



IGNITING THE FUTURE

2 0 1 6
I E E E
A W A R D S





LETTER FROM THE IEEE PRESIDENT AND AWARDS BOARD CHAIR



Dear IEEE Members, Honorees, Colleagues, and Friends:

It is with great pleasure that we welcome you to the 2016 IEEE Honors Ceremony. This year's theme, "Igniting the Future," was inspired by all of our award recipients—the men and women who create, educate, and, yes, ignite further innovation... who stood on the shoulders of giants to accomplish the work they did and on whose shoulders other technology innovators will stand to drive their work further into the future.

The 1957 recipient of the Nobel Prize in Literature and French philosopher, Albert Camus, said "Real generosity towards the future lies in giving all to the present." This year's recipients have done just that, with extraordinary achievements and future-igniting contributions to the fields of broadband and wireless communications, information theory, automotive technology, medical diagnostic imaging, engineering education, artificial intelligence, semiconductors, signal processing, next-generation transistors, real-time systems, and much, much more.

IEEE and its members continue to propel the continuum of technological progress and the advancement of technology for humanity, but the future includes significant challenges. By many estimates there will be another 2–3 billion people on Earth by the middle of this century, and the nonrenewable resources we have relied upon for centuries are of finite supply.

In order to sustainably feed, power, transport, hydrate, and shelter a global community of 9–10 billion people, to safeguard their health, improve their quality of life, and facilitate their rapidly expanding communication requirements, groundbreaking technological advances will be required. As has been the case for more than 132 years, the expertise, determination, and ingenuity of IEEE members and their colleagues will drive these necessary advancements.

On behalf of IEEE's Board of Directors and some 420,000 members worldwide, we would like to extend sincere thanks to our generous awards sponsors and to all of the nominators, endorsers, volunteers, and staff who make our Awards Program possible.

As evidenced by the work and forward-looking vision of the award recipients we honor in New York this year, IEEE members continue to provide the technological spark to ignite a bright, prosperous future for coming generations of humankind.



Barry L. Shoop, Ph.D., P.E.
IEEE President and CEO



Kensall D. Wise
IEEE Awards Board Chair

www.ieee.org/awards

PRESENTATION OF AWARDS AT IEEE HONORS CEREMONY

Saturday, 18 June 2016
Gotham Hall
New York, NY

*OPENING REMARKS—IEEE President and CEO Barry L. Shoop &
IEEE President-Elect Karen Bartleson*

CORPORATE RECOGNITIONS

IEEE Spectrum Technology in the Service of Society Award NeuroPace, Inc.
IEEE Spectrum Emerging Technology Award MC10, Inc.
IEEE Corporate Innovation Award Intel Corporation
IEEE Ernst Weber Managerial Leadership Award David Fairbank Welch

SERVICE AWARDS

IEEE Richard M. Emberson Award Stephen Weinstein
IEEE Haraden Pratt Award Moshe Kam

HONORARY MEMBERSHIP

IEEE Honorary Membership Serge Haroche
IEEE Honorary Membership Rodolfo Zich

MEDALS

IEEE Alexander Graham Bell Medal Roberto Padovani
IEEE Edison Medal Robert Brodersen
IEEE Richard W. Hamming Medal Abbas El Gamal
IEEE Medal for Innovations in Healthcare Technology Charles A. Mistretta
IEEE Jack S. Kilby Signal Processing Medal Louis Scharf
IEEE/RSE James Clerk Maxwell Medal Geoffrey Hinton
IEEE James H. Mulligan, Jr. Education Medal Simon Haykin
IEEE Jun-ichi Nishizawa Medal Masayoshi Esashi
IEEE Robert N. Noyce Medal Takuo Sugano
IEEE Dennis J. Picard Medal for Radar Technologies and Applications Nadav Levanon
IEEE Medal in Power Engineering Arun G. Phadke
IEEE John von Neumann Medal Christos H. Papadimitriou
IEEE Medal for Environmental and Safety Technologies Masahiko Miyaki, Yukihiro Shinohara,
Katsuhiko Takeuchi
IEEE Simon Ramo Medal John P. Lehoczky, Ragunathan Rajkumar, Lui Sha
IEEE Medal of Honor G. David Forney, Jr.

Gold Partner of the 2016 IEEE Honors Ceremony



2016 AWARDS SPONSORS

IEEE Awards proudly acknowledges its 2016 Technical Field Award sponsors. These are some of the world's leading organizations, societies, and individuals whose generous support helps to recognize and promote technological advances for the benefit of humanity. Our partners include:

- Brunetti Bequest
- Robert and Ruth Halperin Foundation in Memory of Herman and Edna Halperin
- Hitachi, Ltd.
- Keithley Instruments, Inc.
- Leon K. Kirchmayer Memorial Fund
- Motorola Solutions Foundation
- NEC Corporation
- Nokia Bell Labs
- Nokia Corporation
- Philips Electronics N.V.
- Sony Corporation
- SRI International Sarnoff
- Dr. Kiyo Tomiyasu
- Wolong Electric Group Co., Ltd.
- IEEE Antennas and Propagation Society
- IEEE Components, Packaging, and Manufacturing Technology Society
- IEEE Circuits and Systems Society
- IEEE Computational Intelligence Society
- IEEE Computer Society
- IEEE Control Systems Society
- IEEE Education Society
- IEEE Electromagnetic Compatibility Society
- IEEE Electron Devices Society
- IEEE Engineering in Medicine and Biology Society
- IEEE Geoscience and Remote Sensing Society
- IEEE Industry Applications Society
- IEEE Industrial Electronics Society
- IEEE Instrumentation and Measurement Society
- IEEE Intelligent Transportation Systems Society
- IEEE Life Members Fund
- IEEE Microwave Theory and Techniques Society
- IEEE Nuclear and Plasma Sciences Society
- IEEE Photonics Society
- IEEE Power & Energy Society
- IEEE Power Electronics Society
- IEEE Robotics and Automation Society
- IEEE Signal Processing Society
- IEEE Solid-State Circuits Society
- IEEE Standards Association
- IEEE Vehicular Technology Society

The awards presented at the 2016 IEEE Honors Ceremony Gala are supported by the generosity of the following organizations and societies.



2016 TABLE OF CONTENTS



Letter from the IEEE President and Awards Board Chair	Inside Front Cover
Honors Ceremony Program	1
2016 IEEE Award Sponsors	2

IEEE MEDALS, AWARDS & RECOGNITIONS

The following awards are presented at the annual IEEE Honors Ceremony Gala

IEEE Spectrum Technology in the Service of Society Award... 4	IEEE Jack S. Kilby Signal Processing Medal..... 10
IEEE Spectrum Emerging Technology Award..... 4	IEEE/RSE James Clerk Maxwell Medal..... 10
IEEE Corporate Innovation Award..... 5	IEEE James H. Mulligan, Jr. Education Medal..... 11
IEEE Ernst Weber Managerial Leadership Award..... 5	IEEE Jun-ichi Nishizawa Medal..... 11
IEEE Richard M. Emberson Award..... 6	IEEE Robert N. Noyce Medal..... 12
IEEE Haraden Pratt Award..... 6	IEEE Dennis J. Picard Medal for Radar Technologies and Applications..... 12
IEEE Honorary Membership..... 7	IEEE Medal in Power Engineering..... 13
IEEE Honorary Membership..... 7	IEEE John von Neumann Medal..... 13
IEEE Alexander Graham Bell Medal..... 8	IEEE Medal for Environmental and Safety Technologies..... 14
IEEE Edison Medal..... 8	IEEE Simon Ramo Medal..... 14
IEEE Richard W. Hamming Medal..... 9	IEEE Medal of Honor..... 15
IEEE Medal for Innovations in Healthcare Technology..... 9	

IEEE TECHNICAL FIELD AWARDS & PRIZE PAPERS

The following awards are presented at 2016 IEEE technical conferences

IEEE Biomedical Engineering Award..... 20	IEEE Koji Kobayashi Computers and Communications Award..... 23
IEEE Cleo Brunetti Award..... 20	IEEE William E. Newell Power Electronics Award..... 24
IEEE Components, Packaging, and Manufacturing Technology Award..... 20	IEEE Daniel E. Noble Award for Emerging Technologies.... 24
IEEE Control Systems Award..... 20	IEEE Donald O. Pederson Award in Solid-State Circuits.... 24
IEEE Electromagnetics Award..... 21	IEEE Frederik Philips Award..... 24
IEEE James L. Flanagan Speech and Audio Processing Award..... 21	IEEE Photonics Award..... 25
IEEE Fourier Award for Signal Processing..... 21	IEEE Robotics and Automation Award..... 25
IEEE Andrew S. Grove Award..... 21	IEEE Frank Rosenblatt Award..... 25
IEEE Herman Halperin Electric Transmission and Distribution Award..... 22	IEEE David Sarnoff Award..... 25
IEEE Masaru Ibuka Consumer Electronics Award..... 22	IEEE Marie Sklodowska-Curie Award..... 26
IEEE Internet Award..... 22	IEEE Innovation in Societal Infrastructure Award..... 26
IEEE Richard Harold Kaufmann Award..... 22	IEEE Charles Proteus Steinmetz Award..... 26
IEEE Joseph F. Keithley Award in Instrumentation and Measurement..... 23	IEEE Nikola Tesla Award..... 26
IEEE Gustav Robert Kirchhoff Award..... 23	IEEE Eric E. Sumner Award..... 27
IEEE Leon K. Kirchmayer Graduate Teaching Award..... 23	IEEE Kiyo Tomiyasu Award..... 27
	IEEE Transportation Technologies Award..... 27
	IEEE Undergraduate Teaching Award..... 28
	IEEE Donald G. Fink Award..... 29

IEEE Spectrum Feature Article	16–29
IEEE Eric Herz Outstanding Staff Member Award.....	28
Joyce E. Farrell IEEE Staff Award	28
IEEE Fellows Class of 2016 and Fellow Committee Roster.....	30–36
IEEE Board of Directors and Awards Board Committee Rosters	Inside Back Cover

2016 IEEE SPECTRUM'S CORPORATE AWARDS

IEEE Spectrum Technology in the Service of Society Award*Sponsored by IEEE Spectrum*

The RNS[®] System is an award-winning technology developed and manufactured in Silicon Valley that has been recognized for its innovation. Similar to a pacemaker that monitors and responds to heart rhythms, the RNS System is the first and only medical device that can monitor and respond to brain activity. It constantly monitors brainwaves—including during sleep—looking for unusual activity that may lead to a seizure.

The device is personalized to recognize the electrical patterns specific to a recipient's brain, rapidly identifying unusual activity that can lead to a seizure. Within milliseconds of detecting unusual activity, the device sends brief pulses to instantly disrupt this activity and normalize brainwaves, often before seizure symptoms are felt.

The RNS[®] System consists of a small, implantable neurostimulator connected to leads (tiny wires) that are placed in up to two seizure onset areas. It comes with a simple remote monitor that recipients use at home to wirelessly collect information from the neurostimulator and then transfer it to the Patient Data Management System (PDMS). The doctor can log into the PDMS at any time to review accurate, ongoing information about seizure activity and treatment progress. This helps the doctor learn more about the recipient's seizures and improve care. Find out more about NeuroPace online at www.neuropace.com.

IEEE Spectrum Emerging Technology Award*Sponsored by IEEE Spectrum*

MC10 uses cutting-edge technology to create the most intelligent, flexible platform for biometric healthcare analytics. Our hardware and software systems are uniquely designed to minimize burden and maximize health insights.

Traditional electronic devices are rigid, bulky, and fundamentally mismatched to the properties of the human body. MC10 products are thin and flexible, and built to stretch, bend, and twist seamlessly with our bodies and the world around us.

MC10's software platform consists of a complete end-to-end system with mobile interfaces, cloud storage, and analytical tools. Lean, agile software development allows us to create robust systems to support the high volume of data gathered by the BioStamp[®] and WiSP[™] platforms. Using the most powerful tools in big data analytics and machine learning, MC10's software translates the body's data into a language understandable to humans.

MC10's technology empowers all of us to better understand our bodies and work towards improving human health.

MC10 is a private company backed by a strong syndicate of financial and strategic investors that is improving human health through digital healthcare solutions. The company combines its proprietary ultra-thin, flexible body-worn sensors with advanced analytics to unlock health insights from physiological data.

MC10 has received widespread recognition for its revolutionary technology and was recently named in Fast Company's Most Innovative Companies in 2016 as a leader in healthcare. MC10 is headquartered in Lexington, MA, USA. Visit MC10 online at www.mc10inc.com.

2016 IEEE CORPORATE RECOGNITIONS

IEEE Corporate Innovation Award

Sponsored by IEEE



Intel Corporation

For pioneering the use of high-k metal gate and tri-gate transistor technologies in high-volume manufacturing

Leading the semiconductor industry in developing revolutionary transistor technologies and achieving early high-volume manufacturing of microprocessor products, Intel's high-k metal gate and tri-gate transistor innovations have allowed the continuation of Moore's Law and enabled products with improved performance and lower power consumption. The semiconductor industry had been scaling metal-oxide-semiconductor field-effect-transistors (MOSFETs) for more than four decades until the early 2000s, when further scaling of traditional silicon dioxide/polysilicon materials presented leakage problems. New materials and structures would be needed for continued progress, and Intel's Technology and Manufacturing Group was first to meet the challenge with its introduction of high-k metal gate transistors and then with its tri-gate (FinFET) technology. Intel replaced most of the traditional dielectric MOSFET materials with a high-k hafnium-based dielectric to reduce leakage power, and metal gate electrode materials replaced doped polysilicon to provide improved transistor performance. Intel was the first to manufacture and ship these high-k metal gate transistors, beginning with its 45 nm technology in 2007. Intel then overcame the manufacturing challenges of using tri-gate transistors to surpass the limitations of planar MOSFETs. Tri-gate transistors feature channels on tall and narrow silicon fins instead of a planar surface. With a steeper sub-threshold slope, tri-gate transistors result in lower power leakage and can operate at lower voltage for lower active power consumption. Intel was the first to ship microprocessors using tri-gate transistors in 2011 with its 22-nm technology. Intel's manufacturing success with these transistor technologies fundamentally changed the direction of the semiconductor industry. Other semiconductor companies have followed Intel's footsteps in developing high-k and tri-gate products, and foundry companies have accelerated efforts to meet the fabrications needs of their customers.

Headquartered in Santa Clara, CA, USA, Intel's Technology and Manufacturing Group is led by Sohail U. Ahmed, senior vice president and general manager, and Ann B. Kelleher, corporate vice president and general manager.

Scope: For an outstanding and exemplary innovation by an industrial entity, governmental or academic organization, or other corporate body, within the fields of interest to the IEEE.

IEEE Ernst Weber Managerial Leadership Award

Sponsored by IEEE



David Fairbank Welch

For leadership in enabling the growth of cloud-based services and the Internet in optical transport networks

A leader in driving technology innovations from concept to commercial success, David Fairbank Welch's contributions to optical devices for telecommunications networks have enabled the growth of the Internet and cloud-based services, providing faster communications for service providers, businesses, and consumers around the world. As chief technology officer and vice president of corporate development for Spectra Diode Labs, Welch played a critical role in launching the first commercially available 980-nm semiconductor pump laser for optical amplifiers. His design became the standard for pump lasers and enabled the proliferation of dense-wave-division-multiplexed systems for long-haul communications networks that allowed service providers to increase network capacity to meet the demanding bandwidth requirements of emerging Internet applications. In addition, Welch led the design, development, and commercialization of high-power semiconductor lasers and solid-state lasers for a diversity of materials processing applications. Welch has proven that his vision of photonic integration improves performance and reliability while reducing cost in telecommunication systems. He cofounded Infinera in 2001 and led the company in the architecture and development of the most widely deployed photonic integrated circuit (PIC) in industry. PICs are highly functional optical subsystems on a chip that overcome the data communications bottleneck between users and servers in the cloud. Welch then led Infinera's next-generation technology, which now serves as the foundation for the DTN-X optical transport networking platform. Where the entire transmission capacity of the Internet in 2005 was less than 9 terabits (Tb), DTN-X allows 9 Tb per second of long-haul capacity on a single optical fiber. As president of Infinera, since 2013 Welch introduced several new systems that make it easier for network operators to automate the digital switching and optical transport layers of the multi-Tb transport systems, including the industry's first super-channel reconfigurable optical add drop multiplexer and the first 500G flexible-grid super-channels.

An IEEE Fellow and recipient of the Institution of Engineering and Technology's J.J. Thomson Medal for Electronics (2013), the Optical Society's John Tyndall Award (2011), and elected to the U.S. National Academy of Engineering (2016), Welch is president of Infinera Corporation, Sunnyvale, CA, USA.

Scope: For exceptional managerial leadership in the fields of interest of the IEEE.

2016 IEEE SERVICE AWARDS

IEEE Richard M. Emberson Award

Sponsored by the IEEE Technical Activities Board



Stephen Weinstein

For contributions to IEEE publications, awards, and globalization

Known for inspiring others to always give their best in each of their IEEE volunteer activities and to pursue increasing involvement, Stephen Weinstein's contributions to IEEE have strengthened the Institute's global reach, its publications, and its awards program. A communications engineer with over 45 years of experience, Weinstein served as president of the IEEE Communications Society (ComSoc) in 1996-97, was a member of the IEEE Board of Directors in 2002-03, and was Vice Chair of the IEEE Awards Board in 2010-12. To encourage globalization of IEEE and extend the reach of ComSoc, while ComSoc president Weinstein initiated "sister society" agreements with the Korean Institute of Communications Society (KICS) and the Russian A.S. Popov Society and traveled to Vietnam and Germany to initiate sister society negotiations. He also was dedicated to developing numerous joint international technical initiatives and conference events. His efforts resulted in ComSoc becoming the first IEEE Society to have non-U.S. membership exceed U.S. members. Weinstein's contributions to publications include cofounding *IEEE Communications Magazine* and the *IEEE/ACM Transactions on Networking*. He also helped establish the *Journal of Communications Networks* as an English-language journal of the KICS technically cosponsored by ComSoc, served as its first editor-in-chief, and established a prestigious editorial board with global representation. His contributions as member and Vice Chair of the IEEE Awards Board included redefining corporate recognitions as major IEEE awards, which was critical to enhancing the importance of IEEE's awards to industry. As chair of the Awards Policies and Procedures Board, he significantly improved the clarity and value of the guidelines for finding and rewarding excellent award candidates.

An IEEE Life Fellow and recipient of the IEEE Communications Society Exemplary Global Service Award (2007), Weinstein is president of Communication Theory and Technology Consulting, New York, NY, USA.

Scope: For distinguished service to the development, viability, advancement, and pursuit of the technical objectives of IEEE.

