Lecture Notes in Computer Science

3958

Commenced Publication in 1973
Founding and Former Series Editors:
Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison

Lancaster University, UK

Takeo Kanade

Carnegie Mellon University, Pittsburgh, PA, USA

Josef Kittler

University of Surrey, Guildford, UK

Jon M. Kleinberg

Cornell University, Ithaca, NY, USA

Friedemann Mattern

ETH Zurich, Switzerland

John C. Mitchell

Stanford University, CA, USA

Moni Naor

Weizmann Institute of Science, Rehovot, Israel

Oscar Nierstrasz

University of Bern, Switzerland

C. Pandu Rangan

Indian Institute of Technology, Madras, India

Bernhard Steffen

University of Dortmund, Germany

Madhu Sudan

Massachusetts Institute of Technology, MA, USA

Demetri Terzopoulos

University of California, Los Angeles, CA, USA

Doug Tygar

University of California, Berkeley, CA, USA

Moshe Y. Vardi

Rice University, Houston, TX, USA

Gerhard Weikum

Max-Planck Institute of Computer Science, Saarbruecken, Germany

Moti Yung Yevgeniy Dodis Aggelos Kiayias Tal Malkin (Eds.)

Public Key Cryptography – PKC 2006

9th International Conference on Theory and Practice of Public-Key Cryptography New York, NY, USA, April 24-26, 2006 Proceedings



Volume Editors

Moti Yung RSA Laboratories and

Columbia University

Computer Science Department

1214 Amsterdam Avenue, New York, NY 10027, USA

E-mail: moti@cs.columbia.edu

Yevgeniy Dodis New York University Department of Computer Science 251 Mercer Street, New York, NY 10012, USA E-mail: dodis@cs.nyu.edu

Aggelos Kiayias University of Connecticut Department of Computer Science and Engineering Storrs CT 06269-2155, USA E-mail: aggelos@cse.uconn.edu

Tal Malkin
Columbia University
Department of Computer Science
1214 Amsterdam Avenue, New York, NY 10027, USA
E-mail: tal@cs.columbia.edu

Library of Congress Control Number: 2006924182

CR Subject Classification (1998): E.3, F.2.1-2, C.2.0, K.4.4, K.6.5

LNCS Sublibrary: SL 4 – Security and Cryptology

ISSN 0302-9743

ISBN-10 3-540-33851-9 Springer Berlin Heidelberg New York ISBN-13 978-3-540-33851-2 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

springer.com

© Springer-Verlag Berlin Heidelberg 2006 Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India Printed on acid-free paper SPIN: 11745853 06/3142 5 4 3 2 1 0

Preface

The 9th International Conference on Theory and Practice of Public-Key Cryptography (PKC 2006) took place in New York City. PKC is the premier international conference dedicated to cryptology focusing on all aspects of public-key cryptography. The event is sponsored by the International Association of Cryptologic Research (IACR), and this year it was also sponsored by the Columbia University Computer Science Department as well as a number of sponsors from industry, among them: EADS and Morgan Stanley, which were golden sponsors, as well as Gemplus, NTT DoCoMo, Google, Microsoft and RSA Security, which were silver sponsors. We acknowledge the generous support of our industrial sponsors; their support was a major contributing factor to the success of this year's PKC.

PKC 2006 followed a series of very successful conferences that started in 1998 in Yokohama, Japan. Further meetings were held successively in Kamakura (Japan), Melbourne (Australia), Jeju Island (Korea), Paris (France), Miami (USA), Singapore and Les Diablerets (Switzerland). The conference became an IACR sponsored event (officially designated as an IACR workshop) in 2003 and has been sponsored by IACR continuously since then. The year 2006 found us all in New York City where the undertone of the conference was hummed in the relentless rhythm of the city that never sleeps.

This year's conference was the result of a collaborative effort by four of us: Moti Yung served as the conference and program chair. Moti orchestrated the whole project and led the Program Committee's efforts in the careful selection of the 34 papers that you will find in this volume. Yevgeniy Dodis served as the general and sponsorship chair, coordinating the sponsorship efforts. Aggelos Kiayias served as the publicity and publication chair, tending to the conference's publicity aspects, Web-site, submission and reviewing site as well as the editorial preparation of the present volume. Tal Malkin served as the general and local arrangements chair and was responsible for the very critical job of hosting PKC 2006 at Columbia University.

The selection of papers for this year's program was a delicate and laborious task. PKC 2006 had received a total of 124 submissions by the day of the submission deadline, November 15, 2005. Each paper was refereed by at least four committee members who were frequently assisted by external reviewers. The online discussions together with the reviews that were posted on the online reviewing site, if printed, would require more than 450 pages of densely printed text. The present proceedings volume contains the revised versions of the accepted extended abstracts as submitted by the authors after an alloted three week revision period based on the Program Committee's comments. The PKC 2006 Program Committee had the pleasure of according this year's *PKC Best Paper Award* to Daniel Bleichenbacher and Alexander May for their advancement

VI Preface

of RSA cryptanalysis in their paper entitled "New Attacks on RSA with Small Secret CRT-Exponents."

