

# 2016 International Teletraffic Congress (ITC 28) Report

## The First International Conference in Networking Science & Practice

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### ABSTRACT

The 28th International Teletraffic Congress (ITC 28) was held on 12–16 September 2016 at the University of Würzburg, Germany. The conference was technically cosponsored by the IEEE Communications Society and the Information Technology Society within VDE, and in cooperation with ACM SIGCOMM. ITC 28 provided a forum for leading researchers from academia and industry to present and discuss the latest advances and developments in design, modelling, measurement, and performance evaluation of communication systems, networks, and services. The main theme of ITC 28, *Digital Connected World*, reflects the evolution of communications and networking, which is continually changing the world we are living in. The technical program was composed of 37 contributed full papers, 6 short demo papers and three keynote addresses. Three workshops dedicated to timely topics were sponsored: Programmability for Cloud Networks and Applications, Quality of Experience Centric Management, Quality Engineering for a Reliable Internet of Services.

See ITC 28 Homepage: <https://itc28.org/>

### CCS Concepts

•Networks → Network architectures; Network protocols; Network components; Network algorithms; Network performance evaluation; Network properties; Network services; •Computing methodologies → Modeling and simulation; Machine learning; •Security and privacy → Network security;

### Keywords

Performance Analysis and Modeling; Measurements; Traffic and Network Management; Clouds and Data Center; Wireless and Cellular; Video Streaming; Caching; Information Centric Networks; Softwarization; Virtualization

## 1. INTRODUCTION

The evolution of communication and networking is continually changing the world we are living in. The digital connected world is triggered by the advances in telecommunications, the global penetration of the Internet, the massive

\*with contributions from Hisashi Kobayashi, Phuoc Tran-Gia, Brian Mark, Prosper Chemouil, Thomas Zinner, Florian Wamser, and all ITC 28 session chairs.

deployment of mobile communications and optical fiber, the adoption of collaborative networking and social networks, the ever-increasing speed and flexibility of new communication technologies, networks, user devices, and applications, and various operational challenges arising from these developments.

ITC was originally established as the first international conference on networking science and practice. Since its inception in 1955, ITC has contributed to the evolution in communication and networking with state-of-the-art measurement studies, performance analyses of new technologies, recommendations for provisioning and configuration, and the advancement of new methodologies for network design and analysis. It gathers together a wide and lively community of researchers and practitioners dedicated to pushing the envelope in the area of networking. As such, ITC has provided a forum for leading researchers from academia and industry to present and discuss the latest advances and developments in design, modelling, measurement, and performance evaluation of communication systems, networks, and services. ITC's inherent roots in solid methodological foundations has allowed it to constantly adapt its technological focus without losing its original identity. ITC continues to serve as a broad and lively community for researchers and practitioners dedicated to advancing the limits of knowledge in networking. As such, ITC regularly organizes such events as congresses, specialist seminars and workshops for experts to gather and discuss the latest developments in design, modelling, and performance evaluation of communication systems, networks, and services. ITC 28 has continued this tradition, while employing some new approaches to attract high-quality papers and researchers. In particular, ITC 28 was structured into eight different areas, each of which addressed a hot topic in networking. In addition, a demo session was introduced into the ITC 28 program that cut thematically across the areas.

## 2. TECHNICAL PROGRAM

ITC 28 attracted 108 international paper submissions across all areas, while 157 papers were registered. Finally, 37 full papers were accepted, yielding an acceptance rate of 34%. In addition, 6 short demo papers were accepted. From among the authors of accepted papers, 28% were from USA and Canada, 61% from Europe/Middle East/Africa, 8% from Asia/Pacific and 3% from Latin America.

Given the accepted papers, the Technical Program Committee (TPC) chairs then grouped the papers according to

their topics. As a result, an excellent technical program covering a wide range of topics was presented, consisting of 12 technical oral sessions and a demo session.

