Auto5G — Intelligent Vehicle Telemetry and Supervision System

1. Overview

Intelligent Vehicle Telemetry and Supervision System (Auto5G) is a joint RD&I effort of LISHA, Intelbras and Yak on the utilization of low-level 5G protocols for vehicular telemetry and supervision within the paradigm of the Internet of Things (IoT).

The project aims at developing and validating a Proof-of-Concept (PoC) focusing on diagnostic and preemptive maintenance application in the automotive domain. For this purpose, we'll validate Machine-to-Machine (M2M) communication protocols within the paradigm of the Industrial Internet of Things (IIoT) over 5G using two platforms, one developed by LISHA in the scope of IASE and SDAV, and another one developed by Intelbras. Vehicular data will be securely stored and process using LISHA's IoT Platform.

1.1. Auto5G Architecture

An overview of the Auto5G architecture is depicted in Figure 1 and illustrates the major entities:

- **Connected Vehicles** that communicate with an IoT Platform to send telemetry information about their operating status (e.g. ECUs and other CAN-connected components, non-CAN components) and also sensing data (e.g. GPS, IMU, LiDAR, Cameras) that might be of interest to fleet managers.
- **5G M2M services such as URLLC** as the connectivity technology.
- **SmartData** to provide secure, georeferenced and timed communication.
- **IoT Platform** to implement the microservices used by the vehicles to send data and by the fleet managers to securely store, retrieve, and process such data.
- **Analytics** algorithms to extract useful management and operation information from the acquired dataset, including visualization.
- **Machine Learning Models** built on the acquired data to support management and operation optimizations, including fault detection and maintenance predictions.

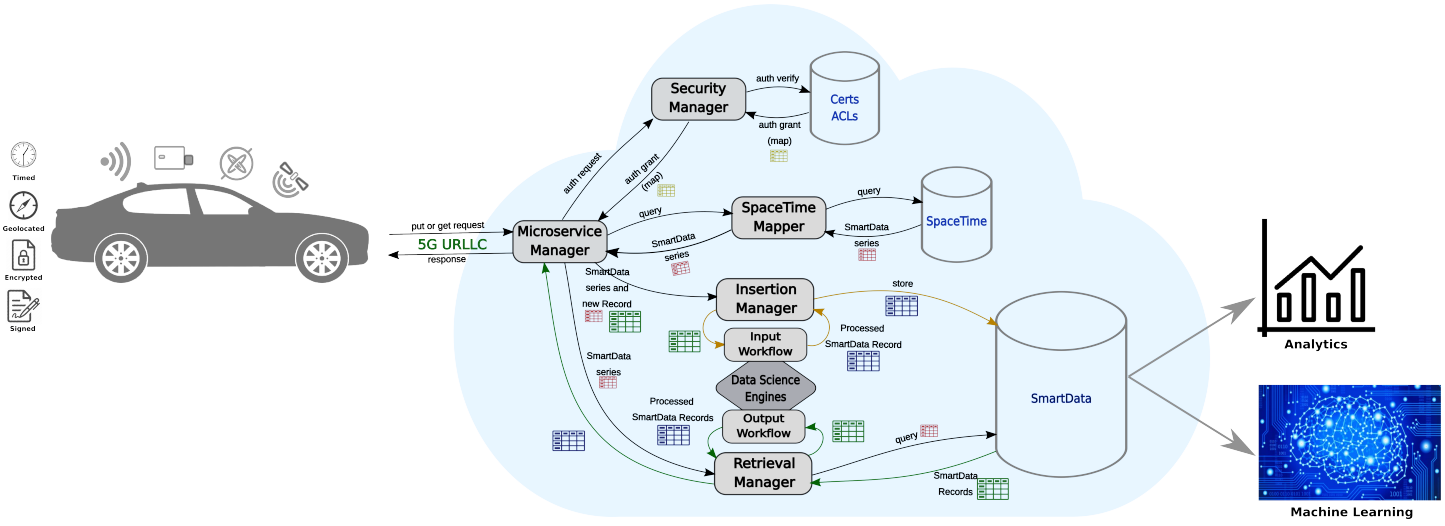

Fig 1: Auto5G Architecture Overview.

These entities also define the project's goals and work packages.

1.2. A Review of the Solution Proposed for Vehicle Telemetry in Auto5G

Project

The proposed solution envisioned in the project Auto5G consists of developing a gateway to be installed in the cargo vehicle capable of receiving information from sensors connected to it and forwarding the data securely to a platform where it will be analyzed, as shown in the figure below.

