Computer Networks II

User Datagram Protocol

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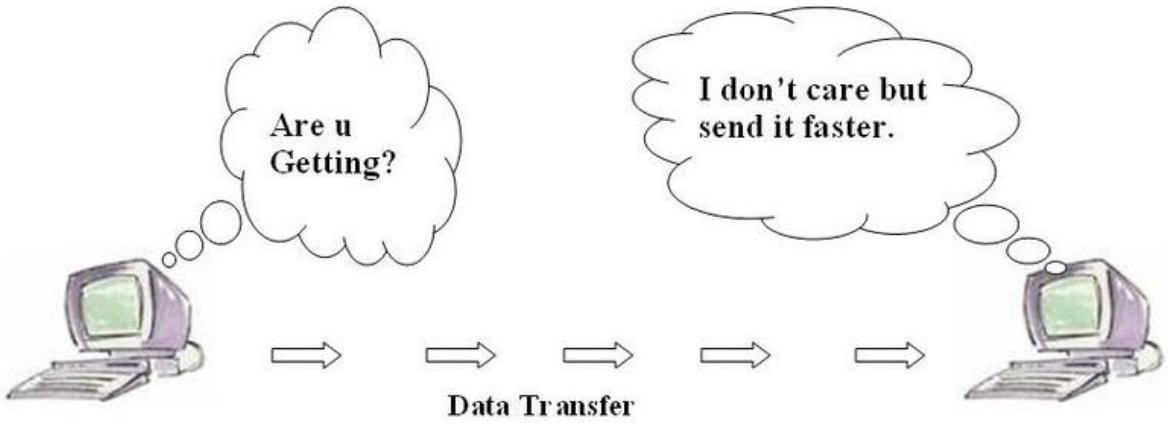
UDP: User Datagram Protocol

- "No frills," "bare bones" Internet transport protocol
- "Best effort" service, UDP segments may be:
  - Lost, duplicated
  - Delivered out-of-order to app



Src: https://commons.wikimedia.org/wiki/File:Fig2_UDPwork.jpg

- Connectionless:
  - No handshaking between UDP sender, receiver
  - Each UDP segment handled independently of others

UDP: User Datagram Protocol

Why is there a UDP?

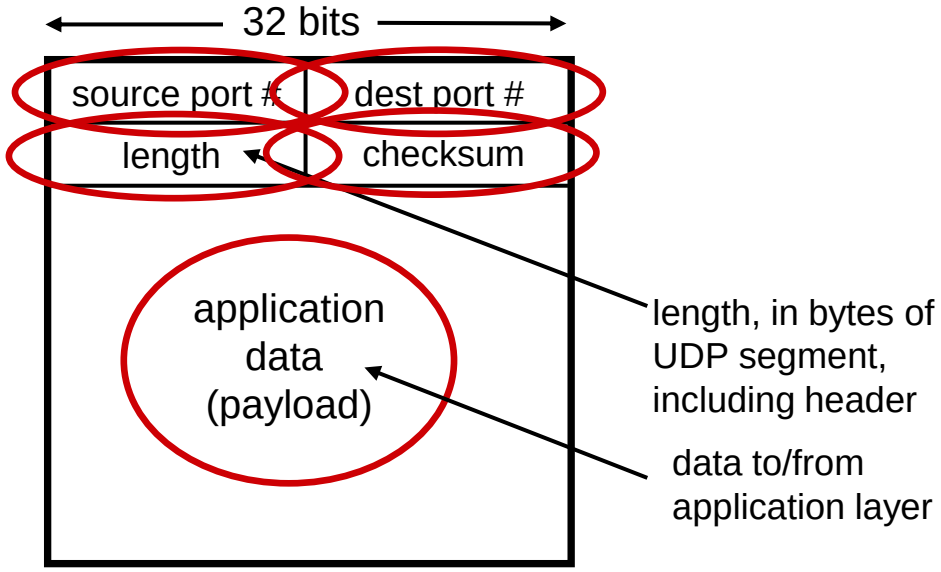
- No connection establishment (which can add RTT delay)
- Simple: no connection state at sender, receiver
- Small header size
- No congestion control
  - UDP can blast away as fast as desired!

