CSc 450/550
Computer Networks
Connection Management

Jianping Pan

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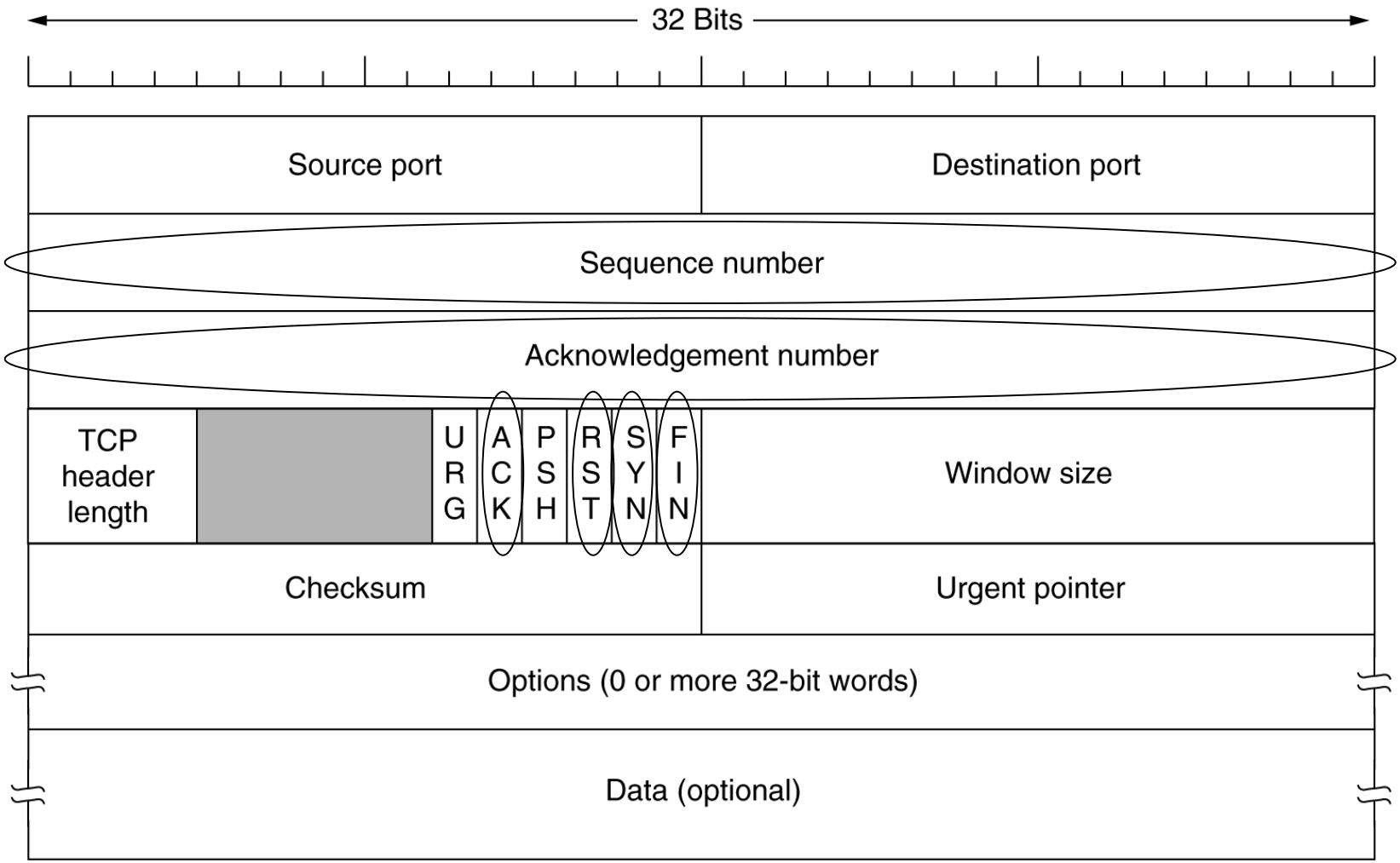
Review: TCP

