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LEGACY VEHICLES INTEGRATION PROPOSAL USING HYBRID C-ITS ARCHITECTURE

Petru Lucian Sandu, José Simão, Antonio Serrador

ISEL

a47082@alunos.isel.pt, jose.simao@isel.pt, antonio.serrador@isel.pt

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Summary: The growing interest in highway vehicle automation has brought increased prominence to the Cooperative Intelligent Transport Systems (C-ITS), prompting major companies to invest significant resources to develop these systems. C-ITS aims to enhance road safety and traffic efficiency by enabling real-time communication between vehicles and infrastructure elements such as road sensors, traffic lights and variable information panels. Current C-ITS architectures rely on the ITS-G5 standard for direct short-range communication between On-Board Units (OBUs) and Roadside Units (RSUs). However, ITS-G5 faces limitations in accessibility, such as connecting legacy vehicles, which slows down the widespread development and implementation of this technology. To address this challenge, this paper proposes a hybrid ITS architecture that extends ITS-G5 communications messages into legacy vehicles, using an additional communication layer based on MQTT brokers. This approach enables real-time message distribution with improved flexibility and low latency, allowing legacy vehicles to receive critical traffic information, using cellular mobile networks via a mobile application, effectively integrating them into modern C-ITS networks.

In the conventional C-ITS implementation, OBUs communicate with RSUs using ITS-G5. To bridge the gap between the ITS-G5 network and cellular mobile networks, the architecture includes a message transformation layer that converts ITS-G5 messages into JSON format. This transformation allows for standardized data representation and can then be integrated with MQTT, a lightweight publish-subscribe protocol optimized for efficient message distribution. While MQTT protocol applications are not natively structured in topics based on geographic regions, our proposed architecture introduces a region-based organization to ensure that messages relevant to specific locations are efficiently distributed. Mobile applications subscribe to the relevant topic corresponding to their current location, retrieving real-time traffic and safety information based on a geographical context. This architecture enables vehicles, infrastructure, and mobile users to access critical C-ITS data while minimizing unnecessary message overhead. Furthermore, by using lightweight and scalable messaging protocols, the system can be extended to support a wide range of C-ITS use cases, including traffic congestion alerts, hazard notifications, and cooperative awareness applications, among others.

To ensure the effectiveness and practicality of the proposed solution, a pilot implementation of the architecture will be designed to simulate real-world conditions as closely as possible. This will allow for the assessment of key factors such as system scalability, message propagation performance, and communication latency. The collected measurements will provide valuable insights into the architecture's efficiency and guide potential refinements for optimal real-world deployment.

Overall, the proposed approach enhances system availability by enabling seamless integration with modern mobile platforms, improving scalability, and maintaining low-latency communication while promoting the integration of legacy vehicles and the ITS-G5 networks using C-ITS.