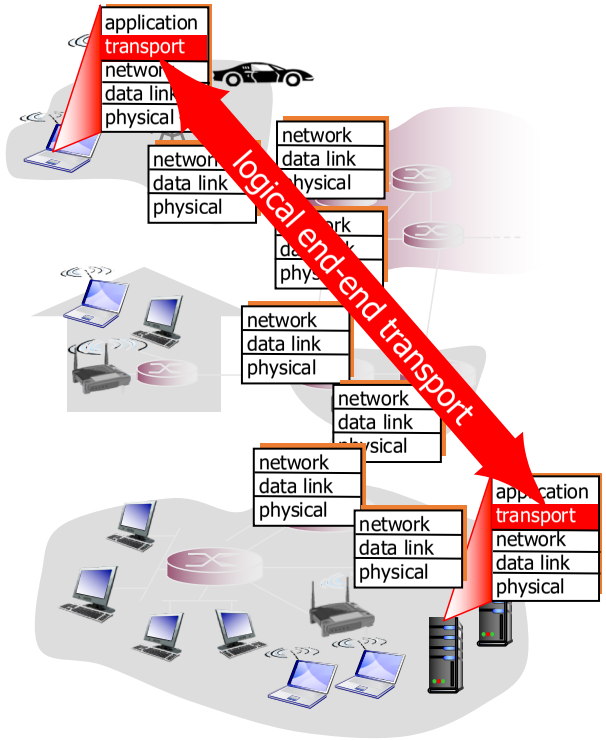
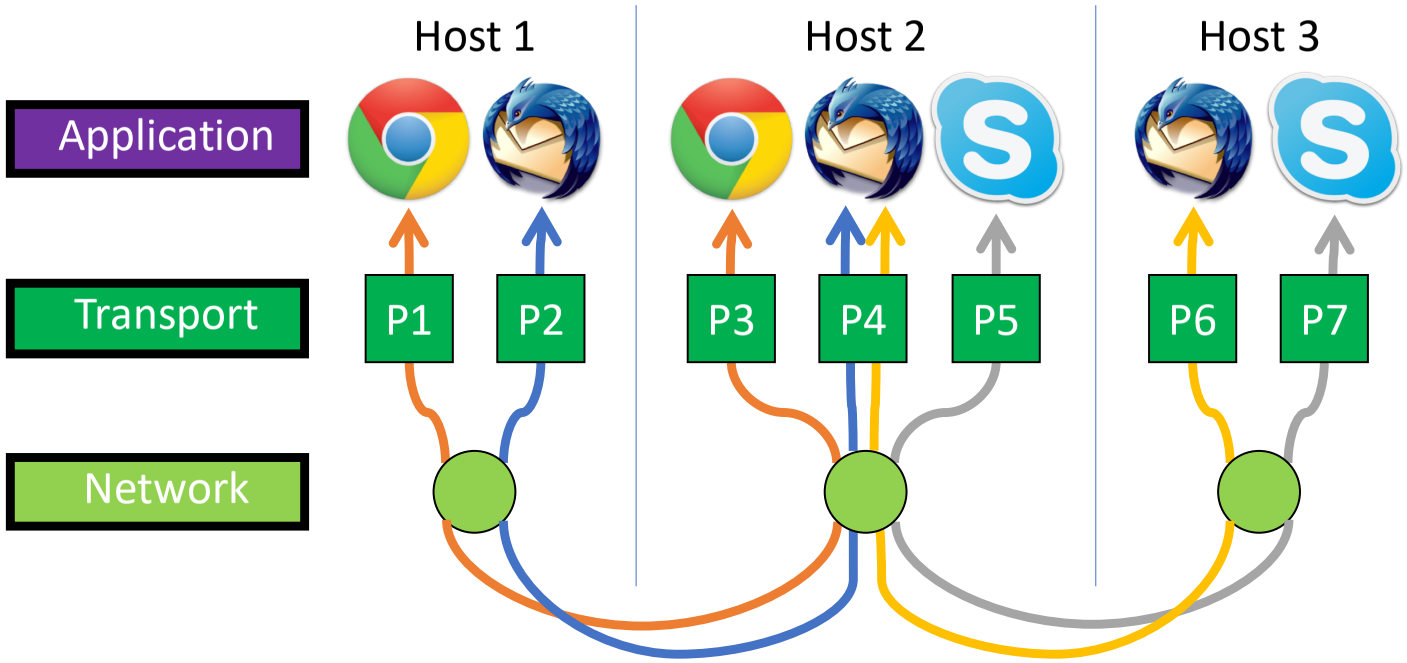
Transport Layer: UDP and TCP

