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White Paper

Understanding What Makes a Computer Run Slowly or Fast

How to Increase your Computer's Speed

Now that you have a High Speed Internet connection, you may notice that it's not as fast as you anticipated or that it has become slower over time or not as fast as you've experienced when using other computers. The reason is most often related to hardware and software issues with your computer, many of which you have control over and can adjust, thereby making your computer run faster in general and specifically when you are on the Internet.

Overview

This paper will discuss the effect of hardware and operating system software and its settings on your ability to realize the full speed potential of your High Speed Internet connection. It will then discuss environmental variables which, if present, can bring your computer and your Internet speed to a crawl.

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Hardware

The computer industry builds new and faster hardware at an enormously rapid rate. The lifecycle of a computer system motherboard in production is 90 days or less. The reason is that design engineers are continuously finding ways to increase the speed of computer systems and reduce their manufacturing cost. For example, when I worked for IBM in the early 80's, the company made its employees a "deal" and sold us a fully configured 8088 4Mhz IBM PC with two 512k floppy drives and 512k of memory, a green monochrome display, serial and parallel ports and a modem, plus a lot of useless software for...are you ready? \$5,000.00! Ok, you can pick yourself up off the floor and stop laughing now! It's true! Today, I can buy a 2.4Ghz Intel processor PC with 4gb RAM and a 500 GB hard drive and all of the rest of the stuff for under \$600.

The reason for relating this history lesson is that if your computer is more than 2 years old, there is significantly faster hardware available and you may want to consider either upgrading your PC or replacing it, depending upon how much you have invested, and how much the upgrades cost vs. how much a new PC costs. Remember, you don't have to replace the monitor if you have a 17" or larger recent vintage display.

Now, let's consider the building blocks of a PC and their effect on the PC's speed. The parts we want to consider here are:

- Amount of RAM Memory and its speed

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- Video Graphic Controller Speed
- Hard Drive speed
- Processor (CPU) speed
- I/O Bus Speed
- Ethernet (Network Interface Card) speed

RAM Memory

First, let's take a brief digression and discuss Virtual Memory and Windows and how Windows manages memory. There are two kinds of storage on your computer, Random Access Memory or RAM and your Hard Disk Drive. Windows stores software and data (long term) on the Hard Drive and runs or executes the software and holds the data that the software is using in real time in RAM. This includes the incoming Internet pages and graphics loaded into your computer over your High Speed Internet connection when you are browsing web sites. Prior to the advent of Windows 95, we ran DOS on our computers. The amount of RAM memory available to our software was the amount of physical main memory that we had installed in our computers. Then came Windows and Graphics and the amount of Main Memory practically and economically available became insufficient. Consequently, Windows implemented a technology called Virtual Memory whereby demands for more memory than was physically available could be satisfied by SWAPPING RAM contents not currently being used out to the Hard Drive in a file called the Windows Swap File, thus freeing the space in RAM for more data.

The point to be considered here is that the more RAM you have installed on your computer, the less frequently a SWAP has to occur. A PC with only 64megs of RAM may SWAP thousands of times per second. During a SWAP, no useful work is being performed. If one simply increases the RAM to 2gb-4gb, SWAPPING may diminish to close to ZERO SWAPS per second, thus eliminating the overhead of the SWAP. The impact on the perceived speed of your computer is simply enormous! What might take 5 seconds to occur with zero swaps could take 5 minutes to occur with thousands of SWAPS per second.

So, hardware feature number one is **RAM Memory**. I believe that with today's Windows Operating Systems and the suite of programs that most of us use, 2-4gb of RAM should be your minimum goal and 6gb or more is preferable. So, depending upon your computer's capability, how much RAM you currently have in it and the cost of additional RAM, you should consider adding more. Most existing PCs have 256-512megs. Upgrade to 4gb if possible and buy a new PC with at least 6gb.

Here's another Tip. The more Windows you have open simultaneously, the more RAM you are consuming. So, if you have Word, Excel, your IM and two or three Internet Explorer windows open at the same time, you are consuming more RAM than if you have only one Internet Explorer window open. So, until you have more RAM installed, you can help your computer run faster by closing down windows that you are not using.

