Network Communication Methods

After examining the main physical devices used in a network, we can now consider how data is actually transmitted.

Networks can use different communication methods, meaning different ways of connecting devices and transmitting information.

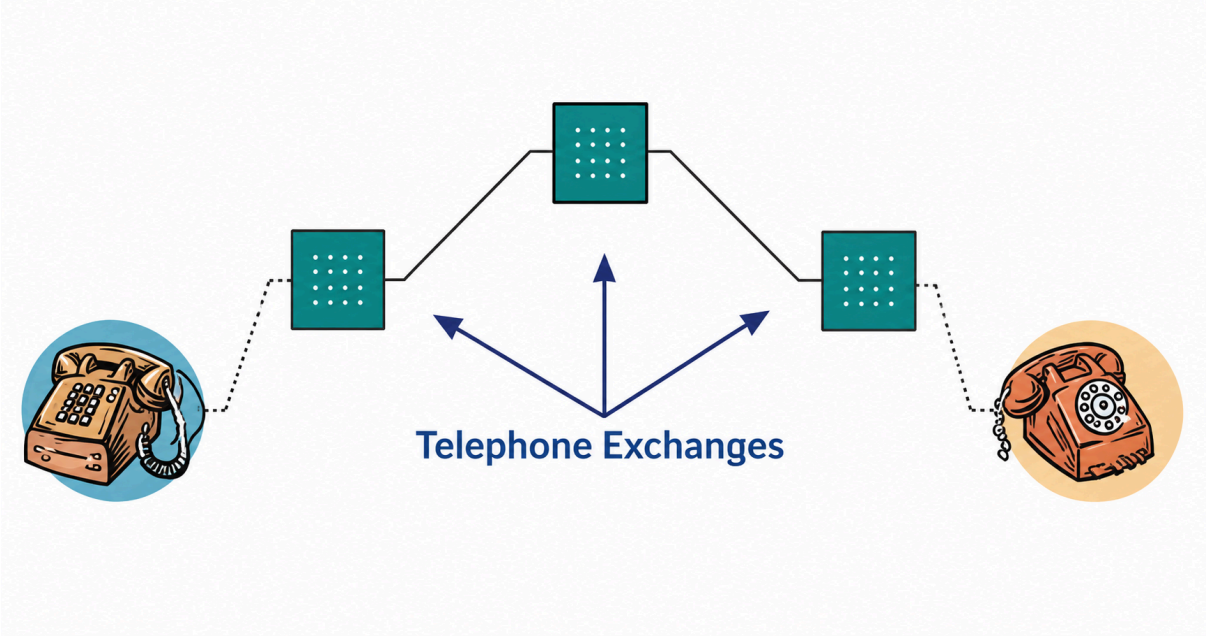
Circuit Switching

Circuit switching is typically associated with connection-oriented communication because a dedicated path is established before data is exchanged.

This happens, for example, in a traditional telephone call, where a temporary circuit connects the two callers through a series of connections between telephone exchanges.

Transmission resources, such as telephone equipment, lines, and parts of the exchanges, remain allocated to the two callers until the call ends.

Connection-oriented services may use transmission resources inefficiently. When the two callers are not transmitting any signal—for example, when they remain silent—the reserved resources are not being used.



I servizi orientati alla connessione hanno un utilizzo inefficiente delle risorse trasmissive, poiché se i due interlocutori non trasmettono alcun segnale (ad esempio sono in silenzio) le risorse non vengono sfruttate.

Example

Imagine that there are two telephones, one in city A and the other in city B, and that we want to establish a direct telephone call between them using circuit switching:

- **Initialisation:** When the user in city A dials the telephone number in city B, the circuit-switching system at city A's local telephone exchange detects the call request and reserves a dedicated connection between A and B.
- **Connection:** Telephone exchange A establishes a physical or virtual connection, known as a circuit, through the telecommunications network to the telephone exchange in city B. During this phase, resources and communication channels are reserved for the entire duration of the call.
- **Communication:** Once the connection has been established, the users in cities A and B can begin speaking and listening to one another. Because a dedicated connection has been established, voice data is transmitted continuously, supporting real-time communication between the two users.
- **Termination:** When one of the users hangs up or ends the call, the circuit-switching system releases the dedicated connection, making the network resources previously reserved for the call available again.

