COMP202-08B
Computer Communications

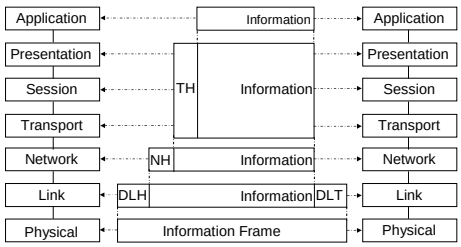
Lecture 15

TCP part 3

TCP

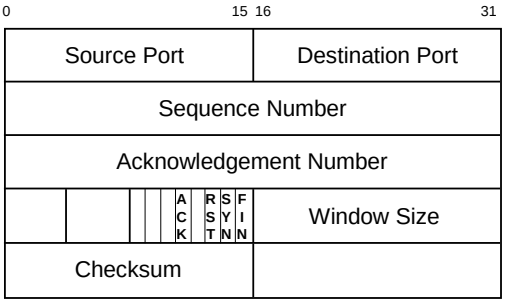
- Transmission control protocol (TCP)
- TCP is known as a *transport protocol* that is:
  - reliable,
  - connection-oriented,
  - stream-based

Encapsulation: TCP + Internet model



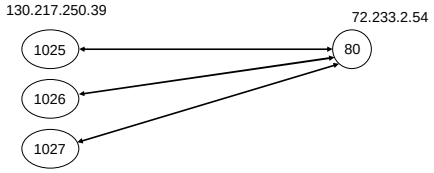
•TCP + Sockets cover the presentation, session, and transport layers
•Difficult to build an efficient network stack using the 7-layer model

TCP header: needed for 202

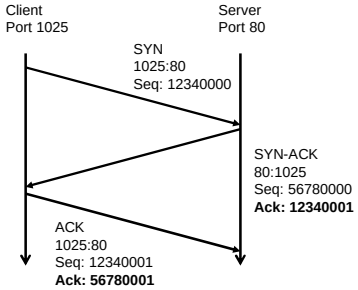


TCP connections

- A TCP connection can be uniquely identified by:
  - Source IP address
  - Destination IP address
  - Source port
  - Destination port



Establishing a TCP connection



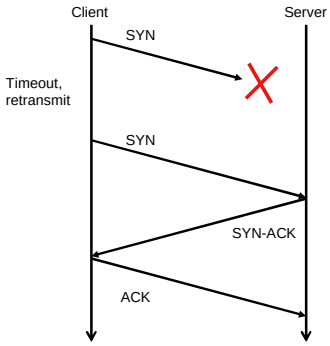
TCP is a reliable transport protocol

- If a packet is lost or corrupted, TCP will try sending it again
  - Detecting corruption:
    - checksum computation did not match.
  - Detecting loss: multiple methods
    - Simplest: no acknowledgement received before timeout
- Note: a TCP receiver does not explicitly tell the sender it is missing a packet, or that one was corrupted
  - The sender infers this when an acknowledgement is not received before a time-out occurs.

Why not tell the sender when a packet is lost?

- TCP assumes if a packet is lost, the network was unable to forward it, due to congestion
- Congestion occurs when packets cannot be forwarded at the rate they are arriving at.
- Loss implying congestion is not entirely true, some mediums are more likely to have packets corrupted
  - e.g. wireless.
- Theory goes that sending a new packet into the network to say something was lost only adds to the congestion problem
  - This is not entirely true

Example loss: Establishing a connection



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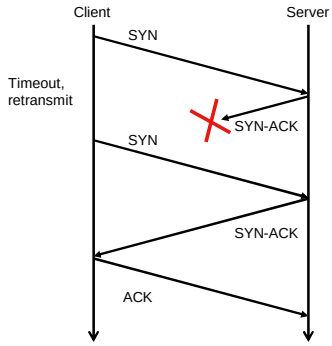


Denial of Service: SYN flood

- Each time a SYN probe is sent, the receiver has to
  - Check if there is a socket listening for new connections (ServerSocket)
  - If there is, search a table of existing connections to see if there is already a connection established with the same 4-tuple of values (source-IP, destination-IP, source-port, destination-port)
  - If no connection is found, add a new connection record to the table and send a SYN-ACK in reply
- Simple TCP denial of service attack:
  - Send as many SYN packets with randomised source port values, and spoofed (randomised) source addresses.
  - Receiver has to
    - Search a table of existing connections (consumes CPU time)
    - allocate a record (consumes memory)