- Service provided by TCP
  - connection-oriented
  - reliable data transfer
- Service used by TCP
  - IP: connectionless, unreliable
- TCP packet header
- TCP protocol mechanisms
  - **connection management**
  - flow, error and congestion control

Today's topics

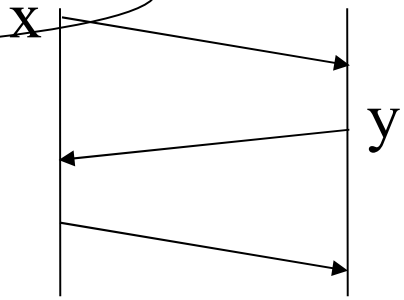
- Connection management
  - how to construct a connection-oriented service over connectionless services
    - TCP: connection-oriented
    - IP: connectionless
  - TCP connection management
    - connection establishment
      - three-way handshake
    - connection release
  - TCP connection state machine

Last lecture: TCP packet header



Last lecture: Sequence number

- TCP 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



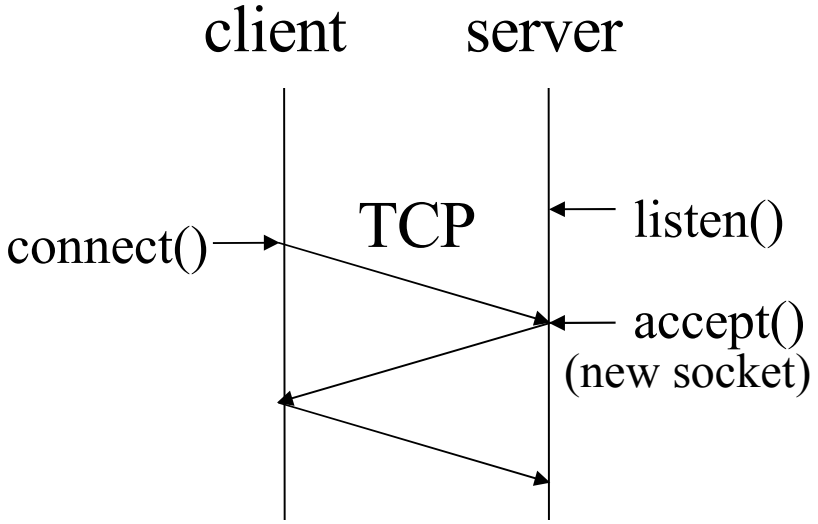
Q: why random ISN?

Last lecture: Control flags

- URG: urgent pointer meaningful
- ACK: acknowledgment number meaningful
- PSH: logic message boundary
- RST: connection reset
- SYN: synchronization (connection establishment)
- FIN: finish (graceful connection release)
  - stay tuned: “TCP connection management”

