DATA COMMUNICATION AND SECURITY

Prof. Shankar Mali

UNIT-I

Unit 1: Introduction and Physical Layer (15 Sessions)

- Overview of Computer Network
- OSI and TCP/IP Reference Models,
- Guided and Unguided Transmission Media
- Analog and Digital Communication, Encoding and Modulation
- Nyquist Theorem, Shannon's capacity,
- Switching techniques- TDM, FDM.

UNIT-II

Unit II: Unit 2: Data Link Layer (15 Sessions)

- Framing
- Error detection and Error correction, Vertical Redundancy Check (VRC), Longitudinal Redundancy Check (LRC), Hamming Distance, Hamming Code, Cyclic Redundancy Check (CRC),
- Stop and Wait Protocol, Sliding Window Protocol, Go-Back-n ARQ, Selective-Reject ARQ, HDLC,
- Channel Allocation, ALOHA Systems, CSMA Protocols, Collision Free Protocols

UNIT-III

Unit 3: Network Layer (10 sessions)

- Introduction to the Network Layer
- Network Layer Protocols IPv4 and IPv6 : header structure and
- features, Comparison of IPv4 and IPv6, Transition strategies (Dual stack, Tunneling),
- Addressing in the Network Layer, Classful vs Classless addressing,
- Routing Fundamentals, Types of routing: static, dynamic, Routing protocol, Causes and effects of network congestion
- Congestion control techniques: Leaky Bucket and Token Bucket, Network Address Translation (NAT)

UNIT-IV

Unit 4: Transport Layer (5 sessions)

- Process-To-Process delivery
- user datagram
- Transmission control protocol

UNIT-V

Unit 5: Application Layer (5 sessions)

- Client-Server Model
- Socket interface
- A brief introduction to DNS, SMTP, FTP

UNIT-VI

Unit-6: Network Security (10 sessions)

- Introduction to Network Security
- Common threats: malware, phishing, and DoS attacks
- Cryptography Basics, plaintext, ciphertext, encryption, decryption, Authentication and Authorization, passwords, two factor
- authentication, and biometrics, Firewalls and VPNs

BOOKS

1. Data Communications & Networking, Behrouz A. For4uzan, Tata McGrawHill, 4th edition
2. Data Communication and Computer Networks, Rajneesh Agarwal, Vikas Publication house
3. Computer Networks by Andrew Tanenbaum, Fourth Impression, Pearson Education India
4. Internetworking with TCP/IP, Vol. 3, Client-Server Programming and Applications by Douglas E. Comer, Prentice Hall Publisher, 2014

CCA (CLASS CONTINUOUS ASSESSMENT)

Sr. No.	Type of assessment	Marks	Scheduled Date
1.	Test-1	10 Marks	18th August 2025
2.	Assignment	5 Marks	10th September 2025
3.	Mid Term	30 Marks	6th to 17th October 2025
4.	Presentations/ Certification	15 Marks	November 2025

COMPUTER NETWORK?

- Computer network means interconnection of Autonomous computers
- Two computers are interconnected if they ara able to exchange information
- Connection may be through copper wire, fiber optics, microwaves, infrared, satellites etc.

INTERNET?

- The Internet is not single network but networks of network
- World Wide web is Distributed system that runs on top of Internet
- Distributed system is collection of independent computers appears to the its user as single coherent system.
- In effect distributed system is software system built on top of network.
- Thus the distinction between a network and distributed system lies with the software.
- Even there is considerable overlap between two subject

TRANSMISSION TECHNOLOGY

Types of transmission technology

- Broadcast links
- Point-to-point links

BROADCAST LINK

- Broadcast networks have single communication channel that is shared by all the machines on the networks.
- Short messages, called Packets in certain context sent by any machine are received by all others. Upon receiving packets machine checks the address field. If the packet is intended for the receiving machine, it is just ignored.
- As a general rule smaller, geographically localized networks tend to use broadcasting.

POINT-TO-POINT LINKS

- Point-to-point networks consist of many connections between individual pairs of machines.
- To go from source to destination, a packet on this type of network may visit one or more intermediate machines. Often multiple routes of different lengths are possible
- Hence finding good path is important in point-to-point networks.
- Larger networks usually are point-to-point.

LAN

- Privately owned networks
- They are widely used to connect personnel computers and workstations in company, office to share the resources.
- LAN can be distinguished from other networks by three characteristic
  1. Their size
  2. Their transmission technology
  3. Their topology

LAN

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- Various topologies are possible for broadcast LAN
- IEEE 802.3 popularly known as Ethernet is Bus based broadcast network
- IEEE 802.5 is is ring based network.
- Broadcast network are further divided in to static and dynamic depending on how the channel is allocated.
- Static allocation: A typical static allocation would be divide time into discrete intervals and use a round-robin algorithm , allowing each machine to broadcast only when its time slot comes up.