This year's ITC technical program was composed of 37 contributed full papers and 6 short demo papers presented in two parallel sessions, three keynote addresses. A demo session was introduced into the ITC 28 program that cut thematically across the areas. The technical program of the main conference was presented in the form of double-track sessions spanning three days, from September 13 to 15, 2016. The demo session, the three keynote speeches, and two selected sessions were presented as plenary sessions. ITC 28 had three excellent keynote speakers in the main program presenting their visions.

- Nikhil Jain (Vice President of Technology, Qualcomm Technologies, Inc.): Internet of Everything: Engineering Challenges and Opportunities;
- Wolfgang Kellerer (Technical University of Munich (TUM), Germany): Towards flexible networking in dynamically changing environments;
- Eitan Altman (INRIA Sophia Antipolis, France): Dynamic games for analyzing competition in the Internet.

On the first day of the congress, September 12, 2016, a half-day workshop on Programmability for Cloud Networks and Applications (PROCON) took place. On the final day of the congress, September 16, there were two full-day workshops: (1) 2016 International Workshop on Quality of Experience Centric Management (QCMAN) and (2) Workshop of COST Action ACROSS on "Quality Engineering for a Reliable Internet of Services".

A brief overview of the main conference sessions is provided next. The session reports were compiled by the ITC 28 session chairs, who are indicated for each of the sessions.

## 1.A – Clouds and Data Center

*(Session Chair: Andreas Timm-Giel, Hamburg University of Technology, Germany)*

In session 1.A three papers were presented. The first paper, titled "Offering Resilient and Bandwidth Guaranteed Services in Multi-tenant Cloud Networks: Harnessing the Sharing Opportunities", was presented by Hyame Assem Alameddine from University of Concordia, Canada. The focus of the paper is on different options of how to share backup resources (bandwidth, virtual machines) in multi-tenant cloud networks. For a given embedding and protection plan design for each tenant, the objective followed here is to find the optimal bandwidth sharing allocation. The problem is formulated in the paper and as it is NP hard, a heuristic approach is presented and evaluated showing significant improvements.

The second paper, titled "Dynamic Virtual Network Traffic Engineering with Energy Efficiency in Multi-Location Data Center Networks" was presented by Mirza Mohd Shariar Maswood from the University of Missouri-Kansas. The focus of this paper is on the embedding of virtual networks with network bandwidth and processing demand at the end host considering energy efficiency. An MILP formulation is presented, which is solved at different time instances (review points). With this approach, insights on how different VN customers are affected in terms of resource allocation with north-south traffic in data centers are gained.

The third paper on "An Energy-Aware Embedding Algorithm for Virtual Data Centers" was presented by Manh

Nam Tran from Hanoi University of Science and Technology in Vietnam. In this paper a virtual data center embedding algorithm is proposed together with an SND-based virtualization architecture. The algorithm has the objective to be resource efficient in terms of CPU, memory and bandwidth, and to be energy efficient and flexible at the same time. Results are shown for the acceptance rate, resource-efficiency rate and power consumption, demonstrating superior behaviour of the proposed algorithm.

