Joint Navigation Conference 2024

June 3-6, 2024
Northern Kentucky Convention Center
Greater Cincinnati Area

DOD DTS Conference (ID: N20150610734)

ADVANCE PROGRAM
Robust, Resilient, Assured PNT for Warfighters and Homeland Defense
## Technical Program Overview

### TRACK A: Space

**MONDAY, JUNE 3: CUI US-ONLY TUTORIALS AND SESSIONS**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>8:30 a.m. - 10:00 a.m.</td>
<td>A1: Quantum PNT (Drs. Maxwell Greigo and Bonnie Marlow)</td>
</tr>
<tr>
<td>10:45 a.m. - 10:45 a.m.</td>
<td>Break in Meeting Room Foyer (Third Floor)</td>
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### TRACK B: Complementary PNT

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<tbody>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>A2: Cooperative Space-Based Sources: Experimentation</td>
</tr>
<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch Served in Event Hall 1 (First Floor)</td>
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### TRACK C: Military

<table>
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<tbody>
<tr>
<td>8:30 a.m. - 10:00 a.m.</td>
<td>B1: Signals of Opportunity (Dr. Frank van Gaas)</td>
</tr>
<tr>
<td>10:45 a.m. - 10:45 a.m.</td>
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### TRACK D: Situational Awareness/Degraded Operations

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<tbody>
<tr>
<td>8:30 a.m. - 10:00 a.m.</td>
<td>C1: Approaches for Resilient &amp; Robust Positioning, Navigation, and Timing (PNT) (Logan Scott)</td>
</tr>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>D1: Machine Learning 101 and PNT (Brian Zufelt, Renee Yazdi, and Clarizza Morales)</td>
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### TRACK E: GPS/Inertial

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<tbody>
<tr>
<td>8:30 a.m. - 10:00 a.m.</td>
<td>E1: GPS/GNSS 101 (Dr. John Raquet)</td>
</tr>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>E2: Software Defined Receivers (SDRs) for PNT</td>
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### TRACK F: Magnetic Navigation (MagNav)

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<tbody>
<tr>
<td>8:30 a.m. - 10:00 a.m.</td>
<td>F1: Magnetic Navigation (MagNav) (Dr. Aaron Canciani)</td>
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<tbody>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>B2: Novel Clock Technologies and Timing Applications</td>
</tr>
<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch Served in Event Hall 1 (First Floor)</td>
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### TRACK B: Complementary PNT

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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>1:45 p.m. - 3:15 p.m.</td>
<td>B3: Complementary PNT: Celestial</td>
</tr>
<tr>
<td>3:15 p.m. - 4:00 p.m.</td>
<td>Break in Meeting Room Foyer (Third Floor), Sponsored By GPS Source</td>
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<tbody>
<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>C2: GPS in Military Applications/NAVWAR</td>
</tr>
<tr>
<td>5:30 p.m. - 7:00 p.m.</td>
<td>C4: Military PNT User Equipment: MGUE</td>
</tr>
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### TRACK D: Situational Awareness/Degraded Operations

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<tbody>
<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>D2: PNT Situational Awareness: Arrays Research</td>
</tr>
<tr>
<td>5:30 p.m. - 7:00 p.m.</td>
<td>D3: PNT Situational Awareness: Arrays Testing</td>
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### TRACK E: GPS/Inertial

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<tbody>
<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>E2: Software Defined Receivers (SDRs) for PNT</td>
</tr>
<tr>
<td>5:30 p.m. - 7:00 p.m.</td>
<td>E3: Inertial Navigation Technologies 1</td>
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<tbody>
<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>F2: M&amp;S: Hardware in the Loop (HWIL) and Digital</td>
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<tr>
<td>1:45 p.m. - 3:15 p.m.</td>
<td>A7: Quantum PNT (Drs. Maxwell Greigo and Bonnie Marlow)</td>
</tr>
<tr>
<td>3:15 p.m. - 4:00 p.m.</td>
<td>Break in Exhibition Hall (First Floor), Sponsored by EMCORE</td>
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### TRACK B: Complementary PNT

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<tbody>
<tr>
<td>3:15 p.m. - 4:00 p.m.</td>
<td>B4: Complementary PNT: RF Aided (Non-GPS)</td>
</tr>
<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>C4: Military PNT User Equipment: Other</td>
</tr>
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<tbody>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>C6: PANEL: GNSS and NAVWAR</td>
</tr>
<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch Served in Event Hall 1 (First Floor)</td>
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<tbody>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>D5: PNT Situational Awareness: Algorithms</td>
</tr>
<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch Served in Event Hall 1 (First Floor)</td>
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<tbody>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>E5: Integrity and Assurance</td>
</tr>
<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch Served in Event Hall 1 (First Floor)</td>
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<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>F4: PANEL: Field Testing of PNT Technologies</td>
</tr>
<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch Served in Event Hall 1 (First Floor)</td>
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<tbody>
<tr>
<td>8:30 a.m. - 10:00 a.m.</td>
<td>A5: Receivers for New Space-Based Sources</td>
</tr>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>B6: Complementary PNT: Vision Aided/Optical Air + Unique</td>
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<tbody>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>C7: Multi-GNSS Receivers for Military Applications</td>
</tr>
<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch Served in Event Hall 1 (First Floor)</td>
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<tbody>
<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>C8: Anti-Jam and Anti-Spoofing Technologies: Receiver-Based</td>
</tr>
<tr>
<td>5:30 p.m. - 7:00 p.m.</td>
<td>C9: Anti-Jam and Anti-Spoofing Technologies: GPS</td>
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<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>D8: AI/Machine Learning: MagNav</td>
</tr>
<tr>
<td>5:30 p.m. - 7:00 p.m.</td>
<td>D9: Navigating in Challenged Environments 1</td>
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### TRACK E: GPS/Inertial

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<tbody>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>E6: GPS Modernization, Space-Based PNT Services, and Constellation Status</td>
</tr>
<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch Served in Event Hall 1 (First Floor)</td>
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<tbody>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>F7: Operational Systems: Live Demonstrations 1</td>
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<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch Served in Event Hall 1 (First Floor)</td>
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<tr>
<td>8:30 a.m. - 10:00 a.m.</td>
<td>A10: Applications of Time Transfer and Dissemination 2</td>
</tr>
<tr>
<td>11:00 a.m. - 12:30 p.m.</td>
<td>D10: Navigating in Challenged Environments 2</td>
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<tr>
<td>8:30 a.m. - 10:00 a.m.</td>
<td>B10: MagNav Calibration and GravNav</td>
</tr>
<tr>
<td>11:00 a.m. - 12:30 p.m.</td>
<td>C10: Anti-Jam and Anti-Spoofing Technologies: GNSS</td>
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<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>D11: PNT Open Systems Architecture 2</td>
</tr>
<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch at National Museum of the United States Air Force</td>
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<tbody>
<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>E10: PNT Open Systems Architecture 3</td>
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<tr>
<td>12:15 p.m. - 1:15 p.m.</td>
<td>Attendee Lunch at National Museum of the United States Air Force</td>
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<tr>
<td>10:45 a.m. - 12:15 p.m.</td>
<td>F10: Operational Systems: Live Demonstrations 2</td>
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<td>Attendee Lunch at National Museum of the United States Air Force</td>
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**A1: Quantum PNT**  
**Date:** Monday, June 3, 2024  
**Time:** 8:30 a.m. - 10:00 a.m.  
**Location:** Ballroom D

Amid the Department of Defense’s concerted efforts to create position, navigation, and timing (PNT) that are complementary to GPS, quantum sensors and timing devices are entering the commercial world and being developed for specific military applications and they are rapidly rising in technological readiness. In this context, it is important to understand how the further development of these technologies will lead to improvements in PNT. In this tutorial, we will compare today’s quantum sensors and complementary PNT systems to their classical counterparts, compare different complementary PNT techniques, and provide a broad overview of where quantum sensors are likely, or unlikely, to make an impact on complementary PNT.

**Dr. Maxwell Gregoire** is a physicist at the Air Force Research Laboratory, Space Vehicles Directorate. For the last five years, Maxwell has led an in-house research group and managed acquisition programs developing high-precision inertial sensors using atom interferometry and levitated optomechanics for air and space applications. Maxwell earned his PhD in physics at the University of Arizona where he used atom interferometry to make high-accuracy measurements of alkali atom properties. He earned is BS in Physics and Mathematics at the University of Nebraska, where he conducted theoretical and experimental research studying electron quantum optics and analyzing Large Hadron Collider data.

**Dr. Bonnie Marlow** is a physicist specializing in quantum sensors and nonlinear optics. Her work is centered around enabling risk reduction for the development and deployment of quantum technologies, with a focus on atomic sensors. Currently, Bonnie is the leader of the Quantum Sensors Group at MITRE, where she is responsible for technical and strategic leadership in quantum sensing across multiple work programs. Bonnie earned an AB degree in Physics from Bryn Mawr College and AM and PhD degrees in Physics from Duke University. Her doctoral research focused on experimental and theoretical studies of nonlinear optical effects in ultracold atoms. She was also a postdoctoral researcher at the Joint Quantum Institute, where her research focused on non-classical states of light for precision metrology.
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**B1: Signals of Opportunity**

**Date:** Monday, June 3, 2024  
**Time:** 8:30 a.m. - 10:00 a.m.  
**Location:** Ballroom C

This course covers space-based radio frequency (RF) signals that were not designed or intended to be used for PNT. Principles of operation with Signals of Opportunity (SoOP) will be presented along with benefits and drawbacks of the incorporation of SoOP into a PNT solution. Position and timing solutions will be reviewed for stationary and dynamic users, including measurement types and quality, dominant error sources, geometry considerations, and expected PNT performance.

**Dr. Frank van Graas** is a Research Professor of Electrical Engineering in the Department of Electrical and Computer Engineering at the Air Force Institute of Technology (AFIT). He performs research with the Autonomy & Navigation Technology (ANT) Center in the areas of Global Navigation Satellite Systems, signal processing, and integrated navigation systems. Before joining AFIT in 2022, he served on the faculty of Ohio University since 1988. He authored or co-authored over 200 publications and two patents. He is a Fellow, past president and current treasurer of the Institute of Navigation.
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**C1: Approaches for Resilient & Robust Positioning, Navigation, and Timing (PNT)**

**Date:** Monday, June 3, 2024  
**Time:** 8:30 a.m. - 10:00 a.m.  
**Location:** Ballroom B

Diverse elements of international infrastructure are critically reliant on GNSS for precise location and time, often in ways that are not obvious. This tutorial provides a high-level perspective on the effects of interference on GNSS receivers and offers some possible threat mitigation approaches and policy recommendations.

