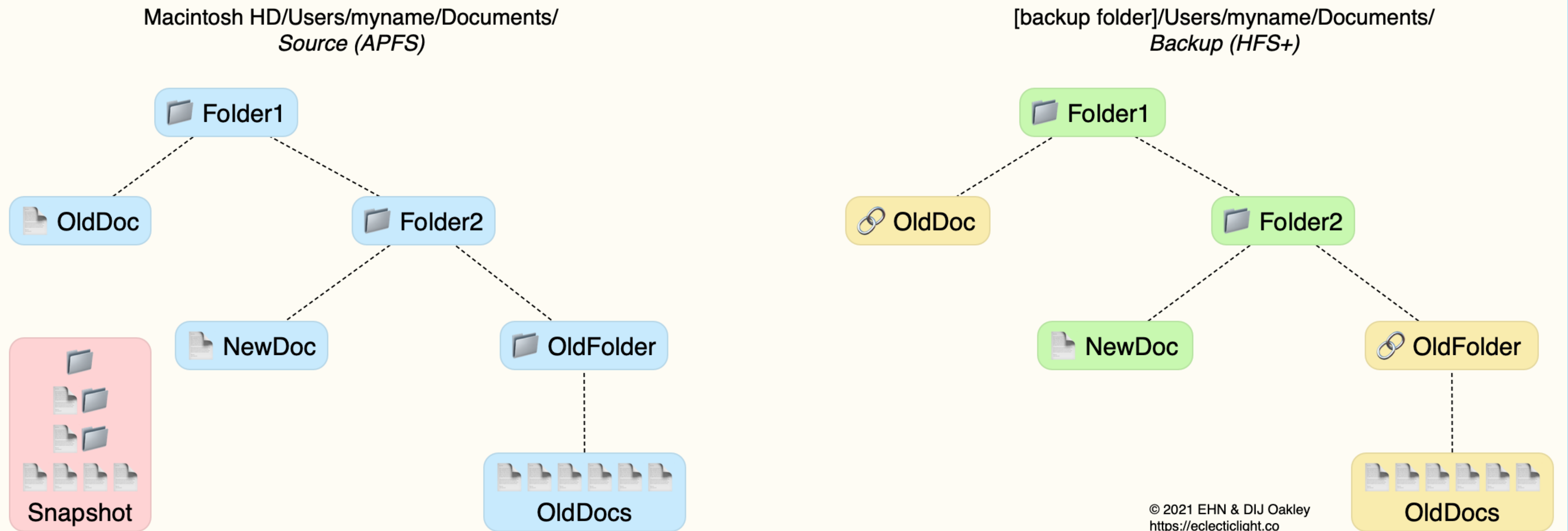
September 2018

Time Machine: macOS 10.14 + APFS



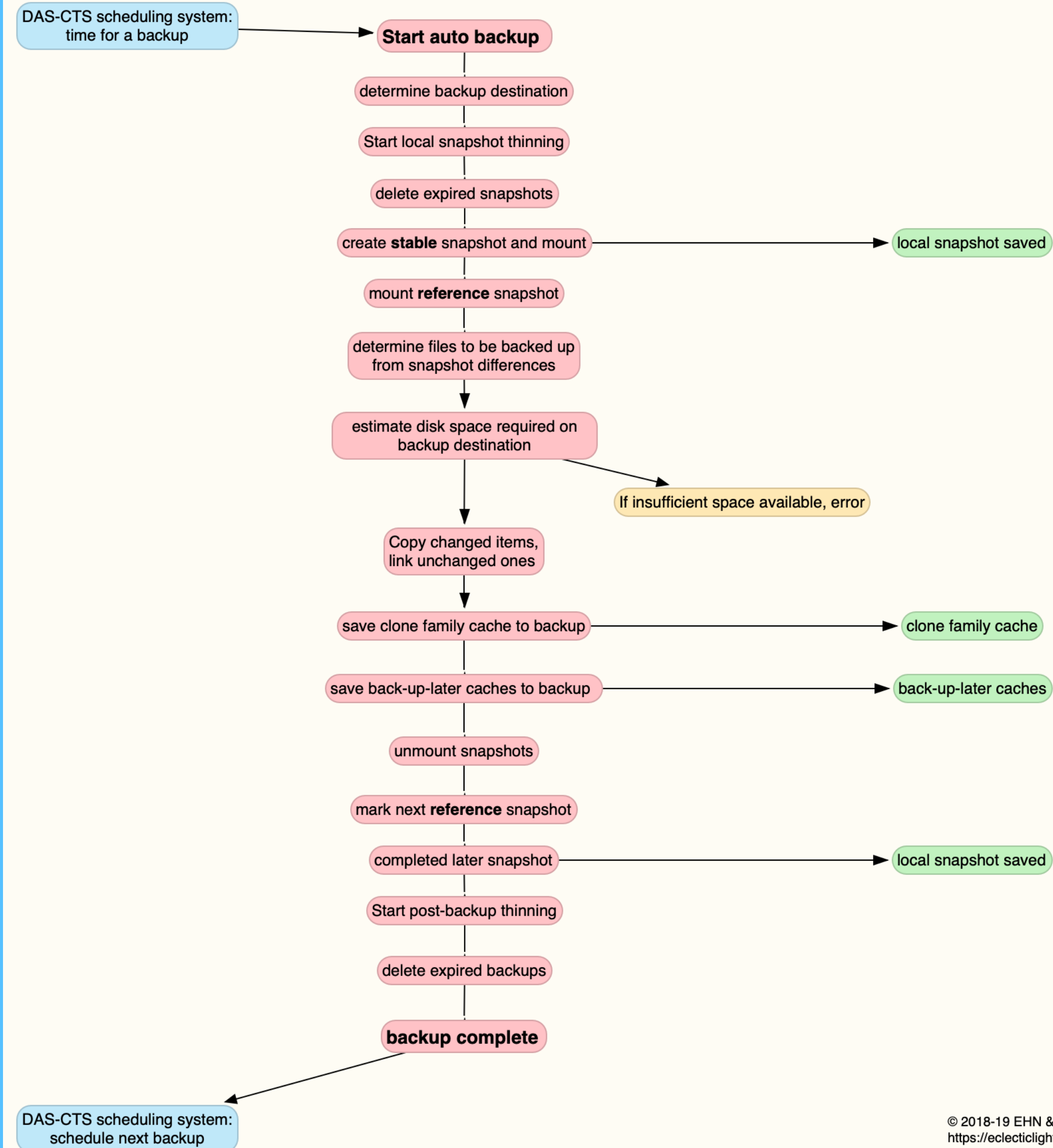


Mixed APFS & HFS+ Backup





Time Machine backups from APFS (10.13-10.14)

