How to Achieve High Internet Speeds and Better Performance

Date: 2/22/21

Introduction

This document is intended to cover some interesting facts associated with internet access. In particular, I intend to explain why many who pay for high speed internet in excess of 100 mb/s (download speed) cannot actually achieve what they are paying for unless they have the right equipment.

Our internet service at our Willabay Shores condo in Williams Bay has been provided by ATT since 2007 when we first subscribed to internet service in WI. The original DSL service has been upgraded slightly but ATT cannot provide more than about 10 mb/s service to our area using today's ADSL based subscriber lines. ADSL service is provided over phones lines; the same phone lines we have used in our building for 30 years. I am not going to touch on ATT's UVERSE service since that service is supported over fiber lines and we cannot yet get that service in our area.

In October of 2020, we finally abandoned our ADSL service in favor of Charter's Spectrum service which was a huge improvement in download speeds but not exactly what we paid for at first.

Before I get into some technical details, it helps to review some definitions.

ADSL Modem – The device that connects to your phone line when you subscribe to a phone company's DSL service. A modem simply captures data received over the line and transfers it to a standard network format for use in your network. These are sometimes called VDSL modems.

Cable Modem – A cable modem does the same thing as an ADSL modem but pulls your data from a cable provider's coaxial cable. That cable carries TV, internet data, and one or more phone line channels if a subscriber uses the cable service's phone option.

Router – In a computer network, a router is used to split off internet connections from one interface (which is usually your modem) and make these connections available over a number of additional wired or wireless interfaces. A router usually has a yellow connector for the cable from a modem and up to 5 local network connections for your computers, other devices, or a smart TV.

Wireless Router – A wireless router is just a regular router that is equipped to operate as a wireless Access Point (AP). It is sometimes called a Wireless Gateway. This is where your Wi-Fi signal comes from and usually supports one or two wireless signals for your wireless devices (phones, laptops, tablets, and many more).

Combined Modem/Router – This type of device combines the modem function with the router function. Combined ADSL Routers and Cable Routers are available from places like Best Buy or Office Max/Office Depot or online.

IP Switch – This type of device is normally used in larger networks but I use them for in-unit internet connections. They let you get to more than the 5 connections available on a router. It's not necessary to understand anything more about an IP Switch other than it has bandwidth limitations. It's sort of like a cable splitter for network cables but switches a network connection at the IP level.

802.11 G, N, AC, or AX – These are the names of different versions of the FCC standards that govern Wi-Fi. Years ago, a G band router was as fast as you could buy. Then came N routers and AC routers. AX is about to roll out in network products. Each of these designations provided for more features and more speed. Today, an AC1000 Router is the minimum you should be looking at. There are some references to AC Router being a Generation 5 device. AX gets us to G6. This designation that will be on your router's box when you buy one.

Ethernet Port – Most PCs and older laptops will have a port on the device to plug a network cable. These are Ethernet Ports; often referred to as a NIC (for Network Interface Card/Controller). Older PCs had a port that was capable of supporting a data transfer rate of 100 mb/s. Newer devices support what is called Gigabit Ethernet at 1000 mb/s. The connectors on these ports are also called RJ45 connectors.

Download Speed – This is the rate for which data can be delivered from your internet access provider to your computer. The rate is measured in Megabits per second or mb/s. There is also an upload equivalent that is not as important for this discussion.

Today's Technology and its Impact on Speeds

All of the cable companies try to lock you in on their equipment; packaged in such a way that if you need an upgrade, you call your friendly cable service and have them install new equipment. The same thing was true for ATT and other ADSL based service providers.

In the early days of the internet, all you needed was a modem (Dial-UP in the old days, now DSL or cable) and a computer. You simply plugged your computer into the modem and you were in business. As time marched on and Wi-Fi began to be integrated into everything we own, it became necessary to have a wireless router in every home. Granted if you just had two desktop computers you could run two network cables from a router; one to each computer. As Wi-Fi became the way we live, routers had to become Wireless Routers.

