### PRE-CONFERENCE TUTORIALS
**January 25 - January 26, 2021**

*Must add tutorials on ITM/PTTI Registration Form. Additional fee applies.*

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<th>6:00 a.m. - 10:15 a.m. (PST)</th>
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| 6:00 - 7:15 a.m.         | Fundamental of Time and its Measurement  
                          | Dr. Elisa Felicitas Arias |
| 7:30 - 8:45 a.m.         | Time Transfer Protocols       
                          | Francisco Girela         |
| 9:00 - 10:15 a.m.        | Microwave Oscillators         
                          | Dr. Patrick Berthoud     |

#### Special Live Streamed Event
ITM/PTTI Plenary Session Keynote and Exhibitor Presentations
**Wednesday, January 27, 2020 ● 7:30 a.m. (PST)**

### ITM/PTTI TECHNICAL SESSIONS
**January 26 - January 28, 2021**

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#### Special Live Streamed Event
ION Annual Awards and Fellows Presentation
**Thursday, January 28, 2021 ● 7:30 a.m. (PST)**
Plenary Session
Date: Wednesday, January 27, 2021
Time: 7:30 a.m. - 10:00 a.m.

Welcome

KEYNOTE: Why, How and When Redefining the SI Second

Dr Elisa Felicitas Arias (PhD, Professor), Long Term Visitor at LNE/SYRTE, Observatoire de Paris, France

A new generation of frequency standards, operating in optical wavelengths achieved uncertainties of parts in 10^18, facing metrology to consider a future redefinition of the SI second. In preparation for this, the Consultative Committee for Time and Frequency (CCTF) maintains a list of frequencies recommended as secondary representations of the second measured at various laboratories. The roadmap towards the redefinition is under revision based on the progress in the assessment of these optical frequency standards and the perspectives for operating highly accurate time and frequency transfer techniques without distance limitations. This conference presents the present situation, the future perspective, and the impact in other fields of science.

Dr. Elisa Felicitas Arias directed the BIPM Time Department during 18 years. She retired end of 2017 but continues contributing to time metrology and space reference frames programmes at Paris Observatory.

KEYNOTE: Google’s Use of 3D Building Models to Solve Urban GNSS

Dr. Frank van Diggelen

When GPS/GNSS was first developed in the 1970s, it was premised on line-of-sight signals with expected civilian accuracy of tens of meters. Almost immediately, commercial industry pioneers began to use GPS outside its intended design envelope. Almost all the accuracy, signal processing, and use-case limitations were solved: Differential GNSS, Carrier phase positioning, Assisted GNSS, High Sensitivity, and even GNSS in space. The one big unsolved problem is inaccuracy in cities.

GNSS constructively places you on the wrong side of street, or the wrong city block, in a situation where line-of-sight (LOS) signals are blocked, because the receiver tracks the non-line-of-sight signals (NLOS) reflected off buildings, and the entire system assumes line-of-sight time-of-flight. Now Google has deployed a system that solves this problem.

Using Google’s vast database of 3D building models, the asymmetric NLOS propagations are modeled so that the NLOS pseudorange errors can be corrected, leading to 50 to 90% reduction in Wrong-Side-of-Street occurrences from GNSS in phones.

In this talk, we will review the problem, and previous attempts to find a solution - revealing the deeply embedded difficulties facing researchers. Then we will give an overview of the Google solution, the rollout in Android phones, and before/after results.

Dr. Frank van Diggelen is a Principal Engineer at Google, where he leads the Android Core-Location Team. He also teaches GPS: he and Prof. Per Enge created an on-line GPS course, offered through Stanford University and Coursera and available on YouTube.

Van Diggelen is a pioneer in Assisted GNSS, the technique that allows GPS to work in cell phones. He is the inventor of coarse-time GNSS navigation, co-inventor of Long Term Orbits for A-GNSS, and holds over 90 issued US patents on A-GNSS. He is the author of “A-GPS” the first textbook on Assisted GNSS, and Co-editor of “PNT in the 21st Century” (Morton, van Diggelen, Spilker, and Parkinson), the latest book on GNSS and Navigation. He is Executive Vice President of the Institute of Navigation and a Fellow of the ION and the Royal Institute of Navigation (UK), and past recipient of both the Thurlow and Kepler awards of the ION.

Previously, he was a Navigation Officer in the South African Navy. He obtained his bachelor’s degree from the University of the Witwatersrand, South Africa, and Ph.D. in electrical engineering from Cambridge University, England.
1. **Why, How and When Redefining the SI Second**, Dr. Elisa Felicitas Arias, Long Term Visitor at LNE/SYRTE, Observatoire de Paris, France

2. **Google’s Use of 3D Building Models to Solve Urban GNSS**, Dr. Frank van Diggelen, Google
ITM Session
GNSS and Security: Interference, Jamming, and Spoofing

Session Chairs:

Fabian Rothmaier
Stanford University

Barbara Clark
Federal Aviation Administration

Presentations in this session have been ordered alphabetically.


