# Data Communications
# &
# Computer Network

**Dr. Sumit Srivastava**

**Dept. of CSE, BIT Mesra Ranchi**

**Email:- sumit.srivs88@gmail.com**

# References

- Data and Computer Communications, William Stallings, PHI
- Tanenbaum and David J Wetherall, Computer Networks, 5th Edition, Pearson Edu, 2010
- Computer Networks: A Top-Down Approach, Behrouz A. Forouzan, Firouz Mosharraf, McGraw Hill Education
- Larry L. Peterson and Bruce S. Davie, “Computer Networks – A Systems Approach” (5th ed), Morgan Kaufmann/ Elsevier, 2011
- Data Communications and Networking, Behrouz A. Forouzan, TMH
- Computer Networks, Andrew S. Tanenbaum, PHI Version 2 CSE IIT, Kharagpur
- Internetworking with TCP/IP; Principles, Protocols, and Architecture, Douglas E. Commer, 3rd Edition, Prentice Hall of India

# What is the Objective of Networking?

- Communication between applications on different computers

- Must understand application needs/demands
  - Traffic data rate
  - Traffic pattern (bursts or constant bit rate)
  - Traffic target (multipoint or single destination, mobile or fixed)
  - Delay sensitivity
  - Loss sensitivity

# Problem…

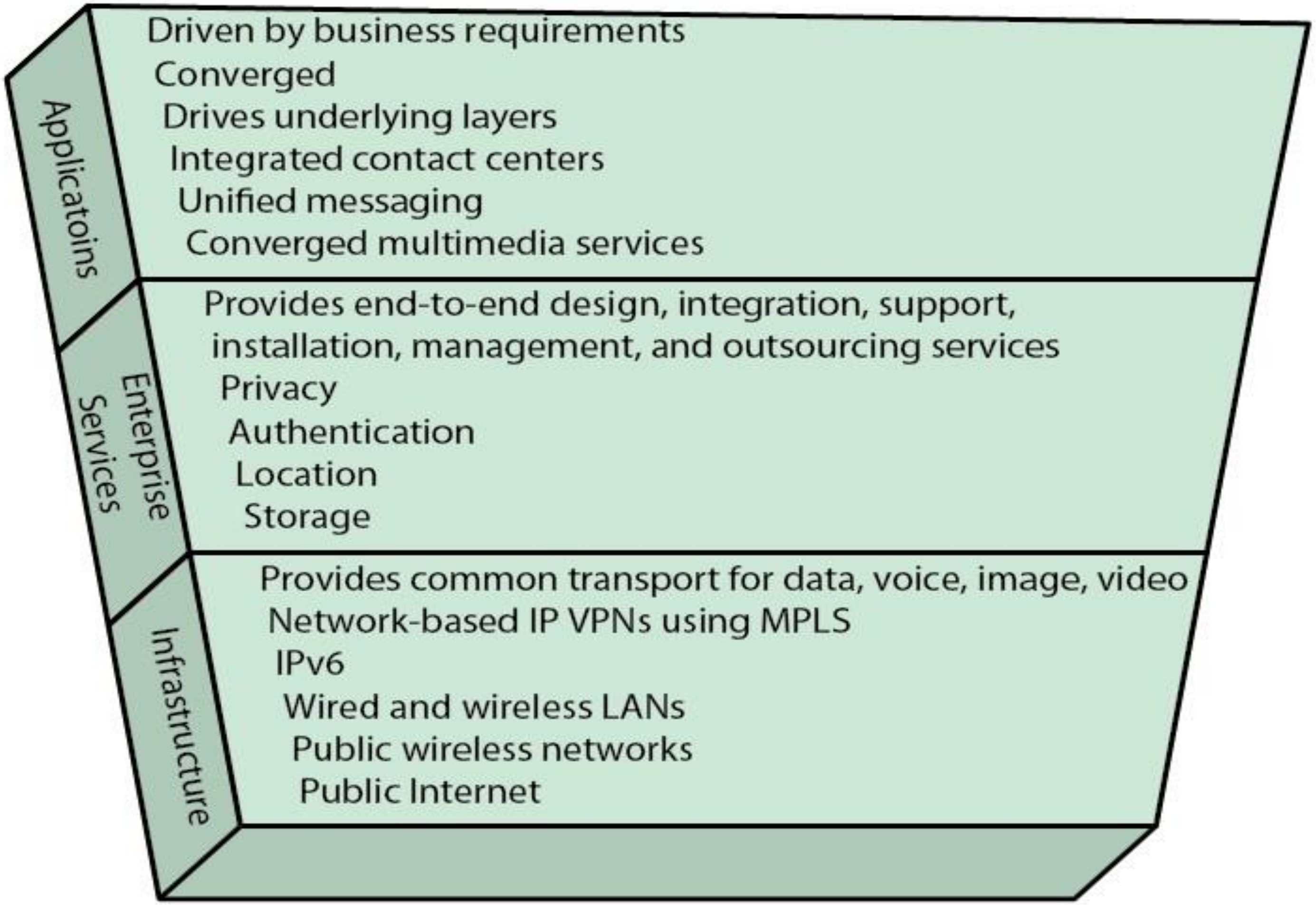
*“The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point”*

# Technological Advancement  Driving Forces

Traffic growth at a high & steady rate

- Development of new services
- Advances in technology

# Convergence Layers



Applicatoins

Driven by business requirements
Converged
Drives underlying layers
Integrated contact centers
Unified messaging
Converged multimedia services

Enterprise Services

Provides end-to-end design, integration, support, installation, management, and outsourcing services
Privacy
Authentication
Location
Storage

Infrastructure

Provides common transport for data, voice, image, video
Network-based IP VPNs using MPLS
IPv6
Wired and wireless LANs
Public wireless networks
Public Internet

# Benefits

- Convergence benefits include:

### Efficiency

- better use of existing resources, and implementation of centralized capacity planning, asset and policy management

### Effectiveness

- the converged environment provides users with flexibility, rapid standardized service deployment and enhanced remote connectivity and mobility

### Transformation

- enables the enterprise-wide adoption of global standards and associated service levels

