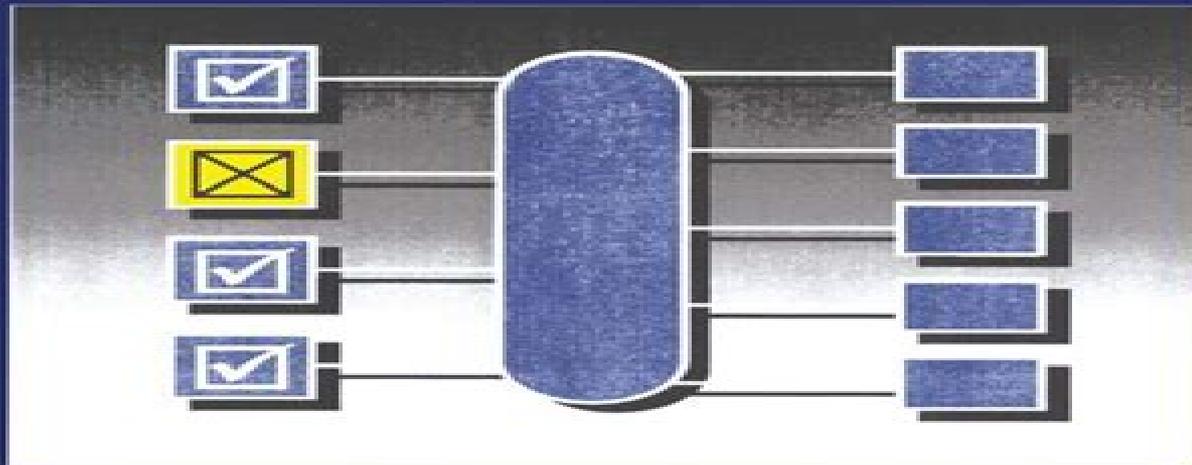


FAULT-TOLERANT PARALLEL COMPUTATION



Paris Christos Kanellakis
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Foreword by Franco P. Preparata

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Fault Tolerant Parallel Computation

Alexander Allister Shvartsman



Fault Tolerant Parallel Computation:

Fault-Tolerant Parallel Computation Paris Christos Kanellakis, Alex Allister Shvartsman, 2013-03-09 Fault Tolerant Parallel Computation presents recent advances in algorithmic ways of introducing fault tolerance in multiprocessors under the constraint of preserving efficiency The difficulty associated with combining fault tolerance and efficiency is that the two have conflicting means fault tolerance is achieved by introducing redundancy while efficiency is achieved by removing redundancy This monograph demonstrates how in certain models of parallel computation it is possible to combine efficiency and fault tolerance and shows how it is possible to develop efficient algorithms without concern for fault tolerance and then correctly and efficiently execute these algorithms on parallel machines whose processors are subject to arbitrary dynamic fail stop errors The efficient algorithmic approaches to multiprocessor fault tolerance presented in this monograph make a contribution towards bridging the gap between the abstract models of parallel computation and realizable parallel architectures Fault Tolerant Parallel Computation presents the state of the art in algorithmic approaches to fault tolerance in efficient parallel algorithms The monograph synthesizes work that was presented in recent symposia and published in refereed journals by the authors and other leading researchers This is the first text that takes the reader on the grand tour of this new field summarizing major results and identifying hard open problems This monograph will be of interest to academic and industrial researchers and graduate students working in the areas of fault tolerance algorithms and parallel computation and may also be used as a text in a graduate course on parallel algorithmic techniques and fault tolerance

Fault-Tolerant Parallel and Distributed Systems Dimitri R. Avresky, David R. Kaeli, 2012-12-06 The most important use of computing in the future will be in the context of the global digital convergence where everything becomes digital and every thing is inter networked The application will be dominated by storage search retrieval analysis exchange and updating of information in a wide variety of forms Heavy demands will be placed on systems by many simultaneous re quests And fundamentally all this shall be delivered at much higher levels of dependability integrity and security Increasingly large parallel computing systems and networks are providing unique challenges to industry and academia in dependable computing espe cially because of the higher failure rates intrinsic to these systems The chal lenge in the last part of this decade is to build a systems that is both inexpensive and highly available A machine cluster built of commodity hardware parts with each node run ning an OS instance and a set of applications extended to be fault resilient can satisfy the new stringent high availability requirements The focus of this book is to present recent techniques and methods for im plementing fault tolerant parallel and distributed computing systems Section I Fault Tolerant Protocols considers basic techniques for achieving fault tolerance in communication protocols for distributed systems including synchronous and asynchronous group communication static total causal order ing protocols and fail aware datagram service that supports communications by time

