

IC2E
4th

International
Conference on
Cloud Engineering

April 4-8
2016

IoTDI
1st

International Conference
on Internet-of-Things
Design and Implementation

CONFERENCE PROGRAM



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IC2E

4th

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Conference on
Cloud Engineering

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MESSAGE FROM THE GENERAL CHAIRS

We like to welcome you, with great pleasure, to IEEE IC2E 2016, the 4th edition of the IEEE annual international conference on cloud engineering. This year, IC2E will be held in Berlin, Germany's capital and one of Europe's main digital hubs of scientists, creative talents and entrepreneurs.

IEEE IC2E is a high-quality forum to bring together experts working on different levels of the cloud stack – systems, storage, networking, platforms, databases, and applications – to address challenges needed to shape the future of cloud-transformed business and society. This year, the main conference spans over three full days, featuring a research track with full, short, work-in-progress and poster papers, as well as an industry track. The main program is accompanied by two full days of workshops, tutorials, and a doctoral symposium. IEEE IC2E 2016, for the first time, is also co-located with IEEE IoTDI, a new conference on Internet of Things design and implementation. We are honored to have Gustavo Alonso, Jon Crowcroft, and Roger Barga as the joint keynote speakers for both conferences, and Ian Foster as an IC2E invited speaker.

An excellent team has worked very hard to organize IEEE IC2E 2016. First, we would like to thank the TPC Co-Chairs Lucy Cherkasova, Peter Pietzuch, and Cho-Li Wang for their leadership and for ensuring a high-quality program. A carefully selected TPC has done a great job in reviewing the research submissions. We are very grateful to the other Chairs of the Organizing Committee, including Dennis Gannon (Workshops Chair), Shu Tao (Industry Tracks Chair), Seetharami Seelam (Panels Chair), David Eysers and Jatinger Singh (Tutorials Chairs), Judy Qiu (Doctoral Symposium Chair), Sonia Ben Mokhtar (Proceedings Chair) and Ali Kanso and Ningfang Mi (Publicity Chairs). Notably, our sincere thanks go to the local team at TU Berlin: David Bermbach (Local Chair), Dominik Ernst (Finance Chair) and Jacob Eberhardt (Web Chair).

Last but not least, we would like to thank the IC2E Steering Committee and especially Hui Lei for his continuous support of the IC2E conference series, both as spokesman of the Steering Committee and as Chair of IEEE TCBIS, the Technical Committee on Business Informatics and Systems. Further, we would like to thank the entire management team at IEEE USA and at TUBS (TU Berlin Science Marketing). Finally, we would like to thank all authors, tutorial presenters, workshop organizers, and participants for making IEEE IC2E 2016 a success. We wish you an enjoyable, inspiring and fruitful stay in Berlin!

Geoffrey Fox and Stefan Tai

MESSAGE FROM THE PROGRAM COMMITTEE CO-CHAIRS

It is our great pleasure to welcome you to the IEEE International Conference on Cloud Engineering 2016 (IC2E 2016). This year marks the fourth edition of the conference, which first started in 2013 and since then has evolved into a high-quality and comprehensive forum that focuses on the development of cloud computing, infrastructures and applications, and where researchers and practitioners exchange knowledge on engineering principles, enabling technologies, and practical experiences related to cloud computing. By bringing together experts that work at different levels of the cloud stack - systems, storage, networking, platforms, databases, and applications, IC2E offers an end-to-end view on the challenges and technologies in cloud computing, fosters research that addresses the interaction between different layers of the stack, and ultimately helps shape the future of cloud-transformed businesses and society.

This year the conference received 91 abstracts, which resulted in 73 paper submissions (54 long research papers and 19 short papers) with authors from 24 countries spanning five con-

tinents (Americas: 41%, Europe: 36%, Asia: 19%, Africa: 2%, Oceania: 2%), on all of the conference topics, with a particular focus on "cloud applications and services" (37 submissions), „resource management and optimization in the cloud" (34 submissions), "performance, dependability, and service level agreements" (20 submissions), "cloud security, privacy, compliance, and trust" (15 submissions), and „Big data management, platforms and analytics" (14 submissions).

Each paper received an average of 3.5 reviews from the 57 PC members, aided by 7 external reviewers. All submissions were discussed in depth during a 7-day on-line PC meeting. The papers were evaluated with respect to their originality, technical merit, presentation quality, and relevance to the conference themes. In total, 17 papers have been accepted (acceptance rate: 23%): 16 research papers and 1 short paper.

The selected papers represent the latest results both in traditional areas as well as new directions. Big data processing, cloud security and

privacy, energy management in cloud data centers are some of the vanguard areas this year. In addition, traditional topics are also well represented, such as cloud applications and services, and cloud programming models, benchmarks, and tools.

This year, the IC2E 2016 conference is honored to host three prestigious keynote speakers: Gustavo Alonso from ETH (Switzerland), Roger Barga from Amazon Web Services (USA), and Jon Crowcroft from the University of Cambridge (UK), as well as an invited talk by Ian Foster from the University of Chicago (USA).

In addition to the conference research track, the conference features a new work-in-progress (WIP) session, a poster session, and a range of exciting workshops. The IC2E 2016 conference would not have been possible without the help and dedication of a large team of volunteers, and the help of the research and industrial community at large. We would like to thank the authors who submitted their work and all the PC members and reviewers who worked very hard to create this program. We would also like to express our deepest gratitude to Geoffrey Fox and Stefan Tai, the 2016 General Chairs, for their dedication and advice. We are deeply indebted to Sonia Ben Mokhtar, the 2016 Proce-

dings Chair, for her efficient help and sense of a timely schedule, and to Jacob Eberhardt, the Web Chair, for keeping the conference web site up-to-date. Special thanks are also due to the Publicity Co-Chairs, Ali Kalso and Ningfang Mi, for their efforts in promoting the conference. Finally, we wish to extend our heartfelt gratitude to the rest of the Organization and Steering Committees, whose actions and help have been instrumental in setting up IC2E 2016.

January 20, 2016

Lucy Cherkasova
(Hewlett Packard Labs)

Peter Pietzuch
(Imperial College London)

Cho-Li Wang
(University of Hong Kong)

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IC2E: CONFERENCE PROGRAM

DAY	TIME	IC2E	Location
MON	MONDAY		
	9:00 - 17:00	Workshops and Tutorials <i>Details on page 62 and 77</i>	MAR building
	Joint Welcome Reception with Posters <i>Drinks and light snacks will be served</i>		
	18:00 - 19:30	<ul style="list-style-type: none"> - <i>Multiple Virtual Machines Live Migration Performance Modelling – Vmware vMotion based Study</i>, Christoph Meinel - <i>A Taxonomy on Dynamic Environments for Provider-oriented Virtual Machine Placement</i>, Jammily Ortigoza, Fabio Lopez-Pires, and Benjamin Baran - <i>uCCP: An Approach for Continuous Capacity Planning in the Cloud with Uptime-based Pricing</i>, Kamil Smuga and Christina Thorpe - <i>Towards Audio-Visual Cues for Cloud Infrastructure Monitoring</i>, David Bermbach and Jacob Eberhardt - <i>A Hot-page Aware Hybrid-copy Migration Method</i>, Shuang Wu, Bei Wang, Ce Yang, Qinming He, and Jianhai Chen - <i>Exploring GPU Acceleration of Apache Spark</i>, Dieu-donne Manzi and David Tompkins - <i>On IO Latency Prediction Accuracy and Automated Load Balancing in Consolidated VM Environments</i>, Jun Nemoto and Gregory R. Ganger 	Lichthof

DAY	TIME	IC2E	Location
MON		- <i>Reducing Power Consumption in Data Center by Predicting Temperature Distribution and Air Conditioner Efficiency with Machine Learning</i> , Yuya Tarutani, Kazuyuki Hashimoto, Go Hasegawa, Yutaka Nakamura, Takumi Tamura, Kazuhiro Matsuda, and Morito Matsuoka	Lichthof
		- <i>Enabling Enterprise-Class Workloads in the Cloud</i> , Valentina Salapura and Ruchi Mahindru	
		- <i>A Budget Constrained Scheduling Algorithm for Hybrid Cloud Computing, Systems Under Data Privacy</i> , Amin Rezaeian, Hamid Abrishami, Saeid Abrishami, and Mahmoud Naghibzadeh	
		- <i>IoT End-User Applications Provisioning in the Cloud State of the Art</i> , Sami Yangui, Roch H. Glitho, Fatna Belqasmi, Monique J. Morrow, and Paul A. Polakos	
		- <i>Availability Analysis of Cloud Deployed Applications</i> , Manar Jammal, Ali Kanso, Parisa Heidari, and Abdallah Shami	

DAY	TIME	IC2E	Location
TUE	TUESDAY		
	8:00-8:25	Breakfast 	Lichthof
	Session 1		
	Session Chair: Stefan Tai, TU Berlin, Germany		
	8:30-9:00	Welcome Welcome Message by Stefan Tai, <i>General Co-Chair, IC2E 2016,</i> and Hui Lei, <i>General Co-Chair, IoTDI 2016</i> Welcome Message by Christian Thomsen, <i>President, TU Berlin</i> Welcome Message by Lucy Cherkasova and Peter Pietzuch, <i>PC Co-Chairs, IC2E 2016</i> Welcome Message by Tarek Abdelzaher and Jiannong Cao, <i>PC Co-Chairs, IoTDI 2016</i>	H1012
	9:00-10:00	Keynote 1: Gustavo Alonso (ETH): <i>Generalization versus Specialization in cloud computing infrastructures</i>	H1012
	10:00-10:30	Coffee Break 	Lichthof
	Session 2: Data Processing in the Cloud		
Session Chair: Peter Pietzuch, Imperial College London, UK			
10:30-12:30	- Not All Joules are Equal: Towards Energy-Efficient and Green-Aware Data Processing Frameworks, Zhaojie Niu, Bingsheng He (Nanyang Technological University, Singapore), Fangming Liu (Huazhong University of Science and Technology, China)	H1012	

