JNC GUIDANCE, NAVIGATION & CONTROL

Sponsored by
The Military Division of
The Institute of Navigation

Joint Navigation Conference 2014

"Military Navigation Technology: The Foundation for Military Ops"



ONSITE PROGRAM

June 16-19, 2014 ▪ Tutorials: June 16 ▪ FOUO Technical Sessions: June 16-18

Renaissance Orlando at SeaWorld, Orlando, Florida

Classified Session will be held June 19 at Shades of Green on Walt Disney World Resort

Registration Hours:
Monday, June 16: 9:00 a.m. – 5:00 p.m.
Tuesday, June 17: 7:30 a.m. – 5:00 p.m.
Wednesday, June 18: 7:30 a.m. – 5:00 p.m.

Conference Dress:
Battledress uniform or business casual.

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

Passcodes for Wireless Internet:
Network: Renaissance_CONF
Access Code: jnc2014

Note: Renaissance meeting room connectivity and sleeping room connectivity are on separate networks. The JNC internet codes will not work in your sleeping room and vice versa.

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Technical Session Overview June 16–19, 2014 Orlando, Florida

ROOM:	Oceans Ballroom 1	Oceans Ballroom 2	Oceans Ballroom 3	Oceans Ballroom 4
MONDAY, JUNE 16				
10:30 a.m. – 12:00 p.m.	Tutorial: Strapdown Navigation	Tutorial: GPS 101	Tutorial: Wide Area Imaging Georegistration & Calibration	Tutorial: GPS Interference & Antispoofing 1
Lunch — 12:00 p.m. – 1:30 p.m. (Lunch is on your own)				
1:30 p.m. – 3:00 p.m.	Tutorial: Sensor Modeling	Tutorial: Inertial Navigation	Tutorial: Precise Time & Frequency Applications	Tutorial: GPS Interference & Antispoofing 2
Break — 3:00 p.m. – 3:30 p.m.				
	Track A: Jalal Mapar, *Dept. of Homeland Security*	**Track B: Ron Beard,** *Naval Research Observatory*	**Track C: John Langer,** *The Aerospace Corporation*	**Track D: Paul Olson,** *U.S. Army CERDEC*
3:30 p.m. – 5:00 p.m.	**A1:** Precision Azimuth Sensing	**B1:** Multi-GNSS Receivers for Military Applications	**C1:** GPS Constellation Performance	**D1:** Operational Product Demonstrations 1 (3:30 p.m.- 5:40 p.m.)
TUESDAY, JUNE 17				
8:30 a.m. – 10:00 a.m.	**A2:** Alternate Navigation Technologies 1	**B2:** Atomic Clocks and Timing Applications	**C2:** Antenna Technologies and Interference Mitigation	**D2:** Warfighter Requirements and Solutions
Break in Exhibit Hall — 10:00 a.m. – 10:30 a.m.				
10:30 a.m. – 12:00 p.m.	**A3:** Alternate Navigation Technologies 2	**B3:** Aviation Applications 1	**C3:** GPS Modernization 1	**D3:** Space and Satellite Applications
Lunch in Exhibit Hall — 12:00 p.m. – 1:30 p.m.				
1:30 p.m. – 3:00 p.m.	**Plenary Session 1: Assured PNT 1 (Oceans Ballroom 3/4)**			
Break in Exhibit Hall — 3:00 p.m. – 3:30 p.m.				
3:30 p.m. – 5:00 p.m.	**A4:** Navigatin in Challenged Environments	**B4:** Aviation Applications 2	**C4:** GPS Modernization 2	**D4:** Operational Product Demonstrations 2 (3:30 p.m.- 5:40 p.m.)
Exhibitor Hosted Reception — 6:00 p.m. – 8:00 p.m.				
WEDNESDAY, JUNE 18				
8:30 a.m. – 10:00 a.m.	**A5:** Inertial Measurement Unit 1	**B5:** Robust Navigation Systems/ Solutions	**C5:** Receiver Technology	
Break in Exhibit Hall — 10:00 a.m. – 10:30 a.m.				
10:30 a.m. – 12:00 p.m.	**A6:** Inertial Measurement Unit 2	**B6:** Collaborative Navigation Techniques 1	**C6:** Navigation Warfare 1	
Lunch in Exhibit Hall — 12:00 p.m. – 1:30 p.m.				
1:30 p.m. – 3:00 p.m.	**Plenary Session 2: Assured PNT 2 (Oceans Ballroom 3/4)**			
Break in Exhibit Hall — 3:00 p.m. – 3:30 p.m.				
3:30 p.m. – 5:00 p.m.	**A7:** Inertial Measurement Unit 3	**B7:** Collaborative Navigation Techniques 2	**C7:** Navigation Warfare 2	
THURSDAY, JUNE 19	**Classified Session Buses Depart Renaissance SeaWorld at 7:00 a.m.**			
7:45 a.m.–8:25 a.m.	**Security Validation**			
8:40 a.m.–11:55 p.m.	**E8: Classified Session (4-Eyes):** NAVWAR Landscape: Threats and Operations			
Lunch — 11:55 a.m. – 12:55 p.m.				
12:55 p.m.–2:55 p.m.	**E9: Classified Session (4-Eyes):** Warfighter Crosstalk Panel			
3:25 p.m.–5:25 p.m.	**E10: Classified Session (4-Eyes):** Rising to the Challenge: Emerging NAVWAR Capabilities			
	Buses Load at **5:40 p.m.**			

Note that the photographing of sessions/presentations and/or the audio or video recording of sessions/presentations is prohibited. As a courtesy to others, please silence all mobile devices.

JNC 2014

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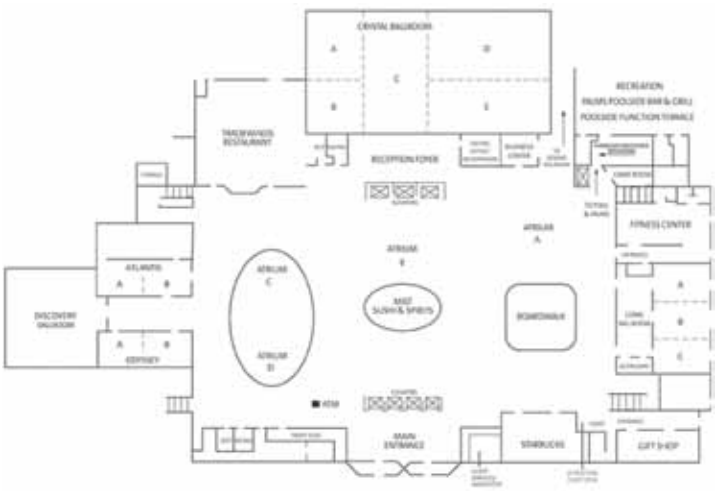
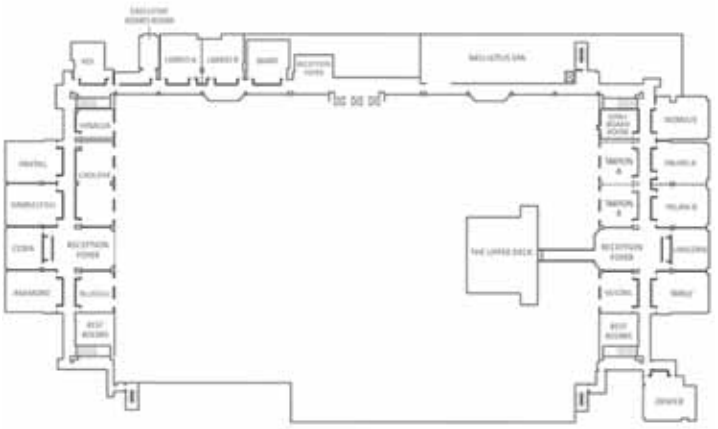
Floor Layout





