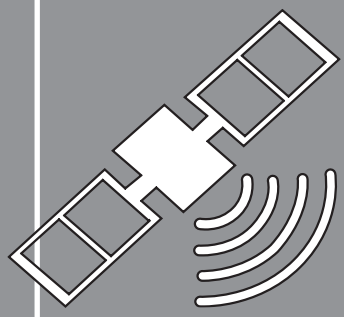
ION IEEE AESS

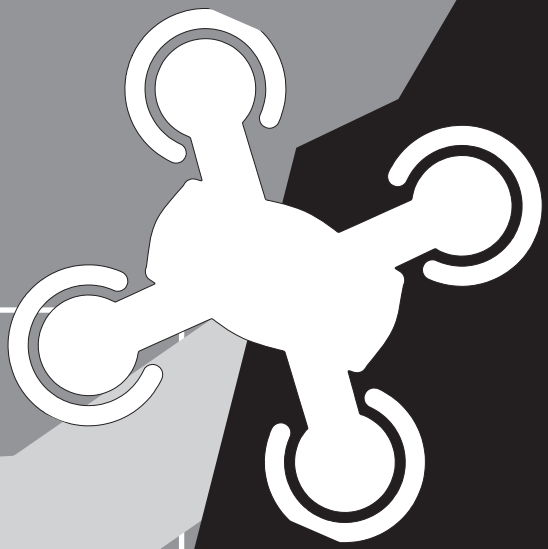
PLANS

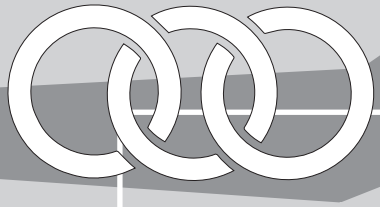
IEEE/ION Position, Location, and Navigation Symposium

April 28–May 1, 2025

Marriott Salt Lake Downtown City Creek
Salt Lake City, UT







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See page 3 for details.

CONFERENCE PROGRAM

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ION President & PLANS Executive Comm.Chair
Dr. Gary McGraw
Genova Technologies

Program Chair
Dr. Christian Gentner
German Aerospace Center (DLR)

Tutorial Chair
Dr. Fabio Dovis
Politecnico di Torino

Track A:
Dr. Vibhor Bageshwar
Honeywell

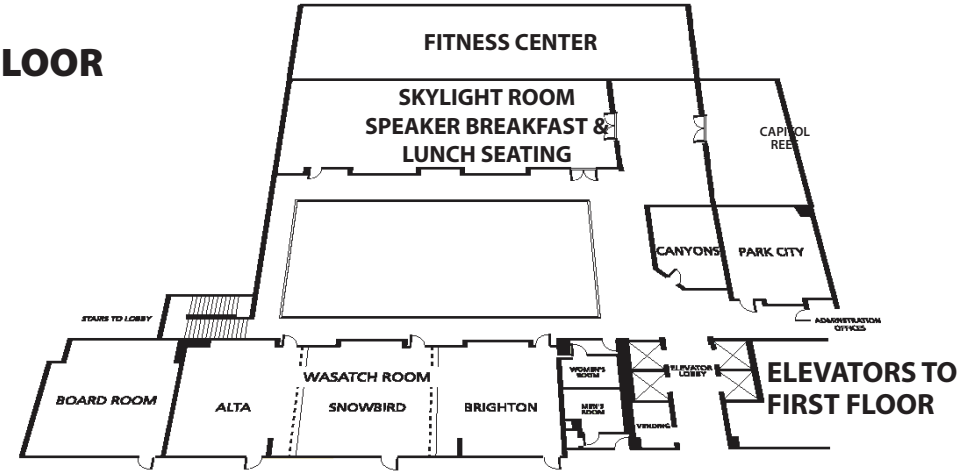
Track B:
Dr. Thomas Pany
University of the Bundeswehr Munich

Track C:
Dr. Zak Kassas
The Ohio State University

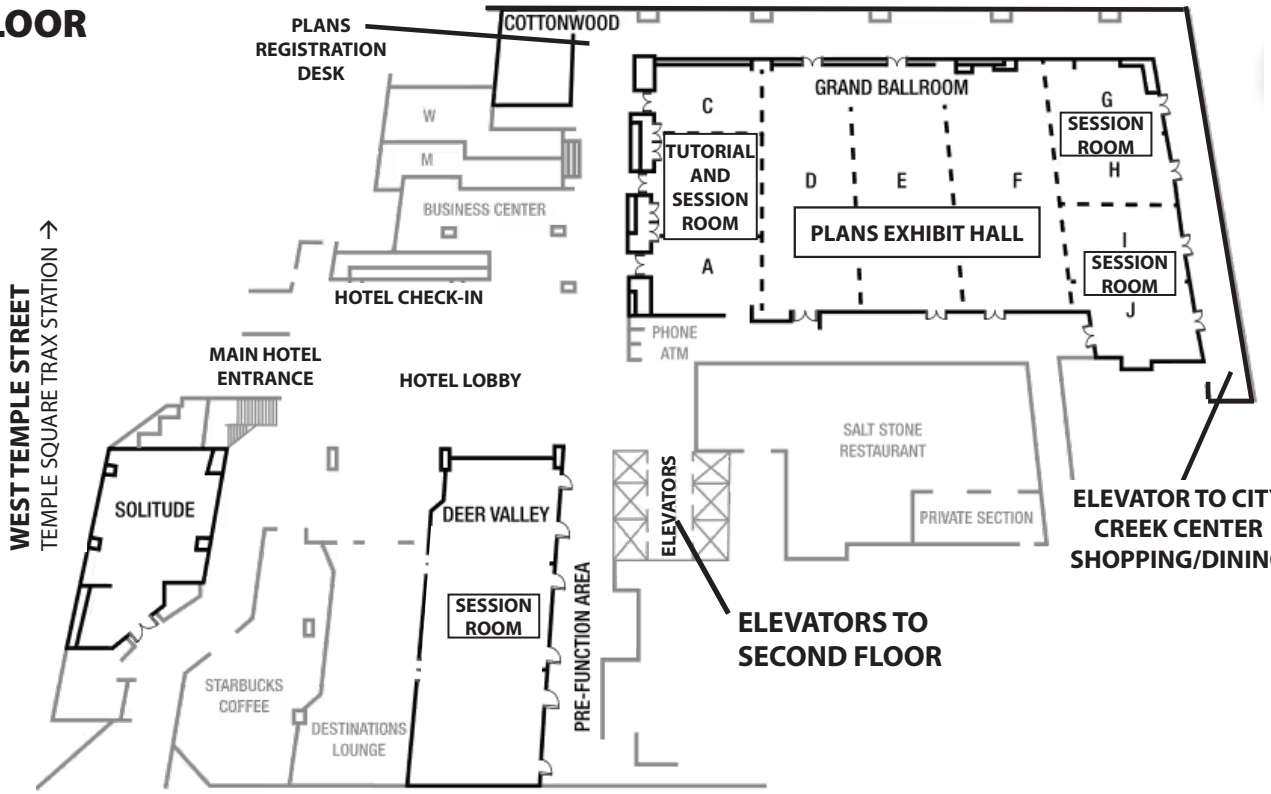
Track D:
Dr. Mohammed Khider
Google

SALT LAKE MARRIOTT AT CITY CREEK CENTER FLOOR PLAN

SECOND FLOOR



FIRST FLOOR



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Conference Special Events

The following meals and events are all included in all full-conference and student registrations. Single day registrations include events taking place on the day the attendee is registered.

Tuesday, April 29

- Informal Luncheon, 12:15 p.m. - 1:15 p.m., Exhibit Hall
- Evening in Exhibit Hall, 5:30 p.m. - 6:30 p.m., Exhibit Hall

Wednesday, April 30

- Informal Luncheon, 12:15 p.m. - 1:15 p.m., Exhibit Hall

Thursday, May 1

- Awards Luncheon, 12:15 p.m. - 1:45 p.m.
  (late arrivals cannot be served after 12:30 p.m.)
  The IEEE will present the Kershner Award and Walter Fried Award. This event is included in all full-conference or Thursday-only registrations. Guest tickets may be purchased at the PLANS registration desk.

For Speakers and Session Chairs

A mandatory Speakers ' Breakfast will be held at 7:30 a.m. Tuesday - Thursday in the Skylight Room on the second floor. This event is for session chairs and the presenting author (for both primary and alternate presentations), who are presenting that day only. Names will be checked at the door. Please attend the Speakers' Breakfast the morning of your presentation only.

Access to Technical Papers/Presentations

Qualified attendees may download copies of conference papers online for FREE by logging in at ion.org/plans. Only papers provided to the ION by the presenting author will be available. If a desired document is not available, we recommend you contact the author directly. Official conference proceedings will be distributed electronically in May to eligible participants.

New! ION Conferences App

The ION Conferences app enables attendees to view the current program, create a custom schedule, view exhibit information and more, right from their mobile device. Download "ION Conferences" from your device's app store, and click on "IEEE/ION PLANS 2025" on the app home screen to download the meeting guide.

Local Attractions

City Creek Center

Located right next door to the hotel, City Creek Center is a shopping and dining destination featuring over 100 shops and restaurants. For a list of shops and restaurants visit https://shopcitycreekcenter.com.

To get to City Creek Center, either exit through the main hotel lobby and turn right on W. Temple St., or take the elevator located by Grand Ballroom J up into the heart of the Center.

The Tabernacle Choir

For more than nine decades, The Tabernacle Choir has presented a weekly program, "Music & the Spoken Word." Public audiences are invited to join the live rehearsals held each Thursday at 7:30 p.m. Rehearsals are held 3 blocks from the hotel at the Tabernacle on Temple Square, 50 NW Temple St.

Getting Around Salt Lake City

TRAX Light Rail Service

Public transportation to/from Salt Lake City International Airport and throughout downtown is provided by the TRAX light rail system. The closest TRAX stop to the hotel is the Temple Square Station (Green Line), located one block from the hotel at the intersection of S. Temple St. and W. Temple St. TRAX runs seven days per week, with 15-minute frequency during peak times. Fare is free within the Free Fare Zone, pictured below. One-way fare for the train outside of this zone is $2.50. Tickets should be purchased before boarding, and can be purchased at the station using the ticket vending machine, or in advance using the UTA's app, called Transit. More information: ideuta.com/Rider-Info.

Free Fare Zone on the TRAX Green Line:

Scan QR for full color free zone map and more information.

GREENbike SLC

GREENbike, Salt Lake City's bike-share program, provides an alternate, green, transportation option to get around town. Access passes for GREENbike are available for as little as $7 for a 24-hour access pass. Riders can purchase passes at GREENbike stations, at greenbikeslc.org, or using the BCycle App. The closest bike station to the hotel is one block away at 100 S Main St.

