EcoCloud e-newsletter

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In this issue:

Welcome Message from the Executive Committee

Welcome to EcoCloud's third annual electronic newsletter!

In this issue, we are delighted to report EcoCloud's achievements last year and what is new in 2014. We have new faculty members in our community bringing a wealth of knowledge, research and industrial expertise, over half a dozen projects spanning from data analytics to green infrastructure, and a number of prestigious awards by EcoCloud researchers, making 2013 a fantastic year. Besides these accomplishments including research highlights covered in international media, we also hosted collaborators and researchers from peer institutions in our Visiting Scholars program.

This year, our **annual event** will be **on June 5th and 6th, 2014** in **Lausanne Palace**. We look forward to seeing you there!

In the News

3 papers in SOSP! A Coup for Systems Researchers

George Candea, Rachid Guerraoui and Willy Zwaenepoel, and their teams each presented a paper at this year's SOSP conference. The papers represented 10% of the conference program, which is a coup for EPFL having only presented a paper for the first time in 2007, and having won a best paper in 2009. The papers covered topics from data race detection, to synchronization efficiency in parallel programs, to high bandwidth graph processing. The biennial SOSP is the world's premier forum for researchers, developers, programmers, and teachers of computer systems technology. Academic and industrial participants present research and experience papers that cover the full range of theory and practice of computer systems software. This year the conference attracted 600+ attendees.

CloudSuite 2.0 Released

CloudSuite was released in 2012 in a response to an overwhelming demand from industry and academia for a benchmark suite representing emerging popular online scale-out services. CloudSuite is now in use by many of our affiliates and industrial collaborators at large including AMD, Google, HP, Huawei, Microsoft, and Intel. This year we added two new benchmarks including the latest release of Memcached with twitter feeds, and a home-grown graph analytics workload implementing Page rank using GraphLab. For more information, please visit the CloudSuite **website**.

Optimizing Datacenter TCO

Computing Now, the online portal highlighting IEEE Computer Society's top articles features Boris Grot's recent results on **Optimizing Datacenter TCO with Scale-Out Processors**. These results make

the case that DRAM accounts for a large fraction of both server capital and operation cost, referred to as Total Cost of Ownership (TCO), for in-memory scale-out services. To optimize performance over TCO, server processors must optimize architecture, organization and die size to maximize efficiency in serving data and amortize the DRAM cost. Computing Now's guest editor writes "The article defines TCO as an optimization metric that considers the costs of real estate, power delivery and cooling infrastructure, hardware-acquisition costs, and operating expenses. This excellent study will have far-reaching impact on server system architecture."

Technology to Revolutionize Cooling

Cooling has taken center stage in server infrastructure innovation to enable designs that can both dissipate higher levels of power to improve server performance and improve cooling efficiency to reduce the Total Cost of Ownership. John Thome and Jackson Marcinichen, our pioneers in two-phase liquid cooling in servers have recently invented two-phase cooling at the chip level for maximum efficiency. Two-phase liquid cooling circulates coolant in two phases to improve heat removal efficiency while requiring a lower flow rate (for lower operation cost) and enabling better temperature uniformity across the chip. Their technology is showcased on the cover of the June 2013 issue of **Electronics Cooling**, a high-profile magazine dedicated to thermal management in electronics industry.

New Members

Volkan Cevher

We welcome Volkan Cevher, an Assistant Professor in Electrical Engineering and an expert in machine learning and compressive sensing. Volkan is an ERC Starting Grant winner, investigating algorithms and technologies to improve the efficiency of signal conversion in large-scale media repositories. Volkan's research interests include machine learning, signal processing and information theory. Volkan received a PhD from Georgia Tech in 2005 and was on the faculty at Rice, where he currently holds the position of a Faculty Fellow, prior to joining EPFL.

