Computer Networks

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Session Goals

- Introduction
- Applications of Computer Networks
- Network Hardware
- Network Software*
- Reference Models*

Introduction

- **Computer Network : " Collection of Autonomous computers interconnected by a single technology "**

- **Interconnected**
  - **Able exchange information**
- **Autonomous**
  - **Individuality in terms of h/w, s/w and services**
- **Single Technology**
  - **Structure , medium etc..**

Introduction

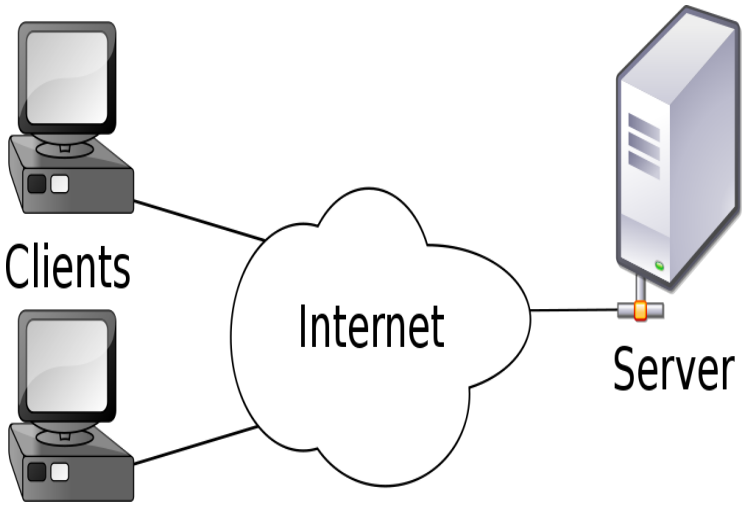
- **Need of Computer Networks**
  - **Single computer is serving to all computational needs in olden days.**
  - **Large number of separated but interconnected computers do that job.**
- **Fast**
- **Able to cop up the information processing grows, process and gather.**

Computer Networks Vs Distributed system

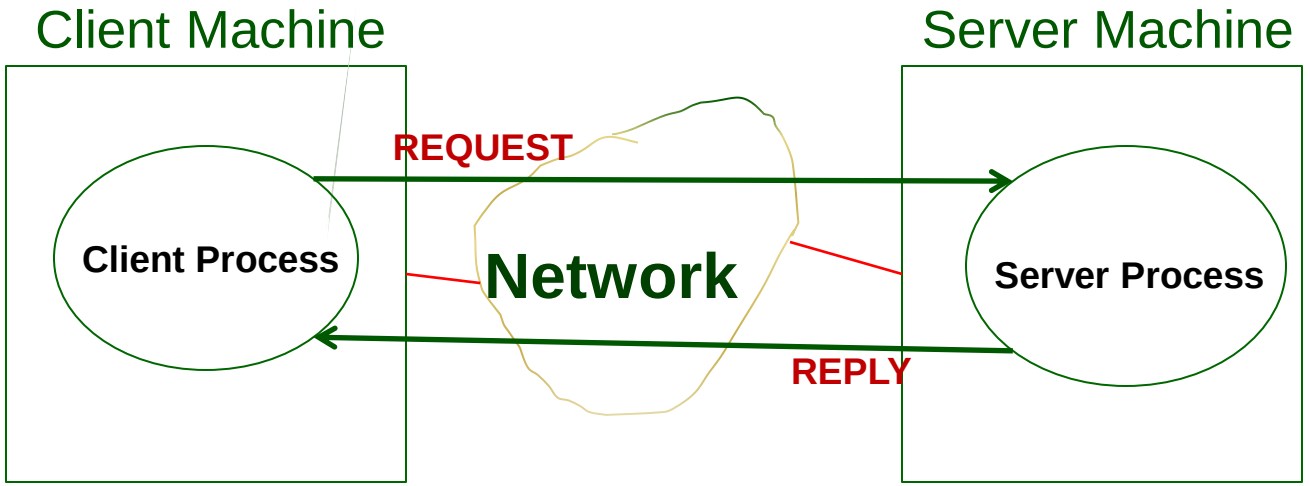
- **Distributed System**
  - **uses middleware, which is s/w built on OS.**
  - **Views as a single coherent system to user even though it is a collection of computers.**
  - **It's a model / paradigm**
  - **Example is WWW.**
- **Computer Networks**
  - **No Coherent, model and software**
  - **Exposed to work on actual machines**
- **Example :**
  - **Gmail (Distributed System)**
  - **Remote login (Computer Networks)**

Uses of Computer Networks

- **Business Applications**
  - **Resource Sharing**
    - **Client – Server Model**
  - **Communication Media**
    - **E – Mail**
    - **E – Commerce**
- **Home Applications**
  - **Person – Person Communication**
    - **Instant Messaging**
  - **Accessing Remote Information**
    - **New Paper, Digital Library**
  - **Interactive Entertainment**



Client Server Architecture



Network Hardware

- **Two Dimensions of Computer Networks**
  - **Transmission Technology**
  - **Scale**

- **Transmission**
  - **Broadcast link**
  - **Point-to-point link**

Network Hardware

- **Broadcast Networks:**
  - **" It has a single Communication CHANNEL, shared by all machines on the networks"**
  - **It uses intend address (receiver) in the data message and placed on channel.**
  - **All machines receives and examines the address.**
  - **If it is intended to that, it will process otherwise it ignores.**
  - **Usually in LAN's Only.**
- **Example : calling a person with his name in class.**
- **Broadcast Networks Transmission modes :**
  - **Broadcasting: " addressing a packet to all destinations by using special code in address field".**
    - **Receives and process all machines in a network.**
  - **Multicasting: " Transmit a packet to a subset of Machines in network "**
    - **Uses grouping.**

Network Hardware

- **Point-to-Point Networks:**
  - **" It has many connection between individual pairs of machines"**
  - **Data Packet may visit one or more intermediate machines , in network to reach destination.**
  - **Often multiple routes to destination.**
  - **Usually used in Large networks like WAN**
  - **Challenge:**
    - **Finding the best and good route between source to destination.**
- **Point-to-Point Networks Transmission Mode:**
  - **Unicasting: "It able to send data packets from one sender to one receiver only, by inserting destination address in address field"**

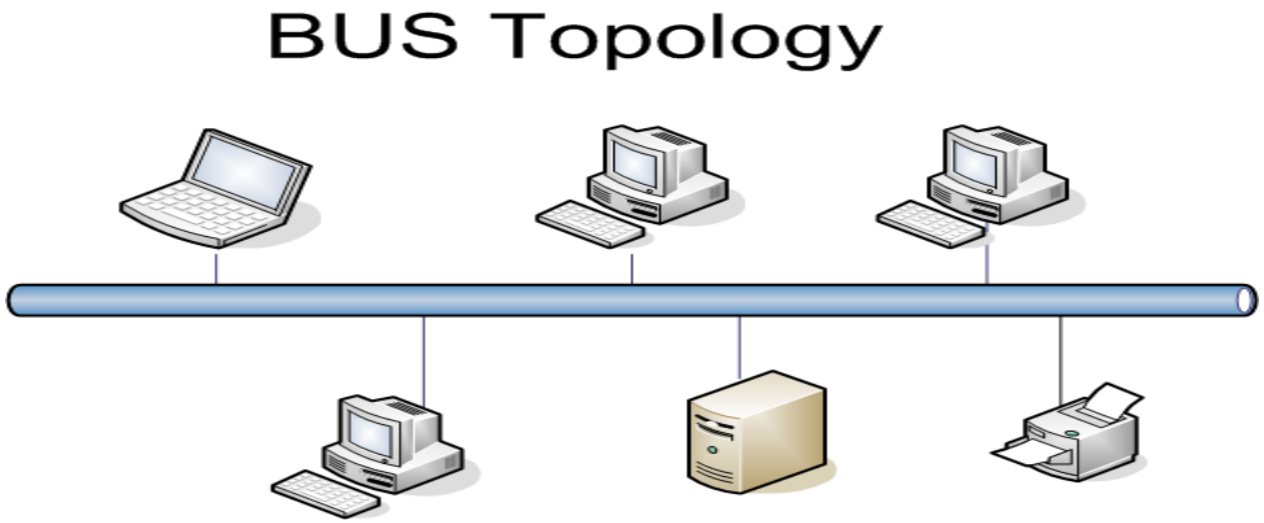
Network Hardware

- **Scale: Classification based on network size/scale**

Distance	Location	Example
1m	Square Meter	PAN
10m	Room	LAN
100m	Building	
1 km	Campus	
10km	City	MAN
100km	Country	WAN
1000km	Continent	
10000km	Planet	Internet

Local Area Networks (LAN)

- LAN: "Privately Owned Network with in a single building or Campus of up to a few kilometers in Size"
- Used for resource sharing.
- Example : Ethernet (IEEE 802.3, IEEE 802.5)
- LAN's are distinguish from other networks
  - Size (Worst case time known)
  - Transmission Technology(10Mbps-100Mbps, 10Gbps)
  - Topology (ring, star, bus etc)

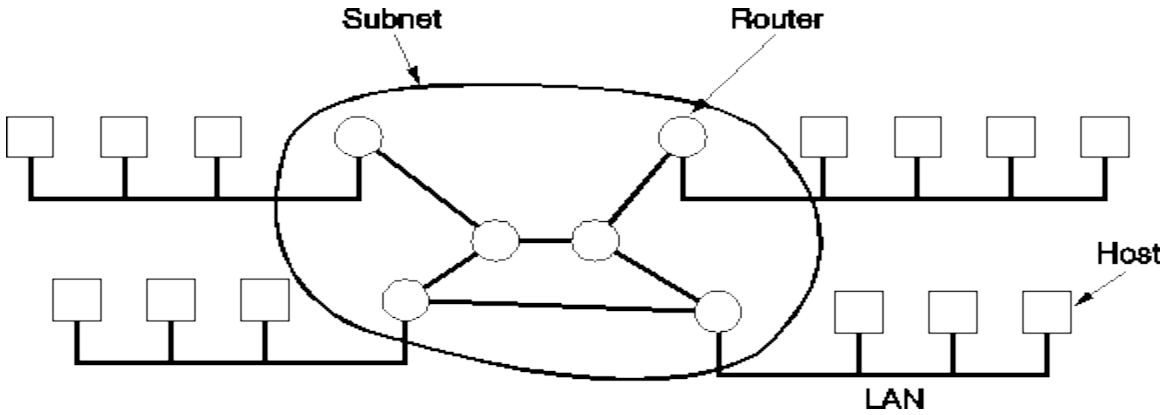


Metropolitan Area Network (MAN)

