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Graph Computations Made Easier!

Several universities across the United States have come together to develop a new environment for graph-based applications, solving a critical need for researchers in science, engineering, and informatics.

Led by Indiana University, the "PXGL: Cyberinfrastructure for Scalable Graph Execution" project will include a parallel programming model for graph computations, a corresponding execution platform, a graph-optimized soft-core architecture, and a graph library. Louisiana State University is among the collaborators for the project, led by Hartmut Kaiser, team lead of the Center for Computation & Technology's (CCT) STE||AR group. Others include members from New Mexico State University and Sandia National Laboratories.

The importance, applications, and scale of data-centric computing have grown dramatically. The computational resource requirements for graph-based computations for large-scale applications are just as vast as for traditional compute-intensive science, thus there is a pressing need to expand the scope of high-performance computing to include graph-based computations. Problems plague graphic computations, however, because they are often completely data driven, have poor locality, and result in fine-grained data accesses, or a high ratio of data accesses to computation.

PXGL (ParalleX Graphic Library) is an integrated hardware and software framework for solving large-scale graph problems, enabling and facilitating efficient execution of dynamic graph applications on current terascale and petascale systems, as well as future exascale systems. PXGL will enable and fundamentally improve scalability and user productivity for graph-based applications.

In addition, the project will create an experimental processor core called ELVIS (Edge-Linked Vertices Information System) to provide a new compute model for solving graph problems. ELVIS will serve as a vehicle to test the hypothesized requirements of a computer system to efficiently perform graph computation. The teams hope the combination of a non-coherent global address space, multithreading, fine-grained synchronization, and lightweight active messages will lead to the creation of substantially simpler processor architectures capable of supporting graph-based information processing. ELVIS is a unique opportunity to rethink computing as the traditional building-blocks for computer architectures—heavyweight threads, cache coherency, and hardware speculation—are unsuited to graph-based analysis.

The four institutions the PXGL project brings together all have significant experience in particular areas related to large-scale graph processing, and together provide the unique set of capabilities necessary to successfully develop the entire hardware and software system. Development of the parallel graph components of this work will be primarily conducted by the Indiana University team. LSU will be in charge primarily of the HPX runtime development. New Mexico State University and Sandia National Laboratory will be the co-architects of the processor and memory hardware systems. The teams will work closely together to integrate their effort into PXGL and to collaborate with application developers

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Center for Computation & Technology
2003 Digital Media Center • Telephone: +1 225/578-5890 • Fax: +1 225/578-8957