
COMPUTER NETWORKS- (20MCA23C)

UNIT-I

‘ INTRODUCTION ’



FACULTY:

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SYLLABUS

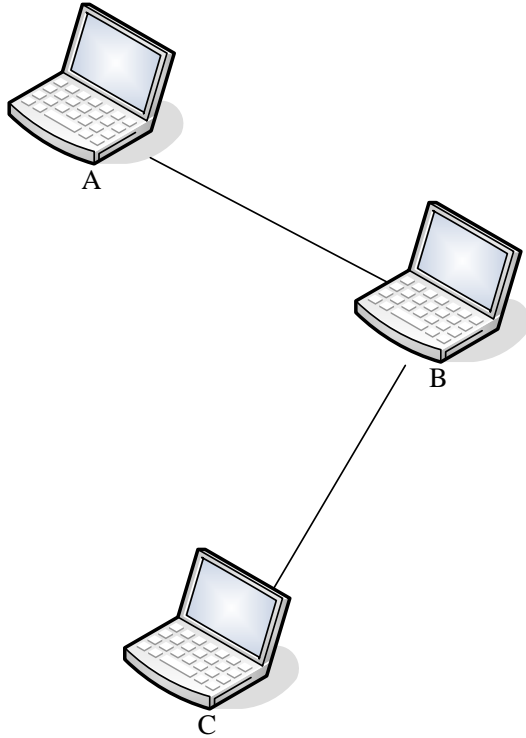
- UNIT I: Introduction: Use of computer networks - Network Hardware - Network Software - Reference models - Example of networks.
- UNIT II: The Physical Layer: The Theoretical basis for data communication - Guided transmission Media - Wireless transmission - Communication satellites - The Public switched Telephone network - Cable Television - Mobile telephone system.
- UNIT III: Data Link Layer: Data link layer design issues - Error detection and correction - Elementary data link protocols - Sliding window protocols - Example data link Protocols.
- UNIT IV: Network Layer: Network layer design issues - Routing algorithms - Congestion, Control algorithms - Quality of service - Internetworking - Network layer in the internet.

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- UNIT V: Transport Layer: The transport service - Elements of transport protocol - A simple transport protocol - The internet Transport Protocols: UDP - The Internet Transport Protocols: TCP. Application Layer: DNS - Electronic mail: The World Wide Web- Basics of Network Security.
 - TEXT BOOKS: I. Andrew S. Tanenbaum, “Computer Networks”, 2012, Pearson Education,
 - REFERENCE BOOKS:
 1. **P. Green - Computer Network Architectures and Protocols, Plenum Press, 1982.**
 2. **Harry Katzan - An Introduction to “Distributed Data Processing”, A Petrocelli Book, New York / Princeton.**
 3. **Tittel - Theory and Problems of Computer Networking, Schaum’s outline series, TMH.**
 4. **Godbole - Data Communication & Networking, TMH.**
 5. **Leon Garcia - Communication Networks: Fundamental Concepts & Key Architecture, TMH.**

INTRODUCTION

- What is Computer Network?
 - we will use the term "computer network" to mean a collection of autonomous computers interconnected by a single technology.
 - Two computers are said to be interconnected if they are able to exchange information.
 - copper wire; fiber optics, microwaves, infrared, and communication satellites, etc.

INTRODUCTION (CONT'D)



A very simple network (Problems)

Digital-Analog ; Analog-Digital.

What if error happens?

Capture of physical lines – short message.

Routing.

Channel utilization (flow control).


Who say first?


Masking the details.

USE OF COMPUTER NETWORKS

Computer networks have become invaluable to organizations as well as individuals. Some of its main uses are as follows –

- **Information and Resource Sharing** – Computer networks allow organizations having units which are placed apart from each other, to share information in a very effective manner. Programs and software in any computer can be accessed by other computers linked to the network. It also allows sharing of hardware equipment, like printers and scanners among varied users.
- **Retrieving Remote Information** – Through computer networks, users can retrieve remote information on a variety of topics. The information is stored in remote databases to which the user gains access through information systems like the World Wide Web.

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- **Speedy Interpersonal Communication** – Computer networks have increased the speed and volume of communication like never before. Electronic Mail (email) is extensively used for sending texts, documents, images, and videos across the globe. Online communications have increased by manifold times through social networking services.
 - **E-Commerce** – Computer networks have paved way for a variety of business and commercial transactions online, popularly called e-commerce. Users and organizations can pool funds, buy or sell items, pay bills, manage bank accounts, pay taxes, transfer funds and handle investments electronically.

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- **Highly Reliable Systems** – Computer networks allow systems to be distributed in nature, by the virtue of which data is stored in multiple sources. This makes the system highly reliable. If a failure occurs in one source, then the system will still continue to function and data will still be available from the other sources.
 - **Cost-Effective Systems** – Computer networks have reduced the cost of establishment of computer systems in organizations. Previously, it was imperative for organizations to set up expensive mainframes for computation and storage. With the advent of networks, it is sufficient to set up interconnected personal computers (PCs) for the same purpose.
 - **VoIP** – VoIP or Voice over Internet protocol has revolutionized telecommunication systems. Through this, telephone calls are made digitally using Internet Protocols instead of the regular analog phone lines.