- Metropolitan Area Network (MAN) : it is a large computer networks span over a city.
- Owned and operated by single organization
- Inter networking of logical networks.
- Technologies used are ATM, FDDI
- Example : Cable TV, IEEE 802.6

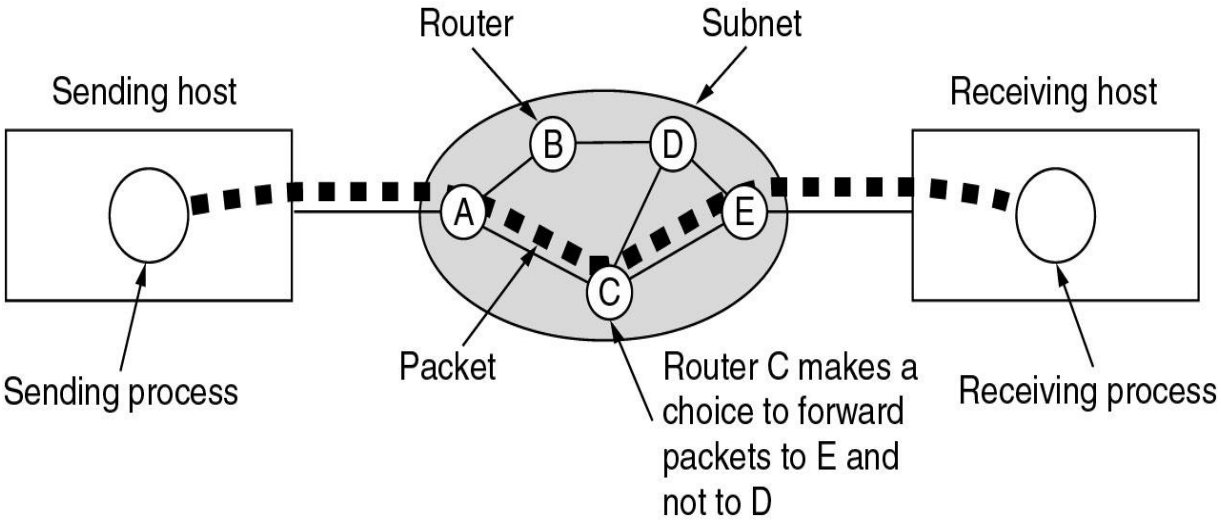
Wide Area Network (WAN)

- **Wide Area Network (WAN) : it spans a large geographical area, often country or continent.**
- **Host/End System: The WAN contains machine , which are intend to run user or application programs.**
- **Communication Subnet: which interconnected hosts.**
  - **it is owned by ISP or Telephone company**
- **WAN subnet consists of**
  - **Transmission lines (moves the bits)**
  - **Switching elements (connects 2 / 3 transmission lines)**



Wide Area Network (WAN)

- **Communication Subnet Uses a principle**
- **Store-and-forward or packet-switched**
  - **Message divided into packets with sequence numbers**
  - **Packets are injected into network**
  - **Packets uses different paths to reach destination**
  - **Resembles at destination with the help of sequence number**

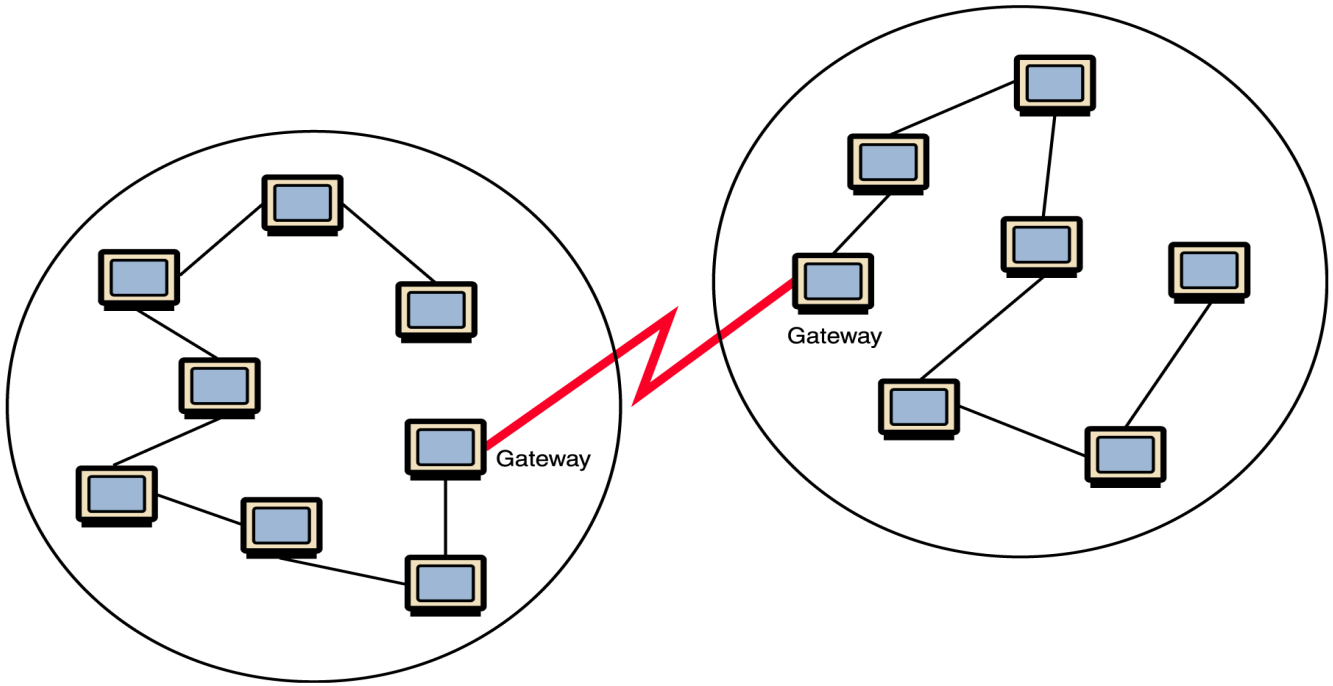


Wireless Networks

- It is one type of Computer networks, that are not connected by physically visible medium like cable.
- It uses air for transmission.
- Speed is some what slow
- High Error rate
- High Interference
- 3 categories based on size and technology
  - System Interconnection (Bluetooth)
  - Wireless LANs (uses radio and antenna to communicate, IEEE 802.11)
  - Wireless WANs (Cellular Networks)

Internetworks

- Collection of interconnected networks is called an Internetworks or internet.
- Gateway used to connect one network to other networks.
- Simply internet → LAN + WAN



Network Software

- Initially computer networks depends on Hardware.
- Now it depends on Software
- To reduce Design Complexity, networks are organized as stack of layers or levels, each one built upon one below it.
- No of Layers
- Name of the layer
- Content of layer
- Function of layer

Network to network

- Each Layer offers some services to layer above it.

