

ION ITM AND PTTI 2023 TECHNICAL COMMITTEE

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ABSTRACTS DUE OCTOBER 7

Abstract Submission

Abstracts should be submitted electronically via the ION Abstract Management Portal, no later than October 7, 2022.

ION strongly encourages authors to present in-person in Long Beach. Authors will be given the option at the point of abstract submission to submit for "in-person presentation with video presentation for remote viewers" or "virtual presentation only." Authors will not be permitted to change from in-person presentation to virtual presentation after the program is finalized.

To submit an abstract, sign in at ion.org/abstracts. If you have not used the Abstract Management Portal before, click "Create My Account." Once signed in, click on the appropriate meeting name and complete the form.

- Abstracts should describe objectives, anticipated or actual results, conclusions, any key innovative steps and the significance of your work.
- Authors will be provided with an electronic author's kit with presentation and publication guidelines in early November.
- All authors presenting at the meeting, in-person or virtually, are required to pay registration fees.

Final Manuscripts

ITM Peer Reviewed Sessions: Completed manuscripts must be uploaded to the Abstract Management Portal (AMP) by December 1, 2022. Manuscripts will be peer reviewed by session co-chairs and designated as a primary paper, or as an alternate paper, in the onsite program based on peer review of the full manuscripts. Manuscripts not received by December 1, 2022 will not be peer reviewed. Manuscripts meeting established peer review standards will be designated as "peer reviewed" in the conference proceedings. Manuscripts will only be peer reviewed one time. Authors will be given the opportunity to make corrections/revisions to their manuscripts for inclusion in the proceedings through February 6, 2023. However, revised manuscripts will not be re-reviewed for peer review designation.

To be included in the conference proceedings:

1. Manuscripts must be uploaded into AMP by December 1, 2022.
2. The submitted manuscript must be representative of the original abstract submitted.
3. The presenting author must be registered for the conference and pay the conference registration fee (in-person and virtual presentations).
4. Video file, presentation file, and media/copyright release form must be uploaded into AMP by January 13, 2023.
5. The presenting author must attend the mandatory speakers' breakfast the morning of their session.
6. Corrections to manuscript (and optional presentation file) must be submitted to AMP by February 6, 2023 to be included in the conference proceedings.

PTTI Sessions: PTTI manuscripts will not be peer reviewed. Manuscripts (optional) and/or presentations not representative of the original abstract submitted will not be included in the conference proceedings regardless of whether or not they were presented at the conference, and this may affect the acceptance of future abstracts by the author. Manuscripts and/or presentations will be accepted for conference proceedings through February 6, 2023.

To be included in the conference proceedings:

1. Manuscripts and/or presentations must be uploaded into AMP by February 6, 2023.
2. The submitted manuscript and/or presentation must be representative of the original abstract submitted.
3. The presenting author must be registered for the conference and pay the conference registration fee (in-person and virtual presentations).
4. Video file, presentation file, and media/copyright release form must be uploaded into AMP by January 13, 2023.
5. The presenting author must attend the mandatory speakers' breakfast the morning of their session.

Journal Publication

Authors of appropriate papers are encouraged to submit papers for possible publication in the ION's archival journal, NAVIGATION (indexed in the Web of Science). Papers may be submitted at <http://mc.manuscriptcentral.com/navigation>.

Exhibit Hall

Exhibit space is available. Booths are sold in 10' x 10' increments and include one full complimentary conference registration per booth purchased. For an exhibitor prospectus, or for more information, go to ion.org/itm/exhibits.cfm or contact Megan Andrews at the ION National Office via phone at 703-366-2776 or email at mandrews@ion.org.