Lime Scooters

Lime has deployed hundreds of ready-to-ride scooters at convenient locations around the city. Download the Lime app to see a map of scooters near you, and be on your way. Once you arrive, set your scooter on the sidewalk for the next person.

Reduced Parking Fees for Attendees

The conference has negotiated a parking price of $12.50 per night for attendees, reduced from the hotel's normal $25 per night fee. This reduced rate will be automatically applied to those attendees staying in the hotel room block (your room key is also your key to the garage). For those who did not book a hotel in the PLANS room block, validation stickers will be available at the PLANS registration desk.

1. Attach Validation sticker to the Parking Voucher you were given when entering the parking garage.
2. Insert the voucher, with affixed sticker, into the machine as you are leaving the parking garage.
3. The machine will scan the validation sticker and discount the parking accordingly.

PLANS Pre-Conference Tutorials

Monday, April 28 - 8:30 a.m. – 5: 00 p.m., Grand Ballroom ABC

Tutorial and Instructor Information

Pre-conference tutorials have been organized to provide in-depth learning prior to the start of the technical program. Separate registration and fee is required for full day of tutorial courses. Tutorials will be taught in a classroom setting. Electronic notes will be made available to registrants for download in advance of courses. Power for attendee laptops will not be available. ION reserves the right to cancel a portion of the tutorial program based on availability of the instructor.

Vision-Based Navigation: Techniques and Applications

8:30 a.m. - 10:15 a.m.

This tutorial provides an introduction to vision-based navigation, a rapidly advancing field at the intersection of computer vision, robotics, and artificial intelligence. Vision-based navigation enables autonomous systems, such as drones and self-driving vehicles, to interpret and navigate their environment using visual data. Additionally, it offers potential benefits for pedestrians in infrastructure-free indoor navigation. We will cover key topics, including feature extraction, object recognition, visual odometry, simultaneous localization and mapping (SLAM), and path planning. Participants will learn how to process and utilize visual information for accurate positioning and navigation in dynamic environments. We will also discuss recent machine learning advancements in this field and examine why they have yet to be widely implemented in real-world applications.

Dr. Laura Ruotsalainen is a professor in computer science at the University of Helsinki and a steering group member for the Finnish Center for Artificial Intelligence (FCAI).

Estimation of Noise Parameters in State Space Models

10:30 a.m. - 12:15 p.m.

The tutorial introduces a more than six decades-long history as well as recent advances and state-of-the-art methods for estimating the properties of the stochastic part of the state-space model. In particular, estimation of the state and measurement noise means, covariance matrices, and other parameters are treated. The tutorial covers all major groups of noise statistics estimation methods, including correlation, maximum likelihood, covariance matching, machine learning, and Bayesian methods. The methods are introduced in the unified framework highlighting their basic ideas, key properties, and assumptions. Algorithms of individual methods are described and analyzed to provide a basic understanding of their nature and similarities. The performance of the methods is compared using a numerical illustration and available MATLAB implementations.

Dr. Jindrich Duník is an associate professor of cybernetics at the University of West Bohemia and a senior scientist at Honeywell Aerospace.

Dr. Ondrej Straka is an associate professor of cybernetics at the University of West Bohemia working in the areas of state estimation, fault detection, and GNSS navigation.

GNSS in the Age of Machine Learning

1:15 p.m. - 3:00 p.m.

The use of machine learning - based solutions is one of the emerging trend in GNSS to to enhance the accuracy, reliability, and robustness of PNT systems. The tutorial discusses the role and opportunities given by such techniques in the GNSS field, discussing its use with respect to analytical approaches. In particular, deep learning algorithms are data-driven models that, instead of using complex-to-derive physics-based models, use large datasets to learn the correlations in the data. This has been applied to address several typical issues of GNSS, such as multipath identification, robust acquisition, spoofing and jamming mitigation, scintillation detection and classification.

Dr. Pau Closas, associate professor, at Northeastern University, specializes in signal processing for GNSS and wireless communications. He has received several honors, including the ION Early Achievement Award.

LEO PNT: From Theory to Implementation

3:15 p.m. - 5:00 p.m.

This tutorial provides an introduction to positioning, navigation, and timing (PNT) with low Earth orbit (LEO) satellites, highlighting basic theory and implementation considerations. We will overview the challenges associated with exploiting megaconstellation LEO satellites for PNT purposes, namely their unknown signals, poorly known ephemerides, loose synchronization and oscillator instability, and propagation effects. We will present a cognitive software-defined receiver (SDR) to deal with unknown LEO signals. We will formulate and compare several LEO PNT frameworks to deal with their poorly known ephemerides and timing: open-loop, adaptive, machine learning, differential, and simultaneous tracking and navigation (STAN). We will present experimental demonstrations of LEO PNT on ground and aerial vehicles, navigating with multi-constellation LEO satellite signals (Starlink, OneWeb, Orbcomm, Iridium, and NOAA) to an unprecedented level of accuracy.

Dr. Zak Kassas is the TRC Endowed Chair in Intelligent Transportation Systems and professor at The Ohio State University. He is also the director of the U.S. Department of Transportation Center for Automated Vehicles Research with Multimodal AssurEd Navigation (CARMEN) .

PLANS Plenary Session

Monday, April 28 - 5:30 p.m. – 6: 30 p.m., Grand Ballroom G-J

Welcome, Meeting Highlights, and Introduction of the Technical Committee

Dr. Gary McGraw
ION President & PLANS Executive Committee Chair

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Opening of the Plenary Session

Dr. Christian Gentner
PLANS Technical Program Chair

Keynote Address - GPS: Past and Present Challenges

Dr. Bradford Parkinson

This keynote delves into the incredible evolution of GPS, from its early struggles to its indispensable role in today's world. Dr. Parkinson will address GPS's surprising applications, growing infrastructure dependency, and its significance as a tool of national power. He will also addresses current challenges, such as defeating interference and enhancing system resilience, while celebrating GPS's exceptional 99.999% availability. A glimpse into the future rounds out this exploration of one of the most vital technologies of our time.

Dr. Bradford Parkinson, known as the "Father of GPS", was the chief architect for the design of GPS who led the Pentagon battle to gain approval, and then led the program through its capability in 1978. He later led pioneering GPS research at Stanford University in robotic farming and aviation; as well as relativity and astronautics. As a U.S. military instructor and developer, he has earned multiple military citations and military recognitions; is the winner of the IEEE Gold Medal and the Marconi; the ION's Thurlow and Kepler Awards; the Charles Stark Draper Prize; and the Queen Elizabeth Prize for Engineering. Dr. Parkinson is a member of the National Academy of Engineering, and an ION and IEEE Fellow.

Tuesday Morning Technical Sessions

April 29, 8:30 a.m. – 12: 15 p.m.

Session A1: Cutting-Edge Inertial-Based Pedestrian Localization - *Invited Session*

Room: Grand Ballroom ABC

8:30 a.m. – 12: 15 p.m.

Dr. Valérie Renaudin
Gustave Eiffel University

Sally Ann Keyes
Honeywell Aerospace

8:35 Pedestrian Attitude Estimation Using a Multiplicative Extended Kalman Filter with Geometrically-Defined Innovation Covariance: Walter B. Livingston and David M. Bevly, Auburn University

8:57 A Constrained Factor Graph Optimization-Based Networked Inertial Navigation System for Pedestrian Navigation: Yingjie Hu, University of Minnesota, Twin Cities; Wang Hu, University of California, Riverside

9:20 On Neural Inertial Classification Networks for Pedestrian Activity Recognition: Zeev Yampolsky, Ofir Kruzel, Victoria Khalfin Fekson, and Itzik Klein, ANSFL University of Haifa

9:43 PDRNN: Modular Data-Driven Pedestrian Dead Reckoning on Loosely Coupled Radio- and Inertial-Signalstreams: Peter Bauer, Andreas Porada, Felix Ott, Christopher Mutschler, Fraunhofer Institute for Integrated Circuits (IIS); Tobias Feigl, Fraunhofer IIS & Friedrich- Alexander-Universität Erlangen-Nürnberg

10:05 a.m.-10:35 a.m., Refreshment Break in Exhibit Hall

10:40 Anticipating Pedestrian Movements: Future Activity Prediction for Floor-Change Scenarios: Pavel Pascacio, Université Gustave Eiffel; Thomas Bonis, LAMA, Université Gustave Eiffel; Valérie Renaudin, Université Gustave Eiffel

11:03 Anomaly Detection for Trustworthy Personalized Pedestrian Dead Reckoning (PDR) Navigation: Hanyuan Fu, and Valerie Renaudin, University Gustave Eiffel

11:26 Advanced Step Detection with Anomaly Filtering for Enhanced Positioning Accuracy: Mohamad Issam Sayyaf, Ni Zhu, and Valerie Renaudin, Gustave Eiffel University

11:48 NEVERLOST: Navigation Environment Merging Virtuality, Ecotone, and Reality for Localization of SubjecTs: Eudald Sangenis and Andrei M. Shkel, University of California, Irvine

Session B1: Integrity and Augmentation

Room: Grand Ballroom GH

8:30 a.m. – 12: 15 p.m.

Dr. Omar García Crespillo
German Aerospace Center (DLR)

Dr. Eugene Bang
Gyeongsang National University

8:35 Group Delay Characterization of Multipath Limiting Ground Station Antennas for Enhanced GBAS Performance: Simon P. Hehenberger, Maria Caamano, German Aerospace Center (DLR); Bernd Gabler, Microwaves and Radar Institute, DLR; Stefano Caizzone, DLR

8:57 Multi-Component Stochastic Multipath Model for Terrestrial Radio Navigation Systems in Aviation: Gianluca Zampieri, German Aerospace Center (DLR) & RWTH Aachen; Gary McGraw, Consultant; Omar García Crespillo, DLR; Michael Meurer, DLR & RWTH Aachen

9:20 GNSS-Based Solutions Testing in an ERTMS Context: A Framework for Statistical Performance Analysis: Q. Mayolle, Railenium; J. Marais, Université Gustave Eiffel; M. Fasquelle, Railenium; V. Tardif, SNCF; E. Chéneau-Grehalle, SNCF

9:43 Paired Cauchy-Gaussian Overbound for not Symmetric Unimodal Heavy-Tailed Distributions: Zhengdao Li, Penggao Yan, Weisong Wen, Li-Ta Hsu, The Hong Kong Polytechnic University

10:05 a.m.-10:35 a.m., Refreshment Break in Exhibit Hall

10:40 Exploitation of Modernized GPS Crosslinks to Improve User Integrity and Availability with ARAIM: Sukrut Oak, Sam Pullen, Sherman Lo, Juan Blanch, and Todd Walter, Stanford University; Mark Crews, Robert Jackson, and Charles Frey, Lockheed Martin

11:03 Overbounding Time-Correlated Errors for a Multi-Constellation Precise Point Positioning Integrity Service: Rebecca Wang, Juan Blanch, and Todd Walter, Stanford University

11:26 Exploration of Temporal and Spatial Correlations of Gaussian-Markov Processes in Orbit and Clock Errors of BeiDou-3 Satellites: Songyan Zhang, Zhihong Li, Rong Yang, Xingqun Zhan, Shanghai Jiao Tong University

11:48 Robust Filtering for PPP-AR Under Multiple Faults: Andrea Bellés and Daniel Medina, German Aerospace Center (DLR)

12:15 p.m. - 1:15 p.m. • Attendee Luncheon in the Exhibit Hall • Grand Ballroom DEF

Overflow seating in Skylight Ballroom, second floor

Session C1: Multisensor Integrated Systems and Sensor Fusion Technologies

Room: Deer Valley 1-3
8:30 a.m. – 12: 15 p.m.