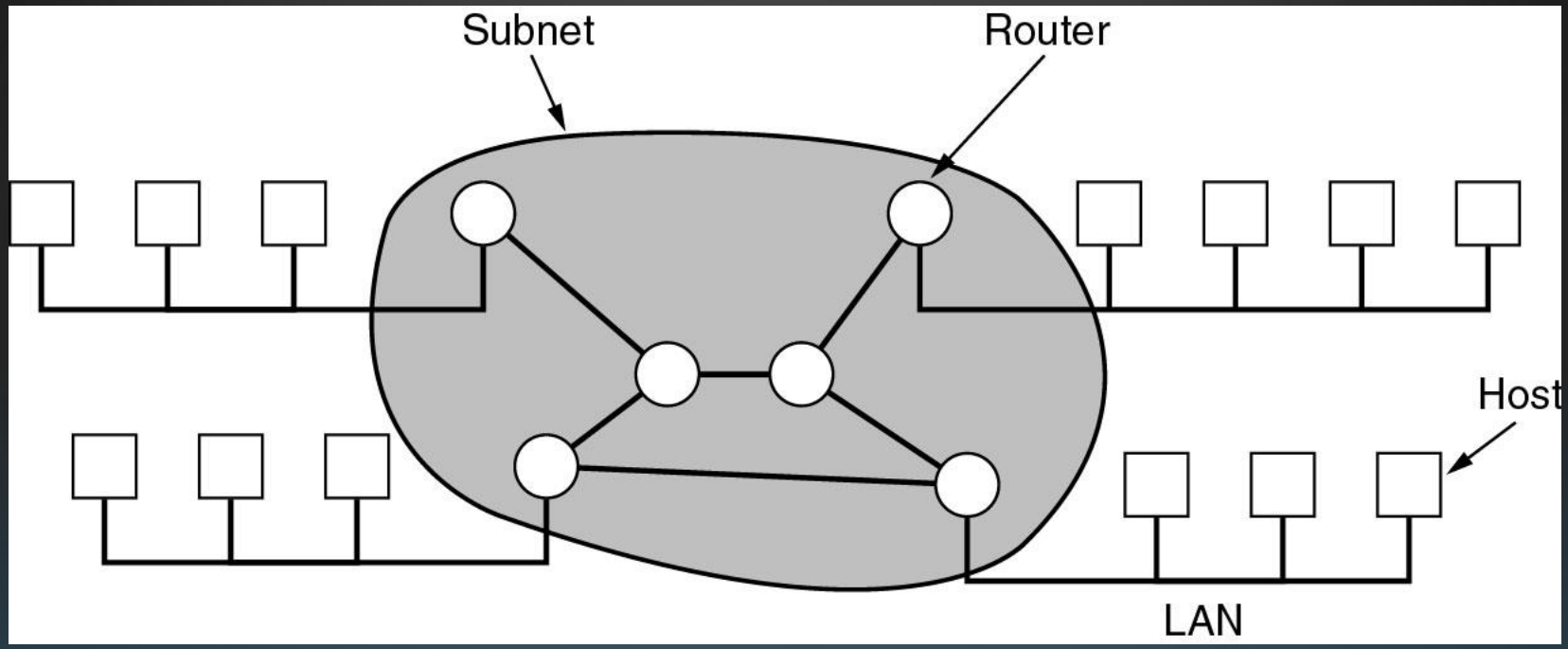
LAN

- Dynamic allocation method for a common channel are either centralized or decentralized
- In centralized channel allocation method there is single entity which determine who goes next. It might do this my accepting request and making decision according to some internal algorithm.
- In decentralized method there is no central entity, each machine must decide when to transmit.

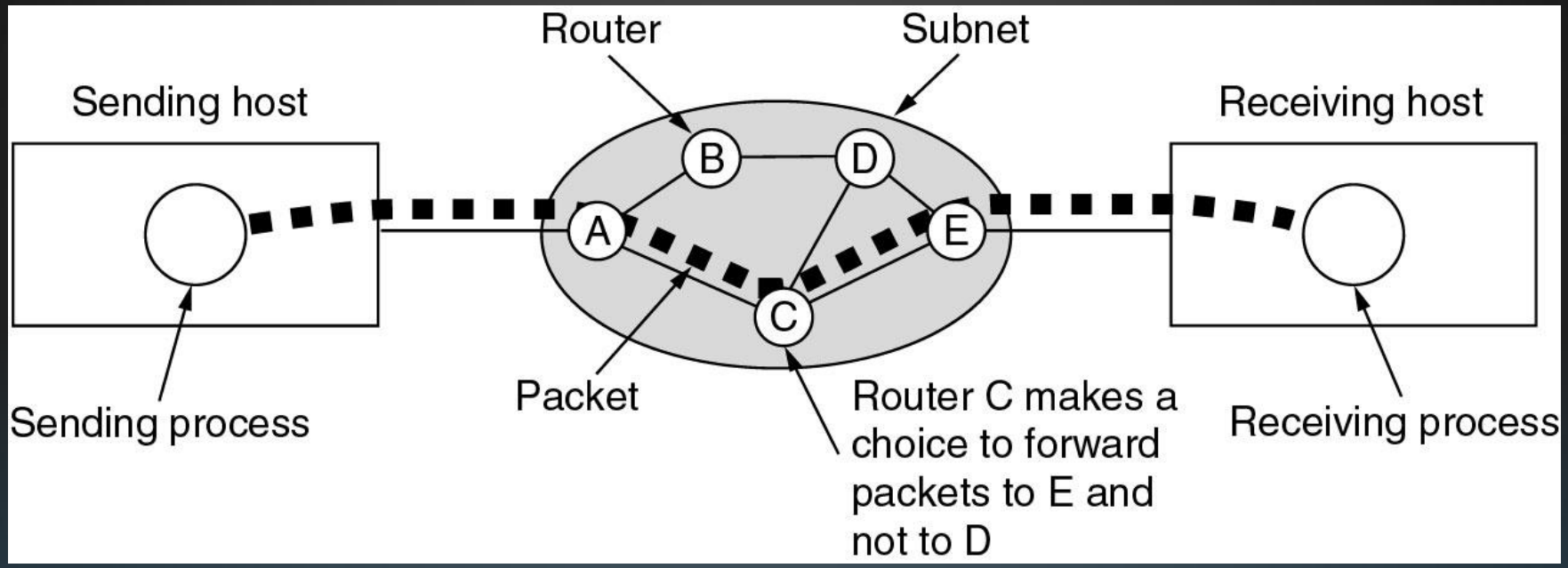
MAN

- MAN covers a city.
- Best example of MAN is cable television network available in many cities.
- The unused spectrum of the cable can be used for the internet use also.

