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Editorial

While large-scale parallel computing is fast becoming a viable and cost-effective means of realizing outstanding performance, a number of challenges need to be overcome first. Notably, as the size and scale of the parallel machines grow rapidly, it becomes increasingly hard and expensive to assure high levels of reliability or predictable timely behavior at all levels, all the time. For example, it is entirely likely that a few of the processors or memory units either become slow, or completely faulty. Using the remaining resources redundantly to perform the same task – this is the traditional approach to realizing "dependability" – is counter to the spirit and goals of parallel computing, wherein these resources are used to perform different tasks to achieve very high performance.

Therefore, realizing dependability while harnessing the promise of large-scale parallel computing poses several new challenges to researchers in computer science. Recently, these questions have attracted increasing attention and a number of breakthroughs have been achieved. We, the editors, are pleased to be able to include ten outstanding papers that address the challenges arising out of making large-scale parallel computing dependable.

The first group of papers provide algorithmic solutions to cope with the difficulties that arise out of making parallel computing systems dependable – the challenges include faults, asynchrony as well as other timing aberrations that arise at run-time. These phenomena violate the expectations of the programmer or system designer. Aumann and Rabin's paper provides an extremely elegant and novel design of a clock that maintains itself and advances correctly and very efficiently in a fully asynchronous setting, by harnessing the power of randomization. They also describe important applications of this clock. Leighton provides a thorough and insightful overview of the work done on coping with the challenge of routing, in interconnection networks, including those which are fault-prone. This paper also discusses results that depend on the power of randomization and complements the Aumann and Rabin

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paper by addressing "hardware" driven concerns; whereas the Leighton paper is more inclined towards the "software" end of the issue of dependability. Garofalakis, Rajsbaum, Spirakis and Tampakas present an extremely efficient way of coping with faults while achieving synchronization in a network, by combining optimistic schemes that are error-prone – albeit with low probability. They checkpoint periodically and roll-back (infrequently) whenever a past error is detected. Koren and Shasha address the fundamental issue of dependability with the context of real-time constraints. They provide on-line algorithms that perform very well for efficiently scheduling tasks in multiprocessors. In their short paper, Bruck, Cypher and Ho present a novel scheme for tolerating faults in multiprocessors with a mesh as the interconnection structure.

The second group of papers provide specification and verification approaches to transform a distributed program into a fault-tolerant program, verify the correctness of the program, and develop semantic for replication. Peled and Joseph present an elegant framework for reasoning about distributed fault-tolerant program. The basic program is transformed into one where recovery algorithms can be specified and the transformations can be verified. Schepers and Hooman's paper addresses the specification and verification of safety properties for fault-tolerant distributed systems. The method is compositional and allows reasoning with specification processes while ignoring their implementations. Krishnan uses process algebraic approach to the semantics of replicated systems. Replication has a major impact on the behavior of the system and the paper presents a hierarchy of faulty processes and fault-tolerant processes.

The third group of papers present stochastic models to study dependable parallel systems. Models with dynamic recovery and optimization goals are very hard to evaluate. De Meer, Trivedi and Dal Cin introduce Extended Markov Reward Models to represent dynamic control of repair decisions. They also provide numerical computation technique to evaluate time-dependent optimal strategies. Pai, Schäffer and Varman provide performance models to study prefetching strategies to maximize I/O performance. Their model yields nonintuitive and potentially very useful results.

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Guest Editors