

Real-Time Connected Car Services

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Abstract—In recent years, the patterns of connected car are tied in with giving drivers more answers for making the journey consistent. Vehicles today are outfitted with high innovation highlights and in-vehicle availability. The Integrated Connected Vehicle Services is produced to convey an incorporated driving experience to all vehicle owners, to make a communication stage for drivers to impart and share data between vehicles. The system allows to discover nearby vehicles inside range, giving the driver early notice caution of crisis vehicles inside certain range. Moreover, the system likewise enables the driver to share basic data which later plots into the maps for alternate drivers to view and plan the journey. The information of transmission between the vehicles are incorporated through firebase cloud services. Firebase is known as an effective cloud database and ready to screen the application development.

Keywords—cloud based, connected car, car system, integration

I. INTRODUCTION

Advancement in embedded computing and wireless technologies have discovered various applications. Vehicles may exchange applicable data with each other. Communication between vehicles has pulled in light of a legitimate concern for some researchers around the globe. In Malaysia, some research ventures investigate the capability of reducing road fatalities under the safety activity (e.g. vehicle to vehicle).

Vehicle to vehicle (V2V) communication gives vehicle a chance to communicate their position, speed, guiding wheel position, brake status, and other information to different vehicles inside a couple of hundred meters. The other vehicle can utilize such data to manufacture clear information of surrounding environment, uncovering inconvenience that even the most cautious and ready drivers to avoid potential risk [1, 2].

In Malaysia, empowering new services in vehicle may posture many difficulties on innovation, conventions, and security that increase the requirement for inquire about, in this field. It is normal that the communication between vehicles can give drivers more data about environment, enabling them to decide on better choices, bringing about the expansion of their proficiency. High-end car manufacturers today offer a few services, for example, GPS navigation, accident detection system and weather, traffic and entertainment applications on vehicle's head unit. On older and lower end car manufacturers, mobile phones are now being utilized, to bring those propelled highlights and services. Smartphones these days are a significant answer for new services and are effective gadgets that can be incorporated with vehicles [3].

Besides that, there has been a significant enthusiasm from the academic and from the industry in interfacing vehicles with mobile phone framework to offer services to drivers. The mobile phone is continually changing on how the individuals interface with general environment. In present, Google's android working framework has been the most

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broadly perceived usage by users. Users are proposed for mobile phones that radiantly suits embedded devices, for instance, those used for vehicle infotainment [4].

In certain situation, any unattended action, for example, car doors are not closed or numerous other that are unnoticeable by the drivers are done by giving hand signal or honking over the road. This ascents irruption for specific people at basic places, for example, schools, hospitals or oil stations. Furthermore, if there is an emergency vehicle drawing nearer, a driver's ordinary practice is to give way and a portion of the drivers do not know about this in the front line, which may delay in responding the urgency of the emergency vehicle. For instance, along the roadway, a vehicle can caution different vehicles by sending alert messages. Alternate vehicles can start appropriate proactive action. Moreover, essential route, for example, weather, traffic, road closure and accident are broadly accessible and such service will improve the need of the application. In present time, there is no current stage that enables a driver to convey, to share or to alert any close-by drivers over a communication medium in Malaysia. In addition, the data transmitted is not conveyed to the recipient real-time.

The applications world is moving to the vehicle with drivers demanding at the opportunity to interface with the internet in the vehicles. The internet and social network services give a premise to vehicles to share different sort of data, for example, driving important data with different vehicles. With respect to that, this project imposes integration of application that provides few services and creates a platform for the V2V communication to take place.

II. FINDINGS

A. *Connected Car*

When it comes to the specifics of identifying on what makes a vehicle "connected," there are multiple directions one can go because there does not seem to be any one standard definition. The automotive industry and the connected cars have created a new ecosystem, which is forging a large group of companies

that are in the field of technology, equipment and manufacturing. These collaborations are winding up progressively around creating new services and product to meet the different way of life needs of an individual. Some industry experts suggested that these developments would be a good start to enable the numbers of the connected cars in the worldwide market by 2020.

