

# **2019 IEEE 20th International Symposium on ‘A World of Wireless, Mobile and Multimedia Networks’ (WoWMoM 2019)**

**Washington, DC, USA  
10 – 12 June 2019**



**IEEE Catalog Number: CFP19WOW-POD  
ISBN: 978-1-7281-0271-9**

**Copyright © 2019 by the Institute of Electrical and Electronics Engineers, Inc.  
All Rights Reserved**

*Copyright and Reprint Permissions:* Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

***\*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP19WOW-POD
ISBN (Print-On-Demand):	978-1-7281-0271-9
ISBN (Online):	978-1-7281-0270-2

**Additional Copies of This Publication Are Available From:**

Curran Associates, Inc  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: (845) 758-0400  
Fax: (845) 758-2633  
E-mail: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

CURRAN ASSOCIATES INC.  
**proceedings**  
.com

# TABLE OF CONTENTS

<b>KEEPING DATA ALIVE: COMMUNICATION ACROSS VEHICULAR MICRO CLOUDS</b> .....	1
<i>Gurjashan Singh Pannu ; Florian Hagenauer ; Takamasa Higuchi ; Onur Altintas ; Falko Dressler</i>	
<b>A LIGHTWEIGHT BLOCK VALIDATION METHOD FOR RESOURCE-CONSTRAINED IOT DEVICES IN BLOCKCHAIN-BASED APPLICATIONS</b> .....	10
<i>Tam Le ; Matt W. Mutka</i>	
<b>AN AGE CONTROL TRANSPORT PROTOCOL FOR DELIVERING FRESH UPDATES IN THE INTERNET-OF-THINGS</b> .....	19
<i>Tanya Shreedhar ; Sanjit K. Kaul ; Roy D. Yates</i>	
<b>MODELING CYCLING BEHAVIOR TO IMPROVE BICYCLISTS' SAFETY AT INTERSECTIONS - A NETWORKING PERSPECTIVE</b> .....	26
<i>Julian Heinovski ; Lukas Stratmann ; Dominik S. Buse ; Florian Klingler ; Mario Franke ; Marie-Christin H. Oczko ; Christoph Sommer ; Ingrid Scharlau ; Falko Dressler</i>	
<b>MEASURING AND MODELING CAR PARK USAGE: LESSONS LEARNED FROM A CAMPUS FIELD-TRIAL</b> .....	34
<i>Thanchanok Sutjarittham ; Gary Chen ; Hassan Habibi Gharakheili ; Vijay Sivaraman ; Salil S. Kanhere</i>	
<b>HIRO-NET: SELF-ORGANIZED ROBOTIC MESH NETWORKING FOR INTERNET SHARING IN DISASTER SCENARIOS</b> .....	44
<i>Ludovico Ferranti ; Salvatore D'Oro ; Leonardo Bonati ; Emrecan Demirors ; Francesca Cuomo ; Tommaso Melodia</i>	
<b>ESTIMATING DOWNLINK THROUGHPUT FROM END-USER MEASUREMENTS IN MOBILE BROADBAND NETWORKS</b> .....	53
