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Welcome

Message from the General Co-Chairs

Welcome to the 2017 International IEEE Symposium on Precision Clock Synchronization for Measurement, Control, and Communication (ISPCS) to be held in Monterey, California. This year marks the 11th anniversary of ISPCS, the first ISPCS conference being held in Vienna in 2007.

Monterey is just a short distance from Silicon Valley where many companies are involved in the use and development of IEEE 1588-based technologies. Some of these companies are actively contributing to the upcoming revision of the IEEE 1588 standard, see [PI588 Working Group - Current Activities](#).

The ISPCS consists of a Plugfest and a symposium. It provides an outstanding opportunity for attendees to hear about the latest topics, learn about state-of-the-art advancements, and see current solutions in precise clock synchronization and distributed time-based applications.

The Plugfest provides an opportunity to test and demonstrate IEEE 1588-based device and system interoperability and to resolve compatibility issues. Implementers cooperate with each other to demonstrate system-wide clock synchronization and operation of protocols across as wide a spectrum of devices and systems as possible. Companies present their products/prototypes in the form of an exhibition as well.

The aim of the symposium is to provide a forum in which researchers and practitioners from industry, academia, and government involved in precise clock synchronization using IEEE 1588 or similar techniques and protocols can exchange ideas.

We value your participation and contribution in the Plugfest and symposium and encourage you to take any opportunity to network with your peers on your areas of interest. We also urge you to take some time to visit the city of Monterey and the surrounding area, one of the most beautiful areas of the California coast. If we can be of any assistance, please don't hesitate to let us know.

Enjoy ISPCS 2017 with us,

John C. Eidson and Kang B. Lee
ISPCS 2017 General Co-Chairs

Welcome

Message from the Technical Program Co-Chairs

On behalf of the Program Committee, we are pleased to welcome you to ISPCS 2017, the eleventh IEEE Symposium on Precision Clock Synchronization for Measurement Control and Communication. We welcome our speakers and attendees to Monterey after holding the symposium in Europe last year and Asia the prior year.

We are delighted to have three keynote presentations this year. The first keynote, *Resurrecting Laplace's Demon: The Case for Deterministic (Timing) Models*, will be given by Dr. Edward Lee, the Robert S. Pepper Distinguished Professor in Electrical Engineering and Computer Science at the University of California at Berkeley. The second keynote, *Timing in the Internet of Things*, will be given by Dr. Marc Weiss, consultant and formerly scientist at the National Institute of Standards and Technology (NIST). The third keynote, *The Accelerating Expansion of the Universe: Dark Energy and a New Twist*, will be given by Dr. Alex Filippenko, the Richard & Rhoda Goldman Distinguished Professor in the Physical Sciences at the University of California at Berkeley.

The symposium call for papers resulted in high quality submissions coming from all over the world. Just like the submissions, the members of the program committee formed a geographically diverse group representing both academia and industry. After careful deliberation, the program committee selected 20 papers to be presented at the conference.

Welcome to ISPCS 2017 and thank you for your attendance and contributions!

Radim Bartos and Lee Cosart
ISPCS 2017 Program Committee Co-Chairs

ISPCS 2017

Symposium Committee

ISPCS 2017 General Co-Chairs:

John Eidson, University of California

Kang Lee, National Institute of Standards and Technology

ISPCS 2017 Technical Program Co-Chairs:

Radim Bartos, University of New Hampshire

Lee Cosart, Microsemi

ISPCS 2017 Promotional Partners Chair:

Hans Weibel, Zurich University of Applied Sciences

ISPCS 2017 Program Committee:

Douglas Arnold, Meinberg USA

Zdenek Chaloupka, Khalifa University

Samer Darras, Microsemi

Greg Dowd, Microsemi, FTD

Pedro Estrela, IMC Financial Markets

Paolo Ferrari, University of Brescia

Geoffrey Garner, Consultant

Sulaiman Hussaini, University of Michigan

Nikolaus Kerö, Oregano Systems Design & Consulting GmbH

Hubert Kirmann, ABB Switzerland

Maciej Lipinski, CERN

John MacKay, Progeny Systems Inc.

Cristian Marinescu, OMICRON electronics GmbH

ISPCS 2017 Plugfest Committee:

Douglas Arnold (Co-Chair), Meinberg USA

Ken Harris (Co-Chair), Rockwell Automation

Heiko Gerstung, Meinberg

Timo Koskiahde, Flexibilis

Denis Reilly, Spectracom

Judy Zhu, Kyland Technology Co., Ltd.

