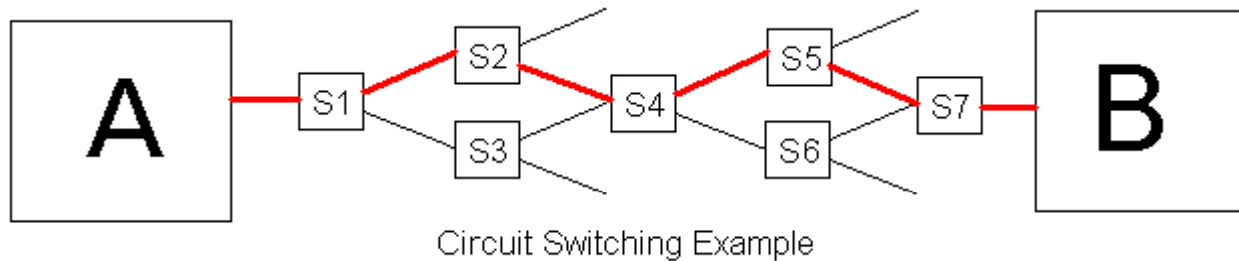


Packet Switching and Computer Networks



Switching

- As computer networks became more pervasive, more and more data and also less voice was transmitted over telephone lines. Circuit Switching
 - The telephone network used circuit switching. Circuit switching operates by first reserving a complete route from the sender to the receiver. This bandwidth does not change during a call, and remains reserved even if the connection is not transmitting any data but is still active. An example follows:



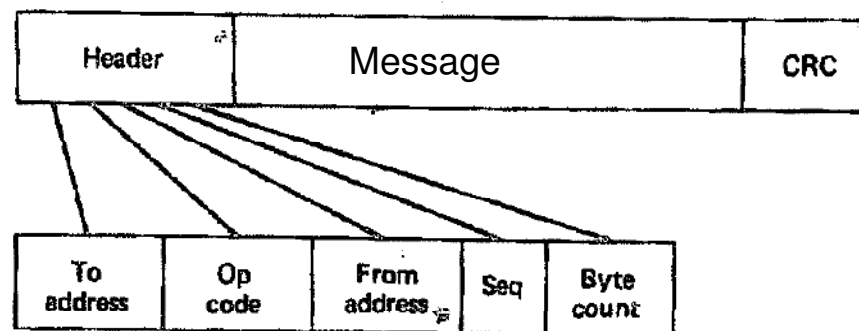
- A fixed bandwidth will be reserved at S1,S2,S4,S5, and S7 for the duration

Packet Switching

- ❑ Packet switching is similar to message switching using short messages. Any message exceeding a network-defined maximum length is broken up into shorter units, known as packets, for transmission; the packets, each with an associated header, are then transmitted individually through the network.
- ❑ The performance of Packet Switching is called *Best Effort* performance. If you transmit from sender to receiver, all the network will do its best to get the packet to the other end as fast as possible, but there are no guarantees on how fast that packet will arrive.

Packet Formats

- ❑ A packet contains three major fields:
 - ❑ The header, the message, and redundancy check bits
 - ❑ Most popular technique uses cyclic redundancy checks (CRCs)
 - ❑ CRC is nothing more than a set of parity bits that cover overlapping fields of message bits.
 - ❑ CRC can detect small number of errors
 - ❑ A header typically contain numerous subfields in addition to the necessary address field

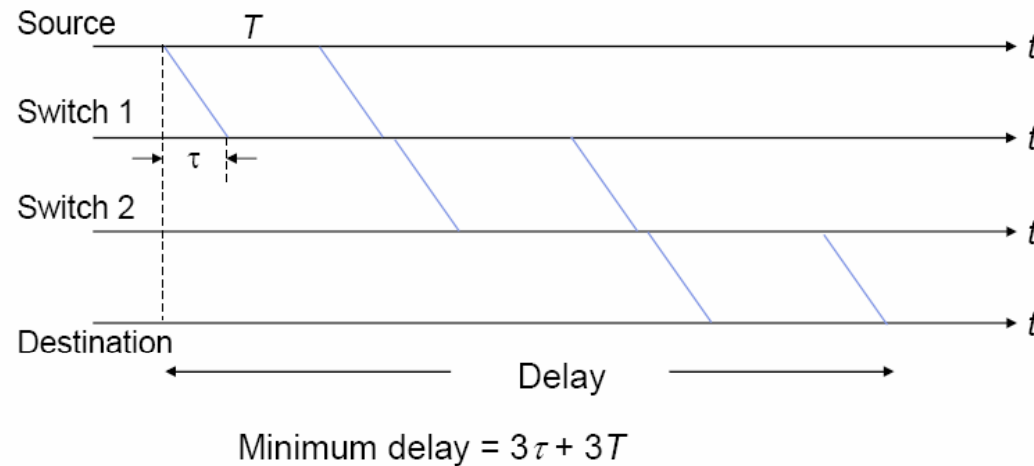


Message Switching

- ❑ Packet switching has its origin in message switching
- ❑ A message switch typically operates in the store-and-forward fashion
- ❑ Message has to be completely received and stored by the switch before it can be forwarded to the next switch.

Delays in Message switching

□ Minimum delay in message switching

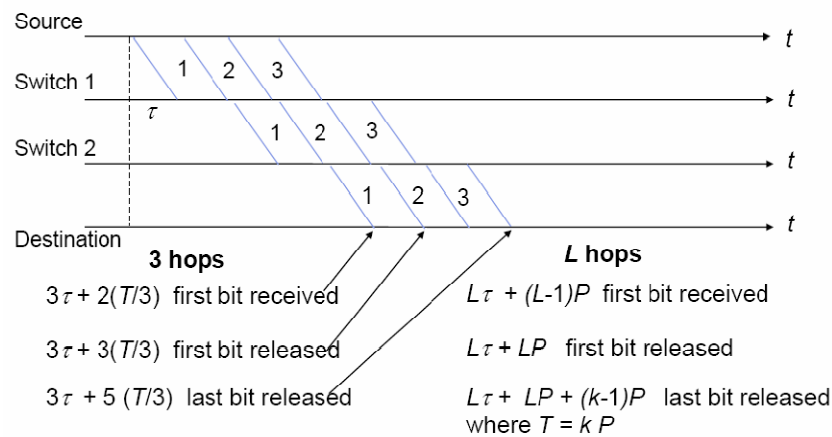


Datagram Packet Switching

- ❑ Each packet is routed independently through network
- ❑ It is also called connectionless packet-switching
- ❑ Routers in the internet are packet switches that operate in datagram mode