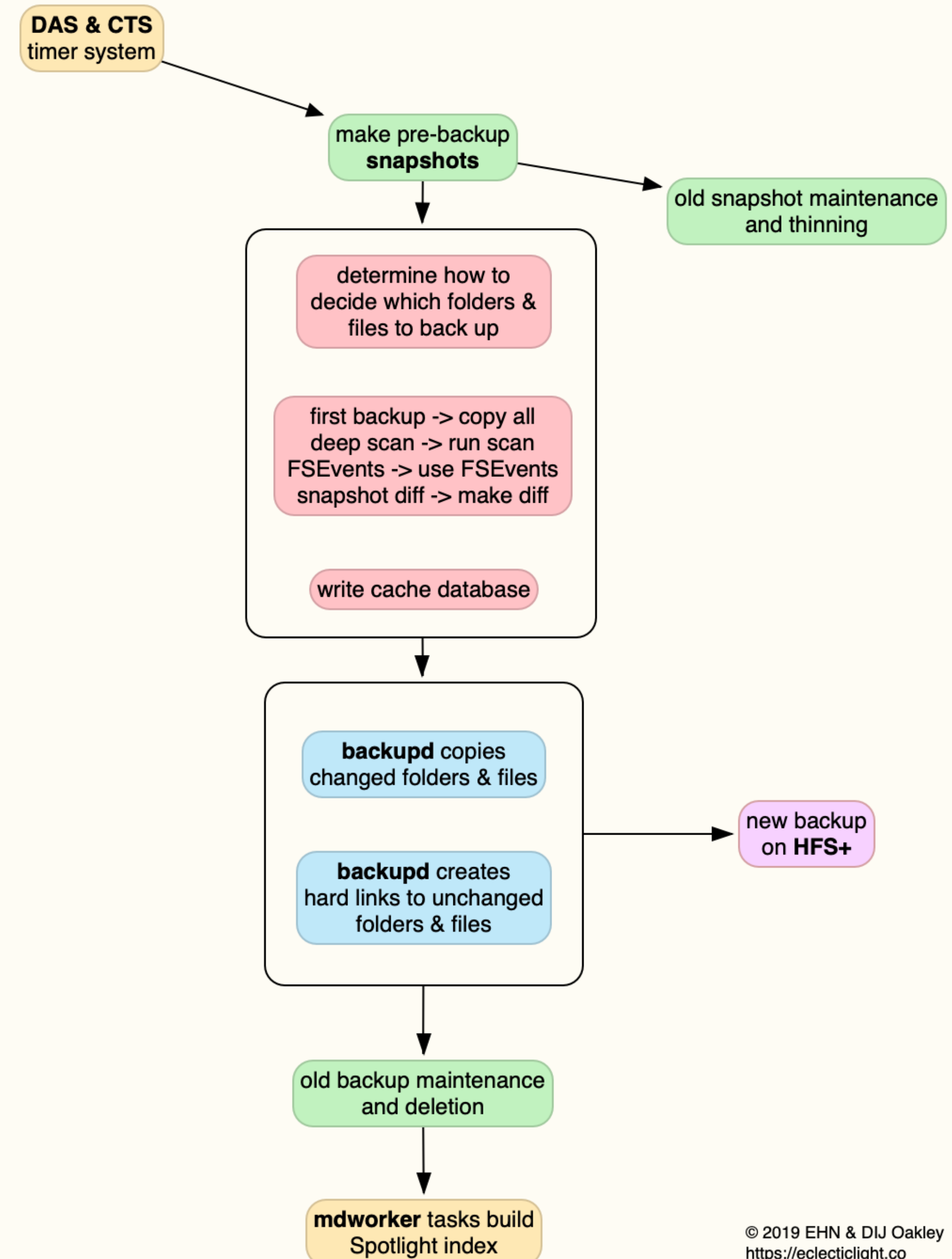




macOS Catalina

October 2019

Time Machine: macOS 10.15 + APFS

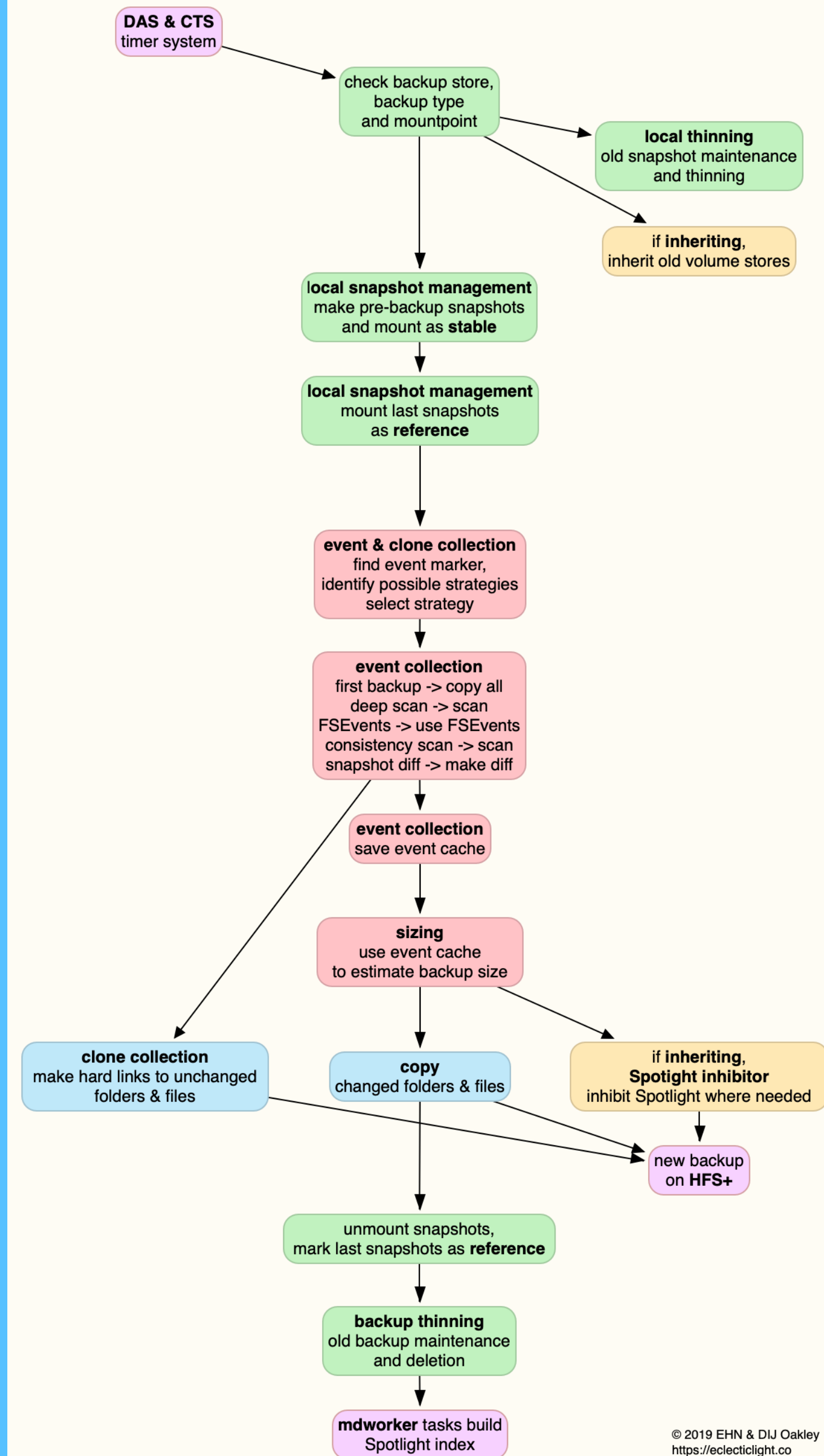