DAY	TIME	IC2E	Location
TUE		- Supporting On-demand Elasticity in Distributed Graph Processing, Mayank Pundir, Manoj Kumar, Luke M. Leslie, Indranil Gupta, Roy H. Campbell (University of Illinois at Urbana-Champaign) - Stela: Enabling Stream Processing Systems to Scale-in and Scale-out On-demand, Le Xu (University of Illinois at Urbana Champaign), Boyang Peng (Yahoo! Inc.), Indranil Gupta (University of Illinois at Urbana Champaign) - Awan: Locality-aware Resource Manager for Geo-distributed Data-intensive Applications, Albert Jonathan, Abhishek Chandra, Jon Weissman (University of Minnesota Twin-Cities)	H1012
	12:30-13:30	Lunch 	Lichthof
	Session 3: Secure and Reliable Clouds		
	Session Chair: David Bermbach, TU Berlin, Germany		
	13:30-15:00	- Information Flow Audit for PaaS clouds, Thomas F. J.-M. Pasquier, Jatinder Singh, Jean Bacon (University of Cambridge), David Eysers (University of Otago) - Surviving Failures with Performance-Centric Bandwidth Allocation in Private Datacenters, Li Chen, Baochun Li (University of Toronto), Bo Li (The Hong Kong University of Science and Technology) - LOGAN: Problem Diagnosis in the Cloud Using Log-based Reference Models (Short paper), Byung Chul Tak, Shu Tao (IBM TJ Watson Research Center), Lin Yang, Chao Zhu (IBM Research China Lab), Yaoping Ruan (IBM TJ Watson Research Center)	H1012

DAY	TIME	IC2E	Location
TUE	15:00-15:30	Coffee Break ☕	Lichthof
	Session 4: Invited Talk		
	Session Chair: Lucy Cherkasova, Hewlett Packard Labs, USA		
	15:30-16:30	Invited Talk: Ian Foster (University of Chicago): <i>The Discovery Cloud: Accelerating and Democratizing Research on a Global Scale</i>	H1012
WED	WEDNESDAY		
	8:30-8:55	Breakfast ☕	Lichthof
	Session 5		
	Session Chair: Hui Lei, IBM Research, USA		
	9:00-10:00	Keynote 2: Jon Crowcroft (University of Cambridge): What could possibly go wrong?	H1012
	10:00-10:30	Coffee Break ☕	Lichthof
	Session 6: Efficient Cloud Management		
	Session Chair: Jean Bacon, University of Cambridge, UK		
	10:30-12:30	<ul style="list-style-type: none"> - <i>Cost-aware scalability of applications in public clouds</i>, Daniel Moldovan, Hong-Linh Truong, Schahram Dustdar (TU Wien) - <i>Cloud Instance Management And Resource Prediction For Computation-as-a-Service Platforms</i>, Joseph Doyle, Vasileios Giotsas, Mohammad Ashraful Anam, Yiannis Andreopoulos (University College London) 	H1012

DAY	TIME	IC2E	Location
WED		<ul style="list-style-type: none"> - <i>A Comparative Evaluation on Algorithms for Auction-based Cloud Pricing Prediction</i>, Sara Arevalos (National University of Asuncion), Fabio Lopez-Pires (Itaipu Technological Park), Benjamin Baran (National University of Asuncion) - <i>Autoscaling for Hadoop Clusters</i>, Anshul Gandhi, Sidhartha Thota (Stony Brook University), Parijat Dube, Andrzej Kochut, Li Zhang (IBM Research) 	H1012
	12:30-13:30	Lunch X	Lichthof
	Session 7: WIP Session		
	Session Chair: David Eysers, University of Otago, New Zealand		
	13:30-15:00	<ul style="list-style-type: none"> - <i>UIE: User-centric Interference Estimation for Cloud Applications</i>, Seyyed Ahmad Javadi, Sagar Mehra, Bharath Kumar Reddy Vangoor, Anshul Gandhi (Stony Brook University) - <i>GeoScale: Providing Geo-Elasticity in Distributed Clouds</i>, Tian Guo, Prashant Shenoy (Umass Amherst), Hakan Hacigumus (Google) - <i>Attribute-Based Partial Geo-Replication System</i>, Hobin Yoon, Ada Gavrilovska, and Karsten Schwan (Georgia Institute of Technology) - <i>A Genetic Algorithm for Dynamic Cloud Application Brokerage</i>, Lino Chamorro (National University of Asuncion), Fabio Lopez-Pires (Itaipu Technological Park), Benjamin Baran (National University of Asuncion) 	H1012

DAY	TIME	IC2E	Location
WED		<p>- <i>A Reinforcement Learning-Based Power Management Framework for Green Computing Data Centers</i>, Xue Lin (University of Southern California), Yanzhi Wang (Syracuse University), Massoud Pedram (University of Southern California)</p> <p>- <i>Automatic Extraction of Metrics from SLAs for Cloud Service Management</i>, Sudip Mittal, Karuna P. Joshi, Claudia Pearce and Anupam Joshi (UMBC)</p> <p>- <i>SENDIM for Incremental Development of Cloud Networks: Simulation, Emulation & Deployment Integration Middleware</i>, Pradeeban Kathiravelu, Luis Veiga (INESC-ID Lisboa/Instituto Superior Técnico, Universidade de Lisboa)</p> <p>- <i>Building Compliance and Security Reference Architectures (CSRA) for Cloud Systems</i>, Dereje Yimam, Eduardo B. Fernandez (Florida Atlantic University)</p>	H1012
	15:00-15:30	Coffee Break ☕	Lichthof
	Joint IC2E and IoTDI Panel		
	Session Chair: Seetharami R. Seelam, Research Staff Member, IBM T. J. Watson Research Center		
	15:30-16:30	For more information visit page 58	H1012

DAY	TIME	IC2E	Location
WED	Session 8: Cloud Networking		
	Session Chair: Abhishek Chandra, University of Minnesota, USA		
	16:30-17:30	<p>- <i>Barrier-Aware Max-Min Fair Bandwidth Sharing and Path Selection in Datacenter Networks</i>, Li Chen, Baochun Li (University of Toronto), Bo Li (The Hong Kong University of Science and Technology)</p> <p>- <i>Phurti: Application and Network-Aware Flow Scheduling for Multi-Tenant MapReduce Clusters</i>, Chris X. Cai, Shayan Saeed, Indranil Gupta, Roy H. Campbell (University of Illinois, Urbana-Champaign), Franck Le (IBM Research T. J. Watson)</p>	H1012
	Conference Banquet 🤝		
	19:00	Conference Banquet at Heeresbäckerei	More information on page 59
THU	THURSDAY		
	8:30-8:55	Breakfast ☕	Lichthof
	Session 9		
	Session Chair: Stefan Tai, TU Berlin, Germany		
	9:00-10:00	Keynote 3: Roger Barga (Amazon Web Services): <i>Processing Big Data in Motion</i>	H1012
THU	10:00-10:30	Coffee Break ☕	Lichthof

DAY	TIME	IC2E	Location
THU	Session 10: Cloud Performance		
	Session Chair: Lucy Cherkasova, Hewlett Packard Labs, USA		
	10:30-12:30	<ul style="list-style-type: none"> - <i>Exploring The Use of Tags for Georeplicated Content Placement</i>, Stéphane Delbruel (Université de Rennes 1 - IRISA), Davide Frey (INRIA), François Taïani (Université de Rennes 1 - IRISA/ESIR) - <i>Multi-Cache: Dynamic, Efficient Partitioning for Multi-Tier Caches in Consolidated VM Environments</i>, Sundaresan Rajasekaran, Shaohua Duan, Wei Zhang, Timothy Wood (The George Washington University) - <i>Container-Based Cloud Benchmarking</i>, Blesson Varghese, Lawan Thamsuhang Subba, Long Thai, Adam Barker (University of St Andrews, UK) - <i>Container and Microservice Driven Design for Cloud Infrastructure DevOps</i>, Hui Kang, Michael Le, Shu Tao (IBM T. J. Watson Research Center) 	H1012
	12:30-13:30	Lunch X	Lichthof
	Session 11: Industry Session and Conference Closing		
	Session Chair: Shu Tao, IBM Watson Research, USA		
	13:30-15:00	<ul style="list-style-type: none"> - <i>Dynamic Block Sizing for Data Stream Processing System</i>, Robert Birke (IBM Research - Zurich), Evangelia Kalyvianaki (City University London), Walter Binder (University of Lugano), Martin Schmatz and Lydia Y. Chen (IBM Research - Zurich). 	H1012

DAY	TIME	IC2E	Location
THU		<ul style="list-style-type: none"> - <i>Efficient User Opt-out from Block Stores</i>, Erwan Le Merrer and Nicolas Le Scouarnec (Technicolor). - <i>Cloud Adaptation with Control Theory in Industrial Clouds</i>, Cornel Barna, Marios Fokaefs, Marin Litoiu, Mark Shtern (York University) and Joe Wigglesworth (IBM Canada). - <i>Comparing Automatic Load Balancing using VMware DRS with a Human Expert</i>, Sogand Shirinbab, Lars Lundberg (Blekinge Institute of Technology) and Jim Håkansson (Ericsson AB). 	
		Conference Closing	
	15:00-15:30	Coffee Break ☕	Lichthof
	FRIDAY		
FRI	9:00-17:00	Workshops and Tutorials Details on page 62 and 77	MAR building

Abstract

Modern science and engineering require increasingly sophisticated information technology (IT) for data analysis, simulation, and related tasks. Yet the small to medium laboratories (SMLs) in which the majority of research advances occur increasingly lack the human and financial capital needed to acquire and operate such IT. New methods are needed to provide all researchers with access to state-of-the-art scientific capabilities, regardless of their location and budget. Industry has demonstrated the value of cloud-hosted software and platform-as-a-service approaches; small businesses that outsource their IT to third-party providers slash costs and accelerate innovation. However, few business cloud services are transferable to science.



