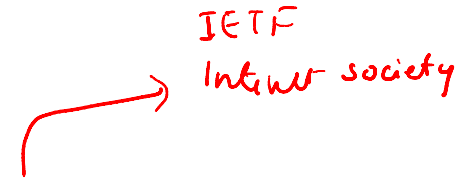


Transmission Control Protocol (TCP) – Overview

Kameswari Chebrolu

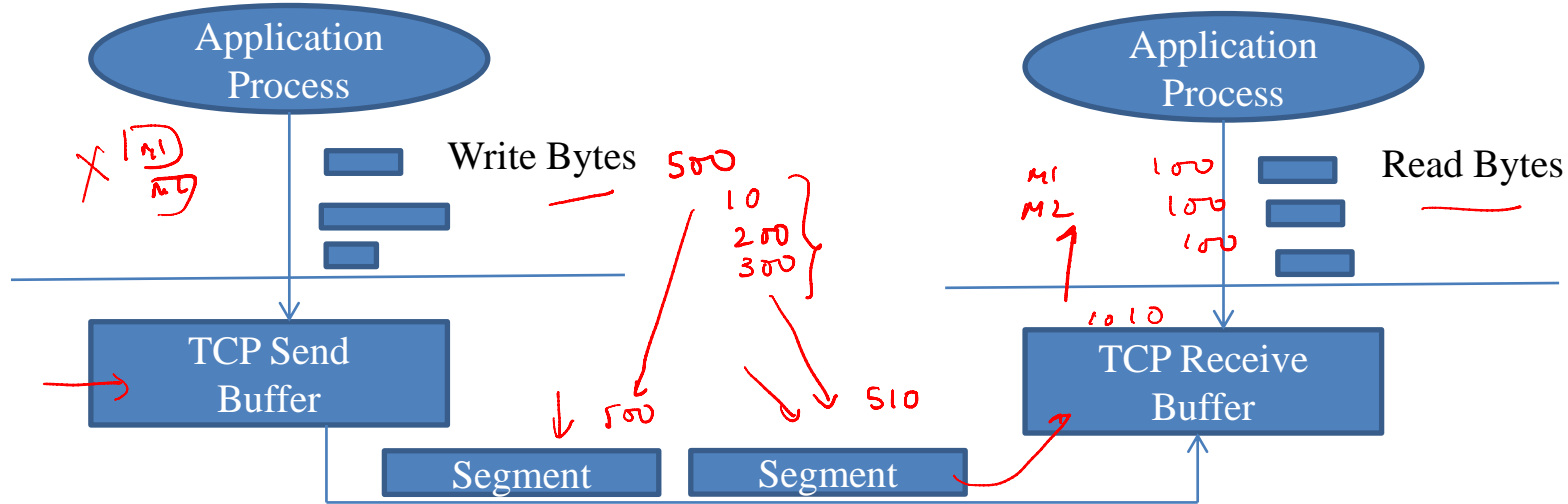
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Background

- 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
- 

TCP Model

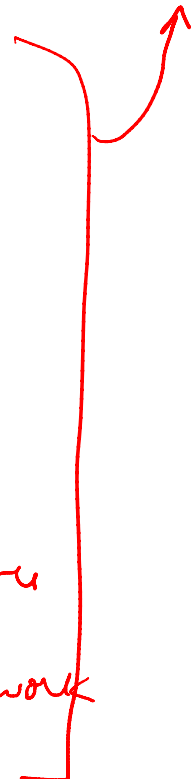
- Connection oriented byte-stream protocol



