Founding Editors
Gerhard Goos
  *Karlsruhe Institute of Technology, Karlsruhe, Germany*
Juris Hartmanis
  *Cornell University, Ithaca, NY, USA*

Editorial Board Members
Elisa Bertino
  *Purdue University, West Lafayette, IN, USA*
Wen Gao
  *Peking University, Beijing, China*
Bernhard Steffen
  *TU Dortmund University, Dortmund, Germany*
Gerhard Woeginger
  *RWTH Aachen, Aachen, Germany*
Moti Yung
  *Columbia University, New York, NY, USA*
More information about this series at http://www.springer.com/series/7411
Preface

We welcome you to the joint proceedings of the 19th NEW2AN (Next Generation Teletraffic and Wired/Wireless Advanced Networks and Systems) and 12th Conference on the Internet of Things and Smart Spaces ruSMART (Are You Smart) held in St. Petersburg, Russia, during August 26–28, 2019.

Originally, the NEW2AN conference was launched by ITC (International Teletraffic Congress) in St. Petersburg in June 1993 as an ITC-Sponsored Regional International Teletraffic Seminar. The first edition was entitled “Traffic Management and Routing in SDH Networks” and held by R&D LONIIS. In 2002, the event received its current name, the NEW2AN. In 2008, NEW2AN acquired a new companion in Smart Spaces, ruSMART, hence boosting interaction between researchers, practitioners, and engineers across different areas of ICT. From 2012, the scope of ruSMART conference has been extended to cover the Internet of the Things and related aspects.

Presently, NEW2AN and ruSMART are well-established conferences with a unique cross-disciplinary mixture of telecommunications-related research and science. NEW2AN/ruSMART are accompanied by outstanding keynotes from universities and companies across Europe, USA, and Russia.

The 19th NEW2AN technical program addressed various aspects of next-generation data networks. This year, special attention was given to advanced wireless networking and applications. In particular, the authors demonstrated novel and innovative approaches to performance and efficiency analysis of 5G and beyond systems, employed game-theoretical formulations, advanced queuing theory, and stochastic geometry. It is also worth mentioning the rich coverage of the Internet of Things, cyber security, optics, signal processing, as well as business aspects.

The 12th Conference on the Internet of Things and Smart Spaces, ruSMART 2019, provided a forum for academic and industrial researchers to discuss new ideas and trends in the emerging areas of the Internet of Things and smart spaces that create new opportunities for fully customized applications and services. The conference brought together leading experts from top affiliations around the world. This year, we saw good participation from representatives of various players in the field, including academic teams and industrial companies, particularly representatives of Russian R&D centers, which have a good reputation for high-quality research and business in innovative service creation and applications development.

We would like to thank the Technical Program Committee members of both conferences, as well as the associated reviewers, for their hard work and important contribution to the conference. This year, the conference program met the highest quality criteria with an acceptance ratio of around 35%.

The current edition of the conferences was organized in cooperation with National Instruments, IEEE Communications Society Russia Northwest Chapter, YL-Verkot OY, Open Innovations Association FRUCT, Tampere University, Peter the Great St. Petersburg Polytechnic University, Peoples’ Friendship University of Russia.
(RUDN University), The National Research University Higher School of Economics (HSE), St. Petersburg State University of Telecommunications, and Popov Society. The conference was held within the framework of the RUDN University Program 5-100.

We also wish to thank all of those who contributed to the organization of the conferences. In particular, we are grateful to Roman Kovalchukov for his substantial work on the compilation of camera-ready papers.

We believe that the 19th NEW2AN and 12th ruSMART conferences delivered an informative, high-quality, and up-to-date scientific program. We also hope that participants enjoyed both technical and social conference components, the Russian hospitality, and the beautiful city of St. Petersburg.