Ian Foster

(Professor of Computer Science at the University of Chicago)

The Discovery Cloud: Accelerating and Democratizing Research on a Global Scale

We thus propose the Discovery Cloud, an ecosystem of new, community-produced services to which SMLs can outsource common activities, from data management and analysis to collaboration and experiment automation. We explain the need for a Discovery Platform to streamline the creation and operation of new and interoperable services, and a Discovery Exchange to facilitate the use and sustainability of Discovery Cloud services. We report on our experiences building early elements of the Discovery Platform in the form of Globus services, and on the experiences of those who have applied those services in innovative applications.

Biography

Ian is a Professor of Computer Science at the University of Chicago, a Distinguished Fellow at Argonne National Laboratory, and Director of the Computation Institute. He is also a fellow of the American Association for the Advancement of Science, the Association for Computing Machinery, and the British Computer Society. His awards include the British Computer Society's Lovelace Medal, honorary doctorates from the University of Canterbury, New Zealand, and CINVESTAV, Mexico, and the IEEE Tsutomu Kanai award.



IoTDI

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MESSAGE FROM THE IoTDI 2016 GENERAL CHAIRS

Welcome to Berlin, Germany's capital and a premier intellectual and cultural hub of the world.

And, welcome to the First IEEE International Conference on Internet-of-Things Design and Implementation (IoTDI), the melting pot of ideas from researchers and practitioners involved in the development of IoT systems and applications. Sponsored by the IEEE Computer Society, and hosted on the campus of the Technical University of Berlin (TU Berlin), IoTDI 2016 features a full program intended to promote the exchange of information on design principles, enabling technologies, and practical experiences as they relate to the Internet of Things.

The Internet of Things is characterized by a confluence of many technological advances. Exponential instrumentation delivers the genesis point for understanding the world around us as billions of systems are developed and generate data at an unprecedented pace. As Cyber

systems, physical systems, and social systems become ever interconnected, the separation between them increasingly blurs. Our planet is growing more intelligent, thanks to cognitive computing capabilities that transform big data into real-time actionable insights at a massive scale. IoTDI offers an interdisciplinary venue to discuss challenges, technologies, and emerging directions that pertain to the Internet of Things. Many sub-systems need to come together to address the needs of current and future IoT applications. These subsystems extend from cyber-physical front ends to cloud back ends. New, IoT-empowered medical, social, environmental, energy, and automation applications must be supported by advances in cloud resource management, data analytics, network protocols, and smart embedded devices. The IoTDI 2016 conference program is a testament to the exciting set of research and development challenges to be tackled.

We would like to acknowledge the tireless efforts of the Program Committee, led by Tarek Abdelzaher, Jiannong Cao, and Pedro Marron. We are also grateful to Mohamed Sarwat, Kun Bai, David Bermbach, Jatinder Singh, Dong Wang, and Dominik Ernst for their excellent work on managing conference publicity, logistics, proceedings, Web site, and finance. In addition, we want to express our deep appreciation to the Organizing Committee of the 2016 IEEE International Conference on Cloud Engineering (IC2E) for supporting the co-location of IoTDI and IC2E in 2016. Special thanks are due to Professor Stefan Tai, for hosting the joint conferences at TU Berlin and for his leadership on many fronts. Last but not least, we want to thank members of the IoTDI Steering Committee for their guidance and support.

We hope that you will enjoy the conference and the beautiful, historical city of Berlin, that you reap all the benefits the program has to offer, and that you will return to IoTDI for many years to come!

Hui Lei, IBM

Wei Zhao, University of Macau

IoTDI 2016 General Co-chairs

MESSAGE FROM THE IoTDI 2016 PROGRAM CHAIRS

Welcome to the inaugural edition of the International IEEE Conference on Internet-of-Things (IoT) Design and Implementation! This conference is created to offer a premier publication venue that covers a broad spectrum of systems issues related to the emerging field of the Internet of Things. The desire to start a new conference in the field was born out of an observation that while many publication venues exist today on different aspects of IoT, they are generally either more specialized or more regional. There is room for a new top conference that brings together researchers in academia, industry, and government around the growing interdisciplinary challenges related to IoT. Indeed, there are established top conferences in fields such as Cyber-Physical

Systems (CPS), Networked Sensing, Networking, Mobile Computing, and Cloud Computing, but IoT systems span across the boundaries of these disciplines. No single current venue exists today that offers such a multidisciplinary perspective, motivated explicitly by IoT systems research. For example, while some conferences cover sensing and CPS, they do not necessarily cover cloud-related issues, and while others are premier venues on cloud computing, they do not cover front-end challenges. Most current conferences that are labeled IoT also specialize in a subset of topics, such as security, enterprise, or industrial perspectives.

With the above in mind, a new program committee was put together, composed of world experts on several fields deemed central to IoT problems, including CPS, Networking (with a focus on Networked Sensing), Mobile Computing, and Cloud Computing. More than 90 abstracts were submitted, out of which 55 full papers underwent the review process. Of these, 11 full contributed papers were selected. (In addition, 3 papers were accepted as short papers and 2 papers were withdrawn.) To complement the contributed program, 8 papers were invited on special topics appropriate to the inaugural issue. These papers covered general IoT visions from different perspectives (such as platforms, security, and mobility), as well as ways the Internet of Things changes existing Internet paradigms. The resulting program reflects what we believe to be the important research dimensions of IoT systems. Overall, this year's program features several full paper sessions, three keynote talks, a panel, and a short paper session. Sessions cover topics ranging from IoT enablers to architectural paradigms and novel services (both front-end and backend). They also cover applications, from outdoor infrastructure to smart buildings and vehicular networks.

We hope you enjoy our inaugural program and contribute to future issues of this conference. We would like to thank the technical program committee for working hard on selecting the highest-quality papers that represent the intended scope. We also thank the general chairs and organizers' team for handling the many details that make a conference a success! It has been a great pleasure working with this team. Last but not least, we thank the authors and attendees for making this conference a reality. With your help, we hope this year will be the beginning of a successful and growing series. We look forward to seeing you again and wish you a great time in Berlin.

Tarek Abdelzaher,
University of Illinois, USA

Giannong Cao,
Hong Kong Polytechnic University, China

Pedro Marrón,
University of Duisburg-Essen, Germany

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China;

Adam Wolisz, *TU Berlin, Germany;*



IoTDI: CONFERENCE PROGRAM

DAY	TIME	IoTDI	Location
MON	MONDAY		
	9:00 - 17:00	Workshops and Tutorials <i>Details on page 62 and 77</i>	MAR building
	Joint Welcome Reception with Posters <i>Drinks and light snacks will be served</i>		
	18:00 - 19:30	Welcome Reception	Lichthof
TUE	TUESDAY		
	8:00-8:25	Breakfast 	Lichthof
	Keynote		
	<i>Session Chair: Stefan Tai, TU Berlin, Germany</i>		
	8:30-9:00	Welcome Welcome Message by Stefan Tai, <i>General Co-Chair, IC2E 2016,</i> and Hui Lei, <i>General Co-Chair, IoTDI 2016</i> Welcome Message by Christian Thomsen, <i>President, TU Berlin</i> Welcome Message by Lucy Cherkasova and Peter Pietzuch, <i>PC Co-Chairs, IC2E 2016</i> Welcome Message by Tarek Abdelzaher and Jiannong Cao, <i>PC Co-Chairs, IoTDI 2016</i>	H1012

DAY	TIME	IoTDI	Location
TUE	9:00-10:00	Keynote 1: Gustavo Alonso (ETH): <i>Generalization versus Specialization in cloud computing infrastructures</i>	H1012
	10:00-10:30	Coffee Break 	Lichthof
	IoT Visions and Enablers		
	<i>Session Chair: Jean Bacon, University of Cambridge, UK</i>		
TUE	10.30-12.30	- <i>Enabling Synergy in IoT - Platform to Service and Beyond</i> Michael P Andersen (University of California, Berkeley, USA); Gabe Fierro (University of California, Berkeley, USA); David E. Culler (University of California, Berkeley, USA) - <i>World of Empowered IoT Users</i> Sayed Hadi Hashemi (University of Illinois, Urbana Champaign, USA); Faraz Faghri (University of Illinois, Urbana Champaign, USA); Paul Rausch (ExaByte Labs); Roy H. Campbell (University of Illinois, Urbana Champaign, USA) - <i>Internet of Mobile Things: Mobility-Driven Challenges, Designs, and Implementations</i> Klara Nahrstedt (University of Illinois, Urbana Champaign, USA); Hongyang Li (University of Illinois, Urbana Champaign, USA); Phuong Nguyen (University of Illinois, Urbana Champaign, USA); Siting Chang (University of Illinois, Urbana Champaign, USA); Long Vu (University of Illinois, Urbana Champaign, USA)	H1028
	12.30-13.30	Lunch 	Lichthof