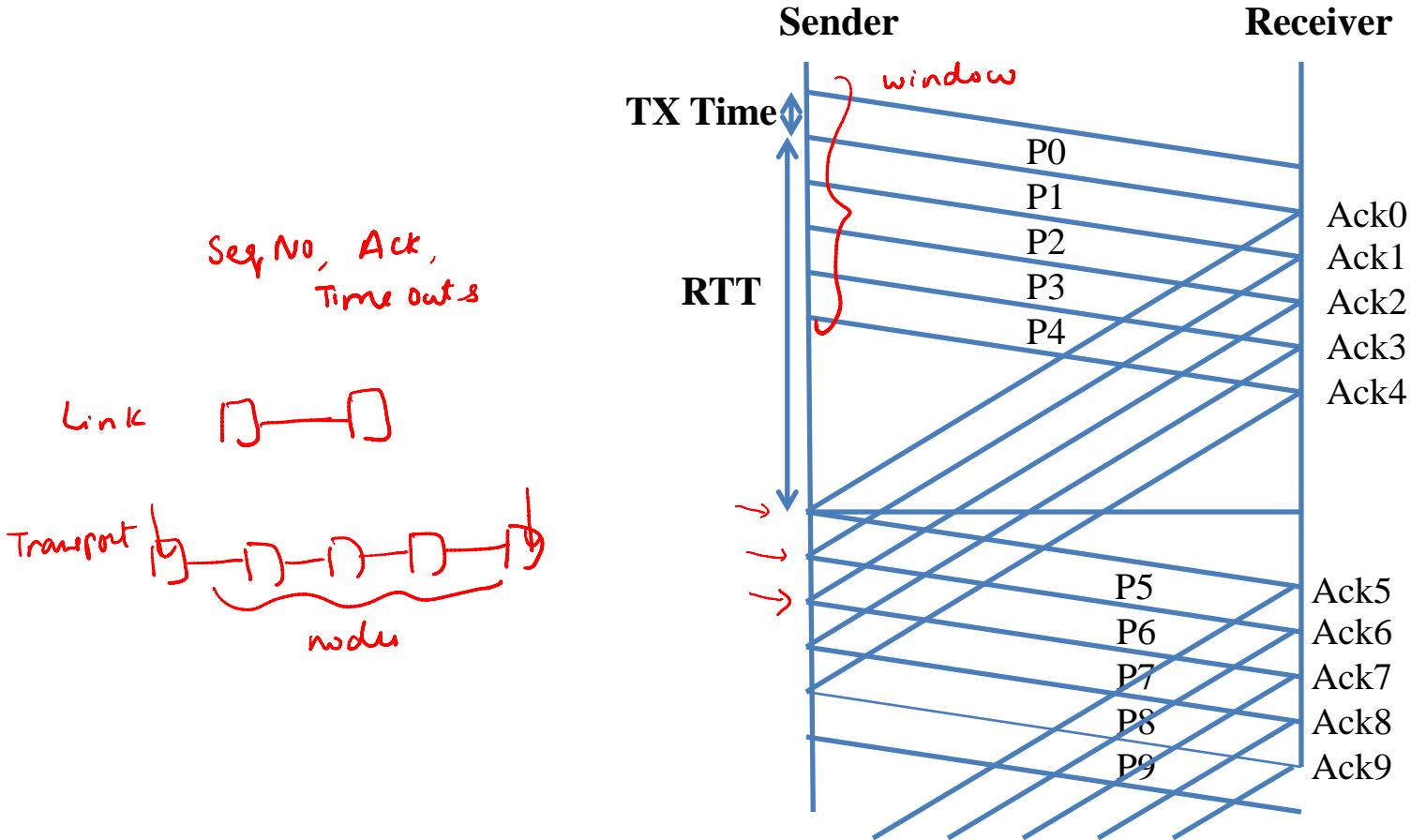
TCP Services

- Multiplexing/Demultiplexing
- Reliable point-to-point data transfer
- Full-duplex
- Flow control
 - receiver control sending rate
 - sender overwhelming receiver
- Congestion control → sender " network



Sliding window



Recap: Sliding Window Protocol



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

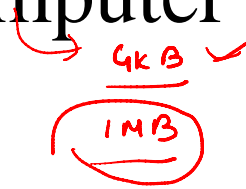
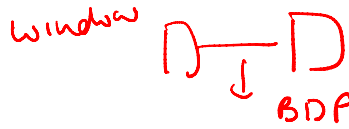


Sliding Window: Reordering


- 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)



