Introduction to Computer Networks

Connection Establishment (§6.5.6, §6.5.7, §6.2.3)

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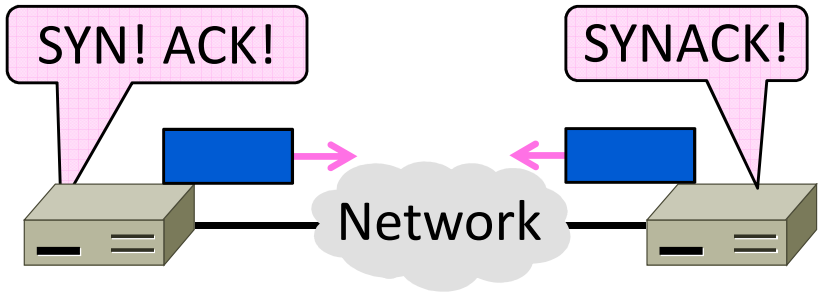
Topic

- How to set up connections
  - We'll see how TCP does it



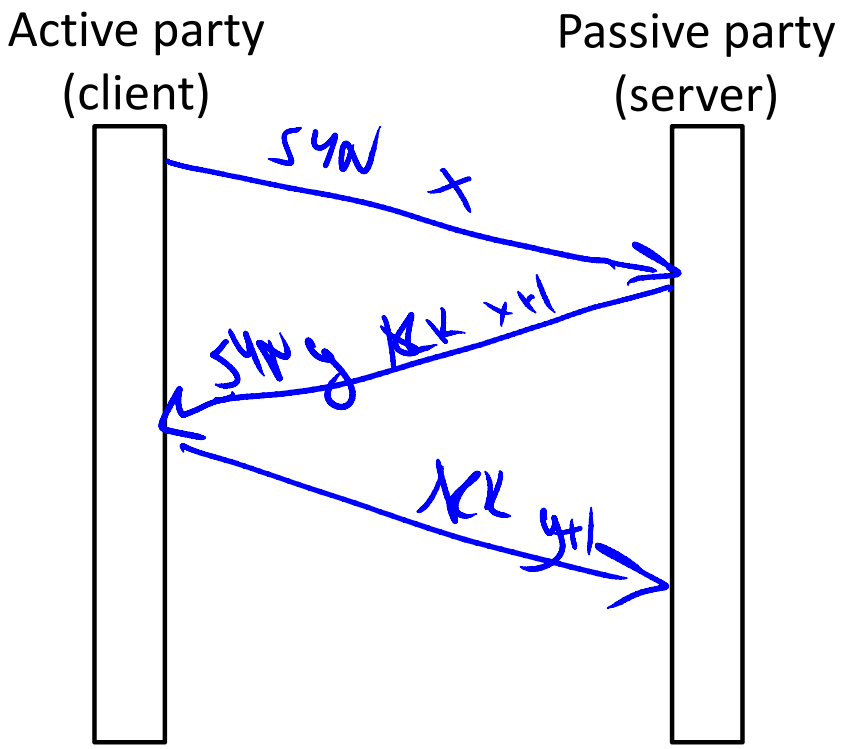
Connection Establishment

- Both sender and receiver must be ready before we start the transfer of data
  - Need to agree on a set of parameters
  - e.g., the Maximum Segment Size (MSS)

- This is signaling
  - It sets up state at the endpoints
  - Like “dialing” for a telephone call