DAY	TIME	IoTDI	Location
TUE	IoT Applications (I): Personal, Participatory, and Vehicular		
	Chair: Tarek Abdelzaher, University of Illinois at Urbana Champaign, USA		
	13:30-15:00	<p>- <i>VShare: A Wireless Social Network Aided Vehicle Sharing System Using Hierarchical Cloud Architecture</i> Yuhua Lin (Clemson University, USA); Haiying Shen (Clemson University, USA)</p> <p>- <i>Towards a Sustainable Incentive Mechanism for Participatory Sensing</i> Xiaoshan Sun (University of Science and Technology, P.R. China); Jinyang Li (University of Science and Technology, P.R. China); Wei Zheng (Sanofi-Aventis US, USA); Hengchang Liu (University of Science and Technology, P.R. China)</p> <p>- <i>Developing Adaptive Quantified-Self Applications Using DynaSense</i> Pratik Lade (University at Buffalo, USA); Yash Upadhyay (University at Buffalo, USA); Karthik Dantu (University at Buffalo, USA); Steven Y. Ko (University at Buffalo, USA)</p>	H1028
	15:00-15:30	Coffee Break ☕	Lichthof

DAY	TIME	IoTDI	Location
TUE	Edge and Backend Services for IoT		
	Chair: Steven Ko, University at Buffalo, USA		
	15:30	<p>- <i>Adaptive Edge Analytics for Distributed Networked Control of Water Systems</i> Sokratis Kartakis (Imperial College London, UK); Weiren Yu (Imperial College London, UK); Julie A. McCann (Imperial College London, UK)</p> <p>- <i>Query Processing For The Internet-of-Things: Coupling Of Device Energy Consumption And Cloud Infrastructure Billing</i> Francesco Renna (University College London, UK); Joseph Doyle (University College London, UK); Vasilios Giotsas (University College London, UK); Yiannis Andreopoulos (University College London, UK)</p> <p>- <i>An Intelligent, Performance Interference-aware Resource Management Scheme for IoT Cloud Backends</i> Faruk Caglar (Meliksah University, Turkey); Shashank Shekhar (Vanderbilt University & Institute for Software Integrated Systems, USA); Aniruddha Gokhale (Vanderbilt University, USA); Xenophon Koutsoukos (Vanderbilt University, USA)</p> <p>- <i>Enhancing Dependability of Cloud-based IoT Services through Virtualization</i> Kashif Dar (University of Oslo, Norway); Amir Taherkordi (University of Oslo, Norway); Frank Eliassen (University of Oslo, Norway)</p>	H1028

DAY	TIME	IoTDI	Location
WED	WEDNESDAY		
	8:30-8:55	Breakfast 	Lichthof
	Keynote		
	Session Chair: Hui Lei, IBM Research, USA		
	9:00-10:00	Keynote 2: Jon Crowcroft (University of Cambridge): What could possibly go wrong?	H1012
	10:00-10:30	Coffee Break 	Lichthof
	Network Architecture Paradigms for IoT		
	Chair: Roy Campbell, University of Illinois at Urbana Champaign, USA		
	10:30-12:30	<p>- <i>Named Data Networking of Things</i> W. Shang (University of California, Los Angeles, USA); A. Bannis (Carnegie Mellon University, USA); T. Liang (University of Arizona, USA); Z. Wang (University of California, Los Angeles, USA); Y. Yu (University of Cali- fornia, Los Angeles, USA); A. Afanasyev (University of California, Los Angeles, USA); J. Thompson (University of California, Los Angeles, USA); J. Burke (University of California, Los Angeles, USA); B. Zhang (University of Arizona, USA); L. Zhang (University of California, Los Angeles, USA)</p> <p>- <i>MF-IoT: A MobilityFirst-Based Internet of Things Archi- tecture with Global Reachability and Communication Diversity</i> S. Li (Rutgers University, USA); H. Yu (Rutgers Univer- sity, USA); J. Chen (Rutgers University, USA); Y. Zhang (Rutgers University, USA); D. Raychaudhuri (Rutgers University, USA); R. Ravindran (Huawei Research Cen- ter, P.R. China); H. Gao (China Agricultural University, P.R. China); L. Dong (Huawei Research Center, P.R. China); G. Wang (Huawei Research Center, P.R. China)</p>	H1028

DAY	TIME	IoTDI	Location
WED		- <i>A Layered Protocol Architecture for Scalable Innovation and Identification of Network Economic Synergies in the Internet of Things</i> T. Wolf (University of Massachusetts, Amherst, USA); A. Nagurney (University of Massachusetts, Amherst, USA)	H1028
	12:30-13:30	Lunch 	Lichthof
	Application-inspired Networking Challenges		
	Chair: Tilman Wolf, University of Massachusetts Amherst, USA		
WED	13:30-15:00	- <i>Resilient Overlays for IoT-based Community Infrastruc- ture Communications</i> Kyle Benson (University of California, Irvine, USA); Qing Han (University of California, Irvine, USA); Kyungbaek Kim (Chonnam National University, South Korea); Phu Dinh Nguyen (University of California, Irvine, USA); Nalini Venkatasubramanian (University of California, Irvine, USA)	H1028
		- <i>DIAL: A Distributed Adaptive-Learning Routing Me- thod in VDTNs</i> Bo Wu (Clemson University, USA); Haiying Shen (Clemson University, USA); Kang Chen (Southern Illinois University Carbondale, USA)	
		- <i>Maximizing Network Lifetime of WirelessHART Net- works under Graph Routing</i> Chengjie Wu (Yahoo Inc., USA); Dolvara Gunatilaka (Washington University in St. Louis, USA); Abusayeed Saifullah (Missouri University of Science and Technolo- gy, USA); Mo Sha (Binghamton University, USA); Paras Tiwari (Washington University in Saint Louis, USA); Chenyang Lu (Washington University in St. Louis, USA); Yixin Chen (Washington University in St Louis, USA)	





IC2E

4th

International
Conference on
Cloud Engineering

&

IoTDI

1st

International Conference
on Internet-of-Things
Design and Implementation

Keynotes

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Generalization versus Specialization in cloud computing infrastructures



Gustavo Alonso

(Professor at the Department of Computer Science of ETH Zurich)

Abstract

Cloud computing represents a fundamental change in the business model behind IT: a shift from manufacturing of software and hardware products towards packaging infrastructure, processing, and storage as services. Cloud data centers, given their intended use for general purpose computing, would seem to push towards homogeneity in architectures and platforms. Modern applications and use cases, from scientific computing to big data, push in exactly the opposite direction: an increase in specialization as a way to efficiently meet demanding requirements.

In this talk I will illustrate both trends and argue that, contradictory as they seem to be, there are many opportunities in combining them. Doing so requires to work in two areas. One is to find better ways to extend the performance and efficiency advantages of specialization to general purpose settings. The other is to develop the necessary software and hardware layers to allow generalized use of specialized systems. Taking together, these efforts outline an exciting research and development landscape that I will outline as a conclusion of the talk.

Biography

Gustavo Alonso is a professor at the Department of Computer Science of ETH Zurich (ETHZ) in Switzerland, where he is a member of the Systems Group. Gustavo has a M.S. and a Ph.D. in Computer Science from UC Santa Barbara. Before joining ETH, he was at the IBM Almaden Research Center.

His research interests encompass almost all aspects of systems, from design to run time. His applications of interest are distributed systems and databases, with an emphasis on system architecture. Current research is related to multi-core architectures, large clusters, FPGAs, and big data, mainly working on adapting traditional system software (OS, database, middleware) to modern hardware platforms.

Gustavo is a Fellow of the ACM and of the IEEE. He has received numerous awards, the most recent include the FCCM 2013 Best Paper Award, the AOSD 2012 Most Influential Paper Award, the VLDB 2010 Ten Year Best Paper Award, and the 2009 ICDCS Best Paper Award. He was the Chair of ACM EuroSys (the European Chapter of SIGOPS), and PC-Chair of a number of conferences in several areas, among others: Middleware (2004), VLDB (2006), Business Process Management (2007), ICDE (2008), VLDB Experimental and Analysis Track (2012), ICDCS (2014), EDBT (2015), VLDB Industrial Track (2016).

What could possibly go wrong?

Abstract

There are many more things with moving parts in the world than computers. These are the objects that are being connected, initially artefacts, but also the natural world. They are connected both by being sensed, and via actuators. For a true Internet of things to emerge with all its potential value for innovation in efficiencies, the sensors and actuators must actually be reachable from anywhere,

anytime, just like computers on today's internet. And they must be locally and remotely programmable. Of course, there must be mechanisms to implement policies about access and use. However, these policies are complex, since they don't merely reflect informational rules, but also rules about the physical world - a car may be restricted to certain speeds in certain areas, but also to different speeds and areas at different times, due to the driver.

