

Message from the IWCMC 2019 Chairs

It is a great pleasure to welcome all participants to the 15th IEEE International Wireless Communications and Mobile Computing Conference (IEEE IWCMC 2019) in the beautiful city of Tangier, Morocco! We are indeed delighted that this year's IEEE IWCMC accomplishes its goal under the conference theme of "*Connecting the IoT*" and continues its tradition of providing a premier forum for presentation of research results and experience reporting on the cutting edge research in the general areas of wireless communications and mobile computing. This year, we have received many submissions from more than forty countries. Each paper received three or more peer technical reviews, comprised of more than four hundred TPC members from academia, industry and government laboratories. After carefully examining all review reports, the IEEE IWCMC 2019 TPC finally selected about 38% high-quality papers for presentation at the conference and publication in the IEEE IWCMC 2019 proceedings.

The conference program starts on Monday June 24th with a full day of Tutorials that are free of charge to all our attendees. This year, we have added a new event in parallel with the Monday Tutorials: *the 5G Summit*. This event has more than 14 renowned speakers from around the world presenting their opinion about 5G and discussing the most recent advances through panel discussions and brainstorming. On the other hand, the tutorial speakers are *Prof. Fumiyuki Adachi (Tohoku University, Japan)*, *Prof. Huseyin Arslan (USF, USA)*, *Prof. Ala Al-Fuqaha (HBKU, Qatar)* and *Dr. Junaid (ITU—Punjab, Pakistan)*. Then, each day starts with a keynote speaker chosen from renowned world-class leaders in the area – *Prof. Latif Ladid (University of Luxembourg, Luxembourg)*, *Prof. Abdallah Shami (Western University, Canada)*, and *Prof. Magdy Bayoumi (University of Louisiana, USA)*, highlighting the latest research trends in the wireless communications, mobile computing, and networks. This year, the technical sessions reflect the continued and growing interests in a wide range of spectrum, including wireless communications and networks, machine learning, wireless sensor networks, network security, next generation networks, vehicular communications and smart cities. Outstanding papers will be selected for Special Issues in prestigious international journals. Our objective in the future is to broaden the technical coverage and make this conference very competitive and of extremely high quality.

The Organizing Committee would like to acknowledge the hard work and dedication of many people to make this event a success already. We want to thank all authors who submitted their manuscripts, as well as all the Symposia and Workshop Chairs/Co-Chairs, TPC members, invited reviewers for all their contribution to the conference. Special gratitude goes to IEEE as well as the IEEE Morocco Section for their technical sponsorship and to Mohammed V University of Rabat, Morocco for its support.

We hope you all enjoy *IEEE IWCMC 2019* technical program and find this conference a productive opportunity to explore, exchange ideas, make new friends, and renew old ones. It is a pleasure to have you this year and invite you to come back next year and contribute to **IWCMC 2020** that will be held in **Beirut/Byblos, Lebanon**.

Finally, we would like to dedicate this event to the **memory of Prof. Mario Gerla (UCLA, USA)** who passed away February 2019. Prof. Gerla was a strong supporter of IWCMC since its inception more than 15 years ago. The IWCMC personnel and steering committee will remember Mario forever!

IWCMC 2019 Chairs

- *Prof. Said Amzazi, Minister of Higher Education, Morocco; **Honorary General Chair***
- *Prof. Mario Gerla, University of California-Los Angeles, California, USA; **General Chair***
- *Prof. Mohammed Essaaidi, Director of ENSIAS, Mohammed V University of Rabat, Morocco; **General Chair***
- *Prof. Abdellatif Kobbane, ENSIAS, Mohammed V University of Rabat, Morocco; **Honorary Program Chair***
- *Prof. Tomohiko Taniguchi, Fujitsu Laboratories Limited, Japan; **Program Chair***
- *Prof. Aiman Erbad, Director of Research Planning and Development, Qatar University; **Program Chair***

TABLE OF CONTENTS

Scroll to the title and select a [Blue](#) link to open a paper. After viewing the paper, use the bookmarks to the left to return to the beginning of the Table of Contents.

Tuesday, June 25th, 2019

TM-1: Invited Papers

Session Chair: Sofiene Affes (INRS-EMT, University of Quebec, Canada)

[ML EM Estimation of Fast Time-Varying OFDM-Type Channels](#) 1

Souheib Ben Amor (University of Quebec, Canada)
Sofiene Affes (University of Quebec, Canada)
Faouzi Bellili (University of Manitoba, Canada)

[A CMOS Transimpedance Amplifier with Ambient Light Rejection for Visible Light Communication in Intelligent Transport Systems](#) 7

Moaaz Ahmed (Hamad Bin Khalifa University, Qatar)
Amine Bermak (Hamad Bin Khalifa University, Qatar)

[Mobility Traffic Model based on Combination of Multiple Transportation Forms in the Smart City](#) 14

Mohammed Bin Hariz (University of Ottawa, Canada)
Dhaou Said (University of Ottawa, Canada)
Hussein T. Mouftah (University of Ottawa, Canada)

[Dictionary Learning-Based Beamspace Channel Estimation in Millimeter-Wave Massive MIMO Systems with a Lens Antenna Array](#) 20

Mahmoud Nazzal (Istanbul Medipol University, Turkey)
Mehmet Ali Aygül (Istanbul Medipol University, Turkey)
Ali Görçin (Yıldız Technical University and TÜBİTAK, Turkey)
Hüseyin Arslan (Istanbul Medipol University, Turkey and University of South Florida, USA)

[Single Carrier Transmission for URLLC with Adaptive Radio Resource Utilization](#) 26

Armed Tusha (Istanbul Medipol University, Turkey)
Seda Doğan (Istanbul Medipol University, Turkey)
Huseyin Arslan (Istanbul Medipol University, Turkey and University of South Florida, USA)

TM-2: Network Management (Wireless Nets Symposium)

Session Chair: Essaid Sabir (ENSEM, Casablanca, Morocco)

[An Event Prediction-based IP Multimedia Subsystem Service Exposure](#) 31

Armielle Noulapeu Ngaffo (SupCom, Tunisia)
Walid El Ayeb (SupCom, Tunisia)
Zied Choukair (SupCom, Tunisia)

A Distributed Predictive Road Traffic Management System in Urban VANETs	37
Ahmed Mejdoubi (Mohammed V University in Rabat, Morocco and URCA, France)	
Hacène Fouchal (Université de Reims Champagne-Ardenne, France)	
Oquadoudi Zytoune (Mohammed V University in Rabat and Ibn-Tofail University, Morocco)	
Mohamed Ouadou (Mohammed V University in Rabat, Morocco)	
Reputation based Intelligent Control Protocol	43
Nabila Bermad (University of Bejaia, Algeria)	
Salah Zemmoudj (University of Bejaia, Algeria)	
Mawloud Omar (University of Bejaia, Algeria)	
Interference Management by Adaptive Beamforming Algorithm in Massive MIMO Networks	49
Hosni Manai (University Tunis El Manar, Tunisia)	
Larbi Ben Hadj Slama (SupCom, Tunisia)	
Ridha Bouallegue (SupCom, Tunisia)	
A Novel Crowd-sourcing Inference Method	55
Jia Liu (Dalian University of Technology, P.R. China and University of California-Irvine, USA)	
William C. Tang (University of California-Irvine, USA)	
Yuanfang Chen (Hangzhou Dianzi University, P.R. China)	
Mingchu Li (Dalian University of Technology, P.R. China)	
Mohsen Guizani (University of Idaho, USA)	
TM-3: IoT Services (5G-IoT Workshop)	
Session Chair:	Bo Rong (Communications Research Centre, Canada)
Bayesian Model Updating Method based Android Malware Detection for Iot Services	61
Fei Wu (Beihang University, P.R. China)	
Limin Xiao (Beihang University, P.R. China)	
Jinbin Zhu (Beihang University, P.R. China)	
Traffic Analysis of LEO Satellite Internet of Things	67
Cong Jin (Nanjing University of Posts and Telecommunications, P.R. China)	
Xin He (Academy of Military Sciences PLA, P.R. China)	
Xiaojin Ding (Nanjing University of Posts and Telecommunications and Southeast University, P.R. China)	
A Multi-objective Service Function Chain Mapping Mechanism for IoT Networks	72
Cong Han (Beijing University of Posts and Telecommunications, P.R. China)	
Siya Xu (Beijing University of Posts and Telecommunications, P.R. China)	
Shaoyong Guo (Beijing University of Posts and Telecommunications, P.R. China)	
Xuesong Qiu (Beijing University of Posts and Telecommunications, P.R. China)	
Ao Xiong (Beijing University of Posts and Telecommunications, P.R. China)	
Peng Yu (Beijing University of Posts and Telecommunications, P.R. China)	
Kunya Guo (State Grid Liaoning Electric Power Co., Ltd., P.R. China)	
Dong Guo (Beijing Guodiantong Network Technical Co. Ltd., P.R. China)	

TM-4: Network Security (Security Symposium)

Session Chair: Mohamed El Kamili (University Sidi Mohammed Ben Abdellah, Morocco)

Generative Adversarial Networks for Launching and Thwarting Adversarial Attacks on Network Intrusion Detection Systems 78

Muhammad Usama (Information Technology University, Pakistan)
Muhammad Asim (Information Technology University, Pakistan)
Siddique Latif (University of Southern Queensland, Australia)
Junaid Qadir (Information Technology University, Pakistan)
Ala Al-Fuqaha (Hamad Bin Khalifa University, Qatar)

Black-box Adversarial Machine Learning Attack on Network Traffic Classification 84

Muhammad Usama (Information Technology University, Pakistan)
Adnan Qayyum (Information Technology University, Pakistan)
Junaid Qadir (Information Technology University, Pakistan)
Ala Al-Fuqaha (Hamad Bin Khalifa University, Qatar)

Using Advanced Detection and Prevention Technique to Mitigate Threats in SDN Architecture 90

Anass Sebbar (Université Internationale de Rabat and University Mohammed V, Morocco)
Karim Zkik (Université Internationale de Rabat, Morocco)
Youssef Baddi (Université Chouaib Doukkali, Morocco)
Mohammed Boulmalf (Université Internationale de Rabat, Morocco)
Mohamed Dafir Ech-Cherif El Kettani (University Mohammed V, Morocco)

A Secret Classified Label Control Model based on the Identity-based Cryptography 96

Zhijun Wu (Civil Aviation University of China, P.R. China)
Shan Tian (Civil Aviation University of China, P.R. China)
Wen Li (Civil Aviation University of China, P.R. China)
Meng Yue (Civil Aviation University of China, P.R. China)
Jian Wang (Civil Aviation University of China, P.R. China)

A Bilinear Pairing based Secure Data Aggregation Scheme for WSNs 102

Vimal Kumar (University of Waikato, New Zealand)

Hierarchical Anomaly based Intrusion Detection and Localization in IoT 108

Aymen Yahyaoui (University of Carthage, Tunisia)
Takoua Abdellatif (University of Carthage, Tunisia)
Rabah Attia (University of Carthage, Tunisia)

CASK: Conditional Authentication and Session Key Establishment in Fog-assisted Social IoT Network 114

Arij Ben Amor (University of Tunis El Manar and University of Sousse, Tunisia)
Mohamed Abid (University of Gabes, Tunisia)
Aref Meddeb (University of Sousse, Tunisia)

TM-5: SatCom Physical Layer and Multiple Access (Satellite Symposium)

Session Chair: Rui Xin (Tsinghua University, P.R. China)

An Enhanced Random Access Scheme: Multi-Power Contention Resolution Diversity Slotted Aloha 120

Yu Liang (Tsinghua University, P.R. China)
Zuyao Ni (Tsinghua University, P.R. China)
Linling Kuang (Tsinghua University, P.R. China)

Joint Active User and Data Detection in Uplink Grant-Free NOMA by Message-Passing Algorithm	126
Rui Xin (Tsinghua University, P.R. China)	
Zuyao Ni (Tsinghua University, P.R. China)	
Linling Kuang (Tsinghua University, P.R. China)	
Haoge Jia (Tsinghua University, P.R. China)	
Purui Wang (Tsinghua University, P.R. China)	
Research on LoRa Adaptability in the LEO Satellites Internet of Things	131
Tingwei Wu (Nanjing University of Posts and Telecommunications, P.R. China)	
Dexin Qu (Nanjing University of Posts and Telecommunications, P.R. China)	
Gengxin Zhang (Nanjing University of Posts and Telecommunications, P.R. China)	
Analysis of Co-channel Interference in Low-orbit Satellite Internet of Things	136
Dajian Xu (Nanjing University of Posts and Telecommunications, P.R. China)	
Gengxin Zhang (Nanjing University of Posts and Telecommunications, P.R. China)	
Xiaojin Ding (Nanjing University of Posts and Telecommunications and Southeast University, P.R. China)	
Physical Layer Representation in LEO Satellite with a Hybrid Multi-Beamforming	140
Andrey Ivanov (Skolkovo Institute of Science and Technology, Russia)	
Maria Stoliarenko (Skolkovo Institute of Science and Technology, Russia)	
Andrey Savinov (Skolkovo Institute of Science and Technology, Russia)	
Serafim Novichkov (Skolkovo Institute of Science and Technology, Russia)	
Communication Experiments and Analysis based on the Plasma Sheath Channel Simulation System	146
Yawei Hu (Tsinghua University, P.R. China)	
Ning Ge (Tsinghua University, P.R. China)	
A New UWB-MIMO Multi-Antennas with High Isolation for Satellite Communications	152
Chafai Abdelhamid (University of Gabes, Tunisia)	
Marwa Daghari (University of Gabes, Tunisia)	
Hedi Sakli (University of Tunis El Manar, Tunisia)	
Chafaa Hamrouni (University of Gabes, Tunisia)	
Three-Dimensional Visible Light Positioning using Regression Neural Network	156
Peixi Liu (Tsinghua University, P.R. China)	
Tianqi Mao (Tsinghua University, P.R. China)	
Ke Ma (Tsinghua University, P.R. China)	
Jiaxuan Chen (Tsinghua University, P.R. China)	
Zhaocheng Wang (Tsinghua University, P.R. China)	
TM-6: Data and Energy Management in WSNs (WSNs Symposium)	
Session Chair:	Mohammed Boulmalf (IUR, Morocco)
Clustering in WSNs based on Artificial Fish Swarming Algorithm	161
Djamila Mechta (Université Ferhat Abbas de Sétif, Algeria)	
Saad Harous (UAE University, UAE)	
Two Tier Data Reduction Technique for Reducing Data Transmission in IoT Sensors	168
Ali Kadhum M. Al-Qurabat (University of Babylon, Iraq)	
Chady Abou Jaoude (Antonine University, Lebanon)	
Ali Kadhum Idrees (University of Babylon, Iraq)	

Principal Component Analysis based Clustering Approach for WSN with Locally Uniformly Correlated Data	174
Zakia Jellali (SupCom, Tunisia)	
Leila Najjar Atallah (SupCom, Tunisia)	
Sofiane Cherif (SupCom, Tunisia)	
A Two-Tier Clustering based Downlink Resource Allocation Algorithm for Small Cell Networks	180
Jun Zheng (Southeast University, P.R. China)	
Donghong Jia (Southeast University, P.R. China)	
Baoxian Zhang (University of Chinese Academy of Sciences, P.R. China)	
New Sensing Matrices based on Orthogonal Hadamard Matrices for Compressive Sensing	186
Hamid Nouasria (National Institute of Posts and Telecommunications, Morocco)	
Mohamed Et-tolba (National Institute of Posts and Telecommunications, Morocco)	
Abla Bedoui (National Institute of Posts and Telecommunications, Morocco)	
Instantaneous Throughput Maximization for Cognitive Radio Networks	192
Ghassan Alnwaimi (King Abdulaziz University, Saudi Arabia)	
Hatem Boujemaa (SupCom, Tunisia)	
A Stochastic Method to Physical Layer Security of an Amplify-and-Forward Spectrum Sensing in Cognitive Radio Networks: Secondary User to Relay	197
Oluyomi Simpson (University of Hertfordshire, United Kingdom)	
Yichuang Sun (University of Hertfordshire, United Kingdom)	
A Task Allocation Algorithm for Profit Maximization in NFC-RAN	203
Yang Cai (Xidian University, P.R. China)	
Xiaofeng Lu (Xidian University, P.R. China)	
Yuansheng Luo (Changsha University of Science and Technology, P.R. China)	
Kezhi Wang (Northumbria University, United Kingdom)	
Dongwei Chen (University of Electronic Science and Technology of China, P.R. China)	
Kun Yang (UESTC, P.R. China and University of Essex, United Kingdom)	
TM-7: Emerging Technologies and Applications (Wireless Nets Symposium)	
Session Chair:	Soumaya Cherkaoui (Université de Sherbrooke, Canada)
Design and Evaluation of Self-Assembled Actin-Based Nano-Communication	208
Abderrahmane Oussama Dambri (Université de Sherbrooke, Canada)	
Soumaya Cherkaoui (Université de Sherbrooke, Canada)	
Biswadeep Chakraborty (Jadavpur University, India)	
Multi-user Detection in Optical Wireless Communication	214
Federica Aveta (University of Oklahoma, USA)	
Hazem H. Refai (University of Oklahoma, USA)	
Peter LoPresti (University of Tulsa, USA)	

Energy Modeling of Wireless Body Area Networks with On-Body Communication Channel Characterization	220
Amina Nahali (ISITCom, Tunisia)	
Abdelaziz Hamdi (ISITCom, Tunisia)	
Matthieu Gautier (Université de Rennes 1, France)	
Antoine Courtay (Université de Rennes 1, France)	
Rafik Braham (ISITCom, Tunisia)	
Important Complexity Reduction of Random Forest in Multi-Classification Problem	226
Kawther Hassine (Qatar University, Qatar)	
Aiman Erbad (Qatar University, Qatar)	
Ridha Hamila (Qatar University, Qatar)	
Research on Indoor Location Algorithm based on K Value Selection	232
Guanghua Zhang (Harbin Engineering University and Northeast Petroleum University, P.R. China)	
Xue Sun (Northeast Petroleum University, P.R. China)	
Tao Jiang (Harbin Engineering University, P.R. China)	
Weidang Lu (Zhejiang University of Technology, P.R. China)	
A New Weighted Indoor Positioning Algorithm based on the Physical Distance and Clustering	237
Hao Qin (Harbin Institute of Technology, P.R. China)	
Shuo Shi (Harbin Institute of Technology, P.R. China)	
Xiangyu Tong (Harbin Institute of Technology, P.R. China)	
Accurate Blind Synchronization for Free Space Optical Communication System using 2-PPM Modulation	243
Mohamed Maalej (ESPRIT School of Engineering and SupCom, Tunisia)	
Hichem Besbes (SupCom, Tunisia)	
TA-1: Fog/Edge/Cloud IoT (5G IoT Symposium)	
Session Chair:	Qiu Xue-song (Beijing University of Posts and Telecommunications, P.R. China)
Design of a Service Caching and Task Offloading Mechanism in Smart Grid Edge Network	249
Mengyu Li (Beijing University of Posts and Telecommunications, P.R. China)	
Lanlan Rui (Beijing University of Posts and Telecommunications, P.R. China)	
Xuesong Qiu (Beijing University of Posts and Telecommunications, P.R. China)	
Shaoyong Guo (Beijing University of Posts and Telecommunications, P.R. China)	
Xiuzhi Yu (China Electronics Standardization Institute, P.R. China)	
Energy-efficient Mobile Edge Computation Offloading with Multiple Base Station	255
Peng Zhang (Beijing Institute of Technology and CETC, P.R. China)	
Jie Yang (Beijing Institute of Technology, P.R. China)	
Rongfei Fan (Beijing Institute of Technology, P.R. China)	
Content Caching Strategy for Edge and Cloud Cooperation Computing	260
Biyao Li (Beijing University of Posts and Telecommunications, P.R. China)	
LanLan Rui (Beijing University of Posts and Telecommunications, P.R. China)	
Xuesong Qiu (Beijing University of Posts and Telecommunications, P.R. China)	
Haoqiu Huang (China Electronics Standardization Institute, P.R. China)	

