

Automated Calibration of a Simulator of MPI Application Executions

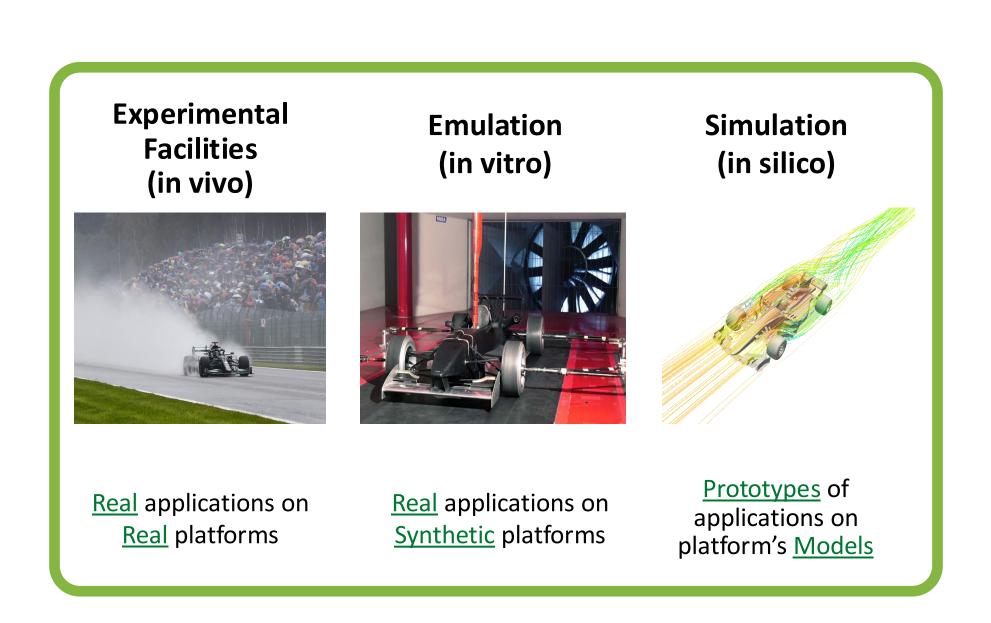
Yick Ching Wong¹, Jesse McDonald¹, Fred Suter², Kshitij Mehta², Henri Casanova¹

¹University of Hawai'i at Mānoa - Information and Computer Sciences, Honolulu HI, USA

²Oak Ridge National Laboratory - Computer Science and Mathematics Division, Oak Ridge TN, USA

Why Simulation-based Performance Assessment?

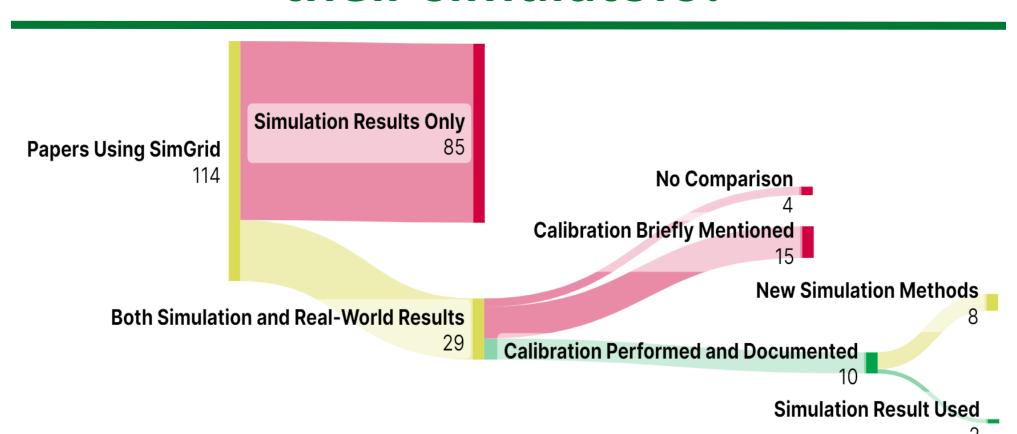
- Theoretical studies are not enough to account for the unprecedented complexity of modern systems
- Simulations are repeatable and fully observable
- Simulations enable experiments with arbitrary platform/application configurations
- Often less time-, labor-, and cost-intensive than real-world experiments



Do we need to calibrate our simulators?