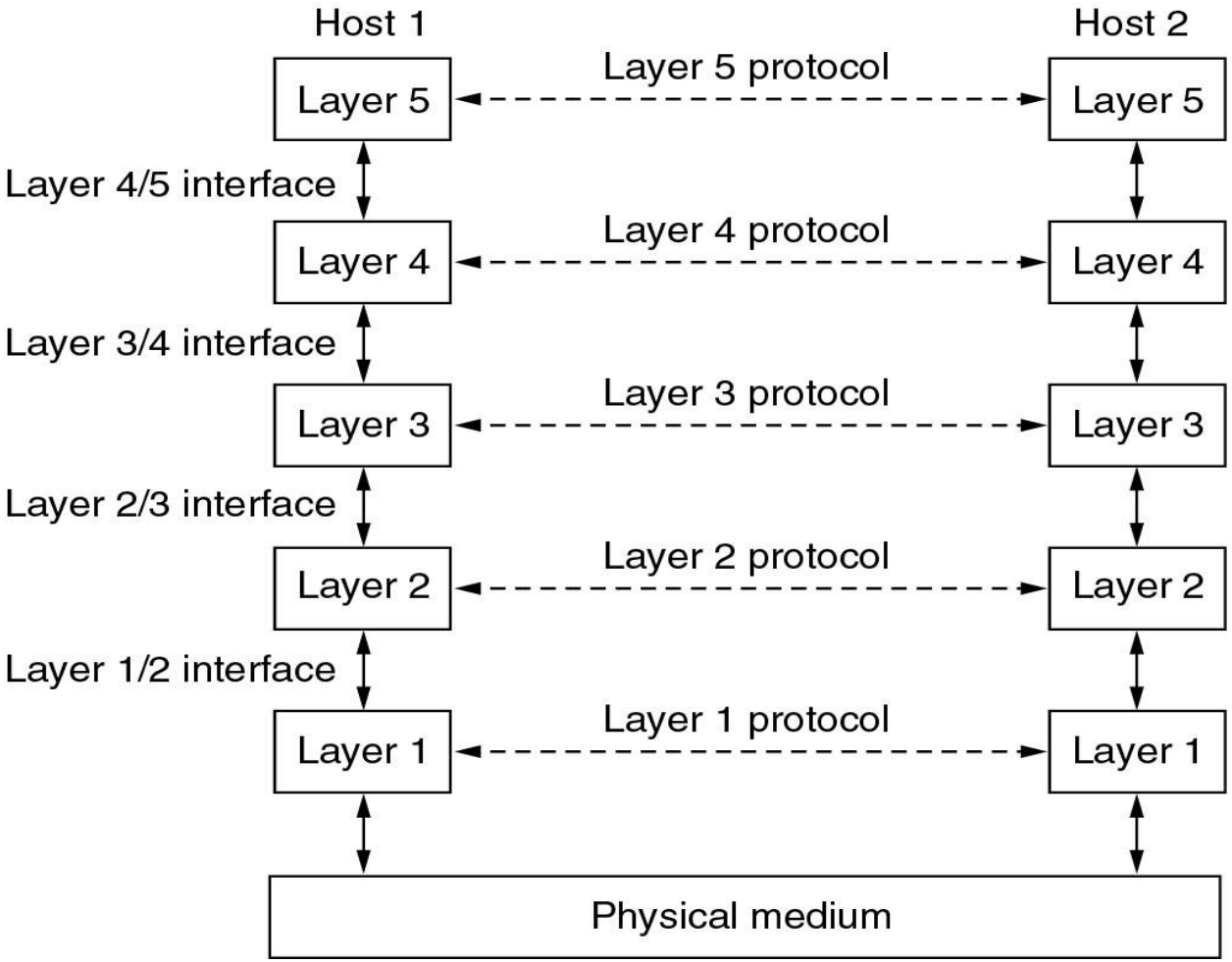
Network Software

- A entity of layer on one host talks to the same layer entity on another host (its peer).
- The entities of layers on different machines are termed peers.
- The rules and conventions used in that conversation is called Protocol.
- Protocol is an agreement and rules between the communication parties, on which the communication can takes place.
- Interface defines the primitive operations and services offer to the above layer. Clearly defined Interfaces are needed to avoid unnecessary data transmission.

Network Software

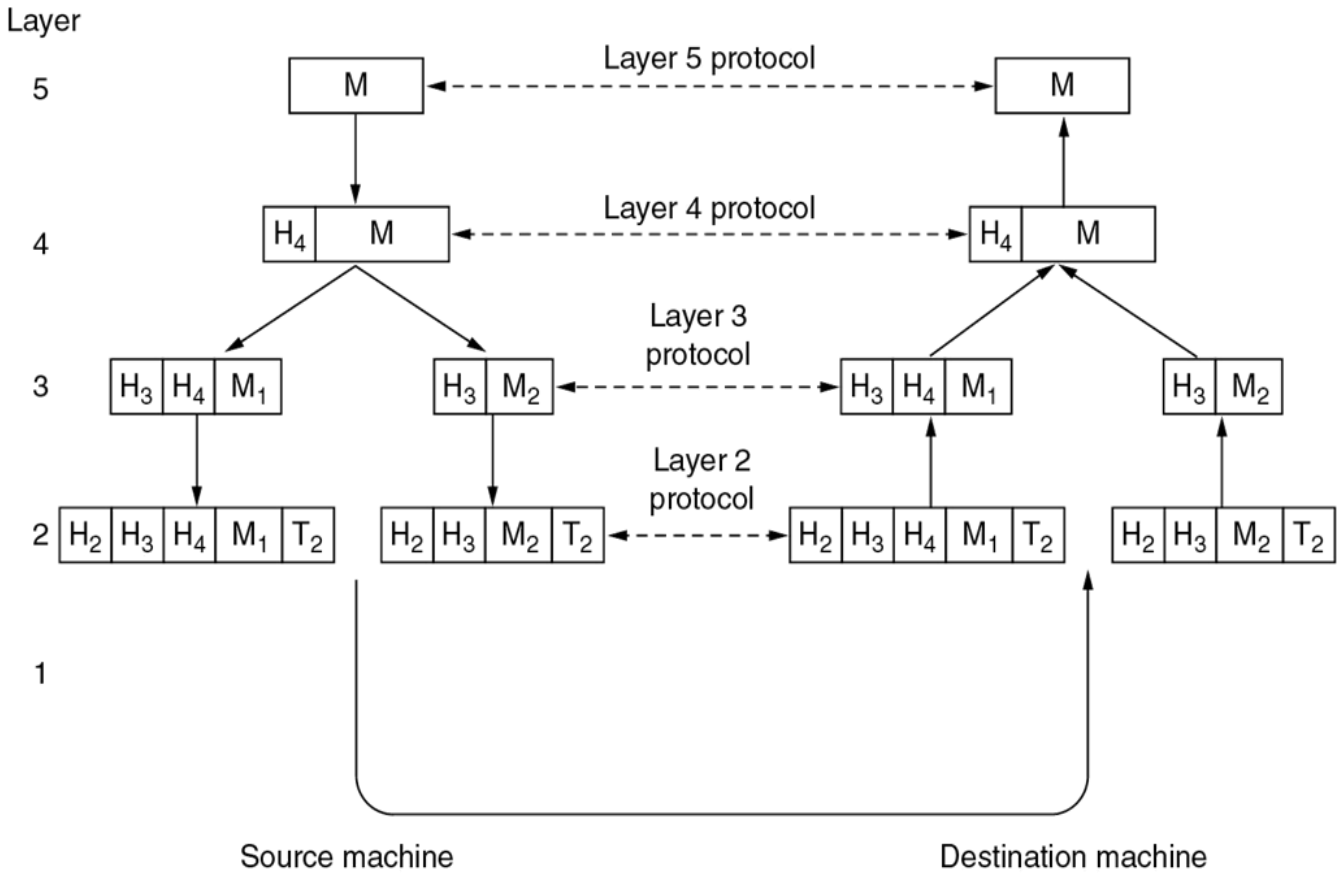
- **Network Designer decides,**
  - **number of layers**
  - **Functionalities of layers**
  - **Interfaces between layers.**
- **Network Architecture : A set of Layers and Protocols is called network architecture.**
- **Protocol Stack : List of Protocols used by a system, i.e one protocol per layer.**

Network Software



Network Software

- Protocol Hierarchies
- **Protocols of Lower Layer in hierarchy are implemented in hardware**



Design issues of Layers

- Addressing (Each needs to identify sender and receiver)
- Data Transfer
  - simplex
  - Half duplex
  - Full duplex
  - Two logical channels (urgent and normal)
- Error Control (agreement)
- Packets arrived out of order(protocol)
- Flow Control
- Message Breaking, Reassemble @ Receiver
- Multiplexing and Demultiplexing.
- Routing

Layer's Services

- Two different services to the layer above on it.
  - Connection Oriented Services
  - Connection Less Services
- **Connection Oriented Services**
  - Its like a Telephone System.
  - It has 3 phases
  - Connection Establishment
  - Data Transfer
  - Connection Termination
  - Its like a tube after connection setup.
  - Negotiations
    - **QoS, Maximum Message Size…**

Layer's Services

- Two different services to the layer above on it.
  - Connection Oriented Services
  - Connection Less Services
- **Connection Less Services**
  - Its like a Postal System.
  - Message has destination address.
  - May Use different routes to reach destinations.

Layer's Services

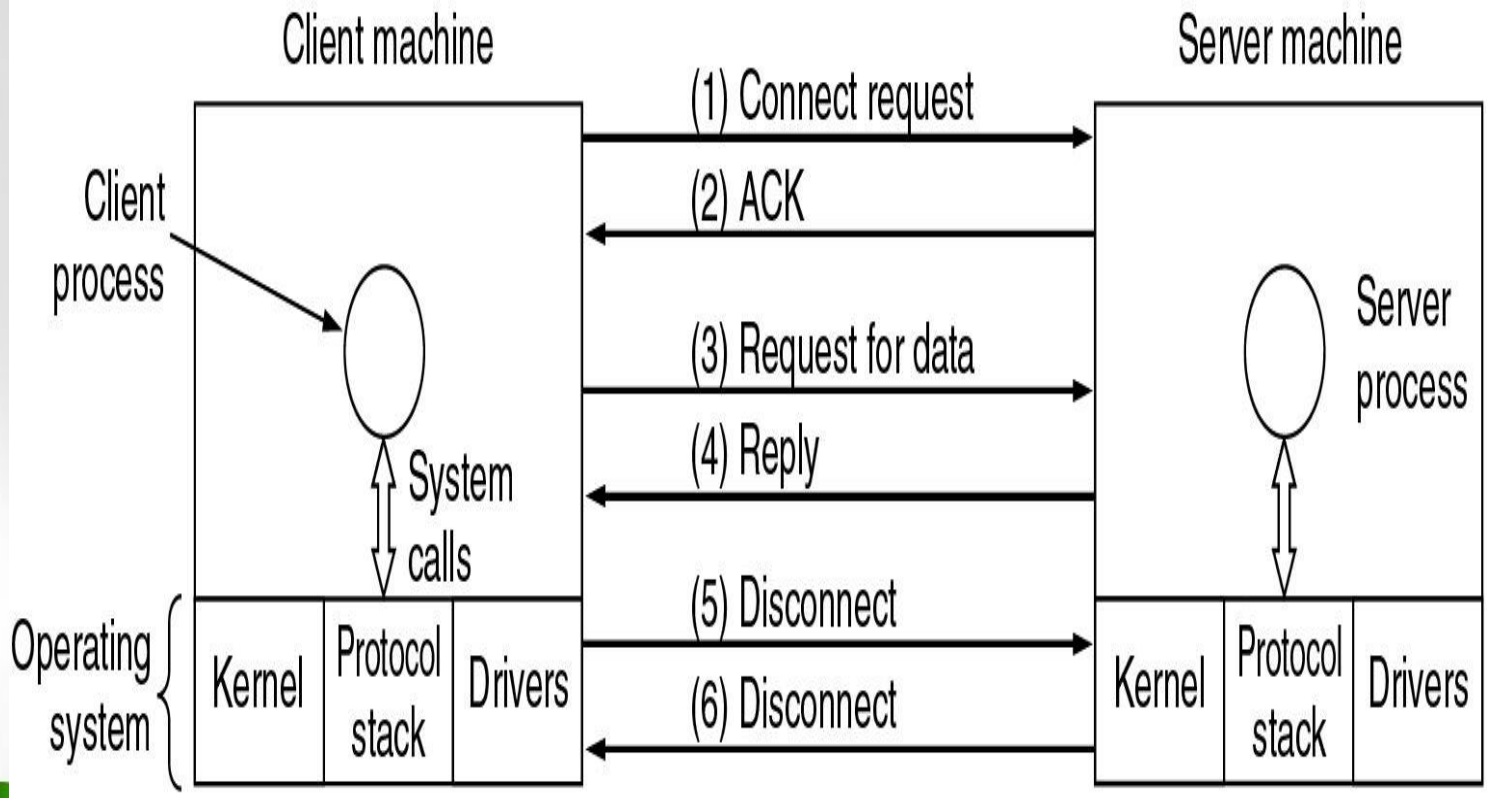
- Service is Characterized by QoS.
- Reliable :
  - waiting for a acknowledgment for sent data.
  - Never lose data
  - Overheads and delays
- Reliable Connection Oriented Services
  - Message Sequences (message boundary)
  - Byte Streams (boundary)
- Connection less services are not reliable.
- Datagram Services
- Unreliable Connection less Services are called Datagram Services
- Request – Reply Services

