SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

COURSE NAME :19IT401 COMPUTER NETWORKS

II YEAR /IV SEMESTER

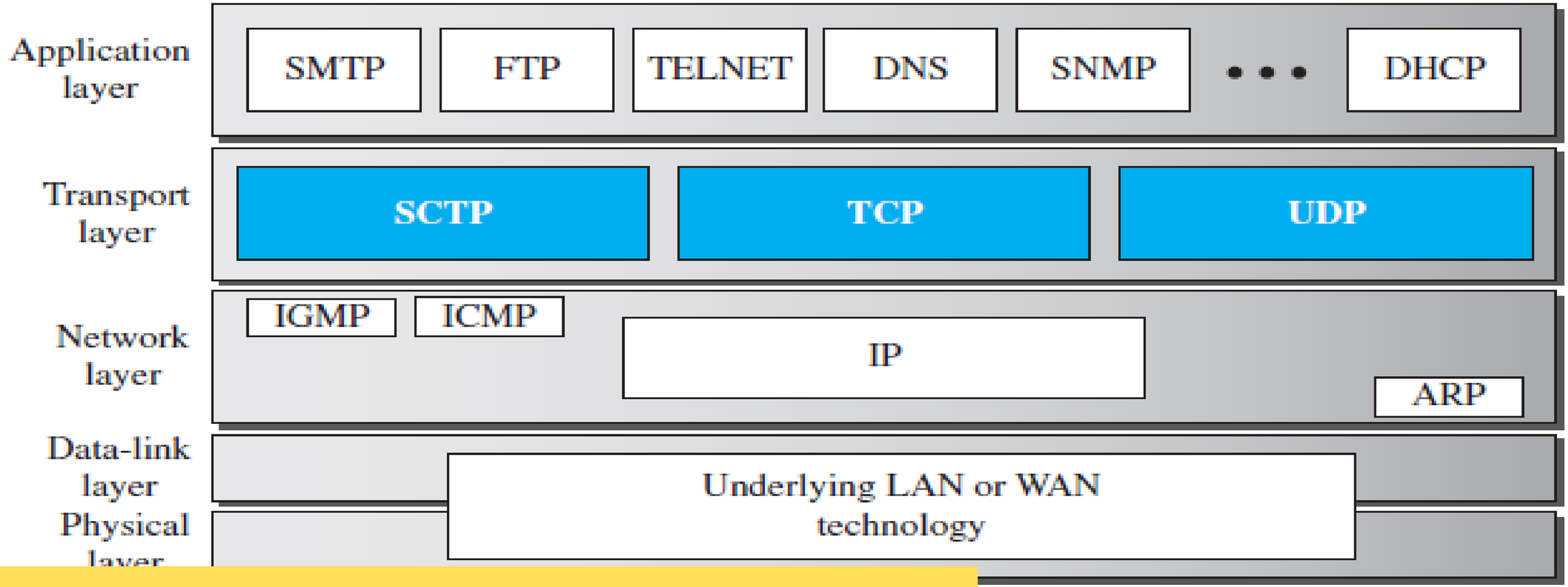
Unit 4-Transport layer

Topics 1 : Transport layer Services

Transport layer services

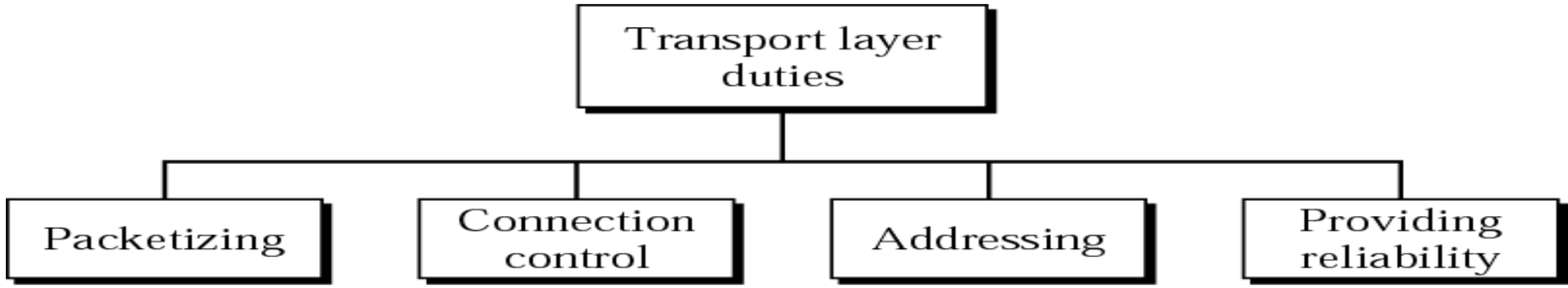
- ✓ Process-to-Process Communication
- ✓ Addressing: Port Numbers
- ✓ Encapsulation and Decapsulation
- ✓ Multiplexing and Demultiplexing
- ✓ Flow Control
- ✓ Error Control
- ✓ Congestion Control
- ✓ Connectionless and Connection-Oriented Services