The tutorial starts with a discussion of potential GNSS threats and vulnerabilities. Then, after a quick review of how receivers determine position, the focus is on the effects of various interference types on select signals. The effects of ground mobile propagation in limiting effective jammer range are examined. Mitigations such as adaptive arrays, and IMU aiding are discussed.

Civil jamming examples and incidents are covered along with methods to detect, identify, and militate against their effects. In particular, the importance of maintaining situational awareness for establishing environmental context is examined. Techniques for detecting civil spoofing and authenticating signals will be discussed.

**Logan Scott** has over 40 years of military and civil GPS systems engineering experience. He is a consultant specializing in radio frequency signal processing and waveform design. At Texas Instruments, he pioneered approaches for building high-performance, jamming-resistant digital receivers and adaptive arrays. In 1985, his team built the first all-digital GPS receiver. At Omnipoint (now T-Mobile), he developed spectrum sharing techniques that led to a Pioneer’s preference award from the FCC. Logan has been an active advocate for improved civil GPS location assurance for over 25 years and was the first to describe how civil navigation signals could be authenticated using delayed key concepts central to the Chimera and ACAS signals. For the past seven years he has been developing advanced signal concepts for NTS-3, AFRL, and the University of Colorado. He has also been active in developing LEO system architectures. Logan is a Fellow of the Institute of Navigation and a Senior Member of IEEE. In 2018 he received the GPS World Signals award. He is the author of Interference: Origins, Effects, and Mitigation in PNT21 and in 2022 was awarded the Capt. P.V.H. Weems award for continuing contributions to the art and science of navigation. Logan holds 46 US patents and is a member of the President’s National PNT Advisory Board.
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D1: Machine Learning 101 and PNT

Date: Monday, June 3, 2024
Time: 8:30 a.m. - 10:00 a.m.
Location: 1-3

This course introduces the fundamentals of machine learning (ML) and how it applies to position, navigation, and timing (PNT). Basic machine learning concepts like types of ML, importance and collection of data sets, deployment strategies, and the development toolchain will be covered. Some of the common pitfalls in ML developments will be highlighted, along with strategies for avoiding falling victim to the pitfalls. Through example, the ML concepts that are outlined will be employed to demonstrate how ML can be used to speed and facilitate PNT OODA loop closure. The PNT OODA loop will be discussed in the context of the system construct to include architectural elements and concepts of operation. Questions of how to collect, when to collect, and where to send the data will be explored, as well as how to respond and automated response options. ML unique requirement considerations and specifications will be outlined, as well as ongoing challenges. Foundational tools developed for addressing the unique challenges of ML applied to PNT will be introduced. Attendees will have the opportunity to experiment with the tools.

This course employs a package of readily available ML tools that are either created or assembled for government use. These tools include a data collection system, a set of reference ML algorithms as a good starting point in that they have a good performance history in a contested environment (affectionately called the model zoo), a ML development and test environment that employs standardized and compatible toolsets, and a set of vetted and conditioned data sets; everything that a ML developer or evaluator needs to get started on applying ML solutions to PNT in a contested environment.

Prerequisites: Basic understanding of optimization and the Python programming language are useful but not required for this course. Those that want to follow-along can bring a laptop, but it is optional.

Brian Zufelt serves as the deputy director of Cosmiac from the University of New Mexico's School of Engineering. His current work with the Air Force Research Lab focuses on using machine learning to detect, mitigate, and predict future threats to the GNSS. Also, Mr. Zufelt has experience in machine learning algorithm optimization for various hardware platforms (TPU, GPU, CPU [ARM,x86], FPGA). His interests include optimizing a machine learning solution for specific hardware architecture, critical to achieving a deployed system’s lowest possible size, weight, and power requirement.

Renee Yazdi currently primarily supports AFRL PNT projects in her role as a System Engineering Consultant for Canyon Consulting. Renee has spent most of her career in and around space. Besides GPS, she has had the privilege to contribute to a variety of system engineering and technology development efforts with emphasis in remote sensing, communications, and missiles.

Luis Hernandez has completed his MSME from The University of New Mexico. Hernandez has worked at AFRL’s space vehicles directorate under the Spacecraft Charging and Instrument Calibration Laboratory (SCICL). He tested the characteristics of electrostatic discharges in advanced solar array designs by using simulated space weather conditions. His Master’s research was focused on material science and characterizes the effects of an electron irradiated and chemically enhanced polymer used in the space industry. Hernandez currently works with the Advanced GPS Technologies group at AFRL assisting with mechanical design components.
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**E1: GPS/GNSS 101**

**Date:** Monday, June 3, 2024  
**Time:** 8:30 a.m. - 10:00 a.m.  
**Location:** 6-8

This course presents the fundamentals of the GPS, and other GNSS, and is intended for people with a technical background who do not have significant GPS experience. Topics covered include time-of-arrival positioning, overall system design of GPS, signal structure, error characterization, Dilution of Precision (DOP), differential GPS, GPS modernization, and other GNSS systems.

Dr. John Raquet is currently the director of IS4S-Dayton, where he is leading the development of open architecture approaches to developing navigation systems. Previously, he was the founding director of the Autonomy and Navigation Technology (ANT) Center at AFIT. Dr. Raquet has a PhD in Geomatics Engineering from the University of Calgary, an MS in Aero/Astro Engineering from MIT, and a BS in Astronautical Engineering from the USAFA. He is an ION Fellow and past president.
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**F1: Magnetic Navigation (MagNav)**

**Date:** Monday, June 3, 2024  
**Time:** 8:30 a.m. - 10:00 a.m.  
**Location:** Ballroom E

This course will focus on practical considerations for implementation of magnetic anomaly navigation systems. The basic theory of how both an Extended Kalman Filter as well as a Particle Filter can use magnetic anomaly maps to navigate will be described. We will show where this theory can break down on real-world implementations. The two practical challenges that must be resolved are platform calibration as well as map errors. We will discuss the current state of the art for magnetic calibration. We will also discuss the real-world factors that influence map error and how to design navigation systems that are robust to these errors. Finally, we will go over a wide tradespace of magnetic anomaly simulations live in class to provide intuition on how magnetic anomaly navigation is influenced by altitude, map variation, velocity, calibration errors, and other factors.

**Dr. Aaron Canciani** is a senior research scientist with the Leidos Applied Science Division. He focuses on many aspects of GPS-denied navigation systems. His current research focuses are on using AI/ML to reduce drift of inertial systems, geophysical navigation, as well as SAR and Interferometric SAR navigation. Dr. Canciani has been a part of dozens of projects focused on magnetic anomaly navigation and previously led this exciting research area from within the government during a 12-year Air Force career.
A2: Cooperative Space-Based Sources: Experimentation
Date: Monday, June 3, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Room 1-3

Session Chairs:

Katherine Coens
USSF/SSC

Brian Zufelt
COSMIAC, University of New Mexico


11:10. Analysis of PNT Signals Generated by an Advanced Satnav Signal Synthesizer and Transmitter: Eric Hahn, Sanjeev Gunawardena, Evan McKnight, Logan Reich, Tristan Williams, Air Force Institute of Technology; Joanna Hinks, AFRL Space Vehicles Directorate

11:30. Testing of Xona PULSAR LEO PNT Signals for Resilience in GNSS Contested Environments: Michael Armatys, Dana Jensen, Dave Anderson, Collins Aerospace; Roger Hart, Phillip Bonilla, Jan Ackermann, Stuart Duncan, Felix Krefft, Spirent; Andrew Neish, Paul Tarantino, Jessica Hulsey, Tyler Reid, Xona Space Systems


Alternate Presentations:

1. Results from Prototype Agile Navigation Aid (PrANA) on-the-Wire and Over-the-Air Transmissions: Andrew Cochrane, Jim Aarestad, COSMIAC at The University of New Mexico; Alex Hostick, ARES Corporation

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in Event Hall (First Floor)
**B2: Novel Clock Technologies and Timing Applications**

**Date:** Monday, June 3, 2024  
**Time:** 10:45 a.m. - 12:15 p.m.  
**Location:** Ballroom D

**Session Chairs:**

Elizabeth Dreifus  
The MITRE Corporation  
Dr. Sean Krzyzewski  
Air Force Research Laboratory

10:50. **Designing Timing Systems for System Requirements – A Performance Characterization of Oscillators in Harsh Environments:**  
Brent Abbott, Safran Federal Systems

11:10. **Atomic Clock Performance in Flight:**  
Stephen McConnell, Andrew Jameson, Prabodh Jhaveri, Daniel Thrasher, Connor Brashar, Sandia National Laboratories

11:30. **±1 ppb MEMS Oven-Controlled Oscillator Technology for PNT Applications:**  
Jay Mitchell, Gary Giust, Jim Holbrook, Carl Arft, Aaron Partridge, SiTime

11:50. **Ytterbium Ion Microwave Clock Technology: Supporting Defense with Commercial Solutions:**  
K Richard Overstreet, Microchip Technology Inc

**Alternate Presentations:**

1. **Development of a Ruggedized Rubidium CPT Clock Platform:**  
Will Krzewick, Igor Kosvin, Matthew Stanczyk, Robert Conners, Chris Higgins and John Bollettiero, Microchip Technology Inc.

