**Assignment 2.**

**Schedulability Analysis (100 points)**

Ankit Wagle(ASU ID- 1211289687)

Pavan Linga(ASU ID- 1213267638)

In this report, we present a comparative study of various scheduling analysis algorithms, namely EDF, RM and DM, and perform comparative analysis using 5000 synthetic task sets with different specifications. We try to observe the results from these scheduling analysis algorithms to understand how same task sets with certain specifications can be better handled using different scheduling algorithms.

Our conclusions include the choice of Scheduling algorithm based on utilization values. Also, in the presence of task-set generation randomness, the final values may vary when the program is run for the second time. However, the trends were mostly observed to be similar across all the runs.

Fig 1. Plot 1: 10 tasks in each task set and the deadline distribution of [Ci,,Ti]

Based on Plot 1, we can see that EDF is performing better than RM and DM for higher utilization numbers, as EDF can allow better utilization of system resources [Ref. Rate Monotonic vs. EDF: Judgment Day; Buzzato]

Also, note that RM and DM perform in a similar fashion, with DM performing slightly better than RM. DM is known to be optimal amongst fixed priority scheduling algorithms [J Liu].

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| --- | --- | --- | --- |
| PLOT1 |  |  |  |
| Utilization | EDF | RM | DM |
| 0.05 | 4977 | 4883 | 4990 |
| 0.15 | 4862 | 4519 | 4951 |
| 0.25 | 4710 | 4023 | 4885 |
| 0.35 | 4551 | 3519 | 4782 |
| 0.45 | 4279 | 3153 | 4595 |
| 0.55 | 4023 | 2706 | 4324 |
| 0.65 | 3659 | 2282 | 3915 |
| 0.75 | 3128 | 1885 | 3261 |
| 0.85 | 2327 | 1415 | 2354 |
| 0.95 | 518 | 701 | 522 |
|  |  |  |  |
|  |  |  |  |
| PLOT1 |  |  |  |
| Utilization % | EDF | RM | DM |
| 5% | 0.9954 | 0.9766 | 0.998 |
| 15% | 0.9724 | 0.9038 | 0.9902 |
| 25% | 0.942 | 0.8046 | 0.977 |
| 35% | 0.9102 | 0.7038 | 0.9564 |
| 45% | 0.8558 | 0.6306 | 0.919 |
| 55% | 0.8046 | 0.5412 | 0.8648 |
| 65% | 0.7318 | 0.4564 | 0.783 |
| 75% | 0.6256 | 0.377 | 0.6522 |
| 85% | 0.4654 | 0.283 | 0.4708 |
| 95% | 0.1036 | 0.1402 | 0.1044 |

Table 1. Plot 1 successful jobs and % Utilization Tables

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Fig 2. Plot 2: 25 tasks in each task set and the deadline distribution of [Ci,,Ti]

For Plot 2, we can see that RM and DM are working almost exactly identical. From Liu & Layland’s original paper, if relative deadline is equivalent to the period, then RM and DM are equivalent. However, later research then revealed that relative deadline is what matters the most in fixed priority scheduling. Relative deadlines are better handled in DM, and hence typically we see DM outperforming RM, by a small margin.

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| --- | --- | --- | --- |
| PLOT2 |  |  |  |
| Utilization | EDF | RM | DM |
| 0.05 | 4618 | 4988 | 4988 |
| 0.15 | 3700 | 4873 | 4873 |
| 0.25 | 2578 | 4698 | 4698 |
| 0.35 | 1637 | 4496 | 4496 |
| 0.45 | 1017 | 4342 | 4342 |
| 0.55 | 644 | 4085 | 4085 |
| 0.65 | 441 | 3762 | 3762 |
| 0.75 | 238 | 3285 | 3285 |
| 0.85 | 141 | 2407 | 2407 |
| 0.95 | 14 | 225 | 225 |
|  |  |  |  |
|  |  |  |  |
| PLOT2 |  |  |  |
| Utilization % | EDF | RM | DM |
| 5% | 0.9236 | 0.9976 | 0.9976 |
| 15% | 0.74 | 0.9746 | 0.9746 |
| 25% | 0.5156 | 0.9396 | 0.9396 |
| 35% | 0.3274 | 0.8992 | 0.8992 |
| 45% | 0.2034 | 0.8684 | 0.8684 |
| 55% | 0.1288 | 0.817 | 0.817 |
| 65% | 0.0882 | 0.7524 | 0.7524 |
| 75% | 0.0476 | 0.657 | 0.657 |
| 85% | 0.0282 | 0.4814 | 0.4814 |
| 95% | 0.0028 | 0.045 | 0.045 |