Most of the customers I worked with when I had a computer service in Lisle, IL simply had a DSL or Cable modem and their own Wireless Router. Others subscribed to an unnecessary subscription service where they leased a router and a modem from their service provider. I still see people paying Spectrum a monthly fee for a box (the router, or a combined modem/router) that they can buy themselves.

Getting to today's version of the internet, it's virtually impossible to live with an internet access that is less than 20 mb/s (again download only for simplicity). If you do not use a streaming service, never download movies, and don't use Zoom, Goto Meeting, or one of the other video communication apps that we now depend on, you might be able to operate with low speed internet (20-50 mb/s). However, things started to get complicated when access to web pages turned into a means of advertising with ads

popping up and video's playing on your screen. All this takes modem, router, and computer horsepower and faster internet speeds.

Let's say that you subscribe to Spectrum or another cable company's internet service and paid for 200 mb/s of download access. You are simply not going to achieve these speeds unless all of your equipment is fairly new and you are not connected via Wi-Fi to your router. I'll try to explain why this is the case. Keep in mind that the cable companies are selling 1 Gig speeds as well as 400 + mb/s. Unless you have many users in your household that need a video based service, you don't need that bandwidth.

One thing the service providers always tell you in the fine print is that their advertised speeds are over a wired internet connection. When you introduce Wi-Fi into the equation, your speed is going to be dramatically reduced; but certainly usable if your other equipment is fast enough.

Background for our Move to Charter Spectrum

Not that long ago, I had heard from a friend that he paid Spectrum for 200 mb/s and is only getting about 100 mb/s. That friend only uses streaming services to watch TV and has a few computing devices to access the internet. These include smartphones, laptops or other computers. I had usually advised neighbors to start with lower speeds to save money. Unless you are always streaming TV, you can get by just fine with 25 mb/s in a second home.

As mentioned above, we had DSL service for years with ATT. We were paying for 12 mb/s and things were operating ok until recently. We started to see speed test readings of less than 5 mb/s using a fairly new $250 dual-band combined ADSL/Router from NETGEAR. Clearly the problem was not our router. My theory is that ATT is trying to support an internet audience that has many folks communicating over a Zoom connection and they simply can't keep up. We might have been able to get 12 mb/s in 2019, but the day of reckoning had arrived. This old former Bell Labs guy had to switch to cable.

Equipment Ordered from Spectrum

We subscribed to Charter Spectrum's internet service and signed up for their 200 mb/s plan. I kept our existing high-end ADSL Modem/Router and set it up as a Wi-Fi Router only. The same thing could be done with any modern N or AC Wi-Fi Router. When we turned this baby on, our condo unit's cable setup simply could not handle the task. Almost all cable modem setups will look like one shown below.
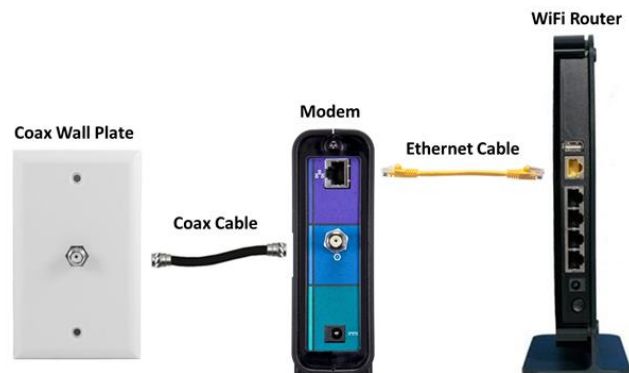
Going back a number of years, remember when analog TV hit the dust? Charter and every other cable company went to digital and High Def (HD) TV became a reality. Back then, I had to upgrade a few cable splitters but we had a great TV signal.

