

# Todd E. Humphreys

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## CONTACT INFORMATION

Assistant Professor  
Department of Aerospace Engineering and Engineering Mechanics  
The University of Texas at Austin  
WRW 411C, MC C0600  
Austin, TX 78712  
*Email:* todd.humphreys@mail.utexas.edu    *Office:* (512) 471-4489

## EDUCATION

### **Cornell University**, Ithaca, New York USA

- Ph.D., Aerospace Engineering, January 2008
- Advisors: Mark L. Psiaki (primary) and Paul M. Kintner (co-advisor)
  - Dissertation: Modeling Ionospheric Scintillation and its Effects on GPS Carrier Tracking Loops and Two Other Applications of Modeling and Estimation

### **Utah State University**, Logan, Utah USA

- M.S., Electrical and Computer Engineering, May 2003
- Thesis: Attitude Determination For Small Satellites With Modest Pointing Constraints

### **Utah State University**, Logan, Utah USA

- B.S., Electrical and Computer Engineering, May 2000
- Minors: Mathematics and Spanish

## CURRENT & PREVIOUS ACADEMIC POSITIONS

**Associate Professor** **Sept. 2015 - present**  
**The University of Texas at Austin**  
Director of the Radionavigation Laboratory at the University of Texas at Austin.

**Assistant Professor** **Aug. 2009 - Aug. 2015**  
**The University of Texas at Austin**  
Director of the Radionavigation Laboratory at the University of Texas at Austin.

**Adjunct Faculty** **Aug. 2007 - Dec. 2007**  
**Cornell University**  
Taught a graduate-level course in model-based estimation.

**Post-Doctoral Researcher** **Aug. 2007 - Aug. 2008**  
**Cornell University**  
Began development of a civilian dual-frequency software-defined GPS receiver-spoofers for navigation and timing security research. Development of a K-band software receiver and orbital analysis of the Iridium satellite constellation.

**Research Assistant** **2003 - 2007**  
**Cornell University under Dr. Mark Psiaki**  
Attitude estimation for the SIERRA sounding rocket mission. Analysis of atmospheric tidal signatures in GPS tropospheric delay data. Development and implementation of a 43-channel C/A-code DSP-based GPS software receiver. Development of a scintillation channel model that synthesizes scintillation effects and predicts the rate of cycle slipping in a GPS phase tracking loop.

OTHER PROFESSIONAL EXPERIENCE	<b>Co-Founder, Scientific Advisor</b> <b>Radiosense</b> Centimeter-accurate positioning for the mass market.	<b>Feb. 2015 - Present</b>
	<b>Researcher/Developer/Co-Founder</b> <b>Coherent Navigation</b> Exploiting Iridium telephony signals and software radio technology to harden navigation and timing sensors.	<b>Aug. 2008 - Aug. 2009</b>
	<b>IONF Satellite Constellation Attitude Determination Lead</b> <b>Space Dynamics Laboratory (Logan, Utah)</b> Developed magnetometer-based satellite attitude determination algorithms and a code implementation for the ION-F mission of the University Nanosatellite Program.	<b>2001 - 2002</b>
	<b>MEMS Inertial Sensors Researcher</b> <b>NASA's Jet Propulsion Laboratory – Microdevices Laboratory</b> Analysis, design, and validation of meso-scale vibratory rate sensors.	<b>1999 - 2002 (summers)</b>
CONSULTING	Coherent Navigation, Aug. 2009 - Aug. 2012	
	U.S. Department of Homeland Security Risk Assessment: Critical infrastructure dependence on GPS, March - Sept., 2011	
MEMBERSHIPS	Member, Institute of Navigation (ION) Member, Institute of Electrical and Electronics Engineers (IEEE) Member, American Institute of Aeronautics and Astronautics (AIAA)	
PROFESSIONAL ACTIVITIES	<p><i>Editing Positions</i></p> <ul style="list-style-type: none"> <li>- Editor, IEEE Transactions on Wireless Communications, May 2014-present</li> </ul> <p><i>Institute of Navigation Positions</i></p> <ul style="list-style-type: none"> <li>- Land Representative, Institute of Navigation Governing Council, 2012-2014</li> </ul> <p><i>Conferences Organized</i></p> <ul style="list-style-type: none"> <li>- Lead organizer, 2013 Texas Wireless Summit</li> <li>- Lead organizer, University-of-Texas-hosted meeting of the world's experts on civil GPS security, September 2010</li> </ul> <p><i>Congressional Testimony</i></p> <ul style="list-style-type: none"> <li>- Invited witness, U.S. House Subcommittee on Homeland Security Oversight hearing on the threat of unmanned aerial systems, March 2015</li> <li>- Invited witness, U.S. House Judiciary Subcommittee on Crime, Terrorism, and Homeland Security field forum on privacy in an age of drones, October 2012</li> <li>- Invited witness, U.S. House Subcommittee on Homeland Security Oversight hearing on drone security, July 2012</li> </ul> <p><i>Technical Program Committee</i></p> <ul style="list-style-type: none"> <li>- Track chair, Institute of Navigation GNSS+ conference, September 2013</li> </ul>	

