

**22nd International Technical
Meeting of the Satellite Division of
the Institute of Navigation 2009**

(ION GNSS 2009)

**Savannah, Georgia, USA
22-25 September 2009**

Volume 1 of 6

ISBN: 978-1-61567-748-1

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2009) by the Institute of Navigation
All rights reserved.

Printed by Curran Associates, Inc. (2010)

For permission requests, please contact the Institute of Navigation
at the address below.

Institute of Navigation
8551 Rixlew Lane
Suite 360
Manassas, VA 20109

Phone: (703) 366-2723
Fax: (703) 366-2724

membership@ion.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

VOLUME 1

PLENARY SESSION

GPS and Smartphones - The technology revolution that put GPS in your phone	1
<i>Frank Van Diggelen</i>	
Urban Challenges	20
<i>Casey Miller, Caroline New</i>	

A1: GNSS INTERFERENCE & SPECTRUM ASPECTS

GNSS Receiver Testing by Hardware Simulation with Measured Interference Data from Flight Trials	28
<i>Holmer Denks, Alexander Steingass, A. Hornbostel, Vincent Chopard</i>	
Comparative Interference Vulnerability Assessment of GPS TMBOC and Galileo CBOC Signals	38
<i>Davide Margaria, Simone Savasta, Fabio Dovis, Beatrice Motella</i>	
Entropy AGC – An Optimized AGC in Severe Jamming Environments	49
<i>Kuan-I Li, Chun-Nan Chen, Ping-Hsuan Tsu, Wen-Chieh Tsai, Kun-Tso Chen, Hsin-Chung Yeh</i>	
First Field Experience with L5 Signals: DME Interference Reality Check	56
<i>Andrew Simsky, Wim De Wilde, Tom Willems, David Mertens, Evald Koitsalu, Jean-Marie Sleewaegen</i>	
Real-World Interferences’ Impacts Analysis using High Dynamic Range GNSS RF/IF Signals Record and Playback	65
<i>Iurie Ilie, Dominique Fortin, Rene Jr. Landry, Marc-Antoine Fortin</i>	
A Laboratory Test Bed for GNSS Interference Impact Assessment	76
<i>M. Wildemeersch, J. Fortuny-Guasch</i>	
RNSS Signal Modeling for Interference Analysis	82
<i>E. Wasle, P. Berglez, J. Seybold, B. Hofmann-Wellenhof</i>	
Trustworthiness GNSS Signal Validation by a Time-Frequency Approach	93
<i>Simone Savasta, Letizia Lo Presti, Fabio Dovis, Davide Margaria</i>	
Initial On-Orbit Observations of the L5 Demo Payload on GPS IIR-20	103
<i>Jason Hsu, Alan Choy, Thomas D. Powell, Alexander C. Utter, Phillip A. Dafesh</i>	
A Simple Approach to Obtain the CA Code Spectral Separation Coefficient	113
<i>Srini Raghavan, Thomas Powell</i>	

B1: MULTI-SENSOR NAVIGATION

An Integrated IMU, GNSS and Image Recognition Sensor for Pedestrian Navigation	122
<i>C. Hide, T. Botterill, M. Andreotti</i>	
Development and Evaluation of a Combined WLAN & Inertial Indoor Pedestrian Positioning System	133
<i>Korbinian Frank, Bernhard Krach, Noel Catterall, Patrick Robertson</i>	
Augmenting Low-cost GPS/INS with Ultra-Wideband Transceivers for Multi-platform Relative Navigation	142
<i>Arun Vydhyathan, Henk Luinge, Makoto Tanigawa, Fred Dijkstra, Michael S. Braasch, Maarten Uijt De Haag</i>	
A Novel Yaw Rate Sensor Bias Error Containment Method Using Existing Vehicle Sensors	150
<i>Chaminda Basnayake</i>	
Multi-sensor Bayesian Estimation Interior Positioning for Stationary and Mobile Structures	159
<i>B. Tanju, S. Sarkani, T. Mazzuchi</i>	
A Tightly-Coupled Reduced Multi-Sensor System for Urban Navigation	177
<i>Tashfeen Karamat, Jacques Georgy, Umar Iqbal, Aboelmagd Noureldin</i>	
Nonlinear Modeling and Identification of Inertial Errors with Application to 2D Vehicle Navigation	188
<i>Zhi Shen, Jacques Georgy, Michael J. Korenberg, Aboelmagd Noureldin</i>	
Vision Aided GPS/INS System for Robust Land Vehicles Navigation	195
<i>Jianguo Jack Wang, Sarath Kodagoda, Gamini Dissanayake</i>	
A Novel Time Synchronization on PC104 Platform for Implementation of a MEMS-IMU/GPS Integrated System	205
<i>Zhenkai Xu, Yong Li, Chris Rizos, Xiaosu Xu</i>	

A DSP-based Multi-sensor Multi-network Positioning Platform	210
<i>Ruizhi Chen, Yuwei Chen, Ling Pei, Wei Chen, Jingbin Liu, Heidi Kuusniemi, Helena Leppakoski, Jarmo Takala</i>	

C1: GNSS GROUND BASED AUGMENTATION SYSTEMS (GBAS)

Ionosphere Threat Space Model Assessment for GBAS.....	217
<i>C. Mayer, B. Belabbas, N. Jakowski, M. Meurer, W. Dunkel</i>	
Natural Signal Deformations Observed in New Satellites and their Impact on GBAS.....	226
<i>Mats Brenner, Fan Liu, Kim Class, Randy Reuter, Per Enge</i>	
Study of a GBAS Model for CAT II/III Simulations	238
<i>P. Neri, C. Macabiau, L. Azoulai</i>	
Putting the Standardized GBAS Ionospheric Anomaly Monitors to the Test	250
<i>Matt Harris, Tim Murphy</i>	
Study of Effects of the Plasma Bubble on GBAS by a Three-Dimensional Ionospheric Delay Model.....	267
<i>Susumu Saito, Takayuki Yoshihara, Naoki Fujii</i>	
Enabling the LAAS Differentially Corrected Positioning Service (DCPS): Design and Requirements Alternatives	275
<i>Young Shin Park, Sam Pullen, Per Enge</i>	
Performance Assessment of Dual Frequency GBAS Smoothing Algorithms using a Dual Constellation and Non-Gaussian Error Distributions.....	285
<i>Patrick Remi, Boubeker Belabbas, Thomas Dautermann, Michael Meurer</i>	
Preparation of upcoming multi constellation GBAS concepts	292
<i>Thomas Feuerle, Benedikt Von Wulfen, Ulf Bestmann, Meiko Steen, Peter Hecker, Andreas Lipp</i>	
Design Practice of Integrity Monitoring Scheme for Ground-based Regional Integrity Monitoring System.....	301
<i>R. Xue, J. Zhang, Y. Zhu</i>	
A Novel Sampling Method for GBAS Availability Assessment Based on Multi-constellation	307
<i>Zhipeng Wang, Jun Zhang, Yanbo Zhu, Rui Xue</i>	
An Evaluation of OmniSTAR XP and PPP as a Replacement for DGPS in Airborne Applications	314
<i>Janet S. Booth, Robert N. Snow</i>	
A Study of DGPS Performance in Case of Limited Bandwidth Availability	321
<i>Gianluca Marucco, Fabrizio Dominici, Gianluca Falco, Fabio Dosis</i>	

D1: URBAN & INDOOR NAVIGATION TECHNOLOGY 1

A VDLL Approach to GNSS Cell Positioning for Indoor Scenarios	329
<i>Fernando D. Nunes, Fernando M. G. Sousa, Nuria Blanco-Delgado</i>	
A Novel Algorithm Based on FFT for Ultra High-Sensitivity GPS Tracking.....	339
<i>Ba Xiaohui, Liu Haiyang, Zheng Rui, Chen Jie</i>	
Multipath Mitigation via Synthetic Aperture Beamforming	346
<i>Sasha Draganov, Marc Harlacher, Lin Haas</i>	
Getting Back on the Sidewalk: Doppler-Aided Autonomous Positioning with Single-Frequency Mass Market Receivers in Urban Areas.....	355
<i>Mojtaba Bahrami</i>	
Applying the Genetic NIORAIM Algorithm to High Sensitivity GNSS Receivers Operating Indoor.....	365
<i>Angelo J. Joseph, Gerard Lachapelle</i>	
GPS L1 Indoor Fading Characterization using Block Processing Techniques.....	381
<i>Shashank Satyanarayana, Daniele Borio, Gerard Lachapelle</i>	
Enhanced GNSS Indoor Signal Detectability Using Polarization Diversity	395
<i>Mohammadreza Zaheri, Ali Broumandan, Cillian O'Driscoll, Gérard Lachapelle</i>	
Magnetic Field Aided Vehicle Tracking	406
<i>William F. Storms, John F. Raquet</i>	

E1: GNSS SIMULATION AND TESTING

Design of a High Fidelity Signal Simulator Aided with Precise Point Positioning	414
<i>Feng Xu, Yang Gao, Changsheng Cai</i>	
Multi-Constellation GNSS Signal Simulator and Its Software Implementation	422
<i>Yun Zhao, Yanhong Kou, Zhigang Huang</i>	