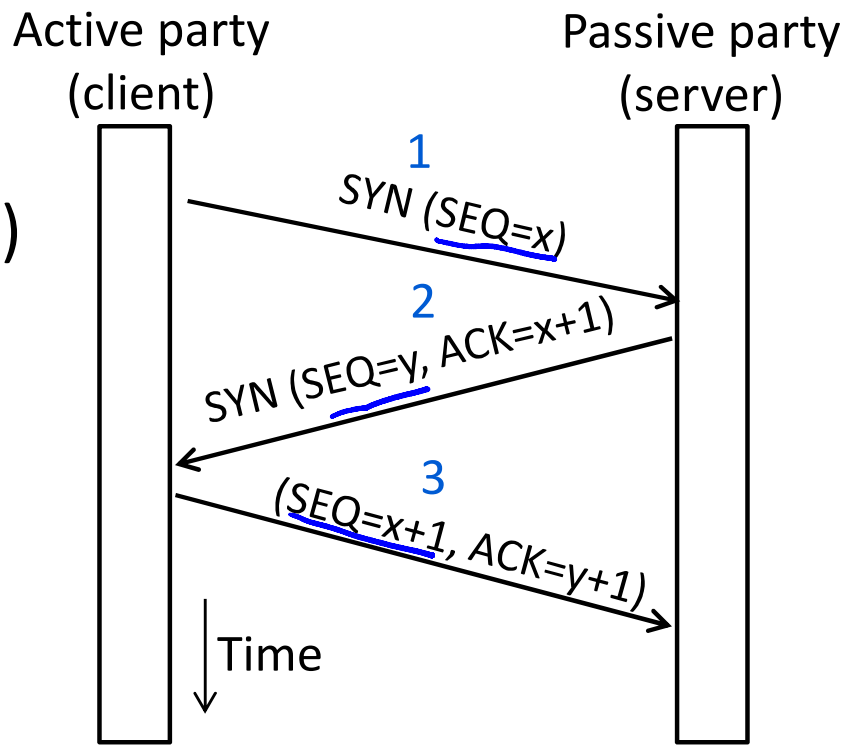
Three-Way Handshake

- Used in TCP; opens connection for data in both directions
- Each side probes the other with a fresh Initial Sequence Number (ISN)
  - Sends on a SYNchronize segment
  - Echo on an ACKnowledge segment
- Chosen to be robust even against delayed duplicates



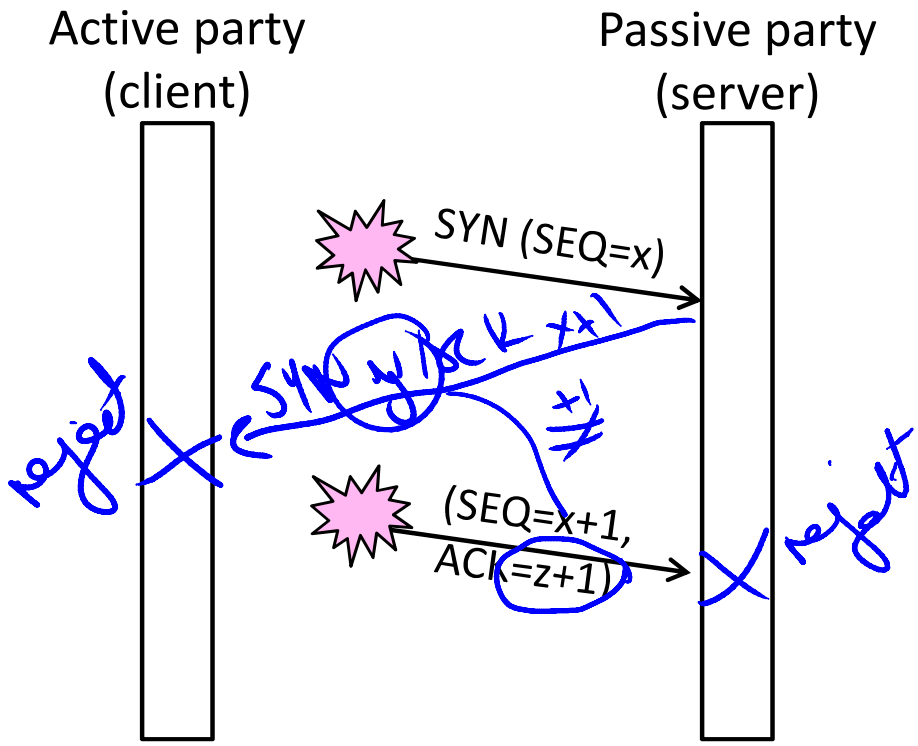
Three-Way Handshake (2)

- Three steps:
  - Client sends SYN(x)
  - Server replies with SYN(y)ACK(x+1)
  - Client replies with ACK(y+1)
  - SYNs are retransmitted if lost
- Sequence and ack numbers carried on further segments



