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Control of Vehicular Traffic through the IoV

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Abstract

There are many strategies that man has used to control vehicular traffic in medium and large cities, one of these strategies is the nascent technology of Ad Hoc Vehicle Networks, known as VANET with the Internet interaction of Things, Giving rise to a new technological paradigm called Internet of Vehicles (IoV - Internet of vehicles) that allow between giving greater security in the roads, protection of the environment, and even the conservation of energy.
The article will present a concrete definition on IoV, as well as a review of implementations made with this new technology or projects that are close to it. Finally will make a proposal of control of vehicular traffic by means of IoV.

Keywords: IoV, Protocols, VANET, Vehicle Traffic

1 Introduction

Throughout history it has been shown that the evolution of society is strongly linked to the way in which it is mobilized. The invention of the wheel can be considered as one of the most important creations of man, since it gave way to the

success of different civilizations and revolutions (such as the Industrial Revolution) and at present it is a fundamental piece of different types of land transport, both public and private, including air transport.
Nowadays, men move motor vehicles, motorcycles and even bicycles. But the accelerated growth of the number of cars in the large and medium cities has led to the formation of vehicular congestion on the main roads and highways or the collapse of these; Seeming a problem of not having a solution beyond restricting the use of the private car or motivate to use public transport or alternative means such as bicycles. A solution related to new technologies to solve this problem is the VANET, which is a type of communication network that uses vehicles as network nodes, where vehicles have more and better information about traffic conditions, and can access services and data that improve travel comfort for passengers. In addition, currently we are working on a new technological paradigm called Internet of Vehicle (IoV) and in Spanish Internet of vehicles.
This document will expose generalities about the Internet of Vehicle, such as its definition, its components, its impact and evolution from the VANET. The rest of the article is broken down as follows: definition and general characteristics in the second section. In the third section the different implementations of IoV, advantages and disadvantages will be treated. Moreover, in the fourth section you will see the objectives or achievements that have been achieved.

2 Background

It is estimated that by the year 2020 there will be 25 billion "things" connected to the Internet, where vehicles constitute a considerable portion, and because of this increase in vehicles connected to the Internet, VANETs are changing to Internet of Vehicles (IoV). In VANET each participating vehicle is converted into a wireless router or mobile node, allowing vehicles to connect with each other and, in turn, create a network with a wide range. Then, when vehicles fall out of range of the signal and leave the network, other vehicles can join, connecting vehicles together to create a mobile Internet. It has been determined that VANET only covers a very small mobile network that is subject to mobility restrictions and the number of connected vehicles. Several characteristics of large cities, such as high traffic on highways, tall buildings, bad behavior of drivers and complex road networks, make it even more difficult to use. Therefore, for VANET, the objects involved are temporary, random and unstable, and the range of use is local and discrete, that is, VANET can not provide complete and sustainable services / applications for clients. In recent decades, there has been no classical or popular implementation of VANET. The desired commercial interests have not emerged either. Therefore, the use of VANET has begun to stagnate.
In contrast to VANET, IoV has two main technological directions: "network" vehicles and "smart" vehicles. The vehicle network consists of VANET (also called vehicle interconnection), telematic vehicle (also called connected vehicles) and Mobile Internet (the vehicle is like a mobile terminal with wheels).

Therefore, IoV focuses on the intelligent integration of human beings, vehicles, things and environments and is a larger network that provides services for large cities or even a country. IoV is an open and integrated network system with high management capacity, controllability, operationalization and credibility and is composed of multiple users, multiple vehicles, multiple things and multiple networks. On the basis of cooperation between computing and communication, for example, collaborative awareness of human beings and vehicles, or swarm intelligence computing and cognition, IoV can obtain, manage and calculate the complex and dynamic large-scale data of human beings, vehicles, things and environments to improve the pre-processing, extensibility and sustainability of complex systems of networks and information services.

