International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 8 (2018) pp. 6244-6247

Cloud Computing for Vehicular Communication Support

Abdullah Saleh Al-Saleh[1, 2]

[1] *Department of Information Engineeting, Florence University, Florence, Italy,*
[2] *Department of Computer Science, Majmaah University, Majmaah, Saudi Arabia.*

Abstract

Although connectivity services have already been incorporated in most recent car models, the benefits of a car as a highly mobile sensor platform in the internet of things (IoT) have not been fully realized. The European AutoMat project has defined the open Common Vehicle Information Model and added a cloud-based big data marketplace. The vehicle sensor data can be used for the design of entirely new services—some even beyond traffic-related applications. This paper aims to provide an in-depth analysis of integrated vehicle traffic simulators using several models. It uses the large-area street network in combination with a cellular Long-Term Evolution (LTE), which determines the cumulative amount of data produced within each network cell.

Keywords: cloud computing; fog computing; internet of things; vehicular cloud computing; vehicular communication

INTRODUCTION

Modern vehicles are being manufactured with a sharply increasing number of sophisticated sensors, which makes them extremely appropriate to be used as mobile sensor platforms in the internet of things (IoT). The use of vehicle data for non-automotive applications is not widespread as quality of service is not efficiently guaranteed. The main aim of this paper is to predict the achievable data rate in car-to-cloud vehicle sensor networks. This achievement provides the fulfillment of the application requirements, which can be assessed in a situation-aware manner.

Cloud computing is new and developed computing model that uses physical computing resources called data centers. It is defined as the delivery of computing services over the internet, mostly the cloud. Cloud computing uses virtualization, through which physical resources can be imprinted into intellectual and virtual properties as the need arises. At times, it uses cloudlets, which are small-scale data centers that are designed to provide cloud computing services; they can use mobile devices within a close geographical location. For the desired degree of latency, performance, reliability, and security for any application that runs using the cloud, a new technology was recently proposed called fog computing.

Vehicular network communication systems are networks that vehicles can use to interact with other roadside units. The use of both the cloud computing system and the vehicular system allows for reduced delays, efficiency, scalability, reliability, and security, which improve safety on the roads and the comfort of passengers through the intelligent transportation system (ITS). Vehicles have recently started to come equipped with extremely intelligent and classy systems that serve as real-time security applications. This research paper focuses on the different elements of cloud computing in the coordination of communication with either a single vehicle or group of cars.

Recently developed applications in software, hardware, and communication technologies have been encouraging the implementation of different types of network usage in various environments; to support all this implementation, a model known as VANET-Cloud has been suggested. The model extends the traditional cloud infrastructure, including the majority of stationary nodes, to the edge of the vehicles. Communication networks in vehicular systems, such as VANET, have specific properties, for example, high-speed and dynamic topology. Recently, vehicle manufacturers have made an effort to realize potential services to both passengers and drivers, thus making sure they are safe and comfortable. VANET enables the development of several vehicular applications, such as communication. VANET is a subsection of a mobile network that establishes a wireless communication system within the automobiles. The short-range communication system supports vehicular infrastructures. Essential features of this infrastructure may include Infrastructure as a Service, Platform as a Service, and Software as a Service.

The emerging communication technologies allow for information and resource distribution among vehicles. Several automobile resources can be unified and constructed over the cloudlet VANET. Cars can have access to these assets. Thus, vehicular data can be sensed, analyzed, accumulated, and transferred using cloud computing, which is known as vehicular cloud computing (VCC). VCC allows the users who have the authorization to dynamically access the resources of a group of coordinated vehicles. The resources mentioned are calculating, storage, distinguishing, and the internet. Countries have an ongoing implementation or are planning to summarize these characteristics to help their automotive firms.

Car-to-cloud traffic data use the brand-independent Common Vehicle Information Model. The model has been developed in the European Union's Horizon 2020 AutoMat project. Its goal is to harmonize and standardize in-vehicle sensor measurements for car-to-cloud traffic data. The model has been applied to a vehicle traffic simulator, which can efficiently produce data streams as the result of the individual behavior of each vehicle. The communication model uses LTE technology to create a realistic imitation of a large mobile network provider. The result quantifies the available data rate for car-to-cloud communication, and its evaluation provides a reference for network planning and resource scheduling for car-to-cloud services.

