

2020 6th IEEE Conference on Network Softwarization (NetSoft 2020)

**Ghent, Belgium
29 June – 3 July 2020**



**IEEE Catalog Number: CFP20A76-POD
ISBN: 978-1-7281-5685-9**

**Copyright © 2020 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:	CFP20A76-POD
ISBN (Print-On-Demand):	978-1-7281-5685-9
ISBN (Online):	978-1-7281-5684-2

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
Web: www.proceedings.com

CURRAN ASSOCIATES INC.
proceedings
.com

Table of Content

Table of Content

Message from the Chairs

Patrons and Sponsors

Technical Program

Organizing Committee

Steering Committee

Technical Program Committee (TPC)

Additional Reviewers

Ioannis Dimolitsas, Dimitrios Dechouniotis, Vasileios Theodorou, Panagiotis Papadimitriou, Symeon Papavassiliou, A Multi-Criteria Decision-Making Method for Network Slice Edge Infrastructure Selection	p. 1
Vasileios Theodorou, Maria-Evgenia Xezonaki, Network Slicing for Multi-tenant Edge Processing over Shared IoT Infrastructure	p. 8
Nabhasmita Sen, Antony Franklin A, Impact of Slice Granularity in Centralization Benefit of 5G Radio Access Network	p. 15
Ioakeim Fotoglou, Georgios Papathanail, Angelos Pentelas, Panagiotis Papadimitriou, Vasileios Theodorou, Dimitrios Dechouniotis, Symeon Papavassiliou, Towards Cross-Slice Communication for Enhanced Service Delivery at the Network Edge	p. 22
Ali Esmaily, Katina Kravetska, Danilo Gligoroski, A Cloud-based SDN/NFV Testbed for End-to-End Network Slicing in 4G/5G	p. 29

Abdullah A. Al-khatib, Abdelmajid Khelil, Priority- and Reservation-based Slicing for Future Vehicular Networks	p. 36
Hamed Z. Jahromi, Declan Delaney, Andrew Hines, How Crisp is the Crease? A Subjective Study on Web Browsing Perception of Above-The-Fold	p. 43
Tobias Hoßfeld, Poul E. Heegaard, Martín Varela, Lea Skorin-Kapov, Markus Fiedler, From QoS Distributions to QoE Distributions: A Systems Perspective	p. 51
Sam Van Damme, Maria Torres Vega, Filip De Turck, Human-Centric Quality Management of Immersive Multimedia Applications	p. 57
Susanna Schwarzmann, Thomas Zinner, Linking QoE and Performance Models for DASH-Based Video Streaming	p. 65
Selim Ickin, Konstantinos Vandikas, Farnaz Moradi, Jalil Taghia, Wenfeng Hu, Ensemble-Based Synthetic Data Synthesis for Federated QoE Modeling	p. 72
Steven Van Rossem, Thomas Soenen, Wouter Tavernier, Didier Colle, Mario Pickavet, Piet Demeester, Adaptive & Learning-Aware Orchestration of Content Delivery Services	p. 77
Muhammad Umar Masood, Ihtesham Khan, Arsalan Ahmad, Muhammad Imran, Vittorio Curri, Smart Provisioning of Sliceable Bandwidth Variable Transponders in Elastic Optical networks	p. 85
Michael Iannelli, Muntasir Raihan Rahman, Nakjung Choi, Le Wang, Applying Machine Learning to End-to-end Slice SLA Decomposition	p. 92
Mario Di Mauro, Antonio Liotta, Maurizio Longo, Fabio Postiglione, Statistical Characterization of Containerized IP Multimedia Subsystem through Queueing Networks	p. 100
Reza Rokui, Henry Yu, Lingli Deng, David Allabaugh, Mahdi Hemmati, Christopher Janz, A Standards-Based, Model-Driven Solution for 5G Transport Slice Automation and Assurance	p. 106
Masahiro Sasabe, Takanori Hara, Shortest Path Tour Problem Based Integer Linear Programming for Service Chaining in NFV Networks	p. 114