## 1.B – Traffic and Network Management

*(Session Chair: Peter Reichl, University of Vienna)*

Session 1.B focused on different facets of traffic and network management. Three papers were presented in the session. The first paper "Disaster Avoidance Control Against Tsunami" (by Phuong Nga Tran and Hiroshi Saito) investigates challenges in network disaster management on the relevant use case of tsunamis. Network operators aim at managing their network in case of tsunamis by proper prediction of the disaster and then to reduce the damaging effect of tsunamis on the network. The paper developed and evaluated heuristic algorithms to efficiently migrate service (virtual) networks away from a disaster affected area to minimize traffic loss when a tsunami arrives. On the basis of the tsunami predicted information and network status, network operators can select a suitable algorithm for their disaster management action. The paper was presented by Phuong Nga Tran. The second paper "Building a Low Latency Linux Software Router" (by Alexander Beifuss; Torsten M. Runge; Daniel Raumer; Paul Emmerich; Bernd E. Wolfinger; Georg Carle) was presented by Torsten Runge and Alexander Beifuss and focuses on technologies and architectures for network and traffic/service management. The authors argue that more routers will be CPU bounded in future due to flexible CPU based data plane devices where general purpose hardware in combination with software serves arbitrary needs. On commodity hardware the CPU typically becomes the bottleneck in packet processing. As a key contribution, a QoS concept for a Linux software router to prioritize latency-sensitive traffic at the incoming network interface is developed and investigated. The measurement results of a prototype implementation show that software routers are able to cope with real-time traffic and may improve the packet processing w.r.t. the latency of delay-sensitive traffic even under high traffic loads. The third paper "Traffic-Driven Implicit Buffer Management - Delay Differentiation Without Traffic Contracts" (by Martin Karsten; Daniel S. Berger; Jens Schmitt) focuses on buffer and delay management of traffic. In particular, the problem of guaranteeing queueing delay bounds for multiple service classes without traffic contracts and without affecting the throughput rate for each class is investigated. A solution to this problem is given by decoupling throughput and delay management via traffic-driven implicit buffer management. The Delay Segment FIFO (DSF) packet scheduler is proposed which guarantees differentiated delay targets in the presence of unregulated throughput rates and satisfies a strict interpretation of network neutrality. The paper was presented by Martin Karsten. The session was well attended with about 35 people. A "Best Question Award" was announced for the best question from the audience which stimulated lively discussions. Robert Bauer who also won the Best Student Paper Award received this Best Question Award from Peter Reichl.

## 2 – Wireless

*(Session Chair: Michela Meo, Politecnico di Torino, Italy)*

The three papers presented in session 2, devoted to Wireless, focused on different and timely technologies in wireless communications: software defined radios, multi-user MIMO and device-to-device communications. The first paper was titled “Self-Optimization of Software Defined Radios Through Evolutionary Algorithms”, by Muhammed Zubair Basha Shaik, Andre Puschmann and Andreas Mitschele-Thiel and was presented by Muhammed Zubair Basha Shaik. The paper proposes a framework for optimizing radio transmission parameters in a software-defined radio environment. The peculiar and particularly interesting aspect of the proposed framework is that the choice of the parameters is done by using genetic algorithms. This allows the system to cope with situations with many parameters and several possible choices, situations that would not be treatable with optimization solutions. Since the paper also presents a prototype, it was selected to receive the best demo award of ITC 28. Ryan E. Guerra presented the second paper of the session, entitled “Opportunistic Channel Estimation for Implicit 802.11af MU-MIMO”, which was co-authored by Ryan E. Guerra, Narendra Anand, Clayton Shepard and Edward W. Knightly. The work focuses on multi-user MIMO channel coding and proposes a technique to estimate downlink channel conditions by using uplink transmissions. By not requiring the explicit transmission of channel sounding frames, the proposed solution greatly reduces channel sounding overhead. The proposed technique is shown to be quite effective in the presence of many users and when the channel conditions are stable. Finally, the last paper of the session, namely “DiVote: A Distributed Voting Protocol for Mobile Device-to-Device Communication”, by Peter Danielis, Sylvia T. Kouyoumdjieva and Gunnar Karlsson, was presented by Peter Danielis. The paper proposes a protocol for distributed voting based on device-to-device communications. The idea is that users equipped with mobile devices can participate in distributed polls in given areas by exchanging simple information with other devices. The mobiles use the information they receive from other devices to derive local estimates of the global polling results. The solution is evaluated by extensive simulations.

