# Lecture Notes in Computer Science

3557

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

New York University, NY, 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

Henri Gilbert Helena Handschuh (Eds.)

# Fast Software Encryption

12th International Workshop, FSE 2005 Paris, France, February 21-23, 2005 Revised Selected Papers



#### Volume Editors

Henri Gilbert

France Telecom, 92794 Issy les Moulineaux, France

E-mail: henri.gilbert@francetelecom.com

Helena Handschuh

Gemplus SA, Issy-les-Moulineaux, France E-mail: Helena.Handschuh@gemplus.com

Library of Congress Control Number: 2005928340

CR Subject Classification (1998): E.3, F.2.1, E.4, G.2, G.4

ISSN 0302-9743

ISBN-10 3-540-26541-4 Springer Berlin Heidelberg New York ISBN-13 978-3-540-26541-2 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

springeronline.com

© International Association for Cryptologic Research 2005 Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India Printed on acid-free paper SPIN: 11502760 06/3142 5 4 3 2 1 0

## Preface

The Fast Software Encryption 2005 Workshop was the twelfth in a series of annual workshops on symmetric cryptography, sponsored for the fourth year by the International Association for Cryptologic Research (IACR). The workshop concentrated on all aspects of fast primitives for symmetric cryptology, including the design, cryptanalysis and implementation of block and stream ciphers as well as hash functions and message authentication codes. The first FSE workshop was held in Cambridge in 1993, followed by Leuven in 1994, Cambridge in 1996, Haifa in 1997, Paris in 1998, Rome in 1999, New York in 2000, Yokohama in 2001, Leuven in 2002. Lund in 2003, and New Delhi in 2004.

This year, a total of 96 submissions were received. After an extensive review by the Program Committee, 30 submissions were accepted. Two of these submissions were merged into a single paper, yielding a total of 29 papers accepted for presentation at the workshop. Also, we were very fortunate to have in the program an invited talk by Xuejia Lai on "Attacks and Protection of Hash Functions" and a very entertaining rump session that Bart Preneel kindly accepted to chair. These proceedings contain the revised versions of the accepted papers; the revised versions were not subsequently checked for correctness.

We are very grateful to the Program Committee members and to the external reviewers for their hard work. Each paper was refereed by at least three reviewers, and at least five reviewers in the case of papers (co-)authored by Program Committee members; eventually, an impressive total of 334 reviews was produced. Special thanks are also due to the members of the Local Organizing Committee, Côme Berbain, Olivier Billet (who designed the FSE 2005 Web pages and assembled the preproceedings), Julien Brouchier (who managed the submission and Webreview servers), Stanislas Francfort, Aline Gouget, Françoise Levy, Pierre Loidreau, and Pascal Paillier (who managed on-site registration), for their generous efforts and strong support.

Many thanks to Kevin McCurley for handling the registration server, to Patrick Arditti, Virginie Berger and Claudine Campolunghi for providing assistance with the registration process, and to the research group COSIC of the K.U.Leuven for kindly providing their Webreview software.

Last but not least, we would like to thank the conference sponsors France Telecom, Gemplus, and Nokia for their financial support, DGA and ENSTA for hosting the conference on their premises, and all submitters and workshop participants who made this year's workshop such an enjoyable event.

## **FSE 2005**

February 21–23, 2005, Paris, France

Sponsored by the International Association for Cryptologic Research (IACR)

#### Program and General Chairs

France Telecom, France
Gemplus, France
NTT, Japan
Vodafone, UK
Technion, Israel
INRIA, France
IBM Research, USA
STMicroelectronics, Belgium
Lund University, Sweden
.DGA and Université de Versailles, France
Shanghai Jiaotong University, China
Universität Mannheim, Germany
Mitsubishi Electric, Japan
FH Aargau, Switzerland
Nokia, Finland
K.U.Leuven, Belgium
Royal Holloway, University of London, UK
Indian Statistical Institute, India

## Local Organizing Committee

Côme Berbain, Olivier Billet, Julien Brouchier, Stanislas Francfort, Henri Gilbert, Aline Gouget, Helena Handschuh, Françoise Levy, Pierre Loidreau, Pascal Paillier

