EXPLORATION 1

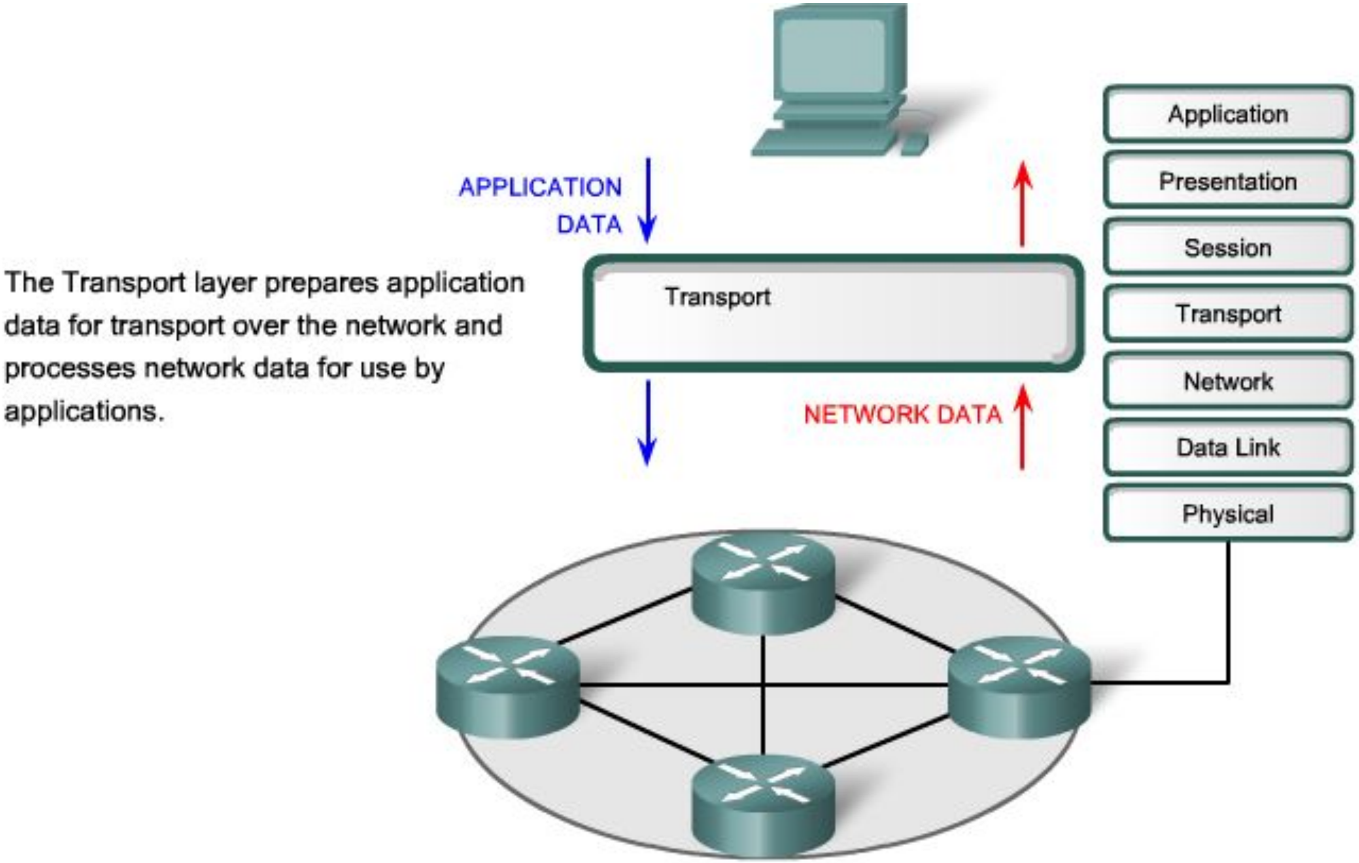
Chapter 4
OSI Transport Layer

By Zhamanov Azamat

Upon completion of this chapter, you will be able to:

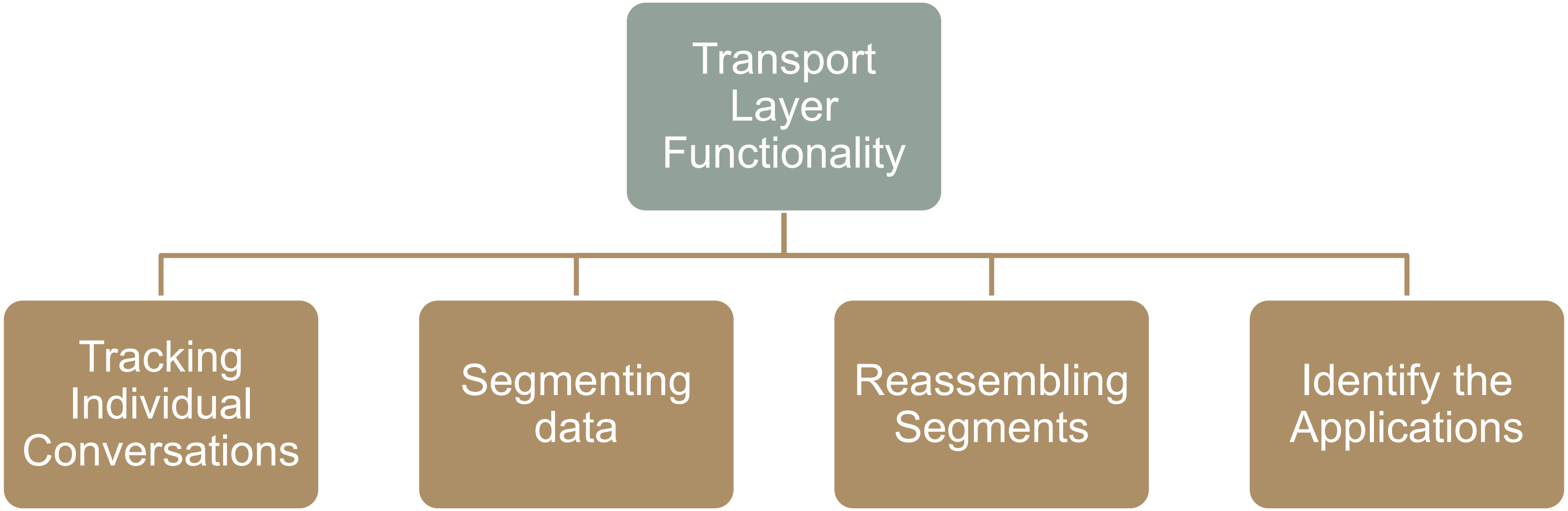
- Explain the need for the Transport layer.
- Identify the role of the Transport layer as it provides the end-to-end transfer of data between applications.
- Describe the role of two TCP/IP Transport layer protocols: TCP and UDP.
- Explain the key functions of the Transport layer, including reliability, port addressing, and segmentation.
- Explain how TCP and UDP each handle key functions.
- Identify when it is appropriate to use TCP or UDP and provide examples of applications that use each protocol.

Transport Layer



The Transport layer prepares application data for transport over the network and processes network data for use by applications.

Purpose of Transport Layer



Transport Layer Functionality

Tracking Individual Conversations

Segmenting data

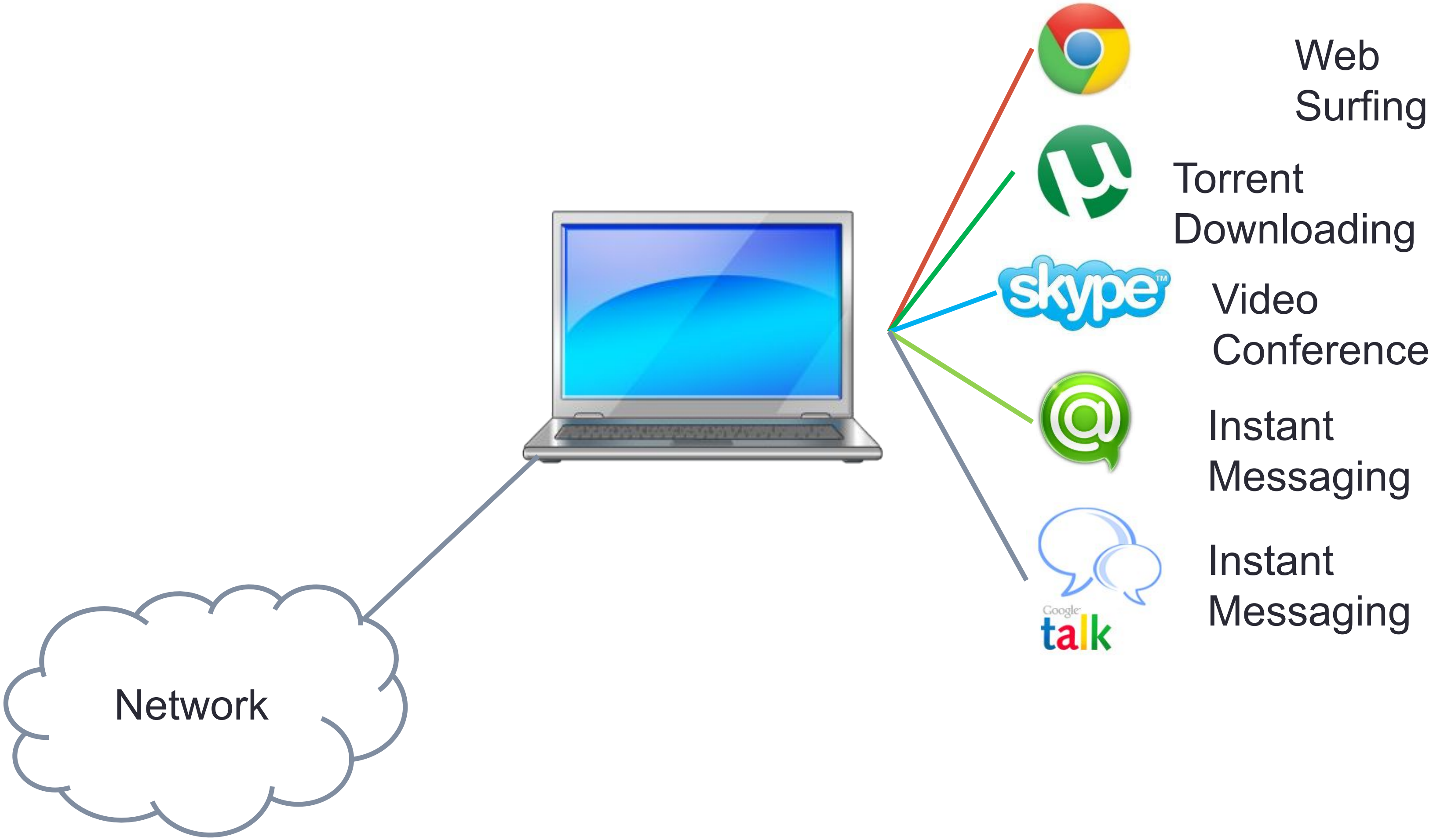
Reassembling Segments

Identify the Applications

Tracking Individual Conversations

- Any host may have multiple applications that are communicating across the network. Each of these applications will be communicating with one or more applications on remote hosts. It is the responsibility of the Transport layer to maintain the multiple communication streams between these applications.

