

SUSTAINABLE CAMPUS: INNOVATING ATTENDANCE TAKING WITH THE USE OF BEACON-INTEGRATED MOBILE APP

HuiKeng Lau, SengKheau Chung
Universiti Malaysia Sabah, Sabah, Malaysia

ABSTRACT

Many institutions of higher learning (IHL) are moving towards the establishment of a sustainable campus. In addition, budget cuts in IHL demand innovative ways of transforming business processes for efficiency and savings. Attendance taking is one of the many routine processes in many settings ranging from seminars, trainings, meetings, workshops, and classes. Although it may seem insignificant, it actually uses huge amount of resources due to its frequency of practise. In any IHL, there can be up to a total of hundreds of meetings, classes, trainings, workshops, and seminars. In addition to the resources for printing, many pen and papers are used. Therefore, re-engineering of this practise can offer cost and time savings. With the advancement of technologies and the ubiquitous of mobile devices, this paper proposes an innovative way of taking attendance with the integration of beacon devices with mobile technologies. A beacon is a device that uses Bluetooth Low Energy to broadcast its universally unique identifier. This new technology offer advantages in terms of cost and indoor positioning over other technologies such as Global Positioning System, QR code, and Radio Frequency Identification.

Keywords: mobile apps, beacon technology, attendance app, android app

1.0 INTRODUCTION

Currently, the move towards the establishment of a sustainable campus together with budget cuts in IHL demands innovative ways of transforming business processes for efficiency and savings. Taking attendance is one of the many routine processes in many settings. Everyday, attendance are taken for up to hundreds of seminars, trainings, meetings, and classes. The report of attendance is often used for the purposes of claiming expenses, evaluation of performance, analysis of participations, and so on. Although it seems insignificant, attendance taking actually uses huge amount of energy and resources due to its frequency of practise. In addition to the resources for printing, many pen and papers are used. Therefore, re-engineering of this practise not only can offer cost and time savings, it can also be more environmental friendly and sustainable.

Traditionally with pen and paper, the practise is carried out by either the instructor calls out students' name and then mark their attendance, or let the attendees sign on an attendance sheet. In a class setting, calling out student's name one by one is time consuming, especially when the number of student in a class is huge, as it takes a long time before a class can start. Letting the students to sign on the attendance sheet seems to be more practicable but there are problems with this practise. Firstly, the students can and will sign the attendance sheet on behalf of their friends who are absent. Secondly, the attendance sheet may be misplaced or damaged. On top of that, in some institutions, the attendance needs to be transferred onto to computerised system. During the process of manual insertion, human carelessness may led to some of the data be skipped or wrongly inserted.

2.0 LITERATURE REVIEW

2.1 Attendance Apps

There are some attendance apps on the market such as TeacherKit, Easy Attendance School College, and Attendance as shown in Figure 1. All these apps have the functionalities to manage the courses and students' attendance. However, the adding of the students to classes and taking attendance are done manually by the teacher/lecturer without students' involvement. When taking attendance, Easy Attendance School College is different to TeacherKit and Attendance in that the lecturer only mark those who are absent. This way, it is less time consuming especially when the class is large. All these apps do not have the function to generate reports of the attendance for the individual or the class.

