

***44<sup>TH</sup> ANNUAL***  
**PRECISE TIME AND TIME INTERVAL (PTTI)**  
**SYSTEMS AND APPLICATIONS MEETING**

**PROCEEDINGS OF A MEETING SPONSORED BY**

**THE U.S. NAVAL OBSERVATORY**  
**THE U.S. NAVAL RESEARCH LABORATORY**  
**THE NASA JET PROPULSION LABORATORY**  
**THE DEFENSE INFORMATION SYSTEMS AGENCY**

**HELD AT**  
**THE HYATT REGENCY RESTON**  
**RESTON, VIRGINIA, USA**  
**26-29 NOVEMBER 2012**

**NANCY C. BLEMLY, EDITOR**  
**U.S. DEPARTMENT OF DEFENSE**



## TABLE OF CONTENTS

PTTI Executive Committee .....	vii
PTTI Advisory Board .....	viii
PTTI 2012 Meeting Officers .....	ix
Distinguished PTTI Service Award 2012 Selection Committee .....	x
Past Recipients of the Distinguished PTTI Service Award .....	x
Distinguished PTTI Service Award to Mr. Ronald L. Beard..... Presented by Dr. Dennis D. McCarthy	xi
PTTI 2012 Session Chairs .....	xiii
List of Attendees at PTTI 2012 .....	xiv

### SESSION I: VENDOR PRESENTATIONS

TRAK Microwave, Inc.; TimeTech GmbH; Synergy Systems, LLC; Symmetricom, Inc.; SpectraTime; SpectraDynamics, Inc.; Spectracom; Piktime Systems; Pascall Electronics, LTD; Masterclock, Inc.; Linear Photonics, LLC; GuideTech; Furuno Electric Company, LTD; Frequency Electronics, Inc.; ESE; Digital Instruments; Brandywine Telecommunications.

### SESSION II: LABORATORY REPORTS AND ACTIVITY UPDATES

<b>ACTIVITY REPORT FROM NICT</b> .....	1
Yuko Hanado, Kuniyasu Imamura, Tsukasa Iwama, Ryuichi Ichikawa, Mamoru Sekido, Tadahiro Gotoh, and Toshio Iguchi	
<b>TIME AND FREQUENCY ACTIVITIES AT THE U. S. NAVAL OBSERVATORY</b> .....	11
Demetrios Matsakis	
<b>TIME AND FREQUENCY ACTIVITIES AT THE JHU APPLIED PHYSICS LABORATORY</b> .....	29
Mihran Miranian, Gregory L. Weaver, Jeffrey F. Garstecki, and Richard A. Dragonette	
<b>RECENT CALIBRATIONS OF UTC(NIST) –UTC(USNO)</b> .....	35
Victor Zhang, Thomas E. Parker, Russell Bumgarner, Jonathan Hirschauer, Angela McKinley, Stephen Mitchell, Ed Powers, Jim Skinner, and Demetrios Matsakis	

### **SESSION III: TIME AND FREQUENCY TRANSFER - SATELLITE**

<b>ACCURACY / PRECISION OF USNO PREDICTED CLOCK ESTIMATES FOR GPS SATELLITES</b> .....	43
Christine Hackman	
<b>USING IGS PRODUCTS FOR NEAR REAL-TIME COMPARISONS OF UTC(K)'S</b> .....	53
Pascale Defraigne, Quentin Baire, and Eric Pottiaux	
<b>GNSS ACTIVITIES AND PERFORMANCE AT USNO</b> .....	65
Stephen Mitchell, Ed Powers, Jeff Prillaman, Valeri Makarov, and Demetrios Matsakis	
<b>REPLICATING UTC(NIST) AT REMOTE SITES</b> .....	79
Michael A. Lombardi, Andrew N. Novick, Jose Mauricio López-Romero, and Rodrigo Ramos P.	
<b>THREE YEARS OF GLONASS USE FOR UTC</b> .....	91
Z. Jiang and W. Lewandowski	

### **SESSION IV: NEUTRINO TIME OF FLIGHT METROLOGY**

<b>SYNCHRONIZATION BETWEEN REMOTE SITES FOR THE MINOS EXPERIMENT</b> .....	99
S. Römisch, S. R. Jefferts, V. Zhang, T. E. Parker, N. Ashby, P. Adamson, G. Barr, A. Habig, J. Meier, C. James, R. Nicol, R. Plunkett, C. Rosenfeld, R. Bumgarner, M. Christensen, J. Hirschauer, B. Fonville, S. Mitchell, A. McKinley, E. Powers, J. Wright, and D. Matsakis	
<b>MEASUREMENT OF THE VELOCITY OF THE NEUTRINO WITH MINOS</b> .....	119
P. Adamson, N. Ashby, R. Bumgarner, M. Christensen, B. Fonville, J. Hirschauer, S. R. Jefferts, D. Matsakis, A. McKinley, T. E. Parker, E. Powers, S. Römisch, J. Wright, and V. Zhang	
<b>MEASUREMENT OF CNGS MUON NEUTRINOS SPEED WITH BOREXINO: INRIM AND ROA CONTRIBUTION</b> .....	133
Giancarlo Cerretto, Hector Esteban, Marco Pallavicini, Valerio Pettiti, Cedric Plantard, and Alessandro Razeto	
<b>RELATIVE CALIBRATION OF THE TIME TRANSFER LINK BETWEEN CERN AND LNGS FOR PRECISE NEUTRINO TIME OF FLIGHT MEASUREMENTS</b> .....	141
Thorsten Feldmann, A. Bauch, D. Piester, P. Alvarez, D. Autiero, J. Serrano, and G. Brunetti	

### **SESSION V: TIME AND FREQUENCY TRANSFER – OPTICAL FIBER**

<b>SUPPRESSION OF SBS-INDUCED RF PHASE NOISE IN AN RF-PHOTONIC LINK</b> .....	151
James P. Cahill, Olukayode Okusaga, Weimin Zhou, and Gary M. Carter	
<b>TWO-WAY TIME TRANSFER VIA A COMMON-PATH FIBER LINK</b> .....	159
Wen-Hung Tseng, Shinn-Yan Lin, Yi-Jiun Huang, Fang-dar Chu, and Kai-Ming Feng	

