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Research paper

An Evaluation Using Cloud Services for Car-To-Car Communication

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Abstract

Modern hand-held devices such as smartphones and tablets have become high in demand. Wide range of commercial concepts and possibilities have come into the limelight due to the extra features fitted in these devices. In particular, most smartphones and tablets regularly include cameras, high-speed processors, GPS and internet access. With emerging technology, there are many applications that allow the processing of real time information and location based services. Mobile devices from various platforms gain much popularity and become more advanced these days. In short, we are using them to accomplish our daily tasks. Hence, two applications are developed and tested with cloud services integration.

Keywords: *car communication; cloud services; platform; android; GPS*

1. Introduction

For many years, the transportation field has been waiting for automated technologies that will make road journeys safer, more enjoyable, and less stressful for drivers when they are on the move. Now, with the advancement in the technologies, everyone can experience vehicle-to-vehicle communications in most of the high-end cars. This brings the automobile industry closer towards a future where all vehicles have integrated connected car systems [1] [2].

This project is an android application that is developed to establish communication between cars using smartphones. The communication between two cars can be done via push notification message. Push notification allows an application to send us new messages or notifications, similar to traditional text message system. This application enables drivers on the road to notify or alert each other if there is a problem faced by any of them; for example, traffic jams bad weathers, opened car doors, non-functioning headlights and so forth. Moreover, the application enables the user to capture images of road accidents, road closure and road works in the current location.

This application is designed to help users save more time and avoid traffics. The idea is to connect cloud systems to automobile platforms, which can provide information in real time. Since mobile devices are already popular among the people in this current age, it presents a golden opportunity to integrate connected car systems in mobile devices to bring seamless driving experiences for the drivers. Cloud services will be used for a real time information exchange as a strong backend database.

2. Literature Review

Cloud computing, which is considered as the "Next Version of Internet", can be described in many ways. In the simplified version, the word "cloud" is known as a representation of the Internet. In simple terms, "the cloud" is a representation of the Internet; as such, when it is merged with "computing", it refers to computations done through the Internet. A convenient environment of development and deployment is where the future of cloud computing services are heading. Challenging software issues such as cost efficiency, scalability and crucial need of coding in operation workflow are the issues raised by cloud computing platforms [3].

These days, mobile devices are used for more than just call and text purposes. The popular brands of iOS, Android, Windows and Blackberry series are no longer selling just smartphones only as the functionalities of it are not limited to calls, texts, emails and web browsing [4]. Being widely used for navigations, optics, gravity and orientation and other purpose, smartphones have attracted many vehicle manufacturers' interests where an appropriate and intellectual experience can be felt by the users. It is believed that with the emerging cloud computing service development, mobile phones will become gradually complex and advance to a portable super computer [5].

2.1. Existing Application Use

Certain existing applications have been compared in two different perspectives, which are social messaging and traffic flow. HiCarPlate is an android application that communicates with users by searching the car's plate number and immediately searches for empty parking slots. Additionally, HiCarPlate allows users to communicate with the owner of a car using just the car's plate number. The application is useful for the drivers to communicate

among themselves by sending messages in case of an emergency. The functions of HiCarPlate include chatting with nearby drivers, finding parking lots, calculating routes to help drivers find their parked cars, setting parking ticket expiration time and receiving notifications. In addition, the parking module allows the driver to see where other cars are parked. Driver can see the time at which the car was parked, the ticket expiration time (if any) and the spots that have just been released [6].

Other than that, Car Chat is another communications platform, which allows users to interact with other users by the means of car's plate numbers. Once the user has downloaded the app to their smartphone, they can register for an account [7]. All the user needs to do is search for the car's plate number of the person with whom he/she wants to make contact with and open up a chat session with the owner of the vehicle. Another function of the applications is to send predefined messages to other drivers using the plate number.

Adding into the list of existing systems, CarBeep is another global network application for meeting new people. It enables users to expand their social network with the tap of a button. Users are able to make new friends or meet new people, anytime, anywhere with options of browsing through other users' profiles and pictures [8].

For the traffic flow, many applications have come out with the technology of traffic and route navigations, with the most popular one being Waze. Waze is unlike traditional GPS navigation software as it is more towards community-driven, gathering complementary map data and traffic information from the users [9]. It operates in a two-way medium where user inputs such as accidents, traffic jams, speed traps and police roadblocks are pinned on the map. Besides, through online map editor, landmarks and house numbers can also be updated in the application. Additionally, Waze calculates the nearest fuel station along the route.

