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ABSTRACTS DUE OCTOBER 4

CALL FOR ABSTRACTS: ABSTRACTS DUE OCTOBER 4, 2024

Abstract Submission

Abstracts should be submitted electronically via the ION Abstract Management Portal, no later than October 4, 2024.

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 "on-demand presentation only." Authors will not be permitted to change from in-person presentation to on-demand 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 on-demand, 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, 2024. 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, 2024 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 5, 2025. However, revised manuscripts will not be re-reviewed for peer review designation.

To be included in the conference proceedings:

1. The submitted manuscript must be representative of the original abstract submitted.
2. The presenting author must be registered for the conference and pay the conference registration fee (in-person and on-demand presentations).
3. Video file, presentation file, and media/copyright release form must be uploaded into AMP by January 17, 2025.
4. The presenting author must attend the mandatory speakers' breakfast the morning of their session.
5. Corrections to manuscript (and optional presentation file) must be submitted to AMP by February 5, 2025 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 5, 2025.

To be included in the conference proceedings:

1. Manuscripts and/or presentations must be uploaded into AMP by February 5, 2025.
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 on-demand presentations).
4. Video file, presentation file, and media/copyright release form must be uploaded into AMP by January 17, 2025.
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 ion.org/navi/submit-navi.cfm.

Exhibit Hall

Exhibit space is available. Booths are sold in 10′ × 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 3, 2025, start at:

- Member Rate: $1,100
- Non-member Rate: $1,180
- Student Rate: $750
- On-Demand Access: $699
- Exhibit Hall Only: $760

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 4, 2024. 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 $209 per night for single/double occupancy. These rooms will be available until January 3, 2025, 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 $300 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 $300 discount when registering for the conference. Hotel discounts will not 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.

Co-located ITM and PTTI 2025: ONE Registration Fee, TWO Technical Events and a Commercial Exhibit

ITM SESSION TOPICS

Advancements in Navigation Algorithms
Chairs: Dr. Élisa Gallon, Airbus Defence and Space and Dr. Todd Walter, Stanford University
Application of modern machine learning techniques to enhance navigation, including deep neural networks, boosting, graphical models, and both interpretable and unsupervised learning methods. Algorithms and techniques leveraging network connectivity to assist and improve navigation. Innovative estimation methods such as distributed state estimation, advanced filtering, and integration of 3D models, landmarks, and other data sets. Utilization of cloud and crowd-sourced data for navigation. Development of algorithms for new applications and fresh approaches to modeling and numerical challenges in navigation and positioning. Robust positioning techniques suitable for challenging environments. Collaborative and cooperative positioning algorithms and theories.

Alternatives, Backups, Complements to GNSS
Chairs: Dr. Tyler Reid, Xona Space Systems and Christian Ardito, StarNav
Alternative PNT solutions for terrestrial applications such as aviation, maritime, road, and rail. Technologies addressing the vulnerability of GNSS users to natural threats and security vulnerabilities. New positioning methods and technologies from existing and emerging terrestrial and space-based transmitters. Technologies that complement or replace GNSS when denied. Solutions for terrestrial multipath and degenerate geometries on positioning. Examination of atmospheric distortions and integrity monitoring for terrestrial radionavigation.

Atmospheric Effects, GNSS Remote Sensing, and Scientific Applications
Chairs: Yu-Fang (Frank) Lai, Stanford University and Dr. Jade Morton, University of Colorado, Boulder
GNSS technologies used for environmental and scientific monitoring, measuring atmospheric effects, and sensing Earth's surface properties and changes. Applications in radio occultation, ionospheric TEC and scintillation, and detecting geophysical events such as earthquakes and volcanic eruptions. GNSS reflectometry for environmental monitoring of soil moisture, vegetation, ocean wind, ocean wave, tsunamis, hurricane, flood surveillance, ice, and inland water bodies. Novel GNSS applications exploring gravitational measurements and dark matter detection.

