Windows 7 and SSDs: just how fast are they?

By Ed Bott | January 23, 2011, 5:50pm PST

Part 1: Windows 7 and SSDs: Just how fast are they?

Part 2: Windows 7 and SSDs: Setup secrets and tune-up tweaks

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Does a solid-state drive make a difference in the performance of Windows 7?

In a word: Yes.

Conventional hard disks are typically the biggest bottleneck in any computing environment. If you can speed up disk activity, especially reads, the effects on system startup and application launch times can be breathtaking.

This technology is still new and expensive, and many of the kinks are still being worked out. I've been using SSD-equipped PCs with Windows 7 since October 2009, and I now have two laptops and one desktop PC that are fitted with these superfast drives. Over the holidays, I set out to fine-tune the storage configuration in all three systems and was able to increase overall system performance dramatically. In a follow-up post, I'll explain exactly what you need to know to squeeze maximum performance out of an SSD.

But first, how much of a difference does an SSD make? I have an ideal platform to test: a new Dell XPS desktop system with an i7-920 CPU, 16GB of RAM, and two disks, a conventional 7200RPM Seagate 1TB hard disk drive (one of the fastest desktop models in its class) and a 60GB OCZ Vertex2 SSD. I've installed Windows 7 on each drive and configured a dual-boot menu.

I've been switching between the two systems for roughly a month. Today I went through the performance logs for both Windows installations and averaged the results for the last 15 starts for each setup. (If you want to see these results for your system, follow the instructions I published in this 2007 post—the event log format for Windows 7 is the same as it was for Vista.)

Measurement	SSD	HDD
Main-path boot time (sec)	9.1	24.1
Total boot time (sec)	30.3	65.7

That's a 62% improvement in the time it takes for the system to get to the Windows desktop and a 54% improvement in the total boot time, which includes drivers and processes that are loaded with low-priority I/O. (The latter value includes third-party programs that are configured to run at startup.)

There's also some interesting data in the Windows System Assessment Tool (WinSAT) logs, which contain the detailed benchmarks that make up the Windows Experience Index. On the Sequential Read test, the SSD wins going away, recording a throughput of 249.76 MB/sec, compared to 105.63 MB/sec for the conventional hard disk. The WinSAT benchmark also calculates a mysterious and undocumented Overall Responsiveness index, where the SSD in this system clocks a blistering score of 20.02, compared to 86.17 for the hard disk.

And my personal experience bears out those benchmarks. Startup times are startlingly fast, and I'm still practically giddy when I click an app and watch it spring to life in a second or less. The feeling of fast is practically visceral.

So, slap an SSD into a PC, fasten your seat bet, and prepare for the whoosh. Right?

Not so fast.

As I learned from more than a year's hands-on experience, it takes cooperation from hardware manufacturers to get the most from an SSD. In the next part of this series, I explain where things can go wrong and how to set them right. See Windows 7 and SSDs: Setup secrets and tune-up tweaks, for the details.

Windows 7 and SSDs: Setup secrets and tune-up tweaks

By Ed Bott | January 26, 2011, 5:08am PST

Solid-state drives are wicked fast. SSDs start and shut down fast, and they perform read operations (especially random reads) at speeds that blow the doors off conventional hard drives. In the first installment of this series, I gathered the numbers to show just how much faster you can expect an SSD to perform in the real world.

But you might need to jump through some setup hoops to get top performance out of an SSD-equipped PC running Windows 7. That's because Windows has evolved over many years with features that specifically target the behavior of conventional hard disks. Features like Superfetch and Prefetch and ReadyBoot are designed to monitor files you access at startup and when you launch programs and then arrange them on the disk for optimal access. Because SSDs don't have motors and spindles and platters and magnetic heads, they don't benefit from those features and need to be handled differently.

In fact, there are a series of steps that must be performed before an SSD can perform to its full potential on a Windows PC. Skip any of those steps and the results can be disappointing.

My own personal experience bears this out.