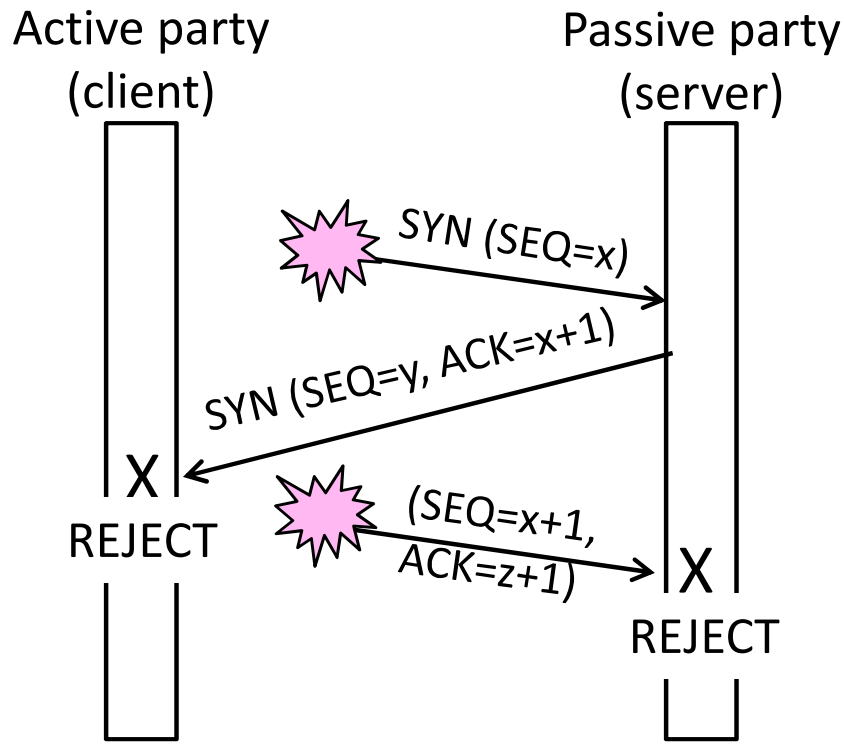
Three-Way Handshake (3)

- Suppose delayed, duplicate copies of the SYN and ACK arrive at the server!
  - Improbable, but anyhow …



Three-Way Handshake (4)

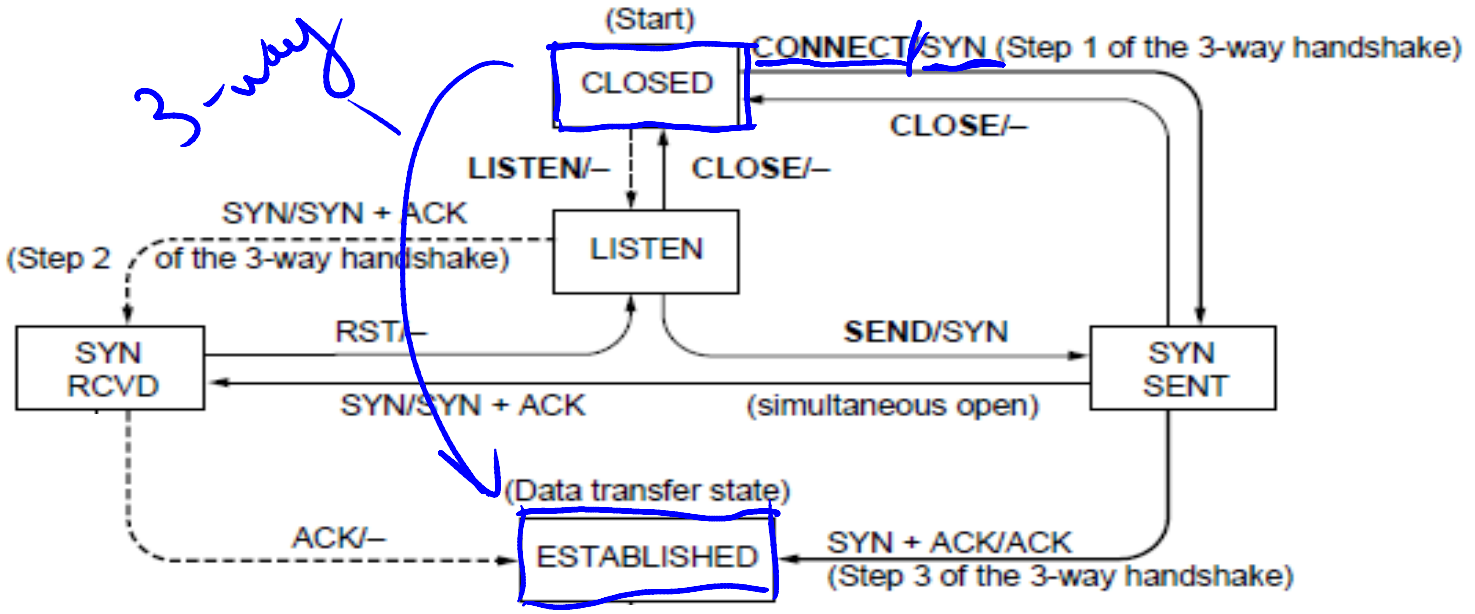
- Suppose delayed, duplicate copies of the SYN and ACK arrive at the server!
  - Improbable, but anyhow …
- Connection will be cleanly rejected on both sides ☺



