Master thesis project proposal (30hp)

Mapping high-level parallel DSL programs to HPC clusters using GPI-Space

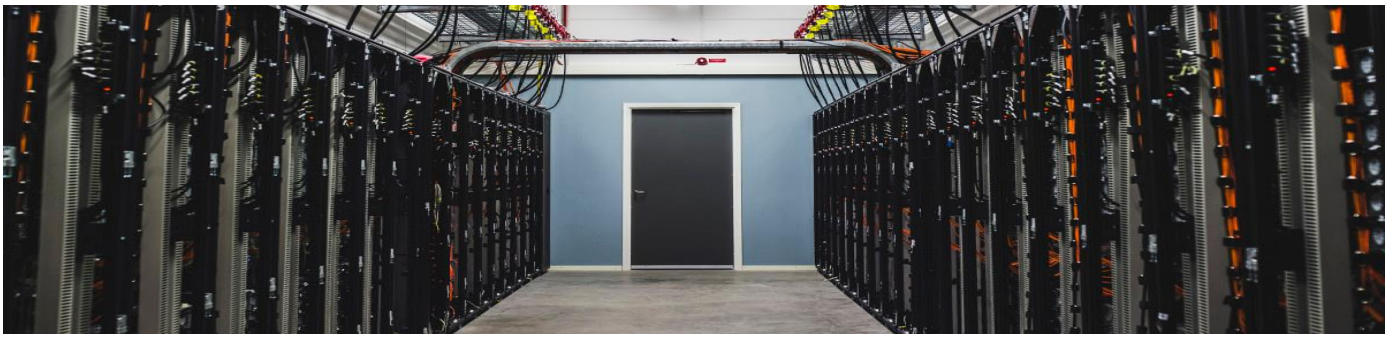

Image source: Tetralith supercomputer at National Supercomputer Centre (NSC) at Linköping University, © NSC, www.nsc.liu.se

SkePU (http://www.ida.liu.se/labs/pelab/skepu) is a C++ based, domain-specific high-level programming framework targeting heterogeneous and parallel systems, developed at Linköping University, Sweden. SkePU provides powerful generic programming constructs (called *algorithmic skeletons*) such as *Map*, *Reduce*, *Stencil* etc. that implement common patterns of computationally intensive computations, that can be customized by plugging in sequential problem-specific code, and for which efficient parallel implementations are available. While SkePU was originally developed for portable computing on heterogeneous *single*-node systems, the current development version of SkePU also supports execution on multiple nodes in high-performance computing (HPC) clusters, however using a specific version of two-sided MPI message passing.

GPI-Space (http://www.gpi-space.de) is a new task-based runtime system for HPC clusters, developed at Fraunhofer ITWM in Kaiserslautern, Germany. It provides flexible one-sided communication (i.e., direct remote memory access) between tasks through the PGAS communication library *GPI*, which is an implementation of the *GASPI* standard. However, GPI-Space has a library-based programming API and lacks a high-level programming frontend with specific support of concise HPC constructs.

We thus expect that SkePU and GPI-Space will complement each other well, and suggest a master thesis project that should investigate:

- What are different possible ways to combine the two technologies, and which one is most suitable to achieve high efficiency and scalability of the resulting code? This version should be prototypically implemented.
- Which application program patterns benefit most from the integration, compared to the existing SkePU MPI backend prototype?
- How does the integration with SkePU improve programmability compared to equivalent code written directly using the GPI-Space API?

This master thesis project will be jointly supervised as a cooperation between Fraunhofer ITWM and Linköping University, and likewise between the EU H2020 research projects EPIGRAM-HS and EXA2PRO. The project can be performed at either site.

Prerequisites: Some course in parallel programming, such as TDDC78 (LiU). Very good knowledge of modern C++, esp. template metaprogramming. Program development under Linux.

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