# A Communications Model

- Source

  Generates data to be transmitted

- Transmitter

  Converts data into transmittable signals

- Transmission System

  Carries data

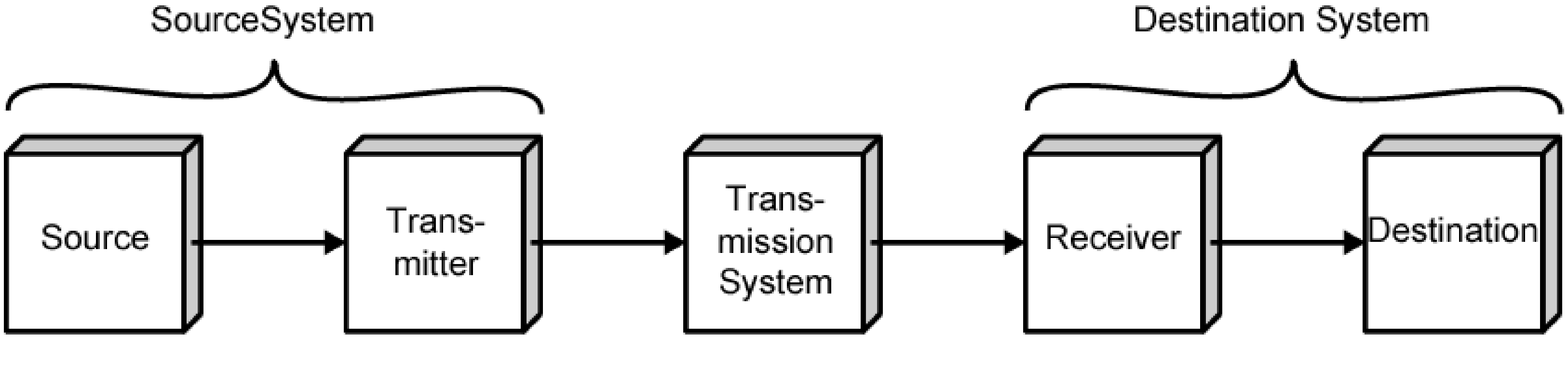
- Receiver

  Converts received signal into data

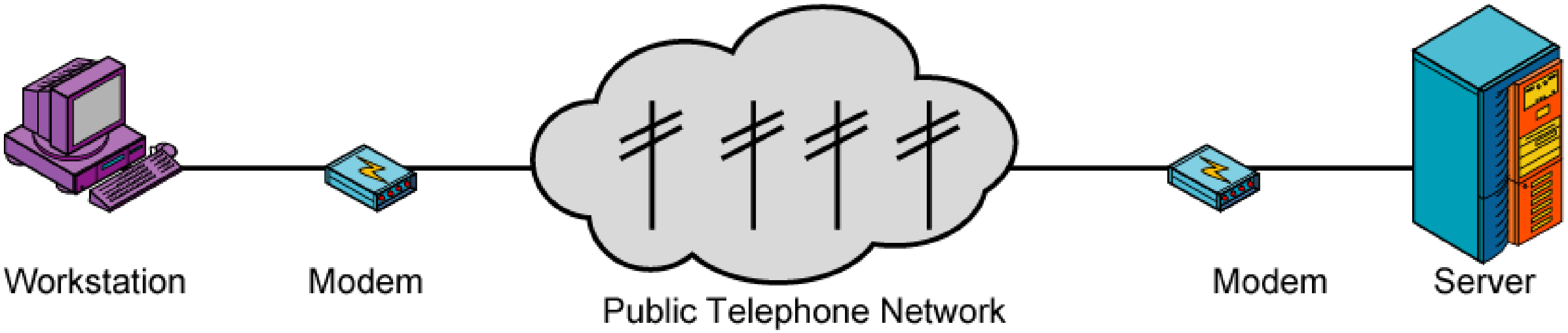
- Destination

  Takes incoming data

# A Communications Model



(a) General block diagram

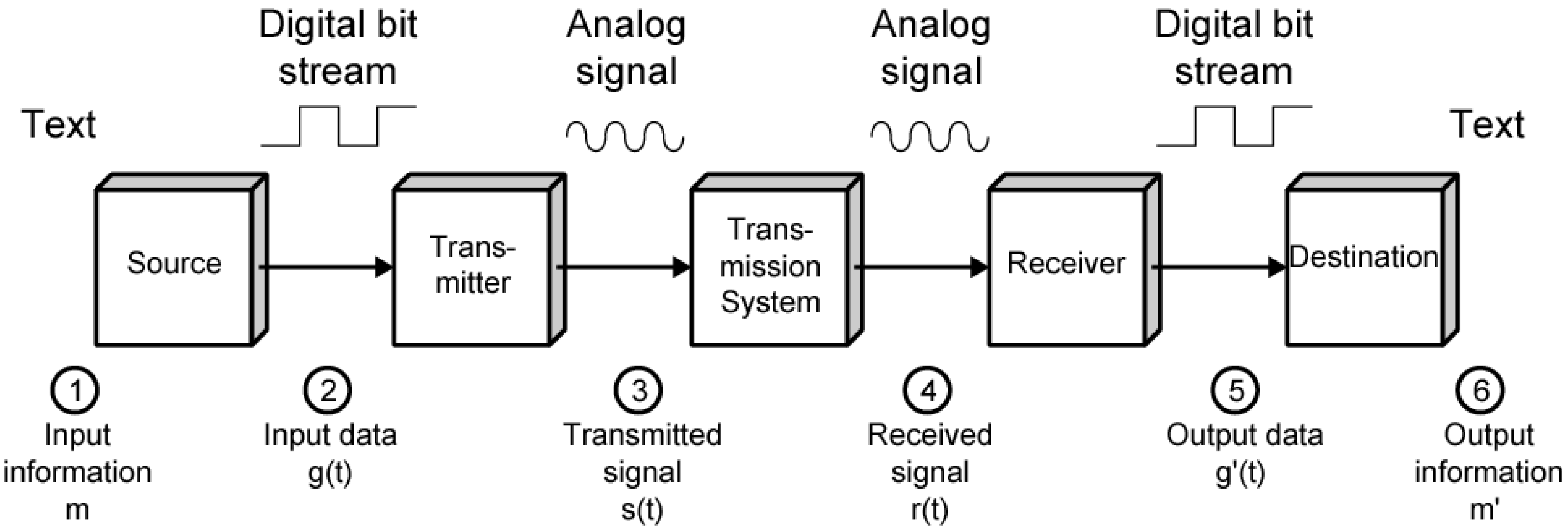


(b) Example

# Communications Tasks

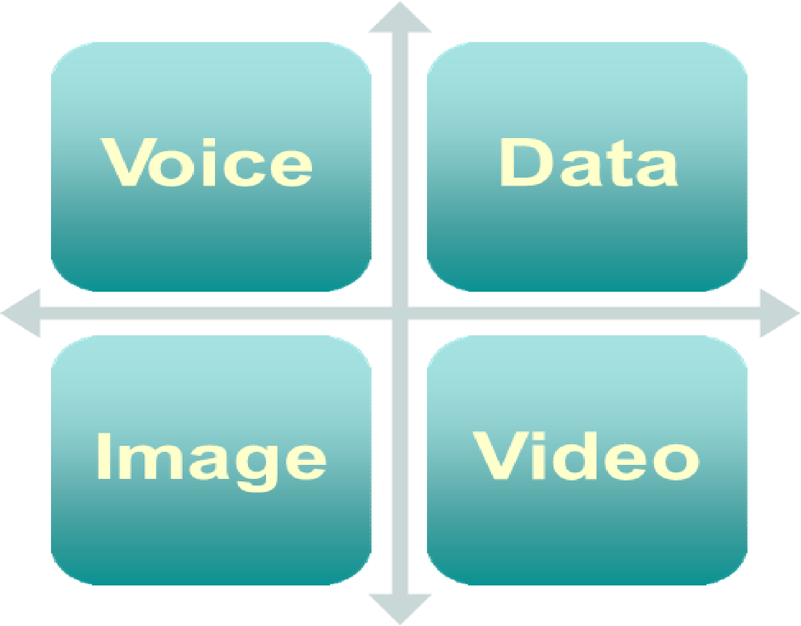
- Transmission System Utilization
- Interfacing
- Signal Generation
- Synchronization
- Exchange Management
- Error detection and correction
- Addressing and routing
- Recovery
- Message formatting
- Security
- Network Management

# Data Communications Model

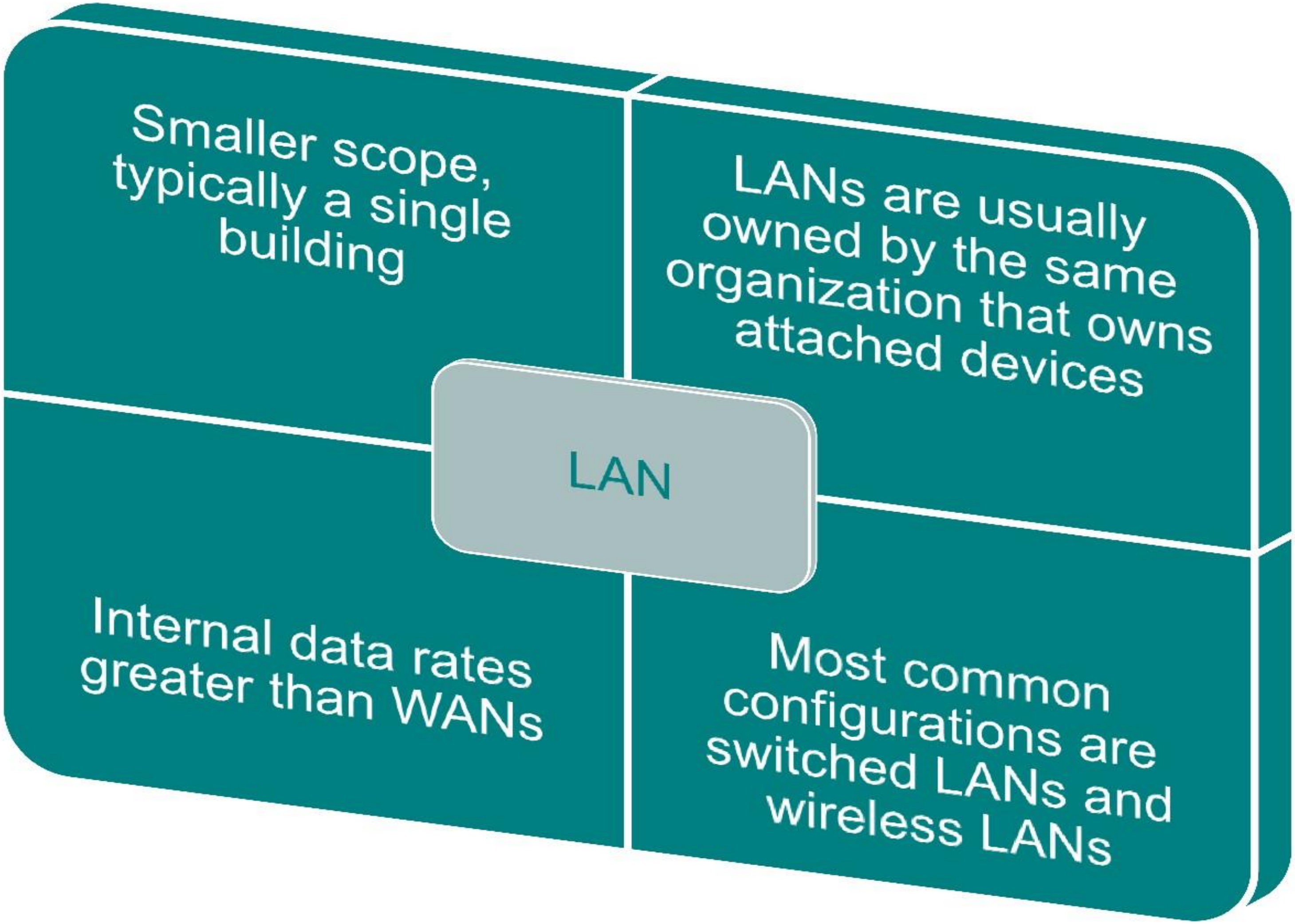


# Networking

- Advances in technology have led to greatly increased capacity and the concept of integration, allowing equipment and networks to work simultaneously.



# Local Area Networks (LAN)



LAN

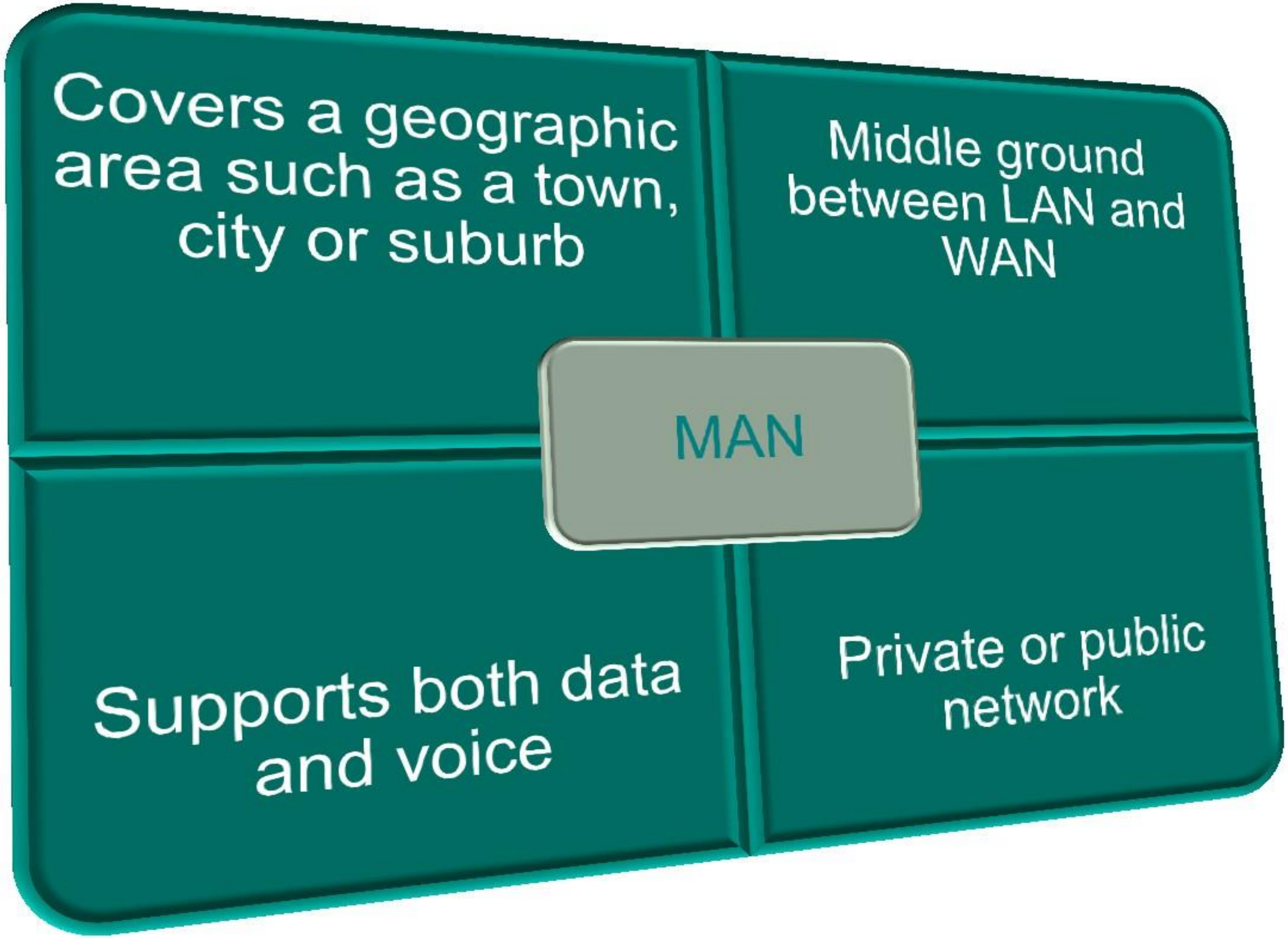
Smaller scope, typically a single building

LANs are usually owned by the same organization that owns attached devices

Internal data rates greater than WANs

Most common configurations are switched LANs and wireless LANs

# Metropolitan Area Networks (MAN)



MAN

Covers a geographic area such as a town, city or suburb

Middle ground between LAN and WAN

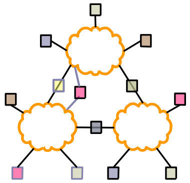
Supports both data and voice

Private or public network

# Four Steps to Networking

- Communicating across a link
- Connecting together multiple links (internetworking)
- Finding and routing data to nodes on internetwork
- Matching application requirements

# Challenge



- Many differences between networks
  - Address formats
  - Performance – bandwidth/latency
  - Packet size
  - Loss rate/pattern/handling
  - Routing
- How to translate between various network technologies

# Network Functionality Summary

- Link
- Multiplexing
- Routing
- Addressing/naming (locating peers)
- Reliability
- Flow control
- Fragmentation
- Etc….