GNSS Constellation and Performance Simulator for Testing and Certification	429
<i>P. Berglez, E. Wasle, J. Seybold, B. Hofmann-Wellenhof</i>	
Design and Implementation of a Flexible Software-based GNSS IF Signal Simulator	438
<i>Xi Yin, Yanhong Kou, Zhengwen Zhang</i>	
Delivering the Outdoors down a Cable: An RF Test Environment for Hybrid Systems	450
<i>Rachel L. Maw, Murray R. Jarvis, Nicolas G. A. Graube, Xuguang Long</i>	
Navigation Simulation Options for Ground Testing of Installed Systems	457
<i>P. Cook, Jack McCune</i>	
Proper GPS/GNSS Receiver Testing	460
<i>Eric Vinande, Brian Weinstein, Dennis Akos</i>	
Modeling Multi-Core Software GNSS Receiver with Real Time SW Receiver	468
<i>Jussi Raasakka, Heikki Hurskainen, Tommi Paakki, Jari Nurmi</i>	
Multi-channel Record and Playback System for GNSS RF/IF Receivers' Design Validation and Fine-Tuning	474
<i>Iurie Ilie, Dominique Fortin, Marc-Antoine Fortin</i>	

F1: GALILEO INTEGRITY, MULTI-CONSTELLATION RAIM

First Integrity Results in Galileo: GIOVE-A Performances Obtained with the Experimental Integrity Process Facility	485
<i>A. M. Curiel, B. Martín, A. Juez, M. E. Ramírez, C. Igual, F. Amarillo, A. Ballereau, B. Schlarmann</i>	
Promising Results on Detection Capability of Galileo OSPF and IPF Integrity Barriers	498
<i>A. Belen Martin Peiro, M. Eva Ramirez, Carmen Igual Bets, Ana M. Curiel, Andres Juez Munoz, Francisco Amarillo Fernandez, Alexandre Ballereau, Bernd Schlarmann</i>	
New Developments for the user Integrity Processing with Galileo Implementation and Testing of Galileo user Integrity Algorithms	509
<i>F. Amarillo, P. D'Angelo</i>	
Enhancements of the DichoTomy based RAIM	517
<i>Zhang Miaoyan, Zhang Jun, Zhu Yanbo</i>	
GNSS RAIM Assumptions for Vertically Guided Approaches	525
<i>A. Martineau, C. Macabiau, M. Mabillean</i>	
Assessment of Combined Integrity Algorithms	538
<i>F. Kneissl, C. Stoeber, B. Eissfeller</i>	
Hysteresis in RAIM	552
<i>Juan Blanch, Christoph Mayer, Sherman Lo, Todd Walter, Per Enge</i>	
Methodology and Case Studies of Signal-in-Space Error Calculation Top-down Meets Bottom-up	558
<i>Grace Xingxin Gao, Haochen Tang, Juan Blanch, Jiyun Lee, Todd Walter, Per Enge</i>	
SBAS Equations with Complementary Conditions in Galileo	566
<i>F. Amarillo, P. D'Angelo</i>	
Improved Signal In Space Accuracy based on Matrix Indicators	573
<i>L. Fernández, C. Catalán, A. Mozo, F. Amarillo</i>	

PANEL 1: PROGRAM UPDATES (GPS, GALILEO, QZSS)

GPS Program Update to ION GNSS 2009	586
<i>Dave Madden</i>	

VOLUME 2

GALILEO Program Status Update	604
<i>Marco Lisi</i>	
Quasi-Zenith Satellite System Program Update	648
<i>Noriyasu Inaba</i>	

A2: MILITARY GPS & GPS-INS INTEGRATION

Failure Detection for a Pseudolite-Based Reference System	674
<i>Michael Ciampa, John Raquet</i>	

The Observability Analysis and SPKF for the In-motion Alignment of the Loosely-integrated GPS/INS System	683
<i>Qin Wang, Yong Li, Kedong Wang, Chris Rizos, Shiyi Li</i>	
Positioning in GPS-challenged Environments: Dynamic Sensor Network with Distributed GPS Aperture and Inter-nodal Ranging Signals	690
<i>D. A. Grejner-Brzezinska, C. K. Toth, L. Li, J. Park, X. Wang, H. Sun, I. J. Gupta, K. Huggins, Y. F. Zheng</i>	
Use of GPS Navigation in the Norwegian Naval Strike Missile	703
<i>Morten Meen, John Nielson</i>	
Integrating Evolving Military GPS Receiver Technology and Enhanced LORAN with New and Legacy Shipboard Systems	713
<i>William R. Woodward, Richard Webb</i>	
Streamlining Dilution of Precision Analysis for GPS Constellations	719
<i>B. J. Stanton, Charles D. Jones, Julia C. Flom</i>	
AFRL Navigation Warfare (NAVWAR) Testbed	726
<i>Dana Howell, Denice Jacobs, Dan Dresher</i>	
The Effect of M-Code Multipath on Ephemeris Generation	734
<i>R. Benjamin Harris, E. Glenn Lightsey</i>	
GPS Accuracy and Reliability Assessment – The Truth in the Truth Source	746
<i>Theodore A. Miller, Philip Zalesak, David Schug, Doug Herndon</i>	
Gradient-Type Minimization Methods for Initializing State Variables in GPS/INS Integration	756
<i>Joseph M. Strus, Michael R. Kirkpatrick, James W. Sinko</i>	

B2A: SURVEYING & GEODESY

GPS-over-fiber Architecture with Relative Cable Delay Monitoring for High Precision GPS applications	765
<i>Daniel Macias-Valadez, Rock Santerre, Sophie Larochelle, Rene Landry</i>	
Skyscrapers Watch Using an INS/GPS Integrated POS Grid	778
<i>Naomi Chia-Yuan Li</i>	
Controlled Antenna Changes at GNSS Reference Stations	792
<i>Lambert Wanninger, Volker Frevert, Martin Fettke</i>	
Atmospheric Pressure Loading and its Effects on Precise Point Positioning	801
<i>Landon Urquhart</i>	
A Survey of Techniques and Algorithms in Deformation Monitoring Applications and the use of the Locata Technology for Such Applications	811
<i>M. M. Choudhury, Chris Rizos, Bruce Harvey</i>	
Mapping and Visualisation of Sub-surface Utilities in Urban Environments	822
<i>O. Ogundipe, C. Hancock, A. Taha, G. W. Roberts, J-P. Montillet</i>	

B2B: MARINE APPLICATIONS

Experimental Results of Relative Speeds and Distances in STS Lightering by Application of GPS-based Systems	837
<i>Yunja Yoo, Egil Pedersen, Nobuyoshi Kouguchi, Yasuo Arai</i>	
Improving Underwater Navigation and Docking with Three-Dimensional Sonar	845
<i>William R. Woodward, Richard Webb, Rolf Kahrs Hansen, Blair Cunningham, Donald J. Weber, Robert F. Weingaertner</i>	
Evaluation of Tropospheric and Ionospheric Effects on Arctic Navigation Conditions	852
<i>Suzanna C. Barth Diener</i>	
Advanced GNSS RTK and GNSS Heading in Single OEM Board: Algorithms and Performance	858
<i>Aleksey Boriskin, Gleb Zyryanov</i>	
Research on Terrain Suitability of Iterative Closest Contour Point Algorithm for Underwater Navigation	866
<i>Kedong Wang, Yong Li, Chris Rizos</i>	

C2: GNSS SPACE BASED AUGMENTATION SYSTEMS (SBAS)

Experimental Flight Tests with EGNOS on A380 to support RNAV LPV Operations	871
<i>Laurent Azoulai, Sebastien Virag, Romain Leinekugel-Le Cocq, Cyril Germa, Bernard Charlot, Pierre Durel</i>	

Availability Benefit of Future Dual Frequency GPS Avionics under Strong Ionospheric Scintillation	884
<i>Jiwon Seo, Todd Walter, Per Enge</i>	
Overbounding Revisited: Toward a More Practical Approach for Error Modeling in Safety-Critical Applications.....	893
<i>Jason Rife, Boris Pervan</i>	
PRN-21 Carrier Phase Perturbations Observed by WAAS	904
<i>Stephen Gordon, Karl Shallberg, Swen Ericson, Joe Grabowski, Tom Morrissey, Frank Lorge</i>	
Multi-Constellation Regional System Performance Enhancements due to Galileo and Modernized GPS	912
<i>Jose F. M. Lorga, Pedro F. Silva, Manuel Marcote, Michel Tossaint</i>	
Modeling Vertical Structure of Ionosphere for SBAS	925
<i>Takeyasu Sakai, Takayuki Yoshihara, Susumu Saito, Keisuke Matsunaga, Kazuaki Hoshinoo, Todd Walter</i>	
The Benefits of Multi-constellation GNSS: Reaching up Even to Single Constellation GNSS Users	936
<i>B. Bonet, I. Alcantarilla, D. Flament, C. Rodriguez, N. Zarroa</i>	
GNSS Integrity Achievement by using Extreme Value Theory	949
<i>Jean-Marc Azais, Sebastien Gadat, Jean-Christophe Levy, Berenger Rols, Cecile Mercadier, Norbert Suard</i>	
Research on Global Navigation Satellite System (GNSS) Autonomous Navigation Technology Based on Inter Satellite Links (ISL)	956
<i>D. Zoui, X. Lu, H. Wu, T. Han</i>	
An Improved Method on Ionospheric Delay Calculation in Multi-Constellation Navigation Systems	966
<i>Shan Wang, Jun Zhang, Rui Li, Qifeng Xu</i>	