Socket interface

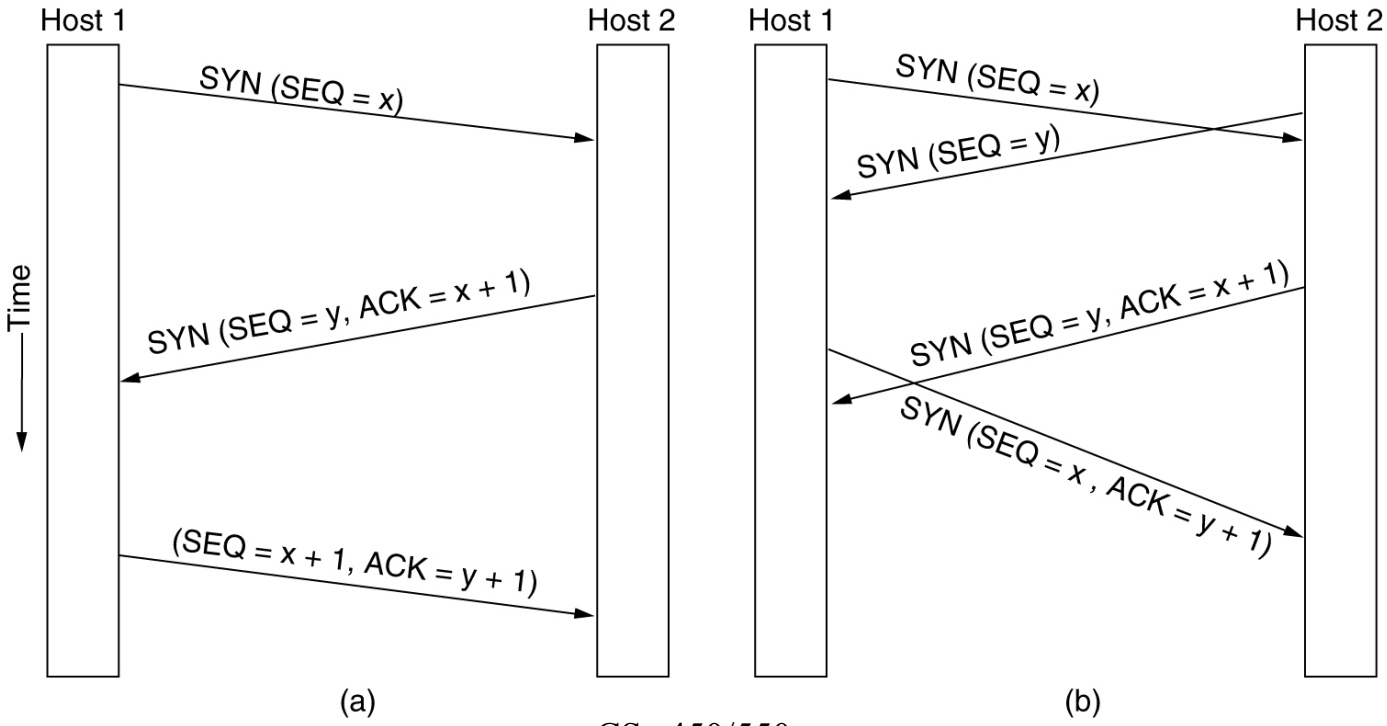
- Server
  - listen()
- Client
  - connect()
- Server
  - accept()
- The purpose of 3-way handshake
  - connection establishment
  - initial sequence number exchange
  - TCP option negotiation



Q: why not ISN = 0?