## **SESSION VI: POSTER SESSION**

*Poster and student papers have been incorporated into the topical sessions.*

## **SESSION VII: RECEIVER PERFORMANCE ON PTTI SYSTEMS**

<b>TIMING CALIBRATION OF A GPS/GALILEO COMBINED RECEIVER .....</b>	<b>167</b>
Blair Fonville, Edward Powers, Rigas Ioannides, Jörg Hahn, and Alexander Mudrak	
<b>IN SEARCH OF A NEW PRIMARY GPS RECEIVER FOR NIST .....</b>	<b>179</b>
M. A. Weiss, J. Yao, and J. Li	
<b>IN SITU GNSS RECEIVER BIAS CALIBRATIONS USING PICOSECOND PULSES.....</b>	<b>187</b>
Johnathan York, Otto Caldwell, Aaron Kerkhoff, Jon Little, David Munton, Scot Nelsen, Brent Renfro, and Thomas Gaussiran	
<b>ENABLING ACCURATE DIFFERENTIAL CALIBRATION OF MODERN GPS RECEIVERS .....</b>	<b>203</b>
S. Römisch, V. Zhang, T. E. Parker, and S. R. Jefferts	

## **SESSION VIII: LOCAL CLOCK TIMEKEEPING USING INNOVATIVE SOURCES**

<b>CLOCK STEERING USING FREQUENCY ESTIMATES FROM STAND-ALONE GPS RECEIVER CARRIER PHASE OBSERVATIONS .....</b>	<b>211</b>
Edward Byrne, Thao Q. Nguyen, Lars Boehnke, Frank van Graas, and Samuel Stein	
<b>EXPERIMENTAL AND SIMULATION STUDY FOR COMMERCIAL TIME TRANSFER SERVICE OVER GEOSTATIONARY SATELLITE .....</b>	<b>221</b>
Jacqueline Walker and Marco Genova	
<b>PROGRESS ON TWO-WAY SATELLITE TIME TRANSFER USING DPN SIGNALS.....</b>	<b>239</b>
Tadahiro Gotoh, Jun Amagai, Miho Fujieda, and Masanori Aida	
<b>HIGH-PRECISE PORTABLE TIME INTERVAL AND FREQUENCY COUNTER .....</b>	<b>247</b>
R. Szplet, Z. Jachna, K. Różyk, and P. Kwiatkowski	
<b>A VOICE TIME MONITORING AND RECORDING SUB-SYSTEM FOR THE TELEPHONE SPEAKING CLOCK.....</b>	<b>257</b>
C.C. Lin, P. C. Chang, J. L. Wang, T. Y. Chiu, and S. Y. Lin	

## **SESSION IX: TIME SCALES AND ALGORITHMS**

<b>PERFORMANCE AND APPLICATIONS OF AN ENSEMBLE OF ATOMIC FOUNTAINS .....</b>	<b>269</b>
Steven Peil, James Hanssen, Thomas B. Swanson, Scott Crane, and Christopher R. Ekstrom	
<b>SOLVING FOR TIME: A UNIFIED, COVARIANCE-BASED COMPARISON OF CELESTIAL AND RADIONAVIGATION ALGORITHMS FROM 1770 TO THE PRESENT .....</b>	<b>273</b>
Daniel G. Jablonski	

<b>DISCRETE SIMULATION OF POWER LAW NOISE .....</b>	<b>289</b>
Neil Ashby	
<b>TIME SCALES COMPARISONS USING SIMULTANEOUS MEASUREMENTS IN THREE FREQUENCY CHANNELS.....</b>	<b>301</b>
Petr Pánek and Alexander Kuna	
<b>TESTS OF THE BIPM PORTABLE CALIBRATION STATION - METODE: MEASUREMENT OF TOTAL DELAY .....</b>	<b>311</b>
Z. Jiang, L. Tisserand, and G. Petit	
<b>GPS CARRIER-PHASE TIME TRANSFER BOUNDARY DISCONTINUITY INVESTIGATION .....</b>	<b>317</b>
Jian Yao and Judah Levine	
 <b>SESSION X, MINI 1: MICRO-ATOMIC CLOCKS</b>	
<b>A COLD-ATOM CLOCK BASED ON COHERENT POPULATION TRAPPING .....</b>	<b>327</b>
Elizabeth A. Donley, Francois-Xavier Esnault, Eric Blanshan, and John Kitching	
 <b>SESSION X, MINI 2: SPACE-BASED CLOCKS</b>	
<b>LONG TERM BEHAVIOR OF QUARTZ OSCILLATORS IN SPACE .....</b>	<b>335</b>
James C. Camparo, James O. Hagerman, and Thomas A. McClelland	
<b>OSCILLATOR SOURCES FOR A DORIS SATELLITE SDR RECEIVER SYSTEM.....</b>	<b>351</b>
Benjamin H. Barnum, Chris Haskins, Wesley Millard, David Rainwater, and Michael Kelly	
<b>MESSENGER ONBOARD TIMEKEEPING ACCURACY DURING THE FIRST YEAR IN ORBIT AT MERCURY .....</b>	<b>361</b>
Stanley B. Cooper, J. Robert Jensen, and Gregory L. Weaver	
 <b>SESSION XI: NETWORK SYNCHRONIZATION</b>	
<b>EVALUATION OF TIME TRANSFER UNITS FOR TIME AND FREQUENCY TRANSFER IN OPTICAL FIBERS UTILIZING A PASSIVE TECHNIQUE BASED ON SONET/SDH .....</b>	<b>371</b>
James Hanssen, Christopher Ekstrom, Sven-Christian Ebnehag, and Kenneth Jaldehag	
<b>ASYMMETRY MITIGATION THROUGH LINE SWAPPING IN IEEE 802.3 ETHERNET.....</b>	<b>377</b>
Reinhard Exel, Thomas Bigler, and Nikolaus Kerö	
<b>IRIG-B TIME SIGNAL DISTRIBUTION OVER GEOSTATIONARY SATELLITES .....</b>	<b>391</b>
Senol Gulgonol, Mesut Gokte, Thomas Meinerz, Erdem Demircioglu, and Nedim Sozbi	
<b>TOWARDS TIMELY INTELLIGENCE IN THE POWER GRID.....</b>	<b>399</b>
Julien Amelot, Dhananjay Anand, Thomas Nelson, Gerard Stenbakken, Ya-Shian Li-Baboud, and James Moyne	