<i>Konstantinos Kousias ; Özgü Alay ; Antonios Argyriou ; Andra Lutu ; Michael Riegler</i>	
<b>USE OF MACHINE LEARNING TO DETECT CAUSES OF UNNECESSARY ACTIVE SCANNING IN WIFI NETWORKS</b> .....	63
<i>Harish Fulara ; Gursimran Singh ; Dheryta Jaisinghani ; Mukulika Maity ; Tanmoy Chakraborty ; Vinayak Naik</i>	
<b>CHARACTERIZING AND REMOVING OSCILLATIONS IN MOBILE PHONE LOCATION DATA</b> .....	72
<i>Panagiota Katsikouli ; Marco Fiore ; Angelo Furno ; Razvan Stanica</i>	
<b>SIZING UP USER TRAFFIC: FLOW-BASED MOBILE DATA OFFLOADING OVER WIFI</b> .....	81
<i>Delia Ciullo ; Thrasyvoulos Spyropoulos ; Navid Nikaein ; Bruno Jechoux ; Giannis Sarantidis</i>	
<b>IOTTRACKER: AN ENHANCED ENGINE FOR DISCOVERING INTERNET-OF-THING DEVICES</b> .....	90
<i>Xu Wang ; Yucheng Wang ; Xuan Feng ; Hongsong Zhu ; Limin Sun ; Yuchi Zou</i>	
<b>PRIVACY-PRESERVING AND UNDENIABLE AUTHENTICATION FOR MOBILE RFID TAGS</b> .....	99
<i>Jiannan Wei ; Nan Li</i>	
<b>ADAPTIVE LOW-POWER WIRELESS SENSOR NETWORK ARCHITECTURE FOR SMART STREET FURNITURE-BASED CROWD AND ENVIRONMENTAL MEASUREMENTS</b> .....	105
<i>Mohamed A. Nassar ; Len Luxford ; Peter Cole ; Giles Oatley ; Polychronis Koutsakis</i>	
<b>ENABLING MULTI-HOP FORWARDING IN 6LOWPANS THROUGH SOFTWARE-DEFINED NETWORKING</b> .....	114
<i>Giacomo Tanganelli ; Antonio Viridis ; Enzo Mingozzi</i>	
<b>GETTING THE MOST OUT OF YOUR VNFS: FLEXIBLE ASSIGNMENT OF SERVICE PRIORITIES IN 5G</b> .....	123
<i>Francesco Malandrino ; Carla-Fabiana Chiasserini</i>	
<b>MINIMIZING TRANSMISSION AND PROCESSING DELAY IN A NFV-BASED NETWORK</b> .....	132
<i>Yang Chen ; Jie Wu</i>	
<b>PROBABILISTIC KNOWLEDGE-GRAPH BASED WORKFLOW RECOMMENDER FOR NETWORK MANAGEMENT AUTOMATION</b> .....	138
<i>Erik Aumayr ; Mingxue Wang ; Anne-Marie Bosneag</i>	
<b>A SOFTWARE DEFINED MULTI-PATH TRAFFIC OFFLOADING SYSTEM FOR HETEROGENEOUS LTE-WIFI NETWORKS</b> .....	145
<i>Pengyuan Du ; Qi Zhao ; Mario Gerla</i>	
<b>COMPUTATION RATE MAXIMIZATION FOR WIRELESS POWERED MOBILE EDGE COMPUTING WITH NOMA</b> .....	154
<i>Ming Zeng ; Rong Du ; Viktoria Fodor ; Carlo Fischione</i>	
<b>AUTONOMIC SERVICE PLACEMENT IN FOG COMPUTING</b> .....	163
<i>Paridhika Kayal ; Jörg Liebeherr</i>	

