

# Information Technology Essentials — Lecture 10

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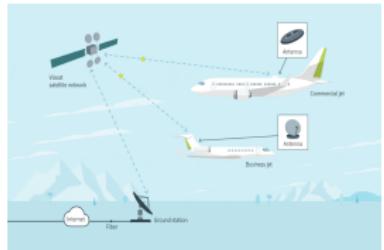
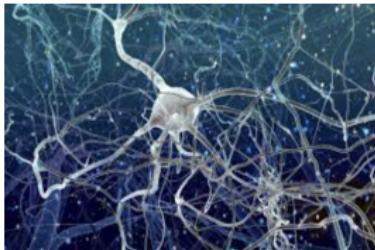
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# Networks

## Computer Networks

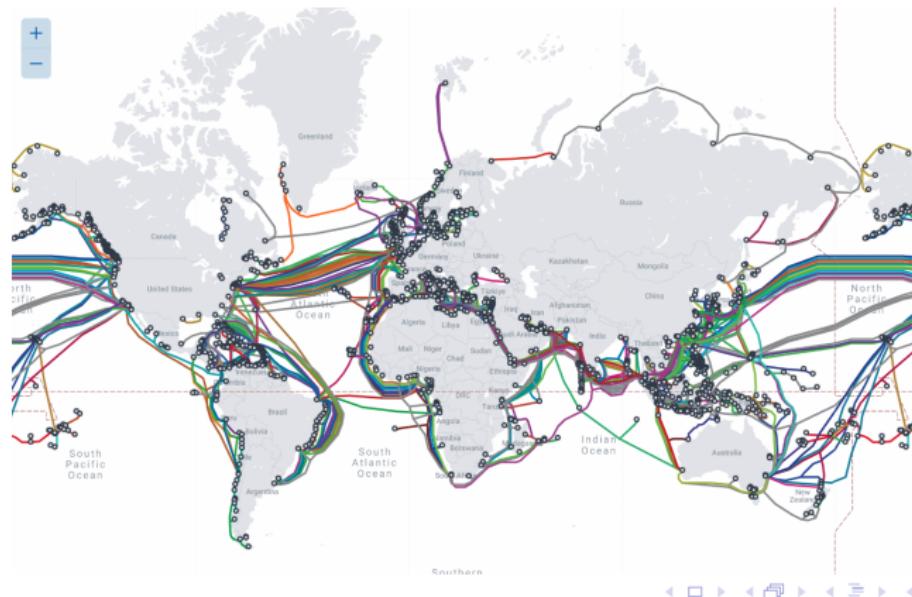
# What is a Network?



# Network (Generalization)

## Definition

**Network.** It is a set of nodes (physical or logical) that are connected together using communication means (a.k.a., mediums or channels).



# Network Characteristics

Networks are generally characterized by:

- ① **Connectivity.** This features the nature of the communication means used in the network (e.g., cables, roads, contact information, tube, tunnels, etc).
- ② **Topology.** Defines the geometrique layout of the network (e.g., bi-point, bus, star, hierarchical, circular — ring, mesh, hybrid, etc).
- ③ **Protocol.** Defines the rules and conventions for communication between the nodes (e.g., traffic law, netiquette, standard processing, etc).
- ④ **Technology.** Defines mechanisms, techniques, tools, and protocols to facilitate the communication (e.g., smart road signs, wireless tech, sensors, etc).
- ⑤ **Bandwidth.** Defines the amount of elements that can transit throughout the communication medium per time unit (e.g., 100Mbps, 100 cars per minute).
- ⑥ **Coverage.** Defines the area covered by the network, e.g., personal, local, metropolitan, and wide.

Additional features: Availability (24/7), accessibility, scalability, security, safety, reliability, interoperability, manageability, privacy, etc.



# Computer Networks

## Definition

**Computer Network.** It is a set of computers and networking devices that are connected together using communication means (links), e.g., cables and radio, enabling resource sharing, data exchange, and collaboration.

In a computer network:

- We exchange **packets** (~ **network traffic**).
- Applications generate **messages**.
- The messages contain text (e.g., html code), data, voice, video, images, etc.
- The operating system takes messages from various applications to creates packets.
- Through the computer's network card, packets are **transmited** into the communicaiton medium — links — i.e., wired or a wireless medium.



# Computer Networks

## Definition

Computer Networks is a collection of computer systems connected together so that they can share resources and communicate with each other.

**Transmitting** means, transforming the bits (of the packet) into either an electrical signal (to be put in a cable — wired medium) or an electromagnetic wave sent over the radio (wireless medium):

In

- The bits are transmitted at a data rate. E.g., A 10Mbps data rate means we are pushing 10 Million of bits per second into the cable. A packet of size 70 bytes get transmitted in  $70 \cdot 10^{-7}$  seconds.
- The network link (e.g., that connects two computers) can transport a certain amount of bits per time unit. That is known as the link capacity, or the link bandwidth, e.g., 100Mbps.
- There is a download rate (input rate: used for downloading content, etc) and a upload rate (output rate: used for sending email, etc).

# Computer Networks

## Definition

Computer Network is a collection of computer systems connected together sharing resources and information.

**Transmitting** means, transforming the bits (of the packet) into either an electrical signal (to be put in a cable — wired medium) or an electromagnetic wave sent over the radio (wireless medium):

In

- When the transmission rate of a computer is less than the link capacity, then the computer (its' network card) is constituting a bottleneck. I.e., engenders delays, packet loss, etc.
- To avoid delays the transmission rate should match the link capacity.
- The transmitted packets are structured in a standard form, dictated by the communicaiton protocol being used for communication.
- A standard packet will allow all computers to correctly read and interpret the content of the packets — communication convention.

