Balman, Mehmet, M.S. (2006), B.S. (2000), Bogazici University
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ABSTRACT

Over the years, scientific applications have become more complex and more data intensive. Especially large scale simulations and scientific experiments in areas such as physics, biology, astronomy and earth sciences demand highly distributed resources to satisfy excessive computational requirements. Increasing data requirements and the distributed nature of the resources made I/O the major bottleneck for end-to-end application performance. Existing systems fail to address issues such as reliability, scalability, and efficiency in dealing with wide area data access, retrieval and processing. In this study, we explore data-intensive distributed computing and study challenges in data placement in distributed environments. After analyzing different application scenarios, we develop new data scheduling methodologies and the key attributes for reliability, adaptability and performance optimization of distributed data placement tasks. Inspired by techniques used in microprocessor and operating system architectures, we extend and adapt some of the known low-level data handling and optimization techniques to distributed computing. Two major contributions of this work include (i) a failure-aware data placement paradigm for increased fault-tolerance, and (ii) adaptive scheduling of data placement tasks for improved end-to-end performance. The failure-aware data placement includes early error detection, error classification, and use of this information in scheduling decisions for the prevention of and recovery from possible future errors. The adaptive scheduling approach includes dynamically tuning data transfer parameters over wide area networks for efficient utilization of available network capacity and optimized end-to-end data transfer performance.