

Introduction to Computer Networks

Transmission Control Protocol (TCP) (§6.5)



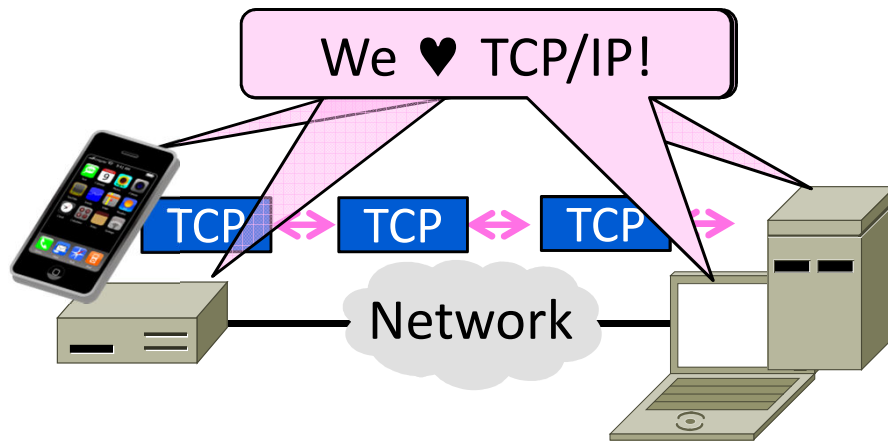
David Wetherall (djw@uw.edu)

Professor of Computer Science & Engineering

UNIVERSITY *of* WASHINGTON

Topic

- How TCP works!
 - The transport protocol used for most content on the Internet

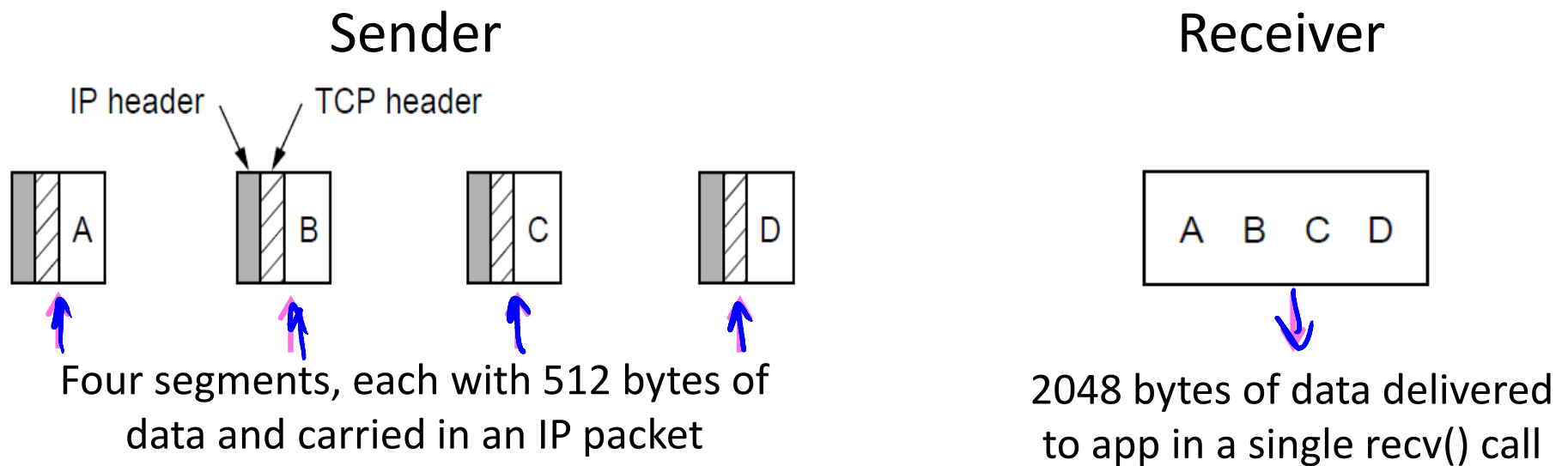


TCP Features

- A reliable bytestream service »
 - Based on connections
 - Sliding window for reliability »
 - With adaptive timeout
 - Flow control for slow receivers
- } This time
- Congestion control to allocate network bandwidth
- } Next time