2. **Broadcast Data Authentication Concepts for Future SBAS Services**, Luciano Tosato, Andrea Dalla Chiara, Chris Wullems, Guillermo Fernandez Serrano, Alessandra Calabrese, Adrian Perrig, Mikael Mabilleau, Giovanni Vecchione, Qascom, Italy

3. **Dynamic Time Warping (DTW) based GNSS Interference Detection Algorithm for Edge Devices**, Wilbur Myrick, ENSCO, Inc Daniel Goff, ENSCO, Inc Stanley Radzevicius, ENSCO, Inc

4. **AGC on Android Devices for GNSS**, Dong-Kyeong Lee, Nicholas Spens, Dennis Akos, Benon Granite Gattis, University of Colorado Boulder

5. **GNSS Spoofing Mitigation in the Position Domain**, Fabian Rothmaier, Yu-Hsuan Chen, Sherman Lo, Todd Walter, Stanford University

6. **GNSS Spoofing Discrimination Method Based on Doppler Frequency Double Difference for Multiple Independent Moving Receivers**, Zhongxiao Wang, Hong Li, Jian Wen, Mingquan Lu, Tsinghua University, China

7. **Key Management Concepts for Future SBAS Services**, Luca Canzian, Luciano Tosato, Andrea Dalla Chiara, Oscar Pozzobon, Qascom, Italy; Mikael Mabilleau, GSA


9. **Management of Active Data and Authentication in Future SBAS Receivers**, Chris Wullems, Luciano Tosato, Andrea Dalla Chiara, Oscar Pozzobon, Qascom, Italy; Guillermo Fernandez Serrano, Mikael Mabilleau, GSA

10. **Performance Analysis and Tests for GNSS Spoofing Detection Based on the Monitoring of Cross Ambiguity Function and Automatic Gain Control**, Tao Zhang, Xin Chen, Di He, Shanghai Key Laboratory of Navigation and Location Based Services, School of Electronic Information and Electrical Engineering, Shanghai Jiao Tong University, China; Yi Jin, State Grid Shanghai Municipal Electric Power Company, China

11. **SBAS Message Authentication: a review of Protocols, Figures of Merit and Standardization Plans**, Ignacio Fernández Hernández, European Commission, Belgium; Todd Walter, Andrew M. Neish, Jason Anderson, Stanford University; Mikael Mabilleau, European GNSS Agency/RHEA, Belgium; Giovanni Vecchione, European Commission/RHEA, Belgium; Eric Châtre, European Commission, Belgium

12. **Time Synchronized Signal Generator GNSS Spoofing Attacks Against COTS Receivers in Over the Air Tests**, Ronny Blum, Nikolas Dütsch, Jürgen Dampf, Thomas Pany
ITM Session
GNSS Integrity and Augmentation

Session Chairs:

Dr. Jinsil Lee
KAIST, South Korea
Dr. Michael Felux
zurich University of Applied Sciences, Switzerland

Presentations in this session have been ordered alphabetically.

1. A Signal Quality Monitoring Algorithm Based on Chip Domain Observables for BDS B1C Signal, Xiang Wang, Department of Electronic Engineering, Tsinghua University, China; Yang Gao, Beijing Satellite Navigation Center, China; Xiaowei Cui, Gang Liu, Department of Electronic Engineering, Tsinghua University, China; Mingquan Lu, Department of Electronic Engineering, and Beijing National Research Center for Information Science and Technology, Tsinghua University, China

2. Analysis of BDS B1C/B2a Acquisition, Tracking and Data Demodulation Thresholds for Civil Aviation, Chuanrui Wang, Xiaowei Cui, Department of Electronics Engineering, Tsinghua University, China; Xiao Li, Beijing Hualong Tong Science and Technology Co., Ltd, China; Gang Liu, Department of Electronics Engineering, Tsinghua University, China; Mingquan Lu, Department of Electronics Engineering and Beijing National Research Center for Information Science and Technology, Tsinghua University, China

3. ARAIM for Military Users: ISM Parameters, Constellation-Check Procedure and Performance Estimates, Alec Katz, Sam Pullen, Sherman Lo, Juan Blanch, Todd Walter, Stanford University; Andrew Katronick, Mark Crews, Robert Jackson, Lockheed Martin

4. Investigation into September 2020 GPS SVN 74 Performance Anomaly, Todd Walter, Kazuma Gunning, Juan Blanch, Stanford University; Kristy Pham, John Mick, William Wanner, William J. Hughes FAA Technical Center