Differentiated Service Mechanism According to Vehicle Environment in Vehicular Edge Network 266

Zuoyan Tan (Beijing University of Posts and Telecommunications, P.R. China)
LanLan Rui (Beijing University of Posts and Telecommunications, P.R. China)
Wenjing Li (Beijing University of Posts and Telecommunications, P.R. China)
Xuesong Qiu (Beijing University of Posts and Telecommunications, P.R. China)
Shaoyong Guo (Beijing University of Posts and Telecommunications, P.R. China)
Xiuzhi Yu (China Electronics Standardization Institute, P.R. China)

Cost-Efficient Tasks Scheduling for Smart Grid Communication Network with Edge Computing System 272

Jiming Yao (State Grid Corporation of China, P.R. China)
Zhifeng Li (State Grid Jibei Electric Power Company, P.R. China)
Yintao Li (State Grid Jibei Electric Power Company, P.R. China)
Jie Bai (State Grid Jibei Electric Power Company, P.R. China)
Jue Wang (State Grid Jibei Electric Power Company, P.R. China)
Peng Lin (Beijing Vectinfo Technologies Company, Ltd., P.R. China)

A Clustering Algorithm based on Communication Overhead and Link Stability for Cloud-assisted Mobile Adhoc Networks 278

Kun Xiao (Beijing University of Posts and Telecommunications, P.R. China)
Siya Xu (Beijing University of Posts and Telecommunications, P.R. China)
Shaoyong Guo (Beijing University of Posts and Telecommunications, P.R. China)
Xuesong Qiu (Beijing University of Posts and Telecommunications, P.R. China)
Peng Yu (Beijing University of Posts and Telecommunications, P.R. China)
Xingyu Chen (Beijing University of Posts and Telecommunications, P.R. China)
Wei Deng (Beijing Guodiantong Network Technical Co. Ltd., P.R. China)
Kunya Guo (State Grid Liaoning Electric Power Co. Ltd., P.R. China)

A Deep Reinforcement Learning based Mechanism for Cell Outage Compensation in Massive IoT Environments 284

Jianli Guo (The 54th Research Institute of China Electronics Technology Group Corporation, P.R. China)
Zhihao Wang (The 54th Research Institute of China Electronics Technology Group Corporation, P.R. China)
Xiujuan Shi (The 54th Research Institute of China Electronics Technology Group Corporation, P.R. China)
Xiao Yang (Beijing University of Posts and Telecommunications, P.R. China)
Peng Yu (Beijing University of Posts and Telecommunications, P.R. China)
Lei Feng (Beijing University of Posts and Telecommunications, P.R. China)
Wenjing Li (Beijing University of Posts and Telecommunications, P.R. China)

Study on Sharing and Compatibility between ITS and Fixed Service 290

Zhang Yanyan (China Mobile Group Design Institute Co., Ltd., P.R. China)
Wang Baocong (China Mobile Group Design Institute Co., Ltd., P.R. China)
Li Xin (China Mobile Group Design Institute Co., Ltd., P.R. China)
Liu Na (China Mobile Group Design Institute Co., Ltd., P.R. China)

TA-2: e-Health (e-Health Symposium)

Session Chair: Ali Idri (ENSIAS, Mohammed V of Rabat, Morocco)

ThermCont: A Machine Learning Enabled Thermal Comfort Control Tool in a Real Time	294
Bouziane Brik (University of Technology of Troyes, France)	
Moez Esseghir (University of Technology of Troyes, France)	
Leila Boulahia (University of Technology of Troyes, France)	
Hichem Snoussi (University of Technology of Troyes, France)	
An Investigation of Different Machine Learning Approaches for Epileptic Seizure Detection	301
Paulo Resque (Federal University of Pará, Brazil)	
Alex Barros (Federal University of Pará, Brazil)	
Denis Rosário (Federal University of Pará, Brazil)	
Eduardo Cerqueira (Federal University of Pará, Brazil)	
Heart of IoT: ECG as Biometric Sign for Authentication and Identification	307
Alex Barros (Federal University of Pará, Brazil)	
Denis Rosário (Federal University of Pará, Brazil)	
Paulo Resque (Federal University of Pará, Brazil)	
Eduardo Cerqueira (Federal University of Pará, Brazil)	
Intrusion Cancellation for Anomaly Detection in Healthcare Applications	313
Mbarka Belhaj Mohamed (National Engineering School of Gabes, Tunisia)	
Amel Meddeb-Makhlouf (University of Sfax, Tunisia)	
Ahmed Fakhfakh (National Engineering School of Gabes, Tunisia)	
An Ontology-based Healthcare Monitoring System in the Internet of Things	319
Sondes Titi (University of Sfax, Tunisia)	
Hadda Ben Elhadj (University of Sfax, Tunisia)	
Lamia Chaari (University of Sfax, Tunisia)	
Maximizing Lifetime in Energy-Harvesting WBSN for Health Monitoring Systems through Dynamic Slots Allocation	325
Nedia Badri (University of Manouba, Tunisia)	
Leila Nasraoui (University of Manouba and University of Carthage, Tunisia)	
Leila Azouz Saidane (University of Manouba, Tunisia)	
Salama Ikki (Lakehead University, Canada)	
DASS-CARE: A Decentralized, Accessible, Scalable, and Secure Healthcare Framework using Blockchain	330
Jamal N. Al-Karaki (Abu Dhabi Polytechnic, UAE)	
Amjad Gawanmeh (Khalifa University of Science and Technology, UAE)	
Meryeme Ayache (Mohammed V University in Rabat, Morocco)	
Ashraf Mashaleh (Balqa Applied University, Jordan)	

TA-3: Communication Systems (General Symposium)

Session Chair: Abderrahim Benslimane (University of Avignon, France)

Cost based Optimal Data Sampling Rate in Wireless Sensor Network	336
Koffi V.C. Kevin De Souza (University of Moncton, Canada)	
Catherine Almhana (University of Moncton, Canada)	
Jalal Almhana (University of Moncton, Canada)	
Lutful Karim (Seneca College of Applied Arts and Technology, Canada)	
Cognitive Radio Networks Channel State Estimation using Machine Learning Techniques	342
Dina Tarek (Cairo University, Egypt and University of Avignon, France)	
Abderrahim Benslimane (University of Avignon, France)	
M. Darwish (Cairo University, Egypt)	
Amira M. Kotb (Cairo University, Egypt)	
Can the Max-Min Fairness-Based Coalitional Mechanism in Competitive Networks be Trustful?	348
Zheng Shen (Zhejiang University, P.R. China)	
Zhaoquan Gu (Guangzhou University, P.R. China)	
Yuxuan Wang (Zhejiang University, P.R. China)	
Zhihong Tian (Guangzhou University, P.R. China)	
Mingli Song (Zhejiang University, P.R. China)	
Chunsheng Zhu (University of British Columbia, Canada)	
QFM-MRPL: Towards a QoS and Fault Management based of Mobile-RPL in IoT for Mobile Applications	354
Djamila Bendouda (University of Mustapha Stambouli, Algeria)	
Hafid Haffaf (Oran 1 Ahmed Benbella University, Algeria)	
Optimal Resource Allocation in Joint Secret Key Generation and Data Transfer Schemes	360
Miroslav Mitev (University of Essex, United Kingdom)	
Arsenia Chorti (Université Paris Seine, France)	
Martin Reed (University of Essex, United Kingdom)	
Video Summarization based on Motion Detection for Surveillance Systems	366
Omar Elharrouss (Qatar University, Qatar)	
Noor Al-Maadeed (Qatar University, Qatar)	
Somaya Al-Maadeed (Qatar University, Qatar)	
Practical Optimisation of Path Planning and Completion Time of Data Collection for UAV-enabled Disaster Communications	372
Trung Q. Duong (Queen's University, Canada)	
Long D. Nguyen (Duy Tan University, Vietnam)	
Loi Kim Nguyen (Nong Lam University, Vietnam)	
Error Probability Analysis for Dual-Hop Mixed RF-FSO System using CSOC Codes with MLGD Decoding	378
Souad Labghough (Mohammed V University in Rabat, Morocco)	
Fouad Ayoub (CRMEF, Morocco)	
Mostafa Belkasmi (Mohammed V University in Rabat, Morocco)	

TA-4: Comm. & SP (Comm. & SP Symposium)

Session Chair: Rodolfo Oliveira (NOVA University of Lisbon, Portugal)

An Iterative Massive-MIMO NOMA Receiver with Superimposed Pilots based Estimator for Sparse Channels 384

Syed Junaid Nawaz (COMSATS University Islamabad, Pakistan)
Babar Mansoor (COMSATS University Islamabad, Pakistan)
Mohammad N. Patwary (Birmingham City University, United Kingdom)
Mak Sharma (Birmingham City University, United Kingdom)

Decision-based Algorithm for Robust 2D-DoA Estimation with L-shaped Array 391

Sahbi Mazlout (University of Carthage, Tunisia)
M.-Bassem Ben Salah (University of Carthage, Tunisia)
Abdelaziz Samet (University of Carthage, Tunisia)

Performance Analysis of Rateless-Coded Non-Orthogonal Multiple Access 397

Yingmeng Hu (Beihang University, P.R. China)
Rongke Liu (Beihang University, P.R. China)
Aryan Kaushik (University of Edinburgh, United Kingdom)
John Thompson (University of Edinburgh, United Kingdom)
Xinwei Yue (Beijing Information Science Technology University, P.R. China)

A New Self-adaptive Wireless Communication System for Spinal Codes 403

Xiangqiang Gao (Beihang University, P.R. China)
Rongke Liu (Beihang University, P.R. China)
Hongxiu Bian (Beihang University, P.R. China)
Yingmeng Hu (Beihang University, P.R. China)

Weighted-Sum Average Age of Information in Unilaterally Powered Two-Way Data Exchanging Systems 409

Cheng Hu (Nanjing University of Information Science & Technology, P.R. China)
Yunquan Dong (Nanjing University of Information Science & Technology, P.R. China)

TA-5: Heterogeneous Networks (Wireless Nets Symposium)

Session Chair: Mohamed Sadik (Hassan II University of Casablanca, Morocco)

PPSA: Profiling and Preventing Security Attacks in Cloud Computing 415

Nahid Eddermoug (Hassan II University of Casablanca, Morocco)
Mohamed Sadik (Hassan II University of Casablanca, Morocco)
Essaid Sabir (Hassan II University of Casablanca, Morocco)
Abdeljebar Mansour (Hassan II University of Casablanca, Morocco)
Mohamed Azmi (Mohammed V University of Rabat, Morocco)

Canonical Coalition Game for Solving Wifi and LTE Coexistence Issues on the 5Ghz Band 422

Hager Hafaiedh (University of Manouba, Tunisia and University Paris-Est Marne-la-Vallée, France)
Inès El Korbi (University of Manouba, Tunisia)
Rami Langar (University Paris-Est Marne-la-Vallée, France)
Leila Azzouz Saidane (University of Manouba, Tunisia)
Abdellatif Kobbane (Mohammed V University in Rabat, Morocco)

Two Dimensional Markov Chain Approximation for MPTCP over HetNets: Performance Evaluation	428
Emad Abd-Elrahman (National Telecommunication Institute, Egypt)	
Adel Mounir Said (National Telecommunication Institute, Egypt)	
Towards a Distributed Computation Offloading Architecture for Cloud Robotics	434
Rihab Chaari (University of Mannouba, Tunisia)	
Omar Cheikhrouhou (University of Sfax, Tunisia)	
Anis Koubaa (Prince Sultan University, Saudi Arabia)	
Habib Youssef (University of Sousse, Tunisia)	
Habib Hamam (University of Moncton, Canada)	
An Evolutionary Game-Theoretic Approach for Cache-Enabled Cognitive D2D Networks	442
Basma Nissar (Sidi Mohammed Ben Abdellah University, Morocco)	
Ahmed El Ouadrhiri (University of Quebec, Canada)	
Mohamed El Kamili (Hassan II University of Casablanca, Morocco)	
Toward a Mapping Cost Minimization Model under Delay and Resource Constraints in NFV	449
Inès Raïssa Djouela Kamgang (SupCom, Tunisia)	
Ghayet El Mouna Zhioua (SupCom, Tunisia)	
Nabil Tabbane (SupCom, Tunisia)	
Low Energy System Proposal for UAV Applications using Flexible Solar Cells	455
Sghaier Guizani (Alfaisal University, Saudi Arabia)	
 TA-6: Vehicular Communications I (Vehicular Symposium)	
Session Chair:	Abdulla Al-Ali (Qatar University, Qatar)
Audio based Drone Detection and Identification using Deep Learning	459
Sara Al-Emadi (Qatar University, Qatar)	
Abdulla Al-Ali (Qatar University, Qatar)	
Amr Mohamed (Qatar University, Qatar)	
Abdulaziz Al-Ali (Qatar University, Qatar)	
Long-term QoE Optimization in IoV based on Cross-layer Resource Management	465
Yanhua He (North China Electric Power University, P.R. China)	
Liangrui Tang (North China Electric Power University, P.R. China)	
Zhenyu Zhou (North China Electric Power University, P.R. China)	
Yun Ren (State Grid Zhejiang Electric Power Company, P.R. China)	
A Comparison of AI-Based Throughput Prediction for Cellular Vehicle-To-Server Communication	471
Josef Schmid (Ostbayerische Technische Hochschule, Germany)	
Mathias Schneider (Ostbayerische Technische Hochschule, Germany)	
Alfred Höß (Ostbayerische Technische Hochschule, Germany)	
Björn Schuller (University of Augsburg, Germany)	
Proactive Eavesdropping via Jamming for Trajectory Tracking of UAVs	477
Kai Li (CISTER, Portugal)	
Salil S. Kanhere (The University of New South Wales, Australia)	
Wei Ni (Commonwealth Scientific and Industrial Research Organization, Australia)	
Eduardo Tovar (CISTER, Portugal)	
Mohsen Guizani (University of Idaho, USA)	

Dynamic Scheduling Algorithm based on Priority Assignment for LTE-V2X vehicular Networks	483
Ala DinTrabelsi (University of Sfax, Tunisia)	
Hend Marouane (University of Sfax, Tunisia)	
Faouzi Zarai (University of Sfax, Tunisia)	
Amel Meddeb-Makhlouf (University of Sfax, Tunisia)	
On Building Cooperative Intelligent Transportation Systems over Public Transports	489
Imen Mahjri (Luxembourg Institute of Science and Technology, Luxembourg)	
Sébastien Faye (Luxembourg Institute of Science and Technology, Luxembourg)	
Djamel Khadraoui (Luxembourg Institute of Science and Technology, Luxembourg)	
Efficient Scheduling and Resource Allocation for D2D-based LTE-V2X Communications	496
Ahlem Masmoudi (University of Sfax, Tunisia)	
Souhir Feki (University of Sfax, Tunisia)	
Kais Mnif (University of Sfax, Tunisia)	
Faouzi Zarai (University of Sfax, Tunisia)	
TA-7: Internet of Things (Wireless Nets Symposium)	
Session Chair:	Aiman Erbad (Qatar University, Qatar)
A Survey on Blockchain based Access Control for Internet of Things	502
Imen Riabi (University of Manouba, Tunisia)	
Hella Kaffel Ben Ayed (University of Tunis El Manar, Tunisia)	
Leila Azzouz Saidane (University of Manouba, Tunisia)	
A Scalable Slotted Aloha for Massive IoT: A Throughput Analysis	508
Soukaina Ihirri (Hassan II University of Casablanca, Morocco)	
Essaid Sabir (Hassan II University of Casablanca, Morocco)	
Ahmed Errami (Hassan II University of Casablanca, Morocco)	
Mohammed Khaldoun (Hassan II University of Casablanca, Morocco)	
Enhanced ADR for LoRaWAN Networks with Mobility	514
Norhane Benkahla (SupCom, Tunisia)	
Hajer Tounsi (SupCom, Tunisia)	
Ye-Qiong Song (University of Lorraine, France)	
Mounir Frikha (SupCom, Tunisia)	
Indoor Localization Algorithm based on Combination of Kalman Filter and Clustering	520
Guanghua Zhang (Harbin Engineering University and Northeast Petroleum University, P.R. China)	
Ke Bao (Northeast Petroleum University, P.R. China)	
Tao Jiang (Harbin Engineering University, P.R. China)	
Weidang Lu (Zhejiang University of Technology, P.R. China)	
Power Saving Extension for the NDN-Based GIF Protocol for the Internet of Things	525
Ahmed Aboud (National Engineering School of Sfax, Tunisia)	
Haifa Touati (University of Gabes, Tunisia)	
Brahim Hnich (University of Sfax, Tunisia)	
Efficient Data Dissemination in Electromagnetic Wireless Nano-Sensor Networks	531
Hanan Ferjani (University of Gabes, Tunisia)	
Haifa Touati (University of Gabes, Tunisia)	

NB-IoT Network Field Trial: Indoor, Outdoor and Underground Coverage Campaign	537
Hassan Malik (Tallinn University of Technology, Estonia)	
Sikandar Zulqarnain Khan (Tallinn University of Technology, Estonia)	
Jeffrey Leonel Redondo Sarmiento (Tallinn University of Technology, Estonia)	
Alar Kuusik (Tallinn University of Technology, Estonia)	
Muhammad Mahtab Alam (Tallinn University of Technology, Estonia)	
Yannick Le Moulllec (Tallinn University of Technology, Estonia)	
Sven Päränd (Tallinn University of Technology, Estonia)	

TA-8: Physical Layer Security (Security Symposium)

Session Chair: Amr Mohamed (Qatar University, Qatar)

Impact of outdated CSI on the Secrecy Performance of Dual-hop Networks using Cooperative Jamming	543
---	------------

Walid Mallat (SupCom, Tunisia)
Wided Hadj Alouane (SupCom, Tunisia)
Hatem Boujemaa (SupCom, Tunisia)
Farid Touati (Qatar University, Qatar)

Secure Semi-Blind AF Relaying Networks using Multiple Eavesdroppers	549
--	------------

Wided Hadj Alouane (SupCom, Tunisia)

Partial Relay Selection for Secure Outdated-CSI AF in Untrusted-Relay Networks	555
---	------------

Wided Hadj Alouane (SupCom, Tunisia)

Benchmarking Convolutional and Recurrent Neural Networks for Malware Classification	561
--	------------

Haidar Safa (American University of Beirut, Lebanon)
Mohamed Nassar (American University of Beirut, Lebanon)
Wael Al Rahal Al Orabi (American University of Beirut, Lebanon)

A Lightweight IoT Security Solution	567
--	------------

Hisham Yassine (Arab Open University, Lebanon)
Mohammad Malli (Arab Open University, Lebanon)

Iterative Nonlinear Detection and Decoding in Multi-User Massive MIMO	573
--	------------

