Studies in Systems, Decision and Control

Volume 255

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Editors

Recent Developments on Industrial Control Systems Resilience

Springer

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ISSN 2198-4182 ISSN 2198-4190 (electronic)
Studies in Systems, Decision and Control
ISBN 978-3-030-31327-2 ISBN 978-3-030-31328-9 (eBook)
https://doi.org/10.1007/978-3-030-31328-9

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

Dedicated to our beloved families for supporting us all along.
Emil Pricop, Jaouhar Fattahi, Nitul Dutta and Mariam Ibrahim

Preface

Industrial control systems (ICS) have a critical place in the functioning and development of today's world. They are key components of every technical infrastructure around us, ranging from air conditioning in our homes and cars to the big factories, the energy production and distribution, the water distribution systems, and even the nuclear plants. The correct operation of the industrial control systems is essential for the functioning of our society, so they have to be designed to be resilient. This means that the ICS should be able to recover from various process faults and failures and to withstand emerging cyberattacks. These objectives can be achieved only by assuring both safety and security, being it physical or cybernetic. Also, a special interest is presented by predictive and preventive maintenance activities.

The main goal of the book is to collect valuable contributions of renowned researchers in the field of control engineering, Internet of Things, and cybersecurity. Some chapters are based on presentations and discussions that took place at the previous editions of the International Workshop on Systems Safety and Security (IWSSS, https://www.iwsss.org). The workshop, initiated in 2013, become a traditional annual scientific event in Romania. IWSSS is now a recognized venue for the exchange of experience and ideas in the field of systems safety, security, and resilience with the scope of stimulating joint work at a regional and international level.

The book comprises research based on theory, subsequent simulation and experimental results, numerous case studies, and practical implementations. Given the detailed discussion in the said context, the book offers profound insights on increasing the resilience of industrial control systems. Both fundamental and advanced topics are discussed, having the theoretical approaches sustained by practical examples.

The structure and chapters of the book are broadly grouped into core topics that address challenges related to safe operations of control systems, risk analysis and assessment, usage of attack graphs to evaluate and increase the resiliency of control systems, preventive maintenance, and malware detection and analysis. The resilience and cybersecurity of sensor networks and the Internet of Things devices, which are now an integral part of the various industrial control systems, are discussed in different chapters of the book.

Another notable contribution of this book is the inclusion of necessary and timely response to malicious attacks or hazardous situations. This topic will certainly help readers to decide the best approaches to handle such unwanted situations.

We believe, the contents of the book is essential readings for system engineers, researchers, and specialists. The topics discussed in the book are challenging and recent and we anticipate the book to represent a useful reference for all the professionals in the field of ICS resilience, safety, and security. Finally, the editors expect that this book will be a supportive auxiliary to undergraduate and graduate students, to academia and researchers trying to address security and safety issues related to the modern implementations of the industrial control systems.

Ploiesti, Romania — Dr. Emil Pricop
Quebec City, Canada — Dr. Jaouhar Fattahi
Rajkot, India — Dr. Nitul Dutta
Amman, Jordan — Dr. Mariam Ibrahim
August 2019

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Editors and Contributors

About the Editors

Emil Pricop is currently with the Control Engineering, Computers and Electronics Department of the Petroleum-Gas University of Ploiesti, Romania. He holds the position of Senior Lecturer since 2018 and he is teaching Computer Networking, Software Engineering, and Human–Computer Interaction courses. He received his Ph.D. in Systems Engineering from Petroleum-Gas University of Ploiesti by defending in May 2017 the thesis with the title "Research regarding the security of control systems". His research interest is cybersecurity, focusing especially on industrial control systems security. Dr. Emil Pricop is co-editor of the book *Recent Advances in Systems Safety & Security (Springer, 2016)* and author or co-author of two national (Romanian) patents, five book chapters published in books edited by Springer, and over 30 papers in journals or international conferences. From 2013, Dr. Pricop is the initiator and chairman of International Workshop on Systems Safety and Security—IWSSS, a prestigious scientific event organized annually.

Jaouhar Fattahi is currently working with Defence Research and Development Canada (DRDC) at the Valcartier Research Centre as a defence scientist. He is also an adjunct professor with Laval University, Quebec City, Canada. He obtained his Ph.D. on the security of cryptographic protocols from Laval University in October 2015. He completed his postdoctoral fellowship at the Canadian Armed Forces Research Centre in the field of cybersecurity. He has also been a computer engineer since 1995. Dr. Jaouhar Fattahi is the author of *The Theory of Witness-Functions* for verifying security of cryptographic protocols. He now specializes in reverse engineering and machine and deep learning applied to security and cybersecurity. He is an IEEE member.

Nitul Dutta is a professor in the Computer Engineering Department, Faculty of Engineering (FoE), Marwadi University, Rajkot, Gujarat, since 2014. He has a total experience of 20 years. He received B.E. degree in Computer Science and

Engineering from Jorhat Engineering College, Assam (1995), and M. Tech. degree in Information Technology from Tezpur University, Assam (2002). He completed Ph.D. (Engineering) degree in the field of Mobile IPv6 at Jadavpur University (2013) and published 15 Journal and 30 conference papers. He has completed two AICTE sponsored research projects of worth Rs. 25 Lakhs (approx.) (Rs. Twenty-Five Lakhs only). His current research interests are wireless communication, mobility management in IPv6-based network, cognitive radio networks, and cybersecurity.

Mariam Ibrahim received her Bachelor's degree in Electrical and Computer Engineering from the Hashemite University, Jordan, in 2008, and M.S. in Mechatronics Engineering from Al-Balqa Applied University, Jordan, in 2011, and the Ph.D. in Electrical Engineering from Iowa State University, USA, in 2016. She was a lab supervisor with EE department at the Hashemite University (2008–2011). She joined the German Jordanian University (2011) as an RA, where she got a scholarship to pursue her Ph.D. studies; she is currently an assistant professor at GJU. Her research interests include discrete-event systems, stochastic systems, power systems, communication networks, healthcare systems, together with their control and resiliency analysis, and system model-based verification/attack graph generation using AADL. She is a member of Iowa Section IEEE Control Systems Society Technical Chapter. She serves as a scientific reviewer in the international scientific committee of the International Workshop on Systems Safety and Security—IWSSS since 2017, journal of *IET Cyber-Physical Systems: Theory & Application, 2018*, and *IEEE Network Magazine, 2018*.

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