



IFIP Networking 2018

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Proceedings

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IFIP Networking 2018 General Chair's Welcome Message

Dear Participants of the 17th IFIP Networking 2018!

Exactly eighteen years ago the IFIP Networking conference history took off with its first instance on May 14, 2000 in Paris, France, forming at that point for the first time a joint event on formerly separated and since then integrated conferences on Broadband Communications (1995-1999), Performance of Communication Networks (1981-1998), and High Performance Networking (1987-1998). While IFIP Networking took place in the past for 11 times in Europe, for 3 times in North America, and twice in Asia, now the 17th IFIP Networking instance starts in Zürich, Switzerland. Thus, it is my pleasure to welcome you in my position as the IFIP Networking 2018 General Chair – and on behalf of the entire IFIP Networking Organizing Committee and Local Arrangements Team – to the 17th IFIP Networking 2018!

Since you are already holding these proceedings in your hands, you have arrived by now safely to the beautiful location of Zürich, either by plane, train, or even car. Therefore, please find this program now at your hands as a guideline to your technical session planning for IFIP Networking 2018, the conference venue, information on the social event, conference services, and last but not least on lots of activities in and around Zürich. As you will have noted, the public transport toward the Swissôtel in Zürich-Oerlikon is most likely the very shortest one you may have ever seen for any conference you may participate in! The 8 minutes travel by train or S-Bahn (so called fast, short distance trains in Switzerland) from the train station of the Zürich Unique Airport (ZRH) to Oerlikon Bahnhof (station) and only an additional 60 m footpath from there to the hotel's entrance is not only a great coincidence, it is Zürich's dedication to offer a frequent, timely, reliable, and efficient public transport, running besides trains, S-Bahn, and tram lines also buses and boats on the same ticket!

And you will learn during IFIP Networking 2018 that this public transport is also working for IFIP Networking's social program, supported by IFIP Networking's provision of sponsored local transport ticket for 24 hours. Besides for its use for the social event, please check out on such ticket-wide travel options within Zürich's travel zone 110! Main details are available on the route map provided in your participants' welcome package. And for sure, do not hesitate to talk to the Zürich local team or the reception desk for more detailed inquiries.

During IFIP Networking 2018 you can enjoy as a registered participant (please wear always your badge for room access) the welcome and key note sessions, technical sessions, the poster and demo session, the panel, a modern hotel of up-to-date conference facilities, complimentary WLAN access, and a great setting for work, coffee breaks, and joint lunches.

Such an event would not be possible without you, the attendees and paper authors! Thus, thank you for being with us and presenting your work. But additionally, it is the great help and drive of the IFIP Networking 2018 Organizing Committee, who made sure that all of you do see this great program and nice location. Special thanks go here to the three TPC Co-chairs of IFIP Networking 2018: Claudio Casetti, Fernando Kuipers, and James P. G. Sterbenz.

Last but not least it is my pleasure to address many thanks to the sponsors of IFIP Networking 2018 especially the Communication Systems Group CSG of the Department of Informatics IfI, the University of Zürich UZH, the Canton of Zürich, and the City of Zürich, who help to make your experience of IFIP Networking 2018 a unique one! Also, IFIP Networking 2018 is pleased to acknowledge the support by IFIP TC6 and the technical co-sponsoring by the IEEE Computer Society. Thus again, the entire Zürich local arrangements team wishes you a very warm welcome, a highly successful conference, productive "in-between" meetings, new contacts and ideas, and some great days out in and around the city of Zürich!

Burkhard Stiller

IFIP Networking 2018 General Chair

IFIP Networking 2018 Program Chairs' Welcome Message

It is with great pleasure that we welcome all attendees of the 17th edition of IFIP Networking in Zürich, Switzerland. The main objective of IFIP Networking is to bring together members of the networking community from both academia and industry, to discuss recent advances in the broad and quickly evolving fields of computer and communication networks, to highlight key issues, identify trends, and develop a vision for Future Internet technology, operation, and use.

As in the past editions, IFIP Networking 2018 has attracted a large number of papers in four main areas: (1) Network Architectures, Applications and Services, (2) Network Modeling and Analysis, (3) Network Security and Privacy, and (4) Wireless Networking.

This year, we received 225 submissions from a total of 41 countries. At a time when all major conferences are vying to attract research works, the high number of this year's submissions confirms that IFIP Networking is a well-established, reputed venue for high quality papers.

