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Essaid Sabir · Ana García Armada
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Ubiquitous Networking

Third International Symposium, UNet 2017
Casablanca, Morocco, May 9–12, 2017
Revised Selected Papers

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About the UNet Conference Series

The International Conference on Ubiquitous Networking (UNet) is an international scientific event that highlights new trends and findings in hot topics related to ubiquitous computing/networking. Ubiquitous networks sustain the development of numerous paradigms/technologies such as distributed ambient intelligence, context-awareness, cloud computing, wearable devices, and future mobile networking (e.g., B4G and 5G). Various domains are then impacted by such a system, for example, security and monitoring, energy efficiency and environment protection, e-health, precision agriculture, intelligent transportation, home-care (e.g., for elderly and disabled people), etc. Communication in such a system has to cope with many constraints (e.g., limited capacity resources, energy depletion strong fluctuations of traffic, real-time paradigm, dynamic network topology, radio link breakage, interferences, etc.) and has to meet the new application requirements. Ubiquitous systems bring many promising paradigms aiming to deliver significantly higher capacity to meet the huge growth of mobile data traffic and to accommodate efficiently dense and ultra-dense systems. A crucial challenge is that ubiquitous networks should be engineered to better support existing and emerging applications including broadband multimedia, machine-to-machine applications, Internet of Things, sensor networks, and RFID technologies. Many of these systems require stringent quality-of-service (QoS) including better latency, reliability, higher spectral and energy efficiency, but also some quality-of-experience and quality-of-context constraints.

The main purpose of this conference is to serve as a forum that brings together researchers and practitioners from academia and industry to discuss recent developments in pervasive and ubiquitous networks. This conference will provide a forum to exchange ideas, discuss solutions, debate identified challenges, and share experiences among researchers and professionals. UNet also aims to promote the adoption of new methodologies and to provide the participants with advanced and innovative tools able to catch the fundamental dynamics of the underlying complex interactions (e.g., game theory, mechanism design theory, learning theory, SDR platforms, etc.). Papers describing original research on both theoretical and practical aspects of pervasive computing and future mobile computing (e.g., LTE-A, LTE-B, 5G, IoT) were invited for submission to UNet 2017.

Welcome Message from the UNet 2017 Chairs

It is our pleasure to welcome you to the proceedings of the 2017 edition of the International Symposium on Ubiquitous Networking, UNet 2017. The conference was held in the city of Casablanca, Morocco, during May 9–12, following up on the success of past editions. Morocco boasts a growing and active community of networking researchers and the choice of Casablanca for UNet 2017 allowed its attendees, coming from all parts of the globe, to interact in a fascinating environment.

The growth of pervasive and ubiquitous networking in the past few years has been unprecedented. Today, a significant portion of the world's population is connected to the Internet most of the time through smart phones, while the Internet of Things promises to broaden the impact of the Internet to encompass devices ranging from electric appliances and medical devices to unmanned vehicles. The goal of UNet is to be a premier forum for discussing technical challenges and solutions related to such a widespread adoption of networking technologies, including broadband multimedia, machine-to-machine applications, Internet of Things, sensor networks, and RFID technologies. Toward this aim, we organize four main technical tracks of papers covering all the aspects of ubiquitous networks.

The UNet 2017 program featured four special talks addressed by distinguished keynote speakers: Prof. George K. Karagiannidis from the University of Thessaloniki (Greece), Prof. Sofie Pollin from KU Leuven/ESAT/TELEMIC (Belgium), Prof. Liuqing Yang from Colorado State University (USA), and Prof. Halim Yanikomeroglu from Carleton University (Canada). Three tutorials on Backhaul/Fronthaul for 5G heterogeneous networks, on IoT for smart cities and on the most recent efforts in 5G area were also scheduled; they were delivered by Prof. Mohamed-Slim Alouini from KAUST (Saudi Arabia), Prof. Muhammad Zeeshan Shakir from the University of West Scotland (UK), Prof. Antonio J. Jara from the University of Applied Sciences (Western Switzerland), and Prof. Mehdi Bennis from Oulu University (Finland). This year, UNet was co-located with the IEEE 5G Summit Casablanca led by Prof. Latif Ladid (founder and chair of the IPv6 Forum and the 5G World Alliance, University of Luxembourg), Prof. Essaid Sabir (ENSEM, Hassan II University of Casablanca), and Prof. Mounir Ghogho (UIR Rabat-Morocco; University of Leeds, UK) exhibiting the new trends and research efforts, as well as the latest industrial innovations in 5G networks.

This new edition of the UNet conference series boasted a rich program that reflects the most recent advances in ubiquitous computing, involving a broad range of theoretical tools (e.g., game theory, mechanism design theory, learning theory, etc.) and practical methodologies (e.g., SDR/SDN platforms, Embedded systems, etc.) to study modern technologies (e.g., LTE-A, LTE-B, 5G, IoT).

We are very grateful to our technical sponsors, without whom UNet 2017 would not have been viable. We would like to thank Springer, IPv6 Forum, 5G World Alliance, IEEE Internet of Things, and IEEE Big Data. Among our Moroccan collaborators, we are especially thankful to the Hassan II University of Casablanca, ENSEM, FSTM,

and ESTC for hosting and co-organizing this exciting event. We are also very thankful to all our sponsors and patrons (ANRT, CNRST, CN&S, National Instruments, MasterTec, SERDILAB, VOCALCOM, etc.)