D2: LAND BASED APPLICATIONS 1

Vehicle Heading Determination Using Only Single-antenna GPS and a Single Gyro	973
<i>Paul D Groves, Robin J Handley, Simon T Parker</i>	
Performance Evaluation of Ultra-tight Integration of GPS/Vehicle Sensors for Land Vehicle Navigation	983
<i>Tao Li, Mark G. Petovello, G. Lachapelle, C. Basnayake</i>	
Robust Car Localization for an Autonomous Vehicle in Urban Environments	995
<i>Andreas Sasse, Tobias Nothdurft, Peter Hecker</i>	
Propagating Integrity Bounds in Nonlinear State Estimation	1005
<i>Kyle O'Brien, Jason Rife</i>	
Pattern Classification for Geotag Generation	1017
<i>Di Qiu, Sherman Lo, Per Enge, Dan Boneh</i>	
Multiple IMU Integration for Vehicular Navigation	1026
<i>Jared B. Bancroft</i>	
First MAGES Demonstrations - Applications of GNSS for Emergency Scenarios	1039
<i>R. Hass, C. S. Dixon</i>	
Camera Vision and Inertial Measurement Unit Sensor Fusion for Lane Detection and Tracking using Polynomial Bounding Curves	1047
<i>Christopher Rose, David M. Bevly</i>	
Hybrid Extended Particle Filter (HEPF) for INS/GPS Integrated System.....	1056
<i>Priyanka Aggarwal, Naser El-Sheimy</i>	
Improving Detection of Low Frequency Vibrations using High Rate Data and Filtering Techniques in Time Series of GPS Baseline	1065
<i>Ana P. C. Larocca, Ricardo E. Schaal, Augusto C. B. Barbosa</i>	

E2: MULTIPATH EFFECTS & MITIGATION

Performance Comparison of ELP and DELP for Multipath Detection	1074
<i>Omer Mohsin Mubarak, Andrew G. Dempster</i>	
A Location and Movement Dependent GNSS Multipath Error Model for Pedestrian Applications	1082
<i>Alexander Steingass, Andreas Lehner, Frank Schubert</i>	
Post-Correlation Peak Sharpening.....	1095
<i>Chun Yang, Thao Nguyen, Mikel Miller</i>	
A Statistical Detector of Multipath for Antenna-array based GNSS Receivers	1104
<i>Carles Fernandez-Prades, Pau Closas, Juan A. Fernandez-Rubio</i>	

Real-Time Low-Cost Multipath Mitigation Technique Calibrated through Real Data Repeatable Testing	1114
<i>Marc-Antoine Fortin, Jean-Christophe Guay, Rene Jr Landry</i>	
A Novel Real-time Platform for Digital Beamforming with GNSS Software Defined Receivers	1127
<i>Javier Arribas, David Bernal, Carles Fernandez-Prades, Pau Closas, Juan A. Fernandez-Rubio</i>	
The Aid of Wavelets Correlator in Carrier Phase Multipath Reduction and Motion Detection	1142
<i>Ahmed El-Ghazouly</i>	
Effects of Rotor Blade Modulation on GNSS Receiver Measurements	1150
<i>Andrew J. O'Brien, Kyle Hayhurst, Inder J. Gupta</i>	
Empirical Analysis and Characterization of Indoor GPS Signal Fading and Multipath Conditions	1160
<i>Henrik Blunck, Mikkel Baun, Kjaergaard, Torben Godsk, Thomas Toftkjaer, Dan Lund Christensen, Kaj Gronbaek</i>	
Modeling the GNSS Rural Radio Channel: Wave Propagation Effects Caused by Trees and Alleys	1170
<i>F. M. Schubert, A. Lehner, A. Steingass, P. Robertson, B. H. Fleury, R. Prieto-Cerdeira</i>	
Development of a GPS Deterministic Multipath Simulator for an Efficient Computation of the Positioning Errors	1176
<i>Adrien Chen, Alexandre Chabory, Anne-Christine Escher, Christophe Macabiau</i>	
Using Dirichlet Process Mixtures for the Modelling of GNSS Pseudorange Errors in Urban Canyon	1189
<i>Asma Rabaoui, Nicolas Viandier, Juliette Marais, Emmanuel Duflos</i>	

F2: GALILEO SIGNAL STRUCTURE, GPS/GALILEO INTEROPERABILITY

Joint Optimization of Spectral Separation and Navigation Performance in GNSS Signal Design	1198
<i>Felix Antreich, Josef A. Nossek, Jean-Luc Issler, Michael Meurer</i>	
Phase-Optimized Constant-Envelope Transmission (POCET) Modulation Method for GNSS Signals	1206
<i>P. A. Dafesh, C. R. Cahn</i>	
On Differential Demodulation in GNSS Receivers	1213
<i>Sandeep Rao</i>	
Demodulation Performance of Galileo E1 OS and GPS L1C Messages in a Mobile Environment	1221
<i>Axel Garcia Pena, Marie-Laure Boucheret, Christophe Macabiau, Anne-Christine Escher, Lionel Ries</i>	
Determination and Analysis of Interference affecting Signal in Space Measurement	1236
<i>Steffen Tholert, Stefan Erker, Johann Furthner, Michael Meurer</i>	

VOLUME 3

The Off-Line SIS Quality Analysis (OASIS) Tool: Design, Development and Validation	1245
<i>M. Rapisarda, D. Hannes, T. Burger, M. Soellner, C. Kurzhals</i>	
Geometry-free Analysis of GIOVE-A/B E1-E5a, and GPS L1-L5 Measurements	1257
<i>Christian C. J. M. Tiberius, Peter F. De Bakker, Hans Van Der Marel, Roel, J. P. Van Bree</i>	
Dithered Sampling and Averaging for GNSS Signal Decoding Using Conventional Hardware	1272
<i>Gianluca Falco</i>	
Design, Architecture and Validation of a New GNSS Multi Constellation Simulator: NAVYS	1280
<i>Geraldine Artaud, Antoine De Latour, Joel Dantepal, Lionel Ries, Jean-Luc Issler, Jeremy Tournay, Olivier Fudulea, Jean-Marc Aymes, Nicolas Maury, Jean-Pascal Julien, Virginie Dominguez, Eric Senant, Mathieu Raimondi</i>	
Optimum Data Rate and Signal Power Split for Next Generation GNSS Architectures	1288
<i>Jong-Hoon Won, Marco Anghileri, Bernd Eissfeller, Andreas Schmitz-Peiffer, Jean-Jacques Floch</i>	

PSA: PROGRAM UPDATES: HIGH INTEGRITY SYSTEMS

GPS Augmentation Systems Status	1302
<i>Leo Eldredge</i>	
EGNOS Status Update	1322
<i>C. Seynat, D. Flament, D. Brocard</i>	
GNSS Evolutionary Architecture Study	1349
<i>Per Enge</i>	
Surveillance and Broadcast Services - ADS-B Overview	1367
<i>Doug Arbuckle</i>	
GNSS use on Airbus Aircraft Today & Tomorrow	1391
<i>Laurent Azoulai</i>	

GNSS Positioning and Future Trends in Air Traffic Management	1425
<i>Tim Murphy</i>	

P2B: SVN-49 REVIEW

GPS IIR-20 (SVN-49) Panel Discussion	1444
<i>David Goldstein</i>	

A3: GNSS RECEIVER ALGORITHMS 1

Development and Validation of a Parametric Model for Vector Tracking Loops	1456
<i>Susmita Bhattacharyya, Demoz Gebre-Egziabher</i>	
Digital Phase Locked Loop With Frequency Rate Feedback	1471
<i>Pejman L. Kazemi, Cillian O'Driscoll, Gerard Lachapelle</i>	
Performance Analysis of Doppler Aided Tracking Loops in Modernized GPS Receivers	1479
<i>Sana Ullah Qaisar</i>	
A Self-Adaptive Maximum Likelihood Bit Synchronization Approach for a GPS Receiver	1489
<i>Rui Zheng, Mohan Chen, Xiahui Ba, Jie Chen</i>	
Tracking GPS Signals under Ionosphere Scintillation Conditions	1497
<i>Lei Zhang, Yu T. Morton</i>	
To What Extent Can Standard GNSS Ambiguity Resolution Methods be used for Single-Frequency Epoch-by-Epoch Attitude Determination?	1505
<i>P. J. G. Teunissen, G. Giorgi</i>	
Use of a Vector-based Tracking Loop Receiver for Solving the Near-Far Problem in a Pseudolite Navigation System	1513
<i>Hyounghmin So, Taikjin Lee, Sanghoon Jeon, Chongwon Kim, Changdon Kee, Moon Beom Heo</i>	
A Complex Channel Structure for Generic GNSS Signal Tracking	1522
<i>Th. Lueck, J. Winkel, M. Bodenbach</i>	

