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Internet of Vehicles: Challenges and Issues

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Abstract- Internet of Things (IoT) enables physical devices or objects called "things" in the world to connect with each other and to provide various services via their data collected from their surrounding environments. Currently, many service domains try applying IoT to their services including smart city, healthcare, and smart home. This paradigm led to novel Intelligent Transport System (ITS) called Internet of Vehicles (IoV). IoV allows to connect with each vehicle through the Internet and to provide vehicle-to-infrastructure (V2I) services as well as vehicle-to-vehicle (V2V) communication services without constructing vehicular ad hoc networks (VANETs). Although the IoV is an emerging concept, we have to consider several critical factors to realize IoV. Accordingly, in this paper we discuss the technical challenges and issues to realize IoV.

Keywords- IoT, Internet of Things, IoV, Internet of Vehicles, V2V, Vehicle-to-Vehicle, V2I, Vehicle-to-Infrastructure, ITS

1. Introduction

Internet of Things (IoT) is the network of devices or objects called "things" embedded with electronics, software, sensors and connectivity to enable it to achieve greater value and service by exchanging data with other connected devices. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure [1]. Internet of Things (IoT) enables things to provide various services via their data collected from their surrounding environments. Due to this advantage of IoT, many service domains try applying IoT to their services including smart city, healthcare, and smart home. IoT is one of the Future Internet technologies, and the idea is that it can control things and derive information via connecting between virtual devices and physical devices in cyberspace [2]. This paradigm lead to novel Intelligent Transport System (ITS) called Internet of Vehicles (IoV).

IoV allows to connect with each vehicle through Internet and to provide not only new vehicle services such as vehicle-to-human (V2H) [3] and vehicle-to-sensor (V2S) [4] but also existing vehicle services including vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) without any constructing vehicular ad hoc networks (VANETs) [5-6]. IoV can combine existing internet services, IoT, and mobile communications. Although the IoV is an emerging concept, some nascent forms exist today for example ITS in Europe and Japan has adopted certain forms of IoV technology [7].

In the IoV, all of vehicles can share their data through On Board Unit (OBU) located in vehicles and Road Side Unit (RSU) located in infrastructure and then provide ITS services to users. Accordingly, a common way for realizing IoV is to combine existing VANET. To this end, however we have to resolve several issues (1) global unique ID and description to distinguish each vehicle; (2) interoperability existing VANET for novel ITS; (3) real time data and reliability; and (4) ecosystem for IoV. Therefore, in this paper we discuss the tecnical challenges and issue to realize IoV when we combine between IoV and VANET.

The rest of this paper is organized as follows. The challenges and issues to realize IoV are introduced in Section 2. We conclude this paper with remarks about future work in Section 3.

2. Challenges and Issues to realize IoV

IoV is composed of device platform called OBU and service platform as cloud system. Through these, all of vehicle in the IoV can store their information such as driving information, road condition and traffic information to a service platform located in infrastructure. IoV also provide ITS [8] services using information collected from another service domain such as a whether service and parking service. For example, whether information collected from a weather service domain can be used to safety driving service including notification of road surface condition. Likewise, a combination of parking space information and navigation system can provide a new mashup service for efficient parking guide service to drivers. Fig. 1 shows the concept of IoV.

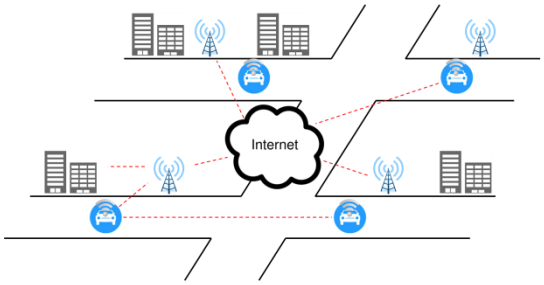

Fig. 1. Concept of IoV

As mentioned above, however IoV is still an emerging concept. To realize IoV we have to resolve several issues. In this Section we discuss the issues and then propose challenges in other to resolve the issues.

2.1. Global unique ID

In the IoV, we have to consider global unique ID to identify each vehicle due to the fact that all of vehicles connect with each other using Internet. The global unique ID can used to provide a specific service to a vehicle or a vehicle use a specific service. Hence, definition of global unique ID is very important issue in IoV. Although we can use a static IP address about OBU in a vehicle, the static IP address would be changed because vehicles have higher velocity and mobility. Consequently, definition of global unique ID is also a challenging task to realize IoV in the World.

