

3.4 Networks

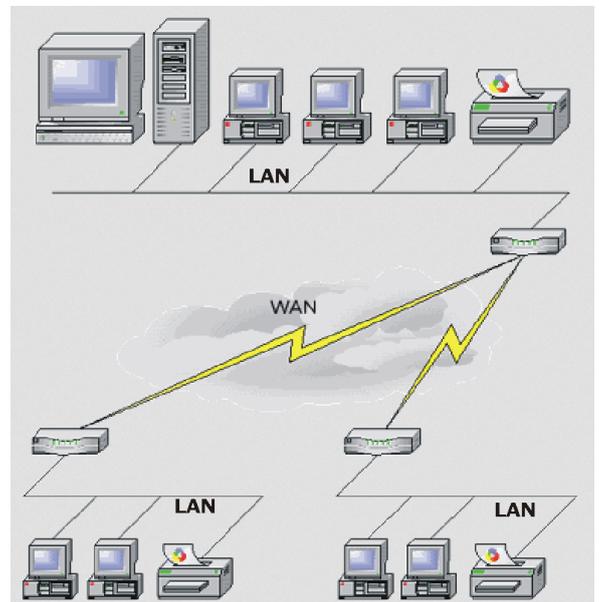
What is a Network?

A **network** is a group of two or more computer systems linked together. There are many types of computer networks, including:

- **Local Area Network (LAN)**: The computers are geographically close together (that is, in the same building). A variation of LAN is the **WLAN (Wireless LAN)**.
- **Wide Area Network (WAN)**: The computers are farther apart and are connected by telephone lines or radio waves.
- **Campus Area Network (CAN)**: The computers are within a limited geographic area, such as a campus or military base.
- **Metropolitan Area Network (MAN)**: A data network designed for a town or city.
- **Home Area Network (HAN)**: A network contained within a user's home that connects a person's digital devices.

In addition to these types, the following characteristics are also used to categorize different types of networks:

- **Topology**: The geometric arrangement of a computer system. The most common topologies are the following:
 - Bus
 - Star
 - Ring
 - Mesh
- **Protocol**: The protocol defines a common set of rules and signals that computers on the network use to communicate. One of the most popular protocols for LANs is called Ethernet. Another popular LAN protocol for PCs is the IBM Token-Ring network.
- **Architecture**: Networks can be broadly classified as:
 - Peer-to-Peer or
 - Client/Server.



A WAN consists of a connection of a number of LANs distributed over a large geographical area.

Computers on a network are sometimes called **nodes**.

Advantages and Disadvantages of Networks

Advantages	Disadvantages
<ul style="list-style-type: none">• Sharing devices such as printers saves money.• Site (software) licences are likely to be	<ul style="list-style-type: none">• Purchasing the network cabling and file servers can be expensive.• Managing a large network is

<p>cheaper than buying several standalone licences.</p> <ul style="list-style-type: none"> • Files can easily be shared between users. • Network users can communicate by email and instant messenger. • Security is good - users cannot see other users' files unlike on stand-alone machines. • Data is easy to backup as all the data is stored on the file server. • Video conferencing. 	<p>complicated, requires training and a network manager usually needs to be employed.</p> <ul style="list-style-type: none"> • If the file server breaks down the files on the file server become inaccessible. Email might still work if it is on a separate server. The computers can still be used but are isolated. • Viruses can spread to other computers throughout a computer network. • There is a danger of hacking, particularly with wide area networks. Security procedures are needed to prevent such abuse, e.g. a firewall.
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Shareable and Non-Shareable Resources