Andrey Ivanov (Skolkovo Institute of Science and Technology, Russia)
Andrey Savinov (Skolkovo Institute of Science and Technology, Russia)
Dmitry Yarotsky (Skolkovo Institute of Science and Technology, Russia)

Efficient Lossless Feedback Compression for FDD Massive MIMO	579
---	------------

Papis Ndiaye (Université Cheikh Anta Diop, Senegal)
Moussa Diallo (Université Cheikh Anta Diop, Senegal)
Moustapha Mbaye (Université Cheikh Anta Diop, Senegal)
Idy Diop (Université Cheikh Anta Diop, Senegal)
Madoune Robert Seye (Université Cheikh Anta Diop, Senegal)

Efficient Kalman Modeling of Multipath Wireless Channel for Secret Key Generation	586
--	------------

Abdelkader Aljerme (Oregon State University, USA)
Huaping Liu (Oregon State University, USA)

TA-9: Digital Investigation & Information Assurance Techniques (DIAT)

Session Chair: Mohammed Boulmalf (International University of Rabat, Morocco)

A Game Theoretical based Rebroadcasting Protocol for Content Dissemination in VANETs	591
Assia Naja (Mohammed V University and International University of Rabat, Morocco)	
Mohammed Boulmalf (International University of Rabat, Morocco)	
Mohammad Essaaidi (Mohammed V University in Rabat, Morocco)	
Emergent LBS: If GNSS Fails, How Can 5G-enabled Vehicles get Locations using Fogs?	597
Sheng Yu (Shanghai Jiao Tong University, P.R. China)	
Jianhua Li (Shanghai Jiao Tong University, P.R. China)	
Jun Wu (Shanghai Jiao Tong University, P.R. China)	
A Name-to-Hash Encoding Scheme for Vehicular Named Data Networks	603
Hakima Khelifi (Beijing Institute of Technology, P.R. China)	
SenLin Luo (Beijing Institute of Technology, P.R. China)	
Boubakr Nour (Beijing Institute of Technology, P.R. China)	
Hassine Moun gla (Paris Descartes University, Sorbonne Paris Cite University and Telecom SudParis, France)	
Performance of Topology-based Data Routing with regard to Radio Connectivity in VANET	609
Chérifa Boucetta (University Paris Descartes, France)	
Oumaya Baala (University of Burgundy - Franche-Comté, France)	
Kahina Ait Ali (Orange, France)	
Alexandre Caminada (Université Nice Sophia Antipolis, France)	
Delay Study in Multi-controller Software Defined Vehicular Network using OpenDaylight for Emergency Applications	615
Karima Smida (SupCom, Tunisia)	
Hajer Tounsi (SupCom, Tunisia)	
Mounir Frikha (SupCom, Tunisia)	
Ye-Qiong Song (University of Lorraine, France)	
MAVSec: Securing the MAVLink Protocol for Ardupilot/PX4 Unmanned Aerial Systems	621
Azza Allouch (University of Tunis El Manar, Tunisia)	
Omar Cheikhrouhou (Taif University, Saudi Arabia and University of Sfax, Tunisia)	
Anis Koubaa (Prince Sultan University, Saudi Arabia)	
Mohamed Khalgui (Jinan University, P.R. China and University of Carthage, Tunisia)	
Tarek Abbes (University of Sfax, Tunisia)	
BlockLoc: Secure Localization in the Internet of Things using Blockchain	629
Omar Cheikhrouhou (Taif University, Saudi Arabia and University of Sfax, Tunisia)	
Anis Koubaa (Prince Sultan University, Saudi Arabia)	
Empirical Performance Evaluation of QUIC Protocol for Tor Anonymity Network	635
Lamiaa Basyoni (Qatar University, Qatar)	
Aiman Erbad (Qatar University, Qatar)	
Masha el Alsabah (Hamad Bin Khalifa University, Qatar)	
Noora Fetais (Qatar University, Qatar)	
Mohsen Guizani (Qatar University, Qatar)	

TA-10: Multimedia Information Processing (Multimedia Symposium)

Session Chair: Omar Elharrouss (Qatar University, Qatar)

- A DASH-based Efficient Throughput and Buffer Occupancy-based Adaptation Algorithm for Smooth Multimedia Streaming** 643
Abid Yaqoob (Dublin City University, Ireland)
Ting Bi (Dublin City University, Ireland)
Gabriel-Miro Muntean (Dublin City University, Ireland)
- SE-PSO: Resource Scheduling Strategy for Multimedia Cloud Platform based on Security Enhanced Virtual Migration** 650
Tengchao Ma (Beijing University of Posts and Telecommunications, P.R. China)
Changqiao Xu (Beijing University of Posts and Telecommunications, P.R. China)
Zan Zhou (Beijing University of Posts and Telecommunications, P.R. China)
Xiaohui Kuang (Institute of System and Engineering, CAS, P.R. China)
Lujie Zhong (Capital Normal University, P.R. China)
- Joint Social-Aware and Mobility-Aware Caching in Cooperative D2D** 656
Zhe Yuan (Nanjing University of Posts and Telecommunications, P.R. China)
Wenqin Zhuang (Nanjing University of Posts and Telecommunications, P.R. China)
Xin Wei (Nanjing University of Posts and Telecommunications, P.R. China)
Liang Zhou (Nanjing University of Posts and Telecommunications, P.R. China)
- Energy Efficient for Scalable Video Caching Service over Device-to-Device Communication** 662
Han Xiao (Beijing University of Posts and Telecommunications, P.R. China)
Changqiao Xu (Beijing University of Posts and Telecommunications, P.R. China)
Tengfei Cao (Beijing University of Posts and Telecommunications, P.R. China)
Shujie Yang (Beijing University of Posts and Telecommunications, P.R. China)
Lujie Zhong (Capital Normal University, P.R. China)
Gabriel-Miro Muntean (Dublin City University, Ireland)
- A Load Balancing Strategy based on Request Queue for P2P-VoD System** 668
Xin Wei (Nanjing University of Posts and Telecommunications and NUPT, P.R. China)
Pingchuan Ding (Nanjing University of Posts and Telecommunications, P.R. China)
Fang Zhou (Anhui University of Technology, P.R. China)
Jinglei Lou (Nanjing University of Posts and Telecommunications, P.R. China)
Yun Gao (Nanjing University of Posts and Telecommunications and NUPT, P.R. China)
- Weighted Feature Fusion based Emotional Recognition for Variable-length Speech using DNN** 674
Sifan Wu (Nanjing University of Posts and Telecommunications, P.R. China)
Fei Li (Nanjing University of Posts and Telecommunications, P.R. China)
Pengyuan Zhang (University of Chinese Academy of Sciences, P.R. China)
- Mining User Opinion Influencers on Twitter Social Network: Find that Friend who Leads your Opinion using Bayesian Method and a New Emotional PageRank Algorithm** 680
Armielle Noulapeu Ngaffo (University of Carthage, Tunisia)
Walid El Ayebe (University of Carthage, Tunisia)
Zied Choukair (University of Carthage, Tunisia)

TA-11: Multimedia & Networking (Multimedia Symposium)

Session Chair: Mohamed Bouhorma (University Abdelmalk Essaadi, Morocco)

- A Mobile Quality-oriented Cooperative Multimedia Delivery Solution** 686
John Monks (Dublin City University, Ireland)
Cristina Muntean (Dublin City University, Ireland)
Gabriel-Miro Muntean (Dublin City University, Ireland)
- Enhancing Dynamic Adaptive Streaming over HTTP for Multi-homed Users using a Multi-Armed Bandit Algorithm** 692
Ali Hodroj (Saint Joseph University of Beirut, Lebanon)
Marc Ibrahim (Saint Joseph University of Beirut, Lebanon)
Yassine Hadjadj-Aoul (University of Rennes 1, France)
Bruno Sericola (University of Rennes 1, France)
- A Novel Opportunistic Fuzzy Logic based Objective Function for the Routing Protocol for Low-Power and Lossy Networks** 698
Ines Kechiche (University of Carthage, Tunisia)
Ines Bousnina (University of Carthage, Tunisia)
Abdelaziz Samet (University of Carthage, Tunisia)
- Drone Disrupted Denial of Service Attack (3DOS): Towards an Incident Response and Forensic Analysis of Remotely Piloted Aerial Systems (RPASs)** 704
Fahad E. Salamh (Purdue University, USA)
Umit Karabiyik (Purdue University, USA)
Marcus Rogers (Purdue University, USA)
Fawaz Al-Hazemi (KAIST, Republic of Korea)
- Energy Efficiency Analysis of FeICIC in Dense Heterogenous Networks** 711
Yanzan Sun (Shanghai University, P.R. China)
Han Xu (Shanghai University, P.R. China)
Shunqing Zhang (Shanghai University, P.R. China)
Yating Wu (Shanghai University, P.R. China)
Tao Wang (Shanghai University, P.R. China)
Yong Fang (Shanghai University, P.R. China)
Shugong Xu (Shanghai University, P.R. China)
- Passive TCP Identification for Wired and Wireless Networks: A Long-Short Term Memory Approach** 717
Xiaoyu Chen (Shanghai University, P.R. China)
Shugong Xu (Shanghai University, P.R. China)
Xudong Chen (Shanghai University, P.R. China)
Shan Cao (Shanghai University, P.R. China)
Shunqing Zhang (Shanghai University, P.R. China)
Yanzan Sun (Shanghai University, P.R. China)
- Delay Constrained-Rate Allocation for SVC over Device-to-Device Networks** 723
Lei Wang (Nanjing University of Posts and Telecommunications, P.R. China)
Huangda Lin (Nanjing University of Posts and Telecommunications, P.R. China)
Mingkai Chen (Nanjing University of Posts and Telecommunications, P.R. China)
Bin Kang (Nanjing University of Posts and Telecommunications, P.R. China)
Xuguang Zhang (Nanjing University of Posts and Telecommunications, P.R. China)
Wenqin Zhuang (Nanjing University of Posts and Telecommunications, P.R. China)

TA-12: Relay (Wireless Nets Symposium)

Session Chair: Aiman Erbad (Qatar University, Qatar)

Impact of the Direct Link on the Performance of Single-Relay Buffer-Aided FSO Communications 729

Chadi Abou-Rjeily (Lebanese American University, Lebanon)

Wissam Fawaz (Lebanese American University, Lebanon)

Packet Length Optimization for Two Way Relaying 735

Ghassan Alnwaimi (King Abdulaziz University, Saudi Arabia)

Hatem Boujemaa (SupCom, Tunisia)

Kamran Arshad (Ajman University, United Arab Emirates)

RL-Based User Association and Resource Allocation for Multi-UAV enabled MEC 741

Liang Wang (Northumbria University, United Kingdom)

Peiqiu Huang (Central South University, P.R. China)

Kezhi Wang (Northumbria University, United Kingdom)

Guopeng Zhang (China University of Mining and Technology, P.R. China)

Lei Zhang (University of Glasgow, United Kingdom)

Nauman Aslam (Northumbria University, United Kingdom)

Kun Yang (University of Essex, United Kingdom)

Energy Efficiency Optimization in OFDM based Two-Way DF Relaying Networks with Energy Harvesting 747

Weidang Lu (Zhejiang University of Technology, P.R. China)

Weilin Zhao (Zhejiang University of Technology, P.R. China)

Hong Peng (Zhejiang University of Technology, P.R. China)

Su Hu (University of Electronic Science and Technology of China, P.R. China)

Yuan Gao (Tsinghua University and Academy of Military Science of PLA, P.R. China)

Secure Half-duplex Dual-hop AF Relaying Networks with Partial Relay Selection 752

Walid Mallat (SupCom, Tunisia)

Wided Hadj Alouane (SupCom, Tunisia)

Hatem Boujemaa (SupCom, Tunisia)

Farid Touati (Qatar University, Qatar)

Temporal Mobility Evolution of Freely Floating Underwater Sensor Networks 758

Fatma Bouabdallah (King Abdulaziz University, Saudi Arabia)

An NB-IoT-based Smart Trash Can System for Improved Health in Smart Cities 763

Yujie Zhu (Hangzhou Dianzi University, P.R. China)

Gangyong Jia (Hangzhou Dianzi University, P.R. China)

Guangjie Han (Hohai University, P.R. China)

Zeren Zhou (Hohai University, P.R. China)

Mohsen Guizani (Qatar University, Qatar)

TA-13: Satellite Internet and Applications (Satellite Symposium)

Session Chair: Tianle Mai (Beijing University of Technology, P.R. China)

Small Number but Big Influence: Analysis of Routing Usability in ISTN 769

Wenying Dai (Tsinghua University, P.R. China)

Hewu Li (Tsinghua University, P.R. China)

Qian Wu (Tsinghua University, P.R. China)

Xiaomo Wang (China Academy of Electronics and Information Technology, P.R. China)

Self-learning Congestion Control of MPTCP in Satellites Communications 775

Tianle Mai (Beijing University of Technology, P.R. China)

Haipeng Yao (Beijing University of Posts and Telecommunications, P.R. China)

Yaqing Jin (Beijing University of Technology, P.R. China)

Xiaobin Xu (Beijing University of Technology, P.R. China)

Xiaolong Wang (Beijing University of Technology, P.R. China)

Zhe Ji (Beijing University of Posts and Telecommunications, P.R. China)

Experimental Performance Evaluation of TCP over an Integrated Satellite-Terrestrial Network Environment 781

Anas A. Bisu (Durham University, United Kingdom and Bayero University, Kano-Nigeria)

Andrew Gallant (Durham University, United Kingdom)

Hongjian Sun (Durham University, United Kingdom)

Katharine Brigham (Durham University, United Kingdom)

Alan Purvis (Durham University, United Kingdom)

Space Edge Cloud Enabling Network Slicing for 5G Satellite Network 787

Cao Suzhi (Chinese Academy of Sciences, P.R. China)

Wei Junyong (Chinese Academy of Sciences and University of Chinese Academy of Sciences, P.R. China)

Hao Han (Chinese Academy of Sciences and University of Chinese Academy of Sciences, P.R. China)

Zhao Yi (Chinese Academy of Sciences and University of Chinese Academy of Sciences, P.R. China)

Yang Shuling (Chinese Academy of Sciences and University of Chinese Academy of Sciences, P.R. China)

Yan Lei (Chinese Academy of Sciences, P.R. China)

Wu Shaojun (Chinese Academy of Sciences, P.R. China)

Gong Yongsheng (Chinese Academy of Sciences, P.R. China)

An Efficient Method for Multipath Mitigation Applicable to BOC Signals in GNSS 793

Fahad Alhussein (Oregon State University, USA)

Huaping Liu (Oregon State University, USA)

Space-Time Variation of Property Crime in Beijing with ESDA Method 799

Sheng Li (Beihang University, P.R. China)

Wenzhong Tang (Third Research Institute of the Ministry of Public Security, P.R. China)

TA-14: Physical Layer (Wireless Nets Symposium)

Session Chair: Adel Ben Mnaouer (CUD, UAE); Farid Touati (Qatar University, Qatar)

- Secrecy Performance of AF relaying in Cooperative NOMA over Rician Channel** 805
Nesrine Zaghdoud (SupCom, Tunisia)
Wided Hadj Alouane (SupCom, Tunisia)
Hatem Boujemaa (SupCom, Tunisia)
Adel Ben Mnaouer (Canadian University Dubai, UAE)
Farid Touati (Qatar University, Qatar)
- An MMSE Integrated Equalization for HARQ Chase Combining in OQAM-FBMC Systems** 811
Abla Bedoui (National Institute of Posts and Telecommunication, Morocco)
Mohamed Et-tolba (National Institute of Posts and Telecommunication, Morocco)
Hamid Nouasria (National Institute of Posts and Telecommunication, Morocco)
- On Correlation-Based Channel Sensing with IQ Imbalance** 817
Ahmed ElSamadouny (Qatar University, Qatar)
Heba Shehata (Qatar University, Qatar)
Tamer Khattab (Qatar University, Qatar)
Khalid Abualsaud (Qatar University, Qatar)
Mohsen Guizani (Qatar University, Qatar)
- Design and Simulations of Stable Pass-Band Filtering Response using Miniaturized Element Frequency Selective Surface (MEFSS)** 821
Marwa Daghari (National School of Engineers of Gabes, Tunisia)
Chafai Abdelhamid (National School of Engineers of Gabes, Tunisia)
Hedi Sakli (National School of Engineers of Gabes, Tunisia)
Divitha Seetharamdoo (IFSTTAR, France)
- Novel Frequency Offset Estimation Scheme for Reliable Wireless Communication using Modified K-Means Clustering** 826
Naji Albakay (University of Nebraska-Lincoln, USA)
Michael Hempel (University of Nebraska-Lincoln, USA)
Mahmoud Alahmad (University of Nebraska-Lincoln, USA)
Hamid Sharif (University of Nebraska-Lincoln, USA)
- Matrix Approximate Inversion based Signal Detection in Large-scale 3D-MIMO Systems** 830
Wei Ren (Nanjing University of Posts and Telecommunications, P.R. China)
Yang Zhou (Nanjing University of Posts and Telecommunications, P.R. China)
Wei Ji (Nanjing University of Posts and Telecommunications, P.R. China)
Ting Li (Nanjing University of Posts and Telecommunications, P.R. China)
Yan Liang (Nanjing University of Posts and Telecommunications, P.R. China)
Fei Li (Nanjing University of Posts and Telecommunications, P.R. China)
- Location Aided and Machine Learning-Based Beam Allocation for 3D Massive MIMO Systems** 836
Yuchen Xie (Nanjing University of Posts and Telecommunications, P.R. China)
Wei Ji (Nanjing University of Posts and Telecommunications, P.R. China)
Ting Li (Nanjing University of Posts and Telecommunications, P.R. China)
Yan Liang (Nanjing University of Posts and Telecommunications, P.R. China)
Fei Li (Nanjing University of Posts and Telecommunications, P.R. China)

- Subchannel Assignment for SWIPT-NOMA based HetNet with Imperfect Channel State Information 842**
Ishan Budhiraja (Thapar Institute of Engineering and Technology, India)
Sudhanshu Tyagi (Thapar Institute of Engineering and Technology, India)
Sudeep Tanwar (Nirma University, India)
Neeraj Kumar (Thapar Institute of Engineering and Technology, India)
Nadra Guizani (Purdue University, USA)

Wednesday, June 26th, 2019

WM-1: Machine Learning I (ML for NGS&N Workshop)

Session Chair: Tamer Khattab (Qatar University, Qatar)

- Averaging Neural Network Ensembles Model for Quantification of Volatile Organic Compounds 848**
Atiq ur Rehman (Hamad Bin Khalifa University, Qatar)
Amine Bermak (Hamad Bin Khalifa University, Qatar)

- Using a Kalman Filter to improve Schedulers Performance in Mobile Networks 853**
Márcio José Teixeira (University of Campinas, Brazil)
Varese Salvador Timóteo (University of Campinas, Brazil)

- Training Genetic Neural Networks Algorithms for Autonomous Cars with the LAOP Platform 859**
Jihene Rezgui (Collège de Maisonneuve, Canada)
Léonard Oest O'Leary (Collège de Maisonneuve, Canada)
Clément Bisailon (Collège de Maisonneuve, Canada)
Lamia Chaari (University of Sfax, Tunisia)

- Relay Selection based on Deep Learning for Broadcasting in VANET 865**
Abir Mchergui (University of Sfax, Tunisia)
Tarek Moulahi (Qassim University, Saudi Arabia)
Salem Nasri (University of Monastir, Tunisia)

