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Near Field User Detection Strategy using Wi-Fi/BLE Networks

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***Abstract*—With the spread of IT technologies, we offer a novel near field user detection method by convenient and correct way to take advantage of the Wi-Fi 802.11x technology on smart mobile devices. In this research managers initiate AP mode Wi-Fi service or BLE peripheral advertisement for user detection. The key algorithm in this research is as follows; An advertisement signal is broadcasted only to a person who is closed to the Wi-Fi AP or BLE beacon. If a member has detected advertisement signal, a smart application of the member(or student) will connect and report to the server that the member are near the manager node. If the member does not get the advertisement signal, the smart application of member will report to the server that the users/students are not near the manager node. By this way instructors/managers can conveniently check whether members are near the instructors/manager nodes.**

***Keywords*—Near Field User Detection, Wi-Fi AP, BLE**

I. Introduction

Near field user detection within a malls or stores is very useful, because the sale information or user attraction has to call each person by person when the number of students/users are big. So, instructors/leaders have to consume much time for students to check attendance. I suggest a smartphone based near field user detection system using Wi-Fi or BLE. In this research, students/users do not have to recognize or tag such a RFID card to reader. Attendance is automatically checked just if I have only the smartphone. I aggregate statistics about absences, late, attendance, automatically.

In the past, we used to call the name of members (including students, travellers, children, etc) for the purpose of near field user detection by managers(teachers, leaders, employer, etc). Usually, instructors verify the identity of students by human with facial and voice recognition. The matching along with facial and voice recognition will be done against the presence status of the student. The instructor may recheck any of the student's presence during the lecture by manually checking the updated attendance list that shows the matching weights during or after class. Recently, an automatic near field user detection by using a RF communication is widely used. However, if the RF card is faulty or students/users not get the RF card, this RF based near field user detection cannot work properly. Moreover, it is not enough to cover the entire areas of a certain lecture room for Near Field Communication and Bluetooth technologies.

To resolve these problems, we offer a novel near field user detection method by convenient and correct way to take advantage of the Wi-Fi 802.11x technology on smart mobile devices. In this research managers initiate AP mode Wi-Fi service for checking attendance of users. Whereas managers have to install a manager version smart application, users can optionally install a client version smart application only if the users are necessary to use add-on functionalities. Manager's smart device is connected to the student's smart device at all times. Therefore, the manager can decide whether a student is close to the manager during a specified period of time.

a) This method prevents the student from leaving the classroom right after checking a present or from answering the call for checking instead of other students.

b) During outdoor activities, it can automatically check periodically whether children and infants are close to leader (instructor or teacher, etc.), since the leader must move together with children or infants during outside activities. Otherwise, the children or infants may get hurts from car accidents.

c) When groups of tourists move (for purposes such as tourism, business trips) somewhere using a charter bus, a tour guide can easily check whether all the people on board the vehicle.

When you move a large number of members group by a group of transport (charter bus, etc.) for purposes such as travel, tourism, business trip, you need to stop moving and then start moving again, repetitively. Here we take advantage of this system because we can easily check all members (only if predefined) whether or not the instructors/managers are easily able to check, get in touch quickly by displaying the smartphone leader in instant contact list of members and do not ride the the present invention relates to using a Wi-Fi to be automated attendance management method.

In order to verify that a user is within a defined distance to manager, beacon signal, alive message, or packet are interchanged by communication at regular time intervals (for example, 10 seconds, 60 seconds, etc.) periodically with each other. For the purpose of checking the attendance of the

members (students, etc.), students has to connect instructor's smartphone (not necessary only for smartphone, it may be any embedded systems) which is Wi-Fi AP enabled system. In addition, this system supports that unlimited number of devices may be connected. We just make use of Wi-Fi scan to the manager's AP enabled smart devices, rather than be connected to the manager. [6][7]

The rest of this paper is organized as follows: Section 2 describes the architecture and process of our E-authentication system and presents the experimental results using our system. Section 3 shows the implementation in detail. Finally, we conclude and summary our work in Section 4.

