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# Ubiquitous Networking


5th International Symposium, UNet 2019  
Limoges, France, November 20–22, 2019  
Revised Selected Papers

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# Preface

UNet is an international scientific event that highlights new trends and findings in hot topics related to ubiquitous computing/networking. This 5th edition was held during November 20–22, 2019, in the fascinating city of Limoges, France.

Ubiquitous networks sustain development of numerous paradigms/technologies such as distributed ambient intelligence, Tactile Internet, context awareness, cloud computing, wearable devices, and future mobile networking (e.g., B4G, 5G, 6G). Various domains are then impacted by such a system, one cite 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 constraint, 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 including better latency, reliability, higher spectral, and energy efficiency, but also some quality-of-experience and quality-of-context constraints.

The main purpose of the UNet 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. The conference provides 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., artificial intelligence, game theory, mechanism design theory, machine learning theory, SDR platforms, etc.).

## Welcome Message from the UNet 2019 Chairs

It is our pleasure to welcome you to the proceedings of the 2019 edition of the International Symposium on Ubiquitous Networking (UNet 2019). The conference was held in the city of Limoges, France, during November 20–22, following up on the success of past editions. France has a prominent and active community of networking researchers and the choice of Limoges for UNet 2019 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, and 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, 5G, Internet of Things, Tactile Internet, artificial intelligence for networking, security and privacy, data engineering, sensor networks, and RFID technologies. Toward this aim, we had five main technical tracks of papers covering all aspects of ubiquitous networks.

The UNet 2019 program featured four invited talks presented by distinguished keynote speakers: Prof. Jean-Claude Belfiore from Huawei Technologies (France), Prof. Sofie Pollin from Catholic University of Leuven (Belgium), Prof. Latif Ladid from University of Luxembourg (Luxembourg), and Prof. Catherine Douillard from IMT Atlantique (France). With a rich program that reflects the most recent advances in ubiquitous computing and ambient intelligence, involving a broad range of theoretical tools (e.g., game theory, mechanism design theory, learning theory, machine learning, etc.) and practical methodologies (e.g., SDR/SDN platforms, embedded systems, privacy and security by design, etc.) to study modern technologies (5G, Internet of Things, Tactile Internet, industry 4.0, etc.). We were very pleased to welcome our attendees to this new edition of the UNet conference series.

We are very thankful to the XLIM, ENSIL-ENSCI School of Engineering, and NEST Research Group for co-organizing this exciting event. We are grateful to our technical sponsor Springer Science+Business Media, without whom UNet 2019 would not have been possible. We are also very thankful to all our sponsors and patrons (ENSIL-ENSCI, University of Limoges, ENSEM, Hassan II University of Casablanca, and Maghreb Solutions).

Enjoy the proceedings!

November 2019

Oussama Habachi  
Stefano Secci  
Jean-Pierre Cances

## **Welcome Message from the UNet 2019 TPC Chairs**

It is with great pleasure that we welcome you to the proceedings of the 2019 International Symposium on Ubiquitous Networking (UNet 2019), which was held in Limoges, France. The conference featured an interesting technical program of five technical tracks reporting on recent advances in ubiquitous communication technologies and networking, Tactile Internet and Ubiquitous Internet of Things, mobile edge networking and fog-cloud computing, AI and machine learning for ubiquitous communications, and data engineering, cyber security, and pervasive services. UNet 2019 also featured four keynote speeches by world-class experts, and one invited paper session.

We received 41 paper submissions from 14 countries and 4 continents. From these, 17 regular papers and 1 short paper were accepted after a careful review process to be included in the UNet 2019 proceedings. We also included two invited papers from acknowledged researchers. The regular-paper acceptance rate was 41% whereas the overall acceptance rate in UNet 2019 was 43%.

The preparation of this excellent program would not have been possible without the dedication and hard work of the different chairs, the keynote 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 2019 will be remembered as a high-quality event.

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

November 2019

Bo Ji  
Essaid Sabir  
Vahid Meghdadi

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## **UNet 2019 Keynote Speakers**

# From Learning to Reasoning: A Topos Perspective

Jean-Claude Belfiore

**Abstract.** With the explosion of data, the evolution of 5G networks towards 2020–2030 will be mostly based on machine learning techniques. They provide the first era of intelligent networks which we call learning networks. The second era of beyond 5G intelligent network for the period 2030–2040 are networks which are able to think. This requires new advanced mathematical tools which go beyond the perceptual framework of machine learning now. This can be done by linking the topology of perception and the logic of thinking, using category theory and its deeper notion of topos, invented by Alexandre Grothendieck at IHES in the 60s. As a bonus, this intriguing connection makes the notion of semantics appear naturally. Can we finally now start to build the foundations of semantic communication evoked by Shannon and Weaver in the early 50s?



