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Social Internet of Vehicles: Architecture and enabling technologies☆

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ABSTRACT

The key goal of Internet of Things (IoT) has been the provision of value-added services based on the ubiquitously available smart devices that can offer diverse services by interacting with each other. However, the paradigm has evolved to its next phase, Social Internet of Things (SIoT), with the inception of an idea to empower these devices with consciousness. This cognizance enables these smart devices to socialize with each other based on shared context and mutual interests. The Social Internet of Vehicles (SIoV) applies SIoT concepts in the vehicular domain to revolutionize the existing ITS (Intelligent Transport System) by adding value to existing VANET (Vehicular Ad-hoc Network) technology. This paper presents a scalable SIoV architecture based on Restful web technology. Furthermore, this paper emphasizes the importance of web technology to meet the required interoperability to support the composition of numerous services. The paper also discusses the enabling technologies and protocols.

1. Introduction

VANETs (Vehicular Ad-hoc Networks) have seen impressive progress in recent decades due to escalation of communication technologies. Vehicular networks have leveraged the benefits of various short range and long range wireless technologies for Vehicle to Vehicle (V2V), Vehicle to Infrastructure (V2I) and Vehicle to Sensors (V2S) communication. Employment of Internet in Vehicular Networks has significantly enhanced the opportunities of developing applications for VANETs that seemed far-fetched in the past. Internet of Vehicles (IoV) [1] is hence emerged as an advancement to old-fashioned VANETs. IoV is conceptualized to solve several problems faced in traditional VANETs, such as, lack of coordination between disparate vehicles that are travelling at a distance from each other, scalability, ubiquity and information insufficiency, etc. In IoVs, each entity of the network can connect to the Internet. All time Internet connectivity brings the luxury of sharing information between different components of IoV network, e.g., Road Side Units (RSUs), vehicles, pedestrians, driver and passengers, etc. Besides information sharing, Internet connectivity provides the flexibility of widening the scale of the network.

Social Internet of Vehicle (SIoV) is the modern trend towards IoV [2]. In SIoV, entities socialize with each other by sharing information of common interests such as traffic information, weather conditions, road situations, toll gates, vacant car parking slots and media sharing, etc. Socializing in SIoV is not limited to vehicles only, as the network can include drivers, passengers and infrastructure as well. The sharing of information in SIoV depends on several factors such as context, connection type, network

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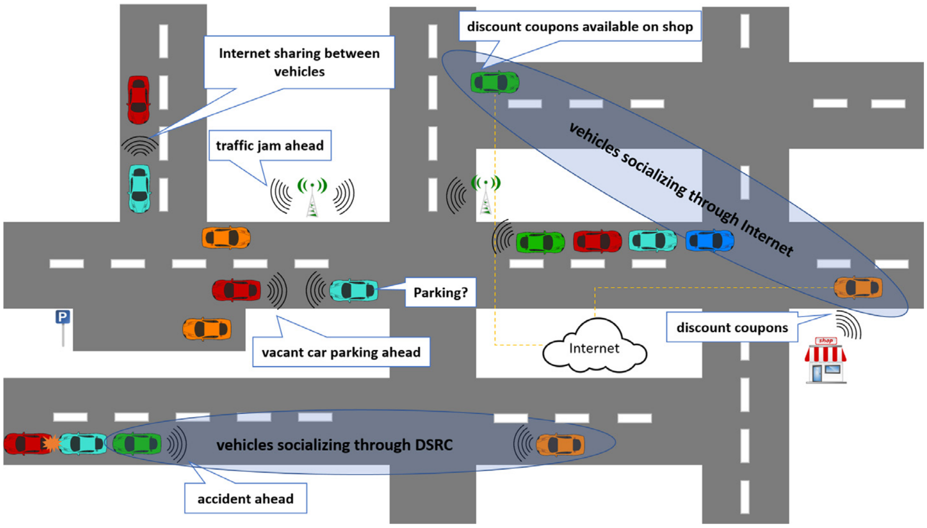

Fig. 1. Traditional SIoV model.

structure, nature of application and environment. A SIoV system initiates at the manufacturing site of the vehicle. Once a vehicle is manufactured, it is equipped with sensors that can talk to the manufacturer for various operations such as maintenance and recovery. Subsequently, in SIoV, a vehicle maintains a social relationship list of other vehicles and talks to the owner through On-Board Unit (OBU) installed in the vehicle for sending and receiving information like navigation, etc. While on the road, a vehicle can communicate with other vehicles, infrastructures (RSUs) and pedestrians. Fig. 1 illustrates the traditional SIoV model.

A key aspect of SIoV systems for socializing among its entities is centrality. It assists in providing a measure for finding entities that play a pivot role for a group of vehicles and facilitates efficient information dissemination by enabling the entities to act as a relay node. Clustering also plays a key role in socializing of entities in SIoV by categorizing vehicles based on parameters like interests of the vehicles, distance, speed and location. One of the major advantages of clustering is circumventing the broadcast storming problems along with assistance in increasing throughput and improving bit error rate.

One of the core objectives of SIoV is to focus on enabling the social relationships among various entities of the system. Mostly, these relationships are built on the context considering the mutual interests of the entities. For example, the transportation aspect of smart cities can be further enriched with the SIoV features by collecting real-time data from the connected vehicles based on their social relationships and taking smart decisions through intelligent analytics.

Nature of SIoV systems poses several challenges like dynamicity, interoperability, security, privacy, trust management, uncertainty, dependability, managing social relationship and heterogeneity, etc. Besides, these challenges, SIoV lacks a standard architecture. Recently, there has been efforts to develop a general architecture of IoV, however, a comprehensive understanding of SIoV architecture is still missing in the literature. This article is an effort towards proposing a general architecture of SIoV. The main contributions of this article are:

- Propose a scalable SIoV architecture based on Restful web technology to provide a foundation for developing SIoV applications.
- Emphasize on the importance of web technology to meet the required interoperability for supporting the composition of diverse services.
- Highlight the enabling technologies and protocols for SIoV systems.

The article's organization is presented in Fig. 2. Section 2 reviews the related work conducted in the field of SIoV architecture. Section 3 discusses the challenges involved in designing the SIoV architecture. Section 4 proposes a scalable SIoV architecture based on Restful web technology along with enabling technologies and discusses the service management for seamless integration of information provided by different entities of SIoV systems. Section 5 presents the use cases based on the proposed architecture to analyze its viability. Finally, Section 6 discusses the future research challenges, and paper is concluded in Section 7.

2. Related work

SIoV has the potential to enable new effective applications such as traffic safety, real-time control, and infotainment. Moreover, it allows businesses to benefit from the new paradigm by offering value-added services. The SIoV architecture requires addressing various issues such as heterogeneous devices and communication protocols in various domains, privacy, scalability and dependability.

The literature mostly addressed the general IoT requirements while defining the architecture [3,4] and few are focused on bringing web services based architecture to address the interoperability issue [5]. There are few efforts that focus on bringing the

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