Networks

Network

A network is a collection of computers that are connected in such a way that data can be transferred between them.

LANs and WANs

Local Area Network (LAN)

Found in a single room or single building. The business/organisation owns all of the hardware.

Wide Area Network (WAN)

Connect separate LANs over a large geographical area (i.e. the different branches of a chain store in different towns). WANs usually make use of the telecommunication network, i.e. they use equipment owned by other companies.

Routers are used to connect together the computers on a LAN. **Gateways** (or a Gateway router) are used to connect a LAN to a WAN.

This is a network router.

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Network Speeds

The speed of a network is measured in bits per second (bps). Note, that is **bits** per second, not **bytes** per second.

A kilobit connection is 1000 bits per second (kbs), a megabit connection is 1000000 bits per second (Mbps), and a gigabit connect is 1000000000 per second (Gbps)
Eg.1, If a network has a connection speed of 2kbs, how long will it take to download a 20 kilobyte file?
20 kilo**bytes** = 20 x 8 kilo**bits** = 160 kilo**bits**
The connection is 2 kilobits per second, so the time taken is = 160/2 = 80 seconds

Eg.2. If a network has a connection speed of 10kbs, how long will it take to download a 2 Megabyte file?

2 **Mega**bytes = 2000 **kilobytes** = 2000 x 8 kilo**bits** = 16 000 kilobits
The connection is 10 kilobits per second, so time taken = 16 000 / 10 = 1600 seconds

Question 1. If a network had a connection speed of 10 kbs, how long would it take to download a 5 kilobyte file?

Question 2 If a network had a connection speed of 400 kbs, how long would it take to download a 2 Megabyte file?

Question 3. If a network had a connection speed of 2 Mbps, how long would it take to download a 24 Megabyte file?

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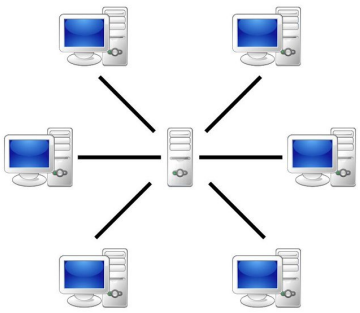
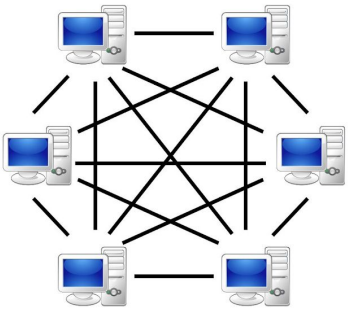
Client-server and peer-to-peer networks



Server-based



P2P-network

A peer-to-peer network is a simple network, usually containing only a few computers, where all computers are equals. It allows data to be shared between computers more easily, and for hardware (like printers) to be shared.

- Data is stored on each computer, making back-ups slower and more complicated
- Each computer handles its own security
- Relatively easy to set up and maintain

A client-server network is more complex and expensive to set up and maintain. A single, more powerful, computer acts as a server, centralising file storage and security.

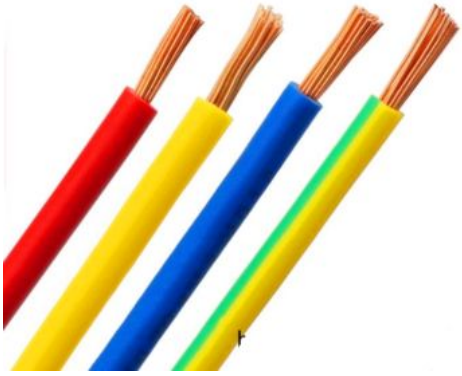
- Data is stored centrally, making back-ups easier
- Security is controlled centrally
- All client machines connect to the server
- If the server goes down, the whole network is unusable
- Requires the knowledge and expertise of a SysAdmin to maintain and service

Why is backing up a peer-to-peer network more complex, and why are mistakes more likely?