*Session Chair*

- Session chair, Institute of Navigation GNSS conference, September 2015: GNSS Vulnerabilities and Anti-Jamming
- Panel Session chair, Institute of Navigation GNSS conference, September 2015: Privacy Issues
- Session chair, Institute of Navigation GNSS conference, September 2014: GNSS Vulnerabilities 1: Interference
- Session chair, Institute of Navigation GNSS conference, September 2014: GNSS Vulnerabilities 2: Spoofing and Authentication
- Panel Session chair, Institute of Navigation GNSS conference, September 2014: GNSS Vulnerabilities and Threats
- Session chair, IEEE/ION PLANS conference, May 2014: Interference and Robust Navigation
- Session chair, Institute of Navigation International Technical Meeting, Jan. 2013: Interference and Spectrum Management
- Session chair, Institute of Navigation GNSS conference, September 2012: Spectrum Interference
- Session chair, IEEE/ION PLANS conference, April 2012: Receiver and Antenna Technology Session
- Panel session chair, Institute of Navigation GNSS conference, September 2011: GNSS Security
- Session chair, IEEE/ION PLANS conference, May 2010: Algorithms and Processing

*Invited Subject Matter Expert*

- Subject matter expert, Dept. of Homeland Security risk assessment of critical infrastructure dependence on GPS, March-September, 2011
- Subject matter expert, U.S. Patent and Trademark Office briefing on advances in GNSS technology, April 2011
- Invited presenter, National Executive Committee on Position Navigation and Timing, Advisory Board Meeting, October 2010

UNIVERSITY  
COMMITTEES;  
ADMINISTRATIVE  
ASSIGNMENTS

*Administrative Assignments*

- Director, Radionavigation Laboratory, 2009-present
- Faculty advisor, UT student chapter of AIAA, 2010-present

*University Committees*

- None

*College Committees*

- Cockrell School Honors Committee, 2011-present
- College of Engineering Faculty Committee

*Department Committees*

- ASE Department Faculty Committee
- ASE Orbits Area Faculty Committee
- ASE Graduate Studies Committee
- ECE Graduate Studies Committee

HONORS &  
AWARDS

NSF CAREER Award, 2015

Institute of Navigation Thurlow Award, 2015

Outstanding Faculty Award, Dept. of Aerospace Eng. and Eng. Mechanics, 2015

GPS World Magazine Leadership Award, 2012

University of Texas System Regents' Outstanding Teaching Award, 2012

Cockrell School Dean's Award for Outstanding Teaching by an Assistant Professor, 2012

Best Overall Paper Award, IEEE/ION PLANS Conference, 2012 (given to my student Jahshan Bhatti)

Best Student Paper Award, IEEE/ION PLANS Conference, 2012 (given to my student Ken Pesyna)

Ralph Bolgiano, Sr. Outstanding Teaching Assistant Award, 2006

NASA Space Grant Fellowship, 2004-2005

Hertz Foundation Fellowship Finalist, 2004

AIAA Guidance, Navigation, and Control Graduate Award, 2004

2nd place, AIAA/USU Small Satellite Conference Student Paper Competition, 2002

Utah State University Presidential Fellowship, 2000-2001

REFEREED  
JOURNAL  
ARTICLES

**Articles are sorted by key topic and appear only once.**

**Secure Perception**

- J1 J. Bhatti and T. Humphreys, "Hostile control of ships via false GPS signals: Demonstration and detection," *Navigation, Journal of the Institute of Navigation*, 2015. (Submitted for review.)
- J2 A. J. Kerns, D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "Unmanned aircraft capture and control via GPS spoofing," *Journal of Field Robotics*, vol. 31, no. 4, pp. 617–636, 2014 [pdf](#)
- J3 B. W. O'Hanlon, M. L. Psiaki, T. E. Humphreys, J. A. Bhatti, and D. P. Shepard, "Real-time GPS spoofing detection via correlation of encrypted signals," *Navigation, Journal of the Institute of Navigation*, vol. 60, no. 4, pp. 267–278, 2013 [pdf](#)
- J4 M. Psiaki, B. O'Hanlon, J. Bhatti, D. Shepard, and T. Humphreys, "GPS spoofing detection via dual-receiver correlation of military signals," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 49, no. 4, pp. 2250–2267, 2013 [pdf](#)
- J5 D. P. Shepard, T. E. Humphreys, and A. A. Fansler, "Evaluation of the vulnerability of phasor measurement units to GPS spoofing attacks," *International Journal of Critical Infrastructure Protection*, vol. 5, no. 3-4, pp. 146–153, 2012 [pdf](#)
- J6 T. E. Humphreys, "Detection strategy for cryptographic GNSS anti-spoofing," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 49, no. 2, pp. 1073–1090, 2013 [pdf](#)

- J7 K. D. Wesson, M. P. Rothlisberger, and T. E. Humphreys, “Practical cryptographic civil GPS signal authentication,” *Navigation, Journal of the Institute of Navigation*, vol. 59, no. 3, pp. 177–193, 2012 [pdf](#)

### **Robust Perception**

- J8 Z. M. Kassas, A. Arapostathis, and T. E. Humphreys, “Greedy motion planning for simultaneous signal landscape mapping and receiver localization,” *IEEE Journal of Selected Topics in Signal Processing*, vol. 9, pp. 247 – 258, March 2015 [pdf](#)
- J9 Z. M. Kassas and T. E. Humphreys, “Receding horizon trajectory optimization in opportunistic navigation environments,” *IEEE Transactions on Aerospace and Electronic Systems*, vol. 51, pp. 866–877, April 2015 [pdf](#)
- J10 Z. M. Kassas and T. E. Humphreys, “Observability analysis of collaborative opportunistic navigation with pseudorange measurements,” *IEEE Transactions on Intelligent Transportation Systems*, vol. 15, pp. 260–273, Feb. 2014 [pdf](#)