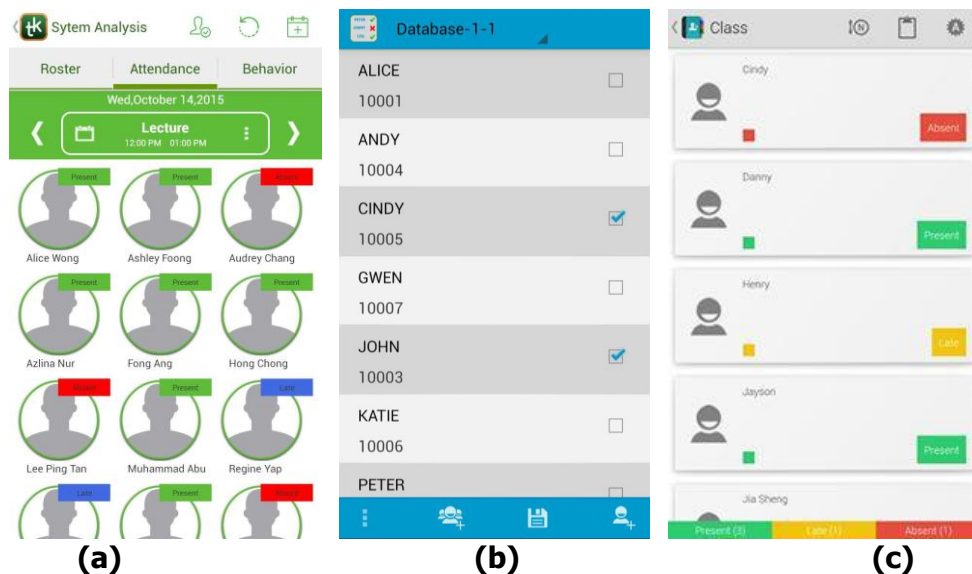


Figure 1: (a) TeacherKit (b) Easy Attendance School College (c) Attendance.

2.2 Feasible Technologies

With the advent of technologies and the ubiquity of mobile devices, there are new approaches of attendance taking through the use of mobile apps. The first approach is transform the practise from physical pen-and-paper to electronic touch-and-click in which the attendance is still taken by the instructor. Our survey on current Android apps on Google PlayStore discovered many such apps. TeacherKit, Easy Attendance School College, and Attendance reviewed in previous section belong to this category. Therefore, the advances offered by mobile and networking technologies are not fully explored.

The second approach is to use navigation technologies such as Global Positioning System (GPS). For example, Masalha and Hirzallah (2014) used GPS to validate the attendees in their system. GPS, however, suffers from the problem of indoor signalling because the satellite signals may not work well indoor due to physical obstruction.

The third approach is to use uniquely identifiable construct such as QR code and Radio Frequency Identification (RFID). With RFID, each person only need to place their identity card affixed with RFID tag on the RFID reader for their attendance to be taken (Lim et al, 2009). The problem with using technology for attendance app is the cost. On top of the

RFID proximity card reader, each individual needs to have a card with affixed RFID tag, the cost is high. To use QR Code for attendance, the QR code needs to be generated for each class (Masalha and Hirzallah, 2014). The instructor needs to generate the code and display it during or at the beginning of each class. The attendees have to scan the encrypted QR code to confirm their attendance. Using QR code for attendance taking is cost saving and can be implemented easily. Having said that, there is another technology that can offer equally good solution and the instructor does not need to repeatedly do extra preparation for attendance in every class. This technology is developed into a device called a beacon.

In 2013, Apple Inc. introduced iBeacon™ at the Apple Worldwide Developers Conference. iBeacon™ is a device that broadcast its universally unique identifier (UUID) using Bluetooth Low Energy (BLE) to nearby devices (Apple Inc, 2015). The UUID can be used to determine the device's physical location and trigger a location-based action on the devices. Therefore, this device can be used for indoor positioning and thus can be integrated into attendance app. Our initial investigation on this technology is that the beacon device can be placed at a fixed location (e.g., class, lecture hall) or to be carried around by each instructor. Whenever there is a class, the attendee's smartphone can detect the UUID of the beacon and thus allows the attendance to be taken. To the best of our knowledge, to date, no attendance app has utilise this technology.

3.0 METHODOLOGY

Agile development methodology (Ihme and Abrahamsson, 2005) is the system development methodology. Figure 2 shows the six phases in Agile development methodology. This methodology offer the flexibility of adapting to changes as prototypes are released to be accessed and improved.

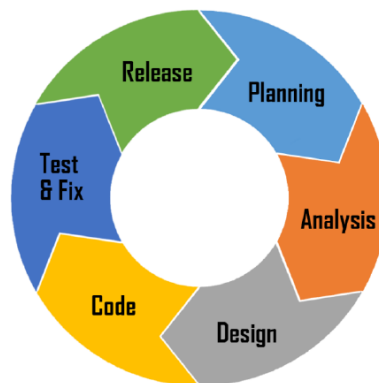


Figure 2: Phages in Agile development methodology.

