Computer Network I

Reti di Calcolatori I

Università di Napoli Federico II – Scuola Politecnica e delle Scienze di Base
Corso di Laurea in Informatica

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UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

DIETI

UNINA

Introduction

Personal Information

- Riccardo Caccavale, PhD
  - Ricercatore (RTD-A) presso il dipartimento di Ingegneria Elettrica e Tecnologie dell'Informazione (DIETI).
    - E-mail: riccardo.caccavale@unina.it
    - Web: https://www.docenti.unina.it/riccardo.caccavale
  - Research activities in the field of robotics, specifically in AI-based, cognitive, and autonomous robotics.
  - Member of the PRISMA Lab (from 2016).
    - Website: https://prisma.dieti.unina.it/index.php
  - Ricevimento:

Giorno	Ora	Luogo
Lunedì	10:00 – 11:00	Teams - Via Claudio 21, edificio 3/A, stanza 2.11

Previo appuntamento

Introduction

About the Course

- Lessons calendar:
  - Thursday (Giovedì) 10:30 – 12:30, Via Claudio aula CL-II-1.
  - Friday (Venerdì) 16:30 – 18:30, Via Claudio aula CL-II-3.

- Teams:
  - Code *b51ai1p*

- Text books:
  - James Kurose, Keith Ross, Computer Networking A Top-Down Approach. [Main reference]
  - Andrew Tanenbaum, David Wetherall, Computer Networks.

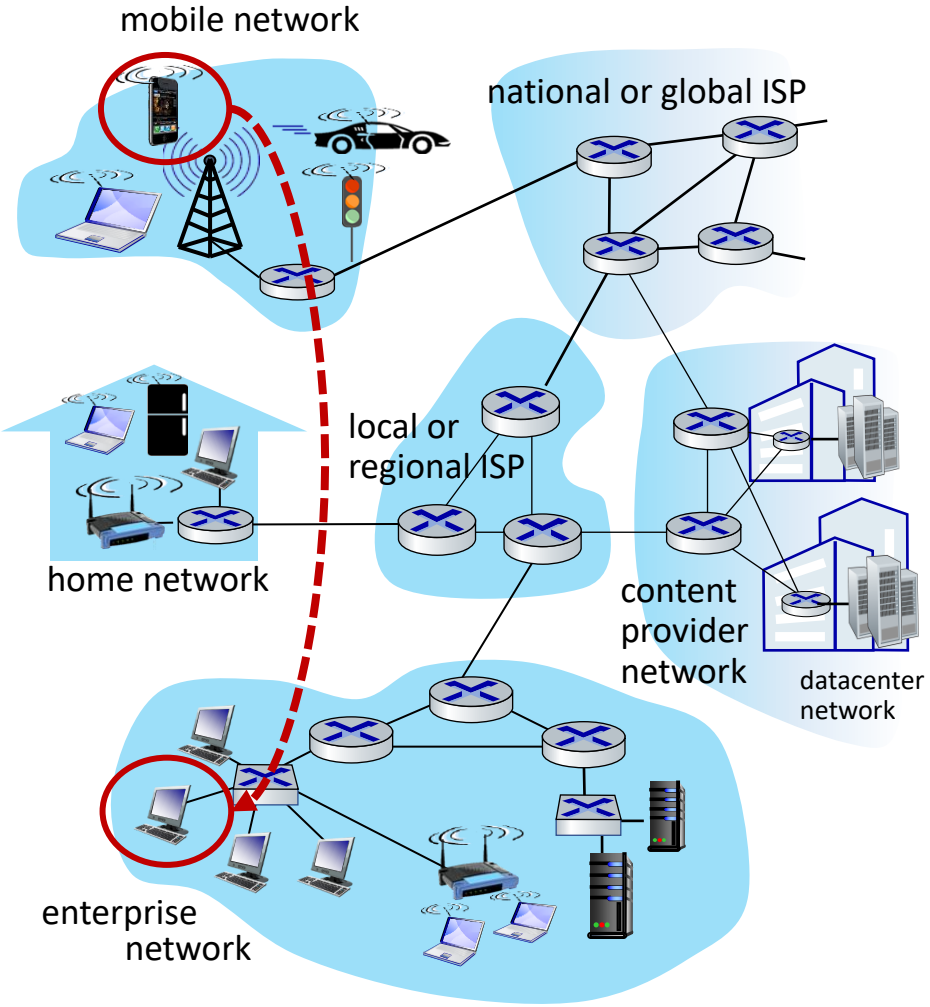
- Additional Materials:
  - Slides (in English).

Introduction

Computer Networks and Internet

Computer networking: the process of connecting computer together so that they can share information.

[Cambridge Dictionary]



