

## **PROGRAM**

# **FORTY-SECOND ANNUAL PRECISE TIME AND TIME INTERVAL (PTTI) SYSTEMS AND APPLICATIONS MEETING**



**November 15 – 18, 2010**

**42 Years of Progress  
1969 – 2010**

**Hyatt Regency  
Reston, Virginia**

## **SCHEDULE**

### **Monday, November 15, 2010**

0800 – 1300 Exhibition setup of booth for Exhibitors  
0730 – 0830 Tutorials Breakfast  
0830 – 1630 Tutorials  
1300 – 1700 Exhibitor Setup  
1700 – 1830 Icebreaker - Exhibitor Area  
1830 – 2100 Exhibitor Setup  
1900 – 2100 Registration\*

### **Tuesday, November 16, 2010**

0700 – 1600 Registration\*  
0700 – 0800 Speakers' Breakfast  
0700 – 1600 Speakers' Room  
0700 – 0800 Attendees' Breakfast  
0800 – 1700 Technical Exhibits\*\*  
0800 – 0805 Opening  
0805 – 0810 Distinguished PTTI Service Award  
0810 – 0815 In Memoriam – Harry Peters  
0815 – 0830 Opening Remarks  
0830 – 0835 Technical Chair Call to Session  
0835 – 0950 Session I: National Laboratory Updates  
0950 – 1010 Intermission  
1010 – 1140 Session II: Vendor Presentations  
1140 – 1300 Lunch  
1300 – 1420 Session III: Atomic Standards  
1420 – 1440 Intermission  
1440 – 1600 Session IV: Space Clocks and GNSS  
1600 – 1620 Introduction of Student Papers  
1620 – 1740 Session V: Poster Session  
1830 – 2000 Reception

### **Wednesday, November 17, 2010**

0700 – 1600 Registration\*  
0700 – 0800 Speakers' Breakfast  
0700 – 1600 Speakers' Room  
0700 – 0800 Attendees' Breakfast  
0800 – 1700 Technical Exhibits\*\*  
0800 – 0940 Session VI: Time Transfer  
0940 – 1000 Intermission  
1000 – 1140 Session VII: IEEE 1588 and NTP  
1140 – 1150 Announcement of Student Paper Winners  
1150 – 1320 Lunch  
1320 – 1500 Session VIII: PTTI and Network Applications  
1500 – 1520 Intermission  
1520 – 1620 Session IX: Panel Discussion – GPS Mitigation in Challenged Environments  
1700 – 1800 Joint Executive and Advisory Board Meeting  
1900 – 2030 Special Event

### **Thursday, November 18, 2010**

0700 – 1200 Registration\*  
0700 – 0800 Speakers' Breakfast  
0700 – 1600 Speakers' Room  
0700 – 0800 Attendees' Breakfast  
0800 – 0940 Session X: Optical Time and Frequency Transfer  
0940 – 1000 Intermission  
1000 – 1140 Session XI: Clock Performance  
1140 – 1310 Lunch  
1310 – 1510 Session XII: Algorithms and Calibration  
1510 – 1520 General Discussion  
1520 Close of Meeting

\*Registration is available each day.     \*\*Exhibits are open Tuesday and Wednesday only.

**REGISTRATION FORM FOR PTTI 2010**  
**Hyatt Regency, Reston, Virginia**  
**November 15 – 18, 2010**

NAME: \_\_\_\_\_  
First \_\_\_\_\_ Last \_\_\_\_\_  
AGENCY: \_\_\_\_\_ Company or Organization \_\_\_\_\_  
ADDRESS: \_\_\_\_\_ Street \_\_\_\_\_  
\_\_\_\_\_ City, State and Country \_\_\_\_\_  
TELEPHONE: \_\_\_\_\_ FAX: \_\_\_\_\_  
E-MAIL: \_\_\_\_\_

Speaker

Session Chairman

Exhibitor

**Full Registration fee - \$600; \$550, if payment received/postmarked on or before October 15.**  
Includes entry to the sessions and exhibit hall, the Tuesday and Wednesday luncheons, the Monday evening Ice Breaker, the Tuesday evening Welcoming Reception and one copy of the Proceedings.

**Retiree registration fee - \$75.** The attendee must be fully retired to qualify for the reduced registration fee. Includes entry to the sessions and exhibit hall only.

**Student registration fee - \$75.** The attendee must be a full-time student to qualify for the reduced registration fee. Includes all Full Registration benefits.

**One Day registration fee - \$200;** includes entry to the sessions, exhibit hall and the offered luncheon for that day ONLY.

**Tutorials Registration fee - \$300; \$250 if payment received/postmarked on or before October 15.**

<input type="checkbox"/> Registration Fee	\$ _____
<input type="checkbox"/> One Day Registration (\$200)	\$ _____
<input type="checkbox"/> Tutorials Registration	\$ _____
<input type="checkbox"/> Extra Reception Tickets (\$55 each) No. _____	\$ _____
<input type="checkbox"/> Extra Lunch Tickets (\$25 each) No. _____	\$ _____
<input type="checkbox"/> Extra Proceedings (\$150 each) No. _____	\$ _____
<b>TOTAL AMOUNT DUE</b> \$ _____	

Check Enclosed       Will pay onsite (fax to 202-767-2845)

Mark here if purchasing Proceedings only and not attending conference.

Make checks payable to **Treasurer, PTTI**. If paying in advance, mail the payment and a copy of the registration card to:

**Treasurer, PTTI**  
c/o Mrs. Sheila Faulkner  
3159 Patrick Henry Drive  
Falls Church, VA 22044, USA

When paying by check, the envelope must be postmarked on or before **October 15** to receive all early discounts. All checks must be received no later than **November 1**.

