

Topic: 1.2.1 Networks

Introduction:

The history of computing started off with centralized computers (in many cases mainframes) or servers performing all the calculations. Client computers were then attached to these centralised computers (servers) and if you wanted to calculate something, you would have to wait for the central computer to respond. As computing power got cheaper, client nodes became more powerful and the central computer less important. However, with the growth of the internet, there has been a shift back to a client server model. Powerful central computers store information such as emails, documents, music and videos or offer services such as file hosting, printing, game hosting and internet access; client computers fetch information and use services from these central servers. In the next few years you are likely to see more and more software moving away from running on your desktop to running on remote servers and you accessing it as a client, this is called software as a service.



The client-server model

As an example of modern client server model consider a video sharing website. The website, let's call it *mutube*, has a server that stores all the videos that are uploaded to the site. The website is used by millions of clients a day and each of them connects to the server to watch videos. When a client connects to *mutube*, the server asks for a particular video, the server loads the video into RAM from a large array of hard disks and *mutube* sends the video to the client. The client on receiving the video presses play and watches the video.

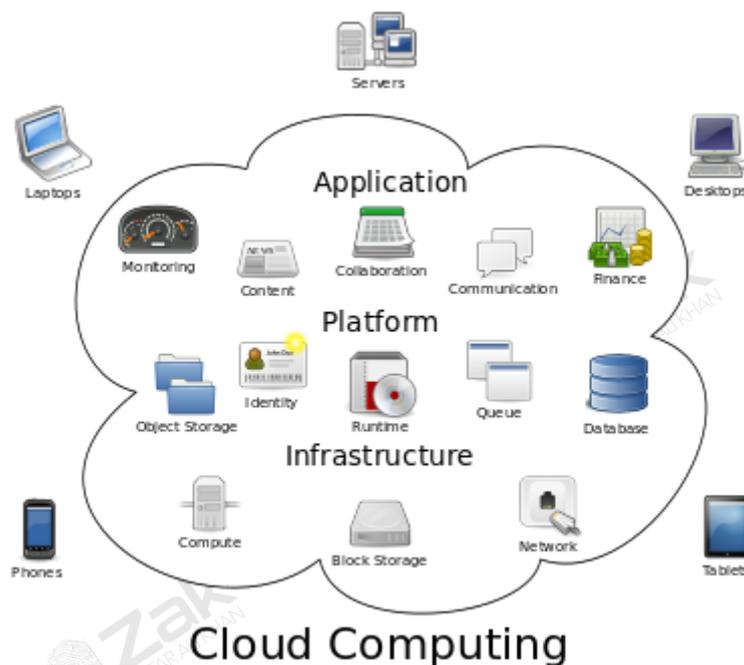
Other examples of servers might be a shared printing service in a college. The print server will be hosted on a single computer, and when anyone in the building wants to print, the request is sent to the server. In this case the server will keep track of how much printing credit each user has and make sure that the print queue is dealt with properly.



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Extension: Cloud Computing

The current client-server model is starting to change, with companies being less likely to offer services with a centralized server. Increasingly internet firms are reaching a global clientele, it makes little sense to have a server or servers based in one location as if your servers are in America and some of your users in Armenia, these users will experience slow access to your services. Another problem is if a power cut effects your server or the connection to that one server or set of servers goes down then the service you are offering the internet will also stop.



With cloud computing the services may be distributed all over the globe, meaning that wherever you are, you'll have a server reasonably close to you offering access to the data and services you need. It also means that if one server goes down, other servers in different locations can keep the service running. Keeping databases synchronized across the globe, so your mail client has the same mails in Switzerland as in Swaziland, is a complex task and firms such as amazon and rackspace offer services to help you handle this. One downside with cloud computing is you are never quite sure where your data is, and if you're not careful you might find data being stored in countries that have less stringent data protection laws than your own.



