OSI and TCP/IP Models for Computer Communication

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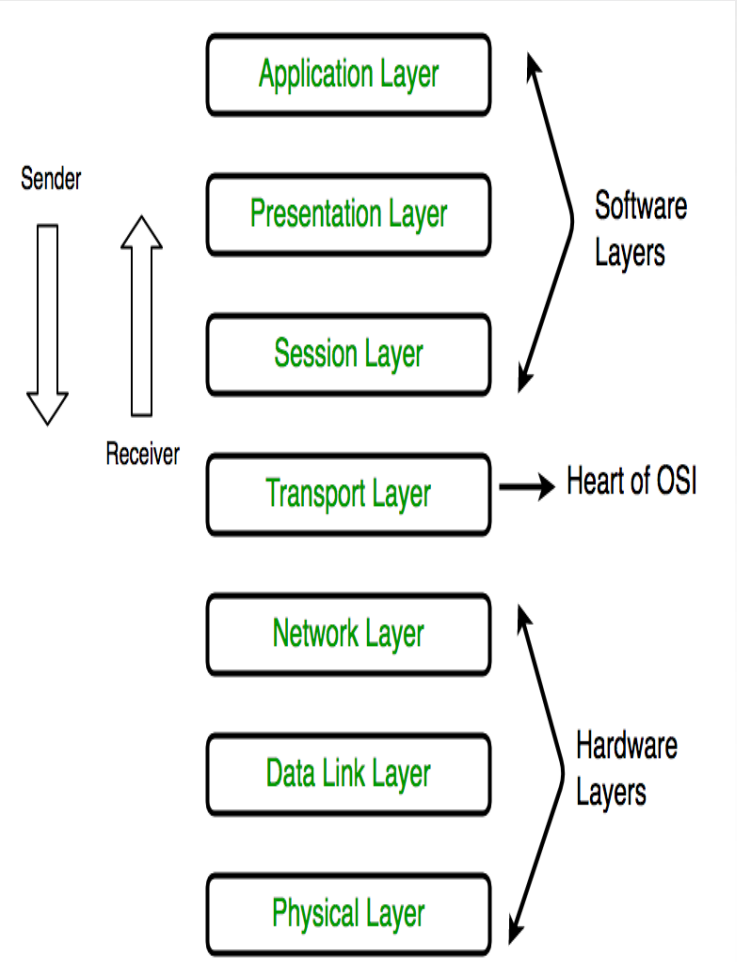
OSI Model:

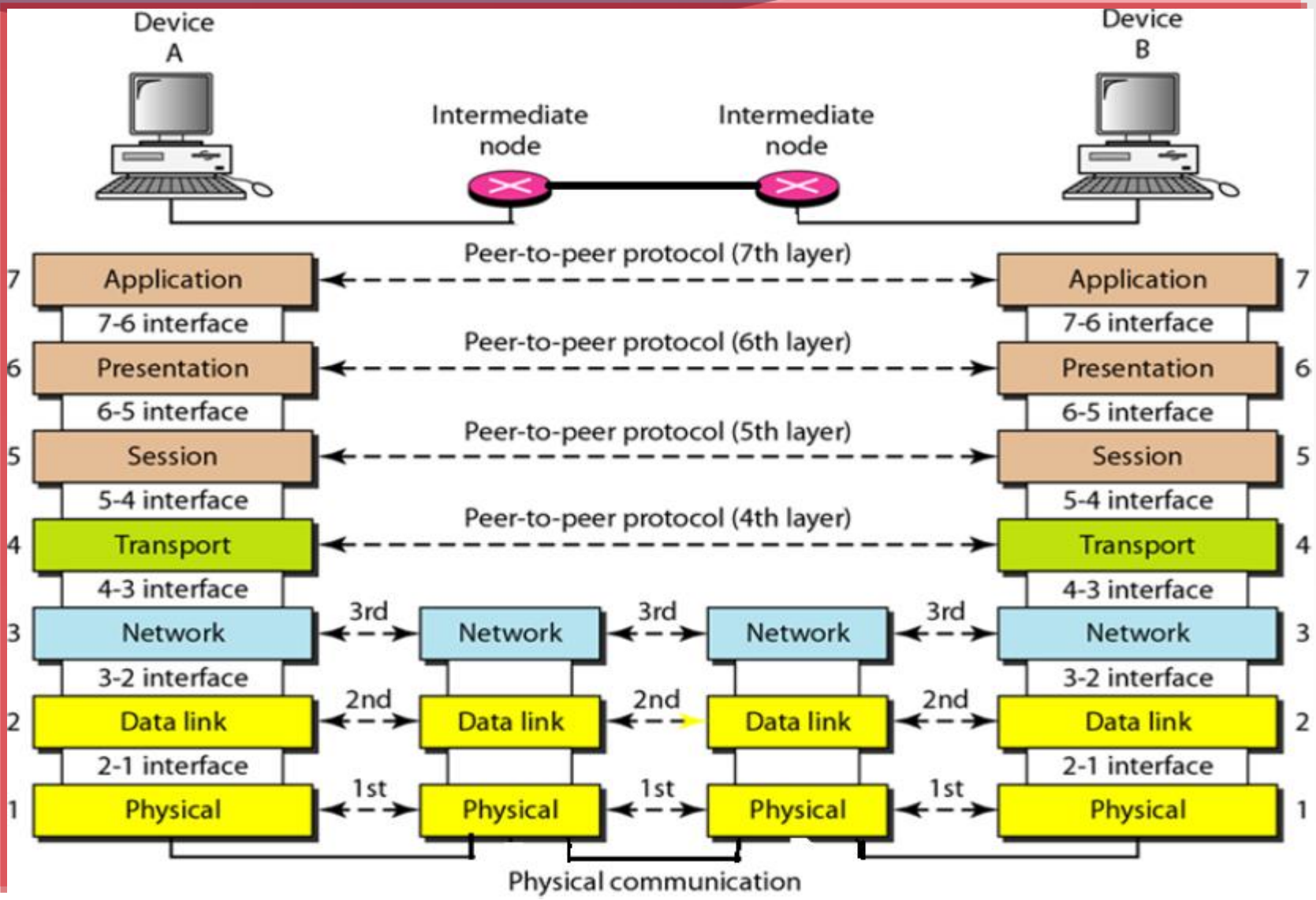
- ISO: International Standards Organization (1947)
- For computer communication, open system interconnection (OSI) model (1977)
- Open system is a model that:
  - Allow any two different systems to communicate regardless their fundamental architecture
  - Establishes the communication between different systems without requiring changes in the logic of basic hardware and software
- OSI is a reference model (not a protocol)

