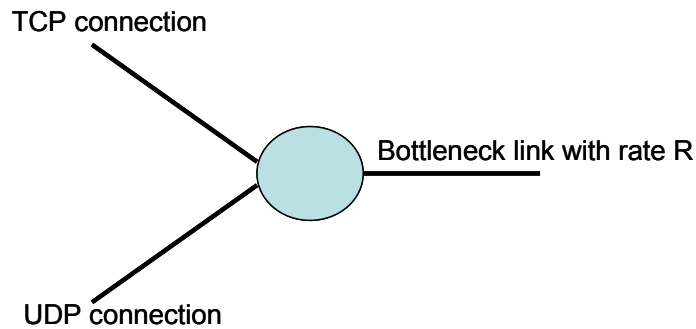




6. Given the following network scenario with two connections via the same router.



Assume the two connections are sending data with a rate higher than what the router can process due to its bottleneck output link. After some time of network operation, which connection would take a bigger share of the resources (output link capacity) at the router? Explain why. **[5 points]**

7. Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates  $R_1 = 500$  kbps,  $R_2 = 2$  Mbps, and  $R_3 = 1$  Mbps. **[5 points]**
- Assuming no other traffic in the network, what is the throughput for the file transfer?
  - Suppose the file is 4 million bytes. How long will it take to transfer the file to Host B?
  - Repeat (a) and (b), but now with  $R_2$  reduced to 100 kbps.

8. Describe how a botnet can be created, and how it can be used for a DDoS attack. **[5 points]**

9. Suppose that a transmitter operating at 10 Mbps (equivalently: 10,000,000 bps) is connected to one end of a 23 km length of coaxial cable. The signal propagation speed in coaxial cable can be taken to be 230,000 km/sec. If packet-switching is used with a packet length of 10,000 bits, how many packets have been transmitted and are propagating along the cable when the first bit reaches the other end? **[5 points]**

10. HTTP: **[5 points]**

- a. In http, explain the objective of the ETag field
- b. How is it different from the "last modified" field

11. BitTorrent: **[15 points]**

- a. In BitTorrent, suppose Alice provides chunks to Bob throughout a 30-second interval. Will Bob necessarily return the favor and provide chunks to Alice in this same interval? Why or why not? **(5 pts)**

- b. Consider a new peer Alice that joins BitTorrent without possessing any chunks. Without any chunks, she cannot become a top-four uploader for any of the other peers, since she has nothing to upload. How then will Alice get her first chunk? **(5 pts)**

- c. Because an integer in  $[0, 2^{n-1}]$  can be expressed as an  $n$ -bit binary number in a DHT, each key can be expressed as  $k = (k_0, k_1, \dots, k_{n-1})$ , and each peer identifier can be expressed  $p = (p_0, p_1, \dots, p_{n-1})$ . Let's now define the XOR distance between a key  $k$  and peer  $p$  as

$$d(k, p) = \sum_{j=0}^{n-1} |k_j - p_j| 2^j$$

Describe how this metric can be used to assign (key, value) pairs to peers. **(5 pts)**

12. Assume that you opened your Web Browser, wrote in the address bar [www.aub.edu.lb](http://www.aub.edu.lb), and pressed [enter]. **[15 points]**

- a. What is the application layer protocol of the first packet that you should expect your machine to send? Why? **(3 pts)**

- b. Assume AUB uses a proxy server, will web caching reduce the delay for all objects requested or for only some of the objects? Why? (3 pts)
- c. How is the web caching (proxy server) functionality implemented using the HTTP protocol messages? (3 pts)
- d. Assume that the *aub* website has 6 images and 1 Java applet. The Java applet retrieves 3 more images before it can run. Ignore the objects' transmission time and connection termination time
1. How many messages must be sent when using non-persistent HTTP before this web page can be viewed? How many RTTs? Justify your answer. (3 pts)
  2. Would you expect persistent connections and pipelining to give you a bigger benefit over non-persistent connections in a high bit rate network or a low bit rate network? Justify your answer. (3 pts)

