

# Manual and Automatic Energy Tuning for HPC Codes

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We present the results of the BMBF project *Scalable Tools for the Analysis and Optimization of Energy Consumption in HPC (Score-E)*<sup>1</sup> (Grant No. 01IH13001; October 2013–September 2016). Specifically, within the framework of this project the established performance analysis tools *Vampir*<sup>2</sup>, *Scalasca*<sup>3</sup> and *Periscope Tuning Framework (PTF)*<sup>4</sup> and their joint underlying measurement infrastructure *Score-P*<sup>5</sup> have been extended; in addition to their traditional features they now contain the capability to investigate HPC codes with respect to their energy requirements.

Moreover, the project developed concepts and tools for reducing the energy consumption of HPC applications. For example, a new energy tuning plugin for *PTF* was designed and implemented. This plugin searches for the best settings of important tuning parameters such as the number of processes and threads as well as the clock frequency.

Furthermore, since not all energy related data that may be relevant for tuning and optimization purposes is accessible for direct measurements, appropriate models have been developed that allow a reliable prediction of the code’s behaviour in such cases too. Other key outcomes of *Score-E* are *Extra-P*<sup>6</sup>, a tool for the automatic detection of unintentionally poor scalability behaviour, and the *Performance Visualization Toolkit (pvt)*<sup>7</sup>, a software system that adds a significant amount of new possibilities for visualizing the performance and energy measurement data. This includes, among others, automatic tools that support the user in analyzing the measurements, thus simplifying the search for bottlenecks, and the possibility to display performance data on the real geometry of the simulated process, hence improving the understanding of the connections between the behaviour of the code under investigation and the properties that are currently being simulated.

Finally we indicate currently ongoing activities that extend the results from *Score-E*, in particular with respect to the automation of the tuning workflow, thus relieving the software developer from this possibly highly time-consuming task.

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<sup>1</sup><http://www.vi-hps.org/projects/score-e>

<sup>2</sup><http://www.vampir.eu>

<sup>3</sup><http://www.scalasca.org>

<sup>4</sup><http://periscope.in.tum.de>

<sup>5</sup><http://www.score-p.org>

<sup>6</sup><http://www.scalasca.org/software/extra-p>

<sup>7</sup><https://devhub.vr.rwth-aachen.de/VR-Group/pvt>