- IoT-based Seismic Hazard Detection in Coal Mines using Grey Systems Theory 871**
Nimisha Ghosh (Siksha 'O' Anusandhan, India)
Indrajit Banerjee (Indian Institute of Engineering Science and Technology, India)

WM-2: Theory and Applications for Security (SeNTApE Workshop)

Session Chair: Alman Erbad (Qatar University, Qatar)

- A Dendritic Cell Algorithm based Approach for Malicious TCP Port Scanning Detection 877**
Nuha Masalmeh (UAE University, UAE)
Firas Saidi (University of Manouba, Tunisia)
Zouheir Trabelsi (UAE University, UAE)

- Predicting Probing Rate Severity by Leveraging Twitter Sentiments 883**
Hicham Hammouchi (Université Internationale de Rabat and Mohammed V University, Morocco)
Ghita Mezzour (Université Internationale de Rabat, Morocco)
Mounir Ghogho (Université Internationale de Rabat, Morocco)
Mohammed El Koutbi (Mohammed V University in Rabat, Morocco)

State of the Art on Privacy Risk Estimation Related to Android Applications	889
Zied El May (University of Tunis El Manar, Tunisia)	
Hella Kaffel Ben Ayed (University of Tunis El Manar, Tunisia)	
Dorra Machfar (University of Tunis El Manar, Tunisia)	
Anomaly Detection Model over Blockchain Electronic Transactions	895
Sirine Sayadi (SupCom, Tunisia)	
Sonia Ben Rejeb (SupCom, Tunisia)	
Zied Choukair (SupCom, Tunisia)	
A Light-Weight Implementation of Latch-Based True Random Number Generator	901
Naoki Fujieda (Aichi Institute of Technology, Japan)	
Hitomi Kishibe (Toyohashi University of Technology, Japan)	
Shuichi Ichikawa (Toyohashi University of Technology, Japan)	
Augmented Perception by V2X Cooperation (PAC-V2X): Security Issues and Misbehavior Detection Solutions	907
Mohamed Hadded (VEDECOM, France)	
Oyunchimeg Shagdar (VEDECOM, France)	
Pierre Merdrignac (VEDECOM, France)	
A Novel Sybil Attack Detection Mechanism for C-ITS	913
Marwane Ayaida (University of Reims Champagne-Ardenne, France)	
Nadhir Messai (University of Reims Champagne-Ardenne, France)	
Geoffrey Wilhelm (University of Reims Champagne-Ardenne, France)	
Sameh Najeh (University of Carthage, Tunisia)	
WM-3: SatCom Resource Allocation (Satellite Symposium)	
Session Chair:	Jun Du (Tsinghua University, P.R. China)
Computing Resource Allocation in LEO Satellites System: A Stackelberg Game Approach	919
Tianle Mai (Beijing University of Technology, P.R. China)	
Haipeng Yao (Beijing University of Posts and Telecommunications, P.R. China)	
Feixiang Li (Beijing University of Technology, P.R. China)	
Xiaobin Xu (Beijing University of Technology, P.R. China)	
Yaqing Jin (Beijing University of Technology, P.R. China)	
Zhe Ji (Beijing University of Posts and Telecommunications, P.R. China)	
Resource Allocation for Beam-hopping User Downlinks in Multi-beam Satellite System	925
Lin Wang (Nanjing University of Posts and Telecommunications, P.R. China)	
Chen Zhang (Nanjing University of Posts and Telecommunications, P.R. China)	
Dexin Qu (Nanjing University of Posts and Telecommunications, P.R. China)	
Gengxin Zhang (Nanjing University of Posts and Telecommunications, P.R. China)	
Dynamic Resource Allocation in LEO Satellite	930
Andrey Ivanov (Skolkovo Institute of Science and Technology, Russia)	
Maria Stoliarenko (Skolkovo Institute of Science and Technology, Russia)	
Stanislav Kruglik (Skolkovo Institute of Science and Technology, Russia)	
Serafim Novichkov (Skolkovo Institute of Science and Technology, Russia)	
Andrey Savinov (Skolkovo Institute of Science and Technology, Russia)	

Double Auction based Resource Allocation for Secure Video Caching in Heterogeneous Networks	936
Jun Du (Tsinghua University, P.R. China)	
Chunxiao Jiang (Tsinghua University, P.R. China)	
Haijun Zhang (University of Science and Technology Beijing, P.R. China)	
Yong Ren (Tsinghua University, P.R. China)	
Tony Q.S. Quek (Singapore University of Technology and Design, Singapore)	
Second-Price Auction based Cognitive Traffic Offloading in Heterogeneous Networks	942
Jun Du (Tsinghua University, P.R. China)	
Chunxiao Jiang (Tsinghua University, P.R. China)	
Haijun Zhang (University of Science and Technology Beijing, P.R. China)	
Yong Ren (Tsinghua University, P.R. China)	
Victor C.M. Leung (University of British Columbia, Canada)	
Multi-Resource Management for Multi-Tier Space Information Networks: A Cooperative Game	948
Xinru Mi (Xidian University, P.R. China)	
Chungang Yang (Xidian University, P.R. China)	
Zheng Chang (University of Jyväskylä, Finland)	
WM-4: Clustering and General Mechanisms for WSNs (WSNs Symposium)	
Session Chair:	Rafik Braham (University of Sousse, Tunisia)
Body Area Networks MAC Protocols for Healthcare: Performance Evaluation	954
Ferdawss Douma (ISITCom, Tunisia)	
Rafik Braham (ISITCom, Tunisia)	
A Two-Level Clustering based on Position, Data Correlation and Residual Energy in WSN	961
Marwa Fattoum (SupCom, Tunisia)	
Zakia Jellali (SupCom, Tunisia)	
Leila Najjar Atallah (SupCom, Tunisia)	
On Improving Flight Energy Efficiency in Simultaneous Transmission and Reception of Relay using UAVs	967
Ayaka Hanyu (Tohoku University, Japan)	
Yuichi Kawamoto (Tohoku University, Japan)	
Nei Kato (Tohoku University, Japan)	
Integrated Divide and Conquer with Enhanced k-means Technique for Energy-saving Data Aggregation in Wireless Sensor Networks	973
Ali Kadhum Idrees (University of Babylon, Iraq)	
Ali Kadhum M. Al-Qurabat (Antonine University, Lebanon)	
Chady Abou Jaoude (Antonine University, Lebanon)	
Wathiq Laftah Al-Yaseen (Al-Furat Al-Awsat Technical University, Iraq)	
A Distributed Processing Technique for Sensor Data Applied to Underwater Sensor Networks	979
Mohamad Mortada (University of Burgundy - Franche-Comté, France)	
Abdallah Makhoul (Antonine University, Lebanon)	
Chady Abou Jaoude (Antonine University, Lebanon)	
Hassan Harb (Antonine University, Lebanon)	
David Laiymani (University of Burgundy - Franche-Comté, France)	

Proposal of a New Self-organizing Protocol for Data Collection regarding Mobile Wireless Sensor and Actor Networks	985
Kamel Barka (University of Batna 2, Algeria)	
Lyamine Guezouli (University of Batna 2, Algeria)	
Samir Gourdache (University of Batna 2, Algeria)	
Djallel Eddine Boubiche (University of Batna 2, Algeria)	
Distributed Interference and Power Control based-Game Theory for D2D Communication	991
Sameh Najeh (SupCom, Tunisia)	
Ammar Bouallegue (University of Tunis - El Manar, Tunisia)	
Energy Trading Scheme based on Contract Theory in Cooperative Relay Network	997
Chen Liu (Zhejiang University of Technology, P.R. China)	
Weidang Lu (Zhejiang University of Technology, P.R. China)	
Hong Peng (Zhejiang University of Technology, P.R. China)	
Su Hu (University of Electronic Science and Technology of China, P.R. China)	
Yuan Gao (Tsinghua University and Academy of Military Science of PLA, P.R. China)	
 WM-5: Mobile Computing II (Mobile Computing Symposium)	
Session Chair:	Nidal Nasser (Alfaisal University, Saudi Arabia)
Self-organization Smart Protocol for Mobile Wireless Sensor Networks	1002
Lyamine Guezouli (University of Batna 2, Algeria)	
Kamel Barka (University of Batna 2, Algeria)	
Samir Gourdache (University of Batna 2, Algeria)	
Djallel Eddine Boubiche (University of Batna 2, Algeria)	
Resource Management in Cloud Data Centers: A Survey	1007
Khaoula Braiki (ISITCom, Tunisia)	
Habib Youssef (ISITCom, Tunisia)	
Sub-Optimum Detection Scheme with Double the Full Diversity for Asynchronous Cooperative Relay Network	1013
Abdulghani Elazreg (University of Derby, United Kingdom)	
Ahmad Kharaz (University of Derby, United Kingdom)	
Performance and Correctness of Mobile Cloud Computing Systems: Taxonomy and Open Challenges	1019
Fairouz Fakhfakh (University of Sfax, Tunisia)	
Impact of Clustering Algorithms on the Performance of Multilevel Switch Boxes FPGA with Long Wires	1025
Khouloud Bouaziz (National School of Engineers of Sfax, Tunisia)	
Sonda Chtourou (National School of Engineers of Sfax, Tunisia)	
Mohamed Abid (National School of Engineers of Sfax, Tunisia)	
Zied Marrakchi (Mentor Graphics, Tunisia)	
Abdulfattah M. Obeid (King Abdulaziz City for Science and Technology, Saudi Arabia)	
CEET: Cooperative Energy Efficient Tracking System using Smartphones	1031
Yousef Ali (King Fahd University of Petroleum and Minerals, Saudi Arabia)	
Uthman Baroudi (King Fahd University of Petroleum and Minerals, Saudi Arabia)	

WM-6: Application-level Trust (Security Symposium)

Session Chair: Abdellatif Kobbane (Mohammed V University of Rabat, Morocco)

Securing Fast PMIPv6 Protocol in case of Vertical Handover in 5G network 1037

Wafa Haddar (University of Sfax, Tunisia)
Sirine Ben Ameer (University of Sfax, Tunisia)
Faouzi Zarai (University of Sfax, Tunisia)

FW-TR: Towards a Novel Generation of Firewalls based on Trust-Risk Assessment of Filtering Rules and Policies 1043

Faouzi Jaidi (ESPRIT School of Engineering, Tunisia)

SAMAFog: Service-Aware Mutual Authentication Fog-based Protocol 1049

Arij Ben Amor (University of Tunis El Manar and University of Sousse, Tunisia)
Mohamed Abid (University of Gabes, Tunisia)
Aref Meddeb (University of Sousse, Tunisia)

The Security Evaluation of Big Data Research for Smart Grid 1055

Zhifeng Li (State Grid Jibei Electric Power Company, P.R. China)
Yintao Li (State Grid Jibei Electric Power Company, P.R. China)
Peng Lin (Beijing Vectinfo Technologies Company, Ltd., P.R. China)

A Novel Approach for Privacy-Preserving Data Aggregation in Smart Grid 1060

Rihem Ben Romdhane (SupCom, Tunisia)
Hamza Hammami (University of Tunis El Manar, Tunisia)
Mohamed Hamdi (SupCom, Tunisia)
Tai-hoon Kim (University of Tasmania, Australia)

At the Cross Roads of Lattice-Based and Homomorphic Encryption to Secure Data Aggregation in Smart Grid 1067

Rihem Ben Romdhane (SupCom, Tunisia)
Hamza Hammami (University of Tunis El Manar, Tunisia)
Mohamed Hamdi (SupCom, Tunisia)
Tai-hoon Kim (University of Tasmania, Australia)

A New Vehicular Blackbox Architecture based on Searchable Encryption 1073

Emna Jaidane (University of Tunis El Manar, Tunisia)
Mohamed Hamdi (SupCom, Tunisia)
Taoufik Aguilu (University of Tunis El Manar, Tunisia)
Tai-hoon Kim (University of Tasmania, Australia)

WM-7: Green Communications (Wireless Nets Symposium)

Session Chair: Khalil Ibrahimi (Ibn Tofail University, Morocco)

Study on the Parameters for the Convergence of the Method of Auxiliary Sources 1079

Sami Hidouri (National Engineering School of Tunis, Tunisia)
Eljamai Messaoud (National Engineering School of Tunis, Tunisia)
Taoufik Aguilu (National Engineering School of Tunis, Tunisia)

Energy Consumption of Virtual Machine Migration within varied DCN Architectures	1084
Nawel Kortas (ISITCom, Tunisia)	
Habib Youssef (ISITCom, Tunisia)	
Green Handoff in Femtocell Network	1090
Ines Damak (University of Tunis El Manar, Tunisia)	
Hela Hachaichi (University of Tunis El Manar, Tunisia)	
Ridha Bouallegue (University of Tunis El Manar, Tunisia)	
Online Transmission Policy in Wireless Powered Networks with Urgency-aware Age of Information	1096
Yang Lu (Beijing Jiaotong University, P.R. China)	
Ke Xiong (Beijing Jiaotong University, P.R. China)	
Pingyi Fan (Tsinghua University, P.R. China)	
Zhangdui Zhong (Beijing Jiaotong University, P.R. China)	
Khaled Ben Letaief (The Hong Kong University of Science and Technology, P.R. China)	
Broadcast Age of Information in CSMA/CA based Wireless Networks	1102
Mei Wang (Nanjing University of Information Science & Technology, P.R. China)	
Yunquan Dong (Nanjing University of Information Science & Technology, P.R. China)	
Green Data Center Networks: A Holistic Survey and Design Guidelines	1108
Emna Baccour (Qatar University, Qatar)	
Sebti Foufou (New York University, UAE and University of Burgundy, France)	
Ridha Hamila (Qatar University, Qatar)	
Aiman Erbad (Qatar University, Qatar)	
WA-1: Smart IoT (5G IoT Symposium)	
Session Chair:	Peng Yu (Beijing University of Posts and Telecommunications, P.R. China)
Dynamic Spectrum Allocation with Priority for Different Services in Cognitive-Radio-based Neighborhood Area Network for Smart Grid	1115
Kepeng Yang (Beijing University of Posts and Telecommunications, P.R. China)	
Yueqi Zi (Beijing University of Posts and Telecommunications, P.R. China)	
Lei Feng (Beijing University of Posts and Telecommunications, P.R. China)	
Peng Yu (Beijing University of Posts and Telecommunications, P.R. China)	
Wenjing Li (Beijing University of Posts and Telecommunications, P.R. China)	
Qinghai Ou (State Grid Corporation of China, P.R. China)	
Transmission Strategy of GOOSE Service based on Cellular Multimedia Broadcasting in Smart Grid ...	1121
Jiming Yao (Global Energy Interconnection Research Institute, P.R. China)	
Zhifeng Li (State Grid Jibei Electric Power Company, P.R. China)	
Yintao Li (State Grid Jibei Electric Power Company, P.R. China)	
Jie Bai (State Grid Jibei Electric Power Company, P.R. China)	
Jue Wang (State Grid Jibei Electric Power Company, P.R. China)	
Peng Lin (Beijing Vectinfo Technologies Company, Ltd., P.R. China)	

Resource Allocation for Multi-class Businesses in LTE-A Uplink Communication for Smart Grid	1127
Yun Liang (State Grid Corporation of China, P.R. China)	
Yao Wang (State Grid Corporation of China, P.R. China)	
Wenfeng Tian (State Grid Corporation of China, P.R. China)	
Pengfei Zeng (State Grid Corporation of China, P.R. China)	
Xiaoyan Sun (State Grid Corporation of China, P.R. China)	
Lei Feng (Beijing University of Posts and Telecommunications, P.R. China)	
Jinlong Chai (Beijing University of Posts and Telecommunications, P.R. China)	
Qiang Zhao (Beijing University of Posts and Telecommunications, P.R. China)	
Yueqi Zi (Beijing University of Posts and Telecommunications, P.R. China)	
Analysis of the Impact of eMTC on Legacy LTE	1133
Zhirong Zhang (China Telecom Beijing Research Institute, P.R. China)	
Xuetian Zhu (China Telecom Beijing Research Institute, P.R. China)	
Zhijun Li (China Telecom Beijing Research Institute, P.R. China)	
Yong Zeng (China Telecom Beijing Research Institute, P.R. China)	
CAPM: Context-Aware Privacy Model for IoT-based smart hospitals	1139
Salah Zemmoudj (University of Bejaia, Algeria)	
Nabila Bermad (University of Bejaia, Algeria)	
Mawloud Omar (University of Bejaia, Algeria)	
Combining Deep Neural Networks with SVM to Identify Speakers used in IoT	1145
Nguyen Nang An (Chongqing University of Posts and Telecommunication, P.R. China)	
Nguyen Quang Thanh (Chongqing University of Posts and Telecommunication, P.R. China)	
Liu Yanbing (Chongqing University of Posts and Telecommunication, P.R. China)	
Fei Wu (Beihang University, P.R. China)	
Intelligent Tag Prediction Algorithms for Acupuncture Experts	1150
Qingtao Zeng (Beijing Institute of Graphic Communication, P.R. China)	
Anping Xu (Beijing University of Chinese Medicine, P.R. China)	
Yeli Li (Beijing Institute of Graphic Communication, P.R. China)	
Chunhe Piao (Yanbian University, P.R. China)	
WA-2: IoT I (IoT Symposium)	
Session Chair:	Phone Lin (National Taiwan University, Taiwan)
A Survey on Multi-Agent Reinforcement Learning Methods for Vehicular Networks	1154
Ibrahim Althamary (National Central University, Taiwan)	
Chih-Wei Huang (National Central University, Taiwan)	
Phone Lin (National Taiwan University, Taiwan)	
Service Discovery in Heterogeneous IoT Environments based on OCF/IoTivity	1160
Khaled Elsayed (Cairo University, Egypt)	
Mohamed Abu Baker Ibrahim (Cairo University, Egypt)	
Haitham S. Hamza (Cairo University, Egypt)	

Virtual Network Function Placement in IoT Network 1166
Duong Tuan Nguyen (Université du Québec, Canada)
Chuan Pham (Université du Québec, Canada)
Kim Khoa Nguyen (Université du Québec, Canada)
Mohamed Cheriet (Université du Québec, Canada)

Upper Bound Performance of Uplink Class A LoRa Networks 1172
João Pacheco (Universidade Nova de Lisboa, Portugal)
António Furtado (Instituto de Telecomunicações, Portugal)
Rodolfo Oliveira (Universidade Nova de Lisboa and Instituto de Telecomunicações, Portugal)

Analysis of RSSI Fingerprinting in LoRa Networks 1178
Mahnoor Anjum (National University of Sciences and Technology, Pakistan)
Muhammad Abdullah Khan (National University of Sciences and Technology, Pakistan)
Syed Ali Hassan (National University of Sciences and Technology, Pakistan)
Aamir Mahmood (Mid Sweden University, Sweden)
Mikael Gidlund (Mid Sweden University, Sweden)

Enhancing MQTT-SN Performance via Fountain Codes in Extreme Conditions 1184
Ahmad Alshantout (King Fahd University of Petroleum and Minerals, Saudi Arabia)
Louai Al-Awami (King Fahd University of Petroleum and Minerals, Saudi Arabia)

A Survey on Recent Approaches in Intrusion Detection System in IoTs 1190
Aliya Tabassum (Qatar University, Qatar)
Aiman Erbad (Qatar University, Qatar)
Mohsen Guizani (Qatar University, Qatar)