13. Consider the following traceroute output to [www.aub.edu.lb](http://www.aub.edu.lb). [9 points]

```

1  cs-gw (128.119.240.254) 1 ms 1 ms 2 ms
2  cht-vbns.gw.umass.edu (128.119.3.130) 6 ms 5 ms 5 ms
3  jn1-so7-0-0-0.wae.vbns.net (204.147.136.136) 21 ms 18 ms 18 ms
4  abilene-vbns.abilene.ucaid.edu (198.32.11.9) 22 ms 18 ms 22 ms
5  nycm-wash.abilene.ucaid.edu (198.32.8.46) 22 ms 22 ms 22 ms
6  62.40.103.253 (62.40.103.253) 104 ms 109 ms 106 ms
7  * * *
8  www.aub.edu.lb (193.55.113.50) 132 ms 128 ms 136 ms

```

- a. How many routers are there between the source and the web server [www.aub.edu.lb](http://www.aub.edu.lb)? (3 pts)
- b. What is the average RTT between the source and [www.aub.edu.lb](http://www.aub.edu.lb)? (3 pts)
- c. What do the stars (\* \* \*) in step 7 mean? (3 pts)

14. Given the following Wireshark snapshot, what is the application layer protocol carried in the payload? [5 points]

The screenshot shows a Wireshark capture of an HTTP GET request. The packet list pane shows a single packet of type HTTP. The packet details pane shows the structure of the request, including Ethernet II, Internet Protocol, and Transmission Control Protocol. The packet bytes pane shows the raw hex and ASCII data of the request, with a red circle highlighting the 'Keep-Alive: Timeout=30' header field.

Filter: http

No.	Time	Source	Destination	Protocol	Info
68	9.391155	192.168.198.212	193.188.129.179	HTTP	GET http://www.solvemyproblem.net/ HTTP/1.1

Frame 68 (155 bytes on wire, 155 bytes captured)