# Protocols

- Module in layered structure
- Set of rules governing communication between network elements (applications, hosts, routers)
- Protocols define:
  - Interface to higher layers (API)
  - Interface to peer
    - Format and order of messages
    - Actions taken on receipt of a message

# Layering Characteristics

- Each layer relies on services from layer below and exports services to layer above
- Interface defines interaction
- Hides implementation - layers can change without disturbing other layers (black box)

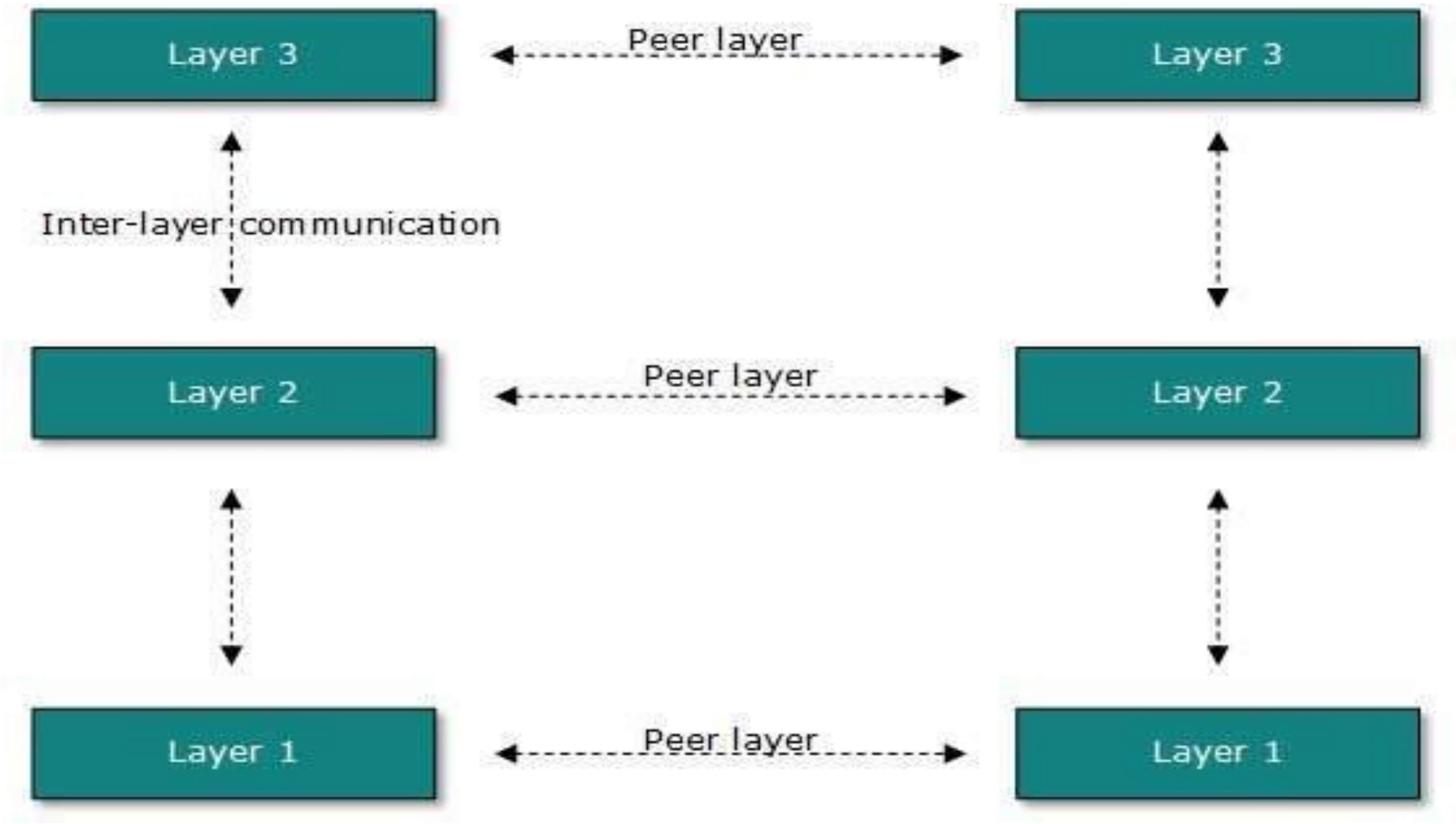
# Layering Characteristics

- In layered architecture of Network Model, one whole network process is divided into small tasks. Each small task is then assigned to a particular layer which works dedicatedly to process the task only.
- Every layer does only specific work.
- In layered communication system, one layer of a host deals with the task done by or to be done by its peer layer at the same level on the remote host.
- The task is either initiated by layer at the lowest level or at the topmost level.

# Layering Characteristics

- If the task is initiated by the-topmost layer, it is passed on to the layer below it for further processing. The lower layer does the same thing, it processes the task and passes on to lower layer.
- If the task is initiated by lower most layer, then the reverse path is taken.
- Every layer clubs together all procedures, protocols, and methods which it requires to execute its piece of task.
- All layers identify their counterparts by means of encapsulation header and tail.

# Layering Characteristics



# Layered Architecture

- The main aim of the layered architecture is to divide the design into small pieces.
- Each lower layer adds its services to the higher layer to provide a full set of services to manage communications and run the applications.
- It provides modularity and clear interfaces, i.e., provides interaction between subsystems.
- It ensures the independence between layers by providing the services from lower to higher layer without defining how the services are implemented. Therefore, any modification in a layer will not affect the other layers.

# Layered Architecture

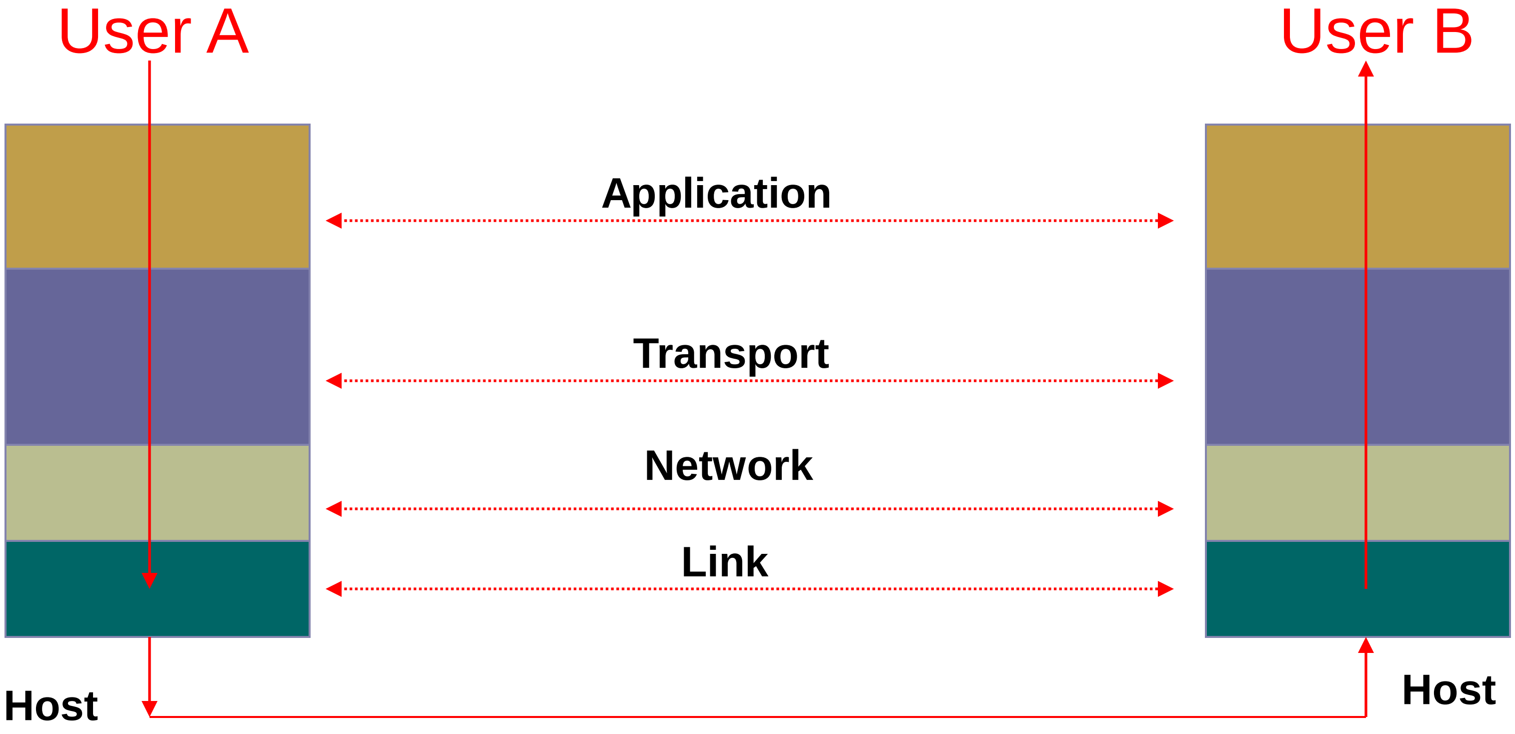
- The number of layers, functions, contents of each layer will vary from network to network. However, the purpose of each layer is to provide the service from lower to a higher layer and hiding the details from the layers of how the services are implemented.

- In a layer n architecture, layer n on one machine will have a communication with the layer n on another machine and the rules used in a conversation are known as a layer-n protocol.

# Layered Architecture

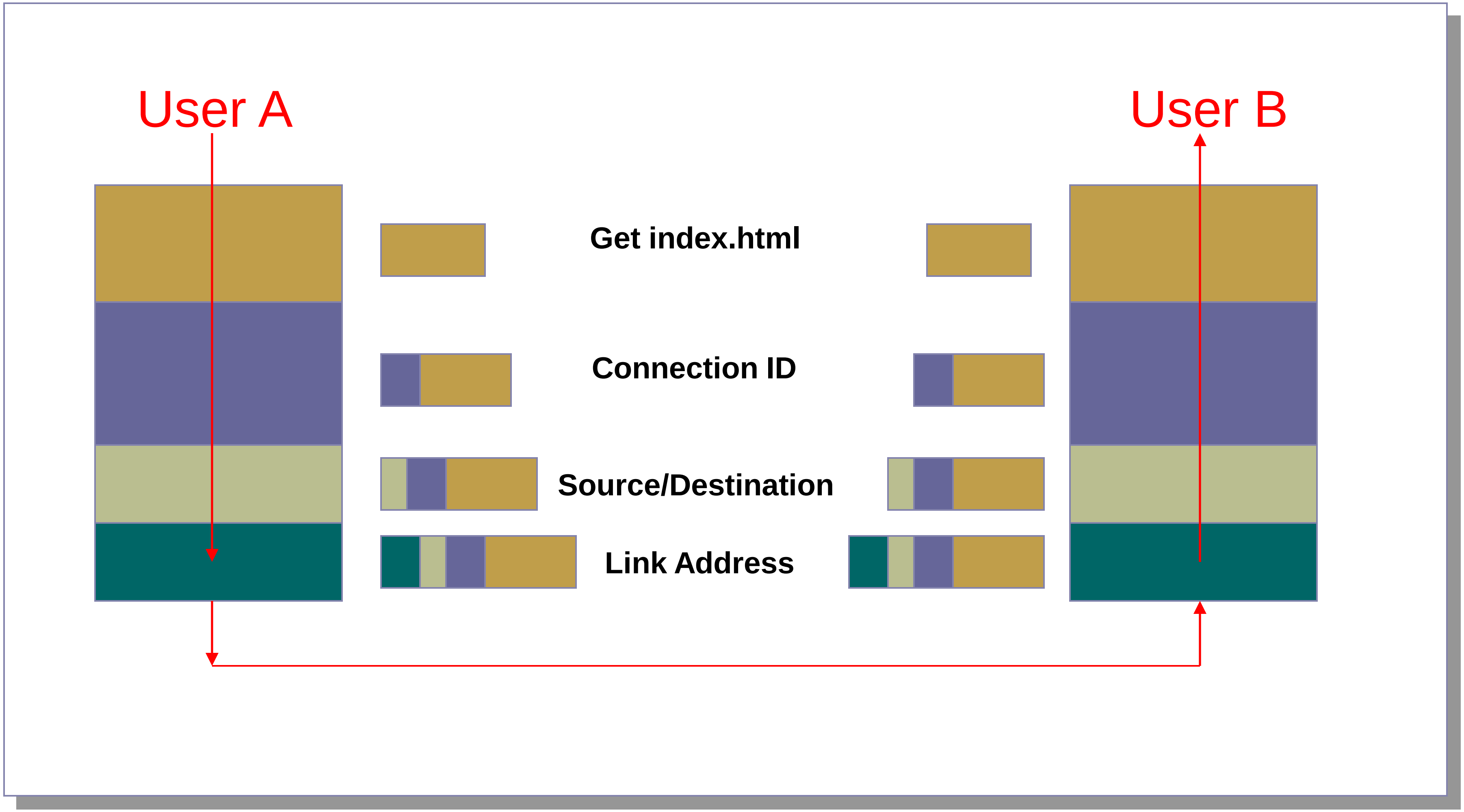
- The basic elements of layered architecture are services, protocols, and interfaces.
  - **Service**: It is a set of actions that a layer provides to the higher layer.
  - **Protocol**: It defines a set of rules that a layer uses to exchange the information with peer entity. These rules mainly concern about both the contents and order of the messages used.
  - **Interface**: It is a way through which the message is transferred from one layer to another layer.