Video Graphic Controller

The vast majority of the data that you view and download on the Internet is graphical data. Graphical data takes a lot of RAM which we discussed above, and it takes a lot of Video RAM on the Video Graphic Controller board. The more RAM on the board, the faster the graphics can appear on your screen. If, when you display an Internet page with a lot of graphical content, your screen "paints" visibly slowly from top to bottom, your speed is suffering because of one or a combination of three factors:

- Amount of RAM
- Amount of Video RAM
- Speed of your Video Graphic board controller

Assuming that you've added more RAM as discussed above, replacing your Video Graphic Controller board or adding more Video RAM to it, significantly improves the perceived speed of your Internet connection. What usually happens when the Video board is the issue is that data arrives from the Internet into your computer faster than the Video board can process and display it; therefore, if you have insufficient RAM, the in-

coming Internet data is SWAPped to your hard drive, and, as your Video board can handle it, data is recalled into RAM. Data is then moved to Video RAM, then processed by the CPU on the Video Controller and finally displayed on your monitor.

If your PC has a slow graphic controller with little memory, you can replace it usually for under \$100.00

Hard Drive Speed

Assuming that you've got at least 512megs of RAM, the speed of your hard drive may not affect the perceived speed of your Internet connection because you've eliminated SWAPping; however, the speed of your hard drive **can** dramatically affect the speed of all of the other tasks you perform on your PC.

By "speed of your hard drive" we mean rotational speed. Most PCs come standard with hard drives that rotate at 4,200rpm. Hard drives are available that rotate at 5,400, 7,200 and 10,000rpm. Consider that data, when written to and read from your hard drive, can stream from the drive only as fast as the drive surface moves the data under the read/write heads which are stationary. A drive which rotates at 10,000rpm can position data under the read/write heads more than twice as fast as a drive which rotates at 4,200rpm. Consider also that when your computer software is reading or writing to and from the hard drive, the software stops executing while it waits for the disk Input / Output (I/O) operation to complete. If data arrives twice as fast using a 10,000rpm drive, software programs wait half the time they wait for a 4,200rpm drive's I/O operations to complete.

CPE Processor Speed

Processor speed is important only when your computer is executing software program instructions. Processor speed has virtually no impact on the speed of Input / Output (I/O) operations. Given that you have a processor less than 2 years old, it most likely is not affecting the speed of your Internet connection; however, the faster the CPU, the faster your day to day PC based software will operate. There are two ways to increase the speed of your CPU:

- If your motherboard can accept a variety of CPU processor speeds, and your CPU is plugged, not soldered, onto the motherboard, you may be able to purchase a faster CPU replacement.
- If your PC case accepts generic PC motherboard sizes, you may be able to replace your motherboard with one that accepts faster CPUs and faster RAM memory.

Generally, if you are starting with an economy PC, replacing the motherboard is probably not economically viable. If you are starting with a custom built PC in which all other components are already super fast, then, replacing the motherboard may make economic sense.

I/O Bus Speed

As computer processor speeds increase and as RAM memory speed increases, designers have been increasing the speed and design of the I/O bus, which is the highway over which data travels between I/O cards, RAM Memory and the CPU. The only way to increase the speed of the I/O bus is to replace the motherboard. So if you are in the mode of replacing the motherboard, select one that has the fastest currently available I/O bus.

Ethernet (NIC) card Speed

Basically, there are 10megabit Ethernet cards, 10/100megabit cards and Gigabit Cards. For 99% of us, a 10/100megabit Ethernet card is all we need and most computers built in the last two or three years come standard with a 10/100 Ethernet port. If your PC doesn't have one, you can pick one up at Office Max, Office Depot, Wal-mart or any computer store for under \$20.00. If installing the card is not something you wish to do, ask your computer professional or AZCI.net to supply and install the card.

Software (Operating System)

I will confine the details of this discussion to Microsoft Windows. Suffice it to say, however, that the general principles discussed here also apply to Mac's.