Internet transport-layer protocols

- Provides end-to-end abstraction and multiplexing
- reliable, in-order delivery (TCP)
  - congestion control
  - flow control
  - connection setup
- unreliable, unordered delivery: UDP
  - no-frills extension of "best-effort" IP



Demultiplexing Traffic

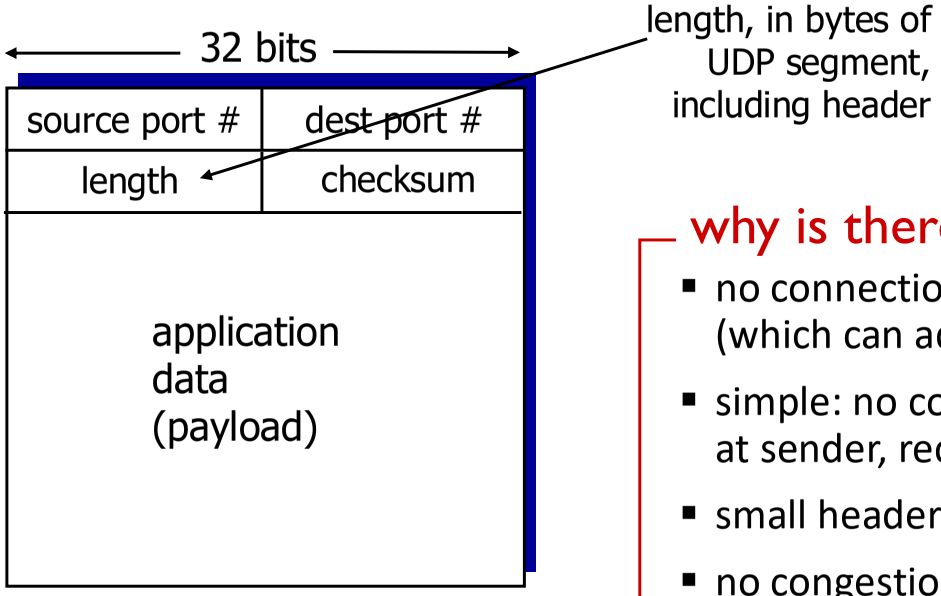


Endpoints identified by *<src_ip, src_port, dest_ip, dest_port>*

What is UDP?

- User Datagram Protocol
- Connectionless end-to-end abstraction
- Does not require connection set up
- No guarantees on packet delivery

UDP: segment header



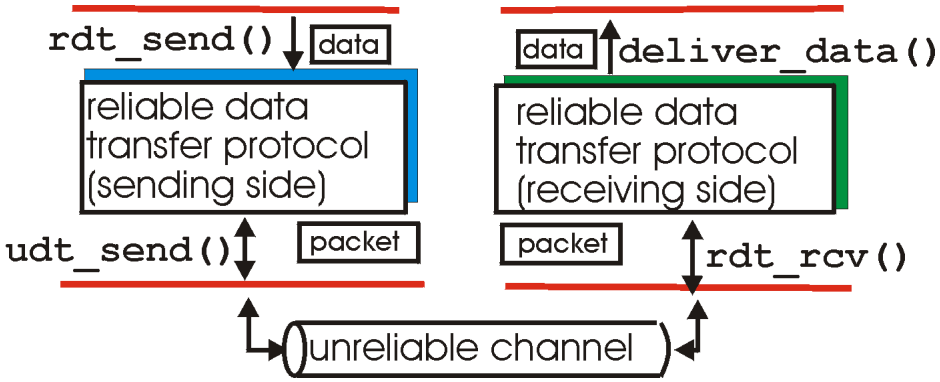
UDP segment format

why is there a UDP?

