Welcome to the 10th ACM SIGPLAN/SIGOPS Conference on Virtual Execution Environments (VEE’14). We are happy to present the community with a strong program covering a wide range of virtualization topics.

This year, authors registered 56 papers, of which 49 were finalized as complete submissions. The program committee (PC) consisted of 2 chairs and 18 researchers active in virtualization-related aspects of programming languages and operating systems. Members were allowed to submit papers; the co-chairs chose not to submit anything. Reviewing was double-blind and was done almost entirely by the committee, with a little assistance from outsiders with special expertise. All submissions received 4–5 reviews, and authors were given the opportunity for rebuttal before the PC meeting.

The program committee meeting was held in January at the IBM T.J. Watson Research Center in New York. Most of the committee members were present in person. In an 8-hour session, we individually discussed all papers but those that were marked as early rejects due to receiving only negative reviews. We followed conventional rules for conflict of interest, with conflicted members (including co-chairs) leaving the room during discussion of the conflicted papers. In the end, we accepted 18 papers for presentation at the conference, of which about half were shepherded by PC members.

In addition to the 18 accepted papers, the VEE’14 program includes two keynote presentations by Galen Hunt and Jan Vitek. We hope that the resulting proceedings will serve as a valuable reference for researchers and practitioners in the area of virtualization.

Putting together VEE’14 was a team effort. Without the contributions of all the authors, the conference would not continue to be relevant and interesting. The program committee worked hard in reviewing papers and shepherding accepted submissions into their final forms. Our colleagues on the organizing committee of ASPLOS 2014 were helpful in coordinating the local arrangements, registration, and logistics for the conference itself. Lastly, we would like to thank our sponsors (ACM SIGPLAN and SIGOPS) and our corporate supporters (VMware, Facebook, IBM, and Microsoft Research) for their continued support.

We hope that you find the conference interesting and stimulating, and that it provides the opportunity to meet and engage with colleagues new and old from around the world.

