

FAST '19: 17th USENIX Conference on File and Storage Technologies
February 25–28, 2019
Boston, MA, USA

Persistent Memory Systems

Reaping the performance of fast NVM storage with uDepot	1
Kornilios Kourtis, Nikolas Ioannou, and Ioannis Koltsidas, <i>IBM Research</i>	
Optimizing Systems for Byte-Addressable NVM by Reducing Bit Flipping	17
Daniel Bittman, Darrell D. E. Long, Peter Alvaro, and Ethan L. Miller, <i>UC Santa Cruz</i>	
Write-Optimized Dynamic Hashing for Persistent Memory	31
Moohyeon Nam, <i>UNIST (Ulsan National Institute of Science and Technology)</i> ; Hokeun Cha, <i>Sungkyunkwan University</i> ; Young-ri Choi and Sam H. Noh, <i>UNIST (Ulsan National Institute of Science and Technology)</i> ; Beomseok Nam, <i>Sungkyunkwan University</i>	
Software Wear Management for Persistent Memories	45
Vaibhav Gogte, <i>University of Michigan</i> ; William Wang and Stephan Diestelhorst, <i>ARM</i> ; Aasheesh Kolli, <i>Pennsylvania State University and VMware Research</i> ; Peter M. Chen, Satish Narayanasamy, and Thomas F. Wenisch, <i>University of Michigan</i>	

File Systems

Storage Gardening: Using a Virtualization Layer for Efficient Defragmentation in the WAFL File System	65
Ram Kesavan, Matthew Curtis-Maury, Vinay Devadas, and Kesari Mishra, <i>NetApp</i>	
Pay Migration Tax to Homeland: Anchor-based Scalable Reference Counting for Multicores	79
Seokyoung Jung, Jongbin Kim, Minsoo Ryu, Sooyong Kang, and Hyungsoo Jung, <i>Hanyang University</i>	
Speculative Encryption on GPU Applied to Cryptographic File Systems	93
Vandeir Eduardo, <i>Federal University of Paraná and University of Blumenau</i> ; Luis C. Erpen de Bona and Wagner M. Nunan Zola, <i>Federal University of Paraná</i>	

Deduplication

Sketching Volume Capacities in Deduplicated Storage	107
Danny Harnik and Moshik Hershcovitch, <i>IBM Research</i> ; Yosef Shatsky, <i>IBM Systems</i> ; Amir Epstein, <i>Citi Innovation Lab TLV</i> ; Ronen Kat, <i>IBM Research</i>	
Finesse: Fine-Grained Feature Locality based Fast Resemblance Detection for Post-Deduplication Delta Compression	121
Yucheng Zhang, <i>Hubei University of Technology</i> ; Wen Xia, <i>Harbin Institute of Technology, Shenzhen & Peng Cheng Laboratory</i> ; Dan Feng, <i>WNLO, School of Computer, Huazhong University of Science and Technology</i> ; Hong Jiang, <i>University of Texas at Arlington</i> ; Yu Hua and Qiang Wang, <i>WNLO, School of Computer, Huazhong University of Science and Technology</i>	
Sliding Look-Back Window Assisted Data Chunk Rewriting for Improving Deduplication Restore Performance ..	129
Zhichao Cao, <i>University of Minnesota</i> ; Shiyong Liu, <i>Ocean University of China</i> ; Fenggang Wu, <i>University of Minnesota</i> ; Guohua Wang, <i>South China University of Technology</i> ; Bingzhe Li and David H.C. Du, <i>University of Minnesota</i>	

Storage Potpourri

DistCache: Provable Load Balancing for Large-Scale Storage Systems with Distributed Caching 143
Zaoxing Liu and Zhihao Bai, *Johns Hopkins University*; Zhenming Liu, *College of William and Mary*; Xiaozhou Li, *Celer Network*; Changhoon Kim, *Barefoot Networks*; Vladimir Braverman and Xin Jin, *Johns Hopkins University*; Ion Stoica, *UC Berkeley*

GearDB: A GC-free Key-Value Store on HM-SMR Drives with Gear Compaction 159
Ting Yao, *Huazhong University of Science and Technology and Temple University*; Jiguang Wan, *Huazhong University of Science and Technology*; Ping Huang, *Temple University*; Yiwen Zhang, Zhiwen Liu, and Changsheng Xie, *Huazhong University of Science and Technology*; Xubin He, *Temple University*

