

CSc 450/550

Computer Networks

Transmission Control Protocol

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Review: application layer

- HTTP
 - client-server model
 - request-reply transaction
 - based on TCP
- DNS
 - DNS hierarchy
 - DNS queries
 - based on UDP

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Transport layer services

- Services offered by transport layer
 - endpoint-to-endpoint communication
 - *endpoint*: an application process in end-hosts
 - connection vs connectionless
 - reliable vs unreliable
- Services offered by network layer
 - move packets from one end-host to another
 - possibly through many intermediate systems

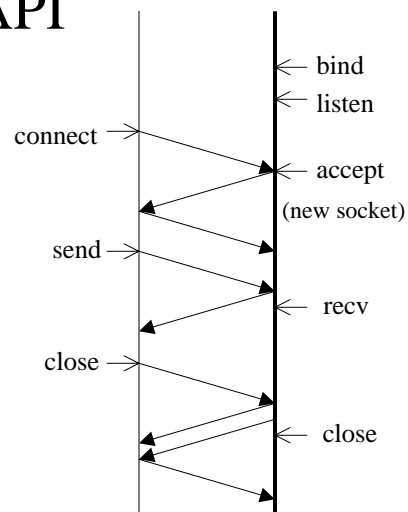
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Socket API

- Server
 - bind, listen
- Client
 - connect
- Server
 - accept
- Client-server
 - send, recv, close



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Socket, TCP, IP

- Socket
 - send (socketid, pointer_to_buffer, length, flags);
- TCP
 - TCP segmentation: TCP segments
 - TCP *packet* header: TCP control information
- IP
 - IP packetization: IP packets
 - IP packet header: IP control information

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TCP

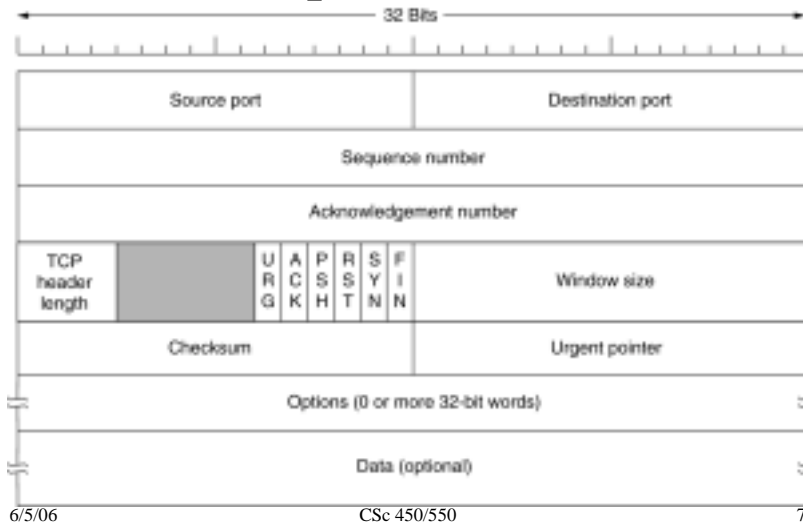
- Transmission control protocol [RFC793]
- Services offered by TCP
 - connection-oriented, bi-directional
 - reliable, in-sequence, stream-like
- Packets delivered by IP
 - maybe duplicated, lost, reordered, corrupted
- TCP protocol mechanisms
 - connection management
 - flow, error and congestion control

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TCP packet header



TCP port number

- Port number (16-bit)
 - source, destination port numbers
 - multiplexing and de-multiplexing
 - Port number allocation (ref: iana.org)
 - well-known port numbers (0~1023, privileged)
 - 80: http; 443: https
 - registered port numbers
 - 8080: http-alt
 - dynamically allocated port numbers
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TCP connection ID

- TCP connections
 - connection: initiator, responder
 - (initiator IP, initiator port, responder IP, responder port)
- One connection: one flow in each direction
 - for each flow: source, destination
 - (source IP, source port, destination IP, destination port)
 - 5-tuple (or 4-tuple when protocol is implied)
 - (src IP, src port, protocol ID, dst IP, dst port)
- Socket, connection, flow

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TCP sequence number

- Sequence number (32-bit)
 - byte sequence for the *first* byte in payload
 - exception: SYN/FIN sequence number
 - random initial sequence number
 - exchanged during 3-way handshake
 - sequence number rollover
- Acknowledgment number (32-bit)
 - byte sequence for the *next* byte to expect