5. Nominal Range Error Analysis of BDS for ARAIM, Hengwei Zhang, Yiping Jiang, The Hong Kong Polytechnic University, China

6. Vertical Protection Level Optimization Method for BDS/GPS Navigation System, Ershen Wang, Xidan Deng, Shenyang Aerospace University, China; Jing Guo, China Academy of Civil Aviation Science and Technology, China; Gang Tong, Pingping Qu, Tao Pang, Caimiao Sun, Shenyang Aerospace University, China

7. Reevaluating the Message Loss Rate of the Wide Area Augmentation System (WAAS) in Flight, Todd Walter, Sherman Lo, Matthew J. Hirschberger, Stanford University
PTTI Session
GNSS/RNSS Time and Frequency Transfer and Emergent Timing Technologies

Session Chairs:

Dr. Joerg Hahn  Katarzyna Oldak
ESA, The Netherlands USNO

Presentations in this session have been ordered logically.

1. **Hardening Accurate Timing Receivers Against low-cost 1PPS Spoofing**, Yoav Zangvil, Technion Institute of Technology, Regulus Cyber
   Gal Cohen, Technion Institute of Technology, Regulus Cyber

2. **Advancements in the GIANO Project: Galileo-Based Timing Receiver for Increasing Critical Infrastructures Resilience**, Piotr Dunst, Jerzy Nawrocki, Edoardo Detoma, Space Research Center PAS, Poland; Pawel Nogas, PikTime Systems, Poland; Livio Marradi, Gianluca Franzoni, Marco Puccitelli, Roberto Campana TAS-I, Italy; Roberto Muscinelli, BIP, Italy; Valeria Catalano, Ciro Gioia, Antonio Danesi, European GNSS Agency

3. **Galileo System Status**, Dr. Jörg Hahn, Daniel Blonski, G. Galluzzo, Paolo Zoccarato, ESA, The Netherlands

4. **Comparing the Timescales in Public, Precise Ephemeris Products**, William Konyk, National Geospatial-Intelligence Agency

5. **IPPP Links for UTC: Comparison to Existing Techniques**, Gérard Petit, BIPM Frédéric Meynadier, BIPM, France
ITM Session
Navigation in GNSS Challenged Environments

Session Chair:

Dr. Çagatay Tanil
Amazon

Presentations in this session have been ordered alphabetically.

1. Development of a Navigation and Information Service for a University Library, Guenther Retscher and Alexander Leb, Department of Geodesy and Geoinformation, TU Wien, Austria

2. Evaluating GNSS/INS Availability for Self-Driving Cars in Urban Environments, Kana Naga, Matthew Spenko, Ron Henderson, and Boris Pervan, Illinois Institute of Technology


4. Multipath Rejection Using Multicorrelator Based GNSS Receiver With an Extended Kalman Filter, Christian Siebert, Institute of Communications and Navigation, German Aerospace Center (DLR), & Chair of Navigation, RWTH Aachen University, Germany; Andriy Konovaltsev, Institute of Communications and Navigation, German Aerospace Center (DLR), Germany; Michael Meurer, Institute of Communications and Navigation, German Aerospace Center (DLR), & Chair of Navigation, RWTH Aachen University, Germany

5. Performance Analysis of GNSS Spoofing Mitigation Techniques based on Array Antennas in Various Spoofing Scenarios, Jae Hee Noh, Department of Electronic Engineering, Chungnam National University, South Korea; Heon Ho Choi, Satellite Navigation Team, Korea Aerospace Research Institute, South Korea; Byung Hyi Gong, Young Seok Lee, Bang Chul Jung, Sang Jeong Lee, Department of Electronic Engineering, Chungnam National University, South Korea

6. Positioning Performance in Deep Pit Mines using GNSS Augmented with Locata, Maria J. Evans, The Pennsylvania State University-Brandywine; Sean Evans Eagen, Virginia Polytechnic Institute and State University

7. Scalability and Latency Analysis of the Centralized 3D Mapping Aided GNSS-Based Collaborative Positioning, Guohao Zhang, Hoi-Fung Ng and Li-Ta Hsu Interdisciplinary Division of Aeronautical and Aviation Engineering, The Hong Kong Polytechnic University, Hong Kong. Han Gao and Dingzhong Yao are with Huawei Technology.
ITM Session
Navigation of Unmanned Aerial Vehicles and Other Autonomous Systems

Session Chairs:

Dr. Jiwon Seo
Yonsei University, South Korea

Sriramya Bhamidipati
University of Illinois at Urbana-Champaign

Presentations in this session have been ordered alphabetically.

