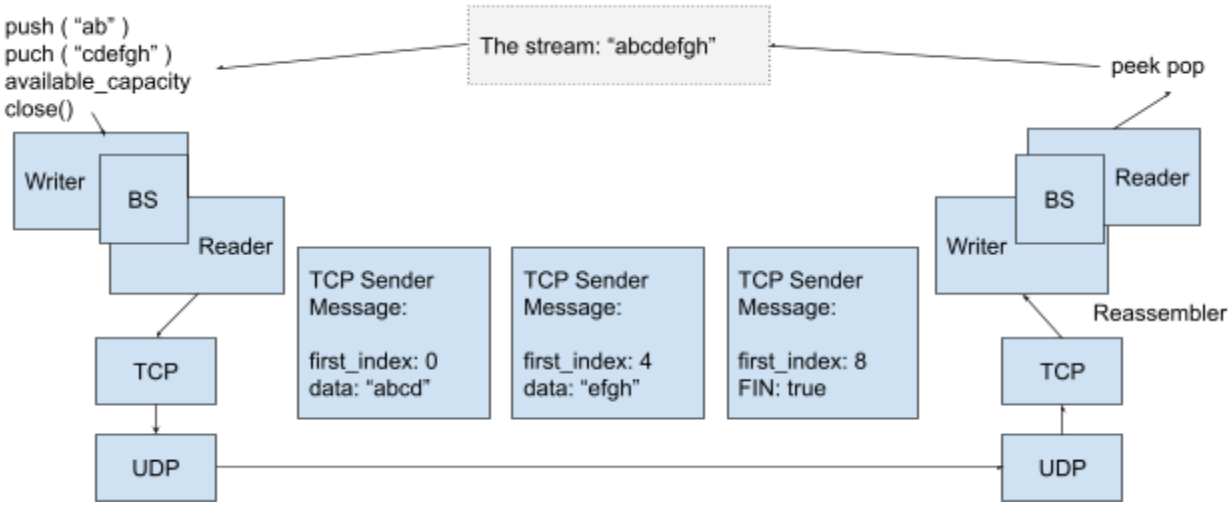
- Stacks of service abstraction
    - Short gets (DNS, DHCP) -> Use datagrams -> Internet Datagrams
    - Byte Stream –(TCP)--> User datagrams -> Internet Datagrams
        - Web requests/responses (`HTTP`) -> Byte Stream
            - Youtube/Wikipedia -> Web requests/responses
        - Email sending (SMTP) -> Byte Stream
        - Email receiving (IMAP) -> Byte Stream
- Multiplexing ByteStream
    - “u8 u8” (Which byte stream; what is the byte)
        - Any reading and writing of one byte would be actually two bytes, the first byte for which byte stream and the second for the actual byte
    - “u8 u8 {u8 u8 … u8}” (which byte stream; size of payload; sequence of characters of the string chunk)
        - Any reading and writing of n bytes would be actually n + 2 bytes
        - Tagged byte stream: HTTP/2 | SPDY
- How to make ByteStream push idempotent?
    - TCP Sender Message

