COE 431 – Computer Networks

Welcome to Exam I
Thursday March 26, 2016

Instructor: Wissam F. Fawaz

Name: __Solution_______

Student ID: _________________

Instructions:

1. This exam is **Closed Book**. Please do not forget to write your name and ID on the first page.
2. You have exactly **75 minutes** to complete the **6** required problems.
3. Read each problem carefully. If something appears ambiguous, please write your assumptions.
4. Do not get bogged-down on any one problem, you will have to work fast to complete this exam.
5. Put your answers in the space provided only. No other spaces will be graded or even looked at.

Good Luck!!

<u>Problem I:</u> Comparing terminologies (**10 minutes**) [10 Points]

What is the difference between each of the following pairs of concepts?

1. Type MX record and a type CNAME record

For type MX: Name = alias name of mail server, Value = canonical name of server
For type CNAME: Name = canonical name of web server, Value = alias name of web server.

2. OSI protocol stack and Internet protocol stack

OSI protocol stack consists of 7 layers: Physical, data link, network, transport, session, presentation, and application layers
Internet protocol stack consists of 5 layers: Physical, data link, network, transport, and application layers.

3. Content Distribution Network and Information Centric Network

CDN uses dedicated servers to store copies of multimedia content. When a user requests the content, its request is directed to the server that can provide him with the best user experience.
ICN caches web content in routers with the objective of bringing content closer to the end user.

4. Centralized DNS architecture and distributed DNS architecture

Centralized DNS architecture is not scalable while a distributed one is scalable.

5. HFC and ADSL

HFC uses cable-based modems and runs over the TV plant while ADSL uses DSL-based modems and runs over the telephone network.

<u>Problem II:</u> Short questions (**10 minutes**) [20 Points]

1. In ADSL, the downstream bit rate is about 12 Mbps whereas the upstream bit rate is about 2 Mbps. What is the key factor in ADSL physical layer design/characteristics that results in this difference between upstream and downstream bit rate capabilities?

Since the frequency bandwidth allocated for the downstream is larger than that allocated for the upstream, there is a difference between upstream and downstream bit rates.

2. Give an example of a user service that is loss tolerant but requires bandwidth and timing guarantees?

Voice over IP or video over IP are loss-tolerant but require bandwidth and timing guarantees.

   Give an example of an application service that allows no losses and requires **bandwidth and timing guarantees** (Be creative)?

Real time gaming requires no losses, bandwidth and timing guarantees.

3. Does web caching reduce the delay for all objects requested by a user or for only selected objects? Explain **briefly**.

The delay is reduced only for selected objects depending on what is stored in the cache.

4. Bob uses Hotmail to send a message to Alice who accesses her mail from her mail server using Hotmail as well. Discuss **briefly** how the message gets from Bob to Alice and list the series of application layer protocols that are involved in the process of moving the message between them.

Bob uses HTTP to send the message to his mail server. Bob's mail server uses SMTP to send the mail to Alice's mail server. Alice retrieves her mail from Hotmail using HTTP.

5. Suppose a process in Host C has a UDP Socket with port number 3456. Suppose both Host A and Host B each sends a UDP segment to Host C with destination port number 3456. How will the process at Host C know that these two segments originated from two different hosts?

It will know that based on the IP addresses of the source hosts.

Problem III: Delays (**20 minutes**) [25 Points]

Assume an FTP server receives a file transfer request for a 1000-Bytes file from Host A. For each FTP message, suppose that the transport layer adds a header of length 20 bytes, the network layer adds a header of length 20 bytes, and the data link layer adds a header of length 24 bytes. The distance between the FTP server and Host A is 8 km and the propagation speed is 2 x 10^8 m/s. Assume that the FTP server and Host A are separated by two equidistant routers and that all links have a transmission rate of 1 Gbps. Moreover, assume that: a) the frame processing delay at each router is 1 µs; and b) the datagram processing delay at each router is 2 µs. Finally, assume that the amount of time required to establish a TCP connection between the FTP server and Host A is 100 µs.

