

# *Network Models*

# Organizations have developed standard sets of protocols

- Some of these organizations are:
- The International Standards Organization (ISO)
- The Institute of Electrical and Electronic Engineers (IEEE)
- The American National Standards Institute (ANSI)
- The Electronic Industries Association (EIA)
- The International Telecommunications Union-Telecommunication Standards Sector (ITU-T). This group was formerly known as the Consultative Committee on International Telephone and Telegraph (CCITT)

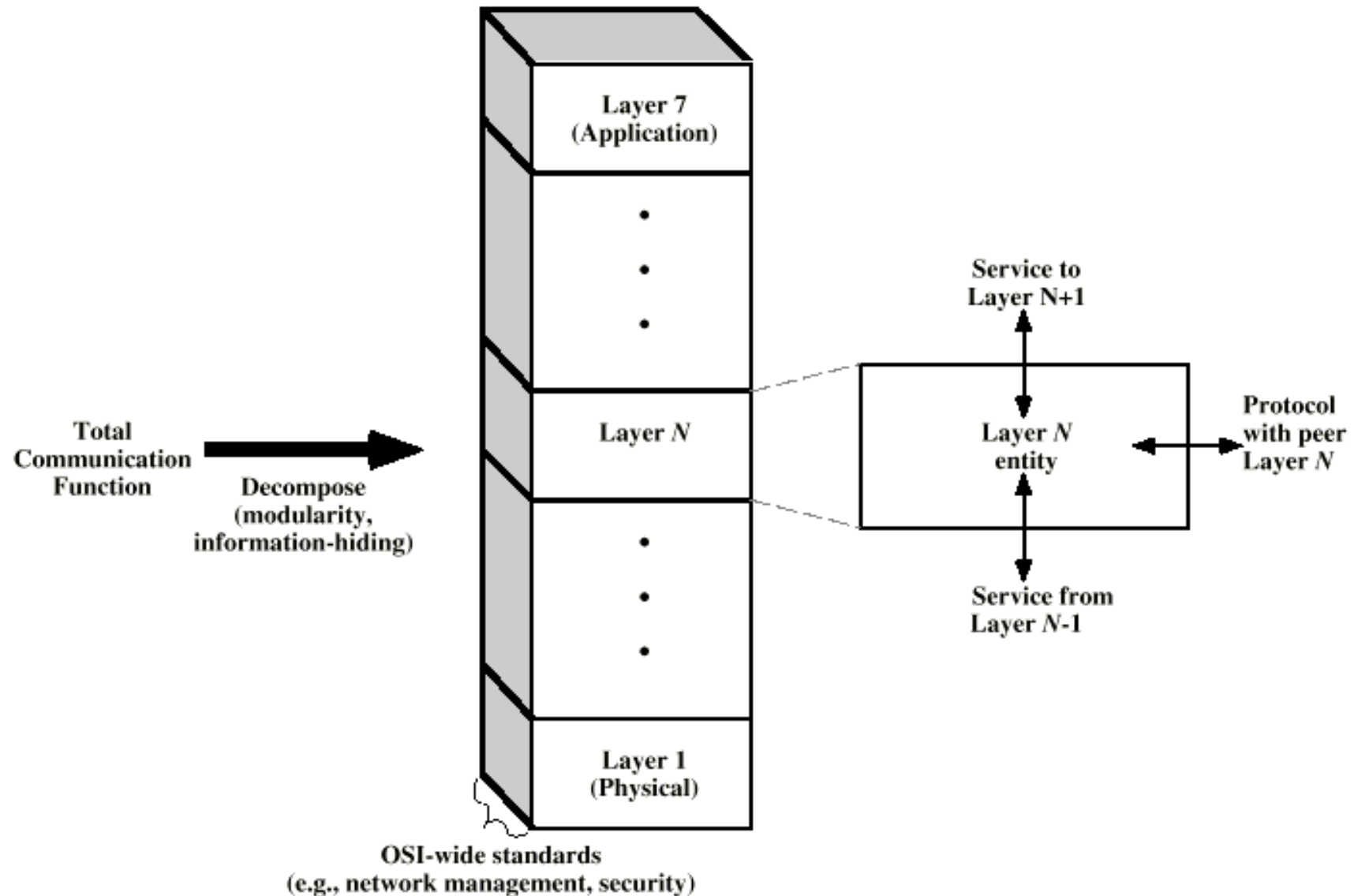
# Elements of Standardization

- Protocol specification
  - Operates between the same layer on two systems
  - May involve different operating system
  - Protocol specification must be precise
    - Format of data units
    - Semantics of all fields
    - allowable sequence of PCUs
- Service definition
  - Functional description of what is provided
- Addressing
  - Referenced by SAPs

# Key Elements of a Protocol

- Syntax
  - Data formats
  - Signal levels
- Semantics
  - Control information
  - Error handling
- Timing
  - Speed matching
  - Sequencing