**Jean-Claude Belfiore** graduated from Supelec, France, received a PhD from Télécom ParisTech, and the Habilitation (HdR) from Université Pierre et Marie Curie (UPMC). Until 2015, he was with Télécom ParisTech as a Full Professor in the Communications and Electronics Department. In 2015, he joined the Mathematical and Algorithmic Sciences Lab of Huawei.

Jean-Claude Belfiore has made pioneering contributions on modulation and coding for wireless systems (especially space-time coding) by using tools of number theory. He is also one of the co-inventors of the celebrated Golden Code of the Wi-Max standard.

Jean-Claude Belfiore is author or co-author of more than 200 technical papers and communications and has served as advisor for more than 30 PhD students.

He was Associate Editor of the *IEEE Transactions on Information Theory for Coding Theory* and has been the recipient of the 2007 Blondel Medal.

Since November 2015, Jean-Claude Belfiore has joined the Paris Research Center of Huawei Technologies where he leads a department. He has been involved in the 5G standardization process, essentially for the channel coding track (polar codes for 5G).

He now participates in the definition of 6G. Among other areas at Huawei, he is also actively related to the foundations of artificial intelligence.



# Electrosense, Open and Big Spectrum Data

Sofie Pollin

**Abstract.** With the explosion of wireless devices, there is a growing number of applications that require a deep understanding of the actual spectrum usage. New technologies are needed that go beyond or can complement classical high-end spectrum analyzers. Electrosense is the first initiative that exploits the paradigms of low-cost programmable spectrum sensors, crowdsourcing to users, and big data architecture to gather and make available spectrum data and events to scientists, practitioners, and stakeholders. In this talk we will review the main design concepts of the Electrosense network, the main research findings, and how the scientific community can contribute to the network.



**Sofie Pollin** obtained her PhD degree at KU Leuven, Belgium, with honors in 2006. From 2006–2008 she continued her research on wireless communication, energy-efficient networks, cross-layer design, coexistence, and cognitive radio at UC Berkeley. In November 2008 she returned to imec to become a principal scientist in the green radio team. Since 2012, she is tenure track Assistant Professor at the Electrical Engineering Department at KU Leuven. Her research centers around networked systems that require networks that are ever more dense, heterogeneous, battery powered, and spectrum constrained. Prof. Pollin is a BAEF and Marie Curie fellow, and an IEEE Senior Member.

# IPv6-Based Internet Empowering Super IoT, 5G and Blockchain while Cybersecurity is Looming

Latif Ladid

**Abstract.** The recent McKinsey report on IoT projects 3 to 11 trillion dollars of IoT business by 2025. IoT is just the Internet sneaking everywhere. The current deployment of IoT is run over NAT converted logically to InterNAT of Things. The Hackers cannot wait to go after small fish to take down networks for money. 4G deployed over NAT except top notch ISPs like T-Mobile in the US using IPv6 and serving v4 customers with v4 as a service, or due to simply a lack of v4 address space such as in India with Reliance Jio deploying 4G with IPv6 and capturing 250 million 4G users, basically demonstrating a great case of a greenfield scenario leapfrogging developing countries into use of IPv6 without even knowing it. Blockchain is hailed to save the planet with its security. Again, the usual hype hits the road as blockchain is based on IPv4/NAT and the July 2018 hack of the keys got Bitcoin stumbling from 20 thousand dollars to 5 thousand dollars. However, people are not aware of these issues and keep speculating with Bitcoin, and some have even lost their keys, as is the case for one who lost 75 million dollars. This digital coin is not made for a layman. This talk will restore some sanity by looking at the historical developments of these technologies and learn from past mistakes and mind-boggling hypes.



**Latif Ladid** is a Senior Researcher at the Interdisciplinary Centre for Security, Reliability and Trust (SnT), Luxembourg. As a member of Secan-Lab, he works on multiple European Commission Next Generation Technologies IST Projects, including: 6INIT, [www.6init.org](http://www.6init.org) – First Pioneer IPv6 Research Project; 6WINIT, Euro6IX, [www.euro6ix.org](http://www.euro6ix.org); Eurov6, [www.eurov6.org](http://www.eurov6.org); NGNi, [www.ngni.org](http://www.ngni.org); project initiator of SEINIT, [www.seinit.org](http://www.seinit.org); and SecurIST, [www.securitytaskforce.org](http://www.securitytaskforce.org).

