A Study on Practical Real-Time Task Scheduling

Aotong Yin (1010229)

School of Information Science,
Japan Advanced Institute of Science and Technology

August 9, 2012

Keywords: ITRON System, real-time task scheduling, RM, EDF, PES, TBS.

1 Introduction

In modern times, real-time systems, which focus on computing correctness both on the value and the responding time, are in a critical position in our society. In this case, task scheduling is extremely important for real-time systems. So in order to adapt and improve the real-time systems, various scheduling algorithms have been devised. However, these algorithms were either too theoretical to be used in actual system, or too heavy computing. In this research, our aim is to study typical scheduling algorithms on real-time operating systems, and try to reach a solution to improve the actual used real-time operating system, ITRON. And this solution had better consider all kinds of tasks, concern practical constraints, and be achieved by lightweight computation. We choose ITRON System as our research environment because ITRON System is in actual use, and the limitation of scheduling policy on ITRON System is right what we can try and replace by a new strategy or algorithm.

2 Related Algorithms

To realize real-time task scheduling, many typical and classical algorithms were devised. For example, Rate Monotonic[2] is specially for periodic task scheduling, focusing on periods of tasks; Earliest Deadline First[2] concerns absolute deadline of all tasks, considering both periodic tasks and aperiodic tasks; Priority Exchanged Server[3], which is one of the most complicated algorithms, leads a conception of capacity into computation to gain a good schedule bound of the periodic task set; Total Bandwidth Server[4], considerable but much simpler, does not introduce too heavy computation, taking both periodic and aperiodic, hard real-time and soft real-time tasks into account. The above four typical algorithms are what we used in this research. We analyzed their features and implemented them on ITRON System by replacing the old strategy, and also evaluated their performance.

3 Implementation

There are two significant problems when these four algorithms are implemented into real use, especially being realized on ITRON System. One is too theoretical that real task's execution would be exactly a multiple of a tick. But in actual situations, the execution time can be off a multiple of a tick, and even be shorter than a tick. In addition, in actual environment, tasks can be activated at any timing (not at a multiple of a tick). The other one is in the implementation process, the author needs to concern which scheduling strategy is considerable and at the same time which strategy introduces fewer overheads. For Rate Monotonic, task inserting operation should be modified to achieve the strategy. Earliest Deadline First uses the same method task inserting operation with Rate Monotonic but adds aperiodic tasks by invoking interruptions. Since Priority Exchange Server imports the capacity conception, a capacity management is created to control replenishing, consuming, and preserving the capacities. And at the same time, the scheduler of ITRON is changed to schedule the tasks according to the capacity information in the capacity management. For implementing Total Bandwidth Server, a virtual absolute deadline is as-

signed at every aperiodic task's invoking time, because TBS is based on EDF, and it schedules tasks according to their absolute deadline information.

By considering the practical environment, two improved ideas are raised and implemented in this research for PES and TBS. The overheads utility is taken into consideration then the deadline missing can be decreased after the modification.

4 Evaluation

Several task sets were chosen to experiment the performance of each algorithm. And some of their results were chosen to show the relative information of their schedulability and resposiveness. The results of the four typical existing algorithms show coincident effect as we imagine according to the theory. After we take the practical overheads into consideration, the result in TBS got a obvious improvement of the performance with smaller deadline missing number. In the future, we will choose more task sets as our experiment groups to prove the improvement more strongly.

5 Conclusion

In this research, we make four typical existing algorithms usable on ITRON System. After using the simulating, the performance of the four algorithms on ITRON System shows the coincident effects of their theories. Then two improved strategies of PES and TBS are raised and implemented on ITRON, too. By considering the practical systems' overheads, the raised strategies show better responsive performance with smaller deadline missing number. In the future, more experiment task sets will be tested to prove the improvement of the two algorithms on practical system.