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Server: a computer program running to serve the requests of other programs, the "clients"

Servers are software programs that in most cases run off normal computing hardware. Server software includes:

- Zak Printing
- Zak File sharing
- Zak Game hosting
- Zak Websites
- Zak Other web services

Client: an application or system that accesses a service made available by a server

Clients are software programs and processes that connect to servers, sending requests and receiving responses. Client examples include:

- Zak Web browser page requests
- Zak Chat systems on mobile phones
- Zak Online games

Definition: The term "**WWW**" refers to the "**World Wide Web**" or simply the Web. The World Wide Web consists of all the public Web sites connected to the Internet worldwide, including the client devices (such as computers and cell phones) that access Web content. The WWW is just one of many applications of the Internet and computer networks.

The World Web is based on these technologies:

- HTML - Hypertext Markup Language
- HTTP - Hypertext Transfer Protocol
- Web servers and Web browsers

Researcher Tim Berners-Lee led the development of the original World Wide Web in the late 1980s and early 1990s. He helped build prototypes of the above Web technologies and coined the term "**WWW**." Web sites and Web browsing exploded in popularity during the mid-1990s.





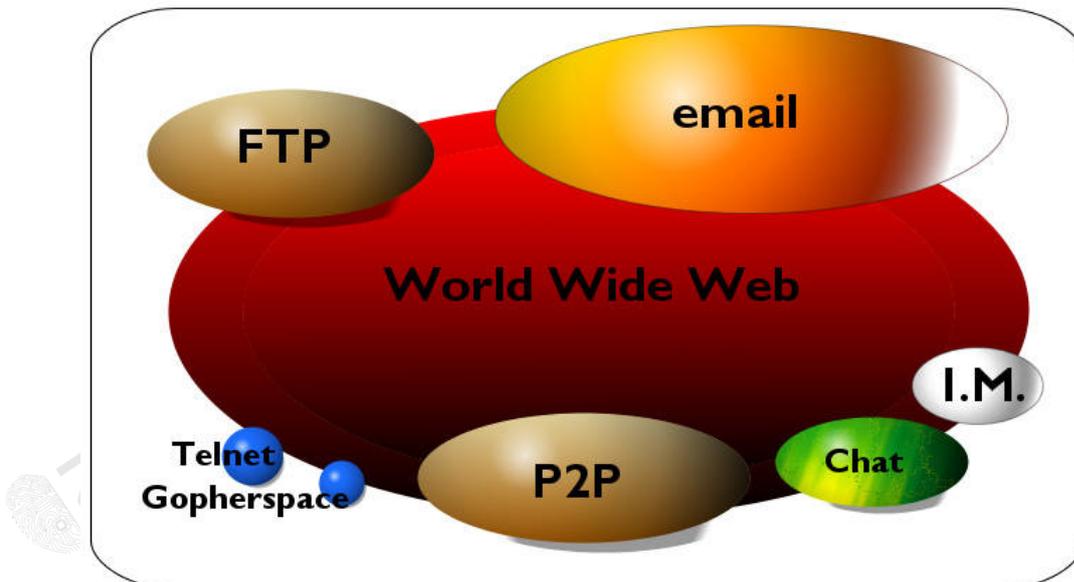
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Internet

The Internet is named for "interconnection of computer networks". It is a massive hardware combination of millions of personal, business, and governmental computers, all connected like roads and highways. The Internet started in the 1960's under the original name "ARPAnet". ARPAnet was originally an experiment in how the US military could maintain communications in case of a possible nuclear strike. With time, ARPAnet became a civilian experiment, connecting university mainframe computers for academic purposes. As personal computers became more main stream in the 1980's and 1990's, the Internet grew exponentially as more users plugged their computers into the massive network. Today, the Internet has grown into a public spider web of millions of personal, government, and commercial computers, all connected by cables and by wireless signals.

No single person owns the Internet. No single government has authority over its operations. Some technical rules and hardware/software standards enforce how people plug into the Internet, but for the most part, the Internet is a free and open broadcast medium of hardware networking.

The Internet: a collection of subnetworks





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How internet works?

When you want to send a message or retrieve information from another computer, the TCP/IP protocols are what make the transmission possible. Your request goes out over the network, hitting **domain name servers (DNS)** along the way to find the target server. The DNS points the request in the right direction. Once the target server receives the request, it can send a response back to your computer. The data might travel a completely different path to get back to you. This flexible approach to data transfer is part of what makes the Internet such a powerful tool.