Back in October 2009, I bought a Dell Latitude XT2 with a 256GB SSD. One of the first things I did was to replace the Dell-supplied copy of Windows XP Professional with Windows 7 Professional. Disk performance was reasonably fast, but it certainly wasn't jaw-dropping, and the disk score in the Windows Experience Index was stuck stubbornly at 5.9.

I did a little research last summer and learned that a lot of Dell customers were experiencing the same disappointment with this particular hardware combination. The problem was that the hardware—a Samsung PB22-CS3—needed a firmware update to work properly with the advanced disk-handling features in Windows 7. That update had to come from Dell, and as of last July, it wasn't available.

A third-party utility, CrystalDiskInfo, confirmed that this disk did not offer support for the TRIM command, which is one of the key requirements for proper SSD operation. (Using the TRIM command allows the system to properly erase blocks of data in the background; for an explanation, see this excellent article by Anand.) Windows 7 supports the TRIM command natively; earlier Windows versions don't.

Over the holidays, I decided to check again and was pleasantly surprised to learn that Dell had released a firmware update for this drive several months earlier. Because the firmware update wipes out all data on the drive, I had to do a clean install of Windows 7.

The performance difference was like night and day. And benchmark results show why. Here are the Windows System Assessment Tool (WinSAT) results from July 2010 (original OEM configuration) and then from December 2010 after updating the SSD firmware and installing the latest Intel storage drivers:

Disk throughput (bigger=better)	Original	Optimized
Sequential Read (MB/s)	151.9	219.39

Random Read (MB/s)	10.77	130.25
IO/Responsiveness (smaller=better)	**Original**	**Optimized**
Average IO Rate (ms/IO)	4.29	1.14
Grouped IOs (units)	15.43	8.94
Long IOs (units)	36.69	2.65
Overall Responsiveness (units)	566.01	23.72
Disk score capped at 5.9?	Yes	No

With the new setup, the disk subscore in the Windows Experience Index jumped from 5.9 to 7.4, and the difference is noticeable. The system is 13 12 times faster in random reads, which is what makes the most profound difference in everyday operation.

Updating the firmware was the key that unlocked the performance of this device, but it isn't the only crucial step. On the next page, I list the steps you need to go through to ensure that an SSD performs properly with Windows 7.

Setting up Windows on an SSD requires a few extra steps that aren't necessary with an installation on a conventional hard disk. Here's what I recommend:

1. Make sure you have the latest firmware. Because firmware updates wipe out all data on the drive, you must do this operation as the first step; make sure to back up all existing data first. You'll need to check with the drive manufacturer or the OEM, depending on whether you purchased the drive as a retail upgrade or as part of an OEM PC. Follow the instructions to complete the firmware update; this typically requires booting from removable media such as a USB flash drive.

2. Set the disk controller to AHCI mode. In the system BIOS, set the SATA controller for Advanced Host Controller Interface (AHCI) operation before installing Windows. This step is crucial. Using the legacy IDE or ATA mode prevents you from installing the proper disk controller driver later and will result in reduced performance.

3. Consider using a Secure Erase utility to reset the drive to its original, out-of-the-box state. This step isn't essential but can be helpful, especially on a well-used drive. Do not perform a full format using Windows disk management tools. For Intel drives, you can use the Intel Solid State Drive Toolbox. If you have a Lenovo computer, this feature is available as part of a BIOS Menu Setup Extension. For OCZ drives, see this discussion thread for links to a Secure Erase utility. The HDDErase tool also works with many drives; see this tutorial for download links and instructions.

