

# **2022 International Conference on Localization and GNSS (ICL-GNSS 2022)**

**Tampere, Finland  
7-9 June 2022**



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## Conference Program

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### TUESDAY, 7<sup>th</sup> JUNE

09:30 Conference Opening

Prof. Jari Nurmi (Tampere University)

10:00 Keynote **Keynote: Ignacio Fernandez Hernandez**

**Galileo new signal-in-space features: why and how to use them?**

Session Chair: Jari Nurmi, Tampere University

11:00am – 11:40am Coffee and exhibit break

11:40am – 1:00pm **GNSS Jamming and Spoofing**

Session Chair: Ignacio Fernandez Hernandez, European Commission

11:40 Detection and Classification of GNSS Jammers Using Convolutional Neural Networks.....1

**Best Paper Award**



Iman Ebrahimi Mehr, Fabio Dovis  
*Politecnico di Torino, Italy*

12:00 Participatory Sensing for Localization of a GNSS Jammer.....7

Glädje Karl Olsson<sup>1</sup>, Erik Axell<sup>1</sup>, Erik G. Larson<sup>2</sup>, Panos Papadimitratos<sup>3</sup>

1) *FOI Totalförsvarets forskningsinstitut*; 2) *Linköping University*; 3) *Royal Institute of Technology (KTH)*



12:20 Disruptive GNSS Signal Detection and Classification at Different Power Levels Using Advanced Deep-Learning Approach.....14

Arul Elango, Sahar Ujan, Laura Ruotsalainen

*Department of Computer Science, University of Helsinki, Finland*



12:40 Experimental testing and impact analysis of jamming and spoofing attacks on professional GNSS receivers.....N/A

Sanja Miljanovic<sup>1</sup>, Francesco Ardizzon<sup>1</sup>, Laura Crosara<sup>1</sup>, Nicola Laurenti<sup>1</sup>, Luca Canzian<sup>2</sup>, Enrico Lovisotto<sup>2</sup>, Nicola Montini<sup>2</sup>, Oscar Pozzobon<sup>2</sup>, Rigas Ioannides<sup>3</sup>

1) *University of Padova, Italy, Italy*; 2) *Qascom, Bassano del Grappa, Italy*; 3) *European Space Agency, Noordwijk, The Netherlands*

1:00pm – 2:00pm Lunch

2:00pm – 3:00pm **Positioning Security and Robustness**

Session Chair: Aleksandr Ometov, Tampere University

14:00 Guidelines for Galileo Assisted Commercial Authentication Service Implementation.....21

Rafael Terris-Gallego<sup>1</sup>, Ignacio Fernandez-Hernandez<sup>2</sup>, José A. López-Salcedo<sup>1</sup>, Gonzalo Seco-Granados<sup>1</sup>

1) *Universitat Autònoma de Barcelona (UAB), IEEC-CERES, Barcelona, Spain*; 2) *DG DEFIS, European Commission, Brussels, Belgium*



2) 14:20 On Cryptographic Algorithms and Key Length for Delayed Disclosure Authentication of GNSS.....28

Maki Yoshida<sup>1</sup>, Sumio Morioka<sup>2</sup>, Satoshi Obana<sup>3</sup>

1) *National Institute of Information and Communications Technology, Japan*; 2) *Interstellar Technologies Inc., Japan*; 3) *Hosei University, Japan*



14:40 Low-Complexity Adaptive Direct-State Kalman Filter for Robust GNSS Carrier Tracking.....34

Iñigo Cortés<sup>1,2</sup>, Natalia Conde<sup>1</sup>, Johannes Rossouw van der Merwe<sup>1</sup>, Elena Simona Lohan<sup>2</sup>, Jari Nurmi<sup>2</sup>, Wolfgang Felber<sup>1</sup>

1) *Fraunhofer Institute for Integrated Circuits IIS, Nuremberg, Germany*; 2) *Tampere University, Electrical Engineering Unit, Tampere, Finland*



3:00pm - 3:30pm Coffee and exhibit break

3:30pm - 4:30pm ***IoT, Wearables and Maritime***

Session Chair: Joaquin Torres Sospedra, University of Minho

15:30 Positioning by fingerprinting with multiple cells in NB-IoT networks.....41