**To register online and/or pay by credit card, visit:**  
<http://pttimeeting.org/registration.html>

Online registration ends **November 1**. After that date, registration must be completed onsite.  
Questions? Contact Ms. Jardine at 202-767-2595, DSN 297-2595, or nikki.jardine@nrl.navy.mil

## **PROGRAM**

# **FORTY-SECOND ANNUAL PRECISE TIME AND TIME INTERVAL (PTTI) SYSTEMS AND APPLICATIONS MEETING**

Sponsored by

U.S. Naval Observatory  
U.S. Naval Research Laboratory  
NASA Jet Propulsion Laboratory  
Defense Information Systems Agency  
U.S. Coast Guard Navigation Center

**November 15 — 18, 2010**



**Hyatt Regency Reston Town Center  
Reston, Virginia**

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## **OBJECTIVES**

The objectives of the PTTI Systems and Applications Meeting are to:

- Disseminate and coordinate PTTI information at the user level;
  - Review present and future PTTI requirements;
  - Inform Government engineers, technicians and managers of precise time and frequency technology and its problems; and
  - Provide an opportunity for an active exchange of new technology associated with PTTI.
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This year, the PTTI addresses:

- PTTI Vendor Presentations
- Time and Frequency Standards Laboratories: Activities and Updates
- Time Transfer — Theory, Techniques and Applications
- PTTI in Current Applications
- Atomic and Advanced Clocks
- Novel PTTI Applications
- Time Scales, Algorithms & Methods
- Timing Systems & Applications
- Military Applications
- Global Navigation Satellite Systems (GNSS)
- Receivers — Timing and Calibration
- Student Poster Competition

## **WELCOME TO PTTI 2010**

Please make checks payable to **Treasurer, PTTI**. If paying in advance, please mail the check and a copy of the registration card to:

Treasurer, PTTI  
c/o Mrs. Sheila Faulkner  
3159 Patrick Henry Drive  
Falls Church, VA 22044 USA

When paying by check, the envelope must be postmarked on or before **October 15** to receive all early discounts. All checks must be received no later than **November 1**.

Register online: <http://pttimeeting.org/registration.html>. Online registration will be available until **November 1**. After that date, registration must be completed onsite.

If you are unable to register online, please fill out the enclosed Registration Card and send it to Ms. Nikki Jardine via fax (202-767-2845) or email ([nikki.jardine@nrl.navy.mil](mailto:nikki.jardine@nrl.navy.mil)).

**PTTI accepts Visa, MasterCard and Discover via PayPal.** A PayPal account is not required to complete the transaction. To pay with your credit card, please register online <http://pttimeeting.org/registration.html>. The resulting charge will appear on your statement as "PTTI Meeting."

**The full registration fee is \$600** (early discounted fee is \$550). Full registration includes entry to the sessions and exhibit hall, the Tuesday and Thursday luncheons, the Monday evening Ice Breaker, the Tuesday evening Welcoming Reception and one copy of the Proceedings. The fee increases on **October 16**.

**The registration fee for full-time students is \$75** and includes all Full Registration benefits. **The registration fee for full-time retirees is \$75** and includes entry to the sessions and exhibit area only. **The One Day registration fee is \$200** and includes entry to the sessions, exhibit hall and the offered lunch for that day **ONLY**.

**The tutorials registration fee is \$300** (early discounted fee is \$250) and includes breakfast, lunch and a copy of the presentations. The fee increases on **October 16**. The tutorials will be held **Monday, November 15**.

Tickets for the luncheons (\$25 each) and the reception (\$55 each) can be purchased at the PTTI Registration Desk. Extra copies of the Proceedings are also available for purchase.

All attendees, including presenters and exhibitors, must register and receive a badge. The badge must be worn for admission to all sessions and functions and is not transferable. The exhibit area is open to everyone; visitor badges can be picked up at the registration desk.

If you have special dietary or physical requirements, please contact Mrs. Faulkner at 703-532-6411, Fax 703-532-6338 or [bopenyan@aol.com](mailto:bopenyan@aol.com).

### **Cancellation policy**

**All requests for cancellation must be received in writing before October 15, 2010. On or after October 15, there is a \$300 cancellation fee. Refunds are not given for "no shows"; however, substitutions are allowed.**

### **PTTI on the Web**

Access PTTI online: <http://www.pttimeeting.org>

## **PTTI 2010 Tutorials Session**

The Tutorials Session will take place on **Monday, November 15**. The Tutorials are intended for engineers, mathematicians, scientists or anyone who is new to the field of PTTI, as well as those who have been a part of the PTTI community. Please contact **Francine Vannicola**, [francine.vannicola@nrl.navy.mil](mailto:francine.vannicola@nrl.navy.mil), 202-404-4015 (DSN 754-4015) for information on the Tutorials Session. Additional Information on the speakers and the presentations is also available on the PTTI website, <http://www.pttimeeting.org/tutorials.html>.

Time	Subject	Presenter
0830 – 0930	Time Recovery in the Field	<b>Sam Stein</b> Symmetricom, Inc.
0930 – 1030	Satellite Time & Frequency Transfer	<b>Ron Beard</b> U.S. Naval Research Laboratory
1045 – 1145	Traceability in Time and Frequency Metrology	<b>Mike Lombardi</b> National Institute of Standards and Technology
1330 – 1430	Advanced Clocks	<b>Robert Lutwak</b> Symmetricom, Inc.
1445 – 1545	IEEE-1588 Telecommunications Applications	<b>Lee Cosart</b> Symmetricom, Inc.

The registration fee for the Tutorials Session is **\$250 postmarked on or before October 15** and **\$300 on and after October 16**. The fee includes breakfast, lunch and a copy of the Tutorials presentations (notebook and CD).

