ECE 697O: Homework 5

Due on May 1, 2007

(1) In class, we showed that choosing the median clock as the reference would not assure synchronization when malicious failure can happen. In this problem, we will extend this slightly.

Suppose you are given a five-clock system and two faulty clocks. The good clocks, c_1, c_2, c_3 have drift rates ρ_1, ρ_2, ρ_3, respectively, such that $\rho_1 < \rho_2 < \rho_3$.

Show how the faulty clocks should behave in order to ensure that, over time, none of the non-faulty clocks is telling a time within δ of any other non-faulty clock. Note that this is a stronger requirement than that some clocks may be more than δ away from some other clocks: we want *every* pair of good clocks to be ultimately separated by more than δ.

Assume that you are using the median-clock signal as reference. Mention any assumptions you make.

(2) We showed that $N \geq 3m + 1$ is necessary and sufficient when there are m malicious failures in phase-locked clocks. Suppose there are up to m malicious and b benign failures. Derive a necessary and sufficient condition for synchronization. Then, obtain reference functions, $f_{p_i}(N, m, b)$.

(3) Consider any software synchronization algorithm. (We have not covered any such algorithms in this course, but assume you are given a software package that will synchronize the clocks. Simply treat this package as a black box). Suppose the time taken by each processor to run the synchronization algorithm during each resynchronization period is $5N$, where N is the number of processors to be synchronized. Suppose also that we require the processors to run the application workload for at least 80% of the time. The operating system and associated tasks take up another 10% of the time, so that only 10% is left to run the resynchronization algorithm. What is the tightness with which an N-processor system can be synchronized?Assume that the drift rate is upper-bounded by $\rho = 10^{-6}$.