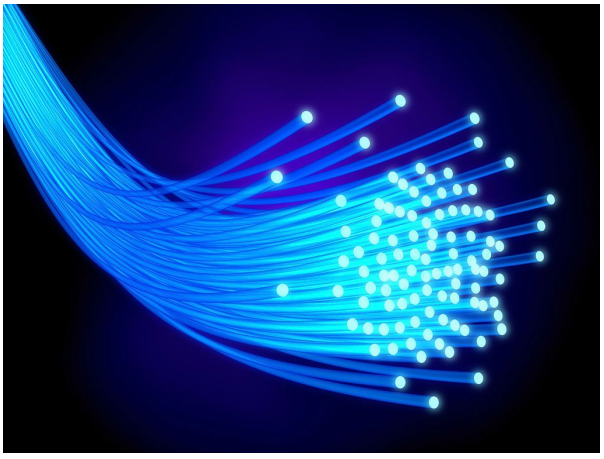
Wired and Wireless connectivity

Types of cable

Copper wire - cheap, but slow



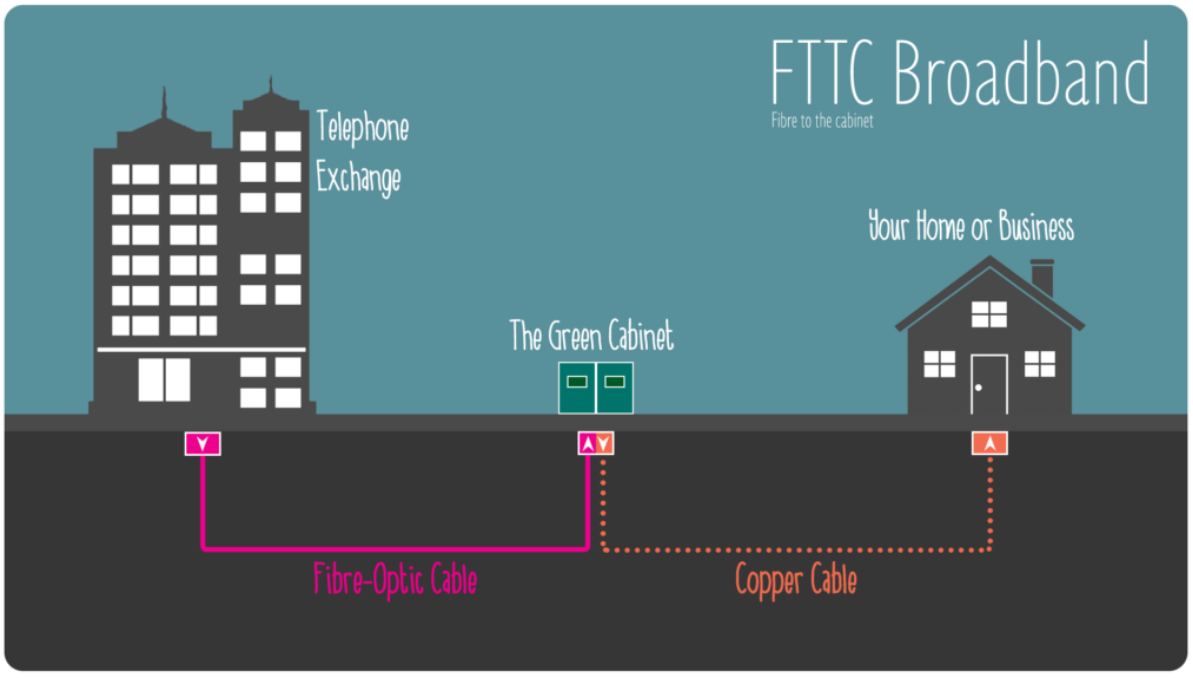
Fibre optic cable - high transmission speeds, but expensive



Example transmission speeds (sometimes called bandwidth)

- Wireless - up to 600 Mbps
- Copper Cable - up to 1 Gbps
- Fibre Optic - up to 10 Gbps