TCP Connection State Machine

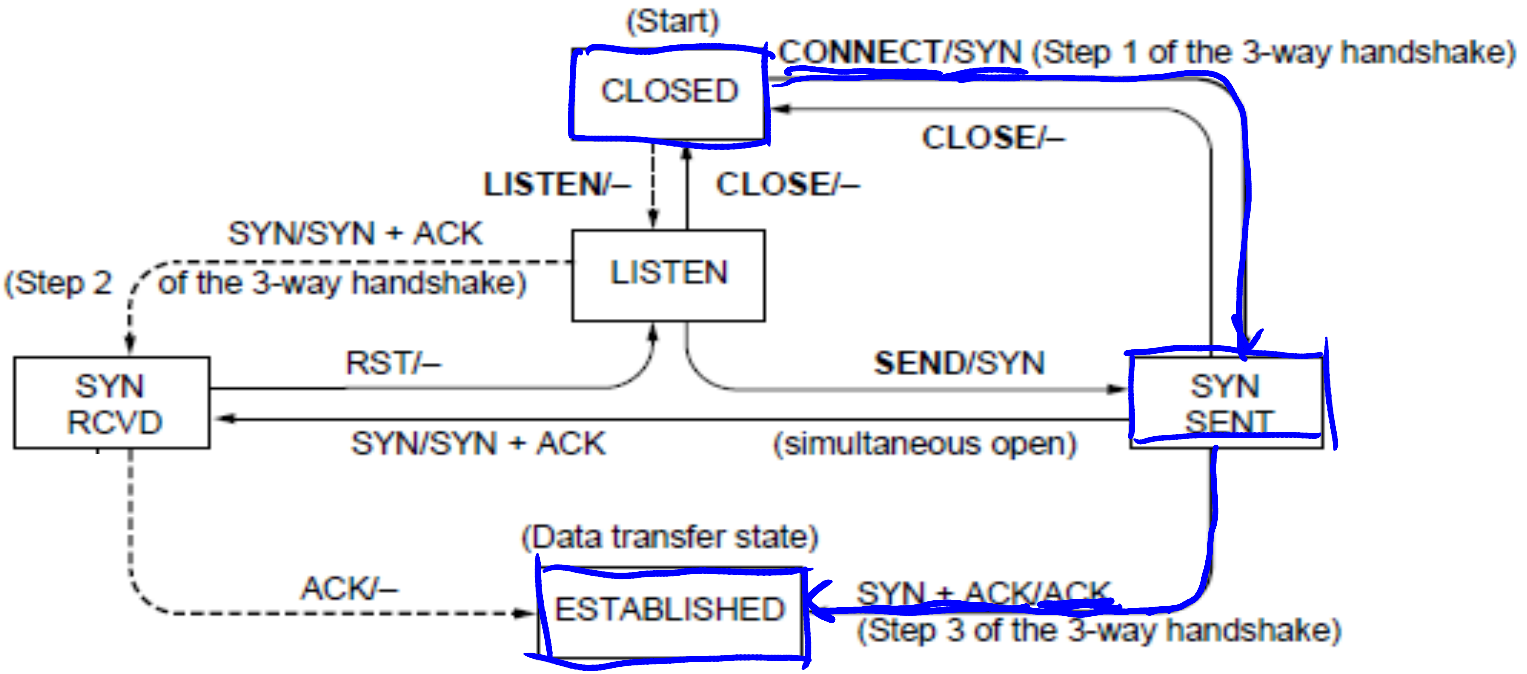
- Captures the states (rectangles) and transitions (arrows)
  - A/B means event A triggers the transition, with action B

