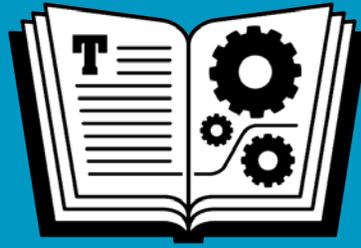


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TAKE CONTROL OF

YOUR DIGITAL STORAGE

**FOR
MAC**

by **JEFF CARLSON**

\$14.99

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Read Me First

Welcome to *Take Control of Your Digital Storage, Second Edition*, version 2.1, published in September 2020 by alt concepts inc. This book was written by Jeff Carlson and edited by Joe Kissell.

This book guides Mac users through their ever-growing digital storage needs, from replacing or adding hard disks and SSDs to using network-attached storage (NAS) devices and cloud services. It demystifies deep-dive topics such as RAID, Apple’s APFS file system, creating and resizing volumes and partitions, and disk encryption, and it offers real-world advice on avoiding data loss due to failing storage, freeing up disk space, and choosing where data resides.

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What's New in Version 2.1

Storage on the Mac continues to get more interesting. I admit, that's not the type of statement to open with at parties (I guess it depends on the party), but digital storage is changing and affecting all of us.

This version 2.1 release covers changes made in macOS 11.0 Big Sur:

- Apple has tinkered again with the way APFS volumes work (not only splitting the startup drive into two separate volumes behind the scenes, but also adding other invisible volumes), which has been updated in [Understand File Systems](#). This is important material to understand when erasing drives and creating new volumes.
- Speaking of the APFS format, macOS Big Sur at last adds support for APFS-formatted Time Machine disks. See [Which File System for Which Drive?](#)
- It turns out that if you want to encrypt a Mac OS Extended (Journaled) disk, you'll end up with an APFS (Encrypted) disk instead of an Mac OS Extended (Journaled, Encrypted) disk. The latter option no longer appears as an option in Disk Utility when erasing disks. See [Encrypt a Non-Startup Volume](#).
- I've updated screenshots to use the Big Sur versions where necessary. Although Big Sur introduces a new interface design, in most cases the controls and placements of items is the same as in macOS Catalina.

What Was New in Version 2.0

The version 2.0 update involved more significant changes over the first edition of the book:

- APFS is now the default file system for macOS, and so I've expanded the discussion of APFS snapshots (also known as Time Machine local snapshots). Snapshots are similar to backups, but not exactly the same; I describe why and how to take advantage of them in the [Make Backups](#) section. I also answer the frequently asked question, [What About Using an SD Card for Backups?](#)
- Physical storage is changing, too. The [Solid-State Drives](#) discussion has been broadened to include more detail on how data is stored. I also talk about NVMe (Non-Volatile Memory Express), a much faster type of solid-state memory compared to the replacement SSDs I originally included in the last edition.
- Structurally, it made sense to move [External Drives](#) into its own section, since prices and form factors of external SSDs are now much more reasonable.
- Of course, these topics assume everything is working well. In [Identify a Failing Drive](#), I bring up early warning signs and use the app DriveDx to diagnose drive troubles before they become serious.
- The section on how to [Use Network-Attached Storage \(NAS\)](#) helps to answer why you'd consider a NAS (and discusses the many factors involved in buying and using one).

Introduction

In an ideal world, this book wouldn't exist. You should never need to worry about the specifics of where your documents, photos, videos, and other files are stored, only that they're safe and accessible when you want them.

We live in the real world, though, and you're likely reading this because your current storage arrangement needs adjustment: You're running out of disk space. You need to replace or repair a drive that's not working, or you suspect a drive is on its last days. Perhaps you're in the market to buy a network-attached storage (NAS) device, but the sheer number of options is overwhelming. (Or, you might just like to learn new information. Hooray for curiosity!)

Storage mostly recedes into the background—until something goes wrong, or you need more of it, or you get a new computer and realize that what you really *should* do is re-evaluate your entire storage system.

