Networks and Web technologies

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Introduction to Computer Networks

I

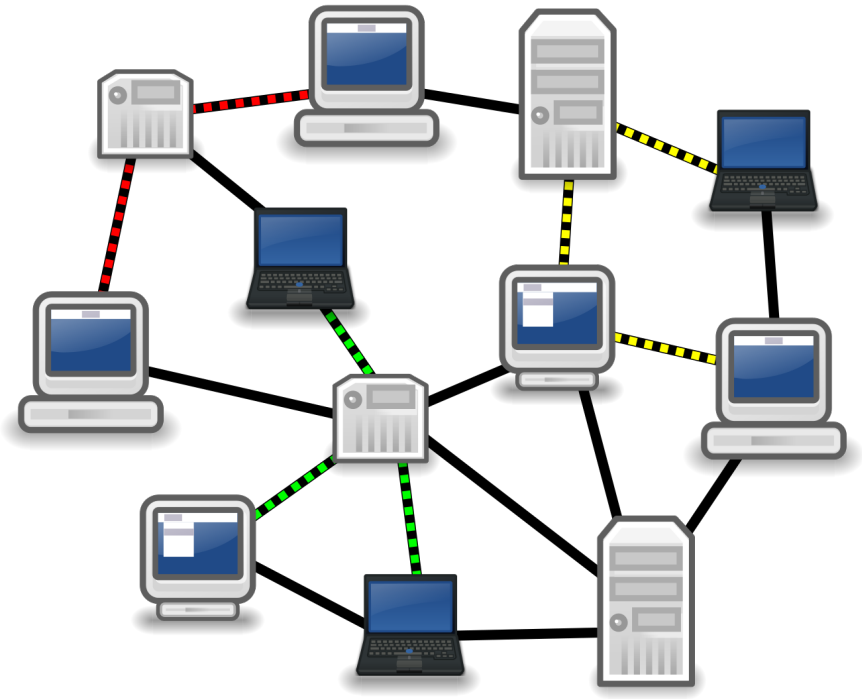
1. Definition of computer networks

Définition : What is a Computer Network?

A computer network is a communication system (hardware and software) that enables a group of **interconnected devices** (PC*s, servers, smartphones, printers, etc) to **exchange information and share services** (File sharing, email, access to the World Wide Web, etc).

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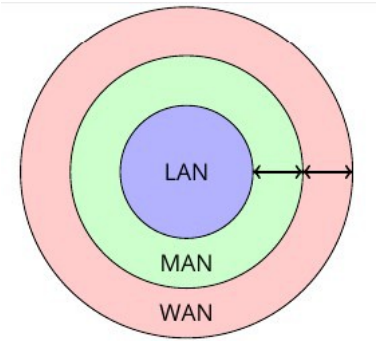
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2. Types of networks

Networks can be classified according to various criteria. It can for examle be classified according to its size*.

- Local Area Network (LAN*)
- Metropolitan Area Network (MAN)*
- Wide Area Network (WAN)*



2.1. LAN

Définition : Definition

A high-speed network connecting computers within a small geographic area (**from 10 m to 1km**), such as an office, a single building or a university campus.

Exemple : Technologies

Ethernet, Wi-Fi*

2.2. MAN

Définition : Definition

Covers a city or a large campus (**dozens of kilometers**). Connects multiple LAN*s.

Exemple : Technologies

WiMAX*, WiBro*, WRAN*

2.3. WAN

Définition : Definition

Connects organizations **over large distances**, from countries to global networks.

Exemple : Technologies

Internet

3. Components of a network

Fondamental : Network devices

Nodes: A node is any device connected to a network **capable of communication**. It consists of :

- Host (End-device): A special node directly used by users or applications to generate, send, or receive dat
- Clients: Devices that request services (PCs*, laptops, smartphones).
- Servers: Devices that provide services and resources to clients.
- Each host has a Network Interface Card (NIC)* to connect to the network.

Intermediary Network Devices: Devices that **forward data** between hosts and **interconnect** network segments.

- Router: Connects different networks.
- Switch: Connects devices within the same network.
- Hub: Basic device that broadcasts data to all connected devices.
- Access Point: Provides wireless connectivity

Complément : Other Basic Components

Transmission Medium (Link):

- Wired: Twisted-pair, coaxial, fiber-optic cables.
- Wireless: Radio waves, microwave.
- Network Protocol: A set of rules that defines how data is formatted, addressed, transmitted, and received.

4. OSI and TCP/IP reference models

To connect machines, the physical components must first be assembled. However, to ensure correct information transfer with sufficient quality of service, a **software architecture is required**.

If there are n machines, then $\frac{n(n-1)}{2}$ different communication interfaces are required. Therefore, **the standardization of the software architecture becomes essential**.

4.1. OSI Model

Définition

Developed by ISO* in 1983, the OSI* model comprises **seven layers**, numbered from bottom to top. Each layer has a specific task and communicates with the layers directly above and below it. **Each layer has specific functions and protocols**.