Martin Hirzel  
IBM Research, USA  
VEE’14 General Chair

Erez Petrank  
Technion, Israel  
VEE’14 Program Chair

Dan Tsafrir  
Technion, Israel  
VEE’14 Program Chair
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>VEE 2014 Organization</strong></td>
<td>vii</td>
</tr>
<tr>
<td></td>
<td><strong>VEE 2014 Sponsors and Supporters</strong></td>
<td>ix</td>
</tr>
<tr>
<td><strong>Session 1: Keynote #1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dan Tsafir <em>(Technion - Israel Institute of Technology)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Experiences in the Land of Virtual Abstractions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galen C. Hunt <em>(Microsoft Research)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Session 2: Bridging the Semantic Gap</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don Porter <em>(Stony Brook University)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Real-Time Deep Virtual Machine Introspection and Its Applications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jennia Hizver <em>(Stony Brook University)</em>, Tzi-cker Chiueh <em>(Industrial Technology Research Institute, Taiwan)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Tesseract: Reconciling Guest I/O and Hypervisor Swapping in a VM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kapil Arya <em>(Northeastern University)</em>, Yury Baskakov <em>(VMware, Inc.)</em>, Alex Garthwaite <em>(CloudPhysics, Inc.)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Virtual Asymmetric Multiprocessor for Interactive Performance of Consolidated Desktops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hwanju Kim, Sangwook Kim, Jinkyu Jeong, Joonwon Lee <em>(Sungkyunkwan University)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Session 3: Memory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galen Hunt <em>(Microsoft Research)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ginseng: Market-Driven Memory Allocation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orna Agmon Ben-Yehuda, Eyal Posener <em>(Technion)</em>, Muli Ben-Yehuda <em>(Technion and Stratoscale)</em>, Assaf Schuster <em>(Technion)</em>, Ahuva Mu’alem <em>(Technion - Israel Institute of Technology and Ort Braude)</em></td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>• Mortar: Filling the Gaps in Data Center Memory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jinho Hwang <em>(IBM T.J. Watson Research Center)</em>, Ahsen Uppal, Timothy Wood, H. Huang <em>(The George Washington University)</em></td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>• CMD: Classification-Based Memory Deduplication Through Page Access Characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Licheng Chen, Zhipeng Wei, Zehan Cui <em>(Chinese Academy of Sciences and University of Chinese Academy of Sciences)</em>, Mingyu Chen <em>(State Key Laboratory of Computer Architecture)</em>, Haiyang Pan <em>(Chinese Academy of Sciences and University of Chinese Academy of Sciences)</em>, Yungang Bao <em>(State Key Laboratory of Computer Architecture)</em></td>
<td>65</td>
<td></td>
</tr>
<tr>
<td><strong>Session 4: Runtimes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eric Eide <em>(University of Utah)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Muscalietjs: Rethinking Layered Dynamic Web Runtimes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behnam Robatmili, Călin Cașcaval <em>(Qualcomm Research Silicon Valley)</em>, Mehrdad Reshadi <em>(Instant Logic)</em>, Madhukar N. Kedlaya <em>(University of California, Santa Barbara)</em>, Seth Fowler <em>(Mozilla)</em>, Vrajesh Bhavsar, Michael Weber <em>(Qualcomm Research Silicon Valley)</em>, Ben Hardekopf <em>(University of California, Santa Barbara)</em></td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>• A Fast Abstract Syntax Tree Interpreter for R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomas Kalibera <em>(Purdue University)</em>, Petr Maj <em>(ReactoLabs)</em>, Floreal Morandat <em>(University of Bordeaux)</em>, Jan Vitek <em>(Purdue University)</em></td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>• Deoptimization for Dynamic Language JITs on Typed, Stack-based Virtual Machines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Madhukar N. Kedlaya <em>(University of California, Santa Barbara)</em>, Behnam Robatmili, Călin Cașcaval <em>(Qualcomm Research Silicon Valley)</em>, Ben Hardekopf <em>(University of California, Santa Barbara)</em></td>
<td>103</td>
<td></td>
</tr>
</tbody>
</table>
Session 5: Keynote #2
Erez Petrank (Technion - Israel Institute of Technology)

• The Case for the Three R’S of Systems Research: Repeatability, Reproducibility and Rigor ..........115
  Jan Vitek (Purdue University)

Session 6: Binary Instrumentation
Orna Agmon Ben-Yehuda (Technion - Israel Institute of Technology)

• Efficient Memory Virtualization for Cross-ISA System Mode Emulation ........................................117
  Chao-Jui Chang, Jan-Jan Wu (Academia Sinica, Taiwan),
  Wei-Chung Hsu, Pangfeng Liu (National Taiwan University),
  Pen-Chung Yew (University of Minnesota at Twin Cities)

• A Platform for Secure Static Binary Instrumentation .........................................................................129
  Mingwei Zhang, Rui Qiao, Niranjan Hasabnis, R. Sekar (Stony Brook University)

• DBILL: An Efficient and Retargetable Dynamic Binary Instrumentation Framework
  Using LLVM Backend .........................................................................................................................141
  Yi-Hong Lyu, Ding-Yong Hong, Tai-Yi Wu, Jan-Jan Wu (Academia Sinica, Taiwan),
  Wei-Chung Hsu, Pangfeng Liu (National Taiwan University),
  Pen-Chung Yew (University of Minnesota at Twin Cities)

Session 7: Optimizations
Gilles Muller (INRIA)

• COMMA: Coordinating the Migration of Multi-tier Applications ..................................................153
  Jie Zheng, T.S. Eugene Ng (Rice University), Kunwadee Sripandkulkchai (NECTEC, Thailand),
  Zhaolei Liu (Rice University)

• Friendly Barriers: Efficient Work-Stealing with Return Barriers ..................................................165
  Vivek Kumar, Stephen M. Blackburn (Australian National University),
  David Grove (IBM T.J. Watson Research)

