Computer Network And Network Design(CNND) ITC402

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Module 1

Introduction to Computer Networks

Outline

- Introduction
- Uses Of Computer Networks
- Network Hardware
- Network Software
- Protocol Layering
- Reference Models: OSI, TCP/IP
- Comparison of OSI & TCP/IP
- Network Devices.

INTRODUCTION

- A **network** is a set of devices (often referred to as nodes) connected by communication links. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network.
- **Computer network** is a collection of autonomous computers interconnected by a single technology. Two computers are said to be interconnected if they are able to exchange information.
- Networks come in many sizes, shapes and forms. They are usually connected together to make larger networks, with the Internet being the most well-known example of a network of networks.
- **Data communications** are the exchange of data between two devices via some form of transmission medium such as a wire cable.
- For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs).
- The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter.

INTRODUCTION

A data communications system has five components:

1. Message
2. Sender
3. Receiver
4. Transmission medium
5. Protocol

Data Flow

Communication between two devices can be simplex, half-duplex, or full-duplex.

Network Criteria

A network must be able to meet a certain number of criteria. The most important of these are performance, reliability, and security.

INTRODUCTION

Type of Connection

- A network is two or more devices connected through links. A **link** is a communications pathway that transfers data from one device to another.
- There are two possible types of connections: point-to-point and multipoint.

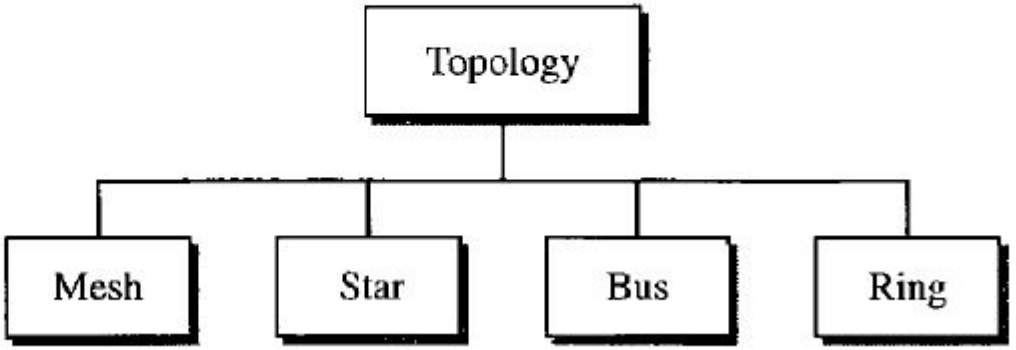
1. Point-to-Point: A point-to-point connection provides a dedicated link between two devices. The entire capacity of the link is reserved for transmission between those two devices.
2. Multipoint: A multipoint (also called multidrop) connection is one in which more than two specific devices share a single link. In a multipoint environment, the capacity of the channel is shared, either spatially or temporally.

INTRODUCTION

Physical Topology

- The term physical topology refers to the way in which a network is laid out physically.
- Two or more devices connect to a link; two or more links form a topology. The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to one another.

Figure **1.4** *Categories of topology*



MESH TOPOLOGY

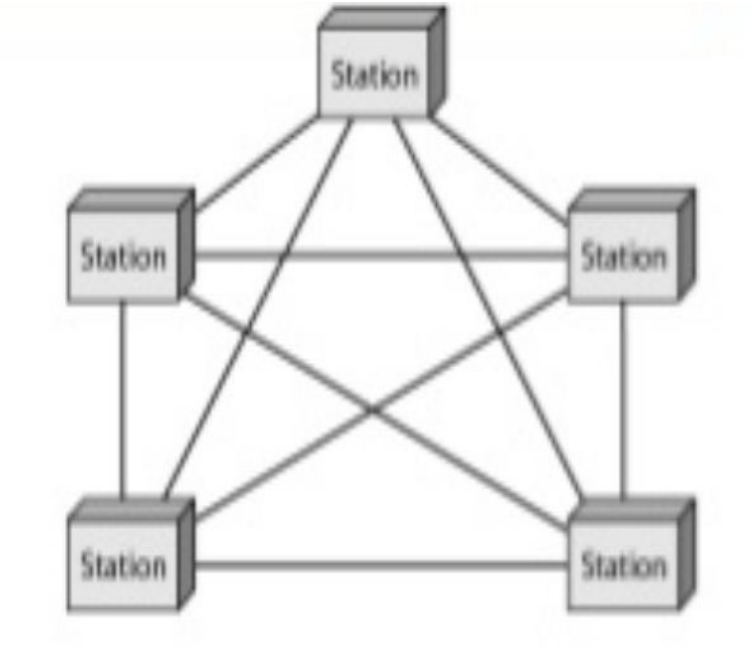
- In a mesh topology, every device has a dedicated point-to-point link to every other device.

Advantages:

- High speed
- Little network failure
- Privacy and security
- Fault identification & isolation

Disadvantages:

- Number of I/O ports
- Cost



STAR TOPOLOGY

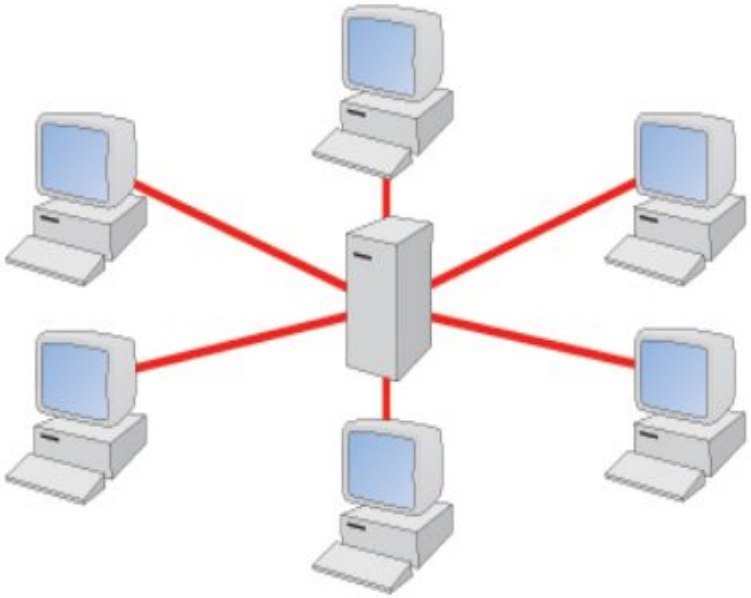
- In a star topology, each device has a dedicated point-to-point link only to a central controller, usually called a hub.
- The controller acts as an exchange: If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device .

Advantages:

- Less expensive
- Easy to install
- Robustness

Disadvantage:

- Single point of dependency



BUS TOPOLOGY

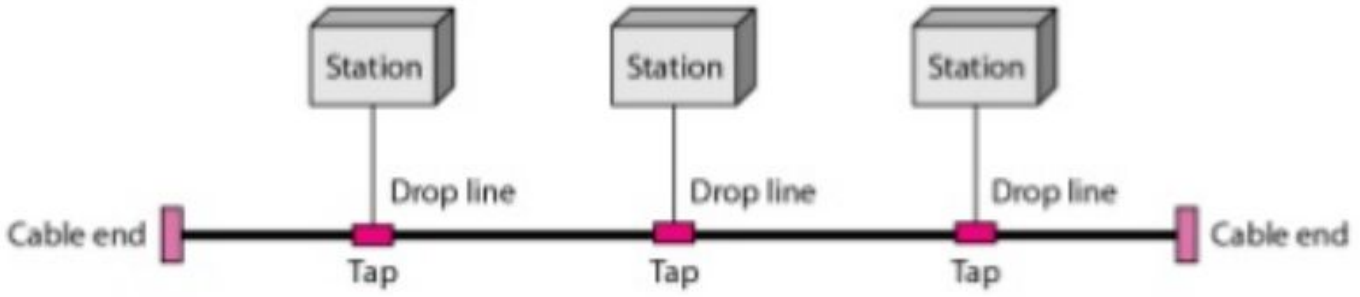
- A bus topology, is multipoint. One long cable acts as a backbone to link all the devices in a network.
- Nodes are connected to the bus cable by drop lines and taps. A tap is a connector that either splices into the main cable or punctures the sheathing of a cable to create a contact with the metallic core.