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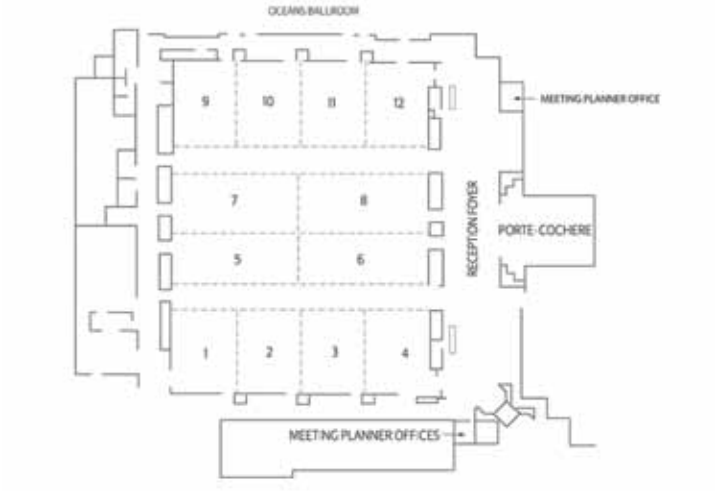


Exhibit Hall Information

Tuesday, June 17

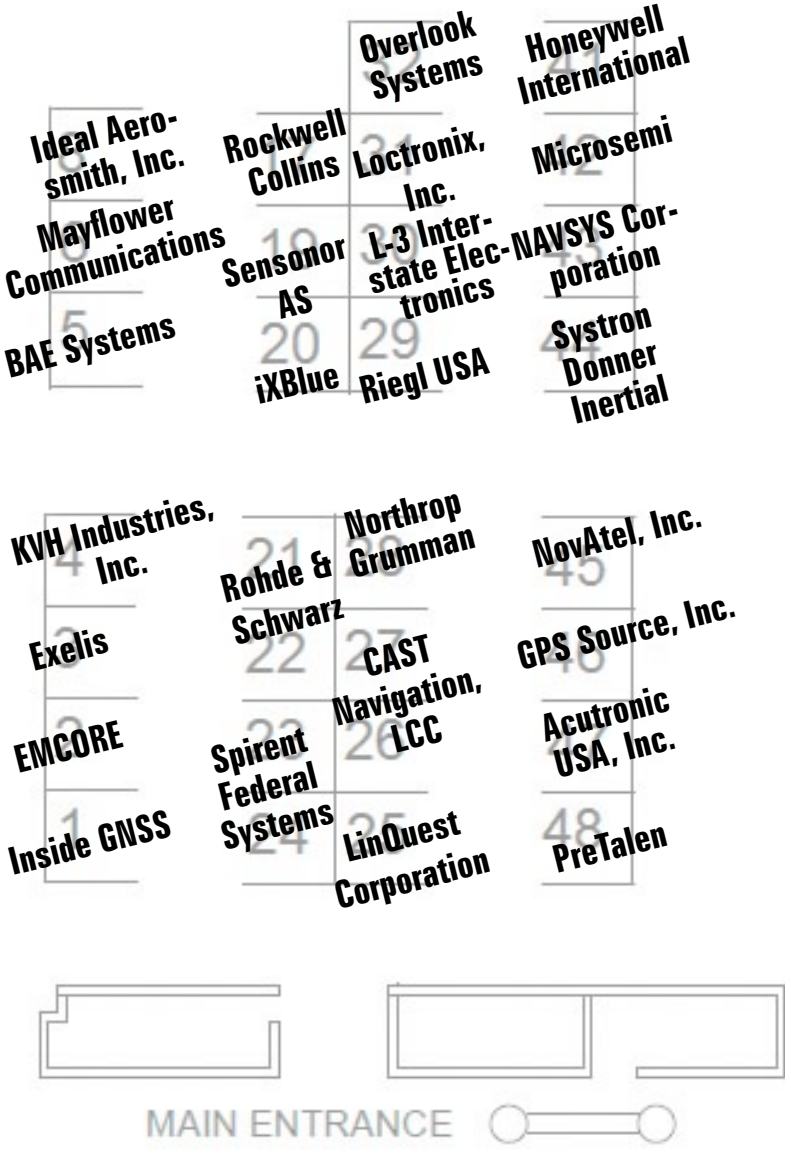
10:00 a.m.- 4:00 p.m.	Exhibits Open
12:00 p.m.-1:30 p.m.	Lunch in Exhibit Hall
6:00 p.m.- 8:00 p.m.	Exhibitor Hosted Reception

Wednesday, June 18

10:00 a.m.- 4:00 p.m.	Exhibits Open
12:00 p.m.-1:30 p.m.	Lunch in Exhibit Hall

All conference refreshments will be served in the exhibit hall during hall hours on Tuesday and Wednesday.

Exhibit Hall Diagram



JNC Conference Events

Tuesday, June 17

Informal Lunch with Exhibitors:
12:00 p.m.-1:30 p.m., Exhibit Hall
This event is included in the price of a full registration.
Guest tickets may be purchased for $60 each.

Exhibitor Hosted Reception:
6:00 p.m. - 8:00 p.m., Exhibit Hall
Join exhibitors as they host an evening of information and cuisine. A cash bar will be offered. This event is included with any type of registration. Spouses and traveling companions ages 21 years and older are welcome to attend.

Wednesday, June 18

Informal Lunch with Exhibitors:
12:00 p.m.-1:30 p.m., Exhibit Hall
This event is included in the price of a full registration.
Guest tickets may be purchased for $60 each.

Thursday, June 19

Informal Lunch for Classified Session Attendees:
11:45 a.m.-12:45 p.m., Shades of Green on Walt Disney World Resort. This event is included in the price of a full registration.

See www.ion.org/exhibits for a current list of exhibiting organizations.

FOUO and Classified Session Requirements

FOUO US ONLY SESSIONS

(Monday-Wednesday, June 16-18)

All US ONLY FOUO sessions and exhibits (June 16-18) will be held in an US ONLY FOR OFFICAL USE ONLY (FOUO) environment at the Renaissance Orlando at SeaWorld. To attend you must provide the following:

1. Proof of U.S. citizenship.
2. Visit Request/including a Need-to-Know Statement (Need-to-Know not required if using JPAS)
3. Photo ID
4. JNC Conference Badge and Paid Registration

Visit Request and Need-to-Know Statements:

All Visit Requests must be received by May 12, 2014 and be approved by the JNWC Security Office.

Prospective U.S. attendees must submit their Visit Authorization Requests through JPAS to JPAS SMO: OD3QFJ6ZB6. JPAS visit request POC field must be filled with "JNC 2014" instead of a POC name. For your convenience, if JPAS is not an option, Visit Request Form can be found at www.ion.org/jnc.

It is recommended that personnel planning to attend the FOUO or classified sessions verify that their Visit Request has been received and approved by the JNWC security office prior to making any travel arrangements. Visit authorization requests received after May 12, 2014 may not be processed/approved.

Fax all FOUO Visit Requests to:

Diane Jacobson, Personnel Security Specialist

JNWC/JFCC SPACE/USSTRATCOM

1351 Wyoming Blvd SE, Bldg 20201

Kirtland AFB, NM 87117

P: 505-853-6360; F: 505-853-6677

Diane.Jacobson.ctr@us.af.mil

CLASSIFIED SESSION

(Thursday, June 19)

The CLASSIFIED SESSION will be held in a classified 4-eyes environment (open to citizens of Australia, Canada, U.K. and U.S.A.) at Shades of Green on Walt Disney World. Citizens of Australia, Canada and U.K. should submit their visit requests through normal embassy process. Information required for embassy Clearances is as follows:

Classification: Secret//REL TO 4 EYES

Visit Type: One Time

Request Type: Facility Invitation

Request Category: Government

Anticipated Level of Classified Information: Secret//REL TO 4 EYES

Visit Dates: 19 June 2014

Purpose of Visit: Attend the 2014 Joint Navigation Conference, Orlando, FL

Facility Information: Shades of Green on Walt Disney World

Way to Contact: E-mail

Name: Joint Navigation Warfare Center/USSTRATCOM

Program/Agreement: Navigation Warfare MOU

Knowledgeable US POC:

Name: Diane Jacobson

Phone: 505-853-6360/Fax: 505-853-6677/Email: Diane.Jacobson.ctr@us.af.mil

Organization: Joint Navigation Warfare Center/USSTRATCOM

Tutorials, Monday, June 16 10:30 a.m. – 12:00 p.m.