Figure 24.1 *Position of transport-layer protocols in the TCP/IP protocol suite*



Transport layer duties

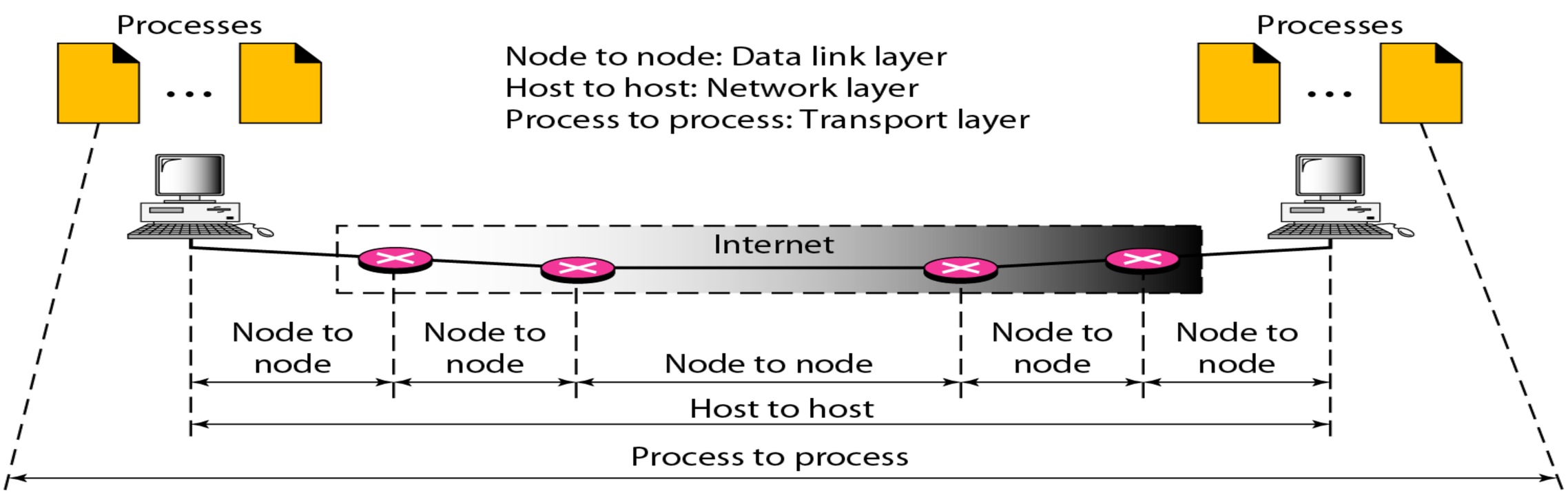
- Packetizing
  - Sender side: breaks application messages into segments, passes them to network layer
  - Transport layer at the receiving host deliver data to the receiving process
- Connection control
  - Connection-oriented
  - Connectionless
- Addressing
  - Port numbers to identify which network application
- Reliability
  - Flow control
  - Error Control



Processes communicating across network

- Process is an instance of a program in execution.
- Processes on two hosts communicate with each other by **sending and receiving messages**
- The process receives messages from, and sends messages into the network through its **socket**
- A socket is the **interface** between the **application layer** and the **transport layer** within a host.
- **Sockets** are the **programming interface** used to build network applications over the internet.
- Programmers can select which transport layer protocol (UDP or TCP) to be used by the application and select few transport-layer parameters (maximum buffer size, Maximum segment size, starting sequence number of segment).

