## 2018 IEEE International Parallel and Distributed Processing Symposium (IPDPS 2018)

Vancouver, British Columbia, Canada 21-25 May 2018

Pages 1-588



**IEEE Catalog Number: ISBN:** 

CFP18023-POD 978-1-5386-4369-3

## Copyright © 2018 by the Institute of Electrical and Electronics Engineers, Inc. All Rights Reserved

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

\*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.

 IEEE Catalog Number:
 CFP18023-POD

 ISBN (Print-On-Demand):
 978-1-5386-4369-3

 ISBN (Online):
 978-1-5386-4368-6

ISSN: 1530-2075

#### Additional Copies of This Publication Are Available From:

Curran Associates, Inc 57 Morehouse Lane Red Hook, NY 12571 USA Phone: (845) 758-0400

Fax: (845) 758-2633

E-mail: curran@proceedings.com Web: www.proceedings.com



# 2018 IEEE International Parallel and Distributed Processing Symposium IPDPS 2018

#### **Table of Contents**

Massaca fuens the Consuel Chein un
Message from the General Chair xx.  Message from the Program Chair and Vice Chair xxii
Technical Program xxiv.
Conference Organization xxyii
Outside Reviewers xxxvi
Keynote 1
The Algorithmics of Write Optimization .1.  Michael A. Bender (Stony Brook University)
Session 1: Graph Algorithms 1
MIDAS: Multilinear Detection at Scale 2
Optimizing Parallel Graph Connectivity Computation via Subgraph Sampling .12
Parallel Algorithms Through Approximation: B-Edge Cover .22
A Parallel Algorithm for Bayesian Network Inference Using Arithmetic Circuits 34
Session 2: Large-Scale Applications 1
Cataloging the Visible Universe Through Bayesian Inference at Petascale .44.  Jeffrey Regier (University of California), Kiran Pamnany (Intel Corporation), Keno Fischer, Andreas Noack, Maximilian Lam, Jarrett Revels, Steve Howard, Ryan Giordano, David Schlegel, Jon McAuliffe, Rollin Thomas, and Prabhat _ (Lawrence Berkeley National Laboratory)

Efficient, Parallel At-Scale Correlation Analysis for Atom Probe Tomography on Hybrid Architectures .54...... Hao Lu (Oak Ridge National Laboratory), Sudip K. Seal (Oak Ridge National Laboratory), Gregory Muzyn (University of Tennessee), Wei Guo (Oak Ridge National Laboratory), and Jonathan D. Poplawsky (Oak Ridge National Laboratory) A Fast and Massively-Parallel Inverse Solver for Multiple-Scattering Tomographic Image Reconstruction 64. Mert Hidayetoglu (University of Illinois at Urbana-Champaign), Carl Pearson (University of Illinois at Urbana-Champaign), Izzat El Hajj (University of Illinois at Urbana-Champaign), Levent Gurel (University of Illinois at Urbana-Champaign), Weng Cho Chew (University of Illinois at Urbana-Champaign), and Wen-Mei Hwu (University of Illinois at Urbana-Champaign) Real-Time Massively Distributed Multi-object Adaptive Optics Simulations for the European Extremely Large Telescope 75. Hatem Ltaief (KAUST), Ali Charara (KAUST), Damien Gratadour (Observatoire de Paris), Nicolas Doucet (Observatoire de Paris), Bilel Hadri (KAUST), Eric Gendron (Observatoire de Paris), Saber Feki (KAUST), and David Keyes (KAUST) **Session 3: Performance / QoS / Resilience** Performance Isolation of Data-Intensive Scale-out Applications in a Multi-tenant Cloud .85..... Palden Lama (University of Texas at San Antonio), Shaoqi Wang (University of Colorado), Xiaobo Zhou (University of Colorado), and Dazhao Cheng (University of North Carolina at Charlotte) QoS Support for Scientific Workflows Using Software-Defined Storage Resource Enclaves 95..... Suman Karki (Washington State University Vancouver), Bao Nguyen (Washington State University Vancouver), and Xuechen Zhang (Washington State University Vancouver) Scalable Data Resilience for In-Memory Data Staging .105. Shaohua Duan (Rutgers Discovery Informatics Institute), Pradeep Subedi (Rutgers Discovery Informatics Institute), Keita Teranishi (Sandia National Labortory), Philip Davis (Rutgers Discovery Informatics Institute), Hemanth Kolla (Sandia National Labortory), Marc Gamell (Intel Corporation), and Manish Parashar (Rutgers Discovery Informatics Institute) Performance and Scalability of Lightweight Multi-kernel Based Operating Systems .116. Balazs Gerofi (RIKEN Advanced Institute For Computational Science), Rolf Riesen (Intel Corporation), Masamichi Takagi (RIKEN Advanced Institute For Computational Science), Taisuke Boku (University of Tsukuba), Kengo Nakajima (University of Tokyo), Yutaka Ishikawa (RIKEN Advanced Institute For Computational Science), and Robert W. Wisniewski (Intel Corporation)