# Layering



Layering: technique to simplify complex systems

# Layer Encapsulation

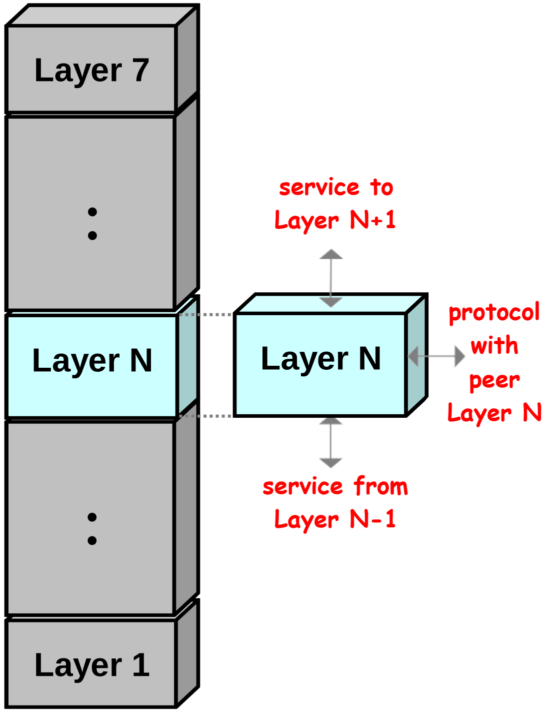


# Why do we require Layered architecture?

- **Divide-and-conquer approach**: Divide-and-conquer approach makes a design process in such a way that the unmanageable tasks are divided into small and manageable tasks. In short, we can say that this approach reduces the complexity of the design.
- **Modularity**: Layered architecture is more modular. Modularity provides the independence of layers, which is easier to understand and implement.
- **Easy to modify**: It ensures the independence of layers so that implementation in one layer can be changed without affecting other layers.
- **Easy to test**: Each layer of the layered architecture can be analyzed and tested individually.

# Layered Architecture

**Protocol Layering** – **grouping of related communication functions into hierarchical set of layers**



- **each layer:**
  - **(1) performs a subset of functions required for communication with another system**
  - **(2) relies on next lower layer to perform more primitive functions**
  - **(3) provides service to next higher layer**
  - **(4) implements protocol for communication with peer layer in other systems**
- **vertical communication – commun. between adjacent layers – requires mutual understanding of what services and/or information lower layer must provide to layer above**
- **~~horizontal communication~~ – commun. between software or hardware elements running at the same layer on different machines**

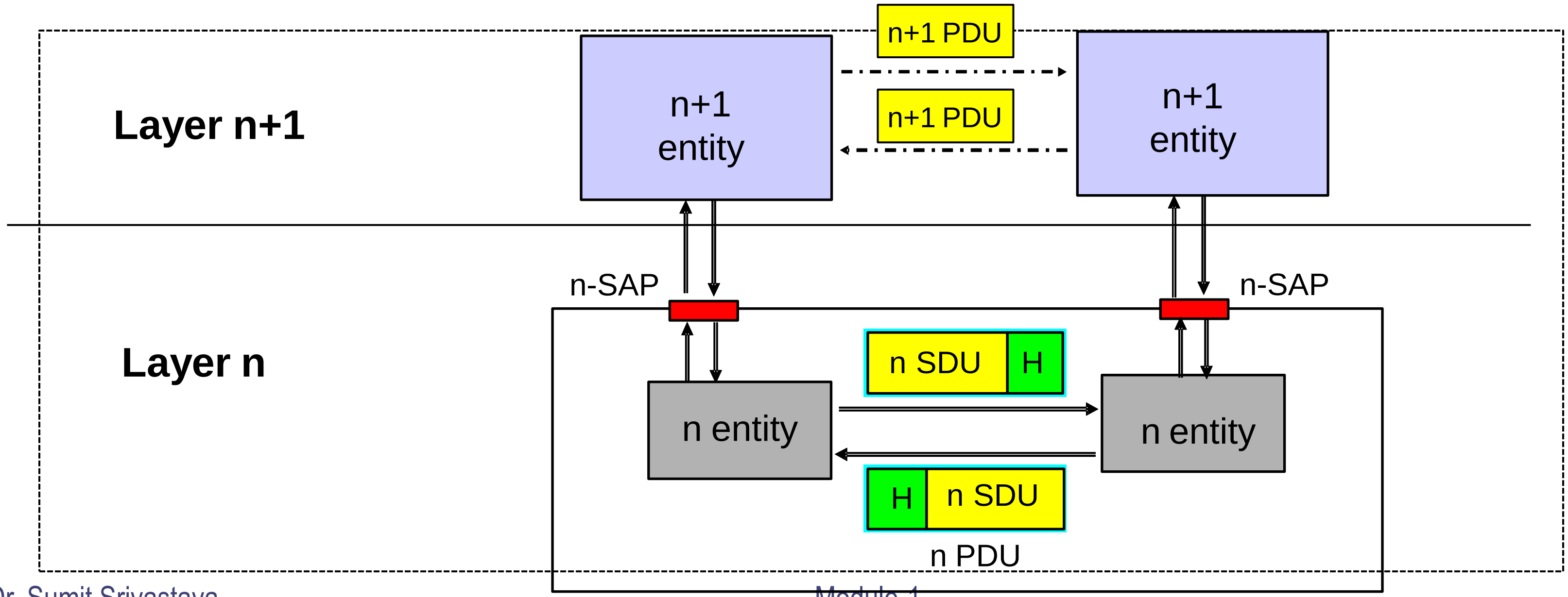
**Communication between peer processes is virtual, i.e. indirect.**

**Protocol** – set of rules that govern data comm. between peer entities

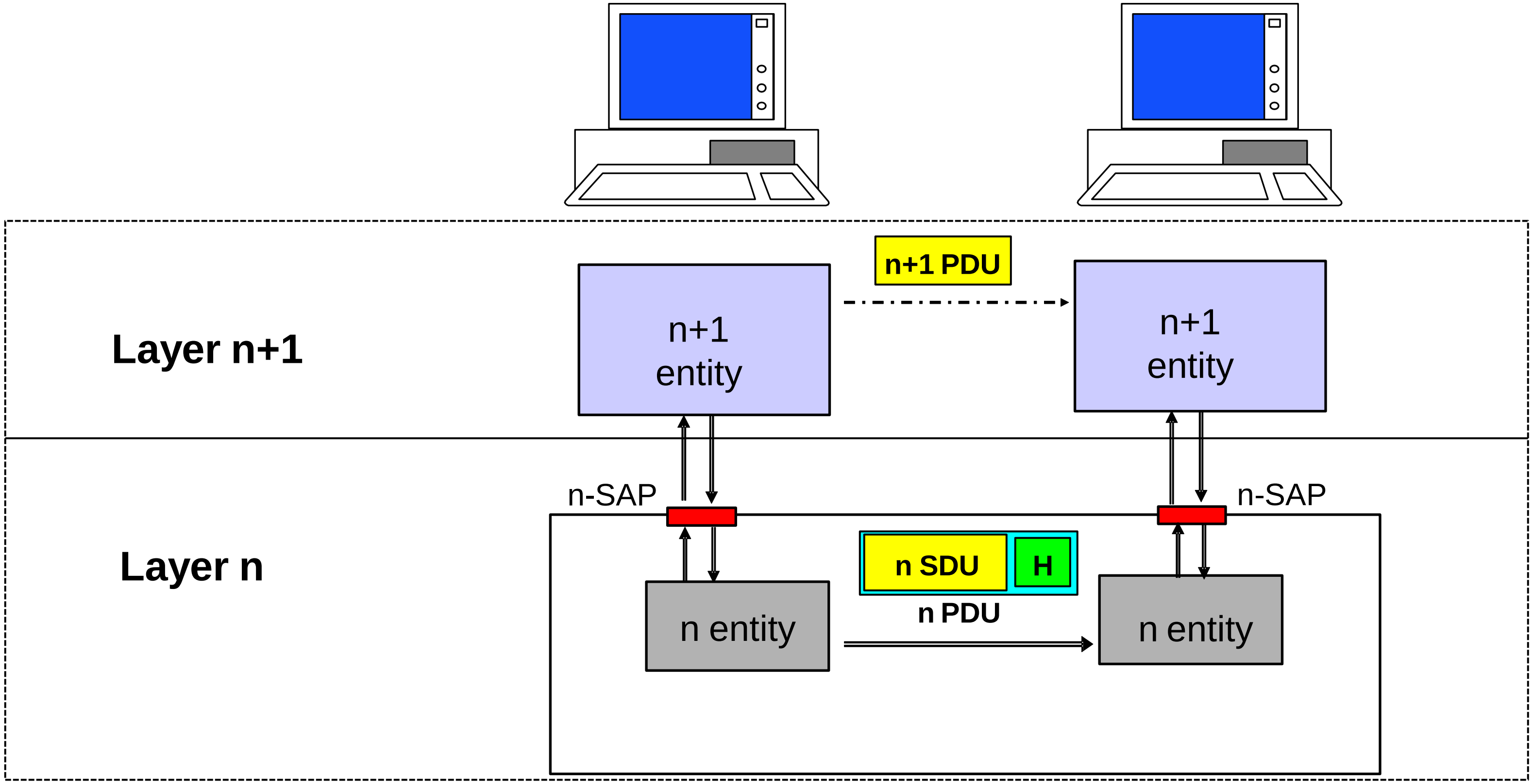
- layer-n peer processes communicate by exchanging **Protocol Data Units** (PDUs)

**Service** – can be accessed through **Service Access Points** (SAP's)

- <u>layer n+1 PDU = layer n SDU</u> (SDU = **Service Data Unit**)
- layer n process adds control information (**header**) to its SDU to produce layer n PDU – **encapsulation**!
- layer n does not interpret or make use of information contained in its SDU



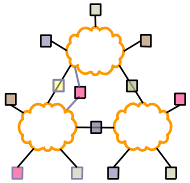
## Example [ layering – vertical vs. horizontal flow of information ]



