Transmission Control Protocol (TCP) – Overview

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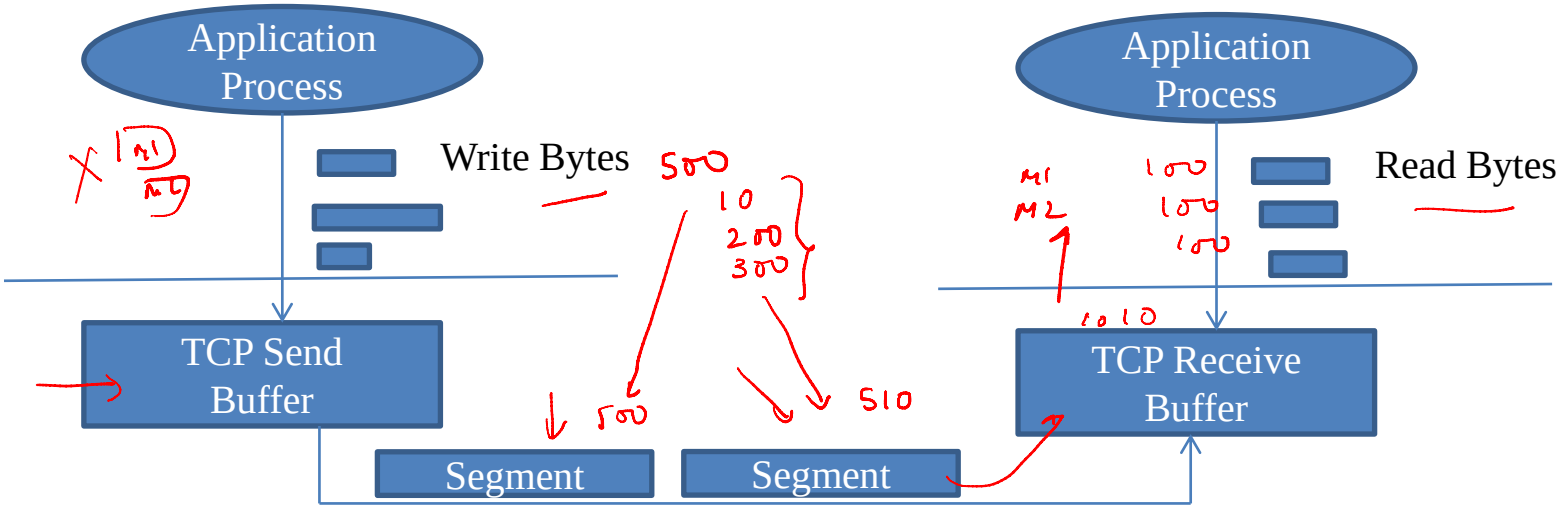
Background

- TCP most widely used transport layer protocol
- Entire Internet Protocol suite is often called TCP/IP suite
- Most carefully tuned protocol
  - Many Request For Comment (RFC): 675, 793, 1122, 1323, 2018, 2581, 5681 etc

