Editor-in-Chief

Kai Rannenberg, Goethe University Frankfurt, Germany

Editorial Board Members

TC 1 – Foundations of Computer Science
   Luis Soares Barbosa, University of Minho, Braga, Portugal

TC 2 – Software: Theory and Practice
   Michael Goedicke, University of Duisburg-Essen, Germany

TC 3 – Education
   Arthur Tatnall, Victoria University, Melbourne, Australia

TC 5 – Information Technology Applications
   Erich J. Neuhold, University of Vienna, Austria

TC 6 – Communication Systems
   Burkhard Stiller, University of Zurich, Zürich, Switzerland

TC 7 – System Modeling and Optimization
   Fredi Tröltzsch, TU Berlin, Germany

TC 8 – Information Systems
   Jan Pries-Heje, Roskilde University, Denmark

TC 9 – ICT and Society
   David Kreps, University of Salford, Greater Manchester, UK

TC 10 – Computer Systems Technology
   Ricardo Reis, Federal University of Rio Grande do Sul, Porto Alegre, Brazil

TC 11 – Security and Privacy Protection in Information Processing Systems
   Steven Furnell, Plymouth University, UK

TC 12 – Artificial Intelligence
   Eunika Mercier-Laurent, University of Reims Champagne-Ardenne, Reims, France

TC 13 – Human-Computer Interaction
   Marco Winckler, University of Nice Sophia Antipolis, France

TC 14 – Entertainment Computing
   Rainer Malaka, University of Bremen, Germany
IFIP – The International Federation for Information Processing

IFIP was founded in 1960 under the auspices of UNESCO, following the first World Computer Congress held in Paris the previous year. A federation for societies working in information processing, IFIP’s aim is two-fold: to support information processing in the countries of its members and to encourage technology transfer to developing nations. As its mission statement clearly states:

*IFIP is the global non-profit federation of societies of ICT professionals that aims at achieving a worldwide professional and socially responsible development and application of information and communication technologies.*

IFIP is a non-profit-making organization, run almost solely by 2500 volunteers. It operates through a number of technical committees and working groups, which organize events and publications. IFIP’s events range from large international open conferences to working conferences and local seminars.

The flagship event is the IFIP World Computer Congress, at which both invited and contributed papers are presented. Contributed papers are rigorously refereed and the rejection rate is high.

As with the Congress, participation in the open conferences is open to all and papers may be invited or submitted. Again, submitted papers are stringently refereed.

The working conferences are structured differently. They are usually run by a working group and attendance is generally smaller and occasionally by invitation only. Their purpose is to create an atmosphere conducive to innovation and development. Refereeing is also rigorous and papers are subjected to extensive group discussion.

Publications arising from IFIP events vary. The papers presented at the IFIP World Computer Congress and at open conferences are published as conference proceedings, while the results of the working conferences are often published as collections of selected and edited papers.

IFIP distinguishes three types of institutional membership: Country Representative Members, Members at Large, and Associate Members. The type of organization that can apply for membership is a wide variety and includes national or international societies of individual computer scientists/ICT professionals, associations or federations of such societies, government institutions/government related organizations, national or international research institutes or consortia, universities, academies of sciences, companies, national or international associations or federations of companies.

More information about this series at [http://www.springer.com/series/6102](http://www.springer.com/series/6102)
ICT Systems Security and Privacy Protection

35th IFIP TC 11 International Conference, SEC 2020
Maribor, Slovenia, September 21–23, 2020
Proceedings
Preface

In these challenging times caused by the COVID-19 situation, we are honored to bring you this collection of the best papers submitted to the 35th IFIP International Conference on ICT Systems Security and Privacy Protection, which was held in Maribor, Slovenia, September 21–23, 2020. IFIP SEC conferences are the flagship events of the International Federation for Information Processing (IFIP) Technical Committee 11 on Information Security and Privacy Protection in Information Processing Systems (TC-11).