### **Registration Desk Hours**

The registration desk will be open during the following hours:

Monday, November 15, 1900 – 2100  
Tuesday, November 16, 0700 – 1600  
Wednesday, November 17, 0700 – 1600  
Thursday, November 18, 0700 – 1200

### **Questions**

Please contact the following people for information on matters concerning:

#### **Technical questions**

Francine Vannicola  
202-404-4015  
[francine.vannicola@nrl.navy.mil](mailto:francine.vannicola@nrl.navy.mil)

#### **General**

Sheila Faulkner  
703-532-6411, Cell: 703-244-6346  
[bopenyan@aol.com](mailto:bopenyan@aol.com)

#### **Exhibits**

Gary Geil  
949-361-0212  
[gary@gmasales.com](mailto:gary@gmasales.com)

#### **Registration**

Nikki Jardine  
202-767-2595  
[nikki.jardine@nrl.navy.mil](mailto:nikki.jardine@nrl.navy.mil)

Don Mitchell  
928-474-1088  
[don@gmasales.com](mailto:don@gmasales.com)

## **Hotel Reservations**

Mail or FAX the hotel reservation card (located on the last page) to:

**Hyatt Regency Reston Town Center  
(PTTI 2010 Room Block)  
1800 Presidents Street  
Reston, Virginia, USA 20190  
703-709-1234, Fax 703-925-8295**

When making your reservations, be sure to mention PTTI 2010 to receive the group sleeping room rate. The PTTI rate is available November 10 – 22. Check-in time is 1500 (3:00 PM) and checkout time is Noon. Rooms will only be held if guaranteed with a credit card. The block of reserved rooms will be released **October 20**, so reserve early. If you leave before your scheduled departure date without informing the Hyatt, you will be charged an early departure fee. Reston offers a wide range of restaurants and shops.

The PTTI 2010 room rate is the government per diem rate of \$207.

## **Messages**

Messages may be left for PTTI attendees through the hotel's telephone number:  
**703-709-1234**.

## **Temperature**

The climate during November in the Washington, DC area will be cold. A coat or raincoat is recommended.

## **Tours**

Tour information will be posted on the PTTI website, <http://pttimeeting.org>.

## **Transportation Information**

### **Official Airline**

**American Airlines** is the official airline for **PTTI 2010**. The Promotion Code is **35N9AI**.

U.S. and Canadian attendees: To make reservations, Please visit <http://www.AA.com> or call **800-433-1790** and refer to the Promotion Code.

**International attendees:** To make reservations, please call your local reservations number and refer to the Promotion Code (STARfile 35N9AI).

Please be advised that there is a separate ticketing charge of \$20.00 USD per ticket for tickets purchased via the phone or \$30.00 USD per ticket for tickets purchased at the airport (this amount is subject to change). At this time, there is no ticketing fee for reservations made and ticketed through the American Airlines website.

### **Official Rental Car**

**Avis** is the official rental car agency for **PTTI 2010**. The Avis Worldwide Discount (AWD) Number is **G027999**. Please use this AWD number when calling Avis directly at **888-754-8878** to receive the best car rental rates available. The discount includes unlimited mileage and is available from seven days before to seven days after the meeting. To make your reservation online, visit <https://www.avis.com>.

### **Airport Shuttle**

The hotel offers a complimentary shuttle that arrives at the top of each hour from 6 am to 10 pm. It takes you directly to Dulles Airport; the drop off and pick up point will be at curbs 2A and 2H, adjacent to the lower level baggage claim level.

## Parking

Covered valet and self parking are available. Valet parking is \$24.00 overnight, with in/out privileges. Valet parking for the day only is \$12.00. Self parking is available at no charge. The parking areas are large enough to accommodate vans.

## Directions

### Washington Dulles International Airport (6.59 miles)

From airport take Dulles Access Road East toward Washington, DC. At Reston, use Exit 12, Reston Parkway / VA 602 and make a Left on to Reston Parkway. Third traffic light turn left onto Bluemont Way. Turn right onto Presidents Street to the Northern VA hotel.

### Ronald Reagan Washington National Airport / Washington, DC (22 miles)

Head north on the George Washington Memorial Parkway (crossing over into Virginia). Take the VA-123 exit toward Chain Bridge / McLean. Keep right at the fork to go on VA -123 S. Merge onto VA-267 W toward I-495 N / Dulles Airport (Portions toll). Take Reston Parkway / VA-602 exit- Exit 12. At the second traffic light turn left onto Bluemont Way. Turn right onto Presidents Street to the hotel in Northern VA.

### Baltimore and Points North (55.11 miles or more)

Follow I-95 South to Washington, DC beltway then exit right (west) onto I-495. Follow I -495 across the Potomac River into Virginia and exit right onto Rt. 267-Exit 45A toward Dulles Airport / Dulles Toll Road. Take Reston Parkway / VA-602 exit-Exit 12. At the second traffic light turn left onto Bluemont Way. Turn right onto Presidents Street to the Northern VA hotel.

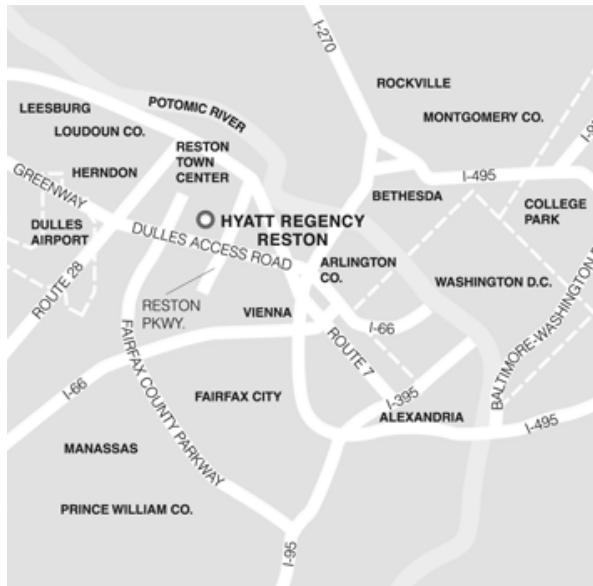
### Richmond and Points South (115.20 miles or more)

Follow I-95 North to Washington, DC beltway (at Springfield), then exit onto I-495 (north). Follow I-495 to Rt. 267-Exit 45A, toward Dulles Airport / Dulles Toll Road. Take Reston Parkway / VA-602 exit-Exit 12. Keep right at the fork to go on Reston Parkway / VA-602 N. Turn Left onto Bluemont Way. Turn right onto Presidents Street to the hotel in Northern VA.

### Leesburg and Points

#### West (19.72 miles or more)

Two choices: (A) Follow Rt. 7 East to Dranesville and turn right onto Reston Parkway (Rt. 602). Proceed south approximately 3 miles. Hotel will be on the right. (B) Take Dulles Greenway Toll Road East past Dulles International Airport to Exit 12, Reston Parkway. Turn left onto Reston Parkway. Third traffic light turn left onto Bluemont Way. Turn right onto Presidents Street to the Northern VA hotel.