• String Deduplication for Java-Based Middleware in Virtualized Environments ..............................177
  Michihiro Horie, Kazunori Ogata, Kiyokuni Kawachiya, Tamiya Onodera (IBM Research - Tokyo)

Session 8: Reorganizing & Debugging
Jonathan Appavoo (Boston University)

• Shrinking the Hypervisor One Subsystem at a Time: A Userspace Packet Switch
  for Virtual Machines .........................................................................................................................189
  Julian Stecklina (TU Dresden)

• A Virtualized Separation Kernel for Mixed Criticality Systems ....................................................201
  Ye Li, Richard West, Eric Missimer (Boston University)

• Composable Multi-Level Debugging with Stackdb .........................................................................213
  David Johnson, Mike Hibler, Eric Eide (University of Utah)

Author Index ........................................................................................................................................226
VEE 2014 Organization

General Chair  Martin Hirzel (*IBM Research*)

Program Co-Chairs  Erez Petrank (*Technion*)
                  Dan Tsafrir (*Technion*)

Program Committee  Remzi Arpaci-Dusseau (*UW Madison*)
                    David F. Bacon (*IBM Research*)
                    Muli Ben-Yehuda (*Technion & Stratoscale*)
                    Dilma Da Silva (*Qualcomm Research*)
                    Angela Demke Brown (*University of Toronto*)
                    David Dice (*Oracle*)
                    Ajay Gulati (*VMware*)
                    Sam Guyer (*Tufts University*)
                    Antony Hosking (*Purdue University*)
                    Galen Hunt (*Microsoft Research*)
                    Doug Lea (*SUNY at Oswego*)
                    Gilles Muller (*INRIA*)
                    Todd Mytkowicz (*Microsoft Research*)
                    Mathias Payer (*UC Berkeley*)
                    Donald Porter (*Stony Brook University*)
                    Karsten Schwan (*Georgia Tech*)
                    Liuba Shrira (*Brandeis University*)
                    Bjarne Steensgaard (*Microsoft*)

Steering Committee Head  Dilma Da Silva (*Qualcomm Research*)

Steering Committee  Steve Blackburn (*Australian National University*)
                    Marc Fiuczynski (*Akamai*)
                    Steven Hand (*University of Cambridge*)
                    Gernot Heiser (*NICTA and UNSW*)
                    Doug Lea (*SUNY at Oswego*)
                    Steve Muir (*Comcast*)
                    Brian Noble (*University of Michigan*)
                    Erez Petrank (*Technion*)
                    Andrew Warfield (*UBC*)

External Reviewers  Nadav Amit (*Technion*)
                    Emery Berger (*UMass Amherst*)
                    Yoav Etsion (*Technion*)
                    Ed Nightingale (*Microsoft Research*)
Sub-Reviewers  Orna Agmon Ben-Yehuda *(Technion)*  
Samer Al-kiswany *(UW Madison)*  
Vijay Chidambaran *(UW Madison)*  
Florian David *(INRIA)*  
Thanh Do *(UW Madison)*  
Peter Goodman *(University of Toronto)*  
Abel Gordon *(Stratoscale)*  
Jun He *(UW Madison)*  
Benoit Hudzia *(Stratoscale)*  
William Jannen *(Stony Brook University)*  
Rafal Kolanski *(Purdue University)*  
Julia Lawall *(INRIA)*  
Lanyue Lu *(UW Madison)*  
Thanu M. Pillai *(UW Madison)*  
Lior Segev *(Stratoscale)*  
Gaël Thomas *(INRIA)*  
Zev Weiss *(UW Madison)*  
Suli Yang *(UW Madison)*  
Yang Zhan *(Stony Brook University)*  
Tao Zhang *(Stony Brook University)*  
Yupu Zhang *(UW Madison)*
VEE 2014 Sponsors and Supporters

Sponsors

In-cooperation with

Supporters

Microsoft Research

IBM

Facebook

vmware

USENIX

ACM SIG on Operating Systems

SIGPLAN