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Welcome

Message from the General Co-Chairs

Welcome to the 2018 International IEEE Symposium on Precision Clock Synchronization for Measurement, Control, and Communication (ISPCS) that revolves around the IEEE 1588 Precision Time Protocol (PTP) standard, as well as other advanced research in precise time synchronization. This year marks the 12th anniversary of ISPCS conference, 10th anniversary of the current release of the PTP standard, and final year of the work on the next edition of PTP standard, expected to be published in 2019.

We are especially excited to bring the 12th ISPCS conference to the European Organization for Nuclear Research (CERN) located just outside the Swiss city of Geneva. At CERN, physicists and engineers are probing the fundamental structure of the universe using the world's largest and most complex scientific instruments, including the 27 km long Large Hadron Collider (LHC). This fundamental research pushes the limits of knowledge and technologies making CERN a birthplace of such innovations as the World Wide Web (WWW) and White Rabbit (WR). WR extends the IEEE 1588-2008 standard to allow sub-nanosecond accuracy of synchronization required for the operation of CERN's scientific instruments. Not only has CERN been using this PTP-based technology in its accelerators, but it has been also contributing to the upcoming revision of the PTP standard to bring PTP implementations into the sub-nanosecond realm. We would like to celebrate the completion of the work on the revised PTP standard, including the WR-inspired Default High Accuracy Profile, during this year's ISPCS conference at CERN.

The ISPCS conference consists of a Plugfest and a symposium. It provides an outstanding opportunity for attendees to hear about the latest topics in precise clock synchronization and distributed time-based applications, learning about their state-of-the-art advancements. The Plugfest gives product developers and researchers the opportunity to perform interoperability testing of diverse hardware and software implementations of the IEEE 1588 standard. This year, we expect early implementations of new features of the upcoming PTP release, such as security mechanisms and High Accuracy Default Profile. 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 can exchange ideas. The symposium starts with inspiring keynotes that provide insight into the fundamental research at CERN and highlight the essential role of synchronization in science and space missions. The industrial exhibition accompanying the symposium gives companies an opportunity to present their products and gain new contacts in the precise timing community. The closing note of the ISPCS conference is the complimentary CERN tour that provides attendees with an insight in the fundamental research carried out at CERN and the technologies required for it to happen.

We would like to thank attendees for their participation and contribution to ISPCS 2019. The conference would not be possible without excellent supports of the ISPCS Organizing Committee, the Conference Catalysts, and a team of CERN employees working tirelessly behind the scene. Therefore, we would like to take this opportunity to thank the people who helped to make the ISPCS conference happen smoothly and successfully.

Have a fruitful conference, take any opportunity to network with your peers, enjoy the CERN tour, and take some time to visit the city of Geneva with its beautiful surroundings. If we can be of any assistance, please let us know.

Maciej Lipinski and Kang B. Lee
ISPCS 2018 General Co-Chairs

Welcome

Message from the Program Co-Chairs

On behalf of the Program Committee, we are pleased to welcome you to ISPCS 2018, the twelfth IEEE Symposium on Precision Clock Synchronization for Measurement Control and Communication. We welcome our speakers and attendees to Geneva after holding the symposium in America last year.

We are delighted to have three keynote presentations this year. The first keynote, *The Asymmetric Universe*, will be given by Frank Close, Professor Emeritus of Theoretical Physics at Oxford University. The second keynote, *Timing in Scientific Experiments*, will be given by Javier Serrano, leader of the Hardware and Timing section in the Beams Department at CERN. The third keynote, *Precise Time and Frequency Signals for Space Missions*, will be given by Pierre Waller of the European Space Agency.

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 22 papers to be presented at the conference and published in the ISPCS 2018 Proceedings.

Welcome to ISPCS 2018 and thank you for your attendance and contributions!