II. System Architecture

The overall system architecture of our Wi-Fi/BLE near field user detection system is as shown in Fig. 1. Our system consists of two sub-systems : smart device application and smart device operating systems. Smart device operating system is to check the student/user's attendance by sensing the Wi-Fi signals. The attendance management system comprised of RESTful open API web service and smartphone/web client applications. The implementation details are described in Section 4.

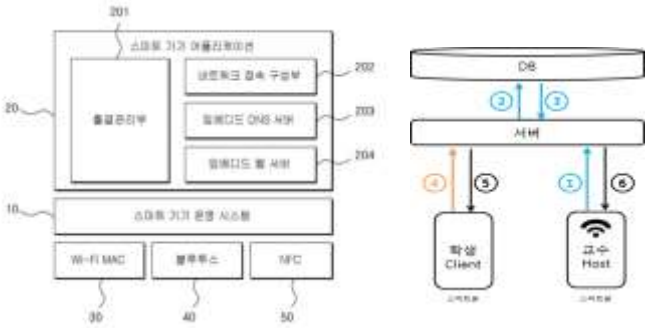

Figure 1 Overall system architecture

As shown in the left side of Fig. 1, our platform supports not only Wi-Fi but also Bluetooth and near field communication(NFC) protocols for checking attendance from students/users. The smart phone/device operating system will schedule and allocate system resources such as CPU, hardware, and software into the required modules/processes. On top of the start phone/device operating system, the smart phone/device application works on checking attendance by Wi-Fi consisting of attendance management part, network connection management part, embedded DNS server(optional), and embedded web server (optional). In the right side of Fig. 1, Wi-Fi using the automatic attendance management process will be described. Users/students connect to server and the manager/instructor, and manager/instructor also connects to server. If the user has "token", the user/student smart application will report to the server that the users/students are attended the class. If the user has not "token", the user/student smart application will report to the server that the users/students are not attended the class.

Moreover, the system requires a setup in priori by the manager/instructor through its server module to configure the class/tour information for advertising the title/purpose of the tour program or the class. The manager/instructor may choose to encrypt this code depending on the level of protection needed. This will include the following information: course or tour id, date and beginning time of the lectures/tours, manager/instructor name, some passcode (if necessary). This can be added or modified at any time before class/tour. During the class/tour, or at it beginning, the manager/instructor leverages the users/students to participate the class/tour from their signed-up classes/tours/programs through clicking on their participation button. From then on, the students can then be tracked their location using the system, as shown in Fig. 2;

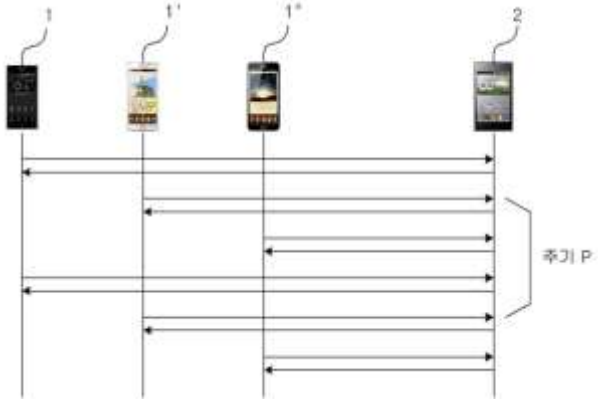

Figure 2. Communication among the constituents

As shown in Fig. 2, the smart phone/device of user/student communicate Wi-Fi primitives (such as beacon signals, alive messages, or packets) which are interchanged by the communication at regular time intervals (for example, 10 seconds, 60 seconds, etc.). For the purpose of checking the attendance of the members (students, etc.), students has to connect (not "connect" strictly, just "scan") instructor's smartphone (not necessary only for smartphone, it may be any embedded systems) which is Wi-Fi AP enabled system.

