Options for backing up your computer

Aryeh Goretsky, MVP, ZCSE

NOTE: An earlier version of this white paper appeared as a guest blog at The Windows Club website.

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Both hardware and software needed to back up your computer

While personal computers range in cost from a few hundred dollars for a basic system to an enthusiast's rig costing thousands of dollars (or more), a computer is a physical object, and it can be replaced. What really makes your computer valuable is what's unique about it, and that is your data. While you can always purchase a replacement computer, you're not too likely to find one at the local computer store that comes preinstalled with your business records; family multimedia (pictures, audio and video recordings); personal documents; and other data you have saved on your computer over the years.

In order to back up data from your computer, you will need two things: hardware and software.

Hardware backup

So, with that in mind, what options are available to back up and restore your data in the event of a computer emergency? Well, a typical backup solution consists of both hardware and software. Let's take a look at the different types of hardware with the following chart before we go into further detail.

Type	Pros	Cons
USB Flash Drives	• Inexpensive at lower capacities (<32GB) • Faster than disc or tape • More rugged than other media • Easily portable • Readable on a variety of computers	• Expensive at higher capacities (>32GB) • Slower than hard disks • Easily lost • Long-term reliability unknown
External Hard Disk Drives	• Inexpensive • Fastest media for backups • Easily portable • Often comes with backup software • Readable on variety of computers	• More fragile than other media • Ruggedized versions available (pricey) • May require special power supply
Optical Media	• Inexpensive • Faster than tape • More rugged than hard drives • Easily portable	• Can be expensive • Require human intervention • May require additional software • Long-term reliability unknown
Tape	• Inexpensive • Rugged • Easily portable • Reliable	• Expensive • Compatibility issues • Availability can be poor • May require additional software • May be slower than other media

USB flash drives are the newest medium available, ranging in size from under one gigabyte (GB) to at least 256GB, although at the latter sizes, you can expect to pay a hefty premium. The main advantage of USB flash drives is their size: They easily fit in a pocket or a keychain and can be kept just about anywhere. Of course, the disadvantage of this is that they occasionally end up going through the laundry. One concern about the medium is how reliable they will be over time. Some manufacturers offer lifetime or ten-year guarantees on their flash drives, but these only apply to the drive itself, not to any data you may have stored on it. Also, like discs and tapes, you can periodically buy several flash drives inexpensively and copy your data to them, reducing the likelihood of total data loss in the event of one failing. If you do not have a lot of files to back up, USB flash drives are the obvious choice.

External hard disk drive systems have been around for many years. Current systems place a 2.5" (notebook) or 3.5" in an enclosure, with USB, FireWire and/or eSATA connectors for attachment to a computer. External hard disk drive systems based on the 2.5" hard disk drives used in notebooks are physically smaller than those using 3.5" hard disk drives installed in desktop computers. They often store less information and are not as fast as their larger counterparts, but they make up for it in portability—some as small as a deck of playing cards—and often require just a single cable to provide both power and data to their host computer. External hard disk drive systems based on 3.5" hard disk drives are often less expensive and faster than their smaller brethren, but they are larger (about the size of a hardback book) and always require an external power supply adapter, since desktop 3.5" hard disk drives require additional electricity.

When purchasing an external hard disk drive, I recommend looking at the warranty, keeping in mind that warranties only cover failure of the device itself and not the recovery of any data stored on them. Also, check what type of connections it has for both data and, if applicable, power. USB connections are recommended because they are the most common; however, purchasing an external hard disk drive enclosure with several types of connections will give you some flexibility, in the event that the computer to which you are restoring your data does not have a USB connection. If an external hard disk drive enclosure requires an external power source, I recommend buying one that uses a standard "barrel" connector for its power jack, as opposed to the proprietary multi-pin connectors used with some external hard disk drives. In the event that you lose your external power supply, a standard power source will be easier to replace.

