

## ABOUT THE JNC

The Military Division of the Institute of Navigation will host the 2022 Joint Navigation Conference (JNC 2022) for the Department of Defense and Department of Homeland Security. The theme of this year's conference will be:

*Enhancing Dominance and Resilience for Warfighting and Homeland Security PNT*

JNC is the largest U.S. military Positioning, Navigation and Timing (PNT) conference of the year with joint service and government participation. The event will focus on technical advances in PNT with emphasis on joint development, testing and support of affordable PNT systems, logistics and integration. From an operational perspective, the conference will focus on advances in battlefield applications of GPS; critical strengths and weaknesses of field navigation devices; warfighter PNT requirements and solutions; and navigation warfare.

FEDCON U.S. only conference attendance will be screened by the Joint Navigation Warfare Center and will be restricted to U.S. only. The classified sessions will have U.S. only Secret Clearance access. The exhibit hall (June 7-8) will be open to all conference participants, exhibitors, their employees and related organizations. All materials displayed in the exhibit hall shall be Publicly Releasable After Review.

## TECHNICAL PROGRAM COMMITTEE

**Military Division Chair:** John Langer, The Aerospace Corporation

**Military Division Vice Chair:** Jan Anzperger, Draper

**Program Chair:** John Del Colliano, DEVCOM C5ISR

**Program Vice-Chair:** David Wolfe, USGC C5ISC

**Tutorials Chair:** Paul Olson, DEVCOM C5ISR

**Plenary Chair:** Dr. Thomas Powell, The Aerospace Corporation

## Track Chairs:

- Dr. J.P. Laine, Draper
- Dr. Steven Lewis, The Aerospace Corporation
- Dr. Keith McDonald, The MITRE Corporation
- Dr. Madeleine Naudeau, AFRL

## Other Members:

- Dr. Jacob Campbell, AFRL Sensors Directorate
- Eddy Emile, Space Systems Command/Production Corps
- Elliott Kaplan, The MITRE Corporation
- Chad Pinkelman, NIWC Pacific
- Dr. Greg Reynolds, Army DEVCOM AvMC
- Joseph Schneckner, NIWC Pacific
- Ben Wash, Joint Navigation Warfare Center (JNWC)

## JOURNAL PUBLICATION

JNC presenters are encouraged to write Publicly Releasable After Review technical papers based on their JNC presentations to submit for possible publication in the ION's archival journal, *NAVIGATION* (indexed by Thomson Reuters). Papers may be submitted for publication online at <http://mc.manuscriptcentral.com/navigation>.

## EXHIBITS

Over 50 companies exhibit annually at JNC, showcasing their products and services. This forum also provides valuable networking opportunities. For more information, visit the Exhibitor Resource Center at [ion.org/jnc](http://ion.org/jnc) or email Megan Andrews at [mandrews@ion.org](mailto:mandrews@ion.org).

## ABSTRACT SUBMISSION GUIDELINES

### Abstracts Due: February 4, 2022

All abstracts must be written for public release with intent to present in a Federal Employees and Contractors Only (FEDCON) U.S. ONLY environment. Abstracts not approved for public release will not be accepted. Note that you must be a citizen of the USA to submit an abstract.

Abstracts should be submitted electronically via the ION Abstract Management Portal (AMP), no later than February 4, 2022. To submit an abstract, sign in at [www.ion.org/abstracts](http://www.ion.org/abstracts).

- If you have not used AMP before, click "Create My Account"
- Once signed in, click on JNC and complete the form.
- Abstracts should include a presentation summary; describe objectives, anticipated or actual results, conclusions, any key innovative steps and the significance of your work; and limited to 500 words.
- Authors will be notified of acceptance in March and sent an electronic author's kit with presentation and publication guidelines.

## PRESENTATION REQUIREMENTS

Sessions will consist of presentations. Unless otherwise noted, all presentations must be approved as Publicly Releasable After Review or FEDCON. An electronic copy of your final presentation (typically a PowerPoint file) with a signed release form must be received by the ION National Office by June 13 to be included in the FEDCON proceedings. Presenters will receive a speaker's kit with presentation guidelines and additional meeting information. You must be a citizen of the USA to present at the conference and meet all established security validation requirements.