RELATED WORK

The increasing transportation of people and property comes at high costs, for example, traffic overcrowding, mortalities, and injuries. Recently, efforts have been made to alleviate these problems. At the same time, vehicles have numerous onboard controls and data foundations that allow the driver to have an experience and remain up to date [1]. Recent technological developments, mostly in mobile computing, wireless communication, and remote settings, are now on the rise in intelligent transport systems. Vehicles already have sophisticated computing systems that have several computer parts, such as on-board sensors, each dedicated to a specific portion of the driving process.

Cloud computing has been researched a lot over the past few decades, for on-road security and driver comfortability purposes; however, on-board computation, communication, and data loading are some of the concerns for several real-time safety uses. Marston *et al.* studied the transference of data into the cloud for analysis [2]. Cloud computing services have had an increase in support due to their unusual features such as real-time calculation and computer-generated data storage. Tonguz and Boban claim that vehicular data can be administered and information can be distributed among vehicles, thus allowing the control of traffic flow [3].

Kundra claims that cloud computing occurred as a disrupting technology, as it provided a lucrative substitute to old, in-house data technology solutions vehicles can use [4]. In VANET, vehicle-to-vehicle communication is performed through the exchange of safety and navigation messages, enabling the sharing of road traffic statuses, thoroughfare conditions, and data-related occurrences on the road, according to Schoch *et al.* [5]. The main advantage of cloud computing is that there is a small cost of entry for computing exhaustive commercial analytics, increased scalability, and the ability to support new and innovative applications that may not have been possible in older IT settings. Because of the ample storage, processing, and message properties of smart vehicles, a future with cars that use the cloud has attracted many investors and investigators in the past few years, according to Olariu *et al.* [6].

The vehicular network provides a communication substructure for traffic flow organization applications. Emerging technologies, such as cloud computing, have laid the background for the progression of the new format and shifted the entire expansion paradigm [7]. One of the most common techniques is connection management. Traffic information aggregation is a beneficial system for reducing vehicle-to-vehicle infrastructure bandwidth and resolving scalability issues. Appropriate analytical methods should be adopted in interactions to minimize duplicate data. Aggregation is a beneficial method [8]; however, the most suitable method for vehicle-to-vehicle schemes must detect overcrowding without the assistance of any road traffic authorities.

The assimilated architecture of cloud computing and VANET is a comprehensive scheme for real-time performance, intricate computing, and abundant storage [9]. The cloud computing architecture may include Software as a Service, Platform as a Service, and Infrastructure as a Service features. The structure has many possible uses, including simultaneous computing, mobile storage, and secluded data access. These services solve problems in VANET, which is able to account for the varying and strong network mobility and the changing paths of vehicles [10].

Whaiduzzaman *et al.* compared the advances in vehicular technology and provided resources such as fixed storage, better computing power, cognitive radios, and programmable sensor nodes [11]. Wireless sensor networks enhance communication and improve the driving safety and traffic efficiency. The arrival of cloudlets in vehicles combines the innovation and elements of the internet, which are beneficial for enhancing social impacts. The collection, dissemination, and multi-hop forwarding of vehicle data with LTE for car-to-car analysis regarding efficiency and packet loss were performed by Gerla and Kleinrock [12].

The internet and social networks within automobiles connect them to the world, thus making driving safer and increasing comfort. According to Zeadally *et al.*, VANET is an unscrupulous network as it moves out of the way of other networks' access and communication [13]. The computing and storage properties of the vehicles are quickly assessible by the network users to make them easy to use. The interaction of cars with infrastructure helps with expedient data sorting, using, for instance, sensors in the vehicles. The data are then directed to a common depository of the vehicle for low-degree statistics processing. Later, the use of a program design interface rotates these data to other associated hardware, thus generating alarms or cautions regarding the dangers associated with them. Dinh *et al.* proposed a new security provisioning model, known as a vehicle-to-cloud interaction, that has fewer security threat issues [14]. The flooding of in-routes using the previously researched system was the most common issue, causing delays, wasting bandwidth, increasing network congestion, and, in the long run, causing bad performance between sources and destinations.

PROPOSED WORK

The main aim of this research is to identify ways that cloud computing coordinates with vehicular systems. The methodology is to use a new algorithm for simulations that will help in the development of a first-level prototype and tests in an actual vehicle. Most of the vehicular communication will be on lane change speed, crash avoidance, video or photo surveillance, accident detection, time of arrival based on localization, and broadcasting emergency messages. The algorithm enables lane change speed, vehicle recognition, accident recognition, automatic braking, video/photo reconnaissance, vehicle locating, localization, and smart road traffic observations. The algorithm has three portions grounded on the stage and the applications. The first component of the system acts as the localization and the unidentified automobile locating application. The second manages the lane conversion, automobile and accident discovery, camera instigation, emergency message transmission, and spontaneous braking applications. The third portion provides a transitory scheme for the smart applications that complete the traffic checking system.