WA-3: Vehicular Communications III (Vehicular Symposium)

Session Chair: Wassim El-Hajj (American University of Beirut, Lebanon)

On the Use of Software Defined Wireless Network in Vehicular Fog Computing Environments 1198
Joseph Houry (American University of Beirut, Lebanon)
Hani Sami (American University of Beirut, Lebanon)
Haidar Safa (American University of Beirut, Lebanon)
Wassim El-Hajj (American University of Beirut, Lebanon)

Inhomogeneous Multi-UAV Aerial Base Stations Deployment: A Mean-Field-Type Game Approach 1204
Yan Sun (Northwestern Polytechnical University, P.R. China)
Lixin Li (Northwestern Polytechnical University, P.R. China)
Kaiyuan Xue (Northwestern Polytechnical University, P.R. China)
Xu Li (Northwestern Polytechnical University, P.R. China)
Wei Liang (Northwestern Polytechnical University, P.R. China)
Zhu Han (University of Houston, USA)

An Evaluative Review of the Formal Verification for VANET Protocols 1209
Faten Fakhfakh (University of Sfax, Tunisia)
Mohamed Tounsi (University of Sfax, Tunisia and Umm Al-Qura University, Saudi Arabia)
Mohamed Mosbah (Umm Al-Qura University, Saudi Arabia)

Adaptive Security for the Intra-Electric Vehicular Wireless Networks	1215
Yosra Fraiji (University of Manouba, Tunisia)	
Lamia Benazzouz (University of Manouba, Tunisia)	
Wassim Trojet (Normandy University, France)	
Leila Azzouz Saidane (University of Manouba, Tunisia)	
Ghaleb Hoblos (Normandy University, France)	
Video Streaming in Vehicular Ad Hoc Networks: Applications, Challenges and Techniques	1221
Nadia Zribi (University of Gabes, Tunisia)	
Bechir Alaya (Qassim University, Saudi Arabia)	
Tarek Moulahi (Qassim University, Saudi Arabia)	
WA-4: Artificial Intelligence for WSNs (WSNs Symposium)	
Session Chair:	Khalid Elgazzar (University of Ontario Institute of Technology, Canada)
Forecasting Traffic Congestion using ARIMA Modeling	1227
Taghreed Alghamdi (University of Ontario Institute of Technology, Canada)	
Khalid Elgazzar (University of Ontario Institute of Technology, Canada)	
Magdy Bayoumi (University of Louisiana at Lafayette, USA)	
Taysseer Sharaf (University of Michigan-Dearborn, USA)	
Sumit Shah (CGI, USA)	
Automated Sensor-Fusion based Emergency Rescue for Remote and Extreme Sport Activities	1233
Benjamin Leiding (University of Göttingen, Germany)	
Arne Bochém (University of Göttingen, Germany)	
Luca Hernández Acosta (University of Göttingen, Germany)	
Adaptive Range-based Anomaly Detection in Drone-assisted Cellular Networks	1239
Chérifa Boucetta (University of Paris Descartes, France)	
Boubakr Nour (Beijing Institute of Technology, P.R. China)	
Seif Eddine Hammami (Telecom SudParis, France)	
Hassine Moun gla (University of Paris Descartes and Telecom SudParis, France)	
Hossam Afifi (Telecom SudParis, France)	
Stacked Auto-Encoder for Scalable Indoor Localization in Wireless Sensor Networks	1245
Souad BelMannoubi (University of Gabes, Tunisia)	
Haifa Touati (University of Gabes, Tunisia)	
Hichem Snoussi (University of Technology of Troyes, France)	
A Comparative Analysis of Machine Learning Classification Approaches for Fountain Data Estimation in Wireless Sensor Networks	1251
Fatma Belabed (University of Tunis El Manar, Tunisia)	
Ridha Bouallegue (SupCom, Tunisia)	
An Adaptive Sampling Technique for Massive Data Collection in Distributed Sensor Networks	1255
Ahmad Karaki (Lebanese University, Lebanon)	
Abbass Nasser (American University of Culture and Education, Lebanon)	
Chady Abou Jaoude (Antonine University, Lebanon)	
Hassan Harb (Antonine University and American University of Culture and Education, Lebanon)	

WA-5: QoS and e-Health

Session Chair: Haidar Safa (American University of Beirut, Lebanon)

Efficient EEG Mobile Edge Computing and Optimal Resource Allocation for Smart Health Applications	1261
Abeer Z. Al-Marridi (Qatar University, Qatar)	
Amr Mohamed (Qatar University, Qatar)	
Aiman Erbad (Qatar University, Qatar)	
Abdulla Al-Ali (Qatar University, Qatar)	
Mohsen Guizani (Qatar University, Qatar)	
Analysis of the Effect of QoS on Video Conferencing QoE	1267
N. Rao (Western University, Canada)	
A. Maleki (Western University, Canada)	
F. Chen (Western University, Canada)	
W. Chen (Western University, Canada)	
C. Zhang (Western University, Canada)	
N. Kaur (Western University, Canada)	
A. Haque (Western University, Canada)	
A Comparative Study on the Quality of Narrow-Band and Wide-Band AMR VoLTE Calls	1273
Elena Cipressi (University of Modena and Reggio Emilia, Italy)	
Maria Luisa Merani (University of Modena and Reggio Emilia, Italy)	
Evaluating QoS in SDN-Based EPC: A Comparative Analysis	1279
Y. Al Mtawa (Western University, Canada)	
A. Memari (Western University, Canada)	
A. Haque (Western University, Canada)	
H. Lutfiyya (Western University, Canada)	
Dynamic QoS-aware Queuing for Heterogeneous Traffic in Smart Home	1287
Maroua Ben Attia (Université du Québec, Canada)	
Kim-Khoa Nguyen (Université du Québec, Canada)	
Mohamed Cheriet (Université du Québec, Canada)	
Accurate Passive Indoor RFID Alignment System for Service Station	1293
Rahma Zayoud (University of Moncton, Canada)	
Habib Hamam (University of Moncton, Canada)	
Novel Hybrid Physical Layer Security Technique in RFID Systems	1299
Gehad Essam (Qatar University, Qatar)	
Heba Shehata (Qatar University, Qatar)	
Tamer Khattab (Qatar University, Qatar)	
Khalid Abualsaud (Qatar University, Qatar)	
Mohsen Guizani (Qatar University, Qatar)	

WA-6: 5G Networks (Wireless Nets Symposium)

Session Chair: Shuai Han (Harbin Institute of Technology, P.R. China)

Joint Optimization of EE and SE Considering Interference Threshold in Ultra-Dense Networks 1305

Xu Chen (Harbin Institute of Technology, P.R. China)
Xuanli Wu (Harbin Institute of Technology, P.R. China)
Shuai Han (Harbin Institute of Technology, P.R. China)
Ziyi Xie (Harbin Institute of Technology, P.R. China)

A Secure Efficient and Lightweight Authentication Protocol for 5G Cellular Networks: SEL-AKA ... 1311

Ikram Gharsallah (University of Sfax, Tunisia)
Salima Smaoui (University of Sfax, Tunisia)
Faouzi Zarai (University of Sfax, Tunisia)

A Machine Learning Approach of Load Balance Routing to Support Next-Generation

Wireless Networks 1317

Haipeng Yao (Beijing University of Posts and Telecommunications, P.R. China)
Xin Yuan (Beijing University of Posts and Telecommunications, P.R. China)
Peiyong Zhang (Beijing University of Posts and Telecommunications, P.R. China)
Jingjing Wang (Tsinghua University, P.R. China)
Chunxiao Jiang (Tsinghua University, P.R. China)
Mohsen Guizani (Qatar University, Qatar)

Enhancing Energy Efficiency by Neighbors-Aware Algorithm in Femtocell Networks 1323

Dorsaf Ghozlani (SupCom, Tunisia)
Seifeddine Bouallegue (SupCom, Tunisia)
Aymen Omri (SupCom, Tunisia)
Anthony Busson (University of Lyon, France)
Ridha Bouallegue (SupCom, Tunisia)

Average and Instantaneous Throughput Maximization for Millimeter Wave Communications 1328

Ghassan Alnwaimi (King Abdulaziz University, Saudi Arabia)
Hatem Boujemaa (SupCom, Tunisia)

Joint Power and Channel Allocation for Underlay D2D Communications with Proportional Fairness 1333

Miaomiao Liu (University of Leeds, United Kingdom)
Li Zhang (University of Leeds, United Kingdom)
You You (University of Leeds, United Kingdom)

WA-7: Vehicular Communications II (Vehicular Symposium)

Session Chair: Fumiyuki Adachi (Tohoku University, Japan)

Low-Complexity Channel Tracking in Fast-varying MIMO Environments 1339

Ruoxu Wang (Huazhong University of Science and Technology, P.R. China)
Wei Peng (Huazhong University of Science and Technology and Southeast University, P.R. China)
Tao Jiang (Huazhong University of Science and Technology, P.R. China)
Fumiyuki Adachi (Tohoku University, Japan)

Shipwrecked Victims Localization and Tracking using UAVs	1344
Imen Nasr (ESPRIT School of Engineering, Tunisia)	
Meriem Chekir (ESPRIT School of Engineering, Tunisia)	
Hichem Besbes (SupCom, Tunisia)	
Software Defined Internet of Vehicles: A Survey from QoS and Scalability Perspectives	1349
Karima Smida (SupCom, Tunisia)	
Hajer Tounsi (SupCom, Tunisia)	
Mounir Frikha (SupCom, Tunisia)	
Ye-Qiong Song (University of Lorraine, France)	
Semidefinite Relaxation of a Joint Beamforming and Power Control for Downlink V2X Communications	1355
Brahmi Ibtissem (University of Sfax and ISITCom, Tunisia)	
Monia Hamdi (University of Gabes, Tunisia and Princess Nourah bint Abdulrahman University, Saudi Arabia)	
Fadoua Mhiri (University of Sfax, Tunisia)	
Faouzi Zarai (University of Sfax, Tunisia)	
Coverage Optimization using Multiple Unmanned Aerial Vehicles with Connectivity Constraint	1361
Amani Lamine (University of Manouba, Tunisia)	
Fethi Mguis (Jouf University, Saudi Arabia)	
Hichem Snoussi (University of Technology of Troyes, France)	
Khaled Ghèdira (University of Manouba, Tunisia)	
A Reinforcement Learning-based Radio Resource Management Algorithm for D2D-based V2V Communication	1367
Souhir Feki (University of Sfax, Tunisia)	
Aymen Belghith (University of Sfax, Tunisia)	
Faouzi Zarai (University of Sfax, Tunisia)	
 WA-8: IoT II (IoT Symposium)	
Session Chair:	Chih-Wei Huang (National Central University, Taiwan)
SeMLAS: An Efficient Secure Multi-Level Authentication Scheme for IoT-Based Smart Home Systems	1373
Bacem Mbarek (Masaryk University, Czech Republic)	
Barbora Buhnova (Masaryk University, Czech Republic)	
Tomás Pitner (Masaryk University, Czech Republic)	
Optimized Flow Assignment in a Multi-Interface IoT Gateway	1379
Mohamed Ghazi Amor (University of Quebec, Canada)	
Kim Khoa Nguyen (University of Quebec, Canada)	
Chuan Pham (University of Quebec, Canada)	
Mohamed Cheriet (University of Quebec, Canada)	

Joint Security and Energy Efficiency in IoT Networks through Clustering and Bit Flipping	1385
Elias Yaacoub (American University of Beirut, Lebanon)	
Ali Chehab (American University of Beirut, Lebanon)	
Mohammed Al-Husseini (American University of Beirut, Lebanon)	
Khalid Abualsaud (Qatar University, Qatar)	
Tamer Khattab (Qatar University, Qatar)	
Mohsen Guizani (Qatar University, Qatar)	
Edge Computing-Enhanced Uplink Scheduling for Energy-Constrained Cellular Internet of Things ...	1391
Zih-Ning Lin (National Tsing Hua University, P.R. China)	
Shun-Ren Yang (National Tsing Hua University, P.R. China)	
Phone Lin (National Taiwan University, Taiwan)	
Content Delivery in Named Data Networking based Internet of Things	1397
Kaoutar Ahed (University Moulay Ismaïl, Morocco)	
Maria Benamar (University Moulay Ismaïl, Morocco)	
Rajae El Ouazzani (University Moulay Ismaïl, Morocco)	
Computer-Aided Software Engineering (CASE) Tool for Big Data and IoT Architecture	1403
M. Saifeddine Hadj Sassi (Digital Research Center of Sfax, Tunisia)	
Faiza Ghozzi Jedidi (University of Sfax, Tunisia)	
Lamia Chaari Fourati (Digital Research Center of Sfax, Tunisia)	
Performance Analysis of Relay Selection for IoT Networks over Generalized K Distribution	1411
Ali Dziri (CEDRIC-CNAM, France)	
Michel Terre (Afaisal University, Saudi Arabia)	
WA-9: RF and Antenna Design (Wireless Nets Symposium)	
Session Chair:	Shuai Han (Harbin Institute of Technology, P.R. China)
Design of Printed Log-periodic Antennas for Long Range Communication Modules: Preliminary Simulation Results	1416
Gian Luigi Gragnani (University of Genoa, Italy)	
Claudio Montecucco (Atel Antennas s.r.l, Italy)	
A Frequency-Reconfigurable Printed Antenna with Switchable Capacitively Loaded Loops	1422
Moheddine Smari (University of Carthage, Tunisia)	
Saber Dakhli (University of Carthage, Tunisia)	
Fethi Choubani (University of Carthage, Tunisia)	
The effect of High Power Amplifier Nonlinearity on MU-Massive MIMO System Performance over Rayleigh Fading Channel	1426
Maha Cherif (SupCom, Tunisia)	
Antenna Polarization Impact on Electromagnetic Power Density for an Off-Body to In-Body Communication Scenario	1430
Aymen Ben Saada (SupCom, Tunisia)	
Sofiane Ben Mbarek (SupCom, Tunisia)	
Fethi Choubani (SupCom, Tunisia)	

MoM-GEC Modeling of Frequency-Reconfigurable Antenna for Wireless Communications	1434
Heithem Helali (University of Tunis El Manar, Tunisia)	
Mourad Aidi (University of Tunis El Manar, Tunisia)	
Mohamed Hajji (University of Tunis El Manar, Tunisia)	
Ahmed Nouainia (University of Tunis El Manar, Tunisia)	
Taoufik Aguilu (University of Tunis El Manar, Tunisia)	
Design of a Switched Line Phase Shifter for Reconfigurable mm-Wave Antennas	1440
Ilhem Gharbi (University of Carthage, Tunisia)	
Rim Barrak (University of Carthage, Tunisia)	
Mohamed Latrach (ESEO Angers, France)	
Hedi Ragad (University of Tunis El Manar, Tunisia)	
Mourad Menif (University of Carthage, Tunisia)	
RADR: Routing for Autonomous Drones	1445
Nicole Chow (Western University, Canada)	
Gopi Gagan (Western University, Canada)	
Anwar Haque (Western University, Canada)	
Ranking Fog nodes for Task Scheduling in Fog-Cloud Environments: A Fuzzy Logic Approach	1451
Mohammed Anis Benblidia (University of Technology of Troyes, France)	
Bouziane Brik (University of Technology of Troyes, France)	
Leila Merghem-Boulahia (University of Technology of Troyes, France)	
Moez Esseghir (University of Technology of Troyes, France)	
WA-10: Machine Learning II (ML for NGS&N Workshop)	
Session Chair:	Mohamed Lahby (University Hassan II of Casablanca, Morocco)
Predicting Solar Irradiance using Machine Learning Techniques	1458
Abeera Javed (BUIITEMS, Pakistan)	
Bakhtiar Khan Kasi (BUIITEMS, Pakistan)	
Faisal Ahmad Khan (BUIITEMS, Pakistan)	
Enhancing Cloud of Things Performance by Avoiding Unnecessary Data through Artificial Intelligence Tools	1463
Sami Mahfoudhi (Qassim University, Saudi Arabia)	
Musheera Frehat (Qassim University, Saudi Arabia)	
Tarek Moulahi (Qassim University, Saudi Arabia)	
Pose-based Human Activity Recognition: A Review	1468
Sameh Neili Boualia (University of Sousse and University of Tunis El Manar, Morocco)	
Najoua Essoukri Ben Amara (University of Sousse, Morocco)	
Fast CNN-Based Object Tracking using Localization Layers and Deep Features Interpolation	1476
Al-Hussein A. El-Shafie (Cairo University, Egypt)	
Mohamed Zaki (Azhar University, Egypt)	
S.E.D. Habib (Cairo University, Egypt)	

Machine Learning based Prediction and Classification of Computational Jobs in Cloud Computing Centers	1482
Zheqi Zhu (Tsinghua University, P.R. China)	
Pingyi Fan (Tsinghua University, P.R. China)	
A Modified Balls-into-Bins Model for Expected Buffer Occupancy in Mobile Opportunistic Networks ...	1488
Gourish Goudar (BITS Pilani, India)	
Suvadip Batabyal (BITS Pilani, India)	
WA-11: Mobile IoT (5G IoT Symposium)	
Session Chair:	Michel Kadoch (ETS University of Quebec, Canada)
Pose Determination from Multi-View Image using Deep Learning	1494
Shantong Sun (Beihang University, P.R. China)	
Rongke Liu (Beihang University, P.R. China)	
Yu Pan (Beihang University, P.R. China)	
Qiuchen Du (Beihang University, P.R. China)	
Shuqiao Sun (Beihang University, P.R. China)	
Han Su (Beijing Institute of Astronautical Systems Engineering, P.R. China)	
UAV Detection and Identification in the Internet of Things	1499
Jingcheng Zhao (Beihang University, P.R. China)	
Xinru Fu (Beihang University, P.R. China)	
Zongkai Yang (Beihang University, P.R. China)	
Fengtong Xu (Beihang University, P.R. China)	
Research on Reliability Modeling of Image Transmission Task based on UAV Avionics System	1504
Qiang Zhou (Beihang University and BUAA, P.R. China)	
Jing Yang (Beihang University, P.R. China)	
3D Aerial Vehicle Base Station (UAV-BS) Position Planning based on Deep Q-Learning for Capacity Enhancement of Users with Different QoS Requirements	1508
Jianli Guo (The 54th Research Institute of China Electronics Technology Group Corporation, P.R. China)	
Yonghua Huo (The 54th Research Institute of China Electronics Technology Group Corporation, P.R. China)	
Xiujuan Shi (The 54th Research Institute of China Electronics Technology Group Corporation, P.R. China)	
Jiahui Wu (Beijing University of Posts and Telecommunications, P.R. China)	
Peng Yu (Beijing University of Posts and Telecommunications, P.R. China)	
Lei Feng (Beijing University of Posts and Telecommunications, P.R. China)	
Wenjing Li (Beijing University of Posts and Telecommunications, P.R. China)	
A Low-Complexity Implementation Scheme for PCM/FM Based on MLSD	1513
You Zhou (Beihang University, P.R. China)	
Ruifeng Duan (Beijing Forestry University, P.R. China)	
Bofeng Jiang (Beijing Xinwei Telecom Technology Co., Ltd., P.R. China)	
Double-layer Satellite Communication Network Routing Algorithm based on Priority and Failure Probability	1518
Yu Zhu (Beijing University of Posts and Telecommunications, P.R. China)	
Lanlan Rui (Beijing University of Posts and Telecommunications, P.R. China)	
Xuesong Qiu (Beijing University of Posts and Telecommunications, P.R. China)	
Haoqiu Huang (China Aerospace Science and Industry Corporation, P.R. China)	