IETF
Internet society

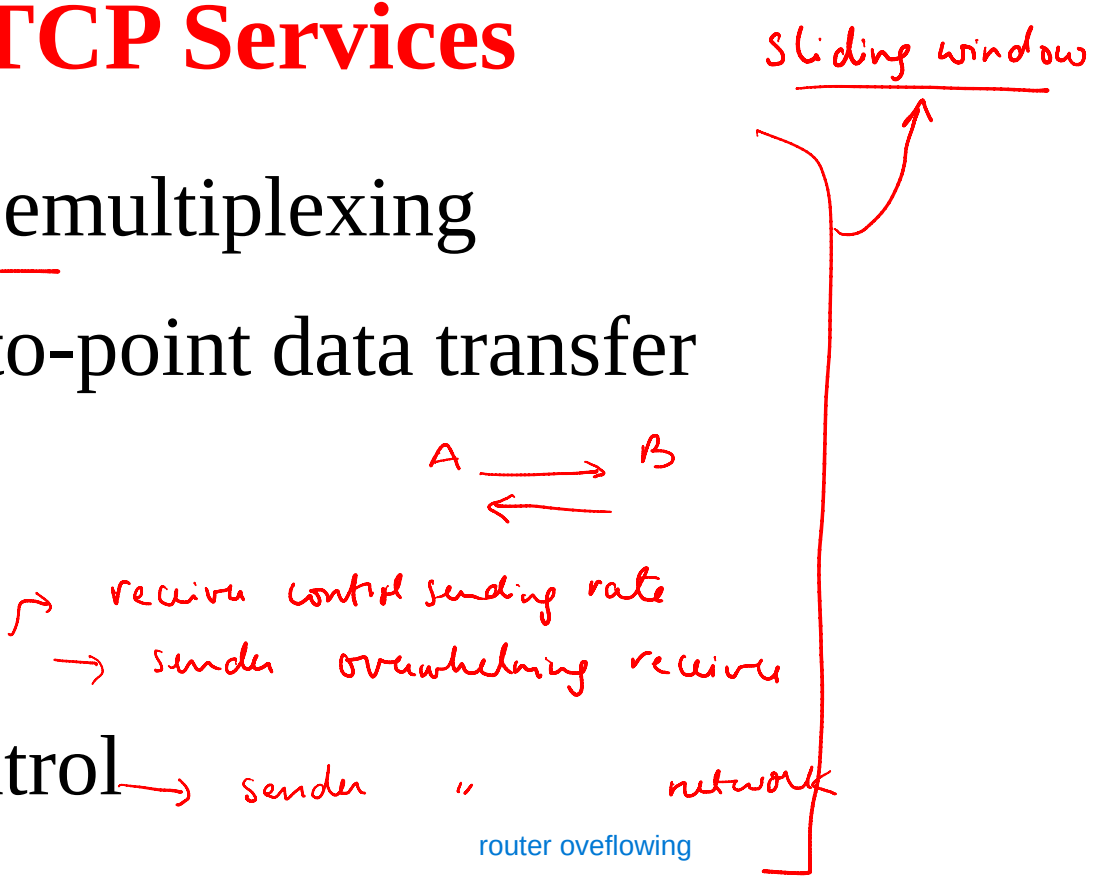
TCP Model

- Connection oriented byte-stream protocol

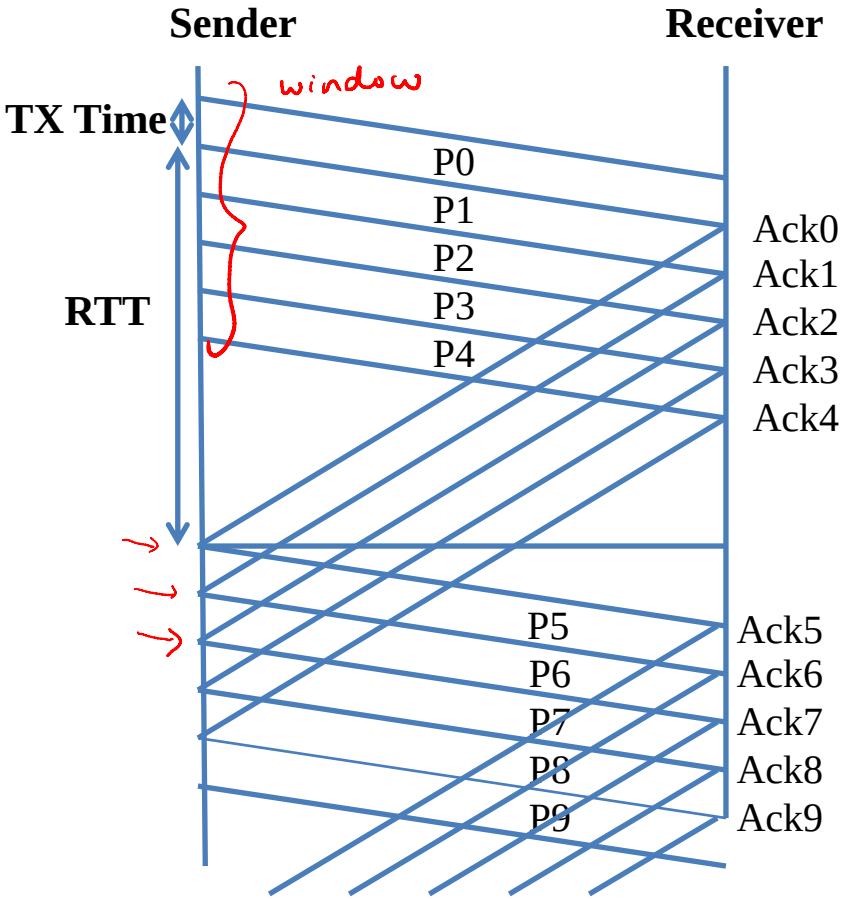


TCP Services

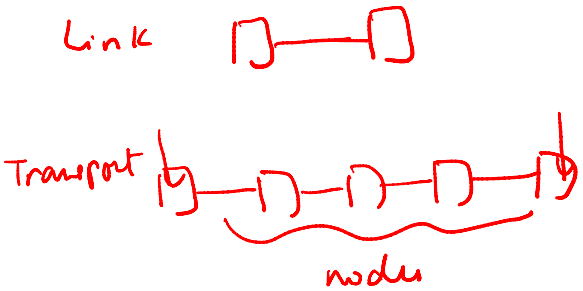
- Multiplexing/Demultiplexing
- Reliable point-to-point data transfer
- Full-duplex
- Flow control
- Congestion control



Recap: Sliding Window Protocol



Seq No, Ack, Time outs



Sliding Window: Connection Management

- Link: Dedicated physical link connects same two hosts

- Transport: Connects processes running on any two hosts in the Internet
  - Needs explicit connection establishment before data exchange and tear down after done

Sliding Window: RTT

- Link: Fixed (almost) RTT
- Transport: Varies from connection to connection and can be highly variable within connection

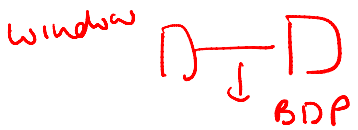
- Time out mechanism has to be adaptive

Sliding Window: Reordering

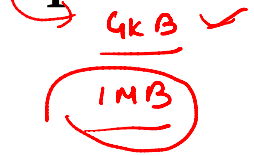
- Link: No reordering
- Transport: Packets can take different paths and suffer arbitrary delays
  - Protocol needs to be robust against old packets suddenly showing up