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in Event Hall (First Floor)
C2: GPS in Military Applications/NAVWAR

Date: Monday, June 3, 2024  
Time: 10:45 a.m. - 12:15 p.m.  
Location: Ballroom B

Session Chairs:

Kelly Fang  
LtCol Robinson Hughes

Kelly Fang  
Army DEVCOM CSISR  
LtCol Robinson Hughes  
USAF PNT PO

10:50. NAVFEST – 20 Years of Cost-Effective GPS NAVWAR Testing: Orlando Padilla, Raymond Johnson, Nicholas George, and Geneva Quinn, 746th Test Squadron


11:30. Countering GNSS Denial with Tactical Radio Satellites: Sang Wu Kim, Iowa State University, and Khanh D. Pham, Air Force Research Laboratory


12:15 p.m. – 1:15 p.m., Attendee Lunch Served in Event Hall (First Floor)
D2: PNT Situational Awareness: Arrays Research

Date: Monday, June 3, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Ballroom C

Session Chairs:
Jaime Ayinde, NTA, Inc.
Dr. Brady O'Hanlon, The MITRE Corporation

10:50. GPS Interference Direction of Arrival (DOA) Initiative for User Purposes (GIDIUP): An Implementation and Initial Results:
Chun Yang, Andrey Soloviev, QuNav; McLaina Mazzone, Joseph Schnecker, USN NIWC Pacific

11:10. Electrically Small Antenna Arrays for Underdetermined Direction of Arrival Estimation:
Krutant Mehta and Inder J. Gupta; ElectroScience Laboratory, The Ohio State University

11:30. Array Manifold Measurement and Validation:
Dennis Jones, Gabriel Wiggins, UHU Technologies

11:50. Single-Platform Geolocation of Multiple GPS Interferers:
William Lies, UHU Technologies

Alternate Presentations:
1. Atypical Arrays for NAVWAR Situational Awareness Objectives:
Joshua Starling, Jeremy Shepard, William Travis, IS4S; Amelia Fortmayer, US Army DEVCOM C5ISR Center

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in Event Hall (First Floor)
**E2: Software Defined Receivers (SDRs) for PNT**

*Date:* Monday, June 3, 2024  
*Time:* 10:45 a.m. - 12:15 p.m.  
*Location:* Room 6-8  

**Session Chairs:**

- Brittany Wells  
  *AFRL*  
- Amelia Fortmayer  
  *Army DEVCOM CSISR*

10:50. **High Performance Satnav SDR Data Collection System for Signal Quality Characterization Applications:** Logan Reich, Sanjeev Gunawardena, and Eric Hahn, Air Force Institute of Technology

11:10. **NIWC Pacific Advanced GPS Analysis and Testing Receiver (GATR):** Jacob Bencke, Nicholas Jenkins, Ryan Kim, NIWC Pacific

11:30. **Modernized Protection Device (MoPD):** Ryan Kral, David Urrea, Sandia National Labs; Jeff DeCoste, Hughes Design Group

11:50. **SDR Based GNSS and Signal of Opportunity Receiver Tightly Integrated into an INS:** Scott Czeck, Safran Federal Systems

**Alternate Presentations:**

1. **Alternative Navigation System for use in GPS Denied Environments and its Adaptation for Lunar and Cislunar PNT Applications:** Jacob Spagnolli, Trey Taylor, Ben Gattis, University of Colorado Boulder; Dennis Akos, Stanford University & University of Colorado Boulder; Mark Crews, Stephen Robertson, Lockheed Martin Corporation

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in Event Hall (First Floor)
F2: M&S: Hardware in the Loop (HWIL) and Digital
Date: Monday, June 3, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Ballroom E

Session Chairs:

Maj Mathew Coates
USAF SWAC SpOC/NAVWAR

Charles Frey
Lockheed Martin

10:50. Fieldable Antenna Wavefront Simulator Next Generation (FANG): Andi Thomas, Josh Felde, Andrew Halverson, Joe Fargey, Adam Hebert and Dan Dresher, Northrop Grumman; Dana Howell and Denice Jacobs, Air Force Research Laboratory/RYWN


11:30. Calibration and Signal Repeatability of Seven Element Wavefront HWIL Simulator using Anti-Jam Electronics as a Measurement Source: Loretta Painter, U.S. Army Combat Capabilities Development Command Aviation & Missile Center; Patrick Carter, Logan Cruse, Jonathan Jones, Adam Simmons, NTA, Inc.

11:50. NIWC Pacific Advanced Laboratory GPS Simulation Capabilities: Jacob Bencke, Mark McSharry, NIWC Pacific; Jayson Roberts, CTSI

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in Event Hall (First Floor)
A3: PANEL: Alternative and Assured Commercial PNT Services

Date: Monday, June 3, 2024
Time: 1:45 p.m. - 3:15 p.m.
Location: Ballroom B

Moderator:

Vincent Squitieri
Navy PEO C4I PMW/A 170

With the proliferation of Low and Medium Earth Orbit (LEO/MEO) satellite services, the advent of alternative and assured commercial PNT services are also starting to proliferate. This panel will explore the alternatives to traditional GNSS and include discussions on applications, technical means, performance, service offerings, anticipated start of services, and shaping of services to yield military unique capabilities.

Panel Members:

1. Brian Manning, CEO & Co-Founder of Xona Space:
2. Patrick Shannon, CEO & Founder of TrustPoint:
3. Dr. Joe Bravman, Chief Engineer, Lynk Global:
4. Doug Aiken, VP for Govt Solutions, Iridium:
5. Jack Rockaway, Space-X:

3:15 p.m. – 4:00 p.m., Break in Meeting Room Foyer (Third Floor), Sponsored by GPS Source
B3: Complementary PNT: Celestial
Date: Monday, June 3, 2024
Time: 1:45 p.m. - 3:15 p.m.
Location: Room 6-8

Session Chairs:
Dr. Sharon Marroquin
The MITRE Corporation
Chris McDowell
Draper

1:50. NoGAPSS GPNTS ACNS BDU Integration: Gladys Callagy and Christopher Aguirre, NIWC Pacific

2:10. Celestial Navigation as Part of Boeing All Source PNT Design for Aircraft & Missile Applications: R (Ken) Li, Tom Tsao, C. J. Yoo, Keith Mefford, Cody Gruebele, Gabriel Bonita, The Boeing Company; Minh Nguyen, David Needelman, Nigel Stepp, HRL Lab. LLC

2:30. Imaging of LEO and MEO Satellites with a Portable Telescope and SWIR Sensor: Mikhail Belenkii and Timothy Brinkley, Trex Enterprises Corporation

2:50. Kearfott Celestial Positioning and Attitude Determination Systems: Christopher Sweet & Colin Brinster, Kearfott Corporation

Alternate Presentations:
1. Low Cost, Low SWaP Day/Night Capable SWIR Star-Tracker for Terrestrial Navigation Applications: Minh Nguyen, Nigel Stepp, David Needelman, Michael Hooi, HRL Lab. LLC; R (Ken) Li, Keith Mefford, Cody Gruebele, Alberto Perez, Tom Tsao, C. J. Yoo, Gabriel Bonita, The Boeing Company

3:15 p.m. – 4:00 p.m., Break in Meeting Room Foyer (Third Floor), Sponsored by GPS Source
C3: Military PNT User Equipment: MGUE
Date: Monday, June 3, 2024
Time: 1:45 p.m. - 3:15 p.m.
Location: Ballroom C

Session Chairs:

Col. Matthew Spencer
SSC/CGU

Dr. Anne Le
The Aerospace Corporation

1:50. BAE Systems Status Update for M-Code User Equipment: Charles A. Popeck & Shawn Ryan, BAE Systems

2:10. L3Harris MGUE Program Status Updates: Rick Bieniak, L3Harris

2:30. Collins Aerospace MGUE Program Status: Cyrus Weaver, Collins Aerospace Resilient Navigation Solutions


Alternate Presentations:


3:15 p.m. – 4:00 p.m., Break in Meeting Room Foyer (Third Floor), Sponsored by GPS Source
D3: PNT Situational Awareness: Arrays Testing
Date: Monday, June 3, 2024
Time: 1:45 p.m. - 3:15 p.m.
Location: Ballroom D

Session Chairs:
Jaime Ayinde  
NTA, Inc.
Dr. Erik Lundberg  
The MITRE Corporation

1:50. GPS Interference in the Wild: A Jamming Detection and Mapping Extravaganza: John Weger, BAE Systems

2:10. Global Navigation Satellite System (GNSS) Spoofing Mitigation Augmentation Using Controlled Reception Pattern Antenna (SMAC): Cedric Logan, Christopher Zarowski, Huan-Wan Tseng, Nareshbabu Jarmale, Mayflower Communications Company, Inc.; Daniel Smith, AFLCMC/WNX; Jason Pontious, Dana Howell, Barbara Frantom, AFRL/RYWN; Megan Binsbacher, Nicholas Smothers, GSA


3:15 p.m. – 4:00 p.m., Break in Meeting Room Foyer (Third Floor), Sponsored by GPS Source
E3: Inertial Navigation Technologies 1

Date: Monday, June 3, 2024
Time: 1:45 p.m. - 3:15 p.m.
Location: Room 1-3

Session Chairs:

Jared Judy  
NIWC Atlantic

Shane Stone  
Northrop Grumman

1:50. Progress in Developing a High-Performance Gyroscope for GPS Denied Applications: Marc Smiciklas, Glen Sanders, Honeywell International, Aerospace Advanced Technology; Brian Irelan, Stephen Pethel, Scott David, Chris Roberts, Jeff Williams, NTA, Inc.; Patrick Renfroe, U.S. Army Combat Capabilities Development Command Aviation & Missile Center (DEVCOM AvMC)

2:10. (U) Advanced Inertial Measurement Unit (IMU) for Navigation of GPS Challenged Platforms: Alex Trusov, Daniel Rampacek, Farzin Dinyarian, Youngmin Choi, Cole Umemura, Lawrence Linick, James Pavell, Jorge Gutierrez, Aaron Hofmann, Daniel Fong, Northrop Grumman; Scott David, Stephen Pethel, Brian Ireland, NTA; Patrick Renfroe, DEVCOM AvMC


Alternate Presentations:

1. Enhanced Characterization of Low Size, Weight, Power, and Cost Inertial Navigators: Simone B. Bortolami, Nicholas V. Saluzzi, David Redington, Scott Gift, Navigation Research and Development Center (NRDC), ARL, Pennsylvania State University; Travis Hillyer, and Frank Walker II, Sandia National Laboratories

2. Effects of Sensor Block Dithering on Accelerometer Allan Variance Analysis: Sean T. Carda, Stew M. Kohler, Jerad L. Simon, Michael R. Walker II, Sandia National Laboratories

3:15 p.m. – 4:00 p.m., Break in Meeting Room Foyer (Third Floor), Sponsored by GPS Source
F3: M&S: Platform and Environmental Considerations

Date: Monday, June 3, 2024
Time: 1:45 p.m. - 3:15 p.m.
Location: Ballroom E

Session Chairs:
Daniel Smith  
Army DECOM AC  
Mathew Oliver  
LinQuest


2:10. Simulation and Modeling of Navigation Sensors and Timing for Evaluation and Research (SimMoNSTER) Applied to Magnetometers and Vision: Jeremy Gray, CTR AFIT/ANT HII; Johnathan Accurso, CTR AFIT/ANT CAL; Richard Nyquist, CTR AFIT/ANT HII; Clark Taylor AFIT/ANT

2:30. Including Environmental Error Sources in Atomic Clock Models: Jakob Wachter, Marianna Konstantopoulos and Yoonkee Kim, US Army C5ISR Center


Alternate Presentations:

1. CRPA Munition Modeling Results and Lessons Learned for Emerging SDAE Standards Using ANEFS and ANEFS Within GIANT: Avram Tetewsky, Jeff Lozow, Isaac Ehrenberg, Tuli Herscovici, George Gillespie, Rami Mangoubi, Draper; R. Scott Boughton, The Aerospace Corporation; James Fitch, LinQuest; Greg Panas, Daniel Smith, Mauricio Guevara, Army DEVCOM AC; Brian Louie, USSF SSC CGU