## **PTTI EXECUTIVE COMMITTEE**

**MS. FRANCINE M. VANNICOLA, CHAIRMAN**  
U.S. Naval Research Laboratory

**MR. RONALD L. BEARD**  
U.S. Naval Research Laboratory

**MRS. NANCY C. BLEMLY**  
Department of Defense

**DR. DENNIS D. MCCARTHY**  
U.S. Naval Observatory

**MRS. ANGELA D. MCKINLEY**  
U.S. Naval Observatory

**MS. LISA ORR**  
Defense Information Systems Agency

**DR. ROBERT TJOELKER**  
NASA Jet Propulsion Laboratory

**DR. JOSEPH D. WHITE**  
U.S. Naval Research Laboratory

### **ADMINISTRATIVE ASSISTANCE**

**MS. NICOLETTE M. JARDINE**  
U.S. Naval Research Laboratory

## **PTTI ADVISORY BOARD**

**MR. S. CLARK WARDRIP, CHAIRMAN**  
Sotera Defense Solutions, Inc.

**MR. MARTIN B. BLOCH, TREASURER**  
Frequency Electronics, Inc.

**DR. JAMES CAMPARO**  
The Aerospace Corporation

**DR. EDOARDO DETOMA**  
Avio Group SpA

**MRS. SHEILA FAULKNER**  
Sotera Defense Solutions, Inc.

**MR. HUGO FRUEHAUF**  
The Hugo Fruehauf Company

**MR. GARY GEIL**  
Geil Marketing Associates, Inc.

**MR. WERNER R. LANGE**  
Lange-Electronic GmbH

**MR. ROBERT LUTWAK**  
Symmetricom, Inc.

**DR. LEO A. MALLETT**  
The Aerospace Corporation

**MR. DONALD H. MITCHELL**  
Geil Marketing Associates, Inc.

**MR. ALLEN OSBORNE, III**  
The MITRE Corporation

**DR. VICTOR S. REINHARDT**  
Raytheon Space and Airborne Systems

**MR. PASCAL ROCHAT**  
SpectraTime

**MR. RONALD C. ROLOFF**  
Geil Marketing Associates, Inc.

**MR. GEORGE SHATON**  
Northrop Grumman (Retired)

**DR. SAMUEL R. STEIN**  
Symmetricom, Inc.

**DR. PATRIZIA TAVELLA**  
INRIM

**PROFESSOR JACQUES VANIER**  
University of Montreal

**DR. YAKOV L. VOROKHOVSKY**  
Morion, Inc.

**MR. GEORGE ZAMPETTI**  
SYMMETRICOM, INC.



## **PTTI 2012 MEETING OFFICERS**

### **GENERAL CHAIRMAN**

**DR. STEVEN JEFFERTS**

National Institute of Standards and Technology

### **TECHNICAL PROGRAM COMMITTEE CHAIRMAN**

**MR. GREGORY WEAVER**

JHU/Applied Physics Laboratory

### **TUTORIALS CHAIRMAN**

**MR. PETER CASH**

Symmetricon, Inc.

### **EDITORIAL COMMITTEE CHAIRMAN**

**MRS. NANCY BLEMLY**

Department of Defense

### **EXHIBITS AND PUBLICITY CHAIRMAN**

**MR. GARY GEIL**

Geil Marketing Associates, Inc.

### **EXHIBITS AND PUBLICITY CO-CHAIRMAN**

**MR. DON MITCHELL**

Geil Marketing Associates, Inc.

### **TECHNICAL ASSISTANCE**

**MR. DOUG BOEHM**

U. S. Naval Research Laboratory

### **MEETING LOGISTICS**

**MRS. SHEILA FAULKNER**

Sotera Defense Solutions, Inc.

### **REGISTRATION**

**MS. NICOLETTE JARDINE**

U. S. Naval Research Laboratory

## **DISTINGUISHED PTTI SERVICE AWARD 2012 SELECTION COMMITTEE**

**DR. DENNIS D. MCCARTHY, CHAIRMAN**  
U.S. Naval Observatory

**DR. LEO A. MALLETTE**  
The Aerospace Corporation

**MR. DON H. MITCHELL**  
Geil Marketing Associates

**DR. PATRIZIA TAVELLA**  
Istituto Nazionale di Ricerca Metrologica

**DR. JACQUES VANIER**  
University of Montreal

---

### **PAST RECIPIENTS OF THE DISTINGUISHED PTTI SERVICE AWARD**

---

**1994**

**DR. GERNOT M. R. WINKLER**  
U.S. Naval Observatory (Ret.)

**2003**

**MR. S. CLARK WARDRIP**  
National Aeronautics and Space Administration

**1995**

**DR. JAMES A. BARNES**  
National Institute of Standards and Technology (Ret.)

**2005**

**DR. NORMAN F. RAMSEY**  
Harvard University

**1996**

**PROF. SIGFRIDO M. LESCHIUTTA**  
Politecnico di Torino and Istituto Elettrotecnico  
Nazionale Galileo Ferraris

**2006**

**PROF. DAVID L. MILLS**  
University of Delaware

**1997**

**PROF. BERNARD R. GUINOT**  
Bureau International des Poids et Mesures (Ret.) and  
Honorary Astronomer, Paris Observatory, France

**2007**

**DR. R. MICHAEL GARVEY**  
Symmetricom, Incorporated

**1998**

**DR. JACQUES VANIER**  
National Research Council, Canada (Ret.)

**2008**

**DR. PATRIZIA TAVELLA**  
Istituto Nazionale di Ricerca Metrologica

**1999**

**DR. LEONARD S. CUTLER**  
Agilent Technologies

**2009**

**DR. JUDAH LEVINE**  
National Institute of Standards and Technology

**2000**

**MR. ROGER EASTON**  
U.S. Naval Research Laboratory

**2010**

**DR. JOSEPH D. WHITE**  
Naval Research Laboratory

**2001**

**DR. ROBERT F. C. VESSOT**  
Smithsonian Astrophysical Observatory

**2011**

**MR. WILLIAM J. RILEY**  
Hamilton Technical Services

**2002**

**MR. HARRY PETERS**  
Sigma Tau, Incorporated

## **DISTINGUISHED PTTI SERVICE AWARD**

**MR. RONALD L. BEARD**  
**U.S. NAVAL RESEARCH LABORATORY**

**Presented by**  
**Dr. Dennis D. McCarthy**  
**U.S. Naval Observatory**



The Distinguished PTTI Service Award acknowledges contributions related to the management of PTTI systems. It recognizes individuals who have provided exceptional leadership and demonstrated ability and ingenuity in the development or application of PTTI over a number of years or who have designed or developed a significant PTTI system. Since it was instituted in 1994, it has been awarded in seventeen years.

This year the award is presented to a person familiar to all in the PTTI Meeting community, to someone who has been a member of the PTTI Planning Meeting Executive Committee since

1984, the Technical Program Chair for the 1994 Meeting, General Chair in 1995, and technical session chair many times over the years. That would be Ronald Beard, Head of the Space Applications Branch of the Naval Research Laboratory. At NRL, Ron oversees three sections that provide the scientific expertise, manpower, and technical management to perform research and development in areas that include space systems designed to furnish accurate navigational information, the precise location of equipment, and time synchronization. The development of highly stable atomic frequency standards for space borne application in GPS is a primary mission area. The Branch continues in its role as the Center of Excellence for time and frequency testing of military and commercial GPS timing receivers and user equipment within the Joint Test Agency Working Group centered at Holloman AFB.

