CS655 Homework 3

Changhao Liang (U16843909)

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1 Problem 1

1.1 Question a

The congestion window is initialized to the size of a single segment which is 1KB. We know that in slow start phrase, the window size will be doubled every RTT. So let's say after n RTTs, the sender's congestion window reaches 2MB. We have

$$\begin{aligned} 1KB * 2^n &\geq 2MB \\ 2^n &\geq 2014 \\ n &\geq 11 \end{aligned}$$

So it takes 11 RTTs until the sender's congestion window reaches 2M bytes.

1.2 Question b

The segments we need are $16MB/1KB = 16 * 1024$.
Before the sender window size reaches 2MB, the number of segments sent is $2^0 + 2^1 + \ldots + 2^{10}(KB) = 2047KB$.
The number of RTTs it uses is 11.
The left size of file is $16MB - 2047KB = 14337KB$.
The 12th RTT, 2MB data will be sent, and the window size won't be doubled because it has reached the threshold.
And the current left file size is $14337KB - 2048KB = 12289KB$.
So left RTTs are $12289KB/2M = 7$ It takes 2RTT to send the left file.
So the total RTTs are 12 + 7 = 19RTT.

1.3 Question c

If the total time to send the file is $19 * 200ms = 3800ms$, the effect throughput for the transfer is $16M * 8/3.8s \approx 33.68Mbps$. The percentage of the utilized link capacity is $33.68/1000 = 3.37\%$.

2 Problem 2

Datagram-forwarding table for router node A:

Destination	Distance	Next-Hop
A	0	A
B	7	D
C	6	D
D	3	D
E	5	D
F	12	D

Datagram-forwarding table for router node B:

Destination	Distance	Next-Hop
A	7	E
B	0	B
C	3	E
D	4	E
E	2	E
F	9	E

Datagram-forwarding table for router node C:

Destination	Distance	Next-Hop
A	6	E
B	3	E
C	0	C
D	3	E
E	1	E
F	6	F

3 Problem 3

The updated routing table of K is

Destination	Distance	Next-Hop
Net1	0	direct
Net2	0	direct
Net5	5	Router J
Net17	6	Router M
Net22	9	Router J
Net24	6	Router J
Net30	2	Router Q
Net42	4	router J

4 Problem 4

The routing table is $8 * 60 = 480bits$. The capacity per link should be $480bits/0.5s = 960bps$.

5 Problem 5

Yes, the fragmentation would take place because MTU is smaller than the size of the TCP data which is $2000-20 = 1980B$.
With an MTU of 262 bytes, $262 - 20 = 242bytes$ of data can be transmitted in each fragmentation. In each fragment, 242 bytes are used for data field and 20 bytes are used for header field.
The fragmentation offset is expressed in a multiple of 8B, so for the first 8 datagrams, 240B data will be sent, and for the last datagram, $(2000 - 20) - 240 * 8 = 60B$ data will be sent. Totally, 9 datagrams are needed to send the 2000B.

6 Problem 6

The CIDR address can be 145.98.0.0/16 which is 10010001.01100010.00000000.00000000/16.
Dividing two subnets takes 1 digits from host IDs, so the CIDR address for each subnet is

- 10010001.01100010.00000000.00000000/17 = 145.98.0.0/17.
  So the subnet 1 address can be from 145.98.0.1/17 to 145.98.127.255/17
- 10010001.01100010.10000000.00000000/17 = 145.98.128.0/17.
  So the subnet 2 address can be from 145.98.128.0/17 to 145.98.255.255/17.

7 Problem 7

The CIDR address is 214.13.192.0 which is 11010110.00001101.11000000.00000000 in binary and it belongs to class C address.
The netmask is 21, so the first 21 digits of the address is fixed. So the lowest address is 11010110.00001101.1100000.0000000 which is 214.13.192.0 and the highest address is 11010110.00001101.11000111.111111 which is 214.13.199.255. Totally the addresses can cover 2048 hosts.

8 Problem 8

8.1 Question a

The routing table for a router in provider P is

Destination	Next Hop
C1.B3.0.0/16	PA
C1.A0.0.0/12	PB
C2.0.0.0/8	Q
C3.0.0.0/8	R

8.2 Question b

Destination	Next Hop
C1.B3.0.0/16	PA
C1.A0.0.0/12	Q
C2.0.0.0/8	Q
C2.0B.10.0/20	R
C3.0.0.0/8	R