16 or 32 Bit

Windows 95 was a 16 bit Operating System (OS). This means that each instruction in the software could access a maximum of 16 bits at a time and the fundamental size of the instructions themselves was 8 or 16 bits.

Windows 98 was also a 16 bit OS and Windows ME was Windows 98 in disguise.

Windows 2000 was part 16 bit and part 32 bit

Windows XP Home and Pro are both pure 32 bit.

Windows Vista and 7 come in both 32bit and 64bit versions.

“So what?”, you ask! The answer is Windows 64bit Windows supports more RAM memory than 32bit Windows, and because Windows Vista and 7 are themselves fully 64 bit, they run faster and run applications faster than any of its predecessor Windows versions. Secondly, Windows 7 is more robust and better protected by the PC hardware, reducing dramatically the probability of a crash (lock up or “blue screen of death”).

7 also implements new hardware device driver architecture which runs faster, installs easier, and is more robust.

The point of the foregoing is that if you observe all of the hardware recommendations above, you should also upgrade to Windows 7. It's that simple!

Environmental Variables

OK. So now you've got a wiz bang fast computer running Windows XP. You get your high speed Internet connection and everything is running wicked fast. Time goes by and you perceive that not only is your computer beginning to run more slowly than it did when you first got it, but your high speed Internet connection also seems to be running slowly. What's going on?

Hard Drive Fragmentation

Your hard drive file system is designed to grab free space to add to growing files a chunk at a time. That is to say, when the file is created, it is not created at its maximum size. It is created with a space allocation equal to that asked for by the software when it creates the file. Time goes by and the file needs to grow. So the file system provides additional space which is appended to the original file; however, most often that incremental space is NOT contiguous to the end of the original file. It is located somewhere else on the surface of the hard drive. Roll forward and consider thousand of files with their structures spread all over the hard drive in small fragments.

The hard drive is organized in concentric circles called “tracks”. Data is stored within a track in a sector. The hard drive has read/write heads attached to an actuator which can move (seek) in and out across the surface of the hard drive from track to track. In order for the software to read the file from front to back, the read / write heads of the hard drive's actuator must “seek” the read/write heads to and from many tracks, thousands of times. While the actuator is moving the heads, it takes milliseconds during which time NO data is being read or written from/to the hard drive. This causes your computer to gradually go slower and slower and slower.

Fortunately, Windows Accessories System Tools contains a utility program, Disk Defragmenter, which will DEFAGMENT your hard drive. In other words, it will reorganize all of the non-contiguous clusters of information that make up a file so that they are contiguous to one another thus minimizing the number of seeks and the distance that the seek has to travel from multiple tracks to just the next track. Once your hard drive has been “defragged”, you should notice a small but nevertheless consistent performance improvement, especially when you load programs that use large files.

The defragmenter utility begins by telling you whether or not you will “benefit” from defragmentation. If it recommends defragmentation, you should do it. However, here ere is a caution! Should the power fail during a defragmentation, the possibility exists that your hard drive might become corrupted because the process was interrupted by the power failure. During a defragmentation, you can tell the process to stop and it will do so, leaving the drive partially defragmented, but intact. Hence, a word to the wise; if you haven't already purchased an uninterruptible power supply (UPS) with a built-in surge protector, you should do so BEFORE you defragment your hard drive. You will also reap the benefits of being able to survive a power failure without losing your work and, if your UPS has built-in surge protection, you may protect your computer from a power surge which could destroy it.

Registry

Windows implements a structure called the Registry to store information about programs and the data that programs use. The registry grows every time you run a program or access the Internet. The registry is read into RAM when Windows boots up. Clearly, the larger the registry becomes, the more RAM it occupies and the greater the probability that SWAPPING, caused by registry accesses, will occur. The number of registry accesses during the course of running software and/or accessing the Internet can reach tens of thousands or more; therefore, anything that can reduce the size of the registry will shorten the access time and reduce the possibility of SWAPs.

