

*Commenced Publication in 1973*

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

## Editorial Board

David Hutchison

*Lancaster University, Lancaster, UK*

Takeo Kanade

*Carnegie Mellon University, Pittsburgh, PA, USA*

Josef Kittler

*University of Surrey, Guildford, UK*

Jon M. Kleinberg

*Cornell University, Ithaca, NY, USA*

Friedemann Mattern

*ETH Zurich, Zurich, Switzerland*

John C. Mitchell

*Stanford University, Stanford, CA, USA*

Moni Naor

*Weizmann Institute of Science, Rehovot, Israel*

C. Pandu Rangan

*Indian Institute of Technology, Madras, India*

Bernhard Steffen

*TU Dortmund University, Dortmund, Germany*

Demetri Terzopoulos

*University of California, Los Angeles, CA, USA*

Doug Tygar

*University of California, Berkeley, CA, USA*

Gerhard Weikum

*Max Planck Institute for Informatics, Saarbrücken, Germany*

More information about this series at <http://www.springer.com/series/7407>

Michela Taufer · Bernd Mohr  
Julian M. Kunkel (Eds.)

# High Performance Computing

ISC High Performance 2016 International Workshops  
ExaComm, E-MuCoCoS, HPC-IODC, IXPUG, IWOPH, P<sup>3</sup>MA, VHPC, WOPSSS  
Frankfurt, Germany, June 19–23, 2016  
Revised Selected Papers

*Editors*

Michela Taufer  
University of Delaware  
Newark, DE  
USA

Julian M. Kunkel  
DKRZ  
Hamburg  
Germany

Bernd Mohr  
Forschungszentrum Jülich  
Jülich  
Germany

ISSN 0302-9743                      ISSN 1611-3349 (electronic)  
Lecture Notes in Computer Science  
ISBN 978-3-319-46078-9            ISBN 978-3-319-46079-6 (eBook)  
DOI 10.1007/978-3-319-46079-6

Library of Congress Control Number: 2016942512

LNCS Sublibrary: SL1 – Theoretical Computer Science and General Issues

© Springer International Publishing AG 2016

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer imprint is published by Springer Nature  
The registered company is Springer International Publishing AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Preface

A separate workshop day attached to the ISC High Performance, formerly known as the International Supercomputing Conference, was first added to the technical program in 2015 under the leadership of Bernd Mohr (Forschungszentrum Jülich GmbH). Supported by the success of the last year, ISC High Performance renewed and further extended the workshop program in 2016. This year Michela Taufer (University of Delaware, USA) joined Bernd Mohr to co-lead the workshop organization. Julian Kunkel (German Climate Computing Center) joined the team as the proceedings chair and managed the organization of proceedings for the workshops.

As in 2015, the 21 workshops at ISC High Performance provided a focused, in-depth platform with presentations, discussions, and interaction on topics related to all aspects of research, development, and application of large-scale, high-performance experimental and commercial systems. Workshop topics included: HPC computer architecture and hardware; programming models, system software, and applications; solutions for heterogeneity, reliability, power efficiency of systems; virtualization and containerized environments; big data and cloud computing; as well as international collaborations. Workshops were selected via a peer-review process by an international committee of 10 experts in the field from Europe, the USA, and Asia.

For the first time, ISC High Performance provided a platform for workshops with their own call for papers and individual peer-review process through an early deadline in December 2015. In all, 13 workshop proposals were submitted before this deadline from organizers all over the world; the committee accepted 10 workshops (seven full-day and two half-day workshops) after a rigorous review process in which each proposal received three reviews. Additionally, each reviewer was given the possibility to discuss all the submissions.

Workshops without a call for papers were invited to submit their proposals in February 2016. For this second deadline, 13 workshop proposals were submitted and 11 workshops (two full-day and nine half-day workshops) were accepted by the committee with the same rigorous peer-review process as for workshops with proceedings.

The 21 workshops were held on Thursday, June 26, 2016, at the Frankfurt Marriott Hotel with over 600 registered attendees, about 170 presentations, and over a dozen panel discussions. Workshop organizers were asked to collect the slides of all presentations at their workshops. PDF versions of the presentation slides were included in the ISC 2016 online proceedings, which were made available online to conference attendees a few days after the conference.

The workshop proceedings volume collects all the accepted papers of the workshops with a call for papers. Each chapter of the book contains the accepted and revised papers for one of the workshops. For some workshops, an additional preface describes the review process for the workshop and provides a summary of the outcome.