Stefan Schneider, Narayanan Puthenpurayil Satheeschandran, Manuel Peuster, Holger Karl, Machine Learning for Dynamic Resource Allocation in Network Function Virtualization	p. 122
Daniel Camps, Ferran Canellas, Azahar Machwe, Jorge Paracuellos, Kostas Choumas, Dimitris Giatsios, Thanasis Korakis, Hadi Razzaghi Kouchaksaraei, 5GOS: Demonstrating multi-domain orchestration of end-to-end virtual RAN services	p. 131
Kostas Choumas, Thanasis Korakis, When Raft Meets SDN: How to Elect a Leader over a Network	p. 140
Giannis Giakoumakis, Eva Papadogiannaki, Giorgos Vasiliadis, Sotiris Ioannidis, Pythia: Scheduling of Concurrent Network Packet Processing Applications on Heterogeneous Devices	p. 145
Alessio Sacco, Flavio Esposito, Guido Marchetto, A Federated Learning Approach to Routing in Challenged SDN-Enabled Edge Networks	p. 150
Kokouvi Benoit Nougnanke, Marc Bruyere, Yann Labit, Low-Overhead Near-Real-Time Flow Statistics Collection in SDN	p. 155
Ahmed Al-Jawad, Purav Shah, Orhan Gemikonakli, Ioan-Sorin Comşa, Ramona Trestian, Performance Evaluation of Routing Strategies over Multimedia-based SDNs under Realistic Environments	p. 160
Fabricio E Rodriguez Cesen, Levente Csikor, Carlos Recalde, Christian Esteve Rothenberg, Gergely Pongrácz, Towards Low Latency Industrial Robot Control in Programmable Data Planes	p. 165
Asma Chiha, Marlies Van der Wee, Keith Briggs, Didier Colle, Techno-economic evaluation of a brokerage role in the context of integrated satellite-5G networks	p. 170
Jorge Baranda, Josep Mangles-Bafalluy, Ricardo Martinez, Luca Vettori, Kiril Antevski, Carlos J. Bernardos, Xi Li, 5G-TRANSFORMER meets Network Service Federation: design, implementation and evaluation	p. 175
Raffaele Bolla, Roberto Bruschi, Franco R. Davoli, Chiara Lombardo, Jane Frances Pajo, Debunking the “Green” NFV Myth: An Assessment of the Virtualization Sustainability in Radio Access Networks	p. 180

Douglas Harewood-Gill, Trevor Martin, Reza Nejabati, The Performance of Q-Learning within SDN Controlled Static and Dynamic Mesh Networks	p. 185
Sergio Gramacho, Felipe Gramacho, Avani Wildani, Autonomic Formation of Large-Scale Wireless Mesh Networks	p. 190
Benjamin Ujcich, Adam Bates, Bill Sanders, Provenance for Intent-Based Networking	p. 195
Arij Elmajed, Armen Aghasaryan, Eric Fabre, Machine Learning Approaches to Early Fault Detection and Identification in NFV Architectures	p. 200
Abdunasser Alowa, Thomas Fevens, A Dynamic Recovery Module For In-band Control Channel Failure In Software Defined Networking	p. 209
Kurt Friday, Elie F. Kfoury, Elias Bou-Harb, Jorge Crichigno, Towards a Unified In-Network DDoS Detection and Mitigation Strategy	p. 218
Shwetha Vittal, Mohit Kumar, Antony Franklin A, Adaptive Network Slicing with Multi-Site Deployment in 5G Core Networks	p. 227
Pol Alemany, Ricard Vilalta, Felipe Vicens, Ignacio Domínguez Gómez, Ramon Casellas, Ricardo Martinez, Sonia Castro, Josep Martrat, Raul Muñoz, Hybrid Network Slicing: Composing Network Slices based on VNFs, CNFs Network Services	p. 232
Roberto Bruschi, Franco R. Davoli, Guerino Lamanna, Chiara Lombardo, Sergio Mangialardi, Jane Frances Pajo, Enabling Edge Computing Deployment in 4G and Beyond	p. 237
Sławomir Kuklinski, Lechosław Tomaszewski, Pawel Korzec, Robert Kołakowski, 5G-UASP: 5G-based multi-provider UAV platform architecture	p. 242
Paul Veitch, John J Browne, Jonas Krogell, An Integrated Instrumentation and Insights Framework for Holistic 5G Slice Assurance	p. 247
Josué Castañeda, Sami Yangui, Saul Pomares, Julio César Pérez Sansalvador, Khalil Drira, Coordination Algorithm for Migration of Shared VNFs in Federated Environments	p. 252