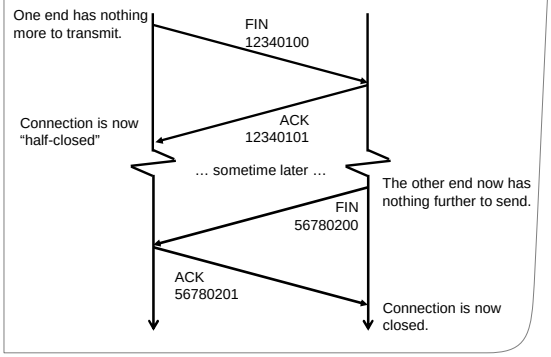
Denial of Service: SYN flood

- Note: this technique not so useful these days, most operating systems have some defence mechanism

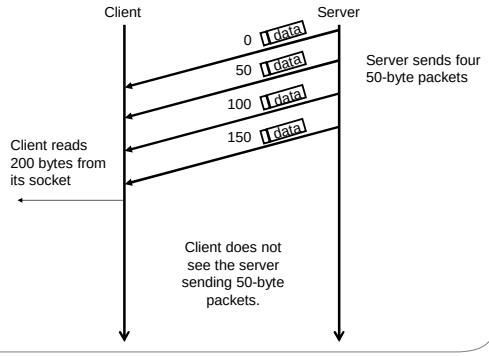
Closing a connection

- Closing a connection in TCP is done in two steps
  - One host A tells the other host B it has nothing more to send
    - (is finished)
    - Connection is now in *half-open* state
  - Eventually, the host B tells host A it too has finished.
  - Connection is now finished.

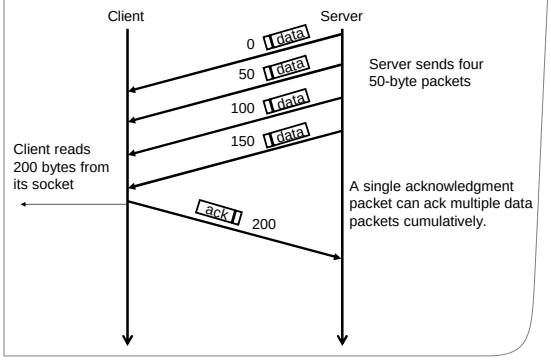
Closing a connection



TCP is a stream-based protocol



TCP is a reliable, stream-based protocol



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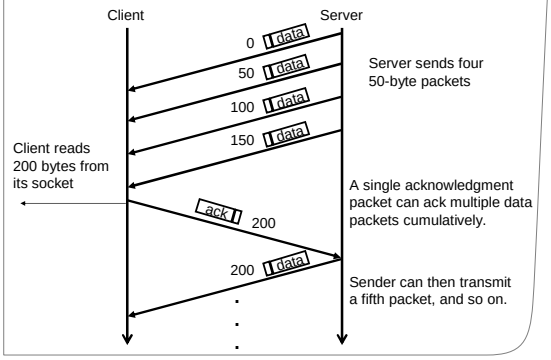

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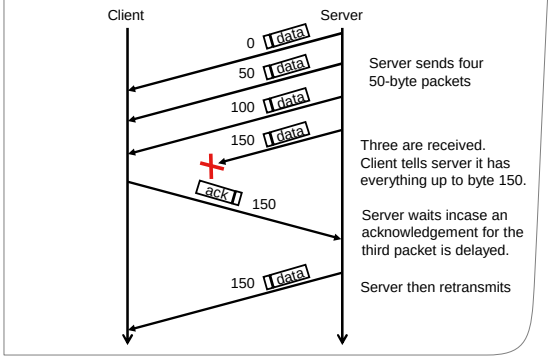

Implementation of a reliable transport

- Requires sender to keep a copy of the data that the receiver has not yet acknowledged.
  - Operating system keeps data in a buffer in the kernel
- Requires sender to decide when data should be declared lost and retransmitted
  - Operating system keeps track of how long it took previous data to be acknowledged

Summary

- TCP is a *transport protocol* that is:
- Reliable
  - Unacknowledged packets are retransmitted after they are lost and/or time out
- connection-oriented,
  - Hosts establish connection with 3-packet handshake
  - tear-down connections with 4-packet exchange
- stream-based
  - Client socket sees a stream of bytes, like reading or writing a file.
  - Does not see individual packets, or retransmitted packets, or connection establishment/teardown packets.

Next lecture

- TCP fairness
  - Slow-start
  - Retransmission timer
  - Aspects of congestion control