3 The IoV technology

IoV technology refers to dynamic mobile communication systems that communicate between vehicles and public networks using: * V2V (vehicle to vehicle), V2R (vehicle to road), * V2H (vehicle to human) and * V2S (vehicle to sensor). It allows the exchange of information and the collection of information about vehicles, roads and their surroundings. In addition, it offers the processing, exchange and secure release of information on information platforms. Based on this data, the system can effectively guide and monitor vehicles, and provide abundant multimedia application and mobile Internet services. [1]
This seen from the perspective of the network, an IoV system is a three-tier system "Client-Connection-Cloud".
-*Customer system:* The client system is an intelligent sensor of the vehicle, which gathers vehicular intelligence and detects the driving state and the environment. A ubiquitous communications terminal offers intra-vehicle, inter-vehicle and vehicle-network communications. In addition, a device allows IoV addressing and the achievement of a trustworthy vehicular identity in cyberspace. [2]
-*Connection system:* This layer is directed to the interconnection V2V, V2R, V2H and V2I (vehicle to Internet) to perform communication and roaming between ad hoc vehicular networks (VANET) and other heterogeneous networks. It guarantees the ubiquity of the network in real time in terms of functionality and performance. It is also a fusion of public and private networks. [2]

4 Some implementations

Although the Internet of vehicles is a new technology, you can find different jobs and implemented implementations:
In [3], the authors propose a system to ensure the safety of drivers while driving, in which they can detect in real time the dangerous driving behavior and give advice, at the same time, the information of improper driving will be, widely analyzed and more suggestions will be given in the control center in order to help drivers improve their driving habits; using technology on the Internet of vehicles to request risk infor-

mation from other vehicles and to help the driver to take preventative measures in advance.

In [4], they mention that the current and main Internet applications of vehicles are to collect information on the status of the vehicle, value-added service to the customer. Moreover, that current safety systems are activated based on sensors in the vehicle could not give more previous warnings about potential hazards on the road, or could simply do an active safety action based on the detection of hazards around vehicles at close range. Therefore, they propose an integration proposal includes wireless communication solutions, transmission and distribution standards, and related infrastructure requirements. This integration system based on Internet of vehicles and active security system having a broad application perspective.

In [5], they designed a device called Smart-Eye, with which they provide a solution to accident prevention, with the exchange of video and information between vehicles and secure cloud networks. In case of accident, the video of the accident can be shared instantly between the other vehicles so they can take a detour, avoid successive collisions, and share the information contained in the video of the vehicle accident along with the location to the interested party, authorities and relatives. In [6], they affirm that the paradigm of connected vehicles goes from research to implementation, thus allowing new applications that start from the improvement of security and extend to the so-called Internet of vehicles (IoV). Enabling technologies enabled in the radio frequency (RF) bands are cellular and short-range technologies, but the limited shared bandwidth between several applications encourages researchers to look for new technological solutions. In [7], they claim that the delivery of content is a key functionality for the development of vehicle Internet but the task of delivering content in such a dynamic network is far from trivial. In [8], they affirm that the paradigm of connected vehicles goes from research to implementation, thus allowing new applications that start from improving security and expand to the so-called Internet of vehicles (IoV). The technologies enabled in the radiofrequency (RF) bands are cellular and short-range technologies, but the limited shared bandwidth between several applications encourages researchers to look for new technological solutions. Therefore, they propose the adoption of VLC (visible light communication) as complementary technology to RF for the exchange of data between vehicles and between vehicles and RSUs in vehicular networks in cooperation with DSRC and cellular communications to increase the global resources available for the future IoV. In addition, in [9], the authors agree along that mentioned in this article, highlighting that vehicular congestion occurs more frequently in urban areas and that of the solutions that exist, a large number of these is useful for after the congestion.

The authors in [10] affirm that the new era of Internet of Things is driving the evolution of VANETS Networks in the Internet of Vehicles, where a variety of applications, such as road safety, traffic efficiency, assistance driver, among others are part of the benefits. In addition, that in 3GGP vehicular communications assisted by LTE, the dissemination of information within IoV can be more reliable and efficient, thus allowing some critical security applications. From work in [11]

they state that devices are becoming ubiquitous and interconnected due to the rapid advances in computing and new technologies. And that the Internet of Vehicles (IoV) is an example that consists of vehicles that converse with each other, as well as with public networks through V2V (vehicle to vehicle), V2P (vehicle to pedestrian) and V2I (vehicle- A -infrastructure). Therefore, they developed a social network called Social Internet of Vehicles (SIoV).