NETWORK HARDWARE (TRANSMISSION TECHNOLOGIES)

■ Broadcast

- Broadcast networks have a single communication channel that is shared by all the machines on the network. Short messages, called packets in certain contexts, sent by any machine are received by all the others. (Address Checking required)

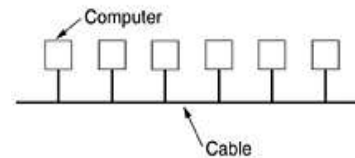
■ Point-to-point

- In point-to-point networks, there consist of many connections between individual pairs of machines.
- As a general rule (although there are many exceptions), smaller, geographically localized networks tend to use broadcasting, whereas larger networks usually are point-to-point.

- 
- Network Hardware (Scale Perspective)
 - personal area networks (1m)
 - LAN: local area networks (10m ~ 1km)
 - MAN: metropolitan area networks (10km)
 - WAN: wide area network (100km ~ 1000km)
 - Internet

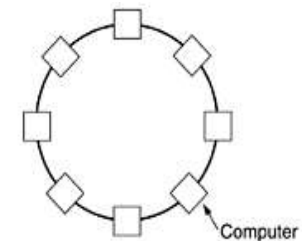
■ LAN: local area network

- Local area networks, generally called LANs, are privately-owned networks within a single building or campus of up to a few kilometers in size.
- LANs may use a transmission technology consisting of a cable to which all the machines are attached.
- Traditional LANs run at speeds of 10 Mbps to 1000 Mbps, have low delay (microseconds or nanoseconds), and make very few errors.
- Various topologies are
 - possible for broadcast
 - LANs.



(a)

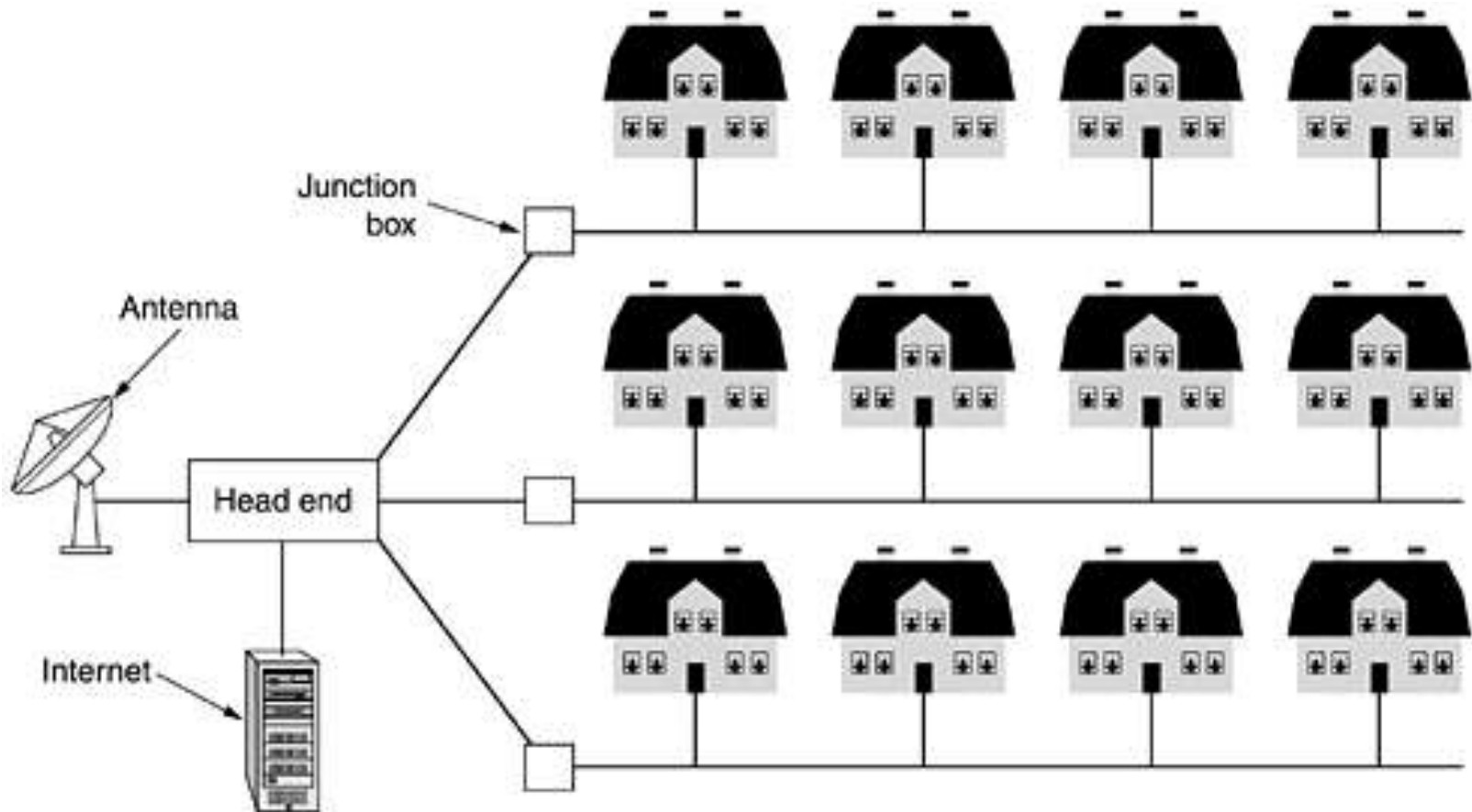
(a) Bus



(b)