Dr. Charles Toth
The Ohio State University

Dr. Ali Abdallah
Google

8:35 GNSS Array-Based Multipath Detection Employing UKF on Manifolds: Abdelgabar Ahmed, Tarig Ballal, Xing Liu, Mohanad Ahmed, and Tareq Y. Al-Naffouri, King Abdulla University (KAUST)

8:57 Assessment of a Multipath Mitigation Approach for GNSS/INS Ultra-Tightly Coupled Integration System: Hsiang-En Chien, Shau-Shiun Jan, National Cheng Kung University

9:20 Performance-Driven Reference Network Design for Accurate LEO PNT with Poorly Known Satellite Ephemerides: Joe Saroufim and Zak (Zaher) M. Kassas, The Ohio State University

9:43 IMM-JPDAF with Sensor Fusion for Enhanced Maneuvering Target Association: Tsui-Yu Chan, Shau-Shiun Jan, and Shuo-Ju Yeh, National Cheng Kung University

10:05 a.m.-10:35 a.m., Refreshment Break in Exhibit Hall

10:40 A Coarse-to-Fine Optimization Framework for LiDAR-Based Air-Ground Cooperative Mapping: Mengchi Ai, University of Calgary; Mohamed Elhabiby, Micro Engineering Tech. Inc.; Yandi Yang, and Naser El-Sheimy, University of Calgary

11:03 Leveraging Prior ALS Point Clouds for Enhanced LiDAR-Inertial Odometry in Low-Cost Mobile Mapping Systems: Yandi Yang, University of Calgary; Jianping Li, Nanyang Technological University; Mengchi Ai, University of Calgary; Xin Zhao, Yizhe Zhang, Wuhan University; Naser El-Sheimy, University of Calgary

11:26 Tightly-Coupled Wi-Fi/LiDAR/Inertial Integration via Factor Graph Optimization for UAS: Ruijie Xu, Xikun Liu, and Weisong Wen, The Hong Kong Polytechnic University

11:48 An FPGA-Based Hardware Accelerator for Digital Inertial Attitude Estimation Using the Madgwick Quaternion Filter: Alexander J. Crownshaw and K. Offor, University of Sheffield

Session D1: Lunar, Mars and Space Navigation

Room: Grand Ballroom IJ
8:30 a.m. – 12: 15 p.m.

Dr. Masaya Murata
Japan
Aerospace Exploration Agency

Dr. Tyler Reid
Xona Space Systems

8:35 Direct Position Estimation Framework for Lunar Positioning, Navigation, and Timing: Shuo Tang, Northeastern University; Haoqing Li, University of Calgary; Pau Closas. Northeastern University

8:57 GNSS Precise Point Positioning in Cislunar Space: A Study on Regularized Least Squares and Availability: Oliviero Vouch, Luca Morichi, Simone Zocca, Alex Minetto, Fabio Dovis, Politecnico di Torino

9:20 Batch Integrity Monitoring for an Extended Kalman Filter Using the Lunar Communication and Navigation System: Heiko Engwerda, Royal Netherlands Aerospace Centre; Yoann Audet, Richard Swinden, European Space Agency (ESA); Maarten Uijt de Haag, Technical University of Berlin; Cosimo Stallo, Floor Melman, Javier Ventura-Traveset, ESA

9:43 Acquiring GNSS Signals in Cislunar Space: A Hardware-in-the-Loop Investigation for LuGRE Mission Data: Lorenzo Sciacca, Alex Minetto, Andrea Nardin, Simone Tedesco, Matilde Boschiero, Samuele Fantinato, Luca Canzian, and Fabio Dovis, Politecnico di Torino & Qascom s.r.l.

10:05 a.m.-10:35 a.m., Refreshment Break in Exhibit Hall

10:40 3D Keypoint Detectors from Scanning Mirror LIDAR Scans for Localization of Lunar Rovers: Tuan Luong and Jordan Larson, University of Alabama

11:03 A Sequence Matching Approach for GNSS-Based Orbit Determination Using Dynamic Time Warping: Francesco Fiorina, Oliviero Vouch, Andrea Nardin, Fabio Dovis, Politecnico di Torino; Claudia Facchinetti, and Mario Musmeci, Italian Space Agency (ASI)

11:26 Hardware-in-the-Loop Testing of a Galileo Receiver for Improved Space Situational Awareness: The SARGASSIA Project: Francesco Menzione, Andrea Piccolo, Luca Cucchi, European Commission's Joint Research Centre (JRC)

11:48 Using Simulations to Develop Terrain Relative Navigation for Mars-UAVs: Is it Realistic Enough?: Max Hofacker, Michael Schleiss, Thomas Pany, Roger Förstner, University of the Bundeswehr München

12:15 p.m. - 1:15 p.m. • Attendee Luncheon in the Exhibit Hall • Grand Ballroom DEF
Overflow seating in Skylight Ballroom, second floor

Tuesday Afternoon Technical Sessions

April 29, 1:45 p.m. – 5:30 p.m.

Session A2a: Quantum Inertial Sensor Technologies and Applications

Room: Deer Valley 1-3

1:45 p.m. – 3:25 p.m.

Dr. Steffen Schön
Leibniz University Hannover

Dr. Karl Nelson
Honeywell Aerospace

1:50 Quantum Inertial Sensors for Gravimetry and Inertial Navigation in the Field: M. Cashen, J. Kohler, C. Corder, M. Everton, J. Wolf, N. Crescimanno, A. Vitouchkine, A. Rakholia, G. Skulason, A. Dowd, J. Abo-Shaeer, Vector Atomic; S.A. Keyes, and C. Parks, Honeywell

2:12 Observability and Estimability Analysis of a Hybrid Error State CAI-IMU Filter for Different Dynamic Environments: N.B. Weddig, B. Tennstedt, and S. Schön, Leibniz University Hannover

2:35 Investigation of Atom Interferometry Data Extraction Requirements for Alternative Navigation Applications: Toby Dytrych, Kevin Ridley, Michael Holynski, Quantum Sensing Group, University of Birmingham

2:58 Preliminary Maritime Operation of Quantum Sensors in a Strapdown Configuration: Adam Seedat, Andrew Hinton, Farzad Hayati, University of Birmingham; Jonathan Winch, Andrew Lamb, Delta g; Kevin Ridley, and Michael Holynski, University of Birmingham

Alternate

1. Can Quantum Sensors Operate Efficiently in Harsh Environment and Challenging Conditions in Space?: Alireza Hosseiniarani, Arpetha C. Sreekantaiah, Benjamin Tennstedt, Xingchi He, Urs Hugentobler, and Steffen Schön, Institute of Geodesy (IfE)

3:25 p.m. - 3:55 p.m., Refreshment Break in Exhibit Hall

Session A2b: Resilient Inertial Navigation Systems and Alternative Sensors

Room: Deer Valley 1-3

3:55 p.m. – 5:30 p.m.

Dr. Jindrich Dunik
University of West Bohemia

Dr. Mathieu Joerger
Virginia Tech

4:00 Factor Graph Optimization for Robust Navigation via High Precision GNSS/IMU Corroboration: Kyle Leland, Clark Taylor, and Frank van Graas, AFIT

4:23 A Particle Filter Based Sensor Fusion Approach for GNSS Spoofing Detection Incorporating Ground Vehicle Navigation Constraints: Muhammad Sami Irfan, Sagar Dasgupta, and Mizanur Rahman, The University of Alabama

4:46 Warm Start Navigation with Non-Cooperative LEO Satellite via Online Ephemeris Error Estimation: Samer Hayek and Zak (Zaher) M. Kassas, The Ohio State University

5:08 Automotive Speed Estimation: Sensor Types and Error Characteristics from OBD-II to ADAS: Hany Ragab, Sidney Givigi, Queen's University; Aboelmagd Noureldin, Royal Military College of Canada

Session B2: Frontiers of GNSS- *Invited Session*

Room: Grand Ballroom GH

1:45 p.m. – 4:20 p.m.

Dr. Michael Meurer
German Aerospace Center (DLR)

Dr. Joanna Hinks
AFRL Space Vehicles

1:50 Novel Resilient GNSS Architectures Based on Optical Technologies: Gabriel Giorgi, German Aerospace Center (DLR)

2:12 Complementing MEO GNSS by LEO Constellations: Zak Kassas, The Ohio State University

2:35 Emerging Jamming/Spoofing Threat and Countermeasures: Todd Humphreys, The University of Texas at Austin

2:58 Pushing Boundaries by Novel Signal Processing and AI: Fabio Dovis, Politecnico di Torino

3:25 p.m. - 3:55 p.m., Refreshment Break in Exhibit Hall

4:00 User-Specific Dynamic Authenticated Encryption for Xona's PULSAR: Jason Anderson, Xona Space Systems

5:30 p.m. - 6:30 p.m.
Evening Hour in the Exhibit Hall
Grand Ballroom DEF

Session C2: Non-Terrestrial Signals of Opportunity-Based Navigation Systems

Room: Grand Ballroom IJ
1:45 p.m. – 5:30 p.m.