IEEE Haraden Pratt Award

Sponsored by the IEEE Foundation



Moshe Kam

For original and high-impact contributions to IEEE's Educational Activities, expanding IEEE's global reach and effectiveness

Moshe Kam has dedicated his career to breaking down the barriers that limit access to the engineering profession, and to helping people from all backgrounds understand what engineers do. As an IEEE volunteer he has transformed IEEE's educational activities to spur interest in engineering by new audiences and facilitate the pursuit of engineering as a career path by young students worldwide. In 2005 Kam spearheaded TryEngineering.org, IEEE's most popular and successful online education program. This portal serves as the predominant source of pre-university engineering education for students, parents, and school counselors. The success of TryEngineering.org led to the development of the IEEE's TryNano.org and TryComputing.org portals. Kam also championed the development of IEEE's version of the Engineering Projects in Community Service (EPICS) project. Developed by Purdue University but originally implemented mostly in the United States, EPICS provides students with the opportunity to create technological solutions for their communities in cooperation with nongovernmental organizations and humanitarian groups. Using IEEE's resources and working with fellow volunteers, Kam expanded EPICS' reach around the world with over 40 projects, including a project that supplied reliable electricity to rural schools in Uruguay and a joint industry-IEEE venture to provide solar-energy-heated water for an orphanage in South Africa. Kam has also expanded the IEEE Teacher-in-Service Program, which trains IEEE volunteers to work with pre-university teachers on lesson plans in engineering and engineering design, thereby bringing hands-on engineering activities into the classroom. Another area where Kam induced change was IEEE's participation in accreditation of engineering programs outside the United States. Going beyond the traditional IEEE educational workshops on accreditation, he played a pivotal role in developing training programs for program evaluators in Peru, assisting accreditation programs in China, and creating a new accreditation body for Caribbean nations.

An IEEE Past President, IEEE Fellow, and recipient of the IEEE Third Millennium Medal (2000), Kam is dean of the Newark College of Engineering at the New Jersey Institute of Technology, Newark, NJ, USA.

Scope: For outstanding service to IEEE.

2016 IEEE HONORARY MEMBERSHIPS

IEEE Honorary Membership

Sponsored by IEEE



Serge Haroche

For the development of cavity quantum electrodynamics, leading to fundamental quantum physics studies and to a wide range of applications

A Nobel-Prize-winning physicist who pioneered the discipline of cavity quantum electrodynamics (CQED), Serge Haroche has pushed the frontiers of CQED toward new achievements leading to practical applications in quantum optics and laser physics. With CQED, which involves studying the interaction of atoms with the quantum radiation field confined in highly reflective cavities, Haroche led a revolution in quantum electronics that brought quantum engineering into reality and has given substance to quantum thinking beyond what had been possible before. Building on Purcell's proposal from the 1940s that the atomic spontaneous emission rate could be enhanced at will by a resonant cavity, Haroche opened the modern era of experimental CQED during the 1980s. He explored the strong coupling regime in which the atom field interaction overwhelms the dissipative process. He demonstrated spectacular effects of quantum mechanics, such as the modification of atomic spontaneous emission by properly engineering the vacuum field boundary conditions and the observation of atomic superradiance in a cavity. Haroche made photon-by-photon observations possible, giving scientists the ability to watch a quantum measurement unfold in real time. During the 1990s, Haroche was the first to investigate the decoherence of a mesoscopic quantum superposition, which is essential in the quantum measurement process and also provides an explanation of the lack of quantum superposition at the macroscopic scale. Haroche's most recent work has focused on improving the quality of superconducting microwave cavities to enable real-time observation of quantum jumps of light through a quantum nondemolition photon counting process, which has opened new lines of research and helped realize quantum feedback loops.

A recipient of the 2012 Nobel Prize in Physics and member of the European Physical Society, Haroche is a professor and chair of quantum physics with the Collège de France, Paris, France.

Scope: For those who have rendered meritorious service to humanity in IEEE's designated fields of interest and who are not members of IEEE.

IEEE Honorary Membership

Sponsored by IEEE



Rodolfo Zich

For leadership in the global integration of electrical and electronics engineering education and research

A leading scientist in the area of electromagnetic wave scattering and antennas, Rodolfo Zich has continuously worked to expand international collaborations in electronics and telecommunications by establishing university exchange programs and international conferences that have promoted research and higher education in information and communications technology engineering around the world. While president of the Politecnico di Torino, the leading technical university of Italy, he worked tirelessly to greatly strengthen the cooperation with industry, increase the competition in European research space, develop joint teaching and research programs with several European institutions, and to create a worldwide network of cooperative efforts with over 50 universities from all continents. Zich was instrumental in transforming the Politecnico into an international venue of excellence for engineering research and education, increasing the foreign student population to 20% and attracting some of the best electronics researchers in the world. He developed graduate-level student-exchange programs with several European and U.S. universities that have been in effect for over 20 years. In 1992 he created and directed a network to provide remote education at the master's level, the first in Italy and one of the most advanced in Europe. To further promote international collaborations in diverse areas of electronics and communications, Zich established (in 1989) and has expanded the International Conference on Electromagnetics in Advanced Applications (ICEAA). The ICEAA has become a prestigious venue for international scientists and engineers held each year in different locations around the world. Zich also founded and has been chairing both the Istituto Superiore Mario Boella in Torino and the Torino Wireless Foundation, which are devoted to research and dissemination of advanced wireless technologies.

Zich is president of the Torino Wireless Foundation and president of the Istituto Superiore Mario Boella, Torino, Italy.

Scope: For those who have rendered meritorious service to humanity in IEEE's designated fields of interest and who are not members of IEEE.

2016 IEEE MEDALS

IEEE Alexander Graham Bell Medal

Sponsored by Nokia Bell Labs



Roberto Padovani

For innovations enabling efficient, wide-band, wireless access to the Internet, that is central to all third-generation cellular networks

The third-generation (3G) cellular technology enabled by the vision and leadership of Roberto Padovani is transforming lives around the world by supporting voice and wireless Internet access via mobile devices to over 3 billion people. Padovani provided key leadership in developing and commercializing code-division-multiple-access (CDMA) technology during the 1980s and 1990s to substantially increase circuit-switched voice capacity and enable efficient high-data-rate (HDR) packet-switched communications. His work has formed the basis for all 3G cellular systems and has also influenced fourth-generation long-term evolution (LTE) systems. Padovani later adapted CDMA technology, which was originally heavily tuned for voice services, to support data services. To overcome the challenges of asymmetry in data traffic in the up- and downlinks and the bursty nature of data, Padovani developed innovations including the scheduling of high and low rate users, variable modulation and code rate, and power control strategies for more efficient Internet data transfer, resulting in the HDR technology. He realized early on that, for packet data, symmetric performance across uplink and downlink and equal grade of service across users could be relaxed to improve total system throughput, in contrast to voice designs that focused on giving all users equal service in all conditions. Slow to be accepted by operators who were primarily concerned only with voice capacity, the demand for HDR communications grew as mobile phones began to support e-mail and Internet services. HDR evolved into the 1X EVDO system, which paved the way for high-speed data services on 3G systems. The availability of packet-switched Internet access made possible by Padovani's innovations has impacted business, safety, entertainment, navigation, social networking, education, and health in developed and especially developing countries around the world.

An IEEE Fellow and member of the U.S. National Academy of Engineering, Padovani is executive vice president and fellow with Qualcomm Technologies, San Diego, CA, USA.

Scope: For exceptional contributions to the advancement of communications sciences and engineering.

IEEE Edison Medal

Sponsored by Samsung Electronics Co., Ltd.



Robert Brodersen

For contributions to integrated systems for wired and wireless communications, including wireless connectivity of personal devices

With the vision that wireless technology would fundamentally change the way we interact with information, Robert Brodersen has been at the forefront of introducing innovative technologies that are changing the wireless landscape even today. Focusing on using standard low-cost complimentary metal-oxide semiconductor (CMOS) technologies for integrated systems, Brodersen's work has enabled higher data rates, better energy efficiency, and better spectrum utilization critical to wireless devices. A testament to Brodersen's vision was the development of the Infopad as the first wireless tablet during the early 1990s. A complete integrated system, the project demonstrated the potential of cloud computing, broadband wireless connectivity, and low-power mobile computing well before the true emergence of the Internet and wireless networks. It took technology 15 years to catch up to his concept with the emergence of devices like the iPad, but the proliferation of personal devices we now take for granted shows that Brodersen's vision was spot on. Before energy efficiency of devices was an issue, Brodersen was one of the first to demonstrate that improving energy efficiency was critical to the continued scaling of digital circuitry. His combination of concurrency with voltage scaling in 1992 radically changed the way we build computer systems, making possible the multicore paradigms that fuel today's high-performance and mobile computing systems. He later extended this concept to include dynamic voltage scaling, which allows processors to scale energy efficiency proportional to the requested performance. In the late 1970s Brodersen also pioneered the idea of using switched capacitors for monolithic integrated filters. Originally used for single-chip realizations of pulse code modulation interfaces for wired telephony, switched-capacitor circuits have been the preferred choice for the efficient implementation of on-chip filters for the past four decades.

An IEEE Fellow and member of the U.S. National Academy of Engineering, Brodersen is a Professor Emeritus with the University of California, Berkeley, CA, USA.

Scope: For a career of meritorious achievement in electrical science, electrical engineering or the electrical arts.

2016 IEEE MEDALS

IEEE Richard W. Hamming Medal

Sponsored by Qualcomm, Inc.



Abbas El Gamal

For contributions to network multi-user information theory and for wide-ranging impact on programmable circuit architectures

Abbas El Gamal's lasting contributions to information theory, wireless networks, field programmable gate arrays (FPGAs), and digital imaging have immensely impacted a wide variety of information technology applications critical in today's society. His early work formed the basis for several new areas in multi-user information theory, paving the way to capacity results integral to today's communications networks. He determined the capacity of the product of Gaussian broadcast channels and of deterministic interference channels leading to recent advances in multi-antenna and interference-limited wireless networks. Together with Thomas Cover, he established the first upper and lower bounds on the capacity of the three-node relay network. This work introduced the cut-set upper bound for networks, which is widely used in information theory today, as well as the compress-forward and decode-forward schemes, which continue to be the dominant relaying techniques. His recent work has involved the creation of coding schemes for sending multiple sources over noisy networks, and significant contributions to wireless networks through characterizing their optimal delay-throughput tradeoff and devising schemes for energy-efficient packet transmission scheduling. His book *Network Information Theory* (Cambridge Press, 2011) with Young-Han Kim provides the first unified and comprehensive coverage of the field. El Gamal's contributions to hardware design include the development of integrated circuit fabrics and tools that significantly reduce design time and cost of systems used in computing, communication, and signal-processing applications. In 1986, he cofounded Actel, where he coined the routing architecture used in all commercial FPGAs today. He subsequently pioneered the use of FPGAs in teaching digital system design, which has become standard in all electrical engineering programs.

An IEEE Fellow and member of the U.S. National Academy of Engineering, El Gamal is a professor and chair in the Department of Electrical Engineering at Stanford University, Stanford, CA, USA.

Scope: For exceptional contributions to information sciences, systems, and technology.

IEEE Medal for Innovations in Healthcare Technology

Sponsored by the IEEE Engineering in Medicine and Biology Society



Charles A. Mistretta

For the development of imaging instrumentation and techniques that have transformed the diagnosis and treatment of vascular disease

The pioneering accomplishments and vision of Charles A. Mistretta in developing digital subtraction angiography (DSA), time-resolved magnet resonance angiography (MRA), and accelerated imaging algorithms have transformed diagnostic radiology. During the 1970s, screen film X-rays were the standard for radiography and angiography. However, film angiograms were limited due to interference from overlying anatomy. Mistretta recognized the importance that electronic subtraction in imaging could play in providing vascular images that were free of obscuring anatomy. Incorporating a hand-made, custom-designed digital image processor, Mistretta introduced his DSA technique. He went on to refine and optimize DSA to provide virtually real-time visualization of vascular structures without obstructions, revolutionizing angiography with a safer and more effective technology that is now found in practically every medical center. DSA is also considered an enabling technology that made minimally invasive vascular therapeutic procedures such as angioplasty and stenting possible. During the 1990s, Mistretta applied DSA technology to overcome the limitations of slow magnetic resonance data acquisition in contrast-enhanced MRA techniques. He developed the time-resolved imaging of contrast kinetics (TRICKS) method for three-dimensional visualization of previously difficult-to-image vascular beds. TRICKS provides clinicians with dynamic vascular information and eliminates the timing uncertainty associated with single-image contrast-enhanced MRA. This radiation-free MRA method uses less toxic contrast material and is performed intravenously rather than intra-arterially for enhanced safety and effectiveness. Mistretta's recent efforts include work on image acceleration. His highly constrained reconstructions from projections (HYPR) method provides rapid accelerations of dynamic or parametric imaging by using imaging data acquired over a short time interval to weight an image acquired over a much longer time interval.

A member of the U.S. National Academy of Engineering, Mistretta is a professor with the Department of Medical Physics, Radiology, and Biomedical Engineering at the University of Wisconsin-Madison, Madison, WI, USA.

Scope: For outstanding contributions and/or innovations in engineering within the fields of medicine, biology, and healthcare technology.

2016 IEEE MEDALS

IEEE Jack S. Kilby Signal Processing Medal

Sponsored by Texas Instruments, Inc.



Louis Scharf

For pioneering and sustained contributions to statistical signal processing and its practice.

Pioneering and introducing the use of statistical invariance for the design of detectors and estimators, Louis Scharf has profoundly impacted the way statistics are used in modern signal processing to provide solutions for a wide range of engineering problems. Scharf is most known for his work on modal analysis, invariance theories for subspace signal processing, dimension reduction in subspaces for managing performance metrics, and for his recent work on coherence statistics for space-time signal processing. His work on modal analysis is being applied to mode tracking in power systems to identify and track low-frequency modes of oscillation that reveal vulnerabilities to system instabilities. He introduced invariance as an important principle for designing optimal detectors, which has resulted in matched and adaptive subspace detectors for radar, sonar, and hyper-spectral imaging. These detectors adaptively find tell-tale signatures in broadband multisensor time series while maintaining invariance to unknown channel variations that cannot be modeled or estimated. Scharf's work on coherence is bringing attention to the commonality of a variety of seemingly disparate problems in detection and estimation theory. He also pioneered the geometric approach to interpreting signal processing problems and their solutions, leading to the application of problem-solving tools such as subspace projections (orthogonal and oblique), canonical coordinates, and principal angles between subspaces. His early work on the geometrical point of view provided a pathway for future researchers resulting in new insights and useful ways of approaching and solving problems. Scharf's *Statistical Signal Processing: Detection, Estimation, and Time Series Analysis* (Addison Wesley, 1991) is considered a definitive text on the subject.

An IEEE Life Fellow and recipient of an IEEE Third Millennium Medal (2000) as well as a Technical Achievement Award (1995) and Society Award (2004) from the IEEE Signal Processing Society, Scharf is Research Professor of Mathematics and Emeritus Professor of Electrical and Computer Engineering, Colorado State University, Fort Collins, CO, USA.

Scope: For outstanding achievements in signal processing.

IEEE/RSE James Clerk Maxwell Medal

Sponsored by IEEE



Geoffrey Hinton

For pioneering and sustained contributions to machine learning, including developments in deep neural networks

Driven by the desire to understand the mechanisms of cognition in the human brain and how to apply them to machines that learn, Geoffrey Hinton is considered the leading authority on machine learning. Hinton's development of the backpropagation algorithm was key to the resurgence of the machine learning field during the 1980s. He realized and demonstrated that, in addition to performing nonlinear regression and classification, backpropagation allowed neural networks to develop their own internal representations. The backpropagation algorithm has been used successfully in applications including speech and visual object recognition, fraud detection, plant monitoring, and automated check verification. His early work on the Boltzmann machine during the 1980s introduced many of the concepts that have remained at the forefront of neural network learning. Boltzmann machines were initially considered too slow for widespread application. However, as computing power improved, Hinton was able to develop a specific Boltzmann machine that provides much faster training properties than the earlier general machines. The ability to pre-train each of the layers of neural networks having up to 20 layers of parameters ushered in the era of deep-learning neural networks. Hinton demonstrated that deep networks, which partition the neural network into many layers, can be trained using mostly unsupervised learning, level by level, with each level learning to represent slightly more abstract concepts than the previous level, by composing those concepts represented by the previous levels. Hinton's work on deep learning has completely revolutionized the field of machine learning, especially impacting machine vision applications including image classification, medical diagnostics, law enforcement, computer gaming, and enhanced vehicle safety.

A Fellow of the Royal Society (U.K.) and recipient of the IEEE Neural Network Pioneer Award (1998), Hinton is a Distinguished Emeritus Professor with the Department of Computer Science at the University of Toronto, Toronto, Ontario, Canada, and a Distinguished Researcher at Google Inc., Mountain View, CA, USA.

Scope: For groundbreaking contributions that have had an exceptional impact on the development of electronics and electrical engineering or related fields.

2016 IEEE MEDALS

IEEE James H. Mulligan, Jr. Education Medal

Sponsored by MathWorks, Pearson, and the IEEE Life Members Fund



Simon Haykin

For contributions to engineering education in adaptive signal processing and communication

With a passion for ensuring that education and research regularly reinforce each other, Simon Haykin is among the most influential electrical engineering educators of our generation. A prolific writer of textbooks, Haykin believes that, whenever possible, an author should make sure that the teacher adopting the textbook and the student studying from the book both feel comfortable in reading the textbook. This belief has been key to the success of his many landmark books on signal processing, adaptive filtering, communications (both analog and digital), neural networks, and learning machines that have made him well known throughout the world. The use of his textbooks is so widespread that many if not most of today's practicing engineers learned their fundamentals in communications, radio, and radar from Haykin. In 2015, it was estimated that over 14,000 students at over 120 universities in the United States and Canada alone were using one of Haykin's textbooks. He continues to define new topics that bring together signal processing, communications, controls, machine learning, and cognitive science. Haykin's current focus is devoted to a new way of thinking about human cognition from an engineering perspective. He has written books on cognitive networks and the fundamentals of cognitive radio and is currently working on what he considers his most important text, *Cognitive Dynamic System Theory*. This book builds on the teaching of cognitive dynamic systems at the graduate level and beyond by mimicking the brain and complementing it with engineering fundamentals. Haykin was the founding director of McMaster University's Communications Research Laboratory, which has distinguished itself for contributions to signal processing, adaptive filtering, radar, and communications.

An IEEE Life Fellow, Fellow of the Royal Society of Canada, and recipient of many international awards, Haykin is a Distinguished University Professor with the Electrical and Computer Engineering Department at McMaster University, Hamilton, Ontario, Canada.

Scope: For a career of outstanding contributions to education in the fields of interest of IEEE.

IEEE Jun-ichi Nishizawa Medal

Sponsored by the Federation of Electric Power Companies, Japan



Masayoshi Esashi

For pioneering contributions to micro-electro-mechanical systems (MEMS), and their uses in automobiles, cellular phones, industrial equipment, and medical devices

Masayoshi Esashi has been a pioneering force of micro-electro-mechanical systems (MEMS) technology for over 40 years, developing and bringing to market the tiny sensors and actuators that provide advanced functionalities in today's automobiles, cellular phones, industrial equipment, and medical devices. Esashi's key contributions to biomedical microsensors began in the 1970s, where his work on an ion-sensitive field-effect transistor (ISFET) led to the development of medical catheters for in-vivo pH and PCO₂ monitoring. During the 1980s, Esashi developed many MEMS and integrated circuit (IC) devices including a servo-type accelerometer, networked tactile sensor, multifreedom active catheter, and a monolithically integrated capacitive pressure sensor that was commercialized by Toyoda Machine Works. The micro-fluidic system developed by Esashi during the 1990s, which featured microchannels, flow sensors, valves, and pumps on a silicon wafer, provided the foundation for the micro total analysis system/lab-on-a-chip technologies of today. To provide the often-lacking tools needed for continued innovation of MEMS-based devices, Esashi used his IC research and development experience to help develop etchers, deposition machines, and special lithography and evaluation tools. His development of an ion-reactive etcher enabled the fabrication of deep trenches in silicon, which was critical to the commercialization of inertial sensors now used in over 1 million automobiles for active safety control. Another hallmark of Esashi's career has been his belief in "open innovation" collaboration. He established the Micro System Integration Center where companies can work together to advance MEMS technologies. This has resulted in wafer-level-based hetero-integrated devices such as piezoelectric MEMS switches for mobile phones, monolithic tunable filters for cognitive radios, MEMS-on-IC networked tactile sensors for human-friendly robots, and massively arrayed electron beam emitters for maskless high-speed nanolithography.