In the Planning phase, review on the suitability of using beacon for attendance taking was carried out and the scope of the project was defined. In the next phase (Analysis), review of existing apps and technologies have been carried out. In Design phase, software designs such as Use Case Diagram, activity diagram, sequence diagrams, and database design are produced to guide the development of prototypes in the Code phase. Testing phase involves the testing of the modules and the integration of modules of the app under development. The next phase is Release of the prototypes. If there are more changes from the users, the cycle restarts.

The Integrated Development Environment (IDE) used for the development for the app is Android Software Development Kit (SDK) using Java Programming language and XML. The database administration tool used for the server-side of the app is phpMyAdmin together with MySQL database.

4.0 BEACON-INTEGRATED APP

In this work, use case diagram is used to depict the users, modules, and the interactions between them for the beacon-integrated app. In a typical class setting in IHL, the users are the lecturer, students, and tutor or demonstrator. There are ten modules for the app as shown in Figure 3. Different users can access different modules. The modules to manage course, class, beacon and generate report for the course can only be accessed by the lecturer. Similarly, the modules to mark attendance, enrol to class are specific to students. The remaining modules (manage authentication, view timetable and attendance record) can be used by all users.

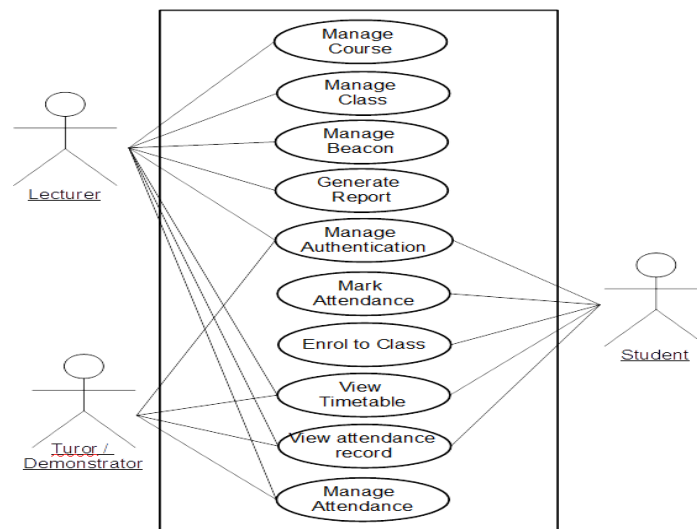


Figure 3: Use case diagram of the attendance app.

4.1 Manage Authentication

After installing the app, the user have to register a user account as shown in Figure 4(a). In each user account, the particulars of the user (e.g., full name, username, id) as well as the device's Unique Device ID (UDID) are stored. The UDID is not displayed during registration as shown in Figure 4(b). Each device is only allowed to register for one user account. When a user changes device, the new UDID has to be updated in the user account and the new UDID has to be unique and not linked to any other user account. This prohibit the students from taking attendance on behalf of other people. At any time, the user can update their profile as shown in Figure 4(c).