Jim Larus

We welcome Jim Larus, our Microsoft Research advisory board member, who is now the Dean of Computer and Communication Sciences at EPFL, joining the EcoCloud family. Jim brings to us a wealth of expertise, experience and visibility in both industry and academia and is one of the rare researchers with both impact on the research community and product development in industry. He is the founder of the Singularity OS project at MSR, building operating systems ground up for dependability, the Orleans project, introducing a new programming model and environment for cloud computing, and is a co-author of a book on Transactional Memory. Jim's research interests are programming languages, compilers and computer architecture.

Martin Odersky

Martin Odersky is the father of Scala, a programming language and environment that unifies functional and object-oriented programming, while maintaining compatibility with Java and .NET. Scala is now widely used by an international community of developers and researchers, and is at the core of Typesafe, a fast growing startup Martin founded that supports the Scala commercial community with tools, training and consulting. Martin is also the author of the javac compiler, the most popular compiler used by Java programmers and developers today. Last but not least, Martin is a pioneer in the MOOC movement, having taught the first course from EPFL on Coursera with not only one of the largest enrollments but also the highest completion rate of all the courses in the history of the company.

New Projects

3D Smart Memories

With the end of Dennard Scaling on the horizon and the emergence of popular in-memory services, die stacking promises to save the day with both density and bandwidth scaling while reducing much power dissipated at the chip peripherals. In a recent award-winning FP7 project, EuroCloud Servers, Babak Falsafi and collaborators in academia and industry explored architectures to stack a few layers of DRAM organized as a hardware cache with a scale-out processor die. In a recent project funded by Microsoft Research titled "3D Smart Memories", the researchers will investigate thin logic die organizations that would be stackable on commercially available full DRAM stacks (e.g., Micron's HMC) with constrained thermal and power densities. The project will explore data-centric accelerators and memory/communication assist logic suitable for placement on a full DRAM stack.

Adversary-Oriented Computing

Building high-assurance distributed programs is notoriously challenging. Distributed system designers often target several daunting goals including high efficiency, robustness, and maintaining a desired quality of service in a variety of conditions. The resulting programs end up being difficult to design, verify, implement, test and debug. Rachid Guerraoui has been awarded an Advanced ERC grant for a proposal titled "Adversary-Oriented Computing", a novel distributed programming paradigm whereby composable sub-programs, each implementing a specific strategy to cope with a given adversary and modeling a specific working condition, are designed, verified, implemented, tested, and debugged independently. These sub-programs are then composed as a block-box with well-defined interfaces statically or at runtime to form a single distributed program.

Holistic Energy Optimization in YINS

As the industry continues squeezing more efficiency out of stock server hardware and software, there are diminishing returns in the solutions presented by the low-hanging fruits. David Atienza of EcoCloud, however, has a completely different opinion about how to build datacenters right. In a first ever Nano-Tera project targeting server design, in collaboration with researchers at ETH and our industrial affiliates, David with co-PIs Ed Bugnion and Babak Falsafi are pursuing a holistic approach to solve the energy problem in datacenters from emerging silicon technologies and circuits for reduced power consumption to server software and hardware stacks fully integrated with the infrastructure. YINS, which are letters derived from "Energy- and thermal-aware design of manycore heterogeneous datacenters", is a pronoun used in the Irish/Scottish dialect of Pittsburgh, referring to "you all" and reflecting the all encompassing and holistic approach the project pursues.

Learning with Big Data

With data repositories growing at unprecedented rates, dwarfing all conventional learning techniques, searching for information in data resembles finding a needle in a haystack. This is exactly the subject of a SINERGIA project led by Volkan Cevher in collaboration with researchers at ETH. Their key observation is that while a problem's ambient dimension is large, the relevant information therein can be typically represented in a much lower dimensional space due to natural clustering or parameterizations of the data. To this end, they have isolated three key concepts whose interplay can mitigate the key representational, computational, and reasoning bottlenecks: sparsity, sub-modularity, and Bayesian inference. By unifying ideas from the latter, they propose to develop novel theories and algorithms to impact the fundamental intellectual problem of automated discovery from Big Data.

