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White Paper
Enabling your devices and home network for Streaming Videos

Understanding What Makes a Computer or your Home Network Run Slowly or Fast!
How to Increase your Computer's and Network's Speed!

Before the coming of Video Streaming as an alternative to cable or satellite TV, the average computing device connected to the average home network, provided an acceptable Internet experience. These Internet activities were, for the most part, not SESSION BASED or STREAMING activities, rather Point, Click, Download, View, and Contemplate and then repeat the activity again. There was no requirement for your computing devices or your home network to be able to support a continuous incoming flow of data without causing momentary interruptions.

Enter Video Streaming. This phenomenon is a whole new "breed of cat", as it were, for Trans-National Internet Carriers, Internet Service providers, equipment and equally importantly, the consumers' home networks and computing devices. This paper strives to illuminate in lay terms the obstacles to enjoying an uninterrupted home video streaming experience.

Understanding the Requirements

Video Streaming is an application that continuously downloads video and audio content into a buffer while at the same time sending the content to your computer or TV screen and speakers. Think of the buffer as a bucket with a hole in the bottom. Your goal is to keep water (video) flowing into the bucket (buffer) at a fast enough rate, while at the same time water (video) is flowing out of the bucket (buffer) at a constant rate), so that there is never a break in the outflow of water (video); in other words, so that there is always some quantity of water (content) in the bucket to provide a constant outflowing stream.

When the water (video) in the bucket (buffer) is temporarily exhausted, because the flow rate of water (video) incoming to the bucket (buffer) was slower than the outflow rate, the consumer sees his video and audio presentation pause on the screen and the words "buffering" or something similar, appears. That is happing is that there is no more content in the buffer to permit the video and audio to continue..so the application simply waits for more content to arrive and fill up the buffer so that output streaming to your computer or television screen can resume.

Knowing the Flow Rates

The computer or television screen gobbles up standard definition content at a rate between 2mbps and 4mbps (mbps is the abbreviation for **M**illions of **B**its **P**er **S**econd), and high definition content at a rate of 4mbps to 6mbps. So, the incoming flow rate to your computer or television has to be slightly higher than the rate of consumption and must continue without long delays between blocks of incoming data in order for you to enjoy uninterrupted viewing.

But data does not travel the Internet as a continuous, unending flow of information. Data is packaged into what we call Packets. The length of the packet can vary but it cannot exceed 1500 bytes (a Byte is 8 Bits. A bit is has the value of one (1) or zero (0) and is the most elementary form of data that flows through the Internet). Because traffic flows in packets, the traffic management devices along the Internet pathways to your device or television move traffic destined for different destinations a packet at a time. This includes the routers, phone adapters providing Internet phone service, Ethernet switches, and devices like the Wii or Roku Box or Vudo Box as well as your computers.

Powering Community Hi Speed Internet

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Transnational carriers and ISPs like AZCI.net are spending tons of money to upgrade their networks to enable packets to flow to consumers at rates sufficient to maintain constant video streams. But most consumers are unaware of the changing demands on their devices or computers and the design of their home networks. In the paragraphs that follow, we will illuminate those factors which constrain content from arriving at your devices or televisions fast enough to permit a continuous, uninterrupted viewing experience.

Overview

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

- Hardware
- RAM Memory
- Video
- Hard Drive
- CPU Processor Speed
- I/O Bus Speed
- Network Adapter Speed
- Home Network Speed
- Operating System
- Fragmentation
- Registry
- TCP Window
- Virus and Spyware
- Reloading Windows

Hardware

The computer industry builds new and faster hardware at an enormously rapid rate. The manufacturing life-cycle 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, consumers can buy an Intel Core I-7 Processor PC with 8gb RAM and a 750 GB hard drive and all of the rest of the stuff for under $600. In fact, you can buy a new laptop for under $400 today from multiple sources.

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
- Video Graphic Controller Speed and RAM Memory Quantity
- Hard Drive speed
- Processor (CPU) speed and the number of Cores
- I/O Bus Speed
- Ethernet (Network Adapter) 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, graphics and audio loaded into your computer over your High Speed Internet connection when you are browsing web sites or downloading content.

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. We are talking about 100s, maybe 1,000s, of SWAPs per second. A PC with only 256megs 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, 8gb or more, SWAPping may diminish to a point 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. I'm sure that you have experienced your Windows computer during the Boot Up process and watched for minutes waiting for your computer to settle down so that you can begin to use it. The Boot Up process is one during which literally hundreds of thousands of programs and programs parts are being loaded into RAM and unless you have a computer with 8gb RAM or more, you are experiencing the delays caused by RAM memory SWAPs.