Autonomous Navigation and Safety-Critical Applications
Chairs: Andrew Videmsek, Reliable Robotics and Dr. Ilaria Martini, u-blox
Navigation systems for assisted and autonomous vehicles and mobile platforms. Integrity monitoring for safety-critical applications using GNSS and additional sensors. Support through assistance and cloud-based technologies for reliable and secure autonomous systems. Innovative integrity algorithms, Advanced Receiver Autonomous Integrity Monitoring (ARAIM), novel error models taking into account no gaussian errors and time correlation effects. Enhanced safety, availability, and efficiency in guided vehicle systems and pilot assistance within demanding environments. Safety protocols, integrity standards (e.g., automotive ISO SOTIF) and certification criteria for autonomous navigation and guidance systems.

GNSS Integrity and Augmentation
Chairs: Dr. Okuary Osechas, ZHAW Centre for Aviation and Dr. Samer Khanafseh, Illinois Institute of Technology / TruNav LLC
Integrity monitoring, fault detection, and exclusion in GNSS augmentation systems. Identification and modeling of GNSS faults, including satellite and constellation failure modes, as well as external threats like spoofing. Anomaly detection and protection level characterization, testing, and results. Requirements for receiver-based integrity to enhance reliability, safety, and efficiency. Dissemination of integrity support information, impact of data channel capacity and latency. Development of novel augmentation systems and multi-GNSS solutions including GBAS and SBAS, but also urban augmentation and mitigation of multipath. Challenges in providing integrity in multi-frequency/multi-constellation services, including DFMC airborne models for antenna and measurement errors. Application of high-performance and safety-critical GNSS applications across sectors including civil aviation, automotive, UAVs, rail, and maritime.

GNSS Security: Interference, Jamming, and Spoofing
Chairs: Zixi Liu, Stanford University and Dr. Jianming She, The MITRE Corporation
Detection, characterization, and geolocation of intentional and unintentional interference. Mitigation strategies and improved robustness against spoofing, jamming, and general interference. Signal-to-noise ratio characterization in the presence of interference and its effects on GNSS receivers. Development of software and hardware solutions, including signal processing and authentication. Utilization of backup and complementary PNT technologies. Applications in robust positioning and secure time transfer. Threat modeling and analysis of GNSS disruption events. Spectrum monitoring and localization of interference sources using ground, airborne, and spaceborne receivers. Establishment of networks for spectrum monitoring. Use of smartphone GNSS data for spectrum monitoring. Techniques to enhance GNSS robustness through advanced signal processing, authentication, and complementary PNT methods.

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

Innovations in Navigation for Smartphones and Wearables
Chairs: Dr. Christina Selle and Dr. Li-Ta Hsu, Hong Kong Polytechnic University
Applications requiring reliable positioning solutions in smartphones and wearables. Enhanced positioning techniques in smartphones and wearables for improved indoor, outdoor, and urban-canyon navigation. Improved stochastic modeling of GNSS observables. Algorithms and multi-sensor fusion for enhanced accuracy in varied environments. Use of smartphone raw GNSS measurements for scientific applications in geosciences. Detection and mitigation of jamming and spoofing threats in smartphone-based positioning systems. Quality assessment of GNSS antennas in smartphones and wearables, including evaluation of antenna phase center offsets and variations. Navigation for AR and VR using smartphones.

Next-Generation Satellite Navigation Technology
Chairs: Sam Morgan, University of Texas at Austin and Dr. José-Ángel Ávila-Rodríguez, European Space Agency
Innovations in future generation satellite navigation technology; advancements in satellite constellations. Strategies and approaches for the interoperability and compatibility of GNSS constellations. Multi-layer satellite navigation: Development of new (institutional and private) navigation systems and extension of GNSS into Low Earth Orbit (LEO) and/or other orbits. Adaptations for fused broadband and navigation satellite systems. Updates on constellation characteristics and programmatic elements, along with ground control and monitoring segments. Evaluation of the performance of new satellites and services. Examination of RF compatibility, mutual interference, and antenna pattern characterization. Enhancements in GNSS signal structure through codes and data messages. Cutting-edge technologies, including highly stable frequency standards on-board navigation satellites and intersatellite links.