There are a variety of sizes and formats of optical discs, but the most common are CDs, which hold 650MB, and DVDs, which hold a minimum of 4.7GB per side. Both recordable CD and DVD formats include discs that can be written to once (CD-R and DVD±R) and/or multiple times (CD-RW, DVD±RW and DVD-RAM). I recommend avoiding the reusable "RW" discs, since they can only be written to a finite number of times before failing. The DVD-RAM format handles rewriting better but uses special optical discs that may be more difficult to find and are expensive. The 650MB stored on a recordable CD may seem very small these days, but they are inexpensive, and a single CD might hold several years' worth of correspondence and documents, such as tax records. However, if you have more data than will comfortably fit on a CD or two, recordable DVDs are probably a better choice. Recordable DVDs cost only a little more than their CD counterparts and hold about seven times as much data as a CD. While individual CDs and DVDs may be too small to back up your computer's hard disk drive, backup programs allow you to back it up across a set of discs; we'll talk more about backup software later. You will still need to swap discs in and out of your CD/DVD drive as you record your backup to them. Recordable Blu-ray discs are also currently available in capacities up to 50GB, however, both Blu-ray disc recording drives and the media they use are expensive and may be difficult to find. Check with your disc vendor to make sure the discs you purchase for use are archival quality; otherwise they may degrade over time.

Tape is the oldest backup medium, with usage dating back about half a century. As such, it has arguably withstood the test of time, although proper storage of both media and the equipment to read them becomes an issue. Today's tape backup systems store from tens to hundreds of gigabytes of data—and even more with compression—and are highly reliable, which is one reason they are still used. A tape backup system is expensive, though, with tape drives running from the hundreds to thousands of dollars, and individual backup tapes in the tens to hundreds of dollars range. Tape is no longer widely used as a backup medium on the desktop, but it is still used in the enterprise, where the costs of maintaining tape drives and storing backup tapes is less of a concern. Tape might fill a niche for some, though.

Software backup

Just as there are several different types of devices on which to back up your data, there are several different types of programs with which to back up your data to those devices. Although there has been a lot of consolidation over the past few years and the lines between types of program have blurred, they can still be classified by what features they originally started with, since that is where they will be strongest performance—and feature—wise. Here's a handy chart delineating the differences.

Type	Pros	Cons
"Classic" Archive Programs	• Inexpensive (some free) • Economizes disk space • Available for various operating systems • Usually readable on various OSs • Offer password protection for archived files • May create archives spanning multiple disks	• Can be difficult to configure • Limited automatic backup support • Time required for backup • Vendor support varies
"Classic" Backup Programs	• Expensive (typically commercial) • Economizes disk space • OS support may be limited • May offer incremental backups • Creates backups spanning multiple disks • Typically provide very good scheduling	• Typically use proprietary format • Can be slow
File Copy/Sync Programs	• Inexpensive (some free) • Available for various OSs • Readable on any OS that recognizes media • May have some scheduling capability	• May be difficult to configure • Limited support for scheduling • Don't allow file compression
Disk Imaging Programs	• Can be expensive (some free) • Make self-booting restoration programs • May offer file compression • May offer incremental backups • Typically provide excellent scheduling • Can backup machine state to restore a failed computer	• Proprietary format for images • May not provide individual file restore • May only restore to same hardware

The value of archive programs

Classic archive programs are normally used to compress a large, infrequently used file into a smaller one or to store a collection of several files in one compressed "container." This is usually done in order to transfer files over slow network connections or to use less media when copying files to a disk for transport. The archived file(s) can then be expanded on arrival. However, these same benefits of reducing the size of files for transport make archive programs useful for backing up files. Archive programs compress files to the smallest size possible according to the compression algorithm used, so that the resulting archive(s) use up the least amount of space.

Archive programs tend to use standardized formats, such as .7z, .RAR and .ZIP; can often open archives created by each other; and, increasingly, create archives in each other's native formats. Most other types of backup programs do offer some sort of file compression feature to reduce the amount of space required for a backup, but they typically do not do as good a job as dedicated archiving programs, resulting in backups that use up more space. Many archive programs allow you to password-protect their archive files, so they cannot be viewed or opened without first entering the password. One concern about using an archive program for backing up your files is that while they may technically be capable of doing so, they are not typically designed for this use. In the event of an error with your backup archive, the program's technical support may be of limited assistance in repairing very large archive files.

Like their archive program counterparts, "classic" backup programs are designed to store many files inside of one file using some form of compression, although some may not use compression in order to speed up the backup process. Unlike an archive program, though, most backup programs use a proprietary format that only they can read and often write to specialized media, such as tape or DVD-RAM discs, which are used almost exclusively for backups. Backup programs typically have strong scheduling capabilities, allowing you to perform backups when a computer is not used, and can often backup files that cannot be accessed because they are in use by an application. Another area where backup programs excel is in their handling of large backups. Most backup programs allow you to "span" a hard disk drive backup across several DVDs, tapes or other media, and then restore files by reloading them in sequence. Some backup programs allow you to back up only files that are new or have changed since your last backup. These types of backups are called differential backups. Many backup programs allow you to password-protect your backed up files so they cannot be restored without your permission. "Classic" backup programs are something of a rarity these days; however, they work well when used with a medium like tape for a backup mechanism.