Registration Information

All full-conference registrations include technical sessions, conference meal functions and events, and access to electronic proceedings. Registration for tutorials will be an additional fee. Individual registration benefits are non-transferable. Registration fees for registrants staying at the Hyatt Regency Long Beach, that are received and paid by January 4, 2023, start at:

- Member Rate: \$995
- Non-member Rate: \$1,075
- Student Rate: \$600
- Virtual-Only Access: \$699
- Exhibit Hall Only: \$660

Student Conference Registration Grants

Student conference registration grants will be awarded on a "need basis." The registration grant will include a full technical meeting registration to include all conference sessions, meal functions, events, and access to electronic proceedings. Full-time graduate or undergraduate students who are the lead and presenting author of worthy technical paper(s) are encouraged to apply. Grants are limited and are awarded on a first come, first served basis to those meeting the criteria. Prior grant recipients are not eligible. An application must be submitted with an abstract no later than October 7, 2022. See ion.org for details.

Accommodations

Accommodations are offered at the Hyatt Regency Long Beach. A block of rooms has been set aside for conference attendees at the discounted rate of \$199 per night for single/double occupancy. These rooms will be available until January 4, 2023, or until the block fills, whichever comes first.

A limited number of government rate rooms for qualified federal agencies are also available. Reservations made after the deadline will be on a space-available basis and may not be at the special ION rate. We encourage you to make your hotel reservations early.

Save \$200 on your registration fees by staying at the official conference hotel. All attendees who stay at the Hyatt Regency Long Beach and submit their hotel confirmation number at the time of conference registration will receive a \$200 discount when registering for the conference. Hotel discounts cannot be applied retroactively.

Make Your Hotel Reservation Today:

- Online at ion.org/itm
- By calling 1-562-491-1234. Be sure to identify yourself as an ION ITM/PTTI attendee to receive the discounted attendee rate.



January 23-26, 2023
Hyatt Regency Long Beach
Long Beach, CA

INTERNATIONAL
TECHNICAL MEETING

ITM

PRECISE TIME AND TIME
INTERVAL SYSTEMS AND
APPLICATIONS MEETING

PTTI



One Registration Fee, Two Technical Events and a Commercial Exhibit

CALL FOR ABSTRACTS
IN-PERSON AND VIRTUAL PRESENTATION OPTIONS
ABSTRACTS DUE OCTOBER 7

INTERNATIONAL TECHNICAL MEETING (ITM) SESSION TOPICS

ITM KEYNOTE ADDRESS

Dr. Han Park, Deputy CTO and Head of R&D at Hyundai Urban Air Mobility

Alternatives, Backups, Complements to GNSS

Recognizing the vulnerability of GNSS users to both natural threats and security vulnerabilities, this session will bring together a variety of topics and applications. This session is looking for contributions describing new positioning methods or technologies, navigation aids, terrestrial transmitters or pseudolites, as well as anything that would complement or replace GNSS during an outage situation. Other topics may include dealing with terrestrial multipath, impact of degenerate geometries on positioning, atmospheric distortions and integrity monitoring for terrestrial radionavigation. Papers can address any domain, including (but not limited to) aviation, maritime, transportation, railway, or space flight.

Chair: Dr. Okuary Osechas, German Aerospace Agency (DLR)

Autonomous Navigation Applications

Advanced positioning and navigation algorithms for autonomous navigation. Use of novel sensors, sensor fusion, and signals of opportunity. Algorithms and methods for high-performance applications using low-cost sensors. Derivation of multi-sensor system navigation performance requirements. New approaches for dealing with delayed and out-of-sequence measurements. Sensor and measurement fault detection and exclusion.

Chairs: Dr. Nikolay Mikhaylov, Robert Bosch Corp. and Laura Norman, Hexagon

Collaborative Navigation

Algorithms and methods of collaborative navigation for GNSS challenged and denied environments. Improvements in satellite availability via data exchange at the measurement level. Improved resilience of GNSS signal processing via multi-node signal accumulation and beamforming in collaborative acquisition and tracking. Applications of collaborative techniques to sensor-fusion with signals of opportunity (SOOP) and non-RF aiding (e.g., vision and lidar) of inertial systems.

Chairs: Dr. Adam Rutkowski, Air Force Research Laboratory and Dr. Kirsten Strandjord, University of Minnesota

Extraterrestrial Navigation

Navigation system design and implementation for extraterrestrial navigation. Surface and near-surface navigation for the Earth's moon, Mars, or other planets and moons. Cis-lunar and trans-lunar navigation beyond the Earth's geosynchronous belt. Relative navigation near asteroids and comets. Navigation technologies including GNSS or GNSS-equivalent, other RF signals, electro-optical systems, and global or local magnetic fields.

