OSI Reference Model and Networking Review

Internetworking - Module 2

Athar Mahboob

Computer Networking Concepts

- Computer Communication Model
- OSI Reference Model
- Functions of Seven Layers
- Types of Networks
  - Local Area Networks
  - Wide Area Networks

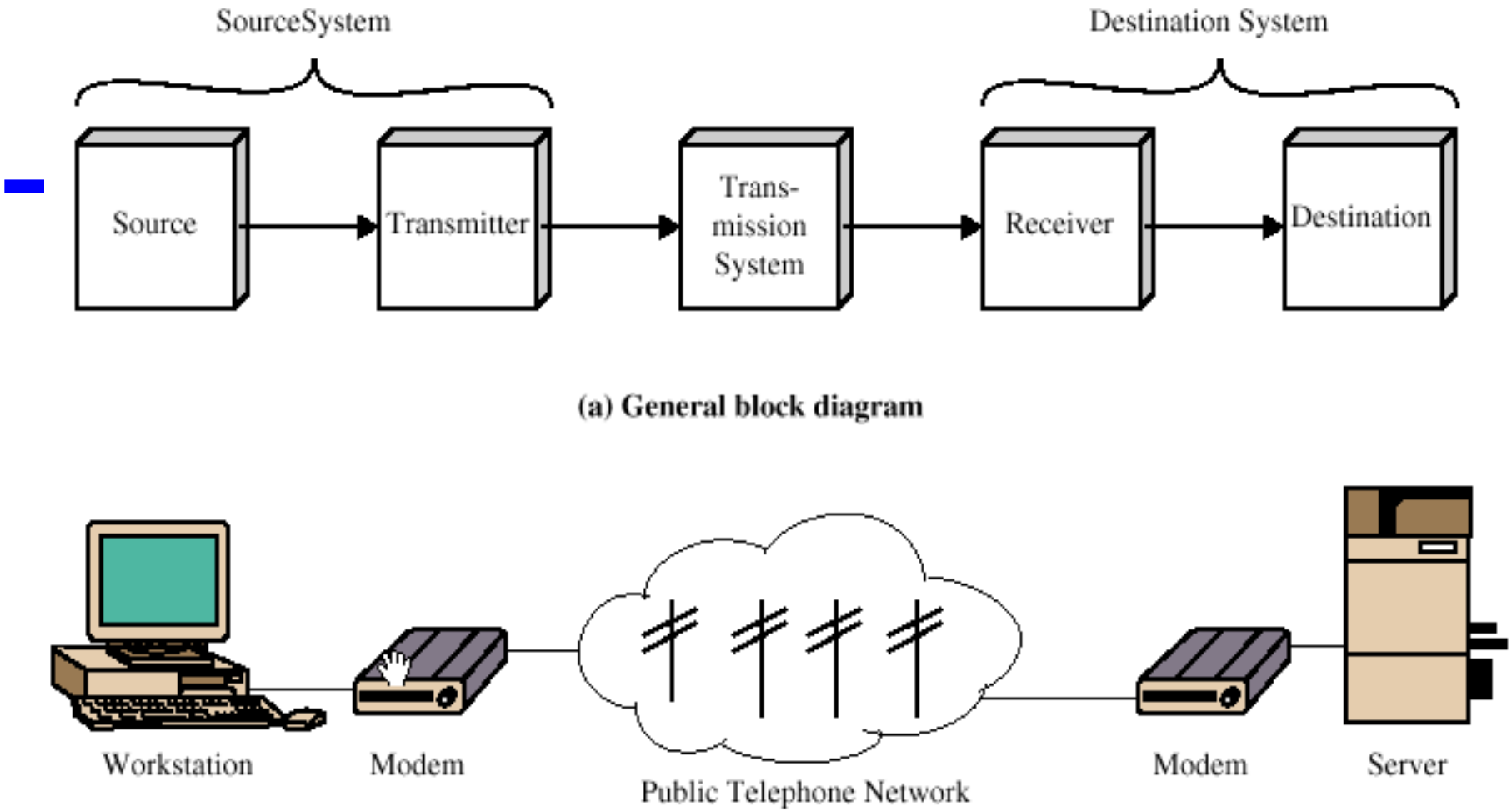
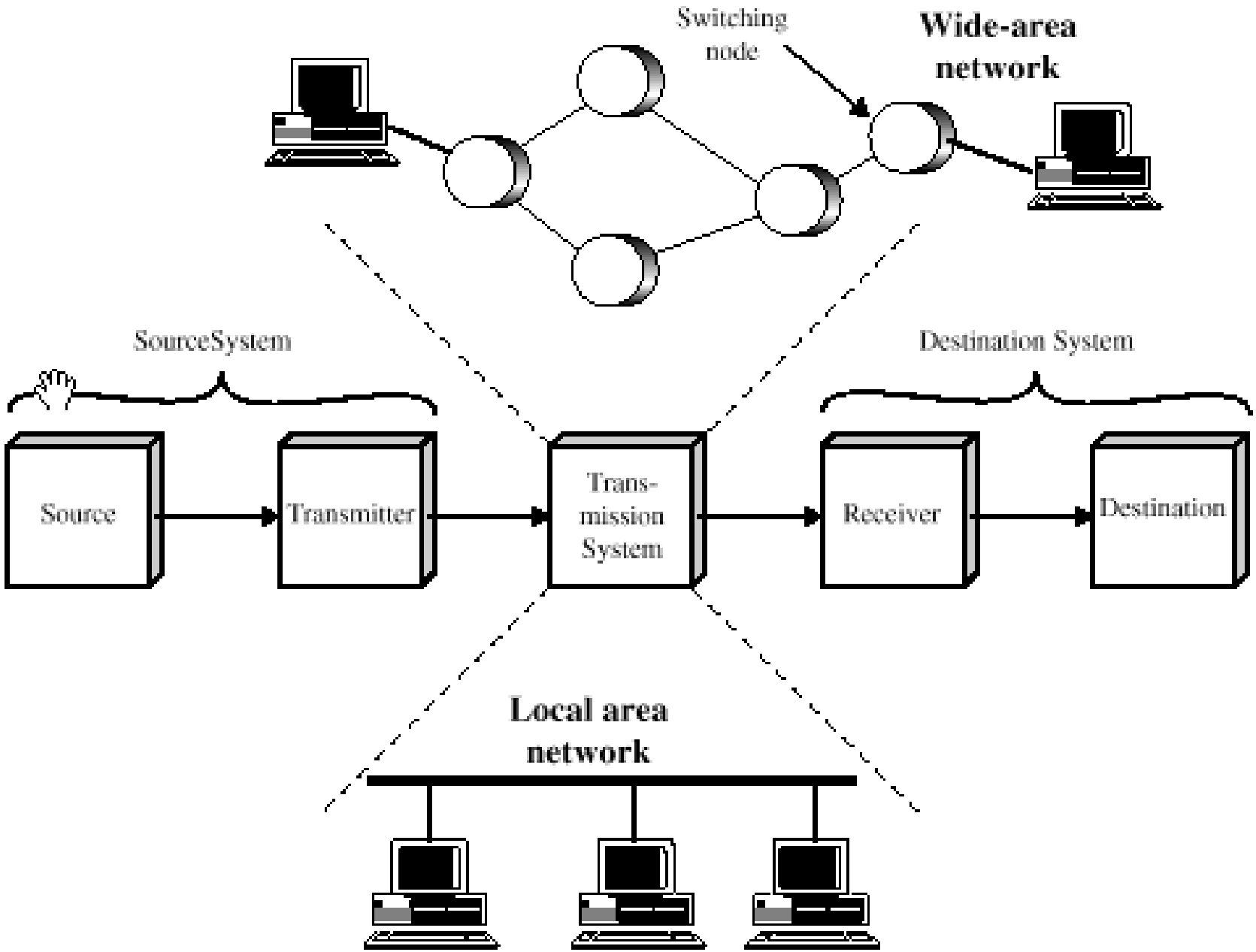


