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Additional Information

Recent Advances on Telematics Engineering

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1 Guest editorial

Telematics engineering addresses the emerging symbiosis between computers, in its most general acceptance, and data networks, focusing on the convergence of networking, computing and information organization, access and management. Recent advances in telematics engineering have dramatically changed our daily life, completely transforming the way technologies, applications and services are being developed, accessed and used. However, telematics engineering is continuously facing many new challenges such as the management of novel technologies and techniques, most notably on the mobile networking realm (virtualization, software defined networking, energy efficiency, densification and offloading, just to name a few). The need to address them is spurring this area of research and, capitalizing on the celebration of the Jornadas de Ingeniería Telemática (JITEL), which is a bi-annual Spanish National Conference on Telematics Engineering, the goal of this special issue is to report on cutting-edge research on this area.

Since JITEL was first organized in 1997, it has provided a meeting point for researches and students working on a rather

broad range of topics, which have greatly evolved during the last 20 years. Indeed, this scientific community covers an area of knowledge and research that spans almost all the protocol stack, starting from scheduling and resource management solutions up to service management and security issues at the application layer. In fact, we can say that there is not a one-to-one match of this area in other countries, since there exist some common points with the electrical engineering community, but there are as well some overlaps with the computer science realm.

Considering the increasing relevance that Information and Communication Technologies (ICT) have in our day-to-day life, this conference has established itself as a focal point to discuss the most avant-garde solutions, techniques and algorithms in several related areas, and their impact on the Spanish society.

The 2015 edition of JITEL was held in Palma de Mallorca, and featured more than 60 papers. Six of such papers were afterwards selected, based on their score during the peer-review phase of the conference as well as on the feedback received by the audience during the conference itself. As a result of this, extended versions of such works were submitted to this Special Issue, which also received 16 additional manuscripts. The 22 papers were reviewed by at least 3 independent experts, thus ensuring that the six selected works have the quality to warrant publication in *Mobile Networks and Applications* journal.

We strongly believe that the six papers establish a good snapshot of the current situation on the Telematics Engineering research. In this sense, they provide an illustrative example of such broadness, since they cover aspects that go from interference management and link scheduling in wireless systems to security aspects at the application layer. We have structured them in a bottom-up fashion, following the traditional protocol stack model.

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In the first paper of the SI, entitled *Performance Analysis and Optimisation of FFR-Aided OFDMA Networks using Channel-Aware Scheduling*, Jan Garcia-Morales et al. propose an analytical framework that can be used to analyse the performance of interference coordination schemes for OFDMA-based networks. In particular, they focus on Fractional Frequency Reuse (FFR) and the paper derives closed-form expressions for three of the most widespread scheduling solutions (Proportional Fair, Maximum SINR and Round Robin). These can be exploited to leverage optimum (interference-aware) schemes, which in addition differentiate users at the cell-edge from those who are closer to the Base Station. Numerical results based on a system-level approach are used to assess the validity of the proposed framework. The outcome of this study can certainly be used in the improvement of scheduling solutions for current and forthcoming wireless systems, which will be based on OFDMA.

It goes without saying that wireless communications have helped to develop a new paradigm in the way people interact among them. Besides, they have also stirred up other more specific application scenarios. Sergio Montero et al. focus, in the work entitled *Link Scheduling Scheme with Shared Links and Virtual Tokens for Industrial Wireless Sensor Networks*, on one of these application scenarios, since they propose a scheduling technique to be used on industrial wireless sensor networks, which have some particular characteristics that need to be taken into consideration. Some of these requirements include strict reliability and latency, which might become more complicated to ensure, given the growing number of sensor devices that are used in factories. In order to tackle such stringent requirements, the paper introduces a novel link scheduling scheme, which can be used by nodes sharing the same multi-hop path, based on the concept of virtual tokens. An analytical model for the performance is derived and an exhaustive simulation-based study is used to assess the validity of such model and to compare the performance of the proposed scheme with other alternatives. The study is carried out over various scenarios, all of them mimicking realistic conditions, and the outcome yields that the proposed scheduling scheme clearly outperforms other approaches.