Kallol Krishna Karmakar, Vijay Vardharajan, Uday Tupakula, Surya Nepal, Chandra Thapa, Towards a Security Enhanced Virtualised Network Infrastructure for Internet of Medical Things (IoMT)	p. 257
Uday Tupakula, Vijay Varadharajan, Kallol Krishna Karmakar, Attack Detection on the Software Defined Networking Switches	p. 262
Yukito Ueno, Ryo Nakamura, Yohei Kuga, Hiroshi Esaki, Spider: Parallelizing Longest Prefix Matching with Optimization for SIMD Instructions	p. 267
Takahiro Hirayama, Masahiro Jibiki, Ved P. Kafle, Regressor Relearning Architecture Adapting to Traffic Trend Changes in NFV Platforms	p. 272
Xin Zhe Khooi, Levente Csikor, Dinil Mon Divakaran, Min Suk Kang, DIDA: Distributed In-Network Defense Architecture Against Amplified Reflection DDoS Attacks	p. 277
Mikhail Zolotukhin, Sanjay Kumar, Timo Hämäläinen, Reinforcement Learning for Attack Mitigation in SDN-enabled Networks	p. 282
Nikos Kostopoulos, Dimitris Kalogeras, Vasilis Maglaris, Leveraging on the XDP Framework for the Efficient Mitigation of Water Torture Attacks within Authoritative DNS Servers	p. 287
Michel Gokan Khan, Javid Taheri, Mohammad Ali Khoshkholghi, Andreas J. Kessler, Carolyn Cartwright, Marian Darula, Shuiguang Deng, A Performance Modelling Approach for SLA-Aware Resource Recommendation in Cloud Native Network Functions	p. 292
Alireza Erfanian, F. Tashtarian, Reza Farahani, Christian Timmerer, Hermann Hellwagner, On Optimizing Resource Utilization in AVC-based Real-time Video Streaming	p. 301
Anastasios Zafeiropoulos, Eleni Fotopoulou, Manuel Peuster, Stefan Schneider, Panagiotis Gouvas, Marcel Müller, Patrick-Benjamin Bök, Panagiotis Trakadas, Panagiotis Karkazis, Holger Karl, Benchmarking and Profiling 5G Verticals' Applications: an Industrial IoT Use Case	p. 310
Danny Alex Lachos Perez, Christian Esteve Rothenberg, Mateus Santos, Pedro Henrique Gomes, ANI: Abstracted Network Inventory for Streamlined Service Placement in Distributed Clouds	p. 319

Cristina Dominicini, Diego Mafioletti, Ana Locateli, Rodolfo S Villaca, Magnos Martinello, Moises R. N. Ribeiro, Alexander Gorodnik, PolKA: Polynomial Key-based Architecture for Source Routing in Network Fabrics	p. 326
Bin Li, Yipeng Wang, Ren Wang, Tsung-Yuan (Charlie) Tai, Ravishankar Iyer, Zhu Zhou, Andrew Herdrich, Tong Zhang, Ameer Haj-Ali, Ion Stoica, Krste Asanović, RLDRM: Closed Loop Dynamic Cache Allocation with Deep Reinforcement Learning for Network Function Virtualization	p. 335
Pedro Heleno Isolani, Jetmir Haxhibeqiri, Ingrid Moerman, Jeroen Hoebeke, Johann M. Marquez-Barja, Lisandro Z Granville, Steven Latré, An SDN-based framework for Slice Orchestration using In-Band Network Telemetry in IEEE 802.11	p. 344
Marcel Müller, Daniel Behnke, Patrick-Benjamin Bök, Stefan Schneider, Manuel Peuster, Holger Karl, Cloud-Native Threat Detection and Containment for Smart Manufacturing	p. 347
Estefania Coronado, Gabriel Cebrián-Márquez, Roberto Riggio, Enabling Autonomous and Connected Vehicles at the 5G Network Edge	p. 350
Christian Esteve Rothenberg, Danny Alex Lachos Perez, Nathan F. Saraiva de Sousa, Raphael Rosa, Raza UI Mustafa, Md Tariqul Islam, Pedro Henrique Gomes, Intent-based Control Loop for DASH Video Service Assurance using ML-based Edge QoE Estimation	p. 353
Hiroki Baba, Takayuki Nakamura, Aki Fukuda, Hiroshige Tanaka, Taiki Yamazaki, Noriyoshi Yamazaki, Noritaka Abe, 5G xHaul Sharing as Slice Implementation with inter- and intra-operator orchestration	p. 356
Shiku Hirai, Takuya Tojo, Saburo Seto, Seisho Yasukawa, Automated Provisioning of Cloud-Native Network Functions in Multi-Cloud Environments	p. 359
José Santos, Tim Wauters, Bruno Volckaert, Filip De Turck, Live Demonstration of Service Function Chaining allocation in Fog Computing	p. 362
Carlos Manso, Ricard Vilalta, Ramon Casellas, Ricardo Martinez, Raul Muñoz, Cloud-native SDN Controller Based on Micro-Services for Transport Networks	p. 365
Davide Sanvito, Andrea Marchini, Ilario Filippini, Antonio Capone, CEDRO: an in-switch elephant flows rescheduling scheme for data-centers	p. 368

