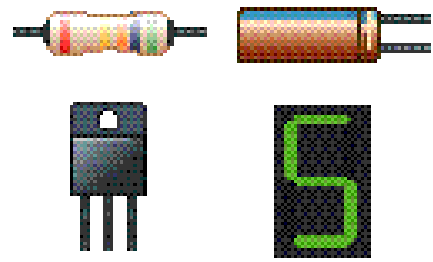


ELECTRONICS



Electronic components clockwise from top left: resistor, capacitor, LED display and transistor.

Electronics is the study of how electrons behave and how they can be made to do useful jobs. Electrons are tiny particles inside atoms, the building blocks of matter. In some materials, such as metals, they can move easily from one atom to another. If electrons are made to flow along a pathway, such as a metal wire, an electric current is produced. By controlling electric currents, an electronic device can carry out a wide range of tasks.

Amplifier An electronic circuit that increases the strength of an electric signal. For example, an amplifier can convert the weak signal from a radio tuner (▶14) into a signal strong enough to power a speaker.

Analogue Whereas digital systems use only two values, 1 or 0, to store data, analogue, or non-digital systems, use an infinite range of values. In an **analogue circuit**, current can be of any strength, while in a digital circuit, current can only be on or off.

Binary A number system that uses only the digits 0 and 1. This can be represented in digital circuits by turning currents on (1) or off (0). A binary “word” uses multiple binary digits to represent decimal numbers (see illustration right). Almost any information can be represented in binary.

Bit The basic unit of information in digital electronics. A “bit”, short for “binary digit”, is represented either by 1 or 0.

Byte A sequence of eight bits, the number needed to represent a number or letter on a computer. Bytes are often used to measure the size of a computer’s memory.

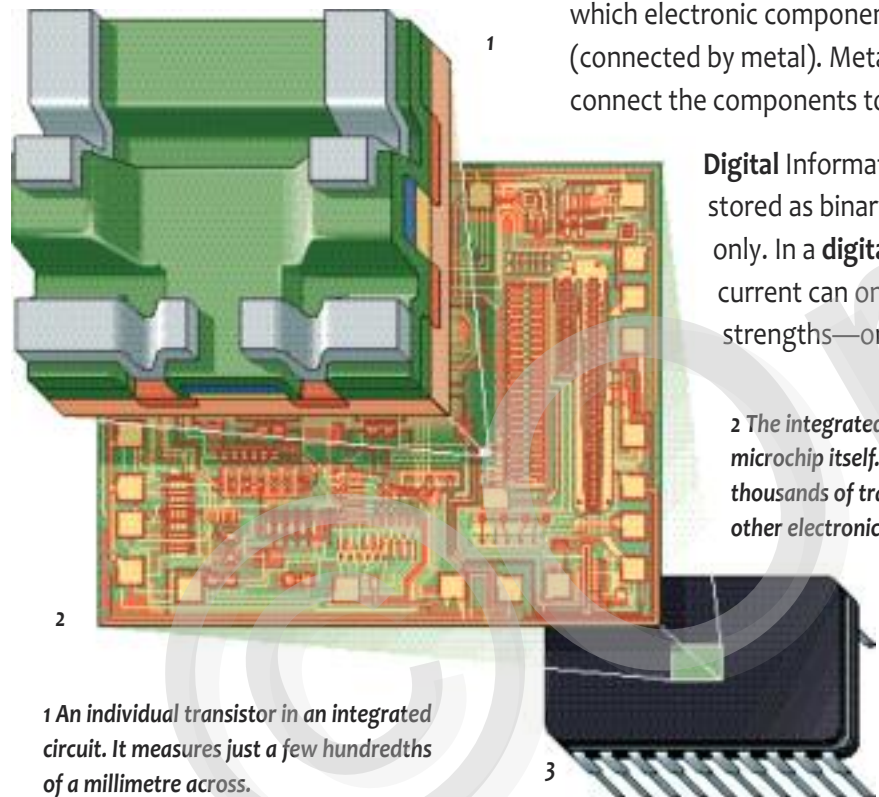
Capacitor An electronic component that stores electric charge. It consists of an insulator between two conducting plates.

Circuit board An insulating board on to which electronic components are soldered (connected by metal). Metal tracks connect the components to form a circuit.

Digital Information that is stored as binary numbers only. In a **digital circuit** current can only have two strengths—on and off.