SPEICHER: Securing LSM-based Key-Value Stores using Shielded Execution 173
Maurice Bailleu, Jörg Thalheim, and Pramod Bhatotia, *The University of Edinburgh*; Christof Fetzer, *TU Dresden*; Michio Honda, *NEC Labs*; Kapil Vaswani, *Microsoft Research*

NVM File and Storage Systems

SLM-DB: Single-Level Key-Value Store with Persistent Memory 191
Olzhas Kaiyrakhmet and Songyi Lee, *UNIST*; Beomseok Nam, *Sungkyunkwan University*; Sam H. Noh and Young-ri Choi, *UNIST*

Ziggurat: A Tiered File System for Non-Volatile Main Memories and Disks 207
Shengan Zheng, *Shanghai Jiao Tong University*; Morteza Hoseinzadeh and Steven Swanson, *University of California, San Diego*

Orion: A Distributed File System for Non-Volatile Main Memory and RDMA-Capable Networks 221
Jian Yang, Joseph Izraelevitz, and Steven Swanson, *UC San Diego*

Big Systems

INSTalytics: Cluster Filesystem Co-design for Big-data Analytics 235
Muthian Sivathanu, Midhul Vuppallapati, Bhargav Gulavani, Kaushik Rajan, and Jyoti Leeka, *Microsoft Research India*; Jayashree Mohan, *Univ. of Texas Austin*; Piyus Kedia, *IIT Delhi*

GRAPHONE: A Data Store for Real-time Analytics on Evolving Graphs 249
Pradeep Kumar and H. Howie Huang, *George Washington University*

Automatic, Application-Aware I/O Forwarding Resource Allocation 265
Xu Ji, *Tsinghua University*; *National Supercomputing Center in Wuxi*; Bin Yang and Tianyu Zhang, *National Supercomputing Center in Wuxi*; *Shandong University*; Xiaosong Ma, *Qatar Computing Research Institute, HBKU*; Xiupeng Zhu, *National Supercomputing Center in Wuxi*; *Shandong University*; Xiyang Wang, *National Supercomputing Center in Wuxi*; Nosayba El-Sayed, *Emory University*; Jidong Zhai, *Tsinghua University*; Weiguo Liu, *National Supercomputing Center in Wuxi*; *Shandong University*; Wei Xue, *Tsinghua University*; *National Supercomputing Center in Wuxi*

Flash and Emerging Storage Systems

Design Tradeoffs for SSD Reliability 281
Bryan S. Kim, *Seoul National University*; Jongmoo Choi, *Dankook University*; Sang Lyul Min, *Seoul National University*

Fully Automatic Stream Management for Multi-Streamed SSDs Using Program Contexts 295
Taejin Kim and Duwon Hong, *Seoul National University*; Sangwook Shane Hahn, *Western Digital*; Myoungjun Chun, *Seoul National University*; Sungjin Lee, *DGIST*; Jooyoung Hwang and Jongyoul Lee, *Samsung Electronics*; Jihong Kim, *Seoul National University*

Large-Scale Graph Processing on Emerging Storage Devices 309
Nima Elyasi, *The Pennsylvania State University*; Changho Choi, *Samsung Semiconductor Inc.*; Anand Sivasubramaniam, *The Pennsylvania State University*

(continued on next page)

Erasure Coding and Reliability

Fast Erasure Coding for Data Storage: A Comprehensive Study of the Acceleration Techniques..... 317

Tianli Zhou and Chao Tian, *Texas A&M University*

OpenEC: Toward Unified and Configurable Erasure Coding Management in Distributed Storage Systems..... 331

Xiaolu Li, Runhui Li, and Patrick P. C. Lee, *The Chinese University of Hong Kong*; Yuchong Hu, *Huazhong University of Science and Technology*

Cluster storage systems gotta have HeART: improving storage efficiency by exploiting disk-reliability heterogeneity..... 345

Saurabh Kadekodi, K. V. Rashmi, and Gregory R. Ganger, *Carnegie Mellon University*

ScaleCheck: A Single-Machine Approach for Discovering Scalability Bugs in Large Distributed Systems..... 359

Cesar A. Stuardo, *University of Chicago*; Tanakorn Leesatapornwongsa, *Samsung Research America*; Riza O. Suminto, Huan Ke, and Jeffrey F. Lukman, *University of Chicago*; Wei-Chiu Chuang, *Cloudera*; Shan Lu and Haryadi S. Gunawi, *University of Chicago*