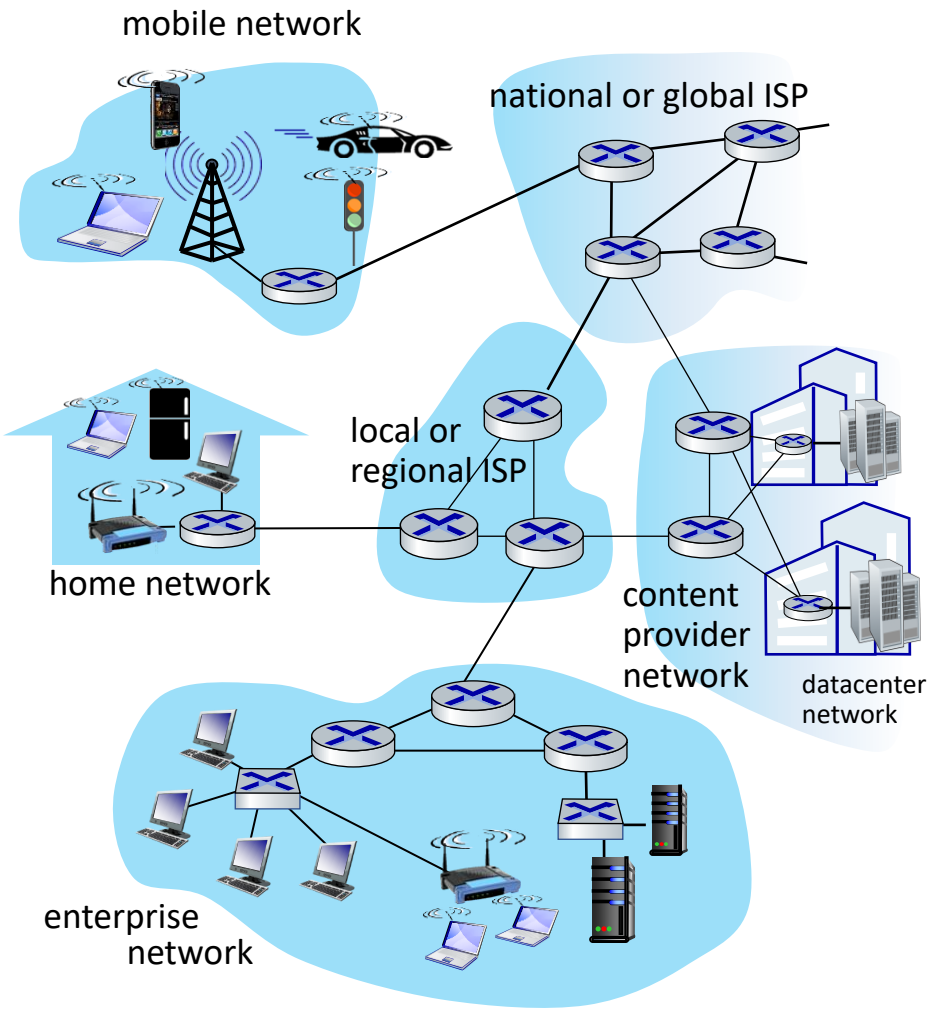
- **Internet** is the most important and widespread computer network, not to mention probably the **largest engineered system ever created**.
  - Internet includes hundreds of millions of network **devices**, **links**, **computers**, etc. offering hundreds of **services** for the users.

- There are also **smaller networks** (local or detached from internet).

Introduction

Computer Networks and Internet

- In the past years, internet was mainly used to connect devices such as desktop PCs, workstations, and servers that store and transmit information such as Web pages and e-mail messages.
- Nowadays, not only computers are connected (laptops, smartphones, tablets, TVs, gaming consoles, home devices, etc.).
- Networking is now **pervasive:** internet connection is everywhere; complex devices may have networks of their own.

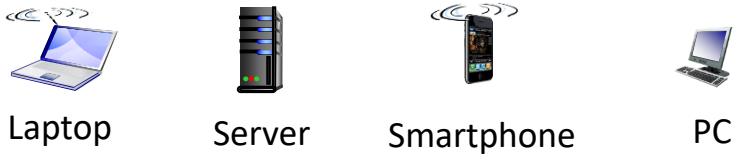


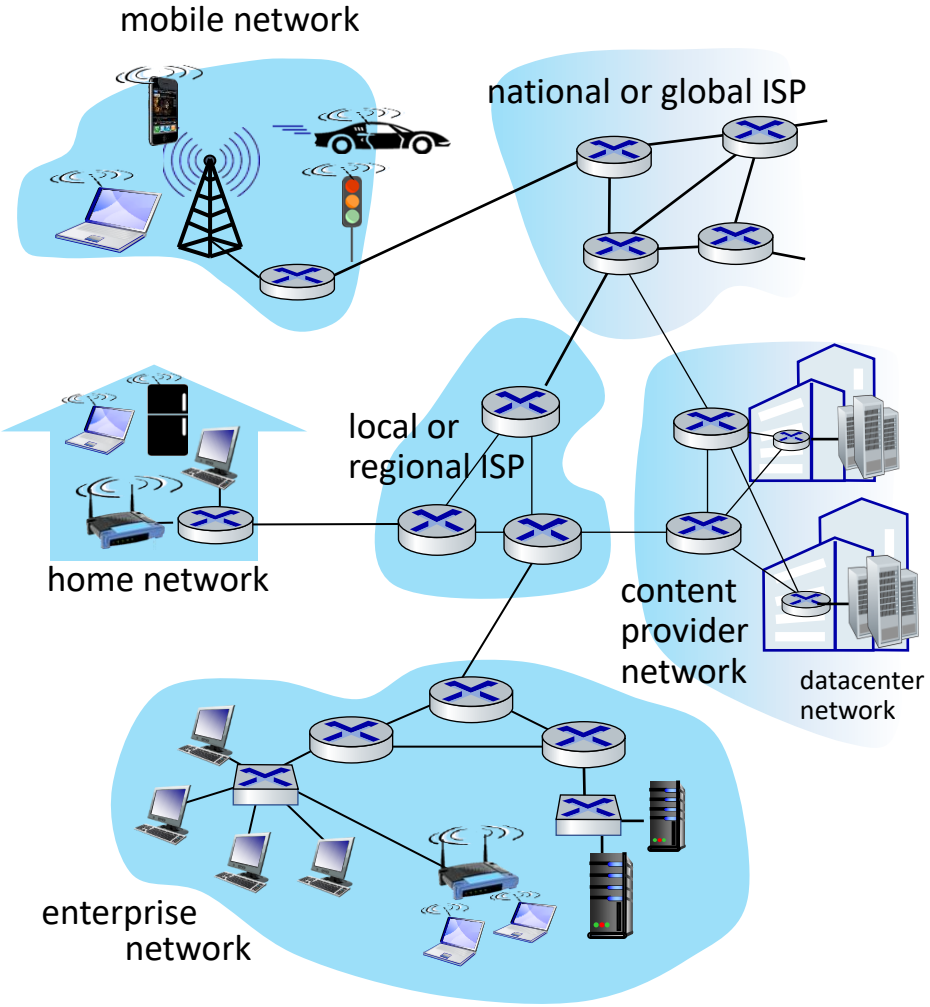
Introduction

Devices, Links, Hosts

- Network **devices** and **links** are the **infrastructure** that allow hosts to connect:

- **Hosts** are devices on which **applications** (or programs) runs:



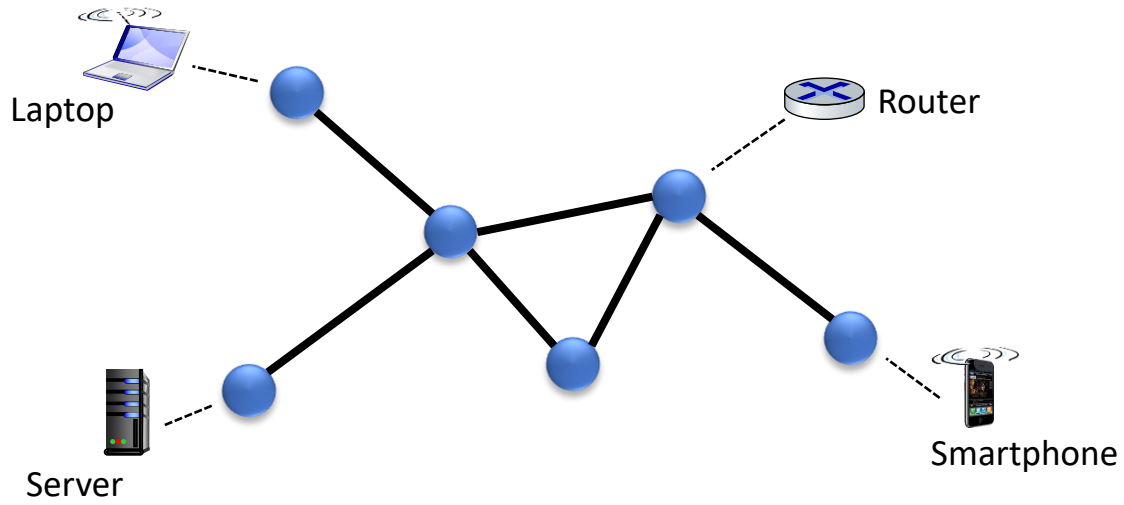


Introduction

Computer Networks and Graph Theory

- Computer networks share terminologies with graph theory:
  - The devices connected through the network are called **nodes** while the connections between nodes are called communication **links** (or **channels**).
  - A **sequence** of nodes/links is called path.

- The end-points (or end-systems) of the network, which provide or use **services**, are special nodes called **hosts**.



Ideally hosts are the leaves of the network (often it is not true) while intermediate nodes are routing devices (routers, switches).

Introduction

Data Communication

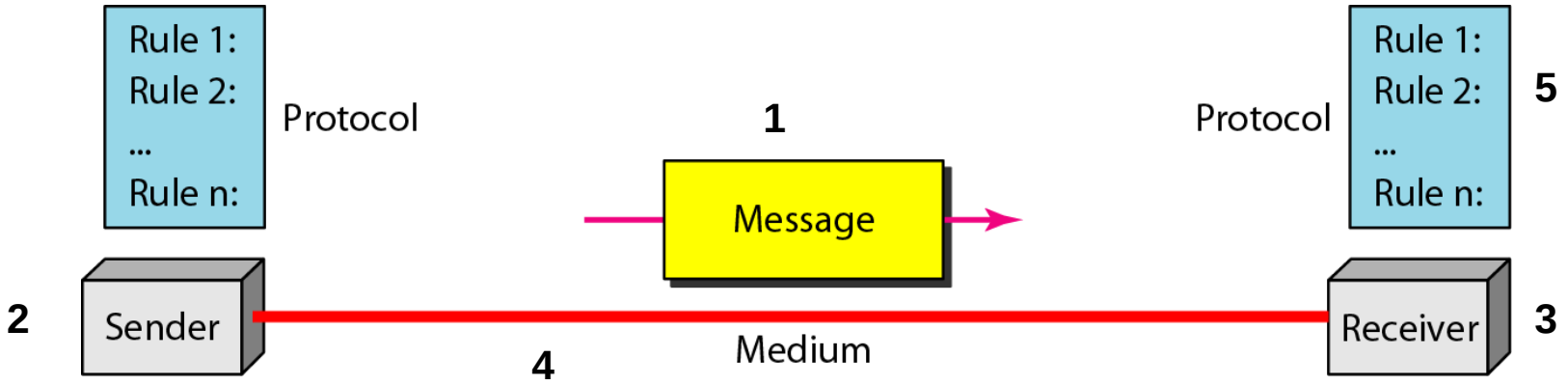
- The **goal of networking** is to share information: to allow large-scale internet functionalities as well as small-scale network functionalities we need to connect two hosts so they can **communicate data over distance**.

- The term **telecommunication** means communication at a distance. The word data refers to information presented in whatever form is agreed upon by the parties creating and using the data.

- **Data communication** is the process of exchanging data between two devices via some form of transmission medium such as a wire cable or wireless, ensuring a certain degree of:
  - **Reliability**: data is received correctly.
  - **Performance**: data is received within a reasonable amount of time.

Introduction
Data Communication

- Data communication has basically **five** components:
  1. **Message**: contains the **data** we want to communicate.
  2. **Sender**: the entity which is sending the message.
  3. **Receiver**: the entity which is supposed to receive the message.
  4. **Medium**: the channel between **sender** and **receiver** where the **message** travels.
  5. **Protocol**: a set of rules, known to **sender** and **receiver** used to manage the **message**.

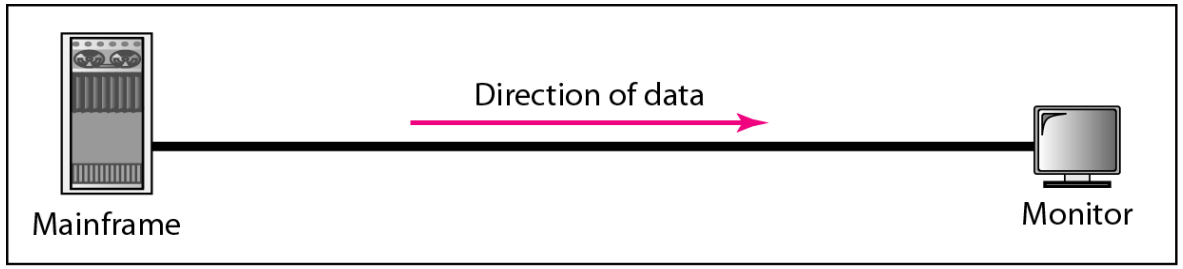


Introduction

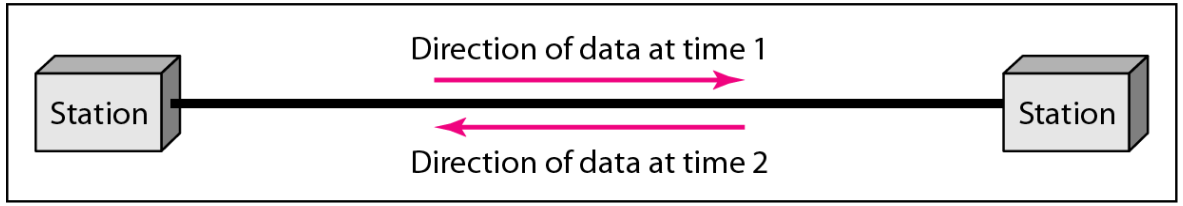
Data Representation and Flow

- The **data** we want to exchange can be represented in different forms.
  - Text, numbers, images, audio, video, etc.

