### Navigation Adventures: Stan Honey

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>Thursday, 28 Sep</td>
<td>1:45 p.m. – 5:30 p.m.</td>
<td>A1: Applications of Raw GNSS Measurements from Smartphones (Invited)</td>
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<tr>
<td></td>
<td>8:30 a.m. – 12:15 p.m.</td>
<td>A1: Applications of Raw GNSS Measurements from Smartphones</td>
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<td>8:30 a.m. – 12:15 p.m.</td>
<td>B1: PANEL: Status of GPS, GLONASS, Galileo, Beidou, IRNSS and QZSS</td>
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<td></td>
<td>8:30 a.m. – 12:15 p.m.</td>
<td>B2: Regional and Global Integrity Solutions</td>
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<td></td>
<td>1:45 p.m. – 5:30 p.m.</td>
<td>B3: The Navigation of Satellites</td>
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<tr>
<td></td>
<td>1:45 p.m. – 5:30 p.m.</td>
<td>C1: Aerospace Applications</td>
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<td>1:45 p.m. – 5:30 p.m.</td>
<td>C2: Aerospace Applications</td>
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<td></td>
<td>1:45 p.m. – 5:30 p.m.</td>
<td>D1: UAV Navigation Technology and Algorithms</td>
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<td>1:45 p.m. – 5:30 p.m.</td>
<td>D2: Advanced Integrity Algorithms for Safe Autonomous Operation</td>
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<td>1:45 p.m. – 5:30 p.m.</td>
<td>E1: Multisensor Navigation in Challenging Environments 1</td>
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<td>1:45 p.m. – 5:30 p.m.</td>
<td>E2: Multisensor Navigation in Challenging Environments 2</td>
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<td>Room: A107/108/109</td>
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<td></td>
<td>4:30 p.m. – 6:00 p.m.</td>
<td>Informal Luncheon, Exhibit Hall</td>
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<td>6:30 p.m. – 8:30 p.m.</td>
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<td>6:30 p.m. – 8:30 p.m.</td>
<td>Exhibitor Hosted Reception in the Exhibit Hall</td>
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<td>8:30 a.m. – 12:15 p.m.</td>
<td>A3: Navigation in Urban Environments</td>
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<td>8:30 a.m. – 12:15 p.m.</td>
<td>C3: Marine Applications</td>
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<td>1:45 p.m. – 5:30 p.m.</td>
<td>C4: Land-Based Applications</td>
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<td>1:45 p.m. – 5:30 p.m.</td>
<td>D4: PANEL: Hostile Micro Aerial Vehicles (MAV) Threats: Detection and Countermesures</td>
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<td>1:45 p.m. – 5:30 p.m.</td>
<td>E4: Navigation Using Environmental Features</td>
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<td>1:45 p.m. – 5:30 p.m.</td>
<td>F4: High Precision GNSS Positioning</td>
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<td>8:30 a.m. – 12:15 p.m.</td>
<td>A4: Location and Proximity Authentication in Mobile Consumer Applications</td>
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<td>8:30 a.m. – 12:15 p.m.</td>
<td>B4: Spectrum: Protection and Optimization</td>
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<td>8:30 a.m. – 12:15 p.m.</td>
<td>B5: Applications in Sectorial Policies</td>
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<td>8:30 a.m. – 12:15 p.m.</td>
<td>C5: GNSS+ Augmentations for High Performance and Safety Critical Applications</td>
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<td>8:30 a.m. – 12:15 p.m.</td>
<td>D5: PANEL: The Future of GNSS in Civil Aviation</td>
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<td>8:30 a.m. – 12:15 p.m.</td>
<td>E5: Remote Sensing, Timing, and Clock Technology</td>
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<td>8:30 a.m. – 12:15 p.m.</td>
<td>F5: Atmospheric Science and Space Applications</td>
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<td>Room: C123/C124</td>
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<td>1:45 p.m. – 4:50 p.m.</td>
<td>A4: Location and Proximity Authentication in Mobile Consumer Applications</td>
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<td>1:45 p.m. – 4:50 p.m.</td>
<td>B6: Future Trends of Satellite Navigation</td>
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<td>1:45 p.m. – 4:50 p.m.</td>
<td>C6: Precise Point Positioning (PPP) and L-band Services</td>
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<td>1:45 p.m. – 4:50 p.m.</td>
<td>D6: GNSS Interference Detection and Localization Algorithms</td>
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<td>1:45 p.m. – 4:50 p.m.</td>
<td>E6: Next Generation RF, Antenna and Digital Signal Processing</td>
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<td>Receiver Techniques</td>
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<td>1:45 p.m. – 4:50 p.m.</td>
<td>F6: GNSS Augmentation Systems and Integrity</td>
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<td>Room: C123/C124</td>
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Google

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The 31st INTERNATIONAL TECHNICAL MEETING OF THE SATELLITE DIVISION OF THE INSTITUTE OF NAVIGATION

$SAVE THE DATE!
September 24–28, 2018
Tutorials: September 24 and 25
Exhibit Hall: September 26 and 27

HYATT REGENCY MIAMI
MIAMI, FLORIDA

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# Monday Concurrent Subcommittees Room A105/A106 • September 25, 2017

## Timing Session

- **09:00** Introduction – Dr. Wlodzimierz Lewandowski, GUM
- **09:10** Report from NIST – Dr. Stefania Romisch, National Institute of Standards and Technology (NIST)
- **09:35** Report from USNO – Mr. Stephen Mitchell, U.S. Naval Observatory (USNO)
- **10:00** Report from NRL – Ms. Francine Vannicola, Naval Research Laboratory (NRL)

### Break

- **10:40** Report from APL – Ms. Erika Sanchez, Johns Hopkins Applied Physics Lab (APL)
- **11:00** State of the Art Timing Applications – Mr. Said Jackson, JacksonLabs Technologies, Inc.
- **11:20** Robust GNSS Receivers for Ultra-Precise Time Frequency Transfer – Dr. Demetrios Matsakis, U.S. Naval Observatory
- **11:40** Traceability and GPS Timing Signals – Dr. Demetrios Matsakis, U.S. Naval Observatory

### Discussion

- **12:00** Group Discussion
- **12:30** Session End

## International Information Session

- **14:00** Introduction – Mr. John Wilde, NAVBLUE
- **14:10** GPS/GNSS Civil Signal Monitoring – Dr. Andrew Hansen, U.S. Dept. of Transportation
- **14:30** Quazi-Zenith Satellite System (QZSS) Update – Mr. Yoshiyuki Murai, NEC Corporation
- **14:50** Update on Canadian PNT Activities – Mr. Peter Sullivan, Chair PNT Board Canada, Natural Resources Canada
- **15:10** International Space Weather Initiative (ISWI) – Ms. Sharafat Gadimova, United Nations Office for Outer Space Affairs

### Break

- **15:40** Review of Dependencies on GNSS for Critical Services and Economic Impact to the UK of Losing GNSS – Mr. Andy Proctor, Innovation Lead, Innovate UK
- **16:00** Status of GNSS Applications in the Nordic Countries – Mr. Mattias Eriksson, GNSS Applications
- **16:20** New Zealand Country Report – Mr. Matt Amos, Land Information New Zealand

### Q&A

- **16:40** Discussion
- **17:00** Session End

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# Monday Concurrent Subcommittees Room A107/A109 • September 25, 2017

## U.S. States and Local Government Session

- **09:00** Introductions, Opening and Administrative Items – Mr. James Arnold, U.S. Dept. of Transportation
- **09:10** Oregon Department of Transportation’s Virtual Corridor – Mr. Chris Harris, Engineering Technology Group, Oregon DOT
- **09:30** Boeing’s Experimental Landing System at Moses Lake – Mr. Roger Friedman, Boeing Company
- **10:00** Use of Precision GNSS in Large Scale Asset Management – Mr. Mark Congdon, Regional Manager – Western Region, Hydromax USA

### Break

- **10:20** Break

## Survey, Mapping and Geosciences Session

- **10:50** Standardization of GNSS Threat Reporting and Receiver Testing (STRIKE3 Project) – Mr. Mark Dumville, General Manager, NSL
- **11:10** Group Discussion
- **12:00** Session End

## 14:00-17:30

### Survey, Mapping and Geosciences Session

- **14:00** Introduction – Dr. Kevin Choi, NOAA National Geodetic Survey (NGS), Chair
- **14:05** OPUS Projects – Future Plans for Loading GPS Projects to the NGS ID – Mr. Rick Foote, National Geodetic Survey
- **14:35** Oregon Real Time GNSS Network: Critical Infrastructure for Emergency Response – Mr. Randy Oberg, Oregon Dept. of Transportation
- **15:00** A New Approach for Error Compensation Using Compact RTK for GPS/GLONASS Signals – Dr. Junseol, Seoul National University

### Break

- **15:20** Break

## PNT Product Progress/Space Weather Approaching Solar Minimum

- **15:40** PNT Product Progress/Space Weather Approaching Solar Minimum – Mr. Robert Steenburgh, NOAA Space Weather Prediction Center
- **16:05** Earthquake Fault Deformation Monitoring Program with Focus on Use of GNSS – Mr. Larry Hothen, United States Geological Survey
- **16:30** Determination of Tolerable Transmitter EIRP for High Precision GNSS Receivers – Dr. Hadi Wassaf & Mr. Steve Mackey, U.S. Department of Transportation
- **16:55** Applied Applications for GNSS Reflectometry in Alaska – Dr. Nichole Kinsman, NOAA National Geodetic Survey

### Q&A

- **17:20** Q&A
- **17:30** Session End
# 57th Meeting of the Civil GPS Service Interface Committee

at the ION GNSS+ 2017 Conference
Oregon Convention Center • Portland, Oregon
September 25 - 26, 2017
The CGSIC is open and free to all ION GNSS+ registrants

**Tuesday, September 26, 2017**

## Room A105/A106

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<th>Time</th>
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<tbody>
<tr>
<td>09:00</td>
<td>Welcome/ Opening</td>
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<tr>
<td>09:05</td>
<td>Meeting Overview</td>
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<td>09:10</td>
<td>Key Note Address</td>
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<td>09:30</td>
<td>National Space-Based PNT Update</td>
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<td>09:50</td>
<td>GPS Program Update</td>
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<td>10:10</td>
<td>GPS Constellation Status and Performance</td>
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<td>10:30</td>
<td>Break</td>
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<td>10:50</td>
<td>U.S. GPS/GNSS International Activities Update</td>
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<td>11:10</td>
<td>DHS PNT Update</td>
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<td>11:35</td>
<td>Q/A Panel</td>
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<td>12:00</td>
<td>Lunch</td>
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## Room A105/A106

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<tr>
<td>13:30</td>
<td>Subcommittee Reports</td>
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<tr>
<td>14:10</td>
<td>FAA Navigation Programs Update</td>
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<td>14:30</td>
<td>DOT PNT Update</td>
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<td>14:50</td>
<td>GPS User Support Forum</td>
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<td>15:30</td>
<td>Break</td>
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<td>15:50</td>
<td>NASA Update on GPS/GNSS Initiatives for Enhanced Space Operations and Science</td>
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<td>16:10</td>
<td>GPS Use in our National Parks</td>
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<td>16:30</td>
<td>GPS User Perspectives</td>
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<td>17:00</td>
<td>Q/A Panel</td>
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<td>17:30</td>
<td>Adjourn</td>
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Short courses are provided on a complimentary basis to all paid ION GNSS+ attendees with the compliments of the Satellite Division and the ION Master Instructors. ION Master Instructors are internationally recognized GNSS experts and educators. All of the ION Masters have generously donated their time and talents to this effort, as a service to the GNSS community, with the ION's gratitude. Short courses are presented lecture style. Electronic course notes are the intellectual property of the ION Master Instructor and are provided to registered attendees at the discretion of the instructor via the meeting website.

Fundamentals of GNSS Receiver Design

**Date:** Monday, September 25, 2017  
**Time:** 1:30 p.m. - 3:00 p.m.  
**Room:** Room B115/B116

This course will cover the design and practical implementation of GNSS receivers using state-of-the-art RF and digital signal processing technologies. Topics covered are applicable to a wide range of GNSS user equipment designs, from reference receivers through aviation-grade, military and low power consumer-grade single chip devices. Material will be presented from both a theoretical and practical perspective including case studies when appropriate.

- Overview of received GNSS signals (GPS, GLONASS, Galileo, BeiDou, QZSS and NAVIC), link budget, system noise figure, PSD, spreading codes and auto/cross-correlation properties.
- Front-end architectures and their implementation. Selecting the appropriate architecture for a given application.
- Correlation processing: time and frequency-domain techniques. Advanced correlator architectures for multipath mitigation and signal deformation monitoring.
- Acquisition algorithms, transition to tracking, bit/symbol synchronization, and state machine-based low-level channel control.
- Tracking and measurement computation: FLL/PLL and DLL, carrier aided code, inter-frequency aiding, loop tightening techniques and batch processing.
- Implementation techniques and platforms.

**Dr. Sanjeev Gunawardena** is a research assistant professor with the Autonomy & Navigation Technology (ANT) Center at the Air Force Institute of Technology (AFIT). He has over 20 years of experience in RF, digital and FPGA-based system design. His expertise includes GNSS receiver design, advanced GNSS signal processing and implementation. He received the 2007 RTCA William E. Jackson Award for outstanding contribution to aviation for the application of transform-domain technology for high-fidelity GNSS performance monitoring. Dr. Gunawardena received a BS in engineering physics, and a BSEE, MSEE and PhD EE from Ohio University.
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**GNSS 101 – An Introduction**

**Date:** Monday, September 25, 2017  
**Time:** 1:30 p.m. - 3:00 p.m.  
**Room:** Room B113/B114

This course will include a broad overview of the principles of satellite navigation which have been known forever, and the newer technologies that matured in the second-half of the 20th century and led to the development of Transit in 1964, and GPS in 1995. The principal technologies required for a global navigation satellite system are stable space platforms in predictable orbits, global coordinate frames, spread spectrum signals, and ultra-stable clocks. These technologies made GNSS possible, but it’s the revolution in integrated circuits that led to a receiver chip, which adds about $1 to the cost of a smartphone, and can virtually instantaneously determine your position within a few meters, velocity within 5 cm/s, and time within 50 ns, bringing about a transformation in how we move about, do commerce, and fight wars.

Dr. Pratap Misra, an ION Fellow and ION Kepler Award recipient, has been active in the GNSS field for over 25 years, starting with a project at MIT Lincoln Laboratory aimed at combining measurements from GPS and GLONASS to improve navigation for civil aviation and avert KAL007-type disaster of 1983. He is currently a research associate professor of mechanical engineering at Tufts University.
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**Image Aided Navigation**

**Date:** Monday, September 25, 2017  
**Time:** 1:30 p.m. - 3:00 p.m.  
**Room:** Room B117/B118/B119

This course will cover the fundamentals of vision based navigation, and it will include such topics as camera modeling, camera calibration, the epipolar constraint, and image feature detectors, vision sensor integration approaches. Examples of a variety of image-based navigation systems will also be described. Finally, several commonly-used vision navigation software packages and vision navigation references will be provided.

**Dr. John Raquet** is the director of the Autonomy and Navigation Technology (ANT) Center at the Air Force Institute of Technology (AFIT), where he is also a professor of Electrical Engineering. He has published over 170 navigation-related papers and taught 60 navigation-related short courses to over 3600 students in many different organizations. He is an ION Fellow and currently serving as ION president.
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Precise Time and Time Interval (PTTI) Services from GPS and GNSS Systems

Date: Monday, September 25, 2017
Time: 1:30 p.m. - 3:00 p.m.
Room: Room B110/B111/B112

For many decades, GPS has provided the fundamental synchronizing timing service supporting much of the world’s critical infrastructure. New GNSS services are emerging that will augment and enhance the robustness of the world’s timing services. This short course will provide an overview of how GNSS timing services operate and how their underlying timing references are used for providing PTTI services. The course will provide details about GPS/GNSS user receiver level PTTI interface specifications and how precise timing systems are constructed and operate, including best practices for using GPS PTTI services. It will also include information about Universal Coordinated Time (UTC), the Global standards, and the supporting network of precise timing laboratories that keep the traceable master timing references.

Ed Powers received his BS and MS degrees in Electronic Engineering and Instrumental Science from the University of Arkansas in 1984 and 1987, respectively. In 1987, he joined the U.S. Naval Research Laboratory as an engineer working on the GPS satellite clock development program, GPS UE testing and advanced GPS timing systems. In 1997, he joined the U.S. Naval Observatory (USNO) in Washington, D.C., and is the GNSS and Network Timing Operations Division chief responsible for development of improved precise time synchronization and GPS timing.
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**A Practical Introduction to GNSS/INS Integration**

**Date:** Monday, September 25, 2017  
**Time:** 3:30 p.m. - 5:00 p.m.  
**Room:** Room B110/B111/B112

This course will walk attendees through how inertial navigation becomes GNSS/INS integration. The course will start with a brief history of the technology and its uses to inform attendees of its current role in navigation and positioning. Course will review the fundamental concepts of mechanization, which is one type of integration, and error estimation, which is the other type of integration. The strengths and limitations of GNSS/INS integration will be discussed, along with the considerations that need to be made for practical implementations. References will be given for those that would like to study further on their own.

**Sandy Kennedy** graduated from the University of Calgary with a Masters in Geomatics Engineering in 2002. She briefly worked in inertial surveying for pipeline inspection before joining NovAtel’s research group in 2004, where she helped launch the SPAN™ GNSS/INS product line from 2005-2013. Currently, she is director of applied research, and chief engineer of receiver cards at NovAtel.
Short courses are provided on a complimentary basis to all paid ION GNSS+ attendees with the compliments of the Satellite Division and the ION Master Instructors. ION Master Instructors are internationally recognized GNSS experts and educators. All of the ION Masters have generously donated their time and talents to this effort, as a service to the GNSS community, with the ION’s gratitude. Short courses are presented lecture style. Electronic course notes are the intellectual property of the ION Master Instructor and are provided to registered attendees at the discretion of the instructor via the meeting website.

