CS 372 Lecture #23

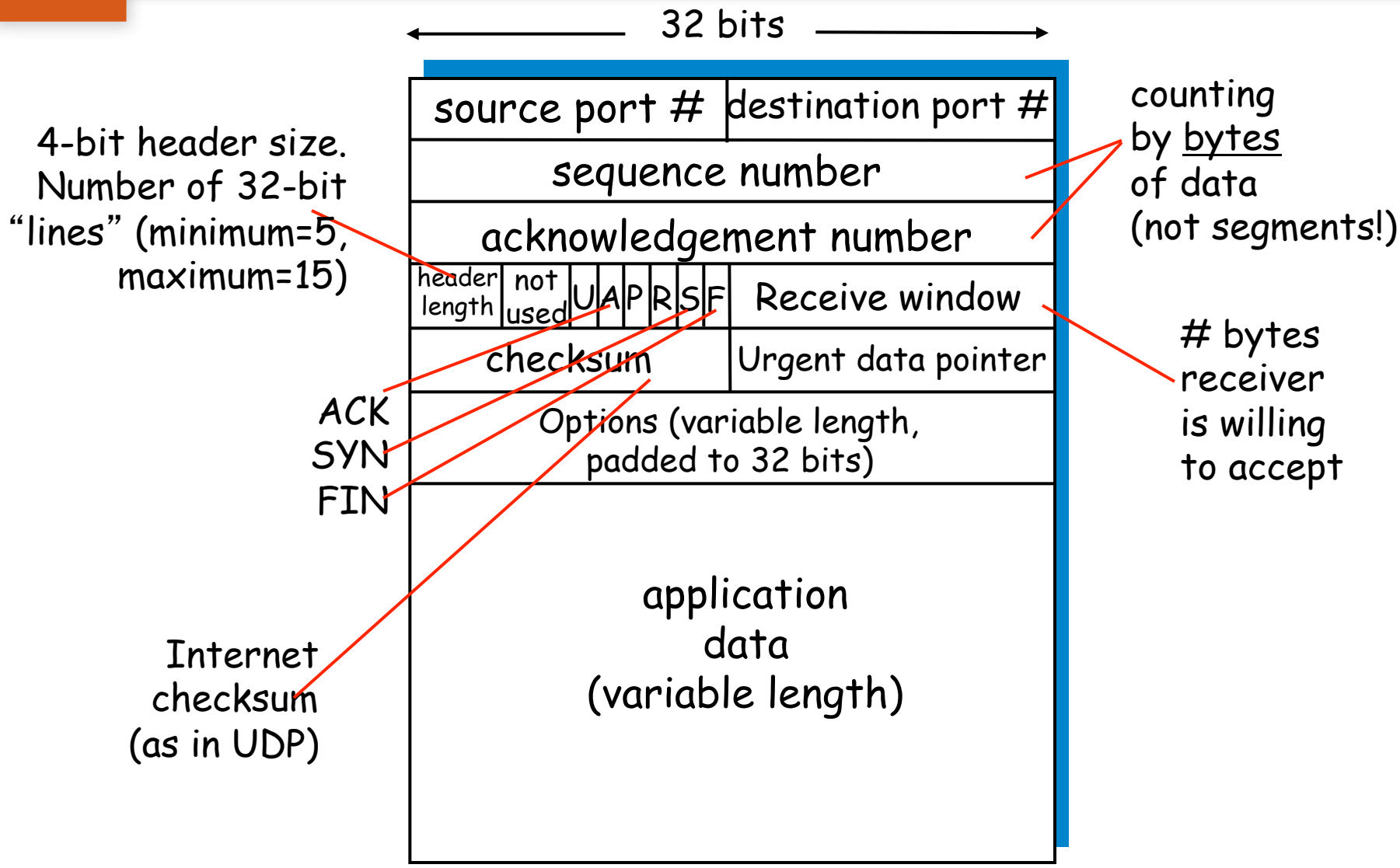
Reliable data transfer with TCP

- connection setup/teardown
- fairness

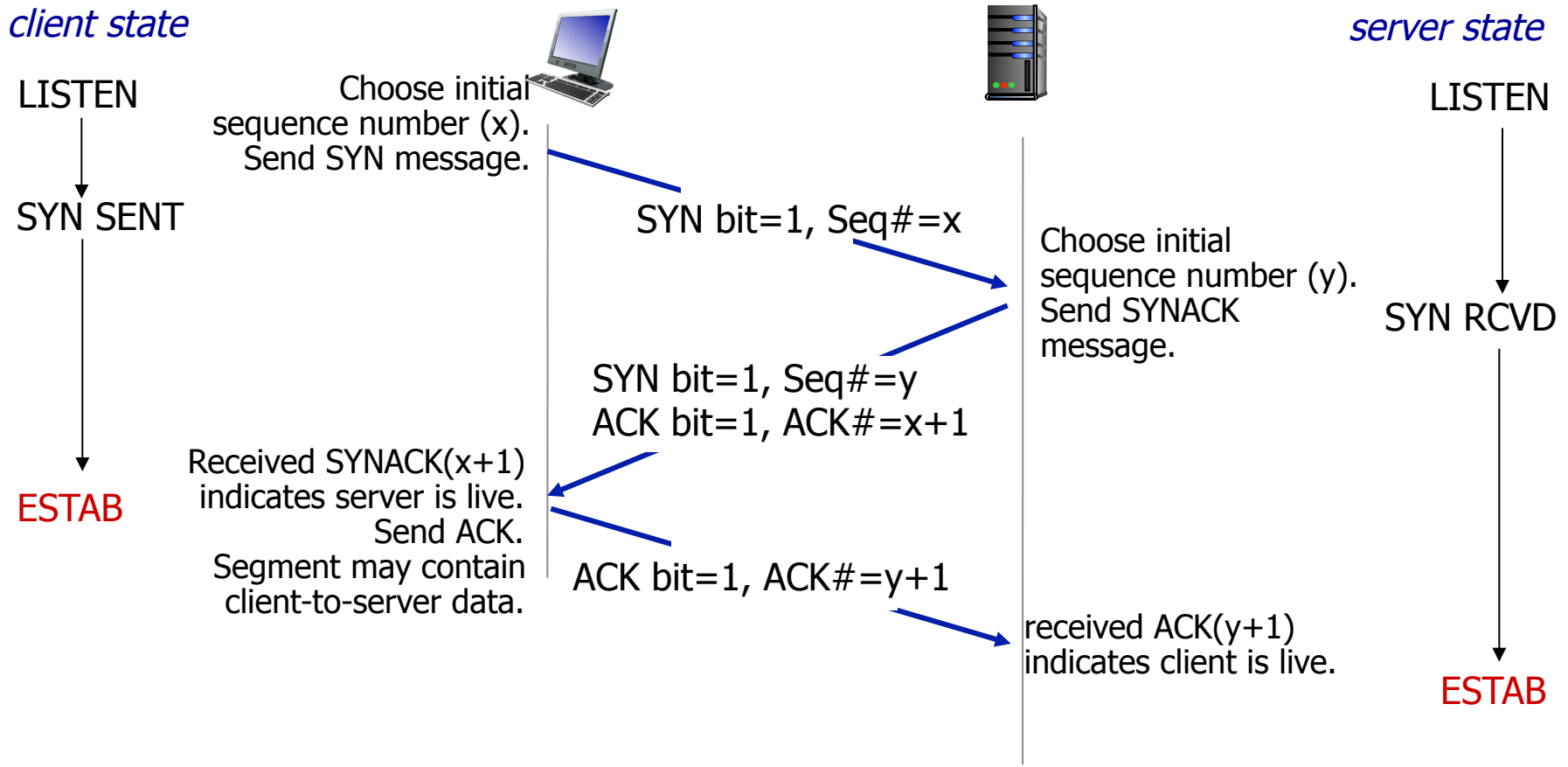
- Wrap up TCP/UDP
- Wrap up transport layer

Note: Many of the lecture slides are based on presentations that accompany *Computer Networking: A Top Down Approach,* 6th edition, by Jim Kurose & Keith Ross, Addison-Wesley, 2013.