OSI Model:

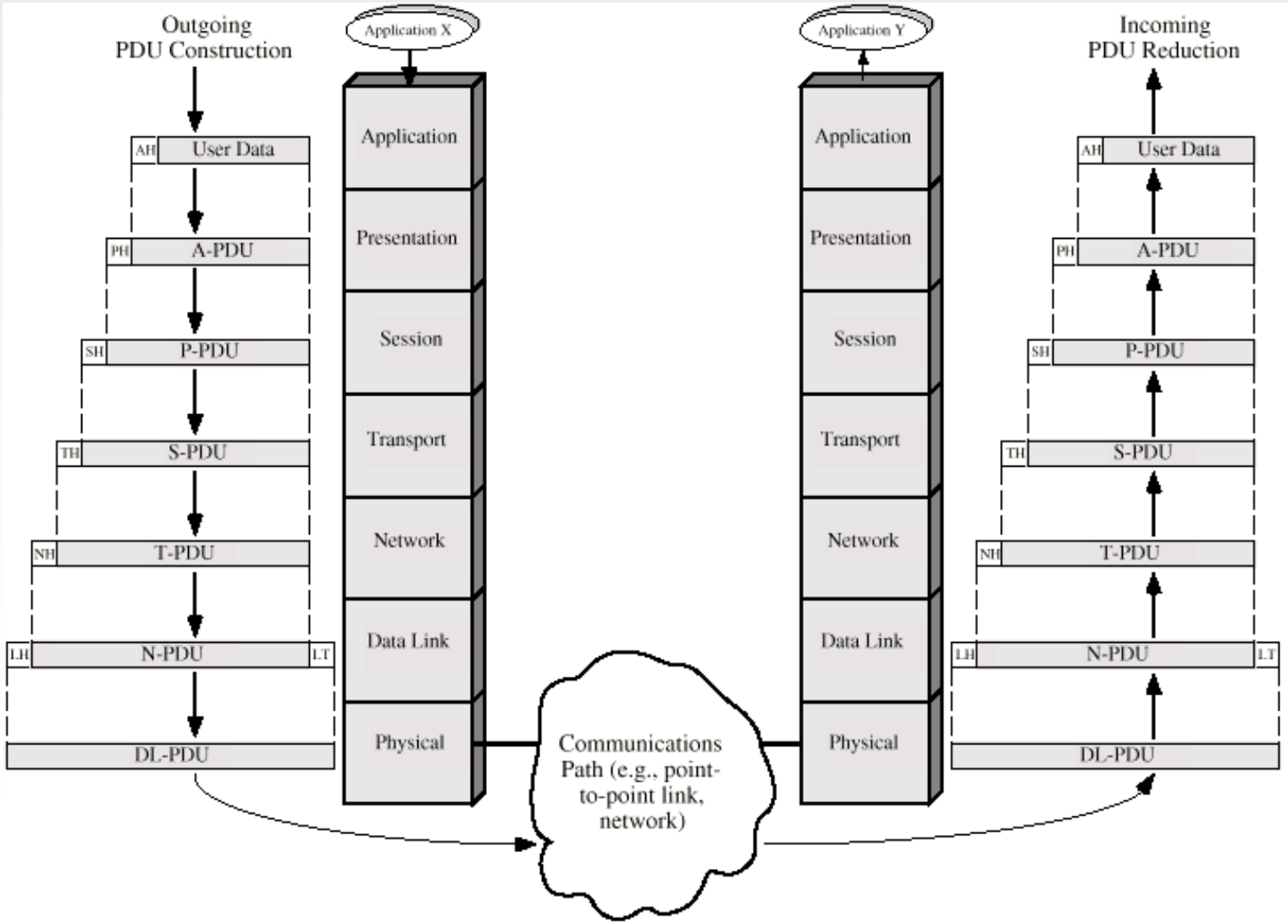


- 7-layered model
- Each layer performs a subset of the required communication functions
- Each layer relies on the next lower layer to perform more primitive functions
- Each layer provides services to the next higher layer
- Changes in one layer should not require changes in other layers
- Once Very promising (early 90's)
- But too complex, TCP/IP was already in practice, now it is default standard.

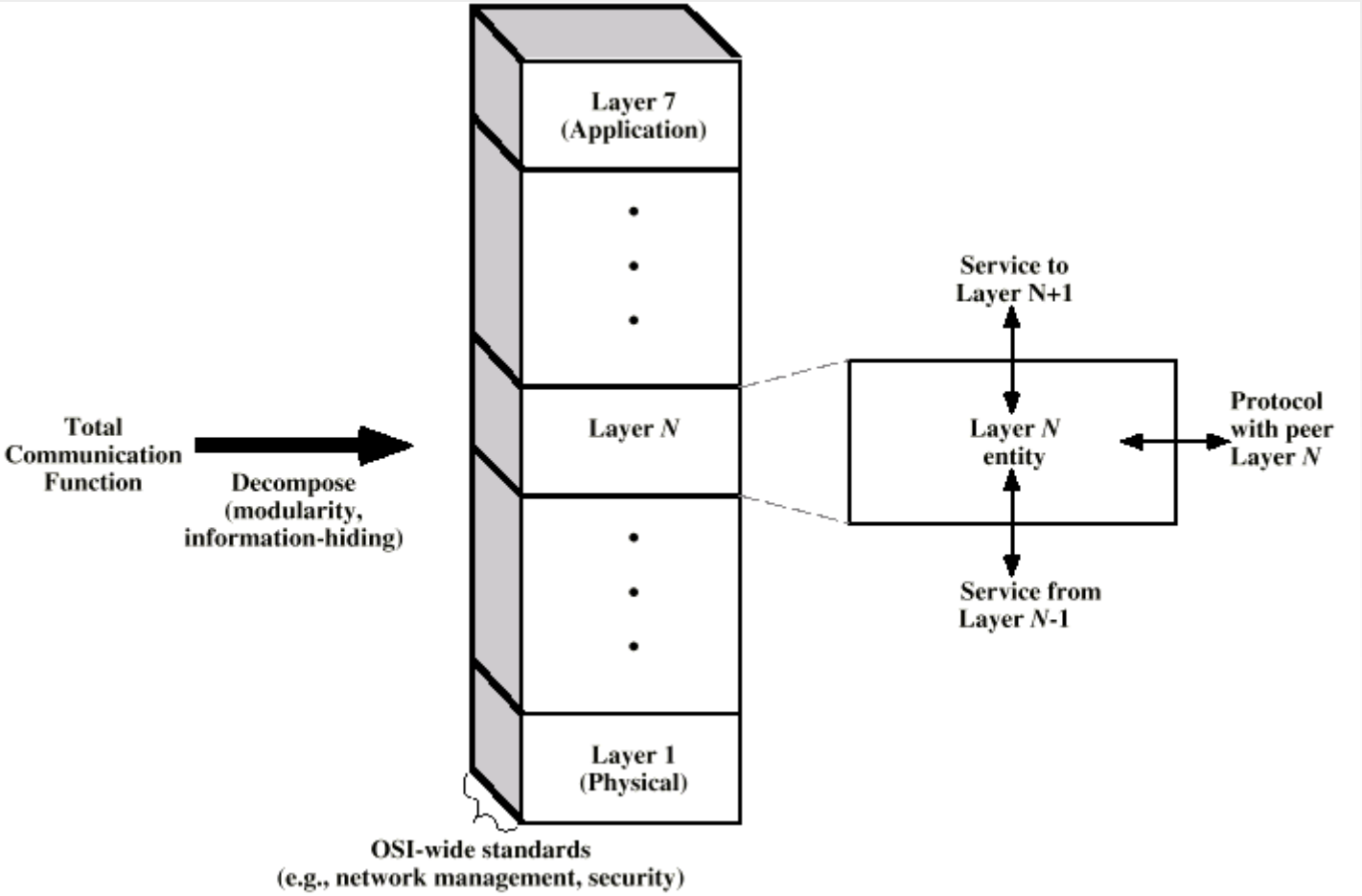
OSI Model:


Device A
Device B
Intermediate node
Intermediate node
Peer-to-peer protocol (7th layer)
Peer-to-peer protocol (6th layer)
Peer-to-peer protocol (5th layer)
Peer-to-peer protocol (4th layer)
7 Application
7-6 interface
6 Presentation
6-5 interface
5 Session
5-4 interface
4 Transport
4-3 interface
3 Network
3-2 interface
2 Data link
2-1 interface
1 Physical
3rd
2nd
1st
Physical communication

OSI Model:

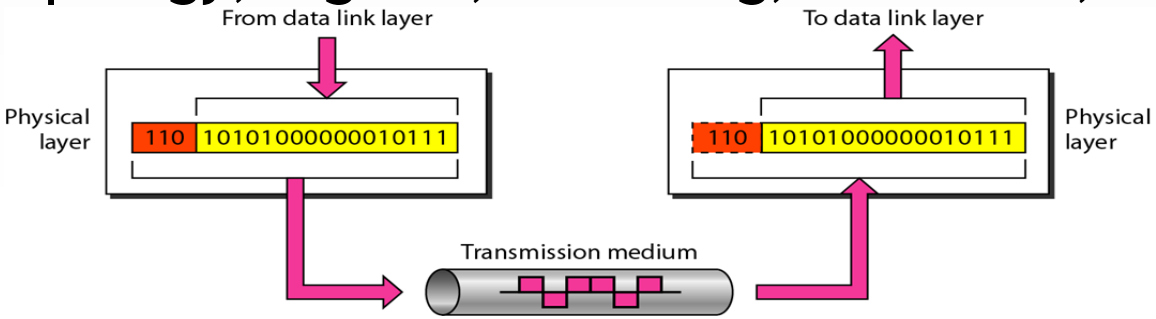

Outgoing
PDU Construction
Application X
Application Y
Incoming
PDU Reduction
AH
User Data
PH
A-PDU
SH
P-PDU
TH
S-PDU
NH
T-PDU
LH
N-PDU
LT
DL-PDU
Application
Presentation
Session
Transport
Network
Data Link
Physical
Communications
Path (e.g., point-
to-point link,
network)

OSI as Framework for Standardization:



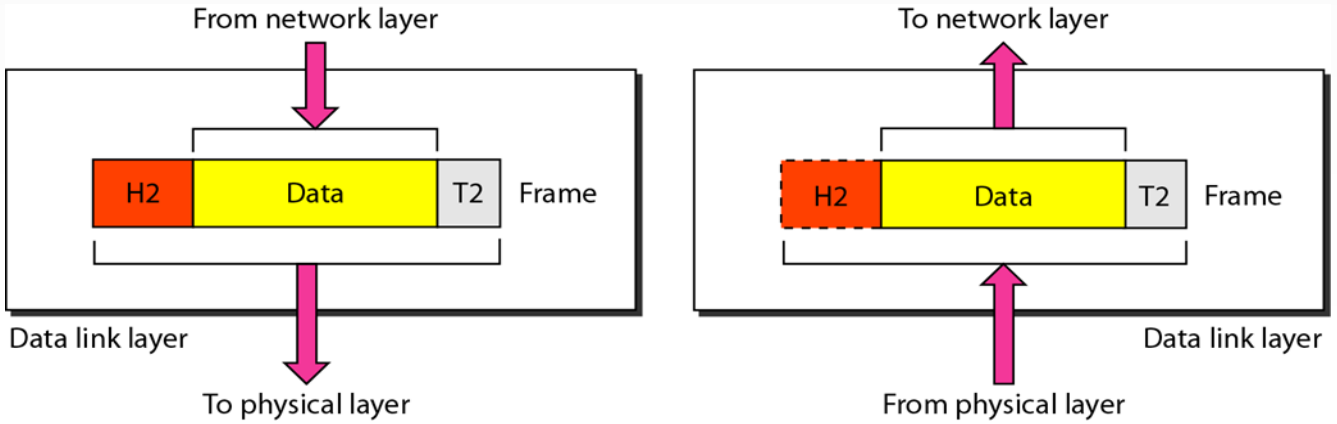
Physical Layer:

- Physical interface between devices
- Characteristics
  - Mechanical (e.g. connectors)
  - Electrical (e.g. Voltage levels, data transmission rates)
  - Functional (specifies functions performed by individual circuits)
  - Procedural (Specifies the sequence of events by which bit stream are exchanged)
- In short, it takes care of line configuration, transmission mode, topology, Signals, encoding, interface, medium