Service Primitives

- Service is a set of primitives (Operations) available to user process to access the service.
- Primitives are system calls, if protocol is in OS.
- Service Primitives depends upon service being provided and different for COS and CLS.
- Some of COS primitives are

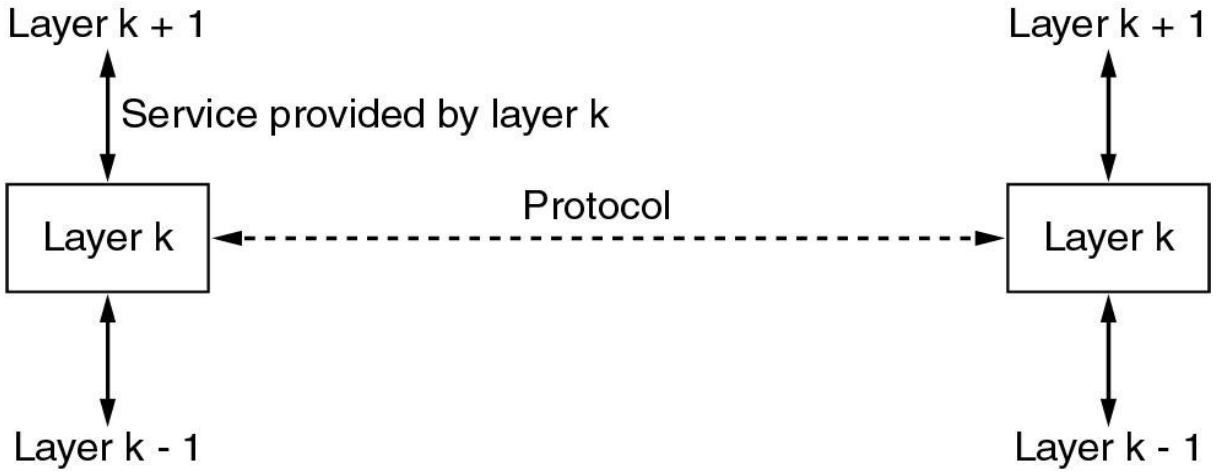
Primitive	Meaning
LISTEN	Block waiting for an incoming connection
CONNECT	Establish a connection with a waiting peer
RECEIVE	Block waiting for an incoming message
SEND	Send a message to the peer
DISCONNECT	Terminate a connection

Service Primitives



Services Vs Protocols

- Service defines the operation perform on be half of user
- Service relates to interface between layers
- Protocol is set of rules between peer entities to access data.
- Protocol relates to implementation of services, which is not visible to user



Reference Models

- Two main Reference models
  - 1. OSI Reference Model
    - protocols are not so popular and rarely used
    - Features of layers are valid and so important.
    - Model is popular due to layers functionality
  - 2. TCP/IP Reference Model
    - Model is not popular
    - Protocol are very popular
    - Internet Using these protocols

OSI Reference Model

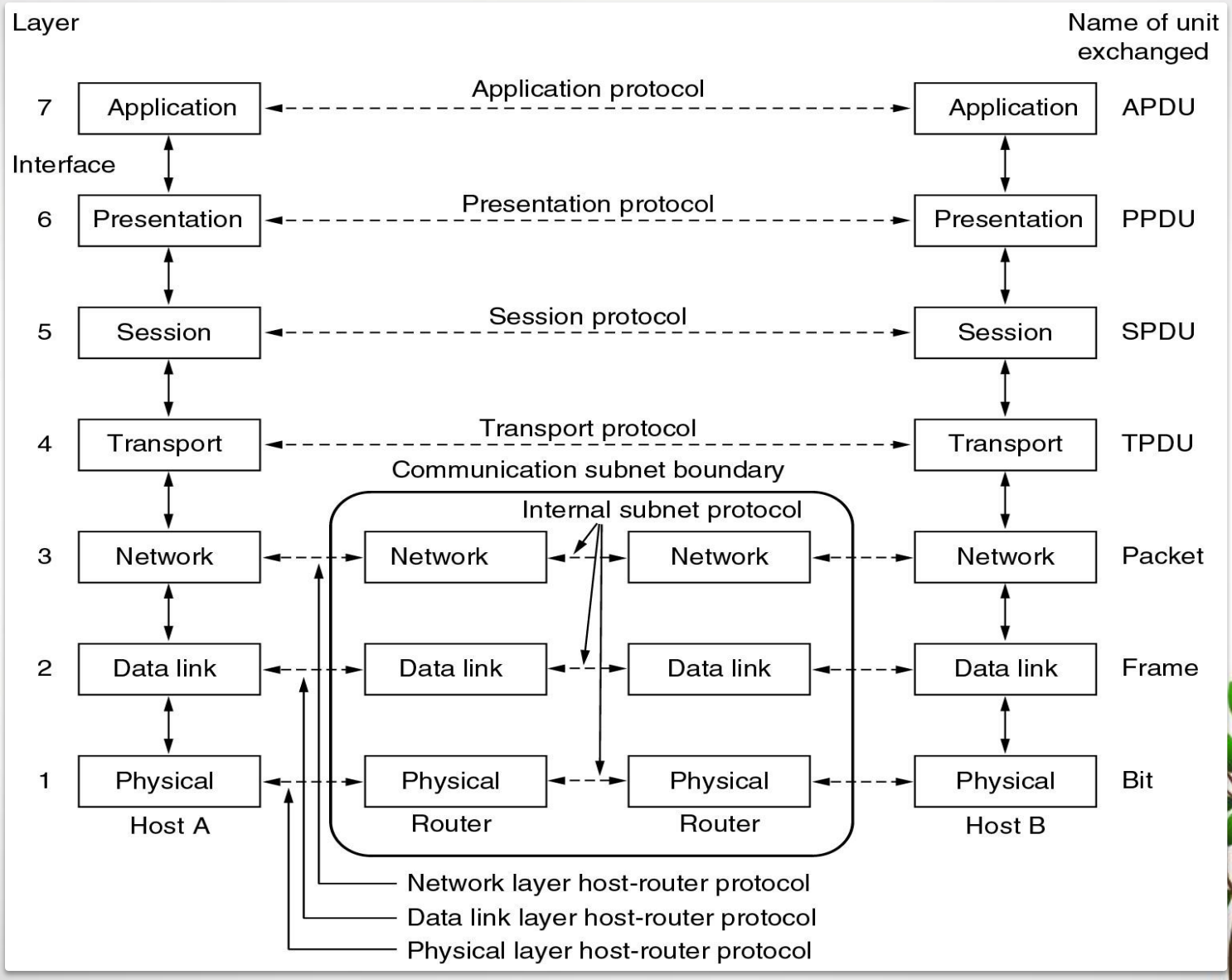
- The idea of Seven Layer was provided by the work of Charles Bachman in ARPANET.
- It is standard in 1983.
- Day and Zimmerman used these protocols.
- It was again revised in 1995, called ISO/OSI
- It is used to connect two open systems (communication)

- Why did has 7 layers?
  - A layer should be created where a different abstraction needed
  - Each layer should performed a well defined function
  - The functions of each layer should follows, international standards.
  - These should be minimized information across layers
  - The number of layers and functions should be balanced.

OSI Reference Models

- 1. Physical Layer
- 2. Data Link Layer
- 3. Network Layer
- 4. Transport Layer
- 5. Session Layer
- 6. Present Layer
- 7. Application Layer