One of the technologies that is in the core of this wireless revolution is the so-called Wi-Fi (commercial name given to the IEEE 802.11 standard). Since the publication of the first standard version in 20 years, the technology has experienced an evaluation without comparison (for instance, the raw capacity has increased from 2 Mbps to 10 Gbps). However, there are still many aspects under development, and the scientific community is requested not only to focus on theoretical or simulation-based studies, but to foster experimentation over real platforms. This is exactly what Jose Aurelio Santana et al. tackle in their work *Adaptive Estimation of WiFi RSSI and Its Impact Over Advanced Wireless Services*. Based on an exhaustive, hands-on, analysis, they conclude that current RSSI estimation

methods are very much dependent on the particular characteristics of the terminals and Access Points. In addition, some of them are too complex to be exploited for real-time services and applications. In order to overcome these limitations, the paper introduces Thresholded Local Gradient (TLG), a novel estimation method with a very low complexity, which has been challenged in several realistic environments, including various terminals and both indoor and outdoor scenarios.

The fourth paper of this SI discusses Network Coding (NC), a technique that has gathered an increasing attention from the scientific community lately, since it has many possible applications, ranging from security, multicast transmissions, or energy-efficient communications. In *Providing Reliable Services over Wireless Networks Using a Low Overhead Random Linear Coding Scheme*, Pablo Garrido et al. focus on intra-flow solutions, where packets belonging to the same data flow are combined before being transmitted. They propose an improvement for the traditional Random Linear Network Coding (RLNC) solution, which strongly alleviates the overhead, by including the seed used by the transmitter to build the coded packets, instead of the corresponding coefficients. The paper derives an analytical model to establish the performance of the proposed scheme and afterwards exploit an implementation of NC over the ns-3 simulator to assess the benefits that such solution has over traditional reliable communication services (TCP). The improved RLNC implementation not only yields a relevant performance gain (up to 20%), especially when channel conditions are worse, but also leverages a fairer distribution of the shared resources.

Although the technological evolution is of outmost relevance, it is not less true that operators need to appropriately manage and operate the networks, in order to offer an adequate service to their customers. The increasing complexity of network topologies, the growing number of users and the services and applications they use make this task a real challenge. Hence, it becomes particularly important to promote solutions that can support network operators in this task, by leveraging automatic and self-x (x could be healing, configuration, organizing, etc.) procedures. In the fifth paper of the SI, *Facing Network Management Challenges with Functional Data Analysis: Techniques & Opportunities*, David Muelas et al. study the application of Functional Data Analysis (FDA) techniques for network management and analysis. In particular, they focus on measurement pre-processing, clustering, bandwidth allocation, and anomalies detection. They use real traces to compare the performance of their proposed technique with other state-of-the-art approaches, showing that the use of FDA can yield relevant enhancements in this area, whose relevance is undoubtedly growing in the forthcoming years, especially with the advent of the Software Defined Networking paradigm.

One of the most relevant challenges that ICT needs to face is security. Security has been shown to be an integral part of all communication solutions and techniques, and experience tells

that it cannot be considered as an orthogonal solution that can be later integrated as a patch. Hence, security needs to be considered from the very beginning in the design phase. This SI highlights the relevance of security aspects in ICT with the sixth paper, entitled *Design and Performance Evaluation of Two Approaches to Obtain Anonymity in Transferable Electronic Ticketing Schemes*. M. Magdalena Payeras-Capellà et al. propose electronic ticketing schemes with anonymity and transferability, following two different approaches: RSA and group signatures. Furthermore, a real implementation over a mobile platform has been used to assess the feasibility of the proposed solutions. The results show that, despite providing a more robust solution, the use of group signatures leads to some performance degradation, compared to the RSA based approach.

Ramón Agüero, received his MSc in Telecommunications Engineering (1st class honors) from the University of Cantabria in 2001 and the PhD in 2008. He is currently an Associate Professor at the Communications Engineering Department in that university. His research focuses on future network architectures, especially regarding the (wireless) access part of the network and its management. He is also interested on multi-hop (mesh) networks, and Network Coding. He has published more than 170 scientific papers in such areas and he is a regular TPC member and reviewer on various related conferences and journals. Ramon Agüero serves in the Editorial Board of IEEE Communication Letters and Wireless Networks (Springer). He is a senior member of IEEE.

