6.13. NETWORKS

A network is set of interconnected devices (sometime referred as nodes) which are used to transmit data between them with agreed protocols. The networks are used to connect the people, machines, devices to share the data anywhere in the world. The devices can be computers, printers, mobile phones, servers which are capable of sending and receiving data.

The data can be generated by a device. There is considerable confusion in the literature between a computer network and a distributed system. The key distinction is that in a distributed system, a collection of independent computers appears to its users as a single coherent system (Figure 6.4).

Usually, it has a single model or paradigm that it presents to the users. Often a layer of software on top of the operating system, called middleware, is responsible for implementing this model. A well-known example of a distributed system is the World Wide Web, in which everything looks like a document (Web page).

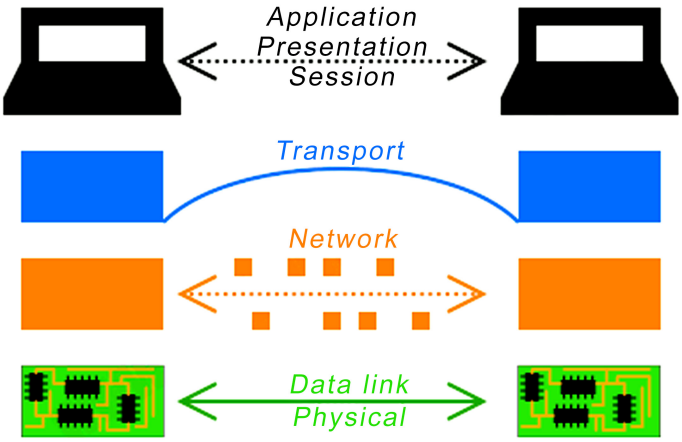


Figure 6.4. How do network work?

Source: Image by Explain that stuff.

6.14. HISTORY OF NETWORK

A computer network is a digital telecommunications network which allows nodes to share resources. In computer networks, computing devices exchange data with each other using connections (data links) between nodes. These data links are established over cable media such as wires or optic cables, or wireless media such as Wi-Fi.

Remember

Computer networking as we know it today may be said to have gotten its start with the Arpanet development in the late 1960s and early 1970s. Prior to that time there were computer vendor "networks" designed primarily to connect terminals and remote job entry stations to a mainframe.

In 1940, George Sit bit used a teletype machine to send instructions for a problem set from his model at Dartmouth college to his complex number calculator in New York and received results back by the same means. In 1950's, early networks of communicating computers included the military radar system Semi-Automatic Ground Environment (SAGE) was started.

Later, in 1960s, the notion of networking between computers viewing each other as equal peers to achieve "resource sharing" was fundamental to the Arpanet design. The other strong emphasis of the Arpanet work was its reliance on the then novel technique of packet switching to efficiently share communication resources among "bursty" users, instead of the more traditional message or circuit switching.

6.15. DISTRIBUTED PROCESSING

Most networks use distributed processing, in which a task is divided among multiple computers. Instead of one single large machine being responsible for all aspects of process, separate computers (usually a personal computer or workstation) handle a subset.

6.16. NETWORK PREREQUISITES

A network must therefore be capable of satisfying a range of requirements. The three which are the most crucial are safety, dependability, and effectiveness.

6.16.1. Execution

There are various approaches to examining the outcomes, such as transportation and processing times. The duration of time needed for a signal to transfer from one machine to another is known as the transit time. The time that passes between a request and a reaction is known as the response time.

Numerous variables, like the number of customers, the type of data transmission, the capabilities of the linked equipment, and the quality of the software, influence a network's performance. Throughput and delay are two networking measures that are frequently used to measure progress.

Fewer interruptions and increased bandwidth are usually required. And yet, these two requirements frequently conflict with one another. Users might be able to boost bandwidth by sending more data via the network, but the lag will increase as a result of traffic overcrowding.

6.16.2. Reliability

Delivery precision is influenced by the number of inadequacies, the pace at which a connection can be restored after a collapse, and the system's adaptability to major disasters.