**Assisted GNSS (A-GNSS)**

**Date:** Monday, September 25, 2017  
**Time:** 3:30 p.m. - 5:00 p.m.  
**Room:** Room B113/B114

A-GNSS is the technology that enables GNSS in mobile phones. This course provides the essentials of A-GNSS: what it is, how it works, and why we need it.

GNSS antennas in smartphones are tiny, and unassisted time-to-fix is very slow. Assistance reduces TTFF while increasing sensitivity. The course covers:

- The basics of GNSS signal strength, antennas, and TTFF; showing why traditional GNSS is a non-starter in a phone.
- What Assistance is, where it comes from, how it reduces acquisition time, and how this leads to increased acquisition sensitivity.
- The differences among the different GNSS systems (GPS, GLONASS, etc), and how this affects A-GNSS.
- Quantified benefits of A-GNSS, namely: the resultant TTFF and sensitivity and what this means for GNSS in phones, in wearables, and indoors.

You will leave with a solid understanding of the basis, theory and implementation of A-GNSS.

**Dr. Frank van Diggelen** leads the Android Location Team at Google. He is a pioneer of A-GNSS, and invented techniques that are now industry standard. He holds over 90 issued U.S. patents on A-GNSS, and is the author of "A-GPS" the first textbook on Assisted GNSS. He is an ION Fellow and Kepler Award winner.
Short courses are provided on a complimentary basis to all paid ION GNSS+ attendees with the compliments of the Satellite Division and the ION Master Instructors. ION Master Instructors are internationally recognized GNSS experts and educators. All of the ION Masters have generously donated their time and talents to this effort, as a service to the GNSS community, with the ION’s gratitude. Short courses are presented lecture style. Electronic course notes are the intellectual property of the ION Master Instructor and are provided to registered attendees at the discretion of the instructor via the meeting website.

**Nonlinear Estimation Techniques for Navigation Systems**

**Date:** Monday, September 25, 2017  
**Time:** 3:30 p.m. - 5:00 p.m.  
**Room:** Room B117/B118/B119

Optimal estimation techniques have revolutionized the integration of sensors for navigation applications. These estimation techniques typically make assumptions about the sensor measurements, namely that the sensor measurements and associated errors are well modeled as linear, Gaussian systems. Unfortunately, there is a large class of potential navigation sources which are non-linear, non-Gaussian or both.

This short course will provide an overview of recursive nonlinear estimation techniques which are suitable for integrating non-traditional measurements into a navigation system.

The course will begin with a short overview of traditional techniques and a demonstration of the deleterious effects of nonlinearities on these techniques, then will proceed to an overview of estimation strategies to mitigate these undesirable effects. The short course includes coverage of Gaussian sum filters, unscented Kalman filters, and particle filters. Examples are provided to illustrate the strengths and weaknesses of each approach.

**Dr. Michael J. Veth, Ph.D.**, is the president and CEO of Veth Research Associates. He leads a team of engineers dedicated to pursuing novel solutions in autonomous navigation, control, and tracking applications for GNSS-denied and degraded environments. He received his BSEE from Purdue University and a Ph.D. in Electrical Engineering from the Air Force Institute of Technology. He is a member of the ION, a Senior Member of the IEEE, and a graduate of the US Air Force Test Pilot School.
Short courses are provided on a complimentary basis to all paid ION GNSS+ attendees with the compliments of the Satellite Division and the ION Master Instructors. ION Master Instructors are internationally recognized GNSS experts and educators. All of the ION Masters have generously donated their time and talents to this effort, as a service to the GNSS community, with the ION’s gratitude. Short courses are presented lecture style. Electronic course notes are the intellectual property of the ION Master Instructor and are provided to registered attendees at the discretion of the instructor via the meeting website.

Resilient Position Navigation and Time
Date: Monday, September 25, 2017
Time: 3:30 p.m. - 5:00 p.m.
Room: Room B115/B116

Cyber-attacks are the largest challenge to modern navigation. A jammer broadcasts strong radio signals in the GNSS bands to overwhelm a GNSS receiver and deny service. A spoofer introduces an artfully designed radio signal to counterfeit the authentic GNSS signals and cause the receiver to output false data without detection.

This presentation will focus on the following techniques for jammer mitigation and spoof detection:

- Air navigation is backed up by the extensive network of navigation aids that preceded GNSS (e.g. VOR, DME and ILS).
- Time transfer could be reasonably backed up by a sparse network of enhanced Loran transmitters.
- Inexpensive accelerometers can generate an un-spoofable signature for vehicles that are stable in one direction of motion.
- Digital message authentication (DMA) can be used to ascertain the providence of the GNSS navigation messages.
- Two-state antennas could switch polarization and differentiate between right-handed circularly polarized (RHCP) signals from satellites and spoofing signals from the ground that have mixed polarization.

Dr. Per Enge is the Vance and Arlene Coffman Professor in the School of Engineering at Stanford University, where he is also the director of the Stanford Center for Position Navigation and Time. For his navigation work, Per Enge was elected to the National Academy of Engineering; and the U.S. Air Force inducted him into the GPS Hall of Fame. He is an ION Fellow and former ION president.
Tutorials: Tuesday, September 26

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 to registered tutorial attendees from the conference website one week prior to the course; tutorial registrants are encouraged to download notes in advance of courses. ION reserves the right to cancel a portion of the tutorial program based on availability of the instructor.

Android Raw Measurements - Including All Constellations and AGC: Theory and Application

Date: Tuesday, September 26, 2017
Time: 9:00 a.m. - 5:00 p.m.
Room: Room C121/C122

Registration Fee:
$800 if paid on or before August 25
$900 if paid after August 25

Note: This is a two part, all-day course (9:00 a.m.-12:30 p.m. and 1:30 p.m.-5:00 p.m.).

Google launched raw GNSS measurements availability to apps in the Android N operating system.

This means you can get Pseudoranges, Dopplers and Carrier Phase from a phone or tablet. In this daylong course, you will learn to access and use these raw measurements.

The tutorial is hands-on, we will bring phones for you to use. You will collect, view, and process raw-measurements. You will leave the class with the data, Google software tools, and the knowledge of how to use them.

The daylong class is comprised of the following parts:

1. The Android Software Stack. You will learn how data flows through the Android software stack. In this part of the course, you will open your laptops, and we will show you where online to find the definitions of the different data structures. You will learn which of these is available to you at the Application layer.
2. Updates to Android O. What are the new changes that you can expect to see with the release of our latest Operating System.
3. Description of the available data. We will review the data that is accessible by developers (i.e. you) in Android. This is the theoretical part of the class. We will review the definitions of the different types of GNSS measurements, their physical meaning, and how to use them for analysis and location. At the end of this section, we will provide Android N phones that you can use for the rest of the class.
4. Using the data. Collect GNSS measurements outside, you will download the data from the phones and do some processing. We will provide software tools that you can use during the class. The tools allow you to log data from an Android N or Android O devices, view the raw measurements, and do basic measurement analysis and position computation.
5. Finally, we will give you specific examples of research projects and applications that you can develop with the tools and knowledge obtained in the class. For example: how to build a GNSS data analysis app; how to build a crowd-sourced jammer detector; etc.

To tailor this tutorial to your own needs, visit this online form and let us know what you would like us to cover in the class: https://goo.gl/forms/ECXpobtEHMtbcBaC2

Wyatt Riley is a software engineer in Google’s Android Location & Context team. His focus is on GNSS, from the raw measurements to location, to fusion with other location technologies. Prior to Google, Mr. Riley worked on GNSS location estimation at Qualcomm, working with hardware, measurement and OS teams, and led the GNSS-Inertial Location software development in use on billions of devices today. He holds a M.S. in Astronautical Engineering from Stanford, a B.S. in Engineering from Harvey Mudd, and has authored or co-authored 46 patents across GNSS, network and inertial location.

Steve Malkos is the Technical Program Manager in the Android Location and Context Group at Google. He manages all engineering aspects for Android’s Location and Context programs. Mr. Malkos is responsible for defining these initiatives within Google which includes everything from GPS, Fused Location Provider (FLP), Android Sensor Hub, Sensors, Emergency Location Service, and more. Mr. Malkos has been involved in the field of location now for almost 15 years. Prior to his role at Google, he worked as an Associate Program Management Director at Broadcom, where he managed engineering teams within Broadcom’s GNSS software. He holds a B.S. in Computer Science from Purdue University, currently holds eight patents in the field of location.

Dr. Mohammed Khider is a software engineer in Google’s Android Location & Context team. Within Android, he is a member of a research team that works on improving positioning accuracy of mobile devices in challenging indoor and urban canyon environments. He received his PhD in Electrical Engineering with focus on “Multisensor based Positioning for Pedestrian Navigation” from the University of Ulm, Germany. Prior to his role at Google, he was a research associate at the Institute of Communication and Navigation at the German Aerospace Center (DLR) where he worked on various research projects related to positioning and navigation. Mohammed has been actively involved in the field of location and context for over 10 years. His research interests are navigation, multi-sensor fusion, mobility models, signal processing and context-aware services.
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 to registered tutorial attendees from the conference website one week prior to the course; tutorial registrants are encouraged to download notes in advance of courses. ION reserves the right to cancel a portion of the tutorial program based on availability of the instructor.

**Introduction to Multi-Constellation GNSS Signals**

**Date:** Tuesday, September 26, 2017  
**Time:** 9:00 a.m. - 12:30 p.m.  
**Room:** Room C123

**Registration Fee:**  
$400 if paid on or before August 25  
$450 if paid after August 25

This course provides an overview of multi-constellation GNSS signals. Digital modulation techniques used for satellite navigation systems will be described, including a discussion of important characteristics such as pseudorandom noise codes, autocorrelation/cross-correlation properties, power levels, and polarization. Common features found in modern GNSS signal designs will be introduced, including dataless (pilot) components, square-wave subcarriers, secondary codes, forward error correction, and error detecting coding.

The present and future signals of the Global Positioning System (GPS), including C/A-code, P(Y)-code, L2 civil (L2C), L5, M-code, and L1 civil (L1C) will be detailed, as will the signals for GLONASS, GALILEO, BeiDou, satellite-based augmentation systems (SBAS), and other emerging satellite navigation systems.

This class is intended for anyone with an interest in better understanding multi-constellation GNSS signals, including researchers, design engineers, application developers, end-users, systems engineers, managers and executives. Attendees are assumed to have a familiarity with the basic concepts of satellite navigation.

**Dr. John W. Betz** is a Fellow of The MITRE Corporation. He has contributed to the design of modernized GPS signals, including developing the binary offset carrier (BOC) modulation. He has also influenced many aspects of GNSS engineering, including international efforts to achieve compatibility and interoperability among GPS and other satnav systems. He is a Fellow of the ION and the IEEE, and has extensively served the ION in programs and in officer capacities, most recently as chair of the Satellite Division. He received the ION's Burk and Thurlow Awards, the Satellite Division’s Kepler Award, the IEEE AES’s Carlton Award, and the IAIN’s Harrison Award. Dr. Betz served on the U.S. Air Force Scientific Advisory Board from 2004 to 2013, including chairing it for three years, and is a member of the National Space-Based Positioning, Navigation and Timing Advisory Board. He received his PhD in Electrical and Computer Engineering from Northeastern University.
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 to registered tutorial attendees from the conference website one week prior to the course; tutorial registrants are encouraged to download notes in advance of courses. ION reserves the right to cancel a portion of the tutorial program based on availability of the instructor.

**Kalman Filter Applications to Integrated Navigation 1**

**Date:** Tuesday, September 26, 2017  
**Time:** 9:00 a.m. - 12:30 p.m.  
**Room:** Room C124

**Registration Fee:**  
$400 if paid on or before August 25  
$450 if paid after August 25

The focus of this course is on the basic theory, an intuitive understanding as well as practical considerations, for the design and implementation of Kalman filters. Although many new types of filters are published in the literature, the Kalman filter is still the optimal and most efficient solution for the majority of integrated navigation systems. The course starts with a review of statistics and detailed insights into the most important noise processes, including random walk and Gauss-Markov processes. This is followed by a review of state variables and an overview of Kalman filters, including linear, linearized and extended filters. Matlab®-based examples are provided to facilitate hands-on experience with Kalman filters for integrated navigation applications.

For those having no previous experience with modern estimation, a review of fundamentals is included. Linear systems are characterized in terms of (1) a vector containing the minimum number of independent quantities required to define its state at any instant of time and (2) a matrix expression capable of propagating that state from one time to another. In combination with expressions relating measurements to states, a standard cycle is formed whereby a system’s entire time history is continuously produced, with the best accuracies achievable from any combination of sensors, extravagant or austere, providing any sequence of measurements that can be incomplete, intermittent and indirect, as well as imprecise. That already wide versatility is broadened further by straightforward extension to systems with nonlinearities (Extended Kalman Filter; EKF) which has proved adequate for a host of applications (including some to be discussed in this tutorial). The relation between Kalman (sequential) and block (weighted least squares) estimation is illustrated, and a number of important subtleties that often go unrecognized will be uncovered.

**Dr. James L. Farrell** is an ION Fellow and author of over 80 journal and conference manuscripts. He authored Integrated Aircraft Navigation (Academic Press, 1976) and GNSS Aided Navigation and Tracking (2007). His technical experience includes teaching appointments at Marquette and UCLA, Honeywell, Bendix-Pacific, and Westinghouse in design, simulation, and validation/test for modern estimation algorithms in navigation and tracking applications, and digital communications system design. As president and technical director of VIGIL INC. he has continued his teaching and consulting on inertial navigation and tracking for private industry, DOD, and university research.

**Dr. Frank van Graas** is a Fritz J. and Dolores H. Russ Professor of Electrical Engineering at Ohio University, where he has been on the faculty since 1988. He is an ION past president (1998-99) and currently serves as the ION treasurer. He served as the ION’s Executive Branch Science and Technology Policy Fellow at NASA (2008-2009 academic year). At Ohio University his research includes GNSS, inertial navigation, low-frequency signals, LADAR/EO/IR, surveillance and flight test. He is an ION Fellow and has received the ION’s Kepler (1996), Distinguished Service (1999), Thurlow (2002), and Burka (2010) awards.
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 to registered tutorial attendees from the conference website one week prior to the course; tutorial registrants are encouraged to download notes in advance of courses. ION reserves the right to cancel a portion of the tutorial program based on availability of the instructor.

**GNSS Error Characterization, Analysis, and Mitigation**

**Date:** Tuesday, September 26, 2017  
**Time:** 1:30 p.m. - 5:00 p.m.  
**Room:** Room C123

**Registration Fee:**  
$400 if paid on or before August 25  
$450 if paid after August 25

This tutorial provides the attendee with an understanding of GNSS error characterization, analysis, and mitigation in various GNSS architectures and applications. The course begins with an overview of the various error components for GNSS and how their bias, variation, and rate may affect the overall user solution performance. Error characterization, isolation, analysis, and mitigation will be presented for stand-alone, multi-frequency, and differential-based GNSS architectures for various GNSS applications. Error considerations in various differential-based GNSS architectures will be discussed including correction and measurement-based, SBAS, PPP, and RTK architectures.

**Course Outline:**

- Error component characterization for GNSS  
- Error budgets for various GNSS architectures and applications  
- A GNSS signal model and error terms  
- Truth position, velocity, and time references for error analysis  
- Satellite orbit and clock errors  
- Atmosphere errors  
- Ionosphere errors (characterization, analysis, mitigation)  
- Troposphere errors (characterization, analysis, mitigation)  
- Multipath (code and carrier) errors (characterization, analysis, mitigation)  
- Error mitigation by smoothing  
- Code bias terms  
- Error considerations in differential GNSS architectures and mitigation approaches (corrections and measurement-based, SBAS, PPP, RTK)

**Dr. Chris G. Bartone, P.E.** is a professor at Ohio University with over 30 years of professional experience. He received his PhD EE from Ohio University, a MSEE from the Naval Postgraduate School, and BSEE from Penn State. He previously worked for the Naval Air Warfare Center, performing RDT&E on CNS systems. Dr. Bartone has developed and teaches a number of GPS, radar, wave propagation and antenna classes. His research concentrates on all aspects of navigation.
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 to registered tutorial attendees from the conference website one week prior to the course; tutorial registrants are encouraged to download notes in advance of courses. ION reserves the right to cancel a portion of the tutorial program based on availability of the instructor.

**Kalman Filter Applications to Integrated Navigation 2**

**Date:** Tuesday, September 26, 2017  
**Time:** 1:30 p.m. - 5:00 p.m.  
**Room:** Room C124

**Registration Fee:**  
$400 if paid on or before August 25  
$450 if paid after August 25

Integration of GPS with an Inertial Measurement Unit (GPS/IMU) is used to illustrate the application of Kalman Filtering to integrated navigation. The course starts with a brief summary of the Kalman Filter followed by the steps required to implement the filter, including the selection of the state variables, observability, error sources, sensor bandwidth, update rate, time synchronization, lever arm, and identification of the noise processes. At the conclusion of the course, participants should be able to understand the underlying principles that lead to the successful design and implementation of Kalman filters for integrated navigation applications.

The approach presented offers a major benefit enabled by a departure from other IMU/satnav integrations. Precise carrier phase observations one second apart provide streaming velocity for dead reckoning, yielding huge improvement in multiple aspects of performance (robustness, integrity, interoperability, immunity to belowmask ionospheric and tropospheric degradations, etc.). Flight-verified cm/sec velocity performance, including an instance of zero elevation above horizon, is shown. Of crucial significance, integration with a low-cost IMU is shown to be sufficiently dramatic to conclude that there is little reason not to use it.

Dr. James L. Farrell is an ION Fellow and author of over 80 journal and conference manuscripts. He authored Integrated Aircraft Navigation (Academic Press, 1976) and GNSS Aided Navigation and Tracking (2007). His technical experience includes teaching appointments at Marquette and UCLA, Honeywell, Bendix-Pacific, and Westinghouse in design, simulation, and validation/test for modern estimation algorithms in navigation and tracking applications, and digital communications system design. As president and technical director of VIGIL INC., he has continued his teaching and consulting on inertial navigation and tracking for private industry, DOD, and university research.