B3: ALGORITHMS FOR MULTI-SENSOR FUSION 1

Multi-sensor Fusion Using a Kalman Filter and Knowledge-based Systems	1529
<i>Guenther Retscher</i>	
Estimating Motion Parameters of Head by Using Hybrid Extended Kalman Filter	1537
<i>Sejong Heo, Oksik Shin, Chan Gook Park</i>	
Using OrthoSLAM and Aiding Techniques for Precise Pedestrian Indoor Navigation	1544
<i>Christian Ascher, Christoph Kessler, Matthias Wankerl, Gert F. Trommer</i>	
Adaptive Update Strategy for GNSS/IMU Integration	1551
<i>Mingquan Lu, Peng Li, Zhenming Feng</i>	
Integrated Multi-Aperture Sensor and Navigation Fusion	1560
<i>Andrey Soloviev, Jimmy Touma, Timothy Klausutis, Mikel Miller, Adam Rutkowski, Kyle Fontaine</i>	
Multi-Sensor Fusion for Localization Concept and Simulation Results	1568
<i>Damien Kubrak, Francois Le Gland, Liyun He, Yann Oster</i>	
Developing a Framework for Image-based Integrity	1579
<i>Craig Larson, John F. Raquet, Michael J. Veth</i>	
Maps and Floor Plans Enhanced 3D Movement Model for Pedestrian Navigation	1591
<i>Mohammed Khider, Susanna Kaiser, Patrick Robertson, Michael Angermann</i>	
A New GPS/RFID Integration Algorithm Based on Iterated Reduced Sigma Point Kalman Filter for Vehicle Navigation	1604
<i>Jing Peng, Falin Wu, Ming Zhu, Kefei Zhang, Feixue Wang</i>	
The Merits of UKF and PF for Integrated INS/GPS Navigation Systems	1612
<i>Sara Saeedi, Naser El-Sheimy, Zainab Syed</i>	

C3: NEXT GENERATION GNSS INTEGRATION

Providing Integrity for Satellite Navigation: Lessons Learned (Thus Far) from the Financial Collapse of 2008 – 2009	1619
<i>Sam Pullen</i>	

Evaluation of Signal in Space Error Bounds to Support Aviation Integrity	1631
<i>Todd Walter, Juan Blanch, Per Enge</i>	
Satellite Autonomous Integrity Monitoring (SAIM) for GNSS Systems	1644
<i>Irma Rodríguez, Cristina García, Carlos Catalán, Álvaro Mozo, Patrizia Tavella, Lorenzo Galleani, Pascal Rochat, Qinghua Wang, Francisco Amarillo</i>	
Characterizing Nominal Analog Signal Deformation on GNSS Signals	1657
<i>R. Eric Phelts, Todd Walter, Per Enge</i>	
A Convex Geometry Approach to Dynamic GNSS Satellite Selection for a Multi-Constellation System	1665
<i>Nuria Blanco-Delgado, Fernando D. Nunes</i>	
Rover Autonomous Integrity Monitoring of GNSS RTK Positioning Solutions with Multi-Constellations	1675
<i>Jun Wang, Yanming Feng, Charles Wang</i>	
Iridium/GPS Carrier Phase Positioning and Fault Detection Over Wide Areas	1685
<i>Mathieu Joerger, Jason Neale, Boris Pervan</i>	
Regional Advanced Autonomous Localization system (GRAAL)	1700
<i>Eric Senant, Charles Fernet, Daniel Brocard, Lionel Ries</i>	
A New User Integrity Prediction and Monitoring Algorithms for Aviation Application	1710
<i>Hua Su, Walter Ehret</i>	

D3: NEW PRODUCT ANNOUNCEMENTS

NavX® - NCS A Multi-Constellation RF Simulator: Latest Product Developments and Test Applications	1718
<i>Markus Irsigler, Bernhard Riedl, Thomas Pany, Robert Wolf, Gunter Heinrichs</i>	
G2 - The First Real-Time GPS and GLONASS Precise Orbit and Clock Service	1727
<i>T. Melgard, E. Vigen, K. De Jong, D. Lapucha, H. Visser, O. Oerpen</i>	
Inertially Aided Precise Point Positioning	1734
<i>Eun-Hwan Shin, Bruno Scherzinger</i>	
Tightly Coupled Processing of Precise Point Position (PPP) and INS Data	1740
<i>Greg Roesler, Hugh Martell</i>	
Introducing the LV100™ Series GPS Compass from Hemisphere GPS®	1748
<i>Kirk Burnell, Arpad Barabas</i>	
NavCom's SF-3050: A Software Upgradeable GNSS Receiver	1752
<i>Yilei Jia, Kurtis Kenne, Jerry Knight, Cheryl Kung, James Williams</i>	
Achieving Sub 20 cm Autonomous Positioning Accuracy Using Nexteq PAD Dual-frequency Receivers	1760
<i>Y. Zhang, S. Lee, C. Chen</i>	
An Open Source AGPS/DGPS Capable C-coded Software Receiver	1768
<i>Scott Gleason, Morgan Quigley, Pieter Abbeel</i>	
Configuring an RF Record and Playback System from General Purpose RF Instrumentation	1774
<i>David A. Hall</i>	
SAT-SURF and SAT-SURFER: a Novel Multireceiver Hardware and Software Platform for Research and Education on GNSS and Augmentation Systems	1779
<i>Khalid Charqane, Antonio Defina, Fabrizio Dominici, Gianluca Marucco, Paolo Mulassano</i>	
The GPSTk: GLONASS, RINEX Version 3.00 and More	1785
<i>Thomas L. Gaussiran, Eric Hagen, R. Benjamin Harris, Chris Kieschnick, Jon C. Little, Richard G. Mach, David C. Munton, Scot L. Nelsen, Colin P. Petersen, David L. Rainwater, Brent A. Renfro, Brian W. Tolman, Dagoberto Salazar</i>	

E3: PPP AND NETWORK-BASED RTK 1

Real Time Satellite Clocks in Single Frequency Precise Point Positioning	1797
<i>R. J. P. Van Bree, C. C. J. M. Tiberius, A. Hauschild</i>	
Orbits and Clocks for GLONASS Precise-Point-Positioning	1812
<i>R. Piriz, D. Calle, A. Mozo, P. Navarro, D. Rodriguez, G. Tobias</i>	
Shortening the Convergence Time of Wide-Area Real-Time Kinematic Solutions	1822
<i>Oscar L. Colombo</i>	
Rapid Re-convergence in Real-time Precise Point Positioning with Ambiguity Resolution	1834
<i>Jianghui Geng</i>	
Study on Precise Point Positioning Based on Combined GPS and GLONASS	1846
<i>Xingxing Li, Xiaohong Zhang, Fei Guo</i>	

Zero-difference Integer Ambiguity Fixing on Single Frequency Receivers	1857
<i>D. Laurichesse, F. Mercier, J. P. Berthias</i>	
Improving Real-Time Kinematic PPP with Instantaneous Cycle-Slip Correction	1867
<i>Simon Banville, Richard B. Langley</i>	
Precise Point Positioning for Real-Time Determination of Co-Seismic Crustal Motion	1876
<i>Paul Collins, Joe Henton, Yves Mireault, Pierre Heroux, Mike Schmidt, Herb Dragert, Sumil Bisnath</i>	

VOLUME 4

Effect of Second-Order Ionospheric Delay on GPS Orbit and Precise Point Positioning	1886
<i>Mohamed Elsobeiey, Ahmed El-Rabbany</i>	
PPP Based on GR Models with Estimating Tropospheric and Ionospheric Delays	1893
<i>Kazuhiro Nishikawa, Seigo Fujita, Yukihiro Kubo, Sueo Sugimoto</i>	
Ionosphere Effect Mitigation for Single-Frequency Precise Point Positioning	1905
<i>Constantin-Octavian Andrei, Ruizhi Chen, Heidi Kuusniemi, Manuel Hernandez-Pajares, José Miguel Juan, Dagoberto Salazar</i>	