3:15 p.m. – 4:00 p.m., Break in Meeting Room Foyer (Third Floor), Sponsored by GPS Source
A4: Cooperative Space-Based Sources: Architecture
Date: Monday, June 3, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Ballroom C

Session Chairs:

LtCol Matthew Garvin  
OUSD

Renee Yazdi  
Canyon Consulting

4:05. Leveraging a Dedicated and Secure LEO PNT System for DoD Applications: Adrien Perkins, Xona Space Systems


4:45. SWAC/NAVWAR Approach to Orbital Resilience: Damon Van Buren, The MITRE Corporation, SWAC/NAVWAR; Matthew Coates, Daniel DeVargas, USSF SWAC/NAVWAR


Alternate Presentations:

1. The Lightweight SatNav Security Architecture: James T. Gillis, Aerospace Corporation; Scott Minas, AFRL/RVBYs; Joseph J. Rushanan, The MITRE Corporation
B4: Complementary PNT: RF Aided (Non-GPS)

Date: Monday, June 3, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Ballroom E

Session Chairs:
John Edwards
USCG CSISC
Christopher Walter
Army DEVCOM CSISR

4:05. Phased-Array Radio SLAM in Many-Jammer Environments: Matthew Boler and Connor Brashar, Sandia National Labs; Scott Martin, Auburn University


4:45. Characterization and Orbit Determination of RF-based Signals of Opportunity: Johnathan York, Benjamin Feuge-Miller, Andrew Joplin, Applied Research Laboratories, The University of Texas at Austin

5:05. Further Considerations for Doppler Positioning using LEO Satellite Constellations: Jacob Stewart, Caleb Perry, NTA, Inc.; Edwin Hogan, DEVCOM AvMC

Alternate Presentations:
1. Radar Velocity vs. DMI Aided Tactical INS Performance in GNSS-Denied Surface Vehicle Applications: Zafer Vatansever, Matthew Berntson, Emma Grant, Chris Matthews, Honeywell International
C4: Military PNT User Equipment: Other

Date: Monday, June 3, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Room 1-3

Session Chairs:

Lt Col Gregory Smith  
SSC/SYD1

Nik Hartney  
Honeywell Aerospace

4:05. Organizing to Optimize PNT Unified Mission Readiness: Matt Spencer, SSC/PNT SYD

4:25. EGI-M 3rd Party Application utilizing ALTNAV to Aid Navigation in GPS Denied Environments: Juan Carlos Oliveros and Neal Dahlen, Northrop Grumman

4:45. Honeywell EGI Approach to Expanded AltNav/Alt PNT Capabilities: Jim Waid, Honeywell, Inc.

5:05. Curve-Fitting Enhancement of Angular Momentum Forecasts for Earth Orientation Parameter Estimation: Nick Stamatakis, Dennis McCarthy, Mark Psiaki, David Salstein, and Jessica Page, US Naval Observatory

Alternate Presentations:

D4: PNT Situational Awareness: Operations

Date: Monday, June 3, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Room 6-8

Session Chairs:

Arthur Scholz
The MITRE Corporation

Jacob Jost
The Aerospace Corporation

4:05. PNT SA: TRL 6 NAVWAR SA Demonstration: Robert M. Beckinger, Fritz Newcomer, Amelia Fortmayer, US Army CSISR Center, RTI, PNT Division


4:45. The CONEMP for the SDA On-Orbit SA GNSS Terrestrial Monitoring System for Tranche 1: Gregory Weaver, SDA/JHUAPL, Ed Powers, SDA/Aerospace Corp., Somdatta Nath, General Dynamics Mission Systems

5:05. Trusted GNSS Ephemeris for Military Applications from a Long Term Orbit and Clock Correction Source: Eric Vinande, Jason Pontious, Mark Carroll, AFRL/RWYN; Jason Drotar, Michael Merrigan, NSWCDD

Alternate Presentations:


E4: Inertial Navigation Technologies 2  
**Date:** Monday, June 3, 2024  
**Time:** 4:00 p.m. - 5:30 p.m.  
**Location:** Ballroom D

**Session Chairs:**

Patrick Renfroe  
Army DEVCOM AvMC

Ann Witt  
Honeywell

4:05. **Closed Loop Control of Temperature Stabilized MEMS Capacitor for Inertial Sensing Application:** Robert R. Benoit, Ryan Q. Rudy, Ryan R. Knight, Glynis S. Sullivan, DEVCOM US Army Research Laboratory; Ryan N. Jackson, Joseph Giannattasio, Oak Ridge Associated Universities; Jonathan M. Puder, Jeffery S. Pulskamp, DEVCOM US Army Research Laboratory

4:25. **Investigating the Effects of Gamma and Neutron Radiation on Inertial Measurement Units in a Static and Dynamic Environment:** Colton Ream and Sean Abrahamson, 746th Test Squadron

4:45. **Unveiling the Nuances: A Detailed Journey from Tactical to High-End Navigation-Grade MEMS Accelerometers at EMCORE:** Sergey Zotov, EMCORE Corporation


**Alternate Presentations:**

1. **Exploring the Efficacy of a Sled Track Interrupter Based Time Space Position Information (TSPI) Reference System for Inertial Guidance System Evaluation:** Sean Abrahamson, Trenton Hugranes, 746th Test Squadron

This panel will focus on three stages of field testing PNT technologies: pre-planning, operations, and post-test activities. The discussion will center on the current state of US DoD PNT field testing, including best practices and lessons learned for range and test site selection and coordination, multiorganizational collaboration, challenges and opportunities of international partnerships, writing of test plans, obtaining frequency clearances, range safety, leading a large team, achieving operational security, the use of modeling and laboratory testing to down-scope and reduce risk, data analysis approaches and tools, data collection/storage/reuse, and post-test analysis and out-briefings/after action reports.

Panel Members

1. Ms. Amanda Humphrey, Joint Navigation Warfare Center:

2. Ms. Geneva Quinn, 746th Test Squadron, NAVWAR Test Management Element Chief:

3. Mr. Joshua Messner, OSD DOT&E, Operational Test and Evaluation Target Management Initiative (Office of the Secretary of Defense - Director Operational Test & Evaluation):

A5: Receivers for New Space-Based Sources
Date: Tuesday, June 4, 2024
Time: 8:30 a.m. - 10:00 a.m.
Location: Ballroom C

Session Chairs:

Natalia Shu
AFRL

Amy-Marie Dykstra
Naval Surface Warfare Center

8:35. Signals of Opportunity: A Proposed Standard for Rapid Proliferation and Adoption in Tactical Use: Daniel R. Smith, Joint Program Executive Office Armaments and Ammunition; Philip M. Guerieri, OUSD(A&S) and Joint Lethality PNT and NAVWAR OIPT; Matthew Garvin, OUSD(R&E); Jeffrey M. Hebert, Air Force Research Laboratory; Paul C. Manz, Joint Program Executive Office Armaments and Ammunition and Joint Lethality PNT and NAVWAR OIPT; Amy Dykstra, NSWCDD E24 Munitions Integration and Weaponization; and Thomas J. Blenk Jr., Joint Program Executive Office Armaments and Ammunition


9:35. Xona PULSAR Software Reprogrammable Receiver Augmentation to GPS: Robert Fries, Justin Miller, Matt Flach, and Rod Wright, L3Harris Technologies

Alternate Presentations:

1. Weak Signal Acquisition and Tracking of the Starlink Ku-Band Downlink to Enable Global PNT: Zacharias M. Komodromos, Department of Electrical and Computer Engineering, The University of Texas at Austin; Wenkai Qin, Department of Aerospace Engineering and Engineering Mechanic, The University of Texas at Austin; Todd E. Humphreys, Department of Aerospace Engineering and Engineering Mechanic, The University of Texas at Austin

2. Practical Precision Tracking for Proliferated Space-Based Sources: Nathan Green, Coherent Technical Services, Inc.; Mark Psiaki, Virginia Tech; Eric Bickford, CSISR RTI; Paul Olson, CSISR RTI

10:00 a.m. - 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by EMCORE
B5: Complementary PNT: Vision Aided/Optical Ground

Date: Tuesday, June 4, 2024
Time: 8:30 a.m. - 10:00 a.m.
Location: Room 6-8

Session Chairs:

Dr. Gary Katulka  
US Army/CSISR Center

Dr. David Goldstein  
The Aerospace Corporation


8:35. Development of an Optical Multilateration Prototype: Kevin N. Stanzione, Eric Bozeman, Nathan S. Barnwell, Elizabeth Izaguirre, Kari Moran, Angelica Sarmiento, Li Sun, Naval Information Warfare Center - Pacific


10:00 a.m. - 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by EMCORE
C5: Precision Guided Munitions PNT Technologies  
**Date:** Tuesday, June 4, 2024  
**Time:** 8:30 a.m. - 10:00 a.m.  
**Location:** Room 1-3

**Session Chairs:**  
Kevin Schaal  
Tim DeLoache  
*Army DEVCOM AC*  
*Booz Allen Hamilton*

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8:35. **Precision Guided Munition (PGM) All-In-One, Software Defined Satellite Navigation Receiver (PGM SDRx):**  
Michael Braasch, Anthony Rogers, Tim Huang, Northrop Grumman; Dan Smith, Tom Blenk, Greg Panas, Michael Sweetman, US Army JPEO AA; Mathew Cosgrove, Shane Stone, Northrop Grumman

8:55. **NavStormTM-M: A Gun-Hardened, Small Form-Factor, Five Element, Dual Frequency, Modernized GPS Receiver for Highly Contested Environments:**  
Nelson Wiese & Mike Cook, BAE Systems

9:15. **Effects of Antijam Electronics on PGM Hot Start:**  
Edwin Hogan, U.S. Army Combat Capabilities Development Command Aviation & Missile Center; Joshua Wood, Logan Cruse, Jonathan Jones, NTA, Inc.

9:35. **Navigation Informed Trajectory Optimization:**  
Caleb H. Peck, Timothy Bernard, Connor Brashar, Julie Parish, Sandia National Laboratories

**Alternate Presentations:**

1. **CRPA Phase Measurements while under Temperature and Vibration Testing and Associated Errors in AOA:**  
Edwin Hogan, U.S. Army Combat Capabilities Development Command Aviation & Missile Center; Patrick Carter, Brian Ireland, Jamil Stafford, NTA, Inc.