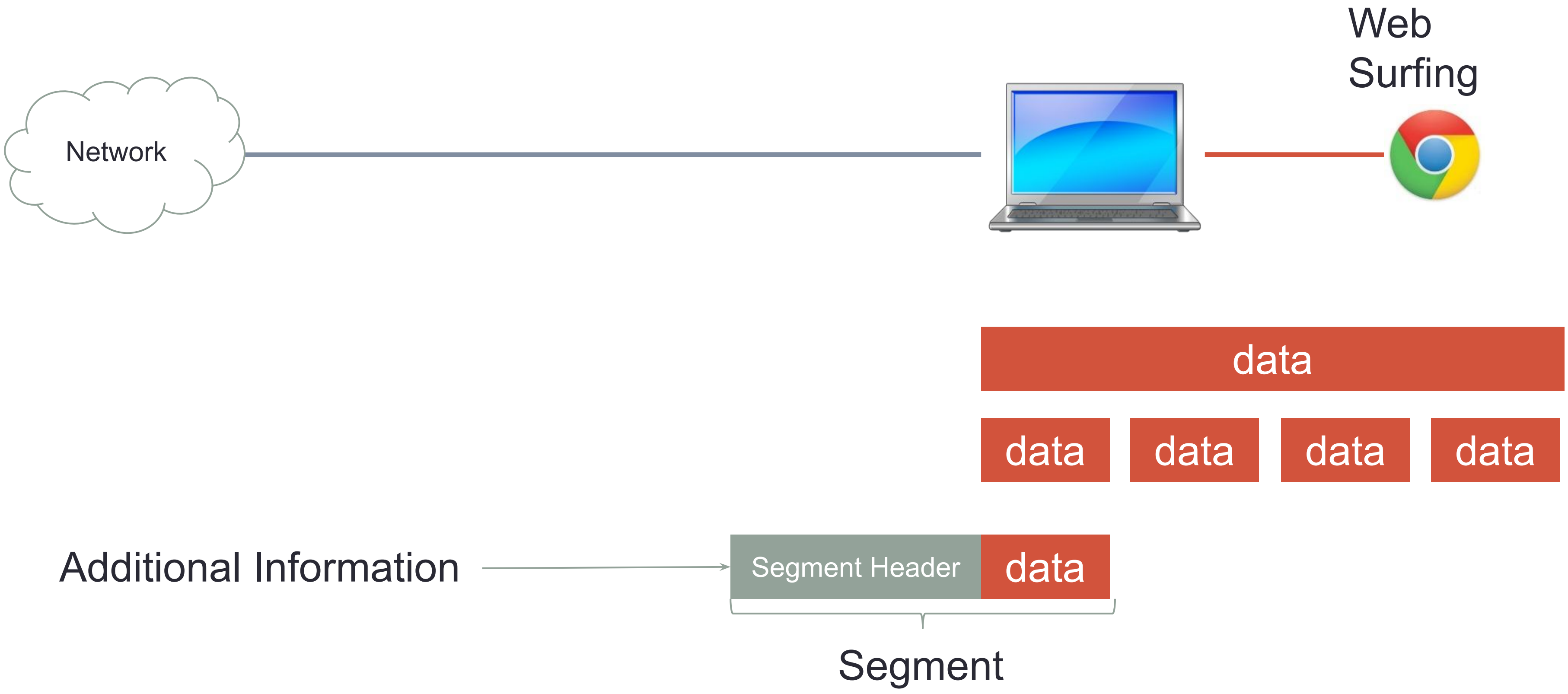
Tracking Individual Conversations



Segmenting Data

- The Transport layer protocols describe services that segment data from the Application layer.
- This includes the encapsulation required on each piece of data.
- Each piece of application data requires headers to be added at the Transport layer to indicate to which communication it is associated.

Segmentation



Network

Web Surfing

data

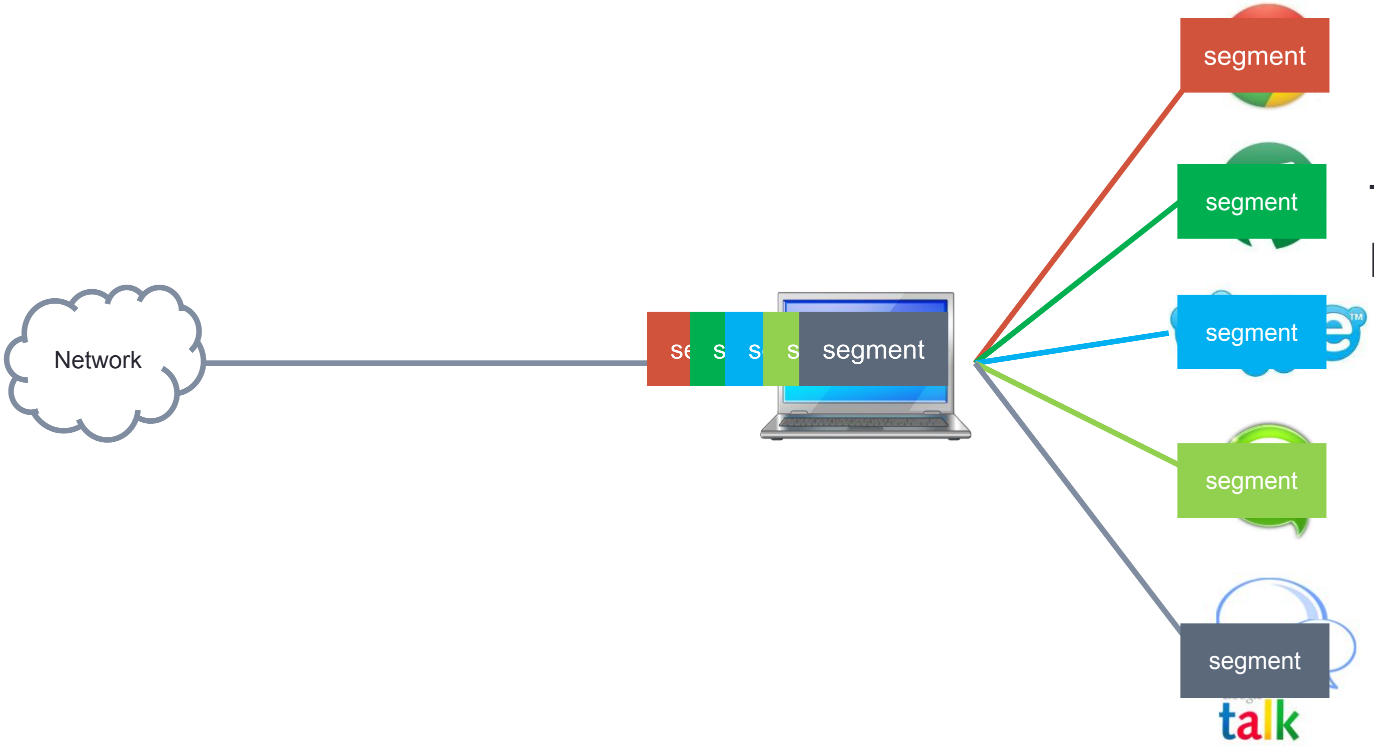
data data data data

Additional Information

Segment Header data

Segment

Segmentation



Web Surfing

Torrent Downloading

Video Conference

Instant Messaging

Instant Messaging

Reassembling Segments

- At the receiving host, each piece of data may be directed to the appropriate application.
- Additionally, these individual pieces of data must also be reconstructed into a complete data stream that is useful to the Application layer.
- The protocols at the Transport layer describe the how the Transport layer header information is used to reassemble the data pieces into streams to be passed to the Application layer.

Reassembling Segments, Application Identification

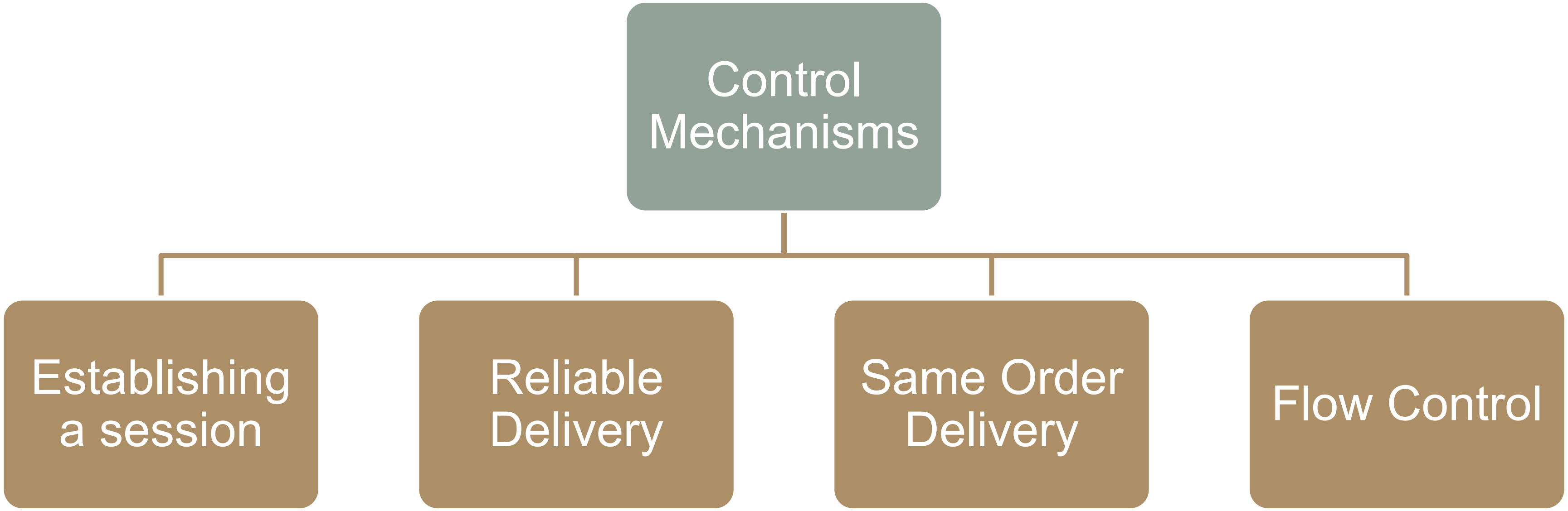
Web
Surfing
Network

data

data data data data

Segment Header data

Controlling the Conversations



Establishing a Session

- The Transport layer can provide this connection orientation by creating a sessions between the applications. These connections prepare the applications to communicate with each other before any data is transmitted. Within these sessions, the data for a communication between the two applications can be closely managed.

Reliable Delivery

- For many reasons, it is possible for a piece of data to become corrupted, or lost completely, as it is transmitted over the network. The Transport layer can ensure that all pieces reach their destination by having the source device to retransmit any data that is lost.

Same Order Delivery

- Because networks may provide multiple routes that can have different transmission times, data can arrive in the wrong order. By numbering and sequencing the segments, the Transport layer can ensure that these segments are reassembled into the proper order.

Flow Control Mechanism

- Network hosts have limited resources, such as memory or bandwidth. When Transport layer is aware that these resources are overtaxed, some protocols can request that the sending application reduce the rate of data flow. This is done at the Transport layer by regulating the amount of data the source transmits as a group. Flow control can prevent the loss of segments on the network and avoid the need for retransmission.

Transport Layer Protocols

- Computers uses different types of Transport layers protocols by some reasons.
- What is the reason for it?

Question

- What kind of Computer Network Communications do you know?