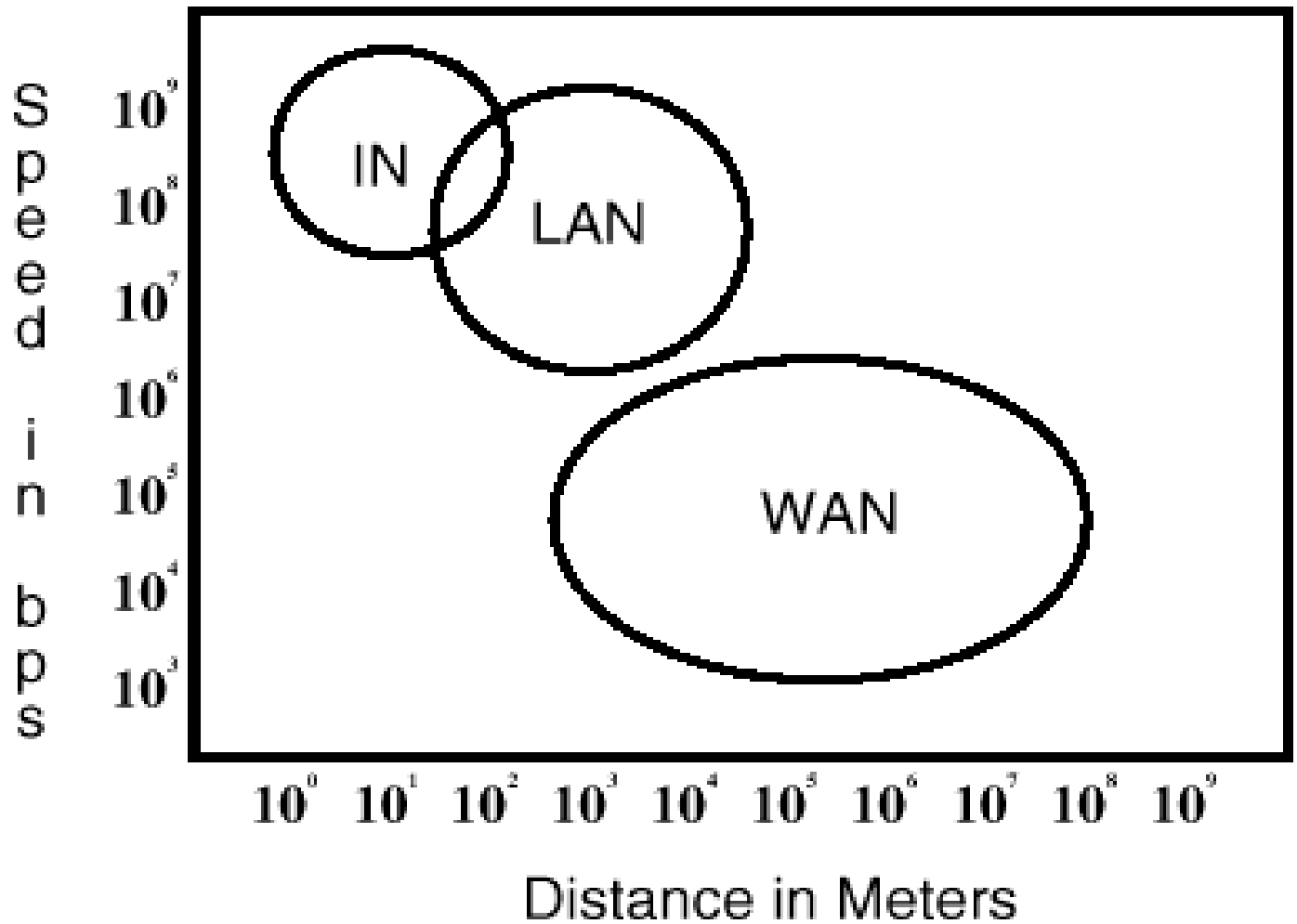
Figure 1.1 Simplified Communications Model

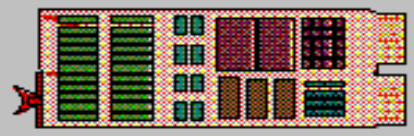
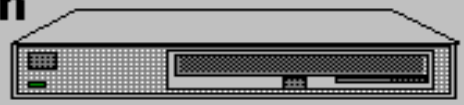
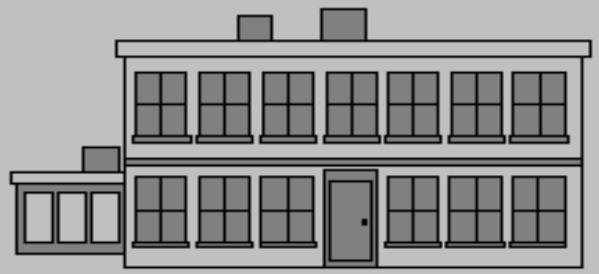
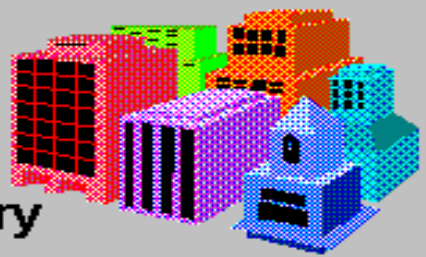
Types of Networks

- By Communication Technique
  - Switched Networks
  - Broadcast Networks e.g. LANs
- By Geographical Coverage
  - Wide Area Network
    - Cover large geographical areas, often crossing public right-of-ways
    - Usually consist of several interconnected switching points
  - Local Area Network
    - Small scope, usually a building or cluster
    - Typically owned by the same organization that owns the equipment


Switching node
Wide-area network
SourceSystem
Destination System
Source
Transmitter
Trans-mission System
Receiver
Destination
Local area network

Type of Networks LANs, WANs and INs



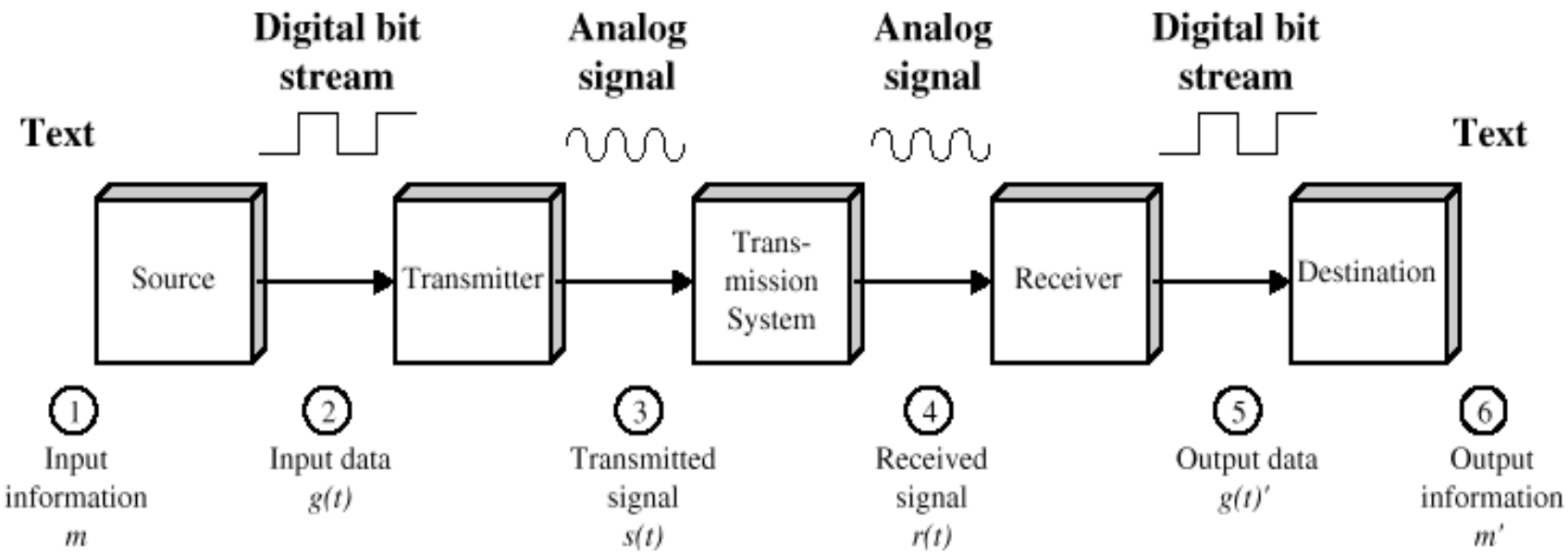
Distance	Processors located in same	Network Type
0.1 m	board 	Data Flow Machine
1 m	system 	Multiprocessor
10 m 100 m 1 km	 room, building, campus	L A N Local Area Network
10 km 100 km	city country 	W A N Wide Area Network
1000 km 10000 km	continent planet 	Interconection of WANs

Trends in Computer Networks

- Higher speed networks > 1000 Mbps
- Wider geographic coverage
- Integrated services: text, graphics, voice, audio, image, video,…
- Merger of LANs and WANs??
- Converged networks?