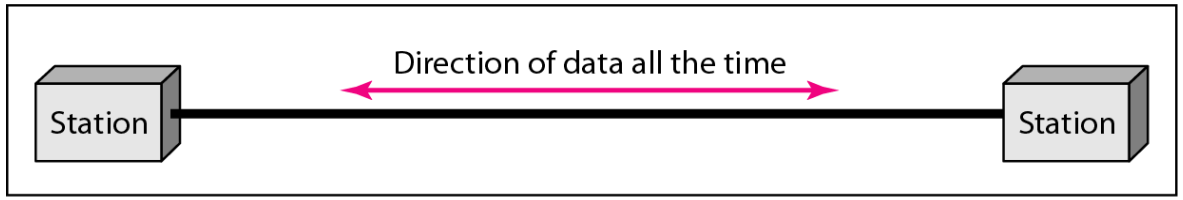
- Depending on the type and the purpose of the communication, the **data flow** can be:
  - **Simplex**: monodirectional.
  - **Half-duplex**: bidirectional (taking turns).
  - **Full-duplex**: bidirectional (simultaneous).



a. Simplex



b. Half-duplex



c. Full-duplex

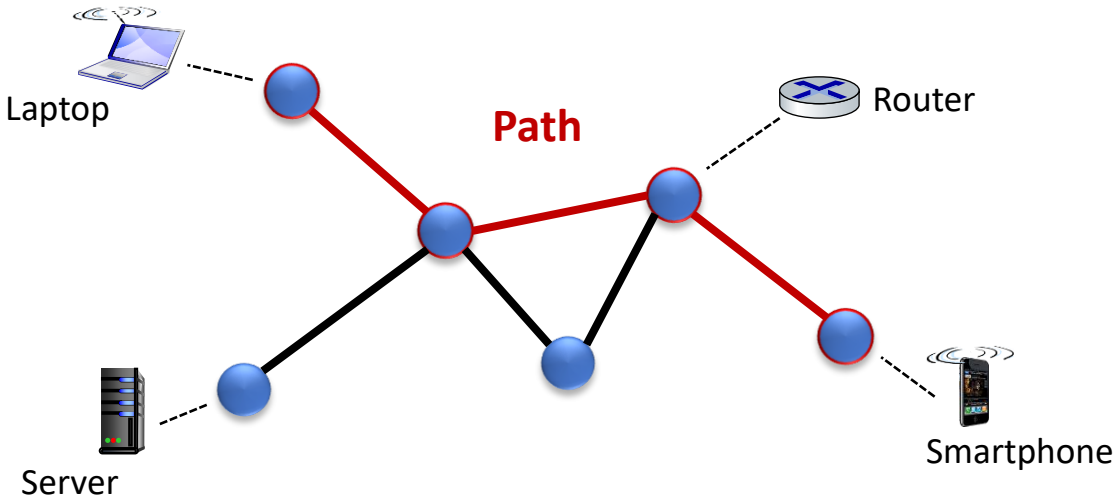
Introduction

Data Representation and Flow

- The **transmission rate** is the **maximum** amount of information that a **channel** can transmit and is measured in bits/secs (or bytes/secs).

- The **bandwidth** is the **maximum** amount of information that a **path** (links and nodes) can transmit, measured in **bits/secs** (or bytes/secs).

- The **throughput** is the **actual** (instantaneous) amount of information that a path or a link transmits, also measured in **bits/secs** (or bytes/secs).

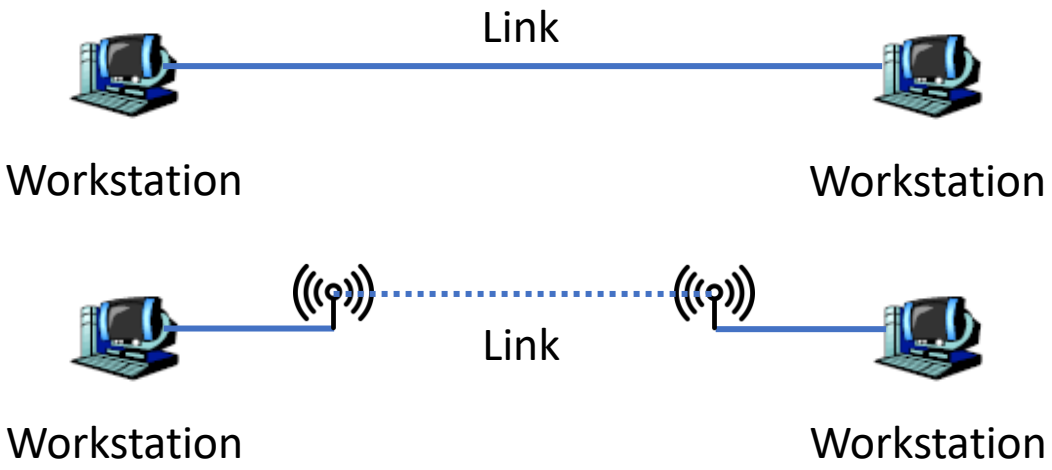


Introduction

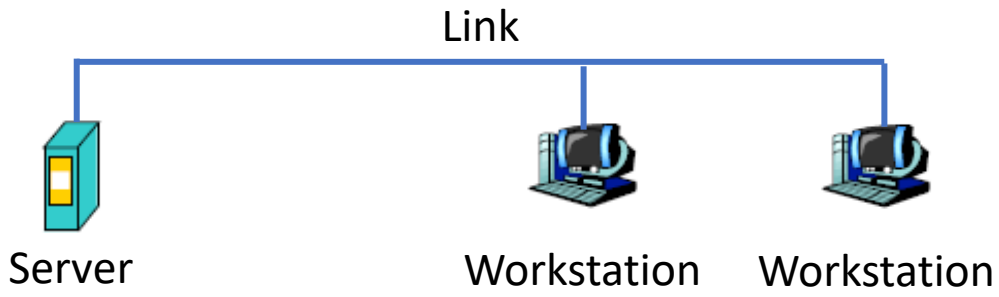
Types of Connections

- The **hosts** of a network can be connected in different ways.