Dr. Joe Khalife
Apple

Mark Smearcheck
Air Force Research Laboratory

1:50 A Mock Implementation of Fused LEO GNSS: Samuel C. Morgan, Zacharias M. Komodromos, Wenkai Qin, Zachary L. Clements, The University of Texas at Austin; Andrew Graff, CesiumAstro; W. Jeremy Morrison, and Todd E. Humphreys, The University of Texas at Austin

2:12 Error Correction Analysis and Enhanced Algorithm for Standalone Doppler-Based Positioning Using Iridium-Next and Orbcomm Constellations: Ya-Xun Yang and Shau-Shiun Jan, National Cheng Kung University

2:35 Doppler Offset Analysis for Satellite Clock Error Characterization from the Starlink Observations: Xinyue Lin, Shengjie Zhou, Rong Yang, Shanghai Jiao Tong University; Yafeng Li, Beijing Information Science and Technology University; Jihong Huang, Xingqun Zhan, Shanghai Jiao Tong University

2:58 Simulation of the Impact of Low-Earth-Orbit GNSS on Carrier Phase Ambiguity Resolution: Claire Mah and Kyle O'Keefe, University of Calgary

3:25 p.m. - 3:55 p.m., Refreshment Break in Exhibit Hall

4:00 Maximum Likelihood Time of Arrival and Doppler Estimation for Precise Starlink-Based PNT: Wenkai Qin, Zacharias M. Komodromos, Samuel C. Morgan, and Todd E. Humphreys, University of Texas in Austin

4:23 Light will Guide You: Passive Joint DOA/FOA Sensing, Tracking, and Navigation with Unknown LEO Satellites: Sharbel Kozhaya and Zak (Zaher) M. Kassas, The Ohio State University

4:46 Space Based Augmentation Service for Opportunistic LEO-PNT: Francesco Menzione, European Commission Joint Research Centre (JRC); Ottavio M. Picchi, External consultant for European Commission JRC; Christian A. Lichtenberger, and Thomas Pany, University of the Bundeswehr Munich

5:08 Code-Based GNSS Ranging Between Asynchronous Lunar Receivers: Effect of the Large Dynamics on the Measurements Time Extrapolation Quality: Anaïs Delépaut, Alex Minetto, and Fabio Dovis, Politecnico di Torino

Session D2: AI-Enhanced Navigation

Room: Grand Ballroom ABC
1:45 p.m. – 5:30 p.m.

Dr. Michael Veth
Veth Research Associates

Dr. Tobias Feigl
Fraunhofer IIS

1:50 Real-Time Detection of Transport Modes and Movement States via Smartphone Data: Aicha Karite and Christian Gentner, German Aerospace Center (DLR)

2:12 Exploitation of Hidden Context in Dynamic Movement Forecasting: A Neural Network Journey from Recurrent to Graph Neural Networks and General Purpose Transformers: Lukas Schelenz, Shobha Rajanna, Denis Gosalci, Lucas Heublein, Jonas Pirkl, Jonathan Ott, Felix Ott, Christopher Mutschler, Fraunhofer Institute for Integrated Circuits IIS; Tobias Feigl, Fraunhofer IIS & Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)

2:35 Cross Ambiguity Function Resolution Enhancement Using Neural Networks for Direct Position Estimation Computational Cost Reduction: Haoqing Li, University of Calgary; Shuo Tang, Northeastern University; Kyle O'Keefe, University of Calgary; Pau Closas, Northeastern University

2:58 On Using Artificial Neural Networks for Multipath Radio Channel Estimation: Rostislav Karasek and Christian Gentner, German Aerospace Center (DLR)

3:25 p.m. - 3:55 p.m., Refreshment Break in Exhibit Hall

4:00 Gaussian Process Regression for Improved Underwater Navigation: Nadav Cohen and Itzik Klein, University of Haifa

4:23 Leveraging 4D Voxel Representation to Enhance Sim2Real Transfer in Autonomous Navigation: Chaoyi Xu, Wen Liu, and Zhongliang Deng, Beijing University of Posts and Telecommunications

4:46 WaveSenseNet: A Self-Supervised Learning Framework for Robust GPR-Based Localization in Autonomous Systems: Anisha Singrodia and Amol Vagad, GPR, Ground Positioning Radar

5:08 GenAI for Energy-Efficient and Interference-Aware Compressed Sensing of GNSS Signals on a Google Edge TPU: Thorben Wegner, Lucas Heublein, Fraunhofer Institute for Integrated Circuits IIS; Tobias Feigl, Fraunhofer IIS & Friedrich-Alexander-Universität Erlangen-Nürnberg; Felix Ott, Christopher Mutschler, and Alexander Rügamer, Fraunhofer IIS

Alternates

1. **Surveying CNNs for Estimating Trailer Articulation Angle using Monocular Cameras:** Tahn Thawainin, Tyler Flegel, and David Bevly, Auburn University
2. **Temporal Modeling and Prediction of Global Ionospheric Total Electron Content: A Comparative Study of Deep Learning Approaches:** Xinran Bu, Zheng Gong, Kunlin Yang, Yifei Chen, Beihang University; Yang Liu, Beihang University & Abdus Salam International Centre for Theoretical Physics

5:30 p.m. - 6:30 p.m. • Evening Hour in the Exhibit Hall • Grand Ballroom

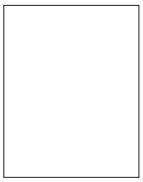
Wednesday Morning Technical Sessions

April 30, 8:30 a.m. – 12: 15 p.m.

Session A3a: Advances in MEMS-Based Inertial Sensors and Inertial Measurement Units

Room: Deer Valley 1-3

8:30 a.m. – 10:05 a.m.



Dr. John Reinke
Honeywell

Tom Jakel
Veth Research Associates

8:35 Non-Metallized Dual-Shell Hemispherical Resonator Gyroscope: Austin R. Parrish, University of California; Nicholas A. Strnad, DEVCOM Army Research Laboratory; Zachariah J. Klutts, Lois Meira Lopez, Danmeng Wang, University of California; Jeffrey S. Pulskamp, DEVCOM Army Research Laboratory; Andrei M. Shkel, University of California

8:57 Enhancing Silicon-Based Accelerometer Performance Using the f-Squared Method: Theo Miani, Lokesh Gurung, Guillermo Sobreviela-Falces, Colin Baker, Ashwin Seshia, Silicon Microgravity

9:20 Rotational Testbed Simulator: An Investigation of Complex Rotational Testbed Motion for the Test and Evaluation of Inertial Measurement Units: Jason K. Bingham, Michael R. Walker II, Sandia National Laboratories

10:05 a.m.-10:35 a.m., Refreshment Break in Exhibit Hall

Session A3b: Inertial Vehicle Navigation

Room: Deer Valley 1-3

10:35 a.m. – 12:15 p.m.

Dr. Demoz Gebre-Egziabher
University of Minnesota

Dr. Rajnikant Sharma
Air Force Institute of Technology

10:40 Performance Evaluation of High-Grade HRG-Based INS with ZUPT & NHC Aiding for Land Vehicle Navigation in GNSS-Denied Environments: Suktae Kang, Kijeong Yoo, Kyungdon Ryu, Sunghyuk Choi, Jin Seung Lee, Agency for Defense Development

11:03 Quantifying Code Binding Performance for Navigation Algorithms: Daniel Foreman, Siddarth Chalasani, Michael R. Walker II, Sandia National Laboratories

11:26 Fault Detector Sensitivity in Centralized Collaborative Localization: Shinsaku Kuwada, Illinois Institute of Technology; Mathieu Joerger, Virginia Tech; Matthew Spenko, Illinois Institute of Technology

11:48 Multi-Robot Cooperative Navigation with Active Sensing in a GPS-Denied Environment: Shahbaz P. Qadri Syed and He Bai, Oklahoma State University

Session B3: Interference, Jamming, and Spoofing 1

Room: Grand Ballroom GH

8:30 a.m. – 12:15 p.m.

Dr. Jong-Hoon Won
Inha University

Dr. Juan Blanch
Stanford University

8:35 Effectiveness of Detection Methods for GNSS Spoofing Signals in the Eastern Mediterranean Airspace: A Flight Study: Philipp Rudnik, German Aerospace Center (DLR); Manuel Cuntz, and Michael Meurer, DLR and RWTH Aachen University

8:57 Inertial Measurement Aiding for an Attitude-Aided Baseline Spoofing Detection Technique: Mike Blois and Kyle O'Keefe, University of Calgary

9:20 Multiple Statistical Tests for Spoofing Detection and Rejection Using Tightly-Coupled GNSS/INS: Isaac Lyss-Loren, Gina Staimer, Fatah Iskandar, Michael Thompson, and Sharad Shankar, The Aerospace Corporation

9:43 Experimental Validation for GNSS Spoofing Detection by Decomposition of the Complex Cross Ambiguity Function: Sahil Ahmed, Samer Khanafseh, Boris Pervan, Illinois Institute of Technology

10:05 a.m.-10:35 a.m., Refreshment Break in Exhibit Hall

10:40 Machine Learning Detection and Classification of Internal and External Radio Frequency Interference in Spire Global GNSS-RO Signals: Jason Li, Hyeyeon Chang, Tim Dittmann, and Yu (Jade) Morton, University of Colorado Boulder

11:03 Spoofing Detection in Time Domain for Stationary and Moving Receiver: Oliver Kost, Ondrej Straka, Ondrej Dohnal, University of West Bohemia; Jindrich Dunik, Honeywell International, and University of West Bohemia

11:26 Spoofing Mitigation Based on Doppler Frequency and Pseudorange Corrections in GNSS Receivers: Jingxiaotao Fang and Bing Xu, The Hong Kong Polytechnic University

11:48 UnReference: Spoofing GNSS Differential Reference Stations and Effects on Connected Rovers: Marco Spanghero and Panos Papadimitratos, KTH Royal Institute of Technology

Alternate

1. Advancing Towards a Comprehensive GNSS Interference Management Framework: A Deep Learning Neural Network Approach for Classification of FM Chirp Jammers: Yasmine Chaiben, University Gustave Eiffel; Syed Ali Kazim, IRT Railenium; Juliette Marais, University Gustave Eiffel

12:15 p.m. - 1:15 p.m. • Attendee Luncheon in the Exhibit Hall • Grand Ballroom DEF

Overflow seating in Skylight Ballroom, second floor

Session C3: Frontiers of Radionavigation: Signals of Opportunity, 5G, LEO, and Beyond- *Invited Session*

Room: Grand Ballroom IJ
8:30 a.m. – 12:15 p.m.