PNT Solutions for Space Applications
Chairs: Rob McBride, Blue Origin and Dr. Rebecca Bishop, The Aerospace Corporation
This session focuses on emerging technologies in space navigation and positioning systems at locations near Earth (e.g., LEO, GEO, HEO) and beyond (e.g., Moon, cis-lunar, Mars, asteroids). Types of navigation techniques and technologies of interest include, but are not limited to, GNSS precision navigation, relative navigation techniques, snapshot-based positioning, signals of opportunity utilization, electro-optical systems, and cooperative positioning. All aspects of enhanced and next-generation navigation systems from design, testing, and performance will be covered. Other applications to spotlight for enhanced navigation techniques are satellite constellation build-up and maintenance, interplanetary missions, and celestial and docking maneuvers.

Precise GNSS Positioning Applications
Chairs: Dr. Kaz Gunning, Xona Space Systems and Sandy Kennedy, Hexagon
Advances in GNSS positioning methods including Multi-GNSS Precise Point Positioning (PPP), Real-Time Kinematic (RTK), PPP-RTK, and network RTK. Development of partial ambiguity resolution techniques and Integer Ambiguity Resolution (IAR) using high precision geodetic-quality and/or low-cost antennas and receivers, including smartphones. Utilization of positioning algorithms with space-based augmentation services like the Galileo High Accuracy Service (HAS). Multi-constellation solutions employing single-/multi-frequency geodetic and/or low-cost receivers/antennas. Characterization and modeling of GNSS satellite clock errors; precise orbit determination for scientific purposes. Interoperability of GNSS correction services with diverse user equipment, ensuring robustness against multipath, interference, and other local effects. Comprehensive GNSS signals and performance characterization and monitoring. Applications of high precision and high integrity GNSS positioning in fields like crustal and structural deformation monitoring, GNSS seismology, atmospheric remote sensing, and precision agriculture. New algorithms and methods enhancing precise positioning techniques and robustness against local environmental effects.

Receiver Design, Signal Processing, and Antennas
Chairs: Dr. Yu (Joy) Jiao, Trimble and Dr. Jean-Marie Sleewaegen, Septentrio
GNSS receiver signal processing techniques for enhanced resiliency in challenging environments such as indoor, urban canyons, foliage, scintillation, high dynamics, and under interference. Design of receivers optimized for modernized GNSS signals. Development and application of software-based GNSS receivers. Enhancements in acquisition and tracking sensitivity, robustness, and accuracy. Mitigation strategies for multipath and non-line of sight signals. Design and evaluation of GNSS antennas and antenna electronics. Optimization of receiver architecture, signal processing and/or antenna for mass-market devices. Calibration processes for multi-GNSS receivers. Utilization of multi-GNSS signal simulators for testing and development.

Sensor-Fusion for GNSS-Challenged Navigation
Chairs: Dr. Ciro Gioia, European Commission Joint Research Centre and Dr. Andrey Soloviev, QuNav
Integration of data from multiple sensors and information sources in GNSS-challenged environments. Application of estimation theories, algorithms, and data processing techniques. Testing and results from integrating diverse sensors: GNSS, inertial sensors, odometers, magnetometers, radar, lidar, cameras, barometers, map, infrared, ultrasound sensors, signals of opportunity (SOOP) and non-RF aiding. Navigation strategies for urban canyons, indoor settings, and GNSS-denied environments. Use of low-cost devices for pedestrian and automotive applications. Modeling environmental effects on navigation sensors, including magnetic and gravity models.

ABSTRACTS DUE OCTOBER 4

PTTI SESSION TOPICS

PTTI PRE-CONFERENCE TUTORIALS
- **Optical Atomic Clocks**: past, present, and future
- **TAI, UTC, and UTC(k)**: the role of the time laboratories in the realization of reference time scales
- **GNSS**: the importance of timing, best practice in the remote comparison of atomic clocks/timescales, and achievement of traceability to UTC through satellite measurements
- **Time Dissemination Techniques**: state-of-the-art and regulatory aspects in disseminating traceable reference time scales
- **Low-noise Digital Electronics for Time and Frequency Metrology**

Activities at National Metrology Institutes
Session Chairs: Dr. Aidan Montare, NIST and Terrence Jones, Bureau of Standards Jamaica
This session welcomes Time and Frequency Laboratories operated at National Metrology Institutes (NMIs) providing an opportunity to present advancements and updates in precise timing. It will involve topics such as methods used in the generation of UTC(k), presentation of timescale hardware and algorithms used or developed. The various Time and Frequency services offered by NMIs and how these services are administered as well as information monitored for each service.