## **Speakers' Breakfast**

The author giving the oral presentation must attend the Speakers' Breakfast on the morning of the presentation. Please ask at the PTTI Registration Desk for the location. The Speakers' Breakfast will be held from 0700-0800 on Tuesday, Wednesday and Thursday. The purpose of this breakfast is to allow the Session Chairs to meet each of the presenters and coordinate any last minute details. This is also the time when the audio-visual equipment and the timing lights will be demonstrated. The Speakers' Breakfast is a mandatory event for each speaker giving a scheduled paper that day. If the presenter is not in attendance, the Session Chairs will not know if the presenter is prepared to present and may be forced to cancel the presentation.

## **Presented Papers**

Presenters must send their presentations in PowerPoint (versions accepted up to 2010: all files must be PC/Windows compatible) to [presentations@pttimeeting.org](mailto:presentations@pttimeeting.org) by November 8. In the event this deadline cannot be met, a CD-ROM or flash drive containing the presentation must be delivered to Mr. Douglas Boehm by 1800 the day before the presentation.

Please send a Microsoft Word electronic version of your Paper (e-mail, CD-ROM), formatted according to the PTTI Paper Preparation Instructions included in the Author's Kit, to Dr. Lee Breakiron, Editorial Chairman ([lee.breakiron@usno.navy.mil](mailto:lee.breakiron@usno.navy.mil)) by November 18. If prior arrangements have not been made, the Paper will not be published in the Proceedings. The Author's Kit can be downloaded from [http://www.pttimeeting.org/author\\_kit.pdf](http://www.pttimeeting.org/author_kit.pdf)

## **Exhibits**

The exhibits co-chairs are:

### **Gary Geil and Don Mitchell**

Geil Marketing Associates

934 Calle Negocio Suite B, San Clemente, CA 92673

949-361-0212, Fax 949-361-0312

[gary@gmasales.com](mailto:gary@gmasales.com) or [don@gmasales.com](mailto:don@gmasales.com)

### **List of Potential Exhibitors for PTTI 2010**

Astrogeodynamical Observatory

AccuBeat, Ltd.

Brandywine Communications

Brilliant Instruments, Inc.

Brilliant Telecommunications

EndRun

Evertz

Frequency Electronics, Inc.

Furuno GPS OEM

GMV Aerospace and Defence, S.A.

GPS Networking

GPS World/Questex Media

GPS Source

GuideTech

The Historical Electronics Museum

Inside GNSS

The Institute of Navigation

ITT

Jackson Labs

JTime! Meinberg USA

Lange-Electronic GmbH

Locus

Military University of Technology

Mira Vista Technologies

Masterclock, Inc.

Morion, Inc.

NavTech GPS Supply

Noise eXtended Technologies S.A.S.

OEwaves

Osborne Technologies

Pascall

PikTime Systems, LTD

Poseidon Scientific Instruments

Precise Time and Frequency, Inc.

Quartzlock

Sanders & Associates, Inc.

SigNav

Spectracom Corp/Pendulum Instruments

SpectraDynamics, Inc.

SpectraTime

Spectrum Instruments, Inc.

Symmetricom – Timing Test and Measurements

Synergy Systems

Time & Frequency Solutions

TimeTech, LLC GmbH

TRAK Microwave Corporation

Trimble Navigation

U.S. Naval Observatory

XECO, Inc.

## **Student Poster Competition**

The fourth annual PTTI Student Poster competition will take place at this year's PTTI. The goal is to get students thinking early in their careers about the engineering and scientific applications of precise timing (in the broadest sense) and in that way maintain the vitality of our field in the 21st century. The competition also offers an opportunity for students to meet future employers and for employers to get a better sense of what skills young engineers and scientists are bringing to the marketplace.

The competition has an undergraduate and graduate division and submitted abstracts will cover any area dealing with "precise" timekeeping systems or applications. In light of the competition's goal, there is a wide range of topics that students might address (i.e., biological to geophysical to astronomical). Consequently, the specific meaning of the word "precise" is taken in context. Abstracts can be submitted for posters dealing with literature reviews, laboratory work, or computational investigations.

Questions concerning the Student Poster Competition should be addressed to Mrs. Rachel Evans-Binfield, [rachel.binfield@jhuapl.edu](mailto:rachel.binfield@jhuapl.edu).

## **PTTI 2010 Evening Activities**

On Monday, November 15 at 1700, the "Get Acquainted" Icebreaker function will be held in the Exhibits Hall. Refreshments will be served.

The Welcoming reception will be held Tuesday, November 16 at 1830.

On Wednesday, November 17 at 1900, PTTI 2010 is pleased to have Mrs. Carlene E. Stephens, Curator, Division of Work and Industry from the Smithsonian's National Museum of American History. Mrs. Stephens will provide a preview of "Time and Navigation," a new exhibit opening in late 2012 at the Smithsonian's National Air and Space Museum. Refreshments will be served.

## **Proceedings**

The Proceedings will be available on CD and mailed to the attendees in 2011. If you cannot attend, but wish to reserve a copy of the Proceedings, please return the Registration Card with a check for \$150 made out to **Treasurer, PTTI**. Please note on the card that you are not attending. Your reserved copy will be sent to you. If you wish extra copies, they will also be available at \$150.

## **Forty-third Annual PTTI Meeting**

The 43<sup>rd</sup> Annual PTTI Systems and Applications Meeting (PTTI 2011) will be held November 14 — 17, 2011, at the Hyatt Regency, Long Beach, California.

## **PTTI EXECUTIVE COMMITTEE**

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

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

**DR. LEE A. BREAKIRON**  
U.S. Naval Observatory

**MR. RICHARD CAMP**  
Defense Information Systems Agency

**MS. NANCY C. HAMILTON**  
Department of Defense

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

**CAPT. FRED PARKER**  
U.S. Coast Guard Navigation Center

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

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

## **PTTI ADVISORY BOARD MEMBERS**

### **MR. S. CLARK WARDRIP, CHAIRMAN**

Global Strategies Group (North America) (GSGNA), Inc.

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Frequency Electronics, Inc.