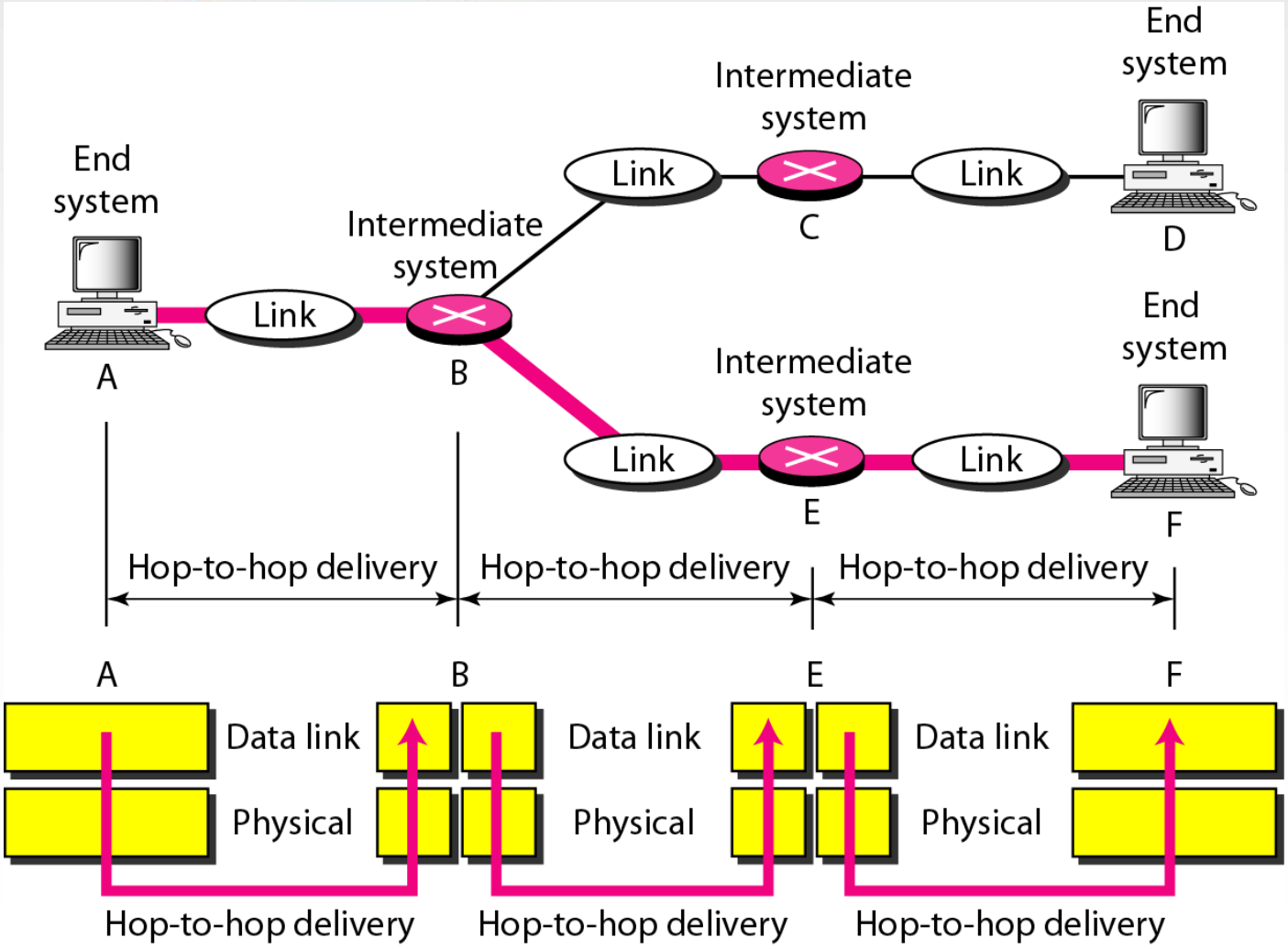


Data Link Layer:

- Attempts to make the physical link reliable
- Means of activating, maintaining and deactivating reliable link
- Addressing (Physical)
- Error Detection and Control
- Flow Control/Access Control/Synchronisation
- e.g. HDLC, Ethernet, Wi-Fi, Bluetooth

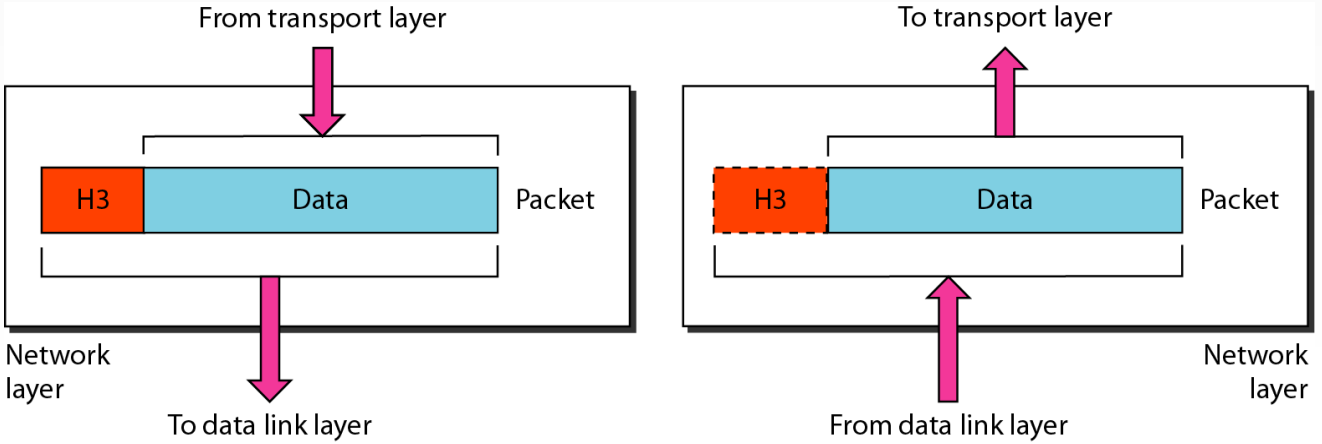


Data Link Layer (Hop to Hop Delivery):