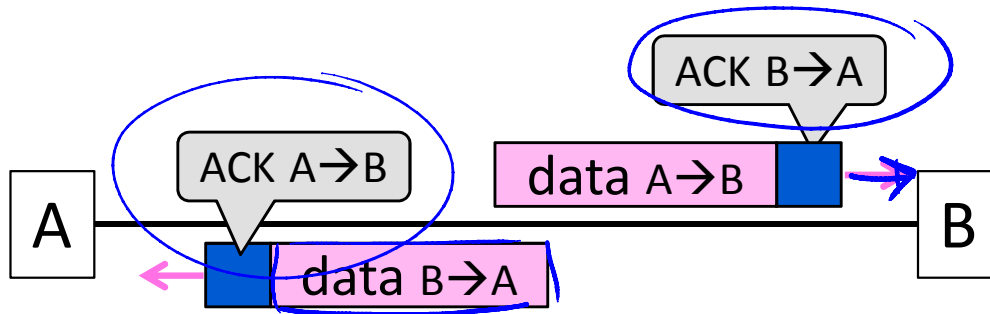
Reliable Bytestream

- Message boundaries not preserved from `send()` to `recv()`
 - But reliable and ordered (receive bytes in same order as sent)



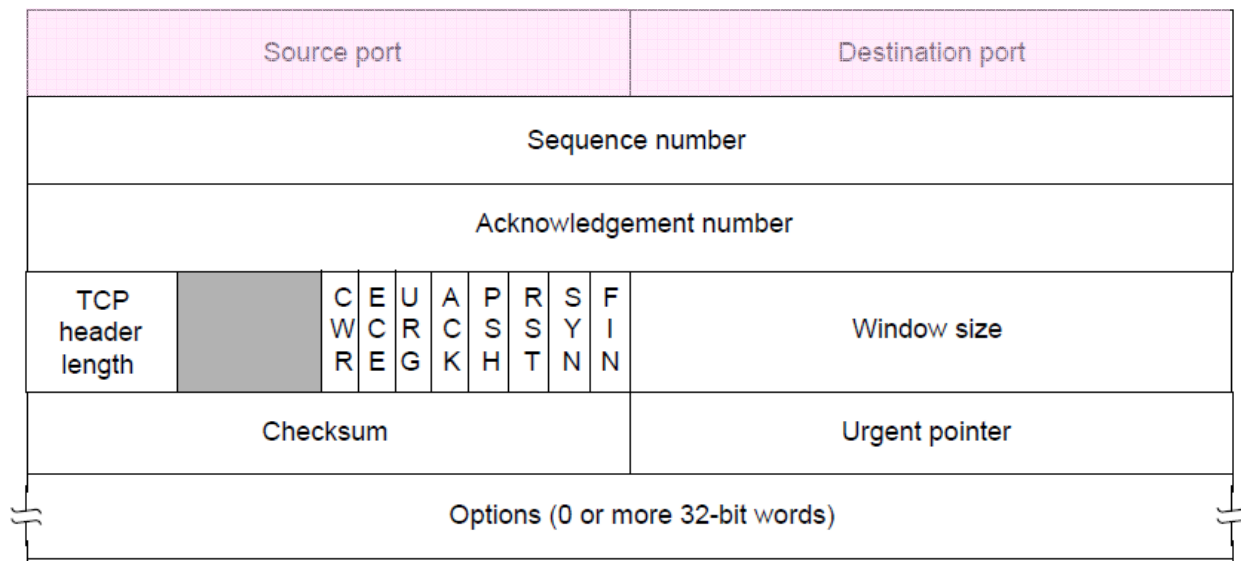
Reliable Bytestream (2)

- Bidirectional data transfer
 - Control information (e.g., ACK) piggybacks on data segments in reverse direction



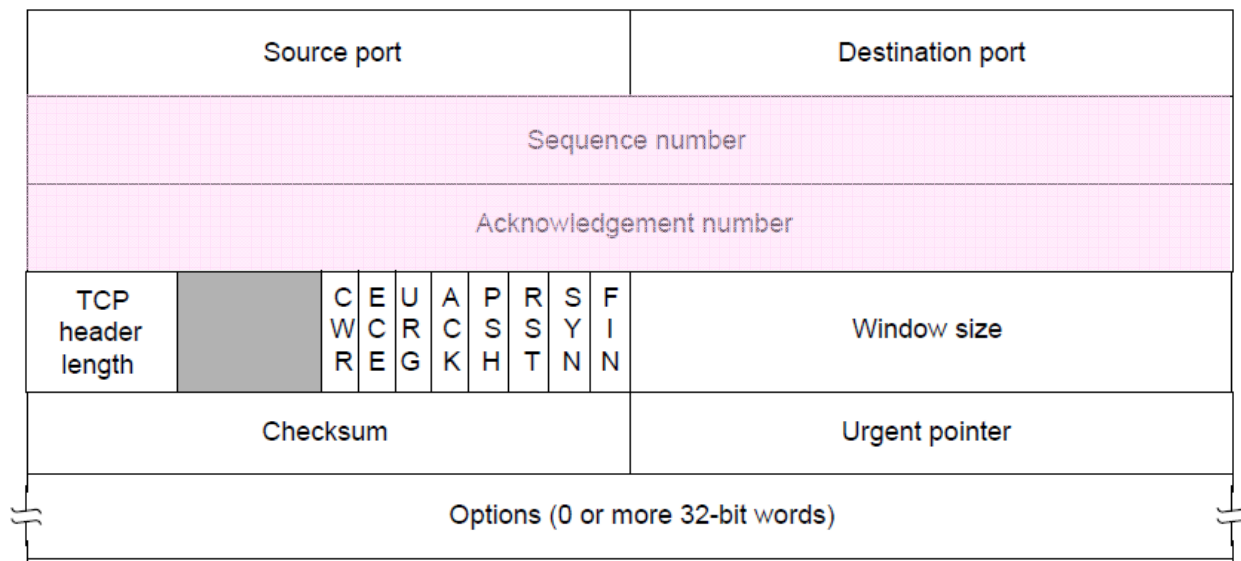
TCP Header (1)

