Advanced Software Technologies for Post-Peta Scale Computing

Mitsuhisa Sato
Editor

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The Japanese Post-Peta CREST Research Project

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Preface

Computational Science, which enables us to explore uncharted fields of science through applications of high performance computing, is a third paradigm of scientific research which has become indispensable for the development of science and technology of the twenty-first century.

Computational Science has been making great progress rapidly. The computational capability of supercomputers is now reaching on the verge of surpassing a Peta-flops (10^{15} floating operations per second). This advance allows us in making it possible to explore a wide range of phenomena through computer simulations which was impossible in the past, for example, the creation and evolution of the universe, the quantum origin of the functions of nano- and biomaterials and its implication to life, and global climate changes. At the same time, the development of intelligent information processing technologies is beginning to enable a handling and analysis of enormous amount of data, which are accelerating discoveries in many science disciplines, such as genome analyses, high energy accelerator experiments, astronomical observations, and satellite observation of geo-environments. In short, computational science is rapidly developing into a unified framework in which large-scale modeling and simulation, large-scale data analysis, and experiments/observation are integrated together to solve grand challenge issues in various branches of science. As such, computational science has now become an indispensable tool to better understand nature, life, and environment in order to create a better future for mankind.

In Japan, the importance of computational sciences was explicitly noted in the Japanese Government's Third Basic Plan of Science and Technology (2006–2010), and a national project for the development of "Next Generation Supercomputer" has been carried out from 2006 as one of the key technologies of national importance. The K computer has been produced as a major result of the project, achieving world's best performance in TOP500 list in 2011. Currently, the FLAGSHIP 2020 project for the development of the next Japanese flagship supercomputer has been launched in 2014, and the development is under way. The operation for the public service will be scheduled around 2020.

In 2010, the Japan Science and Technology Agency (JST) has initiated a research area, titled "Development of System Software Technologies for Post-Peta Scale High Performance Computing," as a part of its Strategic Basic Research Program (CREST). The project was named "JST CREST Post-Petascale software project." The research area of the project aimed at developing system software technologies as well as related systems to be used for high performance computing systems including the next generations of the Japanese flagship system, the K computer, which is under development. Several researches and developments were conducted for system software enabling us to exploit maximum efficiency and performance from supercomputers composed of general purpose many-core processors as well as accelerators such as GPUs and FPGA. From 2010 to 2012, 14 research teams were selected, and 5-year research has been being conducted by each research team. Many Japanese researchers and graduate students related to HPC have been participating in these research teams.

This book describes the major outcomes obtained by research teams of the JST CREST post-petascale software project.

Advanced system software is the key technology for post-petascale and exascale high performance computing systems which will be developed in next decade. I hope that the technologies developed in the JST CREST post-petascale software project will play a role bridging to exascale computing and beyond through system software technologies and advance the future computational science.

Kobe, Japan Mitsuhisa Sato
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