An Improved Wavelet Packet Denoising Algorithm based on Sample Entropy for IoT 1524
Cheng Liu (Chongqing University of Posts and Telecommunications, P.R. China)
Hongguang Duan (Chongqing University of Posts and Telecommunications, P.R. China)
Ling Zhao (Beihang University, P.R. China)

Simulation and Analysis of Device Positioning in 5G Ultra-Dense Network 1529
Qirui Liu (University of Science and Technology Beijing, P.R. China)
Rongke Liu (Beihang University, P.R. China)
Zijie Wang (Beihang University, P.R. China)
Yifan Zhang (Beihang University, P.R. China)

Thursday, June 27th, 2019

ThM-1: Mobile Computing I (Mobile Computing Symposium)

Session Chair: Khalid Elgazzar (University of Ontario Institute of Technology, Canada)

Minimization of Offloading Delay for Two-Tier UAV with Mobile Edge Computing 1534
Jingfang Liu (Northwestern Polytechnical University, P.R. China)
Lixin Li (Northwestern Polytechnical University, P.R. China)
Fucheng Yang (Naval Aviation University, P.R. China)
Xiaomin Liu (Northwestern Polytechnical University, P.R. China)
Xu Li (Northwestern Polytechnical University, P.R. China)
Xiao Tang (Northwestern Polytechnical University, P.R. China)
Zhu Han (University of Houston, USA)

Segmented CRC-Aided Spinal Codes with a Novel Sliding Window Decoding Algorithm 1539
Hongxiu Bian (Beihang University, P.R. China)
Rongke Liu (Beihang University, P.R. China)
Aryan Kaushik (University of Edinburgh, United Kingdom)
Ruifeng Duan (Beijing Forestry University, P.R. China)

Tensor-Train based Deep Learning Approach for Compressive Sensing in Mobile Computing 1544
Cong Zou (Tsinghua University, P.R. China)
Fang Yang (Tsinghua University, P.R. China)

CE-D2D: Dual Framework Chunks Caching and Offloading in Collaborative Edge Networks with D2D Communication 1550
Emna Baccour (Qatar University, Qatar)
Aiman Erbad (Qatar University, Qatar)
Amr Mohamed (Qatar University, Qatar)
Mohsen Guizani (Qatar University, Qatar)

ThM-2: AI for IoT (AI for IoT Workshop)

Session Chair: Yousaf Bin Zikria (Yeungnam University, South Korea)

- A Scalable and Adaptive Tasks Orchestration Platform for IoT** 1557
Charafeddine Mechalikh (University of Tunis El Manar, Tunisia)
Hajer Taktak (University of Tunis El Manar, Tunisia)
Faouzi Moussa (University of Tunis El Manar, Tunisia)
- Artificial Intelligence based Camera Calibration** 1564
Syed Navid Raza (Yeungnam University, Republic of Korea)
Hafiz Raza ur Rehman (Yeungnam University, Republic of Korea)
Suk Gyu Lee (Yeungnam University, Republic of Korea)
Gyu Sang Choi (Yeungnam University, Republic of Korea)
- Towards New Clustering Algorithm based on Trust Management and Edge Computing for IoT** 1570
Nadia Kammoun (SupCom, Tunisia)
Ryma Abassi (SupCom, Tunisia)
Sihem Guemara (SupCom, Tunisia)
- CAPE: Continuous Access Policy Enforcement for IoT Deployments** 1576
Ashraf Alkhresheh (Queen's University, Canada)
Khalid Elgazzar (University of Ontario Institute of Technology, Canada)
Hossam S. Hassanein (Queen's University, Canada)
- Distributed Access Control Solution for the IoT based on Multi-endorsed Attributes and Smart Contracts** 1582
Sophie Dramé-Maigné (Gemalto SA and Télécom-SudParis, France)
Maryline Laurent (Télécom-SudParis, France)
Laurent Castillo (Gemalto SA, France)
- A Cloud and Fog based Architecture for Energy Management of Smart City by using Meta-heuristic Techniques** 1588
Ayesha Anjum Butt (COMSATS University Islamabad, Pakistan)
Sajjad Khan (COMSATS University Islamabad, Pakistan)
Tehreem Ashfaq (COMSATS University Islamabad, Pakistan)
Sakeena Javaid (COMSATS University Islamabad, Pakistan)
Norin Abdul Sattar (Poonch University, Pakistan)
Nadeem Javaid (COMSATS University Islamabad, Pakistan)
- Towards Buildings Energy Management: Using Seasonal Schedules under Time of Use Pricing Tariff via Deep Neuro-Fuzzy Optimizer** 1594
Sakeena Javaid (COMSATS University Islamabad, Pakistan)
Muhammad Abdullah (COMSATS University Islamabad, Pakistan)
Nadeem Javaid (COMSATS University Islamabad, Pakistan)
Tanzeela Sultana (COMSATS University Islamabad, Pakistan)
Jawad Ahmed (Capital University of Science and Technology, Pakistan)
Norin Abdul Sattar (The University of Poonch, Pakistan)

Forecasting Day, Week and Month ahead Electricity Load Consumption of a Building using Empirical Mode Decomposition and Extreme Learning Machine	1600
Sajjad Khan (COMSATS University Islamabad, Pakistan)	
Nadeem Javaid (COMSATS University Islamabad, Pakistan)	
Annas Chand (COMSATS University Islamabad, Pakistan)	
Raza Abid Abbasi (COMSATS University Islamabad, Pakistan)	
Abdul Basit Majeed Khan (Abasyn University, Pakistan)	
Hafiz Muhammad Faisal (COMSATS University Islamabad, Pakistan)	

ThM-3: Advances Towards 5G Communications (5G Symposium)

Session Chair: Mustapha Benjillali (INPT, Morocco)

On Optimal Power Allocation for Downlink NOMA Transmissions under PHY QoS Constraints	1606
Rajaa Elouafadi (INPT, Morocco)	
Mustapha Benjillali (INPT, Morocco)	

TCO Game in 5G Multi-Tenant Virtualized Mobile BackHaul (V-MBH) Network	1612
Nassim Haddaji (ÉTS, Canada)	
Kim-Khoa Nguyen (ÉTS, Canada)	
Mohamed Cheriet (ÉTS, Canada)	

Low-Complexity Cross-Layer Resource Allocation for Low-Latency D2D-Based Relay Networks	1619
Yahui Wang (North China Electric Power University, P.R. China)	
Chen Xu (North China Electric Power University, P.R. China)	
Yanhua He (North China Electric Power University, P.R. China)	
Zhenyu Zhou (North China Electric Power University, P.R. China)	

User Grouping based Multi-Layer Precoding for Multi-Cell 3D MIMO System with Statistical CSI	1625
Jishi Xue (Nanjing University of Posts and Telecommunications, P.R. China)	
Yan Liang (Nanjing University of Posts and Telecommunications, P.R. China)	
Ting Li (Nanjing University of Posts and Telecommunications, P.R. China)	
Wei Ji (Nanjing University of Posts and Telecommunications, P.R. China)	
Fei Li (Nanjing University of Posts and Telecommunications, P.R. China)	

5G Dynamic Borrowing Scheduler for IoT Communications	1630
Ahlem Saddoud (University of Sfax, Tunisia)	
Wael Doghri (University of Sfax, Tunisia)	
Emna Charfi (University of Sfax, Tunisia)	
Lamia Chaari Fourati (University of Sfax, Tunisia)	

Social Weak-Tie Assisted Cross-domain Short Video Recommendation	1636
Xichen Wang (Tsinghua University, P.R. China)	
Chen Gao (Tsinghua University, P.R. China)	
Jingtao Ding (Tsinghua University, P.R. China)	
Long Hu (Huazhong University of Science and Technology, P.R. China)	
Ying Hu (Hubei University of Education, P.R. China)	
Yong Li (Tsinghua University, P.R. China)	
Depeng Jin (Tsinghua University, P.R. China)	

Deep Convolutional Neural Network with Multi-Task Learning Scheme for Modulations Recognition ... 1644

Omar S. Mossad (Alexandria University, Egypt)
Mustafa ElNainay (Alexandria University, Egypt)
Marwan Torki (Alexandria University, Egypt)

ThM-4: Heterogeneous Network Mechanisms (WSNs Symposium)

Session Chair: Haidar Safa (AUB, Lebanon)

Enhancing Energy Efficiency in Wireless Heterogeneous Networks using Coordinated Multipoint and eNB Parameters Tuning 1650

Narjes Lassoued (University of Carthage, Tunisia)
Noureddine Boujnah (Waterford Institute of Technology, Ireland)
Ridha Bouallegue (University of Carthage, Tunisia)

Improving Channel Utilization of LoRaWAN by using Novel Channel Access Mechanism 1656

Shahzeb Ahsan (National University of Sciences and Technology, Pakistan)
Syed Ali Hassan (National University of Sciences and Technology, Pakistan)
Ahsan Adeel (DeepCI, United Kingdom)
Hassaan Khaliq Qureshi (National University of Sciences and Technology, Pakistan)

Performance Analysis on Fractal Small Cell Networks with MIMO Antennas 1662

Xiaotong Tian (Huazhong University of Science and Technology, P.R. China)
Jiaqi Chen (Huazhong University of Science and Technology, P.R. China)
Xiaohu Ge (Huazhong University of Science and Technology, P.R. China)
Qiang Li (Huazhong University of Science and Technology, P.R. China)
Yonghui Li (University of Sydney, Australia)

Efficient Pilot Design based on the Divide and Conquer Approach for Pilot Contamination Mitigation in Massive MIMO 1668

Maroua Boudaya (University of Sfax, Tunisia)
Inès Kammoun (University of Sfax, Tunisia)
Mohamed Siala (SupCom, Tunisia)

Centralized Cognitive Radio based Frequency Allocation for UAVs Communication 1674

Amira Chriki (University of Manouba, Tunisia)
Haifa Touati (University of Gabes, Tunisia)
Hichem Snoussi (University of Technology of Troyes, France)
Farouk Kamoun (University of Manouba, Tunisia)

Channel Estimation for TDD Uplink Massive MIMO Systems via Compressed Sensing 1680

Noura Derria Lahbib (SupCom, Tunisia)
Maha Cherif (SupCom, Tunisia)
Moez Hizem (SupCom, Tunisia)
Ridha Bouallegue (SupCom, Tunisia)

An Optimized Spatially Cooperative Caching Strategy for Heterogeneous Caching Network 1685

Shubin Zhang (Xidian University, P.R. China)
Wen Sun (Xidian University, P.R. China)
Jiajia Liu (Xidian University, P.R. China)

Spectrum Occupancy for 802.11a/n/ac Homogeneous and Heterogeneous Networks 1690

Nika Mostahinic (University of Oklahoma, USA)
Hazem Refai (University of Oklahoma, USA)

ThM-5: Intelligent Algorithms for IoT (5G IoT Symposium)

Session Chair: Shuangli Wu (Chinese Academy of Sciences, P.R. China)

Hopfield Neural Network-based Fault Location in Wireless and Optical Networks for Smart City IoT 1696

Bohui Wang (Beijing University of Posts and Telecommunications, P.R. China)
Hui Yang (Beijing University of Posts and Telecommunications, P.R. China)
Qiuyan Yao (Beijing University of Posts and Telecommunications, P.R. China)
Ao Yu (Beijing University of Posts and Telecommunications, P.R. China)
Tao Hong (Beihang University, P.R. China)
Jie Zhang (Beijing University of Posts and Telecommunications, P.R. China)
Michel Kadoch (Université du Québec, Canada)
Mohamed Cheriet (Université du Québec, Canada)

Data Mining and Statistical Analysis on Smart City Services based on 5G Network 1702

Yu Lei (Inner Mongolia University, P.R. China)
Lv Qiang (Inner Mongolia University, P.R. China)
Zhang Yonghao (Inner Mongolia University, P.R. China)
Li Hao (Beijing University of Posts and Telecommunications, P.R. China)
Yu Peng (Beijing University of Posts and Telecommunications, P.R. China)
Feng Lei (Beijing University of Posts and Telecommunications, P.R. China)
Li Wenjing (Beijing University of Posts and Telecommunications, P.R. China)
Qiu Xuesong (Beijing University of Posts and Telecommunications, P.R. China)

Location Prediction based on Comment Analysis 1708

Chang Su (Chongqing University of Posts and Telecommunications, P.R. China)
Pengfei Wu (Chongqing University of Posts and Telecommunications, P.R. China)
XianZhong Xie (Chongqing University of Posts and Telecommunications, P.R. China)

A Novel Multipath Mitigation Method for 5G Positioning 1714

Zijie Wang (Beihang University, P.R. China)
Rongke Liu (Beihang University, P.R. China)
Yifan Zhang (Beihang University, P.R. China)
Qirui Liu (University of Science and Technology Beijing, P.R. China)

An Access Point Load-balancing Algorithm based on Service Attribute in Wireless Network 1719

Kunhong Li (Yuxi Power Supply Bureau, P.R. China)
Shanke Huang (Yuxi Power Supply Bureau, P.R. China)
Teng Zhang (Yuxi Power Supply Bureau, P.R. China)

A Scheme of Seamless Handover in Wireless Communications based on Sentinel Mechanism 1725

Yanzhi Sun (Yunnan Electric Power Dispatching Control Center, P.R. China)
Yuming Liu (Yunnan Electric Power Dispatching Control Center, P.R. China)
Liqiong Jiang (Yunnan Electric Power Dispatching Control Center, P.R. China)

A Time-compensation TDOA-based Wireless Positioning Method for Multi-level IoT Positioning 1731
Junhua Chen (Chongqing University of Posts and Telecommunications, P.R. China)
Tongtong Shi (Chongqing University of Posts and Telecommunications, P.R. China)
Yanfei Liu (Chongqing University of Technology, P.R. China)
Shuangli Wu (University of Chinese Academy of Sciences, P.R. China)

ThA-1: Big Data (Big Data Symposium)

Session Chair: Halima Elbiaze (UQAM, Canada)

A Vibrating Mechanism to Prevent Neural Networks from Overfitting 1737

Jian Xiong (Tsinghua University, P.R. China)

Kai Zhang (Tsinghua University, P.R. China)

Hao Zhang (Tsinghua University, P.R. China)

An ANTLR-based Feature Extraction and Detection System for Scratch 1743

Pai Liu (Beijing University of Posts and Telecommunications, P.R. China)

Yan Sun (Beijing University of Posts and Telecommunications, P.R. China)

Hong Luo (Beijing University of Posts and Telecommunications, P.R. China)

Business Information Architecture for Big Data and Internet of Things 1749

M. Saifeddine Hadj Sassi (Digital Research Center of Sfax, Tunisia)

Lamia Chaari Fourati (Digital Research Center of Sfax, Tunisia)

Faiza Ghozzi Jedidi (University of Sfax, Tunisia)

Embedding Multiple-Step-Ahead Traffic Prediction in Network Energy Efficiency Problem 1757

Abdolkhalegh Bayati (University of Quebec, Canada)

Kim-Khoa Nguyen (University of Quebec, Canada)

Mohamed Cheriet (University of Quebec, Canada)

High Data Rate Multiband GFDM Over Long-haul Standard Single Mode Fiber Communication 1764

Khalil Issaoui (Tunisia Polytechnic School, Tunisia)

Sofien Mhatli (Tunisia Polytechnic School, Tunisia)

Rabah Attia (Tunisia Polytechnic School, Tunisia)

ThA-2: Routing Protocols & WSN-based Monitoring Systems (WSNs Symposium)

Session Chair: Attahiru Alfa (University of Manitoba, Canada)

Flow-Based Multiple Spectrum Access in Cognitive Wireless Sensor Networks 1767

Haitham Abu Ghazaleh (Tarleton State University, USA)

Attahiru Sule Alfa (University of Pretoria, South Africa and University of Manitoba, Canada)

MOO-SNLP: Multi Objectives Optimization for Sensor Network Localization Problem 1773

Badia Bouhdid (University of Manouba, Tunisia)

Wafa Akkari (University of Manouba, Tunisia)

Abdelfettah Belghith (King Saud University, Saudi Arabia)

Routing of Spatial Queries over IOT Enabled Wireless Sensor Networks 1779
Karim Fathallah (University of Tunis El Manar, Tunisia)
Mohamed Amine Abid (University of Passau, Germany)
Najib Ben Hadj-Alouane (University of Tunis El Manar, Tunisia)

Cooperative Sensing and Analysis for a Smart Pothole Detection 1785
Van Khang Nguyen (Télécom SudParis, France and Hue University, Vietnam)
Éric Renault (Télécom SudParis, France)

DEEP: Design and Evaluation of an Energy-efficient Wireless Sensor Node for Leak Detection in Water Pipes 1791
Fatma Karray (National Engineering School of Sfax, Tunisia)
Mariam Triki (National Engineering School of Sfax, Tunisia)
Mohamed Abid (CES-ENIS, Tunisia)

Exploiting Energy Efficient Routing Protocols for Void Hole Alleviation in IoT enabled Underwater WSN 1797
Muhammad Awais (COMSATS University Islamabad, Pakistan)
Nadeem Javaid (COMSATS University Islamabad, Pakistan)
Nidal Nasser (Alfaisal University, Saudi Arabia)
Muhammad Imran (King Saud University, Saudi Arabia)

ThA-3: Smart Systems (Smart Cities & Connected communities Symposium)
Session Chair: Ala Alfuqaha, (Hamad Bin Khalifa University, Qatar)

Autonomous Living Building: Adapting to Occupant's Behavior 1803
Driss Benhaddou (University of Houston, USA)
Lotanna Afugbuom (University of Houston, USA)
Farouk Attia (University of Houston, USA)
Muhammad Anan (Alfaisal University, Saudi Arabia)

Towards a New Graph-based Occupant Behavior Modeling in Smart Building 1809
Nour Haidar (University of La Rochelle, France)
Nouredine Tamani (University of La Rochelle, France)
Yacine Ghamri-Doudane (University of La Rochelle, France)
Alain Bouju (University of La Rochelle, France)

A Fog Computing Architecture for Energy Demand Scheduling in Smart Grid 1815
Samira Chouikhi (University of Technology of Troyes, France)
Leila Merghem-Boulaïhia (University of Technology of Troyes, France)
Moez Esseghir (University of Technology of Troyes, France)

An Attention-Mechanism-Based Traffic Flow Prediction Scheme for Smart City 1822
Xiao Hu (Nanjing University of Posts and Telecommunications, P.R. China)
Xin Wei (Nanjing University of Posts and Telecommunications and NUPT, P.R. China)
Yun Gao (Nanjing University of Posts and Telecommunications, P.R. China)
Wenqin Zhuang (Nanjing University of Posts and Telecommunications and NUPT, P.R. China)
Mingzi Chen (Nanjing University of Posts and Telecommunications, P.R. China)
Haibing Lv (ZTE Corporation, P.R. China)

An Ad Hoc Communication System for an Efficient Milk Collection within White Areas 1828
Madoune R. Seye (Université Cheikh Anta Diop, Senegal and Sorbonne Université, France)
Moussa Diallo (Université Cheikh Anta Diop, Senegal)
Bamba Gueye (Université Cheikh Anta Diop, Senegal)
Christophe Cambier (Sorbonne Université, France)

ThA-4: System Security (Security Symposium)

Session Chair: Aiman Erbad (Qatar University, Qatar)