Amy-Marie Dykstra
Naval Surface Warfare Center Dahlgren

Dr. John Janeski
The Aerospace Corporation

8:35 Accuracy and Integrity Assessment of a sUAS UWB-Indoor Positioning System Using Factor Graph Optimization: Mats Martens and Maarten Uijt de Haag, Technical University Berlin

8:57 Evaluating and Integrating Positioning Technologies: A Framework for Industrial Applications: Dennis Salzmann, Florian Hermann, Christoph Fischer, and Hans D. Schotten, DFKI

9:20 Pseudorandom Code-Aided Acquisition and Tracking of Globalstar Satellite Signals for Opportunistic Navigation: Xing Liu, King Abdullah University of Science and Technology (KAUST); Jose A. Lopez-Salcedo, Gonzalo Seco-Granados, Universitat Autònoma de Barcelona; Tareq Y. Al-Naffouri, KAUST

9:43 Error Source Analysis for Doppler Shift Based Opportunistic LEO-PNT With Starlink Signals: Winfried Stock, Robert T. Schwarz, Andreas Knopp, University of the Bundeswehr Munich

10:05 a.m.-10:35 a.m., Refreshment Break in Exhibit Hall

10:40 Analysis of Time-Diverse Doppler-Only PNT: Megan O. Moore, Mark L. Psiaki, and R. Michael Buehrer, Virginia Tech

11:03 Innovations in Signals of Opportunity User Navigation Algorithms: Andrew Blackney, Alan Choy, Hayden Crabbs, John Janeski, Lauren Monzon, Phillip Vu, Joseph Zales, Eugene Grayver, Robert Nelson, Ron Trerotola, Ashtin Cheng, Nicholas A Oune, Kevin Sauerwein, Daniel Thomlinson, The Aerospace Corporation

11:26 Positioning and Location Integrity Validation Using Signals of Opportunity: Reino Virrankoski, Aalto University; Heidi Kuusniemi, University of Vaasa & Finnish Geospatial Research Institute (FGI), National Land Survey (NLS); Jaakko Yliaho, Petri Välisuo, FGI, NLS; Riku Jäntti, Aalto University

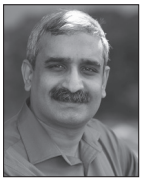
11:48 LEO PNT Navigation Frameworks with Non-cooperative Satellites: Zak (Zaher) M. Kassas, Joe Saroufim, Sharbel Kozhaya, and Samer Hayek, The Ohio State University

12:15 p.m. - 1:15 p.m.
Attendee Luncheon in the Exhibit Hall
Grand Ballroom DEF
Overflow seating in Skylight Ballroom, second floor

Session D3: Navigation in Challenging Environments 1

Room: Grand Ballroom ABC
8:30 a.m. – 12:15 p.m.

Dr. Heidi Kuusniemi
University of Vaasa



Dr. Rajesh Krishna Balan
SMU University

8:35 React-G: GNSS Signal Multipath Simulation Framework for Small Uncrewed Aerial Systems: Bohan Zhang, Saint Louis University; Julian Gutierrez, NASA Langley Research Center; Ankit Agrawal, Saint Louis University

8:57 MAPT: A Near Real-Time Adaptive Multipath Modeling and Clustering Algorithm for GNSS Urban Positioning: Julian Gutierrez, Russell Gilabert, Tanner Slagel, Evan Dill, NASA Langley Research Center; Pau Closas, Northeastern University

9:20 Comparison of GNSS LOS/NLOS Labeling Techniques Based on a 3D model and Sky View Imagery for Soft Mobility and Vehicle Data in Urban Areas: Benjamin Beaucamp, University Gustave Eiffel; Thomas Leduc, Myriam Servières, Nantes Université, ENSA Nantes, École Centrale Nantes, CNRS, AAU-CRENAU, UMR; Ni Zhu, University Gustave Eiffel

9:43 Scalable GNSS Performance Assessment and Environment Categorization Under Vegetation: Jiayi Zhou, The Hong Kong Polytechnic University; Timothée Guillemaille, Cyril Meurie, University Gustave Eiffel, COSYS-LEOST; Guohao Zhang, The Hong Kong Polytechnic University; Juliette Marais, University Gustave Eiffel, COSYS-LEOST

10:05 a.m.-10:35 a.m., Refreshment Break in Exhibit Hall

10:40 Statistical Analysis of GNSS Multipath Errors in Urban Canyons: Matt Peretic, The MITRE Corporation; Russell Gilabert, NASA Langley Research Center; Johnson Carroll, The MITRE Corporation; Julian Gutierrez, Andrew Moore, NASA Langley Research Center; Jonathan Christie, The MITRE Corporation; Evan T. Dill, NASA Langley Research Center

11:03 RTK Performance of Synthetic Aperture Processing on top of the ULB-PLL Method with Real-World Urban GPS/Galileo L1/L5 Signals (TEXCUP): Jürgen Dampf, Mohamed Bochkati, and Thomas Pany, Universität der Bundeswehr München

11:26 Robust Position Estimation by Rao-Blackwellized Particle Filter without Integer Ambiguity Resolution in Urban Environments: Daiki Niimi, An Fujino, Meijo University; Taro Suzuki, Chiba Institute of Technology; Junichi Meguro, Meijo University

11:48 Robust Multi-Sensor Fusion Positioning Based on GNSS/IMU Using Factor Graph Optimization: Elham Ahmadi, Mahmoud Elsanhoury, Kannan Selvan, Petri Välisuo, University of Vaasa; Heidi Kuusniemi, University of Vaasa, and Finnish Geospatial Research Institute, National Land Survey

Alternate

1. **Performance Evaluation of EKF and AKF Relative Navigation Using GPS-Based Measurements in LEO Spacecraft Rendezvous:** Junghyun Kim and Sangkyung Sung, Konkuk University

Session B4: Interference, Jamming, and Spoofing 2

Room: Grand Ballroom GH
1:45 p.m. – 5:30 p.m.

Dr. Sanjeev Gunawardena
Air Force Institute of Technology

Zachary Clements
University of Texas at Austin

1:50 Towards Robust Collaborative DGNSS in the Presence of Outliers: Helena Calatrava, Northeastern University; Daniel Medina, German Aerospace Center (DLR); Pau Closas, Northeastern University

2:12 Beam Steering Adaptive Noise Cancellation with a Controlled Reception Pattern Antenna for GNSS Anti-Jamming: Jacob W. Harris and David M. Bevly, Auburn University

2:35 Determining Protection Levels Using Multiple Antennas Under Spoofing Conditions: Juan Blanch, Sherman Lo, Yu-Hsuan Chen, Argyris Kriezis, and Todd Walter, Stanford University

2:58 Scalable, Occlusion-Aware Geolocation of Ground-Based GNSS Jammers with Networked Smartphones: Glenn Jones, Daniel Broyles, Tim Machin, and Frank van Graas, Air Force Institute of Technology

3:25 p.m. - 3:55 p.m., Refreshment Break in Exhibit Hall

4:00 Jammer Source Localization with Federated Learning: Mariona Jaramillo Civill, Peng Wu, Northeastern University; Andrea Nardin, Politecnico di Torino; Tales Imbiriba, University of Massachusetts Boston; Pau Closas, Northeastern University

4:23 Towards a Faster GNSS Interference Classification: a GRU-Based Approach Using Spectrograms: Iman Ebrahimi Mehr, Politecnico di Torino; Gianfranco Caputo, Maurizio Fantino, Dario Salza, Fondazione LINKS; Fabio Dovis, Politecnico di Torino

4:46 Self-Supervised Federated GNSS Spoofing Detection with Opportunistic Data: Wenjie Liu and Panos Papadimitratos, KTH Royal Institute of Technology

5:08 Range Authentication of Galileo E1 / E5a Signals Using the ACAS Method on a GNSS Hardware Receiver: Benedikt Schreiber, Fabio Garzia, Rocío Parra, Himanshu Gupta, Matthias Overbeck, and Alexander Rügamer, Fraunhofer Institute for Integrated Circuits IIS

Alternate

1. **Data-Driven Analysis of PNT Resilience: Insights and Lessons from Jammertest 2024 Vehicular Data:** Jaakko Yliaho, Petri Välisuo, Elham Ahmadi, Kannan Selvan, Mahmoud Elsanhoury, University of Vaasa; Heidi Kuusniemi, University of Vaasa & Finnish Geospatial Research Institute, National Land Survey

Session C4: Navigation Using Environmental Features

Room: Grand Ballroom IJ
1:45 p.m. – 5:30 p.m.

Tucker Haydon
Sandia National Labs

Benjamin Siebler
German Aerospace Center (DLR)

1:50 Analysis of Magnetic Anomaly Maps and Navigation Performance Using Flight Test Data: Brandon Blakely and Aaron Nielsen, AFIT/ANT Center

2:12 On the Connection Between Magnetic-Field Odometry Aided Inertial Navigation and Magnetic-Field SLAM: Isaac Skog, KTH Royal Institute of Technology; Manon Kok, Delft University of Technology; Gustaf Hendeby, Linköping University; Chuan Huang, KTH Royal Institute of Technology; Thomas Edridge, Delft University of Technology

2:35 Mixed-Integer Moving Horizon Estimation for Terrain-Aided Navigation Using Hybrid Zonotopes: Andrew F. Thompson, Joshua A. Robbins, The Pennsylvania State University; Matthew E. Boler, Sandia National Laboratories; Herschel C. Pangborn, The Pennsylvania State University

2:58 Context-Adaptive GNSS/INS Estimation Strategies Based on Prior Statistical Multipath Knowledge: Maximilian Von Arnim, Damien Vivet, and Yoko Watanabe, Fédération ENAC ISAE-SUPAERO ONERA, Université de Toulouse

3:25 p.m. - 3:55 p.m., Refreshment Break in Exhibit Hall

4:00 Satellite Image Informed Path Planning for Improved Visual Localization of UGVs in GNSS-Denied Environments: Jordan Westphal, University of Illinois at Urbana-Champaign; Arturo Saucedo, Maribel DeLaTorre, and Ahmet Soylemezoglu, Engineer Research and Development Center

4:23 Improving Celestial AltPNT Availability and Performance: Full Sky Polarization Tracking Algorithms for Challenging Conditions: Laura Eshelman and Adam Smith, Polaris Sensor Technologies, Inc.

4:46 Infrastructure Planning for Multi-Vehicle Routing with Cooperative Localization: Rohith Boyinine, University of Cincinnati; Anusna Chakraborty, Utopia Compression Corp.; Rajnikant Sharma, Air Force Institute of Technology; Abhinav Sinha, University of Cincinnati

5:08 Semantic LiDAR Point Cloud Mapping and Cloud-Based SLAM for Autonomous Driving: Franz Andert, Oliver Böttcher, Aditya Mushyam, and Philipp Schmälzle, German Aerospace Center (DLR)

Session D4a: Navigation in Challenging Environments 2

Room: Grand Ballroom ABC
1:45 p.m. – 5:30 p.m.