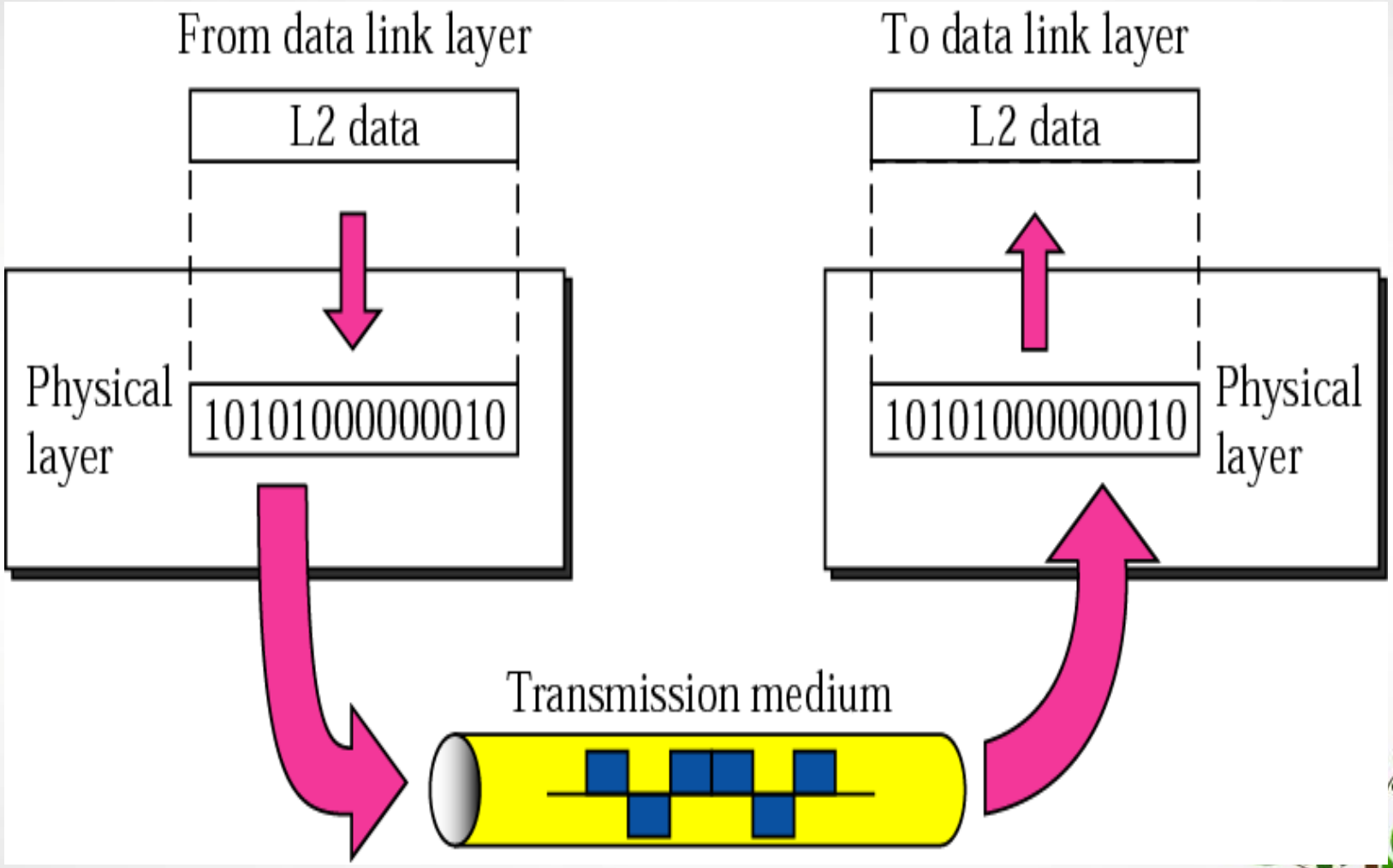
OSI Reference Model



Physical layer

- It is concerned with transmitting of raw bits over communication Channel.
- How the raw bits are transmitting.
- Questions?
  - 1. How many volts are needed to represent 1 bit
  - 2. How many volts are needed to represent 0 bit
  - 3. How many nanoseconds a bit last
  - 4. Transmission directions ; simultaneously on both
  - 5. How the initial connection is established
  - 6. How the connection is torn down
- The design issues related mechanical, electrical and timing interfaces.

Physical layer

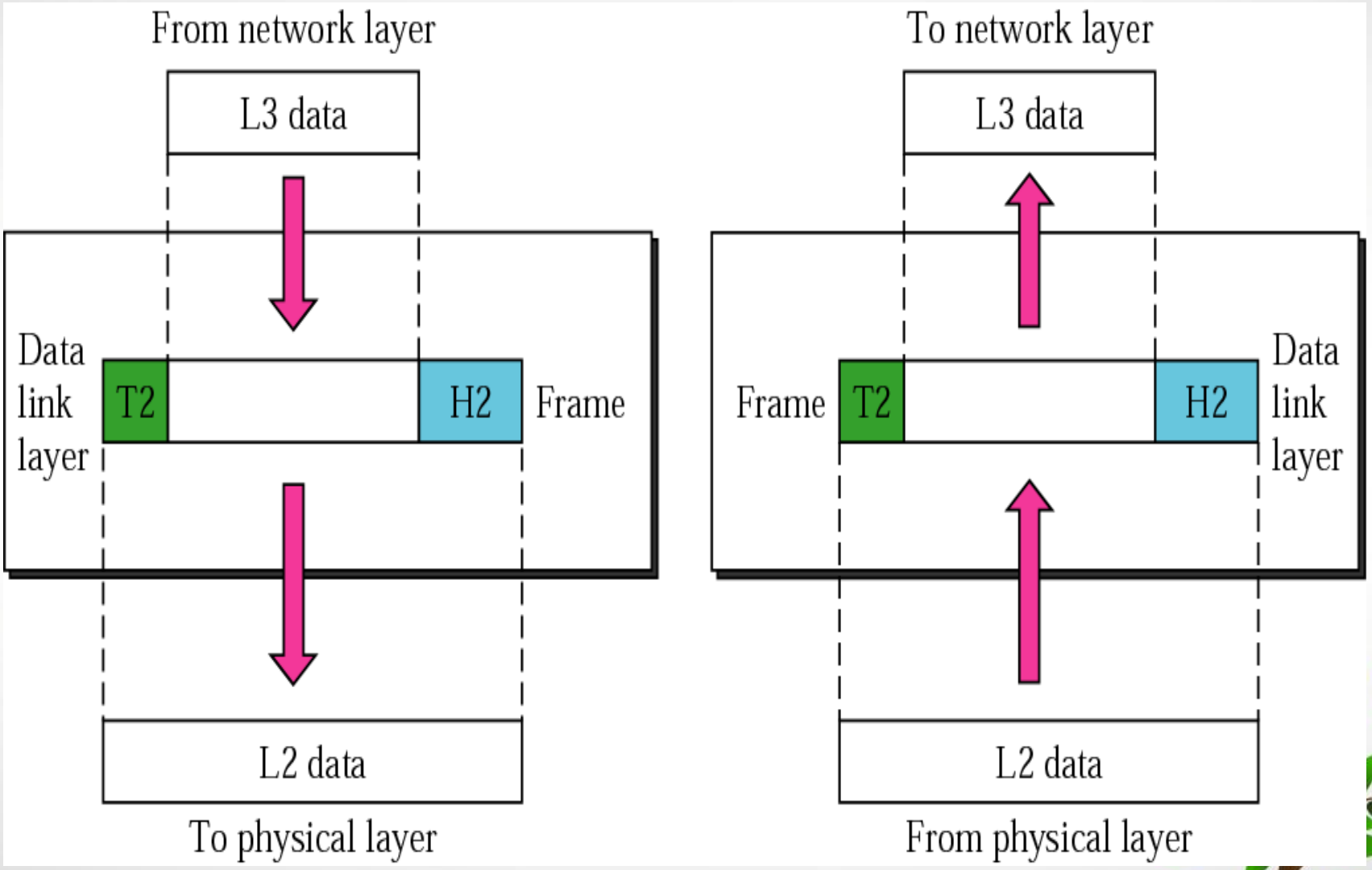


Data Link layer

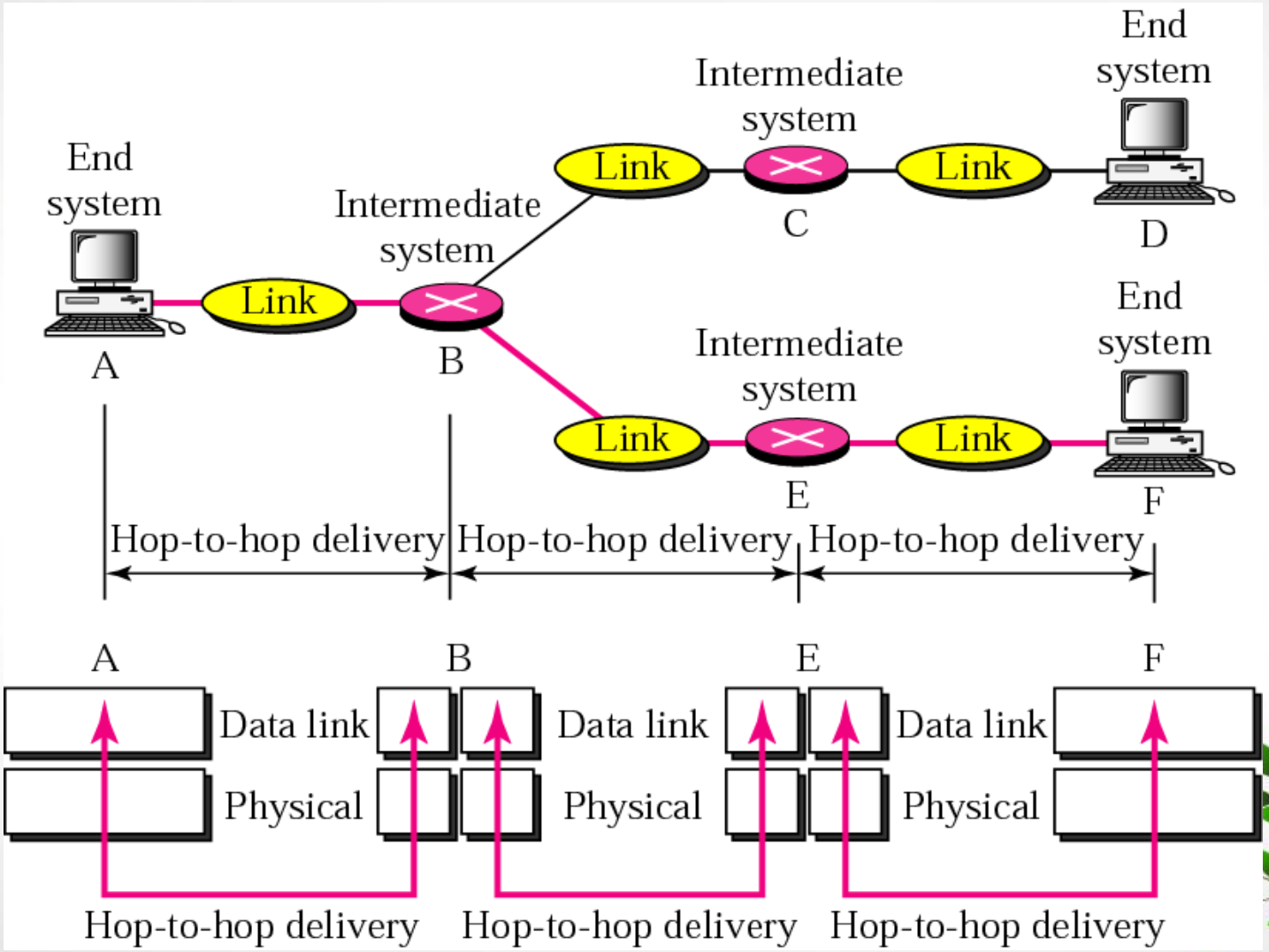
- Its task is to transform raw transmission into a line, which does not contains any errors.
  - HOW ?
  - the sender sends a data in break up format. Which is called data frames. (hundred / thousand bytes)
  - Data frames are transmitted sequentially.
  - If the layer offers a reliable service, then acknowledgment frame.
  - Issue : fast transmitter and slow receiver. ???? (flow control mechanism).
  - Issue : error control
  - If network is a broadcast network , DLL issue is