      first_index

      data

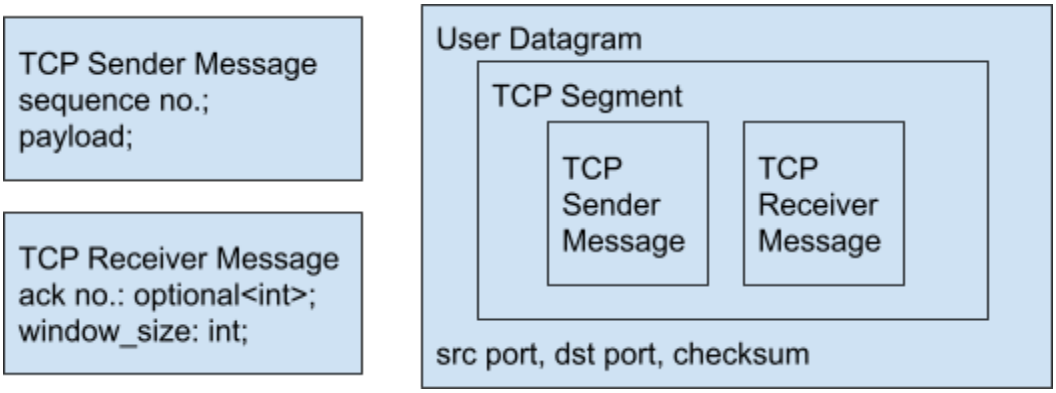
      FIN



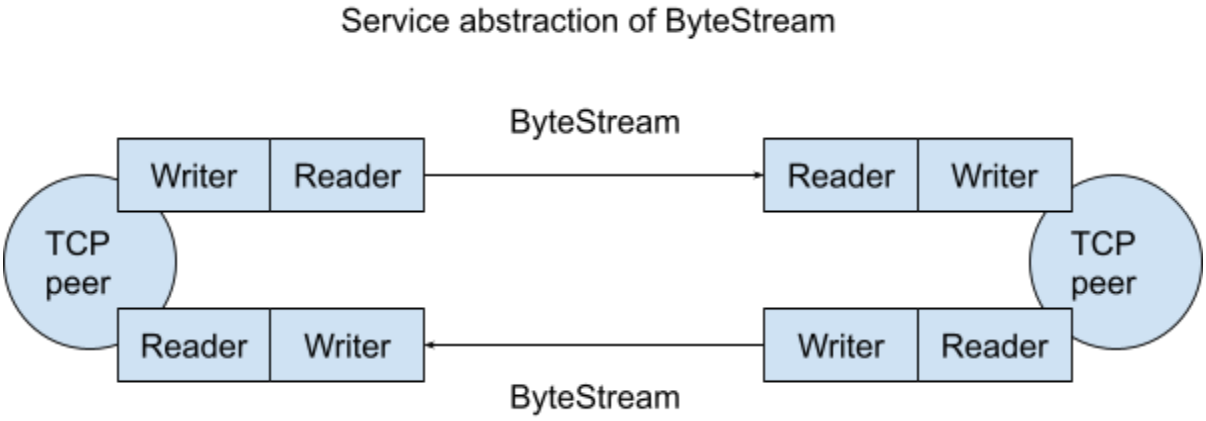
    - This works for out-of-order or multiple deliveries. Since UDP has a checksum field, altered TCP Message would be ignored on the UDP layer.
    - What if datagrams are missing?
        - How does the sender know that a datagram needs to be sent multiple times?
        - DNS/DHCP: if we don’t receive an answer, then we retransmit. But such response/answer does not exist in `pushing` (void push())
    - Acknowledgement
        - TCP Receiver Message
            - “A B C D E F G” each byte sent as a separate TCP sender message, and “D” is not received.

        - “I got the sender message with first-index = 2, length = 1.”
            - Valid but more work. There will be one receiver message for each sender message.
        - “Got anything? Y/N. Next needed: #3.”
            - Acknowledgements are accumulative, and that make life simpler.
        - Give FIN flag a number: “A B C D E F G FIN”.
          TCP Sender Message: {sequence number, data}
          TCP Receiver Message: {Next needed: optional<int>}
          and TCP Receiver Message {Next needed: optional(8)} would mean FIN is received.
        - TCP Receiver Message: {Next needed: optional<int>; available capacity:int}
            - {Next needed: optional(3); available capacity: 2} === Receiver wants to here about “DE”.
            - “DE” is the **window**. (Red area in that picture of lab 1)
    - **TCP Receiver Message: {Ack no: optional<int>; window size: int}**

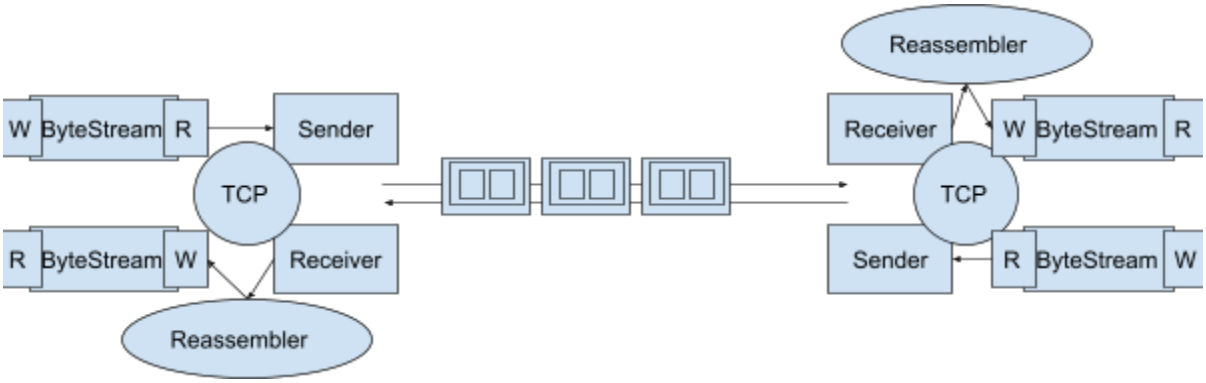
- TCP Segment



- This is the service abstraction that TCP is providing:



- And this is what happens under the hood (and also what you will be implementing in the labs)



- Rules of TCP
    - Reply to any nonempty TCP Server Message