## **Session 4: Memory Designs and Optimizations**

Efficient Gradient Boosted Decision Tree Training on GPUs 234.  Zeyi Wen (National University of Singapore), Bingsheng He (National University of Singapore), Ramamohanarao Kotagiri (The University of Melbourne), Shengliang Lu (National University of Singapore), and Jiashuai Shi (South China University of Technology)
BitFlow: Exploiting Vector Parallelism for Binary Neural Networks on CPU .244
Session 7: Compilers and Libraries
Lightweight MPI Communicators with Applications to Perfectly Balanced Quicksort .254
Improving Network Throughput with Global Communication Reordering .266.  Wim Lavrijsen (LBNL), Costin Iancu (LBNL), and Xing Pan (UNC)
Highly Efficient Compensation-Based Parallelism for Wavefront Loops on GPUs .276.  Kaixi Hou (Virginia Tech), Hao Wang (Virginia Tech), Wu-chun Feng (Virginia Tech), Jeffrey S. Vetter (Oak Ridge National Lab), and Seyong Lee (Oak Ridge National Lab)
Development and Application of a Hybrid Programming Environment on an ARM/DSP System for High Performance Computing 286
Session 8: Optimizations for Emerging Storage Systems
GC-Aware Request Steering with Improved Performance and Reliability for SSD-Based RAIDs .296
A Set-aware Key-Value Store on Shingled Magnetic Recording Drives with Dynamic Band 306
Software-Hardware Managed Last-level Cache Allocation Scheme for Large-Scale NVRAM-Based Multicores Executing Parallel Data Analytics Applications 3.16

MOCA: Memory Object Classification and Allocation in Heterogeneous Memory Systems .326
Best Paper Nominees - Plenary
Communication-Free Massively Distributed Graph Generation 336.  Daniel Funke (Karlsruhe Institute of Technology), Sebastian Lamm (Karlsruhe Institute of Technology), Peter Sanders (Karlsruhe Institute of Technology), Christian Schulz (Karlsruhe Institute of Technology), Darren Strash (Karlsruhe Institute of Technology), and Moritz von Looz (Karlsruhe Institute of Technology)
Understanding and Modeling Lossy Compression Schemes on HPC Scientific Data .348.  Tao Lu (New Jersey Institute of Technology), Qing Liu (New Jersey Institute of Technology), Xubin He (Temple University), Huizhang Luo (New Jersey Institute of Technology), Eric Suchyta (Oak Ridge National Laboratory), Jong Choi (Oak Ridge National Laboratory), Norbert Podhorszki (Oak Ridge National Laboratory), Scott Klasky (Oak Ridge National Laboratory), Mathew Wolf (Oak Ridge National Laboratory), Tong Liu (Temple University), and Zhenbo Qiao (New Jersey Institute of Technology)
UBIS: Utilization-Aware Cluster Scheduling 358  Karthik Kambatla (Facebook Inc.), Vamsee Yarlagadda (Cloudera Inc.),  Íñigo Goiri (Microsoft Research), and Ananth Grama (Purdue University)
Hardware Transactional Memory Meets Memory Persistency .368
Keynote 2
Empowering Flexible and Scalable High Performance Architectures with Embedded Photonics .378
Session 9: Numerical Algorithms
Large Bandwidth-Efficient FFTs on Multicore and Multi-socket Systems .3.79.  Doru Thom Popovici (Carnegie Mellon University), Tze Meng Low (Carnegie Mellon University), and Franz Franchetti (Carnegie Mellon University)
Lattice H-Matrices on Distributed-Memory Systems 389.  Akihiro Ida (The University of Tokyo)