Moreover, a unified system is being built in today's practice, and each system collects data and processes it on its own. The EU's Horizon 2020 Automat project is one of the projects that is developing a holistic solution of one of the problems in the fragmentation of the marketplace. The standard vehicle information model of the project is to create a vehicle data service, mostly in the non-automotive industry. The market for such a service requires the combination of preselected data without knowing its intended use. The data should be measured with the highest quality possible while in a fixed environment. The restriction is that the environment has limited computing power, communication bandwidth, and data storage capacity. All this leads to the need for a car-to-cloud communication system model [15].

The simulation architecture has been comprehensively described. There are several ways in which the simulations are achievable. The first way is by using street and mobile environmental modeling; this method is based on the OpenStreetMap project. The project map of a specific place is imported and used as a roadmap for the mobility stimulation step. The area must have both high and low speed limits. Moreover, the different traffic states must be in use, for instance, for traffic jams and even for low-traffic driving. It also provides the base stations that serve as inputs for the communication model.

The second method is the car-to-cloud communication model. The data are uploaded to the vehicle through LTE. The signal quality is first calculated using the Winner-2 B1 urban micro-cell path loss model, which depends on the distance of the car to the LTE base station, the power of transmission, noise power, and both the figure and antenna gain of the LTE user equipment and LTE base station.

RESULTS AND DISCUSSION

This section discusses the deliverability of the recommended framework and the algorithms with the different simulations. Nodes are the start and end points of segments. If a car in the top lane is stuck and requires help, it broadcasts messages at regular intervals. The vehicle in the bottom lane is a reference vehicle that approaches the range of the transmission message; it begins to approximate the location of the unknown vehicle with the assistance of the algorithm. On the highway, the cars can alter lanes by either increasing or decreasing speed following the least gap criteria. The speed limit in lane 1 is the highest, followed by lanes two and then three. The results of this simulation rely on the assumption that the network operator provides his total capacity regarding radio bandwidth. Most of the network operators spend only a limited amount of radio bandwidth on car-to-cloud communication. Conversely, the data rate is significantly reduced; the proportion of low-traffic states to traffic jams stays equal because of the features of the Round Robin scheduler, which scales linearly with the amount of radio bandwidth earmarked for car-to-cloud communication. The model always provides the amount of radio bandwidth it needs when the car manufacturers require a guaranteed data rate for their car-to-cloud service.

Analyses of the car-to-cloud data traffic are performed. The mean data rate in the low-traffic scenario is 482.1 kbs, and it is seven times higher than the 69.9 kbs in the traffic jam scenarios. For low traffic, the density of vehicles is much lower, and therefore, cars move faster and there is a more significant gap between two successive cars. Thus, the number of vehicles per cell is more moderate, and each vehicle is assigned more resources by the LTE cell. The roads in the traffic jam scenario are crowded by cars. Hence, they have short gaps between them, and the vehicle density per path segment is high. In the case of low traffic, multimedia data such as photos from in-vehicle cameras are also transferable. Vehicle sensor data are aggregated in one-second intervals into individual data packages per vehicle. Only LTE cells with cars passing through the cells are taken into consideration. The vehicle sensor incorporating the one-second intervals into data packages shows that for low traffic, the number of packages is significantly lower than that in the traffic jams.

The first-level hardware performs speed recognition, lane modification aid, vehicle recognition, and emergency message transmission applications as needed. The first trial basis was meant to prove the location and the lane alteration model by following the smallest gap criteria on two lanes with two different speed limits. The position of the vehicle on the road was quickly verified by matching the speed limits. The second trial was to check emergency messages and the several warning signals to indicate a problem where one of the vehicles was made to stand in the middle of the road. It was noticed that when the other cars came close to the stopped one, the computing system of the moving vehicle produced a cautionary signal, camera instigation signal, electric brake sign, and emergency message signal. The last trial assessed the return of the system when it sensed another barrier on the road. It occurred in the same manner as the previous trial. However, based on experience, the camera instigation signal and electric brake sign were turned on. The structure was operational and very efficient in the generation of warning signs and emergency communications in real time. Cloud computing for coordinating a vehicular interface allows the car to efficaciously achieve track changing, location confirmation, and alert signals, for instance, automatic braking and emergency message transmission.

