Moving a Science Workload to Exascale Computing

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With petascale systems becoming broadly available in high end computing, attention is now focused on the challenges associated with the next major performance milestone: exascale computing. Demand for computational capability grows unabated, with areas of national and commercial interest including global climate change, alternative energy sources, defense and medicine, as well as basic science. Past growth in the high end has relied on a combination of faster clock speeds and larger systems, but the clock speed benefits of Moore's Law have ended, and 200-cabinet petascale machines are near a practical limit. Future system designs will instead be constrained by power density and total system power demand, resulting in radically different architectures. The challenges associated with exascale computing will require broad research activities across computer science, including the development of new algorithms, programming models, system software and computer architecture.

In future computing systems, performance and energy optimization will be the combined responsibility of hardware and software developers. Since data movement dominates energy use in a computing system, minimizing the movement of data throughout the memory and communication fabric are essential. These challenges exist for scientific computing across scales, as represented by the hundreds of projects and applications that run at the National Energy Research Scientific Computing Center (NERSC). This workload includes data-intensive, compute-intensive, and throughput-limited scientific problems. NERSC's challenge is to move thousands of users across a broad scientific workload to next energy-efficient architectures. In this talk I will describe some of the open problems in programming models and algorithms design and promising approaches used so far, and NERSC's strategy for taking advantage of this work. Overall, the trends in hardware demand that the community develop a deeper understanding of the current and projected workloads, and undertake a broad set of research activities to sustain the growth in computing performance.

Biography: Kathy Yelick is the Associate Laboratory Director for Computing Sciences at Lawrence Berkeley National Laboratory. She is also a Professor of Electrical Engineering and Computer Sciences at the University of California at Berkeley and former Director of the National Energy Research Scientific Computing Center (NERSC). She co-invented the UPC and Titanium languages as well as techniques for self-tuning sparse matrix kernels, and has published over 100 technical papers. She earned her Ph.D. in EECS from MIT and has been a professor at UC Berkeley since 1991 with a joint appointment at LBNL since 1996. She has received multiple research and teaching awards and is a member of the California Council on Science and Technology and the National Academies Computer Science and Telecommunications Board.