



## IEEE European Test Symposium (ETS)

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# IEEE European Test Symposium (ETS)

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**Abstract**—This paper is dedicated to the IEEE European Test Symposium (ETS). It offers an overview of all the European Test Workshop and Symposium events, from its first edition in 1996 to the next edition in 2020.

## I. INTRODUCTION

The IEEE European Test Symposium (ETS) is Europe's premier forum dedicated to presenting and discussing scientific results, emerging ideas, applications, hot topics and new trends in the area of electronic-based circuits and system testing, reliability, security and validation. The areas of interest include (but are not limited to) the following topics: Analog, Mixed-signal and RF Test; ATE Hardware and Software; Automatic Test Generation; Board Test and Diagnosis; Boundary Scan Test; Built-In Self-Test (BIST); Current-Based Test; Defect-Based Test; Delay and Performance Test; Dependability and Functional Safety; Design for Test (DFT); Design for Manufacturing (DFM); Design Verification and Validation; Diagnosis and Silicon Debug; Economics of Test; Failure Analysis; Fault Modeling and Simulation; Fault Tolerance; Hardware Trojans; Hardware Security; High-Speed I/O Test; GPU Test; Low-Power IC Test; Memory Test and Repair; MEMS Test; Microprocessor Test; Multi-/Many-core Processor Test; Nanotechnology Test; On-line Test; Power Issues in Test; Design for Reliability; Reliability-Security Trade-offs; Security Issues in Test; Self-Repair; Signal Integrity Test; Stacked or 3D ICs Test; Standards in Test; System Test; SiP and SoC Test; Test Synthesis; Test, Reliability and Security of Emerging Technologies and Architectures; Test of Reconfigurable Systems; Test Quality; Thermal Issues in Test; Transient and Soft Errors; Variability Issues in Test; Yield Analysis and Enhancement.

This paper offers an overview of all the European Test Workshop and Symposium events, from the first edition in 1996 to the next edition in 2020. Its purpose is three-fold: (i) to take the reader through a journey of ETS past events, (ii) to acknowledge all those who, through their vision, hard work and dedication, have helped ETS grow into the successful event it is today, (iii) to attract and incentivize readers to participate or even organize future events.

## II. HISTORY

The 1<sup>st</sup> IEEE European Test Workshop (ETW) was held in Montpellier/Sète, France, during the second week of June 1996. According to the 90+ participants from academia as well as from industry from all over the world, this event was considered as a great success in the technical aspect, the terrific weather specially ordered by the organizing committee and the gorgeous meals. Since the first organization in 1996, ETW continued to grow and took place on an annual basis until 2003 (including), after which it was elevated to a symposium and renamed to *IEEE European Test Symposium (ETS)*. Table 1 lists the dates and locations for all the organizations of ETW/ETS between 1996 – 2019, along with the names of the General Chair and Program Chair of each edition. Typically, the event has been taking place during the last week of May. Throughout the years, it has been organized in locations spanning all the geographic regions of Europe, from locations with spectacular natural beauty, historical importance, but also strong technical/industrial relevance.

The best contributions from the 2<sup>nd</sup> edition of ETW held in 1997 were published in a special issue of the Journal of Electronic Testing: Theory and Applications (JETTA), published by Kluwer. The first formal proceedings of ETW were published in 1999, for the 4<sup>th</sup> edition held in Constance, Germany. In the following year of 2000, ETW took place at Cascais, 25km away from Lisbon, Portugal. This was the first edition sponsored by the IEEE Computer Society – Test Technology Technical Council (TTTC). The first ETS Best Paper Award was given in 2004, the 9<sup>th</sup> edition of the event. The ETS Fringe workshops were also organized for the first time in 2004 and ever since they have become an integral part of the *European Test Week*. The *ETS Vendor Sessions* and *Student Forum* were initiated in the 11<sup>th</sup> edition held in 2006 at Southampton, UK. The 14<sup>th</sup> edition, which was held in Sevilla (Spain) in 2009 included also a post-graduate Student's Forum, consisting of a short oral presentation session and a dedicated student's poster session. The 2009 edition, was also the last edition at which the participants were handed printed proceedings. In 2010, the first edition of the 3-days *Test Spring School (TSS@ETS)* took place. This school, which typically