So you dig in...and it's like opening a wall in your house. Which wires carry the electricity? Is that a cold water or hot water pipe? Is it even a water pipe? Are these old connections, or has some new technology emerged to replace them? And how did all that dust and crud get in here?

This is when knowledge of how storage works in your Mac helps immeasurably. The options are varied and can make even the most ardent technologist glaze over. But with an understanding of your storage options at hand, you can make better decisions that let you focus on the data that's important to you, not on finding or dealing with it.

Your Digital Storage Quick Start

As we expand our digital storage needs to consume more data, we also find ourselves expanding the ways in which we manage and work with that data. Although you don't need to read this book front-to-back, I recommend you go through the [Understand Storage](#) chapter to get a baseline on which the rest of the book is built.

Understand storage basics:

- Learn the differences between internal and external [Hard Drives](#) (and the many ways they connect to your computer).
- Learn the advantages of [Solid-State Drives](#) (SSDs) compared to traditional hard drives, and when to choose one or the other.
- If you're looking to expand your capacity, [How Much Storage Do You Need?](#)
- Learn about [Disk Images](#) and when you'd use them.

Understand RAID:

- Learn what a [RAID](#) is and under what circumstances you'd use one.
- Determine which of the [RAID Levels](#) is best for your situation.

Look to cloud storage:

- Use [Cloud Storage](#) such as Dropbox, iCloud Drive, and Google Drive to store data remotely.
- Learn about which types of data are applicable when you [Choose Cloud Storage](#), including the option to optimize storage on your Mac.

Learn about file systems:

- Understand [APFS](#) (Apple File System), Apple's new underlying file system, and its advantages.

- Learn about other file systems, such as [Mac OS Extended](#), MS-DOS (FAT), and ExFAT.
- [Manage Partitions and Volumes](#) using both APFS and Mac OS Extended, and learn how they work independently and together.

Use disk encryption:

- Use [FileVault](#) to protect your disk's data.
- [Encrypt a Non-Startup Volume](#) for security beyond your startup disk.
- What if you lost your password? [Recover Access to a FileVault-Protected Disk](#).

Manage drives:

- [Format a Disk and Erase Its Contents](#) using Disk Utility.
- [Run First Aid](#) when a disk seems ill (and understand [What First Aid Does](#)).
- [Identify a Failing Drive](#) before it's too late.

Work with Network-Attached Storage (NAS):

- Learn which [Features to Look for in a NAS](#) if you're in the market to buy one.
- Learn how to [Work with Files on a NAS](#).
- Since photography occupies so much storage, learn how to use [NAS for Photography](#). (Thanks to smartphone cameras, we're all photographers now, so don't skip over this section.)

Manage your data:

- [Determine Available Storage](#) on a disk (and know when that number might not be accurate).
- Learn smart strategies to [Free Up Disk Space](#).
- [Take Advantage of Time Machine Local Snapshots](#) to restore data even when you haven't connected to an external Time Machine drive recently.

Understand Storage

Generally speaking, computer storage comes in two forms: hard drives and solid-state memory. Those can exist inside the computer, outside the computer (in external cases connected by a cable, or flash memory drives and cards), or as memory chips soldered directly to the computer's main logic board. This chapter looks at the structural details of how they work, which we will build on for other topics.

Hard Drives

The term *hard drive* has become a catch-all for nearly any type of computer storage, but in the context of this book, I'm talking about the traditional, spinning-platter media that has been the standard for decades. A hard drive (sometimes referred to as a *hard disk drive*, or *HDD*) is a self-contained box that includes several circular platters, with an actuator arm that reads and writes data to the magnetic surface of the platters (**Figure 1**).



Figure 1: Each metal enclosure here contains spinning platters and 4 TB of storage.

Typically, the platters spin continuously, although most drives also support power-saving features that pause them when they're not actively being used. If you've come back to your computer and experienced a short lag before it's responsive again, chances are the hard drive was spinning back up.