2 The integrated circuit or microchip itself. It contains thousands of transistors and other electronic components.

3 The delicate integrated circuit is encapsulated in a plastic case to protect it.



1 An individual transistor in an integrated circuit. It measures just a few hundredths of a millimetre across.

16	8	4	2	1	
0	0	0	0	0	0
0	0	0	0	1	1
0	0	0	1	0	2
0	0	0	1	1	3
0	0	1	0	0	4
0	0	1	0	1	5
0	0	1	1	0	6
0	0	1	1	1	7
0	1	0	0	0	8
0	1	0	0	1	9
0	1	0	1	0	10
0	1	0	1	1	11
0	1	1	0	0	12
0	1	1	0	1	13
0	1	1	1	0	14
0	1	1	1	1	15
1	0	0	0	0	16

BINARY DECIMAL

This diagram shows how binary numbers combine bits of 0 and 1 to represent decimal numbers.

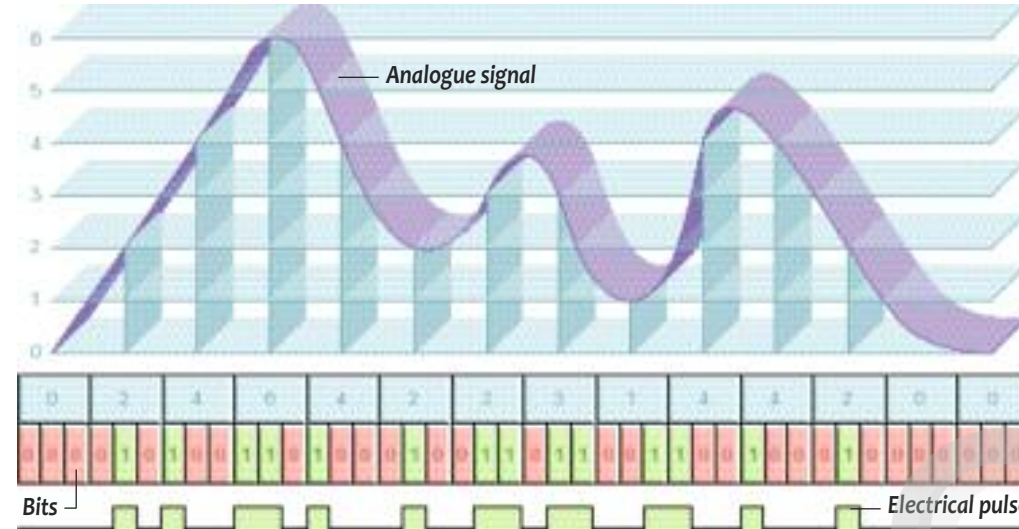
Digital picture An image on a computer, made up of pixels in a grid pattern. Each pixel has a position, colour and brightness, stored as binary on the computer.

Digitization The process of turning analogue information into digital form. Many types of analogue information must be turned into digital form before they can be handled by digital circuits.

Diode A semiconductor device that allows an electric current to flow through it in one direction but not the other.

Electric conductor A material that allows electrons to flow through it freely.

Electric insulator A material that reduces or stops the flow of electricity.



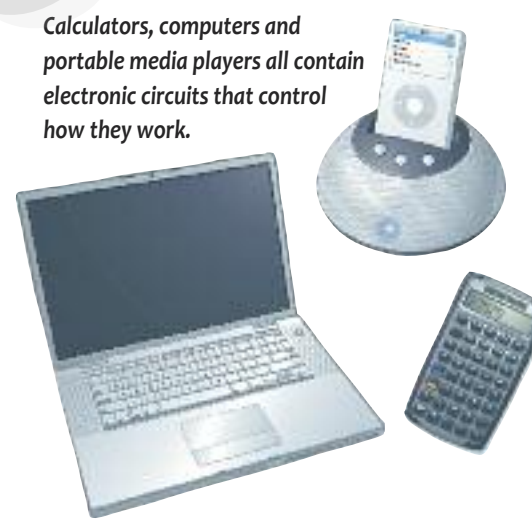
An analogue electrical signal is converted to digital. The bits become electrical pulses: on (1) and off (0).

Electrode An electric conductor that leads electricity to or from the non-metallic parts of a circuit.

Electronic circuit An electric circuit made up of electronic components. By combining different components in different ways, it is possible to make electronic circuits which can do almost any job.

Electronic component A basic part of an electronic circuit, such as a resistor or diode. Components control the flow of electric current in order to carry out tasks.

Calculators, computers and portable media players all contain electronic circuits that control how they work.



Electronic signal A signal made by continuously changing the strength and direction of an electric current. Digital signals use pulses of electricity to represent binary numbers.

Integrated circuit An electronic circuit made of microscopic components built into a small piece of silicon. Components are built in using chemical and photographic processes (▶18). Integrated circuits are often called silicon chips or **microchips**.

Light emitting diode (LED) A diode that makes light when an electric current flows through it.

Pixel A tiny coloured dot, which is the smallest part of a digital image. Pixel is short for “picture element”.