Process to process communication

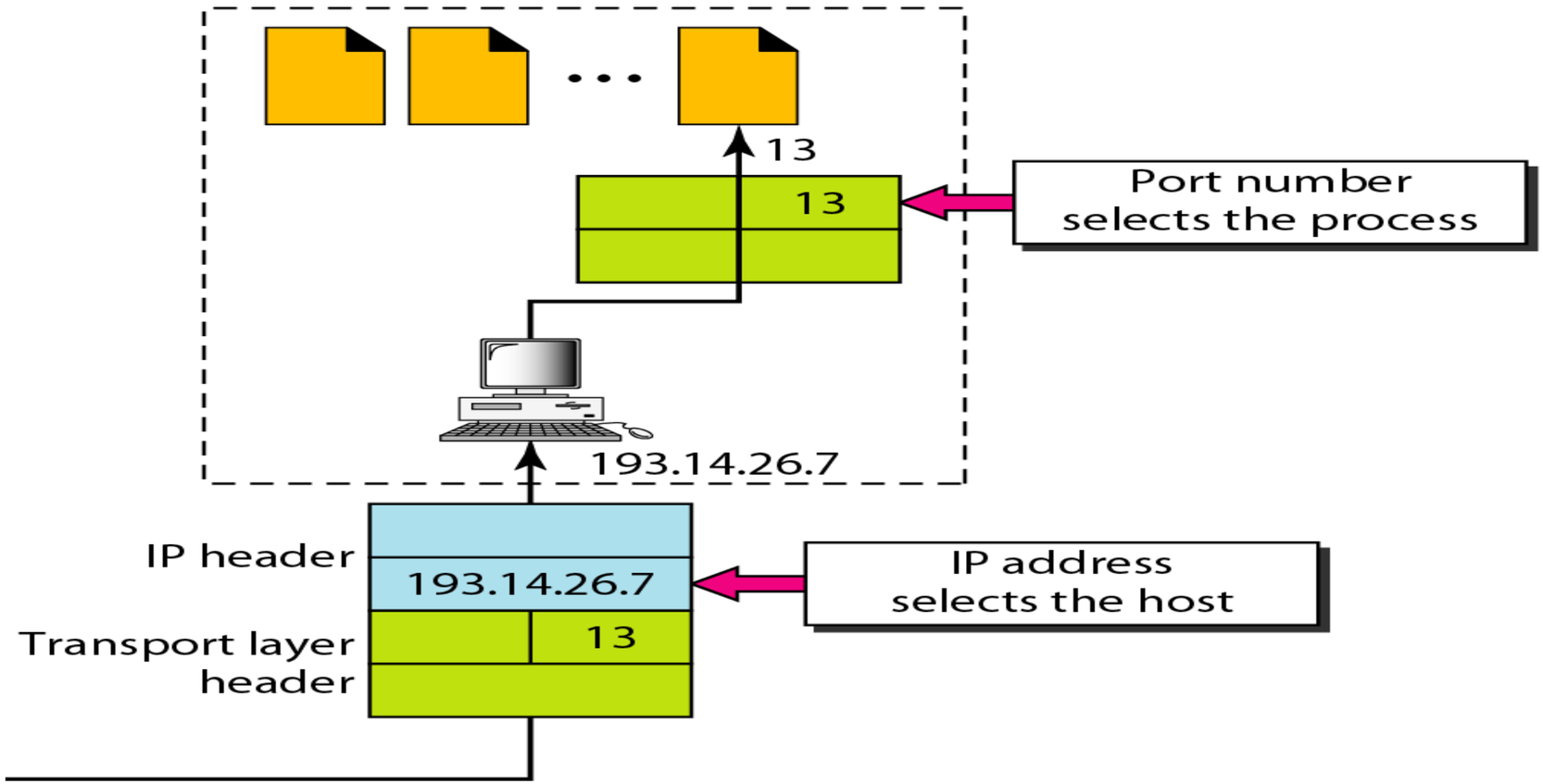


Port Numbers

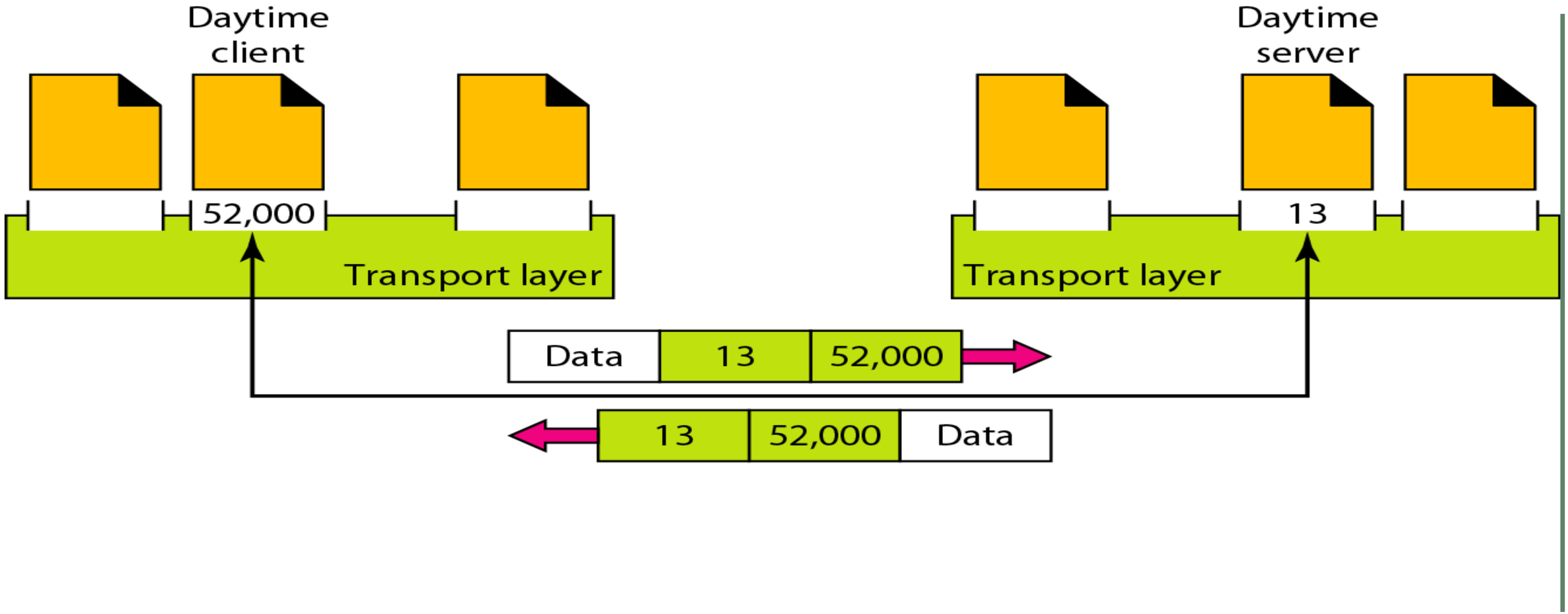
- ✓ Port numbers are used to accomplish process-to-process communication .
- ✓ Port numbers provide end-to-end addresses at the transport layer and allow multiplexing and demultiplexing at this layer, just as IP addresses do at the network layer

IP addresses versus port numbers

Process-to-Process delivery needs IP address and Port number



Port numbers



✓IP addresses and port numbers play different roles in selecting the final destination of data.

✓The destination IP address defines the host among the different hosts in the world.

✓ After the host has been selected, the port number defines one of the processes on this particular host

Addressing: Port numbers

- ✓Transport layer at the receiving host delivers data to the socket
- ✓There should be a unique identifier for each socket.
- ✓Socket identifier is called socket address
- ✓Socket address = IP address & Port number