June 2016

Michela Taufer  
Bernd Mohr  
Julian M. Kunkel

# Organization

## ISC High Performance Workshops Co-chairs

|                |                                        |
|----------------|----------------------------------------|
| Bernd Mohr     | Forschungszentrum Jülich GmbH, Germany |
| Michela Taufer | University of Delaware, USA            |

## ISC High Performance Workshops Committee

|                        |                                             |
|------------------------|---------------------------------------------|
| Rosa M. Badia          | Barcelona Supercomputing Center, Spain      |
| François Bodin         | University of Rennes, France                |
| Bronis R. de Supinski  | Lawrence Livermore National Laboratory, USA |
| Jay Lofstead           | Sandia National Laboratories, USA           |
| Craig Lucas            | NAG, UK                                     |
| Naoya Maruyama         | RIKEN, Japan                                |
| Satoshi Matsuoka       | Tokyo Institute of Technology, Japan        |
| Marie-Christine Sawley | Intel, France                               |
| Seetharami Seelam      | IBM T.J. Watson Research Center, USA        |
| John Shalf             | Lawrence Berkeley National Laboratory, USA  |
| Antonino Tumeo         | Pacific Northwest National Laboratory, USA  |

## ISC High Performance Workshops Proceedings Chair

|               |               |
|---------------|---------------|
| Julian Kunkel | DKRZ, Germany |
|---------------|---------------|

## International Workshop on OpenPOWER for HPC (IWOPH)

## Organizing Committee

|              |                                       |
|--------------|---------------------------------------|
| Dirk Pleiter | Jülich Supercomputing Centre, Germany |
| Jack Wells   | Oak Ridge National Laboratory, USA    |

## Program Committee

|                       |                                               |
|-----------------------|-----------------------------------------------|
| Zaid Al-Ars           | TU Delft, The Netherlands                     |
| Mike Ashworth         | STFC, UK                                      |
| Costas Bekas          | IBM, Switzerland                              |
| Sunita Chandrasekaran | University of Delaware, USA                   |
| Norbert Eicker        | Jülich Supercomputing Centre, Germany         |
| Oscar Hernandez       | Oak Ridge National Laboratory, USA (Co-chair) |
| Guido Juckeland       | TU Dresden, Germany                           |

|                    |                                               |
|--------------------|-----------------------------------------------|
| Graham Lopez       | Oak Ridge National Laboratory, USA (Co-chair) |
| Barney Maccabe     | Oak Ridge National Laboratory, USA            |
| Marek Michalewicz  | A-Star, Singapore                             |
| Rob Neely          | Lawrence Livermore National Laboratory, USA   |
| Kevin O'Brien      | IBM, USA                                      |
| Duncan Poole       | NVIDIA, USA                                   |
| Swaroop Pophale    | Oak Ridge National Laboratory, USA            |
| Maciej Remiszewski | ICM, Poland                                   |
| Vivek Sarkar       | Rice University, USA                          |
| Jim Sexton         | IBM, USA                                      |
| Gilad Shainer      | Mellanox, Israel                              |
| Pavel Shamis       | Oak Ridge National Laboratory, USA            |
| Sameer Shende      | University of Oregon, USA                     |
| Tjerk Straatsma    | Oak Ridge National Laboratory, USA            |
| Bronis de Supinski | Lawrence Livermore National Laboratory, USA   |
| Michael Wolfe      | PGI, USA                                      |

## **Workshop on Performance & Scalability of Storage Systems (WOPSSS)**

### **Organizing Committee**

Jean-Thomas Acquaviva      DDN, USA

### **Program Committee**

|                     |                                                       |
|---------------------|-------------------------------------------------------|
| Francisco J. Alfaro | University of Castilla-La Mancha, Spain               |
| André Brinkmann     | Mainz University, Germany                             |
| Jason Chun Xue      | City University of Hong Kong, Hong Kong,<br>SAR China |
| Toni Cortes         | Barcelona Supercomputing Centre, Spain                |
| Stefano Cozzini     | NR, Italy                                             |
| Liu Duo             | Chongqing University, China                           |
| Juan Piernas        | University of Murcia, Spain                           |
| Rekha Singhal       | Tata CS Innovation Labs, India                        |

## **International Workshop on Performance Portable Programming Models for Accelerators (P<sup>3</sup>MA)**

### **Organizing Committee**

Sunita Chandrasekaran      University of Delaware, USA  
Graham Lopez      Oak Ridge National Laboratory, USA