To get a picture of how hard disks work, and the specifications you need to know about them, let's start inside a drive and move outward.

Drive, Disk, and Disc Delineation

The terms "hard drive" and "hard disk" are often used interchangeably, but in a book like this, it's important to know the difference.

- ✦ A *hard drive* refers to the physical container that houses the hard disk and includes the necessary processors and connections to run the disk. The term is also used to describe an external hard drive, a case that contains the drive itself and provides power and ports for connecting it to the computer.
- ✦ A *hard disk* or *disk* is the storage medium on which data is stored. Typically the terms refer to the magnetic platters within a hard drive, but I've heard "hard disk" or just "disk" used informally when discussing solid-state memory, even though SSDs are composed of just memory chips, not magnetic platters. Since SSDs perform the same function as spinning platter disks, the terms have stuck for any electronic storage in a computer.
- ✦ A *disc*, with a C, describes optical media such as CDs (compact discs) or DVDs (digital video discs), where data is burned onto a specially coated surface and then read by a laser that measures the dips etched there.

Important Hard Drive Specifications

We think of drive capacity first when it's time to replace or upgrade storage, but just as important are the drive's dimensions, rotation speed, amount of cache, and the connection type.

Capacity

This comparison isn't practically relevant now, but bear with me, because it's fun to think about: The original Apple I and Apple II

Format and Partition Disks

I'm a terrible handyman, and yet even I know that if you start a project on shaky ground or incorrect measurements, you'll wind up with cascading problems later.

So when we look at managing the data on a hard disk or SSD, we need to start at the base layer and work upward from there. The file system that undergirds macOS is an invisible, but essential, component of the operating system that controls how and where data is written on the sectors on a spinning platter or in the cells of a solid-state memory chip. For years, the file system wasn't anything most people had to think about, but with the arrival of macOS High Sierra in 2017, the default Mac file system changed from Mac OS Extended to APFS (Apple File System).

When you need to format a disk or split it into sub-volumes, you'll want to make an informed choice.

Understand File Systems

To be fair, the file system is still something that most people don't need to think about. If you've upgraded to High Sierra (or later) and your Mac has an SSD, it was automatically upgraded to APFS. You may notice faster copying and other file operations, but otherwise you shouldn't notice a big change—that's a good thing. macOS Mojave and later automatically upgrade the startup disk regardless of type, whether it's an SSD, mechanical, or Fusion drive; secondary or attached drives aren't converted. Before we get to formatting or partitioning a disk later in this chapter, let's cover the file system options you'll encounter and how they differ.

Mac OS Extended

The default Mac file system for years, Mac OS Extended (Journaled) is still in wide use, making it the most compatible option. Also commonly

known as *HFS+* (where HFS stands for Hierarchical File System), it's designed to read and write data to spinning disks using the read/write heads at the end of the armature.

The “journalled” parenthetical in the name refers to a method of error correction used to prevent bad sectors or other data abnormalities. When copying a file, for instance, the operating system may need to write it in pieces to several sectors on the disk; journaling checks to make sure all the pieces are successfully written and the file is intact.

The disadvantage to Mac OS Extended (Journaled), and the reason it's being replaced by APFS, is that it's not optimized for use with solid state storage. The physical location of a piece of data isn't as important within an SSD's memory cells as it is on the surface of a magnetic platter.

For our purposes, the important part of Mac OS Extended is the way it allocates space on a disk.

Imagine the disk is a factory that builds rockets. (I suppose I could instead use an office building as a metaphor, but wouldn't you rather imagine spaceships?)

On a disk formatted as Mac OS Extended, the factory is a giant open space where the rockets can be assembled, parts can be stacked in certain areas (or strewn across the floor, because they're all easily located, but the factory manager keeps things orderly). That's the free space on the disk.

There's also a secret door that opens to a hidden room filled with emergency equipment that nobody pays attention to unless something goes wrong on the factory floor. That room represents macOS Recovery, the invisible startup partition that runs a scaled down version of the operating system when you want to run repairs on your main macOS installation (**Figure 24**).

