ITM/PTTI 2016 Meeting Schedule

**Monday, January 25**
Tutorials .................................. 9:00 a.m.–5:00 p.m.

**Tuesday, January 26**
Exhibit Hall Open.......................... 8:00 a.m.–5:00 p.m.
Exhibitor Hosted Breakfast ............. 8:00 a.m.–9:30 a.m.
ITM/PTTI Plenary Session .............. 9:30 a.m.–12:30 p.m.
Lunch in Exhibit Hall ..................... 12:30 p.m.–1:30 p.m.
Afternoon Sessions ...................... 2:00 p.m.–5:45 p.m.
PTTI Poster Session ...................... 6:00 p.m.–7:00 p.m.

**Wednesday, January 27**
Exhibit Hall Open.......................... 8:00 a.m.–4:30 p.m.
Morning Sessions ......................... 8:30 a.m.–12:00 p.m.
Lunch in Exhibit Hall ..................... 12:00 p.m.–1:30 p.m.
Afternoon Sessions ...................... 1:40 p.m.–5:45 p.m.

**Thursday, January 28**
Morning Sessions ......................... 8:30 a.m.–12:00 p.m.
Awards Luncheon ......................... 12:00 p.m.–2:00 p.m.
Afternoon Sessions ...................... 2:00 p.m.–5:45 p.m.

Access to Technical Papers/ Proceedings

Qualified attendees may download copies of conference presentations and papers online for FREE by logging in to the ION website at www. ion.org/itm or www.ion.org/ptti. Only presentations and papers provided to the ION by the presenting author will be available. Presentations will only be made available once the full technical paper is submitted. If a desired document is not available, we recommend you contact the author directly. Official conference proceedings will be distributed electronically in March to all eligible conference participants.

Mobile Conference Site

Access the technical program, real-time attendee list, and other conference information from your mobile device at m.ion.org.

Free Internet Access

Network: Hyatt-Meeting
Access Code: ion2016

Photography Policy

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<table>
<thead>
<tr>
<th>Day</th>
<th>Event</th>
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| **Monday, January 25** | Tutorial Sessions: Spyglass Room  
9:00 a.m.–12:15 p.m., Tutorial Sessions  
12:15 p.m.–1:45 p.m., Lunch On Your Own  
1:45 p.m.–5:00 p.m., Tutorial Sessions  
  
ITM Track A  
Room: Big Sur  
  
ITM Track B  
Room: Windjammer  
  
ITM Track C:  
Room: Cypress  
  
PTTI Sessions  
Room: Spyglass  
  
Exhibit Hall Open, 8:00 a.m.–5:00 p.m., Regency Ballroom  
| **Tuesday, January 26** |  
9:30 a.m.–12:30 p.m. ITM/PTTI Plenary Session: Autonomous Vehicles—Beyond the Navigation Technology  
Monterey Ballroom (located in main building next to front desk)  
12:30 p.m.–1:30 p.m. Lunch in the Exhibit Hall, Regency Ballroom  
  
2:00 p.m.–5:30 p.m.  
A1: Alternatives and Backups to GNSS  
B1: Interference and Spectrum Management  
C1: Advanced RAIM and Integrity  
  
2:00 p.m.–5:45 p.m.  
P1a: PTTI Opening Session  
P1b: Time and Frequency Laboratory Activities and Updates  
6:00 p.m. - 7:00 p.m. (Spyglass Foyer)  
PTTI Poster Presentation Session  
  
| **Wednesday, January 27** | Exhibit Hall Open, 8:00 a.m.–4:30 p.m.  
12:00 p.m.–1:30 p.m. Lunch in Exhibit Hall, Regency Ballroom  
  
8:30 a.m.–12:00 p.m.  
A2: Multi-Sensor Fusion  
B2: Augmentation Systems  
C2: Algorithms and Methods  
  
8:30 a.m.–10:00 a.m.  
P2a: Low-Cost Timing and Applications  
P2b: PTTI Interference  
  
| **Thursday, January 28** |  
12:00 p.m.–2:00 p.m. Awards Luncheon, Regency Ballroom (late arrivals cannot be served after 12:30 p.m.)  
  
2:00 p.m.–5:30 p.m.  
A5: GNSS in Environmentally Challenged Environments  
B5: Emerging GNSS and Modernization  
C5: High Precision GNSS  
  
2:00 p.m.–3:45 p.m.  
P5a: Time Scales and Algorithms  
P5b: Calibration's Role in Achieving Precise Time  
  
### Hyatt Regency Monterey Floor Plan

**Main Building, Lobby Level**  
(Plenary Session)  

**Conference Center, First Floor**  
(ITM/PTTI Sessions)  

**Conference Center, Second Floor**  
(Exhibit Hall)
Tutorial Costs and Information

Pre-conference tutorials have been organized to provide in-depth learning prior to the start of the technical program. All courses will be taught in a classroom setting. Electronic notes will be made available for download by registered attendees from the meeting website; registered attendees are encouraged to download notes in advance of courses. Paper notes will not be provided. Power will not be available to course attendees for individual laptop computers; please come prepared with adequate battery power if required.

Tutorial Schedule

<table>
<thead>
<tr>
<th>Time</th>
<th>Course</th>
<th>Presenter</th>
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<tr>
<td>9:00 a.m. - 10:30 a.m.</td>
<td>Precise Time Scales and Navigation Systems</td>
<td>Dr. Patrizia Tavella, Istituto Nazionale Di Ricerca Metrologica (INRIM), Italy</td>
</tr>
<tr>
<td>10:30 a.m. - 10:45 a.m.</td>
<td>Break</td>
<td></td>
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<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>An Introduction to Time Transfer: Comparing Clocks and Measuring Time at Remote Locations</td>
<td>Dr. Judah Levine, National Institute of Standards and Technology (NIST)</td>
</tr>
<tr>
<td>12:15 p.m. - 1:45 p.m.</td>
<td>Lunch on Your Own</td>
<td></td>
</tr>
<tr>
<td>1:45 p.m. - 2:45 p.m.</td>
<td>Time Transfer Via Global Navigation Satellite Systems (GNSS)</td>
<td>Dr. Gerard Petit, Bureau International des Poids et Mesures (BIPM), France</td>
</tr>
<tr>
<td>2:45 p.m. - 3:45 p.m.</td>
<td>Time Transfer Via Optical Fibers</td>
<td>Dr. Per Olof Hedekvist, SP Technical Research Institute of Sweden, Sweden</td>
</tr>
<tr>
<td>3:45 p.m. - 4:00 p.m.</td>
<td>Break</td>
<td></td>
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<tr>
<td>4:00 p.m. - 5:00 p.m.</td>
<td>The Statistics of Time Transfer</td>
<td>William J. Riley, Hamilton Technical Services</td>
</tr>
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Tutorial Descriptions and Instructor Biographies

Precise Time Scales and Navigation Systems

Today, atomic clocks enable precision estimates of time and position. Through the use of ultra-precise atomic frequency standards, we can form time scales, such as the international time standard Universal Coordinated Time (UTC), capable of dating events with nanosecond accuracy. Similarly, Global Navigation Satellite Systems (GNSS), provide location all over the world with sub-meter accuracy. In timekeeping, as well as in navigation systems, we need precision clocks, measuring systems, and a reference time scale, in both cases we need to estimate how often the clocks are to be resynchronized and what is the acceptable time error that a clock may accumulate without compromising system performance. We require a mathematical model to predict clock behavior in order to maintain agreement with another reference clock or to ensure updated navigation messages. We need to understand the “normal” behavior of a clock to be able to quickly identify anomalies which can lead to incorrect estimates. The lecture reviews the needs of precise timing and navigation, providing giving insight into the most demanding topics that still challenge time metrologists.

