Module 1 Assessment: What is the Internet?

Please keep each question on a single page to make grading simpler. You do not need to use the entire page to answer each question. You may use any resource (except for other people) to help you answer these questions. You may ask LLMs questions to help you understand concepts however the answers you submit should represent your understanding of the material, not merely the output of an AI tool. Questions should be answered within the context of this course's material.

Q1: What is the Internet? What is the World Wide Web? Explain the relationship between the two.

The Internet is a network of networks that spans the globe using the TCP/IP protocol stack. The World Wide Web is software that runs on the Internet.

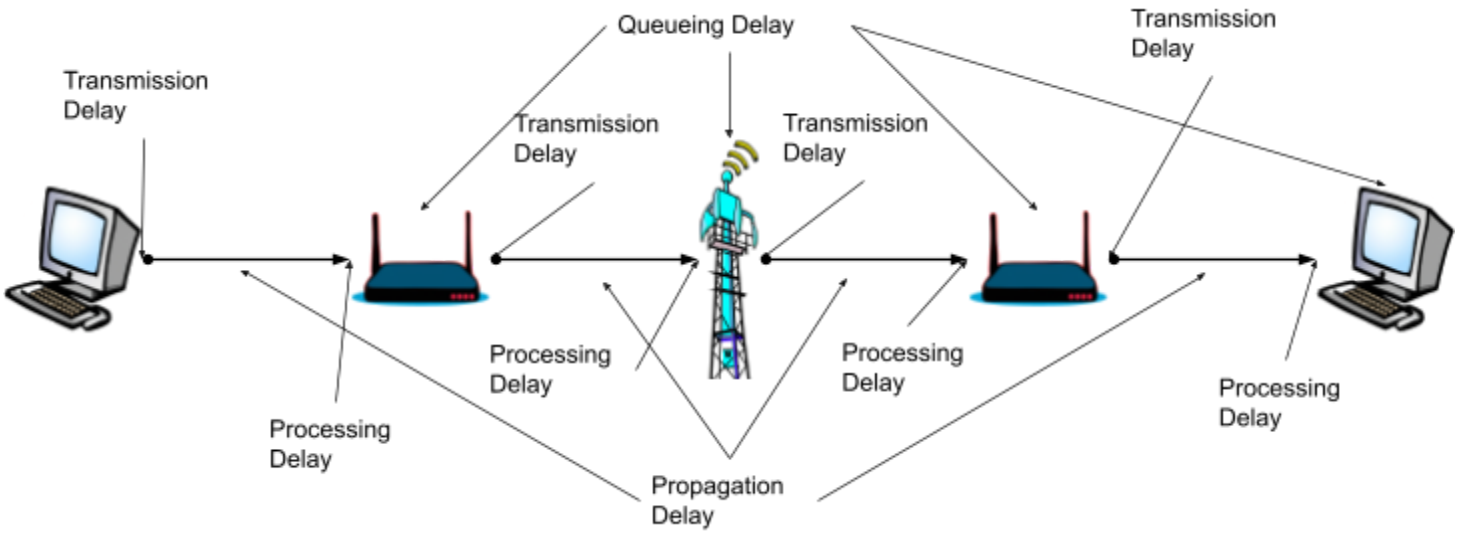
Q2: What are the five layers of the Internet's protocol stack and what purpose does each layer serve?

1. Application Layer - the layer where data is created and pushed to the network
2. Transport Layer - the layer where data is addressed to a destination application (UDP or TCP)
3. Network Layer - the layer where data is addressed AND routed to a destination host (using IP addresses)
4. Link Layer - the layer where data is addressed to the next adjacent host (ex. Ethernet)
5. Physical Layer - the layer where data is translated from digital bits to an analog signal for whatever media is going to be used

Q3: Name and explain each of the components of network latency that we discussed in class.

1. Transmission Delay (dtrans)
    a. The time required to transmit a packet onto the “wire”
    b. dtrans = packet length in bytes / transmission rate in bits per second = L / R
2. Propagation Delay (dprop)
    a. The time required for data to travel along the “wire” to a destination
    b. dprop = distance / data speed on “wire” = d / sprop
        i. Speed depends on the medium being used
3. Processing Delay (dprocess)
    a. The time for the receiving device to read and process the packet
    b. Usually negligible
    c. No simple equation to solve for dprocess
4. Queueing Delay (dqueue)
    a. The time the packet spends waiting to be transmitted because the outgoing link is busy
    b. a = average packet arrival rate
    c. L = packet length in bits
    d. R = link bandwidth in bits per second
    e. L * a / R ~ 0 -> average queueing delay is small
    f. L * a / R ~ 1 -> average queueing delay is large
    g. L * a / R > 1 -> average queueing delay is infinite
5. Total Latency (dtotal) = dtrans + dprop + dprocess + dqueue

Q4: Label the below diagram with **every** point where **each** component of latency may occur (label the points by writing the name of the latency component and drawing an arrow pointing to where it occurs, or a similar system).



Q5. You discover an old network in a dusty closet at the School of Computing. There are two identical routers connecting two old PCs. You measure the cabling connecting everything together and find that the total length is only 2 meters and confirm that the cable is copper-based (meaning data travels at $2x10^8$ m/s). You transfer a 10 kB file between the machines and measure that it takes 2 minutes to transfer the file (these are OLD machines!). Assuming that all network elements involved have the same transmission rate/bandwidth and that no queuing delay or processing delay is involved, what is the bandwidth the network elements are capable of?

Report your answer in bps rounded to the nearest bit. Show your work.

Transfer time = 120 seconds
File size in bits = 10,000 * 8 = 80,000 bits

dprop = d / sprop = 2 meters / (2 x 10^8) meters per second = 1 x 10^-8 seconds

Bandwidth = bits / (time + dprop)
Bandwidth = 80,000 bits / (120 seconds + (1 x 10^-8 seconds))
Bandwidth = 80,000 bits / 120 seconds (1 x 10^-8 is so small it is negligible to count it)
Bandwidth = 667 bps