precedes the Symposium, is offered to Ph.D. and M.Sc. students in order to introduce them into the most up-to-date concepts and hot-topics related to test, reliability and security. *TSS@ETS* has been offered uninterruptedly since 2010, contributing towards the strong technical and educational activities, which take place during the *European Test Week*, whose cornerstone event is the *European Test Symposium*. Another important activity, initiated in the 19<sup>th</sup> edition of 2014, was the *ETS<sup>2</sup>-track on emerging test solutions* to provide a one-day informal forum for discussing upcoming problems and solutions in the test industry. The 20<sup>th</sup> edition of the symposium, which was held in Cluj-Napoca, Romania, was an anniversary edition, and it was the opportunity to acknowledge the most influential papers published by ETS during its first 20 years, in a compendium included in the *ETS 20<sup>th</sup> Anniversary Book*.

Table 1 – I IEEE ETW/ETS Organization 1996 – 2019

Date Location	General Chair Program Chair
June 14-16, 1996 Montpellier, France	C. Landrault - <i>LIRMM (FR)</i> H. J. Wunderlich - <i>University of Stuttgart (DE)</i> K. Baker - <i>Philips (NL)</i>
May 28-30, 1997 Cagliari, Italy	P. Prinetto - <i>Politecnico di Torino (IT)</i> T. W. Williams - <i>IBM (US)</i> H. J. Wunderlich - <i>University of Siegen (DE)</i>
May 27-29, 1998 Barcelona, Spain	J. Figueras - <i>Univ. Politècnica de Catalunya (ES)</i> T. W. Williams - <i>IBM (US)</i> C. Landrault - <i>LIRMM (FR)</i> M. Sachdev - <i>Philips, NL</i>
May 25-28, 1999 Constance, Germany	H. J. Wunderlich - <i>University of Stuttgart (DE)</i> C. Landrault - <i>LIRMM (FR)</i>
May 23-26, 2000 Cascais, Portugal	J. P. Teixeira - <i>IST/INESC (PT)</i> P. Prinetto - <i>Politecnico di Torino (IT)</i>
May 29 - June 1, 2001 Stockholm, Sweden	Z. Peng - <i>University of Linköping (SE)</i> H. J. Wunderlich - <i>University of Stuttgart (DE)</i>
May 26-29, 2002 Corfu, Greece	D. Gizopoulos - <i>University of Piraeus (GR)</i> A. Paschalis - <i>University of Athens (GR)</i> S. Hellebrand - <i>University of Innsbruck (AU)</i>
May 25-28, 2003 Maastricht, The Netherlands	E. J. Marinissen - <i>Philips Research (NL)</i> S. Hellebrand - <i>University of Innsbruck (AU)</i>
May 23-26, 2004 Ajaccio, France	M. Renovell - <i>LIRMM (FR)</i> P. Prinetto - <i>Politecnico di Torino (IT)</i>
May 22-25, 2005 Tallinn, Estonia	R. Ubar - <i>Tallinn Univ. of Technology (EE)</i> P. Prinetto - <i>Politecnico di Torino (IT)</i> M. Renovell - <i>LIRMM (FR)</i>
May 21-25, 2006 Southampton, United Kingdom	B. Al-Hashimi - <i>Univ. of Southampton (UK)</i> E. J. Marinissen - <i>Philips Research (NL)</i>
May 20-24, 2007 Freiburg, Germany	B. Becker - <i>University of Freiburg (DE)</i> Z. Peng - <i>University of Linköping (SE)</i>
May 25-29, 2008 Lago Maggiore, Italy	M. Sonza Reorda - <i>Politecnico di Torino (IT)</i> P. Girard - <i>LIRMM (FR)</i>
May 25-29, 2009 Sevilla, Spain	J. L. Huertas Diaz - <i>IMSE-CNM (SP)</i> O. Novak - <i>Czech Technical University (CZ)</i> J.-P. Teixeira - <i>IST/INESC (PT)</i>
May 24-28, 2010 Prague, Czech Republic	O. Novak - <i>Czech Technical University (CZ)</i> S. Hellebrand - <i>Paderborn University (DE)</i>
May 23-27, 2011 Trondheim, Norway	E. J. Aas - <i>Norwegian U. of Science (NO)</i> E. Larsson - <i>University of Linköping (SE)</i>
May 28 - June 1, 2012 Annecy, France	L. Anghel - <i>TIMA (FR)</i> M. Violante - <i>Politecnico di Torino (IT)</i>
May 27-31, 2013 Avignon, France	P. Girard - <i>LIRMM (FR)</i> Z. Peng - <i>University of Linköping (SE)</i>
May 26-30, 2014 Paderborn, Germany	S. Hellebrand - <i>Paderborn University (DE)</i> J. Tyszer - <i>Poznan University (PL)</i>
May 25-29, 2015 Cluj-Napoca, Romania	L. Miclea - <i>Techn. Univ. of Cluj-Napoca (RO)</i> P. Prinetto - <i>Politecnico di Torino (IT)</i>
May 23-27, 2016	S. Hamdioui - <i>Technical Univ. of Delft (NL)</i>