# E.g.: OSI Model: 7 Protocol Layers

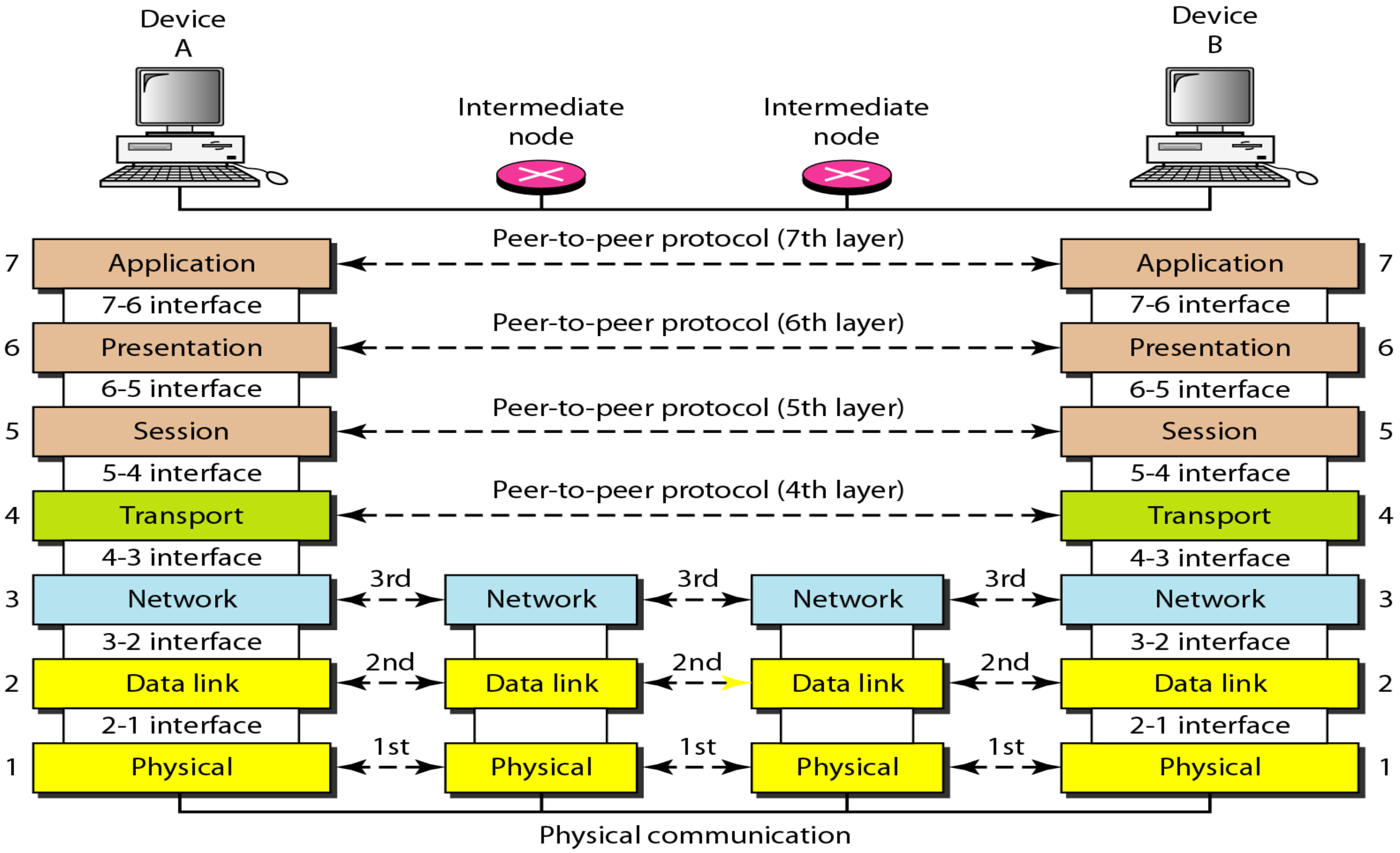
- Physical:  how to transmit bits
- Data link: how to transmit frames
- Network:  how to route packets
- Transport: how to send packets end2end
- Session: how to tie flows together
- Presentation: byte ordering, security
- Application: everything else

# THE OSI MODEL

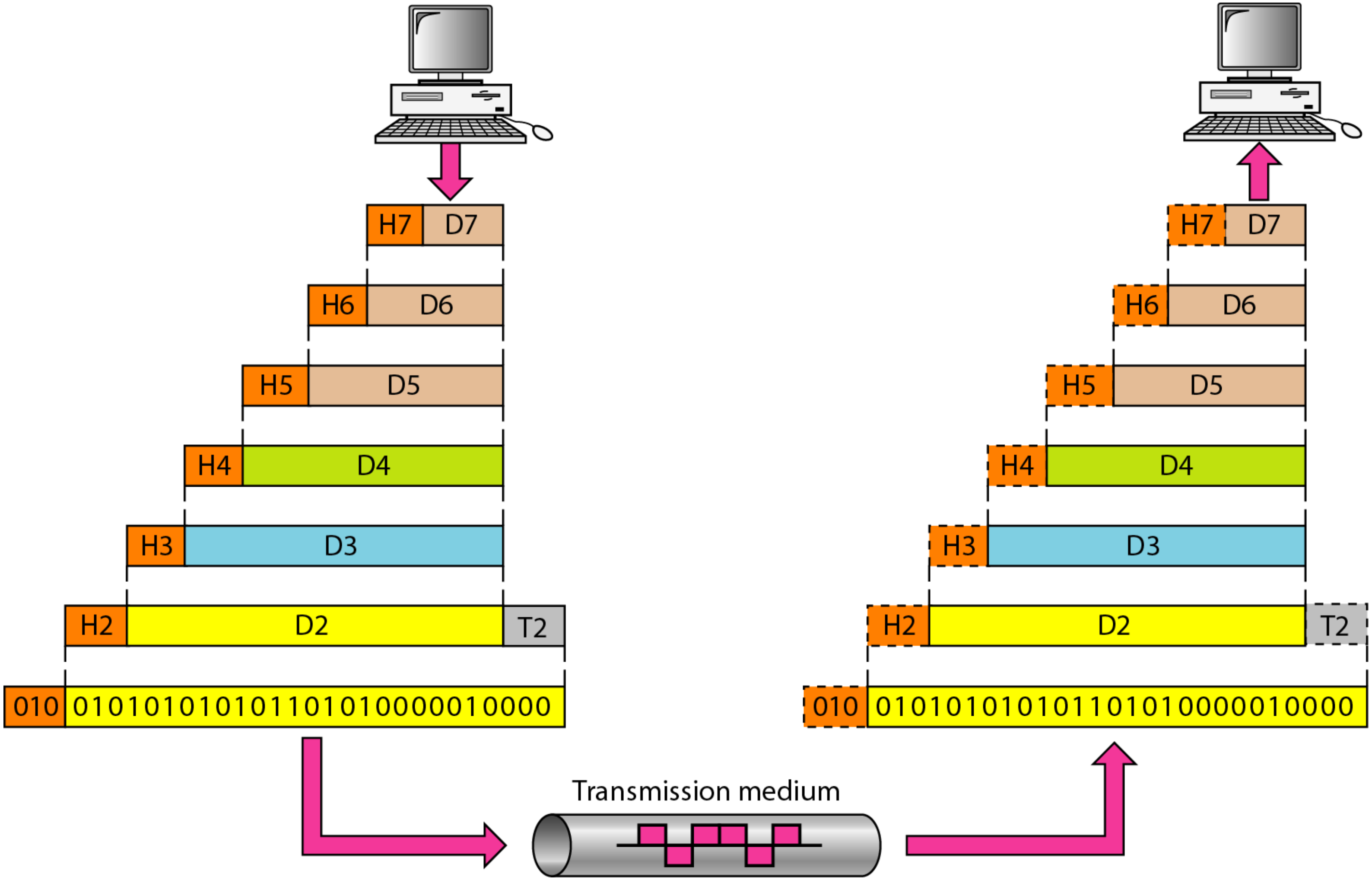


- Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards. An ISO standard that covers all aspects of network communications is the Open Systems Interconnection (OSI) model. It was first introduced in the late 1970s.

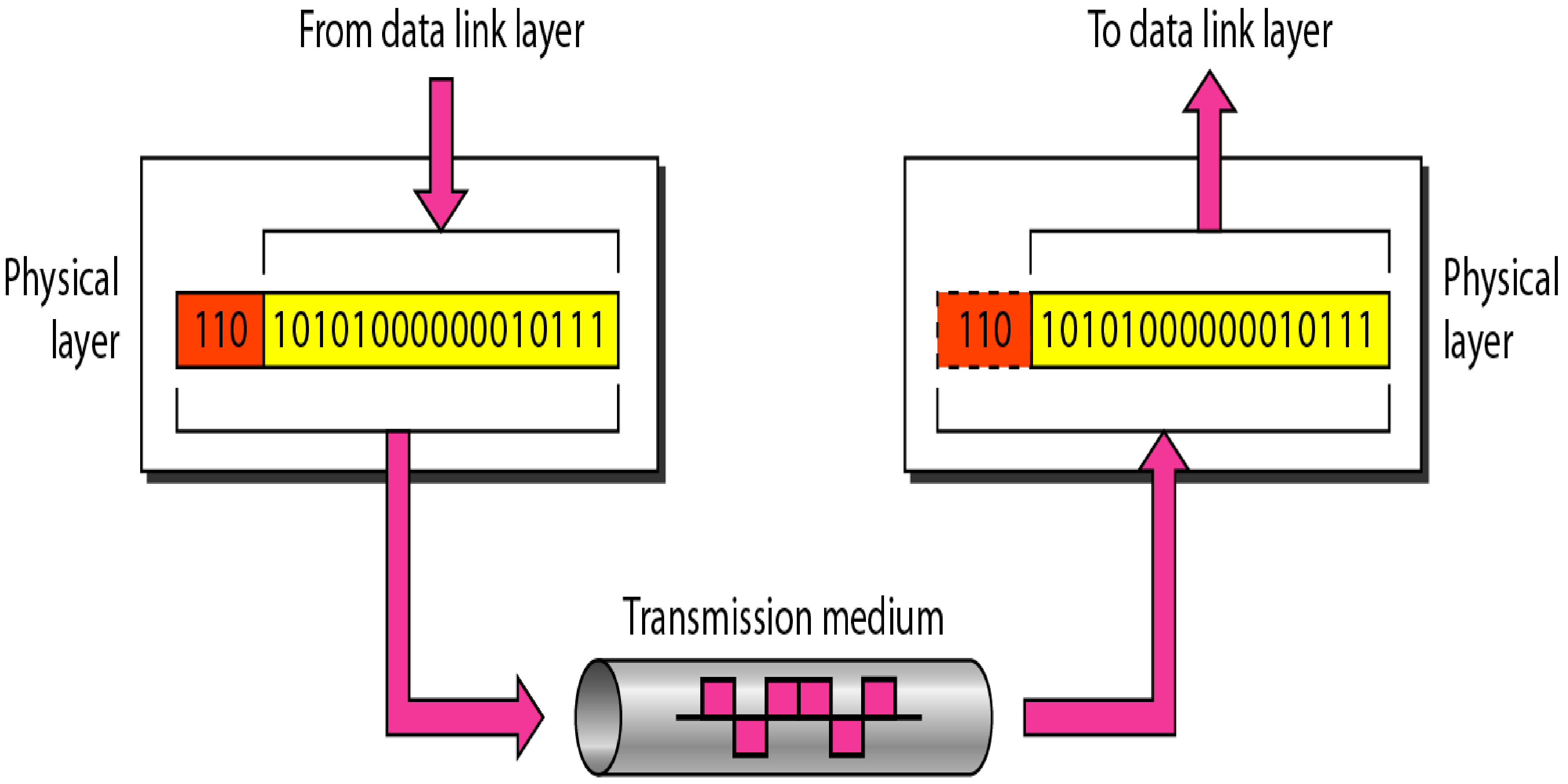
# The interaction between layers in the OSI model



