

Types of Networks

An important criterion for classifying networks is their geographical scale, since networks of different sizes may use different technologies.

Based on their scale, we can distinguish between:

- **PAN, Personal Area Network:** a personal network used to connect devices located very close to the user, such as smartphones, Bluetooth headphones, smartwatches, mice, or keyboards.
- **LAN, Local Area Network:** a local network used within a home, laboratory, office, school, or building.
- **WAN, Wide Area Network:** a network covering a large geographical area, used to connect networks distributed over long distances, for example between cities, countries, or continents.

The following table provides a summary. The distances shown are approximate values: they are intended to illustrate the general scale of each network, but in practice the boundaries between different network types may vary depending on the technology and context.

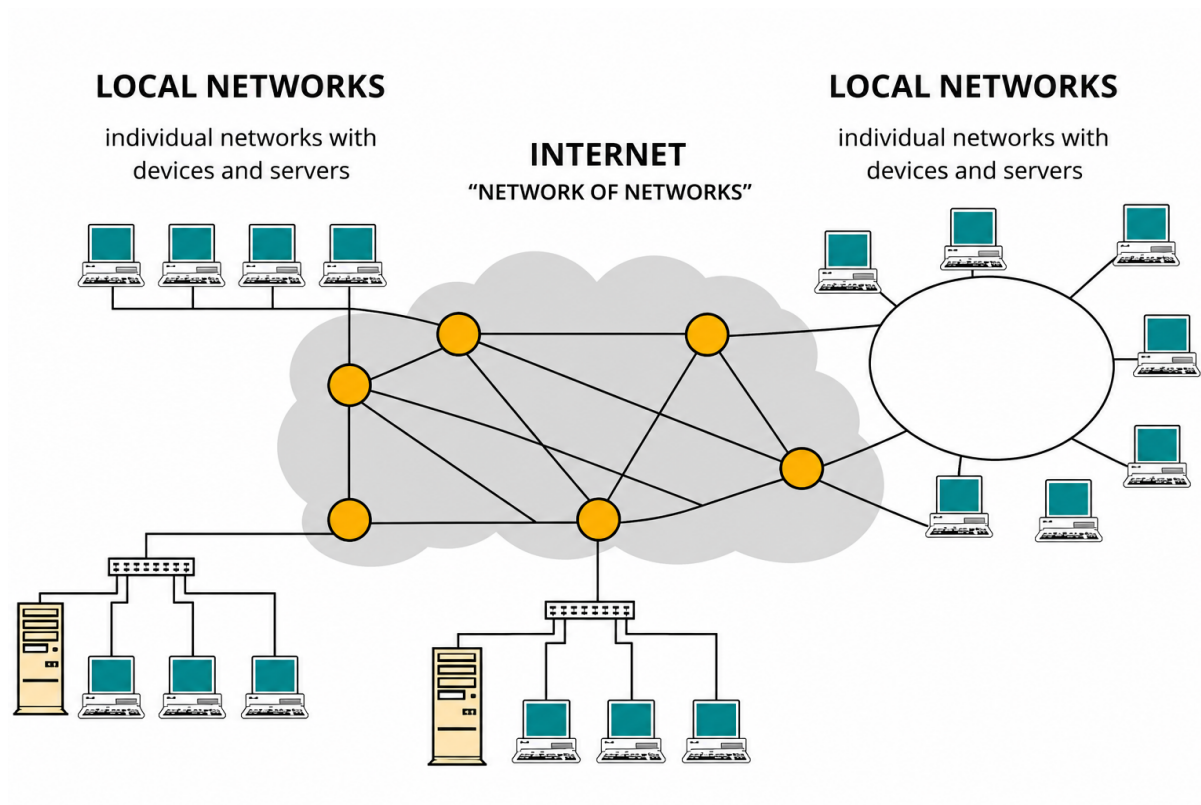
Distance between devices	Example area	Network type
1 m	One square metre	Personal area network (<i>PAN</i>)
10 m	Room	Local area Network (<i>LAN</i>)
100 m	Building	Local area Network (<i>LAN</i>)
1 km	Campus	Local area Network (<i>LAN</i>)
10 km	City	Wide area network (<i>WAN</i>)
100 km	Country	Wide area network (<i>WAN</i>)
1.000 km	Continent	Wide area network (<i>WAN</i>)
10.000 km	Planet	Internet

he connection of two or more networks is called an **internetwork**, or an **internet** with a lowercase *i*.