### **Precise Mass-Market Positioning and Mapping**

- J11 K. M. Pesyna, Jr., D. P. Shepard, R. W. Heath, Jr., and T. E. Humphreys, “VISRTK: Fusion of camera and GNSS carrier phase measurements for fast, robust, precise, and globally-referenced mobile device pose determination,” *IEEE Transactions on Signal Processing*, 2015. (In preparation.)
- J12 K. M. Pesyna, Jr., T. Novlan, C. Zhang, R. W. Heath, Jr., and T. E. Humphreys, “Exploiting antenna motion for faster initialization of centimeter-accurate GNSS positioning with low-cost antennas,” *IEEE Transactions on Aerospace and Electronic Systems*, 2015. (Submitted for review.)
- J13 K. M. Pesyna, Jr., Z. M. Kassas, R. W. Heath, Jr., and T. E. Humphreys, “A phase-reconstruction technique for low-power centimeter-accurate mobile positioning,” *IEEE Transactions on Signal Processing*, vol. 62, pp. 2595–2610, May 2014 [pdf](#)

### **Estimation and Signal Processing**

- J14 J. Bhatti, B. Ledvina, and T. Humphreys, “Analysis and experimental results of direct geolocation techniques,” *Navigation, Journal of the Institute of Navigation*, 2015. (In preparation.)
- J15 T. E. Humphreys, M. L. Psiaki, and P. M. Kintner, Jr., “Modeling the effects of ionospheric scintillation on GPS carrier phase tracking,” *IEEE Transactions on Aerospace and Electronic Systems*, vol. 46, pp. 1624–1637, Oct. 2010 [pdf](#)
- J16 T. E. Humphreys, M. L. Psiaki, B. M. Ledvina, A. P. Cerruti, and P. M. Kintner, Jr., “A data-driven testbed for evaluating GPS carrier tracking loops in ionospheric scintillation,” *IEEE Transactions on Aerospace and Electronic Systems*, vol. 46, pp. 1609–1623, Oct. 2010 [pdf](#)
- J17 T. E. Humphreys, M. L. Psiaki, J. C. Hinks, B. O’Hanlon, and P. M. Kintner, Jr., “Simulating ionosphere-induced scintillation for testing GPS receiver phase tracking loops,” *IEEE Journal of Selected Topics in Signal Processing*, vol. 3, pp. 707–715, Aug. 2009 [pdf](#)
- J18 T. E. Humphreys, M. Psiaki, E. Klatt, S. Powell, and P. M. Kintner, Jr., “Magnetometer-based attitude and rate estimation for a spacecraft with wire booms,” *Journal of Guidance, Control, and Dynamics*, vol. 28, pp. 584–593, July–Aug. 2005 [pdf](#)

### **Ionosphere and Troposphere**

- J19 H. Kim, C. Clauer, K. Deshpande, M. Lessard, A. Weatherwax, G. S. Bust, G. Crowley, and T. E. Humphreys, “Ionospheric irregularities during a substorm event: Observations of ULF pulsations and GPS scintillations,” *Journal of Atmospheric and Solar-Terrestrial Physics*, vol. 114, pp. 1–8, 2014 [link](#)

- J20 K. B. Deshpande, G. S. Bust, C. R. Clauer, H. Kim, J. E. Macon, T. E. Humphreys, J. A. Bhatti, S. B. Musko, G. Crowley, and A. T. Weatherwax, “Initial GPS scintillation results from CASES receiver at South Pole, Antarctica,” *Radio Science*, vol. 47, no. 5, 2012 [link](#)
- J21 T. E. Humphreys, M. C. Kelley, N. Huber, and P. M. Kintner, “The semidiurnal variation in GPS-derived zenith neutral delay,” *Geophysical Research Letters*, vol. 32, no. 24, 2005 [pdf](#)

### Instrumentation

- J22 C. R. Clauer, H. Kim, K. Deshpande, Z. Xu, D. Weimer, S. Musko, G. Crowley, C. Fish, R. Nealy, T. E. Humphreys, J. A. Bhatti, and A. J. Ridley, “Autonomous adaptive low-power instrument platform (AAL-PIP) for remote high latitude geospace data collection,” *Geoscientific Instrumentation, Methods and Data Systems*, vol. 3, pp. 211–227, 2014 [link](#)
- J23 E. G. Lightsey, T. E. Humphreys, J. A. Bhatti, A. J. Joplin, B. W. O’Hanlon, and S. P. Powell, “Demonstration of a space capable miniature dual frequency GNSS receiver,” *Navigation, Journal of the Institute of Navigation*, vol. 61, no. 1, pp. 53–64, 2014 [pdf](#)