## Program Committee

|                   |                                        |
|-------------------|----------------------------------------|
| Samuel Thibault   | Inria, University of Bordeaux, France  |
| James Beyer       | NVIDIA, USA                            |
| Wei Ding          | AMD, USA                               |
| Saber Feki        | King Abdullah University, Saudi Arabia |
| Robert Henschel   | Indiana University, USA                |
| Michael Klemm     | Intel, USA                             |
| Eric Stotzer      | Texas Instruments, USA                 |
| Amit Amritkar     | University of Houston, USA             |
| Guido Juckeland   | HZDR, Germany                          |
| Will Sawyer       | ETH, Zurich                            |
| Sameer Shende     | University of Oregon, USA              |
| Costas Bekas      | IBM Zurich, Switzerland                |
| Toni Collis       | University of Edinburgh, UK            |
| Adrian Jackson    | University of Edinburgh, UK            |
| Henri Jin         | NASA, USA                              |
| Andreas Knuepfer  | TU Dresden, Germany                    |
| Steven Olivier    | Sandia National Laboratory, USA        |
| Suraj Prabhakaran | TU Darmstadt, Germany                  |
| Bora Ucar         | ENS Lyon, France                       |
| Sandra Wienke     | Aachen University, Germany             |

## Application Performance on Intel Xeon Phi – Being Prepared for KNL & Beyond (IXPUG)

### Organizing Committee

|                |                                                      |
|----------------|------------------------------------------------------|
| Richard Gerber | NERSC and Lawrence Berkeley National Laboratory, USA |
| Kent Milfeld   | TACC, USA                                            |
| Chris Newburn  | Intel, USA                                           |
| Thomas Steinke | ZIB, Germany                                         |

### Program Committee

|                       |                                                      |
|-----------------------|------------------------------------------------------|
| Damian Alvarez-Mallon | Forschungszentrum Jülich GmbH, Germany               |
| Ryan Coleman          | Sandia National Laboratories, USA                    |
| Douglas Doerfler      | NERSC and Lawrence Berkeley National Laboratory, USA |
| Antonio Gomez         | TACC, USA                                            |
| Simon Hammond         | Sandia National Laboratories, USA                    |
| Rahul Hardikar        | Indian Institute of Science, India                   |
| Helen He              | NERSC and Lawrence Berkeley National Laboratory, USA |



|                      |                                            |
|----------------------|--------------------------------------------|
| Dave M. Hiatt        |                                            |
| Michael Klemm        | Intel, Germany                             |
| Lars Koesterke       | TACC, USA                                  |
| Rakesh Krishnaiyer   | Intel, USA                                 |
| Olli-Pekka Lehto     | CSC - IT Center for Science Ltd., Finland  |
| John Linford         | ParaTools, Inc., USA                       |
| Simon McIntosh-Smith | Bristol University, UK                     |
| John Michalakes      | NREL, USA                                  |
| Dmitry Prohorov      | Intel, USA                                 |
| Karthik Raman        | Intel, USA                                 |
| Carlos Rosales       | TACC, USA                                  |
| Hideki Saito         | Intel, USA                                 |
| Abhinav Sarje        | Lawrence Berkeley National Laboratory, USA |
| Estella Suarez       | Forschungszentrum Jülich GmbH, Germany     |
| Srinath Vadlamani    | Paratools, Inc., USA                       |
| Jerome Vienne        | TACC, USA                                  |

## **HPC I/O in the Data Center (HPC-IODC)**

### **Organizing Committee**

|                 |                                   |
|-----------------|-----------------------------------|
| Julian Kunkel   | DKRZ, Germany                     |
| Jay Lofstead    | Sandia National Laboratories, USA |
| Colin McMurtrie | CSCS, Switzerland                 |

### **Program Committee**

|                    |                                                                           |
|--------------------|---------------------------------------------------------------------------|
| Wolfgang Frings    | Jülich Supercomputing Centre, Germany                                     |
| Javier Garcia Blas | University Carlos III of Madrid, Spain                                    |
| Rob Ross           | Argonne National Laboratory, USA                                          |
| Carlos Maltzahn    | University of California, Santa Cruz, USA                                 |
| Kathryn Mohror     | Lawrence Livermore National Laboratory, USA                               |
| Xiaosong Ma        | North Carolina State University and Oak Ridge<br>National Laboratory, USA |