- no connection establishment (which can add delay)
- simple: no connection state at sender, receiver
- small header size
- no congestion control: UDP can blast away as fast as desired

TCP

- Transmission Control Protocol
- Reliable data transfer (rdt) over an unreliable data transfer (udt)
- The abstraction TCP gives you is that of a **pipe**



Components of TCP

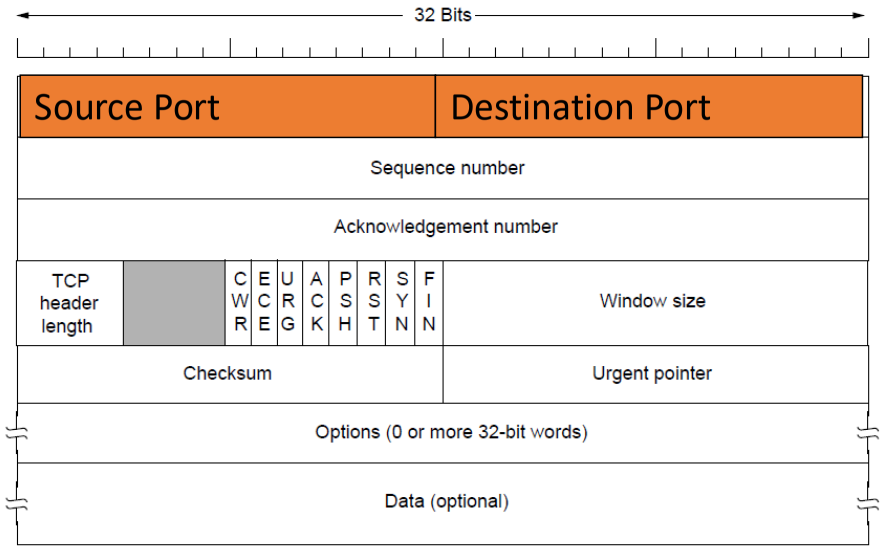
- Connection establishment
- Flow control (do not sent too much data that can overwhelm the receiver)
- Congestion control (do not send too much data that can overwhelm the network)

Connection Establishment in TCP

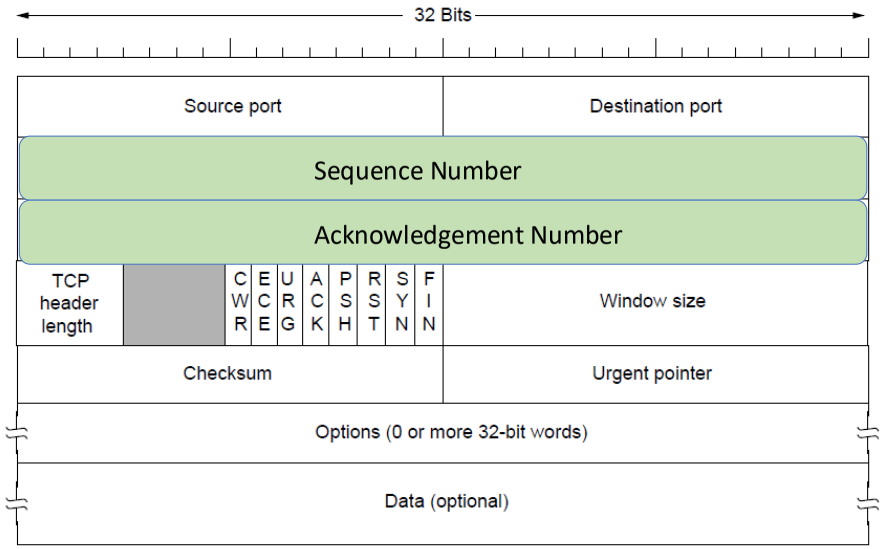
- Both sender and receiver must be ready before we start to transfer the data
- Sender and receiver need to agree on a set of parameters
  - This is signaling. It sets up state at the endpoints
  - Compare to “dialing” in the telephone network
  - **TCP is stateful**

