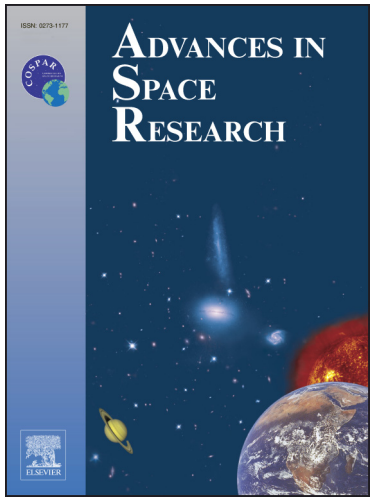

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Survey and Future Directions of Fault-Tolerant Distributed Computing on Board Spacecraft

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ABSTRACT

Current and future space missions demand highly reliable on-board computing systems, which are capable to carry out high-performance data processing. At present no single computing scheme could efficiently tackle high-performance computing as well as reliability. This paper aims to address that gap. In the first part of the paper, a detailed survey of fault-tolerant distributed computing systems for space applications is presented. Fault types and performance parameters for assessment of a fault-tolerant system are introduced. Redundancy schemes for distributed systems are analysed. A review of the state-of-the-art on fault-tolerant distributed systems is presented and limitations of current approaches are discussed. In the second part of the paper, a new fault-tolerant distributed computing platform with wireless links among the computing nodes is proposed. Novel algorithms, enabling important aspects of the architecture, such as time slot priority adaptive fault-tolerant channel access and fault-tolerant distributed computing using task migration are introduced.

KEYWORDS:

Fault-tolerance, Wireless, distributed computing, high-performance, adaptive algorithms, spacecraft.

1 INTRODUCTION

In general, a distributed computing system is any computing system that involves multiple processors, remotely located from each other, where each processor plays a particular role in the execution of a computation or control problem. This type of distributed computing is referred to as *physically distributed computing*. Nowadays physically distributed embedded systems are ubiquitous, having penetrated deeply into our society [1]. Main industry sectors using distributed emebbeded computing are telecommunications, automotive, avionics/aerospace, industrial automation, consumer electronics, health and medical systems. The overall value of the embedded computing market worldwide is about 1600 billion Euro per year [2], with distributed systems accounting for a dominant share of it. The widespread deployment of distributed embedded systems is due to their advantages, namely, high reliability, scalability, suitability for inherently distributed high-performance computing applications [3]. In mission critical applications, such as nuclear power stations or spacecraft systems, for which high reliability is extremely important, the use of distributed embedded computing is a key design consideration. This is mainly because in the event of a single processor failure, the collapse of the whole system could be prevented by distributing the computing load to the redundant processors [4] [5].