All tutorials will be held in an FOUO U.S.-ONLY environment.Tutorials are included in a full registration or Monday single day registration.

Chuck Bye,
Honeywell

Strapdown Navigation, *Oceans Ballroom 1*

Strapdown Navigation describes the implementation of a wander azimuth frame strapdown navigation implementation. This includes a description of the reference frames used in a typical strapdown navigation system, earth model and corrections for earth induced rates and acceleration. Transformation matrices and the integration of these matrices are discussed.

Chuck Bye is currently a Senior Fellow in the Sensor, Guidance, and Navigation COE at Honeywell. He has a broad range of technical expertise in the field of navigation that includes system engineering, software development, microelectronics, Kalman filtering, GPS, inertial sensors, and system testing. Mr. Bye has a MSEE from the University of Colorado, Boulder. He is the chair of the ION North Star section; and member of the ION Council and PLANS executive committee.

Dr. John Raquet,
Airforce Institute of Technology

GPS 101, *Oceans Ballroom 2*

This course presents the fundamentals of the GPS system, and is intended for people with a technical background who do not have a 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, and GPS modernization.

Dr. John Raquet is the director of the Advanced Navigation Technology (ANT) Center at the Air Force Institute of Technology, where he is also an associate professor of electrical engineering. He has been involved in navigation-related research for over 22 years, has published over 140 navigation-related conference and journal papers and taught 44 navigation-related short courses to over 1500 students. He is the recipient of numerous awards and is an ION Fellow. He received his Ph.D. in Geomatics Engineering from the University of Calgary and M.S. in Aeronautical/Astronautical Engineering from MIT.

Dr. Curtis Cohenour,
Ohio University

Wide-Area Imaging, Georegistration and Calibration, *Oceans Ballroom 3*

Given an aerial image we would like to map each pixel in the image to an absolute position on the Earth in WGS84 coordinates. This tutorial provides the attendees with the basics necessary to generate an absolute camera calibration and projection. A simple camera model and projection are provided. A method of absolute calibration using ground reference points is described. The results are analyzed along with a discussion of error sources and some accuracy rules of thumb. The techniques are illustrated with imagery from persistent surveillance platform. The tutorial does not require knowledge of image processing. Some familiarity with navigation concepts will be helpful, but is not required.

Dr. Curtis Cohenour is an electrical engineer with the Ohio University Avionics Engineering Center in Athens, Ohio. He has worked on projects covering a wide variety of avionics and navigation systems such as, the Instrument Landing System (ILS), Microwave Landing System (MLS), Distance Measuring Equipment (DME), LAAS, WAAS, and GPS. His recent work has included research with the Air Force Research Laboratory in Dayton, Ohio, aimed at understanding and correcting image georegistration errors from a number of airborne platforms. He received his Ph. D. in Electrical Engineering from Ohio University in 2009. He is a registered professional engineer in West Virginia, and Ohio.

Logan Scott,
LS Consulting

GPS Interference & Antispoofing 1, *Oceans Ballroom 4*

This two part course provides a high level perspective on the effects of jamming and spoofing on GPS receivers and offers some possible mitigation approaches and policy recommendations. After a quick review of how GPS determines position, the focus is on the effects of various interference types on specific GPS signals. The effects of ground mobile propagation in limiting effective jammer range are examined. Military mitigations such adaptive arrays, and IMU aiding are discussed. Civil jamming and spoofing examples and incidents are then covered along with methods to detect, identify and militate against their effects. Challenges in locating ground based jammers are discussed and proposals are made for crowdsourced geolocation methods. The need for military and civil receiver testing and certification is then covered. Finally, specific, actionable national policy recommendations are made.

Logan Scott, is president of LS Consulting and has over 35 years of military and civil GPS systems engineering experience and has been an active advocate for improved civil GPS location assurance. 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. At Omnipoint (now T-Mobile), he developed spectrum sharing techniques that led to a Pioneer's preference award from the FCC. He is a cofounder of Lonestar Aerospace, an advanced decision analytics company located in Texas. Logan is an ION Fellow and holds 36 US patents.

Lunch is on Your Own

Tutorials, Monday, June 16 1:30 p.m. – 3:30 p.m.

All tutorials will be held in an FOUO U.S.-ONLY environment.Tutorials are included in a full registration or Monday single day registration.

Chuck Bye, *Honeywell*

Sensor Modeling, *Oceans Ballroom 1*

Sensor Modeling provides a brief description of gyro and accelerometer modeling. This course will not cover specific sensor technologies, but rather how to model any gyro or accelerometer from a system perspective. Modeling of deterministic errors such as bias, scale factor, and non-linearity; and stochastic errors will be discussed. The stochastic errors discussion will include a description of how to interpret Allan Deviation plots and modeling of the sensor errors using random Walk, Gauss Markov processes. Several examples will be presented, including guidelines for interpreting manufacturer's product brochures as they pertain to modeling inertial sensors.

Chuck Bye is currently a Senior Fellow in the Sensor, Guidance, and Navigation COE at Honeywell. He has a broad range of technical expertise in the field of navigation that includes system engineering, software development, microelectronics, Kalman filtering, GPS, inertial sensors, and system testing. Mr. Bye has a MSEE from the University of Colorado, Boulder. He is the chair of the ION North Star section; and member of the ION Council and PLANS executive committee.

Marvin B. May, *ARL Penn State's Navigation Research & Development Center*

Inertial Navigation, *Oceans Ballroom 2*

This overview course addresses the critical role that inertial navigation systems play in modern military warfare. The history, advantages and disadvantages of inertial navigation are addressed. A description and demonstration of systems presently being utilized or in development is provided. Introductory lectures on the theory and operation of accelerometers, gyroscopes, gimballed and strapdown systems are given. A futuristic look at new applications and the role of Microelectromechanical sensors concludes the course.

Marvin B. May is the chief navigation technologist at ARL Penn State's Navigation Research and Development Center where is manages their navigation education program. He is a recognized navigation specialist with expertise in GPS, inertial and geophysical navigation. He has a Masters Degree from New York University and Polytechnic Institute, doctoral courses at Polytechnic Institute and is a Professional Engineer. He has written numerous technical articles on navigation and has served on high level navigation committees. He was the 2007 winner of the ION's Weems Award and is an ION Fellow.

Dr. Joe White, *Sotera Defense Solutions*

Precise Time and Frequency Applications, *Oceans Ballroom 3*

This tutorial will introduce precise time and frequency (PT&F) applications and includes an overview of the fundamentals of PT&F signals their generation and measurement. An introduction to time scales, those in use, and their origin will be described to provide an understanding of how traceability of PT&F is needed throughout its generation, dissemination and use. The distinction between global time scales and those generated and used within systems will be described to provide an understanding of their basic differences and strengths. The distinctions and commonalities between telecommunications and navigation positioning will be discussed. How GPS supports time dissemination and time transfer interfaces with many and varied systems will be covered and examples of different system applications will be discussed. The session will conclude with a projection of future directions of PT&F and its application.

Dr. Joe White is a research physicist with Sotera Defense Solutions and a retiree from the Space PNT Branch, U.S. Naval Research Laboratory. Dr. White has expertise in GPS space clock development, space GPS receivers, GPS receiver testing and calibration, applications of GPS to military timing systems, precision clock testing, and environmental testing of clocks and timing hardware. He chaired the Precise Time and Time Interval (PTTI) Systems and Applications Meeting 1997 to 2009 and holds a Ph.D. in physics from American University.

Logan Scott, *LS Consulting*

GPS Interference & Antispoofing 2, *Oceans Ballroom 4*

This two part course provides a high level perspective on the effects of jamming and spoofing on GPS receivers and offers some possible mitigation approaches and policy recommendations. After a quick review of how GPS determines position, the focus is on the effects of various interference types on specific GPS signals. The effects of ground mobile propagation in limiting effective jammer range are examined. Military mitigations such adaptive arrays, and IMU aiding are discussed. Civil jamming and spoofing examples and incidents are then covered along with methods to detect, identify and militate against their effects. Challenges in locating ground based jammers are discussed and proposals are made for crowdsourced geolocation methods. The need for military and civil receiver testing and certification is then covered. Finally, specific, actionable national policy recommendations are made.

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Break: 3:00 p.m. - 3:30 p.m.