Evaluating the Performance and Cost of Accelerating Seismic Processing with CUDA, OpenCL, OpenACC, and OpenMP 399
Tiago Lobato Gimenes (Institute of Computing - University of
Campinas), Flávia Pisani (Institute of Computing - University of
Campinas), and Edson Borin (Institute of Computing - University of Campinas)
Avoiding Synchronization in First-Order Methods for Sparse Convex Optimization .409
Aditya Devarakonda (University of California), Kimon Fountoulakis
(University of California), James Demmel (University of California),
and Michael W. Mahoney (University of California)
Session 10: GPU Hashing and Searching
A Dynamic Hash Table for the GPU 4.19
GPU LSM: A Dynamic Dictionary Data Structure for the GPU .430
California), Martin Farach-Colton (Rutgers University), Nina Amenta
(University of California), and John D. Owens (University of
California)
WarpDrive: Massively Parallel Hashing on Multi-GPU Nodes 441.
Daniel Jünger (Johannes Gutenberg University), Christian Hundt
(Johannes Gutenberg University), and Bertil Schmidt (Johannes
Gutenberg University)
Quotient Filters: Approximate Membership Queries on the GPU .451.
Afton Geil (University of California), Martin Farach-Colton (Rutgers
University), and John Owens (University of California)
Session 11: Domain-Specific, Runtime and Autotuning
BabelFlow: An Embedded Domain Specific Language for Parallel Analysis and Visualization .463
Steve Petruzza (University of Utah), Sean Treichler (Stanford
University), Valerio Pascucci (University of Utah), and Peer-Timo Bremer (Lawrence Livermore National Lab)
Online Tuning of Parallelism Degree in Parallel Nesting Transactional Memory .474
Jingna Zeng (Kungliga Tekniska högskolan), Paolo Romano (Instituto
Superior Técnico), João Barreto (Instituto Superior Técnico), Luís
Rodrigues (Instituto Superior Técnico), and Seif Haridi (Kungliga
Tekniska högskolan/RISE SICS)
Work-Stealing, Locality-Aware Actor Scheduling .484.
Saman Barghi (University of Waterloo) and Martin Karsten (University
of Waterloo)

ndigo: A Domain-Specific Language for Fast, Portable Image Reconstruction .495.  Michael Driscoll (UC Berkeley and LBNL), Benjamin Brock (UC Berkeley and LBNL), Frank Ong (UC Berkeley), Jonathan Tamir (UC Berkeley), Hsiou-Yuan Liu (UC Berkeley), Michael Lustig (UC Berkeley), Armando Fox (UC Berkeley), and Katherine Yelick (UC Berkeley and LBNL)
Session 12: Resource Management
Swallow: Joint Online Scheduling and Coflow Compression in Datacenter Networks .505
Auto-tuning Streamed Applications on Intel Xeon Phi .5.15  Peng Zhang (National University of Defense Technology), Jianbin Fang (National University of Defense Technology), Tao Tang (National University of Defense Technology), Canqun Yang (National University of Defense Technology), and Zheng Wang (Lancaster University)
Analyzing Resource Trade-offs in Hardware Overprovisioned Supercomputers .526.  Ryuichi Sakamoto (The University of Tokyo), Tapasya Patki (Lawrence Livermore National Laboratory), Thang Cao (The University of Tokyo), Masaaki Kondo (The University of Tokyo), Koji Inoue (Kyushu University), Masatsugu Ueda (Kyushu University), Daniel Ellsworth (Colorado College), Barry Rountree (Lawrence Livermore National Laboratory), and Martin Schulz (Technical University of Munich)
Harnessing the Power of Many: Extensible Toolkit for Scalable Ensemble Applications .536
Session 13: Tensors
A Fill Estimation Algorithm for Sparse Matrices and Tensors in Blocked Formats 546
Communication Lower Bounds for Matricized Tensor Times Khatri-Rao Product .557
Blocking Optimization Techniques for Sparse Tensor Computation .568.  Jee Choi (IBM T. J. Watson Research), Xing Liu (Intel), Shaden Smith  (University of Minnesota), and Tyler Simon (University of Maryland)

