# Lecture Notes in Computer Science

Edited by G. Goos and J. Hartmanis

304

David Chaum Wyn L. Price (Eds.)

# Advances in Cryptology – EUROCRYPT '87

Workshop on the Theory and Application of Cryptographic Techniques
Amsterdam, The Netherlands, April 13–15, 1987
Proceedings



Springer-Verlag

Berlin Heidelberg New York London Paris Tokyo

#### **Editorial Board**

D. Barstow W. Brauer P. Brinch Hansen D. Gries D. Luckham

C. Moler A. Pnueli G. Seegmüller J. Stoer N. Wirth

#### Editors

David Chaum

Centre for Mathematics and Computer Science (CWI)

Kruislaan 413, 1098 SJ Amsterdam, The Netherlands

Wvn L. Price

National Physical Laboratory

Teddington, Middlesex TW11 OLW, U.K.

#### Workshop Organizers:

General Chairman: D. Chaum (CWI)

Programme Committee: W.L. Price (NPL), Chairman T. Herlestam (U. Lund)

T. Beth (U. Karlsruhe) F. Piper (U. London)
J.-H. Evertse (CWI) J.J. Quisquater (Philips)

L. Guillou (CCETT)

Organising Committee: J. van de Graaf (CWI) G. Roelofsen (PTT-DNL)

C. J. Jansen (Philips USFA) J. van Tilburg (PTT-DNL)

The workshop was sponsored by the International Association for Cryptologic Research with support from the Centre for Mathematics and Computer Science (CWI), Amsterdam

CR Subject Classification (1987): D.4.6. E.3. F.1.3, F.2.1, H.2.0, H.2.4

ISBN 3-540-19102-X Springer-Verlag Berlin Heidelberg New York ISBN 0-387-19102-X Springer-Verlag New York Berlin Heidelberg

Library of Congress Cataloging-in-Publication Data, EUROCRYPT '87 (1987; Amsterdam, Netherlands) Advances in cryptology—EUROCRYPT '87. (Lecture notes in computer science; 304) Sponsored by the International Association for Cryptologic Research, Includes indexes.

1. Computers—Access control—Congresses, 2. Cryptography—Congresses, I. Chaum, David, II. Price, Wyn L., 1930-, III. International Association for Cryptologic Research, IV. Title, V. Series, QA76, 9.A25E963, 1987, 005, 8.88-6664, ISBN 0-387-19102-X (U.S.)

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 other ways, and storage in data banks. Duplication of this publication or parts thereof is only permitted under the provisions of the German Copyright Law of September 9, 1965, in its version of June 24, 1985, and a copyright fee must always be paid. Violations fall under the prosecution act of the German Copyright Law.

Springer Verlag Berlin Heidelberg 1988
 Printed in Germany

Printing and binding: Druckhaus Beitz, Hemsbach/Bergstr

2145/3140-543210

#### **Preface**

1987 marked a major upswing in attendance and contributions for this fifth in the series of Eurocrypt meetings. Response was so great that, to our regret, we were only able to accommodate less than half the submitted papers. Attendance was also up by a healthy margin.

The first two open meetings devoted to modern cryptography were organised independently: one by Allen Gersho during late Summer 1981 in Santa Barbara. and the other by Thomas Beth and Rudiger Dierstein in Germany the following Spring. David Chaum organised a successor to the Santa Barbara meeting the next year. which launched the International Association for Cryptologic Research. The sponsorship of the association has enabled the series of annual Summer CRYPTO meetings in the U.S. 4-7 and annual Spring EUROCRYPT meetings in Europe to be continued unbroken. 8-11

It is our pleasure to thank all those who contributed to making these proceedings possible: the authors, programme committee, organising committee, IACR officers and directors, and all the attendees.

We were all deeply saddened when we learned that Tore Herlestam, a member of the programme committee, had died unexpectedly. This volume is dedicated to him.

Amsterdam, the Netherlands London, England January 1988 D.C. W.L.P.

Advances in Cryptology: A Report on CRYPTO 81, Allen Gersho, Ed., UCSB ECE Report no. 82-04, Department of Electrical and Computer Engineering, Santa Barbara CA 93106.