Different kinds of Computer Networks

- Web Browsing
- File sharing
- IP Telephony
- Video Streaming (conference or online lesson)
- Working with mail

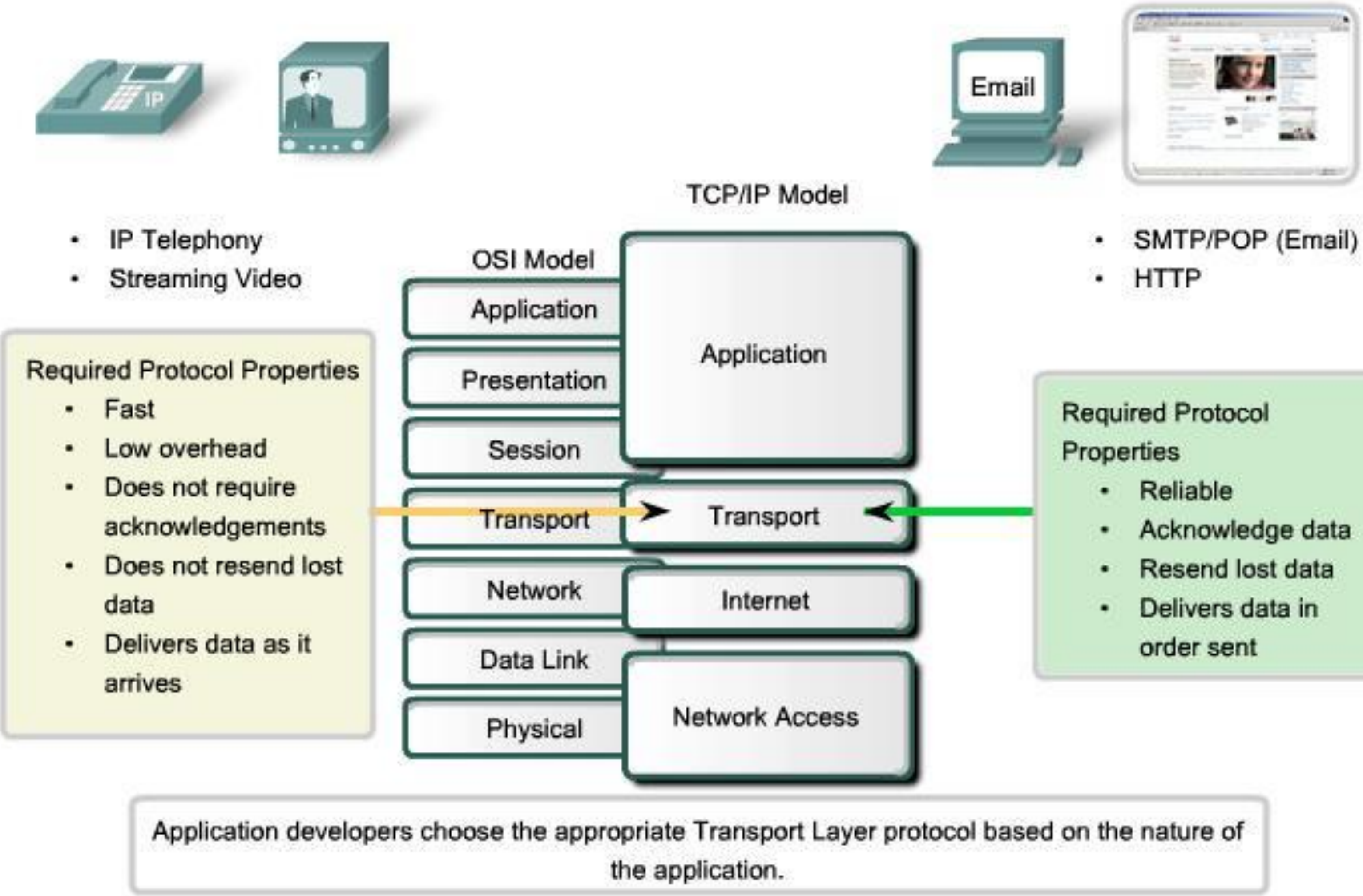
Question

- For which of them we need reliability in delivery?

Question

- For which of them we need Speed in delivery?

Transport Layer Protocols



- IP Telephony
- Streaming Video

Required Protocol Properties

- Fast
- Low overhead
- Does not require acknowledgements
- Does not resend lost data
- Delivers data as it arrives

- SMTP/POP (Email)
- HTTP

Required Protocol Properties

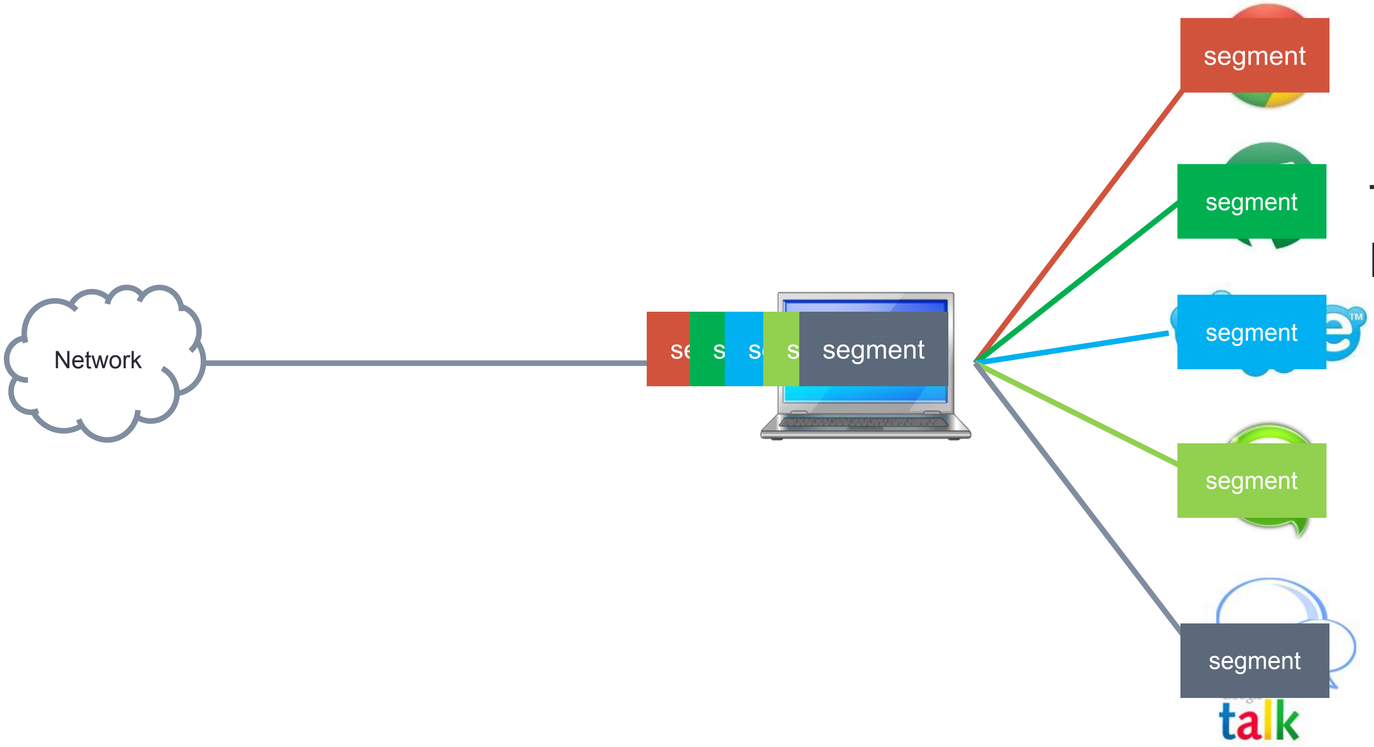
- Reliable
- Acknowledge data
- Resend lost data
- Delivers data in order sent

Application developers choose the appropriate Transport Layer protocol based on the nature of the application.

TCP - Transmission Control Protocol and UDP – User Datagram Protocol

- TCP
  - Web Browsers
  - E-mail
  - File Transfers
- UDP
  - Video Streaming
  - Voice over IP (VoIP)

Identifying Conversations



Web Surfing

Torrent Downloading

Video Conference

Instant Messaging

Instant Messaging

Question

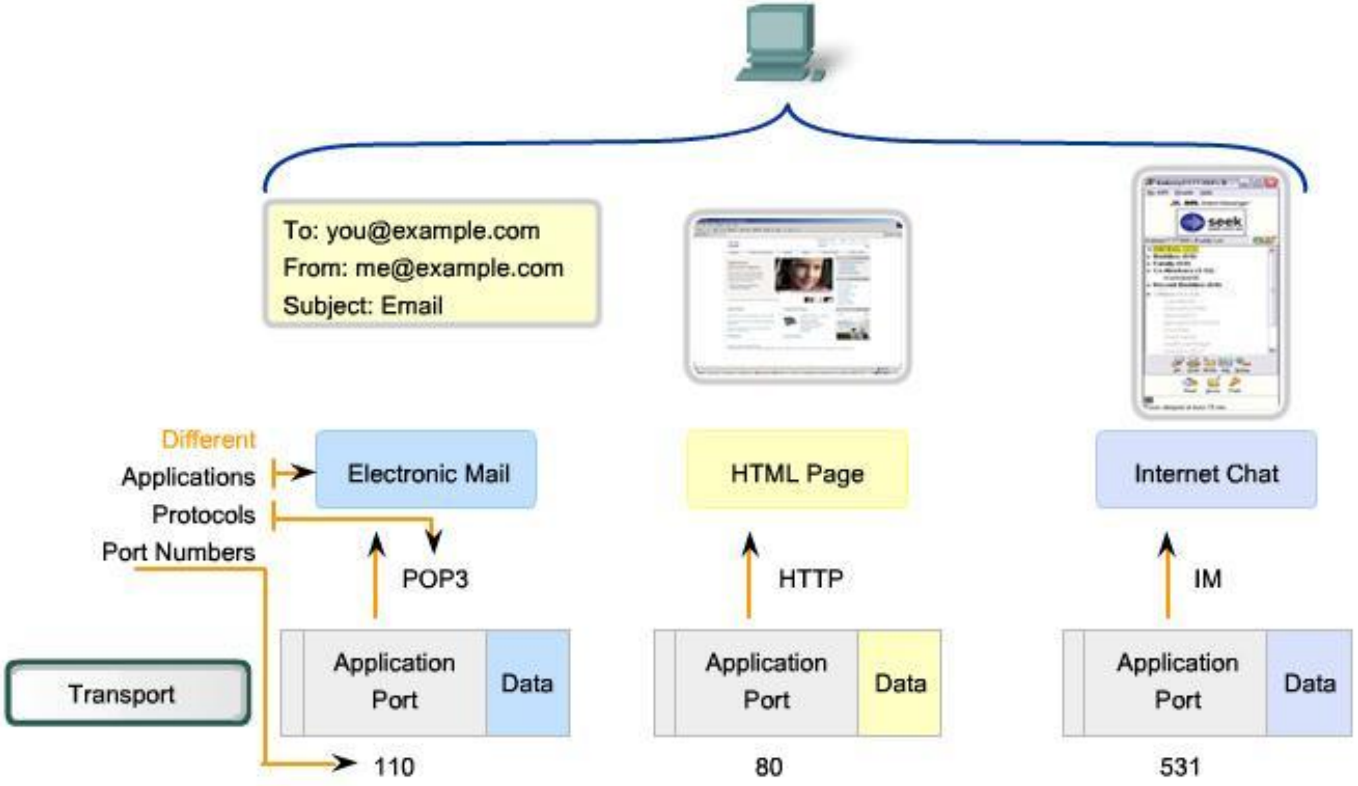
- We can see visual different colors of segments, by using colors we separate segments.
- How computers make separation between segments?

Answer

- Computers use ***Port Addresses***

Port Addressing

- Ports are using to identify conversations



Data for different applications is directed to the correct application because each application has a unique port number.

Port Addresses

- Well Known Ports (Numbers 0 to 1023)
- Registered Ports (Numbers 1024 to 49151)
- Dynamic or Private Ports (Numbers 49152 to 65535)

- NETSTAT is an important network utility that can be used to verify current connections

Well Known Ports

- Are served for services and applications.
- They are commonly used for applications such as HTTP (web server) POP3/SMTP (e-mail server) and Telnet.