Patrick Pitoscia, US Army CERDEC

A1: Precision Azimuth Sensing

3:30 p.m. - 5:00 p.m., *Oceans Ballroom 1*

3:35 **1. A Roadmap for Azimuth Sensing in Army Systems:** B. Thomas and W. Thodos, Army NVESD

3:55 **2. Advances in Lightweight Precision Azimuth System:** N. Mathur, EOIR Technologies, UA Army, PM-SPTD; J. Bias, R.T. Thorpe, Jacobs, US Army, PM-SPTD

4:15 **3. Azimuth and Vertical Angle Module (AVAM) Prototype Test Results:** V.C. LeFevre, US Army AMRDEC; S.J. Pethel, Navigation Technology Associates, Inc.; N.G. Mathur, EOIR Technologies, US Army, PM-SPTD

4:35 **4. Rapid Gyrocompassing for Manportable Targeting Systems:** J.E. Pritchett, C.H. Lange, J.W. Warren, JHU/APL

Alternates

1. **Adaptive Approach for Azimuth Determination:** M. Slama, Honeywell, International; P. White, AMRDEC
2. **Emcore's Azimuth and Vertical Angle Module (AVAM):** C. Reynolds, Consultant to Emcore; K.K. Wong, Emcore

Phil Bruner, Northrop Grumman

Karl Kovach, The Aerospace Corporation

B1: Multi-GNSS Receivers for Military Applications

3:30 p.m. - 5:00 p.m., *Oceans Ballroom 2*

3:35 **1. Military Utility of GNSS: Strengthening the Resilience of GPS:** J.M. Hebert, AFRL/RYWN

3:55 **2. GNSSTA: Global Navigation Satellite System Test Architecture:** A. Cerruti, K. Skey, J. Davis, S. Miller, The MITRE Corporation; E. Emile, USAF

4:15 **3. Multi-GNSS Receiver-based Signal Authentication:** J.C. Macdonald Jr., USAF AFRL/RYWN

4:35 **4. Singapore International Global Navigation and Localization (SIGNAL) Project Agreement:** E. Vinande, N. Pujara, AFRL/RYW; J. Morton, Miami University, OH; F. van Graas, Ohio University

Alternate

1. **A Enhanced Approach to GNSS CRPA Testing in a Zoned Anechoic Chamber:** P.G. Boulton, Spirent Communication plc, United Kingdom; N. Fedora, Spirent Federal Systems, Inc. USA; S. Hickling, Spirent Communication plc, UK

Logan Scott, LS Consulting

Lt. Col. Thomas Ste. Marie, 2SOPS

C1: GPS Constellation Performance

3:30 p.m. - 5:00 p.m., *Oceans Ballroom 3*

3:35 **1. Computation of User Range Errors (URE) from Precise Ephemeris Data:** J. Bingham, 746th Test Squadron

3:55 **2. Inter Signal Correction Sensitivity Analysis: Assessing SV Aperture Dependent Delays and Ground Control Approximations on Modernized GPS Dual Frequency Navigation:** A. Tetewsky, C.S. Draper Laboratory; G. Okerson, SRI International

4:15 **3. Triple Frequency GPS Signal Tracking During High Latitude Ionospheric Scintillations:** M. Carroll, Y. Morton, Miami University (Ohio); E. Vinande, Air Force Research Laboratory (AFRL)

4:35 **4. Improving Information Assurance for GPS Data:** W. Al-Masyabi and C. Corwin, Raytheon Company

Alberto Arredondo, The Aerospace Corporation

Marvin May, Penn State

D1: Operational Product Demonstrations 1

3:30 p.m. - 5:40 p.m., *Oceans Ballroom 4*

3:35 **1. GLANSER Demonstration:** W. Hawkinson, P. Samanant, R. McCroskey, R. Invalson, A. Kulkarni, Honeywell International

4:15 **2. RF Ranging for Squad-Level Situation Awareness:** C.M. Foster, B.D. Farnsworth, R.B. Alwood and D.W.A. Taylor, ENSCO, Inc.

4:55 **3. Simulated Programmable Aircraft-Embedded Jammer (SPACE JAM):** J. Hebert, AFRL/RYWN; D. Levene, AFIT/TPS; J. Raquet, AFIT; W. Deike, AFRL/RYWN; D. Dresher, Northrop Grumman

Alternate

1. **Signal Architect GPS Jamming Demonstration Kit for Military GPS User Equipment Training:** A. Brown, J. Redd, and J. Seabaugh, NAVSYS Corporation

Dr. R. James Duckworth, Worcester Polytechnic Institute


Don Venable, AFRL Sensors Directorate

A2: Alternate Navigation Technologies 1
8:30 a.m. - 10:00 a.m., *Oceans Ballroom 1*


Dr. Michael Veth, Veth Research Associates

8:35 **1. A Real-Time GPS-Challenged Navigation and Image Geo-Registration System for Airborne Platforms:** S. Berardi, H. Park, Northrop Grumman Electronic Systems; A. Brown, Toyon Research Corporation; C. Taylor, Air Force Research Laboratory

8:55 **2. Evaluation of Multi-State Constraint Kalman Filter for Video/Inertial Navigation:** R. Madison, P. DeBitetto, R. Truax, C.S. Draper Laboratory

9:15 **3. Unmanned Aerial System Vision Aided Navigation (UVAN) Rapid Reaction Effort:** D. Venable, Air Force Research Laboratory; K. Kauffman, Air Force Institute of Technology (AFIT); J. Campbell, Air Force Research Laboratory; J. Raquet, Air Force Institute of Technology

9:35 **4. Vision Navigation Test Results for Army Ground Platforms and Applications:** K. Johnson, US Army CERDEC, Command, Power and Integration Directorate; A. Baron, Five Focal, LLC; G. Katulka, US Army CERDEC, Command, Power and Integration Directorate; H. Watch, B. Frevert, Five Focal, LLC; A. Fortmayer, US Army CERDEC, Command, Power and Integration Directorate

Alternates

1. **NEOGEO - Large Scale Satellite Image Aided Navigation:** D. Venable, Air Force Research Laboratory; J. Raquet, K. Kauffman, Air Force Institute of Technology
2. **Vision Aided Navigation Using iOS and Embedded Devices:** M. Lashley, J. Seal, Navigation Technology Associates, Inc.; G. Reynolds, US Army, AMRDEC

Van Tran, U.S. Army CERDEC

B2: Atomic Clocks and Timing Applications
8:30 a.m. - 10:00 a.m., *Oceans Ballroom 2*


Gregory Weaver, Johns Hopkins APL

8:35 **1. Chip-Scale Atomic Clock Manufacturing Technology Development:** Y. Kim, US Army Communications-Electronics RD&E Center (CERDEC)

8:55 **2. Performance of Composite Clock Control Systems under Abrupt Dynamic Motion:** L. Anthony Watkins and G.L. Weaver, Johns Hopkins University Applied Physics Laboratory

9:15 **3. Assured High Accuracy Velocity and Frequency during Aircraft Maneuvers:** F. van Graas, Ohio University; P. Howe, T. Nguyen, Air Force Research Laboratory

9:35 **4. Measurement of GPS Time Recovery in Clear and Challenged Environments:** E. Byrne, Microsemi; T.Q. Nguyen, D. Howell, AFRL/RYWN; L. Boehnke, Microsemi; J. Campbell, AFRL/RYWN; J. Warriner, Microsemi; P. Howe, MBO Partners

Alternates

1. **Development of Highly Manufacturable Optical Frequency Standards for Land and Space:** C.J. Erickson, AFRL, N.D. Zameroski, SARA; J. Crow, J.H. Burke, AFRL
2. **Precision Time Transfer for Direct-Y Acquisition using a AN/PRC-154A Rifleman Radio:** D. Hodo, W. Travis, IS4S; S. Khoury, GDC4S; D. Bevly, Auburn University


Eddy Emile, USAF GPS Directorate

C2: Antenna Technologies and Interference Mitigation
8:30 a.m. - 10:00 a.m., *Oceans Ballroom 3*


Dr. Keith McDonald, The MITRE Corporation

8:35 **1. New Protected GPS Antenna Technology:** P. Molchanov, Compass Systems Inc.

