Homework Assignment 4: 100 points

Due date: Nov. 30, 2024 (Saturday)

Question 1: (10 points)

Regarding the IP fragmentation, suppose that there is a datagram of 5000 bytes, and the MTU of the link is 1000 bytes. How many datagrams will be generated after the IP fragmentation, and why?

Solution: 6 datagrams.

Original datagram: length=5000, fragflag=0, there are 4980 bytes in data field.

1st datagram: length=1000, fragflag=1, there are 980 bytes in data field.

2nd datagram: length=1000, fragflag=1, there are 980 bytes in data field.

3rd datagram: length=1000, fragflag=1, there are 980 bytes in data field.

4th datagram: length=1000, fragflag=1, there are 980 bytes in data field.

5th datagram: length=1000, fragflag=1, there are 980 bytes in data field.

6th datagram: length=100, fragflag=0, there are 80 bytes in data field.

Question 2: (10 points)

(a) What does "CIDR" refer to? (5 points)

(b) What does "DHCP" refer to? (5 points)

Solution:

(a) Class InterDomain Routing

  ・ Subnet portion of address of arbitrary length

  ・ Address format: a.b.c.d/x, where x is # bits in subnet portion of address

(b) Dynamic Host Configuration Protocol

  ・ Dynamically get address from as server

Question 3: (10 points)

Regarding the shortage of the IPv4 addresses, please specify two ways to address this issue of the shortage of the IPv4 addresses.

Solution:

(a) Use NAT. (b) Upgrade to IPv6.

Question 4: (20 points)

(a) To identify a TCP socket, what are the 4-tuple information required? (5 points)

(b) To identify a UDP socket, what are the 2-tuple information required? (5 points)

(c) What are the differences between TCP and UDP? (10 points)

Solution:

(a) Source IP address, destination IP address, source port number, and destination port number.

(b) destination IP address and destination port number.

(c)

TCP	UDP
· Connection management · Connection-oriented · Send and receive buffers exist · Full duplex data · Reliable data transfer · Flow controlled · Congestion controlled	· No connection establishment (which can add delay) · Simple: no connection state at sender, receiver · Small header size · No congestion control: UDP can blast away as fast as desired

Question 5: (5 points)

What are the three mechanisms to realize the reliable data transfer protocols?

Solution: Feedback (control messages (ACK, NAK) from receiver to sender), sequence number, and timer.

Question 6: (15 points)

Consider the situation of reliable data transfer. Each packet size is 5000bits. The link bandwidth is 5Mbits/ sec. The single-trip signal propagation delay is 0.005sec.

(a) What is the utilization ratio of this link if the stop-and-wait based reliable data transfer protocol is adopt? (5 points)

(b) How to improve the utilization ratio of this link? To make a full utilization of the link, what is the maximum number of packets which can be sent without requiring acknowledgement? (5 points)

(c) What are the differences between the GBN protocol and selective repeater protocol?

Solution:

(a) $RTT = 2 * 0.005 = 0.01 \ sec$

$U = \frac{L/R}{RTT+L/R} = \frac{0.001}{0.01+0.001} = 0.0909$

(b) By pipelined protocols: go-back-N or selective repeat.

$\frac{RTT}{L/R} + 1$=10+1=11 packets.

(c)

Go-back-N	Selective repeat
· Sender can have up to N unacked packets in pipeline · Receiver only sends cumulative ack: doesn't ack packet if there's a gap · Sender has timer for oldest unacked packet: when timer expires, retransmit all unacked packets	· Sender can have up to N unacked packets in pipeline · Receiver sends individual ack for eack packet · Sender maintains timer for each unacked packet: when timer expires, retransmit only that unacked packet

Question 7: (20 points)

(a) What are the differences between TCP congestion control and TCP flow control? (5 points)

(b) What are the three mechanisms used for TCP congestion control? (10 points)

(c) Please explain why TCP needs to perform the fast-transmission mechanism after receiving three duplicated ACKs? (5 points)

Solution:

(a) Flow control: Avoid the sender overflowing receiver's buffer by transmitting too much, too fast.

　Congestion control: Avoid too many sources sending too much data too fast for network to handle.

(b) AIMD, slow start, and conservative after timeout events.

(c) After the sender receives 3 duplicate ACKs, it assumes that the packet is lost and retransmit that packet without waiting for a retransmission timer to expire.

Question 8: (10 points)

(a) What does DNS refer to? (5 points)

(b) What are the two query-schemes used by DNS? (5 points)

Solution:

(a) Domain Name System.

(b) Iterated query and recursive query.