What was happening now with the addition of internet service on top of HD TV, was a degradation of service caused by the Spectrum supplied modem not being able to adequately capture the internet signal. We had a Spectrum tech come out and upgrade our cable connections. This only involved a few new splitters and a brand new, Spectrum supplied, signal amplifier, similar to the version shown below, that can split a cable signal 8 ways; clearly a bit of overkill but it worked great.
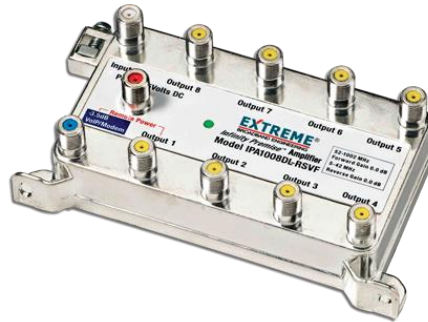
This is the same thing that Spectrum is doing with some of our neighbors. Without this signal amplifier, Spectrum's modem simply won't be able to continually separate the internet band off of the coaxial cable and the service will not work.

Another thing to watch out for is your home's cable connections and bandwidth of any splitters in your system. These are similar to the one shown below but may not even be in your residence. Cable companies are notorious for hiding these things in attics and utility rooms. All of your connections have to be solid to be able to use a cable based internet service. You have to have high bandwidth splitters in excess of 5 MHz for HD TV and internet service. Any old splitters have to go.

Next Up – Testing our 200 mb/s Service

Once the above hardware induced issues were resolved, I ran a standard speed test using Spectrum's software as well as other testing sites I had used before. Speedtest.net is a good alternative. Low and behold, I was seeing about 98 mb/s download speeds using a wired connection from my test computer

to the router. This test was performed using a fairly new 3.4 GHz PC that has a Gigabit Ethernet port. Since we paid for 200 mb/s, I thought I should have been seeing faster download speeds.

After doing a bit of research into Gigabit networks and reading the fine print on my cables, I discovered that I was still using some older network cables that are called Category 5e cables (marked Cat 5e on the cable). I have a fairly complex network setup that had mixed Cat 5e and Cat 6 on some routes. I had to upgrade all the connections and buy more Cat 6 cables from Lowes. Then I bypassed my IP switches (too slow) and tested a full Cat 6 connection between my router and my PC. Low and behold, I measured 235 mb/s. Lights went off in my aging, but highly trained head! How can I get more than we paid for?

After testing access via a wired connection, I tried running a speed test using my wife's fairly new laptop. Using wireless access to the router, I was seeing download speeds of about 35-40 mb/s. This was expected since the Wi-Fi chips in the laptop support wireless using the "N" standard, not the newer "AC" or soon to be available "AX" standard. The process of transferring data from a wireless interface to a circuit inside your router also adds delay. This delay will impact any download speed test. I saw similar speeds using every Wi-Fi device I could test with.

When I again tested our internet speeds with a wired connection to an older laptop, I could not get close to 100 mb/s. Whether you have a streaming device, a PC, a laptop, or anything else, you need a Gigabit speed Ethernet interface to get more than 100 mb/s. To test this out, I went back to Best Buy and bought another device; a Gig Speed IP-Switch. Bingo! I'm now in business with speeds over 200 mb/s and we only have to pay for 200 and Spectrum's modem. It is amazing what kind of improvement I have on Zoom chats with this kind of access. One would ask if we had subscribed to 100 mb/s access, would we still see 235? I can't answer that question yet.

I suspect that had we subscribed to Spectrum's 400 mb/s service, we might actually see even faster downloads but that is not certain. At some point, users that want really high speed internet are going to have to get their cable company to install new cable. Those orange cables you see outside are an example of such higher speed access.

New Test in a New State

Our area is made up of second homes and our Willabay Shores condo owners travel far and wide over the winter. My wife and I travel to Colorado often and finally managed to do so in mid-February of this year (2021).

Out in CO, we subscribe to Century Link's ADSL service using a fairly new modem supplied by Century Link. I had previously purchased a fairly fast AC1000 router for our use in CO but did not go for the high end expensive router that I bought in WI. I thought we had a subscription to 12 mb/s ADSL service but after checking our Century Link account, it seems we now have 20 mb/s service. Surprise.