1. A Feasibility Study on Smartphone Localization using Image Registration with Segmented 3D Building Models based on Multi-Material Classes, Max Jwo Lem Lee and Li-Ta Hsu, Interdisciplinary Division of Aeronautical and Aviation Engineering, The Hong Kong Polytechnic University, Hong Kong


4. Analysis of Ground Vehicle Integrity Monitoring Aided by Signals of Opportunity, Mu Jia, Joe Khalife, and Zaher (Zak) M. Kassas; University of California, Irvine

5. Precise Real-Time Relative Orbit Determination for Large-Baseline Formations Using Differential GNSS, Vincent Giralo, Space Rendezvous Laboratory, Stanford University; Simone D’Amico, Space Rendezvous Laboratory, Stanford University

6. Real-Time Horizontal Velocity Estimation of a Landing Craft using Computer Intelligence, Lavanya Karthikeyan, Department of Computer Science and Engineering, Amrita School of Engineering-Bangalore, India; Malavika R. Nair, Department of Computer Science and Engineering, Amrita School of Engineering-Bangalore, India; S.V. Apoorva, BMS Institute of Technology and Management, India; Dr. Vinod Kumar, UR Rao Satellite Centre, India
PTTI Session
Network Synchronization Technologies for High-end Science and Robust Critical Infrastructure

Session Chairs:

Dr. Elizabeth Laier English
National Physical Laboratory, UK

John Clark
Masterclock

Presentations in this session have been ordered logically.

1. **Time Determination for Network Analytics**, Charles Barry, Luminous Cyber

2. **An Analysis of Performance Statistics Reported by the NTPv4 Reference Implementation and Their Effect on Calibration Uncertainty**, Andre Charbonneau and Marina Gertsvolf, National Research Council Canada

3. **The WRITE (White Rabbit for Industrial Timing Enhancement) Project Status Update**, Elizabeth Laier English, Belinda Eglin, Adam Parsons, Conway Langham, Peter Whibberley, NPL, UK; Davide Calonico, INRIM, Italy; Anders Wallin, VTT, Finland; Peter Jansweijer, NIKHEF, Netherlands; Paul-Eric Pottie, Paris Observatory, France; Erik Dierikx, Marijn Van Veghel, Yan Xie, VSL, Netherlands; José Luis Gutiérrez, José López-Jiménez, Javier Diaz, Seven Solutions, Spain; Carsten Rieck, RISE, Sweden; Hermann Virgile, Francois Keckemeti, Thales, France; Sapia Adalberto, Massari Maurizio, Leonardo, Italy; Luca Liberati, OPNT, Netherlands

4. **Geostamp for Legal Time Traceability and 4D GIS Applications**, Brooks Harris, EdlMax, Cambrea Ezell, ALV, and Son VoBa, Sync-n-Scale.

5. **A Metrological White-Rabbit Link between two UTC(k) Labs**, P. Waller, C. Plantard, ESA/ESTEC, European Space Research and Technology Centre, The Netherlands; E. Dierikx, M. van Veghel, VSL, Dutch Metrology Institute, The Netherlands; R. Smets, A. van den Hil, SURF, Dutch ICT cooperative for Education and Research, The Netherlands

6. **CLONETS-DS – Clock Network Services-Design Study: Strategy and Innovation for Clock Services Over Optical-fibre Networks**, Josef Vojttech, Vladimir Smotlacha, Pavel Skoda, Rudolf Vohnout, CESNET, Czech Republic; Tara Liebisch, Harald Schnatz, Physikalisch-Technische Bundesanstalt, Germany; Tryfon Chiotis, Guy Roberts, Vincenzo Capone, GÉANT VERENIGING; Artur Binczewski, Wojbor Bogacki, Krzysztof Turza, Poznan Supercomputing and Networking Center, Poland; Paul-Eric Pottie, Philip Tuckey LNE-SYRTE, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universités, UPMC, France; Davide Calonico, Istituto Nazionale di Ricerca Metrologica, Italy; Ronald Holzwarth, Ben Sprenger, Menlo Systems, Germany; Ondej Cíp, Lenka Pravdová, Simon Rerucha, Institute of Scientific Instruments of the CAS, v.v.i. (ISI), Czech Republic; Javier Díaz Alonso, Eduardo Ros Vidal, University of Granada, Spain; Trinidad García, José López, Seven Solutions S.L., Spain; Ulrich Schreiber, Jan Kodet, Technical University of Munich, Germany; Jürgen Kutsche, Simon Stellmer, Dieter Meschede Rheinische, Friedrich-Wilhelms-Universität; Bonn Robert Urbaniak, Pktime Systems sp. z o.o., Poland; Przemysaw Krehlik, Lukasz Slwczynski, AGH University of Science and Technology, Poland; Anne Amy-Klein LPL, Université Sorbonne Paris Nord, CNRS, France; Nicolas Quintin Réseau, National de Télécommunications pour la Technologie, l’Enseignement et la Recherche, France; Alwyn Seeds, University College London, UK; Bruno Desruelle, Vincent Ménoire, Jean Lautier-Gaud, Martin Rabaut Muquans, Talence, France
PTTI Session
Optical Clocks and Possible Scenario Towards the Redefinition of the Second

Session Chairs:

Dr. Bin Jian
National Research Council, Canada

Dr. Tetsuya Ido
NICT, Japan

Presentations in this session have been ordered logically.