6.16.3. Safety

The safeguarding of information from unauthorized exposure, the protection of lost data and advancement, and the establishment of policies and procedures for recovering data from intrusions are all concerns related to network security.

KEYWORD

Bandwidth is the maximum rate of data transfer across a given path.

6.17. PHYSICAL STRUCTURES

Users must first describe a few network attributes prior to actually talking about network systems.

6.17.1. Connection Type

When two or more pieces of equipment are linked together, they create a network. A connection is a communication medium that allows the transfer of data between two devices. The simplest and most effective way to illustrate any link is to think of it in terms of a line connecting the two points.

Two devices must be simultaneously connected to a single link in some sort of way to be able to communicate. Point-to-point and multipoint links are both possible options.

6.17.1.1. Point-to-Point

A dedicated link between two devices is supplied by a point-to-point connection. Transfer between these two devices can only be permitted at the link's highest output. Point-to-point links usually involve physical wires or cables operating between the opposite

edges, but other possibilities exist as well, including microwave or satellite links.

By using an infrared remote controller to switch the channel on the television, users are creating a point-to-point linkage between both the remote control and the television's control method.

Multipoint In a multipoint linkage (also known as a multidrop connection), two distinct devices use the same channel. The channel's ability is shared, be it geographically or temporally, in the multipoint surroundings. It constitutes a spatially common linkage if various devices can use it at the same time. A timeshare linkage is one which consumer must alter.

KEYWORD

Topology is concerned with the properties of a geometric object that are preserved under continuous deformations, such as stretching, twisting, crumpling, and bending; that is, without closing holes, opening holes, tearing, gluing, or passing through itself.

6.17.2. Physical Topology

One or more devices may be connected to a connection, and two or more connections can make up a topology. This would be known as a physical topology. The spatial depiction of a network's topology demonstrates how each of the connections and connecting elements (commonly referred to as nodes) connect to each other. There are four potential fundamental topologies: ring, bus, star, and mesh.

6.17.2.1. MESH

Each device that is connected to another device in a mesh topology does have a unique point-to-point connection. Based on the definition of dedicated, a connection can only carry traffic in between two devices that it links. Users first take into account the necessity of how each node is linked to every other node in order to calculate the total quantity of physical links in a mesh network with n nodes.

Node 1 must be connected to n-I nodes, preceded by node 2, then node 1, and at last node n, all of which need to be linked to n-I nodes. n (n – 1) physical links are needed. As opposed to this, users could split the number of connections by two if each physical link continues to support duplex communication.

Optionally, users could conclude that duplex-mode connections are required in a mesh topology. Each network device must have n-1 input/output (VO) ports in order to communicate with the other n-1 stations and support as many linkages as possible.

When compared to other network topologies, a mesh has a number of benefits. Firstly, using dedicated links assures that each linkage can support its own collected data, exterminating any traffic issues that might arise when links are shared between multiple gadgets. A mesh topology is also reliable. The system is not rendered useless if just one connection breaks.

The positive impact of confidentiality or safety comes in third. Each message employs a distinct line to ensure that only the intended receiver can see it. Physical restrictions keep other users from accessing messages.

KEYWORD

Hybrid network is any network that can use more than one type of connecting technology.

At last, failure isolation and fault diagnosis are made simple by point-to-point connections. Traffic could be detoured to avoid connections that might have issues. This facility gives the network manager the ability to pinpoint the fault precisely and helps in deciding its reason and fixing it. A large percentage of a mesh's drawbacks are linked to how much wiring and how many I/O access points are usually needed.

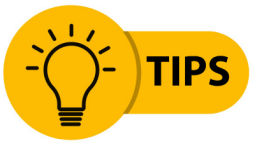
Setup and reconnecting are demanding since every system needs to be linked with every other machine. Second, there is a possibility that the setup will simply take up more area than the walls, ceilings, or floors can support. Finally, the equipment (I/O ports and cable) needed to link each connection may be impossible to afford.