The main technical program is the result of a very selective, rigorous two-step peer-review process by experts in the areas of the conference. With all papers receiving an average of 4.4 reviews (at least 3 reviews and some of them up to 6 reviews) plus a meta-review summarizing the online discussion, we were able to guarantee that the works that made it into the main program are of outstanding quality. Overall, we accepted 55 full papers, which corresponds to an acceptance ratio of around 24%. In addition, 8 papers were accepted as short presentation papers. Within a fully separate submission track from the main papers, 4 demonstrations and 3 posters had been accepted, too, to enable an interactive discussion of operational systems and work-in-progress.

The technical program is complemented by three keynotes, namely "Blockchain for Cyber Physical Systems", "Flexibility Matters: On the Design and Evaluation of Softwarized Networks", and "Artificial Intelligence in Network Operations and Management", and a panel on "Security and Privacy in the Internet of Things", as well as by a poster/demo session.

We would like to thank all the members of the Organizing Committee who worked hard to make this conference a real success. First and foremost, we express our gratitude to Burkhard Stiller, the General Chair of IFIP Networking 2018, for his unflagging support and constant input. Of course, a special thanks is due to all authors who selected IFIP Networking 2018 as a platform to present their latest research results. Last, but not least, we would also like to acknowledge all TPC members and reviewers for their time in providing their rigorous, high-quality 1009 reviews.

Hopefully, you will find this program a source of inspiration of new ideas for your research and work. We encourage you to use the three days of the conference to discuss and create new connections with colleagues from all over the world. Finally, besides attending intellectually inspiring talks and discussions, make sure to enjoy Zürich!

Claudio Casetti
Fernando Kuipers
James P. G. Sterbenz

IFIP Networking 2018 Technical Program Co-chairs

Keynote I: Blockchain for Cyber Physical Systems

Salil Kanhere, University of New South Wales, Sydney, Australia

In Cyber Physical Systems (CPS), computing elements coordinate and communicate with sensors, which monitor cyber and physical indicators, and actuators, which modify the cyber and physical environment where they are run. Current CPS ecosystems rely on centralized, brokered communication models, otherwise known as the client-server paradigm. All devices are identified, authenticated, and connected through cloud servers. The data collected by devices is stored in the cloud for further processing. While this model has connected generic computing devices for decades and will continue to support small-scale CPS networks as we see them today, it will not be able to respond to the growing needs of the large-scale CPS ecosystems of tomorrow with billions of connected devices. Cloud servers will remain a bottleneck and point of failure that can disrupt the entire network. This is especially important as critical services and infrastructure such as healthcare, electric grids, logistics, and transportation become dependent on CPS. The current stove-piped architecture has also created isolated data silos, where users have limited control over their data and how it is used. Users have to trust the cloud and application providers and have no choice but to rely on their promises of security and availability.

This keynote will explore how the Blockchain (BC) technology has the potential to overcome the aforementioned challenges. BC is an immutable timestamp ledger of blocks that is used for storing and sharing data in a distributed manner. The data stored might be payment history, e.g., Bitcoin, or a smart contract or even personal data. In recent years, BC has attracted tremendous attention from practitioners and academics in different disciplines (including law, finance, and computer science) due to its salient features, which include decentralization, immutability, auditability, security, and privacy. Thus, the talk will specifically consider three key aspects of CPSes: (i) Internet of Things, (ii) Intelligent Transportation, and (iii) Supply Chain and will explain relevant concepts, will review the state-of-the-art, will present representative solutions, and will discuss open challenges.

Prof. Dr. Salil Kanhere received his M.S. and Ph.D. degrees, both in Electrical Engineering, from Drexel University, Philadelphia, U.S.A. He is an Associate Professor in the School of Computer Science and Engineering at UNSW Sydney, Australia. He is also a conjoint researcher at Data61 CSIRO, Faculty Associate at Institute of Infocomm Research Singapore, and on the advisory board of two technology start-ups.



His research interests include Internet of Things, pervasive computing, blockchain, crowdsourcing, data analytics, privacy, and security. He has published over 180 peer-reviewed articles and delivered over 20 tutorials and keynote talks on these research topics. He has received 4 Best Paper Awards. His research has been featured on ABC News Australia, Forbes, Wired, ZDNET, MIT Technology Review, IEEE Spectrum and other media outlets. Salil serves on the Steering Committee of IEEE LCN and is the program co-chair for IEEE WoWMoM 2018 and ACM MSWiM 2018. He regularly features on the organizing committee of a number of IEEE and ACM international conferences. He is on the Editorial Board of Elsevier's Pervasive and Mobile Computing and Computer Communications and on the Executive Committee of the IEEE Computer Society's Technical Committee on Computer Communications (TCCC). Salil is a Senior Member of both the IEEE and the ACM. He is a recipient of the Alexander von Humboldt Research Fellowship.

