Stanford

Todd Walter

Sr Research Engineer, Aeronautics and Astronautics

Curriculum Vitae available Online

Bio

BIO

I am the director of the wide-area differential Global Navigation Satellite System(GNSS) laboratory at Stanford University. My work focuses on implementing high-integrity air navigation systems. I am also active in the international standards bodies coordinating the use of GNSS to implement these systems.

ACADEMIC APPOINTMENTS

- Sr Research Engineer, Aeronautics and Astronautics

HONORS AND AWARDS

- Leadership Award in Signal Design, GPS World Magazine (September, 2015)
- Distinguished Service Award, Institute of Navigation (January, 2012)
- Kepler Award, Institute of Navigation (September, 2010)
- Thurlow Award, Institute of Navigation (January, 2008)
- Fellow of the ION, Institute of Navigation (June, 2006)
- Early Achievement Award, Institute of Navigation (June, 2000)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- President, Institute of Navigation (2010 - 2012)
- Member, Institute of Navigation (1994 - present)
- Member, IEEE (2014 - present)

PROFESSIONAL EDUCATION

- Ph.D., Stanford University , Applied Physics (1994)
- M.S., Stanford University , Applied Physics (1990)
- B.S., Rensselaer Polytechnic Institute , Physics (1987)

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

High integrity satellite navigation for guiding aircraft, including satellite based augmentation systems (SBAS) and advanced receiver autonomous integrity monitoring (ARAIM).

Teaching

STANFORD ADVISEES

Doctoral Dissertation Reader (NonAC)

Kazuma Gunning, Andrew Neish

Publications

PUBLICATIONS

- **WAAS at 15** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Walter, T., Shallberg, K., Altshuler, E., Wanner, W., Harris, C., Stimmler, R.
  2018; 65 (4): 581–600
- **MATLAB Algorithm Availability Simulation Tool** *GPS SOLUTIONS*
  Jan, S., Chan, W., Walter, T.
  2009; 13 (4): 327-332
- **Worldwide Vertical Guidance of Aircraft Based on Modernized GPS and New Integrity Augmentations** *PROCEEDINGS OF THE IEEE*
  Walter, T., Enge, P., Blanch, J., Pervan, B.
  2008; 96 (12): 1918-1935
- **Robust Detection of Ionospheric Irregularities** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Walter, T., et al
  2001; 48 (2): 89–100
- **Wide area augmentation of the global positioning system** *PROCEEDINGS OF THE IEEE*
  Enge, P., Walter, T., Pullen, S., Kee, C., Chao, Y. C., Tsai, Y. J.
  1996; 84 (8): 1063-1088
- **Weighted RAIM for precision approach** *8th International Technical Meeting of the Satellite Division of the Institute-of-Navigation (ION GPS-95)*
  Walter, T., Enge, P.
  INST NAVIGATION.1995: 1995–2004
- **Broadband LEO Constellations for Navigation** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Reid, T. R., Neish, A. M., Walter, T., Enge, P. K.
  2018; 65 (2): 205–20
- **Validation of the Unfaulted Error Bounds for ARAIM** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Walter, T., Gunning, K., Phelts, R., Blanch, J.
  2018; 65 (1): 117–33
- **Effective GPS Spoofing Detection Utilizing Metrics from Commercial Receivers**
  Manfredini, E., Akos, D. M., Chen, Y., Lo, S., Walter, T., Enge, P., Inst Navigat
  INST NAVIGATION.2018: 672–89
- **GNSS Multipath Detection in Urban Environment Using 3D Building Model**
  Zhang, S., Lo, S., Chen, Y., Walter, T., Enge, P., IEEE
  IEEE.2018: 1053–58
- **WASS at 15**
  Walter, T., Shallberg, K., Altshuler, E., Wanner, W., Harris, C., Stimmler, R., Inst Navigat
  INST NAVIGATION.2018: 301–21
- **Quantum Resistant Authentication Algorithms for Satellite-Based Augmentation Systems**
  Neish, A., Walter, T., Enge, P., Inst Navigat
  INST NAVIGATION.2018: 365–79