Hardware and Software Fault Tolerance in Parallel Computing Systems Dimitri Ranguelov Avresky, 1992 □□□□ □□□□

1960, [Fault-Tolerant Parallel Computer Systems for Teal-Time Applications](#), 1992 The objective of our research was to investigate techniques for designing fault tolerant parallel computer systems for critical real time applications The focus of our research was to develop the practical fault tolerance design implementation and analysis technology with the considerations of real time recovery structuring of recoverable interactions and handling of software as well as hardware failure in distributed parallel computing environments We also investigate techniques for scheduling of real time messages as well as real time tasks in fault tolerant distributed systems [Fault-tolerant and Efficient Parallel Computation](#) Alexander Allister Shvartsman,1992 **Simulation of Fault Tolerance in a Hypercube Arrangement of Discrete Processors** Gil Zilberstein,AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF ENGINEERING.,1987 The purpose of this study was to implement a technique for fault tolerant parallel computation on the Intel Corporation s Hypercube computer This work was motivated by the recent progress in parallel computation and neural network techniques This study focuses on the implementation of one particular type of parallel processing architecture on the Intel Hypercube The architecture in question is known as the cube connected cycle CCC This architecture is used as a basis for a reconfiguration scheme known as reconfigurable cube connected cycles The aim of this reconfiguration is to build a parallel computing system with fault tolerance capability Implementation of this technique on the Intel Hypercube was by simulation The loading of only part of the hypercube available nodes holding the remaining nodes in reserve was accomplished followed by a simulation of the replacement of a deactivated node with a spare node Conclusions are reached regarding the suitability of the Intel machine for fault tolerance experiments versus the rapid computation for which it was designed Recommendations are made regarding the next logical steps in continuation of the work presented in this study **Digest of Papers** ,1992 [Fault-tolerant and Efficient Parallel Computation](#) Alexander Allister Shvartsman,1992 [Fault-Tolerance Techniques for High-Performance Computing](#) Thomas Herault,Yves Robert,2015-07-01 This timely text presents a comprehensive overview of fault tolerance techniques for high performance computing HPC The text opens with a detailed introduction to the concepts of checkpoint protocols and scheduling algorithms prediction replication silent error detection and correction together with some application specific techniques such as ABFT Emphasis is placed on analytical performance models This is then followed by a review of general purpose techniques including several checkpoint and rollback recovery protocols Relevant execution scenarios are also evaluated and compared through quantitative models Features provides a survey of resilience methods and performance models examines the various sources for errors and faults in large scale systems reviews the spectrum of techniques that can be applied to design a fault tolerant MPI investigates different approaches to replication discusses the challenge of energy consumption of fault tolerance methods in extreme scale systems [Fault-tolerant Parallel Computing on Networks of Non-dedicated Workstations](#) Peter Wyckoff,1998 **Parallel and Distributed Processing** Jose Rolim,1998-03-18 This book constitutes the refereed proceedings of 10

international workshops held in conjunction with the merged 1998 IPPS SPDP symposia held in Orlando Florida US in March April 1998 The volume comprises 118 revised full papers presenting cutting edge research or work in progress In accordance with the workshops covered the papers are organized in topical sections on reconfigurable architectures run time systems for parallel programming biologically inspired solutions to parallel processing problems randomized parallel computing solving combinatorial optimization problems in parallel PC based networks of workstations fault tolerant parallel and distributed systems formal methods for parallel programming embedded HPC systems and applications and parallel and distributed real time systems

Fault-tolerant Parallel Computing Using Shuffle Exchange Hypercube and Cube-connected Cubes Praduemn K. Goyal,1998

Information Dispersal and Parallel Computation Yuh-Dauh Lyuu,2004-07-05 In 1989 Michael Rabin proposed a fundamentally new approach to the problems of fault tolerant routing and memory management in parallel computation based on the idea of information dispersal Yuh Dauh Lyuu developed this idea in a number of new and exciting ways in his PhD thesis Further work has led to extensions of these methods to other applications such as shared memory emulations This volume presents an extended and updated printing of Lyuu s thesis It gives a detailed treatment of the information dispersal approach to the problems of fault tolerance and distributed representations of information which have resisted rigorous analysis by previous methods

Supporting Fault-tolerant Parallel Programming in Linda University of Arizona. Department of Computer Science,David Edward Bakken,R. D. Schlichting,1993 Abstract Linda is a language for programming parallel applications whose most notable feature is a distributed shared memory called tuple space While suitable for a wide variety of programs one shortcoming of the language as commonly defined and implemented is a lack of support for writing programs that can tolerate failures in the underlying computing platform This paper describes FT Linda a version of Linda that addresses this problem by providing two major enhancements that facilitate the writing of fault tolerant applications stable tuple spaces and atomic execution of tuple space operations

