

IEEE INFORMATION THEORY SOCIETY



The Information Theory Society is an organization, within the framework of the IEEE, of members with principal professional interests in information theory. All members of the IEEE are eligible for membership in the Society and will receive this TRANSACTIONS upon payment of the annual Society membership fee of \$30.00. For information on joining, write to the IEEE at the address below. *Member copies of Transactions/Journals are for personal use only.*

BOARD OF GOVERNORS

<i>President</i> GIUSEPPE CAIRE EE Dept. Univ. of Southern California Los Angeles, CA 90089 USA	<i>Secretary</i> NATASHA DEVROYE Dept. ECE Univ. of Illinois Chicago, IL 60607 USA	<i>Treasurer</i> NIHAR JINDAL Dept. Elec. Eng. Comp. Sci. Univ. of Minnesota Minneapolis, MN 55455 USA	<i>Transactions Editor</i> HELMUT BÖLCSKEI Dept. IT & EE ETH Zurich Zurich, Switzerland	<i>Conference Committee Chair</i> BRUCE HAJEK Dept. EECSS and Coordinated Science Lab. Univ. of Illinois Urbana, IL 61801 USA
---	--	--	---	--

<i>First Vice President</i> MURIEL MÉDARD	<i>Second Vice President</i> GERHARD KRAMER	<i>Junior Past President</i> FRANK R. KSCHISCHANG	<i>Senior Past President</i> ANDREA J. GOLDSMITH
HELMUT BÖLCSKEI (2011)	ALEX GRANT (2011)	MURIEL MÉDARD (2012)	EMINA SOLJANIN (2011)
MARTIN BOSSERT (2012)	ROLF JOHANNESON (2012)	PRAKASH NARAYAN (2012)	DAVID TSE (2013)
MAX H. M. COSTA (2012)	GERHARD KRAMER (2011)	L. PING (2012)	ALEXANDER VARDY (2013)
MICHELLE EFFROS (2013)	J. NICHOLAS LANEMAN (2013)	AMIN SHOKROLLAHI (2013)	SERGIO VERDÚ (2011)
ABBAS EL GAMAL (2011)	HANS-ANDREA LOELIGER (2012)	PAUL SIEGEL (2011)	EMANUELE VITERBO (2013)

IEEE TRANSACTIONS ON INFORMATION THEORY

HELMUT BÖLCSKEI, *Editor-in-Chief*

Executive Editorial Board

G. DAVID FORNEY, JR.	SHLOMO SHAMAI (SHITZ)	ALEXANDER VARDY	SERGIO VERDÚ
----------------------	-----------------------	-----------------	--------------

CYRIL MÉASSON, *Publications Editor* PREDRAG SPASOJEVIĆ, *Publications Editor*

ERDAL ARIKAN <i>Coding Theory</i>	ELZA ERKIP <i>Shannon Theory</i>	NAVIN KASHYAP <i>Coding Theory</i>	DANIEL P. PALOMAR <i>Detection and Estimation</i>	ANTONIA M. TULINO <i>Communications</i>
ALEXEI ASHIKHMIN <i>Coding Techniques</i>	CHRISTINA FRAGOULI <i>Communication Networks</i>	IOANNIS KONTOYIANNIS <i>At Large</i>	MATTHEW G. PARKER <i>Sequences</i>	TOMOHIKO UYEMATSU <i>Shannon Theory</i>
IAN F. BLAKE <i>Complexity and Cryptography</i>	MASSIMO FRANCESCHETTI <i>Communication Networks</i>	MARCO LOPS <i>Detection and Estimation</i>	REIHANEH SAFAVI-NAINI <i>Complexity and Cryptography</i>	ADRIAAN J. VAN WIJNGAARDEN <i>Communications</i>
MARIO BLAUM <i>Coding Theory</i>	MICHAEL GASTPAR <i>Shannon Theory</i>	KEITH M. MARTIN <i>Complexity and Cryptography</i>	ERCHIN SERPEDIN <i>Signal Processing</i>	PASCAL O. VONTOBEL <i>Coding Techniques</i>
DAVID BURSHTEIN <i>Coding Techniques</i>	DONGNING GUO <i>Shannon Theory</i>	JAMES L. MASSEY <i>Book Reviews</i>	MIKAEL SKOGLUND <i>Communications</i>	TSACHY WEISSMAN <i>Shannon Theory</i>
NICOLÒ CESA-BIANCHI <i>Pattern Recognition, Statistical Learning, and Inference</i>	VENKATESAN GURUSWAMI <i>Complexity and Cryptography</i>	MEHUL MOTANI <i>Communication Networks</i>	YOSSEF STEINBERG <i>At Large</i>	ROY D. YATES <i>Communication Networks</i>
GÉRARD COHEN <i>Coding Theory</i>	PATRICK HAYDEN <i>Quantum Information Theory</i>	ARIS L. MOUSTAKAS <i>Communications</i>	SEKHAR TATIKONDA <i>Communications</i>	NAM YUL YU <i>Sequences</i>
SUHAS DIGGAVI <i>Shannon Theory</i>	FRANZ HLAWATSCH <i>Detection and Estimation</i>	GEORGE V. MOUSTAKIDES <i>Detection and Estimation</i>	JEAN-PIERRE TILLICH <i>Coding Theory</i>	WEI YU <i>Shannon Theory</i>
URI EREZ <i>Coding Techniques</i>	SYED ALI JAFAR <i>Communications</i>	YASUTADA OOHAMA <i>Source Coding</i>		

