14-740: Fundamentals of Computer and Telecommunication Networks

Fall 2018
Quiz #1
Duration: 45 minutes

Name: Answer Key Andrew ID: _____

Important:

- Each question is to be answered in the space provided. Material written on the back of the page or in space above or below the question will not be graded.
- This is a closed book exam -- you may not use any reference materials, crib sheets, or formula cards.
- Calculators are not needed, nor allowed.
- **Write legibly**. Unreadable work will be considered incorrect.
- At the end of the final duration, you will be told to "Cease Work." Immediately stop writing and turn in your paper. Any writing after this point will result in a zero grade.

Page 2	_____ (15 possible)
Page 3	_____ (35 possible)
Page 4	_____ (20 possible)
Page 5	_____ (30 possible)
Total	_____ (100 possible)

I understand that the CMU and course policies on cheating apply to this quiz.

_____

signature date

1. Which of the following are **NOT** included in the "Nuts and Bolts" model of the internet: (Circle one or more answers) (5 points)

   A) Fiber optic connections

   B) Standards documents

   C) End Users (THIS ONE)

   D) Hierarchical network of networks

   E) Radio transmission links

   F) Routers

   G) The HTTP Protocol

   H) End hosts

2. Match each layer of the ISO OSI Network Model to the mission of that layer. If the mission is not stated correctly, choose option F. You may use A-G more than once if you wish. (10 points)

   _____ Data Link (B)

   _____ Physical (A)

   _____ Transport (D)

   _____ Presentation (E)

   _____ Network (C)

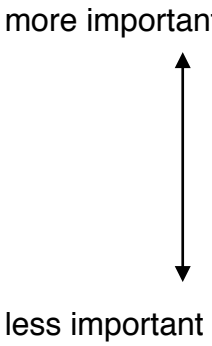
   A) Transfer bits across a link
   B) Transfer data across a direct connection
   C) Logical connection between any two computers
   D) Transfer data between any two applications
   E) Machine-independent data representation
   F) Some other mission
   G) This is not a layer in the ISO OSI model

3. Which goal did Clark88 describe as the "Fundamental Goal" of DARPA internet protocol development? (5 points)

Interconnect existing networks

4. Write a short description of any 4 of the other goals in Clark88's list (i.e. not including the one in the previous question). List them in descending order of importance. Use one sentence or less for each goal.(10 points)

Robust against failure
Multiple types of communication services
Multiple types of network (data link)
Distributed Management
Cost effective
Easy host attachment
Accounting



5. Imagine a growing Tier-2 ISP that is expanding and wishes to become Tier-1. What is the likely outcome of interaction with the Tier-1 ISPs in this "internet region?" (10 points)

Trouble! The other Tier-1 ISPs don't want to peer with the new guy — they'd rather treat him as a customer. The Tier-2 will have to find a way to force the Tier-1s to recognize him.

6. Which is the better caching method, web proxies or content distribution networks? Explain and support your answer. (10 points)

Neither is better — they serve different missions and complement each other well. Proxies are a good caching method for organizations to reduce the web load caused by their users. CDNs improve performance for a content owner's users, especially when geographically distributed, but the content owner pays for it.

7. A basic router receives, on average, 100 packets per second and processes each in an average of 5mS. You may leave answers as unsimplified fractions if you wish.(10 points)

   A) What is the Kendall53 notation for this system (i.e. A/B/C/X/Y)? (2 points)
   M/M/1

   B) What is λ? (1 point)
   100 packets / second

   C) What is μ? (1 point)
   200 packets / second

   D) What is ρ? (1 point)
   $\lambda / \mu = 100/200$ or .5

   E) What is the average length of the queue? (2 points)
   For M/M/1, $L_q = \lambda^2 / \mu(\mu - \lambda) \rightarrow 100^2 / 200(200 - 100) = .5$ packet

   F) What is the average waiting time for a packet? (2 points)
   $W=1/(\mu - \lambda) \rightarrow 1 / (200-100) = 10$ mSec

8. In the Saltzer84 paper, the author illustrates and motivates the end-to-end argument with an imaginary program. He shows how the designers of the program could write it to defend against a long list of threats (he lists 5) or they could write it to do *end-to-end check and retry*. What was this imaginary program called? (10 points)

careful file transfer

9. In the lecture on P2P networks, I stated that "The overlay network is not the network." (15 points, 5 for A, 10 for B)

A) What is the overlay network?

The connections between peers that we draw or think of when we are describing the structure of the P2P network.

B) Why is that not the network? Explain using the internet's layered architecture.

The transport of data associated with connecting those peers travels over the transport layer of the internet,and sometimes even over HTTP or TLS (higher layers). Thus, the overlay network operates above those layers -- it can't replace those levels.

10. A photo page on www.example.com contains 20 photos. The round-trip time for each HTTP request/response (or any other communication) is 1 second. Transmission time for each web object (HTML page or image) is 2 seconds. Ignore any connection tear-down and use the same model for set-up as discussed in lecture. How long does it take for a browser to load the entire page (with the images) in the following scenarios. Show your work for full credit.

A) Non-persistent HTTP with no parallel connections (5 points)

Photo HTML page: 1 sec setup, 1 sec HTTP get/response, 2 sec transmission = 4 sec

Each photo after: 1 sec setup, 1 sec HTTP get/response, 2 sec transmission = 4 sec

Total = 4 + 20*4 = 84 seconds

B) Non-persistent HTTP with 2 parallel connections (5 points)

Photo HTML page: 1 sec setup, 1 sec HTTP get/response, 2 sec transmission = 4 sec

Each photo after: 1 sec setup, 1 sec HTTP get/response, 2 sec transmission = 4 sec

But, 2 in parallel means this takes half the total time.

Total = 4 + (20/2)*4 = 44 seconds

C) Persistent HTTP without pipelining (5 points)

Photo HTML page: 1 sec setup, 1 sec HTTP get/response, 2 sec transmission = 4 sec

Each photo after: 1 sec HTTP get/response, 2 sec transmission = 3 sec

Total = 4 + 20*3 = 64 seconds

D) Persistent HTTP with pipelining (5 points)

Photo HTML page: 1 sec setup, 1 sec HTTP get/response, 2 sec transmission = 4 sec

First photo: 1 sec HTTP get/response, 2 sec transmission.

Each photo after, HTTP get/response happens during transmission of previous: 2 sec transmission.

Total = 4 + 3 + 19*2 = 45 seconds