High Performance Technique for Ultrareliable Execution of Tasks Under Both Hardware and Software Faults

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Abstract

Various studies have shown that both hardware and software are subject to failures. However, the majority of the existing works have dealt with the problem by considering that either software is fault-free but hardware is subject to failure, or hardware is fault-free but software is subject to failure. Thus, techniques for dealing with both software and hardware faults must be developed.

In this work, we propose an efficient integrated fault-tolerant approach for ultrareliable execution of tasks where both hardware and software failures, and on-line fault diagnosis are considered. The proposed approach called the Integrated Fault-Tolerant (IFT) approach. We also propose a scheduling algorithm called the Integrated Fault-Tolerant Scheduling (IFTS) algorithm based on the IFT technique.

1 Introduction

Various studies have shown that both hardware and software are subject to failures. However, the majority of the existing works have dealt with the problem by considering that either software is fault-free but hardware is subject to failure, for instance see [1]-[3], or hardware is fault-free but software is subject to failure, for instance see [4]-[6]. Thus, techniques for dealing with hardware and software faults must be developed.

1.1 Dynamic group maximum matching concept

In an earlier work [7] we have introduced the concept of the *dynamic group maximum matching* for grouping the system graph into groups of different sizes according to the tasks arriving at the system. We have also proposed the Dynamic Group Maximum Matching (DGMM) algorithm for finding the dynamic group maximum matching. In the following we discuss the work.

The maximum number of hardware faults that a system can tolerate with respect to a task T_i is defined as the task *hardware reliability degree* t_{hi}. As a task hardware reliability degree increases, more redundancy is used. In [8,9], the researchers assumed that all the tasks running in the system have equal hardware reliability degree t, and they partitioned the system into groups of size $(t+1)$.

The concept of *group maximum matching* has been introduced by Hosseini in [8], which is a generalization of the classical maximum matching concept. The concept of the classical matching problem is used to group nodes of a graph into 2-node disjoint groups. A generalization to the classical matching is to group the nodes into $(t+1)$-node disjoint groups. In classical maximum matching problem, 2-node nodes are grouped such that the number of groups is maximum. Similarly, the generalization maximum matching problem, nodes are grouped (each group is of size $(t+1)$) such that the

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