This new ecosystem system has changed the mobility by telecommunications, platforms, analytics, operating systems, among different components, into the driving experience. The ecosystem is quick in developing it to meet the changing and the progressive complex needs of an individual. At the point when connected car entered the market in around 2010, most services and products concentrated on traditional car related issues, for example, maintenance notifications and parts requesting for vehicles, GPS navigation and advanced system that provides awareness. As the new technologies provides greater integration, for instance, smartphones which is saw a noteworthy change in hands-free systems and incorporated entertainment choices. Most services and products can be gathered into five center useful bunches, to be specific interaction, driving, management, infotainment, convergence and safety & security.

These skylines are being extended further as the route in which individuals utilize and depend on innovation changes the path in which they interface with the world, a dynamic that will turn out to be considerably more refined as the Internet of Things (IoT) progresses toward becoming reality. Similarly, as connected devices have made it workable for any individual to oversee for all intents and purposes any part of their life, the car manufacturers and their associated partners, are currently acknowledging and investigating on how the connected cars can satisfy and encourage the similar needs and requests. The technology of connected cars has made many companies are working together to quicken the innovation across the world.

Connected car technologies are turning into the absolute most vigorously research automotive technologies. In present, some connected car technologies are available, however are just a

small amount of what will be accessible in future. Despite the fact that this contains only several sections of the connected car technologies. In the near future a large number of the technologies may overlap. For example, to have an automated car in future, the car must also be a connected car in the first place [5].

B. Operating System Platform

A mobile operating system platform is the operating system that operates a digital mobile device to run applications or programs. Besides, a mobile operating system platform typically runs when a device is power on presenting a screen with icons or titles that present information and provide application access to an individual. The current mobile operating systems combine the features of a personal computer operating system. In the most recent, the emergence of mobile devices is moving forward with tablets, in-vehicle head unit and smartphones.

There are three mobile operating system platform have been chosen for reviewing in this section. Comparison will be carried out in order to know the characteristics and features in these three mobile operating system platform. These three operating system are Android, iOS, and Windows.

Android

Android is developed by Google, which is a mobile operating system and designed for touchscreen devices, such as smartphone and tablets. Android was first released on 23rd of September 2008. In most recent, Android has released its new operating system version known as Android Nougat. Android operating system is known to be an open source, which is incorporates with any development system or applications. The application development usually are in Java programming that works along with Android SDK.

iOS

iOS is developed by Apple Inc, which is also a mobile operating system that was released on 29 June 2007. iOS is also designed for touchscreen devices such as smartphones and tablets. iOS is

recently release the operating system known as iOS 11. iOS is known as an exclusive operating system or basically known as closed source operating system which means the source code is not available for developers to build their own version of operating system. iOS is coded with C, C++ and Objective programming languages.

Windows

Windows is a development by Microsoft Corporation, which is a mobile operating system. Windows was designed for touchscreen devices, such as smartphones and tablets. Windows was first released on 8 November 2010 and in most recent, they have released their latest operating system version known as Windows 10. Windows is also an exclusive operating system, which is known to be closed source. Windows is developed with C and C++ programming languages [6].

TABLE I. COMPARISON OF DIFFERENT OPERATING SYSTEM PLATFORM

Operating System	Android	iOS	Windows
Developer	Google	Apple	Microsoft
Released	2008	2007	2010
Programming Language	C, C++, Java	C, C++, Objective-C, Swift	C#, VB.NET, F#, C++, JScript
Source	Open	Closed	Closed
Store	Google Play	App Store	Windows Phone Store
OS Family	Unix-like	Unix-like, Darwin (BSD), OS X	Microsoft Windows
Performance	Laggy, High Memory and CPU Usage	Very Light, Low Memory and CPU Usage	Very Light, Low Memory and CPU Usage
Application	First Leader in the field	Second leader in the field	Third leader in the field
Battery Demand	Highest	Less	Least
Diversity	Countless	IPhone	Nokia and Microsoft
Security	Softest to crack	Hard to crack	Hardest to crack
Customizability	Highest	Less	Least
User Friendliness	Most Preferred	Less Preferred	Least Preferred

Based on Table 1, respective operating system platform has its own particular highlights. Android being an open source with most noteworthy level of customization. However, iOS does not allow for any customization due to security concerns. Nevertheless, Windows is a little bit behind compared to other operating system because of their existing issues but it is still coming up with updates that could resolve and cater for other development purpose. Besides, when it comes to friendliness and application, Android seems to be the first in the field to lead compared to iOS and Windows. This could be because of the development ease that is able to be compatible for any individuals.