# An exchange using the OSI model

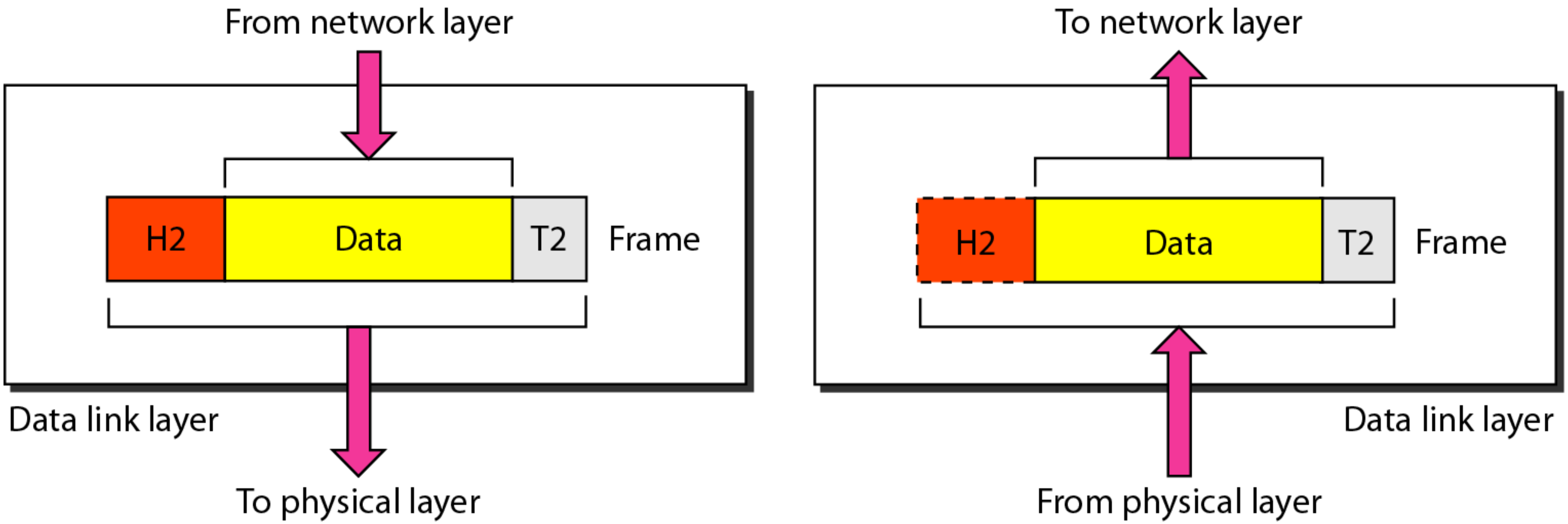


# Physical Layer



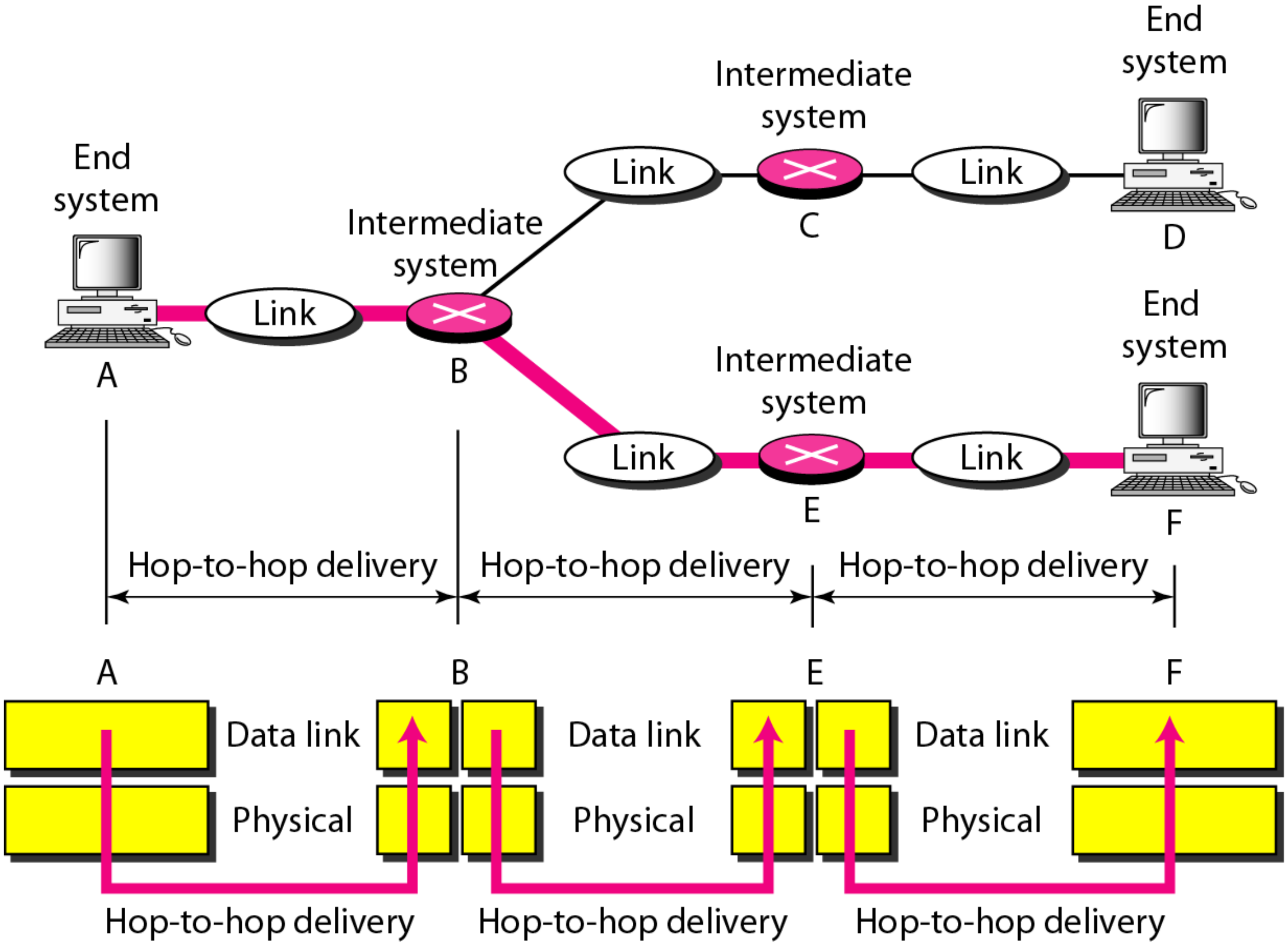
The physical layer is responsible for movements of individual bits from one hop (node) to the next.

# Data link layer

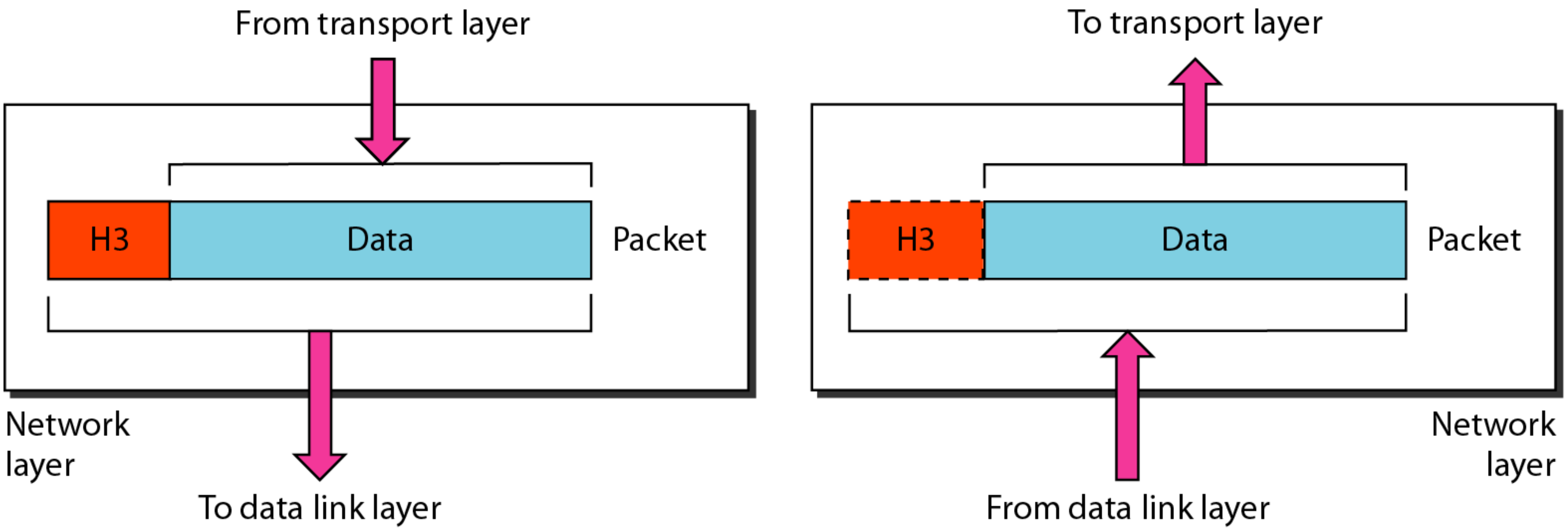


The data link layer is responsible for moving frames from one hop (node) to the next.

