PeCoH

Raising Awareness for Costs and Performance

Nathanael Hübbe

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PeCoH (Performance Conscious HPC)

Funded Partners:

DKRZ German Climate Computing Center
J. Kunkel, N. Hübbe, M. Kuhn, T. Ludwig

RRZ Regional Computing Center (Universität Hamburg)
K. Himstedt, H. Stüben, Stephan Olbrich

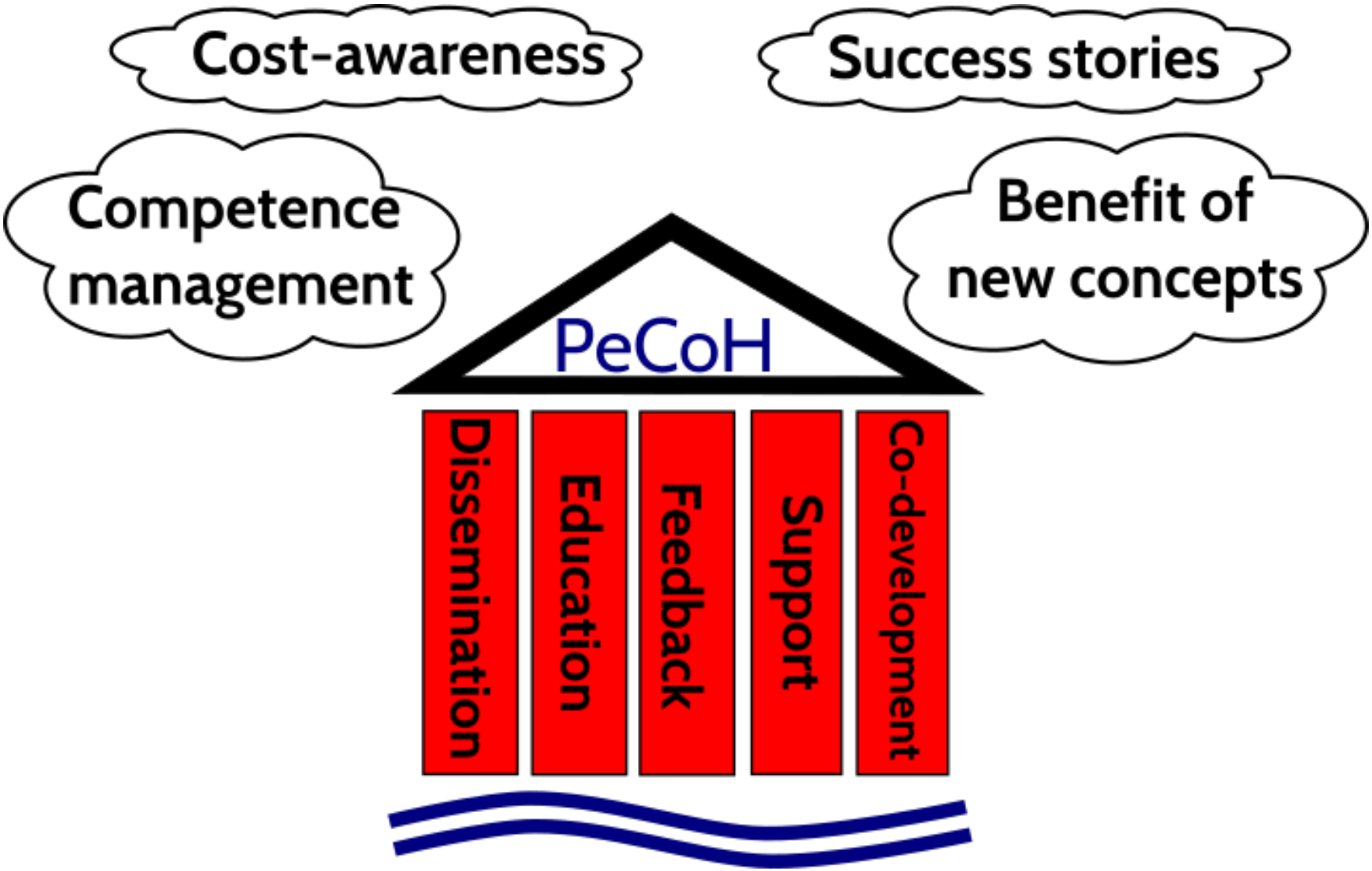
Uni HH Universität Hamburg
S. Schröder, M. Riebisch