WIDE AREA NETWORKS



WIDE AREA NETWORKS (2)



WAN

- WAN spans a large geographical area, often a country or continent
- It contains collection of machines intended for running users we call it as hosts.
- Host are connected by communication subnet or just subnet.
- The host is owned by the customer whereas communication subnet is owned by telephone company or Internet service provider.
- Subnet consist of two distinct component
  - **Transmission lines** moves bits between machines
  - **Switching element** or **routers** are specialized computer , when data arrive on incoming line routers choose an outgoing line

NETWORK SOFTWARE

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

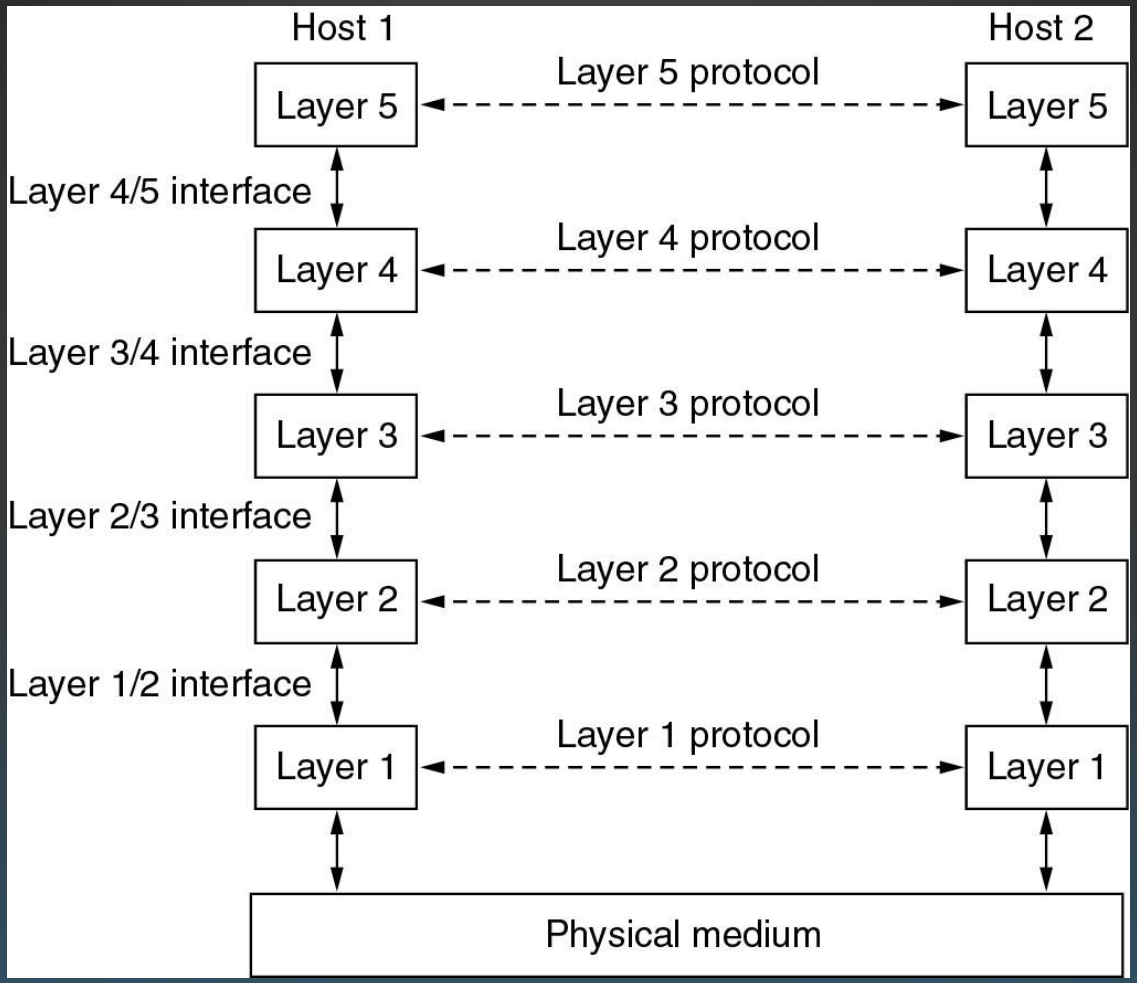
PROTOCOL HIERARCHIES

- Most networks are organized as a stack of **layers** or levels
- The number of layers, the name of each layer, the content of each layer and function of each layer differ from network to network
- The purpose of each layer is to offer certain services to the higher layers.
- Layer n on one machine carries on an conversation with layer n on another machine.
- The rule and convention used in this conversation are collectively known as the layer n **protocol**.
- In reality, no data are directly transferred from layer n on machine to layer n on another machine.

