

Enhancement of Cyber Security in Electric Microgrids

Summary

This PhD position addresses the domain of cyber security in cyber-physical systems. Increased integration of individual renewable energy production units and distribution systems enlarges the cyber attack surface of cyber-physical systems supporting energy management processes. The PhD candidate is expected to research cyber security threats and their implications on electric microgrids and distribution systems. More specifically, the research will focus on developing cyber threat modelling and risk assessment methods for identifying the relevant cyber risk aversion and mitigation methods in the respective systems.

Research field:	Electrical power engineering and mechatronics
Supervisors:	Prof. Dr. Hayretdin Bahsi Dr. Tarmo Korõtko
Availability:	This position is available.
Offered by:	School of Engineering Department of Electrical Power Engineering and Mechatronics
Application deadline:	Applications are accepted between June 01, 2023 00:00 and June 30, 2023 23:59 (Europe/Zurich)

Description

The EU has set ambitious renewable energy targets to mitigate the effects of climate change, which results in a significant increase in renewable generation units connected to electrical distribution grids and microgrids. In contrast to system operators, common SMEs and natural persons neither have the necessary know-how nor the budget to assess cyber security matters of their distributed generation unit, an Internet-connected PV inverter, for example. Limited awareness about cyber threats makes micro- and small-scale generation units vulnerable targets for malicious actors. Cyber attacks on renewable energy assets connected to microgrids and distribution system can result in various consequences ranging from equipment and infrastructure damages to power outages. Considering the tendency to utilise cloud computing services to manage a high number of Microgrids and integrate artificial intelligence (AI) based system components into the overall system architecture, the scale and variation of cyber threats may increase.

For instance, adversarial and system security attacks can threaten AI-based energy management systems.

This research focuses on systematically identifying cyber-security risks and mitigation techniques in the evolving cyber threat landscape for the addressed systems, given the limited awareness of energy end-users and constrained resources assigned for the system development. A particular interest will be given to the cyber threats targeting the cloud- and AI-based system components. The risk mitigation can be done in cyber, physical or both spaces, depending on the feasibility of the alternatives.

The main objective of this research is to develop a novel threat modelling and risk management framework aimed at the owners of micro- and small-scale renewable generation units to significantly reduce their vulnerability and limit the effects of cyber-attacks on the physical system. The developed framework will be demonstrated in various case studies. One of the other aims is to develop a lab environment that emulates/simulates some target systems and realizes the selected technical attacks and the mitigation techniques.

Supervisors:

Main supervisor: Dr. Tarmo Korõtko

Co-supervisor: Prof. Dr. Hayretdin Bahsi

Responsibilities and (foreseen) tasks

- Research and development of threat modelling and risk assessment methods applicable to cyber-physical systems
- Research and development of risk mitigation methods applicable to cyber-physical systems aimed at energy end-users.
- Creating a simulation/emulation environment in the lab for testing the cyber attacks and mitigation techniques



Applicants should fulfil the following requirements:

- master's degree in electrical engineering or computer systems from the last five years
- a clear interest in the topic of the position
- principal understanding of electric power systems, computer systems and cyber security concepts
- excellent command of the English language
- profound writing and analytical skills
- capacity to work both as an independent researcher and as part of an international team
- capacity and willingness to aid in relevant organizational tasks

The following experience is beneficial:

- (co-)authored published scientific papers
- programming using high-level programming languages (e.g., Python, C++, C#, Java or similar)
- mathematical optimization, programming, and algorithm development
- operations systems engineering
- Machine learning implementations

The candidate should submit a research plan for the topic, including the overall research and data collection strategy. The candidate can expand on the listed research questions and tasks and propose theoretical lenses to be used.

We offer:

- 4-year PhD position in the leading microgrids research group in the region with a large portfolio of pan-European and national research and development and study projects, mainly concerned with renewable energy integration, digital and AI applications in electric power systems.
- This position will be co-supervised by a researcher from one of the leading cyber security research centers in the region.
- The opportunity to carry out high-level research in the highly relevant domain of cyber security in cyber-physical systems.
- Access to state-of-the-art research facilities for microgrids, renewables integration and power system digitalization.
- Opportunities for student exchange through EuroTeQ and Erasmus+ programmes, visits to research conferences and laboratory facilities and networking with leading universities and research centers.

About the department

The Department of Electrical Power Engineering and Mechatronics of Tallinn University of Technology is an interdisciplinary research center focusing on socially relevant and future-oriented research and teaching issues related to power engineering and mechatronics. The mission of the Department is to be a leader in electrical engineering and technical studies and development projects in Estonia, known and valued in society, and a respected partner in national and international cooperation networks and organizations. The department has coordinated and partnered with several international projects, including Horizon 2020, INTERREG, 7FP, Nordic Energy Research etc.

The Department of Electrical Power Engineering and Mechatronics conducts research within seven research groups and operates a state of the art laboratories with high-end equipment, offering accredited services in lighting and different electrical measurements. The department's focus areas are related to domestic and global challenges related to increasing digitalization, decarbonization and decentralization of electric power systems and increasing use of renewable energy sources. The department carries out research in the following relevant areas:

- optimization of electric power systems and system analysis to find possibilities for electrification and decarbonization
- diagnostics and monitoring of equipment and systems
- cyber security, 5G data communications and artificial intelligence
- energy networks and research on hydrogen technologies, including energy storage, renewable energy, low carbon technologies, consumption management, IoT applications in energy



- implementation of smart industry, including industrial robotics, automation, 3D printing, machine vision
- implementation of energy and resource efficiency, including digitization of supply chains, mapping of opportunities to optimize systems and reduce energy consumption
- development of smart city solutions, including environmentally friendly and self-driving vehicles / drones, digital twin applications.

Additional information

For further information, please contact Dr. Tarmo Korõtko tarmo.korotko@taltech.ee



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