Chapter 87
Vehicular Fog Computing Paradigm:
Scenarios and Applications

Jyoti Grover
Manipal University Jaipur, India

ABSTRACT

The main objective of vehicular ad hoc networks (VANETs) is to improve driver safety and traffic efficiency. Most VANET applications are based on periodic exchange of safety messages between nearby vehicles and between vehicles and nearby road side communication units (e.g., traffic lights, road-side lights, etc.). This periodic communication generates huge amount of data that have typical storage, computation, and communication resources needs. In recent years, there has been huge developments in automotive industry, computing, and communication technologies. This has led to vehicular cloud computing (VCC) as a solution to satisfy the requirements of VANETs such as computing, storage, and networking resources. Vehicular fog computing (VFC) is a standard that comprehends cloud computing and related services to the proximity of a network. Since VANET applications have special mobility, low latency, and location awareness requirements, fog computing plays a significant role in VANET applications and services. In urban cities, vehicles parked at shopping malls, offices and similar other places are under-utilized. These can offer great opportunity and value to implement applications of VFC by utilizing vehicles as an infrastructure. In this chapter, we present real time scenarios and applications of VANET that can be implemented using VFC. VANET applications and quality of service can be enhanced by aggregating the resources of these vehicles. We discuss different types of scenarios of moving and parked vehicles as computational, communication, storage and network infrastructures. We have also discussed the challenges and open problems to implement VFC system. This chapter provides the thorough understanding of novel research paradigm and about vehicular communication infrastructures.

1. INTRODUCTION

Driving has become integral part of our everyday lives. Globally, average driving time of people is increasing up to 84 minutes per day (Ding, D. & Gebel, K. & Phongsavan, P. & Bauman, A. E. & Merom, D., 2014). Some of the major reasons of traffic accidents are poor road conditions, traffic congestion and long driving time. With the large scale improvement in computation and wireless communication technologies, vehicles can communicate with other vehicles and communication units on roadside. Such communication creates new opportunities for enhancing road safety. VANET has emerged as a solution to many road safety problems by providing safety information to drivers on time (Bai, F. & Krishnan, H. & Sadekar, V. & Holl, G. & Elbatt, T., 2006). VANET is a special class of Mobile Ad Hoc Network (MANET) (Yousefi, S. & Fathy, M., 2006). Main characteristics of VANET (Biswas, S. & Tatchikou, R. & Dion, F., 2006) that distinguish it from MANET are high mobility of nodes, scalability and frequent topology changes. VANETs use short range radios (Jiang, D. & Taliwal, V. & Meier, A. & Holfelder, W. & Herrtwich., R., 2006) in each vehicle, which allows various vehicles to communicate with other vehicles and roadside infrastructure. Safety and traffic management applications require real time information and can play significant role in life and death decisions. VANET is considered as a most important component of future intelligent transportation systems (Khabazian, M. & Aissa, S. & Mehmet, M., 2011) and support various mobile services such as content sharing applications, emergency information of any disaster or terrorist attack etc.

In VANET, Vehicle to Vehicle (V2V) and Vehicle to Roadside (V2R) communication is used to propagate safety information to nearby vehicles on time. Apart from the communication unit, each vehicle is also equipped with high computation and storage unit. But most of the time, these units are under-utilized. Vehicular cloud computing (VCC) is the paradigm (Whaiduzzaman, M. & Sookhak, M. & Gani, M., 2014) emerged to utilize VANET resources efficiently by taking advantages of cloud computing. It serves the drivers of VANET with a pay as you go model. In VCC, group of vehicles cooperate with each other to dynamically share computing, sensing and communication resources for decision making on the road in order to improve traffic management and road safety. Some examples of VCC applications are:

1. Local traffic condition can be collected from nearby vehicles for route planning.
2. Current transportation system can be improved by big data processing of traffic information by local traffic authorities.
3. Collaborative image of critical events can be reconstructed such as car accident, congestion on the road etc.

VCC is a very promising solution to share the computation and storage resources among the vehicles and roadside units in order to implement these applications. But VCC is not sufficient for many VANET applications due to mobility of vehicles and the latency sensitive requirements imposed by these. It is difficult to meet the Quality of Service (QoS) requirements using VCC. So, a new approach is designed that comprehend cloud computing with VANET applications named as Fog computing. Fog computing leverage computation infrastructure that is closer to the network edge to compliment cloud computing in providing latency sensitive applications and services. Fog computing is similar to cloud computing but the only difference is that time sensitive applications can be implemented at the network edge rather than sending huge amount of data to remote cloud. The idea of Fog computing (Stojmenovic, I.

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