Basis of Computer Communications

- Computer communications is based on electronic communications
- The Electronic communications model is shown in the following figure



Communication Tasks

- Analogy with human communications
- Computer communications is similar to human communications
- Computer communication is very complex but human communication is more complex still
- A lot of tasks have to be performed in computer communications. Let us look at them.

Communication Tasks

- Transmission system utilization
- Interfacing
- Signal generation
- Synchronization
- Exchange management
- Error detection/correction
- Flow control
- Addressing
- Routing
- Recovery
- Message formatting
- Security
- Network management

Networks Are Complex

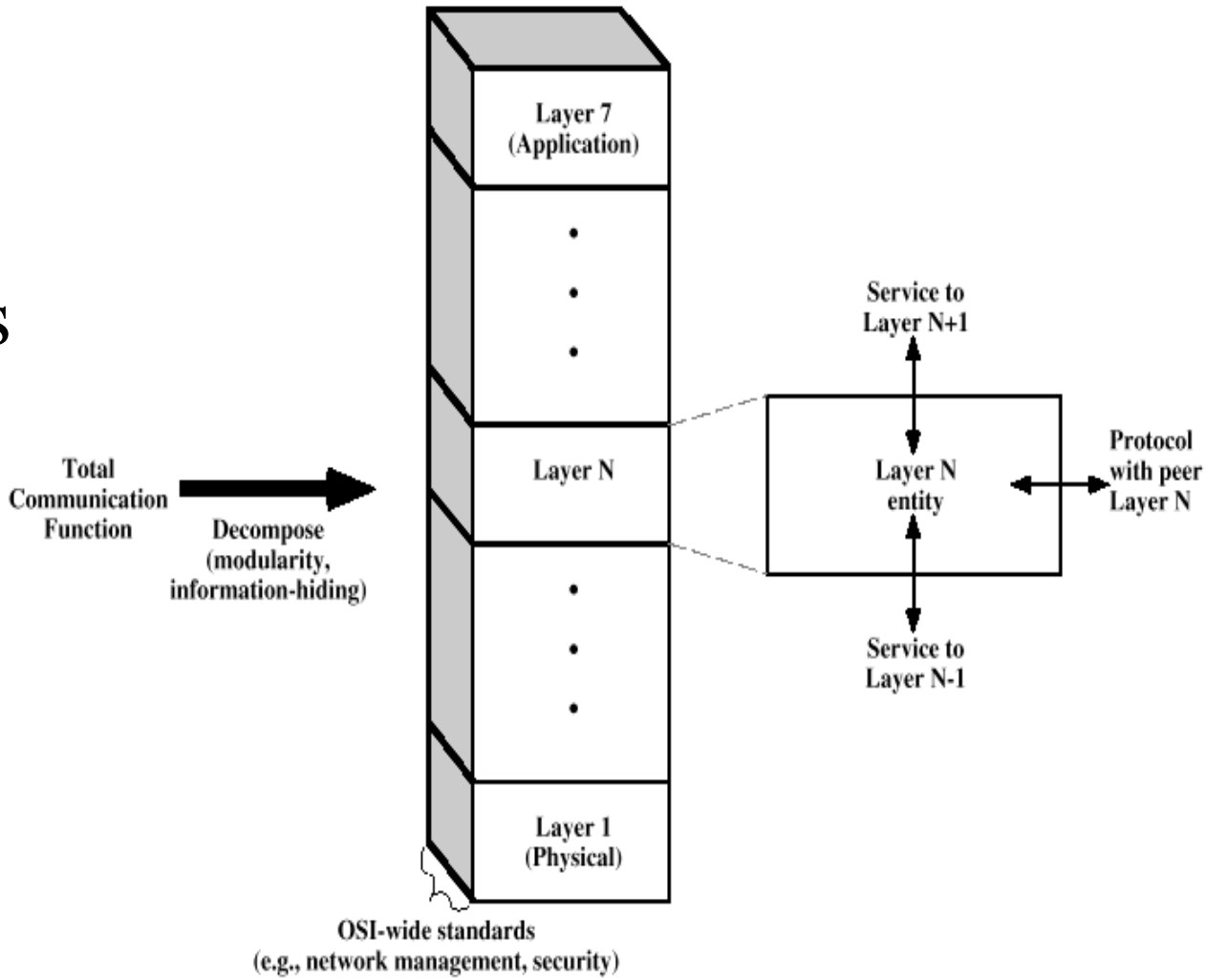
- Many things have to be done right for computers to communicate successfully
- Much chance for things to go wrong
- Result is that computer communication systems are very complex both for designing and understanding
- How to handle a complex/difficult thing?

Layered Models

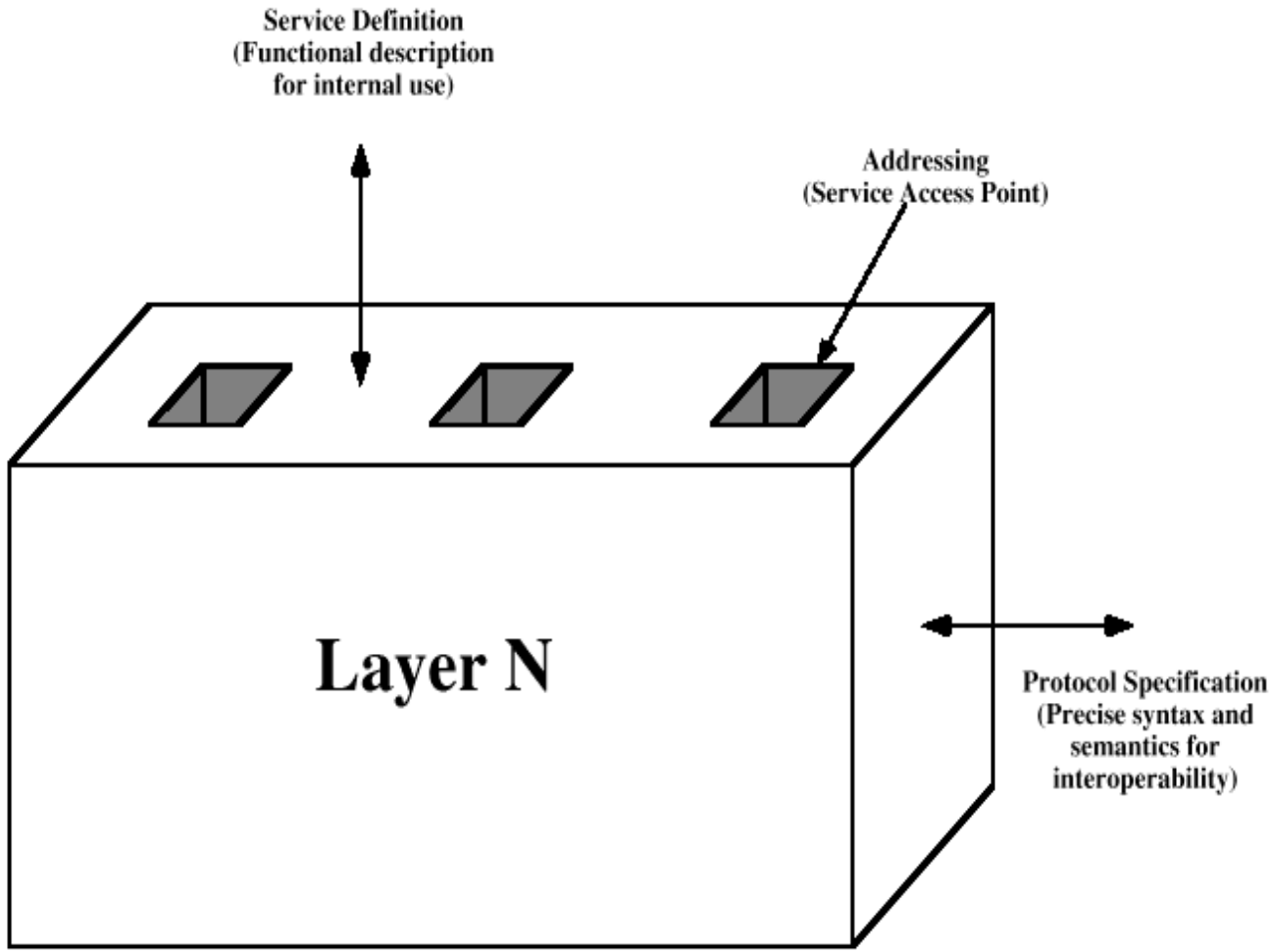
- Divide and Conquer approach
- Benefits of the layered model approach to understanding and design of computer communication systems
- Layered means that related communication tasks are grouped together and implemented as a module or layer
- Layered vs. monolithic approach