## 3.A – Cellular

*(Session Chair: Zhisheng Niu, Tsinghua University, China)*

Three papers were presented in the session 3.A, all of them on user-BS/RRH association in heterogeneous cellular networks. In the first presentation, Farah Moety presented a joint work with her colleagues in Orange Labs Networks - Chatillon, on “Joint Optimization of User Association and User Satisfaction in Heterogeneous Cellular Networks”. The key contribution of this paper is the reformulation of the Mixed Integer Linear Programming problem into a computationally tractable form. The results were quite interesting, and attracted four questions from the audience. The second presentation was made by Ying Loong Lee from Multimedia University in Malaysia who talked about the “Joint Resource Allocation and User Association for Heterogeneous Cloud Radio Access Networks” to improve energy efficiency. The questions from the audience were also mainly on the suboptimal algorithm itself and the energy saving gain. In the last talk, Abishek Sankararaman from UT Austin presented a paper on “Performance-Oriented Association in Large Cel-

lular Networks with Technology Diversity”, which takes a slightly different approach from the previous two talks. It considers multiple RATs rather than a single RAT in order to exploit the diversity of different RATs. In summary, all three talks are closely related, focusing on user association and joint resource allocations. The session was well attended with approximate 30 attendees.

## 3.B – Video Streaming

*(Session Chair: Poul Heegaard, Norwegian University of Science and Technology, Norway)*

Three papers were presented in the session 3.B on Video Streaming. Christian Moldovan (University of Duisburg-Essen) presented his work on Bridging the Gap Between QoE and User Engagement in HTTP Video Streaming, a very challenging topic and timely use case (of video streaming). A general model for bridging the gap between QoE and UE is very challenging, as also pointed out by questions from the audience. The second presenter was Jan Willem Kleinrouweler (CWI, Amsterdam). He presented his work on resource sharing policies for DASH assisting network elements. He has developed a Markov model that can be used for the evaluation of different possible policies. He received some questions about the realism in the model assumptions. The last presenter, Philip Lundrigan (University of Utah), explained how to utilize nearby smartphones to improve video upstreaming performance. He received questions, among others, about incentives for allow sharing, and whether utilizing nearby smartphones helps if they are all connected to the same mobile operators. In summary, it was an interesting and engaging session with very good presenters, and many timely questions (and answers) to their work. This impression is based on the session chair’s opinion, but also on the feedback from the audience provided directly to the session chair. It is worth noting that two of the presenters in the session (Kleinrouweler & Lundrigan) received a student travel grant, see Section 3.

## 4.A – Caching Strategies

*(Session Chair: Hans van den Berg, TNO / University of Twente, The Netherlands)*

Three papers were presented in this well focused session 4.A on caching strategies. The papers and presentations were of very high quality (all of them were nominated for the Best Paper Award) and triggered lively discussions. In the first presentation Andrea Araldo, PhD student at Universit  ParisSud and Tcom ParisTech, presented joint work with Gyrgi Dan (KTH) and his supervisor Dario Rossi (Tcom ParisTech) on “Stochastic Dynamic Cache Partitioning for Encrypted Content Delivery”. The key contribution of the paper is a content-oblivious cache allocation algorithm, based on a perturbed stochastic subgradient method, that ‘nearly’ maximizes the overall cache hit rate. The main novelty lies in the fact that, to protect business-critical information, ISPs only need to measure the aggregated miss rates of the individual Content Providers and do not need to be aware of the objects that are requested, as in classic caching. The second presentation was provided by Damiano Carra (University of Verona, Italy) about the paper “Access-time aware cache algorithms” co-authored with a colleague from Inria and researchers from University of Verona, Akamai and Eurecom. This paper investigates the impact of caches’ limitations to serve re-

quests fast enough. In particular, a new, hierarchical cache replacement policy was presented that takes these limitations into account. The policy is optimal when requests follow the independent reference model, and significantly reduces the hard-disk load, as shown also by realistic, trace-driven evaluations. The last presentation, by Nicolas Gast from Inria, France, was about the paper “Asymptotically Exact TTL-Approximations of the Cache Replacement Algorithms LRU(m) and h-LRU” co-authored by Benny van Houdt (University of Antwerp, Belgium). The authors propose time-to-live (TTL) approximations to determine the cache hit probability of two classes of cache replacement algorithms: the recently introduced h-LRU and LRU(m). These approximations only require the requests to be generated according to a general Markovian arrival process. The speaker provided both numerical (by trace-based simulation) and theoretical support for the claim that the proposed TTL approximations are asymptotically exact. The session was very well attended with about 40 people in the room.