CONT.

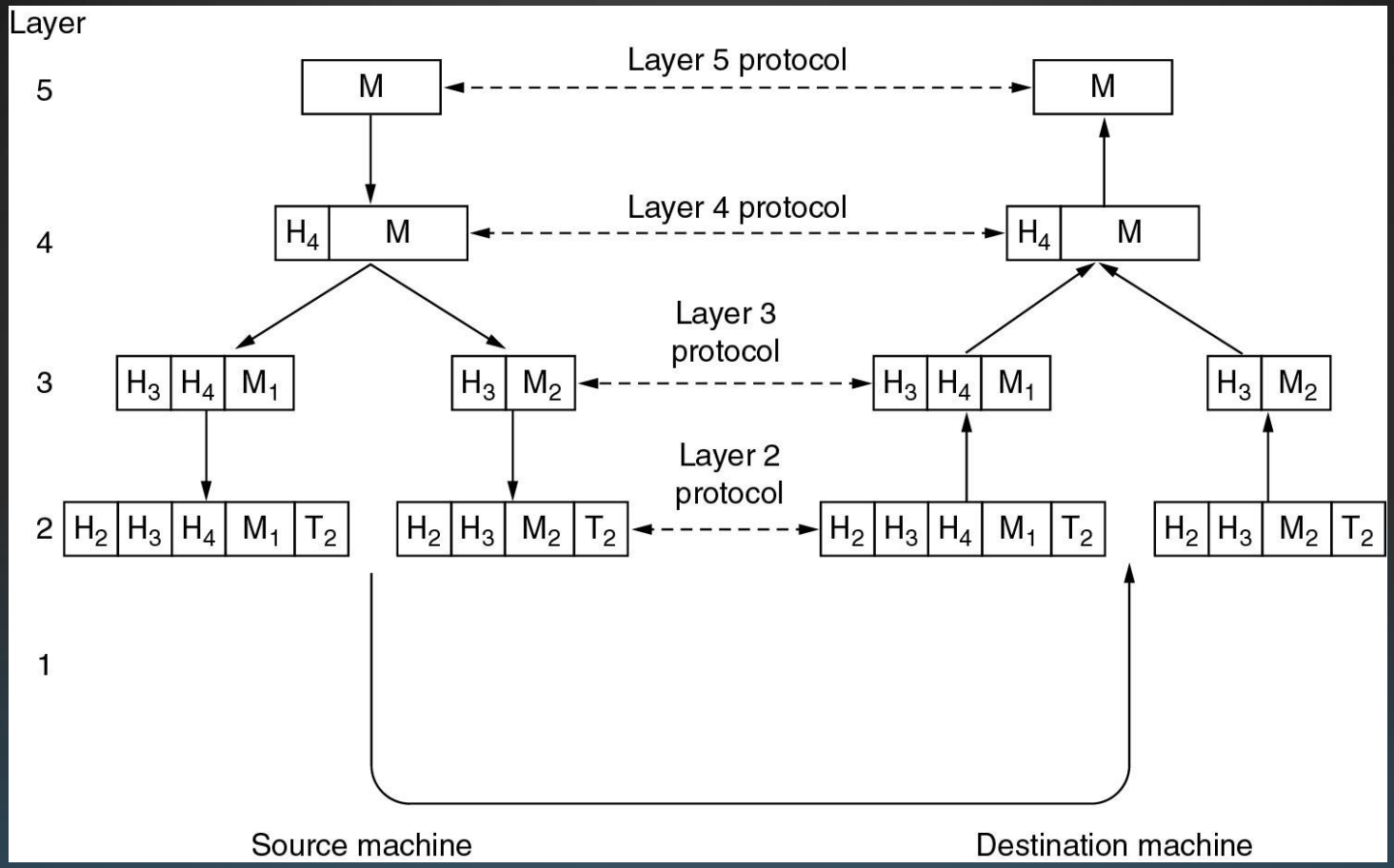
- Each layer passes data and control information to the layer immediately below it, until the lowest layer is reached.
- Below layer 1, the physical medium through which actual communication occurs.
- Between each pair of adjacent layers is an **interface**. The interface defines which primitive operation and services the lower layer makes available to the upper one.
- A set of layers and protocol is called a **network architecture**.
- The specification of architecture must contain enough information to allow implementer to write the program. But details of implementation nor the specification of interface is part of architecture.

NETWORK SOFTWARE
PROTOCOL HIERARCHIES



Layers, protocols, and interfaces.

PROTOCOL HIERARCHIES



EXAMPLE INFORMATION FLOW

- A message M is produced by an application process running in layer 5 and given to layer 4
- Layer 4 puts header in front of message to identify the message and passes result to layer 3. The header includes control information such as sequence number.
- Layer 3 break up the incoming message into smaller units , packets. In this example M is split into two parts M1 and M2. Layer 3 also decides which outgoing lines to use and passes packet to layer 2
- Layer 2 adds not only a header to each piece, but also a trailer and gives the resulting unit to layer 1 for physical transmission
- At the receiving machine the message moves upward from layer to layer with headers being stripped off as it progresses.

