# **Lecture Notes in Computer Science**

13783

### **Founding Editors**

Gerhard Goos

Karlsruhe Institute of Technology, Karlsruhe, Germany

Juris Hartmanis

Cornell University, Ithaca, NY, USA

#### **Editorial Board Members**

Elisa Bertino

Purdue University, West Lafayette, IN, USA

Wen Gao

Peking University, Beijing, China

Bernhard Steffen

TU Dortmund University, Dortmund, Germany

Moti Yung

Columbia University, New York, NY, USA

More information about this series at https://link.springer.com/bookseries/558

Lejla Batina · Stjepan Picek · Mainack Mondal (Eds.)

# Security, Privacy, and Applied Cryptography Engineering

12th International Conference, SPACE 2022 Jaipur, India, December 9–12, 2022 Proceedings



Editors
Lejla Batina
Radboud University
Nijmegen, The Netherlands

Stjepan Picek D Radboud University Nijmegen, The Netherlands

Mainack Mondal 
Indian Institute of Technology Kharagpur Kharagpur, India

ISSN 0302-9743 ISSN 1611-3349 (electronic) Lecture Notes in Computer Science ISBN 978-3-031-22828-5 ISBN 978-3-031-22829-2 (eBook) https://doi.org/10.1007/978-3-031-22829-2

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Switzerland AG 2022

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

#### **Preface**

The 12th International Conference on Security, Privacy, and Applied Cryptography Engineering 2022 (SPACE 2022), was held during December 9–12, 2022. This annual event is devoted to various aspects of security, privacy, applied cryptography, and cryptographic engineering. This is a challenging field, requiring expertise from diverse domains, ranging from mathematics and computer science to circuit design. The event was hosted by the Center for Cryptography, Cyber Security and Digital Forensics (C3-SDF) at The LNM Institute of Information Technology, Jaipur, India.

This year we received 61 submissions from authors in many different countries, mainly from Asia and Europe. The submissions were evaluated based on their significance, novelty, technical quality, and relevance to the SPACE conference. The submissions were reviewed in a double-blind mode by at least two members of the Program Committee, which consisted of 47 members from all over the world. After an extensive review process, 18 papers were accepted for presentation at the conference, leading to an acceptance rate of 29.5%.

The program also included five keynotes and four tutorials on various aspects of applied cryptology, security, and privacy delivered by world-renowned researchers: Ingrid Verbauwhede, Nele Mentens, Jeyavijayan "JV" Rajendran, Chester Rebeiro, Sanjay K. Jha, Łukasz Chmielewski, Sikhar Patranabis, Nitin Singh, and Matthias Kannwischer. We sincerely thank the invited speakers for accepting our invitations in spite of their busy schedules. As in previous editions, SPACE 2022 was organized in cooperation with the International Association for Cryptologic Research (IACR). We are grateful to general chairs Jayaprakash Kar and Debdeep Mukhopadhyay for their willingness to host it physically at LMNIT Jaipur.

There is a long list of volunteers who invested their time and energy to put together the conference. We are grateful to all the members of the Program Committee and their sub-reviewers for all their hard work in the evaluation of the submitted papers. We thank our publisher Springer for agreeing to continue to publish the SPACE proceedings as a volume in the Lecture Notes in Computer Science (LNCS) series. We are grateful to the local Organizing Committee who invested a lot of time and effort in order for the conference to run smoothly.

Last, but not least, our sincere thanks go to all the authors who submitted papers to SPACE 2022 and everyone who participated (either in person or virtually).

December 2022

Lejla Batina Stjepan Picek Mainack Mondal

## **Organization**

#### **General Chairs**

Jayaprakash Kar The LNM Institute of Information Technology,

India

Debdeep Mukhopadhyay Indian Institute of Technology, Kharagpur, India

#### **Program Committee Chairs**

Lejla Batina Radboud University, The Netherlands

Mainack Mondal Indian Institute of Technology, Kharagpur, India

Stjepan Picek Radboud University, The Netherlands

#### **Program Committee**

Amr Youssef Concordia University, Canada

Anupam Chattopadhyay Nanyang Technological University, Singapore Bodhisatwa Mazumdar Indian Institute of Technology, Indore, India

Bohan Yang Tsinghua University, China

Chester Rebeiro Indian Institute of Technology, Madras, India

Chitchanok Chuengsatiansup University of Adelaide, Australia

Claude Carlet University of Bergen, Norway and University of

Paris 8, France

Dirmanto Jap Nanyang Technological University, Singapore

Domenic Forte University of Florida, USA
Eran Toch Tel Aviv University, Israel
Fan Zhang Zhejiang University, China

Guilherme Perin Radboud University, The Netherlands Ileana Buhan Radboud University, The Netherlands

Jakub Breier Silicon Austria Labs, Austria

Jayaprakash Kar The LNM Institute of Information Technology,

India

Jean-Luc Danger Télécom Paris, France

Kazuo Sakiyama University of Electro-Communications, Japan Kerstin Lemke-Rust Bonn-Rhein-Sieg University of Applied Sciences,