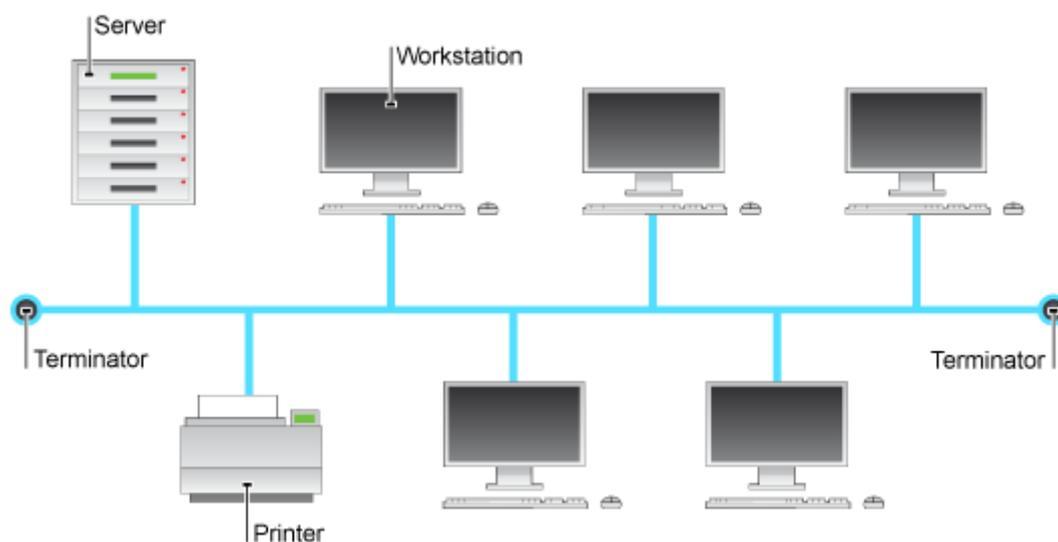
A **resource**, or system resource, is any physical or virtual component of limited availability within a computer system. Every device connected to a computer system is a resource. Every internal system component is a resource. Virtual system resources include files, network connections and memory areas. Examples of resources are: CPU, RAM and virtual memory, hard disk space, database table etc.

Shareable resources: i.e. can be used by several users at the same time. Examples: program code, data areas if read only.

Non-shareable resources: i.e. can only be used by one user at a time. Examples: data areas that need to be written, printers, the processor.

The Bus Network

In a **bus network** all the nodes (workstations, servers and printers) are joined to one cable (called the **bus**). At each end of the cable a **terminator** is fitted to stop signals reflecting back down the bus.



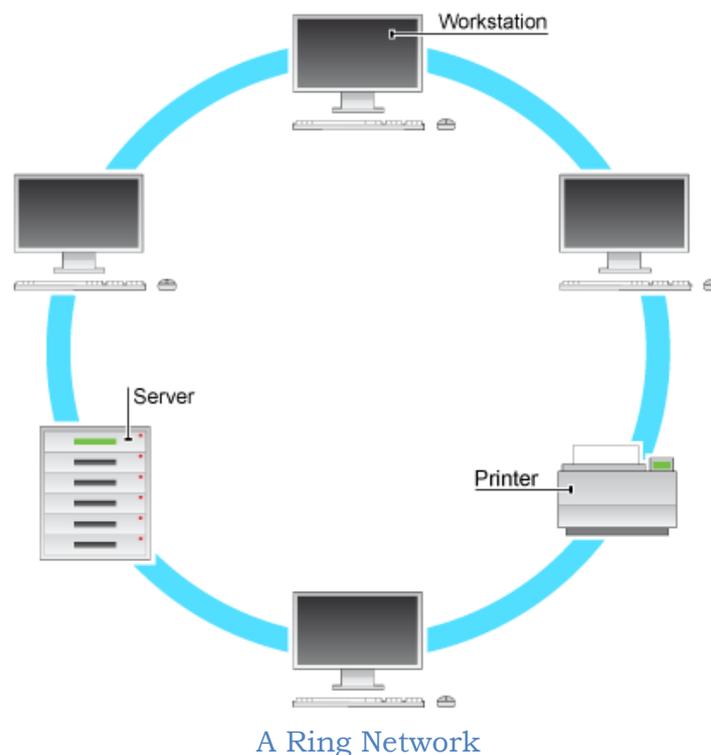
A Bus Network

Advantages and disadvantages of a bus network

Advantages	Disadvantages
easy to install	if the main cable fails or gets damaged the whole network will fail
cheap to install, as it doesn't require much cable	as more workstations are connected the performance of the network will become slower because of <i>data</i> collisions
	every workstation on the network "sees" all of the data on the network – this is a security risk

The Ring Network

In a **ring network** each device (workstation, server and printer) is connected to two other devices, this forms a ring for the signals to travel around. Each packet of data on the network travels in one direction and each device receives each packet in turn until the destination device receives it.



