

HPC Certification Program

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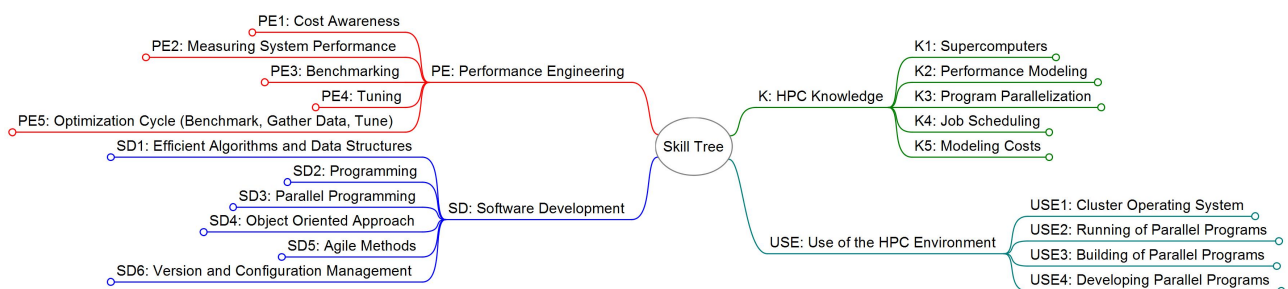
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HPC Knowledge and Competences

Our goal is to establish a certification program for HPC competences and an open governance body for data centers that curates the certification framework. Welcome any institution to contribute or participate in the governance body.

The HPC Certification Program will provide a tree of HPC competences (named skills) where each skill provides descriptions about covered knowledge, scope and dependencies. A subsection of the tree is shown below. Note that the tree is understandable as a curriculum where different user roles may have another view to the tree to indicate relevant skills. This way a user can gain those custom-tailored HPC-skills which are beneficial for the HPC environment he would like to use or the parallel application he would like to speed up. A further benefit exists for the compute centers: a certified user, able to exploit the full potential of a HPC system and being aware of utilizing the expensive HPC resources appropriately, will reduce their operating costs.



Tree of the Top Level Skills

A skill can cover multiple levels of expertise: basic, intermediate and expert. The governance body will curate the tree, define certificates based on the skills and provide technical infrastructure for conducting examinations and issue certification. However, it will not create or provide teaching material directly. We believe the separation of curriculum and teaching material fits with the teaching practice and, in the long term, offers opportunities to increase the focus and quality of teaching materials.

The initial effort to setup a certification framework is supported by the PeCoH project: We will bundle teaching material required to master the initial certification levels and organize standardized online examinations for participants to acquire the certificates. The online examinations to gain the HPC certificates will be multiple-choice tests. For each skill and level, a pool of questions will be developed, of which a subset is selected for each individual examination. Once the test is completed, the system will automatically assess the results and create a PDF with the certificate. At the beginning, we will manually approve the test results.

We are currently working on the classification of the HPC competences and have initially identified four major topics for the HPC Certification Program as “HPC Knowledge”, “Use of the HPC Environment”, “Performance Engineering”, and “Software Development”.

The tree is the basis to easily create different views of the content. As an example, the table below shows how HPC topics can be categorized to enable the learner to master a certain skill level. In the example used for the table the skills are based on one another. For example, the HPC knowledge provided to be able to develop a parallel program requires the knowledge of both lower levels.

Skill Levels	HPC Knowledge	Use of the HPC Environment	Performance Engineering	Software Development
Running of Parallel Programs	Shared Memory and Distributed Systems, Job Scheduling, File Systems, Network Bandwidth and Latency, Moore's Law, Amdahl's Law	Linux Command Line, Shell Scripts, Environment Selection (e.g. via modules load ...), Workload Manager	Measuring System Performance, Benchmarking (using 1, 2, 4, 8, 16, ... cores), Tuning via Runtime Options (e.g. for MPI and OpenMP), Process Mapping to Nodes, CPU Pinning	Automated Testing
Building of Parallel Programs (e.g. via Open Source Packages)	SMP-, NUMA-, GPU-, Many Core-Architectures, Hybrid Approaches (e.g. CPU + GPU), Domain Decomposition		Package Options, Optimized Libraries, Compiler Options, Profile Guided Optimization	Compilers, Libraries, Linker, Programming Environments, Portability for Job Scripts, Load Balancing
Developing Parallel Programs	Pipelining, Vectorization, CPU-, Cache-, Memory-, I/O-, Communication-Bounds, Overheads for Communication, Synchronization, and Redundant Computations, Multi Level Approaches (e.g. OpenMP + MPI)	Advanced Linux Commands	Profiling, Detecting Performance Bottlenecks, Tuning via Reprogramming (e.g. using Functional Units (Fused-Multiply-Add)) Vectorization, SIMD, GPUs, More Efficient Algorithms	Debugger, Test-Driven Development, Object Oriented Development, Communication Pattern, Domain Decomposition Pattern, Version- and Configuration Management-Tools

Categorization for Three Skill Levels

Collaboration

We welcome institutions to participate in forming the governance structure and any comments for the HPC Certification Program: helpdesk.hhcc@uni-hamburg.de

To receive news about or contribute to the HPC Certification Program, subscribe to our mailinglist: <http://www.hhcc.uni-hamburg.de> → *Certification* → *subscribe to our mailinglist*.

Performance Conscious HPC (PeCoH)

This effort is part of the joint PeCoH project, in which we focus on raising the user awareness for performance engineering. In April 2017 the three Hamburg compute centers involved in PeCoH, German Climate Computing Center (DKRZ), Regional Computing Center at the Universität Hamburg (RRZ), and Computer Center at the Technische Universität Hamburg (TUHH RZ) started the Hamburg HPC Competence Center (HHCC) as a virtual institution and central contact point for their HPC users.

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