Dr. Adyasha Mohanty
Harvey Mudd College

Dr. Siwei Zhang
German Aerospace Center (DLR)

1:50 A Pointcloud Registration Framework for Relocalization in Subterranean Environments: David Akhihiero and Jason N. Gross, West Virginia University

2:12 Data Association for Autonomous LEO Satellite Identification: Jennifer Sanderson and Zak (Zaher) M. Kassas, The Ohio State University

2:35 Prototype-Development for Combined Indoor Navigation, Communication, and Mapping for First Responder Applications: Susanna Kaiser, Stephan Sand, Umut Güloglu, Oliver Heirich, Thomas Wiedemann, German Aerospace Center (DLR)

2:58 Barometer-Driven Height Estimation for Indoor Positioning Including Elevator and Escalator Detection Mechanisms: Philipp Hager, Susanna Kaiser, and Christian Gentner, German Aerospace Center (DLR)

3:25 p.m. - 3:55 p.m., Refreshment Break in Exhibit Hall

4:00 Analysis of the Unscented Transform for Cooperative Localization with Only Inter-Vehicle Ranging Information: Uthman Olawoye, West Virginia University; Cagri Kilic, Embry-Riddle Aeronautical University; Jason N. Gross, West Virginia University

4:23 Assessing Material Impacts in NLOS UWB Ranging Errors: Characterization for Museum Environments: Angeliki Makellaraki, Vincenzo Di Pietra, and Paolo Dabove, Politecnico di Torino

4:46 B-Spline Based Path Planning with Visual Based Collision Avoidance: Jen-Jui Liu, Curtis P. Evans, Randy W. Beard, Brigham Young University

5:08 Navigation-Aware Path Planning and Multi-Agent Coordination in Challenging Environments: Kristen Michaelson, The University of Texas at Austin; Manan Gandhi, Sandia National Laboratories; Renato Zanetti, The University of Texas at Austin

Alternate

1. **Dataset for Sensor Fusion of Stereo Thermal, Optical, Scanning Mirror LIDAR and Inertial for Navigation in Urban and Unstructured Environment:** Tuan Luong, and Jordan Larson, University of Alabama

Session D4b: Ground, Aerial, and Maritime Navigation

Room: Deer Valley 1-3
1:45 p.m. – 5:30 p.m.

Dr. Camila Françolin
Draper

Dr. Maarten Uijt de Haag
Technical University of Berlin

1:50 Performance Assessment of GNSS Pseudorange Differencing for Resilient Cooperative Train Positioning: Enki Saura, IKOS Consulting; Alex Minetto, Fabio Dovis, Politecnico di Torino; Juliette Marais, Université Gustave Eiffel

2:12 Robust Railway Ground Truth and Confidence Bounds Estimation Based on RTK/INS Forward-Backward Smoothing: Anja Grosch and Omar Garcia Crespillo, German Aerospace Center (DLR)

2:35 Multi-Drone Decentralized Cooperative Navigation Strategy for GNSS Integrity Monitoring: Flavia Causa and Giancarmine Fasano, University of Naples "Federico II"

2:58 Range and Range-Rate Constraints from Cellular Networks for Airborne Navigation: Adrian Winter, Norwegian University of Science and Technology (NTNU); Aiden Morrison, Nadezda Sokolova, SINTEF Digital; Tor Arne Johansen, NTNU

3:25 p.m. - 3:55 p.m., Refreshment Break in Exhibit Hall

4:00 VDES R-Mode Flight Experiments: Markus Wirsing, Ronald Raulefs, and Armin Dammann, German Aerospace Center (DLR)

4:23 Barometer-Free Aircraft Terrain-Aided Navigation System: Prototype Design and Flight-Test Validation: Milos Vesely, Honeywell International; Jindrich Dunik, Honeywell International, and University of West Bohemia; Tomas Beda, Honeywell International

4:46 A Reinforcement Learning Framework for Optimizing Multi-UAV Trajectories in Neural Radiance Field Reconstruction: Adyasha Mohanty, Harvey Mudd College

5:08 Exploiting Starlink and OneWeb LEO Satellite Signals for High-Altitude Platform Station Opportunistic Navigation: Will Barrett, Jennifer Sanderson, Sharbel Kozhaya, Joe Saroufim, and Zak (Zaher) M. Kassas, The Ohio State University

Alternate

1. **Spatial Correlation Analysis of Ionospheric Delays at Different Spatial Scales:** Zhihong Li, Rong Yang, Zhen Gao, Jihong Huang, Xingqun Zhan, Shanghai Jiaotong University

Thursday Morning Technical Sessions

May 1, 8:30 a.m. – 12:15 p.m.

Session B5a: LEO-PNT: Concepts, Systems and Use Cases

Room: Grand Ballroom ABC

8:30 a.m. – 12:15 p.m.

Dr. Bernd Eissfeller
University of the Bundeswehr Munich

Maria Manzano Jurado
GMV

8:35 Performance Analysis of LEO PNT Constellations: Hyun-Jung Lee, Young-Jin Song, Subin Lee, Jong-Hoon Won, Inha University

8:57 Certifiably Optimal Satellite Orbit Determination Based on Doppler Measurements for Low-Earth-Orbit Satellite: Baoshan Song, Weisong Wen, and Li-Ta Hsu, The Hong Kong Polytechnic University

9:20 Fused PNT on Future Wideband European Non-Terrestrial Network Infrastructure: Ottavio M. Picchi, Consultant for European Commission (EC), Joint Research Centre (JRC); Francesco Menzione, EC, JRC; Francis Soualle, and Jose A. del Peral-Rosado, Airbus Defence and Space GmbH

9:43 Multi-constellation Opportunistic Positioning Technology from LEO Signals: Simulation and Performance Analysis: Bowen Ai, Shengjie Zhou, Rong Yang, and Xingqun Zhan, Shanghai Jiao Tong University

10:05 a.m.-10:35 a.m., Refreshment Break in Foyer

10:40 Network-Aided Pseudorange-Based LEO PNT from OneWeb: Zacharias M. Komodromos, Sam C. Morgan, Zachary L. Clements, Wenkai Qin, W. Jeremy Morrison, and Todd E. Humphreys, The University of Texas at Austin

11:03 Strategies for Ambiguity Resolution in LEO-PNT Systems with Various Frequency Bands: Lotfi Massarweh, Sandra Verhagen, Delft University of Technology

11:26 Statistical Analysis of an Improved Clock Model for Opportunistic LEO Navigation: Angel Slavov, Ferran Valdes Crespi, Sebastian Durst, Peter Knott, Fraunhofer FHR

11:48 Validation of Pseudolites with a Loop-Back Time Synchronization Scheme Using a GNSS Signal Simulator: Muhammad Subhan Hameed, Mathias Phillip Blum, Thomas Pany, University of the Bundeswehr Munich; Daniel Sanroma, Sowmyashree Lakshmaiah, WORK Microwave GmbH

Session B5b: Precise Positioning and Atmosphere

Room: Grand Ballroom GH

8:30 a.m. – 12:15 p.m.

Dr. Y. Jade Morton
University of Colorado Boulder

Dr. Sandra Verhagen
Delft University of Technology

8:35 Collaborative Code-Based Differential GNSS for Multi-User Positioning: Helena Calatrava, Northeastern University; Daniel Medina, German Aerospace Center (DLR); Pau Closas, Northeastern University

8:57 Enhanced Single Station PPP-RTK Using CNES SSR Corrections: Yu-Sheng Yang and Shau-Shiun Jan, National Cheng Kung University

9:20 Monitoring the Effects of the October 10-11 Solar Storm at Mid-Latitudes Using a GNSS SDR Receiver: Iman Ebrahimi Mehr, Alex Minetto, Politecnico di Torino; Emanuele Pica, Rayan Imam, Claudio Cesaroni, Lucilla Alfonsi, Istituto Nazionale di Geofisica e Vulcanologia (INGV); Luca Spogli, Vincenzo Romano, INGV and SpacEarth Technology; Fabio Dovis, Politecnico di Torino

9:43 Lightning Prediction of GNSS PWV in Tibet: Kong Wenjing, Hang Guo, Chunpeng Kong, Nanchang University; Min Yu, Jiangxi Normal University; Jian Xiong, Nanchang University

10:05 a.m.-10:35 a.m., Refreshment Break in Foyer

10:40 Assessing Low-Cost GNSS Network Performance for Atmospheric and Positioning Applications: A preliminary Multi-Station Analysis of a Low-cost Network: Paolo Dabove and Milad Bagheri, Politecnico di Torino

11:03 Ionospheric Observations of May 2024 Geomagnetic Superstorm Using Space- and Ground-based GNSS Receivers: Hyeyeon Chang, Yang Pan, and Y. T. Jade Morton, The University of Colorado Boulder

11:26 Long-Lasting Plasma Bubble Over Asia-Pacific Region Triggered by May 2024 Geomagnetic Storm Observed by POD Measurements from Multiple LEO Satellites: Pin-Hsuan Cheng, Y. Jade Morton, Lei Liu, and Hyeyeon Chang, University of Colorado Boulder

11:48 Residual GNSS Ionospheric Error Analysis in Future Low Earth Orbit Applications: Can Oezmaden, Sarah Pelzer, RWTH Aachen University; Omar García Crespillo, German Aerospace Center (DLR); Marius Brachvogel, Michael Niestroj, RWTH Aachen University; Michael Meurer, RWTH Aachen University & DLR

Alternate

1. Signatures of Vertical Gradients Captured Southward of the Arabian Peninsula by GNSS RO Possibly Associated with Scintillation: Muhamad Mubasshir Shaikh, University of Sharjah, Sharjah Academy for Astronomy, Space Sciences and Technology; Abdollah Masoud Darya, Manar Anwar Khaleel Abusirdaneh, Space Weather & Ionosphere Laboratory, Sharjah Academy for Astronomy, Space Sciences and Technology

12:15 p.m. – 1:45 p.m. • Awards Luncheon • Grand Ballroom DEF

Late arrivals will not be served after 12:30 p.m.

Session C5: Vision, Radar and Lidar-Based Navigation System

Room: Grand Ballroom IJ
8:30 a.m. – 12:15 p.m.

Dr. Boris Pervan
Illinois Institute of Technology

8:35 Fisheye Camera-Based Local Effects Mitigation for Better Accuracy in land Transportation Applications: Juliette Marais, Timothée Guillemaille, Cyril Meurie, Corentin Menier, Sébastien Ambellouis, Univ Gustave Eiffel

8:57 Exploring Lidar Resilience: A Review of Spoofing Threats in Autonomous Driving: Mihir Nemana, Kana Nagai, Samer Khanafseh, and Boris Pervan, Illinois Institute of Technology

9:20 Flight Test Evaluation of a LIDAR/inertial Navigator for Autonomous Drone Operations in GNSS-Denied Urban Environments: Anne-Sophie Polz, Fabian Frickenstein, Maarten Uijt de Haag, Technical University of Berlin

9:43 LiDAR-to-Map Registration: Comparative Analysis of Mechanical and Solid-State LiDAR Technologies Across ICP and NDT Algorithms: Mohamed Elsayed, Queen's University; Eslam Mounier, Queen's University, and Ain Shams University; Emma Dawson, Queen's University; Aboelmagd Noureldin, Royal Military College, and Queen's University

10:05 a.m.-10:35 a.m., Refreshment Break in Foyer

10:40 Comparative Analysis of Vision-Based Navigation Performance According to Feature Point Placement in Cooperative Scenarios: Jiyeon Lee, Hyeongseob Shin, Dongyeon Park and Sangkyung Sung, Konkuk University

11:03 GPR-Based Positioning System for Robust Autonomous Vehicle Navigation: A Low-Latency SLAM Framework with V2X Capabilities in Mixed-GPS Environments: Akshay Pramod Roy, Mubarik Mohamoud, Venkata Ashok Masimukku, and Vamshi Krishna Uppununthala, GPR Inc.

