

COMPUTER AND CONTROL ENGINEERING

MUR DM 117/Italdesign - Software-Defined Vehicle

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Context of the research activity	<p>This project aims at investigating the challenges behind the “Software-Defined Vehicle”, in particular with respect to (1) the evolution of the automobile towards cloud-native technologies, (2) the management of software processes and services with real-time and mission critical requirements, and (3) the integration of the vehicle into the “computing continuum.”</p> <p>Progetto finanziato nell'ambito del PNRR - DM 117/2023 -CUP E14D23002020004</p>
	<p>Research objectives</p> <p>The research goal the “Software-Define Vehicle” is expected to be achieved by pursuing some of the following objectives:</p> <ul style="list-style-type: none">- Local orchestration algorithms with support for multiple computing devices available on a future car, with support for safety and real-time constrained applications.- Resource offloading algorithms suitable in case of short-lived/unreliable connections between devices, some of which may be energy constrained.- Distributed processing algorithms, enabled by the presence of computing/sensing resources nearby (e.g., other cars with their own set of sensors), whose results are shared among the different cars participating in a swarm.- Decentralized orchestration algorithms, enabling autonomous cars to carry out their tasks taking the best of the surrounding environment, e.g., leveraging edge resources or swarms of vehicles when available, but being able to operate also in harsh (and resource-limited) environments if needed.- Algorithms for load balancing / seamless switching between edge-based, swarm-based, or local services for the sake of resiliency and energy consumption.

- Resource sharing models supporting multiple administrative domains (e.g., car manufacturer, city council, telco operator).

Outline of the research work plan

A possible outline of the research plan is the following:

- First year: the Ph.D. student will review the state of the art regarding software-defined vehicle, including the current status of the standardization activities as well as emerging open-source initiative. A conference publication is expected to be produced based on the results of the review. Afterward, the candidate will explore the characteristics of resource-constrained orchestration algorithms with support for real-time services, providing the ground for possible optimizations, which is expected to originate another initial workshop paper.
- Second year: the Ph.D. will develop a model for performance prediction for services running in different locations (on board of the vehicle, at the edge of the network, in the cloud), which is expected to be published in a paper. Then he/she will leverage the above model to determine the best technology to be used in each running condition, based on static (e.g., software requirements) and dynamic (status of the infrastructure) data. This is expected to originate a fourth paper.
- Third year: the Ph.D. will integrate the previous findings in two directions: (1) optimize the location of each running service including real-time ones over the entire computing continuum, and (2) predict the future infrastructure conditions and software requirements in order to possibly optimize, in advance, the running software. The above activities are expected to be published in two separate papers.

Expected target publications

Top conferences:

- USENIX Symposium on Operating Systems Design and Implementation (OSDI)
- USENIX Symposium on Networked Systems Design and Implementation (NSDI)
- IEEE Vehicular Technology Conference
- International Conference on Computer Communications (INFOCOM)

Journals:

- IEEE Transactions on Cloud Computing
- IEEE Transactions on Vehicular Technology
- IEEE Transactions on Computers
- ACM Transactions on Computer Systems (TOCS)
- IEEE/ACM Transactions on Networking

Magazines:

- IEEE Vehicular Technology Magazine, IEEE Computer, IEEE Networks

Objectives

Skills and competencies for the development of the activity

The ideal candidate has good knowledge and experience in cloud computing and networking. Availability for spending periods abroad would be preferred for a more profitable investigation of the research topic.