F3: GALILEO SYSTEM DESIGN & SERVICES

Galileo System Performance Status Report	1915
<i>Veit Oehler, Jan M. Krueger, Tanja Beck, Michael Kirchner, Hans L. Trautenberg, Jorg Hahn, Daniel Blonski</i>	
Building Galileo Navigation System: Two years of GIOVE-M Experimentation	1926
<i>Guillermo Tobias, Irene Hidalgo, Alvaro Mozo, Daniel Rodriguez, Stefano Binda, Francisco Gonzalez, Alexander Mudrak, Patrizia Tavella, Ilaria Sesia, Giancarlo Cerratto</i>	
Development and Verification of Galileo Ground Mission Segment (GMS)	1939
<i>A. Quiles, B. Kl. Schlarmann, A. Ballereau, M. Hollreiser, J. L. Durand, E. Robert, A. Schmid</i>	
Development and Early Results of a Galileo UERE/UERRE Monitoring Facility	1949
<i>Wolfgang Werner, Udo Rossbach, Massimo Eleuteri, Daniele Cretoni</i>	
GPS – GIOVE Mixed PVT Experimentation	1955
<i>Bernard Bonhoure, Cyrille Boulanger, Jerome Legenne</i>	
GIOVE-B Satellite Design and Performance Validation	1967
<i>G. J. Robertson, R. Kieffer, M. Malik, G. Gatti, V. Alpe, M. Johansson</i>	
GIOVE-B Navigation Message Performance Analysis and Signal in Space User Ranging Error (SISRE) Characterization	1976
<i>Gaetano Galluzzo, Manuel Sanchez-Gestido, Francisco Gonzales, Stefano Binda, Gianmarco Radice, Andreas Hedqvist, Richard Swinden</i>	
Latest Achievements in GIOVE Signal and Sensor Station Experimentations	1984
<i>J. Giraud, V. Borrel, M. Crisci</i>	

P3: GNSS IN UNINHABITED VEHICLES

John Deere - Beyond Assisted Steering	1996
<i>Michael A. Zeitzew</i>	
Guidance & Navigation System for an Autonomous Lawnmower: CWRU Cutter	2016
<i>B. Hughes, J. Beno, A. Schepelmann, D. Bennett, H. Snow, K. Daltorio, J. Green, R. D. Quinn</i>	
Mini-Urban Challenge National High School Competition	2024
<i>Casey Miller, Caroline New</i>	

A4: SOFTWARE RECEIVERS

Development of a Universal GNSS Tracking Channel	2041
<i>Marc-Antoine Fortin, Jean-Christophe Guay, Rene Jr. Landry</i>	
FPGA Implementation of a Vector Tracking GPS Receiver using Model-Based Tools	2055
<i>W. Luke Edwards, Matthew Lashley, David M. Bevly</i>	
Achieving Precise Real-Time GNSS Positioning with Software-based Receivers	2063
<i>D. Lu, Y. Zhang, S. Lee, C. Chen</i>	
Optimizing Real-World GNSS Receiver Performance: A Software Approach	2070
<i>Alexander Mitelman, Jakob Almqvist, Robin Hakanson, David Karlsson, Fredrik Lindstrom, Thomas Renstrom, Christian Stahlberg, James Tidd</i>	

GNSS Signal Channel Impulse Response Estimation: Modified Inverse Filter vs. Wiener Filter	2077
<i>Chun Yang, Thao Nguyen, Mikel Miller</i>	
Doppler Measurements and Velocity Estimation: a Theoretical Framework with Software Receiver Implementation	2086
<i>Daniele Borio, Nadezda Sokolova, Gerard Lachapelle</i>	
Development and Field Testing of a DSP-Based Dual-Frequency Software GPS Receiver	2099
<i>Brady W. O'Hanlon, Mark L. Psiaki, Paul M. Kintner, Todd E. Humphreys</i>	
Exploiting Multicore Technology in Software-Defined GNSS Receivers	2108
<i>Todd E. Humphreys, Jahshan A. Bhatti, Thomas Pany, Brent M. Ledvina, Brady W. O'Hanlon</i>	
The Optimized Method and Algorithms in the CPU&GPU-Based GNSS Software Receiver	2121
<i>Wu Cailun, Qian Yi, Cui Xiaowei, Lu Mingquan</i>	

B4: ALTERNATIVES AND BACKUPS TO GNSS

Integration of Ladar Vision and Inertial Data for GNSS Denied Navigation	2126
<i>Andrey Soloviev, David Eaton, Maarten Uijt De Haag, Zhen Zhu</i>	
Performance Evaluation of Coupling between Vehicle Guidance and Vision Aided Navigation	2134
<i>Don T. Venable, Jacob L. Campbell, Jared Kresge, Daylond Hooper, Gilbert Peterson, Ph. D, Michael Veth</i>	
Use of Vision Sensors and Lane Maps to Aid GPS/INS under a Limited GPS Satellite Constellation	2143
<i>John W. Allen, David M. Bevely</i>	
Integration of a RFID Time-based CoO Positioning with INS Using a Time Data Capture Tool for Verification	2153
<i>Qing Fu, Guenther Retscher</i>	
Method and Apparatus for High Precision GNSS/UWB Surveying	2161
<i>Glenn D. Macgougan, Richard Klukas</i>	
Non-GNSS Radio Positioning Using the Digital Audio Broadcasting (DAB) Signal	2172
<i>Duncan Palmer, Terry Moore, Chris Hill, Marcus Andreotti, David Park</i>	
GNSS and eLORAN Tightly Coupled	2181
<i>Philip G. Mattos</i>	
Detection of Time-Hopped AD-CDMA Signal for Pseudolite-based Positioning System	2189
<i>Joon Wayn Cheong, Andrew G. Dempster, Chris Rizos</i>	
A Hybrid Carrier Phase Measurement Weighting Scheme for Carrier Point Positioning Solution Improvement	2200
<i>Faisal A. Khan, Mazher Choudhury, Andrew G. Dempster, Chris Rizos</i>	
Efficient Authentication Mechanisms for Navigation Systems - a Radio-Navigation Case Study	2209
<i>Georg T. Becker, Sherman Lo, David De Lorenzo, Di Qiu, Christof Paar, Per Enge</i>	
ASF Correction Technique using Multiple eLoran Monitor Sites in Korea	2221
<i>Sang Wook Hwang, Mi Young Shin, Sang Jeong Lee, Sung-Hoon Yang, Chang-Bok Lee, Chansik Park, Dong-Hui Yu</i>	

C4: SPACE APPLICATIONS

Dual-Frequency Spaceborne GPS Receiver for the Advanced Land Observing Satellite (ALOS): Design and Flight Results	2227
<i>Takanori Iwata, Kenichi Toda, Yoshinori Kondoh, Toru Yamamoto, Masahiro Kakinuma, Susumu Kumagai</i>	
GPS Signal Tracking on Spinning Vehicles with Antenna Diversity Techniques	2236
<i>Takuji Ebinuma, Hirobumi Saito, Koji Tanaka, Takahiro Miyoshi</i>	
European Spaceborne Dual Frequency GPS Receiver for Science and Earth Observation	2242
<i>Manfred Sust, Anders Carlstrom, Alberto Garcia-Rodriguez</i>	
Navigation of Formation Flying Spacecraft using GPS: the PRISMA Technology Demonstration	2250
<i>Simone D'Amico, J-S. Ardaens, O. Montenbruck</i>	
TriG - A GNSS Precise Orbit and Radio Occultation Space Receiver	2265
<i>Stephan Esterhuizen, Garth Franklin, Ken Hurst, Anthony Mannucci, Tom Meehan, Frank Webb, Larry Young</i>	
GPS Navigation for the Magnetospheric Multi-Scale Mission	2270
<i>William Bamford, Jason Mitchell, Michael Southward, Philip Baldwin, Luke Winternitz, Gregory Heckler, Rishi Kurichh, Steve Sirotzky</i>	
The Information-Theoretic Limits for the Performance of X ray Source Based Navigation (Xnav) and X ray Communication (Xcom)	2281
<i>Daniel G. Jablonski</i>	
Onboard Real-Time Navigation for the Sentinel-3 Mission	2290
<i>Oliver Montenbruck, Andre Hauschild, Franz Zangerl, Wolfgang Zsalcsik, Pere Ramos-Bosch, Ulf Klein</i>	

Non Linear Sigma Point Kalman Filter Applied to Orbit Determination Using GPS Measurements	2301
<i>P. C. P. M. Pardal, H. K. Kuga, R. Vilhena De Moraes</i>	
High-Fidelity Measurement Models for Optical Spacecraft Navigation	2309
<i>John A. Christian, E. Glenn Lightsey</i>	

D4: MODELING AND ALGORITHMS

Inclusion of Rotor Blade Modulation in Computer Simulations or Wavefront Simulators	2327
<i>Khadir A. Griffith, Inder J. Gupta</i>	
A New Autoregressive Error Modeling Method Based on Wavelet Decomposition for MEMS Inertial Sensors	2337
<i>Y. Yuksel, N. El-Sheimy, A. Noureldin</i>	
On Performance Assessment of GNSS Receivers.....	2346
<i>Mariano Vergara, Felix Antreich, Geraldine Artaud, Michael Meurer, Jean-Luc Issler</i>	
SNACS - The Satellite Navigation Radio Channel Signal Simulator	2354
<i>F. M. Schubert, R. Prieto-Cerdeira, P. Robertson, B. H. Fleury</i>	
SDR Technologies Supporting RF Signal Power Calibration in GNSS Receivers Testing.....	2361
<i>Marco Pini, Beatrice Motella, Emanuela Falletti</i>	
Singularity Detection Technique for GPS Cycle Slip in Wavelets Domain.....	2371
<i>Mohamed Elhabiby, Ahmed El-Ghazouly, Naser El-Sheimy</i>	
Estimation of the Vector Effective Height of GPS Antennas Using Carrier Phase Measurements	2380
<i>Romeo Ahohe</i>	
Analysis of Three Ambiguity Resolution Methods for Real Time Static and Kinematic Positioning of a GPS Receiver	2392
<i>Leandro Baroni, Helio Koiti Kuga, Kyle O'Keefe</i>	
An Extended Propagation Ephemeris with Graceful Degradation	2401
<i>Michael A. Walker, James L. Garrison</i>	
Error Compensation Algorithm and Calibration Experiment Based on Ellipse Model for Magnetic Compass in Land Navigation System.....	2408
<i>Ping Ye, Gang Du, Chuanrun Zhai, Haowen Wu, Xingqun Zhan</i>	