Unfortunately, in the rush to instrument and control the world of things, the complexity of the world seems to have been forgotten. Worse, the typical system software being deployed in many places does not reflect the last few decades evolution of safety and security work that has gone in to the implementation of operating systems and protocols. All too often, we here another system uses an embedded OS with no isolation or a protocol stack with known vulnerabilities, or is shipped with default access control credentials to millions of customers.

This is not good enough.

In this talk, I will cover some of the work we've been doing in the Microsoft sponsored project in Cambridge and QMUL, on the technical and legal challenges that are now facing our community.

Biography

Jon Crowcroft has been the Marconi Professor of Communications Systems in the Computer Laboratory since October 2001. He has worked in the area of Internet support for multimedia communications for over 30 years. Three main topics of interest have been scalable multicast routing, practical approaches to traffic management, and the design of deployable end-to-end protocols. Current active research areas are Opportunistic Communications, Social Networks, and techniques and algorithms to scale infrastructure-free mobile systems. He leans towards a „build and learn“ paradigm for research.

He graduated in Physics from Trinity College, University of Cambridge in 1979, gained an MSc in Computing in 1981 and PhD in 1993, both from UCL. He is a Fellow the Royal Society, a Fellow of the ACM, a Fellow of the British Computer Society, a Fellow of the IET and the Royal Academy of Engineering and a Fellow of the IEEE.

He likes teaching, and has published a few books based on learning materials.



Jon Crowcroft

(Professor of Communications Systems
at the University of Cambridge)

Processing Big Data in Motion



Roger Barga
(General Manager,
Amazon Web Services)

Abstract

Streaming analytics is about identifying and responding to events happening in your business, in your service or application, and with your customers in near real-time. Sensors, mobile and IoT devices, social networks, and online transactions are all generating data that can be monitored constantly to enable a business to detect and then act on events and insights before they lose their value. The need for large scale, real-time stream processing of big data in motion is more evident than ever before but the potential remains largely untapped by most firms. It's not the size but rather the speed at which this data must be processed that presents the greatest technical challenges. Streaming analytics systems can enable business to inspect, correlate and analyze data in real-time to extract insights in the same manner that traditional analytics tools have allowed them to do with data at rest. In this talk I will draw upon our experience with Amazon Kinesis data streaming services to highlight use cases, discuss technical challenges and approaches, and look ahead to the future of stream data processing and role of cloud computing.

Biography

Roger Barga is General Manager and Director of Development at Amazon Web Services, responsible for Kinesis data streaming services including Kinesis Streams, Kinesis Firehose, and Kinesis Analytics. Before joining Amazon, Roger was in the Cloud Machine Learning group at Microsoft, where he was responsible for product management of the Azure Machine Learning service. His experience and research interests include data storage and management, data analytics and machine learning, distributed systems and building scalable cloud services, with emphasis on stream data processing and predictive analytics. Roger is also an Affiliate Professor at the University of Washington, where he is a lecturer in the Data Science and Machine Learning programs. Roger holds a PhD in Computer Science, a M.Sc. in Computer Science with an emphasis on Machine Learning, and a B.Sc. in Mathematics and Computer Science. Roger holds over 30 patents, he has published over 100 peer-reviewed technical papers and book chapters, and authored a book on predictive analytics.

PANEL

When Internet of Things (IoT) Meets Cloud Computing

Seetharami R. Seelam,
Research Staff Member,
IBM T. J. Watson Research Center (Panels Chair)

Abhishek Chandra,
Associate Professor in the Department of Computer Science and Engineering
at the *University of Minnesota*

David Eyers,
Senior Lecturer,
University of Otago

Jiannong Cao,
Chair professor and the head of the Department of Computing
at *The Hong Kong Polytechnic University*

Lucy Cherkasova,
Principal scientist
at *Hewlett Packard Labs*

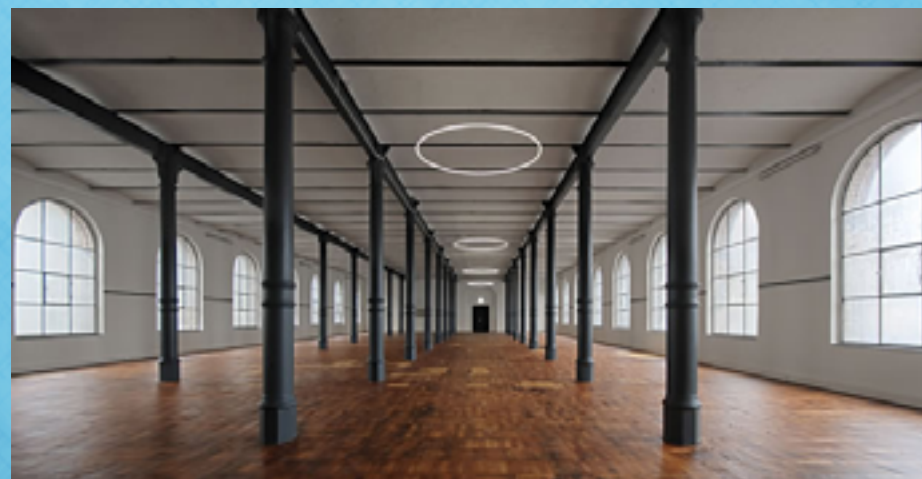
Chenyang Lu,
Professor,
Washington University in St. Louis

SOCIAL EVENT: *Conference Banquet*

at
Heeresbäckerei (Army Bakery)

The conference banquet will take place on April 6 at Heeresbäckerei Berlin, a building that was constructed in 1890 as part of the Prussian army bakery. Where historically bread was stored, we will now have our gala dinner surrounded by impressive examples of 19th century industrial architecture.

About Heeresbäckerei



© zweit heimat GmbH

Zwieback (a type of crisp, sweetened bread) and Kommissbrot („army loaf“) for the Prussian garrison were once stored here along with coal, salt and canned meat, in what was known as the „Senate's Reserves“ during the Cold War. The former army bakery has since been transformed into a stylish venue and is now home to Club-Restaurant Spindler & Klatt at the rear.

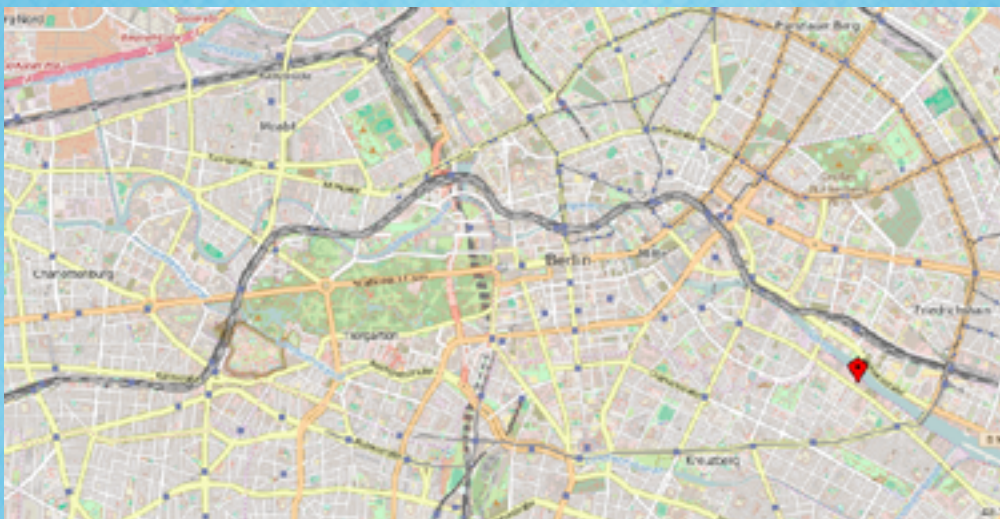
Traces of the old army bakery's history

The army bakery was part of the Royal Prussian Commissariat from 1805 onwards. Its location on the river Spree was perfect for supplying large quantities of grain. The surviving buildings were constructed on the basis of designs by architects Kneister, Arenberg and Böhm during a phase of redevelopment after a fire in 1890. Except for the mill, all of the elements of the building are still standing today. The bakery, granary (warehouse), two residences for civil servants and an administrative building are listed as historical sites.

Club and restaurant behind a yellow clinker brick facade

The former army bakery is a well-maintained facility and an impressive example of industrial architecture from the 19th century. With its fair-faced yellow clinker brickwork, the bakery is sure to catch the attention of passers by on Köpenicker Straße. The different parts of the facility are grouped around a generous interior courtyard. This former granary (warehouse) on the river Spree was transformed into an exclusive venue in 2009. Inside, cast-iron supports hold a five meter high vaulted ceiling in place, the well maintained parquet is made from aged copper beech and the deep arched windows create the impression of the building's former Prussian splendour.