The server then has to run the identity check on the registered group members/users/students. This is done by comparing the Wi-Fi MAC address which is sent from the user's smart phone/device and that stored on file for the users/student in priori. To this end, every travelers or students should register their information before departing their trip or at the beginning of the lecture, respectively. At that time, the Wi-Fi MAC address of the travelers/users are transferred and stored to the server. A matching MAC Address will be added to the attendance sheet so the instructor could perform a

manual check either during the lecture or after the lecture. The identity check can be done once the attendance registration transaction is received, or at a later scheduled time. Although it is recommended to perform the job once the student signs in with the system to be marked as present, but if the number of students and concurrent lectures are large compared to the speed of the server, then the job could be performed say at a random instant in the second half of the lecture. The purpose of this job, is to allow the instructor to check the results of the identity check before the end of the lecture, if he/she wishes to do so.

As shown in Fig. 2, the system comprising of two applications on smart phone/devices (manager and user), a database server , and a web application server[1]. Now we take a look at the operation of the smart phone/device applications. These applications are the parts that students/users usually install on their smart phones. These are standalone applications that communicate with the web application server for near field user detection. The user detection will be achieved by scanning through the Wi-Fi network, and communication will be through the 3G/4G internet.

Manager application activates the Wi-Fi AP mode at the beginning of the application. The attendance recording process on web server is embedded in the instructor's smart devices or APs. Our attendance check application may have an embedded web server and an embedded DNS server. The web server is necessary within the system, since the users/students have to connect to the instructors smart devices or APs through Wi-Fi. But, there is no problem, even if a web server is not embedded. This is because the manager/instruction application can connect and report the attendance check result to the third party web application server through 3G/4G networks, not to the manager/instruction application itself. This is the enhanced version of near field user detection with supporting unlimited concurrent connections.

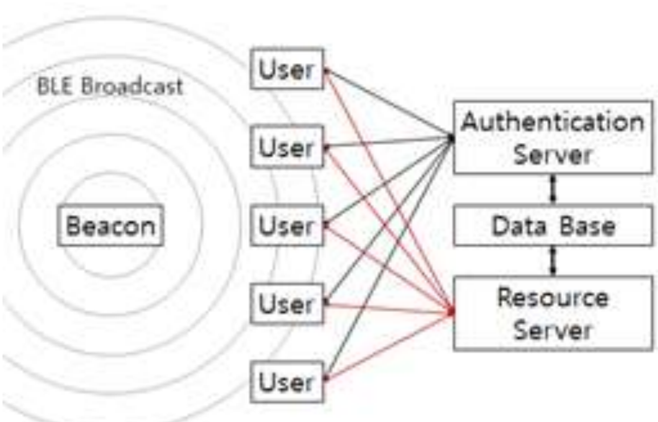

Figure 3. Authentication system architecture using BLE

Figure 3 shows the authentication system architecture. The authentication in our approach consists of user, client with authentication code, authentication server, and a Wi-Fi AP or a bluetooth low energy(BLE) beacon device. The authentication server provides a authentication code for granting the permission of access code. The access code will be verified on login to server which is limited by public. For the use of this authentication, this research gives two options : first one is to make use of Wi-Fi AP or second option is the BLE beacon.

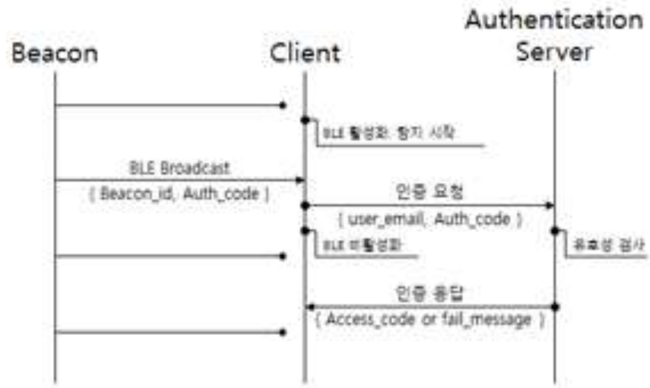

Figure 4. Authentication Flow

Figure 4 describes the authentication flow as follows. Users request to authentication server through client application by sending user information as parameters. Authentication server validate the information by checking time-to-live (TTL). If the TTL is already timed over, then the server return authentication error message. Only if the TTL is okay, the authentication code will be sent to email or something different methods.