As soon as I could, I tried a speed test using the same computer I used in WI. Lo and behold, I'm seeing speeds up to 32 mb/s over a wireless connection using our AC wireless router. Again, we are seeing

higher bandwidth than we paid for. Why can we get 32 mb/s in CO and not Williams Bay? The answer is that our CO condo is very close to the local Century Link switching office. DSL works better over short distances.

Before I wrote this bible, I did some more testing and noticed that our upload speeds are not quite as high as we had in WI. You only use an internet connection's upload channel when you are sending data out of your device. This is necessary on Zoom (or other video) connections and any time you click on a link or send a document via email. High Upload speeds are not necessary because few people are uploading at the same time.

Wi-Fi Recommendations to Save Money and Improve Performance

1. **Select an Optimum Wi-Fi Channel in Your Area**

One of the misunderstood aspects of using Wi-Fi in your home is the fact that your service may have to compete with others in the same neighborhood. If you have a rural home separated by a considerable distance from your nearest neighbors, your Wi-Fi signal will not be degraded by others trying to communicate over the same or nearby Wi-Fi channels that your devices are using. However, if your residence is close to others such as in a condo community, you will be surprised at how many users in your neighborhood are trying to communicate on the same channel you are.

It's important to note that not everyone communicates over the exact same Wi-Fi frequencies. There are 11 disjoint Wi-Fi channels that your device may use. Of these 11, channels 1, 6, and 11 offer the best shot at not interfering with each other. I use a software package called a Xirrus Wi-Fi Inspector to determine which channels are used in my immediate area and try to set up my wireless router to use a channel that is not used by my immediate neighbors. It is beyond the scope of this document to explain how to configure what channel you use but any wireless router is capable of selecting a dedicated channel that you can use. If all of the condo units in your area are using the same channel, your performance will be degraded. In my opinion, this issue is more important today since Wi-Fi signals can be carried longer distances.

2. **Share your Internet Service with a Neighbor**

Since most of us now use a cable based internet service like Charter's Spectrum service or Comcast's Xfinity service, it is likely that we are paying something like $70 or more per month for the service when, in some cases, we are not even around our property at all times. If one neighbor invests in the right network equipment (modem and Wi-Fi Router), why not share that bandwidth with your neighbors and have them all chip in once in a while to help offset the costs. Unless all of you are downloading movies or streaming at the same time, you more than likely have the necessary bandwidth to operate in this manner. I'm not too well versed in how households with 4 kids use the web but small residences like townhomes and condos can certainly save money by sharing the bandwidth. You have to be careful though. If everyone involved is streaming video, this may not be a good idea.

3. Buy a Dual Band Wi-Fi Router

This suggestion gets a bit complicated but I found it useful when I discovered that my work was interfering with my wife's ability to access the web

It turns out that many new routers made by such companies as NETGEAR, LINKSYS, and others have the capability to support Wi-Fi over two distinct frequency bands. They call them dual-band routers. One band is 2.4 GHz and the other is 5 Ghz. You actually set up to Wi-Fi Access Points on these routers so that some users (maybe your kid's phones) are on the 5 Gig band and you use the 2.4 Gig band for work. There are all kinds of pros and cons for using each band but separating your usage across these two bands is a bit improvement. That also helps fix the channel interference problem I discussed earlier.

Keep in mind that it is smart to go with an "AC" router or combined Modem/Router in this case. Trying to work with an old N600 router and have two or more users online at once is going to be problematic.

Related Factors that Eat Up Bandwidth

Not too long ago, most homes had perhaps one computer or laptop and a phone that was not normally tied to your computing network. Today, we have smart TVs, smartphones that support email and document transfer capabilities; even TV viewing via streaming.

A number of big companies are pushing ways to convince us that everything has to be connected. When I initially worked on cellular wireless systems, I did not think text messaging and high volume data transfer from a phone would be that widespread. Boy was I wrong. Today, we are constantly syncing our phones, tablets, and home based devices. We use tremendous amounts of bandwidth watching TV on other computing devices, streaming movies and other entertainment, and simply downloading all kinds of stuff.

