TAKE CONTROL OF
SPEEDING UP YOUR MAC

by JOE KISSELL

EBOOK EXTRAS: v2.1
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Don’t settle for a sluggish Mac! If it seems your Mac has become slower and less responsive over time, it’s not your imagination—but it’s also a problem you can solve without buying a new computer. This comprehensive book teaches you how to find the exact causes of slow performance and take steps to make your Mac snappy again.

If you want to share this ebook with a friend, we ask that you do so as you would with a physical book: “lend” it for a quick look, but ask your friend to buy a copy for careful reading or reference. Discounted classroom and Mac user group copies are available.

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Basics

To review background information that might help you understand this book better, such as finding System Preferences and working with files in the Finder, I recommend reading Tonya Engst’s ebook *Take Control of Mac Basics*.

In this book, when I use the term *disk* by itself, I generally mean your Mac’s primary internal storage device—whether that’s a mechanical hard drive, an SSD, or other solid-state storage. (Apple, after all, still uses the term “Macintosh HD” as the default name for your Mac’s startup volume, even when it’s not stored on a hard disk.) A *drive* is a physical device for storing data; a single drive can comprise one or more *volumes*, or logical storage devices. The volume that contains the copy of macOS currently used to boot your Mac is your *startup volume*. I’ll specify *hard drive* when I need to talk specifically about the little boxes with spinning platters.

What’s New in Version 2.1

Version 2.1 is a minor revision that brings this book up to date with macOS 10.14 Mojave and various changes in third-party hardware and software. Nearly all the changes in this version were quite small, but some of the noteworthy items I addressed were:

- Removed outdated information about obsolete hardware and discontinued software
- Added a sidebar about the perils of APFS with mechanical hard drives; see Hard Disks and Macs Running Mojave
- Noted current limitations in APFS support in Use a Third-Party Disk Repair Tool and Use a Defragmenting Utility
• Added links to ad-blocking extensions suitable for Safari 12 in Block Ads and Trackers
• Added a note about new Wi-Fi naming conventions in 802.11 Flavors
• Updated my recommendations for fast DNS service in Use a Faster DNS Provider
• Included information about the RAM and storage upgradability of newer Mac models in Upgrade Your Hardware

What Was New in the Second Edition

The second edition of this book (version 2.0) represented not only a change in its version number but also in its title. This book’s most recent ancestor in the Take Control series was Take Control of Speeding Up Your Mac, which was published in May 2011 and last updated in September 2012. I subsequently acquired publication rights to the book, updated it significantly, and rereleased it with a new title (Speeding Up Your Mac: A Joe On Tech Guide) in June 2016, followed by a version 1.1 update in September 2016.

After I purchased Take Control Books from TidBITS Publishing Inc. in May 2017, I decided to bring this book back under the Take Control umbrella. That meant reverting to its previous title and incrementing the edition number by one (even though there was, in effect, another edition of the book between the first and second).

Along with a large number of minor changes, here are the major changes between Speeding Up Your Mac: A Joe On Tech Guide version 1.1 and Take Control of Speeding Up Your Mac, Second Edition:

• Updated the book for compatibility with macOS 10.13 High Sierra and the latest Mac models available as of December 2017
• Added iStat Menus to the list of utilities in Use Live Monitoring Tools
• Mentioned a way to speed up Time Machine in Adjust Backup Software Settings

• Clarified details about how much space you should leave available on your disk in Determine How Much Space You Need

• Revised Use Optimized Storage in Sierra or Later with better details and new advice

• Updated various topics in Speed Up Your Browser to cover the latest browser versions

• Revised Monitor Network Activity to use Little Snitch, rather than the now-discontinued Private Eye, as an example

• Added a mention of mesh/hub-and-spoke Wi-Fi routers in Signal Strength

• Explained the importance of using the right kind of Ethernet cable in Check Your Wired Ethernet Connection

• Revised Use a Faster DNS Provider to reflect the fact that namebench is no longer being developed (and has problems under High Sierra and later)

• Added CursorSense to the utilities covered in Adjust Acceleration

• Updated the sidebar Is My Storage Upgradable? and the topic Add a Second (or Larger) Display to cover recent Mac models

• Rewrote most of the chapter Speed Up Your Peripherals, which now contains complete information about USB 3.1 and Thunderbolt 3
Introduction

Tell me if this sounds familiar: You get a new Mac, and your initial impression is “Wow! So fast!” Everything seems so snappy compared to that old computer you were using before. Without even thinking about it, you find yourself opening more apps and documents than you ever could, and it all just works. Everything you do—playing games, running Photoshop filters, searching your massive email archive—seems to happen almost instantly. But as time passes, you begin to notice, every now and then, that something takes a bit longer than it used to. Gradually, those occasions become more frequent. Then you become aware of other strange behavior. Video that used to play smoothly now stutters. Webpages seem to take forever to load. Opening apps and saving files is oddly time-consuming. And that cursed spinning wait cursor (see the sidebar The Spinning Pizza of Death) may rear its ugly head from time to time. You start wondering if your Mac has succumbed to old age and needs to be replaced.

This sort of thing happens to just about everyone, although the severity and the rate at which these slowdowns occur vary. Likewise, it’s not at all uncommon for a Mac to encounter intermittent performance problems rather than a gradual speed degradation. So you’re not alone—but that may be cold comfort; your Mac is still too slow!

Of course Apple would like you to hand them lots of money for a new Mac—and sooner or later that will indeed turn out to be necessary. But take heart: you can reverse the effects of time and return your Mac to its formerly zippy self. (And, if you have a newer Mac that’s still pretty fast, you can squeeze even more power out of it!)

There are hundreds, maybe thousands, of books, articles, blog posts, webpages, and utilities that purport to speed up your Mac. I’ve spent countless hours researching their claims, and I’m sorry to say the vast majority of them are wrong. By “wrong” I mean incomplete at best, dangerous at worst, and nearly always based on guesses, anecdotes, or outdated information rather than, you know, verifiable facts.
Many of these claims have a bit of truth to them, so it’s easy for even smart people to be misled. For example, a friend told me her Mac had become terribly slow, and she suspected she needed a larger hard drive. Her disk was nearly full, and it’s true that a full disk can make your Mac very slow. So without any further research I agreed with her analysis. She bought a new hard drive—a big expense at the time—and I installed it. But a week later she told me with great frustration that her Mac didn’t feel any faster, even if her new disk did have plenty of breathing space. She was enormously disappointed, and although she didn’t want to impose on me by asking me to do further troubleshooting, I later learned that her next computer was a Windows PC.