All presenters must pay conference registration fees.

## CONFERENCE PROCEEDINGS

Submitted presentations, approved as Publicly Releasable After Review and/or FEDCON distribution, will be released to U.S. citizens who were approved to attend the conference by the JNWC in an electronic FEDCON proceedings 2-4 weeks following the conference.

## CONFERENCE ATTENDANCE INFORMATION

The JNC's DTS conference ID is N20150610734

The conference will be hosted in a FEDCON U.S. ONLY environment. Participation will be restricted to U.S. government and U.S. government contractors. Advance visit requests and approvals are required for all attendees.

- **Full-Conference Registration** rates for ION member registrants staying in an official conference hotel, received/paid by May 6, \$995; after May 6, \$1195. Full Conference Registration includes all technical sessions, exhibit hall access, conference refreshments and electronic proceedings.
- **Single-Day Registration** for registrants staying in one of the official conference hotels is \$575. Single-day registration rates include sessions only, no events or proceedings.
- **Accommodations** are available at the Town and Country Hotel, at the prevailing government rate until May 6 or until the hotel block fills, whichever occurs first. Reserve a hotel room at [ion.org/jnc](http://ion.org/jnc)
- Additional information and updates regarding the conference may be found online: [ion.org/jnc](http://ion.org/jnc).

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Abstract Submission: Due February 4, 2022



June 6-9, 2022  
Town and Country Hotel, San Diego, CA



# JOINT NAVIGATION CONFERENCE 2022



June 6-9, 2022

Town and Country Hotel  
San Diego, California  
[ion.org](http://ion.org)



## CALL FOR ABSTRACTS

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## FEDCON SESSION TOPICS

### **NEW!** AI/Machine Learning (ML) for PNT

Using AI/ML techniques to support PNT solutions within devices and systems to improve capabilities for warfighters and military platforms. Novel approaches to provide capabilities for situational understanding, battlefield management and decision making, PNT system performance, integrity monitoring, and other NAVWAR activities. Improvements to operations from big data methodologies and PNT data fusion between entities.

**Topic Leads:** Dr. Camila Francolin, Draper and Amelia Fortmayer, CSISR

### **Antenna Technologies & Interference Mitigation for Robust PNT**

Novel approaches to multi-signal solutions for robust PNT, including novel antenna designs, interference mitigation technologies/techniques, incorporation of signals of opportunity to augment GNSS. While algorithms may be a component of this topic, they must be related to novel antenna approaches. This topic is seeking revolutionary approaches to robust PNT enabled by robust signal detection.

**Topic Leads:** Dr. Rama Gollakota, The Aerospace Corporation and Matt Bousselot, Collins Aerospace

### **Application/Impact of PNT Technologies in the Homeland Critical Infrastructure**

This session will focus on the use of PNT technologies in the critical infrastructure with emphasis on discussing usage, vulnerabilities, and providing mitigating solutions to safeguards against threats to the critical infrastructure. PNT based technologies, such as GPS, are now an integral part of the national critical infrastructure. Many sectors rely on some aspect of PNT ranging from timing for communication systems to clock synchronization for power transmission in the electrical grid. The growing use of PNT along with potential threats and vulnerabilities to the critical infrastructure such as the electrical grid, communication, transportation, finance, and emerging infrastructure for domestic employment of UAV systems creates a challenge for safeguarding national assets and maintaining homeland security.

**Topic Leads:** Dr. Patricia Larkoski, The MITRE Corporation and John Edwards, USCG CSISC

### **Applications of Atomic Standards in DoD Time Transfer and Dissemination**

The transfer and acquisition of time in DoD applications from both GNSS and non-GNSS sources has become an important topic in recent decades with greater demands for precision. Many atomic clock products have been designed to strike a balance between performance and cost that allow these goals to be met. This session invites presentations on the development of such clocks or the use of atomic clocks in: time transfer, timescales, timekeeping, synchronization techniques, ranging measurements, and other applications of interest to DoD applications.

