1. Imagine that you have trained your St. Bernard, Bernie, to carry a box of three 8- mm tapes instead of a flask of brandy. (When your disk fills up, you consider that an emergency.) These taps each contain 7 gigabytes. The dog can travel to your side, wherever you maybe, at 20 km/hour. For what range of distance does Bernie have a higher data rate than a transmission line whose data rate (excluding overhead) is 150 Mbps? How does your answer change if (i) Bernie’s speed is doubled; (ii) each tape capacity is doubled; (iii) the data rate of transmission line is doubled.

where d = distance in kilometers. D is unknown.

**a.**

**b.**

**c.**

2. The performance of a client-server system is strongly influenced by two major network characteristics: the bandwidth of the network (that is, how many bits/sec it can transport) and the latency (that is, how many seconds it takes for the first bit to get from the client to the server). Give an example of a network that exhibits high bandwidth but also high latency. Then give an example of one that has both low bandwidth and low latency.

High Bandwidth, High Latency: Networks used for video conferencing like Zoom and Teams. High Bandwidth because users can schedule meetings and see each other on camera, High latency because there may be video / audio delay during meetings.

Low Bandwidth, Low Latency: Networks for text messages. Not that much bandwidth required to send a text to other users and users can receive messages pretty quickly.

3. Besides bandwidth and latency, what other parameter is needed to give a good characterization of quality of service offered by a network used for (i) digitized voice traffic? (ii) Video traffic? (iii) Financial transaction traffic?

Digitized Voice Traffic: No audio corruption (staticky, cut-outs)

Video Traffic: Reliability / Maintainability of high-definition videos.

Financial Transaction Traffic: Security of data being sent / received

4. The Internet is roughly doubling in size every 18 months. Although no one really knows for sure, one estimate out the number of hosts on it at 600 million in 2009. Use these data to compute the expected number of Internet hosts in the year 2020. Do you believe this? Explain why or why not.

billion hosts in 2020.

I don’t think this is possible because I don’t think we have the resources to create that many hosts that can not only connect to the network but have resources to assign these hosts with important information such as the MAC address and IP Address.

5. An image is 1600\*1200 pixels with 3 bytes/pixel. Assume the image is uncompressed. How long does it take to transmit it over a 56-kbps modem channel? Over a 1-Mbps cable modem? Over a 10-Mbps Ethernet? Over a 100-Mbps Ethernet? Over gigabit Ethernet?

**b**.

**c.**

**d.**

**e.**

6. How many end office codes were there when each office was named by its three-digit area code and the first three digits of the local number named each office? Area codes started with a digit in the range 2 -- 9, had a 0 or 1 as the second digit, and ended with any digit. The first two digits of a local number were always in the range 2 – 9. The third digit could be any digit.

7. Ten signals, each requiring 4000Hz, are multiplexed onto a single channel using FDM. What is the minimum bandwidth required for the multiplexed channel? Assume that the guard bands are 400Hz wide. (The guard band is the intervals between two channels so that two adjacent channels will not affect each other.)

8. Three packet-switching networks each contain n nodes. The first network has a star topology with a central switch, the second is a bidirectional ring, and the third is fully interconnected, with a wire from every node to every other node. What are the best-, average- and worse-case transmission paths in hops? (The number of hops equals to the number of edges of the transmission path between two nodes.)

**Star Topology:**

* Best Case: 2 hops
  + 1 to switch, 1 to node
* Average Case:
  + Switch broadcasts to every link except the link where it received packet
* Worst Case:

**Ring:**

* Best Case: 1
  + Node is adjacent.
* Average Case:
* Worst Case: 2n
  + Node has to backtrack.

**Mesh:**

* Best Case: 1
  + Node is adjacent
* Average, Worst Case:

9. The actual layout of cells is seldom as regular as that shown in the slides. Even the shapes of individual cells are typically irregular. Give a possible reason why this might be. How do these irregular shapes affect frequency assignment to each cell?

I think the reason why these shapes are typically irregular is to cover as much area as possible. When you do the grid layout of cells and draw a shape, there is still some area left that is not covered by any circles. By having an irregular shape layout, you have an increased area to account for data that does not fall into the area of any nearby nodes. These irregular shapes means its much more complex for frequency assignment because then you have to make sure that these frequencies do not overlap.

10. Make rough estimate of the number of microcells 100m in diameter it would take to cover Honolulu (160 square km). Assume Honolulu is flat.