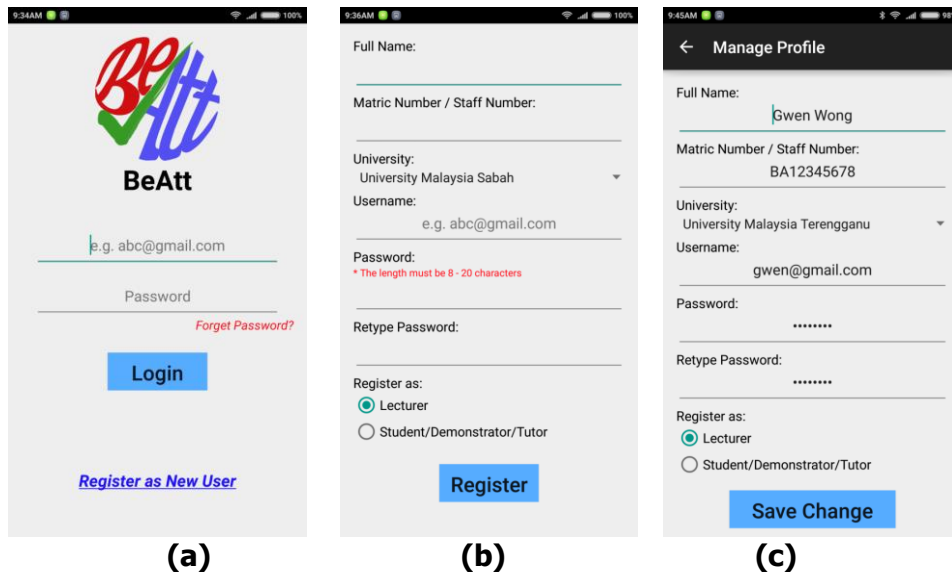


Figure 4: (a) All users need to be registered (b) Registration (b) Updating of user profile.

4.2 Manage Course

After login, users are directed to the main interface with four sub tab as shown in Figure 5(a). The four tab are Main tab, Course tab, Class tab and More tab. Only lecturers can access the manage course module. In this module, the lecturers can add and update courses taught by them. To add a new course, simply provide the required information as shown in Figure 5(b). Figure 5(c) shows list of all courses taught by each individual lecturer is shown.

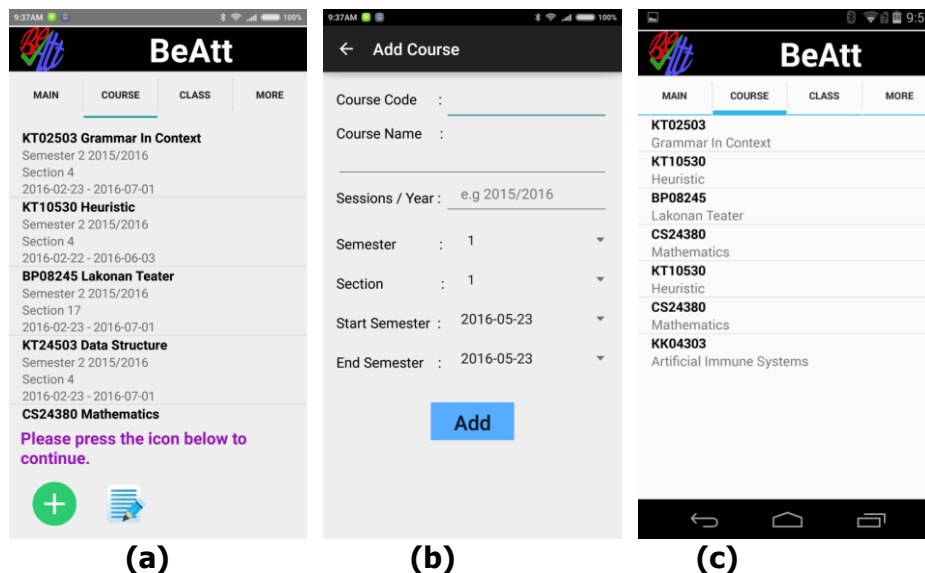
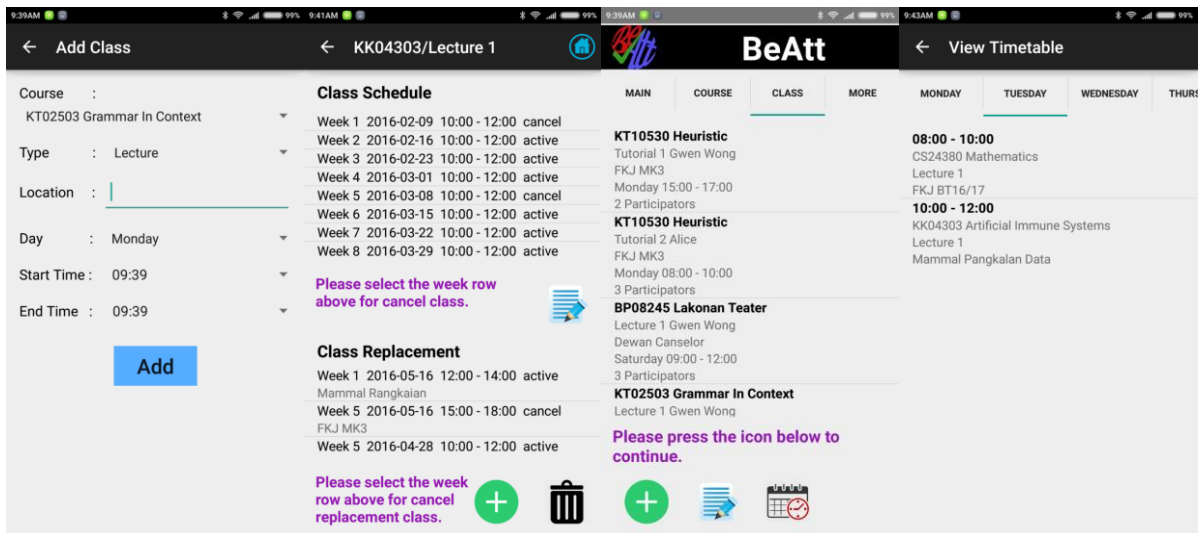