Towards Energy-Neutral Datacenters with GreenDataNet

With electricity consumption in industrial-grade datacenters skyrocketing, designers are turning to

novel solutions to reduce both electricity consumption costs and the negative environmental impact. There are a number of promising avenues to pursue when it comes to improvements in infrastructure power distribution, storage, and even generation. That is exactly the subject of research of an FP7 project titled GreenDataNet and led by a new member of our industrial affiliate family, Eaton in collaboration with EcoCloud and industrial and academic partners throughout Europe. The project investigates integrating novel infrastructure technologies such as renewable energy (photovoltaics) and battery technology for storage to mitigate fluctuations in energy generation in the server stack.

Virtualizing Raw Data into Information using ViDa

Modern data management systems offer tremendous querying power on large datasets, as long as the data is structured and formatted in a pre-specified way. As data volumes and heterogeneity increase, however, database infrastructure is emerging a key bottleneck in data analytics. ViDa is an ERC Consolidator grant proposed by Anastasia Ailamaki to build technologies enabling efficient queries on raw, heterogeneous data, without pre-formatting or loading it into a database. The techniques proposed are based on data virtualization, i.e., abstracting data out of its form, and manipulating it regardless of the way it is stored or structured. Through efficient queries to never-before-seen data, ViDa aims at maximizing efficiency of analytics applications and enabling new discoveries for sciences, businesses, and their users.

Web-Alter-Ego

Rachid Guerraoui is a co-principal investigator of one of only two Google Focused Awards granted in Europe in 2013 with a proposal titled “Web-Alter-Ego”. Google Focus Awards support ambitious research in computer science, in areas of study that are of key interest to Google as well as the research community of social networks and distributed systems. The project is in collaboration with Anne-Marie Kermarrec, a research director at INRIA Rennes, and focuses on an original architecture for personalization of web services across multiple applications. The technologies will address the problem of extracting a web user’s “alter-egos” – i.e., like-minded users who share similar interests, across various Internet-oriented applications – in real time and in the presence of high dynamics.

Visiting Scholars

We started the Visiting Scholars program last year, hosting our first scholar Christos Kozyrakis from Stanford investigating efficiency and resource provisioning in datacenters. This year we hosted two scholars, Stratos Idreos from Harvard designing systems for big data exploration and David Wood from Wisconsin with expertise in memory system design. We are pleased to announce that our visitors’ experience interacting with EcoCloud researchers has been quite fruitful resulting in kudos. In 2014, we will be hosting Panagiota Fatourou with interests in distributed systems, and Subhasish Mitra from Stanford with interests in robust systems and circuits.

Awards

Conference Awards

A paper co-written by Nicolas Braud-Santoni, Rachid Guerraoui and Florian Huc has been selected as a **Best Student Paper** at the flagship distributed computing conference, **ACM PODC**. The paper titled *“*Fast Byzantine Agreement*”* presents the most efficient protocol to date for Byzantine Agreement, a classical problem in the theory of distributing computing and a fundamental building block in devising reliable and secure distributed systems. To learn more about the paper, listen to an **interview** with Florian Huc.

Hamza Harkous, Rameez Rahman, and Karl Aberer received the **2nd Best Poster Award** for their poster on **CloudSpaces** at the ESWC Summer School. There were in total 39 posters participating in the competition. The CloudSpaces project advocates a paradigm shift from application-centric to person-centric models where users will retake control of their information for improved privacy.

Onur Koçberber, Boris Grot, Javier Picorel, and Babak Falsafi along with co-authors from Google and our affiliate HP were honored with the **Runner-Up Award** at **MICRO**. In the awarded paper titled "Meet the Walkers" the researchers identify indexing operations as a critical efficiency bottleneck in data analytics. They propose programmable accelerators to enable indexing a wide spectrum of DB structures at 10x less complexity, silicon area, power and latency.

Nicolas Lamaison, Jackson Marcinichen and John Thome have been awarded the **Best Paper Award** at **InterPACK** for the paper titled "Dynamic Modeling of a Two-Phase On-Chip Cooling System Applied On Parallel High Performance Microprocessors." On-chip liquid cooling requires online thermal models capturing variations in temperature across multiple cores accurately. The authors showcase the need for transient modeling and control of on-chip liquid cooling for the first time and propose online models for effective and accurate cooling control.

