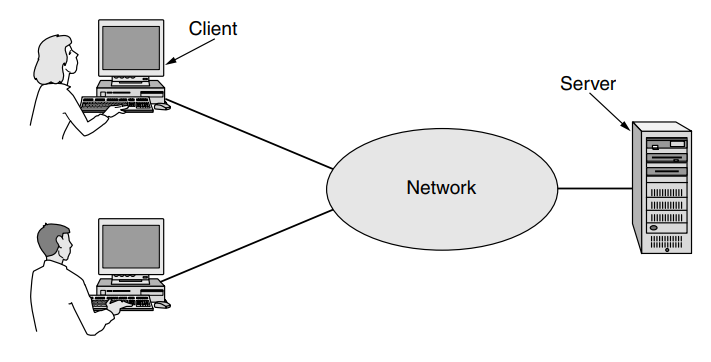
CAPITULO 1

* 1. Uses of Computer Networks

In business scenarios, generally, there is an issue with **resource sharing.** The goal is to make all programs, equipment, and especially data available to anyone on the network without regard to the physical location of the resource or the user. For example, none of the individuals really needs a private printer, and a high-volume networked printer is often cheaper, faster, and easier to maintain than a large collection of individual printers.

Networks called **VPNs** (Virtual Private Networks) may be used to join the individual networks at different sites into one extended network. One can imagine a company’s information system as consisting of one or more databases with company information and some number of employees who need to access them remotely. In this model, the data are stored on powerful computers called servers. Often these are centrally housed and maintained by a system administrator. In contrast, the employees have simpler machines, called clients, on their desks, with which they access remote data.

This whole arrangement is called the **client-server model.** It is applicable when the client and server are both in the same building (and belong to the same company), but also when they are far apart.

Analysing the client-server model in detail, we see that two processes are involved, one on the client machine and one on the server machine. Communication takes the form of the client process sending a message over the network to the server process. The client process then waits for a reply message. When the server process gets the request, it performs the requested work or looks up the requested data and sends back a reply.

Diagram

Description automatically generated

Diagram

Description automatically generatedIn contrast, in **peer-to-peer communication** individuals who form a loose group can communicate with others in the group. Every person can, in principle, communicate with one or more other people; there is no fixed division into clients and servers.

Many peer-to-peer systems, such BitTorrent (Cohen, 2003), do not have any central database of content. Instead, each user maintains his own database locally and provides a list of other nearby people who are members of the system. A new user can then go to any existing member to see what he has and get the names of other members to inspect for more content and more names. This lookup process can be repeated indefinitely to build up a large local database of what is out there.

1.2. Network Hardware

Broadly speaking, there are two types of transmission technology that are in widespread use: **broadcast links** and **point-to-point links**. Point-to-point links connect individual pairs of machines. Often multiple routes, of different lengths, are possible, so finding good ones is important in point-to-point networks.

On a broadcast network, the communication channel is shared by all the machines on the network. An address field within each packet specifies the intended recipient. Upon receiving a packet, a machine checks the address field. If the packet is intended for the receiving machine, that machine processes the packet; if the packet is intended for some other machine, it is just ignored.

1.2.1 Personal Area Networks

**PANs (Personal Area Networks**) let devices communicate over the range of a person. A common example is a wireless network that connects a computer with its peripherals. Bluetooth, a short-range wireless network, uses the master-slave paradigm.

1.2.2 Local Area Networks

The next step up is the **LAN (Local Area Network).** A LAN is a privately owned network that operates within and nearby a single building like a home, office or factory. When LANs are used by companies, they are called **enterprise networks**.

Diagram

Description automatically generatedIn these systems, every computer has a radio modem and an antenna that it uses to communicate with other computers. In most cases, each computer talks to a device. This device, called an **AP (Access Point),** **wireless router, or base station**, relays packets between the wireless computers and also between them and the Internet.

Diagram

Description automatically generated1.2.3 Metropolitan Area Network

A **MAN (Metropolitan Area Network)** covers a city. The best-known examples of MANs are the cable television networks available in many cities. In those early systems, a large antenna was placed on top of a nearby hill and a signal was then piped to the subscribers’ houses.

1.2.4 Wide Area Networks

A **WAN (Wide Area Network)** spans a large geographical area, often a country or continent. A **VPN** has the usual advantage of virtualization, which is that it provides flexible reuse of a resource (Internet connectivity).

* 1. Network Software

1.3.1 Protocol Hierarchies

To reduce their design complexity, most networks are organized as a stack of **layers** or **levels**, each one built upon the one below it. The number of layers, the name of each layer, the contents of each layer, and the function of each layer differ from network to network. The purpose of each layer is to offer certain services to the higher layers while shielding those layers from the details of how the offered services are actually implemented. In a sense, each layer is a kind of virtual machine, offering certain services to the layer above it.

Basically, a protocol is an agreement between the communicating parties on how communication is to proceed. Violating the protocol will make communication more difficult, if not completely impossible.

