

# PhD in Computer and Control Engineering

## Research Title: Blockchain Technology for Intelligent Vehicles

### Blockchain Technology for Intelligent Vehicles

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<b>Context of the research activity</b>	<p>Experts predict that by 2030 there will be a mass adoption of self-driving vehicles. Regardless of whether or not this forecast will occur, the decade 2020-2030 will be characterized by vehicles that are more and more intelligent and capable of acquiring (and processing) increasing amounts of data from sensors positioned on board, from other vehicles or from the outside world.</p> <p>Another technology, which is undergoing a great development, is blockchain. Blockchain enables nodes (devices) of a network to carry out transactions (which cannot be repudiated and cannot be canceled) in a decentralized manner, thanks to cryptographic mechanisms that create trust among participants. The potential of this technology is also increased by the use of smart contracts, programs stored on the blockchain, which are autonomously executed if certain conditions are met, whose code is immutable and can be inspected by anyone.</p> <p>The use of blockchain technology in the context of intelligent vehicles can bring several benefits, such as:</p> <p>a) the use of a shared ledger to store the digital twin of vehicles/components provides transparency to the end user, who can inspect, for example, the (certified) history of a vehicle (registered by the manufacturer, by technicians or by sensors);</p>
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- b) the underlying cryptographic mechanisms guarantee the integrity of the data exchanged between vehicles and/or external sensors, improving security against cyber-attacks;
- c) the ability to send transactions (or to schedule them to be sent upon the occurrence of certain conditions) allows vehicles to exchange money autonomously, e.g, to receive payments when they share data read by their sensors, or to autonomously request and pay for maintenance interventions.

## Objectives

The objective of this research activity is to investigate the impact of the blockchain technology in the context of intelligent vehicles and of the automotive supply chain, in order to analyze the added value and limitations of this technology, as well as the most promising solutions for disintermediated communication between vehicles and for data storage.

In particular, the research activities will be initially aimed at implementing solutions for the traceability of components and of the previous history of the vehicle, which can be used by different actors (manufacturers, dealers, owners and repair shops) and which could guarantee transparency, safety, scalability and privacy. In particular, the solutions will enable, through smart contracts, the tracking of planned/not planned maintenance activities on the vehicle and the automatic verification of warranty coverage.

Subsequently, this research area will be extended to include, among the above actors, the producers of spare parts, in order to evaluate the impact that blockchain technology can have on the automotive supply chain, and to design/develop blockchain-based solutions that will be tested by means of simulations or use in real contexts.

A third area of research will be related to electric vehicles. In particular, the research activities in this area will be devoted to designing blockchain-based systems for the acquisition of data on vehicle's consumption, for the certification of the residual life of the batteries and for the electricity trading as well as for the use of (intelligent) electric vehicles to balance the grid. In this case, the blockchain could also be used as a means to allow vehicles and devices to autonomously make payments.

Finally, a latter area of research will concern the exploitation of the blockchain to manage in a disintermediated manner the distribution of costs/profits between owners/users/maintainers/insurers of (fleets of) vehicles.

To carry out the research activities mentioned above, the candidate will investigate, in particular:

- a) Which blockchain platforms and architectures are most suitable to be used by intelligent vehicles, also considering aspects related to security, scalability and privacy;
- b) Which existing standards are most suitable for the representation of the digital twin of physical vehicles/components (e.g., the MOBI standard), of

	<p>data acquired by sensors and for the transfer of value between humans or between machines;</p> <p>c) How different types of blockchains (for example, public and private) can be combined with each other and how a blockchain-based solution can be integrated with systems for the peer-to-peer storage of large amounts of data (such as the InterPlanetary File System - IPFS);</p> <p>d) How simplified, yet effective visualizations can be created to represent the status of the vehicle(s) and the information saved on the blockchain.</p>
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<b>Skills and competencies for the development of the activity</b>	<p>The candidate must have a Master Degree in Engineering as well as the following characteristics:</p> <ul style="list-style-type: none"><li>- Good programming skills in commonly used programming languages (e.g., Python, Java, C, Node.js, PHP)</li><li>- Good programming skills in blockchain-related programming languages (e.g., Solidity)</li><li>- Good knowledge of existing blockchain frameworks</li><li>- The candidate should be able to autonomously develop decentralized applications</li><li>- Knowledge of cryptography and security as well as machine learning are a plus.</li></ul>
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