Properties of the Layered Model

- Each layer communicates with only the adjacent layers
- Each layer communicates with the corresponding layer in the other system

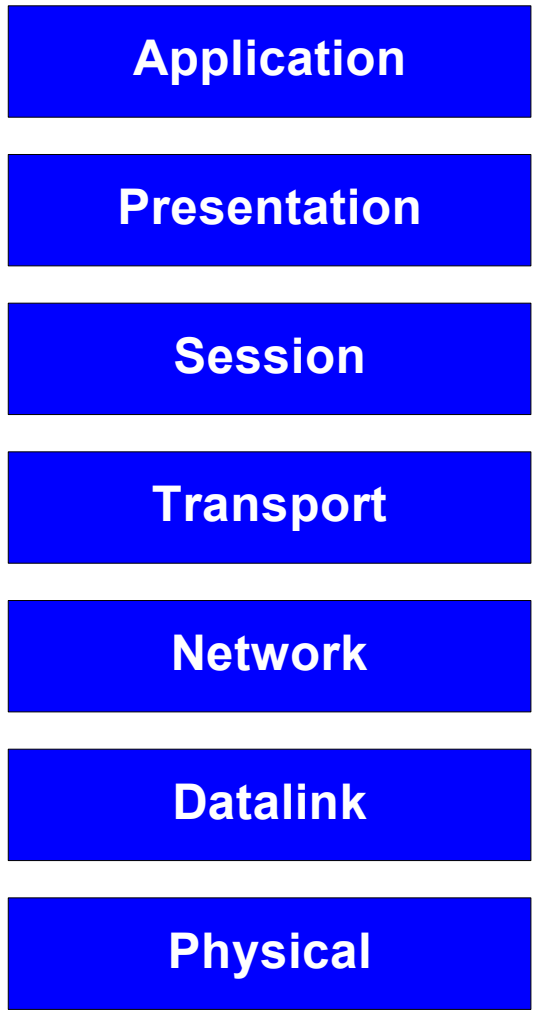


Layer Properties

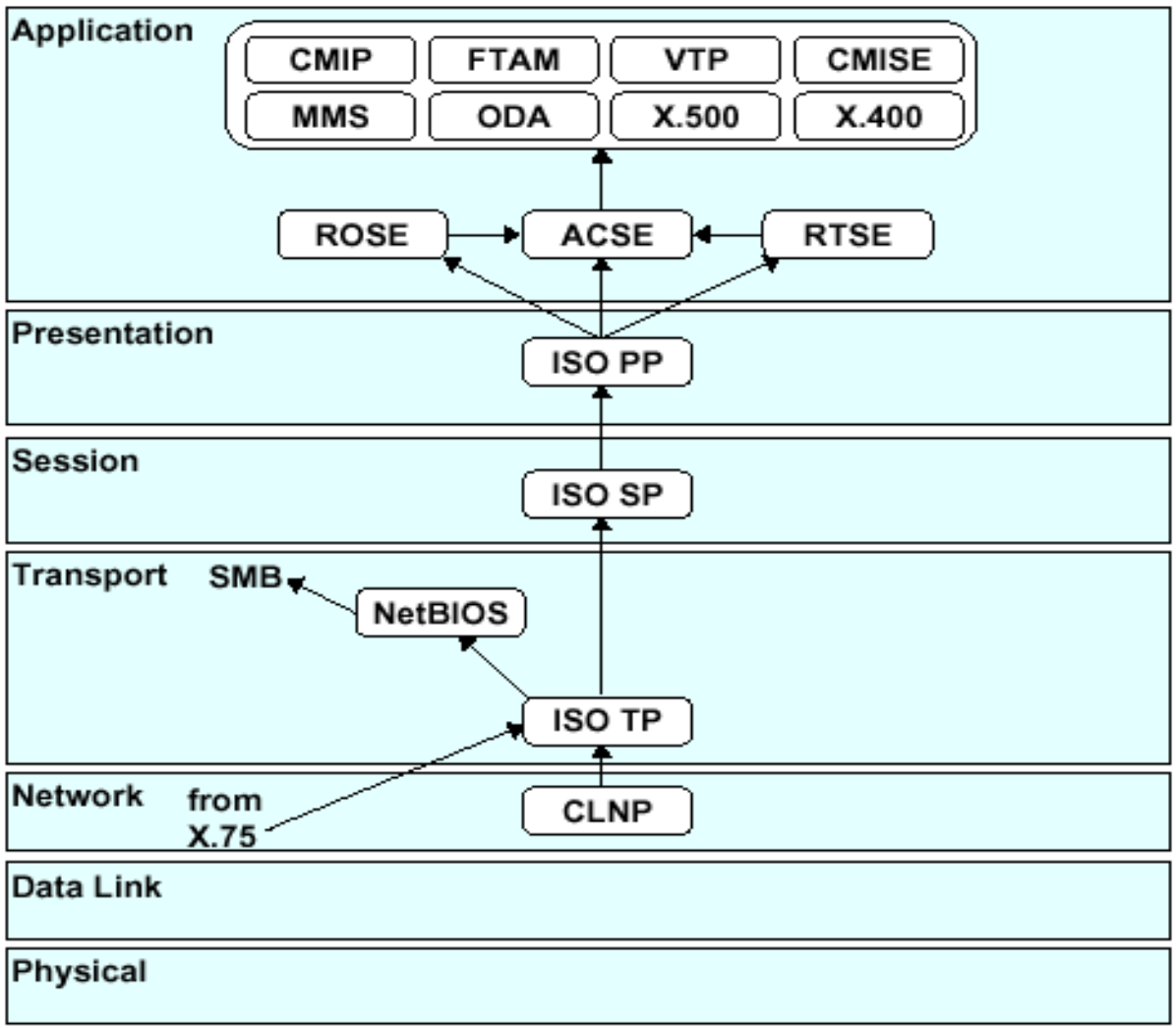


The OSI Reference Model

- Result of standardization work by ISO
- Seven layers
- May have been influenced by the IBM SNA model
- Overly complex
- Good for developing an understanding of computer communication process



OSI is Real


Application
CMIP
FTAM
VTP
CMISE
MMS
ODA
X.500
X.400
ROSE
ACSE
RTSE
Presentation
ISO PP
Session
ISO SP
Transport
SMB
NetBIOS
ISO TP
Network
from
X.75
CLNP
Data Link
Physical

Application Layer

- The Application Layer serves as the window for the application process to access the networking environment. This layer represents the services that directly support users and application tasks.
- The Application Layer contains:
  - Network Virtual Terminals – TELNET
  - File Transfers – FTP, FTAM
  - Remote File Access – SMB, NFS
  - Electronic Mail – SMTP, POP
  - Network Management – SNMP, CMIP

Presentation Layer

- Presentation - Provides independence to the application processes from differences in data representation (syntax) such as Handles conversion between ASCII and EBCDIC
- The Presentation Layer formats the data to be presented to the Application Layer. It can be viewed as the translator for the network.
- The Presentation Layer provides a common representation for data that can be used between application processes.
  - Encoding data
  - Compressing data to reduce the number of bits transmitted
  - Encrypting data for privacy and authentication

Session Layer

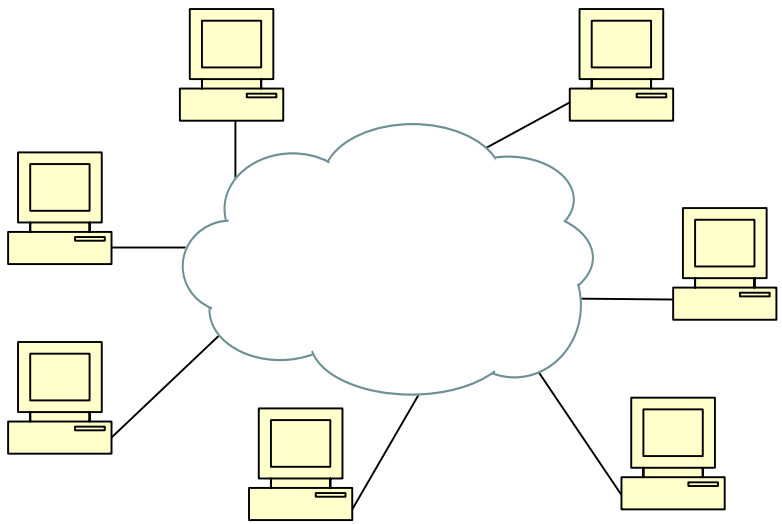
- Session - Establishes, manages, and terminates connections (sessions) between application processes
- Responsible for check pointing and recovery
- The Session Layer provides the means for two application layer entities to synchronize and manage their data exchange. It sets up a communication channel between two Application – or – Presentation layer entities for the duration of the network transaction, manages the communication, and terminates the connections.