Based on Utah Department of Transportation (UDOT), Utah roadways information is directly accessible through UDOT's traffic applications. It has an easy access control panel with zoom and scroll functions to view the road's current status. Current traffic flow on the freeways and main streets are also viewable on UDOT. This application can show current weather conditions, road weather forecasts, closed-circuit television (CCTV) traffic camera images and road closure status [10]. Besides that, this application also shows special events that affect traffic as well as electronic roadway sign messages. Unfortunately, UDOT's application is only available for residents of Utah.

Additionally, there is another application called INRIX. INRIX has traffic news information, which is up to date with current traffic conditions as well as constructions, accidents, events, police alerts and road closures. Based on daily route data, personalized alerts regarding the particular route is also sent to the user. Besides that, this application can share user arrival times to friends. Unfortunately, INRIX is only available in European countries, China, Brazil, Singapore, and UAE. Malaysia does not support this application as of now [11]. Table 1 shows the discussed application services with their features in a comparison view.

Table 1: Comparison of Application Services

Application / Features	Chatting Services			Information Services		
	HiCarPlate	Car Chat	Car Beep	Waze	UDOT	INRIX
GUI	✓	✓	✓	✓	✓	✓
Payments	×	×	×	×	×	×
User Suggestion	×	×	×	✓	×	×
User Registration	✓	✓	✓	✓	✓	✓
User Login	✓	✓	✓	✓	✓	✓
Account	✓	✓	✓	✓	✓	✓
Information	✓	✓	✓	✓	✓	✓
Performance	Fair	Fair	Fair	Good	Fair	Fair
Cloud Based	×	×	×	✓	×	×

2.2. Cloud Services

Development of an android application depends on strong support of software such as Android Studio, Java Platform, Standard Edition (Java SE). However, cloud services are the backend database that works along to provide information in and out of an application. Two well-known cloud services have been compared to get a clear perspective.

Facebook has supported Parse beforehand, yet early this year, Facebook has closed down Parse and designers have been given the open source version, which is Parse Server. Parse Server, which is the open source version of Parse has been upheld by a solid group of open source designers. In fact, Parse Server have

analyzed the deficiencies that were available in Parse and held the great things that were available in Parse. With the Parse Server self-hosted by the users, it can be the best platform to develop new Android or iOS applications or API's. Parse Server needs infrastructure that runs on Node.js and it supports Express web application framework. Once the data is available in the database, the client could use the application for any retrieval or saving. Besides, MongoDB is used by Parse to store information and Amazon S3 as a bucket to store document framework. Parse Server has improved database functionalities, for example, performance refactoring, data backup/restore and indexing [12].

With Parse Server, user can pick a file system of their choice. There is also an alternate choice of storing files in JSON format as backup These JSON files can be accessed at any time. Parse had a limit on the quantity of queries, cloud functions, and database triggers; however, Parse Server has no such restrictions. Parse Server assures on information security without changing client code. Pointer permission is the latest update for the Parse Server and is accessible in the most recent version of Parse Server. Parse was notable for its dashboard, and Parse Server has all the incredible dashboard features of Parse. The dashboard empowers users to control and configure their applications and send push notifications. Users do not need to make similar queries each time they require information. Users can create a query and Parse Server will get real time data and subsequent data changes.

However, Google is supporting Firebase just like how Facebook supported Parse. Firebase is another option that is able to host web applications. Firebase stores the data in JSON format. JSON data is promptly accessible through REST API's or by utilizing client libraries [13]. The data is stored in the cloud and it is easy to be acquired from any place. Firebase consists of a model-observer scheme, which is most beneficial for intelligent applications. Any changes to the data done on the server is updated to the authorized client progressively. The data synchronizes in a split second on the client devices.

Cloud messaging and remote customization of applications allow the application attributes to be updated promptly. It is a robust cross platform API for Android and iOS applications. Additionally, it supports JavaScript with very adaptable security API. Authentication through Twitter, Facebook, and Google are certified. The user need not stress over hosting data, as Firebase will handle

it. With a local database, Firebase can update every one of the users with real time data. Table 2 shows the comparison of two available cloud services for mobile application development.

Table 2: Comparison of Cloud Services

Cloud Services	Parse	Firebase
Provider	Facebook	Google
Type	Open Source	Open Source
Purpose	Backend Real-Time Updates	Backend Real-Time Fast Updates
Database Function	Database has huge relationship	Database supports model observer scheme
Push Notifications	Yes	Yes
Storage	JSON Compatible Data	JSON Data
Installation	Easy, Step by Step	Easy, Step by Step
Suitability	General Purpose Application	Time Application, Query Data

2.2. Technology Advancement and Automotive Industry

Despite the fact that carmakers embraced Apple's CarPlay and Google's Android Auto, numerous carmakers want to build a standard framework option that could bring all domains together. Automakers claim it as a move to make a consistent experience for their customers, yet others in the business consider it an approach to remove Apple and Google from the equation, so car manufacturers can keep on selling new services to the customers [14]. The boldest move towards this path originated from Ford and Toyota, which together established a group called the SmartDeviceLink Consortium. The consortium will focus on creating and advancing the utilization of an innovation called SmartDeviceLink, which is consider free terms as an application store via automakers and equipped for running on any cars [15]. In recent years, Google has introduced the Android Things for developers who want to build connected devices. Android Things is an IoT platform that aims to be built faster, cheaper and more secure. The operating system of Android Things is Android, which powers many of the world's smartphones and drives the interest towards connectivity application.

