Spring 2023, CS 3611: Computer Networks

Homework 2

Problem 1 SMS, iMessage, and WhatsApp are all smartphone real-time messaging systems. After doing some research on the Internet, for each of these systems write one paragraph about the protocols they use. Then write a paragraph explaining how they differ. (10 points)

Problem 2 Consider an HTTP client that wants to retrieve a Web document at a given URL. The IP address of the HTTP server is initially unknown. What transport and application-layer protocols besides HTTP are needed in this scenario? (10 points)

Problem 3 The text below in figure 1 shows the reply sent from the server in response to the HTTP GET message in the question above. Answer the following questions, indicating where in the message below you find the answer.(20 points)

```
HTTP/1.1 200 OK<cr><lf>Date: Tue, 07 MAR 2008 12:40:46GMT<cr><lf>Server: Apache/2.0.52 (Fedora)<cr><lf>
Last-Modified: Sat, 10 Dec 2005 18:28:47GMT<cr><lf>ETag: "526c3-f22-a88a4c80"<cr><lf>Accept-Ranges: bytes<cr><lf>
Content-Length: 3848<cr><lf>Keep-Alive: timeout=max=100<cr><lf>Connection: Keep-Alive<cr><lf>Content-Type: text/
html; charset=ISO-8859-1<cr><lf><cr><lf><!doctype html public "-//w3c//dtd html 4.0
transitional//en"><lf><html><lf><head><lf> <meta http-equiv="Content-Type" content="text/html;
charset=iso-8859-1"><lf> <meta name="GENERATOR" content="Mozilla/4.79 [en] (Windows NT 5.0; U) Netscape]"><lf> <title
>CMPSCI 453 / 591 / NTU-ST550ASpring 2005 homepage</title><lf></head><lf><much more document test following here (
not shown)>
```

Figure 1: The text in P3

1. Was the server able to successfully find the document or not? What time was the document reply provided? (5 points)
2. When was the document last modified? (5 points)
3. How many bytes are there in the document being returned? (5 points)
4. What are the first 5 bytes of the document being returned? Did the server agree to a persistent connection? (5 points)

Problem 4 Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address. Suppose that m DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of RTT_1,...,RTT_m. Further suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Let RTT_0 denote the RTT between the local host and the server containing the object. Assuming zero transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object? (20 points)

Problem 5 Referring to Problem P4, suppose the HTML file references seven very small objects on the same server. Neglecting transmission times, how much time elapses with (15 points)

1. Non-persistent HTTP with no parallel TCP connections? (5 points)
2. Non-persistent HTTP with the browser configured for 5 parallel connections? (5 points)
3. Persistent HTTP? (5 points)

Problem 6 Consider Figure 2 , for which there is an institutional network connected to the Internet. Suppose that the average object size is 750,000 bits and that the average request rate from the institution's browsers to the origin servers is 18 requests per second. Also suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is 2 seconds on average. Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institution router) and the average Internet delay. For the average access delay, use $\Delta/(1-\Delta\beta)$ where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link (10 points)

1. Find the total average response time. (5 points)
2. Now suppose a cache is installed in the institutional LAN. Suppose the miss rate is 0.4. Find the total response time. (5 points)

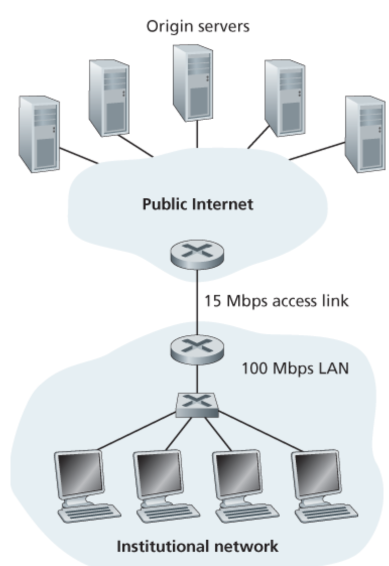

Figure 2: Bottleneck between an institutional network and the Internet

Problem 7 Consider distributing a file of $F = 15$ Gbits to N peers. The server has an upload rate of $u_s = 30$ Mbps, and each peer has a download rate of $d_i = 2$ Mbps and an upload rate of u. For $N = 10$,100 and 1,000 and $u = 300$ Kbps, 700 Kbps, and 2 Mbps, prepare a table giving the minimum distribution time for each of the combinations of N and u for both client-server distribution and P2P distribution. (15 points)