Dr. Patrizia Tavella holds a degree in Physics and a Ph.D. in Metrology, she is now a senior scientist with the Italian Metrology Institute, INRIM, Torino, Italy. Her main interests are mathematical and statistical models mostly applied to atomic time scale algorithms. She has chaired the working groups on “International Atomic Time” and “Algorithms” of the Consultative Committee of Time and Frequency. She is deeply involved in the development of Galileo, the European navigation system. In 2008, Dr. Tavella received the PTTI Distinguished Service Award. She is currently the IEEE Ultrasonics, Frequency and Frequency Control (UffC) Distinguished Lecturer.

An Introduction to Time Transfer: Comparing Clocks and Measuring Time at Remote Locations

This lecture provides an introduction to the science and practice of time transfer, and discusses how time transfer systems are utilized to allow the comparison and synchronization of clocks at remote locations. It introduces and describes the fundamentals of time transfer, including the one-way, common-view, and two-way techniques. It describes how these techniques work over various mediums, including terrestrial radio signals (LF and line of sight), satellite signals (GNSS and geostationary), and networks signals (telephone lines, local area networks, and wide area networks such as the Internet).

Dr. Judah Levine is a fellow of the National Institute of Standards and Technology (NIST). He received his Ph.D. in physics from New York University in 1966. He is a member of the IEEE and a fellow of the American Physical Society. Dr. Levine designed and implemented the time scales AT1 and UTC(NIST), which provide the reference signals for all of the NIST time and frequency services. In addition, he designed and built the servers that support the Automated Computer Time Service (ACTS) and the Internet Time Service (ITS), which provide time and frequency information to users in a number of different digital formats. The NIST ITS servers can be accessed through client software built-in to a number of different operating systems and receives more than 10 billion timing requests per day. Dr. Levine was the recipient of the PTTI Distinguished Service Award in 2009, the Presidential Rank Award in 2011, and the IEEE International Frequency Control Symposium Rabi Award in 2013.
**Time Transfer Via Global Navigation Satellite Systems (GNSS)**

Time and frequency (T/F) comparisons are fundamental to time and frequency metrology at large. Since the beginnings of GPS in the early 1980s, Global Navigation Satellite System (GNSS) have been, and still are, widely used for time and frequency transfer. The lecture will review the current status of GNSS T/F comparisons, the different techniques presently used and the achieved uncertainties. Based on the observations models for GNSS code and phase measurements, examples will be given for GPS common-view, all-in-view and Precise Point Positioning (PPP), along with the requirements, advantages and drawbacks of each technique. With several other navigation systems now available, the expectations and achievements they can bring to the field will be discussed.

- Time vs. frequency transfer: the case of GNSS
- GNSS observations modeling (code, phase)
- T/F transfer with Common-view (GPS)
- T/F transfer with All-in-view (GPS)
- T/F transfer with Precise Point Positioning (GPS)
- T/F transfer with other GNSS and multi GNSS

**Time Transfer via Optical Fibers**

The ability to utilize optical fibers for high performance time and frequency transfer has reached a high level of interest in recent years. The techniques are in discussion in a Bureau International des Poids et Mesures (BIPM) working group on Advanced Time and Frequency Transfer Techniques, and several research groups work actively on the topic, improving the performance. The fiber enables a connection between timing users that unlike GNSS signals, cannot easily be jammed or spoofed, and it has low enough uncertainties to compare the frequency of optical clocks.

Even though the techniques at a first glance may appear straightforward and simple, the fibers have imperfections and limitations. The best case is when a dedicated fiber is used, since the full flexibility of the fiber can be utilized, but there are still crucial parameters to take into account. Furthermore, when only a wavelength channel in an active communication network is available for time-transfer, an additional concern is that these networks are not designed for stable time transfer, which means that novel techniques must be implemented in the existing structure, for better accuracy and stability than common time transfer protocols such as NTP and PTP.

The tutorial will focus on the practical issues of optical telecommunication fibers, covering attenuation, scattering, propagation modes, dispersion, temperature dependence, amplification and detection, with the addition of typical network designs, and how these parameters influence the achievable quality of the time transfer. Finally, a review of the development of time transfer over fiber up to the present date will be given.

**The Statistics of Time Transfer**

This tutorial is an introduction to the statistics involved in time transfer processes. These measures of time deviation are closely related to the tools used for the analysis of frequency stability. In particular, the Time deviation (TDEV) statistic, based on the modified Allan deviation (MDEV) is a particularly useful way to characterize the noise of a time transfer system. There are, of course, other mechanisms besides noise that can affect the performance of a time transfer system, and some of those are also described. The tutorial uses the example of basic one way GPS time transfer to illustrate some of the analytical techniques involved.

**Dr. Gerard Petit** holds engineering degrees from Ecole Polytechnique, Palaiseau, France, 1979, and Ecole Nationale des Sciences Géographiques, Saint Mandé, France, 1981. He received a Ph.D in astronomy from the Paris Observatory in 1994. He was with the French National Geographic Institute until 1990, when he joined the Bureau International des Poids et Mesures (BIPM), Sèvres, France, where he is currently a Principal Physicist with the Time Department. He has authored numerous papers in peer-reviewed journals or books. His current research interests include all aspects of the elaboration and usage of timescales, particularly time and frequency transfer techniques, and the use of frequency standards to generate International Atomic Time. He also interacts with the astrometry and geodesy communities to edit the Conventions of the International Earth Rotation and Reference Systems Service (IERS). Dr. Petit is the recipient of the 2010 European Frequency and Time Award.

**Dr. Per Olof Hedekvist** received his PhD from Chalmers University of Technology in Sweden, with a thesis on applications of nonlinear effects in optical communication fibers. He did a post-doc in Applied Physics at the California Institute of Technology in Pasadena, and returned to Chalmers as Associated Professor. Since 2005 he has worked at the SP Technical Research Institute of Sweden, where he is one of the senior scientists in the implementations of time and frequency transfer over a national fiber communication network. He has been the main supervisor for several Ph.D. students, and teacher in Fiber Optic Communications at Chalmers.

**Mr. William Riley** has worked in the area of frequency control and time and frequency stability analysis his entire career. He is currently the proprietor of Hamilton Technical Services, where he provides software and consulting services in that field, including the Stable program for the analysis of frequency and time stability. From 1999 to 2004, he was manager of rubidium technology at Symmetricom, Inc. From 1980 to 1998, Mr. Riley was the engineering manager of the Rubidium Department at EG&G (now Excelitas), where he directed the design of rubidium frequency standards, including high-performance rubidium clocks for GPS. Prior to that, Mr. Riley worked as an electronic instrumentation design engineer, primarily in the area of frequency control, at Harris Corporation (1978-1979), and GenRad, Inc. (1962-1978). He has a 1962 BSEE degree from Cornell University and a 1966 MSSE degree from Northeastern University. Mr. Riley holds six patents in the area of frequency control, and has published a numerous papers and tutorials in that field. Mr. Riley is an IEEE Fellow, and a member of the IEEE UFFC Society. In 2000, he received IEEE International Frequency Control Symposium Rabi Award and was the recipient of the PTTI Distinguished Service Award in 2011.

PTTI Tutorials Chair
Michael Lombardi
National Institute of Standards and Technology

Tuesday, January 26, 2016
9:30 a.m. – 12:30 p.m.
Monterey Ballroom (located in the main building next to front desk)

Welcome and Introductions

Dr. Dorota Grejner-Brzezinska
ION President
The Ohio State University

Steve Rounds
ITM Program Chair
John Deere

Ryan Dupuis
PTTI Program Chair
Excelitas Technologies

ITM/PTTI PLENARY SESSION
Autonomous Vehicles –Beyond the Navigation Technology

The navigation technology that enables autonomous vehicles is a core competency of the ION membership. This session will address issues outside of the navigation technology, including legal issues, regulatory challenges, transitional periods, markets enabled by autonomous operation, and similar topics beyond the core navigation technology.