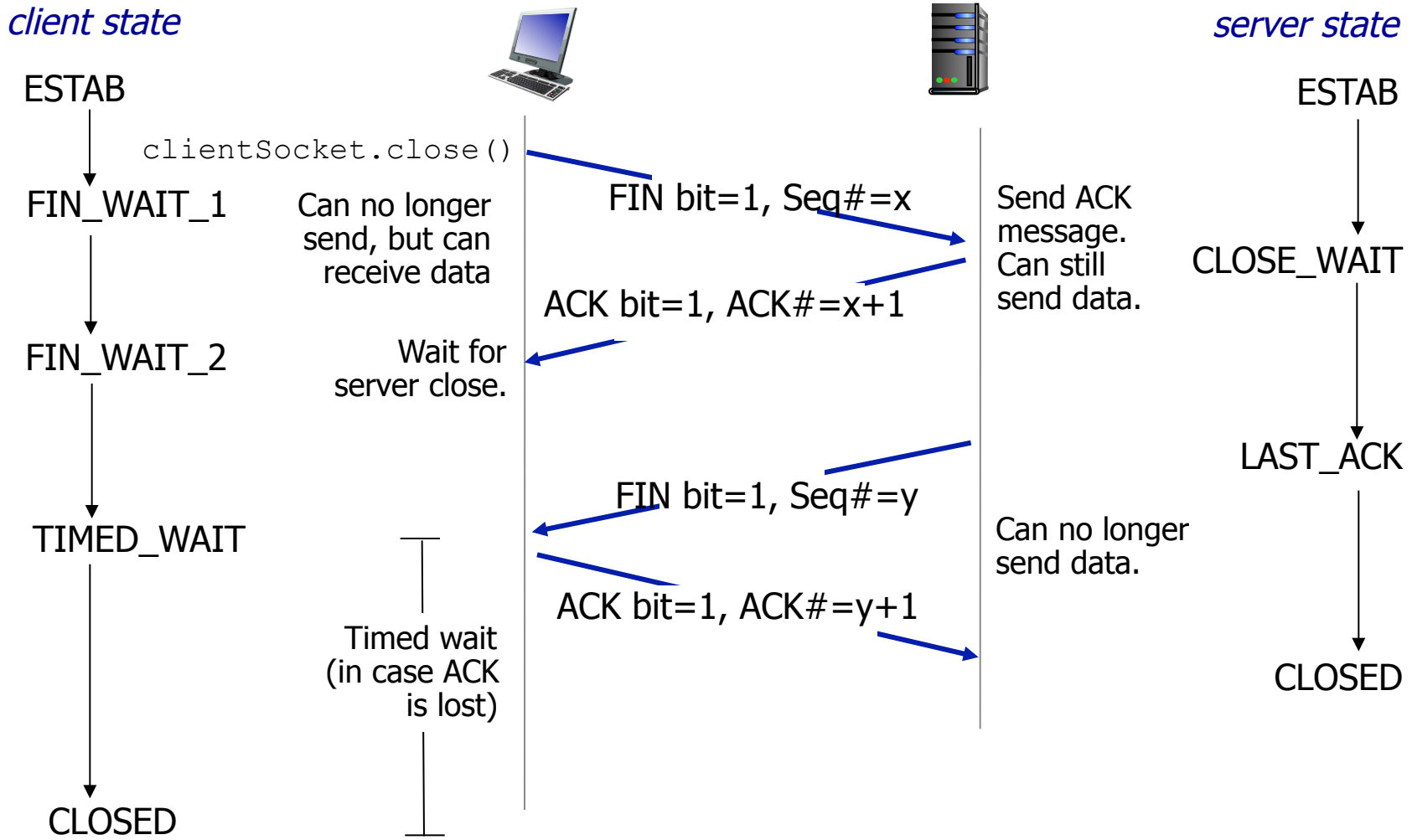
TCP segment structure



TCP 3-way handshake

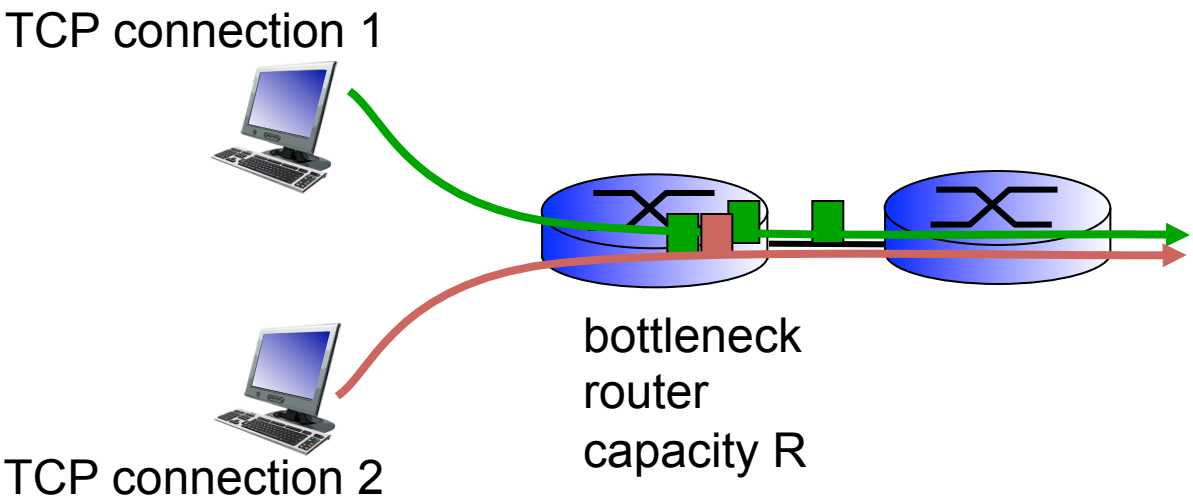


TCP: closing a connection



TCP Fairness

Fairness goal: if **n** TCP sessions share the same bottleneck link of bandwidth **R**, each should have average rate of **R/n**



- TCP is fair to each connection
- Not necessarily fair to each host
  - application can open multiple parallel connections between two hosts
    - web browsers do this

Compare UDP and TCP

- UDP provides
  - connectionless service
  - *end-to-end best-effort (unreliable)* delivery
- TCP provides
  - connection-oriented service
  - *end-to-end reliable byte stream* delivery
- Both
  - use IP (network layer) for delivery to destination
  - send to / receive from multiple applications
  - de-multiplex to destination application protocol ports

Compare UDP and TCP

- UDP is simple and fast
  - 8-byte header
- TCP is complicated
  - 20-byte header (minimum)
  - adds a huge amount of overhead to achieve reliability
    - especially for acknowledgements and congestion control
  - amazingly … it works
    - depends on extremely fast and reliable hardware in the network core.

Summary Lecture #23

- TCP connection setup/teardown
  - 3-way handshake
  - closing a connection
- TCP "fairness"
- Transport layer protocols
  - provide application-to-application delivery
  - accept data from: / deliver data to: application layer processes
  - depend on network layer protocols to carry segments through the network core