Again, fortunately, there are registry optimizing software utilities available for download (free and fee) on the Internet. These utilities find obsolete registry entries, eliminate them and compact the registry. Using one of these utilities frequently (monthly) can help to keep your PC running as fast as possible. Here's one that I have used successfully - <http://www.registry-clean.net/>.

Windows TCP/IP Window Size

A structure exists in Windows called the TCP Window and it has a default size. The TCP Window is a buffer into which Internet data comes and goes to and from the Internet. If you have a high speed Internet connection, increasing the TCP Window size often makes your Internet connection speed increase *dramatically*. A free utility called DRTCP exists on the Internet at <http://www.dslreports.com/drtcp>. Download this utility. Run it, and set your TCP Window size to 32767 and your MaxMTU to 1500. Reboot your computer.

Surreptitiously Installed Malicious Software

No doubt you know about Viruses which can infect your computer and cause programs to crash and generally create havoc.

In addition, there are other malicious pieces of software, some viruses and some called Spyware, which can infect your computer and literally slow Internet access to a crawl or stop it altogether. To find and remove these harmful pieces of software and to “inoculate” your computer against their return, you need to install a good anti-virus program and one or more good anti-spyware programs. We recommend:

- McAfee Virus Scan Anti Virus – Fee – www.mcafee.com
- Symantec Norton Anti-virus – Fee – www.symantec.com
- Microsoft Windows Defender - <http://www.microsoft.com/athome/security/spyware/software/default.mspx>
- Ad Aware Anti-Spyware – Free - <http://www.lavasoftusa.com/software/adaware/>

Once you install one of the anti-viruses and one or both of the anti-spywares, you MUST set them to automatically update their signature files (the footprints of the viruses and Spyware which enable the software to recognize the intruders), you must scan 100% of your hard drive and you must set the software to run in the background in order to “inoculate” your PC against future intrusions.

Reloading Windows and Backing up your computer

OK. You’ve followed all of our recommendations, but your PC still seems to be running slowly. It is possible that your PC is so badly infected that files are corrupted and even the best state of the art anti-viruses and anti-spyware cannot find and remove all of the intruders. There is one and only one solution; you must reinstall Windows from scratch.

Now, before you reinstall Windows, you need to back up data you wish to preserve or it may be lost when you install Windows.

Here are some tips that will make backing up your data simpler and restoration of Windows easier.

When you first install windows, set up some folders as follows:

- C:\ - Only the files and data that Windows puts there upon INITIAL installation
- C:\YourTopFolder – The top folder of your personal data
- C:\YourTopFolder\Folder A – subfolders containing your data
- C:\YourTopFolder\Folder B – subfolders containing your data

Now, the only thing you have to back up is C:\YourTopFolder and all of its subfolders. When you reinstall Windows, if you do NOT format your hard drive, all of the contents of C:\YourTopFolder will be undisturbed.

Here’s another Tip. Invest in a USB 2.0 External Hard Drive as a permanent backup device and invest in some inexpensive software called SecondCopy at <http://www.centered.com/>. I’ve used SecondCopy and an external hard drive to back up my laptop for three years. During that time, I’ve lost my laptop for several reasons:

- Spilling a margarita into the keyboard
- Hard Drive Crashes

And I can report that I have lost zero files of importance. Second Copy runs in the background and continuously backs up your computer. It’s invisible and unnoticeable and if you structure your folders as I’ve shown above, it will continuously backup C:\YourTopFolder. You don’t care if you don’t back up c:\ and all of the programs, because you should have a CD original of all programs OR a folder called C:\YourTopFolder\software into which you store the downloaded copy of every program you are using. The “software” folder plus your set of CDs will contain everything you need to restore the programs on your hard drive. Your backup hard drive with C:\YourTopFolder will contain all of your data.

Summary

I hope that this white paper is not too technical and that it provides a general audience with the information necessary to own and operate a fast performing PC. Over time, it will be necessary to update this document because certainly new hardware, software and intruders will develop, creating the need for additional discussion. We will endeavor to maintain this document with periodic updates and current information.

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