The 2020 edition of the IFIP SEC proceedings includes 29 high-quality papers covering a wide range of research areas in the information security field. They were authored by researchers from 19 different countries. The selection of papers was a highly challenging task: 149 received submissions were evaluated based on their significance, novelty, and technical quality. Each paper received at least three, but most of them four reviews by members of the Program Committee. The Program Committee meetings were held electronically, with intensive discussions over a period of three weeks. Of the papers submitted, 29 were selected for presentation at the conference, leading to an acceptance rate of 19.5%.

We want to express our appreciation to all the contributors who helped to make IFIP SEC 2020 a success. There is a long list of people who volunteered their time and energy to put together the conference and who deserve acknowledgement. We want to thank the members of the Program Committee and the external reviewers, who devoted significant amounts of their time to evaluate all the submissions. Special thanks go to the keynote speakers Elisa Bertino from Purdue University West Lafayette, USA, and Stanka Šalamun and Mitja Koššek from 0patch by ACROS Security, Slovenia, who accepted our invitation to present their insights at the conference.

Further individuals who deserve special thanks and without whom the current program and success of the conference would not have been possible include: the organizing chair Lili Nemec Zlatolas and the members of the Organizing Committee Borut Zlatolas, Luka Hrgarek, and Marko Kompara, all from the University of Maribor, Faculty of Electrical Engineering and Computer Science. They kept all things smooth and flowing, even after the delays caused by the pandemic. The IFIP SEC and WISE had to be postponed without clear information on when public events like it could be safely held again. The IFIP Summer School, which was being organized separately, also got postponed and found a new home at IFIP SEC 2020. Due to the constant changes in local regulation, the questionable safety of international travel and uncertainty regarding the future spread of the disease, the decision was made to hold the conference virtually, despite the best efforts to have it in Maribor, Slovenia. Special recognition goes to Hotel City Maribor and the Maribor Convention Bureau, who were very accommodating and understanding regardless of the economic impact of the unfortunate situation, and we express our regret to the participants, for missing the opportunity to see the beauty Slovenia has to offer.
We also acknowledge the institutional support for IFIP SEC 2020, which came from the University of Maribor, Faculty of Electrical Engineering and Computer Science, Institute of Informatics. Without this support, it would not have been possible to organize the conference.

Last but certainly not least, we thank all the authors who submitted papers and all the conference’s attendees who coped with the changing circumstances in a kind and flexible manner.

We hope you find the proceedings of IFIP SEC 2020 interesting, stimulating, and inspiring for your future research regardless of the challenging times in which the conference took place.

July 2020

Marko Hölbl
Kai Rannenberg
Tatjana Welzer
Organization

General Chair

Tatjana Welzer University of Maribor, Slovenia

Program Committee Chairs

Marko Hölbl University of Maribor, Slovenia
Kai Rannenberg Goethe University Frankfurt, Germany