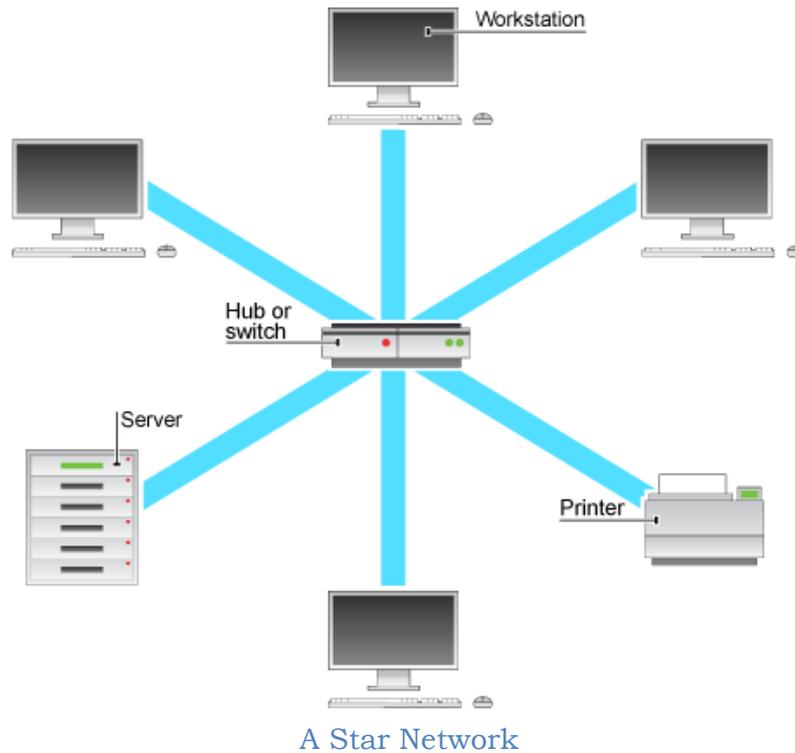
The diagram above shows four workstations, a server and a printer connected in a ring shape.

Advantage of a ring network: This type of network can transfer data quickly, even if there are a large number of devices connected because the data only flows in one direction, so there won't be any data collisions.

Disadvantage of a ring network: If the main cable fails or any device is faulty then the whole network will fail.

The Star Network

In a **star network** each device on the network has its own cable that connects to a switch or hub. A **hub** sends every packet of data to every device, whereas a **switch** only sends a packet of data to the destination device.



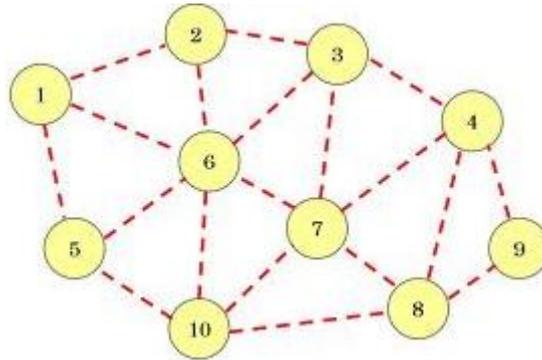
Advantages and disadvantages of a star network

Advantages	Disadvantages
very reliable - if one cable or device fails then all the others will continue to work	expensive to install as this type of network uses the most cable (network cable is expensive)
high performing as no data collisions can occur	extra hardware required (hubs or switches) which adds to cost
	if a hub or switch fails all the devices connected to it will have no network connection

The Mesh Network

A **mesh network** is a communications network in which there are at least two pathways to each node. If one of the paths fails, the other is still available.

A "fully meshed" network means that every node has a direct connection to every other node, which is a very elaborate and expensive architecture. Most mesh networks are partially meshed and require traversing intermediate nodes to go from each node to every other.



A Mesh Network

Advantages of mesh networks:

- A mesh topology can withstand high amounts of traffic.
- Reliability. Mesh topologies do not collapse if a single node disconnects or has connection issues.

Disadvantages of mesh networks:

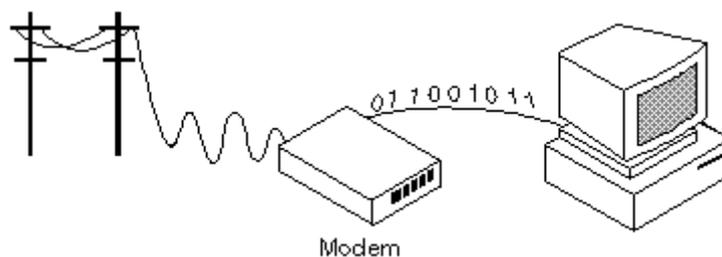
- Highly expensive because of the many connections and supervision it requires.
- High maintenance.