I bear much of the blame for her dashed expectations. I jumped to a conclusion, and I should have known better. We did indeed solve a problem by installing a larger disk, but that didn’t happen to be the major factor contributing to her Mac’s poor performance.

Maybe you’ve had a similar experience. Perhaps you tried something, or a dozen things, that should have worked—or that did indeed work for other people—but your Mac is still slow.

So let’s put all the conventional wisdom and guesswork behind us and turn to science. My aim in this book is to be systematic, factual, and testable. I explain the factors that affect a Mac’s speed and how they interact. I tell you what to check, and what steps you can take to solve various speed problems. But I also show you how to verify numerically if or how much a certain change speeds things up. You don’t have to take my word for it that some procedure may improve your performance—and you don’t have to rely on informal perceptions either. You can measure your Mac’s speed yourself, before and after making changes, and then you’ll know for sure whether it’s better. And if it’s not, you’ll have the tools and knowledge you need to try another technique, and another, until you’ve found and solved the problem.

I hope you feel optimistic—you can and will make your Mac faster! At the same time, I want to set your expectations correctly: you can make your Mac as fast as the day you bought it (and in many cases push it well beyond that) without having to wipe your disk and start from

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scratch, but you’re not going to make a 10-year-old Mac run as fast as a brand-new model.

In particular, I want to be sure you understand the following:

- **The world changes.** Even if you returned your Mac to its exact physical state at the time you purchased it, you may find that some things are slower because of factors outside your control—for example, a website that used to be speedy may have become overloaded with ads and videos and gotten slower as a result, or the latest version of a major app you rely on has become bloated with extraneous features that slow it down. You feel the effect on your Mac, but it’s not your Mac’s fault.

- **You may have to accept trade-offs.** Say your Mac shipped with Mac OS X 10.7 Lion, and you upgraded it repeatedly so that it now runs 10.14 Mojave. Newer versions of macOS (and of third-party apps) may add terrific features but sometimes also require greater system resources to run, which may tax older hardware, especially if your Mac has a small amount of RAM that can’t be expanded further. So it could be that you must decide between speed and features—or make some other unpleasant choice.

- **Returns diminish.** Some easy things you can do will speed up your Mac quite a bit, but as you progress through this book you may find yourself spending more and more time for ever-smaller speed gains. At a certain point, the extra effort isn’t worth the bother.

- **It could cost you.** Many of the techniques in this book can be performed for free, but if you want to make your Mac as fast as possible, you may need to invest in software, hardware, or both.

Nevertheless, my hope is that by the time you finish reading this book, you’ll have a much faster Mac with a new lease on life.

Most of the advice I give here should work regardless of which version of macOS you’re running, but it’s mainly geared toward users with 10.9 Mavericks or later (including 10.14 Mojave). Readers with earlier versions of Mac OS X may notice a few differences in behavior from what I describe here, and some of the steps may not apply at all.
Quick Start

Many factors can influence a Mac’s speed, including some that may not be obvious. So I encourage you to read and follow all the steps in this book. Although I’ve tried to present tasks in a logical progression for the most part, the order in which you do things is not critical. But please be sure to read Learn What Makes a Mac Fast (or Slow) first to get important background information; follow the steps in Try a Few Quick Fixes regardless of the problems you’re experiencing; and acquaint yourself with the test procedures in Diagnose Common Speed Problems, since I refer to them again and again in the remaining chapters.

Start off on the right foot:
• Get a grip on the underlying issues; see Learn What Makes a Mac Fast (or Slow).
• Solve several common speed problems in minutes; see Try a Few Quick Fixes.
• Learn about test procedures, benchmarking, and monitoring resource usage; see Diagnose Common Speed Problems.
• Clean up gremlins on your disk that can have numerous cascading effects; see Fix File and Directory Problems.

Solve general speed problems:
• Make sure your CPU isn’t burdened with unnecessary tasks; see Lighten Your CPU Load.
• Prevent low-memory situations from slowing down your Mac; see Increase Your Free RAM.
• Get data onto and off of your disk faster and more efficiently; see Improve Your Disk Performance.

Speed up specific apps and activities:
• Surf faster; see Speed Up Your Browser.
• Avoid aggravating delays when using Mail, Outlook, or Thunderbird; see Speed Up Your Email.

• Test and optimize all the links between your Mac and an outside server; see Speed Up Your Network.

• Help your Mac get up and running faster; see Speed Up Booting, Sleeping, and Waking.

• Save time with utilities and tricks to increase input efficiency; see Speed Up Mouse and Keyboard Input.

Address hardware issues:
• Replace or add hardware components for increased performance; see Upgrade Your Hardware.

• Eliminate USB and Thunderbolt bottlenecks; see Speed Up Your Peripherals.
Learn What Makes a Mac Fast (or Slow)

In this chapter I set the record straight about what does and does not influence your Mac's speed. Unfortunately, slowdowns are often treated as a sort of voodoo topic, where users are urged to simply Perform the Magical Procedure but with no explanation of what it really does or why it should work. There are a lot of myths floating around; most of them do have an element of truth to them, but that truth is often more constrained or specific than you may have been led to believe. Hence this overview of the positive factors involved, followed by a rogues’ gallery of purported fixes for slow Macs that usually do little good, if any.

The Three Most Important Determiners of Mac Performance

As you’ll see throughout this book, lots of factors contribute to your Mac’s performance. If your Mac is too slow, it may be due to one specific cause (and perhaps not the most obvious one) or to a combination of things. But in my experience, three main factors—CPU power, RAM, and disk speed—exert a greater influence on a Mac’s overall performance than anything else. Because many of the steps I describe in this book are intended to address one or more of those factors, I want to be sure you understand why and how they affect your Mac’s speed.

CPU Power

Your Mac has one or more central processing units (CPUs)—the computer’s “brains.” The CPU is where all the calculations happen that enable your Mac to do everything from displaying a single dot on the screen to surfing the web and editing video. Since calculations are what
a computer is all about, it stands to reason that the more CPU power you have, the faster your computer will be. However, in this case “power” is a slippery notion, and direct comparisons between Macs with different sorts of CPUs get tricky. Several factors come into play.

**Number of CPUs**

If one brain is good, two brains are better! Certain configurations of the (tower-style) Mac Pro and Xserve included two CPUs (although the last Mac to offer such a configuration was discontinued in 2013).