Keynote II: Flexibility Matters: On the Design and Evaluation of Softwarized Networks

Wolfgang Kellerer, Technical University of Munich (TUM), Germany

In order to address network dynamics and highly varying requirements, flexibility has emerged as a key property for networks to cope with increasing dynamics and to be prepared for future demands. Softwarized networks including concepts such as Network Virtualization, Software Defined Networking and Network Function Virtualization promise flexibility. However, so far flexibility is mainly used as a qualitative advantage for a certain design choice where the meaning of flexibility is varying a lot in literature. To provide a better understanding of how to design flexible networks, we propose a definition for flexibility and present an approach for a quantitative measure of flexibility in softwarized networks. In our proposal, we refer to flexibility as the ability to support new requests, e.g., changes in the requirements or new traffic distributions, in a timely manner. We illustrate with use case studies for function placement and SDN resilience, how this measure can be used to evaluate and compare different network designs quantitatively. To address adaptation time in flexible networks, we further present approaches to speed up the execution of algorithms based on machine learning. Examples include virtual network embedding and function placement. With our proposed approach for the definition and evaluation of flexibility, we intend to stimulate the discussion towards a more quantitative analysis of softwarized networks and beyond.

Prof. Dr. Wolfgang Kellerer is a full professor with the Technical University of Munich (TUM), Germany, heading the Chair of Communication Networks at the Department of Electrical and Computer Engineering. Before, he was for over ten years with NTT DOCOMO's European Research Laboratories. His last position was head of the research department for wireless communication and mobile networking.

His current research focuses on flexible networking based on SDN/NFV and wireless M2M networking towards 5G. He received his Dr.-Ing. degree (Ph.D.) and his Dipl.-Ing. degree (Master) from TUM, in 1995 and 2002, respectively. His research resulted in over 200 publications and 35 granted patents. In 2015, he has been awarded with a Consolidator Grant from the European Commission for his project FlexNets: "Quantifying Flexibility in Communication Networks". He is a member of ACM, VDE ITG, and a Senior Member of IEEE.



Keynote III: Artificial Intelligence in Network Operations and Management

Jürgen Quittek, NEC Laboratories Europe, Germany

Complexity of communication networks and their management and operations is continuously growing. At the same time, the capabilities of Artificial Intelligence (AI) technologies, in particular of deep machine learning, are growing rapidly and offer a way to deal with the complexity.

This keynote gives a brief overview of the history of AI technologies and shows how recent advancements provide powerful means of analysis and prediction suited to address several of today's challenges in network operations and management. Several examples illustrate the variety of potential applications of AI to networking. The outlook will address upcoming technology trends, such as reinforcement learning, representation learning, and automated reasoning.

Dr. Jürgen Quittek is Managing Director of the NEC Laboratories Europe in Heidelberg, Germany. He received his degree in communications engineering from RWTH Aachen in 1989 and his Ph.D. from Hamburg University of Technology (TUHH) in 1996. After a postdoctoral year in Berkeley, California, he joined the NEC Laboratories in 1997. In 2000 he was a visiting professor at Freie Universität Berlin.



He conducted research in the areas of neural networks, network management, data security, software-defined networking, energy-efficient communications, and 5G mobile networks, and he served as TCP chair and member of many conferences and workshops. As working group chair, rapporteur, and author he contributed to communication standards at ETSI, IETF, and ONF. His current research interests also include artificial intelligence and the Internet of Things (IoT).

Panel: Security and Privacy in the Internet of Things

Panel Chair: James P. G. Sterbenz, The University of Kansas, U.S.A. and Lancaster University, U.K.

The Internet of Things (IoT) has become not only a hot topic for research, but as usual, is being deployed before we understand the implications of this technology, and without developed usability, security, privacy, resilience, survivability, controllability, accountability, and manageability.

This panel discusses whether IoT can or will be deployed with acceptable security and privacy for users and society, and whether lessons can be learned from the current ubiquitous mobile Internet. Are we racing towards a machine-assisted utopia or a machine-controlled dystopia?

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