    Control of channel (Medium Access Layer (MAC) sub layer) (Channel Allocation Problem)

Data link layer



Network layer

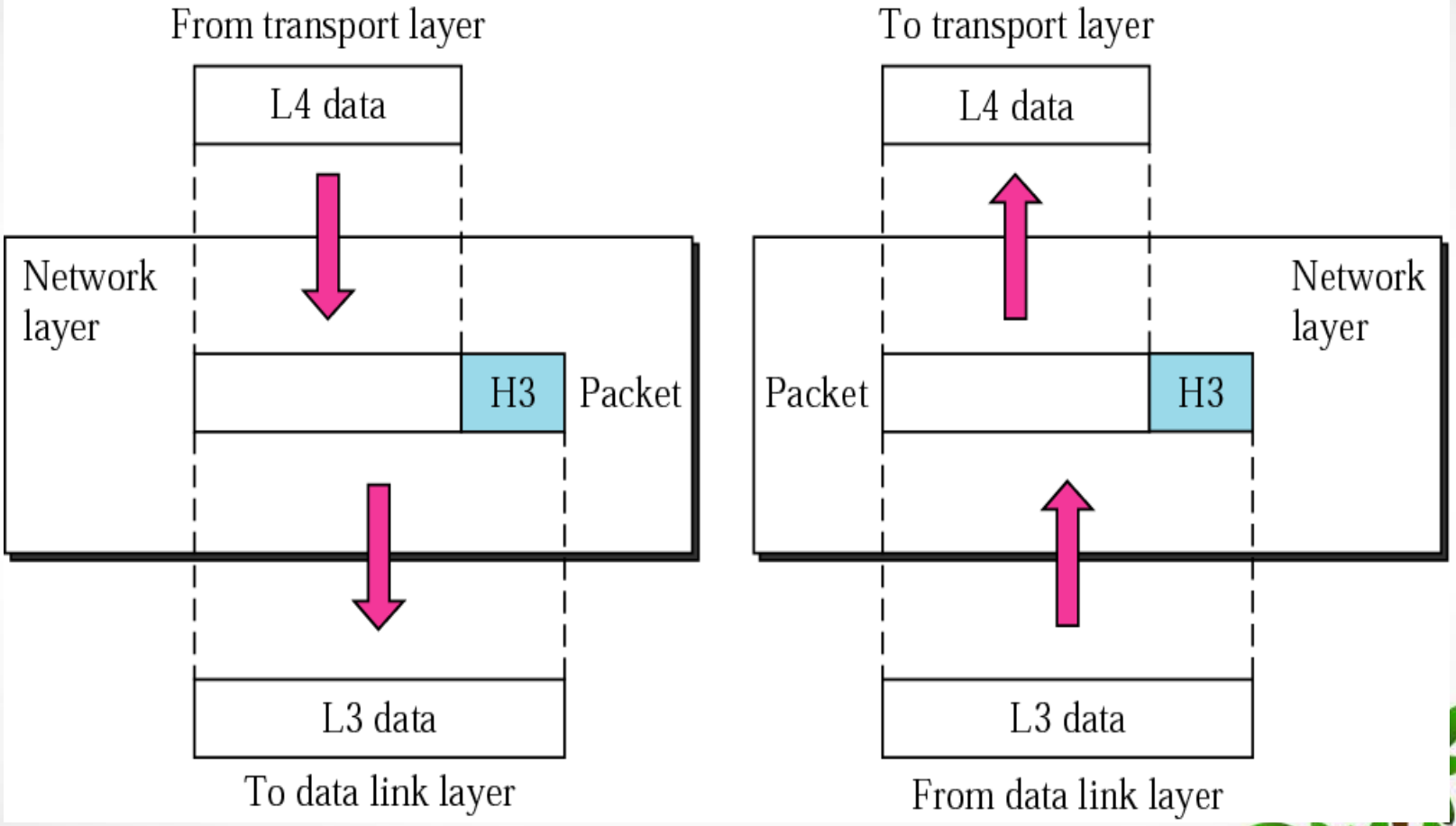


Network layer

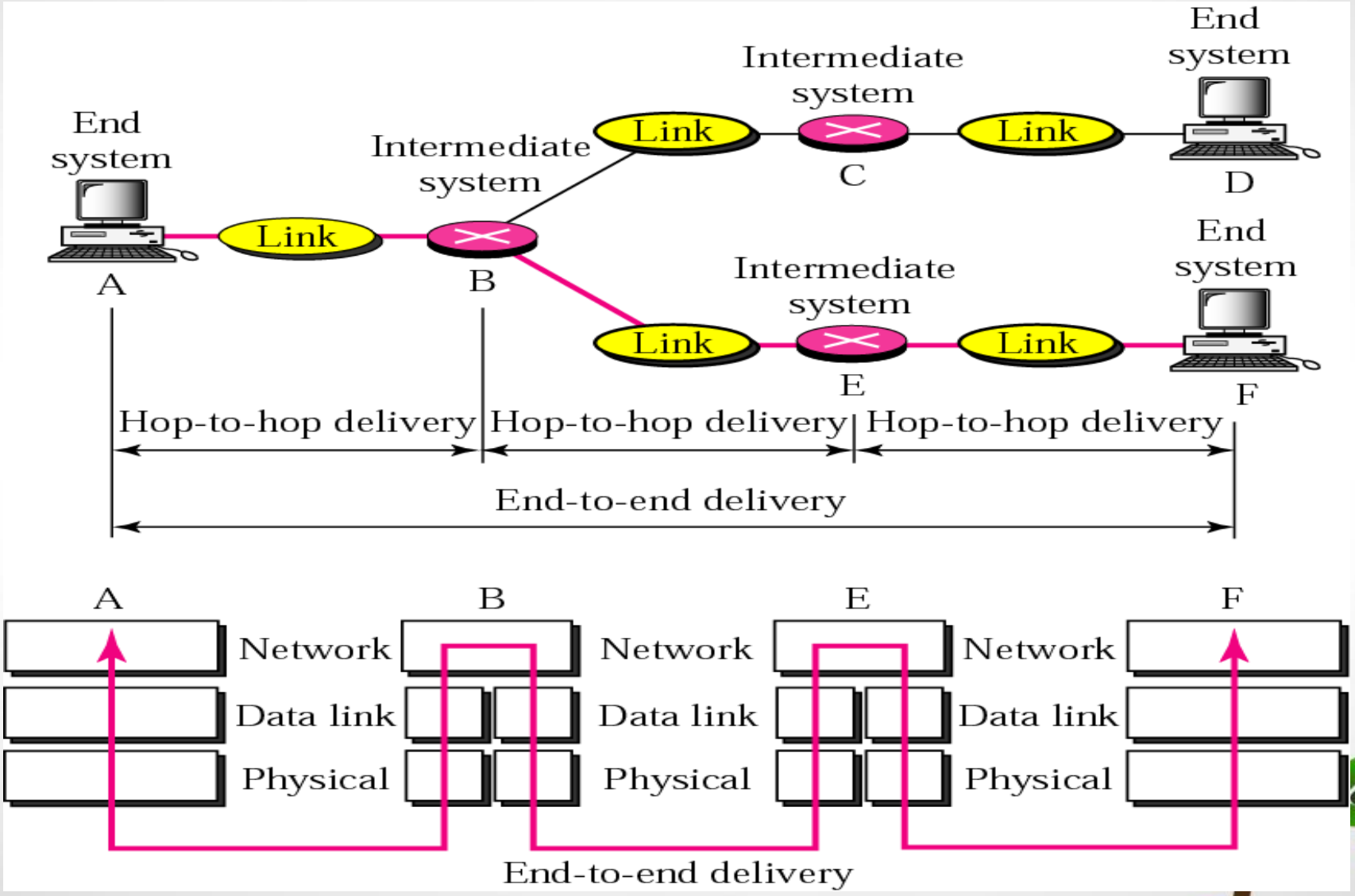
- It mainly concerned with communication subnet.
- Issues :
  - Routing
  - Congestion Control.
  - Quality of Service (QoS)
  - In Heterogeneous network
    - Addressing
    - Protocol
    - Size of Packets