The Importance of Timing to Autonomous Vehicle Navigation
John Fischer, Spectracom

Navigating ‘Autonomous’ Requirements
Dr. Mikel Miller, AFRL, Sensors Directorate

Autonomous or Automated – What’s in a Name?
Carl K. Andersen, Federal Highway Administration

Some Legal and Insurance Issues Related to Self-Driving Cars
Prof. Robert W. Peterson, Santa Clara University School of Law

Informal Luncheon in Exhibit Hall: 12:30 p.m. – 1:30 p.m
Session A1: Alternatives and Backups to GNSS  
2:00 p.m.–5:30 p.m.  
Room: Big Sur

- 2:35 Flight Test of a Pseudolite Signal Compatible with Existing DME Ground Stations: Sherman Lo, Yu Hsuan Chen, Per Enge, Stanford University; Achim Soelter, George Weida, Moog, Inc.
- 3:05 Magnetic Anomaly Navigation Accuracy with Respect to Map Quality and Altitude: Aaron Canciani and John Raquet, Air Force Institute of Technology
  Break: 3:35 p.m.–3:55 p.m.
- 4:00 A New Indoor Positioning Method Based on Visible Light Communication: Yingkui Gong, Yuqi Wang, Bingcheng Liu, Guang Yang, Academy of Opto-Electronics, China
- 4:30 Characterization of the Ground-to-Air Ranging Performance of the 960-1215 MHz ARNS Band Using OFDM Measurements in the 902-928 MHz ISM Band: Okuay Osechas, German Aerospace Center (DLR), Germany; Wouter Pelgrum, Ohio University; Nicolas Schneckenburger, Elisabeth Nossek and Michael Meurer, DLR, Germany
  Break: 3:35 p.m.–3:55 p.m.
- 5:00 Test Results from a LEO-Satellite-Based Assured Time and Location Solution: David Lawrence, H. Stewart Cobb, Gregory Gutt, François Tremblay, Pascal Laplante, and Michael O’Connor, Satelles

Alternate Presentations:

Session B1: Interference and Spectrum Management  
2:00 p.m.–5:30 p.m.  
Room: Windjammer

- 2:35 Spacial Gradient Based TEC Estimation Correction Evaluation Using Simultaneous Incoherent Scatter Radar Measurements: Harrison Bourne, Yu Morton, Colorado State University; Frank Van Graas, Ohio University; Michael Sulzer, Arecibo Observatory, Puerto Rico; Marco Milla, Jicamarca Radio Observatory, Peru
- 3:05 A Kalman Filter Based Method for GPS Spoofing Detection: Hao Chen and H. Howard Fan, University of Cincinnati
  Break: 3:35 p.m.–3:55 p.m.
- 4:00 Multi-user Cooperation Based GNSS Spoofing Detection Method: Yichen Yang, Hong Li, Mingquan Lu, Tsinghua University, China
- 4:30 The Effect of IMU Accuracy on Dual-antenna GNSS Spoofing Detection: Yang Liu, Qiangwen Fu, Sihai Li, Xun Xiao, Northwestern Polytechnical University, China
- 5:00 Direction-of-Arrival Assisted Sequential Detection and Mitigation: M. Meurer, German Aerospace Center and RWTH Aachen University, Germany; A. Konovaltsev, M. Appel, M. Cuntz, German Aerospace Center, Germany

Session C1: Advanced RAIM and Integrity  
2:00 p.m.–5:30 p.m.  
Room: Cypress

- 2:05 Model of Signal in Space Biases and Sigmas for the ARAIM Integrity Support Message: I. Martini, B. Belabas, S. Pereia Diaz, M. Meurer, German Aerospace Center (DLR), Germany
- 2:35 Impact of BOC Modulation on GPS/ Galileo Airborne Receiver Integrity: Olivier Julien, Ni Zhu, Anais Martineau, Carl Milner, Christophe Macabiau, Ezole Nationale de l’Aviation Civile (ENAC), France
- 3:05 New Technologies for GNSS Performance Enhancement in Multi-Constellation: Fanchen Meng, Xiaoying Gu, Lin Tao, Shan Wang and Bocheng Zhu, Peking University, China
  Break: 3:35 p.m.–3:55 p.m.
- 4:00 Clustered ARAIM: Martin Orejas and Jakub Skalicky, Honeywell International, Czech Republic
- 4:30 Demonstrating ARAIM on UAS using Software Defined Radio and Civilian Signal GPS L1/L2C and GLONASS G1/G2: Yu-Hsuan Chen, Adrien Perkins, Sherman Lo, Stanford University; Dennis M. Akos, University of Colorado at Boulder; Juan Blanch, Todd Walter, and Per Enge, Stanford University
- 5:00 A Simple Satellite Exclusion Algorithm for Advanced RAIM: Juan Blanch, Todd Walter and Per Enge, Stanford University

Alternate Presentations:
1. GNSS Environment for GPS & BDS Based ARAIM: Peng Zhao, Yanbo Zhu, R. Xue and Z. Wang, Beihang University, China
2. Bounding Integrity Risk for ARAIM Solution Separation Method: Y. Sun, L. Zheng, R. Xue, Beihang University, China
Session P1a: PTTI Opening Session
2:00 p.m.–3:35 p.m.
Room: Spyglass

2:00 Meeting Opening: Ryan Dupuis, Excelitas Technologies
2:05 Opening Remarks: USNO Superintendent
2:25 In Memoriam - Bob Kern, Nancy Blemly
2:35 Exhibitors Presentations

Break: 3:35 p.m.–3:55 p.m.

Session P1b: Time and Frequency Laboratory Activities and Updates
4:00 p.m.–5:45 p.m.
Room: Spyglass

4:05 Time and Frequency Activities at the JHU Applied Physics Laboratory: Mihran Miranian, Gregory L. Weaver, Jeffrey F. Garstecki, Richard A. Dragonette, JHU/ Applied Physics Laboratory
4:25 Time and Frequency Activities at the AOS: Jerzy Nawrocki, Pawel Nogas, Piotr Dunst, Dariusz Lemanski, Space Research Centre, Astrogeodynamical Observatory (AOS), Poland
4:45 Time and Frequency Activities at the U.S. Naval Observatory: Warren F. Walls, U.S. Naval Observatory
5:05 Timing and Frequency Activities at the ONRJ: Ricardo José de Carvalho and Mário Noto Fittipaldi, Observatório Nacional - DSHO, Brazil
5:25 Realization of UTC(OP) Based on LNE-SYRTE Atomic Fountains: D. Rovera, S. Bize, B. Chupin, J. Guena, Laurent, P. Rosenbusch, P. Uhrich, M. Abgrall, LNE-SYRTE, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universites, UPMC Univ. Paris 06, France

Alternate Presentations:
1. Time and Frequency Comparisons: An Update on Activities at PTB: Julia Leute, Andreas Bauch, Jürgen Becker, Erik Benkler, Dirk Piester, Thomas Polewka, Franziska Riedel, Egle Staliuniene, Physikalisch-Technische Bundesanstalt, Germany
3. A DDS Clock Measurement Module: W.J. Riley, Hamilton Technical Services
4. Diurnal Signature in Two Way Satellite Time Transfer (TWSTT) Data: Demetrios Matsakis, US Naval Observatory
5. Experience with Optical Infrastructure for Time and Frequency Transfer: Vladimir Smotlacha and Josef Vojtech, CESNET, Czech Republic
6. Getting into Sync - IEEE-1588 in Different Industries: Anand Ram, Calnex, United Kingdom
7. Autonomous Distributed Timescale Traceable to UTC Distributed using Network Time Protocol: Peter Löhthberg, STUPI, USA; Ragnar Sundblad, Rolf Andersson, Stefan Liström, Netnod Internet Exchange i Sverige AB, Sweden; Sven-Christian Ebenhag, Time and Frequency SP Technical Research Institute of Sweden, Sweden
9. Ensemble Pulsar Time scale Using NANOGRAV Data: Dongshen Yin, Chinese Academy of Sciences & University of Chinese Academy of Sciences, China; Yuping Gao, Shuhong Zhao, Wei Guang, Haibo Yuan, Wei Li, Chinese Academy of Sciences, China
10. A Study of GPS Carrier-Phase Time Transfer Noise Based on Eight GPS Receivers at NIST: Jian Yao, and Judah Levine, Time and Frequency Division and JILA, National Institute of Standards and Technology and University of Colorado, Boulder