- **Point-to-point**: a dedicated link is provided between two devices (wireless or wired).



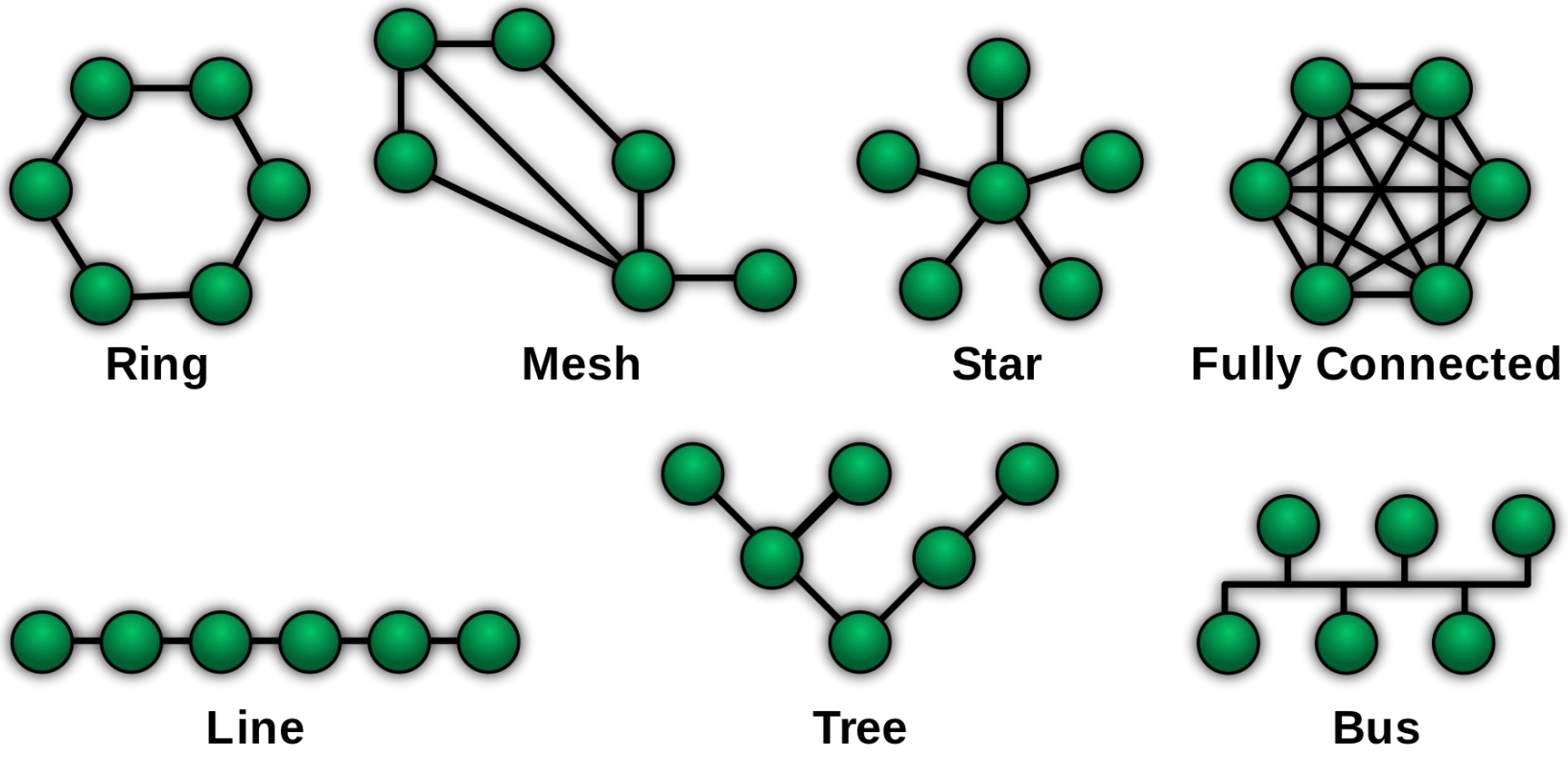
- **Multipoint** (**broadcast**): more than two specific devices share a single link.



Introduction

Network Topologies

- **Network topology** is the arrangement of the elements (links, nodes, etc.) of a communication network.

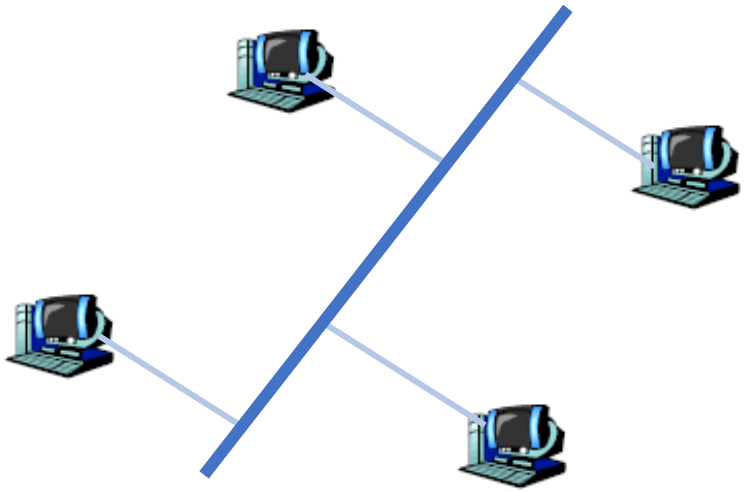


en.wikipedia.org

Introduction

Network Topologies: Bus

- In the **Bus** topology hosts are connected to a central backbone (bus) cable.
  - Messages sent by 2 hosts generate **collisions**.