Other Terms

Bandwidth is the transmission capacity of an electronic pathway such as a communications line or a computer bus. In a digital line, it is measured in bits per second or bytes per second (e.g. Mb/sec).

Some examples are found in the following table:

LAN	Ethernet	10Mbps – 100Mbps	Ethernet was developed by Xerox Corporation in cooperation with DEC and Intel in 1976.
WAN	DSL	144kbps	DSL (Digital Subscriber Line) is a technology that significantly increases the digital capacity of ordinary telephone lines.
Bus	PCI	33MHz	PCI stands for Peripheral Component Interconnect



“Modem” is short for “modulator-demodulator”. A modem is a device or program that enables a computer to transmit data over, for example, telephone or cable lines. A modem can be external or internal.

Transmission media refers to the materials through which the information passes from one point to another in networks.

Cabling refers to the type of wires that are used as transmission media. Information can even be transmitted without the need to have physical wiring (**wireless**).

This is a type of cable that consists of two independently insulated wires twisted around one another. The use of two wires twisted together helps to reduce interference.

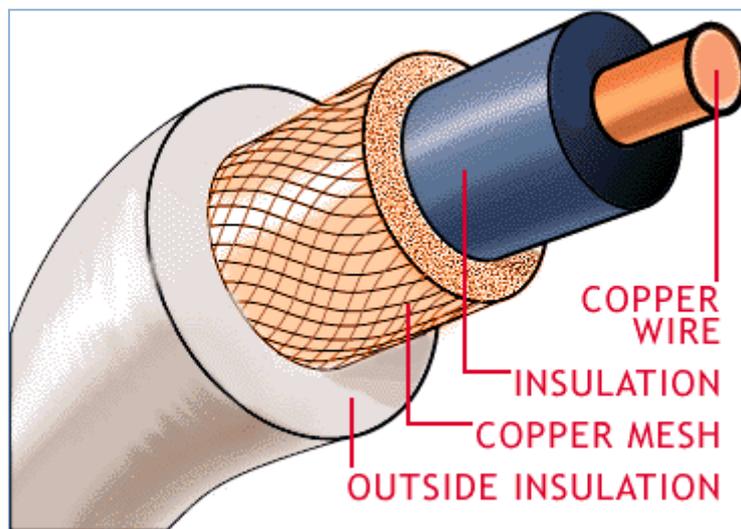
Twisted-pair cable is the least expensive type of local-area network (LAN) cable. It is also used for telephone communication. Other types of cables used for LANs include coaxial cables and fibre optic cables.

Twisted pairs have less bandwidth than coaxial cable or optical fibre. Twisted pair cables are available **unshielded** (UTP) or **shielded** (STP).



Twisted Pair Cable

The **coaxial cable** is a type of wire that consists of a centre wire surrounded by insulation. A shield (copper mesh) minimizes electrical and radio frequency interference.



Coaxial Cable

Coaxial cabling is the primary type of cabling used by the cable television industry and is also widely used for computer networks, such as Ethernet. Although more expensive than standard telephone wire (twisted-pair), it is much less susceptible to interference and can carry much more data.

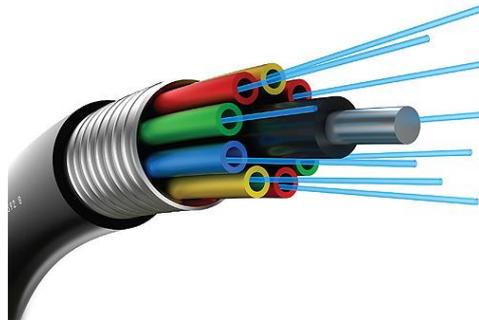
Fibre optics is a technology that uses glass (or plastic) threads (fibres) to transmit data. A fibre optic cable consists of a bundle of glass threads, each of which is capable of transmitting messages modulated onto light waves.

