# CSC/ECE 573 Section 001

# Spring 2017

# Homework #2

**Keywords:** Circuit switching and packet switching, Bandwidth, Ethernet, ARP and RARP, ICMP, UDP and fragmentation.

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## Instructions

* You can do this homework in groups of two (at most).
* The total number of points is 50.
* You must answer all questions for full credit.
* Use only this paper for your answers, in the space provided.
* The due date is as posted on the web page (please submit your answers through Wolfware).

**Question 1. [5 points] Circuit switching and Packet switching.**

Consider users generating data at a rate of 100 kbps each when busy, but are busy generating data only with probability p=0.1. Assume the users are sharing 1 Mbps link.

1. What is N, the maximum number of users that can be supported simultaneously under circuit switching?

In circuit switching, each user gets a dedicated bandwidth. Hence the 1Mbps will be equally divided among N users.

1. Now consider packet switching and a user population of M users. Give a formula (in terms of p, M, N) for the probability that more than N users are sending data.

Assuming M≥N

When k users are sending data each with probability of p=0.1 then

Assuming N = 10 from previous question, we get

1. Repeat parts (A) and (B) when the shared link has a capacity of 1Gbps.

When the shared link capacity is 1Gbps, the link speed is shared among N users each with 100kbps capacity, where N is

Assuming M≥N

When k users are sending data each with probability of p=0.1 then

Assuming N = 10 from previous question, we get

**Question 2. [5 points] Bottleneck Bandwidth.**

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 R1=500kbps, R2=2 Mbps, and R3=1 Mbps.

1. Assuming no other traffic in the network, what is the throughput for the file transfer?

Though the links have different lengths, the throughput is always decided by the link with the lowest speed because it causes a bottleneck. Hence the throughput is min(500kbps,2Mbps,1Mbps) = 500kbps.

1. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?

Time require to transfer a file of 4 million bytes

1. Repeat parts (a) and (b), but with R2 reduced to 100 kbps. 100Kbps, 320s

Though the links have different lengths, the throughput is always decided by the link with the lowest speed because it causes a bottleneck. Hence the throughput is min(500kbps,100kbps,1Mbps) = 100kbps

Time require to transfer a file of 4 million bytes

**Question 3. [5 points] Packets and overhead.**

You are uploading a 2.1 MB (Megabyte) image to Facebook. In order to upload it, your computer will convert it into a series of packets. Each packet will carry at most 1000 bytes of data. The header of each packet (containing routing and other administrative information) is exactly 64 bytes. Assuming that your computer doesn’t need to resend any packets:

1. How many packets will your computer send? 2353

If it is assumed that the 64 bytes header is already part of 1000 bytes (payload = 1000 – 64 = 936 bytes)

If it is assumed that the 64 bytes header is not part of 1000 bytes (payload = 1000 bytes)

Number of packets is 2202 packets (assuming that precision error while rounding off 2.1MB) or 2203 (by assuming the extra data is added to a new packet

1. How many bytes will your computer send in total? 2202010 + 150592 = 2352602

Total header size = Number of packets x size of header = 2353 x 64 = 150592 bytes

Total bytes transmitted = 2.1MB + Total overhead = 2202010 + 150592 = 2352602

1. How many overhead (non-data) bytes did your computer have to send? 150592

Total header size = Number of packets x size of header = 2353 x 64 = 150592 bytes

1. If you have a 3 Mbit/sec internet connection, how long will it take (ideally) to upload the image? 6.273605333333333

**Question 4. [5 points] Bandwidth caps**

Upload bandwidth (sending information from your computer to the internet) is universally less than download bandwidth (receiving information from the internet). This is not a technical constraint; your internet service provider simply decides to limit your upload capacity. Explain why upload and download bandwidth is technically the same. Posit a (non-technical reason) explanation why your ISP would want to limit your upload capacity.

If A and B are two hosts communicating over the Internet. Any download request of A (to B) is an upload request to B and vice versa. So, from the network’s perspective the transaction is always symmetrical. Same protocols are used to send data from A or B. Hence the upload and download bandwidth is technically the same. It just depends of the perspective of the host.

Over the time, ISPs have had the notion that most of the user traffic is downloaded. That is general users are data consumers and not data producers. So, a significant amount of the bandwidth is utilized for download requests. Hence, it was a practical and economical decision to allow higher download speeds than upload speeds. It could also be reasoned that the duplex nature of the link can cause a decrease in download speed when the upload speed is increased.

**Question 5. [5 points] Ethernet.**

The Ethernet layer 2 technology enforces maximum and minimum bounds on the number of bytes that can be carried in the data field of an Ethernet frame. What are the values of these bounds? Explain why these exact values were used.