5 Discussion of results

The results obtained by the different authors in their proposals do not stop being interesting, being the work of Lazar & Stefan [6], the one that tries to work in the present and in the future of the IoV in the area of control by means of the integration of SDN and / or SDN plus Fog Computing, mitigating latency (serious problem for security applications in real time) and helping to scale for a large, wide and very dense network. The general idea of the project is to have a database initially with information that is acquired through an observational study, highlighting the hours of maximum pedestrian influence. For example, the district schools are governed and supervised by the Secretaria Distrital de Educación de Bogotá (SDE), they could report to the Secretaria de Educación the days when the school day will be reduced, extended or canceled, and this in turn will be the project's database. In Bogotá, events that generate massive conglomerations must, among other things, file a permit with the Fondo de Prevención y Atención de Emergencias (FOPAE). In addition to the database, it is necessary to use sensors in traffic signals near the aforementioned places and in the main communication routes that could lead to a route close to these places. In places with high pedestrian density, the sensors will be installed in the signals such as STOP, Reduce your speed, School Zone, Sports Scenario, Traffic Light Announcer and in traffic lights, whose function is to corroborate that in the area there is a high influx of pedestrians and send a signal (specific message in video or text) to the traffic lights of the communication routes and to the vehicles that are approaching and will also alert the drivers on a special type of pedestrian on the road to drive with greater caution. In Figure 1, a special audience can be seen: blind people who are close to the facilities of the National Institute for the Blind of Colombia (INCI), in the city of Bogotá many traffic lights have a sound announcer that was designed to alert the blind when the light is red or green and they can make the decision to move forward or not.

Fig. 1. Special pedestrians crossing a street. Source: Authors

In Figure 2, we see a school that is possibly at the end of school, so it would increase the number of pedestrians on the road, school routes and motor vehicles picking up students. In most of the Educational Institutions of the city, in the hour of entry and exit a chaos of mobility is formed because everyone wants to arrive first and leave first. In the Figure 4, the STOP signal is alerting its neighboring signals and / or traffic lights of the access area, that one of those two moments is being lived, so that the vehicles are alerted with the presence of a high flow of students in the road and travel with caution or take an alternative route or if you must access the institution choose an appropriate time to arrive and not be part of the traffic congestion.

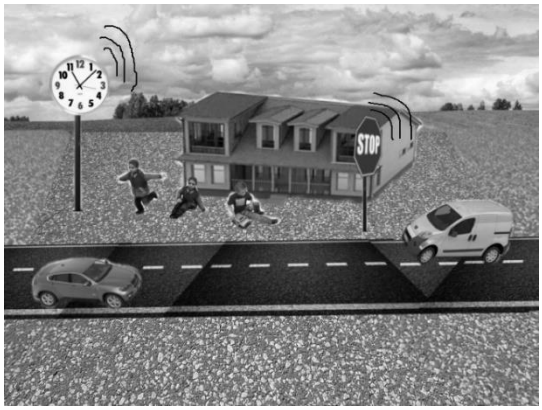

Fig. 2. School in rush hour Source: Authors

In Figure 3, there is a park with a high influx of people and animals at the time of rest, leisure or recreation, the traffic signs that are in the park or near the park will verify the presence of a high number of users and will alert the drivers of this situation so that when they are close to the park, they move in moderation or take an alternative route and avoid passing through the area. The vehicular traffic is a problem that can be attacked from different points with the integration of each of these to arrive at an effective solution, for that reason it was proposed to work from the point of the pedestrian by means of alerts and notifications to the drivers.

Fig. 3. Park with high influx of people and animals. Source: Authors

6 Conclusions

It is a reality that large and medium-sized cities often have problems with vehicular congestion and with the use of new technology tools, a solution to this problem is provided, which is why IoT-related devices and networks VANET and in space with IoV allowed to give a reduction of vehicular traffic in specific places such as the place of a car accident, such is the case of the Smart-Eye application where drivers of vehicles have at their hand information (video) in real time and successive of an accident and with this they can make the decision to take an alternative route or wait parked somewhere before arriving at the accident site.
The vehicular traffic is not only a matter of vehicles, drivers and roads, so it was decided to propose a solution where the protagonist the pedestrian that helps drivers to make better decisions when taking a certain life and / or protect and collaborate with special audiences, in this way the vehicular traffic would be reduced because traffic accidents are being avoided with the public of special need or with the vehicles that identify it and give way; as also avoiding routes with pedestrian conglomerations or if they must arrive at the conglomeration site to be able to choose an appropriate moment.

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