National Taiwan Normal University
Department of Computer Science and Information Engineering
## CSC0056 - Data Communication

Homework 6
(Due on 12/30/2019 before class. Submit your answer via Moodle)

1. (50 points) Review of Lecture 15:
    1a. (10 points) In combining optimal routing and flow control (page 520 in the textbook), briefly explain why the penalty function should be monotonically decreasing and tend to infinity as r_w tends to zero.
    1b. (20 points) (page 17 in the lecture15.pdf) Give one example of soft deadline and one example of hard deadline. 10 points for each example.
    1c. (20 points) (page 19 in the lecture15.pdf) Suppose that a networked application has an end-to-end deadline equal to 500 ms, and suppose we knew that it would take at least 1 ms for a piece of data to be delivered from the sender to the intermediary (messaging broker) and at least 30 ms for the data to be delivered from the intermediary to the receiver. In order to meet the 500 ms end-to-end deadline, can we say that the data should not spend more than 469 ms in the intermediary? In other word, can we say that for a program in the intermediary handling the data, an upper bound of its deadline is 469 ms?

2. (50 points) Review of Lecture 16:
    2a. (30 points) Consider the following figure, with two hosts A and B and their message exchanges:
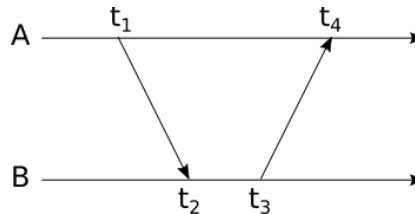
    2a1. (10 points) Let t_1=100, t_2=150, t_3=200, t_4=240. By only considering these timing information, what is the mean time offset between two hosts? Just provide the absolute value of the offset.
    2a2. (10 points) Following 2a1, what is the mean one-way delay?
    2a3. (10 points) Following 2a1, now suppose t_2=180 instead. What is the mean time offset based on this change? What does this tell you about the impact of fluctuations in delay?
    2b. (10 points) Briefly explain why the PTP use of transparent clocks (either end-to-end or peer-to-peer) may improve the accuracy of synchronization (Hint: consider Question 2a3).
    2b. (10 points) For data replication, in terms of resource cost, would you choose active replication or passive replication, and why? Briefly explain your answer.

3. (extra 15 points) In Lecture 16, we have mentioned that the use of hardware timestamping can help improve the accuracy of synchronization because the measurement exempts the fluctuations in software latency (page 20 in lecture16.pdf; take timestamp at point A). Nowadays, on the market there are network cards and network switches supporting hardware timestamping. Now, do some online search to find some of those products and their prices. It will give you some idea about real-world trade-offs in performance and cost. Paste here the URLs and your screenshots (Hint: you may use keyword "PTP" to help your search).

    Note: for those of you who are curious whether your own network cards support hardware timestamping, you may use the `ethtool` utility with option `-T` to figure it out. See, for example,
    https://developernote.com/2018/12/setting-up-time-synchronization-on-ubuntu/