Advanced and Future Clocks
Session Chair: Dr. John Elgin, Air Force Research Laboratory
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 form factors larger than chip-scale atomic clocks. Presentations may be on any type of advanced clock in its present or future form. Examples of these clocks include: hot and cold atom clocks, ion/molecular clocks; microwave, terahertz and optical clocks, optical frequency combs, and cavity stabilized ultra-stable lasers; cryogenic sapphire oscillators; and optically pumped clocks.

Environmental Sensitivity of Clocks and Timing Systems
Session Chairs: Dr. Daniele Monahan, The Aerospace Corporation and Christopher Higgins, Microchip
The release of the IEEE 1193 "Guide for Measurement of Environmental Sensitivities of Frequency Standards" provides an opportunity to improve the accuracy, relevance, and usability of specifications for oscillators and timing systems. IEEE 1993 provides clear definitions and distinction between total sensitivity over a parameter range and linearized sensitivity coefficient over a defined range. The publication of comprehensive sensitivity coefficients provides systems' designers and integrators with valuable input to accurately model system performance in environmentally dynamic environments. This session encourages submissions presenting IEEE 1193 influenced measurements of clocks and timing systems, comparisons of Total Sensitivity measurements with Sensitivity Coefficients, and demonstrations of system modelling and integration.

GNSS Systems Timing Architectures and Capabilities
Session Chairs: Dr. John Janis, L3Harris and Calvin Lin, TL
Timekeeping is the heart of GNSS, and maintaining it requires a complex system with elements in the space, control, and user segments. This session will focus on how present and proposed GNSS constellations maintain time and frequency, and how they provide users with a robust position, navigation, and timing signal. Papers presenting innovative concepts for architectures and timing algorithms in LEO, MEO or Cis-Lunar constellations, as well as reviewing little known details of existing infrastructure, are welcome. The session is especially interested in the diverse representation of the practical or theoretical usage of GNSS timing in any field.

LEO Satellite Timing Requirements and Applications
Session Chair: Greg Weaver, JHU/APL, SDA
The advent of proliferated Low Earth Orbit (pLEO) systems enables the realization of effective LEO-based time transfer. In pLEO systems, low-cost small satellites and commensurate access to space allows the rapid fielding of constellations with hundreds of space vehicles (SV). 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 navigation. The session will capture recent work using pLEO for space-based time transfer to terrestrial user systems. We invite both commercial and defense-oriented space systems to submit papers. Key performance characteristics might include maintaining accuracy when access to UTC is not available, either via GNSS or via space-to-ground links, and reaching ps level time transfer stability.

Low-SWaP Clocks and Oscillators
Session Chair: Peter Cash, Microchip
Low-size, weight, and power (SWaP) clocks and oscillators are critical components for commercial and military applications. The telecom industry has moved toward tighter timing standards with power and form factor restrictions based on application. Military timing needs include communication, navigation and identification aids for soldiers, vehicles, ships, aircraft and spacecraft that require operation in extreme temperature, shock, and vibration environments. This session will discuss the state-of-the-art in low-SWaP, portable and embedded clocks and oscillators, for military, space and telecom applications.

Methods and Algorithms for Timing Applications and Timescales
Session Chairs: Dr. Christine Hackman, US Naval Research Laboratory and Dr. Jian Yao, UCAR/NCAR
Mathematics and statistics play important roles in clock analyses 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 in the presence of 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. New algorithms or new applications using existing algorithms are of particular interest, including machine learning for timing applications, timescale algorithms that include optical clocks, and algorithms for timekeeping in space such as lunar timescales.