1. **Measurement of the frequency ratio of 115In+ ion clock and 87Sr optical lattice clock**, N. Ohtsubo, Y. Li, N. Nemitz, H. Hachisu, K. Matsubara, T. Ido, and K. Hayasaka, National Institute of Information and Communications Technology, Japan

2. **Absolute Frequency of 87Sr at 1.8×10⁻¹⁶ Uncertainty by Tracing NICT-Sr1 to Remote Primary Frequency Standards**, Nils Nemitz, Tadahiro Gotoh, Fumimaru Nakagawa, Hiroyuki Ito, Yuko Hanado, Tetsuya Ido, and Hidekazu Hachisu, National Institute of Information and Communications Technology, Japan

3. **Absolute Frequency Measurement of the NRC’s Strontium ion Clock Using the GPS PPP Method**, Bin Jian, Pierre Dubé, and Marina Gertsvolf, National Research Council Canada
ITM Session
Precise GNSS Positioning

Session Chairs:

Dr. Sandra Verhagen
Delft University of Technology, The Netherlands

Dr. Erin Kahr
Hexagon, Canada

Presentations in this session have been ordered alphabetically.

1. **A Feasibility Study on the Position Hypothesis Based RTK with the Aids of 3D Building Models**, Hoi-Fung Ng and Li-Ta Hsu, Interdisciplinary Division of Aeronautical and Aviation Engineering, The Hong Kong Polytechnic University, China

2. **Attitude Determination and RTK Performances Amelioration Using Multiple Low-Cost Receivers with Known Geometry**, Xiao Hu, Paul Thevenon, Christophe Macabiau, ENAC, Université de Toulouse, France

3. **BIE using multivariant t-distribution and the iFlex method for GNSS PPP**, Viet Duong Hemisphere GNSS (USA) Inc., USA; Suelynn Choy, School of Science, RMIT University, Australia; Chris Rizos, School of Civil and Environmental Engineering, University of New South Wales, Australia

4. **Square Root Information Filtering Method of GPS / BDS Dynamic Precise Point Positioning in Complex Environment**, Hepeng Wang, Huixia Li, Hang Guo, Ping Jiang, Cong Huang, School of Information Engineering, Nanchang University, China
PTTI Session
Present and Future Clocks for Ground and Space Applications

Session Chairs:

Dr. James Camparo
The Aerospace Corporation

Jamie Mitchell
Microchip

Presentations in this session have been ordered logically.

1. **An Advanced-CSAC Testbed for Next-Generation Space Missions: Overview and Recent Results**, Zachary Warren, Hunter Kettering, and James Camparo, Physical Sciences Laboratories, The Aerospace Corporation

2. **Testbed for Low-SWaP Atomic Clock Ensemble Development**, Christopher Flood, Daniel Dowd, Henry Dixon, Luciana Schement, Quinn LaBarge, Prayag Desai, Dr. Penina Axelrad, University of Colorado Boulder


4. **Measuring the Temperature Dependence of Buffer Gas Induced Collision Shifts for Optical Transitions in Rb87**, Hunter Kettering, Travis Driskell, James Camparo, The Aerospace Corporation
ITM Session
Radionavigation Beyond Medium Earth Orbit GNSS

Session Chairs:

Dr. Zak Kassas
University of California Irvine

Dr. Tyler Reid
Xona Space Systems

Presentations in this session have been ordered alphabetically.

1. **Autonomous Lunar Satellite Navigation System: Preliminary Performance Assessment on South Pole**, Mauro Leonardi, Gheorghe Sirbu, University of Rome “Tor Vergata” Department of Electronic Engineering, Italy; Cosimo Stallo, Massimo Eleuteri, Carmine Di Lauro, Claudia Iannone, Ersilia Del Zoppo, Thales Alenia Space, Italy


4. **Terrestrial Precise Positioning System Using Carrier Phase from Burst Signals and Optically Distributed Time and Frequency Reference**, Han Dun, Christian Tiberius, Cherif Diouf and Gerard Janssen, Delft University of Technology, The Netherlands

5. **Trusted Radionavigation via Two-Way Ranging**, Sami Ruponen, Tapio Suihko, Juha Zidbeck, VTT Technical Research Centre of Finland; Ondrej Daniel, Tatjana Petkovic, Huld; Gianluca Caparra, Lionel Ries, European Space Agency, Netherlands
ITM Session
Receiver Design, Signal Processing, and Antennas

Session Chairs:
Dr. Sabrina Ugazio
Ohio University
Ajay Vemuru
Spirent Communications, UK

Presentations in this session have been ordered alphabetically.