**DR. EDOARDO DETOMA**  
SEPA S.p.A

**DR. BRADFORD W. PARKINSON**  
Stanford University

**MRS. SHEILA FAULKNER**  
GSGNA, Inc.

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

**DR. HENRY F. FLIEGEL**  
The Aerospace Corporation

**MR. PASCAL ROCHAT**  
SpectraTime

**MR. HUGO FRUEHAUF**  
ViaLogy LLC

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

**DR. R. MICHAEL GARVEY**  
Symmetricom

**DR. LARA S. SCHMIDT**  
The RAND Corporation

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

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

**DR. WILLIAM J. KLEPCZYNSKI**  
U.S. Naval Observatory (Retired)

**DR. PATRIZIA TAVELLA**  
INRIM

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

**PROFESSOR JACQUES VANIER**  
University of Montreal

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

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

**DR. ANDY WU**  
The Aerospace Corporation

**2010 DISTINGUISHED PTTI SERVICE AWARD  
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. JACQUES VANIER**  
University of Montreal

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1994

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

2002

**MR. HARRY PETERS**  
Sigma Tau, Incorporated (Retired)

1995

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

2003

**MR. S. CLARK WARDRIP**  
National Aeronautics and Space  
Administration (Retired)

1996

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

2005

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

1997

**PROFESSOR BERNARD RENE GUINOT**  
Honorary Astronomer  
Paris Observatory

2006

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

1998

**DR. JACQUES VANIER**  
National Research Counsel (Retired)

2007

**DR. R. MICHAEL GARVEY**  
Symmetricom

1999

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

2008

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

2000

**MR. ROGER EASTON**  
U.S. Naval Research Laboratory (Retired)

2009

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

2001

**DR. ROBERT F. C. VESSOT**  
Smithsonian Astrophysical Observatory  
(Retired)

## **PTTI 2010 MEETING OFFICERS**

### **GENERAL CHAIRMAN**

**DR. LEO A. MALLETE**

The Aerospace Corporation

### **TECHNICAL PROGRAM COMMITTEE CHAIRMAN**

**MRS. RACHEL EVANS-BINFIELD**

Johns Hopkins University/Applied Physics Laboratory

### **TECHNICAL PROGRAM COMMITTEE CO-CHAIRMAN**

**DR. STEVEN JEFFERTS**

National Institute of Standards and Technology

### **TUTORIALS CHAIRMAN**

**MS. FRANCINE VANNICOLA**

U.S. Naval Research Laboratory

### **EDITORIAL COMMITTEE CHAIRMAN**

**DR. LEE A. BREAKIRON**

U.S. Naval Observatory

### **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 ARRANGEMENTS**

**MRS. SHEILA FAULKNER**

Global Strategies Group (North America), Inc.

### **REGISTRATION**

**MS. NICOLETTE JARDINE**

U.S. Naval Research Laboratory

## **PTTI 2010 SESSION CHAIRS**

### **SESSION I: National Laboratory Updates**

**GREG WEAVER**

Johns Hopkins University/Applied Physics Laboratory

### **SESSION II: Vendor Presentations**

**RYAN DUPUIS**  
PerkinElmer Inc.

### **SESSION III: Atomic Standards**

**STEVEN JEFFERTS**

National Institute of Standards and Technology

### **SESSION IV: Space Clocks and GNSS**

**DENNIS MANNING**

National Geospatial-Intelligence Agency

### **SESSION V: Poster Session**

**JAMES CAMPARO**  
The Aerospace Corporation

### **SESSION VI: Time Transfer**

**CHRISTINE HACKMAN**  
U.S. Naval Observatory

### **SESSION VII: IEEE 1588 and NTP**

**GEORGE SHATON**  
Northrup Grumman

### **SESSION VIII: PTTI and Network Applications**

**JAMES WRIGHT**  
L-3 Communications

### **SESSION IX: Panel Discussion – GPS Mitigation in Challenged Environments**

**DENNIS McCARTHY**  
U.S. Naval Observatory

**RONALD BEARD**

U.S. Naval Research Laboratory

### **SESSION X: Optical Time and Frequency Transfer**

**JAMES HANSSEN**  
U.S. Naval Observatory

### **SESSION XI: Clock Performance**

**STEFANIA ROMISCH**

National Institute of Standards and Technology

### **SESSION XII: Algorithms and Calibration**

**PATRIZIA TAVELLA**

Istituto Nazionale di Ricerca Metrologica

**PTTI 2010**  
**FORTY-SECOND ANNUAL**  
**PRECISE TIME AND TIME INTERVAL (PTTI)**  
**SYSTEMS AND APPLICATIONS MEETING**

**TUESDAY, NOVEMBER 16, 2010**

0800 – 0805	<b>OPENING</b> Leo A. Mallette, <i>The Aerospace Corporation</i>
0805 – 0810	<b>IN MEMORIAM – HARRY PETERS</b> Paul Koppang, <i>U.S. Naval Observatory</i> ; Clark Wardrip, <i>GSGNA, Inc.</i>
0810 – 0815	<b>DISTINGUISHED PTTI AWARD PRESENTATION</b>
0815 – 0830	<b>OPENING REMARKS</b> CAPT R. Scott Steadley, <i>Superintendent, U.S. Naval Observatory</i>
0830 – 0835	<b>CALL TO SESSION</b> Rachel Binfield, <i>Johns Hopkins University/Applied Physics Laboratory</i>
<b>SESSION I</b>	<b>NATIONAL LABORATORY UPDATES</b> <b>Chairman:</b> Greg Weaver, <i>Johns Hopkins University/Applied Physics Laboratory</i>
0835 – 0850	<b>Paper 1:</b> TIME AND FREQUENCY ACTIVITIES AT THE U.S. NAVAL OBSERVATORY D. Matsakis, <i>U.S. Naval Observatory</i>
0850 – 0905	<b>Paper 2:</b> TIME AND FREQUENCY ACTIVITIES AT THE JHU APPLIED PHYSICS LABORATORY M. Miranian, G. Weaver, M. Reinhart and R. Dragonette, <i>Johns Hopkins University/Applied Physics Laboratory</i>
0905 – 0920	<b>Paper 3:</b> TIME AND FREQUENCY ACTIVITIES AT THE NAVAL RESEARCH LABORATORY R. Beard, <i>U.S. Naval Research Laboratory</i>
0920 – 0935	<b>Paper 4:</b> ACTIVITIES AT THE STATE TIME AND FREQUENCY STANDARD OF RUSSIA N. Koshelyaevsky, V. Kostromin, O. Sokolova, Zagirova, <i>Department of Metrology for Time and Space FGUP “VNIIFTRI,” Russia</i>
0935 – 0950	<b>Paper 5:</b> TIMEKEEPING OF NTSC IN RECENT YEARS H. Yuan and L. Qu, <i>Chinese Academy of Sciences, China</i>
0950 – 1010	<b>INTERMISSION</b>
<b>SESSION II</b>	<b>VENDOR PRESENTATIONS</b> <b>Chairman:</b> Ryan Dupuis, <i>PerkinElmer Inc.</i>
1010 – 1140	

