

ICT PHD

Research project for a PhD curriculum in ICT, Computer Engineering and Science

Tutor: Riccardo Lancellotti

Proposed Title of the research: Edge and Cloud computing solutions for detecting and evading attacks against ad-hoc vehicular networks

Keywords: Distributed Systems, Cloud Computing, Edge Computing, Ad-hoc vehicular networks, IoT Security

Research objectives

The research aims to propose innovative solutions to guarantee the security of ad-hoc vehicular networks using techniques based on edge and cloud computing infrastructures. To this aim the research will follow two main directions.

On one hand, specific security solutions for vehicular networks will be introduced. As the use of autonomous vehicles or technologies to assist the driver has increased (and is increasing) dramatically over the last years, specific solutions to guarantee a high level of security is a critical and highly innovative field of research. This first research direction involves threat analysis and modeling, defining attack scenarios and defining the effective countermeasures.

The second research direction is motivated by the need to process huge amount of data with strict time windows. To this aim solutions derived from Cloud and Edge computing will be analyzed. The task of analyzing data for detecting/evading/blocking attacks can be modeled as a Directed Acyclic Graph (DAG) of micro-services that must be mapped over a distributed infrastructure composed of edge and cloud nodes, with limited computing power and non-negligible network delays. Infrastructure management and task allocations must consider multiple aspects ranging from (dynamically changing) computing load to network characteristics and up to power efficiency.

Proposed research activity

The research activities can be summarized as follows:

- Define threat models based on the possible vulnerabilities of applications and protocols involved in ad-hoc vehicular networks.
- Propose countermeasures to discover and mitigate the attack scenarios
- Define and solve optimization problems for the deployment of the applications modeled as DAG, including problems of service replication, cloud-based offloading. Solutions can involve both traditional optimization algorithms or ML-based techniques such as Reinforcement Learning
- Define adaptive strategies for dynamic scenarios of service placement (for example leveraging dynamic programming approaches)

- Define on-line load balancing algorithms to mitigate local overload conditions
- Modeling of the protocols and of the countermeasures based on micro-testbeds
- Validation of the solutions using both small-scale realistic testbeds and large scale simulation

Supporting research projects (and Department)

This project will be carried out at the Department of Engineering “Enzo Ferrari” and will be supported by research funds provided by Prof. R. Lancellotti.

Possible connections with research groups, companies, universities.

The research may involve the undergoing collaborations with research groups at:

- Roma “Tor Vergata” (Prof. Chiaraviglio)
- Roma “Tor Vergata” (Prof. Lo Presti)
- Politecnico di Milano (Prof. Ardagna)
- Roma “Sapienza” (Prof. Beraldi)
- King’s College of London (Prof. Pierazzi)
- Unimore – DISMI (Prof. Iori)