TTLG - An Efficient Tensor Transposition Library for GPUs .5.78
Session 14: Large Scale Applications 2
Do Developers Understand IEEE Floating Point? .589  Peter Dinda (Northwestern University) and Conor Hetland (Northwestern University)
sDPF-RSA: Utilizing Floating-point Computing Power of GPUs for Massive Digital Signature Computations 599.
Jiankuo Dong (Chinese Academy of Sciences, Beijing), Fangyu Zheng (Chinese Academy of Sciences, Beijing), Niall Emmart (University of Massachusetts), Jingqiang Lin (Chinese Academy of Sciences, Beijing), and Charles Weems (University of Massachusetts)
Rethinking large-scale Economic Modeling for Efficiency: Optimizations for GPU and Xeon Phi Clusters.6.10. Simon Scheidegger (University of Zurich), Dmitry Mikushin (University of Zurich), Felix Kubler (University of Zurich), and Olaf Schenk (Universit a della Svizzera italiana, Switzerland)
A Fast Scalable Implicit Solver with Concentrated Computation for Nonlinear Time-Evolution Problems on Low-Order Unstructured Finite Elements .620
Session 15: Data Operations
Characterizing Scheduling Delay for Low-Latency Data Analytics Workloads .630
Runtime Scheduling Policies for Distributed Graph Algorithms .640.  Jesun Sahariar Firoz (Pacific Northwest National Lab and Indiana University Bloomington), Marcin Zalewski (Pacific Northwest National Lab), Andrew Lumsdaine (Pacific Northwest National Lab and University of Washington), and Martina Barnas (Indiana University Bloomington)
Communication Efficient Checking of Big Data Operations .650

What Size Should Your Buffers to Disks be? .660
Session 16: Power and Temperature
THOR: THermal-aware Optimizations for extending ReRAM Lifetime .67.0.  Majed Valad Beigi (Northwestern University) and Gokhan Memik (Northwestern University)
CoolPIM: Thermal-Aware Source Throttling for Efficient PIM Instruction Offloading .680.  Lifeng Nai (Google), Ramyad Hadidi (Georgia Institute of Technology),  He Xiao (Georgia Institute of Technology), Hyojong Kim (Georgia  Institute of Technology), Jaewoong Sim (Intel Labs), and Hyesoon Kim  (Georgia Institute of Technology)
GreenSprint: Effective Computational Sprinting in Green Data Centers .690.  Haoran Cai (Huazhong University of Science and Technology), Xu Zhou (Sangfor Technologies Co.), Qiang Cao (Huazhong University of Science and Technology), Hong Jiang (University of Texas at Arlington), Feng Sheng (Huazhong University of Science and Technology), Xiandong Qi (Hong Kong University of Science and Technology), Jie Yao (Huazhong University of Science and Technology), Changsheng Xie (Huazhong University of Science and Technology), Liang Xiao (Huazhong University of Science and Technology), and Liang Gu (Sangfor Technologies Co.)
Joint Server and Network Energy Saving in Data Centers for Latency-Sensitive Applications .700
Keynote 3
The Day After Tomorrow: The Looming Post-Exascale Crisis .7.10
Session 17: Graph Algorithms 2
Implicit Decomposition for Write-Efficient Connectivity Algorithms 7.11.  Naama Ben-David (Carnegie Mellon University), Guy Blelloch (Carnegie Mellon University), Jeremy Fineman (Georgetown University), Phillip Gibbons (Carnegie Mellon University), Yan Gu (Carnegie Mellon University), Charles McGuffey (Carnegie Mellon University), and Julian Shun (Carnegie Mellon University)
Distributed Symmetry Breaking in Graphs with Bounded Diversity .723.  Leonid Barenboim (Open University of Israel) and Tzalik Maimon (Open University of Israel)

Complete Visitability for Autonomous Robots on Graphs .733
Session 18: Performance Modeling and Analysis  Roofline Guided Design and Analysis of a Multi-stencil CFD Solver for Multicore Performance .753  Bahareh Mostafazadeh (University of California Irvine), Ferran Marti (University of California Irvine), Feng Liu (University of California
Irvine), and Aparna Chandramowlishwaran (University of California Irvine)  Taming the "Monster": Overcoming Program Optimization Challenges on SW26010 Through Precise Performance Modeling .763.  Shizhen Xu (Tsinghua University), Yuanchao Xu (Tsinghua University),
Wei Xue (Tsinghua University), Yipeng Shen (North Carolina State University), Fang Zheng (National Research Center of Parallel Computer Engineering and Technology), Xiaomeng Huang (Tsinghua University), and Guangwen Yang (Tsinghua University)
Performance and Accuracy Trade-offs of HPC Application Modeling and Simulation .77.4
PADDLE: Performance Analysis Using a Data-Driven Learning Environment .784
Session 19: Memory and Data Access
Efficient Solving of Scan Primitive on Multi-GPU Systems .794.  Adrián Perez Diéguez (University of A Coruña), Margarita Amor (University of A Coruña), Ramón Doallo (University of A Coruña), Akira Nukada (Tokyo Institute of Technology), and Satoshi Matsuoka (Tokyo Institute of Technology)
Quantifying the Performance and Energy-Efficiency Impact of Hardware Transactional Memory on Scientific Applications on Large-Scale NUMA Systems .804.  Jinsu Park (UNIST) and Woongki Baek (UNIST)