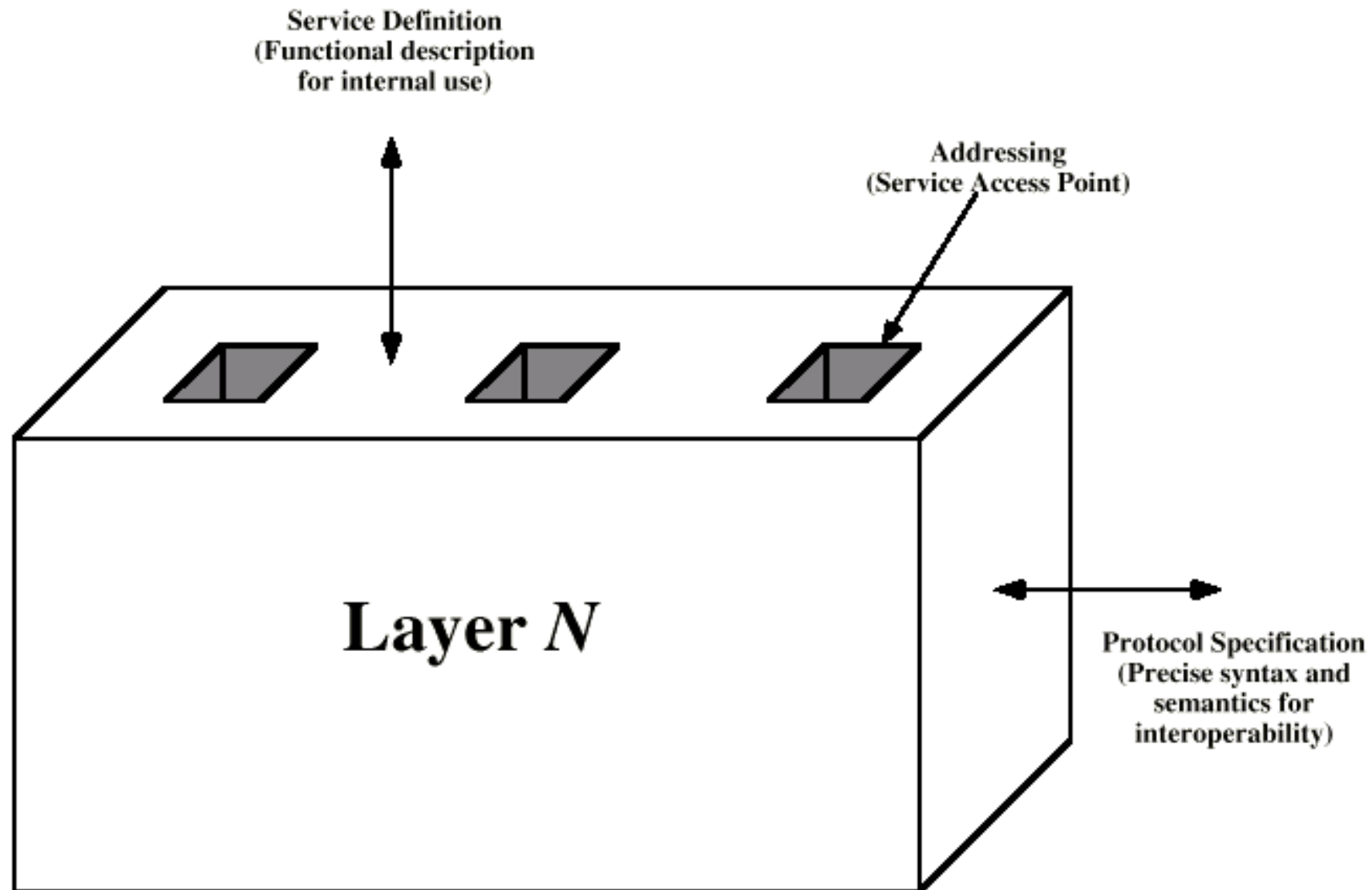
# OSI as Framework for Standardization



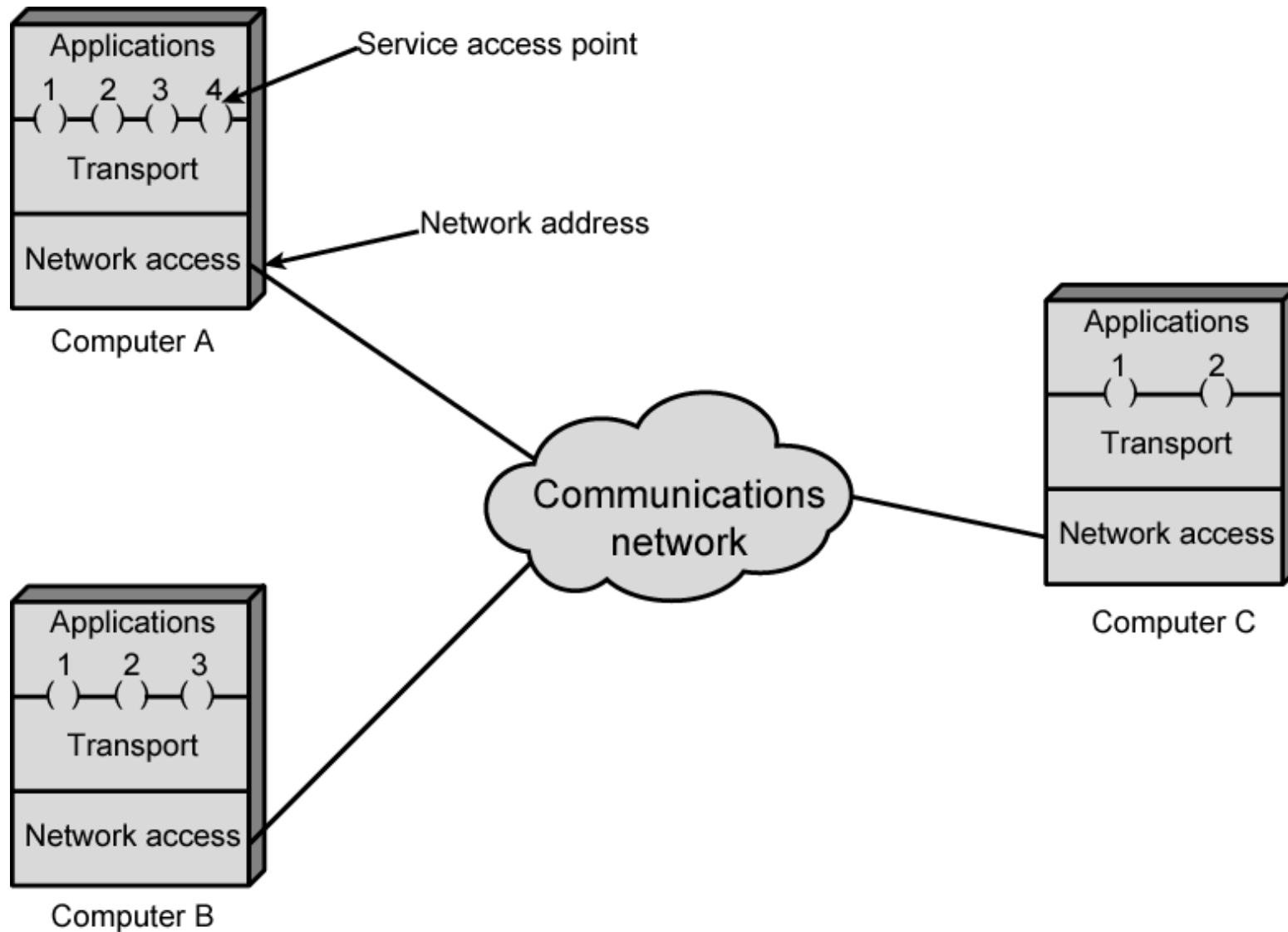
# Protocol Architecture

- Task of communication broken up into modules
- For example file transfer could use three modules
  - File transfer application
  - Communication service module
  - Network access module