macOS Catalina

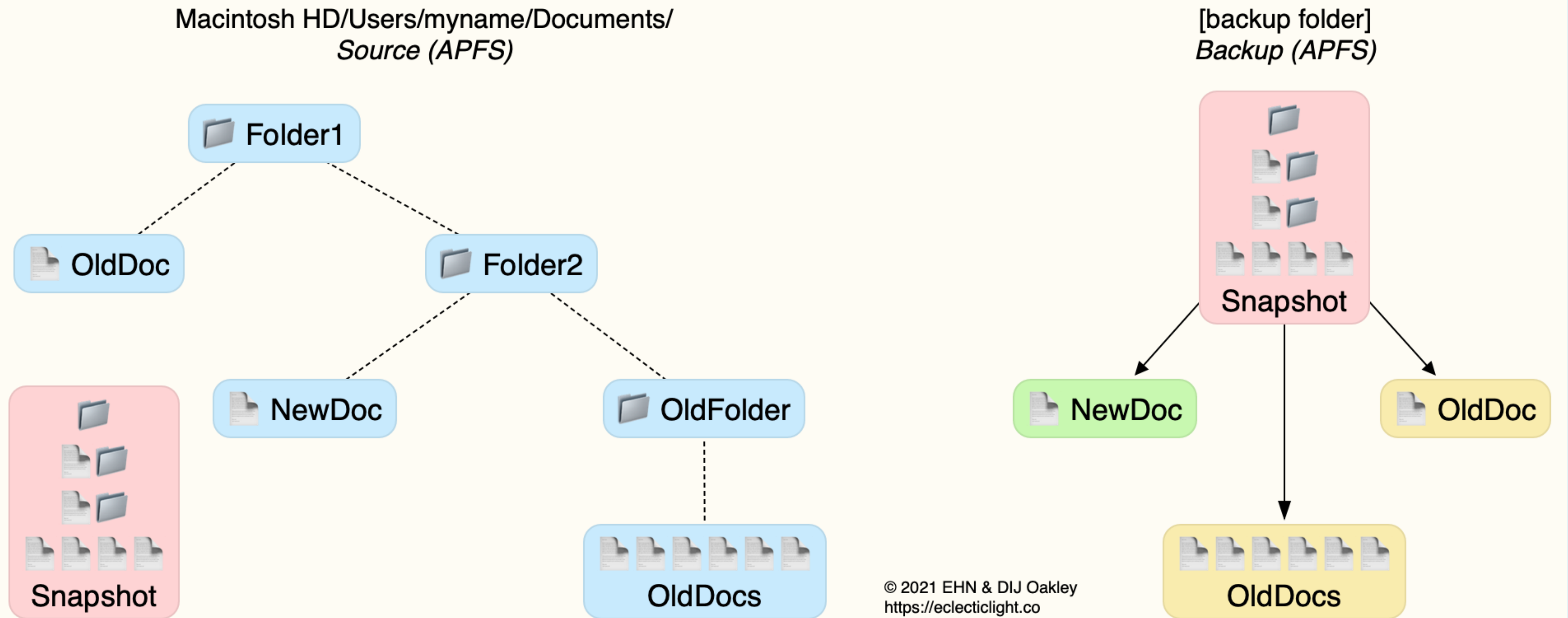
October 2019

Time Machine: macOS 10.15.2 + APFS





New APFS Backup

