Trends in High Performance Computing and Grids

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Abstract: In my talk, I will cover the technical trends in High Performance Computing (HPC) and Grid computing. Since the beginning of digital electronic computers, the computational power has increased by 10**10 in over 50 years. This trend is due to both improvement of the circuits and devices (faster clock), and the cleverness in the system design (i.e., incorporating parallelism in the hardware structure). Especially the parallelism has become essential since the late 70's, when the pace of the computational demands from application users have exceeded that of the hardware speed (clock speed) of a single processor system alone. The parallelism can be seen at different levels of computer system architecture, from inside CPU (e.g., superscalar vs vector) to the total system (SIMD, MIMD and the like). Nowadays we talk about teraflops (10**12 floating point operations per second) of computer power and beyond, with thousands or ten of thousands of CPUs in one system. Also important is the size of memory and how it can be accessed from application programs. There are shared memory systems (e.g., Symmetric Multi-Processor), distributed memory systems (e.g., PC Clusters, MPPs) and the hybrid of the above in a hierarchical fashion (e.g., constellations). There are continuing efforts to develop even higher performance computer systems toward petaflops(10**15). It should be noted that the programming models and methodology are getting more complex as the computer system takes more complex forms.

Another important technology, the grid computing technology, is intended to allow the uniform and transparent access as well as sharing, to the geographically dispersed computational resources, such as computers, databases, experimental and observational equipment etc. via high-speed, high-bandwidth networking. The commonly used analogy is the electrical power grid, where the household electricity is made available from the outlet on the wall, without worrying about where the electricity was generated and how it is transmitted. The usage of grid also includes distributed parallel computing, high throughput computing, data intensive computing (data grid) and collaborative computing. It should be emphasized that HPC platforms and grid computing are not competing technologies, but rather complementary to each other, in order to provide more powerful and user-friendly computational environment to research communities.