DESIGN ISSUES FOR THE LAYERS

- Addressing
- Error Control
- Flow Control
- Multiplexing
- Routing

DESIGN ISSUES

- Every layer needs a mechanism for identifying senders and receivers. As having multiple destination , some form of **addressing** is needed in order to specify a specific destination
- Error control is important issue because physical communication circuits are not perfect.
- An issues that occurs at every levels how to keep a fast sender from swamping a slow receiver with data, the subject is called **flow control**.
- When it is inconvenient or expensive to set up a separate connection for each pair of communication process, the underlying layer may decide to use the same connection for multiple conversation, this is **multiplexing** and **multiplexing**
- When there are multiple paths between source and destination, a route must be chosen. This topic is called as routing.

CONNECTION-ORIENTED AND CONNECTIONLESS SERVICES

	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

CONNECTION-ORIENTED SERVICES

- Connection-oriented system is modeled after the telephone system.
- Connectionless service is modeled after the postal system.
- Reliable connection-oriented service has two minor variation
  - Message stream : Message boundary

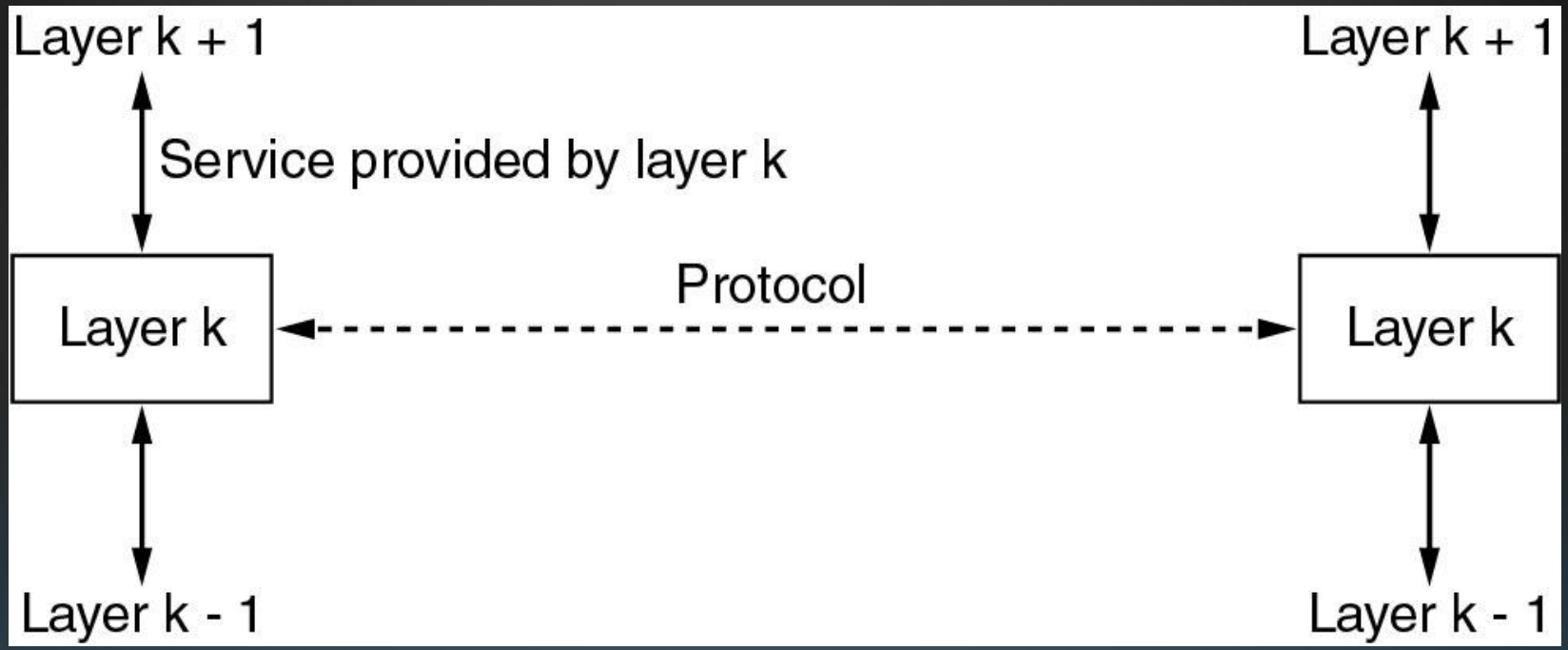
  When two 1024-byte message are sent, they arrive as two distinct 1024-bytes never as one 2048-bytes message
  - Byte stream : No Message boundary

  In this connection is only stream of bytes with no message boundaries.
- For some application, the transit introduced by acknowledgment are unacceptable. Having few pixels wrong is no problem

CONNECTIONLESS SERVICES

- Unreliable connectionless service is is often called datagram service which does not return an acknowledgement to sender
- The acknowledgement datagram service returns acknowledgement to the sender
- In this service the sender transmit a single datagram containing a request and the reply contains the answer.