2. **LR-500: A New Compact IMU With Super-Tactical Performance for Demanding Applications:**  

10:00 a.m. - 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by EMCORE
D5: PNT Situational Awareness: Algorithms

Date: Tuesday, June 4, 2024
Time: 8:30 a.m. - 10:00 a.m.
Location: Ballroom D

Session Chairs:

Lt Col Nicholas Estep
DIU
Michael Orr
Space Force

8:35. A Comparison of Multi Target Tracking Algorithms in GNSS Challenged Environments: Tyler Long and David Bevly, Auburn University; Amelia Fortmayer, US Army DEVCOM C5ISR Center

8:55. Emitter Target Search and Geolocation Using Signal Arrival Angles: Shahram Moafipoor, Brad Despres, Darren Butler, Joel Kronk, AEVEX Aerospace

9:15. GPS Receiver Output Indicators of Valid, Accurate, and Authentic PNT: Matthew Woodley, Jacob Bencke, NIWC Pacific; Donald English, CTSI


Alternate Presentations:

1. Low-Latency ML-Based RF Environment Anomaly Detector and Classifier Enabling Edge-Computing by Exploiting Proliferating Embedded Software-Defined Radios (SDRs): Brent Bateman and Bryce Quilici, Northrop Grumman Corporation

10:00 a.m. - 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by EMCORE
E5: Integrity and Assurance
Date: Tuesday, June 4, 2024
Time: 8:30 a.m. - 10:00 a.m.
Location: Ballroom B

Session Chairs:

McLaina Oum Mazzone
NIWC Pacific

Nik Hartney
Honeywell

8:35. Assured Navigation System Results: John David (JD) Quartararo, Lawrence Elentukh, Alex Kosanovic, Steven E. Langel, William Schwartz, Jerome M. Shapiro, The MITRE Corporation

8:55. Improved M-Code Tracking Loop Convergence Time, Integrity, Accuracy and Higher Jamming Resistance with New BOC Tracking Algorithm: Shuwu Wu, Rob M. Fries, and Roy M. Gentry, L3Harris

9:15. GNSS with Doppler Processing at High Latitudes: Elisabeth Pike, Huntington Ingalls Industries, Inc.; Frank van Graas, Air Force Institute of Technology; Mark Smearcheck, Air Force Research Laboratory


Alternate Presentations:

1. PNT Trust Inference Engine Reference Architecture: Joseph Durkin, Patricia Larkoski, Joseph J. Rushanan, The MITRE Corporation


10:00 a.m. - 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by EMCORE
F5: M&S: Multi-Source PNT M&S and Evaluation  
Date: Tuesday, June 4, 2024  
Time: 8:30 a.m. - 10:00 a.m.  
Location: Ballroom E

Session Chairs:  
Desirae Cuevas  
AFRL  
Christine Rini  
The MITRE Corporation


8:55. Creating an ASPN 2023 Simulator: Paul E. Myers, Safran Federal Systems

9:15. SPACE JAM 3D: Paul Osadchy, Dan Dresher Kyle Mason, Northrop Grumman Corp; Trevor Lines, Dana Howell, Air Force Research Lab; Denice Jacobs, Retired

9:35. Modeling and Simulation: Marco Lombardo and Jim Waid, Honeywell Aerospace

Alternate Presentations:

1. Automated Extended Kalman Filter Tuning Using Boundary Value Optimization: James M. Floyd III, Mathew E. Dentinger, and Harrison P. Slater, Modern Technology Solutions, Inc.

10:00 a.m. - 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by EMCORE
A6: Cooperative Space-Based Sources  
**Date:** Tuesday, June 4, 2024  
**Time:** 10:45 a.m. - 12:15 p.m.  
**Location:** Ballroom C

**Session Chairs:**

Dr. John Janeski  
*The Aerospace Corporation*

Becky Oh  
*PNI Sensor*

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**10:50. Operations Concepts for the Lightweight SatNav Demonstration:** Madeleine Naudeau, Scott Minas, AFRL; Jon Anderson, James Lake, Renee Yazdi, Canyon Consulting

**11:10. Aerospace C-Band Experimental Transmitter and Technology Enabler (ACETaTE):** Andrew Lin, Matthew Pelmear, Bryan Wingert, Vahagn Petrosyan, James Bardeen, Alberto Arredondo, The Aerospace Corporation

**11:30. Navigation with a Minimum Number of LEO Signals:** Frank van Graas, Air Force Institute of Technology; Elisabeth Pike, Andrew Appleget, Huntington Ingalls Industries, Inc.; Mark Smearcheck, Air Force Research Laboratory

**11:50. Ionospheric Effects on Signals Transmitted from LEO Satellites:** Y. Jade Morton, Harrison Bourne, Steve Taylor, University of Colorado Boulder; Chun Yang, QuNav; Madeleine Naudeau, Air Force Research Laboratory

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
B6: Complementary PNT: Vision Aided/Optical Air + Unique

Date: Tuesday, June 4, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Ballroom E

Session Chairs:

Dr. Kevin Brink  
AFRL Munitions Directorate

Dr. Donald Venable  
Veth Research Associates


12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
As applications of Multi-GNSS (MGNSS) technology for civilian and commercial Position Navigation and Timing (PNT) users continue to grow, so has the interest in the use of MGNSS for military applications. This panel will explore the technical, policy, and operational factors affecting the use of Multi-GNSS for military operations.

Panel Members:

1. Dr. Christopher Erickson, Office of the Assistant Secretary for Space Acquisition and Integration:
2. Maj Matthew Coates, Space Warfighting Analysis Center, Navigation Warfare:
3. Dr. Thomas Blenk, Joint PEO Armaments and Ammunition:
4. John Skudlarek, Office of the Department of Defense Chief Information Officer:
5. Amy-Marie Dykstra, Naval Warfare Systems Center Dahlgren:
6. Barry Bolton, US Army CSISR Center:
7. Dr. Jonathan York, Applied Research Laboratories University of Texas at Austin (ARL:UT):

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
D6: PNT Situational Awareness: Multi-Sensor

Date: Tuesday, June 4, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Room 1-3

Session Chairs:

Megan McMarrow  
AFRL RYWN

Dr. William Travis  
IS4S

10:50. Realtime Geolocation of Multiple GPS Interferers with Multiple Receivers: William Lies, UHU Technologies


11:30. MilCloud-Enabled Navigation Warfare Situational Awareness: Taylor Schluter (Northrop Grumman), Bishoy Abdelmalik (Northrop Grumman), and Brent Bateman (Northrop Grumman)


Alternate Presentations:

1. A SWaP-C Constrained Approach To Tracking Vehicles With Unattended Ground Sensors: Daniel Donavanik and Nathan Schomer, DEVCOM Army Research Laboratory

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
E6: GPS Modernization, Space-Based PNT Services, and Constellation Status

Date: Tuesday, June 4, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Ballroom D

Session Chairs:

Dr. Pamela Neal  
The Aerospace Corporation
Nina Faustino  
The MITRE Corporation


11:10. On-Orbit Flex Power Test Results: David Robinson, SSC/GCEV; Gary Okerson, Jeffry Ross, Mark Sroka, Evan Lewis, The MITRE Corporation; Craig O'Grady, SAIC; Roger Welte, Matthew Ressler, Theresa Keeler, Eric Lavelle, SRI; Avram Tetewsky, Norman Vaughn, Christopher O'Brien, John Johnson, Jan Anszperger, Christopher McDowell, Draper; Daniel Stevenson, Wagner Mogga, SSC/CGEV

11:30. GPS Ground Antenna Architectures for Resilience and Increased Constellation Size: Roger Knobbe, Deb Babbitt, and Tom Powell, The Aerospace Corporation

11:50. Characterization and Modeling of GPS III RAFS Phase Steps: Travis Driskell, John Janis, Nicholas Quackenbush, Julia Spillane, Andrew Baker, L3Harris

Alternate Presentations:

1. Maintaining User Accuracy Through Flex Power Transitions: Gary Okerson, Jeffry Ross, The MITRE Corporation; Avram Tetewsky, Draper; Craig O'Grady, SAIC; Roger Welte, SRI

2. GPS IIIF Military Space Service Volume (MSSV) Enhancement: Erik Lier, Chuck Frey, Mark Crews, Lockheed Martin Space; David J. Goldstein, The Aerospace Corporation

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
F6: PNT for Uncrewed Systems

Date: Tuesday, June 4, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Room 6-8

Session Chairs:

Jorge Otero  
NAWC AD  

Virginia Overstreet  
Zeus Research and Technology

10:50. Multi-nodal Cubic Gradiometric Array for MagNav A-PNT: George Hsu, Joe Miller, Jay Trojan, PNI Sensor


11:30. PNT Solutions That Enable Uncrewed Collaborative Operations: David Anderson, Michael Armatys, William Kirchner, Douglas Burch, Collins Aerospace

11:50. Maximum Range of Computer Vision for Aircraft Classification: Ryan Stiffler, Scott Nykl, Air Force Institute of Technology

Alternate Presentations:

1. Fusion Artificial Intelligence Link Synchronization Array for eVTOL Systems (FAILSAFES): Wil Myrick, ENSCO

2. An Analysis of Relative Pose Estimation from Monocular Flight Imagery of Aerial Refueling: Stephanie Hanson, Liam Weinfurtner, Scott Nykl, Air Force Institute of Technology

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
P1: PLENARY 1: Keynotes
Date: Tuesday, June 4, 2024
Time: 1:45 p.m. - 3:15 p.m.
Location: Ballroom B/C

Session Chairs:

Dr. Thomas Powell  
The Aerospace Corporation
Dr. Greg Reynolds  
Army DEVCOM AvMC

Keynotes

Anthony C. Smith
Principal Director for the Deputy Chief Information Officer for Command, Control, & Communications, Office of the Secretary of Defense

Mr. Smith currently serves as the Principal Director for the Deputy Chief Information Officer for Command and Control, Communications (DCIO C3). He leads, directs and manages a staff comprised of SES, GS, Military and Contractor personnel, providing strategic direction and oversight of DoD’s C3 capabilities, to include national leadership command and control capabilities, continuity of operations planning/continuity of government communications, radio frequency spectrum, network operations, positioning, navigation and timing (PNT), satellite communications, tactical datalinks, unmanned aircraft systems, and 5th Generation (5G) and other wireless communications technology.

Previously Mr. Smith served as the Director for C3 Infrastructure (C3I) leading 69 personnel responsible for the governance, oversight and policy development of DoD tactical communications, tactical data links, combat identification systems, public safety communications, satellite communications, positioning, navigation and timing, and mobility/5G systems. While in DOD CIO, he also served as Director, DOD Information Network (DODIN) Transport Capabilities, where he led the modernization of DOD networks, radio systems, satellite communications, positioning, navigation and timing, and mobility/5G systems.