Both parties run instances of this state machine



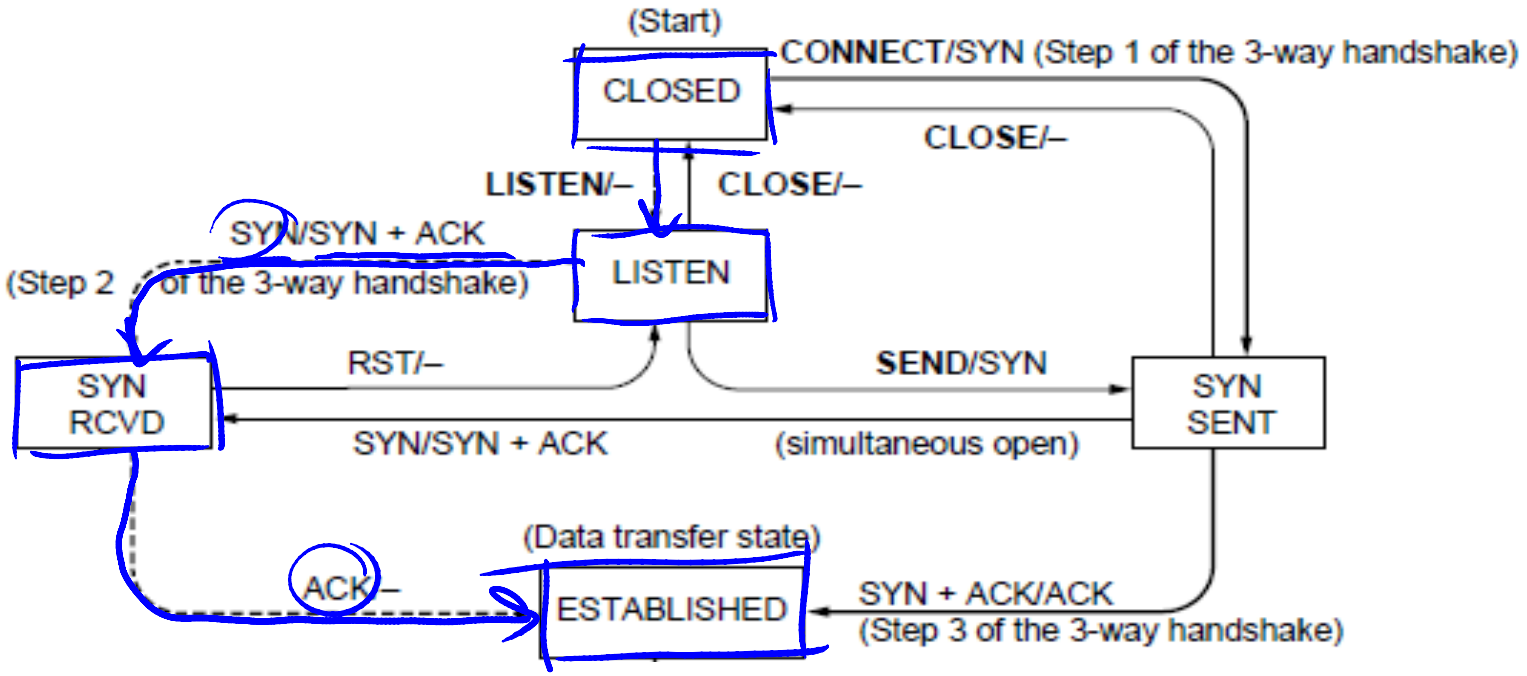
TCP Connections (2)