Figure 5: (a) Main interface after logged in (b) add course (c) all courses under the lecturer.

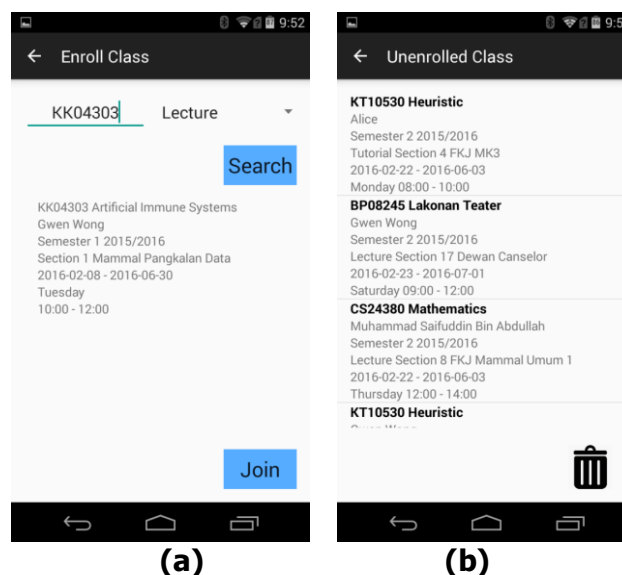
4.3 Manage and Enroll to Class

After created a course, the lecturer can proceed to create the classes (Figure 6(a)). For each course, the class can be lecture, tutorial, or laboratory. Based on the information given when a course is created as well as the details of the classes, the schedule of the class will be generated as shown in Figure 6(b). For each scheduled class, its details can be edited as well as cancelled. For each cancelled class, a replacement class can be added. Both lecturers and students can view their timetable as shown in Figure 6(d).



(a) (b) (c) (d)
Figure 6: (a) Create class (b) class schedule (c) individual list of classes (d) individual timeable.

Figure 6(c) is the list of classes under the lecturer together with the information on the number of students enrolled in each class. When a class type (refer Figure 7(a)) of lab or tutorial is chosen, the lecturer can assign a tutor for tutorial or demonstrator for a lab by selecting from the enrolled student list.



(a) (b)
Figure 7: (a) student enroll to class (b) student unenroll to class.

To enroll to class, students search the course (Figure 7(a)) and enroll themselves. Figure 7(b) shows the list of classes enrolled by the student. The students can also unenroll themselves if they are no longer taking the course.

4.4 Manage Beacon

For all the classes (lecture, tutorial or laboratory), the lecturer has to pair the beacon to the class. In the manage beacon page (Figure 8(a)), simply select the class and pair it with the beacon for that class. For all beacons in range, its universally unique identifier (UUID), and the distance from the smart device are displayed.

For replacement class, the venue of the class might be different. By default, for all replacement classes, the original pairing of class-beacon is used. However, if the lecture hall used is different or different beacon is used, the class-beacon pair can be updated as shown in Figure 8(b).