Felix Bachmann, Robert Bauer, Hauke Heseding, Martina Zitterbart, TopoSync-SFC: SFC-aware Network-driven Synchronization of Multicast Traffic in Software-defined Environments	p. 377
Alessio Ferrari, Jan Kundrát, Esther Le Rouzic, Mark Filer, Andrea Campanella, Andrea D'Amico, Karthikeyan Balasubramanian, Yawei Yin, Ondřej Havliš, Michal Hažlinský, Josef Vojtech, Jean-Luc Auge, Gert Grammel, Gabriele Maria Galimberti, Vittorio Curri, The GNPY Open Source Library of Applications for Software Abstraction of WDM Data Transport in Open Optical Networks	p. 386
Stuart Clayman, Francesco Tusa, Alex Galis, Luis M. Contreras, WIM on-demand – A modular approach for managing network slices	p. 395
José J Alves Esteves, Amina Boubendir, Fabrice M. Guillemin, Pierre Sens, Location-based Data Model for Optimized Network Slice Placement	p. 404
Thomas Lin, Simona Marinova, Alberto Leon-Garcia, Towards an End-to-End Network Slicing Framework in Multi-Region Infrastructures	p. 413
Alessandro Carrega, Luca Caviglione, Matteo Repetto, Marco Zuppelli, Programmable Data Gathering for Detecting Stegomalware	p. 422
Daniel Spiekermann, Joerg Keller, Impact of Virtual Networks on Anomaly Detection with Machine Learning	p. 430
Vasileios Koutsouvelis, Stavros Shiaeles, Bogdan Ghita, Gueltoum Bendiab, Detection of Insider Threats using Artificial Intelligence and Visualisation	p. 437
Gueltoum Bendiab, Stavros Shiaeles, Abdulrahman Alruban, Nicholas Kolokotronis, IoT Malware Network Traffic Classification using Visual Representation and Deep Learning	p. 444
Panagiotis Radoglou-Grammatikis, Panagiotis Sarigiannidis, Eider Iturbe, Erkuden Rios, Antonis Sarigiannidis, Odysseas Nikolis, Dimosthenis Ioannidis, Vasileios Machamint, Michalis Tzifas, Alkiviadis Giannakoulis, Michail K. Angelopoulos, Anastasios Papadopoulos, Francisco Ramos, Secure and Private Smart Grid: The SPEAR Architecture	p. 450

- Tooba Hasan, Adnan Akhunzada, Thanassis Giannetsos, Jahanzaib Malik, p. 457
Orchestrating SDN Control Plane towards Enhanced IoT Security
- Sotirios Brotsis, Nicholas Kolokotronis, Konstantinos Limniotis, Stavros Shiaeles, On p. 465
the Security of Permissioned Blockchain Solutions for IoT Applications
- Daniele Bringhenti, Guido Marchetto, Riccardo Sisto, Fulvio Valenza, Jalolliddin p. 473
Yusupov, Introducing programmability and automation in the synthesis of virtual
firewall rules
- Antonio Suriano, Domenico Striccoli, Giuseppe Piro, Raffaele Bolla, Gennaro p. 479
Boggia, Attestation of Trusted and Reliable Service Function Chains in the ETSI-
NFV Framework
- Mehrdad Hajizadeh, Nima Afraz, Marco Ruffini, Thomas Bauschert, Collaborative p. 487
Cyber Attack Defense in SDN Networks using Blockchain Technology