(b) Ring

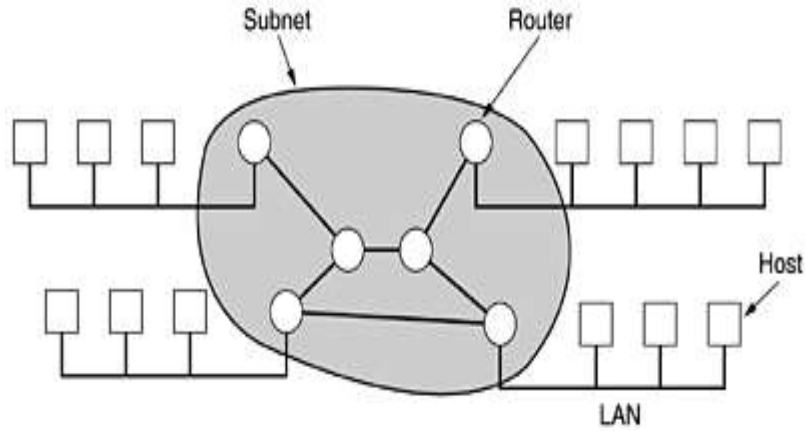
MAN: metropolitan area network



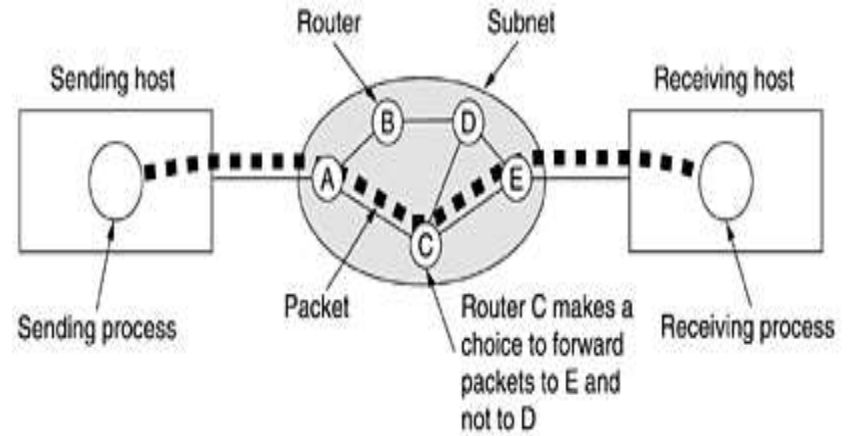


■ WAN and Internet

- Hosts, The hosts are owned by the customers (e.g., people's personal computers).
- Subnet, typically owned and operated by a telephone company or Internet service provider (ISP).
- The hosts are connected by subnets.
- the subnet consists of two distinct components: transmission lines and switching elements. Transmission lines move bits between machines. Switching elements (routers) are specialized computers that connect three or more transmission lines.



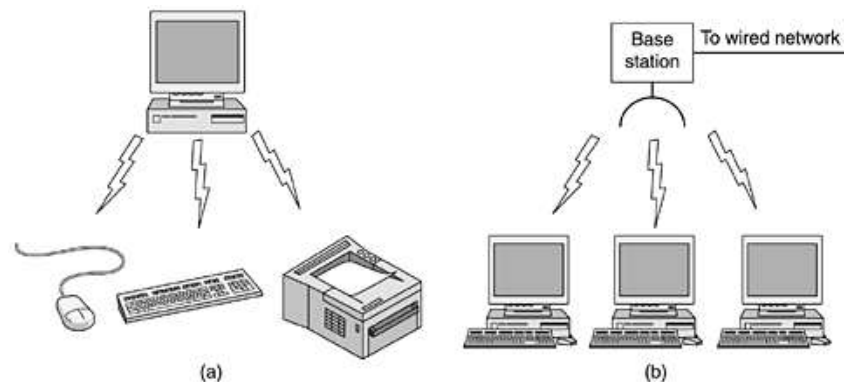
Simple WAN (Internet) illustrated



Packets routing

■ Wireless Networks

- Bluetooth: short range wireless network (<10m).
- Wireless LANs: for moderate range, becomes more and more common today (<100m).
- network used for cellular telephones: distances involved are much greater and the bit rates much lower (above 1km).



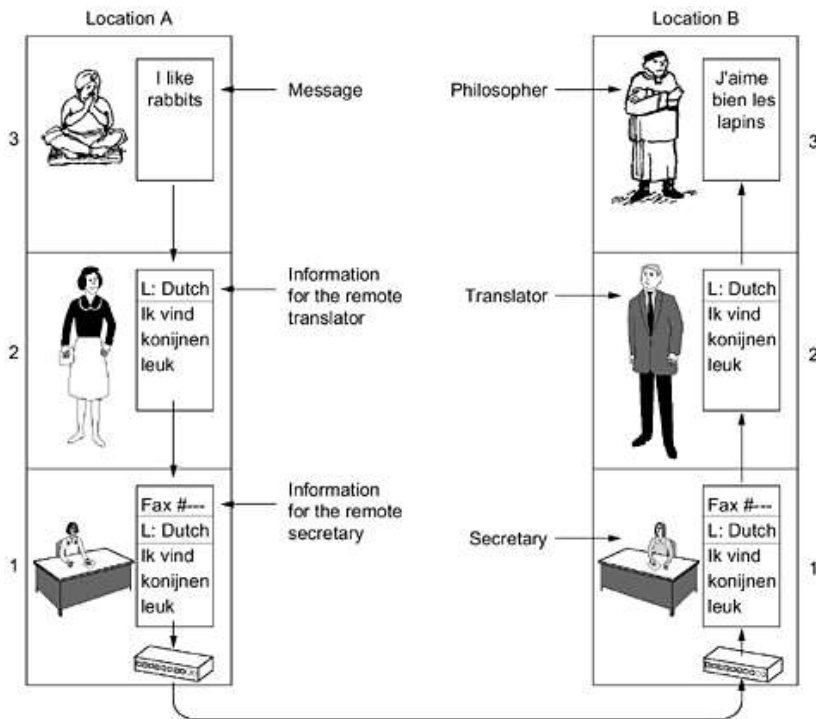
NETWORK SOFTWARE

- Protocol Hierarchies
- Design Issues for the Layers
- Connection-Oriented and Connectionless Services
- Service Primitives
- The Relationship of Services to Protocols

