Homework Assignment #1

Due 9/18 at 5:00pm

EE122 Fall 2012

Please submit your solutions using BSpace (https://bspace.berkeley.edu/). Log in to BSpace with your CalNet ID, click on the EL ENG 122 Fa12 tab, and click on Assignments under Course Tools. Your assignment should be submitted as hw1.txt, using the format described on the class web page (http://www-inst.eecs.berkeley.edu/~ee122/fa12/homework/hw1). The multiple choice answers will be graded automatically, but please show your work so we can check your reasoning. This work can be included in the hw1.txt file, or in a separate hw1work.txt or hw1work.pdf file.

**Assignments with only answers and no shown work will receive no credit.**

**Improperly formatted assignments will receive no credit.**

*Each question is worth a single point, and the total assignment is worth 15 points.*

**Networking Trivia**

(Feel free to check the answers online, but first see if you can guess the answer!)

1) Which of the following best describes a role of APNIC (in the Asia-Pacific region):
   a) Runs a tech support call center, for users whose internet connection is down
   b) Maintains the network routers that connect the major ISPs
   c) Allocates IP addresses
   d) Standardizes the design of Network Interface Cards, such as Ethernet cards
   e) Provides a distributed encyclopedia service

2) You would like to propose a change to the HTTP specification. Which person or organization should you contact?
   a) Vint Cerf
   b) IAB
   c) ICANN
   d) IETF
   e) IRTF
3) We often hear of the difficulty of changing from IPv4 to IPv6. We never hear about switching to IPv5, because:
   a) Netscape skipped version 5 of their browser, which would have introduced IPv5
   b) It’s so difficult changing IP versions, we may as well go directly to IPv6 rather than IPv5
   c) Apple owns the patent on IPv5
   d) IPv5 is the Internet Stream Protocol, which never saw wide usage
   e) IPv5 is fully backwards compatible with IPv4 i.e., all IPv4 networks are already IPv5 too

**Delays**

Panda (one of your esteemed TAs) sends a 100 byte packet from Berkeley to UCLA. Assume that Berkeley is 600km from UCLA and that the propagation speed is 300,000km/s.

4) What is the propagation delay (in milliseconds)
   a) 1ms
   b) 2ms
   c) 3ms
   d) 8ms
   e) 30ms

5) Suppose the first link between Berkeley and Los Angeles is 100Kbps, and all other links are much faster than 100Kbps. What is the transmission delay?
   a) 1ms
   b) 2ms
   c) 4ms
   d) 8ms
   e) 16ms

6) Panda noticed that the transmission of the packet was timestamped by his computer as 1:05:00 PM. The destination server at UCLA records it as arriving at 1:00:00 PM on the same day. Which of the following is the most plausible explanation for this?
   a) Panda’s computer was running on Berkeley time
   b) We incorrectly assumed that packets cannot propagate faster than the speed of light
   c) There was actually substantial processing delay and/or queuing delay
   d) The receiver and sender clocks are not synchronized
   e) There is no need for an explanation
7) The destination server immediately sent an 800 byte reply, traveling over the same links (in reverse direction) that the original packet did (at the same speeds). Only taking into account transmission and propagation delays (i.e., ignoring all processing or queuing delays), what would you expect the time on Panda’s computer to be, when he receives the reply?
   a) 1:05:00 PM + 8ms + 2ms
   b) 1:05:00 PM + 8ms + 2ms + 8ms + 2ms
   c) 1:05:00 PM + 8ms + 2ms + 64ms + 16ms
   d) 1:05:00 PM + 8ms + 2ms + 64ms + 2ms
   e) 1:05:00 PM + 8ms + 2ms + 8ms + 16ms

Statistical Multiplexing

Assume that we have a network technology that uses “frames”. Each frame contains two slots, and each slot can carry a single packet. Assume there are two flows, and each flow generates a random number of packets at the beginning of each frame, with the following probabilities:

- 0 packets with probability $\frac{1}{4}$
- 1 packet with probability $\frac{1}{4}$
- 2 packets with probability $\frac{1}{2}$

8) What is the average number of packets both flows generate in a frame? Remember, we are asking about the total generated by both flows, not the number generated by a single flow.
   a) 1
   b) 1.5
   c) 2
   d) 2.5
   e) 3

9) Assume that each flow is assigned a single slot in each frame. That is, it can use one and only one slot to carry its packets in each frame; if it generates two packets in a frame, one of them must be dropped. What is the average number of packets carried in each frame? (Remember, we are asking about all the packets carried, not just about those for a particular flow.)
   a) 1
   b) 1.25
   c) 1.5
   d) 1.75
   e) 2
10) Assume that the flows share the slots in a frame; if not all the packets fit, then the excess packets are dropped (ignore how we choose which packets to drop; it won’t matter in the answer). That is, if two or fewer packets are generated by the flows (in aggregate), then all of them are carried in that frame, but if more than two are generated than only two are carried in a frame. How many packets are, on average, sent in each frame?

a) 1
b) 1.25
c) 1.5
d) 1.75
e) 2

**Statistical Multiplexing and Little’s Law**

Assume that we have a packet arrival process characterized by an average arrival rate $A$. Assume that we also have a packet service process characterized by an average service rate $C$. That is, we have a queue where packets arrive at an average rate $A$, and packets are served at an average rate $C$. After long and careful deliberation, the TAs in this class have derived an important result: the average number of packets waiting in the queue is given by $F(A/C)$ for some function $F$.

11) While knowing the average queue size is nice, what we really want to know is how long do packets wait in the queue; that is, what is their average queuing time (or, equivalently, waiting time)? Using Little’s Law, how can we express this queuing time in terms of $F$?

a) $F(A/C)$
b) $F(C/A)$
c) $A \times F(A/C)$
d) $F(A/C) \div A$
e) $F(C/A) \div C$

12) Now assume that the arrival process represents $N$ flows, and each flow individually has an arrival process with average $A/N$. Further assume that each flow gets $1/N$th of the service, with no sharing (that is, we use the equivalent of circuit-switching where each flow has a reserved capacity), so each has an effective service rate of $C/N$. How does the queuing time for these flows compare to what you computed above?

a) We aren’t given enough information to know
b) It is exactly the same
c) It is $N$ times larger
d) It is $N$ times smaller
The result is a transcendental number, and I don’t understand what those are.

**Design Principles**

On Tuesday we discussed three principles: Layering, End-to-End, and Fate-Sharing. In this question we ask which principle is primarily responsible for three design decisions. Use each principle for only one answer below. As part of “showing your work” please provide one or two sentences justifying your answer.

13) The Internet protocol IP does not provide reliable delivery. Which principle does this follow from?
   a) Layering
   b) End-to-End
   c) Fate-Sharing

14) TCP often performs poorly over wireless network technologies, yet traditional TCP implementations do not take any special measures to account for wireless links. Which principle does this follow from?
   a) Layering
   b) End-to-End
   c) Fate-Sharing

15) As we will learn later in this course, the hosts are the only places where per-flow state is kept. Which principle does this follow from?
   a) Layering
   b) End-to-End
   c) Fate-Sharing