Radim Bartos and Lee Cosart
ISPCS 2018 Program Committee Co-Chairs

ISPCS 2018

Symposium Committee

ISPCS 2018 General Co-Chairs:

Maciej Lipinski, CERN

Kang B. Lee, National Institute of Standards and Technology

ISPCS 2018 Program Co-Chairs:

Lee Cosart, Microsemi

Radim Bartos, University of New Hampshire

ISPCS 2018 Promotional Partners Chair:

Hans Weibel, Zurich University of Applied Sciences

ISPCS 2018 Program Committee:

Douglas Arnold, Meinberg USA

Rodney Cummings, National Instruments

Samer Darras, Microsemi

Greg Dowd, Microsemi

Pedro Estrela, IMC Financial Markets

Paolo Ferrari, University of Brescia

Geoffrey Garner, Consultant

Sulaiman Hussaini, University of Michigan

Hubert Kirrmann, Solutil

John MacKay, Progeny Systems Inc.

Cristian Marinescu, OMICRON Electronics GmbH

Sven Meier, NetTimeLogic, GmbH

ISPCS 2018 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

Peter Meyer, Microsemi

Tal Mizrahi, Marvell

Claudio Narduzzi, University of Padova

Stefano Rinaldi, University of Brescia

Peter Roberts, Nokia

Silvana Rodrigues, Integrated Device Technology

Opher Ronen, Oscilloquartz, an ADVA Optical Networking Company

Stefano Ruffini, Ericsson

Sebastian Schriegel, Fraunhofer IOSB-INA

Karim Traore, Microsemi

Hans Weibel, Zurich University of Applied Sciences

ISPCS 2018

Organizers & Sponsors



ISPCS 2018

Promotional Partners

Platinum Partner:



The Synchronization Experts.

Silver Partners:



Bronze Partner:



Plugfest

Sunday, September 30th - Tuesday, October 2nd

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

Sunday, September 30, 2018

09:00 Organizers Set-Up
12:00 (No lunch provided)
13:00 Attendee Set-Up and Default Profile Test
17:00 End of Sunday Session

Monday, October 1, 2018

08:30 Doors Open
09:00 Power and Telecom Profile Testing
11:45 Lunch
13:00 Power and Telecom Profile Testing
17:00 Free Testing
19:00 End of Monday Session

Tuesday, October 2, 2018

08:30 Doors Open
09:00 New Profiles/Technology Testing
11:45 Lunch
13:00 New Profiles/Technology Testing
15:00 Open Viewing for Non-Plugfest ISPCS Attendees
16:30 Tear Down, Pack Up
17:30 End of Tuesday Session

Symposium

Wednesday, October 3, 2018

09:00 Opening Session

Conference General Co-Chair Remarks: Kang B. Lee and Maciej Lipinski

Program Committee Co-Chair Remarks: Radim Bartos and Lee Cosart

09:30 Keynote Presentation I

Session Chair: *Maciej Lipinski (CERN, Switzerland)*

"The Asymmetric Universe"

Frank Close, Oxford University

10:30 Morning Break

10:50 Session I: PTP Security

Session Chair: *Kang B. Lee (National Institute of Standards and Technology, USA)*

Secure Time Synchronization Protocol

Faten Mkacher (Grenoble Informatics Laboratory & Gorgy Timing Company, France)

Xavier Bestel (Gorgy Timing, France)

Andrzej Duda (Grenoble Institute of Technology, France)

Implementing Proposed IEEE 1588 Integrated Security Mechanism

Dragos Maftei (University of New Hampshire, USA)

Radim Bartos (University of New Hampshire, USA)

Robert Noseworthy (University of New Hampshire, USA)

Timothy Carlin (University of New Hampshire InterOperability Laboratory, USA)

11:40 Lunch

12:50 **Session I: PTP Security (continued)**
Session Chair: *Kang B. Lee (National Institute of Standards and Technology, USA)*

A Hardware Assisted Implementation of Time Varying Encryption System

Fidel Rodriguez-López (University of Granada, Spain)

Javier Diaz (University of Granada, Spain)

Francisco Girela-López (University of Granada, Spain)