Having more than one CPU means your Mac can process more tasks at the same time. There isn’t a one-to-one correlation between number of CPUs and speed—a two-CPU Mac won’t be exactly twice as fast as an otherwise identical single-CPU Mac—because other factors come into play. For example, if a certain operation depends heavily on disk access, the disk speed could become the bottleneck, regardless of how many CPUs are available. And software must be specially designed to take maximum advantage of multiple CPUs.

**Number of Cores**

Each CPU chip has one or more cores—the parts of the CPU that do the actual computations. Having more cores gives you more processing power, because your Mac can do more calculations at any given time.

The last Mac model to come in a single-core configuration was introduced in early 2006. Assuming your Mac is newer than that, it has at least a dual-core Intel CPU. Many Macs have four-core CPUs, and the iMac Pro can be built to order with a CPU containing up to 18 cores. That might sound like a lot, but in fact chips with hundreds of cores have been produced (though these are expensive chips used mainly in high-end scientific work and are unlikely ever to appear in a Mac).

As with independent CPUs, there isn’t a linear relationship between the number of cores and a Mac’s speed: a four-core CPU won’t be exactly twice as fast as one with two cores. (Depending on several variables, multiple cores yield performance that’s sometimes a bit faster, and sometimes a bit slower, than an equivalent number of independent CPUs.) And, as with multiple CPUs, not all software can
Try a Few Quick Fixes

Lots of the procedures in this book require time, thought, and effort to understand and put into practice. I hope you’ll be systematic about testing speed before and after making changes (as I describe later in Understand Diagnostic Principles), because I think the results are worth it. But that testing might take hours, and meanwhile you’ll still be struggling with a slow Mac.

Fortunately, in many cases you can make significant improvements to your Mac’s performance in a few minutes, with hardly any effort. The procedures I describe in this chapter are not a complete or permanent solution, but it’s the best and easiest place to start.

In fact, even if you plan to work your way carefully through every single procedure in this book, you should start with the items in this chapter; they won’t hurt, they might help, and if nothing else they’ll give your further tests a better foundation.

Restart Your Mac

If your Mac is running slower than usual, the first thing you should do is restart it (choose Apple  > Restart). Merely restarting solves several kinds of problems:

- It forces all apps and background processes to quit, including any that may be chewing up CPU cycles or causing other problems.

  **Note:** The term process refers to a program that’s currently running—not only an app you’ve launched yourself, but also any of numerous parts of macOS and third-party programs that may be active at any given time (possibly without displaying any visible user interface).

- It frees up RAM, giving macOS and apps more room to work when your Mac starts up again.
It deletes certain temporary files, including virtual memory swap files. This can increase speed if you’re critically short on disk space.

In many cases, restarting brings your Mac immediately back to its normal zippy state. It may not stay that way, of course; the very things that slowed it down in the first place can—and probably will—happen again. (Don’t worry, we’ll get to those too.) But restarting is the easiest way to jolt your Mac back to life, at least temporarily.

**Using Safe Mode**

macOS includes an extremely useful diagnostic feature called *safe mode*, which disables a number of components that would otherwise load at startup or login. (The process of entering that mode is known as a *safe boot.*) Safe mode also performs a few low-level cleanup tasks.

To use safe mode, restart your Mac, holding down the Shift key until the login window appears; then release the Shift key and let your Mac start up the rest of the way. Despite the fact that it disables software, a safe boot takes longer than a normal boot because of the aforementioned cleanup tasks, so be patient.

To learn more about safe mode, see Apple’s official description, *Use safe mode to isolate issues with your Mac*. Apple’s description doesn’t mention, however, that safe mode uses much *more* RAM than a normal boot, or that running your Mac in safe mode results in severely *decreased* performance (as measured, for example, by benchmarking tools), all due to the temporary disabling of system resources that would otherwise help your Mac run faster. As a result, you can’t use safe mode to make meaningful judgments about the extent to which startup and login items slow down your Mac.

**Quit Inactive Apps**

If you can’t take the time to restart just yet, you can at least quit apps that aren’t actively in use (and, in the future, try to run fewer apps at once). macOS makes it easy to launch one app after the other and keep them running in the background, and most apps are well-behaved enough to keep their usage of system resources down to a minimum.
Diagnose Common Speed Problems

Saying “My Mac is slow” is like going to the doctor and saying, “I feel yucky.” You won’t get anywhere with a cure—or even a diagnosis—unless you can be much more specific. In this chapter I help you to figure out exactly which aspects of your Mac are too slow (so I can direct you to appropriate fixes) and to actually measure how slow (so we can measure again afterward and determine how effective the fixes were).

We’ll work from general to specific. First, I explain the basic diagnostic principles you’ll use throughout the remainder of the book. Next, I show you how to benchmark your Mac’s raw performance so that you have a baseline against which to compare future results—something you should do regardless of what particular speed problem you’re trying to solve. Then I discuss tools that provide a real-time display of how various system resources are being used at any given moment, which helps you identify software that may be slowing you down. Finally, I provide links to tests described elsewhere in this book that help you narrow down several specific speed problems.

Understand Diagnostic Principles

Something has gone wrong. Your car has stopped moving, or your foot hurts, or your Mac is too slow. You want to solve the problem, but you can’t do that without understanding the cause. Sometimes it’s obvious: your gas gauge is on empty, there’s a rock in your shoe, or you’re trying to edit a 4K video while cloning your hard disk and scanning for malware. But when it’s not obvious, it helps to have general techniques to figure out the source of the problem so you can choose an appropriate solution.
One of the most powerful diagnostic techniques, which can be used to find problems with nearly any complex system, is to *change just one thing* and check whether the problem still exists. This technique isn’t foolproof; problems might have multiple causes, and sometimes several factors interact in ways that are difficult to pin down. But it’s an excellent starting point. If you try changing three things and the problem goes away, you won’t know whether one, two, or all three of those things caused the problem. So, I recommend that you internalize the following sequence of steps, which you’ll follow many times:

1. To the extent possible, eliminate extraneous factors that could affect your test.

   For example, if you’re using your web browser to test the speed of your internet connection, quit other apps and background processes that are using your network, because they could skew your results.