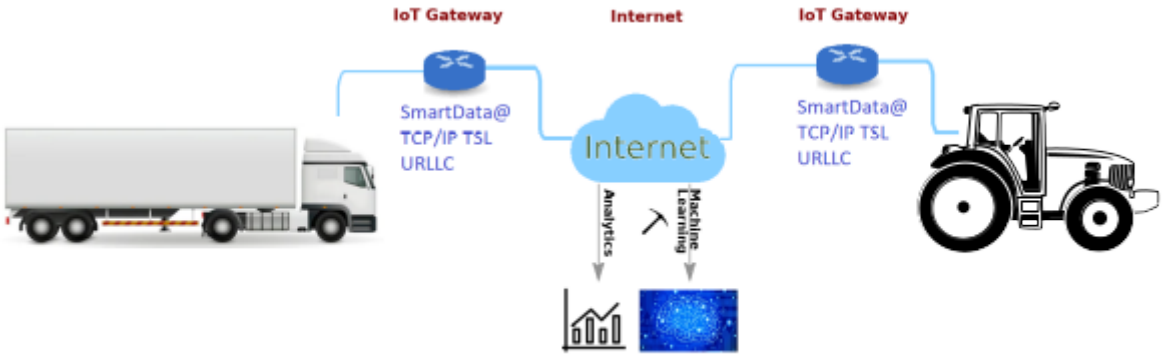

Fig 2: Auto5G Telemetry Solution Overview.

Vehicles produced today feature a significant set of sensors, normally connected to an electronic module, popularly called an "onboard computer." The degree of complexity of the electronic module and the number of sensors depends on the vehicle model, as they have a significant impact on its final cost. The sensors have pre-established physical connection standards and communications protocols approved by the automotive industry. Therefore, it is expected that the gateway presents connectivity for these standards. An alternative to be discussed with the partner manufacturer is the possibility of the onboard computer sending packets with information from the sensors already used to the gateway. This allows two monitoring scenarios to be offered to customers: (i) offering the traditional model, where the vehicle's internal panel shows the values read on digital circuits or light signals, such as LCDs and LEDs; (ii) offering the traditional model and include the gateway, allowing the data also to be monitored remotely by the company that owns the vehicle.

The first proof of concept must be implemented using an embedded Linux system and the LISHA's IIoT Platform as a way of accelerating the validation of the proposed concepts. The embedded system will be adapted to operate as a gateway and will communicate remotely with the IIoT platform through connection protocols for Machine-to-Machine (M2M) in 5G technology. It is important to highlight that cargo vehicles can travel through the most varied regions of Brazil. Although 5G technology is the most current, it must be taken into account that in interior regions of the country, there is only availability of 3G or 4G services. For this reason, the project will be sized to support connectivity with the three generations of cell phones in force in Brazil, thus ensuring that partner companies can immediately make use of other technologies to be developed in the project, such as smart data, if they so wish.

The IIoT Platform will be adapted to process data received from the vehicle. It must operate with the support of Artificial Intelligence (AI) techniques, with guarantees of safe storage and transmission of vehicle data, and constructing predictive failure models aimed at safe operation and preventive maintenance of implements.

2. Knowledge Dissemination

This section presents the main achievements for this project.

2.1. Publications

1. **José Luis Conradi Hoffmann and Antônio Augusto Fröhlich**, Data-Centric Design for Formal Verification of Vehicle Monitoring, In: Proceedings of the SESC '23: Proceedings of the 2023 XIII Brazilian Symposium on Computing Systems Engineering (SBESC), pages 1-6, Porto Alegre, Brazil,

November 2023. DOI: 10.1109/SBESC60926.2023.10324280.
2. **José Luis Conradi Hoffmann, Leonardo Passig Horstmann, and Antonio Augusto Frohlich**, Using Formal Methods for On-The-Fly Time Series Verification, In: Proceedings of the LADC'23: Proceedings of the 12th Latin-American Symposium on Dependable and Secure Computing, Association for Computing Machinery, pages 21-29, La Paz, Bolivia, October 2023. DOI: 10.1145/3615366.3615427.

3. Related Projects

- SmartData on Wheels - a Safe and Secure Runtime Support System for Autonomous Vehicles
- Secure and Privacy-Aware Data Lake for Vehicle Data Storage and Processing

4. Technical Documentation

- EPOS
- IoT Platform
- IoT Platform Internals
- SmartData Series Semantics

5. Publications

https://lisha.ufsc.br/pub/index.php?key=Auto5G