Definition: A **network gateway** is an *internetworking* system capable of joining together two networks that use different base protocols. A network gateway can be implemented completely in software, completely in hardware, or as a combination of both. Depending on the types of protocols they support, network gateways can operate at any level of the OSI model.

Because a network gateway, by definition, appears at the edge of a network, related capabilities like firewalls tend to be integrated with it. On home networks, a broadband router typically serves as the network gateway although ordinary computers can also be configured to perform equivalent functions.

Definition: Routers are small physical devices that join multiple networks together. Technically, a router is a Layer 3 gateway device, meaning that it connects two or more networks and that the router operates at the network layer of the OSI model.

Home networks typically use a wireless or wired Internet Protocol (IP) router, IP being the most common OSI network layer protocol. An IP router such as a DSL or cable modem broadband router joins the home's local area network (LAN) to the wide-area network (WAN) of the Internet.

By maintaining configuration information in a piece of storage called the routing table, wired or wireless routers also have the ability to filter traffic, either incoming or outgoing, based on the IP addresses of senders and receivers. Some routers allow a network administrator to update the routing table from a Web browser interface. Broadband routers combine the functions of a router with those of a network switch and a firewall in a single unit.





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Web Servers:

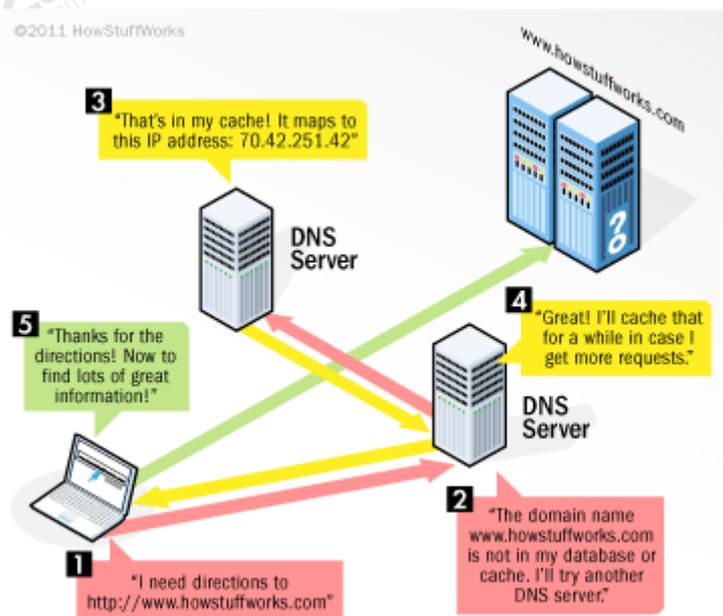
In general, all of the machines on the Internet can be categorized as two types: servers and clients. Those machines that provide services (like Web servers or FTP servers) to other machines are **servers**. And the machines that are used to connect to those services are **clients**. When you connect to Yahoo! at www.yahoo.com to read a page, Yahoo! is providing a machine (probably a cluster of very large machines), for use on the Internet, to service your request. Yahoo! is providing a server. Your machine, on the other hand, is probably providing no services to anyone else on the Internet. Therefore, it is a user machine, also known as a client. It is possible and common for a machine to be both a server and a client, but for our purposes here you can think of most machines as one or the other.

A server machine may provide one or more services on the Internet. For example, a server machine might have software running on it that allows it to act as a Web server, an e-mail server and an FTP server. Clients that come to a server machine do so with a specific intent, so clients direct their requests to a specific software server running on the overall server machine. For example, if you are running a Web browser on your machine, it will most likely want to talk to the Web server on the server machine. Your Telnet application will want to talk to the Telnet server, your e-mail application will talk to the e-mail server, and so on...

DNS:

It's like your computer's GPS for the Internet. Its basic job is to turn a user-friendly domain name like "google.com" into an Internet Protocol (IP) address like 64.233.167.104 that computers use to identify each other on the network.

Computers and other network devices on the Internet use an IP address to route your request to the site you're trying to reach. This is similar to dialing a phone number to connect to the person you're trying to call. Thanks to DNS, though, you don't have to keep your own address book of IP addresses. Instead, you just connect through a domain name server, also called a DNS server or name server, which manages a massive database that maps domain names to IP addresses.