### REFEREED CONFERENCE PAPERS

- C1 M. L. Psiaki, B. W. O’Hanlon, S. P. Powell, J. A. Bhatti, K. D. Wesson, T. E. Humphreys, and A. Schofield, “GNSS spoofing detection using two-antenna differential carrier phase,” in *Proceedings of the ION GNSS+ Meeting*, (Tampa, FL), Institute of Navigation, 2014 [pdf](#)
- C2 Z. M. Kassas, V. Ghadiok, and T. E. Humphreys, “Adaptive estimation of signals of opportunity,” in *Proceedings of the ION GNSS+ Meeting*, 2014 [pdf](#)
- C3 K. M. Pesyna, Jr., R. W. Heath, Jr., and T. E. Humphreys, “Centimeter positioning with a smartphone-quality GNSS antenna,” in *Proceedings of the ION GNSS+ Meeting*, 2014 [pdf](#)
- C4 T. E. Humphreys, D. P. Shepard, J. A. Bhatti, and K. D. Wesson, “A testbed for developing and evaluating GNSS signal authentication techniques,” in *Proceedings of the International Symposium on Certification of GNSS Systems and Services (CERGAL)*, (Dresden, Germany), July 2014 [pdf](#)
- C5 D. P. Shepard and T. E. Humphreys, “High-precision globally-referenced position and attitude via a fusion of visual SLAM, carrier-phase-based GPS, and inertial measurements,” in *Proceedings of the IEEE/ION PLANS Meeting*, May 2014 [pdf](#)
- C6 A. J. Kerns, K. D. Wesson, and T. E. Humphreys, “A blueprint for civil GPS navigation message authentication,” in *Proceedings of the IEEE/ION PLANS Meeting*, May 2014 [pdf](#)
- C7 K. D. Wesson, B. L. Evans, and T. E. Humphreys, “A probabilistic framework for Global Navigation Satellite System signal timing assurance,” in *Proceedings of Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), 2013 [pdf](#)
- C8 K. D. Wesson, B. L. Evans, and T. E. Humphreys, “A combined symmetric difference and power monitoring GNSS anti-spoofing technique,” in *IEEE Global Conference on Signal and Information Processing*, 2013 [pdf](#)
- C9 Z. M. Kassas, J. A. Bhatti, and T. E. Humphreys, “A graphical approach to GPS software-defined receiver implementation,” in *Proceedings of IEEE Global Conference on Signal and Information Processing*, December 2013 [pdf](#)
- C10 Z. Kassas and T. E. Humphreys, “The price of anarchy in active signal landscape map building,” in *Proceedings of IEEE Global Conference on Signal and Information Processing*, December 2013 [pdf](#)

- C11 Z. Kassas, J. A. Bhatti, and T. E. Humphreys, “Receding horizon trajectory optimization for simultaneous signal landscape mapping and receiver localization,” in *Proceedings of the ION GNSS+ Meeting*, September 2013 [pdf](#)
- C12 K. M. Pesyna, Jr., R. W. Heath, Jr., and T. E. Humphreys, “Precision limits of low-energy GNSS receivers,” in *Proceedings of the ION GNSS+ Meeting*, (Nashville, Tennessee), Institute of Navigation, 2013 [pdf](#)  
**Best presentation award in session of 8 papers.**
- C13 Z. M. Kassas and T. E. Humphreys, “Motion planning for optimal information gathering in opportunistic navigation systems,” in *AIAA Guidance, Navigation, and Control Conference (GNC’13)*, (Boston, MA), pp. 4551–4565, Aug. 2013 [pdf](#)
- C14 K. D. Wesson, T. E. Humphreys, and B. L. Evans, “Position paper: Secure time transfer for CPS,” in *NSF/NSA National Workshop on The New Clockwork for Time-Critical Systems*, 2012 [pdf](#)
- C15 D. P. Shepard, K. M. Pesyna, Jr., and T. E. Humphreys, “Precise augmented reality enabled by carrier-phase differential GPS,” in *Proceedings of the ION GNSS Meeting*, (Nashville, Tennessee), Institute of Navigation, 2012 [pdf](#)
- C16 D. P. Shepard, J. A. Bhatti, T. E. Humphreys, and A. A. Fansler, “Evaluation of smart grid and civilian UAV vulnerability to GPS spoofing attacks,” in *Proceedings of the ION GNSS Meeting*, 2012 [pdf](#)
- C17 Z. M. Kassas and T. E. Humphreys, “Observability and estimability of collaborative opportunistic navigation with pseudorange measurements,” in *Proceedings of the ION GNSS Meeting*, (Nashville, Tennessee), Institute of Navigation, 2012 [pdf](#)
- C18 T. E. Humphreys, J. A. Bhatti, D. P. Shepard, and K. D. Wesson, “The Texas Spoofing Test Battery: Toward a standard for evaluating GNSS signal authentication techniques,” in *Proceedings of the ION GNSS Meeting*, 2012. <http://radionavlab.ae.utexas.edu/tebat>
- C19 Z. M. Kassas and T. E. Humphreys, “Observability analysis of opportunistic navigation with pseudorange measurements,” in *Proceedings of AIAA Guidance, Navigation, and Control Conference*, Aug. 2012 [pdf](#)
- C20 J. A. Bhatti, T. E. Humphreys, and B. M. Ledvina, “Development and demonstration of a TDOA-based GNSS interference signal localization system,” in *Proceedings of the IEEE/ION PLANS Meeting*, pp. 1209–1220, April 2012 [pdf](#)  
**Conference overall best paper award.**
- C21 K. M. Pesyna, Jr., Z. M. Kassas, and T. E. Humphreys, “Constructing a continuous phase time history from TDMA signals for opportunistic navigation,” in *Proceedings of the IEEE/ION PLANS Meeting*, pp. 1209–1220, April 2012 [pdf](#)  
**Conference best student paper award.**
- C22 D. Shepard, T. E. Humphreys, and A. Fansler, “Evaluation of the vulnerability of Phasor Measurement Units to GPS spoofing,” in *Sixth Annual IFIP WG 11.10 International Conference on Critical Infrastructure Protection*, (Washington, DC), Mar. 2012 [pdf](#)
- C23 A. J. Joplin, E. G. Lightsey, and T. E. Humphreys, “Development and testing of a minaturized, dual-frequency GPS receiver for space applications,” in *Proceedings of the ION International Technical Meeting*, (Long Beach, CA), Jan. 2012 [pdf](#)
- C24 K. D. Wesson, M. P. Rothlisberger, and T. E. Humphreys, “A proposed navigation message authentication implementation for civil GPS anti-spoofing,” in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011 [pdf](#)
- C25 D. Shepard and T. E. Humphreys, “Characterization of receiver response to a spoofing attack,” in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011 [pdf](#)