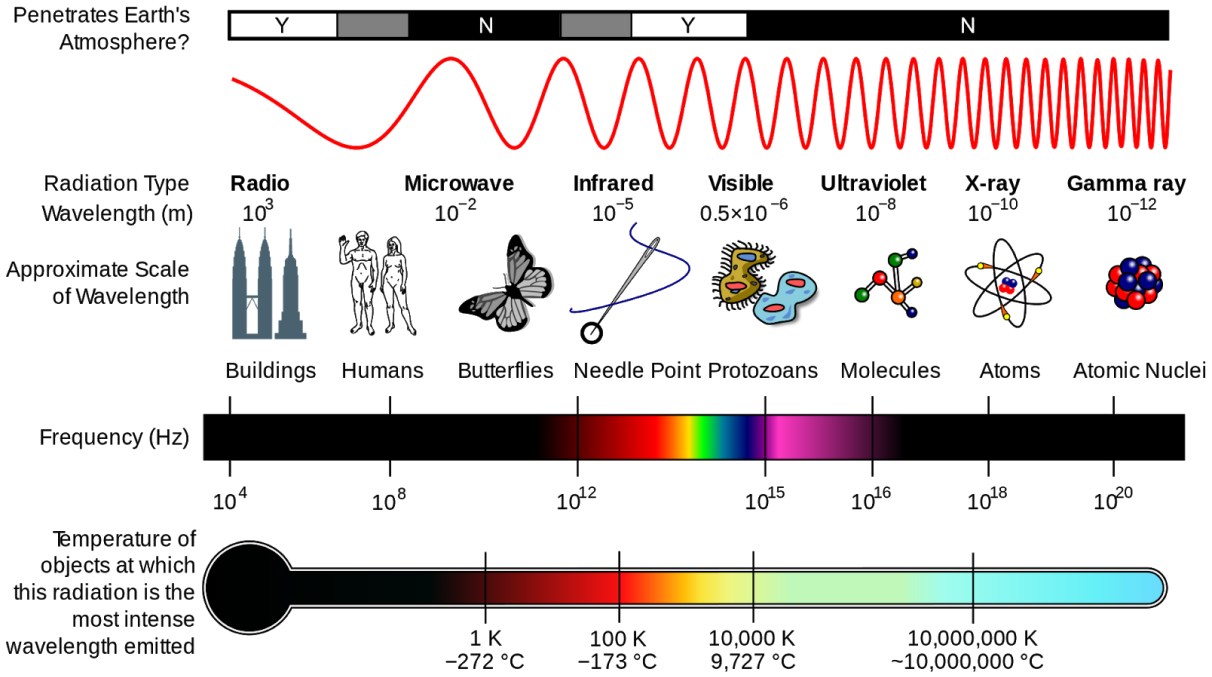
How many times faster is Fibre Optic than Wireless?



Types of Wireless connections

Most commonly we think of wifi, but we also use Bluetooth, 3G and 4G. These are called different wireless **protocols**.

Wireless networks use radio waves to carry data. Different devices use different frequencies to avoid interfering with each other.

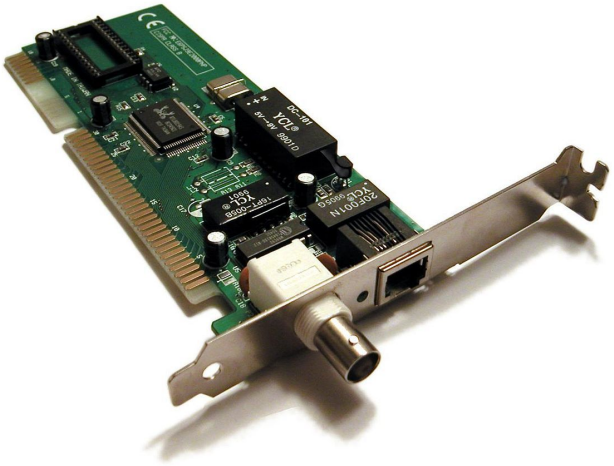


Fitting a wired network is more expensive and more disruptive than fitting a wireless network, but a wired network allows for higher speeds and avoids problems with ‘black spots’ where no network can be accessed. Wired networks are also more secure, as it would be much more difficult to hack into them.

Connecting Computers to LANs

To connect to a network, computers must have a Network Interface Controller (NIC) fitted. These are often built into the motherboard on modern computers, but can be a seperate ‘card’ which slots into the motherboard.

