Homework Assignment 2: 100 points

Due date: Oct. 18, 2022 (Tuesday)

Question 1: Regarding the delay in packet switching systems, (i) please specify four types of delay in packet switching. (ii) Please explain the difference between the queueing delay and transmission delay. (iii) Please explain the reason for the packet loss. (15 points)

Solution: (i) Nodal processing delay, queueing delay, transmission delay, and propagation delay.

(ii) The queueing delay means the time waiting at output link for transmission, and it depends on congestion level of router. The transmission delay means the time used by the network interface card to send the packet into the connected physical link.

(iii) Routers have limited storage, i.e., the buffer space of an output link is limited. When the buffer of the output link is fully used (i.e., a "full" queue), the newly coming packet has to be dropped. As a result, the packet is lost.

Question 2: Consider a packet delivery shown in Figure 1 below. A sending-host sends a packet to a receiving-host via two routers. The packet size is of L. The distance between two different routers and the distance between host and router are denoted by d. The link bandwidth is denoted by R. The signal propagation in each link is denoted by v. For each individual router, its total node processing delay and queuing delay is denoted by T. Please calculate the overall delay for the whole packet is received by the receiving host. (15 points)

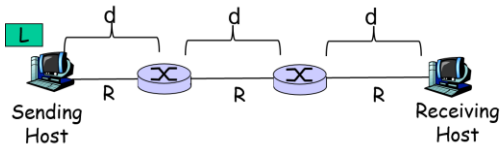

Figure 1

Solution: Total propagation delay: $3\frac{d}{v}$. Total queueing and node processing delay: $2T$. Total transmission delay:$3\frac{L}{R}$. Overall delay:$3\frac{d}{v}+3\frac{L}{R}+2T$.

Question 3: Please specify the difference between the Client/Server (CS) service model and Peer-to-Peer (P2P) service model. (5 points)

Solution:

<table>
<tr><th colspan="2">Client/Server (CS) service model</th><th colspan="2">Peer-to-Peer (P2P) service model</th></tr>
<tr><td rowspan="3">server</td><td>always-on host</td><td rowspan="7">Peers</td><td>no always-on server</td></tr>
<tr><td>permanent address</td><td rowspan="2">arbitrary end systems can directly communicate with each other as the "peers"</td></tr>
<tr><td>server farms for scaling</td></tr>
<tr><td rowspan="4">clients</td><td>communicate with server</td><td rowspan="2">a temporary requesting-peer can obtain content (service) from a temporary providing peer</td></tr>
<tr><td>may be intermittently connected</td></tr>
<tr><td>may have dynamic addresses</td><td>Peers are intermittently connected and change addresses</td></tr>
<tr><td>do not communicate directly with each other</td><td>Highly scalable but difficult to manage</td></tr>
</table>

Question 4: (35 points) Suppose that we have a file of size F=20MBits and we need to distribute this file from one server to a group of peers. The number of the peers is N. Assume that the server's uploading bandwidth u_s =40MHz, and each peer has an equal uploading bandwidth u_i =5 MHz and equal downloading bandwidth d_i =10MHz. Then, please provide your solution to the following four questions:

(a): Suppose that we use Client/Server service model to distribute the file. How long does it for the case N=5, N=10, N=20, N=40, and N=60, respectively? (10 points)

(b): Suppose that we use Peer-to-Peer service model to distribute the file. How long does it for the case N=5, N=10, N=20, N=40, and N=60, respectively? (10 points)

(c): What can you find by comparing the solutions from (a) with the solutions from (b)? (5 points)

(d): Suppose that there are infinite number of the peers in the system, i.e., N=∞, how long does the Client/Server model to distribute the file, and how long does the Peer-to-Peer model to distribute the file? (10 points)

Solution to 4(a) (10 points)

N	$d_{c/s} = \max\{NF/u_s, F/\min(d_i)\}$
5	$d_{c/s} = \max\{5*20/40, 20/10\}$ =2.5s
10	$d_{c/s} = \max\{10*20/40, 20/10\}$ =5s
20	$d_{c/s} = \max\{20*20/40, 20/10\}$ =10s
40	$d_{c/s} = \max\{40*20/40, 20/10\}$ =20s
60	$d_{c/s} = \max\{60*20/40, 20/10\}$ =30s

Solution to 4(b) (10 points)

N	$d_{p2p} = \max\{F/u_s, F/\min(d_i), NF/(u_s+\sum u_i)\}$
5	$d_{p2p} = \max\{20/40, 20/10, 5*20/(40+5*5)\}$ =2s
10	$d_{p2p} = \max\{20/40, 20/10, 10*20/(40+10*5)\}$ =2.222s
20	$d_{p2p} = \max\{20/40, 20/10, 20*20/(40+20*5)\}$ 2.8571s
40	$d_{p2p} = \max\{20/40, 20/10, 40*20/(40+40*5)\}$ =3.3333s
60	$d_{p2p} = \max\{20/40, 20/10, 60*20/(40+60*5)\}$ =3.5294s

Solution to 4(c) (5 points)

When the number of the peers increases, the gap between the P2P model and C/S service model

increases.

Solution to 4(d) (10 points)

$$d_{p2p} = \frac{F}{u_i} = 4$$

$$d_{c/s} = \frac{NF}{u_s} = \infty$$

Question 5: Regarding the layered protocol in Internet, (i) please specify the names of the five layers in the TCP/IP reference model. (ii) Please specify the names of the seven layers in the ISO/OSI reference model. (10 points)

Solution: (i) Physical layer, data-link layer, network layer, transport layer and application layer.
(ii) Physical layer, data-link layer, network layer, transport layer, session layer, presentation layer and application layer.

Question 6: Please specify three types of network attacks. (10 points)

Solution: Denial of Service (DoS), packet "sniffing", and IP spoofing.

Question 7: Regarding the data-link layer service, (i) what is the key functionality of the data-link layer service? (ii) Consider the packet delivery in Figure 2. Suppose that host A sends a packet to Host F. How many times will the encapsulation operations between the data-link layer and the network layer be invoked, and how many times will the de-capsulation operations invoked accordingly? (10 points)

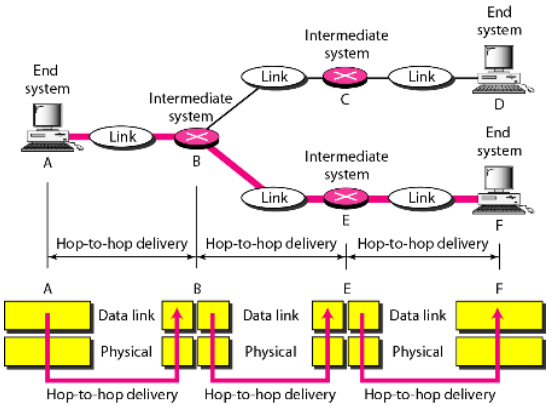

Figure 2

Solution: (i) data-link layer has responsibility of transferring datagram from one node to physically adjacent node over a link. (ii) Encapsulation: 3. Decapsulation: 3