Source: visitberlin.de



Address

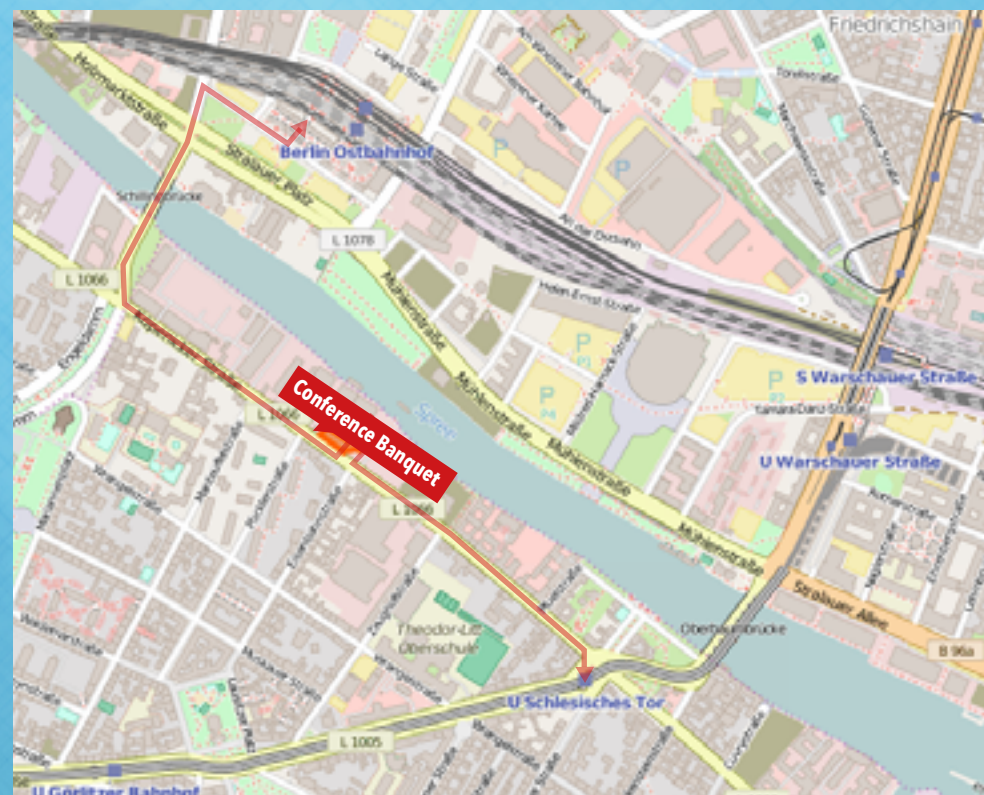
Köpenicker Straße 16-17
10997 Berlin KREUZBERG

Further information about the conference banquet:

TRANSFER INFORMATION

Bus transfer for the social event will depart at **18:00h** sharp in front of the TU main building. For the return trip to your hotel, please, use public transport: S Ostbahnhof (east-west line, S5/S7/S75) and U Schlesisches Tor (U1) are in walking distance.

See also the map below.



Walking directions to S Ostbahnhof and U Schlesisches Tor

Tutorials

Tutorial 1
Cloud Engineering in Education

S.

Tutorial 2
The Internet of Things moves into the Cloud

S.

Tutorial 3
Sensor Cloud: A Cloud of Sensor Networks

S.

Tutorial 4
Apache Flink: Stream Analytics at Scale

S.

Tutorial 5
Building Secure Cloud Architectures Using Patterns

S.

TUTORIAL PROGRAM

	Morning (9:00 - 12:00)	Afternoon (13:30 - 17:00)
Monday	Tutorial 1 MAR 0.001	Tutorial 2 MAR 0.001
Friday	Tutorial 3 MAR 0.003	Tutorial 4 MAR 0.003
	Tutorial 5 MAR 0.009	

There will be coffee breaks at 10:00 and 15:00. Lunch will not be provided.

- *Tutorial 1 (Monday morning):*
Cloud Engineering in Education
David Bermbach (TU Berlin, Germany), Dominik Ernst (TU Berlin, Germany)
- *Tutorial 2 (Monday afternoon):*
The Internet of Things moves into the Cloud
Antonio Iera (University of Reggio Calabria, Italy), Giacomo Morabito (University of Catania, Italy), Luigi Atzori (University of Cagliari, Italy)
- *Tutorial 3 (Friday morning):*
Sensor Cloud: A Cloud of Sensor Networks
Sanjay K Madria (Missouri University of Science and Technology, USA)
- *Tutorial 4 (Friday afternoon):*
Apache Flink: Stream Analytics at Scale
Asterios Katsifodimos (TU Berlin, Germany), Sebastian Schelter (TU Berlin, Germany)
- *Tutorial 5 (Friday full day):*
Building Secure Cloud Architectures Using Patterns
Eduardo B. Fernandez (Florida Atlantic University, USA)

More information on the IC2E Tutorials is also available online:
conferences.computer.org/IC2E/2016/tutorial_program.htm



Cloud Engineering in Education

David Bermbach (TU Berlin, Germany),
Dominik Ernst (TU Berlin, Germany)

As cloud engineering researchers and lecturers, we are frequently confronted with the challenge of teaching advanced concepts to students that are absolute beginners in that area. We believe that teaching complex engineering concepts, e.g., tradeoffs in distributed storage systems, has the highest probability of learning success if done through hands-on coding, systems development, and experiments with actual systems.

In this tutorial, we will start with a brief overview of our strategies in teaching cloud engineering concepts to bachelor's and master's students. Afterwards, we will introduce an assignment where students are asked to develop a simple distributed storage system based on a communication middleware. In our tutorial, we will then have a hands-on part where our tutorial participants work on that assignment. In a third phase, if time permits, we will work on part two of that assignment where students are asked to run a few experiments on geo-distributed cloud servers to analyze consistency-latency tradeoffs for different replication strategies

Prerequisites

- Attendees should have intermediate-level experience of deploying and managing software in the cloud. The material will be well-suited to university lecturers.
- Participants need to bring laptops and have a basic knowledge of Java.
- If time permits, the tutorial will include a live experiment phase. In that case, participants will need access to 3–4 virtual machines, e.g., through Amazon Web Services (< 2 USD).

Biographies of presenters

David Bermbach is a senior researcher within the Information Systems Engineering research group at TU Berlin in Berlin, Germany. At TU Berlin, he is working on novel cloud benchmarking solutions and cloud data management techniques. Prior to his current position, he worked as a researcher at KIT and as a lecturer at DHBW both in Karlsruhe, Germany. David has a Diploma in business engineering (2010) and a Ph.D. with distinction in computer science (2014) both from KIT. He received a best paper runner up award at IC2E 2014 and a best paper award at the 2nd International Conference on Cloud Computing, GRIDs, and Virtualization.

Dominik Ernst has been a PhD student in the Information Systems Engineering research group at TU Berlin since 2015. Before joining the group, he worked as a software engineer for a consulting company. Dominik has a master's degree in business engineering from KIT and is interested in modern container technology and its impact on software architectures as well as cloud and service platforms.

The Internet of Things moves into the Cloud

Antonio Iera (University of Reggio Calabria, Italy),
Giacomo Morabito (University of Catania, Italy),
Luigi Atzori (University of Cagliari, Italy)

This tutorial has three main objectives:

1. Providing insights into the evolution that the IoT has gone through since its introduction.

The idea of IoT has evolved over time and has undergone successive transformations that will predictably still continue over the coming years with the advent of new enabling technologies. New concepts, such as cloud computing, information centric networking, big data, and social networking, have already partially impacted and still are impacting on this paradigm. This trend will surely continue, given the importance of the relevant applications. In this tutorial we will illustrate the evolution of the IoT classifying different generations and give a modern definition of the phenomenon. In this way the audience will become aware of the differences between IoT and the technologies often confused with it (such as sensor networks, RFID systems, M2M, etc.).

2. Presenting the role that Cloud computing technology can play in the support of the IoT.

In the IoT most objects (even the smartest) do not have the (energy, processing, and communication) capabilities to run the services that users expect. Accordingly several solutions have been proposed to offload processing to the cloud. Several possibilities can be considered in this context depending on whether the cloud will just be the responsible for the storage, management, and retrieval of the data generated by smart objects or will provide the environment where virtualized digital instances of the objects and/or the service they offer will run. In this tutorial we will provide a critical overview of the most important solutions proposed so far in the literature.

3. Showing a practical example of cloud support for IoT objects and service virtualization in the cloud.

Finally, we will present a specific solution for supporting IoT in the cloud. More specifically we will show the architecture, the tools utilized to virtualize objects, and the APIs offered to application developers. In this way most of the concepts depicted throughout the tutorial will be illustrated from a practical point of view.

Session details

Part 1: IoT context and history (1 hour)

- Introduction
- The first generation of the IoT: tagged things
 - Major innovations
 - Major architectural solutions: EPCglobal Network, Machine-to-Machine communication architecture, Architectures for integration of RFID systems and WSNs in the IoT
 - Main related projects, main research results, main industrial experimentations
- The second generation of the IoT: full interconnection of things and the (social) web of things
 - Major innovations
 - Major architectural solutions: CoRe Architecture, Web of Things, Social Web of Things
 - Main related projects, main research results, main industrial experimentations
- The third generation of the IoT: the age of "social objects", "cloud computing", and "future internet"
 - Major innovations
 - Major architectural solutions: IoT and Cloud computing, IoT and ICN, Social-IoT
 - Main related projects, main research results, main industrial experimentations

Part 2: Emerging solutions (1 hour)

- **Solutions for the storage and management of IoT data and the APIs offered to application developers**
 - Basic concepts and architectures proposed
 - Implementations available
 - Comparison
- **Solutions for the virtualization of IoT objects and services**
 - Basic concepts and architectures proposed
 - Implementations available
 - Comparison
- **Solutions to run IoT services at the edge of the cloud**
 - Motivations and basic concepts
 - Optimizatoin techniques

Part 3: Practical example (1 hour)

- **General Description of the IoT solution**
- **Architecture and modules**
- **Implementation and development tools and environments adopted**
- **APIs offered to application developers**
- **Example applications**

Prerequisites

No specific prerequisites or required knowledge.