This is a network interface card:

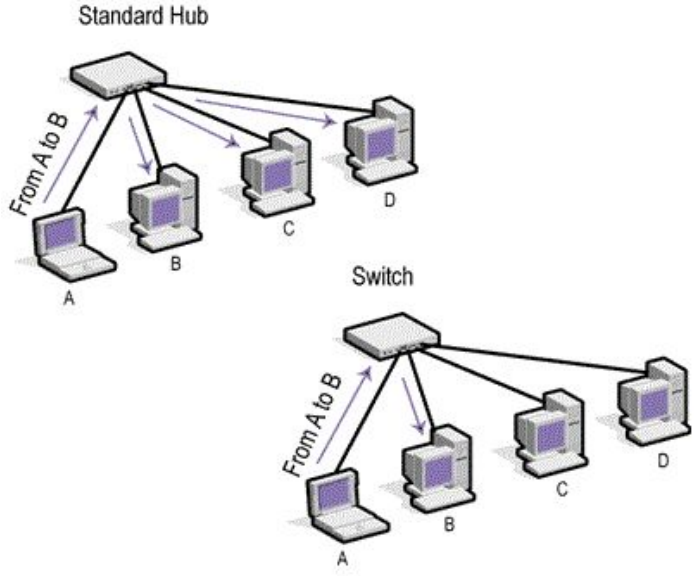


Each NIC has a unique media access control (MAC) number programmed into it at manufacture. A MAC address is the address that ensures every device in the world can be distinguished from every other device. An example of a MAC address is `00:A0:C9:14:C8:29`

Hubs and Switches

These are hardware devices that are used to connect computers together to form a LAN. A switch is a more advanced version of a hub. A hub is a ‘dumb’ device, which rebroadcasts any signal it receives to all of the computers connected to it. A switch is a ‘smart’ device - it knows the addresses of all of the devices connected to it, so that when it receives a signal it only rebroadcasts it to the device that it is the correct destination. This means that hubs ‘tie up’ all of their connections when communicating, whilst a switch can deal with multiple exchanges of information simultaneously. Therefore switches make for faster networks than Hubs.

Diagram of a Hub and a Switch



Routers

A router connects different networks together. They read the address information on data that they receive, and then send the message to the correct network. A network sits between a home network and the internet, handling incoming and outgoing data.

Wireless access point

This is a device that converts data received through cables into wireless signals and vice versa. Wireless access points provide ‘hotspots’ where people can connect their wireless device to wifi. Wireless access points act like hubs in that they transmit all data to all devices in the area.

Note: many devices act as routers, hubs and wireless access points all at once.

Data Transmission

When data is transmitted from one device to another it is broken up into packets. A packet is made up of:

- A header, which contains the address of where the data came from, the address of where it is being sent to, and the ‘packet number’ indicating which part of the message the packet is.
- The body, which contains the actual data being transmitted.
- A footer, which tells the receiving device that all of the data has arrived.

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Protocols

A protocol means a set of rules that are used to govern the transfer of data. These rules cover things like data format, address format, and routing information (which route data should take through a network).

You need to know the name, and meaning of, the following protocols:

FTP - **File Transfer Protocol** - used to transfer files from one computer to another. Often used for uploading and downloading large files to the internet.
HTTP - **Hypertext Transfer Protocol** - the rules that web browsers and web servers use for requesting and serving web pages. It allows a browser to request a particular web page from a server, and that web page to be sent to the correct browser on the correct computer.
HTTPS - **Secure HTTP** - like HTTP, but providing an encrypted connection, so data can be transferred privately.
SMTP - **Simple Mail Transfer Protocol** - provides the rules for ***sending*** emails, and for how emails are routed from one server to another until they reach their destination.
POP - **Post Office Protocol** - rules for how emails are *received*. When using POP all emails are downloaded from the server, and usually then deleted from the server.
IMAP - **Internet Message Access Protocol** - another protocol for receiving email, but unlike POP the messages do not have to be downloaded and deleted. Instead, they are viewed on the server and kept in place. This is now the most commonly used email protocol, as most people now access their emails on multiple devices in multiple locations.

The other commonly used protocol is **TCP/IP**. This is called a 'protocol stack' as it is a series of protocols that are working together to produce a complex outcome. TCP/IP is used to run the internet. TCP/IP is responsible for transmitting packets of data around the internet. It is made up of four parts, or 'layers':

- **The Application layer** - this provides services to applications like web browsers and email
- **The Transport layer** - this divides the data into packets, checks that the data has been sent and received, and notifies sending and receiver that this has happened.
- **The Internet layer** - this layer adds the source and destination IP address to the the data, and routes it to the correct computer
- **The Network Access layer** - this uses network specific protocols to transmit the data through the local network.

You should at least learn the names of the four layers of TCP/IP, and remember the purpose of TCP/IP.