# Hop-to-hop delivery

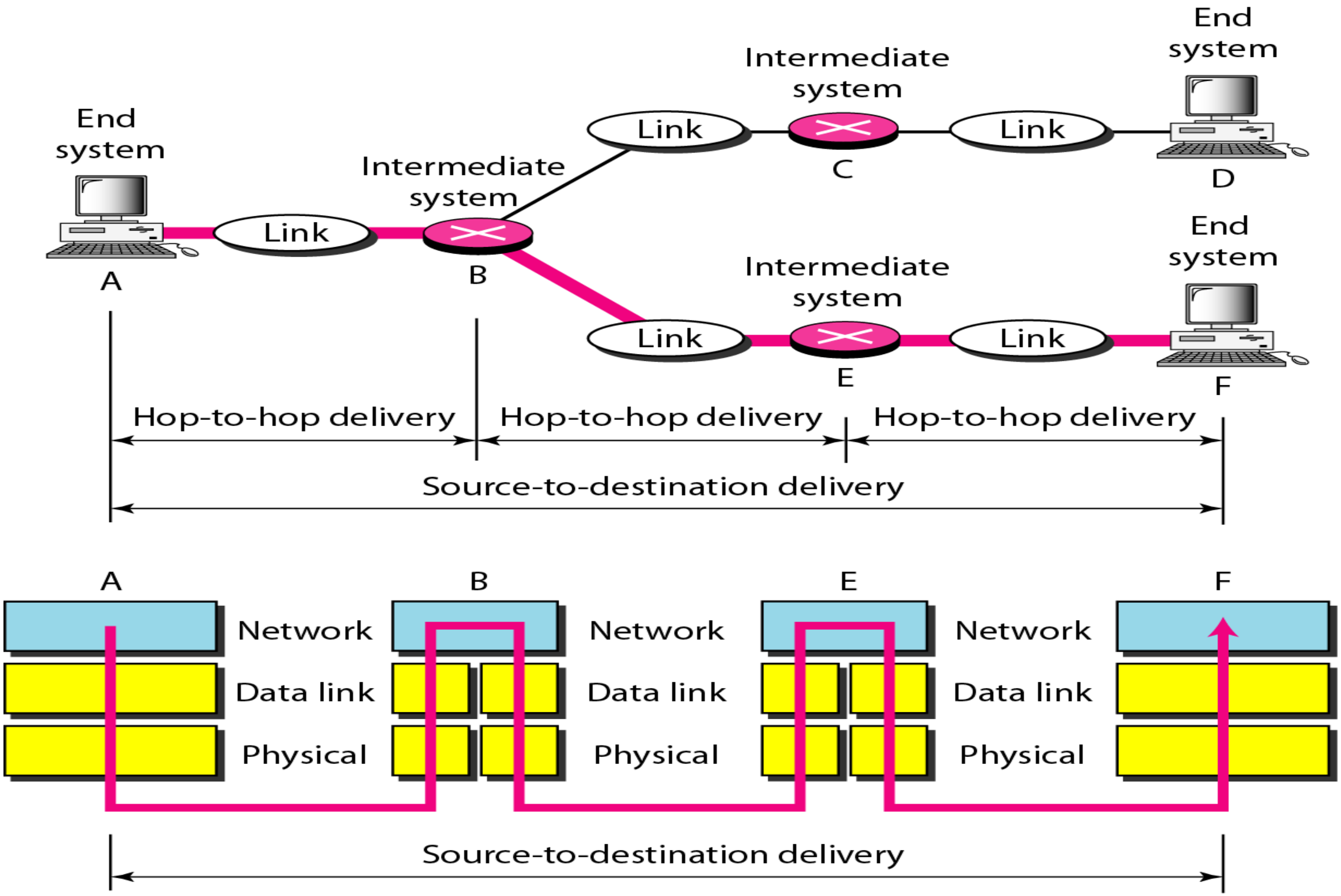


# Network layer

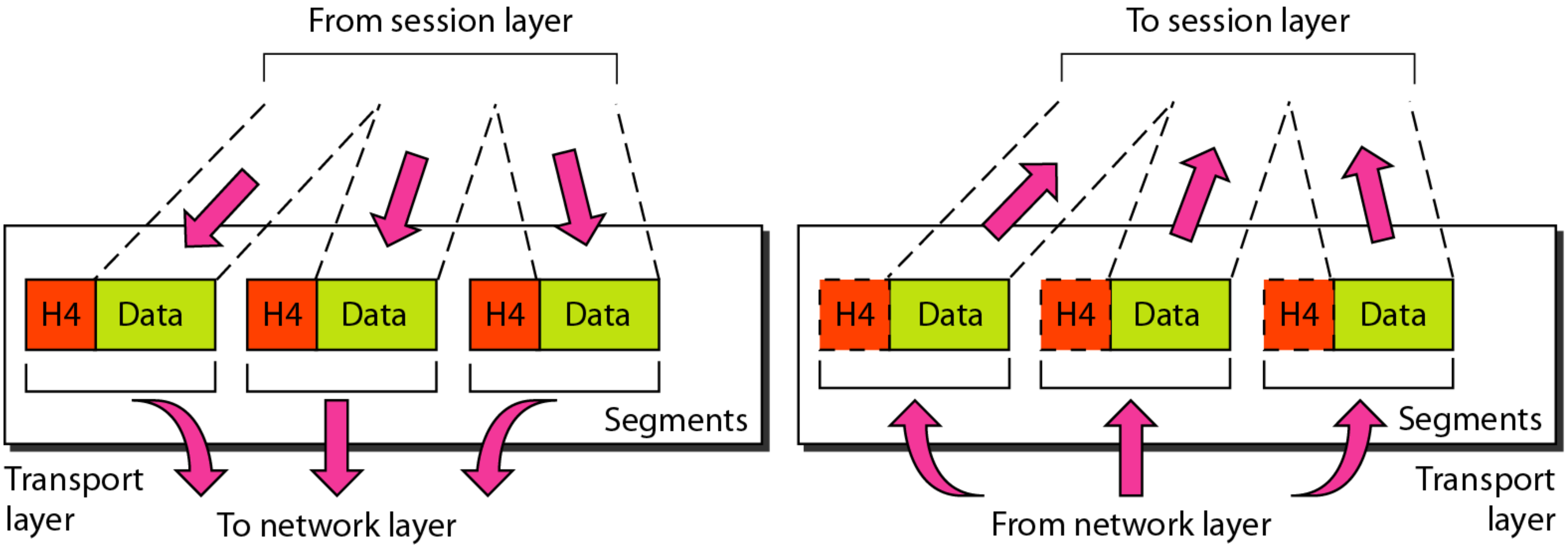


The network layer is responsible for the delivery of individual packets from the source host to the destination host.

# Source-to-destination delivery

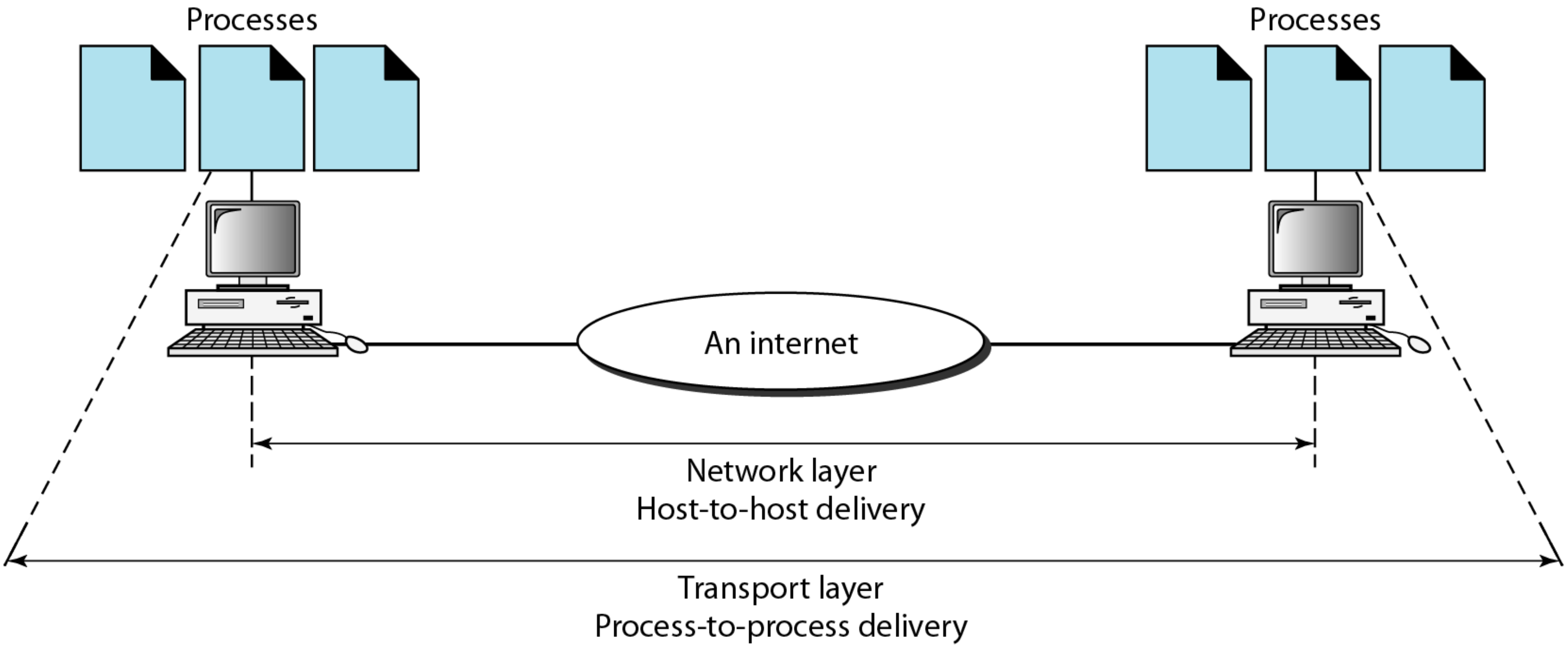


# Transport layer

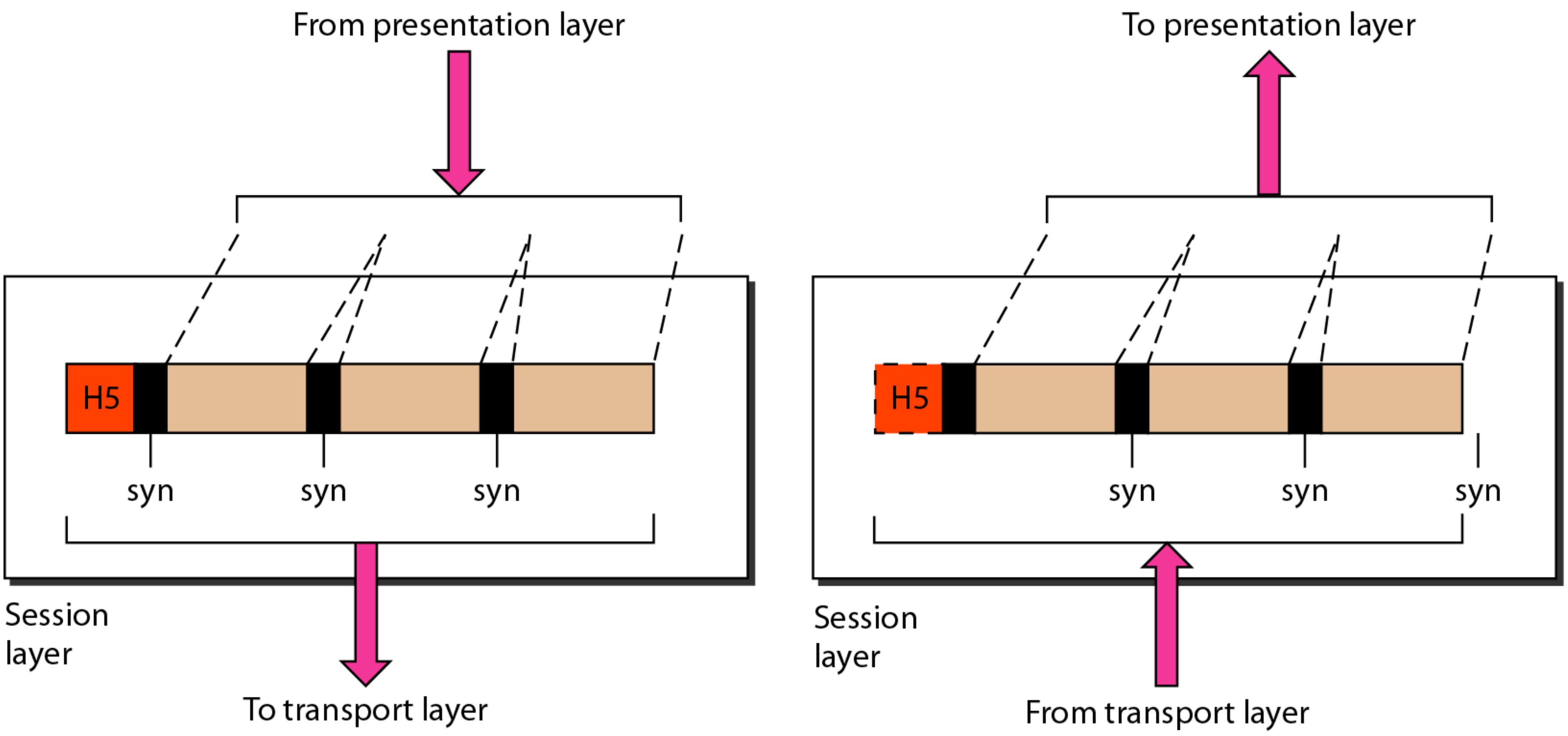


The transport layer is responsible for the delivery of a message from one process to another.