**Topic Leads:** McLaina Oum, NIWC Pacific and Dr. Robert Lutwak, Microchip Corporation

### **Autonomous Systems and PNT**

Autonomous systems are especially reliant on PNT. Topics in this session include autonomous systems, leveraging of AI and machine learning for autonomy and PNT, challenges of using autonomous systems in military environments, use of GPS and non-GPS PNT for autonomous systems. These systems will be operating either independently or in collaborative groups performing tasks, where the PNT systems will need to adapt to the surroundings and make use of the sensors and signals that are functional in the area. Safety, resiliency and OPTEMPO are vital in the definition of the requirements for the PNT system for military autonomous systems.

**Topic Leads:** Dr. Rob Leishman, AFIT and Dr. Scott Martin, Auburn University

### **Collaborative Navigation Techniques**

This topic addresses techniques for the exploitation of network connectivity and ranging information between nodes to assist and improve navigation. In addition, this topic explores navigation techniques, and required system performance envelopes, that enable coherent task execution among networked platforms/instruments. The ability to exchange information among partners in a network can provide synergistic improvements in terms of rapid system initialization, navigation accuracy and resiliency. This includes efforts for supplying accurate up-to-date information to navigation processors; sharing of data for both absolute and relative navigation solutions within a defined group; and determining situational awareness for the warfighter and providing pertinent navigation-related information for missions such as search and rescue, targeting, joint operations and other applications requiring complex coordination. May also include the sharing of geo-registered imagery to support collaborative position/orientation updating, collaborative path planning to optimize joint navigation accuracy, and the use of network connected devices for navigation such as smartphones, navigation apps and GPS-based personal navigation systems with on-line maps.

**Topic Leads:** Dr. Jacob Campbell, AFRL Sensors Directorate and Dr. Dean Bruckner, Chelton

### **Complementary PNT**

Subjects of this session are navigation technologies and techniques that replace, or supplement, traditional GPS/INS solutions for overcoming application related challenges including degraded or denied GPS. This includes vision-aided navigation, RF-aided navigation, exploitation of naturally occurring signals that would be immune to denial of service by an adversary, and high precision quantum-enhanced inertial sensors. Examples include but are not limited to celestial, bathymetric, gravimetric, and quantum-based or other emergent navigation sensor technologies.

1. **Navigation by Celestial Objects, Geophysical Fields and other Naturally Occurring Complementary Sources – including magnetic fields, gravity, lightning, etc.**  
**Topic Leads:** Dr. Hannah Clevenson, Draper and Robert Greer, iXblue
2. **Vision Aided Optical**  
**Topic Lead:** Dr. Jonathan Ryan, Leidos
3. **Vision Aided Air**  
**Topic Leads:** Mark Smearcheck, AFRL and Paul Samanant, Honeywell
4. **Vision Aided Ground**  
**Topic Leads:** Dr. Gary Katulka, DEVCOM CSISR and Kathleen Jones, NAL Research
5. **Terrestrial RF Aided (Non-GPS)**  
**Topic Lead:** David Garigen, Orolia Defense & Security
6. **Non-GPS Sources of Space-based PNT:** Explores new potential sources of space-based PNT, including proliferated LEO & GEO commercial and DoD systems. New sources of PNT may be primary or secondary missions of the spacecraft; they may be at any frequency, RF to optical.  
**Topic Leads:** Renee A. Yazdi, Canyon Consulting and Dr. Lara Schmidt, Aerospace Corporation

### **GPS in Military Applications/NAWWAR**

This session will involve integration of GPS into new and existing military systems; precision weapon delivery and military applications in land, sea, air, and space using GPS; and development of new military GPS and auxiliary sensor hardware. Includes PNT Situation Awareness sensing and information distribution, as well as interference and jamming aspects of GNSS from an unclassified perspective.