Sliding Window: Flow Control

- Link: End points can be engineered to support the link



- Transport: Any kind of computer can be connected to the Internet



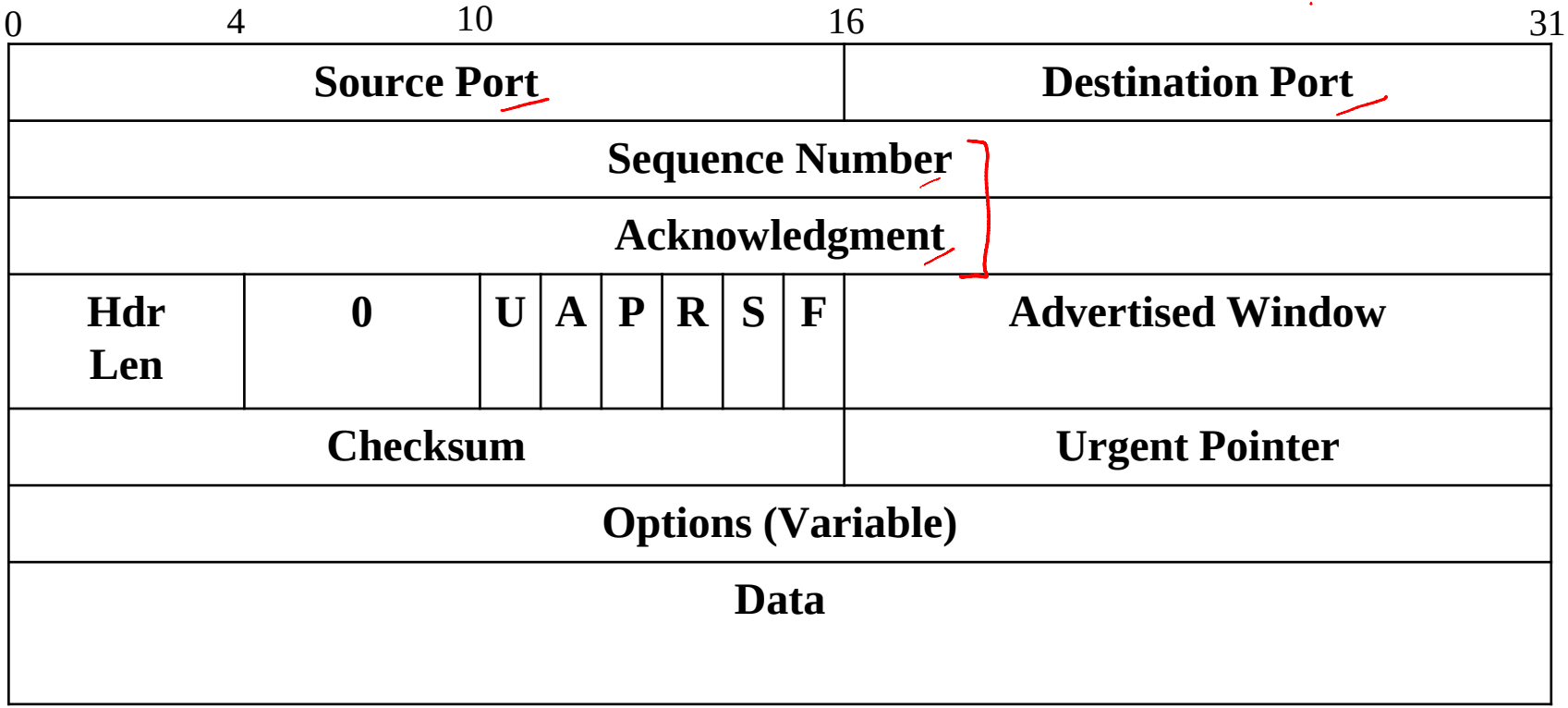
- Need mechanisms to ensure one side doesn't overwhelm other side's resources (e.g. buffer space)

Sliding Window: Congestion Control

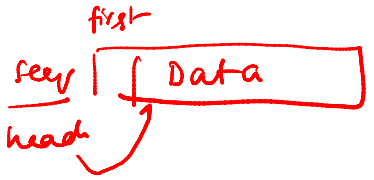
- Link: Not possible to unknowingly congest the link
- TCP: No idea what links will be traversed, network capacity can dynamically vary due to competing traffic
- Need mechanisms to alter sending rate in response to network congestion