Dr. Frank van Graas is a Fritz J. and Dolores H. Russ Professor of Electrical Engineering at Ohio University, where he has been on the faculty since 1988. He is an ION past president (1998-99) and currently serves as the ION treasurer. He served as the ION's Executive Branch Science and Technology Policy Fellow at NASA (2008-2009 academic year). At Ohio University his research includes GNSS, inertial navigation, low-frequency signals, LADAR/EO/IR, surveillance and flight test. He is an ION Fellow and has received the ION's Kepler (1996), Distinguished Service (1999), Thurlow (2002), and Burka (2010) awards.
ION GNSS+ Plenary Session

Welcome, Meeting Highlights and Introduction of Technical Committee

Satellite Division Chair
Dr. Frank van Diggelen
Google

Opening of the Plenary Session

Satellite Division Vice Chair
Dr. Chris Hegarty
The MITRE Corporation

Smart Mobility and Smart Cities – The Importance of GIS in the Internet of Things

Carla Bailo
Assistant Vice President for Mobility Research and Business Development
The Ohio State University

Keynote Address: Navigation Adventures

Stan Honey
Yacht racing navigator, Emmy winning developer of TV graphics, engineer in navigation and remote sensing

Stan Honey is one of the more successful professional navigators in sailing, having won the Volvo Ocean Race around the world, having set the Jules Verne record for the fastest non-stop circumnavigation of the world, and having set multiple 24 hour, TransAtlantic, TransPacific, and singlehanded sailing records as navigator. Honey was awarded the 2010 US Sailing Yachtsman of the Year Award, and was named to the National Sailing Hall of Fame in 2012.

In his work life, Honey is a Yale/Stanford electrical engineer, three-time Emmy Winner for Technical Innovations in Sports TV, and is an inventor on 30 patents in navigation and graphics. Honey led the development of the yellow first-down line widely used in the broadcast of American football, the ESPN “K-Zone” baseball pitch tracking and highlighting system, and the Race/FX tracking and highlighting system used in NASCAR.

Combining his interests, Honey led the team which developed the LiveLine system to track the America’s Cup catamarans and superimpose graphics elements such as ahead-behind lines and laylines on the live helicopter footage of the race.

In earlier navigation related work, Honey co-founded ETAK Inc. in 1983, the company that pioneered vehicle navigation systems with digital map databases, heading-up map display, and map-matching navigation.

Honey will give highlights from a career of navigation-related adventures and developments from the development of ETAK, to Emmy winning RTK tracking, to circumnavigating the world under sail in 48 days non-stop.
A1: Applications of Raw GNSS Measurements from Smartphones

Date: Wednesday, September 27, 2017
Time: 8:30 a.m. - 12:15 p.m.
Room: Room B113/B114

Session Chairs:

Dr. Mohammed Khider
Google

Will Morrison
Qualcomm

8:35. GNSS Raw Measurement on the Latest MediaTek Platform, Pei-Hung Jau and ShengYu Huang, MediaTek Inc., Taiwan

8:57. Assessing Galileo Readiness in Android Devices Using Raw Measurements, Moises Navarro-Gallardo, Michael Kirchner, Nils Bernhardt, Airbus DS GmbH, Germany; Justyna Redenkiewicz Musial, Martin Sunkevic, GSA

9:20. Preliminary Performance Analysis with a GPS+Galileo Enabled Chipset Embedded in a Smartphone, G. Pirazzi, A. Mazzoni, Sapienza University of Rome, DICEA, Italy; L. Biagi, Politecnico di Milano, DICA, Italy; M. Crespi, Sapienza University of Rome, DICEA, Italy

9:43. On the Path to Precision - Observations with Android GNSS Observables, Stuart Riley, Will Lentz and Adam Clare, Trimble Inc.

10:40. SSR Assist for Smartphones with PPP-RTK Processing, Koki Asari, Masayuki Saito, Hisao Amitani, and Izumi Mikami, Satellite Positioning Research and Application Center (SPAC Foudation), Japan

11:03. Trends, Innovations and Enhancements for Low-Cost PPP, D. Calle, E. Carbonell, P. Navarro, I. Rodríguez, P. Roldán, G. Tobias, GMV, Spain

11:26. Smartphone Applications for Precise Point Positioning, D. Laurichesse, F.X. Marmet, C. Rouch, C.N.E.S, France; M. Pascaud, CS-SI, France

11:48. Single-Frequency Divergence-free Hatch Filter for the Android N GNSS Raw Measurements, Donghyun Shin, Cheolsoon Lim, Byungwoon Park, Sejong University, South Korea; Youngsun Yun, KASS (Korean SBAS) Development Team, Korea Aerospace Research Institute, South Korea; Euiho Kim, Hongik University, South Korea; Changdon Kee, Seoul National University, South Korea

Alternate Presentations:

1. Precise Point Positioning (PPP) using Ultra-Low-Cost and Low-Cost GNSS Receivers, Maninder Gill, Sunil Bisnath, John Aggrey, Garrett Seepersad, Lassonde School of Engineering, York University, Canada

12:15 p.m. - 1:15 p.m., Informal Luncheon, Exhibit Hall
1:15 p.m. - 4:45 p.m., Free Time in Exhibit Hall
**B1: PANEL: Status of GPS, GLONASS, Galileo, BDS and QZSS**

**Date:** Wednesday, September 27, 2017  
**Time:** 8:30 a.m. - 12:15 p.m.  
**Room:** Room A105/A106

**Session Chairs:**

Dr. John Betz  
*The MITRE Corporation*

Dr. José Ángel Ávila Rodríguez  
*European Space Agency, The Netherlands*

This Session provides an updated on satellite-based navigation systems in operation or under development. A representative for each system will provide a system overview, summarize current or planned characteristics and performance, report recent programmatic events, updated schedule and plans, and summarize ongoing interactions with other service providers. Questions from the audience are encouraged.

**Panel Topics:**

1. **GPS**, Col Steven Whitney, Director, Global Positioning Systems Directorate  
2. **GLONASS**, Dr. Sergey Karutin, Deputy Director General, Central Research Institute for Machine Building  
3. **Galileo Program Status**, Mr. Eric Chatre, European Commission, Belgium and Mr. Alfredo Quiles, European Space Agency, The Netherlands  
4. **BDS**, Dr. Jun Shen, Deputy Director of International Cooperation Center, China Satellite Navigation Office, China  
5. **QZSS**, Mr. Satoshi Kogure, Executive Director for QZSS Development, National Space Policy Secretariat of Japan  
6. **Panel Discussion**,  

12:15 p.m. - 1:15 p.m., Informal Luncheon, Exhibit Hall  
1:15 p.m. - 1:45 p.m., Free Time in Exhibit Hall
C1: Aerospace Applications 1

Date: Wednesday, September 27, 2017  
Time: 8:30 a.m. - 12:15 p.m.  
Room: Room B115/B116

Session Chairs:

Dr. Demoz Gebre-Egziabher  
University of Minnesota

Angelo Joseph  
Rockwell Collins

8:35. Multi-Antenna GNSS Receiver for Space Launcher, Jérémy Vezinet and Olivier Julien, ENAC, France

8:57. Hardware-in-the-Loop Simulation of GPS L1 C/A, Galileo E1b and BeiDou B1 Weak Signal Tracking in Highly Elliptical Orbits, Erin Kahr, Schulich School of Engineering, University of Calgary, Canada


9:43. Quality Assessment of GNSS Simulations for Flight Procedures based on Onboard Recorded Flight Data, Maurizio Scaramuzza, Marc Troller, Pascal Truffer, Skyguide, Swiss Air Navigation Services Ltd., Switzerland; Heinz Leibundgut, Swiss Air-Rescue, Switzerland; Marc Bertschi, Swiss Air Force, Switzerland


11:03. Accurate and Efficient Terrain Referenced Navigation Using Multiple Measurements by Flash LiDAR, HyunCheol Jeon, Seoul National University/Automation and Systems Research Institute, South Korea; Woo Jeong Park, Seoul National University, South Korea; Chan Gook Park, Seoul National University/Automation and Systems Research Institute, South Korea

11:26. Performance Assessment of the Radio Occultation Experiment for Commercial of-the-shelf Receivers on VELOX-CI Microsatellite, Li Bing Xuan, Bo Han, Lim Wee Seng, Nanyang Technological University (NTU), Singapore; Yung-Fu Tsai, National Space Organization (NSPO), Taiwan; Low Kay Soon, National University of Singapore (NUS), Singapore

11:48. Autonomous One-Way Deep Space Navigation Methods and Clock Stability Requirements, Yansong Meng, Beijing Institute of Technology, China; Wenhua Lei, Tibet University, China; Wenyong Lei, Lang Bian, Ying Wang, Xiaoliang Wang, China Academy of Space Technology(Xi'an), China

Alternate Presentations:

1. Analysis of Ground-based BeiDou and GPS Precipitable Water Accuracy, Fu Zhikang, Wan Rong, Yu Shengjie, Institute of Heavy Rain, CMA, China

2. 3D Water Vapor Tomography Algorithm used the Gaussian Horizontal Restriction and Sounding Vertical Restriction in the Troposphere Using GPS, Wan Rong, Fu Zhikang, Yu Shengjie, Institute of Heavy Rain, CMA, China

12:15 p.m. - 1:15 p.m., Informal Luncheon, Exhibit Hall
1:15 p.m. - 1:45 p.m., Free Time in Exhibit Hall
D1: UAV Navigation Technology and Algorithms (Invited Session)

**Date:** Wednesday, September 27, 2017  
**Time:** 8:30 a.m. - 12:15 p.m.  
**Room:** Room B117/B118/B119

### Session Chairs:

- **Dr. Dieter Moormann**  
  RWTH Aachen University, Germany  
- **Dr. Donald Venable**  
  Air Force Research Laboratory, Sensors Directorate

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8:35. Relative Target Estimation using a Cascade of Extended Kalman Filters, Jerel Nielsen and Randal Beard, Brigham Young University

8:57. Precise RTK Positioning with GNSS, INS, Barometer and Vision, Patrick Henkel, Alexander Blum, Technical University of Munich (TUM) and ANavS GmbH, Germany; Christoph Günther, TUM and German Aerospace Center (DLR), Germany

9:20. Navigating without a Navigator – A Review of Positioning and Navigation Technologies for UAVs, Prof. Terry Moore, University of Nottingham, UK


10:40. Positioning Autonomy of a Fixed-wing UAV through VDM/INS Integration with Experimental Results, Mehran Khaghani, EPFL-TOPO, Switzerland Prof. Jan Skaloud, EPFL-TOPO, Switzerland

11:03. On the Way to Autonomous Reconnaissance in Urban Environment: Intrusion and Indoor Operation in Buildings, Prof. Gert Trommer, ITE Karlsruhe Institute of Technology, Germany

11:26. Towards Autonomous UAV’s for Real-Time Mapping, Prof. Wolfgang Förstner, University of Bonn, Germany

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

1:15 p.m. - 1:45 p.m., Free Time in Exhibit Hall
**E1: Multisensor Navigation in Challenging Environments 1**

**Date:** Wednesday, September 27, 2017  
**Time:** 8:30 a.m. - 12:15 p.m.  
**Room:** Room A107/A108/A109

**Session Chairs:**
- Dr. John Raquet  
  *Air Force Institute of Technology*  
- Dr. Zak Kassas  
  *University of California Riverside*

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**8:35. Cooperative Localization in Indoor Environments Using Constrained Differential Wi-Fi and UWB Measurements**, Guenther Retscher, Hannes Hofer, Vienna University of Technology, Austria; Allison Kealy, The University of Melbourne, Australia; Vassilis Gikas, National Technical University of Athens, Greece; Franz Obex, Freelancer, Austria

**8:57. AoD-based Positioning for Wi-Fi OFDM Receivers**, Nir Dvorecki, Ofer Bar-Shalom, and Yuval Amizur, Location Core Division, Intel Corp., Israel; Carlos Aldana, Intel, USA

**9:20. WiFi Based Robust Positioning System in Large Scale and Weak Signal Environment**, Beomju Shin, Korea Institute of Science and Technology (KIST) & Seoul National University, South Korea; Boseon Yu, Jae Won Bang, KST, South Korea; Changdon Kee, Seoul National University, South Korea; Taikjin Lee, KIST, South Korea

**9:43. A Comparison of Particle Propagation and Distribution Methods for Indoor Positioning Systems**, Tanner Ray, Dan Pierce, and David Bevly, Auburn University

**10:40. Robust Navigation In GNSS Degraded Environment Using Graph Optimization**, Ryan M. Watson and Jason N. Gross, West Virginia University

**11:03. GPS-Lidar Sensor Fusion Aided by 3D City Models for UAVs**, Akshay Shetty and Grace Xingxin Gao, University of Illinois at Urbana-Champaign

**11:26. Railways Augmented Multisensor Positioning System**, Alessandro Neri, Università degli Studi di Roma TRE, Italy; Andrea Coluccia, Radiolabs, Italy; Enrico De Marinis, Dune, Italy; Claudia Facchinetti, Agenzia Spaziale Italiana, Italy; Paola Madonna, T.R.S., Italy; Michele Mascolo, T.R.S., Italy; Federica Pascucci, Pietro Salvatori, Università degli Studi di Roma TRE, Italy; Luca Sfarzo, T.R.S., Italy; Alberto Tuozzi, Agenzia Spaziale Italiana, Italy

**11:48. Comparative Analysis of the Performance of Magnetic-Based RISS using Different MEMS-Based Inertial Sensors**, Ashraf Abosekeen, Queen’s University, Kingston, Canada; Aboelmagd Noureldin, Royal Military College of Canada / Queen’s University, Canada; Tashfeen B. Karamat, Royal Military College of Canada; Michael J. Korenberg, Queen’s University, Canada

**Alternate Presentations:**

2. **A Joint DOA/TOF Estimation Technique for 3D Localization of User Equipment in an Indoor Multipath Environment**, Umer Javed, Di He, Peilin Liu, Shanghai Jiao Tong University, China  
3. **Indoor Localization for Bluetooth Low Energy Devices through Application of Monte Carlo Localization Algorithm**, Xiaoyue Hou and Tughrul Arslan, University of Edinburgh, UK  

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12:15 p.m. - 1:15 p.m., Informal Luncheon, Exhibit Hall  
1:15 p.m. - 1:45 p.m., Free Time in Exhibit Hall
F1: GNSS Receiver Processing and Navigation Algorithms 1

Date: Wednesday, September 27, 2017
Time: 8:30 a.m. - 12:15 p.m.
Room: Room C123/C124

Session Chairs:

Dr. Sanjeev Gunawardena  
Air Force Institute of Technology

Dr. Thomas Pany  
Universität der Bundeswehr München, Germany

8:35. A Correlation, Measurement and Data Decoding Co-processor for Multi-GNSS Receivers, Nagaraj C. Shivaramaiah and Dennis Akos, University of Colorado at Boulder


9:20. Exploring Probabilistic Graphical Models in a Software GNSS Receiver, Xin Zhang and Xingqun Zhan, School of Aeronautics and Astronautics, Shanghai Jiao Tong University, China

9:43. Subcarrier Ambiguity Resolution Techniques for HOBOC Signals under Harsh Realistic Scenarios, Pedro Fernandes, Pedro Boto, GMV, Portugal; Elena Simona Lohan, Tampere University of Technology, Finland; Gonzalo Seco-Granados, Autonomous University of Barcelona, Spain; Jose Garcia-Molina, European Space Agency and HE Space, The Netherlands

10:40. Code and Carrier Tracking Performance Analysis for GNSS Receivers Using Adaptive Blanking, Soualle Francis, Airbus DS GmbH, Germany; Mathieu Cattenoz, Private

11:03. Compressed Sensing-aided Vector Tracking Algorithm for GNSS Receivers, Jumin Zhao, Xiaofang Zhao and Dengao Li, Taiyuan University of Technology, China

11:26. Detect and Remove the Blocked Channel in the Vector Tracking Loop Based on Carrier to Noise Density Ratio, Xiaojun Zou, Baowang Lian, Peng Wu, Haowei Xu, Lin Zhang, Northwestern Polytechnical University, China

11:48. Preliminary Test Results of Variable IF Tracking Loop (VITAL) for GNSS Signals, Chun Yang, Sigtem Technology; Thomas Pany, University FAF Munich, Germany; Andrey Soloviev, QuNav

Alternate Presentations:

2. Combined Algorithm for Satellite Selection for Open-sky and Constrained Environments, Yun-En Lee, An-Lin Tao and Shau-Shiun Jan, Department of Aeronautics and Astronautics, National Cheng Kung University, Taiwan
3. Exploiting Acceleration Features of LabVIEW Platform for Real-Time GNSS Software Receiver Optimization, Erick Schmidt and David Akopian, The University of Texas at San Antonio
4. Implementation of a Multi-frequency, Multi-constellation and Real-time GNSS Software Receiver Using Dual Channel USRP, Kw Woon Park, Chungbuk National University, South Korea; Min Joon Lee, Agency for Defense Development, South Korea; Chansik Park, Chungbuk National University, South Korea
5. An Unaided Scheme for BeiDou Weak Signal Acquisition, Meng Qian, Nanjing University of Aeronautics and Astronautic (NUAA), China/Imperial College London, UK; Liu Jian-ye, NUAA, China; Feng Shao-jun, Imperial College London, UK; Zeng Qing-hua, Xu Rui, NUAA, China

12:15 p.m. - 1:15 p.m., Informal Luncheon, Exhibit Hall
1:15 p.m. - 1:45 p.m., Free Time in Exhibit Hall
A2: PANEL: Ubiquitous Navigation

Date: Wednesday, September 27, 2017
Time: 1:45 p.m. - 5:30 p.m.
Room: Room A105/A106

Session Chairs:
Dr. Dohyoung Chung
Samsung
Sergei Podshivalov
Broadcom

Mobile positioning in indoor and outdoor environments continues to be a difficult problem to solve. Users’ position errors can be very large, especially in deep urban canyons and deep indoors. This panel will present and debate practical strategies to overcome these errors.