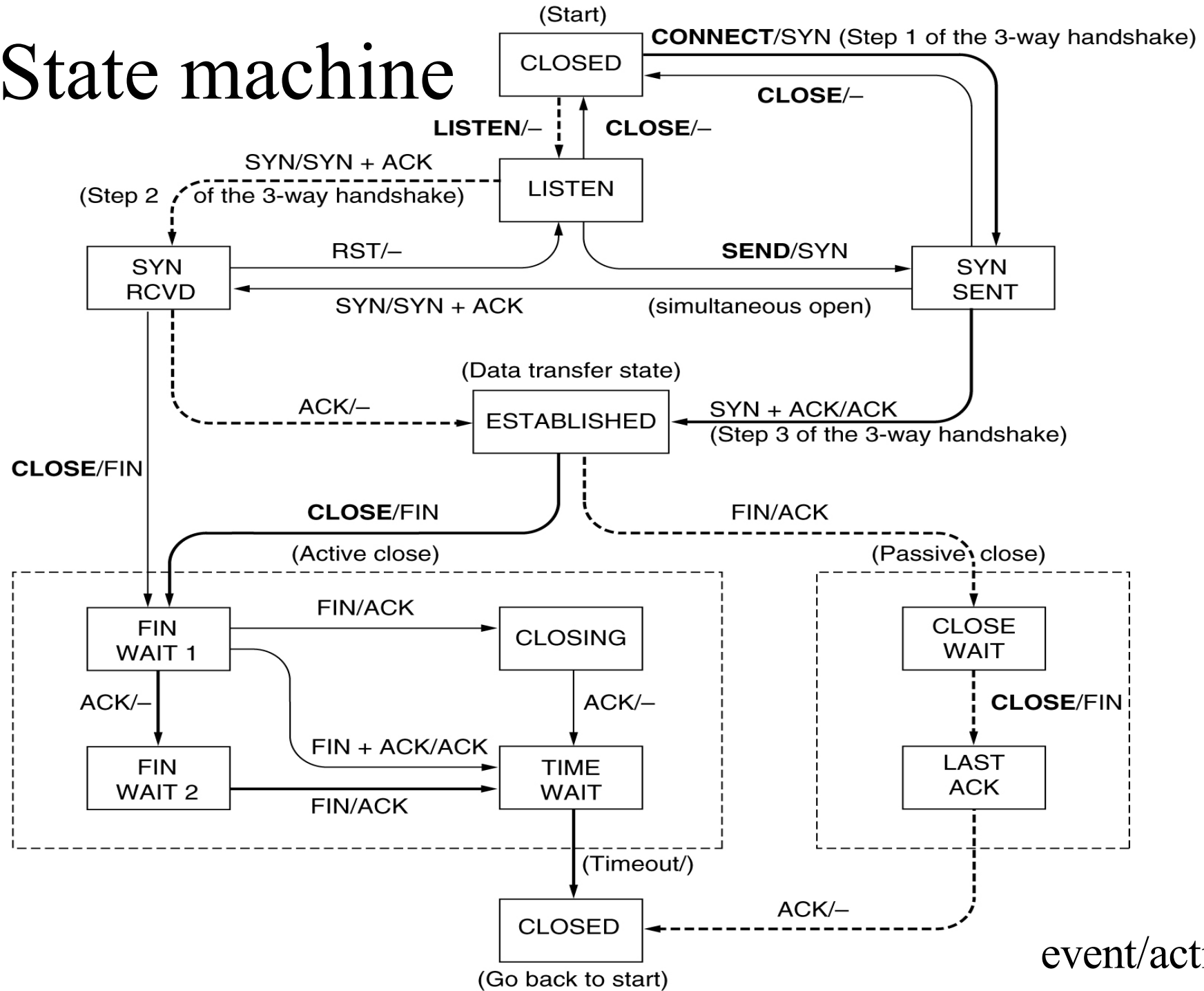
Connection establishment

- Three-way handshake
  - and simultaneous establishment attempts



Q: non-ACK packet?