Advantages:

- Ease of installation
- Less cable required

Disadvantages:

- Difficult reconnection and fault isolation
- Long distance issue



RING TOPOLOGY

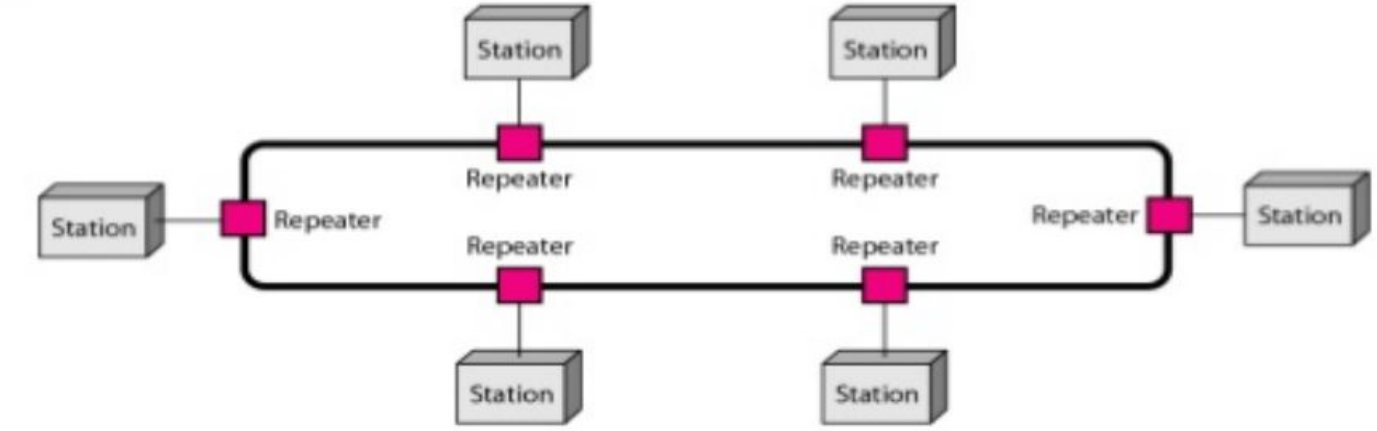
- In a ring topology, each device has a dedicated point-to-point connection with only the two devices on either side of it.
- A signal is passed along the ring in one direction, from device to device, until it reaches its destination.

Advantages:

- Ease of installation
- Fault isolation is simplified

Disadvantage:

- Unidirectional traffic



USES OF COMPUTER NETWORKS

Business Applications

- Most companies have a substantial number of computers. 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.
- However, probably even more important than sharing physical resources is sharing information. Companies small and large are vitally dependent on computerized information.
- Networks called **VPNs (Virtual Private Networks)** may be used to join the individual networks at different sites into one extended network.

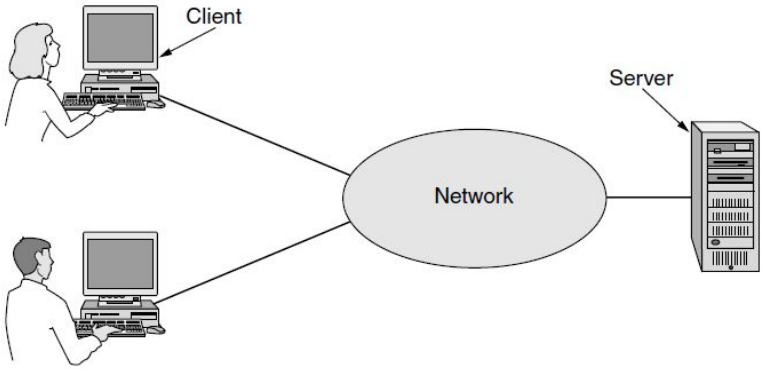


Figure 1-1. A network with two clients and one server.

USES OF COMPUTER NETWORKS

- The most popular realization of a client server model is that of a **Web application**, in which the server generates Web pages based on its database in response to client requests that may update the database.
- If we look at the client-server model in detail, we see that two processes are involved, one on the client machine and one on the server machine.

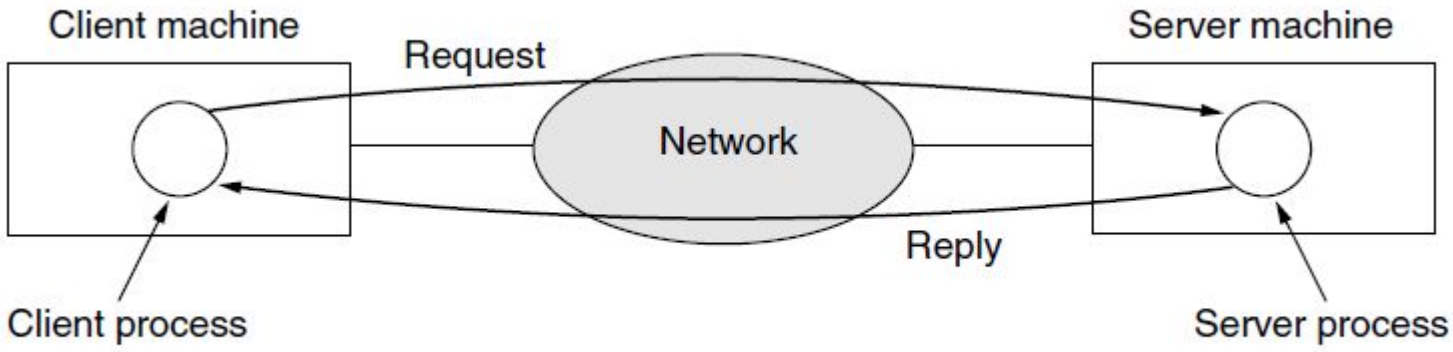


Figure 1-2. The client-server model involves requests and replies.

USES OF COMPUTER NETWORKS

- A second goal of setting up a computer network has to do with people rather than information or even computers.
- A computer network can provide a powerful **communication medium** among employees.
- Virtually every company that has two or more computers now has **email** (**electronic mail**), which employees generally use for a great deal of daily communication.
- Telephone calls between employees may be carried by the computer network instead of by the phone company. This technology is called **IP telephony** or **Voice over IP (VoIP)** when Internet technology is used.
- Video can be added to audio so that employees at distant locations can see and hear each other as they hold a meeting.
- **Desktop sharing** lets remote workers see and interact with a graphical computer screen.
- When one worker makes a change to an online document, the others can see the change immediately, instead of waiting several days for a letter.

USES OF COMPUTER NETWORKS

- A third goal for many companies is doing business electronically, especially with customers and suppliers.
- This new model is called **e-commerce** (electronic commerce) and it has grown rapidly in recent years.
- Airlines, bookstores, and other retailers have discovered that many customers like the convenience of shopping from home.
- Consequently, many companies provide catalogs of their goods and services online and take orders online.
- Using computer networks, manufacturers can place orders electronically as needed. This reduces the need for large inventories and enhances efficiency.

USES OF COMPUTER NETWORKS

- **Home Applications**
- People initially bought computers for word processing and games. Recently, the biggest reason to buy a home computer was probably for Internet access.
- Internet access provides home users with **connectivity** to remote computers.
- As with companies, home users can access information, communicate with other people, and buy products and services with e-commerce.
- Access to remote information comes in many forms. It can be surfing the World Wide Web for information or just for fun.
- Many newspapers have gone online and can be personalized.
- The next step beyond newspapers (plus magazines and scientific journals) is the online digital library. Many professional organizations, such as the ACM and the IEEE Computer Society already have all their journals and conference proceedings online.
- Much of this information is accessed using the client-server model, but there is different, popular model for accessing information that goes by the name of **peer-to-peer communication**.
- Peer-to-peer communication is often used to share music and videos.