2. Measure the speed of some activity—and make a note of it for future reference.

3. Change one thing that might affect that speed.

4. Measure the speed again.

Then, if the problem still exists—that is, the speed hasn’t increased noticeably—repeat the steps, changing something different in step 3. (Depending on the situation, you may choose to return the thing you changed in step 3 to its original state before performing the next test, but in the absence of evidence to the contrary, your default assumption should be that if the tests in steps 2 and 4 showed the same result, then whatever you changed in step 3 was irrelevant to the slowdown.)

Once you have this basic outline down, the only things remaining to be learned are how to measure speed (which I discuss in the remainder of this chapter) and which items to try changing in step 3 (which I discuss throughout the book).

Alert readers may recognize the procedure I’ve just described as a simplified version of the scientific method: form a hypothesis, conduct an experiment to test the hypothesis, analyze the results, and then if
Fix File and Directory Problems

Although less common than many people imagine, it’s possible for things like corrupted fonts, caches, and preference files to result, somewhat indirectly, in a slow Mac. Similarly, disk errors of various sorts, such as directory damage, can result in a slower Mac (or cause other problems).

Fortunately, the majority of file and directory problems are easily solved—as long as you have the right tools and know how to use them. Because these sorts of problems can affect everything your Mac does, you should check for, and repair, file and directory issues before moving on to the more specific steps I cover in later chapters.

Run Disk Utility

Disk Utility, included with every Mac, can repair a variety of disk errors. Most of these problems have nothing to do with speed as such, but some can lead, even if indirectly, to slow performance—and in any case, they’ll cause you headaches of one kind or another. So, before you continue with other tasks in this book, I recommend, on general principle, using Disk Utility to check for and repair disk errors.

Note: These instructions come from my book Take Control of Troubleshooting Your Mac.

Use Disk Utility in El Capitan or Later

If your Mac is running El Capitan or later, follow these steps:

2. In the list on the left, select your startup volume (if it’s not already selected, which it most likely is); see Figure 7. Note that, depending on your version of macOS and your settings in Disk Utility, volume names may be indented underneath the names of the physical devices on which they reside.

![Disk Utility](image)

**Figure 7**: Select your startup volume (which may, as in this case, be the only available volume) in Disk Utility. This image shows Disk Utility as it appears in High Sierra and Mojave; earlier versions look a bit different.

3. Click the First Aid button on the toolbar, then click Run. Disk Utility examines your disk and attempts to repair it if necessary.

4. When the repair is finished, click Done and quit Disk Utility.

**Note**: If you’re unable to start your Mac normally, restart while holding down ⌘-R to boot into macOS Recovery (a special mode in which a minimal version of macOS, stored on a hidden Recovery HD partition of your disk, is used to start up your Mac for troubleshooting and maintenance tasks). Then select Disk Utility, click Continue, and pick up from step 2 above.
Lighten Your CPU Load

As I discussed in *CPU Power*, your CPU is responsible for doing all the actual computations involved in making your Mac run. As a result, when your CPU is being pushed close to its limit, your Mac will slow down, and the way to speed it back up is to reduce some of the demands on your CPU so it can devote its power to the activities that are most important to you.

In this chapter I focus on steps you can take to reduce excess CPU usage. Because any process that uses CPU power also uses some RAM and, in most cases, accesses your disk, stopping or throttling that process can improve all three aspects of your Mac’s performance. The items I discuss in this chapter are those for which, in my judgment, the improvements to CPU load tend to outweigh improvements in RAM usage and disk access.

Prune Startup and Background Items

Earlier (in *Prune Login Items*), I suggested removing any extraneous apps from your Login Items list—partly because they make logging in take longer, and partly because they may use extra CPU cycles and RAM that you might want to reserve for more important tasks. The same is true of startup items (which launch as macOS starts, before any user logs in) and a variety of background items that load on startup but may not actually become active until later on (see the sidebar *Launchd and the Meaning of “Start”*, just ahead).

Sometimes these pieces of software can be tricky to find and remove, because a “startup item” can be any of numerous types of software, stored in several locations on your disk. But the fact that software loads at startup doesn’t in any way mean it’s bad; determining which startup items, if any, should be removed will depend on the particulars of your setup—and whether the strain an item places on your system outweighs its usefulness to you.
Launchd and the Meaning of “Start”

A macOS component called launchd ("launch daemon") runs other processes in response to a particular condition—for example, on startup or login, on a fixed schedule (say, once a day), or if a certain event (such as modifying a file) occurs. Launchd learns what to do by reading specially formatted files found in these locations:

- /System/Library/LaunchAgents
- /System/Library/LaunchDaemons
- /Library/LaunchAgents
- /Library/LaunchDaemons
- ~/Library/LaunchAgents

I count launchd items as “startup items,” with qualifications. Launchd loads the daemons (which are system-wide processes) on startup, but it loads the agents (which are per-user processes) on login. A safe boot (see Using Safe Mode) disables the launchd items found in /Library and ~/Library—though not those located in /System/Library—along with other startup items.

In any case, depending on the instructions in the launchd item, loading (being added to the list of actions launchd initiates) doesn’t imply running; the process(es) referred to by the launchd item may not take action until later. For example, a launchd item associated with Time Machine tells it to run once an hour. Until then, the backupd (Time Machine) process uses no CPU power or RAM, but when it runs, the process can use quite a bit of both.

Because the effects of launchd items may or may not appear immediately after you restart, experiments that seem to either implicate or exonerate startup items may be misleading.

The following are the steps I recommend for finding and cutting back on startup items, as I’ve (broadly) defined them:

1. **Find your startup and background items.** Begin by making a list (in your favorite text editor, or even on paper) of your startup and background items.
Increase Your Free RAM

As I described in detail in RAM, free RAM correlates strongly with speed, and running out of free RAM—which in turn increases virtual memory usage—is a major reason for slowdowns. So in this chapter I explore ways to keep more of your RAM free. The things that free up RAM often reduce CPU usage and disk access too, but here I’m looking at cases where RAM is the main consideration.

Of course, the best way to increase your free RAM is to add more (see Add RAM). But if your Mac won’t hold any more or can’t be upgraded, or if you can’t afford to add physical RAM, the steps in this chapter should help.

Reduce the Number of Open Apps, Windows, and Tabs

Look at your Dock right now. How many apps are open? (Open apps have a dot beneath the icon if your Dock is at the bottom of your screen, or next to the icon if your Dock is on the side. If these dots do not appear, go to System Preferences > Dock and check “Show indicators for open applications.”) Of these, how many are you actively using? How many have you even touched in the last hour? I urged you earlier to Quit Inactive Apps, but here I want to provide more detail and ask you to go further—and to develop some new habits.