2. An Improved Frequency Domain Interference Suppressor for DBT Processing of High Order BOC Signals, Zhenyu Tian, Xiaowei Cui, Gang Liu, Department of Electronic Engineering, Tsinghua University, China; Mingquan Lu, Department of Electronic Engineering, and Beijing National Research Center for Information Science and Technology, Tsinghua University, China

3. Cooperative Vector Processing of GPS Signals, Tanner M. Watts and Scott M. Martin, Auburn University

4. Multi-Band Antenna Array Geometry Impact on Array Interpolation, Marco Marinho, Halmstad University, Sweden; Per Gustafson, Gutec AB, Sweden; Felix Antreich, Aeronautics Technology Institute, Brazil; Stefano Caizzone, German Aerospace Agency, Germany; Alexey Vinel, Halmstad University, Sweden

5. Signal Quality Monitoring Spoofing Identification Methods for GNSS Vector Tracking Structure, Xinran Zhang, Hong Li, Chun Yang, Mingquan Lu. Department of Electronic Engineering, Beijing National Research Center for Information Science and Technology, Tsinghua University, China; China Academy of Engineering Physics, China
ITM Session
Remote Sensing, Atmospheric Effects, and Space Weather

Session Chairs:

Dr. Ningchao Wang
Hampton University

Dr. Larry Sparks
Jet Propulsion Laboratory

Presentations in this session have been ordered alphabetically.

1. **A Risk Assessment of Geomagnetic Conditions Impact on GPS Positioning Accuracy Degradation in Tropical Regions Using Dst Index**, Nenad Sikirica, Krapina University of Applied Sciences, Croatia; Franc Dimc, Faculty of Maritime Studies and Transport, University of Ljubljana, Slovenia; Oliver Jukic, Virovitica College, Croatia; Teodor B Iliev, University of Ruse, Bulgaria; Darko Spoljar, Faculty of Engineering, University of Rijeka, Croatia; Renato Filjar, Faculty of Engineering, University of Rijeka, and Krapina University of Applied Sciences, Croatia

2. **Assessment of Ionospheric Correction Behavior for Use with PPP**, Todd Walter and Juan Blanch, Stanford University; Lance de Groot and Laura Norman, Hexagon, Canada

3. **Bobcat-1, the Ohio University CubeSat: preliminary data analysis.**, Sabrina Ugazio, Brian C. Peters, Ryan McKnight, Gregory Jenkins, Kevin Croissant, Frank van Graas, Ohio University

4. **Machine Learning-based Investigation of Feature Importance for High-latitude Ionospheric Scintillation Forecasting**, Alexis J. Wu, Canyon Crest Academy; Yunxiang Liu, University of Colorado Boulder, Boulder

5. **Measuring Small- and Medium-scale TEC Spatial Variations and Irregularities from Ground-based GNSS Observations**, Xiaoqing Pi, Shadi Oveisgharan, Ekaterina Tymofyeyeva, Heresh Fattahi, Paul Rosen, and Vardan Akopian, Jet Propulsion Laboratory, California Institute of Technology

6. **Pre-sunset L-band Scintillation over Arabian Peninsula**, Muhammad Mubasshir Shaikh and Ilias Fernini, Space Weather and Ionosphere Laboratory, Sharjah Academy for Astronomy, Space Sciences and Technology, University of Sharjah, Sharjah, UAE
ITM Session
Safety-critical Applications of GNSS and Other Sensors

Session Chairs:
Dr. Mihaela-Simona Circiu
German Aerospace Center DLR, Germany
Dr. Steven Langel
The MITRE Corporation

Presentations in this session have been ordered alphabetically.