This tutorial is intended to be of interest to academic and industrial researchers across a wide range of topics.

Biographies of presenters

Antonio Iera graduated in Computer Engineering at the University of Calabria, Italy, in 1991 and received a Master Diploma in Information Technology from CEFRIEL/Politecnico di Milano, Italy, in 1992 and a Ph.D. degree from the University of Calabria, Italy, in 1996. From 1994 to 1995 he has been with the Mobile Network Division Research Center, Siemens AG–Munich, Germany and since 1997 with the University Mediterranea, Reggio Calabria, where he currently holds the positions of full professor of Telecommunications and Director of the ARTS (www.arts.unirc.it)–Laboratory for Advanced Research into Telecommunication Systems. He served as TPC member of several IEEE International Conferences and has been co-Guest Editor for different special issues in the IEEE Wireless Communications Magazine. Elevated to the IEEE Senior Member status in 2007. His research interests include: Next generation mobile systems, Advanced Systems for Personal Communications, RFID systems and Internet of Things.

Giacomo Morabito received the laurea degree in Electrical Engineering and the PhD in Electrical, Computer and Telecommunications Engineering from the Istituto di Informatica e Telecomunicazioni, University of Catania, Catania (Italy), in 1996 and 2000, respectively. From November 1999 to April 2001, he was with the Broadband and Wireless Networking Laboratory of the Georgia Institute of Technology as a Research Engineer. Since April 2001 he is with the Dipartimento di Ingegneria Informatica e delle Telecomunicazioni of the University of Catania where he is currently Associate Professor. He serves (or has served) on the Editorial Boards of Wireless Networks, Computer Networks and IEEE Wireless Communications. Furthermore, he has been editor or co-guest editor of special issues of IEEE Transactions on Multimedia, IEEE Wireless Communication Magazine, Computer Networks and MONET. His research interests focus on analysis and solutions for broadband and wireless networks.

Luigi Atzori is associate professor at the University of Cagliari (Italy). His main research topics of interest are in service management in next generation networks, with particular attention to architectural solutions for the Internet of Things, QoS, service-oriented networking, bandwidth management and multimedia networking. He has published more than 100 journal articles and refereed conference papers. Dr. Atzori has received the Telecom Italia award for an outstanding MSc thesis in Telecommunication and has been awarded a Fulbright Scholarship (11/2003-05/2004) to work on video streaming at the Department of Electrical and Computer Engineering, University of Arizona. He is senior member of IEEE, steering committee chair of the IEEE Multimedia Communications Committee (MMTC). He has been the editor for the ACM/Springer Wireless Networks Journal and guest editor for the IEEE Communications Magazine, Monet and Signal Processing: Image Communications journals. He is currently editor of the IEEE IoT Journal, Ad Hoc Networks Journal and Advances on Multimedia.

Sensor Cloud: A Cloud of Sensor Networks

Sanjay K Madria (Missouri University of Science and Technology, USA)

Traditional model of computing with wireless sensors imposes restrictions on how efficiently wireless sensors can be used due to resource constraints. Newer models for interacting with wireless sensors such as Internet of Things and Sensor Cloud aim to overcome these restrictions. This tutorial will discuss a sensor cloud architecture which enables different wireless sensor networks, spread in a huge geographical area to connect together and be used by multiple users at the same time on demand basis. Virtual sensors will be shown to assist in creating a multi-user environment on top of resource constrained physical wireless sensors, and can help in supporting multiple applications on-demand basis. Security issues will be presented, along with an overview of some potential solutions to these problems such as: energy efficient privacy and data integrity preserving data aggregation algorithms, risk

assessment in sensor clouds, and attribute-based access control for sensor cloud applications.

Session details

- Part 1.** Cloud of Sensors – different architectures
- Part 2.** Virtualization in Sensor Cloud
- Part 3.** Scheduling in Sensor Cloud
- Part 4.** Data Aggregation in Sensor Cloud
- Part 5.** Security, Privacy and Risk Issues in Sensor Cloud

Prerequisites

No specific prerequisites or required knowledge. This tutorial is suitable for academics, researchers and postgraduate students working in the area of sensor networks, cloud computing, and security and privacy.

Biography of presenter

Sanjay Kumar Madria is a full professor in the Department of Computer Science at the Missouri University of Science and Technology (formerly, University of Missouri-Rolla, USA) and site director, NSF I/UCRC center on Net-Centric Software Systems. He has published over 200 Journal and conference papers in the areas of mobile data management, sensor computing, and cyber security and trust management. He won three best papers awards from conferences such as IEEE MDM 2011 and IEEE MDM 2012. His research is supported by several grants from federal sources such as NSF, DOE, AFRL, ARL, ARO, NIST and industries such as Boeing and Unique*Soft. He has also been awarded the JSPS (Japanese Society for Promotion of Science) visiting scientist fellowship in 2006 and the ASEE (American Society of Engineering Education) fellowship at AFRL from 2008 to 2012. In 2012–13, he was awarded a NRC Fellowship by National Academies. He has received faculty awards in 2007, 2009, 2011 and 2013 from his university for excellence in research. He served as an IEEE Distinguished Speaker, and currently, he is an ACM Distinguished Speaker, an IEEE Senior Member, and a Golden Core awardee.

Apache Flink: Stream Analytics at Scale

Asterios Katsifodimos (TU Berlin, Germany),
Sebastian Schelter (TU Berlin, Germany)

Apache Flink is an open source system for expressive, declarative, fast, and efficient data analysis on both historical (batch) and real-time (streaming) data. Flink combines the scalability and programming flexibility of distributed MapReduce-like platforms with the efficiency, out-of-core execution, and query optimization capabilities found in parallel databases. At its core, Flink builds on a distributed dataflow runtime that unifies batch and incremental computations over a true-streaming pipelined execution. Its programming model allows for stateful, fault tolerant computations, flexible user-defined windowing semantics for streaming and unique support for iterations. Flink is converging into a use-case complete system for parallel data processing with a wide range of top level libraries ranging from machine learning and graph processing. Apache Flink originates from the Stratosphere project led by TU Berlin and has led to various scientific papers (e.g., in VLDBJ, SIGMOD, (P)VLDB, ICDE, and HPDC). In this half-day tutorial we will introduce Apache Flink, and give a tutorial on its streaming capabilities using concrete examples of application scenarios, focusing on concepts such as stream windowing, and stateful operators.

Prerequisites

No specific prerequisites or required knowledge.

Biographies of presenters

Asterios Katsifodimos is a postdoctoral researcher co-leading the Stratosphere research project at the Technische Universität Berlin. He received his PhD in 2013 from INRIA Saclay and Université Paris-Sud under the supervision of Ioana Manolescu. His thesis focused on materialized view-based techniques for the management of Web Data. Asterios has been a member of the High Performance Computing Lab at the University of Cyprus, where he obtained his BSc and MSc degrees in 2009. His research interests include query optimization, large-scale distributed data management and Big Data analytics.

Sebastian Schelter is a machine learning scientist at Amazon, as well as a senior researcher at the Database Systems and Information Management Group of TU Berlin. Furthermore, he is engaged in open source as a member of the Apache Software Foundation. His research focuses on scalable data mining on parallel processing platforms. During his PhD, he was an intern at IBM Research Almaden, and at Twitter in California.

Building Secure Cloud Architectures Using Patterns

Eduardo B. Fernandez (Florida Atlantic University, USA)

Patterns abstract good practices to define basic models that can be used to build new systems and evaluate existing systems. Security patterns join the extensive knowledge accumulated about security with the structure provided by patterns to provide guidelines for secure system requirements, design, and evaluation. We have built a catalog of over 100 security patterns, which is still growing. We complement these patterns with misuse patterns, which describe how an attack is performed from the point of view of the attacker and describe how it can be stopped. We integrate patterns in the form of security reference architectures (SRAs) and we extend them to their ecosystems. We show how to build a SRA for clouds and their ecosystems. The use of patterns can provide a holistic view of security, which is a fundamental principle to build secure systems. The patterns and reference architectures are shown using UML models and examples are taken from my two books on security patterns as well as from my recent publications.

Session details

Patterns combine experience and good practices to develop basic models that can be used to build new systems and to evaluate existing systems. Security patterns join the extensive knowledge accumulated about security with the structure provided by patterns to provide guidelines for secure system requirements, design, and evaluation. We consider the structure and purpose of security patterns, show a variety of security patterns, and illustrate their use in the construction of secure systems. These patterns include among others Authentication, Authorization/Access Control, Firewalls, Secure Broker, Web Services Security, and Cloud Security. We have built a catalog of

over 100 security patterns. We introduce Abstract Security patterns (ASPs) which are used in the requirements and analysis stages. We complement these patterns with misuse patterns, which describe how an attack is performed from the point of view of the attacker and how it can be stopped. We integrate patterns in the form of security reference architectures. Reference architectures have not been used much in security and we explore their possibilities. We introduce patterns in a conceptual way, relating them to their purposes and to the functional parts of the architecture. Example architectures include a security cloud reference architecture (SRA) and a cloud ecosystem. The use of patterns can provide a holistic view of security, which is a fundamental principle to build secure systems. Patterns can be applied throughout the software lifecycle and provide a good communication tool for the builders of the system. The patterns and reference architectures are shown using UML models and examples are taken from my two books on security patterns as well as from my recent publications. The patterns are put in context; that is, we do not present a disjoint collection of patterns but instead present a logical architectural structuring where the patterns are added where needed. In fact, we present a complete methodology to apply the patterns along the system lifecycle to build secure systems and a process to build reference architectures.