Session P1c: PTTI Poster Presentation Session
6:00 p.m.–7:00 p.m.
Room: Spyglass Pre-Function Area

1. Time and Frequency Comparisons: An Update on Activities at PTB: Julia Leute, Andreas Bauch, Jürgen Becker, Erik Benkler, Dirk Piester, Thomas Polewka, Franziska Riedel, Egle Staliuniene, Physikalisch-Technische Bundesanstalt, Germany
3. A DDS Clock Measurement Module: W.J. Riley, Hamilton Technical Services
4. Diurnal Signature in Two Way Satellite Time Transfer (TWSTT) Data: Demetrios Matsakis, US Naval Observatory
5. Experience with Optical Infrastructure for Time and Frequency Transfer: Vladimir Smotlacha and Josef Vojtech, CESNET, Czech Republic
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9. Ensemble Pulsar Time scale Using NANOGRAV Data: Dongshen Yin, Chinese Academy of Sciences & University of Chinese Academy of Sciences, China; Yuping Gao, Shuhong Zhao, Wei Guang, Haibo Yuan, Wei Li, Chinese Academy of Sciences, China
10. A Study of GPS Carrier-Phase Time Transfer Noise Based on Eight GPS Receivers at NIST: Jian Yao, and Judah Levine, Time and Frequency Division and JILA, National Institute of Standards and Technology and University of Colorado, Boulder
**Session A2: Multi-Sensor Fusion**
8:30 a.m.–12:00 p.m.
Room: Big Sur

**Dr. Terry Woore**, University of Nottingham, United Kingdom
**Dr. Zak Kassas**, University of California, Riverside

- **8:35** Orbital Filter Aiding of a High Sensitivity GPS Receiver for Lunar Missions: Vincenzo Capuano, Paul Blunt, Cyril Botteron, Pierre-André Farine, Ecole polytechnique fédérale de Lausanne, Switzerland
- **9:05** Alternative Tightly-Coupled EKF with Novel Magnetic Field Aiding for Positioning and Attitude Determination: Gabriel Morales and David Bevly, Auburn University
- **9:35** Multi-sensor SLAM for Tactical Situational Awareness: Laura Ruotsalainen, Martti Kirkko-Jaakkola, Liang Chen, Simo Gröhn, Robert Guinnness, Heidi Kuusniemi, Finnish Geospatial Research Institute (FGI), National Land Survey of Finland, Finland

**Break: 10:05 a.m.–10:25 a.m.**

- **10:30** Use of a FishEye Camera for GNSS NLOS Exclusion and Characterization in Urban Environments: Jan Sanroma, Andreas Gerhmann, Paul Thevenon, Philippe Brocard, Amani Ben Afa, Olivier Julien, Ecole Nationale de l’Aviation Civile (ENAC), France
- **11:00** Position using Fast Orthogonal Search in Wi-Fi Technology: Bassem Sheta, The Military Technical College, Egypt; Mohamed Youssef, Scientific Drilling International
- **11:30** Design and Implementation of Inertial Sensor Based Wearable Gestural Hand Motion Identification System: Qifan Zhou, Chunyang Yu, Zahra Lari, Hai Zhang and Naser El-Sheimy, University of Calgary, Canada

**Alternate Presentations:**

1. The Hybrid GNSS/WCT Multi-coach Multi-constellation Train Positioning and Integrity System: Y. Zheng, M. Hutchinson, D. Lowe, Nottingham Scientific Ltd, UK; S. Arrizabalaga, J. Goya, L. Zamora-Cadenas, Cet and Tecun, Spain; J. Valera, J. Sanchez, INTEGRASYS, Spain
2. Integrating GNSS with Digital Route Map for Train Positioning and Integrity System: Y. Zheng, M. Hutchinson, M. Pattinson, NSL, UK
4. Robust Multi-Sensor Data Fusion Techniques for Detect, Track and Avoid: Francesco Cappello, Roberto Sabatini and Subramanian Ramasamy, Royal Melbourne Institute of Technology, Australia

**Session B2: Augmentation Systems**
8:30 a.m.–12:00 p.m.
Room: Windjammer

**Dr. Michael Meurer**, German Aerospace Center (DLR), Germany
**Dr. Boris Pervan**, Illinois Institute of Technology

- **8:35** Improved User Position Monitor for SBAS: Todd Walter and Juan Blanch, Stanford University
- **9:05** An Availability Prediction Method for Satellite-Based Augmentation System: Wei Zhi, Zhipeng Wang, Yanbo Zhu, Sida Zhang, Beihang University, China
- **9:35** Optimized Selection of Satellite Subsets for a Multi-constellation GBAS: Daniel Gerbeth, Michael Felix, Mihaela-Simona Ciriciu, Maria Caaman, German Aerospace Center (DLR), Germany

**Break: 10:05 a.m.–10:25 a.m.**

- **10:30** Assessment of Equatorial Plasma Bubble Impacts on Ground-Based Augmentation System in the Brazilian Region: Moonseok Yoon, Dongwoo Kim, and Jiyun Lee, Korea Advanced Institute of Science and Technology, South Korea; Sarawoot Rungruengwajake, King Mongkut’s Institute of Technology Ladkrabang, Thailand; Sam Pullen, Stanford University
- **11:00** GBAS Flight Trials for Multi-Constellation / Multi-Frequency GBAS Concept Validation: Thomas Feuerle and Mirko Stanisak, Technische Universität Braunschweig, Institute of Flight Guidance, Germany
- **11:30** Performance Characterization of Multi-Constellation GNSS-based Positioning for Maritime Applications: Iván Herrera-Pinzón and Stefan Gewies, German Aerospace Centre, Germany

**Alternate Presentations:**

1. A Novel Digital Threat Model and Effect Analysis on Modernized BeiDou Signals: Chao Sun, Hongbo Zhao, Wenquan Feng, and Chen Zhuang, Beihang University, China
2. GBAS Function Limited to CAT I: Lenka Zaviralova, Jolana Dvorska, Pavel Ptacek, Honeywell International, Czech Republic
3. Differential-RAIM to aid GBAS Ionospheric Threat Monitoring: Giuseppe Ronotto, Carl Milner, Christophe Macabiau, ENAC, France

**Session C2: Algorithms and Methods**
8:30 a.m.–12:00 p.m.
Room: Cypress

**Megan Mitchell**, C.S. Draper Laboratory

- **8:35** A Frequency-Compensation Algorithm in Kalman Filter-Based Tracking Loop for High-Dynamics GNSS Receivers: Jiannan Shen, Xiaowei Cui, Yonghui Zhu, Mingquan Lu, Tsinghua University, China
- **9:05** Modified MLE-Based GNSS Signal Open Loop Tracking Strategy for Flight Missions in the Space Service Volume: Shuai Jing, Xingqun Zhan, School of Aeronautics and Astronautics, Shanghai Jiao Tong University, China
- **9:35** A Study on the Use of Graph Signal Processing Techniques for Satellite-based Navigation Systems: Jidong Huang, California State University, Fullerton; Siliang Wu, Beijing Institute of Technology, China