The worldwide **Internet**, with a capital *I*, is a particular internet that connects networks across the entire globe.

The Internet is certainly the best-known example of an internetwork. It is a vast global network of interconnected devices that enables communication, information exchange, and access to online resources and services.

Essentially, the Internet is a **network of networks**, in which millions of devices and servers around the world are connected to one another, allowing data to be shared and transferred.



PAN

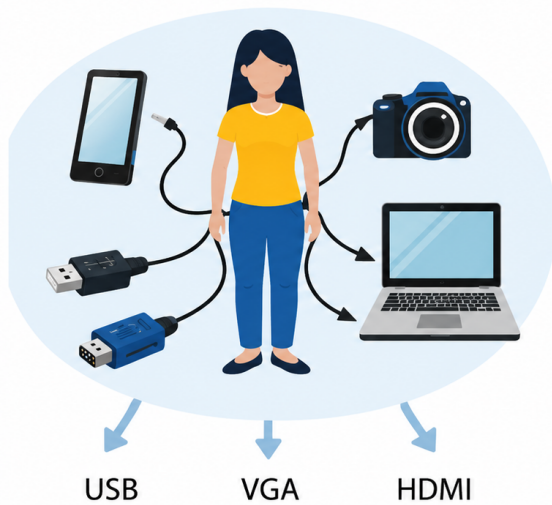
A **PAN**, or **Personal Area Network**, allows devices to communicate within the physical area immediately surrounding a person.

PANs can be either wired or wireless.

A wired PAN can connect nearby devices using cables, such as USB cables. A wireless PAN connects devices without cables, for example through Bluetooth.

Wired networks

Connection via cables



Wireless networks

Connection via Bluetooth



Bluetooth

Bluetooth is a short-range wireless communication standard that allows data and audio signals to be transmitted between devices such as smartphones, computers, tablets, headphones, speakers, and other electronic devices.

Compared with Wi-Fi, which is commonly used for wireless LAN connections, Bluetooth is designed for short-range, low-power communication. This means that it transmits using relatively little power, which is sufficient for connecting nearby devices but is not intended to cover long distances.

Bluetooth is used in a wide range of devices and applications, including wireless headphones and speakers, wireless mice and keyboards, fitness sensors, remote-control devices, and many others.

Thanks to its ease of use, low energy consumption, and security features, Bluetooth remains a widely used standard for short-range wireless communication.

The main differences between Bluetooth and Wi-Fi are:

- Bluetooth is mainly used to connect nearby devices directly, such as headphones, mice, keyboards, smartwatches, and controllers.
- Wi-Fi is mainly used to connect a device to a local network and, through that network, to the Internet.
- Wi-Fi is generally faster than Bluetooth and is more suitable for transferring large quantities of data.
- Bluetooth consumes less energy and is more suitable for small or battery-powered devices.

Bluetooth is designed for short-range connections, while Wi-Fi is intended to cover larger areas, such as a room, house, laboratory, or office.

From the user's perspective, however, using Bluetooth does not simply mean switching it on: the devices must first detect one another, be paired, and establish a connection.

Connecting two Bluetooth devices usually involves several steps:

- **Enabling Bluetooth:** Bluetooth must be switched on on both devices. For example, to connect wireless headphones to a smartphone, Bluetooth must be enabled on both the smartphone and the headphones.
- **Discovery mode:** One of the devices must make itself visible to other nearby devices. For example, when Bluetooth headphones are placed in pairing mode, they become discoverable by the smartphone. The smartphone can then find them in its list of available devices.
- **Pairing:** Pairing is the process through which two Bluetooth devices are associated with each other for the first time. During this process, the devices exchange identification information. In some cases, the user may also be asked to enter a PIN or confirm the connection. For example, when the user selects the name of the Bluetooth headphones on the smartphone, the phone begins the pairing process. If pairing is successful, the smartphone stores the headphones in its list of known devices.