Associated Partners:

TUHH RZ Computing Center (Technische Universität Hamburg Harburg)
M. Stammberger

Contact: Julian Kunkel <kunkel@dkrz.de>

PeCoH (Performance Conscious HPC)



PeCoH (Performance Conscious HPC)

Current achievements and work in progress:

- Started certification program
  - Collect and categorize teaching materials
  - Guide users in learning
- Create a knowledge base

  Investigate and document best practices
- Raise cost-awareness

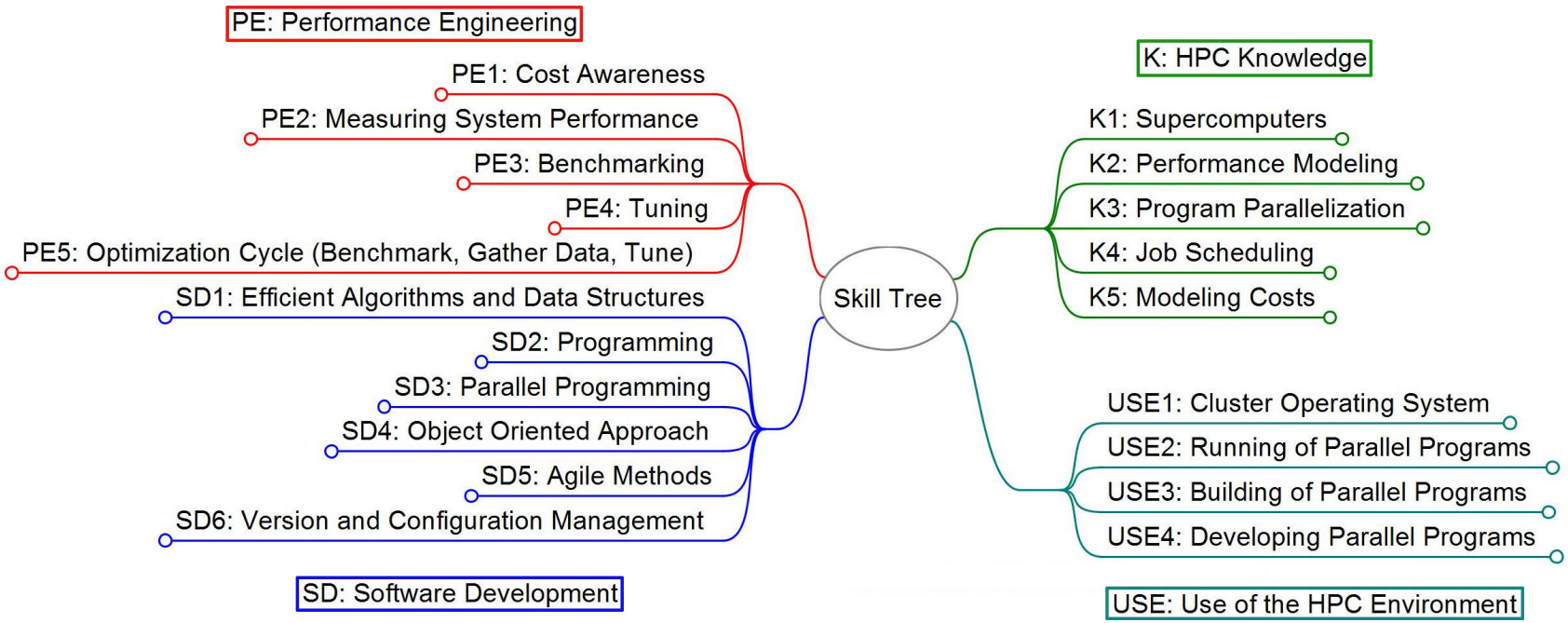
  Help users understand the impact of optimizations

