Lecture Notes in Computer Science

10683

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

Editorial Board

David Hutchison

Lancaster University, Lancaster, 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, Zurich, Switzerland

John C. Mitchell

Stanford University, Stanford, CA, USA

Moni Naor

Weizmann Institute of Science, Rehovot, Israel

C. Pandu Rangan

Indian Institute of Technology, Madras, India

Bernhard Steffen

TU Dortmund University, Dortmund, Germany

Demetri Terzopoulos

University of California, Los Angeles, CA, USA

Doug Tygar

University of California, Berkeley, CA, USA

Gerhard Weikum

Max Planck Institute for Informatics, Saarbrücken, Germany

More information about this series at http://www.springer.com/series/7410

Sokratis K. Katsikas · Frédéric Cuppens Nora Cuppens · Costas Lambrinoudakis Christos Kalloniatis · John Mylopoulos Annie Antón · Stefanos Gritzalis (Eds.)

Computer Security

ESORICS 2017 International Workshops CyberICPS 2017 and SECPRE 2017 Oslo, Norway, September 14–15, 2017 Revised Selected Papers



Editors

Sokratis K. Katsikas 🗅

Norwegian University of Science

and Technology

Gjøvik Norway

Frédéric Cuppens IMT Atlantique

Brest France

Nora Cuppens IMT Atlantique

Brest France

Costas Lambrinoudakis University of Piraeus

Piraeus Greece Christos Kalloniatis D University of the Aegean

Mytilene Greece

John Mylopoulos University of Toronto Toronto, ON

Canada

Annie Antón

Georgia Institute of Technology

Atlanta, GA

USA

Stefanos Gritzalis University of the Aegean

Karlovassi Greece

ISSN 0302-9743 ISSN 1611-3349 (electronic) Lecture Notes in Computer Science ISBN 978-3-319-72816-2 ISBN 978-3-319-72817-9 (eBook) https://doi.org/10.1007/978-3-319-72817-9

Library of Congress Control Number: 2017962874

LNCS Sublibrary: SL4 - Security and Cryptology

© Springer International Publishing AG 2018, corrected publication 2018

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, express 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.

Printed on acid-free paper

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



Preface

This book contains revised versions of the papers presented at the Third Workshop on Security of Industrial Control Systems and Cyber-Physical Systems (CyberICPS 2017) and the First International Workshop on Security and Privacy Requirements Engineering (SECPRE 2017). Both workshops were co-located with the 22nd European Symposium on Research in Computer Security (ESORICS 2017) and were held in Oslo, Norway, on September 15, 2017.

CyberICPS aims to bring together researchers, engineers, and governmental actors with an interest in the security of industrial control systems and cyber-physical systems in the context of their increasing exposure to cyber-space, by offering a forum for discussion on all issues related to cyber-security. Cyber-physical systems range in size, complexity, and criticality, from embedded systems used in smart vehicles, to SCADA and industrial control systems like energy and water distribution systems, smart transportation systems etc.

CyberICPS 2017 attracted 32 high-quality submissions, each of which was assigned to three referees for review; the review process resulted in ten full and two short papers being accepted to be presented and included in the proceedings. These cover topics related to threats, vulnerabilities, and risks that cyber-physical systems and industrial control systems face; cyber attacks that may be launched against such systems; and ways of detecting and responding to such attacks.

For many years, software engineers have focused on the development of new software thus considering security and privacy mainly during the development stage as an ad hoc process rather than an integrated one initiated during the system design stage. However, the data protection regulations, the complexity of modern environments such as IoT, IoE, cloud computing, big data, cyber-physical systems etc. and the increased level of users' awareness in IT have forced software engineers to identify security and privacy as fundamental design aspects leading to the implementation of more trusted software systems and services. Researchers have addressed the necessity and importance of implementing design methods for security and privacy requirements elicitation, modeling, and implementation in the past few decades. Today security by design (SbD) and privacy by design (PbD) are established research areas that focus on these directions. SECPRE aimed to provide researchers and professionals with the opportunity to present novel and cutting-edge research on these topics.

SECPRE 2017 attracted 14 high-quality submissions, each of which was assigned to three referees for review; the review process resulted in accepting five papers to be presented and included in the proceedings. These cover topics related to security and privacy requirements assurance and evaluation, and to security requirements elicitation and modeling.

VI Preface

We would like to express our thanks to all those who assisted us in organizing the events and putting together the programs. We are very grateful to the members of the Program Committees for their timely and rigorous reviews. Thanks are also due to the Organizing Committees for the events. Last, but by no means least, we would like to thank all the authors who submitted their work to the workshops and contributed to an interesting set of proceedings.