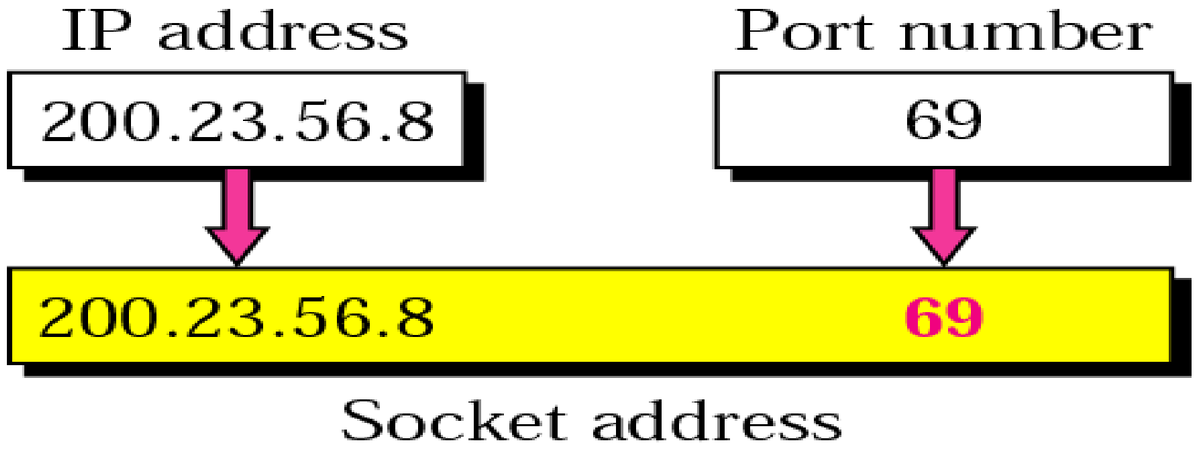


Table 24.1 *Some well-known ports used with UDP and TCP*

Port	*Protocol*	*UDP*	*TCP*	*SCTP*	*Description*
7	Echo	√	√	√	Echoes back a received datagram
9	Discard	√	√	√	Discards any datagram that is received
11	Users	√	√	√	Active users
13	Daytime	√	√	√	Returns the date and the time
17	Quote	√	√	√	Returns a quote of the day
19	Chargen	√	√	√	Returns a string of characters
20	FTP-data		√	√	File Transfer Protocol
21	FTP-21		√	√	File Transfer Protocol
23	TELNET		√	√	Terminal Network
25	SMTP		√	√	Simple Mail Transfer Protocol
53	DNS	√	√	√	Domain Name Service
67	DHCP	√	√	√	Dynamic Host Configuration Protocol
69	TFTP	√	√	√	Trivial File Transfer Protocol
80	HTTP		√	√	HyperText Transfer Protocol
111	RPC	√	√	√	Remote Procedure Call
123	NTP	√	√	√	Network Time Protocol
161	SNMP-server	√			
162	SNMP-client	√			

Encapsulation and decapsulation

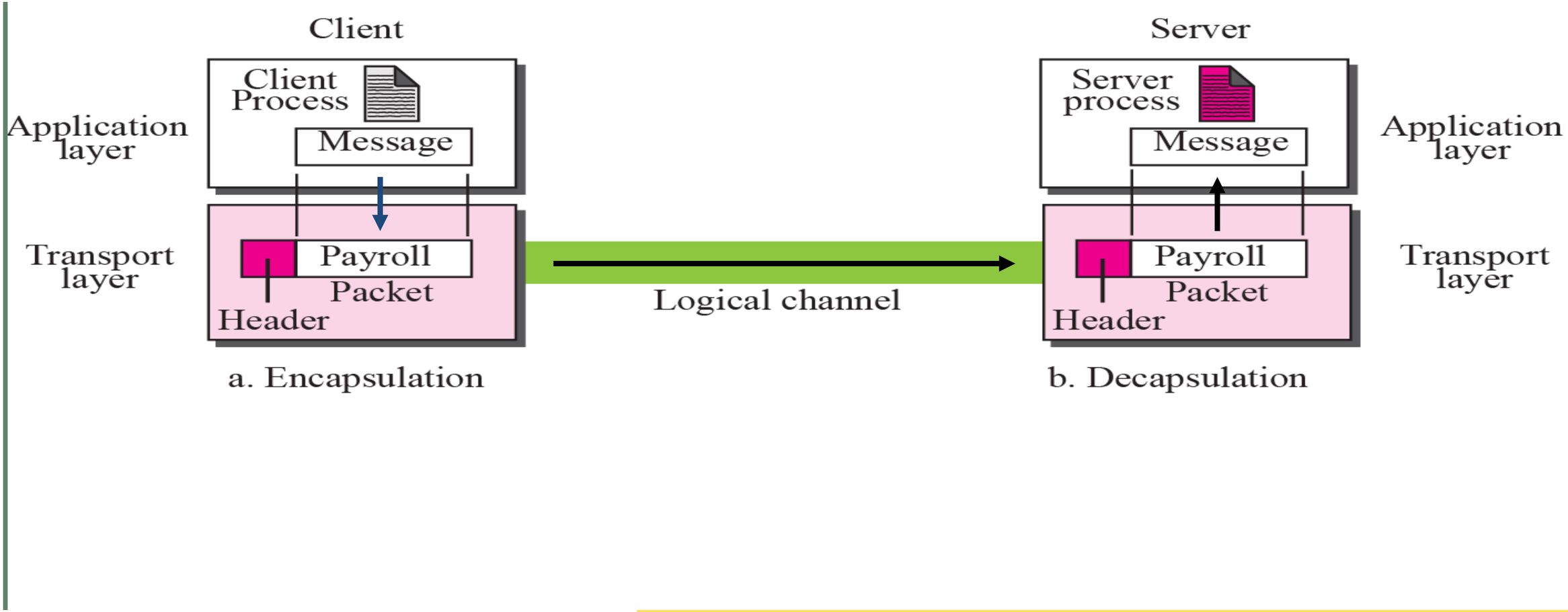
✓Encapsulation happens at the sender site.

✓When a process has a message to send, it passes the message to the transport layer along with a pair of socket addresses and some other pieces of information, which depend on the transport-layer protocol.