In addition to this responsibility, Ron has served as Program Manager for the NAVSTAR GPS Clock Technology Program and the Manager of the NRL Space Surveillance Modernization Program. The former involves the development of atomic clocks for space and ground application ranging from the physics of the clocks to their performance in GPS and other systems. He developed the design and construction of a space qualified hydrogen maser capable of operation in a GPS satellite and a ground model designed for operation in ground tracking stations. A significant capability developed within the Branch is the Precise Clock Evaluation Facility, comprised of precise references, measurement systems and environmental chambers configured to enable prolonged testing of space qualified atomic clocks in a space-like environment.

He has been a member of numerous national and international working groups, was the originator and principal investigator for the Laser Retro-reflector Experiment included as secondary payloads on

NAVSTAR 35 and 36, and was a major contributor to establishing the NATO requirement for common time.

He became a member of the U.S. Working Party 7A of the International Telecommunications Union – Radiocommunications Sector (ITU-R) Study Group 7 in 1994, and has served as ITU-R Representative to the Consultative Committee for Time and Frequency and as Vice Chair of U.S. Working Party 7A from 1999 through 2003. He was the ITU-R Special Rapporteur on the Future of the UTC Time Scale and in that capacity organized a special colloquium on the Future of the UTC Time Scale. He currently serves as the International Chair of ITU-R Sector Working Party 7A.

As a recognized expert he has been actively involved in the development, consultation, or review of a number of space and space-related projects, served as technical reviewer of papers submitted for publication in technical journals, and authored numerous publications.

It is a pleasure to present the PTTI Award to Ron Beard in recognition of his many significant contributions to PTTI.

## **PTTI 2012 SESSION CHAIRS**

**SESSION I: Vendor Presentations**

**JOSEPH WHITE**

Naval Research Laboratory

**SESSION VII: Receiver Performance on  
PTTI Systems**

**MICHAEL LOMBARDI**

National Institute of Standards and Technology

**SESSION II: Laboratory Reports and Activity  
Updates**

**ANGELA MCKINLEY**

U.S. Naval Observatory

**SESSION VIII: Local Clock Timekeeping  
Using Innovative Sources**

**MARC WEISS**

National Institute of Standards and Technology

**JEFF GARSTECKI**

JHU Applied Physics Laboratory

**SESSION III: Time and Frequency Transfer  
– Satellite**

**JOERG HAHN**

European Space Agency

**SESSION IX: Time Scales and Algorithms**

**MIHRAN MIRANIAN**

JHU Applied Physics Laboratory

**SESSION IV: Neutrino Time of Flight  
Metrology**

**STEFANIA RÖMISCH**

National Institute of Standards and Technology

**SESSION X, MINI 1: Micro-Atomic Clocks**

**AMIT LAL**

Cornell University

**WILLIAM RILEY**

Hamilton Technical Services

**SESSION V: Time and Frequency Transfer  
– Optical Fiber**

**VLADIMIR SMOTLACHA**

CESNET

**SESSION X, MINI 2: Space-Based Clocks**

**JOHN PRESTAGE**

Jet Propulsion Laboratory

**SESSION VI: Poster Session**

**RACHEL BINFIELD**

JHU Applied Physics Laboratory

**SESSION XI: Network Synchronization**

**GEORGE ZAMPETTI**

Symmetricom, Inc.

## LIST OF ATTENDEES AT PTTI 2012

Berni Ai-Kuo  
Symmetricom  
2300 Orchard Parkway  
San Jose, CA 95131  
baikuo@symmetricom.com

Malcolm Airst  
MITRE Corporation  
49185 Transmitter Rd.  
Bldg. 626  
San Diego, CA 92152  
619-318-3837  
Fax: 619-222-2260  
mairst@mitre.org

Megan Andrews  
The Institute of Navigation  
8551 Rixlew Lane, Suite 360  
Manassas, VA 20109  
703-366-2723  
Fax: 703-366-2724  
mandrews@ion.org

Franklin Ascarrunz  
SpectraDynamics, Inc.  
1849 Cherry Street Unit 2  
Louisville, CO 80027  
303-870-1524  
franklin@spectradynamics.com

Neil Ashby  
University of Colorado  
Dept. of Physics, UCB 390  
Boulder, CO 80309-0390  
303 497-4385  
Fax: 303 497-6461  
ashby@boulder.nist.gov

Tom Banwell  
Applied Communications  
Sciences  
331 Newman Springs Road  
Red Bank, NJ 07701  
732-898-8400  
tbanwell@appcomsci.com

Paul Barrett  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-0131  
paul.barrett@usno.navy.mil

Peter Barschall  
eRide  
1111 Bayhill Drive, Ste. 150  
San Bruno, CA 94066  
650-737-4202  
Fax: 484-726-7560  
peter@eride.com

Tom Bartholomew  
TASC  
2701 Technology Drive  
Annapolis Junction, MD 20701  
240-456-2019  
thomas.bartholomew@tasc.com

Nikolay Bazhenov  
FGUP VNIIFTRI  
Solnechnogorskiy District  
Mendeleevo 141570 Moscow  
Region  
Russia  
+79057001101  
Fax: +74956624159  
bazhenov@vniifti.ru

Ronald Beard  
Naval Research Laboratory  
4555 Overlook Avenue SW  
Washington, DC 20375  
202-404-7054  
Fax: 202-767-2845  
ronald.beard@nrl.navy.mil

Lisa Beaty  
The Institute of Navigation  
8551 Rixlew Lane, Suite 360  
Manassas, VA 20109  
703-366-2723  
Fax: 703-366-2724  
lbeaty@ion.org

Stacey Bennett  
Symmetricom  
34 Tozer Road  
Beverly, MA 01915  
sbennett@symmetricom.com

Johan Bergerengen  
eRide  
1111 Bayhill Drive, Ste. 150  
San Bruno, CA 94066  
650-737-4266  
peter@eride.com

David Bertauski  
659 Village Parkway  
Fredericksburg, VA 22406  
david.bertauski.ctr@nrl.navy.mil

Thomas Bigler  
Austrian Academy of Sciences  
Institute for Integrated Sensors  
Systems  
Viktor Kaplan Straße,  
Building C  
Wiener Neustadt 2700  
Austria  
0043/026222342010  
office.iiss@oeaw.ac.at

Nancy Blemly  
DoD  
2933 Southview Rd.  
Ellicott City, MD 21042  
nchamilton@wesleyan.edu

Marty Bloch  
Frequency Electronics, Inc.  
55 Charles Lindbergh Blvd.  
Uniondale, NY 11553  
516-301-8791  
martinb@frequelec.com

