# Enabling Performance Engineering in Hesse and Rhineland-Palatinate

**A Project in the DFG Program "Performance Engineering for Scientific Software" (2017-2019)**

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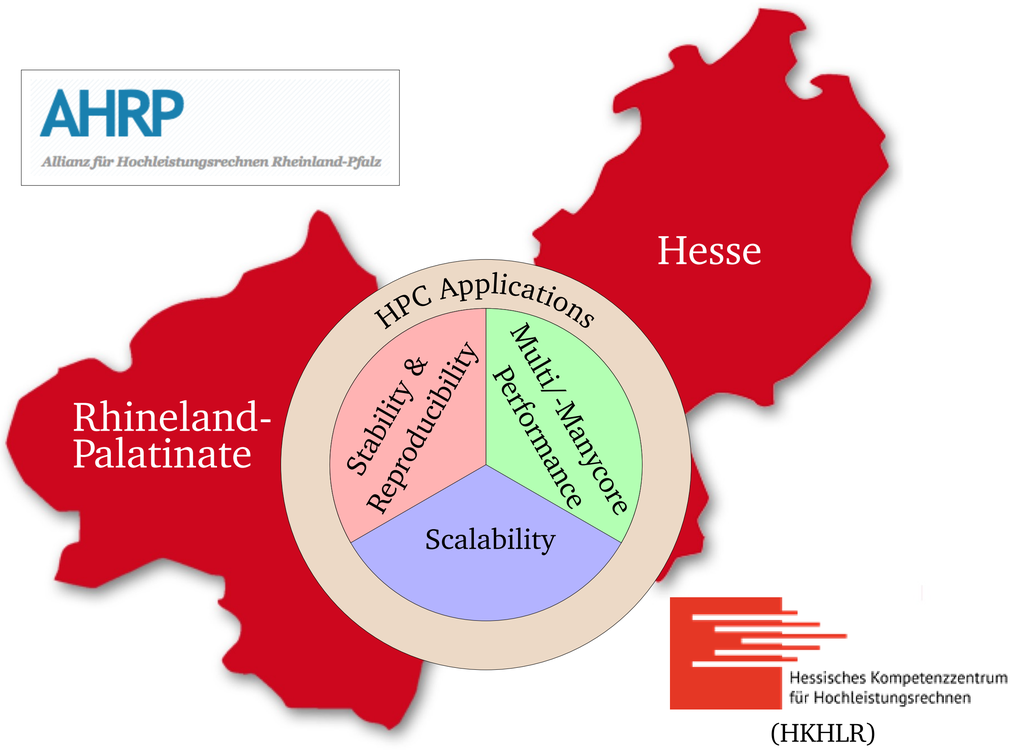
## Overview




- **Objective:** Expand and deepen HPC support in areas where existing scientific expertise coincides with critical user needs.
- **Approach:** Bundle the distributed expertise for HPC support and performance engineering within the HKHLR and the AHRP under a new umbrella organization to support scientists to efficiently use the HPC resources in Hesse and Rhineland-Palatinate.

## Performance Engineering Services

Within our project, we design and provide the following portfolio of consulting services:

### Scalability

- **Objective:** Help developers identify and resolve scalability limitations in their codes
- **Approach:** Define services with increasing degrees of applications engagement around Extra-P, an automatic performance-modeling tool developed at TU Darmstadt

### Stability, Performance, and Reproducibility

- **Objective:** Help developers understand the impact of changes to specific parts of algorithms, especially the exchange of libraries and architectures.
- **Approach:** Measure condition numbers of algorithms with the help of algorithmic differentiation, by leveraging the tools Code Differentiation Package (CoDiPack) and Message Differentiation Package (MeDiPack) of TU Kaiserslautern. Package run-time environments either in containers or virtual machines.

