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IoV distributed architecture for real-time traffic data analytics

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Abstract

In this paper, we present necessary premises for the deployment of the Internet of Vehicles (IoV) integrating Big Data analytics of road network traffic measurements of the city of Mohammedia, Morocco. Thus, we introduce an architecture based on three main layers such as IoV, Fog Computing and Cloud Computing Layer. We specifically put more focus on Fog Computing layer in which we develop a framework for a real-time collecting and processing events generated by intelligent vehicles as well as visualizing traffic state on each road section. Furthermore, we consider deployment and test of the proposed framework using events retrieved from a *Vanets*-type micro simulation. Finally, we present and discuss the first obtained results as well as the advantages and limitations of the proposed architecture.

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Keywords: IoV, Big Data analytics, Fog computing, Real-time data analytics, Traffic control.

1. Introduction and motivation

Intelligent vehicle concept has grown considerably over the past decade. Many vehicles have on-board systems incorporating components monitoring different environmental conditions. The emergence of the internet of things (IoT) and communication technologies allows collecting different types of information from sensors and

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surrounding systems. The convergence and the opening of these technologies lead to the emergence of a new concept called IoV. Exploiting data generated by IoV environment in a centralized manner will certainly have great benefits for traffic control. In this work, we propose the implementation of IoV integrating Big Data analytics. Thus, we introduce an architecture for collecting and analyzing big data traffic respecting IoV environment specificities and allowing efficiency, scalability and high performance. Furthermore, we are developing a traffic data collecting and processing framework. The first tests of this framework are performed thanks to events retrieved from Vanet-type simulation. The rest of this paper is organized as follows. In section 2, we present a state of art of IoV environment interacting with Big Data analytics. Section 3 develops the proposed architecture and its different parts including the developed framework. Deployment, tests and results of the framework are given in section 4. Section 5 highlights advantages and limitations of the proposed architecture. Finally, a conclusion of this work is developed in section 6.

2. State of art

Internet of things is mainly based on smart objects working in a collaborative manner and interacting instantly with surrounding environment. The emergence of IoT has opened new perspectives for intelligent transportation systems. IoV represents a particular case of IoT accepting information exchange between vehicles themselves as well as between vehicles and any kind of surrounding objects (see Fig. 1) such as traffic lights, infrastructure, pedestrians and Cloud[1]. This concept is more general than vehicular ad-hoc networks (Vanets), which is limited to vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communication[2]. IoV technology is more developed than classical intelligent transportation systems based on sensors and cameras throughout road network and monitoring center[3]. The rapid development of wireless communication technologies has favored the emergence of IoV architecture. These technologies involve particularly RFID[4], WSN[5], Zig Bee[6], NFC, Bluetooth, 6LoWPAN[7] and other practices which have shaped M2M communication as well as dedicated communication technologies to vehicular environment[8] such as 802.11p,WAVE and CALM. IoV architecture is also favored by the development of smart infrastructure for smart-cities including MAN networks. Cellular network technologies have recently considerably grown to the extent of testing 5G technology, which will begin deployed by 2020. Ensuring a speed 100 times larger than existing 4G[9], 5G technology will certainly open great opportunities in several areas, especially for IoV[10]. All these communication technologies and other practices support IoV. However, this latter faces many challenges among with exchange standardization and interoperability between different technology kinds as well as routing, storage and analysis of large quantities of data generated by heterogeneous sources.

Interoperability challenge can be overcome by adopting exchange protocols such as MQTT, AMQP, STOMP, HTTP and others. The work cited in[11] propose an architecture based on these protocols ensuring interoperability and transparency between connected objects. Effectively, these protocols require a tiers system such as RabbitMQ and ActiveMQ functioning on the level of a layer called middleware. This latter is often confused with so-called Fog layer, which is positioned between Cloud layer and connected objects layer. Fog computing layer mainly ensures interoperability and security exchanges between connected objects as well as massive data management and data preprocessing. The work of Bonomi[12] introduce the role of this layer integrating IoT and Big Data analytics qualifying it as an ideal layer for the real time data processing showing a low latency. In[13], authors have proposed the creation of several instances of Fog layer according to geographical distribution of connected objects. The Fog layer will certainly have a decisive role in our work tending to integrate IoV with the real-time analysis of events produced by connected vehicles. The design and technological choices for this layer will be done with great care regarding to huge amount of shared data, which we will develop in section 3.

3. Modeling and proposed architecture

We propose an IoV-BigData architecture based on three layers (see Fig. 1). The IoV layer includes connected vehicles, intelligent road infrastructure and communication technologies. The Fog Computing layer is in itself responsible for the collect, real-time processing and storage of events generated by the connected vehicles and