<b>DEEM: ENABLING MICROSERVICES VIA DEVICE EDGE MARKETS</b> .....	172
<i>Argyrios G. Tasiopoulos ; Onur Ascigil ; Sergi Rene ; Michal Król ; Ioannis Psaras ; George Pavlou</i>	
<b>MEFS: MOBILE EDGE FILE SYSTEM FOR EDGE-ASSISTED MOBILE APPS</b> .....	181
<i>Domenico Scotece ; Nafize R. Paiker ; Luca Foschini ; Paolo Bellavista ; Xiaoning Ding ; Cristian Borcea</i>	
<b>TEXTING AND DRIVING RECOGNITION EXPLOITING SUBSEQUENT TURNS</b>	
<b>LEVERAGING SMARTPHONE SENSORS</b> .....	190
<i>Luca Bedogni ; Octavian Bujor ; Marco Levorato</i>	
<b>UNSUPERVISED LEARNING OF SIGNAL STRENGTH MODELS FOR DEVICE-FREE</b>	
<b>LOCALIZATION</b> .....	199
<i>Amal Al-Husseiny ; Neal Patwari</i>	
<b>THE DIVER SYSTEM: MULTIMEDIA COMMUNICATION AND LOCALIZATION USING</b>	
<b>UNDERWATER ACOUSTIC NETWORKS</b> .....	208
<i>Marco Bernardi ; Christian Cardia ; Petrika Gjanci ; Andrea Monterubbiano ; Chiara Petrioli ; Luigi Picari ; Daniele Spaccini</i>	
<b>LEVERAGING TRANSFER LEARNING IN MULTIPLE HUMAN ACTIVITY RECOGNITION</b>	
<b>USING WIFI SIGNAL</b> .....	216
<i>Sheheryar Arshad ; Chunhai Feng ; Ruiyun Yu ; Yonghe Liu</i>	
<b>ON-DEMAND VIDEO-STREAMING QUALITY OF EXPERIENCE MAXIMIZATION IN</b>	
<b>MOBILE EDGE COMPUTING</b> .....	226
<i>Ayman Younis ; Tuyen X. Tran ; Dario Pompili</i>	
<b>D2D-ENABLED COLLABORATIVE EDGE CACHING AND PROCESSING WITH ADAPTIVE</b>	
<b>MOBILE VIDEO STREAMING</b> .....	235
<i>Abbas Mehrabi ; Matti Siekkinen ; Gazi Illahi ; Antti Ylä-Jääski</i>	
<b>AN ONLINE METHOD FOR OPPORTUNISTIC TASK REPLICATIONS</b> .....	245
<i>Ricardo Lent</i>	
<b>NON-SUBMODULARITY AND APPROXIMABILITY: INFLUENCE MAXIMIZATION IN</b>	
<b>ONLINE SOCIAL NETWORKS</b> .....	251
<i>Huanyang Zheng ; Ning Wang ; Jie Wu</i>	
<b>TRUSTED D2D-BASED IOT RESOURCE ACCESS USING SMART CONTRACTS</b> .....	260
<i>Vasilios A. Siris ; Dimitrios Dimopoulos ; Nikos Fotiou ; Spyros Voulgaris ; George C. Polyzos</i>	
<b>COMPUTING REALISTIC AND ADAPTIVE CAPACITY OF D2D CONTACTS</b> .....	269
<i>Clement Bertier ; Farid Benbadis ; Vania Conan ; Marcelo Dias De Amorim</i>	
<b>CROSS-LAYER ASSISTED FORWARDING STRATEGY FOR OPPORTUNISTIC</b>	
<b>COMMUNICATION</b> .....	278
<i>Thiago Teixeira ; Rajvardhan Deshmukh ; Michael Zink</i>	
<b>WEB-BASED FRAMEWORK FOR ACCESSING NATIVE OPPORTUNISTIC NETWORKING</b>	
<b>APPLICATIONS</b> .....	284
<i>Marcin Nagy ; Teemu Kärkkäinen ; Arseny Kurnikov ; Jörg Ott</i>	
<b>STRATEGIES FOR NETWORK SLICING NEGOTIATION IN A DYNAMIC RESOURCE</b>	
<b>MARKET</b> .....	294
<i>Alessandro Lieto ; Eugenio Moro ; Ilenia Malanchini ; Silvio Mandelli ; Antonio Capone</i>	
<b>RISK-AWARE RESOURCE CONTROL WITH FLEXIBLE 5G ACCESS TECHNOLOGY</b>	
<b>INTERFACES</b> .....	303
<i>Panagiotis Vamvakas ; Eirini Eleni Tsiropoulou ; Symeon Papavassiliou</i>	
<b>ENERGY-EFFICIENT HTTP ADAPTIVE STREAMING WITH HYBRID TCP/UDP OVER</b>	
<b>HETEROGENEOUS WIRELESS NETWORKS</b> .....	312
<i>Yunmin Go ; Hyunmin Noh ; Goeon Park ; Hwangjun Song</i>	
<b>ENERGY SHARING BASED CONTENT DELIVERY IN MOBILE SOCIAL NETWORKS</b> .....	322
<i>Aashish Dhungana ; Eyuphan Bulut</i>	
<b>VL-ROUTE: A CROSS-LAYER ROUTING PROTOCOL FOR VISIBLE LIGHT AD HOC</b>	
<b>NETWORK</b> .....	331
<i>Jithin Jagannath ; Tommaso Melodia</i>	
<b>WIDEBAND TEMPORAL SPECTRUM SENSING USING CEPSTRAL FEATURES</b> .....	340
<i>Hanke Cheng ; Brian L. Mark ; Yariv Ephraim</i>	
<b>LOCALVLC: AUGMENTING SMART IOT SERVICES WITH PRACTICAL VISIBLE LIGHT</b>	
<b>COMMUNICATION</b> .....	346
<i>Michael Haus ; Aaron Yi Ding ; Jörg Ott</i>	
<b>ON THE PERFORMANCE OF DATA DISTRIBUTION METHODS FOR WIRELESS</b>	
<b>INDUSTRIAL NETWORKS</b> .....	355
<i>Theofanis P. Raptis ; Andrea Formica ; Elena Pagani ; Andrea Passarella</i>	

