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A first vision…

In Information Technology "a network" can be defined as a connection or joining together of various equipment, all inter-linked. This connection of connected equipment, the exchange of information or data transport is performed between users and / or systems. A network has several distinct characteristics when separated geographically, but how to set them?

What sort criteria of a computer network?

According to a friend, a communication network between computers and / or devices can be classified by one or more criteria. We classify the networks according to him:

- **Debit** (low access, medium, high, very high)
- **Topology** (bus, ring, star, hybrid)
- **Physical media** (copper, fiber optic, microwave, infrared, bluetooth ...)
- **Supporting technology** (packet switching, circuit switching, asynchronous, synchronous, etc.)
- or according to the environment to which they are intended (office networks, industrial networks, military networks, sensor networks, etc.)

However, the most common classification is based on the area - geographical or organizational and then enter the terms that we usually hear: LAN, MAN, WMAN, PAN, SAN ... etc. Let's show a simple explanation of some common definitions of computer networks:

**LAN (Local Area Network)** - Also called Local Area Networks are the type most common networks because they allow interconnect computers, servers and other network equipment in a limited geographic area (examples: Classrooms, Residences, Food Courts, etc).
**WAN** (*Wide Area Network*) - allow the interconnection of local area networks, metropolitan and network equipment in a large geographic area (examples: country, continent, etc.).

**MAN** (*Metropolitan Area Network*) - Allows connection of networks and equipment in a metropolitan area (i.e. sites located in different parts of a city.). *NET Virtua service can be considered a MAN network.*

**RAN** (*Regional Area Network*) is a network of a specific geographic region. Characterized by high-speed connections using fiber optic cable, RANs are larger than the LAN and MAN networks, but are smaller than the WAN. In a narrower sense the RANs Networks are considered a sub-class of MAN networks.
**PAN** (*Personal Area Network*) - It is also referred to as personal area networks, is the type of network where it is used wireless technology to interconnect the various devices (examples: computers, smartphones, tablets, etc.) in a very small area.

**WWAN** (*Wireless Wide Area Network*) - long distance wireless network is a technology that mobile operators use to create their transmission network. (Examples: CDMA, GSM, HSPA, etc.).
**WMAN** (*Wireless Metropolitan Area Network*) - Very similar to MAN networks, but this has no wires. Was assigned to this standard, WiMAX name (*Worldwide Interoperability for Microwave Access*) which provides connectivity for home use, business and hotspots through a single linear point.

**CAN** (*Campus Area Network*) - Network that connects computers located in different buildings in the same complex institutional (examples: universities, condominiums, etc.).
SAN (Storage Area Network) - Regularly storage networks calls, aim the connection between multiple computers and storage devices (storage) in a limited area. Considering it is essential that these networks have large debts (fast access to information), using different technologies such as Fiber Channel.

**Summing up…**

Communication networks or simply Computer networks are in today, essential infrastructure for our communication, research, development, sharing, and everyday life. People increasingly rely on them for the development of several professional or sharing and leisure activities.
Computers and Communication Networks

- The first local networks have been implemented to increase existing installations. For example, by sharing devices, printers or external hard drives.

- The large-scale networks have emerged as a response to need for sharing computing power, associated the high cost of the first digital computers.

- The survey conducted by ARPA was crucial to the future of communication networks. ARPANET development in the 70s.

Brief history

- 60-70
  - Sharing devices.
  - Local Area Networks.

- 70
  - Computing power sharing.
  - US Department of Defense - ARPANET.

- 70-80
  - Research - government and academia.
  - TCP / IP protocols.

- 90
  - Commercial exploitation.
  - Migration to non-governmental networks.

Ping command

- *Ping* - sends a message and waits for a response. It includes summaries for the transfer times (round and back). Simple diagnostic tool but widely used.

Traceroute command

- *Traceroute* - to determine the intermediate machines in path to a remote destination. Windows - tracert.
• Each line represents a path via computer between the source and the specified destination (hop).

**Data transmission**

• At the lowest level, all communications between computers involve the coding of data in a form of energy and sending this energy via a transmission medium.

• Broadcast media
  - Copper cables
  - Optical fiber
  - Radio
  - Satellite
  - Microwave
  - Infrared
  - Laser

**Copper cables**

• Half a used to connect computers. Various types of cables with a view to minimizing interference:
  - Unshielded Twisted Pair (UTP)
  - Coaxial cable
  - Shielded Twisted Pair (STP)

• Advantages
  - Good conductivity.
  - Low cost.
  - Easy installation.

• Disadvantages
  - Vulnerable to electromagnetic noise.
Optical fiber

- Emission of a light pulse through a flexible fiberglass.

- Advantages
  - Immune to electromagnetic interference.
  - Minor losses.
  - Larger debt.

