Real-Time Systems Spring 2006

Exercise 1/6 (Tue 14.3.2006)

1) Which of the following computer systems are real-time systems? Justify your answer in terms of real-time system characteristics [, which include timing constraints, concurrency, reliability, fault tolerance, criticality, testing, certification].
   a) An automatic teller machine that dispenses cash to credit card and bank customers
   b) An elevator system that responds to patron requests inside and outside an elevator, controlling the elevator and door operations
   c) A payroll system that produces employee paychecks every two weeks
   d) A sports system that registers, maintains, and displays scores during sporting events, such as baseball games or track and field.
   e) A gate controller at the intersection of railway tracks and a road that controls the opening and closing of a gate, to ensure that the road is blocked whenever a train is in the intersection area.
   f) A disc controller for a computer system
   g) The floating point unit for a computer
   h) A medical record-keeping system that maintains medical histories of patients in a clinic.

2) Consider the real-time program described by the pseudocode on the side. Names of the jobs are in italic.
   a) Draw a task graph to capture the dependencies among the jobs.
   b) How many differene possible paths there is in the program?
   c) Use as many precedence graphs as needed to represent all the possible paths of the program.

   (Liu 3.2)

9 AM *start*; have breakfast and go to office;
at 10 AM If there is class, *teach*; else, *help* students;
When *teach* or *help* is done, *eat_lunch*;
Until 2 PM *sleep*;
If there is a seminar,
    If topic is interesting, *listen*; else, *read*;
else *write* in the office;
When seminar is over, *attend* social hour;
discuss;
jog;
eat_dinner;
work a little more;
end_the_day;

3) The feasible interval of each job in the precedence graph (Figure on next page) is given next to its name. The execution time of all jobs is equal to 1.
   a) Find the effective release times and deadlines of the jobs in the precedence graph.
   b) Find an EDF (Earliest Deadline First) schedule of the jobs.

   (Liu 4.1)

4) A system consists of three periodic tasks: (3, 1), (5, 2), and (8, 3).
   a) What is the total utilization?
   b) Construct an earliest-deadline-first schedule of this system in the interval (0, 32). Label any missed deadlines.
   c) Construct a rate-monotonic schedule for this system in the interval (0, 32). Label any missed deadlines.
   d) Suppose we want to reduce the execution time of the task with period 3 in order to make the task system schedulable according to the earliest-deadline-first algorithm. What is the minimum amount of reduction necessary for the system to be schedulable by the earliest-deadline-first algorithm?

(Liu 6.15)

Dependence graph for exercise number 3