- Ethernet II, Src: Dell37:c8:09 (00:15:c5:37:c8:09), Dst: IETF-VRRP-virtual-router-VRID\_01 (00:00:5e:00:01:01)
- Internet Protocol, Src: 192.168.198.212 (192.168.198.212), Dst: 193.188.129.179 (193.188.129.179)
- Transmission Control Protocol, Src Port: 2370 (2370), Dst Port: 3128 (3128), Seq: 537, Ack: 1, Len: 101
- [Reassembled TCP Segments (637 bytes): #67(536), #68(101)]
- hypertext Transfer Protocol

```
0000 47 45 54 20 68 74 74 70 3a 2f 2f 77 77 77 2e 73   SET http://www.s
0010 6f 6c 76 65 6d 79 70 72 6f 62 6c 65 6d 2e 6e 65   olvemypr oblem.ne
0020 74 2f 20 48 54 54 50 2f 31 2e 31 0d 0a 41 63 63   t/ HTTP/ 1.1.Acc
0030 65 70 74 3a 20 69 6d 61 67 65 2f 67 69 66 2c 20   pt: ima ge/gif,
0040 69 6d 61 67 65 2f 78 2d 78 62 69 74 6d 61 70 2c   image/x- xbitmap,
0050 20 69 6d 61 67 65 2f 6a 70 65 67 2c 20 69 6d 61   image/j peg, ima
0060 67 65 2f 70 6a 70 65 67 2c 20 61 70 70 6c 69 63   ge/pipeg , applic
0070 61 74 69 6f 6e 2f 78 2d 73 68 6f 63 6b 77 61 76   ation/x- shockwav
0080 65 2d 68 6f 6e 2f 78 2c 20 61 70 70 6c 69 63 61   e-flash, applica
0090 74 69 6f 6e 2f 76 6e 64 2e 6d 73 2d 65 78 63 65   tion/vnd .ms-exce
00a0 6c 2c 20 61 70 70 6c 69 63 61 74 69 6f 6e 2f 76   l, appli cation/V
00b0 6e 64 2e 6d 73 2d 70 6f 77 65 72 70 6f 69 6e 74   nd.ms-po werpoint
00c0 2c 20 61 70 70 6c 69 63 61 74 69 6f 6e 2f 6d 73   , applic ation/ms
00d0 77 6f 72 64 2c 20 61 70 70 6c 69 63 61 74 69 6f   word, ap plicatio
00e0 6e 2f 78 61 6d 6c 2b 78 6d 6c 2c 20 61 70 70 6c   n/xaml+ x ml, appl
00f0 69 63 61 74 69 6f 6e 2f 76 6e 64 2e 6d 73 2d 78   ication/ vnd.ms-x
0100 70 73 64 6f 63 75 6d 65 6e 74 2c 20 61 70 70 6c   psdocume nt, appl
0110 69 63 61 74 69 6f 6e 2f 78 2d 6d 73 2d 78 62 61   ication/ x-ms-xba
0120 70 2c 20 61 70 70 6c 69 63 61 74 69 6f 6e 2f 78   p, appli cation/x
0130 2d 6d 73 2d 61 70 70 6c 69 63 61 74 69 6f 6e 2c   -ms- appli cation,
0140 20 2a 2f 2a 0d 0a 41 63 63 65 70 74 2d 4c 61 6e   /*% .Ac cept-Lan
0150 67 75 61 67 65 3a 20 65 6e 2d 75 73 0d 0a 55 41   guage: e n-us .UA
0160 2d 43 50 55 3a 20 78 38 36 0d 0a 41 63 63 65 70   -CPU: x8 6. Accep
0170 74 2d 45 6e 63 6f 64 69 6e 67 3a 20 67 7a 69 70   t-Encodi ng: gzip
0180 2c 20 64 65 66 6c 61 74 65 0d 0a 49 66 2d 4d 6f   , deflat e. IF-MO
0190 64 69 66 69 65 64 2d 53 69 6e 63 65 3a 20 4d 6f   dified-s ince: Mo
01a0 6e 2c 20 31 30 20 4e 6f 76 20 32 30 30 38 20 30   n, 10 No v 2008 0
01b0 38 3a 30 34 3a 32 38 20 47 4d 54 3b 20 6c 65 6e   8:04:28 GMT; len
01c0 67 74 68 3d 37 31 0d 0a 55 73 65 72 2d 41 67 65   gth=71.. User-Age
01d0 6e 74 3a 20 4d 6f 7a 69 6c 6c 61 2f 34 2e 30 20   nt: Mozil la/4.0
01e0 28 63 6f 6d 70 61 74 69 62 6c 65 3b 20 4d 53 49   (compati ble; MSI
01f0 45 20 37 2e 30 3b 20 57 69 6e 64 6f 77 73 20 4e   E 7.0; w indows N
0200 54 20 35 2e 31 3b 20 49 6e 66 6f 50 61 74 68 2e   T 5.1;
0210 31 3b 20 2e 4e 45 54 20 43 4c 52 20 32 2e 30 2e   1. .NET CLR 2.0.
0220 35 30 37 32 37 3b 20 2e 4e 45 54 20 43 4c 52 20   0727; . NET CLR
0230 33 2e 30 2e 30 34 35 30 36 2e 33 30 29 0d 0a 50   3.0.0450 6.30)..P
0240 72 6f 78 79 2d 43 6f 6e 6e 65 63 74 69 6f 6e 3a   roxy-Con nectio n:
0250 20 4b 65 65 70 2d 41 6c 69 76 65 0d 0a 48 6f 73   Keep-Al ive..Hos
```

Frame (155 bytes) Reassembled TCP (637 bytes)

Hypertext Transfer Protocol (http), 637 bytes

P: 208 D: 36 M: 0 Drops: 0