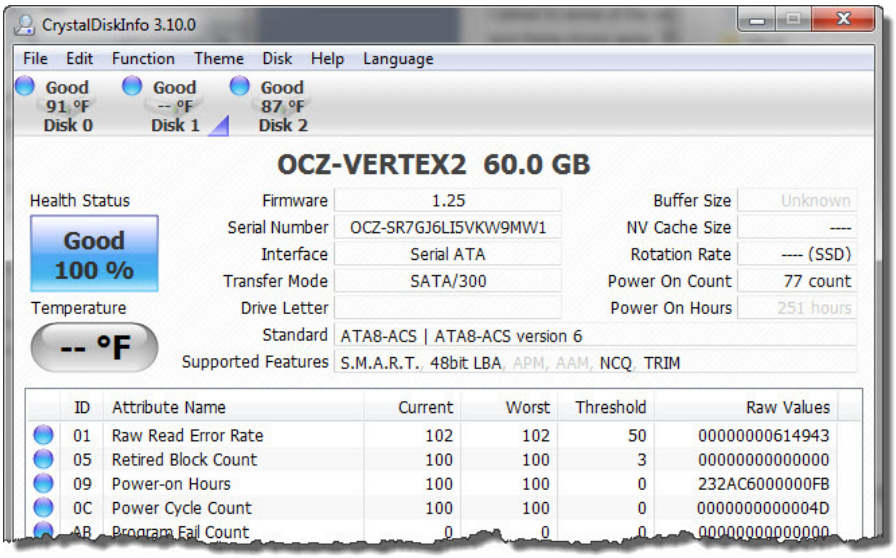
4. Boot from the Windows media and begin the clean install. Use the Windows Setup utility to create the partition. If you have a partition created using any other tool, delete it and use the Windows 7 disk tools to create a new one. This ensures that the partition is properly aligned.

5. Install the latest storage driver. If your system includes an Intel SATA controller, you should use the most recent version of the Intel Rapid Storage Technology driver, which is located here. Currently (*updated January 2012*), the most recent version is 10.8.0.1003.

6. After completing setup, check the Windows Experience Index. Click Start, click Computer, then click System Properties. On the System page, click Windows Experience Index, which takes you to the Performance Information and Tools page. The **Primary hard**

disk score for a properly configured SSD should be over 7.0. If necessary, click Re-run The Assessment to refresh the numbers.

To verify that all the features of the SSD are working properly, install the free CrystalDiskInfo utility. As this example shows, it confirms that Native Command Queuing (NCQ) and TRIM are enabled.



It also offers an interesting glimpse at the health of your disk.

When Windows 7 detects that you have a properly configured, fast SSD drive, it disables several unnecessary features, including Superfetch, Prefetch, and ReadyBoot. It also disables scheduled defragmentation operations for the SSD, which isn't necessary, and can reduce the usable life of the drive.

In the final installment of this series, coming up next, I'll discuss the best ways to split up system and data disks.

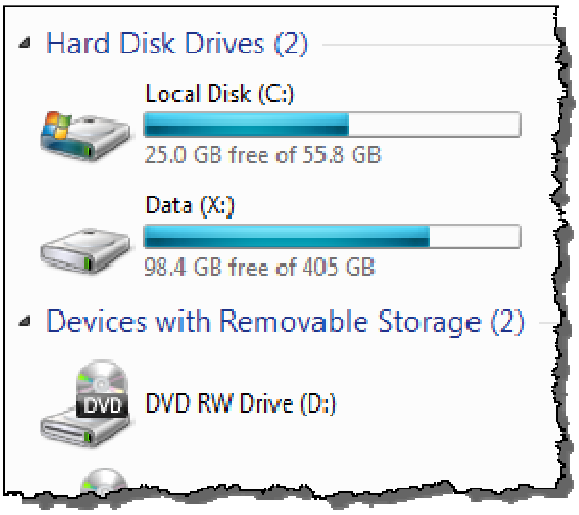
Windows 7 and SSDs: Cutting your system drive down to size

By Ed Bott | February 3, 2011, 11:50pm PST

Summary: Solid-state drives are wicked fast. They're also expensive. So how do you get the performance benefits of an SSD upgrade without breaking the bank? Use a fast SSD as a Windows 7 system drive and install a conventional hard disk for use as a dedicated data drive. Here's the right way to do just that.

Solid-state drives are wicked fast. They can breathe new life into a PC whose performance is being dragged down by a slow conventional hard drive. They're also expensive and (at least for now) limited in total capacity. So how do you get the performance benefits of an SSD upgrade without breaking the bank?

With a notebook, you're generally stuck with a single drive. But with desktop PCs (and with large notebooks that support the installation of a second disk drive), you can do what I've done: use a fast SSD as a Windows 7 system drive and install a conventional hard disk for use as a dedicated data drive.