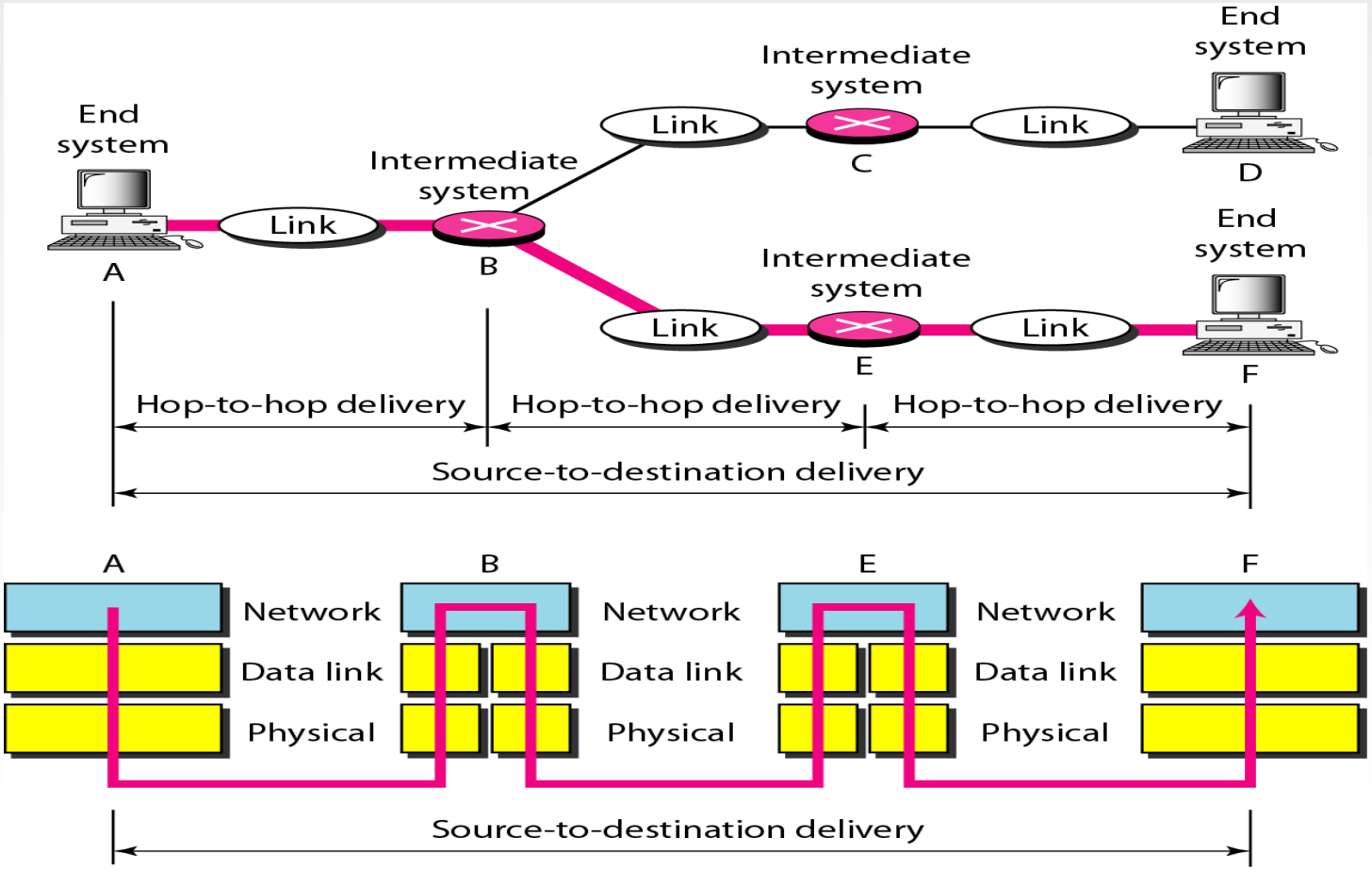


Network Layer:

- Transfer of information between end system
- Higher layers do not need to know about underlying technology (e.g. data transmission, switching techniques)
- Switching and Routing:
  - Source and destination addresses
  - Interpreting logical addresses to find their physical address

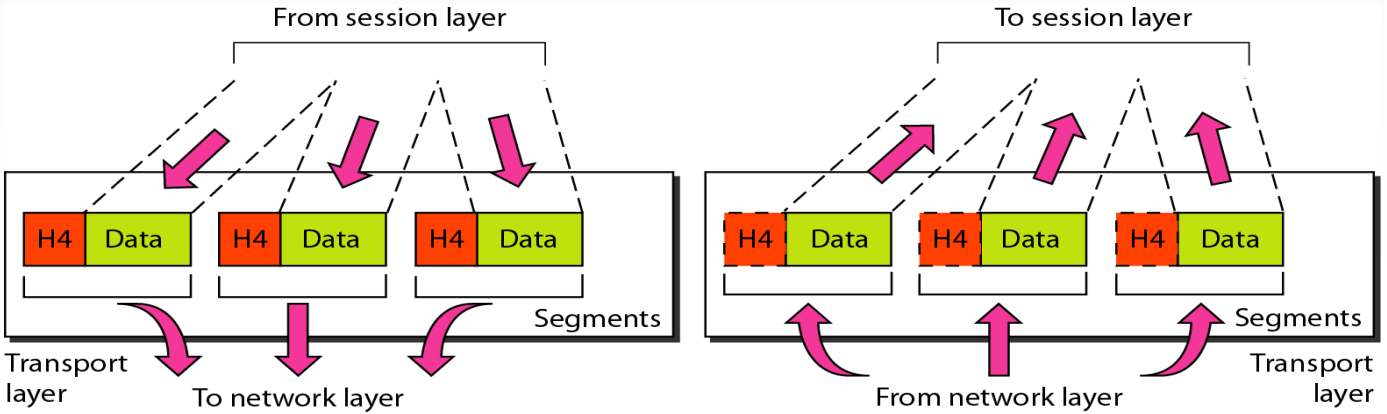


Network Layer (End to End Delivery:



Transport Layer:

- Provides mechanism for exchange of data bet^{n} end systems
- Error free/In sequence/No losses/No duplicates
- Quality of service
- Session layer may specify acceptable error rates, maximum delay, priority, security etc.
- SAP addressing
- Segmentation and reassembly
- Connection control



Session Layer:

- Session
  - Control of dialogues between applications
  - Dialogue discipline
    - Establishes, maintains and synchronises the interaction
    - Session closes with proper procedure, not abruptly
    - Half/full duplex
  - Grouping:
    - Assemble data of a particular sub application
  - Recovery:
    - Provides checkpoint mechanism
    - If failure between check points-session retransmit data from the last check point.