Syncing up

File copying and synchronization programs allow you to transfer files from one location to another. This typically will not allow you to create a bootable copy of any modern operating system, but it is great for backing up data files from your computer's hard disk drive to an external hard disk drive. Backing up to a second internal hard disk drive, or even a different location on the internal hard disk drive, is possible but not recommended, because loss or failure of the computer means loss of the backup. A variation on copying is differential copying, which copies just new and changed files over to the external hard disk drive. This is often called synchronization, or "syncing," for short.

Because an external hard disk drive is mounted and read as a regular hard disk drive by a computer, your backup files can readily be accessed on a different computer, even if it is running a different operating system. While file copying and synchronization programs typically do not offer password protection, since they are essentially copying files from one hard disk drive to another, it may be possible to configure the external hard disk drive so that it requires a password.

Disk imaging programs for backing up

All the previous types of backup programs we have talked about work with files, either individually or in combination. While many disk imaging programs have similar capabilities, they distinguish themselves in that they can copy an entire file system, duplicating it so that files are in the same location as on the original hard disk drive. They can even copy the space occupied by deleted files, allowing you to use the cloned (copied) disk to recover files deleted from the original hard disk drive, which is why similar tools are much used in computer forensics. Typically, a disk imaging program is used when upgrading a computer's hard disk drive, as this clones a fully functional replica that enables the new drive to boot up immediately.

In additional to copying from hard disk drive to hard disk drive, some disk imaging programs may allow you to span backups across multiple CDs or DVDs or back up your hard disk drive to a server. Another benefit of disk imaging programs is that they allow a "bare metal" restore: In the event that a computer's hard disk drive fails, a restore disc can be used to boot from and the disk image is loaded onto a new hard disk drive. When finished, the computer is rebooted and will start exactly as it did after the disk image was created. This could still work even if the entire computer was replaced, although the operating system might not boot up successfully unless (for example) the new computer's hardware was identical to that of the old computer or if the system were hardened to prevent data leakage. Some hard disk drive manufacturers and PC manufacturers provide a disk imaging program with their disk drive either on a CD or available for download from their website.

Blended backups

As noted at the beginning of the section on software, the lines between different types of backup programs have begun to blur in recent years, with many beginning to offer features previously available in other programs. The types of backup mentioned above are not mutually exclusive, and some backup programs may offer to perform several or all of the types of backups mentioned above. For example, the Windows Backup program that comes with versions of Microsoft Windows 7 for business and power users (Enterprise, Professional and Ultimate) allows you to perform file backups and create system images.

Cloud-based data backup

Another class of backup that is becoming popular is storing your backup files "in the cloud." What this means is that your data files are stored on a server connected to the Internet, and you can access or even restore them from another computer connected to the Internet. An advantage of this approach is that it makes your backups accessible wherever you have an Internet connection. This is also, of course, the disadvantage. Spotty, slow or absent Internet connectivity means limited or no access to your backed-up data. There may also be concerns about the privacy of your backup and long-term viability and availability of the service that hosts it.

An enterprise whose business depends on the continuity of their operations may use the "cloud" for off-site backups. In this case, though, the business may own the remote facility or obtain it under service from a specialist provider. That does not mean that off-site backups for home computers (a topic we will discuss later) are a bad idea.

Choosing which data to backup

So, with this in mind, what exactly should you be backing up? Well, on computers running Microsoft Windows, most programs store your data in a folder named "`C:\Documents and Settings\{username}`" (on computers running Microsoft Windows XP and earlier) or "`C:\Users\{username}`" (on computers running Microsoft Windows Vista and newer), where "`{username}`" is the name of the account you use to log on to Windows. However, some older programs store their data in a custom folder located in the root of the C: drive, like "`C:\OLDPROG`." Also, sometimes people get "creative" about where they store their files on a computer. Either way, you'll want to back up these folders. Most backup programs will prompt you to choose which folders to back up the first time they are run, and this can be adjusted later as needed.