In that configuration, your goal is to use just the right amount of space on the relatively small, expensive system drive. That doesn't mean playing "How low can you go?" and ruthlessly deleting as much as possible. Instead, the smart strategy is to look at the total amount of space available on the system drive and then make intelligent, case-by-case decisions on where to store different kinds of files.

In this post and the accompanying gallery, I go through three big buckets of files that potentially consume large amounts of disk space, and I list the strategies you should follow for sizing and, if possible, relocating that data.

First, an overall question: How big should your system drive be? There's no one-size-fits-all answer to that question; the correct choice depends on your needs and your budget. But in general, I recommend choosing a system drive that will allow you to keep at least 20% of total disk space free at all times. That translates into the following general recommendations, organized by PC type:

Netbooks: 30 GB minimum, 60 GB recommended

If you're using a small notebook or netbook almost exclusively for web-based applications and you don't plan to install more than a handful of lightweight Windows programs or download and save large data files, you can probably get by with a 30GB drive. But you'll spend much less time and energy monitoring disk space if you can afford a 60GB drive instead.

Workhorse desktop PC: 60 GB minimum, 120 GB (or more) recommended

I define this class of PC as one where you install and use multiple applications, including large programs like Microsoft Office. Windows 7 uses less disk space than you might think in a default installation; I have a 60 GB system drive on the PC I'm using to write this post, and it's currently showing about 25 GB of free disk space. If you can afford a larger drive, you'll spend less time fretting over free disk space.

Business-class notebook: 120 GB minimum, 256 GB recommended

For a high-end, single-drive notebook that you use as your primary PC, don't skimp on storage. That's especially true if you use it to store, convert, and play back digital media files. HD video and high-resolution digital photos can use a lot of disk space, and you want to make sure you have enough space for them.

In the following pages, I'll go through specific configuration steps for two different categories of data and system files.

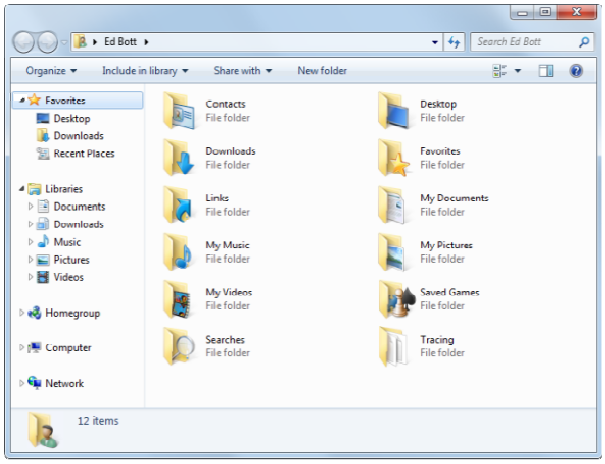
Page 2: Data files This is the largest of the categories and potentially the biggest space-saver. By relocating default data folders to a different drive, you prevent them from consuming space on the system drive.

Page 3: Windows system settings Among the biggest consumers of space on a Windows 7 system drive are hidden files used by the operating system itself—paging files, indexes, and so on. Here's how to safely resize and/or move them.

On a desktop PC with a dedicated data drive, the most important change you can make is to get your everyday data files off your system drive. The difference in performance will be minor, and the savings in disk space can be extreme, especially if you have a large collection of digital media files.

Yes, it would be lovely if Windows was designed like other operating systems (cough, Linux, cough) and you could simply relocate an entire user profile to a different volume. But that's not how Windows works, and in my experience trying to make this sort of radical change is unnecessary and dangerous. (Caution: If you search the Internet, you can find registry hacks that allow you to move an entire user profile. I strongly advise against doing this.)

You'll find your data files in a subfolder of the Users folder, which is located by default in the root of the system drive. Each of the folders in this location is dedicated to a different type of data. To open this folder, click Start and then click your user name, at the top of the right column.