Fault Tolerant Parallel Computing in Orthogonal Shared-Memory and Related Architectures ,1992 The aim of the research summarized in this final report was to investigate a class of orthogonal shared memory architectures and interconnection networks and to obtain generalized methods for implementing algorithm based fault tolerance ABFT on multiprocessor architectures We proposed a theory based on orthogonal graphs to represent many well known interconnection networks such as the binary m cube spanning bus meshes multistage interconnection networks etc A previously proposed multiprocessor architecture called the Orthogonal Multiprocessor OMP is also a special case of this method The simplicity of the graph construction rules permits us to characterize and understand the differences and similarities among networks like the SW banyan the baseline network among others This opens the way for discovering new structures by studying different possible combinations of the parameters which define orthogonal graphs

FT-PAS-A Framework for Pattern Specific Fault-tolerance in Parallel Programming Gopinatha Jakadeesan,2009 Fault tolerance is an important requirement for long running parallel applications

Many approaches are discussed in various literatures about providing fault tolerance for parallel systems. Most of them exhibit one or more of these shortcomings in delivering fault tolerance: non-specific solution, i.e. the fault tolerance solution is general, no separation of concern, i.e. the application developer's involvement in implementing the fault tolerance is significant and limited to inbuilt fault tolerance solution. In this thesis, we propose a different approach to deliver fault tolerance to the parallel programs using a priori knowledge about their patterns. Our approach is based on the observation that different patterns require different fault tolerance techniques, specificity. Consequently, we have contributed by classifying patterns into sub-patterns based on fault tolerance strategies. Moreover, the core functionalities of these fault tolerance strategies can be abstracted and pre-implemented generically, independent of a specific application. Thus, the pre-packaged solution separates their implementation details from the application developer, separation of concern. One such fault tolerance model is designed and implemented here to demonstrate our idea: The Fault Tolerant Parallel Architectural Skeleton (FT-PAS) model implements various fault tolerance protocols targeted for a collection of frequently used patterns in parallel programming. Fault tolerance protocol extension is another important contribution of this research. The FT-PAS model provides a set of basic building blocks as part of protocol extension in order to build new fault tolerance protocols as needed for available patterns. Finally, the usages of the model from the perspective of two user categories, i.e. an application developer and a protocol designer, are illustrated through examples.

Scheduling Fault-tolerant, Parallel Computations in a Distributed Environment Don McLaughlin, 1997

Fault-Tolerant Parallel Algorithms for Adaptive Matched-Field Processing on Distributed Array Systems, 2004

Continuous innovations in adaptive matched field processing (MFP) algorithms have presented significant increases in computational complexity and resource requirements that make development and use of advanced parallel processing techniques imperative. In real-time sonar systems operating in severe underwater environments, there is a high likelihood of some part of systems exhibiting defective behavior, resulting in loss of critical network processor and sensor elements and degradation in beam power pattern. Such real-time sonar systems require high reliability to overcome these challenging problems. In this paper, efficient fault-tolerant parallel algorithms based on coarse-grained domain decomposition methods are developed in order to meet real-time and reliability requirements on distributed array systems in the presence of processor and sensor element failures. The performance of the fault-tolerant parallel algorithms is experimentally analyzed in terms of beamforming performance, computation time, speedup, and parallel efficiency on a distributed testbed. The performance results demonstrate that these fault-tolerant parallel algorithms can provide real-time, scalable, lightweight, and fault-tolerant implementations for adaptive MFP algorithms on distributed array systems.

Distributed Computing for Signal Processing: Modeling of Asynchronous Parallel Computation.

Appendix C. Fault Tolerant Interconnection Networks and Image Processing Applications for the PASM Parallel Processing Systems George B. Adams (III.), PURDUE UNIV LAFAYETTE IN., 1984

The demand for very high speed data

processing coupled with falling hardware costs has made large scale parallel and distributed computer systems both desirable and feasible Two modes of parallel processing are single instruction stream multiple data stream SIMD and multiple instruction stream multiple data stream MIMD PASM a partitionable SIMD MIMD system is a reconfigurable multimicroprocessor system being designed for image processing and pattern recognition An important component of these systems is the interconnection network the mechanism for communication among the computation nodes and memories Assuring high reliability for such complex systems is a significant task Thus a crucial practical aspect of an interconnection network is fault tolerance In answer to this need the Extra Stage Cube ESC a fault tolerant multistage cube type interconnection network is defined The fault tolerance of the ESC is explored for both single and multiple faults routing tags are defined and consideration is given to permuting data and partitioning the ESC in the presence of faults The ESC is compared with other fault tolerant multistage networks Finally reliability of the ESC and an enhanced version of it are investigated Keywords Theses

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