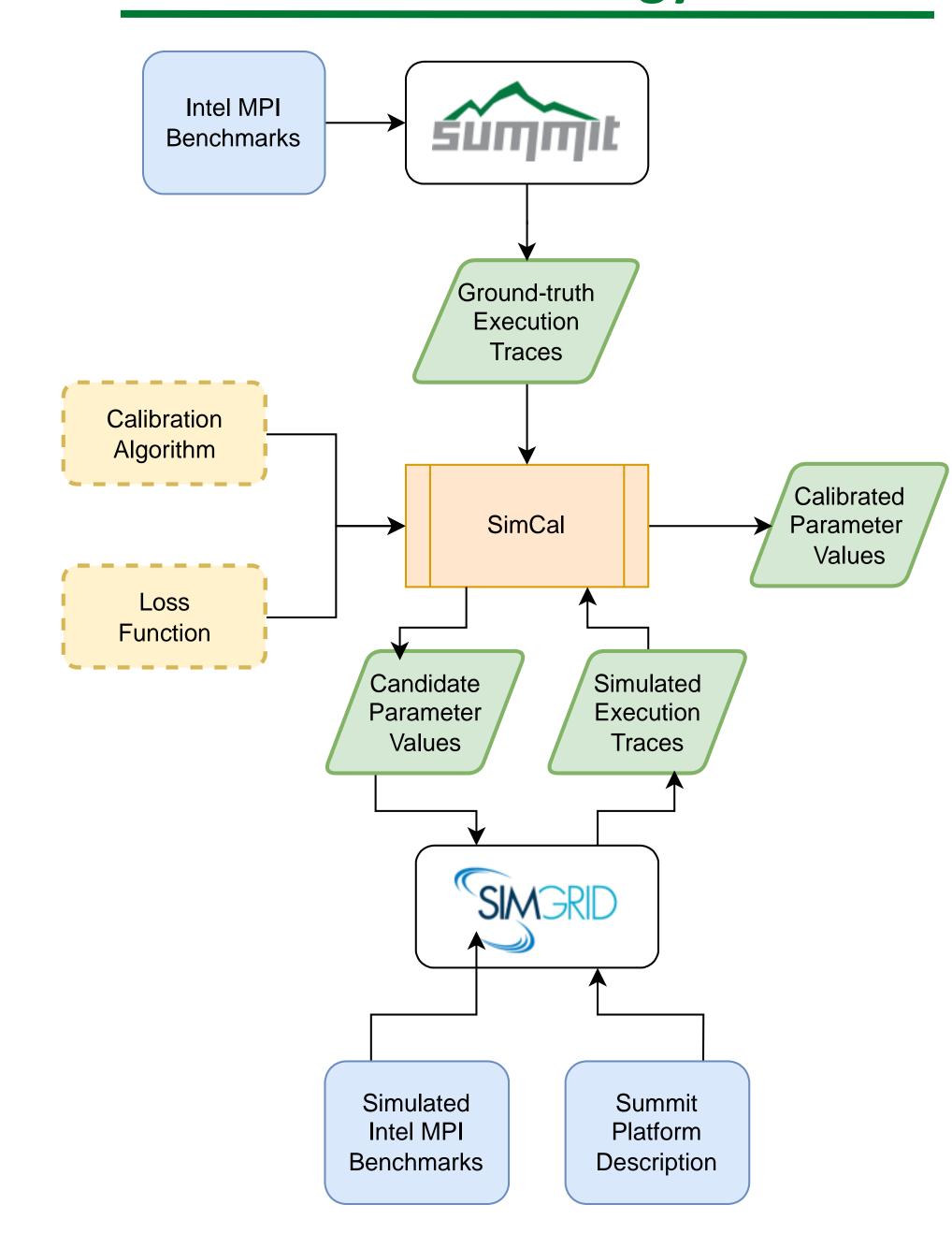
- We want simulators to reflect real-world results but to abstract away real-world behaviors
- To allow versatility, simulation models are configured via parameters
- <u>Challenge</u>: Parameters values cannot always be picked just based on hardware specs
- <u>Approach</u>: Calibrate simulation parameters with respect to ground-truth real-world execution traces

Are people calibrating their simulators?



NOT REALLY! In a study of all 114 SimGrid-based papers published over a 5-year period, only **two** papers that do not focus on simulation as the research result perform and document a sound calibration procedure