Registered Ports

- Are assigned to user processes or applications.
- These processes are primarily individual applications that a user has chosen to install rather than common applications that would receive a Well Known Port.
- When not used for a server resource, these ports may also be used dynamically selected by a client as its source port.

Dynamic or Private Ports

- Also known as Ephemeral Ports, these are usually assigned dynamically to client applications when initiating a connection.
- It is not very common for a client to connect to a service using a Dynamic or Private Port (although some peer-to-peer file sharing programs do).

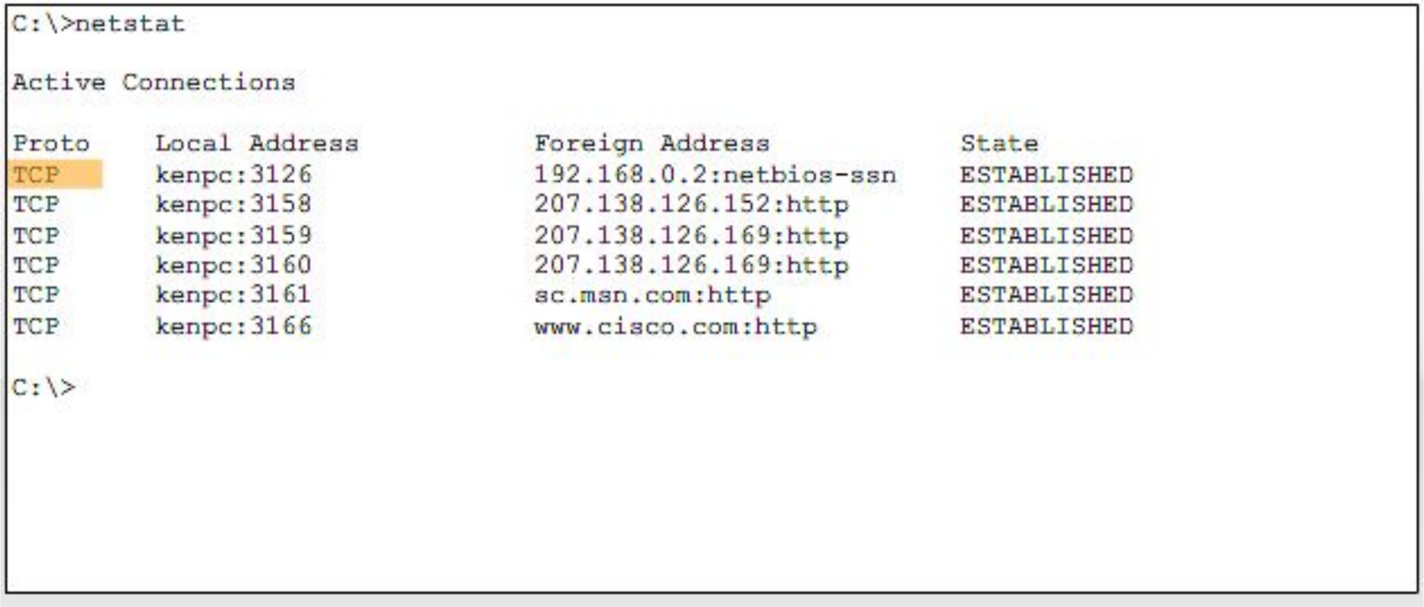
Question

- How to view states of connection in your computer?

Answer

- Use ***Netstat***

Netstat Snapshot



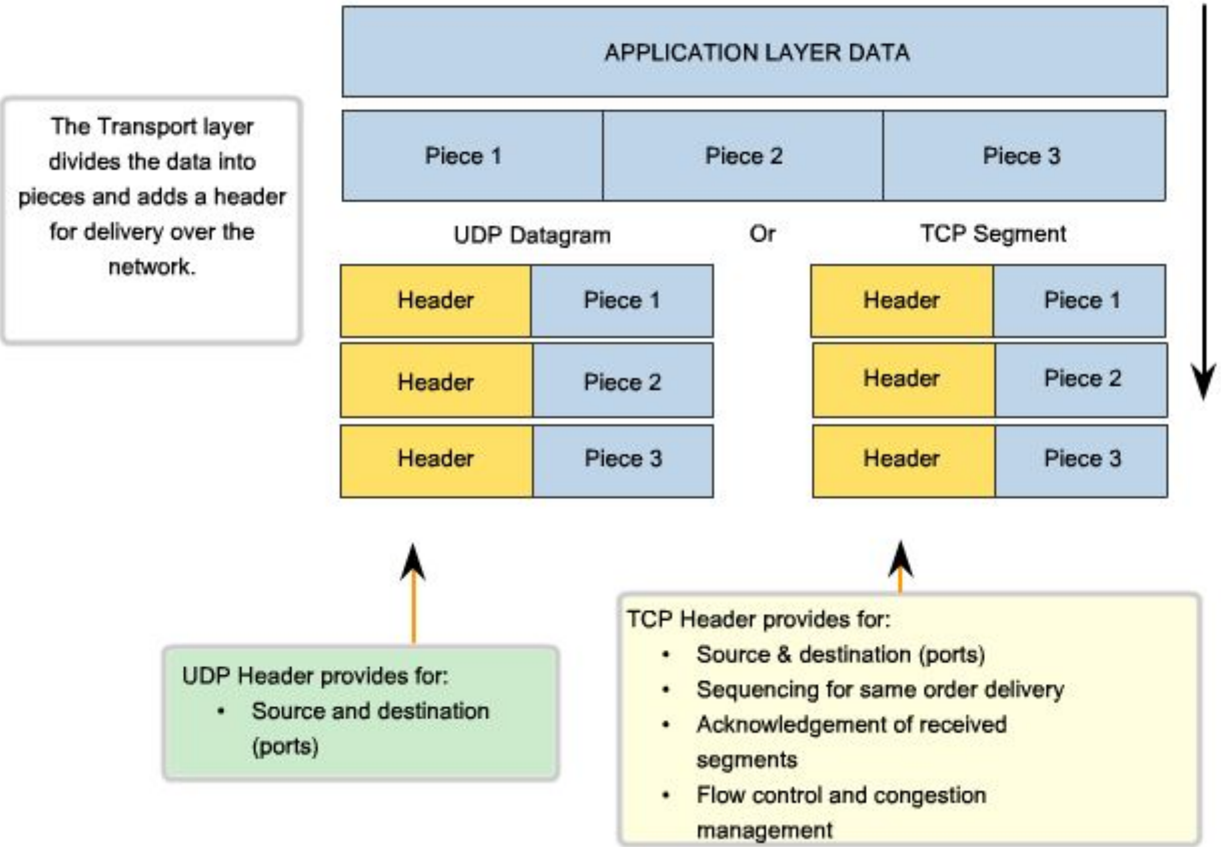
```
C:\>netstat

Active Connections

Proto     Local Address          Foreign Address           State
TCP       kenpc:3126             192.168.0.2:netbios-ssn   ESTABLISHED
TCP       kenpc:3158             207.138.126.152:http      ESTABLISHED
TCP       kenpc:3159             207.138.126.169:http      ESTABLISHED
TCP       kenpc:3160             207.138.126.169:http      ESTABLISHED
TCP       kenpc:3161             sc.msn.com:http           ESTABLISHED
TCP       kenpc:3166             www.cisco.com:http        ESTABLISHED

C:\>
```

TCP and UDP Handle Segmentation Differently.



The Transport layer divides the data into pieces and adds a header for delivery over the network.

UDP Header provides for:

- Source and destination (ports)

TCP Header provides for:

- Source & destination (ports)
- Sequencing for same order delivery
- Acknowledgement of received segments
- Flow control and congestion management

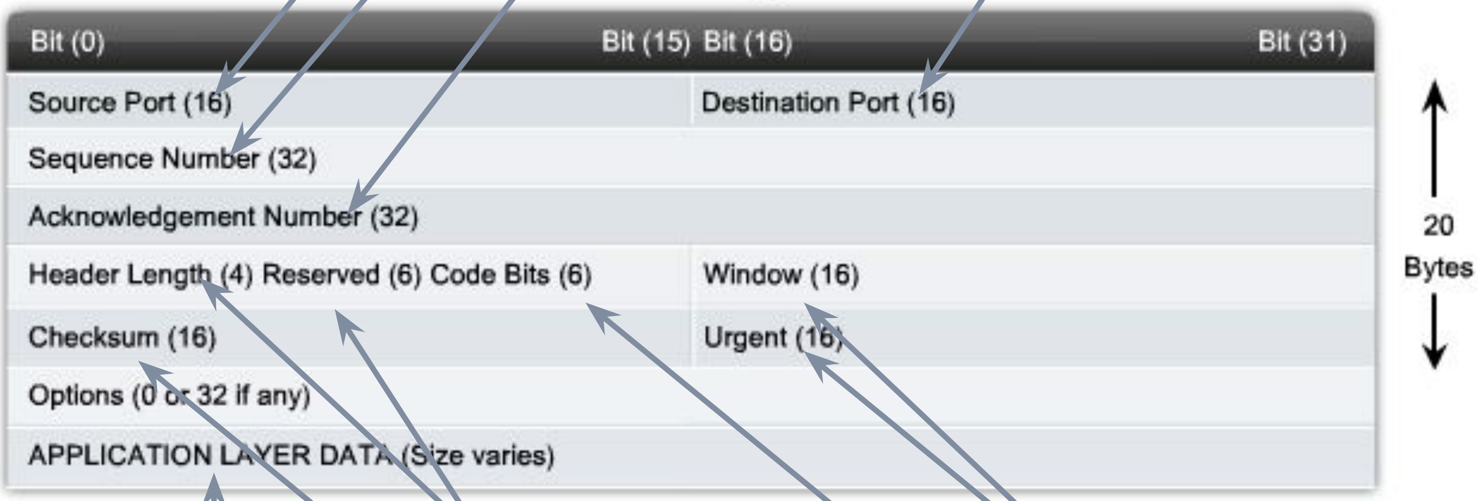
TCP Header

D

Defines the order of segn

Defines to which port data have to be

Defines expectation of next sequence



Bit (0) Bit (15)	Bit (16) Bit (31)
Source Port (16)	Destination Port (16)
Sequence Number (32)	
Acknowledgement Number (32)	
Header Length (4) Reserved (6) Code Bits (6)	Window (16)
Checksum (16)	Urgent (16)
Options (0 or 32 if any)	
APPLICATION LAYER DATA (Size varies)	

