IoT Based Positioning Service Platform

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***Abstract*— This abstract demonstrates an IoT based positioning service platform for future autonomous vehicles. A decision tree is developed which selects the best available positioning algorithm depending on several criteria. The decision tree is then integrated in EURECOM IoT Platform as a web service. We also present an Android Auto application which acts as a vehicular Cloudlet in this context.**

I. Introduction

With IoT technologies maturing, more novel use cases are utilizing them. This paper demonstrates the applicability of an IoT Platform for autonomous vehicles which are an important part of Industry 4.0 initiatives. Such vehicles are expected to improve the safety and protection of Vulnerable Road Users through highly precise position that goes beyond GNSS [1]. The EU H2020 project HIGHTS developed several cooperative localization algorithms aiming to provide geo-temporal awareness which includes knowing with confidence the real-time precise position of vehicles and that of other road users. Each algorithm requires inputs from vehicular, communication, and/or other systems and must be provisioned from Cloud systems by benefiting from the IoT. The goals of the demonstration are twofold - (i) present a prototype of an advanced IoT platform that assists such vehicles in determining the best positing algorithm and (ii) a vehicular Cloudlet developed as an Android Auto application.

II. IoT Based Positioning Service Platform

The capabilities of EURECOM IoT Platform [2] are extended to offer positioning service to future autonomous vehicles. The core of the positioning service is a decision tree shown in Fig 1. It selects the best possible positioning algorithm and its grade depending on the availability of geo-positioning (e.g. GNSS), non geo-positioning, and communication (e.g. ITS-G5) elements [3]. For example, a highly autonomous vehicle just GNSS and HD Maps will be able to utilize IBEOs Map-based algorithm for position calculation which provides absolute position with grade 5 (which corresponds to 15cm level precision). But if the same car goes outside the zone supported by HD Map and if the car also has V2X ITS-G5 connectivity, then in the new context of positioning, the car will be able to use ICP Algorithm that provides absolute positioning with grade 4. So, the platform is important as it can assist in deciding the best positioning algorithm for dynamic context switching.

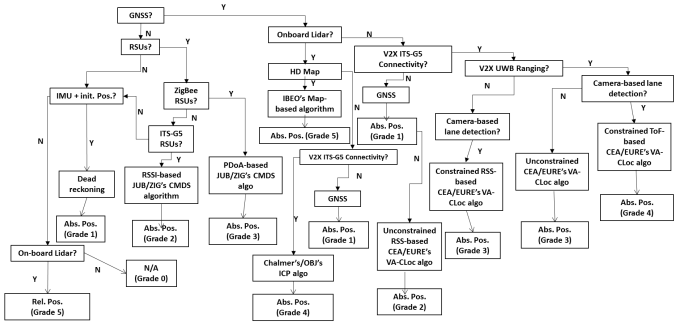

Fig. 1. Decision tree of the positioning service platform.

A. Positioning Web Service

The Cloud based IoT platform (EWPSP) provisions the positioning algorithm and the vehicle can download the same from the positioning web service. Fig. 2 depicts the operational steps for the provisioning of the positioning algorithm. It is assumed that each car is equipped with a Cloudlet (or a vehicular gateway) that includes a Context Switch Manager (CSM), a software element to calculate highly precise position, a communication manager, and a local configuration storage. From the local configuration, the CSM retrieves the in-car and external infrastructure elements available for precision positioning, and encrypts them. The communication manager sends the encrypted message to the IoT Platform (EWPSP) Cloud. Its positioning web service implements the decision tree shown in Fig. 1. This service decrypts the request, determines the appropriate positioning algorithm and its grade and encrypts the response which is then sent back to the Cloudlet on the car. In terms of security, authentication, HTTPS based communication, encrypted payload, and token based access control mechanisms are implemented in the web service.

B. Prototype

For the experimentation, we developed a prototype Android Auto application that emulates the Cloudlet for autonomous vehicles. The positioning web service pis deployed as a microservice in EURECOM IoT Platform[1] and provides a RESTful web interface to interact with the Android Auto application (Cloudlet). Fig. 3 displays the result of one experimentation in which the vehicle has access to GNSS, ITS-G5 connectivity, V2X Ultra Wide Band (UWB) Ranging,