Transport Layer

- The Transport Layer forms the interface between the higher application-oriented layers and underlying network-dependent protocol layers. It provides the session layer with reliable message transfer facilities.
- Transport Layer Provides reliable, transparent transfer of data between end points; provides end-to-end (host-to-host) error recovery and flow control
- Examples: TCP, UDP, AAL

Network Layer

- Network - Provides upper layers with independence from the data transmission and switching technologies used.
- Provides a standard interface to upper layers to access network services
- Examples: Internet Protocol – IP, ATM, X.25

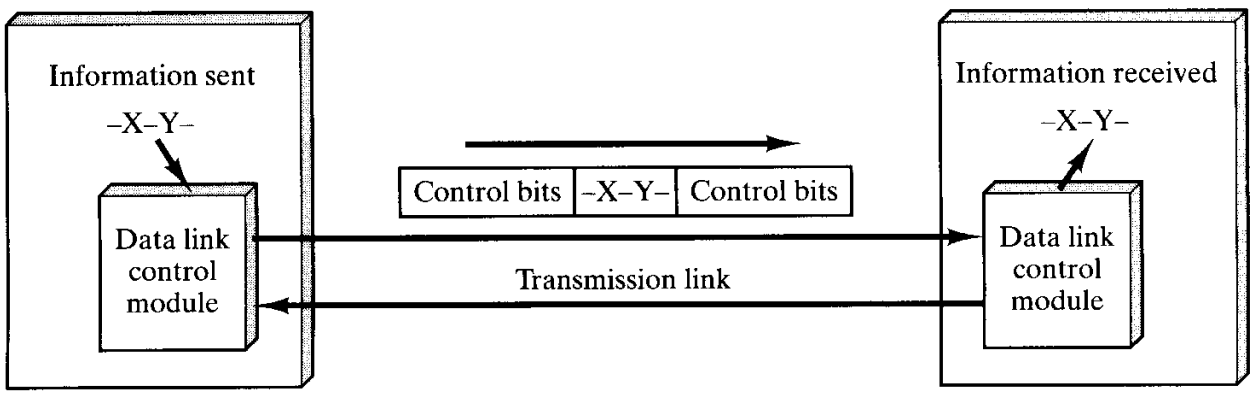


Network Layer

- The Network Layer controls the operation of the network or sub-network (or sub-net). It decides which physical pathway the data should take based on network conditions, priorities of service, and other factors.
- The Network Layer relieves the upper layers of the need to know anything about the data transmission and switching technologies used to connect systems. It is responsible for establishing, maintaining, and terminating connections across the intervening communications facility. Specifically it is responsible for:
  - Addressing messages
  - Setting up the path between communicating nodes on possibly different networks
  - Routing messages among networks
  - Controlling congestion if too many packets are on the subnet
  - Translating logical addresses, or names, into physical addresses
  - Using accounting functions to count packets or bits sent by users to produce billing information

Datalink Layer

- Data Link - Provides for the reliable transfer of information across the physical link; sends blocks of data (frames) with necessary synchronization, error control, and flow control
- Examples: HDLC, SDLC, PPP

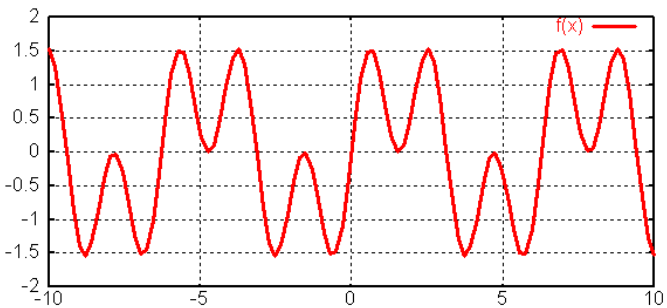


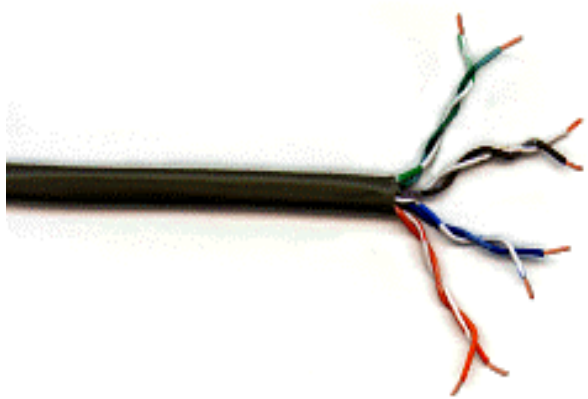
Datalink Layer

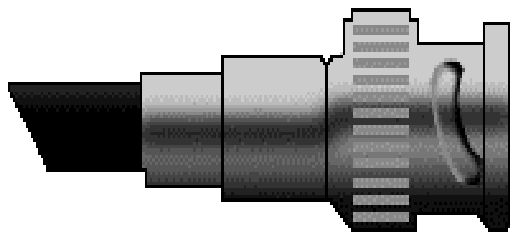
- The primary purpose of the Data Link Layer is to provide error-free transmission of information between two end stations “edge nodes” attached to the same physical cable or media. This then allows the next higher layer to assume virtually error-free transmission over the physical link. The Data Link Layer is responsible for packaging and placing data on the network media. It then manages how the flow process of the bit stream takes place to include the following:
  - Creates and recognizes frame boundaries
  - Checks received messages for integrity
  - Manages channel access and flow control
  - Ensures correct sequence and transmitted data
  - Detects and possibly corrects errors that occur in the Physical Layer without using the functions of the upper layers
  - Provides flow-control techniques to ensure that link buffer capacity is not exceeded

Physical Layer

- Physical - Concerned with transmission of unstructured bit stream over physical medium; deals with the mechanical, electrical, functional, and procedural characteristics to access the physical medium (voltages, pin assignments, bit times, ..)
- Examples – RS-232, Ethernet Physical Layer Specifications