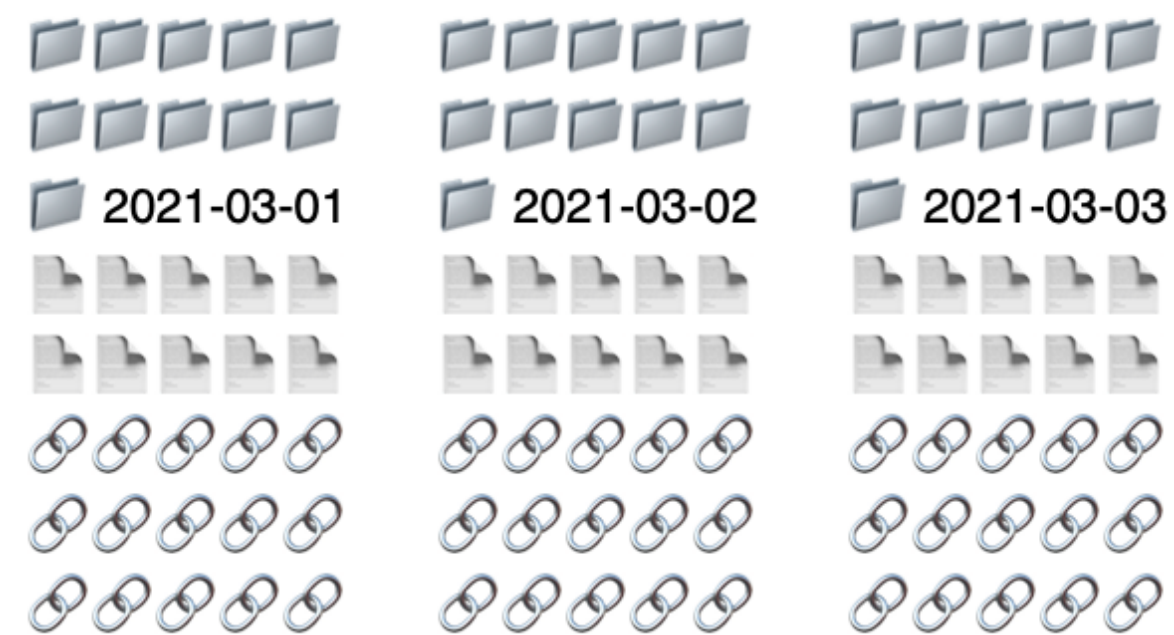




Comparison of Backup Disk Structure for Time Machine

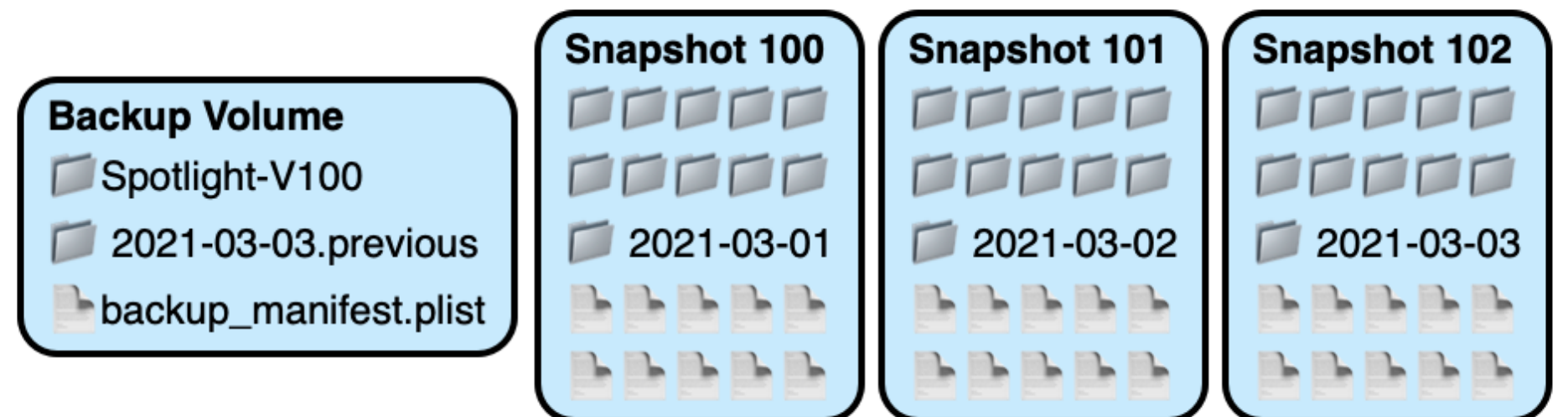
TMH

HFS+ volume (partition)



