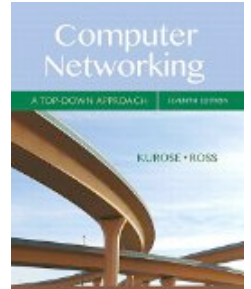


COMP 375: Lecture 21



- **News & Notes:**
 - Quiz #5 in class Monday
 - Project #3 now due Monday
- **Reading (Mon, March 19)**
 - Sections 3.{6,7} (Congestion Control)

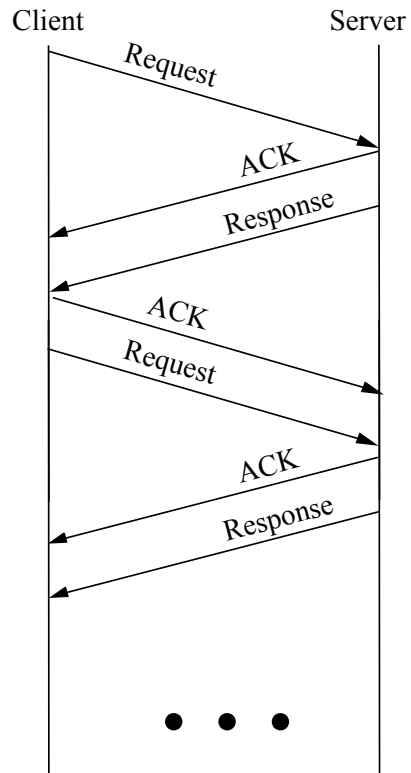
Section 3.5

RELIABLE TRANSPORT WITH TCP

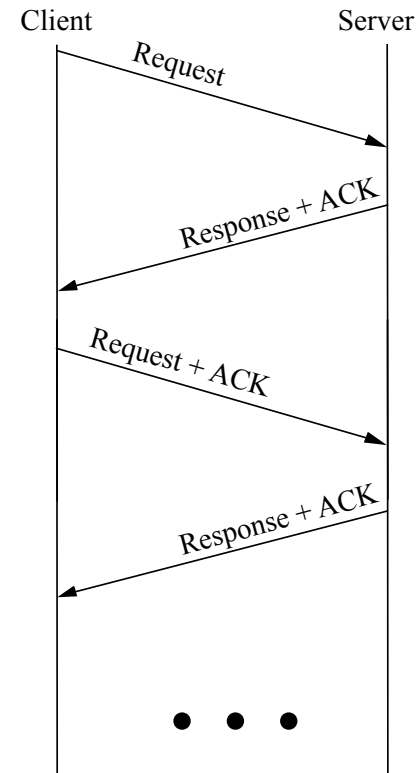
Which of the following is **true** about a **TCP connection**?

- | | |
|-----------|--|
| A. | It has one sending host and one receiving host. |
| B. | Each side can act as both receiver and sender. |
| C. | It will contain separate messages for data and ACKs. |
| D. | A and C |
| E. | B and C |

TCP uses piggybacking to improve performance.