## TUESDAY, NOVEMBER 16, 2010

1140 – 1300      **LUNCH**

### **SESSION III      ATOMIC STANDARDS**

**Chairman:** Steven Jefferts, *National Institute of Standards and Technology*

1300 – 1320      **Paper 6:** MCAFS – A MINIATURE COLD ATOM FREQUENCY STANDARD  
V. Shah, A. Martins and R. Lutwak, *Symmetricom*

1320 – 1340      **Paper 7:** PERFORMANCE OF FEI SPACE-CLASS RUBIDIUM ATOMIC STANDARDS  
M. Bloch, O. Mancini and T. McClelland, *Frequency Electronics, Inc.*

1340 – 1400      **Paper 8:**  $10^{-10}$  LEVEL SIMPLE SINGLE OVEN OCXO  
M. Ito, H. Mitome, T. Oita and N. Dempa, *Kogyo Co., Ltd., Japan*

1400 – 1420      **Paper 9:** A RUBIDIUM PORTABLE ATOMIC FOUNTAIN FREQUENCY STANDARD  
P. Kunz, T.P. Heavner and S.R.Jefferts, *National Institute of Standards and Technology*

1420 – 1440      **INTERMISSION**

### **SESSION IV      SPACE CLOCKS AND GNSS**

**Chairman:** Dennis Manning, *National Geospatial-Intelligence Agency*

1440 – 1500      **Paper 10:** ACTUAL OPERATION SIMULATION OF RESSOX GROUND EXPERIMENTS  
T. Iwata, K. Saito, K. Machita and T. Matsuzawa, *National Institute of Advanced Industrial Science and Technology, Japan*

1500 – 1520      **Paper 11:** GALILEO COMMON VIEW: FORMAT, PROCESSING AND TESTS WITH GIOVE  
P. Defraigne, *Royal Observatory of Belgium*; and A. Mudrak, S. Binda, *Galileo Project Office, European Space Agency*

1520 – 1540      **Paper 12:** LONG-TERM PERFORMANCE ANALYSIS OF GIOVE CLOCKS  
P. Waller, F. Gonzalez, S. Binda, *European Space Agency, ESA-ESTEC, The Netherlands*; D. Rodriguez and G. Tobias, *GMV S.A., Spain*; and A. Cernigliaro, P. Tavella, *Istituto Nazionale di Ricerca Metrologica, Italy*

1540 – 1600      **Paper 13:** GPS BLOCK IIF ATOMIC FREQUENCY STANDARDS ANALYSIS  
F. Vannicola, R. Beard, J. White, K. Senior, *U.S. Naval Research Laboratory*; M. Largay, *Global Defense Technology & Systems Inc.*; and J. Buisson, *Antoine Enterprises Inc.*

## TUESDAY, NOVEMBER 16, 2010

- 1600 – 1620      **INTRODUCTION OF STUDENT PAPERS**  
James Campano, *The Aerospace Corporation*
- SESSION V**      **POSTER SESSION**  
1620 – 1740      **Chairman:** James Campano, *The Aerospace Corporation*
- Poster 1:** STUDIES ON IMPROVED COMPACT PHYSICS PACKAGE FOR RB CELL STANDARDS  
T. Bandi, C. Affolderbach and G. Milet, *Laboratoire Temps-Fréquence, University of Neuchâtel, Switzerland*
- Poster 2:** SPUR CORRELATION IN AN ARRAY OF DIRECT DIGITAL SYNTHESIZERS  
T.M. Comberiate, K.C. Lauritzen, L.B. Ruppalt, C.A. Lugo and S.H. Talisa, *Johns Hopkins University/Applied Physics Laboratory*
- Poster 3:** EVALUATION OF A GPS RECEIVER FOR CODE AND CARRIER-PHASE TIME AND FREQUENCY TRANSFER  
V. Zhang and M. Lombardi, *National Institute of Standards and Technology*
- Poster 4:** HOW TO HANDLE A SATELLITE CHANGE IN AN OPERATIONAL TWTSFT NETWORK?  
K. Liang, *National Institute of Metrology, China*; and T. Feldmann, D. Piester, A. Bauch, *Physikalisch-Technische Bundesanstalt, Germany*
- Poster 5:** CHARACTERIZATION OF PHASE NOISE EFFECTS IN THE PHOTODETECTION OF ULTRASHORT OPTICAL PULSES  
J.A. Taylor, *Department of Physics, University of Colorado*; F. Quinlan, A. Hati, C. Nelson, S.A. Diddams, *National Institute of Standards and Technology*; and S. Datta, A. Joshi, *Discovery Semiconductors, Inc.*
- Poster 6:** INRIM TIME AND FREQUENCY LABORATORY: A NEW DATA MANAGEMENT SYSTEM (DMS)  
V. Pettiti, R. Costa, G. Cerretto, F. Cordara, P. Tavella, D. Orgiazz and G. Reffo, *Istituto Nazionale di Ricerca Metrologica, Italy*
- Poster 7:** THE STABILITY OF CARRIER-PHASE GPS RECEIVERS  
L.A. Breakiron, *U.S. Naval Observatory*
- Poster 8:** PTTI 2030 – SYSTEM APPLICATIONS OF ADVANCED CLOCKS  
R. Dupuis, *PerkinElmer Inc.*; and B. Owings, *Symmetricom*
- Poster 9:** PTTI 2030 – TIME TRANSFER AND APPLICATIONS IN 2030  
J. Wright, *L-3 Communications*; and S. Mitchell, *U.S. Naval Observatory*