1. Is the file transferred by the server sent over a persistent or a non-persistent TCP connection? Justify **briefly** your answer.

In the case of FTP, the file is sent over a non-persistent TCP connection.

2. Assume that the server sends the entire file to Host A as one message. Calculate the total amount of time that elapses from when the server receives the file transfer request until the requested file in its entirety arrives at Host A? Show your steps.

The header is 64 bytes. The data is 1000 bytes long => Message+Header=1064 bytes

T_{prop} = propagation delay = $\frac{8\times10^3}{2\times10^8}$= 40 µs.

T_{proc} = Processing delay per router = $1\ \mu s + 2\ \mu s = 3\ \mu s$

T_{setup} = Connection setup time = 100 µs

T_{tx} = Transmission delay over each 1 Gbps link = $\frac{1064\times8}{10^9}$=8.512µs

T_{total} = 3 T_{tx} + T_{prop} + 2 T_{proc} + T_{setup} = 171.536 µs

3. Assume now that the server can handle up to 2 parallel TCP connections and that it receives two requests from Host A for file transfer, namely one for a 1000-Bytes file and another one for a 2000-Bytes file. Calculate the total time elapsing from when both requests are received by the server until both files are completely received by Host A? Show your steps.

T_{total} for 1000-Bytes file = 3 T_{tx} + T_{prop} + 2 T_{proc} + T_{setup} = 171.536 µs

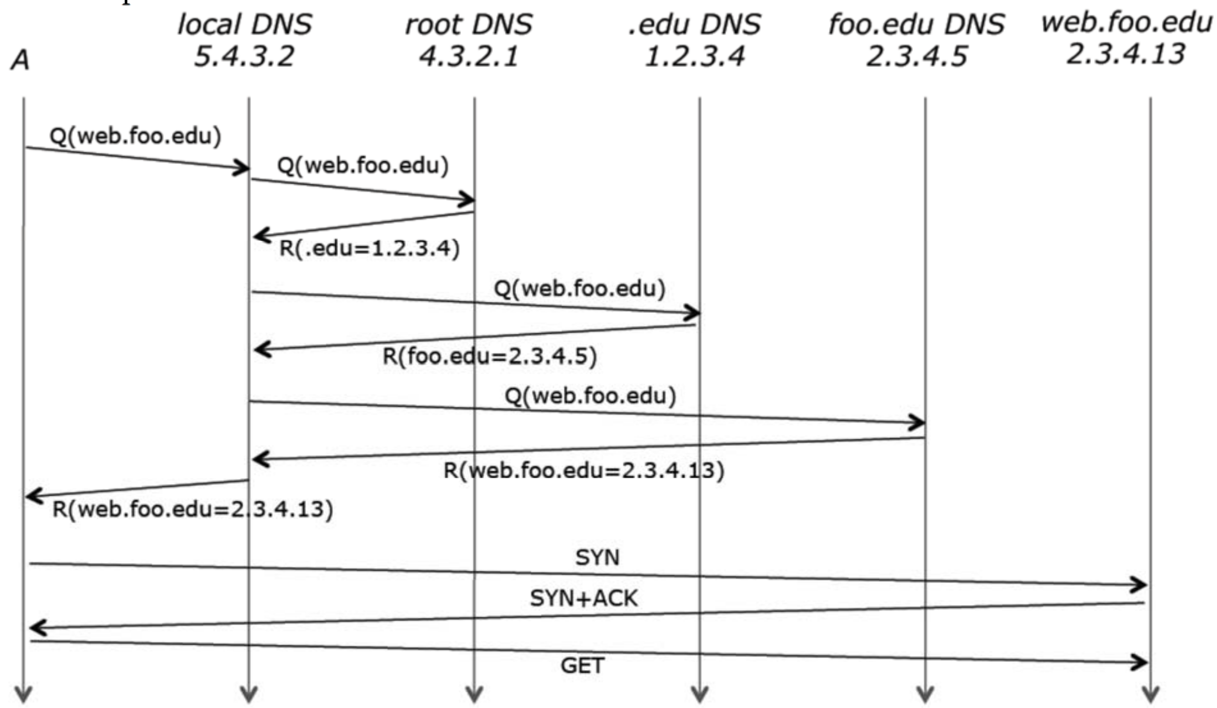
T'_{tx} = Transmission delay over each 1 Gbps link = $\frac{2064\times8}{10^9}$=16.512µs