HPC Certification Program

Based on classification of HPC skills

- Hierarchical tree of skills
  - Teaching materials are attached
- Each certificate is a useful collection of skills
- Examination program to test these skills
- Online tests

Skill Tree


Skill Tree
PE: Performance Engineering
PE1: Cost Awareness
PE2: Measuring System Performance
PE3: Benchmarking
PE4: Tuning
PE5: Optimization Cycle (Benchmark, Gather Data, Tune)
SD: Software Development
SD1: Efficient Algorithms and Data Structures
SD2: Programming
SD3: Parallel Programming
SD4: Object Oriented Approach
SD5: Agile Methods
SD6: Version and Configuration Management
K: HPC Knowledge
K1: Supercomputers
K2: Performance Modeling
K3: Program Parallelization
K4: Job Scheduling
K5: Modeling Costs
USE: Use of the HPC Environment
USE1: Cluster Operating System
USE2: Running of Parallel Programs
USE3: Building of Parallel Programs
USE4: Developing Parallel Programs

Contributing to HPC Certification Program

Still looking for partners

- . . . to sustain a governance structure
- . . . who provide teaching materials
- . . . who want to contribute in other ways

Just mail kunkel@dkrz.de
Mailing list: https://mailman.rrz.uni-hamburg.de/mailman/listinfo/certification.hhcc

Success Stories:
Best practices for existing software

Approach:

- Study tuning opportunities
- Perform benchmarking
- Document recommendable settings
  $\rightarrow$ HHCC website

First results with R:

- Compile with the right compilers/libraries:
  1.3x - 1.5x speedup
- Easy parallelization by replacing `for()` with `foreach()`

HPC Cost Modelling

Motivation

- Supercomputers have high costs
  but users don't understand costs
- Users operate against limits
  Everything's fine as long as the limits are honored?
- Users get no feedback on costly behavior and the feedback they get is compute time only, no storage

Solution: Raise cost awareness by providing feedback

Job Cost Analysis

Investigated options to give feedback

Compute Time ⇒ SLURM epilogue
Online Storage ⇒ daily/monthly reporting
Archive Space ⇒ instrumentation of archiving commands

Implemented scripts for compute computing cost models

- Read a cost model configuration
- Analyse SLURM jobs accordingly
- May run as job epilogue
  or perform post-mortem analysis
- Second script for statistical analysis
- Usable by anyone with any cost model

HPC Cost Models

Four different models:

Simple $job\_costs = \frac{machine\_procurement}{machine\_compute\_time} \cdot job\_compute\_time$

Extras Detailed modeling of extra hardware

Full Add running costs of a data center

Partitioned Extra modelling of storage costs

HPC Cost Models

Resulting rates for an virtual data center:

Cost Model	Compute Time / $\frac{€}{h \cdot node}$		Storage / $\frac{€}{d \cdot TB}$		Total / $\frac{M€}{a}$
	min	max	online	offline	
Simple	0.27	0.27	-	-	8
Extras	0.26	1.16	-	-	8
Full	0.56	0.70	-	-	16.5
Partitioned	0.33	0.47	0.42	0.022	16.5

HHCC (Hamburg HPC Competence Center)

HHCC is a virtual organization

- Partners: DKRZ, RRZ, TUHH RZ
- Preserve and build upon project results

Website: https://www.hhcc.uni-hamburg.de
User support: mailto:helpdesk.hhcc@uni-hamburg.de

HHCC (Hamburg HPC Competence Center)

HHCC provides:

- Contact point between HPC users and computing centers
- Knowledge base
- Certification program

$\Rightarrow$ Makes support more efficient

Summary

- PeCoH
  - Bundle teaching materials
  - Collect best practices
  - Provide certification
  - HPC cost modelling
- HHCC: Virtual organization for support in Hamburg preserving and building upon PeCoH results

Outlook

- User Workshop in February (one day in the range 19.-23.)
- A project poster at the next ISC