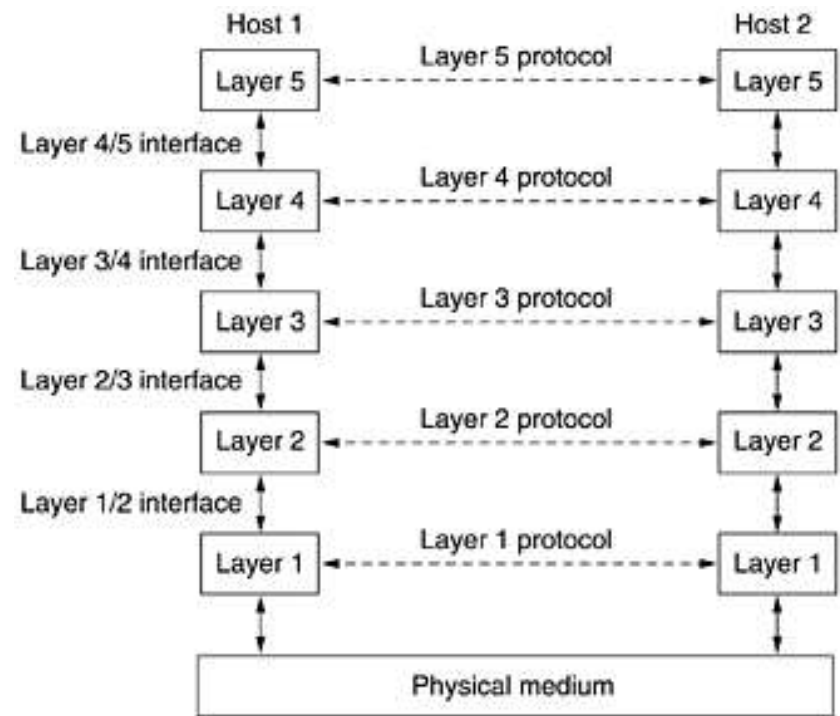


■ Protocol Hierarchies

- 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 purpose of each layer is to offer certain services to the higher layers, shielding those layers from the details of how the offered services are actually implemented.
- A protocol is an agreement between the communicating parties on how communication is to proceed.