Note: This chapter refers to ordinary apps you open yourself; to learn about quitting background processes, see Prune Startup and Background Items.

Each app you run uses at least a bit of RAM, and although its CPU usage may drop to virtually nothing when it’s in the background, it continues to use RAM—sometimes a lot of RAM—until you quit it. Similarly, every new window or tab you open, whether in the Finder or
in any other app, requires a chunk of RAM, even if the app is hidden or the window is minimized to your Dock. So the fewer apps, windows, and tabs you have open, the lower your overall RAM usage.

**Note:** As far as your Mac’s RAM is concerned, a tab (whether in a web browser or any other app) is just another window.

**Tip:** I discuss additional ways to deal with too many browser windows and tabs later, in Have Fewer Tabs and Windows Open.

Closing windows and quitting apps is pretty straightforward, but I do have a few specific tips:

• **Quit and (possibly) reopen.** When you quit an app, macOS recovers the RAM the app was using. Even if you immediately reopen the app, its RAM usage will likely be less than it was before, because many apps use increasing amounts of RAM as they run but then don’t properly give back what they no longer need (see Watch Out for Memory Leaks, ahead).

• **Don’t just close.** As I mentioned earlier, for many Mac apps—especially those that are document-based—merely closing the app’s last open window doesn’t necessarily quit the app. If there’s still a dot by its Dock icon, or if its icon appears when you press ⌘-Tab to switch between apps, the app is still running, even without any visible windows. Right-click (or Control-click) on the Dock icon and choose Quit from the contextual menu.

• **Watch the clock.** macOS makes it easy to open lots of apps and keep them running. If you’re low on RAM and you notice that you haven’t used a given app in more than an hour, consider quitting it. (To automate the process, try a free app called Quitter for Mac, which can quit any designated app after a user-specified period of inactivity.) It might take a bit longer to reopen that app the next time, but you’ll probably more than recover that time in increased performance due to the extra RAM. (If you want to speed up app opening dramatically, get an SSD; see Add an SSD.)
Improve Your Disk Performance

Regardless of your drive’s raw speed, if lots of processes are trying to read/write at the same time, that’s going to dent your Mac’s overall performance—even with a fast CPU and lots of RAM. (The problem is much less severe, but not entirely absent, with SSDs.) In this chapter, I talk about what some of those disk-intensive activities are and how to minimize their impact. In addition, since your Mac can run slow if its startup disk becomes critically low on space, I explore numerous ways to address that problem. And I discuss a few other ways (of varying degrees of utility) to increase a disk’s performance.

Hard Disks and Macs Running Mojave
macOS 10.14 Mojave automatically and unavoidably updates all startup volumes to use Apple’s new APFS file system. APFS offers fantastic performance on SSDs (and pretty good performance on Fusion drives), but awful performance on mechanical hard drives. So:

✦ If you have a Mac with a mechanical hard drive that got mysteriously much slower after upgrading to Mojave, that’s almost certainly why. Failing some magical software update from Apple, the only remedies available to you are to downgrade to your previous version of macOS (likely a complicated undertaking) or replacing your hard drive with an SSD (see Add an SSD).

✦ If your Mac has a mechanical hard drive and is still running High Sierra or earlier, I suggest postponing an upgrade to Mojave unless or until you can outfit your Mac with an SSD.

Tame Disk Access

Earlier, in Disk Speed, I said that your hard disk can do only one thing at a time. If you ask it to do two or more things at once—reading, writing, or searching files—it can accomplish this only by switching back
and forth between the tasks rapidly, which slows all the tasks down. Even an SSD, which doesn’t suffer from the physical constraints of mechanical hard disks, can read or write data from only one location at a time, so giving it too many things to do will reduce its performance.

Apart from ordinary file access, macOS often uses your disk to store virtual memory swap files. If the software you’re running makes demands for memory beyond the physical RAM you have installed, macOS moves pages of memory onto and off of your disk as needed. As I detailed in RAM, although a little of this may go unnoticed, the more heavily macOS is forced to depend on virtual memory, the greater the amount of disk thrashing. That will slow down your Mac all by itself, but when you combine it with other disk-reading and -writing activities, it’s bad news all around—your Mac could freeze up. (And the best remedy, of course, is to Add RAM.)

How might you know if your disk is being overworked? If your Mac has a mechanical hard drive, you might hear it clicking and whirring away, depending on where the Mac is located, the type of disk, and the ambient noise level. But you can get a better idea if you Use Activity Monitor: click Disk at the top of the window, and you’ll see a graph with reading activity shown in blue and writing shown in red. In normal use, both of these spike from time to time, and if you’re reading a large file (such as playing a movie in iTunes) or writing a large file (for example, saving an iMovie project), one or the other might stay high for a while. But if you’re seeing sustained high reading and writing activity for no apparent reason, sort the processes on Activity Monitor’s Disk tab by Bytes Written (to see what’s writing data) or Bytes Read (to see what’s reading data). When you identify the culprit, you can decide whether to let it continue with its task, quit it, or change its settings.

A few types of disk activity warrant additional discussion: Spotlight, backups, and other disk-intensive software.
Speed Up Your Browser

Apart from network issues (which I discuss later, in Speed Up Your Network), lots of things can affect the speed with which a browser downloads and displays pages (and does other things, too, including scrolling pages and playing videos). This chapter explores some of the things you can do to make web browsing as fast as possible from the browser end.

Quit and Reopen Your Browser

Is there an echo in here? Back in Reduce the Number of Open Apps, Windows, and Tabs, I told you that you can increase the amount of free RAM on your Mac by quitting apps (even if you immediately reopen them). I hereby reiterate that advice, but when it comes to web browsers you may need additional information to help you cope effectively with this strategy.

If you’re like me, you don’t browse just one webpage at a time. Perhaps you do a web search and then ⌘-click a bunch of links to open them in background tabs so you can visit them later. Maybe you have a set of webpages you like to visit every day, so you keep them open in tabs or in separate windows. Or you frequently follow links in your email or Twitter client for sites you’d like to explore later, giving you lots of open tabs or windows. Whatever the case, it’s extremely easy to have lots of webpages loaded without even realizing it. Each of those pages uses a bit of RAM, and, depending on which browser you use, some of them may continue using CPU power when the window or tab, or even your entire browser, is in the background. The quickest way to free all those system resources is to quit your browser.