Yassir Madhour and John Thome with collaborators from IBM have been awarded an **Outstanding Paper Award** at **ICEPT-HDP** for their paper titled "Patterned Die-to-Die Thin Film Bonding for 3D Chip Stacks with Integrated Microfluidic Cooling." The authors present a novel chip bonding method to meet the challenges posed by integrating state-of-the-art cooling structures into a 3D chip stack.

Faculty Awards

Anastasia Ailamaki is a winner of **ERC Consolidator Grant** in 2013. The grants "support researchers in consolidating their own independent research team or program and strengthen independent and excellent new individual research teams that have been recently created." With project ViDa, Anastasia will be pioneering Big Data technologies that defy data deluge by enabling efficient queries on raw heterogeneous data, obviating the need to pre-format or load the data into a database.

David Atienza is the recipient of the prestigious **IEEE CEDA Early Career Award** in 2013. The award "honors an individual who has made innovative and substantial technical contributions to the area of Electronic Design Automation in the early stages of his or her career." David has been recognized for "sustained and outstanding contributions to design methods and tools for multi-processor systems-on-chip, particularly for work on thermal-aware design, low-power architectures and on-chip interconnect synthesis." This is the first time the award goes to an awardee outside North America.

Rachid Guerraoui is one of the winners of **ERC Advanced Grant** in 2013. ERC Advanced Grants "allow exceptional established research leaders to pursue ground-breaking, high-risk projects that open new directions in their respective research fields or other domains." Rachid will be pioneering technologies for robust cloud computing with this new project titled "Adversary-Oriented Computing". With Anastasia and Rachid, EcoCloud now boasts over half a dozen ERC award winners, placing it at the top IT research organizations in Europe.

Student Awards

Cloud9, a project developed by Stefan Bucur, Cristian Zamfir and George Candea, was awarded **Gold Prize** at this year's **Open Source Software World Challenge**. This annual competition hosted in Korea targets promoting open source software all over the world. Cloud9 is a tool that employs symbolic execution and reasoning to automate the process of software testing. Gold Prize is the second highest award given.

Michele Catasta, Jean-Eudes Ranvier, Karl Aberer, and co-authors received **3rd prize** at the **Semantic Web Challenge** for building software systems to search browser history. The Semantic Web Challenge offers participants a chance to show the best of the Semantic Web and is open to both industry and academia. The proposed system is an entity-centric search based on the content of each visited page to form an aggregate "memory" and context of a user's experience.

Vitaly Chipounov and Djordje Jevdjic, were awarded the **Intel Doctoral Student Honor Program**. The program awards fellowships to exceptional PhD candidates pursuing leading-edge innovation in fields

related to Intel's business and research interests in the European Union, Switzerland and Russia. Vitaly received the award for S2E, a system for building program analysis tools, now being used by dozens of teams around the world. Djordje's research focuses on multi-gigabyte on-chip DRAM caches, in particular 3D (die-stacked) caches, for future data-centric server processors.

Baris Kasikci received the **VMWare Graduate Fellowship**. This award is highly competitive as VMWare awards fellowships to only four students worldwide. Baris is not just a highly selective recipient, he is also the first for EPFL. His research is centered around building techniques, tools and environments that will ultimately help developers build more reliable software.

Tri Kurniawan Wijaya received an **IBM PhD Fellowship Award**. This highly prestigious award honors exceptional Ph.D. students who have an interest in solving problems that are important to IBM and fundamental to innovation in many academic disciplines. Tri received this fellowship for outstanding contributions to information privacy in energy management.