# Layer Specific Standards



# Protocol Architectures and Networks





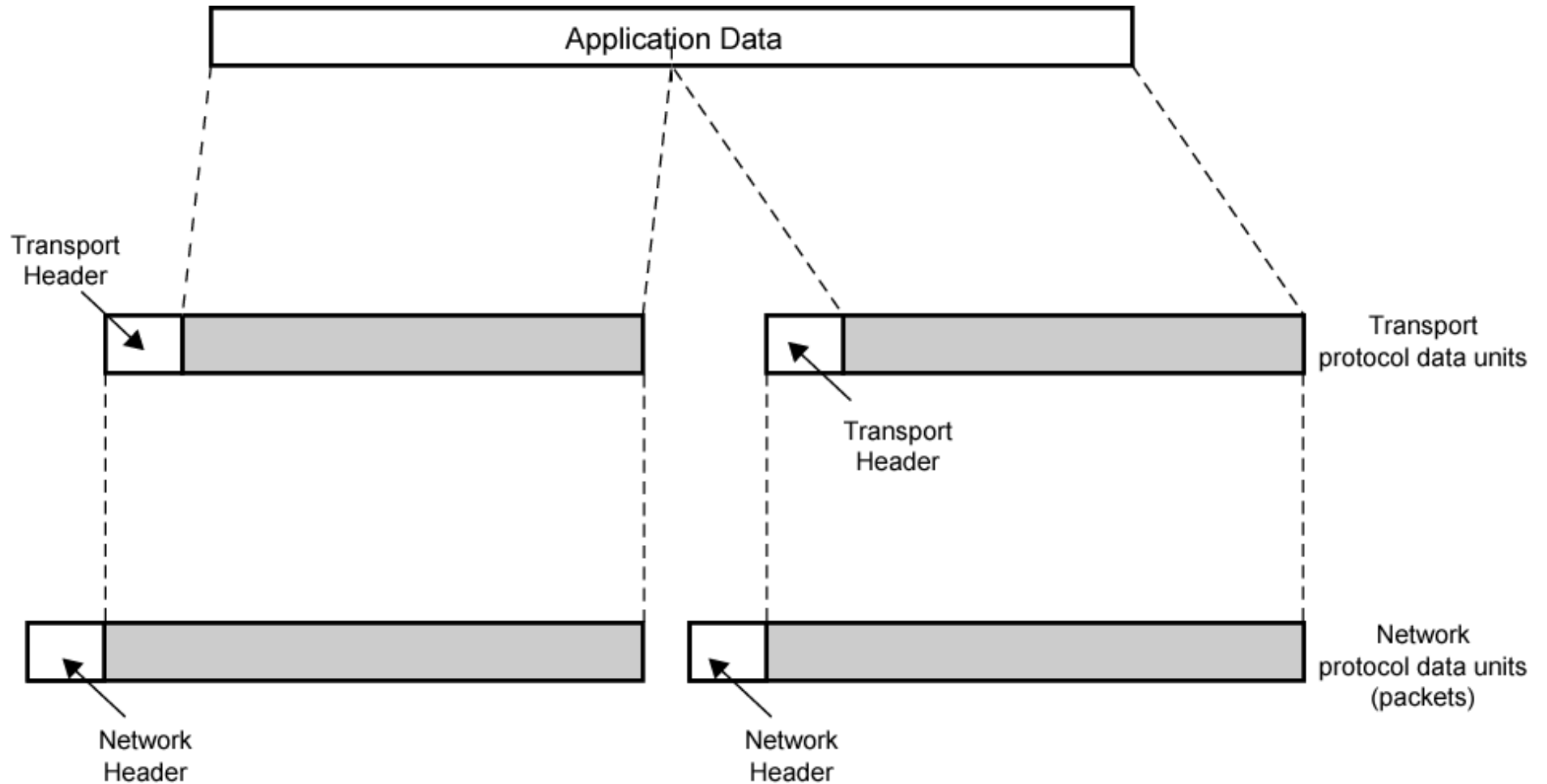
# Addressing Requirements

- Two levels of addressing required
- Each computer needs unique network address
- Each application on a (multi-tasking) computer needs a unique address within the computer
  - The service access point or SAP
  - The port on TCP/IP stacks

# Protocol Data Units (PDU)

- At each layer, protocols are used to communicate
- Control information is added to user data at each layer
- Transport layer may fragment user data
- Each fragment has a transport header added
  - Destination SAP
  - Sequence number
  - Error detection code
- This gives a transport protocol data unit

# Protocol Data Units



# Standardized Protocol Architectures

- Required for devices to communicate
- Vendors have more marketable products
- Customers can insist on standards based equipment
- Two standards:
  - OSI Reference model
    - Never lived up to early promises
  - TCP/IP protocol suite
    - Most widely used
- Also: IBM Systems Network Architecture (SNA)

# Communications Tasks

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

# OSI

- Open Systems Interconnection
- Developed by the International Organization for Standardization (ISO)
- Seven layers
- A theoretical system delivered too late!
- TCP/IP is the de facto standard