## 4.B – Performance Analysis

*(Session Chair: Markus Fiedler, BTH Karlskrona, Sweden)*  
This session provided contributions of a rather fundamental nature in terms of performance challenges and analysis methods. The first paper “Meeting soft deadlines in single- and multi-server systems” was presented by Esa Hyytiä, University of Iceland and Aalto University, Iceland. The key contributions consist of admission policies that take the risk of future deadline violations into account. These policies are proven to be optimal in the single server case; given in the form of efficient heuristics and dispatching policies in the parallel server case; and complemented by closed-form heavy traffic limits. Animations throughout the presentations contributed significantly to the understanding of the properties of the policies in the parameter space.

The second paper “Performance analysis of CoDel and PIE for saturated TCP sources” was presented by Michael Menth, University of Tübingen, Germany. It compared three strategies to deal with the well-known buffer-bloat phenomenon in routers, namely CoDel, the proposed modification CoDel-ACT, and PIE, in a systematic manner. In particular, demonstrations and discussions of the timely evolution of queuing delays and drop patterns helped the audience to understand the pros and cons of the different methods. The third paper “Stochastic upper and lower bounds for general Markov fluids” was presented by Jens Schmitt, Universität Kaiserslautern, Germany. It addresses a gap in stochastic fluid flow modeling, namely to produce some sufficiently tight closed-form upper and lower performance bounds, which was reached through a martingale construction. From these general results, delay distributions for different scheduling schemes are obtained. The discussion phase touched upon, among others issues, the interpretability of the results.

## 5 – Demo Session

*(Session Chair: Michael Jarschel, Nokia Bell Labs, Germany)*

The first ever demo session in the long history of the International Teletraffic Congress was held at ITC 28 in Würzburg. All demonstrations were first introduced to the plenary either in a 30 minute presentation for full paper demos or a 3 minute lightning talk for short paper demos. Additionally,

the demos were shown live during a dedicated demonstration period in separate rooms.

The first of the full paper demos was presented by Zubair Shaik (TU Ilmenau). He demonstrated a framework for self-optimizing parameters for software-defined radios using evolutionary algorithms to maximize the throughput. Both the second and third full paper demo were presented by Rick McGeer (University of Victoria/US Ignite). In the first presentation, he showed PlanetIgnite, a general-purpose, Infrastructure-as-a-Service, self-assembling, lightweight edge cloud for distributed application configuration and deployment. He highlighted its simplicity by adding a new node and creating and instantiating an application live. His second presentation introduced LiveTalk, a framework for collaborative browser-based replicated-computation applications. LiveTalk permits multiple users separated across the wide area to interact with separate copies of a single application, sharing a single virtual workspace, using very little network bandwidth. This was illustrated through a live collaboration with a colleague half way around the world.

The short paper contributions consisted of six papers. Robert Finze (University of Tübingen) showed how different high-performance zones in the university campuses in Baden-Württemberg can communicate directly through the optical 100 Gb/s high-speed network and how the legacy network is used for communication to the campuses. Steffen Gebert (University of Würzburg) showed the application of the SDN concept to Bring Your Own Device scenarios, offering personalized virtual networks that are set up and extended on demand. Francesco Bronzino (Rutgers University & WINLAB, USA) demonstrated an emergency alert system for vehicles assisting first responders that exploits users location awareness to support quick and reliable alert messages for interested vehicles deployed on the GENI testbed in the US. Rastin Pries (Nokia Bell Labs, Munich) presented an approach to 5G network slicing using the example of a health insurance provider offering individual services for the customers with the help of a network slice. Finally, Marcel Großmann (University of Bamberg) showed a fault tolerant, reliable and secure extension to interconnect several independent host with Hypriot Cluster Lab software (Docker on ARM powered single board computers) to achieve QoS-requirements. In general, the session was received very well, as it offered an interesting mix of different fields and technologies that were shown live and will serve as a starting point for more of these sessions in future ITCs.