USES OF COMPUTER NETWORKS

Home Applications

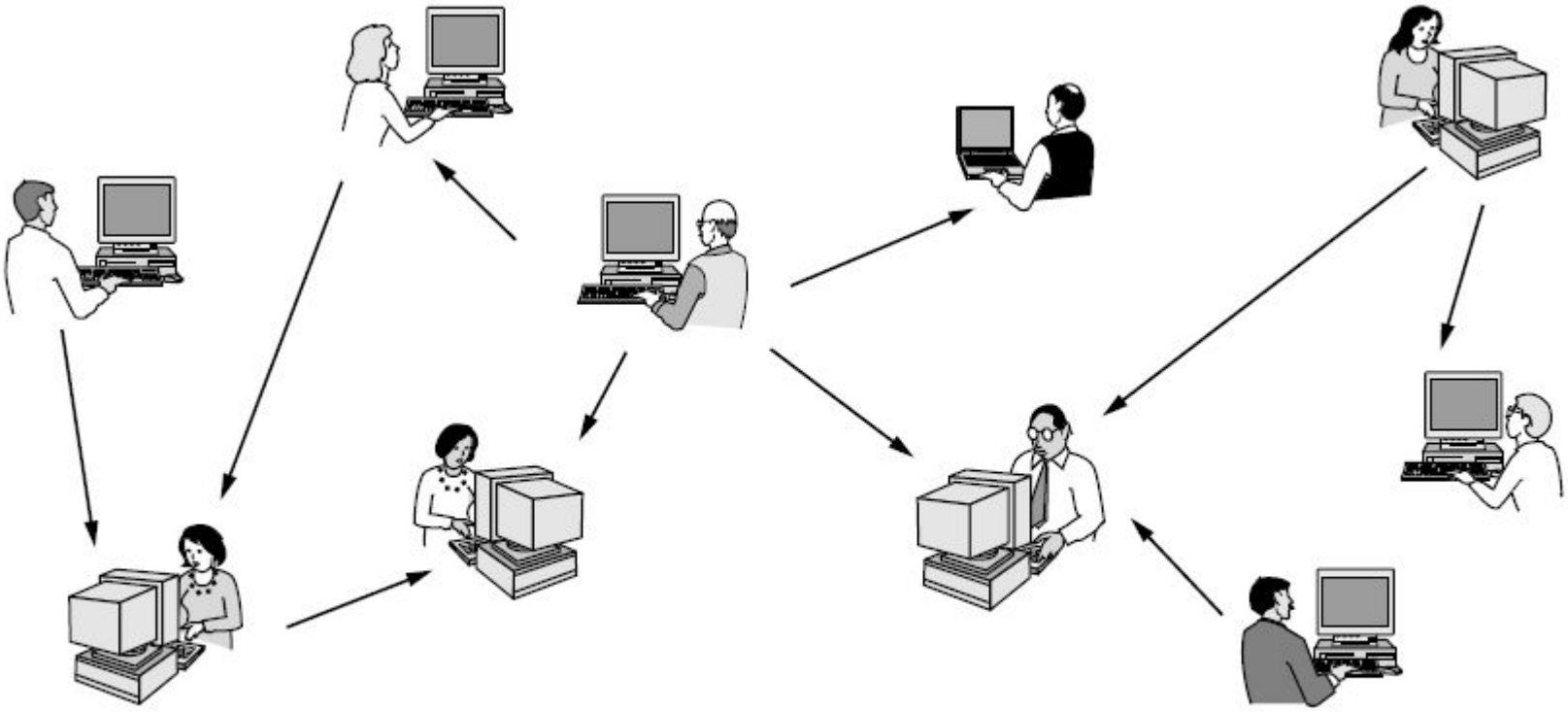


Figure 1-3. In a peer-to-peer system there are no fixed clients and servers.

USES OF COMPUTER NETWORKS

- Any teenager worth his or her salt is addicted to **instant messaging**. There are multi-person messaging services too, such as the **Twitter** service that lets people send short text messages called ‘‘tweets’’ to their circle of friends or other willing audiences.
- The Internet can be used by applications to carry and video . Besides being a cheap way to call to distant friends, these applications can provide rich experiences such as telelearning.
- Between person-to-person communications and accessing information are **social network** applications. Here, the flow of information is driven by the relationships that people declare between each other.
- One of the most popular social networking sites is **Facebook**.
- A **wiki**, for example, is a collaborative Web site that the members of a community edit. The most famous wiki is the **Wikipedia**, an encyclopedia anyone can edit, but there are thousands of other wikis.
- Our third category is electronic commerce in the broadest sense of the term.
- Home shopping is already popular and enables users to inspect the online catalogs of thousands of companies.
- Another area in which e-commerce is widely used is access to financial institutions.

USES OF COMPUTER NETWORKS

- One area that virtually nobody foresaw is electronic flea markets .
- Online auctions of second-hand goods have become a massive industry. Unlike traditional e-commerce, which follows the client-server model, online auctions are peer-to-peer in the sense that consumers can act as both buyers and sellers.
- Our fourth category is entertainment. This has made huge strides in the home in recent years, with the distribution of music, radio and television programs, and movies over the Internet beginning to rival that of traditional mechanisms.
- Users can find, buy, and download MP3 songs and DVD-quality movies and add them to their personal collection.
- TV shows now reach many homes via IPTV (IP TeleVision) systems that are based on IP technology instead of cable TV or radio transmissions.
- Naturally, all of this content can be moved around your house between different devices, displays and speakers, usually with a wireless network.
- Another form of entertainment is game playing.
- Our last category is **ubiquitous computing**, in which computing is embedded into everyday life.

USES OF COMPUTER NETWORKS

- **Mobile Users:**
- Mobile computers, such as laptop and handheld computers, are one of the fastest-growing segments of the computer industry.
- People on the go often want to use their mobile devices to read and send email, tweet, watch movies, download music, play games, or simply to surf the Web for information.
- **Connectivity** to the Internet enables many of these mobile uses. Since having a wired connection is impossible in cars, boats, and airplanes, there is a lot of interest in wireless networks.
- Anyone with a laptop computer and a wireless modem can just turn on their computer on and be connected to the Internet through the hotspot, as though the computer were plugged into a wired network.
- Although wireless networking and mobile computing are often related, they are not identical.

Wireless	Mobile	Typical applications
No	No	Desktop computers in offices
No	Yes	A notebook computer used in a hotel room
Yes	No	Networks in unwired buildings
Yes	Yes	Store inventory with a handheld computer

Figure 1-5. Combinations of wireless networks and mobile computing.

USES OF COMPUTER NETWORKS

- Perhaps the key driver of mobile, wireless applications is the mobile phone.
- **Text messaging** or **texting** is tremendously popular. It lets a mobile phone user type a short message that is then delivered by the cellular network to another mobile subscriber.
- **Smart phones**, such as the popular iPhone, combine aspects of mobile phones and mobile computers.
- The (3G and 4G) cellular networks to which they connect can provide fast data services for using the Internet as well as handling phone calls.
- Electronic book readers can download a newly purchased book or the next edition of a magazine or today's newspaper wherever they roam.
- Since mobile phones know their locations, often because they are equipped with **GPS** (**Global Positioning System**) receivers, some services are intentionally location dependent.
- An area in which mobile phones are now starting to be used is **m-commerce (mobile-commerce)** .
- Short text messages from the mobile are used to authorize payments for food in vending machines, movie tickets, and other small items instead of cash and credit cards.

USES OF COMPUTER NETWORKS

- **Sensor networks** are made up of nodes that gather and wirelessly relay information they sense about the state of the physical world.
- The nodes may be part of familiar items such as cars or phones, or they may be small separate devices.
- Sensor networks are revolutionizing science by providing a wealth of data on behavior that could not previously be observed.
- **Wearable computers** are another promising application.