**Topic Leads:** Chad Pinkelman, NIWC Pacific and Amanda Humphrey, JNWC

### **GPS Modernization and Constellation Status**

Current GPS constellation status. New military capabilities and performance, including integrity and accuracy improvement concepts; modernized space segment and control segment; Regional Military Protect (RMP); new GPS research and development status; and impact on future applications.

**Topic Leads:** Brian Louie, Space Systems Command/PCU and Dr. Anne Le, The Aerospace Corporation

### **Inertial Measurement Unit (IMU)**

A review of the latest developments, materials processing, manufacturing technologies, component integrations and applications of IMUs having performance improvements and the potential to yield Size, Weight, Power and Cost (SWAP-C) benefits for our warfighters. This includes device and electronics minimization, new interface standards and algorithms that will enable accuracy improvement. A review of theoretical physical principles and describe new sensing devices that measure and model such phenomena. Advancements leading to extremely precise inertial navigation devices such as cold atom physics.

**Topic Leads:** Robert Scott Downs, Naval Sea Systems Command (NAVSEA) and Ann Witt, Honeywell

### **Integrity and Assurance**

Positioning, Navigation and Timing (PNT) systems play a critical role in virtually all military systems. Integrity/Assurance is a becoming a principal requirement in all systems to ensure the mission is completed successfully and reducing the risks to our warfighters. Their design must include the capability to assess sensor inputs, detect anomalous/threat conditions, and mitigate properly to retain resiliency. This session will cover the requirements for PNT Integrity/Assurance in various military systems, system functional allocation, algorithm development, design approaches, and review performance results from demonstrations.

**Topic Leads:** Aaron Nascimento, NAVWARSYSCOM and Dr. Dane Wilburne, The MITRE Corporation

### **Military PNT User Equipment**

This session will provide the latest information on Military PNT User Equipment including MGUE, integrated military PNT user equipment such as EGIs, and integrated receiver/antenna electronics. Topics will include status of PNT user equipment development, test, and integration efforts from both contractor and government representatives.

**Topic Leads:** Gina Guiducci, DEVCOM CSISR and Kathleen Fasenfest, Antcom

### **Modeling and Simulation**

Includes GNSS, INS and complementary sensor models capable of assessing advanced algorithms/integrated systems and battlefield operations. Presentation of hardware-in-the-loop simulation capabilities that use software-defined receiver technology or other active/passive techniques for laboratory evaluation. Interfacing of PNT and mission/campaign modeling and simulation capabilities for the assessment of impacts to warfighters and their commander.

**Topic Leads:** Lina Nasori, NIWC Pacific and Ellen Hall, Spirent Federal Systems

### **Multi-GNSS Receivers for Military Applications**

Recent technology developments have explored the combination of military GPS signals with foreign GNSS and commercial GPS signals. The complementary benefits of multi-GNSS include improved accuracy, integrity, availability, frequency diversity, and continued operations in GPS degraded environments. Military applications require considerations for signal assurance and security. Efforts entail concept development, analyses, modeling and simulation, and/or demonstrations. The future of military multi-GNSS receivers includes those, which track and use military signals from multiple GNSSs as well as those, which combine both military and civil signals from multiple GNSSs. This session is also interested in exploring the use and integration of additional terrestrial or space-based cooperative signals for timing, ranging, or augmentation with military multi-GNSS receivers.

**Topic Leads:** Corrie James, JHU/APL and Dr. John Janeski, The Aerospace Corporation

### **Navigating in Challenged Environments (e.g., Urban, Indoor and Sub-Surface Navigation)**

Systems and solutions to challenges to navigation systems due to low Size, Weight, And Power (SWAP) requirements such as in UAVs, UUVs, UGVs, Autonomous UGVs (i.e., robots), missiles, dismounted soldiers, etc., are all of interest. Other environmental challenges of interest are navigating in GPS denied conditions, high multipath locations, underground/cavernous environments, poor terrain (mountainous/canyons), or urban/indoor environments.

