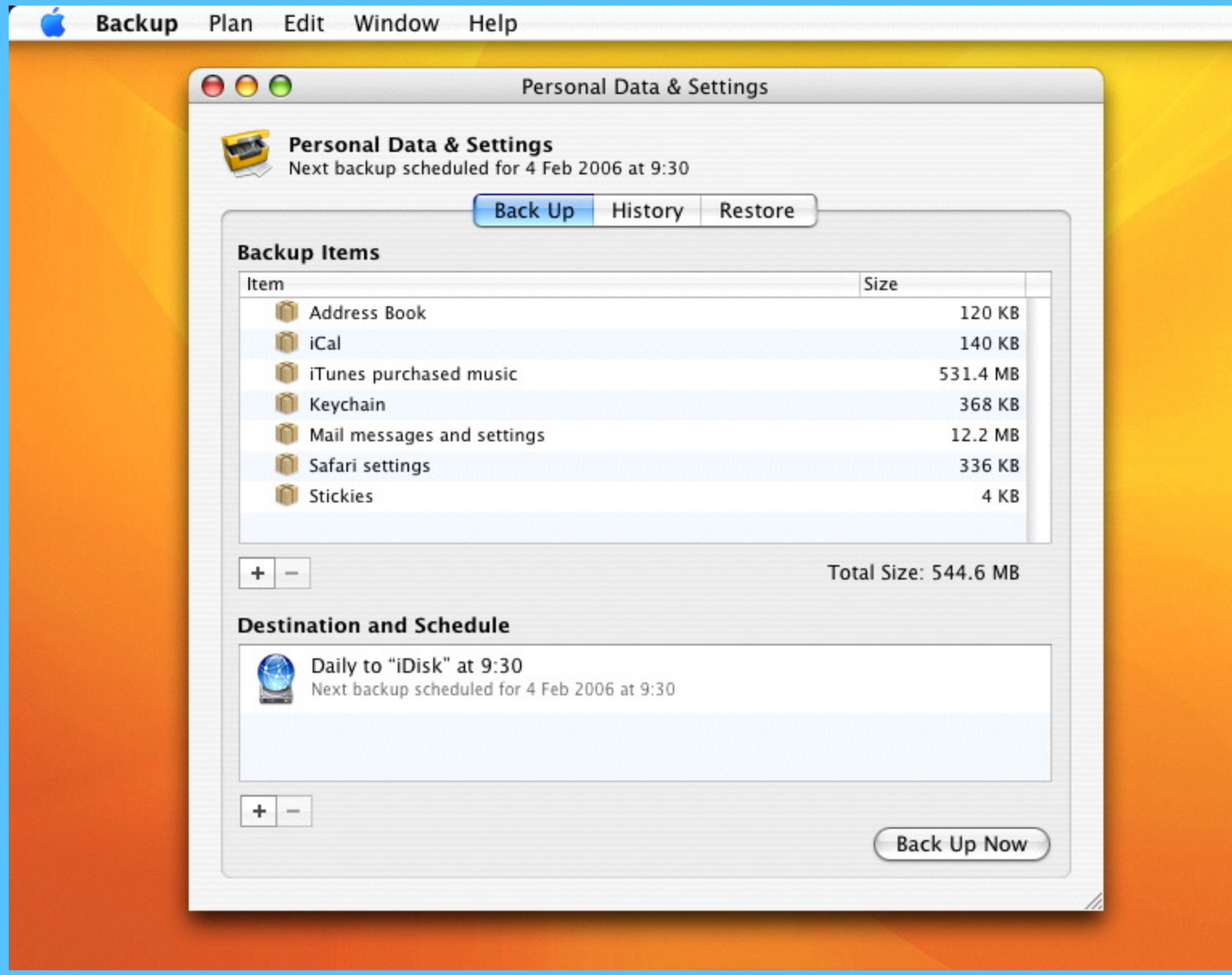
Time Machine to APFS

a 14-year journey

Howard Oakley

Backup

early 2007

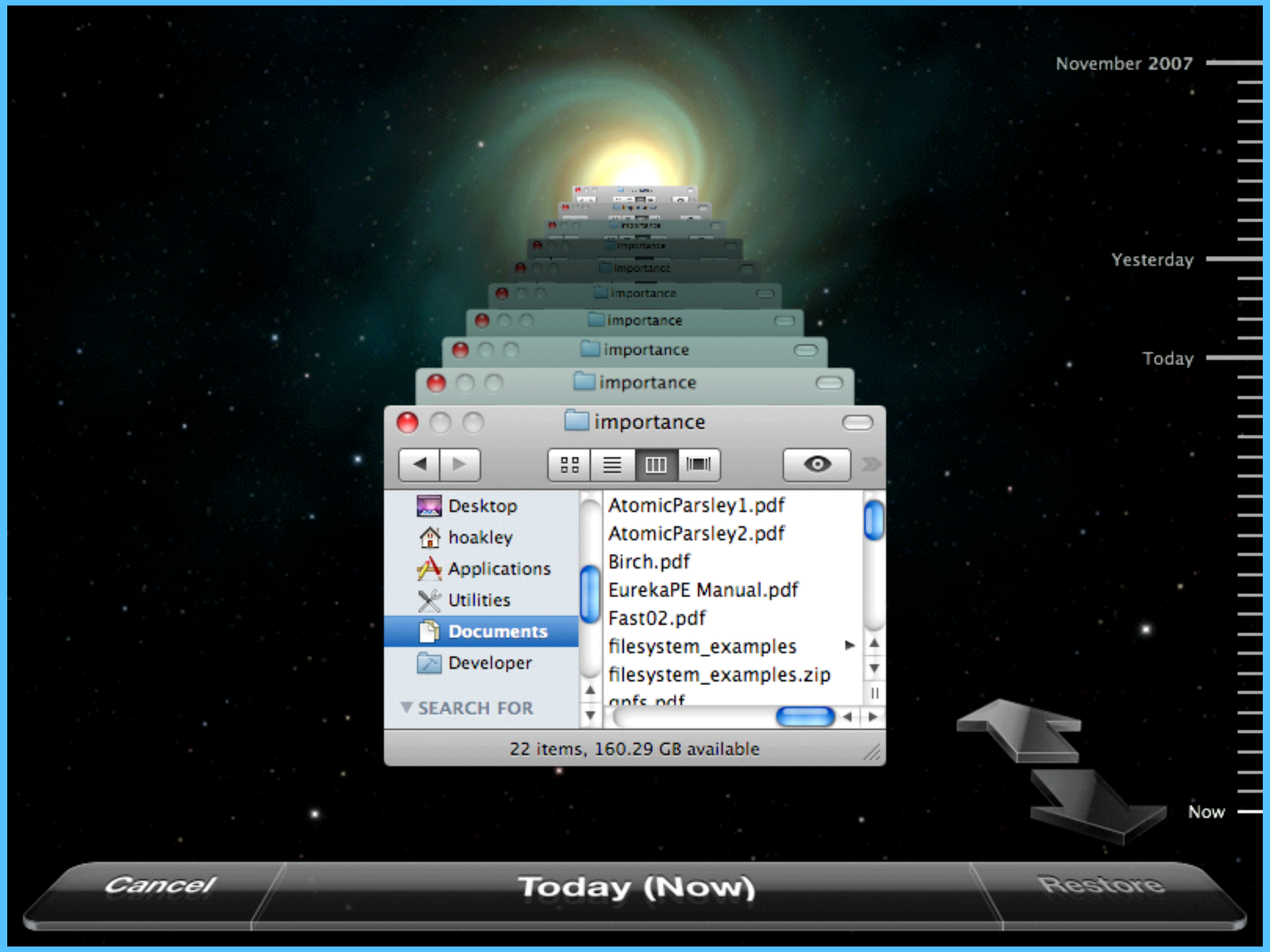


Time Machine

October 2007

Time Machine

October 2007



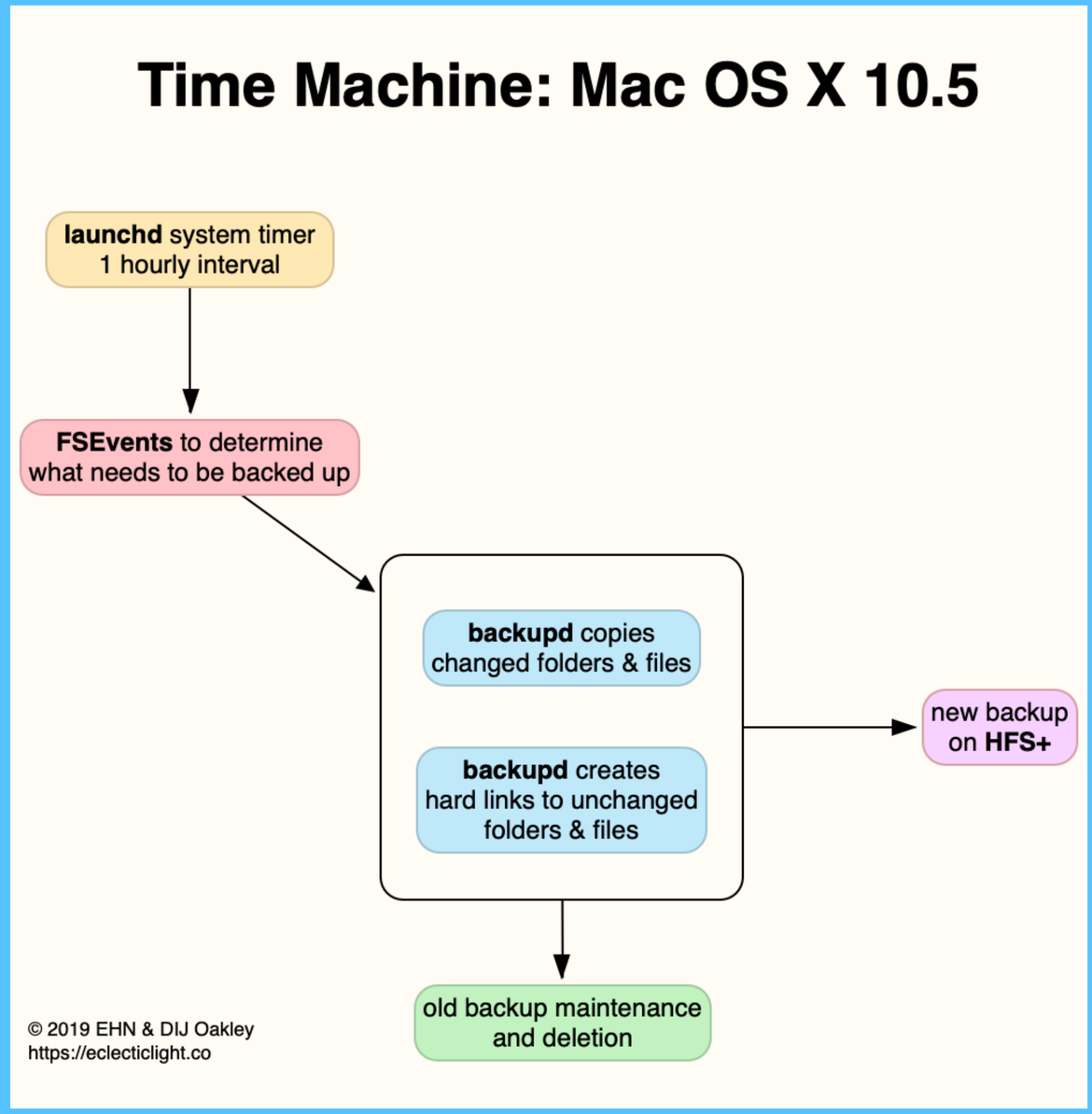
Time Machine

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

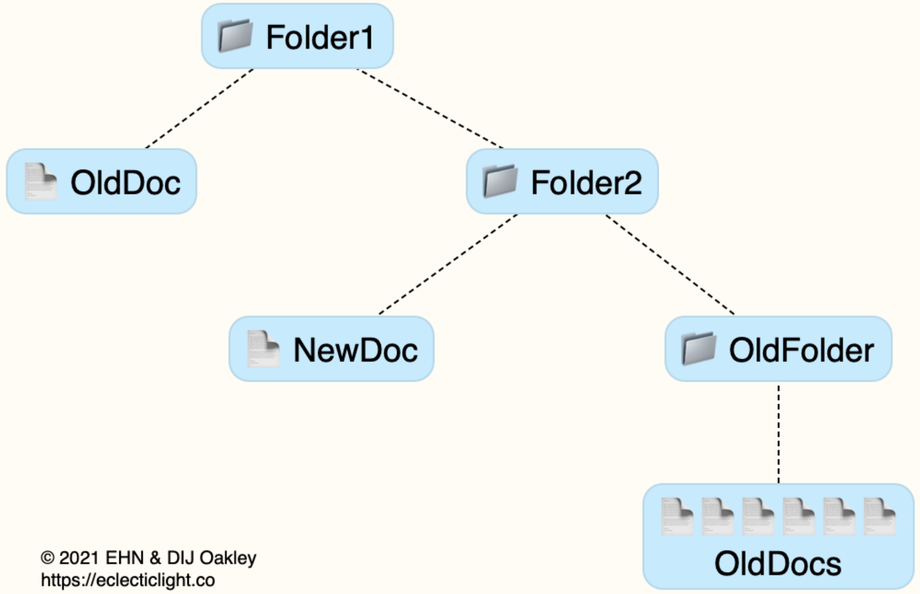
Time Machine