Bob Noseworthy, University of New Hampshire

Sven Meier, NetTimeLogic, GmbH

Peter Meyer, Microsemi

Tal Mizrahi, Marvell

Claudio Narduzzi, University of Padova

Stefano Rinaldi, University of Brescia

Peter Roberts, Nokia

Silvana Rodrigues, Integrated Device

David Roe, Semtech Technology

Opher Ronen, Oscilloquartz, an ADVA

Optical Networking company

Stefano Ruffini, Ericsson

Sebastian Schriegel, Fraunhofer

Karim Traore, Microsemi

Hans Weibel, Zurich University of Applied Sciences

Jian Yao, NIST

ISPCS 2017

Promotional Partners

Platinum Partner:



Gold Partner:



(IEEE Conformity Assessment Program)

Silver Partners:



Bronze Partner:



Plugfest

Sunday, August 27th - Tuesday, August 29th

Plugfest Co-Chairs: *Douglas Arnold, Ken Harris*

Room: San Carlos 3-4

Sunday, August 27, 2017

09:00	Organizers Set-Up & Morning Coffee
10:00	Morning Break
12:00	Lunch
13:00	Registration
13:00	Attendee Set-Up and Default Profile Test
15:00	Afternoon Break
17:00	End of Sunday Session

Monday, August 28, 2017

08:30	Doors Open/Registration
08:30	Morning Coffee/Light Breakfast
09:00	Power and Telecom Profile Testing
10:00	Morning Break
12:00	Lunch
13:00	Power and Telecom Profile Testing
15:00	Afternoon Break
17:00	Free Testing
19:00	End of Monday Session

Tuesday, August 29, 2017

08:30	Doors Open/Registration
08:30	Morning Coffee/Light Breakfast
09:00	New Profiles/Technology Testing
10:00	Morning Break
12:00	Lunch
13:00	New Profiles/Technology Testing
15:00	Open Viewing for Non-Plugfest ISPCS Attendees
15:00	Afternoon Break
16:30	Tear Down, Pack Up
17:30	End of Tuesday Session

Symposium

Wednesday, August 30, 2017

08:00 **Registration**
North Foyer

08:00 **Morning Coffee & Light Breakfast**
San Carlos Foyer

09:00 **Opening Session**
San Carlos 3-4
Conference General Co-Chair Remarks: Kang Lee and John Eidson
Program Committee Co-Chair Remarks: Radim Bartos and Lee Cosart

09:30 **Keynote Presentation I**
San Carlos 3-4
Session Chair: *John C Eidson (University of California, Berkeley, USA)*

“Resurrecting Laplace's Demon: The Case for Deterministic (Timing) Models”
Dr. Edward Lee, University of California at Berkeley

10:30 **Morning Break**
San Carlos Foyer

11:00 **Session I: PTP in the Network**
San Carlos 3-4
Session Chair: *Kang B Lee (NIST, USA)*

Precision Time Protocol over LR-WPAN and 6LoWPAN
Fatima M. Anwar (University of California, Los Angeles, USA)
Mani B. Srivastava (University of California, Los Angeles, USA)

Evaluating Low-Cost Bridges for Time Sensitive Software Defined Networking in Smart Cities
Stefano Rinaldi (University of Brescia, Italy)
Federico Bonafini (University of Brescia, Italy)
Paolo Ferrari (University of Brescia, Italy)
Alessandra Flammioni (University of Brescia, Italy)
Mattia Rizzi (University of Brescia, Italy)

11:50 **Lunch**
San Carlos Foyer

13:15 **Promotional Partner Presentations**
San Carlos 3-4
Chair: *Hans Weibel (Zurich University of Applied Sciences, Switzerland)*

14:55 **Work in Progress Introductions**
San Carlos 3-4
Chair: Radim Bartos (*University of New Hampshire, USA*)

15:15 **Afternoon Break**
San Carlos Foyer

15:45 **Session II: PTP Devices**
San Carlos 3-4
Session Chair: Douglas Arnold (*Meinberg USA, USA*)

A Time Aware Processor (TAP)
John D. MacKay (Progeny Systems, USA)
Henry McHenry (PSC, USA)

Time Synchronization for an Asynchronous Embedded CAN Network on a Multi-Processor System on Chip
Gabriela Breaban (Eindhoven University of Technology, The Netherlands)
Sander Stuijk (Eindhoven University of Technology, The Netherlands)
Kees Goossens (Eindhoven University of Technology, The Netherlands)

Timing models for PTP in Ethernet networks
Chandra Mallela (Intel, Malaysia)
Kiran Tholu (Intel, Malaysia)
Mark Bordogna (Intel, USA)

17:00 **End of Wednesday Session**

18:00 **Welcome Reception**
San Carlos Foyer
Drinks and hors d'oeuvres will be served.