<b>INVESTIGATING THEORETICAL PERFORMANCE AND DEMODULATION TECHNIQUES FOR LORA</b> .....	361
<i>Alexandre Marquet ; Nicolas Montavont ; Georgios Z. Papadopoulos</i>	
<b>AUTONOMOUS COLLISION-FREE SCHEDULING FOR LORA-BASED INDUSTRIAL INTERNET OF THINGS</b> .....	367
<i>Dimitrios Zorbas ; Brendan O'Flynn</i>	
<b>HOW MOBILITY PATTERNS DRIVE DISEASE SPREAD: A CASE STUDY USING PUBLIC TRANSIT PASSENGER CARD TRAVEL DATA</b> .....	372
<i>Ahmad El Shoghri ; Jessica Liebig ; Lauren Gardner ; Raja Jurdak ; Salil Kanhere</i>	
<b>DESIGN GUIDELINES FOR BIG DATA GATHERING IN INDUSTRY 4.0 ENVIRONMENTS</b> .....	378
<i>Paolo Bellavista ; Filippo Bosi ; Antonio Corradi ; Luca Foschini ; Stefano Monti ; Lorenzo Patera ; Luca Poli ; Domenico Scotece ; Michele Solimando</i>	
<b>PERFORMANCE MEASUREMENTS OF IEEE 802.15.4G WIRELESS NETWORKS</b> .....	384
<i>Francesca Righetti ; Carlo Vallati ; Daniela Comola ; Giuseppe Anastasi</i>	
<b>PERFORMANCE ANALYSIS OF TWO MACHINE-TO-MACHINE ARCHITECTURE TYPES IN VEHICULAR COMMUNICATIONS</b> .....	390
<i>Paulo Araújo ; Alexandre Santos ; António Costa ; Fábio Goncalves ; Bruno Ribeiro ; Vadym Hapanchak ; Oscar Gama ; Bruno Dias ; Joaquim Macedo ; M. João Nicolau</i>	
<b>SOTER: TRUST DISCOVERY FRAMEWORK FOR INTERNET OF MEDICAL THINGS (IOMT)</b> .....	397
<i>Maha A. Allouzi ; Javed I. Khan</i>	
<b>SECURE IOT ACCESS AT SCALE USING BLOCKCHAINS AND SMART CONTRACTS</b> .....	403
<i>Nikos Fotiou ; Iakovos Pittaras ; Vasilios A. Siris ; Spyros Voulgaris ; George C. Polyzos</i>	
<b>EXPRESSIVE DATA-CENTRIC MULTICAST ON RPL IN LOW-POWER NETWORKS</b> .....	409
<i>Jonathan Oostvogels ; Stefanos Peros ; Stephane Delbruel ; Danny Hughes</i>	
<b>USER GROUPING AND OPTIMAL RANDOM BEAMFORMING IN MMWAVE MIMO-NOMA TRANSMISSION SYSTEMS</b> .....	415
<i>Mohammad Reza Ghavidel Aghdam ; Seyyed Mahmoud Pishvaei ; Reza Abdolee ; Behzad Mozaffari Tazehkand ; Farid Tabee Miandoab</i>	
<b>A VARIABLE LENGTH ADDRESS ASSIGNMENT SCHEME FOR 6LOWPAN</b> .....	421
<i>Christopher Hickman ; Feng Wang</i>	
<b>OPTIMIZING MMWAVE SPATIAL REUSE: SIGNAL-TO-INTERFERENCE AWARE BEAMTRAINING</b> .....	427
<i>Guillermo Bielsa ; Adrian Loch ; Joerg Widmer</i>	
<b>ADAPTIVE PASSIVE MOBILE SENSING USING REINFORCEMENT LEARNING</b> .....	433
<i>Lihua Cai ; Mehdi Boukhechba ; Navreet Kaur ; Congyu Wu ; Laura E. Barnes ; Matthew S. Gerber</i>	
<b>ADAPTIVE SWARM CONTROL FOR MOBILE RESOURCE PLACEMENT IN WIRELESS AD-HOC NETWORKS</b> .....	439
<i>Bradley Fraser ; Andrew Coyle ; Claudia Szabo ; Robert Hunjet</i>	
<b>RAY TRACING ANALYSIS FOR UAV-ASSISTED INTEGRATED ACCESS AND BACKHAUL MILLIMETER WAVE NETWORKS</b> .....	445
<i>Alberto Perez ; Abdurrahman Fouda ; Ahmed S. Ibrahim</i>	
<b>AN AUTONOMOUS SWARM OF DRONES FOR INDUSTRIAL GAS SENSING APPLICATIONS</b> .....	450
<i>Pietro Tosato ; Daniele Facinelli ; Maurizio Prada ; Luca Gemma ; Maurizio Rossi ; Davide Brunelli</i>	
<b>BLOCKCHAIN TECHNOLOGY FOR NETWORKED SWARMS OF UNMANNED AERIAL VEHICLES (UAVS)</b> .....	456
<i>Isaac J. Jensen ; Daisy Flora Selvaraj ; Prakash Ranganathan</i>	
<b>GROUND LOCALIZATION WITH A DRONE AND UWB ANTENNAS: EXPERIMENTS ON THE FIELD</b> .....	463
<i>Francesco Betti Sorbelli ; Cristina M. Pinotti</i>	
<b>IOT AND THE RISK OF INTERNET EXPOSURE: RISK ASSESSMENT USING SHODAN QUERIES</b> .....	470
<i>Areej Albataineh ; Izzat Alsmadi</i>	
<b>AUTONOMOUS CPS MOBILITY SECURELY DESIGNED</b> .....	475
<i>David Hofbauer ; Christoph Schmittner ; Manuela Brandstetter ; Markus Tauber</i>	
<b>A DATA DISSEMINATION PROTOCOL FOR VEHICLES WITH TEMPORARY CELLULAR NETWORK INACCESSIBILITY</b> .....	481
<i>Ergys Puka ; Peter Herrmann</i>	
<b>BLOCKCHAIN BASED AUTHENTICATION AND AUTHORIZATION FRAMEWORK FOR REMOTE COLLABORATION SYSTEMS</b> .....	488
<i>Logan Widick ; Ishan Ranasinghe ; Ram Dantu ; Srikanth Jonnada</i>	
<b>IMPLEMENTATION OF SOFTWARE-DEFINED 6LOWPANS IN CONTIKI OS</b> .....	495
<i>Giacomo Tanganelli ; Antonio Viridis ; Enzo Mingozzi</i>	