So, hardware feature number one is **Quantity of RAM Memory**. With today's Windows Operating Systems and the suite of programs that most of us use, 4gb of RAM should be your minimum goal and 8gb or more is preferable. So, depending upon your computer's designed in capability, how much RAM you currently have in it and the cost of additional RAM, you should consider adding more. Most PCs manufactured prior to 2009, have 256-512megs with a maximum memory amount of 1Gb. If your computer can't upgrade to 4 or 8gb, it is time to buy a new one.

Here's another Tip. The more Windows you have open simultaneously and the more Icons you have in the SYSTRAY (lower right hand corner of the Windows screen), 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 and icons in your Systray 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. Computer manufacturers who design inexpensive computers save cost by putting little or no RAM on their Video Controllers, instead borrowing RAM from main memory. The more RAM on the Video Controller and the faster the CPU on the Graphics controller, 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 instead of all of the content appearing all at once, 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 constraining factor 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 incoming 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 desktop PC has a slow graphic controller with little memory, you can replace it usually for under $100.00. But, if you have an older laptop with a slow graphics controller, it is time to buy a new one.

Hard Drive Speed

Assuming that you've got at least 4gb 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 and the speed that the Read/Write heads move in and out across the platters of your disk drive. Most PCs come standard with hard drives that rotate at 5,400rpm. Hard drives are available that rotate at 7,200 and 10,000 and even 15,000 rpm. 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 nearly twice as fast as a drive which rotates at 5,400rpm. 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 5,400rpm drive's I/O operations to complete. Lastly

CPE Processor Speed and Cores

Processor speed is important only when your computer is executing <u>software program instructions</u>. Processor speed has some 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 or a laptop, 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.

Network (Ethernet) Adapter 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.

Home Network Speed

As family members acquire their own computers and gaming consoles, the need to connect all of the family's computing and gaming devices to the Internet simultaneously requires the purchase of the components that enable consumers to construct a home network. Most of us opt for a wireless router because it eliminates the need to install costly home network cabling.

Wireless routers operate by transmitting and receiving your data as low power microwave throughout your home or office. Because router radio output power is very weak (for personal safety reasons), many obstacles in your home or office can reduce the speed of the wireless transmissions because they interrupt the flow of data or weaken (Signal Attenuation) the signal and accompanying transmissions. The most obvious source of attenuation are the walls in your home. The wallboard, plaster, brick and stucco walls are opaque to microwaves meaning that they partially or fully block transmission; The more of these material surfaces that the signal must penetrate, the weaker the signal becomes and the slower the traffic moves.

Furniture also impedes the flow of data. The newer N routers and adapters are designed to help overcome this problem, but the N Router only uses N mode if your wireless devices support N. If not, the router falls back to the older G or B mode of operation which does nothing to overcome the affects of furniture.

So, what can you do to improve and maintain the signal strength and speed of your home network?

1) Router Placement is critical – make sure that you place the router in a location that is nearest the majority of your home computing / gaming devices.
2) Upgrade to N capable equipment
3) Consider augmenting signal sources with a 2nd router – install an Ethernet switch into which you plug your internet cable source, a cable going to router 1 and a cable going to router 2 a cable going to your ePhone adapter and a cable going to your Vudo or Roku device. Locate each router nearest the devices that they will serve. Make sure that the two routers channel selection is set to auto or that one is on the lowest channel and the other is on the highest channel.

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, 32 or 64 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 capable, they run faster and run applications faster than any of their 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").

Windows 7 also implements a 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 per second. 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 DEFRAGMENT 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 Read/Write heads have 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 good news is that Windows 7 automatically runs the Defragmentation Utility. When manually executed, the defragmentation utility begins by telling you whether or not you will "benefit" from defragmentation. If it recommends defragmentation, you should do it. However, here 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, grows as you use the computer and is periodically rewritten to the Hard Drive. 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 (weekly) can help to keep your PC running as fast as possible. Here's one that I have used successfully - http://www.systweak.com/RegistryCleaner/.

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 software Viruses and how they 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:

- Mircosoft Software Essential – free -http://www.microsoft.com/en-us/security_essentials/default.aspx
- Vipre AntiVirus – Fee - http://www.vipreantivirus.com/
- 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
- Eliminate your use of the My Documents folder and its subfolders

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. Click Free http://www.clickfree.com/ is, in our opinion, the simplest to use, most thorough combination of backup software and hardware available today.

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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