1. Prof. Todd Humphreys, The University of Texas at Austin
2. Mr. Rich Lee, iPosi
3. Dr. Ramsey Faragher, Focal Point Positioning, UK
4. Mr. Premal Madhani, Broadcom
5. Dr. Frank van Diggelen, Google

6:00 p.m. - 8:00 p.m., Exhibitor Hosted Reception in the Exhibit Hall
B2: Regional and Global Integrity Solutions

**Date:** Wednesday, September 27, 2017  
**Time:** 1:45 p.m. - 5:30 p.m.  
**Room:** Room B110/B111/B112

**Session Chairs:**

![Nathalie Ricard](image1)  
**European GNSS Agency, Czech Republic**  

![Dr. Takeyasu Sakai](image2)  
**Electronic Navigation Research Institute, Japan**

1:50. Performances Monitoring and Analysis for KASS, T. Authié, M. Dall’Orso, S. Trilles, Thales Alenia Space, France; H. Choi, H. Kim, J. Lee, E. Lee, G. Nam, Korean Aerospace Research Institute, South Korea


2:35. Development of Prototype Dual-frequency Multi-constellation SBAS for MSAS, Mitsunori Kitamura, Takahiro Aso, Takeyasu Sakai, and Kazuaki Hoshinoo, Electronic Navigation Research Institute, Japan

2:58. Improved Detectors for Evil Waveform Monitoring, Ikhlas Selmi, Olivier Julien, Jean-Baptiste Pagot, ENAC, France; Jaron Samson, European Space Agency, France

4:00. GPS Simultaneous Uploads and GPS Constellation Fault Probability Determination, Norbert Suard, CNES, France

4:23. Characterization of the Galileo Ranging Accuracy and Integrity Performance: Methodologies and Results, I. Martini, P. Steigenberger, O. Montenbruck, S. Perea Diaz, M. Meurer, German Aerospace Center (DLR), Germany

4:46. Multi-GNSS Constellation Anomaly Detection and Performance Monitoring, Kazuma Gunning, Todd Walter and Per Enge, Stanford University

5:08. A Dedicated ARAIM Ground Monitor to Validate the Integrity Support Message, Yawei Zhai, Michael Jamoom, Illinois Institute of Technology; Mathieu Joerger, The University of Arizona; Boris Pervan, Illinois Institute of Technology

**Alternate Presentations:**

1. **ARAIM Ground Architecture Based on GNSS Monitoring Infrastructures**, Santiago Perea, Michael Meurer, German Aerospace Center (DLR) & RWTH Aachen University, Germany; Ilaria Martini, Markus Ripppl, DLR, Germany; Boris Pervan, Illinois Institute of Technology

2. **Integrity Based on MT28 for EGNOS: New Algorithm Formulation & Results**, T. Authié, S. Trilles, Thales Alenia Space, France; J-C Fort, MAPSS laboratory, Descartes University, France; J-M Azaïs, ESP laboratory, Paul Sabatier University, France

3. **A Rigid Message Scheduler for SBAS**, Todd Walter and Juan Blanch, Stanford University

4. **Performance Analysis on Multi-Constellation SBAS of the Modified L1-only SBAS Message**, Cheolsoon Lim, Ho-yon Hwang, Byungwoon Park, Sejong University, South Korea Eui-ho Kim, Hongik University, South Korea Changdon Kee, Seoul National University, South Korea

6:00 p.m. - 8:00 p.m., Exhibitor Hosted Reception in the Exhibit Hall
C2: Aerospace Applications 2

Date: Wednesday, September 27, 2017
Time: 1:45 p.m. - 5:30 p.m.
Room: Room B115/B116

Session Chairs:

Dr. Rodrigo Leandro
Sapcorda

Stephen Mole
Intel

1:50. A High Sensitive GNSS Receiver for High Altitude Space Missions, Yansong Meng, Beijing Institute of Technology, China & Academy of Space Electronic Information Technology, China; Bo Qu, Yanguang Wang, Lang Bian, Longlong Li, Xiaoliang Wang, Academy of Space Electronic Information Technology, China

2:12. Airborne GPS Interference Cancellation Algorithm Based on Deep Learning, Qiong Yang, Yi Zhang, Baowang Lian, Chengkai Tang, Northwestern Polytechnical University, China

2:35. Design and Analysis of High Sensitivity Algorithms for HEO Orbit GNSS Receivers, Mariano Wis, Giovanni Vecchione, Deimos Space, Spain; Joao S. Silva, Pedro Silva, Deimos Engenharia, Portugal; J.A. Garcia-Molina - ESTEC - ESA, The Netherlands

2:58. RFI Resilient DoA-Based Positioning for PBN, Okuary Osechas, Emilio Pérez and Michael Meurer, German Aerospace Center (DLR), Germany

4:00. Application of GPS to Enable Launch Vehicle Upper Stage Heliocentric Disposal, Anzalone, Evan, NASA/MSFC; Oliver, T. Emerson, NASA/MSFC/DCI


4:46. Exploring the Limits of High Altitude GPS, Benjamin Ashman and Joel Parker, Code 595 Goddard Space Flight Center; Frank Bauer, FBauer Aerospace Consulting; Michael Esswein, University at Buffalo

5:08. P2OD: Real-time Precise Onboard Orbit Determination for LEO Satellites, Pietro Giordano, Paolo Zoccarato, Michiel Otten, Werner Enderle, Massimo Crisci, ESA, The Netherlands

Alternate Presentations:

1. GNSS-Based Precise Orbit Determination of LEO satellites Using Double-Differenced Observations, Z. Kang, B. Tapley, S. Bettadpur, Center of Space Research, The University of Texas at Austin

2. Validation of Existing GNSS Multipath Model, Capucine Amielh, Alexandre Chabory, Christophe Macabiau, ENAC, France; Laurent Azoulai, AIRBUS, France


6:00 p.m. - 8:00 p.m., Exhibitor Hosted Reception in the Exhibit Hall
D2: Advanced Integrity Algorithms for Safe Autonomous Operation

**Date:** Wednesday, September 27, 2017  
**Time:** 1:45 p.m. - 5:30 p.m.  
**Room:** Room B117/B118/B119

**Session Chairs:**

Dr. Jan Wendel  
*Airbus Defence & Space GmbH, Germany*

Logan Scott  
*LS Consulting*

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1:50. **Advanced RAIM Performance Sensitivity to Deviation of ISM Parameter Values**, Young Lee and Brian Bian, The MITRE Corporation

2:12. **Feasibility of Fault Exclusion Related to Advanced RAIM for GNSS Spoofing Detection**, Heidi Kuusniemi, Finnish Geospatial Research Institute, Finland; Juan Blanch, Sherman Lo, Yu-Shuan Chen, Stanford University, USA; Anna Innac, Parthenope University of Naples, Italy; Giorgia Ferrara, Salomon Honkala, M. Zahidul H. Bhuiyan, Sarang Thombre, Stefan Söderholm, Finnish Geospatial Research Institute, Finland; Todd Walter, R. Eric Phelts, Per Enge, Stanford University, USA

2:35. **Tighter Integrity Bounds for ARAIM Wrong Exclusion Risk**, Carl Milner, Eugene Bang, Christophe Macabiau, ENAC, France; Philippe Estival, DSNA, France; Yiping Jiang, TBD


4:00. **Sequential Change Detection for Next-Generation RAIM Algorithms**, Daniel Egea-Roca, Gonzalo Seco-Granados, and José A. López-Salcedo, Universitat Autonoma de Barcelona (UAB), Spain

4:23. **Integrity measures in direct-positioning**, Pau Closas, Northeastern University, USA; Adrià Gusi-Amigó, Vitrociset Belgium SPRL, The Netherlands; Juan Blanch, Stanford University, USA

4:46. **A New Look at Bounding Integrity Risk in the Presence of Time-Correlated Errors**, Steven Langel, The MITRE Corporation; Mathieu Joerger, The University of Arizona; Samer Khanafseh and Boris Pervan, Illinois Institute of Technology

5:08. **A Framework for Regional GNSS Situational Awareness**, Kirsten Strandjord and Penina Axelrad, University of Colorado

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**Alternate Presentations:**

1. **Derivation of Spherical Overbounding for Quadratic Integrity Monitors with Non Gaussian Random Inputs**, Jason H. Rife, Tufts University
2. **ARAIM with Weighted False Alarm Allocation**, Jakub Skalicky, Martin Orejas and Ute Ziegler, Honeywell International, Czech Republic
3. **Integrity Monitoring Improvement by Exploiting the Raw GNSS Signals**, Christophe Charbonniers, ONERA - DEMR/RCP, France; François Vincent, ISAE - DEOS, France; Jonathan Israel, ONERA - DEMR/RCP, France; Guillaume Carrie, Thales Alenia Space - DNF, France; Marion Aubault, CNES - DSO/RF/STR, France

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6:00 p.m. - 8:00 p.m., Exhibitor Hosted Reception in the Exhibit Hall
E2: Multisensor Navigation in Challenging Environments 2

Date: Wednesday, September 27, 2017
Time: 1:45 p.m. - 5:30 p.m.
Room: Room A107/A108/A109

Session Chairs:
Gina Guiducci
US Army CERDEC

Dr. Mathieu Joerger
University of Arizona

1:50. Simultaneous Localization and Mapping using Terrestrial Multipath Signals, GNSS and Inertial Sensors, Christian Gentner, Robert Poehlmann, Markus Ullmschneider, Thomas Jost, and Armin Dammann, German Aerospace Center (DLR), Germany

2:12. Enhancing Micro Air Vehicle Navigation in Dense Urban Areas using 3D Mapping Aided GNSS, Paul D Groves and Mounir Adjrad, University College London, United Kingdom; Jonathan Selbie, Swarm Systems, United Kingdom

2:35. The Development of an Artificial Neural Networks Aided Image Localization Scheme for Indoor Navigation Applications with Floor Plans Built by Multi-platform Mobile Mapping Systems, Jhen-Kai Liao, Guang-Je Tsai, National Cheng Kung University, Taiwan

2:58. A Computational Multivariate-based Technique for Inertial Sensor Calibration, Bakalli Gaetan, University of Geneva, Switzerland; Radi Ahmed, University of Calgary, Canada; Molinari Roberto, University of California Santa Barbara; El Sheimy Nasser, University of Calgary, Canada; Guerrier Stéphane, University of Illinois at Urbana-Champaign

4:00. Approximate Maximum Likelihood Estimation Using a 3D GNSS Simulator for Positioning in MP/NLOS Conditions, N. Kbayer, M. Sahmoudi, ISAE-SUPAERO / TESA, Université de Toulouse, France; C. Rouch, CNES, France

4:23. An Automatic Calibration Approach for the Stochastic Parameters of Inertial Sensors, Ahmed Radi, University of Calgary, Canada; Gaetan Bakalli, University of Geneva, Switzerland; Stéphane Guerrier, University of Illinois at Urbana-Champaign; Naser El Sheimy, University of Calgary, Canada; Roberto Molinari, University of California Santa Barbara

4:46. Advanced GPS-based Attitude Estimation Scheme for Various IMU Failure Scenarios of Low-Cost UAV, Heekwon No and Changdon Kee, School of Mechanical and Aerospace Engineering and the Institute of Advanced Aerospace, Seoul National University, South Korea; Am Cho, Korea Aerospace Research Institute, South Korea; Byungwoon Park, Sejong University, South Korea

5:08. Signal and Data Structure for Navigation with a Terahertz Interferometer, John Scott Parker and Jason Rife, Tufts University

Alternate Presentations:
1. Comparisons of SR-UKF family for a Visual-IMU Tightly-coupled System Based on Tri-focal Tensor Geometry, Maosong Wang, National University of Defense Technology, China & The University of Calgary, Canada; Wenqi Wu, National University of Defense Technology, China; Naser El Sheimy, University of Calgary, Canada

2. Robust Attitude Determination Using GNSS Multi Baseline Carrier Phase and IMU Sensor Fusion, Hiraku Nakamura, Hiroyuki Toda, Naomi Fujisawa, and Takuo Kashia, Furuno Electric Co., Ltd., Japan

3. 3D Map Aided RTK-GNSS Positioning in Urban Environments, Taro Suzuki, Shodai Kato, Yoshiharu Amano, Waseda University, Japan

6:00 p.m. - 8:00 p.m., Exhibitor Hosted Reception in the Exhibit Hall
F2: GNSS Receiver Processing and Navigation Algorithms 2

**Date:** Wednesday, September 27, 2017  
**Time:** 1:45 p.m. - 5:40 p.m.  
**Room:** Room C123/C124

**Session Chairs:**

![Dr. Laura Ruotsalainen](Finnish Geospatial Research Institute, Finland)  
![Dr. David De Lorenzo](Athentek Inc.)

1:50. **GNSS Signal Waveform Estimation with 2.4 m Dish antenna and a Synthetic Aperture Antenna**, Thomas Pany, Dominik Dötterböck, Ronny Blum, Universität der Bundeswehr München, Institute of Space Technology and Applications, Germany

2:12. **Snapshot Processing of High-Order BOC Signals in the Cloud: On Sensitivity and Distortion Effects**, J.A. García-Molina, European Space Agency (ESA) and HE Space, The Netherlands, and Universitat Politècnica de Catalunya (UPC), Spain; J.A. Fernandez-Rubio, UPC, Spain; R. Weiler, M. Crisci, ESA, The Netherlands

2:35. **Computationally Efficient Receiver Design for Mitigating Multipath for Positioning with LTE Signals**, Kimia Shamaei and Zak (Zaheer) M. Kassas, University of California, Riverside

2:58. **Multi-Receiver Direct Position Estimation Tested on a Full-Scale Fixed-wing Aircraft**, Arthur Hsi-Ping Chu and Grace Xingxin Gao, University of Illinois at Urbana-Champaign

4:00. **An Adaptive Carrier Tracking Method to Improve Mountain-based GPS Radio Occultation Signal Processing**, Rong Yang, Jade Morton, Bo Han, Colorado State University

4:23. **Combined Decoding of GNSS Navigation Messages under Weak-Signal Conditions**, James T. Curra, ESA, Netherlands; Cillian O’Driscoll, Independent Consultant, Ireland; Gianluca Caparra, University of Padova, Italy

4:46. **A Collaborative Method for GNSS-based Inter-Agent Range Estimation and Hybrid Positioning Algorithm in Harsh Environment**, Alex Minetto, Calogero Cristodaro, Fabio Dovis, Politecnico di Torino, Italy


5:30. **ION GNSS SDR Metadata Standard Working Group Report**, Sanjeev Gunawardena, Air Force Institute of Technology; Thomas Pany, Bundeswehr University Munich, Germany; James Curran, The Netherlands

**Alternate Presentations:**

1. **Benefits of Adaptive Kalman Filter-Based Single Point Positioning in Dense Urban Environments**, Takaki Tominaga, Nobuaki Kubo, Tokyo University of Marine Science and Technology, Japan

2. **Cycle Slip Detection and Repair for GPS / INS Tightly Integrated System Based on Bayesian Compression Sensing**, Dengao Li, Zhiying Ma, Jumin Zhao, Taiyuan University of Technology, China

3. **Noise Statistics Estimation Techniques for Robust GNSS Carrier Tracking**, Jordi Vilà-Valls, Carles Fernández-Prades, Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA), Spain; Pau Clósas, Northeastern University; Javier Arribas, CTTC/CERCA, Spain

4. **Efficiency Analysis of Cloud GNSS Signal Processing for IoT Applications**, Vicente Lucas-Sabola, Gonzalo Seco-Granados, José A. López-Salcedo, Universitat Autònoma de Barcelona, Spain; José A. García-Molina, European Space Agency (ESA) and HE-Space, The Netherlands; Massimo Crisci, ESA, The Netherlands

5. **The Design of Asynchronous Kalman Filter-based Tracking Loop in Digital Domain**, Wenhui Lin, Xin Chen, Yuze Wang, and Di He, Shanghai Jiao Tong University, China

6:00 p.m. - 8:00 p.m., Exhibitor Hosted Reception in the Exhibit Hall
8:35. **Behavior Recognition and Step Detection for Pedestrian Navigation via a Foot-mounted Inertial Measurement Unit**, Zebo Zhou, Shanhui Mo, Shuang Du, University of Electronic Science Technology of China; Jianghui Geng, GNSS Research Center, Wuhan University, China

8:57. **Garage DRive is the Navigation Engine for under Roof Parking**, Ruslan Budnik and Boris Oblakov, Garage DRive, Russia

9:20. **3D LIDAR Based Vehicle Localization using Vertical Structure Landmark in Urban Road**, Jun-Hyuck Im, Kyu-won Kim and Gyu-In Jee, Department of Electronics Engineering, Konkuk University, South Korea

9:43. **The Ride-hailing Spoof Detection based on the Sensor Measurement Consistency**, Da-peng Li, Hai-tao Wu, Wei-na Hao, Ye Zhang, Meng-meng cui, Yan-kun Li, Academy of Opto-Electronics (AOE), CAS, China

10:40. **Multi-GNSS High Precision Positioning in Urban Environments**, Javier Míguez, European Space Agency (ESA), The Netherlands/Universitat Autònoma de Barcelona (UAB), Spain; José V. Perello Gisbert, Lionel Ries, ESA, The Netherlands; J. A. García-Molina, ESA/HE-Space, The Netherlands; Paolo Zoccarato, ESA/RHEA, The Netherlands; Raúl Orús Perez, Massimo Crisci, ESA, The Netherlands

11:03. **An integrated WLAN and GPS Localization for Urban Canyon Environments using Sparse Data Processing**, Ali Khalajmehrabadi, Nikolaos Gatsis, and David Akopian, University of Texas at San Antonio

11:26. **Evaluation of a GNSS Receiver Performance in Different Multipath Environments with a Novel Real-time Multipath Simulation System**, Tommaso Panicciari, Mohamed Ali Soliman, Spirent Communications, UK; Grégory Moura, OKTAL Synthetic Environment, France