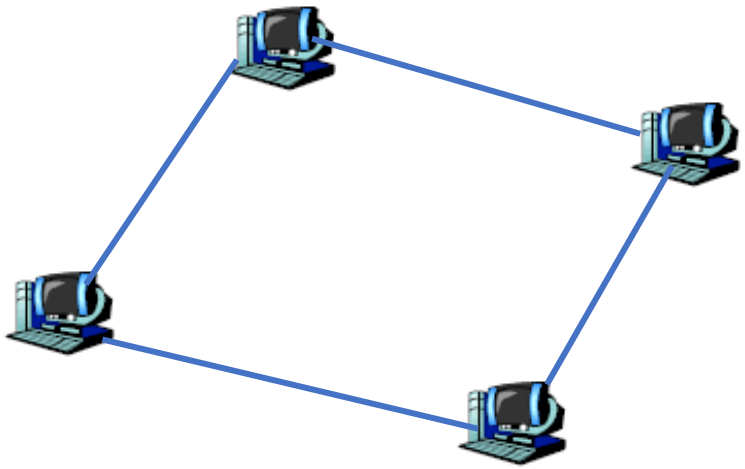
- Pros:
  - Simple and cheap.
  - Good for small networks.
- Cons:
  - Single point of failure (broken bus) but sub networks may still be available.

Bus networks have *1* physical duplex link (or *1* backbone and *n* links).

Introduction

Network Topologies: Ring

- In the **Ring** topology hosts are point-to-point connected to exactly two other ones. The signal is **forwarded** along the ring, from device to device, until it reaches its destination.



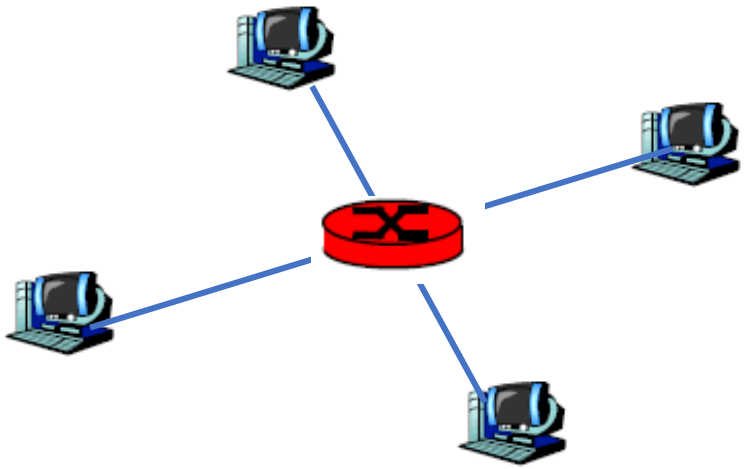
- Pros:
  - Simple and cheap.
  - Performs better than the bus.
- Cons:
  - Adding new nodes is harder.
  - Nodes malfunctioning may impair the network.

Ring networks have *n* duplex links.

Introduction

Network Topologies: Star

- In the **Star** topology hosts are linked to a central controller (hub, switch or router), there is no direct link between hosts.
- The central controller redirects messages.



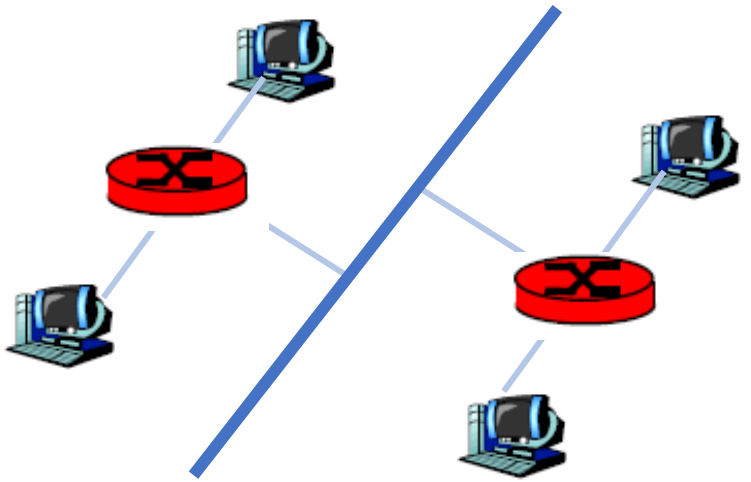
- Pros:
  - Less expensive, simple, robust, more scalable.
- Cons:
  - The controller must be reachable by all hosts.
  - Single point of failure.

Star networks have *1* controller and *n* physical duplex links!

Introduction

Network Topologies: Tree

- In the **Tree** topology multiple star topologies are integrated typically through a bus cable.

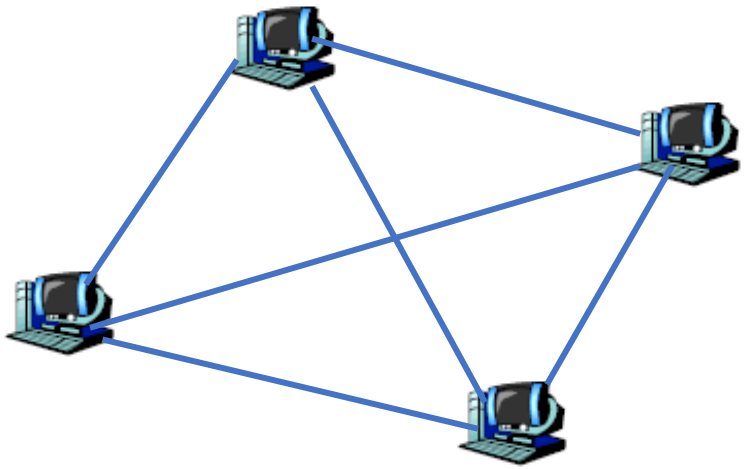


- Pros:
  - Versatile, scalable, robust.
  - Well supported by HW and SW providers.
- Cons:
  - Hard to configure.
  - Weakness of the bus.

