

# On-line Scheduling Of Hard Real-Time Tasks On Multiprocessors

By

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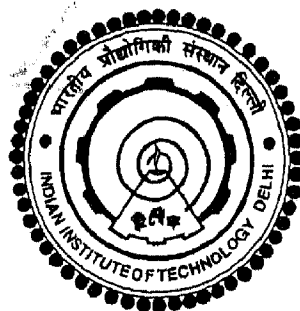
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# CERTIFICATE

This is to certify that the thesis entitled **“On-line Scheduling Of Hard Real-Time Tasks On Multiprocessors”** being submitted by **Mr. M. Dominic Angelo Paulraj** to the Department of Computer Science and Engineering, Indian Institute of Technology, New Delhi for the award of the degree of **“Doctor of Philosophy”** is a record of the bonafide research work carried out by him. Mr. M. Dominic Angelo Paulraj worked under my guidance for the submission of this thesis which to my knowledge has reached the requisite standard.

This thesis or any part thereof has not been submitted to any other university/institution for the award of any degree or diploma.



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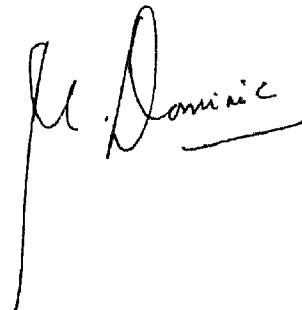
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A handwritten signature in black ink, appearing to read 'Flora Dominic', with a long vertical line extending downwards from the 'F'.

## ABSTRACT

We consider the problem of *on-line* scheduling of *hard real-time sporadic* tasks on *multiple* processors. For a given set of ready tasks, one can propose many schedules. These schedules, however, may not necessarily be suitable for on-line scheduling. A suitable schedule for on-line scheduling is one which can accommodate any future task set when it arrives.

The problem in designing an on-line scheduling algorithm is to schedule the ready tasks (with known parameters) in a manner such that future tasks can be scheduled as and when they arrive. However, the decision taken by an on-line scheduler on the set of ready tasks may or may not be suitable for scheduling future tasks. It is, therefore, important that an on-line scheduler schedules the ready tasks in a manner such that adequate resources are available to schedule future tasks.

The traditional approach to solving the on-line scheduling problem is to propose a heuristic and to prove its effectiveness by comparing it with existing heuristics using simulation. No attempt has, however, been made to obtain a condition on the current schedule which when satisfied will permit one to schedule an arbitrary future task.

In this thesis, we aim at developing such a condition on the schedule for ready tasks, which when satisfied can accommodate any future *feasible* task set. The problem is addressed in the context of time-driven schedulers where real-time constraints are expressed in terms of *time units*, and not *priorities*. We consider only feasible sporadic tasks which are pre-emptable and may migrate from one processor to another without incurring any additional cost.

We then propose an on-line scheduler, called MLLA (Modified Least Laxity Algorithm), which results in a schedule that satisfies the above condition for a class of task sets. We prove that a task set, for which the schedule obtained using MLLA does not satisfy the proposed necessary and sufficient condition, cannot be scheduled on-line.

The modified least laxity algorithm was implemented and tested on a large collection of randomly generated task sets. We generate a set of feasible tasks to be scheduled on  $m$  (typically 3 or 4) processors. From the simulation results we conclude that the schedule obtained by MLLA is better compared to other known algorithms.

# Contents

|          |                                                               |           |
|----------|---------------------------------------------------------------|-----------|
| <b>1</b> | <b>Introduction</b>                                           | <b>1</b>  |
| 1.1      | Real-time systems . . . . .                                   | 1         |
| 1.1.1    | Characteristics of Real-time tasks . . . . .                  | 2         |
| 1.1.2    | Uniprocessor vs. Multiprocessor real-time systems . . . . .   | 2         |
| 1.2      | Preemptive Scheduling . . . . .                               | 3         |
| 1.3      | On-line Scheduling . . . . .                                  | 3         |
| 1.4      | Time Driven Scheduling . . . . .                              | 3         |
| 1.5      | On-line scheduling algorithms - Uniprocessor case . . . . .   | 4         |
| 1.6      | On-line scheduling algorithms - Multiprocessor case . . . . . | 5         |
| 1.7      | Our Model Of Real-Time System . . . . .                       | 6         |
| 1.8      | Motivation . . . . .                                          | 6         |
| 1.9      | Outline of the thesis . . . . .                               | 7         |
| <b>2</b> | <b>On-line Scheduling</b>                                     | <b>8</b>  |
| 2.1      | Time representation . . . . .                                 | 8         |
| 2.2      | Representation of a Schedule . . . . .                        | 8         |
| 2.3      | Problem formulation . . . . .                                 | 9         |
| 2.4      | Summary . . . . .                                             | 13        |
| <b>3</b> | <b>Feasibility Conditions</b>                                 | <b>14</b> |
| 3.1      | Feasibility condition for a task set . . . . .                | 14        |
| 3.1.1    | Definitions . . . . .                                         | 15        |
| 3.2      | Feasibility condition for two task sets . . . . .             | 16        |

|          |                                                  |           |
|----------|--------------------------------------------------|-----------|
| 3.2.1    | Definitions . . . . .                            | 17        |
| 3.3      | Summary . . . . .                                | 20        |
| <b>4</b> | <b>Sub-schedules and their reducibility</b>      | <b>21</b> |
| 4.1      | Definition of a sub-schedule . . . . .           | 21        |
| 4.2      | Algorithm to extract the sub-schedules . . . . . | 24        |
| 4.3      | Reducibility of a sub-schedule . . . . .         | 26        |
| 4.4      | Algorithm for evaluating reducibility . . . . .  | 28        |
| 4.5      | Summary . . . . .                                | 33        |
| <b>5</b> | <b>On-line Schedulability</b>                    | <b>34</b> |
| 5.1      | On-line schedulability condition . . . . .       | 34        |
| 5.2      | Necessary condition . . . . .                    | 35        |
| 5.3      | Sufficient condition . . . . .                   | 36        |
| 5.4      | Summary . . . . .                                | 39        |
| <b>6</b> | <b>Modified Least Laxity Algorithm</b>           | <b>40</b> |
| 6.1      | Least Laxity Algorithm . . . . .                 | 40        |
| 6.2      | Earliest Deadline Algorithm . . . . .            | 43        |
| 6.3      | Modified Least Laxity Algorithm . . . . .        | 43        |
| 6.3.1    | The Algorithm (MLLA) . . . . .                   | 45        |
| 6.4      | Importance of MLLA . . . . .                     | 46        |
| 6.5      | Simulation Results . . . . .                     | 50        |
| 6.6      | Summary . . . . .                                | 53        |
| <b>7</b> | <b>Conclusion and future work</b>                | <b>57</b> |
| <b>A</b> | <b>Proofs of the theorems</b>                    | <b>59</b> |