Delay Calculations

- Delay in datagram packet switching
- Assume $P=T/3$ is required to transmit

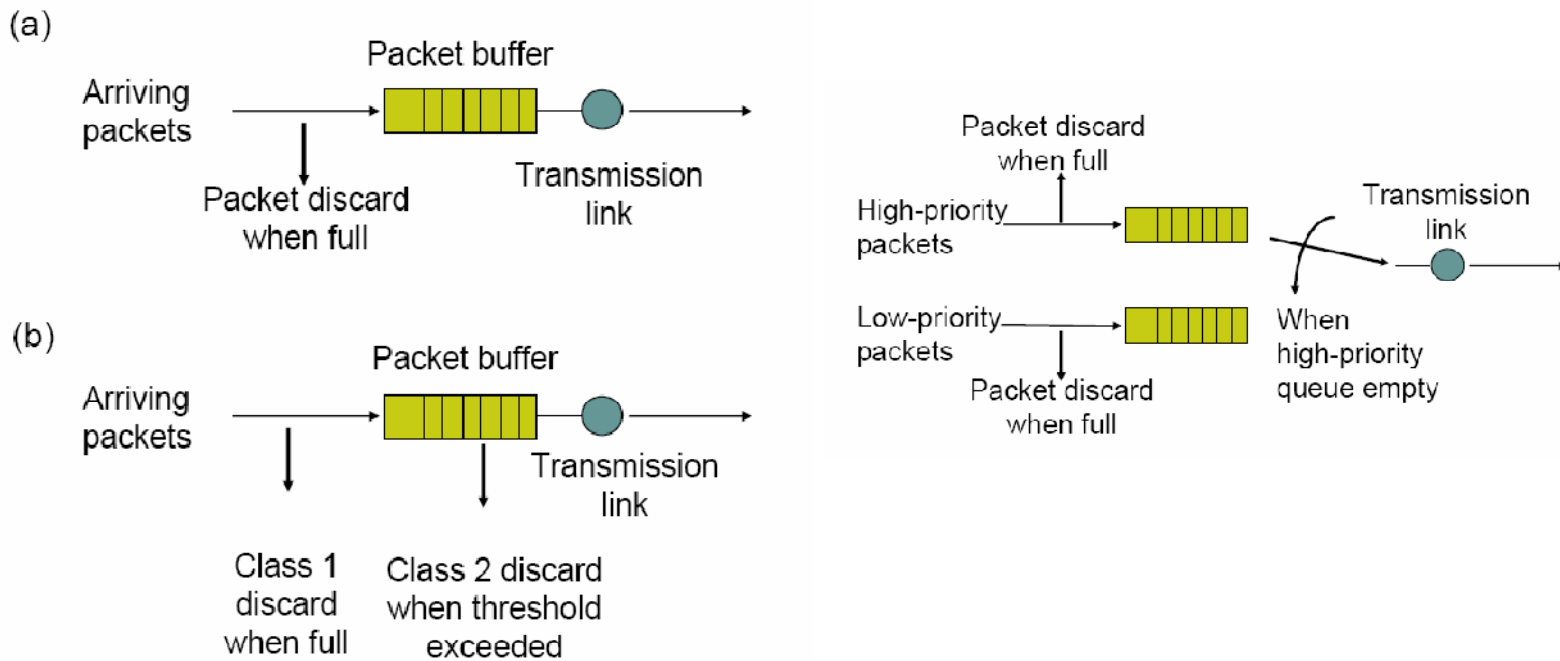


Virtual-Circuit Packet Switching

- VC packet switching involves the establishment of a fixed path, often called a virtual circuit or a connection

Congestion

□ Congestion

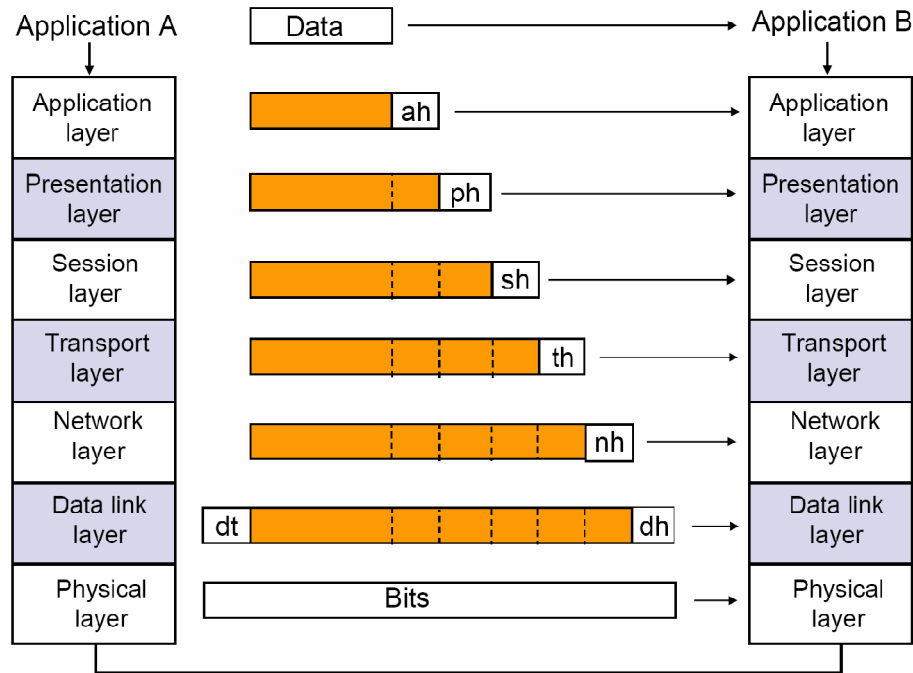


Reference Models

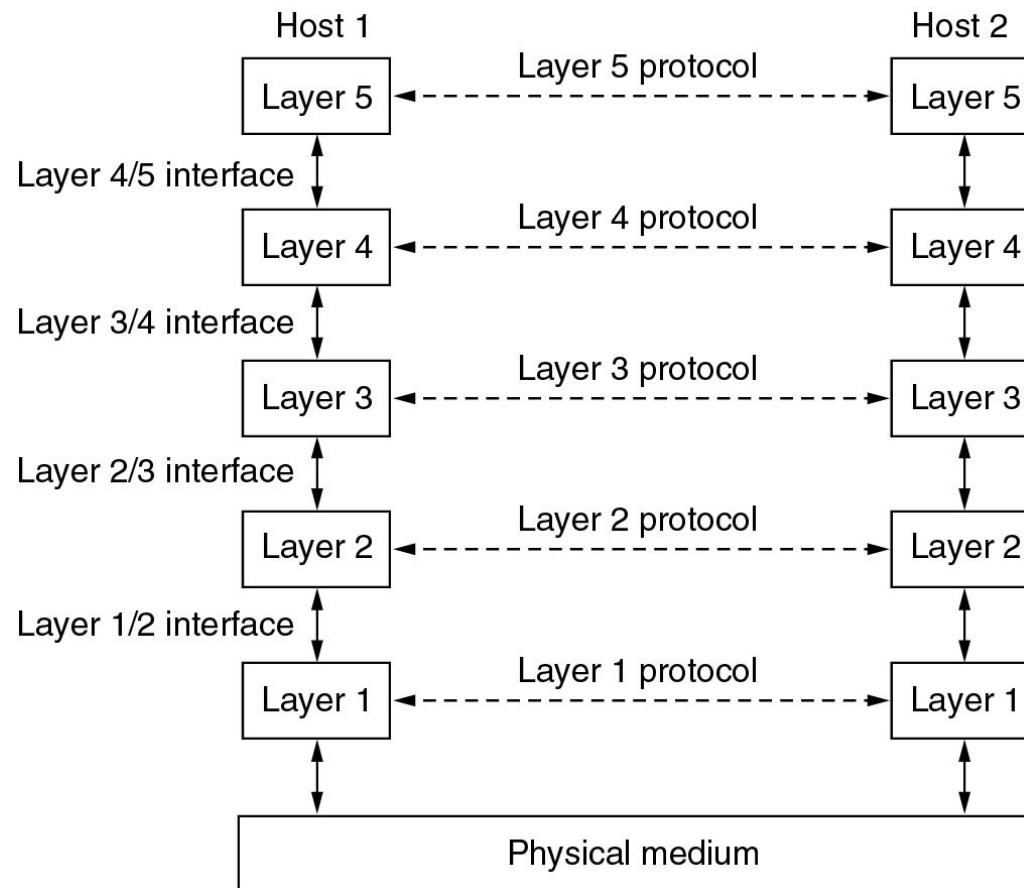
- ❑ The OSI Reference Model
- ❑ The TCP/IP Reference Model
- ❑ A Comparison of OSI and TCP/IP