Luca De Nardis<sup>1</sup>, Giuseppe Caso<sup>2</sup>, Özgü Alay<sup>3</sup>, Usman Ali<sup>1</sup>, Marco Neri<sup>4</sup>, Anna Brunstrom<sup>5</sup>, Maria-Gabriella Di Benedetto<sup>1</sup>

1) *Sapienza University of Rome, Italy*; 2) *Ericsson Research, Sweden*; 3) *University of Oslo, Norway*; 4) *Rohde&Schwarz, Italy*; 5) *Karlstad University, Sweden*



15:50 Velocity Protection Level for Wearable Devices on TDCP-based Pedestrian Navigation.....48

Ziyou Li, Ni Zhu, Valérie Renaudin  
*Université Gustave Eiffel, France*



16:10 Backing-Up GNSS with R-Mode: Positioning Performance for Recursive Estimators.....N/A

Lukas Hösch, Filippo Giacomo Rizzi, Lars Grundhöfer, Ralf Ziebold, Daniel Medina  
*German Aerospace Center (DLR), Germany*

16:30 end of program

5pm – 6pm Visit to Museum Center Vapriikki

6:15pm – 9:30pm Dinner at Restaurant Finlayson Palace

## WEDNESDAY, 8<sup>th</sup> JUNE

9:15am Opening of the second day

9:20 Keynote

***Roberto Muscinelli:***

***RF threats to GNSS based applications impacting achievable performances: overview and countermeasures***

Session Chair: Jari Nurmi, Tampere University

10:20am - 11:20am      **GNSS Antennas**

Session Chair: Roberto Muscinelli, BIP Consulting

10:20      The Gamma Project: Development of a Galileo-Based Multi-Frequency Multi-Purpose Antenna.....N/A

Mario Faliero<sup>1</sup>, Shu Wang<sup>1</sup>, Niccolò Pastori<sup>2</sup>, Gaetano Pastore<sup>2</sup>, Mirko Antonini<sup>3</sup>, Roberto Muscinelli<sup>4</sup>, Joaquin Reyes Gonzalez<sup>5</sup>, Franco Gottifredi<sup>6</sup>

1) *Amphenol SAA KE Elektronik*; 2) *Thales Alenia Space*; 3) *SpaceEXE*; 4) *Business Integration Partners*; 5) *EUSPA*; 6) *GEA Space*

10:40      Dual-Frequency EGNOS and Galileo-based GNSS Receiver and Antenna for Railway: the TRENI Project.....N/A

Marco Puccitelli<sup>1</sup>, Livio Marradi<sup>1</sup>, Gaetano Pastore<sup>1</sup>, Chiara Manno<sup>1</sup>, Haana Al Bitar<sup>2</sup>, Anne-Marie Tobie<sup>2</sup>, Rodolfo Guidi<sup>3</sup>, Giovanni Galgani<sup>3</sup>, Francesco Inzirillo<sup>4</sup>, Filippo Rodriguez<sup>5</sup>, Alessio Martinelli<sup>5</sup>, Youval Bar Yossef<sup>6</sup>, Daniel Lopour<sup>7</sup>

1) *Thales Alenia Space Italy, Italy*; 2) *Thales Alenia Space France, France*; 3) *Eikontech, Italy*; 4) *Mermec, Italy*; 5) *Telespazio, Italy*; 6) *Saphyrion, Switzerland*; 7) *EUSPA, Czechia*

11:00      MAGICA project: Crossed IFA Multi-frequency GNSS Integrated Cost-effective Antenna for Automotive Applications.....N/A

Marco Antonio Vélez<sup>1</sup>, Jose Javier Vicente<sup>1</sup>, Joan Gemio<sup>1</sup>, Laia Vilalta<sup>1</sup>, Laura Tantinyà<sup>1</sup>, Alberto Gil<sup>2</sup>, Adrián Cardalda<sup>3</sup>, Daniel Baños<sup>1</sup>, Pere Mogas<sup>1</sup>, Joaquín Reyes<sup>4</sup>

1) *Nextium by IDNEO Technologies, S.A.U., Spain*; 2) *SEAT S.A., Spain*; 3) *Rohde & Schwarz GmbH & Co. KG, Germany*; 4) *European Union Agency for the Space Programme, Prague, Czechia*