Presentation:

- Presentation
  - Defines syntax used between application entities
  - Data formats and coding
  - Data compression
  - Encryption
  - Security: Validating Login/password

Application Layer:

- Means for applications to access network
- Network Virtual Terminal
- File access, transfer and management
- Mail services

TCP/IP Protocol Suite:

- Dominant commercial protocol architecture
- Since 1990, it became widespread
- Is a result of research conducted
  - On packet switched networks, Advanced Research Project Agency Network (ARPANET)
  - It was funded by Defense Advanced Research Project Agency (DARPA) of US Department of Defense
- Used for the Internet
- There is no official model for TCP/IP as in OSI

Why TCP/IP?

- Specified and enjoyed extensive use prior to OSI
- DOD (Dept. of Defense, USA) made mandatory to use TCP/IP Products hence encouragement to vendors to develop TCP/IP products
- Internet is built on the foundation of TCP/IP suite

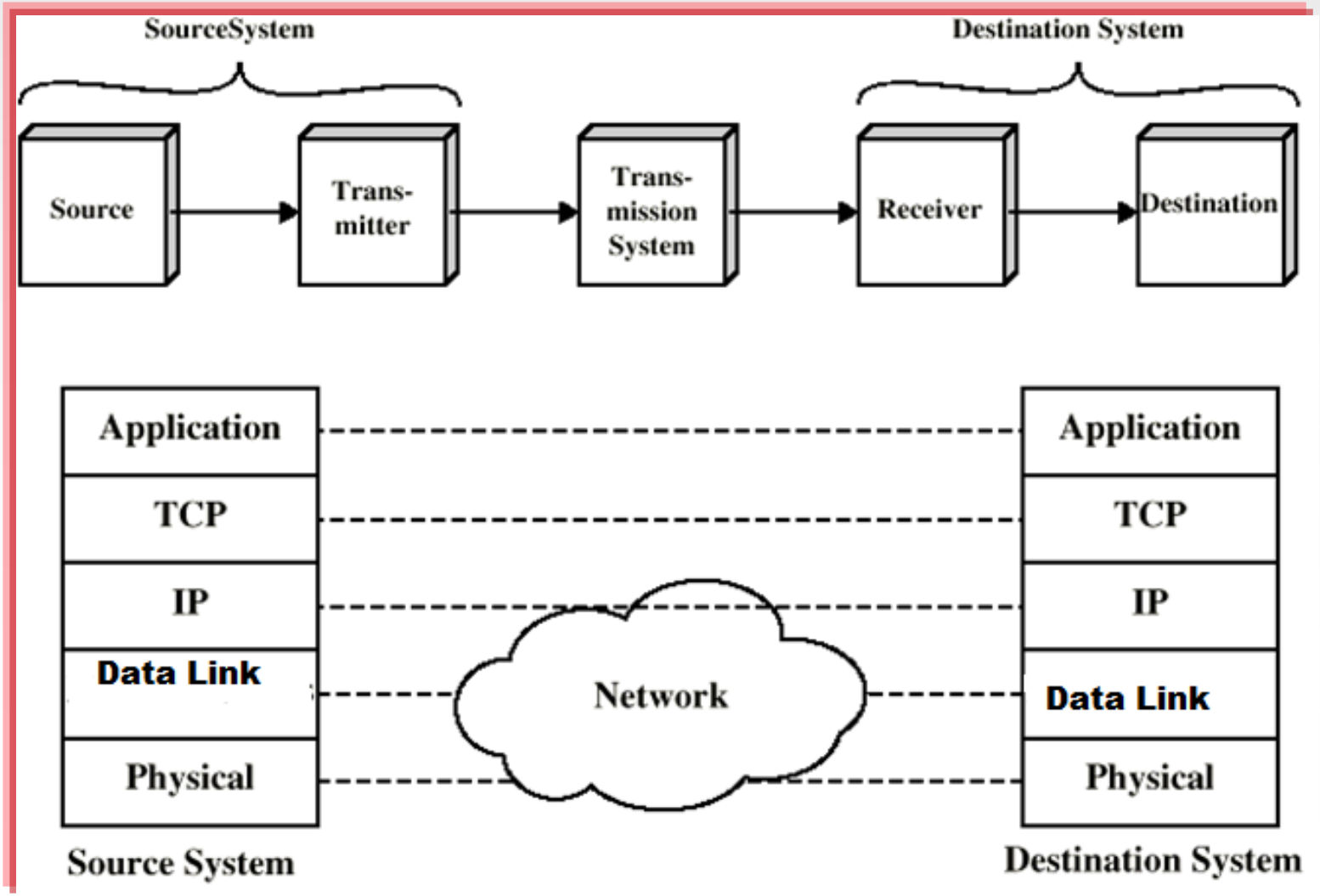
TCP/IP Approach:

- Same as in OSI
  - Communication task is too complex for a single unit
  - Sub task to different layers
  - Arranged in modular and hierarchical fashion
  - In TCP/IP, use of all layer is not mandatory