An IEEE Member and recipient of the Medal with Purple Ribbon from the government of Japan, Esashi is a professor with Tohoku University, Sendai, Miyagi, Japan.

Scope: For outstanding contributions to material and device science and technology, including practical application.

2016 IEEE MEDALS

IEEE Robert N. Noyce Medal

Sponsored by the Intel Foundation



Takuo Sugano

For contributions to and leadership in the research and development of the science and technology of semiconductor devices

Takuo Sugano has dedicated his career to strengthening the understanding of semiconductor materials to enable progress in developing advanced silicon-based electronic devices and the continued growth of the industry. During the 1960s, he tackled instability issues in silicon metal-oxide-semiconductor field-effect transistors (MOSFETs) caused by sodium contamination. Using radio-activation analysis, Sugano demonstrated the physical mechanism of prevention of sodium ions from moving in the dielectric, leading to more stability and enabling more reliable and high-performance MOSFETs. Assuming that chemical bonds between silicon and oxygen or silicon at silicon dioxide-silicon interfaces are stretched, he also proposed a novel model on the origin of the U-shaped energy distribution of density of trap state at silicon dioxide-silicon interfaces. His work on electron transport in the silicon inversion layer highlighted the effect of surface quantization of carriers in MOSFET channels at room temperature to improve the dynamic characteristics of silicon MOSFETs. The resulting improvement in performance helped move the commercial application of silicon MOSFETs beyond personal calculators. To further improve MOSFET reliability, Sugano then focused his efforts on electron and hole trapping in silicon dioxide films that were thermally grown in an ultra-dry or conventional oxidizing atmosphere on the surface of silicon substrates and the generation of interface trap states by electron or hole injection. Also important to increasing the understanding of semiconductor materials was Sugano's role in establishment of a class-100 clean room in 1975 at the University of Tokyo at a time when clean rooms were not popular at universities. Sugano has also made pioneering contributions to III-V semiconductors, superconducting (Josephson junction) devices, and single-electron transistors. He developed an anodic oxidation process for III/V compound semiconductors in inductively coupled plasma and demonstrated its usefulness for fabricating gallium arsenide insulated-gate FETs. He also has made important contributions to plasma processes for fabrication of silicon large-scale integrated circuits, including plasma etching, plasma cleaning, and plasma oxidation.

An IEEE Life Fellow and recipient of the Person of Cultural Merit award (2006) from the government of Japan, Sugano is a Professor Emeritus with the University of Tokyo, Tokyo, Japan.

Scope: For exceptional contributions to the microelectronics industry.

IEEE Dennis J. Picard Medal for Radar Technologies and Applications

Sponsored by the Raytheon Company



Nadav Levanon

For contributions to radar signal design and analysis, pulse compression, and signal processing

With a central research theme of waveform design and analysis, Nadav Levanon is considered one of the world's foremost experts on radar theory and practice with many contributions to techniques that have become fundamental practices in radar signal processing. Levanon is most known for his development of the periodic ambiguity function (PAF), which is an important extension of Woodward's ambiguity function. PAF is the main tool for analyzing and designing continuous-wave radar waveforms and periodic pulsed waveforms. Levanon's early work on multicarrier waveforms for radar provides waveform variability and separability, which are of concern to advanced multiple-input, multiple output (MIMO) coding and are explored by the radar community. His recent work on noncoherent pulse compression has enabled coding concepts normally used in coherent radar to be applied to noncoherent radar such as laser radar. Making use of the laser's natural on-off keying technique, these radars can operate using extremely low-peak optical power, which is important for low-cost operation and stealth applications. Levanon designed and built his first radar during 1968-69 as part of his Ph.D thesis. Hundreds of these balloon-borne radar altimeters flew for months on meteorological balloons that provided data used to enhance the early Antarctic ice elevation maps. His radar was later adapted for aircrafts as the Sperry AA100 Radar Altimeter. He also headed a team that developed the first bird-borne beacon for the ARGOS satellite tracking system that was used to locate and gather information on migrating birds. Levanon also developed the user location concept of Qualcomm's GLOBALSTAR satellite communication system. Levanon's *Radar Principles* (Wiley, 1988) and *Radar Signals* (Wiley, 2004) are important books in the field that have educated two generations of radar students and experts.

An IEEE Life Fellow and Fellow of the Institution of Engineering and Technology, Levanon is a Professor Emeritus of the Faculty of Engineering with Tel Aviv University, Tel Aviv, Israel.

Scope: For outstanding accomplishments in advancing the fields of radar technologies and their applications.

2016 IEEE MEDALS

IEEE Medal in Power Engineering

Sponsored by the IEEE Industry Applications, Industrial Electronics, Power Electronics, and Power & Energy Societies



Arun G. Phadke

For contributions to synchrophasor technology for monitoring, control, and protection of electric power systems

The pioneering work of Arun G. Phadke on computer-based protection equipment for providing precise, real-time data on power transmission system conditions has provided the backbone for today's wide-area measurement and control systems used to ensure power grid reliability and prevent disruptions from leading to large-scale blackouts. Phadke developed synchrophasors for measuring the flow of electricity through the power grid. Synchrophasors are time-synchronized numbers that represent both the magnitude and phase angle of the sine waves found in electricity and are time-synchronized for accuracy. Phadke also developed the phasor measurement unit (PMU) for measuring synchrophasors. PMUs have proven to be the main tool for the monitoring, protection, and control of the grid and are considered a quantum leap over analog technology, quickly providing the information needed to maintain grid stability over a wide region. During the 1990s, Phadke helped develop the concept of adaptive relaying. Using the computing and communications capability of computer relays, this concept allows for automatic adjustment of protective relay characteristics to match prevailing power system conditions to avoid unnecessary trips of equipment as a catastrophic power system event evolves. Phadke's efforts on advancing computer-based protective relaying began in the early 1970s when his implementation of protective algorithms in an IBM minicomputer and its subsequent installation in a 138-kV substation near Roanoke, Virginia, represented the world's first communicating relay and fault recorder. Also, his digital symmetrical component distance relay was a significant contribution to the distance protection of transmission lines. His early work on Fourier transforms for voltage and current calculation serves as the foundation for most of the digital relays installed throughout the world today.

An IEEE Life Fellow and member of the U.S. National Academy of Engineering, Phadke is a University Distinguished Research Professor with the Faculty of Engineering at the Virginia Polytechnic Institute and State University, Blacksburg, VA, USA.

Scope: For outstanding contributions to the technology associated with the generation, transmission, distribution, application, and utilization of electric power for the betterment of society.

IEEE John von Neumann Medal

Sponsored by IBM Corporation



Christos H. Papadimitriou

For providing a deeper understanding of computational complexity and its implications for approximation algorithms, artificial intelligence, economics, database theory, and biology

Christos H. Papadimitriou is a leader in providing an understanding of how computational complexity can be used as a tool for understanding limits and solving problems within the broader scientific community, pioneering connections and collaborations between computer science and other disciplines. Papadimitriou has been the key player in the development of our understanding of "NP total search problems," which are computational challenges where solutions are guaranteed to exist but may be hard to find. He has been very influential in developing algorithmic game theory, which involves the convergence of computer science and economic theory. His work on computing and determining the computational complexity of the Nash equilibrium has provided important insights for game theory and economics. He studied the algorithmic complexity of computing game-theoretic solutions to cooperative and noncooperative game scenarios, which has had important implications for economics and gauging the health of the Internet amid the risks caused by congestion. He defined the "price of anarchy," which provides a measure of the degree of inefficiency of equilibrium in a game, and is important for quantifying loss due to uncoordinated behavior of selfish agents within networks such as the Internet. Papadimitriou has also demonstrated how computational complexity can be applied to natural processes such as biology, describing the algorithmic aspects of protein structure. His novels *Turing* and *Logicomix* have been very successful in reaching the broader public and exposing many people to some of the fundamental principles and ideas of mathematics and computer science.

A member of the U.S. National Academy of Sciences, the National Academy of Engineering, the American Academy of Arts and Sciences, and an ACM Fellow, Papadimitriou is the C. Lester Hogan Professor of Electrical Engineering and Computer Science with the University of California, Berkeley, CA, USA.

Scope: For outstanding achievements in computer-related science and technology.

2016 IEEE MEDALS

IEEE Medal for Environmental and Safety Technologies

Sponsored by Toyota Motor Corporation



Masahiko Miyaki, Yukihiro Shinohara, and Katsuhiko Takeuchi

For development of electronic multipoint fuel-injection systems, enabling fuel-efficient and low-emission diesel engines

The development of electronic multipoint fuel-injection technology by Masahiko Miyaki, Yukihiro Shinohara, and Katsuhiko Takeuchi has revitalized the popularity of diesel engines by enabling high-power operation with better fuel efficiency and lower emissions than conventional injector technology. The trio's concept of common rail direct fuel injection featured an electronically controlled multi-fuel injection system (ECMFIS) to overcome the limitations of common rail system prototypes of the 1960s. Incorporating an electronically controlled injector and sensors for speed, cylinder identification, and pressure, they were the first to successfully commercialize the diesel common rail system in 1995. Prior to their work, the popularity of conventional diesel engines was waning, due to significant black smoke emissions from poor atomization of fuel caused by

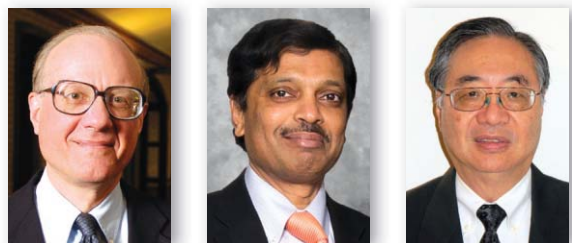
low injection pressure. Their system allowed high fuel injection pressure, even at low engine speeds, for finer atomization resulting in less unburned fuel and fewer particulates. The first-generation ECMFIS reduced emissions of nitrogen oxides and particulates by half and cut combustion noise by as much as 10 dB. Their fourth-generation common rail system (2013) cuts emissions by 80% and further reduces combustion noise. They also developed an innovative feedback control system that can compensate for aging deterioration of the fuel injectors to ensure clean emissions and high drivability throughout the lifespan of the engine.

A Fellow of the Japan Society of Mechanical Engineers, Masahiko Miyaki is executive vice president; Yukihiro Shinohara is executive director of electric systems; and Katsuhiko Takeuchi is head of the diesel business unit—all at DENSO Corporation, Kariya-shi, Japan.

Scope: For outstanding accomplishments in the application of technology in the fields of interest to IEEE that improve the environment and/or public safety.

IEEE Simon Ramo Medal

Sponsored by Northrop Grumman Corporation



John P. Lehoczky, Ragnathan Rajkumar, and Lui Sha

For technical leadership and contributions to fundamental theory, practice, and standardization for engineering real-time systems

The groundbreaking work of John P. Lehoczky, Ragnathan Rajkumar, and Lui Sha on developing the generalized rate-monotonic scheduling (GRMS) theory has revolutionized the modern practice of real-time system design by ensuring that critical tasks can be guaranteed across a wide range of real-world applications. Building upon the RMS theory introduced by Liu and Layland in 1973, the trio developed and refined GRMS theory over two decades to provide predictability, efficiency, and flexibility in scheduling complex concurrent real-time tasks that regular RMS could not satisfy. GRMS transformed the development of real-time systems from what was traditionally a hand-crafted, error-prone process into a scientific engineering discipline for building real-time systems that are pervasive in applications including aerospace, defense systems, transportation, process control, manufacturing, and

medical systems. Their work made it possible to compute both the average-case and worst-case behaviors with useful mathematical precision. Not only does GRMS contribute to keeping development costs in check, it also helps assure that expensive mission failures do not occur. GRMS has been incorporated into IEEE real-time software standards and hardware standards.

An IEEE Member, John P. Lehoczky is the Thomas Lord University Professor of Statistics and Mathematical Sciences, Carnegie Mellon University, Pittsburgh, PA, USA. An IEEE Fellow, Ragnathan Rajkumar is the George Westinghouse Professor with the Department of Electrical and Computer Engineering, Carnegie Mellon University, Pittsburgh, PA, USA. An IEEE Fellow, Lui Sha is the Donald B. Gillies Chair Professor of Computer Science, University of Illinois at Urbana-Champaign, Urbana, IL, USA.

Scope: For exceptional achievement in systems engineering and systems science.

2016 IEEE MEDALS

IEEE Medal of Honor

Sponsored by the IEEE Foundation



G. David Forney, Jr.



For pioneering contributions to the theory of error-correcting codes and the development of reliable high-speed data communications.

In a career spanning more than 50 years, G. David Forney, Jr., has influenced virtually every major advance in the field of coding theory, providing practical solutions that have enabled high-speed data communications for systems ranging from wired to wireless and from electrical to optical. Forney introduced concatenated codes in 1965 as error-correcting codes constructed of two or more simpler codes to achieve good performance with reasonable complexity in detecting and fixing errors during data transmission. His concatenated method became widely used for space communications, and the approach is widely practiced today for satellite communications, mobile telephony, and digital video broadcasting. Forney joined Codex Corporation to develop practical implementations of coding theory, where he designed the first coding system to go into space—a convolutional code with sequential decoding for a NASA Pioneer deep-space mission in 1968. Considered the founder of the modern modem, in 1970 Forney brought quadrature amplitude modulation (QAM) to the marketplace by designing the first high-speed [9,600 bits per second (bps)] QAM telephone-line modem. This became the foundation of Codex’s commercial success, and it revolutionized the industry, providing the foundation for the international V.29 9,600 bps modem standard.

Forney also introduced the now universally used concept of trellis diagrams to describe the Viterbi algorithm, and he is considered the first to recognize the Viterbi algorithm as an opti-

imum sequence detector rather than just a proof technique. His Forney algorithm (FA) is employed by all practical decoders for Reed-Solomon (RS) codes for computing error values after error locations in a received code word have been determined. The FA continues to be widely used in many physical-layer transmission systems and optical/magnetic storage devices, which employ RS coding for outer-layer error control. Another important contribution by Forney is the minimum-phase whitened matched filter for maximum-likelihood sequence decoding of modulation symbols in the presence of intersymbol interference and noise. When turbo codes were introduced in 1993, Forney demonstrated that they could be described as “codes on graphs.” In 2001, with what are now known as “Forney-style factor graphs,” he showed that one graph can simultaneously describe both a code and its dual, which provides for new, efficient decoding algorithms. Forney continues to contribute to error-correcting coding techniques with recent work focusing on tail-biting trellis realizations using Forney-style factor graphs.

An IEEE Life Fellow and member of the U.S. National Academy of Engineering and U.S. National Academy of Sciences, Forney is currently an adjunct professor with the Department of Electrical Engineering and Computer Science and the Laboratory for Information and Decision Systems, Massachusetts Institute of Technology, Cambridge, MA, USA.



Scope: For an exceptional contribution or an extraordinary career in IEEE fields of interest.

IEEE SPECTRUM FEATURE



This is an excerpt from IEEE Spectrum May 2016 print issue as "Modern Maestro."

Modem Maestro

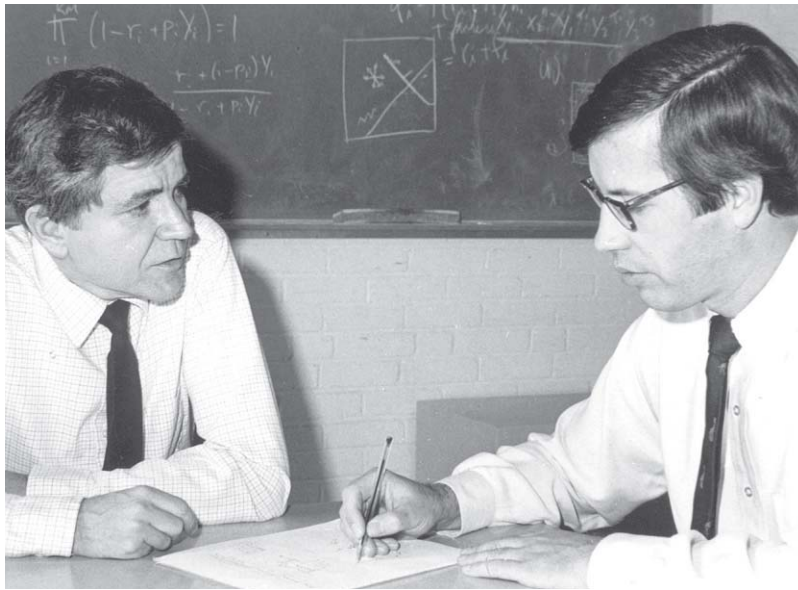
G. David Forney Jr.,
the 2016 IEEE
Medal of Honor
recipient, turns
information theory
into practice

BY MARK ANDERSON

IT CAN SOMETIMES SEEM AS THOUGH there's a gaping chasm between theory and reality. But G. David Forney Jr., the recipient of this year's IEEE Medal of Honor, masterfully straddles both realms, his colleagues say. A key figure in the development of the high-speed modem, a device that opened up the Internet and all its associated world-changing technologies, Forney has balanced the practical and the theoretical throughout his career. Over the years, he has not only made critical contributions to communications and information theory but also put some of this recondite mathematical theory into practice. And as a result, he can claim a key role in the greatest communications revolution in modern history. • "He's one of the people who gets to the heart of abstract subjects very quickly," says Thomas Kailath, an emeritus professor of engineering at Stanford and the 2007 IEEE Medal of Honor recipient. "But uniquely, when needed, he also designed and built circuits, wrote code, and got things working. Everything Dave does, he does well." • And yet, as

PHOTOGRAPH BY Mike McGregor

17 | 2016 IEEE AWARDS BOOKLET

PUSHING THE LIMITS: Forney [right] and Robert Gallager confer at MIT. This photograph was taken around 1965, Forney says.

an underclassman at Princeton in the late 1950s, Forney wasn't necessarily set on a career in engineering. He did ultimately decide to pursue a bachelor of science in engineering, but not out of any burning desire to invent or design.

"I thought, 'I'll keep my options open,' but without any great intention to become an engineer," Forney recalls, relaxing in the sunny sitting area off the kitchen of his Cambridge, Mass., home one December afternoon last year. But an elective course in thermodynamics taught by John Archibald Wheeler stirred a sense of discovery in him.

"I really liked his approach," Forney says of the legendary physicist's down-to-earth teaching style. "It was much more of an engineering course than a physics course. And he [assigned] a term paper instead of a final exam."

For the paper, Forney decided to read Léon Brillouin's 1956 book, *Science and Information Theory*. The book tackled thermodynamics in the context of information theory, then a fledgling field, founded about a decade earlier with a groundbreaking paper by Claude Shannon. In that 1948 paper, "A Mathematical Theory of Communication," Shannon laid out the mathematical foundation for the transmission of information (the centenary of his birth is being celebrated this year).

Forney says he was struck by Brillouin's resolution of the problem

of Maxwell's demon, a thought experiment in which energy appears to be created for free by sorting molecules by their speed. Brillouin noted that every physical system contains information, and extracting that information—in the case of Maxwell's demon, the speed of particles—always costs energy, enough to precisely satisfy the laws of thermodynamics. "Information isn't free; it comes at a cost," Forney says, in summary. "Probably I could poke holes in that now. But certainly as an undergraduate this was all very interesting."