Use Network-Attached Storage (NAS)

When I asked a technical friend about his opinion on which kind of Network-Attached Storage (NAS) device to buy, his response mirrored my own (and perhaps yours, too): He'd been thinking about getting one, but the sheer number of variables involved kept him away from actually making a purchase.

A NAS itself typically looks like an unassuming largish box, sometimes with just a single drive, but more often with two or more drive bays into which you insert bare hard drives or SSDs (making it possible to upgrade the overall storage over time by using higher-capacity drives). The magic that makes it special is that it's also a computer in its own right, with a processor, operating system, and RAM to handle all of its tasks.

The NAS connects to the network via Ethernet cable, making it available to everyone else on the same network. And in many cases, the NAS can be accessed when you're outside the local network. If you arrive somewhere and realize that an important file is stored on a disconnected hard disk (even if you're on the couch downstairs and the drive is in the home office upstairs), it's no problem; that file is available just as if its drive was directly connected to the computer.

Several vendors sell NAS units, such as [Synology](#), [QNAP](#), [Drobo](#), and [WD](#). And among those, you'll find models designed for personal use, for small offices, and for industrial applications. In this section, I cover the thought process of determining whether you might want to get a NAS, look at the important features and components to help you choose one, and walk through the process of incorporating NAS storage into your situation.

Disclaimer: NAS devices come in many sizes, configurations, feature sets, and price ranges. It would be madness to try to cover all of them. So, in this chapter where I'm covering most of the major features to pay attention to in a NAS, I'm using the one I eventually purchased, a Synology model, as an example, not an endorsement.

Why You Might Consider a NAS

You've probably already put some thought toward this topic, or maybe you're looking at your current storage setup and hoping to streamline it. Let's walk through some of the reasons you'd consider buying a NAS:

- You want more storage, but having a drive physically connected to your computer is limiting. I've used laptops as my main Macs for years, precisely because they're mobile. If I'm working in my living room, I don't have to trudge to my home office and plug in a drive to access files, because I can easily [Mount the NAS Volume in the Finder](#).
- You want that storage to be centrally located. "Out of sight is out of mind," as the saying goes, so if I have to guess which of the various drives on my shelves (and closet, and drawers) contains the files I need, the data may as well not exist. The simplicity of knowing that everything you need is in a central location means you're not expending time and brain power searching.
- You want data to be available to anyone else on your home or work network. Family members or colleagues can access all the same files, or you can set up access for individuals. A NAS isn't just a big hard drive—it has an operating system and sophisticated networking features and user permissions.
- You want private access to files. In many ways, cloud services such as Dropbox or Google Drive perform the same storage tasks as a NAS. However, everything runs through those companies' networks, and can be accessed (in various degrees) by their employees.

Manage Your Data

At one point, having all your data on one internal disk was sufficient, but smaller-capacity SSDs and other factors have made storage more complicated. In this chapter, I recommend strategies for choosing which data belongs where—internal storage, external storage, or in the cloud—and how to free up disk space. The goal, as much as possible, is to make sure your stuff is easily accessible and to avoid any surprises.

Choose Your Own Storage Adventure

It's tempting to start shoving data onto other disks when your primary storage fills up, like cramming stuff into a closet when you need to clean a room quickly. That gets the data out of sight, but also out of mind, making it harder to find later. Plus, some types of information need to stay on the internal disk, while others are more suited to external or cloud storage.

Choose Internal Storage

Setting aside nontrivial components like the system itself and apps, you generally want to keep active project files and documents you use on a daily basis on the internal disk. Basically, that includes anything that would interrupt what you need to do on the computer if the data were unavailable. Leave the `/System` and `/Library` folders alone.