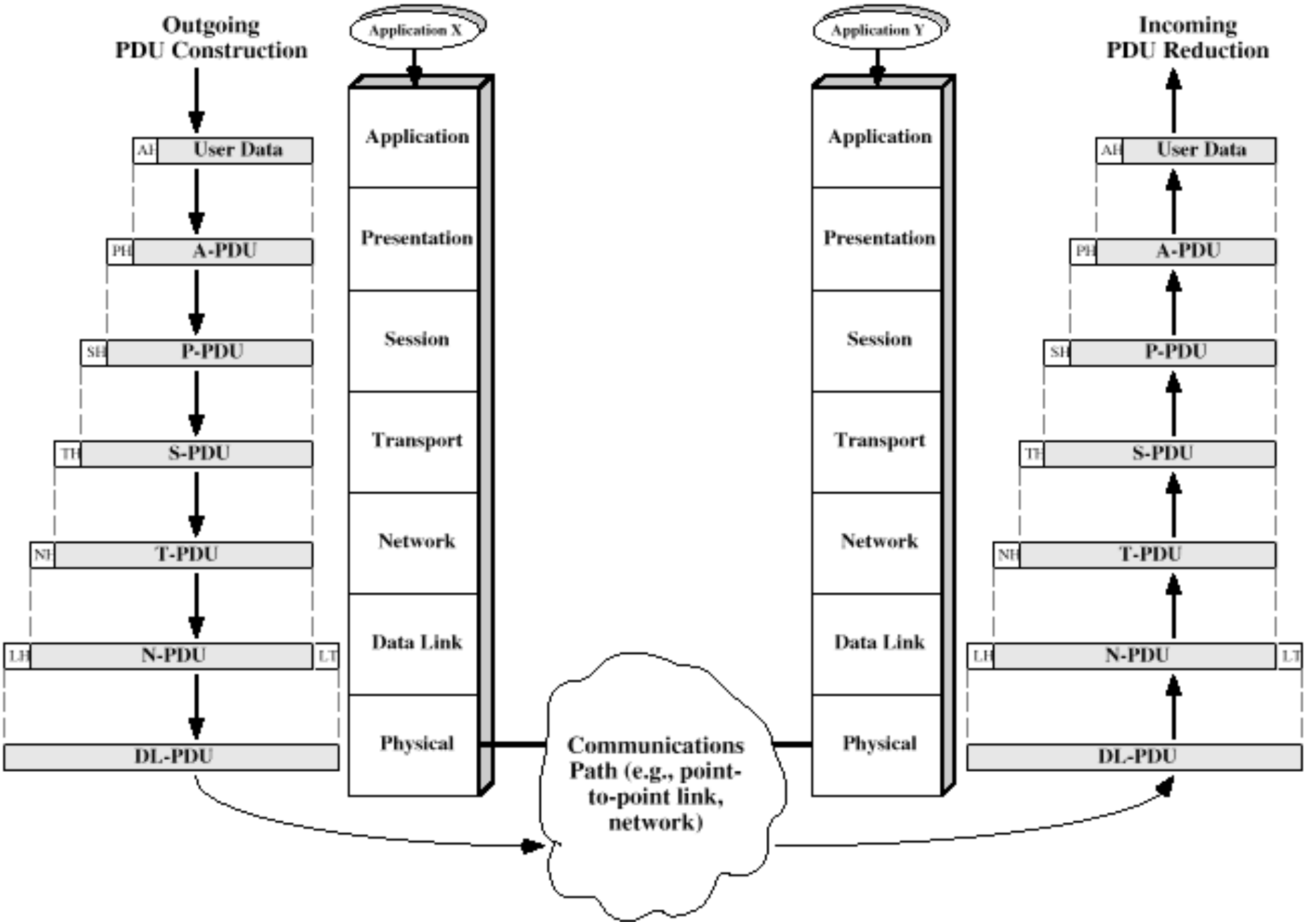






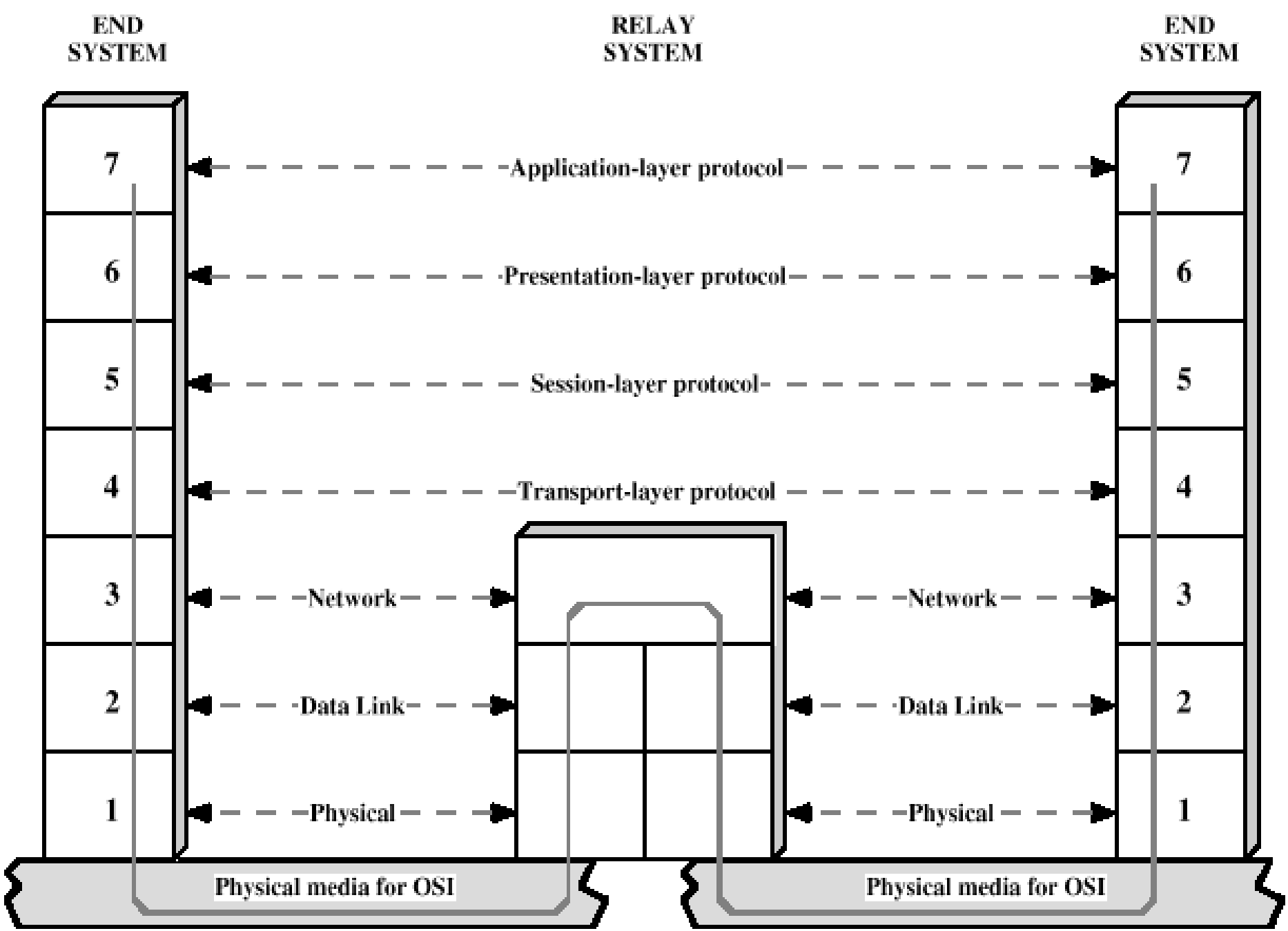
Operation of the Layered Model

- Each layer has a Protocol Data Unit PDU which consists of some data for the layer and a header
- The PDU is passed down the layers within a system
- The PDU for an upper layer becomes the SDU for the lower layer
- The army example: General-Brigadier-Colonel-Major-Subaydar Major-Hawaldar-Sepoy

