

Vuk Lesi

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EDUCATION

Ph.D. in Electrical and Computer Engineering

Department of Electrical and Computer Engineering, Pratt School of Engineering
Duke University, Durham, North Carolina

August 2015 – December 2019
(dissertation defended in Aug. 2019)

B.Sc. in Electrical and Computer Engineering

Signals and Systems Department, School of Electrical Engineering
University of Belgrade, Belgrade, Serbia

September 2011 – July 2015

RESEARCH INTERESTS

Security-Aware Cyber-Physical Systems Design; Real-Time and Networked Embedded Systems; Distributed Embedded Control; Industrial Cyber-Physical Systems; Reconfigurable Manufacturing Systems; Industrial Internet of Things

JOURNAL PUBLICATIONS

V. Lesi, Z. Jakovljevic and M. Pajic, "Security Analysis for Distributed IoT-Based Industrial Automation", *arXiv preprint, arXiv:2006.00044*, 2020.

V. Lesi, Z. Jakovljevic, and M. Pajic, "Distributing Numerical Control for Reconfigurable Manufacturing Systems", **under review**.

Z. Jakovljevic, **V. Lesi**, and M. Pajic, "Attacks on Distributed Sequential Control in Manufacturing Automation", *IEEE Transactions on Industrial Informatics (TII)*, April 2020.

V. Lesi, I. Jovanov, and M. Pajic, "Integrating Security in Resource-Constrained Cyber-Physical Systems", *ACM Transactions on Cyber-Physical Systems (TCPS)*, March 2020.

Z. Jakovljevic, **V. Lesi**, S. Mitrovic, and M. Pajic, "Distributing Sequential Control for Manufacturing Automation Systems", *IEEE Transactions on Control Systems Technology (TCST)*, May 2019.

V. Lesi, I. Jovanov, and M. Pajic, "Security-Aware Scheduling of Embedded Control Tasks", *ACM Transactions on Embedded Computing Systems (TECS)*, presented in the *ACM SIGBED International Conference on Embedded Software (EMSOFT, ESWEEK 17)*, October 2017 **(Best paper award)**.

CONFERENCE PUBLICATIONS

V. Lesi, Z. Jakovljevic, and M. Pajic, "Synchronization of Distributed Controllers in Cyber-Physical Systems", *IEEE International Conference on Emerging Technologies and Factory Automation (ETFA)*, Zaragoza, Spain, September 2019.

V. Lesi, Z. Jakovljevic, and M. Pajic, "Reliable Industrial IoT-Based Distributed Automation", *ACM/IEEE Conference on Internet of Things Design and Implementation (IoTDI, CPS-IoT Week 19)*, Montreal, Canada, April 2019.

V. Lesi, I. Jovanov, and M. Pajic, "Network Scheduling for Secure Cyber-Physical Systems", *IEEE Real-Time Systems Symposium (RTSS)*, Paris, France, December 2017.

V. Lesi, I. Jovanov, and M. Pajic, "Security-Aware Scheduling of Embedded Control Tasks", *ACM SIGBED International Conference on Embedded Software (EMSOFT, ESWEEK 17)*, journal version appeared in *ACM Transactions on Embedded Computing Systems (TECS)*, Seoul, South Korea, October 2017 **(Best paper award)**.

V. Lesi, Z. Jakovljevic, and M. Pajic, "Towards Plug-n-Play Numerical Control for Reconfigurable Manufacturing Systems", *IEEE International Conference on Emerging Technologies and Factory Automation (ETFA)*, Berlin, Germany, September 2016.

Q. Gao, M. Naumann, I. Jovanov, **V. Lesi**, K. Kamaravelu, W. Grill, M. Pajic, "Model-based Design of Closed Loop Deep Brain Stimulation Controller using Reinforcement Learning", *ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)*, Sydney, Australia, April 2020.

PATENTS, DEMOS, POSTERS AND OTHER PUBLICATIONS

"Physics-based approach for attack detection and localization in closed-loop controls for autonomous vehicles", U.S. **Patent App.** 16/021,409.

"Methods and apparatus for anomaly detection and recovery", U.S. **Patent App.** 16/235,812.