August 2019

Olga Galinina
Sergey Andreev
Sergey Balandin
Yevgeni Koucheryavy
## Organization

### NEW2AN and ruSMART Technical Program Committee

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torsten Braun</td>
<td>University of Bern, Switzerland</td>
</tr>
<tr>
<td>Paulo Carvalho</td>
<td>University of Minho, Portugal</td>
</tr>
<tr>
<td>Chrysostomos</td>
<td>Frederick University, Cyprus</td>
</tr>
<tr>
<td>Chrysostomou</td>
<td></td>
</tr>
<tr>
<td>Roman Dunaytsev</td>
<td>The Bonch-Bruevich Saint-Petersburg State University of Telecommunications, Russia</td>
</tr>
<tr>
<td>Dieter Fiems</td>
<td>Ghent University, Belgium</td>
</tr>
<tr>
<td>Alexey Frolov</td>
<td>Skolkovo Institute of Science and Technology, Russia</td>
</tr>
<tr>
<td>Ivan Ganchev</td>
<td>University of Limerick, Ireland</td>
</tr>
<tr>
<td>Jiri Hosek</td>
<td>Brno University of Technology, Czech Republic</td>
</tr>
<tr>
<td>Alexey Kashevnik</td>
<td>SPIIRAS, Russia</td>
</tr>
<tr>
<td>Joaquim Macedo</td>
<td>University of Minho, Portugal</td>
</tr>
<tr>
<td>Ninoslav Marina</td>
<td>University of Information Science and Technology, Macedonia</td>
</tr>
<tr>
<td>Aleksandr Ometov</td>
<td>Tampere University, Finland</td>
</tr>
<tr>
<td>Pavel Masek</td>
<td>Brno University of Technology, Czech Republic</td>
</tr>
<tr>
<td>Edison Pignaton de Freitas</td>
<td>Federal University of Rio Grande do Sul, Brazil</td>
</tr>
<tr>
<td>Andrey Kucheryavy</td>
<td>The Bonch-Bruevich Saint Petersburg State University of Telecommunications, Russia</td>
</tr>
</tbody>
</table>

### NEW2AN and ruSMART Publicity Chair

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nikita Tafintsev</td>
<td>Tampere University, Finland</td>
</tr>
</tbody>
</table>
Contents

New Generation of Smart Services

Proactive Context-Aware IoT-Enabled Waste Management .......................... 3
Orsola Fejzo, Arkady Zaslavsky, Saguna Saguna, and Karan Mitra

Investigation of the IoT Device Lifetime with Secure Data Transmission .... 16
Ievgeniia Kuzminykh, Anders Carlsson, Maryna Yevdokymenko,
and Volodymyr Sokolov

Compression Methods for Microclimate Data Based on Linear
Approximation of Sensor Data .................................................. 28
Olli Väääränäen and Timo Hämäläinen

An Open Multimodal Mobility Platform Based on Distributed
Ledger Technology ................................................................. 41
Robin Lamberti, Christian Fries, Markus Lücking, Raphael Manke,
Niclas Kannengießer, Benjamin Sturm, Mikhail M. Komarov,
Wilhelm Stork, and Ali Sunyaev

Semantic Interoperability in IoT: A Systematic Mapping ........................ 53
Saymon Castro de Souza and José Gonçalves Pereira Filho

Malware Squid: A Novel IoT Malware Traffic Analysis Framework Using
Convolutional Neural Network and Binary Visualisation ......................... 65
Robert Shire, Stavros Shiaeles, Keltoum Bendiab, Bogdan Ghita,
and Nicholas Kolokotronis

Context- and Situation Prediction for the MyAQI Urban Air Quality
Monitoring System .................................................................. 77
Daniel Schürholz, Arkady Zaslavsky, and Sylvain Kubler

Data Mining Algorithms Parallelization in Logic Programming Framework
for Execution in Cluster .......................................................... 91
Aleksey Malov, Sergey Rodionov, and Andrey Shorov

Application of an Autonomous Object Behavior Model to Classify
the Cybersecurity State ......................................................... 104
Viktor V. Semenov, Ilya S. Lebedev, Mikhail E. Sukhoparov,
and Kseniya I. Salakhutdinova

Decision Support Based on Human-Machine Collective Intelligence:
Major Challenges .................................................................. 113
Alexander Smirnov and Andrew Ponomarev
FaceWallGraph: Using Machine Learning for Profiling User Behaviour from Facebook Wall ........................................... 125
Aimilia Panagiotou, Bogdan Ghita, Stavros Shiaeles, and Keltoum Bendiab

