BBIS: Beacon Bus Information System

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Abstract. Lack of bus information for example bus timetable, status of the bus and messy advertisement on bulletin board at the bus stop will give negative impact to tourist. Therefore, a real-time update bus information bulletin board provides all information needed so that passengers can save their bus information searching time. Supported with Android or iOS, Beacon Bus Information System (BBIS) provides bus information between Batu Pahat and Kluang area. BBIS is a system that implements physical web technology and interaction on demand. It built on Backend-as-a-Service, a cloud solution and Firebase non relational database as data persistence backend and syncs between user client in the real-time. People walk through bus stop with smart device and do not require any application. Bluetooth Beacon is used to achieve smart device's best performance of data sharing. IntelliJ IDEA 15 is one of the tools that that used to develop the BBIS system. Multi-language included front end and backend supported Integration development environment (IDE) helped to speed up integration process.

1. Introduction

Beacon Bus Information System (BBIS) is an intelligent information sharing support system to share useful information about bus by using Bluetooth Smart technology. With seamless connection between devices, BBIS built for students and public user to get current bus status information. This application allows user to share the information of buses, check the timetable, view service status, add new related posts or edit the posts. Furthermore, this application allows users based on which bus
stop they are located, estimation bus arrival time as references to user that can inform others user never miss a bus again. Normally, passengers lack of bus information like bus timetable. Moreover, passengers need latest bus information to a destination. Therefore, a real-time update bus information bulletin board is needed to refer so that passenger can save time for bus information searching. The objectives of the project are is to develop a system that provide bus operate time solution and to implement paper-free bus timetable. This bus information sharing system is a responsive web-based application. It supports Android version 4.4.3 above which is built up for those who take bus as they main transport system that around in Johor area with bus routes departed from Batu Pahat Town toward Kluang area.

2. Technology for BBIS

2.1 Physical Web
The Physical Web is an open source approach to unleash the core superpower of the web: interaction on demand. People should be able to walk up to any smart device and not have to download any application at first. Everything should be just a tap away [1]. In this project, BBIS is using physical web technology to discover relevant bus information via Bluetooth low-energy beacons.

2.2 Backend as a Services (BaaS)
Backend as a Service, or BaaS is a cloud computing category that consists of companies that make it easier for developers to setup, use and operate a cloud backend for their mobile, tablet and web apps through customized Software Development Kits (SDK) and Application Programming Interfaces (API) [2] with linking applications to backend cloud storage. This also providing features such as user management, push notifications, and integration with social networking services. Firebase, a cloud backend as service platforms enable BBIS developed with stored, managed and access data through such cloud. Moreover, this helps to develop backend features for web apps faster.

2.3 Non-relational SQL (NoSQL)
NoSQL Database is a distributed key-value database. It is designed to provide highly reliable, scalable and available data storage across a configurable set of systems [3] that function as storage nodes that right answer for involving in big data. Firebase real-time database is used as database of BBIS system which is a non-relational document database. In favor of JSON-like documents with dynamic schemas, binary JavaScript Object Notation file (BSON) which is schema that makes the integration of data in certain types of applications easier and faster.

2.4 Bluetooth Low Energy (BLE)
BLE is a massive overhaul of the Bluetooth specifications, aimed at very low power applications. It sacrifices in range of 50m instead of 100m and data throughput in range of 0.27 Mbps instead of 0.7-2.1 Mbps for a significant savings in power consumption. BLE is aimed at peripheral devices which operate on batteries, and don’t require high data rates, or constant data transmission [4]. BLE is used for BBIS project because BLE do not need to exchange large amounts of data, and can therefore run on battery power [5] for years at a cheaper cost. BLE able to remain in sleep mode constantly except for when a connection is initiated.

2.5 Beacon
Beacon uses BLE radios to detect other nearby BLE devices, sends universally unique identifier (UUID) to the other device. In this project, beacon is used for sending UUID of specific bus stop to allow user access the bus operation timetable and routes will pass through this location that provided by bus company. Beacon is a tiny computer that broadcasts radio signal of current bus stop's UUID. Smartphone can discover, pick up and interpret with this signal. When passenger enters the signal's region for example bus stop Taman Jaya, Parit Raja which corresponding actions can be triggered with Bluetooth enabled for the BBIS launched.
3. Existing System

RapidKL Travel Guide is a dynamic web application that jointly developed by ePetrol Systems SdnBhd (ePetrol) and Prasarana Malaysia Berhad (Prasarana) to plan and travel with ease by using RapidKL Travel Guide apps on the RapidKL LRT and monorail networks [6]. Katsana Global Positioning System (GPS) Tracking and Fleet Management platform is a tight integration of hardware and software to form a thorough web-based application that provides comprehensive functionality to track, manage and monitor fleet of vehicles via Global Positioning System [7]. Transit Kuala Lumpur Navitime is developed by NAVITIME JAPAN CO. LTD that helps users travel to use the offline map. This app will provide user easy journey planning with zoom-able interactive maps of the RapidKL, KTM Komuter and KLIA Express or Transit in Kuala Lumpur, Malaysia with tap the stations to set origin and destination in the interactive maps [8].