Publications

Analytics

- **A Benchmark for Aggregation Techniques in Crowdsourcing,**
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- **An Evaluation of Aggregation Techniques in Crowdsourcing,**
  Q. V. H. Nguyen, T. Nguyen Thanh, T. Lam Ngoc and K. Aberer, The 14th International Conference on Web Information System Engineering (WISE), 2013.
- **Effective Consumption Scheduling for Demand-Side Management in the Smart Grid using Non-Uniform Participation Rate,**
  T. K. Wijaya, T. G. Papioannou, X. Liu and K. Aberer, Sustainable Internet and ICT for Sustainability (SustainIT), Palermo, Italy, October 30-31, 2013.
- **Entity Disambiguation in Tweets leveraging User Social Profiles,**
  S. R. Yerva, M. Catasta, G. Demartini and K. Aberer, 14th IEEE Intl. Conference on Information Reuse and Integration (IEEE IRI 2013), San Francisco, California, USA, August, 2013.
- **Minimizing Human Effort in Reconciling Match Networks,**
  Q. V. H. Nguyen, T. K. Wijaya, Z. Miklos, K. Aberer and E. Levy, 32nd International Conference on Conceptual Modeling (ER 2013), Hong Kong, November 11-13, 2013.
- **SoCo: A Social Network Aided Context-Aware Recommender System,**
  X. Liu and K. Aberer, 22nd international conference on World Wide Web, Rio de Janeiro, Brazil, May 13-17, 2013.
- **TRank: Ranking Entity Types Using the Web of Data,**
  A. Tonon, M. Catasta, G. Demartini, P. Cudré-Mauroux and K. Aberer, 12th International Semantic Web Conference, Sydney, Australia, October 21-25, 2013.
- **TripEneer: User-based Travel Plan Recommendation Application,**
  S. R. Yerva, F. A. Grosan, A. O. Tandrau and K. Aberer, 7th International AAAI Conference on Weblogs and Social Media, Boston, Massachusetts, USA, July 2013.

Data Clouds & Management

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- **AFFINITY: Efficiently Querying Statistical Measures on Time-Series Data,**
  S. Sathe and K. Aberer, ICDE, Brisbane, Australia, April 8-12, 2013.