Due to such factors, mesh topologies are typically only partially put in place. For instance, a mesh topology could act as the backbone linking the primary computer systems of a hybrid network that could also integrate other topologies. The linkage of phone line field offices, where each regional office must be attached to every other regional office, is a good demonstration of a mesh topology.

Star Topology In a star topology, each device has a dedicated point-to-point link only to a central controller, usually called a hub. The devices are not directly linked to one another. Unlike a mesh topology, a star topology does not allow direct traffic between devices. The controller acts as an exchange: If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device.

A star topology is less expensive than a mesh topology. In a star, each device needs only one link and one I/O port to connect it to any number of others. This factor also makes it easy to install and reconfigure. Far less cabling needs to be housed, and additions,

moves, and deletions involve only one connection: between that device and the hub.



An Internet service provider (ISP) is any organization that provides services for accessing the Internet.

Other advantages include robustness. If one link fails, only that link is affected. All other links remain active. This factor also lends itself to easy fault identification and fault isolation. As long as the hub is working, it can be used to monitor link problems and bypass defective links. One big disadvantage of a star topology is the dependency of the whole topology on one single point, the hub.

If the hub goes down, the whole system is dead. Although a star requires far less cable than a mesh, each node must be linked to a central hub. For this reason, often more cabling is required in a star than in some other topologies (such as ring or bus). The star topology is used in local-area networks (LANs). High-speed LANs often use a star topology with a central hub.

6.17.3. Bus Topology

The preceding examples all describe point-to-point connections. A bus topology, on the other hand, is multipoint. One long cable acts as a backbone to link all the devices in a network Nodes are connected to the bus cable by drop lines and taps. A drop line is a connection running between the device and the main cable.

A tap is a connector that either splices into the main cable or punctures the sheathing of a cable to create a contact with the metallic core. As a signal travels along the backbone, some of its energy is transformed into heat. Therefore, it becomes weaker and weaker as it travels farther and farther. For this reason, there is a limit on the number of taps a bus can support and on the distance between those taps.

Advantages of a bus topology include ease of installation. Backbone cable can be laid along the most efficient path, then connected to the nodes by drop lines of various lengths. In this way, a bus uses less cabling than mesh or star topologies. In a star, for example, four network devices in the same room require four lengths of cable reaching all the way to the hub.

In a bus, this redundancy is eliminated. Only the backbone cable stretches through the entire facility. Each drop line has to reach only as far as the nearest point on the backbone. Disadvantages include difficult reconnection and fault isolation. A bus is usually

designed to be optimally efficient at installation. It can therefore be difficult to add new devices.

Signal reflection at the taps can cause degradation in quality. This degradation can be controlled by limiting the number and spacing of devices connected to a given length of cable. Adding new devices may therefore require modification or replacement of the backbone. In addition, a fault or break in the bus cable stops all transmission, even between devices on the same side of the problem.

The damaged area reflects signals back in the direction of origin, creating noise in both directions. Bus topology was the one of the first topologies used in the design of early local area networks. Ethernet LANs can use a bus topology, but they are less popular now for reasons.

KEYWORD

Bus topology, also known as line topology, is a type of network topology in which all devices in the network are connected by one central RJ-45 network cable or coaxial cable.

6.17.4. Ring Topology

In a ring topology, each device has a dedicated point-to-point connection with only the two devices on either side of it. A signal is passed along the ring in one direction, from device to device, until it reaches its destination. Each device in the ring incorporates a repeater.

When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along A ring is relatively easy to install and reconfigure. Each device is linked to only its immediate neighbors (either physically or logically).

To add or delete a device requires changing only two connections. The only constraints are media and traffic considerations (maximum ring length and number of devices). In addition, fault isolation is simplified. Generally, in a ring, a signal is circulating at all times. If one device does not receive a signal within a specified period, it can issue an alarm.

The alarm alerts the network operator to the problem and its location. However, unidirectional traffic can be a disadvantage. In a simple ring, a break in the ring (such as a disabled station) can disable the entire network. This weakness can be solved by using a dual ring or a switch capable of closing off the break. Ring topology was prevalent when IBM introduced its local-area network Token Ring. Today, the need for higher-speed LANs has made this topology less popular (Figure 6.5).