He carried this interest to graduate school at MIT, in 1961, where he found a whirlwind of research activity. Shannon himself had recently arrived from Bell Labs, and a research group was trying to extend his work and find practical uses for it.

In a master's thesis on information theory and quantum mechanics, and a doctoral dissertation on error-correcting codes, Forney displayed a bloodhound's nose for finding the right problems and the right questions to ask about those problems. The 1990 IEEE Medal of Honor recipient, Rob-

ert Gallager, a young faculty member in the mid-1960s and now an emeritus professor at MIT's Research Laboratory of Electronics, singles out Forney's doctoral thesis as a leap forward in the field.

At that time, digital technology was taking off, and researchers were hunting for coding schemes—ways of transforming those 1s and 0s into a form that could be carried from place to place with little power and few errors. In his celebrated 1948 paper, Shannon had already worked out the ultimate limit to such efficiency, a maximum achievable error-free data rate for any communications channel. But reaching that limit was easier said than done.

Disturbances during transmission will flip bits at random. To tackle errors, Shannon proposed adding redundant bits to a sequence of data before transmission to create an encoded packet. The longer the packet, the less likely it would be corrupted to look like another potential sequence. This approach could push transmission to its limits, but it posed a practical challenge at the decoding stage. The straightforward, brute-force approach would compare the incoming sequence with every possible transmitted sequence to find the most likely one. This process could work for relatively short packets, Forney says. But longer packets, which would be needed to obtain very low error rates, would quickly exhaust the computational power of a decoder, even with today's technology.

Researchers proposed various coding schemes to try to achieve data rates close to the Shannon limit with low error rates and reasonable decoding complexity. But there was no single code that could do it all.

Forney had another idea. Why not break the problem down and use multiple, complementary codes to encode and decode data, one operating on the outcome of the other? A simple inner code operating directly on the input and output of a communications channel could achieve a moderate error rate at data rates near Shannon's limit. An outer code, used before data enters the inner code and after exiting it, could drive error rates down further using a

 IEEE SPECTRUM FEATURE

powerful but less computationally complex algorithm.

Forney showed that this approach, dubbed concatenation, could achieve a much better trade-off between data rates and computational complexity, and that it would in principle let existing modems transmit and receive all the way up to Shannon's limit. "Today, almost every coding scheme for transmission is in some form a concatenated scheme," says colleague Gottfried Ungerboeck. "You can transmit information faster and more reliably with the same power and bandwidth."

Coming out of graduate school in 1965, Forney recalls that information theory was a field brimming with ideas and yet-to-be-realized applications. Any such IT field today might have launched a dozen startups, with angel investors hovering to pounce on possible secondary spin-off opportunities. But at the time, startups weren't really part of the culture, Forney says. Smart and capable grads who didn't intend to stay in academia typically sought out big companies.

Forney submitted applications to some of the usual suspects—IBM and Bell Labs. But on the advice of Gallager, Forney also applied to the recently formed Codex Corp. The Massachusetts-based company gave Forney the lowest offer. But he was sold. "They were in business to try to make information theory practical, to make coding practical. Nobody else was doing that," he says.

Forney became the 13th employee in the company, which would be bought by Motorola in 1977 and ultimately employ thousands. One of his first projects was a communications contract for NASA, creating coding and decoding algorithms for some of the agency's Pioneer spacecraft.

But the project that put Codex—and Forney—on the map was a 9,600-bit-per-second modem that became the basis of the company's commercial success. The company had devised the first such modem in 1968, Forney says, and it sold for more than US \$20,000 to big firms with international data networks, such as banks and airlines. But, like its competitors, the modem turned

out to be unreliable owing to a previously unrecognized problem with the telephone networks that added "phase jitter"—random variation in the phase of the signal-carrying waves traveling across them.

Following up on a suggestion made by Gallager, Forney designed a family of modems that used a modulation scheme called quadrature amplitude modulation. This approach, which could better handle phase shifts, produced a more reliable and successful modem. The design eventually became the basis of the international V.29 9,600-bit-per-second modem standard.

But this early practical success didn't lure Forney away from the fundamentals. After his modem work in 1970 and 1971, he spent a sabbatical year at Stanford. And when he returned, he set out to write up some thoughts he'd had on how an algorithm proposed in 1967 by Andrew Viterbi might be applied to signal decoding.

The result was a landmark 1973 paper in the Proceedings of the IEEE that popularized the Viterbi algorithm by introducing a visualization technique called the "trellis diagram." The algorithm can be used to recover data from a patchy or noisy signal. Today, it is used in an extraordinary range of disparate technologies, including modems, wireless communications, and voice and handwriting recognition, as well as DNA sequencing.

To explain how the Viterbi algorithm works, Forney gives a handwriting recognition example. Reading in the letters for the word "hand," the computer might initially determine that the second letter looks more like a q than an a. But a recognizer running the Viterbi algorithm will also factor in the fact that "hand" is a much more likely English word than "hqnd." "It finds the most likely sequences, taking into account both raw likelihood and sequence constraints," Forney says.

Viterbi-algorithm decision trees can be plotted in a latticelike trellis diagram, an approach Forney and his colleagues say is much simpler than writing out formulas and logical if-then statements. Trellis diagrams "laid

things out graphically, which appeals to people more than just a collection of equations [does]," says Stanford's Kailath. "They provided a tool for engineers to appreciate what the Viterbi algorithm could do and make extensions of it."

From 1975 to 1985, Forney served as an R&D executive for Codex and then Motorola, after the company's acquisition. In the 1980s, Forney was inspired by trellis-coded modulation, a new signaling scheme developed by Ungerboeck that was rapidly adopted in modems, and he was drawn back into research. In the decades since, he has worked extensively on codes, with an eye toward continuing to raise the efficiency of data transmission. A number of his papers, as with his work on trellis diagrams, reintroduced key concepts into the field that other researchers could then apply.

Forney retired from Motorola in 1999. He has been an adjunct professor in the department of electrical engineering and computer science and the Laboratory for Information and Decision Systems at MIT since 1996.

Regarding his contributions, Forney says modestly, "I'm just the guy who comes along at the end of the circus parade." After a discovery has been made, he'll add to it, he says. In a sentence he sums up these insights: "You know, the right mathematical language to talk about this invention is this."

Filling out the framework around a new theory or algorithm might not be the kind of work that garners headlines, but it's still critical to progress, Gallager says. "Researchers 'keep score' by counting inventions and weighting them by their popularity," he says, but "what makes a research field grow and evolve is the context, relations, and connection to reality." Forney has created this "context in the information theory and communication technology fields to a greater extent than almost anyone else," Gallager says.

And in the ever-evolving world of engineering, the ability to draw from theory to push the limits of what's practical is one skill that will never go out of style. ●

2016 IEEE TECHNICAL FIELD AWARDS

IEEE Biomedical Engineering Award

Sponsored by the IEEE Circuits and Systems Society, IEEE Computational Intelligence Society, and IEEE Engineering in Medicine and Biology Society



K. Kirk Shung

For contributions to ultrasound imaging and transducer technology

A world-renowned leader of biomedical ultrasound technology, K. Kirk Shung's pioneering discoveries have contributed significantly to the health and welfare of society. His early work involving the interaction of ultrasound and blood has set the standard for research activities and the development of diagnostic ultrasound equipment. His study led to a thorough understanding of the origin of echogenicity of biological tissues in an ultrasonic image. Shung is also credited for developing the world's first high-frequency linear array at 30 MHz for imaging, an important technological breakthrough in the field. His recent innovations include applying high-frequency ultrasound beams to trap micro-particles and cells and in assessing cellular responses to ultra-high-frequency ultrasound stimulation.

An IEEE Life Fellow, Shung is the Dean's Professor in Biomedical Engineering at the University of Southern California, Los Angeles, CA, USA.

IEEE Cleo Brunetti Award

Sponsored by the Brunetti Bequest



Akira Toriumi

For contributions to CMOS device design from materials engineering to device physics

Akira Toriumi's pioneering contributions to understanding advanced gate dielectrics and device physics are driving the continued miniaturization of components needed for current and future electronic devices. His early work on random dopant fluctuation-induced threshold voltage variation and its effect on device reliability addressed an important source of variation facing device design when trying to further scale power supply voltage. In the area of high-k silicon dielectrics, Toriumi demonstrated some of the thinnest reliable dielectrics to date to enable high-k gate stacks. He has also pioneered the investigation of using germanium as an alternative channel material for high-performance complementary metal-oxide semiconductor (CMOS), which will be critical to providing the reduced power supply voltages needed for even smaller future technology generations.

An IEEE Senior Member, Toriumi is a professor with the Department of Materials Engineering at the University of Tokyo, Tokyo, Japan.

IEEE Components, Packaging, and Manufacturing Technology Award

Sponsored by the IEEE Components, Packaging, and Manufacturing Technology Society



Michael Pecht

For visionary leadership in the development of physics-of-failure-based and prognostics-based approaches to electronic packaging reliability

A world leader in electronics packaging reliability, Michael Pecht has developed prediction tools that enable manufacturers to make their products safer and more operationally available. As an alternative to flawed handbook-based reliability prediction methods, Pecht developed the physics-of-failure (PoF) approach to electronics reliability. The PoF approach provides greater accuracy by taking into account the actual failure mechanisms of the device in the operating conditions that the device would likely face in the field. He also developed prognostics-based health assessment methods that have been adopted by industry to predict reliability for critical systems such as vehicle batteries, avionics, and alternative energy sources. Pecht also founded the Center for Advanced Life Cycle Engineering.

An IEEE Fellow, Pecht is director of the Center for Advanced Life Cycle Engineering at the University of Maryland, College Park, MD, USA.

IEEE Control Systems Award

Sponsored by the IEEE Control Systems Society



Arthur J. Krener

For contributions to the analysis, control, and estimation of nonlinear control systems

Arthur J. Krener's foundational work on nonlinear control provided the definitive treatment on controllability and observability of time-variant, real-world systems and has spurred tremendous progress in the development of nonlinear control theory. Krener's work during the 1970s set the cornerstone for control of nonlinear systems and the resulting research paper was selected by the IEEE Control Systems Society as one of the 25 Seminal Papers of the 20th Century for its far-reaching importance. Krener's work on a bifurcation-based approach to controlling models of rotating stall and surge has been invaluable to the U.S. Air Force's study of jet engine instabilities. He has also been a leader in developing software tools for implementing the latest methods of nonlinear control.

An IEEE Life Fellow, Krener is a research professor with the Department of Applied Mathematics at the Naval Postgraduate School, Monterey, CA, USA.

2016 IEEE TECHNICAL FIELD AWARDS

IEEE Electromagnetics Award

Sponsored by the IEEE Antennas and Propagation Society, IEEE Electromagnetic Compatibility Society, IEEE Geoscience and Remote Sensing Society, and IEEE Microwave Theory and Techniques Society



Giorgio Franceschetti

For leadership in the academic world, teaching, research, and scientific activities in advanced electromagnetics

Giorgio Franceschetti has helped advance the field of electromagnetics through innovative research and high-level teaching covering diverse areas ranging from electromagnetic propagation in complex environments to wireless transmission power. Franceschetti introduced the study of electromagnetic fields and waves to Italian universities in 1965 and established an outstanding research community. His contributions to synthetic aperture radar technologies have been successfully used for imaging the Earth's surface from space. His work on the degrees of freedom involving scattering fields has enabled more accurate sampling, which has impacted electromagnetic imaging. As recognition of his long-lasting impact on electromagnetics, the November/December 2014 issue of the *Forum for Electromagnetic Research Methods and Application Technologies* (Vol. 6, NEWS&VIEWS) was dedicated to Franceschetti and contains a salute and a tribute to his accomplishments.

An IEEE Life Fellow, Franceschetti is a Professor Emeritus with the University Federico II, Naples, Italy.

IEEE Fourier Award for Signal Processing

Sponsored by the IEEE Circuits and Systems Society and the IEEE Signal Processing Society



Bede Liu

For foundational contributions to the analysis, design, and implementation of digital signal processing systems

Bede Liu's cutting-edge research has profoundly impacted the digital processing of images and video by enabling signal processing systems that feature lower circuit count, minimal power consumption, and reduced design cost critical to today's mobile multimedia devices. His revolutionary concept of incorporating a fixed number of shift-adds for multiplier-free filters provided a 3-to-1 savings in computation time over the traditional use of full multipliers. Liu's proposal to use 1-bit coefficients on over-sampled data achieved significant savings in chip area and power. He also proposed a highly efficient motion vector search method for video coding, providing better accuracy and substantial time savings compared to prior approaches.

An IEEE Life Fellow, Liu is a Professor Emeritus with the Department of Electrical Engineering, Princeton University, Princeton, NJ, USA. He is a member of U.S. National Academy of Engineering, an Academician of Academia Sinica, and a Foreign Member of Chinese Academy of Sciences.

IEEE James L. Flanagan Speech and Audio Processing Award

Sponsored by the IEEE Signal Processing Society



Takehiro Moriya

For contributions to speech and audio coding algorithms and standardization

Considered one of the most innovative speech and audio coding researchers in the world, the technologies and standards developed by Takehiro Moriya are used internationally for the practical transmission of speech signals over digital networks. His many contributions to standardized coding techniques include the pitch synchronous innovation scheme adopted by the Japanese digital cellular phone system, which is recognized as the lowest bit-rate standard for public telephone service in the world. His speech coder implemented in the ITU-T G.729 standard has become the default technique for VoIP systems, cellular phones, and voice recording devices. Moriya also made a significant contribution to establishing MPEG audio lossless coding (ALS), which has been selected as one of the techniques for the next generation of super-high-definition broadcasting in Japan.

An IEEE Fellow and NTT Fellow, Moriya is head of the Moriya Research Lab, NTT Communication Science Laboratories, Atsugi, Kanagawa, Japan.

IEEE Andrew S. Grove Award

Sponsored by the IEEE Electron Devices Society



Carlos H. Díaz

For sustained contributions to and leadership in foundry advanced CMOS logic transistor technology

The innovations in logic transistor technology developed by Carlos H. Díaz have revolutionized the foundry industry and provided semiconductor companies the ability to bring devices to market more quickly and cost effectively. Díaz has successfully developed multiple generations of foundry technology from 0.18 μm forward. He has demonstrated that it is possible to provide a flexible high-density transistor technology platform that supports multiple device segments with minimal burden on manufacturing. Of note is his work on the 28-nm generation, which meets the needs of both high-performance and low-power applications. The 28-nm high-k/metal-gate transistor technology has set the foundry industry standard in performance-power space coverage on a wide range of devices such as cellular/mobile computing, graphics processors, field-programmable-arrays, and central processing units.

An IEEE Fellow, Díaz is the director of Logic Technology Advanced Development Division with Taiwan Semiconductor Manufacturing Co., Hsinchu, Taiwan.

2016 IEEE TECHNICAL FIELD AWARDS

IEEE Herman Halperin Electric Transmission and Distribution Award

Sponsored by the Robert and Ruth Halperin Foundation, in memory of Herman and Edna Halperin, and the IEEE Power & Energy Society



George J. Anders

For contributions to advances in computational methods for the thermal rating of electric power cables

George J. Anders' expertise has contributed toward setting the standard for rating electric power cables, which has provided significant economic benefits to the power industry. His computational techniques using analytical and finite element methods enable engineers to accurately rate cable circuits. He also developed optimization techniques for selecting the most economic conductor sizes, providing accurate calculations to avoid costly oversizing of buried cables. The software for steady-state and emergency ratings of underground cables, which he developed, is used throughout the world and is considered the industry standard for power cable rating calculations. Anders' contributions to early leak detection methods are also helping to reduce the costs of detection, location, clean up, and repair related to cable leaks.

An IEEE Fellow, Anders is currently president of Anders Consulting, Ltd., Woodbridge, Ontario, Canada.

IEEE Masaru Ibuka Consumer Electronics Award

Sponsored by Sony Corporation



Steven J. Sasson

For designing and building the first digital still camera

Steven J. Sasson's development of the first digital still camera and contributions to groundbreaking digital technologies have revolutionized photography, making it easier and less expensive to capture and share photos. His patented work at Kodak during the 1970s involved using a fast charge-coupled device to capture images to a digital buffer memory and transfer them to a nonvolatile digital storage medium. Sasson saw the potential of emerging memory chips and analog-to-digital converters and decided to store four digital bits per pixel on a cassette tape instead of using traditional analog video circuits. During the 1980s, he also developed the first megapixel digital camera incorporating discrete cosine transform compression for storing images on memory cards.

A recipient of the 2009 U.S. National Medal of Technology and Innovation, Sasson is currently president of Steven J. Sasson Consulting, LLC, Hilton, NY, USA.

IEEE Internet Award

Sponsored by Nokia Corporation



Henning Schulzrinne

For formative contributions to the design and standardization of Internet multimedia protocols and applications

The multimedia-capable Internet that we now take for granted was made possible by Henning Schulzrinne's fundamental contributions to the development of network protocols, applications, and algorithms for the effective transport of audio and video signals. He helped migrate the Internet from a medium containing primarily text and images to one featuring both real-time and on-demand audio/video. Key to the success of the Internet was Schulzrinne's Real-Time Transport Protocol, which became an Internet full standard in 2004. He also developed the Real-Time Streaming Protocol to control delivery of audio and video streams, which is supported by major consumer streaming architectures. And his Session Information Protocol became the standard for Internet telephony and conducting real-time interactive multimedia sessions.

An IEEE and ACM Fellow, Schulzrinne is a professor with the Department of Computer Science at Columbia University, New York, NY, USA and serves as a Technology Advisor to the Federal Communications Commission (FCC) in Washington, DC, USA.

IEEE Richard Harold Kaufmann Award

Sponsored by the IEEE Industry Applications Society



G.S. Peter Castle

For developments of applied electrostatic devices and processes in industry, agriculture, and environmental protection

One of the founders of modern applied electrostatics research, G.S. Peter Castle has developed tools for addressing real-world issues impacting manufacturing, agriculture, and the environment. His work on electrostatic precipitators including two-stage precipitation and space charge suppression has improved air-cleaning applications. He also developed processes for electrostatic liquid painting and powder coating, which have provided more cost-effective and environmentally friendly solutions compared to conventional industrial painting systems. Castle's induction charging concept has enhanced liquid deposition of pesticides on leaves, reducing the amount of chemicals that need to be sprayed for improved crop protection. His research concerning contact charging for electrostatic separation of plastics is benefitting the recycling industry.

An IEEE Life Fellow, Castle is a Professor Emeritus and adjunct research professor with the Department of Electrical and Computer Engineering at the University of Western Ontario, London, Ontario, Canada.

2016 IEEE TECHNICAL FIELD AWARDS

IEEE Joseph F. Keithley Award in Instrumentation and Measurement

Sponsored by Keithley Instruments, Inc. and the IEEE Instrumentation and Measurement Society



Samuel P. Benz

For creating and disseminating quantum-based superconducting voltage standards that form the basis for world-wide precision voltage measurements

Considered the premier researcher in developing and applying superconducting quantum voltage standards, Samuel P. Benz has provided industries around the world with the ability to perform precision measurements. Benz advanced the capabilities of Programmable Josephson Voltage Standard (PJVS) systems that provide improved voltage stability and noise immunity compared to conventional JVS technology. Accuracy is achieved because these voltage standards are based on superconducting Josephson junctions incorporating quantum mechanics, which ensures that the voltage does not drift with time or from environmental conditions. He also helped develop the Quantum Watt, which uses a PJVS for best ever power calibration critical to the electric power industry. The NIST alternating current (ac) JVS produces quantum-accurate ac waveforms and also significantly reduces uncertainties.