CONCLUSION

The vehicular communication network and cloudlets have received a lot of research attention over the past few years. The cloud computing system is still under scrutiny due to the benefits and the broad scope of its applications. The proposed method uses car-to-cloud data traffic analysis in which the vehicle is monitored under different traffic conditions. One of them is low traffic, and the other is a full traffic jam. It was realized that the mean rate in the low-traffic scenario is seven times higher than that in the traffic jam scenario. The variations occurred in contrast to the amount of in-vehicle generated per the LTE cell, which was on the rise due to the slower vehicle speed during traffic jams. The simulated practice included data for both the upper and the lower data rates. The results quantify the available data rate for car-to-cloud communication, and this evaluation provides a reference for network planning and resource scheduling for car-to-cloud services. In this study, the proposed work examined intelligent traffic monitoring software while still using cloudlets and mobile applications. The framework and the equipment that are recommended are useful because they can help in the reduction of traffic, accidents, and improper changing of lanes.

FUTURE WORKS AND LIMITATIONS

The assumption was that the road sections are VANET-approved as they have useful roadside units at consistent distance intervals. Nonetheless, it is impossible to have the substructure at these precise intervals, as VANET has pre-designed road construction parameters. These factors create some delay in time in the transmission of emergency message communication and data exchange between vehicles and the cloud server.

Another assumption is that the vehicular cloud network has full security and is resilient to any attack. It is presumed that all the data that were received from the GPS transmitters were dependable. It is a fact that this case cannot be universal. Moreover, the vehicular cloud server is vulnerable to attacks, which can be carried out through data management. Hence, the vehicular cloud network needs to be as secure as possible using smart and well-organized techniques.

One of the future projects is the development of a partial hardware system to design a complete model. The fully functional system should be integrated with the app to apply it in real-time scenarios. The OBU uses battery power, and at times, the battery runs low and does not function as desired. The optimization of power is one of the future projects to be implemented and will make the system more efficient and reliable.

REFERENCES

[1] Papadimitratos, P., De La Fortelle, A., Evenssen, K., Brignolo, R., & Cosenza, S. (2009). Vehicular communication systems: Enabling technologies, applications, and future outlook on intelligent transportation. *IEEE communications magazine*, 47(11).

[2] Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud computing—The business perspective. *Decision support systems*, 51(1), 176-189.

[3] Tonguz, O. K., & Boban, M. (2010). Multiplayer games over vehicular ad hoc networks: A new application. *Ad Hoc Networks*, 8(5), 531-543.

[4] Kundra, V. (2011). Federal cloud computing strategy.

[5] Schoch, E., Kargl, F., & Weber, M. (2008). Communication patterns in VANETs. *IEEE Communications Magazine*, 46(11).

[6] Olariu, S., Hristov, T., & Yan, G. (2013). The next paradigm shift: From vehicular networks to vehicular clouds. *Mobile Ad Hoc Networking: Cutting Edge Directions, Second Edition*, 645-700.

[7] Shroff, G. (2010). *Enterprise cloud computing: technology, architecture, applications*. Cambridge university press.

[8] Liu, C., Wu, K., & Pei, J. (2007). An energy-efficient data collection framework for wireless sensor networks by exploiting spatiotemporal correlation. *IEEE transactions on parallel and distributed systems*, 18(7), 1010-1023.

[9] Hou, X., Li, Y., Chen, M., Wu, D., Jin, D., & Chen, S. (2016). Vehicular fog computing: A viewpoint of vehicles as the infrastructures. *IEEE Transactions on Vehicular Technology*, 65(6), 3860-3873.

[10] Kumar, A., & Bansal, M. (2017, September). A review on VANET security attacks and their countermeasure. In *Signal Processing, Computing and Control (ISPCC)*, 2017, 580-585.

[11] Whaiduzzaman, M., Sookhak, M., Gani, A., & Buyya, R. (2014). A survey on vehicular cloud computing. *Journal of Network and Computer Applications*, 40, 325-344.

[12] Gerla, M., & Kleinrock, L. (2011). Vehicular networks and the future of the mobile internet. *Computer Networks*, 55(2), 457-469.

[13] Zeadally, S., Hunt, R., Chen, Y. S., Irwin, A., & Hassan, A. (2012). Vehicular ad hoc networks (VANETS): status, results, and challenges. *Telecommunication Systems*, 50(4), 217-241.

[14] Dinh, H. T., Lee, C., Niyato, D., & Wang, P. (2013). A survey of mobile cloud computing: architecture, applications, and approaches. *Wireless communications and mobile computing*, 13(18), 1587-1611.

[15] Packward, H. (2010). The Internet of Things: Today and Tomorrow. *Packward Enterprises*, 4-20.