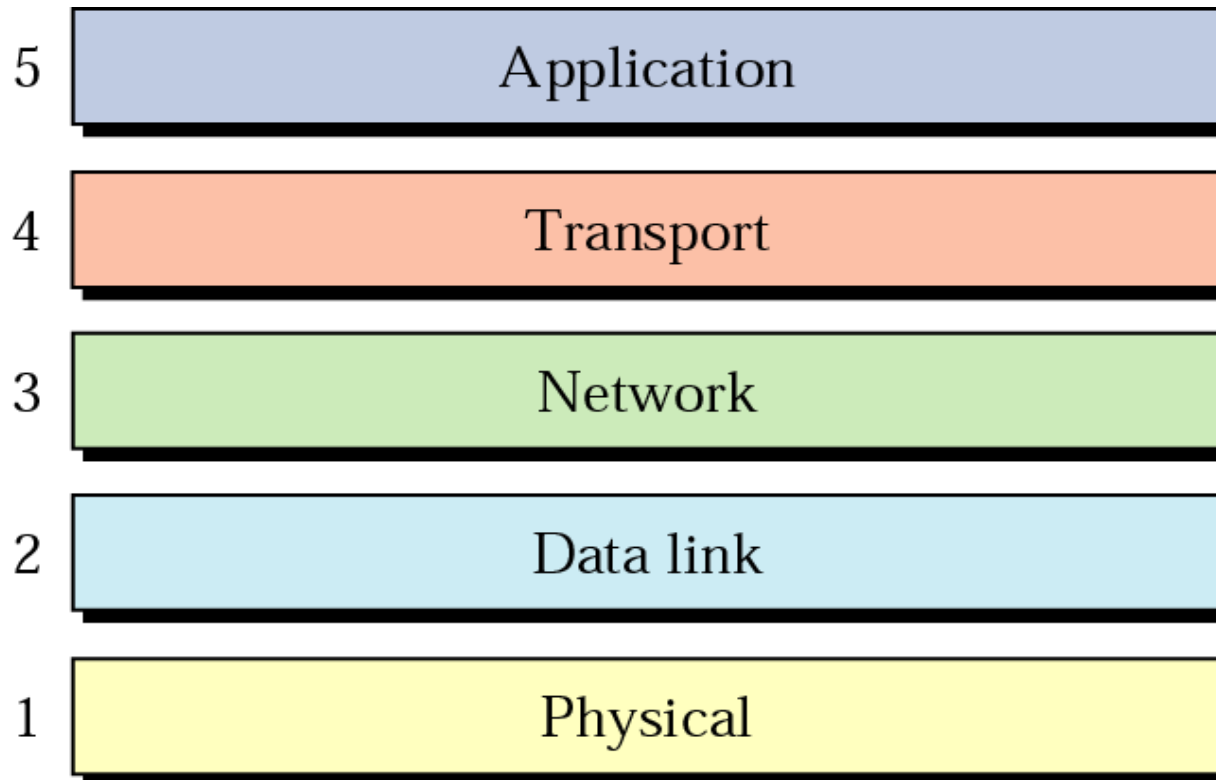
# OSI - The Model

- A layer 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



## *Internet layers*

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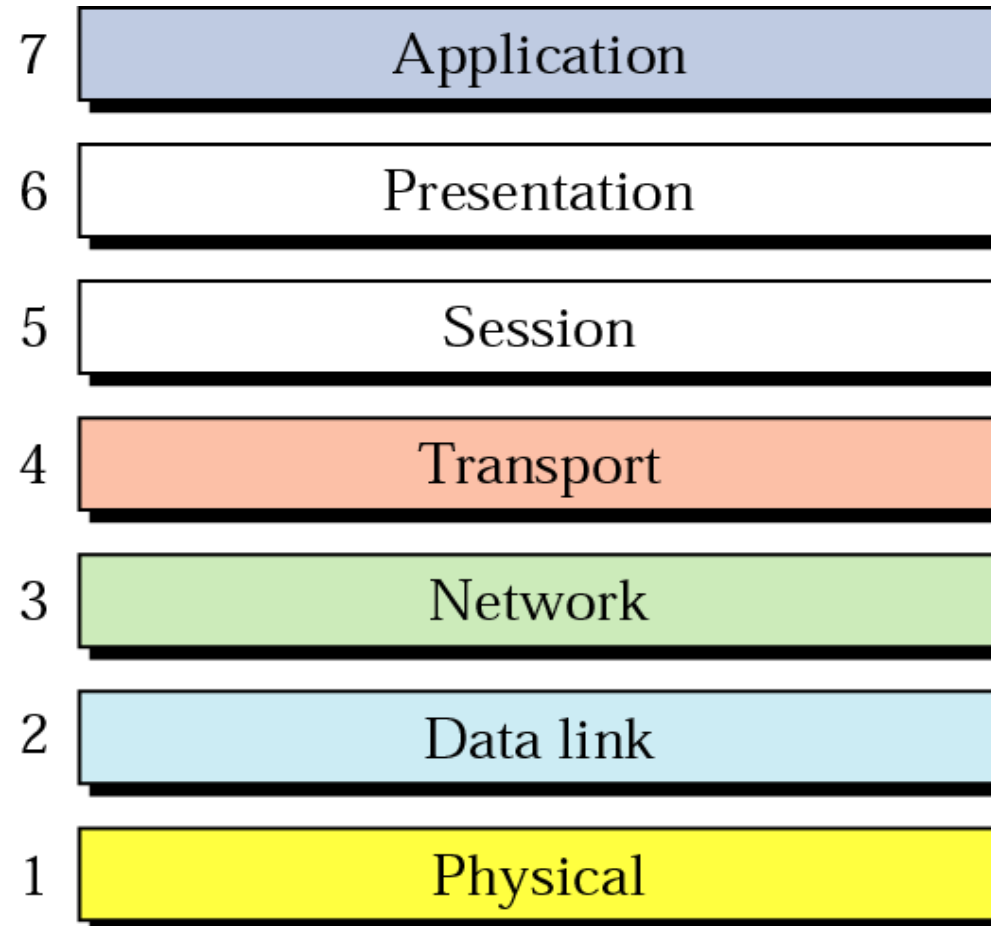