The philosophers analogy

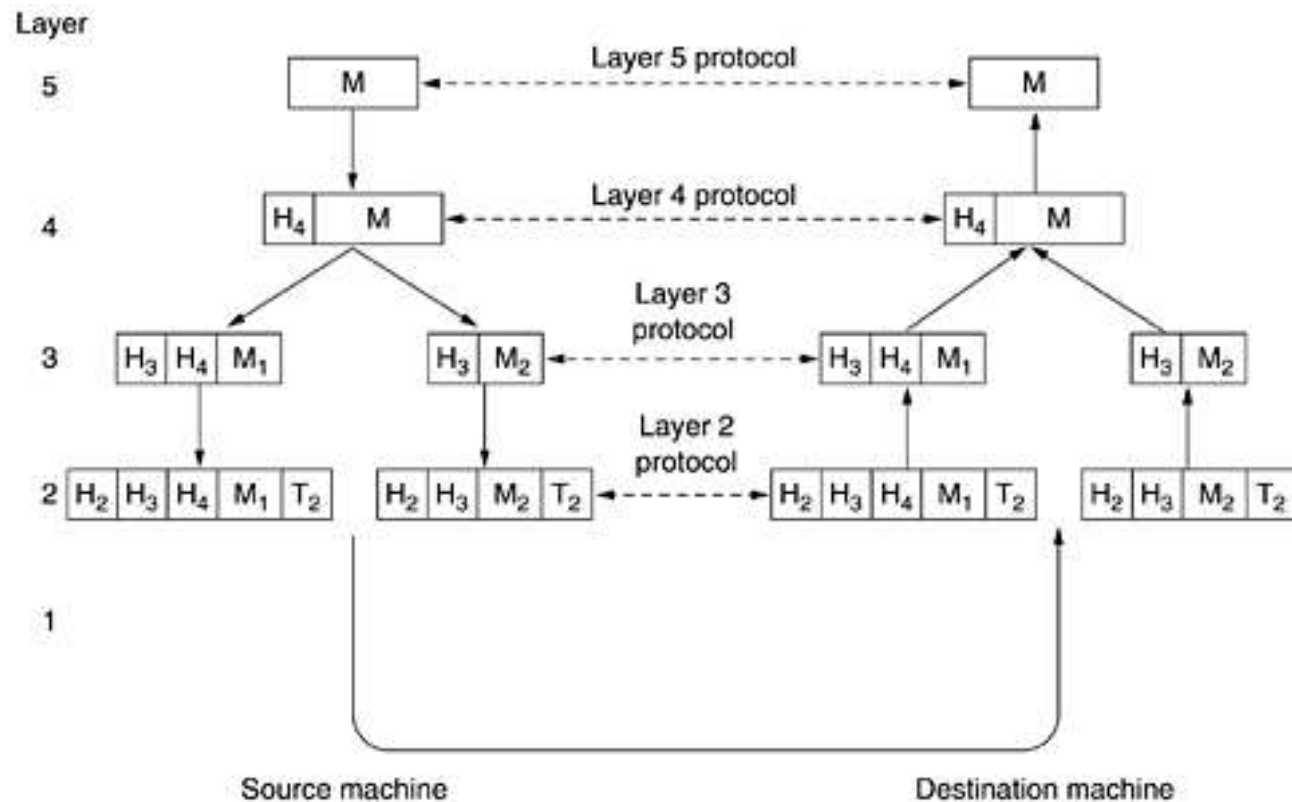




The layered computer network

THE KEY TERMS

- Layers; Protocol;
- Interface: Between each pair of adjacent layers is an interface.
- Network architecture: A set of layers and protocols is called a network architecture.
- Protocol stack: A list of protocols used by a certain system, one protocol per layer, is called a protocol stack.

An example network protocol stack



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- Message is generated by the application of the source machine.
 - Message will be sent from the source to the destination.
 - Message “M” is transferred from layer 5 to layer 4, with a header containing control information, such as sequence numbers, which helps layer 4 maintain the message order.
 - Layer 3 break the message from layer 4 into two pieces to fit the transmission restrictions, while adding another header to tell layer 2 where the dest. is.
 - Layer 2 adds the messages from layer 3 with another header, telling the actual (physical) address of the dest, and a trailer, which is the checksum of the message for correction assertion.
 - At the receiving machine the message moves upward, from layer to layer, with headers being stripped off as it progresses. Message is sent to the dest. machine.

DESIGN ISSUES FOR THE LAYERS

- Every layer needs a mechanism for identifying senders and receivers. (who to talk with)
- The protocol must also determine how many logical channels the connection corresponds to and what their priorities are. (simplex or duplex? single or multiple channel?)
- Error control is an important issue because physical communication circuits are not perfect.
- Message ordering is important 'cause Not all communication channels preserve the order of messages sent on them.
- An issue that occurs at every level is how to keep a fast sender from swamping a slow receiver with data.
- Inability of all processes to accept arbitrarily long messages. (fragmentation and reassembling the messages)

CONNECTION-ORIENTED AND CONNECTIONLESS SERVICES?

- Connection-Oriented Service: the service user first establishes a connection, uses the connection, and then releases the connection. (e.g., the telephone, tube)
- Connectionless Service: Each message carries the full destination address, and each one is routed through the system independent of all the others. (e.g., the postal system)
Usually, connectionless service can not guarantee the order of messages.
- In order to enhance the reliability of transmission of connection-oriented service, acknowledge each received message is helpful. For example, the file transfer.
- However, some applications prefer fast speed than the reliability. For example, the digitized voice traffic, video conference.

Six different types of service

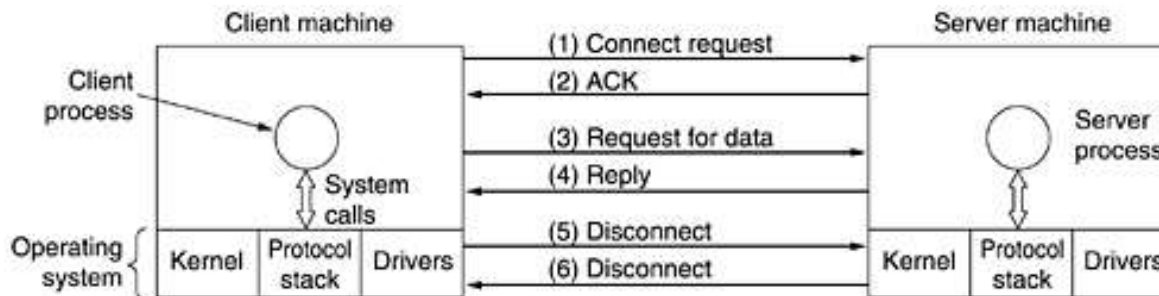
	Service	Example
Connection-oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Remote login
	Unreliable connection	Digitized voice
Connection-less	Unreliable datagram	Electronic junk mail
	Acknowledged datagram	Registered mail
	Request-reply	Database query

both reliable and unreliable connection-oriented and connectionless communication coexist