October 2007

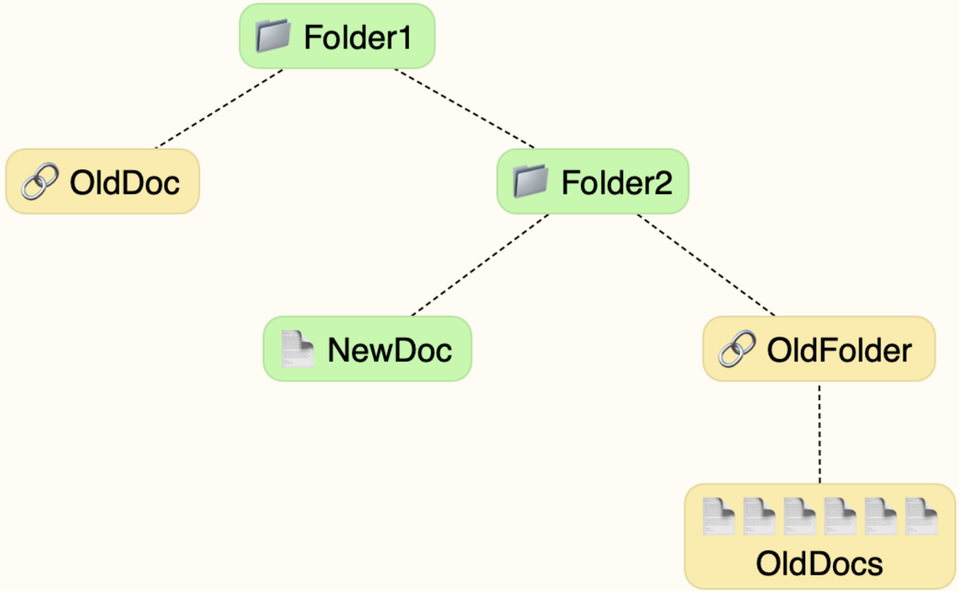


Traditional HFS+ Backup

Macintosh HD/Users/myname/Documents/
Source (HFS+)



[backup folder]/Users/myname/Documents/
Backup (HFS+)



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Time Capsule

February 2008

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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