Amsterdam, The Netherlands	G. Di Natale - <i>LIRMM (FR)</i>
May 22-26, 2017 Limassol, Cyprus	M. K. Michael - <i>University of Cyprus (CY)</i> H.-G. Stratigopoulos - <i>UPMC/CNRS/LIP6 (FR)</i>
May 28 – June 1, 2018 Bremen, Germany	R. Drechsler - <i>University of Bremen (DE)</i> S. Eggersglüß - <i>Mentor, A Siemens Business (DE)</i> B. Becker - <i>University of Freiburg (DE)</i>
May 27-31, 2019 Baden-Baden, Germany	M. Tahoori - <i>Karlsruhe Institute of Tech. (DE)</i> S. Hellebrand - <i>Paderborn University (DE)</i>

Through the years, the European Test Symposium has changed the format of its sessions; however, two categories have always been represented, dedicated to peer-reviewed scientific contributions. The papers accepted for presentation at ETS are in 2 formats: accepted as regular papers and accepted as posters. Figure 1 illustrates the number of accepted papers in these two categories over the course of ETS history. The posters have been published initially in the informal proceedings and from 2010 corresponding extended abstracts were included in the formal proceedings. Today, each work presented as poster has a 2-page paper included in the IEEE proceedings. In addition to the peer-reviewed scientific contributions, the technical program was enriched every year with specific sessions. From the 1998 edition, the technical program included 1 keynote address, technical sessions dedicated to industrial participants and panel sessions. Later-on break-out sessions have been added (from the 2000 to 2003 edition), embedded tutorials (from the 2003 edition until today), special sessions (were organized for most editions starting from 2007), student sessions (were sporadically organized in 2009, 2011, 2018 and 2019), workshop-type papers (in the 2013 and 2019 edition), and a special track with a very high industrial character, the *ETS<sup>2</sup>* (from the 2014 edition of ETS). The *Industrial/Vendor Sessions* are dedicated to commercial vendors and give them the opportunity to give technical presentations in a track parallel to the technical paper sessions. These presentations are listed in the symposium program along with the technical sessions, and target the ETS technical audience. The *Embedded Tutorial Sessions* address important and trendy topics that are of strong interest to the ETS community. The *Special Sessions* are meant to target hot and emerging test topics complementary to the regular sessions of the symposium. One of the objectives is also to cover cross topics, i.e. topics considered "border line" for the test community, but have, or are expected to have, a significant impact on the field. The *Student Sessions* (currently named *PhD Forum*) provide an excellent opportunity for PhD students to present their ongoing work and get feedback from experts in the field. The *Embedded Workshop Sessions* provide a forum for work in progress as well as for case studies. The *ETS<sup>2</sup> Sessions* have a very high industrial character, where industry experts introduce emerging technical issues in the broad area of test, which will be discussed with the audience. Figure 2 illustrates the diversity of the ETS technical program over the years, by showing the constant increase of the types of sessions organized by our symposium. The same trend is observed in the topic diversity. Figure 3 illustrates the number of topics of interests listed every year in the call for papers. If in 1996 only 10 major topics were identified in the call for papers, the 2020 edition, lists 44 topics. This shows the dynamism of the ETS community. With the increase in the number of topics covered by the Symposium, the number of experts needed for assuring a high quality program has also increased. If in 2001, the *Steering Committee of ETS* counted 11 members, today it is constituted by 25 members. The same trend is observed related to the

Technical Program Committee members, which in 1997 had 33 members and for the 2020 edition, it contains 114 members.