## 6.A – Softwarization

*(Session Chair: Nguyen Huu Thanh, Hanoi University of Science and Technology, Vietnam)*

The session 6.A consisted of three papers, which dealt with several issues in softwarization in Software-Defined Networking, Network Function Virtualization contexts. In the first paper, “Sector: TCAM Space Aware Routing on SDN,” presented by Ali Tizghadam, the authors proposed a method to reduce the number of entries in the OpenFlow forwarding tables, thus improving the performance of SDN switches by merging flows under the considerations of flows’ traffic demands for traffic engineering. The presenter and the participants discussed about the impact of flow dynamicity (flows dynamically join and leave the network) on the performance of the proposed algorithm. The second paper “Port Based

Capacity Extensions (PBCEs): Improving SDNs Flow Table Scalability” presented by Robert Bauer also dealt with improving the scalability of the OpenFlow forwarding table by delegating flow processing tasks from an overloaded switch to other available switches. The proposed mechanism is interesting, which can also be applied in some NFV paradigms. Questions has been raised discussing about the complexity of the mechanism as additional control information should be added into the forwarded packets. In the last paper, “Performance Modelling of Softwarized Network Functions Using Time Discrete Analysis,” presented by Steffen Gebert, the authors proposed an analytical queueing network model to evaluate softwarized/virtual network functions. Performance results were presented and discussed. The proposed method is meaningful to evaluate the performance of specific virtual network functions when embedded on physical machines. The presenter received some questions about more realistic arrival patterns of traffic, and also about the stationary conditions of the system. In conclusion, the three papers in the session discussed different and timely problems on softwarized network functions. It was an interesting and engaging session with good presenters, and interesting questions (and answers) to their work.

## 6.B – Information and Social Networks

*(Session Chair: Michael Menth, University of Tübingen, Germany)*

The session 6.B consisted of two papers on information centric networking (ICN) and one on social networks. The first presentation “Cache the Queues: Caching and Forwarding in ICN from a Congestion Control Perspective” by Dinh Nguyen (KDDI R&D Laboratories, Japan) pointed out that caching in ICN may be a way to reduce network congestion and a performance study underlined this claim. The second paper “Optimizing Time to Exhaustion in Service Providers Using ICN” presented by Ali Shariat (University of Toronto, Canada) suggested that caching in ICN reduces congestion and extends the time-to-exhaustion of available capacity in service provider networks. Already a limited fraction of ICN deployment may allow for substantially delayed capacity upgrades. The last study on “Binary Opinion Dynamics with Biased Agents and Agents with Different Degrees of Stubbornness”, presented by Arpan Mukhopadhyay (INRIA, Paris & Bell Labs, France), considered agents in social networks exchanging binary opinions and finding consensus. Among others, the impact of bias and stubbornness of agents on consensus finding times was investigated.

## 7.A – Measurements

*(Session Chair: Marco Mellia, Politecnico di Torino, Italy)*

Three papers were presented in session 7.A on Network Measurements, covering hot topics such as privacy in the Internet and tracking activities, the usage of data science approaches to automatically identify possible malicious traffic, and novel tools to detect network neutrality violations in the wild. The first paper “IntegraTag: a Framework for High-Fidelity Web Client measurement” by Charles Thomas, Jeff Kline, and Paul Barford was presented by Charles Thomas. The second paper “CLUE: Clustering for Mining Web URLs” by Andrea Morichetta, Enrico Bocchi, Hassan Metwalley, and Marco Mellia was presented by Andrea Morichetta. The third paper “Testing for Traffic Differentiation with ChkDiff: The Downstream Case” by Riccardo Ravaoli, Guillaume

Urvoy-Keller, and Chadi Barakat was presented by Riccardo Ravaoli. All three papers were very interesting, presenting measurements, algorithms and insights that the audience appreciated. All presenters did a great job of presenting their works, as testified by the questions asked by colleagues attending the session who continued the discussion with authors after the session ended.