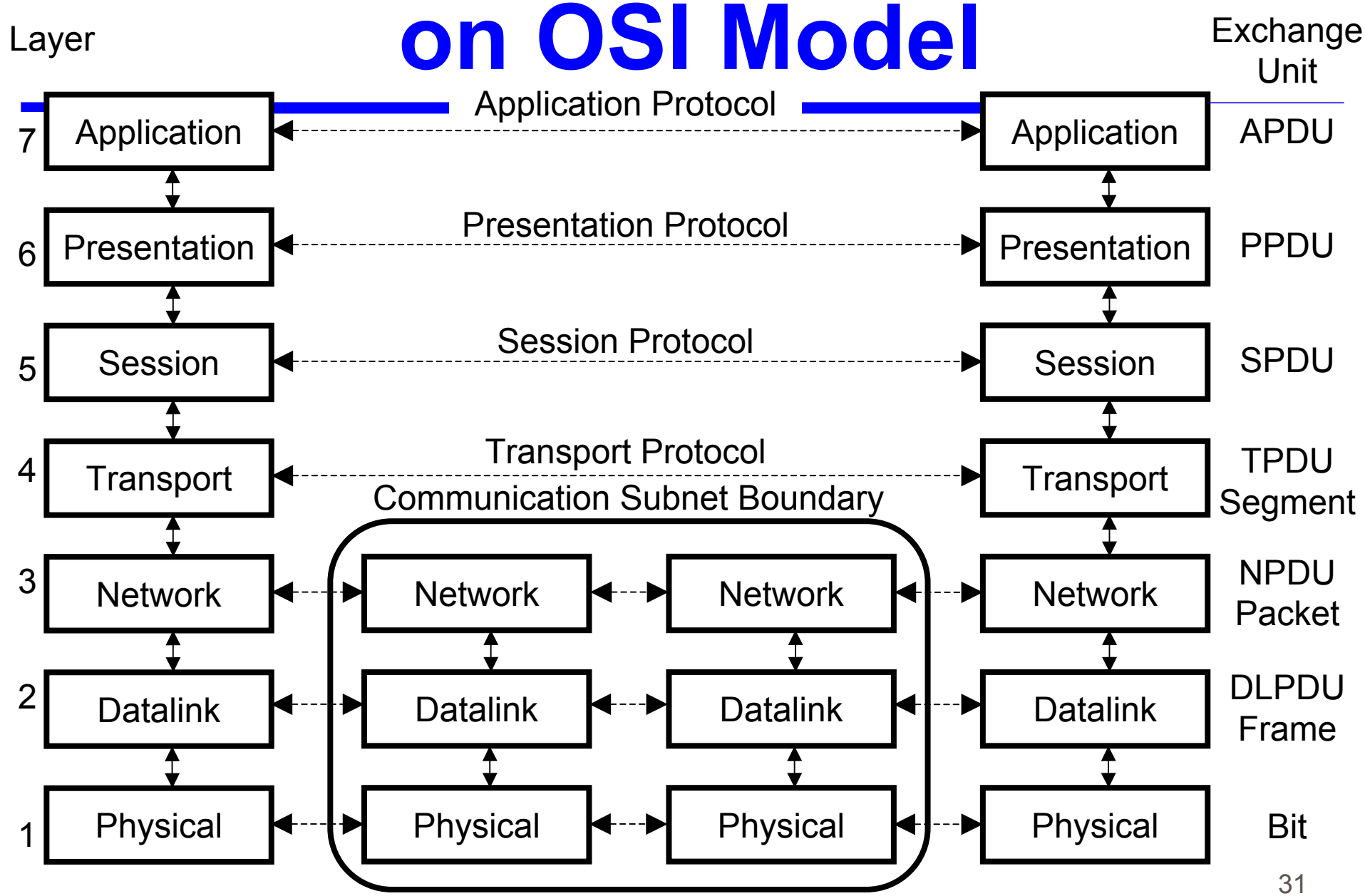

Outgoing
PDU Construction
Application X
Application Y
Incoming
PDU Reduction
AH
User Data
PH
A-PDU
SH
P-PDU
TH
S-PDU
NH
T-PDU
LH
N-PDU
LT
DL-PDU
Application
Presentation
Session
Transport
Network
Data Link
Physical
Communications
Path (e.g., point-
to-point link,
network)

End Systems and Intermediate Systems

- Many times direct physical connection is not practical/possible between a pair of devices – **End Systems** or **ES** in ISO jargon
- Communication happens through the service of intermediaries
- These intermediaries are called **Intermediate Systems** or **IS**
- Intermediate systems may not process information at all layers
- Examples of intermediate systems – repeaters, bridges, switches, routers, gateways


END SYSTEM
RELAY SYSTEM
END SYSTEM
7
6
5
4
3
2
1
Application-layer protocol
Presentation-layer protocol
Session-layer protocol
Transport-layer protocol
Network
Data Link
Physical
Network
Data Link
Physical
7
6
5
4
3
2
1
Physical media for OSI
Physical media for OSI