Speci

Reserved f

Used in

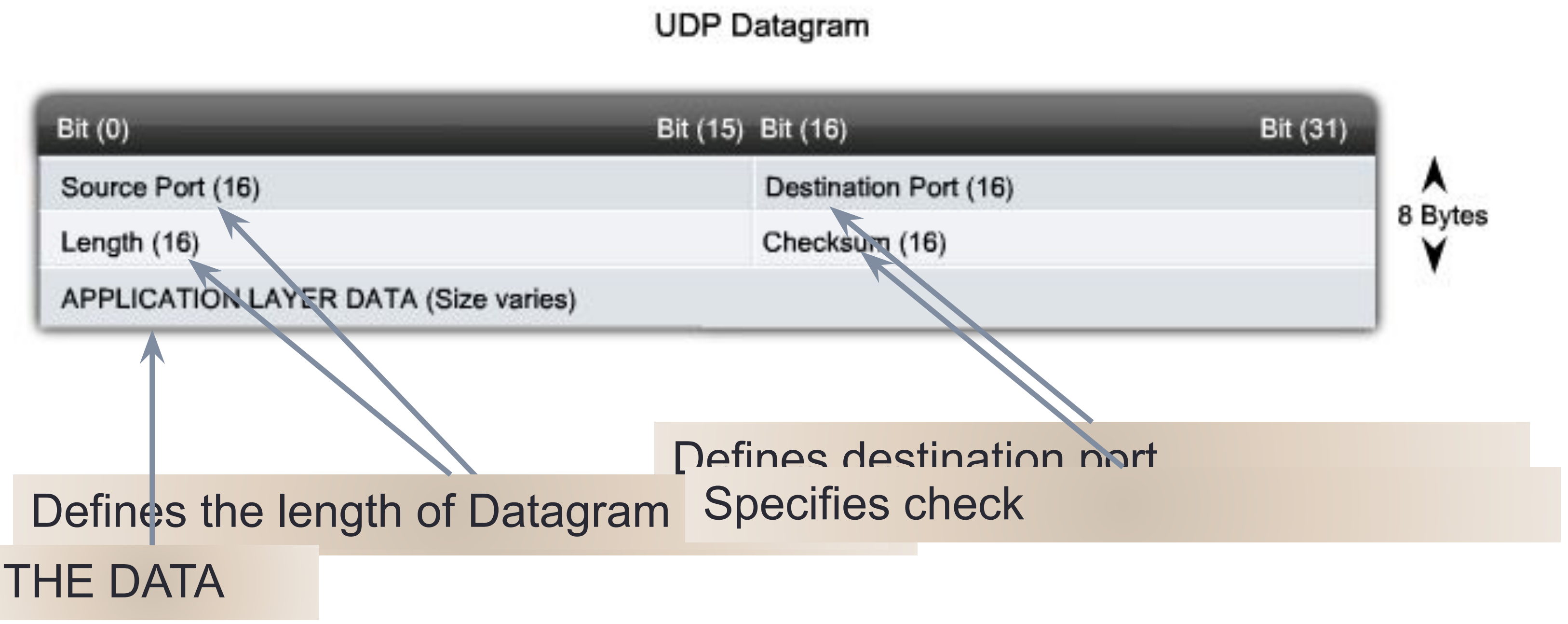
Window size, defines number of bits

Used for error checking of Hea
Data

Used for defining that this Segment must be send in urgent

THE DATA

UDP Header



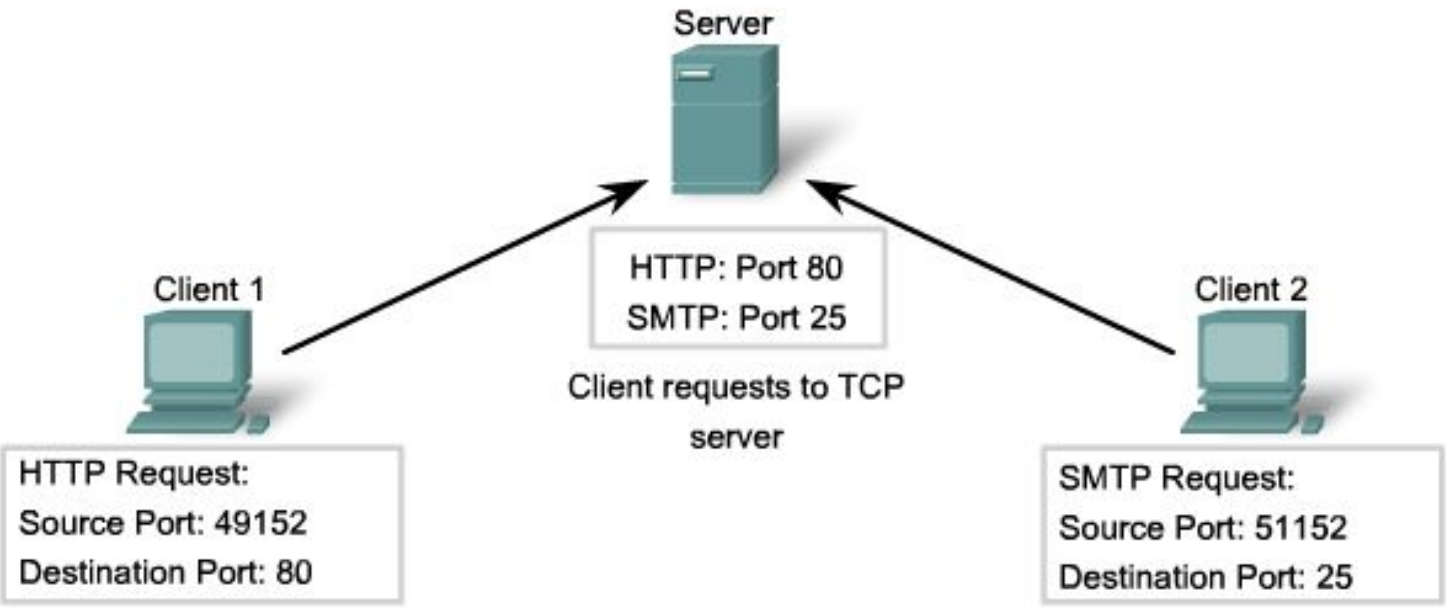
Defines destination port

Defines the length of Datagram

Specifies check

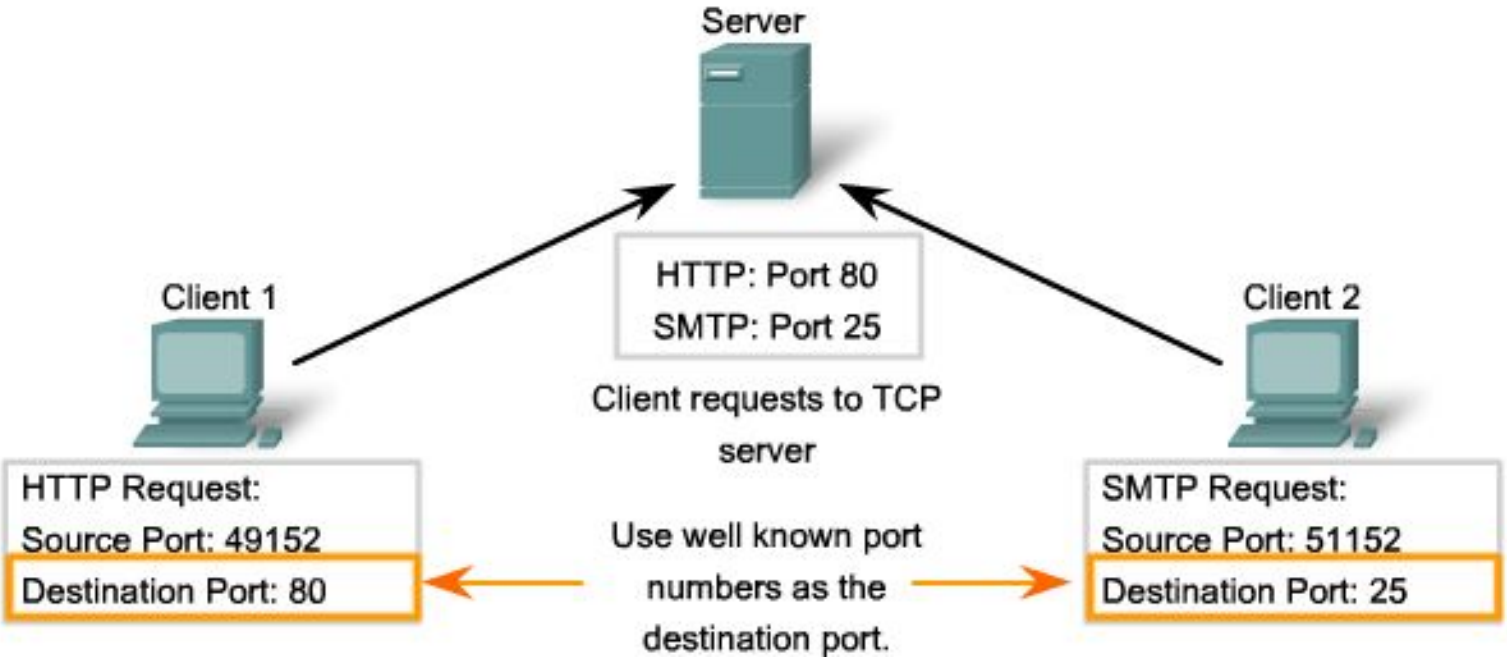
THE DATA

TCP in process



Client requests to TCP server

Clients Define Destination Ports



HTTP: Port 80
SMTP: Port 25

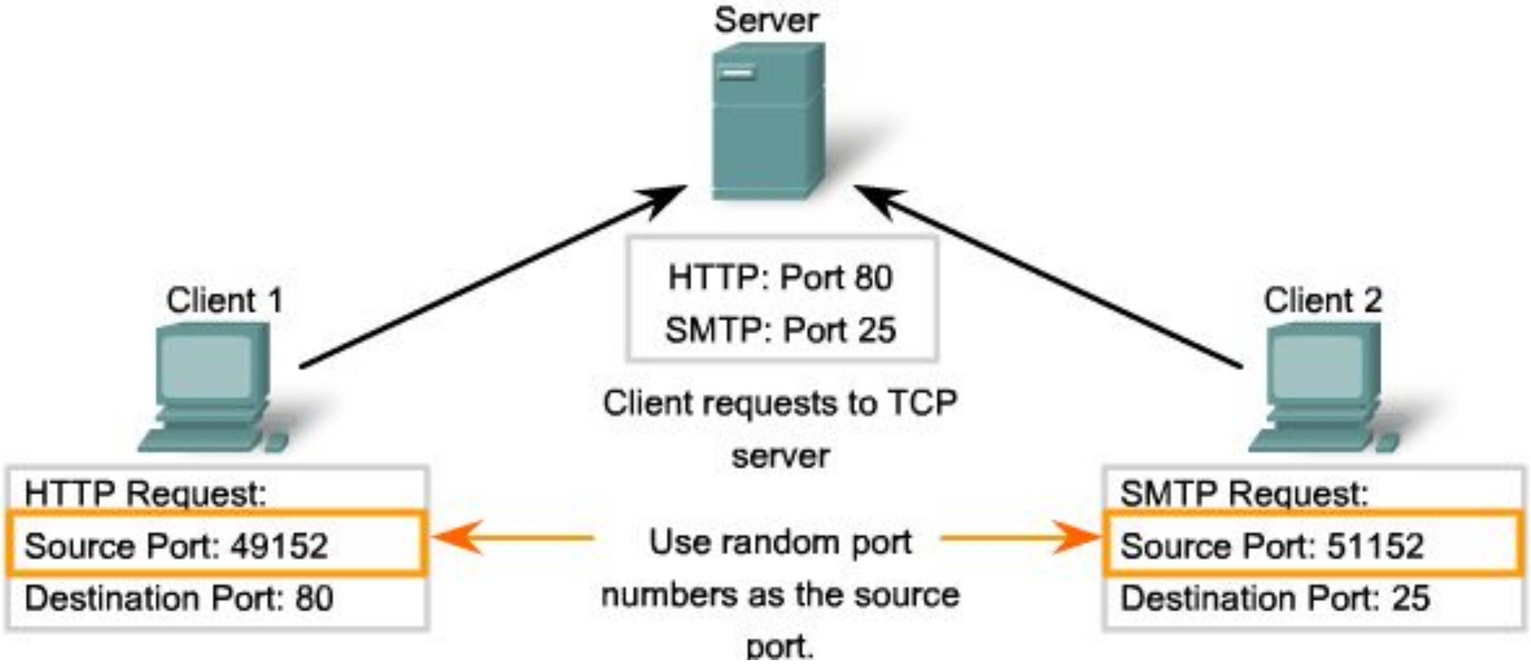
Client requests to TCP server

HTTP Request:
Source Port: 49152
Destination Port: 80

SMTP Request:
Source Port: 51152
Destination Port: 25

Use well known port numbers as the destination port.