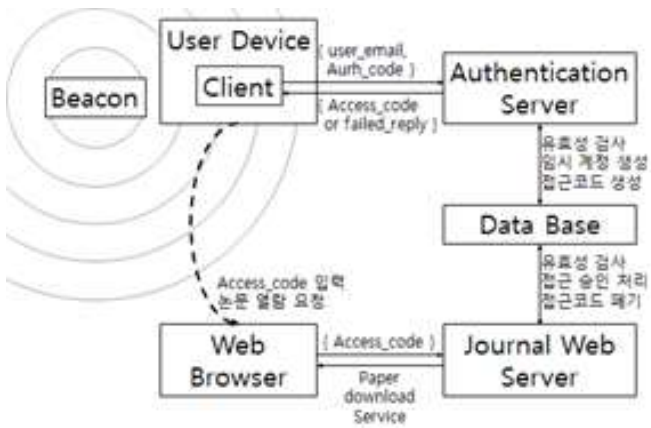

Figure 5 shows the real operation model of our implementation which is applied onto near field user detection application running on Android application (OS version 4.1). If this system is installed on a certain location, the authentication code will be only provides when a user reach to a specified region within the accessible area of BLE or Wi-Fi AP signal.

This results in enhancing the security and authentication using the cutting-edge IoT technology. It provides good accessibility and scalability of system because the user device does not connect to beacon device, but the user device just scan the signal which is broadcasted from the beacon.

III. Implementation

Until nowhere, we described the system architecture and a key algorithm for supporting unlimited concurrent users. From now on, we are going to illustrate system implementation and evaluation in detail. Each communication in Fig. 2 between attendance server and user/student can be implemented by RESTful open API interface or general HTTP web interface[8][9][10]. The reason why we provide both interfaces is because we try to realize the platform independence by supporting as web/mobile application and general PC applications, simultaneously. One of our key approaches in attendance server system is that function of user discrimination and validation during near field user detection depending on a request. To this end, the user client generates MD5 hash fingerprint using MAC address and SSID and upload these information onto server. In this research, we implemented the user client prototype on Android 4.3 operating system by smartphone mobile application, as depicted in Fig. 1. The server runs on Apache Tomcat 8.1 web application server. We make use of JERSEY 1.8 server and Spring Framework 3.1 for REST open API[11][12][13][18] based attendance server implementation. Spring Framework provides an API so that developers may extend Spring to suit their needs. We make use of both Tomcat and Spring in order to implement our systems. We constructed 4 node Linux cluster of Core i5 machines each with 4G RAM. The machines are connected by network and managed by giga-bit Ethernet interconnection network as shown in Fig. 2.

As a result, a user only has to keep both of the the MD5 fingerprint file consisting of MAC address of the user and SSID of an instructor's AP, then a server can check and validate of the attendance request, afterwasds, especially on a specific time and a specific web site. When someone need authentication for a portion of the snapshot screen, it is also possible on our system. User can drag the region using a mouse from the captured screen. Then, authentication/validation will be started additionally through generating the MD5 hash by attendance servers using the submitted MAC address and SSID from users. Then, the attendance server compares the requested MD5 and newly generated MD5 data. It makes a decision of data integrity if they are the same or not. For example, we describe REST open APIs which were used in the attendance server are as follows:

Figure 5. Experimental result 1 : the screenshot of our real system implementation

Figure 6. Experimental result 2 : the screenshot of our real system implementation

Figure 7. Experimental result 3 : the screenshot of our real system implementation

IV. Conclusion

We offered a novel near field user detection method by convenient and correct way to take advantage of the Wi-Fi 802.11x and BLE technologies on smart mobile devices. In this research managers initiate AP mode Wi-Fi service for checking attendance of users. The key algorithm in this research is as follows; A "token" is generated only to a person who is closed to a manager(or instructor). If a member has the "token", a smart application of the member(or student) will connect and report to the server that the users/students are attended the class or near the manager. If the member does not have the "token", the smart application of member will report to the server that the users/students are not attended the class or not near the manager. By this way instructors can conveniently check the member's attendance with a smart phone.

Acknowledgment

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