- C26 R. Mitch, R. Dougherty, M. Psiaki, S. Powell, B. O’Hanlon, J. Bhatti, and T. Humphreys, “Signal characteristics of civil GPS jammers,” in *Proceedings of the ION GNSS Meeting*, 2011 [pdf](#)  
**Best presentation award in session of 8 papers.**
- C27 M. L. Psiaki, B. W. O’Hanlon, J. A. Bhatti, and T. E. Humphreys, “Civilian GPS spoofing detection based on dual-receiver correlation of military signals,” in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011 [pdf](#)
- C28 G. Crowley, G. S. Bust, A. Reynolds, I. Azeem, R. Wilder, B. W. O’Hanlon, M. L. Psiaki, S. Powell, T. E. Humphreys, and J. A. Bhatti, “CASES: A novel low-cost ground-based dual-frequency GPS software receiver and space weather monitor,” in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011 [pdf](#)
- C29 B. O’Hanlon, M. Psiaki, S. Powell, J. Bhatti, T. E. Humphreys, G. Crowley, and G. Bust, “CASES: A smart, compact GPS software receiver for space weather monitoring,” in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), pp. 2745–2753, Institute of Navigation, 2011 [pdf](#)
- C30 K. D. Wesson, D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, “An evaluation of the vestigial signal defense for civil GPS anti-spoofing,” in *Proceedings of the ION GNSS Meeting*, (Portland, OR), 2011 [pdf](#)  
**Best presentation award in session of 8 papers.**
- C31 K. M. Pesyna Jr., Z. M. Kassas, J. A. Bhatti, and T. E. Humphreys, “Tightly-coupled opportunistic navigation for deep urban and indoor positioning,” in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011 [pdf](#)
- C32 K. M. Pesyna, Jr., K. D. Wesson, R. W. Heath, Jr., and T. E. Humphreys, “Extending the reach of GPS-assisted femtocell synchronization and localization through tightly-coupled opportunistic navigation,” in *IEEE GLOBECOM Workshop*, 2011 [pdf](#)
- C33 B. O’Hanlon, J. Bhatti, T. E. Humphreys, and M. Psiaki, “Real-time spoofing detection in a narrow-band civil GPS receiver,” in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010
- C34 T. E. Humphreys, J. Bhatti, and B. Ledvina, “The GPS Assimilator: a method for upgrading existing GPS user equipment to improve accuracy, robustness, and resistance to spoofing,” in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010 [pdf](#)
- C35 K. D. Wesson, K. M. Pesyna, Jr., J. A. Bhatti, and T. E. Humphreys, “Opportunistic frequency stability transfer for extending the coherence time of GNSS receiver clocks,” in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010 [pdf](#)
- C36 T. E. Humphreys, J. Bhatti, T. Pany, B. Ledvina, and B. O’Hanlon, “Exploiting multi-core technology in software-defined GNSS receivers,” in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), pp. 326–338, Institute of Navigation, 2009 [pdf](#)
- C37 B. W. O’Hanlon, M. L. Psiaki, P. M. Kintner, Jr., and T. E. Humphreys, “Development and field testing of a DSP-based dual-frequency software GPS receiver,” in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), Institute of Navigation, 2009 [pdf](#)
- C38 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, B. W. O’Hanlon, and P. M. Kintner, Jr., “Assessing the spoofing threat: Development of a portable GPS civilian spoofer,” in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), Institute of Navigation, 2008 [pdf](#)
- C39 J. C. Hinks, T. E. Humphreys, B. O’Hanlon, M. L. Psiaki, and P. M. Kintner, Jr., “Evaluating GPS receiver robustness to ionospheric scintillation,” in *Proceedings of the*



*ION GNSS Meeting*, (Savannah, GA), Institute of Navigation, 2008 [pdf](#)

**Best presentation award in session of 8 papers.**

- C40 S. Mohiuddin, T. E. Humphreys, and M. L. Psiaki, “A technique for determining the carrier phase differences between independent GPS receivers during scintillation,” *Proceedings of the ION GNSS Meeting*, 2007 [pdf](#)

**Best presentation award in session of 8 papers.**

- C41 M. L. Psiaki, T. E. Humphreys, S. Mohiuddin, S. P. Powell, A. P. Cerruti, and P. M. Kintner, Jr., “Searching for Galileo,” in *Proceedings of the ION GNSS Meeting*, (Fort Worth, TX), Institute of Navigation, 2006 [pdf](#)

**Best presentation award in session of 8 papers.**

- C42 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, and P. M. Kintner, Jr., “GNSS receiver implementation on a DSP: Status, challenges, and prospects,” in *Proceedings of the ION GNSS Meeting*, (Fort Worth, TX), pp. 2370–2382, Institute of Navigation, 2006 [pdf](#)

**Best presentation award in session of 8 papers.**

- C43 T. E. Humphreys, M. L. Psiaki, B. M. Ledvina, and P. M. Kintner, Jr., “GPS carrier tracking loop performance in the presence of ionospheric scintillations,” in *Proceedings of the ION GNSS Meeting*, (Long Beach, CA), Institute of Navigation, Sept. 2005 [pdf](#)