<b>SAFEFLOW-X: AN EFFICIENT AND COMPLETE STRATEGY FOR MULTIPARTY TRUST NEGOTIATION OVER DISTRIBUTED NETWORKS .....</b>	<b>501</b>
<i>Maha Ali Allouzi ; Javed I Khan</i>	
<b>MMWAVE IN VEHICULAR NETWORKS: LEVERAGING TRAFFIC SIGNALS FOR BEAM DESIGN.....</b>	<b>510</b>
<i>Zana Limani Fazliu ; Francesco Malandrino ; Carla-Fabiana Chiasserini</i>	
<b>ADAPTIVE ROUTING IN DISRUPTION TOLERANT NETWORKS.....</b>	<b>516</b>
<i>José Irigon De Irigon</i>	
<b>TOWARD THE NEXT GENERATION OF FLOW COMPRESSION .....</b>	<b>519</b>
<i>Máté Tömösközi ; Frank H. P. Fitzek ; Péter Ekler</i>	
<b>THE ROAD TOWARDS PRIVATE PROXIMITY SERVICES.....</b>	<b>522</b>
<i>Michael Haus ; Aaron Yi Ding ; Jörg Ott</i>	
<b>IMPROVING WATER CONSUMPTION ESTIMATES FROM A BOTTLE-ATTACHABLE SENSOR USING HEURISTIC FUSION.....</b>	<b>525</b>
<i>Henry Griffith ; Subir Biswas</i>	
<b>ENERGY EFFICIENCY ENHANCEMENT IN 5G MOBILE WIRELESS NETWORKS .....</b>	<b>528</b>
<i>Qi Zhao ; Mario Gerla</i>	
<b>PHD FORUM: RESOURCE ALLOCATION AND TASK OFFLOADING IN CLOUD-ASSISTED WIRELESS NETWORKS.....</b>	<b>531</b>
<i>Ayman Younis ; Dario Pompili</i>	
<b>DEMO: OPEN SOURCE PLATFORM FOR IEEE 802.11P NICS EVALUATION .....</b>	<b>534</b>
<i>Francesco Raviglione ; Marco Malinverno ; Claudio Casetti</i>	
<b>DEMO ABSTRACT: MOBILE AUGMENTED REALITY LEVERAGING CLOUD RADIO ACCESS NETWORKS.....</b>	<b>537</b>
<i>Ayman Younis ; Tuyen X. Tran ; Brian Qiu ; Dario Pompili</i>	
<b>PERFORMANCE ASSESSMENT OF OFF-THE-SHELF MM WAVE RADIOS FOR DRONE COMMUNICATIONS .....</b>	<b>540</b>
<i>Guillermo Bielsa ; Marco Mezzavilla ; Joerg Widmer ; Sundeep Rangan</i>	
<b>Author Index</b>	