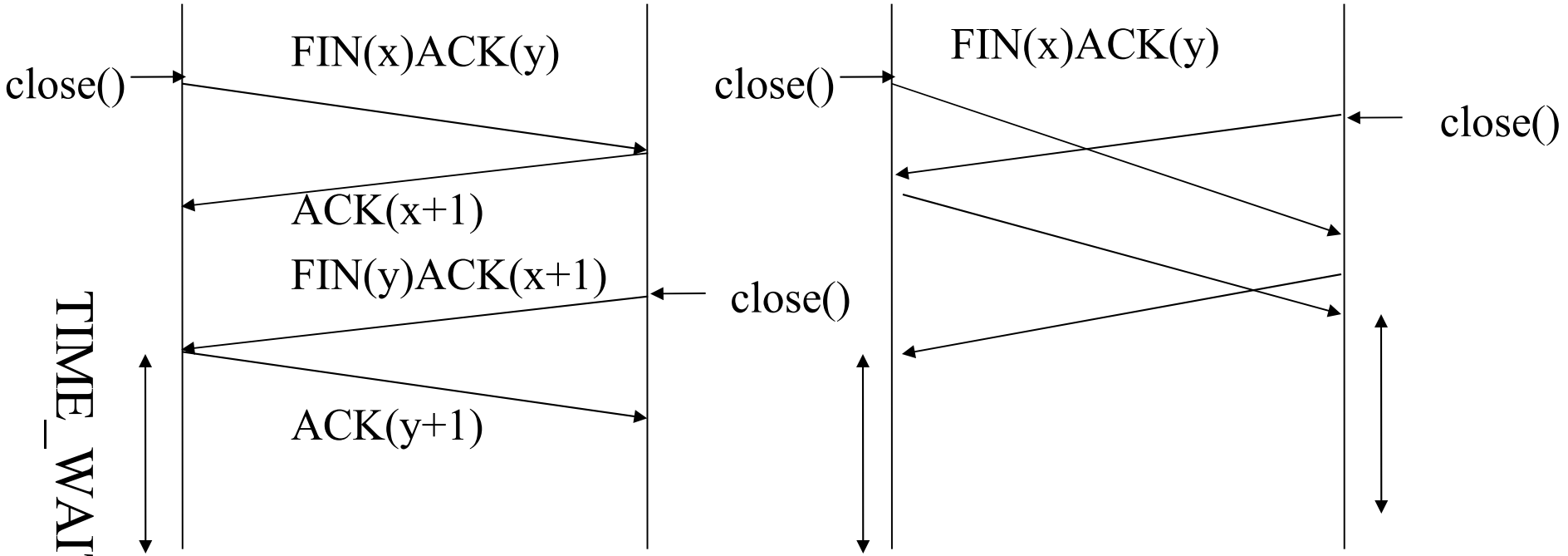
State machine



event/action

Connection release

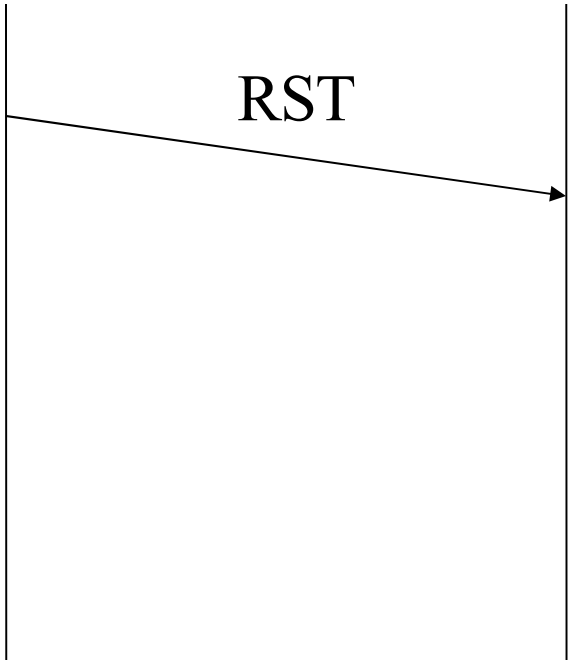
- 2-way handshake in each direction
  - and simultaneous release attempts