Diagram

Description automatically generatedA five-layer network is illustrated here. The entities comprising the corresponding layers on different machines are called **peers**. The peers may be software processes, hardware devices, or even human beings. In other words, it is the peers that communicate by using the protocol to talk to each other.

In reality, no data are directly transferred from layer n on one machine to layer n on another machine. Instead, each layer passes data and control information to the layer immediately below it, until the lowest layer is reached. Below layer 1 is the **physical medium** through which actual communication occurs.

Between each pair of adjacent layers is an interface. The interface defines which primitive operations and services the lower layer makes available to the upper one. Each layer performs a specific collection of well-understood functions. In addition to minimizing the amount of information that must be passed between layers, clearcut interfaces also make it simpler to replace one layer with a completely different protocol or implementation.

A set of layers and protocols is called a **network architecture**.

It is not necessary that the interfaces on all machines in a network be the same, provided that each machine can correctly use all the protocols. A list of the protocols used by a certain system, one protocol per layer, is called a **protocol stack**.

A more technical example: how to provide communication to the top layer of the five-layer network. A message, M, is produced by an application process running in layer 5 and given to layer 4 for transmission. Layer 4 puts a **header** in front of the message to identify the message and passes the result to layer 3. The header includes control information, such as addresses, to allow layer 4 on the destination machine to deliver the message.

Diagram

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In many networks, no limit is placed on the size of messages transmitted in the layer 4 protocol but there is nearly always a limit imposed by the layer 3 protocol. Consequently, layer 3 must break up the incoming messages into smaller units, packets, prepending a layer 3 header to each packet. In this example, M is split into two parts, M1 and M2, that will be transmitted separately. Layer 3 decides which of the outgoing lines to use and passes the packets to layer 2. Layer 2 adds to each piece not only a header but also a **trailer**, and gives the resulting unit to layer 1 for physical transmission. At the receiving machine the message moves upward, from layer to layer, with headers being stripped off as it progresses. None of the headers for layers below n are passed up to layer n.

* 1. Reference Models
     1. TCP/IP Reference Model

TCP/IP Reference Model is a four-layered suite of communication protocols. It was developed by the DoD (Department of Defence) in the 1960s. It is named after the two main protocols that are used in the model, namely, TCP and IP. TCP stands for Transmission Control Protocol and IP stands for Internet Protocol.

The four layers in the TCP/IP protocol suite are:

* **Link Layer −** It is the lowest layer and describes what links such as serial lines and classic Ethernet must do to meet the needs of this connectionless internet layer. TCP/IP does not specifically define any protocol here but supports all the standard protocols. More of an interface between hosts and transmission links rather than a layer.
* **Internet Layer −** the linchpin that holds the whole architecture together. The job of the internet layer is to deliver IP packets where they are supposed to go. They may even arrive in a completely different order than they were sent, in which case it is the job of higher layers to rearrange them, if in-order delivery is desired. The internet layer defines an official packet format and protocol called **IP (Internet Protocol)**, plus a companion protocol called **ICMP (Internet Control Message Protocol)** that helps it function.
* **Transport Layer −** It is designed to allow peer entities on the source and destination hosts to carry on a conversation, just as in the OSI transport layer. Two end-to-end transport protocols have been defined here. The first one, **TCP (Transmission Control Protocol)**, is a reliable connection-oriented protocol that allows a byte stream originating on one machine to be delivered without error on any other machine in the internet. The second protocol in this layer, **UDP (User Datagram Protocol)**, is an unreliable, connectionless protocol for applications that do not want TCP’s sequencing or flow control and wish to provide their own.
* **Application Layer −** This is the topmost layer and defines the interface of host programs with the transport layer services. This layer includes all high-level protocols like Telnet, DNS, HTTP, FTP, SMTP, etc. Applications simply include any session and presentation functions that they require.

A picture containing graphical user interface

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CAPITULO 2

2.6 The public switched telephone network

2.6.5 Switching

Two different switching techniques are used by the network nowadays: **circuit switching** and **packet switching**.

**Diagram, engineering drawing

Description automatically generatedCircuit Switching** - In this example, each office has three incoming lines and three outgoing lines. When a call passes through a switching office, a physical connection is (conceptually) established between the line on which the call came in and one of the output lines, as shown by the dotted lines.

**Diagram

Description automatically generatedPacket Switching** - With this technology, packets are sent as soon as they are available. There is no need to set up a dedicated path in advance, unlike with circuit switching. It is up to routers to use store-and-forward transmission to send each packet on its way to the destination on its own. This procedure is unlike circuit switching, in which the result of the connection setup is the reservation of bandwidth all the way from the sender to the receiver.

With packet switching there is no fixed path, so different packets can follow different paths, depending on network conditions at the time they are sent, and they may arrive out of order. Because no bandwidth is reserved with packet switching, packets may have to wait to be forwarded. This introduces queuing delay and congestion if many packets are sent at the same time. On the other hand, there is no danger of getting a busy signal and being unable to use the network. Thus, congestion occurs at different times with circuit switching (at setup time) and packet switching (when packets are sent).

Diagram, schematic

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