Fibre optics has several **advantages** over traditional metal communications lines:

- Fibre optic cables have a much greater bandwidth than metal cables. This means that they can carry more data.
- Fibre optic cables are less susceptible than metal cables to interference.
- Fibre optic cables are much thinner and lighter than metal wires.
- Fibres allow longer distances to be spanned before the signal has to be regenerated by expensive repeaters.

Disadvantages of fibre optics:

- The cables are expensive to install.
- The cables are more fragile than wire and are difficult to splice.



Fibre Optic Cables

Telephone companies are steadily replacing traditional telephone lines with fibre optic cables. In the future, almost all communications will employ fibre optics.

Microwave data transmission differs from the previously mentioned communications channels in that data is transmitted through the air instead of through cables or wires. Microwaves are high-frequency radio waves that can only be directed in straight lines. Consequently, microwave transmission is usually limited to communications occurring within the limits of a particular city or community. For microwave transmissions to be able to occur over larger distances, data messages must be relayed from one location to another by using antennas placed at high altitudes usually twenty to thirty miles apart.



Microwave Transmission

A **satellite** is an object that goes around, or orbits, a larger object, such as a planet. While there are natural satellites, like the moon, hundreds of man-made satellites also orbit the Earth.

A communications satellite is a satellite that has been stationed in space for the purpose of providing telecommunications. Communications satellites are commonly used for mobile phone signals. They commonly move in a **geostationary** orbit. They are used for such diverse purposes as weather forecasting, television broadcast, amateur radio communications, Internet communications, and the Global Positioning System (**GPS**).



A Communications Satellite

Internet and WWW-related Terminology

The **Internet** is a global network connecting millions of computers. The world countries are linked into exchanges of data, news and opinions.

The Internet is not synonymous with World Wide Web. The Internet is a massive network of networks. It connects millions of computers together globally, forming a network in which any computer can communicate with any other computer as long as they are both connected to the Internet.

The **World Wide Web**, or simply **Web**, is a way of accessing information over the medium of the Internet. It is an information-sharing model that is built on top of the Internet. It is a system of Internet servers that support specially formatted documents. The documents are formatted in a markup language called HTML (HyperText Markup Language) that supports links to other documents, as well as graphics, audio, and video files. This means you can jump from one document to another simply by clicking on hot spots. Not all Internet servers are part of the World Wide Web.

There are several applications called Web browsers that make it easy to access the World Wide Web; two of the most popular being Firefox and Microsoft's Internet Explorer.

The Web is just one of the ways that information can be disseminated over the Internet. The Internet, not the Web, is also used for:

- e-mail (which relies on SMTP)
- Usenet news groups,
- instant messaging
- FTP

So the Web is just a portion of the Internet, albeit a large portion, but the two terms are not synonymous and should not be confused.

What can you do on the Internet?

- browse websites
- send and receive email
- download media files, e.g. Mp3s or video files
- watch streamed video, e.g. BBC iPlayer, YouTube etc
- check your bank balance and make payments
- buy goods from online shops
- access educational material from your school's Virtual Learning Environment (VLE)
- create, store, edit and share your documents using web-based applications, e.g. Google Docs
- interact with friends on social networking sites, e.g. Bebo, MySpace, Facebook etc.
- write a blog
- sign-up to forums and discuss topics that interest you with like-minded individuals
- game with friends
- instant message family and friends
- share photos and videos
- complete free tutorials covering a wide range of subjects

An **Internet Service Provider (ISP)** is a company that provides access to the Internet. Equipped with a modem, you can log on to the Internet and browse the World Wide Web, and send and receive email.

A **web server** is a computer that delivers web pages. For example, if you enter the URL

`http://www.pcwebopedia.com/index.html`

in your browser, this sends a request to the server whose **domain name** is pcwebopedia.com. The server then fetches the page named **index.html** and sends it to your browser.

A **web client** refers to the Web browser in the user's machine.

A **Uniform Resource Locator (URL)** is the global address of documents and other resources on the World Wide Web.

The first part of the address is called a protocol identifier and it indicates what protocol is being used, and the second part is called a resource name and it specifies the IP address or the domain name where the resource is located. The protocol identifier and the resource name are separated by a colon and two forward slashes.