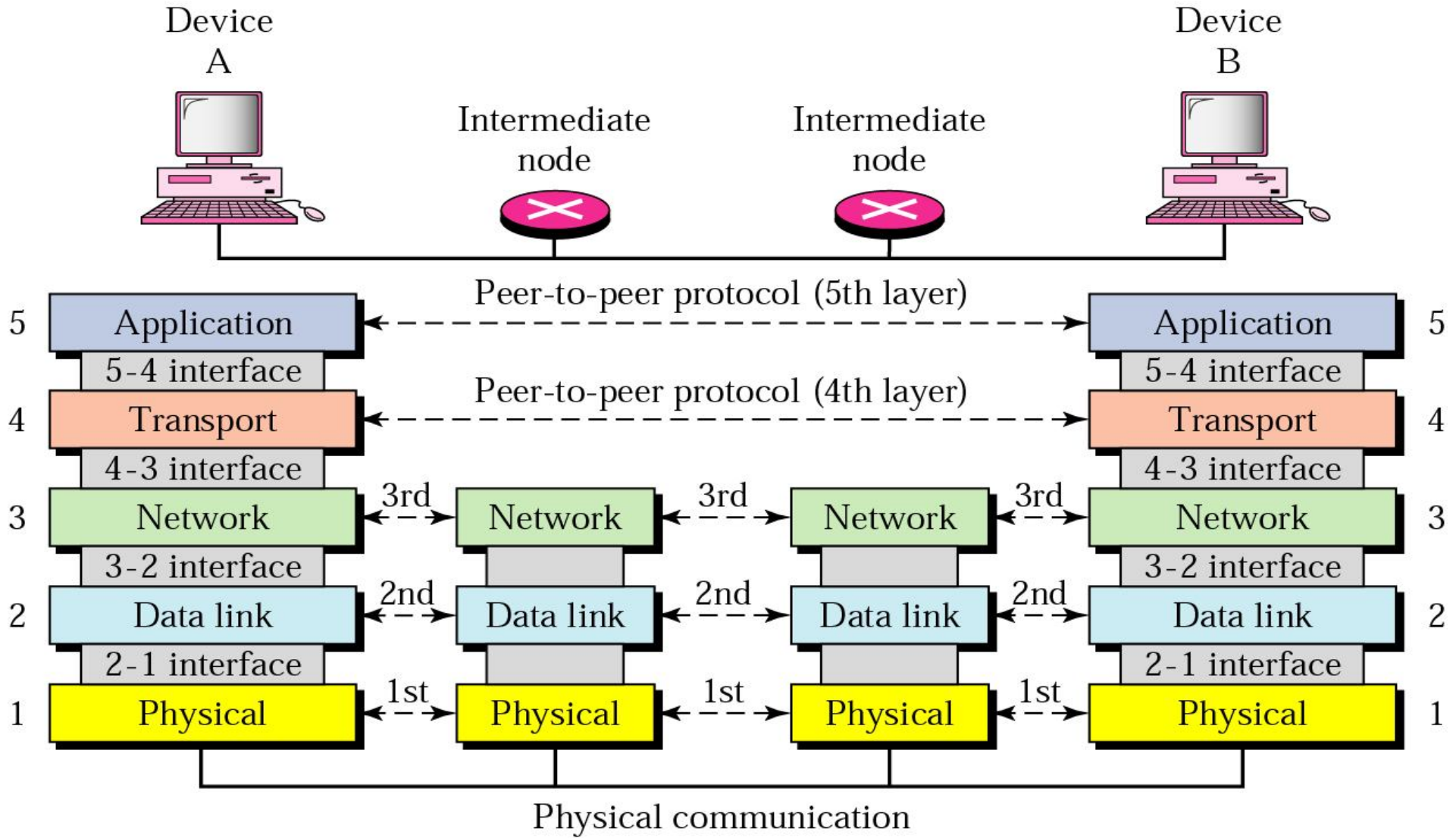


*OSI model*

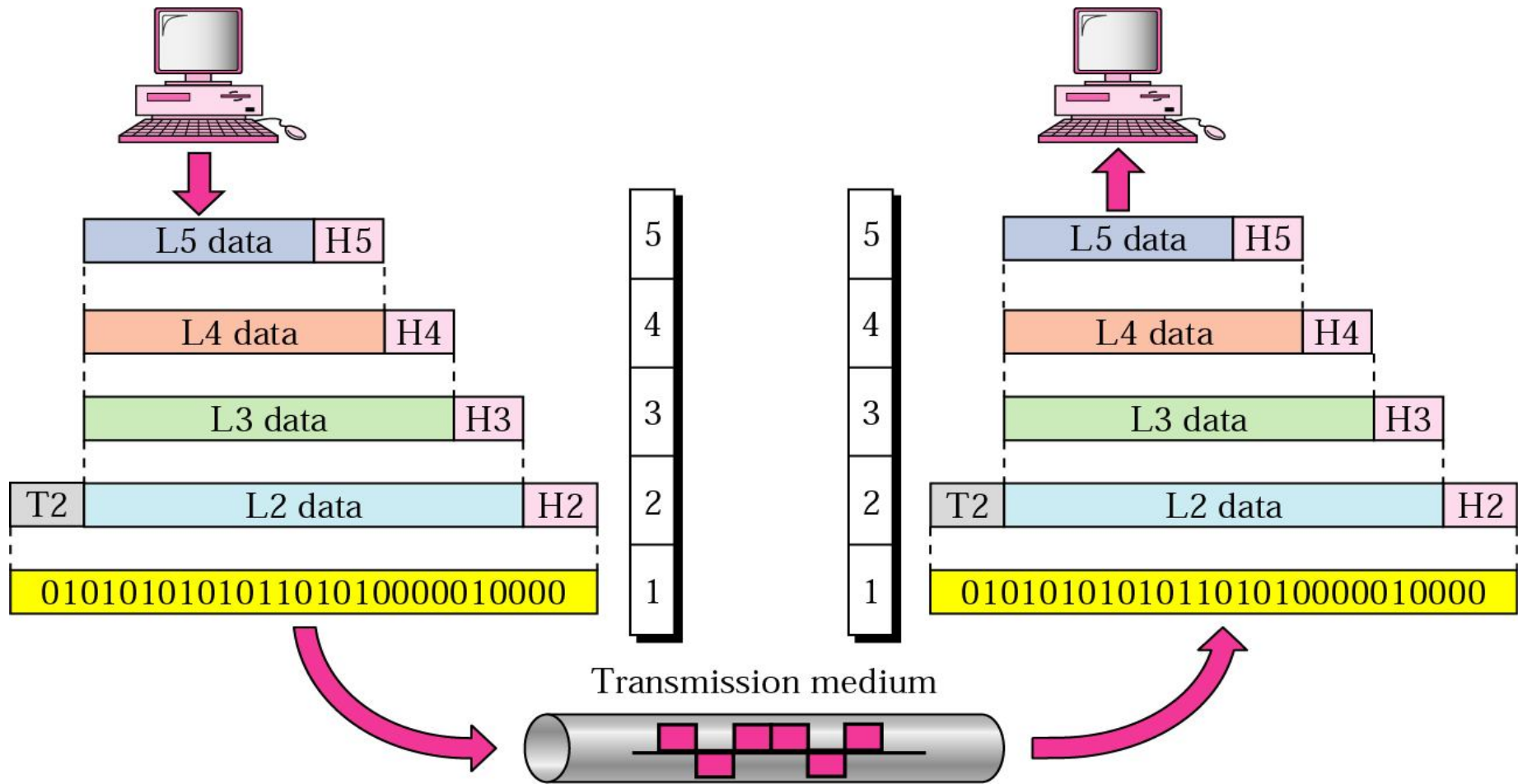
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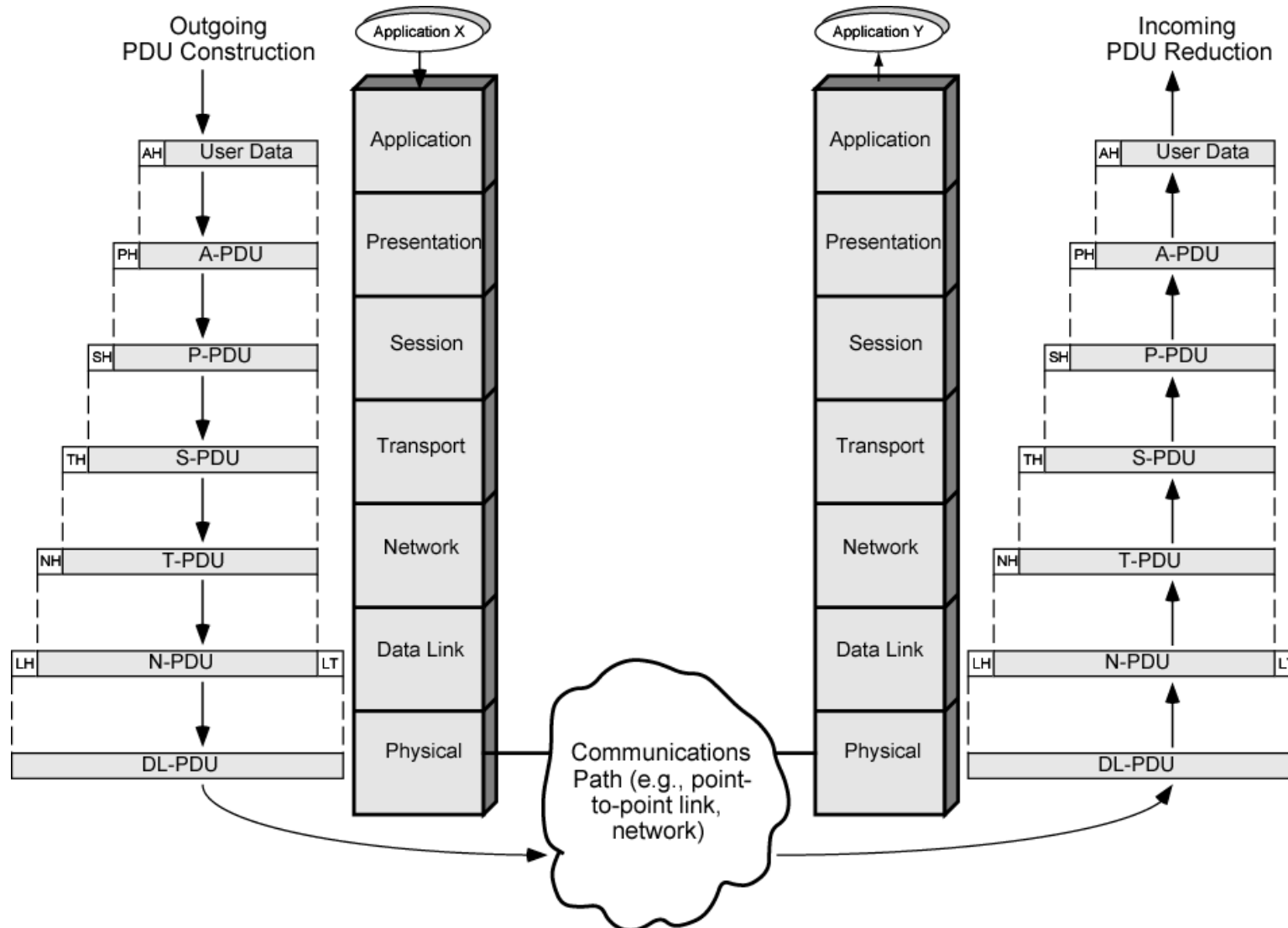
# Peer-to-peer processes



