Preface

In the summer of 2007 we discovered, very much by accident, that the hardware on Red Storm might contain the instrumentation necessary to monitor both the current draw and voltage of board level components. Red Storm, the first instance of the Cray XT architecture line, was the result of a collaboration between Sandia National Laboratories and Cray Inc. Due to this collaboration, a few Sandia engineers had wide access to test both hardware and source code. The light-weight kernel operating system (Catamount) used in the experiments detailed in this book was in fact created by some of the authors of this book. Our virtually un-fettered access to the necessary hardware and software enabled the experiments you will find detailed herein.

Our research was directed toward increasing energy efficiency of large-scale High Performance Computing (HPC) platforms. While HPC, historically, has been a performance-driven sector of computing, it has been recognized that the *performance above all* trend cannot continue. A great deal of research has been conducted in related areas at a number of universities. While important and insightful, prior work did not focus on real scientific applications run at large-scale on production HPC platforms. Using the tools, hardware and software, made available by our collaboration we focused on conducting empirical studies that had high potential impact on energy efficiency. Our experiments included: evaluating power savings opportunities during idle periods, determining the impact of operating system noise on power usage and analyzing the trade-off between energy and performance while tuning the CPU frequency and network bandwidth. All experiments were conducted at large-scale using the fine-grained high-frequency in situ measurement capability developed specifically for this purpose.

While the material contained in this book is focused on large-scale HPC, a broader audience interested in power and energy efficiency in general might find utility in the information presented. What the reader will find amounts to a journal of major phases of our work in this area, each building on the success and lessons learned from previous experiments. Readers unfamiliar with this field of study in general will benefit from the introductory chapters and background presented in

Chaps. 1 through 4, while the more acquainted may want to go directly to the coverage of our experiments in Chaps. 5 through 7.

I have had the pleasure of working with most of the authors of this book for quite some time on a number of challenging projects and I remain humbled to be associated with each of them. Their contributions were essential to this research in a range of ways too extensive to list.

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Measurement and Tuning

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