Selected Areas in Cryptography

14th International Workshop, SAC 2007 Ottawa, Canada, August 16-17, 2007 Revised Selected Papers



Volume Editors

Carlisle Adams

University of Ottawa, School of Information Technology and Engineering (SITE) SITE Building, 800 King Edward Avenue, Ottawa, Ontario K1N 6N5, Canada E-mail: cadams@site.uottawa.ca

Ali Miri

University of Ottawa, School of Information Technology and Engineering (SITE) and Department of Mathematics and Statistics

Colonel By Hall (CBY), 161 Louis Pasture Street, Ottawa, Ontario K1N 6N5, Canada E-mail: samiri@site.uottawa.ca

Michael Wiener Cryptographic Clarity 20 Hennepin Street, Nepean, Ontario K2J 3Z4, Canada E-mail: michael.james.wiener@gmail.com

Library of Congress Control Number: 2007941250

CR Subject Classification (1998): E.3, D.4.6, K.6.5, F.2.1-2, C.2, H.4.3

LNCS Sublibrary: SL 4 – Security and Cryptology

ISSN 0302-9743

ISBN-10 3-540-77359-2 Springer Berlin Heidelberg New York ISBN-13 978-3-540-77359-7 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 2007 Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India Printed on acid-free paper SPIN: 12206629 06/3180 5 4 3 2 1 0

Preface

SAC 2007 was the 14th in a series of annual workshops on Selected Areas in Cryptography. This is the first time this workshop was held at the University of Ottawa. Previous workshops were held at Queen's University in Kingston (1994, 1996, 1998, 1999, and 2005), Carleton University in Ottawa (1995, 1997, and 2003), University of Waterloo (2000 and 2004), Fields Institute in Toronto (2001), Memorial University of Newfoundland in St. Johns (2002), and Concordia University in Montreal (2006). The intent of the workshop is to provide a stimulating atmosphere where researchers in cryptology can present and discuss new work on selected areas of current interest. The themes for SAC 2007 were:

- Design and analysis of symmetric key cryptosystems
- Primitives for symmetric key cryptography, including block and stream ciphers, hash functions, and MAC algorithms
- Efficient implementations of symmetric and public key algorithms
- Innovative cryptographic defenses against malicious software

A total of 73 papers were submitted to SAC 2007. Of these, one was withdrawn by the authors, and 25 were accepted by the Program Committee for presentation at the workshop. In addition to these presentations, we were fortunate to have two invited speakers:

- Dan Bernstein: "Edwards Coordinates for Elliptic Curves"
- Moti Yung: "Cryptography and Virology Inter-Relationships." This talk was designated the Stafford Tavares Lecture.

We are grateful to the Program Committee and the many external reviewers for their hard work and expertise in selecting the program. They completed all reviews in time for discussion and final decisions despite events conspiring to compress the review schedule. We apologize if anyone was missed in the list of external reviewers.

We would like to thank the Ontario Research Network for Electronic Commerce (ORNEC) for financial support of the workshop. We would also like to thank Gail Deduk for administrative support and Aleks Essex and Terasan Niyomsataya for technical support.

Finally, we thank all those who submitted papers and the conference participants who made this year's workshop a great success.

October 2007 Carlisle Adams Ali Miri

Michael Wiener

14th Annual Workshop on Selected Areas in Cryptography

August 16-17, 2007, Ottawa, Ontario, Canada

in cooperation with the International Association for Cryptologic Research (IACR)

Conference Co-chairs

Carlisle Adams University of Ottawa, Canada Ali Miri University of Ottawa, Canada Michael Wiener Cryptographic Clarity, Canada

Program Committee

Roberto Avanzi Ruhr University Bochum, Germany Orr Dunkelman Katholieke Universiteit Leuven, Belgium

Ian Goldberg University of Waterloo, Canada

Helena Handschuh Spansion, France

M. Anwar Hasan

Antoine Joux

University of Waterloo, Canada

DGA, Université de Versailles

St-Quentin-en-Yvelines, France

Pascal Junod Nagravision, Switzerland

Tanja Lange Technische Universiteit, Eindhoven,

Netherlands

Arjen Lenstra EPFL, Switzerland

Christof Paar Ruhr University Bochum, Germany
Bart Preneel Katholieke Universiteit Leuven, Belgium
Vincent Rijmen Graz University of Technology, Austria