SERVICES TO PROTOCOLS RELATIONSHIP



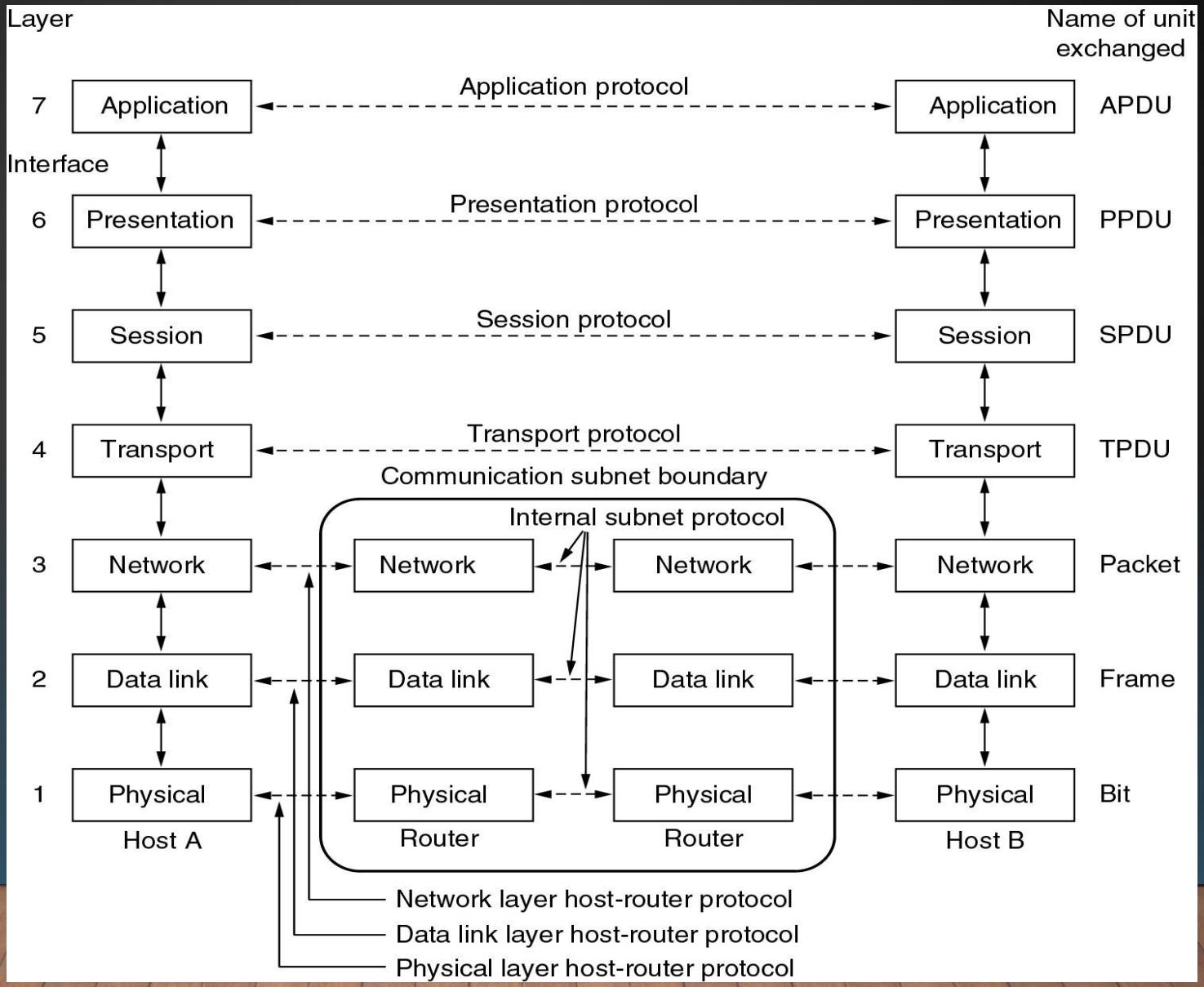
THE RELATIONSHIP OF SERVICES TO PROTOCOL

- A service is a set of operations that a layer provides to the layer above it. The service defines what operations the layer is prepared to perform on behalf of its users
- A protocol is set of rules governing the format and meaning of the packet or message that are exchanged by peer entities within a layer
- Layers are free to change their protocol at their will, provided that they do not change their service visible to them.

REFERENCE MODELS

- The OSI Reference Model
- The TCP/IP Reference Model
- A Critique of the OSI Model and Protocols
- A Critique of the TCP/IP Reference Model

The OSI reference model.



PRINCIPLES APPLIED FOR OSI MODEL

1. A layer should be created where a different abstraction is neeed.
2. Each layer should perform well defined function
3. The function of each layer should be chosen toward defining internationally standardize protocol.
4. The layer boundaries should be chosen to minimize the information flow across the interface
5. The number of layer should be large enough that distinct function need not be thrown together in the same layer and small enough that architecture does not become unwieldy.

THE PHYSICAL LAYER

- Transmits raw bits over a physical medium.
- Defines **hardware** specifications like cables, connectors, voltages.
- Handles **data encoding**, **bit synchronization**, and **modulation**.
- Controls transmission rate and physical topology.
- **The physical layer is responsible for moments of individual bits from one hop (node) to the next**

THE DATA LINK LAYER

- In data link layer the sender break up the input data into data frames and transmit the frames sequentially. If the service is reliable, the receiver confirm correct receipt of each frame by sending back an acknowledgement frame.
- Another issue that arises in the data link layer is how to keep a fast transmitter from drowning a slow receiver in data
- Broadcast networks have additional issue in the data link layer: how to control access to shared channel.
- The special sub layer of the data link layer, the medium access control sublayer, deals with this problem.
- **The data link layer is responsible for moving frames from one hop (node) to the next.**

THE NETWORK LAYER

- The network layer controls the operation of the subnet.
- Design issue is determining how packets are routed from source to destination.
- The control of congestion control is belongs to network layer.
- The problem to allow heterogeneous network to be interconnected.
- **The network layer is responsible for delivery of individual packet from the source host to the destination**