Once pairing has been completed, the devices can connect. **Pairing** and **connecting** are not exactly the same process.

Pairing creates a persistent association between two devices, while a connection is the active link currently being used to exchange data.

For example, Bluetooth headphones may already be paired with a smartphone without currently being connected. When the headphones are switched on, the smartphone may recognise and connect to them automatically. At that point, audio is transmitted from the smartphone to the headphones.

When a Bluetooth device is no longer needed, it can be disconnected. Disconnecting interrupts the active connection without deleting the pairing information. The device therefore remains stored and can reconnect more easily in the future.

For example, when Bluetooth headphones are disconnected from a smartphone, audio is no longer sent to them, but the smartphone still remembers the headphones. When they are switched on again later, they can be reconnected without repeating the entire pairing process.

Unpairing, also called removing or “forgetting” a device, is different. Unpairing deletes the stored association between the devices.

After they have been unpaired, the two devices no longer recognise each other automatically. To use them together again, the pairing process must be repeated.

For example, if the user selects “Forget this device” for a pair of Bluetooth headphones on a smartphone, the smartphone deletes the pairing information. To use those headphones again with the same phone, they must be placed in pairing mode and paired again.

LAN

A **LAN**, or **Local Area Network**, connects multiple devices within a limited geographical area, often through switches and access points.

For example, when several computers, printers, and servers in a home or office need to communicate with one another, they can be connected through a LAN. This allows the devices to exchange data.

Within a LAN, devices use **MAC addresses** to identify one another and exchange data.

When a device sends data to another device on the same local network, the recipient’s MAC address is included in the control information.

When two devices communicate within the same LAN, the data is sent through the local network. If a switch is present, it forwards the data through the correct port based on the recipient’s MAC address.

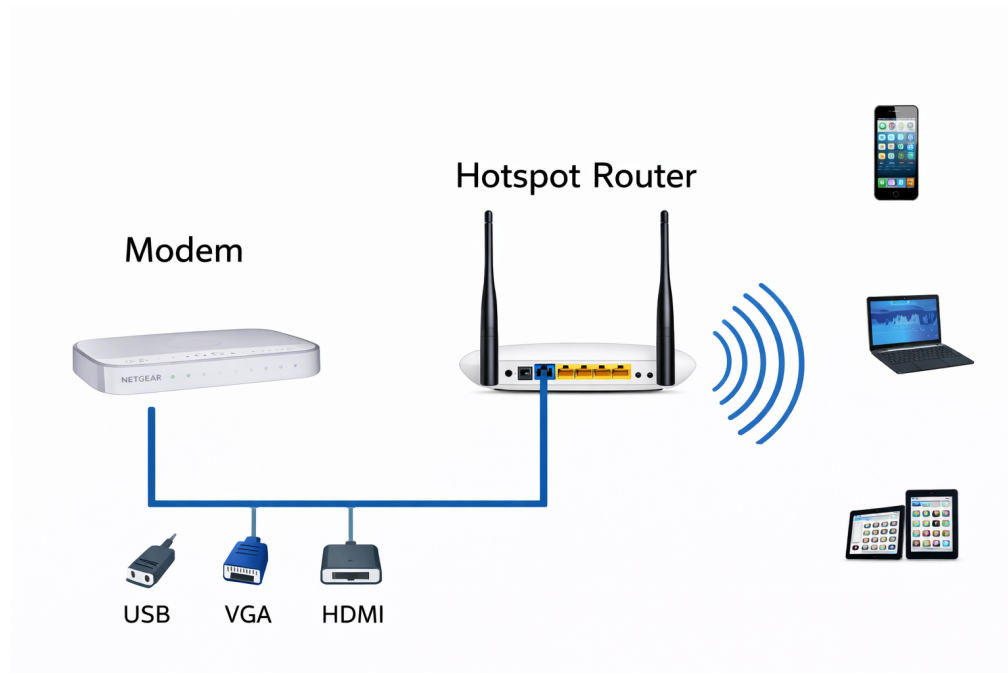
A LAN can be:

- Wired
- Wireless

Wireless LANs

In a wireless LAN, also known as a **WLAN** or **Wireless Local Area Network**, devices communicate through radio waves with an access point or Wi-Fi router.