11:48. **Design, Implementation, and Performance in the Urban Canyon of a Low-cost GNSS/INS/Odometric Sensor Fusion Platform for Ground Intelligent Transportation Systems**, Javier Arribas, Ana Moragrega, Carles Fernández-Prades, Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain; Pau Closas, Northeastern University, USA

**Alternate Presentations:**

1. **Localization in Urban Canyon: Localization Based on Pattern Matching Using LTE or LoRa Signal for ‘GNSS-denied’ Areas**, Boseon Yu, Sensor System Research Center, Korea Institute of Science and Technology (KIST), South Korea; Beomju Shin, SNU-IAMD, Seoul National University, South Korea; Jaewon Bang, KIST, South Korea; Jungho Lee, Leetekorea Seoho Lee, South Korea; Taikjin Lee, Sensor System Research Center, KIST, South

2. **3D Modeling of Buildings Based on RTK and Image Processing**, Lei Shi, Haifen Deng, Chunshui Fang, Chenggang Li, Hi-Target Surveying Instrument Co.Ltd., China

12:15 p.m. - 1:15 p.m., Informal Luncheon, Exhibit Hall
1:15 p.m. - 1:45 p.m., Free Time in Exhibit Hall
B3: The Navigation of Satellites

Date: Thursday, September 28, 2017
Time: 8:30 a.m. - 12:15 p.m.
Room: Room B110/B111/B112

Session Chairs:

Dr. André Hauschild
German Aerospace Center (DLR), Germany

James Miller
NASA

8:35. New Trends for Space Based Positioning, O. Pozzobon, S. Fantinato, A. Dalla Chiara, G. Gamba, A. Pozzobon, Qascom, Italy


9:20. Strategic Parameterization of Solar Radiation Pressure Model in Precision Satellite Orbit Determination, Tae-Suk Bae and Hee-Un Kim, Sejong University, South Korea

9:43. Performance Analysis of Multi-constellation and Multi-frequency GNSS Receivers in Deep Space, Yohan Park and Jong-Hoon Won, Inha University, South Korea

10:40. Angles-Only Relative Navigation Activities during AVANTI, Jean-Sébastien Ardaens and Gabriella Gaias, German Space Operations Center (DLR/GSOC), Germany

11:03. Autonomous Orbit Determination using Observations of a Sodium Guidestar Network, Mark L. Psiaki, Virginia Tech

11:26. Improving GPS AutoNav Orbit Accuracy with Onboard Accelerometers, Jing Qiao and Wu Chen, Department of Land Surveying and Geo-Informatics, Hong Kong Polytechnic University, China


Alternate Presentations:

1. A Novel Heuristic Method for TDMA Inter-Satellite Link Timeslot Scheduling, Daoning Yang, Jun Yang, National University of Defense Technology, China; Gang Li, Beijing Institute of Tracking and Telecommunications Technology, China; Zhi Qu, National University of Defense Technology, China

12:15 p.m. - 1:15 p.m., Informal Luncheon, Exhibit Hall
1:15 p.m. - 1:45 p.m., Free Time in Exhibit Hall
C3: Marine Applications

Date: Thursday, September 28, 2017
Time: 8:30 a.m. - 12:15 p.m.
Room: Room B115/B116

Session Chairs:

Dr. Alan Grant
General Lighthouse Authorities, UK

Dr. Kevin Sheridan
TerraStar, UK


8:57. Deep Running Based Rainfall Forecasting using GNSS Precipitable Water Vapor and Meteorological Data, Hee-Un Kim and Tae-Suk Bae, Sejong University, South Korea


9:43. PPP-RTK Service for Port Navigation using State Space Representation in DGNSS Medium Frequency Wave, Sul Gee Park, Won Seok Jang, Sang Hyun Park, Korea Research Institute of Ships & Ocean, South Korea

10:40. EGNOS for Inner Waterways: Performance and Multipath Model on the Danube River, A.C. Pandele, Institute of Space Science, (ISS), France; Al. Radutu, Romanian Space Agency (ROSA), Romania; M. Porretta, European Space Agency (ESA), France; N.A. Croitoru, ISS, France; L.B. Stefanescu, ROSA, Romania; C.G. Dragasanu, M.F. Trusculescu, M. Balan, ISS, France

11:03. The VHF Data Exchange System – A New Communications System for Maritime, J. Šafár, N. Ward, A. Grant & M. Bransby, The General Lighthouse Authorities of the UK & Ireland

11:26. Towards a Reliable Bridge Collision Warning System for Inland Vessel Navigation Based on RTK Height Determination, Anja Hesselbarth, Ralf Ziebold, German Aerospace Center (DLR), Germany; Martin Sandler, innovative navigation GmbH, Germany; Michael Hoppe, Martin Broeschei, German Federal Waterways and Shipping Administration (FVT), Germany; Jürgen Alberding, Maik Uhlemann, Alberding GmbH, Germany

11:48. Using SNR method to Detect Ocean Tides using GPS and BeiDou Signals, Zhang Yun, Li Binbin, Han Yanling, Hong Zhonghua, Yang Shuhu, Wang Jing, Xu Shenyan, Shanghai Ocean University, China

12:15 p.m. - 1:15 p.m., Informal Luncheon, Exhibit Hall
1:15 p.m. - 1:45 p.m., Free Time in Exhibit Hall
D3: Robust Autonomy Innovations for Robotic Vehicles

**Date:** Thursday, September 28, 2017  
**Time:** 8:30 a.m. - 12:15 p.m.  
**Room:** Room B117/B118/B119

**Session Chairs:**

Dr. Paul D. Groves  
University College of London, UK  
Ernesto Etienne  
Federal Aviation Administration

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8:35. *A Distributed Cooperative UAV Swarm Localization System: Development and Analysis*, Salil Goel, The University of Melbourne, Australia

8:57. *Distributed Signals of Opportunity Aided Inertial Navigation with Intermittent Communication*, Joshua Morales and Zak (Zaher) M. Kassas, University of California, Riverside

9:20. *Planar Pose Estimation using a Camera and Single-Station Ranging Measurements*, Chen Zhu, Gabriele Giorgi, Technische Universität München, Germany; Christoph Günther, German Aerospace Center (DLR) and Technische Universität München, Germany

9:43. *Evaluation of Hybrid Positioning Scenarios for Autonomous Vehicle Applications*, José A. del Peral-Rosado, Roger Estatuet-Castillo, José A. López-Salcedo, Gonzalo Seco-Granados, Universitat Autònoma de Barcelona (UAB), Spain; Zdenek Chaloupka, Lionel Ries, European Space Agency (ESA), The Netherlands; José A. García-Molina, ESA and HE-Space, The Netherlands


11:03. *Opportunistic Landmark Registration for Long Distance Relative Path Following*, Dan Pierce, Scott Martin, and David Bevly, Auburn University


11:48. *Ultra-Tightly Coupled GNSS/INS for small UAVs*, Daniel Olesen, Jakob Jakobsen and Per Knudsen, DTU Space, Denmark

**Alternate Presentations:**

1. *Graphical Approach to Representation and Inference in Multi-sensor State Estimation*, Xin Zhang and Xingqun Zhan, Shanghai Jiao Tong University, China

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12:15 p.m. - 1:15 p.m., Informal Luncheon, Exhibit Hall  
1:15 p.m. - 1:45 p.m., Free Time in Exhibit Hall
E3: PANEL: Assured Navigation and Timing

Date: Thursday, September 28, 2017
Time: 8:30 a.m. - 12:15 p.m.
Room: Room A105/A106

Session Chairs:

Dr. John Betz  
James Platt  
The MITRE Corporation  Department of Homeland Security

Experts from academia, government, and industry will address research and applied issues, as well as steps being taken to provide improved assurance in a range of environments and scenarios.

1. **Professor Grace Xingxin Gao**, University of Illinois Urbana-Champaign
2. **Dr. Jeffrey Hebert**, Air Force Research Laboratory
3. **Prof. Todd Humphreys**, University of Texas at Austin
4. **Dr. Joseph Rushanan**, The MITRE Corporation
5. **Logan Scott**, Logan Scott Consulting
6. **Dr. David Taylor**, Setter Research
7. **Prof. Todd Walter**, Stanford University
8. **Dr. Jesse Wodin**, SRI
9. **Panel Discussion**, 

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ION GNSS+ 2017 • September 25-29, 2017 • Portland, Oregon
F3: GNSS Resilience Technologies

**Date:** Thursday, September 28, 2017

**Time:** 8:30 a.m. - 12:15 p.m.

**Room:** Room C123/C124

**Session Chairs:**

![Dr. Christophe Macabiau](image)

**ENAC, France**

![Mitch Narins](image)

**Strategic Synergies LLC**

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**8:35. A Low-power Authentication Signal for Open Service Signals,** E. Gkougkas, D. Dötterböck, T. Pany and B. Eissfeller, University Federal Armed Forces Munich, Germany

**8:57. A New GNSS Scintillation Model,** Charles L. Rino, Brian Breitsch, Joy Jaio, Jade Morton, Colorado State University; Charles S. Carrano, Boston College, Institute for Scientific Research

**9:20. Adaptive Signal Processing Method Using a Single-Element Dual-polarized Antenna for GNSS Interference Mitigation,** Kwansik Park, Yonsei University, South Korea; Dongkoog Lee, Agency for Defense Development, South Korea; Jiwon Seo, Yonsei University, South Korea

**9:43. Multipath Mitigation Using Circular Rotating Antenna,** Lin Xie, Xiaowei Cui, Tianyi Ma, and Mingquan Lu, Department of Electronic Engineering, Tsinghua University, China

**10:40. Designing and Evaluating Next Generation of Resilience Receivers,** S. Cancela, D. Calle, G. Arroyo GMV, Spain; G. Da Broi, A. Dalla Chiara, O. Pozzobon, Qascom, Italy; E. Göhler, Ifen, Germany; I. Fernández-Hernández, European Commission, Belgium; J. Simón, GSA; G. Seco, Autonomous University of Barcelona, Spain

**11:03. The Scheme and Experiment of Quantum-enhanced Timing,** Tianyi Ma, Wei Zhang, Xiaowei Cui, Yidong Huang, Mingquan Lu, Tsinghua University, China


**11:48. Robust GNSS Ranging in the Presence of Repeater Signals,** Andreas Ililopoulos, Christoph Enneking, Omar Garcia Crespillo, Thomas Jost, Manuel Appel, Institute of Communications and Navigation German Aerospace Center (DLR), Germany; Felix Antreich, Federal University of Ceara (UFC), Brazil

**Alternate Presentations:**

1. **NLOS Multipath Detection by Using Machine Learning in Urban Environments,** Taro Suzuki, Yusuke Nakano, Yoshiharu Amano, Waseda University, Japan
2. **An Accurate Compensation Method for Practical GNSS Antenna Arrays,** Ezequiel A. Marranghelli, G. Ramón López La Valle and Pedro A. Roncaglilo, Instituto de Investigaciones en Electrónica, Control y Procesamiento de Señales (LEICI), Facultad de Ingeniería, UNLP, Argentina
3. **Feasibility and Limitations of Self-Spoofing Attacks on GNSS Signals with Message Authentication,** Gianluca Caparra, Silvia Ceccato, Nicola Laurenti, University of Padova, Italy; Justan Cramer, RadNav Consulting; Chuck J. Walter, Navsec Consulting

12:15 p.m. - 1:15 p.m., Informal Luncheon, Exhibit Hall
1:15 p.m. - 1:45 p.m., Free Time in Exhibit Hall
A4: Location and Proximity Authentication in Mobile Consumer Applications

Date: Thursday, September 28, 2017
Time: 1:45 p.m. - 5:30 p.m.
Room: Room B113/B114

Session Chairs:

Greg Turetzky
Intel Corporation, WPRD

Lionel Garin
Qualcomm

1:50. Localisation of Wearable Ultra-wideband Antenna for Indoor Positioning Application, Fengzhou Wang, Birmingham City University, Birmingham; Guohua Wang, Beihang University, China; Xinyu Wang, Beihang University, China

2:12. Mixed Near-Field and Far-Field Interference Localization using Uniform Linear Array, Kai Wang, Ling Wang, Zhaolin Zhang and Jian Xie, School of Electronic and Information, Northwestern Polytechnical University, China

2:35. DOA Estimation And Localization Using Multi-Base Station Spatial Spectrum Fusion, Madhu Kumari Choudhary, Di He, Lav Kumar Dutta, Fei Wen, Peilin Liu, Wexian Yu, Shanghai Jiao Tong University, China; Yi Zhang, Huawei Technologies Co. Ltd., China

2:58. Method to Characterize Driving Behavior Based on Attitude Determination with Only Accelerometer and Gyro, Paul William McBurney, GopherHush Corp

4:00. Method to Measure and Validate Daily Mobile Phone Distance Traveled and Occupied Locations using Map Matching of Inaccurate and Infrequent Locations and Sensor Data, Paul William McBurney, GopherHush Corp

4:23. The Design of an Energy-saving Vector-based GNSS/INS Deep Integration System, Xinhua Tang, Southeast University, China; Xuehao Yu, Shanghai Aerospace Control Technology Institute, China; Xin Chen, Shanghai Jiao Tong University, China; Haiying Wang, Shanghai Aerospace Control Technology Institute, China

4:46. Smart Fusion of Multi-sensor Ubiquitous Signals of Mobile Device for Localization in GNSS-denied Scenarios, Jichao Jiao, Zhongliang Deng, Fei Li, Beijing University of Posts and Telecommunications, China; Lianming Xu, Beijing RTMAP Technology Co. Ltd., China

5:08. Smartphone-based Hybrid Indoor Positioning System with Magnetic Fingerprint Matching, Guohua Wang, Xinyu Wang, Beihang University, China; Fengzhou Wang, The University of Edinburgh, Scotland

Alternate Presentations:

1. IndoorGuide – Pedestrian Navigation based on a Foot-Mounted IMU, Jan Ruppelt, Nikolai Kronenwett and Gert F. Trommer, Karlsruhe Institute of Technology (KIT), Germany

2. Development of an Accuracy Enhancement Algorithm on Pedestrian Positioning based on GNSS and PDR Using the UWB Radio Navigation Technique, Yong-gu Jang and Seok-jin Song, Korea Institute of Construction Technology, South Korea

3. Development of a 3D GNSS/PDR-integrated Sensor Capable of Tracking the Position of a Moving Object on the Ground and Underground, Seok-jin Song and Yong-gu Jang, KICT, South Korea
**B4: Spectrum: Protection and Optimization**

**Date:** Thursday, September 28, 2017  
**Time:** 1:45 p.m. - 5:30 p.m.  
**Room:** Room B110/B111/B112

**Session Chairs:**

Gerhard Berz  
Eurocontrol, Belgium  
Dominic Hayes  
European Commission, Belgium

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**1:50. Emerging GNSS Resilience Standards – How Good are they Likely to be?,** Guy Buesnel, Joshua Stubbs, Spirent Communications, UK; Paul Crampton, Spirent Federal Systems

**2:12. Air Traffic Radar Interference Event in the Galileo E6 Band: Detection, Analysis and Mitigation,** Javier Arribas, Carles Fernández-Prades, Jordi Vilà-Valls, Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain; Pau Closas, Northeastern University, USA; A. R. de Torres, Signal Theory and Communications Department, Polytechnic University of Catalonia, Spain

**2:35. Hypothesis Test for Spoofing Signal Identification using Variance of Tangent Angle of Baseline Vector Components,** Seong-Hun Seo, Konkuk University, South Korea; Byung-Hyun Lee, Hanwha Systems, South Korea; Sung-Hyuck Im, Korea Aerospace Research Institute, South Korea; Gyu-In Jee, Konkuk University, South Korea; Kwan-Sung Kim, Agency for Defense Development, South Korea

**2:58. A Novel Interference Suppression Algorithm Based on Eigenanalysis Interference Canceler for Satellite Navigation,** Yanyun Gong, Ling Wang, Zhaolin Zhang, Northwestern Polytechnical University, China

**4:00. Spoofing Detection, Mitigation and Source Localization with Single Antenna,** Huiping Zhu, Yuze Wang, Xin Chen, Rendong Ying, Peilin Liu, Shanghai Jiao Tong University, China

**4:23. Jamming of Aviation GPS Receivers: Investigation of Field Trials Performed with Civil and Military Aircraft,** Pascal Truffer, Maurizio Scaramuzza, Marc Troller, skyguide, Swiss Air Navigation Services Ltd., Switzerland; Marc Bertschi, Swiss Air Force, Switzerland

**4:46. Real-time Pre-correlation Anti-jamming System for Civilian GNSS Receivers,** Jorge Querol and Adriano Camps, Universitat Politecnica de Catalunya - BarcelonaTech and IEEC/UPC, Spain

**5:08. Spoofing Threats: Reality Check, Impact and Cure,** Wim De Wilde, Jan Van Hees, Gert Cuypers, Jan Dumon, Jean-Marie Sleewaegen, Bruno Bougard, Septentrio Satellite Navigation, Belgium
C4: Land-Based Applications
Date: Thursday, September 28, 2017
Time: 1:45 p.m. - 5:30 p.m.
Room: Room B115/B116

Session Chairs:

Dr. Günther Retscher
Vienna University of Technology, Austria

Dr. Changdon Kee
Seoul National University, South Korea

1:50. UXO Mapping with UWB/IMU Integration, Zoltan Koppanyi, Charles K. Toth, and Dorota Grejner-Brzezinska, The Ohio State University

2:12. Unmapped Feature Detection and Exclusion in Laser-Based Navigation, Mathieu Joerger, the University of Arizona, Guillermo Dueas Arana, Matthew Spenko, and Boris Pervan, Illinois Institute of Technology

2:35. A New Gravity Absorption Modeling for GPS/RISS in Land Vehicle, Jungbeom Kim, Seoul National University, South Korea; Younsil Kim, Korea Aerospace Research Institute, South Korea; Byungwoon Park, Sejong University, South Korea; Changdon Kee, Seoul National University, South Korea