E4: ATMOSPHERIC EFFECTS & MODELING

Correcting the Negative Values of the Retrieved Ionospheric Electron density Profiles using the NNLS Algorithm.....	2415
<i>Fatemeh Ghafoori</i>	
Benefit of Partial L2C Availability for Correcting Ionospheric Error for Standalone GPS	2427
<i>Kyle O'Keefe, Da Wang, Mark G. Petovello, Cyrille Gernot</i>	
Higher Order Ionosphere Errors at Arecibo, Millstone, and Jicamarca	2436
<i>Nick Matteo, Yu Morton, Priyanka Chandrasekaran, Frank Van Graas</i>	
Characterizing Ionospheric Irregularities for Auroral Scintillations	2448
<i>S. Skone, M. Feng, R. Tiwari, A. Coster</i>	
Positioning Enhancement Based on a New Weighting Scheme to Solve an Ill-Conditioned Case	2456
<i>Yong-Won Ahn</i>	
Near Real-Time Prediction of Zenith Tropospheric Delays for Position Estimation over Long-Baseline CORS Network	2465
<i>C. Wang, Y. Feng</i>	
A GPS Based Earth Troposphere Calibration System for Doppler Tracking of Deep Space Probes	2472
<i>Alberto Graziani, Roberto Bertacin, Paolo Tortora, Aldo Schiavone, Mattia Mercolino, Frank Budnik</i>	
Assimilation of GPS Radio Occultation Observations with a Near Real-Time GPS PPP-inferred Water Vapor System	2481
<i>Junbo Shi, Yang Gao</i>	

F4: GNSS-INERTIAL NAVIGATION SYSTEMS 1

Performance Comparison of Different Forms of Kalman Filter Approach for a Vector-Based GNSS Signal Tracking Loop.....	2488
<i>Jong-Hoon Won, Dominik Dotterbock, Bernd Eissfeller</i>	

Using an Accelerometer Configuration to Improve the Performance of a MEMS IMU: Feasibility Study with a Pedestrian Navigation Application	2500
<i>Thomas Williams, Anshu Pahadia, Mark Petovello, Gerard Lachapelle</i>	
Performance of Different Low-cost GNSS/INS Land Systems	2515
<i>Mattia De Agostino</i>	

VOLUME 5

F4: GNSS-INERTIAL NAVIGATION SYSTEMS 1

Tightly-coupled MEMS-INS/GPS Integration Using Sequential Processing Method.....	2526
<i>Junchuan Zhou, Stefan Knedlik, Otmar Loffeld</i>	
Accelerometer Compensated Differential Wheel Pulse Based Dead Reckoning	2538
<i>Jeffrey L. Wilson, Michael J. Slade</i>	
A Phase-locked Loop Design with External Aiding Based on Kalman Filter	2547
<i>Sihao Zhao, Mingquan Lu, Zhenming Feng</i>	
A Review and Applications of the Nonlinear Filters to GNSS/INS Integrated Algorithms.....	2552
<i>S. Sugimoto, Y. Kubo, M. Tanikawara</i>	
Improving Accuracy with Multiple Sensors: Study of Redundant MEMS-IMU/GPS Configurations.....	2565
<i>Stephane Guerrier</i>	
The Feasibility of MEMS Inertial Sensors for Deep Integration of GPS and INS	2573
<i>Kedong Wang, Yong Li, Chris Rizos</i>	

P4: GNSS CHALLENGES AND OPPORTUNITIES FOR GOVERNMENTAL USE

Introduction	2579
<i>T. Stansell</i>	
Natural Hazards Monitoring	2590
<i>K. W. Hudnut</i>	
GNSS Applications in Transportation	2609
<i>B. Abdulhai</i>	
FRA's Positioning, Navigation, and Timing Requirements and Positive Train Control	2636
<i>L. W. Allen</i>	
The E911 Mandate.....	2650
<i>Wayne Ballantyne, Jeff Markwell</i>	
Vehicle Safety Applications: GM's V2X Systems and GM Contributions in Government Funded Automotive Collaborative R&D	2664
<i>C. Basnayake</i>	
School Bus Safety and Management	2674
<i>B. Bishop</i>	
The National Spatial Reference System	2682
<i>D. Doyle</i>	
DOT's Future GNSS Needs	2710
<i>T. A. Klein</i>	
Optimizing PNT for Agriculture and Natural Resources.....	2721
<i>M. Rasher</i>	

A5: GNSS ANTENNA & RADIO TECHNOLOGY

Calibration of GNSS Adaptive Antennas	2735
<i>Christopher M. Church, Inder J. Gupta</i>	
Compact Co-Planar Dual-Band Microstrip Patch Antennas for Modernized GPS.....	2742
<i>B. Rama Rao, Eddie N. Rosario, Mohamed S. Mahmoud, Jay I. Simon</i>	
Design and Implementation of an Adaptive Interference Mitigation Algorithm Based on FPGA	2751
<i>Yanhong Kou, Yuxiong Ai, Zhongzhi Ma</i>	
Performance Analysis of DBF Algorithm in GPS Software Receiver	2763
<i>Xuebin Zhuang, Xiaowei Cui, Mingquan Lu, Zhenming Feng</i>	
Synthetic Aperture GPS Signal Processing for Multi-Platform Antenna Configurations.....	2771
<i>Andrey Soloviev, Sanjeev Gunawardena</i>	

Robust Beamforming for GNSS Synthetic Antenna Arrays	2778
<i>Tao Lin, Ali Broumandan, John Nielsen, Cillian O'Driscoll, Gerard Lachapelle</i>	
Architecture of a Real-Time Safety of Life Receiver	2793
<i>M. Cuntz, L. A. Greda, M. Heckler, A. Konovaltsev, M. Meurer, L. Kurz, G. Kappen, T. G. Noll</i>	
A Novel Dielectrically-Loaded Helical Antenna Topology for Multi-band GNSS	2804
<i>Oliver P. Leisten</i>	
Topcon Full Wave RTK Antennas Based on Artificial Dielectric Technology	2811
<i>Dmitry Tatarnikov, Andrey Astakhov, Anton Stepanenko, Pavel Shamatulsky, Sergei Emelianov, Igor Soutiaguine</i>	

B5: GNSS-INERTIAL NAVIGATION SYSTEMS 2

Performance of a Partially Coherent Ultra-tightly Coupled GNSS/INS Pedestrian Navigation System Enabling Coherent Integration Times of Several Seconds to Track GNSS Signals Down to 1.5 dBHz	2816
<i>T. Pany, J. Winkel, B. Riedl, M. Restle, T. Worz, R. Schweikert, H. Niedermeier, G. Ameres, B. Eissfeller, S. Lagrasta, G. Lopez-Risueno</i>	
A Novel Initial Alignment Method for GPS/INS Integration with Large Initial Heading Error	2832
<i>Songlai Han, Jinling Wang</i>	
Performance Analysis of Low Cost INS/GPS POS Systems for Land Based MMS Utilizing LC and TC Integration	2843
<i>Yun-Wen Huang, Kai-Wei Chiang, Yen-Shan Lin, Jyh-Ching Lin, Ji-Shin Tsai, Chin-Hui Shih</i>	
Performance of a Tightly Coupled GPS/Inertial System using a FOG-based IMU	2853
<i>T. Martin, P. Vorsmann</i>	
Improved Integer Ambiguity Resolution by Combining LAMBDA and LMS	2860
<i>Anning Chen, Arvind Ramanandan, Jay A. Farrell</i>	
FDE Implementations for a Low-Cost GPS/INS Module	2867
<i>Benjamin J. Clark, David M. Bevly</i>	
Performance Investigation of Real-time MEMS-IMU/GNSS Integrated System	2875
<i>Jieying Zhang, Stefan Knedlik, Otmar Loffeld</i>	
Turntable Calibration of an Optimal Gyro-Free-IMU and its Application in a Full State Intergrated INS-GNSS System	2884
<i>U. Bestmann, P. Hecker</i>	
A Robust Integration of GPS and MEMS-INS Through Trajectory-constrained Adaptive Kalman Filtering	2892
<i>Zebo Zhou, Yong Li, Chris Rizos, Yunzhong Shen</i>	
Full-State Software GNSS and Reduced MEMS IMU Measurement Processing for Urban Navigation	2901
<i>Eric Vinande, Jakob Almqvist, Dennis Akos</i>	