Outline

- Security concepts
- Attacks/threats
- The design of secure systems: relating threats to use cases.
- A methodology to build secure architectures
- Security patterns, abstract security patterns, misuse patterns, threat patterns
- Security models and their patterns—policies, access matrix, multilevel models, RBAC
- Enumerating threats from use cases
- RBAC and security policies from use cases.
- Security Logging/Auditing and Authentication.
- Security reference architectures (SRAs)
- A SRA for cloud systems
- Misuse patterns for clouds
- An architecture for cloud ecosystems
- A pattern for Fog Computing
- Conclusions – the future

Prerequisites

The tutorial has been tailored to fit the interests of the attendees of a cloud computing conference.

Biography of presenter

Eduardo B. Fernandez (Eduardo Fernandez-Buglioni) is a professor in the Department of Computer Science and Engineering at Florida Atlantic University in Boca Raton, Florida, USA. He has published numerous papers on authorization models, object-oriented analysis and design, and security patterns. He has written four books on these subjects, the most recent being a book on security patterns. He has lectured all over the world at both academic and industrial meetings. He has created and taught several graduate and undergraduate courses and industrial tutorials. His current interests include security patterns, cloud computing security, and software architecture. He holds a MS degree in Electrical Engineering from Purdue University and a Ph.D. in Computer Science from UCLA. He is a Senior Member of the IEEE, and a Member of the ACM. He is an active consultant for industry, including assignments with IBM, Allied Signal, Motorola, Lucent, Huawei, and others.

Workshops and Doctoral Symposium

WORKSHOP PROGRAM

	Morning (9:00 - 12:00)	Afternoon (13:30 - 17:00)
Monday	SDS (MAR 0.003 & MAR 0.008)	
	Doctoral Symposium (MAR 0.007)	Intercloud 2016 (MAR 0.007)
	I4T (MAR 0.002)	
Friday	CLaw (MAR 0.008)	CCTE (MAR 0.008)
	WoC (MAR 0.007)	

There will be coffee breaks at 10:00 and 15:00. Lunch will not be provided.

There are six co-located workshops and a doctoral symposium:



Third Symposium on Software Defined Systems (SDS)

CLaw: Second International Workshop on Legal and Technical Issues in Cloud Computing and Cloud-Supported Internet of Things



Cloud Computing Technoeconomic Engineering (CCTE)

First International Workshop on Interoperability, Integration, and Interconnection of Internet of Things Systems (I4T)



Second International Workshop on Container Technologies and Container Clouds (WoC)

Fifth IEEE International Workshop on Cloud Computing Interclouds, Multiclouds, Federations, and Interoperability (Intercloud 2016)



Doctoral Symposium

Local Information

CONFERENCE VENUE

TU BERLIN



IC2E 2016 will be held on the Charlottenburg campus of TU Berlin close to the old West Berlin center.

With almost 34 000 students, circa 100 course offerings and 40 Institutes, the historic Technische Universität Berlin is one of Germany's largest and most internationally renowned technical universities. Located in Germany's capital city – at the heart of Europe – outstanding achievements in research and teaching, imparting skills to excellent graduates, and a modern service-oriented administration characterize TU Berlin.

The range of services offered by our seven Faculties serves to forge a unique link between the natural and technical sciences on the one hand, and the planning, economics and social sciences and humanities on the other. This is indeed a significant achievement for any technical university.

Workshops and tutorials take place in the MAR building. The main conference is held in the main building. Check out the campus map (page 84) of TU Berlin for walking directions.

ABOUT BERLIN

The capital city of the Federal Republic of Germany has a population of 3.5 million. Covering an area of 892 square kilometres, Berlin is the Goliath among German cities. By international comparison, the German capital is the second largest city in the European Union in terms of its population and the fifth largest in terms of its area.



With 175 museums, Berlin has more museums than rainy days. It also boasts more than 50 theatres and around 300 cinemas. The city has 4,650 restaurants, around 900 bars and 190 clubs and discotheques. It also has more doner kebab shops than Istanbul!

Berlin has been the German capital on several occasions throughout its history. Starting out as the capital of the margraviate and electorate of Brandenburg, this city on the River Spree later became the capital of the kingdom of Prussia and then the German Empire. East Berlin was the capital of the German Democratic Republic. Since German reunification in 1990, Berlin has been the capital of Germany once more.

Public Transportation:

Berlin's public transit system will take you almost anywhere you want to go, taxis are generally easy to catch and bike rentals make it possible for you to tour the city as you please: Whether you just want to quickly get from A to B or prefer to take your time and explore the city's sights, Berlin offers you all sorts of possibilities for getting around. Be it by taking a train, taxi or bike, mobility is a breeze in Berlin.

The fastest way to find out how to get to your next destination by public transportation is www.bvg.de. You can enter your current location to find out the quickest possible route.

(text source: visitberlin.de)



www.bvg.de/en

CAMPUS MAP



Technische Universität Berlin

Campus Charlottenburg



MAR

March building / March-Gebäude
Marchstraße 23

H

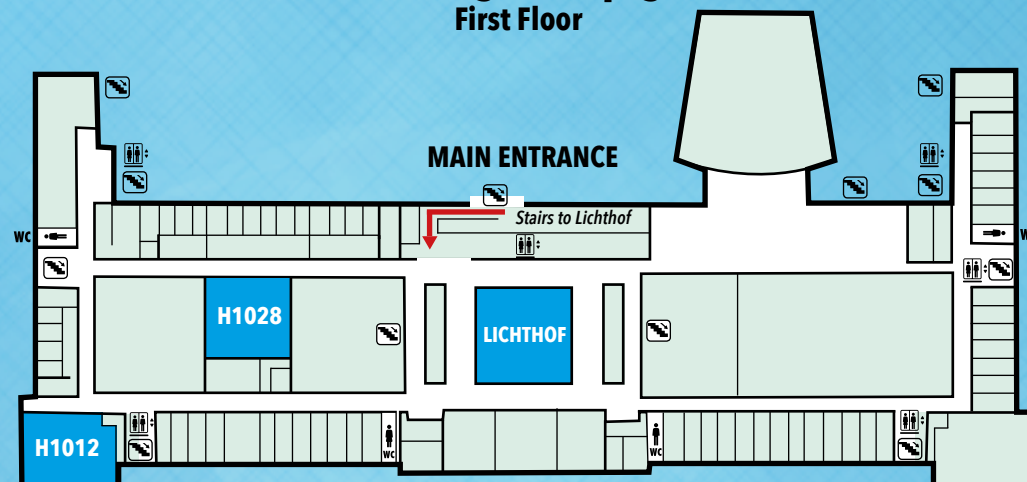
Main building / Hauptgebäude
Straße des 17. Juni 135

FLOORPLAN OF CONFERENCE VENUE

H

Main building / Hauptgebäude

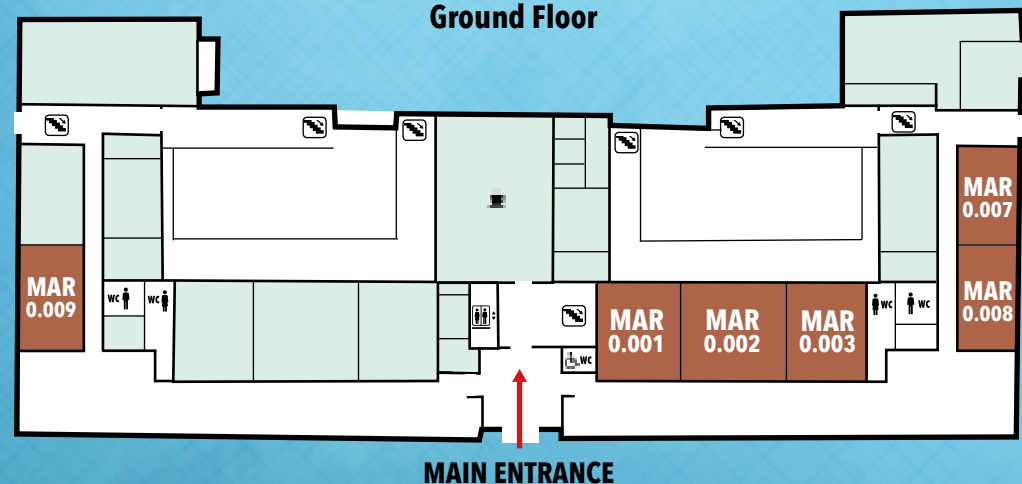
First Floor



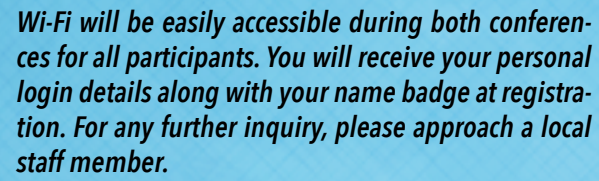
MAR

March building / March-Gebäude

Ground Floor



NOTES

This image shows a full page of blue-lined paper, commonly used for handwriting practice or as a template for writing. The paper has a light blue background color. It features multiple horizontal ruling lines in a slightly darker shade of blue, spaced evenly across the page. There are no margins, text, or other markings present.

NOTES

[illegible]