### Multi-/Manycore Performance

- **Objective:** Help developers use multi-/manycore architectures more effectively
- **Approach:** Identify applications that make intensive use of multi-/manycore architectures and suggest optimizations while maintaining portability

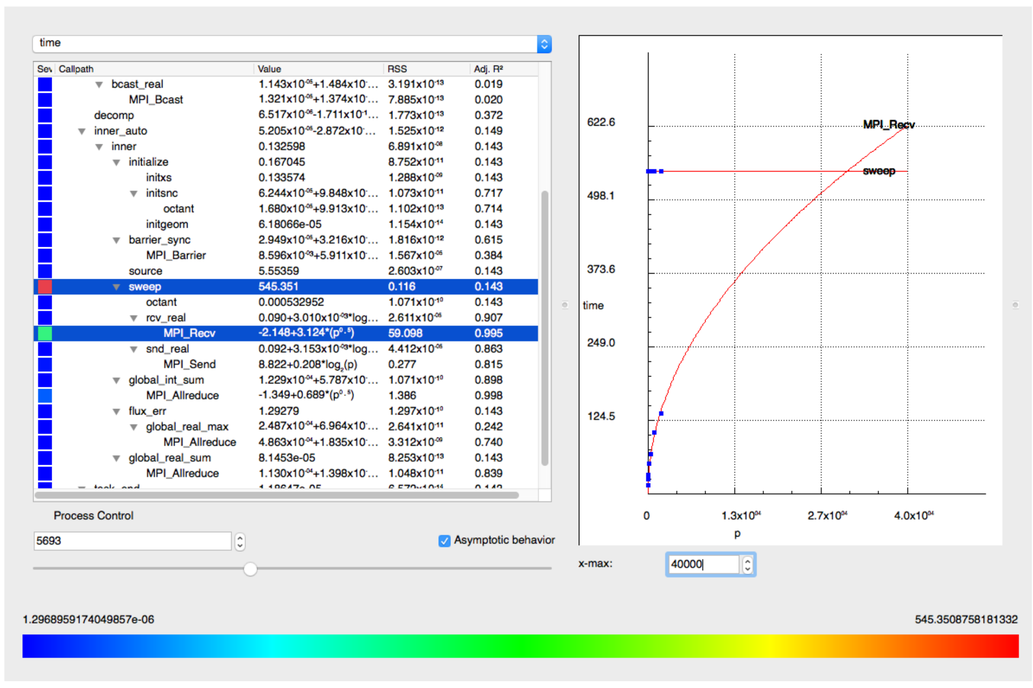
### Support Structures

- Provide local support staff as point of contact for the above services
- Organize workshops, tutorials, and coding weeks for interested HPC users in Hesse and Rhineland-Palatinate

## Example — Scalability Consulting

Scalability expectations of sophisticated algorithms in many HPC applications are based on abstract machine models. Not only is testing these expectations at extreme scale expensive, but hardware constraints or programming bugs might render these expectations also inaccurate.

To help developers validate scalability expectations and to identify scalability bugs, we create empirical performance models for each function of the program. To create the performance models, we use **Extra-P** [1], an automatic performance-modeling tool developed at TU Darmstadt.




Advantages of Extra-P

- Can use profiles generated with **Score-P** as of the possible inputs. Score-P provides automatic instrumentation capabilities, is easy to use, and preinstalled on many HPC systems
- Works well with measurements of as few as five different execution configurations
- Offers insights quickly and with little manual effort

### Services Provided

We aim to provide scalability-consulting on different levels, distinguished by their intensity of application engagement.

**Level I** — **Generate scaling models**
**Identify scaling issues**

**Level II** — **Create scaling plan**
Identify root causes of scaling issues, explore options to mitigate issues, estimate effort, prioritize measures

**Level III** — **Apply solutions**
Support application developers in applying fitting solutions and validating the benefit

### Project Outreach

Partners presented their tools and approaches at the EPE Worskhop, 8-10 May 2017, Mainz.

### References

[1] A. Calotoiu, T. Hoefler, M. Poke, F. Wolf: Using Automated Performance Modeling to Find Scalability Bugs in Complex Codes. Proc. of the ACM/IEEE Conference on Supercomputing (SC), 2013.

[2] S. Shudler, A. Calotoiu, T. Hoefler, A. Strube, F. Wolf: Exascaling Your Library: Will Your Implementation Meet Your Expectations?. In Proc. of the International Conference on Supercomputing (ICS), 2015.

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