**Break: 10:05 a.m.–10:25 a.m.**

- **10:30** Generalized Transparent Constant Envelope Multiplexing Method: F. Guo, Z. Yao, M. Lu, Tsinghua University, China
- **11:00** Monitoring Coastal Wind Speed Using Beidou GEO Reflected Signals: Jiang Wang, Dongkai Yang, Hongxing Gao, Weiqiang Li, Yunlong Zhu, Beihang University, China; Manhong Tu, Yunchang Cao, Meteorological Observation Center, China Meteorological Administration, China
- **11:30** URE Evaluation of BDS MEO Satellite under the Constraint of AOD: Li Yang, Tongyu Che, Haishan Zhao, Zhengzhou Institute of Surveying and Mapping, China; Chuanbing Zhang, Beijing Satellite Navigation Center, China; Wei Feng, Institute of Geodesy and Geophysics, CAS, China

**Alternate Presentations:**

2. A Hybrid Set-theoretic Approach to Assess the Impact of Timing Uncertainty on Dynamic Systems: Dhananjay Anand and Ya-Shian Li-Baboud, National Institute of Standards and Technology
3. Automated Management of Multiple, Dynamic Advanced Algorithms Used for Object Detection in Navigation Systems: P.D. Rizik, GD; Ren Weiqing, University of Singapore
Session P2a: Low Cost Timing and Applications  
8:30 a.m.–10:00 a.m.  
Room: Spyglass


8:55 CSAC Temperature Calibration for Improving GNSS Positioning Performance: Enric Fernandez, David Calero, M. Eulàlia Parési, CTTC, Spain

9:15 Picosecond-level Timing and Frequency Coordination between Dissimilar Clocks: Jason Timmerman, Gina Reyes, James Doty, Patrick Hwang, Gary McGraw, Guolin Peng, Rockwell Collins Advanced Technology Center

9:35 Lowering the Total Cost of Timing with the Increased Reliability of IC-Based OCXOs: Ullas Kumar, Mary Carbin, Ben Reardon, Rakon

Alternate Presentation:  
1. A DDS Clock Measurement Module: W.J. Riley, Hamilton Technical Services

Break: 10:00 a.m.–10:25 a.m.

Session P2b: PTTI Interference  
10:30 a.m.–12:00 p.m.  
Room: Spyglass

10:35 Using a GNSS Spoofing Test Bed to Evaluate the Effects of Replica GPS Signals on Timing Receivers: Tim Frost, Calnex; Guy Buesnel, Fabio Simon-Galabadon, Spirent, UK

10:55 Detecting GNSS Spoofing using a Network of Hardware Oscillators: Dhananjay Anand, National Institute of Standards and Technology; Md Tanvir Arafain, and Gang Qu, University of Maryland, College Park

11:15 GPS Jamming and GPS Carrier-Phase Time Transfer: Jian Yao, Time and Frequency Division and JILA, National Institute of Standards and Technology and University of Colorado, Boulder; Marc Weiss, Time and Frequency Division, NIST; Charles Curry, Chronos Technology Ltd, United Kingdom; Judah Levine, ime and Frequency Division and JILA, NIST and University of Colorado, Boulder

11:35 Time Translational Symmetry in GNSS Assisting Time Transfer Spoofing: Takashi Iwamoto, Tomoaki Takewa, and Wataru Tsujita, Advanced Technology R&D Center, Mitsubishi Electric Corporation, Japan

Break: 12:00 p.m.–1:30 p.m., Lunch in Exhibit Hall, Regency Ballroom
ITM TECHNICAL SESSIONS

Session A3: Robotics and Autonomous Vehicle Navigation
2:00 p.m.–5:30 p.m.
Room: Big Sur

- Dr. Michael Veth, Veth Research Associates
- Dr. Craig Robinson, Google[x]

2:05 GNSS/GPS Robustness for UAS: Joshua Stubbs, Luleå University of Technology, Sweden; Dennis Akos, University of Colorado
2:35 Achieving Consistent Uncertainty Estimates with RANSAC-Based Algorithms: Clark Taylor, Sensors Directorate, Air Force Research Laboratory
3:05 Consistent Uncertainty Estimation in Map-Based Vision-Aided Navigation: Zhen Zhu, East Carolina University; Clark Taylor, Sensors Directorate, Air Force Research Laboratory

Alternate Presentations:
1. Maneuver Recognition Algorithm for RPAS Low-Cost Navigation and Guidance System: Francesco Cappello, Roberto Sabatini, Subramanian Ramasamy, Royal Melbourne Institute of Technology, Australia

Break: 3:35 p.m.–3:55 p.m.

- Indoor Flight Demonstration Results of an Autonomous Multi-copter using Multiple Laser Inertial Navigation: Adam Schultz, Russell Gilbert, Maarten Uijt de Haag, Ohio University
- Context-Dependent Scan Matching for Aided Navigation: Jyh-Ching Juang and Shang-Lin Yu, National Cheng Kung University, Taiwan

Alternate Presentation:
- A Statistical Comparison of Satellite Tracking Performances During Ionospheric Scintillation for the GNSS Constellations GPS, Galileo and GLONASS: S. H. Delay, C. S. Carrano, K. M. Groves and P. H. Doherty, ISR, Boston College

Session B3: Space and Atmospheric Weather
2:00 p.m.–5:30 p.m.
Room: Windjammer

- Dr. Anthea Coster, MIT Haystack Observatory
- Dr. Charles Carrana, Boston College

2:05 Observations and Analysis of the Occurrence Pattern of Large Ionospheric TEC Gradients Over the Brazilian Airspace: Rezy Pradipta, Patricia H. Doherty, Boston College; Richard Cole, Navin Mathur, MIRUS Technology
2:35 Multiple-Phase Screen Modeling of Ionospheric Scintillation for Beidou System: Zhijun He, Hongbo Zhao, Wenquan Feng, Xiumei Guan, Beihang University, China
3:05 A Comparison Study Between SuperDARN HF Backscatter and GNSS Software Receiver Measurements During High Latitude Ionospheric Scintillations: Jun Wang, Yu (Jade) Morton, Colorado State University; Jeffery Sprea, William Bristow, University of Alaska Fairbanks

Break: 3:35 p.m.–3:55 p.m.

- A Novel Kriging-Based Regional Ionospheric Model Using Combined GPS/Beidou Observations: Mohamed Abdelazeem, Rahmi N. Celi, Istanbul Technical University, Turkey; Ahmed El-Rabbany, Ryerson University, Canada
- Modeling of TEC Variations Based on Signals from Near Zenith GNSS Satellite Observed by Dense Regional Network: Yevgen M. Zanimonskiy, Alex V. Pazzukhov, Institute of Radio Astronomy of NASU, Ukraine; Grzegorz Nykiel, Mariusz Figurski, Military University of Technology, Poland
- Ionosphere Monitoring in South East Asia in the ERICA Study: G. Povero, Istituto Superiore Mario Boella, Italy; L. Alfonsi, L. Spogli, D. Di Mauro, C. Cesarioni, Istituto Nazionale di Geofisica e Vulcanologia, Italy; F. Dovis, R. Romero, Politecnico di Torino, Italy; M. Le Huy, Institute of Geophysics, Vietnam; P. Abadi, National Institute of Aeronautics and Space, Indonesia; V. La The, Hanoi University of Science and Technology, Vietnam; N. Floyd, ESA, The Netherlands

Session C3: GNSS Processing and Integration
2:00 p.m.–5:30 p.m.
Room: Cypress

- Dr. Grace Gao, University of Illinois at Urbana-Champaign
- Dr. Walter Lillo, Aerospace Corporation

2:05 A Quasi-Coherent Receiving Algorithm and its Performance Verification for Composite Signals of Next Generation GNSS: Hengwei Zhou, Zheng Yao, Mingquan Lu, Tsinghua University, China
2:35 Improved Ephemeris Monitoring for GNSS: Todd Walter and Juan Blanch, Stanford University
3:05 Wide Area Decimetre Kinematic Positioning with Beidou Triple Frequency Signals: Yanming Feng and Yongchao Wang, Queensland University of Technology, Australia; Xiaopeng Gong and Shengfeng Gu, Wuhan University, China

Break: 3:35 p.m.–3:55 p.m.