Resistor An electronic component that restricts the flow of current in a circuit.

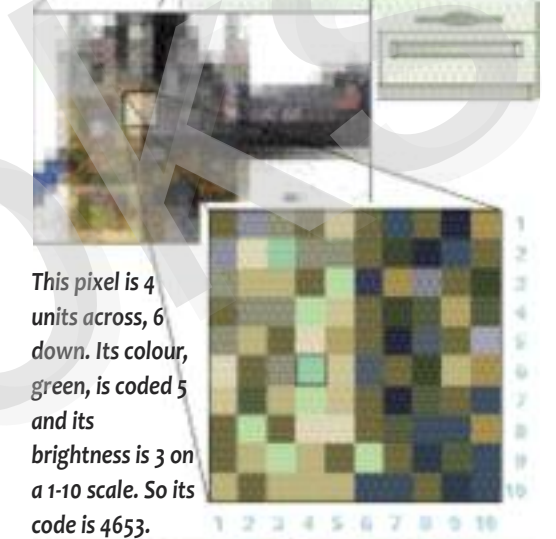
Resolution The concentration of pixels in a picture. High-resolution, or “hi-res”, graphics, made up of millions of pixels, can be viewed on a large screen without individual pixels becoming visible.

Semiconductor A substance that can act either as an electric conductor or as an insulator.

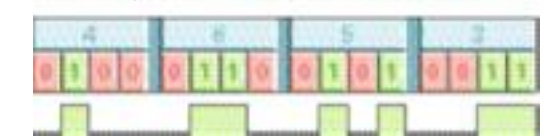
Silicon A non-metallic element found in many rocks. It can be extracted from the rocks, purified and treated to make a semiconductor. Silicon is widely used as a semiconductor in integrated circuits.

Switch An electronic component that can be used to break the flow of electrons around an electronic circuit.

An image on a screen is made up of tiny pixels. Each has a position, colour and brightness, that is stored in binary code.



This pixel is 4 units across, 6 down. Its colour, green, is coded 5 and its brightness is 3 on a 1-10 scale. So its code is 4653.



The pixel code is stored as a binary number which is represented as electrical signals. 1 means an electrical pulse, 0 means no pulse.

Transistor A semiconductor device that can act as a switch or an amplifier. The current flowing between two connections is controlled by a current flowing into a third.

A BRIEF HISTORY

★ **1904** English engineer John Ambrose Fleming invents the thermionic valve, also known as the vacuum tube. It is a basic device used to alter electronic signal by controlling the flow of electrons.

★ **1950s** Thermionic valves are quickly replaced by semiconductor devices.

★ **1959** The first integrated circuit is built by Texas Instruments in the USA. From this point, the number of components that can fit on a chip increases rapidly.



A thermionic triode valve

TELECOMMUNICATIONS

The sending and receiving of information using electricity, radio waves (14) or light is called telecommunications. The information can be phone calls, radio programmes, television pictures or computer data. Most forms of telecommunication require transmitting and receiving machines (14), and a network to link them together. All information is turned into signals that can travel through the network.

Bell, Alexander Graham (1847-1922) Scottish-American inventor who invented the telephone in 1876.

Broadband A high-speed communications network along which multiple streams of data can pass at once. Broadband Internet provides fast upload and download speeds (10).

Coaxial cable An insulated copper wire along which signals are sent as pulses of electricity. Coaxial cables are used in TV, telephone and computer networks.

Email A system for sending messages almost instantly between any two Internet users. Email is short for "electronic mail".