Mr. Smith retired as a Colonel in the United States Air Force, serving from 1983 to 2009. After completing Basic Communications Officer Training at Keesler Air Force Base, he served with the 1st Combat Communications Group at Lindsey Air Station, Germany. He then moved to Hurlburt Field, Florida, as Chief, C4 Architecture and Requirements, Air Force Special Operations Command. During this tour he led Air Force Special Operations communications teams during Desert Shield and Desert Storm. In 1992 he returned to Europe where he was Chief Network Integration and Testing Branch, Headquarters USAF, Ramstein AB, Germany. In 1996 he attended Air Command and Staff College at Maxwell Air Force Base. In 1997 he transferred to Tinker Air Force Base as Commander of the 32d Combat Communications Squadron. In 1999 he was assigned to United States Special Operations Command as Chief of their C4 Modernization Division. In 2002 he took command of the 21st Space Communications Squadron at Peterson AFB. After graduating from the National War College in 2005 he was assigned to The Joint Staff, serving as Chief, Assured Information Sharing Division, Command, Control, Communications and Computer (C4) Systems Directorate. Following Joint Staff, Col Smith served a one year remote assignment in Djibouti, Africa as the Director of C4 Systems, Combined Joint Task Force, Horn of Africa. Upon retirement from the military, Mr. Smith transitioned to Civilian Service as Deputy, Strategic Engagement Division, The Joint Staff. In 2012, he moved to the C4 Systems Directorate, Assistant Secretary for Defense, for Networks and Information Integration.

He received a Bachelor of Science Degree in Manufacturing Engineering Technology in 1984 at Western Washington University, a Master of Science Degree in Management in 1992 at Troy State University, and a Master of Science in National Security Strategy in 2005 at National War College. Mr. Smith was selected as Headquarters USAF/SC Company Grade Officer of the Year for 1993, the C4 Professionalism Award Winner for USAFE and USAF in 1993, won the 1997 Air Defense University award for excellence in research, and was selected as a 2020 Federal 100 Award Winner, recognizing him as a top IT professional in the Federal Government.
Dr. John Burke joined the Office of the Undersecretary of Defense for Research and Engineering (OUSD (R&E)) for Science and Technology (S&T) as the Principal Director for Quantum Science in March 2022. In this role, Dr. Burke was responsible for leading the Department of Defense’s (DoD) strategy for quantum science, one of DoD’s top critical technology areas.

Prior to joining OUSD (R&E), Dr. Burke served as a Defense Advanced Research Projects Agency (DARPA) Program Manager in the Microsystems Technology Office (MTO) and Defense Sciences Office (DSO) from 2017 to 2022. At DARPA, he managed seven programs developing quantum science and technology. Some of these programs advanced quantum sensors including atom interferometers, atomic clocks, magnetometers, and radio frequency (RF) “Quantum Apertures” and applied the sensors toward new capabilities in position, navigation and timing (PNT), biotechnology, as well as in the RF spectrum. Several programs advanced quantum computing qubit technologies based on both superconducting and photon-based platforms. This work resulted in several technology transitions to higher maturity development programs across the DoD, as acknowledged by his receipt of the DARPA “Results Matter” Award.

Previously, Dr. Burke worked in the Air Force Research Laboratory (AFRL) Space Vehicles Directorate as a Senior Research Physicist. There, Dr. Burke led a research team developing atomic clocks, optical time transfer, and cold atom measurement techniques for use in space applications such as the Global Positioning System. He contributed to space experiments including the NASA Cold Atom Laboratory for the International Space Station and the Navigation Technology Satellite –3. Dr. Burke won the AFRL Early Career Award and R-NASA National Award for Space Achievement in recognition for his contributions, multiple publications, and patents.

Dr. Burke holds a Bachelor of Science degree in Physics from Centre College and a Doctorate of Philosophy degree in Physics from the University of Virginia. His thesis work was on atom interferometry with guided matter waves sourced from a Bose Einstein Condensate, which won the University of Virginia Award for Excellence in Scholarship in Science and Engineering.

3:15 p.m. – 4:00 p.m., Break in Exhibit Hall (First Floor), Sponsored by VectorNav
A7: Cooperative Space-Based Sources: Signals

Date: Tuesday, June 4, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Ballroom C

Session Chairs:

Richard (Todd) Parris  
AFRL

Heidi Graziano  
The Aerospace Corporation

4:05. NTS-3 Phased Array Antenna Pattern and Beam Steering Tests: Joanna Hinks, Eric O'Connor, AFRL; Steve Stoyanov, Luigi Greco, L3Harris

4:25. Acquisition of Lightweight Signals from LEO Satellites: Philip Dafesh and Sharif Mutasim, The Aerospace Corporation

4:45. GNSS Interference and Carrier Doppler Manipulation Assessment of Proliferated-LEO (pLEO) Waveforms Using On-orbit Data Collection and Channel Emulator: Taehwan Kim, Brent Bateman, Christian Cavalière, Nicholas Spens, Northrop Grumman Mission Systems

5:05. Waveform Adaptation for Contested RF Environments: Kojo Zilevu, Charles Connors, Mike Tinston, Enrico Mattei, Afsayh Saquib, Expedition Technology, Inc.

Alternate Presentations:

1. Resiliency of Frequency Division BPSK Modulations Broadcast from LEO Satellites: Gina Staimer, Philip Dafesh and Daniel J Agress, The Aerospace Corporation

5:30 p.m. – 7:00 p.m., Exhibit Hall Evening Hours and Cash Bar (Exhibit Hall, First Floor)
Representatives from the services and industry will describe their approach to respond to urgent requirements from the field and to transition emerging technologies. Panelists will contrast the established process with rapid agile development techniques that are being implemented to accelerate transitions. Topics of discussion will include: innovative means of rapidly transitioning technology to the field; application of a PNT Open Systems Architecture (OSA) to promote the ability to plug and play new sensors/software applications; transition through government/industry partnerships; and how to best position promising technology for transition.

Panel Members:

1. Colonel Matthew Garvin, USAF, Director, PNT OUSD(R&E)/ S&T Futures/Emerging Technologies:
2. Ms. Amy-Marie Dykstra, Expeditionary PNT SME, Naval Warfare Systems Center Dahlgren:
3. Mr. John Bowling, R-EGI Lead Engineer, Air Force Life Cycle Management Center:

5:30 p.m. – 7:00 p.m., Exhibit Hall Evening Hours and Cash Bar (Exhibit Hall, First Floor)
C7: Multi-GNSS Receivers for Military Applications

Date: Tuesday, June 4, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Room 6-8

Session Chairs:

LCol Brian Slosman  
JNWC

Thomas Taylor  
NovAtel

4:05. Fear and Loathing in Medium Earth Orbit: Thomas D. Powell, The Aerospace Corporation


Alternate Presentations:


5:30 p.m. – 7:00 p.m., Exhibit Hall Evening Hours and Cash Bar (Exhibit Hall, First Floor)
D7: AI/Machine Learning for PNT

Date: Tuesday, June 4, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Ballroom D

Session Chairs:

Dylan Bowald  
AFRL/RYWN

Luis Hernandez  
COSMIAC, University of New Mexico


4:25. Towards Real-Time Mapping and Navigation with Neural Radiance Fields: Carlos R. Cruz, Evelyn A. Stump, Andrew Raij, Draper

4:45. Machine Learning Aided GPS-Denied Navigation Using Uncertainty Estimation through Deep Neural Networks: Han-Pang Chiu, Angel Daruna, Yunye Gong, Abhinav Rajvanshi, Zhiwei Zhu, Yi Yao, Supun Samarasekera, Rakesh Kumar, SRI International

5:05. Utilizing Asymmetric Aircraft Features for Highly Occluded Position and Orientation Estimation: Jeffrey Choate and Scott Nykl, Air Force Institute of Technology

Alternate Presentations:

1. GNSS-Denied Pedestrian Navigation using Machine Learning Aided Gait Recognition: Minhdao Nguyen, Jeffrey Onners, Roger Sengphanith, Naval Information Warfare Center (NIWC) Pacific


5:30 p.m. – 7:00 p.m., Exhibit Hall Evening Hours and Cash Bar (Exhibit Hall, First Floor)
E7: PNT Situational Awareness: Modeling and Simulation
Date: Tuesday, June 4, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Room 1-3

Session Chairs:

Dr. Thomas Blenk
Army DECOM AC

Alvah Aldrich
Safran Federal Systems


4:45. Sensor Laydown Evaluation for PNT Situational Awareness: Johnson Carroll, Oluwaseun Ogunmodede, Rebecca Widrick, Michael Zowada, Sharon Marroquin, and Dane Wilburne, The MITRE Corporation

5:05. SWAC/NAVWAR Approach to Investigating the Implementation of mGNSS and PNT-SA: Dave Kyger, The Aerospace Corporation, SWAC/NAVWAR Division; Franz Hamilton, Johns Hopkins Applied Physics Laboratory; Jacob Jost, The Aerospace Corporation; Matthew Coates, Daniel DeVargas, USSF SWAC/NAVWAR Division

5:30 p.m. – 7:00 p.m., Exhibit Hall Evening Hours and Cash Bar (Exhibit Hall, First Floor)
F7: Operational Systems: Live Demonstrations 1

Date: Tuesday, June 4, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Ballroom E

Session Chairs:

Alexandra Doan
The Aerospace Corporation

Daniel Weinman
Army DEVCOM C5ISR

4:05. CSISR Ground Vehicle Testbed: Joseph Rufo, Mike Dillon, Joshua Blackburn, John Raquet, Kyle Kauffman, IS4S, Inc.; Eric Bickford, Zach Kjellberg, Jacob Kurth, Andrew Clifton, Michael Caporellie, US Army DEVCOM CSISR Center

4:45. An Overview and Demonstration of how DDS Middleware in your Open Systems Architecture PNT Solution is an Enabler for New Capabilities.: Phong Bach, Chris Brechtel, Rosalba Puentes, Kevin Jansen, Kyle Miller, Brett Balazs, Collins Aerospace

Alternate Presentations:

1. Automated M-Code Testing with SDRs: Paul Myers, Kevin Gruhlke, Kevin Stottler, Safran Federal Systems

5:30 p.m. – 7:00 p.m., Exhibit Hall Evening Hours and Cash Bar (Exhibit Hall, First Floor)
A8: Space Applications for Cislunar and Beyond
Date: Wednesday, June 5, 2024
Time: 8:30 a.m. - 10:00 a.m.
Location: Ballroom B

Session Chairs:
Cheryl Gramling
NASA Goddard

Dr. Andrew Neish
Reliable Robotics

8:35. Assessing Utility of Different Orbits for a Lunar PNT Constellation: Daniel Agress, Michael Thompson, Tom Gallini, Jaime Cruz, Gina Staimer, Evan Tucker, Cheryl Gramling, Theresa Beech, Eric Poole, The Aerospace Corporation


9:15. Computationally Efficient Low-Infrastructure Navigation Solutions using Target Localization Algorithms: Bong-Jun Yang, Enkuang Daniel Wang, and Joseph L. Loof, Georgia Tech Research Institute