11:20am – 12:00pm      Coffee and exhibit break

12:00pm – 1:00pm      **Hybrid Positioning**

Session Chair: Joaquin Torres Sospedra, University of Minho

12:00      Mitigation of GNSS errors in urban canyon using Wi-Fi RTT.....N/A

Miquel Garcia Fernandez, Malgorzata Siutkowska, Aleix Tejada Rokubun, Spain

12:20      WIFI radio node location estimation based on GNSS and motion sensor data.....N/A

Pavel Ivanov<sup>1</sup>, Henri Nurminen<sup>1</sup>, Simo Ali-Löyty<sup>2</sup>, Pasi Raunonen<sup>2</sup>

1) *HERE Technologies, Finland*; 2) *Tampere University, Finland*

12:40      Subterranean positioning for a semi-autonomous robot supporting emergency task forces.....55


Eva Reitbauer<sup>1</sup>, Christoph Schmied<sup>1</sup>, Hamid Didari<sup>2</sup>


1) *Institute of Geodesy, Graz University of Technology, Austria*; 2) *Institute of Software Technology, Graz University of Technology, Austria*




1:00pm – 2:00pm      Lunch

2:00pm – 3:20pm                    **Indoor Positioning**  
Session Chair: Adriano Moreira, University of Minho

14:00                    Lightweight Hybrid CNN-ELM Model for Multi-building and Multi-floor Classification.....62   
Darwin Quezada-Gaibor<sup>1,2</sup>, Joaquín Torres-Sospedra<sup>3</sup>, Jari Nurmi<sup>2</sup>, Yevgeni Koucheryavy<sup>2</sup>, Joaquín Huerta<sup>1</sup>  
1) *Institute of New Imaging Technologies, Universitat Jaume I, Castellón, Spain;*  
2) *Electrical Engineering Unit, Tampere University, Tampere, Finland;*  
3) *Centro Algoritmi, Universidade do Minho, Portugal*


14:20                    Towards Accelerated Localization Performance Across Indoor Positioning Datasets.....68  
Lucie Klus<sup>1,2</sup>, Darwin Quezada-Gaibor<sup>2,1</sup>, Joaquin Torres-Sospedra<sup>3,2</sup>, Elena Simona Lohan<sup>1</sup>, Carlos Granell<sup>2</sup>, Jari Nurmi<sup>1</sup>   
1) *Tampere University, Finland;* 2) *Universitat Jaume I, Spain;* 3) *Universidade do Minho, Portugal*


14:40                    Implementation of Embedded Multiple Signal Classification Algorithm for Mesh IoT Networks.....75   
Tiago Troccoli<sup>1,2</sup>, Juho Pirskanen<sup>2</sup>, Aleksandr Ometov<sup>1</sup>, Jari Nurmi<sup>1</sup>, Ville Kaseva<sup>2</sup>  
1) *Tampere University, Finland;* 2) *WIREPAS Ltd., Tampere, Finland*

15:00                    Labeling for UWB Ranging in Weak NLOS Conditions.....82   
Philipp Peterseil, David Märzinger, Bernhard Etzlinger, Andreas Springer  
*Johannes Kepler University Linz, Austria*

3:20pm – 4:00pm                    Coffee and exhibit break

4:00pm - 4:40pm                    **Interference**  
Session Chair: Sanna Kaasalainen, Finnish Geospatial Research Institute FGI

16:00                    Low-cost COTS GNSS interference detection and classification platform: Initial results.....88  
J. Rossouw van der Merwe, David Contreras Franco, Dorsaf Jdidi, Tobias Feigl, Alexander Rügamer, Wolfgang Felber   
*Fraunhofer IIS, Germany*

16:20                    Space Cognitive Communications: Characterizing Radiofrequency Interference to Improve Digital Space Domain Awareness.....96   
Samuel Lefcourt, Nathaniel Gordon, Hanting Wong, Gregory Falco  
*Johns Hopkins University, United States of America*