3. Experimental

3.1. General Design

This project is concentrated mainly on developing two applications with two different cloud services and compare the differences in their performances. The first application is named as Car Talk with Parse Server integration and the second application is named as Car Sharing with Firebase integration.

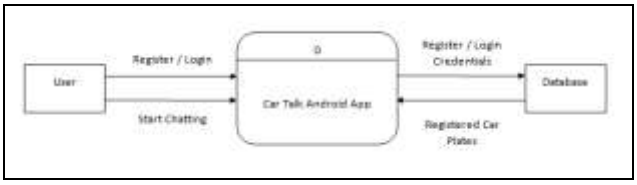


Fig. 1: Car Talk Context Diagram

The deliverables of Car Talk application is concentrated mainly on chatting facilities when the communication between drivers/devices is established.

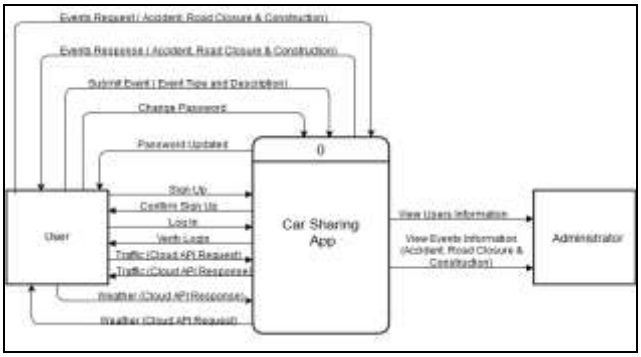


Fig. 2: Car Sharing Context Diagram

Besides, Car Sharing focuses on showing the current location's weather and traffic status. It also allows users to capture images of an accident, road closure and construction that could be sent to the authorities to take action.

3.2. Software Use

Android Things is the platform used for the software development of this project. The word "Android" is intended to refer to robots; however, it is known as the open source mobile phone operating system launched by Google. Android is based on the Linux platform, and composed of operating system, middleware, user interface and application software. Android has been called as the first truly open mobile software for mobile terminals.

Nevertheless, Android Things is a trimmed down version of the company's famous Android operating system. Unlike the standard version of Android, Android Things is not meant to handle all of the complex functions necessary to run a smartphone. Instead, it is a version of Android that is tailored towards IoT development. It is meant to provide a software framework for simple tasks without using more power.

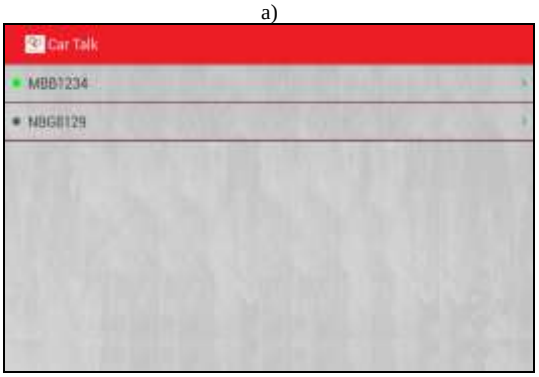
3.3. Hardware Use

The hardware used in this project is the Raspberry Pi Model B+ board along with 7-inch touch screen display. Raspberry Pi is a small, powerful, cheap and education-oriented computer board introduced in 2012. It operates in the same way as a standard PC, requiring a keyboard for command entry, a display unit and a power supply. The Raspberry Pi, like any other computer, uses an operating system. The standard operating system is Linux-based called Raspbian and it is a great match for the Raspberry Pi because it's free and open source. In this case, the platform used is Android Things. One of the great things about the Raspberry Pi is that it has a wide range of usage.