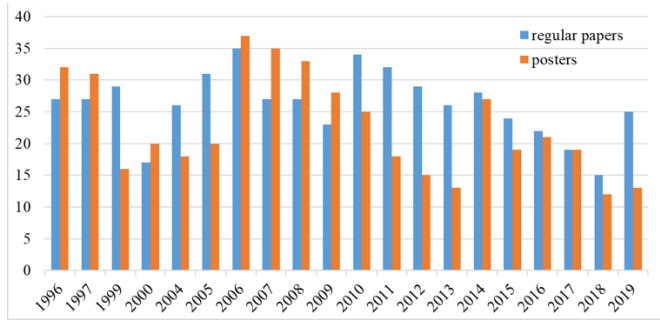


Fig. 1 – Number of accepted peer-reviewed papers per ETS edition

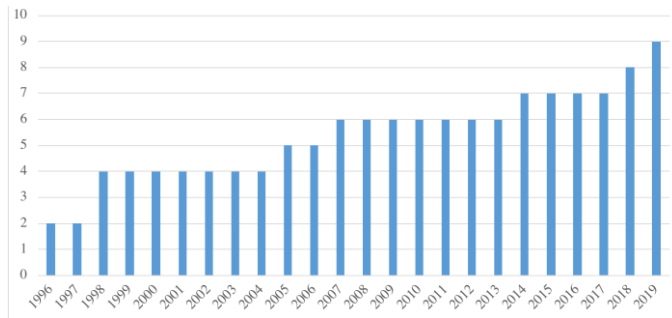


Fig. 2 – Number of session types per ETS edition

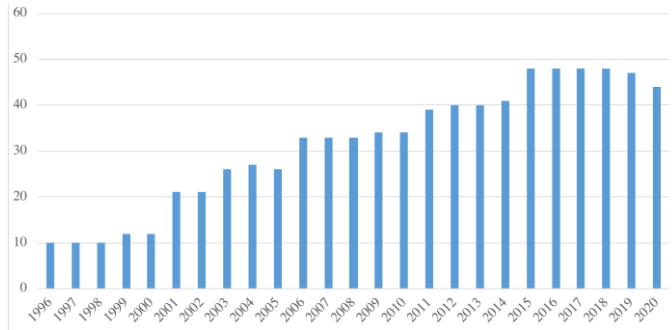


Fig. 3 – Number of topics covered by the ETS announced in the Call for Papers per ETS edition

Table 2 – The IEEE ETS Best Paper Awards

Year	Title and Authors
2004	“Dynamic Read Destructive Fault in Embedded-SRAMs: Analysis and March Test Solution” by L. Dilillo, P. Girard, S. Pravossoudovitch, A. Virazel (LIRMM - CNRS /Univ Montpellier 2 - France), S. Borri, M. Hage-Hassan (Infineon Technologies France - France)
2005	Multiple errors produced by single upsets in FPGA configuration memory: a possible solution by M. Violante, M. Sonza Reorda, L. Sterpone (Politecnico di Torino -Italy)
2006	“Analogue Network of Converters”: A DFT Technique to Test a Complete Set of ADCs and DACs Embedded in a Complex SiP or SOC by V. Kerzérho (LIRMM, France), P. Cauvet (Philips Semiconductors, France), S. Bernard, F. Azais, M. Comte, M. Renovell (LIRMM, France)
2007	“Adaptive Debug and Diagnosis Without Fault Dictionaries” by S. Holst, H.-J. Wunderlich (University of Stuttgart, Germany)
2008	“Critical Path Selection For Delay Test Considering Coupling Noise” by R. Tayade, J. Abraham (University of Texas, USA)
2009	“Defect Filter for Alternate RF Test” by H. Stratigopoulos, S. Mir, (TIMA Laboratory, France), E. Acar, (Duke University, USA), S. Ozev, (Arizona State University, USA)