13:15 **Promotional Partner Presentations**
Session Chair: *Hans Weibel (Zurich University of Applied Sciences, Switzerland)*

14:55 **Special Industry Session**
Session Chair: *Radim Bartos (University of New Hampshire, USA)*

Enhanced Accuracy Metrics and Extended Monitoring Options for the Precision Time Protocol

Opher Ronen (Oscilloquartz an ADVA Optical Networking Company, Israel)

15:20 **Work in Progress Introductions**
Session Chair: *Radim Bartos (University of New Hampshire, USA)*

15:30 **Afternoon Break**

15:50 **Session II: Time and Frequency Distribution**
Session Chair: *Douglas Arnold (Meinberg-USA, USA)*

Time and Frequency Distribution over Fibre for Geodesy, Seismology and Industry

Davide Calonico (Istituto Nazionale di Ricerca Metrologica, Italy)

Cecilia Clivati (Istituto Nazionale di Ricerca Metrologica, Italy)

Alberto Mura (Istituto Nazionale di Ricerca Metrologica, Italy)

Filippo Levi (Istituto Nazionale di Ricerca Metrologica, Italy)

Martina Gertoso (Istituto Nazionale di Ricerca Metrologica, Italy)

Anna Tampellini (Istituto Nazionale di Ricerca Metrologica, Italy)

Exploiting Time Synchronization as Side Effect in UWB Real-Time Localization Devices

Federico Bonafini (University of Brescia, Italy)

Paolo Ferrari (University of Brescia, Italy)

Alessandra Flammini (University of Brescia, Italy)

Stefano Rinaldi (University of Brescia, Italy)

Emiliano Sisinni (University of Brescia, Italy)

Analysis of Controlled Packet Departure to Support Ethernet Fronthaul Synchronization via PTP

Igor Freire (Federal University of Pará, Brazil)

Ilan S Correa (UFPA, Brazil)

Pedro Bemerguy (Federal University of Pará, Brazil)

Aldebaro Klautau (Universidade Federal do Para, Brazil)

Igor Almeida (Ericksson Research, Brazil)

Chenguang Lu (Ericksson Research, Sweden)

Miguel Berg (Ericksson Research, Sweden)

Practical Traceability to UTC(k) from a GNSS Timing Receiver

Ricardo Piriz (GMV Aerospace and Defence S.A., Spain)

Pedro Roldan (GMV Aerospace and Defence S.A., Spain)

Francisco Domingo (GMV Aerospace and Defence S.A., Spain)

Esteban Garbin (GMV Aerospace and Defence S.A., Spain)

Pascale Defraigne (Royal Observatory of Belgium, Belgium)

Javier Diaz (University of Granada, Spain)

17:30 End of Wednesday Session

18:00 Board coaches in front of the CERN Hotel

19:00 Welcome Reception - Brasserie Halles de l'Île (in Geneva)

Thursday, October 4, 2018

09:00 Keynote Presentation II
Session Chair: *Maciej Lipinski (CERN, Switzerland)*

“Timing in Scientific Experiments”
Javier Serrano, CERN

10:00 Morning Break

10:30 Session III: PTP and Measurements
Session Chair: *Lee Cosart (Microsemi, USA)*

Measurement Tools for Substation Equipment: Testing the Interoperability of Time Transfer and Communications protocols

Dhananjay Anand (National Institute of Standards and Technology, USA)
Ya-Shian Li-Baboud (National Institute of Standards and Technology, USA)
Gerald Fitzpatrick (National Institute of Standards and Technology, USA)
Cuong Nguyen (National Institute of Standards and Technology, USA)
Kevin Brady (National Institute of Standards and Technology, USA)
Eugene Song (National Institute of Standards and Technology, USA)
Kang B. Lee (National Institute of Standards and Technology, USA)
Allen Goldstein (National Institute of Standards and Technology, USA)

Delayed Authentication and Delayed Measurement Application in One-Way Synchronization