- Disadvantages
  - Costly interfaces.
  - Troubleshooting hard.

Radio

- Use of electromagnetic radiation to transmit data between computers. Such a network operates on a particular radio frequency.

- The size of the transmitting antenna / receiver determines the range of the network.

- No direct physical connection is required.

- Wireless networks are an example application.

Satellite

- Used for transmission over long distances.

Two types in orbit height of the function:

- Geostationary - remain synchronized with the Earth's rotation. Installed 36,000Km high.

- Low Earth Orbit - Next of 700 Km.

- A mesh configuration can be used with satellites low orbit, allowing for permanent coverage. These cases, a particular communication by using several satellites.

- Due to the high cost of initial installation, it is common multiple connections are shared by the same satellite.
Microwave

- Appeal to electromagnetic radiation in frequency ranges other than those used by radio or television.

- A microwave transmission may be directed, contrary to what happens with the other waves. They also allow carry more information.

- More susceptible to interference. Installation is done with line of sight.

Infrared

- Electromagnetic radiation technology used in remote controls.

- Advantages:
  - Good security.
  - Absence of interference problems.
  - Unlicensed spectrum.

- Disadvantages:
  - Limited to short distances.
  - Transmission line of sight or by reflection.
Laser

- A light beam directed through the air can be used to transmit data.
- The transmission is straight and cannot be blocked.
- Very vulnerable to interference therefore of limited use.

Continuous oscillatory signal

- An electrical current cannot be propagated arbitrary distance. There is a loss of signal on the distance because of resistance.
- The protocols used for local communication (e.g. RS-232) cannot be used in large distances.
- In long-distance transmissions oscillatory continuous signal propagates better than other signals.
- Instead of sending a signal that changes only the value in the long-distance communications is used an oscillatory continuous signal (carrier).

Modulation

- To send data, the signal is changed. In general, these changes are called modulation.
- Technology developed in the context of telephones, radio and television.

Modulation and Demodulation

- An apparatus receives a bitstream and applies modulation to a carrier according to the received bits, is called modulator.
- A device that receives a modulated carrier and recreates the original bit sequence, is called demodulator.
- In practice, communication networks work both ways so it is more economic together in one unit both functions - modem.
Multiplexing

- Two or more signals using carriers with different frequencies can be transmitted simultaneously in the same medium without interference.

- Multiplexing enables multiple pairs of transmitters / receivers communicate over the same medium at the same time. Frequency division, time division.

Network Topologies

- Local networks are grouped into categories according to the *generic form*, or *topology*.

- They represent *logical concepts*, the actual implementation (physical) may vary.

- The main topologies used are:
  - Star
  - Ring
  - Bus

- Each topology has advantages and disadvantages.


**Star Topology**

- Each computer is connected to a central point.

- The central element may be a multiport repeater (hub) or a commutator.

- The partial failure of a link has no impact on the network.

- Example: ATM networks.
Ring Topology

- The computers are connected in a **closed circuit**.

Existence of repeaters in each point.

- Access Coordination is simplified.

- Low fault tolerance on the links.

- Most common access mechanism - passage of witness (token).

- **Token Ring** networks. Using a **testimony** to control the use of the network.

Bus Topology

- Connection via a single cable to which computers are connected.

- Requires less cable installation.

- Low fault tolerance on the links.
Ethernet

- Invented in the 70s at Xerox Parc.
- Currently the standard is controlled by the IEEE.
- It uses a bus topology.
- Original Implementation → 10 Mbps
- Fast Ethernet → 100 Mbps
- Gigabit Ethernet → 1000 Mbps / 1 Gbps
- LAN technology most used.
- While a computer using the medium, all others expect.
- Mechanisms are needed to control the transmission. Eg CSMA / CD.

Network Extension Sites

- A key aspect of LAN is the limitation in terms of distance.
- There are technologies that allow you to extend these distances
  - Fiber Optics: provides a link between a computer and a remote LAN.
  - Repeaters: connects two independent network segments. Resends the amplified signal without any filtering.
  - Bridges: forwards valid packets from one segment to another. It resends interference or other problems.

Repeaters

- Amplifies and sends all the electrical signals which occur in one segment to another segment.
- If a collision occurs in a segment, the repeater causes the same problem(s) other(s).
Bridges

- *Bridges* examine the physical addresses of the packets and decide whether or not to resend other segments.

- The use of *bridges* can improve the network performance.

Store and Forward

- The packet switches work in a store and forward logic - packages are placed in memory until you can resend it to the destination.

- Allows you to handle sudden traffic; Create queues for certain resources; Reduce the need for coordination.

- It is a fundamental paradigm in the WAN, since multiple computers that can communicate simultaneously.

Performance Measures

- **Delay** (*delay*) - time a bit slow to traverse the network from one computer to another, usually in milliseconds.