7pm -10pm    *Lake cruise and dinner, gathering at Laukontori at 18:45*

## THURSDAY, 9<sup>th</sup> JUNE

- 9:15am                                    Opening of the third day
- 9:20am – 10:20am                    **Keynote: Satyam Dwivedi:**  
**3GPP network-based positioning: past, present and immediate future**  
Session Chair: Jari Nurmi, Tampere University
- 10:20am - 11:00am                    **5G Positioning**  
Session Chair: Satyam Dwivedi, Ericsson
- 10:20                                    A CNN Approach for 5G mmWave Positioning Using Beamformed CSI  
Measurements.....103  
Ghazaleh Kia<sup>1</sup>, Laura Ruotsalainen<sup>1</sup>, Jukka Talvitie<sup>2</sup>   
*1) University of Helsinki; 2) Tampere University*
- 10:40                                    Deep Learning-based Fingerprinting for Outdoor UE Positioning Utilising Spatially  
Correlated RSSs of 5G Networks.....110  
Ahmed Al-Tahmeesschi<sup>1</sup>, Jukka Talvitie<sup>2</sup>, Miguel López-Benítez<sup>3,4</sup>, Laura  
Ruotsalainen<sup>1</sup>   
*1) University of Helsinki, Finland; 2) Tampere University, Finland; 3) University of  
Liverpool, United Kingdom; 4) Antonio de Nebrija University, Spain*
- 11:00am - 11:40pm                    Coffee and exhibit break
- 11:40am - 1:00pm                    **GNSS Systems and Applications**  
Session Chairs: Tommaso Senni, RHEA Group; Jari Nurmi, Tampere University
- 11:40                                    Differential ZTD based on high spatial resolution NWP data for the Nordic countries.....117  
Jan Erik Håkegård, Nadezda Sokolova, Aiden Morrison   
*SINTEF, Norway*
- 12:00                                    Transmit Pulse Shaping for 1-bit GNSS Receivers.....124  
Christoph Enneking<sup>1</sup>, Florian Christian Beck<sup>1</sup>, Steffen Thoelet<sup>1</sup>, Felix Antreich<sup>2</sup>  
*1) German Aerospace Center (DLR), Wessling, Germany; 2) Aeronautics Institute of  
Technology (ITA), Sao Jose dos Campos, Brazil* 
- 12:20                                    Evaluation of the Hungarian Algorithm for Optimal Transmission of the Galileo  
HAS Message from Multiple Satellites.....130  
Tommaso Senni<sup>1</sup>, Ignacio Fernández-Hernández<sup>2</sup>, Simòn Cancela<sup>3</sup>   
*1) RHEA group for European Commission, Leiden, The Netherlands; 2) European  
Commission, Brussels, Belgium; 3) GMV, Tres Cantos, Spain*
- 12:40                                    Instantaneous real-time kinematic decimeter-level positioning with Galileo and BDS-3  
penta-frequency signals over long-baseline.....N/A  
Liwei Liu, Shuguo Pan, Wang Gao, Chun Ma  
*Southeast University, China*
- 1:00pm – 2:00pm                    Lunch

2:00pm – 2:40pm                    **Classification and Characterization**

Session Chair: Jari Nurmi, Tampere University

14:00                    LoRaWAN Fingerprinting with K-Means: The Relevance of Clusters Visual  
Inspection.....N/A  
Joaquín Torres-Sospedra<sup>1</sup>, Michiel Aernouts<sup>2</sup>, Adriano Moreira<sup>1</sup>, Rafael Berkvens<sup>2</sup>  
1) *University of Minho - Algoritmi Research Centre, Guimarães, Portugal;*  
2) *University of Antwerp - imec, IDLab - Faculty of Applied Engineering, Antwerp, Belgium*

14:20                    Agriculture Professional GNSS Receivers: Performance Comparison in Controlled  
and Operational Scenarios.....N/A  
Jacopo Capolicchio<sup>1</sup>, Daniele Mennuti<sup>1</sup>, Ileana Milani<sup>1</sup>, Marco Fortunato<sup>2</sup>, Riccardo  
Petix<sup>3</sup>, Joaquin Reyes Gonzalez<sup>4</sup>, Martin Sunkevic<sup>4</sup>  
1) *Thales Alenia Space Italia;* 2) *Randstad Italia;* 3) *Business Integration Partners;*  
4) *EU Agency for the Space Programme (EUSPA)*

2:40pm – 3:00pm                    **Awards and Closing**

Session Chair: Jari Nurmi, Tampere University

6pm – 9pm    *Farewell beers and dinner at brewery restaurant Plevna*