1. **An Overview of the Proposed Mode N System in the Context of Alternative Position, Navigation, and Timing (APNT) Development**, Brandon Weaver, Gianluca Zampieri, Okuary Osechas, German Aerospace Center (DLR), Germany

2. **A Rényi Divergence Based Approach to Fault Detection and Exclusion for Tightly Coupled GNSS/INS System**, Changwei Chen, and Solmaz S. Kia, University of California, Irvine

3. **Antenna Group Delay Variation Bias Effect on Advanced RAIM**, Eugene Bang, Mihaela-Simona Circiu, Stefano Caizzone and Markus Rippl, German Aerospace Center (DLR), Germany

4. **Gaussian Bounding Improvements and an Analysis of the Bias-sigma Tradeoff for GNSS Integrity**, Juan Blanch and Todd Walter, Stanford University

5. **Final Results on Airborne Multipath Models for Dual-constellation Dual-frequency Aviation Applications**, Mihaela-Simona Circiu, Stefano Caizzone, Christoph Enneking, Friederike Fohlmeister, Markus Rippl, Michael Meurer (German Aerospace Center), Michael Felix (ZHAW), Ioana Gulie, David Ruegg (Airbus Defence and Space), Joseph Griggs (Collins Aerospace), Rémy Lazzerini, Florent Hagemann, Francois Tranchet (Airbus Operation SAS), Pierre Bouniol (Thales Avionics), Matteo Sgammini (Joint Research Center of the European Commision)


7. **Sigma-?: A New Constrained at Design GNSS Observation Weighting Parametric Model for Land Applications**, Nourdine Ait Tmaizirte, Institut de Recherche Technologique Railenium, France; Syed Ali Kazim, Juliette Marais, COSYS-LEOST, Univ Gustave Eiffel, IFSTTAR, Univ Lille, France; Maan El Badaoui El Najjar, CRIStAL - Centre de Recherche en Informatique Signal et Automatique de Lille - Univ. Lille, CNRS, UMR, France
ITM Session  
Sensor Fusion  

Session Chairs:  
Dr. Melania Susi  
European Commission JRC, Italy  

Dr. Li-Ta Hsu  
Hong Kong Polytechnic University, China  

Presentations in this session have been ordered alphabetically.

1. **A Testbench with Increased Accuracy for the Calibration of Inertial Navigation Systems and Inertial Sensors**, Bernard Vau, Joachin Honthaas, Mehdi Bussutil, Colin Stevens, Ixblue, France  

2. **Accurate Covariance Estimation for Pose Data from Iterative Closest Point Algorithm**, Rick Yuan and Clark Taylor, Air Force Institute of Technology  

3. **Calibration of Fixed-Wing UAV Aerodynamic Coefficients with Photogrammetry for VDM-based Navigation**, Gabriel Laupré and Jan Skaloud, Geodetic Engineering Laboratory, École Polytechnique Fédérale de Lausanne, Switzerland  

4. **New SLAM Fusion Algorithm Based on Lidar/IMU Sensors**, Ping Jiang, Hang Guo, Hepeng Wang, School of Information Engineering, Nanchang University, China; Min Yu, College of Computer Information and Engineering, Jiangxi Normal University, China; Jian Xiong, School of Information Engineering, Nanchang University, China  

5. **Relative Magnetic Position Sensor assisted Dual Foot IMU Pedestrian Dead Reckoning**, Jordan Eldridge and Clark Taylor, ANT Center, Air Force Institute of Technology
PTTI Session
Space-based Time and Frequency Transfer – Established and Emerging

Session Chairs:

Travis Driskell
The Aerospace Corporation

Gregory Weaver
Johns Hopkins University/APL

Presentations in this session have been ordered logically.

1. **A Comparison of Relativistic Impacts on Satellite Timekeeping for Various Orbits**, Edward A. LeMaster, Lockheed Martin Space

2. **Code-and-carrier-phase-based Two-Way Satellite Time and Frequency Transfer (TWSTFT) Experiment Between INRiM, LNE-SYRTE and PTB**, Tung Thanh Thai, Ilaria Sesia, Istituto Nazionale di Ricerca Metrologica, Italy; Joseph Achkar, Baptiste Chupin, Giovanni Daniele Rovera, LNE-SYRTE, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université, France; Dirk Pester, Physikalisch-Technische Bundesanstalt, Germany; Miho Fujieda, Tadahiro Gotoh, Ryo Tabuchi, National Institute of Information and Communications Technology, Japan

3. **Pulsars as Next Generation Grid Timing Sources**, Peter L. Fuhr, Oak Ridge National Laboratory

PTTI Session
Terrestrial Time and Frequency Transfer

Session Chairs:

Dr. Fabrizio Giorgetta  
NIST

Dr. Jeff Sherman  
NIST

Presentations in this session have been ordered logically.

