Project Design Phase – I

Proposed Solution

Team ID	NM2023TMID04427
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Abstract

The concept of smart cities has become prominent in modern metropolises due to the emergence of embedded and connected smart devices, systems, and technologies. They have enabled the connection of every “thing” to the Internet. Therefore, in the upcoming era of the Internet of Things, the Internet of Vehicles (IoV) will play a crucial role in newly developed smart cities. The IoV has the potential to solve various traffic and road safety problems effectively in order to prevent fatal crashes. However, a particular challenge in the IoV, especially in Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communications, is to ensure fast, secure transmission and accurate recording of the data. In order to overcome these challenges,

Introduction

The IoT is transforming conventional vehicular ad-hoc networks (VANETs) into the Internet of Vehicles (IoV) [2]. The IoV represents the real time data interaction between vehicles and between vehicles and infrastructures through smart terminal devices, vehicle navigation systems, mobile communication technology and information platforms that allow information interaction and share driving instructions, and control the network system.

- Centralization: At the moment, smart vehicle architectures are based on centralized, brokered communication models [4]. More precisely, central cloud servers identify, authenticate, authorize, and connect all the vehicles. Nevertheless, it is not likely that this model will be scaled. The failure of cloud servers can endanger the whole network.

- Lack of Privacy: Typically, user privacy is not protected in the current communication architectures. In other words, data pertaining to the vehicle is exchanged without the owner’s permission. Moreover, noisy or summarized data is revealed to the requester.

- Heterogeneity: The use of connecting devices in IoV is highly variable, as they are deployed by different entities, authorities, and individuals. Moreover, their resolutions, functionalities, and operating conditions differ from each other. Hence, it is challenging to enable the smooth integration of numerous devices at the same time. In particular, merging such devices in a complex network increases the degree of complexity.

- Scalability: A use of miniaturized devices such as actuators and sensors has been increasing due to the prompt rise in embedded technologies. Simultaneously, the data created by such devices is growing indefinitely. Thus, another significant challenge related to the IoV is to manage the number of devices and the data they create.

- Interoperability: Both human and non-human objects represent actors in the IoV ecosystem. Each actor, depending on the environment and the particular situation, can play several roles, such as service providers, data consumer, data provider, and available resource in IoV applications. To materialize the vision of the IoV, it is essential to ensure the smooth interaction of all the actors. If each actor is managed in a different way, their interaction magnifies.

- Mobility: The challenges in terms of mobility are related to protocol efficiency and the IoT network. Currently, the use of sensor networks, Mobile Ad Hoc Networks (MANETs), and mobility protocols of Vehicular Ad Hoc Networks (VANETs) are not adequately equipped to handle standard IoT device because of considerable processing and energy constraints. Moreover, efficient real-time authentication is required instead of the one-time initial configuration considering that the vehicle must continuously authenticate other vehicles present on the roads.

- Safety Threats: The number of autonomous driving functions in smart vehicles keeps growing. Consequently, a security breach that occurs occurred by a malfunction resulting from the installation of malicious software can lead to car crashes and endanger road users.

Blockchain Technique And Ethereum

Bitcoin, a decentralized global currency cryptosystem, was introduced in 2008 by Satoshi Nakamoto [15], based on the Blockchain technology. In Bitcoin, Blockchain is used to ensure secure exchange of digital money for goods and services without a central authority through a trusted peer-to-peer network in a pseudo-anonymous way. Blockchain or public ledger contains a record of all transactions, accessible by all participants in the network, as they are publicly announced.

Proposed Solution

System Overview

The purpose of this paper is to present an IoV solution with Real-Time Application (RTA). This solution provides secure communication between vehicles and other actors in transportation systems. It attempts to overcome limitations such as execution time and accordingly, improves performance. A prototype of DISV was developed and tested it based on the following scenario: if a driver is drowsy, the nearest cars should be alerted by sending a message via Blockchain. Since it is based on an IoT architecture, the proposed solution should contain mainly three layers; the perception, the network, and the application layers, as illustrated in Table 2 and described below:

Table 2. The main features of the developed IoT solution.

