CS305: Computer Networking
2023 Fall Semester Written Assignment # 1

Due: Oct. 21th, 2022, please submit through Blackboard

Please answer questions in English. Using any other language will lead to a zero point.

Q 1 *Explain the five-layer Internet protocol stack. Please include the following details:*

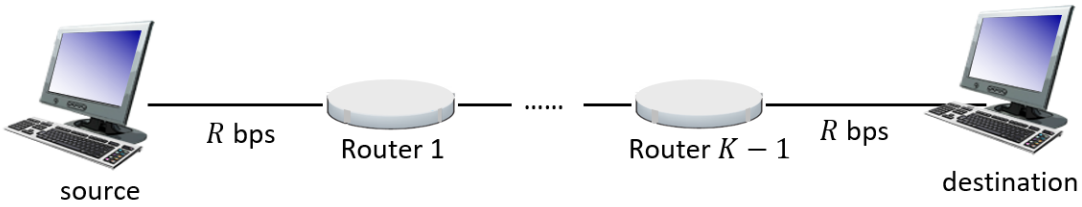
- *What are the five layers?*
- *What is the functionality or description of each layer?*
- *What are the typical protocols of each layer (if any)?*

Q 2 *Answer the following questions:*

(a) *What type of applications is TCP better suited for? Any application examples?*

(b) *What type of applications is UDP better suited for? Any application examples?*

Q 3 *Consider a packet of L bits sending from the source to destination through a K-hop path. That is, there are $K-1$ routers between the source and destination. Suppose each link has a transmission rate of R bits per*



second (bps), and the propagation delay is d for each hop.

(a) *Consider a packet switching network. Suppose there is no nodal processing delay and queuing delay. What is the end-to-end delay?*

(b) *Consider a circuit switching network. Suppose the circuit setup time is τ seconds. Links in the network use frequency division multiplexing (FDM), where the associated frequency band is divided into F subbands, each being allocated to a user (or circuit). [Hint: As a result, the transmission rate allocated to each user (or circuit) is R/F.] What is the end-to-end delay?*

(c) *Consider a packet switching network with $L = 1000$ bits, $K = 2$, $R = 20$ Mbps, $d = 10\mu s$. There are two packets sent one after the other, and there are no other packet in the system. Let the nodal processing delay at the router be $5\mu s$. We ignore the nodal processing delay at the source and destination. Compute the time required to send both packets from the source and destination. [Note: In our lecture, we set 1 Kbit $= 10^3$ bits and 1 Mbit $= 10^6$ bits.]*

Q 4 *Consider a set of packets, each with a size of 10 Mbits and a queue. These packets arrive at the queue with certain patterns defined in (a) and (b), waiting for transmission. The transmission rate is 10 Mbps.*

(a) *Suppose there is one packet arrival every second. What is the average queuing delay of these packets?*

(b) *Suppose K packets arrive simultaneously every K seconds. What is the average queuing delay of these packets?*

(c) *What are the traffic intensity of the scenarios considered in (a) and (b)? Any insights?*

Q 5 *Consider the following message and answer questions.*

```
HTTP/1.1 200 OK\r\n
Date: Sun, 26 Sep 2010 20:09:20 GMT\r\n
Server: Apache/2.0.52 (CentOS)\r\n
Last-Modified: Tue, 30 Oct 2007 17:00:02
   GMT\r\n
ETag: "17dc6-a5c-bf716880"\r\n
Content-Length: 2652\r\n
Keep-Alive: timeout=10, max=100\r\n
Connection: Keep-Alive\r\n
Content-Type: text/html; charset=ISO-8859-
   1\r\n
data data data data data ...
```

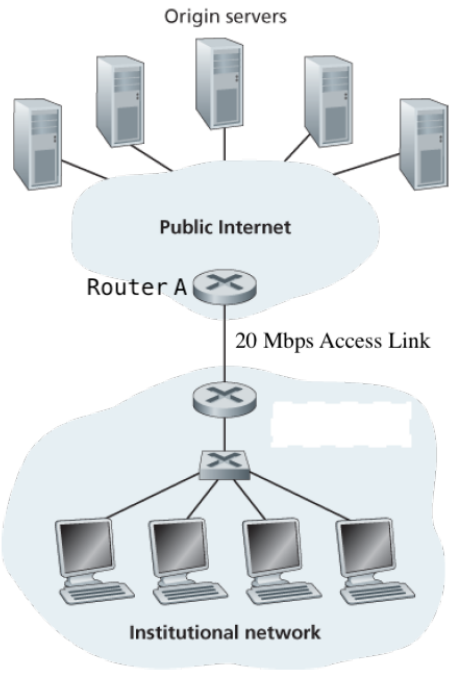
(a) *Is this message an HTTP request message or an HTTP response message?*