## **Second International Workshop on Communication Architectures at Extreme Scale (ExaComm)**

### **Organizing Committee**

|                      |                            |
|----------------------|----------------------------|
| Khaled Hamidouche    | Ohio State University, USA |
| Dhabaleswar K. Panda | Ohio State University, USA |
| Hari Subramoni       | Ohio State University, USA |

## Program Committee

|                  |                                                                                                        |
|------------------|--------------------------------------------------------------------------------------------------------|
| Taisuke Boku     | University of Tsukuba, Japan                                                                           |
| Ron Brightwell   | Sandia National Laboratories, USA                                                                      |
| Hans Eberle      | NVIDIA, Germany                                                                                        |
| Ada Gavrilovska  | Georgia Tech, USA                                                                                      |
| Brice Goglin     | Inria, France                                                                                          |
| Dror Goldenberg  | Mellanox Technologies, Israel                                                                          |
| R. Govindarajan  | Indian Institute of Science, Bangalore, India                                                          |
| Hai Jin          | Huazhong University of Science and Technology,<br>Wuhan, China                                         |
| Yutong Lu        | National University of Defense Technology, China                                                       |
| Takeshi Nanri    | University of Kyushu, Japan                                                                            |
| Sebastien Rumley | Columbia University, USA                                                                               |
| Martin Schulz    | Lawrence Livermore National Laboratory, USA                                                            |
| John M. Shalf    | National Energy Research Scientific Computing Center<br>and Lawrence Berkeley National Laboratory, USA |
| Tor Skeie        | Simula Research Laboratory, Norway                                                                     |
| Sayantan Sur     | Intel, USA                                                                                             |
| Xin Yuan         | Florida State University, USA                                                                          |

## Workshop on Exascale Multi/Many Core Computing Systems (E-MuCoCoS)

### Organizing Committee

|              |                             |
|--------------|-----------------------------|
| Sabri Pllana | Linnaeus University, Sweden |
| Achim Streit | KIT, Germany                |

### Program Committee

|                   |                                            |
|-------------------|--------------------------------------------|
| Erika Abraham     | RWTH Aachen University, Germany            |
| Siegfried Benkner | University of Vienna, Austria              |
| Alécio Binotto    | IBM Research, Brazil                       |
| Eduardo Cesar     | UAB, Spain                                 |
| Jiri Dokulil      | University of Vienna, Austria              |
| Samir Genaim      | Universidad Complutense de Madrid, Spain   |
| Einar Broch       | University of Oslo, Norway                 |
| Ivan Kondov       | Karlsruhe Institute of Technology, Germany |
| Renato Miceli     | SENAI CIMATEC, Brazil                      |
| Hiroyuki Takizawa | Tohoku University, Japan                   |
| Samuel Thibault   | LaBRI, University of Bordeaux 1, France    |

## **Workshop on Virtualization in High-Performance Cloud Computing (VHPC'16)**

### **Organizing Committee**

|                                 |                  |
|---------------------------------|------------------|
| Michael Alexander (Chair)       | TU Wien, Austria |
| Anastassios Nanos<br>(Co-chair) | NTUA, Greece     |
| Balazs Gerofi (Co-chair)        | RIKEN, Japan     |

### **Program Committee**

|                       |                                                 |
|-----------------------|-------------------------------------------------|
| Stergios Anastasiadis | University of Ioannina, Greece                  |
| Costas Bekas          | IBM Zurich Research Laboratory, Switzerland     |
| Jakob Blomer          | CERN                                            |
| Ron Brightwell        | Sandia National Laboratories, USA               |
| Roberto Canonico      | University of Napoli Federico II, Italy         |
| Julian Chesterfield   | OnApp, UK                                       |
| Stephen Crago         | USC ISI, USA                                    |
| Christoffer Dall      | Columbia University, USA                        |
| Patrick Dreher        | MIT, USA                                        |
| Robert Futrick        | Cycle Computing, USA                            |
| Robert Gardner        | University of Chicago, USA                      |
| William Gardner       | University of Guelph, Canada                    |
| Wolfgang Gentzsch     | UberCloud, USA                                  |
| Kyle Hale             | Northwestern University, USA                    |
| Marcus Hardt          | Karlsruhe Institute of Technology, Germany      |
| Krishna Kant          | Temple University, USA                          |
| Romeo Kinzler         | IBM, Switzerland                                |
| Brian Kocoloski       | University of Pittsburgh, USA                   |
| Kornilios Kourtis     | IBM Research, Switzerland                       |
| Nectarios Koziris     | National Technical University of Athens, Greece |
| John Lange            | University of Pittsburgh, USA                   |
| Nikos Parlavantzas    | IRISA, France                                   |
| Kevin Pendretti       | Sandia National Laboratories, USA               |
| Che-Rung Roger Lee    | National Tsing Hua University, Taiwan           |
| Giuseppe Lettieri     | University of Pisa, Italy                       |
| Qing Liu              | Oak Ridge National Laboratory, USA              |
| Paul Mundt            | Adaptant, Germany                               |
| Amer Qouneh           | University of Florida, USA                      |
| Carlos Reaño          | Technical University of Valencia, Spain         |
| Seetharami Seelam     | IBM Research, USA                               |
| Dieter Suess          | TU Wien, Austria                                |
| Josh Simons           | VMWare, USA                                     |
| Borja Sotomayor       | University of Chicago, USA                      |