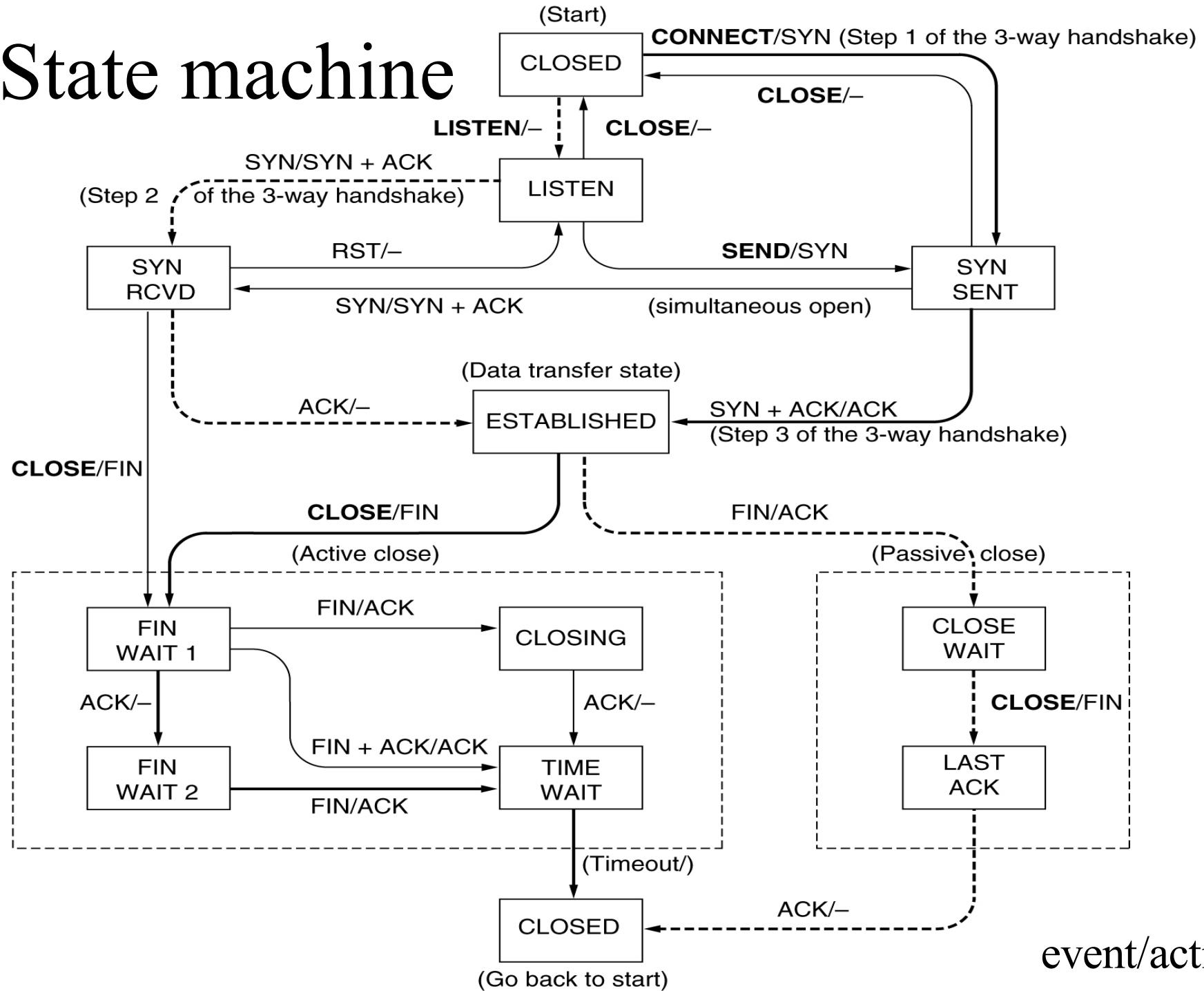
Q: why TIME_WAIT?

Connection reset

- Indicate protocol error
  - go back to CLOSED or LISTEN state
- Reset triggers
  - any packets received in CLOSED
    - except receiving a RESET
  - unacceptable ACK received
    - e.g., acknowledging seqno not used yet
  - unacceptable segments received
    - e.g., seqno above receiver's window

