

# Sustained Petaflop and Beyond: Can Parallel Computing Systems Meet The Challenges?

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**Abstract:** Breakthrough-quality scientific discoveries in the new millennium (such as those expected in computation biology and others), along with optimal engineering designs, have created a demand for *High-End Computing* (HEC) systems with sustained performance requirements at a petaflop scale and beyond. Despite the very pessimistic (if not negative) views on parallel computing systems that have prevailed in 1990s, there seems to be no other viable alternatives for such HEC systems. In this talk, we present a fresh look at the problems facing the design of petascale parallel computing systems. We review several fundamental issues that such HEC parallel computing systems must resolve. These issues include: execution models that support dynamic and adaptive multithreading, fine-grain synchronization, and global name-space and memory consistency. Related issues in parallel programming, dynamic compilation models, and system software design will also be discussed. Present solutions and future direction will be discussed based on (1) application demand (e.g. computation biology and others), (2) the recent trend as demonstrated by the HTMT, HPCS, and the Blue-Genes Cyclops (e.g. Cyclops-64) architectures, and (3) a historical perspective on influential models such as dataflow, along with concepts learned from these models.

**Biographical Sketch:** Professor Gao's main research interests include high-performance architectures and systems, their programming models, system software (particularly compilers), and applications such as computational biology and bioinformatics. He has devoted most of his time in searching for a scalable parallel program execution/architecture model that can serve as a basis for high-end parallel supercomputers. To this end, Professor Gao has many research publications in these fields. He is an active participant in professional activities. Dr. Guang R. Gao received his Ph.D. degrees in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology. Currently, he is a Professor in the Department of Electrical and Computer Engineering at University of Delaware, where he has been the founder and director of the Computer Architecture and Parallel Systems Lab, and the Director of the Bioinformatics Center at Delaware Biotechnology Institute (2001-2004). Prior to the above, he has been a faculty member of the School of Computer Science at McGill University, Montreal, Canada. Born in Beijing, Gao is among the first wave of graduate students from People's Republic of China to attend graduate school in the U.S. in the early 1980s. In fact, he is the first student from PRC to receive a MS and Ph.D. degree in Computer Science from MIT.