For example, the two URLs below point to two different files at the domain "pcwebopedia.com". The first specifies an executable file that should be fetched using the FTP protocol; the second specifies a Web page that should be fetched using the HTTP protocol:

- `ftp://www.pcwebopedia.com/stuff.exe`
- `http://www.pcwebopedia.com/index.html`

Consider the URL: `http://www.clothes.com/men/shirts/formal.html`. The meaning of each part of the above URL is described below:

<code>http:</code>	protocol
<code>//</code>	separators

www.clothes.com/	domain name
men/	subdirectory name
shirts/	subdirectory name
formal.html	document name (Web page)

A **Web browser** (browser) is a software application used to locate and display Web pages. Three popular browsers are Microsoft Internet Explorer, Mozilla's Firefox and Apple's Safari. Two other browsers are Opera and Google Chrome. All of these are graphical browsers. This means that they can display graphics as well as text. In addition, most modern browsers can present multimedia information, including sound and video, though they require plug-ins for some formats.

In order to view a Web site, its address (URL) is typed into the search box at the top of the browser. As a result the site's home page is retrieved.

Browsers have numerous features including bookmarks (Favourites) that store the addresses (URLs) of frequently used pages. Another feature is the possibility to open multiple Web pages.

The following are terms associated with a web browser:

- **home page**: the main page of a website
- bookmarks (favourites)

Plug-in is software that is installed into an existing application in order to enhance its capability. For example plug-ins are widely used in image editing programs such as Photoshop to add some special effect. Plug-ins are added to Web browsers to enable them to support different types of content (audio, video, etc.). The term is widely used for software, but can also refer to a plug-in module for hardware.

A web **search engine** is a program that searches documents for specified keywords and returns a list of the documents where the keywords were found. Examples of search engines are Google, Alta Vista and Excite.

Google is the world's biggest search engine. Most search engine sites are free and paid for by advertising banners, while others charge for the service. Yahoo! was the first search engine to gain worldwide attention, and it initially indexed most of its content manually.

FTP stands for **File Transfer Protocol**, the protocol for exchanging files over the Internet.

User ID (also called '**username**') is name by means of which a user is known to a network. It can be the real name of the user or an invented or abbreviated name. Usernames and passwords are required to access multi-user systems. In an Internet e-mail address, the username is the left part before the @ sign. For example, KAREN B is the username in the address karenb@mycompany.com.

A '**password**' is a secret series of characters that enables a user to access a file, computer, or program.

Ideally, the password should be something that nobody could guess. The following are password tips from the NCSC (National Computer Security Centre). NCSC is the arm of the U.S. National Security Agency that defines criteria for trusted computer products.

- CHANGE PASSWORDS FREQUENTLY - The longer you use a password, the higher the risk.

- USE GOOD PASSWORDS - Don't use persons, places or things that can be identified with you.
- DON'T DISCLOSE YOUR PASSWORD - Your password is as valuable as the information it protects.
- INSPECT YOUR DATA - If you suspect someone has tampered with your files, report it immediately.
- NEVER LEAVE AN ACTIVE TERMINAL UNATTENDED - Always log out or lock your terminal before leaving it.
- REPORT SUSPECTED COMPUTER ABUSE - Whether directed against you or not, abuse or misuse of your computer resources only hinders the timely completion of your tasks.

A password is typically somewhere between four and 16 characters, depending on how the computer system is set up.

Good criteria when choosing a password include the following:

- Don't pick a password that someone can easily guess if they know who you are (for example, not your Social Security number, birthday, or maiden name).
- Don't pick a word that can be found in the dictionary (since there are programs that can rapidly try every word in the dictionary!).
- Don't pick a word that is currently newsworthy.
- Don't pick a password that is similar to your previous password.
- Do pick a mixture of letters, some in uppercase and some in lowercase, and a few digits.
- Do pick a word that you can easily remember

Many networks require that you change your password on some periodic basis.

HTML (Hypertext Markup Language) is the authoring language used to create documents on the World Wide Web. HTML Is Not a Programming Language. It is a markup language. A markup language can also be thought of as a "presentation language". However, in order to make pages interactive, programming code can be embedded in an HTML page. For example, JavaScript code is widely used alongside the HTML code to make the Web page function like an application.

HTML was originally conceived as a simple markup language to render research documents on the Web. No one envisioned Web pages turning into multimedia applications, but HTML pages have been reworked and as a result, the source code behind some of today's Web pages is often a complex concoction of tags and scripting.

