**Midterm Project**

**Problem A**

1. A Network engineer needs to make a decision as of where to do error handling, in the Data Link Layer at frame level or in the TCP Layer at packet level. In most of the error handling protocols, when there is an error, it has to re-transmit the frame or the packet respectively. In general, there are multiple frames in a packet and it costs more to re-transmit a packet than a frame. On the other hand, the overhead cost for initiating error checking is higher for multiple frames than the cost of a single packet, since there is more than one frame within a packet.

Given a physical link with certain quality measurement, p < 1, as the probability of error for a frame, by common sense concerns, in what case you would like to do error handling at the Data Link Layer or at the TCP Layer? (You need to justify your decision in best (case where almost p=0) and worst case (where almost p=1) scenarios with respect to the quality of physical layer.

1. Given the following error handling protocol configuration and specification as a case#1 study example:

P = 0.1 error rate of a frame (probability of frame error)

Cf = 10¢ cost of transmitting a frame (without error checking)

Ef = 1.2¢ cost of error checking for a frame at Data Layer.

Packet size 10 frames/packet

Cp = 100¢ cost of transmitting a packet (without error checking)

Ep = 10¢ cost of error checking for a packet at TCP Layer.

To simplify the problem, we assume (1) each frame can fail with probability of frame error, p, independently from each other. (2) All frame have the same probability of frame error, p.

Answer the question below using quantitative analysis with supporting data (must show your processes how you derive these data).

* 1. What is the average cost of sending a packet if it does error checking at the Data Link Layer?
  2. What is the average cost of sending a packet if it does error checking at the TCP Layer?
  3. In this case, where do you think the error checking should be done?

3. Re-examine the case#2 with the following data,

P = 0.001 error rate of a frame (probability of frame error)

Cf = 10¢ cost of transmitting a frame (without error checking)

Ef = 1.2¢ cost of error checking for a frame at Data Layer.

Packet size 10 frames/packet

Cp = 100¢ cost of transmitting a packet (without error checking)

Ep = 10¢ cost of error checking for a packet at TCP Layer.

Answer the same question below with supporting data (mush show your processes how you derive these data).

1. What is the average cost of sending a packet if it does error checking at the Data Link Layer?
2. What is the average cost of sending a packet if it does error checking at the Network Layer?
3. In this case, where do you think the error checking should be done?

**Problem B**

Write a computer program to simulate the cases in **Problem A.2** and **A.3** (using the same data set in A.2 and A.3). Your program should simulate sending 100 packets and produce the following simulation data for Problem A.2 and Program A.3.

1. The average cost of sending a packet if error handling is done at Data Layer.

2. The average cost of sending a packet if error handling is done at TCP Layer.

You should compare you simulation results with your answers for both Problem A.2 and Problem A.3 and try to explain the differences if there are any. Does your simulation data support your decisions made previously in Part A?

**Hits:**

* You can use any program language as you wish.
* You can use a random number generator to generate a random number x in [0, 1] to simulate the outcome of sending a frame (failure or success). If x <= p (the probability of frame error) then it is a failure, otherwise it is a success.
* To get the average cost of sending a packet for error handling at Data Layer, you need to track the average cost of sending a frame then multiply it by 10. Then you need to get the average cost of sending a packet over 100 packets.
* To get the average cost of sending a packet for error handling at the TCP Layer, you need to track the average number of send/resend a packet (remember if one or more fame failed, the packet failed and the packet needs to be resent).

Data sets for the project



**Project Deliverables**

* Simulation program design and program source code.
* Simulation data set.
* Project report (a MS Word document) shows you analysis about Problem A and supporting data, simulation data analysis in Problem B, and comparison analysis about the results you get for Problem A and Problem B. You can use tables and charts to show your analysis results.