Mastering TCP/IP section 6

KUMO / cat

The transport layer

Defines how to transmit or receive network packets

Protocols mainly used: TCP / UDP

Port number

- There are multiple applications running simultaneously on a computer.
- A port number is required to determine an application to receive the packet.
- An application can open multiple ports.
- A port can accept multiple connections
- A port can separately be opened as each protocol

Example: port number

Port to connect	service program
80	http daemon
22	ssh daemon

* These daemons could be forked from the internet daemon

TCP and UDP

- Two protocols to transmit/receive network packets
- TCP: Transmission Control Protocol
- UDP: User Datagram Protocol

*A protocol is specified in the IP header field.

TCP

Features:

- Establishes a solid connection

- performs packet sequencing, retransmission control and many other processes

- Guarantees the correctly-organized unbroken data is streamed to the receiver

- Tries to optimize the throughput while avoiding too much bandwidth occupation

- Slower than UDP

UDP

Features:

- Does not establish a connection
- Does nothing after sending packets
- Does not care about bandwidth at all
- Packets may be lost on the way to the destination
- Faster than TCP

Which protocol should we use?

TCP:

- Where reliable data transmissions are required

E.G. retrieving website contents, file transferring

UDP:

- Where the transmission speed has more priority than reliability

- Where the amount of packet to transmit is small

- where slight packet losses do not affect the overall performance of the task

E.G. Video streaming, realtime voice chat

Socket API

A set of Application Programming Interface(API) for handling TCP / UDP

Connecting multiple nodes to the same port

- Youtube can be streamed by many users simultaneously
- Every SFC student can tweet like crazy
- A server does not explode with a little flood of F5 attack

Why?

Five elements to distinguish incoming transmissions

- Destination IP address
- Sender IP address
- Destination port number
- Sender port number
- Protocol number

- Compare each element
- Associate to a connection that the five info perfectly matched

- Destination IP address
- Sender IP address
- Destination port number
- Sender port number
- Protocol number

Allocation of the port number

Static:

-Use 0 to 1023(well-known ports) for well-known services

- Use 1024-49151 for your original applications

- Implemented for the server side in most cases

Dynamic:

- Use a port number that the operating system returned as a usable port (in range of 49152-65535)

- Implemented for the client side in most cases

Basics of TCP

Various tricks that TCP is performing for us

Connections

Connection

- The most basic theory of TCP

- A kind of virtual pipe that connects two nodes (technically called virtual circuit)

- Everything put in the pipe certainly reaches the exit

ACK / NACK (1)

- A special packet that the receiver sends to the sender
- Represents the successful reception of the data
- The receiver sends NACK when there is something wrong with the data
- If the sender doesn't receive an ACK within a specified period of time or receives NACK, it resends the associated data

ACK / NACK (2)

- ACK / NACK packet itself may be delayd or lost
- The receiver may receive the same data
- Duplicated data must be automatically disposed, but how?

Sequence number

- Consequential numbers linked to the octet of the data
- With an ACK response, the receiver returns the consequential number that it wants next

Retransmission timeout

- Specifies how long the sender should wait for an ACK before retransmitting

- TCP automatically updates the value using round trip time and their variance

- If a retransmission occurs, TCP doubles the timeout

- If three consequential retransmission occur, TCP closes the connection

Establishing / closing a connection

SYN: "I want to connect to you!"

ACK: "Sure you can."

