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SPECIAL ISSUE ON INFORMATION THEORETIC SECURITY

Introduction to the Special Issue on Information Theoretic Security

THIS special issue of the IEEE TRANSACTIONS ON INFORMATION THEORY is devoted to the exciting research field of Information Theoretic Security. Cryptographic systems that are currently employed in practice are predominantly based on unproven mathematical assumptions such as the assumed infeasibility of factoring large integers and finding discrete logarithms over large finite fields. Advances in cryptoanalytic attack algorithms and new computing technologies such as quantum computers may eventually render these systems insecure and, thus, obsolete in the future. As such, among both information security researchers and practitioners there has long been a sense of urgency to investigate novel encryption and authentication systems that do not rely on unproven mathematical assumptions for their security. The past two decades have witnessed a number of significant developments in information theoretic security, including the discovery of unconditionally secure encryption schemes, authentication codes and signature methods, and the development of quantum key distribution protocols.

Research papers that have been selected for inclusion in this special issue cover a broad range of important topics in information theoretic security, including

- authentication,
- broadcast security,
- channel capacity,
- key agreement,
- two and multiparty computation,
- network coding,
- quantum cryptography,
- secret sharing,
- steganography,
- wire-tap channels,
- complexity of non-number-theoretic problems, and
- anonymity.

Two papers address bounds for unconditionally secure authentication codes. In addition to the more traditional model for authentication, where a sender and a receiver share a short secret key, the paper by Naor, Segev, and Smith examines also a model where the sender and the receiver are connected by a low-bandwidth auxiliary channel that allows the sender to "manually" authenticate a short message to the receiver. The paper by Safavi-Naini and Wild considers a strong attack scenario where an adversary is adaptive and has access to authentication and verification oracles.

Five papers investigate security issues related to broadcast channels. Csiszár and Narayan find new bounds for secrecy capacities of channels with one input terminal, multiple-output terminals, and a public noiseless channel of unlimited capacity. Khisti, Tchamkerten, and Wornell study parallel broadcast channels with one sender, multiple intended receivers, and one eavesdropper. This is followed by Liang, Poor, and Shamai who investigate fading broadcast channels with confidential messages. Liu, Marić, Spasojević, and Yates study secrecy capacity regions for discrete memoryless interference and broadcast channels with independent confidential messages. Finally, Stinson and Zaverucha investigate new bounds for secure frameproof codes that find applications in secure broadcasting.

Two papers fall into the area of secure key agreement. Continuing their earlier work on confidential communication over wireless channels, Bloch, Barros, Rodrigues, and McLaughlin develop practical secret key agreement protocols over Gaussian and quasi-static fading wiretap channels. Yakovlev, Korzhik, and Morales-Luna present new ideas for key distribution protocols over noisy wiretap channels that offer information theoretic security in the presence of an active adversary.

Four papers are concerned with secure multiparty computation. Kosut and Tong investigate a problem in distributed source coding where an unknown number of sensors can be controlled by a malicious intruder. Their work is followed by two papers, one by Kurosawa, Kishimoto, and Koshiba and the other by Nascimento and Winter, both of which investigate information theoretically secure oblivious transfer protocols. Wang and Desmedt study message transmission in a reliable and privacy-preserving manner over a network that can be modeled by a directed graph.

Network coding is an emerging area of importance. The paper by Jaggi, Langberg, Katti, Ho, Katabi, Medard, and Effros addresses security issues with network coding. Specifically, the authors design polynomial-time, rate-optimal network codes that work in the presence of Byzantine nodes.

Two papers are directly related to quantum cryptography. The paper by Horodecki, Horodecki, Horodecki, Leung, and Oppenheim provides proofs for the unconditional security of a quantum key distribution protocol that is based on distilling pbits, whereas the other paper by Horodecki, Pankowski, Horodecki, and Horodecki investigates bound entangled states that have a positive distillable secure key rate.

Three papers examine secret sharing. Beimel and Livne study new secret sharing schemes based on matroids. Cramer, Daza, Gracia, Leander, and Padro reveal connections between codes, matroids, and multiplicative linear secret sharing schemes. Koga employs information-spectrum methods to investigate threshold schemes.

Three papers are devoted to steganography. Anthapadmanabhan, Barg, and Dumer show how to achieve the maximum attainable rate of fingerprinting codes under the marking assumption. Shikata and Matsumoto propose models for unconditionally secure stegosystems against active attacks over an insecure channel. Wang and Moulin show bounds and constructions for perfectly secure steganography.

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Two papers address the classical wiretap channels. Merhav considers a wiretap channel where a wiretapper is allowed to have access to both coded information and side information via channels that are more noisy than the respective channels of between a sender and a legitimate decoder. Tekin and Yener investigate the General Gaussian Multiple Access Wire-Tap Channel (GGMAC-WT) and the Gaussian Two-Way Wire-Tap Channel (GTW-WT) which are common in multiuser wireless communications.

The paper by Kiayias and Yung study the hardness of the Reed–Solomon codes when applied in cryptography. This is followed by a paper by Venkitasubramaniam, He, and Tong where anonymous communication in a wireless environment is investigated.

We have six correspondences addressing different aspects of information theoretic security. Nascimento, Barros, Skludarek, and Imai show that the commitment capacity of the Gaussian channel is infinite. Dziembowski and Maurer prove a tight lower bound on storage for key agreement in the bounded-storage model. Wolf and Wullschleger introduce various monotones and use them to derive lower bounds in multiparty computations. Ho, Leong, Koetter, Medard, and Effros propose an information theoretic approach for detecting Byzantine modifications in networks employing random linear network coding. Zhao, Gui, Chen, Han, and Guo study the hardness of key distillation for reverse reconciliation continuous variable quantum key distribution. Finally, Hayashi and Yamamoto show new coding theorems for the Shannon cipher.

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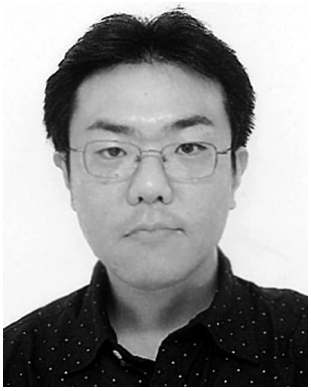
From IEICE (the Institute of Electronics, Information and Communication Engineers), Dr. Imai received Best Book Awards in 1976 and 1991, Best Paper Awards in 1992, 2003, and 2004, the Yonezawa Memorial Paper Award in 1992, the Achievement Award in 1995, the Inose Award in 2003, and the Distinguished Achievement and Contributions Award in 2004. He also received a Golden Jubilee Paper Award from the IEEE Information Theory Society in 1998, and Official Commendations from the Minster of Internal Affairs and Communications in June 2002 and from the Minister of Economy, Trade and Industry in October 2002. He was awarded Honor Doctor degree by Soonchunhyang University, Korea, in 1999 and Docteur Honoris Causa degree by the University of Toulon Var, France, in 2002. He is also the recipient of the Ericsson Telecommunications Award in 2005. He was awarded Wilkes Award from the British Computer Society in 2007. He is a member of the Science Council of Japan. He was elected a Fellow of IEEE, IEICE, and IACR (International Association for Cryptologic Research) in 1992, 2001, and 2007, respectively. He has chaired many committees of scientific societies and organized a number of international conferences. He served as the President of the Society of Information Theory and its Applications in 1997, of the IEICE Engineering Sciences Society in 1998, and of the IEEE Information Theory Society in 2004. He is currently the Chair of CRYPTREC (Cryptography Techniques Research and Evaluation Committee of Japan).



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