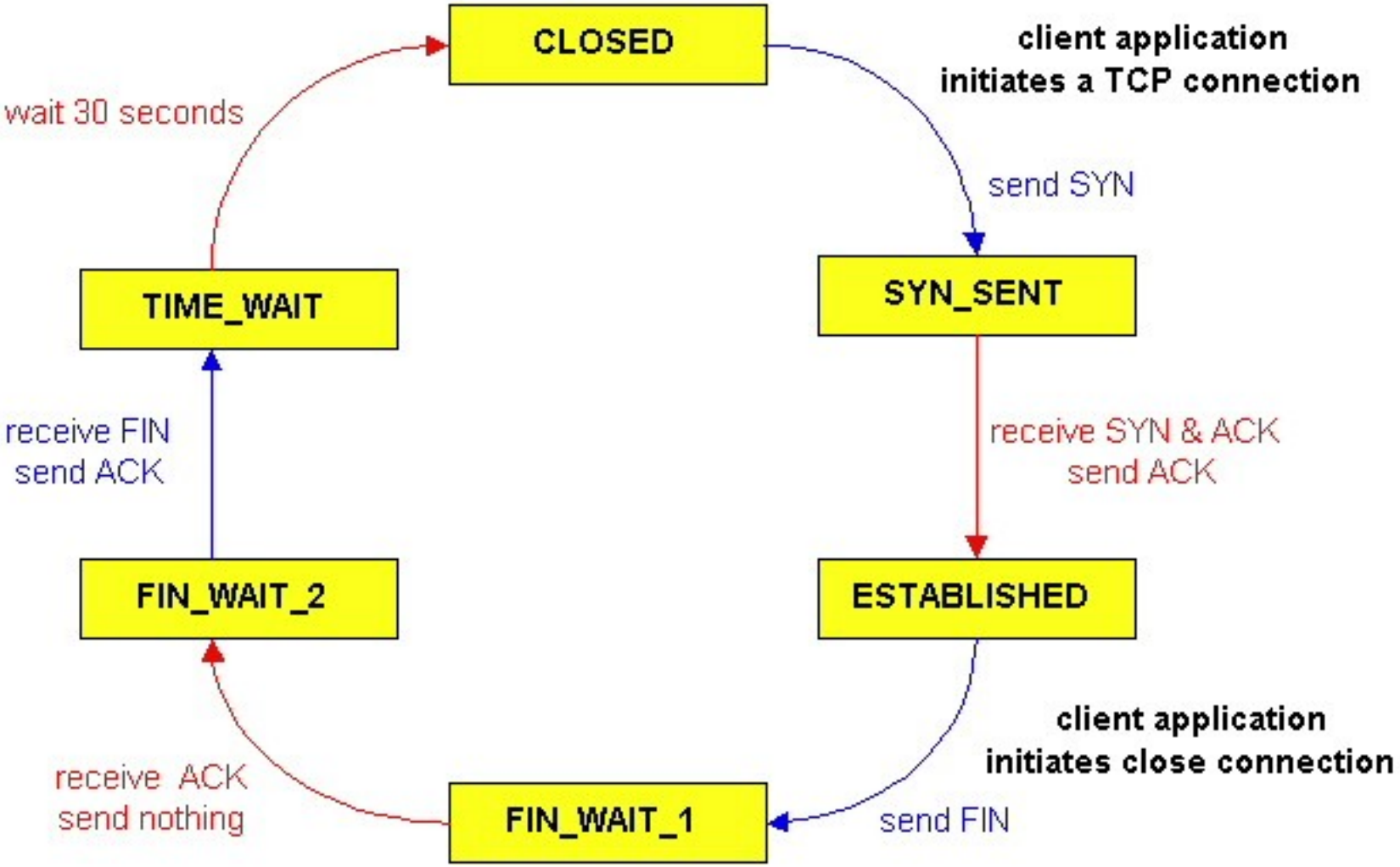


State machine

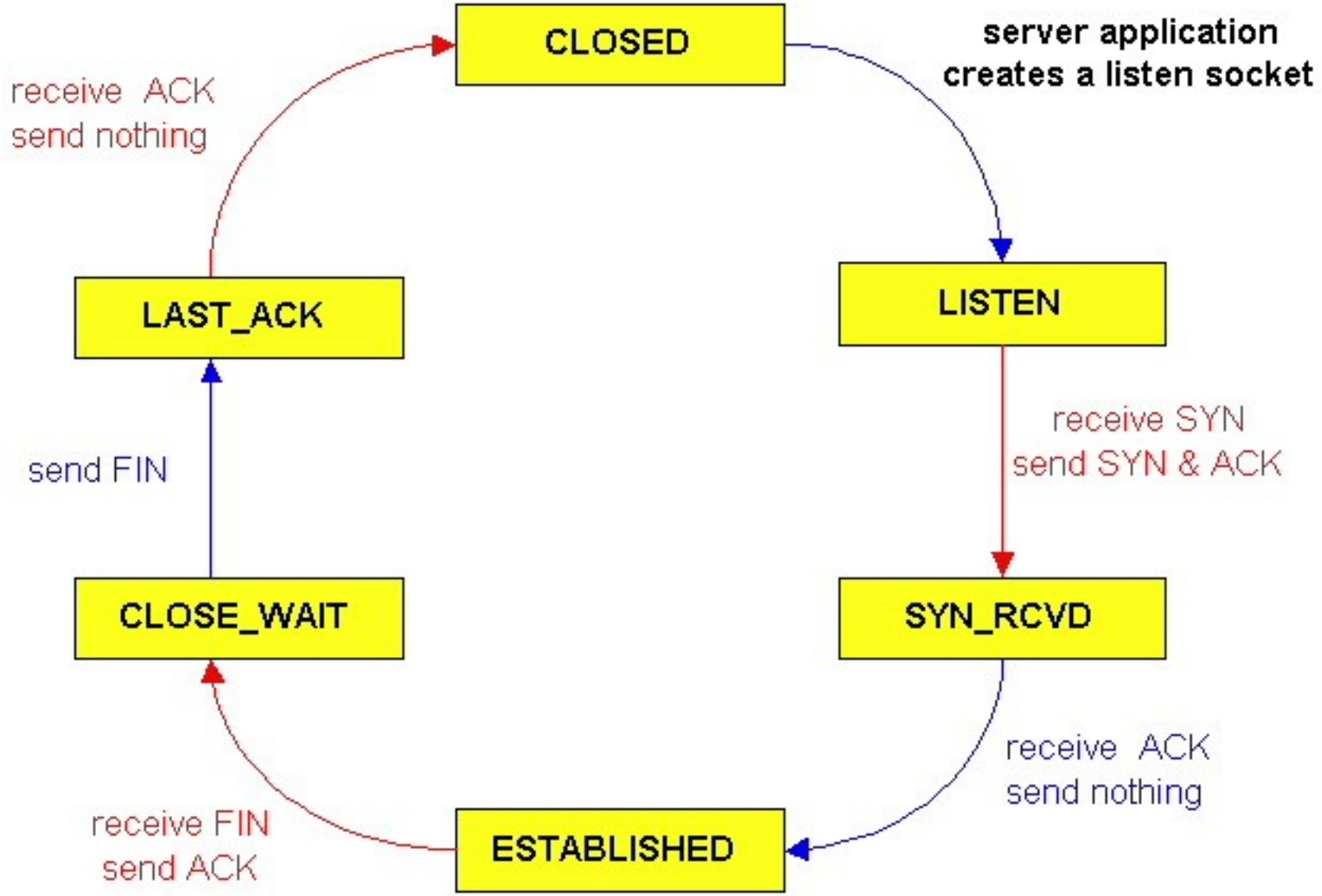


event/action

Client-side view



Server-side view



This lecture

- TCP connection management
  - connection establishment
  - connection release
  - state machine
- Explore further
  - Qs on previous slides
  - RFC793 and RFC1122
  - TCP state machine and implementation

Feedback on E1

- Q1
  - Nyquist limit
  - Shannon limit
  - Ref: 5/14/07, slides 7~11
- Q2
  - message switching
  - packet switching
  - Ref: 5/17/07, slide 7

More feedback on E1

- Q3
  - non-persistent HTTP connection
  - persistent HTTP connection
  - request pipelining
  - recursive DNS query
  - iterative DNS query
  - Ref: 5/24/07, slides 4~7

Feedback on S1

- "More exam-like questions"
  - we do those on blackboard!
  - do take notes in class
- "Heavy reading"
  - use lecture slides as a guide map
  - also check previous offerings
- "Extra office hours in addition to MR"
  - they will be arranged, especially before exams
  - also use the google group for discussion
- Tutorials, labs, etc

Next lectures

- June 11: TCP flow control
- June 14: TCP error control
- June 18 and 21: TCP congestion control