CS 524 Homework #3

Due: March 10, 2020

This homework contains both technical and business-related problems, for the total of **100** points. Note that this homework requires a good deal of a self-study to understand the subject matter fully. To understand the material and complete the homework should take the two weeks allotted, so start working on it now!

To this end, consider it a typical every-day problem you would need to solve if you worked as a product manager in a large company or ran a start-up company yourself.

You also need to complete reading Chapter 4 before the Midterm break.

1. (**10 points)** Given the token bucket size, *b bytes*; token rate, r bytes/sec; and maximum output rate *M* bytes/sec, what is the maximum burst time *T*?

2. **(50 points)** Study the *AWS Direct Connect* service and answer the following questions:

    a. (**business)** You own a company with a data center in Sapporo, Japan. Which company would you choose to connect this location to the Amazon service? Can you find out about pricing and QoS guarantees? (This may require some research. If you are unable to find the exact answers, describe what you have done to find them and what remains to be done.)

    b. **(technical)** As you have noticed, the *AWS Direct Connect* service description refers to the IEEE standard 802.1q. Read this standard (which you should be able to find at http://www.ismlab.usf.edu/dcom/Ch3_802.1Q-2005.pdf or at the Stevens Library) and explain how a dedicated connection can be partitioned into multiple virtual interfaces so as to allow you to "use the same connection to access public resources such as objects stored in Amazon S3 using public IP address space, and private resources such as Amazon EC2 instances running within an Amazon Virtual Private Cloud (VPC) using private IP space."

3. (**10 points)** Describe how the *AWS Direct Connect* service can be used with the *Amazon Virtual Private Cloud (VPC).*

4. (**10 points)** Note that *Amazon VPC* provides NAT.

    a. Explain why you would want to use *NAT* for a *virtual private subnet with* the *Amazon Direct Connect* service. Do you see any cases where you would *not* want to use it?

b. What is the maximum number of connections a single NAT box can maintain? (You need to check the specifications of the three existing transport-layer protocols on the Internet: TCP, UDP, and SCTP, and also keep in mind that the first 4,096 ports have been reserved.)

5. (**10 points)** Read RFC 1930 (http://www.ietf.org/rfc/rfc1930.txt) and also a Washington Post article, https://www.washingtonpost.com/sf/business/2015/05/31/net-of-insecurity-part-2/. and answer the following questions:

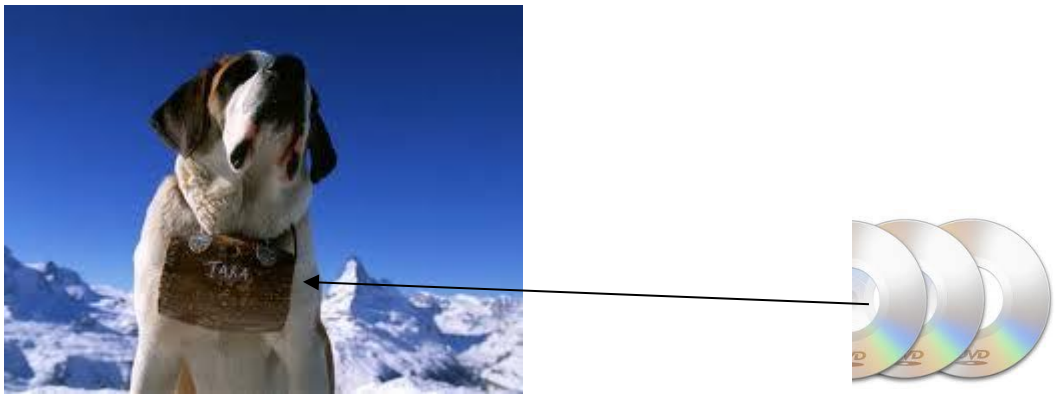
   a. To use AWS Direct Connect with *Amazon VPC,* the Border Gateway Protocol is required. Why?

   b. Can you use your own *ASN* to connect to VPC?

   c. Which RIR would you go to when you need to establish an ASN for your data center in Sapporo, Japan?

   d. What security problems you will have to deal with using BGP, and what how are you going to address them?

6. **(10 points)** *St. Bernard* dogs (a breed originated in a Swiss monastery to save the travelers stranded in snow) have been trained to run on their missions in snow-covered mountains with flasks of brandy attached to their necks. (See the picture below.)



Now, you retrain your company's two St. Bernards, named *Alpha* and *Beta ,* to carry data in DVD ROM disks. (The disks, in bundles of *three*, are attached to a dog's necks where the flask used to be, so one dog can carry three disks.)

Each disk stores **7 Gb** of data. Both Alpha and Beta run at a constant speed of **18 km/h**. (1 Gb = 1,000 megabytes = 1,000,000 bytes.)

Your company has two data centers, which need to be interconnected with two **150-Mbps** data pipes—one in each direction. The distance between the data centers is **5.5 km**. (*Mbps = megabits per second.)*

Your task is to ensure that the data centers be interconnected. You can achieve that by

1) Building a physical network (very expensive, given the terrain);
2) Renting pipes from service providers (pretty expensive); or
3) Writing the data on DVDs, and then running Alpha and Beta between the data centers (in opposite directions), with CDs attached. This is free, and the dogs need to exercise anyway.

Can the dogs provide this service? (Assume that the pipes need to operate for only a couple of hours a day, so the dogs don't get tired. Ignore the overhead of writing and reading DVDs—it is smaller than the data communications overhead anyway.)