C5: ENHANCED AND DEVELOPING SYSTEMS

OD&TS Process Evolution Based on Interoperability Between Different Navigation Satellite Systems	2910
<i>Maria D. Lainez, Miguel M. Romay</i>	
Alternative Architectures for Reduced Age of Data	2925
<i>Ranwa Haddad, John R. Berg, Bernanrd B. Yoo</i>	
An Analysis of Some Important Performance Measures of GPS III Signals	2936
<i>Rajendra Kumar, Jack Holmes</i>	
GPS L5 "Light's on!" – A First Comprehensive Signal Verification and Performance Analysis	2950
<i>Stefan Erker, Steffen Tholert, Johann Furthner, Michael Meurer, Martin Hausler</i>	
Simulation Analysis of GPS/Galileo/Compass Radio Frequency Compatibility	2958
<i>Wei Liu, Chuanrun Zhai, Yanhua Zhang, Xingqun Zhan</i>	
Study on Combined Orbit Determination of Navigation Satellites with Ground Tracking Observation and Cross-link Ranging Observation	2967
<i>Wanke Liu, Zhenghang Li, Xiaoying Gong</i>	
Exploration of Possible GNSS Signals in S-band	2979
<i>I. Mateu, C. Boulanger, J-L. Issler, L. Ries, J-A. Avila-Rodriguez, S. Wallner, T. Kraus, B. Eissfeller, P. Mulassano, M. Caporale, S. Germaine, J-Y. Guyomard, F. Bastide, J Godet, D. Hayes, D. Serant, P. Thevenon, O. Julien, G. W. Hein</i>	
LADO (Launch, Anomaly, and Disposal Operations), New Launch System for GPS Satellites	2994
<i>Surender K. Gupta, Ozel Kirkland, Brian M. Louie</i>	

D5: PORTABLE NAVIGATION DEVICES

A Peer-to-peer Kalman Filter for Pedestrian Navigation	3004
<i>Isabelle Kraemer, Bernd Eissfeller</i>	
A Compact Method to Deliver Extended Ephemeris Information that Complies with SUPL 1.0	3015
<i>Eric Derbez, Ashkan Izadpanah</i>	
A Recursive Quasi-optimal Fast Satellite Selection Method for GNSS Receivers	3022
<i>Min Liu</i>	
Context Detection for Improving Positioning Performance and Enhancing User Experience	3033
<i>Mahesh Chowdhary, Manish Sharma, Arun Kumar, Kolin Paul, Mahaveer Jain, Chinmay Agarwal, Gagan Narula</i>	
Multipath Detection and Mitigation by Means of a MEMS Based Pressure Sensor for Low-Cost Systems	3038
<i>Johannes Gutmann, Lukas Marti, Gerhard Lammerl</i>	
An Economical and Effective Multi-sensor Integration for Portable Navigation System	3049
<i>X. Zhao, Z. Syed, D. B. Wright, N. El-Sheimy</i>	
Inertial Systems Based Joint Mapping and Positioning for Pedestrian Navigation	3057
<i>Patrick Robertson, Michael Angermann, Bernhard Krach, Mohammed Khider</i>	
A Broadcast Ephemeris Extension Method for Standalone Mobile Apparatus	3069
<i>C. T. Weng, Y. C. Chien, C. L. Fu, W. G. Yau, Yj Tsai</i>	
Merging Low-cost Receivers in a GNSS Network of Permanent Stations	3076
<i>Alberto Cina, Mattia De Agostino, Ambrogio Manzino, Chiara Porporato</i>	
Development of a 3D Personal Navigation and LBS System with Demonstration in Shanghai EXPO in 2010	3085
<i>Ruizhi Chen, Juha Hyypä, Jixian Zhang, Jarmo Takala, Risto Kuittinen, Yuwei Chen, Ling Pei, Zhengjun Liu, Lingli Zhu, Heidi Kuusniemi, Jingbin Liu, Yan Qin, Helena Leppakoski, Jianyu Wang</i>	

E5: GNSS RECEIVER ALGORITHMS 2

Performance Evaluation of Combined L1/L5 Kalman Filter-Based Tracking versus Standalone L1/L5 Tracking in Challenging Environments	3091
<i>Dina Megahed, Cillian O'Driscoll, Gerard Lachapelle</i>	
Assisted GPS Positioning under Weak Signal Environments	3102
<i>Congwei Hu, Wu Chen, Jianfen Miao, Zhi Guo, Bing Wei, Zhaokui Yuan</i>	
A New Comparison of Averaging Techniques Used for Weak GNSS Signal Acquisition with Application to GPS L5 Signals	3110
<i>Howard Grant, David Dodds</i>	
Enhancing GNSS Acquisition by Combining Signals from Multiple Channels and Satellites	3117
<i>Penina Axelrad, James Donna, Megan Mitchell</i>	
Time-Frequency Analyses of Global Navigation Satellite System Signals	3129
<i>Chih-Cheng Sun, Shau-Shiun Jan</i>	
A Complex-Ambiguity Function Approach to a GPS Receiver	3137
<i>Johnathan York, Jon Little, David Munton, Kayla Barrientos</i>	
Doppler Search as pre-acquisition step	3146
<i>Ion Suberviola, Stefan Koehler, Jaizki Mendizabal, Guenter Rohmer</i>	
Likelihood of Detection and Computational Complexity of GPS Acquisition Algorithms	3153
<i>Staffan Backen</i>	
Direct Position Estimation Approach: How Good Can it Get?	3161
<i>Pau Closas, Carles Fernandez-Prades, Juan A. Fernandez-Rubio</i>	

VOLUME 6

F5: GALILEO & GPS/GALILEO REFERENCE & USER RECEIVERS

Ionospheric Delay Estimation Strategies Using Galileo E5 Signals Only	3168
<i>Olivier Julien, Christophe Macabiau, Jean-Luc Issler</i>	
Pre-Filtering, Side-Peak Rejection and Mapping: Several Solutions for Unambiguous BOC Tracking	3182
<i>Pratibha B. Anantharamu, Daniele Borio, Gerard Lachapelle</i>	
A Two Steps GNSS Acquisition Algorithm	3196
<i>Kewen Sun, Letizia Lo Presti</i>	

Analytical Model for GNSS Receiver Implementation Losses	3205
<i>Christopher J. Hegarty</i>	
Time and Amplitude Quantisation Losses in GNSS Receivers	3219
<i>Anthony R. Pratt, Jose-Angel Avila-Rodriquez</i>	
A Complexity Reduced Frequency Domain Receiver for Galileo and GPS L1 Signals	3238
<i>Feng Xu</i>	
Applying "BOC-Gated-PRN" to Multiplexed Binary Offset Carrier (MBOC) Signals	3249
<i>Jinghui Wu</i>	
Code Phase Multipath Mitigation by Exploiting the Frequency Diversity in Galileo E5 AltBOC	3259
<i>Nagaraj C. Shivaramaiah</i>	
Correlation Losses and Interference Rejection due to Quantization in CBOC Receivers	3274
<i>Fernando M. G. Sousa, Fernando D. Nunes, Jose J. N. Leitao</i>	
Galileo Test User Receiver Status, Key Results and Performance	3282
<i>Richard Morgan-Owen, Juan De Mateo, Simone Scarafia, Martin Hollreiser, Axel Van Den Berg, Tom Willems, Graham Pye, Wim De Wilde</i>	
Code Acquisition Using Subexpression Elimination (0)	3292
<i>Yu-Tang Lee, Hen-Wai Tsao, Fan-Ren Chang, Hsin-Chung Yeh, Kun-Tso Chen</i>	

A6A: REMOTE SENSING WITH GNSS & INTEGRATED SENSORS

Airborne GPS Positioning with CM-Level Precisions at Hundreds of KM Ranges	3300
<i>Gerald L. Mader</i>	
In-flight Accuracy Estimation for Airborne Lidar Data	3309
<i>Philipp Schaer, Yannick Stebler</i>	
Integrating GNSS, IMU, and Imagery for Automatic Orthomosaic Generation	3317
<i>S. Mills, D. Park, C. Hide, K. Barnsdale, J. Pinchin</i>	
Vision-Aided Inertial Navigation for Pose Estimation of Aerial Vehicles	3328
<i>Sara Saeedi, Farhad Samadzadegan, Naser El-Sheimy</i>	
A New Photogrammetric Combined Approach to Improve the GNSS/INS Solution	3335
<i>Mattia De Agostino, Andrea Lingua, Davide Marenchino, Francesco Nex, Marco Piras</i>	

A6B: URBAN & INDOOR NAVIGATION TECHNOLOGY 2

A Sub-Sampling Receiver Architecture for Ultra-Wideband Time of Arrival Based Ranging	3346
<i>Giovanni Bellusci, Gerard J. M. Janssen, Junlin Yan, Christian C. J. M. Tiberius</i>	
Pseudo-Range Measurements Using OFDM Channel Estimation	3356
<i>Paul Thevenon, Olivier Julien, Christophe Macabiau, Damien Serant, Stephane Corazza, Michel Bousquet, Lionel Ries, Thomas Grelier</i>	
Normalization of Signal Strength Measurements for WLAN Based Indoor Positioning	3369
<i>H. Leppakoski, S. Tikkinen, A. Pertula, J. Takala</i>	
A SUPL-Based A-GPS Simulator Support for Indoor Positioning	3378
<i>Sandesh N Chayapathy, Abhinav Kumar, Pradeep Kashyap, David Akopian, Abhay Samant</i>	
Range Estimation for Indoor Positioning via Drifting Clocks	3391
<i>Kazimieras Bagdonas, Henrik Schioler, Kai Borre</i>	