We would like to thank the Program Committee members as well as the external reviewers for their volunteered hard work invested in selecting the program. We thank the PKC Steering Committee for their support. We also wish to thank the following individuals: Shai Halevi for providing his Web-review and submission system to be used for the conference and for providing technical support; the submission and reviewing-site administrator David Walluck as well as the other students of the CryptoDRM Lab at the University of Connecticut for providing technical support; and Michael Locasto for Web-site administration support at Columbia University. Finally big thanks are due to all authors of submitted papers whose quality contributions make this research area a pleasure to work in, and made this conference a possibility.

March 2006

Moti Yung Yevgeniy Dodis Aggelos Kiayias Tal Malkin

Organization

PKC Steering Committee

Ronald Cramer CWI and Leiden University, The Netherlands

Yvo Desmedt University College London, UK Hideki Imai (Chair) University of Tokyo, Japan

Kwangjo Kim Information and Communications University,

Korea

David Naccache École Normale Supérieure, France

Tatsuaki Okamoto NTT Labs, Japan

Jacques Stern École Normale Supérieure, France

Moti Yung RSA Laboratories and Columbia University,

 $_{
m USA}$

Yuliang Zheng (Secretary) University of North Carolina at Charlotte,

USA

Organizing Committee

Conference and Program Chair
General and Sponsorship Chair
Publicity and Publication Chair
General and Local Arrangements Chair
Tal Malkin

Moti Yung
Yevgeniy Dodis
Aggelos Kiayias

Industrial Sponsors

EADS
Morgan Stanley
Gemplus
NTT DoCoMo
Google
Microsoft
RSA Security

Program Committee

Masayuki Abe NTT Japan Feng Bao I2R, Singapore

Paulo S.L.M. Barreto
Amos Beimel

Xavier Boyen
Serge Fehr
Pierre-Alain Fouque
Juan Garay
Rosario Gennaro

University of São Paulo, Brazil
Ben Gurion University, Israel
Voltage Technology, USA
CWI, The Netherlands
ENS Paris, France
Bell Labs, USA
IBM Research, USA

Nick Howgrave-Graham NTRU Cryptosystems, USA Dong Hoon Lee Korea University, Korea

Wenbo Mao HP Labs, China

Alexander May Paderborn University, Germany

David Naccache ENS, France Rafail Ostrovsky UCLA, USA

Kenny Paterson Royal Holloway, U. of London, UK

Giuseppe Persiano University of Salerno, Italy Benny Pinkas Haifa University, Israel Leonid Reyzin Boston University, USA

Kazue Sako NEC Japan

Jean-Sébastien Coron University of Luxembourg

Alice Silverberg U. C. Irvine, USA Jessica Staddon PARC, USA

Ron Steinfeld Macquarie University, Australia Edlyn Teske University of Waterloo, Canada

Wen-Guey Tzeng NCTU, Taiwan

Susanne Wetzel Stevens Institute, USA

Yiqun Lisa Yin Independent Consultant, USA

Adam Young MITRE, USA

Moti Yung RSA Labs and Columbia U., USA

External Reviewers

Michel Abdalla Ran Canetti Yang Cui
Ben Adida Melissa Chase Martin Döring
Luis von Ahn Lily Chen Paolo D'Arco
Giuseppe Ateniese Liqun Chen Michael De Mare
Joonsang Baek Benoît Chevallier-Mames Breno de Medeiros

Paulo Barreto Chen-Kang Chu Nenad Dedić Daniel Brown Mathieu Ciet Alex Dent Jan Camenisch Scott Contini Glenn Durfee Pooya Farshim
Marc Fischlin
Jun Furukawa
Steven Galbraith
Clemente Galdi
David Galindo
Decio Gazzoni
Kristian Gjøsteen
Dorian Goldfeld
Philippe Golle
Vanessa Gratzer
Shai Halevi
Wei Han
Darrel Hankerson
Anwar Hasan

Javier Herranz
Jason Hinek
Dennis Hofheinz
Nicholas Hopper
Toshiyuki Isshiki
Stanislaw Jarecki
Markus Kaiser
Jonathan Katz
Tim Kerins
Eike Kiltz
Hugo Krawczyk
Sebastien Kunz-Jacques
Kaoru Kurosawa

Eonkyung Lee

Xiangxue Li
Benoît Libert
Shia-Yin Lin
Yehuda Lindell
Pierre Loidreau
Anna Lysyanskaya
John Malone-Lee
Gwenaëlle Martinet
Barbara Masucci
Bernd Meyer
Ulrike Meyer
Peter Montgomery
Kengo Mori
Volker Müller
James Muir

Chanathip Namprempre Phong Nguyen

Jesper Buus Nielsen
Satoshi Obana
Daniel Page
Adriana Palacio
Josef Pieprzyk
David Pointcheval
Geraint Price
Karl Rubin
Tomas Sander
Oliver Schirokauer
Katja Schmidt-Samoa