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Explain how communication systems are used to support the Internet: The Public Service Telephone Network (PSTN), dedicated lines, cell phone network

PSTN (public switched telephone network) is the world's collection of interconnected voice-oriented public telephone networks, both commercial and government-owned. It's also referred to as the Plain Old Telephone Service (POTS). It's the aggregation of circuit-switching telephone networks that has evolved from the days of Alexander Graham Bell ("Doctor Watson, come here!"). Today, it is almost entirely digital in technology except for the final link from the central (local) telephone office to the user.

In relation to the Internet, the PSTN actually furnishes much of the Internet's long-distance infrastructure. Because Internet service providers ISPs pay the long-distance providers for access to their infrastructure and share the circuits among many users through packet-switching, Internet users avoid having to pay usage tolls to anyone other than their ISPs.

Many cell phone service providers offer mobile Broadband Internet Access Services for smartphones, basic phones, tablets, netbooks, USB modems, mobile hotspots and other wireless devices over their 3G and 4G broadband networks.

Networking with Cell Phones and Cell Modems

Cell phones can be used as modems to connect computers to the Internet. Cellular cards (sometimes called aircards) and routers also exist. Cell connections can be a convenient way to get online while traveling but are typically slower than other forms of broadband Internet.





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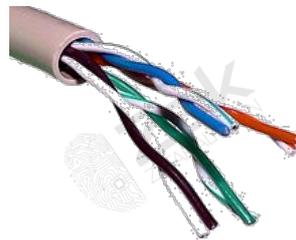
What are the benefits and drawbacks of using copper cable, fiber-optic cabling, radio waves, microwaves, satellites?

Physical media; wires:

One of the key elements that determine bandwidth is the physical nature of the cable being used. A signal becomes weaker and dies down eventually the longer it travels along a cable. Therefore the length of cable determines the bandwidth of the link. For instance the bandwidth of a broadband DSL connection to the home is determined by the length of copper cable between the house and the nearest telephone exchange.

COPPER WIRES

Twisted pair cabling is a type of wiring in which two conductors (wires) are twisted together for the purposes of cancelling out electromagnetic interference from external sources or other twisted pairs. It was invented by Alexander Graham Bell. Twisted pair is used to gain enough bandwidth higher than coax cable.



Unshielded twisted pair (UTP) cable

Unshielded twisted pair or UTP cables are found in many local area networks and telephone systems. A typical subset of these colours (white/blue, blue/white, white/orange, orange/white) shows up in most UTP cables as shown above.

UTP cable is the most common cable used in computer networking and is often used in LAN because of its relatively lower costs compared to optical fibre and coaxial cable. UTP is also finding increasing use in video applications, primarily in security cameras.



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Shielded twisted pair (STP) cables are often copper shielded in an attempt to prevent electromagnetic interference and so allow bandwidth to be higher for any given length. This shielding can be applied to individual pairs, to the collection of pairs or both.

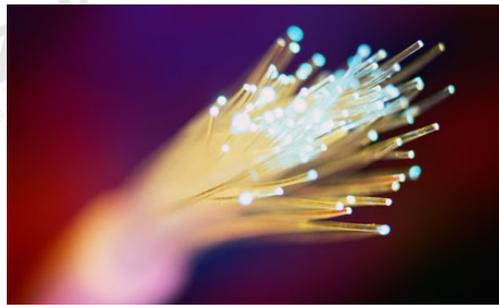


← Shielded twisted pair or STP

Copper cable is adequate for network cable runs for up to 100 meters, but above that the signal becomes too weak, therefore an alternative technology is needed.

FIBER OPTIC

Fiber optics is a technology that uses glass (or plastic) threads (fibers) to transmit data. A fiber optic cable consists of a bundle of glass threads, each of which is capable of transmitting messages modulated onto light waves.



Fiber optic cable.