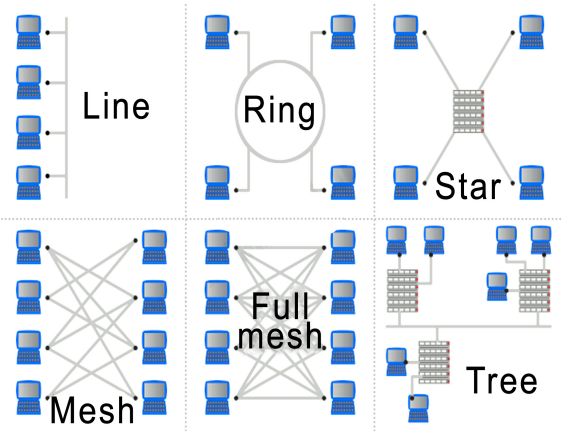


Figure 6.5. Types of topology.

Source: Image by Explain that stuff.

6.17.5. Hybrid Topology

A network can be hybrid. For example, we can have a main star topology with each branch connecting several stations in a bus topology.

Remember

The point-to-point WAN is normally a line leased from a telephone or cable TV provider that connects a home computer or a small LAN to an Internet service provider (lSP). This type of WAN is often used to provide Internet access.

6.18. NETWORK MODELS

Computer networks are created by different entities. Standards are needed so that these heterogeneous networks can communicate with one another. The two best-known standards are the OSI model and the Internet model. we discuss these two models. The OSI (Open Systems Interconnection) model defines a seven-layer network; the Internet model defines a five-layer network. This book is based on the Internet model with occasional references to the OSI model.

6.19. CATEGORIES OF NETWORKS

Today when we speak of networks, we are generally referring to two primary categories: local-area networks and wide-area networks. The category into which a network falls is determined by its size. A LAN normally covers an area less than 2 mi; a WAN can be worldwide. Networks of a size in between are normally referred to as metropolitan area networks and span tens of miles.

6.19.1. Local Area Network

A local area network (LAN) is usually privately owned and links the devices in a single office, building, or campus Depending on the needs of an organization and the type of technology used, a LAN can be as simple as two PCs and a printer in someone's home office; or it can extend throughout a company and include audio and video peripherals. Currently, LAN size is limited to a few kilometers. LANs are designed to allow resources to be shared between personal computers or workstations. The resources to be shared can include hardware (e.g., a printer), software (e.g., an application program), or data. A common example of a LAN, found in many business environments, links a workgroup of task-related computers, for example, engineering workstations or accounting PCs.

One of the computers may be given a large capacity disk drive and may become a server to clients. Software can be stored on this central server and used as needed by the whole group. In this example, the size of the LAN may be determined by licensing restrictions on the number of users per copy of software, or by restrictions on the number of users licensed to access the operating system.

In addition to size, LANs are distinguished from other types of networks by their transmission media and topology. In general, a given LAN will use only one type of transmission medium. The most common LAN topologies are bus, ring, and star. Early LANs had data rates in the 4 to 16 megabits per second (Mbps) range. Today, however, speeds are normally 100 or 1000 Mbps. LANs Wireless LANs are the newest evolution in LAN technology (Figure 6.6).

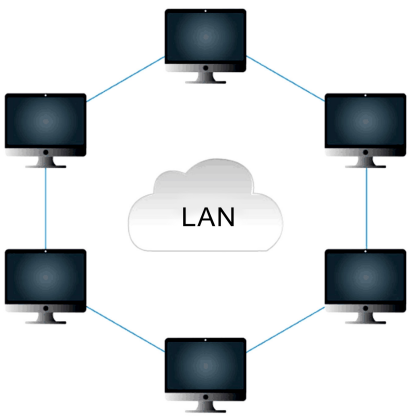


Figure 6.6. LAN.