2.2. Interoperability existing VANET for novel ITS

Support interoperability existing VANET is also very important issue in IoV. Originally, VANET was standardized to provide ITS services to drivers via considering unique characteristics of vehicles. However to use VANET, we have to construct a specific network. Although IoV can provide those ITS services without any constructing network, it completely replace the ITS provided by existing VANET is a very difficult problems. Accordingly, an efficient way is to provide a novel ITS service through interoperability existing VANET. To this end, we have to develop a compatible protocol with VANET (e.g., IEEE 802.11p) and TCP. Furthermore, we can consider combination of multimedia services inside vehicles which would be constructed ZigBee [9] or another network for inter-vehicle multimedia services using IoV. Fig. 2 shows the concept of the inter-vehicle multimedia services using IoV.

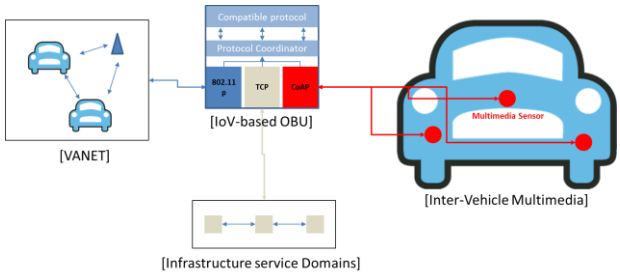

Fig. 2. Concept of inter-vehicle multimedia services using IoV

2.3. Real time data and reliability

In the vehicle environment, all of vehicle has higher velocity and mobility and they move alone with road. All of vehicle also has very short time about connecting with each vehicle to share their vehicle information. Accordingly real time data and reliability is also issue in IoV when each vehicle try send data and received data from/to another vehicle or infrastructure. However the communication mechanism based on TCP in the IoV is not support higher mobility and mobility of vehicles because it uses complex communication procedure. To resolve this problem, we can consider data exchange mechanism based on MQTT [10]. MQTT allows exchanging an interested data called topic between publishers and customers using pub/sub mechanism. However to apply MQTT data exchange mechanism to IoV, management system to accommodate whole publication and subscription about interested data of all of vehicles. Consequently, to support higher mobility and velocity of vehicle, real time data management mechanism is also challenging task in the IoV.

As mentioned above, all of vehicles have to exchange their data at once because all of vehicles have higher velocity and mobility. Hence, when vehicle send/receive data from/to another vehicle, the data reliability is very important and it is also challenging task in IoV.

2.4. Ecosystem for IoV

IoV can provide comfort mashup services to human user via combination of between various service domains as well as existing V2V and V2I in vehicle environment. Thus we consider vitalizing methods of IoV based on creation of IoV-based applications or services. To this end, we need ecosystem for IoV to share various IoV-based applications or services including developing open source-based OBU platform and mashup services between various services using open application program interfaces (APIs). Consequently, to vitalize IoV, a building ecosystem for IoV is most important challenging task in IoV.

3. Conclusions

In this paper, we discuss the technical challenges and issues to realize IoV. Although the IoV is an emerging concept, we can move up realizing IoV through resolving those challenges and issues as mentioned in Section 2. Recently, through numerous internet technology advances, various service domain try to apply the internet technology to their services and then to provide more comfort service to users. Accordingly, if we apply IoV to vehicle environment, we would be provide more efficient services as well as existing ITS services. Future research will include developing compatible protocol with existing IEEE 802.11p and TCP to realize IoV.

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References

[1] Wikipedia, Internet of Things, Available online: http://en.wikipedia.org/wiki/Internet_of_Things

[2] M. Ryu, J. Kim, S.-S Lee, M.-H. Song, Survey on Internet of Things: Toward Case Study, *Smart Computing Review* (2012), vol. 2, no. 3, pp. 195-202.

[3] M. Saffarian, J. C. F. De Winter, R. Happee, Automated driving: human-factors issues and design solutions, *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (2012), Vol. 56. No. 1, pp. 2296-2230.

[4] G. Sibley, Relative bundle adjustment, Department of Engineering Science, Oxford University, Tech. Rep 2307.09 (2009).
[5] L. Nanjie, Internet of Vehicles: Your next connection, *WinWin Magazine* (2011), pp. 23-28.
[6] F. Li, Y. Wang, Routing in Vehicular ad hoc networks: A survey, *IEEE Vehicular Technology Magazine* (2007), Vol. 2, No. 2, pp. 12-22.
[7] Z. M. Ding, F. Lu, C. L. Sun, A Design of Cooperative Vehicle Infrastructure System Based on Internet of Vehicle Technologies, *Applied Mechanics and Materials* (2012), Vol. 552, pp. 363-366.
[8] ETSI, Intelligent Transport System, European Telecommunications Standards Institute (ETSI) ITS (2010).
[9] P. Baronti, P. Pillai, V. W. Chook, S. Chessa, A. Gotta, Y. F. Hu, Wireless sensor networks: A survey on the state of the art and the 802.15. 4 and ZigBee standards, *Computer Communications* (2007), Vol. 30, No. 7, pp. 1655-1695.
[10] MQTT, Available online: http://mqtt.org/

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