Alternate Presentations:

1. PNT and SDA for Cislunar Applications: James Lake, Laura Duffy, and Tim Britt, Canyon Consulting, LLC

10:00 a.m. – 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by L3Harris
B8: MagNav Data
Date: Wednesday, June 5, 2024
Time: 8:30 a.m. - 10:00 a.m.
Location: Ballroom D

Session Chairs:
Mark Smearcheck  
AFRL RYWN
Dr. Aaron Canciani  
Leidos

8:35. Temporal Anomaly Corrections for Magnetic Anomaly Navigation: Anutam Srinivasan and Aaron Nielsen, Air Force Institute of Technology


9:15. On the Accuracy of Upward Continuation and Interpolation of Magnetic Anomaly Maps: Adam Rutkowski, Munitions Directorate, Air Force Research Laboratory; Aaron Nielsen, Air Force Institute of Technology; David Kerr, Torch Technologies


Alternate Presentations:

10:00 a.m. – 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by L3Harris
C8: Anti-Jam and Anti-Spoofing Technologies: Receiver-Based

Date: Wednesday, June 5, 2024
Time: 8:30 a.m. - 10:00 a.m.
Location: Ballroom C

Session Chairs:

Augustus Henninger
Army DECOM AC
Laura McCrain
NTA

8:35. A Frequency-Based Correlator Output Method for GPS Spoofing Detection: Kip Underwood, Auburn University & IS4S; Scott Martin, Auburn University


9:35. Situational Awareness in the Presence of Spoofing Via C/N0 Distribution Monitoring: Joshua Ortiz and Connor Brashar, Sandia National Laboratories

Alternate Presentations:

1. Identification of Authentic and Simulated GNSS Signals in Time-Differenced Carrier Phase Measurements: A Controlled Experiment: Zhen Zhu, East Carolina University; Sanjeev Gunawardena, Air Force Institute of Technology; Eric Vinande, Jason Pontious, Mark Carroll, Air Force Research Laboratory

10:00 a.m. – 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by L3Harris
D8: AI/Machine Learning: MagNav

**Date:** Wednesday, June 5, 2024

**Time:** 8:30 a.m. - 10:00 a.m.

**Location:** Ballroom E

**Session Chairs:**

[Images of session chairs]

Dr. Clark Taylor  
AFIT

Joshua Carrasco  
JNWC


8:55. Map Inferencing Networks for Improving Magnetic Aided Navigation (MINIMAN): Spencer Low, Brigham Young University; Isaac Ege, University of Dayton Research Institute; Theodore Gaydosh, University of Dayton; Enjie Wang, Cornell University; Dylan Bowald, Air Force Research Laboratory


10:00 a.m. – 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by L3Harris
E8: PNT Open Systems Architecture 1

Date: Wednesday, June 5, 2024
Time: 8:30 a.m. - 10:00 a.m.
Location: Room 1-3

Session Chairs:

CDR Daniel Follett  
Navy PEO C4I PMW/A 170

Meghan Bentz  
Army DEVCOM CSISR


9:15. Development of a Modular Architecture for Low-SWAP Navigation Systems: David Hodo, Cody Salmon, IS4S; David Bevly, Auburn University; Daniel Dekowski, DEVCOM CSISR Center

9:35. Continue to Benefit from your MOSA Tactical PNT Solutions by Pairing with an Open Test Architecture Solution, Operating in a DevSecOps Environment: Phong Bach, Chris Brechtel, Rosalba Puentes, Kevin Jansen, Kyle Miller, Brett Balazs, Sean Kearney, Collins Aerospace

10:00 a.m. – 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by L3Harris
F8: Application/Impact of PNT Technologies in the Homeland Critical Infrastructure

Date: Wednesday, June 5, 2024
Time: 8:30 a.m. - 10:00 a.m.
Location: Room 6-8

Session Chairs:

Robert McDermott  
USCG CSISC

Misty Finical  
OSD A&S

8:35. Collateral GNSS Interference Evaluation and Reduction in Precision Counter-UAS: Casey Smith, John Bowman, Mark Psiaki, Virginia Tech; Andrew Young, Black River Systems; Troy R Kiel, USAF AFMC AFRL/RIGD; Mathieu Joerger, Virginia Tech

8:55. Area Protection Against GPS Interferers: Eric Hughes, UHU Technologies

9:15. VLBA HRTRs for Awareness of Spectrum and Timing Enhancements (HASTE) and HRTR-VLBA Co-Observation: Joe Skeens, Russell Friesenhahn, Kyle Herrity, and Johnathan York, Applied Research Laboratories, The University of Texas at Austin

9:35. Beamforming Low-SWAP-C Intelligence Processing Sensor (BLIPS) for PNT Situational Awareness: Wil Myrick, ENSCO

10:00 a.m. – 10:45 a.m., Break in Exhibit Hall (First Floor), Sponsored by L3Harris
A9: Applications of Time Transfer and Dissemination 1
Date: Wednesday, June 5, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Ballroom E

Session Chairs:

Dr. Kimberly Frey
AFRL

Dr. Susannah Dickerson
Draper


11:10. Two Way Time Transfer Computations for Dynamic Platforms: Stefania Romisch and Michaela Villarreal, Northrop Grumman Corporation

11:30. Developing Inexpensive Compact and Distributed Arrays for Time Transfer with Internet of Things: Wil Myrick, ENSCO


12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
B9: MagNav Implementations
Date: Wednesday, June 5, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Ballroom D

Session Chairs:

Jonathan Hirschauer
The MITRE Corporation

Michael Vincelli
Army DEVCOM C5ISR


11:10. Navigating under Magnetic Field Distortion: Robert Fries, L3Harris Technologies


Alternate Presentations:


12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
C9: Anti-Jam and Anti-Spoofing Technologies: GPS
Date: Wednesday, June 5, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Ballroom C

Session Chairs:

Bryan Hoffman
NIWC Pacific

Wesley Kniazeff
Collins Aerospace

10:50. A Modular & Layered Approach to Multi-Orbit Satellite & Fused Sensor-Based Navigation in Highly Contested, Multi-Dimensional Threat Environments Involving Denial of Service Attacks Supported by Evidence from Live Demonstration Example
Scenarios: Adam Gerber and Sayuj Haridas, GDMS

11:10. Fixed-Point Recursive Least Squares (RLS) Anti-Jamming (AJ) System: Gilberto Sada, Jason Wright, Justin Yakura, L3Harris Technologies

11:30. Effects of RMP on GPS Receivers Equipped with Adaptive Antennas: Inder "Jiti" Gupta and Teh-Hong Lee; ElectroScience Laboratory, The Ohio State University

11:50. Collins Aerospace Static Antenna Test Range (SATTR) Anti-Jam Demonstration Results for M-Code enabled GPS Receiver and AJ Applique: Kelsey Fitzgibbons, Collins Aerospace Resilient Navigation Solutions

Alternate Presentations:

1. **High-Fidelity Simulation and Emulation for Mission-critical CRPA Testing:** Roger Hart, Paul Crampton, Spirent Federal Systems; Mark Holbrow, Rafał Zbikowski, Spirent Communications

2. **Position Navigation and Timing Assessment Experiment:** Jason Wideman, APNT/S-CFT; Lisa Reyes, APNT/S-CFT - T2S Solutions

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
D9: Navigating in Challenged Environments 1
Date: Wednesday, June 5, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Room 1-3

Session Chairs:
Lynetta Grajeda  
NIWC Pacific  
Dr. Camila Francolin  
Draper


Alternate Presentations:
1. GPS-Denied Navigation for UAVs Using a High-Performance Low SWaP Silicon Photonics Optical Gyroscope: Kirstin Schauble, Walter Stockwell, Mike Horton, ANELLO Photonics

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
E9: PNT Open Systems Architecture 2

Date: Wednesday, June 5, 2024
Time: 10:45 a.m. - 12:15 p.m.
Location: Room 6-8

Session Chairs:

Dr. John Janeski
The Aerospace Corporation

Brent Abbott
Safran Federal Systems

10:50. OUSD(R&E) PNT Reference Architecture: Incorporating Complementary Architectures: Leah Davis, Mark Elpers, Dan Reineke, Strategic Technology Consulting; Adam Schofield, US Army DEVCOM ARL; Meghan Bentz, US Army DEVCOM C5ISR Center


11:30. FMS TMDM Remote Display: Minh Tong, Christopher Aguirre, NIWC Pacific

11:50. Open Architectures in Honeywell's EGIs: Alfio Leone, Nik Hartney, Honeywell

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
This panel will focus on PNT threats to the national critical infrastructure. Discussion topics may include threats to the electrical grid, communication, transportation, finance, and domestic DoD support infrastructure as well as emerging infrastructure for domestic employment of UAV systems that create a challenge for safeguarding national assets and maintaining homeland security.

Panel Members:

1. Mr. Michael Roskind, Strategic Risk Initiatives, National Risk Management Center, Cybersecurity and Infrastructure Security Agency (CISA), Department of Homeland Security:
2. Mr. Ken Alexander, Chief Scientist for Satellite Navigation Systems, Federal Aviation Administration:
3. Mr. David Howard, Office of Electricity, Department of Energy:
4. Dr. J.N. “Nikki” Markiel, Senior Geoint Authority for Geomatics (DISL-1), Source Directorate, National Geospatial-Intelligence Agency:
5. Mr. James S. Aviles, Senior Engineer, DOT/FAA Spectrum Engineering Services:

12:15 p.m. – 1:15 p.m., Attendee Lunch Served in the Exhibit Hall (First Floor)
P2: PLENARY 2: Warfighters

Date: Wednesday, June 5, 2024  
Time: 1:45 p.m. - 3:15 p.m.  
Location: Ballroom B/C

Moderators:

Sean Memmen  
Booz Allen Hamilton

Amanda Humphrey  
JNWC

An interactive discussion between the audience and a panel of warfighters who have had recent operational experience that informs the community on how to better formulate military PNT systems.