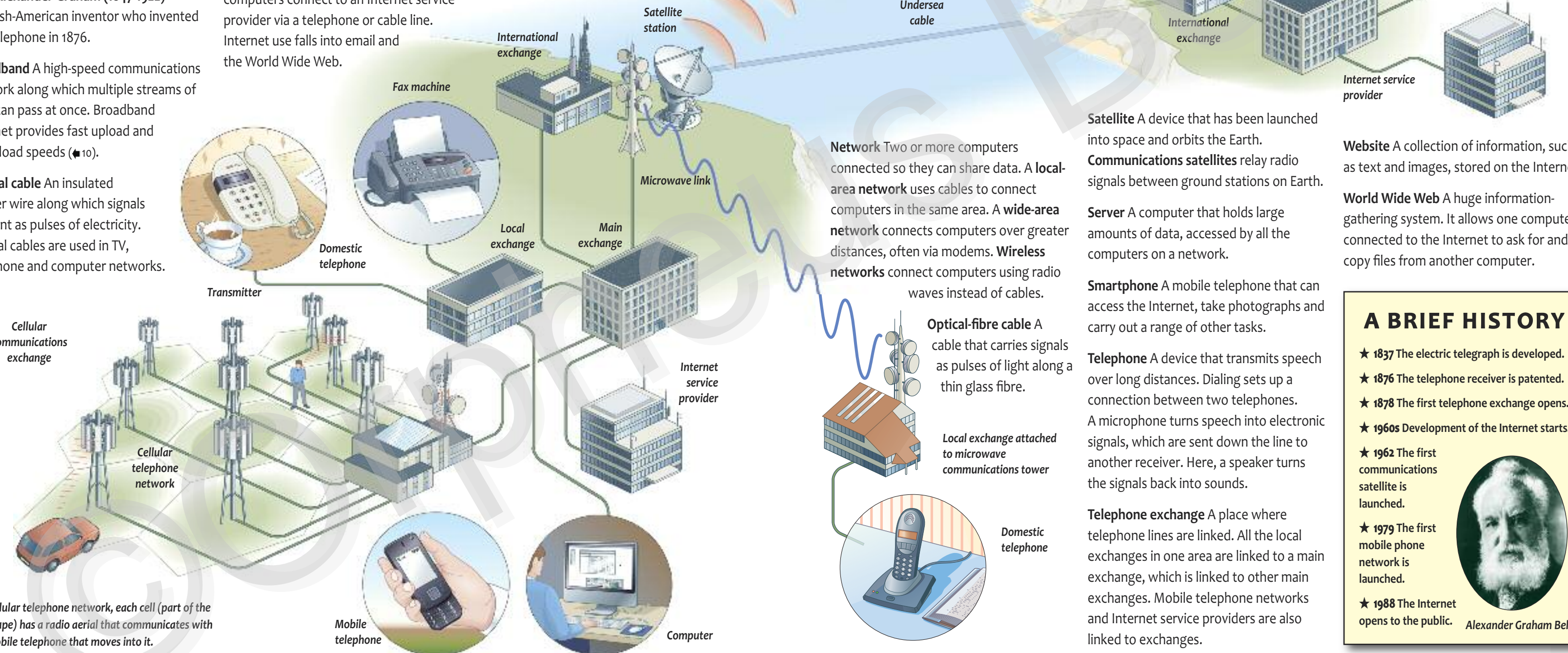
Fax Data sent between two machines via a telephone line. Fax is short for "facsimile". A fax machine scans a document, detects its ink pattern and sends this as a signal down a phone line. The receiving machine reads the signal and rebuilds the document.

Internet A communications network that links computers around the world. Most computers connect to an Internet service provider via a telephone or cable line. Internet use falls into email and the World Wide Web.

Mobile telephone A wireless telephone that connects to the telephone network by radio. The landscape is divided into cells, each with a fixed transmitter and receiver that mobile phones connect to.

Modem A device that connects computers to the Internet via a telephone line. It converts analogue signals from the line into digital signals and back again.

Multiplexing A technique that increases the amount of data a network can carry. It does this by merging data streams into one large signal to be carried down a single cable. At the other end, the data is sorted into separate streams.



Network Two or more computers connected so they can share data. A **local-area network** uses cables to connect computers in the same area. A **wide-area network** connects computers over greater distances, often via modems. **Wireless networks** connect computers using radio waves instead of cables.

Optical-fibre cable A cable that carries signals as pulses of light along a thin glass fibre.

Local exchange attached to microwave communications tower

Satellite A device that has been launched into space and orbits the Earth. **Communications satellites** relay radio signals between ground stations on Earth.

Server A computer that holds large amounts of data, accessed by all the computers on a network.

Smartphone A mobile telephone that can access the Internet, take photographs and carry out a range of other tasks.

Telephone A device that transmits speech over long distances. Dialing sets up a connection between two telephones. A microphone turns speech into electronic signals, which are sent down the line to another receiver. Here, a speaker turns the signals back into sounds.

Telephone exchange A place where telephone lines are linked. All the local exchanges in one area are linked to a main exchange, which is linked to other main exchanges. Mobile telephone networks and Internet service providers are also linked to exchanges.

Website A collection of information, such as text and images, stored on the Internet.

World Wide Web A huge information-gathering system. It allows one computer connected to the Internet to ask for and copy files from another computer.

A BRIEF HISTORY

- ★ 1837 The electric telegraph is developed.
- ★ 1876 The telephone receiver is patented.
- ★ 1878 The first telephone exchange opens.
- ★ 1960s Development of the Internet starts.
- ★ 1962 The first communications satellite is launched.
- ★ 1979 The first mobile phone network is launched.
- ★ 1988 The Internet opens to the public.



Alexander Graham Bell

In a cellular telephone network, each cell (part of the landscape) has a radio aerial that communicates with any mobile telephone that moves into it.