|                    |                                           |
|--------------------|-------------------------------------------|
| Craig Stewart      | Indiana University, USA                   |
| Anata Tiwari       | San Diego Supercomputer Center, USA       |
| Kurt Tutschku      | Blekinge Institute of Technology, Sweden  |
| Amit Vadudevan     | Carnegie Mellon University, USA           |
| Yasuhiro Watashiba | Osaka University, Japan                   |
| Nicholas Wright    | Lawrence Berkely National Laboratory, USA |
| Chao-Tung Yang     | Tunghai University, Taiwan                |
| Gianluigi Zanetti  | CRS4, Italy                               |

# Contents

## E-MuCoCoS

|                                                                                                                                                                                         |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 2016 Workshop on Exascale Multi/Many Core Computing Systems<br>(E-MuCoCoS) . . . . .                                                                                                    | 2  |
| <i>Sabri Pllana and Achim Streit</i>                                                                                                                                                    |    |
| Behavioral Emulation for Scalable Design-Space Exploration of Algorithms<br>and Architectures . . . . .                                                                                 | 5  |
| <i>Nalini Kumar, Carlo Pascoe, Christopher Hajas, Herman Lam,<br/>Greg Stitt, and Alan George</i>                                                                                       |    |
| Closing the Performance Gap with Modern C++. . . . .                                                                                                                                    | 18 |
| <i>Thomas Heller, Hartmut Kaiser, Patrick Diehl, Dietmar Fey,<br/>and Marc Alexander Schweitzer</i>                                                                                     |    |
| Energy Efficient Runtime Framework for Exascale Systems . . . . .                                                                                                                       | 32 |
| <i>Yousri Mhedheb and Achim Streit</i>                                                                                                                                                  |    |
| Extreme-Scale In Situ Visualization of Turbulent Flows on IBM Blue<br>Gene/Q JUQUEEN . . . . .                                                                                          | 45 |
| <i>Jens Henrik Göbbert, Mathis Bode, and Brian J.N. Wylie</i>                                                                                                                           |    |
| The EPiGRAM Project: Preparing Parallel Programming Models<br>for Exascale . . . . .                                                                                                    | 56 |
| <i>Stefano Markidis, Ivy Bo Peng, Jesper Larsson Träff, Antoine Rougier,<br/>Valeria Bartsch, Rui Machado, Mirko Rahn, Alistair Hart,<br/>Daniel Holmes, Mark Bull, and Erwin Laure</i> |    |
| Work Distribution of Data-Parallel Applications on Heterogeneous Systems . . .                                                                                                          | 69 |
| <i>Suejb Memeti and Sabri Pllana</i>                                                                                                                                                    |    |

## ExaComm

|                                                                                                                |    |
|----------------------------------------------------------------------------------------------------------------|----|
| Reducing Manipulation Overhead of Remote Data-Structure by Controlling<br>Remote Memory Access Order . . . . . | 85 |
| <i>Yuichiro Ajima, Takafumi Nose, Kazushige Saga, Naoyuki Shida,<br/>and Shinji Sumimoto</i>                   |    |
| SONAR: Automated Communication Characterization<br>for HPC Applications . . . . .                              | 98 |
| <i>Steffen Lammel, Felix Zahn, and Holger Fröning</i>                                                          |    |