1. **Active Fully Bidirectional Precise Time Transmission Outside the Telecommunication Bands Over 200 km of Single Mode Fiber**, Josef Vojtech, Ondrej Havlis, Martin Slapak, Jan Kundrat, Sarbojeet Bhowmick, Vladimir Smotlacha, Rudolf Vohnout, Radek Velc, Lada Altmannova, Pavel Skoda Tomas Horvath, Petr Munster, CESNET z.s.p.o., Czech Republic; Martin Cezek, Jan Hrabina, Vaclav Hud, Lenka Pravdova, Ondrej Cip, Institute of Scientific Instruments, Czech Academy of Sciences, Czech Republic


3. **The NIST Special Calibration Test, Preliminary Results and Future Plans**, Monty Johnson, OPNT and Judah Levine, NIST

4. **Precise Frequency Transfer with Broadband Transportable VLBI Stations**, Mamoru Sekido, National Institute of Information and Communications Technology (NICT), Japan; Marco Pizzocaro, Istituto Nazionale di Ricerca Metrologica (INRIM), Italy; Kazuhiro Takefuji, NICT & Japan Aerospace Exploration Agency (JAXA), Japan; Hideki Ujjaha, Hidekazu Hachisu, Nils Nemitz, Masanori Tsutsumi, NICT, Japan; Tetsuro Kondo, NICT, Japan and Chinese Academy of Sciences, Shanghai Astronomical Observatory, China; Eiji Kawai, Ryuichi Ichikawa, Kunitaka Namba, Yoshihiro Okamoto, Rumi Takahashi, Junich Komuro, NICT, Japan; Cecilia Clivati, Istituto Nazionale di Ricerca Metrologica (INRIM), Italy; Filippo Bregolin, INRIM, Italy and Toptica Photonics AG, Germany; Piero Barbieri, Alberto Mura, Elena Cantoni, Giancarlo Cerretto, Filippo Levi, INRIM, Italy; Giuseppe Maccaferrri, Mauro Roma, Claudio Bortolotti, Monica Negusini, Istituto Nazionale di Astrofisica (INAF), Istituto di Radioastronomia (IRA), Italy; Roberto Ricci, INRIM and IRA, Italy; Giampaolo Zacchirol, Juri Roda, IRA, Italy; Julia Leute, Bureau International des Poids et Mesures (BIPM), and LNE-SYRTE, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université, France; Gérard Petit, BIPM, France; Federico Perini, IRA, Italy; Davide Calonico, INRIM, Italy; and Tetsuya Ido, NICT, Japan

5. **GNSS Calibrations for Difficult Environments**, Carsten Rieck, RISE, Kenneth Jaldehag, RISE, Sweden
PTTI Session
Time and Frequency Activities and Updates from NMIs and International Organizations

Session Chairs:

Dr. Giancarlo Cerretto  
INRIM, Italy

Francine Vannicola  
Naval Research Laboratory

Presentations in this session have been ordered logically.

1. **Update on UTC(ESTC) Generation and Monitoring**, Pierre Waller, Cedric Plantard, Andrea Samperi, European Space Research and Technology Centre – ESA/ESTEC, The Netherlands


3. **Continuous UTC: Preliminary Steps in Russian State Service for Time and Frequency**, I. Blinov, N. Kosheliaevskii, and A. Naumov, VNIIFTRI Department of Metrology for Time and Space, Russia

4. **Overall Activities of Time and Frequency Metrology in NICT**, T. Ido, K. Matsubara, H. Saito, R. Ichikawa, M. Kumagai and M. Sekido, NICT, Japan

5. **The First Months of Fully Automated Generation of the Italian Time Scale UTC(IT)**, V. Formichella, G. Signorile, T. T. Thai, A. Perucca, F. Fiasca, E. Cantoni, M. Sellone, A. Mura, I. Sesia and F. Levi, Quantum Metrology and Nano Technologies Division, INRIM, Torino, Italy

PTTI Session
Time Scales and Algorithms

Session Chairs:

Dr. Valerio Formichella
INRIM, Italy

Dr. Demetrios Matsakis
Masterclock

Presentations in this session have been ordered logically.

1. Allan Deviation of Atomic Clock Frequency-Corrections: A New Tool for Characterizing Clock Disturbances, Daphna G. Enzer, David W. Murphy, Eric A. Burt, Jet Propulsion Laboratory, California Institute of Technology

2. Testing the Robustness of a Time Scale Algorithm by Using Simulated Optical Clock Data, V. Formichella, Quantum Metrology and Nano Technologies Division, INRiM, Italy; L. Galleani, Department of Electronics and Telecommunications, Politecnico di Torino, Italy; G. Signorile, Quantum Metrology and Nano Technologies Division, INRiM, Italy; I. Sesia, Quantum Metrology and Nano Technologies Division, INRiM, Italy

3. Clock Ensembling to Mitigate GNSS Atomic Clock Frequency Jumps, Kathryn Oleksak and James Camparo, The Aerospace Corporation


5. Resolving a Controversy: Simulating Systematic Uncertainties in UTC-UTC(k), Demetrios Matsakis, Masterclock, Inc., and Wlodek Lewandowski, Polish Academy of Sciences, Galileo Committee, Warsaw, Poland