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

Running

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

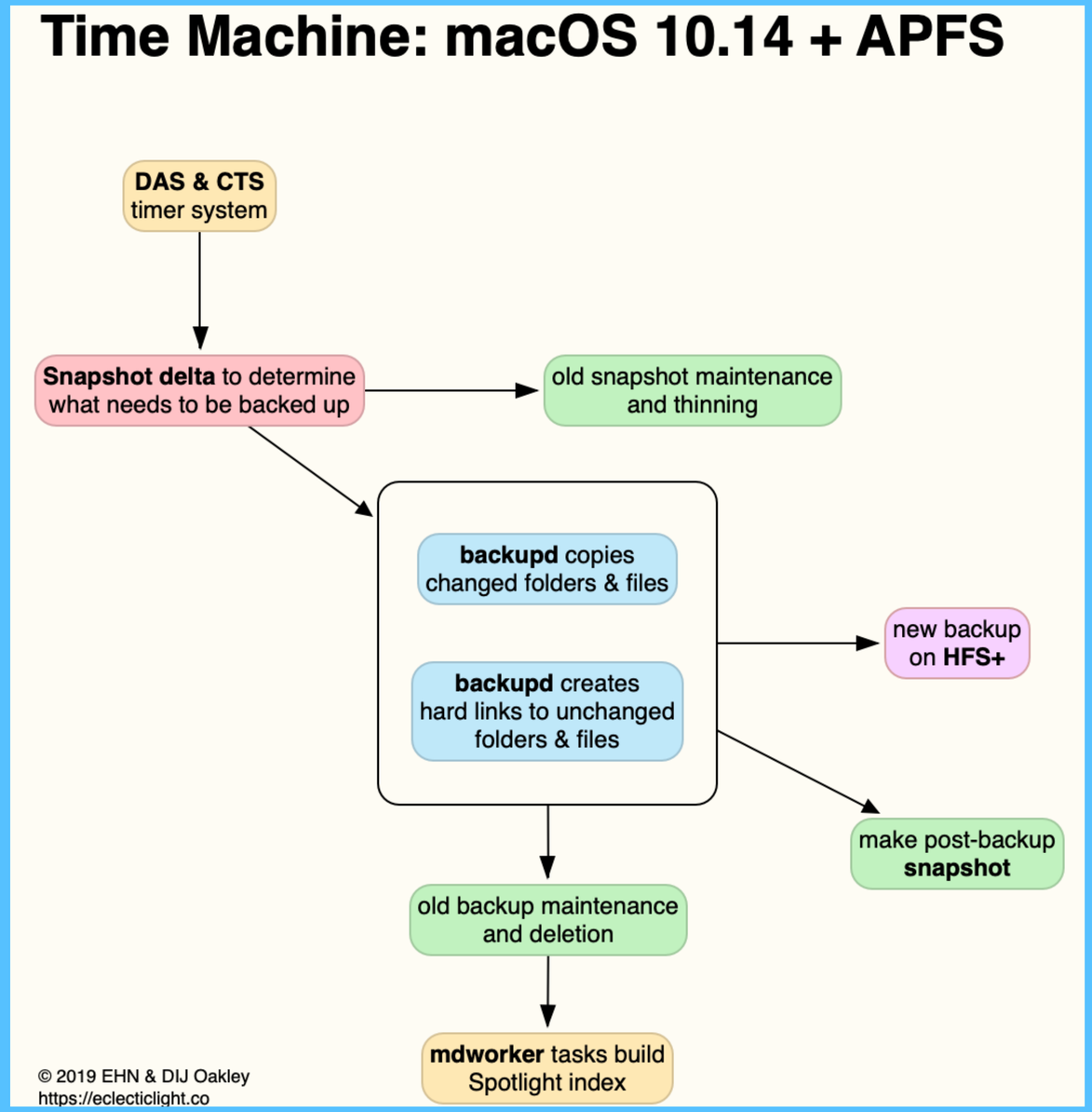
High Sierra: APFS

September 2017

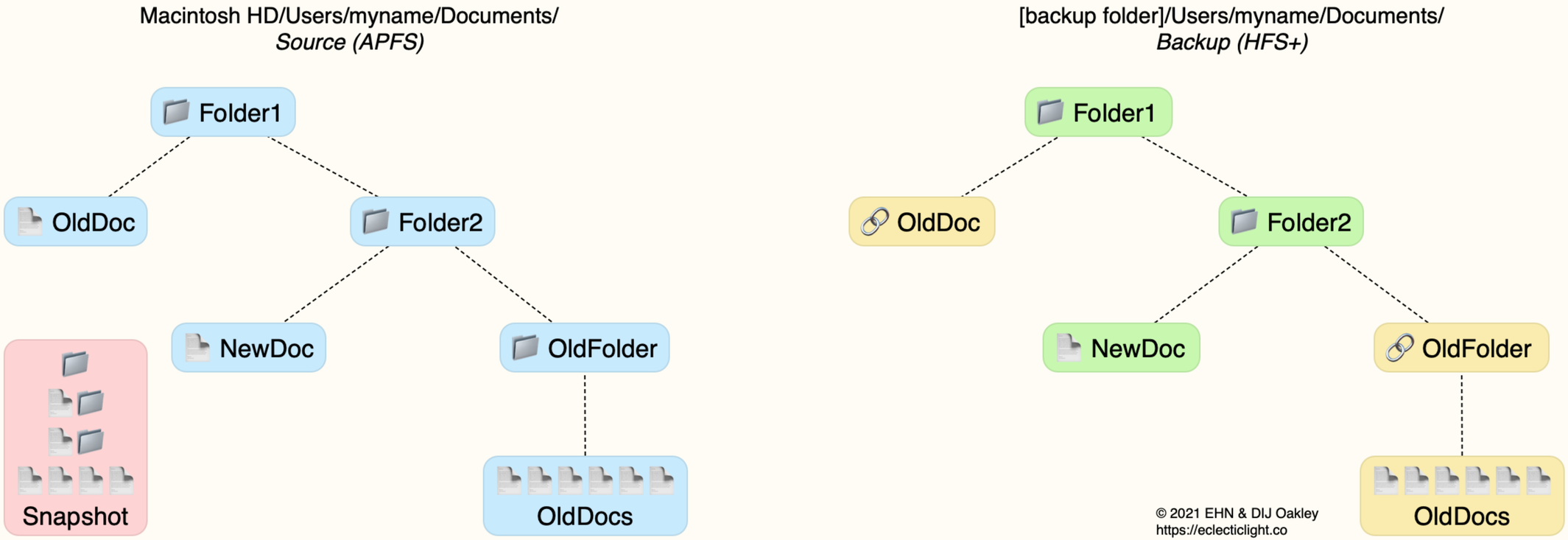
- modern file system
- copy on write for reliability
- snapshots; previous Mobile Time Machine was > 10,000 lines of code
- no directory hard links
- clone files
- sparse files

macOS Mojave

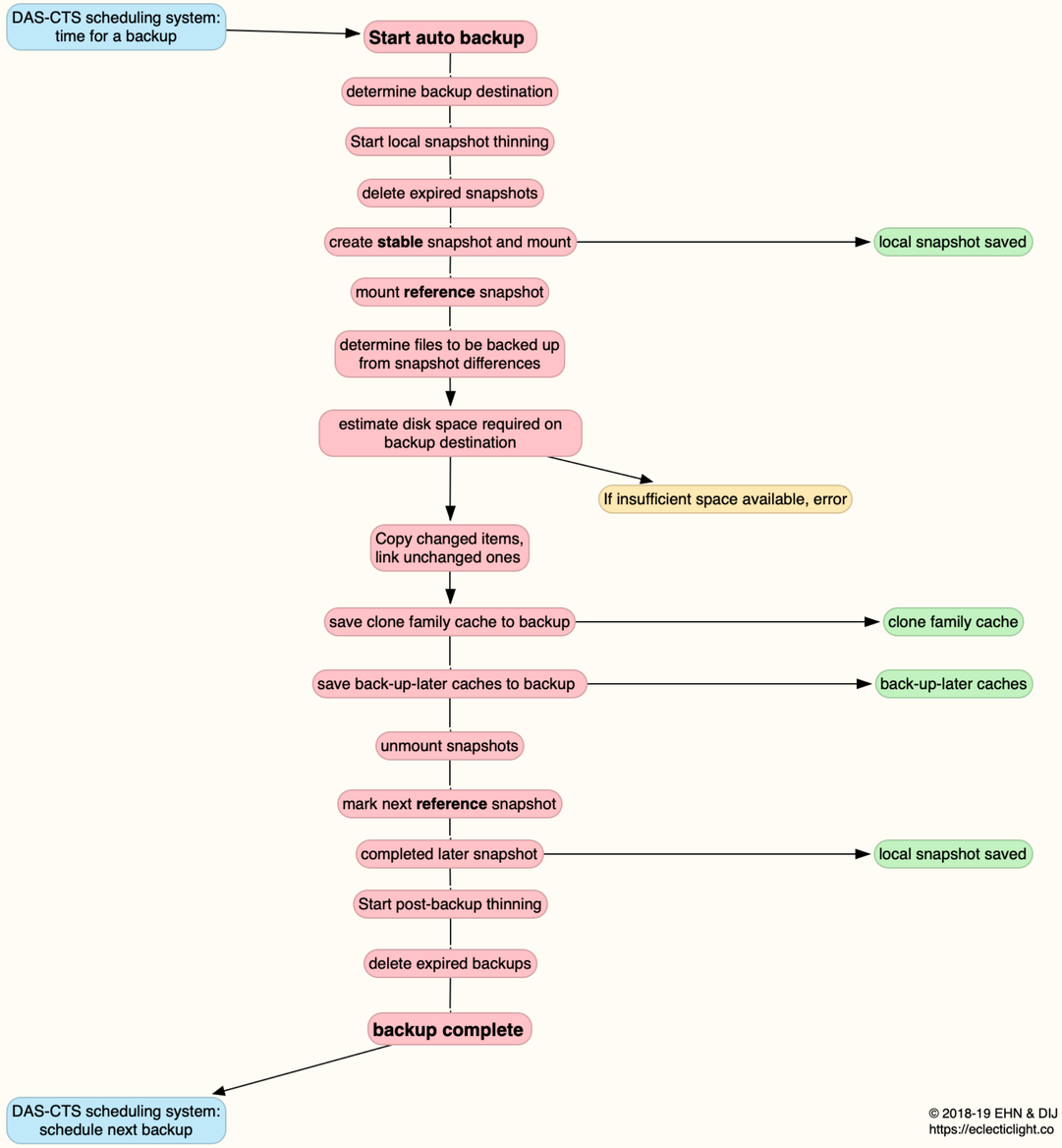
September 2018



Mixed APFS & HFS+ Backup



Time Machine backups from APFS (10.13-10.14)