THE TRANSPORT LAYER

- The basic function of transport layer is to accept data from above, split into smaller units if needed and pass these to network layer and ensure that all pieces are arrive correctly at other end
- The transport layer also determine what type of service to provide to the session layer
- The transport layer is true end to end layer (layer 4 through 7), means source machine carries on conversation with a similar program on the destination machine.
- **The transport layer is responsible for the delivery of message from one process to another**

THE SESSION LAYER

- The session layer allow users on different machine to establish session between them
- Session offers various services
  - Dialog control (keeping track of whose turn to transmit)
  - Token management (preventing two parties attempting same critical operation)
  - Synchronization (check pointing long transmission to allow them to continue from where they were after the crash)
- **The session layer is responsible for dialog control an synchronization**

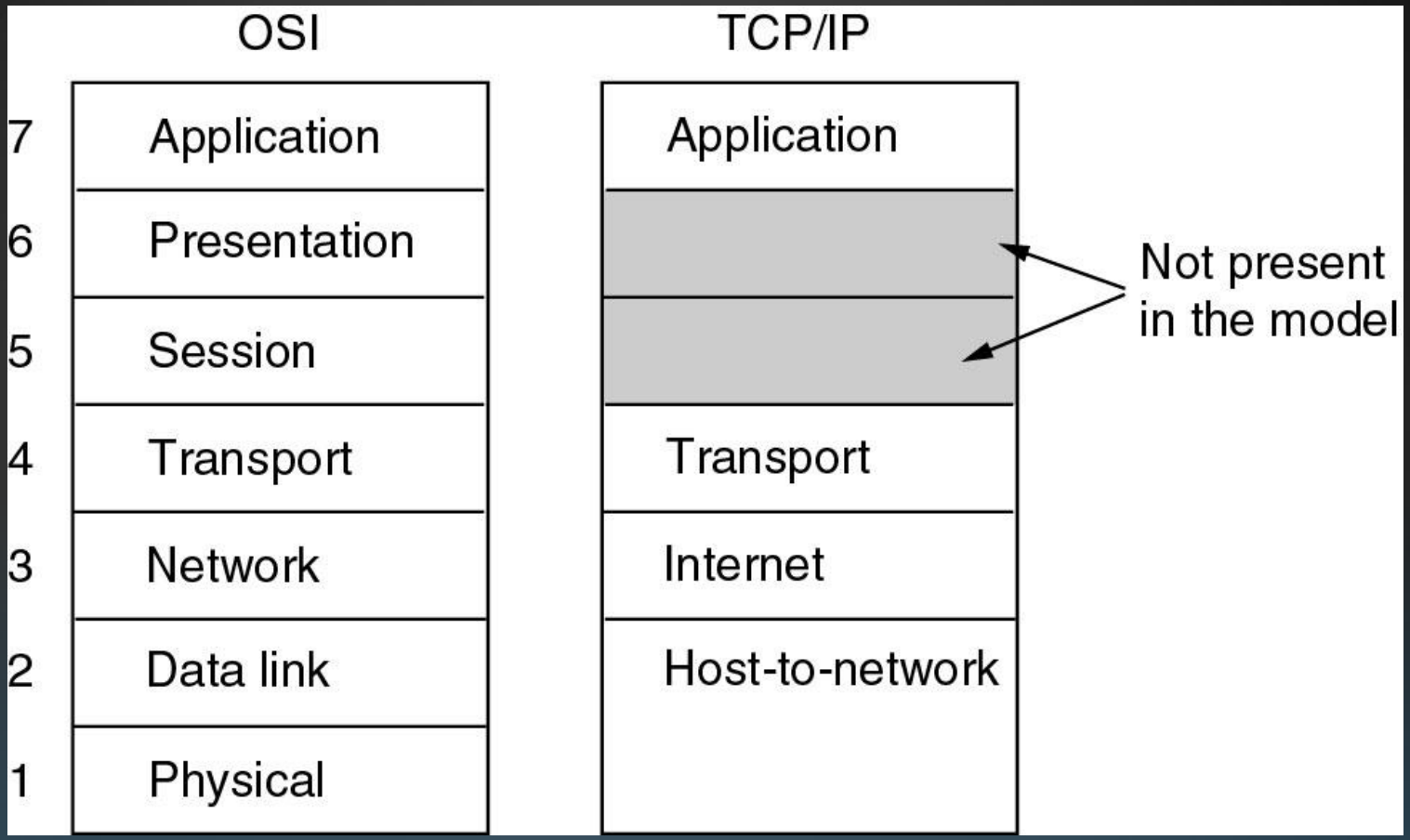
THE PRESENTATION LAYER

- The presentation layer is concern with syntax and semantics of the information transmitted
- **The presentation layer is responsible for translation, compression and encryption.**

