

2025 IEEE 21st International Conference on Factory Communication Systems (WFCS 2025)

**Rostock, Germany
10-13 June 2025**



**IEEE Catalog Number: CFP25WFC-POD
ISBN: 979-8-3315-3006-8**

**Copyright © 2025 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:	CFP25WFC-POD
ISBN (Print-On-Demand):	979-8-3315-3006-8
ISBN (Online):	979-8-3315-3005-1
ISSN:	2835-8511

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 Contents

Live Demonstrations

Chairs: Helge Parzyjegl, Peter Danielis, Axel Sikora

Traffic Pattern-Based Scheduling for Wireless Non-TSN End Nodes.....	1
<i>Pablo Avila-Campos, Jetmir Haxhibeqiri, Xianjun Jiao, Ingrid Moerman, Jeroen Hoebeke</i>	
A Teleoperation Testbed for Resilient Wireless Industrial Collaborative Robotics Evaluations.....	3
<i>Jan Herbst, Jan Petershans, Eric Mittag, Matthias Rüb, Christian König, Hans D. Schotten</i>	
Continuous Streaming in Roaming Scenarios: A Model Truck-Based Demonstration.....	5
<i>Daniel Tappe, Alex Bendrick, Rolf Ernst</i>	
Analysis of the operation of a TSN switch and other devices using executable QR codes	7
<i>Stefano Scanzio, Pietro Chiavassa, Gianluca Cena</i>	
Testing Time-Sensitive Network Schedules for Practical Applicability	9
<i>Willi Brekenfelder, Helge Parzyjegl, Peter Danielis, Gero Mühl, Fabian Kummer, Eike Schweissguth, Frank Golasowski</i>	

Regular Session 1.1: TSN & Integration to 5G

Chairs: Mohammad Ashjaei, Axel Sikora

Modularity-Driven Group Scheduling for Time-Sensitive Networks.....	11
<i>Lei Zhang, Wending Wang, Paul Pop</i>	
A Wireless TSN Scheduling Algorithm Based on Strict Priority with Dynamic Queues.....	19
<i>Mohammed Wahhab, Axel Sikora, Abdulkareem A. Kadhim</i>	
Empirical Analysis of the Impact of 5G Jitter on Time-Aware Shaper Scheduling in a 5G-TSN Network ..	27
<i>Pablo Rodríguez, Oscar Adamuz-Hinojosa, Pablo Muñoz, Julia Caleyá-Sánchez, Jorge Navarro-Ortiz, Pablo Ameigeiras</i>	

Regular Session 1.2: 5G Networks

Chairs: Mohammad Ashjaei, Axel Sikora

A YANG Model-Based Approach for Configuration and Management of 5G-TSN Bridges.....	35
<i>Manuel Schappacher, Dominik Welte, Axel Sikora, Christopher Lehmann</i>	
DeSiRe-NG: An Architecture for Autonomous and Assisted 5G Network Measurement and Emulation	43
<i>Simon Welzel, Niels Hendrik Flidner, Maxim Friesen, Christian Tismer, Philip Mildner, Syed Abdullah Rizvi, Claudius Noack, Lukas Dalhoff, Henning Trsek, Florian Klingler</i>	
User Plane Positioning in 5G Networks: A Design Space Study for Implementation	51
<i>Nico Kalis, Christian Haubelt, Frank Golasowski</i>	

WiP-Presentations

Chairs: Hans-Peter Bernhard, Jetmir Haxhibeqiri

Clustering of Distributed Observations for Traffic Classification in Industrial Networks.....	59
<i>Emiliano Sisinni, Dennis Brandao, Alessandra Flammmini, Massimiliano Gaffurini, Paolo Ferrari</i>	
Comparative Analysis of CAN FD and 10BASE-T1S Ethernet for Time-Critical Applications in Automotive Networks	63
<i>Kirsten Matheus, Christina Hein, Joachim Berlak</i>	
Drive Test Across Europe for 5G Cellular Multi-Connectivity in Roaming Scenarios: The Livestock Transport Use Case	67
<i>Alejandro Ramírez-Arroyo, Miguel Villanueva-Fernández, Michael Nørremark, Jesper Schimann Hansen, Preben Mogensen, David Pradas</i>	