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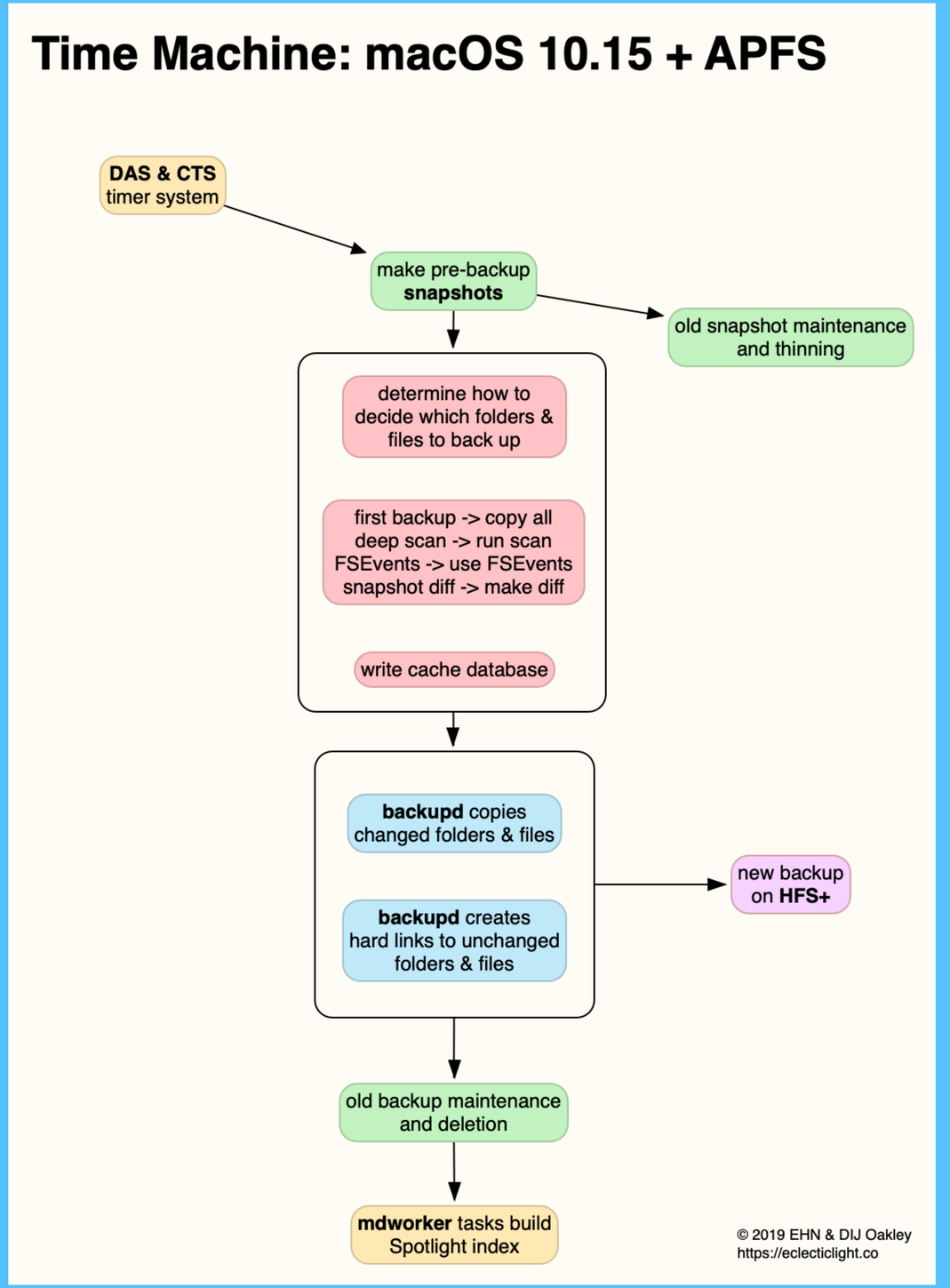
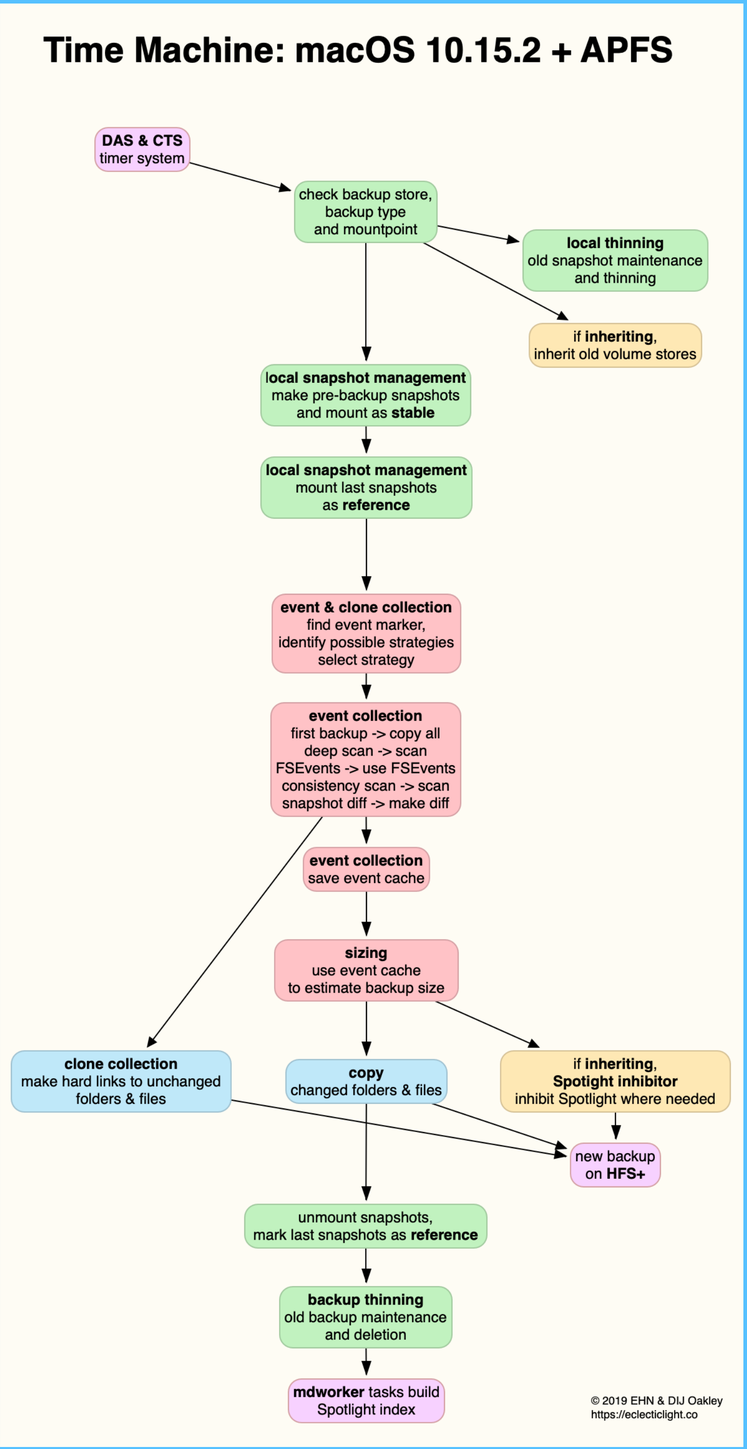
macOS Catalina

October 2019



macOS Catalina

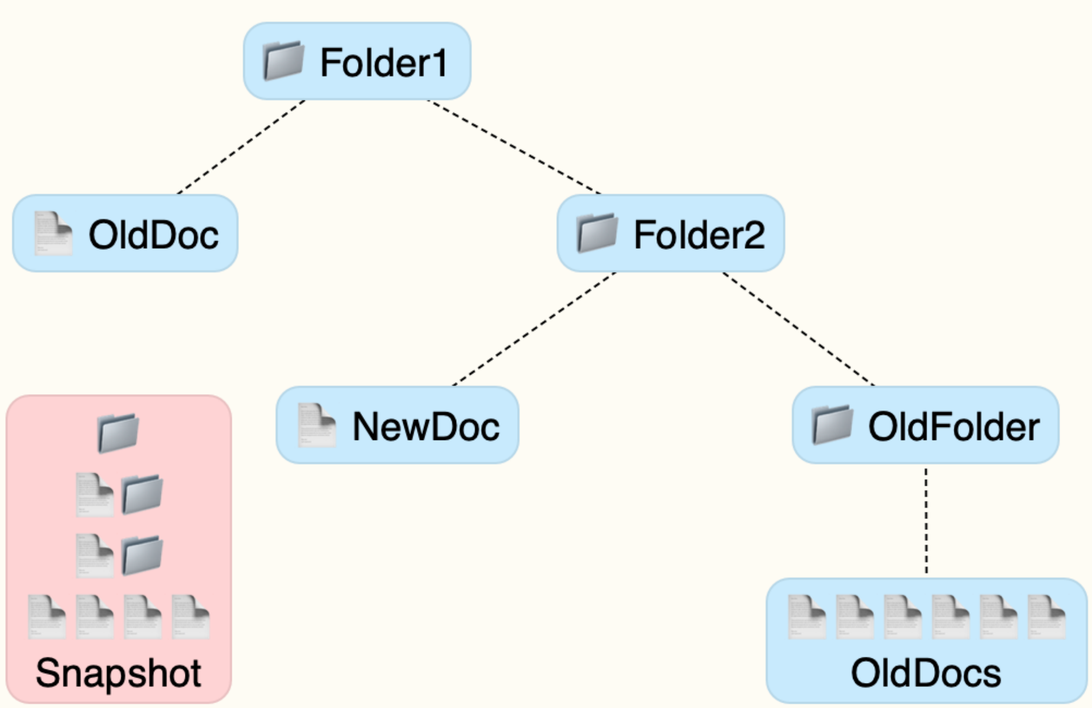
October 2019

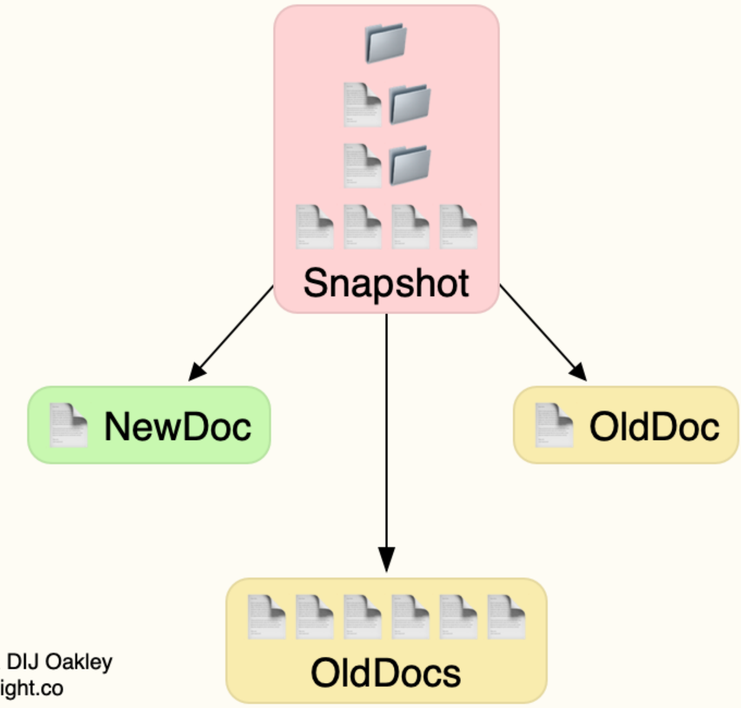


New APFS Backup

Macintosh HD/Users/myname/Documents/
Source (APFS)