Service Primitives

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

Common Primitives

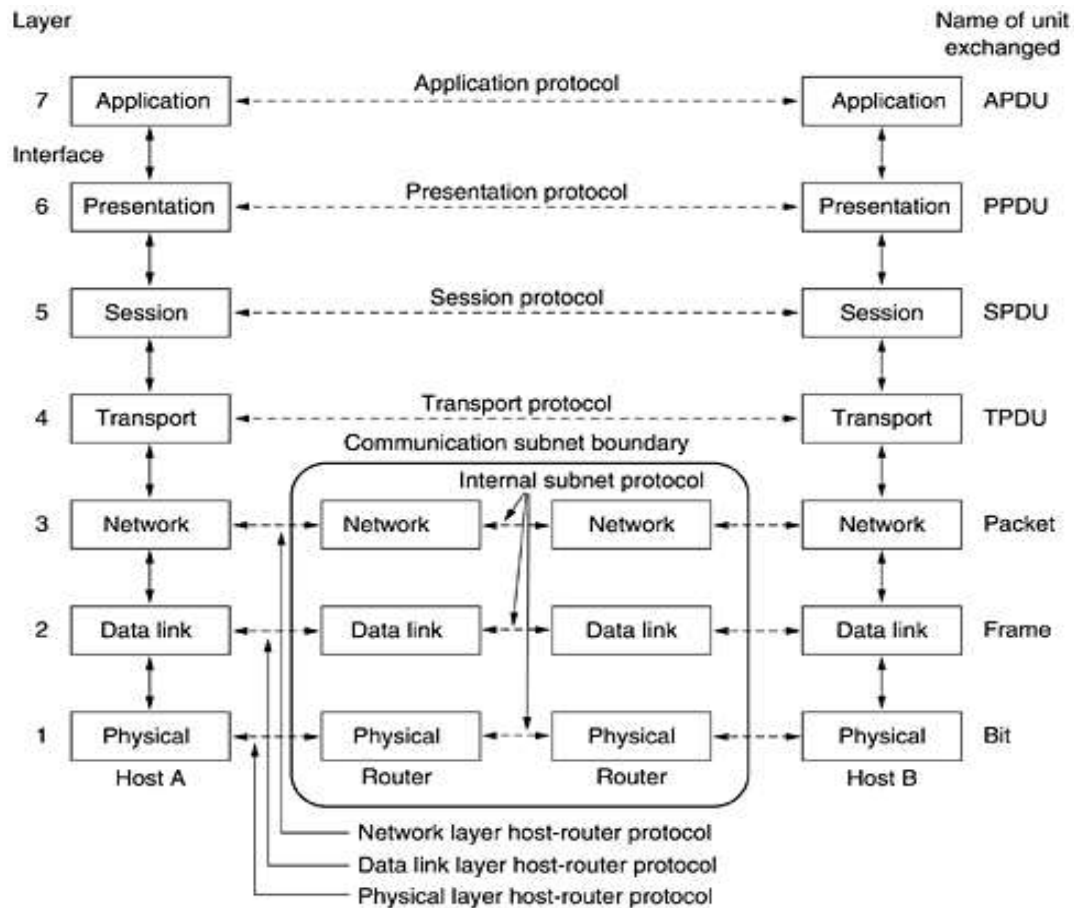


Packets sent in a simple client-server interaction on a connection-oriented network

REFERENCE MODELS

- OSI reference model
 - developed by the International Standards Organization (ISO)
 - OSI means Open Systems Interconnection
 - It is rarely used today, while it is actually quite general and still valid, and the features discussed at each layer are still very important.
 - OSI model itself is not a network architecture because it does not specify the exact services and protocols to be used in each layer.
- TCP/IP reference model.
 - developed by ARPANET
 - Used to construct the Internet today
 - However, the model itself is not of much use

OSI model





■ The Physical Layer

- The physical layer is concerned with transmitting raw bits over a communication channel.
- Typical questions here are how many volts should be used to represent a 1 and how many for a 0, how many nanoseconds a bit lasts, whether transmission may proceed simultaneously in both directions, how the initial connection is established and how it is torn down when both sides are finished, and how many pins the network connector has and what each pin is used for.

■ The Data Link Layer

- The main task of the data link layer is to transform a raw transmission facility into a line that appears free of undetected transmission errors to the network layer.
- having the sender break up the input data into data frames and transmit the frames sequentially



■ The Network Layer

- The network layer controls the operation of the subnet (routing).
- Congestion control, QOS (quality of service)

■ The Transport Layer

- The basic function of the transport layer is to accept data from above, split it up into smaller units if need be, pass these to the network layer, and ensure that the pieces all arrive correctly at the other end.
- The transport layer is a true end-to-end layer, all the way from the source to the destination.
- layers 1 through 3 are chained, and layers 4 through 7 are end-to-end,



■ The Session Layer

- The session layer allows users on different machines to establish sessions between them. Sessions offer various services, including dialog control, token management, and synchronization.