Doug Boehm  
Naval Research Laboratory  
4555 Overlook Avenue SW  
Washington, DC 20375  
202-767-5004  
Fax: 202-767-2845  
douglas.boehm@nrl.navy.mil

Bryan Boyd  
The MITRE Corporation  
1155 Academy Park Loop  
Colorado Springs, CO 80910  
719-573-3131  
Fax: 719-572-8252  
bboyd@mitre.org

Rohit Braggs  
Spectracom  
1565 Jefferson Road, Suite 460  
Rochester, NY 14623  
585-321-5800  
Fax: 585-321-5219  
rohit.braggs@spectracom.rolia.com

Gary Brefini  
The MITRE Corporation  
202 Burlington Road  
Bedford, MA 01730  
781-271-7506  
gbrefini@mitre.org

Walt Bryson  
TRI  
113 Concord Drive  
Williamstown, NJ 08094  
856-629-1025  
walt@trirep.com

Russell Bumgarner  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-0725  
russell.bumgarner@usno.navy.mil

Greg Burdick  
Masterclock, Inc.  
2484 W. Clay St.  
St Charles, MO 63301  
636-724-3666  
Fax: 636-724-3776  
gburdick@masterclock.com

Eddie Byrne  
Symmetricom  
4775 Walnut Street, Suite 1B  
Boulder, CO 80301  
303-539-4907  
Fax: 303-443-5152  
ebyrne@symmetricom.com

James Cahill  
U.S. Army Research  
Laboratory/UMBC  
2800 Powder Mill Road  
Adelphi, MD 20783  
301-394-0061  
james.p.cahill.ctr@us.army.mil

James Camparo  
The Aerospace Corporation  
2310 E. El Segundo Blvd.  
El Segundo, CA 90245  
310-336-6944  
Fax: 310-366-7055  
james.camparo@aero.org

Peter Cash  
Symmetricom  
2300 Orchard Parkway  
San Jose, CA 95131  
pcash@symmetricom.com

I-Chun Chao  
National Taiwan University  
430 Townsend Road  
Newark, DE 19711  
302-887-6225  
r96921048@ntu.edu.tw

Jerry Chappell  
Teracomm  
550 M Ritchie Highway #199  
Severna Park, MD 21146  
240-498-0229  
Fax: 240-766-0572  
jchappell@teracomm.com

Alejandro Cifuentes  
Observatorio Naval BsAs  
Servicio de Hidrografia Naval  
Cav Espana 2055  
Buenos Aires CL107AMA  
Argentina  
54-11-4361-1162  
onb2@hidro.gov

Nicholas Cirillo  
Honeywell  
12001 State Highway 55  
Plymouth, MN 55441  
763-954-2862  
nick.cirillo@honeywell.com

John Clark  
Masterclock, Inc.  
2484 W. Clay Street  
St. Charles, MO 63301  
636-724-3666  
Fax: 636-724-3776  
jclark@masterclock.com

Mike Coleman  
Naval Research Laboratory  
4555 Overlook Avenue SW  
Washington, DC 20375  
202-767-4273  
Fax: 202-767-2845  
michael.coleman@nrl.navy.mil

George Conway  
Linear Photonics  
3 Nami Lane, Ste. 7C  
Hamilton, NJ 08619  
609-584-5747  
conway@litech.com

Stan Cooper  
JHU Applied Physics Laboratory  
11100 Johns Hopkins Road  
Laurel, MD 20723-6099  
240-228-8822  
Fax: 240-228-3353  
stanley.b.cooper@jhuapl.edu

Scott Crane  
Naval Research Laboratory  
4555 Overlook Avenue SW  
Washington, DC 20375  
202-404-4114  
Fax: 202-767-2845  
scott.crane@nrl.navy.mil

Scott Davis  
Symmetricom  
3750 Westwind Boulevard  
Santa Rosa, CA 95403  
sdavis@symmetricom.com

Pascale Defraigne  
Royal Observatory of Belgium  
Avenue Circulaire, 3  
Brussels 1180  
Belgium  
+32/2/373.02.60  
Fax: +32/2/374.98.22  
p.defraigne@oma.be

Maria Delgado  
SpectraDynamics, Inc.  
1849 Cherry Street Unit 2  
Louisville, CO 80027  
303-665-1852  
Fax: 303-604-6088  
dulce@spectradynamics.com

Alyona Diachenko  
Brandywine Communications  
2862 Spring Chapel Court,  
Ste. 100  
Herndon, VA 20171  
571-643-0572  
Fax: 571-643-0573  
adiachenko@brandywinecomm.  
com

William Diener  
Jet Propulsion Lab  
4800 Oak Grove Drive  
Pasadena, CA 91109  
818-354-6670  
Fax: 818-393-6773  
bdiener@jpl.nasa.gov

Tony DiFlorio  
Spectracom  
1565 Jefferson Road, Suite 460  
Rochester, NY 14623  
585-321-5800  
Fax: 585-321-5219  
tony.diflorio@spectracom.orolia  
.com

Ryan Dilbeck  
NRL  
9508 Oak Stream Ct.  
Fairfax Station, VA 22039  
five5bears@hotmail.com

Larry Dombrowski  
2175 Sebastian Road  
Fredericksburg, VA 22405  
larry.dombrowski.ctr@nrl.navy.  
mil

Elizabeth Donley  
NIST  
325 Broadway  
Boulder, CO 80305  
303-497-5173  
Fax: 303-497-6461  
edonley@boulder.nist.gov

Sven-Christian Ebenhag  
SP Technical Research Institute  
of Sweden  
Box 857, Brinellgatan 4  
Boras SE-50115  
Sweden  
+46702959582  
Fax: +46105165620  
sven-christian.ebenhag@sp.se

Christopher Ekstrom  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-0066  
christopher.ekstrom@usno.navy.  
mil

Oren Eliezer  
444 Longfellow Drive  
Plano, TX 75093  
oren.eliezer@gmail.com

Ken Esthus  
The Institute of Navigation  
8551 Rixlew Lane, Suite 360  
Manassas, VA 20109  
703-366-2723  
Fax: 703-366-2724  
kesthus@ion.org

Sheila Faulkner  
GTEC, Inc.  
3159 Patrick Henry Drive  
Falls Church, VA 22044  
703-532-6411  
Fax: 703-532-6338  
bopenyan@aol.com

Blair Fonville  
U.S. Naval Observatory  
3450 Massachusetts Avenue NW  
Washington, DC 20392  
202-762-1450  
blair.fonville@usno.navy.mil



Steve Fossi  
Symmetricom  
3750 Westwind Boulevard  
Santa Rosa, CA 95403  
sfossi@symmetricom.com

Hugo Fruehauf  
The Hugo Fruehauf Company  
29556 Novacella  
Laguna Niguel, CA 92677  
714-724-7069  
Fax: 949-495-4236  
thfc@hugofruehauf.com