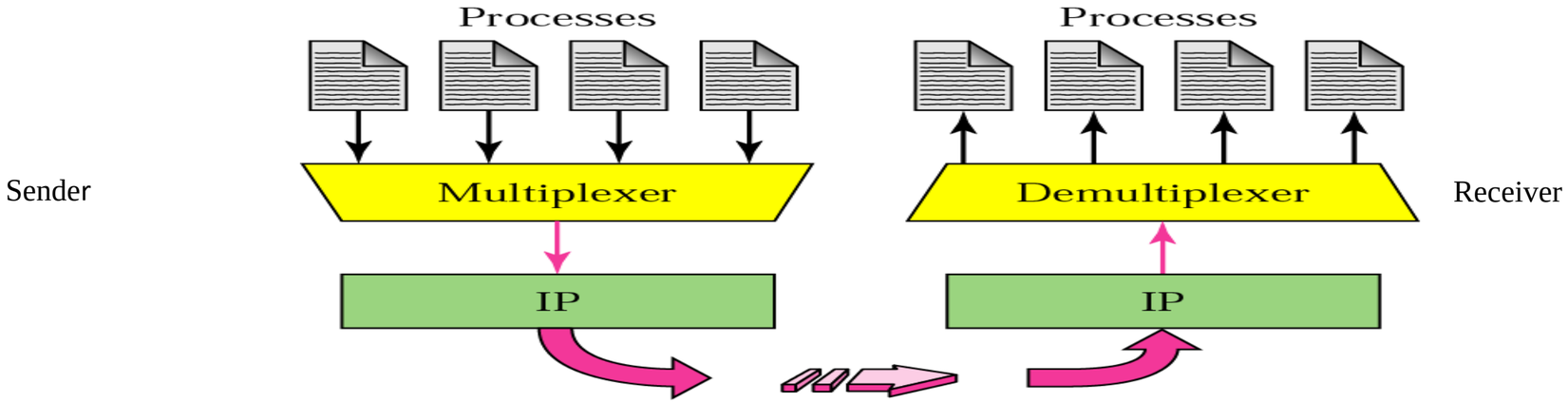
✓Decapsulation happens at the receiver site.

✓ When the message arrives at the destination transport layer, the header is dropped and the transport layer delivers the message to the process running at the application layer.

Encapsulation and decapsulation



Multiplexing and demultiplexing

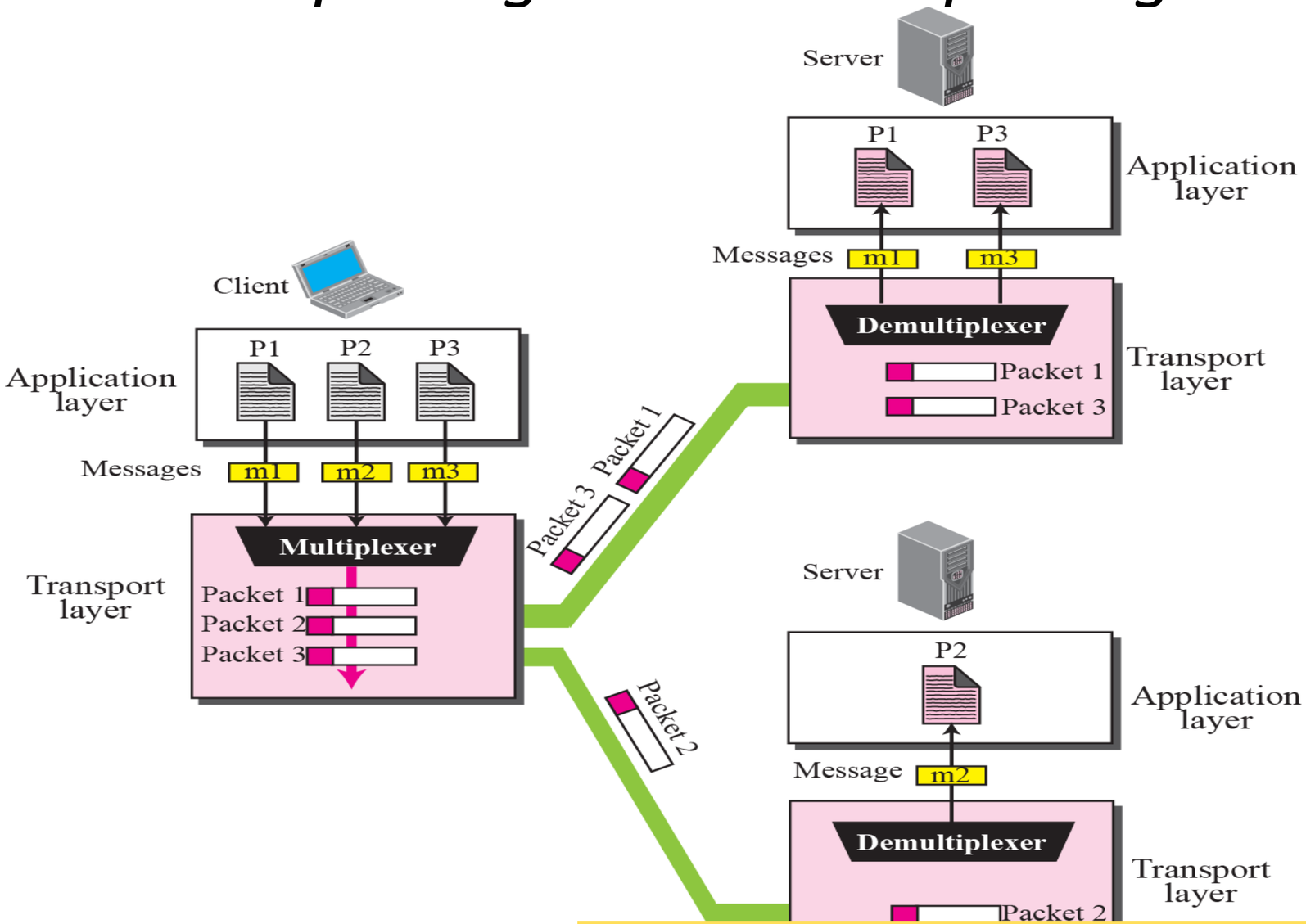


Multiplexing: (at the sending node) The process of encapsulating data messages from different applications sockets with the header information and pass the segments to the network layer