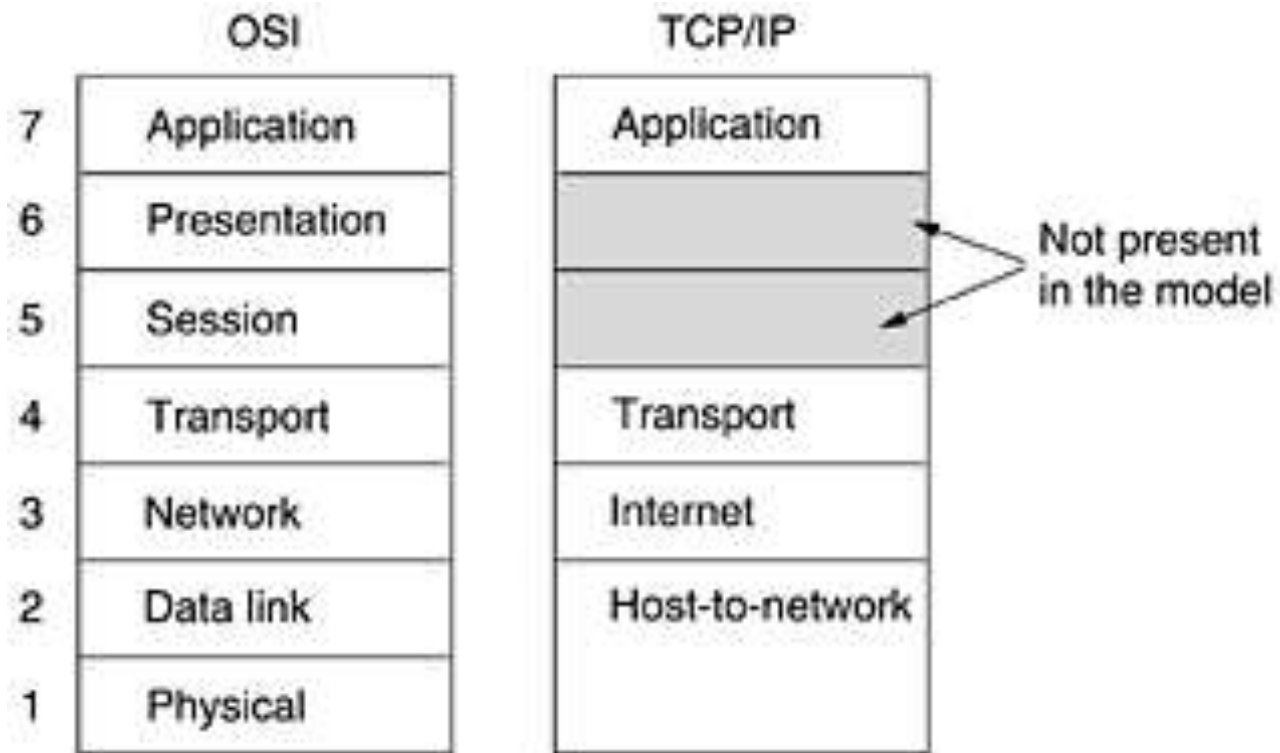
■ The Presentation Layer

- concerned with the syntax and semantics of the information transmitted, to make it possible for computers with different data representations to communicate.

■ The Application Layer

- The application layer contains a variety of protocols that are commonly needed by users.

The TCP/IP Reference Model



The TCP/IP reference model



■ The Internet Layer

- Its job is to permit hosts to inject packets into any network and have them travel independently to the destination (potentially on a different network). They may even arrive in a 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). The job of the internet layer is to deliver IP packets where they are supposed to go.
- The underlining Host-to-Network Layer is a great void. host connected to this layer can send IP packets.



■ 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 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.



■ The Application Layer

- The TCP/IP model does not have session or presentation layers, which are of little use to most applications.
- It contains all the higher-level protocols. The early ones included virtual terminal (TELNET), file transfer (FTP), and electronic mail (SMTP). Many other protocols have been added to these over the years: the Domain Name System (DNS) for mapping host names onto their network addresses, NNTP, the protocol for moving USENET news articles around, and HTTP, the protocol for fetching pages on the World Wide Web, and many others.



■ Comparison of the OSI and TCP/IP Reference Models

■ Similarities

- Both are based on the concept of a stack of independent protocols.
- Both of them have transport layer to provide an end-to-end, network-independent transport service

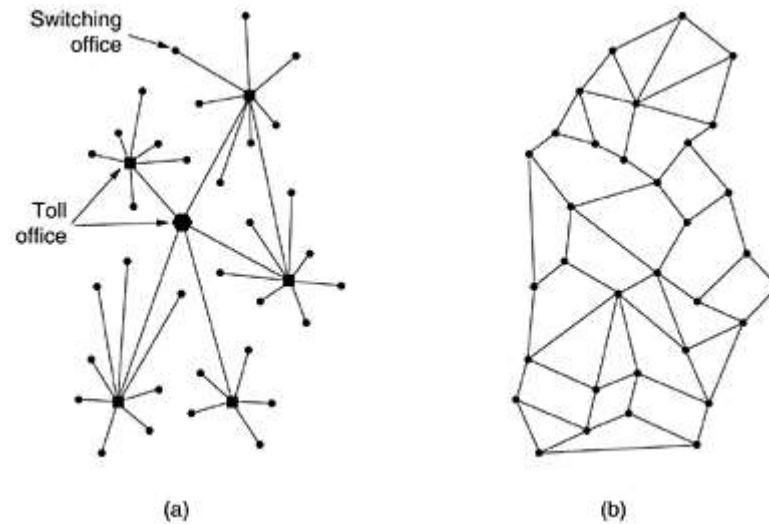
■ Differences

- In OSI, a layer's service definition tells what the layer does, and a layer's interface tells the processes above it how to access it, without explaining how the layers works inside.
- The TCP/IP model did not clearly distinguish between service, interface of the layers.
- As a consequence, the protocols in the OSI model are better hidden than in the TCP/IP model and can be replaced relatively easily as the technology changes.
- OSI model strives to describe the general model of network protocols, while TCP/IP model is specific as it is defined after the real implementations. So TCP/IP model is not useful to describe other protocols.

The hybrid reference model to be used in this book.

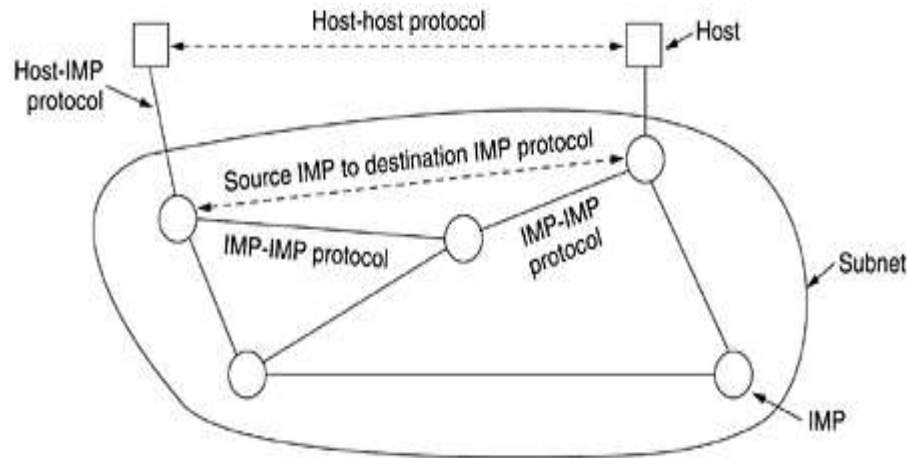
5	Application layer
4	Transport layer
3	Network layer
2	Data link layer
1	Physical layer