USES OF COMPUTER NETWORKS

Social Issues

- Computer networks, like the printing press 500 years ago, allow ordinary citizens to distribute and view content in ways that were not previously possible.
- But along with the good comes the bad, as this new-found freedom brings with it many unsolved social, political, and ethical issues.
- Social networks, message boards, content sharing sites, and a host of other applications allow people to share their views with like-minded individuals.
- Furthermore, opinions need not be limited to text; high-resolution color photographs and video clips are easily shared over computer networks.
- For instance, pirated music and movies fueled the massive growth of peer-to-peer networks, which did not please the copyright holders, who have threatened (and sometimes taken) legal action.
- Computer networks make it very easy to communicate. They also make it easy for the people who run the network to snoop on the traffic.
- This sets up conflicts over issues such as employee rights versus employer rights.
- Another conflict is centered around government versus citizen's rights.
- A new twist with mobile devices is location privacy . As part of the process of providing service to your mobile device the network operators learn where you are at different times of day.

USES OF COMPUTER NETWORKS

- Electronic junk mail (spam) has become a part of life because spammers have collected millions of email addresses and would-be marketers can cheaply send computer-generated messages to them.
- Still other content is intended for criminal behavior. Web pages and email messages containing active content (basically, programs or macros that execute on the receiver's machine) can contain viruses that take over your computer.
- **Phishing** messages masquerade as originating from a trustworthy party.
- It can be difficult to prevent computers from impersonating people on the Internet.
- This problem has led to the development of **CAPTCHAs.**

NETWORK HARDWARE

- There is no generally accepted taxonomy into which all computer networks fit, but two dimensions stand out as important: **transmission technology** and **scale**.
- There are two types of transmission technology that are in widespread use: **broadcast links** and **point-to-point links**.
- Point-to-point transmission with exactly one sender and exactly one receiver is sometimes called **unicasting**.
- In contrast, on a broadcast network, the communication channel is shared by all the machines on the network; packets sent by any machine are received by all the others. An address field within each packet specifies the intended recipient.
- A wireless network is a common example of a broadcast link, with communication shared over a coverage region that depends on the wireless channel and the transmitting machine.
- Broadcast systems usually also allow the possibility of addressing a packet to all destinations by using a special code in the address field. When a packet with this code is transmitted, it is received and processed by every machine on the network. This mode of operation is called **broadcasting**.
- Some broadcast systems also support transmission to a subset of the machines, which known as **multicasting**.

NETWORK HARDWARE

- An alternative criterion for classifying networks is by scale.
- Distance is important as a classification metric because different technologies are used at different scales.

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

Figure 1-6. Classification of interconnected processors by scale.

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.
- Almost every computer has an attached monitor, keyboard, mouse, and printer. Without using wireless, this connection must be done with cables.
- To help these users, some companies got together to design a short-range wireless network called Bluetooth to connect these components without wires.
- Bluetooth can be used in other settings, too.

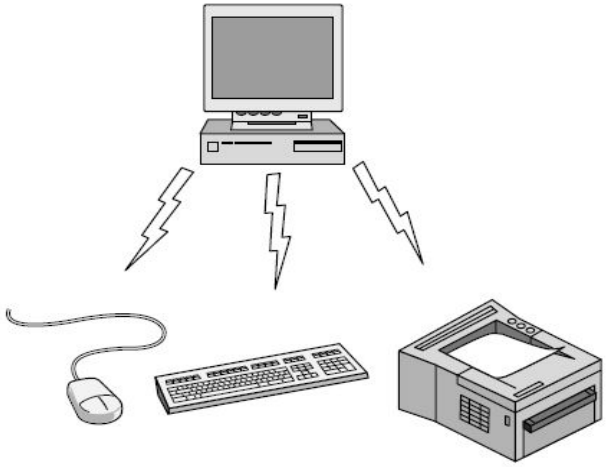


Figure 1-7. Bluetooth PAN configuration.

LOCAL AREA NETWORKS

- **LAN (Local Area Network)** is a privately owned network that operates within and nearby a single building like a home, office or factory.
- LANs are widely used to connect personal computers and consumer electronics to let them share resources (e.g., printers) and exchange information.
- When LANs are used by companies, they are called **enterprise networks**.
- Wireless LANs are very popular these days, especially in homes, older office buildings, cafeterias, and other places where it is too much trouble to install cables.
- In 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 in the ceiling . 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.
- There is a standard for wireless LANs called IEEE 802.11, popularly known as WiFi, which has become very widespread. It runs at speeds anywhere from 11 to hundreds of Mbps.

LOCAL AREA NETWORKS

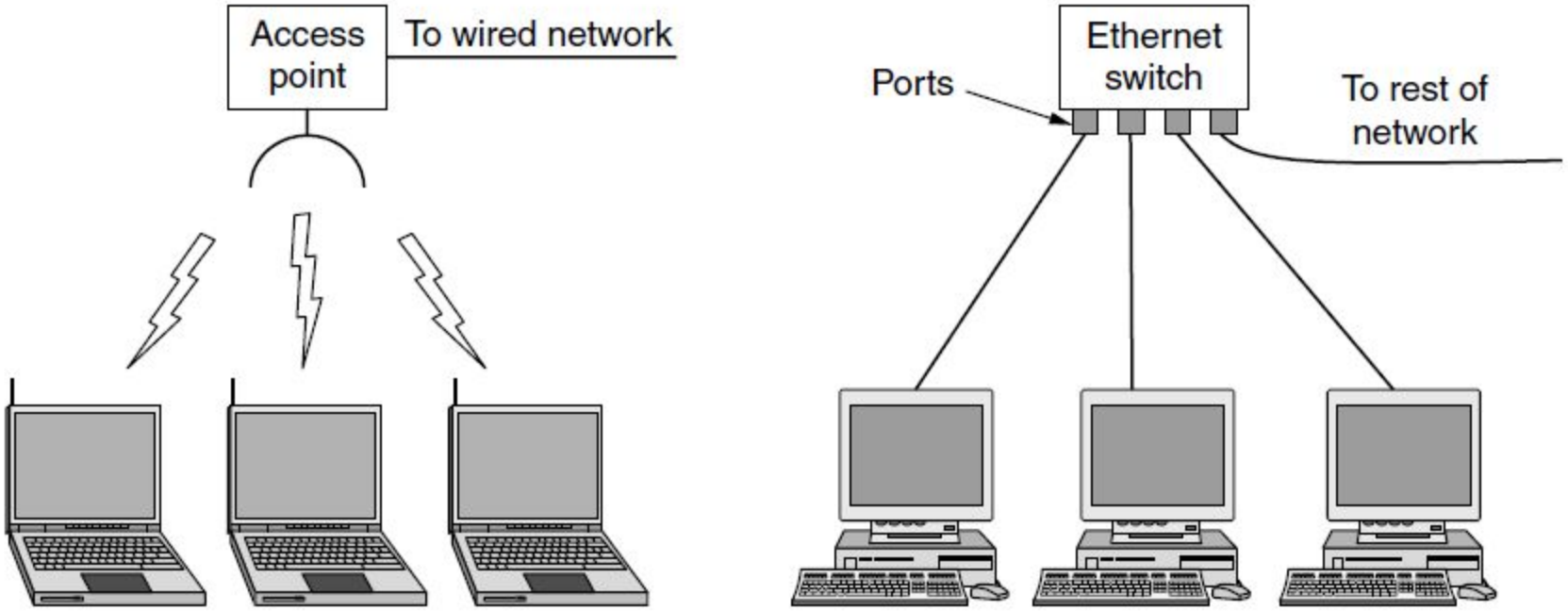


Figure 1-8. Wireless and wired LANs. (a) 802.11. (b) Switched Ethernet.