8:55 **2. GPS Situational Awareness Testing:** E. Hogan/AMRDEC; M. Lashley/NTA, Inc.

9:15 **3. Continuous Adaptive Interference Nulling Antenna Electronics for Defeat of Severe Wideband Jamming of GPS and Other Navigation Signals:** R. Vosburgh and V. Haridasan, Physical Devices Inc.

9:35 **4. Prediction of Antenna Induced Biases in a Real World Anti-Jam GPS Receiver:** A.J. O'Brien, I.J. Gupta, The Ohio State University; S. Sorber, M. Goodwin, Lockheed Martin; A. Trunzo and D.A. Ruff, 746th Test Squadron

Alternates

1. **Compact Anti-Jam GPS Array for Emerging Threats:** J. McVay, D. Pearson, C.J. Reddy, Applied EM, Inc.; C. Lau, J. Hoffman, G. Sinclair, Harris Corporation
2. **Modeling of A/J SFAP/STAP Systems and Resulting Performance Predictions:** A.R. Herrera, S. Boughton, I.M. Weiss, The Aerospace Corporation


Kevin Coggins, U.S. Army, PD PNT


Jules McNeff, Overlook Systems Technologies

D2: Warfighter Requirements and Solutions
8:30 a.m. - 10:00 a.m., *Oceans Ballroom 4*

8:35 **1. DoDs Directive 4650 Family: DoD Policies Driving PNT Architectures for the Warfighter:** R.J. Swider, Jr. PNT Plans & Policy, Office of the DoD Chief Information Officer (DoDCIO)

8:55 **2. Affordably Enabling Assured PNT - Ground Vehicles:** R. Horton, G. Ott, GPS Source, Inc.

9:15 **3. DoD Precise Time and Celestial Reference Frame Management:** B. Connon, U.S. Naval Observatory

9:35 **4. Capturing Soldier Motion: Fort Sill Tests:** V.C. LeFevre, US Army AMRDEC; S.J. Pethel, P.N. Osterc, Navigation Technology Associates, Inc.; N.G. Mathur, EOIR Technologies, US Army PM-SPTD

Alternate

1. **SAASM Approvals and Authorizations Process:** S. Callaghan and M. Nichols; The Aerospace Corporation

Break in Exhibit Hall: 10:00 a.m. - 10:30 a.m.

LtCol Ken Fisher, USAF HQ PACOM

Thomas Pestak, Air Force Institute of Technology

A3: Alternate Navigation Technologies 2

10:30 a.m. - 12:00 p.m., *Oceans Ballroom 1*

10:35 **1. Aided Navigation and Geo-registration in GPS-denied Environments via Factor Graphs:** M. Keck, J. Zampieron, J. Douglas, D. Morgan, STR; C. Taylor, Air Force Research Laboratory

10:55 **2. Star Tracker Integration with Navigation Systems:** S.J. Pierce and J. Raquet, Air Force Institute of Technology

11:15 **3. SAR/Inertial Integration for GPS-Denied Navigation:** A. Soloviev, QuNav; C. Yang, Sigtem Technologies

11:35 **4. High-performance Plug-and-play Bayesian Estimation Software Suite for Navigation:** K. Kauffman, D. Marietta, Air Force Institute of Technology (AFIT); A. Canciani, Air Force Research Laboratory (AFRL); M. Smearcheck, AFIT; D. Venable, AFRL

Alternates

1. **Compact Atomic Magnetometer for Navigation Aiding:** M.S. Larsen, and M.D. Bulatowicz, Northrop Grumman
2. **New Trends in Star Sighting Technology:** J.P. Laine, B. Lane, E. Waldron, G. Blasche, C.S. Draper Laboratory, Inc.

Dr. TJ Klausutis, AFRL Munitions Directorate

B3: Aviation Applications 1

10:30 a.m. - 12:00 p.m., *Oceans Ballroom 2*

Ann Adams, Honeywell

10:35 **1. GPS Wide Area GPS Enhancement-2 (WAGE-2) Utility in Future Aviation Programs:** T. Marquez, U.S. Navy; T. Nix, U.S. Air Force

10:55 **2. Challenges of the F-35 GPS Sensor:** J. Fleming J. Maenpa, Raytheon, Space and Aiborne Systems

11:15 **3. ASR 3.7-DS and GEM-VII as the Basis for ADS-B Out, LPV-200, and GBAS Approach:** J. Weger, Rockwell Collins, Inc.

11:35 **4. Summary of Flight Test Results for Divergence-Free and Ionosphere-Free Variants of Modified Code Noise and Multipath (CNMP) Algorithm on Five Airframes:** D.C. Bruckner, F. van Graas, T.A. Skidmore, Ohio University

Alternates

1. **Compact, Low-Cost Fiber-Optic Gyroscope for Long-Term Antenna Stabilization:** B. Moslehi, L. Oblea, J. Costa, Intelligent Fiber Optic Systems Corporation (IFOS); R. Yahalom, InFiber Technology Inc.; M. Berarducci, J.C. Ha, Air Force Research Laboratory, Sensors Directorate; T. Loakimidis, The MITRE Corporation
2. **Airborne Validation Testing of the JSF GPS Sensor:** J. Maenpa and J. Fleming, Raytheon, Space and Airborne Systems

Dr. Thomas Powell, The Aerospace Corporation

Maj. Nima Emami, USAF SMC/GPS, Military GPS User Equipment Branch

C3: GPS Modernization 1

10:30 a.m. - 12:00 p.m., *Oceans Ballroom 3*

10:35 **1. MGUE Program Update:** Lt Col Wilson, P. Tran, The Aerospace Corporation

10:55 **2. M-Code Security Certification:** M. Nichols, J. Tucker, D. Goldstein, The Aerospace Corporation

11:15 **3. GPS OCX Program Overview and Update:** M.G. Gilligan, Raytheon

11:35 **4. Mission Constellations:** N.N. Faustino, The Aerospace Corporation; J.M. Hempen, U.S. Air Force

Dr. Donna Senft, AFRL Space Vehicles Directorate

D3: Space and Satellite Applications

10:30 a.m. - 12:00 p.m., *Oceans Ballroom 4*

John Langer, The Aerospace Corporation

10:35 **1. GPS III Space Service Volume Improvements:** C.H. Frey and L.J. Reynolds, Lockheed Martin

10:55 **2. Compact Inertial Reference Unit for Space (CIRUS):** T. Trzesniowski, D. Blischok, R. Jajko, P. Wall, L-3 Communications, Space & Navigation; R. Yahalom, InFiber Technology, Inc.

11:15 **3. Products and Services of the Earth Orientation Parameters Combination and Prediction Division for the War Fighter and Others: Earth Orientation, Leap Seconds, and Conventions:** N. Stamatakos and B. Luzum, US Naval Observatory

11:35 **4. Space Electronics Technology Research for Future GPS Satellite Payloads:** K. Bole, Think Strategically LLC, supporting AFRL/RVSE; H. Bradley, USAF AFRL/RVSE

Alternate

1. **GPS TEC Estimation and Validation Using Simultaneous Incoherent Scatter Radar Measurements:** H. Bourne, Y. Morton, Miami University; T. Nguyen, Air Force Research Laboratory; M. Sulzer, Arecibo Observatory, Puerto Rico; M. Milla, Jicamarca Radio Observatory, Peru

Dr. Donna Senft, AFRL Space Vehicles Directorate

Lunch in Exhibit Hall, 12:00 p.m. - 1:30 p.m.

Tuesday, June 17 — 1:30 p.m. - 3:00 p.m.

Bill Bollwerk, USNO

PLENARY SESSION I: Assured PNT, *Oceans Ballroom 3/4*

Welcome: James Doherty, ION Military Division Chair

Introduction of Plenary Speakers: Bill Bollwerk, JNC 2014 Program Chair

Invited Speakers

Break in Exhibit Hall: 3:00 p.m. - 3:30 p.m.

Tuesday, June 17 — 3:30 p.m. - 5:00 p.m.