- Ports identify apps (socket API)
 - 16-bit identifiers



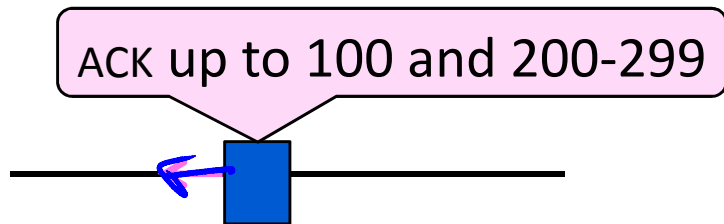
TCP Header (2)

- SEQ/ACK used for sliding window
 - Selective Repeat, with byte positions



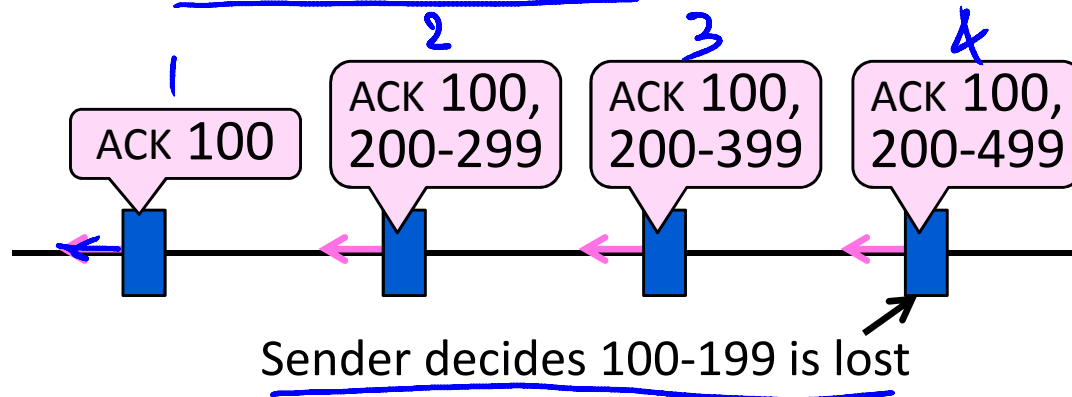
TCP Sliding Window – Receiver

- Cumulative ACK tells next expected byte sequence number (“LAS+1”)
- Optionally, selective ACKs (SACK) give hints for receiver buffer state
 - List up to 3 ranges of received bytes