LOCAL AREA NETWORKS

- Wired LANs use a range of different transmission technologies. Most of them use copper wires, but some use optical fiber.
- LANs are restricted in size, which means that the worst-case transmission time is bounded and known in advance.
- Typically, wired LANs run at speeds of 100 Mbps to 1 Gbps, have low delay (microseconds or nanoseconds), and make very few errors.
- Newer LANs can operate at up to 10 Gbps. Compared to wireless networks, wired LANs exceed them in all dimensions of performance. It is just easier to send signals over a wire or through a fiber than through the air.
- The topology of many wired LANs is built from point-to-point links.
- IEEE 802.3, popularly called **Ethernet**, is, by far, the most common type of wired LAN.
- Both wireless and wired broadcast networks can be divided into static and dynamic designs, depending on how the channel is allocated.
- A typical static allocation would be to divide time into discrete intervals and use a round-robin algorithm, allowing each machine to broadcast only when its time slot comes up.
- Dynamic allocation methods for a common channel are either centralized or decentralized.

LOCAL AREA NETWORKS

- In the future, it is likely that every appliance in the home will be capable of communicating with every other appliance, and all of them will be accessible over the Internet.
- While we could think of the home network as just another LAN, it is more likely to have different properties than other networks.

1. First, the networked devices have to be very easy to install.
2. Second, the network and devices have to be foolproof in operation.
3. Third, low price is essential for success.
4. Fourth, it must be possible to start out with one or two devices and expand the reach of the network gradually.
5. Fifth, security and reliability will be very important.

METROPOLITAN AREA NETWORKS

- A **MAN (Metropolitan Area Network)** covers a city. The best-known examples of MANs are the cable television networks available in many cities.
- At first, these were locally designed, ad hoc systems. Then companies began jumping into the business, getting contracts from local governments to wire up entire cities.
- The next step was television programming and even entire channels designed for cable only. Often these channels were highly specialized, such as all news, all sports, all cooking, all gardening, and so on.
- When the Internet began attracting a mass audience, the cable TV network operators began to realize that with some changes to the system, they could provide two-way Internet service in unused parts of the spectrum.
- Cable television is not the only MAN, though. Recent developments in highspeed wireless Internet access have resulted in another MAN, which has been standardized as IEEE 802.16 and is popularly known as **WiMAX**.

METROPOLITAN AREA NETWORKS

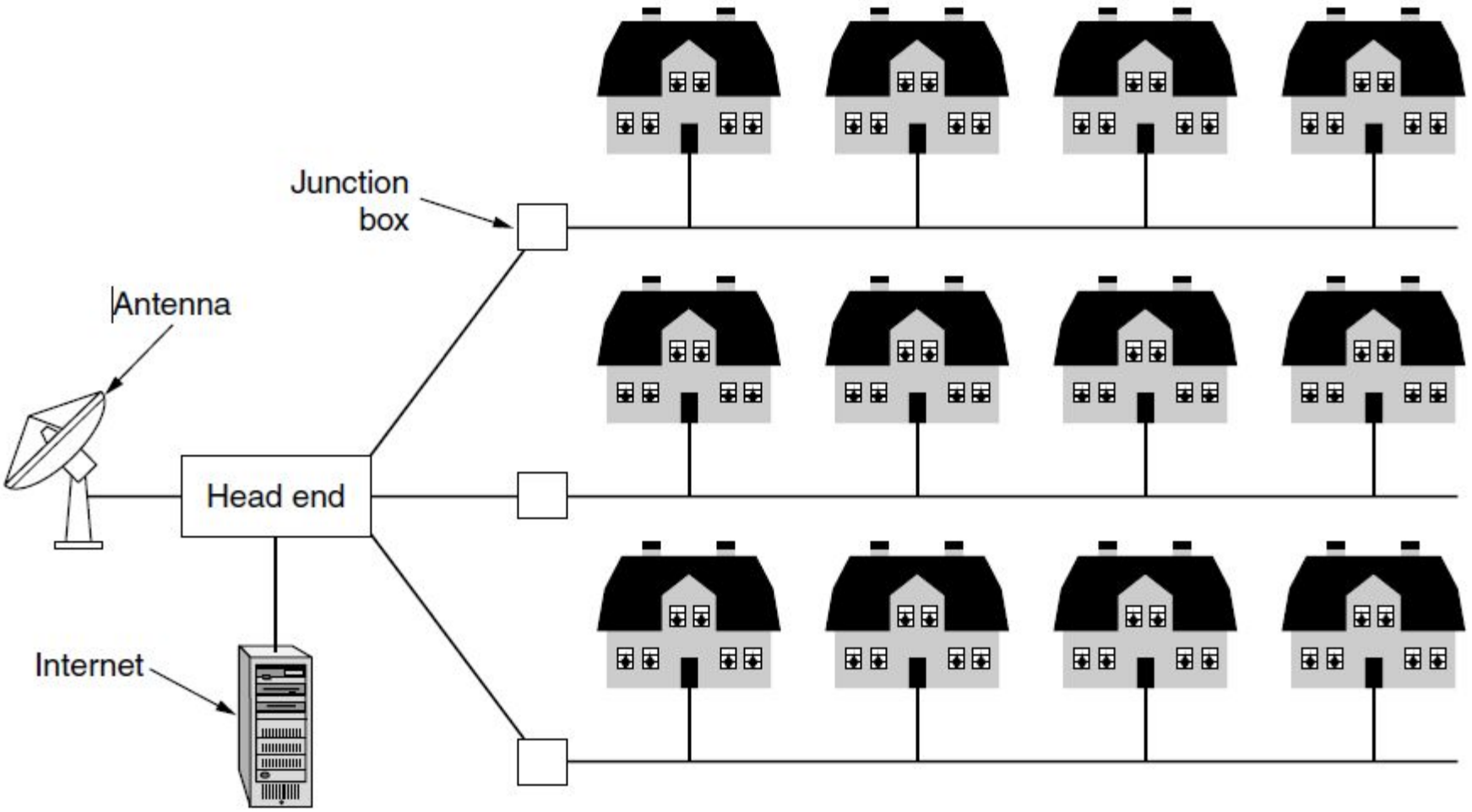


Figure 1-9. A metropolitan area network based on cable TV.

WIDE AREA NETWORKS

- A **WAN (Wide Area Network)** spans a large geographical area, often a country or continent.
- We will begin our discussion with wired WANs, using the example of a company with branch offices in different cities.
- In most WANs, the subnet consists of two distinct components: transmission lines and switching elements.
- **Transmission lines** move bits between machines.
- **Switching elements**, or just **switches**, are specialized computers that connect two or more transmission lines.
- When data arrive on an incoming line, the switching element must choose an outgoing line on which to forward them.
- The WAN as we have described it looks similar to a large wired LAN, but there are some important differences that go beyond long wires.
- Usually in a WAN, the hosts and subnet are owned and operated by different people.