Present and Future Space Clocks for Space Applications
Session Chairs: Dr. James Camparo, The Aerospace Corporation and Dr. Thejesh N. Bandi, The University of Alabama
Size, Weight, and Power (SWaP), reliability, vibration robustness, radiation hardening, and longevity are crucial for the space clocks. Abstracts are encouraged that consider the design, development, and performance of space clocks – presently operating, - planned for near-term operation, or - next-generation optical clocks, that are aimed at LEO, MEO, GEO, Lunar and Deep-Space missions. All types of space clocks are of interest: space-qualified crystal oscillators, warm-vapor lamp or laser pumped clocks, cold-atom clocks, ion-clocks, optical lattice clocks, and other portable clock technologies that can contribute to space-system timekeeping, aiding the ground-based navigation and other direct timing applications such as telecom, mobile and non-wired devices for military, and other scientific applications in space.

Time and Frequency Transfer for Comparing Clocks with 10^{-18} Uncertainty
Session Chairs: Dr. Jochen Kronjaeger, PTB and Dr. Nils Nemitz, NICT
Increasingly precise timing is critical for positioning and navigation, as well as networks and telecommunications. Comparing the latest generation of optical clocks to uncertainties of 5×10^{-18} is a mandatory criterion for the upcoming redefinition of the SI second. The presentations in this session will report on the newest methods for remote synchronization and syntonization that surpass the performance or reliability of conventional GNSS time transfer. Covering both RF and optical techniques, topics include fiber and free-space links to connect clocks on the ground, in the air, and in space.

T&F Transfer Utilizing Existing and Emerging Communication Systems
Session Chairs: Dr. Nathan Barnwell, NIWC Pacific and Dr. Gustav Jonsson RISE
In this session we explore time and frequency transfer utilizing existing or emerging, terrestrial or space based, communication systems and networks. Submissions explore methods beyond the traditional and standardized. The topic also covers unconventional means of transferring time and frequency using naturally occurring phenomenon, non-traditional communication channels and other novel related techniques.

Timekeeping and Quantum Networking
Session Chairs: Dr. Ivan Burenkov, NIST and Dr. Makan Mohageg, Boeing
The goal of this session is to foster dialogue between the precision timekeeping community and technologists developing and operating quantum networks. Precise timing is a critical requirement for emerging quantum networks and related science applications. These applications exhibit a wide range of timing requirements, with some relying on post-processing for timekeeping while others necessitate stringent synchronization of photon-arrival times for advanced quantum communication tasks. We invite submissions that highlight the timing requirements of future quantum networks and other novel scientific applications. Of special interest are experimental demonstrations of timekeeping for quantum networks, timekeeping and time distribution systems using quantum information resources, and novel applications that may currently be constrained by traditional time transfer methods. We welcome contributions related to terrestrial, as well as space-based networks, with a primary focus on their timing needs. Contributions related to timekeeping for quantum communications networks as well as timekeeping for distributed quantum computers and sensors are encouraged. Synchronization concepts that address the unique challenges and opportunities of time transfer for quantum experiments are also of interest.

Updates from Regulatory Agencies and Institutions Involved with Precise Time and Frequency Metrology
Session Chairs: Dr. Marina Gertsvolf, NRC and Edoardo Detoma, Consultant
Time and Frequency (TF) metrology is not limited to National and Designated Institutes, but has a global impact across diverse areas of science and industry. This session will present recent developments related to the domain of TF in various international organizations, specifically focusing on aspects that enhance and improve the utilization of UTC and SI second. We invite organizations such as the BIPM, IERS, IAU, IGS, IGU, ITU, ISO, ETSI, IEEE, CNES, NASA, ESA, ASI and others to inform the audience about their activities and impact on users in the time and frequency field. We invite speakers to address the standardization and calibration issues for topics such as leap second implementation, adoption of optical clocks, high precision network synchronization, as well as to present on the advancement of timing in astronomy/astrophysics, geodesy, and fundamental physics.

ABSTRACTS DUE OCTOBER 4