- **Protection Levels after Fault Exclusion for Advanced RAIM** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Blanch, J., Walter, T., Enge, P.
  2017; 64 (4): 505–13
- **Improved User Position Monitor for WAAS** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Walter, T., Blanch, J.
  2017; 64 (1): 165–75
- **Theoretical Results on the Optimal Detection Statistics for Autonomous Integrity Monitoring** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Blanch, J., Walter, T., Enge, P.
  2017; 64 (1): 123–37
- **Multi-GNSS Constellation Anomaly Detection and Performance Monitoring**
  Gunning, K., Walter, T., Enge, P., INST NAVIGAT
  INST NAVIGATION.2017: 1051–62
- **Feasibility of fault exclusion related to advanced RAIM for GNSS spoofing detection**
  Kuusniemi, H., Blanch, J., Chen, Y., Lo, S., Innac, A., Ferrara, G., Honkala, S., Bhuiyan, M. H., Thombre, S., Soderholm, S., Walter, T., Phelts, R., Enge, et al
  INST NAVIGATION.2017: 2359–70
- **Orbital representations for the next generation of satellite-based augmentation systems** *GPS SOLUTIONS*
  Reid, T. G., Walter, T., Enge, P. K., Sakai, T.
  2016; 20 (4): 737-750
- **Preliminary availability assessment to support single-frequency SBAS development in the Korean region** *GPS SOLUTIONS*
  Bang, E., Lee, J., Walter, T., Lee, J.
  2016; 20 (3): 299-312
- **GNSS Integrity in The Arctic** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Reid, T., Walter, T., Blanch, J., Enge, P.
  2016; 63 (4): 469-492
- **A Simple Position Estimator That Improves Advanced RAIM Performance** *IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS*
  Blanch, J., Walter, T., Enge, P., Kropp, V.
  2015; 51 (3): 2485-U960
- **GNSS Multipath and Jamming Mitigation Using High-Mask-Angle Antennas and Multiple Constellations** *IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS*
  Heng, L., Walter, T., Enge, P., Gao, G. X.
  2015; 16 (2): 741-750
- **Aviation Benefits from Satellite Navigation** *NEW SPACE*
  Enge, P., Enge, N., Walter, T., Eldredge, L.
  2015; 3 (1): 19–35
- **Baseline Advanced RAIM User Algorithm and Possible Improvements** *IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS*
  Blanch, J., Walker, T., Enge, P., Lee, Y., Pervan, B., Rippl, M., Spletter, A., Kropp, V.
  2015; 51 (1): 713-732
- **Future Dual-Frequency GPS Navigation System for Intelligent Air Transportation Under Strong Ionospheric Scintillation** *IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS*
  Seo, J., Walter, T.
  2014; 15 (5): 2224-2236
- **Effects of solar cycle 24 activity onWAAS navigation** *SPACE WEATHER-THE INTERNATIONAL JOURNAL OF RESEARCH AND APPLICATIONS*
  Datta-Barua, S., Walter, T., Bust, G. S., Wanner, W.
  2014; 12 (1): 46-63
- **DME/TACAN interference mitigation for GNSS: algorithms and flight test results** *GPS SOLUTIONS*

Gao, G. X., Heng, L., Hornbostel, A., Denks, H., Meurer, M., Walter, T., Enge, P.
2013; 17 (4): 561-573

- **Critical Elements for a Multi-Constellation Advanced RAIM** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Blanch, J., Walter, T., Enge, P., Wallner, S., Fernandez, F. A., Dellago, R., Ioannides, R., Hernandez, I. F.
  2013; 60 (1): 53-69
- **Incorporating GLONASS into Aviation RAIM Receivers** *International Technical Meeting of the Institute-of-Navigation*
  Walter, T., Blanch, J., Choi, M. J., Reid, T., Enge, P.
  INST NAVIGATION.2013: 239–249
- **Optimal Positioning for Advanced Raim** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Blanch, J., Walter, T., Enge, P.
  2013; 60 (4): 279-289
- **Near Term Improvements to WAAS Availability** *International Technical Meeting of the Institute-of-Navigation*
  Blanch, J., Walter, T., Phelts, R. E., Enge, P.
  INST NAVIGATION.2013: 71–77
- **L1/L5 SBAS MOPS Ephemeris Message to Support Multiple Orbit Classes** *International Technical Meeting of the Institute-of-Navigation*
  Reid, T., Walter, T., Enge, P.
  INST NAVIGATION.2013: 78–92
- **Signal Deformation Monitoring for Dual-Frequency WAAS** *International Technical Meeting of the Institute-of-Navigation*
  Phelts, R. E., Wong, G., Walter, T., Enge, P.
  INST NAVIGATION.2013: 93–106
- **Results on the Optimal Detection Statistic for Integrity Monitoring** *International Technical Meeting of the Institute-of-Navigation*
  Blanch, J., Walter, T., Enge, P.
  INST NAVIGATION.2013: 262–273
- **GPS Signal-in-Space Integrity Performance Evolution in the Last Decade** *IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS*
  Heng, L., Gao, G. X., Walter, T., Enge, P.
  2012; 48 (4): 2932-2946
- **Satellite Navigation for Aviation in 2025** *PROCEEDINGS OF THE IEEE*
  Blanch, J., Walter, T., Enge, P.
  2012; 100: 1821-1830
- **Evolving WAAS to Serve L1/L5 Users** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Walter, T., Blanch, J., Phelts, R. E., Enge, P.
  2012; 59 (4): 317-327
- **OPTIMAL POSITIONING FOR ADVANCED RAIM** *International Technical Meeting (ITM) of the Institute-of-Navigation (ION)*
  Blanch, J., Walter, T., Enge, P.
  INST NAVIGATION.2012: 1624–1631
- **Statistical Characterization of GLONASS Broadcast Clock Errors and Signal-In-Space Errors** *International Technical Meeting (ITM) of the Institute-of-Navigation (ION)*
  Heng, L., Gao, G. X., Walter, T., Enge, P.
  INST NAVIGATION.2012: 1697–1707
- **Availability Impact on GPS Aviation due to Strong Ionospheric Scintillation** *IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS*
  Seo, J., Walter, T., Enge, P.
  2011; 47 (3): 1963-1973
- **Correlation of GPS signal fades due to ionospheric scintillation for aviation applications** *ADVANCES IN SPACE RESEARCH*
  Seo, J., Walter, T., Enge, P.
  2011; 47 (10): 1777-1788