- **Debit** (*throughput*) - measure of the rate at which data can be sent over the network, usually in bits per second (bps).

- The **delay**, measured in seconds, is the time an individual bit remains in transit.

- The **flow rate**, measured in bits per second is the number of bits that can enter the network per unit time. The output is the capacity of the network.

- In practice, the delay and throughput are not completely independent.

- The increase in traffic on a network causes an increase in observed delay. A network that works close to 100% of the total throughput capacity has a high delay.

- Jitter - is the variance of the delay. Important data in data transmission in real-time.

Network Interconnection

- The concept of *network interconnection* (*internetworking*) is essential for communication between computers.

- Networks of *different organizations* and implemented using *different technologies* must be able to communicate.
• Interconnection technologies allow, from connecting multiple physical networks, creating a **homogeneous communication system**.

• Each technology is designed to solve a specific set of constraints.
  
  - For example, LAN technologies for short distances and long distances WAN technologies.

• **No particular technology is ideal for all situations.**

• In the 70's it became apparent that each network implemented was becoming an *island*. The computers could only communicate with other devices **connected to the same network**.

• Require the user to use different terminals to access different services results in a *decrease in individual productivity*.

• A communication system that offers **universal service** allows any arbitrary pair of computers communicates.

• Incompatibility to the hardware level prevent networks implemented in different technologies are connected by bridges to overcome the incompatibilities have been developed technologies that allow provide a **universal service across heterogeneous networks**.

• This solution has the designation of **internetworking** and uses the **hardware** and **software**.

• The system resulting from the connection of physical networks is known as **internetwork** or **internet**.

• There are few internets with networks and internets composed of hundreds of physical networks.

**Routers**

• The basic equipment used to interconnect heterogeneous networks is the **router**.

• **A router is a device specially designed to interconnect networks.** A router can connect networks that use different technologies.
Conclusion

Computer networks establish the standard way of connecting computers for the sharing of physical and logical resources. These features can be defined as CD-ROM drives, hard disk directories, printers, scanners, modem cards among others. Knowing how to define what type of network and operating system should be used, and to make the assembly of this type environment is a prerequisite for any IT professional you want a good placement in the labor market.

Network technology has reached the stage of mass when computers they began to spread throughout the commercial world at the same time multi-user complex programs began to be developed (e-mail, database, Internet). The components for their assembly (hardware, software, infrastructure and accessories) can be found in any specialized shop in computer science, and these elements coming from dozens of manufacturers. That process generated an interesting fact: the low cost of components provided the competition between manufacturers in a first stage, low-end value provided by the competition between the various computer stores. Coupled with all this, technological developments brought simplicity to the process, which makes the easier technical work and with more possibilities. However, not always the cost and interoperability of network equipment were on hand the administrators of cheap and flexible networks.

At the beginning of network design, each manufacturer had its way of working and its own technology development line. As an example, we can name the network card manufacturer x which could only be connected to a card from the same manufacturer, for a physical medium (wire) also developed by him. If there were problems related to prices or relationship between the parties, the company owns the equipment could not look for another option. The only existing alternative at the time was to replace the entire park hardware and software installed by third-party equipment. In this way, the problem was not solved, but circumvented, and the losses were large.

In order to remedy this mismatch between manufacturers in decade 1970 ISO (International Organization for Standardization) has created a standard universal for exchange of information between and within networks and also through geographical boundaries. This standard for network architecture was the OSI Reference Model, established in seven layers, which encouraged the standardization of communication networks and control of distributed processes. The fact of being drawn into seven layers occurs due to the IBM model, SNA Reference Model, have these characteristics. IBM at the beginning of the networks was one of the largest companies involved in this area and one
of the members of the process of standardization of networks and creation of the OSI reference model.

An important fact to be regarded as the OSI was the long time for its definition. During this period, the Department of Defense Government of the United States (DoD - Department of Defense) has developed the TCP / IP Reference Model with the main objective of keeping connected their equipment even if only in part.

This pattern became known as the TCP / IP Reference Model established in four layers. As some manufacturers started developing equipment following this pattern, when the OSI standard was finalized, many equipment were already working in the reference model called TCP / IP, so the OSI Reference Model was born and did not become an industry standard of network. Academic institutions agreed not to replace their equipment, as this would require a high cost and lost time for training and new settings.

The TCP / IP name refers to a stack of protocols whose main protocols TCP (Transmission Control Protocol) and IP (Internet Protocol) in addition to other known protocols such as ARP, RARP, ICMP and UDP. Soon we should not confuse the TCP / IP protocols with the TCP and IP protocol, which have very different operating characteristics from one another. The Internet has emerged based on the US academic institutions network is a good example network that uses the TCP / IP protocols.
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