Organizing Chair

Lili Nemec Zlatolas University of Maribor, Slovenia

Program Committee

Rose-Mharie Åhlfeldt University of Skövde, Sweden
Raja Naeem Akram Royal Holloway, University of London, UK
Vijay Atluri Rutgers University, USA
Man Ho Au The University of Hong Kong, China
Gergei Bana University of Missouri, USA
Joao Paulo Barraca University of Aveiro, Portugal
Pedro Brandão University of Porto, Portugal
Dagmar Brechlerova EuroMISE Prague, Czech Republic
Ricardo Chaves IST, INESC-ID, Portugal
Michal Choras ITTI Ltd., Poland
K. P. Chow The University of Hong Kong, China
Nathan Clarke University of Plymouth, UK
Miguel Correia Universidade de Lisboa, Portugal
Nora Cuppens-Boulahia Polytechnique Montréal, Canada
Paolo D’Arco Università di Salerno, Italy
Ed Dawson QUT, Australia
Sabrina De Capitani di Vimercati Università degli Studi di Milano, Italy
Bart De Decker Katholieke Universiteit Leuven, Belgium
Nicola Dragoni Technical University of Denmark, Denmark
Nicolás Emilio Daz Ferreyra University of Duisburg-Essen, Germany
Isao Echizen National Institute of Informatics, Japan
Simone Fischer-Hübner Karlstad University, Sweden
Sara Foresti Università degli Studi di Milano, Italy
Steven Furnell University of Plymouth, UK
Chaya Ganesh Aarhus University, Denmark
Hélder Gomes, Universidade de Aveiro, Portugal
Jonas Hallberg, Swedish Defence Research Agency (FOI), Sweden
Lucjan Hanzlik, Stanford University, USA
Paul Haskell-Dowland, Edith Cowan University, Australia
Karín Hedström, Örebro University, Sweden
Dominik Herrmann, University of Bamberg, Germany
Xinyi Huang, Fujian Normal University, China
Dieter Hutter, DFKI GmbH, Germany
Pedro Inácio, Universidade da Beira Interior, Portugal
Martin Gilje Jaatun, SINTEF Digital, Norway
Wojciech Jamroga, University of Luxembourg, Luxembourg
Lech Janczewski, The University of Auckland, New Zealand
Christian Damsgaard Jensen, Technical University of Denmark, Denmark
Allen Johnston, University of Alabama, USA
Audun Josang, University of Oslo, Norway
Jan Jürjens, Fraunhofer Institute and University of Koblenz-Landau, Germany
Georgios Kambourakis, University of the Aegean, Greece
Fredrik Karlsson, Örebro University, Sweden
Dogan Kesdogan, Universität Regensburg, Germany
Dongseong Kim, The University of Queensland, Australia
Kamil Kluczniaik, Helmholtz Center for Information Security - CISPA, Germany
Andrea Kolberger, University of Applied Sciences Upper Austria, Austria
Marko Kompara, University of Maribor, Slovenia
Zbigniew Kotulski, Warsaw University of Technology, Poland
Lukasz Krzywiecki, Wroclaw University of Science and Technology, Poland
Miroslaw Kutyłowski, Wroclaw University of Science and Technology, Poland
Kwangjo Kim, Korea Advanced Institute of Science and Technology, South Korea
Heejo Lee, Korea University, South Korea
Yingjiu Li, University of Oregon, USA
Maciej Liskiewicz, University of Luebeck, Germany
Luigi Logrippo, Université du Québec en Outaouais, Canada
Javier Lopez, University of Malaga, Spain
Suryadipta Majumdar, University at Albany, SUNY, USA
Marian Margraf, FU Berlin, Germany
Fabio Martinelli, IIT-CNR, Italy
Vashek Matyas, Masaryk University, Czech Republic
Zlatogor Minchev, Bulgarian Academy of Sciences, Bulgaria
Yuko Murayama, Tsuda College, Japan
Maurizio Naldi, LUMSA Università Maria SS. Assunta di Roma, Italy
Lili Nemec Zlatolas, University of Maribor, Slovenia
Sergio Nunes  
ISEG - School of Economics and Management, Portugal

Balaji Palanisamy  
University of Pittsburgh, USA

Brajendra Panda  
University of Arkansas, USA

Sebastian Pape  
Goethe University Frankfurt, Germany

Stefano Paraboschi  
Università di Bergamo, Italy

Miguel Pardal  
Universidade de Lisboa, Portugal

Gilbert Peterson  
US Air Force Institute of Technology, USA

António Pinto  
ESTG, P.Porto, Portugal

Rami Puzis  
Ben-Gurion University of the Negev, Israel

Arun Raghuramu  
Forescout Technologies Inc., USA

Carlos Rieder  
Isec AG, Switzerland

Juha Röning  
University of Oulu, Finland

Elham Rostami  
Örebro University, Sweden

Reyhaneh Safavi-Naini  
University of Calgary, Canada

Pierangela Samarati  
Università degli Studi di Milano, Italy

Damien Sauveron  
Université de Limoges, France

Ingrid Schaumüller-Bichl  
Upper Austrian University of Applied Sciences, Campus Hagenberg, Austria