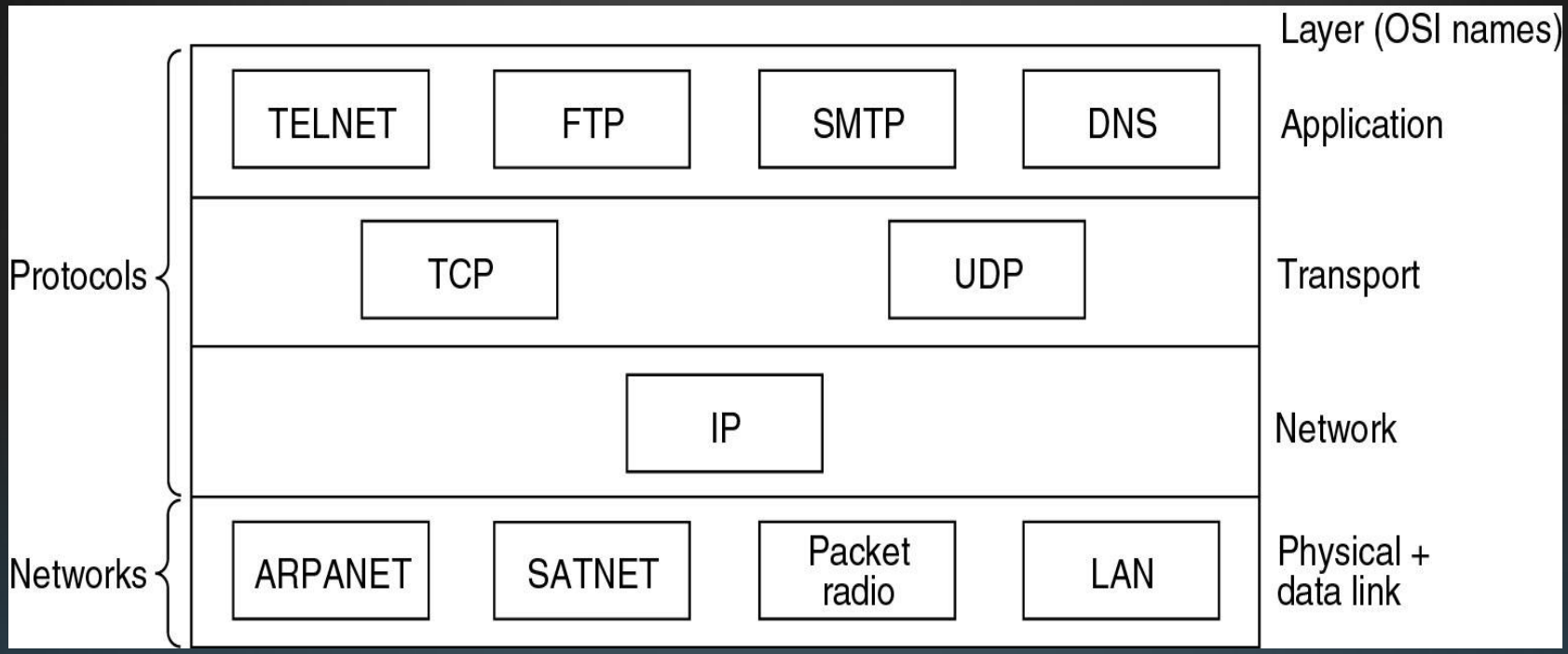
THE APPLICATION LAYER

- The application layer contain a verity of protocols that are commonly needed by users.
- Closest to the user, provides **network services** to applications.
- Supports services like **email**, **file transfer**, **web browsing**.
- Interfaces with software to implement communication components.
- One widely used protocol is HTTP
- **The application layer is responsible for providing service to the user.**

TCP/IP REFERENCE MODELS



REFERENCE MODELS (3)



INTERNET LAYER

- The job of internet layer is to injects packets into any network and have them travel independently to the destination
- The internet layer defines an official packet format and protocol called IP (Internet protocol)
- Packet routing is clearly major issue here.

THE TRANSPORT LAYER

- Two end-to-end transport protocols have been defined here
  - TCP (Transmission Control Protocol)
  - UDP (User Datagram Protocol)
- TCP is reliable connection-oriented protocol that allows byte stream originating on one machine to delivered without error on another machine in the network
- UDP is unreliable connectionless protocol for application that do not want TCP's sequence flow. The application in which prompt delivery is very important UDP is used.

APPLICATION LAYER

- The application layer contains higher level protocols like

  TELNET (Virtual terminal)

  FTP (File transfer)

  SMTP (Electronic mail)

  DNS (mapping host name onto their network address)

DNS

- **Telnet** is a network protocol used on the Internet or local area networks to provide a bidirectional interactive text-oriented communications facility using a virtual terminal connection.
- **File Transfer Protocol** (**FTP**) is a standard network protocol used to transfer files from one host to another host over a TCP-based network, such as the Internet.
- **Simple Mail Transfer Protocol** (**SMTP**) is an Internet standard for electronic mail (e-mail) transmission across Internet Protocol (IP) networks.

DNS

The **Domain Name System** (**DNS**) is a hierarchical distributed naming system for computers, services, or any resource connected to the Internet or a private network. It associates various information with domain names assigned to each of the participating entities. A **Domain Name Service** resolves queries for these names into IP addresses for the purpose of locating computer services and devices worldwide. By providing a worldwide, distributed keyword-based redirection service, the Domain Name System is an essential component of the functionality of the Internet.

HOST-TO-NETWORK

- The TCP/IP reference model does not really says what happens here.

ADDRESSING

- Four levels are used in TCP/IP

1. **Physical addresses(48-bits):** also known as link address, is the address of the a node as defined by its LAN or WAN
2. **Logical addresses(32-bits):** Logical address is important for universal communication that are independent of physical networks. No two publicly addressed and visible host can have same IP address
3. **Port addresses (16-bits):** Computer can run many process at a time, suppose computer A communicate B through TELNET and at the same time communicate with C through FTP.
4. **Specific addresses**: some application have user friendly addresses that are designed for that specific application.

! Thank You !