Please refer to the inside back cover for instructions on submitting manuscripts.

IEEE Officers

MOSHE KAM, <i>President and CEO</i>	DAVID A. HODGES, <i>Vice President, Publication Services and Products</i>
GORDON W. DAY, <i>President-Elect</i>	HOWARD E. MICHEL, <i>Vice President, Member and Geographic Activities</i>
ROGER D. POLLARD, <i>Secretary</i>	STEVE M. MILLS, <i>President, IEEE Standards Association</i>
HAROLD FLESCHER, <i>Treasurer</i>	DONNA L. HUDSON, <i>Vice President, Technical Activities</i>
PEDRO A. RAY, <i>Past President</i>	RONALD G. JENSEN, <i>President, IEEE-USA</i>
TARIQ S. DURRANI, <i>Vice President, Educational Activities</i>	

ALFRED O. HERO, III, *Director, Division IX—Signals and Applications*

IEEE Executive Staff

DR. E. JAMES PRENDERGAST, <i>Executive Director & Chief Operating Officer</i>	PATRICK MAHONEY, <i>Marketing</i>
THOMAS SIEGERT, <i>Business Administration</i>	CECELIA JANKOWSKI, <i>Member and Geographic Activities</i>
MATTHEW LOEB, <i>Corporate Activities</i>	ANTHONY DURNIAK, <i>Publications Activities</i>
DOUGLAS GORHAM, <i>Educational Activities</i>	JUDITH GORMAN, <i>Standards Activities</i>
BETSY DAVIS, <i>SPHR, Human Resources</i>	MARY WARD-CALLAN, <i>Technical Activities</i>
CHRIS BRANTLEY, <i>IEEE-USA</i>	
ALEXANDER PASIK, <i>Information Technology</i>	

IEEE Periodicals

Transactions/Journals Department

<i>Staff Director:</i> FRAN ZAPPULLA	
<i>Editorial Director:</i> DAWN MELLETT	<i>Production Director:</i> PETER M. TUOHY
<i>Managing Editor:</i> MARTIN J. MORAHAN	<i>Senior Editor:</i> MEGAN VOREL HERNANDEZ

IEEE TRANSACTIONS ON INFORMATION THEORY (ISSN 0018-9448) is published monthly by The Institute of Electrical and Electronics Engineers, Inc. Responsibility for the contents rests upon the authors and not upon the IEEE, the Society/Council, or its members. **IEEE Corporate Office:** 3 Park Avenue, 17th floor, New York, NY 10016-5997. **IEEE Operations Center:** 445 Hoes Lane, Piscataway, NJ 08854-4141. **NJ Telephone:** +1 732 981 0060. **Price/Publication Information:** Individual copies: IEEE Members \$20.00 (first copy only), nonmembers \$96.00 per copy. (Note: Postage and handling charge not included.) Member and nonmember subscription prices available upon request. **Copyright and Reprint Permissions:** Abstracting is permitted with credit to the source. Libraries are permitted to photocopy for private use of patrons, provided the per-copy fee indicated in the code at the bottom of the first page is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. For all other copying, reprint, or republication permission, write to Copyrights and Permissions Department, IEEE Publications Administration, 445 Hoes Lane, Piscataway, NJ 08854-4141. Copyright © 2011 by The Institute of Electrical and Electronics Engineers, Inc. All rights reserved. Periodicals Postage Paid at New York, NY and at additional mailing offices. **Postmaster:** Send address changes to IEEE TRANSACTIONS ON INFORMATION THEORY, IEEE, 445 Hoes Lane, Piscataway, NJ 08854-4141. GST Registration No. 125634188. CPC Sales Agreement #40013087. Return undeliverable Canada addresses to: Pitney Bowes IMEX, P.O. Box 4332, Stanton Rd., Toronto, ON M5W 3J4, Canada. IEEE prohibits discrimination, harassment and bullying. For more information visit <http://www.ieee.org/nondiscrimination>. Printed in U.S.A.