C. Cloud Services Platform

Nowadays, in every hour, every minute, every second, there are an uncountable number of data being transferred, shared, exchanged and processed in between different devices. All of these data, often in need to access to and then from the data centres in order to process the transaction, provides the services to all kinds. Thus, cloud is needed to act as a data centre to process and to hold all the data transactions that is being made and accessed by anyone. Practically, all the IT resources at present can reside in cloud, for an instance, a software program or application, a service, a server, storage, networks or even the whole IT infrastructure.

There are three-cloud service providers have been chosen for reviewing purposes in this section. Comparison will be carried out in order to clarify the similarities and the differences between the services and the features offered in these three cloud services providers. These three cloud services providers are Firebase, Microsoft Azure, and Google Cloud Platform.

Firebase

Firebase is a popular cloud services provider and backend as a service (BaaS) company, which was founded, by James Tamplin and Andrew Lee in September 2011. The parent company is under a company named

Alphabet Inc. but in October 2014, the company has been acquired by Google Inc. Firebase currently supports iOS, Android and Web platform. There are four types of main services available in Firebase, which includes analytics, develop, and grow sections. These three main services will be further categorized into several sub-services.

Microsoft Azure

Microsoft Azure, is one of the cloud computing platforms that provide all three services which are Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Microsoft Azure is developed by Microsoft developer team and is released in 1 February 2010. Microsoft Azure offers 13 different services for their clients. Since there are too many services offered by Microsoft Azure, then only three main services will be chosen to review in this part, which are Compute, Web and Mobile, and Storage.

Google Cloud Platform

Google Cloud Platform is a cloud-computing platform developed by Google Inc. in October 6, 2011. It offers the utility of hosting on the same supporting infrastructure that Google uses internally for end-user products such as Google Search and Google Translate. Google Cloud Platform provides a developer of several products to set up a variety of programs from the simple websites to complex websites. Google Cloud Platform provides the enterprise solution from Google for Work, which comprised with a set of modular cloud-based services with a host of development tools.

TABLE II. COMPARISON OF DIFFERENT CLOUD SERVICES PLATFORM

Features/CSP	Firebase	Microsoft Azure	Google Cloud Platform
Types of services	BaaS	IaaS, PaaS, SaaS	IaaS, PaaS, SaaS
Platform Available	iOS and Android	iOS, Android and Windows devices	Google App Engine, Google Compute Engine, Google Cloud Storage, Google BigQuery, Google Cloud SQL
Programming Language Used	Swift, Java (Android), C++, JavaScript	JavaScript, Python, .NET, PHP, Java and Node.js	Java, Python, Go, Ruby
Usage Charges	Free and pay-per-use plan available	Pay-per-use	Pay-per-use
Web Hosting	Yes (Firebase Hosting)	Yes (Web Apps)	Yes (Website & Web Apps Solution or Google App Engine)
Real-time Database	Yes (Firebase Realtime Database)	Yes (SQL Database, SQL Data Warehouse)	Yes (Google Cloud SQL)
Cloud Storage	Yes (Firebase Storage)	Yes (Azure Storage, Blob, Queue, File, Disks Storage and StorSimple)	Yes (Google Cloud Storage)
Notifications	Yes (Firebase Notifications)	Yes (Notification Hubs)	Yes (provides Object Change Notification in Google Cloud Storage)
Analytics	Yes (Firebase Analytics)	Yes (Data Lake Analytics, Stream Analytics)	Yes (Google Analytics Platform, or Big Data Solutions)
Machine Learning	No	Yes (Azure Machine Learning, Cortana Intelligence Suite)	Yes (Google Cloud Machine Learning, Natural Language API)
Error Reporting	Yes (Firebase Crash Reporting)	Yes (Hockey App)	Yes (Stackdriver Error Reporting)
Authentication	Yes (Firebase Authentication)	Yes (Azure Multi-Factor Authentication)	Yes (provides in Google Cloud Storage)
Cloud Identity and Access Management	No	Yes (Azure Active Directory, Azure Active Directory B2C)	Yes (Cloud IAM, Cloud Resource Manager)
Developer Tools or Services	No	Yes (Visual Studio Team Services, Developer Tools)	Yes (Cloud SDK, Deployment Manager, Cloud Tools for IntelliJ)
Management Tools	No	Yes (Microsoft Azure Portal, Operations Management Suite)	Yes (Stackdriver Monitoring, Stackdriver Trace)