Maria Magdalena Payeras Capellà was born in Mallorca. She received her MSc in Telecommunication Engineering (1998) from the Polytechnic University of Catalonia (UPC) and her Ph.D. in Computer Science (2005) from the University of the Balearic Islands (UIB). She won the award to the best doctoral thesis in 2005 from the COIT, Engineers Spanish Association. She has held several positions in the University of the Balearic Islands since 1998 in the department of mathematics and computer science where she is currently Associate Professor. She is the director of the University Master in Telecommunication Engineering. Her research is focused primarily in the security in communications networks, protocols for electronic commerce and technical-legal aspects of electronic commerce. Within these lines of research she has had an active pace of publications in international journals and in international and national conferences, international journals included in Journal Citation Reports (JCR) as well as some book chapters. She has been a member of the scientific and organizing committee in several international congresses. She has participated in European-funded and Spanish-funded research projects and currently is the Project Manager of project ACCESSTUR, funded by the Spanish government. She has participated in the creation of two spin-off companies: the awarded KEYRON, dedicated to telemedicine, formed in 2006 and GeDocu, formed in 2016.

Jaime Lloret (jlloret@ocom.upv.es) received his M.Sc. in Physics in 1997, his M.Sc. in electronic Engineering in 2003 and his Ph.D. in telecommunication engineering (Dr. Ing.) in 2006. He is a Cisco Certified Network Professional Instructor. He worked as a network designer and administrator in several enterprises. He is currently Associate Professor in the Polytechnic University of Valencia. He is the Chair of the Integrated Management Coastal Research Institute (IGIC) and he is the head of the «Active and collaborative techniques and use of technologic resources in the education (EITACURTE)» Innovation Group. He is the director of the University Diploma «Redes y Comunicaciones de Ordenadores» and of the University Master «Digital Post Production». He has been Internet Technical Committee chair (IEEE Communications Society and Internet society) for the term 2013-2015. He has authored 22 book chapters and has more than 360 research papers published in national and international conferences, international journals (more than 140 with ISI Thomson JCR). He has been the co-editor of 40 conference proceedings and guest editor of several international books and journals. He is editor-in-chief of the «Ad Hoc and Sensor Wireless Networks» (with ISI Thomson Impact Factor), the international journal «Networks Protocols and Algorithms», and the International Journal of Multimedia Communications, IARIA Journals Board Chair (8 Journals) and he is (or has been) associate editor of 46 international journals (16 of them with ISI Thomson Impact Factor). He has been involved in more than 320 Program committees of international conferences, and more than 130 organization and steering committees. He leads many national and international projects. He is currently the chair of the Working Group of the Standard IEEE 1907.1. He has been general chair (or co-chair) of 38 International workshops and conferences. He is IEEE Senior and IARIA Fellow.

Guillem Femenias received the Telecommunication Engineer degree and the Ph.D. degree in electrical engineering from the Technical University of Catalonia (UPC), Barcelona, Spain, in 1987 and 1991, respectively. From 1987 to 1994, he worked as a researcher with UPC, where he became an Associate Professor in 1992. In 1995, he joined the Department of Mathematics and Informatics, University of the Balearic Islands (UIB), Mallorca, Spain, where he became Full Professor in 2010. Prof. Femenias is currently leading the Mobile Communications Group at UIB, where he has been the Project Manager of projects ARAMIS, DREAMS, DARWIN, MARIMBA, COSMOS and ELISA, all of them funded by the Spanish and Balearic Islands Governments. In the past, he was also involved with several European projects (ATDMA, CODIT, and COST). His current research interests and activities span the fields of digital communications theory and wireless communication systems, with particular emphasis on cross-layer transceiver design, resource management, and scheduling strategies applied to fourth- and fifth-generation wireless networks. On these topics, he has published more than 90 journal and conference papers, as well as some book chapters. He was the recipient of the Best Paper Awards at the 2007 IFIP International Conference on Personal Wireless Communications and at the 2009 I.E. Vehicular Technology Conference - Spring. He has served for various IEEE conferences as a Technical Program Committee Member, as the Publications Chair for the IEEE 69th Vehicular Technology Conference (VTC-Spring 2009) and as Local Organizing Committee member of the IEEE Statistical Signal Processing (SSP 2016). Prof. Femenias is a Senior Member of IEEE.