Latif initiated the new EU project u-2010 to research Emergency & Disaster and Crisis Management, [www.u-2010.eu](http://www.u-2010.eu); relaunched the Public Safety Communication Forum, [www.publicsafetycommunication.eu](http://www.publicsafetycommunication.eu); supported the new IPv6++ EU Research Project called EFIPSANS, [www.efipsans.org](http://www.efipsans.org), as well as the new Safety & Security Project using IPv6 called Secricom, [www.secricom.eu](http://www.secricom.eu); and

co-initiated the new EU Coordination of the European Future Internet Forum for Member States called ceFIMS, [www.ceFIMS.eu](http://www.ceFIMS.eu).

He holds the following positions: President, IPv6 FORUM, [www.ipv6forum.org](http://www.ipv6forum.org); Chair, European IPv6 Task Force, [www.ipv6.eu](http://www.ipv6.eu); Emeritus Trustee, Internet Society [www.isoc.org](http://www.isoc.org); and Board Member IPv6 Ready & Enabled Logos Program and Board Member World Summit Award, [www.wsis-award.org](http://www.wsis-award.org). Latif is also a Member of 3GPP PCG ([www.3gpp.org](http://www.3gpp.org)), 3GPP2 PCG ([www.3gpp2.org](http://www.3gpp2.org)), Vice Chair, IEEE ComSoc EntNET ([www.comsoc.org/~entnet/](http://www.comsoc.org/~entnet/)), Member of UN Strategy Council, Member of IEC Executive Committee, Board Member of AW2I, Board Member of Nii Quaynor Institute for Research in Africa, and Member of the Future Internet Forum EU Member States, representing Luxembourg: [http://ec.europa.eu/information\\_society/activities/foi/lead/fif/index\\_en.htm](http://ec.europa.eu/information_society/activities/foi/lead/fif/index_en.htm).

# Channel Coding for Tb/s Wireless Communications: Insights into Code Design, Decoding Algorithms and Implementation

Catherine Douillard

**Abstract.** While the wireless world is moving towards the 5G era, wireless Tb/s communications are expected to become a main technology trend within the next 10 years and beyond. On another note, for several decades, improvement in silicon technology has provided higher frequency, lower cost per gate, higher integration density, and lower power consumption. However, microelectronics has now reached a point where it can no longer keep pace with the increasing requirements of communication systems, alone. Therefore, the Tb/s data rate is a significant challenge for the design of transceivers and in particular for forward error correction, the most complex component in the baseband chain. Consequently, silicon implementations of advanced channel coding schemes require a cross-layer approach involving information theory, algorithm development, parallel hardware architectures, and semiconductor technology. This paper deals with the implementation challenges for advanced channel coding techniques, such as turbo codes, low-density parity-check (LDPC) codes or polar codes, when Tb/s throughput is targeted. As an example, we demonstrate how the specific design of codes and decoding algorithms, as well as the development of parallel hardware architectures make it possible to achieve a throughput higher than 100 Gb/s with current semiconductor technology.



**Dr. Catherine Douillard** received the engineering degree in telecommunications from the École nationale supérieure des télécommunications de Bretagne, France, in 1988, a PhD degree in electrical engineering from the University of Western Brittany, France, in 1992, and the accreditation to supervise research from the University of Southern Brittany, France, in 2004.

She is currently a full Professor in the Electronics Department of IMT Atlantique where she is in charge of the Algorithm-Silicon Interaction research team of the Lab-STICC laboratory. Her main research interests are error correcting codes, iterative decoding, iterative detection, coded modulations, and diversity techniques for multi-carrier, multi-antenna, and multiple access transmission systems.

Between 2007 and 2012, she participated in DVB (Digital Video Broadcasting) Technical Modules for the definition of DVB-T2, DVB-NGH, and DVB-RCS NG standards. She also served as the Technical Program Committee (co-)chair of ISTC 2010 and ISTC 2018 (International Symposium on Topics in Coding), as the general chair of ISTC 2016, and she will serve as the general co-chair of ISTC 2020.

In 2009, she received the SEE/IEEE Glavieux Award for her contribution to standards and related industrial impact.