B6A: WIRELESS SENSOR NETWORKS

Low-Complexity Ultra-WideBand Indoor Positioning	3402
<i>Junlin Yan, Giovanni Bellusci</i>	
The Development of an Indoor Location Based Service Test Bed	3414
<i>Wen-Ming Tsai, Li-Ta Hsu, Shau-Shiun Jan</i>	
A Channel Capacity Perspective on Cooperative Positioning Algorithms for VANET	3423
<i>M. Efatmaneshnik, A. Tabatabaei Balaei, A. G. Dempster</i>	
Optimizing Localization Algorithms within Wireless Sensor Networks: An Australian Case Study in Environmental Monitoring	3431
<i>Allison Kealy, Matt Duckham</i>	
Non-GPS Distributed Intelligent Transportation System	3439
<i>Qinghua Zeng, Jianye Liu, Wei Zhao, Yongrong Sun</i>	
Self-Calibrating Position Location Using Signals of Opportunity	3444
<i>Chun Yang, Thao Nguyen</i>	

B6B: UNMANNED AND AUTONOMOUS VEHICLES

Proactive Radio Navigation and Target Tracking	3453
<i>Chun Yang, Mikel Miller, Erik Blasch, Thao Nguyen</i>	
Integrated Flight Path Planning System and Flight Control System for Navigation and Guidance of Unmanned Helicopter	3461
<i>Yu-Hsiang Lin</i>	
Development of a UAV Low-Cost Navigation System Prototype for ATM Applications	3471
<i>Jose J. Rosales, Manuel Toledo, Luca Bonardi, Alessandro Paolinelli, Ignacio Alcantarilla, Andres Cruz, Miguel M. Romay</i>	

C6: AVIATION APPLICATIONS

Preliminary Feasibility Analysis of GPS IIIC Integrated with an Inertial System to Provide CAT IIIB Services	3480
<i>Young C. Lee, Curtis A. Shively, Tan Zou</i>	
Flight Test Criteria for Qualification of GPS-Based Positioning and Landing Systems	3492
<i>D. A. Stratton</i>	
The Integration of a GPS Receiver to a Quasi-Real Time Decision Aid Tool used for the Air Data System Calibration Flight Tests Campaign	3501
<i>Nelson Paiva Oliveira Leite, Leonardo Mauricio De Faria Lopes, Fernando Walter</i>	
Error Propagation Concepts Including Flight Dynamics for Total System Performance Analysis During GBAS Based Initial CAT-III Approach and Landing	3512
<i>Thomas Dautermann, Boubeker Belabbas, Michael Meurer</i>	
Flight Test Data Validation of Dual-Frequency GPS Measurement Error Characteristics	3519
<i>H. Tang, T. Walter, J. Blanch, P. Enge, F-C. Chan</i>	
Weighted RAIM for APV: An Optimised Protection Level	3527
<i>Carl D. Milner</i>	
Stochastic Modeling of GPS Receiver Clocks for Improved Positioning and Fault Detection Performance	3534
<i>Fang-C. Chan, Boris Pervan</i>	
Carrier Phase-based RAIM using a Gaussian Sum Filter	3548
<i>Ho Yun</i>	
Airborne Measurements of DME Interferers at the European Hotspot	3557
<i>Alexander Steingass, Achim Hornbostel, Holmer Denks</i>	
Aging SV's - We Have Solutions	3566
<i>James L. Farrell</i>	

D6A: LAND BASED APPLICATIONS 2

APIS: Advanced Position Increment Solution for Different GNSS Applications	3572
<i>Dmitry Ivanov, Valery Morgoon, Gleb Zyryanov</i>	
Calibrated MEMS inertial sensors with GPS for a Precise Attitude Heading Reference System on Autonomous Farming Tractors	3580
<i>Yong Li, Damien Dush, William Kellar, Andrew Dempster</i>	
The Effects of Railway Track Database Quality on the Performance of Tightly Coupled GNSS/Track Database Train Positioning System	3588
<i>Yuheng Zheng, Paul Cross, Mohammed Quddus</i>	
Enhancing Ambiguity Resolution Performance Using Attitude Determination Constraints	3598
<i>Guijin Zheng, Demoz Gebre-Egziabher</i>	

D6B: ALGORITHMS FOR MULTI-SENSOR FUSION 2

Autonomous GEO Satellite Navigation with Multiple GNSS Measurements	3611
<i>Li Qiao, Samsung Lim, Jianye Liu</i>	
High Integrity GNSS Location Zone Characterization Using Interval Analysis	3620
<i>Vincent Drevelle, Philippe Bonnifait</i>	
Optoelectronics Three Dimensional Tracking System for Collision Risk Model	3630
<i>Yih-Ru P. Huang, John Fagan</i>	

Accuracy Performances of Low Cost Tightly Coupled GPS, DR sensor and DEM Integration System for ITS Applications	3637
<i>Yuheng Zheng, Mohammed Quddus</i>	

E6: PPP AND NETWORK-BASED RTK 2

Development of a Network Real-Time Kinematic Processing Platform	3647
<i>Y. Heo, B. Li, S. Lim, C. Rizos</i>	
Technical and Scientific Aspects Derived by the Processing of GNSS Networks using Different Approaches and Software	3656
<i>Barbarella Maurizio, Cenni Nicola, Gandolfi Stefano, Ricucci Luciano, Zanutta Antonio</i>	
A New Method for Evaluation of the Ionospheric Modeling Error in a VRS based Network RTK Service.....	3668
<i>Jakob Jakobsen</i>	
Assessment of a New Rover-Enhanced Network-Based Real Time Kinematic GNSS Data Processing Strategy.....	3675
<i>Nicholas Zinas</i>	
Atmosphere Decomposition for VRS-Based Network-RTK System	3686
<i>Shaocheng Zhang, Samsung Lim, Chris Rizos, Jiming Guo</i>	
Performance Evaluations of Regional Error Models for NRTK in Victoria	3696
<i>Suqin Wu</i>	
Determination of Un-Differenced Atmospheric Delays for Network-Based RTK	3706
<i>Baocheng Zhang</i>	
Ambiguity Validation with Combined Ratio Test and EIA	3720
<i>Wu Chen, Shengyue Ji, Bing Wei, Xiaoli Ding, Yongqi Chen, Chunmei Zhao, Congwei Hu</i>	

F6A: GLONASS MODERNIZATION, QZSS, & OTHER GNSS

Theoretical Bounds And Reliable C/N₀ Estimation For Modernized GPS Signals	3730
<i>Kannan Muthuraman</i>	
Renovated GLONASS: Improved Performances of GNSS Receivers	3741
<i>Alexei E. Zinoviev, Andrey V. Veitsel, Denis A. Dolgin</i>	
Orbit Determination of COMPASS-M1 Based on Time Synchronization Among Stations	3748
<i>Hui Lei, Xu-Hai Yang, Zhi-Gang, Li, Wen-Hai Jiao, Qiang-Wen Yang</i>	
Navigation Payload Test of Proto-Flight Model (PEM) for the High-Accuracy Positioning Experiment System (HIAPEX) for the Quasi-Zenith Satellite System (QZSS).....	3755
<i>Y. Ohshima, Y. Kawaguchi, T. Takahashi, H. Soga, T. Moriguchi, H. Noda, S. Kogure, M. Kishimoto</i>	
Effect of GLONASS Orbit Error on Long Baseline GPS/GLONASS RTK	3760
<i>Hideki Yamada, Tomoji Takasu, Nobuaki Kubo, Akio Yasuda</i>	
Assessment of GPS/GLONASS RTK Under Various Operational Conditions	3767
<i>Richard B. Ong, Mark G. Petovello, Gerard Lachapelle</i>	

F6B: TIMING & SCIENTIFIC APPLICATIONS

Accurate Millisecond Level Oscillator Phase Noise Estimation for Standalone GNSS.....	3779
<i>Aiden Morrison</i>	
Evaluation of the Clock Stability of Geodetic GPS Receivers Connected to an External Oscillator	3787
<i>Ulrich Weinbach, Steffen Schoen</i>	
Performance Assessment of the Time Difference between EGNOS-Network-Time and UTC	3799
<i>Jerome Delporte, Norbert Suard, Pierre Uhrich</i>	
Development of the Time Management System	3808
<i>Shin'Ichi Hama, Yasuhiro Takahashi, Jun Amagai, Miho Fujieda, Maho Nakamura</i>	
Design and Analysis of Nanosecond Time Synchronization System of Each Station of Each Chain of Chinese LORAN-C	3814
<i>Ma Hong-Jiao, Hu Yong-Hui, Zou De-Cai, Wu Jian-Feng, He Zai-Ming</i>	
Author Index	