WIDE AREA NETWORKS

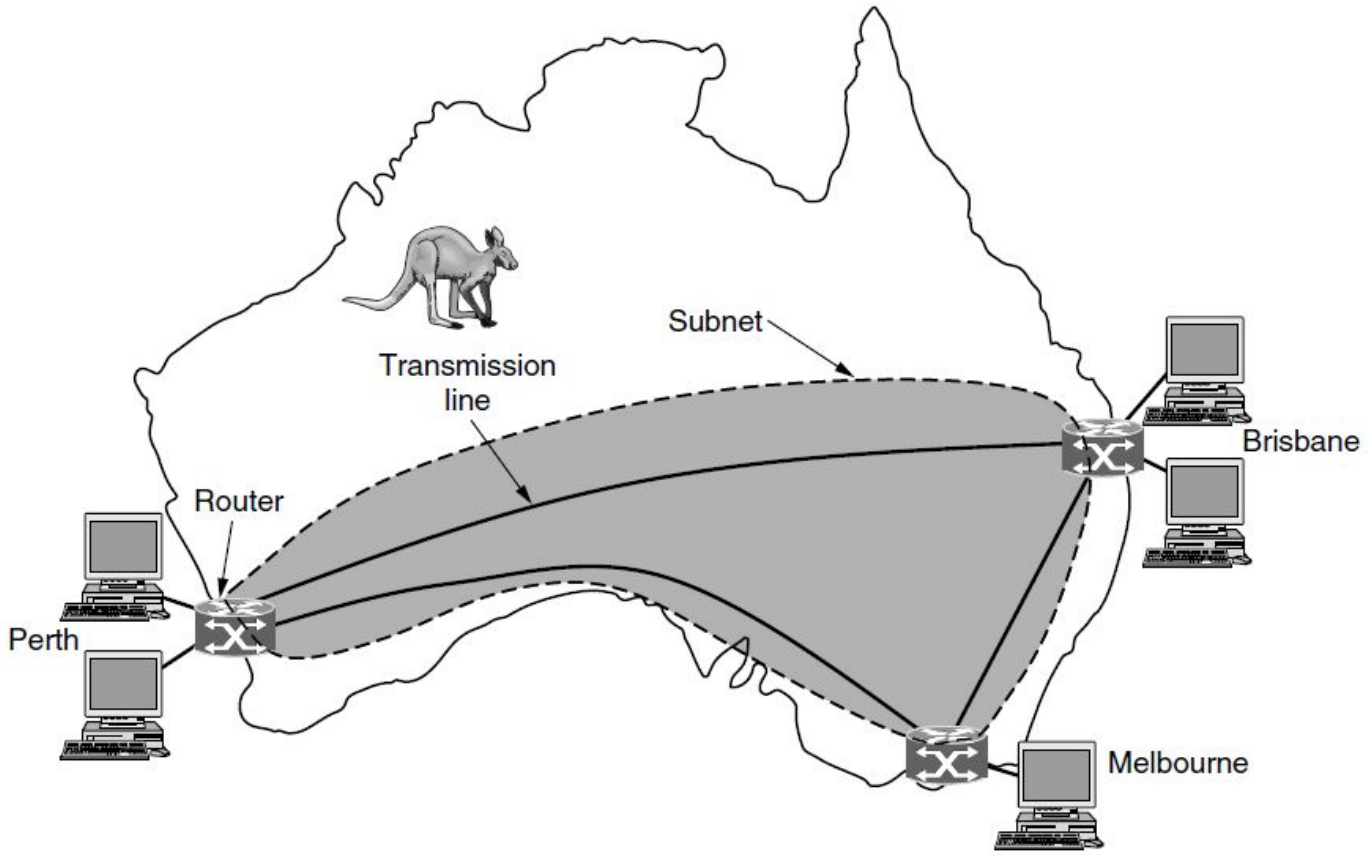


Figure 1-10. WAN that connects three branch offices in Australia.

INTERNETWORKS

- Many networks exist in the world, often with different hardware and software.
- People connected to one network often want to communicate with people attached to a different one.
- The fulfillment of this desire requires that different, and frequently incompatible, networks be connected.
- A collection of interconnected networks is called an **internetwork** or **internet**.
- The Internet uses ISP networks to connect enterprise networks, home networks, and many other networks.
- The general name for a machine that makes a connection between two or more networks and provides the necessary translation, both in terms of hardware and software, is a **gateway**.

NETWORK SOFTWARE

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.
- A five-layer network is illustrated in Fig. 1-13. 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.
- 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.
- A set of layers and protocols is called a **network architecture**.
- A list of the protocols used by a certain system, one protocol per layer, is called a **protocol stack.**

NETWORK SOFTWARE

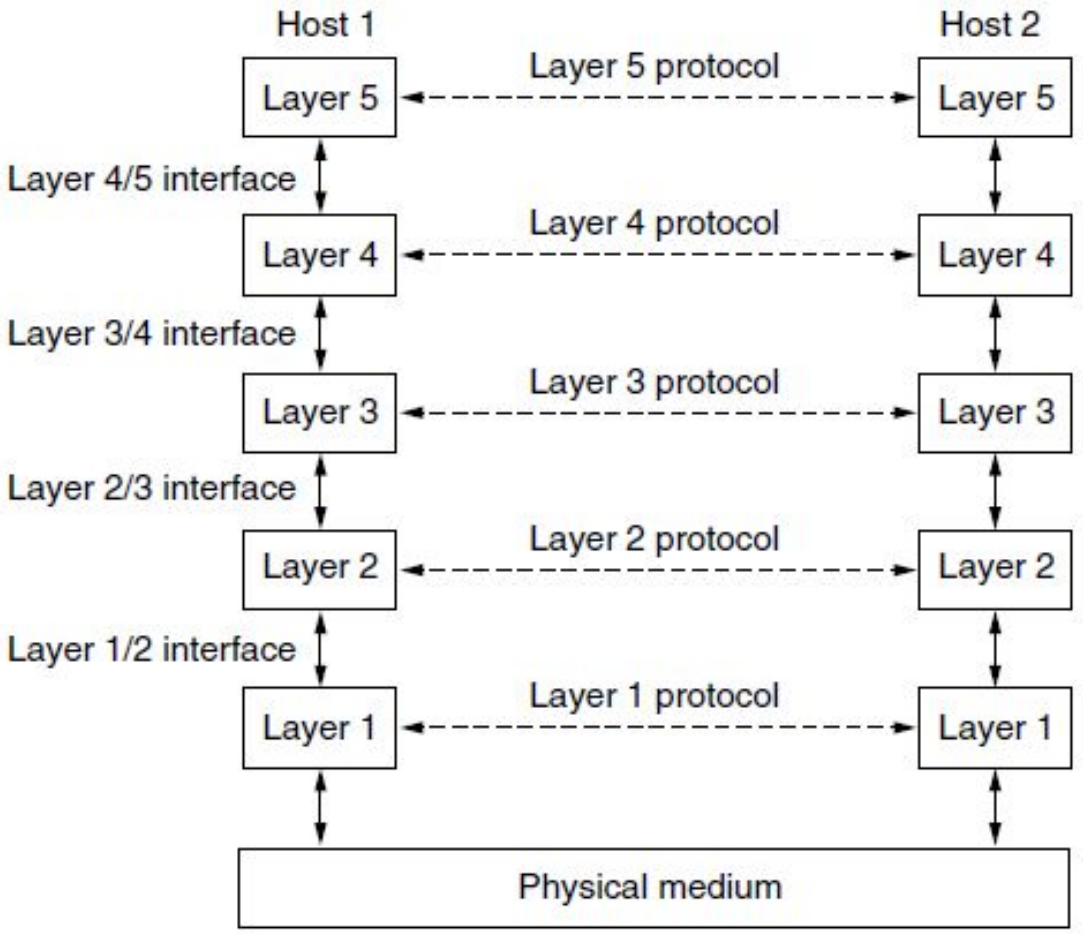


Figure 1-13. Layers, protocols, and interfaces.

NETWORK SOFTWARE

Design Issues for the Layers

- Reliability is the design issue of making a network that operates correctly even though it is made up of a collection of components that are themselves unreliable.
- One mechanism for finding errors in received information uses codes for error detection. Information that is incorrectly received can then be retransmitted until it is received correctly. More powerful codes allow for **error correction**, where the correct message is recovered from the possibly incorrect bits that were originally received.
- They are used at low layers, to protect packets sent over individual links, and high layers, to check that the right contents were received.
- Another reliability issue is finding a working path through a network. This topic is called **routing**.
- A second design issue concerns the evolution of the network. Over time, networks grow larger and new designs emerge that need to be connected to the existing network.
- An aspect of growth is that different network technologies often have different limitations.
- Designs that continue to work well when the network gets large are said to be **scalable**.