Layering

□ Layering



Protocol Hierarchies



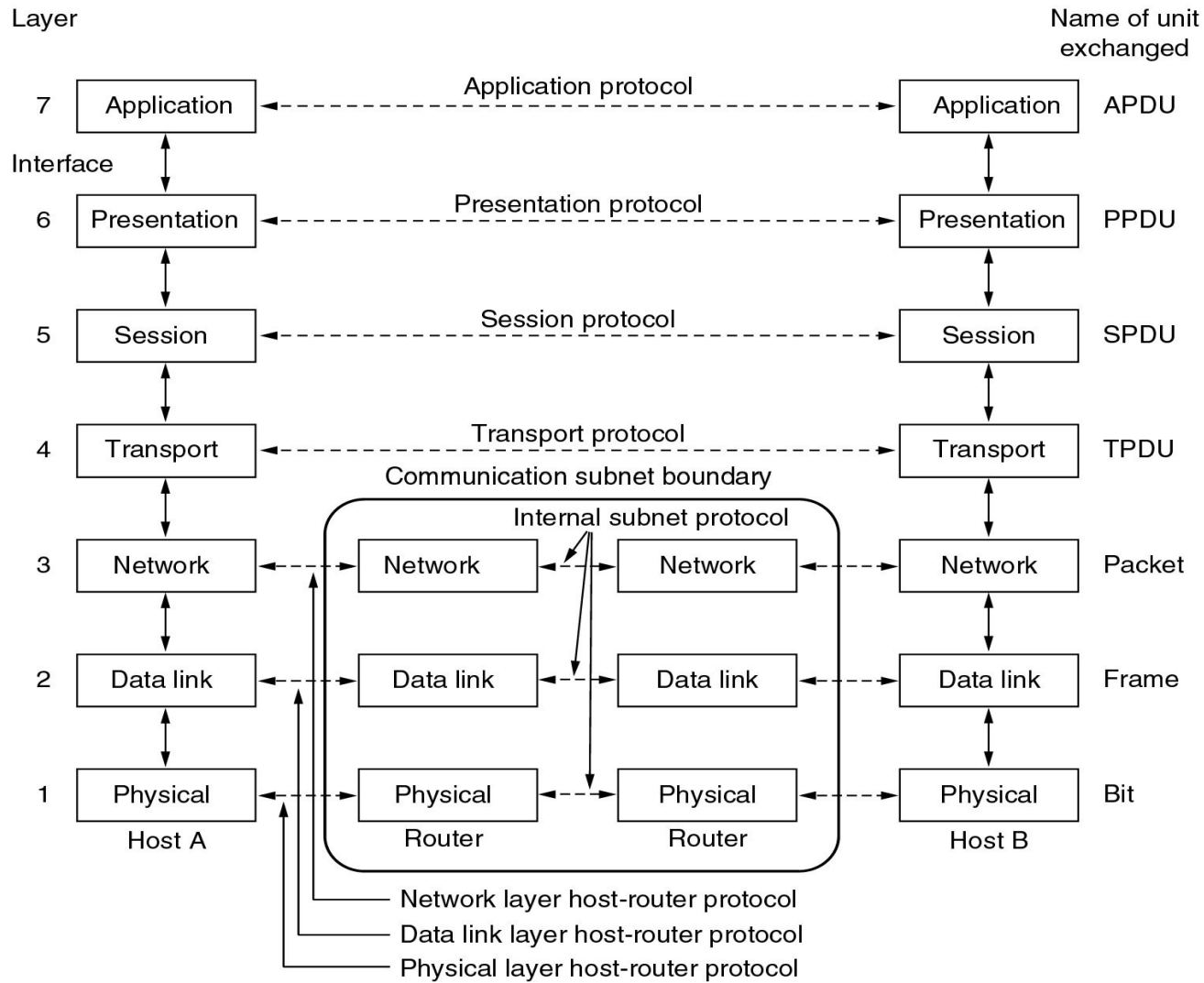
- Layers, protocols, and interfaces.

Open Systems Interconnection (OSI)

- ❑ OSI partitioned the communication process into seven layers and provided a framework for talking about the overall communication process.
- ❑ The OSI work also provided a unified view of layers, protocols, and services.
- ❑ This unified view has provided the basis for the development of networking standards to the present day.

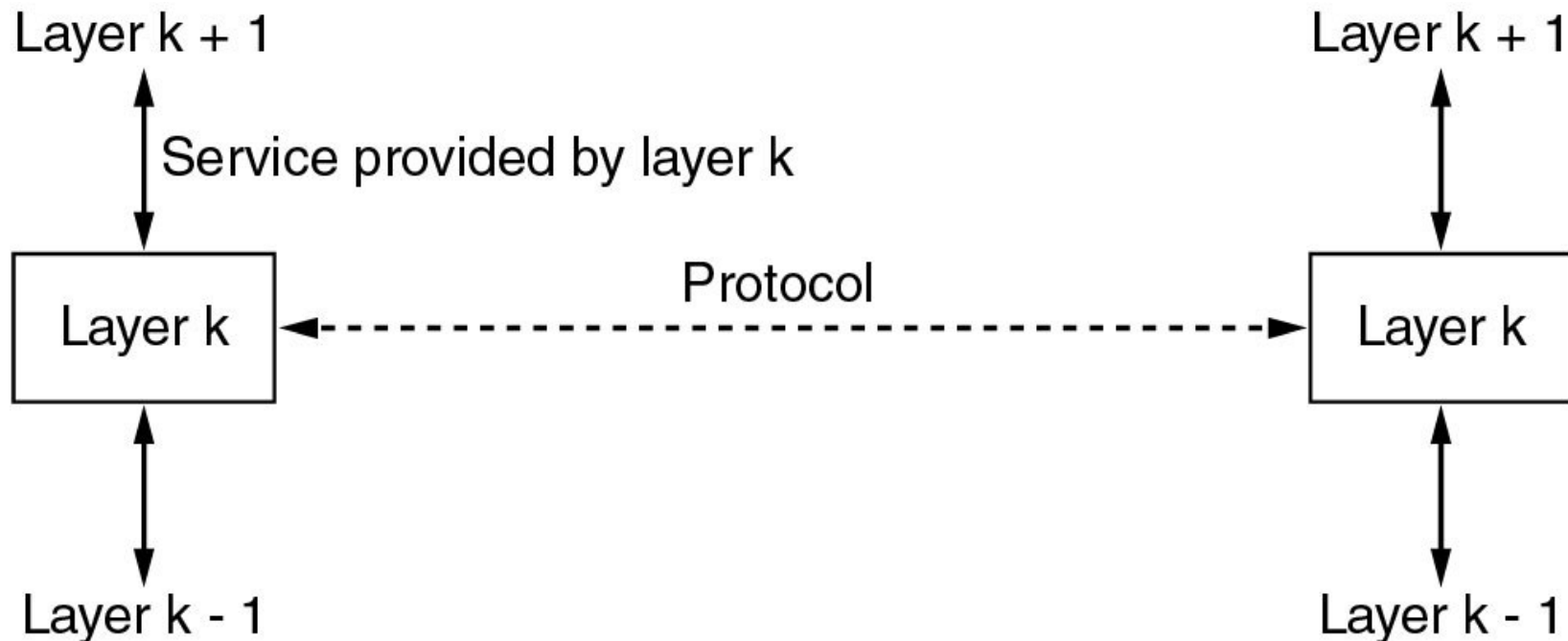
Reference Models

The OSI reference model.



Services to Protocols Relationship

- The relationship between a service and a protocol.

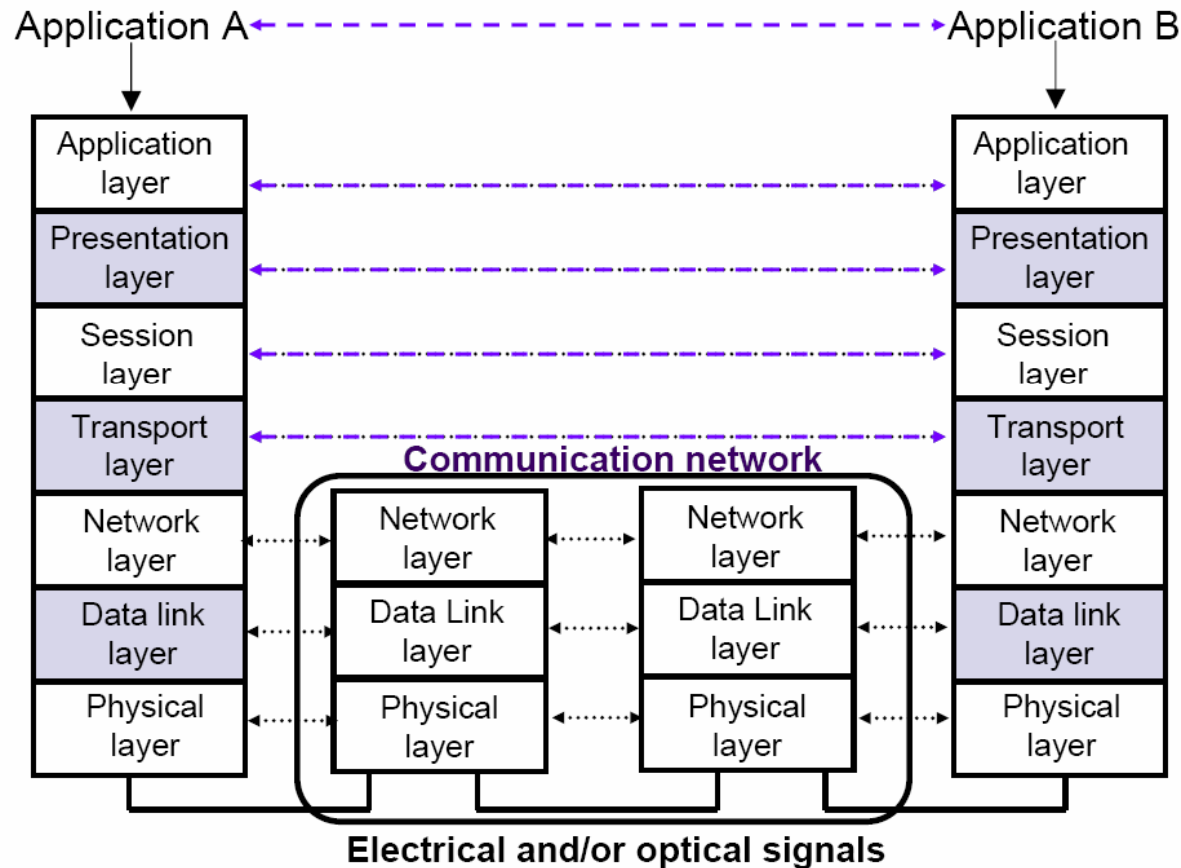


OSI Reference Model

- ❑ The early network architectures developed by various vendors were not compatible with each other.
- ❑ This desire led to an effort to develop a reference model for open system interconnection (OSI)
- ❑ OSI reference model partitioned the communications process into seven layers provided a framework for talking about the overall communications process and hence was intended to facilitate the development standards. The OSI work also provided a unified view of layers, protocols, and services.