Kristof Teichel (Physikalisch-Technische Bundesanstalt, Germany)
Gregor Hildermeier (TU Braunschweig, Germany)
Dieter Sibold (Physikalisch-Technische Bundesanstalt, Germany)

A Software-based Low-Jitter Servo Clock for Inexpensive Phasor Measurement Units

Pietro Tosato (University of Trento, Italy)
David Macii (University of Trento, Italy)
Davide Brunelli (University of Trento, Italy)
Daniele Fontanelli (University of Trento, Italy)
David Laverty (Queen's University of Belfast, UK)

11:45 Lunch

12:45 Session III: PTP and Measurements (continued)

Session Chair: *Lee Cosart (Microsemi, USA)*

Comparison of Software-Defined Radios for Performance Evaluation of High Precision Clocks

Carsten Andrich (Technische Universität Ilmenau, Germany)

Julia Bauer (Technische Universität Ilmenau, Germany)

Alexander Ihlow (Ilmenau University of Technology, Germany)

Niklas Beuster (Ilmenau University of Technology, Germany)

Giovanni Del Galdo (Fraunhofer Institute for Integrated Circuits IIS & Technische Universität Ilmenau, Germany)

Characterizing Timing Uncertainty in NIST CPS Testbeds

Marc Weiss (Marc Weiss Consulting, USA)

Ya-Shian Li-Baboud (National Institute of Standards and Technology, USA)

Dhananjay Anand (National Institute of Standards and Technology, USA)

Paul Boynton (National Institute of Standards and Technology, USA)

Kevin Brady (National Institute of Standards and Technology, USA)

Martin Burns (National Institute of Standards and Technology, USA)

13:35 Session IV: PTP and Devices

Session Chair: *Radim Bartos (University of New Hampshire, USA)*

A Fast and Stable Time Locked Loop for Network Time Synchronization with Parallel FLL and PLL

Carsten Andrich (Technische Universität Ilmenau, Germany)

Julia Bauer (Technische Universität Ilmenau, Germany)

Peter Große (Technische Universität Ilmenau, Germany)

Alexander Ihlow (Ilmenau University of Technology, Germany)

Giovanni Del Galdo (Fraunhofer Institute for Integrated Circuits IIS & Technische Universität Ilmenau, Germany)

Improved Precision Time Protocol with Relative Clock Phase Information

Avneesh Vyas (Ericsson, Sweden)

Satyam Dwivedi (Ericsson Research, Sweden)

Fredrik Gunnarsson (Ericsson Research, Sweden)

OpenClock: A Testbed for Clock Synchronization Research

Fatima M Anwar (University of California, USA)

Amr Alanwar (University of California, USA)

Mani B. Srivastava (University of California, USA)

Prototype Implementation and Performance of Time-based Distributed Scheduling on Linux for Real-Time Cyber-Physical Systems

Tamás Kovács házy (Budapest University of Technology and Economics, Hungary)

Tibor Tusori (Budapest University of Technology and Economics, Hungary)

Dávid Vincze (Budapest University of Technology and Economics, Hungary)

15:15 Afternoon Break

15:30 Session V: PTP in Wireless

Session Chair: *Douglas Arnold (Meinberg-USA, USA)*

IEEE 1588 Clock Synchronization Performance over Time-Varying Wireless Channels

Óscar Seijo (IK4-IKERLAN, Spain)

Iñaki Val (IK4-IKERLAN, Spain)

Jesús Alberto López-Fernández (Universidad de Oviedo, Spain)

Manuel Vélez (University of Basque Country, Spain)

Phase-based High-Precision Synchronization for Wireless Networks using FPGAs

Markus Appel (Humboldt-Universitaet zu Berlin, Germany)

Frank Winkler (Humboldt-Universitaet zu Berlin, Germany)

Beate Meffert (Humboldt-Universitaet zu Berlin, Germany)