Source: Image by Wikimedia Commons.

6.19.2. Wide Area Network

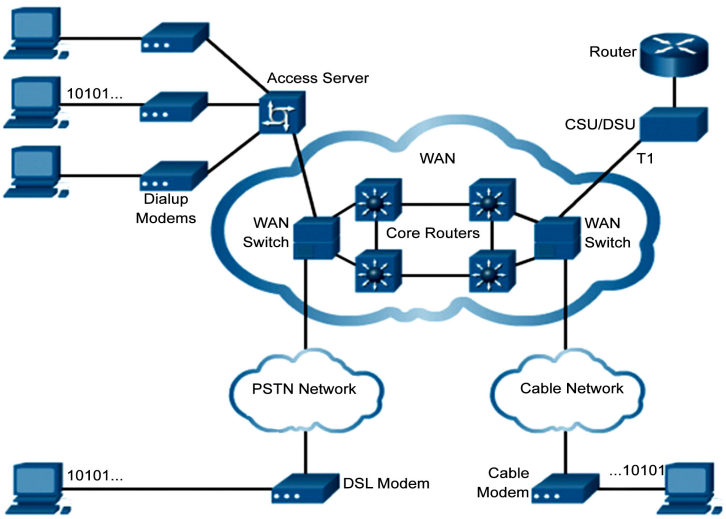
A wide area network (WAN) provides long-distance transmission of data, image, audio, and video information over large geographic areas that may comprise a country, a continent, or even the whole world. we discuss wide-area networks in greater detail. A WAN can be as complex as the backbones that connect the Internet or as simple as a dial-up line that connects a home computer to the Internet.

We normally refer to the first as a switched WAN and to the second as a point-to-point. The switched WAN connects the end systems, which usually comprise a router (internetworking connecting device) that connects to another LAN or WAN.

An early example of a switched WAN is X.25, a network designed to provide connectivity between end users. As we will see, X.25 is being gradually replaced by a high-speed, more efficient network called Frame Relay.

A good example of a switched WAN is the asynchronous transfer mode (ATM) network, which is a network with fixed-size data unit packets called cells. Another example of WANs is the wireless WAN that is becoming more and more popular. We discuss wireless WANs and their evolution (Figure 6.7).

Figure 6.7. WAN.



Source: Image by Wikimedia Commons.

6.19.3. Metropolitan Area Networks

A metropolitan area network (MAN) is a network with a size between a LAN and a WAN. It normally covers the area inside a town or a city. It is designed for customers who need a high-speed connectivity, normally to the Internet, and have endpoints spread over a city or part of city.

A good example of a MAN is the part of the telephone company network that can provide a high-speed DSL line to the customer. Another example is the cable TV network that originally was designed for cable TV, but today can also be used for high-speed data connection to the Internet. We discuss DSL lines and cable TV networks.

ACTIVITY 6.2.

1. Identify some other networks in the real world.
2. Create a hotspot using a Smartphone and connect other devices to it.
3. Find and list a few ISPs in your region.

6.20. INTERCONNECTION OF NETWORKS: INTERNETWORK

Today, it is very rare to see a LAN, a MAN, or a LAN in isolation; they are connected to one another. When two or more networks are connected, they become an internetwork, or internet. As an example, assume that an organization has two offices, one on the east coast and the other on the west coast. The established office on the west coast has a bus topology LAN; the newly opened office on the east coast has a star topology LAN.

The president of the company lives somewhere in the middle and needs to have control over the company from her Horne. To create a backbone WAN for connecting these three entities (two LANs and the president's computer), a switched WAN (operated by a service provider such as a telecom company) has been leased.

To connect the LANs to this switched WAN, however, three point-to-point WANs are required. These point-to-point WANs can be a high-speed DSL line offered by a telephone company or a cable modern line offered by a cable TV provider.

6.21. COMPUTER NETWORK MODELS

When dealing with networking, you may hear the terms "network model" and "network layer" used often. Network models define a set of network layers and how they interact. There are several different network models depending on what organization or company started them.