**Best presentation award in session of 8 papers.**

- C44 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, and P. M. Kintner, “Analysis of ionospheric scintillations using wideband GPS L1 C/A signal data,” in *Proceedings of the ION GNSS Meeting*, (Long Beach, California), pp. 399–407, Institute of Navigation, 2004 [pdf](#)

- C45 T. E. Humphreys, M. Kelley, and P. M. Kintner, Jr., “GPS-based measurement of atmospheric tides,” in *Proceedings of the ION GNSS Meeting*, (Long Beach, California), pp. 864–880, Institute of Navigation, 2004

- C46 T. E. Humphreys, “Attitude determination for small satellites with modest pointing constraints,” in *Proc. 2002 AIAA/USU Small Satellite Conference*, (Logan, Utah), 2002

#### OTHER MAJOR PUBLICATIONS

- M1 T. E. Humphreys, “Statement on the security threat posed by unmanned aerial systems and possible countermeasures.” <http://docs.house.gov/meetings/HM/HM09/20150318/103136/HHRG-114-HM09-Wstate-HumphreysT-20150318.pdf>, Mar. 2015

- M2 K. M. Pesyna, Jr, R. W. Heath, Jr., and T. E. Humphreys, “Accuracy in the palm of your hand: Centimeter positioning with a smartphone-quality GNSS antenna,” *GPS World*, vol. 26, pp. 16–31, Feb. 2015

- M3 M. L. Psiaki, B. W. O’Hanlon, S. P. Powell, J. A. Bhatti, T. E. Humphreys, and A. Schofield, “GNSS lies, GNSS truth: Spoofing detection with two-antenna differential carrier phase,” *GPS World*, vol. 25, pp. 36–44, Feb. 2014

- M4 K. D. Wesson and T. E. Humphreys, “Hacking drones,” *Scientific American*, vol. 309, no. 5, pp. 54–59, 2013

- M5 D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, “Drone hack: Spoofing attack demonstration on a civilian unmanned aerial vehicle,” *GPS World*, Aug. 2012

- M6 D. P. Shepard, T. E. Humphreys, and A. A. Fansler, “Going up against time: The power grid’s vulnerability to GPS spoofing attacks,” *GPS World*, Aug. 2012

- M7 T. E. Humphreys, “Statement on privacy issues related to the domestic use of unmanned aerial vehicles.” <http://radionavlab.ae.utexas.edu/images/stories/files/papers/statementOctober.pdf>, Oct. 2012

- M8 T. E. Humphreys, “Statement on the vulnerability of civil unmanned aerial vehicles and other systems to civil GPS spoofing.” <http://homeland.house.gov/sites/homeland.house.gov/files/Testimony-Humphreys.pdf>, July 2012

- M9 T. E. Humphreys, “The GPS dot and its discontents: Privacy vs. GNSS integrity,” *Inside GNSS*, vol. 7, Mar./Apr. 2012
- M10 R. Mitch, R. Dougherty, M. Psiaki, S. Powell, B. O’Hanlon, J. Bhatti, and T. E. Humphreys, “Know your enemy: Signal characteristics of civil GPS jammers,” *GPS World*, Jan. 2012
- M11 K. D. Wesson, D. P. Shepard, and T. E. Humphreys, “Straight talk on anti-spoofing: Securing the future of PNT,” *GPS World*, Jan. 2012
- M12 T. E. Humphreys, J. Bhatti, and B. M. Ledvina, “The GPS Assimilator: Upgrading receivers via benign spoofing,” *Inside GNSS*, vol. 5, pp. 50–58, June 2010
- M13 P. M. Kintner, Jr., T. E. Humphreys, and J. Hinks, “GNSS and ionospheric scintillation: How to survive the next solar maximum,” *Inside GNSS*, vol. 4, pp. 22–30, July 2009
- M14 P. Y. Montgomery, T. E. Humphreys, and B. M. Ledvina, “A multi-antenna defense: Receiver-autonomous GPS spoofing detection,” *Inside GNSS*, vol. 4, pp. 40–46, April 2009
- M15 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, B. W. O’Hanlon, and P. M. Kintner, Jr., “Assessing the spoofing threat,” *GPS World*, vol. 20, pp. 28–38, Jan. 2009
- M16 T. E. Humphreys, *Modeling Ionospheric Scintillation and its Effects on GPS Carrier Tracking Loops and Two Other Applications of Modeling and Estimation*. PhD thesis, Cornell University, Ithaca, New York, 2008
- M17 T. E. Humphreys, L. Young, and T. Pany, “Considerations for future IGS receivers,” in *Position Paper of the 2008 IGS Workshop*, 2008. <http://www.ngs.noaa.gov/IGSWorkshop2008/docs/recDev-positionpaper.pdf>
- M18 M. L. Psiaki, T. E. Humphreys, S. Mohiuddin, S. P. Powell, A. P. Cerruti, and J. Paul M. Kintner, “Searching for Galileo: Reception and analysis of signals from GIOVE-A,” *GPS World*, vol. 17, pp. 66–72, June 2006
- M19 T. E. Humphreys, “Attitude determination for small satellites with modest pointing constraints,” Master’s thesis, Utah State University, Logan, Utah, 2003