Methodology

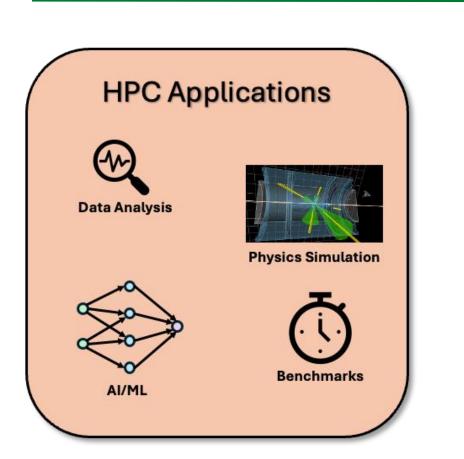


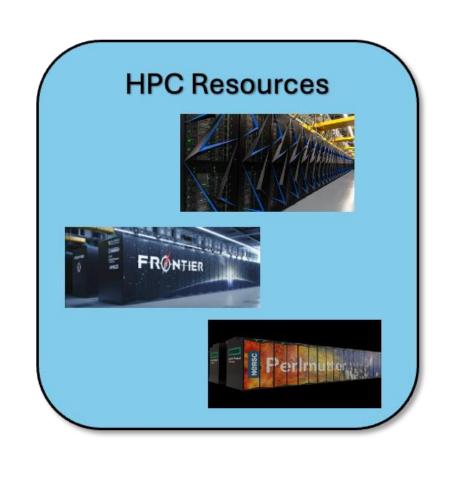
Investigate whether simple algorithms can be used to enable automatic calibration of simulators to provide domain scientists with more accurate simulators for performance assessment

Why MPI Benchmarks?

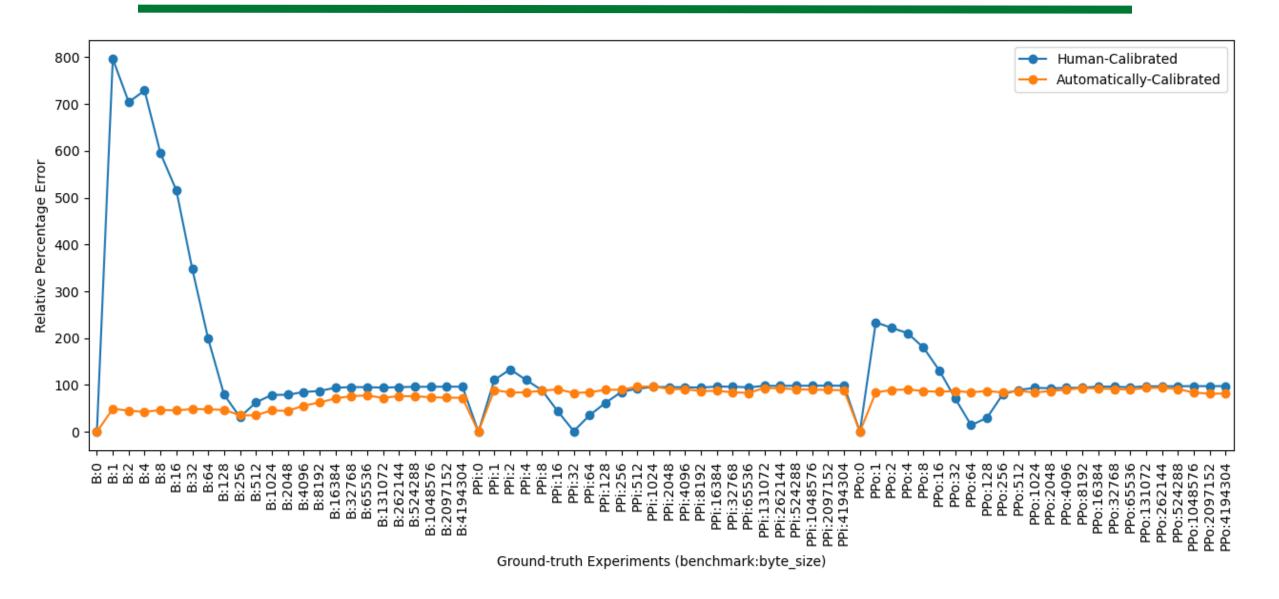
- Many scientific applications relies on MPI communication
- Benchmarks can capture the impact of the platform on network communications, without the complexity of scientific applications

Components of a Simulation





Preliminary Results



Preliminary results, based on limited ground-truth dataset and parameters, indicate that even after only three hours of calibration using RandomSearch, the calibrated parameters obtained through automatic calibration demonstrate a notable difference in Relative Percentage Error of each ground-truth experiment when compared to that of the Human-Calibrated parameters (hardware specs)

SimCal

A simulation calibration framework written in Python. It includes basic algorithms for calibration such as GridSearch, RandomSearch, and Gradient Descent.

<u>SimGrid</u>

A simulation framework for developing simulators of distributed application executions on distributed platforms.

Intel MPI Benchmarks

A series of MPI benchmarks written by Intel. Running via SimGrid's **SMPI** API.

Summit

Multiple instances of the Intel MPI benchmark were ran on Summit, which became the ground-truth data we used for this study.

Then by leveraging SimGrid's programmatic resource description API, we were able to create a simulated platform of Summit in less than 80 lines of code.

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