Without
Piggybacking

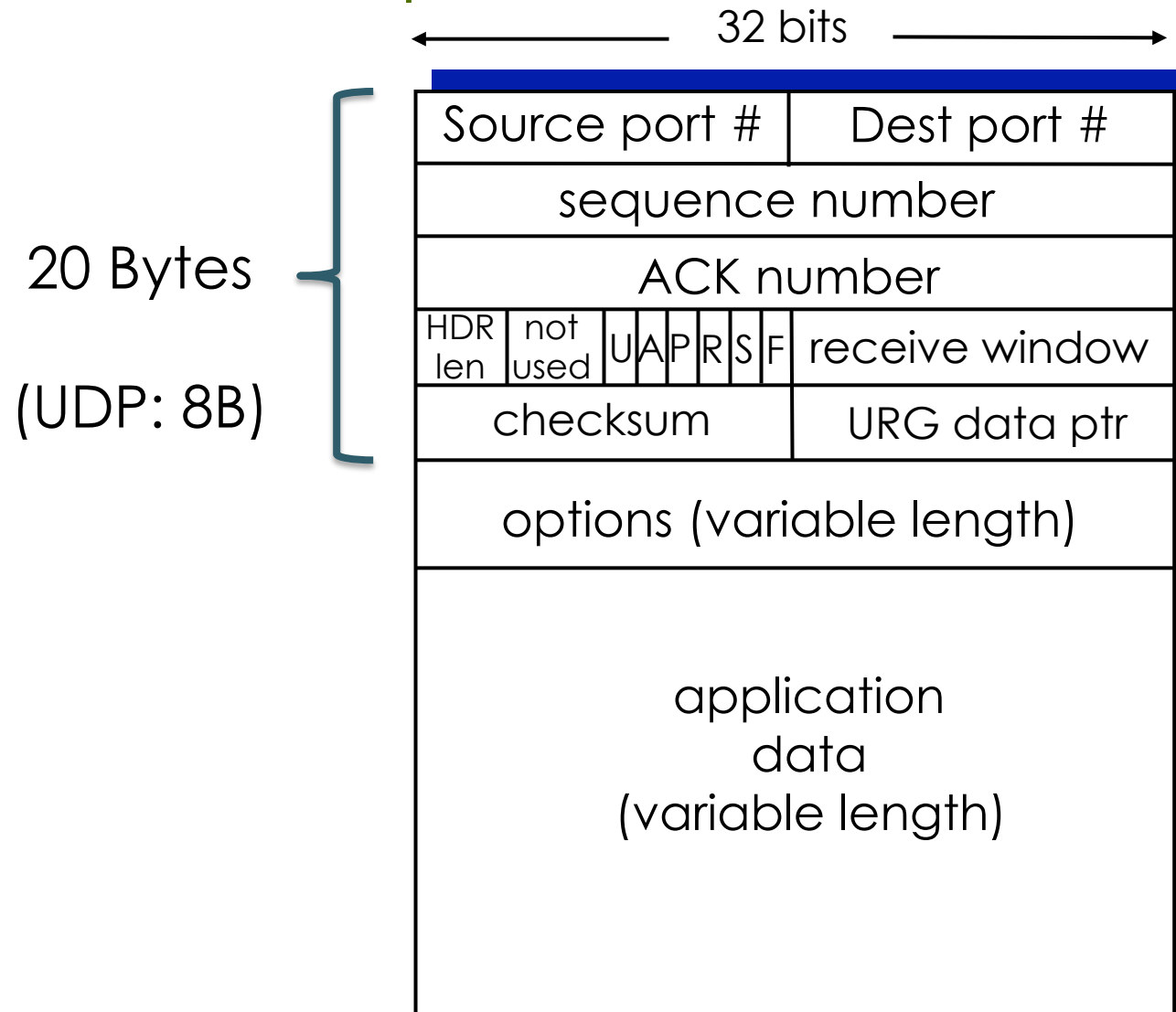


With
Piggybacking

TCP has many interesting properties and useful features.

- Point-to-point
- Full-duplex communication
- Connection-oriented
- Reliable, in-order byte stream
- Pipelined Sending
- Flow Control
- Congestion Control

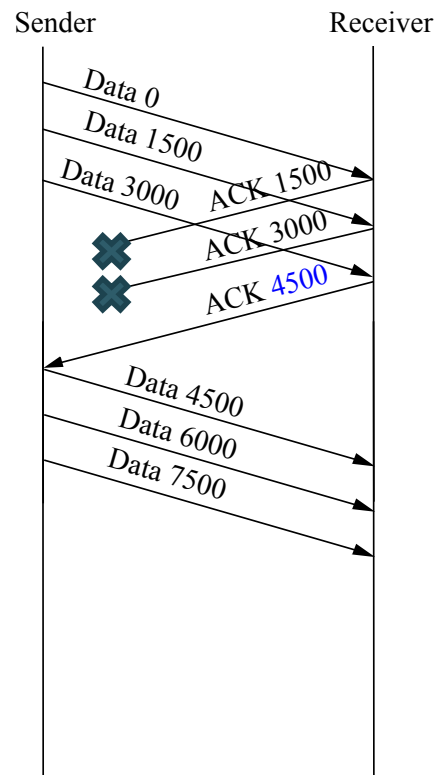
TCP headers are larger and more complex than UDP headers.