Routing is easy in broadcast networks

Network layer



Network layer

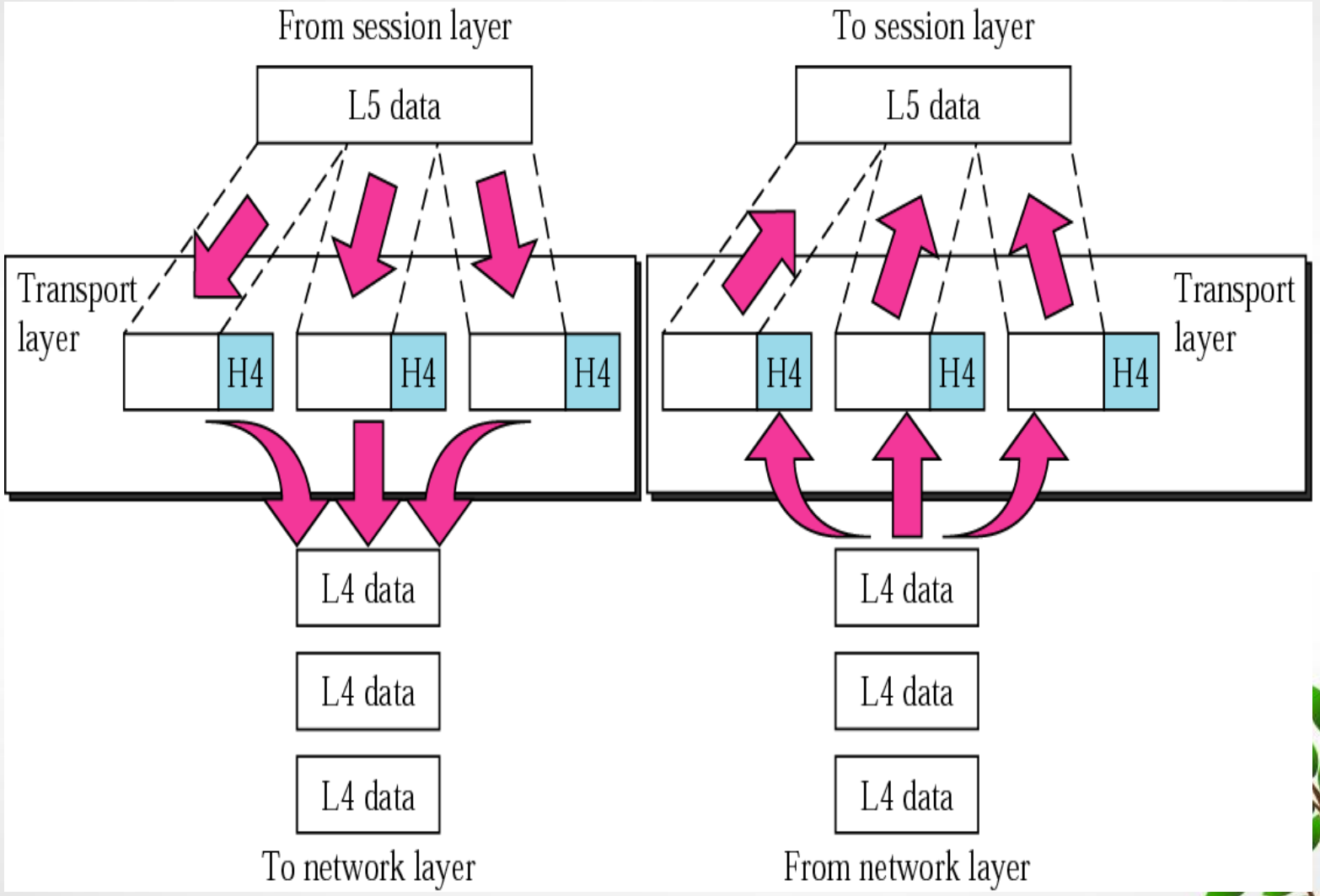


Transport layer

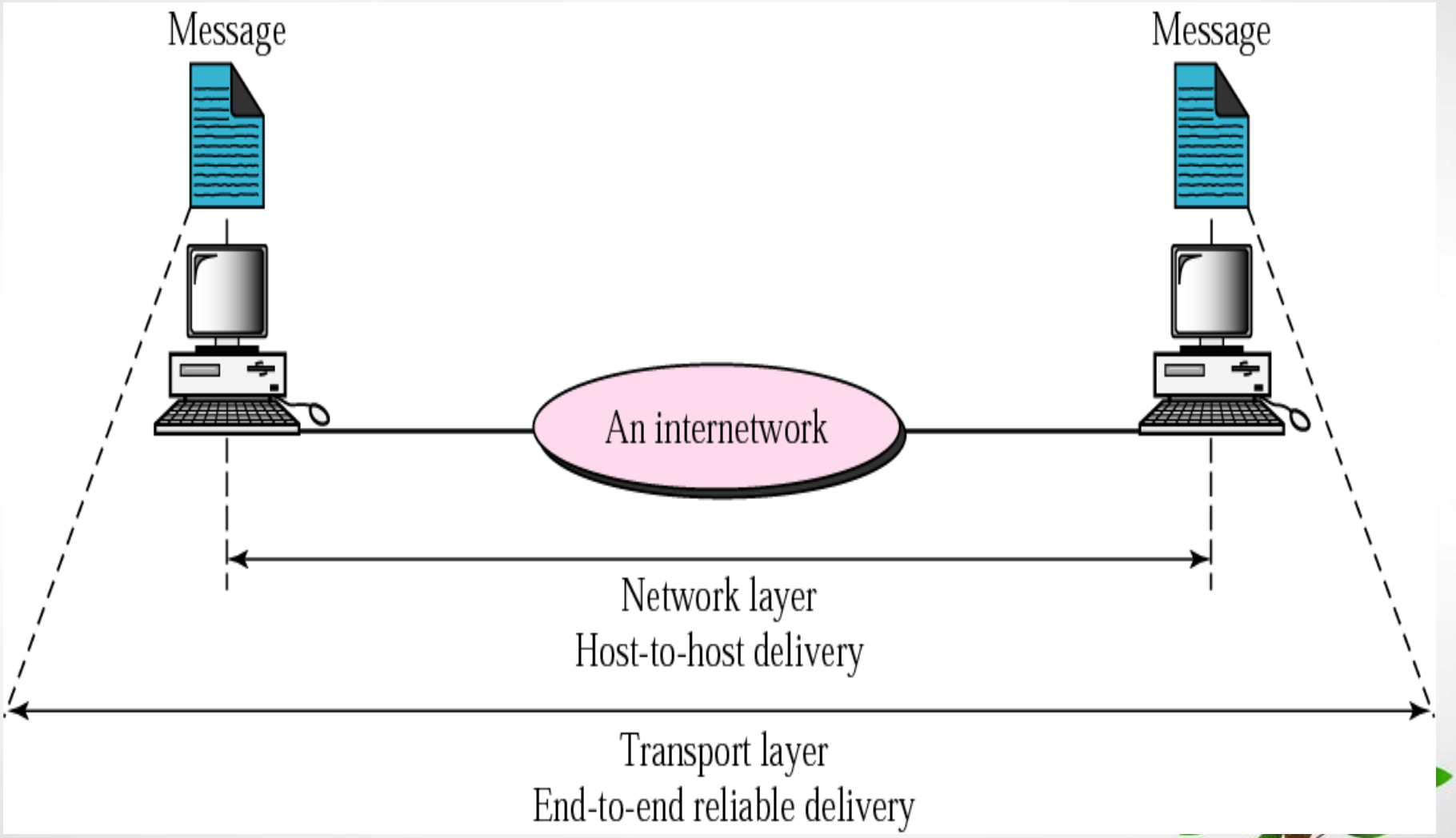
- It accepts the data from session layer , split up into small units it need, passes to the network layer.
- ensures → the data that should be correctly delivered.
- Two different type of services provided
  - 1. Connection Oriented Service
  - 2. Connection Less service
- Transport Layer is True End to End layer. same processes running on different machines for communication

- The able to communicate the destination in network, where as all other lower layer are able to communicate to next neighbor nodes only.

Transport layer



Transport layer



Session layer

- It allows users on different machines to establish session among them.
- Service : Dialog Control (Who's turn next)
- Token Management (avoid collisions)
- Synchronization (check points → after a crash)

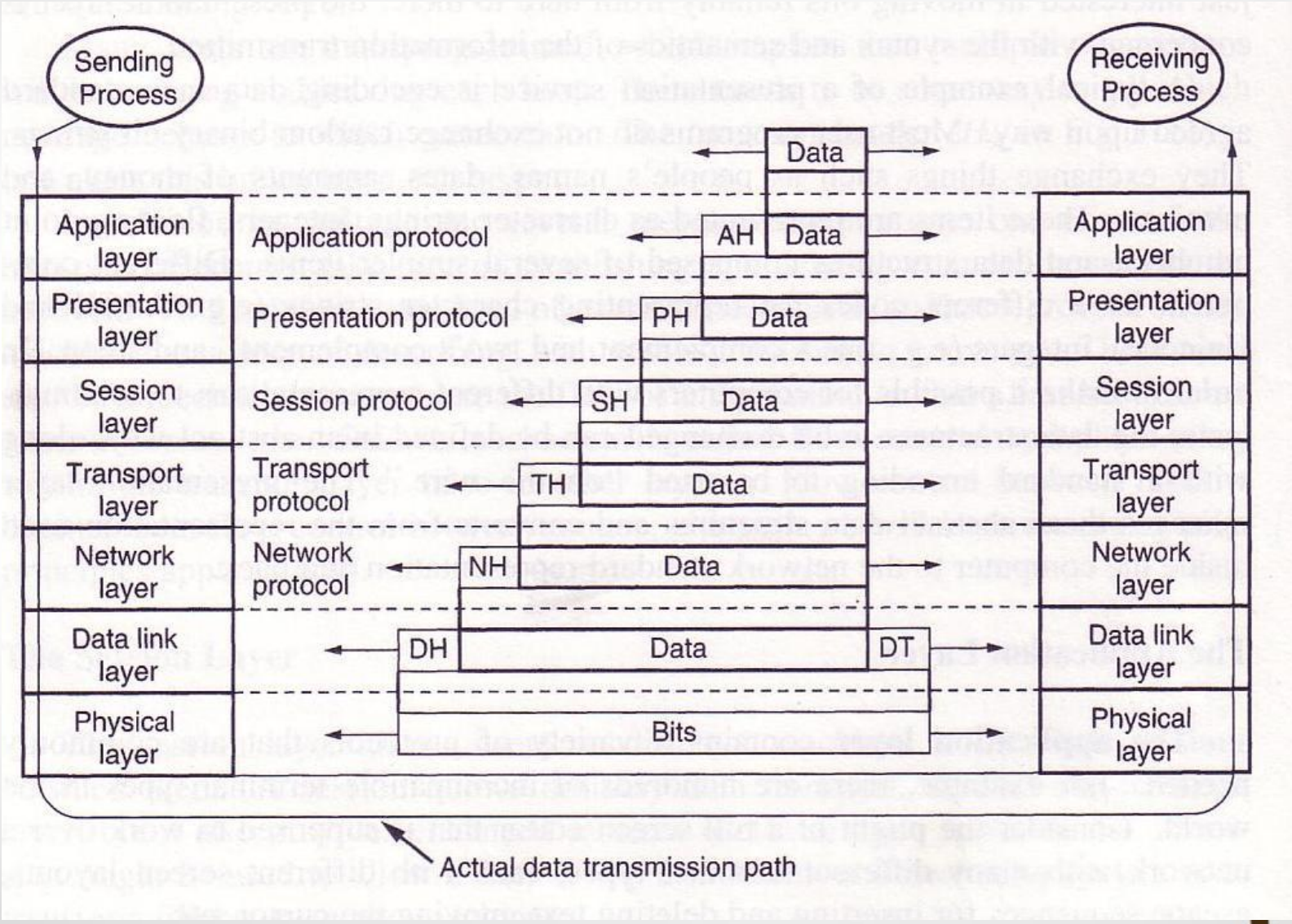
Presentation layer

- It concerns syntax and semantics of the data being transformed.
- It uses abstract data structure to make the communication between different data representation.