Jetzabel Maritza Serna Olvera  
Universitat Politècnica de Catalunya, Spain

Paria Shirani  
Concordia University, Canada

Nicolas Sklavos  
University of Patras, Greece

Daniel Slamanig  
AIT Austrian Institute of Technology, Austria

Kane Smith  
University of North Carolina at Greensboro, USA

Agusti Solanas  
Rovira i Virgili University, Spain

Teodor Sommestad  
Swedish Defence Research Agency (FOI), Sweden

Chunhua Su  
Osaka University, Japan

Shamik Sural  
Indian Institute of Technology, India

Kerry-Lynn Thomson  
Nelson Mandela University, South Africa

Muhamed Turkanović  
University of Maribor, Slovenia

Rossouw Vonsolms  
Nelson Mandela University, South Africa

Jozev Vyskoc  
VaF, Slovakia

Ding Wang  
Peking University, China

Lingyu Wang  
Concordia University, Canada

Edgar Weippl  
University of Vienna, SBA Research, Austria

Vladimir Zadorozhny  
University of Pittsburgh, USA

Filip Zagorski  
Wrocław University of Technology, Poland

Yuexin Zhang  
Swinburne University of Technology, Australia

André Zúquete  
University of Aveiro, Portugal
Additional Reviewers

Mohiuddin Ahmed
Marios Anagnostopoulos
Arash Atashpendar
Sebastian Berndt
Olivier Blazy
Rohit Chadha
Aveek Kumar Das
Tiago Dias
Rong Huang
Vincenzo Iovino
Andreas Jakoby
Manfred Jeusfeld
Jan Kalbantner
Kallol Krishna Karmakar
Joakim Kävrestad
Mathieu Klingler
Vasileios Kouliaridis
Chengjun Lin
Chao Lin
Chang Liu
Francesco Mercaldo
Louis Moreau
Hong-Huy Nguyen
Wojciech Niewolski
Fahad Nife
Jianting Ning
Marcus Nohlberg

Tomasz Nowak
Tomás Oliveira E Silva
Oleksii Osiyak
Ali Padyab
Bernardo Portela
Nektaria Potha
Andreas Put
Sebastian Ramacher
Musa Samaila
Benjamin Semal
Mariusz Sepczuk
Bernardo Sequeiros
Mina Sheikhalishahi
João Marco Silva
Tiago Simões
Marjan Skrobot
Eva Söderström
Patryk Szewczyk
Florian Thäeter
Ngoc Dung Tieu
Ganbayar Uuganbayar
Benito van der Zander
Weizheng Wang
S. J. Yang
Wenjie Yang
Xu Yang
Kai Zhu
Contents

Channel Attacks

Leaky Controller: Cross-VM Memory Controller Covert Channel on Multi-core Systems .................................................. 3
   Benjamin Semal, Konstantinos Markantonakis, Raja Naeem Akram, and Jan Kalbantner

Evaluation of Statistical Tests for Detecting Storage-Based Covert Channels ......................................................... 17
   Thomas A. V. Sattolo and Jason Jaskolka

IE-Cache: Counteracting Eviction-Based Cache Side-Channel Attacks Through Indirect Eviction .................................... 32
   Muhammad Asim Mukhtar, Muhammad Khurram Bhatti, and Guy Gogniat

Connection Security

Refined Detection of SSH Brute-Force Attackers Using Machine Learning ................................................................. 49
   Karel Hynek, Tomáš Beneš, Tomáš Čejka, and Hana Kubátová

MULTITLS: Secure Communication Channels with Cipher Suite Diversity .................................................. 64
   Ricardo Moura, David R. Matos, Miguel L. Pardal, and Miguel Correia

Improving Big Data Clustering for Jamming Detection in Smart Mobility .................................................. 78
   Hind Bangui, Mouzhi Ge, and Barbora Buhnova

Human Aspects of Security and Privacy

Assisting Users to Create Stronger Passwords Using ContextBased MicroTraining .................................................. 95
   Joakim Kävrestad and Marcus Nohlberg

Facilitating Privacy Attitudes and Behaviors with Affective Visual Design .................................................. 109
   Agnieszka Kitkowska, Yefim Shulman, Leonardo A. Martucci, and Erik Wästlund