Chairs: Dr. Sriramya Bhamidipati, Stanford University and Dr. Edward LeMaster, Lockheed Martin

GNSS and Security: Interference, Jamming, and Spoofing

Techniques to make GNSS more robust to spoofing, jamming, and interference in general, through signal processing, complementary PNT, authentication, or other means. Applications in robust positioning and secure time transfer. Threat modeling, assessment, and mitigation. Analysis of GNSS disruption events.

Chairs: Dr. Andriy Konovaltsev, German Aerospace Center (DLR) and Mathew Cosgrove, Northrop Grumman

GNSS Integrity and Augmentation

Fault monitoring, fault detection and exclusion, protection level algorithms and requirements for receiver-based integrity, ground-based, space-based, and aircraft-based augmentation. Challenges in the provision of integrity in multi-frequency/multi-constellation services. Applications include navigation for civil aviation, automotive, UAVs, rail, and maritime.

Chairs: Dr. Santiago Perea Diaz, European Space Agency and Elisa Gallon, Illinois Institute of Technology

Precise GNSS Positioning

New algorithms and methods for improving Precise Point Positioning (PPP), Real-Time Kinematic (RTK) and other precise positioning techniques (e.g., PPP-RTK, network-RTK, partial ambiguity resolution). Multi-constellation solutions using single-/multi-frequency geodetic and low-cost receivers/antennas, including smartphones. Developments on Integer Ambiguity Resolution (IAR). Interoperability of correction services with different user equipment. Robustness against multipath and other local effects.

Chairs: Dr. Daniel Medina, German Aerospace Center (DLR) and Dr. Patrick Henkel, Technical University Munich

Radionavigation Beyond Medium Earth Orbit GNSS

Going beyond signals from Medium Earth Orbit (MEO) GNSS, this session examines alternate and novel radionavigation signals and techniques to support the demands of modern navigation systems. Signals of opportunity include cellular (e.g., LTE and 5G) and communications satellite signals (e.g., low Earth orbit (LEO) Mega Constellations), CubeSat and remote sensing satellite signals. Navigational aids include terrestrial ultra-wideband (UWB) technologies, modern Wi-Fi protocols, near-field communication (NFC) devices, and emerging LEO-based satellite time and location services. Precise orbit determination and clock estimation for opportunistic satellite-based PNT. Combining these sources to demonstrate PNT accuracy, integrity, and robustness, particularly for mission and safety-critical applications including automated vehicles (AVs) and intelligent transportation systems (ITS).

Chairs: Dr. Kazuma Gunning, Xona Space Systems and Dr. Chun Yang, QuNav

Receiver Design, Signal Processing, and Antennas

GNSS receiver signal processing techniques for improved resiliency in challenging environments including indoor, urban canyons, foliage, scintillation, high-dynamics and under interference. Improved acquisition and tracking sensitivity, robustness and accuracy. Mitigation of multipath and non-line of sight signals. Design and evaluation of GNSS antennas and antenna electronics.

Chairs: Dr. Sanjeev Gunawardena, Air Force Institute of Technology and Dr. Yu-Hsuan Chen, Stanford University

Remote Sensing, Atmospheric Effects, and Space Weather

Modeling of ionospheric and tropospheric effects on GNSS navigation. Use of GNSS for remotely sensing the atmosphere and Earth's surface. Scientific applications of GNSS.

Chairs: Dr. Brian Breitsch, University of Colorado, Boulder and Dr. Anthea Coster, MIT Haystack Observatory

Safety-critical Applications of GNSS and Other Sensors

Navigation system design and analysis for safety-critical applications of GNSS and other sensors. Topics include integrity monitoring for filtered solutions, antenna and receiver hardware/software, data collection and analysis techniques including sorting and clustering, and development of statistical models for measurement and process noise for use in safety-critical navigation algorithms.

