Vehicular Ad Hoc Network (VANET)

1. Introduction

Connectivity allows for better automation and greater synergy between connected devices (Hoske, 2013), while generates large amount of data that could be used for analysis. As more recognize the value of connectivity, many begin to introduce connectivity in our devices we use daily. The easiest way to do that is to connect these devices to the Internet, and that drives the hype behind the Internet of Things. But as we upgrade everything we own, from our toasters to our pets, with connection to Internet, one of the many devices that have yet to reap the full benefits of connectivity is our vehicles.

The difficulty of establishing connectivity in vehicle is challenging to say the least. Apart from these devices moves constantly (Zhao, Zhu, Chen, Zhu, & Li, 2013), and often at high speed, the road system in many countries spans large areas. Furthermore, as will be discussed, data transfer in vehicular networks might be time sensitive. Thus, to accommodate a vehicle network that provides practical services timely, we could follow the Internet of Things approach by improve current cellular capabilities or lay down a large network of network infrastructures, such as routers and repeaters, along the road. However, this is financially taxing and requires long period of implementation.

2. MANET

Yet, if we take a step back and consider networks in general, we will be quick to realize that there is no need for a vehicle to be directly connected to the Internet. Recent development in Mobile Ad Hoc Network (MANET) has gain traction over the last couple of years (Priyadarshini & Kashyap, 2014) following advancement in wireless transceivers and the solidification of wireless networks standards. The MANET is a wireless network where nodes are peer to peer connected without the need for a centralized server. Furthermore, these nodes are highly mobile, requiring the underlying technology to consider the ever changing distance between each node. The MANET must also adapt to rapidly

changing network where nodes join and exit the network quickly. Due to the peculiar nature of the MANET, the study and research into the application of MANET branches the field into many specialized area. One of these specialized fields is the Vehicular Ad Hoc Network (VANET) (Garg & Aujla, 2014).

3. VANET

When we considered establishing a vehicle network by extending cellular support, we concluded 2 major shortfalls namely, the cost of implementing a network that is practically useful and the rate of transfer of information. However, by implementing a vehicle network under the VANET framework, it becomes possible to circumvent these two problems.

While much research and resources are still devoted into improving cellular technology, current technology progress such as 2.5g and 3g have somewhat plateau. As these technologies reach their maturity, the return per investment diminishes and it becomes financially impractical to try and extend the limits of these technologies. While newer standards such as 4g LTE (PR Newswire, 2012) and probably 5g in the future will eventually replace the current standards, these newer technology are slow in implementation as the transition is both costly and resource taxing. Under the VANET however, there will be no need to improve the current technology. Furthermore, implementations rely on small vehicular components and local infrastructure of limited wireless connectivity. The aggregated cost of installing these would far less than that of building new satellite towers or upgrading existing ones on top of requiring new expensive end user devices that implements the new standards.

With regards to time sensitive information exchange, it is easy to see why cellular connection in vehicles might not be the best network implementation. Suppose useful information is send from a vehicle to the next through a cellular network implementation, this information would be required to be send through the air over a long distance to a communication tower, be routed through the

Internet, and send back to the communication tower and subsequently through air over a long distance. The total distance such an information travel is much more than the actual physical distance between the two nodes. Time sensitive information such as the car in front is slowing down or is executing an emergency brake would have passed its window of usefulness when it finally reaches its destination. However a VANET implementation would facilitate faster information exchange between vehicles as it sidesteps a long chain of middleman.

4. Applications and implication

However, connectivity in a VANET is only useful when there is valuable information to be exchanged between vehicles. If the objective is merely to give vehicles Internet access, then the VANET makes little sense. Therefore, it is more important to consider what information that a VANET can share to reap the benefits of connectivity.

Before we consider such an issue, let us appreciate the present. As our devices gets "smarter" over the years, so have our vehicles. We now have countless number of sensors, processes and automated systems in place modern vehicles for enhancing safety, performance and convenience. As such, the amount of information that are generated and collected in these systems gets larger over time. Yet, this information is contained in a close system; there is simply no reasonable way another vehicle could access data from another vehicle. However, it takes little imagination to discover how data from one vehicle could possibly benefit another vehicle, especially one that is of close proximity.

For example, suppose a vehicle can broadcast its current speed and driving statues to other vehicle in its proximity and have to apply an emergency brake in order to avoid an accident. This information could be quickly transmitted in a VANET to the vehicles at the rear which, then, can be used as an indicator that these vehicles should engage in similar emergency brake (Segata & Lo Cigno, 2013). Or suppose a vehicle wishes to make a turn and engage its turn signal. A VANET can

supplement the visual signal with digital signals that is transmitted. Data shared could go beyond data from vehicles; Infrastructures could be set up on the road such as a broadcaster at a traffic light, or one that broadcast a sharp turn. Ad hoc traffic conditions such as congestion, accidents or even unsafe driving condition (like potholes) could be "reported" and shared throughout the traffic to vehicles that are potentially far away enough to make a detour. The nature of this information would be time sensitive, justifying VANET over cellular.

Furthermore, the establishment of a VANET opens up a new field of research and development (Garg & Aujla, 2014). Convenience application could be developed that could incorporate real time traffic data into routing algorithms in GPS or even provide directions without GPS connection (Bohlooli & Jamshidi, 2012). States could implement regulations that enforce vehicles to give way to emergency services that broadcast its presence in the network. Automated vehicle research will definitely be accelerated by the implementation of VANET.

The proper and innovative use of VANET can potentially revolutionize driving experience. The ability to share information will vastly improve the safety, performance and convenience of driving by leveraging the unlocked data in isolated systems.

5. Further exploration

While it seems that the proper use of VANET paint a rosy picture of the possible development in the next generation of vehicles, the implementation of VANET itself is not without its problems (Zhao, Zhu, Chen, Zhu, & Li, 2013). On top of being a relatively new field of research, which might require many more years of development and robust testing before a standard is formed; the VANET is also susceptible to abuses by malicious users (Taha, 2013). Further exploration into the VANET could look into how an adversary could manipulate the network and the possible means, based on current security techniques and other theoretical ones could be implemented to circumvent these abuses.

Works Cited

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