The seven-layer OSI Model

OSI reference model



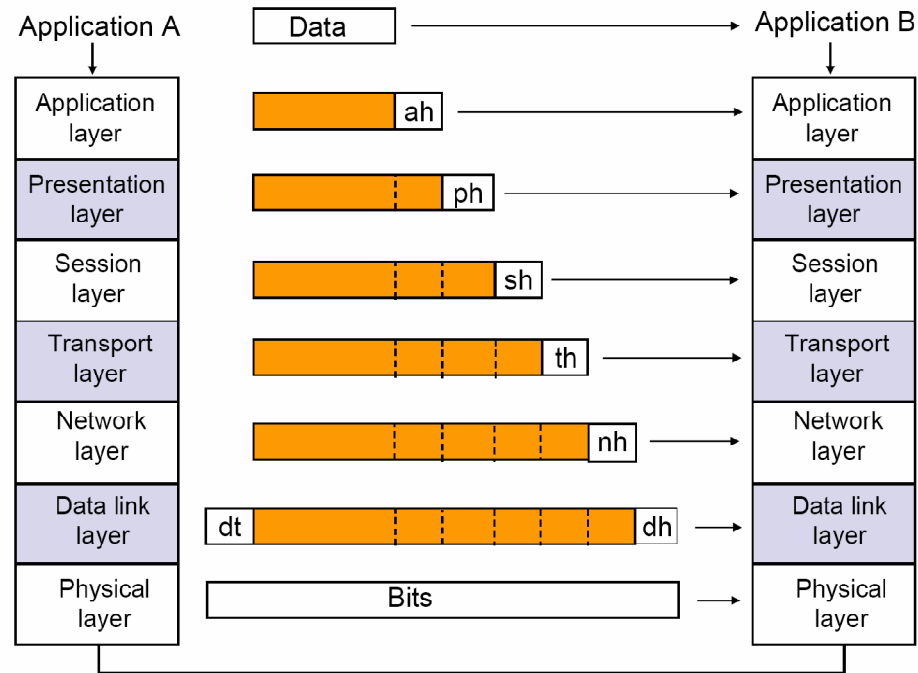
OSI Layers

- ❑ Physical layer deals with transfer of bits over a communication channel
- ❑ Data link layer provides for the transfer of frames across a transmission link (dialup modems use PPP)
- ❑ Network layer provides for transfer of data in the form of packets across a communication network. Addressing and congestion are dealt with network layer
- ❑ Transport layer is responsible for the end-to-end transfer of messages from a process in the source machine to a process in the destination machine.
 - ❑ TCP/IP networks, access the transport layer
 - ❑ Setting up and releasing connections across the network

OSI Layers

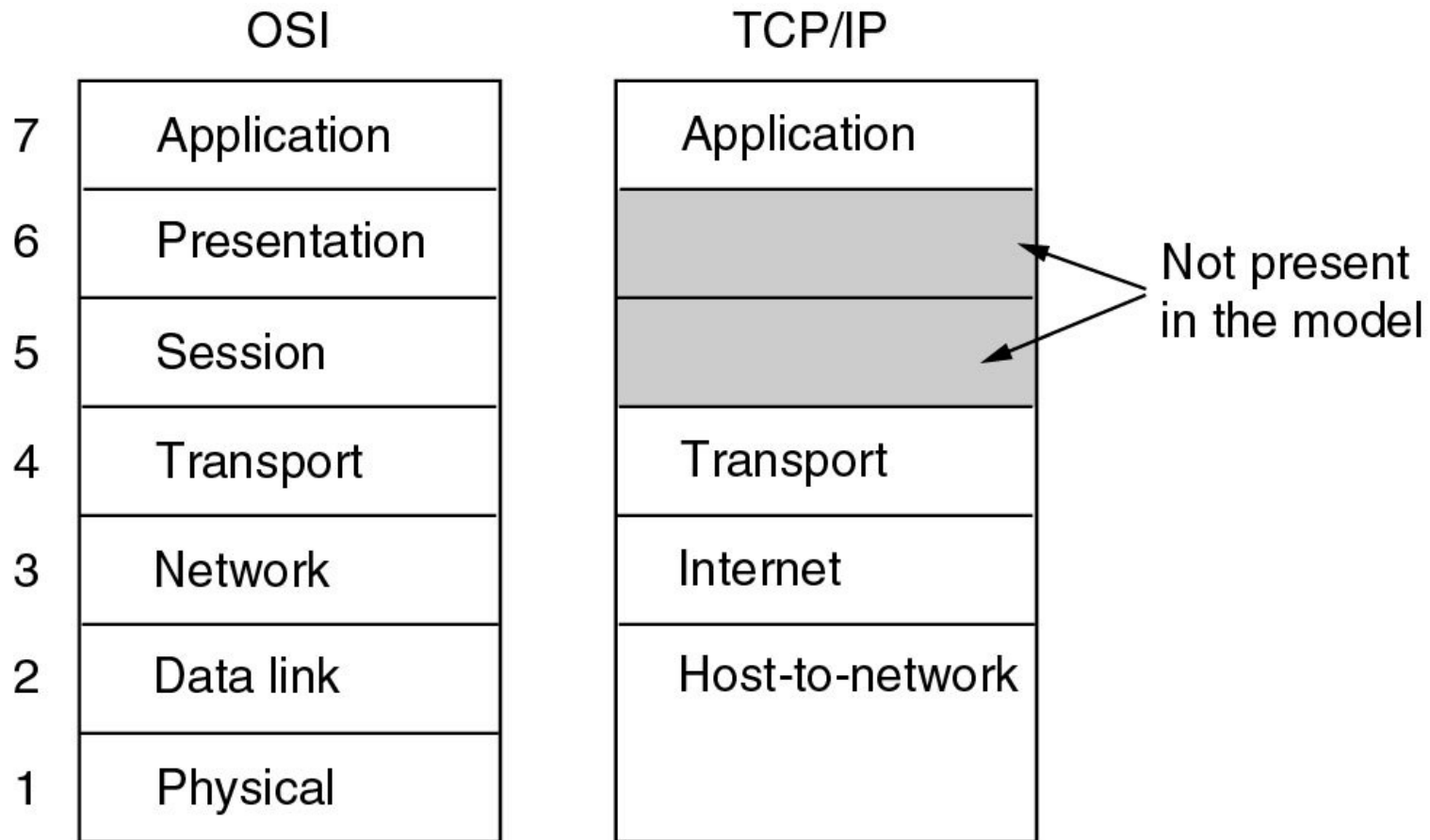
- ❑ Session layer can be used to control the manner in which data are exchanged. Certain applications require a half-duplex dialog where the two parties take turns transmitting information
- ❑ Presentation layer is intended to provide the application layer with independence from differences in the representation of data. For example, different computers use different codes for representing characters and integers, and also different conventions as to whether the first bit or last bit is the most significant bit.
- ❑ Application layer provides services that are frequently required by the applications involve communications. Ex: HTTP, FTP, email