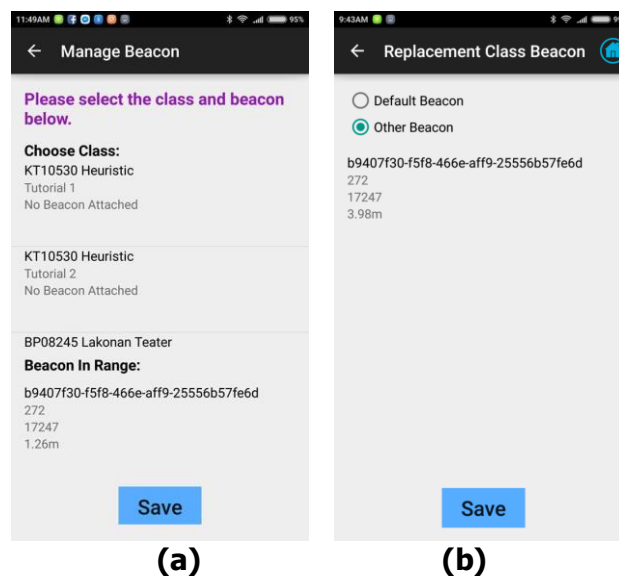


Figure 8: (a) Manage beacon interface (b) Update beacon for replacement class.

4.5 Mark and Manage Attendance

Once a student has enrolled to a class, the marking of attendance can be carried out for each of the scheduled classes. When the class commences, the student simply launch the app and click on a button to mark the attendance (Figure 9(a)). On the background, the app will try to find the paired beacon for that class, check the time, and also the matching device ID under the user profile. Lecturer, tutor, and demonstrator can also mark the attendance for students without smartphones as shown in Figure 9(b).

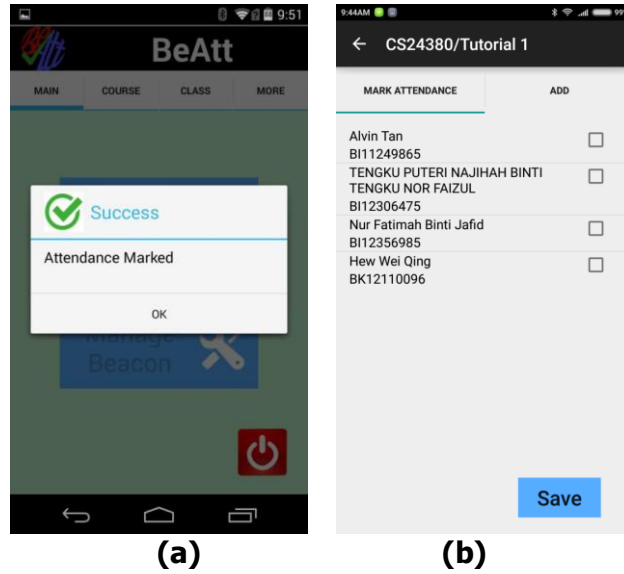


Figure 9: (a) Student marks attendance (b) marking attendance for students.

4.6 View Attendance Record and Generate Report

Both lecturer and student can the attendance record. For student, the attendance record will display the classes the student was absent as shown in Figure 10(a). For lecturers, they can view the list of students absent for each class as shown in Figure 10(b). They can also view the final report of the attendance of the course as shown in Figure 10(c). This report will list all students in the course with their attendance for all the classes.