A Rapid Detection Method for Hidden Danger Points of Urban Gas Pipelines based on the Identification Area 1833

Zhongyu Xie (Beijing University of Posts and Telecommunications, P.R. China)
Zhili Wang (Beijing University of Posts and Telecommunications, P.R. China)
Siya Xu (Beijing University of Posts and Telecommunications, P.R. China)

Forward-Secure Data Outsourcing based on Revocable Attribute-Based Encryption 1839

Van-Hoan Hoang (OODRIVE-Trusted Cloud Solutions and University of La Rochelle, France)
Elyes Lehtihet (OODRIVE-Trusted Cloud Solutions, France)
Yacine Ghamri-Doudane (University of La Rochelle, France)

Solving Security Problems in MEC Systems 1847

Xiao Zheng (Dalian University of Technology, P.R. China)
Mingchu Li (Dalian University of Technology, P.R. China)
Yuanfang Chen (Hangzhou Dianzi University, P.R. China)
Mohsen Guizani (Qatar University, Qatar)
Jia Liu (Dalian University of Technology, P.R. China)
Muhammad Tahir (Dalian University of Technology, P.R. China)

Enhancing Firewall Filter Performance using Neural Networks 1853

Heba Saleous (UAE University, UAE)
Zouheir Trabelsi (UAE University, UAE)

Revocable Sliced CipherText Policy Attribute based Encryption Scheme in Cloud Computing 1860

Mariem Bouchaala (University of Manouba, Tunisia)
Cherif Ghazel (University of Manouba, Tunisia)
Leila Azzouz Saidane (University of Manouba, Tunisia)

Enforcing a Risk Assessment Approach in Access Control Policies Management: Analysis, Correlation Study and Model Enhancement 1866

Pierrette Annie Evina (SupCom, Tunisia)
Faten Labbene Ayachi (SupCom, Tunisia)
Faouzi Jaidi (SupCom and ESPRIT School of Engineering, Tunisia)
Adel Bouhoula (SupCom, Tunisia)

XBAC: A Unified Access Control Model for Heterogeneous Multi-Tenancy Cloud Environments 1872

Meryeme Ayache (Mohammed V University in Rabat, Morocco)
Amjad Gawanmeh (Khalifa University, UAE)
Jamal N. Al-Karaki (Abu Dhabi Polytechnic, UAE)

ThA-5: PHY layer for IoT (5G IoT Symposium)

Session Chair: Tao Hong (Beihang University, P.R. China)

Deep Learning-Aided Constellation Design for Downlink NOMA 1879

Lu Jiang (Beijing Institute of Technology and CETC, P.R. China)

Xiangming Li (Beijing Institute of Technology, P.R. China)

Neng Ye (Beijing Institute of Technology, P.R. China)

Aihua Wang (Beijing Institute of Technology, P.R. China)

Raptor Code based on Punctured LDPC for Secrecy in Massive MiMo 1884

Djedjiga Benzyd (University of Quebec, Canada)

Michel Kadoch (University of Quebec, Canada)

Mohamed Cheriet (University of Quebec, Canada)

Scheme for High-rate LDPC Codes based on Dual-Diagonal Matrix with Girth-6 1890

Yue Hu (Beihang University, P.R. China)

Ling Zhao (Beihang University, P.R. China)

Ji Li (Beihang University, P.R. China)

LSTM based Multiple Beamforming for 5G HAPS IoT Networks 1895

Ke Xiao (North China University of Technology, P.R. China)

Chaoferi Li (North China University of Technology, P.R. China)

Jianyu Zhao (North China University of Technology, P.R. China)

Compressed Sensing based Traffic Prediction for 5G HetNet IoT Video Streaming 1901

Shuangli Wu (University of Chinese Academy of Sciences, P.R. China)

Wei Mao (Internet Domain Name System Beijing Engineering Research Center, P.R. China)

Tao Hong (Beihang University, P.R. China)

Cong Liu (Beihang University, P.R. China)

Michel Kadoch (Université du Québec, Canada)

Design of 5G Dual-Antenna Passive Repeater based on Machine Learning 1907

Tao Tang (Beihang University, P.R. China)

Tao Hong (Beihang University, P.R. China)

Cong Liu (Beihang University, P.R. China)

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Wireless Neural Network: Enabling Neural Computing over Wireless Sensor Network based on Superposition Transmissions 1913

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ThA-6: Energy Efficient Networking for IoT

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Sohail Jabbar (National Textile University, Pakistan)
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- A Robust Digital Watermarking Algorithm for Text Document Copyright Protection based on Feature Coding** 1940
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Ki Jun Han (Kyungpook National University, Republic of Korea)
Jihun Han (Kyungpook National University, Republic of Korea)
Sohail Jabbar (National Textile University, Pakistan)
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ThA-7: Theory & Applications (SeNTApE Workshop)

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Short-range and Long-range Cooperative Communication for Littoral Environment Monitoring 1958

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M. Menard (Université de la Rochelle, France)

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A Comprehensive Survey on Broadcasting Emergency Messages 1983

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Network Packetization in Multi-Path Environments & Next-Gen Networks 1994

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Convolutional Neural Networks for Blind Decoding in Sparse Code Multiple Access	2007
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A Novel Detection and Decoding Receiver for Polar-Coded SCMA System	2013
Imen Abidi (SupCom, Tunisia)	
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A Novel Approach for Performance-based Clustering and Management of Network Traffic Flows	2025
Muna Al-Saadi (University of Plymouth, United Kingdom)	
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Stavros Shiaeles (University of Plymouth, United Kingdom)	
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ThA-9: Enabling Techniques for 5G Communications (5G Symposium)	
Session Chair:	Hamid Sharif (University of Nebraska-Lincoln, USA)
Classification Algorithms for Semi-Blind Uplink/Downlink Decoupling in Sub-6 GHz/mmWave 5G Networks	2031
Hatim Chergui (CTTC, Spain)	
Kamel Tourki (Huawei Technologies Co., France)	
Redouane Lguensat (Université Grenoble Alpes, France)	
Mustapha Benjillali (INPT, Morocco)	
Christos Verikoukis (CTTC, Spain)	
Mérrouane Debbah (Huawei Technologies Co., France)	
A Novel Biomimicry-based Analysis of D2D User Association Retention for Achieving Maximal Throughput	2036
Subharthi Banerjee (University of Nebraska-Lincoln, USA)	
Michael Hempel (University of Nebraska-Lincoln, USA)	
Pejman Ghasemzadeh (University of Nebraska-Lincoln, USA)	
Hamid Sharif (University of Nebraska-Lincoln, USA)	

Distributed Resource Allocation using Iterative Combinatorial Auction for Device-to-Device Underlay Cellular Networks	2043
Mohamed Mahfoudhi (University of Gabes, Tunisia)	
Monia Hamdi (Princess Nourah bint Abdulrahman University, Saudi Arabia)	
Mourad Zaied (University of Gabes, Tunisia)	
Beam Alignment Game for Self-Organized MmWave-Empowered 5G Initial Acces	2050
Wissal Attaoui (Hassan II University of Casablanca, Morocco)	
Khadija Bouraqla (Hassan II University of Casablanca, Morocco)	
Essaid Sabir (Hassan II University of Casablanca, Morocco)	
Mustapha Benjillali (INPT, Morocco)	
Rachid El-Azouzi (University of Avignon, France)	
Optimal TAS for Cross-Interference Mitigation in Cognitive MIMO MRC Systems	2058
Zakaria El-Moutaouakkil (IMT Atlantique Bretagne-Pays de la Loire, France)	
Kamel Tourki (Huawei Technologies Co., France)	
Samir Saoudi (IMT Atlantique Bretagne-Pays de la Loire, France)	
Halim Yanikomeroglu (Carleton University, Canada)	
UAV-GCS Centralized Data-Oriented Communication Architecture for Crowd Surveillance Applications	2064
Amira Chriki (University of Manouba, Tunisia)	
Haifa Touati (University of Gabes, Tunisia)	
Hichem Snoussi (University of Technology of Troyes, France)	
Farouk Kamoun (University of Manouba, Tunisia)	
A Multidimensional Reputation Evaluation Model for Mobile Crowd Sensing	2070
Deyu Lin (Xidian University, P.R. China)	
Quan Wang (Xidian University, P.R. China)	
Pengfei Yang (Xidian University, P.R. China)	
Zhiqiang Zhang (University of Leeds, United Kingdom)	
ThA-10: Emerging Technologies for WSNs (WSNs Symposium)	
Session Chair:	Sghaier Guizani (Alfaisal University, Saudi Arabia)
Real-time Spectrum Sensing of Multiple OFDM Signals using Low Cost SDR based Prototype for Cognitive Radio	2074
F.Z. El Bahi (Université Sidi Mohamed Ben Abdellah, Morocco)	
H. Ghennioui (Université Sidi Mohamed Ben Abdellah, Morocco)	
M. Zouak (Université Sidi Mohamed Ben Abdellah, Morocco)	
Energy Management for Electric Vehicles in Smart Cities: A Deep Learning Approach	2080
Mohammed Laroui (Djillali Liabes University, Algeria and Université de Paris and Télécom SudParis, France)	
Aicha Dridi (Télécom SudParis, France)	
Hossam Afifi (Télécom SudParis, France)	
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Michel Marot (Télécom SudParis, France)	
Moussa Ali Cherif (Djillali Liabes University, Algeria)	

A Blockchain based Access Control for IoT	2086
Imen Riabi (University of Manouba, Tunisia)	
Yosr Dhif (University of Tunis El Manar, Tunisia)	
Hella Kaffel Ben Ayed (University of Tunis El Manar, Tunisia)	
Khaled Zaatouri (University of Tunis El Manar, Tunisia)	
A New Optimal Deployment Model of Internet of Things based on Wireless Sensor Networks	2092
Faten Hajje (University of Gabes, Tunisia)	
Monia Hamdi (University of Gabes, Tunisia and Princess Nourah bint Abdulrahman University, Saudi Arabia)	
Ridha Ejbali (University of Gabes, Tunisia)	
Mourad Zaied (University of Gabes, Tunisia)	
Self-Adaptive Management of SDN Distributed Controllers for Highly Dynamic IoT Networks	2098
Intidhar Bedhief (University of Tunis El Manar, Tunisia)	
Meriem Kassar (University of Tunis El Manar, Tunisia)	
Taoufik Aguil (University of Tunis El Manar, Tunisia)	
Luca Foschini (University of Bologna, Italy)	
Paolo Bellavista (University of Bologna, Italy)	
Electromagnetic Modeling of Rectenna for Wireless Sensor Network	2105
Soulayma Smirani (University of Tunis El Manar, Tunisia)	
Mourad Aidi (University of Tunis El Manar, Tunisia)	
Taoufik Aguil (University of Tunis El Manar, Tunisia)	
An Intelligent Deterministic D2D Communication in Narrow-band Internet of Things	2111
Ali Nauman (Yeungnam University, Republic of Korea)	
Muhammad Ali Jamshed (University of Surrey, United Kingdom)	
Yazdan Ahmad (Yeungnam University, Republic of Korea)	
Rashid Ali (Yeungnam University, Republic of Korea)	
Yousaf Bin Zikria (Yeungnam University, Republic of Korea)	
Sung Won Kim (Yeungnam University, Republic of Korea)	
An IoT and Blockchain-Based Multi-Sensory In-Home Quality of Life Framework for Cancer Patients	2116
Md. Abdur Rahman (University of Prince Mugrin, Saudi Arabia)	
Mamunur Rashid (King's College London, United Kingdom)	
Stuart Barnes (King's College London, United Kingdom)	
M. Shamim Hossain (King Saud University, Saudi Arabia)	
Elham Hassanain (Umm Al-Qura University, Saudi Arabia)	
Mohsen Guizani (University of Idaho, USA)	

An Intelligent Deterministic D2D Communication in Narrow-band Internet of Things

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Abstract—To enable the internet of things (IoT) devices with increased coverage and optimized power consumption, the 3rd generation partnership (3GPP) standardizes the idea of narrow-band IoT (NB-IoT) technology in the fifth generation (5G) of cellular communication. Re-transmission of control and data packets due to a poor link between user equipment (UE) and the base station (BS), is considered as one of the key feature in NB-IoT to ensure the data delivery of delay-sensitive applications, e.g. ambulance services and body sensor networks (BSN). This phenomenon degrades the energy efficiency of the already resource constrained systems. One key solution for NB-IoT UE is to exploit the device-to-device (D2D) communication using two hops instead of transmitting on a direct uplink, due to which the system performance increases. In an attempt to transmit the NB-IoT UE uplink data packet, splendid researchers have focused towards developing a D2D communication based strategy, which typically optimizes the expected packet delivery ratio (EDR) and end-to-end delay (EED) through an opportunistic method. However, such methodology imposes an additional delay due to the unavailability of active relaying nodes and increases the overall energy consumption of the system. This necessitates us to design an intelligent deterministic D2D (2D2D) relay selection strategy for delay sensitive NB-IoT UEs. The EDR and EED have been improved using deterministic programming based algorithm. Simulations with various parameters are carried out, and results are presented. Simulation results show that the deterministic algorithm gives better performance with a 10% increase in EDR and overcomes the additional delay.

Index Terms—Device-to-device (D2D) communication, deterministic D2D (2D2D) communication, end to end delay (EED), expected delivery ratio (EDR), heterogeneous network (HetNet), narrow-band Internet of Things (NB-IoT).

I. INTRODUCTION

INTERNET of things (IoT) is the interconnection of smart objects which are uniquely addressed, self-configurable, and interoperable with the capability to sense and process data [1]. IoT has paved the way for future wireless communication and the smart world. Currently, 23 billion devices are connected to the internet [2], these numbers will stretch to 30 billion by 2020 [3]. The tremendous growth of connected devices and audio-video data requirement shifted the equilibrium towards multimedia data from best effort data. The extraordinary flourishing of IoT raises huge demands for machine type communication (MTC). MTC is further categorized into short-range MTC (range $\leq 10\text{m}$), medium range MTC ($10\text{m} < \text{range} < 100\text{m}$), and long-range MTC (range

$\geq 100\text{m}$). Traditionally IoT devices are resource constrained concerning processing power, memory and energy resources. Long range MTC over such resource constrained devices enhances the need for standardizing low power wide area (LPWA) technology.

Narrowband-Internet of Things (NB-IoT) released by 3rd generation partnership (3GPP) was designed for improved spectrum efficiency, extended and in-depth coverage [4]. NB-IoT is one of the LPWA technologies intended to have a transmission range of more than 3 km in urban and 15 km in open area with strong penetration capabilities for MTC [4]. Its prime objective is to target the devices that are expected to operate for ten years or more [5]. NB-IoT is a novel narrowband radio technology that can be directly deployed in Global System for Mobile Communications (GSM) or Long-Term Evolution (LTE) networks to reuse same hardware and also share spectrum to reduce deployment cost. NB-IoT requires 180 Kilohertz (kHz) of system bandwidth for uplink and downlink within LTE spectrum, thus promoting the limitations of system resources [6]. Efficient use of these scarce resources enhances the challenges for IoT deployment.

IoT devices are mostly concerned with uploading the acquired data towards sink node/gateway or cloud server. Majority of IoT based research presents efficient uplink data transmission. To enhance the coverage, data transmission repetition is adopted by NB-IoT. But increasing data reliability with repetitions will cause spectral efficiency loss [7]. Also, some MTC devices are utilized in deep indoor applications, an additional penetration loss up to 20 dB can be anticipated. To maintain uplink coverage, both narrow-band transmission repetition and massive transmission time interval (TTI) bundling lead to vast consumption of time and energy resources [8]. Therefore, it is vital to have a mechanism that is more energy and resource efficient for wide deployment applications.

D2D communication provides an efficient mechanism to transmit the NB-IoT UE acquired data to the BS using near-by cellular devices, which act as relaying nodes to support D2D communication in duty cycles. Researchers are anticipating sparkles between NB-IoT and D2D communication as NB-IoT is integrated into LTE standard. Some innovative work has been presented in [9], in this article a trust-based approach for effectual D2D improved compliant content uploading in NB-IoT network is proposed. Petrov et al. [10] proposed

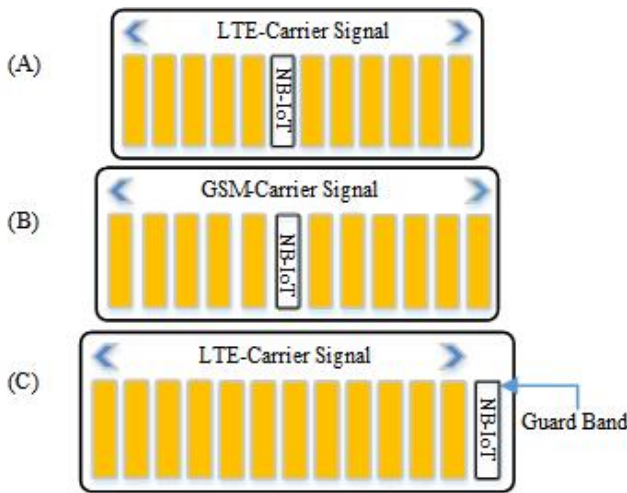


Fig. 1. NB-IoT Deployment Modes.

opportunistic crowd-sensing application over NB-IoT with the help of vehicle-based relaying system. Osama et al. in [11] investigates the impact of mutual interference in D2D NB-IoT UE and cellular UE transmitting in the same resource block to increase the spectral efficiency of the system. Dynamic programming based opportunistic relay selection D2D communication model has been presented in [12], which exploits the D2D communication to select the UE from the UE relaying group to upload the priority data to BS. Authors formulate two optimization problems to maximize the expected delivery ratio (EDR) and minimize end to end (two hop) delay (EED). This scheme shows an EDR of approximately 88% while using a power level of 1 dBm, and this can be increased while increasing the transmission power of NB-IoT UE.

In the above-mentioned work [12], a UE is only able to transmit on the active relaying node in the duty cycle if it gets the opportunity. If the transmission fails, UE re-transmits on next scheduled relay node from relaying group or the packet drops after a certain threshold time interval. In a practical approach, to transmit on opportunity basis and re-transmit on failure eventually results in significant consumption of energy resources and induces huge delay. Since for delay-sensitive applications such as monitoring the vital sign of a heart in smart hospitals, nuclear reactor surveillance in smart industry, regulating heavy traffic in smart city etc., this amount of packet drop and delay is not tolerable. To the best of our knowledge, none of the above-mentioned work considered the deterministic selection of the relay node. To deal with this issue, a deterministic D2D relay selection approach for NB-IoT UE, exploiting D2D communication as uplinks routing extension for NB-IoT has been presented in this article. We name this approach as Deterministic Device-to-device (2D2D) communication. The proposed mechanism augments the energy efficiency by increasing data delivery ratio and minimize end-to-end delay.

The rest of the paper is organized as follows: Section II presents background on NB-IoT technology and D2D

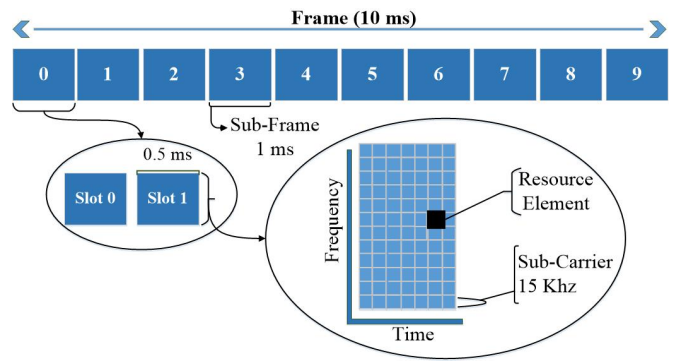


Fig. 2. NB-IoT Frame Structure.

communication. Section III highlights the system model and the proposed scheme. Performance evaluation in comparison with baseline algorithm is presented in Section IV. Section V concludes the overall article. Moreover, a list of symbols used throughout the paper is listed in Table I.