# Reliable process-to-process delivery of a message

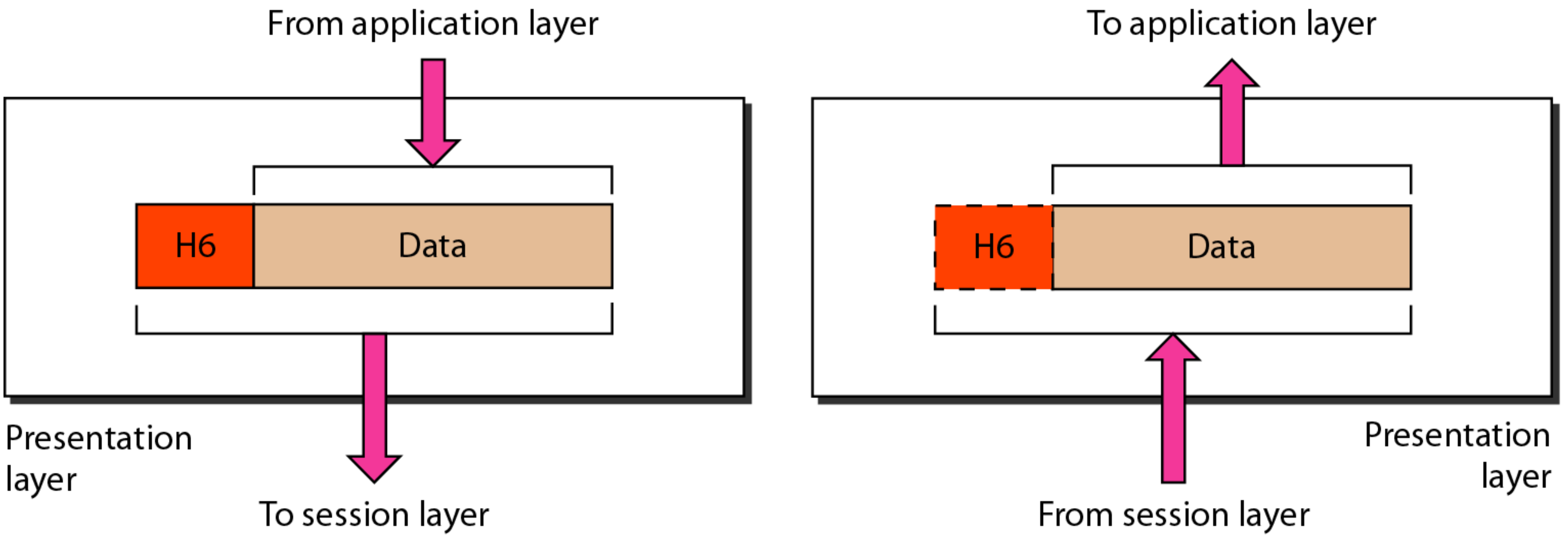


# Session layer



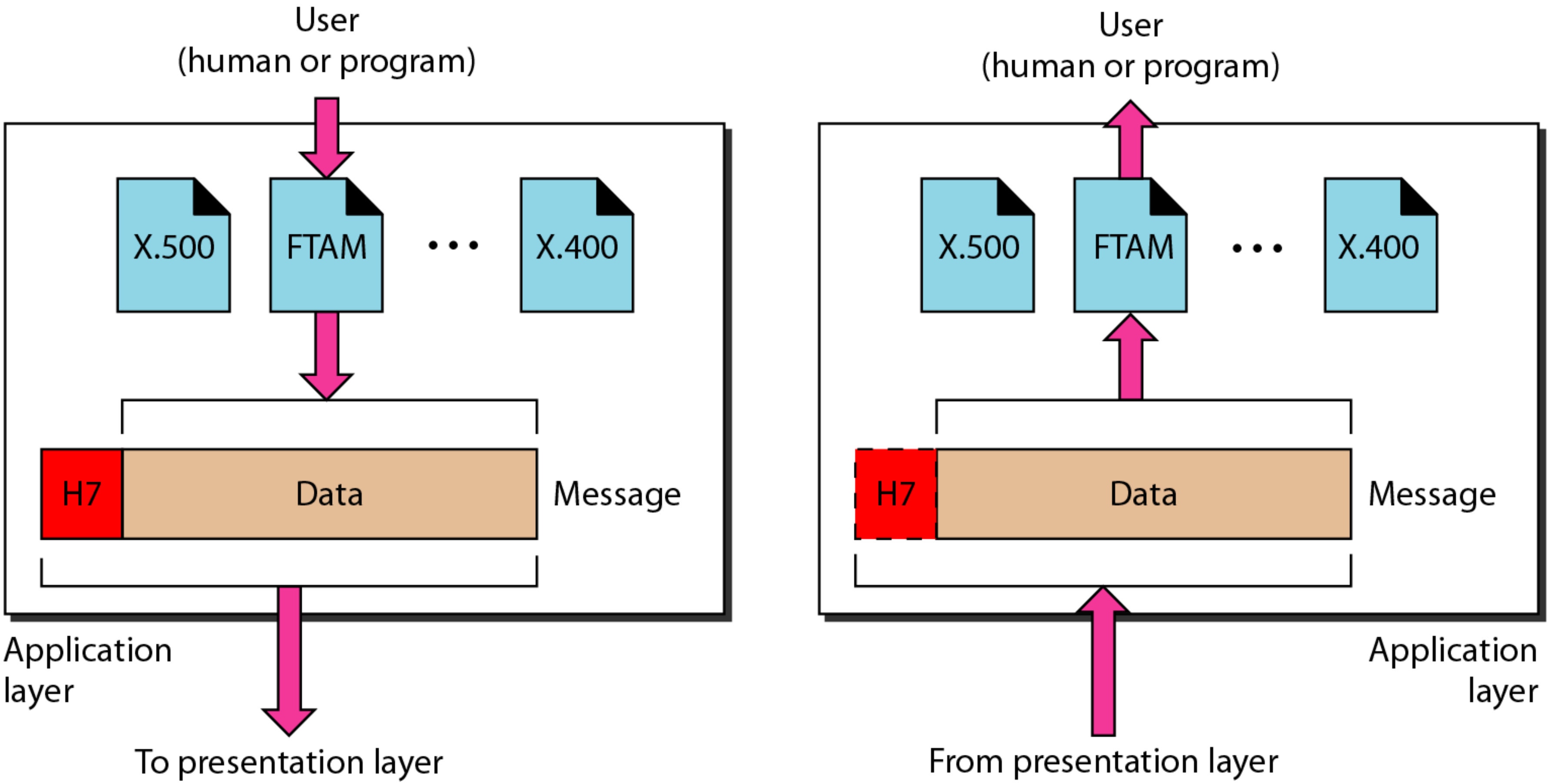
The session layer is responsible for dialog control and synchronization.

# Presentation layer



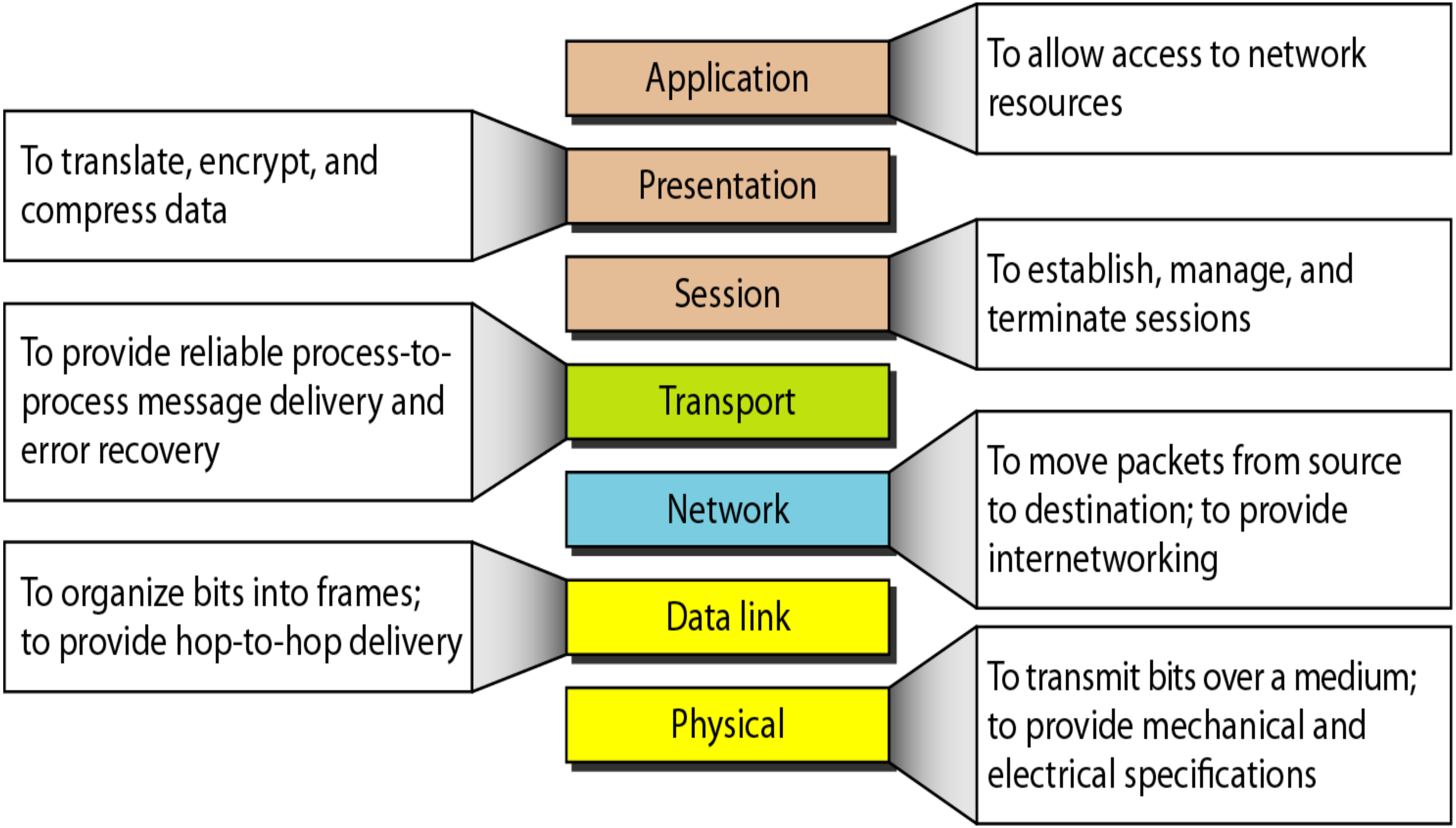
The presentation layer is responsible for translation, compression, and encryption.

# Application layer



The application layer is responsible for providing services to the user.

# Summary of layers



Application: To allow access to network resources

Presentation: To translate, encrypt, and compress data

Session: To establish, manage, and terminate sessions

Transport: To provide reliable process-to-process message delivery and error recovery

Network: To move packets from source to destination; to provide internetworking

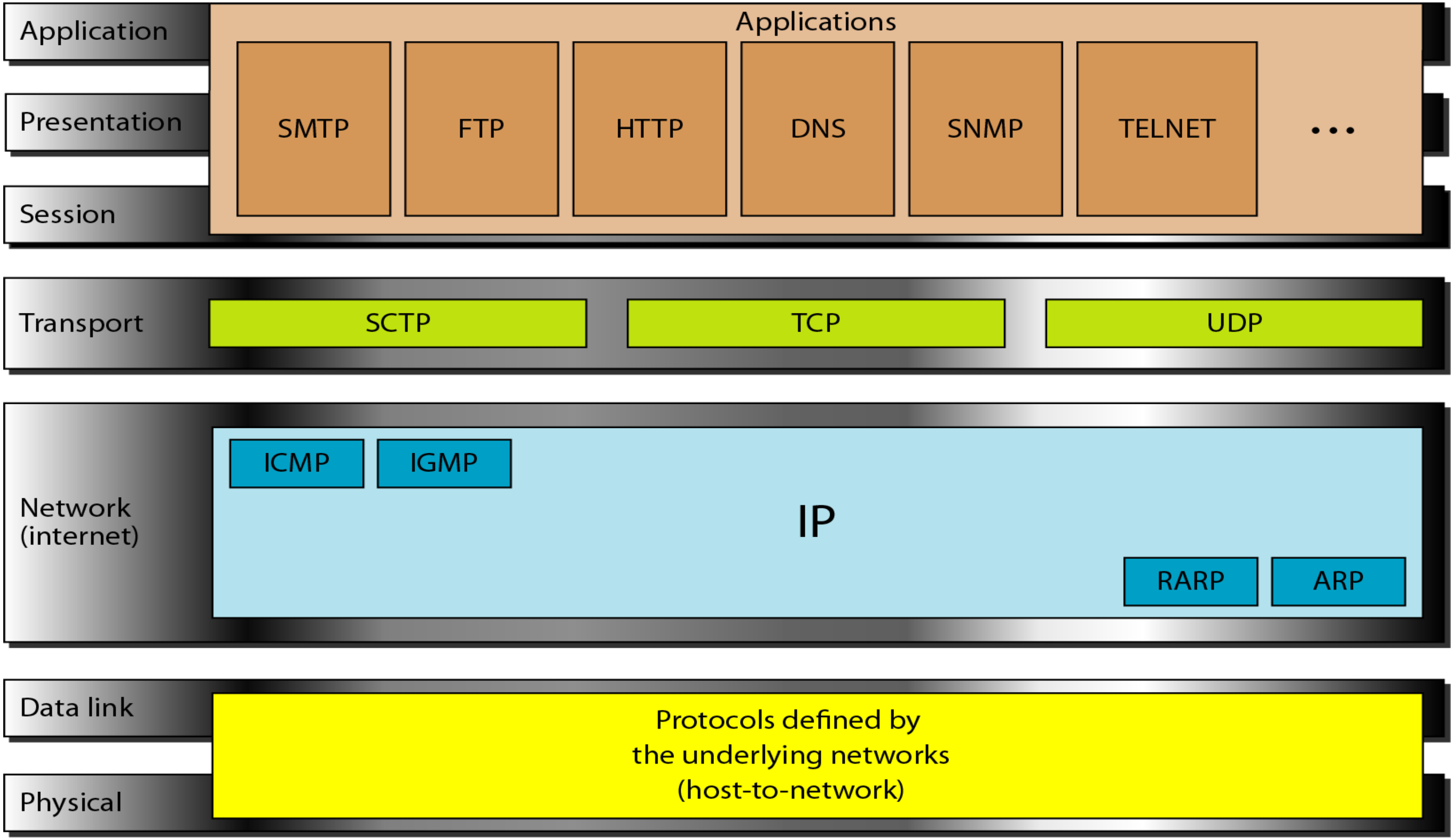
Data link: To organize bits into frames; to provide hop-to-hop delivery

Physical: To transmit bits over a medium; to provide mechanical and electrical specifications

# TCP/IP PROTOCOL SUITE

*The layers in the TCP/IP protocol suite do not exactly match those in the OSI model. The original TCP/IP protocol suite was defined as having four layers: host-to-network, internet, transport, and application. However, when TCP/IP is compared to OSI, we can say that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport, and application.*

# TCP/IP and OSI model



# Thank You