- **Reversion from L1-L5 Dual to L5 Single Frequency WAAS in the Presence of RF Interference** *IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS*
  Jan, S., Walter, T., Enge, P.
  2010; 46 (3): 1110-1126
- **RAIM with Optimal Integrity and Continuity Allocations Under Multiple Failures** *IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS*
  Blanch, J., Walter, T., Enge, P.
  2010; 46 (3): 1235-1247
- **Unaugmented GPS-Based Flight Inspection System** *IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS*
  Kim, E., Walter, T., Powell, J. D.
  2010; 46 (2): 717-724
- **Compass-M1 Broadcast Codes in E2, E5b, and E6 Frequency Bands** *IEEE JOURNAL OF SELECTED TOPICS IN SIGNAL PROCESSING*
  Gao, G. X., Chen, A., Lo, S., De Lorenzo, D., Walter, T., Enge, P.
  2009; 3 (4): 599-612
- **Characteristics of deep GPS signal fading due to ionospheric scintillation for aviation receiver design** *RADIO SCIENCE*
  Seo, J., Walter, T., Chiou, T., Enge, P.
  2009; 44
- **Bounding higher-order ionosphere errors for the dual-frequency GPS user** *RADIO SCIENCE*
  Datta-Barua, S., Walter, T., Blanch, J., Enge, P.
  2008; 43 (5)
- **Position Error Bound Calculation for GNSS using Measurement Residuals** *IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS*
  Blanch, J., Walter, T., Enge, P.
  2008; 44 (3): 977-984
- **Wide area augmentation system-based might inspection system** *JOURNAL OF AIRCRAFT*
  Kim, E., Walter, T., Powell, J. D.
  2008; 45 (2): 614-621
- **Improving GPS-based landing system performance using an empirical barometric altimeter confidence bound** *IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS*
  Jan, S., Gebre-Egziabher, D., Walter, T., Enge, P.
  2008; 44 (1): 127-146
- **Understanding the GIOVE-B Broadcast Codes of the Galileo System** *42nd Asilomar Conference on Signals, Systems and Computers*
  Gao, G. X., Akos, D., Walter, T., Enge, P.
  IEEE.2008: 2086–2090
- **Understanding PHMI for Safety of Life Applications in GNSS** *2007 National Technical Meeting of the Institute-of-Navigation*
  Blanch, J., Walter, T., Enge, P.
  INST NAVIGATION.2007: 305–310
- **Adaptive Carrier Smoothing Using Code and Carrier Divergence** *2007 National Technical Meeting of the Institute-of-Navigation*
  Kim, E., Walter, T., Powell, J. D.
  INST NAVIGATION.2007: 141–152
- **Model Analysis on the Performance for an Inertial Aided FLL-Assisted-PLL Carrier-Tracking Loop in the Presence of Ionospheric Scintillation** *2007 National Technical Meeting of the Institute-of-Navigation*
  Chiou, T., Gebre-Egziabher, D., Walter, T., Enge, P.
  INST NAVIGATION.2007: 1276–1295
- **Galileo GIOVE-A Broadcast E5 Codes and their Application to Acquisition and Tracking** *2007 National Technical Meeting of the Institute-of-Navigation*
  Gao, G. X., De Lorenzo, D. S., Chen, A., Lo, S. C., Akos, D. M., Walter, T., Enge, P.
  INST NAVIGATION.2007: 936–946
- **A Reference Point-based Precise Relative Positioning Method Using a Single Frequency Receiver** *2006 National Technical Meeting of the Institute-of-Navigation*

Kim, E., Walter, T., Powell, J. D.
INST NAVIGATION.2006: 283–292

- **WAAS-based threat monitoring for a Local Airport Monitor (LAM) that supports Category I Precision Approach** *IEEE/ION Position, Location, and Navigation Symposium*
  Rife, J., Pullen, S., Walter, T., Phelts, E., Pervan, B., Enge, P.
  IEEE.2006: 468–482
- **Galileo-GPS RAIM for Vertical Guidance** *2006 National Technical Meeting of the Institute-of-Navigation*
  Ene, A., Blanch, J., Walter, T.
  INST NAVIGATION.2006: 432–440
- **A development of WAAS-aided Flight Inspection Truth System** *2006 IEEE/ION POSITION, LOCATION AND NAVIGATION SYMPOSIUM, VOLS 1-3*
  Kim, E., Peled, U., Walter, T., Powell, J. D.
  2006: 61-70
- **Field Data Analysis for a Range-Based Local Airport Monitor for WAAS** *2006 National Technical Meeting of the Institute-of-Navigation*
  Seo, J., Rife, J., Pullen, S., Walter, T., Enge, P.
  INST NAVIGATION.2006: 748–758