T_{total} for 2000-Bytes file = 3 T'_{tx} + 2 T_{proc} = 55.536 µs

⇨ **T_{total} for both files = 227.072 µs**

<u>Problem IV:</u> DNS (**15 minutes**) [20 Points]

1. The diagram below shows a DNS query from a host A to its local DNS server. The IP addresses of all hosts are shown in the diagram. The label "Q(web.foo.edu)" specifies the query string. Complete the diagram showing all packets sent to resolve the name and continuing through the opening of a TCP connection to the web site and the first HTTP request. All arrows that represent DNS queries should have a label of the form "Q(a.b.edu)" and replies should have a label of the form "R(b.edu=2.3.7.11)". TCP connection packets should be included as well along with the HTTP packets, which should be labeled with the request type. Assume that the local DNS server performs recursive processing and has the addresses of all .edu TLD servers in its cache, while the other DNS servers perform iterative processing. You may assume that all queries and responses are for A records.



2. List all the mappings in the local DNS server's cache after the query has been processed.

.edu=>1.2.3.4, foo.edu=>2.3.4.5, web.foo.edu=>2.3.4.13

3. List all the mappings in the local DNS server's cache if the .edu DNS server did recursive processing rather than iterative processing.

.edu=>1.2.3.4, web.foo.edu=>2.3.4.13

Problem V: HTTP and cookies (**10 minutes**) [10 Points]

Consider the header of an HTTP REQUEST message sent during a web browsing session:

```
GET /wireshark-labs/file1.html HTTP/1.1
Host: gaia.cs.umass.edu
User-Agent: Mozilla/5.0
Connection: keep-alive
If-Modified-Since: Thu, 07 Jan 2016 13:44:01 GMT
Cookie: 198765611
```

a) What is the URL that was entered into the browser?

http://gaia.cs.umass.edu/wireshark-labs/file1.

b) Is the HTTP client requesting a non-persistent or a persistent connection? Justify your answer.

The client is requesting a persistent connection because of the Connection: keep-alive.

c) What does the web server do if the requested object is not modified since the date and time specified in the HTTP REQUEST message? What does the server do if the object is modified since the specified date and time?

If the object is not outdated, the server will not send it back to client. If it is outdated, it will be transferred back to client.

d) What header line did the web server use to inform the HTTP client about the value of the cookie? Besides the header line present in the REQUEST message and the one you identified earlier, list the two other components that the Cookies technology is based upon?

Set-cookie header. Cookies technology includes also: 1) Cookie file maintained by client. 2) back-end database maintained by server.

e) List two uses of cookies:

1. security and authentication
2. Online shopping

Problem VI: Queueing Delay (**10 minutes**) [15 Points]

Assume that the path from a server to a user passes through a 1 Mb/s link at a router R. Suppose that the packets to be sent over this link arrive at router R at the rate of 10 million packets per second 5 percent of the time and at the rate of 0 packets per second 95 percent of the time.

1. What is the traffic intensity offered to the output link?

λ=10 Mpackets/s × 0.05 = 500 Kpackets/s
μ = 1 Mbps/2000 = 500 packets/s
Traffic intensity = $\rho = \lambda/\mu$ = 1000
=> System is unstable

2. If the average packet length is 2000 bits: (**Show your work**)
   a. What is the average queue length at the considered output link?

Given that $\rho > 1$, it follows that the queue length grows without bounds implying that the average queue length is equal to infinity.

   b. What is the average queueing delay at this link?

Given that $\rho > 1$, it follows that the average queueing delay is equal to infinity as well.