## 7.B – Caching

*(Session Chair: Thomas Bauschert, TU Chemnitz, Germany)*

Session 7.B consisted of three talks. The first presentation was given by Emilio Leonardi (Politecnico di Torino, Italy). He outlined a new performance evaluation technique for large scale caching systems called ModelGraft. It integrates elements of stochastic analysis within a Monte Carlo simulation approach and shows significant gains wrt CPU time and memory consumption compared to a classical event-based simulation. The second paper, presented by Valentino Pacifici (KTH, Sweden), formulates the problem of content caching in a mobile backhaul as a binary integer programming problem and suggests a distributed approximation algorithm to solve the problem. The last presentation, given by Gerhard Hasslinger (Deutsche Telekom, Germany), deals with the performance evaluation of the new web caching strategy SG-LRU in terms of the achievable hit rate for realistic scenarios of large user populations. The score gated least recently used strategy combines the usual LRU policy with the flexibility to keep most important content in the cache according to a predefined score function.

## 8 – Virtualization

*(Session Chair: Thomas Zinner, University of Würzburg, Germany)*

The last session, session 8 of this year’s ITC 28 featured two papers in the timely context of Network Function Virtualization. Antonio Marotta (Karlstad University, Sweden) presented his work on “A Power Efficient and Robust Virtual Network Functions Placement Problem.” In the paper, a robust optimization approach was used to solve a facility placement problem by placing network functions and functions chains in case of uncertain traffic demands with respect to energy consumption. Discussions included the limitations of the chosen evaluation approach with respect to scalability and how to investigate realistic topologies. The second presenter was Mathis Obadia (Thales Communications & Security & Telecom Paristech, France). He presented his work on “Elastic Network Service Provisioning with VNF Auctioning.” In the paper, a game theoretic approach including Multi-Unit Combinatorial Auctions to sell leftover VNF capacities for bids was developed. He received questions on how to include the presented approach in a real-world cloud stack and on expected timescales of the presented approach. In summary, it was an interesting and engaging session with very good presenters, and many timely questions (and answers) to their work.

## 3. ITC 28 AWARDS AND GRANTS

### *Arne Jensen Lifetime Award*

The Arne Jensen Lifetime Award is presented at ITCs to an individual for his/her lifetime achievement to the teletraffic

community and exceptional scientific contributions to traffic modeling, control and performance. The Arne Jensen Lifetime Award is granted by the International Advisory Committee (IAC) of the ITC. The IAC is pleased to announce that the recipient of the **2016 Arne Jensen Lifetime Award** is **Prof. Dr.-Ing. Phuoc Tran-Gia** (University of Würzburg, Germany).

### *Best Paper Awards*

ITC 28 has set up three prestigious awards: Best Paper Award, Best Student Paper Award, Best Demo Award. These awards are offered both on the scientific quality of the paper and the presentation of the oral contribution or demo presentation. From the accepted papers, a list of nominees was selected by the TPC. A jury chaired by the award chair, Prosper Chemouil, designated the recipient of the award in each category after all presentations were made.

**ITC 28 Best Paper Award Access-time Aware cache Algorithms** by Giovanni Neglia; Damiano Carra; Mingdong Feng; Vaishnav Janardhan; Pietro Michiardi; Dimitra Tsigkari

**ITC 28 Best Student Paper Award Port Based Capacity Extensions (PBCEs): Improving SDNs Flow Table Scalability** by Robert Bauer; Martina Zitterbart

**ITC 28 Best Demo Award Self-Optimization of Software Defined Radios Through Evolutionary Algorithms** by Zubair Shaik; Andr   Puschmann; Andreas Mitschele-Thiel

### *Student Travel Grants*

The IAC granted 5 (out of 23 applications for) student travel grants. After the conference, the STG recipients reported the benefits of having attended ITC 28, in terms of impact on his/her own research, of overall technical knowledge increase, and on technical exchanges and potential collaboration with other attendees.

