

# 06 - Optical networks - introduction

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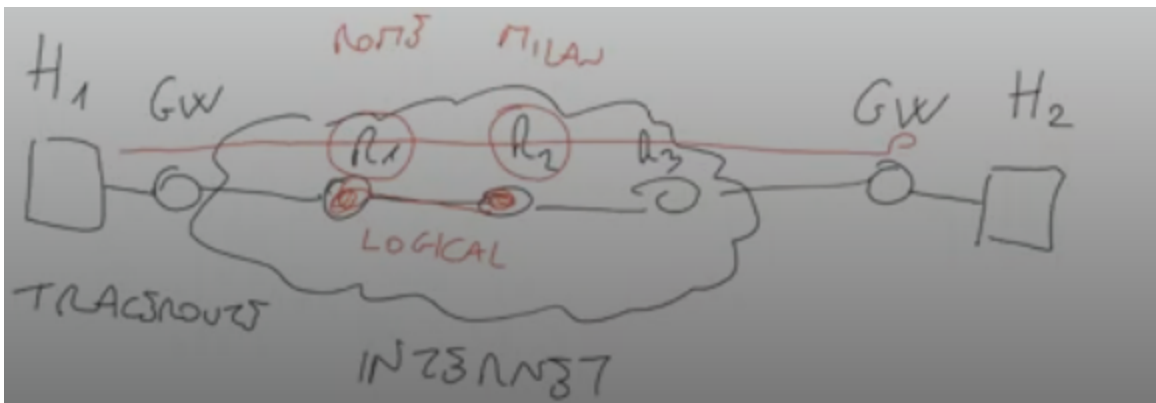
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## Introduction to optical networks

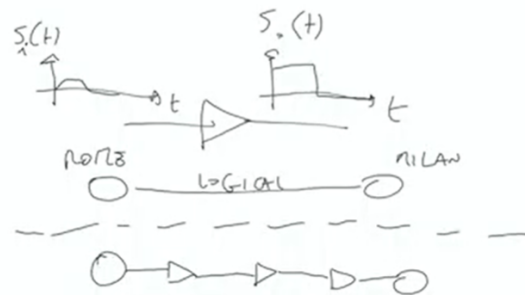
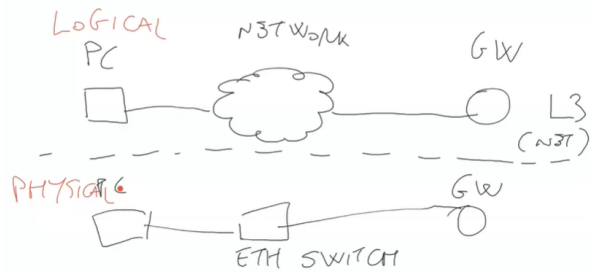
Let's suppose we are in Rome and want to reach Milan to visit its webpage. How can we determine the path that packets take to reach the destination? The tool to use is **traceroute**. Traceroute shows the path taken by packets as they travel through the network.

How are the router in Rome and the router in Milan connected? They are connected through a **transport network**.



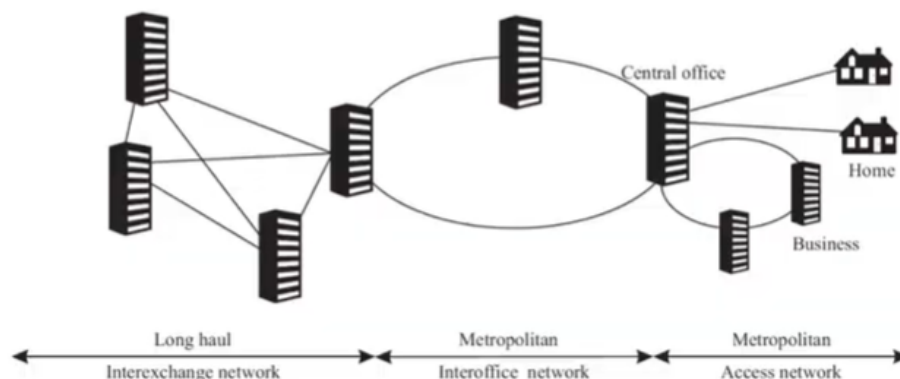
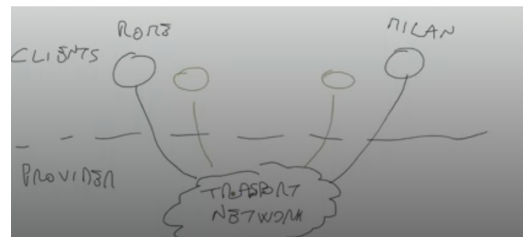
A connection between two routers is typically **logical**. This means the two devices are configured to communicate, but the actual communication depends on the **physical link** between them.