Packet Switching

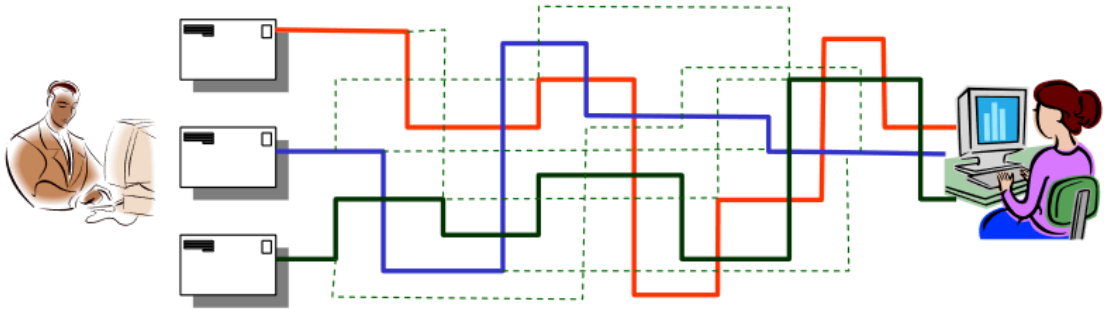
Packet switching does not require a dedicated path to be established in advance: packets are passed to the network and may follow different routes.

The information to be transmitted is divided into data packets and sent through the network together with the recipient's address, in a way similar to the postal system.

The network is then responsible for transporting and routing each packet to its destination.

Unlike circuit switching, packet switching:

- Uses transmission resources more efficiently because they are allocated to a user only for the time required to transmit the packets. The resources can then be allocated to another user.
- Does not guarantee a minimum transmission time or the exact order in which packets will arrive. The network attempts to provide the best possible service according to a **best-effort** approach.



Packet switching is highly flexible and efficient, but it may introduce variable delays.

For this reason, real-time applications such as Internet calls, videoconferences, and online games require specific protocols and techniques to reduce delays and interruptions.

For example, when receiving a file or an email, users may not notice a short delay. During a real-time event, such as a telephone call, however, even a one-second delay can be noticed by both participants.

The Internet uses packet switching: data is divided into packets and forwarded through the network. Some protocols then provide additional controls to manage packet order, errors, and reliability.

Example
Suppose that you want to send an email containing a text message and some images to a friend. Using packet switching, the process may work as follows:

- **Division into packets:** The text message and images are divided into small data packets. For example, the text may be divided into several packets, as may each image.
- **Routing:** The packets are routed through the network. During this process, each packet may follow a different route towards the destination. This happens because packets can be directed towards their destination using the most efficient route available at that particular moment.
- **Transmission:** The packets travel through the network, passing through several routers along the way. Each network device forwards them to the next node according to the routing information required to reach the destination.
- **Arrival at the destination:** Once the packets reach their destination, they are processed. The protocols used for communication make it possible to verify that the data has arrived and to reconstruct the original message. The packets are then reassembled to recreate the original email, including the text and images.
- **Displaying the message:** Your friend receives the email, opens the attachment, and views the text and images that you sent.

Types of Transmission Channel

Two widely used types of transmission channel are:

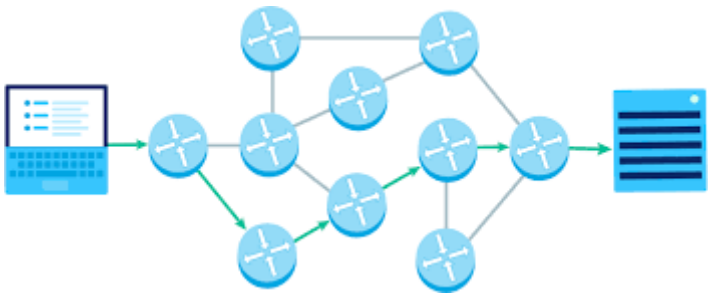
- **Broadcast connections**
- **Point-to-point connections**

Point-to-point connections, also known as **unicast connections**, connect pairs of computers.

In a network made up of point-to-point connections, packets may need to pass through one or more intermediate machines as they travel from the source to the destination.

Individual point-to-point connections are called **links**.

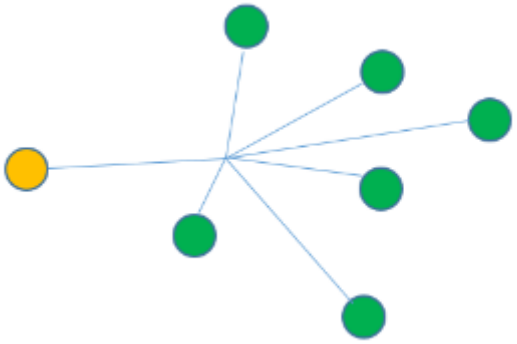
In its most basic sense, a link is a direct communication connection between two nodes.



A set of links connecting a client to a server

In contrast, a broadcast network has a single communication channel shared by all the machines on the network. Packets sent by any machine are received by every machine on the network.

When a message is received, each machine checks the address field. If the address matches that machine, the message is processed; otherwise, it is ignored.



The yellow node is the server, while the green nodes are the clients