International HPC Summer School 2019: Performance analysis and optimization

VI-HPS Overview

VI-HPS Team
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Virtual Institute – High Productivity Supercomputing

- **Goal**: Improve the quality and accelerate the development process of complex simulation codes running on highly-parallel computer systems
- Start-up funding (2006–2011) by Helmholtz Association of German Research Centres
- Activities
  - Development and integration of HPC programming tools
    - Correctness checking & performance analysis
  - Academic workshops
  - Training workshops
  - Service
    - Support email lists
    - Application engagement

HELMHOLTZ ASSOCIATION

http://www.vi-hps.org

VI-HPS partners (founders)

Forschungszentrum Jülich
- Jülich Supercomputing Centre

RWTH Aachen University
- Centre for Computing & Communication

Technische Universität Dresden
- Centre for Information Services & HPC

University of Tennessee (Knoxville)
- Innovative Computing Laboratory

VI-HPS partners (additional members)





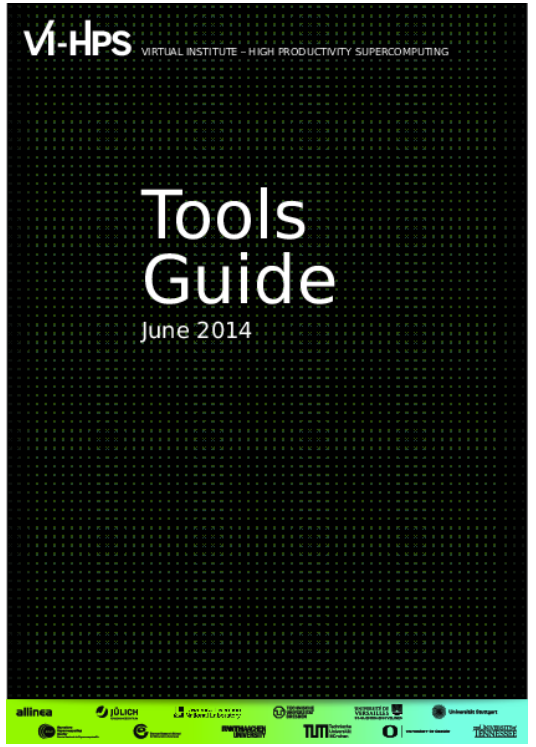



- Barcelona Supercomputing Center
  - Centro Nacional de Supercomputación
- Lawrence Livermore National Lab.
  - Center for Applied Scientific Computing
- Technical University of Darmstadt
  - Laboratory for Parallel Programming
- Technical University of Munich
  - Chair for Computer Architecture and Parallel Systems
- University of Oregon
  - Performance Research Laboratory
- University of Stuttgart
  - HPC Centre
- University of Versailles St-Quentin
  - LRC ITACA
- Allinea Software Ltd (Now part of ARM)

Productivity tools

- MUST & ARCHER
  - MPI usage correctness checking & OpenMP race detection
- PAPI
  - Interfacing to hardware performance counters
- Periscope Tuning Framework
  - Automatic analysis via an on-line distributed search
- Scalasca
  - Large-scale parallel performance analysis
- TAU
  - Integrated parallel performance system
- Vampir
  - Interactive graphical trace visualization & analysis
- Score-P
  - Community-developed instrumentation & measurement infrastructure

For a brief overview of tools consult the VI-HPS Tools Guide:



Productivity tools (cont.)

- DDT/MAP/PR: Parallel debugging, profiling & performance reports
- Extra-P: Automated performance modelling
- JuBE: Benchmark set creation, execution & evaluation framework
- Kcachegrind: Callgraph-based cache analysis [x86 only]
- MAQAO: Assembly instrumentation & optimization [x86-64 only]
- mpiP: MPI profiling tool and analysis viewer
- Open MPI Memchecker: Integrated memory checking
- Open|SpeedShop: Integrated parallel performance analysis environment
- Paraver/Dimemas/Extrae: Event tracing and graphical trace visualization & analysis
- Rubik: Process mapping generation & optimization [BG only]
- SIONlib/Spindle: Optimized native parallel file I/O & shared library loading
- STAT: Stack trace analysis tools