**Use Tanenbaum–**

**Question 6. [5 points] ARP.**

**H1**

**H2**

**H3**

**H4**

**H5**

**R1**

**B1**

N

S

E

W

I4

M4

I1

M1

I3

M3

I5

M5

I2

M2

IR2

IR1

IR3

MR2

MR3

MR1

The figure above illustrates five hosts H1, H2, H3, H4 and H5 connected by an inter-network running IPv4. The hosts are on three Ethernet networks, which are connected by router R1. Note the learning bridge B1 that connects hosts H2, H4, H5 and router R1. The figure shows the IP and MAC addresses of the hosts and the router’s interfaces, and the interface names of the bridge. Hosts and the router each maintain an ARP table (cache), which map IP addresses to MAC addresses. The Bridge maintains a MAC address table, which maps MAC addresses to the bridge interfaces. Assume that the ARP caches and the MAC address table are initially empty and that no packets have been sent yet. The forwarding tables of all hosts and the router are correctly configured. All hosts know each other’s IP addresses. ARP snooping is enabled.

Consider that host H4 sends an IPv4 unicast datagram to host H1.

1. Provide the state of the six ARP caches as they will appear after the IPv4 unicast datagram has been delivered to host H1, that is, after ARP resolution has been made.
2. Provide the state of the bridge’s MAC address table as it will appear after the IPv4 unicast datagram has been delivered to host H1, that is, after ARP resolution has been made.

**Question 7. [5 points] UDP and fragmentation**

Assume an Ethernet link with MTU 1500 bytes connects hosts A and B. An application process on Host A sends 5200 bytes of application data via UDP to a process on Host B. IPv4 is used at the network layer.

1. How many fragments are transmitted?

1500 – 20 = 1480 IP

5208/1480 = 4

1. Give the values of the MF bit, the offset and the total length field of the IP header of each fragment.

1110

Offset = 0,185,370,555

Length = 1500,1500,1500, 768 + 20

**Question 8. [15 points] ICMP**

This problem aims to introduce you to using Wireshark for basic packet analysis. Use the following procedure to capture a packet trace of your computer exchanging ICMP echo requests/responses (i.e., pings and pongs) with Google’s web servers:

1. Download and install Wireshark (www.wireshark.org). On their website, you can find tutorials for this process, as well as everything below.
2. Find the currently used network interface on your computer (e.g., eth0 or en0) and begin capturing.
3. Open a terminal and run ping [www.google.com](http://www.google.com).
4. Stop the packet capture and isolate the ping packets by entering “icmp” into the filter box. (Ping sends packets using the Internet Control Message Protocol, or ICMP.)

Use your trace to answer the following questions:

1. Wireshark displays packets by breaking down the data by layer. How many bytes are in the physical layer packet (i.e., the whole packet)? How many bytes are in the header for each other layer?

Bytes in PL = 98

Ethernet = 14

IP = 20

ICMP – 8

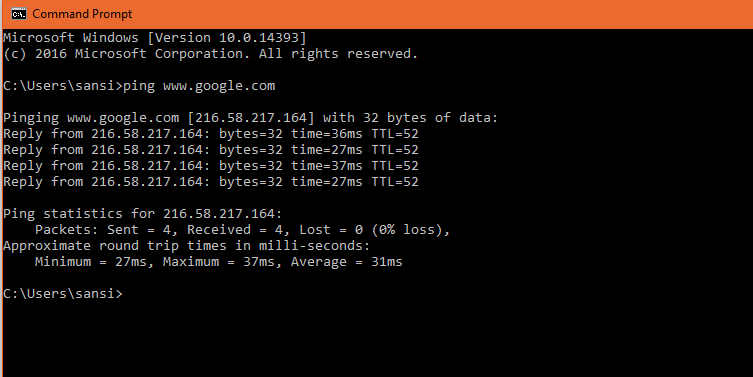
1. The TTL (time to live) limits life of a packet to prevent a packet from looping forever; it is a remaining hop count that is decremented by each router.

• When your system sends a fresh packet, what is its TTL? (Look at one of the pings your computer sent.)

128

• How many hops did each reply packet take to get back to your system from Google?

64 – 52 = 12 hops



(c ) Look at the fields in the ICMP echo messages.

• Examine the Identifier field. Does it change between pings in one execution of the ping command? What is its purpose? Why can’t port numbers be used?

No, it doesn’t change. It is the process PID of the ping process which is sent as a part of ICMP header. To demultiplex requests

• What is the purpose of the Timestamp? How could the ping program be changed to eliminate the need for this field?