

Problem Set #1 Solutions

ENEE 426, Spring 2009

Complete the following problems from the textbook (5 points each):

1. Problem 1.7

$$\text{Propagation time} = (2e3 \text{ meters}) / (2e8 \text{ meters/second}) = 1e-5 \text{ seconds}$$

$$\text{Rate for 100 bytes} = (800 \text{ bits}) / (1e-5 \text{ seconds}) = 80 \text{ Mbps}$$

$$\text{Rate for 512 bytes} = (4096 \text{ bits}) / (1e-5 \text{ seconds}) = 410 \text{ Mbps}$$

2. Problem 1.8

$$\text{Propagation time} = (50e3 \text{ meters}) / (2e8 \text{ meters/second}) = 25e-5 \text{ seconds}$$

$$\text{Rate for 100 bytes} = (800 \text{ bits}) / (25e-5 \text{ seconds}) = 3.2 \text{ Mbps}$$

$$\text{Rate for 512 bytes} = (4096 \text{ bits}) / (25e-5 \text{ seconds}) = 16.4 \text{ Mbps}$$

3. Problem 1.14

$$\text{Latency} = (8000 \text{ bits}) / (1e6 \text{ bits/second}) = 8e-3 \text{ seconds}$$

4. Problem 1.16

$$\text{Propagation time} = (55e9 \text{ meters}) / (3e8 \text{ meters/second}) = 183.3 \text{ seconds}$$

$$\text{Round Trip Time} = 2 * \text{Propagation time} = 366.7 \text{ seconds}$$

$$\text{Bandwidth-Delay Product} = (183.3 \text{ seconds}) * (128e3 \text{ bits/second}) = 2.34e7 \text{ bits}$$

$$\text{Latency} = \text{Propagation time} + \text{Transmission Time}$$

$$= 183.3 \text{ seconds} + (40e6 \text{ bits}) / (128e3 \text{ bits/second})$$

$$= 495.8 \text{ seconds}$$

5. Problem 1.23

$$\text{Latency} = \text{Propagation time} + \text{Transmission time} + \text{Compression time}$$

$$PT + 0.5 * 1\text{MB} / \text{BW} + 1 \text{ sec} = PT + 0.4 * 1\text{MB} / \text{BW} + 2 \text{ sec}$$

$$0.5 * 1\text{MB} / \text{BW} + 1 \text{ sec} = 0.4 * 1\text{MB} / \text{BW} + 2 \text{ sec}$$

$$0.5 * 1\text{MB} / \text{BW} = 0.4 * 1\text{MB} / \text{BW} + 1 \text{ sec}$$

$$0.1 * 1\text{MB} / \text{BW} = 1 \text{ sec}$$

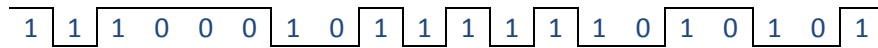
$$\text{BW} = 0.1 * 1\text{MB} / 1 \text{ sec} = 100 \text{ KBps} = 800 \text{ Kbps}$$

Propagation time irrelevant because it canceled on both sides of the equation.

6. Problem 2.2

Original: 1110 0101 0000 0011

4B/5B: 11100 01011 11110 10101



7. Problem 2.11

To prove, show that all equivalent geometries of three-bit errors are detectable, i.e.:

X X X X X X X
X X X X X X X
X X X X X X X

In each, at least one column or row parity bit would be incorrect, demonstrating error.

8. Problem 2.12

The only 4-bit error that's not detectable is of the form:

X X
X X

Complete the following additional problem (10 points each):

9. Read the paper "End-to-End Arguments in System Design" by Salter, Reed, and Clark (Google search on paper title will reveal PDF copies). Describe how you think the ideas in this paper have influenced the design of the modern Internet, specifically with regard to the reliable transport aspects of TCP/IP. I'm not looking for an essay – just a paragraph or two.

PHY/MAC layer provides local connections. IP layer is global, single layer that allows for end-to-end connectivity. By building everything on top of IP, and using end-to-end protocols, the individual PHY/MAC layers throughout the Internet don't matter. By making end hosts responsible for reliability (i.e. through TCP), the Internet doesn't need to be responsible for ensuring this reliability, which makes it scalable. Same thing for security – end hosts encrypt/decrypt data, so the network infrastructure needs minimal security.

10. From your computer, run the trace route command (from Windows, open a command prompt and type "tracert <computer>") to trace the route to "www.google.com" and "www.umd.edu". Include the trace results with your assignment. How many intermediate routers are between you and google, and you and umd? How many of the initial hops are the same? Can you identify the ISP and NSP?