Break

TCP Header Format

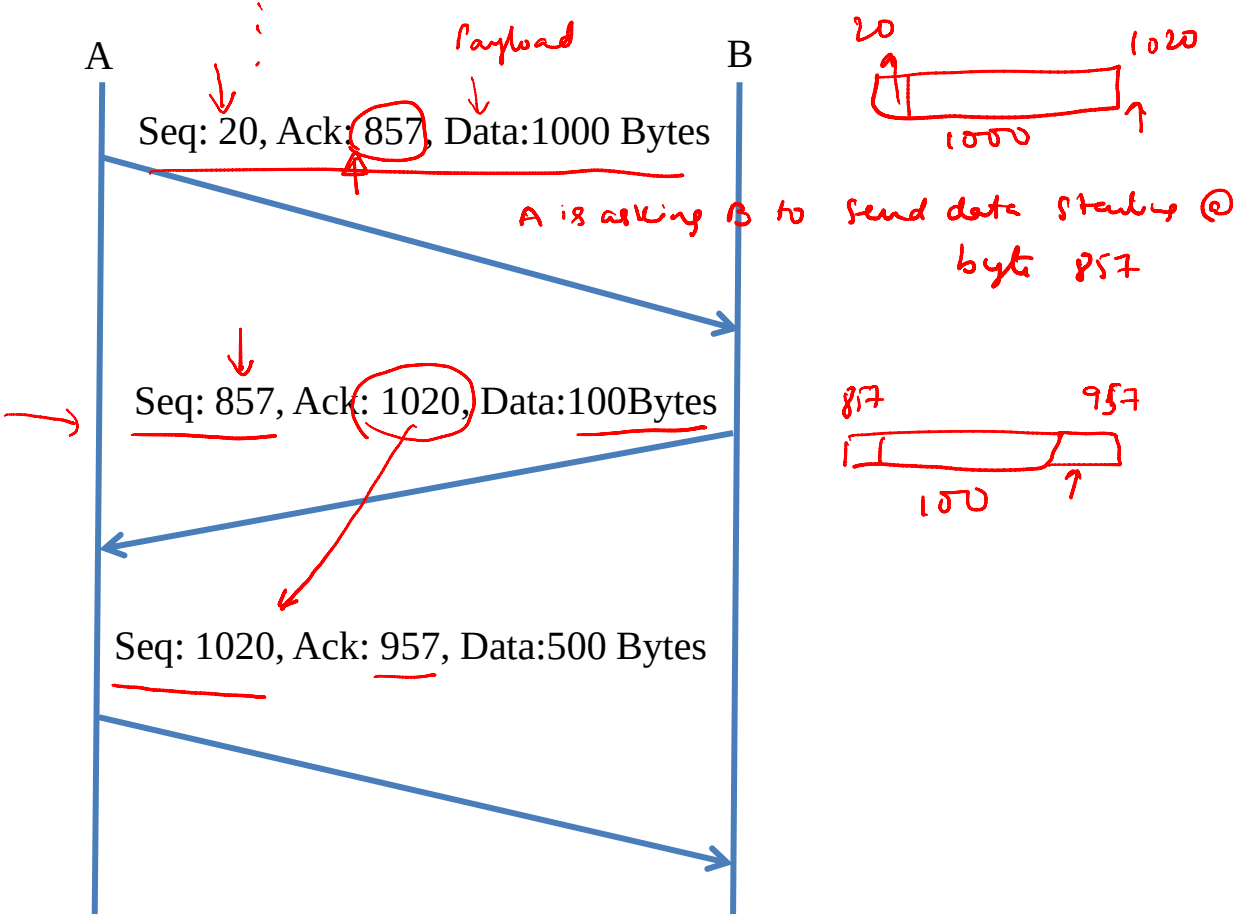


Sequence Number and Acknowledgment

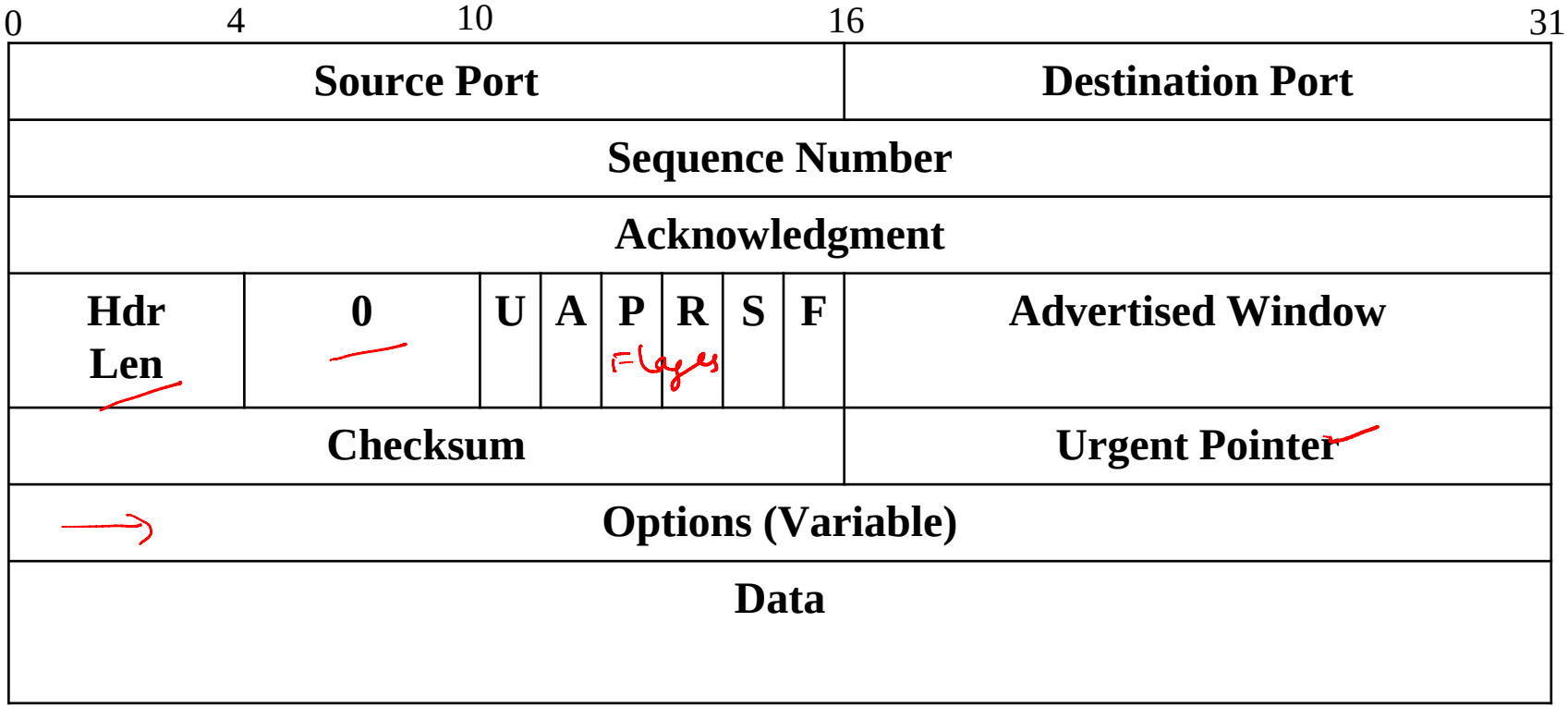


- Each byte has a sequence number
- Sequence number field contains the sequence number of the first byte in the segment
- Acknowledgment field carry information about flow in the other direction
  - Carries sequence number of next byte a host is expecting
  - Unless specified, ack is cummulative

Example


A
B
Payload
Seq: 20, Ack: 857, Data:1000 Bytes
A is asking B to send data starting @ byte 857
Seq: 857, Ack: 1020, Data:100Bytes
Seq: 1020, Ack: 957, Data:500 Bytes
Seq ?
Ack ?
20
1020
1000
857
957
100

TCP Header Format



Flags

- UAPRSF
- U: Urgent flag indicates segment contains urgent data (not used)
  - UrgentPointer (bytes) indicates where in the segment non-urgent data begins