# An exchange using the Internet model

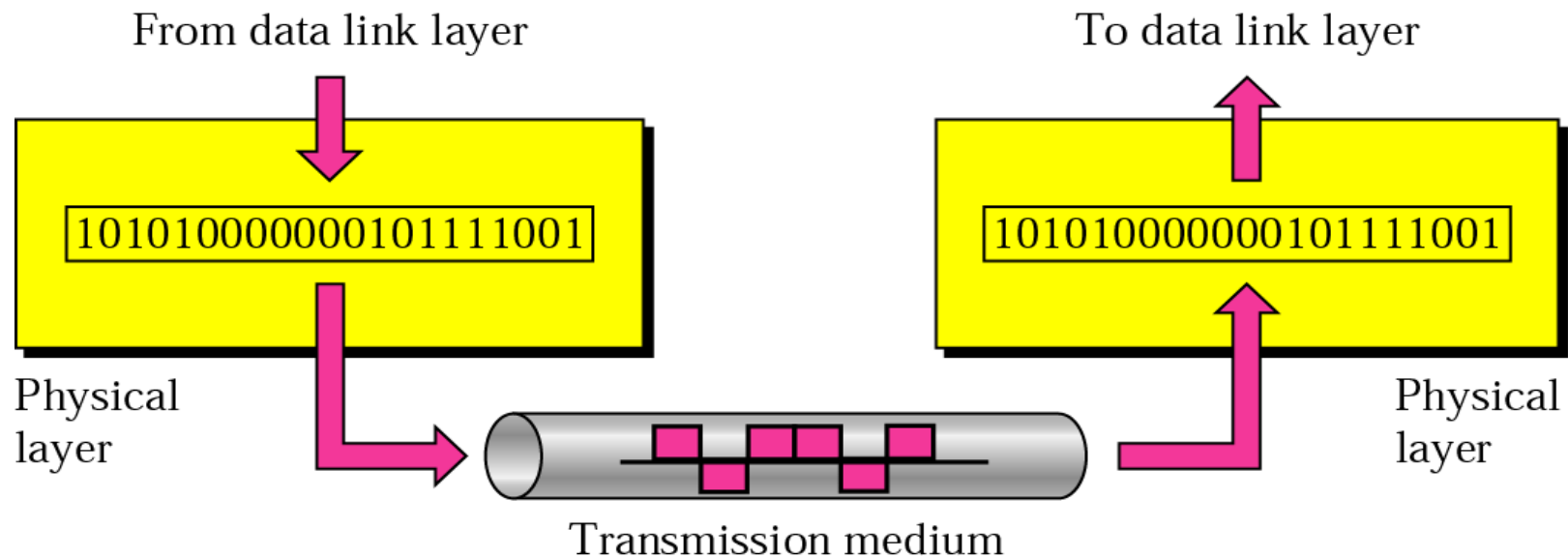


# The OSI Environment



## Physical interface between devices

- Mechanical
- Electrical
- Functional
- Procedural



# *Physical layer*

*The physical layer is responsible for transmitting individual bits from one node to the next.*

*It is concerned with transmitting an unstructured bit stream over a communication channel.*