**Topic Leads:** Roger Fuller, USCG CSISC and Dr. Jennifer Bartlett, USNO

### **Navigation Technology Satellite-3**

New concepts for satellite navigation, developments in PNT payload technologies, and advanced signals. The NTS-3 experiment will explore a specific reprogrammable Satellite Navigation architecture. Topics include advanced signals and space, control and UE segments.

**Topic Leads:** Arlen Biersgreen, AFRL and Maj Richard Shepherd, Space Systems Command

### **Novel Clock Technologies and Timing Applications**

Warfighter systems are reliant upon Precise Time and Frequency (PT&F) synchronization/syntionization for communicating, networking, positioning, and etc. These needs are supported by GPS timing capabilities or alternative time-keeping systems that consist of high-precision clocks synchronized by time dissemination. Development efforts to employ current and novel atomic clock architectures based on optical transitions, laser cooling, and ion trapping, for example, are underway. These efforts seek to produce rugged high-precision clocks for handheld, infrastructure, aerospace, and space-based applications. This session addresses timing device and system approaches, including advanced clocks, time dissemination techniques, and timing applications for military systems.

**Topic Leads:** Dr. Michael Coleman, NRL and Ryan Dupuis, Excelitas Technologies

### **Operational System Demonstrations**

Demonstration of platforms to support PNT for the warfighter, with particular focus on open architecture solutions which allow incorporation of alternate or (r)evolutionary technologies. Demonstrations may include real time component demonstration, video of demonstration, and demonstration of SWiL/HWiL. Demonstrations may include, but are not limited to, human-in-the-loop, PNT sensors & algorithms, or novel approaches to deal with known limitations of current solutions, such as simplified keying solutions, user friendly interfaces, context aware energy conservation, etc. Encouraging demonstrations of technologies at varying stages of technology readiness levels (TRLs 4-6).

**Topic Lead:** William Deike, AFRL and Dan Weinman, DEVCOM CSISR

### **PNT Open Systems Architecture**

Threats to PNT systems are evolving at increasingly faster rates, driving the need for PNT systems to be adaptable to stay ahead of this evolving threat. Open System Architectures (OSA) for PNT can be structured to provide frameworks for affordable adaptable PNT systems. Adaptable PNT systems provide the ability to insert capability, countering threats and providing a resilient solutions. This session covers research, development, procurement, integration and sustainment of OSA PNT concepts and systems (software, hardware, backplanes, interfaces, etc.), including applications of VICTORY, PNTA, FACE, OMS, SOSA and more.

**Topic Leads:** Ruth Burdeshaw, Army PM PNT and Lynetta Grajeda, NIWC Pacific

### **Precision Guided Munitions/Weapon Applications**

The use of navigation technologies in the unique and challenging field of Precision Guided Munitions (PGMs) and weapon systems applications. This includes innovative design concepts, challenging performance and environmental requirements, laboratory and flight test results, compensation methods, alignment/initialization techniques, and size constraints/miniaturation as well as other issues related to the integration of navigation technologies in current and emerging PGM/Weapon systems.

**Topic Leads:** Gregory Panas, Army DEVCOM AC and Dr. Don Kelly, IS4S

### **Reconfigurable and Reprogrammable SatNav**

This session explores the alternatives for advancing the deployment of coordinated, reconfigurable PNT solutions to achieve superiority in a contested EW environment. This includes SatNav and UE reconfigurations that are being studied currently, as well as SA/ES elements that are needed to achieve effective reconfiguration. The topic delves into operational elements needed for reconfigurable SatNav and UE to be effective. This topic includes payloads, signals, control segments, and UE.

**Topic Leads:** Kalyon Jones, USAF and Dr. Joanna Hinks, AFRL Space Vehicles

### **Software Defined Radios (SDRs) for PNT**

This session will focus on the use of software defined radios (SDRs) for military PNT applications. Topics may include SDR architectures, SDR design considerations, operations concepts for SDR maintenance and upgrades, specific hardware/software instantiations, and updates from on-going developmental activities.