- **A model-based back-end for air quality data management,**
  E. C. Un, J. Eberle, Y. Kim and K. Aberer, 2013 ACM conference on Pervasive and ubiquitous computing - UbiComp '13, Zurich, Switzerland, 08-12 09 2013.
- **An Evaluation of Model-Based Approaches to Sensor Data Compression,**
  Q. V. H. Nguyen, H. Jeung and K. Aberer, in IEEE Transactions On Knowledge And Data Engineering, vol. 25, num. 11, p. 2434-2447, 2013.
- **An MAS Negotiation Support Tool for Schema Matching,**
  Q. V. H. Nguyen, H. X. Luong, Z. Miklós, T. T. Quan and K. Aberer, 12th International Conference on Autonomous Agents and Multiagent Systems (AAMAS), 2013.
- **Automatic Synthesis of Out-of-Core Algorithms,**
  I. Klonatos, A. Nötzli, A. Spielmann, C. Koch and V. Kuncak, ACM SIGMOD International Conference on Management of Data, New York, NY, USA, June 22-27, 20013.
- **Collaborative Schema Matching Reconciliation,**
  Q. V. H. Nguyen, H. X. Luong, Z. Miklós, T. T. Quan and K. Aberer, The 21st International Conference on Cooperative Information Systems (CoopIS), 2013.
- **Completeness and Ambiguity of Schema Cover,**
  A. Gal, M. Katz, T. Sagi, K. Aberer and Z. Miklós, The 21st International Conference on Cooperative Information Systems (CoopIS), 2013, Austria.
- **CredibleWeb: A Platform for Web Credibility Evaluation,**
  Z. Huang, A. Olteanu and K. Aberer, CHI'13 Extended Abstracts on Human Factors in Computing Systems
- **Data-driven Neuroscience: Enabling Breakthroughs Via Innovative Data Management,**
  A. Stougiannis, F. Tauheed, M. Pavlovic, T. Heinis and A. Ailamaki, Prooceedings of International Conference on Management of Data (SIGMOD '13), 2013.
- **DBToaster: Higher-order Delta Processing for Dynamic,**
  C. Koch, Y. Ahmad, O. A. Kennedy, M. Nikolic and A. Nötzli, Frequently Fresh Views, 2013.
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- **Eliminating Unscalable Communication in Transaction Processing,**
  R. Johnson, I. Pandis and A. Ailamaki, The VLDB Journal, 2013.
- **Enabling Scientific Discovery Via Innovative Spatial Data Management,**
  T. Heinis, F. Tauheed, M. Pavlovic and A. Ailamaki, Data Engineering Bulletin, vol. 36, num. 4, 2013.
- **From A to E: Analyzing TPC's OLTP Benchmarks -- The obsolete, the ubiquitous, the unexplored,**
  P. Tözün, I. Pandis, I.C. Kaynak, D. Jevdic and A. Ailamaki, Proceedings of the 16th International Conference on Extending Database Technology, pp. 17-28, 2013.
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  M. Pavlovic, F. Tauheed, T. Heinis and A. Ailamaki, Proceedings of the 25th International Conference on Scientific and Statistical Database Management, 2013.
- **Model-View Sensor Data Management in the Cloud,**
  T. Guo, T. G. Papaioannou and K. Aberer, IEEE International Conference on Big Data 2013 (IEEE BigData 2013), Santa Clara, California, USA, October, 6-9,2013.
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  P. Tözün, B. Gold and A. Ailamaki, 9th International Workshop on Data Management on New Hardware, New York, New York, USA, June 24, 2013.
- **Identifying Hot and Cold Data in Main-Memory Databases,**
  J. Levandoski, P. Larson and R. Stoica, 2013.
- **On Leveraging Crowdsourcing Techniques for Schema Matching Networks,**
  Q. V. H. Nguyen, T. Nguyen Thanh, Z. Miklós and K. Aberer, 18th International Conference on Database Systems for Advanced Applications (DASFAA), Wuhan, China, April 22-25, 2013.
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- **Scaling up analytical queries with column-stores,**
  I. Alagiannis, M. Athanassoulis and A. Ailamaki, Proceedings of the 6th International Workshop on Testing Database Systems, 2013.
- **Sharing Data and Work Across Concurrent Analytical Queries,**
  I. Psaroudakis, M. Athanassoulis and A. Ailamaki, Proceedings of the 39th International Conference on Very Large Data Bases, 2013.
- **STREX: Boosting Instruction Cache Reuse in OLTP Workloads Through Stratified Transaction Execution,**
  I. Atta, P. Tözün, X. Tong, A. Ailamaki and A. Moshovos, Proceedings of the 40th International Symposium on Computer Architecture, 2013.
- **Sustainable Energy Consumption Monitoring in Residential Settings,**
  A. Uttama-Nambi S. N., T. G. Papaioannou, D. Chakraborty and K. Aberer, 2nd IEEE INFOCOM Workshop on Communications and Control for Smart Energy Systems (CCSES 2013), Turin, Italy, April 14-19, 2013.
- **Symbolic representation of smart meter data,**
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  Q. V. H. Nguyen, S. T. Do, T. Nguyen Thanh and K. Aberer, 2013.
- **Towards Predicting the Runtime of Iterative Analytics with PREDIcT,**
  A. D. Popescu, A. Balmin, V. Ercegovac and A. Ailamaki, 2013.
- **Utility-driven Data Acquisition in Participatory Sensing,**
  M. Riahi, T. G. Papaioannou, I. Trummer and K. Aberer, 16th International Conference on Extending Database Technology (EDBT), Genoa, Italy, March 18-22, 2013.
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- **Effect of Hot Spots in Microstructured Reactors on Product Distribution During Quasi-instantaneous Exothermic Reactions,**
  J. Haber, B. Jiang, N. Borhani, T. Maeder and J. R. Thome, 9th European Congress of Chemical Engineering (ECCE), The Hague, Holland, 21-24.4.2013.
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  S. Szczukiewicz, N. Borhani and J. R. Thome, in International Journal Of Heat And Mass Transfer, vol. 67, p. 913-929, 2013.
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  J. R. Thome, S. Szczukiewicz and M. Magnini, 4th IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants, Delft, the Netherlands, June 17-19, 2013.
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