[backup folder]
Backup (APFS)





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Comparison of Backup Disk Structure for Time Machine

TMH

HFS+ volume (partition)

2021-03-01 2021-03-02 2021-03-03

TMA

APFS container

Backup Volume
Spotlight-V100
2021-03-03.previous
backup_manifest.plist

Snapshot 100
2021-03-01

Snapshot 101
2021-03-02

Snapshot 102
2021-03-03

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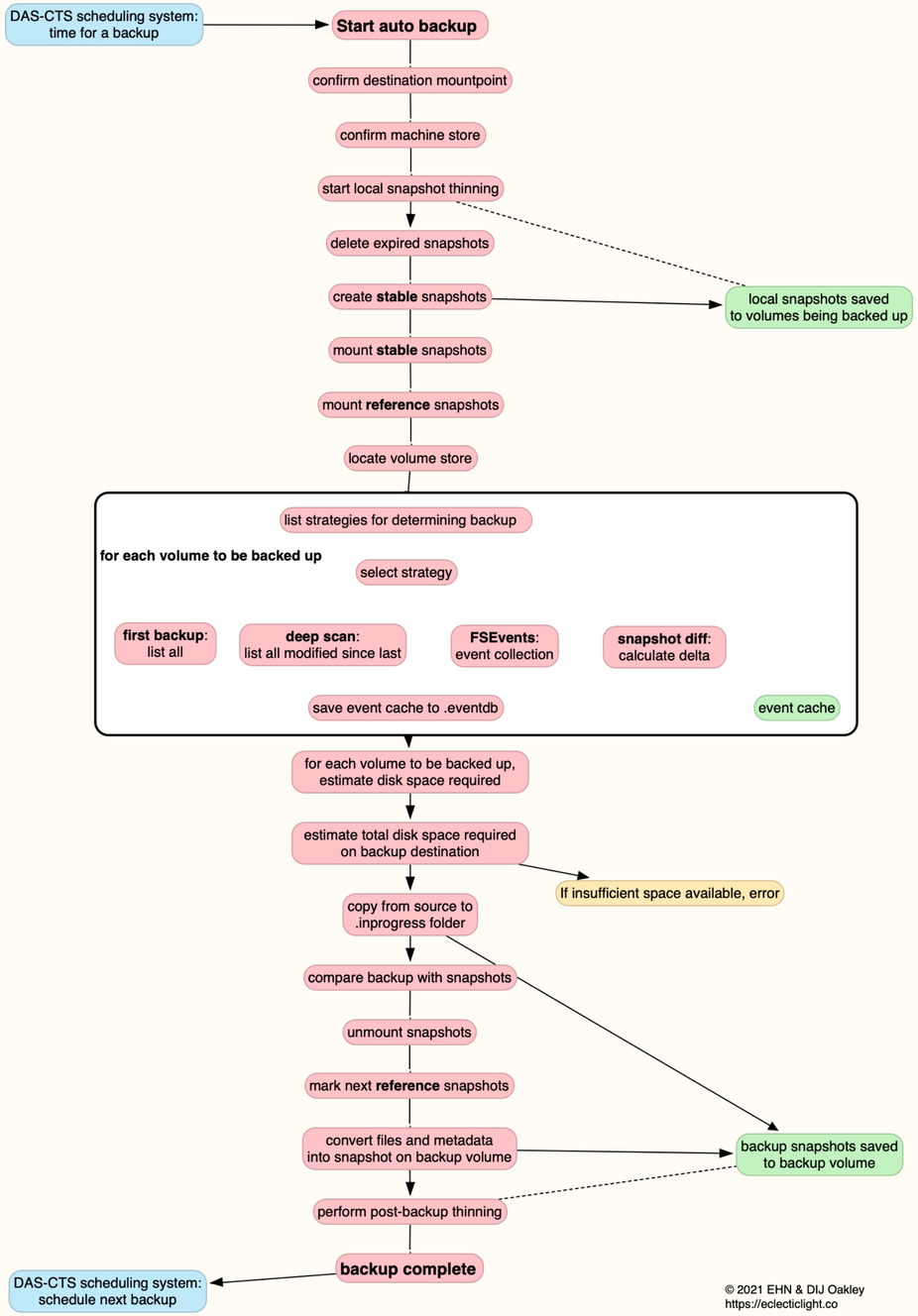
Time Machine backup to APFS (macOS 11)



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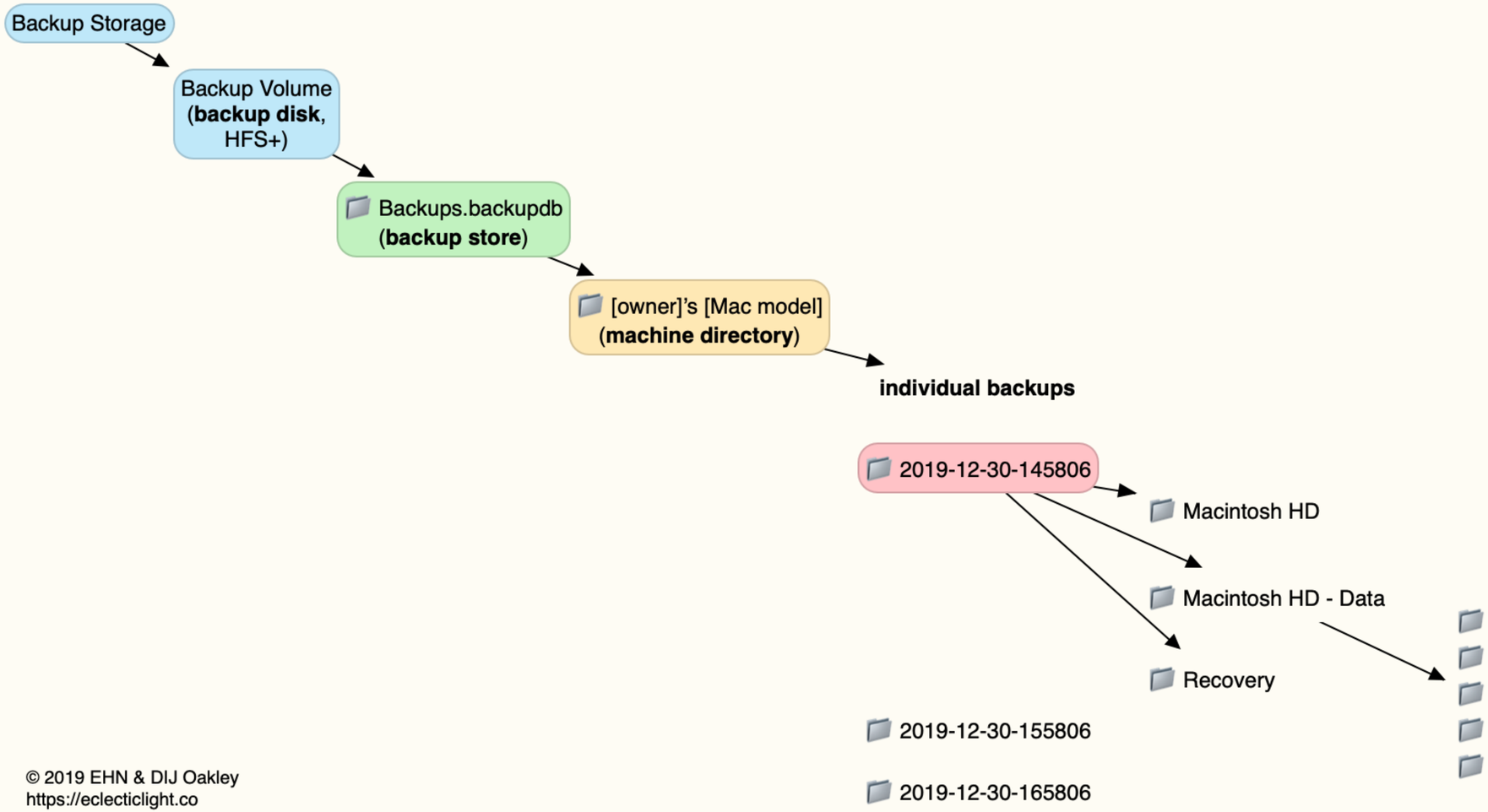
Structure of Time Machine Backups