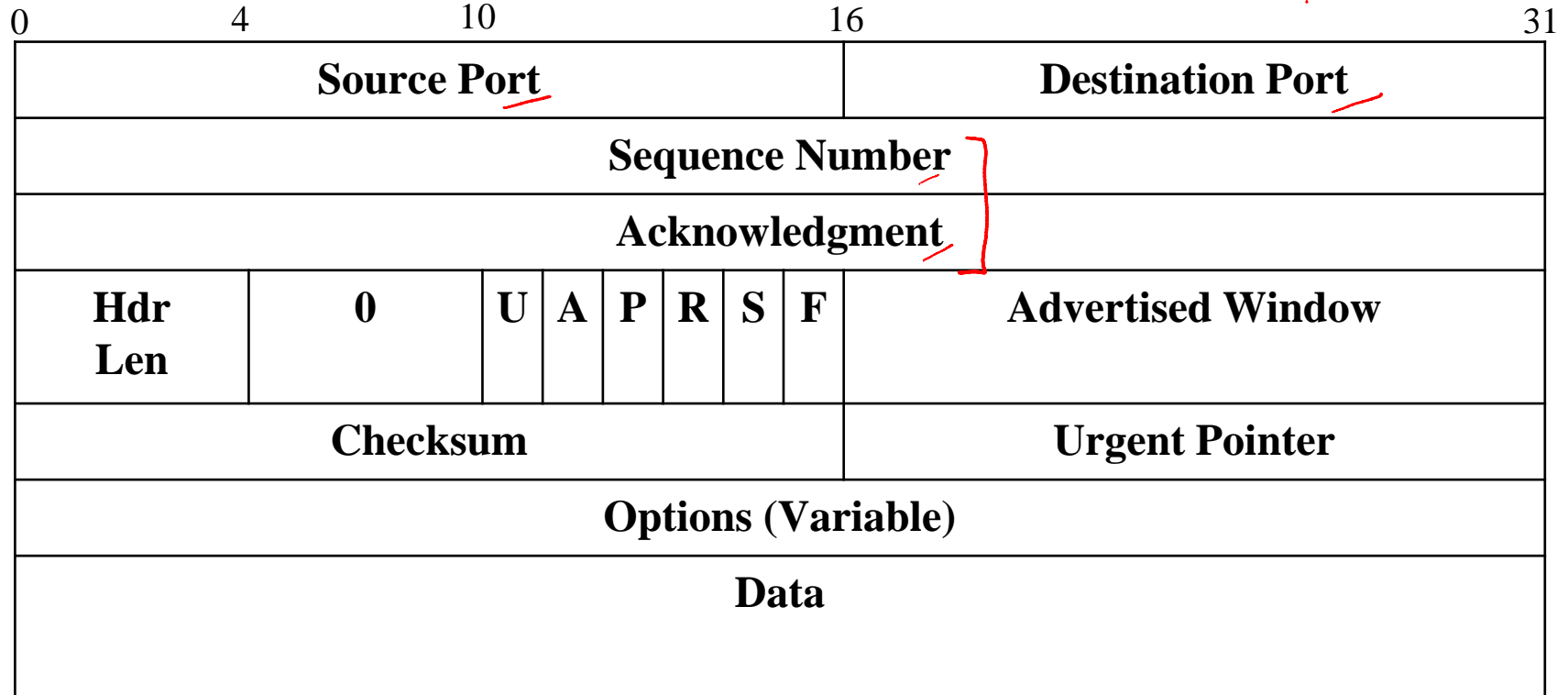
Sliding Window: Congestion Control

- 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

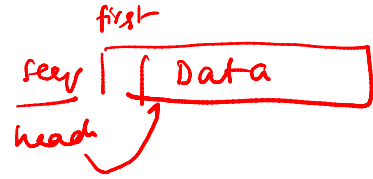


TCP Header Format

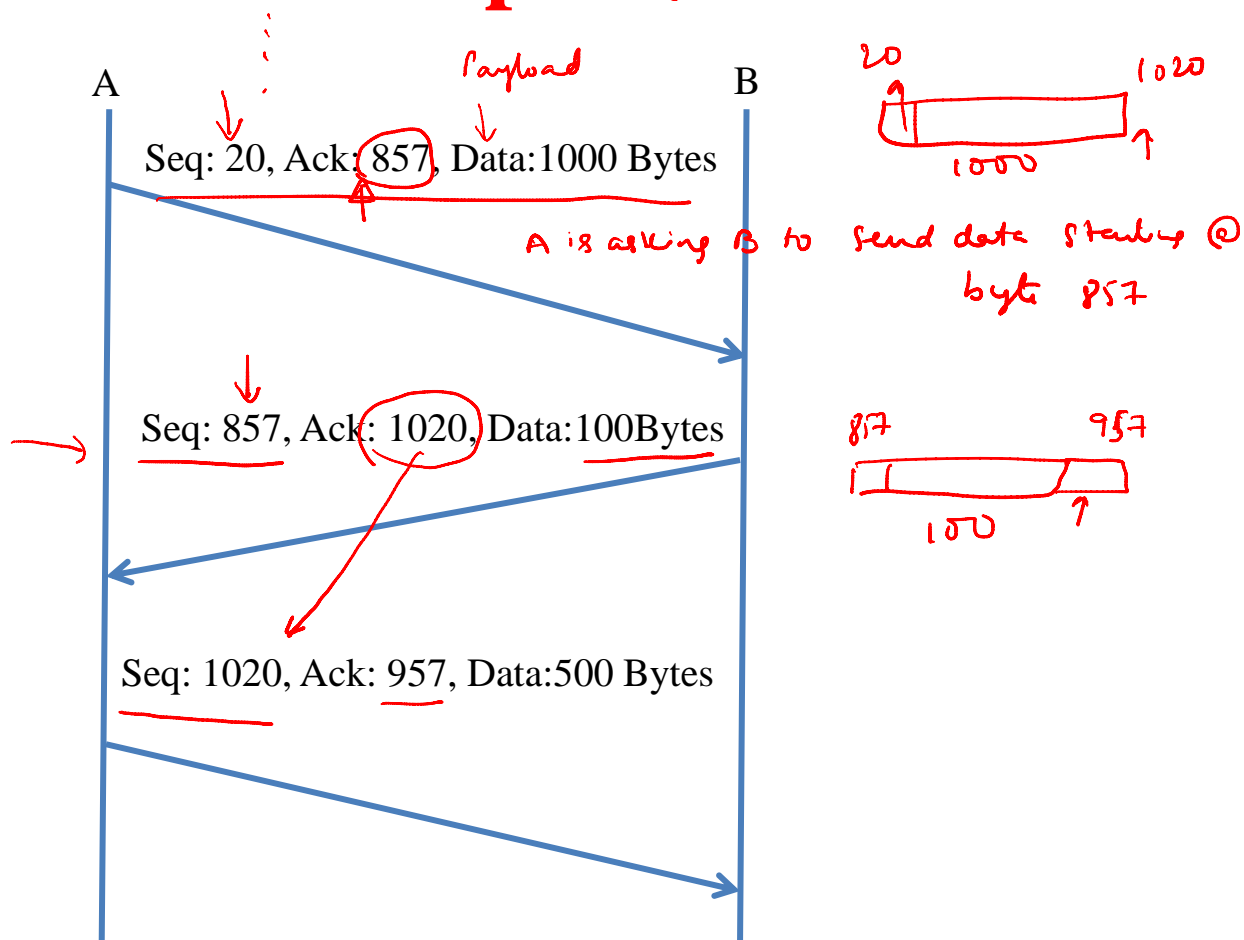


Sequence Number and Acknowledgment

- 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 ← B



TCP Header Format

0	4	10	16	31
Source Port				Destination Port
Sequence Number				
Acknowledgment				
Hdr Len	0	U	A	P R S F
				Advertised Window
Checksum				Urgent Pointer
Options (Variable)				
Data				

Flags

- UAPRSF
 - U: Urgent flag indicates segment contains urgent data (not used)
 - UrgentPointer (bytes) indicates where in the segment non-urgent data begins
 - A: Ack bit is set if the acknowledgment field is valid
- Handwritten notes:*
- A red line connects the 'U' in the first item to the 'U' in the second item.
- A red arrow points from the 'U' in the second item to the 'U' in the third item.
- A red arrow points from the 'segment' in the second item to the 'UrgentPointer' in the third item.
- A red arrow points from the 'bytes' in the third item to the 'Ack bit' in the fourth item.
- A red arrow points from the 'UrgentPointer' in the third item to the 'UrgentPointer' in the fourth item.
- A red arrow points from the 'UrgentPointer' in the third item to the 'UrgentPointer' in the fourth item.
- A red arrow points from the 'UrgentPointer' in the third item to the 'UrgentPointer' in the fourth item.

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

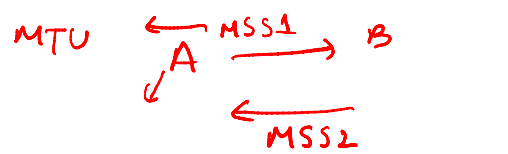
TCP Header Format

0		4		10		16		31			
Source Port						Destination Port					
Sequence Number											
Acknowledgment											
Hdr Len		0		U	A	P	R	S	F	Advertised Window	
Checksum								Urgent Pointer			
Options (Variable)											
Data											

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



- Can negotiate maximum segment size

$\min(,)$

- Can perform window scaling

Adv. wind 16
> $\left(\frac{16}{2} \right)$ bytes

- Permits use of selective-acks

$\rightarrow \left(\frac{3}{2} \right)^x$ window size

- Both to indicate the device supports selective acknowledgments and carry the actual ack information

- Permits use of alternate checksum

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