Development of the Information Layer for the V2G Framework Implementation

Overview and Problem Statement

The Vehicle-to-grid (*V2G*) concept integrates Battery Vehicles (*BVs*) into the grid as controllable loads and generation/storage devices. As the penetration of BVs deepens, decreased gasoline tax payments resulting from decreased gasoline sales are becoming a matter of concern, since funds to support transportation infrastructure will need to be collected in some other way. (Currently, the Motor Fuel Tax is a major source of funding for transportation infrastructure.) In the last 5–6 years, a concept of mileage-based tax has been developed in an attempt to address that concern. This approach calculates tax by monitoring vehicle road usage through the deployment of GPS data. The security and privacy aspects of the monitored fine-grained location data raise major concerns, particularly for the vehicle owners. Our goal is to effectively address those concerns while providing the ability to collect the data needed to allow the collection of funds for the road transportation infrastructure.

Research Objectives

- Design a secure and privacy-preserving tax collection model for BVs that uses mileage and location of the vehicle for tax computation.
- Compute tax amount for each authority (county, state, federal) based on the miles driven in each region. Tax computation must be auditable in case of a challenge by any affected entity.

Technical Description and Solution Approach

- The solution requires the car to calculate the tax based on its location and forward it to the servers of taxing authorities without revealing the location of the car.
- The computed tax is auditable, but in the process, location data will need to be revealed.
- Approach involves documenting and discussing various requirements of the system.
- We are designing the system in conformance with the requirement specification.
- We are implementing the system on an open-source platform, preferably an automotive platform.
- The information flow in our design is presented in Figure 1.

Selecting Android for Implementation

- Car manufacturers are continually introducing embedded functionalities (e.g., Ford Sync®, Mercedes-Benz's mbrace®) similar to those of smartphones, such as navigation, traffic reports, and health status of the car.
- Many ongoing efforts, such as AUTOSAR, OVERSEE, GENIVI, and AutoLinQ™, provide the automotive platform with API support to run third-party applications.
- OVERSEE will be a secure platform for vehicles, with all the intra-vehicle communication regulated through the firewall.
- Software implementing all the above platforms is available only to the project partners or is proprietary.
- The open-source Android platform provides many key functionalities similar to those of automotive platforms, along with excellent documentation.
- Figure 2 presents various Android apps being developed for the system and the interactions between them.

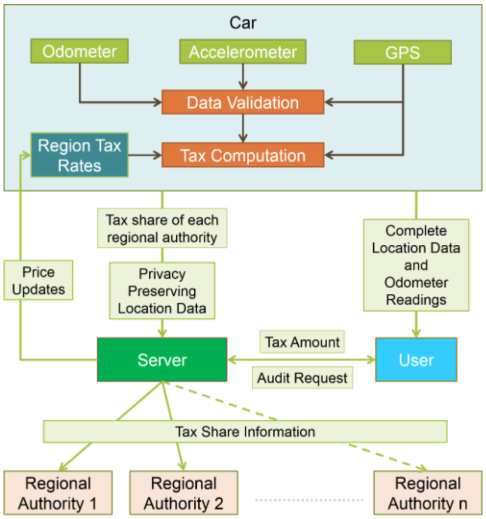

Figure 1. Information Flow

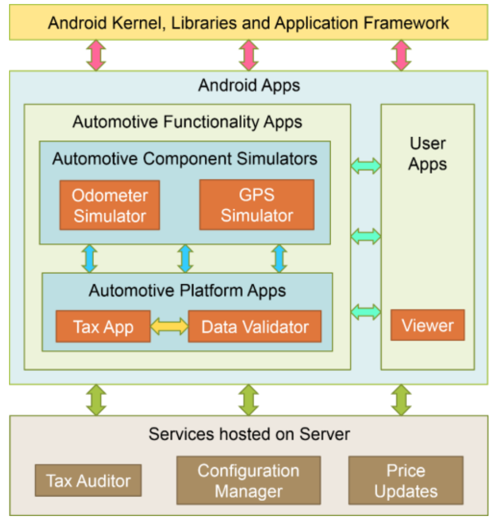

Figure 2. Process Interaction in Android Implementation

Results and Benefits

- The design can also be ported to any automotive platform or smartphone platforms such as iOS, and can be deployed to Pay-As-You-Drive (PAYD) insurance schemes with minor modifications.
- The odometer simulator and GPS simulator can be used to develop other car applications on smartphone platforms.
- **Technology Readiness Level:** In development.

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