- False Lock Probability in BOC Signals: Adrià Gusi, Pau Closas, Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain; Jose A. Garcia-Molina, ESA, ESTEC/TEC-ETN, and HE SPACE, The Netherlands
- Analysis of Multi-Constellation GNSS Signal Quality: Terri Richardson, Chris Hill and Pieter Toor, University of Nottingham, UK

Alternate Presentations:
1. Expanding the Coverage of Local Area Differential Correction: Takeyasu Sakai, Takahiro Aso, Mitsunori Kitamura, Kazuaki Hoshinoo, and Ken Ito, Electronic Navigation Research Institute, Japan
2. The Modified Ziv-Zakai Bound for Time-Of-Arrival Estimation of New Generation GNSS Signals: Zhen Liu, National Digital Switching System Engineering Technology Center (CNDSC), China; Zheng Yao, Mingquan Lu, Tsinghua University, China; Yongjun Zhao, CNDSC, China; Guangyun Li, Zhengzhou Institute of Surveying and Mapping Science and Technology, China
Session P3a: Time Transfer Performance
1:40 p.m.–3:30 p.m.
Room: Spyglass

1:45 Wide Area Network Synchronization Using Locata: Edward Powers and Arnold Colina, United States Naval Observatory; Paul Benshoof, Locata Corporation
2:05 Long Distance Time Transfer using Time Reversal (T3R): Jim Yen and Dhiman Sengupta, Naval Research Lab
2:25 Ethernet Time Transfer through a U.S. Commercial Optical Telecommunications Network, Part 2: Marc Weiss, and Jian Yao, NIST Time and Frequency Division; Lee Cosart, Senior Technologist Microsemi Corp.; James Hanssen, Time Service Department, US Naval Observatory
2:45 Coherent Optical Two-Way Frequency Transfer in a Commercial DWDM Network: Sven-Christian Ebenhag, Martin Zelan, Per Olof Hedekvist, SP Technical Research Institute of Sweden, Sweden; Magnus Karlsson, Photonics Laboratory, Chalmers University of Technology, Göteborg, Sweden; Börje Josefsson, Swedish University Computer Network, Sweden

Alternate Presentations:
1. Diurnal Signature in Two Way Satellite Time Transfer (TWSTT) Data: Demetrios Matsakis, US Naval Observatory
2. To Study the Stability & Behaviour of Internal Delay of Two Co-located GPS Receivers Over a Long Period Using Precise Point Positioning Technique: Preeti Kandpal, Mahavir P Olaniya, A. Chatterjee and A. Sen Gupta, National Physical Laboratory, India
3. Experience with Optical Infrastructure for Time and Frequency Transfer: Vladimir Smotlacha and Josef Vojtech, CESNET, Czech Republic

Break: 3:30 p.m.–3:55 p.m.

Session P3b: Atomic Clocks Current and Future: Ground and Space Performance
4:00 p.m.–5:45 p.m.
Room: Spyglass

4:25 Robust Optical Clocks Based on Alkaline-Earth Vapor Cells: Christopher Erickson, Jordan Armstrong, Nathan Lemke and Kyle Martin, AFRL/RVBYE
4:45 Rubidium Clock Lamplight Variations and Long-Term Frequency Instability: Preliminary Results from Analyses of Multi-Year On-Orbit GPS Data: J. Camparo, The Aerospace Corporation, USA; I. Sesia, V. Formichella, G. Signorile, P. Tavella, INRIM - Istituto Nazionale di Ricerca Metrologica, Italy; L. Galleani, Politecnico di Torino, Italy
5:25 A Compact Optical Rubidium Atomic Frequency Standard: Gretchen Phelps, Nathan Lemke, Space Dynamics Laboratory; Kyle Martin, Advanced Technology Associates; Chris Erickson and John Burke, Air Force Research Laboratory

Alternate Presentation:

Break: 3:30 p.m.–3:55 p.m.
Session A4: Emerging Sensors and Navigation Technologies  
8:30 a.m.–12:00 p.m.  
Room: Big Sur

8:35 A Reduced Camera SLAM Approach for Indoor and Outdoor Navigation Using Laser Information for Landmark Initialization and Relative Motion Prediction: Randy Jaffe, L3/Interstate Electronics Corporation

9:05 A Real-time Relative Navigation Capability for Multi-rotor Collision Avoidance: Maarten Kastelein and Maarten Uijt de Haag, Ohio University


Alternate Presentations:
1. An Analysis of Geometric Altitude Data in ADS-B Messages: Nur Asheila Taib and Busyairah Syd Ali, University of Malaya, Malaysia

Session B4: Mitigation of GNSS Vulnerabilities  
8:30 a.m.–12:00 p.m.  
Room: Windjammer

8:35 A High Fidelity Multi Antenna Software Simulator for Array Processing in GNSS: Dr. Nobuaki Kubo, Tokyo University of Marine Science and Technology, Japan

9:05 Neural Network Based C/N0 Abnormality Detection Method for GPS Anti-spoofing: Li He, Hong Li, Mingquan Lu, University of Tsinghua, China

9:35 Spoofing Detection by a Reduced Acquisition Process: P. Closas, J. Arribas, and C. Fernández-Prades; Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain

Break: 10:05 a.m.–10:25 a.m.

10:30 Motion State Monitoring Based GNSS Spoofing Detection Method for Repeater Spoofing Attack: Wentao Bai, Hong Li, Mingquan Lu, Tsinghua University, China

11:00 GNSS Spoof Detection using Independent Range Information: Peter F. Swaszek, University of Rhode Island; Richard J. Hartnett, U.S. Coast Guard Academy; Kelly C. Seals, U.S. Coast Guard Academy

11:30 GNSS Spoofing Detection Based on Collaborative Raim: Fei Wang, Hong Li, Yichen Yang, and Mingquan Lu, Tsinghua University, China

Alternate Presentation:
1. Suppression of the Narrowband Interferences in GNSS Receivers: N.V. Mikhailov, Bora Ltd., ITMO University, Russia; A. Motorin, Researcher, ITMO University, Russia; D.E. Yadakin, R-NAV, Russia

Session C4: Receivers and Antenna Technology  
8:30 a.m.–12:00 p.m.  
Room: Cypress

8:35 A Study on Snow Reflection Signals Using two GNSS Antennas with Different Gain Patterns and New Application to Monitor Snow Surface Conditions: Takayuki Yoshihara, Susumu Saito, Atsushi Kezuka, Electronic Navigation Research Institute (ENRI), Japan; Hiroki Motoyoshi, Satoru Yamaguchi, National Research Institute for Earth Science and Disaster Prevention (NIED), Japan

9:05 The Evolutionary Development and Performance of the VeraphaseTM GNSS Antenna: Julien Hautcoeur, Tallysman Wireless Inc., Canada; Ronald H Johnston, University of Calgary, Calgary, Canada; Gyles Panther, Tallysman Wireless Inc., Canada

9:35 Performance of Antenna Array Calibration in Multipath Environments: Niranjan Vagle, Ali Broumandan, Ali Jafarnia, Gérard Lachapelle, University of Calgary, Canada

Break: 10:05 a.m.–10:25 a.m.

