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A survey on vehicular cloud computing

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ABSTRACT

Vehicular networking has become a significant research area due to its specific features and applications such as standardization, efficient traffic management, road safety and infotainment. Vehicles are expected to carry relatively more communication systems, on board computing facilities, storage and increased sensing power. Hence, several technologies have been deployed to maintain and promote Intelligent Transportation Systems (ITS). Recently, a number of solutions were proposed to address the challenges and issues of vehicular networks. Vehicular Cloud Computing (VCC) is one of the solutions. VCC is a new hybrid technology that has a remarkable impact on traffic management and road safety by instantly using vehicular resources, such as computing, storage and internet for decision making. This paper presents the state-of-the-art survey of vehicular cloud computing. Moreover, we present a taxonomy for vehicular cloud in which special attention has been devoted to the extensive applications, cloud formations, key management, inter cloud communication systems, and broad aspects of privacy and security issues. Through an extensive review of the literature, we design an architecture for VCC, itemize the properties required in vehicular cloud that support this model. We compare this mechanism with normal Cloud Computing (CC) and discuss open research issues and future directions. By reviewing and analyzing literature, we found that VCC is a technologically feasible and economically viable technological shifting paradigm for converging intelligent vehicular networks towards autonomous traffic, vehicle control and perception systems.

Contents

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1. Introduction

Recent improvements in software, hardware and communication technologies are empowering the design and implementation of several types of networks deployed in different environments. For the last few years, one such network that has received much attention is the Vehicular Ad-Hoc Network (VANET) (Olariu et al., 2011; Zeadally et al., 2010). A VANET is a set of moving vehicles in a wireless network that apply the Information Communication Technology (ICT) to provide state-of-the-art services of traffic management and transport. Presently, VANET has received significant consideration because of the prospect of enabling novel and attractive solutions in areas such as vehicle and road safety, traffic efficiency and Intelligent Transportation Systems (ITS) (Al-Sultan et al., 2013; Hartenstein and Laberteaux, 2008). The promise of vehicular networking has led to a fast convergence with ITS and to the advent of Intelligent Vehicular Networks (Hossain et al., 2010), which are anticipated to transform driving styles by creating a secure, safe and healthy environment that will ultimately encompass our busy city streets and highways. Thus, the intelligent vehicular networks will provide infotainment and will enable a new versatile system that enhances transportation efficiency and safety (Olariu et al., 2013). Although many efforts have been made to reach these objectives, VANET has several drawbacks, such as the high cost of the service constrained communications due to the high mobility of the vehicle (Akbari Torkestani, 2012; Qin et al., 2012).

Advances in vehicular technology have provided resources such as fixed storage devices, better computing power, cognitive radios, and different types of programmable sensor nodes. By using Wireless Sensor Networks (WSNs), intelligent applications enhance ITS and can improve both driving safety and traffic efficiency (Fonseca and Vazão, 2012). The arrival of mobile internet in vehicles brings together the innovative and, widely divergent benefits of the internet, and such developments have a tremendous social impact (Goggin, 2012). Therefore, in the futures, cars and vehicles will be ubiquitously furnished with communication, computing and sensing devices, and universal networks will make the internet available on the move. Thus, the driving experience will be more enjoyable, comfortable, safe and environmental friendly. Eventually, the billboards of our highways will be exchanged for in-vehicle advertising, where the driver can choose advertisement based on their needs. However, the remarkable array of on board computing abilities present in our vehicles is most likely not utilized by the applications mentioned above(Karagiannis et al., 2011).

Mobile Cloud Computing (MCC) is a new paradigm that can be used by vehicle drivers to leverage services as a utility by a pay as you go model, and can process a large amount of data on demand anytime from anywhere. The drivers can use their mobile devices to connect to the cloud via the internet. MCC provides the essential environment and foundation to integrate platforms and technology that will monitor road safety by processing sensor network data using different mobile cloud architectures, such as Platform as a Service (PaaS). However, the mobile devices suffer from computing resources limitations (resource and battery restriction, processing time (Shiraz et al., 2012)). In addition, uploading real-time information on the cloud such as traffic jam or accident situation, by using the internet is costly and time consuming (Fernando et al., 2012). Q4

Vehicular Cloud Computing is a new technological shifting, which takes advantage of cloud computing to serve the drivers of VANETs with a pay as you go model. Thus, the objectives of VCC are to provide several computational services at low cost to the vehicle drivers; to minimize traffic congestion, accidents, travel time and environmental pollution; and to ensure uses of low energy and real time services of software, platforms, and infrastructure with QOS to

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