**TUESDAY, NOVEMBER 16, 2010**

**SESSION V      POSTER SESSION (*cont.*)**

**Poster 10:** PTTI 2030 – THINKING OUTSIDE THE BOX  
P. Kunz and S. Römisch, *National Institute of Standards and Technology*

1830 – 2000      **RECEPTION**

## WEDNESDAY, NOVEMBER 17, 2010

### SESSION VI TIME TRANSFER

**Chairman:** Christine Hackman, *U.S. Naval Observatory*

0800 – 0820 **Paper 14:** ACCURACY AND PRECISION OF USNO GPS CARRIER PHASE TIME TRANSFER

C. Hackman and D. Matsakis, *U.S. Naval Observatory*

0820 – 0840 **Paper 15:** SIMPLE METHODS FOR THE ESTIMATION OF THE SHORT TERM STABILITY OF GNSS ON BOARD CLOCKS

J. Delporte, C. Boulanger and F. Mercier, *CNES – French Space Agency, France*

0840 – 0900 **Paper 16:** NEAR REAL-TIME MONITORING OF FREQUENCY STANDARDS AND TIME SCALES USING PPP

G. Cerretto, P. Tavella, *Istituto Nazionale di Ricerca Metrologica, Italy*, F. Lahaye, Y. Mireault, *Natural Resources Canada*; and D. Rovera, *LNE-SYRTE, OP, France*

0900 – 0920 **Paper 17:** AOS STUDIES ON USE OF GNSS FOR TIME TRANSFER

J. Nawrocki, P. Nogaś and P. Lejba, *Astrogeodynamical Observatory, Poland*

0920 – 0940 **Paper 18:** INTEGRATED DOPPLER CORRECTION TO TWSTFT USING ROUND-TRIP MEASUREMENT

Y. Huang, W. Tseng and S. Lin, *Telecommunication Laboratories, Chunghwa Telecom, Taiwan*

0940 – 1000 **INTERMISSION**

### SESSION VII IEEE-1588 AND NTP

**Chairman:** George Shaton, *Northrup Grumman*

1000 – 1020 **Paper 19:** PERFORMANCE OF IEEE 1588 IN LARGE-SCALE NETWORKS

G. Gaderer, N. Simanic, P. Loschmidt and B. Coric, *Institute for Integrated Sensor Systems, Austrian Academy of Sciences, Austria*

1020 – 1040 **Paper 20:** LAYER 1 ETHERNET CLOCK SYNCHRONIZATION

R. Exel, G. Gaderer, *Institute for Integrated Sensor Systems, Austrian Academy of Sciences*; and N. Kerö, *Oregano Systems*

1040 – 1100 **Paper 21:** IEEE 1588 FREQUENCY AND TIME TRANSFER MEASUREMENT AND ANALYSIS

L. Cosart, *Symmetricom, Inc.*

1100 – 1120 **Paper 22:** A NETWORK TIME PROTOCOL STRATUM-1 SERVER FED BY IEEE-1588

R. Schmidt, *U.S. Naval Observatory*

## WEDNESDAY, NOVEMBER 17, 2010

### SESSION VII IEEE-1588 AND NTP (*cont.*)

- 1120 – 1140 **Paper 23:** TIME SYNCHRONIZING USING IEEE-1588 + SYNCHRONOUS ETHERNET IN A TIME-SETTING MODE OF OPERATION  
P. S. Bedrosian, *LSI Corporation*

- 1140 – 1150 **ANNOUNCEMENT OF STUDENT PAPER WINNERS**  
Leo Mallette, *The Aerospace Corporation*

- 1150 – 1320 **LUNCH**

### SESSION VIII PTTI AND NETWORK APPLICATIONS

**Chairman:** James Wright, *L-3 Communications*

- 1320 – 1340 **Paper 24:** IEEE-1588 DEPLOYED ON THE EASTERN RANGE  
W. Rendla and J. Wright, *L-3 Communications, SpaceLift Range Systems Contract*

- 1340 – 1400 **Paper 25:** A REVIEW AND ANALYSIS OF IEEE 1588 SECURITY MEASURES  
A. Treytl, B. Hirschler and G. Gaderer, *Austrian Academy of Sciences, Institute for Integrated Sensor Systems, Austria*

- 1400 – 1420 **Paper 26:** UTC TIME TRANSFER FOR HIGH FREQUENCY TRADING (HFT) USING IS-95 CDMA BASE STATION TRANSMISSIONS AND PTP  
M. Korreng, *EndRun Technologies*

- 1420 – 1440 **Paper 27:** THE PERFORMANCE OF ULTRA-STABLE OSCILLATORS FOR THE GRAVITY RECOVERY AND INTERIOR LABORATORY (GRAIL)  
G. Weaver, J. Garstecki and S. Reynolds, *Johns Hopkins University/Applied Physics Laboratory*

- 1440 – 1500 **Paper 28:** VERY PRECISE SYNCHRONIZATION OF A GROUP OF PSEUDOLITES  
W. Lange, *Lange-Electronic GmbH, Germany*

- 1500 – 1520 **INTERMISSION**

### SESSION IX PANEL DISCUSSION: GPS MITIGATION IN CHALLENGED ENVIRONMENTS

- 1520 - 1620 **Chairman:** Dennis McCarthy, *U.S. Naval Observatory;*  
Ronald Beard, *U.S. Naval Research Laboratory*

- 1700 – 1800 **JOINT EXECUTIVE AND ADVISORY BOARD MEETING**

- 1830 – 2030 **SPECIAL EVENT – “*Time and Navigation*,”** a new exhibit opening in late 2012 at the Smithsonian’s National Air and Space Museum, will be presented by Mrs. Carlene E. Stephens, Curator, Division of Work and Industry from the Smithsonian’s National Museum of American History.