TCP Header Format

- Ports plus IP addresses identify a connection



Sequence numbers

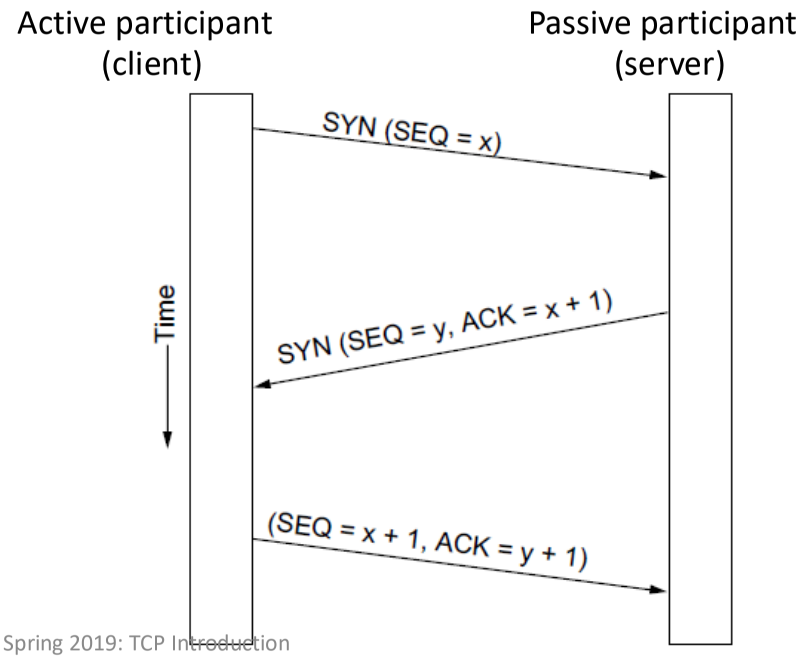


Use a maximum segment lifetime (MSL)

- Wait until MSL to repeat sequence numbers (120 seconds in the Internet)

Three-Way Handshake

- Opens both directions for transfer



ACK semantics

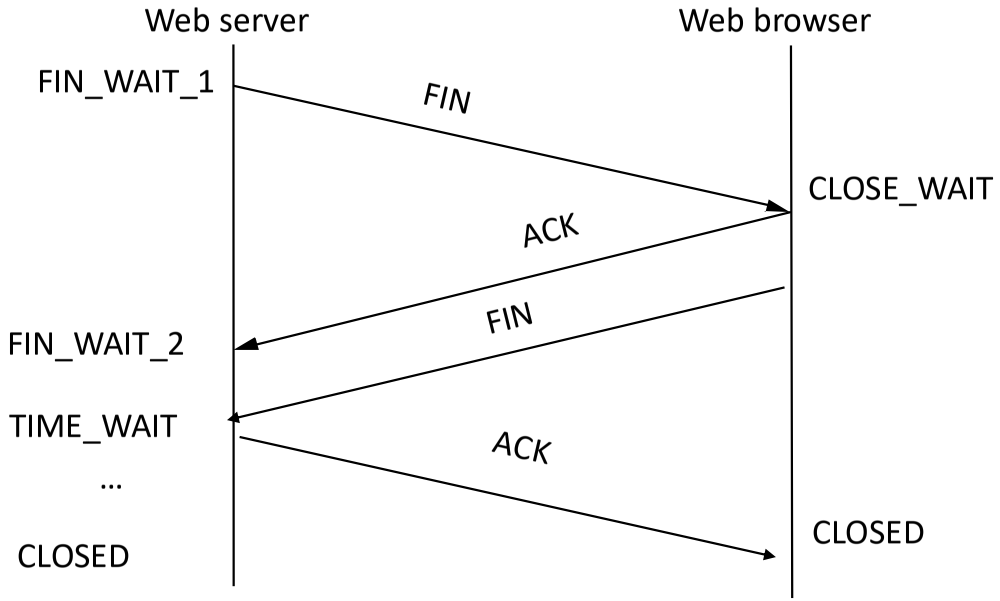
- The ACK in TCP means the packet that is next expected

Why three way handshake?

- TCP is a bi-directional communication. Both directions have to establish a sequence number to be used during the communication

- What else happens during the handshake?
  - Exchange of connection parameters
  - **TCP is a stateful connections**

TCP Connection Teardown with states



TCP Connection Setup and Release State Transitions