- Follow the path of the client:



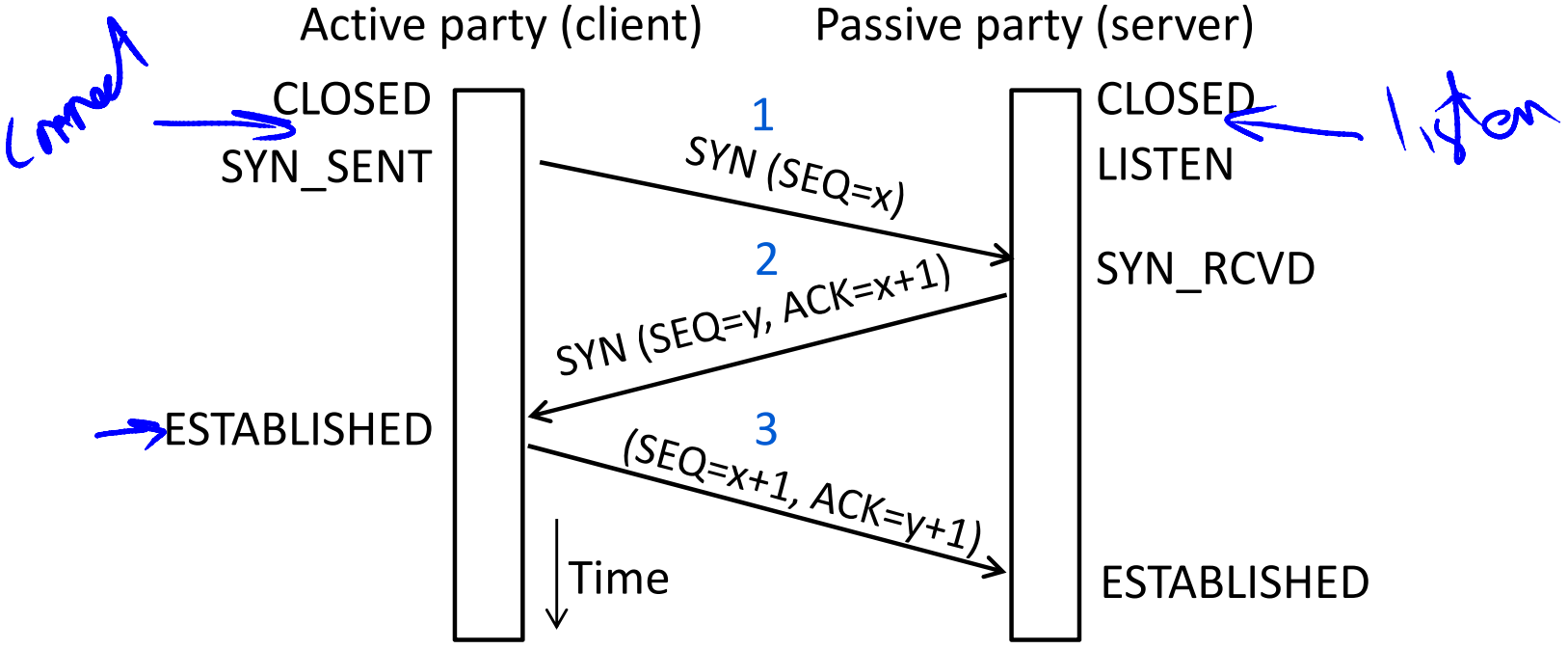
TCP Connections (3)

- And the path of the server:



TCP Connections (4)

- Again, with states …



TCP Connections (5)

- Finite state machines are a useful tool to specify and check the handling of all cases that may occur
- TCP allows for simultaneous open
  - i.e., both sides open at once instead of the client-server pattern
  - Try at home to confirm it works ☺

END