**HPC-IODC**

|                                                                                                                                                |     |
|------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| HPC I/O in the Data Center Workshop (HPC-IODC). . . . .                                                                                        | 116 |
| <i>Julian M. Kunkel, Jay Lofstead, and Colin McMurtrie</i>                                                                                     |     |
| An Overview of the Sirocco Parallel Storage System. . . . .                                                                                    | 121 |
| <i>Matthew L. Curry, H. Lee Ward, Geoff Danielson, and Jay Lofstead</i>                                                                        |     |
| Analyzing Data Properties Using Statistical Sampling Techniques –<br>Illustrated on Scientific File Formats and Compression Features . . . . . | 130 |
| <i>Julian M. Kunkel</i>                                                                                                                        |     |
| Delta: Data Reduction for Integrated Application Workflows<br>and Data Storage. . . . .                                                        | 142 |
| <i>Jay Lofstead, Gregory Jean-Baptiste, and Ron Oldfield</i>                                                                                   |     |
| Investigating Read Performance of Python and NetCDF When<br>Using HPC Parallel Filesystems . . . . .                                           | 153 |
| <i>Matthew Jones, Jon Blower, Bryan Lawrence, and Annette Osprey</i>                                                                           |     |

**IWOPH**

|                                                                                                                                                                     |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| International Workshop on OpenPOWER for HPC (IWOPH). . . . .                                                                                                        | 170 |
| <i>Oscar R. Hernandez, M. Graham Lopez, Dirk Pleiter, and Jack Wells</i>                                                                                            |     |
| Early Application Performance at the Hartree Centre<br>with the OpenPOWER Architecture. . . . .                                                                     | 173 |
| <i>Mike Ashworth, Jianping Meng, Vedran Novakovic, and Sersi Siso</i>                                                                                               |     |
| Early Experiences Porting the NAMD and VMD Molecular Simulation<br>and Analysis Software to GPU-Accelerated OpenPOWER Platforms . . . . .                           | 188 |
| <i>John E. Stone, Antti-Pekka Hynninen, James C. Phillips,<br/>and Klaus Schulten</i>                                                                               |     |
| Exploring Energy Efficiency for GPU-Accelerated POWER Servers . . . . .                                                                                             | 207 |
| <i>Thorsten Hater, Benedikt Anlauf, Paul Baumeister, Markus Bühler,<br/>Jiri Kraus, and Dirk Pleiter</i>                                                            |     |
| First Experiences with <i>ab initio</i> Molecular Dynamics on OpenPOWER:<br>The Case of CPMD. . . . .                                                               | 228 |
| <i>Valéry Weber, A. Cristiano I. Malossi, Ivano Tavernelli, Teodoro Laino,<br/>Costas Bekas, Manish Modani, Nina Wilner, Tom Heller,<br/>and Alessandro Curioni</i> |     |
| High Performance Computing on the IBM Power8 Platform. . . . .                                                                                                      | 235 |
| <i>István Z. Reguly, Abdoul-Kader Keita, Rafik Zurob,<br/>and Michael B. Giles</i>                                                                                  |     |

|                                                                                                                                                                    |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Measuring and Managing Energy in OpenPOWER . . . . .                                                                                                               | 255 |
| <i>Todd Rosedah, Charles Lefurgy, and Martha Broyles</i>                                                                                                           |     |
| Performance Analysis of Spark/GraphX on POWER8 Cluster. . . . .                                                                                                    | 268 |
| <i>Xinyu Que, Lars Schneidenbach, Fabio Checconi, Carlos H.Á. Costa, and Daniele Buono</i>                                                                         |     |
| Performance of the 3D Combustion Simulation Code RECOM®-AIOLOS on IBM® POWER8® Architecture . . . . .                                                              | 286 |
| <i>Alexander Berreth, Benedetto Risio, Markus Bühler, Benedikt Anlauf, and Pascal Vezolle</i>                                                                      |     |
| Performance-Portable Many-Core Plasma Simulations: Porting PIconGPU to OpenPower and Beyond. . . . .                                                               | 293 |
| <i>Erik Zenker, René Widera, Axel Huebl, Guido Juckeland, Andreas Knüpfer, Wolfgang E. Nagel, and Michael Bussmann</i>                                             |     |
| <b>IXPUG</b>                                                                                                                                                       |     |
| Application Performance on Intel Xeon Phi – Being Prepared for KNL and Beyond . . . . .                                                                            | 304 |
| <i>Richard A. Gerber, Kent Milfeld, Chris J. Newburn, and Thomas Steinke</i>                                                                                       |     |
| A Comparative Study of Application Performance and Scalability on the Intel Knights Landing Processor . . . . .                                                    | 307 |
| <i>Carlos Rosales, John Cazes, Kent Milfeld, Antonio Gómez-Iglesias, Lars Koesterke, Lei Huang, and Jerome Vienne</i>                                              |     |
| Application Suitability Assessment for Many-Core Targets. . . . .                                                                                                  | 319 |
| <i>Chris J. Newburn, Jim Sukha, Ilya Sharapov, Anthony D. Nguyen, and Chyi-Chang Miao</i>                                                                          |     |
| Applying the Roofline Performance Model to the Intel Xeon Phi Knights Landing Processor. . . . .                                                                   | 339 |
| <i>Douglas Doerfler, Jack Deslippe, Samuel Williams, Leonid Oliker, Brandon Cook, Thorsten Kurth, Mathieu Lobet, Tareq Malas, Jean-Luc Vay, and Henri Vincenti</i> |     |
| Dynamic SIMD Vector Lane Scheduling . . . . .                                                                                                                      | 354 |
| <i>Olaf Krzikalla, Florian Wende, and Markus Höhnerbach</i>                                                                                                        |     |
| High Performance Optimizations for Nuclear Physics Code MFDn on KNL . . .                                                                                          | 366 |
| <i>Brandon Cook, Pieter Maris, Meiyue Shao, Nathan Wichmann, Marcus Wagner, John O'Neill, Thanh Phung, and Gaurav Bansal</i>                                       |     |
| Optimization of the Sparse Matrix-Vector Products of an IDR Krylov Iterative Solver in EMGeo for the Intel KNL Manycore Processor . . . . .                        | 378 |
| <i>Tareq Malas, Thorsten Kurth, and Jack Deslippe</i>                                                                                                              |     |