For performance reasons, you may want to keep local scratch files used by Photoshop or video editing apps on your startup disk, even though those can temporarily occupy a lot of space. The speedy solid-state memory built into the latest MacBook Pro models will give you better performance than mechanical disks. That said, this is highly dependent on your computer, the amount of RAM installed, and the level of editing you're doing. Serious editing pros typically set up an external drive or a RAID 0 array dedicated solely as a scratch disk.

Note: The flip side of using solid-state storage for scratch files is that the frequent data writes shorten the SSD's lifespan. However, SSDs are designed to last for hundreds of terabytes of use. As always, your mileage may vary.

Choose External Storage

Data you shunt to an external disk is usually old, large, or both. Material you don't need to access day to day can be archived on an external drive; if you have a NAS, you can easily grab the data when you need it (see [Work with Files on a NAS](#)).

Large files seem ideal for transferring to an external disk, since they're usually the first space hogs that you identify when you're looking to [Free Up Disk Space](#). However, that approach can be mixed, depending on the data. Some common considerations include:

- **Virtual machines:** The disk images created by Parallels Desktop and VMware Fusion tend to be huge, because they contain entire operating systems and computing environments. Moving them off your internal storage can slow their performance unless the destination is a fast SSD connected via USB 3.0 or Thunderbolt.
- **Music and videos:** Your Music or iTunes library is composed of many music and movie files you probably don't consume every day, so moving it to an external disk will often free up a lot of disk space. (See [Manage and back up your iTunes media library](#) for detailed steps on how to accomplish the move.) However, the library must be on a disk that's always connected to your Mac, otherwise you can't access the media.

Another option is to keep the Music or iTunes library database on your internal disk, but reference the media files themselves from an external drive. To do this in the Music app, go to Music > Preferences > Files, and then turn off "Copy files to Music Media folder when adding to library" (**Figure 63**). In iTunes, go to iTunes > Preferences > Advanced, and then turn *off* "Copy files to iTunes Media folder when adding to library." When you import new media

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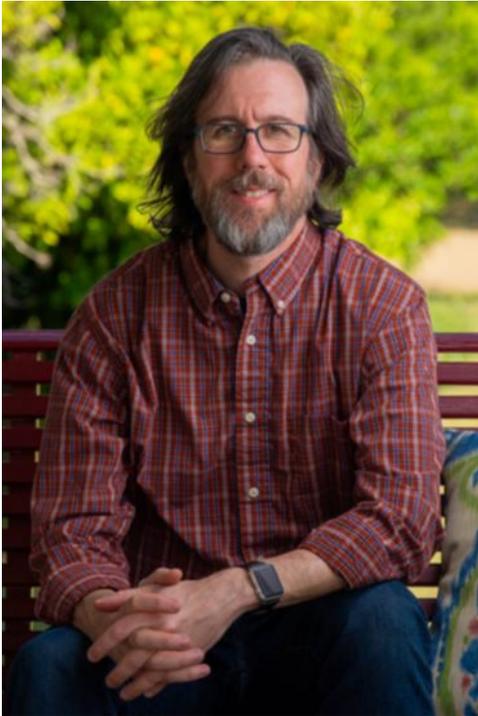
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Shameless Plug

I produce a lot of creative material—something which I'm honored to be able to do—including photographs, books for Take Control and Rocky Nook, the [PhotoActive podcast](#), and articles for Macworld, the Seattle Times, DPReview, CreativePro, and other outlets. Find my work at jeffcarlson.com and sign up for my [low-volume newsletter](#) to learn about new projects and occasional deals and giveaways. Thank you!

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alt concepts inc., publisher of Take Control Books, is operated by [Joe Kissell](#) and [Morgen Jahnke](#), who acquired the ebook series from TidBITS Publishing Inc.'s owners, Adam and Tonya Engst, in May 2017. Joe brings his decades of experience as author of more than 60 books on tech topics (including many popular Take Control titles) to his role as Publisher. Morgen's professional background is in development work for nonprofit organizations, and she employs those skills as Director of Marketing and Publicity. Joe and Morgen live in San Diego with their two children and their cat.

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