See attached example traceroutes.

```
traceroute to www.google.com (64.233.169.99), 30 hops max, 40 byte packets
 1 Wireless_Broadband_Router.home (192.168.0.1) 0.733 ms 0.710 ms 1.430 ms
 2 96.244.133.1 (96.244.133.1) 6.909 ms 6.899 ms 6.889 ms
 3 G4-0-435.LCR-04.BLTMMD.verizon-gni.net (130.81.109.12) 9.616 ms 9.852 ms 9.843 ms
 4 P14-2.LCR-01.NWRKNJ.verizon-gni.net (130.81.28.82) 14.071 ms 16.808 ms 16.798 ms
 5 0.so-6-0-0.XL2.PHL6.ALTER.NET (152.63.3.81) 16.788 ms 17.020 ms 18.997 ms
 6 0.so-7-0-0.XL4.IAD8.ALTER.NET (152.63.32.125) 21.464 ms 13.663 ms 15.892 ms
 7 0.ge-7-0-0.BR2.IAD8.ALTER.NET (152.63.41.157) 12.180 ms 14.406 ms 14.633 ms
 8 te-11-0-0.edge1.Washington4.level3.net (4.68.111.253) 14.621 ms 57.156 ms 57.139 ms
 9 ae-3-89.edge1.Washington1.Level3.net (4.68.17.144) 14.637 ms 16.869 ms 36.847 ms
10 GOOGLE-INC.edge1.Washington1.Level3.net (4.79.228.38) 39.333 ms 39.571 ms 41.806 ms
11 209.85.130.12 41.797 ms 42.032 ms 44.267 ms
12 64.233.175.111 24.515 ms 17.192 ms 17.176 ms
13 72.14.232.21 19.650 ms 22.143 ms 19.696 ms
14 yo-in-f99.google.com 17.173 ms 17.164 ms 17.154 ms
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13 hops
ISP: Verizon FIOS
NSP: ALTER.NET -> Level3
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```
traceroute to www.ece.umd.edu (128.8.111.201), 30 hops max, 40 byte packets
 1 Wireless_Broadband_Router.home (192.168.0.1) 0.756 ms 0.733 ms 1.452 ms
 2 96.244.133.1 (96.244.133.1) 6.929 ms 6.918 ms 6.908 ms
 3 G4-0-435.LCR-04.BLTMMD.verizon-gni.net (130.81.109.12) 9.634 ms 9.624 ms 9.855 ms
 4 P14-2.LCR-01.NWRKNJ.verizon-gni.net (130.81.28.82) 14.342 ms 16.828 ms 16.818 ms
 5 so-0-2-0-0.BB-RTR2.NWRK.verizon-gni.net (130.81.7.186) 19.048 ms 19.040 ms 19.274 ms
 6 130.81.19.96 (130.81.19.96) 21.511 ms 13.418 ms 13.641 ms
 7 so-7-2-0-0.BB-RTR2.NY325.verizon-gni.net (130.81.19.69) 14.680 ms 14.908 ms 14.894 ms
 8 so-7-0-0-0.PEER-RTR1.NY111.verizon-gni.net (130.81.17.131) 14.877 ms 14.682 ms 14.665 ms
 9 po2-0.core01.jfk05.atlas.cogentco.com (154.54.11.45) 14.888 ms 16.870 ms 16.862 ms
10 te4-1.mpd01.jfk05.atlas.cogentco.com (154.54.1.153) 16.851 ms 17.085 ms 19.321 ms
11 te9-3.mpd03.jfk02.atlas.cogentco.com (154.54.26.61) 19.309 ms 19.544 ms 19.537 ms
12 te8-3.mpd01.dca01.atlas.cogentco.com (154.54.5.98) 21.771 ms 14.691 ms *
13 vl3588.na21.b003328-0.dca01.atlas.cogentco.com (66.28.5.222) 17.150 ms 17.143 ms 14.689 ms
14 allied-telecom-umd.demarc.cogentco.com (38.112.19.134) 29.661 ms 29.645 ms 29.635 ms
15 ptx-cogent-r1.net.umd.edu (131.118.255.214) 19.622 ms 19.616 ms 19.606 ms
16 Gi3-6.css-fw-r1.net.umd.edu (128.8.0.237) 19.597 ms 19.826 ms 22.059 ms
17 128.8.7.218 22.052 ms 22.043 ms 22.221 ms
18 128.8.7.209 22.208 ms 24.437 ms 17.460 ms
19 Gi6-6.css-core-r1.net.umd.edu (128.8.0.81) 17.439 ms 17.430 ms 17.422 ms
20 Gi1-1.ptx-dual-r1.net.umd.edu (128.8.0.26) 17.656 ms 19.709 ms 17.451 ms
21 ajclark2.eng.umd.edu (128.8.111.201) 17.686 ms 17.682 ms 17.463 ms
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20 hops
ISP: Verizon FIOS
NSP: Cogent
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