"Security reporting via message tagging", U.S. **Patent App.** 16/712,479.

"Active attack detection in autonomous vehicle networks", U.S. **Patent App.** 16/723,142.

"Systems and methods for message assurance in vehicle systems", U.S. **Patent App.** 16/833,200.

U.S. **Patent Apps.** Drafting in progress, Titles temporarily undisclosed.

V. Lesi, Z. Jakovljevic, and M. Pajic, "Flattening the Automation Pyramid with Industrial Internet of Things: From Electromechanical Parts to Smart Manufacturing Resources", magazine paper under submission.

V. Lesi, Z. Jakovljevic, and M. Pajic, "Towards Resilient and Reliable Distributed Automation for Smart Manufacturing Systems", **Workshop on Smart Manufacturing Modeling and Analysis (SM²N, CPS-IoT Week 19)**, Montreal, Canada, April 2019.

V. Lesi, I. Jovanov, and M. Pajic, "Integrating Security in Resource-Constrained Cyber-Physical Systems", **Demonstration at the Intel-NSF CPS-Security Meeting**, Stanford, California, USA, July 2018.

I. Jovanov, M. Naumann, K. Kumaravelu, **V. Lesi**, A. Zutshi, W. Grill, and M. Pajic, "Learning-Based Control Design for Deep Brain Stimulation", **Demonstration at the 9th ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS, CPSWEEK 18)**, Porto, Portugal, April 2018.

V. Lesi, I. Jovanov, and M. Pajic, "Security-Aware Scheduling of Embedded Control Tasks", **Poster at the ACM SIGBED International Conference on Embedded Software (EMSOFT, ESWEEK 17)**, Seoul, South Korea, October 2017.

V. Lesi, I. Jovanov, and M. Pajic, "Security-Aware Scheduling for Cyber-Physical Systems", **Poster at the Intel-NSF Center on Cyber-Physical Systems Security**, Hillsboro, Oregon, USA, August 2017.

AWARDS AND RECOGNITIONS

Amazing Works Here

Recognitions for results in security and privacy research during two internships; Development of laboratory-scale automotive systems security research platform; Secure automotive systems research; Responsibility of interfacing inter-group collaboration based on embedded control systems expertise; Security-aware analysis of safety-critical cyber-physical systems
Intel Corporation, Intel Labs, Hillsboro, Oregon

Aug. 2018,
Aug. 2017,
July 2017

Best Paper Award

17th ACM International Conference on Embedded Software (EMSOFT 17)
for the paper "Security-Aware Scheduling of Embedded Control Tasks"
Association for Computing Machinery

Oct. 2017

NSF-IEEE RTSS 2017 Travel Grant

Travel expense grant to Paris, France for Real-Time Systems Symposium 2017 (RTSS 17)
National Science Foundation and the IEEE

Nov. 2017

Duke ECE Graduate Student Travel Grant

Excellent research presentation prize, *Department of Electrical and Computer Engineering*
Duke University, Durham, North Carolina

Sep. 2017

ACM SIGBED ESWEEK 2017 Travel Grant

Travel expense grant to Seoul, South Korea for Embedded Systems Week 2017 (ESWEEK 17)
Association for Computing Machinery

Sep. 2017

DISERTATION PROJECTS

Development of Reconfigurable Manufacturing Systems and Industrial IoT

| Control architecture design for tightly synchronized distributed applications (e.g., motion control);
Reconfigurable Numerical Control Kernel distribution with respect to architecture-, platform- and
implementation-dependent trade-offs;

Fall 2015 –
Fall 2019

| Control architecture design for reliable and resilient distributed event-triggered sequential control systems (e.g., based on GRAFCET/SFC/Petri nets); Model-based generation of distributed control firmware; Distributed system modeling, Hardware-In-the-Loop simulation, and formal safety verification; Edge-based performance and reliability monitoring
 | Full-stack research Proof-of-Concept implementations; COTS-based wired and wireless real-time control implementations

Real-Time Scheduling for Security-Aware Cyber-Physical Systems

| Integrating security in resource-constrained/legacy systems while preserving existing functionalities; Optimal resource allocation with security overhead VS quality-of-control trade-off analysis Spr. 2017 – Fall 2019