November 2017

Sokratis K. Katsikas
Frédéric Cuppens
Nora Cuppens
Costas Lambrinoudakis
Christos Kalloniatis
John Mylopoulos
Annie Antón
Stefanos Gritzalis

Organization

CyberICPS 2017 General Chairs

Nora Cuppens IMT Atlantique, France Costas Lambrinoudakis University of Piraeus, Greece

CyberICPS 2017 Program Committee Chairs

Sokratis K. Katsikas Norwegian University of Science

and Technology - NTNU, Norway; and University of Piraeus, Greece

Frédéric Cuppens IMT Atlantique, France

CyberICPS 2017 Technical Program Committee

Cristina Alcaraz University of Malaga, Spain

Samiha Ayed Devoteam, France

Mauro Conti University of Padua, Italy
Mourad Debbabi Concordia University, Canada
Hervé Debar Telecom SudParis, France
David Espes University of Brest, France
Joaquin Garcia-Alfaro Telecom SudParis, France

Dieter Gollmann Technical University of Hamburg, Germany

Wael Kanoun Nokia, France

Jean LeneutreTelecom ParisTech, FranceJavier LopezUniversity of Malaga, SpainMasahiro MamboKanazawa University, Japan

Sjouke Mauw University of Luxembourg, Luxembourg Weizhi Meng Institute for Infocomm Research, Singapore

Chris Mitchell Royal Holloway, UK
Jonathan Petit Security Innovation, USA
Juha Röning University of Oulu, Finland

Yves Roudier EURECOM, France

Pierangela Samarati Università degli Studi di Milano, Italy Radu State University of Luxembourg, Luxembourg

Houbling Song West Virginia University, USA
Craig Valli Edith Cowan University, Australia

Jozef Vyskoc VAF, Slovakia

Khan Ferdous Wahid Airbus Defence and Space GmbH, Germany

Stephen Wolthusen Royal Holloway, UK Stefano Zanero Politecnico di Milano, Italy

CyberICPS 2017 Additional Reviewers

Abbas Acar Saed Alrabaee Nathan Clarke Pallavi Kaliyar Marcello Pogliani Mario Polino Sarada Prasad Davide Quarta Paria Shirani

SECPRE 2017 General Chairs

Annie Antón Georgia Institute of Technology, USA Stefanos Gritzalis University of the Aegean, Greece

SECPRE 2017 Program Committee Chairs

John Mylopoulos University of Toronto, Canada Christos Kalloniatis University of the Aegean, Greece

SECPRE 2017 Technical Program Committee

Travis Breaux Carnegie Mellon University, USA

Frédéric Cuppens Telecom Bretange, France

Sabrina De Capitani Università degli Studi di Milano, Italy

di Vimercati

Theo Dimitrakos University of Kent, UK
Mohamad Gharib University of Florence, Italy
Paolo Giorgini University of Trento, Italy

Maritta Heisel University of Duisburg-Essen, Germany Jan Juerjens University of Koblenz-Landau, Germany

Costas Lambrinoudakis University of Piraeus, Greece

Tong Li Beijing University of Technology, China

Javier Lopez University of Malaga, Spain

Fabio Martinelli National Research Council, C.N.R., Italy

Aaron Massey
University of Maryland, USA
University of Brighton, UK
Liliana Pasquale
University College Dublin, Ireland

Michalis Pavlidis University of Brighton, UK

David Garcia Rosado University of Castilla-La Mancha, Spain

Mattia Salnitri University of Trento, Italy

Pierangela Samarati Università degli Studi di Milano, Italy

Nicola Zannone Eindhoven University of Technology, The Netherlands

SECPRE 2017 Additional Reviewers

Francesco Mercaldo Mina Sheikhalishahi

Contents

Protecting Industrial Control and Cyber-Physical Systems	
Towards End-to-End Data Protection in Low-Power Networks	3
Development of an Embedded Platform for Secure CPS Services	19
Introducing Usage Control in MQTT	35
Threats, Vulnerabilities and Risks	
Towards Security Threats that Matter	47
A Methodology to Assess Vulnerabilities and Countermeasures Impact on the Missions of a Naval System	63
STRIDE to a Secure Smart Grid in a Hybrid Cloud	77
Cyber Attacks in Industrial Control and Cyber-Physical Systems	
Stealthy Deception Attacks Against SCADA Systems	93
On Ladder Logic Bombs in Industrial Control Systems	110
Enforcing Memory Safety in Cyber-Physical Systems	127

Detecting Attacks in Industrial Control and Cyber-Physical Systems	
Supporting the Human in Cyber Defence	147
CRBP-OpType: A Constrained Approximate Search Algorithm for Detecting Similar Attack Patterns	163
Multistage Downstream Attack Detection in a Cyber Physical System Rizwan Qadeer, Carlos Murguia, Chuadhry Mujeeb Ahmed, and Justin Ruths	177
Security and Privacy Requirements Assurance and Evaluation	
A UML Profile for Privacy-Aware Data Lifecycle Models	189
Evaluation of a Security and Privacy Requirements Methodology Using the Physics of Notation	210
Security Requirements Elicitation and Modelling	
What Users Want: Adapting Qualitative Research Methods to Security Policy Elicitation	229
An Anti-pattern for Misuse Cases	250
Decision-Making in Security Requirements Engineering with Constrained Goal Models	262
Erratum to: Enforcing Memory Safety in Cyber-Physical Systems Eyasu Getahun Chekole, John Henry Castellanos, Martín Ochoa, and David K. Y. Yau	E1
Author Index	281