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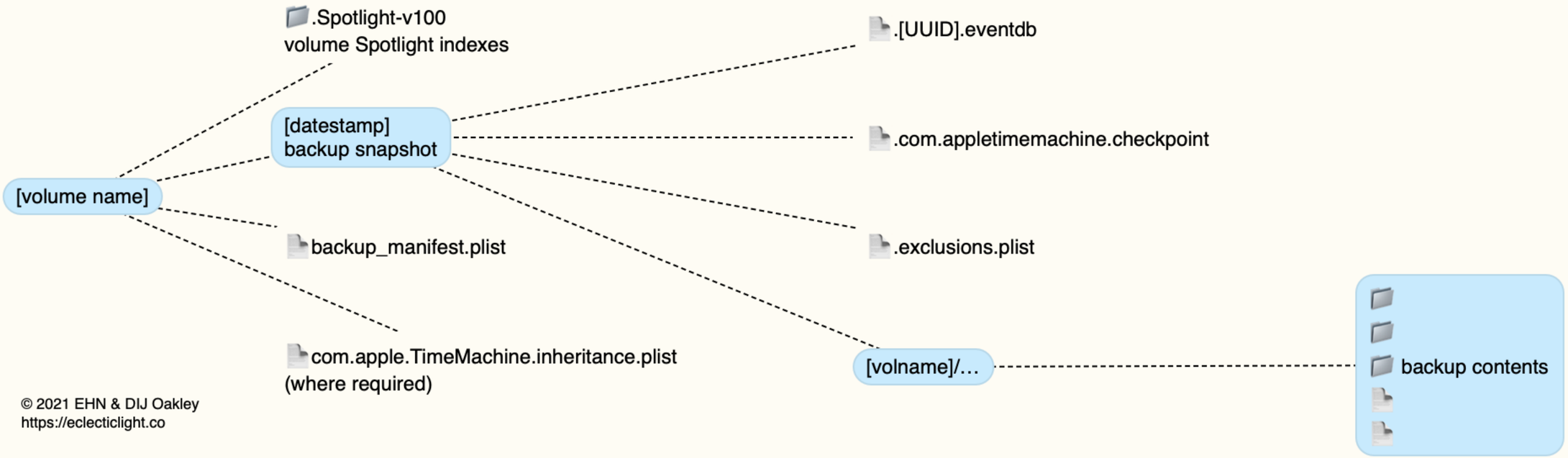
Time Machine APFS Backup Structure



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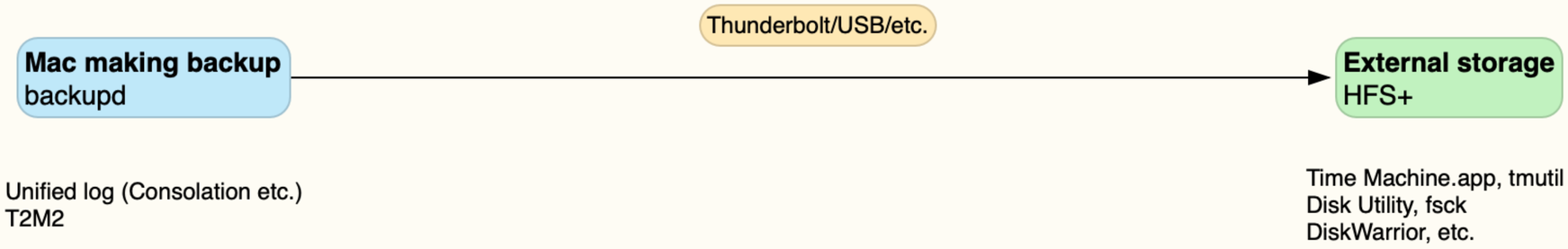
Time Machine local –v– network backup



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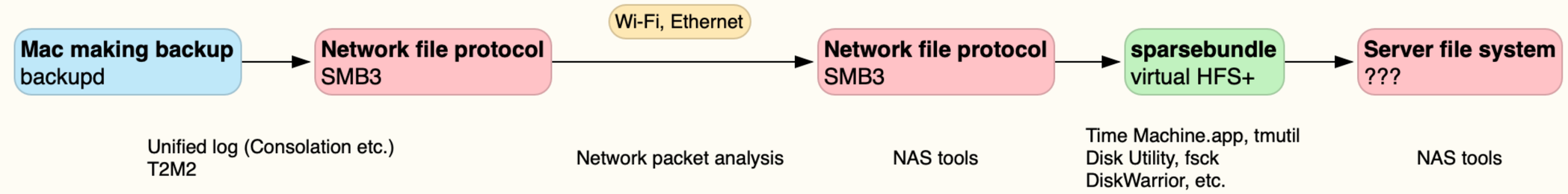


