HPX Applications and Performance Adaptation

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The HPX runtime system is a critical component of the DOE XPress (eXtreme Programming and Environment System Software) project and other projects world-wide. We are exploring a set of innovations in execution models, programming models and methods, runtime and operating system software, adaptive scheduling and resource management algorithms, and instrumentation techniques to achieve unprecedented efficiency, scalability, and programmability in the context of billion-way parallelism. A number of applications have been implemented to drive system development and quantitative evaluation of the HPX system implementation details and operational efficiencies and scalabilities.

Applications and Characteristic Behavior

- **LULESH**: Exercises (structured Lagrangian Exotic Weak Hydrodynamics) for mesh refinement up to 3D.
- **MiniGhost**: A mini-app for exploring boundary exchange strategies using mesh communication in scientific parallel computing. Implemented decoupling the spatial domain, reducing a “data exchange” of points across boundary cells.
- **N-Body**: An event-driven custom QCD evolution model using the Boost-Knowledge Computing Framework and the Boost-Adaptive Scheduling and Operating System Software. Adapts to new scheduling and operating system software, and improves scalability and programmability in the context of billion-way parallelism.
- **PIC**: An event-driven custom QCD evolution model using the Boost-Knowledge Computing Framework and the Boost-Adaptive Scheduling and Operating System Software. Adapts to new scheduling and operating system software, and improves scalability and programmability in the context of billion-way parallelism.
- **mimTri**: Uses optimized triangular kernel execution to exploit data and thread jealous, metricizes the computation requirements of an important set of data streams. Requires high memory and thread-parallel implementation of metrics to be significantly more memory efficient, allowing us to consider much larger graphs.
- **CMA**: Uses mini-apps for details on deep Dive to right.
- **Kernels**: Various computational kernels, such as matrix transpose and fast multipole algorithms, which are used to explore features of HPX and compare to other approaches.

Results Showing Benefits of HPX

- **GTGX Communication Reduction**
- **LULESH Weak Scaling**
- **LULESH (Deep Dive)**
- **CMA (Deep Dive)**

Performance Adaptation, Legacy Applications, and Summary

APLEX : Performance Adaptation

HPX runtime implementation is integrated with APLEX (Autonomic Performance Adaptation Environment), a feedback-driven library for performance measurement and runtime adaptation. APLEX auto-tunes the application, optimizes error exposure of the application, and maintains the APLEX state, while the Policy Engine optimizes policy rules to adapt, automate or otherwise modify application behavior. Within a mode, performance achieved is OpenMP programs using OSMX is comparable to using the Intel OpenMP Runtime. For example, below we show speedups for a licensing, US, climate-driven, and a hypothetical application. These results were obtained using a workload by Bento

Legacy Application Support

IOC79 is an HPX implementation of the Intel OpenMP runtime, enabling existing (OpenMP) applications to execute with HPX. HPX runtime implementations are an important step toward development. Systems based on lightweight threads and data dependencies are an excellent method for extracting parallelism and achieving performance.

HPX is emerging as an important new paradigm with support from the US Department of Energy, the National Science Foundation, the European Commission, the European Commission, the European Commission, and the European Commission.

Applications performance of HPX on very large, including current and multiple tera-scale supercomputers. HPX is significantly better than standard HPX.

Performance adaptation of HPX provides significant energy savings with no performance degradation.

We have shown that legacy applications using HPX can run under the HPX runtime systems effectively.