10:30 A Two-Step Beam-Forming Method Based on Carrier Phases for GNSS Adaptive Array Anti-Jamming: Hai-long Xu, Xiao-wei Cui, Yong-hui Zhu, Mingquan Lu, Tsinghua University, China

11:00 Joint Acquisition of GNSS Codes via Coherent Combining of Multi-Frequency Composite Quadrature Signals: Chun Yang and Andrey Soloviev, Qunav LLC

11:30 Effects of Linear RF Front-end Distortions on High-order BOC Signal Processing Using DBT Technique: Yong-hui Zhu, Xiao-wei Cui, Jian-nan Shen, Mingquan Lu, Tsinghua University, China

Alternate Presentations:
1. Improvements of GNSS On-board Antenna: Feng Zhang, Xiao-wei Cui, Guang-fu Guo, Guang-wei Lu, Qunav LLC
2. Use of Correlator Beamforming to Achieve Multipath Mitigation at Relatively Low Cost: Prototype Details and Initial Performance Results: Sanjeev Gunawardena and John Raquet, Air Force Institute of Technology
Session P4a: PTTI Applications
8:30 a.m.–10:00 a.m.
Room: Spyglass

8:35 NPLTime® - UTC Traceable Time for the Financial Sector: Elizabeth Laier English, Leon Lobo, Peter Whibberley, David Hicks, Conway Langham, NPL, UK

8:55 Galileo Signals for Timing: A New Perspective for Time and Frequency Users?: P. Defraigne, W. Huang, Royal Observatory of Belgium, Brussels, Belgium; G. Cerretto, E. Cantoni, Istituto Nazionale di Ricerca Metrologica (INRIM), Italy; F. Fiasca, A. Perucca, AizoOn Consulting, Italy; A. Mudrak, European Space Agency (ESA), The Netherlands

9:15 The European Project DEMETRA: Demonstrating Time Dissemination Services: Patrizia Tavella, INRIM, Italy; On behalf of the DEMETRA consortium formed by Alzoon, ANTARES, CNES, Deimos, Elproma, INRIM, Metec, NPL, ORB, Politecnico of Torino, Thales Alenia Space, UFE, Vega UK, and VTT

9:35 Trusted Time Distribution with Auditing and Verification facilities Project TSI#2: Tomasz Widomski, Janusz Uzycki, Krzysztof Borgulski, Jerzy Kowalski, Robert Bender, Piotr Olbrysz, ELPROMA, Poland

Alternate Presentations:
1. Getting into Sync - IEEE-1588 in Different Industries: Anand Ram, Calnex, United Kingdom
2. Autonomous Distributed Timescale Traceable to UTC Distributed using Network Time Protocol: Peter Lüthberg, STUPI, USA; Ragnar Sundblad, Rolf Andersson, Stefan Liström, Netnod Internet Exchange i Sverige AB, Sweden; Sven-Christian Ebenhag, Time and Frequency SP Technical Research Institute of Sweden, Sweden

Break: 10:00 a.m.–10:25 a.m.

Session P4b: System Timing Performance
10:30 a.m.–12:00 p.m.
Room: Spyglass

10:35 Historical Overview of the GPS System Time Distribution Service Over the last 30 Years: Edward Powers, Stephen Mitchell, Donald Osmeyer, Arnold Colina, Blair Fonville, United States Naval Observatory

10:55 Galileo System Status Update: J. Hahn, European Space Agency (ESA), ESTEC, The Netherlands

11:15 Integer Precise Point Positioning for Optical Clock Frequency Comparisons: Julia Leute, Physikalisch-Technische Bundesanstalt, Germany; Gérard Petit, Bureau International des Poids et Mesures, France


Break: 10:00 a.m.–10:25 a.m.
Session A5: GNSS in Environmentally Challenged Environments
2:00 p.m.–5:30 p.m.
Room: Big Sur

2:05 Future Automotive GNSS Positioning in Urban Scenarios: Martin Escher, Mirko Stanislik and Ulf Bestmann, Technische Universität Braunschweig, Institute for Flight Guidance, Germany

2:35 Urban RTK Using Adaptive Point Mass Filter with Wide-Lane Measurements: Wenyi Li, Xiaowei Cui, Mingquan Lu, Tsinghua University, China

3:05 Stochastic GNSS Multipath Estimation Using a Particle Filter: Andreas Tollkühn, FAU Erlangen-Nuremberg, Germany; Fabian Amtmann, Audi Electronics Venture GmbH, Germany; Florian Henkenhaf, Alten Engineering; Florian Mickler, Audi Electronics Venture GmbH, Germany; Lucila Patino-Studencka, Jörn Thielecke, FAU Erlangen-Nuremberg, Germany

Break: 3:35 p.m.–3:55 p.m.

4:00 Efficient GNSS Collective Detection with Space Search Speed Reduction: Fei Wang, Hong Li, and Mingquan Lu, Tsinghua University, China

4:30 Power Characterization for L1 and L5 Transmissions: Sara J. Hrbek, Dae Hee Won and Dennis M. Akos, University of Colorado Boulder

5:00 A Research on Sea Ice Based on Reflected Signals from BeiDou GEO Satellites: Gao Hongxing, Yang Dongkai, Wang Qaqing, Wang Feng, Zhu Yunlong, Beihang University, China; Yin Cong, Cao Yunchan, China Meteorological Administration, China

Alternate Presentations:
1. The Mahali Project: Deployment Experiences from a Field Campaign in Alaska: Anthea Coster, Viktor Pankratius, Timothy Morin, Will Rogers, Frank Lind, Philip Erickson, MIT Haystack Observatory; David Mascharka, Drake University; Don Hampton, University of Alaska; Joshua Semeter, Boston University
2. Multipath Mitigation using GPS/INS Integrated Navigation with Adaptive Kalman Filtering: Younsil Kim, Jungneom Kim, Sunkyoung Yu, Changdon Kee, Seoul National University, Byungwoon Park, Sejong University, South Korea
3. Indoor Adaptive GNSS Signal Acquisition—Theory and Simulations: Ilir F. Progrit, Giftet Inc.; P. Huang, Y. Pi, University of Electronic Science and Technology of China, China; Xuan Xia, Huazhong University of Science and Technology, China
4. Proposal for a Vector Tracking Architecture for a Dual Constellation L1/ E1 GPS/Galileo Receiver: Enik Shytermeja, Axel Garcia-Pena, Olivier Julien, ENAC, France

Session B5: Emerging GNSS and Modernization
2:00 p.m.–5:30 p.m.
Room: Windjammer

2:05 Network Delay Modeling and Estimation for A-GNSS Supports Over Cellular Networks: Grant Huang and Mikel M. Miller, Air Force Research Laboratory/Sensors Directorate; David Akopian, University of Texas at San Antonio

2:35 A Novel PN-Code Acquisition Method Based on Local Frequency Folding for BeiDou System: Hongbo Zhao, Wenquan Feng, Xiaodi Xing, Chao Sun, Xiumei Guan, Beihang University, China

3:05 Performance Comparison of Existing Dual-frequency Constant-Envelope Modulations: F. Guo, Z. Yao, M. Lu, Tsinghua University, China

Break: 3:35 p.m.–3:55 p.m.

4:00 Geometry-free Stochastic Analysis of BDS Triple Frequency Signals: Yongchao Wang, Yanning Feng, Queensland University of Technology, Australia; Fu Zheng, Wuhan University, China

4:30 Threat Models Design for New GNSS Signals: Jean-Baptiste Pagot, Olivier Julien, Jean-Baptiste Pagot, Olivier Julien, ENAC, France; Francisco Amarillo Fernandez, ESA; Matthew Dallard, Cap Gemini

5:00 VBOC1(alpha) ACF Pure Signal Optimization: Ilir F. Progrit, Giftet Inc.

Session C5: High Precision GNSS
2:00 p.m.–5:30 p.m.
Room: Cypress

2:05 Analysis and Study on the Influence of BDS TGDI on Positioning: Y. Liu, X. Li, W. Guo, Z. He, National Time Service Center, CAS, China

2:35 GNSS-based High Accuracy Positioning for Railway Applications: Sophie Damy, Amab Majumdar, Washington Y. Ochieng, Imperial College London, United Kingdom

3:05 Precise RTK with GPS/INS Tight Coupling and Multipath Estimation: Patrick Henkel, Technische Universität München, and Advanced Navigation Solutions, ANavS, Germany; Andreas Sperl, Advanced Navigation Solutions, ANavS, Germany

Break: 3:35 p.m.–3:55 p.m.