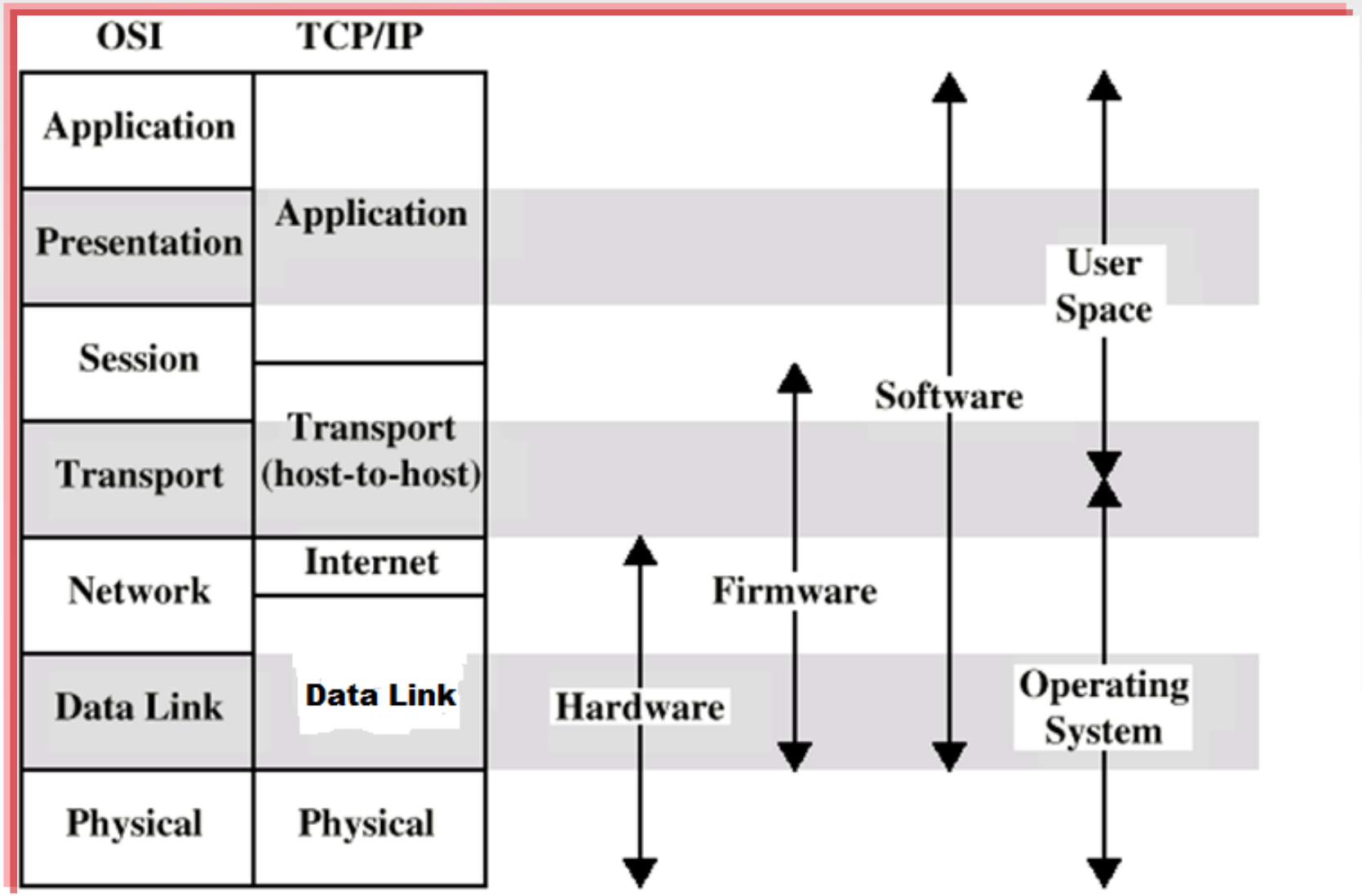
TCP/IP Protocol Architecture:

- Application Layer:
- Transport layer (Host to Host/End to End):
  - TCP
  - UDP
- Network (Internet) Layer:
  - Internet Protocol (IP)
- Data Link:
  - Any Network Access Protocol (e.g. Ethernet for LAN)
- Physical Layer:

TCP/IP Protocol Architecture:



TCP/IP Protocol Architecture:



TCP/IP Layers:

- Application Layer
  - Communication between processes or applications
- End to end or Transport Layer
  - End to end transfer of data
  - May include reliability mechanism
  - Hides details of underlying network
  - Segment/User datagram
  - Two Protocols: TCP/UDP
    - UDP: simple but not reliable, connectionless
    - TCP: reliable, connection oriented

TCP/IP Layers:

- Internet Layer:
  - Routing of data from source to destination host through one or more networks connected by routers
  - Routing functions across multiple networks
  - Internet Protocol (IP)
  - IP Datagram
    - Unreliable and Connectionless
    - No error checking/no reordering

TCP/IP Layers:

- Data Layer
  - Exchange of data between directly connected devices
  - Destination (neighboring device) address provision
  - Invoking services like priority

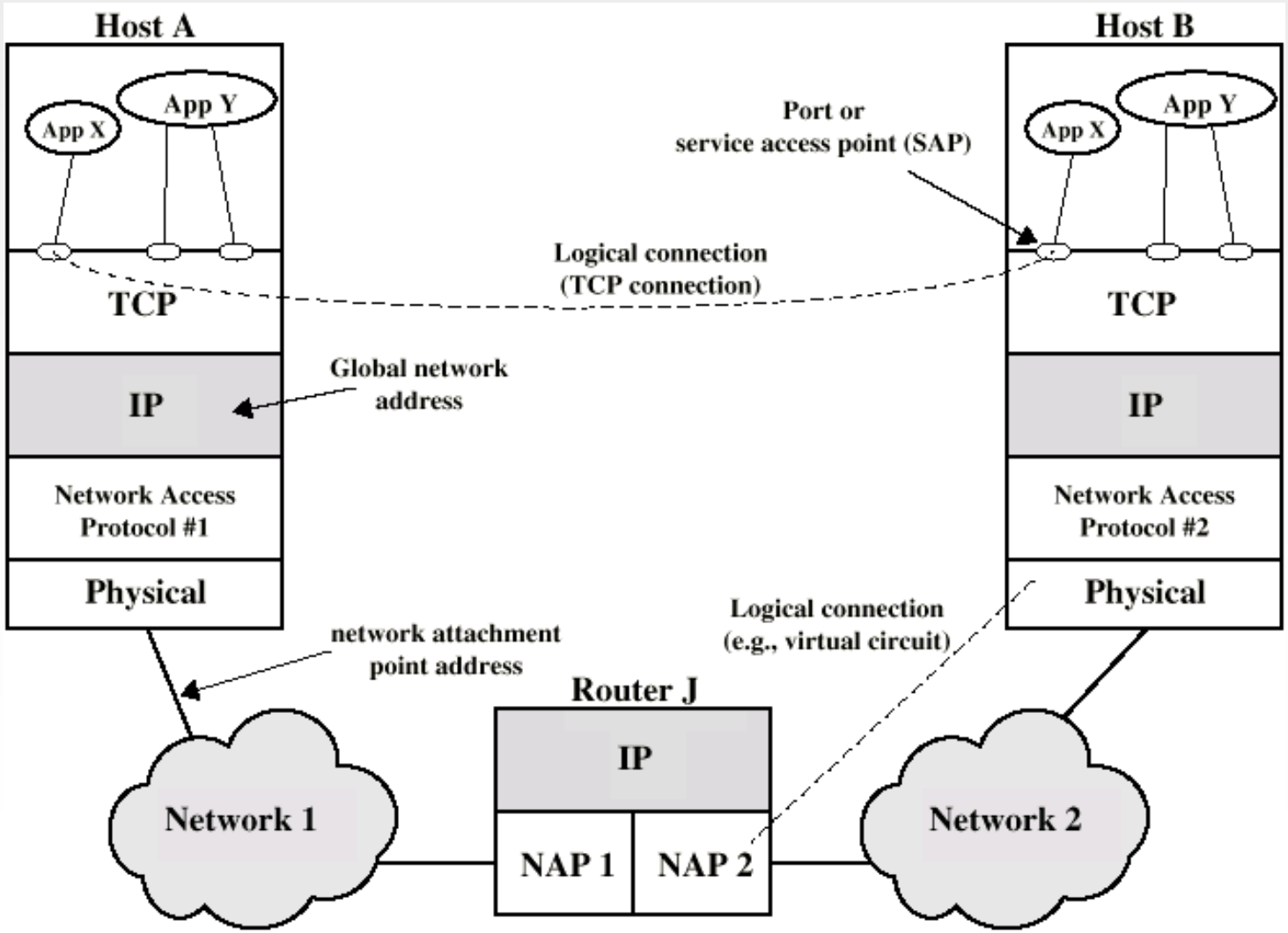
TCP/IP Layers:

- Physical Layer
  - Physical interface between data transmission device (e.g. computer) and transmission medium or network
  - Characteristics of transmission medium
  - Signal levels
  - Data rates

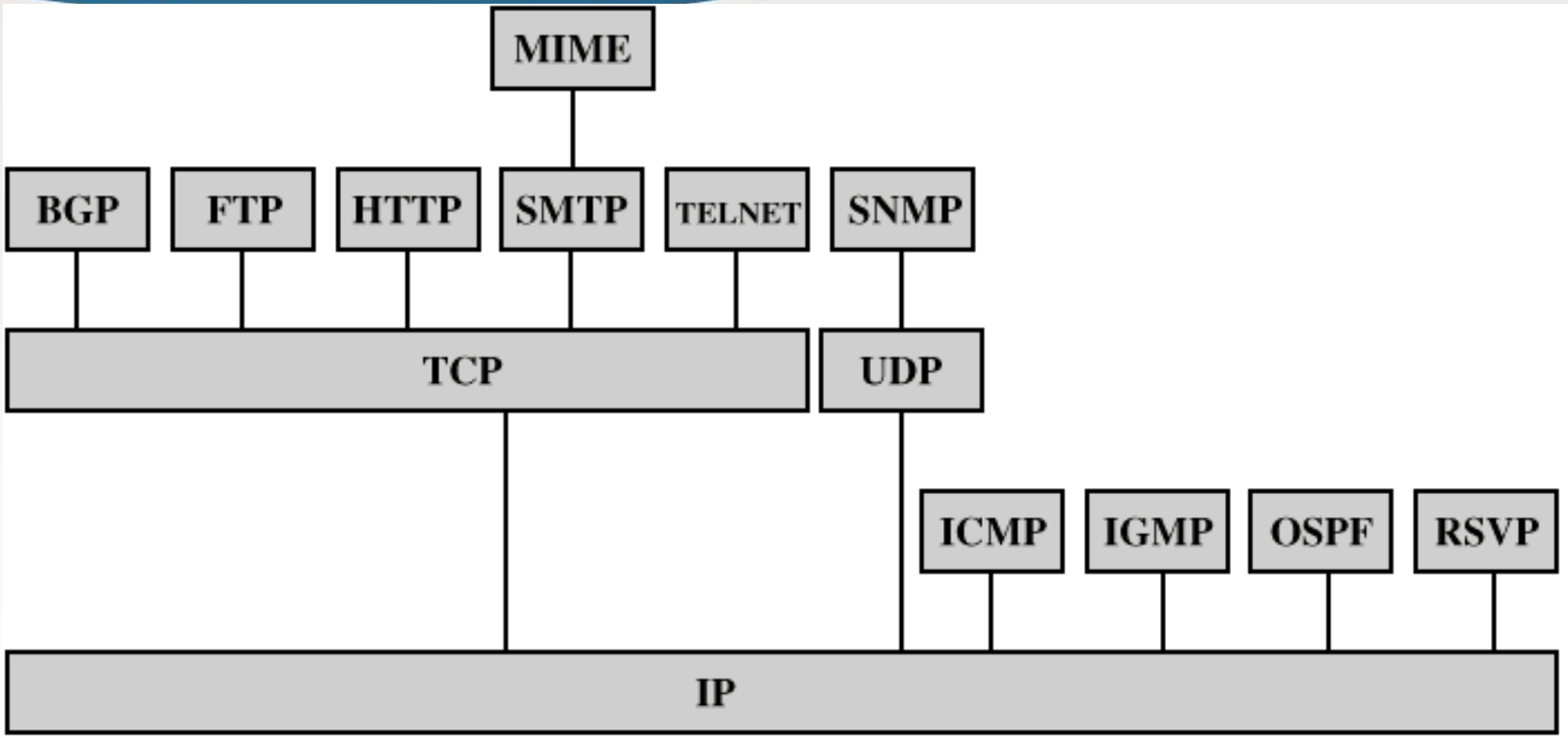
TCP/IP Operation:

- Application Layer:
  - Process X with Port 1 at host A wishes to send data to Host B at Port 2
- TCP Layer:
  - TCP gets above details
  - TCP tells IP: data and host B
- IP Layer:
  - Find the route and tell Data Link layer to send router J

TCP/IP Operation:



Some Protocols in TCP/IP Suite:



BGP = Border Gateway Protocol
FTP = File Transfer Protocol
HTTP = Hypertext Transfer Protocol
ICMP = Internet Control Message Protocol
IGMP = Internet Group Management Protocol
IP = Internet Protocol
MIME = Multi-Purpose Internet Mail Extension
OSPF = Open Shortest Path First
RSVP = Resource ReSerVation Protocol
SMTP = Simple Mail Transfer Protocol
SNMP = Simple Network Management Protocol
TCP = Transmission Control Protocol
UDP = User Datagram Protocol

Required Reading:

- W. Stallings, Data and Computer Communication
- B. Forouzan, Data Communication and Networking