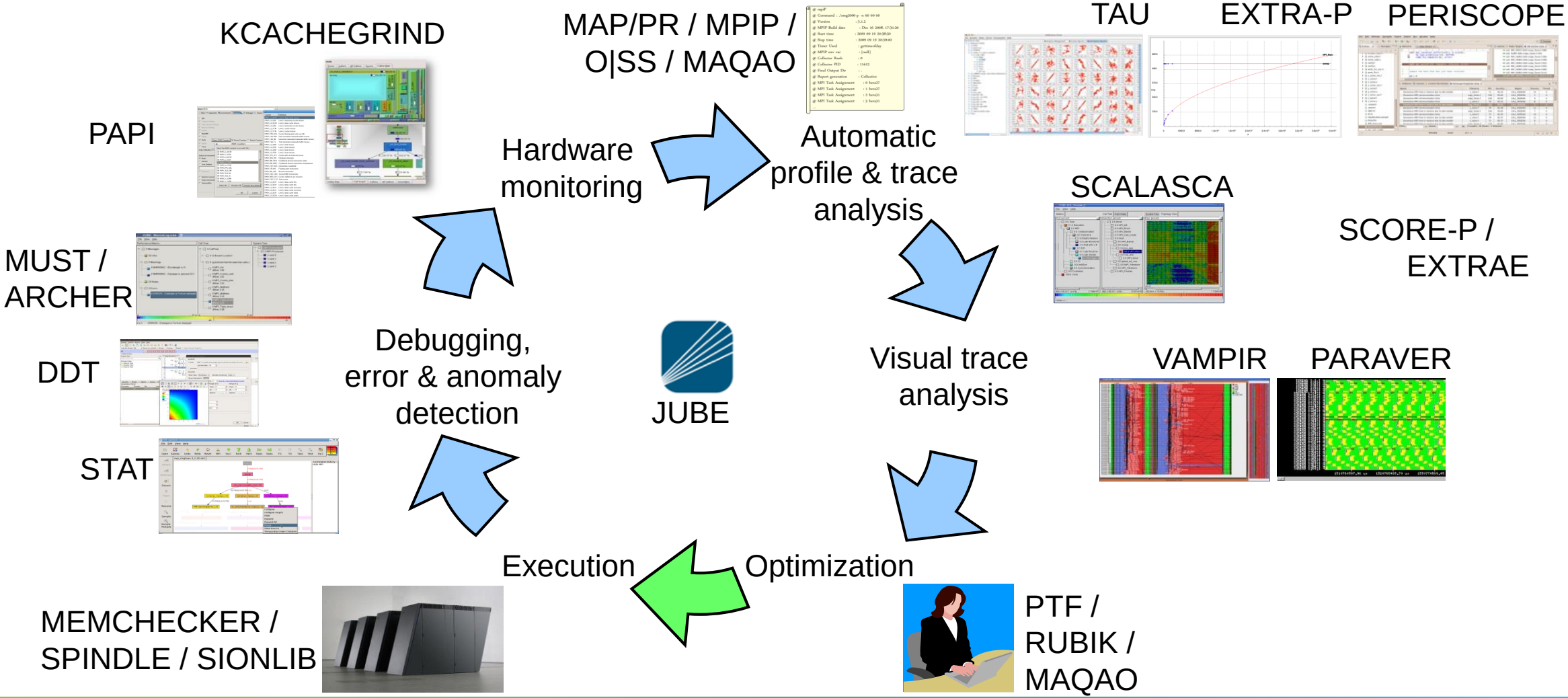
Non VI-HPS performance tools

- HPC Toolkit (Rice University): http://hpctoolkit.org/
- PerfExpert (TACC): https://www.tacc.utexas.edu/research-development/tacc-projects/perfexpert
- Likwid (University of Erlangen-Nuremberg): https://github.com/RRZE-HPC/likwid/wiki
- …

Commercial tools:

- CrayPat (Cray)
- Intel VTune Amplifier XE: https://software.intel.com/en-us/intel-vtune-amplifier-xe
- …

Technologies and their integration



Disclaimer

Tools will ***not*** automatically make you, your applications or computer systems more productive.

However, they can help you understand ***how*** your parallel code executes and ***when / where*** it's necessary to work on correctness and performance issues.

Workshops/Tutorials

- Tuning Workshop Series
  - Three to five days *bring-your-own-code* workshops at HPC centres
  - Usually free of charge
  - http://www.vi-hps.org/training/tws/

- Tutorials at various conferences
  - E.g., ISC19

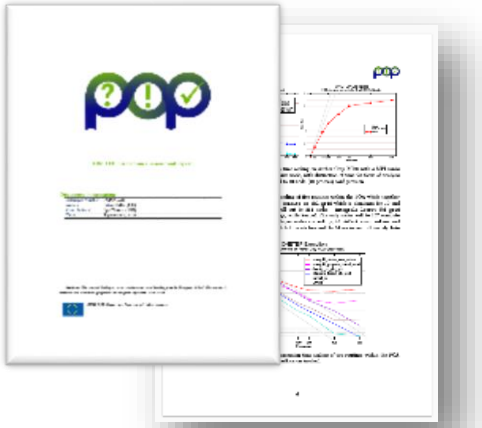
Performance Audits/Plans/Proof-of-concepts