DeMultiplexing: (at the receiving node) The process of delivering the received data segment to the correct application

- Example:
- Suppose that the following is running on the same computer:
  - Downloading a web page while transferring data through FTP
  - Two telnet sessions are also running
  - Transport layer receives TPDUs from network layer for all four processes

Multiplexing and demultiplexing



Flow control

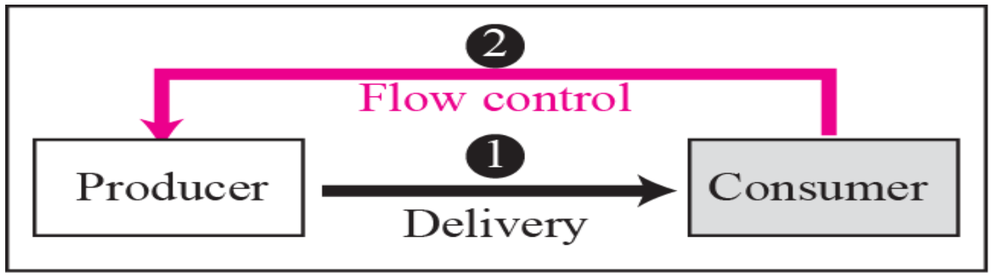
✓If the items are produced faster than they can be consumed, the consumer can be overwhelmed and may need to discard some items.

✓Delivery of items from a producer to a consumer can occur in one of two ways: *pushing* or *pulling.*

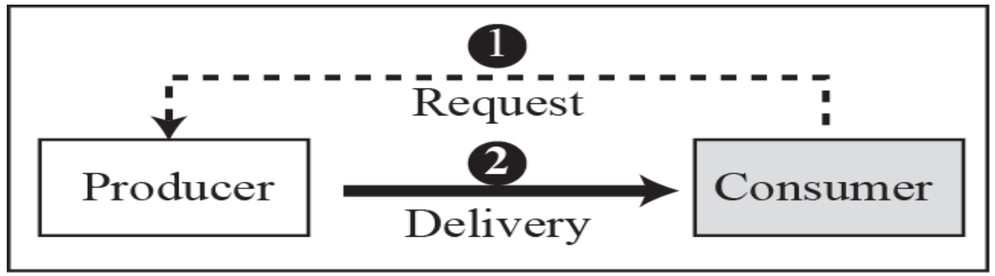
✓*If the sender delivers items whenever they are produced–without a prior* request from the consumer–the delivery is referred to as *pushing.*

✓*If the producer* delivers the items after the consumer has requested them, the delivery is referred to as *pulling.*

Flow control- *Pushing or pulling*

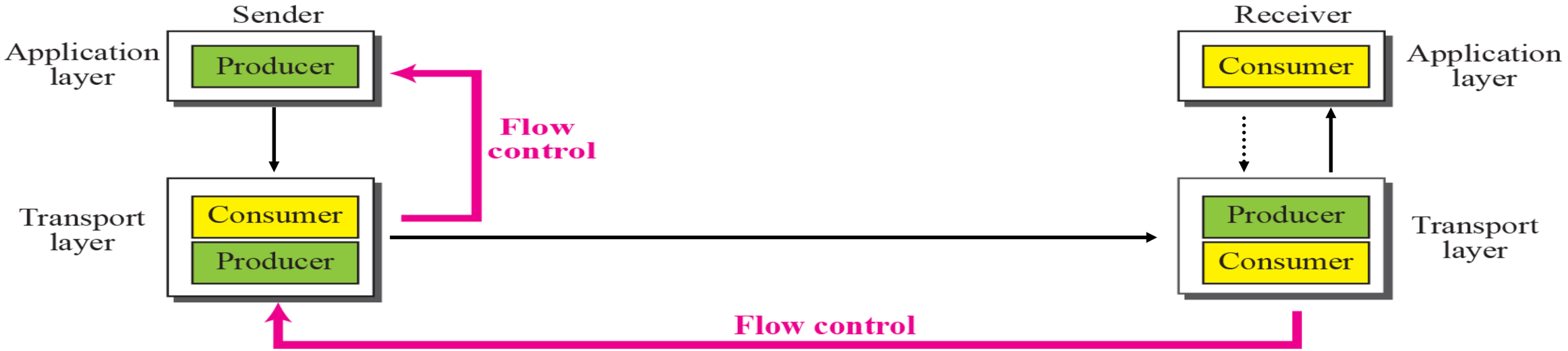


a. Pushing



b. Pulling

Flow control at the transport layer



- ✓Consumers communicate with the producers in two occasions:
- ✓when the buffer is full and when there are vacancies.
- ✓If the two parties use a buffer of only one slot, the communication can be easier.
- ✓ Assume that each transport layer uses one single memory location to hold a packet.
- ✓When this single slot in the sending transport layer is empty, the sending transport layer sends a note to the application layer to send its next chunk;
- ✓when this single slot in the receiving transport layer is empty, it sends an acknowledgment to the sending transport layer to send its next packet.