Chairs: Dr. Charles Toth, The Ohio State University and Dr. Madeleine Naudeau, Air Force Research Laboratory

Sensor-Fusion for GNSS-Challenged Navigation

Fusion of measurements from multiple sensors, data, and information sources for navigation in GNSS-challenged and denied environments. Estimation theories, algorithms, data processing techniques, test methods, and results of new implementations integrating diverse sensors such as GNSS, inertial sensors, odometers, magnetometers, radar, lidar, cameras, barometers, maps, signals of opportunity, infrared, ultrasound sensors, etc.

Chairs: Ryan Dixon, Hexagon, and Dr. Naser El-Sheimy, University of Calgary

ITM/PTTI Exhibit Hall

Bringing together international leaders in the timing, and related positioning and navigation community in a commercial exhibit.

See ion.org/itm/exhibits.cfm for more information

PRECISE TIME AND TIME INTERVAL (PTTI) SESSION TOPICS

PTTI PRE-CONFERENCE TUTORIALS

- GNSS (for time transfers)
- Atomic Clocks
- Optical Clocks
- Optical Transfers
- Optical Combs

Advanced and Future Clocks

Clocks are needed for timekeeping, navigation, positioning, communication, science and exploration in both terrestrial airborne and space applications. The development of clocks is driven by technological advances in these areas that push for devices with unique combinations of performance, reliability, robustness and SWaP. This session considers clocks that offer an advantage over existing clocks with a form factor larger than chip-scale atomic clocks. Presentations may be on any type of advanced clock in their present or potential future form. Examples of these clocks include: hot and cold atom clocks, ion(s)/molecules clocks; microwave, terahertz and optical clocks, optical frequency combs, and cavity stabilized ultra-stable lasers; cryogenic sapphire oscillators; and optically pumped clocks.

Chairs: Roberto Diener, ONR and Dr. Franklin Ascarrunz, Spectradynamics

Environmental Impacts on Clocks and Time Transfer

Clocks and time/frequency transfer systems are being used more commonly in uncontrolled environments like space or field test sites. As such, there is a greater need to understand the impact of thermal, magnetic, acceleration, or other environmental disturbances on these systems. This session will focus on studies that characterize or mitigate these impacts. This is timely as a newly updated version of the IEEE P1193 standard entitled "Guide for Measurement of Environmental Sensitivities of Frequency Standards" is being prepared for release. We invite submissions regarding this document and/or related aspects of studying environmental impacts on timing systems.

Chair: Dr. Daphna Enzer, JPL

Low-SWaP Clocks and Oscillators for 5G and Beyond

Low-size, weight, and power (SWaP) clocks and oscillators are critical components for commercial and military applications. The telecom industry has moved towards tighter timing requirements on each antenna in the last decade. 5G requires microsecond absolute timing, and 6G+ will have even finer timing requirements, putting a premium on local clocks and oscillators. This future has a strong overlap with military timing needs, except the DoD clocks must operate and maintain timing through harsh environments including large temperature swings, high shock, and vibration. This session will discuss the state-of-the-art in low-SWaP, handheld clocks and oscillators, for DoD and telecom applications.

Chairs: Dr. Jonathan Hoffman, DARPA and Dr. Jenna Chan, ARL

Mathematical Methods and Algorithms for Timing Applications

Mathematics and statistics play an important role in clock analysis and timing applications from the classical two-sample variance to advanced filtering techniques. This session seeks contributions on mathematical developments that help to analyze clock measurements, handle data anomalies, compute statistics around missing observations, generate timescales, and/or facilitate time transfer or dissemination. Algorithms presented can support any timing related activity from local oscillator performance to long range timing applications. All techniques are welcome although new and innovative approaches are of particular interest, such as those employing machine learning or artificial intelligence concepts.

Chairs: Dr. Michael Coleman, NRL and Dr. Elizabeth Laier English, NPL

Novel Methods in Time and Frequency Transfer

Precise timing is critical for operations including positioning and navigation, and timing for networks and communications. Despite its ubiquity and reliability, GNSS may not be available or provide the accuracy necessary. Improved one-way free-space time transfer, and increasingly developed two-way time and frequency transfer are becoming more relevant in a world of dynamic PNT needs, utilizing both RF and optical time transfer. From two-way free-space microwave links to optical frequency combs with fiber links, this session will include presentations on the newest methods in the synchronization and syntonization of remote clocks in space, from space to ground, between ground stations, and potentially underwater.