John Del Colliano, U.S. Army CERDEC

Dr. Andrey Soloviev, QuNav

A4: Navigating in Challenged Environments

3:30 p.m. - 5:00 p.m., *Oceans Ballroom 1*

3:35 1. **Tracking and Locating Dismounted Warfighters Independent of GPS:** D.W.A. Taylor, C.M. Foster, B.D. Farnsworth, W.T. Faulkner, R.B. Alwood, and E.J. Kreinar, ENSCO, Inc.

3:55 2. **Velocity-Aided Inertial Navigation for GPS Denied Environments: Army Micro Inertial Navigation Technology (MINT) Test Results:** A.R. Schofield, J. Stevanak, M. Caporellie, D. Weinman, US Army CERDEC; M. Berarducci, J. Ha, Air Force Research Laboratory/Sensors Directorate

4:15 3. **Multipath Rejection using Cooperative GPS Receivers:** M. Munoz, S. Wu, LinQuest Corp; F. Mosuavi, California State University, Fullerton

4:35 4. **Progress in Validation of GPS Error Estimates for Manportable Targeting Systems:** S.B Goldblatt, JHU/APL; J.S. Bias, US Army PM-SPTD; C.H. Lange, JHU/APL; N.G. Mathur, EOIR Technologies; J.E. Pritchett, G.B. Stupp, J.W. Warren, JHU/APL

Alternate

1. **A Robust Navigation Receiver for GNSS Challenged Environments:** M.O. Davies, P.F. MacDoran, M.B. Mathews, Loctronix® Corporation

Michael Berarducci, AFRL Sensors Directorate

Dr. Barry Roberts, Honeywell

B4: Aviation Applications 2

3:30 p.m. - 5:00 p.m., *Oceans Ballroom 2*

3:35 1. **Expandable Flight Reference Data Processing Software:** M. Smearcheck, D. Marietta, J. Raquet, Air Force Institute of Technology; D. Ruff, S. Herrera, A. Trunzo, 746th Test Squadron

3:55 2. **Honeywell EGI SBAS Architecture:** C. Cutright and M. Engel, Honeywell

4:15 3. **Surveillance Performance Analysis for Airborne Sense and Avoid (ABSAA):** S. Calhoun, T. Needham, CalAnalytics; J. Warren, Booz Allen Hamilton; A. Soloviev, Qunav

4:35 4. **Will Your Military GPS Receiver Support ADS-B?:** J.R.A. Stevens, The MITRE Corporation; T. Ying, U.S. Air Force

Dr. Jeff Hebert, AFRL Sensors Directorate

C4: GPS Modernization 2

3:30 p.m. - 5:00 p.m., *Oceans Ballroom 3*

3:35 1. **A Keyless GPS Receiver: An Alternative Security Architecture:** B. Butler, Real Time Logic, Inc.

3:55 2. **Software Enabled Reconfigurable GNSS Embedded Architecture for Navigation and Timing (SERGEANT) – Project Status:** J. Dickman and M. Cosgrove, Northrop Grumman; J.D. Davis, J. Hebert, and J.C. Ha, AFRL

4:15 3. **The Warfighter Benefits of an On-Orbit Reprogrammable Waveform Generator (ORDWG):** K. Slimak, AFRL/RVEP, T. Roberts, AFRL/RVEP, J. Anderson, Canyon Systems, LLC

4:35 4. **Meeting the Vision for the 3Gen GPS:** C. Corwin, S. Law, Raytheon Company; J. Loving, Infinity Systems Engineering

Alternate

1. **GPS OCX Operationally Effective Information Exchange:** W. Al-Masyabi, C. Corwin, S. Law, Raytheon Company

Mary Nichols, The Aerospace Corporation

D4: Operational Product Demonstrations 2

3:30 a.m. - 5:40 p.m., *Oceans Ballroom 4*

Kevin Skey, The MITRE Corporation

3:35 1. **Operational Product Demonstration Proposal Collaborative Feature and Signature Mapping Supporting Enhanced GPS-Denied Navigation and Mapping:** C. Politi and C. Teolis, TRX Systems

4:15 2. **Navigation Enhancements for Android-based Military Systems via NavWarrior App:** A. Brown and A. Blondeau, NAVSYS Corporation; B. Baehr, SMDC BL

4:55 3. **PANACEA: Automating GNSS Receiver Testing - Operational Demonstration:** G. Gerten, J. Hebert, K. Meyer, PreTalen, LTD

Alternate

1. **BroadSense: Recording and Monitoring the Radio-Frequency Spectrum:** G. Gerten and K. Meyer, PreTalen, LTD

Capt. Christopher Brown, U.S. Army PD PNT

Exhibitor Hosted Reception, 6:00 p.m. - 8:00 p.m.


Dr. Adam Schofield, U.S. Army CERDEC

A5: Inertial Measurement Unit 1

8:30 a.m. - 10:00 a.m., *Oceans Ballroom 1*

8:35 **1. Laboratory Test and Evaluation of the Northrop Grumman LITEF uIMU MEMS IMU Over Military Environments:** P. Renfroe, U.S. Army AMRDEC; S. Pethel, NTA, Inc.; B. Norling, Northrop Grumman

8:55 **2. Performance Measurements of Two Low SWaP MEMS-Based Strapdown Gyrocompasses:** B. Thomas and W. Thodos, Army NVESD


Dr. Andrei Shkel, University of California Irvine

9:15 **3. Flat is Not Dead: Current and Future Performance of Si-MEMS Quad Mass Gyro (QMG) System:** A.A. Trusov, D.M. Rozelle, G. Atikyan, Northrop Grumman Corporation; B.R. Simon, S.A. Zotov, A.M. Shkel, University of California, Irvine; A.D. Meyer, Northrop Grumman Corporation

9:35 **4. Co-fabrication of MEMS Gyroscopes on Rotary Stages for Bias Calibration:** G.H. Lodden, J. Reinke, R. Supino, M. Grimm, K.V. Christ, Honeywell Inc.; G. Hatipoglu, S. Tadigadapa, Pennsylvania State University

Alternate

1. Miniature MEMS IMU/INS Achieves Low Noise and Low Drift Sensor Errors for Tactical Grade Performance in GPS-denied Environments: M. Tanenhaus, Tanenhaus and Associates; D. Carhoun, Consultant; T. Geis, Tanenhaus and Associates; E. Wan, Portland State University; A. Holland, Eminent MicroSystems-consultant


Chris Lund, Honeywell

B5: Robust Navigation Systems/Solutions

8:30 a.m. - 10:00 a.m., *Oceans Ballroom 2*

8:35 **1. Early Integration of Modernized Precision Guided Munitions for the Air Domain:** S. Mahmood, AFMC Armament Directorate; T. Sharpe, The Aerospace Corporation

8:55 **2. Integrated Position Navigation and Timing (PNT)- A Path to Flexible-Navigation:** J.L. Campbell, D.T. Venable, S.L. DeVilbiss, AFRL/RYWN

9:15 **3. Honeywell Micro Electro Mechanical Systems (MEMS) Inertial Navigation System (INS):** R.B. Merritt, S.I. Snyder, C.J. Matthews, Honeywell Inc.

9:35 **4. 9 Mar 14 Future U.S. Navy Navigation Efforts: GPS Based Position, Navigation, and Timing Service (GPNTS) and Multi-Platform GPS Navigation Antenna (MAGNA):** T. Marquez, J. Sluder, A. Kurdian, PEO(C4I)


John Nielson, Rockwell Collins

C5: Receiver Technology

8:30 a.m. - 10:00 a.m., *Oceans Ballroom 3*

8:35 **1. Carrier Phase Vector Tracking Performance Analysis:** M. Lashley, NTA, Inc.

8:55 **2. GPS and Anti-Jam Upgrades in Legacy EGI Applications:** J. Weger, Rockwell Collins Inc.; J. Allsop, Hill Air Force Base

9:15 **3. Multipath Effects and Error Mitigation on the M-Code Signal:** A. Brown and P. Burns, NAVSYS Corporation

9:35 **4. Spoofer Detection Through a 'Smooth' GPS Receiver Clock:** P. Misra, R. Filler, and S. Ganop, Pennsylvania State University/ Applied Research Laboratory

Break in Exhibit Hall: 10:00 a.m. - 10:30 a.m.