- Performance Optimisation and Productivity (POP)
  - Offers performance optimisation and productivity services
  - Time-limited offer/project
  - Using VI-HPS tools
  - Funded by European Unions Horizon 2020 research and innovation programme
  - https://pop-coe.eu/services

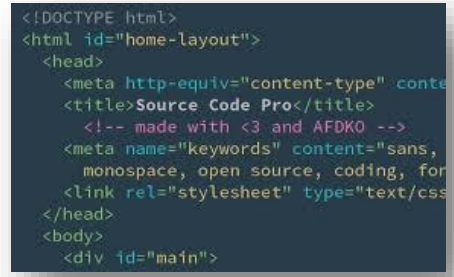
- They help you fix your code, for free!!!

FREE Services provided by the CoE

- **Parallel Application Performance Assessment**
  - Primary service
  - Identifies performance issues of customer code (at customer site)
  - If needed, identifies the root causes of the issues found and qualifies and quantifies approaches to address them (recommendations)
  - **Combines former Performance Audit (?) and Plan (!)**
  - Medium effort (1-3 months)

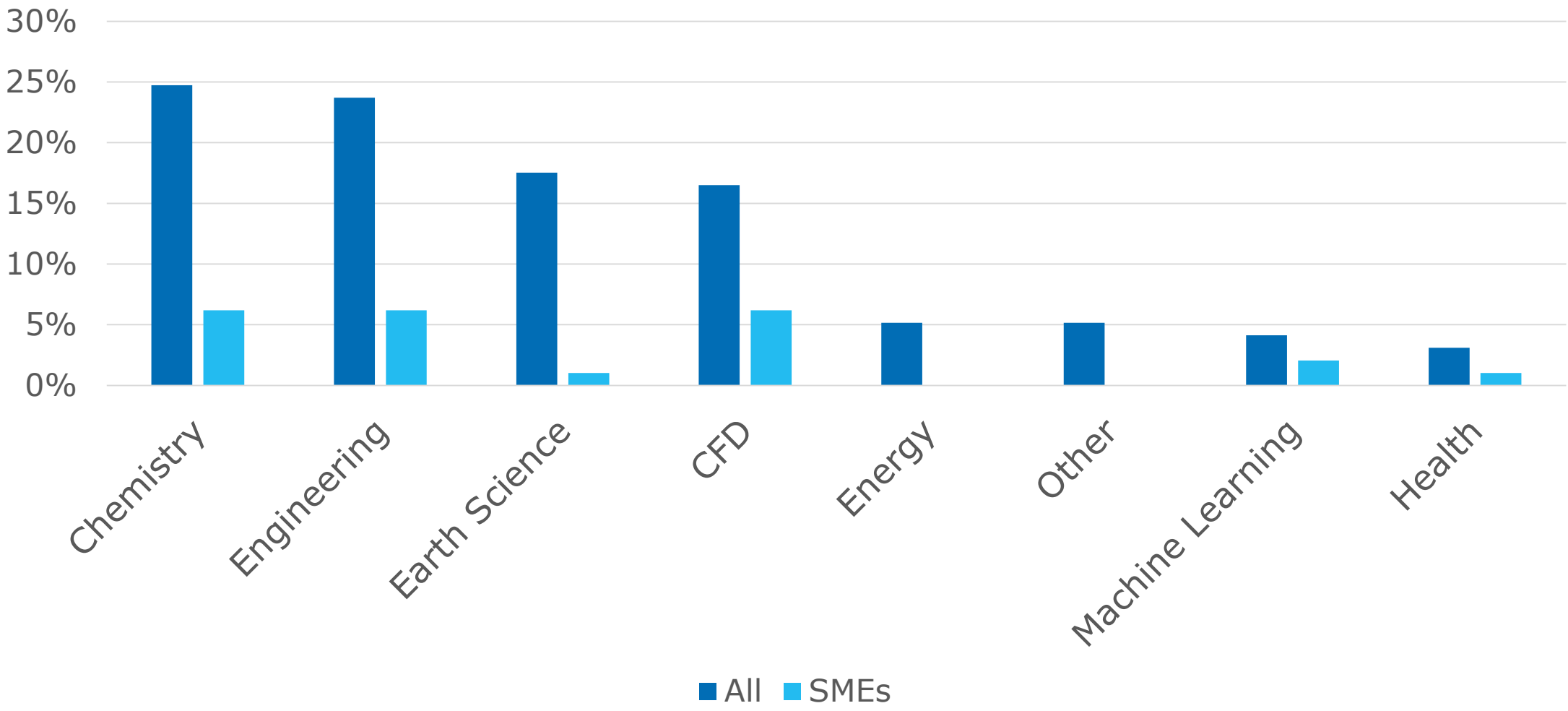


- **Proof-of-Concept (✓)**
  - Follow-up service
  - Experiments and mock-up tests for customer codes
  - Kernel extraction, parallelisation, mini-apps experiments to show effect of proposed optimisations
  - Larger effort (3-6 months)

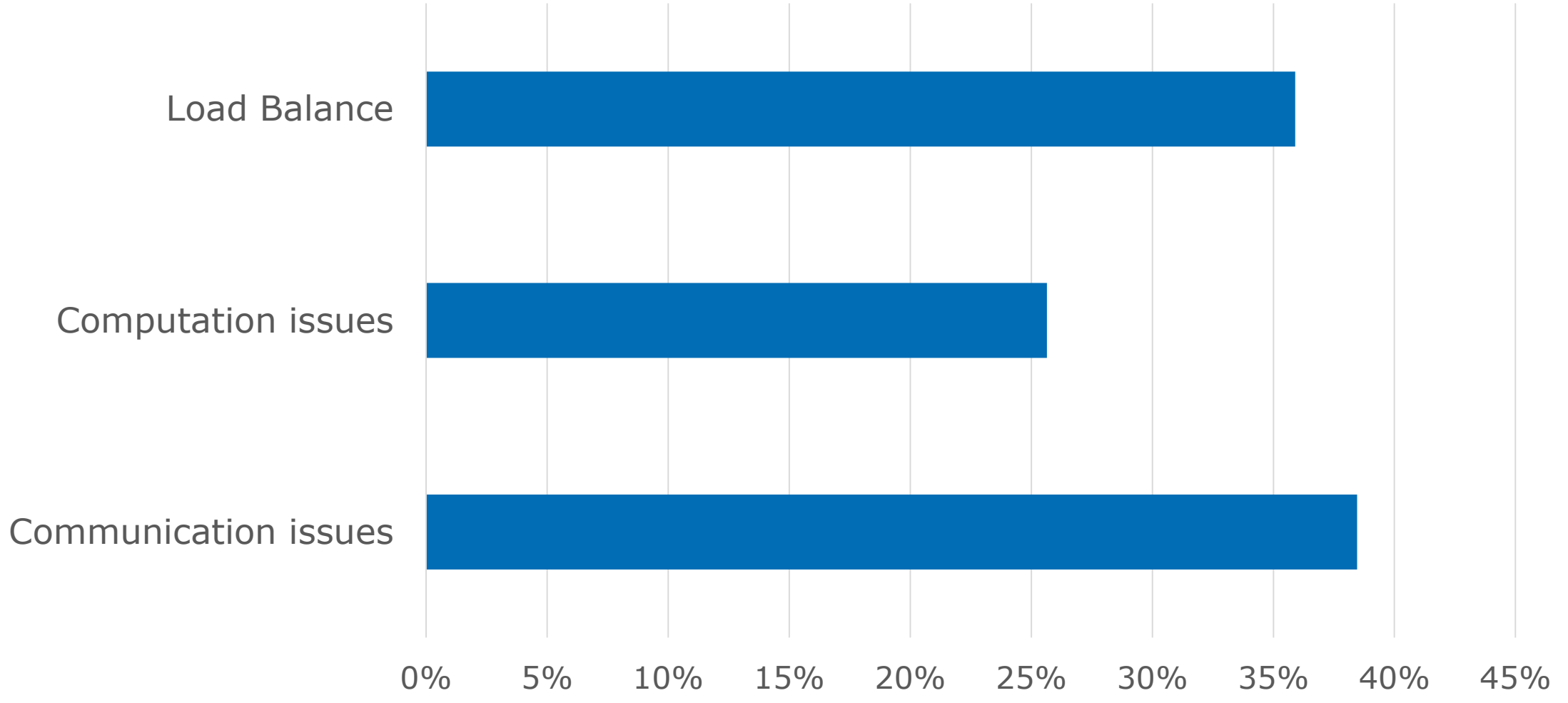


Note: Effort shared between our experts and customer!

Application Sectors



Leading Cause of Inefficiency



Inefficiency by Parallelisation