**What is the difference between a host and an end system?** No difference, they both describe a device that’s hooked up to the Internet.

**Why are standards important for protocols?** Standards are important so that networking systems and properly interact with each other.

**Types of access technologies**: home, Enterprise, wide area

**Is HFC transmission rate dedicated or shared among users? Are collisions possible in a downstream HFC channel? Why or why not?** HFC is a hybrid cable system that uses bot fiber optics and coaxial cables to provide cable TV and internet to homes. The transmission rate is shared. Collisions are not possible because the data originates from a single source, the head.

**What is the transmission rate of Ethernet LANs?** 10 mbps, 100 mbps, 1 Gbps, 10 Gbps

**What are some of the physical media that Ethernet can run over?** Twisted-pair copper wire is the most common.

**Dial-up modems, HFC, DSL and FTTH are all used for residential access. For each of these access technologies, comment on whether the transmission rate is shared or dedicated.** Dial up: dedicated, HFC: shared DSL: dedicated, FTTH: dedicated

**Describe the most popular wireless Internet access technologies today. Compare and contrast them.**Wifi (wireless LAN) and 3G/4G/LTE (wide area wireless access network). For Wifi, users transmit and receive packets to/from a base station within a radius of tens of meters. The base station is connected to the wired Internet and servers to connect wireless users to the wired network. For wide area network, packets are transmitted over the same infrastructure as cell phones with the base station being managed by a telecommunications provider. This provides access of tens of kilometers from the base station.

**Time it takes for source host to transmit a full packet to a switch in store-and-forward switching =** L/R

**What advantage does a circuit-switched network have over a packet-switched network? What advantages does TDM have over FDM in a circuit-switched network?** Circuit-switched network doesn’t suffer from delays (and no risk of information loss) because the resources used to transmit are reserved. The transmission rate is constant. TDM provides more throughput because at your allotted time, you’re the only one transmitting data.

**Suppose users share a 2 Mbps link. Also suppose each user transmits continuously at 1 Mbps when transmitting, but each user transmits only 20 percent of the time. a. When circuit switching is used, how many users can be supported?** If each user transmits 1 Mbps, then it can support 2 users.

b. **For the remainder of this problem, suppose packet switching is used. Why will there be essentially no queuing delay before the link if two or fewer users transmit at the same time? Why will there be a queuing delay if three users transmit at the same time?** With 2 or few users, you’re not going over the max rate. With 3 or more you are.

c. Find the probability that a given user is transmitting.

d. Suppose now there are three users. Find the probability that at any given time, all three users are transmitting simultaneously. Find the fraction of

time during which the queue grows.

**Why will two ISPs at the same level of the hierarchy often peer with each other? How does an IXP earn money?** It’s cheaper to peer with each other vs an intermediary ISP. An Internet Exchange Points (IXP) is a meeting point where multiple ISPs can connect and/or peer together. An ISP earns its money by charging each of the ISPs that connect to the IXP a relatively small fee.

**Describe Google’s network.** Google's private network

connects together all its data centers, big and small. Traffic between the Google data centers passes over its private network rather than over the public Internet. Many of these data centers are located in, or close to, lower tier ISPs. Therefore, when Google delivers content to a user, it often can bypass higher tier ISPs.

**Consider sending a packet from a source host to a destination host over a fixed route. List the delay components in the end-to-end delay. Which of these delays are constant and which are variable?** The delay components are processing delays, transmission delays, propagation delays, and queuing delays. All of these delays are fixed, except for the queuing delays, which are variable.

**How long does it take a packet of length 1,000 bytes to propagate over a link of distance 2,500 km, propagation speed 2.5 · 10^8 m/s, and transmission rate 2 Mbps? More generally, how long does it take a packet of length L to propagate over a link of distance d, propagation speed s, and transmission rate R bps? Does this delay depend on packet length? Does this delay depend on transmission rate?** Propagation time = d/speed = 2500 \* 10^3/2.5 \* 10^8 = 1000 \* 10^-5 = 10^3\*10^-5 = 10^2 = .01 seconds. Length and rate has no bearing on the delay, only the distance and speed.

**Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R1 = 500 kbps, R2 = 2 Mbps, and R3 = 1 Mbps.**

**a. Assuming no other traffic in the network, what is the throughput for the file transfer?** 500 kbps. It’s always gonna be the slowest rate.

**b. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?** 4 million bytes = 32 million bits = 32,000 \* 10^3/500 10^3 = 64 seconds.

**Suppose end system A wants to send a large file to end system B. At a very high level, describe how end system A creates packets from the file. When one of these packets arrives to a packet switch, what information in the packet does the switch use to determine the link onto which the packet is**

**forwarded?** End system A breaks the large file into chunks. It adds header to each chunk, thereby generating multiple packets from the file. The header in each packet includes the IP address of the destination (end system B). The packet switch uses the destination IP address in the packet to determine the outgoing link.

**List five tasks that a layer can perform. Is it possible that one (or more) of these tasks could be performed by two (or more) layers?** The five layers in the Internet protocol stack are – from top to bottom – the application layer, the transport layer, the network layer, the link layer, and the physical layer. Five generic tasks are error control, flow control, segmentation and reassembly, multiplexing, and connection setup. Yes, these tasks can be duplicated at different layers. For example, error control is often provided at more than one layer.

**What is an application-layer message? A transport-layer segment? A network layer datagram? A link-layer frame? data which an application wants to send and passed onto the transport layer; transport-layer segment:** generated by the transport layer and encapsulates application-layer message with transport layer header; network-layer datagram: encapsulates transport-layer segment with a network-layer header; link-layer frame: encapsulates network-layer datagram with a link-layer header.

**Which layers in the Internet protocol stack does a router process? Which layers does a link-layer switch process? Which layers does a host process?**

Routers process network, link and physical layers (layers 1 through 3). Link layer switches process link and physical layers (layers 1 through2). Hosts process all five layers.

**What is the difference between a virus and a worm?**

Virus - Requires some form of human interaction to spread. Worms -No user replication needed. Worm in infected host scans IP addresses and port numbers, looking for vulnerable processes to infect.

**Describe how a botnet can be created, and how it can be used for a DDoS attack.**

Creation of a botnet requires an attacker to find vulnerability in some system. After finding the vulnerability, the attacker needs to scan for hosts that are vulnerable. The target is basically to compromise a series of systems by exploiting that vulnerability. Any system that is part of the botnet can automatically scan its environment and propagate by exploiting the vulnerability. An important property of such botnets is that the originator of the botnet can remotely control and issue commands to all the nodes in the botnet. Hence, it becomes possible for the attacker to issue a command to all the nodes, that target a single node.

**Suppose that cars travel (that is, propagate) on the highway at a rate of 100 km/hour. Suppose next**

**that 10 cars, traveling together as a caravan, follow each other. Also suppose that each tollbooth services (that is, transmits) a car at a rate of one car per 12 seconds.** The time required for the tollbooth to push the entire caravan onto the highway is (10 cars)/(5 cars/minute) = 2 minutes (transmission delay). The time required for a car to travel from the exit of one tollbooth to the next tollbooth is 100 km/(100 km/hour) = 1 hour. Total time = 62 minutes

**Suppose users share a 3 Mbps link. Also suppose each user requires**

**150 kbps when transmitting, but each user transmits only 10 percent of the**

**time.**

a. When circuit switching is used, how many users can be supported? 3 Mbps/150 kbps = 20

b. Find the probability that a given user is transmitting. P = 0.1

c. Suppose there are 120 users. Find the probability that at any given time, exactly n users are transmitting simultaneously.

d. Find the probability that there are 21 or more users transmitting simultaneously.