4. Testing and Discussion

The Car Talk application consists of users and it is managed by the Parse cloud services. In order to use the app, the user must make sure that he has registered his details into the system. Once registered, he may login to use the app. Once the user has logged in, he will see the available cars nearby. Those who are online will be shown in green colour while the offline users will be shown in grey colour. Users can view their previous chats and newly received chat messages. Besides that, the Android app has the facilities to enable the user to edit their profile details. On the other hand, the Parse, which acts as a cloud backend, will verify each login based on the details registered by the user. Those who has not registered with their vehicle numbers will not be able to use the application.

a)



b)

Fig. 3: a) Login Page and b) List of Online Drivers

Fig. 4: Parse Cloud Service Database Interface

The first step is for the user to login into the application where valid vehicle number and password are required. Vehicle number and password will be verified from the user details file. Once the user verification has completed, the user could access the application and will be directed to the main menu. For users who do not have an account; they will need to sign up by registering with required details. The details will be saved into the user details file.

Once logged in, the user will land on the homepage. The homepage contains five functions, which are Traffic, Weather, Accident, Road Closure and Construction. The application that is stored with the details and availability will be retrieved from the database to the application in real time. After that, the user is able to choose from the events. Lastly, the user can update their information such as their password in the application. Account details will be retrieved from the user details file, where the registration information are stored. User can update the password of the account and save over the existing user details file. This is the complete list of the functionalities of the car sharing application.

Then again, the Firebase, which goes about as a cloud backend, will check each login details input by the user. The individuals who have not registered with the vehicle number will not be able to utilize the application. With registered users, they are eligible to make functions update on the selection and it will refresh straight away on the maps for others to see.

a)

b)

Fig. 5: a) Login Page and b) Main Interface


```
"Maps" : {
  "-Kjf5d3uznG9XVnDHRJe" : {
    "EmailAddress" : "loga_dev@gmail.com",
    "EventType" : "Traffic",
    "LocationCoordinate" : {
      "latitude" : 2.2507175000000004,
      "longitude" : 102.27475390624997
    },
    "SubmittedDateTime" : "09-05-2017 10:47 AM",
    "UserID" : "FZJock8SzOVrU8J9h8lOu7PWC7G2"
  },
  "-KwFyxarRkGjthfVI-dl" : {
    "EmailAddress" : "mastersumen@gmail.com",
    "EventType" : "Road Closure",
    "LocationCoordinate" : {
      "latitude" : 2.7037924999999987,
      "longitude" : 101.94482421874997
    },
    "SubmittedDateTime" : "12-10-2017 10:28 pm",
    "UserID" : "FZJock8SzOVrU8J9h8lOu7PWC7G2"
  },
  "-KwFzIELRSoSVNdF63kY" : {
    "EmailAddress" : "mastersumen@gmail.com",
    "EventType" : "Accident",
    "LocationCoordinate" : {
      "latitude" : 2.7043225000000106,
      "longitude" : 101.94058984374996
    },
    "SubmittedDateTime" : "12-10-2017 10:29 pm",
    "UserID" : "FZJock8SzOVrU8J9h8lOu7PWC7G2"
  },
```


Fig. 6: Firebase Database JSON Format

The Raspberry Pi is a low cost single-board computer, which has recently become very popular. This low cost device, which has a resistive touch screen display with Android Things, was used as the hardware component of this project. The integration of this device will give the look of a connected device platform. The only reason for using mobile application is convenience. One of the important elements of any mobile application is about providing high level of convenience. It is much easier for any user to access information and other activities with just one click on the applica-

tion's icon. In this way, organizations have begun to consider developing applications that provide a platform for cars to communicate in their interface head unit rather than using a mobile phone. This draws a possible way to bring mobile experience inside their cars. There are concerns of safety and security of implementing such a development in the car. Nevertheless, it is better to apply it here first and then seek feedback on mobile experience in the car once it is implemented.

Fig. 7: Integration of Raspberry Pi and 7-Inch Touch Screen

5. Conclusion

This system is mainly developed to fulfil the need for a fast and reliable way of communicating among the drivers out there to ease their driving experiences and journeys. Apart from that, this development will also be very useful in case of emergencies faced by any driver or their vehicles in a certain area. They can share information by using these added services. Besides that, the predefined messages will also allow the drivers to send the push notification messages in a fast way. However, to make sure that a good communication is establish between them, a good and effective network connection is needed the most. This pretty much saves the time and increases the efficiency, which is considered one of the system's objectives. In addition, clouds now are accessible anytime in order for drivers or the users to interact with one another. It supports the real time transmission of data, which is very useful for Car Talk and Car Sharing Android applications. Moreover, it significantly reduces the possibility for human errors and security loopholes in the virtual world. This is where cloud services integration comes in handy. With the aid of cloud services, added services can be done and all the data will be able to be analyzed for future enhancement or usage. Despite the development of the application, this approach is still in a testing phase; the room for improvement is definitely needed. In the future, more enriched enhancements can be developed for the application. There are some improvements that can be implemented to increase the functional efficiency of the application.

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