Thursday, August 31, 2017

09:00 **Morning Coffee & Light Breakfast**
San Carlos Foyer

09:30 **Keynote Presentation II**
San Carlos 3-4
Session Chair: Lee Cosart (*Microsemi, USA*)

“Timing in the Internet of Things”
Dr. Marc Weiss, Marc Weiss Consulting, USA

10:30 **Morning Break**
San Carlos Foyer

11:00	Session III: Distributing Time San Carlos 3-4 Session Chair: <i>Opher Ronen (Oscilloquartz an ADVA Optical Networking Company, Israel)</i>
	Cyclops: PRU Programming Framework for Precise Timing Applications <i>Amr Alanwar (University of California, Los Angeles, USA)</i> <i>Fatima M. Anwar (University of California, Los Angeles, USA)</i> <i>Yi-Fan Zhang (University of California, Los Angeles, USA)</i> <i>Justin Pearson (University of California, Santa Barbara, USA)</i> <i>Joao Hespanha (University of California, Santa Barbara, USA)</i> <i>Mani B. Srivastava (University of California, Los Angeles, USA)</i>
	Ultra-accurate Ethernet Time-Transfer with programmable carrier-frequency based on White Rabbit solution <i>Francisco Girela-López (University of Granada, Spain)</i> <i>Felipe Torres-González (University of Granada, Spain)</i> <i>Javier Díaz (University of Granada, Spain)</i>
11:50	Lunch San Carlos Foyer
13:00	Special Industry Session San Carlos 3-4 Session Chair: <i>Radim Bartos (University of New Hampshire, USA)</i>
	The Evolution of the IEEE 1588 Standard <i>Douglas Arnold (Meinberg USA, USA)</i>
	Combining PTP with GNSS: Addressing PTP Asymmetry and GNSS Vulnerability <i>Lee Cosart (Microsemi, USA)</i>
	Testing GNSS Receivers in PTP Grandmasters <i>Lisa Perdue (Spectracom, USA)</i> <i>Denis Reilly (Spectracom, USA)</i>
	Synchronization Sources Addressing Telecom Synchronization Challenges <i>Opher Ronen (Oscilloquartz an ADVA Optical Networking Company, Israel)</i> <i>Nir Laufer (Oscilloquartz an ADVA Optical Networking Company, Israel)</i>
	Experimental Analysis of the Performance Characteristics of the Generalized Precision Time Protocol over a Wireless Network <i>Robert Noseworthy (University of New Hampshire, USA)</i>
	Seamless redundancy with sub-ns accuracy of synchronization in White Rabbit Network <i>Maciej Lipinski (CERN, Switzerland)</i>
15:30	Afternoon Break San Carlos Foyer

- 16:00 Plugfest Report**
(Douglas Arnold and Ken Harris)
San Carlos 3-4
- 16:25 Best Paper Award**
(Radim Bartos and Lee Cosart)
San Carlos 3-4
- 16:40 ISPCS 2018 Invitation**
(Maciej Lipinski)
San Carlos 3-4
- 17:00 End of Thursday Sessions**
- 19:00 Conference Dinner**
Ferrantes Bayview

Friday, September 1, 2017

- 08:30 Morning Coffee & Light Breakfast**
San Carlos Foyer
- 09:00 Keynote Presentation III**
San Carlos 3-4
Session Chair: *John C Eidson (University of California, Berkeley, USA)*
- “The Accelerating Expansion of the Universe: Dark Energy and a New Twist”**
Dr. Alex Filippenko, University of California at Berkeley

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- 10:00 Session IV: GNSS/Security**
San Carlos 3-4
Session Chair: *Lee Cosart (Microsemi, USA)*
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Getting Accurate Time from GNSS Receivers: Considerations to Approach Nanosecond Time

Marc Weiss (Marc Weiss Consulting, USA)

New Security Mechanisms for Network Time Synchronization Protocols

Karen F O'Donoghue (Internet Society, USA)

Dieter Sibold (Physikalisch-Technische Bundesanstalt, Germany)

Steffen Fries (Siemens, Germany)

