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Advanced Scientific Computing - Current Status and Future Trends

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Abstract

Dramatic advances in computer and communications technologies in the past decade have set the stage for a major advancement in computational modeling and simulation. Computing speeds and capacities have been growing exponentially for more than two decades. In 1990, the computers available for scientific computing were capable of a few billion arithmetic operations per second (gigaops). In 2000, computer systems capable of a hundred gigaops or more are widely available. Within the next five years, aggressive exploitation of parallelism—in both computer processors and systems—will lead to computers able of performing more than 100 trillion arithmetic operations per second (teraops). With a 1000-fold increase in computing capability, it will be feasible to predict the behavior of a broad range of complex natural and engineered systems from a knowledge of the underlying physical, chemical, and biological processes. This will not only be an exciting technical achievement, it will also create extraordinary advances in fields from biology to physics and have an enormous impact on the ability of government agencies and industry to solve their most demanding, mission-critical problems.

It is insightful to track the performance of supercomputers of the last decade. The performance of the top 500 supercomputers in the world over the last seven years is given at http://www.top500.org. The plots show an exponential increase in the peak performance (as measured by linpack benchmarks) of the most powerful computer, the 500th most powerful computer, and the cumulative power of the top 500 computers as a function of time. Extrapolating the results, the plots show that we will have a Petaflop of computing capability by Year 2009. The presentation will review the current status and future trends in advanced scientific computing, including ORNL's experience with current generation Terascale computers and their application to grand challenge problems in materials, climate change, and genomics.

Keywords: Computer Processors, Grand Challenge, Petaflop, Scientific Computing, Supercomputers, Teraops

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