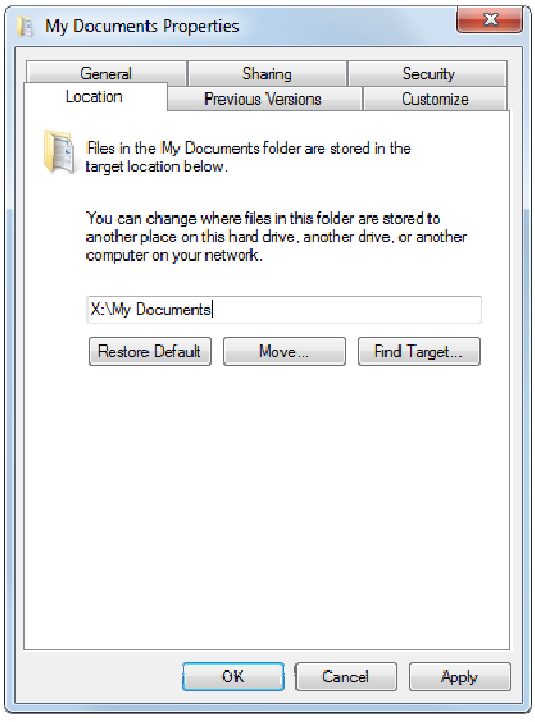
Each of the folders in your user profile is a shell folder that is associated with a physical destination. When you move one or more of those data folders to your dedicated data drive, you also inform Windows of the new location for that shell folder. Once that's done, any modern Windows program will automatically find the correct locations for opening and saving files, and you can open those locations in Windows Explorer by just double-clicking the folder icon in your profile.

Although it's possible to move every folder from your user profile, that isn't necessary. The real space savings come from moving the Downloads, Documents, Music, Pictures, and Videos folders. Here's how the procedure works:

1. Open your data drive in Windows Explorer and create a new, empty folder for each of the data folders you plan to move. This step isn't required, but it will make the remainder of the process easier. In the examples here, I've assigned the drive letter X: to my data drive.

2. Open your user profile in Windows Explorer, right-click the folder you want to move, and click Properties.

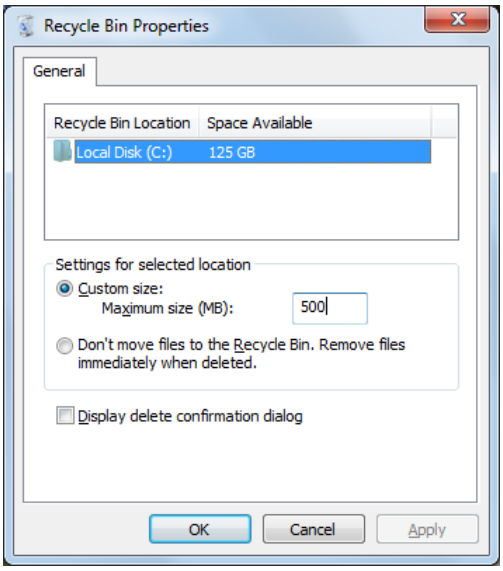
3. Click the Location tab, and then click the Move button. Browse to the folder you created in step 1 that corresponds to the folder you want to move, and select it.



4. Click Apply or OK. A dialog box will ask whether you want to move all files from the current folder to the new location (and delete the existing location). Click Yes.

Repeat steps 2-4 for the other folders you want to move. *(Update: Some people prefer the drag-and-drop approach to moving these shell folders. If that describes you, then follow the steps I outlined for Windows Vista in this post from four years ago. The basic procedure is the same.)*

After you make this change, there's one additional setting you'll want to tweak. As every Windows user knows, files you delete are actually moved to the Recycle Bin, where you can recover them in the event of an accidental deletion. Windows reserves space on each drive for the Recycle Bin. You can specify the maximum amount of space that Windows is allowed to use by right-clicking the Recycle Bin and choosing Properties.



If you have a single drive, as is the case with this notebook, you'll have to decide how much space you want to allocate for deleted files. If you have two drives, you'll want to set a low number for the system drive and a relatively high number for the data drive. Again, there's no right number to choose here. Your setting should be based on your usage patterns and comfort level.