Privacy CURE: Consent Comprehension Made Easy .................................................. 124
   Olha Drozd and Sabrina Kirrane
Detecting Malware and Software Weaknesses

JavaScript Malware Detection Using Locality Sensitive Hashing .................................................. 143
  Stefan Carl Peiser, Ludwig Friborg, and Riccardo Scandariato

RouAlign: Cross-Version Function Alignment and Routine Recovery with Graphlet Edge Embedding .................................................. 155
  Can Yang, Jian Liu, Mengxia Luo, Xiaorui Gong, and Baoxu Liu

Code Between the Lines: Semantic Analysis of Android Applications .................................. 171
  Johannes Feichtner and Stefan Gruber

System Security

IMShell-Dec: Pay More Attention to External Links in PowerShell .................................................. 189
  RuiDong Han, Chao Yang, JianFeng Ma, Siqi Ma, YunBo Wang, and Feng Li

Secure Attestation of Virtualized Environments .................................................. 203
  Michael Eckel, Andreas Fuchs, Jürgen Repp, and Markus Springer

Network Security and Privacy

Security and Performance Implications of BGP Rerouting-Resistant Guard Selection Algorithms for Tor .................................................. 219
  Asya Mitseva, Marharyta Aleksandrova, Thomas Engel, and Andriy Panchenko

Actively Probing Routes for Tor AS-Level Adversaries with RIPE Atlas .................................. 234
  Wilfried Mayer, Georg Merzdovnik, and Edgar Weippl

Zeek-Osquery: Host-Network Correlation for Advanced Monitoring and Intrusion Detection .................................................. 248
  Steffen Haas, Robin Sommer, and Mathias Fischer

Access Control and Authentication

Revisiting Security Vulnerabilities in Commercial Password Managers .................................. 265
  Michael Carr and Siamak F. Shahandashti

Evaluation of Risk-Based Re-Authentication Methods .................................................. 280
  Stephan Wiefling, Tanvi Patil, Markus Dürmuth, and Luigi Lo Iacono

Fuzzy Vault for Behavioral Authentication System .................................................. 295
  Md Morshedul Islam and Reihaneh Safavi-Naini
Crypto Currencies

Improvements of the Balance Discovery Attack on Lightning Network Payment Channels ........................................... 313

   Gijs van Dam, Rabiah Abdul Kadir, Puteri N. E. Nohuddin, and Halimah Badioze Zaman

CCBRSN: A System with High Embedding Capacity for Covert Communication in Bitcoin ................................. 324

   Weizheng Wang and Chunhua Su

Privacy-Friendly Monero Transaction Signing on a Hardware Wallet ................................................................. 338

   Dusan Klinec and Vashek Matyas

Privacy and Security Management

A Matter of Life and Death: Analyzing the Security of Healthcare Networks ....................................................... 355

   Guillaume Dupont, Daniel Ricardo dos Santos, Elisa Costante, Jerry den Hartog, and Sandro Etalle

Establishing a Strong Baseline for Privacy Policy Classification .......................................................... 370

   Najmeh Mousavi Nejad, Pablo Jabat, Rostislav Nedelchev, Simon Scerri, and Damien Graux

Cross-Platform File System Activity Monitoring and Forensics – A Semantic Approach ................................ 384

   Kabul Kurniawan, Andreas Ekelhart, Fajar Ekaputra, and Elmar Kiesling

Machine Learning and Security

A Correlation-Preserving Fingerprinting Technique for Categorical Data in Relational Databases .................. 401

   Tanja Sarcevic and Rudolf Mayer

FDFtNet: Facing Off Fake Images Using Fake Detection Fine-Tuning Network .................................................. 416

   Hyeonseong Jeon, Youngoh Bang, and Simon S. Woo

Escaping Backdoor Attack Detection of Deep Learning ................................................................. 431

   Yayuan Xiong, Fengyuan Xu, Sheng Zhong, and Qun Li

Author Index ........................................................................ 447