The access point connects wireless devices to the local network.

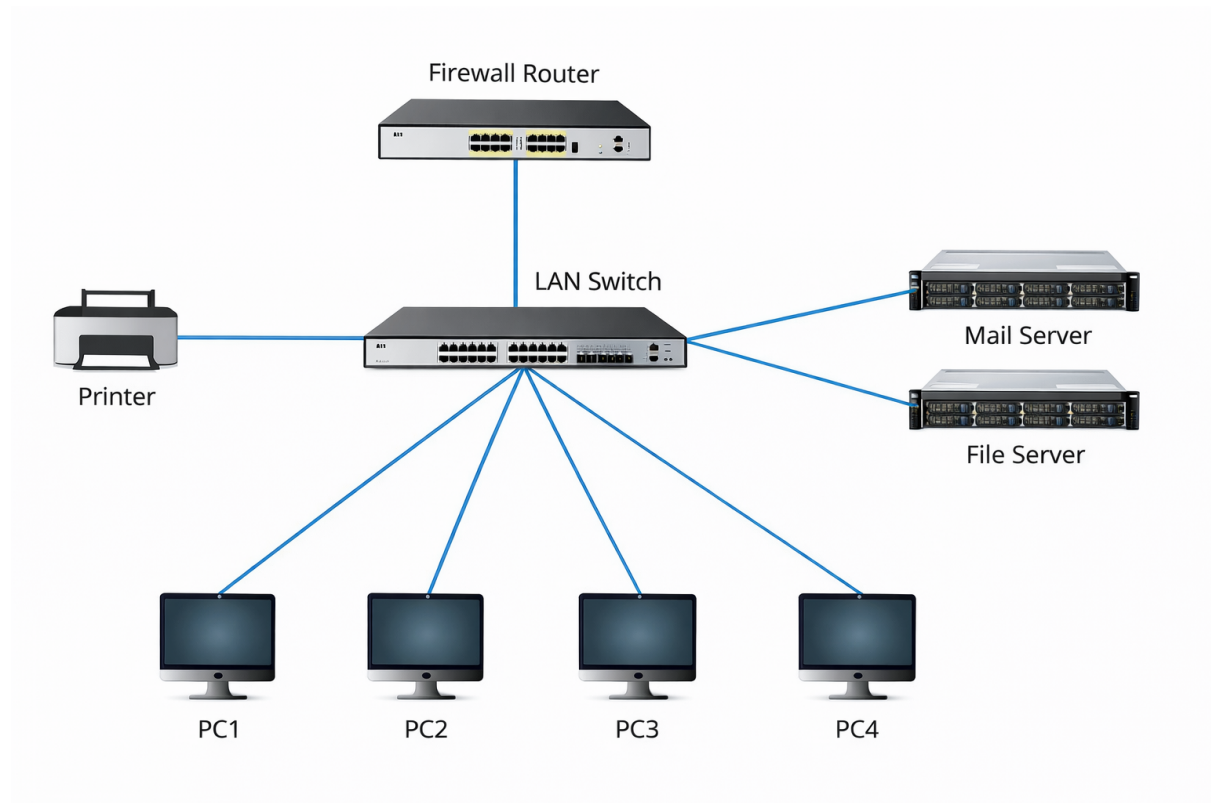


Wired LANs

Wired LANs can use different transmission technologies. For example, some use copper cables, while others use optical fibre.