An IEEE Fellow, Benz is also a NIST Fellow and leads the Superconductive Electronics Group at the National Institute of Standards and Technology, Boulder, CO, USA.

IEEE Gustav Robert Kirchhoff Award

Sponsored by the IEEE Circuits and Systems Society



P.P. Vaidyanathan

For fundamental contributions to digital signal processing

Considered to be one of the pioneering contributors to multirate signal processing research, P.P.Vaidyanathan has heavily influenced the research directions in filter banks and multirate systems. He is most well known for developing the general theory of filter banks with perfect reconstruction, as well as orthonormal filter banks, which have impacted digital communications, audio, and image coders. One of his earliest contributions was in the area of low-sensitivity digital filter structures. He showed how such structures can be designed directly in discrete time, without the need for transforming electrical circuits into the digital domain. An early proponent of applying signal processing methods to genomics, Vaidyanathan developed methods to computationally predict the location of protein coding genes and noncoding genes. His work on coprime and nested arrays is expected to have major impact on applications such as direction finding and radar systems.

An IEEE Fellow, Vaidyanathan is a professor at the California Institute of Technology, Pasadena, CA, USA.

IEEE Leon K. Kirchmayer Graduate Teaching Award

Sponsored by the Leon K. Kirchmayer Memorial Fund



K.J. Ray Liu

For exemplary teaching and curriculum development, inspirational mentoring of graduate students, and broad educational impact in signal processing and communications

K.J. Ray Liu's students aren't just individuals pursuing graduate degrees in signal processing—they become his "extended family." They can attest to how Liu's passion for teaching and mentoring for their professional development goes beyond the classroom, beyond graduation. He is always there for them. Many have gone on to become leaders in academia and industry. Both a world-class researcher and excellent educator who pioneered and cross-pollinated various fields, Liu built the University of Maryland's signal processing program practically from scratch beginning in 1990 and has shaped it into one of the most well-respected graduate programs in the world. He also revamped the University's master's program in telecommunications, creating a unique identity resulting in a scholarly and financially successful program.

An IEEE Fellow, Liu is the Christine Kim Eminent Professor of Information Technology at the University of Maryland, College Park, MD, USA.

IEEE Koji Kobayashi Computers and Communications Award

Sponsored by NEC Corporation



Leandros Tassiulas

For contributions to the scheduling and stability analysis of networks

Leandros Tassiulas has revolutionized how scheduling and stability analysis are performed in communications networks, providing dynamic resource allocation tools to improve performance of wireless networks and Internet switches. Developing control algorithms based on a sound mathematical foundation as an alternative to heuristic approaches, Tassiulas introduced the Max-Weight scheduling algorithm for achieving maximum throughput in systems with conflicting resources as well as the Backpressure routing algorithm for end-to-end traffic forwarding. His Maximum Connected Queue algorithm introduced the concept of opportunistic scheduling that became part of most wireless standards since 3G. Together, these three algorithms provide the basis for cross-layer network design in today's wireless networks.

An IEEE Fellow, Tassiulas is the John C. Malone Professor in the Electrical Engineering Department and the Institute for Network Science at Yale University, New Haven, CT, USA.

2016 IEEE TECHNICAL FIELD AWARDS

IEEE William E. Newell Power Electronics Award

Sponsored by the IEEE Power Electronics Society



Johann W. Kolar

For contributions to the advancement of three-phase pulse-width modulation (PWM) converter systems and power electronics education

A visionary leader in the field of power electronics, Johann W. Kolar has a distinguished record of providing industry with key innovations for ensuring high power quality and saving energy. He has driven advances in three-phase pulse-width modulation rectifier and matrix converter technology, including the Vienna Rectifier and the Sparse Matrix Converter, over the past two decades. Offering outstanding performance concerning efficiency, power density, harmonic distortions, and costs, the Vienna Rectifier is widely employed for power supply of data centers and industry processes, as well as actuators of electric aircraft. Furthermore, Kolar has spearheaded the introduction of multi-objective optimization as a fundamentally new research approach into power electronics and has proposed a revolutionary new approach for education in power electronics that is used today in academia and industry all over the world.

An IEEE Fellow, Kolar is a full professor and chair of the Power Electronic Systems Laboratory at ETH Zurich, Zurich, Switzerland.

IEEE Donald O. Pederson Award in Solid-State Circuits

Sponsored by the IEEE Solid-State Circuits Society



Miles A. Copeland

For contributions to the design and application of switched-capacitor and RF signal processing circuits

Miles A. Copeland's 31-year career is marked by the strength of his achievements as a university teacher, inventor, researcher, and mentor. His innovative approach to industry-university collaboration supported the rapid development of the telecommunication and microelectronics industries in Canada. He coauthored, with Northern Telecom (Nortel), a groundbreaking paper on the use of switched capacitors as resistor equivalents, which demonstrated that filter RC time constants on-chip could depend on the ratio of capacitor sizes. This results in much better integration, repeatability, and accuracy when implementing analog filters on chip than is possible with ordinary resistors. The "filter codec" developed subsequently at Nortel used switched-capacitor filtering. With this innovation the company became an early leader in the shift to fully electronic switching networks. Other research work done by Miles' graduate students included much cited studies of the matching of on-chip capacitors and transistors.

An IEEE Fellow, Copeland is a Professor Emeritus with Carleton University, Ottawa, Ontario, Canada.

IEEE Daniel E. Noble Award for Emerging Technologies

Sponsored by the Motorola Solutions Foundation



Mark G. Allen

For contributions to research and development, clinical translation, and commercialization of biomedical micro-systems

An international leader in the field of micro-electro-mechanical systems (MEMS), the innovations of Mark G. Allen are playing a major role in improving patient care and reducing healthcare costs. His development and commercialization, together with coworkers, of a fully implantable wireless sensor technology for monitoring heart pressure, known as the CardioMEMS Heart Failure System, allows physicians to better regulate patient activity and adjust medication regimes. Allen's innovation represents the first MEMS sensor approved by the U.S. Food and Drug Administration for permanent implantation in humans. Clinical studies of Allen's sensor have demonstrated a 37% reduction in hospital admissions and a 78% reduction in re-admissions, providing better quality of life for patients.

An IEEE Fellow, Allen is the Alfred Fidler Moore Professor with the Department of Electrical and Systems Engineering at the University of Pennsylvania, Philadelphia, PA, USA.

IEEE Frederik Philips Award

Sponsored by Philips Electronics N.V.



Kelin J. Kuhn

For technical leadership in the development and implementation of breakthrough CMOS technology

Kelin J. Kuhn's leadership in turning next-generation complementary metal-oxide semiconductor (CMOS) technology into reality has been critical to enabling the continued miniaturization of transistors required for smaller but more powerful and efficient electronic devices. While working for Intel, Kuhn was responsible for navigating CMOS technology from minimum dimensions of 130 nm to 22 nm. Her involvement with introducing the high-k/metal-gate process was a breakthrough that enabled increased performance with lower power dissipation in electronic devices. She also made significant contributions to enabling the mass production of the TriGate transistor, which facilitates lower operating voltage for a substantial reduction in chip power consumption. These innovations are considered two of the most transformative changes in the history of silicon-based technology.

An IEEE Fellow, Kuhn is a professor with the Materials Science and Engineering Department at Cornell University, Ithaca, NY, USA.

2016 IEEE TECHNICAL FIELD AWARDS

IEEE Photonics Award

Sponsored by the IEEE Photonics Society



Mark E. Thompson

For scientific and technical leadership in the conception, demonstration, and development of phosphorescent materials in organic light-emitting diode (OLED) displays

The highly efficient photonic materials developed by Mark E. Thompson have advanced organic light-emitting diode (OLED) technology from a laboratory curiosity to a booming commercial success, providing low-power, high-resolution displays for mobile devices and the newest generation of flat-panel televisions. With a previous device efficiency of only 25%, OLED performance was severely limited. During the late 1990s, Thompson overcame the limitations by introducing iridium and platinum as materials for electrophosphorescent emitters, which through further development now provide practically 100% device efficiency. Less than 10 years after Thompson's introduction, electrophosphorescent OLEDs were commercialized and are now featured in the very popular Samsung Galaxy smartphones, among other products.

An American Association for the Advancement of Sciences and National Academy of Inventors Fellow, Thompson is a professor with the Department of Chemistry at the University of Southern California, Los Angeles, CA, USA.

IEEE Robotics and Automation Award

Sponsored by the IEEE Robotics and Automation Society



Raffaello D'Andrea

For pioneering contributions to design and implementation of distributed, cooperative robotics and automation systems for commercial applications

Spanning academics, business, and the arts, Raffaello D'Andrea's career is built on his ability to bridge theory and practice. He was the faculty advisor and system architect of the Cornell Robot Soccer Team, four-time world champions at the international RoboCup competition. He was one of the first in the controls community to use a multi-vehicle testbed for research. At ETH Zurich, his research redefines what autonomous systems are capable of. He is cofounder of Kiva Systems, a robotics company that revolutionized material handling by deploying thousands of autonomous mobile robots in warehouses. He recently founded Verity Studios, a company developing a new breed of interactive and autonomous flying machines.

An IEEE Fellow, D'Andrea is professor of dynamic systems and control at ETH Zurich, Zurich, Switzerland.

IEEE Frank Rosenblatt Award

Sponsored by the IEEE Computational Intelligence Society



Ronald R. Yager

For contributions to the theory of fuzzy sets and systems

With almost 40 years of groundbreaking contributions, Ronald R. Yager is one of the most highly cited researchers in the field of computational intelligence. Of major impact has been Yager's introduction of the Ordered Weighted Averaging operator that has been applied to multicriteria decision making, information fusion, database retrieval, and pattern recognition. His methodology for finding linguistic summaries of large data collections makes data easier to understand and has been integral to data mining applications. He also developed a generalized class of logical "and" operators, known as the Yager family of t-norms, that have been widely used to model the intersection of fuzzy sets. Yager's pioneering work on fuzzy-set-based approaches for social network and recommender systems has been important to web applications.

An IEEE Life Fellow, Yager is a professor with the Machine Intelligence Institute at Iona College, New York, NY, USA.

IEEE David Sarnoff Award

Sponsored by SRI International Sarnoff



Hiroyuki Matsunami

For contributions to the development of silicon carbide (SiC) crystals and devices for advanced power electronics

Recognizing early on the potential that silicon carbide (SiC) held for outperforming conventional semiconductor materials in advanced power electronics, Hiroyuki Matsunami has developed many critical breakthroughs to provide SiC-based energy-saving devices. Important to the adoption of SiC for power devices was Matsunami's step-controlled epitaxial growth technique, which enabled single-crystal growth and overcame the barrier of polytype mixing problems. His demonstration of the first high-voltage SiC Schottky barrier diodes for reducing power dissipation during energy conversion is considered a milestone in SiC power device development. Matsunami also played a pioneering role in establishing SiC power metal-oxide semiconductor field-effect transistor technologies. The devices made possible by Matsunami's innovations are being utilized today in trains, high-speed elevators, and hybrid vehicles and are realizing huge energy savings benefitting the environment.

An IEEE Life Fellow, Matsunami is a Professor Emeritus with Kyoto University, Yawata, Kyoto, Japan.

2016 IEEE TECHNICAL FIELD AWARDS

IEEE Marie Sklodowska-Curie Award

Sponsored by the IEEE Nuclear and Plasma Sciences Society



Simon R. Cherry

For contributions to the development and application of in vivo molecular imaging systems

Simon R. Cherry's expertise in developing molecular imaging systems incorporating positron emission tomography (PET) is driving advances in biomedicine and healthcare. Cherry created the first microPET scanner to evaluate radiopharmaceuticals and drugs in small animals. Overcoming the challenges of imaging small animals has been instrumental in allowing researchers and clinicians to gain a better understanding of diseases and potential human therapies. He also developed the first hybrid PET/magnetic resonance imaging (MRI) scanners for even more powerful preclinical imaging applications. His discovery that many radionuclides used in biomedical research produce Cerenkov luminescence and can be imaged using optical cameras has created one of the fastest-growing areas in molecular imaging. Cherry is currently working on developing the first total-body human PET scanner.

An IEEE Fellow, Cherry is a professor with the Departments of Biomedical Engineering and Radiology at the University of California, Davis, CA, USA.

IEEE Innovation in Societal Infrastructure Award

Sponsored by Hitachi, Ltd., and the IEEE Computer Society



William H. Sanders

For the assessment-driven design of trustworthy cyber infrastructures for electric grid systems

A leading cybersecurity expert, the groundbreaking contributions of William H. Sanders have made the electric power grid more safe, secure, reliable, and available. He did so by developing tools and techniques to make the grid more resilient to attacks that may occur as well as methods for quantitatively assessing its cyber security and resiliency. He has worked in every part of the field, from the distribution-side, including smart meters, to long-haul transmission networks. Among other contributions, he is the co-developer of the NP-View software to test NERC-CIP compliance of process control networks, which has changed the way utilities audit their networks.

An IEEE Fellow, Dr. Sanders is a Donald Biggar Willett Professor of Engineering and Head of the Department of Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign, Urbana, IL, USA.

IEEE Charles Proteus Steinmetz Award

Sponsored by the IEEE Standards Association



Hermann Koch

For leadership in and contributions to the development, standardization, and global impact of gas-insulating technology for substations (GIS) and high-voltage lines (GIL)

Hermann Koch's dedication to advancing gas-insulating switchgear (GIS) and line (GIL) technology for the power industry is enabling the safe transmission of high electric power over greater distances and into space-constrained environments where overhead power lines are not viable. Working with Siemens AG, Koch developed new insulating gas mixtures for high-voltage systems, adopted pipeline laying technology to electrical systems, and was responsible for the installation of the first GIL system using these new techniques in 2001. Koch has helped increase global access to GIS and GIL technology by promoting improved standardization efforts between the International Electrotechnical Commission (IEC) and IEEE. He influenced IEEE to develop standards for high- and medium-voltage GIS and GIL and promoted IEC positions while a member of the IEEE Standards Activities Board.

An IEEE Fellow, Koch is a principle expert with the Energy Management Division at Siemens AG, Erlangen, Germany.

IEEE Nikola Tesla Award

Sponsored by Wolong Electric Group Co., Ltd., the IEEE Industry Applications Society, and the IEEE Power & Energy Society



Bruno Lequesne

For contributions to the design and analysis of actuators, sensors, and motors for automotive applications

The patented work of Bruno Lequesne has driven advances leading to the realization of "more electric automobiles" that use electrical and electromechanical systems for improved fuel economy, reduced greenhouse emissions, and better safety. With innovations recognized by multiple awards from industry leaders such as Delphi and General Motors, Lequesne's work on linear actuators provided closed form solutions to identify the best configurations for engine-valve motion or suspension. His work on encoders for brushless motors helped overcome torque ripple in electric power steering systems, contributing to a fuel-saving feature now standard in most vehicles. His camshaft and crankshaft position sensors for engine control help to reduce emissions, and his wheel speed sensors for anti-skid braking have made vehicles safer. He also developed one of the first induction belt-driven starter generators, which has enabled start-stop functionality to help eliminate idling losses in engines.

An IEEE Fellow, Lequesne is president of E-Motors Consulting, LLC, Menomonee Falls, WI, USA.

2016 IEEE TECHNICAL FIELD AWARDS

IEEE Eric E. Sumner Award

Sponsored by Nokia Bell Labs



Shuo-Yen Robert Li, Raymond W. Yeung, and Ning Cai

For pioneering contributions to the field of network coding

The pioneering contributions of Shuo-Yen Robert Li, Raymond W. Yeung, and Ning Cai to network coding have laid the foundation of the field. Their seminal work on linear network coding has changed the landscape of the information technology by demonstrating an improvement of transmission rates over traditional routing techniques in communication networks. Linear network coding has become one of the fastest-growing areas in communication theory. It is now being actively investigated for applications to mobile/wireless, network infrastructure and protocols, cloud storage, content distribution networks, and video streaming.

An IEEE Fellow, Li is a Distinguished University Professor with the University of Electronic Science and Technology of China, Chengdu, China and Professor Emeritus of the Chinese University of Hong Kong. An IEEE Fellow, Yeung is the Choh-Ming Li Professor of Information Engineering with the Chinese University of Hong Kong, Hong Kong, China. An IEEE Fellow, Cai is a Distinguished Professor with the State Key Laboratory of Integrated Services Networks (ISN), Xidian University, Xi'an, Shaanxi, China.

IEEE Kiyo Tomiyasu Award

Sponsored by Dr. Kiyo Tomiyasu, the IEEE Geoscience and Remote Sensing Society, and the IEEE Microwave Theory and Techniques Society



Yonina Eldar

For development of the theory and implementation of sub-Nyquist sampling with applications to radar, communications, and ultrasound

Yonina Eldar's pioneering work on sub-Nyquist sampling and reconstruction of sparse analog signals has demonstrated the potential to improve radar, medical imaging, communication, and storage systems. Bridging the gap between theory and real-world applications, Eldar developed the concept of "Xampling" for sub-Nyquist sampling and built hardware prototypes to demonstrate how the technique works in practical settings. The ability to sample signals at rates significantly lower than the standard Nyquist rate, but without the distortion normally associated with such techniques, positively impacts power consumption, storage memory, size, and digital signal processing rates in analog-to-digital converters. Eldar's innovations will enable portable ultrasound machines for emergency and rural medicine, radar systems with improved resolution, and better wireless capabilities for cognitive (intelligent) radio transmission and reception.

An IEEE Fellow, Eldar is a professor with the Technion-Israel Institute of Technology, Haifa, Israel.

IEEE Transportation Technologies Award

Sponsored by the IEEE Industry Applications, Industrial Electronics, Intelligent Transportation Systems, Microwave Theory and Techniques, Power Electronics, Power & Energy, and Vehicular Technology Societies



Petros Ioannou

For contributions to the design, analysis, and implementation of adaptive cruise-control systems

The pioneering innovations of Petros Ioannou have been instrumental in making adaptive cruise control (ACC) a practical reality and spurring its commercial adoption by the automotive industry. Using forward-looking sensors such as radar, ACC systems automatically adjust a vehicle's speed to maintain a safe driving distance based on vehicles ahead of it. Unique to Ioannou's work was implementing a time-headway approach to vehicle spacing instead of the popular belief of using vehicle-to-vehicle communications. By avoiding the complications of vehicle-to-vehicle communications, manufacturers such as Ford were able to bring ACC technology to market quickly. Ioannou's ACC systems also provide smoother acceleration and speed response, which have demonstrated positive effects on traffic flow, fuel economy, and the environment.

An IEEE Fellow, Ioannou is a professor with the University of Southern California, Director of the Center for Advanced Transportation Technologies, and Associate Director of Research of the University Transportation Center METRANs, Los Angeles, CA, USA.

2016 IEEE TECHNICAL FIELD AWARDS

IEEE Undergraduate Teaching Award

Sponsored by the IEEE Education Society



Terri Fiez

For innovative undergraduate engineering and computing curriculum development fostering student engagement and retention

Terri Fiez has helped ensure that engineering students are well prepared for their careers not only technically but in terms of leadership, teamwork, and communication. While at Oregon State University, Fiez implemented a learner-centered program called TekBots where freshman students develop an autonomous robot and build upon this platform during their four-year curriculum. By engaging students with a real system that does something interesting, students experience the frustration of getting

real systems to work and the satisfaction of accomplishing the task. By graduation, students not only have a robot that they've customized, they also fully understand how it works and how it got there. Fiez also launched the first online post-baccalaureate program to provide computer science degrees for students with degrees from nonengineering disciplines.