GPU-Accelerated Large-Scale Genome Assembly .8.14.  Sayan Goswami (Louisiana State University), Kisung Lee (Louisiana  State University), Shayan Shams (Louisiana State University), and  Seung-Jong Park (Louisiana State University)
GPU Data Access on Complex Geometries for D3Q19 Lattice Boltzmann Method .825
Session 20: Exception Handling & Error Detection
SLIMFAST: Reducing Metadata Redundancy in Sound and Complete Dynamic Data Race Detection .835  Yuanfeng Peng (University of Pennsylvania), Christian DeLozier (University of Pennsylvania), Ariel Eizenberg (University of Pennsylvania), William Mansky (Princeton University), and Joseph Devietti (University of Pennsylvania)
SWORD: A Bounded Memory-Overhead Detector of OpenMP Data Races in Production Runs .845
Unobtrusive Asynchronous Exception Handling with Standard Java Try/Catch Blocks .855.  Mostafa Mehrabi (PhD candidate at the university of Auckland), Nasser  Giacaman (Lecturer at the university of Auckland), and Oliver Sinnen (Senior lecturer at the university of Auckland)
COMPI: Concolic Testing for MPI Applications .865.  Hongbo Li (University of California, Riverside), Sihuan Li (University of California, Riverside), Zachary Benavides (University of California, Riverside), Zizhong Chen (University of California, Riverside), and Rajiv Gupta (University of California, Riverside)
Session 21: Graph Algorithms 3
Experimental Design of Work Chunking for Graph Algorithms on High Bandwidth Memory Architectures .87.5 George M Slota (Rensselaer Polytechnic Institute) and Siva Rajamanickam (Sandia National Labs)
Distributed Louvain Algorithm for Graph Community Detection .885

Northwest National Laboratory), Ananth Kalyanaraman (Washington State

Chavarrià-Miranda (Trovares), Arif Khan (Pacific Northwest National Laboratory), and Assefaw Gebremedhin (Washington State University)

University), Hao Lu (Oak Ridge National Laboratory), Daniel

Application Codesign of Near-Data Processing for Similarity Search .896
Session 22: Linear Solvers
A Communication-Avoiding 3D LU Factorization Algorithm for Sparse Matrices 908.  Piyush Sao (Georgia Institute of Technology), Xiaoye Sherry Li (Lawrence Berkeley National Lab), and Richard Vuduc (Georgia Institute of Technology)
A New GPU Algorithm to Compute a Level Set-Based Analysis for the Parallel Solution of Sparse Triangular Systems .920.  Ernesto Dufrechou (Instituto de Computación) and Pablo Ezzatti (Instituto de Computación)
Performance of Hierarchical-matrix BiCGStab Solver on GPU Clusters .930.  Ichitaro Yamazaki (The University of Tennessee), Ahmad Abdelfattah (The University of Tennessee), Akihiro Ida (The University of Tokyo), Satoshi Ohshima (Kyushu University), Stanimire Tomov (The University of Tennessee), Rio Yokota (Tokyo Institute of Technology), and Jack Dongarra (The University of Tennessee)
Convergence Models and Surprising Results for the Asynchronous Jacobi Method .940
Session 23: Runtime Systems and Libraries
Overhead-Conscious Format Selection for SpMV-Based Applications 950.  Yue Zhao (North Carolina State University), Weijie Zhou (North Carolina State University), Xipeng Shen (North Carolina State University), and Graham Yiu (IBM Toronto Software Lab)
Cudele: An API and Framework for Programmable Consistency and Durability in a Global Namespace .960  Michael A. Sevilla (University of California, Santa Cruz), Ivo Jimenez (University of California, Santa Cruz), Noah Watkins (University of California, Santa Cruz), Jeff LeFevre (University of California, Santa Cruz), Peter Alvaro (University of California, Santa Cruz), Shel Finkelstein (University of California, Santa Cruz), Patrick Donnelly (Red Hat), and Carlos Maltzahn (University of California, Santa Cruz)
SELECT: A Distributed Publish/Subscribe Notification System for Online Social Networks <u>970</u>

