EE450 Introduction to Computer Networks - Fall 2019 - HW 9

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1 Chapter 4, Page 362: R10 (15 points) Three types of switching fabrics are discussed in Section 4.2. List and briefly describe each type. Which, if any, can send multiple packets across the fabric in parallel?

three types of switching fabrics: Memory, bus, and crossbar.

- memory: traditional computers with switching under direct control of CPU, packet copied to system's memory, speed limited by memory bandwidth.
- bus: datagram from input port memory to output port memory via a shared bus, has contention over the shared bus: switching speed limited by bus bandwidth.
- crossbar: A switch which consists of an interconnection network consisting of 2N buses that connect N input puts to N output ports. Capable of forwarding multiple packets in parallel.

2 Chapter 4, Page 362: R11 (15 points) Describe how packet loss can occur at input ports. Describe how packet loss at input ports can be eliminated without using infinite buffers).

If the rate at which packets arrive to the fabric exceeds switching fabric rate, then packets will need to queue at the input ports. If this rate mismatch persists. the queues will get larger and larger and eventually overflow the input port buffers, causing packet loss. Packet loss can be eliminated if the switching fabric speed is at least n times as fast as the input lines speed, where n is the number of input ports.

3 Chapter 4, Page 363: R25 (15 points) Suppose an application generates chunks of 40 bytes of data every 20 msec, and each chunk gets encapsulated in a TCP segment and then an IP datagram. What percentage of each datagram will be overhead, and what percentage will be application data.

20 bytes of TCP head and 20 bytes of IP head. Totally there are 40 bytes of overhead.
Therefore, the percentage of header and application data are 50%.

4 Chapter 4, Page 363: R27 (15 points) What is meant by the term "route aggregation" ? Why is it useful for a router to perform route aggregation?

"route aggregation" is the ability to use a single prefix to advertise multiple networks, because it can minimize the number of routing tables required in an IP network.

5 Chapter 4, Page 367: P8 (20 points) Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all of the interfaces in each of three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support at least 60 interfaces, Subnet 2 is to support at least 90 interfaces, and Subnet 3 is to support at least 12 interfaces. Provide three network addresses of the form a.b.c.d/x that satisfy these constraints.

x interfaces require i bits:

$$2^i - 1 = x \Rightarrow i \geq \log_2(x+1) \tag{1}$$

For subnet 1, $x = 60 \rightarrow i = 6$; for subnet 2, $x = 90 \rightarrow i = 7$; for subnet 3, $x = 12 \rightarrow i = 4$.
Subnet 1: 223.1.17.0/26
Subnet 2: 223.1.17.128/25
Subnet 3: 223.1.17.192/28

6 Chapter 4, Page 366: P14 (20 points) Consider sending a 2400-byte datagram into a link that has an MTU of 700 bytes. Suppose the original datagram is stamped with the identification number 422. How many fragments are generated? What are the values in the various fields in the IP datagram(s) generated related to fragmentation?

IP header takes about 20 bytes, therefore useful data length in a single MTU is 680 bytes. Number of required fragments:

$$\left\lceil \frac{2400 - 20}{700 - 20} \right\rceil = 4 \tag{2}$$

Each fragments will have identification number 422. Each fragment except the last one will be of size 700 bytes. The last datagram will be of size 360 bytes. The offsets of the 4 fragments will be 0, 85, 170, 255. Each of the first 3 fragments has flag $= 1$, the flag of the last fragment equals to 0.