Dr. Frank van Graas, Ohio University

A6: Inertial Measurement Unit 2

10:30 a.m. - 12:00 p.m., *Oceans Ballroom 1*

10:35 **1. Honeywell's Development of a Family of Tactical Grade Inertial Measurement Units (IMUs):** D. Oscarson, T. Braman, S. Goepfert, G. Hanson, J. Henrickson, J. Thorland, Honeywell International

10:55 **2. Nuclear Magnetic Resonance Gyroscope: For DARPA's Micro-Technology for Positioning, Navigation and Timing Program:** M. Bulatowicz and M. Larsen, Northrop Grumman

11:15 **3. Self-Calibrating Vibrating Gyroscope:** M. Weinberg, E. Cook, T. Campbell, M. Chaparala, S. Finberg, T. Henry, D. McGorty C.S. Draper Laboratory; K. Townsend, United Technologies Aerospace Systems, UK; J. Dodge, United Technologies Aerospace Systems, USA

11:35 **4. Laboratory Inertial Testing of the Analog Devices ADIS16488 Ten Degrees of Freedom Inertial Sensor:** D.W. Tarrant, B.E. Grantham, U.S. Army AMRDEC; T.B. Medley, C.T. Hughes, Navigation Technology Associates, Inc.

Alternates

1. **Test and Analysis Techniques for the Exploitation of Seeker Gyroscopes:** C. Blankenship and B. Grantham, US ARMY, Aviation and Missile Research Development and Engineering Center (AMRDEC)
2. **Development of Fused Silica Micro Birdbath Resonator Gyroscope:** J. Cho, J.-K. Woo, T. Nagourney, A. Darvishian, B. Shiari, C. Boyd, and K. Najafi, University of Michigan

Dr. Mikel Miller, AFRL Munitions Directorate

Dr. David Bevly, Auburn University

B6: Collaborative Navigation Techniques 1

10:30 a.m. - 12:00 p.m., *Oceans Ballroom 2*

10:35 **1. Implementing Comm-Nav Messages in an Android Phone:** M. Hajianpour, E. Shokri, The Aerospace Corporation; F. Maurel, SMC/GPU

10:55 **2. Design, Implementation and Evaluation of Ultrasonic Ranging on Commercial Off-The-Shelf Android Smartphones:** H. Han, G. Zhao, H. Zeng, K. Qi, E. Van Doorn, Intelligent Automation, Inc. (IAI); N.M. Vo, J. Del Colliano, Army CERDEC

11:15 **3. Collaborative Navigation through the Establishment and Distribution of Electronic Aids to Navigation in Real Time:** R. Glenn Wright, GMATEK, Inc., USA and World Maritime University, Sweden; M. Baldauf, World Maritime University, Sweden

11:35 **4. Multi-Node GPS Receiver: Design Approach, Test Results and Real-Time Implementation Status:** A. Soloviev, Qunav; J. Dickman, M. Van Antwerp, Northrop Grumman

Alternates

1. **A Multi-Agent Tasking a Control metHod for Simultaneous Localization and Mapping (MATCH-SLAM) -Cooperative Swarms of Very small Aerial Vehicles in GPS-denied Hazardous Environment:** D. Manegold, Physical Sciences Inc.
2. **Collaborative Navigation Using Conditionally Independent Filters:** R. Ingvalson, Honeywell International, Inc.

Robert Greenlee, Joint Navigation Warfare Center

Kent Hyatt, Overlook Systems Technologies

C6: Navigation Warfare 1

10:30 a.m. - 12:00 p.m., *Oceans Ballroom 3*

10:35 **1. GPS Airborne Jammer (ABJ):** J. Diaz, 746th Test Squadron

10:55 **2. The Army PNT System of Systems Architecture - A Path to Resilient Positioning, Navigation and Timing:** Kevin Coggins, US Army PD PNT

11:15 **3. FORTUNE MONGOOSE: RF Model Comparisons and Impacts to NAVWAR:** J. Harlin, C. Vaughan, D. Healey, J. Miller, B. Herndon, K. Johnston, K. Fry, D. Cuevas, S. Sorenson, Joint Navigation Warfare Center

11:35 **3. Development and Demonstration of GPS/INS Targeting Capability for the HELLFIRE Romeo Missile:** P. Renfroe, US Army AMRDEC; M. Lashley, D. Pittman, J. Jones, NTA, Inc.; R.I Johnson, GRA, Inc.

Alternates

1. **Joint Navigation Warfare Center 2014 NAVWAR Assessment:** B. Wash, Joint Navigation Warfare Center
2. **NAVFEST**: W. Warren, 746th Test Squadron

Lunch in Exhibit Hall, 12:00 p.m. - 1:30 p.m.

Wednesday, June 18 — 1:30 p.m. - 3:00 p.m.

Bill Bollwerk, USNO

PLENARY SESSION II: Assured PNT, *Oceans Ballroom 3/4*

Break in Exhibit Hall: 3:00 p.m. - 3:30 p.m.

Wednesday, June 18 — 3:30 p.m. - 5:00 p.m.

Christopher Roberts, U.S. Army AMRDEC

A7: Inertial Measurement Unit 3

3:30 p.m. - 5:00 p.m., *Oceans Ballroom 1*

3:35 **1. A Hybrid Approach to an Atom-Interferometer-Based Inertial Measurement Unit:** D. Butts, M. Bottkol, T. Thorvaldsen, S. Lim, R. Stoner, J. Choy, J. Brown, P. Sherman, M. Chaparala, S.P. Smith, D.M.S. Johnson; C.S. Draper Laboratory; A. Rakholia, G. Biedermann, Sandia National Laboratory; M. Berarducci, Air Force Research Laboratory

3:55 **2. Laboratory Testing to Characterize Acceleration Sensor Contribution to Navigation Accuracy Using Overdetermined Navigation:** D. Tarrant and B.E. Grantham, U.S. Army AMRDEC; T.B. Medley, C.T. Hughes, Navigation Technology Associates, Inc.

4:15 **3. Method for Interweaving Cold-Atom Interferometer and Conventional INS Measurements:** K. Willis and M. Pachter, Air Force Institute of Technology

Brian Fly, Kearfott

4:35 **4. Micro Inertial Navigator (MINav) System for GPS Denied Applications:** C. Reynolds, Consultant to Emcore; V. Franco, AMRDEC; K. K. Wong, Emcore

Alternate

1. Paradigm Shift in Precision Position, Navigation, and Control: K. Shcheglov, S. Orlov, D. Smukowski, Sensors in Motion Inc.; J.C. Ha AFRL/RYWN

B7: Collaborative Navigation Techniques 2

3:30 p.m. - 5:00 p.m., *Oceans Ballroom 2*

Steve Rounds, John Deere

3:35 **1. Collaborative Navigation for GPS-Denied A2AD Environments:** H. Park, Z. Zhu, L. Boroson, S. Berardi, Northrop Grumman; D. Venable, J. Campbell, Air Force Research Laboratory

3:55 **2. Field Test Results of Distributed Network Opportunistic Positioning using Software Defined Radios:** A.K. Brown, J. Redd, and A. Blondeau, NAVSYS Corporation

4:15 **3. Indoor Navigation using Collaborative Mapping:** K. Kordari and C. Teolis, TRX Systems

Sharon Donald, C.S. Draper Laboratory

4:35 **4. From Network-Assisted GPS to Network-Assured GPS:** E. Emile, SMC/GPU; K. Slimak, T. Roberts, AFRL/RVEP; J. Anderson, Canyon Systems, LLC

Alternates

1. Improvement in Ultra-Tight Coupling via Measurement of Change in Pseudorange: W.E. Lillo, S.L Osburn, M. Gollakota, The Aerospace Corporation

2. A Collaborative Interference Detection Algorithm for GNSS-enabled Android Devices: E. Valles and C. Yu, The Aerospace Corporation

C7: Navigation Warfare 2

3:30 p.m. - 5:00 p.m., *Oceans Ballroom 3*

Paul Benshoof, Locata Corporation

3:35 **1. Modernized High Power Jammer (HPJ) Development Programs:** B. Wong and D. Morales, 746th Test Squadron