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Fiber optics has several advantages over traditional metal communications lines:

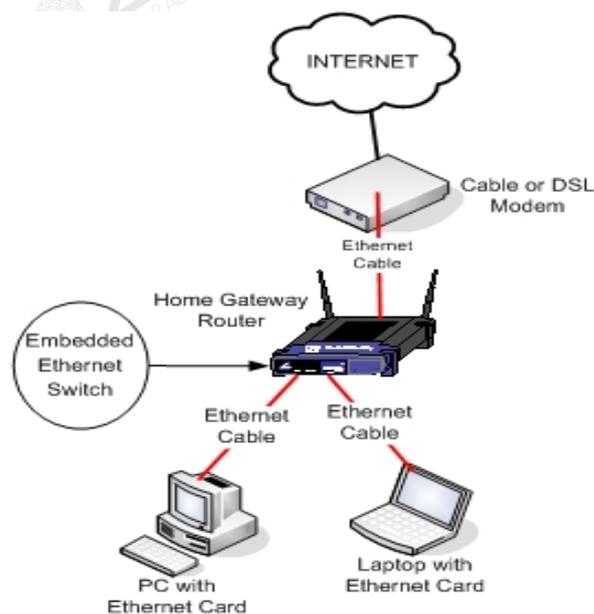
1. Fiber optic cables have a much greater bandwidth than metal cables. This means that they can carry more data.
2. Fiber optic cables are less susceptible than metal cables to interference.
3. Fiber optic cables are much thinner and lighter than metal wires.
4. Data can be transmitted digitally (the natural form for computer data) rather than analogically.

The main disadvantage of fiber optics is that the cables are expensive to install. In addition, they are more fragile than wire and are difficult to splice.

Fiber optics is a particularly popular technology for local-area networks. In addition, telephone companies are steadily replacing traditional telephone lines with fiber optic cables. In the future, almost all communications will employ fiber optics.

Wireless networks:

Wireless network refers to any type of computer network that is not connected by cables of any kind. It is a method by which homes, telecommunications networks and enterprise (business) installations avoid the costly process of introducing cables into a building, or as a connection between various equipment locations. Wireless telecommunications networks are generally implemented and administered using a transmission system called radio waves.





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RADIO WAVES

Radio waves are an electromagnetic radiation with differing wavelengths. These waves are similar to an ocean wave. Radio waves are used for many processes. For example they are used to broadcast TV, in communication between satellites and it enables computers to share information without wires.

Radio waves have a large wavelength so they experience less interference and can travel over large distances. However, since they do not have a high frequency, they cannot transmit as much data.

However, they can carry more signals than wires; they are often used for linking buildings on a college campus or corporate site and increasingly for longer distances as telephone companies update their networks.

MICRO WAVE

Microwave radio also carries computer network signals, generally as part of long-distance telephone systems. Low-power **microwave radio** is becoming common for wireless networks within a building.

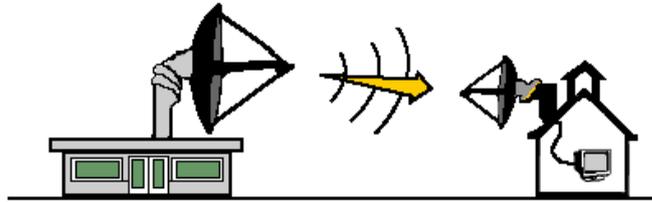
Microwave transmission refers to the technology of transmitting information by the use of electromagnetic waves whose wavelengths are measured in centimeters; these are called microwaves. This part of the radio spectrum ranges across frequencies of roughly 1.0 gigahertz (GHz) to 30 GHz. These correspond to wavelengths from 30 centimeters down to 1 cm.

Microwaves are widely used for point-to-point communications because their small wavelength allows conveniently-sized antennas to direct them in narrow beams, which can be pointed directly at the receiving antenna. This allows nearby microwave equipment to use the same frequencies without interfering with each other, as lower frequency radio waves do. Another advantage is that the high frequency of microwaves gives the microwave band a very large information-carrying capacity; the microwave band has a bandwidth 30 times that of all the rest of the radio spectrum below it. The attenuation of microwave is less than twisted pair or coaxial cable. A disadvantage is that microwaves are limited to line of sight propagation; they cannot pass around hills or mountains as lower frequency radio waves can. It is also affected by anything blocking the line of sight, such as rainfall.