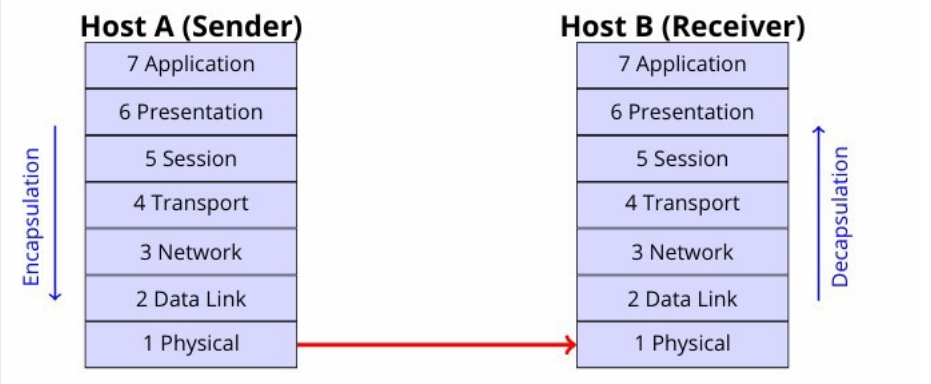
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7	Application Layer	Human-computer interaction layer, where applications can access the network services
6	Presentation Layer	Ensures that data is in usable format and is where data encryption occurs
5	Session Layer	Maintains connections and is responsible for controlling ports and sessions
4	Transport Layer	Transmits data using transmission protocols including TCP and UDP
3	Network Layer	Decides which physical path the data will take
2	Data Link Layer	Defines the format of data on the network
1	Physical Layer	Transmits raw bit stream over the physical medium

OSI model layers

Fondamental : How data moves through the OSI model?

When two devices communicate over a network, the data generated by an application must pass through several layers before reaching the physical medium. The OSI* model describes this process using a layered architecture where each layer performs a specific function.

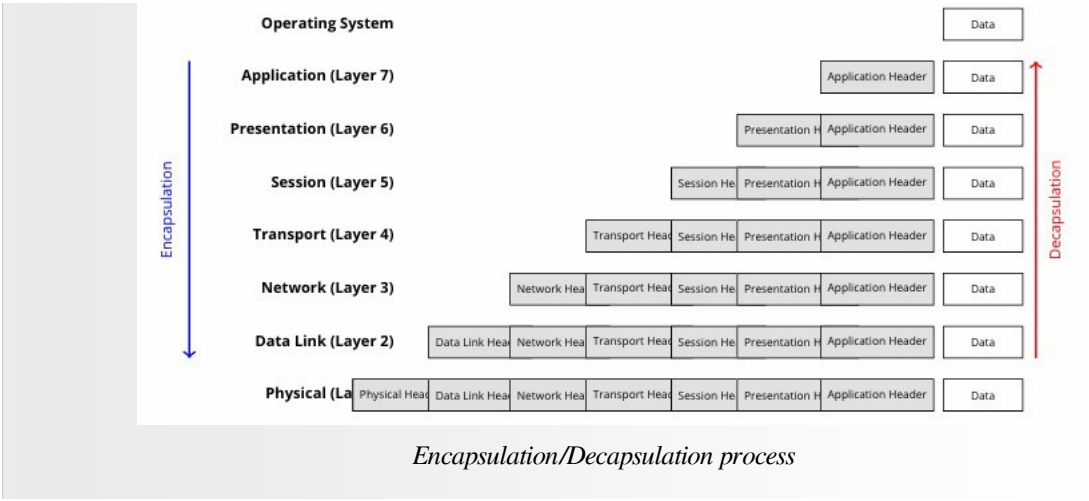


Communication Between Two Devices

As the data moves down the OSI* layers on the sender side, each layer adds its own control information called a **header**. This process is known as **encapsulation**. Each header contains information required by the corresponding layer on the receiving side.

When the data reaches the destination device, the reverse process occurs. As the data moves up through the OSI * layers, each layer removes the header that was added by the corresponding layer on the sender side. This process is called **decapsulation**.

Eventually, the original data is delivered to the application running on the receiving machine.



Encapsulation/Decapsulation process

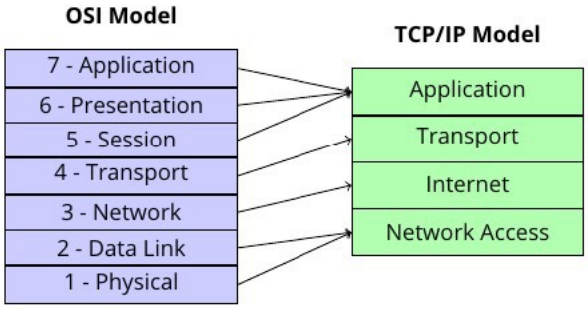
4.2. TCP/IP

Définition

TCP/IP* was developed by the US* Department of Defense to connect machines using different and incompatible protocols. It is composed of **four layers** with each ensuring some functionalities.

4.3. OSI vs TCP/IP

Both models are built on layers, but the TCP/IP* model merges some of the functionalities of multiple OSI* layers into fewer, more practical layers: Network Access (Physical + Data Link), Internet (OSI* Network), Transport (OSI* Transport), and Application (OSI* Session + Presentation + Application).



TCP/IP model is practical and widely implemented, whereas OSI remains mostly theoretical.

Glossaire

Network size

The size of a network implies its scope.

Abréviations

LAN : Local Area Network

MAN : Metropolitan Area Network

NIC : Network Interface Card

OSI : Open Systems Interconnection

PCs : Personal Computers

TCP/IP : Transmission Control Protocol / Internet Protocol

US : United States

WAN : Wide Area Network

WiBro : Wireless Broadband

Wi-Fi : Wireless Fidelity

WiMAX : Worldwide Interoperability for Microwave Access

WRAN : Wireless Regional Area Network

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