- UDP use:
  - Streaming multimedia apps (loss tolerant, rate sensitive)
  - DNS
  - DHCP
  - HTTP/3

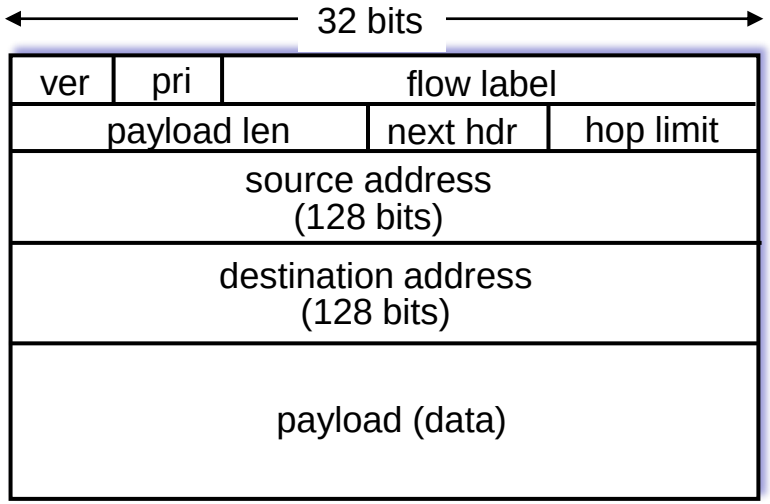
- If reliable transfer needed over UDP (e.g., HTTP/3):
  - Add needed reliability at application layer
  - Add congestion control at application layer

UDP Segment Header

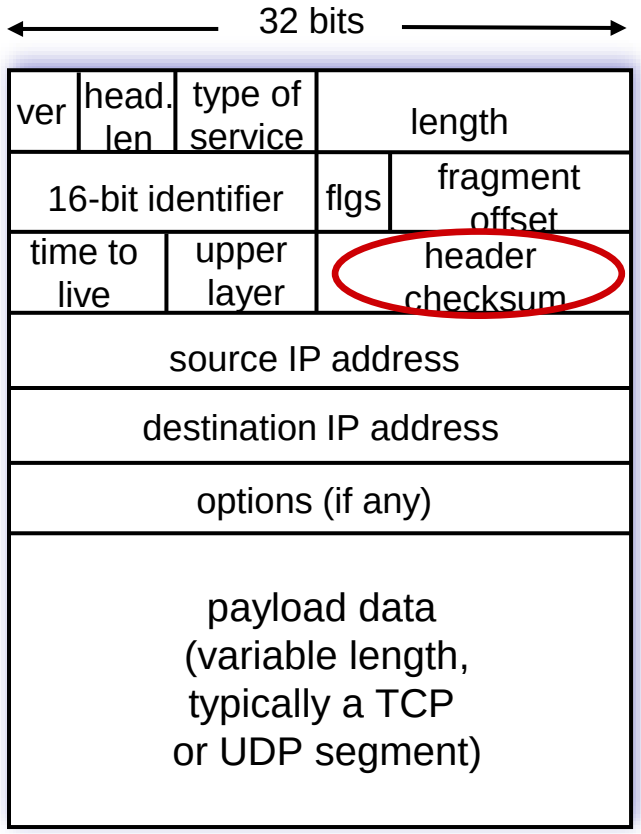
- Checksum covers UDP segment + IP pseudoheader
  - Optional in IPv4, compulsory in IPv6