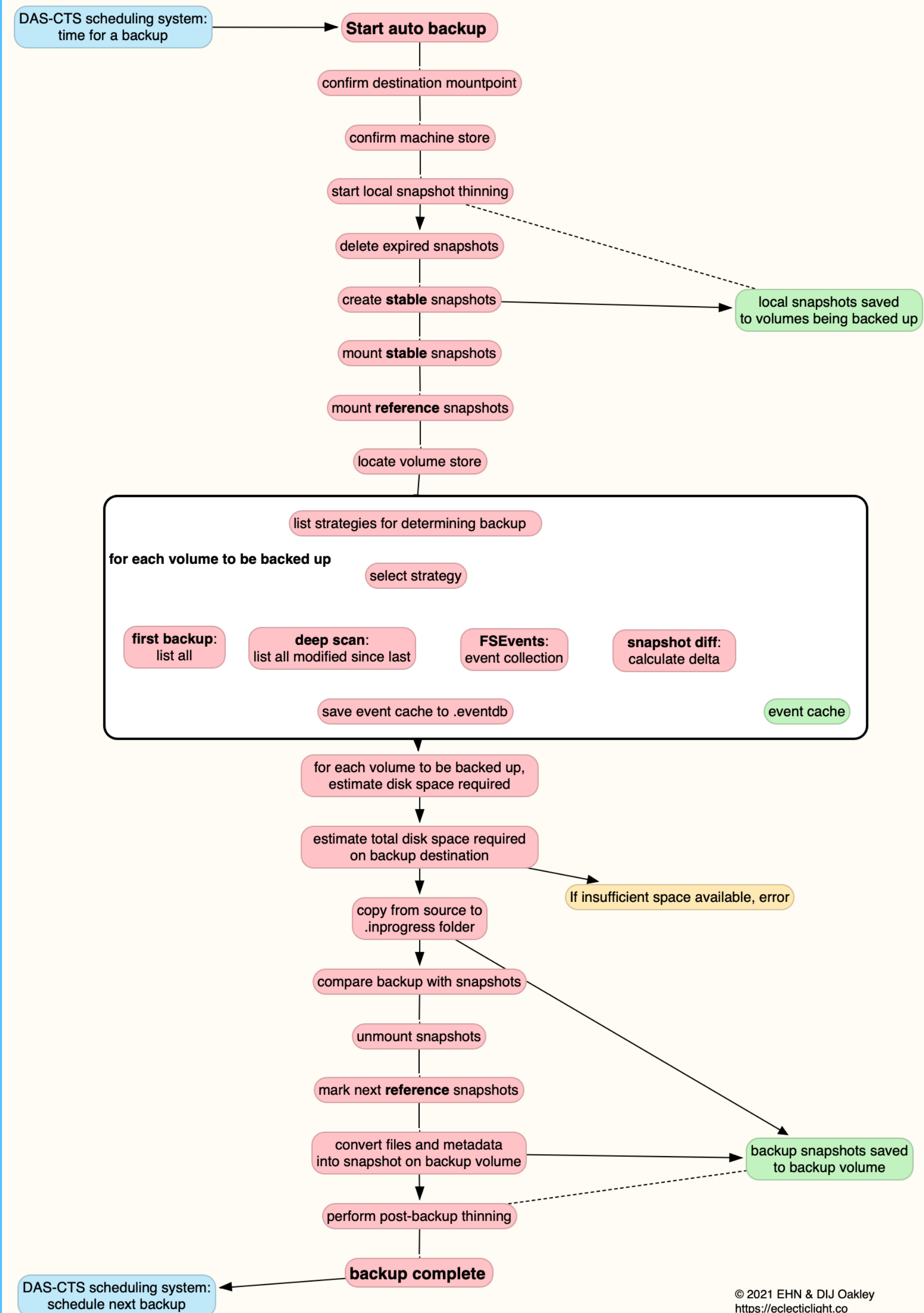
TMA

APFS container



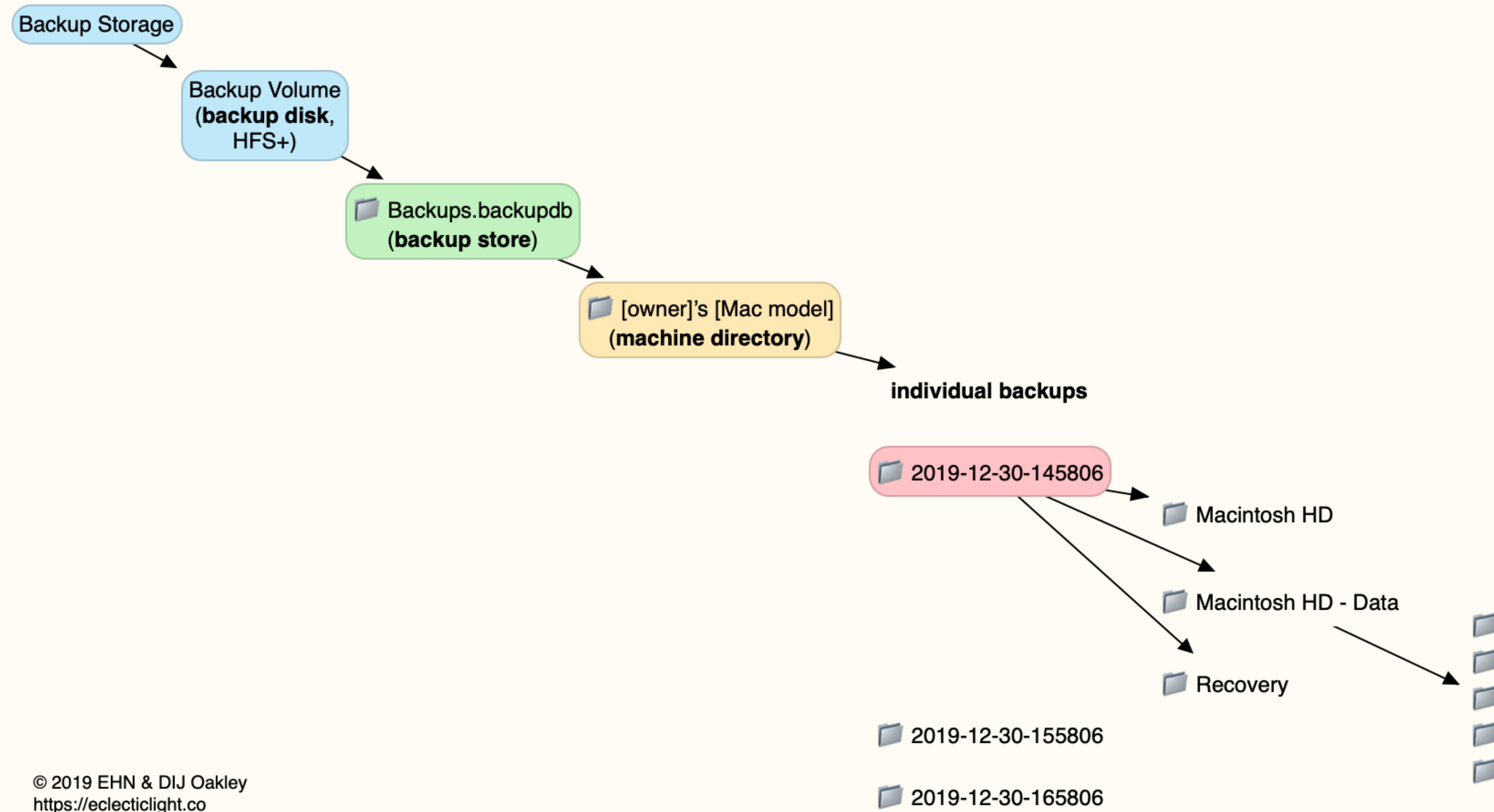


Time Machine backup to APFS (macOS 11)