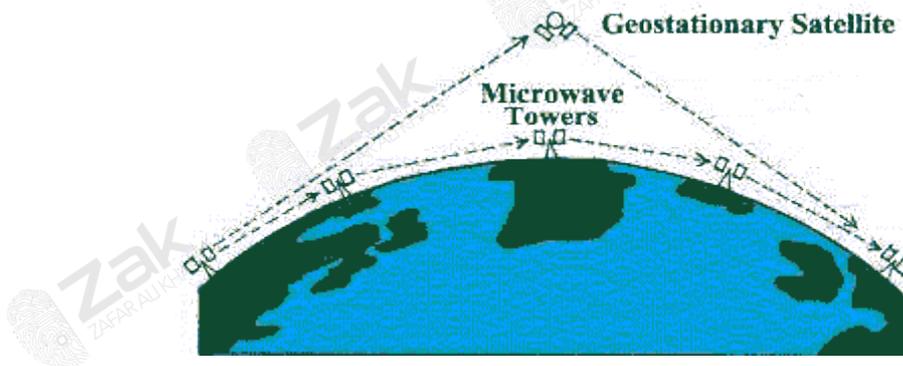
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SATELLITES

A **satellite** is any object that revolves around a planet in a circular or elliptical path. The moon is Earth's natural satellite at 240,000 miles distant. Other satellites that fulfill this definition are man-made and have been launched into orbit to carry out specific functions. These satellites are typically between 100 and 24,000 miles away. Satellites have many purposes including data communications, scientific applications and weather analysis. Satellite transmission requires an unobstructed line of sight. The line of site will be between the orbiting satellite and a station on Earth. Satellite signals must travel in straight lines but do not have the limitations of ground based wireless transmission, such as the curvature of the Earth.

Microwave signals from a satellite can be transmitted to any place on Earth which means that high quality communications can be made available to remote areas of the world without requiring the massive investment in ground-based equipment.





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What is a Bit Stream?

Millions of bits, travel over thousands of computer networks every day. The system works much like the modern post office, which has to constantly send and receive letters from all over the world. Like those letters, computer bits arrive in a continuous, ordered stream known as the bit stream. The bits identify where they are coming from (often a computer) and where they are traveling to (often another computer).

All the information sent to and from a computer turns into a series of 1's and 0's that represent data. When the computer sends a message, the bits travel in a specific order through a wire to their destination. Typically, the bit stream starts with information about where it's going and how to process the information once it arrives. An email, for example, contains information on the sender, the recipient, and the message itself. When the user sends it, it's broken down into bits of data which travel over the bit stream to the recipient's computer.

Video on demand (VOD) is a system that may allow users to select and watch/listen to video or audio content when they choose to, rather than having to watch at a specific broadcast time (Live streaming). Some TV VOD systems such as Netflix or Hulu allow users to watch their favorite shows whenever they please.

Real time or Live streaming, as the name suggests, is streaming a video that is happening at that exact moment. Examples may be a football match, a concert, or a lecture happening at your university.

Video On-demand

- High quality (HD) video and audio
- Plays on computers and smart phones
- Plays smoothly at any Internet speed
- More economical than live streaming

Live Streaming

- No time delay
- Ability to live chat
- Ability to ask and respond to questions
- May require additional hardware and software





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What is Bitrate?

Bitrate is a term used to describe the amount of data that is being passed within a given amount of time. Depending on the context, common measurements of bitrate include Kbps and Mbps, respectively meaning kilobits per second and megabits per second. No matter the units being used, a higher number is generally good, indicating high speed or high quality.

When it comes to Internet speeds, a higher bitrate is always desirable –it simply sends you the content that you want faster. With higher bitrates, you can do more with your Internet connection – stream high-definition movies, play online games with minimal lag, and download large files in just a few seconds. You can figure out what bitrates you're getting by visiting a website such as speedtest.net

When talking about streaming audio or video, bitrates refer to the amount of data stored for each second of media that is played. For example, a 320 kbps MP3 audio file has a higher quality than the same file at just 128 kbps. The same applies to videos – a higher bitrate will have a higher quality when comparing the same video with the same resolution. Bitrates should be expected to go up whenever the resolution goes up, as more data is being processed. Therefore, high bitrates for audio and video may provide excellent quality, but it can also place a major strain on your hardware which can result in stutters or frequent pauses in the media being streamed if your bitrate is not high enough or if there is too much traffic on your line.