Intelligent 5G communication with Smart Resource Flow and EmKoI4.0 Orchestrator.....	71
<i>Fumiko Otori, Santiago Soler Perez Olaya, Hasal Kulasekara Pallevaththe Kankanamge, Gustavo Cainelli, SATOKO ITAYA, Taketoshi Nakajima, Toru Osuga, Noriharu Suematsu, Takashi Shiba, Martin Wollschlaeger</i>	
First Analysis of Time Synchronization for TSN Networks with Hot Standby GM.....	75
<i>Mahin Ahmed, Lucas Haug, Raheeb Muzaffar, Damir Hamidovic, Armin Hadžiaganović, Hans-Peter Bernhard</i>	
On the Prediction of Wi-Fi Performance through Deep Learning.....	79
<i>Gabriele Formis, Amanda Ericson, Stefan Forsström, Kyi Thar, Gianluca Cena, Stefano Scanzio</i>	
Time Sensitive Networking Testbed with Wireless Real-Time Connectivity via Li-Fi and Energy Efficiency Analysis.....	83
<i>Philipp Meißner, Frank Bär, René Kirrbach</i>	
IoTWall: An Efficient Host-Based Firewall for Resource-Constrained IoT Devices.....	87
<i>Markus Schramm, Lukas Bechtel, Florian Hoss, Michael Menth, Tobias Heer</i>	
Analysis and Simulation of Converged Data Traffic in Time-Sensitive Networks.....	91
<i>Julian Oertel, Helge Parzyjegl, Peter Danielis</i>	
Compression of executable QR codes or sQRy for Industry: an example for Wi-Fi access points.....	95
<i>Stefano Scanzio, Gabriele Formis, Pietro Chiavassa, Lukasz Wisniewski, Gianluca Cena</i>	
TSN Schedule Evaluation for Online Compression.....	99
<i>Fabian Kummer, Michael Nast, Frank Golatowski, Christian Haubelt, Willi Brekenfelder, Helge Parzyjegl, Peter Danielis</i>	
Towards a novel gateway selection strategy for LoRaWAN downlink communications.....	103
<i>Mattia Pirri, Luca Leonardi, Lucia Lo Bello, Gaetano Patti</i>	
Characterization of LiFi-over-Powerline Channels for Industrial Internet-of-Things Applications.....	107
<i>Atiyeh Pouralizadeh, Sreelal Maravanchery Mana, Kai Lennert Bober, Volker Jungnickel, Andrea Tonello, christos Giachoudis, Ali Khalighi</i>	
Achieving reduced latency and energy efficiency in Direct-to-Satellite LoRaWAN communications.....	111
<i>Florian Rolland, Zheng Zhou, Nicola Accettura, Pascal Berthou</i>	
Dissimilarity-Based Localization in Wireless Angle-of-Arrival Systems.....	115
<i>Daniel Meiburg, Fabian Kummer, Benjamin Rother, Frank Golatowski, Christian Haubelt</i>	
SS01: Wireless Communication Systems in Real-World Environments	
<i>Chairs: Parva Yazdani, Emiliano Sisinni</i>	
Towards Future Industrial Connectivity: Evaluation of Private 5G and Wi-Fi Networks in Professional Industrial Environments.....	119
<i>Christian Arendt, Stefan Böcker, Hendrik Schippers, Christian Wietfeld, Thomas Ploch, Mario Kuhn, Veit Venjakob, Sebastian Hunger</i>	
Enabling scalable AI-based quality control of production lines through 5G/Wi-Fi aggregation.....	127
<i>Mahdi Darroudi, Ivan Boyano, Miguel Urias, Hugo Dobarro, Ferran Cañellas, Daniel Camps Mur</i>	
Wireless Robotic Motion Controller: System Architecture and Latency Assessment.....	134
<i>Jan Petershans, Florian Lehn, Jan Herbst, Hans D. Schotten</i>	
SS02: Communication Technologies for Rural Areas and Sustainable Agriculture	
<i>Chairs: David Pradas, Alejandro Ramírez Arroyod</i>	
Nomadic 5G Network with Satellite based Internet Connectivity for Agriculture.....	142
<i>Felix Kahmann, Lennart Schonebeck, Ralf Tönjes, Timo Kranz, Till Zimmermann, Dominic Laniewski, Harald Andreesen, Andreas Möller</i>	
Leveraging Satellite Constellations to Boost 5G Reliability for Connected Livestock Transport.....	150
<i>Pradas Pradas, Matthieu Petrou, Mathias Ettinger, Santiago Garcia-Guillen, Alejandro Ramírez-Arroyo</i>	

Latency Analysis for Satellite IoT in Remote Areas	158
<i>Andreadis Alessandro, Giovanni Giambene, Riccardo Zambon</i>	