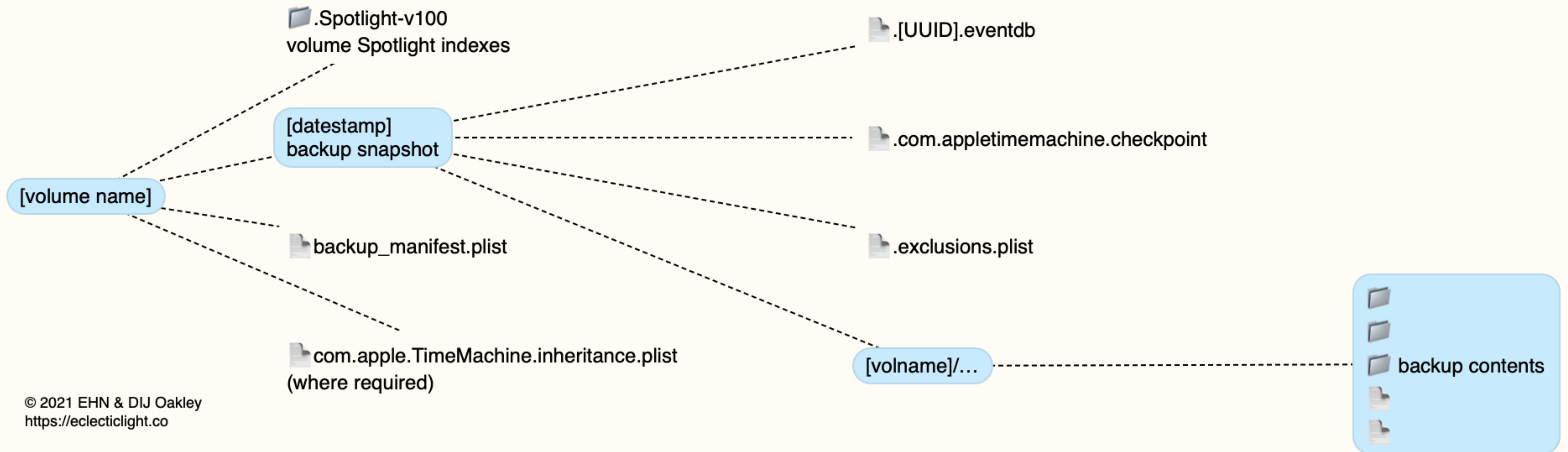


Structure of Time Machine Backups



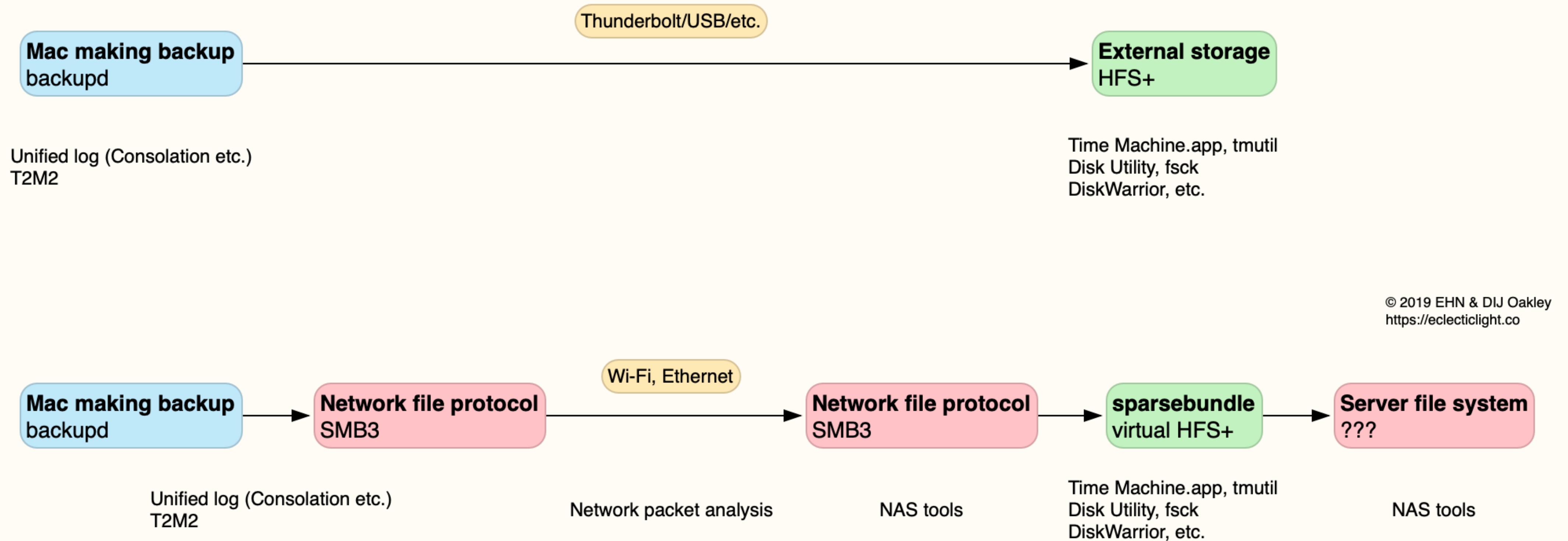


Time Machine APFS Backup Structure





Time Machine local –v– network backup





Time Machine to APFS

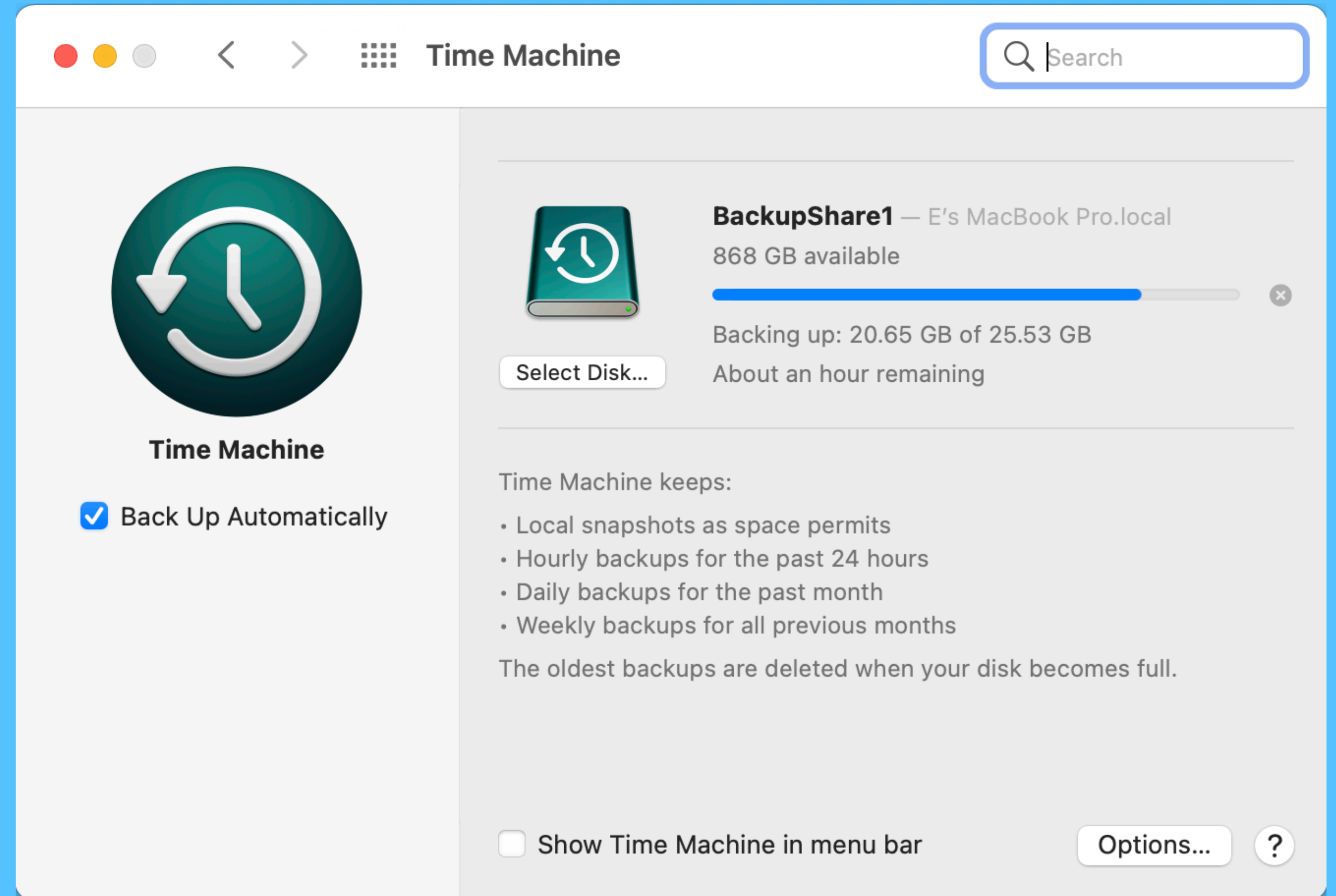
many advantages

- complete compatibility with source file system (clones, sparse files)
- per-block rather than per-file changes copied
- modern copy-on-write file system
- smaller backups copied faster
- low maintenance, repair rare