16:20 Plugfest Report

16:35 Best Paper Award

16:45 ISPCS 2019 Invitation

17:00 End of Thursday Sessions

18:30 CERN Exhibitions (Meeting at the Globe of Science and Innovations)

20:00 Conference Dinner at the Globe of Science and Innovation

Friday, October 5, 2018

08:30 Keynote Presentation III
Session Chair: *Lee Cosart (Microsemi, USA)*

“Precise Time and Frequency Signals for Space Missions”
Pierre Waller, European Space Agency

09:30 Session VI: High-Accuracy PTP – White Rabbit
Session Chair: *Hans Weibel (Zurich University of Applied Sciences, Switzerland)*

White Rabbit Applications and Enhancements

Maciej Lipinski (CERN, Switzerland)
Erik van der Bij (CERN, Switzerland)
Javier Serrano (CERN, Switzerland)
Tomasz Wlostowski (CERN, Switzerland)
Grzegorz Daniluk (CERN, Switzerland)
Adam Wujek (CERN, Switzerland)
Mattia Rizzi (University of Brescia, Italy)
Dimitrios Lampridis (CERN, Switzerland)

White Rabbit Absolute Calibration

Peter Jansweijer (Nikhef, The Netherlands)
Henk Peek (Nikhef, The Netherlands)

10:20 Morning Break

10:40 Session VI: High-Accuracy PTP – White Rabbit (continued)
Session Chair: *Hans Weibel (Zurich University of Applied Sciences, Switzerland)*

High Accuracy Synchronization for Distributed Massive MIMO using White Rabbit

Thomas Bigler (Danube University Krems, Austria)
Albert N. Treytl (Danube University Krems, Austria)
David Löschenbrand (AIT Austrian Institute of Technology GmbH, Austria)
Thomas Zemen (AIT Austrian Institute of Technology GmbH, Austria)

Impact of Network Component Temperature Variation on Long Haul White Rabbit Links

Jose Lopez-Jimenez (University of Granada, Spain)
Javier Díaz (University of Granada, Spain)
Manuel Rodríguez-Álvarez (University of Granada, Spain)

11:30 Closing Session Remarks by General Co-Chairs

11:45 End of Symposium

13:00 CERN Tour starting with an introductory lecture in the Main Auditorium

17:00 End of CERN Tour (allow for up to 30 min delay)

Keynote Speakers

Frank Close



“The Asymmetric Universe”

Frank Close, OBE, Professor Emeritus of Theoretical Physics, Oxford University

BIO

Frank Close, OBE, is Professor Emeritus of Theoretical Physics at Oxford University. He was formerly Head of Theoretical Physics at Rutherford Appleton Laboratory, and of Communications and Public Education at CERN. His research specialises in the quark and gluon structure of nuclear particles, on which he has published over 200 papers. He won the British Institute of Physics Kelvin Medal in 1996, and in 2014 won the Royal Society’s Michael Faraday Prize for Science Communication. Unique among scientists he has won the British Science Writers Prize on three occasions. He is the author of many books including Neutrino, Antimatter, The Infinity Puzzle, - the story of the quest to discover the Higgs Boson, - and most recently Half-Life, biography of physicist and alleged spy Bruno Pontecorvo.

ABSTRACT

What is the Higgs Boson? How does it link to the existence of the material universe, with atoms, molecules and life? And why is everything lopsided – a universe of matter to the exclusion of antimatter; with atoms perfectly balanced electrically – with negatively charged electrons and positively charged protons annulling one another to leave gravity dominant at large scales – yet lopsided in structure, with fundamental electrons encircling a compact massive nucleus constituted from quarks. Why is life itself lopsided – our heart on the left (in most people, but not all), and our DNA coiling only in one direction? Could all of these phenomena have a common cause, and if so, is it the same phenomenon that is manifested by the Higgs Boson? If so, it is what is known as “Hidden Symmetry” – which makes shopping trolleys refuse to go where you push them, ensures that casinos will always win, and makes spiral galaxies, snowflakes and magnets.