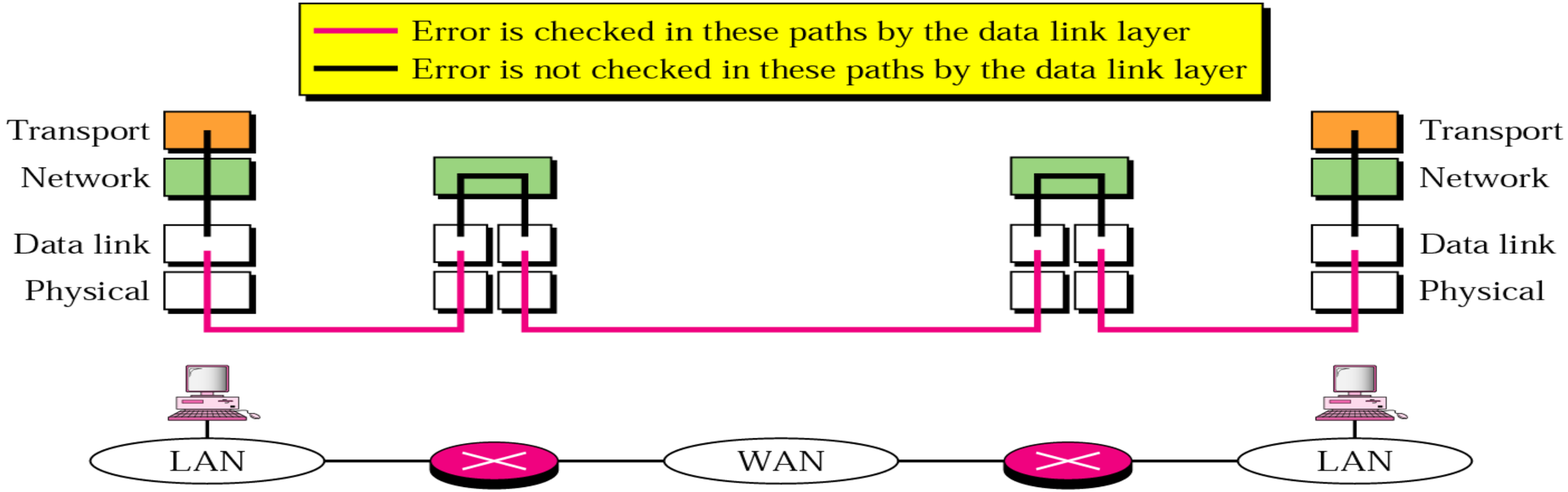
ERROR CONTROL

In the Internet, since the underlying network layer (IP) is unreliable, we need to make the transport layer reliable if the application requires reliability.
Reliability can be achieved to add error control services to the transport layer.
Error control at the transport layer is responsible for

1. Detecting and discarding corrupted packets.
2. Keeping track of lost and discarded packets and resending them.
3. Recognizing duplicate packets and discarding them.
4. Buffering out-of-order packets until the missing packets arrive.

Error control

Why we need error control at the transport layer?



Error control at the transport layer

✓Error control requires that the sending transport layer knows which packet is to be resent and the receiving transport layer knows which packet is a duplicate, or which packet has arrived out of order.

✓This can be done if the packets are numbered .Packets are numbered sequentially. However, because we need to include the sequence number of each packet in the header, we need to set a limit.

✓ If the header of the packet allows *m bits for the sequence number, the sequence numbers range from 0 to* $2^m - 1$.

✓if *m is 4, the only sequence numbers are 0 through 15,*

✓0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, ...

Congestion Control

✓Congestion in a network may occur if the *load on the network—the number of packets* sent to the network—is greater than the *capacity of the network—the number of packets* a network can handle.

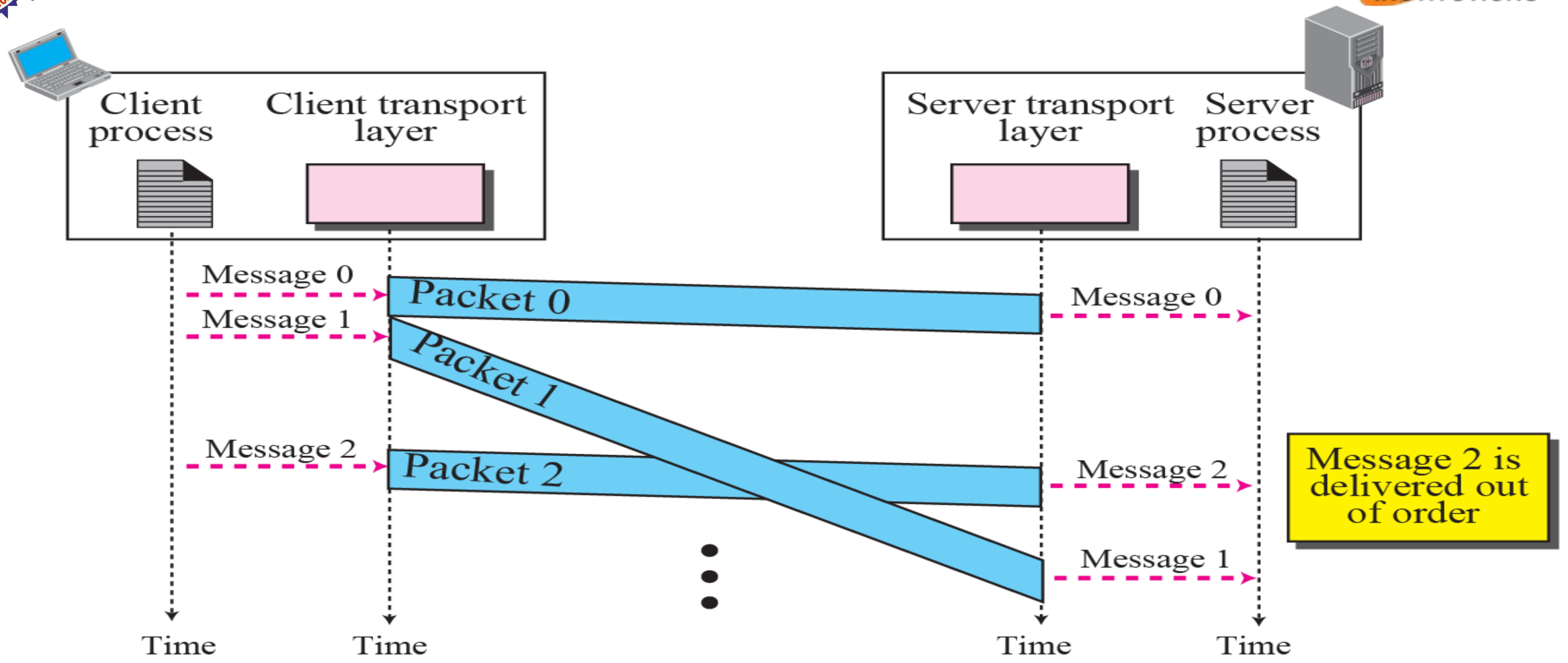
✓**Congestion control refers to the mechanisms and techniques** that control the congestion and keep the load below the capacity.