4. Implementation of BBIS

In this project, document gathering, survey and observation situation that involves detailed communication between user group to understand them expectations and exact requirement. The data collected will be as references to build a system that can achieve what users that they need. In System Design, Relational databases struggle with is related to an exponentially increasing amount of data when standard SQL query operations do not have acceptable performances, NoSQL will be the resolution to solve this problem to perform real-time system and the user requirement document is re-edited accordingly when requirements are not feasible. At integration test, Apache Maven is used to as comprehension tools that manage BBIS system building reporting and documentation with a project object model (POM). POM provides guidelines for best practices BBIS development in the direction. Unit test plan is created and keep the source code in separate but parallel source tree followed with test cases and test data. Once the components have been inherited execute the test cases. Bus and posts information consider as the main test data. Firebase CLI is installed with NPM to create a reusable code across platform. The test data is tested by using Jasmine to make sure data schema is well-performed. These will keep in repeating the test cycle until the components have been successfully integrated.

During BBIS development, inherently wrong on package manager was found and difficult to find the version dependencies. Since Bower doesn't support nested dependencies, a conflict will get. To resolve the problem, bower.json is move to package.json by NPM that provided package repository.

An implementation checklist is prepared before starts the development of the system. To full-fill the system requirement, Java language is used for development Beacon Simulator while Firebase used as backend of BBIS real-time system to serve up the Binary Json (BSON) file information and presented to user through that front-end languages are HTML 5 and AngularJS to make processing faster of the system with the coding guidelines and standards.
Finally, user acceptance testing goes on. Beta testing is launched for user. User experience is focused on to make sure best performance of the BBIS system. The goal of user acceptance testing is to assess if the system able support 24/7 user scenarios and system sufficient to correct user usage.

Hardware requirements for BBIS are 8GB memory, 64 bit processor type, processor speed 1.83 GHz, swap space 2.0 GB, 6.5 GB temporary hard disk space Qualcomm and Atheros AR3012 Bluetooth 4.0+ HS. During setup the system, temporary files will be created on the system drive. Before run installation Setup, at least 6.5 GB of available disk space on the system drive for these files. Actual hard disk space requirements depend on system configuration and features that decided install. Beacon will be used to broadcast dynamic contents. There is an application designs for smart phone device with Android 4.4 or above, API level: 19+ (Bluetooth smart ready) for accessing BBIS.

Firebase Realtime Database 2.4.2 is one of the non-relational database (NoSql) to store bus information and store personal data information. IntelliJ IDEA 15 is complete solution for building BISS system in Java and JavaScript. Multi-programming supported gives a helpful hand in developing web and Android application. Adobe Creative Suite 4 (CS4) is a design kit that will be used for generating vector graphics and user interface. User can add and delete their posts in bulletin board system to make sure less spam found in bulletin board. Only verified user can make post in bulletin board system. Meanwhile, guest only can view the information list, bus timetable and can do searching and as shown in Figure 2, 3 and 4.

![Figure 2. Bulletin board for user.](image1)

![Figure 3. Interface example of BBIS search function.](image2)
5. BBIS Performance Testing

Performance testing pages in BBIS for mobile devices and desktop devices to make sure performing well in user experiences (UX) and user interface (UI). Google PageSpeed Insight is used to fetch the mobile user-agent and desktop-user agent url. Elapsed time to above-the-fold load and time to full page load are focused. The moment a user requests from beacon to landing page to the moment the above-the-fold content is rendered by the BBIS via browser and the page is full rendered by the browser is the scope of the testing. Therefore, the testing objective is score 85 mark above to indicate that BBIS is performing well to user. First testing with PageSpeed Insights is not satisfied and scored 63 in testing. This is moderate mark for a testing but still can has improvement and second testing report is done after bugs fixed. These displayed in Figure 5. A bugs fix list is prepared included the solutions to fix the bugs and listed in Table 1.

6. Discussion and Conclusion

BBIS aims to provide a big community in bulletin board system that enable passenger in bus stop can get related bus information with obtain the maximum information result at least effort, just open Bluetooth and pass through beacon and get the UUID from beacon. These reduce messy work like using keyword searching via related search engine. The development of this information sharing system solves the problems which are user facing problem to find out most related result. Just like a bulletin board, BBIS provide a place to citizen to post their information without paper printing but more than a bulletin board system. Just like a multi-information service centre, people write and make posts comment to involve in communication. No more dirty and messy flyers printing around in bus stop. This keeps a town clean and bring good image to others. Related useful function for passenger like search bus routes, calculate fares and check timetable bring convenience to passenger.
In a nutshell, the objectives of the project have been achieved within the scopes. By using this system, users able to access bus information that they needed. Despite there are several limitations existed in the application which limits the achievement, but this application still can be enhanced and improved by fixing the limitations and adding additional features in the future. There are several improvements can be achieved in order to enhance the performance of BBIS. Firstly, this system able to deliver GPS system on busses, co-operate with bus company to achieve truly real time update bus timetable solution. Therefore, more beacons are needed to achieve this work. This system basically completed to fulfil the user's requirement. However, there is always a space for the enhancement. For future recommendation, this system needs to provide the native application for offline user to check the bus timetable. Another recommendation is added the short messaging system (SMS) that will allow the system notification faster than email notification.

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