Matt Robshaw France Telecom, France Greg Rose QUALCOMM, USA

Doug Stinson University of Waterloo, Canada

Serge Vaudenay EPFL, Switzerland Robert Zuccherato Entrust Inc., Canada

External Reviewers

Abdulaziz Alkhoraidly Elena Andreeva Thomas Baignères Siavash Bayat-Sarmadi Anja Becker Côme Berbain Daniel J. Bernstein Eli Biham Olivier Billet Toni Bluher Andrey Bogdanov Reinier Broker

VIII Organization

Christophe De Cannière Yaniv Carmeli Scott Contini Thomas Eisenbarth Matthieu Finiasz Jovan Golić Arash Hariri Laurent Imbert David Jacobson Alexandre Karlov Cédric Lauradoux Reynald Lercier Marine Minier Dag Arne Osvik Souradvuti Paul Emmanuel Prouff Kai Schramm Marc Stevens Martin Vuagnoux Huapeng Wu

Christophe Doche Lars Elmegaard-Fessel Steven Galbraith Johann Groβschädl Phil Hawkes Sebastiaan Indesteege Shaoquan Jiang Shahram Khazaei Gregor Leander Cameron McDonald Bodo Möller Elisabeth Oswald Raphael Phan Christian Rechberger Yaniv Shaked Nicolas Theriault Johannes Wolkerstorfer Hongjun Wu Brecht Wyseur

Jaewook Chung Nevine Ebeid Andreas Enge Henri Gilbert Tim Guneysu Rafi Hen Takanori Isobe Marcelo Kaihara Mario Lamberger Kerstin Lemke Florian Mendel Jean Monnerat Svlvain Pasini Norbert Pramstaller Arash Reyhani-Masoleh Martijn Stam Frederik Vercauteren Lu Xiao

Table of Contents

| Reduced Complexity Attacks on the Alternating Step Generator | 1 |
|---|-----|
| Extended BDD-Based Cryptanalysis of Keystream Generators Dirk Stegemann | 17 |
| Two Trivial Attacks on Trivium | 36 |
| Collisions for 70-Step SHA-1: On the Full Cost of Collision Search Christophe De Cannière, Florian Mendel, and Christian Rechberger | 56 |
| Cryptanalysis of the CRUSH Hash Function | 74 |
| Improved Side-Channel Collision Attacks on AES | 84 |
| Analysis of Countermeasures Against Access Driven Cache Attacks on AES | 96 |
| Power Analysis for Secret Recovering and Reverse Engineering of Public Key Algorithms | 110 |
| Koblitz Curves and Integer Equivalents of Frobenius Expansions Billy Bob Brumley and Kimmo Järvinen | 126 |
| Another Look at Square Roots (and Other Less Common Operations) in Fields of Even Characteristic | 138 |
| Efficient Explicit Formulae for Genus 2 Hyperelliptic Curves over Prime Fields and Their Implementations | 155 |
| Explicit Formulas for Efficient Multiplication in $\mathbb{F}_{3^{6m}}$ | 173 |
| Linear Cryptanalysis of Non Binary Ciphers | 184 |
| The Delicate Issues of Addition with Respect to XOR Differences Gaoli Wang, Nathan Keller, and Orr Dunkelman | 212 |

X Table of Contents

| MRHS Equation Systems | 232 |
|--|-----|
| A Fast Stream Cipher with Huge State Space and Quasigroup Filter for Software Makoto Matsumoto, Mutsuo Saito, Takuji Nishimura, and | 246 |
| Mariko Hagita | |
| Cryptanalysis of White-Box DES Implementations with Arbitrary External Encodings | 264 |
| Cryptanalysis of White Box DES Implementations Louis Goubin, Jean-Michel Masereel, and Michaël Quisquater | 278 |
| Attacks on the ESA-PSS-04-151 MAC Scheme | 296 |
| The Security of the Extended Codebook (XCB) Mode of Operation David A. McGrew and Scott R. Fluhrer | 311 |
| A Generic Method to Design Modes of Operation Beyond the Birthday Bound | 328 |
| David Lefranc, Philippe Painchault, Valérie Rouat, and Emmanuel Mayer | |
| Passive-Only Key Recovery Attacks on RC4 | 344 |
| Permutation After RC4 Key Scheduling Reveals the Secret Key | 360 |
| Revisiting Correlation-Immunity in Filter Generators | 378 |
| Distinguishing Attack Against TPypy | 396 |
| Author Index | 409 |