↓

three-way handshake

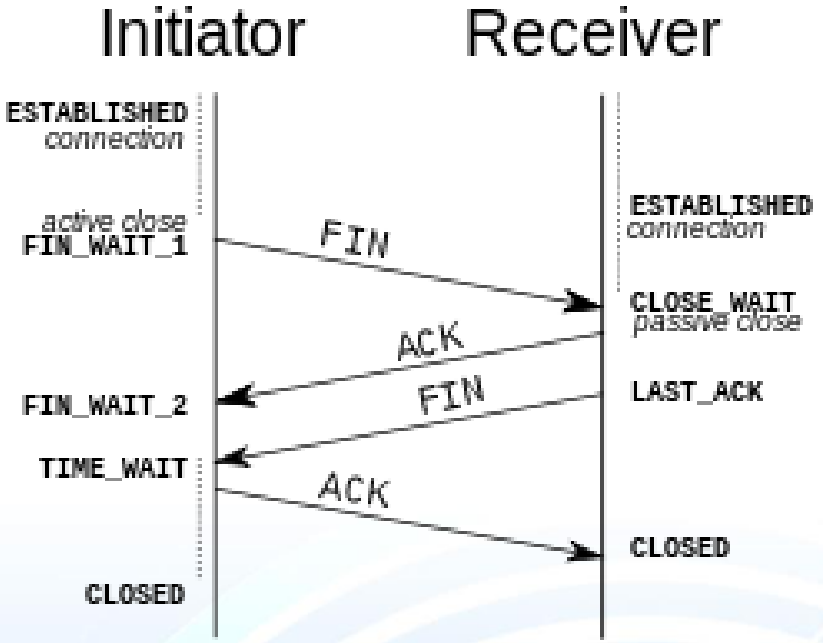
↓

some transmissions

↓

FIN: "That's all today, can I leave?"

ACK: "Yes, thanks!" or NACK: "No, there's some data remaining."



MSS

- Maximum segment size
- Specifies how much data to be sent per transmission
- Also used as the data retransmission unit
- Determined at the three-way handshake prosedure

Window handling (1)

send some data

wait for an ACK

If an ACK arrived, send the next data, if not, resend the current data

↓

We want more speed! Don't want to wait!

Window handling (2)

send data chunk 1

Send data chunk 2

send data chunk 3

…

ACK for data chunk 3 has arrived → forget about data chunk 1 2 3 and load 4 5 6

*If an ACK arrives, forget about the data chunks up to the response number

send data chunk 4

send data chunk 5

send data chunk 6

…

Lessening the number of ACK's

- The receiver knows the sequence number of the data that it wants next
- The receiver does not receive anything other than that
- If the receiver gets anything it doesn't want, it requests the sequence number that it really wants

↓

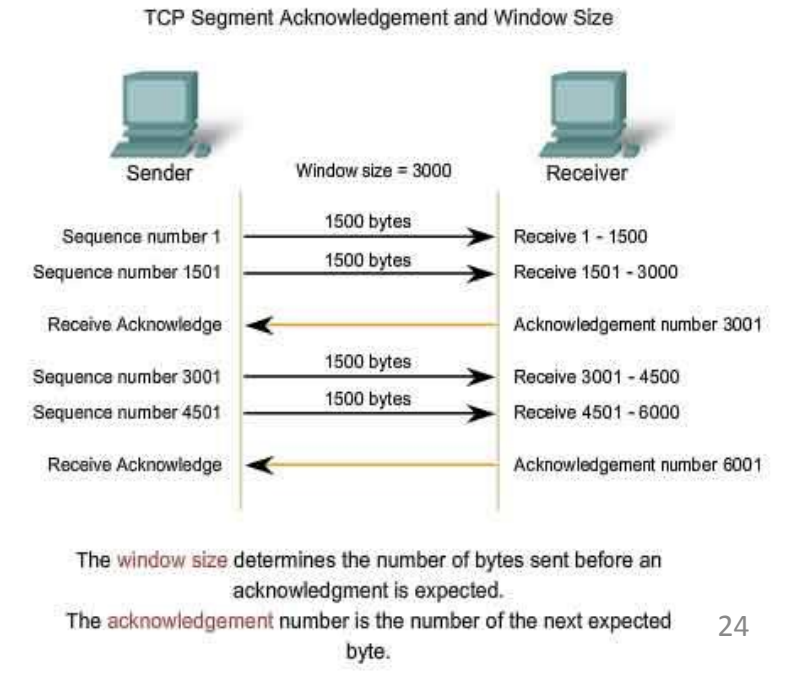
- The correct Arrival of the data prier to the sequence number is ensured

↓

- ACK's for all segments are not necessarily required

Window size

- Window size in the previous example was 3
- Window size is specified by the receiver and dynamically changed
- The receiver periodically notifies updates of window size



Slow start algorithm

- An algorithm to avoid bandwidth occupation
- Starts with a slow speed
- Gradually increases the window size
- drastically decreases the window size when a retransmission is detected
- The amount of decline takes different values by the type of retransmission caused: timeout or duplication response

Piggy back

- An ACK that contains external data such as the echo-backed data of user input

- The algorithm can reduce the total amount of packet to be transferred

Other transport protocols

- UDP-Lite
- SCTP
- DCCP