EXAMPLE NETWORKS — THE INTERNET I



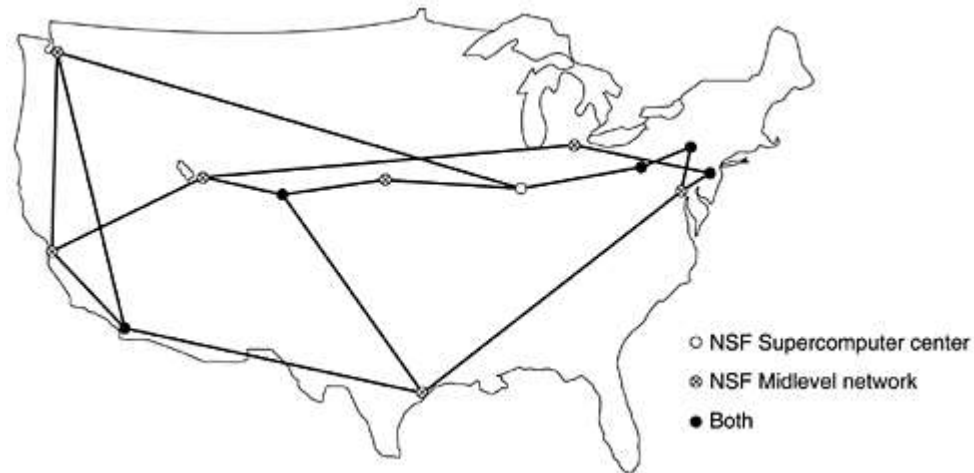
- (a) Structure of the telephone system.
- (b) Baran's proposed distributed switching system.

EXAMPLE NETWORKS — THE INTERNET 2



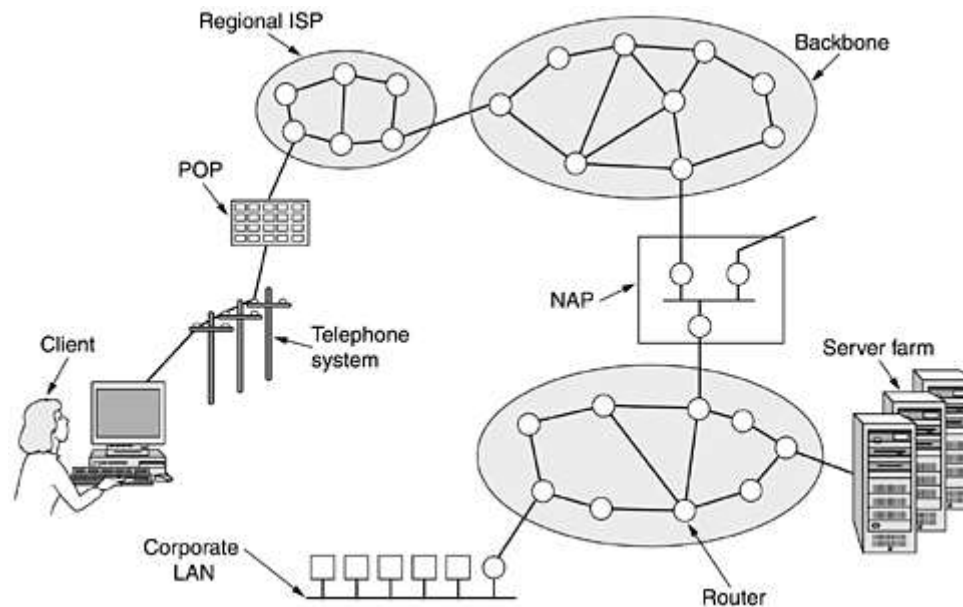
The original ARPANET design (IMP means Interface Message Processors)

EXAMPLE NETWORKS — THE INTERNET 3



The NSFNET backbone in 1988

EXAMPLE NETWORKS — THE INTERNET 4



Architecture of the Internet today

NETWORK STANDARDIZATION

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 IEEE 802 series standards. The important ones are marked with *. The ones marked with ↓ are hibernating. The one marked with † gave up and disbanded itself.

METRIC UNITS

Exp.	Explicit	Prefix	Exp.	Explicit	Prefix
10^{-3}	0.001	milli	10^3	1,000	Kilo
10^{-6}	0.000001	micro	10^6	1,000,000	Mega
10^{-9}	0.000000001	nano	10^9	1,000,000,000	Giga
10^{-12}	0.000000000001	pico	10^{12}	1,000,000,000,000	Tera
10^{-15}	0.000000000000001	femto	10^{15}	1,000,000,000,000,000	Peta
10^{-18}	0.000000000000000001	atto	10^{18}	1,000,000,000,000,000,000	Exa
10^{-21}	0.000000000000000000001	zepto	10^{21}	1,000,000,000,000,000,000,000	Zetta
10^{-24}	0.000000000000000000000001	yocto	10^{24}	1,000,000,000,000,000,000,000,000	Yotta

Take care of “B” and “b”, “B” means byte, while “b” stands bit.

E.g., 1 KB/s = 8 Kb/s. B/s = Bps, b/s = bps.

$$1K = 2^{10} \neq 10^3 \approx 1,000$$

$$1K = 2^{10}; 1M = 2^{20}; 1G = 2^{30} \dots$$



Thank you

The content in this material are from the textbooks and reference books given in the syllabus.