II. BACKGROUND

A. Overview of Narrowband-Internet of Things

1) *NB-IoT Deployment*: NB-IoT requires a minimum of 180 kHz bandwidth in both uplink and downlink transmission. NB-IoT uses one LTE Physical Resource Block (PRB) in the frequency domain which splits into 12 subcarriers of 15 kHz each. NB-IoT supports three different modes of operations which can be directly deployed in the GSM or LTE spectrum to reduce deployment costs. The deployment mode should be translucent to the UE when it is powered on and searches for NB-IoT carrier [13]. Fig. 1 shows the three deployment modes of NB-IoT.

- **In-Band Mode**: NB-IoT is deployed within LTE carrier that is, one or more PRB are reserved for NB-IoT. The total evolved-NodeB (eNB) power is shared between LTE and NB-IoT.
- **Stand-Alone Mode**: NB-IoT is deployed within 180 kHz of GSM spectrum. In this mode, NB-IoT can utilize the BS transmit power which will considerably improve the coverage.
- **Guard-Band Mode**: In this mode, NB-IoT is deployed within the resource block of LTE guard-band.

2) *Uplink and Downlink Transmission*: NB-IoT uses the same frame structure and numerology of LTE to assist in interoperability with LTE. Downlink uses the same 10 ms long frames of LTE which are composed of 10 sub-frames of 1 ms each. Sub-frames are further divided into two slots of 0.5 ms each. Each slot carries seven orthogonal frequency division multiplexed (OFDM) symbols and a normal cyclic prefix (CP). Fig. 2 exhibits the NB-IoT frame structure. Uplink supports single tone and multi-toned transmissions whereas, the single tone further supports two numerologies, i.e., 3.75 and 15 kHz, the former numerology uses 2 ms slots, and the latter is identical to LTE. Multi-tone transmission is single

TABLE I
SYMBOL USED THROUGHOUT THE PAPER

Symbol	Meaning
δ	Packet uploading duration
β	SNR threshold
α	Gain threshold
g_n	Gain of user n
R_{req}	Residual energy threshold
P_n	Received power of user n
Rs_n	Residual energy of user n

carrier frequency division multiple access (SC-FDMA) based with same 15 kHz subcarrier spacing. Quadrature phase shift keying (QPSK) or binary phase shift keying (BPSK) is used for uplinks, while only QPSK is allowed for downlinks [14]. Typically NB-IoT supports 160-200 kbps of the data rate for uplink transmissions and 160-250 kbps of data rate for downlinks [4].

B. Device-to-device Communication

Device-to-device (D2D) communication provides a promising solution in the next-generation cellular network, the 5G. D2D is a proximity-based service (ProSe) which refers to the direct communication between nearby devices without taking network infrastructure into account [15]. D2D was introduced in 2012 after the introduction of LTE release 12 [16]. D2D communication has been standardized in 3GPP to discover and communicate between two devices. The ability of LTE radio interface enables a D2D device to find nearby devices and transmits data towards base-station (BS) using nearby device resources assigned by BS as a relay when the direct link to the BS is not possible. This will lead towards better utilization of spectrum re-usability, and successful data transmission can be achieved with lower transmission power.

III. SYSTEM MODEL AND PROPOSED SCHEME

A. System Model

To keep our system model more straightforward, we have considered a two-tier HetNet, having a macro-cell base station (MBS) surrounded by some UEs, respectively. In the experimental setup, we have randomly generated R UEs and have uniformly deployed them. The MBS is placed in such a way that it is located in the centre of the cell, surrounded by the UEs as shown in Fig. 3. A Rayleigh fading channel has been considered between each transmitter and receiver pair. For Rayleigh fading, the channel gain between each pair is exponentially distributed, i.e. $g = \exp(\gamma)$. Furthermore, the power received at a distance d from the transmitting device can be calculated as:

$$P_r = P_t \cdot g^{-\mu}, \quad (1)$$

where μ is the path loss exponent and P_t is the transmit power. For this setup, we have focused on the uplink transmission of NB-IoT UE, and assume that each NB-IoT UE has to upload

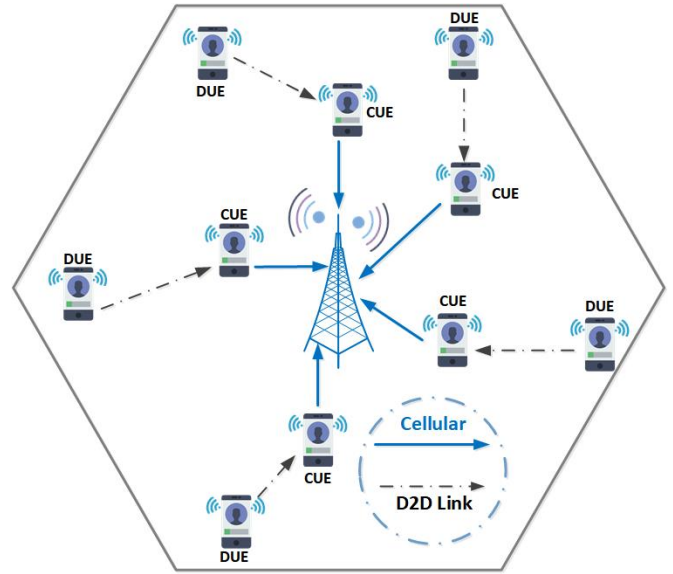


Fig. 3. System model.

the packet at a given time slot t . For the simulation purpose, we have considered minimum one NB-IoT UE is having a poor link with the MBS. A list of UEs is selected using our deterministic approach, explained in the later subsection, to relay a packet of NB-IoT UEs. Moreover, we have assumed that NB-IoT UEs can upload their packets in two hops, i.e. the first hop is between the NB-IoT UE and the relaying UE whereas, the second hop is between relaying UE and the MBS. A unique subcarrier is allocated to each UE to avoid the cross-tier interference. The selection of UEs for relaying the information of NB-IoT UEs strictly depends upon the channel condition and the transmit power. For comparative analysis, we have considered two parameters, i.e. end-to-end delay (EED) and expected packet delivery ratio (EDR) of the total packets transmitted by the NB-IoT UEs, and correlated our proposed technique with a state-of-art technique available in the literature. The EED is being calculated in hops, with packet covering one hop is taken as 1 unit of delay, and every missed opportunity is added as 0.35 units of additional delay, i.e. τ . For, packet delivery ratio (PDR) every successful packet delivered at the MBS is taken as 1 unit. Overall the average percentage is calculated over a T time duration.

B. Proposed Scheme

An intelligent deterministic approach 2D2D is presented to minimize the delay of NB-IoT UE traffic and to increase their packet delivery ratio. Using our proposed scheme, the MBS selects a group of UEs, by analysing their channel gain and the residual energy available to facilitate D2D communication. Based on these parameters the MBS evaluates the pilot signal of each UE and compares them with the set threshold parameters, i.e. β , α and R_{req} respectively (see Table I). After the evaluation, the MBS intelligently assigns a rank to each user,

Algorithm 1 Deterministic device to device communication (2D2D)

```

1: INPUT  $(\beta, g_n, \alpha, N, P_n, R_{s_n})$ 
2: Step 1: Selection of D2D UEs
3: for  $a = 1, \dots, N$  do
4:   if  $P_n(a) > \beta$  then
5:     if  $g_n(a) > \alpha$  &&  $R_{s_n}(a) > R_{req}$  then
6:       Push  $N(a)$  UE in a new array  $Y[a]$ 
7:       Push  $g_n(a)$  in a new array  $X[a]$ 
8:       Push  $R_{s_n}(a)$  in a new array  $Z[a]$ 
9:     end if
10:  end if
11: end for
12: Step 2: User sorting and rank assignment
13: for  $b = 1, \dots, \text{length}(X)$  do
14:   for  $c = 2, \dots, \text{length}(X)$  do
15:     if  $X[b] > X[c]$  &&  $Z[a] > Z[c]$  then
16:       Push value in new array  $K[b]$ 
17:        $K[b] = \text{Rank}1$ 
18:     end if
19:   end for
20: end for
21: OUTPUT List of selected users  $Y[\ ]$  for D2D communication
22: Step 3: Packet uploading strategy
23: for  $d = 1, \dots, \delta$  do
24:   Analyze the information received from  $Y[a]$  users
25:   for  $s = 1, \dots, \text{length}(K)$  do
26:     Find the highest Rank in  $K[b]$ 
27:     Recheck the  $\alpha$  and  $R_{req}$ 
28:     if  $g_{K[b]} > \alpha$  &&  $R_{s_{K[b]}} > R_{req}$  then
29:       Select  $Y[a]$  user for D2D communication
30:     end if
31:   end for
32: end for

```

using the calculated value in decreasing order, i.e. 1 for the highest value and n for lowest value.

Algorithm 1 provides more insight into the proposed technique. Overall the algorithm works in 3 stages. For the selection UEs to perform 2D2D communication, in step 1, the algorithm analyses the pilot signal at MBS using the SNR threshold β , gain threshold α , received the power of UE P_n , and the residual energy R_{s_n} respectively. In step 2, the algorithm sorts the information gathered from step 1, and intelligently assigns the selected UEs with a rank, if they fulfil the set conditions. The output of this stage will equip MBS with a list of UEs that can be used for 2D2D communication. In step 3 of the algorithm, the following procedure is followed to upload the data of NB-IoT UE at the MBS:

- The NB-IoT UE transmits a pilot signal if it has data to upload at MBS.
- The transmitted pilot signal is received by the selected UEs or one of the UE available for the D2D communication.

- The relay UEs that receives the pilot signal from the NB-IoT UE updates the MBS.
- Using the artificial intelligence (AI) based ranks and the current situation of each UE to handle the packet, the MBS allocate a relaying UE for the NB-IoT UE.
- The designated UE will respond to NB-IoT UE, and synchronise with it to receive its information in duty cycles.

IV. PERFORMANCE EVALUATION

To evaluate the performance of our proposed approach, we have performed simulations in the MATLAB. The simulation results are compared with one of the opportunistic D2D communication scheme [12] for NB-IoT UEs. For simulation setup, a total number of $N = 25$ UEs are considered. The coverage area of MBS is set as 150 m^2 . The path loss exponent μ is set as 3.5. The SNR threshold β is selected as -120 dBm. The transmit power of NB-IoT UEs varies from 1 dBm to 8 dBm, whereas the transmit power of relaying UEs is fixed as 10 dBm. The value of noise power density N_o is assumed to be -70 dBm. For these simulations, we have calculated the residual energy R_{s_n} based on the assumption that rank 1 UE has more residual energy in comparison to other UEs. For one unit reduction in received power P_n of selected UE is considered as one unit reduction in residual energy of the same UE. In the simulation setup, the required residual energy threshold R_{req} is similar to the SNR threshold β . The gain threshold α is assumed as -6 dBm, whereas the gain of each UE g_n varies exponentially.

A. Simulation results

To validate our proposed model, we have calculated EED and EDR respectively and compared our results with a state-of-art technique available in the literature [12]. In Fig. 4, the EED is plotted against the varying transmit power of an NB-IoT UE. It is quite evident that our proposed scheme shows a stable two hop delay even for a low transmit power. This trend can be explained from the fact that using the 2D2D approach the NB-IoT UE does not face any extra delay due to unavailability of free slots in the duty cycle of the relay UEs. Moreover, an extra precaution in terms of channel gain and residual energy is considered for the selection of relaying UE to perform D2D communication. In comparison, the variation of delay in [12] can be explained using the opportunistic approach of the NB-IoT UE, while transmitting a packet. In [12], the relaying UEs facilities the packets of NB-IoT UEs whenever there is a free slot in their duty cycle. Moreover, the total energy consumption can be reduced by avoiding the unnecessary retransmission of the packets by the NB-IoT UEs.

In Fig. 5, we have shown a trend of end-to-end packet delivery ratio with varying transmit power of an NB-IoT UE. For this experimental setup, we have transmitted 100 packets from an NB-IoT UE at varying transmit power levels. The increasing trend in both curves can be explained using the variation in transmit power levels. The increase in transmits power to increase the received signal strength at the MBS and

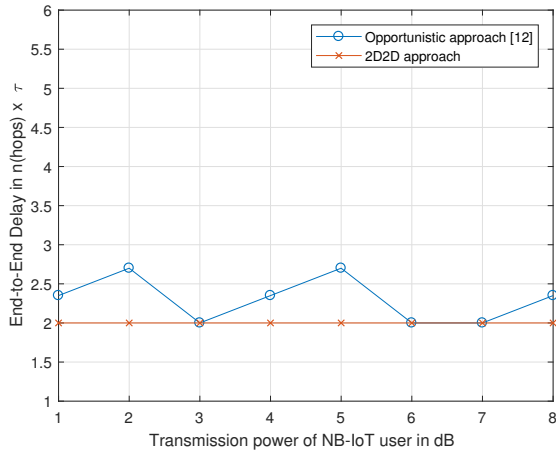


Fig. 4. Estimation of end-to-end delay experienced by the NB-IoT UE to upload the data at the MBS by using varying transmit power levels.

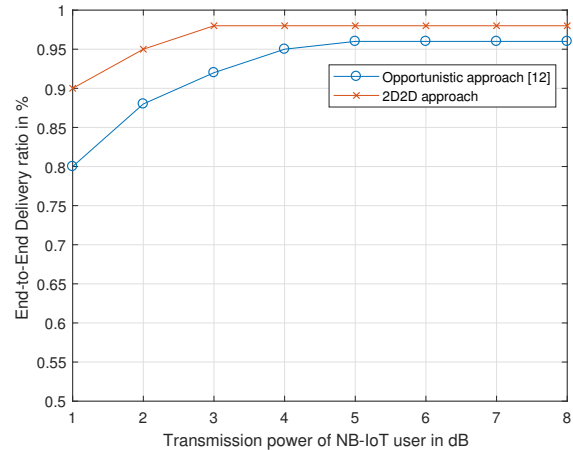


Fig. 5. Estimation of end-to-end packet delivery ratio over a given time interval experienced by the NB-IoT UE to upload the data at the MBS by using varying transmit power levels.

hence results in increased packet delivery. In comparison to [12], our scheme shows an improved performance by 10%. Furthermore, for low transmit power of 1 dBm, our scheme shows a packet delivery ratio of 90%.

V. CONCLUSION

In this paper, we exploit a D2D communication approach as a routing extension to NB-IoT which enables the two-hop route to serve NB-IoT UE. A deterministic D2D (2D2D) algorithm is proposed to maximize the EDR and to minimize the EED. Simulation results illustrate that proposed 2D2D algorithm outperforms the state-of-art technique available in the literature. Our approach results in an increased packet delivery ratio for NB-IoT UEs even with low transmit power. Hence, making 2D2D approach an excellent candidate for the energy efficient and delay sensitive NB-IoT applications incorporating the D2D communication. Moreover, the EED is restricted to two hops by ensuring the availability of relaying UEs to support NB-IoT UEs. In the current version of the proposed 2D2D algorithm, re-transmission is not considered. Efficient re-transmission techniques need to be investigated for improving EDR. Further, implementation of machine learning based relay selection is expected to be our future work.

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REFERENCES

- [1] P. P. Ray, "A survey on Internet of Things architectures," *Journal of King Saud University-Computer and Information Sciences*, vol. 30, no. 3, pp. 291–319, 2018.
- [2] Statista, "Number of mobile phone users worldwide from 2015 to 2020 (in billions)," 2015.
- [3] A. Nordrum *et al.*, "Popular internet of things forecast of 50 billion devices by 2020 is outdated," *IEEE spectrum*, vol. 18, 2016.

- [4] J. Chen, K. Hu, Q. Wang, Y. Sun, Z. Shi, and S. He, "Narrowband internet of things: Implementations and applications," *IEEE Internet of Things Journal*, vol. 4, no. 6, pp. 2309–2314, 2017.
- [5] S. Landström, J. Bergström, E. Westerberg, and D. Hammarwall, "NB-IoT: A sustainable technology for connecting billions of devices," *Ericsson Technology Review*, vol. 4, pp. 2–11, 2016.
- [6] S. Popli, R. K. Jha, and S. Jain, "A Survey on Energy Efficient Narrowband Internet of things (NB-IoT): Architecture, application and challenges," *IEEE Access*, 2018.
- [7] C. Yu, L. Yu, Y. Wu, Y. He, and Q. Lu, "Uplink scheduling and link adaptation for Narrowband Internet of Things systems," *IEEE Access*, vol. 5, pp. 1724–1734, 2017.
- [8] J. Lianghai, B. Han, M. Liu, and H. D. Schotten, "Applying device-to-device communication to enhance IoT services," *IEEE Communications Standards Magazine*, vol. 1, no. 2, pp. 85–91, 2017.
- [9] L. Militano, A. Orsino, G. Araniti, M. Nitti, L. Atzori, and A. Iera, "Trusted D2D-based data uploading in in-band Narrowband-IoT with social awareness," in *Personal, Indoor, and Mobile Radio Communications (PIMRC), 2016 IEEE 27th Annual International Symposium on*, pp. 1–6, IEEE, 2016.
- [10] V. Petrov, A. Samuylov, V. Begishev, D. Moltchanov, S. Andreev, K. Samuylov, and Y. Koucheryavy, "Vehicle-based relay assistance for opportunistic crowdsensing over narrowband IoT (NB-IoT)," *IEEE Internet of Things journal*, vol. 5, no. 5, pp. 3710–3723, 2018.
- [11] O. ElGarhy and L. Reggiani, "Increasing efficiency of resource allocation for D2D communication in NB-IoT context," *Procedia computer science*, vol. 130, pp. 1084–1089, 2018.
- [12] Y. Li, K. Chi, H. Chen, Z. Wang, and Y. Zhu, "Narrowband Internet of Things systems with opportunistic D2D communication," *IEEE Internet of Things Journal*, vol. 5, no. 3, pp. 1474–1484, 2018.
- [13] R. Ratasuk, B. Vejlgaard, N. Mangalvedhe, and A. Ghosh, "NB-IoT system for M2M communication," in *Wireless Communications and Networking Conference (WCNC), 2016 IEEE*, pp. 1–5, IEEE, 2016.
- [14] G. Tsoukaneri, M. Condoluci, T. Mahmoodi, M. Dohler, and M. K. Marina, "Group Communications in Narrowband-IoT: Architecture, Procedures, and Evaluation," *IEEE Internet of Things Journal*, vol. 5, no. 3, pp. 1539–1549, 2018.
- [15] F. Jameel, Z. Hamid, F. Jabeen, S. Zeadally, and M. A. Javed, "A Survey of Device-to-Device Communications: Research Issues and Challenges," *IEEE Communications Surveys & Tutorials*, 2018.
- [16] D. Feng, L. Lu, Y. Yuan-Wu, G. Y. Li, G. Feng, and S. Li, "Device-to-device communications underlying cellular networks," *IEEE Transactions on Communications*, vol. 61, no. 8, pp. 3541–3551, 2013.