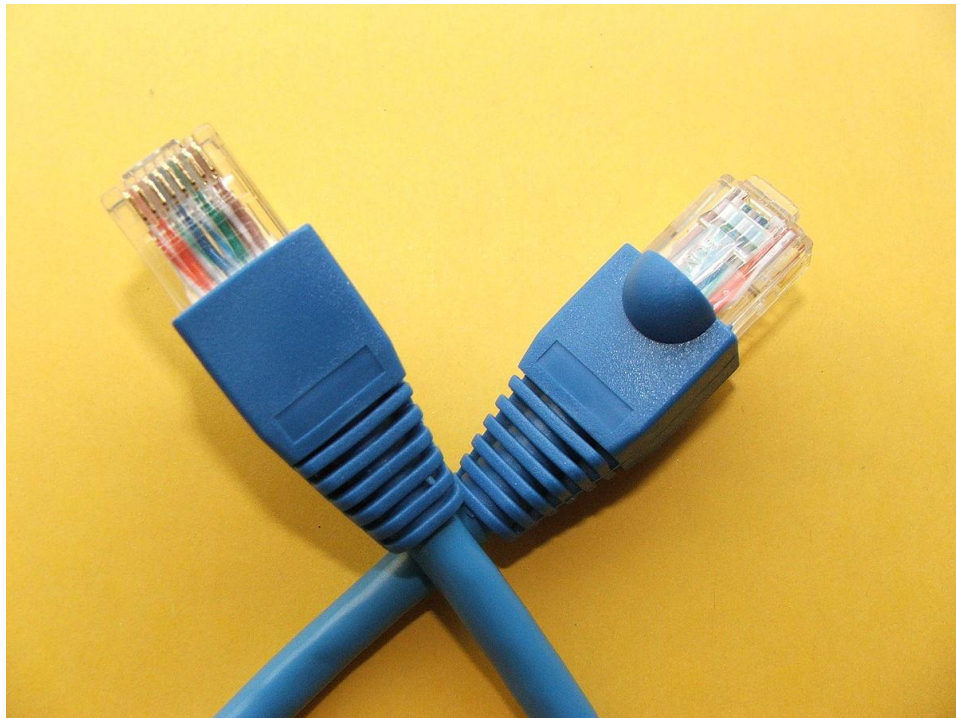
Wired networks generally provide greater stability, lower latency, and more predictable performance than wireless networks because the signal travels through a physical medium that is less affected by interference.

LANs often use point-to-point links: each computer has its own direct connection to a switch.



he most common connection technology used in LANs is known as **Ethernet**, and the cable used to connect Ethernet devices is commonly called an **Ethernet cable**.

In everyday language, the term “Ethernet cable” is widely used. More precisely, however, it is usually a twisted-pair copper network cable, often fitted with an RJ45 connector, that is used to connect Ethernet devices.



Ethernet cable

WAN

A **WAN**, or **Wide Area Network**, covers a large geographical area, often extending across a country or continent.

In simplified terms, a WAN can be divided into two main parts:

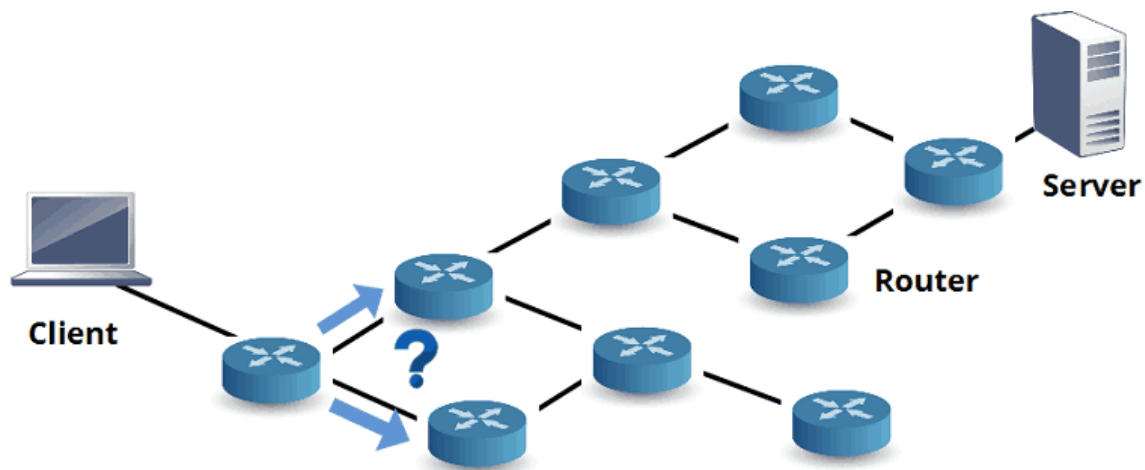
- **Hosts:** the end devices that use the network, such as computers, smartphones, servers, and other systems.
- **The communication infrastructure:** the collection of transmission lines and network equipment that connects the hosts to one another. In networking textbooks, this communication infrastructure is often called the **communication subnet**.

