# Answer on Question #53575, Engineering / Software Engineering

**Task:** Which of the following systems of periodic tasks are schedulable by the rate-monotonic algorithm? By the earliest-deadline-first algorithm? Explain your answer.

(a) T = {(8, 3), (9, 3), (15, 3)}

(b) T = {(8, 4), (12, 4), (20, 4)}

(c) T = {(8, 4), (10, 2), (12, 3)}

**Answer:**

**a) T = {(8, 3), (9, 3), (15, 3)}**

$U_{RM}(3) \approx 0.780$

U = 3/8 + 8/9 + 3/15 = 0.908 > URM

schedulable utilization test is indeterminate for RM, shortest period is highest priority

w1(t) = 3, W1 = 3 ≤ 8, T1 is schedulable

$w2(t) = 3 + \lceil t/8 \rceil \cdot 3 = t$

W2 = 6 ≤ 9, → T2 is schedulable

$w3(t) = 3 + \lceil t/8 \rceil \cdot 3 + \lceil t/9 \rceil \cdot 3 = t$

W3 = 15 ≤ 15, ∴ T3 is schedulable.

All tasks are schedulable under RM, therefore the system is schedulable under RM.

U ≤ 1→the system is schedulable under EDF

**b) T = {(8, 4), (12, 4), (20, 4)}**

The total utilization of tasks = 4/8 + 4/12 + 4/20 = 1.033

A system of independent, preemptable tasks with relative deadlines equal to their periods is schedulable if and only if their total utilization is less than or equal to 1. Therefore, T is not schedulable by RM or EDF.

Use TDA:

Check t= 8, 12, 16, 20

Wi(t) <= t

W1(t) = 4 < = t, t = 8, 12, 16, 20 → Schedulable

$W2(t) = 4 + \lceil t/8 \rceil * 4$

W2(8) = 4 + 4 = 8 <= 8 → Schedulable

$W3(t) = 4 + \lceil t/8 \rceil * 4 + \lceil t/12 \rceil * 4$

W3(8) = 4 + 4 + 4 = 12

W3(12) = 4 + 8 + 4 = 16

W3(16) = 4 + 8 + 8 = 20

W3(20) = 4 + 12 + 8 = 24 → Not schdulable by RM

Schedulability test of EDF algorithm: Since Dk = Pk, U = 1.033 >1 therefore, it is not schedulable by EDF.

**c) T = {(8, 4), (10, 2), (12, 3)}**

The total utilization of tasks = 4/8 + 2/10 + 3/12 = 0.95

For RM:

The tasks are schedulable if the total utilization of tasks, U, is less or equal to n(n^(1/n)-1), where n is the number of tasks.

Urm = n(n^(1/n)-1) = 3(2^(1/3)-1) = 0.78 < U = 0.95 $\rightarrow$ No conclusion.

Use TDA:

Check t = 8, 10, 12

Wi(t) <= t

W1(t) = 4 < = t, t =8, 10, 12 $\rightarrow$ Schedulable

W2(t) = 2 + $\lceil t/8 \rceil 4$

W2(8) = 2 + 4 = 6 <= 8 $\rightarrow$ Schedulable

W3(t) = 3 + $\lceil t/8 \rceil 4$ + $\lceil t/10 \rceil 2$

W3(8) = 3 + 4 + 2 = 9

W3(10) = 3 + 8 + 2 = 13

W3(12) = 3 + 8 + 4 = 15 $\rightarrow$Not schedulable

Therefore, it is not schedulable by using RM.

For EDF:

According to the schedulability Test for EDF algorithm:

$$\sum_{k=1}^{n} e_k / \min(D_k, p_k) \leq 1$$

In the case that Dk = Pk, the expression represents the total utilization of the tasks, which we have calculated. U = 0.95 less than one. Therefore, the periodic tasks are schedulable by EDF algorithm.