UDP segment format



IPv6 datagram format

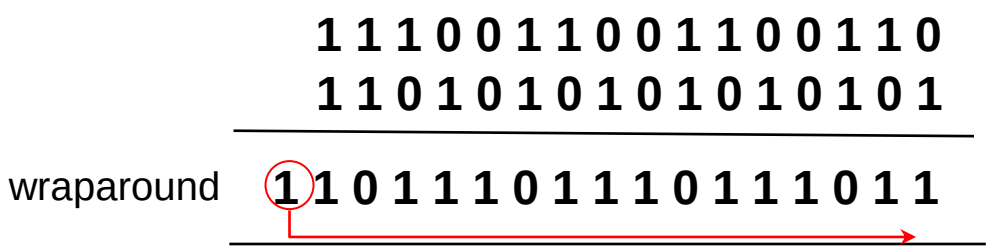


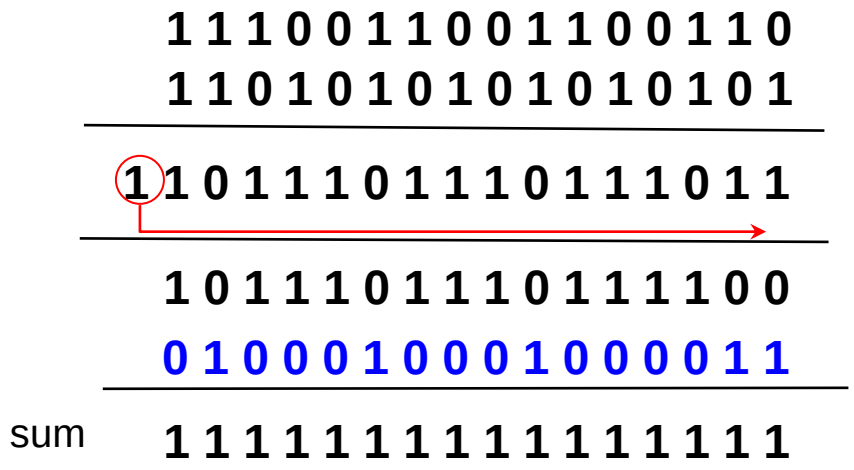
IPv4 datagram format

Info: https://www.packetmania.net/en/2021/12/26/IPv4-IPv6-checksum/

UDP Checksum

Suppose a segment consists of these bits: **1 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0 1 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1**





Transmitted bits: **1 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0 1 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 1**

UDP checksum

Goal: Detect errors (i.e., flipped bits) in transmitted segment

Sender:

- Treat contents of UDP segment (including UDP header fields and IP addresses) as sequence of 16-bit integers
- Checksum: addition (one's complement sum) of segment content
- Checksum value put into UDP checksum field

Receiver:

- Compute the addition of the segment contents including the checksum
- Check if computed sum equals to all 1's:
  - Not all 1's - error detected
  - All 1's - no error detected. But maybe errors nonetheless?

UDP Checksum

Suppose a segment consists of these bits: **1 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0 1 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1**

1 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0
1 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1

wraparound **1** **1 0 1 1 1 0 1 1 1 0 1 1 1 0 1 1**

sum **1 0 1 1 1 0 1 1 1 0 1 1 1 0 0**

checksum **0 1 0 0 0 1 0 0 0 1 0 0 0 1 1**

1 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0
1 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1

0 1
1 0

1 **1 0 1 1 1 0 1 1 1 0 1 1 1 0 1 1**

1 0 1 1 1 0 1 1 1 0 1 1 1 0 0
0 1 0 0 0 1 0 0 0 1 0 0 0 1 1

sum **1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1**

Even though numbers have changed (bit flips), no change in checksum!

Summary: UDP

- “No frills” protocol:
  - Segments may be lost, delivered out of order
  - Best effort service: “send and hope for the best”
- UDP has its plusses:
  - No setup/handshaking needed (no RTT incurred)
  - Helps with reliability (checksum)
- Build additional functionality on top of UDP in application layer (e.g., HTTP/3)