Virtual Machines	No	Yes (Azure Virtual Machines and Virtual Machine Scale Sets)	Yes (Google Compute Engine)
App Service/Engine	No (Only provides App Messaging in Firebase Cloud Messaging)	Yes (Azure App Service)	Yes (Google App Engine)
Networking Management	No	Yes (Azure Virtual Network, Azure DNS, Azure Application Gateway)	Yes (Google Cloud Virtual Network, Google Cloud Load Balancing)
Customers	Viber, PicCollage, Shazam and so on	Pearson, NBC News Digital, ebay and so on	Coca Cola, HTC, Rovio

Based on Table II, Microsoft Azure and Google Cloud Platform are equipped with three basic services models (IaaS, PaaS, and SaaS) whereas the Firebase Cloud provides the only Backend as a Services (BaaS) model. Backend as a Service (BaaS) or Mobile backend as a Service (MBaaS) is a service model which offering an alternative for the web and mobile developers to link their applications to the backend cloud storage, APIs is exposed by backend applications as well as providing the user management, push notifications, features and also capable to integrates with social networking devices. Compare with BaaS model in Firebase, all the three service models provided by the Microsoft Azure and Google Cloud Platform are tailored to the enterprise customers’ needs. The most common used programming language is used in these three cloud service providers is Java. Through this comparison, Java can be claimed as the powerful integrative programming language, which can support different kinds of cloud platforms by interacting with the code written in any other programming languages in different platforms devices. Firebase, Microsoft Azure and Google Cloud Platform are all supports the web hosting, real-time database, cloud storage, analytics, notifications, error reporting and authentications services; whereas the additional services such as Machine Learning, Virtual Machines, Networking Management and others are only offered by Microsoft Azure and Google Cloud Platform for those enterprise customers to support their organizations’ data centres management.

III. PROPOSED STUDY

The application empowers drivers to communicate with registered vehicle number plate without uncovering any data. Fig. 1 demonstrates that drivers can inform any consideration should have been taken forward to another driver amid their excursion over the road. Drivers can likewise send a warning to other drivers if there is an emergency vehicle passing over the road. In addition, drivers could find relevant information, for example, traffic, weather, road closure and accident at a specific area. Be that as it may, investigating the wellbeing components, it distracts drivers center when they are driving. The conceivable path is by giving a provoke message if it is a driver or a traveler, where if the choice is clicked as a driver, the application is out of reach and a perceptible sound will be activated.

Practically, standalone application functions and save data on the devices that are installed or programmed which are not viable. In the most scenarios, a backend is required where data can be saved and controlled for the purpose of the application that was build. The application build in this project is needed of data to be stored and retrieved. In common practice, databases are usually stored in local storage. In current advancement, cloud services introduces and benefits the backend portion of an application developed. This project is developed on android platform with Firebase integrated.

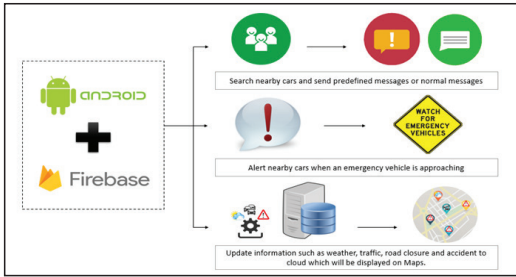


Fig. 1. Illustration Diagram of Connected Car Services Application

An important feature for this application is the Emergency Vehicle Warning (EVW) where the driver will be given an alert to take an action to clear a path for the approaching emergency vehicle. With this alert, it will make the emergency vehicle to travel without much traffic along their way.

Another feature of the application is that to identify nearby vehicles, which enables the drivers to discover available vehicles and communicate. The communication here is to provide a clear message by predefined messages. These predefined messages are as such, brake lights are not working, signal lights are not working, doors are not closed, petrol tank are not closed firmly and trunk bonnet are not closed. The indication here is to provide an alertness towards the driver which they may have overlook over their vehicles while driving.

Besides these, the application does provide an essential assistance, which the drivers could seek. This feature are named as eServices, which provides assistance such as, battery failed, jump-start request, battery water or even tyre replacement assist. This assistance are extremely important for any drivers that are stuck especially in the night.

