

LARGE SCALE PROBLEM SOLVING USING AUTOMATIC CODE GENERATION AND DISTRIBUTED VISUALIZATION

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SCALABILITY CHALLENGES

Programming Productivity

The programming productivity has long been a concern in the computational science community. In addition to possible human errors, the limit for code writing and the ever-growing complexity of many scientific codes make the development and maintenance of many large scale scientific applications an intimidating task. In addressing these issues, we present our latest work on generic methods for generating code that solves a set of coupled nonlinear partial differential equations using the **Kranc** code generation package. Our work greatly benefits from the modular design of the **Cactus** framework.

Scalability to Large Number of Processors

The ever growing complexity in developing highly scalable and efficient parallel scientific applications always leaves a gap for many application developers to cross. We need a bridge, a computational infrastructure, which can not only hide the hardware complexity, but also provide a user friendly interface for scientific application developers to speed up scientific discoveries. We present a highly efficient computational infrastructure that is based on the **Cactus** framework and the **Carpet** adaptive mesh refinement library.

I/O Bandwidth

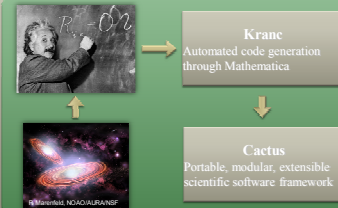
We are faced with difficult challenges in moving data when dealing with large datasets, challenges that arise from I/O architecture, network protocols and hardware resources. I/O architectures that do not use a non-blocking approach are fundamentally limiting the I/O performance. Standard network protocols such as TCP cannot utilize the bandwidth available in emerging optical networks and cannot be used efficiently on wide-area networks. Single disks, or workstations are not able to saturate high-capacity network links. We build a system that combines an efficient pipeline-based architecture, can take advantage of non-standard high-speed data transport protocols such as UDT and use distributed grid resources to increase the I/O throughput.

Interactive Visualization of Large Data

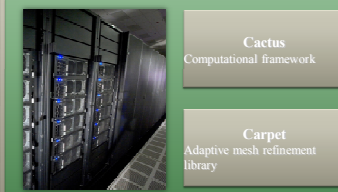
Bringing efficient visualization and data analysis power to the end users' desktop while visualizing large data and maintain interactivity, by as having the ability to control and steer the visualization by the user is a major challenge for visualization applications today. We are looking at the case where sufficiently powerful visualization resources are not available at either the location where the data was generated or at the location where the user is located, and we use visualization clusters in the network to interactively visualize large amounts of data.

SPECIFIC APPLICATION GRAVITATIONAL WAVE MODELING

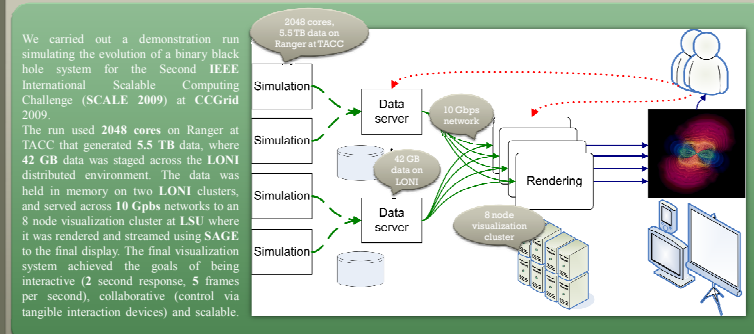
Programming productivity Translating complex science into code



Scalability to large number of processors Efficient utilization of high-concurrency machines



I/O Bandwidth and interactive visualization Moving and analyzing large datasets



Weak scaling benchmark results on different supercomputer systems and volume rendering of gravitational waves

