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**ENERGY AND MAKESPAN TRADEOFFS IN HETEROGENEOUS COMPUTING SYSTEMS USING EFFICIENT LINEAR PROGRAMMING TECHNIQUES**

**ABSTRACT**

Resource management for large-scale high performance computing systems pose difficult challenges to system administrators. The extreme scale of these modern systems require task scheduling algorithms that are capable of handling at least millions of tasks and thousands of machines. These large computing systems consume vast amounts of electricity leading to high operating costs. System administrators try to simultaneously reduce operating costs and offer state-of-the-art performance; however, these are often conflicting objectives. Highly scalable algorithms are necessary to schedule tasks efficiently and to help system administrators gain insight into energy/performance trade-offs of the system. System administrators can examine this trade-off space to quantify how much a difference in the performance level will cost in electricity, or analyze how much performance can be expected within an energy budget. In this study, we design a novel linear programming based resource allocation algorithm for a heterogeneous computing system to efficiently compute high quality solutions for simultaneously minimizing energy and makespan. These solutions are used to bound the Pareto front to easily trade-off energy and performance. The new algorithms are highly scalable in both solution quality and computation time compared to existing algorithms, especially as the problem size increases.