But wait! Won’t you lose all those open pages when you restart your browser? What if you haven’t looked at them yet—or don’t want to go to the bother of individually bookmarking them and reopening them?
Safari, Chrome, and Firefox can automatically restore windows and tabs when you reopen them. To set this up:

- **Safari:** First, go to System Preferences > General and make sure “Close windows when quitting an app” is selected. Then, in Safari, go to Safari > Preferences > General and choose “All windows from last session” from the “Safari opens with” pop-up menu.

- **Chrome:** Go to Chrome > Preferences and select “Continue where you left off” under “On startup.”

- **Firefox:** Go to Firefox > Preferences and select “Show your windows and tabs from last time” under “When Firefox starts.”

## Have Fewer Tabs and Windows Open

Not to belabor the point, but the more browser windows or tabs you have open, the more RAM (and perhaps CPU resources) you’re using. If you don’t want to quit the browser altogether, at least close the tabs and windows that you aren’t currently using and don’t expect to return to soon. But if you are willing to quit the browser, you can follow the tip for your browser in the preceding section to automatically restore windows and tabs when you reopen it.

## Block Ads and Trackers

I can think of many excellent reasons to block ads on webpages, including privacy and security considerations—topics I cover in detail in *Take Control of Your Online Privacy*—to say nothing of reducing visual clutter. In addition, many webpages have code that loads and runs invisibly but enables advertisers to track your activities on the web and build up detailed dossiers of your interests. The same tools that block visible ads usually block these unseen trackers as well.

Whatever your feelings about the virtues or vices of web advertising and tracking, one thing’s for sure: pages with lots of ads and trackers on them load more slowly than pages without! Ergo, you can speed up...
Speed Up Your Email

In this chapter I talk about some of the things that can make email much slower than it needs to be when accessed using desktop clients such as Apple Mail and Microsoft Outlook, and how to address those issues. But be sure to also read the next chapter, Speed Up Your Network, which covers general network issues that could also have an effect on your email.

Adjust Checking Frequency

If you depend heavily on the timely receipt of email, you may have set your email client to check your IMAP or POP account as frequently as possible—say, once per minute. Paradoxically, such frequent checks can slow down your email client, in some cases increasing the amount of time it takes to receive new messages.

The reason is that each check takes time; the more accounts you have, and the more messages in each one, the greater that time is. If a single check takes longer than the interval you’ve designated between checks, the result is that your client is perpetually checking for messages. Depending on how your client is designed, this may mean that a series of checks are queued up such that checking your first account may have to wait until your client is finished checking several other, slower accounts; or it could mean that multiple checks are happening in parallel, which can slow down all of them.

In any case, my advice is simple: try a longer interval between checks—5, 10, or 15 minutes. See how that goes for a day or two; you can always adjust it again later. To change the frequency of email checks, do this:

• **Apple Mail**: Go to Mail > Preferences > General and choose a frequency from the “Check for new messages” pop-up menu. (The default choice, Automatically, means the interval depends on whether your Mac is running on batteries or on AC power.)
• **Microsoft Outlook 2011:** Go to Tools > Run Schedule > Edit Schedules. Double-click the Send & Receive All schedule, enter a time in the Repeating Schedule row, and click OK. Repeat with any additional schedules you may have.

• **Microsoft Outlook 2016 or later:** Go to Tools > Accounts and select an account. Click Advanced, followed by Server. Make sure “Sync all IMAP folders every ___ minutes” is selected, and change the number in the blank. Click OK. Repeat this for any additional accounts.

• **Mozilla Thunderbird:** Go to Tools > Account Settings. Under any email account in the list on the left, select Server Settings. Change the number in “Check for new messages every ___ minutes” and click OK. Repeat this for each of your accounts.

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**Consolidate Your Accounts**

Your email client can check as many different accounts as you have—and many of us have quite a few! But you can speed up your email client and reduce email management hassles by consolidating your accounts so that your client has fewer servers to talk to (ideally only one). Of course, you may still need to receive mail from multiple addresses (say, a work address and a home address) and also send mail from multiple addresses (so that replies go to the right place). With a bit of effort, you can potentially do all this while still checking only one email account for incoming messages.

**Receiving Email**

If you have multiple personal POP or IMAP accounts, you can choose one as your primary account—that’s the one you’ll actively check with your email client—and then redirect email from your other (secondary) accounts to this primary account.

[Click here to buy the full 205-page “Take Control of Speeding Up Your Mac” for only $14.99!](#)
Speed Up Your Network

What some perceive as a slow Mac may have nothing to do with the Mac itself, but rather with one or more of the links in the network between the Mac and another computer (such as a web server). In this chapter I look at several parts of that chain to help you identify and clear bottlenecks.

This discussion of network speed is deliberately shorter on details than most of this book, for two reasons:

• Because of the many variables involved in optimizing a wireless network, it would take an entire book to do that topic justice. Luckily, such a book exists: Glenn Fleishman’s *Take Control of Wi-Fi Networking and Security*, which I recommend.

• The last comment notwithstanding, a large percentage of network speed issues can be solved readily with a few simple tests and tips, which I’m happy to provide in the following pages.

Understand Factors Influencing Network Speed

Suppose something you’re doing that involves resources on the internet—such as loading webpages—seems slow. This sort of thing can be tricky to diagnose, because there may be a great many links in the chain between your Mac and the server it’s talking to, and any one of them could be the bottleneck. For example:

• Your Mac itself could have network configuration problems.

• Your browser, or an extension or plugin, might be at fault (as discussed earlier, in *Speed Up Your Browser*).

• A particular process (such as an online backup app) could be monopolizing your internet bandwidth.
• You could have a bad Ethernet cable. (Seriously!)

• The Wi-Fi connection between your Mac and your wireless router might be too slow.

• The broadband link to your ISP could be inherently slow, or the ISP could be experiencing temporary congestion.

• The DNS servers that map domain names to IP addresses could be responding slowly, adding delays to each request you make.

• The server on the other end—or any of the intervening routers, switches, hubs, gateways, and other equipment—might be too slow (see the sidebar When I Say “Slow”... ahead).

The problem could also be caused by more than one of these things—or by something else entirely. Some of them are out of your control, but you should be able to at least find out approximately where the issue lies, and take steps to deal with elements you can control.

The first thing to do, as with any problem, is not jump to conclusions. The way to diagnose network problems is to proceed step by step, examining each link in the chain as you go. When you find a bottleneck, you can take steps to clear it. Then keep looking, because there might be another one!