2010	“Diagnosis of Failing Scan Cells through Orthogonal Response Compaction” by B. Benware, G. Mrugalski, A. Pogiel, J. Rajski (Mentor Graphics Corporation USA) J. Solecki, J. Tyszer (Poznań University of Technology, Poland)
2011	“A Robust Metric For Screening Outliers From Analogue Product Manufacturing Tests Responses” by S. Krishnan, (TNO The Netherlands), H. Kerkhoff (University Of Twente, The Netherlands)
2012	“An Enhanced Reduced Code Linearity Test Technique For Multibit/Stage Pipelined ADCs” by A. Laraba, H. Stratigopoulos, S. Mir (TIMA Laboratory, France), H. Naudet and C. Forel (STM, France)
2013	“Information-Theoretic Syndrome and Root-Cause Analysis for Guiding Board-Level Fault Diagnosis” by Fangming Ye (Duke University, USA), Zhaobo Zhang (Huawei Technologies, USA), Krishnendu Chakrabarty (Duke University, US), Xinli GU (Huawei Technologies, USA)
2014	“Variation-Aware Deterministic ATPG” by M. Sauer (University of Freiburg, Germany), I. Polian (University of Passau, Germany), M. E. Imhof, A. Mumtaz, E. Schneider (University of Stuttgart, Germany), Alexander Czuto (University of Freiburg, Germany), Hans-Joachim Wunderlich (University of Stuttgart, Germany), Bernd Becker (University of Freiburg, Germany)
2015	“High Frequency Jitter Estimator for SoCs” by H. Le Gall, R. Alhakim, M. Valka, S. Mir, H. Stratigopoulos, E. Simeu (TIMA, France)
2016	“A Self-Reconfiguring IEEE 1687 Network for Fault Modeling” by F. Ghani Zadegan, D. Nikolov, E. Larsson (Lund University, Sweden)
2017	“Automatic Testing of Analog ICs for Latent Defects using Topology Modification” by N. Xama, A. Coyette, B. Esen, W. Dobbelaere, R. Vanhooren, G. Gielen (KU Leuven and ON Semiconductor – Belgium)
2018	“Assisted test design for non-intrusive machine learning indirect test of millimeter-wave circuits” by F. Ciliciy, M. J. Barragan, S. Mir, E. Lauga-Larrozey, S. Bourdel (Université Grenoble Alpes – France)

### III. IEEE EUROPEAN TEST SYMPOSIUM 2019

This year’s edition of ETS took place in Baden-Baden, Germany and it was organized by the Karlsruhe Institute of Technology (KIT), which co-sponsored the event jointly with the IEEE Council on Electronic Design Automation (CEDA). ETS is the cornerstone event of the European Test Week, which also includes the Test Spring School (TSS) and Fringe Workshops. The main topic for this year's TSS, which precedes the symposium, is *Cutting Edge Approaches for Test*. Three Fringe Workshops were organized immediately following ETS’19, namely the 4th International Test Standards Application (TESTA) Workshop, which focused on test standards, the 8th Workshop on Trustworthy Manufacturing and Utilization of Secure Devices (TRUDEVICE), as well as the Secure Hardware, Integrity and preVention of Attacks Workshop (SHIVA).

ETS’19 received a significant number of scientific paper submissions from 28 countries all over the world. Each paper was evaluated by 5 expert reviewers, on average. Based on the written reviews and follow-up online discussions among the reviewers, the Organizing Committee and the Topic Chairs convened in Karlsruhe, Germany, on February 8, 2019, and recommended to accept 25 papers for oral presentation, distributed over 9 regular sessions, and 13 papers for poster presentation, distributed over 3 poster sessions. An Award Committee has been formed and has selected the best paper based on the reviewers' comments and the ratings provided by the attendees. The authors of the best paper will receive the Best Paper Award during the opening ceremony of ETS’20.

Apart from scientific paper presentations and posters, the ETS'19 program included 3 plenary keynote addresses, 2 one-hour embedded tutorials and 2 TSS@ETS Monday tutorials, 2 panel sessions, 3 special sessions, the PhD contest, and several vendor sessions. In addition, ETS featured a special session on Emerging Test Strategies (ETS<sup>2</sup>), where new issues are presented by the industry and are discussed in an informal atmosphere. Furthermore, the new Embedded Workshop track was dedicated to work in progress and case studies, while the newly established PhD Forum provided an excellent opportunity for PhD students to present their ongoing work and get feedback from experts in the field.

The ETS'19 was well attended, with more than 260 participants from 28 countries spanning over 4 continents, as it is illustrated in Fig. 4.