# Contents

## Ubiquitous Communication Technologies and Networking

Comparison of Multi-channel Ranging Algorithms for Narrowband LPWA Network Localization. . . . .	3
<i>Florian Wolf, Mohamed Sana, Sébastien de Rivaz, François Dehmas, and Jean-Pierre Cances</i>	
Iterative Decoding for SCMA Systems Using Log-MPA with Feedback LDPC Decoding . . . . .	18
<i>Bilal Ghani, Frederic Launay, Jean Pierre Cances, Clency Perrine, and Yannis Pousset</i>	
A Fast TDMA Schedule Based on Greedy Approach. . . . .	32
<i>Shuai Xiaoying</i>	
Extended Low Rank Parity Check Codes and Their Efficient Decoding for Multisource Wireless Sensor Networks . . . . .	41
<i>Nicolas Aragon, Jean Pierre Cances, Imad El Qachchach, Philippe Gaborit, and Oussama Habachi</i>	
Analysis of the Coexistence of Ultra Narrow Band and Spread Spectrum Technologies in ISM Bands . . . . .	56
<i>Mohamed Amine Ben Temim, Guillaume Ferré, and Romain Tajan</i>	
Energy-Efficient MIMO Multiuser Systems: Nash Equilibrium Analysis . . . .	68
<i>Hang Zou, Chao Zhang, Samson Lasaulce, Lucas Saludjian, and Patrick Panchatici</i>	
Combined Beam Alignment and Power Allocation for NOMA-Empowered mmWave Communications. . . . .	82
<i>Wissal Attaoui and Essaid Sabir</i>	
Fast Uplink Grant for NOMA: A Federated Learning Based Approach . . . . .	96
<i>Oussama Habachi, Mohamed-Ali Adjif, and Jean-Pierre Cances</i>	
Global Modelling of Diffraction Phenomena by Irregular Shapes with Hybrid MOM-GTD Method . . . . .	110
<i>Samir Mendil and Taoufik Aguil</i>	

## Ubiquitous Internet of Things

Multi-hop LoRa Network with Pipelined Transmission Capability . . . . .	125
<i>Dinh Loc Mai and Myung Kyun Kim</i>	
IoT-Based Vital Sign Monitoring Using UWB Sensor . . . . .	136
<i>Mohamad Mostafa, Mohammad Saeed Dayari, Somayyeh Chamaani, Vahid Meghdadi, Oussama Habachi, and Yannis Pousset</i>	
IIoT-Based Prognostic Health Management Using a Markov Decision Process Approach . . . . .	146
<i>Khadija Berhili, Mohammed-Amine Koulali, and Yahya Berrehili</i>	
A Wearable IoT-Based Fall Detection System Using Triaxial Accelerometer and Barometric Pressure Sensor . . . . .	158
<i>Elahe Radmanesh, Mehdi Delrobaei, Oussama Habachi, Somayyeh Chamani, Yannis Pousset, and Vahid Meghdadi</i>	
A Congestion Game Analysis for Route-Parking Selection with Dynamic Pricing Policies. . . . .	171
<i>Bassma Jioudi, Essaid Sabir, Fouad Moutaouakkil, and Hicham Medromi</i>	
Initial Centroid Selection Method for an Enhanced K-means Clustering Algorithm. . . . .	182
<i>Youssef Aamer, Yahya Benkaouz, Mohammed Ouzzif, and Khalid Bouragba</i>	

## Pervasive Services and Applications

Dependency Between the Distance and International Voice Traffic . . . . .	193
<i>Zagroz Aziz and Robert Bestak</i>	
IoT Platforms for 5G Network and Practical Considerations: A Survey . . . . .	205
<i>Sejuti Banik, Irvin Steve Cardenas, and Jong-Hoon Kim</i>	
Optical Wireless Transmission of Electrocardiogram During Effort . . . . .	226
<i>Stéphanie Sahuguède, Anne Julien-Vergonjanne, Olivier Bernard, Kostiantyn Vasko, and Boris Shtangei</i>	
Emergency Patient's Arrivals Management Based on IoT and Discrete Simulation Using ARENA . . . . .	234
<i>Kaouter Karboub, Tabaa Mohamed, Fouad Moutaouakkil, Dellagi Sofiene, and Abbas Dandache</i>	

MSND: Multicast Software Defined Network Based Solution to Multicast  
Tree Construction . . . . .

245

*Youssef Baddi, Anass Sebbar, Karim Zkik, Mohammed Boulmalf,  
and Mohamed Dafir Ech-Cherif El Kettani*

Author Index . . . . .

257