Clients Define Source Ports



HTTP: Port 80
SMTP: Port 25

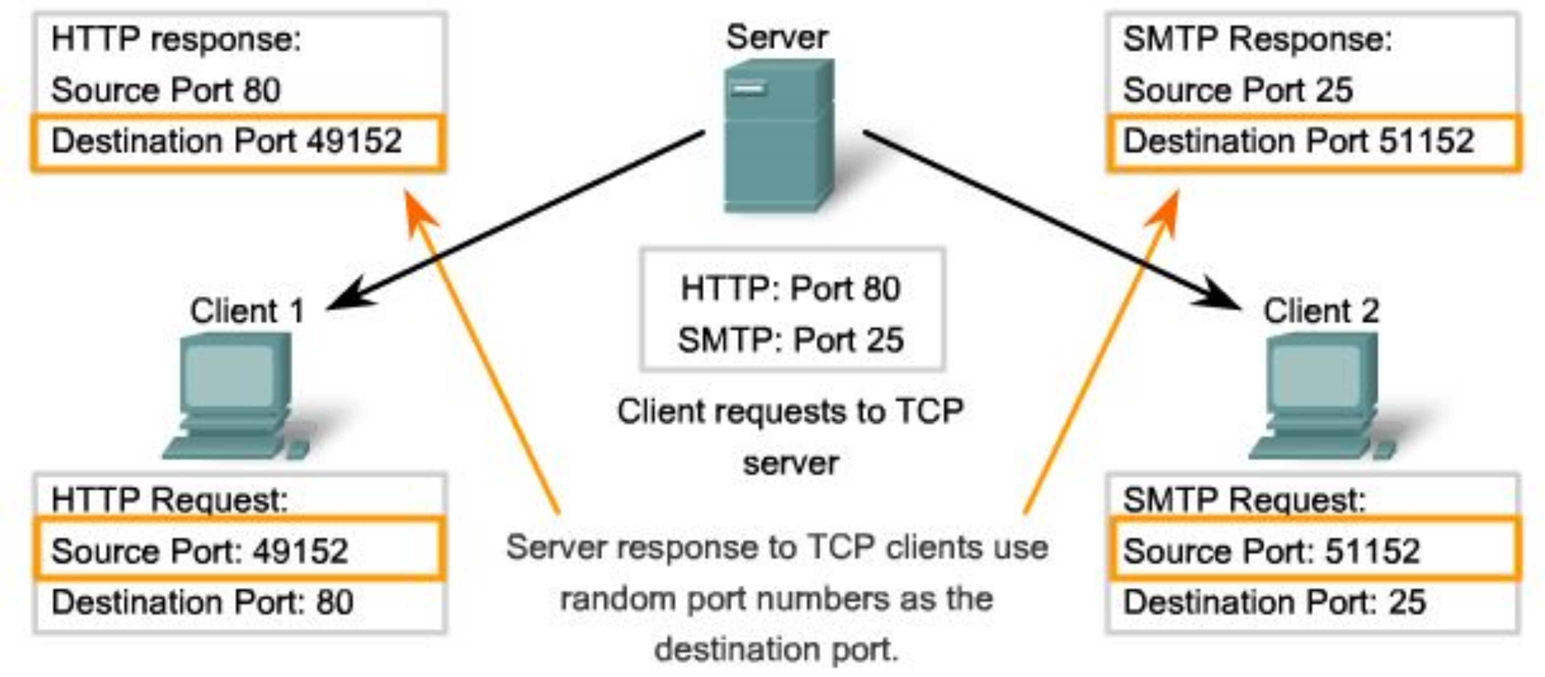
Client requests to TCP server

HTTP Request:
Source Port: 49152
Destination Port: 80

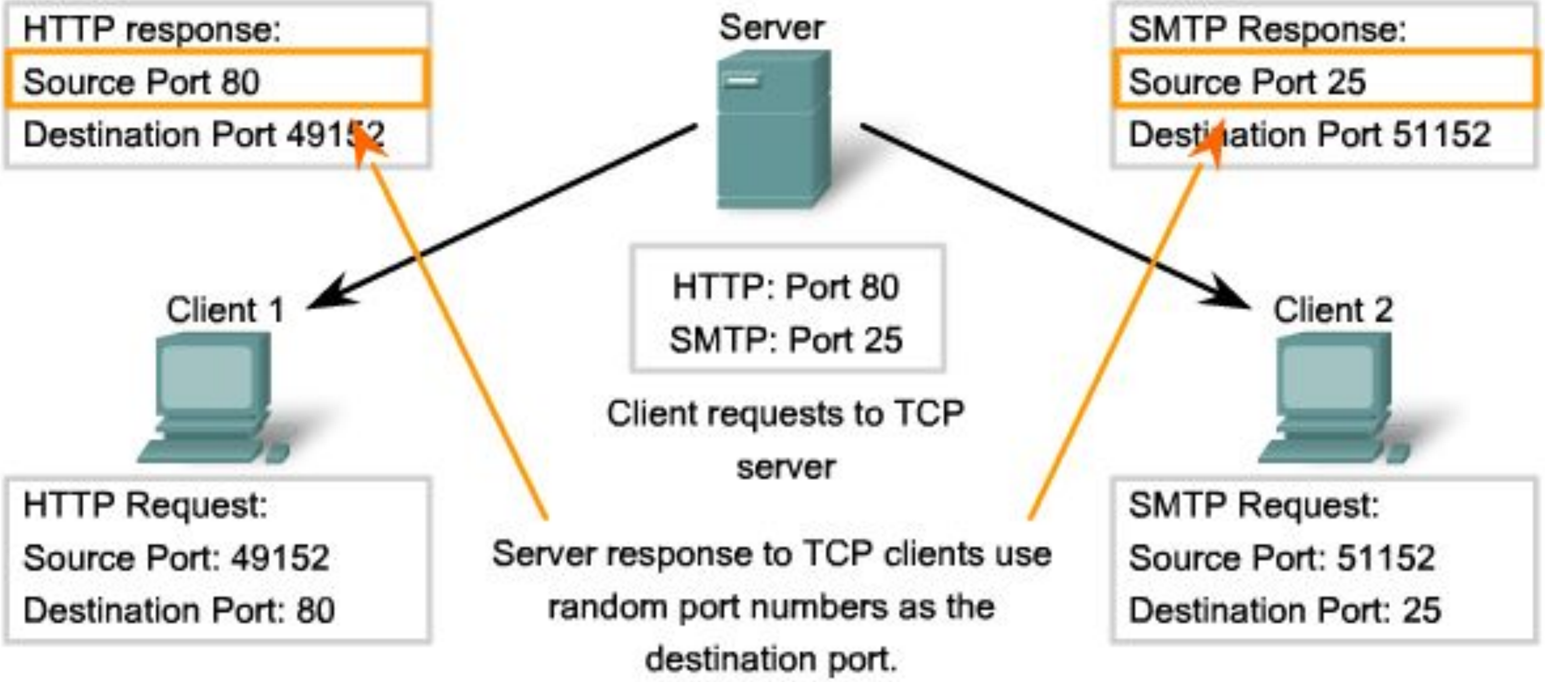
Use random port numbers as the source port.

SMTP Request:
Source Port: 51152
Destination Port: 25

Server Defines Destination Ports



Server Defines Source Ports



TCP CONNECTION ESTABLISHMENT AND TERMINATION

Question

- Establishment?

Answer

Question

- How me make handshake?

Answer

Question

- How many way do we have in handshake process?

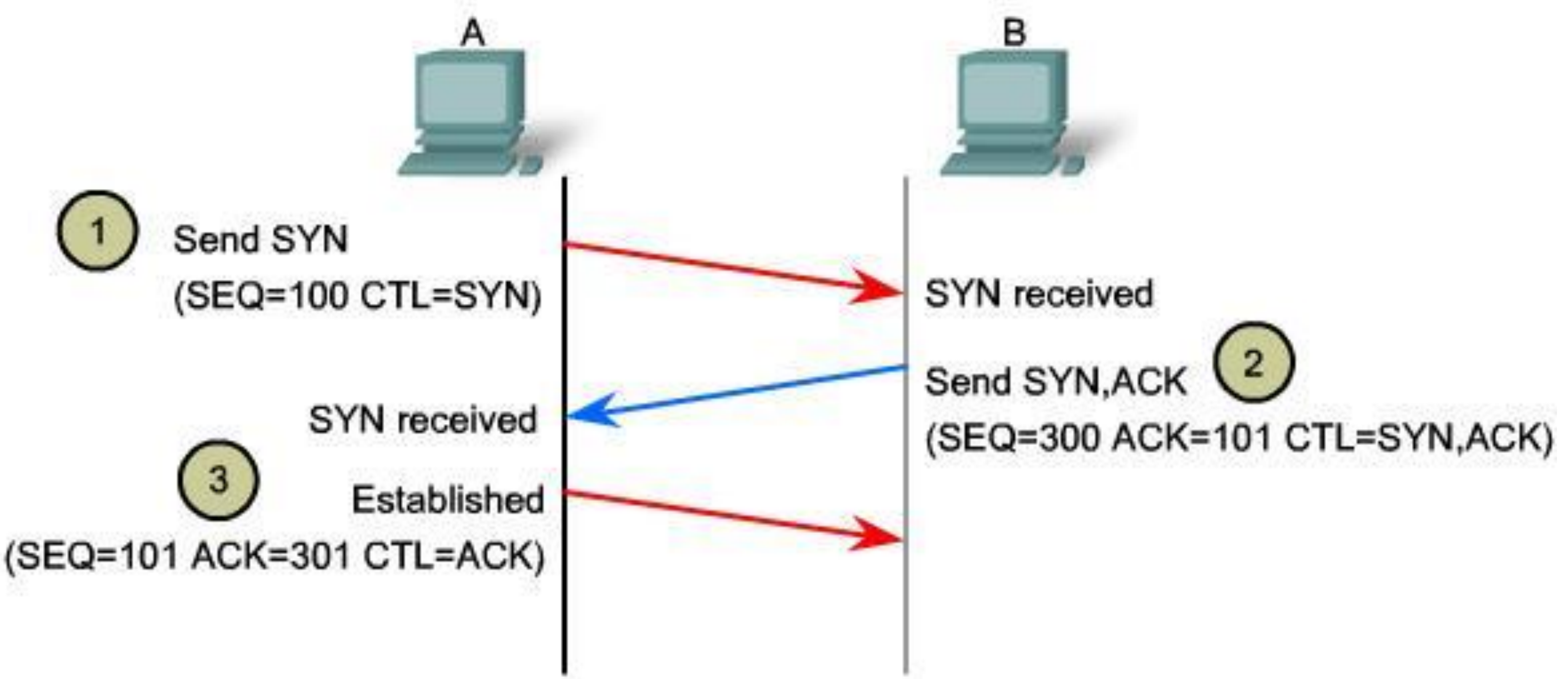
Answer

LOSE YOUR BELLY FAT
AND GET SIX PACK ABS
THIS VIDEO SH
Ads by Goo

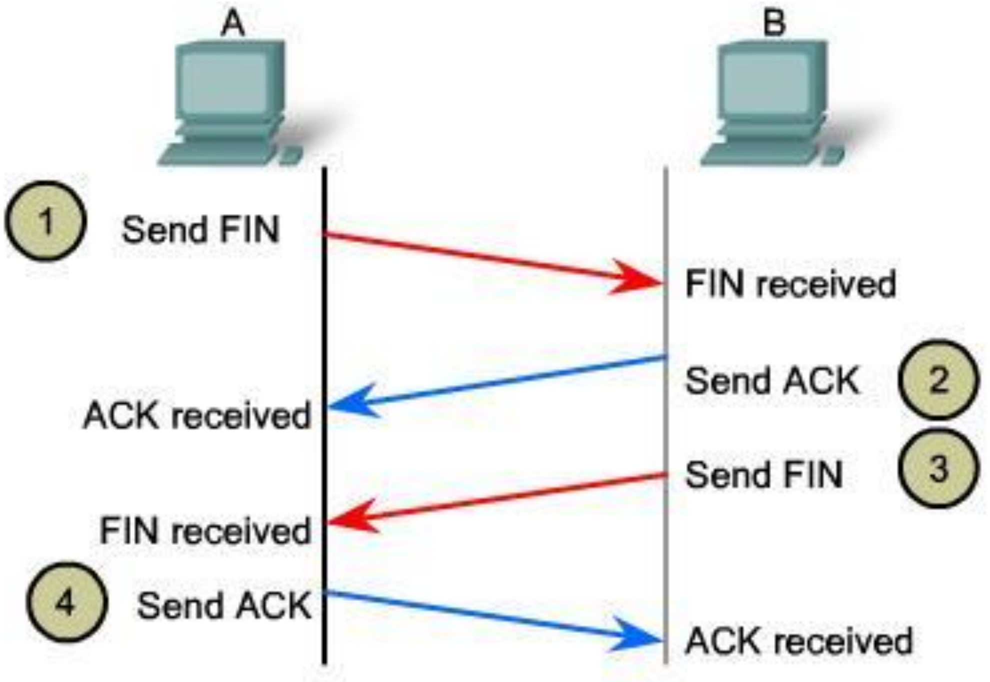
TCP Have to do Establishment before it Starts Transmission