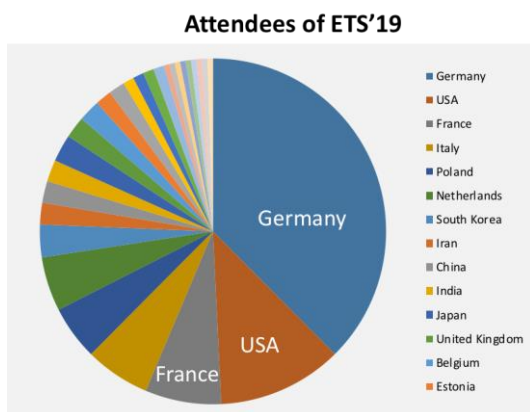


Fig. 4 – ETS'19 participants per country of origin

#### IV. FUTURE EDITIONS OF IEEE EUROPEAN TEST SYMPOSIUM

In 2020 we will celebrate the 25th edition of ETS. It will take place on May 25-29 in the Radisson Blu Sky Hotel in Tallinn, Estonia. The city is known for the picturesque Old Town with its medieval architecture. It is organized by the Tallinn University of Technology (TalTech), which co-sponsors the event jointly with the IEEE Council on Electronic Design Automation (CEDA). The General Chairs of the ETS'20 are: Artur Jutman (Testonica Lab) and Jaan Raik (TalTech), while the program chairs are: Görschwin Fey (TU Hamburg) and Maksim Jenihhin (TalTech).

In addition to scientific paper submissions, for the first time in 2020 ETS will offer a track for informal contributions dedicated to *early hot ideas* and relevant *case studies*. A PhD forum will also be organized where students will present their work in the form of a poster. The Ph.D. forum selection committee will review all the student works checking their technical content and the presentation capacity of the candidates, and will select the Best Ph.D. forum work. The Ph.D. Forum Award will be announced during the ETS'20 closing session. A Test Spring School and Fringe Workshops will be organized in conjunction with ETS'20.

ETS'20 seeks original, unpublished contributions of the following types:

- Scientific Papers for the Formal Proceedings, presenting novel and complete research work

- Informal Contributions including case studies and work in progress on hot topics
- PhD Forum Contributions from students eager to discuss their on-going research
- Proposals for Panels, Embedded Tutorials, Special Sessions and Fringe Workshops
- Vendor Presentations focusing on new features of test related products

Detailed submission information and guidelines are posted on the ETS'20 web page. Key Dates for Scientific Papers:

- Submission deadline December 9, 2019;
- Notification of acceptance February 13, 2020
- Camera-ready manuscript April 1, 2020.

The 26<sup>th</sup> edition of ETS will take place in Bruges, Belgium.

#### V. CONSTITUTING NEW ETS VENUES

The Steering Committee obtains proposals for new ETS venues through an open call for proposals. Submitting a proposal implies that the proposers commit to follow the rules provided by the Steering Committee for the organization of ETS.

Individuals or institutions interested to propose and organize a future ETS should follow the following steps. Written proposals for the ETS should be sent to the Chair of the Steering Committee to fulfill the stated deadline. The decision on the ETS will generally be made at least 24 months before the actual event occurrence. Proposals shall list facilities, venue, proposed management, a brief summary of the ETS structure, names of individual(s), who will serve as General Chair(s), as Program Chair, and any other information required by the Steering Committee. At least one of the General Chair(s) shall be from the country hosting the ETS. The Steering Committee reviews proposals and may seek advice from anonymous reviewers. If the evaluation is positive, the Steering Committee will accept the proposal and appoint the General Chair(s) and the Program Chair.

The General Chair will set up the Organizing Committee, will prepare a detailed budget using the Sponsor appropriate forms and submit the forms according to the rules and deadlines of the Sponsor(s). The budget must be preliminarily approved by the Steering Committee before being sent to the Sponsor(s).

In order to support the organization of each event, an Operating Committee (OpCom) is appointed, composed of local organizers and experienced members of the ETS Steering Committee. The OpCom visits the locations of the upcoming edition and periodically interacts with the organizers since they are selected in order to guide and support them towards a new successful ETS edition.

#### VI. CONCLUSIONS

The objective of the European Test Symposium (ETS) is to provide a first class forum in Europe dedicated to test technology topics. At ETS, test and design professionals can confront the challenges faced by test community and learn how these challenges are being addressed by academia and industry.