- 10:50 Morning Break**
San Carlos Foyer

11:10	Session V: PTP Clocks San Carlos 3-4 Session Chair: <i>Hans Weibel (Zurich University of Applied Sciences, Switzerland)</i>
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	PTP Accuracy Measurement Comparison between Boundary Clock and VLAN Priority <i>Kouki Horita (Graduate School of Keio University, Japan)</i> <i>Shota Shiobara (SOFTBANK Corp., Japan)</i> <i>Takao Okamawari (SOFTBANK Corp., Japan)</i> <i>Fumio Teraoka (Keio University, Japan)</i> <i>Kunitake Kaneko (Keio University, Japan)</i>
	An Enhanced End-to-End Transparent Clock Mechanism for the Kernel-based Virtual Machines <i>Mingwu Yao (Xidian University, P.R. China)</i> <i>Zhenlin Huang (Xidian University, P.R. China)</i>
12:00	Closing Session/Remarks by General Chairs San Carlos 3-4
12:15	End of Symposium

Keynote Speakers

Alex Filippenko



“The Accelerating Expansion of the Universe: Dark Energy and a New Twist”

Alex Filippenko, Professor of Astronomy, University of California, Berkeley

BIO

Alex Filippenko, an elected member of both the National Academy of Sciences and the American Academy of Arts & Sciences, is one of the world's most highly cited astronomers. He is the recipient of numerous prizes for his scientific research, and he was the only person to have been a member of both teams that revealed the Nobel-worthy accelerating expansion of the Universe. In 2017, he was selected for the Caltech Distinguished Alumnus Award. Winner of the most prestigious teaching awards at UC Berkeley and voted the “Best Professor” on campus a record 9 times, he was named the U.S. National Professor of the Year in 2006. He has produced 5 astronomy video courses with The Great Courses, coauthored an award-winning astronomy textbook, and appears in more than 100 TV documentaries. He has given about 1000 public presentations, and he was awarded the 2004 Carl Sagan Prize for Science Popularization. He is addicted to observing total solar eclipses throughout the globe (15 so far, all successfully).

ABSTRACT

We expected the attractive force of gravity to slow down the rate at which the Universe is expanding. But observations of very distant exploding stars (supernovae) show that the expansion rate is actually speeding up, an amazing discovery that was honored with the 2011 Nobel Prize in Physics to the teams' leaders and the 2015 Breakthrough Prize in Fundamental Physics to all team members. Over the largest distances, the Universe seems to be dominated by a mysterious, repulsive “dark energy” that stretches space itself faster and faster. The physical origin and nature of dark energy, which makes up about 70% of the contents of the Universe, may be the most important unsolved problem in all of physics, providing clues to a unified quantum theory of gravity. But our most recent measurements yield an additional surprise: the current rate of expansion is even faster than expected, perhaps showing that dark energy is actually growing stronger with time or revealing the presence of a new type of relativistic particle.

Keynote Speakers (Continued)

Edward Lee



“Resurrecting Laplace's Demon: The Case for Deterministic (Timing) Models”

Edward Lee, Robert S. Pepper Distinguished Professor, University of California, Berkeley

BIO

Edward A. Lee is the Robert S. Pepper Distinguished Professor in Electrical Engineering and Computer Science at the University of California at Berkeley, where he has been on the faculty since 1986. He is the author of *Plato and the Nerd - The Creative Partnership of Humans and Technology* (MIT Press, 2017), a number of textbooks and research monographs, and more than 300 papers and technical reports. Lee has delivered more than 170 keynote talks and other invited talks at venues worldwide and has graduated at least 35 PhD students. Professor Lee's research group studies cyber-physical systems, which integrate physical dynamics with software and networks. His focus is on the use of deterministic models as a central part of the engineering toolkit for such systems. He is the director of the nine-university TerraSwarm Research Center (<http://terraswarm.org>), a director of iCyPhy, the Berkeley Industrial Cyber-Physical Systems Research Center, and the director of the Berkeley Ptolemy project. From 2005-2008, he served as chair of the EE Division and then chair of the EECS Department at UC Berkeley. He has led the development of several influential open-source software packages, notably Ptolemy and its various spinoffs. He received his BS degree in 1979 from Yale University, with a double major in Computer Science and Engineering and Applied Science, an SM degree in EECS from MIT in 1981, and a PhD in EECS from UC Berkeley in 1986. From 1979 to 1982 he was a member of technical staff at Bell Labs in Holmdel, New Jersey, in the Advanced Data Communications Laboratory. He is a co-founder of BDTI, Inc., where he is currently a Senior Technical Advisor, and has consulted for a number of other companies. He is a Fellow of the IEEE, was an NSF Presidential Young Investigator, won the 1997 Frederick Emmons Terman Award for Engineering Education, and received the 2016 Outstanding Technical Achievement and Leadership Award from the IEEE Technical Committee on Real-Time Systems (TCRTS).