Jeff Garstecki  
JHU Applied Physics Laboratory  
11100 Johns Hopkins Road  
Laurel, MD 20723  
jeffrey.garstecki@jhuapl.edu

Mike Garvey  
Symmetricom  
85 Monument Avenue  
Swampscott, MA 01907-1947  
781-595-4978  
rmgarvey@ieee.org

Gary Geil  
Geil Marketing  
934 Calle Negocio, Suite B  
San Clemente, CA 92673  
949-361-0212  
Fax 949-361-0312  
gary@gmasales.com

Marco Genova  
Mixed Processing  
Office 301  
Shannon Airport House  
Shannon Free Zone Shannon-  
County Clare  
Ireland  
+353 (0) 61714030  
marco.genova@mixed-  
processing.ie

Bill Glase  
Spectracom  
1565 Jefferson Road, Suite 460  
Rochester, NY 14623  
585-321-5800  
Fax: 585-321-5219  
bill.glase@spectracom.rolia.  
com

Shigeyoshi Goka  
Tokyo Metropolitan University  
1-1 Minamiosawa  
Hachioji Tokyo 192-0397  
Japan  
+81426771111  
goka@tmu.ac.jp

Tadahiro Gotoh  
National Institute of Information  
and Communications  
Technology  
4-2-1, Nukui-Kita  
Koganei Tokyo 184-8795  
Japan  
+81 42 327 5629  
Fax: +81 42 327 6664  
tara@nict.go.jp

Senol Gulgonul  
Turksat UYDH Hab.  
Konya Yolu 40km Golbasi  
Ankara 06839  
Turkey  
sgulgonul@turksat.com.tr

Christine Hackman  
U.S. Naval Observatory  
3450 Massachusetts Avenue NW  
Washington, DC 20392  
202-762-1428  
christine.hackman@usno.navy.  
mil

Per-Olof Haettner  
FMV  
Banergatan 62  
Stockholm 115 88  
Sweden  
+46703419947  
poh@defence.se

James Hagerman  
4470 Wintergreen Circle  
Colorado Springs, CO 80916  
719-567-6075  
james.o.hagerman@lmco.com

Jörg Hahn  
ESA-ESTEC  
NAV-NMS  
Noordwijk 2200AG  
The Netherlands  
+31.71.565.4918  
Fax: +31.71.565.4369  
joerg.hahn@esa.int

Yuko Hanado  
National Institute of Information  
and Communications  
Technology  
4-2-1, Nukuikita  
Koganei Tokyo 184-8795  
Japan  
81 42 327 7624  
Fax: 81 42 327 6664  
yuko@nict.go.jp

James Hanssen  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-1086  
james.hanssen@usno.navy.mil

Mike Harms  
RT Logic  
12515 Academy Ridge View  
Colorado Springs, CO 80921  
719-598-2801  
mharms@rtlogic.com

Ken Hartman  
CW-NavSync  
2111 Comprehensive Dr.  
Aurora, IL 60505  
815-375-2818  
khartman@navsync.com

Per Olof Hedekvist  
SP Technical Research Institute  
of Sweden  
Box 857  
Boras 50115  
Sweden  
per.olof.hedekvist@sp.se

Arthur Helwig  
UrsaNav, Inc.  
63 Mt Vernon St., Apt 1  
Cambridge, MA 02140  
617-391-6841  
arthur.helwig.ica@ursanav.com

Tomoyasu Hirose  
Marubun Corp.  
8-1, Nihonbashi-Odemacho  
Chuo-ku Tokyo 103-8577  
Japan  
+81-3-3639-9811  
Fax: +81-3-3662-1349  
hirose@marubun.co.jp

Jonathan Hirschauer  
U.S. Naval Observatory  
3450 Massachusetts Avenue NW  
Washington, DC 20392  
202-762-0306  
jonathan.hirschauer@usno.navy.  
mil

David Howe  
NIST  
325 Broadway  
MS847.3, Rm4035  
Boulder, CO 80305  
303-497-3277  
dhowe@nist.gov

Sunbae Hwang  
Cadastral Training Institute(CTI)  
624 Unhak-dong Cheoin-gu  
Youngin-si Kyonggi-do 449-050  
South Korea  
+82 31 8006 7011  
Fax: +82 31 8006 7019  
sbhwang@lx.or.kr

Daniel Jablonski  
JHU Applied Physics Laboratory  
Johns Hopkins Road  
Laurel, MD 20723  
240-228-6907  
dan.jablonski@jhuapl.edu

Bongbae Jang  
Cadastral Training Institute(CTI)  
624 Unhak-dong Cheoin-gu  
Youngin-si Kyonggi-do 449-050  
South Korea  
+82 31 8006 7032  
Fax: +82 31 8006 7019  
jangbb@hotmail.com

Nikki Jardine  
Naval Research Laboratory  
4555 Overlook Avenue SW  
Washington, DC 20375  
202-767-2595  
Fax 202-767-2845  
nikki.jardine@nrl.navy.mil

Steven Jefferts  
NIST  
325 Broadway  
Boulder, CO 80305  
303-497-7377  
steven.jefferts@nist.gov

Zhiheng Jiang  
Bureau International des Poids et  
Mesures (BIPM)  
Pavillon de Breteuil  
Sevres F-92312  
France  
33 1 4507 7034  
Fax: 33 1 4507 7059  
zjiang@bipm.org

Kenneth Johnston  
U.S. Naval Observatory  
3450 Mass Ave NW  
Washington, DC 20392  
202-762-1513  
kenneth.johnston@usno.navy.  
mil

Samy Khadem-Al-Charieh  
SL-Rasch GmbH  
Kesslerweg 22  
Leinfelden-Echterdingen 70771  
Germany  
+49 175 8866234  
samy.khadem@sl-rasch.de

Aftab Khan  
Pascall Electronics Ltd  
Westridge Business Park  
Cothey Way, Ryde  
Isle of Wight PO33 1QT  
United Kingdom  
01983-817300  
Fax: 01983-817311  
akhan@pascall.co.uk

Paul Koppang  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-0207  
paul.koppang@usno.navy.mil

Alexander Kuna  
Institute of Photonics and  
Electronics AS CR  
Chaberska 57  
Prague 182 51  
Czech Republic  
+420 266 773 426  
Fax: +420 284 680 222  
kuna@ufe.cz

Paul Kushmeider

Oliver Lange  
Lange-Electronic GmbH  
Rudolf-Diesel-Str. 29a  
Gernlinden 82256  
Germany  
+4981422845820  
Fax: +4981422845822  
olange@lange-electronic.de