It is important to keep in mind that everyone in a given neighborhood is competing for the same bandwidth; either on a cell phone or Wi-Fi network. When things get busy, things slow down. Until we all own 5G phone service and Giga-speed network equipment and devices, those with older equipment are going to get impacted.

When we all started to communicate remotely with friends over video based connections like Zoom or GoToMeeting in response to the Covid-19 pandemic, all of our local service providers started to see problems. They were faced with having to handle traffic loads that they never saw before. While the cable companies could still support fast download speeds, web page loading started to be impacted.

It's a new world out there.

Conclusions

Out of this whole investigation, my general conclusions are as follows.

1. 200 mb/s is great for Zoom calls but not really necessary if there are few users in a household who are online at once. If you have 4 kids in school using remote Zoom connections, a high speed cable connection helps the cause.
2. The advertised cable speeds assume WIRED connections; not via Wi-Fi.
3. You need full Cat 6 cabling to get more than 100 mb/s.
4. You need a pretty fast computer to realize the capability of today's routers and modems. An old 2 Gig PC won't get you there. If you are using a wired connection to your router, your PC needs a Gigabit Ethernet interface.
5. You ONLY need a modem from your service provider and may be able to upgrade to your own combined modem/router, even on cable.
6. No matter what equipment you have, internet speeds are very dependent on conditions and load.
7. If you have marginal Spectrum service, you are capable of fixing it yourself using your own hardware; such as signal amplifiers, combined modems, Cat 6 cables, a newer computer or laptop, etc.).

I hope this summary helps folks understand a bit more of what they are getting into.

Author's Background and Experience

The author has a BS in Electrical Engineering degree from Drexel Institute of Technology in Philly (now Drexel University) and a Masters in Engineering from Brown University. I started working for Bell Labs, then part of the Bell System right out of Drexel. The Naperville Bell Labs facility eventually became part of ATT, then Lucent Technologies, then Alcatel Lucent, and now Nokia.

At Drexel, my technical focus was on communications but I quickly migrated to computer software after starting to work at Bell Labs. Some of my major projects were associated with developing a second generation electronic switching system for handling phone calls, developing the software for the first commercial service of ISDN, and helping develop the architecture for the first digital wireless system. All of these areas involved networks.

The author has been using the internet almost from day one, even before computer monitors and browsers became available. Bell Labs in Naperville IL was at the forefront of computer networking and I became one of the company's network experts as soon as networks were invented. Early on, telephone networks and computer networks used different protocols but things have changed. TCP/IP and other related protocols are the basis for what we use today.

I have also been working with home networks and wireless routers since they first became commercially available and have followed the technology long after I retired from Lucent in 2001. Immediately after retiring that first time, I set up a computer repair business in Lisle, IL called DGY Services. This was more of a hobby business where I made virtually no profit but had fun.

After moving to Williams Bay (and Silverthorne CO) in 2008, I started to redirect my computer business to a network based software security business and founded Willabay Design in 20011. This small

business has been in the development stage for almost 10 years and is focused on providing highly reliable sensor data reporting from distributed sites such as condo's or rooms in a large house. Eventually it became clear that Willabay Design was not going to be able to compete with new home security and monitoring startups such as Nest

Over the past year, while the world has moved towards a remote access basis due to the Covid-19 pandemic, I have found time to address additional interests such as understanding what cable companies really do and how they make money. This document came out of the need to do a deep dive into how cable internet service actually works. I hate to see folks spend big money on things they don't need or put up with poor internet performance when they could fix things themselves.

David G Yost

Retired, Distinguished Member of Technical Staff (DMTS), Bell Labs – Lucent Technologies, Naperville IL.

Owner and Founder, Willabay Design LLC, Williams Bay, WI

Former Community Columnist at the Lake Geneva Regional News and Guest Columnist at the Summit Daily News in Summit County, CO.

BSEE Drexel 1969, ScM Engineering Brown 1971

Now living in Williams Bay, WI and Silverthorne, CO