Introduction

Network Topologies: Mesh

- In the **Mesh** topology hosts are point-to-point linked in a non-hierarchical way.
  - **Full mesh**: all nodes connected (full-connected).
  - **Partial mesh**: nodes connected with some others.



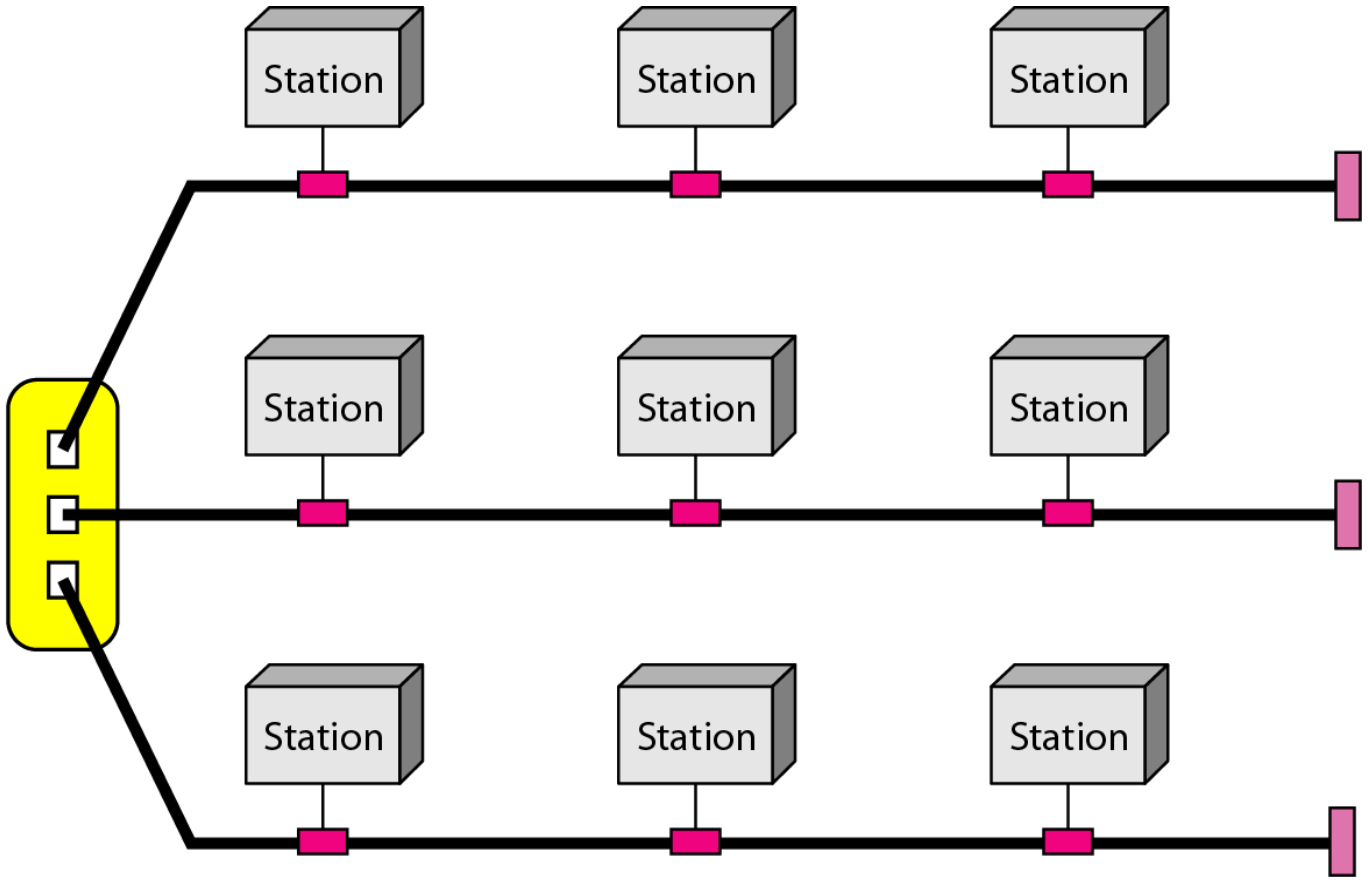
- Pros:
  - Low traffic, robust, secure, dedicated.
- Cons:
  - Hardly scalable.
  - Expansive (need for devices with multiple ports).

Full mesh networks have ${}^{n}C_{2} = n(n-1)/2$ physical duplex links!

Introduction

Network Topologies: Hybrid

- Topologies can be **mixed** into a hybrid network.

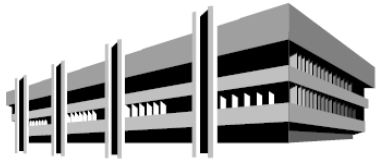


Star-backbone with 3 bus networks

Introduction

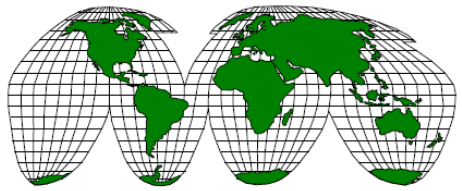
Categories of Networks

- Networks are categorized by dimension, number of hosts, bandwidth.
  - **Local Area Network** (LAN) or Wireless Local Area Network (WLAN).
  - **Metropolitan Area Network** (MAN).
  - **Wide Area Network** (WAN)