Headers and Trailers

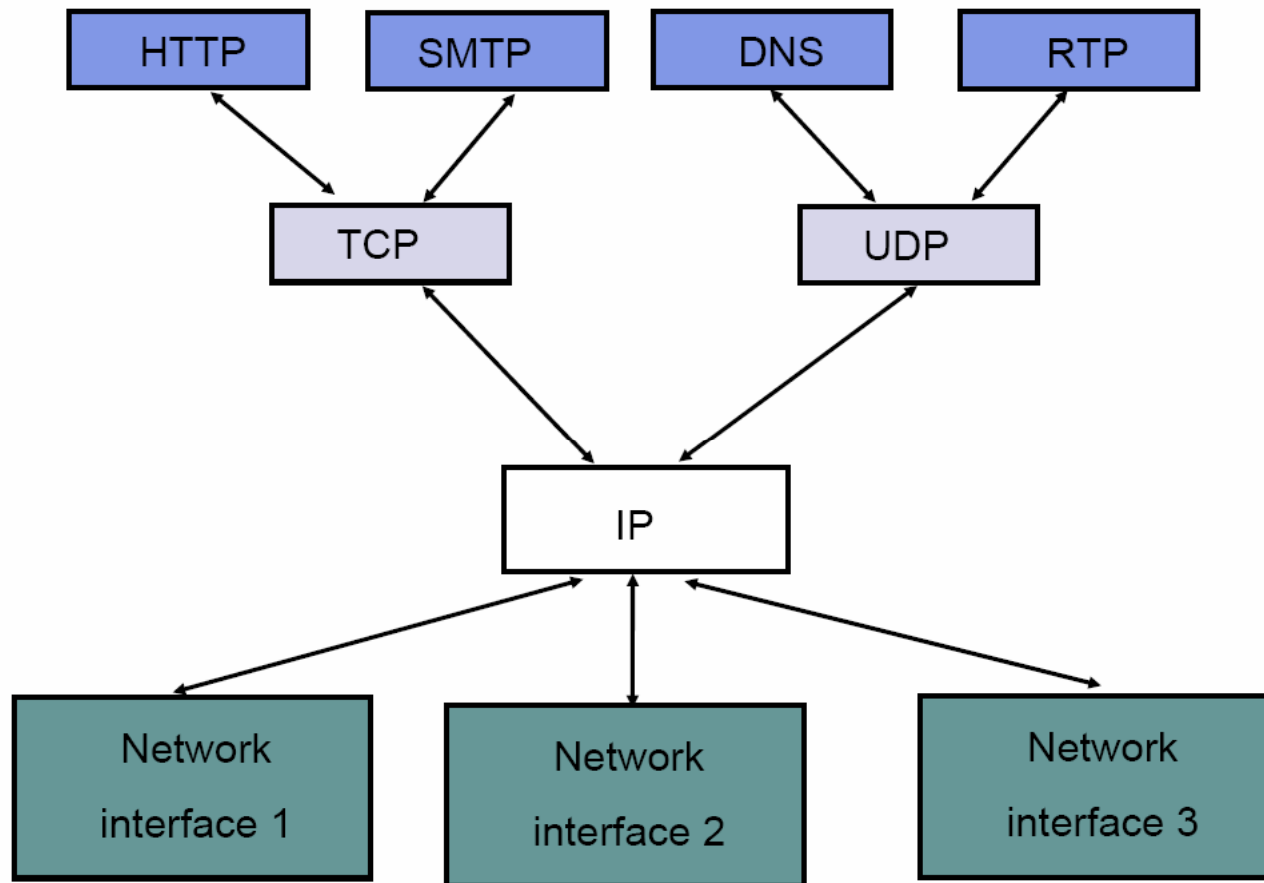


TCP/IP Reference Model

- The TCP/IP reference model.