Germany

Kostas Papagiannopoulos University of Amsterdam, The Netherlands Luca Mariot Radboud University, The Netherlands

Lukasz Chmielewski Radboud University, The Netherlands

#### Organization

viii

Maël Gay University of Stuttgart, Germany

Marc Stoettinger RheinMain University of Applied Science,

Germany

Marc Manzano Sandbox@Alphabet, Spain

Marine Minier Université de Lorraine and Loria, France

Martin Henze Fraunhofer FKIE, Germany Md Masoom Rabbani KU Leuven, Belgium

Nadia El Mrabet EMSE, France

Nalla Anandakumar Nachimuthu University of Florida, USA Naofumi Homma Tohoku University, Japan

Nele Mentens Leiden University, The Netherlands Olga Gadyatskaya Leiden University, The Netherlands

Peter Schwabe MPI-SP, Germany, and Radboud University,

The Netherlands

Rahul Chatterjee University of Wisconsin-Madison, USA

Rajat Subhra Chakraborty Indian Institute of Technology, Kharagpur, India

Rajesh Pillai DRDO, India

Ruben Niederhagen University of Southern Denmark, Denmark

Sébastien Canard Orange Labs, France

Shivam Bhasin Nanyang Technological University, Singapore

Sikhar Patranabis IBM Research, India

Silvia Mella Radboud University, The Netherlands
Sk Subidh Ali Indian Institute of Technology, Bhilai, India
Somitra Sanadhya Indian Institute of Technology, Jodhpur, India
Soumyajit Dey Indian Institute of Technology, Kharagpur, India

Sujoy Sinha Roy TU Graz, Germany

Urbi Chatterjee Indian Institute of Technology, Kanpur, India Vishal Saraswat Bosch Engineering and Business Solutions,

Bengaluru, India

#### **Additional Reviewers**

Martin Serror Fraunhofer FKIE, Germany Wenping Zhu Tsinghua University, China

Soumyadyuti Ghosh Indian Institute of Technology, Kharagpur, India Rajat Sadhukhan Indian Institute of Technology, Kharagpur, India Durba Chatterjee Indian Institute of Technology, Kharagpur, India

# **Contents**

Symmetric Cryptography	
Modeling Large S-box in MILP and a (Related-Key) Differential Attack on Full Round PIPO-64/128	3
Tarun Yadav and Manoj Kumar	
Light but Tight: Lightweight Composition of Serialized S-Boxes with Diffusion Layers for Strong Ciphers	28
Hardware Implementation of Masked SKINNY SBox with Application	
to AEAD	50
Bias Cancellation of MixColumns	70
Big Brother Is Watching You: A Closer Look at Backdoor Construction  Anubhab Baksi, Arghya Bhattacharjee, Jakub Breier, Takanori Isobe, and Mridul Nandi	81
Public-Key Cryptography, Post-quantum Cryptography, Zero Knowledge Proofs	
KEMTLS vs. Post-quantum TLS: Performance on Embedded Systems	99
Protecting the Most Significant Bits in Scalar Multiplication Algorithms Estuardo Alpirez Bock, Lukasz Chmielewski, and Konstantina Miteloudi	118
Combining Montgomery Multiplication with Tag Tracing for the Pollard	100
Rho Algorithm in Prime Order Fields  Madhurima Mukhopadhyay and Palash Sarkar	138
Card-Based Zero-Knowledge Proof for the Nearest Neighbor Property:	
Zero-Knowledge Proof of ARC End View	147

Takuro Fukasawa and Yoshifumi Manabe

# **Hardware Security and AI**

What Do You See? Transforming Fault Injection Target Characterizations  Marina Krček	165
Dual-Tone Multi-Frequency Assisted Acoustic Side Channel Attack	
to Retrieve Dialled Call Log  Abhishek Revskar, Mahendra Rathor, and Urbi Chatterjee	185
Machine Learning Attacks on Low-Cost Reconfigurable XRRO and XRBR PUF Designs	204
Manthan Kojage, Neelofar Hassan, and Urbi Chatterjee	
HWGN <sup>2</sup> : Side-Channel Protected NNs Through Secure and Private Function Evaluation	225
Mohammad Hashemi, Steffi Roy, Domenic Forte, and Fatemeh Ganji	
How Many Cameras Do You Need? Adversarial Attacks and Countermeasures for Robust Perception in Autonomous	
Vehicles Tu Anh Ngo, Reuben Jon Chia, Jonathan Chan, Nandish Chattopadhyay, and Anupam Chattopadhyay	249
Network Security, Authentication, and Privacy	
SMarT: A SMT Based Privacy Preserving Smart Meter Streaming	
Methodology Soumyadyuti Ghosh, Soumyajit Dey, and Debdeep Mukhopadhyay	267
An Analysis of the Hardware-Friendliness of AMQ Data Structures	
for Network Security	287
RemOD: Operational Drift-Adaptive Intrusion Detection	314
A Short Note on a Paper Titled: A Delaunay Quadrangle-Based Fingerprint Authentication System with Template Protection Using Topology Code	
for Local Registration and Security Enhancement  SrinivasaRao SubramanyaRao	334
Author Index	343