

3. 0/0/0011

$$\begin{array}{r} + 01100110 \\ \hline 10111001 \end{array}$$

10111001

$$\begin{array}{r} + 01101000 \\ \hline 00101110 \end{array}$$

① The complement is 110/0001

② These four will be added to detect errors. If zero is contained in sum, there is an error.

③ One-bit errors can't escape, but two-bit errors may not be detected when two bits are reversed and lead to the same sum.

25. (a) When sending a message, UDP will encapsulate in a segment whatever the application gives



it rather than putting some unnecessary data concerning the connection like TCP.

(b) UDP doesn't have delays due to flow control or congestion control like TCP.

28. Host A's sending rate can at most reach 100Mbps due to the 100Mbps link capacity. It's faster than host B can remove data from the buffer. The receive buffer fills up at a rate of roughly 50Mbps. When the buffer is full, host B signals to host A to stop sending data by setting  $RcvWindow = 0$ . Host A then



stops sending until it receives a TCP segment with  $RcvWindow > 0$ . Host A will thus stop and start repeatedly sending as a function of the  $RcvWindow$  values it receives from Host B. On average, the long-term rate at which host A sends data to host B as part of this connection is no more than 50 Mbps.

40. (a)  $[1, 6]$  and  $[23, 26]$

(b)  $[6, 16]$  and  $[17, 22]$

(c) By a triple duplicate ACK. The  $cwnd$  would have dropped to 1 if there were a timeout.

(d) By timeout. The  $cwnd$  is set



to 1.

(e) According to the picture, about 32.

(f) About 21.

(g) About 14.

(h)  $T$ th transmission round.

(i) The new value of the threshold should be 4 and window will be 7.

(j)  $ssthresh = 21$ . Window size = 1.

(k)  $1 + 2 + 4 + 8 + 16 + ssthresh = 52$ .

46. (a) 
$$\frac{W \times MSS}{RTT} = 10 \text{ Mbps}$$

$$\Rightarrow W = 125$$

(b)  $avg = 0.75 W \approx 94$ .

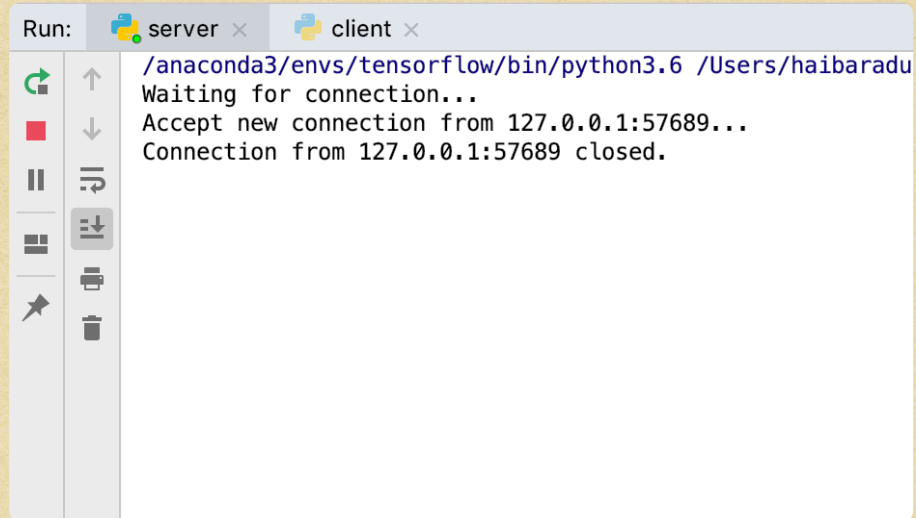
Average throughput is

$$94 \times 1500 \times 8 / 0.15 = 7.52 \text{ Mbps}.$$

(c)  $W/2 = 62$

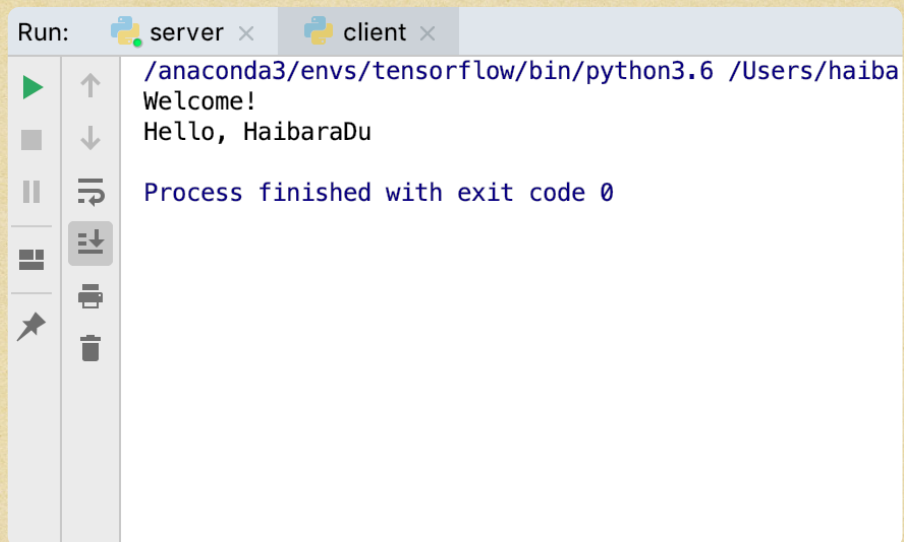


$$t = \frac{W}{2} \times RTT = 9.45s$$



A screenshot of a terminal window with two tabs: 'server' and 'client'. The 'server' tab is active. The terminal output shows the following messages:

```
/anaconda3/envs/tensorflow/bin/python3.6 /Users/haibaradu  
Waiting for connection...  
Accept new connection from 127.0.0.1:57689...  
Connection from 127.0.0.1:57689 closed.
```



A screenshot of a terminal window with two tabs: 'server' and 'client'. The 'client' tab is active. The terminal output shows the following messages:

```
/anaconda3/envs/tensorflow/bin/python3.6 /Users/haiba  
Welcome!  
Hello, HaibaraDu  
  
Process finished with exit code 0
```