A Lightweight Communication Runtime for Distributed Graph Analytics .980.  Hoang-Vu Dang (University of Illinois at Urbana-Champaign), Roshan  Dathathri (The University of Texas at Austin), Gurbinder Gill (The  University of Texas at Austin), Alex Brooks (University of Illinois at  Urbana-Champaign), Nikoli Dryden (University of Illinois at  Urbana-Champaign), Andrew Lenharth (The University of Texas at  Austin), Loc Hoang (The University of Texas at Austin), Keshav Pingali  (The University of Texas at Austin), and Marc Snir (University of  Illinois at Urbana-Champaign)
Session 24: Networks and Communication
Intra-Cluster Coalescing to Reduce GPU NoC Pressure .990.  Lu Wang (Ghent University), Xia Zhao (Ghent University), David Kaeli (Northeastern University), Zhiying Wang (National University of Defense Technology), and Lieven Eeckhout (Ghent University)
HybridPass: Hybrid Scheduling for Mixed Flows in Datacenter Networks 1000.  Bo Peng (Shanghai Jiao Tong University), Jianguo Yao (Shanghai Jiao Tong University), Zhengwei Qi (Shanghai Jiao Tong University), and Haibing Guan (Shanghai Jiao Tong University)
Scalable Power-Efficient Kilo-Core Photonic-Wireless NoC Architectures .1010.  Avinash Kodi (Ohio University), Kyle Shifflet (Ohio University), Savas  Kaya (Ohio University), Soumyasanta Laha (Ohio University), and Ahmed  Louri (George Washington University)
Designing Efficient Shared Address Space Reduction Collectives for Multi-/Many-cores .1020
Session 25: Distributed Computing
Tiny Groups Tackle Byzantine Adversaries .1030
Skueue: A Scalable and Sequentially Consistent Distributed Queue 1040.  Michael Feldmann (Paderborn University), Christian Scheideler (Paderborn University), and Alexander Setzer (Paderborn University)
Self-Stabilizing Supervised Publish-Subscribe Systems .1050.  Michael Feldmann (Paderborn University), Christina Kolb (Paderborn University), Christian Scheideler (Paderborn University), and Thim Strothmann (Paderborn University)
Spartan: A Framework For Sparse Robust Addressable Networks .1060

### **Session 26: Graph Algorithms 4**

Beyond Binary Search: Parallel In-Place Construction of Implicit Search Tree Layouts .1070
An Energy-Efficient Single-Source Shortest Path Algorithm 1080.  Sara Karamati (Georgia Institute of Technology), Jeffrey Young (Georgia Institute of Technology), and Richard Vuduc (Georgia Institute of Technology)
Scalable Breadth-First Search on a GPU Cluster 1090.  Yuechao Pan (University of California, Davis), Roger Pearce (Lawrence Livermore National Laboratory), and John D. Owens (University of California, Davis)
Session 27: Communication Performance
Chameleon: Online Clustering of MPI Program Traces .1.102
Trade-Off Study of Localizing Communication and Balancing Network Traffic on a Dragonfly System .1.113.  Xin Wang (Illinois Institute of Technology), Misbah Mubarak (Argonne National Laboratory), Xu Yang (Illinois Institute of Technology), Robert B. Ross (Argonne National Laboratory), and Zhiling Lan (Illinois Institute of Technology)
Level-Spread: A New Job Allocation Policy for Dragonfly Networks .1.123
Session 28: Storage & FileSystem
A Migratory Heterogeneity-Aware Data Layout Scheme for Parallel File Systems .1.133.  Shuibing He (Wuhan University), Xian-He Sun (Illinois Institute of Technology), Yang Wang (Shenzhen Institute of Advanced Technology), and Chengzhong Xu (Shenzhen Institute of Advanced Technology)
LALCA: Locality-Aware Lock Contention Avoidance for NVMe-Based Scale-out Storage System .1.143  Myoungwon Oh (SK Telecom), Sejin Park (Keimyoung University), Jugwan  Eom (SK Telecom), Seungmin Kim (SK Telecom), Sangjae Kim (SK Telecom),  Kang-won Lee (SK Telecom), and Heon Y Yeom (Seoul National University)

#### **Author Index**