Homework Assignment 1: 100 points
Due date: Oct. 7, 2022 (Friday)

Question 1: From the network structure perspective, what are the key components in Internet? (5 points)
Solution: network edge (host, clients, and server), access networks and network core.

Question 2: Please specify three typical types of access networks. (5 points)
Solution: residential access nets, institutional access networks, mobile access networks

Question 3: Please specify three types of guided physical links (media) and three types of the radio (unguided) links. (10 points)
Solution:
Guided physical links: copper, fiber, and coax.
Radio (unguided) links: terrestrial microwave, WiFi, cellular, and satellite.

Question 4: Regarding the hierarchical structure of Internet, please provide your solutions to the following two questions. (10 points)
(a) In Internet, what is the difference between Tier-I ISP and Tier-II ISP.
(b) How do two different Tier-I ISPs exchange data?
Solution:
(a) Tier-I ISP has the national-level Internet coverage and sufficient traffic volume (i.e., the number of users). Tier-I ISPs are usually peered with each other for exchange data via the "Internet exchange point". Tier-II ISP has the region-level coverage (e.g., access networks) and uses Tier-I ISP to reach a global access. Nevertheless, two different Tier-2 ISPs can also be peered with each other for exchanging data.
(b) Tier-I ISPs are usually peered with each other for exchange data via the "Internet exchange point".

Question 5: Regarding the circuit switching and packet switching, please provide your solutions to the following two questions. (30 points)
(a) What are the key differences between the circuit switching and packet switching? (10 points)
Solution:

	Circuit Switching	Packet Switching
Resource (e.g., bandwidth) reservation	Yes	No (on-demand manner)
Call setup and tear up	Yes	No (very simple)
Number of served users	Limited due to limited link capacity	Multiplexing gain
Performance	Guaranteed performance	Packet delay, loss, and network congestion
Application	Telephone networks	Internet, and computer networks

(b) What are the advantages and disadvantages of the circuit switching? (10 points)

Solution:

Advantage: Circuit switching can provide reliable performance (e.g., bandwidth, router capacity, and latency) for delivering data from source host to destination host.

Disadvantage: resource is idle if not used by the owning call (no sharing): a low-efficient utilization of network resources

(c) What are the advantages and disadvantages of the packet switching? (10 points)

Solution:

Advantage: Packet switching can achieve the multiplexing-gain when the Internet users' traffic is bursty, and thus can accommodate a large number of users. The management is simple, since no call setup and management are required compared to the circuit switching.

Disadvantage: Packet switching cannot provide a 100% guaranteed performance, and the transmission of the datagram via packet switching suffers from latency, congestion, and packet loss.

Question 6: We consider the following scenario in Figure 1. There is an access link with bandwidth of 1Mbit per second (i.e., 1Mbps) to serve a number of hosts (i.e., end-system) in a local area network. Each host requires a bandwidth of 100kbps for sending its data when its active, and each host's active probability is 0.2. Please provide your solutions for the following two questions (20 points)

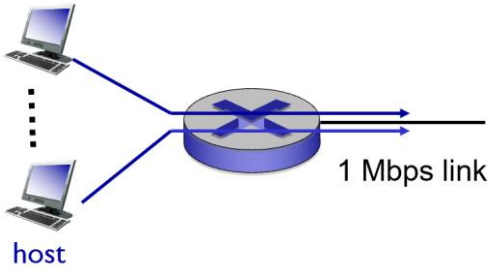

Figure 1

(a) Suppose that circuit switching is adopted, how many hosts can be admitted by this access link? (5 points)

Solution: 1Mbps/100kbps=10.

(b) Suppose that packet switching is adopted and that there are 25 hosts are admitted by this access link. In this case, what is the probability that admitted hosts cannot obtain the required bandwidth (i.e., 100kbps)? (15 points)

Solution: Under packet switching, when more than ten hosts (not including ten) are active in the link, the admitted hosts cannot obtain the required bandwidth. Such a probability (i.e., more than 10 users are actively sending their packets) is as follows.

$\sum_{n=11}^{25} C_{25}^{n} \cdot (0.2)^{n} \cdot (1-0.2)^{25-n} = 0.005554920487475.$

Question 7: Suppose that we consider the store-forward-delay in packet switching. As shown in Figure 2, a source host send 3 packets to a destination host via one router. The size of each packet is L bits, and the bandwidth of each link is R bps. The source host sends the three packets in sequence. Assume that only the transmission delay in considered in this scenario. What is the overall latency for the destination host to receive all the three packets?

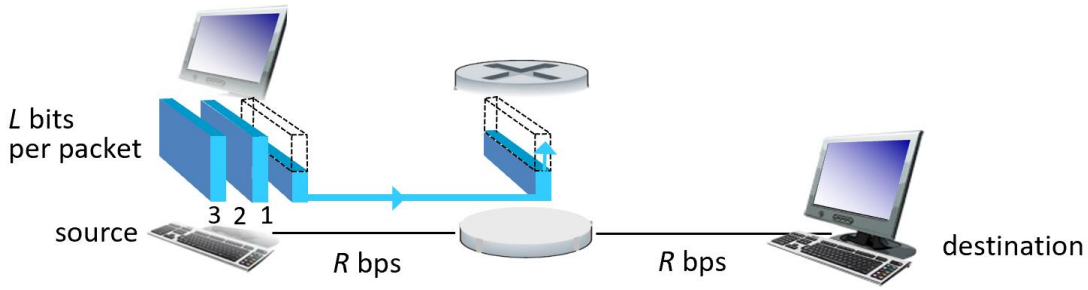

Figure 2

Solution: the overall latency for the destination host to receive all the three packet is $4\frac{L}{R}$.