System Tools and Advanced Runtimes (STAR)
The System Tools and Advanced Runtimes (STAR) group focus on research crossing multiple software layers, from OS, runtimes and low-level APIs to programming models, providing support to HPC applications on massively parallel systems. We are involved in several European and industrial projects.

Objectives

Data-flow programming models
We develop and maintain the OmpSs-2 programming model, a versatile data-flow programming model to build HPC applications. OmpSs-2 main targets are multi-core, heterogeneous and distributed systems. The OmpSs-2 programming model is implemented by the LLVM compiler and the Nanos6 runtime system.

Compilers and Domain-Specific Languages (DSLs)
The OmpSs-2 compiler for C and C++ languages leverages the LLVM infrastructure to generate high-performance code. We also develop a Domain-Specific Language (DSL) compiler for HPC applications, demonstrating the feasibility of DSLs on HPC systems and leveraging many of the OmpSs-2 features to run on HPC systems.

OS and Runtimes Systems
Runtime systems are a crucial component to exploit current multi-core and heterogeneous systems. Our research on runtime systems includes work with the Linux kernel to better support advanced runtime systems. Finally, we have augmented the LLVM OpenMP runtime with low-level APIs required to support the Task-Aware (TA) libraries described below.

Interoperability with other programming models and APIs
Our Nanos6 and LLVM OpenMP runtime systems provide several features to integrate other programming models and low-level APIs. We provide several Task-Aware (TA) libraries that ease the orchestration of complex hybrid and heterogeneous applications. The TAMPI and TAGASPI libraries support MPI and GASPI message-passing APIs, respectively, while TA-CUDA, TA-OpenCL and TACL leverage CUDA, OpenCL and other APIs to support task-aware programming on GPUs. Additionally, we develop a small microkernel to facilitate the integration of the Linux io_uring high-performance asynchronous storage API with OmpSs-2 and OpenMP.

Heterogeneous Computing
OmpSs-2 provides high-level support to develop applications on heterogeneous systems composed of multi-cores, GPUs and other accelerators. We conduct research on runtime systems that can manage all data transfers between the host and accelerators. This research line is conducted closely with the Programming Models and AccelCom groups.

Benchmarks, libraries and tools
The Garlic application suite comprises several mini-apps and benchmarks that represent common computational patterns. We provide optimized kernels to perform the Tensor Vector Multiply operation using the OpenMP fork-join model. Finally, the ovni instrumentation library is used to obtain detailed execution traces, facilitating the analysis and optimization of applications and programming models.

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