Multi-agent Approach to Computational Resource Allocation in Edge Computing ........................................... 135
Alexey Kovtunenko, Marat Timirov, and Azat Bilyalov

The Use of Context-Dependent Modelling for the Construction of an Anti-fraud System in Transport ......................... 147
Yulia Shichkina and Alexander Koblov

An Approach to the Analysis of the Vehicle Movement on the Organization Territory ........................................... 157
Evgenia Novikova, Yana Bekeneva, and Andrey Shorov

Building Blocks of an Innovative Approach to Education in the Field of Cyber Operations in Smart Environment ............. 168
Blaž Ivanc, Iztok Podbregar, and Polona Šprajc

Next Generation Wired/Wireless Advanced Networks and Systems

Channel Switching Protocols Hinder the Transition to IP World: The Pentagon Story ........................................... 185
Manfred Sneps-Sneppe, Dmitry Namiot, and Maris Alberts

Network Anomaly Detection in Wireless Sensor Networks: A Review ......................................................... 196
Rony Franca Leppänen and Timo Hämäläinen

Polarization Direction Finding Method of Interfering Radio Emission Sources ................................................ 208
Alexey Simonov, Grigoriy Fokin, Vladimir Sevidov, Mstislav Sivers, and Sergey Dvornikov

Coexistence Management Approach for Densification of Randomly Deployed Low Power Nodes in TVWS Spectrum .... 220
Inam Ullah, Edward Mutafungwa, Muhammad Zeeshan Asghar, and Jyri Hämäläinen

Toward an Ultra-low Latency and Energy Efficient LoRaWAN ............................................................... 233
Mohammed Saleh Ali Muthanna, Ping Wang, Min Wei, Abdelhamied A. Ateya, and Ammar Muthanna

Novel AI-Based Scheme for Traffic Detection and Recognition in 5G Based Networks .................................... 243
Volkov Artem, Abdelhamied A. Ateya, Ammar Muthanna, and Andrey Koucheryavy
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Connectivity Game with Incomplete Information on Jammer’s Location</td>
<td>256</td>
</tr>
<tr>
<td>Andrey Garnaev and Wade Trappe</td>
<td></td>
</tr>
<tr>
<td>Ray-Based Modeling of Unlicensed-Band mmWave Propagation</td>
<td>269</td>
</tr>
<tr>
<td>Inside a City Bus</td>
<td></td>
</tr>
<tr>
<td>Aleksei Ponomarenko-Timotheev, Aleksandr Ometov, and Olga Galinina</td>
<td></td>
</tr>
<tr>
<td>Maximizing Achievable Data Rate in Unlicensed mmWave Networks</td>
<td>282</td>
</tr>
<tr>
<td>with Mobile Clients</td>
<td></td>
</tr>
<tr>
<td>Nadezhda Chukhno, Olga Chukhno, Sergey Shargin,</td>
<td></td>
</tr>
<tr>
<td>Konstantin Samoylov, Olga Galinina, and Yuliya Gaidamaka</td>
<td></td>
</tr>
<tr>
<td>Runtime Minimization of the Threshold Distributed Computation Protocol</td>
<td>295</td>
</tr>
<tr>
<td>in the Case of Participants Failures</td>
<td></td>
</tr>
<tr>
<td>Alexandra Afanasyeva, Ivan Evstafiev, and Andrey Turlikov</td>
<td></td>
</tr>
<tr>
<td>Preemptive Priority Queuing System with Randomized Push-Out</td>
<td>305</td>
</tr>
<tr>
<td>Mechanism and Negative Customers</td>
<td></td>
</tr>
<tr>
<td>Polina Shorenko, Oleg Zayats, Alexander Ilyashenko,</td>
<td></td>
</tr>
<tr>
<td>and Vladimir Muliukha</td>
<td></td>
</tr>
<tr>
<td>Development of Analytical Framework for Evaluation of LTE-LAA</td>
<td>318</td>
</tr>
<tr>
<td>Probabilistic Metrics</td>
<td></td>
</tr>
<tr>
<td>Maksym V. Korshykov, Anastasia V. Daraseliya, and Eduard S. Sopin</td>
<td></td>
</tr>
<tr>
<td>Beamforming Signal Processing Performance Analysis for Massive</td>
<td>329</td>
</tr>
<tr>
<td>MIMO Systems</td>
<td></td>
</tr>
<tr>
<td>Irina Stepanets and Grigoriy Fokin</td>
<td></td>
</tr>
<tr>
<td>Autonomous UAV Landing on a Moving Vessel: Localization Challenges</td>
<td>342</td>
</tr>
<tr>
<td>and Implementation Framework</td>
<td></td>
</tr>
<tr>
<td>Carlos Castillo, Alexander Pyattaev, Jose Villa, Pavel Masek,</td>
<td></td>
</tr>
<tr>
<td>Dmitri Moltchanov, and Aleksandr Ometov</td>
<td></td>
</tr>
<tr>
<td>Features of Multi-target Detection Algorithm for Automotive</td>
<td>355</td>
</tr>
<tr>
<td>FMCW Radar</td>
<td></td>
</tr>
<tr>
<td>Vladimir D. Kuptsov, Sergei I. Ivanov, Alexander A. Fedotov,</td>
<td></td>
</tr>
<tr>
<td>and Vladimir L. Badenko</td>
<td></td>
</tr>
<tr>
<td>Cell State Prediction Through Distributed Estimation of Transmit Power</td>
<td>365</td>
</tr>
<tr>
<td>Muhammad Zeeshan Asghar, Farhan Azhar, Muhammad Nauman,</td>
<td></td>
</tr>
<tr>
<td>Nouman Ali, Muaz Maqbool, Muhammad Saqib Ilyas, and Mirza Mubasher Baig</td>
<td></td>
</tr>
<tr>
<td>Performance Study of 5G Downlink Cell</td>
<td>377</td>
</tr>
<tr>
<td>Aymen I. Zreikat and Suat Mercan</td>
<td></td>
</tr>
</tbody>
</table>
Downlink Power Allocation in Delta-OMA (D-OMA) 6G Networks ...... 390
    Jerzy Martyna