Table 2. Plot 2 successful jobs and % Utilization Tables

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Plot 3: 10 tasks in each task set and the deadline distribution of [Ci+(Ti-Ci)/2,,Ti]

In this plot(Plot 3), we can see that EDF is performing similar to RM and DM in lower part of the graph and in the highest utilization parts of the graph. In the middle section however, EDF does not perform as well as RM and DM. We have noticed fluctuations in the graph due to the presence of randomness in the task-set generation. However, in all the randomness, for higher utilization cases, EDF performs best.

|  |  |  |  |
| --- | --- | --- | --- |
| PLOT3 |  |  |  |
| Utilization | EDF | RM | DM |
| 0.05 | 5000 | 5000 | 5000 |
| 0.15 | 4999 | 5000 | 5000 |
| 0.25 | 4994 | 5000 | 5000 |
| 0.35 | 4955 | 5000 | 5000 |
| 0.45 | 4877 | 5000 | 5000 |
| 0.55 | 4738 | 5000 | 5000 |
| 0.65 | 4573 | 5000 | 5000 |
| 0.75 | 4406 | 4951 | 4963 |
| 0.85 | 4091 | 4275 | 4303 |
| 0.95 | 3147 | 1009 | 1013 |
|  |  |  |  |
|  |  |  |  |
| PLOT3 |  |  |  |
| Utilization % | EDF | RM | DM |
| 5% | 1 | 1 | 1 |
| 15% | 0.9998 | 1 | 1 |
| 25% | 0.9988 | 1 | 1 |
| 35% | 0.991 | 1 | 1 |
| 45% | 0.9754 | 1 | 1 |
| 55% | 0.9476 | 1 | 1 |
| 65% | 0.9146 | 1 | 1 |
| 75% | 0.8812 | 0.9902 | 0.9926 |
| 85% | 0.8182 | 0.855 | 0.8606 |
| 95% | 0.6294 | 0.2018 | 0.2026 |

Table 3. Plot 3 successful jobs and % Utilization Tables

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Plot 4: 25 tasks in each task set and the deadline distribution of [Ci+(Ti-Ci)/2,,Ti]

In this plot(Plot 4), we can see that EDF is performing similar to RM and DM in lower part of the graph and in the highest utilization parts of the graph. In the middle section however, EDF does not perform as well as RM and DM. We have noticed fluctuations in the graph due to the presence of randomness of task-set generation. However, in all the randomness, for higher utilization cases, EDF performs best.

|  |  |  |  |
| --- | --- | --- | --- |
| PLOT4 |  |  |  |
| Utilization | EDF | RM | DM |
| 0.05 | 5000 | 5000 | 5000 |
| 0.15 | 5000 | 5000 | 5000 |
| 0.25 | 4989 | 5000 | 5000 |
| 0.35 | 4900 | 5000 | 5000 |
| 0.45 | 4628 | 5000 | 5000 |
| 0.55 | 4162 | 5000 | 5000 |
| 0.65 | 3802 | 5000 | 5000 |
| 0.75 | 3320 | 4997 | 4997 |
| 0.85 | 2747 | 4543 | 4543 |
| 0.95 | 1333 | 458 | 458 |
|  |  |  |  |
|  |  |  |  |
| PLOT4 |  |  |  |
| Utilization % | EDF | RM | DM |
| 5% | 1 | 1 | 1 |
| 15% | 1 | 1 | 1 |
| 25% | 0.9978 | 1 | 1 |
| 35% | 0.98 | 1 | 1 |
| 45% | 0.9256 | 1 | 1 |
| 55% | 0.8324 | 1 | 1 |
| 65% | 0.7604 | 1 | 1 |
| 75% | 0.664 | 0.9994 | 0.9994 |
| 85% | 0.5494 | 0.9086 | 0.9086 |
| 95% | 0.2666 | 0.0916 | 0.0916 |

Table 4. Plot 4 successful jobs and % Utilization Tables

**Conclusion**

Based on the above 4 experiments, we can see that EDF performs best when the utilization requirement is higher. When utilization requirement is low, all EDF, RM and DM perform in a similar way. When utilization requirement is in the middle, DM performs best followed by EDF followed by RM. This conclusion is based on the results observed for the randomly generated task-set. We have noticed fluctuations, which may lead to different results over different runs. The above conclusions are based on the typical values that we observed over the multiple runs that we performed locally.