2:58. Monitoring Rail Infrastructure using Multisensor Navigation on a Moving Platform and Autonomous Robots, Xiaolin Meng, Simon Roberts, Lukasz Bonenberg, Julia Jing, Sean Ince, Andrew Sowter and Paul Bhatia, University of Nottingham, UK

4:00. GNSS for Monitoring the Forth Road Bridge Structural Failures and Assisting Re-opening Decision Making, Qusen Chen, School of Geodesy and Geomatics, Wuhan University, China Xiaolin Meng, Nottingham Geospatial Institute/Sino-UK Geospatial Engineering Centre, The University of Nottingham, United Kingdom Weiping Jiang, GNSS Research Centre, Wuhan University, China Simon Roberts, Nottingham Geospatial Institute, The University of Nottingham, United Kingdom

4:23. Precise Attitude and Position Determination of the Trailer using a Single Camera System for Agricultural Applications, Himanshu Sharma, Arkadiusz Szumski, Thomas Pany and Bernd Eissfeller, Universität der Bundeswehr münchen (ISTA), Germany


5:08. Research on Multi-sensor Navigation System based on PPP-GNSS, Optical Speed Sensor and Inertial Navigation System, Si-rui Chen, Wei Jiang, Bai-gen Cai, Wei-jie Tao, Jian Wang, Wei Shangguan, Beijing Engineering Research Center of EMC and GNSS Technology for Rail Transportation, China

Alternate Presentations:

1. Digital Track Map Generation for Safety-Critical Railway Applications, Wei-jie Tao, Bai-gen Cai, Jian Wang, Jiang Liu, Wei Shang-guan, School of Electronics and Information Engineering, Beijing Jiaotong University, China

2. EDAS (EGNOS Data Access Service): Differential GPS Corrections Performance Test with State-of-the-art Precision Agriculture System, E. Lacarra, J. Vázquez, M.A. Sánchez, ESSP SAS, Spain; J. Rioja, Topcon Precision Agriculture Europe, J. Bruzual, Topcon Precision Agriculture Europe, Spain

3. Multiple Interactive Model for MEMS IMU in GPS/INS Integrated Navigation System, Maged Ismail, Ezzeldin Abdelqawey, MTC, Egypt, and Nesseen I. Ziedan, Zagazig University, Egypt

4. Statistical Model Based on Markov Chain for GPS and BDS Signal in Different Environment, Yuze Wang, Xin Chen, Peilin Liu, and Muhammad Adeel, Shanghai Jiao Tong University, China
D4: PANEL: Hostile Micro Aerial Vehicles (MAV) Threats: Detection and Countermeasures

Date: Thursday, September 28, 2017
Time: 1:45 p.m. - 5:30 p.m.
Room: Room A105/A106

Session Chairs:

Dr. Christoph Günther
German Aerospace Center (DLR), Germany
Dr. Per Enge
Stanford University

Experts discuss scenarios of hostile MAVs and propose efficient technologies for detection and countermeasures against this upcoming threat. How are we dealing with the various operational hazards of UAS operations? What additional infrastructure will be required to detect and ground hostile UAS?

1. Prof. Dr.-Ing.habil. Michael Meurer, Head of Department, German Aerospace Center (DLR), Institute of Communications and Navigation, Germany
2. Dr. Andrew Hansen, Principal Technical Advisor, US Department of Transportation, Volpe Center
3. Mr. Kunal Jain, Enterprise Sales Manager at Dedrone
4. Mr. Justin Butler, Partner at Eclipse Ventures
5. Mr. Braden J. Eggerl, Rohde & Schwarz, C-UAS Detection and Counter Solutions
6. Prof. Todd Humphreys, The University of Texas at Austin
E4: Navigation Using Environmental Features

**Date:** Thursday, September 28, 2017  
**Time:** 1:45 p.m. - 5:30 p.m.  
**Room:** Room A107/A108/A109

**Session Chairs:**

- Dr. Aaron Canciani  
  *Air Force Institute of Technology*
- Dr. Taro Suzuki  
  *Waseda University, Japan*

1:50. **Bounding INS Positioning Errors with Magnetic-Field-Signatures in Railway Environments**, Benjamin Siebler, Oliver Heirich, Stephan Sand, German Aerospace Center (DLR), Germany

2:12. **Onboard Train Localization with Track Signatures: Towards GNSS Redundancy**, Oliver Heirich and Benjamin Siebler, DLR, Institute of Communications and Navigation, Germany

2:35. **Sound Based Positioning**, David Weathers and John Raquet, Air Force Institute of Technology


4:00. **SIAM: Extruded Shapefile based Interference Avoidance and Mitigation for GNSS Navigation in Urban Canyons**, Guoyu Fu, Colton Riedel, Tyler Holmes and Jyh-Charn Liu, Texas A&M University

4:23. **WiFi and PDR Based Robust SLAM Implementation using Surface Correlation**, Beomju Shin, Korea Institute of Science and Technology (KIST) & Seoul National University, South Korea; Boseon Yu, Jae Won Bang, KIST, South Korea; Changdon Kee, Seoul National University, South Korea; Taikjin Lee, KIST, South Korea

4:46. **Integrated IMU/Image Collaborative Navigation for Indoor Environments**, Lin Zhang, Northwestern Polytechnical University, China & The Ohio State University; Haowei Xu, Baowang Lian, Northwestern Polytechnical University, China; Charles K. Toth, Dorota Grejner-Brzezinska, The Ohio State University


**Alternate Presentations:**

1. **A Sparse Direct Visual-Inertial Method for Pedestrian Navigation Using Smartphone Sensors**, Zhaosheng Wang, Jiuchao Qian, Yuze Wang, Peilin Liu, Wenzian Yu, Shanghai Jiao Tong University, China

2. **Research and Performance Analysis of Tightly Coupled Vision, INS and GNSS System for Land Vehicle Applications**, M. Adeel, Xin Chen, Zheng Gong, Peilin Liu, Shanghai Jiao Tong University, China

3. **A Magnetic-Aided PDR Localization Method Based on the Hidden Markov Model**, Yi Lu, University of Chinese Academy of Sciences, Academy of Opto-Electronics, CAS, China; Dongyan Wei, Hong Yuan, Academy of Opto-Electronics, CAS, China

4. **Multisensor Concept for Autonomous Navigation of Unmanned Systems in GNSS-Denied Environments**, Mario Gäbel, Stefan Nowak, Thomas Krüger, Ulf Bestmann, Technical University of Braunschweig, Germany
F4: High Precision GNSS Positioning

Date: Thursday, September 28, 2017
Time: 1:45 p.m. - 5:30 p.m.
Room: Room C123/C124

Session Chairs:

Jianghui Geng
Wuhan University, China
Dr. Samer Khanafseh
Illinois Institute of Technology

1:50. New Methodology and Operational Service for Near-Real-Time Calibration of GNSS Inter-Signal Biases, Bela Szilagyi, Yoaz Bar-Sever, Willy Bertiger, Larry Romans, Jet Propulsion Laboratory, California Institute of Technology

2:12. Satellite Phase Bias Estimation with Global Networks and High-Dimensional Integer Ambiguity Fixing, Patrick Henkel, Dimitrios Psychas, Technical University of Munich, Germany; Christoph Guenther, Technical University of Munich & German Aerospace Center (DLR), Germany

2:35. GNSS Antenna Phase Center Variation Calibration for Attitude Determination on Short Baselines, Daniel Willi, Michael Meindl, Hui Xui, Markus Rothacher, ETH Zurich Institute of Geodesy and Photogrammetry, Switzerland

2:58. Fast and Reliable Triple-frequency Cycle-slip Detection and Recovery with Dynamical Detection Threshold, Chenlong Deng, Wuhan University, China; Weiming Tang: Wuhan University, Key Laboratory of Navigation and Location Service, National Administration of Surveying, Mapping and Geoinformation, China; Jianhui Cui, Chuang Shi, Jingnan Liu, Wuhan University, China

4:00. BDS/BDS+GPS Network Pseudorange Differential Positioning with a Position Domain Smoothing Method using Inter-epoch Single-differenced Solution Information, Weiming Tang, Jianhui Cui, GNSS Research Center, Wuhan University, China; Chenlong Deng, GNSS Research Center, Wuhan University/Key Laboratory of Navigation and Location Service, National Administration of Surveying, Mapping and Geoinformation, China

4:23. High Availability of Real-time PPP by Extending SSR Orbit and Clock Corrections, Hongzhou Yang, Department of Geomatics, University of Calgary, Canada

4:46. Single-Epoch Ambiguity Resolution for Urban Ultra-Short Baseline Attitude Determination Using Low-Cost GNSS Receivers, Wenyi Li, Xiaowei Cui, Sihao Zhao, Mingquan Lu, Department of Electronic Engineering, Tsinghua University, China

5:08. Single-Frequency GNSS Positioning for Assisted, Cooperative and Autonomous Driving, Peter F. de Bakker and Christian C.J.M. Tiberius, Delft University of Technology, The Netherlands

Alternate Presentations:

1. Cycle-slip Detection for Triple-frequency GPS Observations Under Ionospheric Scintillation, Dongsheng Zhao, The University of Nottingham Ningbo China; Gethin Wyn Roberts, The University of the Faroe Islands; Craig M. Hancock, Lawrence Lau, Ruibin Bai, The University of Nottingham Ningbo China

2. GPS/BDS Combined Precise Point Positioning with Geostationary Satellites Offset, Longwei Xu, Hui Liu, Bao Shu, Chuang Qian, Mingkun Su, GNSS Research Center, Wuhan University, China

3. Research on Tracking Station Distribution Optimization Algorithm of Satellite Orbit Determination, Rui Zhang, National Time Service Center, CAS, China
A5: Autonomous and Assisted Vehicle Applications

Date: Friday, September 29, 2017
Time: 8:30 a.m. - 12:15 p.m.
Room: Room B113/B114

Session Chairs:

Dr. Charles Toth
The Ohio State University

Dr. Jiyun Lee
KAIST, South Korea

8:35. A Prototype for a Surrogate Ambulatory Multi-Sensor Platform (SAMP) for First Responders and other Virtual localization Applications, Zachary Allen, Michael coco, Quentin Corich, David Emmert, Ansel Rothstein-Dowden, George Sciss, Mitchell Smith, Booz Allen Hamilton

8:57. Computer Vision Combined with Convolutional Neural Network aid GNSS/INS Integration for Misalignment Estimation of Portable Navigation, Hsiu-Wen Chang, Tz-Chiau Su, National Cheng Kung University, NCKU, Taiwan

9:20. Vehicle-to-vehicle Angular Determinations by Means of DSRC Signals, Ilya V. Korogodin, Evgeniy N. Boldenkov, and Vladimir V. Dneprov, MPEI Moscow Power Engineering Institute, Russia

9:43. A New Path Planning Algorithm Based on GNSS Localization Error Map, Guohao Zhang and Li-Ta Hsu, The Hong Kong Polytechnic University, Hong Kong


11:03. Performance Comparison of Different GNSS-based Multi-sensor Systems for Detecting Wrong-way Driving on Highways, Hanno Beckmann, Kathrin Frankl, Andreas Schütz, Mathias Philips-Blum, Universität der Bundeswehr München, Germany; Jinyue Wang, Martin Metzner, Volker Schwieger, University of Stuttgart, Germany; Thomas Pany, Bernd Eissfeller, Universität der Bundeswehr München, Germany

11:26. Systems and Algorithms of OTTO-XL, an Autonomous Snow Removal Vehicle, Matthew A. Klein, William Baskin, Case Western Reserve University; Charles Hart, Case Western Reserve University, MTD Products, Inc.; Roger D. Quinn, Case Western Reserve University

11:48. First Testing Results in using V2X Technology to Enhance N-RTK Availability in the UK, Xiaolin Meng, Chang Xu, Xinao Wang, Simon Roberts, Yijian Cui, Qi Yi He, the University of Nottingham, UK; Queen Chen, Wuhan University/The University of Nottingham, China

Alternate Presentations:

1. JTIDS/INS Based on Global-Measurements-Sharing for UAV Flight Formation, Jianwen Fan, Chuang Lei, Xi'an Research Institute of Navigation Technology, China; Guoliang Sun, Beihang University, China

2. Unmanned Mini-Multicopter Carrier System for Entering a High Floor of Skyscraper, Jae Won Bang, Boseon Yu, Sensor System Research Center, Korea Institute of Science and Technology (KIST), South Korea; Beomju Shin, SNU-IAMD, Seoul National University, South Korea; Minjoon Choi, U3 Robotics, South Korea; Taikjin Lee, Sensor System Research Center, KIST, South Korea

3. INS/GNSS Tightly Coupled Integration System Aided by Barometer and Automatic Adjustment of the Selection of Satellite for Integrity Enhancing, Hsiu-Wen Chang and Chung-Lin Tseng, National Cheng Kung University, Taiwan

12:15 p.m. - 1:30 p.m., ION GNSS+ Awards Luncheon, Oregon Ballroom
B5: Applications in Sectorial Policies

Date: Friday, September 29, 2017
Time: 8:30 a.m. - 12:15 p.m.
Room: Room B110/B111/B112

Session Chairs:

Arunima Sengupta  
European Commission, Belgium

Gard Ueland  
Kongsberg Seatex, Norway

8:35. Morphometrics for Early Warning, James L. Farrell, Vigil, Inc.

8:57. The SAR/Galileo Return Link Service in the Works, Xavier Maufroid, European Commission, Belgium; Jesús Cegarra, José Caro, Joaquín Estremera, Laura Garciaq, GMV, Spain; Chiara Scaleggi, Didier Delcuvelerie, CNES, France

9:20. Clock-Unrelated Features for GNSS Receiver Fingerprinting, Daniele Borio, Ciro Gioia, Gianmarco Baldini, European Commission Joint Research Centre, Italy

9:43. SBAS Service Based in IMO Res. A.1046 (27): EGNOS Maritime Performance, Pedro Pintor, Carlos de la Casa, European Satellite Services Provider (ESSP SAS), Spain; Manuel Lopez-Martinez, European GNSS Agency (GSA), Czech Republic; Roberto Roldan, ESSP SAS, Spain

10:40. A Practical Way Forward for Aviation Multi-Constellation Service Provision based on the ICAO GNSS Charter, Gerhard Berz, EUROCONTROL, Belgium; Federico Bergamasco, University of Luxemburg, Luxemburg

11:03. Spoofing of Electrical Power Grid: It’s Easier Than You Think, Iurie Ilie, Serge Malo, Skydel Solutions Inc., Canada; Romain Guilbault, Thomas Kirk, Opal-RT Inc., Canada

11:26. GNSS Data Provenance Traceability Research, Yi Qu, Haitao Wu, Ting Liu, Academy of Opto-Electronics, Chinese Academy of Sciences, China

11:48. Using a Wide Area Receiver Network to Support GBAS Ionospheric Monitoring, María Caamano, Daniel Gerbeth, Michael Felux, and Mihaela-Simona Circiu, German Aerospace Center, DLR, Germany

Alternate Presentations:

1. Development and Implications of the Singapore GBAS Ionospheric Threat Model (GITM), Tim Cashin, Bakry El-Arini, Vince Massimini, Rick Niles, Ali Odeh, and Guijin Zheng, The MITRE Corporation; Sam Pullen, Stanford University; Chew Guang Wei and Gao Shu, Civil Aviation Authority of Singapore

2. SAR/Galileo Initial Service: A European Contribution to International Search and Rescue Efforts, Xavier Maufroid, Antonio Rolla, Eric Chatre, European Commission, Belgium; Chiara Scaleggi, CNES, France; Igor Stojkovic, European Space Agency

12:15 p.m. - 1:30 p.m., ION GNSS+ Awards Luncheon, Oregon Ballroom
C5: GNSS+ Augmentations for High Performance and Safety Critical Applications

**Date:** Friday, September 29, 2017
**Time:** 8:30 a.m. - 12:15 p.m.
**Room:** Room B115/B116

**Session Chairs:**
Dr. Andrey Soloviev, QuNav
Dr. Zainab Syed, TDK, Canada

8:35. **SBAS DFMC Analysis with a Software Prototype**, Daniel Salos, Mikael Mabilleau, Egis Avia, France; Catalina Rodriguez, Norbert Suard, Hugues Secretan, François Dufour, CNES, France; Philippe Estival, DSNA, France

8:57. **High-Integrity and Low-Cost Local-Area Differential GNSS Prototype for UAV Applications**, Dongwoo Kim, Jinsil Lee, Minchan Kim and Jiyun Lee, Korea Advanced Institute of Science and Technology, South Korea; Sam Pullen, Stanford University

9:20. **Monitoring Space Weather with GNSS Networks: Expanding GNSS Networks into Northern Alaska and Northwestern Canada**, Anthea J. Coster, MIT Haystack Observatory; Susan Skone, University of Calgary, Canada; Donald Hampton, University of Alaska; Eric Donovan, University of Calgary, Canada

9:43. **Second Generation Real Time GEO-based SBAS-PPP Combined System for Australia and New Zealand**, Julián Barrios, Jesús David Calle, Enrique Carbonell, Jose María López, Guillermo Fernández, José Gabriel Pericacho, Victor Manuel Esteban, Daniel Martínez, Beatriz González, Miguel Ángel Fernández, Laura Martínez, Carlos Moriana, Daniel Pérez, Fernando Bravo, Miguel M. Romay, José Caro, Javier Ostolaza, Irma Rodríguez, María Dolores Lainez, GMV, Spain; Robert Jackson, Lockheed Martin; Patrick E. Reddan, Deane Bunce, Zeta Associates; Claudio Soddu, Inmarsat

10:40. **Impact of Ionospheric Anomalies on GBAS GAST D Service and Validation of Relevant ICAO SARPs Requirements**, Sam Pullen, Stanford University; Rick Cassell, Systems Enginuity, Inc.; Bruce Johnson, Mats Brenner, Doug Weed, and Lucas Cypriano, Honeywell; Morten Topland and Morten Stakkeland, Indra Navia, Norway; Boris Pervan, Illinois Institute of Technology; Matt Harris, Boeing; Susumu Saito, ENRI, Japan; Jiyun Lee, KAIST, South Korea; Barbara Clark and Shelly Beauchamp, Federal Aviation Administration; Joseph Dennis, Pragmatic, Inc.