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- ORAL PRESENTATIONS
- O1 July 15, 2015, “Secure Perception for Autonomous Systems,” (invited keynote presentation) International GNSS Conference, Gold Coast, Australia.
  - O2 June 11, 2015, “Toughening Techniques for GPS Receivers: Navigation Message Authentication,” (invited) National Executive Committee on Position Navigation and Timing, Advisory Board Meeting, Washington, DC.
  - O3 March 18, 2015, “Unmanned aerial system threats: Exploring security implications and mitigation technologies,” (invited) U.S. House Subcommittee on Homeland Security Oversight hearing, Washington, DC. [link](#)
  - O4 February 25, 2015, “Navigation Under Threat,” (invited keynote presentation) International Navigation Conference, Manchester, UK.
  - O5 November 21, 2014, “Drones: Myths, Facts, Hacks, and the Future,” (invited) Hot Science Cool Talks, The University of Texas at Austin Environmental Science Institute. [link](#)
  - O6 April 15, 2014, “Secure Perception for Autonomous Systems,” (invited) University of Texas Student Engineering Council Symposium, Austin, TX.
  - O7 March 13, 2014, “Secure Perception for Autonomous Systems,” (invited) University of Illinois at Urbana-Champaign, Urbana, IL. Slides available at <http://tinyurl.com/onksode>.

- O8 March 6, 2014, “Secure Perception for Autonomous Systems, (invited keynote presentation) Cornell Sibley Graduate Research Symposium, Ithaca, NY.
- O9 March 7, 2014, “Location Deception,” (invited) SXSW Interactive, Austin, TX. Audio available at <https://soundcloud.com/officialsxsw/location-deception-yacht-vs>.
- O10 November 14, 2013, “Secure PNT for Autonomous Systems,” (invited) Stanford PNT Symposium, Stanford University, Stanford, CA.
- O11 September 26, 2013, “Maritime Navigation Security,” (invited) International Hydrographic Organisation & Professional Yachters Association Sea Changes Seminar, Monaco.
- O12 March 8, 2013, “Extreme GPS,” (invited) SXSW Interactive, Austin, TX. Audio available at [http://schedule.sxsw.com/2013/events/event\\_IAP6353](http://schedule.sxsw.com/2013/events/event_IAP6353). Slides available at <http://tinyurl.com/qbolhgv>.
- O13 March 6, 2013, “Drones in the Classroom,” (invited) SXSW Edu, Austin, TX.
- O14 February 13, 2013, “Secure Navigation and Timing,” (invited keynote) Royal Institute of Navigation Interference Conference, Teddington, UK.
- O15 February 12, 2013, “UAV Integration: Privacy and Security Hurdles,” Royal Institute of Navigation UAV Conference, Teddington, UK.
- O16 February 7, 2013, “GPS Vulnerabilities and Implications for Telecom,” (invited) international webinar. Slides available at <http://tinyurl.com/k9gmfxw>.
- O17 December 5, 2012, “Navigation and Timing Security,” (invited) U.S. Air Force GPS Directorate, Los Angeles, CA.
- O18 November 15, 2012, “Future Directions in GNSS Research,” (invited) international GPS World webinar. Slides available at <http://tinyurl.com/mcskesm>.
- O19 October 25, 2012, “Privacy Issues Related to the Domestic Use of Unmanned Aerial Vehicles,” (invited) statement to the U.S. House Judiciary Subcommittee on Crime, Terrorism, and Homeland Security field forum, Houston, TX. Statement available at <http://tinyurl.com/pvuzpzv>.
- O20 October 17, 2012, “Secure Civil Navigation and Timing,” (invited) Sandia National Laboratory, Albuquerque, NM.
- O21 September 17, 2012, “Receiver Certification for Hardening Against Spoofing,” (invited) Civil GPS Service Interface Committee, Nashville, TN.
- O22 September 10, 2012, “Secure Civil Navigation and Timing,” (invited) Aerospace Corporation research seminar, virtual from Austin, TX.
- O23 July 20, 2012, “Secure Civil Navigation and Timing,” (invited) MITRE corporation and government customers, McLean, VA.
- O24 July 19, 2012, “Radionavigation Robustness and Security,” (invited) Office of Naval Research, Arlington, VA.
- O25 July 19, 2012, “The vulnerability of civil unmanned aerial vehicles and other systems to civil GPS spoofing,” (invited) U.S. House Subcommittee on Homeland Security Oversight hearing on drone security, Washington, DC. Video available at <http://www.c-span.org/video/?307143-1/domestic-drone-oversight>. Statement available at <http://tinyurl.com/lka3fkp>.
- O26 June 6, 2012, “Privacy vs. GPS Integrity,” (invited) Civil GPS Service Interface Committee (CGSIC) Meeting, Austin, TX.
- O27 February 22, 2012, “PVT Security: Privacy and Trustworthiness,” (invited keynote) Royal Institute of Navigation Conference on GNSS Vulnerability: Present Dangers, Future Threats 2012, Teddington, UK.
- O28 February 11, 2012, “How to fool a GPS,” (invited) TEDxAustin, Austin, TX. Video available at [http://www.ted.com/talks/todd\\_humphreys\\_how\\_to\\_fool\\_a\\_gps](http://www.ted.com/talks/todd_humphreys_how_to_fool_a_gps).