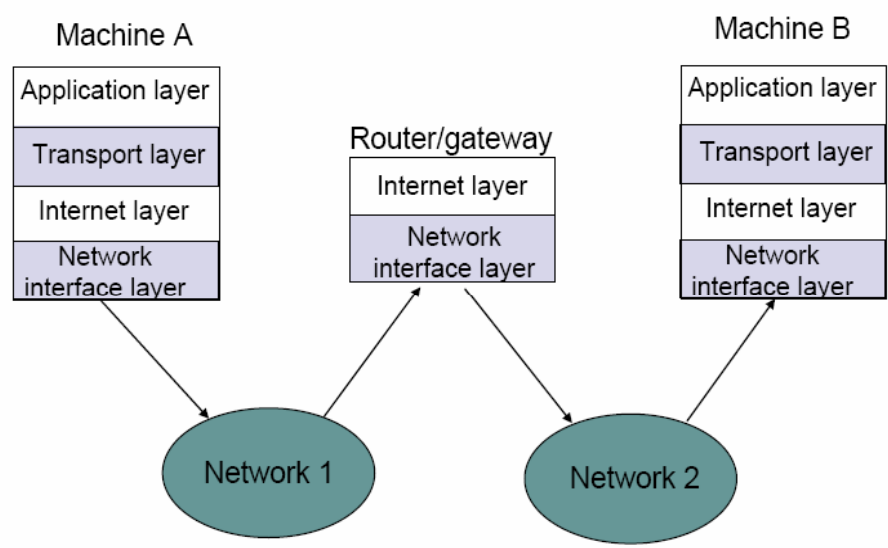


TCP/IP Protocol Graph

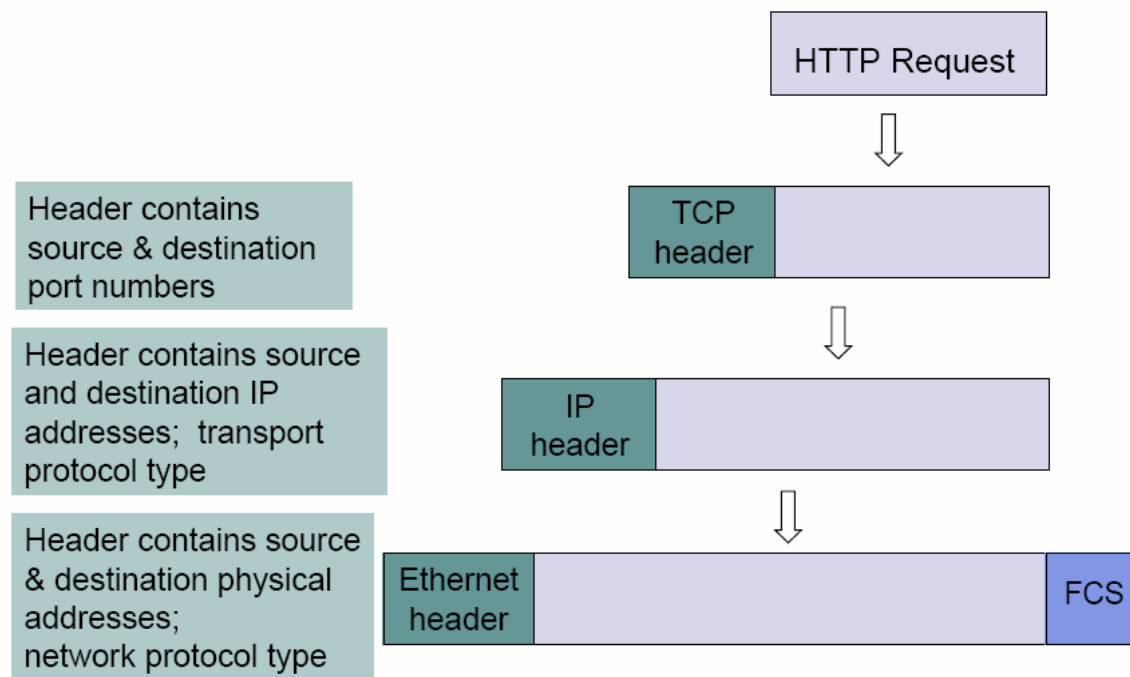


Routing

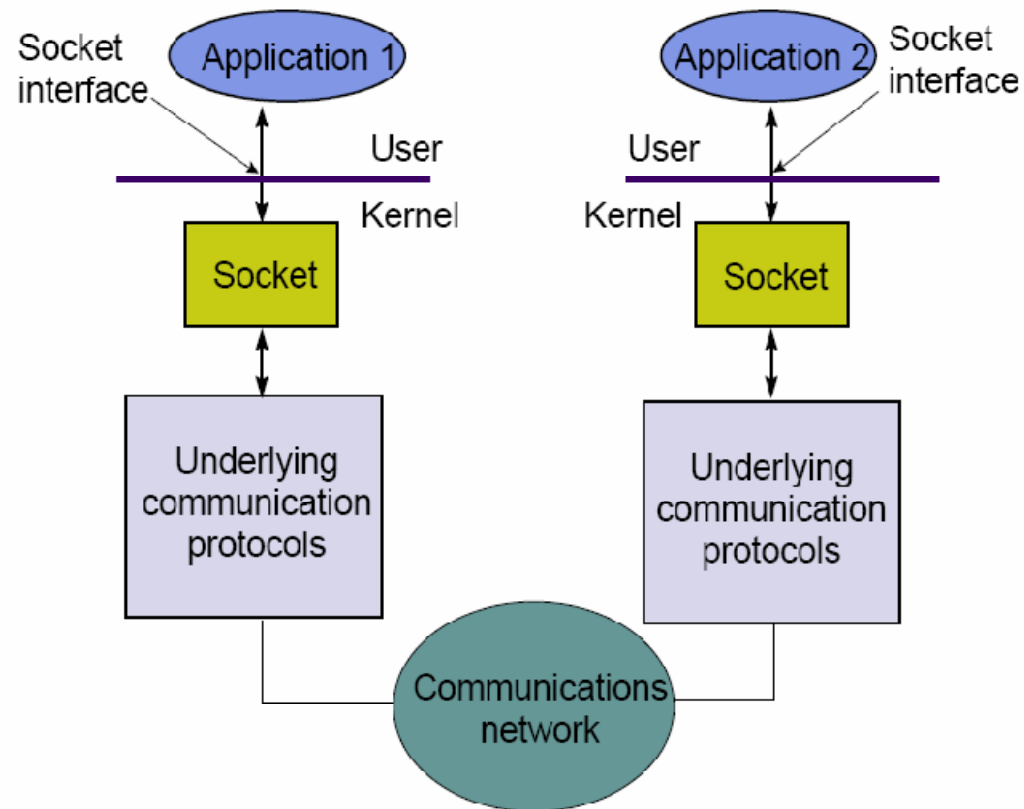
□ Routing the packets



HTTP Example

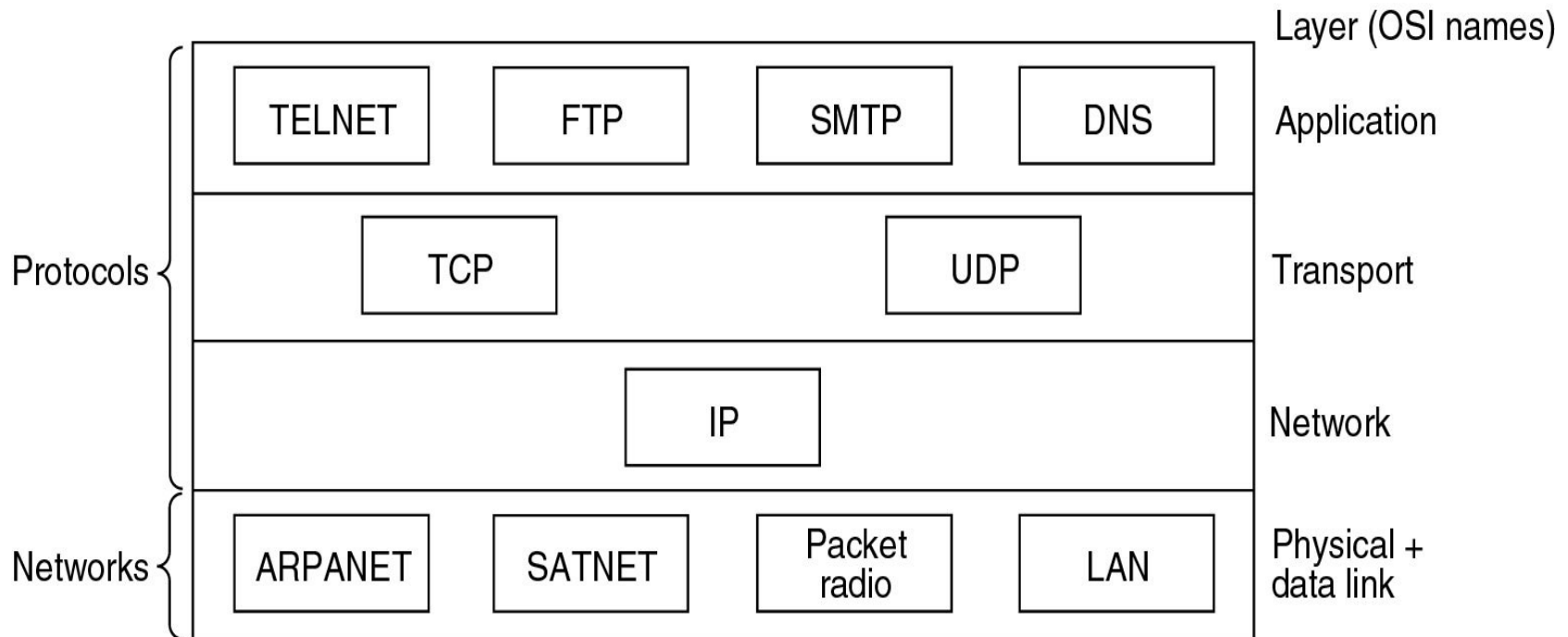


Application



Reference Models

- Protocols and networks in the TCP/IP model initially.



Network Standardization

ITU

□ Main sectors

- Radiocommunications
- Telecommunications Standardization
- Development

□ Classes of Members

- National governments
- Sector members
- Associate members
- Regulatory agencies

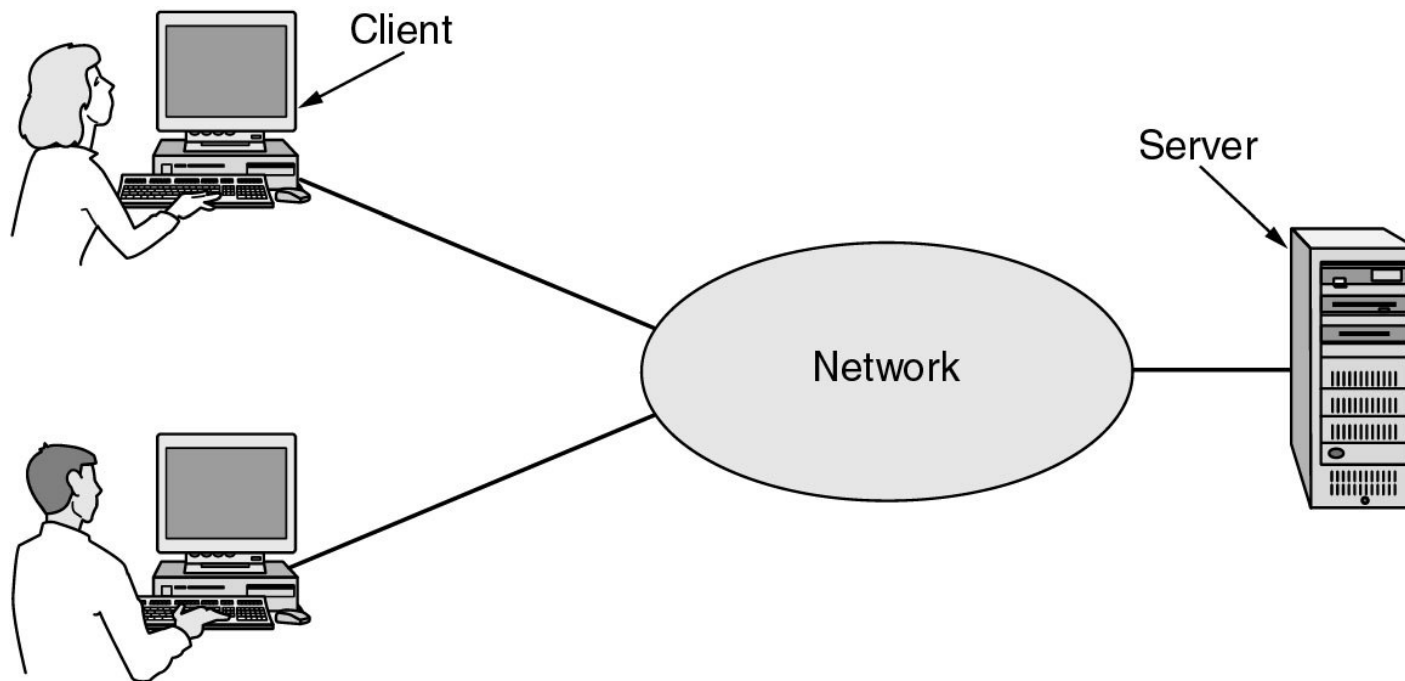
IEEE 802 Standards

Number	Topic
802.1	Overview and architecture of LANs
802.2 ↓	Logical link control
802.3 *	Ethernet
802.4 ↓	Token bus (was briefly used in manufacturing plants)
802.5	Token ring (IBM's entry into the LAN world)
802.6 ↓	Dual queue dual bus (early metropolitan area network)
802.7 ↓	Technical advisory group on broadband technologies
802.8 †	Technical advisory group on fiber optic technologies
802.9 ↓	Isochronous LANs (for real-time applications)
802.10 ↓	Virtual LANs and security
802.11 *	Wireless LANs
802.12 ↓	Demand priority (Hewlett-Packard's AnyLAN)
802.13	Unlucky number. Nobody wanted it
802.14 ↓	Cable modems (defunct: an industry consortium got there first)
802.15 *	Personal area networks (Bluetooth)
802.16 *	Broadband wireless
802.17	Resilient packet ring

The 802 working groups. The important ones are marked with *. The ones marked with ↓ are hibernating. The one marked with † gave up.

