SOLLVE

Exascale architectures are expected to feature a dramatic increase in the amount of intra-node threading, greater heterogeneity, and more complex hierarchical memory subsystems. OpenMP is a directive-based standard specification and runtime for programming shared-memory and accelerator systems and is used by many exascale applications for in-node programming. The SOLLVE project is advancing the OpenMP specification to address exascale application exascale challenges including programmability gaps for core technologies such as accelerator support, interoperability with MPI, and data migration of complex data structures.

OpenMP is a popular tool for in-node programming and is supported by a strong community including vendors, national labs, and academic groups. Most ECP applications include OpenMP as part of their strategy for reaching exascale levels of performance. Several application teams identified gaps in OpenMP functionality with respect to movement of complex data structures to/from accelerator memories, some require compatibility with the latest C++ standards, and others expect the ability to generate performance portable code. The SOLLVE project is working with application partners and the members of the OpenMP language committee to extend the OpenMP feature set to meet these application needs.

The SOLLVE team is focused on delivering a high-quality, robust implementation of OpenMP and project extensions in LLVM; developing the LLVM BOLT runtime system to exploit light-weight threading for scalability and interoperability with MPI; and creating a validation suite to ensure that quality implementations of OpenMP are being delivered. The team directly interacts with end users to understand and consolidate their application software needs, allowing them to drive and prioritize features in the OpenMP standard, with the goal of delivering the best possible solutions for functionality and performance gaps. They also engage with key vendors and the broader OpenMP community to seek the best-possible solutions to exascale application challenges, aiming to secure their adoption in new versions of the standard and to address scalability requirements in the implementation.

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Progress to date

- The SOLLVE team has introduced substantial extensions to the OpenMP 4.5 and 5.0 specifications including features to facilitate movement of complex data structures to accelerators and offering more control on the work-sharing directives.
- The team designed and implemented many enhancements to the LLVM compiler and OpenMP runtime implementation including optimizations for parallel regions, improved code generation, and overall data movement optimization. Runtime enhancements concentrated on improving the interoperability of the BOLT runtime with several MPI implementations and providing new data locality and scheduling heuristics.
- The team produced a beta version of their validation suite that supports assessment of compliance to the OpenMP standard and performance of the delivered OpenMP implementation.