Michael Scott

Hovav Shacham
Junji Shikata
Nigel Smart
Diana Smetters
Jerry Solinas
Rainer Steinwandt
Willy Susilo
Koutaro Suzuki
Isamu Teranishi
Nicholas Theriault
Richard M. Thomas
Xiaojian Tian
Ivan Visconti
Guilin Wang
Huaxiong Wang

Ralf-Philipp Weinmann

Brent Waters

Enav Weinreb
Kai Wirt
Duncan Wong
David Woodruff
Rui Zhang
Yunlei Zhao
Sheng Zhong
Huafei Zhu

Sebastien Zimmer

Table of Contents

Cryptanalysis and Protocol Weaknesses

New Attacks on RSA with Small Secret CRT-Exponents Daniel Bleichenbacher, Alexander May	1
An Attack on a Modified Niederreiter Encryption Scheme Christian Wieschebrink	14
Cryptanalysis of an Efficient Proof of Knowledge of Discrete Logarithm Sébastien Kunz-Jacques, Gwenaëlle Martinet, Guillaume Poupard, Jacques Stern	27
Distributed Crypto-computing	
Efficient Polynomial Operations in the Shared-Coefficients Setting Payman Mohassel, Matthew Franklin	44
Generic On-Line/Off-Line Threshold Signatures Chris Crutchfield, David Molnar, David Turner, David Wagner	58
Linear Integer Secret Sharing and Distributed Exponentiation Ivan Damgård, Rune Thorbek	75
Encryption Methods	
Encoding-Free ElGamal Encryption Without Random Oracles Benoît Chevallier-Mames, Pascal Paillier, David Pointcheval	91
Parallel Key-Insulated Public Key Encryption Goichiro Hanaoka, Yumiko Hanaoka, Hideki Imai	105
Provably Secure Steganography with Imperfect Sampling Anna Lysyanskaya, Mira Meyerovich	123
Cryptographic Hash and Applications	
Collision-Resistant No More: Hash-and-Sign Paradigm Revisited **Ilva Mironov**	140

Higher Order Universal One-Way Hash Functions from the Subset Sum Assumption	
Ron Steinfeld, Josef Pieprzyk, Huaxiong Wang	157
Number Theory Algorithms	
An Algorithm to Solve the Discrete Logarithm Problem with the Number Field Sieve An Commeine, Igor Semaev	174
Efficient Scalar Multiplication by Isogeny Decompositions Christophe Doche, Thomas Icart, David R. Kohel	191
Curve25519: New Diffie-Hellman Speed Records Daniel J. Bernstein	207
Pairing-Based Cryptography	
Strongly Unforgeable Signatures Based on Computational Diffie-Hellman Dan Boneh, Emily Shen, Brent Waters	229
Generalization of the Selective-ID Security Model for HIBE Protocols Sanjit Chatterjee, Palash Sarkar	241
Identity-Based Aggregate Signatures Craig Gentry, Zulfikar Ramzan	257
On the Limitations of the Spread of an IBE-to-PKE Transformation Eike Kiltz	274
Cryptosystems Design and Analysis	
Inoculating Multivariate Schemes Against Differential Attacks Jintai Ding, Jason E. Gower	290
Random Subgroups of Braid Groups: An Approach to Cryptanalysis of a Braid Group Based Cryptographic Protocol Alexei Myasnikov, Vladimir Shpilrain, Alexander Ushakov	302
High-Order Attacks Against the Exponent Splitting Protection Frédéric Muller, Frédéric Valette	315

	Signature	and	Identification
--	-----------	-----	----------------

New Online/Offline Signature Schemes Without Random Oracles Kaoru Kurosawa, Katja Schmidt-Samoa	330
Anonymous Signature Schemes Guomin Yang, Duncan S. Wong, Xiaotie Deng, Huaxiong Wang	347
The Power of Identification Schemes Kaoru Kurosawa, Swee-Huay Heng	364
Authentication and Key Establishment	
Security Analysis of KEA Authenticated Key Exchange Protocol *Kristin Lauter, Anton Mityagin	378
SAS-Based Authenticated Key Agreement Sylvain Pasini, Serge Vaudenay	395
The Twist-AUgmented Technique for Key Exchange Olivier Chevassut, Pierre-Alain Fouque, Pierrick Gaudry, David Pointcheval	410
Password-Based Group Key Exchange in a Constant Number of Rounds Michel Abdalla, Emmanuel Bresson, Olivier Chevassut, David Pointcheval	427
Multi-party Computation	
Conditional Oblivious Cast Cheng-Kang Chu, Wen-Guey Tzeng	443
Efficiency Tradeoffs for Malicious Two-Party Computation Payman Mohassel, Matthew Franklin	458
PKI Techniques	
On Constructing Certificateless Cryptosystems from Identity Based Encryption Benoît Libert, Jean-Jacques Quisquater	474
Building Better Signcryption Schemes with Tag-KEMs Tor E. Bjørstad, Alexander W. Dent	491

XIV Table of Contents

Security-Mediated Certificateless Cryptography Sherman S.M. Chow, Colin Boyd, Juan Manuel González Nieto	508
k-Times Anonymous Authentication with a Constant Proving Cost Isamu Teranishi, Kazue Sako	525
Author Index	543