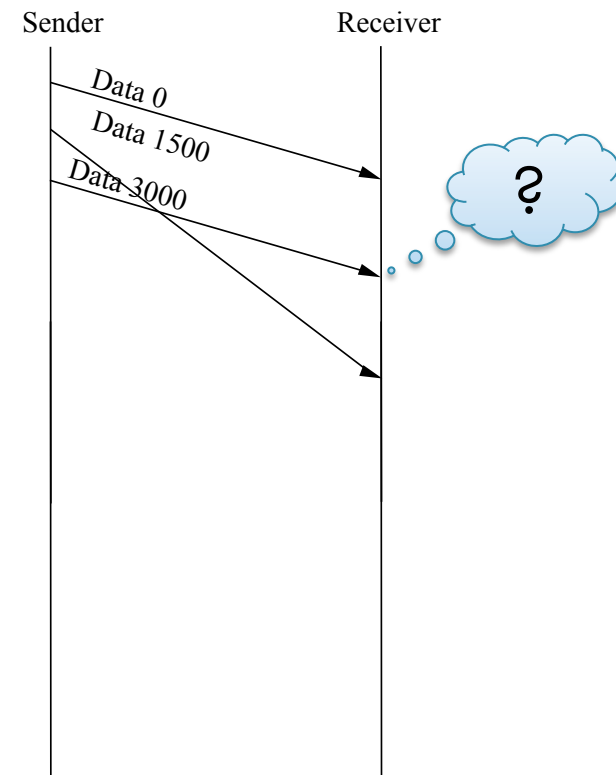
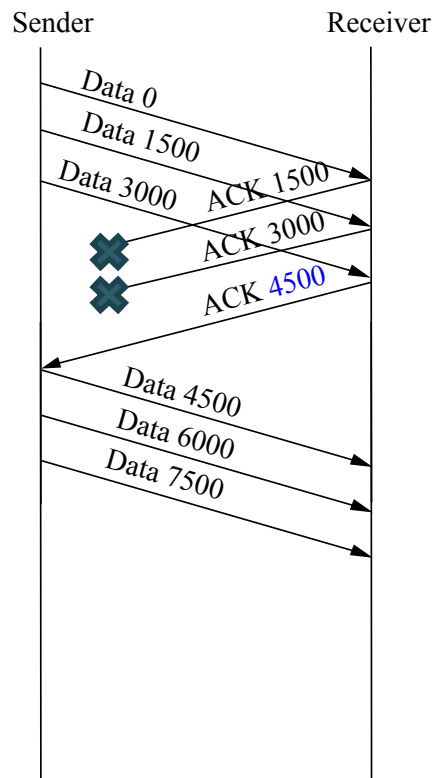
Over the next two classes, we'll look to answer the following questions about TCP.

- **How is pipelining handled?**
- How should we choose timeout values?
- What does connection establishment look like?
- How many segments should be pipelined?

TCP isn't purely GBN, but it does use cumulative acknowledgments.



The network can reorder packets: What happens then?



Here's a idea: Let's delay sending
an ACK for 500 ms.

```
if packet_received_must_be_acked:  
    send_ack_now( );
```



```
if packet_received_must_be_acked:  
    sleep(500 milliseconds);  
    send_ack_now( );
```

Is it a good or bad idea to delay the ACK for up to 500 ms?

A. **Bad idea** because it increases the chance of a time out.

B. **Bad idea** because it can interfere with the window size.

C. **Good idea** because it reduces the number of messages sent.

What's the best thing to do if we get an out-of-order segment at the receiver?

- | | |
|-----------|----------------------------|
| A. | Drop/Ignore it. |
| B. | Save it, then ACK it. |
| C. | Save it, but don't ACK it. |
| D. | Something else (explain). |

Over the next two classes, we'll look to answer the following questions about TCP.

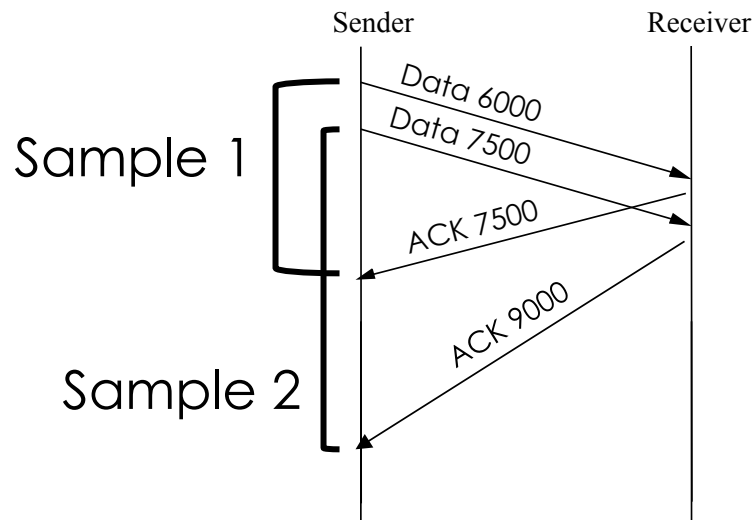
- How is pipelining handled?
- **How should we choose timeout values?**
- What does connection establishment look like?
- How many segments should be pipelined?

Setting the timeout requires careful thought about the tradeoffs.

*What is the trade-off involved with having a **long** timeout value?*

Estimating RTT is challenging because it varies over time.

- **Idea:** Sender samples the RTT based on how long it took to get an ACK.



TCP uses the equation below to calculate estimated RTT after each new sample.

$$\text{EstimatedRTT} = (1 - \alpha) * \text{EstimatedRTT} + \alpha * \text{SampleRTT}$$

Which samples are given more weight?

(Note: SampleRTT is the most recent RTT time.)

- | | |
|-----------|------------------------------------|
| A. | Newer samples given more weight. |
| B. | Older samples given more weight. |
| C. | All samples have the same weight. |
| D. | It depends on α and β |