Je Young Lee  
Korea Aerospace University  
100, Hanggongdae gil, Hwajeon-  
dong, Deogyang-gu  
Goyang-city 412-791  
South Korea  
82-2-300-0131  
jeylee@kau.ac.kr

Judah Levine  
NIST  
Mail Stop 847, 325 Broadway  
Boulder, CO 80304  
303-492-7785  
Fax: 303-497-6461  
jlevine@boulder.nist.gov

Wlodzimierz Lewandowski  
Bureau International des Poids et  
Mesures  
Pavillon de Breteuil  
Sevres F-92312  
France  
33 1 4507 7063  
Fax: 33 1 4507 7059  
wlewando@bipm.org

Ya-Shian Li-Baboud  
National Institute of Standards  
and Technology  
100 Bureau Drive  
MS 8970  
Gaithersburg, MD 20899  
301-975-5319  
Fax: 301-975-3136  
ya-shian.li-baboud@nist.gov

Calvin S. Y. Lin  
Telecommunication Labs.  
No 99 Dianyan Rd.  
YangMei T'ao-yuan 32601  
Taiwan  
886-3-4245483  
Fax: 886-3-4245474  
sylin@cht.com.tw

Michael Lombardi  
NIST  
Time and Frequency Division  
325 Broadway  
Boulder, CO 80305  
303-497-3212  
lombardi@nist.gov

Pete Lopez  
TRAK Microwave  
4726 Eisenhower Blvd.  
Tampa, FL 33634  
813-901-7475  
Fax 813-901-7491  
plopez@trak.com

Peter Lothberg  
Stupi LLC  
101 1St Street, Ste 553  
Los Altos, CA 94022  
703-864-7887  
Fax: 650-472-1183  
roll@stupi.com

John Lowe  
NIST  
325 Broadway, MS 847.00  
Boulder, CO 80305  
303-497-5453  
Fax: 303-497-6461  
lowe@boulder.nist.gov

Robert Lutwak  
Symmetricom  
34 Tozer Road  
Beverly, MA 01915  
978-232-1461  
rlutwak@symmetricom.com

John MacDonald  
Linear Photonics  
3 Nami Lane, Ste. 7C  
Hamilton, NJ 08619  
609-584-5747  
macdonald@linphotonics.com

Demetrios Matsakis  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-1587  
demetrios.matsakis@usno.navy.  
mil

Thomas McClelland  
Frequency Electronics, Inc.  
55 Charles Lindbergh Blvd.  
Uniondale, NY 11553  
516-301-8791  
Fax 516-794-4340  
tomm@frequelec.com

Angela McKinley  
U.S. Naval Observatory  
3450 Massachusetts Avenue NW  
Washington, DC 20392  
202-762-1457  
angela.mckinley@usno.navy.mil

John Miles  
Symmetricom  
2300 Orchard Parkway  
San Jose, CA 95131  
jmiles@pop.net

Mihran Miranian  
JHU/Applied Physics  
Laboratory  
11100 Johns Hopkins Road  
Laurel, MD 20723  
240-228-6210  
Fax: 443-778-5883  
mihran.miranian@jhuapl.edu

Don Mitchell  
Geil Marketing  
PO Box 1470  
Payson, AZ 85547  
928-474-1088  
Fax: 949-361-0312  
don@gmasales.com

Stephen Mitchell  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-0740  
stephen.mitchell@usno.navy.mil

SeungJu Mun  
Cadastral Training Institute(CTI)  
624 Unhak-dong Cheoin-gu  
Youngin-si Kyonggi-do 449-050  
South Korea  
+82 31 8006 7034  
Fax: +82 31 8006 7019  
seungju@lx.or.kr

Marco Muritti  
Digital Instruments, S.r.l.  
Via A.M Ampere  
103-20131 Milano  
Italy  
+39-0266506250  
marco.muritti@digital-  
instruments.it

Andrey Naumov  
FGUP VNIIFTRI  
Solnechnogorskiy District  
Mendeleev 141570 Moscow  
Region  
Russia  
+79031664110  
Fax: +74956605724  
nav\_andrey@vniifti.ru

Jerzy Nawrocki  
Space Research Centre  
Astrogeodynamical Observatory  
Drapalka 4  
Kornik 62-035  
Poland  
+48 61 8170187  
Fax: +48 61 8170219  
nawrocki@cbk.poznan.pl

Nathan Newbury  
NIST  
325 Broadway  
Boulder, CO 80305  
303-497-4227

Anton Niessner  
Bundesamt fuer Eich- und  
Vermessungswesen  
Arltgasse 35  
Wien 1160  
Austria  
anton.niessner@bev.gv.at

Nancy Oliveren  
U.S. Naval Observatory  
3450 Massachusetts Ave., NW  
Washington, DC 20392-5420  
202-762-0687  
Fax: 202-762-1612  
nancy.oliveren@navy.mil

Ben Ong  
SAIC  
300 N. Sepulveda Blvd. Suite  
3000  
El Segundo, CA 90245  
714-454-5738  
ben.ong.ctr@us.af.mil

Allen Osborne  
MITRE Corp.  
2401 E. El Segundo Blvd., Suite  
460  
El Segundo, CA 90245  
310-297-8367  
osborne@mitre.org

Richard Overstreet  
Symmetricom  
34 Tozer Rd  
Beverly, MA 01915  
978-232-3782  
roverstreet@symmetricom.com

H. B. Owings  
Symmetricom  
1711 Holt Rd. NE  
Tuscaloosa, AL 35404  
205-553-0038  
bowings@symmetricom.com

Chris Pagels  
Symmetricom  
3750 Westwind Boulevard  
Santa Rosa, CA 95403  
cpagels@symmetricom.com

Gil Passwaters  
Furuno USA Inc.  
70 Engerman Avenue  
Denton, MD 21629  
410-479-4420  
gil@furuno.com

Steven Peil  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-1564  
steven.peil@usno.navy.mil

Rolondo Penabade  
TRAK Microwave  
4726 Eisenhower Blvd.  
Tampa, FL 33634  
813-901-7200  
Fax 813-901-7491  
rpenabade@trak.com

Dirk Piester  
PTB  
Bundesallee 100  
Braunschweig 38116  
Germany  
+495315924421  
Fax: +495315924479  
dirk.piester@ptb.de

Edward Powers  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-1451  
edward.powers@usno.navy.mil

John Prestage  
Jet Propulsion Laboratory  
4800 Oak Grove Dr m/s 298  
Pasadena, CA 91109  
818-354-2888  
Fax: 818-393-6773  
John.D.Prestage@jpl.nasa.gov

Jeffrey Prillaman  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-0756  
jeffrey.prillaman@usno.navy.mil