ABSTRACT

In this talk, I will argue that deterministic models have historically proven extremely valuable in engineering, despite fundamental limits. But useful deterministic models for cyber-physical systems, which integrate computing, networking, and physical dynamics, remain elusive primarily because of the lack of temporal semantics on the cyber side. I show that useful deterministic models for CPS are both possible and practical. I will examine particularly the mechanisms by which time can be modeled in such systems and how such models of time can be faithfully realized in engineered systems.

Keynote Speakers (Continued)

Marc Weiss



“Timing in the Internet of Things”

Marc Weiss, Marc Weiss Consulting

BIO

Dr. Marc Weiss who worked at National Institute of Standards and Technology (NIST) from 1979, specializing in time transfer techniques and statistics of timing systems, has now been a contractor for NIST since 2014. He received the National Bureau of Standards (NBS – the former name of NIST) Applied Research Award for a first GPS timing receiver in 1983. He was awarded a patent for the Smart Clock algorithm in 1993. Dr. Weiss won the 2013 NIST William P. Slichter Award for linking NIST with industry, in large part because of WSTS and ITSF. Marc founded and has led WSTS, the Workshop on Sync and Timing Systems in North America, annually since 1992, which inspired ITSF as a European sister conference. He also co-founded in 2013 a research collaboration on Time-Aware Applications, Computers and Communications Systems. Marc is the NIST co-chair of the Timing subgroup of the NIST Cyber-Physical Systems Public Working Group, and led the NIST program to support GPS in developing their clocks and timing systems from 1980 until his retirement at the end of 2013. Marc also has worked on and published Relativity issues as they relate to GPS and to primary frequency standards.

ABSTRACT

A new economy built on the massive growth of endpoints on the internet will require precise and verifiable timing in ways that current systems do not support. Perhaps the Internet of Things is the core of this new economy. Three aspects of timing that need development are synchronization, processing, and latency. Synchronization describes the delivery of frequency, phase or time from a source to an endpoint. Processing describes the consumption of synchronization. And latency describes the delay from transmission to reception of a number of types of time-sensitive packets.

Synchronization is delivered to users by GPS and GNSS with great accuracy and across wide areas. But there are significant problems, such as jamming, spoofing and the inability to receive the signal indoors. Synchronization is also delivered through networks. But networks have been built to optimize data transfer in ways that severely impede time and frequency transfer. For example, nodes that store and forward data create unpredictable delays that result in poor timing for the endpoints.

State-of-the-art processing systems currently use timing only as a performance metric. Correctness of timing as a metric cannot currently be designed into systems independent of hardware and/or software implementations. Creating processing systems that support precision timing is currently labor intensive, requiring a cycle of designing, building, calibrating, then adjusting hardware and software and recalibrating repetitively until timing meets requirements.

Time-sensitive data must be delivered with deterministic latencies. Three kinds of time intervals that can be required are 1) delivering packets within a time interval bound, 2) delivering packets with a specific delay, and 3) delivering a packet to arrive at an absolute time. In order to make the delay in delivering such time-sensitive data predictable, management systems must control scheduling and bandwidth.

To enable the massive growth predicted, accurate timing needs cross-disciplinary research to address each of these issues. This talk will suggest some potential solutions to meet these challenges and support the kind of growth we hope for.

ISPCS 2018

Announcement



ISPCS
CERN 2018
September 30 - October 5

International IEEE Symposium on Precision
Clock Synchronization for Measurement,
Control, and Communication
The European Organization for
Nuclear Research, Switzerland

www.ispcs.org

September 30 – October 5, 2018

Geneva, Switzerland

European Organization for Nuclear Research, CERN

CERN, the European Organization for Nuclear Research, is located just outside of Geneva and conveniently close to the airport. It hosts the world's largest particle physics laboratory. The symposium will take place in the main auditorium where CERN has announced major physics discoveries in the past. Accommodation will be available in the CERN Hotel, conveniently located near the venue for the symposium. Participants will have an opportunity to visit the laboratory on a guided-tour. On behalf of the ISPCS 2018 committee, we invite you to join us next year at CERN, home to the Large Hadron Collider and birthplace of the World Wide Web.