***The physical layer responsibilities include:***

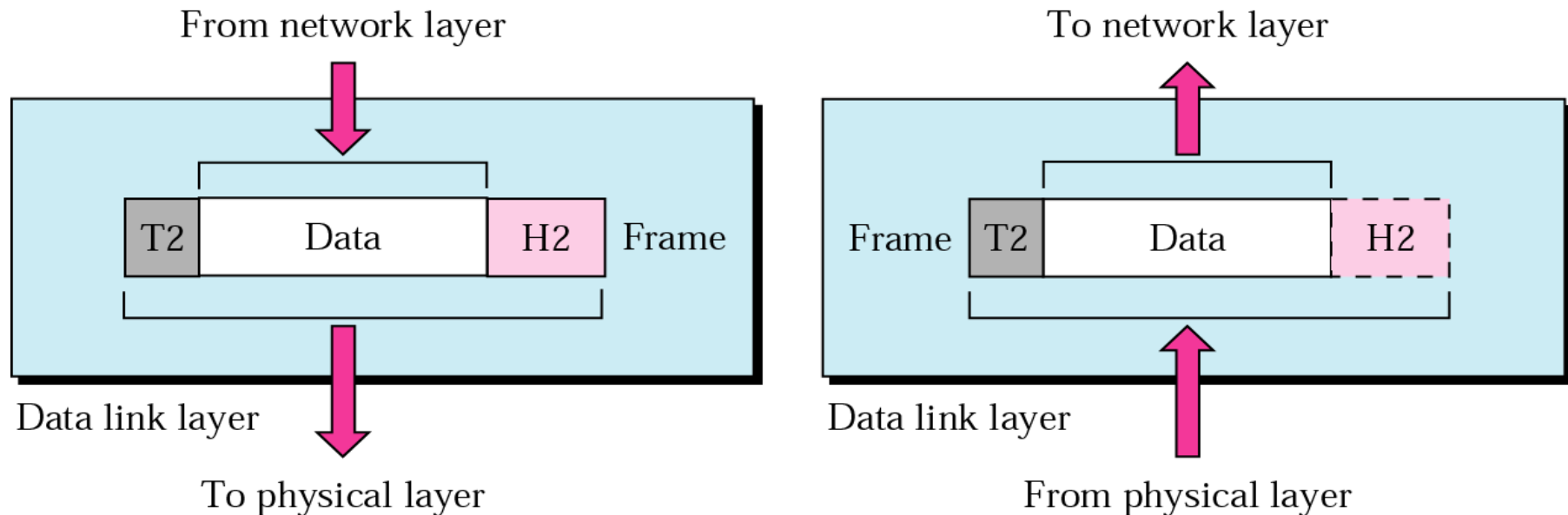
- *mechanical connection*
- *transmission medium*
- *representing and synchronizing bits*
- *establishing the transmission rate or number of bits transmitted per second*
- *establishing line configuration*
- *establishing physical topology*
- *establishing transmission mode*

## *Data link layer*

The data link layer transfers blocks of data between two nodes in a network.

It is concerned with creating and transmitting frames that contain these blocks of data.

- Means of activating, maintaining and deactivating a reliable link
- Error detection and control



## *Data Link*

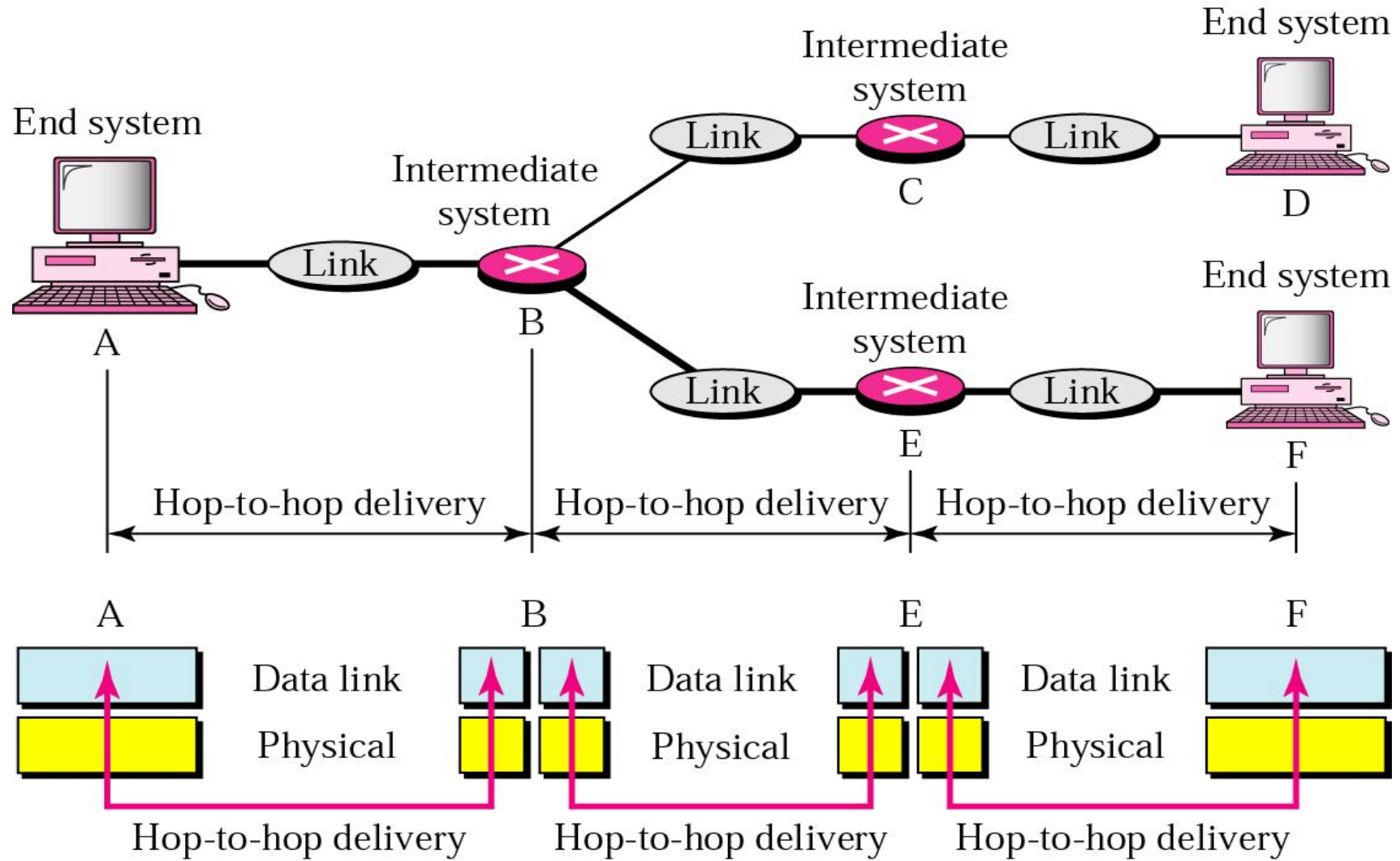
*The data link layer is responsible for transmitting frames from one node to the next.*