11:03. **SBAS Authentication Proposals and Performance Assessment**, Andrea Dalla Chiara, Giacomo Da Broi, Oscar Pozzobon, Qascom, Italy; Ignacio Fernandez-Hernandez, European Commission, Belgium; Silvia Sturaro, Gianluca Caparra, Nicola Laurenti, University of Padova, Italy; Javier Fidalgo, Miguel Odriozola, GMV, Spain


11:48. **Innovation vs Residual KF Based GNSS/INS Autonomous Integrity Monitoring**, Omar Garcia Crespillo, Anja Grosch, Jan Skaloud, Michael Meurer, German Aerospace Center (DLR), Germany

**Alternate Presentations:**

1. **PPP+ - Extending PPP for High-availability and Low-cost in Real-time Applications**, Hongzhou Yang, Yang Gao, Profound Positioning Inc., Canada
2. **Precise Orbit Determination of Combined GNSS and LEO Constellations with Regional Ground Stations**, Bofeng Li, Liangwei Nie, College of Surveying and GeoInformatics, Tongji University, China; Haibo Ge, College of Surveying and GeoInformatics, Tongji University, China; GeoForschungsZentrum (GFZ), Germany; Maorong Ge, GFZ, Germany; Ling Yang, Haojun Li, College of Surveying and GeoInformatics, Tongji University, China
3. **Projected Performance of a Baseline High Integrity GNSS Railway Architecture under Nominal and Faulted Conditions**, Sherman Lo, Sam Pullen, Stanford University; Veronica Palma, Maurizio Salvitti, Cosimo Stallo, RadioLabs, Italy; Juan Blanch, and Per Enge, Stanford University
4. **Modelling the Range and Position Error after EGNOS Orbit and Clock Corrections**, Quentin Tessier, Christophe Macabiau, Carl Milner, ENAC, France; Laurent Azouali, AIRBUS Operations SAS, France; Francisco Amarillo Fernandez, ESA, The Netherlands
5. **FOSTER a GNSS Receiver Designed to Improve Resilience and Trust in Navigation: Concept, Results and Performances**, François
6. The Method of Receiver-Spoof Signal Mitigation of Wide-band BOC Signal, Tianyi Ma, Meng Zhou, Yonghui Zhu, Xiaowei Cui, Mingquan Lu, Tsinghua University, China

12:15 p.m. - 1:30 p.m., ION GNSS+ Awards Luncheon, Oregon Ballroom
D5: PANEL: The Future of GNSS in Civil Aviation

Date: Friday, September 29, 2017
Time: 8:30 a.m. - 12:15 p.m.
Room: Room A105/A106

Session Chairs:
Dr. Todd Walter
Stanford University

Laurent Azoulai
Airbus Operations S.A.S, France

Experts from academia, government and industry discuss the use of GNSS in the future of civil aviation. Subjects addressed include adoption of multiple GNSS constellations, impact of ARAIM, management of UAS traffic, GNSS threats, and GNSS spectrum.

1. Ms. Deborah Lawrence, Federal Aviation Administration
2. Mr. Laurent Azoulai, Airbus, France
3. Mr. Tim Murphy, Boeing
4. Mr. Francisco Salabert, EUROCONTROL, Belgium
5. Mr. Noppadol Pringvanich, IATA, Thailand

12:15 p.m. - 1:30 p.m., ION GNSS+ Awards Luncheon, Oregon Ballroom
8:35. Receiver-Level Robustness Concepts for EGNSS Timing Services, Martti Kirkko-Jaakkola, Sarang Thombre, Salomon Honkala, Stefan Söderholm, Sanna Kaasalainen, and Heidi Kuusniemi, Finnish Geospatial Research Institute, Finland; Heinz Zelle and Henk Veerman, Netherlands Aerospace Centre, The Netherlands; Anders Wallin, VTT MIKES Metrology, Finland; Kjell Arne Aarmo and Juan Pablo Boyero, European Commission, Belgium

8:57. Ionospheric Effects on High Gain Antenna GNSS Measurements – TEC Estimation and Correction, Steffen Thoelert, Ulrich Hörmann, German Aerospace Center (DLR), Germany; Felix Antreich, DLR, Germany & Federal University of Ceara (UFC), Brazil; Michael Meurer, DLR & RWTH Aachen University, Germany

9:20. Estimating Height and Thickness of an Ionospheric Irregularity Layer with a Closely-Spaced GNSS Receiver Array, Yang Su, Johns Hopkins University Applied Physics Laboratory; Kshitija Deshpande, Embry-Riddle Aeronautical University; Seebany Datta-Barua, Illinois Institute of Technology

9:43. Spaced Multi-GNSS Receiver Array as Ionosphere Radar for Irregularity Drift Velocity Estimation During High Latitude Ionospheric Scintillation, Jun Wang, Yu Morton, Colorado State University; Robert Robinson, The Catholic University of America


11:03. GNSS Inter-satellite Ranging for Atmospheric Monitoring, Gregor Möller, Fabian Hinterberger, Robert Weber, TU Wien, Austria; Philipp Berglez, TeleConsult Austria, Austria; Janina Boisits and Johannes Böhm, TU Wien, Austria; Michel Tossaint, ESA / ESTEC, Netherlands

11:26. Real-Time Detection of Tsunami Ionospheric Disturbances using the VARION Algorithm with Stand-Alone GNSS Receivers, Giorgio Savastano, University of Rome, La Sapienza, Italy and Jet Propulsion Laboratory (JPL), California Institute of Technology (Caltech); Attila Komjathy, Olga Verkhoglyadova, Yoaz Bar-Sever, Anthony J. Mannucci, JPL, Caltech; Yong Wei, Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration and University of Washington; Augusto Mazzoni and Mattia Crespi, University of Rome, La Sapienza, Italy

11:48. Coordination of GNSS Signals with Lidar for Reflectometry, Rooollah Parvizi, Erik Donarsi, Norikazu Honda, James Henry, Boris S. Pervan and Seebany Datta-Barua, Illinois Institute of Technology

Alternate Presentations:

1. Tomographic Reconstruction of Ionospheric Irregularities Using GPS Carrier Wave Phase Observation, Liang Zhang, Wuhan University, China, and The University of Calgary, Canada; Yang Gao, The University of Calgary, Calgary, Canada; Yibin Yao, Wuhan University, China

2. Ionosphere Monitoring and GNSS Correction by a Real-time Ionospheric Tomography System in Japan, Susumu Saito, Electronic Navigation Research Institute, National Institute of Marine, Port, and Aviation Technology, Japan; Mamoru Yamamoto, National Cheng Kung University, Taiwan; Akinori Saito, Kyoto University, Japan

3. Ocean-Reflected GNSS Signals Detection with Generalized Likelihood Ratio Test, Santiago Ozafraín, Instituto de Investigaciones en Electrónica, Control y Procesamiento de Señales (LEICI), CONICET-UNLP, Argentina; Pedro A. Roncagliolo, UIDET - Sistemas Electrónicos de Navegación y Telemetría (SENYT), UNLP, Argentina; Carlos H. Muravchik, Instituto de Investigaciones en Electrónica, Control y Procesamiento de Señales (LEICI), CONICET-UNLP, Argentina

4. GPS Data Analysis to Study Early Warnings Opportunities Applying Morphometrics-Based Methods for Earthquakes Early Warnings, S. Ugazio, F. van Graas, Ohio University
12:15 p.m. - 1:30 p.m., ION GNSS+ Awards Luncheon, Oregon Ballroom
F5: Atmospheric Science and Space Applications

Date: Friday, September 29, 2017
Time: 8:30 a.m. - 12:15 p.m.
Room: Room C123/C124

Session Chairs:

Dr. Seebany Datta-Barua
Illinois Institute of Technology

Dr. Susan Skone
University of Calgary, Canada

8:35. GNSS Enabling New Capabilities in Space on the TechDemoSat-1 Satellite, Martin Unwin, Philip Jales, Stuart Duncan, Andy Palfreyman, SSTL, UK; Christine Gommenginger, NOC; Philip Moore, Jing Guo, Newcastle University, UK; Josep Rosello, ESA

8:57. Ground-to-Air Tropospheric Mapping Function for Elevation Angles Below Three Degrees, Shrivathsan Narayanan, Okuary Osechas and Christoph Günther, German Aerospace Center (DLR), Germany

9:20. Modified Kriging Based Double-Difference Tropospheric Correction Interpolation Method for Compact Network RTK User, Donguk Kim, Junesol Song, Deoktwa Han, Sunkyoung Yu, and Changdon Kee, Seoul National University, South Korea; Seungwoo Seo and Junpyo Park, Agency for Defense Development, South Korea

9:43. A Machine Learning Approach to GNSS Scintillation Detection: Automatic Soft Inspection of the Events, A. Favenza, A. Farasin, Istituto Superiore Mario Boella, Italy; N. Linty, and F. Dovis, Politecnico di Torino, Italy


11:03. Characteristics of Ionospheric Scintillation Observed in Alaska and Hawaii, Xiaoqing Pi, Jet Propulsion Laboratory, California Institute of Technology


Alternate Presentations:

1. Analysis of Fog in South Korea Using the GPS Tropospheric Products, Hasu Yoon, Byung-Kyu Choi, Jungho Cho, Korea Astronomy and Space Science Institute, South Korea

2. Improved Ionospheric Correction using NTCM Aided by GPS Klobuchar Model for GNSS Applications, M. M. Hoque, N. Jakowski and J. Berdermann, German Aerospace Center (DLR), Institute of Communications and Navigation, Germany

3. Analysis of Mapping Function Impacts on Ionospheric Modeling and DCB Estimation, Yan Xiang; Yang Gao, University of Calgary, Canada

12:15 p.m. - 1:30 p.m., ION GNSS+ Awards Luncheon, Oregon Ballroom
A6: Autonomous Systems - Non-GNSS and Sensor Positioning

Date: Friday, September 29, 2017
Time: 1:45 p.m. - 4:50 p.m.
Room: Room B113/B114

Session Chairs:

Dr. Paul McBurney
GopherHush

Christian Gentner
German Aerospace Center (DLR), Germany

1:50. Inertial Attitude Determination Systems in Reduced Gravity and Dynamics Environment, A. Szumski, T. Pany, B. Eissfeller, Universität der Bundeswehr München, Institute of Space Technology and Applications, Germany

2:12. Carrier Phase Tracking of OFDM-Based DVB-T Signals for Precision Ranging, Chun Yang, Sigtem Technology; Liang Chen, Finnish Geospatial Research Institute, Finland; Olivier Julien, Ecole Nationale d’Aviation Civile, France; Andrey Soloviev, QuNav; Ruizhi Chen, Wuhan University, China

2:35. Positioning and Analytics from Consumer Mobile Devices in Retail Stores, Amr Shebl Ahmed, Sheng Mao, Jacques Georgy, Chris Goodall, Rahul Bakshi, Ardalan Heshmati, TDK, Canada

2:58. A Compact, Lightweight Sensor to Measure Bearing Angle to a Radio Transmitter, Liangchun Xu, Tufts University

3:20. Design and Implementation of a Wireless Time Synchronization based Positioning System, Sihao Zhao, Xiaowei Cui, Mengdi Jia, Shuang Xu, Mingquan Lu, Tsinghua University, China


4:04. Joint GPS Direct Positioning and Vision Estimation Using an Adaptive Filter, Shubhendra Vikram Singh Chauhan and Grace Xingxin Gao, University of Illinois at Urbana Champaign


Alternate Presentations:

1. Augmenting SLAM with an Audio-based GPS-like System for Indoor Positioning, Craig Babiarz and Grace Xingxin Gao, University of Illinois at Urbana-Champaign

2. Deeply/Ultra Tightly Coupled GNSS/INS Based on High Degree Cubature Kalman Filtering, Hamza Benzerrouk, Alexander Nebylov, Saint Petersburg State University of Aerospace Instrumentation, International Institute for Advanced Aerospace Technologies IIAAT, Russia

Date: Friday, September 29, 2017
Time: 1:45 p.m. - 4:50 p.m.
Room: Room B110/B111/B112

Session Chairs:

Karl Kovach
The Aerospace Corporation

Miguel Manteiga Bautista
European Space Agency, The Netherlands


2:35. Fountain Codes for GNSS, D. Calle, S. Cancela, A. Fernández, GMV, Spain; P. Walker, CGI; I. Fernández, EC; G. Seco-Granados, UAB, Spain

2:58. Implementation and Testing of OSNMA for Galileo, Carlo Sarto, Oscar Pozzobon, Samuele Fantinato, Stefano Montagner, QASCOM, Italy; Ignacio Fernández-Hernández, European Commission, Belgium; Javier Simon, European GNSS Agency, Czech Republic; Jesus David Calle, Simón Cancela Díaz, GMV, Spain; Paul Walker, Daniel Burkey, CGI, UK; Gonzalo Seco-Granados, UAB, Spain; Vincent Rijmen, Tomer Ashur, KU Leuven; Eckart Göhler, IFEN, Germany

3:20. Multicarrier Constant Envelope Composite Signal - A Solution to the Next Generation Satellite Navigation Signals, Zheng Yao, Junjie Ma, Jiayi Zhang, Mingquan Lu, Tsinghua University, China

3:42. An Optimal Joint Processing Method for BDS B1I and B1C Signals, Chuhan Wang, Xiaowei Cui, Tianyi Ma, Mingquan Lu, Tsinghua University, China


4:26. Feasibility Study of Using UAVs as GNSS Satellites, Thomas Pany, Thomas Kraus, Daniel Maier, Ronny Blum, Mathias Philips-Blum, Gerhard Kestel, Universität der Bundeswehr München, Institute of Space Technology and Applications, Germany

Alternate Presentations:

1. Joint Time-to-CED Reduction and Improvement of CED Robustness in the Galileo I/NAV Message, Birgit E. Schotsch, Marco Anghileri, Airbus Defence and Space GmbH, Germany; Thomas Burger, ESA, The Netherlands; Mahamoudou Ouedraogo, Airbus Defence and Space GmbH, Germany

2. Evaluation of New Message Structures for Navigation Message Authentication, E. Gkougkas, D. Dötterböck, T. Pany and B. Eissfeller, University Federal Armed Forces Munich, Germany

3. Analytic Efficiency Optimal Constant-Envelope Multiplexing Technique for GNSS Signals, Junjie Ma, Zheng Yao, Mingquan Lu, Tsinghua University, China

4. A GNSS Positioning Method without the Range Measurements, Xiaokun Zhang, Hong Yuan, Yangyang Tang, Academy of Opto-Electronics, Chinese Academy of Sciences, China

5. GPS IIR-M L1 Transmit Power Redistribution: Analysis of GNSS Receiver and High-Gain Antenna Data, Steffen Thoelert, German Aerospace Center (DLR), Institute for Communications and Navigation (IKN), Germany; André Hauschild, Peter Steigenberger, DLR/GSOC, Germany; Richard Langley, University of New Brunswick, Canada
C6: Precise Point Positioning (PPP) and L-band Services

Date: Friday, September 29, 2017
Time: 1:45 p.m. - 4:50 p.m.
Room: Room B115/B116

Session Chairs:

Dr. Jihye Park
Oregon State University

Dr. Di Qiu
Polaris Wireless, Inc.

1:50. Performance Analysis of Atmospheric Constrained Uncombined Multi-GNSS PPP, John Aggrey, York University, Garrett Seepersad and Sunil Bisnath, York University, Canada

2:12. The Approach of BDS Real-time and Fast Point Positioning by Augmentation Information, Rui Tu, National Time Service Center (NTSC) & Key Lab of PNT Technology, Chinese Academy of Sciences, CAS and University of Chinese Academy of Sciences, China; Rui Zhang, NTSC & Key Lab of PNT Technology, CAS, China; Pengfei Zhang, University of Chinese Academy of Sciences, China; Jinhai Liu, NTSC/ University of Chinese Academy of Sciences, China; Xiaochun Lu, NTSC, University of Chinese Academy of Sciences and Key Lab of PNT Technology, China

2:35. Do we need ambiguity resolution in multi-GNSS PPP for accuracy or integrity?, G. Seepersad, J. Aggrey and S. Bisnath, York University, Canada

2:58. Quality Analysis for Satellite Bias Estimation and GNSS PPP Ambiguity Resolution, Shuyang Cheng, School of Civil and Environmental Engineering, The University of New South Wales, Australia


3:42. PPP-RTK by Means of S-system Theory: Revisiting the Undifferenced, Uncombined Network Model and a Case Study, Baocheng Zhang, Yunbin Yuan, Jiuping Zha, Institute of Geodesy and Geophysics, Chinese Academy of Sciences, China

4:04. VPPP Algorithms with Multiple Antennas and Highly Accurate Attitude Estimation by the Ambiguity Resolution Methods, Goshi Okuda, Atsushi Mouri, Hirokazu Hasegawa, Yuma Arakawa, Yukihiro Kubo and Sueo Sugimoto, Ritsumeikan University, Japan

4:26. GISMO: A Smart Sensor To Mitigate and Monitor Ionospheric Effects, Luca Siniscalco, Niccolò Pastori, Alberto Zin, Andrea Emmanuele, Alessandro Ferrario, Chiara Manno, Thales Alenia Space Italia S.p.A, Italy; Biagio Forte, University of Bath, UK
D6: GNSS Interference Detection and Localization Algorithms

Date: Friday, September 29, 2017  
Time: 1:45 p.m. - 4:50 p.m.  
Room: Room B117/B118/B119

Session Chairs:

Dr. Patrick Henkel  
Technical University of Munich, Germany

Dr. David Bevly  
Auburn University


2:12. Frequency Tracking and Mitigation Method of Multiple GNSS Interferences Using an Adaptive Linear Kalman Notch Filter, Sun Young Kim, Chang Ho Kang, and Chan Gook Park, Seoul National University, Republic of Korea

2:35. GPS Spoofer Localization Using Multi-Receiver Direct Time Estimation for PMUs, Sriramya Bhamidipati and Grace Xingxin Gao, University of Illinois at Urbana-Champaign