Network Architecture Based on OSI Model

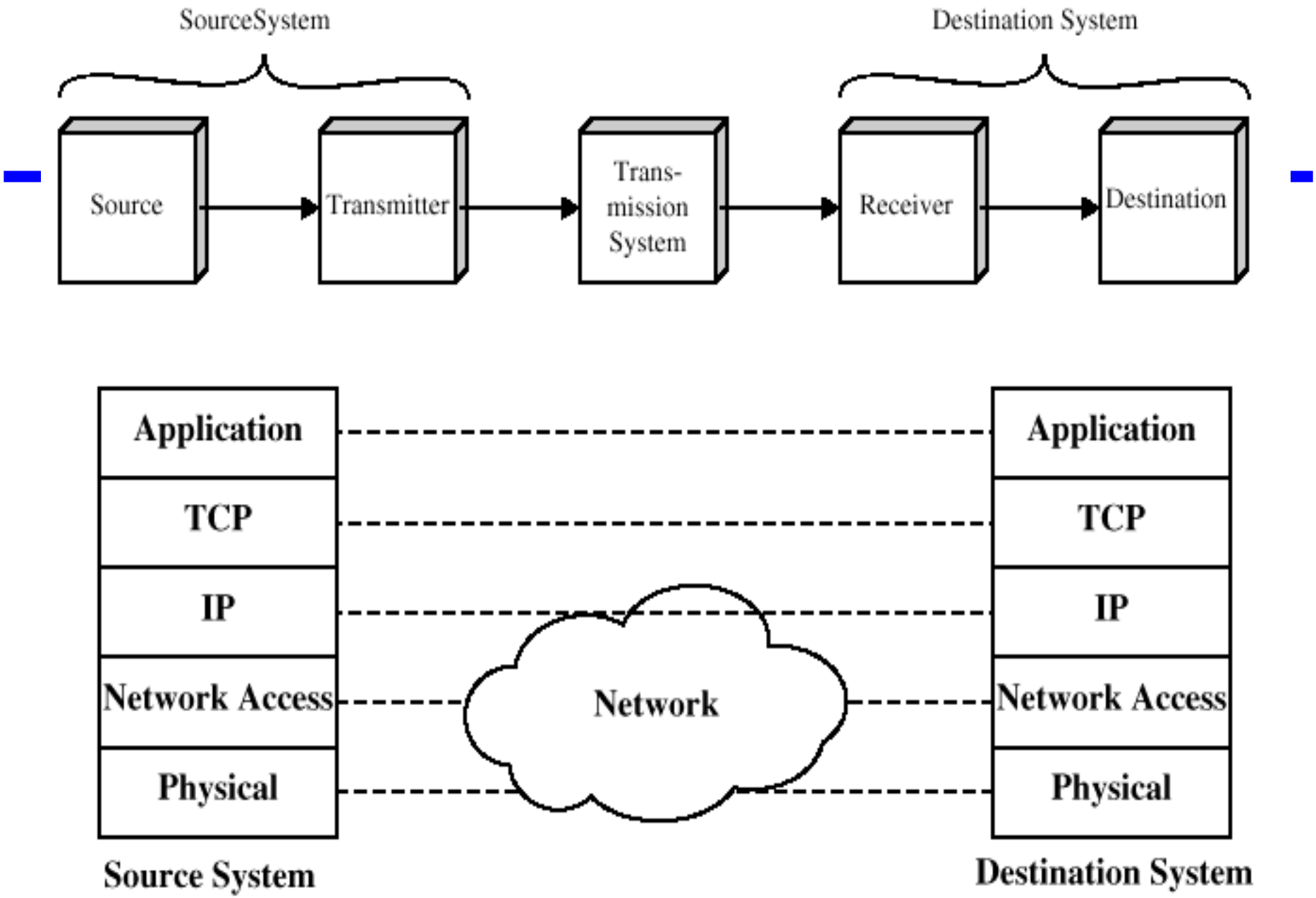


Problems with Layering

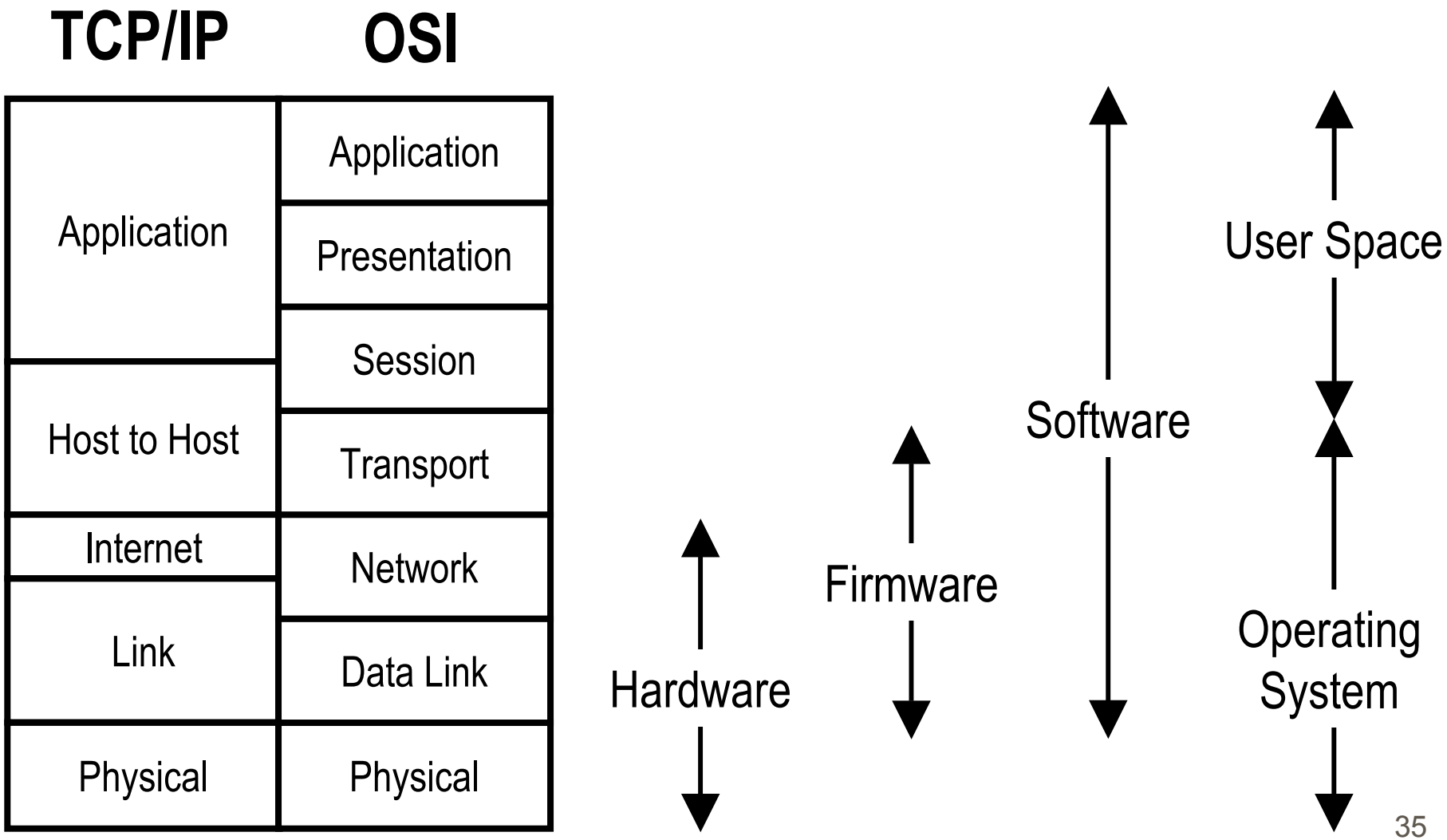
- Inefficiency - each layer introduces overhead
- Restrictive - layer *N* may need access to lower layers than *N* – *1*. Examples?
- Redundancy - of functions such as flow control error handling, addressing, packetizing, and encapsulation between layers

Internet/DOD Model - TCP/IP Protocol Architecture

- Roughly five layers (originally four)
- Used in the grandparent of all computer networks, the ARPANET, and its successor, the Internet
- Application layer (TELNET, FTP, SMTP, ...)
- Host-to-host, or transport layer (TCP, UDP)
- Internet layer (IP)
- Network access layer (PPP, LLC)
- Physical layer (Fiber, UTP, Coax, Wireless)


SourceSystem
Destination System
Source
Transmitter
Trans-
mission
System
Receiver
Destination
Application
TCP
IP
Network Access
Physical
Network
Application
TCP
IP
Network Access
Physical
Source System
Destination System

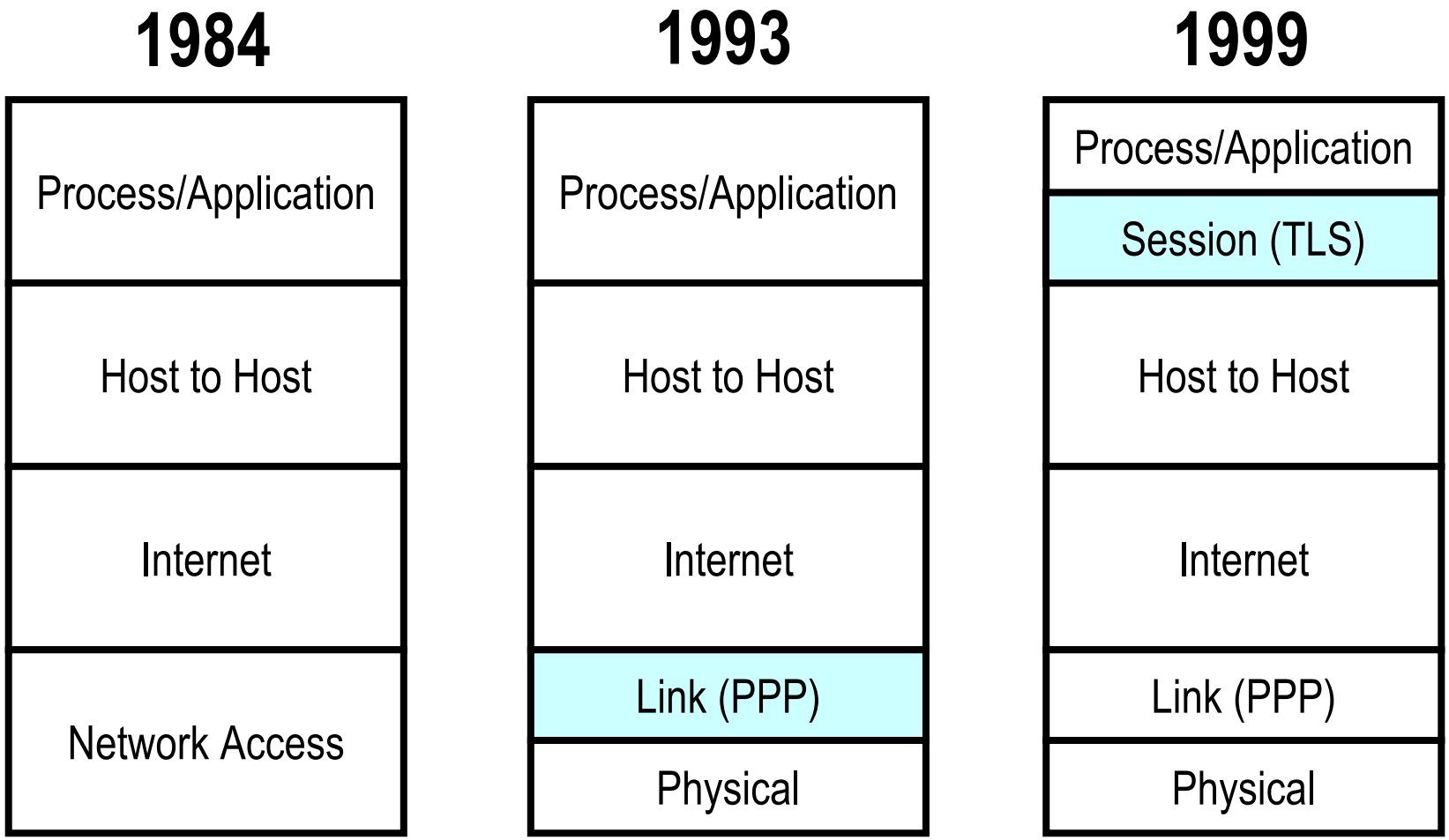
What's Where?


TCP/IP
OSI
Application
Application
Presentation
Session
Host to Host
Transport
Internet
Network
Link
Data Link
Physical
Physical
Hardware
Firmware
Software
User Space
Operating System

Evolution of the Internet

- Internet is like a **chameleon** – changes colors
- Examples of changing Internet behavior:
  - From a research network to a global network
  - From best effort, free for all, first come first served network to a Quality of Service and class of service based network
  - From an insecure network to a secure network
  - From a data network to a multimedia network

Evolution of the Internet Model



Strengths of the Internet

- Open
- Democratic
- Rough consensus and running code
- Practical
- ISOC, IRSG, IESG, IETF, IRTF, Areas, Working Groups
- RFCs – standards, others
- Internet Drafts – working documents
- http://www.ietf.org, http://www.iana.org