## **Industry Sponsors**

France Telecom Gemplus SA Nokia

#### **External Referees**

Frederik Armknecht

Daniel Augot Gildas Avoine

Thomas Baignères

Elad Barkan

An Braeken

Claude Carlet

Pascale Charpin Sanjit Chatterjee

Rafi Chen

Rafi Chen Debra L. Cook

Christophe De Cannière

Orr Dunkelman

Matthieu Finiasz

Pierre-Alain Fouque Soichi Furuya

Louis Granboulan

Tor Helleseth

Shoichi Hirose

Tetsu Iwata

Pascal Junod

Charanjit Jutla

Grigory Kabatyanskiy

Jonathan Katz

Alexander Kholosha

Yuichi Komano

Matthias Krause

Ulrich Kühn

Simon Künzli

Shreekanth Laksmeshwar

Joseph Lano

Cédric Lauradoux

Yi Lu

Marine Minier

Håvard Molland

Jean Monnerat

Shiho Moriai

Frédéric Muller

Sean Murphy

Philippe Oechslin

Kenji Ohkuma

Katsuyuki Okeya

Elisabeth Oswald

Souradyuti Paul

Gilles Piret

Zulfikar Ramzan

Vincent Rijmen

Akashi Satoh

Takeshi Shimoyama

Taizo Shirai

François-Xavier Standaert

Dirk Stegemann

Henk van Tilborg

Hiroki Ueda

Kan Yasuda

Erik Zenner

# **Table of Contents**

New Designs	
A New MAC Construction Alred and a Specific Instance Alpha-MAC Joan Daemen, Vincent Rijmen	1
New Applications of T-Functions in Block Ciphers and Hash Functions Alexander Klimov, Adi Shamir	18
The Poly1305-AES Message-Authentication Code  Daniel J. Bernstein	32
Stream Ciphers I	
Narrow T-Functions Magnus Daum	50
A New Class of Single Cycle T-Functions  Jin Hong, Dong Hoon Lee, Yongjin Yeom, Daewan Han	68
F-FCSR: Design of a New Class of Stream Ciphers François Arnault, Thierry P. Berger	83
Boolean Functions	
Cryptographically Significant Boolean Functions: Construction and Analysis in Terms of Algebraic Immunity  Deepak Kumar Dalai, Kishan Chand Gupta, Subhamoy Maitra	98
The ANF of the Composition of Addition and Multiplication mod $2^n$ with a Boolean Function  An Braeken, Igor Semaev	112
Block Ciphers I	
New Combined Attacks on Block Ciphers  Eli Biham, Orr Dunkelman, Nathan Keller	126
Small Scale Variants of the AES  Carlos Cid, Sean Murphy, Matt J.B. Robshaw	145

# Stream Ciphers II

Unbiased Random Sequences from Quasigroup String Transformations Smile Markovski, Danilo Gligoroski,	
Ljupco Kocarev	163
A New Distinguisher for Clock Controlled Stream Ciphers  Håkan Englund, Thomas Johansson	181
Analysis of the Bit-Search Generator and Sequence Compression Techniques	
Aline Gouget, Hervé Sibert, Côme Berbain, Nicolas Courtois, Blandine Debraize, Chris Mitchell	196
Some Attacks on the Bit-Search Generator  Martin Hell, Thomas Johansson	215
Hash Functions	
SMASH - A Cryptographic Hash Function  Lars R. Knudsen	228
Security Analysis of a 2/3-Rate Double Length Compression Function in the Black-Box Model  Mridul Nandi, Wonil Lee, Kouichi Sakurai,  Sangjin Lee	243
Preimage and Collision Attacks on MD2  Lars R. Knudsen and John E. Mathiassen	255
Modes of Operation	
How to Enhance the Security of the 3GPP Confidentiality and Integrity Algorithms  Tetsu Iwata, Kaoru Kurosawa	268
1etsu Iwata, Kaoru Kurosawa	208
Two-Pass Authenticated Encryption Faster Than Generic Composition Stefan Lucks	284
Padding Oracle Attacks on CBC-Mode Encryption with Secret and Random IVs	
Arnold K.L. Yau, Kenneth G. Paterson, Chris J. Mitchell	299

Stream	Ciphers	III
--------	---------	-----

Analysis of the Non-linear Part of Mugi  Alex Biryukov, Adi Shamir	320
Two Attacks Against the HBB Stream Cipher  Antoine Joux, Frédéric Muller	330
Two Linear Distinguishing Attacks on VMPC and RC4A and Weakness of RC4 Family of Stream Ciphers  *Alexander Maximov**	342
Impossible Fault Analysis of RC4 and Differential Fault Analysis of RC4  Eli Biham, Louis Granboulan, Phong Q. Nguyễn	359
Block Ciphers II	
Related-Key Rectangle Attacks on Reduced Versions of SHACAL-1 and AES-192	
Seokhie Hong, Jongsung Kim, Sangjin Lee, Bart Preneel	368
New Attacks Against Reduced-Round Versions of IDEA  Pascal Junod	384
Implementations	
How to Maximize Software Performance of Symmetric Primitives on Pentium III and 4 Processors Mitsuru Matsui, Sayaka Fukuda	398
A Side-Channel Analysis Resistant Description of the AES S-Box Elisabeth Oswald, Stefan Mangard, Norbert Pramstaller, Vincent Rijmen	413
	_3
DPA Attacks and S-Boxes  Emmanuel Prouff	424
Author Index	443