As usual, I recommend starting with a relatively clean state, removing as many variables as possible. So, before performing any tests, restart your Mac, and don’t run any apps except the ones you’re using for the tests.
In this chapter, I discuss a number of factors that can influence how long it takes a Mac to boot. In addition, I explore an issue that can significantly affect how long it takes for a notebook Mac to enter and exit sleep mode—as well as how much disk space is used.

Learn What Influences Startup Speed

When you turn on or restart your Mac, it has to read thousands of files from your disk, copy a fair amount of data into RAM, and launch a number of processes, most of which run invisibly in the background. Beyond what macOS itself needs in order to function, the process may include loading third-party software of various kinds, such as kernel extensions (which modify the behavior of macOS at a low level) and startup items (often helper apps that run in the background).

Once macOS has started, the login process begins. Depending on your preferences, this may happen immediately and automatically or you may have to supply a username and password to log in. Either way, macOS then loads still more files and runs still more processes, including any items shown in System Preferences > Users & Groups > Login Items.

All of the above could take less than 30 seconds or more than 10 minutes—or anywhere in between. What could account for that tremendous difference in time?

Here are some of the key factors:

- **Disk speed**: Because so many files must be read, the speed with which your disk can transfer data into RAM is key. In general, hard disks with lower rotational speeds are the slowest; disks with higher rotational speeds are faster; and SSDs are fastest. And, as hard disks
go, external disks tend to be slower than internal disks with comparable specs, and external USB 2.0 disks are *crazy slow*.

- **Directory health:** In this context, *directory* is the informal term for a set of special files on any disk that keep track of where all the data is. Because any given file may be stored in dozens or hundreds of smaller pieces scattered over the disk, the directory enables macOS to find and reassemble all those pieces (among other functions). Any number of factors can result in a damaged or inefficiently structured directory, which in turn makes it more time-consuming to locate and read the files necessary to start macOS.

- **Caches:** Some of the components that macOS must load at startup, including fonts and kernel extensions, are cached to provide faster access. Reading caches is faster than reading all the individual files—unless the caches are damaged (see Clearing Caches). In situations where a cache is outdated or has been deleted, the startup process takes longer, both because macOS must read all the individual files from scratch and because it must also rebuild and write the cache. This may be the case, for example, when you boot from a duplicate for the first time.

- **Startup and login items:** Although many startup and login items load almost instantly (especially *launchd* items that don’t necessarily *run* apps when they load; see the sidebar *Launchd and the Meaning of “Start”*), some of these are full-blown apps that can take several seconds or more each to open.

- **Safe boot factors:** As I explained in *Using Safe Mode*, holding down the Shift key when you start your Mac disables a number of things, which sounds as though it should make your Mac boot faster. But because a safe boot bypasses the cache of kernel extensions and also runs a directory check, it takes much longer than a regular boot. In addition, your first regular boot *after* a safe boot may take a bit longer as caches are rebuilt.

- **System updates:** The first time you restart after updating macOS (for example, from 10.13.1 to 10.13.2), the boot process usually takes longer, largely because the caches associated with various updated
People have written to tell me their Mac is too slow, and on further investigation I discovered that what they really meant was that their mouse pointer was too slow—an easily solvable problem, if you know what to do. This is just one of several cases where benchmarking and timed tests don’t tell the whole story, because so many factors figure into one’s subjective perception of speed.

In this brief chapter I tell you what to do if your pointer seems slow; I also cover how to make your Mac seem faster by using a variety of utilities to get more done with less mousing and fewer keystrokes.

**Speed Up Your Pointer**

You may have noticed that the average mouse pad is a lot smaller than the average display. Likewise, if you have a trackpad (either built into your Mac or external), you may have noticed that it’s quite a bit smaller than your Mac’s display. And yet you can usually move the pointer from one corner of your display to the other in a single motion without running out of space! That’s because pointing devices (of whatever sort) don’t have a one-to-one correspondence between the distance moved physically and the distance the pointer moves on screen. To save wrist movement and disk space, your pointing device can translate small physical movements into larger virtual distances.

However, it’s not a fixed ratio (as in, one inch of mouse movement equals three inches of pointer movement on the screen). Sometimes you want to be able to move your pointer a tiny amount, and if the mapping were linear, that would be terribly difficult to do. So macOS, like all operating systems, builds in an *acceleration curve*, a mathematical model that basically says: if your mouse (or your finger on the trackpad) is moving slower, the pointer should travel smaller dis-
stances, and if it’s moving faster, it should travel larger distances. In practice, most of us instinctively move the mouse faster when we want the pointer to travel large distances, and we’re never even conscious of the acceleration effect, but trust me: you’d miss it if it were gone!

Depending on such variables as the type of pointing device you use, the size of your hands, the size and resolution of your display, the type of work you’re doing, and what you’ve become accustomed to, you may find the default mouse settings uncomfortable; the pointer movement may seem too slow, too fast, or too unpredictable. (Former Windows users who have recently moved to the Mac often fall into the “This mouse feels awful!” camp.)

Apple includes a slider that lets you adjust “tracking speed,” and that’s an easy thing to try first, but it may or may not do the trick for you. That’s because what Apple refers to as tracking speed amounts to a simplistic scaling of the acceleration curve (making pointer movements uniformly larger or smaller in proportion to distance moved), without changing the basic shape of the curve—the rate and extent of change in the pointer’s speed based on the mouse’s speed. To do that, you’ll need third-party software.

**Adjust Tracking Speed**

To make basic adjustments to your pointer speed, all you need to do is move the tracking speed slider left (slower) or right (faster). The trick is finding that slider! Here’s where to look:

- **Mouse:** If you have a mouse, you configure it in System Preferences > Mouse.

- **Trackpad:** If you have a Mac notebook or an Apple Magic Trackpad, you configure the trackpad in System Preferences > Trackpad.

If you have a third-party pointing device, see the sidebar Preferences for Third-Party Input Devices, ahead.
Fiddling with the apps and files on your disk can solve many problems that decrease your Mac’s performance, but if you want to make your Mac faster than the day you bought it, you may need to undertake some hardware modifications. These range from easy and inexpensive (yet incredibly effective) to expensive and scary (while not so effective). But if you’re serious about speed, you’ll almost certainly do at least some of these things.

Add RAM

I’ve mentioned RAM many times in this book because the correlation between free RAM and speed is so strong. By now I hope I don’t have to convince you how valuable it is, but you may still be wondering how much RAM to add, where to get it, and how to go about installing it. Allow me to address these questions briefly.