Application layer

- It provides set protocol to end user to communicate network.
- FTP,SMTP,POP3 etc…..

Data Transmission in OSI



TCP/IP Reference Model

- It is a older Reference model
- Its design goal is provide the connection among the networks seamlessly.
- It is defined by Cerf and Khan in 1974, updated in 1985 and 1988.
- It is composed of 4 layers
  - 1. Host-to-Network Layer
  - 2. Internet Layer
  - 3. Transport Layer
  - 4. Application Layer
- There is no Session and Presentation Layer.

Internet Layer

- TCP/IP should provide services to user even any one of the node failed in network.
- TCP/IP should provide seamless services.
- So it leads to use packet switching at Internet layer and support to provided connection less services.
- So the internet layer injects the packets in network and allow them travel independently to destination.
- If the destination receives out of order packets, higher layers will take about that.
- Internet layer uses Special Protocol, IP (internet protocol) and special meaningful format of IP.
- Packet routing with avoiding congestion → issue

Transport Layer

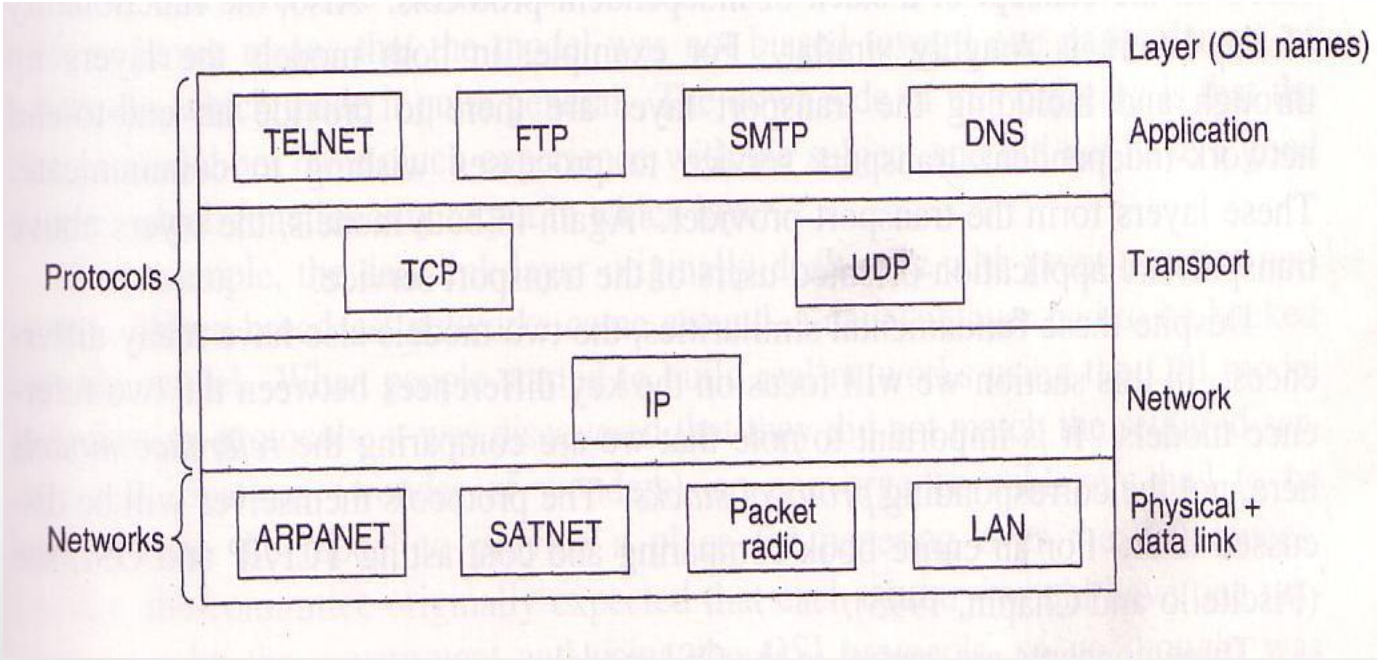
- Its task is to design a paradigm that allows two peer entities on source and destination for conversions.
- It use two different protocol :
- TCP (Transmission Control Protocol)
  - It is a reliable connection oriented protocol
  - Byte stream with out errors.
  - Support assembling.
  - Handles flow of control (Overhead is high)
- UDP (User Data Gram Protocol)
  - Unreliable connection less protocol
  - Speech , video applications ..
  - No control of flow, no sequence numbering…
  - Less overhead

Application Layer

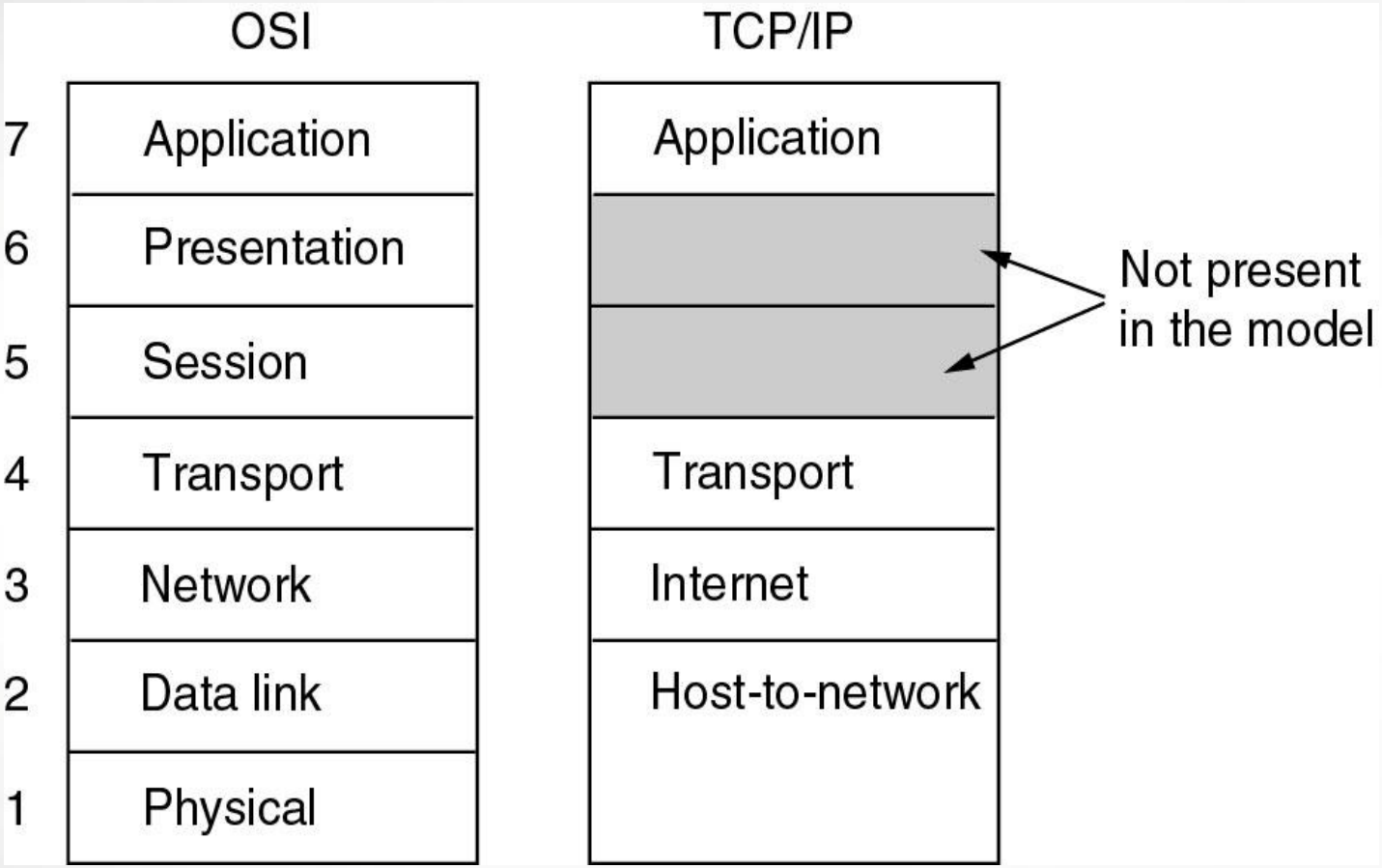
- No Session and presentation layers.
- The application layer will includes the functions of session and presentation layer.
- It contains all high level protocols
- It have the protocols like FTP, TFTP, SMTP, DNS, HTTP..

Host-to-Network Layer

- **Host is connect to Network using some protocols.**
- **These protocols are vary based on the host to host and network to network.**
- **It does not specially defines the protocol used to transfer the packets at this level.**



Comparison of OSI with TCP/IP



Comparison of OSI with TCP/IP

- **Similarities**
  - **Stack of Independent protocol**
  - **Functionalities of layers are some what similar**
  - **Layers above transport layers are application oriented**
- **Differences**
- **Services, interfaces and protocols**
  - **No clear distinguish among them in TCP/IP**
  - **Protocols**
  - **In OSI, Model first, then protocols**
  - **No of layers**
  - **Protocols are better hidden, can replace easily.**
  - **CLS and COS in OSI network layer.**