- O29 December 2, 2011, “Radionavigation Robustness and Security,” (invited) Draper Laboratory, Cambridge, MA.
- O30 December 1, 2011, “Cubesat-Sized Radio Occultation Experiments,” (invited) Massachusetts Institute of Technology Aeronautics and Astronautics Department, Cambridge, MA.
- O31 April 4, 2011, “State of the art and future trends in radionavigation,” (invited) US Patent and Trademark Office, virtual presentation from Austin, TX. Slides available at <http://tinyurl.com/lbn998y>.
- O32 March 10, 2011, “Briefing to DHS and DOD on GPS Security and Integrity,” (invited), Austin, TX. Slides available at <http://tinyurl.com/m9h35tt>
- O33 October 4, 2010, “Spoofing the timing signal: What else is vulnerable?” (invited) National Executive Committee on Position Navigation and Timing, Advisory Board Meeting, Washington, DC.
- O34 June 25, 2010, “Advances in GNSS Equipment,” (invited) 2010 IGS Workshop, International GNSS Service, Newcastle upon Tyne, UK.
- O35 January 12, 2010, “Riding out the rough spots: Scintillation-robust GNSS carrier tracking,” (invited) 2010 Air Force Orion Conference, Dayton, OH.
- O36 March, 2009, “Assessing the GPS spoofing threat,” (invited) Cornell University, Ithaca, NY.
- O37 June 5, 2008, “Considerations for future IGS receivers,” (invited) 2008 IGS Workshop, International GNSS Service, Miami Beach, FL.
- O38 March, 2006, “The semidiurnal variation in GPS-derived zenith neutral delay,” (invited) 2006 IGS Workshop, Darmstadt, Germany.

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- P1 K. J. Hayworth, K. V. Shcheglov, T. E. Humphreys, and A. D. Challoner, “Electrostatic spring softening in redundant degree of freedom resonators,” Nov. 30 2004. US Patent 6,823,734
- P2 W. J. Bencze, C. E. Cohen, B. T. Galusha, T. E. Humphreys, B. M. Ledvina, and M. L. Psiaki, “Practical method for upgrading existing GNSS user equipment with tightly integrated nav-com capability,” July 12 2011. US Patent 7,978,130
- P3 D. P. Shepard, T. E. Humphreys, K. M. Pesyna, Jr., and J. A. Bhatti, “A system and method for using global navigation satellite system (GNSS) navigation and visual navigation to recover absolute position and attitude without any prior association of visual features with known coordinates,” Feb. 2014. US Patent filed on Feb., 3, 2014

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- S1 T. E. Humphreys, J. A. Bhatti, and D. P. Shepard, “General radionavigation interfusion device (GRID) software suite (GSS),” 2010. UTA Tech ID 5900 HUM
- S2 T. E. Humphreys, J. A. Bhatti, and D. P. Shepard, “Radionavigation security testbed software,” 2012. UTA Tech ID 6199 HUM

RESEARCH TOPICS

Optimal estimation and detection, navigation and timing security, cyber-physical systems security, Global Navigation Satellite Systems (GNSS) signal processing, GNSS-based study of the ionosphere and neutral atmosphere, GNSS integrity and security, software-defined radio.

CURRENT  
GRADUATE  
STUDENTS

*Ph.D.-track Students Admitted To Candidacy*

- Daniel Shepard

*Ph.D.-track Students not yet Admitted To Candidacy*

- Andrew Kerns
- Nathan Green
- Lakshay Narula
- Michael Wooten
- Nick Montalbano
- Matthew Murrian

GRADUATE  
SUPERVISION  
COMPLETED

*Ph.D. Dissertations*

- K. M. Pesyna, Jr., *Advanced Techniques for Centimeter-Accurate GNSS Positioning on Low-Cost Mobile Platforms*. PhD thesis, The University of Texas at Austin, Aug. 2015. Current position: Chief Technology Officer, Radiosense. Primary supervisor: Humphreys; Co-Supervisor: Robert Heath (ECE)
- J. Bhatti, *Sensor Deception Detection and Radio-Frequency Emitter Localization*. PhD thesis, The University of Texas at Austin, Aug. 2015. Current position: Senior Location Engineer, Apple.
- Z. M. Kassas, *Analysis and Synthesis of Collaborative Opportunistic Navigation Systems*. PhD thesis, The University of Texas at Austin, May 2014. Current position: Assistant professor, Department of Electrical Engineering, University of California, Riverside. Primary supervisor: Humphreys; Co-supervisor: Aristotle Arapostathis (ECE).
- K. Wesson, *Secure Navigation And Timing Without Local Storage Of Secret Keys*. PhD thesis, The University of Texas at Austin, May 2014. Current position: Senior Researcher, Zeta Associates. Primary supervisor: Humphreys; Co-supervisor: Brian Evans (ECE).

*M.S. Reports and Theses*

- A. J. Joplin, "Development and testing of a miniaturized, dual-frequency, software-defined GPS receiver for space applications," Master's thesis, The University of Texas at Austin, Dec. 2011. Current position: Research staff, Applied Research Laboratories. Primary supervisor: Glenn Lightsey; Co-supervisor: Humphreys.
- M. W. Bright, "GPS L2C signal survey and the development of the emergent MATLAB L2C (EMAL2) receiver," master's report, The University of Texas at Austin, Aug. 2012. Current position: Technical staff, John Deere Intelligent Solutions Group. Primary supervisor: Humphreys; Co-supervisor: Bob Schutz.

OTHER RESEARCH  
SUPERVISION

*Ph.D. Defense Committees*

Kien Trung Truong, Kumar Appaiah, Thomas Novlan, Vidur Bhargava, Drew Jones, Jaegan Ko, Jing Lin, Chao Jia, Yezhou Wang, Noah Smith, Ehab Hussein,

*Ph.D. Qualifying Committees*

Kien Trung Truong, Kumar Appaiah, Thomas Novlan, Vidur Bhargava, Ehab Hussein Hassan, Yousof Mortazavi, Drew Jones, Jaegan Ko, Jing Lin, Chao Jia, Yezhou Wang

*M.S. Report Committees*

Constance McDaniel Wyman

*Undergraduate Honors Projects*  
Daniel Shepard, Shubhodeep Mukherji