Robust Estimation of VANET Performance-Based Robust Neural Networks Learning ......................................................... 402
    Ali R. Abdellah, Ammar Muthanna, and Andrey Koucheryavy

Multi-level Architecture for P2P Services in Mobile Networks ............ 415
    Rustam Pirmagomedov, Aram A. Ahmed, and Ruslan Glushakov

Network Anomaly Detection Based on WaveNet .................................. 424
    Tero Kokkonen, Samir Puuska, Janne Alatalo, Eppu Heilimo,
    and Antti Mäkelä

Steganographic WF5 Method for Weighted Embedding: An Overview
and Comparison .................................................................................. 434
    Tamara Minaeva, Natalia Voloshina, Sergey Bezzateev,
    and Vadim Davydov

Modeling of Routing as Resource Distribution in SDN ............................ 441
    Alexander Paramonov and Regina Shamilova

Survey of Cyber Security Awareness in Health, Social Services
and Regional Government in South Ostrobothnia, Finland ................. 455
    Tero Haukilehto and Jari Hautamäki

Data Delivery Algorithm for Latency Sensitive IoT Application .............. 467
    Omar Abdulkareem Mahmood, Ammar Muthanna,
    and Alexander Paramonov

Development of the Mechanism of Assessing Cyber Risks in the Internet
of Things Projects .............................................................................. 481
    Sergei Grishunin, Svetlana Suloeva, Tatiana Nekrasova,
    and Alexandra Egorova

Engineering and Architecture Building of 5G Network for Business Model
of High Level Mobile Virtual Network Operator ................................ 495
    Valery Tikhvinskiy, Sergey Terentyev, Altay Aitmagambetov,
    and Bolat Nurgozhin

Development of Infocommunications Services in Russia ....................... 505
    Tatyana Nekrasova, Valery Leventsov, and Vladimir Gluhov
A Concept of Smart Medical Autonomous Distributed System for Diagnostics Based on Machine Learning Technology .......................... 515

Elena Velichko, Elina Nepomnyashchaya, Maxim Baranov, Marina A. Galeeva, Vitalii A. Pavlov, Sergey V. Zavjalov, Ekaterina Savchenko, Tatiana M. Pervunina, Igor Govorov, and Eduard Komlichenko