- This process is called 3 way handshake

3 way handshake



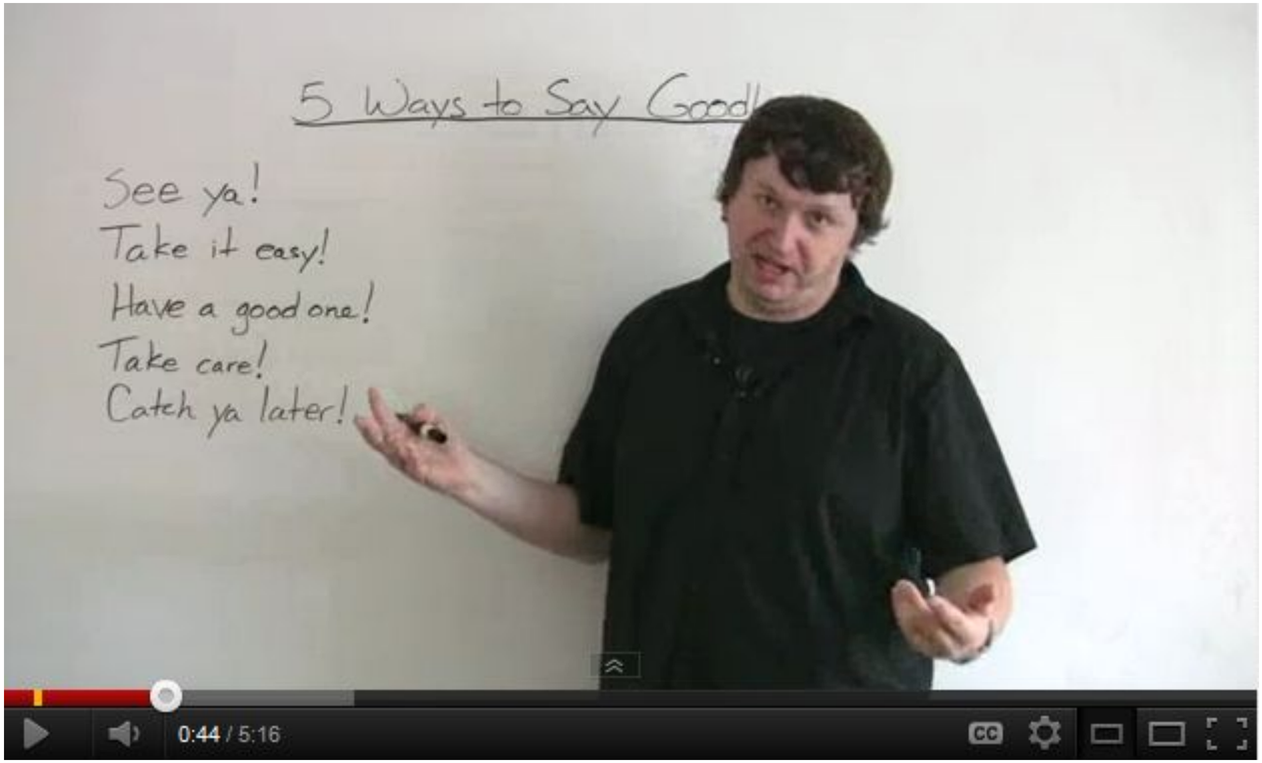
TCP Session Termination



Question

- How people say goodbye?

Answer



5 Ways to Say Goodb

See ya!

Take it easy!

Have a good one!

Take care!

Catch ya later!

REORDERING SEGMENTS AFTER RECEIVING

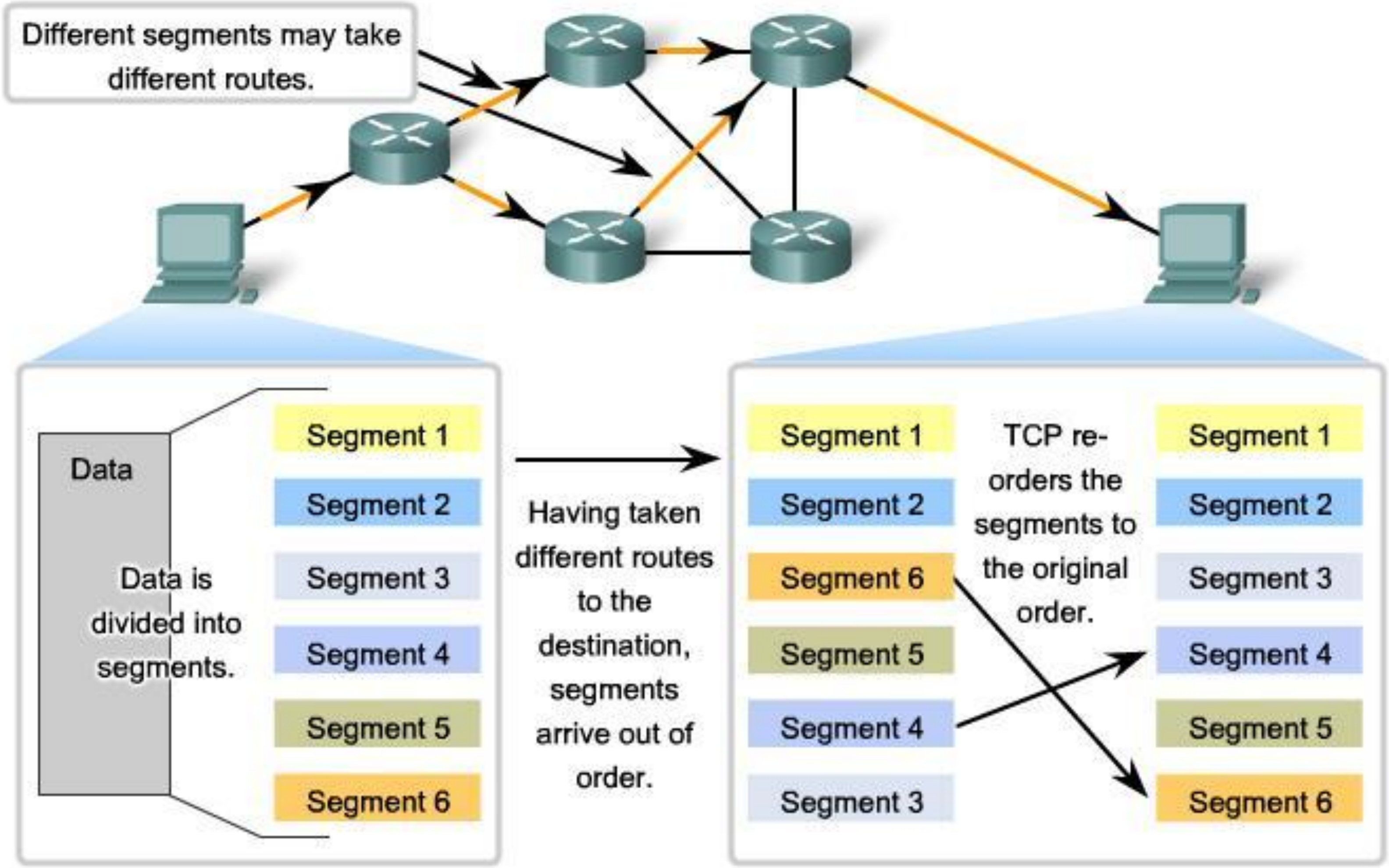
Question

- Why it is needed?

Answer

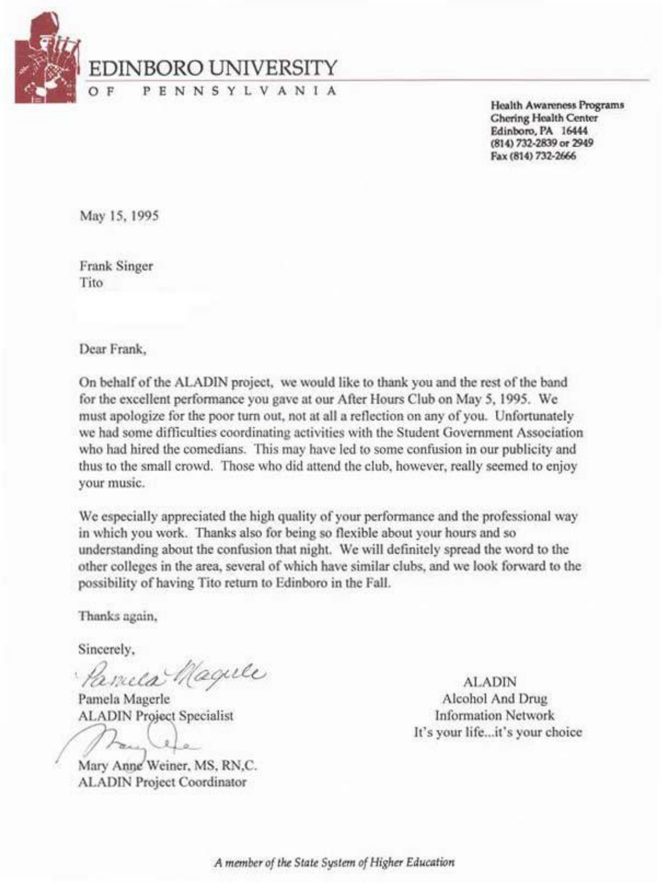
- Segments can be delivered in wrong order

Re-ordering segments


Different segments may take different routes.
Data
Data is divided into segments.
Segment 1
Segment 2
Segment 3
Segment 4
Segment 5
Segment 6
Having taken different routes to the destination, segments arrive out of order.
Segment 1
Segment 2
Segment 6
Segment 5
Segment 4
Segment 3
TCP re-orders the segments to the original order.
Segment 1
Segment 2
Segment 3
Segment 4
Segment 5
Segment 6

Acknowledgement

- is?