Panel Members:

1. SMSgt Joshua Griffin, US Space Force
3. LT Christine McCulla, US Coast Guard
5. QMCM Aurora Robles, US Navy
6. LT Brandon Vitton, US Navy

3:15 p.m. – 4:00 p.m., Break in Exhibit Hall (First Floor), Sponsored by Inside GNSS
A10: Applications of Time Transfer and Dissemination 2

Date: Wednesday, June 5, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Ballroom E

Session Chairs:
Dr. Kimberly Frey  
AFRL/RV
Dr. Susannah Dickerson  
Draper

4:05. SWAC/NAVWAR Approach to Investigating Timing Over Space Data Networks: Olukayode Kami Okusaga, Johns Hopkins Applied Physics Laboratory SWAC/NAVWAR; Matthew Coates, Daniel DeVargas, USSF SWAC/NAVWAR


4:45. Multidomain Resilient Collaborative PNT: Mike Badamo, Travis Young, Peter Kapteyn, Carole Teolis, Carol Politi, TRX Systems; David Nelson, L3Harris Technologies, Communication Systems-West; Dan Dekowski, Eric Bickford, Yoonkee Kim, Nhuot Vo - U.S. Army Combat Capabilities Development Command (DEVCOM) CSISR Center

B10: MagNav Calibration and GravNav

Date: Wednesday, June 5, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Ballroom D

Session Chairs:
Dr. Kelly Backes  MITRE
Dr. Cort Johnson  Draper


4:45. Improving Tolles-Lawson Calibration with F-16 Data: Brandon Blakely, Jonnathan Bonifaz, Aaron Nielsen, AFIT/ANT Center

5:05. Magnetic Sensor Compensation Utilizing Factor Graph Estimation: Frederic W Lathrop, Clark N Taylor, Aaron Nielsen, Air Force Institute of Technology

Alternate Presentations:

C10: Anti-Jam and Anti-Spoofing Technologies: GNSS
Date: Wednesday, June 5, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Ballroom C

Session Chairs:

Lt. Elizabeth Page  
U.S. Space Force

John David Quartararo  
The MITRE Corporation

4:05. SWAM: Single Weight and Multiple-Beam Antenna Electronics for all Signal GNSS Receivers: Inder “Jiti” Gupta; ElectroScience Laboratory, The Ohio State University


4:45. Quad-Band GPS/GNSS Anti-Jam Antenna Electronics System (Q-GAAS) Test Results: William LeComte & Cedric Logan, Mayflower Communications Co., Inc.; Michael Berarducci, & Dana Howell, AFRL/RWYN, Wright-Patterson AFB

D10: Navigating in Challenged Environments 2

Date: Wednesday, June 5, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Room 1-3

Session Chairs:

Kevin Cammie
USCG

Paul Heim
WR Systems

4:05. Determining Latitude and Longitude Using ONLY a Low SWaP-C Inertial Sensor-Based Module: George Hsu, Davy Figaro, and Jay Trojan, PNI Sensor


4:45. Efficient Implementation of Complementary Sensor Measurement and Map-Matching Pedestrian Navigation: Andrew Weir and David Bevly, Auburn University; Dan Dekowski, DEVCOM C5ISR Center


Alternate Presentations:

1. Hybrid Camera-LiDAR Trilateration with Lens Distortion Correction: Travis W. Moleski, Jay P. Wilhelm, Ohio University
E10: PNT Open Systems Architecture 3

Date: Wednesday, June 5, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Room 6-8

Session Chairs:

Kamal Joshi  Victor Rizzo
Northrop Grumman  Booz Allen Hamilton

1. **Open System Architecture Adoption – A Truly Modular Hardware and Software Design to Support Rapid Prototyping and Growth:** Brent Abbott, Safran Federal Systems

2. **Applications of Containers in Open Architecture PNT Data Fusion and Distribution Systems:** Kyle Miller, Phong Bach, Collins Aerospace; Jay Lala, Raytheon; Alex Tran, Sean Kearny, Collins Aerospace

3. **GPNTS MGUE Independent Verification and Validation (IV&V):** Jei Chen, Rebecca Conner, Richard Huynh, Dominic Ludden, Samir Shammas, Timothy Tu, Christopher Aguirre, NIWC Pacific

4. **WRN-6/7 Replacement with GPNTS:** Truong Bui, Chad Kemp, and Christopher Aguirre, Naval Information Warfare Center Pacific (NIWC Pacific)
F10: Operational Systems: Live Demonstrations 2

Date: Wednesday, June 5, 2024
Time: 4:00 p.m. - 5:30 p.m.
Location: Ballroom B

Session Chairs:

Alexandra Doan  
The Aerospace Corporation

Daniel Weinman  
Army DEVCOM CSISR


4:45. New Advances in Automation Provide More Robust Test Coverage: Roger Hart, Phillip Bonilla, Spirent Federal Systems; Ricardo Verdeguer Moreno, Jan Ackermann, Spirent Communications

Alternate Presentations:

1. Automated M-Code Testing with SDRs: Paul Myers, Kevin Gruhlke, Kevin Stottler, Safran Federal Systems
The JNC’s 2024 SECRET program was curated by invitation from the JNC Military Division. After consultation with PNT leadership across the services, presentations concerning PNT threats, major PNT studies, current operational conditions and challenges, requirements development, and results from rapidly fielding material solutions were selected.

6:30 a.m. Buses Depart for AFIT from the Covington Convention Center
8:00-9:00 a.m. Security Validation/Entry

Introductions
9:00-9:10 Welcome: Dr. Keith McDonald, The MITRE Corporation; and Amanda Humphrey, JNWC

Threat Background
9:20-10:20 Counter-PNT Delivery: Threats and Opportunities: Scott Feairheller, NSIC

Operations 1
10:20-10:40 Reverse Engineering of Adversary PNT in Weapons Systems: Steven Billman, KBR
10:40-11:00 Operational Evaluation for Advanced Technology: Amanda Humphrey, JNWC; Kevin Martin and Jeff Melville, The MITRE Corporation
11:00-11:30 Break

Major Studies and Initiatives
11:30-11:50 DSB Task Force on PNT Control Results of the Defense Science Board Task on PNT Control: Dr. John Betz, DSB Task Roce on PNT Control Results of the Defense Science Board Task on PNT Control
11:50-12:10 PNT Force Design: Maj. Matthew Coates, SWAC Division Chief
12:10-12:30 Oceanographer of the Navy Initiatives: Dr. Christopher Ekstrom, OPNAV N2N6E

LUNCH
12:30-2:30 Attendee Lunch at National Museum of the USAF

Operations 2
2:30-2:50 Navigation Warfare in the Undersea Environment: George Klaus, JHU/APL
2:50-3:10 Operational Impacts of GPS Jamming: LT Prasanna Chandrasekhar, USNR; Gregory Panas, Army DEVCOM AC; Dr. Dane Wilburne, The MITRE Corporation; and Dr. Brian McMloore, The MITRE Corporation
3:10-3:30 Failing Fast Pursuing PNT: John Sternitzky, USOCOM – Manned Airborne ISR
3:30-3:50 USINDOPACOM – Building Capabilities to Counter Threats: Dr. Gregory Power, USD(R&E) Prototyping and Experimentation Liaison to USINDOPACOM
3:50-4:10 SOCPAC PNT: Ryan Mowery, Kavaliro

PNT Situational Awareness:
4:10-4:30 Jaded Unicorn: Joseph Lortie, T2S Solutions
4:30-4:50 PNT SA Visualization: Mr. Jameson McGee, NRL
4:50-5:10 PNT Situational Awareness Update and Use Cases: LT Brandon Vitton, JNWC
5:10-5:30 Future Army NAVWAR Opportunities: Michael Trzeciak, Army PM PNT

5:30 p.m. Buses Depart for Covington

Alternates:
Stricklin, Sandia National Laboratories 2.

Conference Information

Conference Dress
Battle dress uniform or business casual.

JNC Mobile Website: m.ion.org
During the meeting, point your mobile device’s web browser to m.ion.org to access JNC information such as:
- Real-time conference program
- Current exhibit hall map
- Local area info/weather
- Restaurant reservations

Conference Proceedings
Digital CUI conference proceedings will be distributed in July to eligible conference participants. A unique link will be sent from registration@ion.org to the verified email address you used when registering. This link is tied to your account and cannot be shared. The link will expire after 30 days; ION is unable to distribute conference proceedings after the 30 day period has expired.

Customized Schedule
Log into the JNC website at ion.org/jnc to build a customized schedule of conference presentations you wish to attend.

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Free Wireless Internet Access
Complimentary wireless internet access will be available in public lobby areas and conference meeting rooms.

JNC Conference Events

Monday, June 3
Informal Lunch
12:15 p.m. - 1:15 p.m
Included in a full or Monday single-day registration.

Tuesday, June 4
Informal Lunch
12:15 p.m. - 1:15 p.m., Exhibit Hall
Included in a full or Tuesday single-day registration.

Exhibit Hall Evening Hours
5:30 p.m. - 7:00 p.m., Exhibit Hall
A cash bar will be offered. Included with all registrations. Spouses/traveling companions ages 21+ are welcome.

Wednesday, June 5
Informal Lunch
12:15 p.m. - 1:15 p.m., Exhibit Hall
Included in a full or Wednesday single-day registration.

Thursday, June 6
SECRET Session Informal Lunch
12:15 p.m. - 1:30 p.m.
Included in a full or Thursday single-day registration.

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**Exhibit Hall Information**

**Exhibit Hall Access**
Exhibits are hosted in a public release environment. Conference registration and valid identification are required for entry. **Individuals who are only registering for an exhibit hall pass do not need to complete a visit request.**

**Exhibit Hall Hours**
Tuesday, June 4: 10:00 a.m.- 7:00 p.m.  Exhibits Open  
Wednesday, June 5: 10:00 a.m.- 4:00 p.m.  Exhibits Open

**Exhibit Hall Floor Plan**
Gray shading indicates booths reserved as of 2/7/2024

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**Current Exhibitors**
- Acutronic USA Inc.
- Aevex
- Air Force Research Laboratory
- Anello
- Applied Research Laboratories - UT Austin
- BAE Systems
- Brandywine Communications
- CAST Navigation, LLC
- Chelton Limited
- Collins Aerospace
- EMCORE Corporation
- Exai1 Defense Systems Inc.
- FIBERPRO, Inc.
- Fibertronics
- Fizoptika Malta - Sentech Malta FP LTD
- Frequency Electronics, Inc.
- General Dynamics Mission Systems
- Gladiator Technologies, LLC
- GPS Networking Inc.
- Hexagon/NovAtel/Antcom
- Ideal Aerosmith
- Inside GNSS
- Integrated Solutions for Systems
- Kearfott Corporation
- L3Harris
- LinQuest
- Lockheed Martin Space Systems Co
- Mayflower Communications Company
- Microchip Technology Inc.
- NAL Research
- NAVSYS Corporation
- NavtechGPS
- Northrop Grumman
- NTA. Inc.
- OxTS
- PNI Sensor
- Psionic LLC
- Safran Federal Systems
- Septentrio
- Spirent Federal Systems
- Technology Advancement Group (TAG)
- TRX Systems
- UHU Technologies LLC
- VectorNav Technologies
- VIAVI Solutions

**Prospective Exhibitors**
A limited number of booths remain available for JNC 2024. The exhibitor prospectus and booth contract are available for download at ion.org/jnc. Questions? Contact Megan Andrews at mandrews@ion.org.

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