macOS Big Sur

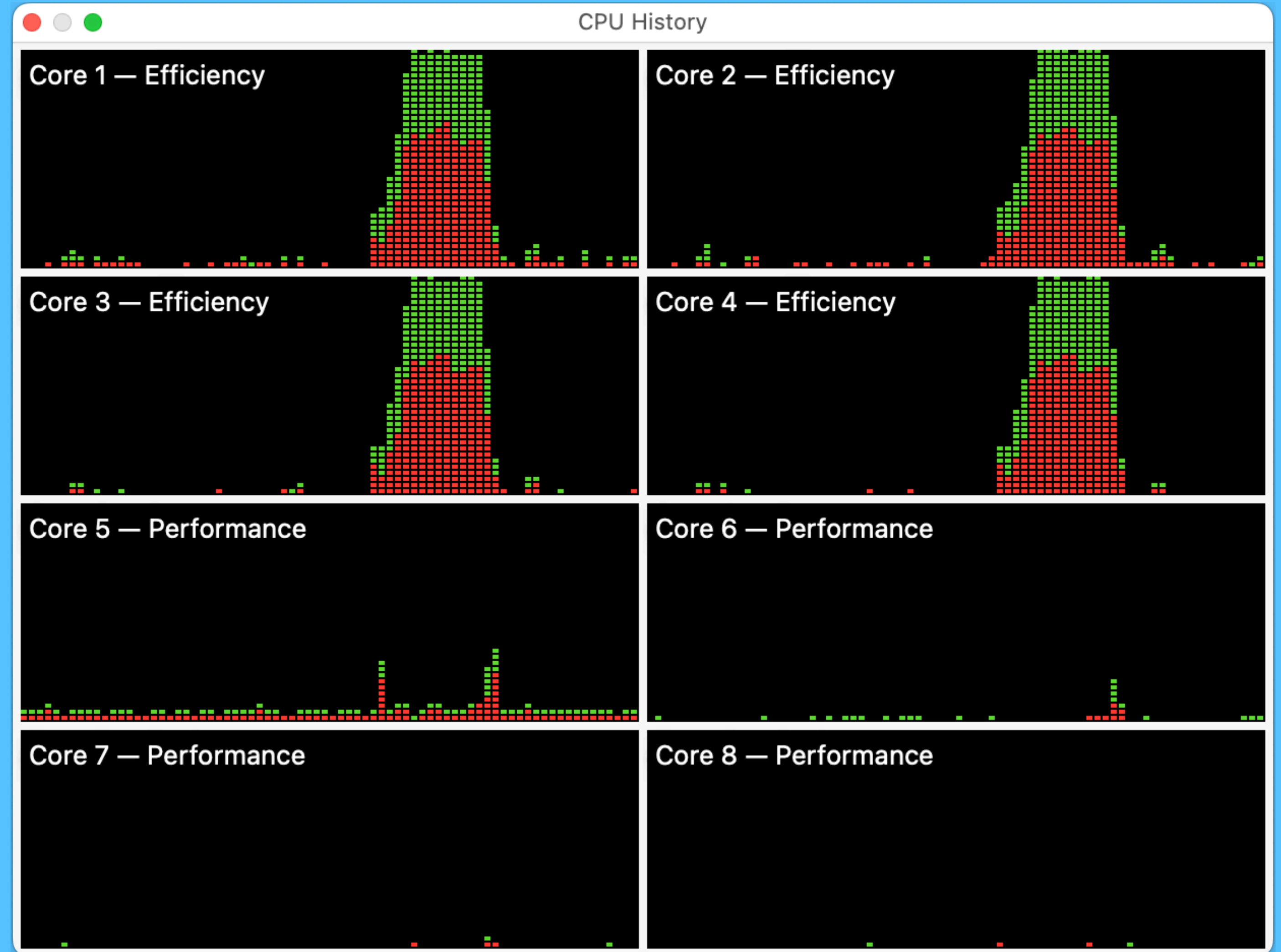
November 2020





M1 Mac

November 2020





BackupLoupe

soma-zone

BackupLoupe
Idle

ThunderBay2
07.09.2021 19:06:27

Time Machine
Idle

auto
turbo

Howard's iMac Pro

Icon 1.96 MB

Documents (4) 1.15 MB

Today

08.09.2021 01:06:58 57.34 kB

08.09.2021 00:06:59

This Week

0 B 07.09.2021 23:06:57

577.54 kB 07.09.2021 22:06:41

258.05 kB 07.09.2021 21:06:37

49.15 kB 07.09.2021 20:06:28

3.12 MB 07.09.2021 19:06:27

0 B 07.09.2021 18:06:12

274.43 kB 07.09.2021 17:06:08

0 B 07.09.2021 16:06:07

0 B 07.09.2021 15:06:05

782.34 kB 07.09.2021 14:06:00

81.92 kB 07.09.2021 13:05:56

OnewDownloads (4) 1.1 MB

.DS_Store 53.25 kB

goya (4) 1.1 MB

04blog (4) 1.07 MB

goyasai...na.jpg 359.92 kB

goyaself...15.jpg 266.66 kB

goyafer...14.jpg 255.62 kB

goyalas...ph.jpg 192.03 kB

La_últi...anz.jpg 192.03 kB

Ferdina...ya.jpg 255.62 kB

Autorret...15.jpg 266.66 kB

Francis...29.jpg 359.92 kB

captions.txt 22.44 kB

Howard's iMac Pro > External1 > Documents > OnewDownloads > goya > 04blog



Carbon Copy Cloner

Bombich Software

CCC

TasksVolumes

Macintosh HD - Data

1 TB PCI-Express Volume

Macintosh HD

1 TB PCI-Express Volume

ThunderBay2

2 TB Thunderbolt Volume

ThunderBay4

2 TB Thunderbolt Volume

ThunderBay3

2 TB Thunderbolt Volume

ThunderBay1

2 TB Thunderbolt Volume

External2

2 TB USB Volume

External1

2 TB USB Volume

External1

49%

2 TB

Used

985.65 GB

Snapshots

406.1 MB

Other Volumes

300 MB

Available

1.01 TB

StarTech: .com PM

/Volumes/External1

USB 3.1ownershipNot encryptedAPFS

SidebarPreferencesNew TaskRestorePreviewCompareTask HistoryTipsHelp

SnapshotsRelated Tasks

Snapshot Date	Size	Kind
Yesterday, 15:06	Zero KB	
Yesterday, 14:05	33 KB	
Yesterday, 13:05	6.3 MB	
Yesterday, 12:05	78 KB	
Yesterday, 11:05	70 KB	
Yesterday, 10:05	10 MB	
Yesterday, 04:15	13 MB	
06/09/2021, 04:15	28.6 MB	
05/09/2021, 04:15	21.7 MB	
04/09/2021, 04:15	18.9 MB	
03/09/2021, 04:15	28.2 MB	
02/09/2021, 04:15	73.6 MB	

CCC Snapshots:

?

CCC will create snapshots according to your backup task schedules. CCC will keep, at most:

• One snapshot per hour for the past day

• One snapshot per day for the past month

• One weekly snapshot for previous months

• SafetyNet snapshots will be kept for 7 days

CCC will remove the oldest snapshots when free space is less than 30GB.

Customize...



T2M2

The Eclectic Light Co.

