Mobile Netw Appl (2016) 21:223–225
DOI 10.1007/s11036-016-0687-7

Recent Advances on Future Networks and their Management

Ramón Agüero[1] · **Thomas Zinner**[2] · **Andreas Timm-Giel**[3] · **Phuoc Tran-Gia**[2]

Published online: 11 February 2016

1 Guest Editorial

The rapid growth in mobile traffic and broadband wireless connections, together with the advent of the Internet-of-Things call for novel mobile and wireless network management techniques, able to cope with an increasing number of challenges. Individual techniques can no longer be considered in isolation, but there must be a clear cooperation and cross fertilisation amongst them. Since 2009, the International Conference on Mobile Networks and Management (MONAMI) provides researchers with the opportunity to describe and discuss their latest research results on the aforementioned topics. The Call-for-Papers of this Special Issue was a result of the 6th edition of the MONAMI conference, which was held in Würzburg, in September 2014. Besides, this is the fifth Mobile Networks and Applications issue on these topics; we have been able to witness, thanks to this already consolidated series, some of the advances that this challenging and continuously evolving area has undergone in the latest years.

Six papers were finally selected for publication among the 28 received submissions, after a thorough review process in which each paper was reviewed by at least three experts in the area. They provide a good picture of the currently most relevant topics within the field of mobile and wireless networking and management. They give an interesting perspective on some of the most challenging problems and discuss interesting techniques and solutions to address them. The papers are grouped in three distinct groups, each of them addressing some of the most active lines of research within the Management of Mobile Networks realm.

The first two papers depict some of the changes that Mobile Operators are facing in order to adapt their networks to the forthcoming new technologies, evolving from 3G to 4G and even 5G. One of the most demanding challenges comes not only from the expected increase of mobile data traffic and connected devices, but also from the fact that end-users are expecting an almost permanent connection to the mobile network. In the first work of this Special Issue, Luis M. Contreras et al. discuss new mobility management schemes needed to tackle this challenge. In particular, they propose a mobility architecture for 5G that exploits the possibilities brought by Software-Defined Networking. After briefly going through the state of the art mobility solutions both in the 3GPP and IETF, the paper drafts a Software-Defined Mobility Management scheme intended to be integrated within LTE networks. The paper presents an experimental evaluation of such proposal within an OpenFlow testbed, comprising 14 switches and one network controller. It includes a study of the handover delay and identifies the components with a stronger impact over the overall latency.

In the second paper Ioannis Loumiotis et al. lay out the question on how and when a mobile operator should evolve their current networks from existing 3G technology to support 4G. The authors argue that in most of the cases this type of strategical decisions are made based on looking at similar processes in other countries and that this approach might be rather inefficient and time-consuming, based on the

✉ Ramón Agüero
ramon@tlmat.unican.es

[1] University of Cantabria, Plaza de la Ciencia s/n, 39005 Santander, Spain

[2] University of Würzburg, Sanderring 2, 97070 Würzburg, Germany

[3] Hamburg University of Technology, Am Schwarzenberg-Campus 1, 21073 Hamburg, Germany

differences that might exist amongst various countries. In order to promote a more appropriate strategy, the authors of the paper exploit Game Theory. In this sense, they pose an evolutionary game, in which the players are the technologies that a Mobile Operator might use (3G and 4G) as well as the two different types of demand (high bandwidth and low bandwidth services) requested by the end users; the authors model in this way the interactions between the operator and its subscribers. The paper proposes the various cost and satisfaction values for the different elements and discuss the transition strategy to 4G based on the demand for high bandwidth services. It concludes that under appropriate conditions, the prevalence of 4G technology can be greatly facilitated.

The second group of papers looks at one of the challenges at which the scientific community has paid attention in the latest years. The increase of wireless networks, devices, and users, as well as the advance of the available devices, have come with the cost of a much higher energy consumption. Promoting an energy-aware behavior in wireless communications is indeed one of the most important requirements for forthcoming wireless communication networks and technologies. This applies to both the end-users, who would benefit from longer live devices and mobile operators, since the operational expenses required to run the deployed base stations is already too large. In the third paper of this special issue, Maliha U. Jada et al. propose an energy efficient scheme for HSDPA systems, which aggregates carriers on a dynamic way taking into account network traffic. They exploit the selective deactivation of base stations and/or carriers, but opposed to other works that have made similar proposals, they guarantee that this can be done without jeopardizing the quality of service perceived by the end-users. For doing so, they propose a Joint Management scheme, in which both base stations and carriers are jointly considered; furthermore, they combine it with remote electrical downtilts, to cope with potential outages. We would like to particularly highlight this paper, since it is the revised version of the work which was awarded the best paper during the MONAMI'14 conference.

While the previous paper focused on energy reduction from the perspective of the network (base stations), Ping-Jung Hsieh et al. discuss, in the fourth paper of the special issue, a mechanism that is meant to conserve the power on end-user devices and terminals. In particular they propose an accurate model for the discontinuous reception (DRX) mechanism, which turns off the terminal radio when no packets are being received, particularly suited to the LTE-Advanced technology. The authors argue that, despite the existing work on this particular issue, most of the existing studies do not take into account the detailed characteristics of such technology. The paper proposes an analytical model, based on a semi-Markov process, which is later validated by means of a system level simulation study. Two key performance indicators are identified: the power saving factor and the average buffering delays of radio-off period, and the paper compares the performance of the proposed model with previous works, concluding that the discrepancies between the two approaches are more relevant when the traffic load increases.