Moreover, with the current advancement, everyone is familiar with navigation, but with the navigation, sometimes it is not clear with the information displayed. In this feature, the application has a feature, named as a route information that enables the drivers to share of real-time update for events such as weather, traffic, road closure and accident. This features plots the real-time data along with a picture to allow other drivers to view of the situation over a particular

location. This could help many drivers to ensure their journey clear and no time is wasted.

IV. RESULT & DISCUSSION

A. Result

The display of the application for testing carried out in University. There are few features of the application, Nearby Vehicles, eServices and Route Information. Besides this features, there are two alert notification, which will only display on the home screen if it is triggered.

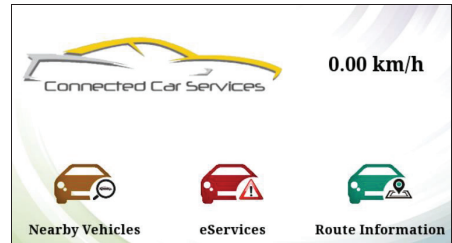


Fig. 2. Application Home Screen

As a driver, it is often to happen of inattentiveness of our vehicle surroundings. Probably of forgotten bonnet to be closed or in a rush of door not closed tightly. The nearby vehicles features would help the driver to take precaution as shown in Fig. 3.

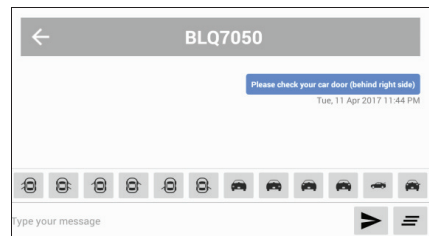


Fig. 3. Nearby Drivers

Generally, there are unpredictable issues to happen in the midst of driving. The most frequent issues are battery life, either battery water is low or battery is weak. In this event, if a driver is stranded and needs assistance, this feature probably will help. If the other drivers along the road that has this application would like to help, they could just click on the help option and the application redirects them to the location of the stranded driver.

This assistance is only localized within 2 km. The following feature is shown in Fig. 4 and Fig. 5.

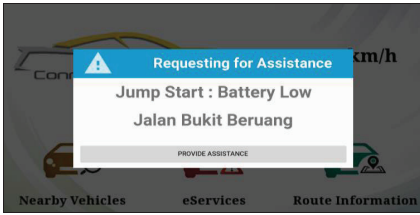


Fig. 4. eServices Request

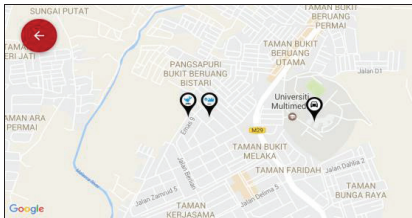


Fig. 5. eServices Available Helpline

Drivers are usually busy with the routine of travelling over from one destination to another. It is important for them to know if the destination is effected with accidents, traffic jam, road closure or even weather condition. Based on this feature, the drivers are able to update instantly to give other drivers information of a particular place. The following feature is shown in Fig. 6.

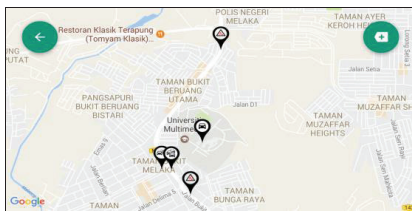


Fig. 6. Route Information

The emergency vehicle warning is the important element of the application. As the vehicle is moving on a particular road and an emergency vehicle is approaching towards the vehicle that is travelling along the road will receive an alert notification on the home screen as shown in Fig. 7.



Fig. 7. Emergency Vehicle Warning

B. Discussion

Build-in systems in vehicles are usually known to be the head-unit system. In Malaysia, it is common to see the system with basic functionalities such as music player, video player, FM radios. With the latest technologies, USB supports, Bluetooth connect and even mirror link is available. The question that arises is that, all smartphones are possible to be brought in to the vehicles, why do we still need such application. Focusing in Malaysian vehicles, this proposed study is to ensure the drivers can be able to use this system as add-ons in their usual standard providing service. As the system is developed with cloud service integration and at real time, the big data analytics can be done for analyzing purpose. If some particular analytics has to be done, the data that is stored in the cloud can be evaluated based on behaviors such as the driver behavior and the vehicle behavior.