EDINBORO UNIVERSITY
OF PENNSYLVANIA

Health Awareness Programs
Ghering Health Center
Edinboro, PA 16444
(814) 732-2839 or 2949
Fax (814) 732-2666

May 15, 1995

Frank Singer
Tito

Dear Frank,

On behalf of the ALADIN project, we would like to thank you and the rest of the band for the excellent performance you gave at our After Hours Club on May 5, 1995. We must apologize for the poor turn out, not at all a reflection on any of you. Unfortunately we had some difficulties coordinating activities with the Student Government Association who had hired the comedians. This may have led to some confusion in our publicity and thus to the small crowd. Those who did attend the club, however, really seemed to enjoy your music.

We especially appreciated the high quality of your performance and the professional way in which you work. Thanks also for being so flexible about your hours and so understanding about the confusion that night. We will definitely spread the word to the other colleges in the area, several of which have similar clubs, and we look forward to the possibility of having Tito return to Edinboro in the Fall.

Thanks again,

Sincerely,

Pamela Magerle

Pamela Magerle
ALADIN Project Specialist

Mary Anne Weiner, MS, RN,C.
ALADIN Project Coordinator

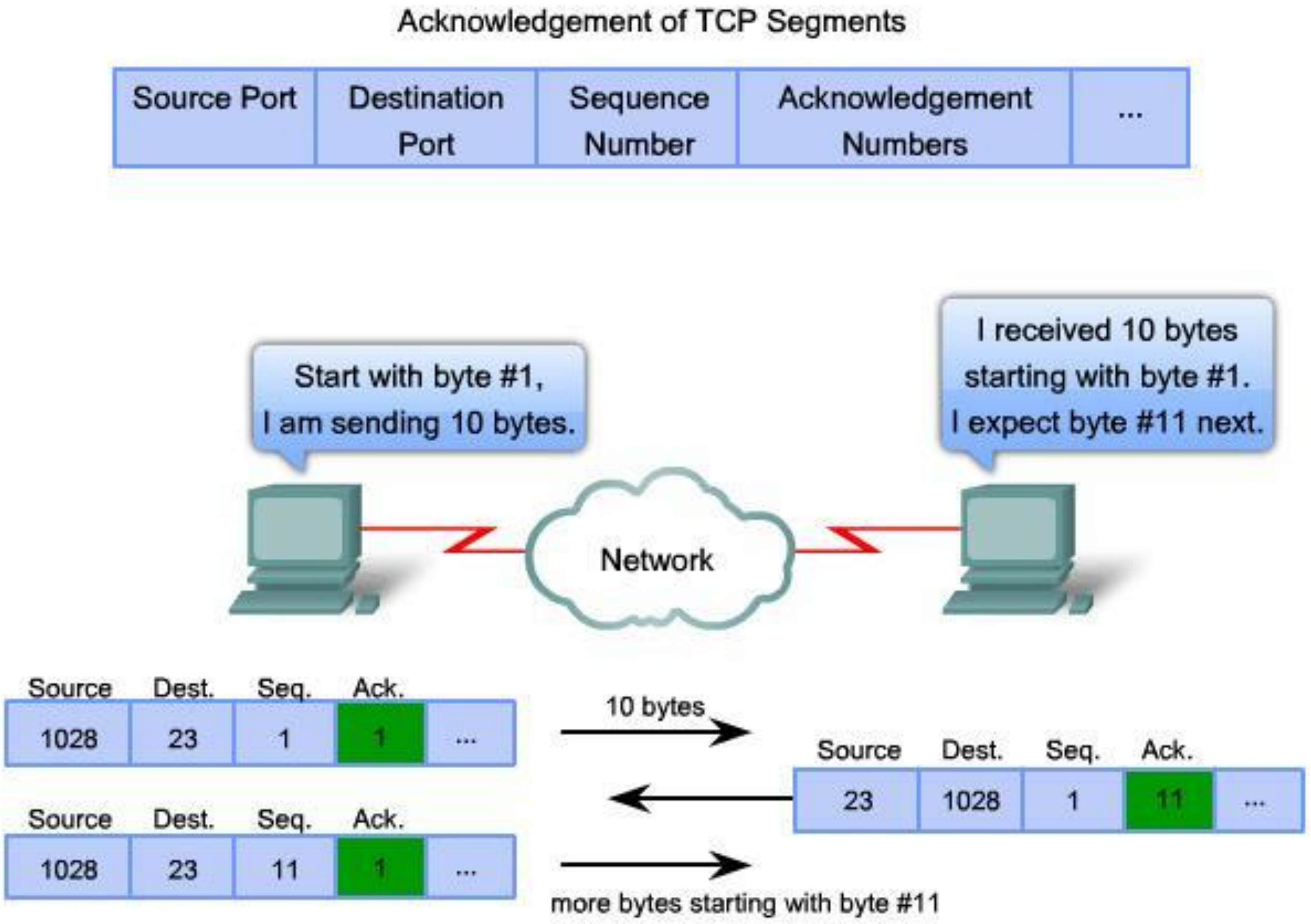
ALADIN
Alcohol And Drug
Information Network
It's your life...it's your choice

A member of the State System of Higher Education

Computer Acknowledgment

- Computers often sends acknowledgement to each other, to confirm that they have received data.

Clients retransmit data if they don't get acknowledgement



Acknowledgement of TCP Segments

Source Port	Destination Port	Sequence Number	Acknowledgement Numbers	...

Start with byte #1, I am sending 10 bytes.

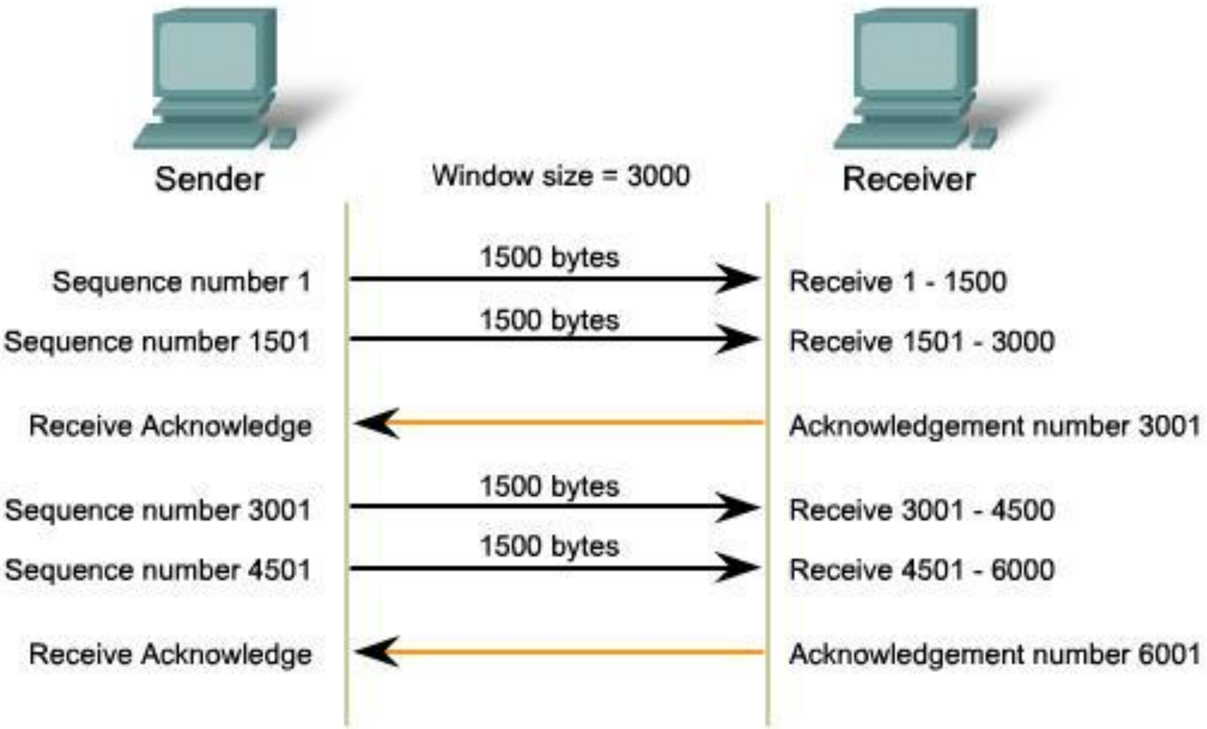
I received 10 bytes starting with byte #1. I expect byte #11 next.

Source	Dest.	Seq.	Ack.	
1028	23	1	1	...

Source	Dest.	Seq.	Ack.	
23	1028	1	11	...

Source	Dest.	Seq.	Ack.	
1028	23	11	1	...

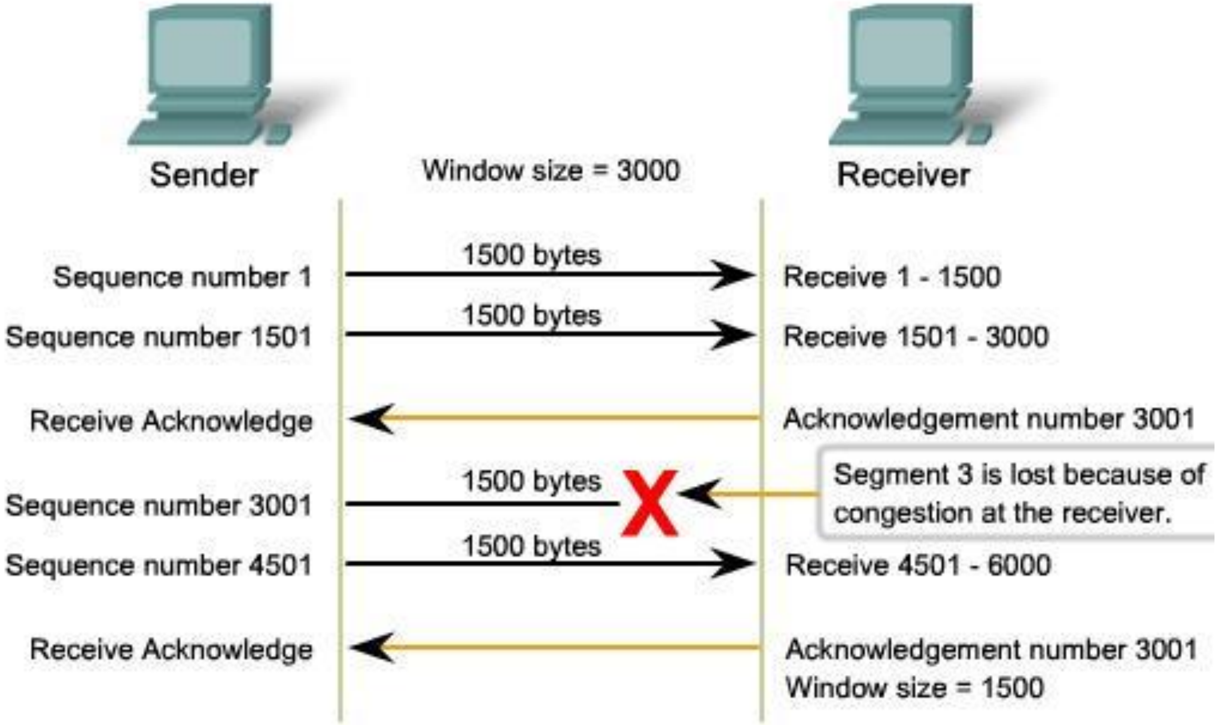
Flow Control



The window size determines the number of bytes sent before an acknowledgment is expected.

The acknowledgement number is the number of the next expected byte.

Flow Control with problems



If segments are lost because of congestion, the Receiver will acknowledge the last received sequential segment and reply with a reduced window size.

UDP – USER DATAGRAM PROTOCOL

UDP

- UDP protocol is the protocol of OSI model's 4th layer (transport layer), is not reliable but very very very fast!!!

QUESTIONS