4:00 RTK-based GNSS Drifters for Monitoring in Estuaries and Rivers and Field Experimental Results: Charles Wang, Kabir Adewale Suara, Richard Brown, Yanning Feng, Queensland University of Technology, Australia

4:30 Performance Evaluation and Future Application of Real-Time PPP Product in Japan: Eiko Saito, Nobuki Kubo, Tokyo University of Marine Science and Technology, Japan; Kazumasa Shimoda, National Institute for Sea Training

5:00 An Effect of Tropospheric Delay Irregularity Among the Reference Stations on Precise Positioning: Younghoon Han, Jaeyoung Ko, Mi Young Shin, Sang Hyun Park, KRISO, South Korea

Alternate Presentations:
1. Precise Point Positioning Method Based on Wide-lane and Narrow-lane Phase Observations and Between Satellites Single Differencing: Grzegorz Nykiel and Mariusz Figurski, Military University of Technology, Poland
2. An Improved Algorithm of Real Time Cycle Slip Detection and Determination of Multi-frequency GNSS Measurements Combining Wavelet Transform and Kalman Filter: Xiaoying Gu, Fanchen Meng, Lin Tao, Bocheng Zhi, Peking University, China
3. Tightly Coupled INS/BDS Integration Precise Point Positioning Based on AUKF: Fanchen Meng, Lin Tao, Xiaoying Gu, Shan Wang and Bocheng Zhi, Peking University, China
Session P5a: Time Scales and Algorithms
2:00 p.m.–3:45 p.m.
Room: Spyglass

Dr. Patrizia Tavella, Istituto Nazionale di Ricerca Metrologica, Italy
Dr. Michael Coleman, U.S. Naval Research Laboratory

2:05 The Rapid Realization of UTC: UTCr: G. Petit, F. Arias, A. Harmegnies, G. Panfilo and L. Tisserand, BIPM Time Department, France
2:25 Time Scale of the Satellite and Station Clocks for the Next Generation GPS Ground Control Segment: Ken Senior and Michael J. Coleman, US Naval Research Laboratory
2:45 An Auto-Regressive Moving-Average Time Scale Algorithm (ARMA) for Synchronizing Networked Clocks: Judah Levine, Time and Frequency Division NIST
3:05 Estimation of the Dynamics of Frequency Drift in Mature Ultra-stable Oscillators, a Study Based on the In-flight Performance from New Horizons: Gregory L. Weaver, J. Robert Jensen, Johns Hopkins University Applied Physics Laboratory; Cristina Zucca, University of Turin, Italy; Patrizia Tavella, Valerio Formichella, INRIM, Italy; Goran Peskir, The University of Manchester
3:25 A New “Real-Time Clock” Combines the Inputs of Several Clocks and Provides a More Stable Output than Any of the Input Clocks: Wolfgang Klische, K+K Messtechnik GmbH, Germany; Werner Lange, Lange Electronic GmbH, Germany

Alternate Presentations:
1. Monte Carlo Simulation of Precise Timekeeping in Elliptical Orbits: Nathan P. Wells, The Aerospace Corporation
2. Ensemble Pulsar Time Scale Using NANOGRAD Data: Dongshan Yin, Chinese Academy of Sciences & University of Chinese Academy of Sciences, China; Yiping Gao, Shuhong Zhao, Wei Guang, Haibo Yuan, Wei Li, Chinese Academy of Sciences, China

Break: 3:45 p.m.—3:55 p.m.

Session P5b: Calibration’s Role in Achieving Precise Time
4:00 p.m.–5:45 p.m.
Room: Spyglass

Dr. Marco Siccardi, SKK Electronics
Angela McKinley, U.S. Naval Observatory

4:05 Preliminary Results for a Multiple US/ EU GNSS Calibration Campaign: S. Romisch, B. Patla, V. Zhang, National Institute of Standards and Technology (NIST); D. Rovera, P. Uhrich, M. Abgrall, LNE-SYRTE, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universités, UPMC Univ. Paris 06, France; A. Bauch, D. Piester, Physikalisch-Technische Bundesanstalt (PTB), Germany
4:25 Calibrating Primary Reference Time Clocks for ITU G.8272 with GNSS Simulators: Richard Chan, Spirent Communications, UK; Tim Frost, Calnex Solutions
4:45 The First Absolute Delay Determination of GLONASS Time Receiver for TAI Time Transfer Link Calibration: I. Blinov, V. Fedotov, N. Kosheleyaveksy, The Main Metrology Center of the State Service for Time and Frequency FGUP “VNIIFTI” - Russia
5:05 A TWSTFT Calibration Guideline and the use of a GPS Calibrator for UTC TWSTFT Link Calibrations: Z. Jiang, Bureau International des Poids et Mesures, France; D. Matsakis, US Naval Observatory; V. Zhang, National Institute of Standards and Technology; H. Esteban, Real Instituto y Observatorio de la Armada en San Fernando, Spain; D. Piester, Physikalisch-Technische Bundesanstalt, Germany; S.Y. Lin, National Standard Time and Frequency Laboratory, Chungwha Telecom, China
5:25 European TWSTFT Calibration Campaign 2014 of UTC(k) Laboratories in the Frame of Galileo FCC TGVF: F.J. Galindo, H. Esteban, Real Observatorio de la Armada, Spain; A. Bauch, Physikalisch-Technische Bundesanstalt, Germany; D. Piester, Physikalisch-Technische Bundesanstalt, Germany & Real Observatorio de la Armada, Spain; S. Welcher, National Geographic Institute, Spain; I. Acker, LNE-SYRTE, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universités, UPMC University Paris 06, France; K. Jaldehag, SP Technical Research Institute of Sweden, Sweden; R. Piriz, GMV, Spain

Alternate Presentation:
1. A Study of GPS Carrier-Phase Time Transfer Noise Based on Eight GPS Receivers at NIST: Jian Yao, and Judah Levine, Time and Frequency Division and JILA, National Institute of Standards and Technology and University of Colorado, Boulder
Conference Special Events
The following events are included in a full-conference registration. Single day registrations include events taking place on the day the attendee is registered. Student and retired registrations include meals in the exhibit hall; a ticket is required for the Awards Luncheon.

Exhibitor Hosted Breakfast
Tuesday, January 26, 8:00 a.m. – 9:30 a.m. Exhibit Hall, Regency Ballroom

Informal Luncheon
Tuesday, January 26, 12:30 p.m. – 1:30 p.m. Exhibit Hall, Regency Ballroom

Informal Luncheon
Wednesday, January 27, 12:00 p.m. – 1:30 p.m. Exhibit Hall, Regency Ballroom

Annual Awards and Fellows Luncheon
Thursday, January 28, 12:00 p.m. - 2:00 p.m. (late arrivals cannot be served after 12:30 p.m.) Regency Ballroom

Exhibitor List
(as of January 5, 2016)

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<td>TimeTech GmbH</td>
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<td>Spectracom</td>
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<td>Jackson Labs</td>
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<td>Masterclock, Inc.</td>
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<td>Linear Photonics, LLC</td>
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<td>Microsemi Corporation</td>
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<td>The Institute of Navigation</td>
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<td>Lange Electronic GmbH</td>
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<td>IFEN Inc.</td>
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Exhibit Hall Hours:

**Tuesday, January 26**
8:00 a.m. – 5:00 p.m. Hall Open
8:00 a.m. – 9:30 a.m. Exhibitor Hosted Breakfast

**Wednesday, January 27**
8:00 a.m. – 4:30 p.m. Hall Open

For Speakers and Session Chairs
A mandatory Speakers’ Breakfast will be held at 7:30 a.m. daily in the Grove section of the Monterey Ballroom (located in the main building next to the front desk). This event is for session chairs and the presenting author (primary and alternate presentations), who are presenting that day only. Names will be checked at the door. Please attend the Speakers’ Breakfast only on the morning(s) of your presentation(s).