2:58. Attitude Independent Direction of Arrival-based Detection of Spatially Spread Repeaters and Spoofers, Manuel Appel, Omar García-Crespillo, Andreas Illiopolous, Friederike Fohlmeister, German Aerospace Center (DLR), Germany; Michael Meurer, DLR and RWTH Aachen University, Germany


3:42. Simultaneous Localization of Multiple GNSS Interference Sources via Neural Networks, David Besson, GPS Directorate

4:04. A Method for GNSS Real-time Multipath Mitigation Based on CEEMD-HT Algorithm, Dengao Li, Ya Liu and Jumin Zhao, Taiyuan University of Technology, China

4:26. Using Range Information to Detect Spoofing in Platoons of Vehicles, Peter F. Swaszek, University of Rhode Island; Richard J. Hartnett, U.S. Coast Guard Academy; Kelly C. Seals, U.S. Coast Guard Academy

Alternate Presentations:

1. A Beamforming Algorithm Based on the Uncertainty Set of the Space-Frequency Vector, Chao Ren, Yongxiang Zheng, Yi Qian and Gang Hu, Unicore Communication Inc., China

2. RAIM and SBAS based Detection of GNSS Spoofing by Timing and Content Consistency Rules, Guoyu Fu, Tyler Holmes, Colton Riedel and Jyh-Charn Liu, Texas A&M University

3. Assessment of the De-sense Criteria for Measuring GNSS Robustness to Interference, Bryan Townsend, Marino Phocas, Rui Zuo, Justin Satchwell, Daniel Schwartz, and Esther Anyaegbui, Intel Mobile Communications

4. The Effect of Multipath and Cross-correlation Items on GNSS Radio Frequency Compatibility Assessment, Xufang Huang, Binxue Chen, Xuyang Wang, Tangchao Li, Guangxi University, China
E6: Next Generation RF, Antenna and Digital Signal Processing Receiver Techniques

Date: Friday, September 29, 2017
Time: 1:45 p.m. - 4:50 p.m.
Room: Room A107/A108/A109

Session Chairs:

Dr. Andriy Konovaltsev
German Aerospace Center (DLR), Germany

Dr. Sherman Lo
Stanford University

1:50. A Single Hemispiral Antenna for GNSS Interference Mitigation and Direction Estimation, Cara Yang Kataria, Jennifer Truman Bernhard, and Grace Xingxin Gao, The University of Illinois at Urbana-Champaign


2:35. Maximum Theoretical Interference Mitigation Capability of a GNSS Receiver as Limited by the GNSS Frontend, Thomas Kraus, Thomas Pany, Bernd Eissfeller, Universität der Bundeswehr München, Germany

2:58. Self-contained Antenna Crosstalk and Phase Offset Calibration by Jointly Solving the Attitude Estimation and Calibration Problem, S. Zorn, M. Niestroj, M. Brachvogel, RWTH Aachen University, Germany; S. Caizzone, German Aerospace Center (DLR), Germany; M. Meurer, RWTH Aachen University & German Aerospace Center (DLR), Germany


3:42. Codeless Processing of BOC(10,5) Signals, Cillian O’Driscoll, Independent Consultant, Ireland

4:04. Carrier Tracking using Extended Kalman Filters for GNSS Synthetic Aperture Processing with a Rotating Antenna, Miguel Angel Ribot, Joaquín Cabeza, École Polytechnique Fédérale Lausanne (EPFL), Switzerland; Pau Closas, Northeastern University, USA; Cyril Botteron, École Polytechnique Fédérale Lausanne (EPFL), Switzerland; Ferran Valdés, Bartomeu Alorda, Universitat Illes Balears, Spain; Pierre-André Farine, École Polytechnique Fédérale Lausanne (EPFL), Switzerland

4:26. An Anti-jamming and Anti-spoofing Digital Beamforming Platform for the GNSS-based ERTMS Train Control System, Alessandro Neri, Cosimo Stallo, Andrea Coluccia, Veronica Palma, Pietro Salvatori, Alessia Vennarini, Radiolabs, Italy; Oscar Pozzobon, Giovanni Gamba, Samuele Fantinato, Qascom, Italy; Mirko Barbuto, Alessio Monti, University “Nicolò Cusano, Italy; Filiberto Bilotti, Alessandro Toscano, ROMA TRE University; Francesco Rispoli, Ansaldost, Italy; Massimiliano Ciaffi, RFI, Italy

Alternate Presentations:

1. Towards a Self Contained Determination of Multi Antenna Radio Patterns, M. Niestroj, M. Brachvogel, S. Zorn, RWTH Aachen University, Germany; M. Meurer, RWTH Aachen University and German Aerospace Center (DLR), Germany

2. Design and Implementation of Thirty-channel Dual Frequency (GPS-L1, Beidou B1) Real-time SDR on a Low Cost Embedded Platform, Muhammad Ali Akhtar, Muhammad Hammad Ahmed, Rana Muhammad Bilal, Omer Misbah Shami, Osman Hasan, National University of Sciences and Technology, Pakistan

3. GNSS System Design and Evaluation for IoT Applications, Toru Katsumoto, Katsumi Takaoka, Kazukuni Takahashi, IoT Solutions Business Division, Sony Semiconductor Solutions Corporation, Japan; Mohamed Youssef, IoT Solutions Business Division, Sony North America

4. The Possibility of Using Power Inversion Adaptive Arrays in High-Precision GNSS Receivers, Hailong Xu, Xiaowei Cui, Wenyi Li, Mingquan Lu, Tsinghua University, China
F6: GNSS Augmentation Systems and Integrity

**Date:** Friday, September 29, 2017  
**Time:** 1:45 p.m. - 4:50 p.m.  
**Room:** Room C123/C124

**Session Chairs:**
- Takashi Iwamoto  
  Mitsubishi Electric Corporation, Japan  
- Dr. Juan Blanch  
  Stanford University

1:50. Kinematic PPP Ambiguity Resolution with Aid of Map Matching, Fei Liu, University of Calgary, Canada

2:12. A Novel Ionosphere Correction and Monitoring Method for Korean Navigation Satellite System, Jungmin Jo and Moonbeom Heo, Korea Aerospace Research Institute, South Korea

2:35. Coasting Through Wideband Interference using a Robust Tracking Architecture and Carrier-Phase Measurements, Stefan Stevanovic and Boris Pervan, Illinois Institute of Technology


3:20. Satellite Selection in the Operational GBAS Context, Daniel Gerbeth, Maria Caamano, Mihaela-Simona Ciriciu, Michael Felux, German Aerospace Center (DLR), Germany

3:42. GDOP Bounds for GNSS Augmented with 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

4:04. A MATLAB Toolset to Determine Strict Gaussian Bounding Distributions of a Finite Sample Distribution, Juan Blanch, Todd Walter, Per Enge, Stanford University

4:26. Multi-Constellation T-RAIM: An Experimental Evaluation, Ciro Gioia and Daniele Borio, European Commission, Joint Research Centre (JRC), Italy
THANK YOU TO OUR EVENT SUPPORTERS:

- Mobile Application
- Self-Service Business Center
- Women in PNT

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EXHIBIT HALL FLOOR PLAN

EXHIBIT HALL HOURS

Wednesday:
10:00 a.m. – 6:00 p.m. Hall Open
6:00 p.m. – 8:00 p.m. Reception

Thursday:
9:00 a.m. – 6:00 p.m. Hall Open

Exhibitors - to reserve your exhibit space, please contact:

Megan Andrews,
ION National Office
Phone: 1-703-366-2723
Fax: 1-703-366-2724
E-mail: mandrews@ion.org

List of exhibitors as of April 12, 2017

Acutronic
CAST Navigation
ComNav Technology, Ltd.
DataGrid/NavXperience GmbH
European Commission
Fraunhofer IIS
German Aerospace Center
GPS Networking
GPS World
Harris Corporation
Ideal Aerosmith, Inc.
IFEN GmbH
Inside GNSS
Jet Propulsion Laboratory
L-3 Interstate Electronics Corporation
Labsat By Racelogic
Lockheed Martin
Microsemi Frequency and Time Corporation
NavtechGPS
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Septentrio
Silicon Sensing Systems Limited
Skydel Solutions
Spectracom
Spirent Communications
Spirent Federal
SYNTONY SAS
Systron Donner Inertial
Technology Advancement Group
The Institute of Navigation
VectorNav Technologies
Wednesday, September 27

Attendee Luncheon
12:15 p.m. – 1:15 p.m., Exhibit Hall

This event is included with all full conference, student, exhibit only, and Wednesday single day registrations. See registration desk onsite to purchase tickets for guests.

Women in PNT: Meeting with Leaders and Legends
12:15 p.m. – 1:45 p.m.
Oregon Ballroom 201

Now in its third year, the Women in PNT event provides an outstanding opportunity for women who are in the early stages of their careers to meet positioning, navigation and timing leaders in a stimulating and supportive environment.

The program is designed to provide participants a brief, ice-breaking, face-to-face meeting with GNSS legends and leaders from industry, academia and government representing a wide variety of interests and specialties - the professionals who have literally created and shaped today’s positioning, navigation and timing platforms.

The event will be organized in a round-robin interview style, where you will have approximately two minutes to talk one-on-one with one of the invited leaders, and then will move to another leader, then another. These brief meetings will make it easier for you to engage later with these and other professionals during the remainder of the ION GNSS+ meeting and beyond.

You are encouraged to come to this event prepared with 1) a short statement about yourself - who you are, your goals and experiences, etc., 2) prepared questions and 3) printed contact/business cards. Additionally, think about what you want from these meetings. This Women in PNT event promises to be your most important networking opportunity of the year. All the big names, all in one place, waiting to meet and engage with you.

For advance information and biographies on GNSS legends and leaders that will be participating in this year’s event, please see https://www.ion.org/gnss/special-events.cfm

Following the formal exercise, an informal networking lunch will be provided to all event participants. Please arrive at the event promptly as the event’s design will make it difficult to join late.

Sponsored by:

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Wednesday, September 27

Exhibitor Hosted Reception
6:00 p.m. – 8:00 p.m., Exhibit Hall

Join this year’s exhibitors as they host a social evening of information and cuisine. All exhibit booths will be open. Take this opportunity to review developments in GNSS technology, talk shop, get the specifics directly from the vendors, and learn about what has been happening in the GNSS marketplace during the past year. This event is included with any type of registration. Spouses and traveling companions 21 and older are welcome.

Thursday, September 28

Attendee Luncheon
12:15 p.m. – 1:15 p.m., Exhibit Hall

This event is included with all full conference, student, exhibit only and Thursday single day registrations. See registration desk onsite to purchase tickets for guests.

Friday, September 29

Johannes Kepler and Bradford W. Parkinson Awards Luncheon
12:15 p.m. – 1:30 p.m., Oregon Convention Center

The purpose of the Kepler Award is to honor an individual for sustained and significant contributions to the development of satellite navigation.

The Bradford Parkinson Award, which honors Dr. Parkinson for his leadership in establishing both the U.S. Global Positioning Systems and the Satellite Division of The Institute of Navigation, is given to an outstanding graduate student in the field of Global Navigation Satellite Systems. The deadline for submitting nominations for both awards is June 30. See www.ion.org/awards for application requirements.

This event is included with a full, or Friday single day, conference registration. Tickets for exhibitors, students and/or guests may be purchased during registration or by visiting the ION GNSS+ registration desk onsite.

Previous Kepler Award Winners at ION GNSS+ 2016 (left to right): Dr. Pratap Misra, Dr. Richard Langley, Dr. Chris Hegarty, Dr. AJ Van Dierendonck, Dr. Per Enge, Dr. Gary McGraw, Mr. Patrick Fenton, Dr. Dorota Grejner-Brzezinska, Dr. Frank van Diggelen, Dr. John Betz, Mr. Tom Stansell, Mr. Karl Kovach, Mr. Phillip Ward, and Dr. Todd Walter.
Climate
Portland sees an average daytime September temperature of 76 Fahrenheit/24 Celsius and 53 Fahrenheit/12 Celsius in the evenings.

Conference Location and Parking
The conference will be held at the Oregon Convention Center, located at 777 NE Martin Luther King Jr Blvd, Portland, OR 97232. The building’s underground garage provides plentiful onsite parking. Enter the garage through either the Northeast First Avenue (P1) or Lloyd Boulevard (P2) entrance. The maximum daily rate to park is $10. Overnight parking is prohibited.

Local Transportation
MAX Light Rail: The Metropolitan Area Express (MAX) Light Rail runs about every 15 minutes daily. There are stations located at Portland International Airport, the Oregon Convention Center, and 2 blocks from both the Hilton Portland and the Quality Inn. The current adult fare is $2.50 for 2 hours, or $5 for a one-day pass. Ticket machines are located at each MAX station. Free passes good for use September 25-29 are available to ION GNSS+ attendees, and can be picked up at the ION GNSS+ registration desk when you pick up your conference badge. These transit passes are valid on buses, MAX light rail and streetcars in the city of Portland. For information on routes, schedules, how to ride MAX light rail or instructions in other languages, visit www.trimet.org

Portland Streetcar: The Portland Streetcar offers convenient and affordable transportation throughout greater Portland, including the Pearl District, Old Town, Chinatown, the Lloyd District, Downtown, and South Portland.

Taxi Service: Several taxi companies operate in and around Portland. Estimated taxi fare from Portland International Airport to the three conference hotels is $36 plus tax and tip.
For more ION GNSS+ travel information, visit www.ion.org/gnss/travel.cfm

Session Papers Online
Registered attendees may download copies of conference presentations and papers online for free by logging in to the ION website at www.ion.org/gnss. 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.

Conference Proceedings
Official conference proceedings are scheduled for distribution in November to all eligible conference participants.

Customize Your Conference Schedule
Once you are registered for the conference, visit the ION website to build a customized schedule of presentations you wish to attend. Log in to the ION GNSS+ website at www.ion.org/gnss to create your schedule.

Other Services
A Business Center will be provided at the Convention Center to provide access to basic business services including copying and printer capabilities. A baggage coat check will be offered in the registration area on Friday.

Photographic/Video Recording Policy
Your presence at ION GNSS+ constitutes your agreement to be photographed, filmed, videotaped or otherwise recorded by conference management, or its agents, and your agreement that your image or voice may be distributed in print or electronic communications media without any compensation being paid to you.

Video recording by participants is not allowed without permission of ION during any portion of the conference. Speakers may record their own presentation to provide to attendees at their discretion.

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Travelers from ALL Visa Waiver Program countries must present either a machine-readable passport or a U.S. Visa. To learn more about the Visa Waiver Program and Machine Readable Passports see http://travel.state.gov/visa.

Non-Visa Waiver Countries:
We recommend that you apply for your Visa at least three months in advance. Currently there is a mandatory security check period of 30 days for people whose passports are issued from several countries. U.S. consular offices now interview most applicants as part of the application process. Please ensure you arrive at the embassy with all required documentation at the time of your interview. Note that the Institute does not intervene in U.S. State Department’s issuance of Visas.

Conference attendees requesting a visa letter to attend a conference must:
1. Submit the visa letter request form found at http://www.ion.org/gnss
2. Register and pay all conference registration fees BEFORE a letter of invitation will be sent

Exemptions to this policy apply only to those authors whose papers have been accepted for presentation, company personnel working in the exhibit area or trade associated press.
If the attendee is unable to secure a Visa, he/she will need to apply for a refund according to the printed refund rules of the event.
Book your hotel with ION and save $200 in registration fees! Make your reservations by August 25 to qualify for special rates!

How to Book:
• Online: Go to www.ion.org/gnss/hotel.cfm
• Phone: 1-503-275-9295 or Toll Free 1-877-678-5263 x2
• Email: housing@travelportland.com

Headquarters Hotel:
Hilton Portland and Executive Tower
921 SW Sixth St. Portland, OR 97204
(2 blocks and a 9-minute MAX ride from the Convention Center)
Rate: $179 single/double, limited government rate availability*
In-Room Internet: Free for ION GNSS+ attendees
Parking: Valet - $39 per day

August 25 is the last day that this rate will be available, but rooms at the discounted rates may fill up before then. Make your reservations now to avoid missing out on discounted room rates!

Additional Hotel Options:
Quality Inn Downtown Convention Center
431 NE Multnomah St. Portland, OR 97232
(2.5 blocks from the Convention Center)
Rate: $109 single/double, limited government rate availability*
In-Room Internet: Free ION GNSS+ attendees
Parking: Complimentary
Includes a complimentary breakfast.

Courtyard by Marriot Portland Downtown
435 NE Wasco St. Portland, OR 97232
(3 blocks from the Convention Center)
Rate: $168 single/double, limited government rate availability*
In-Room Internet: Free for ION GNSS+ attendees
Parking: Valet - $24 per day

*About Government Rates:
Government rates are only for U.S. government personnel paying for a room with a U.S. government issued credit card. Failure to pay with a U.S. government issued credit card will result in your reservation being honored at the group rate. Government contractors not traveling with government travel orders are not eligible for this rate. MITRE/Aerospace personnel do qualify.

How to Register
1. Make your hotel reservation at one of the three official conference hotels. Make your reservation at www.ion.org/gnss/hotel.cfm, by calling 1-503-275-9295, or by email at housing@travelportland.com
2. Record your hotel confirmation number. All ION GNSS+ attendees staying at one of the three official conference hotels listed to the left) are eligible to receive a $200 discount on their conference registration fees. Attendees must provide their valid hotel confirmation number at the start of the registration process to claim this discount. Hotel discounts will not be provided retroactively.
3. Register for ION GNSS+ at www.ion.org. Rates for attendees registering by August 25 and staying in an official conference hotel start at:
   • Full Technical Registration: $980.00
   • Single Day: $460.00
   • Student: $400.00
   • Tutorials (per course): $400
4. Complete the online registration process. Be sure to input your hotel confirmation number during the registration process to claim your discount.
5. Check in onsite at ION GNSS+ 2017

A PDF registration form is available online at: www.ion.org/gnss/registration.cfm

See you in Portland!