NETWORK SOFTWARE

- A third design issue is resource allocation.
- Networks provide a service to hosts from their underlying resources, such as the capacity of transmission lines.
- To do this well, they need mechanisms that divide their resources so that one host does not interfere with another too much.
- An allocation problem that occurs at every level is how to keep a fast sender from swamping a slow receiver with data. Feedback from the receiver to the sender is often used. This subject is called **flow control**.
- Sometimes the problem is that the network is oversubscribed because too many computers want to send too much traffic, and the network cannot deliver it all. This overloading of the network is called **congestion**.
- Most networks must provide service to applications that want **real-time** delivery at the same time that they provide service to applications that want high throughput.
- The last major design issue is to secure the network by defending it against different kinds of threats.

NETWORK SOFTWARE

Connection-Oriented Versus Connectionless Service

- Layers can offer two different types of service to the layers above them: connection- oriented and connectionless.
- **Connection-oriented** service is modeled after the telephone system.
- In some cases when a connection is established, the sender, receiver, and subnet conduct a **negotiation** about the parameters to be used, such as maximum message size, quality of service required, and other issues.
- In contrast to connection-oriented service, **connectionless** service is modeled after the postal system.
- Each kind of service can further be characterized by its reliability. Some services are reliable in the sense that they never lose data.
- Usually, a reliable service is implemented by having the receiver acknowledge the receipt of each message so the sender is sure that it arrived.
- Unreliable (meaning not acknowledged) connectionless service is often called datagram service, in analogy with telegram service, which also does not return an acknowledgement to the sender.
- Still another service is the **request-reply** service.

NETWORK SOFTWARE

Service Primitives

- A service is formally specified by a set of primitives (operations) available to user processes to access the service.
- These primitives tell the service to perform some action or report on an action taken by a peer entity.
- The set of primitives available depends on the nature of the service being provided.
- The primitives for connection-oriented service are different from those of connectionless service.

Primitive	Meaning
LISTEN	Block waiting for an incoming connection
CONNECT	Establish a connection with a waiting peer
ACCEPT	Accept an incoming connection from a peer
RECEIVE	Block waiting for an incoming message
SEND	Send a message to the peer
DISCONNECT	Terminate a connection

Figure 1-17. Six service primitives that provide a simple connection-oriented service.

THE OSI REFERENCE MODEL

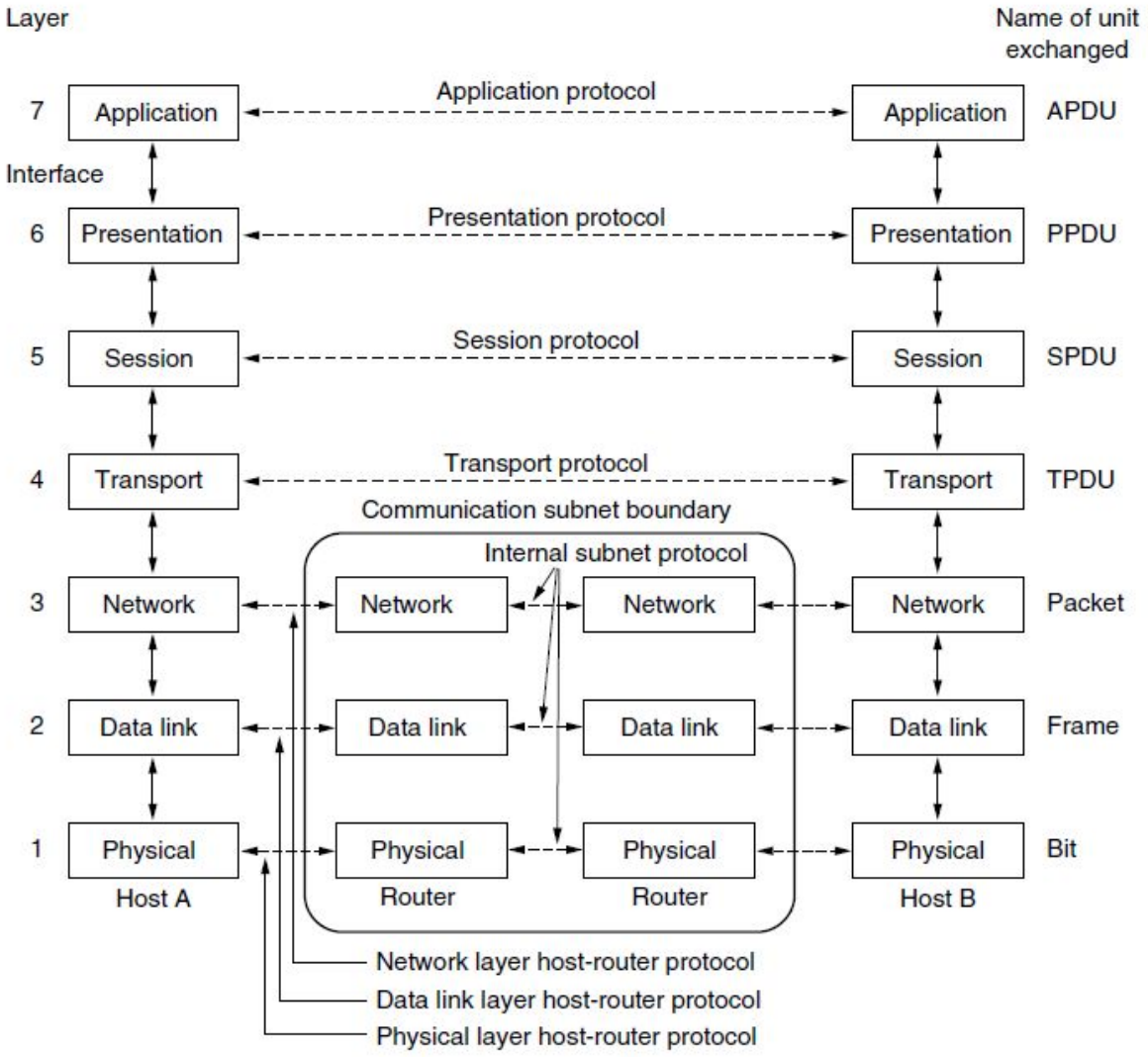


Figure 1-20. The OSI reference model.

THE OSI REFERENCE MODEL

The Physical Layer

The physical layer is also concerned with the following:

1. Physical characteristics of interfaces and medium.
2. Representation of bits.
3. Data rate
4. Synchronization of bits
5. Line configuration
6. Physical topology
7. Transmission mode.

THE OSI REFERENCE MODEL

Data Link Layer

- The data link layer transforms the physical layer, a raw transmission facility, to a reliable link.
- Other responsibilities of the data link layer include the following:

1. Framing.
2. Physical addressing
3. Flow control
4. Error control
5. Access control

Network Layer

- The network layer is responsible for the source-to-destination delivery of a packet, possibly across multiple networks (links).
- Other responsibilities of the network layer include the following:

1. Logical Addressing
2. Routing

THE OSI REFERENCE MODEL

Transport Layer

- The transport layer is responsible for process-to-process delivery of the entire message.
- A process is an application program running on a host.
- The transport layer, ensures that the whole message arrives intact and in order, overseeing both error control and flow control at the source-to-destination level.
- Other responsibilities of the transport layer include the following:

1. Service-point addressing
2. Segmentation and reassembly
3. Connection control.
4. Flow control.
5. Error control.

THE OSI REFERENCE MODEL

Session Layer

- The session layer is the network dialog controller.
- It establishes, maintains, and synchronizes the interaction among communicating systems.
- Specific responsibilities of the session layer include the following:

1. Dialog Control
2. Synchronization

Presentation Layer

- The presentation layer is concerned with the syntax and semantics of the information exchanged between two systems.
- Specific responsibilities of the presentation layer include the following:

1. Translation
2. Encryption
3. Compression

THE OSI REFERENCE MODEL

Application Layer

- The application layer enables the user, whether human or software, to access the network.
- It provides user interfaces and support for services such as electronic mail, remote file access and transfer, shared database management, and other types of distributed information services.
- Specific services provided by the application layer include the following:

1. Network virtual terminal
2. File transfer, access, and management.
3. Mail services.
4. Directory services.

TCP/IP REFERENCE MODEL

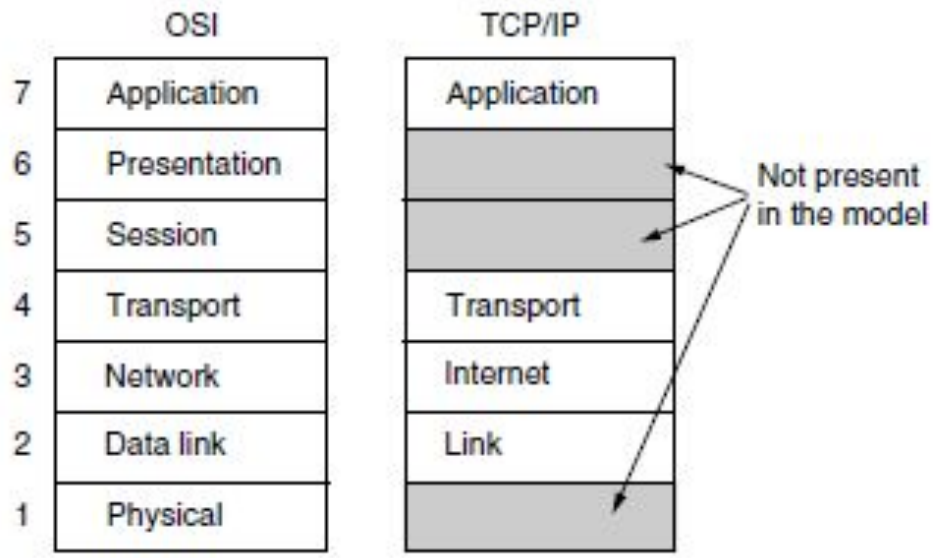


Figure 1-21. The TCP/IP reference model.

TCP/IP REFERENCE MODEL

The Link Layer

- The lowest layer in the model, the link layer describes what links such as serial lines and classic Ethernet must do to meet the needs of this connectionless internet layer.
- It is not really a layer at all, in the normal sense of the term, but rather an interface between hosts and transmission links.

The Internet Layer

- The internet layer is the linchpin that holds the whole architecture together.
- Its job is to permit hosts to inject packets into any network and have them travel independently to the destination .
- They may even arrive in a completely different order than they were sent.
- The protocols present in this layer are Internet Protocol (IP) and Internet Control Message Protocol (ICMP).
- The various functions performed by the Internet Layer are:
  - Delivering IP packets
  - Performing routing
  - Avoiding congestion

TCP/IP REFERENCE MODEL

The Transport Layer

- It is designed to allow peer entities on the source and destination hosts to carry on a conversation.
- Two end-to-end transport protocols have been defined here. The first one, TCP (Transmission Control Protocol), is a reliable connection-oriented protocol
- The second protocol in this layer, UDP (User Datagram Protocol), is an unreliable, connectionless protocol.

The Application Layer

- Different types of application and the protocols reside in this layer and they handle different types of communication.
- It contains all the higher- level protocols.
- The early ones included virtual terminal (TELNET), file transfer (FTP), and electronic mail (SMTP).

TCP/IP PROTOCOL SUITE

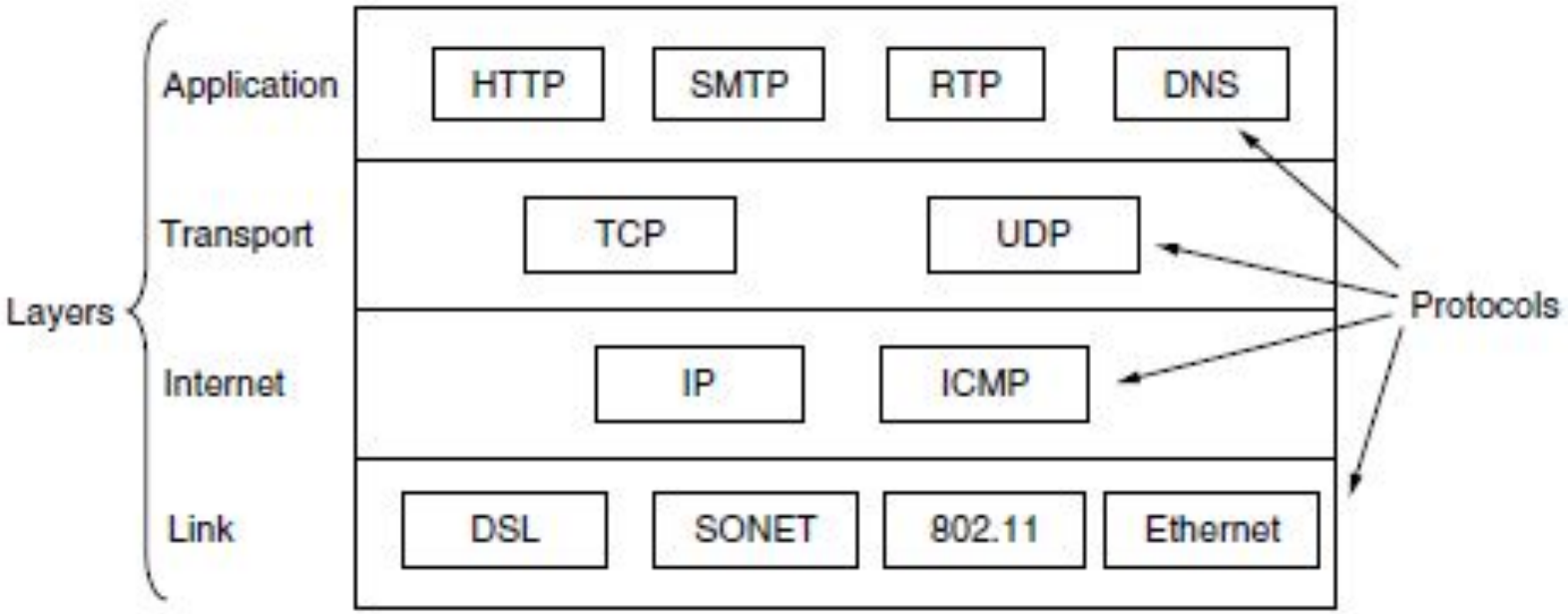


Figure 1-22. The TCP/IP model with some protocols we will study.

COMPARISON OF OSI AND TCP/IP

OSI	TCP/IP
• OSI model is a generic model that is based upon functionalities of each layer.	TCP/IP model is based on standard protocols.
• OSI model distinguishes the three concepts, namely, services, interfaces, and protocols.	TCP/IP does not have a clear distinction between these three
• OSI model has a separate Presentation layer and Session layer.	TCP/IP does not have a separate Presentation layer or Session layer.
• OSI is a reference model around which the networks are built.	TCP/IP model is, in a way implementation of the OSI model.
• In OSI, the model was developed first and then the protocols in each layer were developed.	In the TCP/IP suite, the protocols were developed first and then the model was developed.

NETWORK DEVICES

Hub:

- Several networks need a central location to connect media segments together. These central locations are called as hubs.
- There are two types of hub:
  Active Hub
  Passive Hub

Repeater:

- A repeater operates at the physical layer.
- Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted.
- Repeaters do not amplify the signal when the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength.

NETWORK DEVICES

Bridge:

- A bridge operates at data link layer.
- A bridge is a repeater, with add on functionality of filtering content by reading the MAC addresses of source and destination.
- It is also used for interconnecting two LANs working on the same protocol.

Switch:

- A switch is a multi port bridge with a buffer and a design that can boost its efficiency and performance.
- Switch is data link layer device.
- Switch can perform error checking before forwarding data.

NETWORK DEVICES

Router:

- A router is a device like a switch that routes data packets based on their IP addresses.
- Router is a Network Layer device.
- Routers normally connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets.

Gateway:

- A gateway is a passage to connect two networks together that may work upon different networking models.
- Gateways are called protocol converters and can operate at any network layer.

Thank you …