Alexey S. Podstrigaev, Andrey V. Smolyakov, Vadim V. Davydov, Nikita S. Myazin, Nadya M. Grebenikova, and Roman V. Davydov

Signal Transmitting in Pheromone Networks ........................................ 534

Maxim Zakharov, Ruslan Kirichek, Maria Makolkina, and Andrey Koucheryavy

Integrating Internet of Things with the Digital Object Architecture ............ 540

Mahmood Al-Bahri, Kirichek Ruslan, and Borodin Aleksey

Industrial Internet of Things Classification and Analysis Performed on a Model Network .................................................. 548

V. Kulik, R. Kirichek, and A. Sotnikov

Mobile Edge Computing for Video Application Migration ........................ 562

Steve Manariyo, Dmitry Poluektov, Khakimov Abdukodir, Ammar Muthanna, and Maria Makolkina

An Accurate Approximation of Resource Request Distributions in Millimeter Wave 3GPP New Radio Systems .......................... 572

Roman Kovalchukov, Dmitri Molitchanov, Yuliya Gaidamaka, and Ekaterina Bobrikova

Numerical Study of the Consensus Degree Between Social Network Users in the Group Decision Making Process .......................... 586

Olga Chukhno, Nadezhda Chukhno, Anna Gaidamaka, Konstantin Samouylov, and Enrique Herrera-Viedma

Joint Device-to-Device and MBSFN Transmission for eMBB Service Delivery in 5G NR Networks .............................................. 599

Federica Rinaldi, Olga Vikhrova, Sara Pizzi, Antonio Iera, Antonella Molinaro, and Giuseppe Araniti

Calculation of Packet Jitter for Correlated Traffic .................................. 610

Igor Kartashevskiy and Marina Buranova
Modeling and Performance Analysis of Elastic Traffic with Minimum Rate Guarantee Transmission Under Network Slicing 621
Anastasiya Vlaskina, Nikita Polyakov, and Irina Gudkova

Probability Model for Performance Analysis of Joint URLLC and eMBB Transmission in 5G Networks 635
Elena Makeeva, Nikita Polyakov, Petr Kharin, and Irina Gudkova

Optimization of Shaping Pulse by Spectral Mask to Enhance DVB-S2 649
Phuoc Nguyen Tan Hoang and Aleksandr Gelgor

BER Performance Improvement for Optimal FTN Signals with Increased Signal Constellation Size 661
Anna S. Ovsyannikova, Sergey V. Zavjalov, and Sergey B. Makarov

The Efficiency of Detection Algorithms for Optimal FTN Signals 670
Sergey V. Zavjalov, Anna S. Ovsyannikova, Ilya I. Lavrenyuk, and Sergey V. Volvenko

The Effectiveness of Application of Multi-frequency Signals Under Conditions of Amplitude Limitation 681
Dac Cu Nguyen, Sergey V. Zavjalov, and Anna S. Ovsyannikova

BER Analysis in Dual Hop Differential Amplify-and-Forward Relaying Systems with Selection Combining Using M-ary Phase-Shift Keying over Nakagami-m Fading Channels 688
Mamoun F. Al-Mistarihi, Arwa S. Aqel, and Khalid A. Darabkh

Closed-Form Expression for BER in Relay-Based DF Cooperative Diversity Systems Over Nakagami-m Fading Channels with Non-identical Interferers 700
Mamoun F. Al-Mistarihi, Rami Mohaisen, and Khalid A. Darabkh

A New Scheme for Transmitting Heterodyne Signals Based on a Fiber-Optical Transmission System for Receiving Antenna Devices of Radar Stations and Communication Systems 710
Angelina V. Moroz, Roman V. Davydov, and Vadim V. Davydov

Simulation of Simplex Acousto-Optic Channel on Few-Mode Optical Fiber 719
Vladimir A. Burdin and Olga Yu. Gubareva

Broad-Band Fiber Optic Link with a Stand-Along Remote External Modulator for Antenna Remoting and 5G Wireless Network Applications 727
Aleksei Petrov, Elena Velichko, Vladimir Lebedev, Igor Ilichev, Peter Agruzov, Mikhail Parfenov, Andrei Varlamov, and Aleksandr Shamrai