Business Applications of Networks

- A network with two clients and one server.



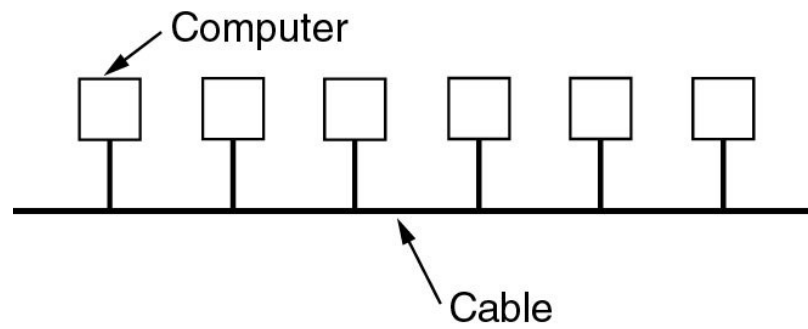
Home Network Applications

- Access to remote information
- Person-to-person communication
- Interactive entertainment
- Electronic commerce

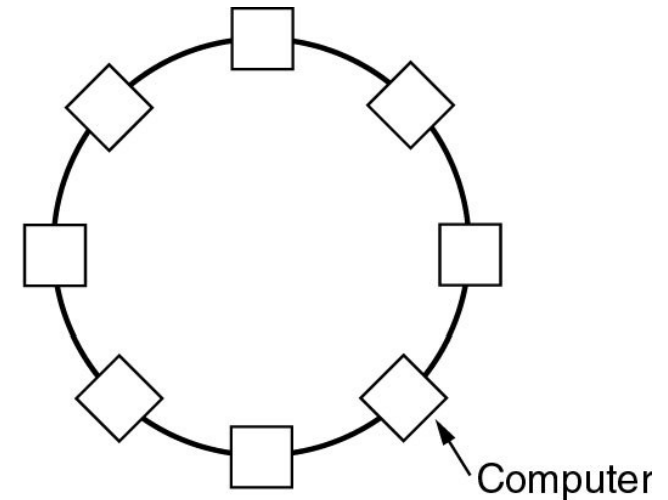
Network Hardware

- ❑ Local Area Networks
- ❑ Metropolitan Area Networks
- ❑ Wide Area Networks
- ❑ Wireless Networks
- ❑ Home Networks
- ❑ Internetworks

Local Area Networks



(a)

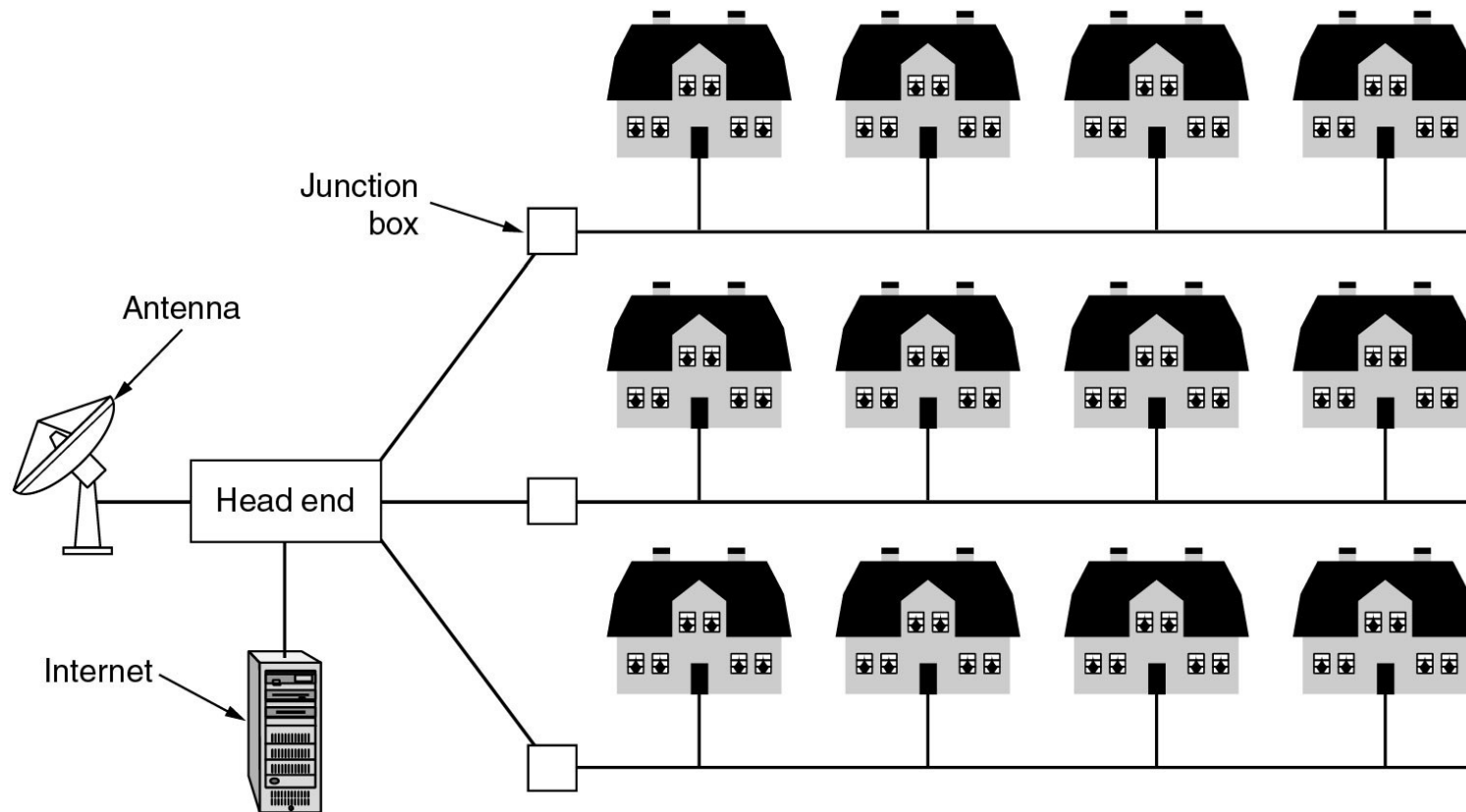


(b)