# Computer Networks

## Definition

**Computer Network.** It is a set of computers and networking devices that are connected together using communication means (links), e.g., cables and radio, enabling resource sharing, data exchange, and collaboration.

In a computer network:

- Each computer has a logical address where it can be reached out, called **IP address**.
- Every computer runs various applications that communicate over the network.
- Every communicating application listens on a specific communication **port** (door) to send and receive dedicated messages.



So, the messages that belong to one application do not get mixed up with messages that belong to another application running on the same computer.

# Computer Networks

## Definition

**Computer Network.** It is a set of computers and networking devices that are connected together using communication means (links), e.g., cables and radio, enabling resource sharing, data exchange, and collaboration.

In a computer network:

- There are devices that cooperate to deliver the packets to the right destination.
- Each network card (interface) is given by its manufacturer, a physical value, called MAC address (Media Access Control).
- Each application, running on an OS and willing to communicate over the network, uses a **socket** to send and receive messages.



A socket is a combination of IP address and communication port (0-65535).

# Computer Networks

## Definition

**Computer Network.** It is a set of computers and networking devices that are connected together using communication means (links), e.g., cables and radio, enabling resource sharing, data exchange, and collaboration.

In a computer network:

- Packets can be transmitted in **unicast**, **multicast**, or **broadcast** mode.
- Logical IPv4 addresses are used for **end-to-end** communication (or localhost).
- Physical MAC addresses are used for **point-to-point** communication.



☞ End-to-end, mean service to service, whereas point-to-point, means computer to computer (generally direct connection).

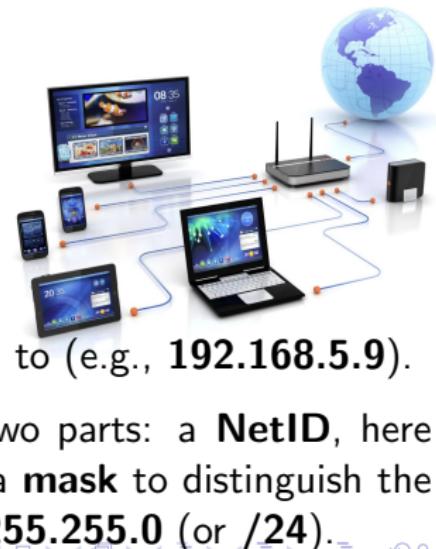
# Computer Networks

## Definition

**Computer Network.** It is a set of computers and networking devices that are connected together using communication means (links), e.g., cables and radio, enabling resource sharing, data exchange, and collaboration.

In a computer network:

- Every network is assigned an IPv4 address that can be used to reach out computers in that network (e.g., **192.168.5.0**).
- Every computer in a network, is assigned an IPv4 address, derived from the IPv4 address of the network to which it is connected to (e.g., **192.168.5.9**).
- An IPv4 address is generally composed of two parts: a **NetID**, here **192.168.5**, and a **HostID**, here **9**. We use a **mask** to distinguish the two parts given an IPv4 address. E.g., **255.255.255.0** (or **/24**).



# Computer Networks

Below is an animation of how a network works. We have an application on **Computer 1** sends messages to another application on **Computer 2** using a cable, and how another application on **Computer 2** sends messages to another application on **Computer 3** using wireless radio.

# Networking (Exercise)

Answer the following questions:

- Which network feature defines the rules of communication?
- What is the difference between message and packet?
- How much it takes to transmit 20Mb packet using 10Mbps data rate ?
- What are the two different types of computer addresses?
- How do we call a tuple of this form: (192.168.1.2:22)?
- What are the different transmission modes?
- What is the IPv4 address of the network to which computer 172.15.2.2/16 is connected? And what is the host ID, and mask?

# Computer Networks

## Definition

Computer Networks is a collection of computer systems connected by a communication link.

Packets are structured objects that contain the message (of an application), or part of it, in addition to other information, called headers:

- The **source and destination address** of the computers: There is a 32-bit logical address, called IPv4 address, and there is a 48-bit physical address, called MAC address. If you type ifconfig:

```
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
        ether 3c:06:30:17:ea:46
        inet6 fe80::c87f:f348:5943%en0 prefixlen 64 secured scopeid 0xc
        inet 192.168.193.170 netmask 0xffffffff broadcast 192.168.193.255
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
```

The value 3c:06:30:17:ea:46 is the MAC (Media Access Control) address, whereas the value 192.168.193.170 is an IPv4 address.

- A **sequence number** to restructure — in the correct order — the original message in case it got fragmented into small pieces.

# Computer Networks

## Definition

Computer Network is a collection of computer systems connected together.

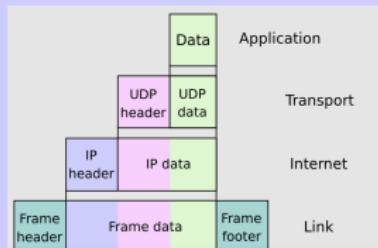
are **Packets** are structured objects that contain the message (of an application), or part of it, in addition to other information, called headers:

- A **checksum value**, computed over the packet and used to detect whether the packet got accidentally **modified** during its transfer.
- The **communication protocol identifier**, which tells how to read and interpret the packets correctly.

Every communication protocol defines a structure for the packet (i.e., a content).

When a packet is sent from a computer, the packet may have been **encapsulated** by various protocols. I.e:

- ☞ Each protocol takes the packet from a previous protocol and appends to it a **header** to become another packet (viz., figure on the right).



- End.