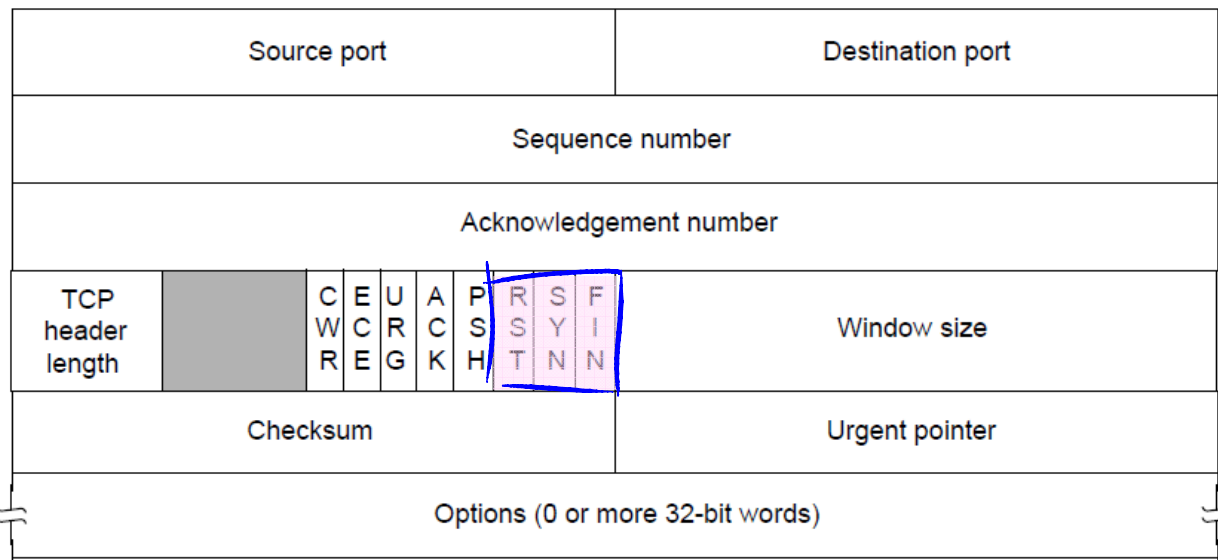
TCP Sliding Window – Sender

- Uses an adaptive retransmission timeout to resend data from LAS+1
- Uses heuristics to infer loss quickly and resend to avoid timeouts
 - “Three duplicate ACKs” treated as loss



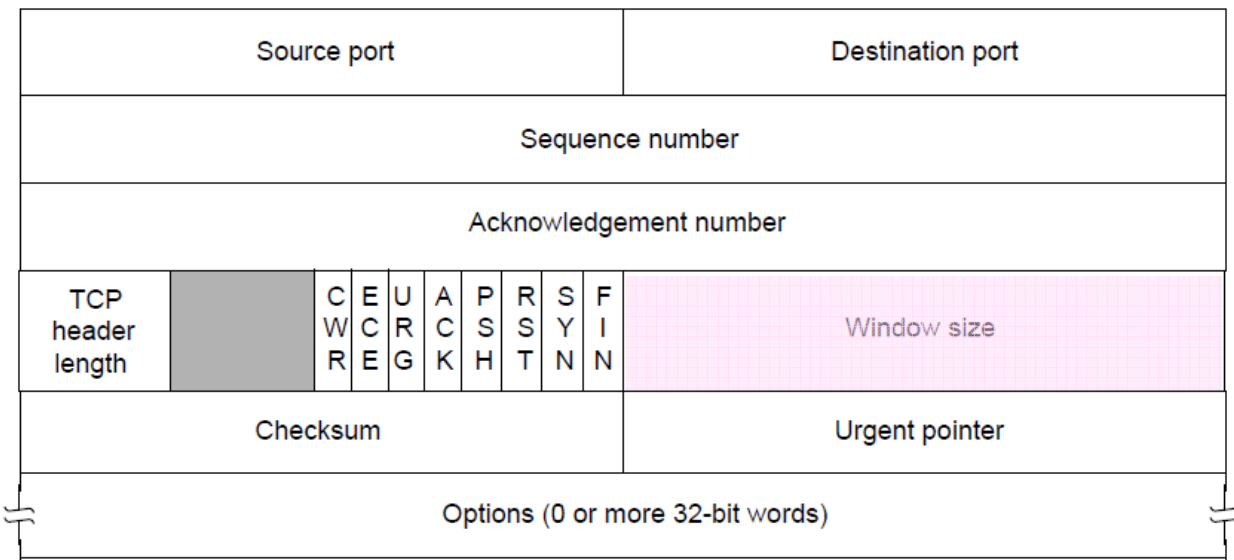
TCP Header (3)

- SYN/FIN/RST flags for connections
 - Flag indicates segment is a SYN etc.



TCP Header (4)

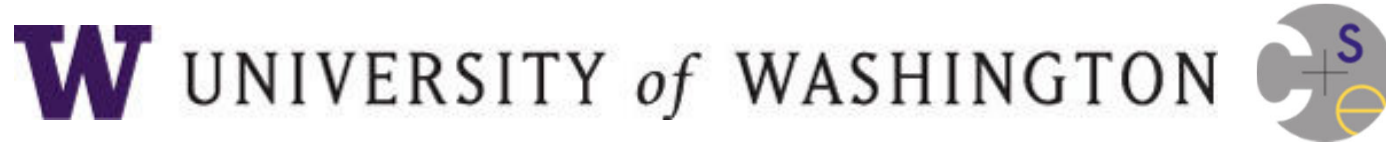
- Window size for flow control
 - Relative to ACK, and in bytes



Other TCP Details

- Many, many quirks you can learn about its operation
 - But they are the details
- Biggest remaining mystery is the workings of congestion control
 - We'll tackle this next time!

END



© 2013 D. Wetherall

Slide material from: TANENBAUM, ANDREW S.; WETHERALL, DAVID J., COMPUTER NETWORKS, 5th Edition, © 2011.
Electronically reproduced by permission of Pearson Education, Inc., Upper Saddle River, New Jersey