One STG recipient discussed about “[...]Open vSwitch which is a software switch implementation that also provides an OpenFlow interface to allow for software defined networking. The current version only includes limited possibilities for quality of service. [...]Andreas Kessler showed me how I can use their traffic control implementation in my system, and also benefit from better traffic management. Furthermore, we discussed how I could adjust the switch implementation to suit my needs, specifically for DASH streaming. As part of my PhD, I would like to add an evaluation of my system through the means of user experiments.” With Samira Tavakoli, he “[...]discussed the possibilities (and pitfalls) of performing a crowdsourcing study, that will take place in the near future.” Åke Arvidsson “[...]recognized that my system could not directly be transferred to be used in cellular network. We had an interesting discussion on the particularities of cellular network, and brainstormed how my system could be adjusted to fit this use case as well.”

A second STG recipient is working towards his PhD in “Software-Defined Networking, Network Function Virtualization and Green ICT. [...]The keynote talks were very interesting, especially the talk of Prof. Wolfgang Kellerer in his Keynote. This gave me some ideas of implementing SDN/NFV platform by using mix SDN/NFV design and trading off between “quality of flexibility” and the energy-consumption in my research work. [...]The paper of Robert Bauer, “Port Based Capacity Extensions (PBCEs): Improv-

ing SDNs Flow Table Scalability”, is a good one with the idea of the outsourcing-like flow capacity of a SDN switch by using extension SDN switches. Additionally, I also liked the demo “Demonstrating a Personalized Secure-By-Default Bring Your Own Device Solution Based on Software Defined Networking” by Steffen Gebert which showed the flexible security of mobile devices (BYOD) by using SDN technology.”

“During the demo session of the conference,” another STG recipient “talked with Marcel Großmann and Andreas Eiermann about their work on bringing Docker to Raspberry Pis [...]and I was able to ask them practical questions about using Docker with Raspberry Pis. [...]I also talked with Rick McGeer about his work with PlanetIgnite, GENI, and distributed computing.”

Finally a last recipient had a meaningful technical exchange after his presentation with the session chair, Zhisheng Niu who “[...]has pointed out a very important issue of my study, whereby my study did not address the problem that could arise due to the instantaneous wireless channel variations, which may degrade the performance of the algorithm proposed in my study. [...]Throughout the ITC conference, I have been exposed to many interesting topics, particularly software-defined networking (SDN) and network function virtualization (NFV), which are currently intensively investigated in the area of cellular communications. [...]These studies have given me several important insights about the nature, features and mechanism of SDN and NFV that may be useful to my future study on SDN and NFV for cellular networks.” The keynote talk given by Nikhil Jain “[...]gave me the motivation to explore the IoT topics as my future research in view of its vast potentials in the future. [...]Overall, I have gained much benefit from the ITC conference in terms of research knowledge, networking and presentation skills.”

## **4. OUTLOOK TO ITC 29**

The **ITC 29 conference in 2017** will be held at the University of Genoa, Italy from September 4 to September 8. The 29th event of the series will feature the topic of ubiquitous, software-based, and sustainable networks and services.

The ongoing “softwarization” process in networks, along with hardware capability and new services, is setting the pace for a tighter integration between computing and telecommunications technologies. At the same time, 5G and IoT are coming on the scene and will produce an unprecedented growth in wireless access and data generation. According to some estimates, there might be 25 billion connected things by 2020. The exponential growth of IoT nodes, flexibility in service provisioning, and programmability, are making networks more complex to manage and operate. In addition, network design presents new challenges, raised by ultra-low power consumption requirements of IoT nodes and by the use of less energy-efficient general-purpose hardware. The new paradigms will affect and shape the statistical features of teletraffic, along with its performance analysis and control. ITC 29 is organized into five areas and a demo session, which will cover quite a few relevant aspects.

### **Contact Information**

More information on ITC, past and future conferences, award recipients, as well as access to the ITC Digital Library is available at <http://itc-conference.org/>.