Cryptography: Proceedings, Burg Feuerstein 1982 (Lecture Notes in Computer Science; 149), Thomas Beth, Ed., Springer-Verlag, 1983.

Advances in Cryptology: Proceedings of CRYPTO 82, David Chaum, Ronald L. Rivest, and Alan T. Sherman, Eds., Plenum NY, 1983.

<sup>4.</sup> Advances in Cryptology: Proceedings of CRYPTO 83, David Chaum, Ed., Plenum NY, 1984.

Advances in Cryptology: Proceedings of CRYPTO 84 (Lecture Notes in Computer Science; 196),
 G.R. Blakley and David Chaum, Eds., Springer-Verlag, 1985.

<sup>6.</sup> Advances in Cryptology: Proceedings of CRYPTO 85 (Lecture Notes in Computer Science; 218), Hugh C. Williams, Ed., Springer-Verlag, 1986.

Advances in Cryptology: Proceedings of CRYPTO 86 (Lecture Notes in Computer Science; 263), A.M Odlyzko, Ed., Springer-Verlag, 1987.

<sup>8.</sup> No proceedings were published for EUROCRYPT 83, which was held in Udine Italy.

Advances in Cryptology: Proceedings of EUROCRYPT 84 (Lecture Notes in Computer Science: 209). T. Beth, N. Cot, and I. Ingemarsson, Eds., Springer-Verlag, 1985.

Advances in Cryptology: Proceedings of EUROCRYPT 85 (Lecture Notes in Computer Science; 219), Franz Pichler, Ed., Springer-Verlag, 1986.

<sup>11.</sup> No proceedings were published for EUROCRYPT 86, which was held in Linköping, Sweden.

# **CONTENTS**

# SECTION I: SEQUENCES AND LINEAR COMPLEXITY

In Memoriam Tore Herlestam (1929-1986)	3
Alternating Step Generators Controlled by De Bruijn Sequences	5
Generation of Binary Sequences with Controllable Complexity and Ideal r-Tupel Distribution	15
Some Remarks on the Cross Correlation Analysis of Pseudo Random Generators	25
Sequences with Almost Perfect Linear Complexity Profile	37
When Shift Registers Clock Themselves	53
Finite State Machine Modelling of Cryptographic Systems in Loops  Franz Pichler	65

## **SECTION II: HARDWARE TOPICS**

Random Sources for Cryptographic Systems	77
Physical Protection of Cryptographic Devices	83
The RSA Cryptography Processor	95
SECTION III: PUBLIC KEY TOPICS	
Extension of Brickell's Algorithm for Breaking High Density Knapsacks  F. Jorissen, J. Vandewalle, and Ř. Govaerts	109
On Privacy Homomorphisms (Extended Abstract)  Ernest F. Brickell and Yacov Yacobi	117
An Improved Protocol for Demonstrating Possession of Discrete Logarithms and Some Generalizations	127
A Public Key Analog Cryptosystem	143
SECTION IV: AUTHENTICATION AND SECURE TRANSAC	TIONS
Message Authentication with Arbitration of Transmitter/Receiver Disputes  Gustavus J. Simmons	151
Perfect and Essentially Perfect Authentication Schemes (Extended Abstract)	167
Message Authentication and Dynamic Passwords	171
IC-Cards in High-Security Applications	177

### **SECTION V: HASH FUNCTIONS AND SIGNATURES**

Collision Free Hash Functions and Public Key Signature Schemes	203
Hash-Functions Using Modulo-N Operations	217
Blinding for Unanticipated Signatures	227
SECTION VI: SYMMETRIC CIPHERS: THEORY	
Non-Expanding, Key-Minimal, Robustly-Perfect, Linear and Bilinear Ciphers	237
Linear Structures in Blockciphers	249
Fast Data Encipherment Algorithm FEAL  Akihiro Shimizu and Shoji Miyaguchi	267
SECTION VII: SYMMETRIC CIPHERS: APPLICATION	
Modes of Blockcipher Algorithms and their Protection Against Active Eavesdropping	281
Security Considerations in the Design and Implementation of a New DES Chip	287
High-Performance Interface Architectures for Cryptographic Hardware  David P. Anderson and P. Venkat Rangan	301
Author Index	
Keyword Index	313