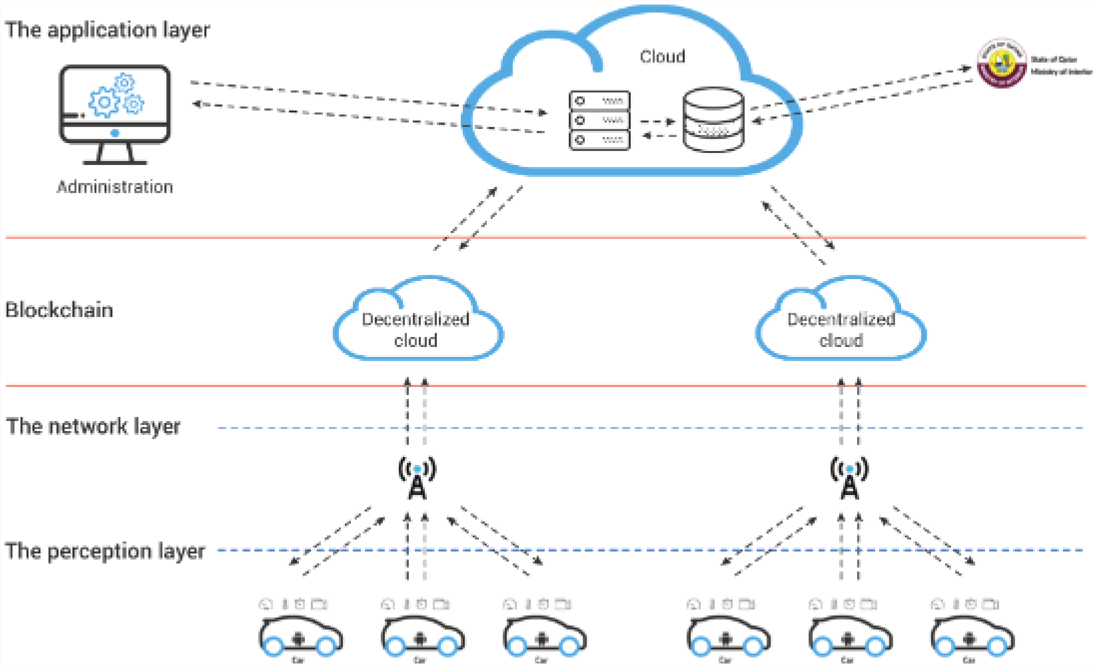
Layers	Developed Solution	Main Features
Perception layer	Android Application for Vehicles (AV)	Collects and analyze data about the trip, the vehicle, and the driver's behavior.
	Android Application for Infrastructure (AP)	Simulate the role of IoT devices integrated into the roads such as radars, traffic lights, roadside electronic signs and other.
Network layer		Connects the sensors to other servers, networks devices and smart things.
Application layer	Blockchain Application	Managing communication between vehicles and other actors in the transportation system.
	Central Cloud Server	Processes and analysis obtained data Manages invitations of the of other actors.

1. The perception layer is the physical layer. It consists of several IoT devices equipped with sensors designed to identify and collect information about the environment (i.e., physical parameters) and to detect nearby smart objects. The Android Application for Vehicles (AV) embedded into the perception layer collects and analyze data about the trip, the vehicle, and the driver's behavior. Android Application for Infrastructure (AP) simulates the role of IoT devices

integrated into the roads such as radars, traffic lights, roadside electronic signs and others.

2. The network layer connects the sensors to other servers, network devices, and smart things, and also transmits and processes sensor data.
3. The application layer consists of Blockchain application and Central Cloud Server. It delivers application-specific services to the IoT devices. More precisely, the Blockchain application manages communication between vehicles and other actors in the transportation system. The Central Cloud Server is in charge of processing and analyzing the obtained data and managing invitations of other actors.

Figure 1. The architecture of the proposed Internet of Things solution.



The Perception Layer

In order to test possible scenarios involving various components, an Android applications has been developed in the Android Application for Vehicles (AV) and for infrastructure (AP) as detailed in the following sections.

Android Application for Vehicles (AV)

1. VDCS is designed to collect information about the car, such as the car model and characteristics of the motor including horsepower, speed and engine size. Finally, the system collects the data related to the trip such as start and end time, distance, and minimum, maximum, and average speed as illustrated in **Figure 2**. It is set to detect measures such as rotational velocity along the Roll, Pitch and Yaw axes; acceleration; distance; and GPS position every 15 s.
2. The purpose of Driver Drowsiness Detection is to detect driver's drowsiness and prevent potential accidents it might cause. This system is an element of

the Advanced Driver Assistance System (ADAS), which is an integral part of contemporary automotive technology. The role of ADAS is to improve safety and ensure the satisfying driving experience. This system was developed on the basis of Real-Time Driver Drowsiness Detection using Deep Neural Networks techniques. More details about this system can be found in [45,46,47] .