An IEEE Fellow, Fiez is currently vice chancellor for research at the University of Colorado, Boulder, CO, USA.

2015 IEEE STAFF AWARDS

IEEE Eric Herz Outstanding Staff Member Award

Sponsored by IEEE



Susan Hassler

For enhancing the global impact of IEEE by creating the distinctive publication *IEEE Spectrum*, which exemplifies the highest values of science, technology, and engineering journalism

Susan Hassler has transformed IEEE's flagship member magazine *IEEE Spectrum* into an internationally renowned source for insightful and understandable coverage of science, technology, and engineering. She has repositioned the magazine and extended its digital platform strategy, establishing *IEEE Spectrum* as an essential member benefit while also expanding the visibility of IEEE among the larger technology community and general public by developing outlets for the magazine's material beyond IEEE. Hassler developed a mobile-friendly state-of-the-art website and introduced a very popular video series and podcast service. Under her leadership, *IEEE Spectrum* has won numerous awards for both its print and online efforts, including three Grand Neal Awards and a National Magazine Award for General Excellence in the Thought Leader Category (2012).

An IEEE Member, Hassler is currently editor-in-chief of *IEEE Spectrum*, New York, NY, USA.

Joyce E. Farrell IEEE Staff Award

Sponsored by IEEE



Ken Gilbert

For demonstrating distinguished job performance and serving as a role model to IEEE professional staff

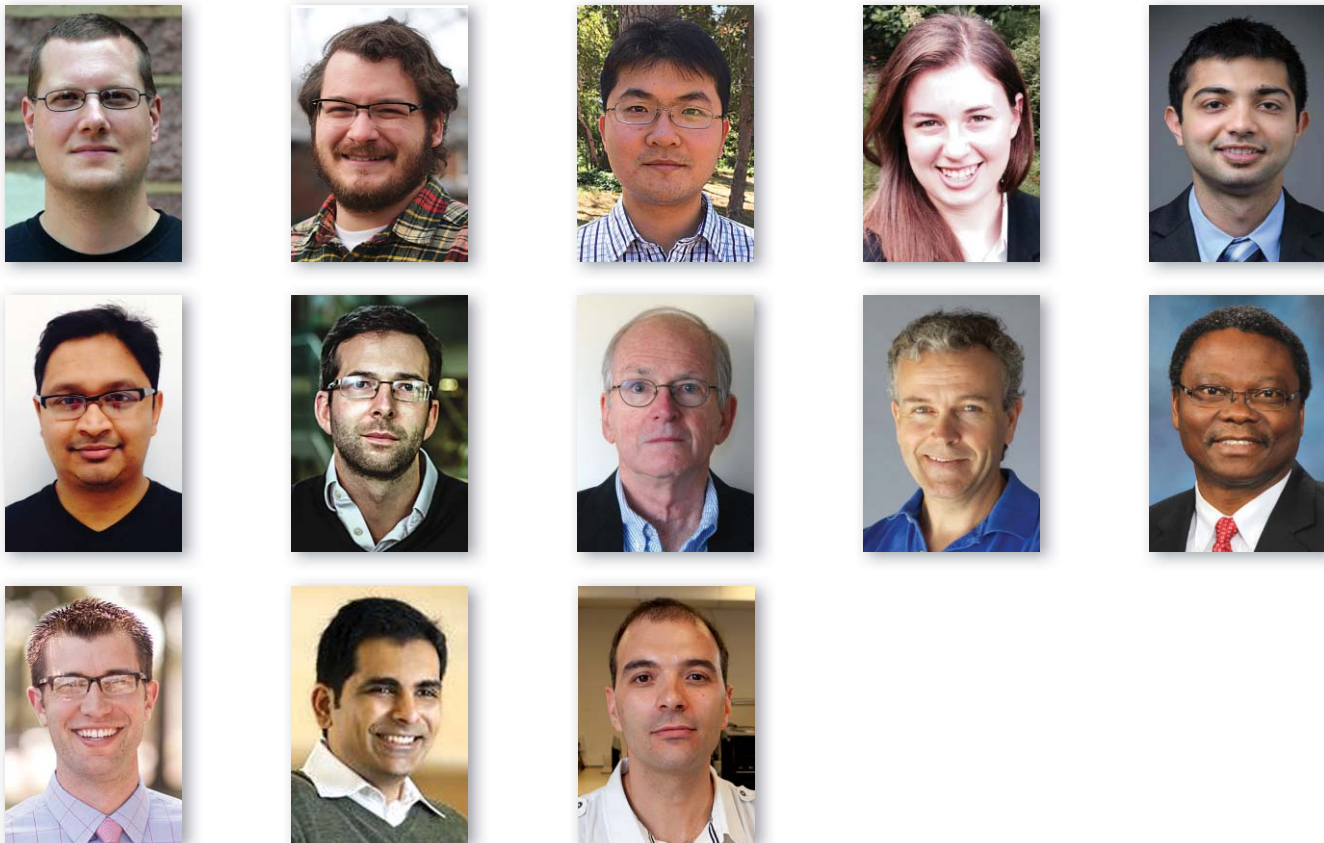
Entering his 20th year at IEEE, Ken Gilbert has learned a thing or two about how to manage a staff that really *works* together, and he knows just how influential and diverse IEEE really is. Starting his IEEE career as an accounting director, Gilbert moved over to Technical Activities Operations, where he is senior director. With a knack for maximizing the many different strengths that his staff members possess, his skills as a team builder are well known. He works to understand each person's abilities and interests to find the best organizational fit, bringing the employee with the right skills to a task rather than based just on a job description. He receives great satisfaction in assembling and maintaining diverse teams that complement each other, knowing that when his staff members feel that they are involved and making a difference, good things are accomplished.

Gilbert is the senior director of IEEE Technical Activities Operations, Piscataway, NJ, USA.

2016 IEEE PRIZE PAPER

IEEE Donald G. Fink Award

Sponsored by the IEEE Life Members Fund



Timothy York, Samuel B. Powell, Shengkui Gao, Lindsey Kahan, Tauseef Charanya, Debajit Saha, Nicholas W. Roberts, Thomas W. Cronin, Justin Marshall, Sanuel Achilefu, Spencer P. Lake, Baranidharan Raman, and Viktor Gruev

For the paper, “Bioinspired Polarization Imaging Sensors: From Circuits and Optics to Signal Processing Algorithms and Bio-medical Applications”

Representing an integration of work in biology, mathematics, optics, materials science, and electronics, Timothy York and his colleagues present recent developments in bioinspired polarization imaging sensors and their applications to biomedicine in their paper “Bioinspired Polarization Imaging Sensors: From Circuits and Optics to Signal Processing Algorithms and Biomedical Applications.” To emulate the highly efficient sensory systems found in biology to better detect features that are hard to see with the human eye, the paper, which appeared in the October 2014 issue of the *Proceedings of the IEEE* (vol. 102, no. 10, pp. 1450–1469), presents a bioinspired complimentary metal-oxide semiconductor (CMOS) current-mode polarization imaging sensor based on the compound eye of the mantis shrimp. The work presented in the paper has important implications for applications such as noninvasive neural recording, tissue evaluation, and tumor detection.

Timothy York is an IEEE Member and assistant professor with the Department of Electrical and Computer Engineering at Southern Illinois University, Edwardsville, IL, USA. Samuel B. Powell is a Ph.D. student with the Department of Computer Science and

Engineering, Debajit Saha is a postdoctoral fellow with the Department of Biomedical Engineering, Samuel Achilefu is director of the Optical Radiology Lab, Spencer P. Lake is an assistant professor with the Department of Mechanical Engineering and Materials Science, Baranidharan Raman is an assistant professor with the Department of Biomedical Engineering, and Viktor Gruev is an IEEE Senior Member and associate professor with the Department of Computer Science and Engineering at Washington University, St. Louis, MO, USA. Lindsey Kahan is a research assistant with the Washington University School of Medicine, St. Louis, MO, USA. Shengkui Gao is an electrical engineer with Apple, Inc., Cupertino, CA, USA. Tauseef Charanya is a management consultant with Boston Consulting Group, Toronto, Canada. Nicholas W. Roberts is director of research with the School of Biological Sciences at the University of Bristol, Bristol, UK. Thomas W. Cronin is a professor with the Department of Biological Sciences at the University of Maryland Baltimore County, Baltimore, MD, USA. Justin Marshall is a professor of neuroscience and marine biology at the Queensland Brain Institute, University of Queensland, Brisbane, Australia.


IEEE FELLOWS CLASS OF 2016

The grade of IEEE Fellow recognized exceptional distinction in the profession. It is conferred by the IEEE Board of Directors upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. The total number of IEEE Fellows elevated in any one year must not exceed one-tenth of one percent of the total voting membership of the IEEE on record as of 31 December of the preceding year. In 2016, 297 IEEE Fellows were elevated. To learn more about the Fellow program or to nominate, visit: www.ieee.org/fellows.

David Abramson

University of Queensland
Queensland, Australia
for contributions to software tools for high performance, parallel, and distributed computing

Vassilios Agelidis

University of New South Wales
Sydney, NSW, Australia
for contributions to power electronics, renewable energy conversion and integration with electricity grid

Kiyoharu Aizawa

University of Tokyo
Tokyo, Japan
for contributions to model-based coding and multimedia lifelogging

Ozgur B. Akan

Koc University
Istanbul, Turkey
for contributions to wireless sensor networks

Alin Albu-Schaeffer

Technical University Munich
Oberpfaffenhofen-Wessling, Germany
for contributions to compliant and lightweight robots

Massimo Alioto

National University of Singapore
Singapore, Singapore
for contributions to energy-efficient VLSI circuits

Alexandre P. Alves da Silva

GE Global Research
Rio de Janeiro, Brazil
for contributions to dynamic security assessment and load forecasting in power systems

Lorenzo Alvisi

University of Texas at Austin
Austin, TX, USA
for contributions to reliable distributed systems

Massoud Amin

University of Minnesota
Minneapolis, MN, USA
for leadership in smart grids and security of critical infrastructures

Plamen Angelov

Lancaster University
Lancaster, United Kingdom
for contributions to neuro-fuzzy and autonomous learning systems

Tatsuo Arai

Osaka University
Osaka, Japan
for contributions to micro manipulators and sensors, and applications to cellular biology

Huseyin Arslan

University of South Florida
Tampa, FL, USA
for contributions to spectrum sensing in cognitive radio networks

David Atienza

EPFL - École polytechnique fédérale de Lausanne
Lausanne, Switzerland
for contributions to design methods and tools for multiprocessor systems on chip

Ronald Azuma

Intel Laboratories
Santa Clara, CA, USA
for contributions to augmented reality

Fan Bai

General Motors Global R&D
Detroit, MI, USA
for contributions to vehicular networking and mobility modeling

Christopher Baker

Ohio State University
Columbus, OH, USA
for contributions to cognitive sensing in passive and diversity radars

William Baldygo

U.S. Air Force Research Laboratory
Dayton, OH, USA
for leadership in signal processing for radar systems

Sanghamitra Bandyopadhyay

Indian Statistical Institute
West Bengal, India
for contributions to genetic algorithm based classification and clustering techniques

Edward Baranoski

Intelligence Advanced Research,
Projects Activity (IARPA)
McLean, VA, USA
for leadership in knowledge-aided radar systems for indoor environments

Kenneth Barner

University of Delaware
Newark, DE, USA
for contributions in nonlinear signal processing

Siegfried Bauer

Johannes Kepler-University Linz
Linz, Austria
for contributions to the understanding and application of electroactive polymer dielectrics

B. Wayne Bequette

Rensselaer Poly Institute
Troy, NY, USA
for contributions to design and control of chemical and biomedical systems

Karl Berggren

Massachusetts Institute of Technology
Cambridge, MA, USA
for contributions to nanofabrication and nanomanufacturing in the sub-10 nm regime

Shannon Blunt

University of Kansas
Lawrence, KS, USA
for contributions to radar waveform diversity and design

Kwabena Boahen

Stanford University
Stanford, CA, USA
for contributions to system design for neuromorphic chip

Francesco Borrelli

University of California - Berkeley
Berkeley, CA, USA
for contributions to the theory and application of model predictive control

Laura Bottomley

North Carolina State University
Raleigh, NC, USA
for leadership in increasing student interest in STEM education

Brian Brandt

Maxim Integrated Products
San Jose, CA, USA
for leadership in data converters and mixed-signal circuits

Michael Branicky

University of Kansas
Lawrence, KS, USA
for contributions to switched and hybrid control systems

Henning Braunsch

Intel Corporation
Phoenix, AZ, USA
for contributions to high-bandwidth microprocessor packaging

David Brooks

Harvard University
Cambridge, MA, USA
for contributions to power-efficient and resilient computer system design

Juergen Brugger

EPFL - École polytechnique fédérale de Lausanne
Lausanne, Switzerland
for contributions to micro and nano manufacturing technology

Tracy Camp

Colorado School of Mines
Golden, CO, USA
for contributions to wireless networking

Eugenio Cantatore

Eindhoven University of Technology
Eindhoven, Netherlands
for contributions to the design of circuits with organic thin film transistors

Carlos Canudas de Wit

CNRS-GIPSA-Lab
Grenoble, France
for contributions to modeling and control of mechanical, robotic, and networked systems

Jinde Cao

Southeast University
Nanjing, China
for contributions to the analysis of neural networks

Bruce Carlsten

Los Alamos National Laboratory
Los Alamos, NM, USA
for contributions to high-brightness electron beams and vacuum electron devices

Sandro Carrara

Swiss Federal Institute of Technology
Lausanne, Switzerland
for contributions to design of nanoscale biological CMOS sensors

Umit Catalyurek

Ohio State University
Columbus, OH, USA
for contributions to combinatorial scientific computing and parallel computing


 IEEE FELLOWS CLASS OF 2016
Yiu Tong Chan

Royal Military College
Kingston, ON, Canada
for development of efficient localization and tracking algorithms

Tony Chan

Hong Kong University of Science & Technology
Clearwater Bay, Hong Kong, China
for contributions to computational models and algorithms for image processing

Chong-Ping Chang

Applied Materials, Inc.
Santa Clara, CA, USA
for contributions to replacement gate and shallow trench isolation for CMOS technology

Jie Chen

University of Alberta, Canada
Edmonton, AB, Canada
for contributions to low-power and biomedical ultrasound circuits and devices

Xilin Chen

Institute of Computing Technology
Beijing, China
for contributions to machine vision for facial image analysis and sign language recognition

Chun-Hung Chen

George Mason University
Fairfax, VA, USA
for contributions to simulation-based optimization of automation systems

Shigang Chen

University of Florida
Gainesville, FL, USA
for contributions to quality of service provisioning and policy-based security management in computer networks

Degang Chen

Iowa State University
Ames, IA, USA
for contributions to testing of analog and mixed-signal integrated circuits

Shu-Ching Chen

Florida International University
Miami, FL, USA
for contributions to multimedia data and disaster information management

Gyu Hyeong Cho

KAIST-Korea Advanced Institute of Science and Technology
Daejeon, Korea
for contributions to power management circuit design

Henry Chung

City University of Hong Kong
Kowloon Tong, Hong Kong, China
for contributions to power electronic converters for lighting

C. Y. Chung

University of Saskatchewan
Saskatoon, SK, Canada
for contributions to power system stability and control

Wan Kyun Chung

Pohang University of Science & Technology
Pohang, Korea
for developments in robust control theory for mechanical systems

Terry Cisco

Consultant
Glendale, CA, USA
for leadership in the development of airborne active array transmit and receive module technologies

George Clark

Alabama Power Company
Birmingham, AL, USA
for contributions to distribution automation for power

Armando Colombo

Schneider Electric Automation GmbH
Bayern, Germany
for contributions to industrial cyber-physical systems

Ian Craddock

University of Bristol
Bristol, United Kingdom
for leadership in imaging for healthcare applications

Lorrie Cranor

Carnegie Mellon University
Pittsburgh, PA, USA
for contributions to privacy engineering

Luiz Da Silva

Trinity College Dublin
Dublin, Ireland
for contributions to cognitive networks and resource management for wireless networks

Gilles Dambrine

IEMN - Institute of Electronic, Microelectronic and Nanotechnology
Lille, France
for contributions to the modeling of small signal and noise characteristics in nanoscale high-frequency devices

Timothy Davis

Texas A&M University
College Station, TX, USA
for contributions to sparse matrix algorithms and software

Leila De Floriani

University of Genova
Genova, Italy
for contributions to geometric modeling and visualization

Robert Deng

Singapore Management University
Singapore, Singapore
for contributions to security algorithms, protocols and systems

Yixin Diao

IBM T. J. Watson Research Center
Yorktown Heights, NY, USA
for contributions to modeling, optimization, and control of computing systems

Maria-Gabriella Di Benedetto

Sapienza University of Rome
Rome, Italy
for contributions to impulse-radio ultra wideband and cognitive networks for wireless communications

Warren Dixon

University of Florida
Gainesville, FL, USA
for contributions to adaptive control of uncertain nonlinear systems

Ananth Dodabalapur

University of Texas at Austin
Austin, TX, USA
for contributions to organic electronic devices and circuits

David Doman

USAF Air Force Research Laboratory
Rome, NY, USA
for contributions to flight dynamics and control

Ravindranath Droopad

Texas State University
San Marcos, TX, USA
for contributions to epitaxial growth of advanced materials for RF and CMOS applications

Frederic Dufaux

Telecom ParisTech
Paris, France
for contributions to visual information processing and coding

Schahram Dusdar

Vienna University of Technology
Vienna, Austria
for contributions to elastic computing for cloud applications

Michael Eineder

TUM - Technische Universität München
München, Germany
for contributions to synthetic aperture radar image processing for geodesy

Georges El Fakhri

Massachusetts General Hospital/
Harvard Medical School
Boston, MA, USA
for contributions to biological imaging

Danilo Errico

University of Illinois
Chicago, IL, USA
for contributions to electromagnetic scattering and associated computational algorithms

Karu Esselle

Macquarie University
Sydney, NSW, Australia
for contributions to resonance-based antennas

Giuseppe Fabrizio

Defence Science & Technology Group
Edinburgh, SA, Australia
for contributions to adaptive array signal processing in over-the-horizon radar systems

Jun Fan

Missouri University of Science & Technology
Rolla, MO, USA
for contributions to power delivery networks in printed circuit designs

Mukta Farooq

IBM Corporation
Hopewell Junction, NY, USA
for contributions to 3D integration and interconnect technology

Patrick Fay

University of Notre Dame
Notre Dame, IN, USA
for contributions to compound semiconductor tunneling and high-speed device technologies

Faramarz Fekri

Georgia Institute of Technology
Atlanta, GA, USA
for contributions to coding theory and its applications

Leonard Feldman

Rutgers University
Piscataway, NJ, USA
for contributions to semiconductor-dielectric interfaces for MOS technologies

Claudia Felser

Max-Planck-Institut für CPIS
Gesellschaft, München, Germany
for contributions to the design and chemical synthesis of new materials with multi-functional properties

Gabor Fichtinger

Queens University
Kingston, ON, Canada
for contributions to medical robotics and computer-assisted intervention

Dinei Florencio

Microsoft Research
Redmond, WA, USA
for contributions to statistical and signal processing approaches to adversarial and security problems