That takes care of your user data. On to Windows itself.

Like any modern operating system, Windows 7 does a fair amount of behind-the-scenes housekeeping to help it respond more smoothly when you launch a program or open a file. Those features can consume a fair amount of disk space. On a conventional hard disk, the impact is almost unnoticeable, but on a small SSD it can add up quickly. Here are four places where you can minimize the amount of space used on the system drive.

Several of these settings use the System Properties dialog box. You can access it from Control Panel, but I find it easier to c lick Start, then click Computer, and finally click System Properties. From the sidebar on the left, click Advanced System Settings.

Paging file

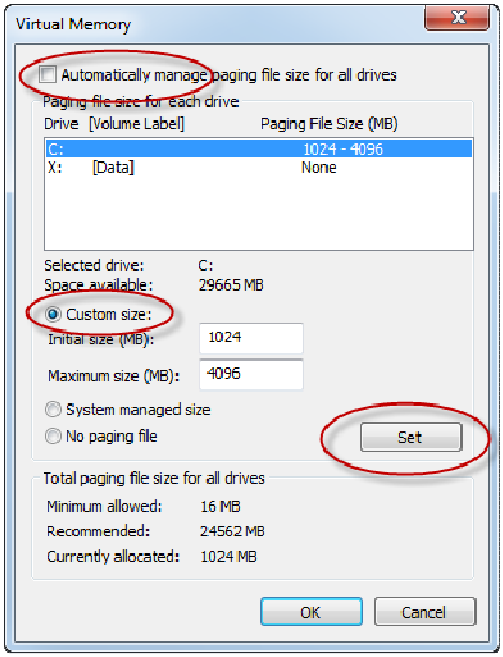
Let's start with the most controversial one of all. Windows creates a paging file (sometimes referred to, inaccurately, as a swap file) on the system drive. The initial size of the paging file is determined by the amount of memory you have installed. The more memory you have, the larger the paging file.

The paging file is literally that: a file, called Pagefile.sys, stored by default in the root of the system drive.

You can move the paging file to your alternative data drive, or you can resize the existing paging file on your system drive. I could spend hundreds of words on the pros and cons of each strategy and the calculations you can use to calculate the correct paging file size, but I'll save that for another day.

To change these settings, you have to burrow deep into dialog boxes. On the Advanced tab of the System Properties dialog box, under Performance, click Settings. That opens the Performance Options dialog box, where you'll find yet another Advanced tab (yes, this is very advanced). Under Virtual Memory, click Change.

The first thing you need to do is clear the Automatically Manage box at the top. That unlocks the remaining options on the page.



In my case, because my desktop system has plenty of RAM and never uses it all, I have set the initial size to a svelte 1024 MB, allowing it to grow to 4 GB if necessary. After you make any changes, be sure to click Set.

To move the paging file to a different drive, first select the system drive, click No Paging File, and click Set. Then select the secondary drive and choose either System Managed Size or Custom Size (entering appropriate values); then click Set.

Hibernation file

Windows supports two types of low-power states. One is sleep, and the other is hibernation. Hibernation is essential for notebooks, less so for desktops, especially those that have a reliable uninterruptible power supply. Hibernation works by reserving space in a hidden file called hiberfil.sys, which is stored in the root of the system drive. By default, this file uses 75% of your total installed memory.