- ❑ Two broadcast networks
 - ❑ Bus
 - ❑ Ring

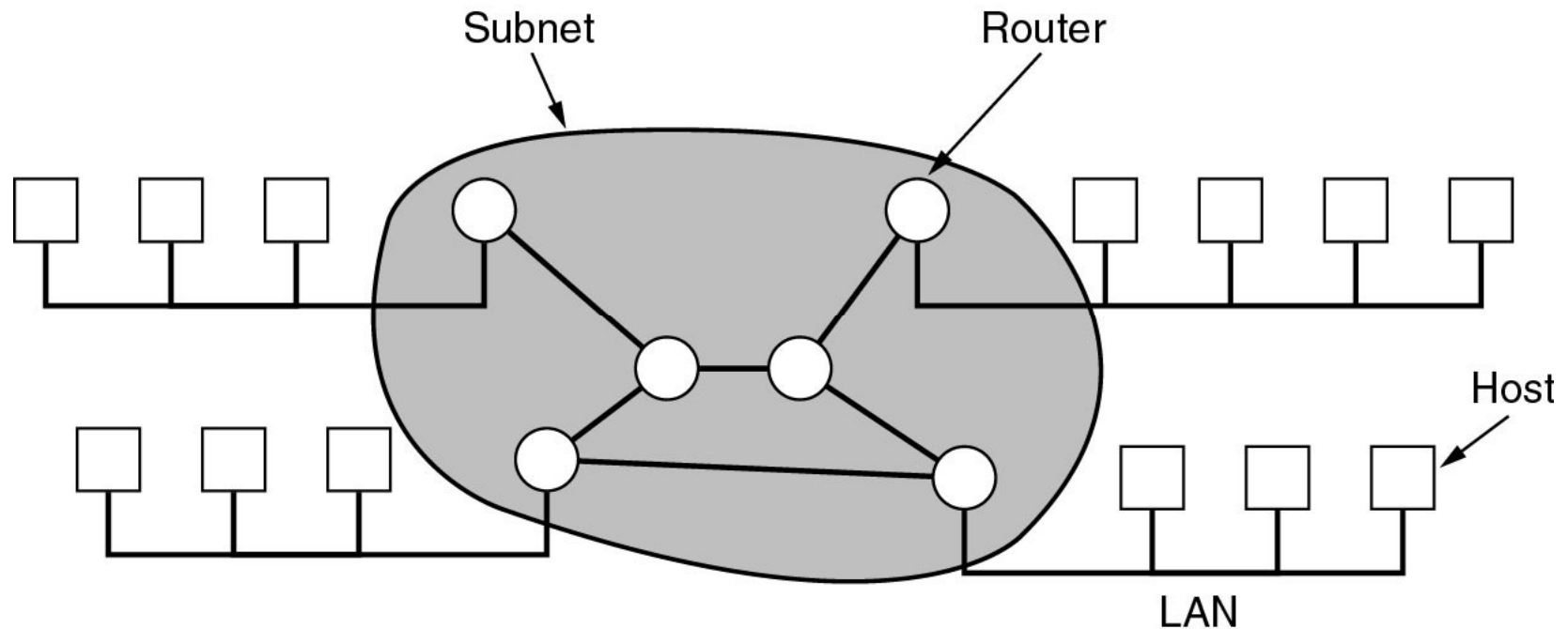
Metropolitan Area Networks

- A metropolitan area network based on cable TV.



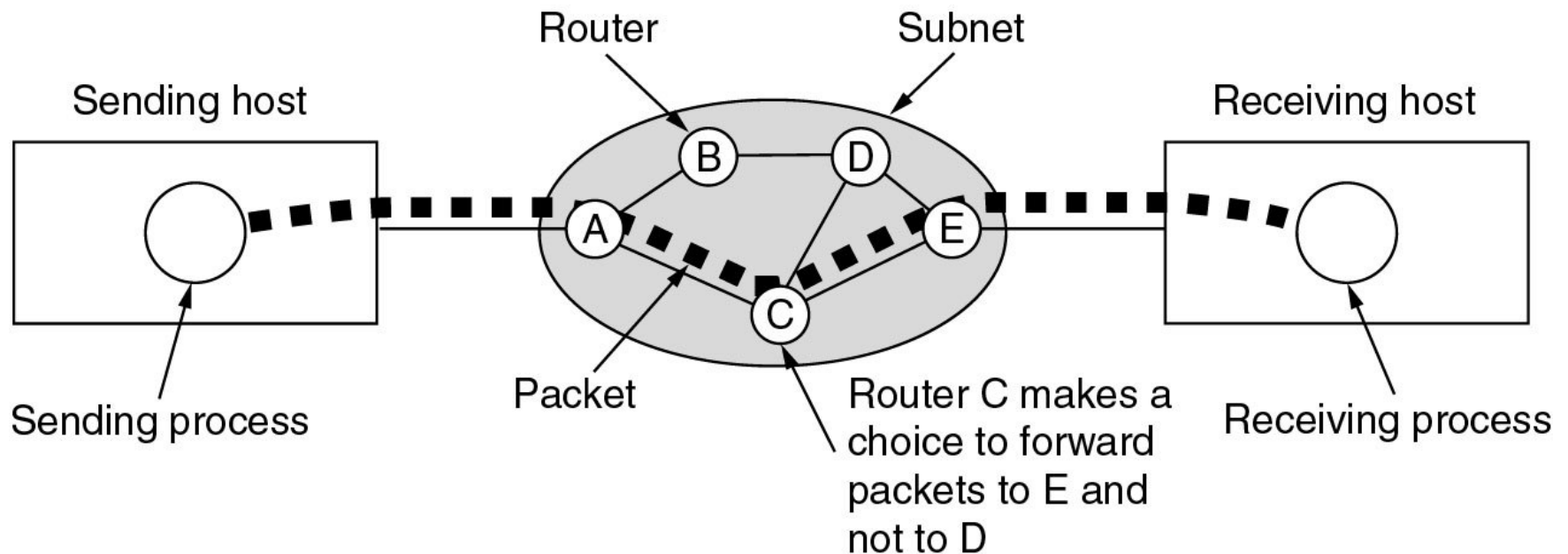
Wide Area Networks

- Relation between hosts on LANs and the subnet.



Wide Area Networks (2)

- A stream of packets from sender to receiver.

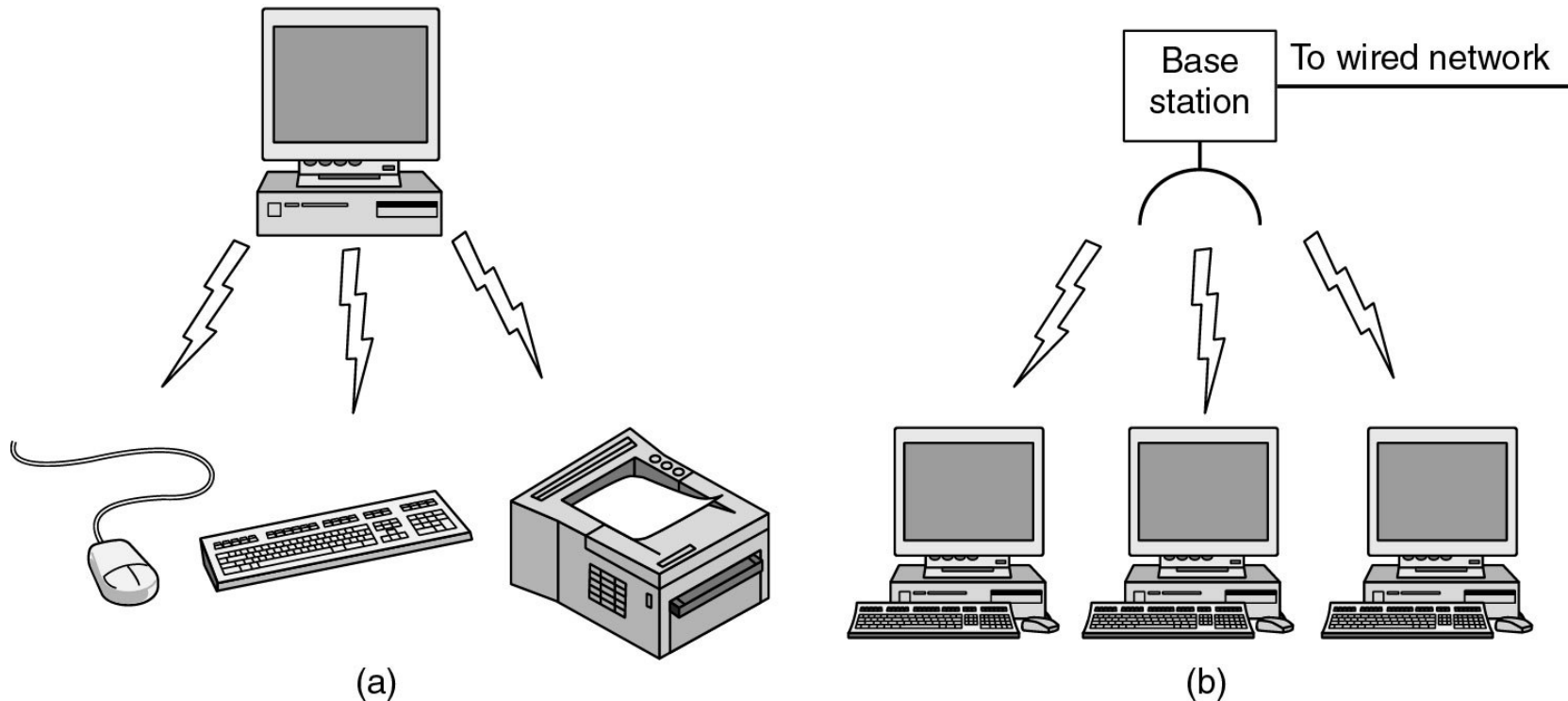


Wireless Networks

- ❑ Categories of wireless networks:
 - ❑ System interconnection
 - ❑ Wireless LANs
 - ❑ Wireless WANs

Wireless Networks (2)

- ❑ Bluetooth configuration
- ❑ Wireless LAN



Wireless Networks (3)

- ❑ Individual mobile computers
- ❑ A flying LAN