Thor Fossen

Norwegian University of Science & Technology
Trondheim, Norway
for contributions to modelling and controlling of marine crafts



IEEE FELLOWS CLASS OF 2016

F. Stuart Foster
Sunnybrook & Women's College-
Health Sciences Centre
Toronto, ON, Canada
for contributions to the development and
commercialization of ultrasound technology

Christina Fragouli
University of California - Los Angeles
Los Angeles, CA, USA
for contributions to network coding

Michael Franz
University of California - Irvine
Irvine, CA, USA
for contributions to just-in-time compilation and
to computer security through compiler-generated
software diversity

Patrick French
TU Delft- Delft University of Technology
Delft, Netherlands
for contributions to micro-electromechanical
devices and systems

Jessica Fridrich
Binghamton University- SUNY
Binghamton, NY, USA
for contributions to digital media forensics,
steganography, and steganalysis

Masayuki Fujita
Tokyo Institute of Technology
Tokyo, Japan
for contributions to passivity-based control in
robotics and robust control

Vincenzo Galdi
University of Sannio
Benevento, Italy
for contributions to modeling the interaction
between electromagnetic waves and complex
materials

Alan Gatherer
Huawei
Plano, TX, USA
for contributions to systems-on-chip for 3G and
4G cellular systems

Maryellen Giger
University of Chicago - Radiology
Chicago, IL, USA
for contributions to computer-aided biomedical
imaging and diagnosis

Fernando Gomide
University of Campinas
Sao Paulo, Brazil
for contributions to fuzzy systems

Tibor Grasser
Technische Universität Wien : TU Wien
Vienna, Austria
for contributions to modeling the reliability of
semiconductor devices

Anthony Grbic
University of Michigan
Ann Arbor, MI, USA
for contributions to the theory and design of
electromagnetic metamaterials

Anthony Guiseppi-Elie
Clemson University
Clemson, SC, USA
for contributions to organic electronic materials
in biotechnology and biomedicine

Gerhard Hancke
University of Pretoria
Pretoria, South Africa
for contributions to wireless sensor networks

Edwin Hancock
University of York
N. Yorkshire, United Kingdom
for contributions to pattern recognition and
computer vision

Alan Hanjalic
TU Delft- Delft University of Technology
Delft, Netherlands
for contributions to multimedia information
retrieval

Tomohiro Hase
Ryukoku University
Shiga, Japan
for contributions to embedded software for real-
time applications

Dimitrios Hatzinakos
University of Toronto
Toronto, ON, Canada
for contributions to signal processing
techniques for communications, multimedia
and biometrics

Scott Hauck
University of Washington
Seattle, WA, USA
for contributions to Field-Programmable Gate
Array based systems

Aaron Hawkins
Brigham Young University
Provo, UT, USA
for contributions to optofluidics

George Hayhoe
Mercer University
Macon, GA, USA
for contributions to professional and technical
communication

Larry Heck
Google
Mountain View, CA, USA
for leadership in application of machine
learning to spoken and text language
processing

Maurice Heemels
Eindhoven University of Technology
Eindhoven, Netherlands
for contributions to analysis and design of
hybrid, networked, and event-triggered systems

Gernot Heiser
University of New South Wales
Sydney, NSW, Australia
for contributions to security and safety of
operating systems

Michael Henderson
ISO New England
Springfield, MA, USA
for contributions to the application of high-
voltage DC and flexible AC transmission
systems

Mark Hersam
Northwestern University
Evanston, IL, USA
for contributions to carbon nanomaterial
processing methods and devices

John Heywood
University of Dublin
Dublin, Ireland
for contributions to engineering education
research

Mark Horenstein
Boston University
Boston, MA, USA
for contributions to the modeling and
measurements of electrostatics in industrial
processes

Tzzy-Sheng Horng
Nat'l Sun Yat-Sen University
Kaohsiung, Taiwan
for contributions to system-in-package modeling
and design

Yu Hu
Purdue University
West Lafayette, IN, USA
for contributions to power modeling and energy
management of mobile devices

Xiaobo Hu
University of Notre Dame
Notre Dame, IN, USA
for contributions to resource management for
embedded systems

Jiang Hu
Texas A&M University
College Station, TX, USA
for contributions to gate, interconnect, and clock
network optimization in VLSI circuits

Xian-Sheng Hua
Alibaba Group
Hangzhou, China
for contributions to multimedia content analysis
and image search

Tony Jun Huang
Penn State University
University Park, PA, USA
for contributions to acousto-opto-fluidics, and
nanoelectromechanical systems

Jianwei Huang
Chinese University of Hong Kong
Shatin, NT, Hong Kong
for contributions to resource allocation in
wireless systems

Qiang Huang
Beijing Institute of Technology
Beijing, China
for contributions to the design and control of
biped robots

Qing-An Huang
Southeast University
Nanjing, China
for contributions to modeling and packaging of
microsensors and microactuators

Jiwu Huang
Shenzhen University
Shenzhen, China
for contributions to multimedia data hiding and
forensics

Adrian Ionescu
EPFL - École polytechnique fédérale de Lausanne
Lausanne, Switzerland
for contributions to the development of novel
devices for low power applications

Mohammad Islam
Halla Mechatronics
Bay City, MI, USA
for development of electromagnetic sensors and
actuators for automotive applications

Rabih Jabr
American University of Beirut
Beirut, Lebanon
for application of robust optimization to power
systems

Yungtaek Jang
Delta Products Corporation
Fremont, CA, USA
for contributions to efficiency optimization of
ac-dc power supplies

Dan Jiao
Purdue University
West Lafayette, IN, USA
for contributions to computational
electromagnetics

Yaochu Jin
University of Surrey
Surrey, United Kingdom
for contributions to evolutionary optimization

Alvin Joseph
IBM Thomas J. Watson Research Center
Yorktown Heights, NY, USA
for contributions to silicon-germanium
bipolar-CMOS and RF silicon-on-insulator
technology



IEEE FELLOWS CLASS OF 2016

Mahmut Kandemir
Penn State University
University Park, PA, USA
for contributions to compiler support for performance and energy optimization of computer architectures

Lance Kaplan
Army Research Laboratory
Adelphi, MD, USA
for contributions to signal processing and information fusion for situational awareness

Sheldon Kennedy
Niagara Transformer Corporation
Cheektowaga, NY, USA
for leadership in the technology and standards for rectifier, inverter and harmonic-mitigating transformers

Nam Sung Kim
University of Wisconsin-Madison
Madison, WI, USA
for contribution to circuits and architectures for power-efficient microprocessors

JoungHo Kim
KAIST- Korea Advanced Institute of Science and Technology
Daejeon, Korea
for contributions to modeling signal and power integrity in 3D integrated circuits

Katsumi Kishino
Sophia University
Tokyo, Japan
for contributions to III-V light emitter technology

Hitoshi Kiya
Tokyo Metropolitan University
Tokyo, Japan
for contributions to filter structure, data hiding, and multimedia security

Stuart Kleinfelder
University of California - Irvine
Irvine, CA, USA
for contributions to sensors and instrumentation for high-speed imaging applications

Michael Kneissl
Technische Universitaet Berlin
Berlin, Germany
for contributions to the development of wide bandgap semiconductor laser diodes and ultraviolet LEDs

Vladimir Kolobov
CFD Research Corporation
Huntsville, AL, USA
for contributions to theory, simulation and software development for industrial plasma

Avinoam Kolodny
Technion - Israel Inst. of Technology
Technion City, Haifa, Israel
for contributions to VLSI design and automation tools

Danica Kragic
Royal Institute of Technology
Stockholm, Sweden
for contributions to vision-based systems and robotic object manipulation

William Krupke
Lawrence Livermore National Laboratory
Livermore, CA, USA
for leadership in laser science and technology

Lawrence Kushner
BAE Systems, Inc.
Merrimack, NH, USA
for leadership in RF/microwave circuits for military and commercial applications

Akhlesh Lakhtakia
Pennsylvania State University
University Park, PA, USA
for contributions to isotropic chiral, bianisotropic materials, and metamaterials

Erik Larsson
Linkoping University
Linkoping, Sweden
for contributions to the technology of multi-antenna wireless communications

Mark Laubach
Broadcom Corporation
Irvine, CA, USA
for leadership in design and standardization of cable modems

Eugene Lavretsky
The Boeing Company
Everett, WA, USA
for contributions to the development of adaptive and robust flight control technologies

Ta Sung Lee
National Chiao Tung University
Hsinchu, Taiwan
for leadership and contributions in communication systems and signal processing

Jong Ho Lee
Seoul National University
Seoul, Korea
for contributions to development and characterization of bulk multiple-gate field effect transistors

Inkyu Lee
Korea University
Seoul, Korea
for contributions to multiple antenna systems for wireless communications

Hui Lei
IBM T. J. Watson Research Center
Yorktown Heights, NY, USA
for contributions to scalable and dependable data access in distributed computing systems

Charles Leiserson
MIT-Massachusetts Institute of Technology
Cambridge, MA, USA
for leadership in parallel and distributed computing

Peng Li
Texas A&M University
College Station, TX, USA
for contributions to the analysis and modeling of integrated circuits and systems

Shaoqian Li
University of Electronic Science & Technology of China
Sichuan, China
for leadership in development of broadband wireless networks

Zhiwu Li
Xidian University
Xi'an, Shaanxi, China
for contributions to Petri nets and their applications to automated manufacturing systems

Tsong-Juu Liang
National Cheng Kung University
Tainan, Taiwan
for contributions to power conversion for lighting and sustainable energy

Weisi Lin
Nanyang Technical University
Singapore, Singapore
for contributions to perceptual modeling and processing of visual signals

Xuemin Lin
University of New South Wales
Sydney, NSW, Australia
for contributions to algorithmic paradigms for database technology

Kai Liu
University of California- Davis
Davis, CA, USA
for contributions to the understanding of magnetotransport effects and magnetization reversal in nanostructures

Blake Lloyd
Iris Power Engineering
Mississauga, ON, Canada
for development of non-intrusive diagnostics for electrical motors and generators

Stefano Lonardi
University of California, Riverside
Riverside, CA, USA
for contributions to computational biology and data mining

Songwu Lu
University of California, Los Angeles
Los Angeles, CA, USA
for contributions to wireless and mobile networking and network security

Chenyang Lu
Washington University in St. Louis
Saint Louis, MO, USA
for contributions to adaptive real-time computing systems

Shih-Lien Lu
Intel Corporation
Portland, OR, USA
for contributions to low-voltage microarchitecture and approximate computing

Victor Lubecke
University of Hawaii at Manoa
Honolulu, HI, USA
for leadership in the development of microwave transducers for biomedical application

Fa-Long Luo
Element CXI, Inc.
San Jose, CA, USA
for contributions to adaptive signal processing for hearing and multimedia applications

Jian-Guo Ma
Tianjin University
Tianjin, China
for leadership in microwave electronics and RFIC applications

Xiaoli Ma
Georgia Institute of Technology
Atlanta, GA, USA
for contributions to block transmissions over wireless fading channels

Souvik Mahapatra
IIT- Indian Institute of Technology Bombay
Mumbai, India
for contributions to CMOS transistor gate stack reliability

Gabriele Manganaro
Analog Devices Inc.
Norwood, MA, USA
for leadership in the design of high-speed converters

Dimitris Manolakis
MIT Lincoln Laboratory
Lexington, MA, USA
for contributions to signal processing education, algorithms for adaptive filtering, and hyperspectral imaging

Jonathan Manton
University of Melbourne
Parkville, VIC, Australia
for contributions to geometric methods in signal processing and wireless communications

Joao Marques Silva
IST/INESC-ID
Lisboa, Portugal
for contributions to decision and optimization algorithms for propositional logic

Frank Marzano
Sapienza University of Rome
Rome, Italy
for contributions to microwave remote sensing in meteorology and volcanology

Shinji Matsuo
NIT Device Technology Laboratories
Kanagawa, Japan
for contributions to heterogeneous integration of semiconductor lasers



IEEE FELLOWS CLASS OF 2016
Clyde Maughan

Maughan Engineering Consultants
Schenectady, NY, USA
for contributions to large generator insulation systems and generator failure mechanisms

Sudip Mazumder

University of Illinois at Chicago
Chicago, IL, USA
for contributions to analysis and control of power electronics systems

Nenad Medvidovic

University of Southern California
Los Angeles, CA, USA
for contributions to the architecture of complex software systems

Farid Melgani

University of Trento
Trento, Italy
for contributions to image analysis in remote sensing

Ellis Meng

University of Southern California
Los Angeles, CA, USA
for contributions to biomedical microelectromechanical systems

Dimitri Metaxas

Rutgers University
Piscataway, NJ, USA
for contributions to computer vision, medical image analysis, and sparse learning methods

Risto Miikkulainen

University of Texas at Austin
Austin, TX, USA
for contributions to techniques and applications for neural and evolutionary computation

Federico Milano

University College Dublin
Dublin, Ireland
for contributions to power system modeling and simulation

Lamine Mili

Virginia Tech
Blacksburg, VA, USA
for contributions to robust state estimation for power systems

Hlaing Minn

University of Texas at Dallas
Richardson, TX, USA
for contributions to synchronization and channel estimation in communication systems

Vishal Misra

Columbia University
New York, NY, USA
for contributions to network traffic modeling, congestion control and Internet economics

Daniele Mortari

Texas A&M University
College Station, TX, USA
for contributions to navigational aspects of space systems

David Moss

RMIT University
Melbourne, VIC, Australia
for contributions to all-optical signal processing chips and commercial products for fibre optic communications

Frank Mueller

North Carolina State University
Raleigh, NC, USA
for contributions to timing analysis of real-time systems

Annette Muetze

Graz University of Technology
Graz, Austria
for contributions to the analysis and mitigation of bearing currents in variable-speed drives

Satoshi Nakamura

Nara Institute of Science and Technology
Nara, Japan
for contributions to speech recognition and speech-to-speech translation

Thyagarajan Nandagopal

National Science Foundation
Arlington, VA, USA
for contributions to wireless network optimization, RFID systems, and network architectures

Antonio Napolitano

University of Naples - Parthenope
Napoli, Italy
for contributions to the statistical theory of nonstationary signal processing

Robert Nelson

Siemens
Orlando, FL, USA
for contributions to flexible AC transmission system (FACTS) devices and wind power generation

Andrea Neto

TU Delft- Delft University of Technology
Delft, Netherlands
for contributions to dielectric lens antennas and wideband arrays

Branislav Notaros

Colorado State University
Fort Collins, CO, USA
for contributions to higher order methods in computational electromagnetics

Richard Nute

Consultant
Bend, OR, USA
for contributions to safety engineering of electrical and electronic products

Claude Oestges

Universite Catholique de Louvain
Louvain-La-Neuve, Belgium
for contributions to channel characterization and modeling for multiple-input multiple-output wireless communications

Haruhiko Okumura

Toshiba
Tokyo, Japan
for contribution to image processing and display technologies

Peggy O'Neill

NASA - Goddard Space Flight Center
Greenbelt, MD, USA
for contributions to the remote sensing of soil moisture

Kenichi Osada

Hitachi LTD.
Tokyo, Japan
for contributions to reliable and low-power nanoscale SRAM

Pablo Parrilo

MIT - Massachusetts Institute of Technology
Cambridge, MA, USA
for contributions to semidefinite and sum-of-squares optimization

Mahendra Patel

Electric Power Research Institute
Palo Alto, CA, USA
for contributions to synchrophasors standardization

Keith Paulsen

Thayer School of Engineering at Dartmouth
Hanover, NH, USA
for leadership in biomedical technologies in medical imaging for diagnosis and intervention

Joao Abel Pegas Lopes

INESC-Instituto de Engenharia de
Sistemas e Computadores, Tecnologia e Ciéncia
Porto, Portugal
for contributions to microgrids and the integration of wind generation

Fernando Perez-Gonzalez

University of Vigo
Vigo, Spain
for contributions to multimedia security

Luca Perregrini

University of Pavia
Pavia, Italy
for contributions to numerical techniques for electromagnetic modeling

Zhouyue Pi

Consultant
Allen, TX, USA
for leadership in millimeter wave communication technology

William Plant

University of Washington
Seattle, WA, USA
for contributions to the modeling electromagnetic scattering from the sea surface and its application to microwave remote sensing

Ajay Poddar

Synergy Microwave Corporation
Paterson, NJ, USA
for contributions to microwave oscillators

Ting-Chung Poon

Virginia Tech
Blacksburg, VA, USA
for contributions to optical image processing and digital holography

Petar Popovski

Aalborg University
Aalborg, Denmark
for contributions to network coding and multiple access methods in wireless communications

Alexandros Potamianos

National Technical University of Athens
Athens, Greece
for contributions to human-centered speech and multimodal signal analysis

Domenico Prattichizzo

Universita di Siena
Siena, Italy
for contributions to haptics and multi-fingered robotic hands

Calton Pu

Georgia Institute of Technology
Atlanta, GA, USA
for contributions to system software specialization, information security, and services computing

Min Qiu

Zhejiang University
Zhejiang, China
for contributions to nanophotonic devices

Wendi Rabiner Heinzelman

University of Rochester
Rochester, NY, USA
for contributions to algorithms, protocols, and architectures for wireless sensor and mobile networks

Stojan Radic

University of California, San Diego
La Jolla, CA, USA
for contributions to optical signal processing by leveraging optical fiber non-linearities

B. M. Azizur Rahman

City University London
London, United Kingdom
for contributions to the application of fully vectorial finite element methods to photonic design

Sreeranga Rajan

Fujitsu Laboratories of America
Sunnyvale, CA, USA
for contributions to scalable formal verification of software and hardware systems



 IEEE FELLOWS CLASS OF 2016
Rajeev Ram

MIT - Massachusetts Institute of Technology
Cambridge, MA, USA
for contributions to semiconductor lasers and integration of photonics with CMOS electronics

Sundeep Rangan

NYU Polytechnic School of Engineering
Brooklyn, NY, USA
for contributions to orthogonal frequency division multiple access cellular communication systems

Gregory Raybon

Bell Labs
New Providence, NJ, USA
for contributions to high-speed optical communication systems

Leonard Register

University of Texas At Austin
Austin, TX, USA
for contributions to modeling of charge transport in nanoscale CMOS devices

Andreas Reigber

German Aerospace Center (DLR)
Wessling, Germany
for contributions to SAR tomography and airborne multi-band SAR

Kui Ren

State University of New York at Buffalo
Buffalo, NY, USA
for contributions to security and privacy in cloud computing and wireless networks

Wei Ren

University of California- Riverside
Riverside, CA, USA
for contributions to distributed coordination and control of multi-agent systems

Stefan Ritt

Paul Scherrer Institute
Aargau, Switzerland
for the development of the Domino Ring Sampler series of chips

Pablo Rodriguez

Telefonica
Madrid, Spain
for contributions to the design and development of content distribution architectures in the Internet

Stergios Roumeliotis

University of Minnesota
Minneapolis, MN, USA
for contributions to visual-inertial navigation and cooperative localization

Chris Rowen

Cadence Design Systems
San Jose, CA, USA
for leadership in the development of microprocessors and reduced instruction set computers

Xinbo Ruan

Nanjing University of Aeronautics & Astronautics
Nanjing, China
for contributions to switching-mode power converter topologies and modulation strategies

Daniel Rueckert

Imperial College
London, United Kingdom
for contributions to biomedical image computing

Daniel Sabin

Electrotek Concepts, Inc.
Beverly, MA, USA
for leadership in power quality database management and analysis software