|                                                                                                                                                                                                                                                                                                                                                    |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Optimizing a Multiple Right-Hand Side Dslash Kernel for Intel Knights Corner . . . . .                                                                                                                                                                                                                                                             | 390 |
| <i>Aaron Walden, Sabbir Khan, Bálint Joó, Desh Ranjan, and Mohammad Zubair</i>                                                                                                                                                                                                                                                                     |     |
| Optimizing Excited-State Electronic-Structure Codes for Intel Knights Landing: A Case Study on the BerkeleyGW Software . . . . .                                                                                                                                                                                                                   | 402 |
| <i>Jack Deslippe, Felipe H. da Jornada, Derek Vigil-Fowler, Taylor Barnes, Nathan Wichmann, Karthik Raman, Ruchira Sasanka, and Steven G. Louie</i>                                                                                                                                                                                                |     |
| Optimizing Wilson-Dirac Operator and Linear Solvers for Intel® KNL . . . . .                                                                                                                                                                                                                                                                       | 415 |
| <i>Bálint Joó, Dhiraj D. Kalamkar, Thorsten Kurth, Karthikeyan Vaidyanathan, and Aaron Walden</i>                                                                                                                                                                                                                                                  |     |
| <b>P<sup>3</sup>MA</b>                                                                                                                                                                                                                                                                                                                             |     |
| First International Workshop on Performance Portable Programming Models for Accelerators (P <sup>3</sup> MA). . . . .                                                                                                                                                                                                                              | 430 |
| A C++ Programming Model for Heterogeneous System Architecture . . . . .                                                                                                                                                                                                                                                                            | 433 |
| <i>Ralph Potter, Russell Bradford, Alastair Murray, and Uwe Dolinsky</i>                                                                                                                                                                                                                                                                           |     |
| Battling Memory Requirements of Array Programming Through Streaming . . .                                                                                                                                                                                                                                                                          | 451 |
| <i>Mads R.B. Kristensen, James Avery, Troels Blum, Simon Andreas Frimann Lund, and Brian Vinter</i>                                                                                                                                                                                                                                                |     |
| From Describing to Prescribing Parallelism: Translating the SPEC ACCEL OpenACC Suite to OpenMP Target Directives . . . . .                                                                                                                                                                                                                         | 470 |
| <i>Guido Juckeland, Oscar Hernandez, Arpith C. Jacob, Daniel Neilson, Verónica G. Vergara Larrea, Sandra Wienke, Alexander Bobyr, William C. Brantley, Sunita Chandrasekaran, Mathew Colgrove, Alexander Grund, Robert Henschel, Wayne Joubert, Matthias S. Müller, Dave Raddatz, Pavel Shelepugin, Brian Whitney, Bo Wang, and Kalyan Kumaran</i> |     |
| GPU-STREAM v2.0: Benchmarking the Achievable Memory Bandwidth of Many-Core Processors Across Diverse Parallel Programming Models . . . .                                                                                                                                                                                                           | 489 |
| <i>Tom Deakin, James Price, Matt Martineau, and Simon McIntosh-Smith</i>                                                                                                                                                                                                                                                                           |     |
| Porting the MPI Parallelized LES Model PALM to Multi-GPU Systems – An Experience Report . . . . .                                                                                                                                                                                                                                                  | 508 |
| <i>Helge Knoop, Tobias Gronemeier, Christoph Knigge, and Peter Steinbach</i>                                                                                                                                                                                                                                                                       |     |