***The data link layer responsibilities include:***

- *creating frames of data*
- *determining where a frame starts and ends*
- *physical addressing at the link level of sender and receiver*
- *providing flow control to keep one node from overwhelming the other node*
- *detecting transmission errors*
- *providing access control to determine who has control of the link at any one time*

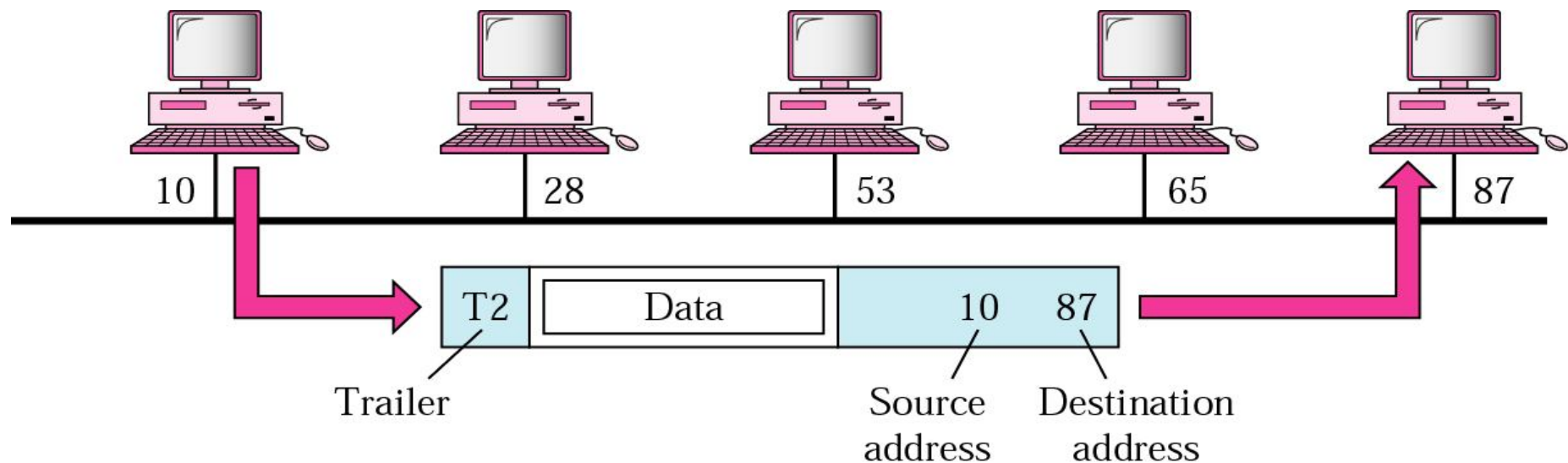


# Node-to-node delivery



## Example

A node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link. At the data link level this frame contains physical addresses in the header. These are the only addresses needed. The rest of the header contains other information needed at this level. The trailer usually contains extra bits needed for error detection

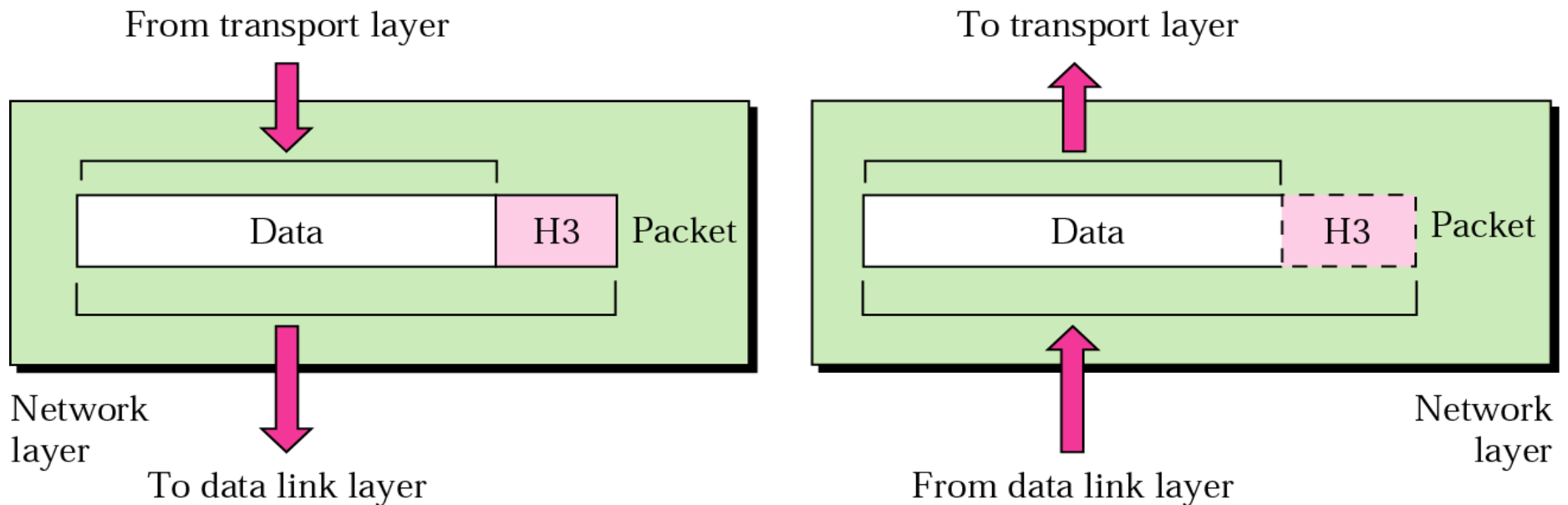


## Network layer

### Network

***The network layer is responsible for the delivery of packets from the original source to the final destination.***

- Transport of information
- Higher layers do not need to know about underlying technology
- Not needed on direct links



# Network layer

- The network layer provides data transfer of a segment of a message from a source [end-system](#) to a destination end-system across switched telecommunications networks, possibly involving multiple data links. The message segments in the network layer are called *packets*.
- The network layer responsibilities include:
  - *logical addressing at the network level of sender and receiver*
  - *routing packets through the network*
  - *network control (by providing node status to other nodes)*
  - *congestion control (by routing around points of congestion)*
  - *collecting accounting data for billing purposes*

# Source-to-destination delivery