I shall demonstrate how the Higgs mechanism works, using well known phenomena and without analogy. I shall also describe symmetry, what it is, and why it is not always best. The Higgs mechanism explains why there is structure in Nature – why atoms have a size, why the nucleus is compact, why the sun burns so slowly that evolution has had time to work its magic. I shall show that the ideas are essential to our existence and also suggest that they might be even more widely applicable, even to offering an explanation of why the observable universe is made of matter to the exclusion of antimatter.

Keynote Speakers (Continued)

Javier Serrano



“Timing in scientific experiments”

Javier Serrano, leader of the Hardware and Timing section, Beams Department, CERN

BIO

Javier Serrano is the leader of the Hardware and Timing section in the Beams Department at CERN. He is also the initiator and leader of the White Rabbit project, which focuses on the development of a set of IEEE-1588 compliant components for distributed synchronization in the nanosecond realm. Javier is also an ardent advocate of open source as a way to maximise the impact of technological developments. The creation of the Open Hardware Repository (ohwr.org) was his initiative, and he is co-author of the CERN Open Hardware Licence, which aims at providing an efficient mechanism for sharing hardware designs, similar to what existing free and open source licences do in the software domain. All the basic building blocks of White Rabbit, including software, firmware, gateway and hardware, are open source. In 2017, he received the ICALEPCS Lifetime Achievement Award, meant to honour individuals who, throughout their careers, have made invaluable and lasting contributions to the field of control systems for large experimental physics facilities.

ABSTRACT

Historically, our ability to measure time and its inverse, frequency, has greatly benefited from scientific advances. In fact, if one looks at the latest generation of high-precision clocks, they appear very much like other complex scientific experimental setups. So science helps timing, that's well known. But how does timing help science? In this talk, I will go through a number of scientific experiments of different kinds. For each type of experiment, I will provide a quick introduction and some context to appreciate its scientific relevance, and then focus on the role of timing and synchronization subsystems within the experiment. Along the way, we will see the different techniques used in timing systems to cope with the widely varying constraints in factors such as accuracy, precision and geographic distribution.

Keynote Speakers (Continued)

Pierre Waller



“Precise Time and Frequency Signals for Space Missions”

Pierre Waller, Time and Frequency Engineer, European Space Research and Technology Centre

BIO

Pierre Waller is Time and Frequency Engineer at the European Space Research and Technology Centre (aka ESA/ESTEC). He is involved in the development and validation of techniques and technologies for the generation, characterization and dissemination of precise time and frequency signals, as required for the ESA missions and systems, in particular for Galileo. He has been the initiator and now the team leader of the Timing Lab operated at ESTEC where a local realisation of UTC is realised, monitored and distributed to dedicated users. Pierre holds a MSc and PhD in Physics from the University of Paris (F).

ABSTRACT

All space missions and systems critically rely to some extent on the availability of precise time and frequency signals, with a wide range of characteristics in terms of frequency, stability, accuracy, availability, reliability. A good example of such mission is Global Navigation Satellite Systems like Galileo, for which the navigation and positioning service performance ultimately depends on the performance of the on-board clock and how good it can be predicted. This calls for two types of requirements. On-board the satellite first, the clock shall be able to withstand the stress of the launch, to be compact and of reasonable power consumption, to operate continuously over extended period of time (typically 12 to 15 years), and to maintain a stability that guarantees a good predictability over a period that can extend up to several days. Second, a stable and properly coordinated system time shall be generated to serve as a reference time against which all clocks in the system (both on-board the satellites and on the ground stations) can be referred to. In both cases, advanced and various types of techniques and technologies for signal synchronisation are used.

The keynote presentation will review these various techniques and technologies for precise time/frequency generation and distribution in space missions and in particular for GNSS, and will provide an overview of activities currently on-going at the European Space Agency in the domain, including advanced GNSS signal processing and White Rabbit technology.

ISPCS 2019

Announcement



www.ispcs.org

September 22 – 27, 2019
Portland, Oregon, USA

Notes

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