## Physical and logical connection



If we want to buy a 400 km cable to connect the routers in Rome and Milan, we must address the issue of **signal loss** over such a long distance. To counteract this, we can use an **amplifier** to boost the signal's power and ensure reliable communication.

To reduce costs (since a direct connection would be expensive), we use a **transport network**. A **provider** (or carrier) offers this service, providing connectivity between Rome and Milan (the clients). The transport network establishes a **physical connection** (a path in reality) between the two clients, enabling communication.



A **ring topology** is more robust against node failures. In an access network, all connections typically refer back to a **central office**.

The **transport network** operates based on two different service models:

### 1. **Connection-Oriented Model**

- A client requests the network to establish a connection before it can send data (e.g., TCP, telephone networks).
- This model is typically used when specific requirements need to be met, such as bandwidth, delay, packet loss, or reliability.
- The network evaluates the request and establishes the connection only if it can satisfy the specified requirements.

### 2. **Connectionless Model**

- The client connects to the network and immediately starts sending messages without prior setup (e.g., UDP for streaming services).
- This model does not guarantee specific quality parameters but is simpler and faster for certain applications.

## **Multiplexing**

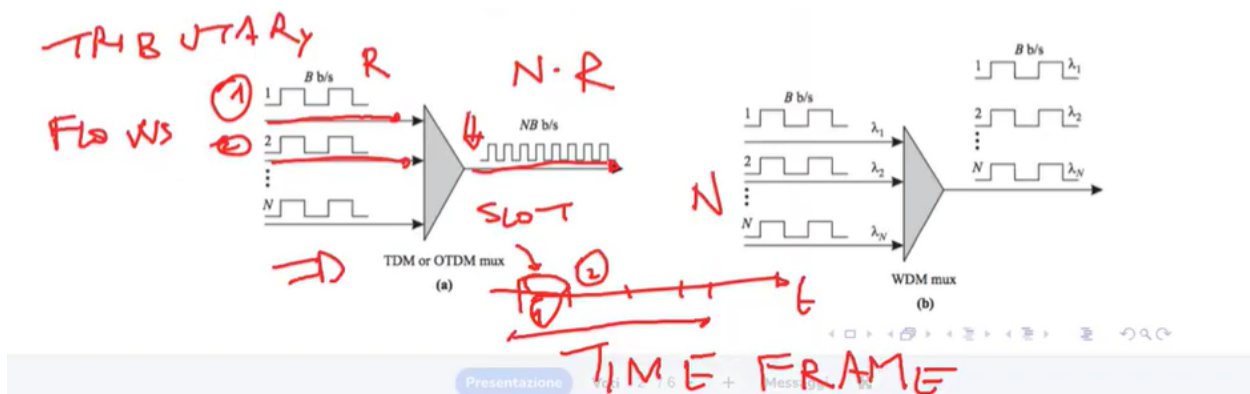
**Multiplexing:** This refers to the sharing of resources among multiple users or channels.

### 1. **Static Multiplexing**

- Resources are divided into fixed sub-channels, such as in **Time Division Multiplexing (TDM)** or **Frequency Division Multiplexing (FDM)**.
- In this case, routing tables are used to manage the flow of data. For example, if input data arrives on **interface 1** with **sub-channel c1**, the routing table instructs the switch to forward the output to **interface 2** on **sub-channel c2**. This ensures orderly data routing.

### 2. **Statistical Multiplexing**

- Communication is not treated as a fixed end-to-end channel but as a sequence of packets exchanged among multiple users (**N users**).
- Unlike static multiplexing, no specific resources are pre-assigned. The first packet to arrive gets full access to the available capacity.
- **Conflict resolution**: If two packets arrive at the same time, the network assigns a **delay** to one or more packets to avoid collision.



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**TDM (Time Division Multiplexing)**, using hierarchical multiplexing can make it complex to calculate the effective bitrate at a certain depth, as the tributary flow represents the total data from all users.

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**WDM (Wavelength Division Multiplexing)**, the idea of transmitting signals on different wavelengths (commonly referred to as "colors") is utilized. In this case, the tributary flow is always 1, greatly simplifying data management. Additionally, a key advantage of this technique is that the data rate remains constant, regardless of the number of connected users.

## Quiz

Put in the correct order the different phases of the circuit setup procedure

Vai su [wooclap.com](https://www.wooclap.com) e usa il codice **ICOKOH**

Put in the correct order the different phases of the circuit setup procedure

- 1 the communication happens
- 2 new rules are inserted in the switching table of the network nodes
- 3 the clients are notified that the circuit is up
- 4 the network monitors the circuit
- 5 the network checks if, in each link of the path, there is an available sub-channel
- 6 the source node ask to the network the creation of a new circuit
- 7 the network tears down the circuit
- 8 the network compute a path from the source to the destination node

✓ La combinazione corretta era:

- the source node ask to the network the creation of a new circuit
- the network compute a path from the source to the destination node
- the network checks if, in each link of the path, there is an available sub-channel
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