urgent data begins right after the header

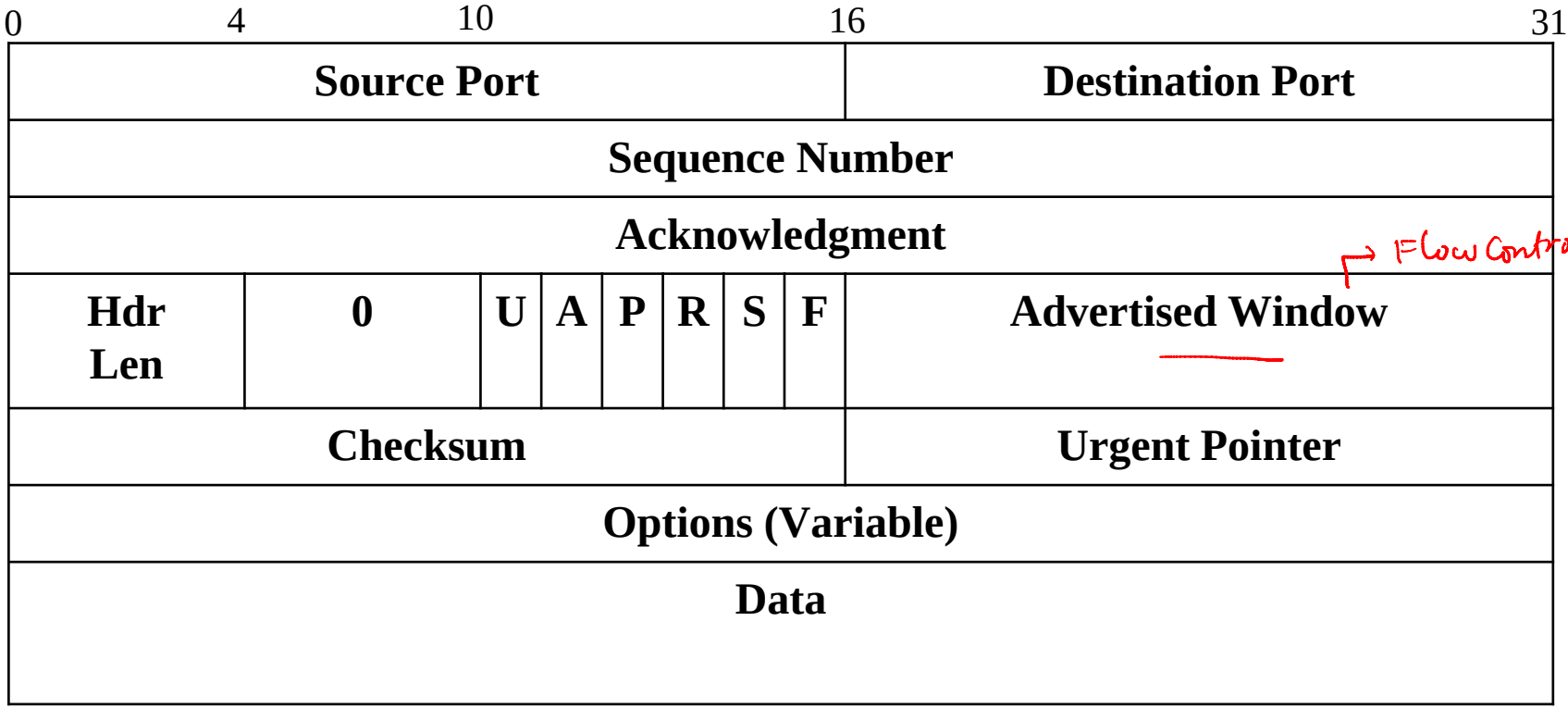
- A: Ack bit is set if the acknowledgment field is valid

sometimes ACK need not be ackknowledged so, we dont set A bit

Flags

- UAPRSF
- P: Push flag indicates receiver should pass data to higher layers immediately (not used)
- R: Reset, used to abort connection
- S/F: Syn and Fin flags are used during connection establishment and termination

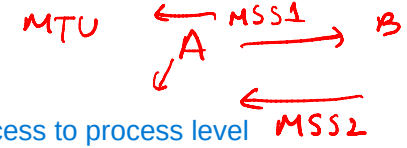
TCP Header Format



Checksum

- Similar to UDP
- Compulsory in IPv4 and IPv6
- Calculated over TCP header, data and pseudoheader
  - Pseudoheader: source, destination, protocol of IP header and TCP segment total length (calculated)

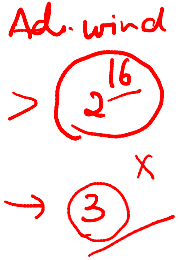
Options



just at the process to process level
routers not involved
so fragmentation can still happen

min(,)

- Can negotiate maximum segment size
- Can perform window scaling
- Permits use of selective-acks
  - Both to indicate the device supports selective acknowledgments and carry the actual ack information
- Permits use of alternate checksum



advertised window size is 16bits

so max size to specify 2^16

but we can use options to indicate to use 3X that as window size

Summary

- TCP: a very popular, finely tuned protocol
- Provides quite a few features at the transport layer
- Heart of TCP is the sliding window protocol
- Examined TCP header
- Ahead: TCP connection management