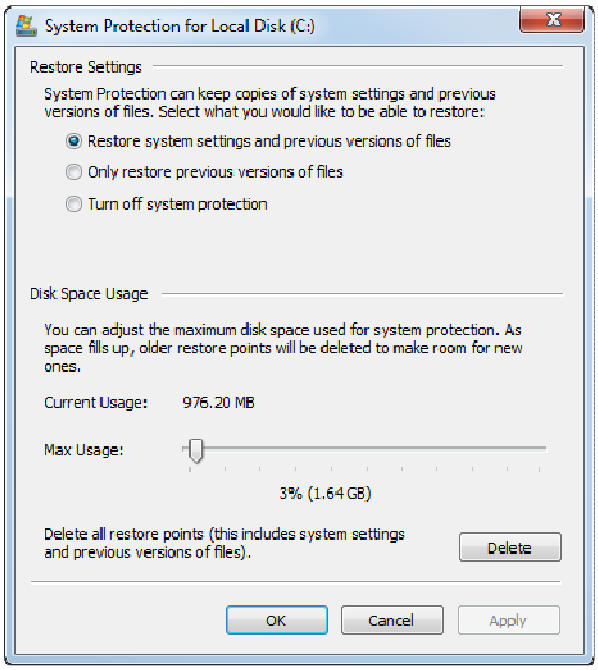
You can reclaim this space on a desktop PC with a small system drive by disabling hibernation. To do so, you need to open an elevated Command Prompt. Click Start, type **cmd**, then press Alt+Shift+Enter. In the command window, enter **powercfg –h off** and press Enter. (To re-enable hibernation, use the same command, but change **off** to **on**.) From that same

command prompt, you can verify the size of both your paging file and your hibernation file: use the command **dir c:\ /as**.

System Restore

The System Restore feature has two benefits: it allows you to reverse system configuration changes, and it keeps track of previous versions of files that you change. It does this by periodically saving snapshots of the current configuration and saving them as restore points. You can completely disable System Restore on any drive, but I don't recommend this extreme measure for your system drive. Instead, change the amount of space set aside for restore points.

To restrict the amount of space used, open the System Properties dialog box and click System Protection. From the list of drives, click the system drive (C:) and then click Configure. That allows you to configure settings. As you can see here, I've adjusted the amount of reserved space so that it uses only 3% of the total disk. That's enough to save a handful of restore points—enough to get out of trouble in the event of a failed driver installation.



Index

Windows Search is one of the killer features of Windows 7, but it comes at a price. Every file that you save in user data folders is indexed so that you can find it based on its contents or properties. The same is true of e-mail. This index is stored as a group of files in a hidden folder on the system drive, and the total size of the index can get very large—even into multiple gigabytes, depending on how many documents you have on your data drive.

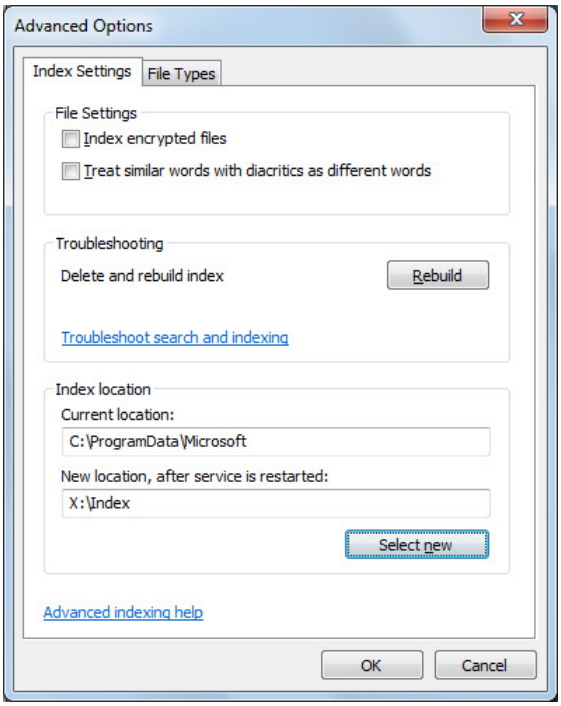
I have seen some authors recommend turning the Windows Search service off completely. That is very bad advice, in my opinion. Instead, move the index so that it is stored on your data drive. Here's how:

1. On your data drive, create a new, empty folder to hold your index files. In this example, I've created a folder called Index on the X: (data) drive.

2. Click Start and type **index** in the search box. Click Indexing Options from the results list to open the Indexing Options dialog box.

3. Click Advanced to open the Advanced Options dialog box.

4. In the Index Location section, you can see the current location of the Index (by default, this is in C:\ProgramData\Microsoft). Click Select New and pick the folder you created in step 1.



When you click OK, Windows moves the index files off your system drive and onto the location you specified. The net result is you recover a potentially large amount of disk space without compromising your ability to search quickly.