Machine Learning-Based Attack/Anomaly Detection

| Development of machine learning-based models suitable for capturing cyber-physical state and attack/anomaly detection with focus on autonomous driving and industrial applications. Spr. 2019 – Fall 2019

Embedded Deep Brain Stimulation Device Design

| Embedded stimulation controller SW/HW design and implementation with tight timing requirements Fall 2017 – Fall 2019

PROFESSIONAL EXPERIENCE AND SERVICE

Research Scientist, Security and Privacy Research

Intel Labs, Hillsboro, Oregon Feb. 2020 – present

Research Assistant, Cyber-Physical Systems Lab

Department of Electrical and Computer Engineering, Duke University, Durham, North Carolina Aug. 2015 – Dec. 2019

Cyber-Physical Systems Research Intern

Development of laboratory-scale automotive systems research platform with emphasis on real-world complexities and functionalities; Security mechanisms development for vehicular systems May – Aug. 2017, 2018, 2019
Security and Privacy Research, Intel Labs, Hillsboro, Oregon

Invited Technical Program Committee for the ACM Symposium on Applied Computing (SAC 21): Cyber-Physical Systems (CPS) Track Jun. – Nov. 2020

Invited Reviewer for the ACM Transactions on Computing for Healthcare (HEALTH) Apr. – Jun. 2020

Invited Reviewer for the IEEE Transactions on Industrial Informatics (TII) regular issue and special issues on: Industrial Cyber-Physical Systems: New Trends in Computing and Communication; Configuration Security for Industrial Automation and Control Systems Feb. – Sep. 2020

Invited Technical Program Committee Member of the IEEE Real-Time and Embedded Technology and Applications Symposium: Brief Presentations Track (RTAS 20) Jan. – Apr. 2020

Invited Technical Program Committee Member for the IEEE International Conference on Embedded and Real-Time Computing Systems and Applications: IoT, CPS, and Emerging Applications Track (RTCSA 20) Jan. – Aug. 2020

Invited Reviewer for the IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD) Aug. 2019 – Sep. 2020

Invited Review Committee Member for the ACM International Conference on Embedded Software: WiP Track (EMSOFT 19, 20) May. – Oct. 2019

Teaching Assistant/Tutor, Introduction to Embedded Systems (ECE 459)

Included full-stack platform and laboratory exercise development and implementation for first course offering; Full laboratory syllabus development with focus on introduction of higher-level programming languages; Final project student guidance Fall 2016, Fall 2017, Fall 2019
Department of Electrical and Computer Engineering, Duke University, Durham, North Carolina

Tutor, Cyber-Physical Systems Design (ECE 590), Independent Study (ECE494)

Student guidance and design support for projects: *Design of autonomous UAVs, Brain model on a GPGPU, and DC/DC converter controller for hydrogen-powered drone* Spr. 2019
Department of Electrical and Computer Engineering, Duke University, Durham, North Carolina

Automatic Controls Intern

Introduction to SCADA/PLC/DCS supervisory/automatic controls maintenance engineering
Electric Power Industry of Serbia, Thermal Power Plants and Coal Mines Kostolac, Serbia

Summer 2014

TECHNICAL SKILLS

- | Embedded system software development in C/C++
 - Development of bare-metal and RTOS-based *general purpose embedded applications, motor controls and advanced timing applications, wired and wireless timing synchronization in distributed control, low-power wireless communication, real-time communication stacks, real-time sensing applications with direct memory access*
 - Architecture-specific experience with *Microchip PIC xxF*, and *Arm Cortex-M* microcontrollers (extensive debugging in Microchip MPLAB, Arm Keil, and NXPXpresso environments)
- | Rapid embedded application prototyping on *NXP, ST, TI, Microchip, mbed, Raspberry Pi, Arduino* solutions
- | Multidomain simulation, engineering computation software, and control system design in Matlab/Simulink
- | Basic machine learning with Anaconda/Python/Scikit-learn
- | Industrial application development in IEC 61131-3 languages (LD, FBD, ST, SFC)
 - Practical knowledge acquired on Step 7/TIA automation tools (Siemens TIA-MICRO1 certificate)

Last update: August 2020