Regular Session 2: Wireless Communication & IoT Applications

Chairs: Gianluca Cena, Santiago Soler Perez Olaya

On the Suitability of Wi-Fi for Interconnecting Moving Equipment in Industrial Environments	166
<i>Pietro Chiavassa, Stefano Scanzio, Gianluca Cena</i>	
Analysis of Communication and Control Performance of Multi-Hop IEEE 802.15.4-based WNCs under Wi-Fi Interference	174
<i>Muhammad Azeem Khan, Yuriy Zacchia Lun, Piergiuseppe Di Marco, Aamir Mahmood, Fortunato Santucci, Mikael Gidlund</i>	
Digital Twin-Based in Next-Generation Wi-Fi Networks: Survey and Future Challenges	182
<i>Jose Pulido Alegre, Sergio Fortes, Raquel Barco</i>	
Sparse Vector Coding for Sensor Data Transmission in Cyber-Physical Systems and Digital Twins	190
<i>Iñigo Bilbao, Myung-Sun Baek, Eneko Iradier, Won-Jae Shin, Jon Montalban, Pablo Angueira</i>	
Evaluating Differential Firmware Updates for Embedded IoT Device Fleets	196
<i>Jayden Sorensen, Syed Aftab Rashid, Hossam ElHussini, Andrei-Marian Dan</i>	
Performance Analysis of Multi-Hop Networks at Terahertz Frequencies	204
<i>Sara Cavallero, Andrea Pumilia, Giampaolo Cuzzo, Alessia Tarozzi, Chiara Buratti, Roberto Verdone</i>	

SS03: Intelligent Systems and Artificial Intelligence for Industrial Networks and Distributed Applications

Chairs: Mahin Ahmed, Kyi Thar

DIAMOND: Dynamic Industrial and ML-Optimized Network Design	211
<i>Marco Reisacher, Nikolaos Mitsakis, Andreas Blenk</i>	
On the Development and Application of a Structured Dataset for Data-Driven Risk Assessment in Industrial Functional Safety	219
<i>Padma Iyengar</i>	
WiFi-CSI sensing for human presence and machine activity in industrial environments	227
<i>Elizabeth De Armas, Iker Sobron, Iñaki Eizmendi, José María Matías, Guillermo Díaz</i>	
Risk-Aware Prioritization of Data Clumps Refactoring in Industrial Automation	235
<i>Padma Iyengar, Nils Baumgartner, Elke Pulvermueller</i>	

SS04: Unlicensed Spectrum Technologies: The Next Frontier for Reliable Industrial Wireless

Chairs: Volker Jungnickel, Pablo Angueira

Wi-Fi Performance Evaluation in Industrial Scenarios	243
<i>Jian Wen, Ki Won Sung, Slimane Ben Slimane, Charlie Pettersson, Sebastian Max</i>	
Seamless Roaming based on Distributed Multi-Link Operation over IEEE 802.11bn	251
<i>Ben Mecklenburg, Ahmed Hasan Ansari, Bjoern Richerzhagen, Michael Bahr, Georg Carle</i>	
Widening the Coverage of Reference Broadcast Infrastructure Synchronization in Wi-Fi Networks	259
<i>Gianluca Cena, Pietro Chiavassa, Gabriele Formis, Stefano Scanzio</i>	

Regular Session 3: Security Performance

Chairs: Ramez Daoud, Steffen Lindner

How Low Can You Go? Revisiting (S)NTP Time Synchronization for Industrial Networks	267
<i>Steffen Lindner, Amin Shahraki, Dirk Schulz</i>	
Ultra-wideband System Simulation Using SystemC-AMS in Industrial Environment	275
<i>Wolfgang Scherr, Dennis Jeurissen, Bernhard Auinger, Shrief Rizkalla, Antonius Dorda, Andreas Gaich, Florian Peter Michel, Shilpa Shyam</i>	

Transforming the Network into a Filter: Distributed Firewall Rules for Time-Critical Traffic	281
<i>Lukas Bechtel, Samuel Müller, Michael Menth, Tobias Heer</i>	

Regular Session 4: AI for Industrial Applications

Chairs: Stefano Scanzio, Malek Ali

Code and Test Generation for I4.0 State Machines with LLM-based Diagram Recognition	289
<i>Björn Otto, Assanali Aidarkhan, Marko Ristin, Nico Braunsch, Christian Diedrich, Hans Wernher van de Venn, Martin Wollschlaeger</i>	
Enhancing Intrusion Detection in CPS and IIoT with Lightweight Explainable AI Models	297
<i>Amanda Ericson, Kyi Thar, Stefan Forsström</i>	
A Gated-Guided Serial CNN-Transformer Network for High-Speed Railway Traffic Prediction	305
<i>Haoyi Ma, binjie Lu, Tao Zheng, Kyi Thar, Mikael Gidlund</i>	
Enhancing People Counting in Cluttered Environments Using mm-Wave Radar, LSTM, and Ensemble Learning	313
<i>Malek Ali, Roman Marsalek</i>	