

Transmission Control Protocol (TCP)

TCP Properties

- **point-to-point:**
 - one sender, one receiver
- **connection-oriented**
 - handshaking (exchange of control messages between sender and receiver before data exchange)
- **full duplex data**
 - bi-directional data flow
- **reliable segment delivery**
 - package acknowledgements
- **in order segment delivery**
 - send & receive buffers
- **flow control**
- **congestion control**

Obstacles to Reliable Data Transfer

Datagrams in an IP network can be lost due to

- routing failures
- queue overflows at switches because of congestion
- repeated collisions over shared media
- uncorrectable bit errors

Datagrams can arrive out-of-order due to

- datagrams taking different paths
- variable delays due to queues
- datagram duplication by the network

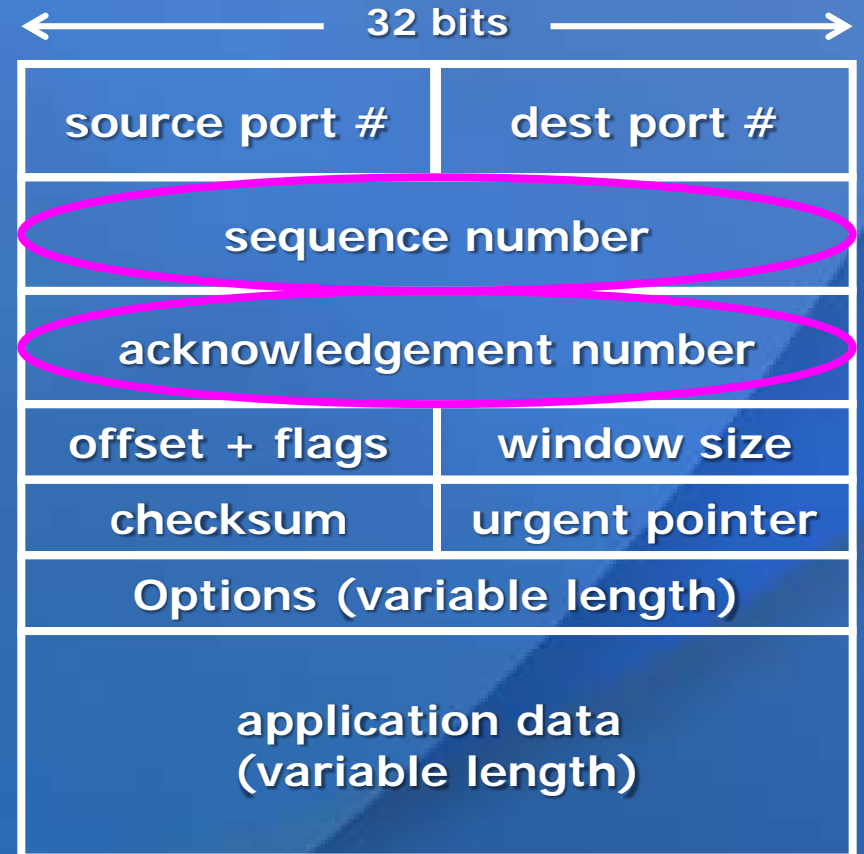
Reliable Data Transfer

Sender

- Each segment contains sequence number
- Sent segments saved in buffer
- When acknowledgement (ACK) received from destination, remove segment from buffer
- Retransmit segment if ACK not received after "a while."

Receiver

- Send ACK to sender for each received packet. Indicate sequence number.
- Deliver segments to application according to sequence number



TCP segment format