3:55 **2. UAV-Based Preliminary Testing of a Multi-Emitter Localization System for the 800-2400 MHz Frequency Range:** B. Ledvina, J. Diamond, Coherent Navigation, Inc.; J. Bhatti, T. Humphreys, The University of Texas at Austin

4:15 **3. GPS Interference and Navigation Tool – Reliability Prediction Model Version 1.1.14.88 Comparison with Version 1.0:** C. Vaughan, D. Cuevas, D. Healey, M. Torres and S. Sorenson, Joint Navigation Warfare Center

4:35 **4. Direct Mapping of Ground-Based Emitters in the Presence of Antenna Array Manifold Mismatch:** A. Kintz and I. Gupta, The Ohio State University

Alternate

1. IDM (Interference Detection & Mitigation) / IDL (Interference Detection & Location): P.F. MacDoran, M.B. Mathews and M.O. Davies, Loctronix® Corporation

CLASSIFIED DAY AGENDA: Shades of Green

Buses Depart Renaissance Orlando at SeaWorld **7:00 a.m.**

Security Validation/Entry Control: Ms. Diane Jacobson, JNWC **7:45 a.m. – 8:25 a.m.**

Opening Remarks: Mr. Bob Greenlee, JNWC **8:25 a.m. – 8:40 a.m.**

Administrivia: Mr. Benjamin Wash, JNWC

Security Policies: Ms. Diane Jacobson, JNWC

- There is only one door assigned for entry and exit; do not attempt to use any other door.
- You may only leave the room between presentations. If you exit, you will not be allowed back into the room until the next scheduled break.
- No electronics or mobile devices are allowed in the room at any time.
- Note taking is prohibited.
- No classified discussions outside of the room, or when the door is open.

Robert Greenlee, Joint Navigation Warfare Center

E8: Classified Session (4-Eyes): NAVWAR Landscape: Threats and Operations

8:40 a.m. - 11:55 a.m., *Magnolia Ballroom, Shades of Green*

8:40 **1. Plenary Presentation: PNT Perspectives:** Major General Robert Wheeler, Deputy CIO, C4 & Info Infrastructure Capabilities

9:15 **2. DOD PNT S&T:** M. Warner, ASE (R&E), U.S. Air Force

9:40 **3. Advanced Threat: Intelligence, Laboratory Demonstration, and Impact Analysis:** K. McDonald, K. Martin, D. Shultz, T. Bielicki, M. Kolb, The MITRE Corporation; F. Scenna, Lt. J. Lowery, NASIC; M. Knight, DSTO

Break — 10:05 a.m. - 10:35 a.m.

Benjamin Wash, Joint Navigation Warfare Center

10:35 **4. GYPSY INDIA Threats, Impacts, and Results:** J. Aldrich, D. Cuevas, R. Dodolak, R. Earwood, K. Fry, J. Harlin and S. Sorenson, Joint Navigation Warfare Center

10:55 **5. U.S. Pacific Command NAVWAR Capability Gaps:** K.A. Fisher, HQ US PACOM

11:15 **6. Advanced Emerging GPS Threat Systems:** E. Casson , 746th Test Squadron

11:35 **7. Blue Force Electronic Attack Capability Gap Identification:** K. McDonald, V. Benvenuto, The MITRE Corporation; J. Lortie, Independent Consultant

Alternates

1. **Evaluation of Spoofing Protection using Controlled Radiation Pattern Antenna:** G.W Jolly and A. Manz, NovAtel Inc., Canada
2. **Blue Force Electronic Attack (BFEA) Jamming Waveform Design Methods:** T. Kurp and D. Shultz, The MITRE Corporation
3. **EGI with G-STAR DAE Virtual Flight Test Results:** M. Engel and J. Elam, Honeywell; S. Sorber, Lockheed Martin
4. **Virtual Flight Testing Anti-Jam GPS Solutions Fly Off:** D. Howell, D. Jacobs, AFRL/RYWN; D. Dresher, Northrop Grumman (AFRL/RYWN)

Lunch — 11:55 a.m. - 12:55 p.m.

Mr. James T. Doherty, Institute for Defense Analyses

Mr. Don Jewell, Institute for Defense Analyses

E9: Classified Session (4-Eyes): Warfighter Crosstalk Panel

12:55 p.m. - 2:55 p.m., *Magnolia Ballroom, Shades of Green*

"Crosstalk" is an interactive discussion with war fighters who have had recent operational experience that informs the navigation development community on how to better formulate military navigation systems. Panel members will make an opening statement on how current navigation systems are meeting the needs of their missions, followed by questions from the audience.

Break — 2:55 p.m. - 3:25 p.m.


Robert Greenlee, Joint Navigation Warfare Center


Benjamin Wash, Joint Navigation Warfare Center

E10: Classified Session (4-Eyes): Rising to the Challenge: Emerging NAVWAR Capabilities

3:25 p.m. - 5:25 p.m., *Magnolia Ballroom, Shades of Green*

3:25 1. **Army NAVWAR and Pseudolite Technology Testing in 2013:** C. Brown, APM PD PNT

3:45 2. **Joint Navigation Warfare Center Functional Staff Estimates Rollup:** B. Wash, Joint Navigation Warfare Center

4:05 3. **eLoran's Capabilities to Provide Positioning, Navigation, and Time, and Data in GPS Challenged Environments:** C. Schue, E. Johannessen, S. Bartlett, A. Grebnev, G. Offermans, UrsaNav; G. Klaus, M. Sommerville, D. Stark, M. London, John Hopkins University Applied Physics Laboratory (JHU/APL)

4:25 4. **Evaluating the Navigation Potential of a Navigation Warfare Emitter:** H. Honaker, U.S. Air Force; M. Haker, Air Force Institute of Technology

4:45 5. **Authenticating Received Global Positioning System Signals using Transmitted Physical Layer Attributes:** M. Haker, Air Force Institute of Technology; K. Carroll, Air Force Research Laboratory

5:05 6. **Simulation and Flight Test Results from GPS Embedded Module Retrofit Demonstration Activities:** J. Allsop, Hil Air Force Base; J. Weger, Rockwell Collins, Inc.

Closing Remarks — 5:25 p.m.

Bob Greenlee, JNWC

James T. Doherty, Military Division Chair, The Institute of Navigation

Buses Load — 5:40 p.m.

Buses load for return to Renaissance Orlando at SeaWorld.

Transportation/Parking for Classified Session

Buses will depart the Renaissance Hotel SeaWorld promptly at 7:00 a.m. Conference management highly recommends taking advantage of the bus transportation provided to and from the classified session at Shades of Green on Walt Disney World. However, parking is available. Note that busing will only be provided in the morning and the evening (no mid-day shuttles will be available).

Note that no electronic devices will be permitted in the classified session. It is highly recommended that all electronic devices, notebooks, planners, etc. are left at the hotel.

If you are planning to depart to the airport directly from Shades of Green please check your baggage at the Shades of Green bell desk.

Driving Directions from Renaissance SeaWorld to Shades of Green

1. Head southwest on Sea Harbor Dr. toward Academic Dr.
2. Take the 2nd right onto Central Florida Pkwy
3. Slight left to merge onto I-4 W toward Tampa
4. Take exit 67 toward Epcot/Downtown Disney
5. Merge onto Epcot Center Dr.
6. Exit onto World Dr.
7. Turn left onto Seven Seas Dr.
8. Turn right onto Floridian Way
9. Turn left onto Magnolia Palm Dr.
10. Arrive at 1950 Magnolia Palm Dr., Lake Buena Vista, FL 32830

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It Knows Where You're Headed

Systron Donner Inertial's SDN500 tightly coupled INS/GPS delivers precise 1.5 mrad (0.086°) heading and 1.0 mrad (0.057°) pitch/roll accuracy for navigation, stabilization and geolocation platforms. The SDN500 features 100Hz position data, <1.0°/hr. in-run gyro bias, low 0.02°/√hr. ARW noise in a compact 26-cubic-inch, 1.6-pound package. The SDN500 is environmentally robust and maintains navigation performance during short-term GPS outages. The SDN500 can also be integrated with an external SAASM GPS Anti-Jam (AJ) Receiver.

SYSTRON DONNER INERTIAL

The Leader in Quartz MEMS Technology

for more information visit Systron Donner at Booth #44