SSY191 - Model-based development of cyberphysical systems
Individual Assignment 3

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Problem 1

Legend for all the figures in this question: "r" means that a task was released, green "d" means deadline met and red "d" means deadline missed. The x axis is in time units.

A)

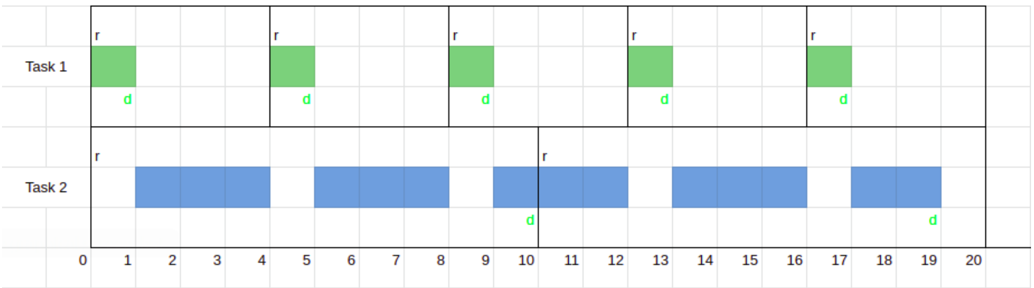

Figure 1: *Rate-monotonic schedule for tasks 1 and 2*

B) Adding a mutex lock to the processes make rate-monotonic schedule not feasible, since some deadlines will no longer be met. This can be shown with the following sketch:

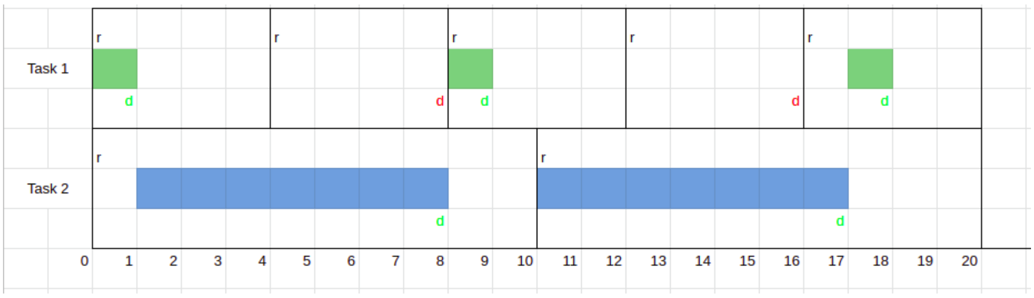

Figure 2: *Rate-monotonic schedule with mutex*

C) Assuming now that task 2 is running an *anytime algorithm*, we can calculate the maximum execution time for task 2, such that rate-monotonic schedule is feasible, using the Liu-Layland-Criteria, which is a sufficient condition for schedulability:

$$\sum_{i}^{N} \frac{C_i}{T_i} \leq N(2^{1/N} - 1) \tag{1}$$

$$\frac{1}{4} + \frac{e_2}{10} \leq 2(2^{1/2} - 1) \tag{2}$$

$$\Rightarrow e_2 \leq 5.7842 \tag{3}$$

which means that the execution task of task 2 must be equal or less than 5. This can be proven to be sufficient with the following sketch:

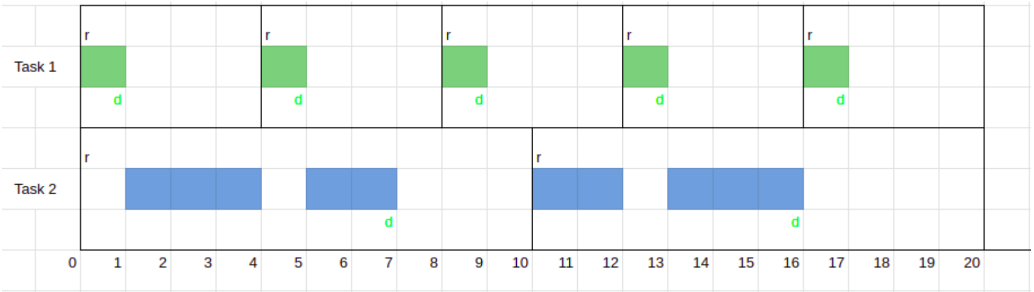

Figure 3: *Rate-monotonic schedule. Task 2 running an anytime algorithm*

D) If an EDF schedule is used, the deadlines are still met, as can be shown bellow:

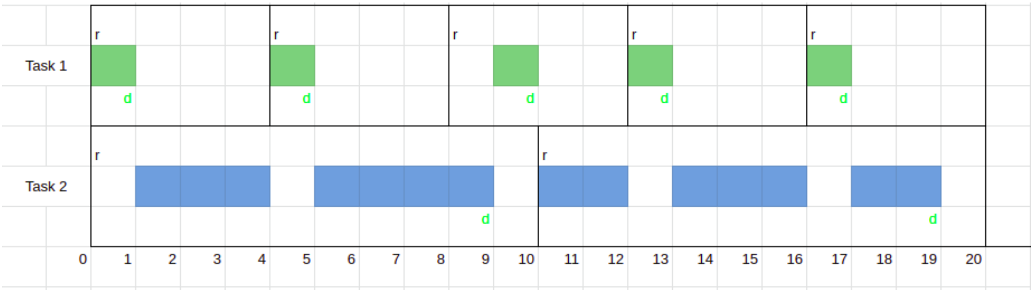

Figure 4: *EDF schedule*

E) To evaluate the maximum execution time for task 2 in an EDF schedule we can use the utilization-based test:

$$\sum_{i}^{N} \frac{C_i}{T_i} \leq 1 \tag{4}$$

$$\frac{1}{4} + \frac{e_2}{10} + \frac{2}{5} \leq 1 \tag{5}$$

$$\Rightarrow e_2 \leq 3.5 \tag{6}$$

which tell us that the maximum execution time for task 2 is equal 1, as can be seen bellow:

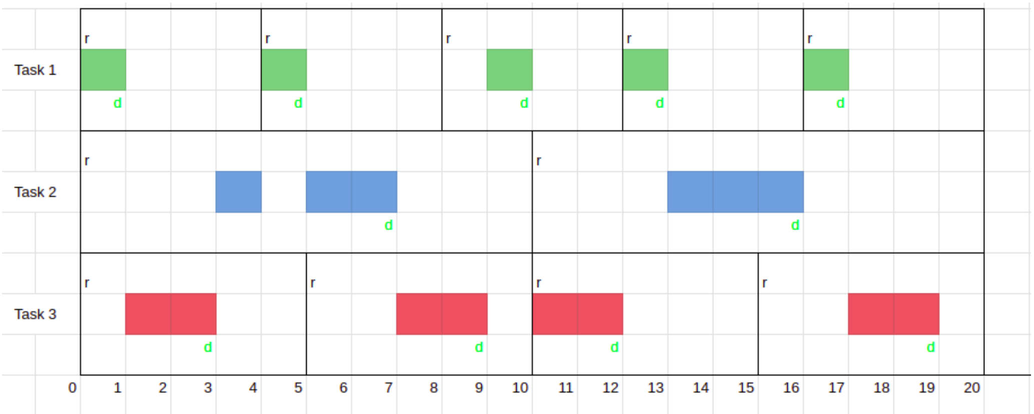

Figure 5: *EDF schedule. Task 2 running an anytime algorithm*

Problem 2

A) $\Box\neg(T_{1,use} \wedge T_{2,use})$

B) $\neg\Diamond\Box(T_{1,use}) \wedge \neg\Diamond\Box(T_{2,use})$

C) $\Box(T_{1_{req}} \rightarrow \Diamond T_{1,use}) \wedge \Box(T_{2_{req}} \rightarrow \Diamond T_{2,use})$

D) $\neg\Diamond\Box(T_{1,req}) \wedge \neg\Diamond\Box(T_{2,req})$

E) $\Box(T_{1,rel} \rightarrow (\neg T_{1,use} \bigcup T_{2,use})) \quad \wedge \quad \Box(T_{2,rel} \rightarrow (\neg T_{2,use} \bigcup T_{1,use}))$