Moreover, this could enable the future technologies to take place such as vehicle to x communication. The term vehicle to x communication would probably take place in the next 3 years. All vehicles need a system that is connected directly from the vehicle to the cloud and the internet. With this growing and fast moving expectation, it can ensure drivers will be filled with safety elements. Safety in that sense could provide the drivers with early warning message or audible alert sound. Vehicle to x communication is referred as the vehicle to vehicle communication and vehicle to infrastructure communication. As our scope is within Malaysia, the research and development on this scale is still new and fresh. Furthermore, with the advancement of such, the car manufacturers will be looking forward to

adapt such technologies that will increase their vehicle owners with much interest of the latest functionalities.

V. CONCLUSION

In this paper, the reason for this undertaking is that, driver could communicate with other drivers with possible of a system in their vehicle. This system could enable the drivers to provide alert of inattentiveness of the vehicle surroundings. In addition, the system empowers to offer warning to other drivers of emergency vehicle moving towards and provide assistance of any emergency cases.

In future, significantly the safety features will be extended with the vehicle communication platform. The vehicle can proficiently warn drivers without the interaction of the head unit system. In this way, the scope of the consciousness of the driver is stretched out towards the node of wireless.

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REFERENCES

- [1] Lu, N., Cheng, N., Zhang, N., Shen, X., & Mark, J. W. (2014). Connected Vehicles: Solutions and Challenges. *IEEE Internet of Things Journal*, 1(4), 289-299.
- [2] Fernandes, B., Gomes, V., Ferreira, J., & Oliveira, A. (2015). Mobile Application for Automatic Accident Detection and Multimodal Alert. 2015 IEEE 81st Vehicular Technology Conference (VTC Spring).
- [3] Riener, A., Jeon, M., Alvarez, I., & Zambonelli, F. (2014). Special Issue on "The Social Car: Socially-inspired Mechanisms for Future Mobility Services". *Pervasive and Mobile Computing*, 14, 66-70.
- [4] Manik, R. (2014). Wanted: Technologies to Enable the Connected Car. *Auto Tech Review*, 3(5), 12-13.
- [5] Novac, O. C., Novac, M., Gordan, C., Berczes, T., & Bujdoso, G. (2017). Comparative study of Google Android, Apple iOS and Microsoft Windows Phone mobile operating systems. 2017 14th International Conference on Engineering of Modern Electric Systems (EMES).
- [6] Hadiwardoyo, S. A., Patra, S., Calafate, C. T., Cano, J., & Manzoni, P. (2017). An Android ITS Driving Safety Application Based on Vehicle-to-Vehicle (V2V) Communications. 2017 26th International Conference on Computer Communication and Networks (ICCCN).
- [7] Kovacevic, B., Kovacevic, M., Maruna, T., & Papp, I. (2017). A java application programming interface for in-vehicle infotainment devices. *IEEE Transactions on Consumer Electronics*, 63(1), 68-76.
- [8] Meseguer, J. E., Calafate, C. T., Cano, J. C., & Manzoni, P. (2013). DrivingStyles: A smartphone application to assess driver behavior. 2013 IEEE Symposium on Computers and Communications (ISCC)
- [9] Frank, R., Bronzi, W., Castignani, G., & Engel, T. (2014). Bluetooth Low Energy: An alternative technology for VANET applications. 2014 11th Annual Conference on Wireless On-demand Network Systems and Services (WONS).
- [10] S. A. Hadiwardoyo, S. Patra, C. T. Calafate, J. C. Cano and P. Manzoni, "An Android ITS Driving Safety Application Based on Vehicle-to-Vehicle (V2V) Communications," 2017 26th International Conference on Computer Communication and Networks (ICCCN), Vancouver, BC, 2017, pp. 1-6.
- [11] M. Vochin and H. AL-Amily, "Mobile communication application for V2V systems," 2017 International Symposium on Signals, Circuits and Systems (ISSCS), Iasi, 2017, pp. 1-4.
- [12] S. Yogarayan et al., "A study of cloud based connected car services," 2017 5th International Conference on Information and Communication Technology (ICoICT), Melaka, 2017, pp. 1-6.