## THURSDAY, NOVEMBER 18, 2010

<b>SESSION X</b>	<b>OPTICAL TIME AND FREQUENCY TRANSFER</b> <b>Chairman:</b> James Hanssen, <i>U.S. Naval Observatory</i>
0800 – 0820	<b>Paper 29:</b> STABILIZATION OF THE PROPOGATION DELAY IN THE FIBER OPTIC FREQUENCY DISTRIBUTION USING ELECTRONIC DELAY LINES A. Czubla, <i>Central Office of Measures; Ł. Śliwcyński, P. Krehlik, Ł. Buczek, M. Lipiński, AGH University of Science and Technology; and Jerzy Nawrocki, Polish Academy of Sciences, Poland</i>
0820 – 0840	<b>Paper 30:</b> TIME TRANSFER BY LASER LINK – T2L2: FIRST RESULTS OF THE 2010 CAMPAIGN Ph. Guillemot, S. Leon, <i>CNES –French Space Agency; P. Exertier, E. Samain, F. Pierron, OCA – Observatoire de la Côte d'Azur; and Ph. Laurent, M. Abgrall J. Achkar, D. Rovera, K. Djerroud, SYRTE – Observatoire de Paris, France</i>
0840 – 0900	<b>Paper 31:</b> SINGLE WAY FIBER-BASED TIME TRANSFER WITH ACTIVE DETECTION OF TRANSFER TIME VARIATIONS S. Ebenhag and P. Hedekvist, <i>SP Technical Research Institute of Sweden</i>
0900 – 0920	<b>Paper 32:</b> TIME TRANSFER IN OPTICAL NETWORK V. Smotlacha, <i>CESNET, Czech Republic; A. Kuna, Institute of Photonics and Electronics, AS CR, Czech Republic; and W. Mache, Bundesamt für Eich - und Vermessungswesen, Austria</i>
0920 – 0940	<b>Paper 33:</b> COMPENSATED FIBER OPTIC FREQUENCY DISTRIBUTION EQUIPMENT J. MacDonald and G. Conway, <i>Linear Photonics, LLC</i>
0940 – 1000	<b>INTERMISSION</b>
<b>SESSION XI</b>	<b>CLOCK PERFORMANCE</b> <b>Chairman:</b> Stefania Romisch, <i>National Institute of Standards and Technology</i>
1000 – 1020	<b>Paper 34:</b> PRIMARY FREQUENCY STANDARDS AT NIST T.P. Heavner, T.E. Parker, P. Kunz, J.H. Shirley and S.R. Jefferts, <i>National Institute of Standards and Technology</i>
1020 – 1040	<b>Paper 35:</b> CORRELATIONS IN HYDROGEN MASER FREQUENCIES T.E. Parker, S.R. Jefferts and T.P. Heavner, <i>National Institute of Standards and Technology</i>
1040 – 1100	<b>Paper 36:</b> AN AUTOMATIC SWITCHING MATRIX (ASM) FOR THE GALILEO PTF E. Detoma and P. Griseri, <i>SEPA S.p.A., Italy; A. Moudrak, M. S. Gestido, ESA ESTEC, The Netherlands; and M. Blanchi, R. Zanello, Thales Alenia Space Italia, Italy</i>

## THURSDAY, NOVEMBER 18, 2010

### SESSION XI     CLOCK PERFORMANCE (*cont.*)

- 1100 – 1120     **Paper 37:** ON-BOARD GPS CLOCK MONITORING  
M. Weiss, *National Institute of Standards and Technology*; R. Beard,  
*U.S. Naval Research Laboratory*; P. Shome, *Federal Aviation Administration*
- 1120 – 1140     **Paper 38:** PERFORMANCE COMPARISON OF TWO COMPOSITE CLOCKS SIMULATING FUTURE GPS CLOCK SCENARIOS  
M. Suess, *German Aerospace Center – DLR, Germany*; D. Matsakis,  
*U.S. Naval Observatory*; and C.A. Greenhall, *Jet Propulsion Laboratory*
- 1140 – 1310     **LUNCH**
- ### SESSION XII     ALGORITHMS AND CALIBRATION

**Chairman:** Patrizia Tavella, *Istituto Nazionale di Ricerca Metrologica*
- 1310 – 1330     **Paper 39:** AN ALGORITHM FOR THE DETECTION OF FREQUENCY JUMPS IN SPACE CLOCKS  
L. Galleani, *Politecnico di Torino*; P. Tavella, *INRIM*
- 1330 – 1350     **Paper 40:** ADVANCED GPS BASED TIME LINK CALIBRATION WITH PTB'S NEW CALIBRATION SYSTEM  
T. Feldmann, A. Bauch, D. Piester, M. Rost, *Physikalisch-Technische Bundesanstalt, Germany*; and E. Goldberg, S. Mitchell, B. Fonville, *U.S. Naval Observatory*
- 1350 – 1410     **Paper 41:** MULTI-SCALE CLOCK ENSEMBLING USING WAVELETS  
K. Senior, *U.S. Naval Research Laboratory*; and D. Percival, *University of Washington*
- 1410 – 1430     **Paper 42:** PROGRESS REPORT OF THE CNES ACTIVITIES REGARDING THE ABSOLUTE CALIBRATION METHOD  
A. Proia, *Centre National d'Etudes Spatiales, France*; and G. Cibiel, *Bureau International des Poids et Mesures, France*
- 1430 – 1450     **Paper 43:** EVALUATION OF GNSS TIMING RECEIVERS  
J. Prillaman, S. Mitchell, B. Fonville, B. Goldberg and E. Powers, *U.S. Naval Observatory*
- 1450 – 1510     **Paper 44:** THE REALIZATION OF TA(NIM) AND UTC(NIM)  
Y. Gao, X. Gao, A. Zhang, W. Wang, D. Ning, L. Nianfeng, P. Wang, M. Li, P. Lin, W. Chen, Y. Lin and T. Li, *National Institute of Metrology, China*
- 1510 – 1520     **GENERAL DISCUSSION**  
Francine Vannicola, *U.S. Naval Research Laboratory*
- 1520     **CLOSE OF MEETING**

**TYPE, PRINT AND FAX (see number below)**

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