✓Congestion in a network or internetwork occurs because routers and switches have queues—buffers that hold the packets before and after processing.

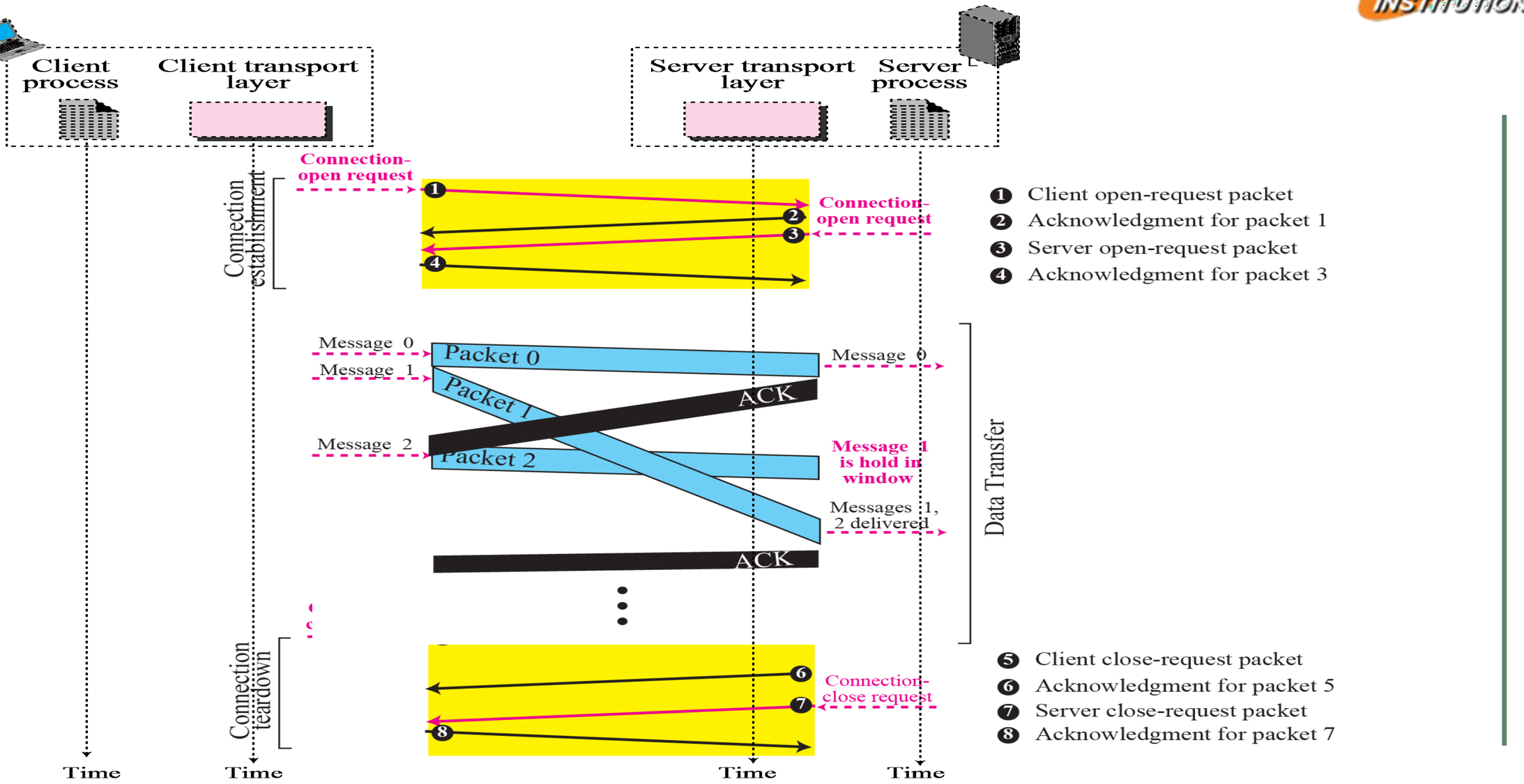
✓ A router, for example, has an input queue and an output queue for each interface. If a router cannot process the packets at the same rate at which they arrive, the queues become overloaded and congestion occurs.

✓ Congestion at the transport layer is actually the result of congestion at the network layer, which manifests itself at the transport layer

Connectionless service



Connection-oriented service



Assessment

a) List Transport layer services.
b) What is UDP?
c) What is TCP?
d) Compare connection oriented and connectionless network.

Reference

TEXT BOOKS

Behrouz A. Forouzan, Data Communications and Networking, Fifth Edition TMH, 2013.

REFERENCES

1. William Stallings, Data and Computer Communications, Tenth Edition, Pearson Education, 2013.
2. Andrew Tanenbaum, Computer Networks, Fifth Edition, Pearson (5th Edition) Education, 2013.
3. James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet, Sixth Edition, Pearson Education, 2013.
4. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.