(b) *Does this message corresponds to a non-persistent or a persistent connection? Explain the idea of persistent connection.*

(c) *There is one formatting mistake in this message. What is this mistake?*

(d) *Why do we need the header of "Last-Modified"? Consider from the perspective of proxy server.*

Q 6 *Consider the following figure with an institutional network connected to the Internet. There are a set of objects, each with a size of 1 Mbits. Suppose the institution's browsers has an average request rate of 10 requests per second, and all those requests are sent to the origin servers.*



The average response time is determined as follows:

$$\texttt{Average Response Time} = \texttt{Internet Delay} + \texttt{Average Access Delay}. \tag{1}$$

- *Internet delay is the round trip time between router A and the origin server. It is equal to 2 seconds.*
- *Average access delay is the delay from Router A to the institution router. The transmission rate of the access link is 20 Mbps. The average access delay is equal to $\Delta/(1-\Delta\beta)$, where Δ is the average time required to transmit an object over the access link (i.e., the transmission delay of an obejct); β is the arrival rate (in requests per second) at the access link.*
- *Note: The delays over other links, e.g., local area network (LAN) delay, are regarded as zero.*

Answer the following questions:

(a) *Derive average response time of the system.*

(b) *Suppose there is a cache installed in the institutional LAN. Compute the hit rate $x \in [0,1]$ that leads to an average response time that is less than 1 second.*

Q 7 *Suppose you click a web page within your Web browser, and your local DNS server has stored the related resource records. Let RTT_0 denote the round trip time (RTT) between your host and your local DNS server. On the web page you visit, there are an HTTP basic file and 12 referenced objects. Let RTT_1 denote the RTT between the local host and the Web server. The HTTP basic file has a size of L Mbit, and each referenced object has a size of L Mbit. The transmission rate is R Mbps. Compute how much time elapses from when you click the link until your web browser receives the objects.*

(a) Non-persistent HTTP with no parallel TCP connections?

(b) Non-persistent HTTP with the browser configured for 4 parallel connections?

(c) Persistent HTTP? Note that in this case, if a client knows the URLs of its requested referenced objects, the client can send requests of referenced objects back-to-back without waiting for the responses.

Q 8 *Answer the following questions:*

(a) Explain the differences between HTTP and SMTP.

(b) Can HTTP be used as a mail access protocol? Why?

(c) Can we place the receiver's mail server at the receiver's PC? How about placing the sender's mail server at the sender's PC?

Q 9 *Suppose you want to register your domain name* exmple.com *with a TLD server, you need to provide the TLD server with the information of your authoritative DNS server:*

- *The hostname of your authoritative DNS server is* dns.example.com.
- *The IP address of your authoritative DNS server is 200.200.200.[last-two-digits-of-your-SID]. Note that [last-two-digits-of-your-SID] should be fill in with the last two digits of your own student ID.*

17

Answer the following questions:

(a) At which TLD server you need to register the information of your authoritative DNS server?

(b) A Type NS and a Type A record are needed to be inserted into the TLD server. What are these records?

Q 10 *Consider a server distributes a file of $F = 20$ Gbits to N peers. The server has a upload rate of $u_s = 15$ Mbps. Each peer has a upload rate of u Mbps and a download rate of $d = 4$ Mbps. Please plot or draw the following curves with x-axis corresponding to N (ranging from 1 to 1000) and y-axis corresponding to the minimum distribution time.*

(a) Client-server distribution;

(b) P2P distribution with $u = 100$ Kbps, 600 Kbps, 4 Mbps, respectively.

Please draw all the aforementioned four curves in the same figure.

(c) Based on (a) and (b), which one is better in terms of reducing the distribution time, P2P or client-server? Why? How does u affect the distribution time?