INST346 HW01

Introduction and Basics

Cody Buntain

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0 Introduce Yourself

1. Come by my office hours and introduce yourself (see syllabus for office hours and location).
2. Why are you taking this course?
3. What do you expect to get out of this course?
4. What challenges do you anticipate encountering during this course?
5. On a scale of 1-5, with 1 being no knowledge and 5 being expert knowledge, how would you rank your current understanding of how the Internet works?
6. **Pre-Semester Evaluation** Without using the textbook or other references, explain with as much detail as possible the process of retrieving Google's homepage on your phone when you type `www.google.com` into the browser.

1 Accessing the Internet

1. Computers communicate according to *protocols* that govern how they exchange information. Give an example of a protocol from your day-to-day life that governs your interactions with someone or something.
2. Why do you think two computers might require a predefined protocol to communicate over a network?
3. Why are *standards* important for these communication protocols? Do you think it possible for two computers to implement a standard protocol differently and still communicate?
4. List the available residential access technologies in your neighborhood. For each type of access, what is its advertised downstream rate, upstream rate, and monthly price?
5. Dial-up, cable modems, DSL, fiber, and cellular networks are all used for residential access. For each of these technologies, what is the range of transmission rates they provide? Are these rates shared or dedicated? Is the downstream/upstream symmetric or asymmetric?
6. Describe a situation in which a *symmetric* upstream/downstream access technology might be desired. When might *asymmetric* upstream/downstream access be acceptable?

2 Moving Data Between Systems

1. What advantages does circuit switching have over packet switching?

2. Suppose users share a 3 Mbps link, and each user requires 150 kbps when transmitting. Each user, however, only transmits 10% of the time.

   a) If circuit switching is used, what is the maximum number of users N the link can support?

   b) For the remainder of this problem, suppose packet switching is used. What is the probability that a given user is transmitting?

   c) Suppose the network contains 120 users. What is the probability that, at any given time, exactly n users are transmitting simultaneously? (*Hint:* Use the binomial distribution.)

   d) What is the probability that 21 or more users are transmitting simultaneously?

3. Consider an application that transmits data at a steady rate (for example, the sender generates an N-bit unit of data every k unites of time, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Answer the following questions, briefly justifying your answer:

   a) Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?

   b) Suppose a packet-switched network is used and the only traffic in this network comes from applications like that describe above. Furthermore, assume the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?

4. What advantages does packet switching have over circuit switching?

5. Why do you think the store-and-forward packet switching method might be more common in routers than continuous transmission?

6. Suppose there is exactly one packet switch between a sender and receiver. The transmission rates between the sender and the switch and between the switch and receiver are R_1 and R_2 respectively. Assuming the switch uses store-and-forward packet switching, what is the total end-to-end delay to send a packet of length L (ignoring queueing, propagation, and processing delays)?

7. We saw that Equation 1 gives the formula for the end-to-end delay of sending one packet of length L over N links of transmission rate R. Generalize this formula for sending P such packets back-to-back over the N links.

$$d_{end-to-end} = N\frac{L}{R} \tag{1}$$

8. Suppose you need to deliver a 40-terabyte data set from Boston to Los Angeles. You have available a 100 Mbps dedicated link for data transfer. Would you prefer to transmit the data via this link or instead use FedEx over-night delivery? Explain.

3 The Layered Internet

1. What are the five layers of the Internet protocol stack? What are the principal responsibilities of each of these layers?

2. What are the seven layers of the OSI model? How do these layers differ from those in the Internet protocol stack?

3. What is an application-layer message? A transport-layer segment? A network-layer datagram? A link-layer frame?

4. Which layers in the Internet protocol stack does a router process? Which layers does a host process?