John Puhle  
TRAK Microwave  
4726 Eisenhower Blvd.  
Tampa, FL 33634  
813-901-7408  
Fax 813-901-7491  
jpuhle@trak.com

Ramki Ramakrishnan  
Symmetricom  
2300 Orchard Parkway  
San Jose, CA 95131  
vramakrishnan@symmetricom.com

William Riley  
Hamilton Technical Services  
650 Distant Island Drive  
Beaufort, SC 29907  
843-525-6495  
Fax: 843-525-0251  
bill@wriley.com

Rob Ritter  
Integral Marketing  
2139 Espey Court, Ste 7  
Crofton, MD  
21114  
703-652-7858  
rritter@integralmktg.com

Stefania Romisch  
NIST  
Time and Frequency Division  
MS847.50, 325 Broadway  
Boulder, CO 80305  
303-497-3446  
romisch@boulder.nist.gov

Michael Rosso  
Continental Electronics Corp.  
4212 S. Buckner Blvd.  
Dallas, TX 75227  
724-880-2458  
Fax: 214-275-2397  
mrosso@contelec.com

Gary Scheer  
Schweitzer Engineering  
Laboratories, Inc.  
2350 NE Hopkins Court  
Pullman, WA 99163  
509-336-4429  
garysc@selinc.com

David Scherer  
Symmetricom  
34 Tozer Road  
Beverly, MA 01915  
978-232-3770  
dscherer@symmetricom.com

Charles Schue  
UrsaNav, Inc.  
44160 Scholar Plaza, Suite 380  
Leesburg, VA 20176  
703-858-5111  
cschue@ursanav.com

Peter Schwindt  
Sandia National Laboratories  
MS 1082, PO Box 5800  
Albuquerque, NM 87185  
505-845-4040  
schwinpd@sandia.gov

Norio Seki  
SET JAPAN LTD  
12-16-513, Hongo 4-Chome  
Bunkyo-ku, Tokyo 113-0033  
Japan  
(03) 3812-0240  
Fax: (03) 3812-0242  
seki@spectradynamics.com

Ken Senior  
Naval Research Laboratory  
4555 Overlook Avenue SW  
Washington, DC 20375  
202-767-2043  
Fax: 202-767-2845  
ken.senior@nrl.navy.mil

Jeff Shykula  
Symmetricom  
4775 Walnut Street, Suite 1B  
Boulder, CO 80301  
303-539-4958  
Fax: 303-443-5152  
jshykula@symmetricom.com

James Skinner  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-6389  
james.skinner@usno.navy.mil

Gary Smith  
Brandywine Communications  
1153 Warner Ave.  
Tustin, CA 92780  
gary@brandywinecomm.com

Vladimir Smotlacha  
CESNET  
Zikova 4  
Prague 16000  
Czech Republic  
+420 602217921  
vs@cesnet.cz

Armin Soering  
SPM Perrot GmbH & Co. KG  
Special Clocks  
Breslauer Str. 1  
Calw Baden-Wuerttemberg  
75365  
Germany  
+49 6151 312572  
armin.soering@online.de

Sam Stein  
Symmetricom  
4775 Walnut Street, Suite 1B  
Boulder, CO 80301  
sstein@symmetricom.com

Michael Street  
GPS Source  
64 North Mission Dr.  
Pueblo West, CO 81007  
719-561-9520  
mstreet@gpssource.com

Ryszard Szplet  
Military University of  
Technology  
Kaliskiego 2  
Warsaw 00-908  
Poland  
+48 22 683 76 30  
Fax: +48 22 683 90 38  
rszplet@wat.edu.pl

Jennifer Taylor  
U.S. Naval Observatory  
3450 Massachusetts Avenue NW  
Washington, DC 20392  
202-762-0066  
jennifer.taylor@usno.navy.mil

Robert Urbaniak  
Piktime Systems sp. z o.o.  
ul. Cytrynowa 22  
Poznan 61-602  
Poland  
0048616243637  
Fax: 0048616243876  
rurbaniak@piktime.com

Tom Van Baak  
LeapSecond.com  
5171 150th Place SE  
Bellevue, WA 98006  
tvb@leapsecond.com

Francine Vannicola  
Naval Research Laboratory  
4555 Overlook Avenue SW  
Washington, DC 20375  
202-404-4115  
Fax: 202-767-2845  
francine.vannicola@nrl.navy.mil

Jonatan Walck  
Netnod Internet Exchange  
Franzengatan 5  
Stockholm 11336  
Sweden  
0046702766848  
Fax: 004684420967  
jwalck@netnod.se

Jacqueline Walker  
University of Limerick  
Limerick  
Ireland  
jacqueline.walker@ul.ie

Warren Walls  
U.S. Naval Observatory  
3450 Massachusetts Ave NW  
Washington, DC 20392  
202-762-1581  
warren.walls@usno.navy.mil

S. Clark Wardrip  
726 Foxenwood Drive  
Santa Maria, CA 93455-4221  
805-937-6448  
skyclark1@msn.com

Rick Watkins  
JT3 LLC  
PO Box 217  
Clearfield, UT 84089  
801-777-4845  
Fax: 801-586-5982  
rick.watkins@hill.af.mil

Brian Way  
ESE  
142 Sierra Street  
El Segundo, CA 90245  
310-322-2136  
Fax: 310-322-8127  
bway@ese-web.com

Gregory Weaver  
JHU Applied Physics Laboratory  
11100 Johns Hopkins Road  
Laurel, MD 20723  
240-228-5595  
Fax: 240-228-5883  
gregory.weaver@jhuapl.edu

Joe White  
Naval Research Laboratory  
4555 Overlook Avenue SW  
Washington, DC 20375  
202-767-5111  
Fax: 202-767-2845  
joe.white@nrl.navy.mil

Jeffrey Wilkes  
U. of Washington/Seattle  
Dept of Physics  
Seattle, WA 98195-1560  
206-543-2770  
Fax: 206-685-9242  
wilkes@uw.edu

Harry Wilson  
U.S. Coast Guard  
2100 2nd Street SW  
Washington, DC 20593  
202-372-1562  
harry.l.wilson@uscg.mil

Jian Yao  
University of Colorado  
JILA, 440 UCB  
Boulder, CO 80309  
jian.yao@colorado.edu

Tomoki Yonekawa  
Marubun Corp.  
8-1, Ohdenma-cho, Nihonbashi  
Chuo-ku Tokyo 103-8577  
Japan  
+81336399811  
tyonekaw@marubun.co.jp

Johnathan York  
Applied Research Labs / The  
University of Texas  
PO Box 8029  
Austin, TX 78713  
512-835-3143  
york@arlut.utexas.edu

George Zampetti  
Symmetricom  
2300 Orchard Parkway  
San Jose, CA 95131  
gzampetti@symmetricom.com