[1] `https://iotplatform.eurecom.fr`

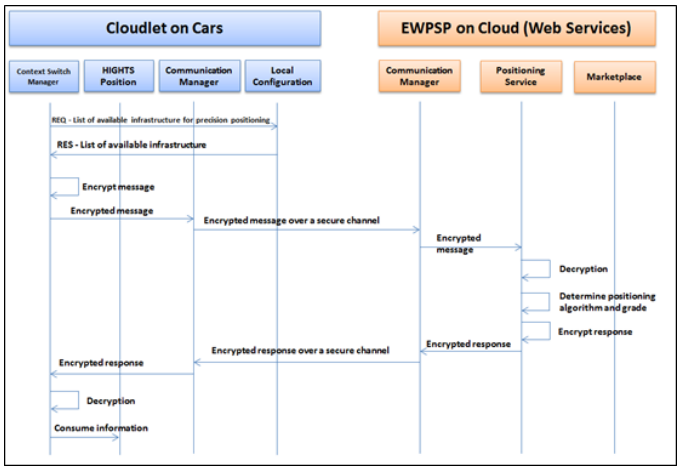

Fig. 2. Steps for positioning algorithm provisioning.

Camera based lane detection. The positioning service from the IoT Platform recommends the suitable algorithm for that. The demonstration is available at[2].

C. Experimental Results

We evaluated the prototypes in terms of consumption of computational (e.g. CPU, memory) and communication resources. The results are reported below.

- The memory footprint of the Android auto application is 3.19 MB.
- The memory footprint of the EWPSP web services is 37 KB.
- The average CPU load during the life cycle of the Android auto application is 4-6%.
- The average CPU load during the life cycle of the positioning web service is 2%.
- The encrypted payload exchanged for positioning service provisioning is less than 1KB.

From these early evaluation results, we can conclude that the prototype implementations (for the car and Cloud both) were lightweight in terms of both computational and communication resources.

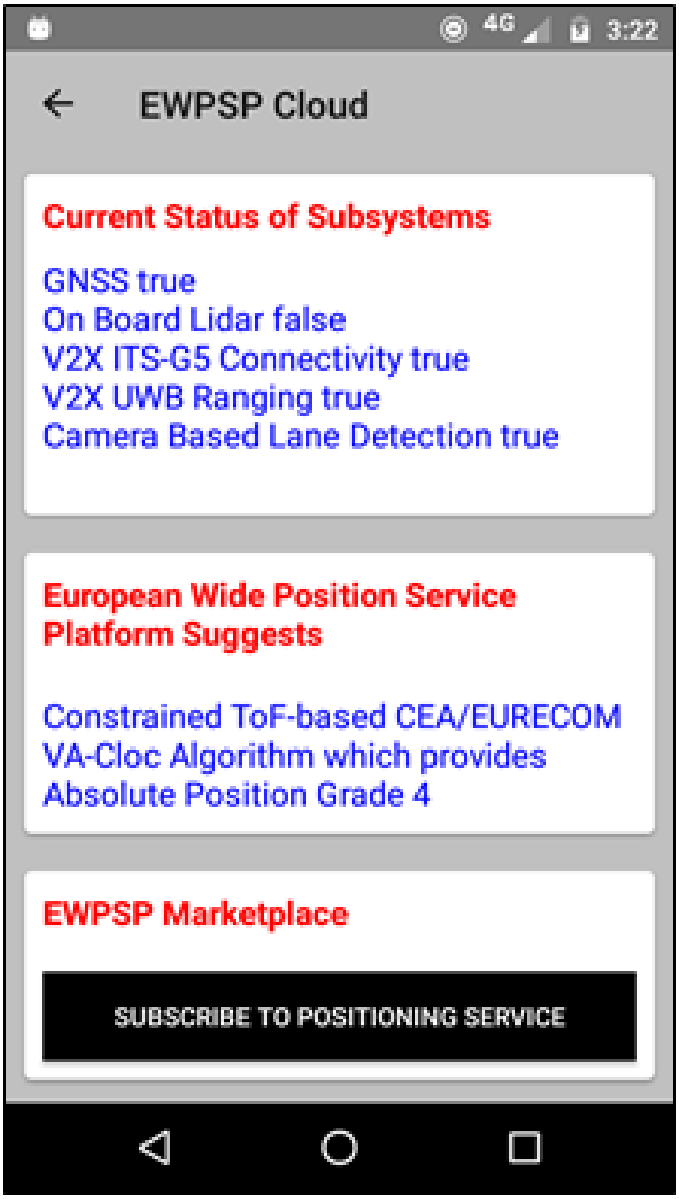

Fig. 3. Positioning service prototyping and experimentation.

III. Conclusion

The demonstration showcases the applicability of EURECOM IoT Platform for assisting future autonomous vehicles in determining the best positioning algorithm depending on available context. The Cloud based secure positioning web service implements a decision tree which translates the available subsystems into a suitable positioning algorithm. It can also be downloaded from the platform.

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[2]https://www.youtube.com/watch?v=26WYk6uNJ34

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