|                                                                                                                              |     |
|------------------------------------------------------------------------------------------------------------------------------|-----|
| Software Cost Analysis of GPU-Accelerated Aeroacoustics Simulations<br>in C++ with OpenACC . . . . .                         | 524 |
| <i>Marco Nicolini, Julian Miller, Sandra Wienke,<br/>Michael Schlottke-Lakemper, Matthias Meinke, and Matthias S. Müller</i> |     |
| Task-Based Cholesky Decomposition on Knights Corner Using OpenMP. . . .                                                      | 544 |
| <i>Joseph Dorris, Jakub Kurzak, Piotr Luszczek, Asim YarKhan,<br/>and Jack Dongarra</i>                                      |     |
| Using C++ AMP to Accelerate HPC Applications on Multiple Platforms . . . .                                                   | 563 |
| <i>M. Graham Lopez, Christopher Bergstrom, Ying Wai Li, Wael Elwasif,<br/>and Oscar Hernandez</i>                            |     |

## WOPSSS

|                                                                                                                                                                      |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Analysis of Memory Performance: Mixed Rank Performance<br>Across Microarchitectures . . . . .                                                                        | 579 |
| <i>Mourad Bouache, John L. Glover III, and Jalil Boukhobza</i>                                                                                                       |     |
| Considering I/O Processing in CloudSim for Performance and Energy<br>Evaluation . . . . .                                                                            | 591 |
| <i>Hamza Ouarnoughi, Jalil Boukhobza, Frank Singhoff, Stéphane Rubini,<br/>and Erwann Kassis</i>                                                                     |     |
| Early Evaluation of the “Infinite Memory Engine” Burst Buffer Solution . . . .                                                                                       | 604 |
| <i>Wolfram Schenck, Salem El Sayed, Maciej Foszczynski,<br/>Wilhelm Homberg, and Dirk Pleiter</i>                                                                    |     |
| Motivation and Implementation of a Dynamic Remote Storage System<br>for I/O Demanding HPC Applications . . . . .                                                     | 616 |
| <i>Matthias Neuer, Jürgen Salk, Holger Berger, Erich Focht,<br/>Christian Mosch, Karsten Siegmund, Volodymyr Kushnarenko,<br/>Stefan Kombrink, and Stefan Wesner</i> |     |
| Parallel I/O Architecture Modelling Based on File System Counters . . . . .                                                                                          | 627 |
| <i>Salem El Sayed, Matthias Bolten, and Dirk Pleiter</i>                                                                                                             |     |
| User-Space I/O for $\mu$ s-level Storage Devices. . . . .                                                                                                            | 638 |
| <i>Anastasios Papagiannis, Giorgos Saloustros, Manolis Marazakis,<br/>and Angelos Bilas</i>                                                                          |     |
| Scaling Spark on Lustre. . . . .                                                                                                                                     | 649 |
| <i>Nicholas Chaimov, Allen Malony, Costin Iancu, and Khaled Ibrahim</i>                                                                                              |     |

**VHPC**

|                                                                                              |     |
|----------------------------------------------------------------------------------------------|-----|
| Accelerating Application Migration in HPC . . . . .                                          | 663 |
| <i>Ramy Gad, Simon Pickartz, Tim Süß, Lars Nagel, Stefan Lankes,<br/>and André Brinkmann</i> |     |
| Migrating Linux Containers Using CRIU . . . . .                                              | 674 |
| <i>Simon Pickartz, Niklas Eiling, Stefan Lankes, Lukas Razik,<br/>and Antonello Monti</i>    |     |
| Providing Security in Container-Based HPC Runtime Environments . . . . .                     | 685 |
| <i>Holger Gantikow, Christoph Reich, Martin Knahl, and Nathan Clarke</i>                     |     |
| <b>Author Index</b> . . . . .                                                                | 697 |