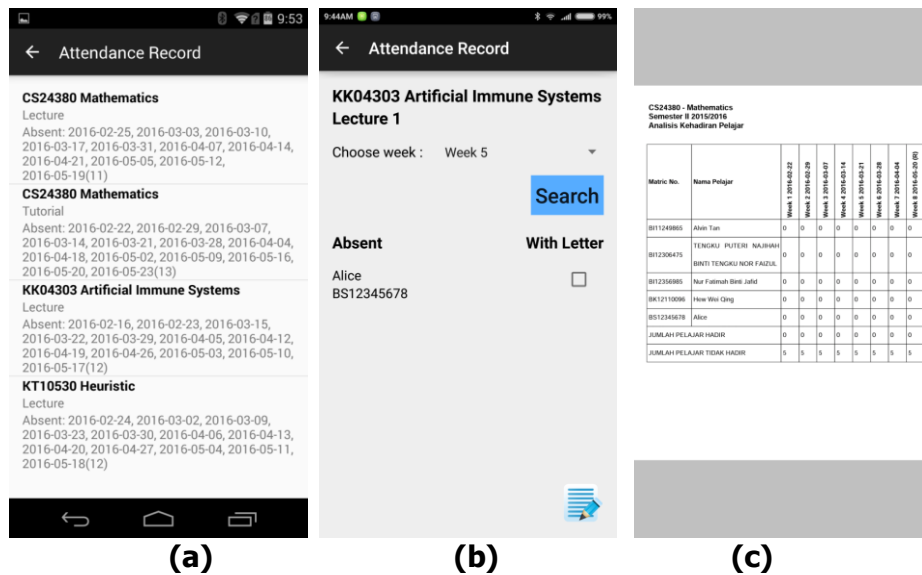


Figure 10: (a) students attendance record (b) viewing list of absent students (c) attendance report.

5.0 IMPLEMENTATION

The proposed beacon-integrated attendance system follows a typical client-server architecture. The client is the Android app installed on the smart devices while the server handles requests and stores data (Figure. 3).

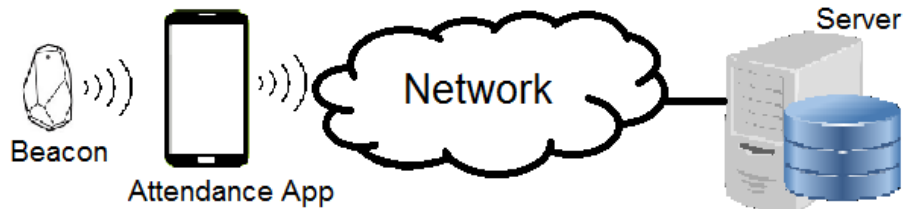


Figure 3: Architecture of the beacon-integrated system

We propose three ways to use the beacon-integrated app for attendance taking in the university. Firstly, the beacons can be affixed in the lecture halls. The advantage of this approach is that it minimises the movements of the beacons and thus reduces the risk of misplacing the beacons. The potential problem with this approach is the cost if there are too many lecture halls. In addition, there is also the risk of the beacons being stolen.

Secondly, provides each lecturer with a beacon. The beacon is carried around by the individual lecturer to classes for all subjects taught by that lecturer. This approaches reduces the cost of installation of beacons on the lecture halls.

Thirdly, the beacons are managed by the faculty or department. Whenever it is needed, the lecturer borrows the beacon and return it after each class. This is more cost effective but with the burden of managing the usage of the beacons.

Students have to be in the range of selected beacon so that their smartphone can trigger an action to enable them to mark attendance. Both student and lecturer have to install the attendance app in their smart devices in order to complete the attendance marking.

6.0 CONCLUSION

In this paper, a beacon-based attendance app is proposed. This app offers advantages over existing apps in that it is more efficient and time saving. Lecturers do not have to add students and take attendance manually. In addition, the beacon offer advantages over other existing technologies such as GPS, RFID and QR Code. We have presented designs of the system and offer potential implementation of the system. The app can still work even with students without smartphones. The potential saving in terms of energy and resources especially with papers is huge considering the number of frequencies and people involved. Finally, this work can be applied not only for attendance taking in classes but also be generalised to any setting requiring the taking of attendance.

REFERENCES

- F. Masalha and N. Hirzallah. (2014). A Students Attendance System using QR Code. *International Journal of Advanced Coputer Science and Applications*, pp. 75-78.

T.S. Lim, S.C. Sim, and M.M. Mansor. (2009). RFID Based Attendance System. In: *IEEE Symposium on Industrial Electronics and Application*. Kuala Lumpur: IEEE, pp. 778-782.

Ihme, T. and Abrahamsson, P. (2005). The Use of Architectural Patterns in the Agile Software Development of Mobile Applications. In: *Proceedings of the International Conference on Agility*. Finland:Helsinki University of Technology, pp. 155-162.

Apple Inc. (2015). iOS: Understanding iBeacon, [online] pages. Available at: <https://support.apple.com/en-gb/HT202880> [Accessed 20 March 2017].