The last two papers of this special issue deal with wireless sensor networking, which has recently led to the so-called *Internet of Things* (IoT) paradigm, one of the cornerstones of the Future Internet. The third group of papers discusses technical solutions that aim at improving the behavior of particular issues that affect such networks. Adnan Ahmed et al. discuss, in the fifth paper of this issue a secure routing protocol that combines trust and energy awareness. They start from the assumption that this type of networks remain exposed to different security attacks, since they do not have a strict supervision. The authors argue that existing solutions might not be suitable, especially since they assume that all nodes are trustworthy and do not take into account the constraints (in terms of computational and energy resources) that sensor devices might have. They conduct a thorough review of the existing solutions to identify their most relevant shortcomings. In order to deal with these, the paper proposes the Trust and Energy aware Secure Routing Protocol (TESRP), which exploits a distributed trust model and promotes a multi-parametric approach, entailing trust, energy and route lengths, to take routing decisions. The performance of TESRP in terms of throughput, energy consumption and network lifetime is compared with other approaches that also consider node trustworthiness by means of a NS-2 simulation, studying the impact of both the number of malicious nodes as well as the overall traffic load in the network. The results show that TESRP clearly outperforms other solutions.

The sixth and last paper of this Special Issue discusses one of the most relevant applications of Wireless Sensor Networks, presenting a hybrid localization algorithm. Rajika Kumarasiri et al. propose a solution that simultaneously combines received signal strength (RSS) and time difference of arrival (TDOA) measurements. Furthermore, the technique is improved by incorporating RSS measurements from Wi-Fi networks by means of cooperating communications. The solution is based on two different estimations: one based on a Taylor series expansion and the other one using Maximum-Likelihood estimation. The numerical results obtained by means of a system level simulation show that the proposed technique clearly outperforms the traditional RSS or TDOA schemes, especially when the Maximum-Likelihood estimator is used. They also show the additional gain that can be obtained by exploiting the cooperation with external WiFi networks.

Ramón Agüero received a degree in Telecommunications Engineering from the University of Cantabria in 2001 and the PhD in 2008. He is currently an Associate Professor at the Communications Engineering Department at that university. Since 2015 he is also the Head of the Department. He has participated in several collaborative research projects and his research focuses on future network architectures, especially regarding the (wireless) access part of the network. He is also interested on multi-hop (mesh) networks, device-to-device communications, and Network Coding. He has published more than 160 technical papers in such areas and he is a regular TPC member and reviewer on various related conferences and journals.

Thomas Zinner received his diploma degree in Computer Science from the University of Würzburg in 2006 and the PhD in 2008. Since then he is when he received his diploma. Since then he is a postdoctoral researcher at the chair of Communication Networks at the University of Würzburg and heading the research group on "Next Generation Networks". He is acting as MC member and Working Group Chair in the COST action IC1303 AAPELE. His research interests cover future internet architectures with emphasis on Software-Defined Networking and Network Function Virtualization. He is also interested in video streaming techniques, Quality-of-Experience, and application-network interaction.

Andreas Timm-Giel was between 1994 and 1999, group leader at the University of Bremen in the area of mobile and satellite communications and involved in several EU funded projects. After receiving his PhD in 1999 he moved to MediaMobil GmbH and M2SAT Ltd. as Technical Project Leader and Manager Network Operations. In December 2002 he joined the Communication Networks group at the University of Bremen as senior researcher and lecturer. He was leading several industrial, national and EC funded research projects and from 2006 he was additionally directing the interdisciplinary activity "Adaptive Communications" of TZI (Center of Computing and Communication Technologies). In November 2009 he was appointed full professor at Hamburg University of Technology (TUHH) and is heading the Institute of Communication Networks. Since 2012 he is coordinator of the research cluster SOMSED "Self-organizing mobile sensor and data networks" at TUHH and from 2013 to 2014 deputy head of the TUHH's school of electrical engineering, computer science and mathematics. Since October 2014 he is Vice President for Research at TUHH. His research interests are mobile and wireless communications, sensor networks and the Future Internet.

Phuoc Tran-Gia is professor and director of the Chair of Communication Networks, University of Würzburg, Germany and since October 2015 Vice President of the University of Würzburg.

He is also Member of the Advisory Board of Infosim (Germany) specialized in IP network management products and services. Prof. Tran-Gia is also cofounder and board member of Weblabcenter Inc. (Dallas, Texas), specialized in Crowdsourcing technologies. Previously he was at academia in Stuttgart, Siegen (Germany) as well as at industries at Alcatel (SEL) and IBM Zurich Research Laboratory. He is active in several EU framework projects and COST actions. Prof. Tran-Gia was coordinator of the German-wide G-Lab Project 'National Platform for Future Internet Studies' aiming to foster experimentally driven research to exploit future Internet technologies. His research activities focus on performance analysis of the following major topics: Future Internet & Smartphone Applications; QoE Modeling & Resource Management; Software Defined Networking & Cloud Networks; Network Dynamics & Control; Crowdsourcing. He has published more than 100 research papers in major conferences and journals and received the Fred W. Ellersick Prize 2013 (IEEE Communications Society).

Since 2015, Phuoc Tran-Gia serves as Vice President of the University of Würzburg being responsible for internationalization, alumni, information technology, and public relations.