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TCP control flags

- URG: urgent pointer meaningful
- ACK
 - acknowledgment number meaningful
- PSH: logic message boundary
- RST: connection rest
- SYN
 - synchronization (connection establishment)
- FIN
 - finish (graceful connection release)

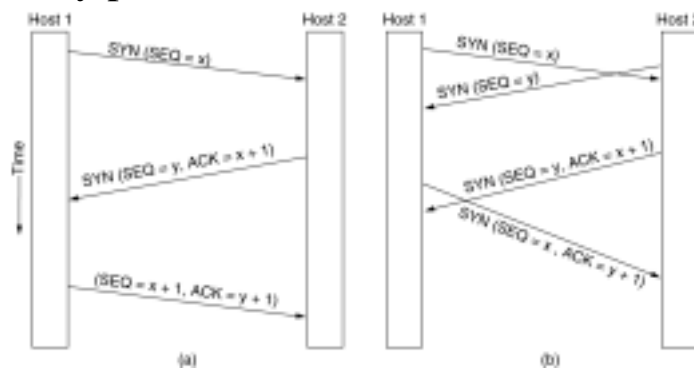
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TCP connection establishment

- 3-way packet handshake



- Simultaneous establishment attempts

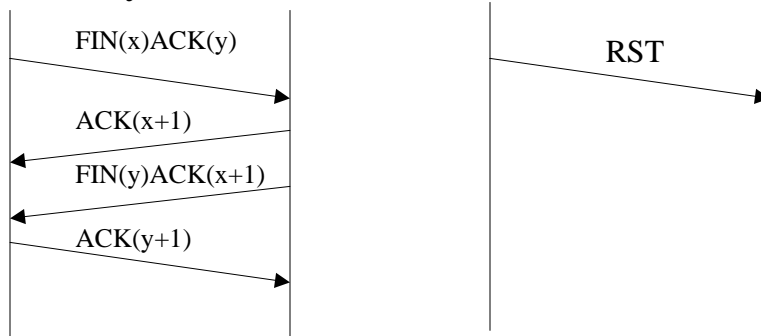
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TCP connection release

- 2-way handshake in each direction

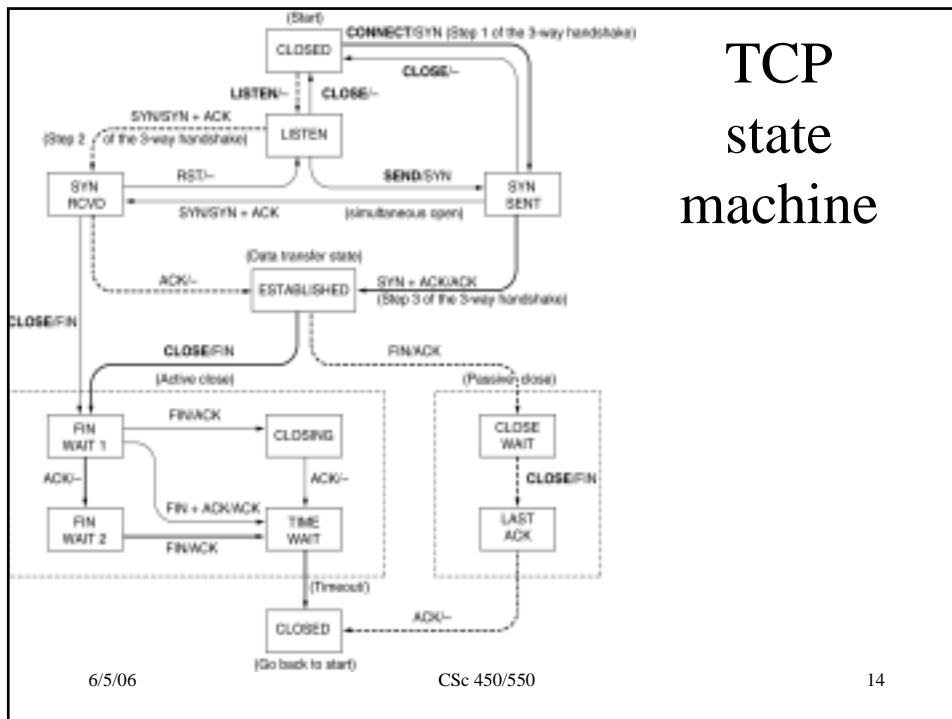


- Connection reset

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This lecture

- TCP
 - services offered by TCP
 - TCP connection management
 - connection establishment
 - connection release
 - TCP state machine
- Explore further
 - tcpdump (or Ethereal) your P1!

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Next lecture

- TCP flow and error control
 - read CN Chapter 6

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