How Much RAM

As of early 2019, the lowest amount of RAM any new Mac ships with is 8 GB, though millions of Macs that are in active use—and capable of running the latest version of macOS—shipped with as little as 4 GB (and some Macs that can run 10.13 High Sierra shipped with only 2 GB). In my opinion, 2 GB is such an absurdly small amount that it virtually guarantees poor performance, and even 4 GB is inadequate for most people. macOS itself uses so much RAM that if you have 4 GB or less, you’ll be severely restricted in how many apps and files you can open before virtual memory begins swapping memory to disk. That swapping slows you down significantly, especially if your Mac has a mechanical hard drive (an SSD, such as the one in the MacBook Air, can compensate to some degree).

At the other end of the spectrum, the Mac Pro (2013) and the iMac Pro can hold as much as 128 GB of RAM. Based on today’s software, very
few people can productively keep that much RAM busy, which is fortunate because very few people can afford that much RAM!

**Note:** For reasons I could only guess at, the amount of RAM Apple states as the maximum for any model is sometimes lower than the amount you can actually install. For example, Apple says the iMac (Retina 5K, 27-inch, Late 2015) can hold a maximum of 32 GB of RAM, but it can actually hold 64 GB. The Mactracker app lists both Apple’s claimed maximum and the true maximum for each model.

For most people and most common activities, I believe something in the range of 8 to 16 GB should be sufficient. At those quantities, RAM is fairly inexpensive compared to the price of a new Mac, and the incremental cost of an extra 4 or 8 GB is usually quite small. So it pays to add as much as you can, within reason.

Unfortunately, not all Macs offer the option to upgrade their RAM after purchase. If you have any currently shipping Mac laptop, the RAM is not user-upgradable. In some models, like the iMac Pro and the Mac mini (2018), you can upgrade the RAM, but only with the equivalent of major surgery. For non-upgradable models, if you want more than the base amount, you have to add it to your configuration when ordering your Mac.

**Note:** Macs get a slight performance boost when RAM modules are installed in matched pairs—that is, pairs of the same size. If you have an odd number of modules, or modules of different sizes (say, a 4 GB module and an 8 GB module), performance will be a tiny bit slower, but even the suboptimal speed of unmatched pairs will give you better performance than a smaller amount RAM in matched pairs.

If you buy a new Mac without user-upgradable RAM, select the configuration with the highest amount of RAM you can afford. For owners of Macs that do have user-upgradable RAM, however, here are my suggestions:

- If your Mac has a capacity of 8 GB of RAM or less, install the maximum it can hold.
Speed Up Your Peripherals

USB and Thunderbolt are the most commonly used interfaces for the sorts of external devices (such as hard drives) that can most significantly affect your Mac’s speed. In this final chapter I get into some admittedly geeky territory, discussing somewhat obscure concepts like bus bandwidth—but it’s all in the service of speeding up your Mac. By understanding what I explain here, you can make informed decisions about which devices to connect to your Mac and how to do so in a way that keeps overall performance as high as possible.

Note: In this edition of the book, I’ve removed most of the discussion of FireWire from this chapter, since it’s an obsolete technology. If FireWire 800 is the fastest port your Mac has, then by all means, use it! But beyond that, there’s no longer much to be said.

Learn About Buses and Ports

If you look at your Mac, you’ll see one or more USB ports (physical connectors where you can attach cables) and perhaps one or more Thunderbolt ports. (There are other ports on some Macs, too, such as Ethernet and HDMI, but I’m ignoring those in this chapter.)

Note: Thunderbolt 3 and USB 3.1 use the same USB-C connector. Some Macs use their USB-C ports only for USB, while others use them for both USB and Thunderbolt 3. I say more about this confusing situation shortly, in Explore USB and Thunderbolt Options.

It’s fairly obvious that if you have three USB ports, you can plug in three USB devices. (And, if one of those devices is a hub, which increases the number of available ports, you can plug in still more devices.) All the ports of a given type look the same, but details about your Mac’s internal configuration could determine which of those ports you might want to attach a device to.
To make sense of this, you must understand the concept of a bus, which is essentially a particular set of physical circuits that carry some sort of data. Your Mac has many different buses for communicating with a variety of internal and external devices, and ordinarily you need never concern yourself with any of them. However, there’s a crucial fact about buses that can affect your Mac’s performance: every bus has a fixed amount of bandwidth, which is to say that no matter how many devices connect to it, only a certain amount of data can travel through the bus at any given time. So, if a bus has just one device on it, that device can use the bus’s full bandwidth; connect two or more, and the devices must share that bandwidth. Of course, all the devices may not actively be transferring data at any point in time, but to the extent that they do, the bus bandwidth can limit their effective speed.

Now here’s the interesting part: the number of USB or Thunderbolt buses your Mac has may be completely different from the number of ports it has! For example, your Mac may have only one USB port but two USB buses (the second of which is used for internal devices such as the trackpad and camera). Or it may have more USB ports than buses, meaning each bus controls multiple ports. If it’s a Mac Pro (2013), you have three Thunderbolt buses but six Thunderbolt ports—two for each bus (with the HDMI port sharing the third Thunderbolt bus).

Why should you care about this? It’s simple: knowing that each bus has a limited amount of bandwidth, you’ll get the best performance if you spread out the load. For example, let’s say you have two USB hard drives and two USB ports on your Mac, which you’ve discovered (as I explain in a moment) correspond to two different USB buses. You could connect one drive to each port, or you could connect a hub to one of the ports and connect both drives to the hub (leaving the other port free for additional devices). In this example, connecting one drive to each port is the better choice, because then the two drives don’t have to share the bandwidth of a single bus. If you need to attach more devices, you can still use a hub, plugging one of your drives (and the other devices) into it, but keeping that on a separate USB bus from the other drive will increase the performance of both.
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Joe Kissell is the author of more than 60 books about technology. As of May 2017, he also became the publisher of Take Control Books, when alt concepts inc.—the company he runs along with his wife, Morgen Jahnke—acquired the Take Control series from TidBITS Publishing Inc.’s owners, Adam and Tonya Engst.

Joe is also a contributing editor to TidBITS and a senior contributor to Macworld. Before he began writing full-time in 2003, Joe spent nearly eight years managing software development. He holds a bachelor’s degree in Philosophy and a master’s degree in Linguistics.

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