If you are in doubt about where an important program stores its data files, contact the software company's technical support for assistance. Tech support engineers are usually much happier when helping customers locate and back up data before a disaster occurs. Unsurprisingly, so are customers.

If you are not sure about which files to back up, then a full backup may be the best solution. While such backups may take more time to run, it will be a lot easier for you if you back up files that you never will need to restore, as opposed to needing to restore files that were never backed up! Some computer manufacturers offer an integrated rescue and recovery or one-button recovery solution that automatically manages everything for you. If you are buying a new computer, you might want to look for this feature.

How often to back up your computer

Another frequently asked question about backups is this: How often should they be run? Some backup programs come with an automatic scheduler to run them on a fixed schedule, like once a day or once a week. Others operate manually, allowing you to determine the schedule. The answer, though, depends on a number of factors, such as:

- How much data can you afford to lose? Is a single day's loss acceptable? What about a week? A month?
- How much does it cost to make a backup, in terms of consumables like DVD±R discs?
- How long does it take to perform a backup? Minutes? Hours?

Once you factor those three expenses, you can generally come up with a backup interval. I find that, for most people, somewhere between a day and a week is the norm. People may also choose to back up some files more frequently than others, particularly if the data is very valuable or it changes frequently.

Diversify your backup methods

An important thing to keep in mind is that you do not have to use just one type of backup method, or have only a single backup. You might choose to clone your hard disk drive using disk imaging software once a month, while synchronizing new and changed files on a daily basis. You might also have several sets of media for performing backups. For example, you could use two external hard disk drives for backups and perform a backup each week to one of the hard disk drives. This way, you would have two levels of backup in case a problem occurred or you needed to go back and restore data from the previous backup. A full backup of a computer, coupled with incremental backups of new and changed files, would provide similar functionality, allowing you to restore different versions of a file over time.

Where to store your backups

Another thing to consider is where you store your backups. Keeping them at home in a desk drawer is fine, but what would happen if you could not get home for some reason or into the room in which they are kept? This is one area in which a cloud-based backup solution might be ideal. Another solution is to keep a copy of your backup files—a backup of your backup, if you will—with a trusted friend or family member. You could even store your backups at a bank or with your lawyer. If you do choose to store your backup off-site, be sure to protect it with a password, though.

Replace your backups periodically

A final consideration is the life of your backup media: Tape drives, tapes, and hard disk drives are mechanical in nature and, just like any other mechanical component, will eventually fail. Optical media can be scratched or degrade over time. Even USB flash drives can only be written a finite number of times. With that in mind, you should think about how long you wish to back up to a particular piece of media before you replace it. Most modern tape backup systems keep track of how many times a particular tape has been used and will notify you when it needs to be replaced. For hard disk drives and USB flash drives, my rule of thumb is use it for half the length of the manufacturer's warranty; so, for a hard disk drive with a five-year warranty, I would use it for about two-and-a-half years before looking to replace it. For optical discs containing your backed-up data, I would suggest verifying their readability on a yearly basis.

Regularly replace your backup media, and periodically test that your backup was successful, preferably by restoring a small amount of data onto a different computer. This helps ensure that your backup program was successful and gives you a chance to test restore procedures before there is any trouble.

Data recovery services as a last option

To conclude, I would like to mention data recovery services. While it is possible to recover data from hard disk drives damaged by heat, moisture, smoke or just an ordinary mechanical failure, it can cost thousands of dollars (or more) and take days to weeks to recover all the data—and there's no guarantee that all data will be recovered and restored in a meaningful fashion. While there are several external hard disk drives on the market that are ruggedized to the point of being fire safe, there's no such thing as a completely failure-proof hard disk drive. Remember, it is far less expensive to back up your data than to recover it from a damaged hard disk.

Aryeh Goretsky, MVP, ZCSE

Aryeh Goretsky began answering questions about computers and viruses in 1989 at McAfee Associates, where he gained a healthy respect for backing up one's data. A veteran of several software and networking companies, today he serves as Distinguished Researcher at global security software developer ESET and frequently contributes to the ESET Threat Blog. A Microsoft MVP since 2004, he is active on a number of professional and technical mailing lists and forums, including those belonging to Lenovo, Lockergnome, Neowin and the Wilders Security Forums. He lives in Southern California with his dog and several years' worth of backed-up data.

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