11:26 TEXR: The University of Texas Extended Reality Dataset: Robert M. Tenny, Nicholas Christner, Raymond Jiang, and Todd E. Humphreys, The University of Texas at Austin

11:48 Performance Assessment of LiDAR-Visual-Inertial Fusion for GNSS-Resilient Aerial Navigation: Lorenzo Turci, Gennaromaria Crispino, Flavia Causa, Roberto Opromolla, University of Naples Federico II; Luca Orsolillo, Federico Corraro, Roberto Senatore, Civitanavi Systems; Giancarmine Fasano, University of Naples Federico II

Alternate

1. A Patch Based Fisheye Image Segmentation for Satellite State Characterization: Corentin Menier, Cyril Meurie, Yassine Ruichek, and Juliette Marais, Université Gustave Eiffel

Session D5: Optimization for PNT and Sensor Fusion - *Invited Session*

Room: Deer Valley 1-3
8:30 a.m. – 12:15 p.m.

Dr. Li-Ta Hsu
The Hong Kong Polytechnic University

Dr. Clark Taylor
Air Force Institute of Technology

8:35 Posing Geo Assets and Building World Maps at Google Scale: Luigi Bruno, Google

8:57 An Open-Source Factor Graph Optimization Package for GNSS: Examples and Applications: Taro Suzuki, Chiba Institute of Technology

9:20 FGO Based Integrity Monitoring for Urban Positioning with Dynamic Covariance Scaling: Oussama Tahri, David Bétaille, Ni Zhu, University Gustave Eiffel

9:43 GNSS/INS/VDM Integration with Batch Factor Graph Optimization for Reliable Trajectory Estimation in Urban Canyons: Yihan Zhong, Hoi-Fung Ng, Li-Ta Hsu, and Weisong Wen, The Hong Kong Polytechnic University

10:05 a.m.-10:35 a.m., Refreshment Break in Foyer

10:40 Autonomous Vehicle Trajectory Planning for Minimum Position Uncertainty: Adam J Rutkowski, Air Force Research Laboratory; Yetong Zhang, Frank Dellaert, Georgia Institute of Technology

11:03 Experimental Analysis of Quadcopter Drone Hover Constraints for Localization Improvements: Uthman Olawoye, David Akhihiero, and Jason Gross, West Virginia University

11:26 Factor Graph-Based Collaborative Localization and Incremental UWB Network Deployment in Indoor Environments for Emergency Task Forces: Eva Buchmayer, Axel Koppert, Fabian Theurl, Markus Watzko, Graz University of Technology

11:48 Continuous-Time Estimation in the Flat Output Space Using B-Splines: Jacob C. Johnson, and Joshua, G. Mangelson, and Randal W. Beard, Brigham Young University

12:15 p.m. – 1:45 p.m. • Awards Luncheon • Grand Ballroom DEF

Late arrivals will not be served after 12:30 p.m.

Session B6: Receiver Design, Signal Processing, and Antenna Technology
Room: Grand Ballroom GH
1:45 p.m. – 4:50 p.m.

Dr. Nesreen Ziedan
Zagazig University

Hendrik Osenberg
German Aerospace Center (DLR)

1:50 Mitigating GNSS Measurement Errors in Suspended Aircraft Tests for Effective INS/GNSS Integration: VS. Biju, VS. Vinoj, OT. Anand Shankar, A. Mohammed Basim, Krishan Kumar, Biju V. Gopal, A.R. Rekha, C. Radhakrishna Pillai, E.S. Padmakumar, ISRO Inertial Systems Unit

2:12 Evaluation of Adaptive Ultra-Tight Integration in a Forested Environment: Simon Kocher, Iñigo Cortés, Katrin Dietmayer, Matthias Overbeck, Alexander Rügamer, Fraunhofer Institute for Integrated Circuits IIS

2:35 Multi-Frequency Vector Tracking GNSS Receiver with Ionosphere Estimation: Christian Siebert, German Aerospace Center (DLR) & RWTH Aachen University; Andriy Konovaltsev, DLR; Michael Meurer, DLR & RWTH Aachen University

2:58 Joint Design of Error Correction and Error Detection using CRC-Aided Polar Code for Ultra-Reliable Space Communications and Navigation with Applications to GNSS L1C: Nuwan J. G. Kankanamge, Nghi H. Tran, The University of Akron; Khanh Pham, Air Force Research Laboratory; Tom Halford, Caliola Engineering, LLC.

3:25 Derivation and Validation of a Higher-Fidelity GPS Correlator Model: Blake Baker and Scott Martin, Auburn University

3:48 5G Signals of Opportunity for High-Altitude Navigation: Faezeh Mooseli and Zak (Zaher) M. Kassas, The Ohio State University

4:11 An Additional Secondary Factor Correction Strategy for Loran-C Based on Theoretical Prediction Models and a Small Amount of Measured Data: Jiaxin Song, Yurong Pu, Chaofan Tuo, Jiaju Zhou, Rongshuang Sun, Xiaoli Xi, Xi'an University of Technology

4:46 Multipath Error Propagation Characterization Using GNSS Multi-Frequency Direct Position Estimation: Jihong Huang, Shanghai Jiao Tong University & University of Colorado Boulder; Rong Yang, Xingqun Zhan, Shanghai Jiao Tong University; Jade Morton, University of Colorado Boulder

Alternate

1. **Signal Power-Assisted Autonomous Verification Method for eLoran Positioning Ambiguity Resolution:** Chaofan Tuo, Jiaju Zhou, Jiaxin Song, and Xiaoli Xi, Xi'an University of Technology

Session C6: Terrestrial Signals of Opportunity-Based Navigation Systems
Room: Grand Ballroom IJ
1:45 p.m. – 4:50 p.m.

Dr. Jiwon Seo
Yonsei University

Sharbel Kozhaya
The Ohio State University

1:50 5G Direct Position Estimation for Precise Localization in Dense Urban Area: Sijia Li, Sergio Vicenzo, and Bing Xu, The Hong Kong Polytechnic University

2:35 Blind Opportunistic Localization with 5G, LTE, and Digital TV Signals: Shaghayegh Shahcheraghi and Zak (Zaher) M. Kassas, The Ohio State University

2:58 An Empirical Assessment of Indoor-Outdoor Localization Based on Signals of Opportunity from Multiple Systems: Albrecht Michler, Paul Schwarzbach, Jonas Ninnemann, Muhammad Ammad, Oliver Michler, TUD Dresden University of Technology

3:25 Low-SWaP GNSS-Denied Navigation Using LTE Signals of Opportunity: Tyler Sweat, Michael Rice, Willie K. Harrison, and Randal W. Beard, Brigham Young University

3:48 Maximum Likelihood Time-Delay Estimation in Multipath Channels with Two- and Three-Paths Models Using OFDM: Lucas Alvarez Navarro, Christian C. J. M. Tiberius, Gerard J. M. Janssen, Delft University of Technology

4:11 Heteroscedastic Gaussian Process Model for Received Signal Strength Based Device-Free Localization: Ossi Kaltiokallio, Tampere University; Roland Hostettler, Uppsala University; Jukka Talvitie, and Mikko Valkama, Tampere University

4:46 Indoor Localization Based on Machine Learning-Assisted PDR and Signals of Opportunity from Ambient Generic BLE Devices: Masakatsu Kourogi, Akihiro Sato, Satoki Ogiso, Ryosuke Ichikari, and Takashi Okuma, AIST

4:46 Wi-Fi RTT Range Offset and Multi-Band Analysis: Challenges and Opportunities for Indoor Localization: Sultan Al Sulami, Tarig Ballal, Muhammad Moinuddin, and Tareq Al-Naffouri, King Abdulaziz University

Session D6a: Navigation in Challenging Environments 3

Room: Deer Valley 1-3
1:45 p.m. – 4:50 p.m.

Dr. Eva Buchmayer
Graz University of Technology

Dr. Robert Leishman
IS4S

1:50 GNSS Fault Rejection Using Robust Kalman Filter with Integrity Indicator-Constrained Innovation Adaptive Adjustment: Yingying Jiang, Ni Zhu, and Valerie Renaudin, Gustave Eiffel University

2:12 Contributions to Velocity Integrity for Autonomous Navigation in Urban Environments: Dennis Kulemann and Steffen Schön, Leibniz University Hannover

2:35 Lane-Level Localization of Vehicle in GPS-Denied Environment: Nur Uddin Javed, Russell Zhu, Andrei Kopanev, Shengzhe Tan, and Qadeer Ahmed, Ohio State University

2:58 Clock Drift Monitoring to Discriminate GNSS Signal After Prolonged Signal Loss: Jose Manuel Rubio Hernan, SAMOVAR, Institut Polytechnique de Paris; Christian Gentner, German Aerospace Center (DLR); Alexandre Vervisch-Picois, Nel Samama, SAMOVAR, Institut Polytechnique de Paris

3:25 Aerial Intruder Interception Based on Threat Classification for Enhanced Situational Awareness: Eshaan Khanapuri, Anusna Chakraborty, Ross Thayer, Jayanth Ammapalli, Jiarui Liu, Szu Wei Lin, and Joseph Yadegar, UtopiaCompression Corporation

3:48 Swarm Navigation in Lunar Caves: The First Proof-of-Concept Mission on Lanzarote: Siwei Zhang, Fabio Broghammer, Emanuel Staudinger, Robert Poehlmann, Christian Gentner, Martin Schmidhammer, Armin Dammann, German Aerospace Center (DLR)

4:11 Challenges of Trajectory Estimation Using Inertial Sensors in Smartwatches: Jae Hong Lee, Jae Wook Park, Junu Park, Sohee Park, and Chan Gook Park, Seoul National University

4:46 Integrity Monitoring of Cascading Faults in LEO-PNT Using Service Volume Simulations: Heiko Engwerda, Royal Netherlands Aerospace Center; Francesco Menzione, European Commission - Joint Research Centre

Session D6b: Smartphone-Based Localization

Room: Grand Ballroom ABC
1:45 p.m. – 4:50 p.m.

