Universität Hamburg

DER FORSCHUNG | DER LEHRE | DER BILDUNG

REGIONALES
RECHENZENTRUM

PeCoH – Performance Conscious HPC

Hinnerk Stüben

FEPA Workshop "Job-specific Performance Monitoring"

Regionales Rechenzentrum Erlangen (RRZE)

20 July 2017

Applicants

Professors at Department of Informatics at Universität Hamburg:

- Thomas Ludwig, *Scientific Computing*

- Stephan Olbrich, *Scientific Visualization and Parallel Processing*

- Matthias Riebisch, *Software Engineering and Construction Methods*

Partners

- Deutsches Klimarechenzentrum (DKRZ)

- Regionales Rechenzentrum der Universität Hamburg (RRZ)

- Rechenzentrum der Technischen Universität Hamburg (TUHH)

Topics

- development of a cost model

- transfer of HPC know-how

- HPC certification program (German: „HPC-Führerschein")

- software engineering for HPC

Cost model

- goal

  – raise cost- and performance awareness

- based on resource usage

  – compute node usage
  – disk usage
  – electric power consumption

- give feedback to users

  – automated reports appendaed to batch log files

- prototype implementation

  – with the Slurm Workload Manager

Transfer of HPC know-how

- Hamburg HPC Competence Center (HHCC) $\rightarrow$ `https://www.hhcc.uni-hamburg.de/`

  - knowledge base   see e.g. the following slides
  - user support $\rightarrow$ `mailto:helpdesk.hhcc@uni-hamburg.de`
  - HPC certification

- best practices for existing software packages

  - study tuning possibilities (input parameters, environment variables)
  - benchmarking
  - document recommendable settings

HPC skills (I)

| Skill Level	HPC Knowledge	Use of the HPC Environment	Performance Engineering	Software Engineering
Run Parallel Programs	Shared Memory and Distributed Memory Systems, Job Scheduling, File Systems, Network Bandwidth and Latency, Moore's Law, Amdahl's Law	Linux Command Line, Shell Scripts, Environment Modules, Workload Managers	Measuring System Performance, Benchmarking, Scaling Studies, Tuning via Runtime Options (e.g. for MPI and OpenMP), Process Mapping to Nodes, CPU Pinning	Automated Testing

HPC skills (II)

Skill Level	HPC Knowledge	Use of the HPC Environment	Performance Engineering	Software Engineering
Build Parallel Programs (e.g. from Open Source Packages)	Architectures (SMP, NUMA, GPU, Many Core), Hybrid Approaches (e.g. CPU+GPU), Domain Decomposition, Load Balancing	Programming Environments (Compilers, Libraries, Linker, . . .)	Package Options, Optimized Libraries, Compiler Options, Profile Guided Optimization	Computational Complexity, Portability for Job Scripts

HPC skills (III)

Skill Level	HPC Knowledge	Use of the HPC Environment	Performance Engineering	Software Engineering
Develop Parallel Programs	Pipelining, Vectorization, Performance-Bounds (CPU, Cache, Memory, I/O, Communication), Overheads for Communication, Synchronization and Redundant Computations, Multi Level Approaches (e.g. MPI+OpenMP)	Programming Environments (Debuggers, IDEs), Version- and Configuration Management-Tools	Profiling, Detecting Performance Bottlenecks, Tuning via Reprogramming (e.g. using Functional Units (Fused-Multiply-Add)), Vectorization, SIMD, GPUs, More Efficient Algorithms	Test-Driven Development, Object Oriented Development, Communication Patterns, Blocking and Non-Blocking I/O, Domain Decomposition Patterns

HPC competences
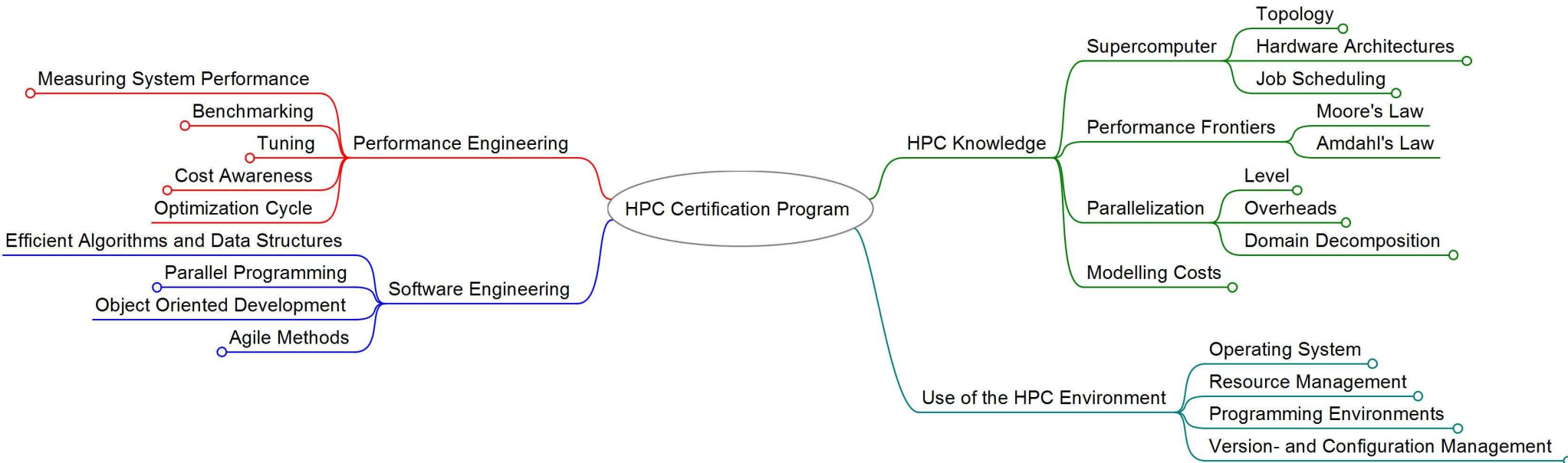
HPC certification program

- analysis and classification of HPC competences

- development of a program to check on these competences

- collection of teaching material

- online examination

$\rightarrow$ looking for collaboration partners!

$\rightarrow$ `https://www.hhcc.uni-hamburg.de`
$\rightarrow$ Certification
$\rightarrow$ subscribe to our mailing list

Software engineering for HPC

Impact of using software engineering on scientific productivity:

- efficient algorithms and data structures

- object oriented development

- agile software development, automated testing / test-driven development

- coding guidelines, refactoring

- version and configuration management

Status

- positions filled (starting March and July 2017)

- HHCC web page established $\rightarrow$ `https://www.hhcc.uni-hamburg.de/`

- poster presentation at *ISC High Performance 2017*

  $\rightarrow$ `https://www.hhcc.uni-hamburg.de/en/files/isc2017-pecoh-poster.pdf`

$\rightarrow$ `https://www.hhcc.uni-hamburg.de/en/files/isc2017-hpc-certification-program.pdf`