The communication subnet is itself made up of two main components:

- **Transmission lines:** transmission lines carry packets between machines. They may use copper cables, optical fibre, or other transmission media.
- **Switching elements:** switching elements are specialised routers that connect two or more transmission lines. When data arrives through an incoming line, the router must select an outgoing line through which to forward it.

For example, in the image below:

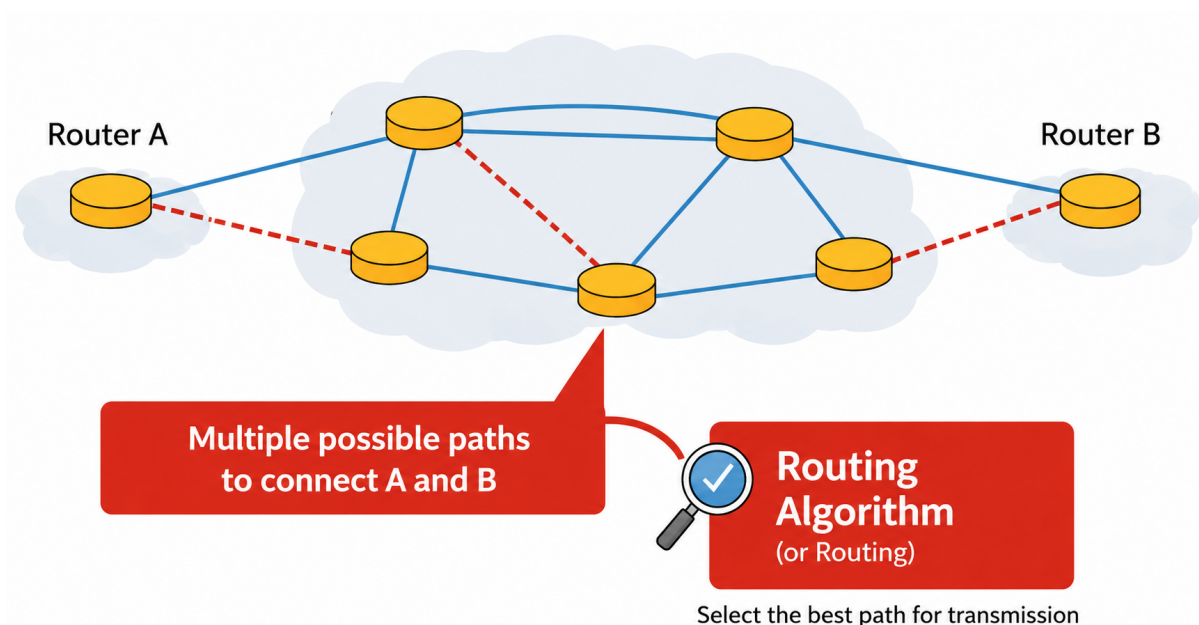
- The hosts are the client and the server.
- The switching elements are the routers located between the two hosts.
- The transmission lines are the cables connecting the routers.



In most WANs, the communication subnet contains many transmission lines, each of which connects a pair of routers.

When two routers that are not connected by the same transmission line need to communicate, they must do so indirectly by passing data through other routers.

Because several possible routes may exist, routers use routing algorithms to decide which path packets should follow.



ISP

In public or commercial WANs, the hosts often belong to end users or service providers.

The communication infrastructure, however, is managed by network service providers that connect the different hosts requiring their services.

A network service provider connected to the Internet is called an **ISP**, or **Internet Service Provider**, and its communication network is called an **ISP network**.

Customers who connect to an ISP receive an Internet access service.

Example

Examples of Italian ISPs include TIM, Vodafone, Fastweb, WindTre, and other operators that provide Internet access through optical fibre, mobile networks, or other technologies.

To summarise:

- **Communication subnet:** the collection of routers and communication lines owned or managed by the network operator.
- **Network:** the communication subnet together with its hosts.
- **Internetwork:** a collection of interconnected networks.
- **Internet:** a particular internetwork that connects networks throughout the world.