A major attempt to standardize HTML as a Web application platform is HTML Version 5. It consolidates features and adds numerous programming functions.

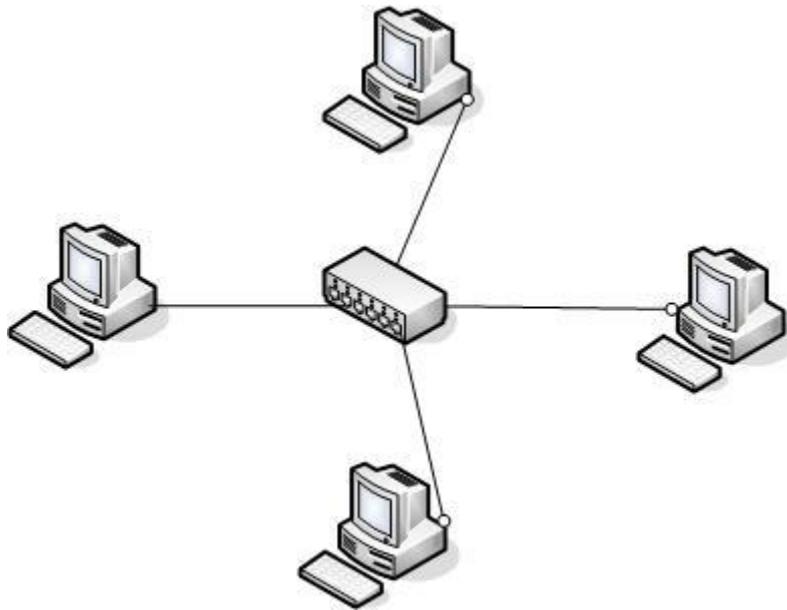
Hypermedia is an extension to **hypertext** that supports linking graphics, sound, and video elements in addition to text elements.

Authoring tools (also known as **authorware**) are programs that help you write hypertext or multimedia applications.

The distinction between authoring tools and programming tools is not clear-cut. Typically, though, authoring tools require less technical knowledge to master and are

used exclusively for applications that present a mixture of textual, graphical, and audio data.

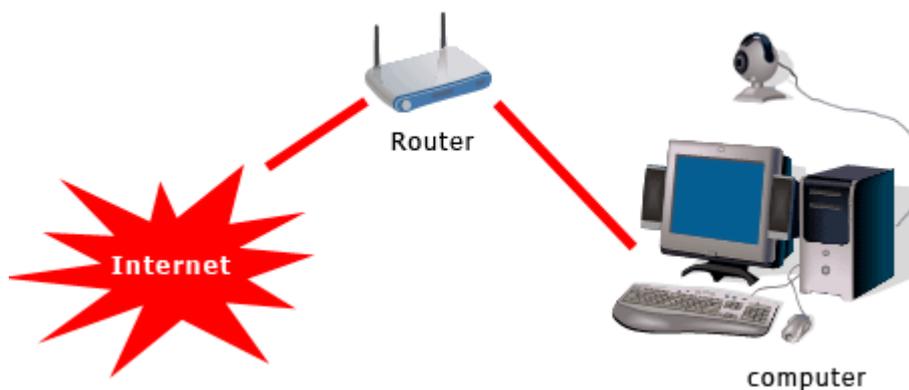
A **hub** is a common connection point for devices in a network. Hubs are commonly used to connect segments of a LAN. A hub contains multiple ports. When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets.



A Network with a central Hub

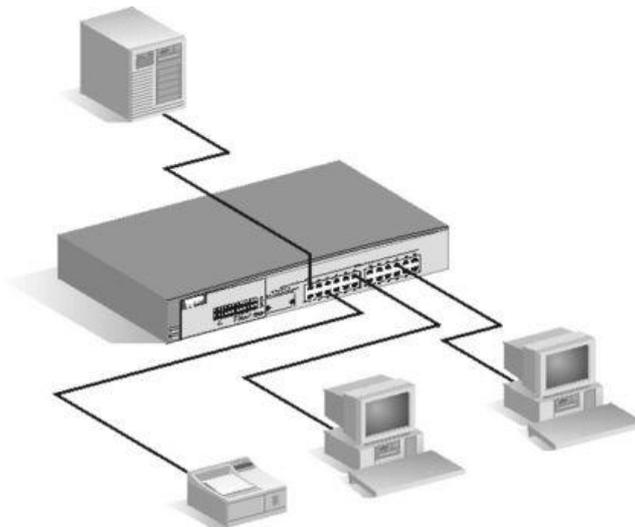
A **router** is a device that forwards data packets along networks. A router is connected to at least two networks. Routers are located at gateways, the places where two or more networks connect.