Dr. Sunil Bisnath
York University

Dr. Robert Odolinski
University of Otago

1:50 Performance Evaluation of the Latest Smartphones and Smartwatch Using GNSS Raw Measurements: Joohan Chun, Jacob Mark Spagnolli, Tanner Holmes, Ashton Unzicker, Dong-Kyeong Lee, Tim Everett, Dennis M. Akos, University of Colorado Boulder

2:12 Cycle Slip Repair for Single-Frequency Smartphone GNSS Using the Best Integer Equivariant Estimator: Naman Agarwal and Kyle O'Keefe, University of Calgary

2:35 Enhancing Smartphone Positioning with Galileo HAS Corrections and an Environmentally-Aware PPP/IMU Approach: Ding Yi, Caitlyn Hayden, and Sunil Bisnath, York University

2:58 Accuracy of the Network Location Provider in Android Devices: Joohan Chun, Christopher Kong, Dennis M Akos, University of Colorado Boulder

3:25 Real-Time Emitter Localization Using Crowdsourced Date from Android Smartphones Tested with Real-World Interference: Benon Gattis, Ethan Pyke, Dennis Akos, University of Colorado Boulder, Mark Crews, Stephen Robertson, Lockheed Martin

3:48 Analysis of Factors Affecting Ionospheric Refraction Estimates Obtained From Smartphone GNSS: Caitlyn Hayden, Ding Yi, Anurag Raghuvanshi, and Sunil Bisnath, York University

4:11 A Method to Estimate User Position and Orientation Based on Relative Position Measurement Between a Navigation Robot and a Smartphone: Satoki Ogiso, National Institute of Advanced Industrial Science and Technology (AIST); Daisuke Sato, Carnegie Mellon University; Ryosuke Ichikari, Takahiro Miura, Masakatsu Kourogi, Takashi Okuma, Takeshi Kurata, Takeshi Tanabe, AIST

4:46 Investigating the Accuracy of Google's Visual Positioning System: Viktor Horvath, Arpad Barsi, Budapest University of Technology and Economics; Charles Toth, The Ohio State University

Alternate

1. **Evaluating Dual-Frequency, Multi-Constellation GNSS Performance of Modern Smartphones for Atmospheric Monitoring Across Mountainous and Urban Areas:** Milad Bagheri, Neil Gogoi, Paolo Dabove, and Vincenzo Di Pietra, Politecnico di Torino

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EXHIBIT HALL FLOOR PLAN

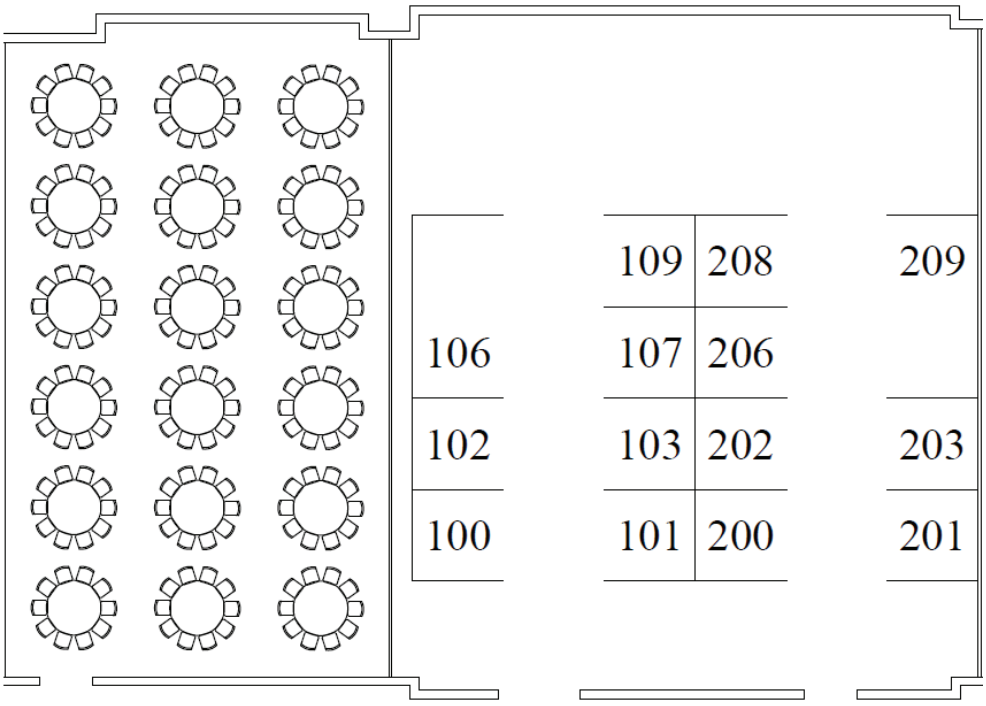

EXHIBIT HALL HOURS

Tuesday

8:00 a.m. - 9:30 a.m.	Exhibitor Setup
9:30 a.m. - 6:30 p.m.	Exhibit Hall Open
5:30 p.m. - 6:30 p.m.	Evening Exhibit Hour

Wednesday

8:30 a.m. - 9:30 a.m.	Exhibitor Setup
9:30 a.m. – 4:00 p.m.	Hall Open
4:00 p.m. – 6:00 p.m.	Exhibit Hall Teardown

PLANS 2025 EXHIBITORS

BOLDED = ION CORPORATE MEMBER

- **Acutronic USA Inc. (Booth 203)**
- Advanced Test Equipment Rental (Booth 102)
- **CAST Navigation, LLC (Booth 106)**
- **exail (Booth 107)**
- FIBERPRO, Inc. (Booth 200)
- **Gladiator Technologies, LLC (Booth 109)**
- **Ideal Aerosmith (Booth 100)**
- **Inertial Labs, a VIAVI Solutions Company (Booth 202)**
- Institute of Navigation (Booth 209)
- **Silicon Sensing Systems Ltd. (Booth 101)**
- SMG (Booth 103)
- Tronics Microsystems, a TDK Group Company (Booth 201)
- **VectorNav Technologies (Booth 208)**

PROGRAM OVERVIEW

Monday, April 28 - Pre-Conference Tutorial Sessions - Grand Ballroom ABC (Additional Registration and Fee Required)

8:30 a.m. - 10:15 a.m. Vision-Based Navigation: Techniques and Applications, Dr. Laura Ruotsalainen
10:30 a.m. - 12:15 p.m. Estimation of Noise Parameters in State Space Models, Dr. Jindrich Dunik and Dr. Ondrej Straka

12:15 p.m.–1:15 p.m. Lunch Served for Tutorial Attendees

1:15 p.m. - 3:00 p.m. GNSS in the Age of Machine Learning, Dr. Pau Closas
3:15 p.m. - 5:00 p.m. LEO PNT: From Theory to Implementation, Dr. Zak Kassas

Monday, April 28 - IEEE/ION PLANS Plenary Session- Grand Ballroom G-J -5:30 p.m. - 6:30 p.m.

GPS: Past and Present Challenges
Presented by Dr. Bradford Parkinson

IEEE/ION PLANS Technical Sessions

	Track A: Inertial Sensing and Technology	**Track B:** Global Navigation Satellite Systems	**Track C:** Integrated and Opportunistic Nav.	**Track D:** Applications of Localization Technologies
Tuesday, April 29	**Exhibit Hall Open, 9:30 a.m.– 6:30 p.m., Grand Ballroom DEF**			
	A1: Cutting-Edge Inertial-Based Pedestrian Localization 8:30 a.m. - 12:15 p.m. *Grand Ballroom ABC*	B1: Integrity and Augmentation 8:30 a.m. - 12:15 p.m. *Grand Ballroom GH*	C1: Multisensor Integrated Systems and Sensor Fusion Technologies 8:30 a.m. - 12:15 p.m. *Deer Valley 1-3*	D1: Lunar, Mars and Space Navigation 8:30 a.m. - 12:15 p.m. *Grand Ballroom IJ*
	12:15 p.m.–1:15 p.m. Lunch Served in the Exhibit Hall, Grand Ballroom DEF			
	A2a: Quantum Inertial Sensor Technologies and Applications 1:45 p.m. - 3:25 p.m. *Deer Valley 1-3*	B2: Frontiers of GNSS 1:45 p.m. - 4:20 p.m. *Grand Ballroom GH*	C2: Non-Terrestrial Signals of Opportunity-Based Navigation Systems 1:45 p.m. - 5:30 p.m. *Grand Ballroom IJ*	D2: AI-Enhanced Navigation 1:45 p.m. - 5:30 p.m. *Grand Ballroom ABC*
	A2b: Resilient Inertial Navigation Systems and Alternative Sensors 3:55 p.m. - 5:30 p.m. *Deer Valley 1-3*			
	Evening Hour in Exhibit Hall 5:30 p.m. - 6:30 p.m., Grand Ballroom DEF			
Wednesday, April 30	**Exhibit Hall Open, 9:30 a.m.–4:00 p.m.**			
	A3a: Advances in MEMS-Based Inertial Sensors and Inertial Measurement Units 8:30 a.m. - 10:05 a.m. *Deer Valley 1-3*	B3: Interference, Jamming, and Spoofing 1 8:30 a.m. - 12:15 p.m. *Grand Ballroom GH*	C3: Frontiers of Radionavigation: Signals of Opportunity, 5G, LEO, and Beyond 8:30 a.m. - 12:15 p.m. *Grand Ballroom IJ*	D3: Navigation in Challenging Environments 1 8:30 a.m. - 12:15 p.m. *Grand Ballroom ABC*
	A3b: Inertial Vehicle Navigation 10:35 a.m. - 12:15 p.m. *Deer Valley 1-3*			
	12:15 p.m.–1:15 p.m. Lunch Served in the Exhibit Hall, Grand Ballroom DEF			
		B4: Interference, Jamming,and Spoofing 2 1:45 p.m. - 5:30 p.m. *Grand Ballroom GH*	C4: Navigation Using Environmental Features 1:45 p.m. - 5:30 p.m. *Grand Ballroom IJ*	D4a: Navigation in Challenging Environments 2 1:45 p.m. - 5:30 p.m. *Grand Ballroom ABC*
				D4b: Ground, Aerial, and Maritime Navigation 1:45 p.m. - 5:30 p.m. *Deer Valley 1-3*
Thursday, May 1		B5a: LEO-PNT: Concepts, Systems and Use Cases 8:30 a.m. - 12:15 p.m. *Grand Ballroom ABC*	C5: Vision, Radar and Lidar-Based Navigation System 8:30 a.m. - 12:15 p.m. *Grand Ballroom IJ*	D5: Optimization for PNT and Sensor Fusion 8:30 a.m. - 12:15 p.m. *Deer Valley 1-3*
		B5b: Precise Positioning and Atmosphere 8:30 a.m. - 12:15 p.m. *Grand Ballroom GH*		
	12:15 p.m.–1:45 p.m. Awards Luncheon, Grand Ballroom DEF (late arrivals cannot be served after 12:30 p.m.)			
		B6: Receiver Design, Signal Processing, and Antenna Technology 1:45 p.m. - 4:50 p.m. *Grand Ballroom GH*	C6: Terrestrial Signals of Opportunity-Based Navigation Systems 1:45 p.m. - 4:50 p.m. *Grand Ballroom IJ*	D6a: Navigation in Challenging Environments 3 1:45 p.m. - 4:50 p.m. *Deer Valley 1-3*
				D6b: Smartphone-Based Localization 1:45 p.m. - 4:50 p.m. *Grand Ballroom ABC*