David Sampson

University of Western Australia
Western Australia, Australia
for contributions to fiber-optic biophotonics and biomedical optical imaging

Jagannathan Sarangapani

University of Missouri
Rolla, MO, USA
for contributions to nonlinear discrete-time neural network adaptive control and applications

Lorenz Schmidt

University of Erlangen-Nuremberg, Germany
Erlangen, Germany
for contributions to millimeter-wave and terahertz imaging systems

Noel Schulz

Kansas State University
Manhattan, KS, USA
for leadership in advancing women in engineering and electric ship technologies

Karsten Schwan

Georgia Institute of Technology
Atlanta, GA, USA
for contributions to high-performance, real-time and virtualized computing systems

Ivan Selesnick

NYU - Polytechnic School of Engineering
Brooklyn, NY, USA
for contributions to wavelet and sparsity based signal processing

Subhabrata Sen

AT&T Labs Research
Bedminster, NJ, USA
for contributions to analysis of cross-layer interactions in cellular networks

Sudipta Sengupta

Microsoft Research
Redmond, WA, USA
for contributions to network design, routing and applications to Internet backbone, data centers, and peer-to-peer systems

Weisong Shi

Wayne State University
Detroit, MI, USA
for contributions to distributed systems and internet computing

Yuhui Shi

Xi'an Jiaotong - Liverpool University
Suzhou, China
for contributions to particle swarm optimization algorithms

Thomas Silva

National Institute of Standards and Technology (NIST)
Boulder, CO, USA
for contributions to the understanding and applications of magnetization dynamics

Oswaldo Simeone

NJIT - New Jersey Institute of Technology
Newark, NJ, USA
for contributions to cooperative cellular systems and cognitive radio networks

Marcelo Simoes

Colorado School of Mines
Golden, CO, USA
for application of artificial intelligence in control of power electronics systems

Theodore Sizer

Bell Labs, Alcatel-Lucent
New Providence, NJ, USA
for leadership in wireless communications technology

Bruce Smith

Rochester Institute of Technology
Rochester, NY, USA
for contributions to semiconductor lithography

Jian Song

Tsinghua University
Beijing, China
for contributions to digital television broadcasting

Matteo Sonza Reorda

Politecnico di Torino
Torino, Italy
for design of test algorithms for reliable circuits and system

Mehmet Soyuer

IBM Thomas J. Watson Research Center
Yorktown Heights, NY, USA
for contributions to the design of high-frequency integrated circuits for clocking and communications

Giovanni Spagnuolo

University of Salerno
Salerno, Italy
for contributions to control of photovoltaic systems

Thomas Stuetzle

Universite Libre de Bruxelles (ULB)
Brussels, Belgium
for contributions to the design and engineering of heuristic optimization algorithms

Il Hong Suh

Hanyang University
Seoul, South Korea
for contributions to the design and control of redundant and multiple-arm robot systems

Sun Sumei

Institute for Infocomm Research
Singapore, Singapore
for leadership in design and standardization of wireless communication systems

Toru Tanzawa

Micron Technology, Inc. - Japan
Tokyo, Japan
for contributions to integrated high-voltage circuits

Vladimir Terzija

University of Manchester
Manchester, United Kingdom
for contributions to power systems protection

Diane Thiede Rover

Iowa State University
Ames, IA, USA
for contributions to active learning methods in engineering education

John Thompson

University of Edinburgh
Edinburgh, United Kingdom
for contributions to multiple antenna and multi-hop wireless communications

Qi Tian

University of Texas at San Antonio
San Antonio, TX, USA
for contributions to multimedia information retrieval

Akira Toriumi

University of Tokyo
Tokyo, Japan
for contributions to device physics and materials engineering for advanced CMOS technology

Sennur Ulukus

University of Maryland
College Park, MD, USA
for contributions to characterizing performance limits of wireless networks

Ben U Seng Pan

Synopsys Macau Limited
Macau, Macao
for leadership in the analog circuit design

K. Venugopal

University Visvesvaraya College of Engineering - Bangalore
Bangalore, India
for contributions to computer science and electrical engineering education

Silverio Visacro

Universidade Federal de Minas Gerais: UFMG
Belo Horizonte, Brazil
for contributions to lightning protection

IEEE FELLOWS CLASS OF 2016

Martin Vossiek
University of Erlangen-Nuremberg
Erlangen, Germany
for contributions to the design of wireless and radar positioning systems

Sarma Bala Vrudhula
Arizona State University
Tempe, AZ, USA
for contributions to low-power and energy-efficient design of digital circuits and systems

Bernhard Walke
RWTH Aachen University
Aachen, Germany
for contributions to packet switching and relaying in cellular mobile system

Pengjun Wan
Illinois Institute of Technology
Chicago, IL, USA
for contributions to scheduling and resource allocation in wireless networks

Cliff Wang
US Army Research Office
Durham, NC, USA
for leadership in trusted computing and communication systems

Jia Wang
AT&T Labs Research
Bedminster, NJ, USA
for contributions to measurement and management of large operational networks

Yue Wang
Virginia Polytechnic Institute & State University
Blacksburg, VA, USA
for contributions to genomic signal analytics and image-based tissue characterization

Zhengdao Wang
Iowa State University
Ames, IA, USA
for contributions to multicarrier communications and performance analysis of wireless systems

Zhong Feng Wang
Broadcom Corporation
Irvine, CA, USA
for contributions to VLSI design and implementation of forward error correction coding

David Wolpert
Santa Fe Institute
Santa Fe, NM, USA
for contributions to optimization, machine learning, distributed control, and game theory

Vincent Wong
University of British Columbia
Vancouver, BC, Canada

for contributions to mobility management in wireless networks and demand side management in smart grid

Kaikit Wong
University College London
London, United Kingdom
for contributions to multiuser communication systems

Jieh Wu
National Chiao-Tung University
Hsin-Chu, Taiwan
for contributions to design and calibration of high-performance data converters

Ernest Wu
IBM Microelectronics- Avent, Inc.
Burlington, VT, USA
for contributions to gate oxide reliability of CMOS devices

Liang-Liang Xie
University of Waterloo
Waterloo, ON, Canada
for contributions to fundamental limits of feedback control systems and wireless networks

Chenyang Xu
Siemens Technology-To-Business Center
Berkeley, CA, USA
for contributions to medical imaging and image-guided interventions

Shugong Xu
Intel Labs Research
Santa Clara, CA, USA
for contributions to the improvement of wireless networks efficiency

Chengzhong Xu
Wayne State University
Detroit, MI, USA
for leadership in resource management for parallel and distributed systems

Li Xu
Old Dominion University
Norfolk, VA, USA
for contributions to theory and applications of enterprise information systems

Lie Liang Yang
University of Southampton
Southampton, United Kingdom
for contributions to multicarrier communications and wireless transceivers

Mark Yeary
University of Oklahoma
Norman, OK, USA
for contributions to radar systems for meteorology

Kiat-Seng Yeo
Singapore University of Technology & Design
Singapore, Singapore
for contributions to low-power integrated circuit design

Jinhong Yuan
University of New South Wales
Sydney, NSW, Australia
for contributions to multi-antenna wireless communication technologies

Luca Zaccarian
University of Trento
Trento, Italy
for contributions to the development and application of nonlinear and hybrid control systems

Daniel Zeng
University of Arizona
and CAS Institute of Automation
Tucson, AZ, USA
for contributions to collaborative computing with applications to security informatics

Bing Zeng
University of Electronic Science
and Technology of China
Sichuan, China
for contributions to image and video coding

Xi Zhang
Texas A&M University
College Station, TX, USA
for contributions to quality of service in mobile wireless networks

Jianzhong Zhang
Samsung Research America
Mountain View, CA, USA
for leadership in standardization of cellular systems

Yi Zhang
Sichuan University
Chengdu, China
for contributions to convergence theory for neural networks and subspace learning

Lizhong Zheng
MIT - Massachusetts Institute of Technology
Cambridge, MA, USA
for contributions to the theory of multiple antenna communication

Ping Zhou
ANSYS Incorporated
Canonsburg, PA, USA
for contributions to finite element methods applied to electromagnetic devices and electrical machines

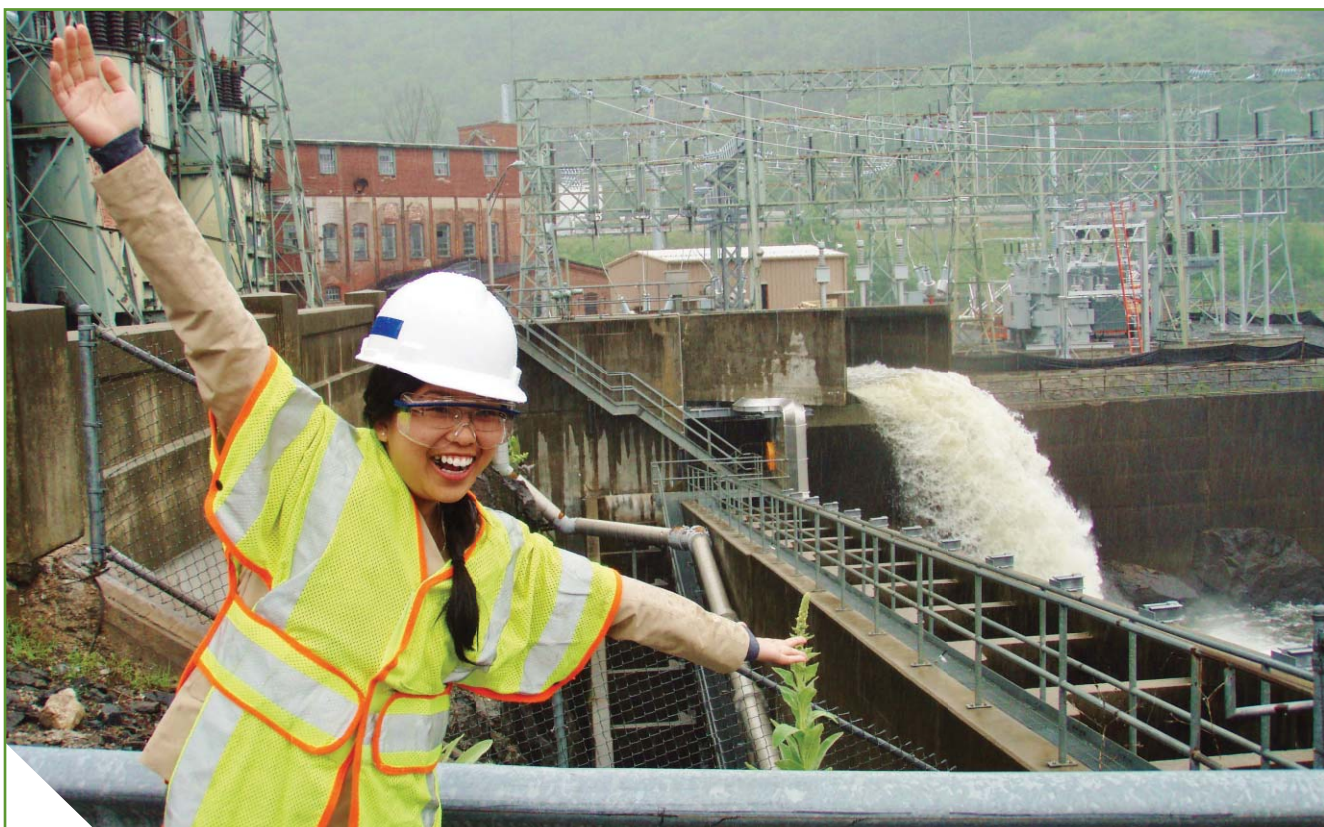
2016 IEEE FELLOW COMMITTEE ROSTER

Amy Reibman (Chair)
Stefano Galli (Vice Chair)
Amir Amini
Alessandro Astolfi
David Bader
John Baillieul
Supriyo Bandyopadhyay
Fil Bartoli
Piero Bonissone
Christos Cassandras
Babu Chalamala
George Christos
Cor Claeys
Mariesa Crow

Serge Demidenko
Paulo Diniz
Miwako Doi
Jay Farrell
Victor Fouad-Hanna
Maria Greco
Donna Hudson
William Hurley
Pooi-Yuen Kam
Mark Karol
Mostafa Kaveh
Michael Kennedy
V. Prasad Kodali
Kazuo Kyuma

Jae Hong Lee
Yong Lian
Zhi-Pei Liang
K J Ray Liu
Franco Maloberti
A.P. Sakis Meliopoulos
Carmen Menoni
Dejan Milojicic
David Neuhoff
Marios Polycarpou
Peter Ramadge
Marina Ruggieri
Magdalena Salazar-Palma
Morris Sloman

Robert Staszewski
Michael Steer
Isabel Trancoso
Leung Tsang
Chi Tse
Maria Elena Valcher
Joos Vandewalle
Pramod Varshney
Bo Wahlberg
Yuan-Fang Zheng
Cecelia Jankowski
Rosann Marosy
Donna Dukes



Transforming Lives through the Power of Technology

The IEEE Foundation and its donors energize IEEE Programs that transform lives.

Together we enable IEEE programs that improve access to technology, enhance technological literacy, and support technical education and the IEEE professional community.

Congratulations to the IEEE award recipients for igniting the future with their extraordinary contributions that transform lives throughout the world.

We celebrate engineering excellence by supporting the IEEE Honors Ceremony and sponsoring these awards:

IEEE Medal of Honor

G. David Forney, Jr.

IEEE Haraden Pratt Award

Moshe Kam

IEEE Foundation

Discover how you can do a world of good today.

Learn more about the IEEE Foundation at ieeefoundation.org.
To make a donation now, go to ieeefoundation.org/donate.



BUILDING THE FUTURE FOR 100 YEARS.

In less than a century, Boeing took the world from seaplanes to spaceplanes, across the universe and beyond. Technological innovation and excellence are a key part of this achievement. Boeing is proud to support IEEE and the 2016 Honors Ceremony Gala. Congratulations to the award recipients.

www.boeing.com/careers/IEEE



IEEE BOARD OF DIRECTORS & AWARDS BOARD COMMITTEES

2016 IEEE Board of Directors

IEEE President and CEO..... Barry L. Shoop
 IEEE President-Elect.....Karen Bartleson
 IEEE Past President Howard E. Michel
 Director & Secretary.....Parviz Famouri
 Director & TreasurerJerry Hudgins
 Director & Vice President, Educational Activities..... S.K. Ramesh
 Director & Vice President, Publication Services and Products.....Sheila Hemami
 Director & Vice President, Member and Geographic Activities..... Wai-Choong Wong
 Director & President, Standards Association Bruce P. Kraemer
 Director & Vice President, Technical ActivitiesJose M.F. Moura
 Director & President IEEE-USA..... Peter Alan Eckstein
 Director & Delegate, Region 1 Ronald A. Tabroff
 Director & Delegate, Region 2Timothy P. Kurzweg
 Director & Delegate, Region 3James M. Conrad
 Director & Delegate, Region 4 Robert C. Parro
 Director & Delegate, Region 5Francis B. Grosz, Jr.
 Director & Delegate, Region 6.....Thomas Coughlin
 Director & Delegate, Region 7..... Witold M. Kinsner
 Director & Delegate, Region 8..... Costas M. Stasopoulos
 Director & Delegate, Region 9.....Antonio C. Ferreira
 Director & Delegate, Region 10.....Ramakrishna Kappagantu
 Director & Delegate, Division I..... Maciej Ogorzalek
 Director & Delegate, Division II.....Hirofumi Akagi
 Director & Delegate, Division III..... Celia L. Desmond
 Director & Delegate, Division IV.....William W. Moses
 Director & Delegate, Division V..... Harold Javid
 Director & Delegate, Division VI..... Rob Reilly
 Director & Delegate, Division VII..... Alan C. Rotz
 Director & Delegate, Division VIII.....John W. Walz
 Director & Delegate, Division IX..... Ray Liu
 Director & Delegate, Division X..... Kazuhiro Kosuge
 Director Emeritus.....Eric Herz
 Director Emeritus..... Theodore W. Hissey

2016 IEEE Awards Board Committee

Awards Board Chair, Kensall (Ken) D. Wise
 Past Chair, Lewis M. Terman
 Vice Chair, Mark J. Karol
 Member-at-Large, David J. Allstot
 Member-at-Large, Elizabeth L. Burd
 Member-at-Large, Victor Fouad Hanna
 Member-at-Large, Moshe Kam
 Division Director, Kazuhiro Kosuge
 Region Director & IEEE BoD Coordinator, Timothy P. Kurzweg
 Medals Council Chair, David G. Messerschmitt
 Recognitions Council Chair, Adam Drobot
 Technical Field Awards Council Chair, T. Russell Hsing
 AB Presentation and Publicity Chair & WIE liaison, Leslie Martinich
 Awards Finance Committee Chair, Joseph Lillie
 AB Awards Review Committee Chair, Earl E. Swartzlander
 AB Joint Awards with National Societies Committee Chair, Richard V. Cox
 EAB/ARC Chair & WIE liaison, Karen A. Panetta
 MGA/ARC Chair and Young Professionals liaison, John Johnson
 SA/ARC Chair, Ronald C. Petersen
 TAB/ARC Chair, John O'Reilly
 USA/ARC Chair, Bernard Sander

<p><i>Editor</i> Leslie Russell</p> <p><i>Sr. Editor</i> Lynn Frassetto</p> <p><i>Assistant Editor</i> April Compertore</p> <p><i>Copy Editor</i> Brian Benbrook</p> <p><i>Director and Periodical Production Services</i> Peter Tuohy</p> <p><i>Supervisor and Periodical Production Services</i> Louis Vacca</p> <p><i>Senior Art Director</i> Janet Dudar</p> <p><i>Art and Production</i> Gail Schnitzer, Theresa Smith</p> <p><i>Awards Program & Budget Manager</i> Melissa Swartz</p>	<p><i>Advisory Board</i> <i>Marybeth Denike</i> Director, IEEE Awards Activities</p> <p><i>Donna Hourican</i> IEEE Staff Executive—Corporate Activities</p> <p><i>Kensall D. Wise</i> Awards Board Chair</p> <p><i>Scott Sandman</i> Executive Communications Manager</p> <p>Awards Presentation and Publicity Committee Leslie Martinich (Chair), Martin Bastiaans, Holly Cyrus, Margaretha Eriksson, Jason Hui, Karen Panetta, Cary Yang</p> <p>IEEE Operations Center 445 Hoes Lane Piscataway, NJ 08854-4141 USA Telephone: +1 732 562 6588 www.ieee.org/awards Follow us at: twitter.com/IEEEAwards Like us at: www.facebook.com/IEEEAwards</p>
--	--



The 2016 Awards Booklet is printed on 100% paper fibers from sustainable forestry.

IEEE prohibits discrimination, harassment and bullying.
 For more information, visit <http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html>

JOIN US

for the 1st annual IEEE Vision, Innovation, and Challenges Summit (IEEE VICS), 25 May 2017, Palace Hotel, San Francisco, CA, USA.

IEEE VICS, hosted by IEEE Awards, is a one-day event showcasing the breadth of engineering by bringing together innovators, visionaries, and leaders of technology to discuss what is imminent, to explore what is possible, and what these emerging areas will mean for our future...

This must-attend event will culminate with IEEE's most prestigious event, the IEEE Honors Ceremony.

Look for more information coming soon on www.ieee-vics.org



An IEEE Summit and Honors Ceremony



INNOVATION EXCELLENCE INGENUITY ENGINEERING

WWW.IEEE.ORG/AWARDS 3 PARK AVENUE 17TH FLOOR NEW YORK, NY 10016