Routers use headers and forwarding tables to determine the best path for forwarding the packets, and they use protocols to communicate with each other and configure the best route between any two hosts.



A Router connecting a Home Network to the Internet

A **switch** is a device that filters and forwards packets between LAN segments.

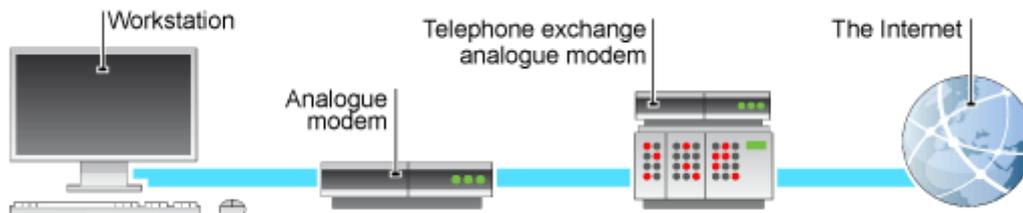


A Switch connecting the devices of a network

A connection made to the Internet will be either **analogue** or **digital**.

Analogue connection

A **dial-up** modem converts digital signals from a computer to analogue signals that are then sent down the telephone line. A modem on the other end converts the analogue signal back to a digital signal the computer can understand.



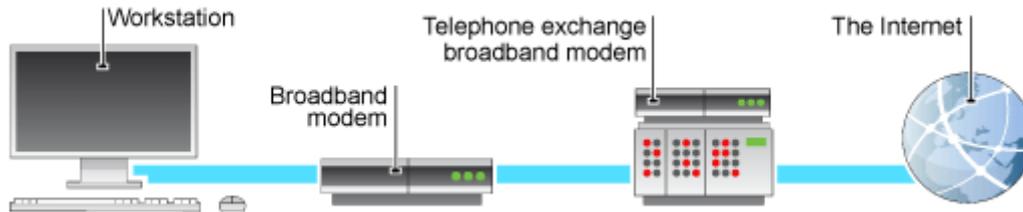
An analogue Internet connection

The maximum theoretical connection speed is 56Kbps. Dial-up is very slow by today's standards and in real world use will typically result in a download speed of roughly 5KBps. Phone calls cannot be made whilst connected to the Internet.

Digital connections

An **ISDN** (Integrated **S**ervices **D**igital **N**etwork) capable phone line can provide connection speeds of up to 64Kbps (single channel) or 128Kbps (dual channel) using a terminal adaptor often referred to as an ISDN modem. The terminal adaptor removes the need to convert digital signals to analogue signals before they're sent down the telephone line, this results in a more reliable Internet connection.

ADSL (Asymmetric **D**igital **S**ubscriber **L**ine) provides connection speeds of up to 24Mbps and uses a telephone line to receive and transmit data. ADSL supports faster data rates for receiving data (known as the **downstream** rate) than for sending data (known as the **upstream** rate).



A digital Internet connection

The speed that data can be transferred is dependent on a number of factors: Phone lines were designed to carry voice signals - not data. Signal quality can vary between lines and whilst it doesn't affect voice signals, it **does** affect data transmissions. The distance between your house and the telephone exchange has an effect on the speed at which data is transferred. A distance of 4Km is considered the limit for ADSL technology, beyond which it may not work.

An **ADSL** modem/router is needed for broadband Internet access over ADSL. This is usually provided by your ISP. Phone calls can still be made whilst connected.

Another digital connection is by means of **cable**. Cable companies do not use traditional telephone lines to provide broadband Internet access. They have their own network, a combination of coaxial copper cable and fibre optic cable.

With their purposefully built infrastructure cable companies are able to provide speeds of up to 50Mbps - considerably faster than the highest available ADSL speed (24Mbps).

A **cable** modem/router is needed for broadband Internet access over cable. This is usually provided by your ISP.

The making and receiving of phone calls is not affected because the telephone line is not used.