**Topic Leads:** Jon Stanich, Navy PEO C4I and John David (JD) Quartararo, The MITRE Corporation

### **NEW!** Space Applications for Cislunar or XGEO

This session will focus on applications of PNT systems on space platforms for cislunar or beyond GEO (XGEO) activities, including the use of navigation services and sensors to aid primary objectives of guidance, navigation and control (GNC) or bus and payload timing functions. This encompasses, but is not limited to, orbit determination, attitude determination, trusted autonomous systems, and application objectives such as space exploration, mapping, lunar resource identification and extraction, situational or domain awareness, advances in cislunar user equipment. This session also includes the advancements of enabling technologies applied to cislunar PNT service volume architecture, reference frame, time transfer, time keeping, service monitoring, sustainment, and resiliency.

**Topic Leads:** Dr. Kiana Ross, The Aerospace Corporation and Dr. Andrew Neish, Xona Space Systems

### **Warfighter Requirement and Solutions**

Warfighter requirements, needs and possible solutions involving operational PNT. Logistical concerns (applied maintenance concepts; spares/replacement availability; interchangeability within host platforms; interoperability with form, fit, and function of host platforms) and international restrictions/concerns, as well as requirements for future technologies. PNT for pointing and stabilization; tri-service programs and commonality considerations; user comments and feedback; NDI/COTS; Homeland Security; and other critical issues such as target location errors.

**Topic Leads:** Ben Wash, JNWC and Michael Stanitis, The Aerospace Corporation

## PANEL DISCUSSIONS (FEDCON U.S. ONLY)

### **NEW!** PANEL: Future Space-based Sources of PNT

New sources of space-based PNT are coming available! Some are DoD-owned, many are commercial; Some are delivering PNT as a primary and some as a secondary service. Representatives from Commercial and DoD constellations will talk about what the new services offer above and beyond GPS, the challenges of offering new services to government users, the specific services they are/will be offering and how to access these services.

**Moderator:** William Joo, NIWC Pacific

### **PANEL: MGUE Integration**

This panel will feature representatives from weapon systems conducting some of the initial integration of MGUE receivers. Panelists will share experience and lessons learned working with the first generation of M-Code receivers.

**Moderator:** Dr. Thomas Powell, The Aerospace Corporation

### **PANEL: National Critical Infrastructure Threat**

This FEDCON 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.

**Moderator:** Karen Van Dyke, US DOT/ OST-R

### **NEW!** PANEL: Rapid Agile Development and PNT Technology Transition

Representatives from the services and industry will describe their approach to respond to urgent requirements from field and to transition emerging technologies. Panelists will contrast the established process with rapid agile development techniques that are being implemented in order 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) in order 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.

**Moderator:** Dr. Adam Schofield, Army Research Lab

## CLASSIFIED PROGRAM: SECRET U.S.-ONLY

This includes topics where classified material is key to conveying the intent of the presentation. Abstracts submitted for consideration must be written/approved for public release. Sessions will include counter PNT, operational PNT developments related to Joint Urgent Operational Needs, and Joint Emergent Operational Needs support and provide venues for the presentation for additional topics at the SECRET-U.S. Please identify if your presentation is unable to be shared at FEDCON/CUI. This session will include a keynote from a ranking general officer.

**Topic Leads:** Joe Page and Ben Wash, Joint Navigation Warfare Center

### **PANEL: Warfighters**

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.

**Moderators:** Kevin Coggins and Sean Memmen, Booz Allen Hamilton

### **NEW!** PANEL: Counter PNT, What Our Adversaries are Using Against Us

An open discussion about how PNT and specifically GNSS technologies are being used by our adversaries to weaken US capabilities, interfere with military and civilian operations, attack our forces, and defend against US offensive operations. Additionally, with the understanding of how PNT is employed against the USA, what techniques are we pursuing to counter these activities to prevent their success? How effective can these techniques really be, and are the solutions cost prohibitive for operational use? What Intelligence and NAVWAR information may be needed to properly understand the attacks and deploy appropriate counter measures?

**Moderator:** Rod Earwood, JNWC

# ABSTRACTS DUE FEBRUARY 4, 2022