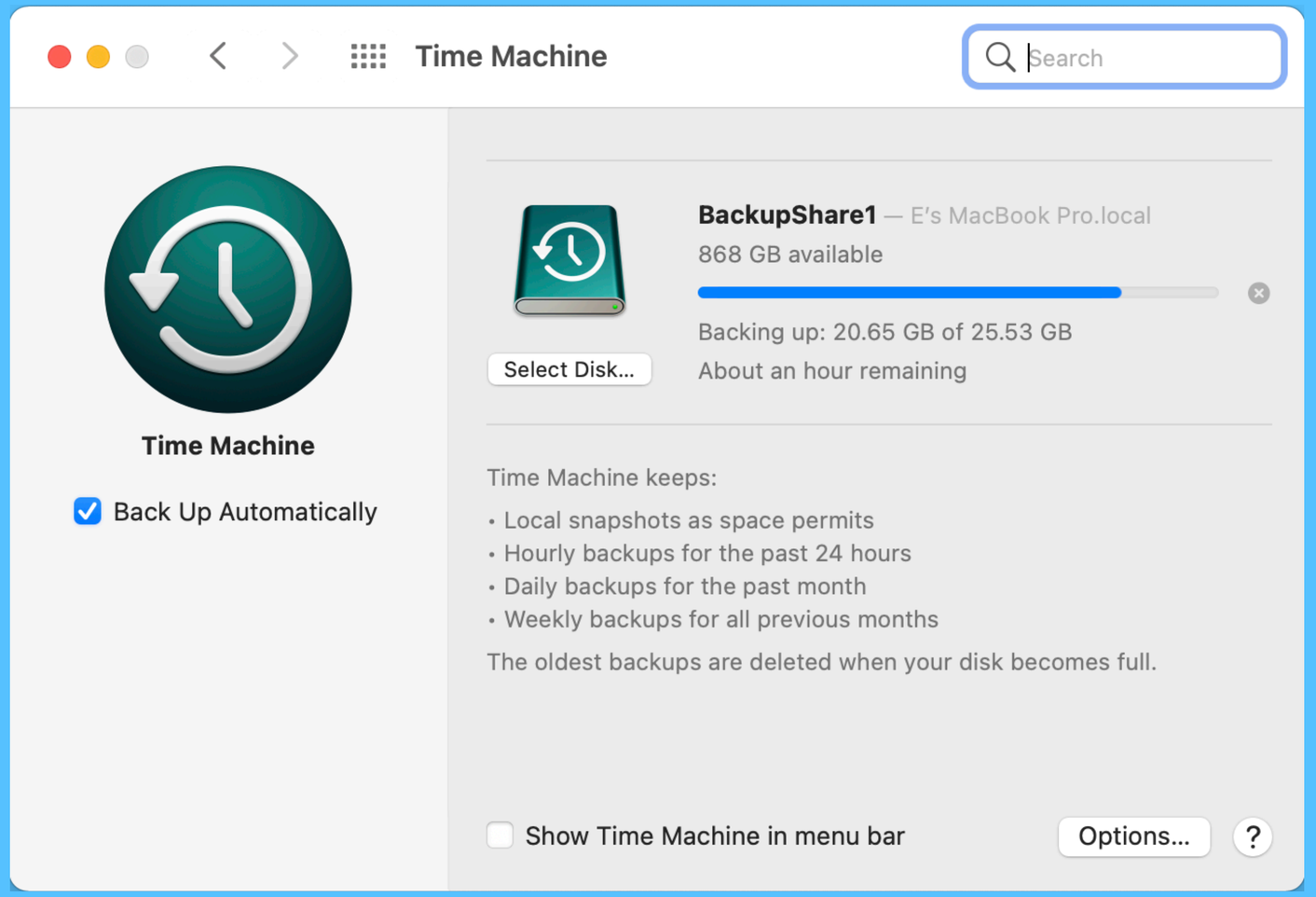
Time Machine to APFS

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

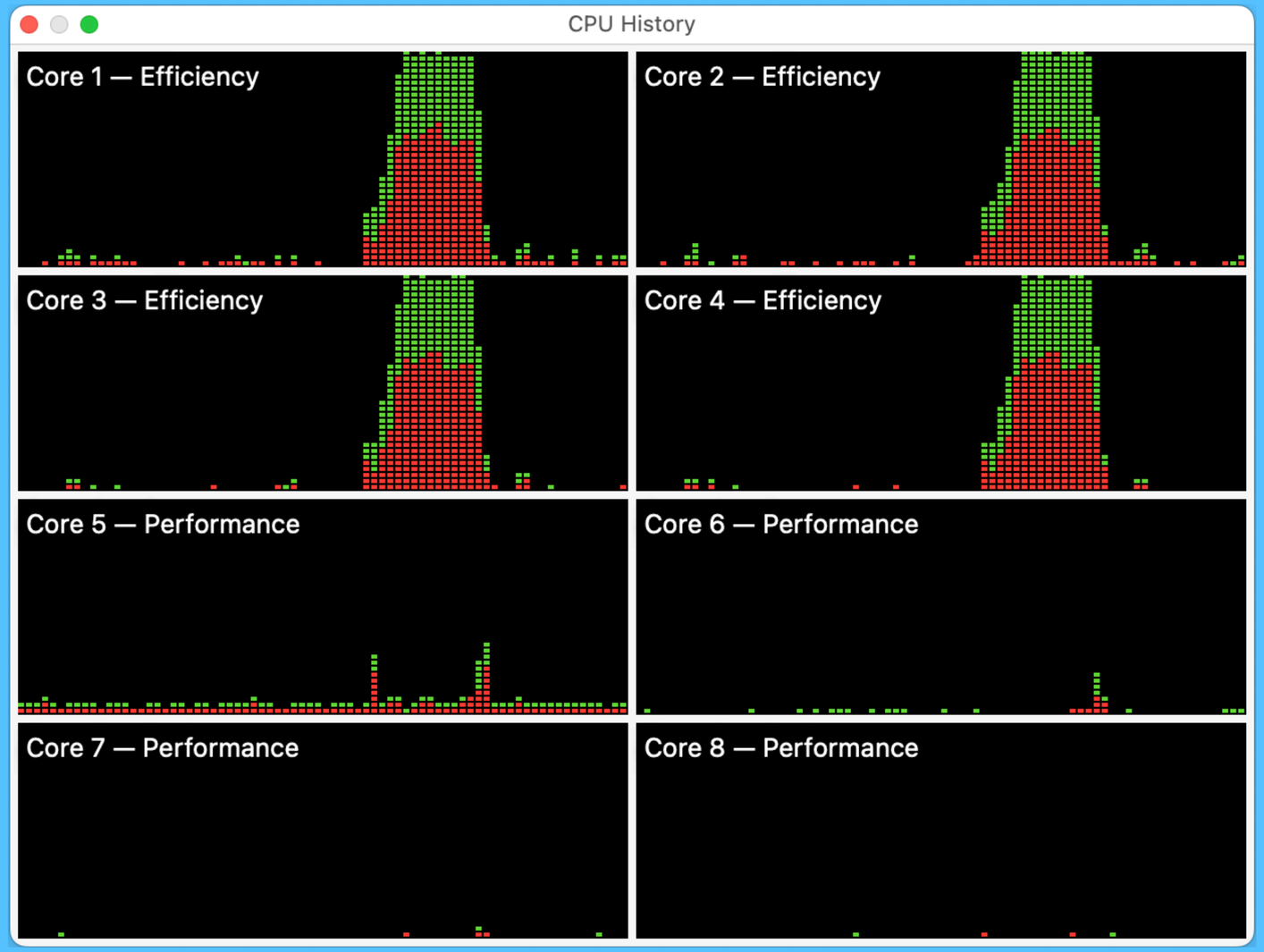
macOS Big Sur

November 2020



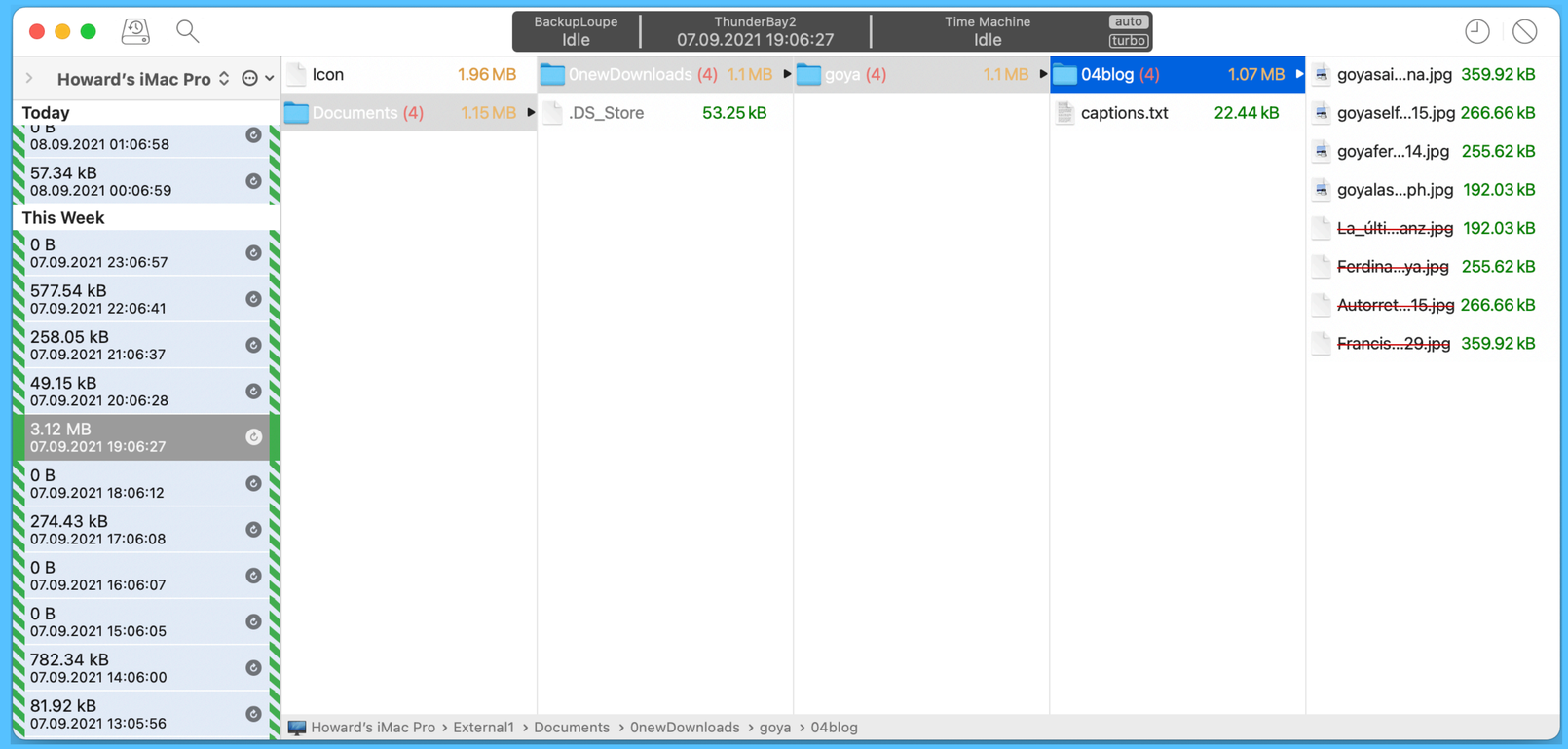
M1 Mac

November 2020



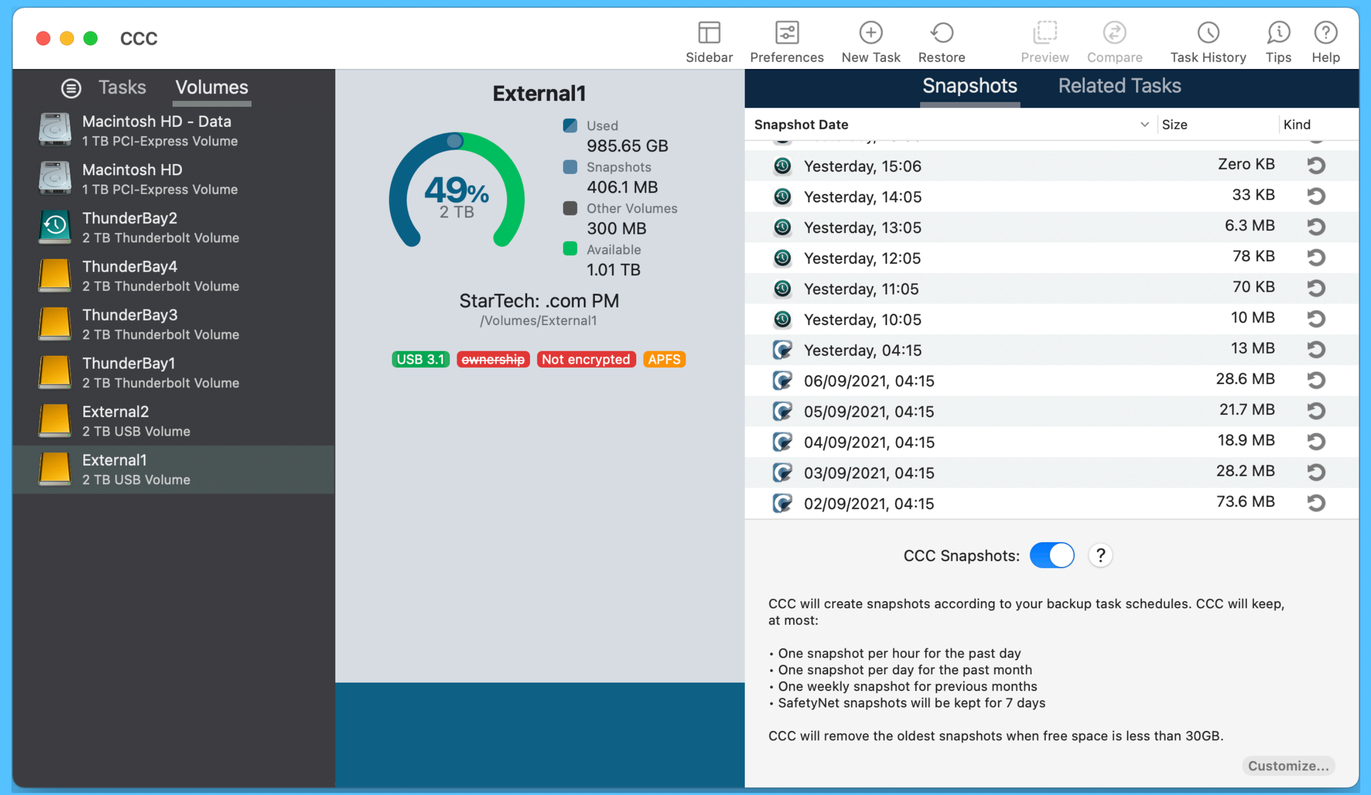
BackupLoupe

soma-zone



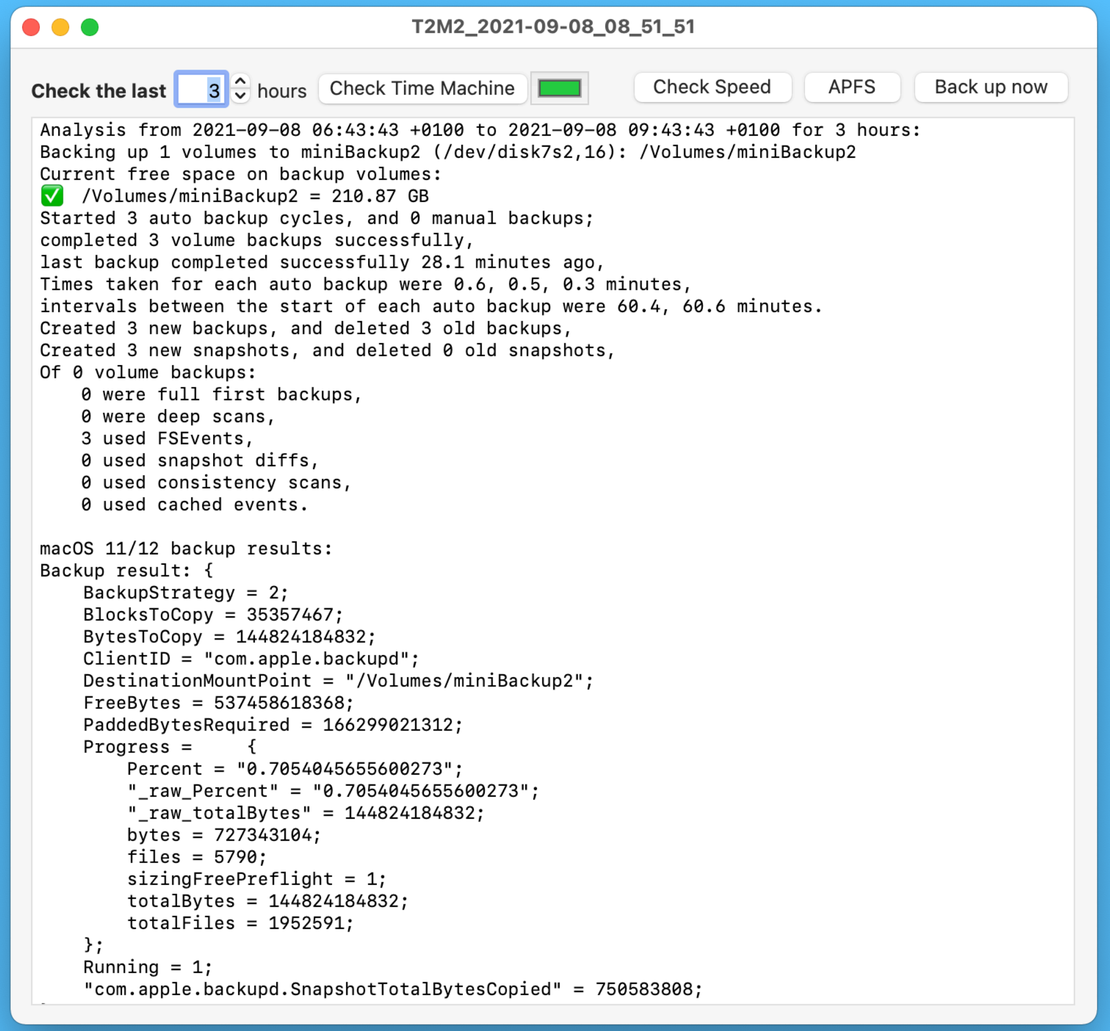
Carbon Copy Cloner

Bombich Software

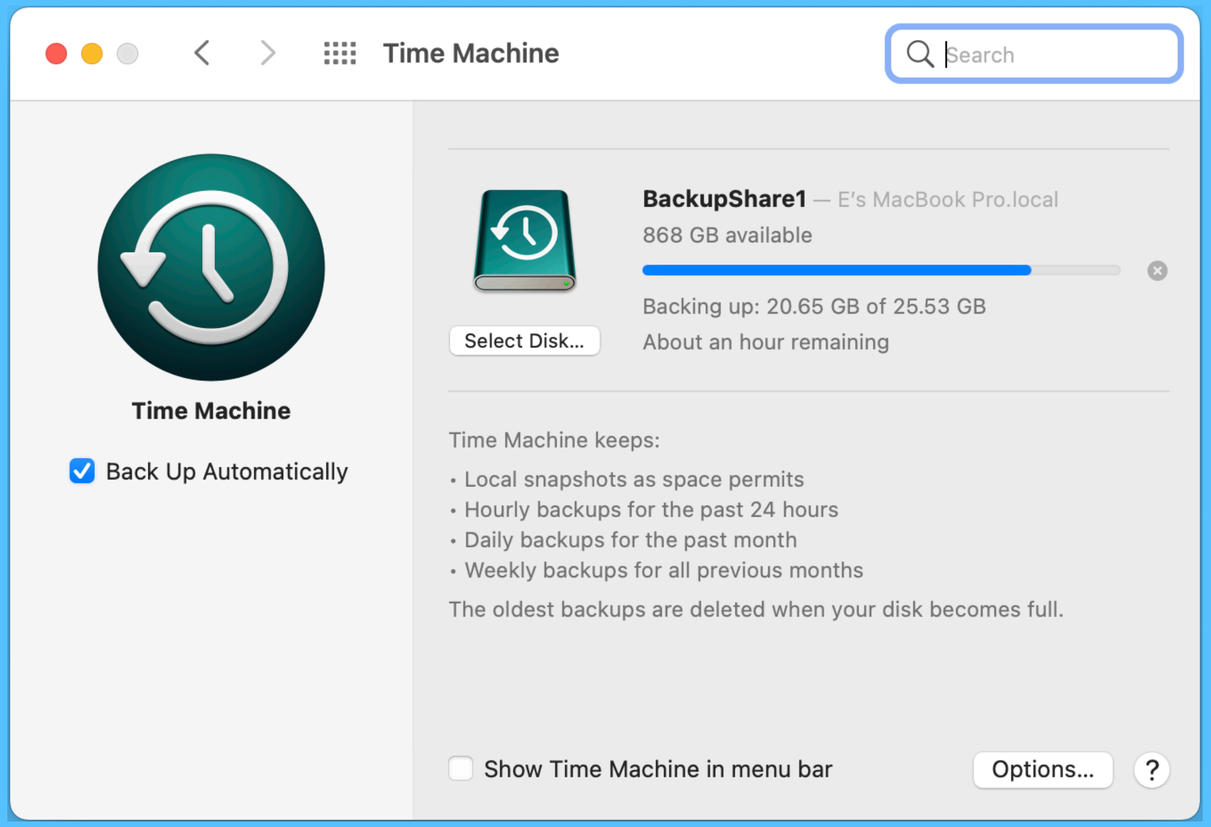


T2M2

The Eclectic Light Co.



Time Machine
Show All
Time Machine
OFF
ON
Name: HD03
Available: 98.5 GB of 465.4 GB
Oldest Backup: 7 November 2007
Latest Backup: Today, 19:04
Backing up:
44.5 MB of 115.9 MB
Change Disk...
Options...
Time Machine keeps
• Hourly backups for the past 24 hours
• Daily backups for the past month
• Weekly backups until your backup disk is full
Click the lock to prevent further changes.


Time Machine
Search
Time Machine
Back Up Automatically
BackupShare1 — E's MacBook Pro.local
868 GB available
Backing up: 20.65 GB of 25.53 GB
About an hour remaining
Select Disk...
Time Machine keeps:
• Local snapshots as space permits
• Hourly backups for the past 24 hours
• Daily backups for the past month
• Weekly backups for all previous months
The oldest backups are deleted when your disk becomes full.
Show Time Machine in menu bar
Options...