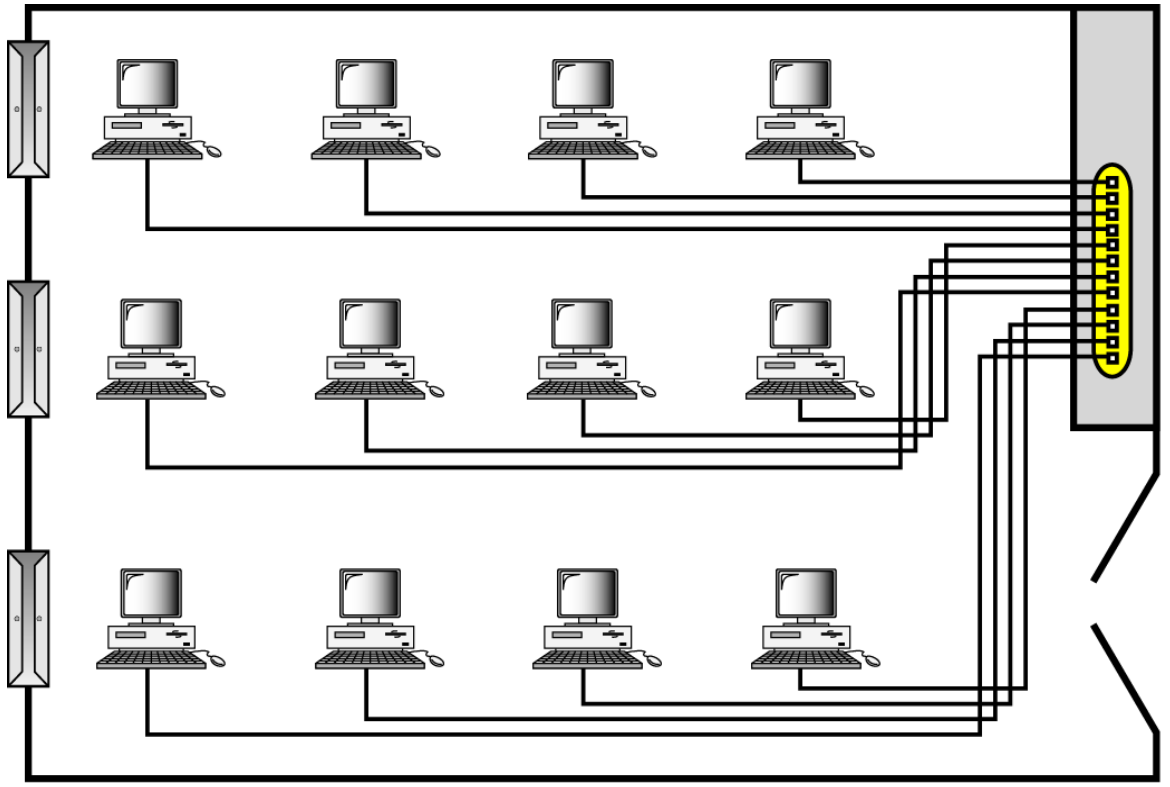


LAN/WLAN

MAN



WAN



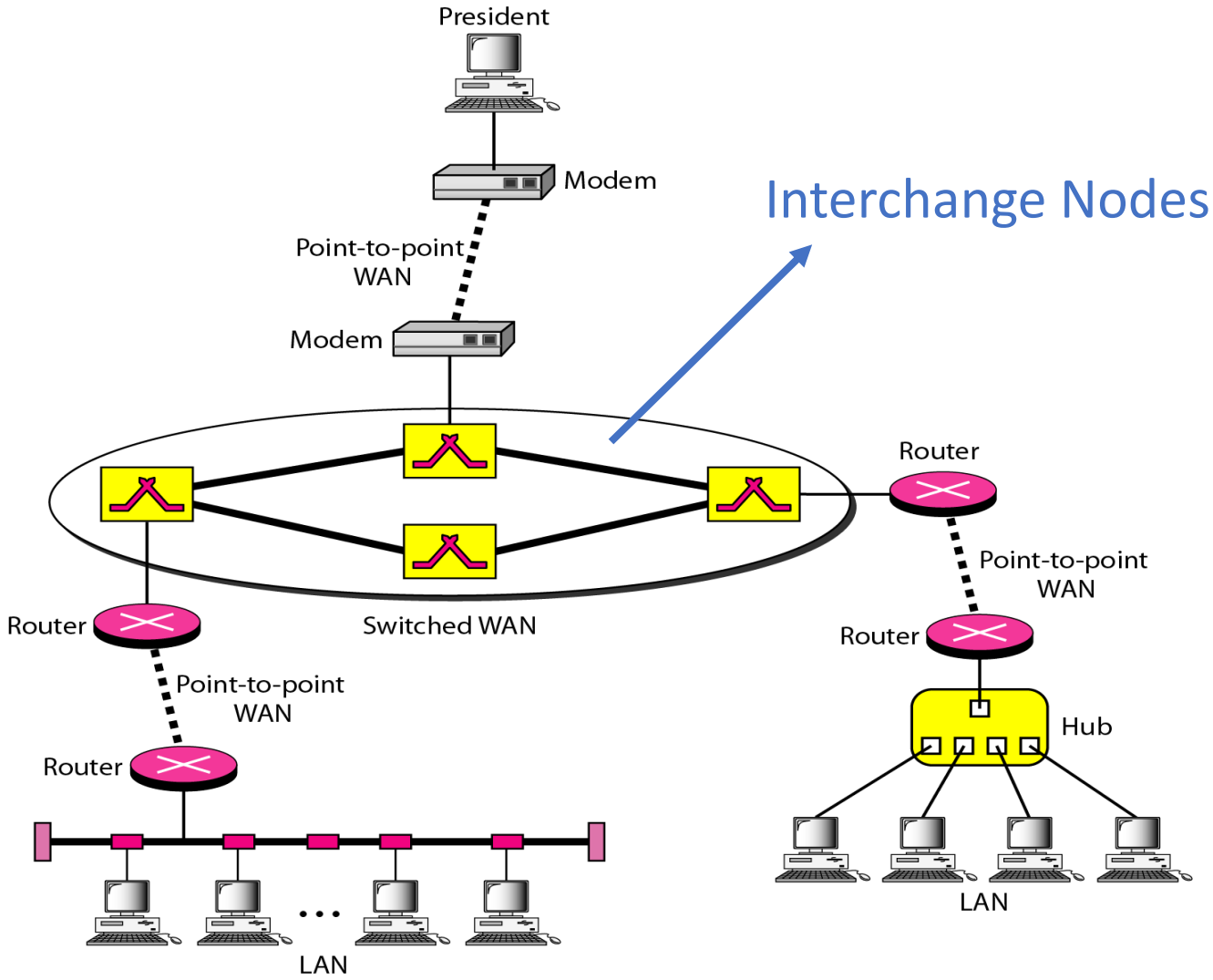
Example of LAN connecting 12 computers to a switch

Introduction

Complexity of WANs

- The complexity of the topology may increase with the increased dimension of the network.

- WANs connecting nations or continents can obviously be very complex and heterogeneous.



Example of heterogeneous WAN