Chairs: Dr. Kari Moran, NIWC Pacific and Dr. Zachary Warren, The Aerospace Corporation

Present and Future Space Clocks

Abstracts are encouraged that consider the design, development and performance of clocks presently operating in space, or planned for near-term operation in space (LEO, MEO, GEO and deep-space). Abstracts are encouraged that discuss next-generation space clocks. For space, issues of Size, Weight and Power (SWaP), reliability, radiation hardening, and longevity are often more crucial for clock design than clocks solely aimed at terrestrial applications. All types of space clocks are of interest: space-qualified crystal oscillators, warm-vapor lamp or laser optically-pumped clocks, cold-atom clocks, ion-clocks, optical lattice clocks, and any other clock technologies that can contribute to space-system timekeeping.

Chairs: Dr. James Camparo, The Aerospace Corporation and Dr. Thejesh Bandi, The University of Alabama

Recent Innovations at Time Laboratories and National Metrology Institutes

This session will provide the opportunity for time and frequency laboratories, including those operated by national metrology institutes (NMIs), military, scientific and academic organizations, to highlight their innovations in PTTI sectors. Compliant topics are related to UTC(k) generation and performance, time dissemination, time services, calibrations and specific PTTI measurements. Progress reports on primary frequency standards and optical clock contributions to TAI as secondary frequency standards..

Chairs: Dr. Giancarlo Cerretto, INRIM and Roger Brown, NIST

Role of Timing and How it is Maintained in Present and Future GNSS Architectures

Keeping time is the heart of any GNSS and it takes a complex system with elements in the control segment, onboard the satellite, and with the user equipment to maintain it. This session will focus on how both present and proposed GNSS maintain time and frequency to provide users with a robust navigation signal. Papers presenting both innovative concepts for architectures in LEO, MEO or Cis-Lunar as well as reviewing little known details of existing infrastructure are welcome. The session is especially interested in a diverse representation of timing solutions from GNSS around the world.

Chairs: Dr. John Janis, L3-Harris and Dr. John Elgin, AFRL

Time Transfer and PNT from Proliferated LEO Constellations

Satellite-based time transfer and navigation from Low Earth Orbit (LEO) has been considered for over a decade, but the advent of proliferated LEO (pLEO) systems now opens up the realization of an effective implementation. In pLEO systems, the production of low-cost small satellites, and the commensurate access to space allows the rapid formation of constellations numbering in the hundreds of space vehicles (SV). These architectures featuring meshed inter-satellite links, allow for the near immediate propagation of timing corrections to SV clocks, supported by two-way inter-satellite ranging. This also enables robust and resilient terrestrial and cislunar navigation. The session will capture the most recent work in using LEO for space-based time transfer and navigation. Both commercial and defense oriented space systems are welcome to submit papers. Key performance characteristics might include maintaining accuracy under periods when access to UTC is not available, either from GNSS, or space to ground links, and the anticipated precision in time transfer approaching ps stability. The session will also consider submissions discussing the evolution of pLEO systems to lunar applications.

Chairs: Greg Weaver, JHU-APL/SDA and Chris Erickson, Space Force

Time Transfer Over Comms and Unconventional Methods

Traditional RF time transfer using point to point signals or one-way through GNSS use either a GNSS receiver or purpose-built time transfer modems. In this session we explore alternatives to traditional methods in the vein of the convergence between time and frequency transfer and existing communication systems; exploring existing or emerging communications systems and their cooperative or non-cooperative use for time and frequency transfer. In addition to timing over comms systems, we're also interested in exploring submissions that cover unconventional means of transferring time and frequency using naturally occurring phenomenon or using non-traditional communication channels.

Chairs: Jonathan Hirschauer, The MITRE Corporation and Dr. Per Olof Hedekvist, RISE