May 2017

M. Ghogho
M. Debbah
M. Sadik
A. Badri

Welcome Message from the TPC Chairs

It is with great pleasure that we welcome you to the proceedings of the 2017 International Symposium on Ubiquitous Networking (UNet 2017) held in Casablanca, Morocco. The symposium comprised an interesting technical program of four technical tracks reporting on recent advances in context-awareness, autonomy paradigms, mobile edge networking, virtualization, ubiquitous Internet of Things and discussing the enablers, the challenges, and the applications of ubiquitous communications and networking in today's contexts as well as those of the future. UNet 2017 also featured: four keynote speeches by world-class experts; three tutorials covering the new trends and the research and industrial efforts in 5G, Internet of Things, next-generation fronthauling/backhauling, and software-defined networking; and two invited papers sessions.

We have received 127 paper submissions from 18 countries and four continents. From these, 51 were accepted as main track papers and five additional papers were accepted as invited session papers after a careful review process to be included in the UNet 2017 proceedings. The overall acceptance rate for UNet 2017 was 40%.

The preparation of this excellent program would not have been possible without the dedication and the hard work of the different Chairs, the Keynote speakers, the Tutorial speakers, and all THE Technical Program Committee members and reviewers. We take this opportunity to acknowledge their valuable work and sincerely thank them for their help in ensuring that UNet 2017 will be remembered as a high-quality event.

We hope that you will enjoy this edition's proceedings.

May 2017

E. Sabir
A. Armada
R. El-Azouzi
M. Benjillali
S. Lasaulce
F. De Pellegrini

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Abstracts of Keynote Talks

5G is Just Around the Corner; So What is Next?

Halim Yanikomeroglu

Abstract. Since the completion of the first 4G LTE standard in the late 2000s, the research community has been conceiving 5G, mainly from two tangled angles, the novel use cases and the enabling technologies. At the time of the writing of this book, the 5G standardization process has already started; the first 5G standards are scheduled to be finalized in the late 2010s. The 5G is expected to evolve throughout the 2020s; and, probably sometime in the latter part of the 2020s, the 6G standardization process will start, with possible deployments in the early 2030s. It is rather early at this point to over-speculate on 6G. Nevertheless, it is possible to highlight a number of important points in light of the experience gained from the first four or five generations.

The big promise of 5G is that the use cases in this generation will not be confined to the smart phone environment. Therefore, the success of 5G is closely tied to how quickly and to what extent these novel use cases will have market acceptance. Although the maturity of the 5G technologies for enabling the new use cases is essential, this is not the only factor for the success of 5G; arguably, market-readiness of these use cases will play an even more important role. One of the reasons for the great success of 4G LTE has been that the standard involved a number of technologies which were highly successful in enabling a primary use case, namely, video delivery on smart phones. At the same time, there was a great market/demand for this use case – the right synergy for success. 5G is coming with many powerful enabling technologies, many of which are highlighted in this book. However, anticipating the market adoption timeline of the 5G use cases is more difficult, as this timeline depends on factors beyond engineering. For example, the fully autonomous and connected vehicle paradigm cannot become a reality in a short time frame. A number of new use cases, such as this one, require policy and legislation changes which are inherently long processes. Therefore, during the latter part of the 2020s, when the 6G standardization is likely to occur, the discussions around many of the use cases attributed to 5G will likely to continue in the 6G context as well.

5G marks the start of a new era in wireless. The road towards 5G has been very exciting. The road towards 6G will be even more exciting...

Massive MIMO: From Channel, Antennas and SDR Towards User Fairness

Sofie Pollin

Abstract. Massive MIMO is widely seen as a promising candidate for 5G as it promises high throughput, long range, low cost or power consumption, and perfect fairness among users. We will introduce the key principles behind Massive MIMO, and highlight the main assumptions that underly its world record performance. Then, implementation aspects will be discussed going from the signal processing algorithms to the antennas. By looking at the real measured performance as function of various implementation choices, such as the antenna elements, we will shed some new light on Massive MIMO.

Simultaneous Lightwave Information and Power Transfer (SLIPT) for Indoor IoT Applications

George K. Karagiannidis

Abstract. The era of Internet-of-Things (IoT) opens up the opportunity for a number of promising applications in smart buildings, health monitoring, and predictive maintenance. It is remarkable that most of the data consumption/generation, which are related to IoT applications, occurs in indoor environments. Motivated by this, optical wireless communication (OWC), such as visible light communications (VLC) or infrared (IR), have been recognized as promising alternative/complimentary technologies to RF, in order to give access to IoT devices in indoor applications. However, due to the strong dependence of the IoT on wireless access, their applications are constrained by the finite battery capacity of the involved devices.

In this talk, for first time will be presented a framework for simultaneous optical wireless information and power transfer, which we call Simultaneous Lightwave Information and Power Transfer (SLIPT), and can be used for indoor IoT applications through VLC or IR systems.

Vehicular Communications and Networking: The Gateway to Connected Mobility

Liuqing Yang

Abstract. Vehicular communications and networking is an area of significant importance in our increasingly connected and mobile world. In the past decade, this area has gained significant attention from both industry and academia for its potential of ensuring road safety, improving transportation efficiency and of enhancing travel quality. Vehicular environments are inherently challenging with doubly selective physical channels, constrained radio spectrum bandwidth resources, and constantly changing network connectivity and topology. As such, research in this area is essential for bringing to reality the many demanding vehicular applications that consist of the gateway towards the ultimate connected mobility. In this talk, I will introduce fundamentals of vehicular channels, and various practical communications and networking techniques that we particularly developed for such channels. Challenges and opportunities in this field will also be discussed to stimulate future research and development.

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