

## BLE Beacon-Based Etiquette System of Smart Devices

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**Abstract:** Recently, smartphones has become necessary electronic devices to use the various mobile services in everyday life. Rude uses of smartphones cause many troubles such as invasions of others privacy and rights. For these reasons, smartphones are controlled in a variety of ways via. the compulsory collection and the smartphone regulation service but these methods have side effects such as infringing individual rights due to excessive smartphone usage restriction and control. Therefore, it is necessary to switch to a more positive etiquette service than the service centered on the usage regulation and to have a social mobile etiquette service for mutual respect among members of society. We propose public etiquette services of smartphone which use BLE (Bluetooth Low Energy) beacons to show the rules of etiquette and set your smartphone to etiquette mode. We are very confident that BLE beacons are suitable devices to determine the scope of etiquette service indoors because BLE signals are at the core of the indoor location technology. This study provides a study on technology for providing public etiquette services based on low power Bluetooth technology (BLE) and smartphone control techniques to limit and release based on BLE beacon.

**Key words:** Beacon, etiquette, smartphone control, Bluetooth, MDM (Mobile Device Management), public

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### INTRODUCTION

A range of social problems caused by the rude uses of smart phones has occurred worldwide. Smartphone's flash lights and cameras get in the way of concentrating on the play in cinemas, theaters, concerts and music venues all over the world. In the library noises caused by smartphone ringing and vibration are disturbing their studies.

The French word etiquette, literally signifying a tag or label is a code of behavior that delineates expectations for social behavior according to contemporary conventional norms within a society.

We thought what if using beacons as electronic labels or tags to show the rules of etiquette and set your smartphone to etiquette mode. Based on this idea, we propose a novel service which convey the etiquette message and set etiquette mode to smartphones within the reception range of BLE beacon signals. It helps users easily to comply with the public etiquette on their smartphones.

**Literature review:** Bluetooth Low Energy (BLE) has the ability to exchange data in one of two states: connected

mode and advertising mode (Bluetooth SIG., 2014; Lee and Lee, 2015; Hyo-In *et al.*, 2016; Kwon, 2016; Liu *et al.*, 2013; Cho *et al.*, 2014). BLE beacons are hardware transmitters that broadcast their identifier to nearby portable electronic devices. BLE beacons take advantage of the Generic Access Profile (GAP) advertising mode to broadcast periodically advertising packets.

A service to regulate strictly the smartphone usage of students has been provided (Souppouris, 2014) but these caused to infringe other's individual freedom and rights seriously. The other service was stop because serious security flaws were discovered.

According to Lee *et al.* (2016), addiction prevention software being implemented in schools did not have any significant impact in preventing addiction. Overall, they argue that the effects of mediation strategies are weak and furthermore, these effects are limited to young adolescents.

The research, Lim *et al.* (2016) present the design of MDM system to limit the mobile devices according to the location of the room using BLE beacons in a controlled area. However, it turned out to be used only as an in-house mobile security system.

Eddystone is an open beacon format developed by Google and the Eddystone UID format consists of 10 byte namespace and 6 byte instance. Namespace is used to set the ID of a group consisting of multiple beacons (Anonymous, 2017). For example, UUID is used as 8B0CA750095477CB3E77 except for the middle area in 8B0CA750-24A7-4E14-BD99-095477CB3E77 and it can be changed. In addition, the instance is used to set the ID of a specific beacon in the group. The maximum number of beacons that can be used in the same group is  $2^{48}$ .

To support MDM service in iPhone, Apple provide MDM check-in protocol that is used to validate a device's eligibility for MDM enrollment during the initialization procedure and to inform the server that a device's push token has been updated. If a check-in server URL is provided in the MDM payload, the check-in protocol is used to communicate with that check-in server. If no check-in server URL is provided, the main MDM server URL is used instead. And they provide Mobile Device Management (MDM) protocol that gives a way to tell a device to execute certain management commands remotely.

**MATERIALS AND METHODS**

**Proposed system:** The proposed system utilizes BLE beacon to determine the position of the user's smart phone, Fig. 1 shows the etiquette rules to comply and sets some functions of smart phone to follow the rules within the communication range of the beacon. Figure 1 is the system structure of BLE beacon-based smartphone etiquette service.

The system includes the etiquette server, the beacon management application and the etiquette service

application. The etiquette server has modules such as selling beacons and managing service and MDM server to control the smartphone. Beacon sales and management module provides functions for selling beacons (sales and order) and setting the beacon ID (security ID settings). The etiquette service management module includes function of beacon certification (services certification), in particular, because misallocated and unregistered beacons make the service unreliable, it is needed inadequate beacon management to provide a highly reliable service.

The beacon manager App. provides the function to purchase beacons that provide etiquette services and to manage purchased beacons. It consists of purchasing etiquette beacons (buy online), monitoring current state of user's beacon (beacon status management), changing beacon's etiquette mode, charging etiquette point (charge point). Especially, beacon management of this App. can set of etiquette mode, use of etiquette beacons and disabling and provides an operating range setting.

Etiquette service App. is composed of registering user's etiquette zone and showing etiquette status, setting smart phone to etiquette mode, reporting inadequate beacon and requesting point transition. This App. is an application for receiving public etiquette services. It is used to determine whether or not to accept the etiquette service in the area, called etiquette zone where the etiquette service is provided and to check the etiquette-complying time and to accumulate the etiquette point in proportion to the time.

In this study, we implemented this system and the followings were studied for configuring the above system architecture.

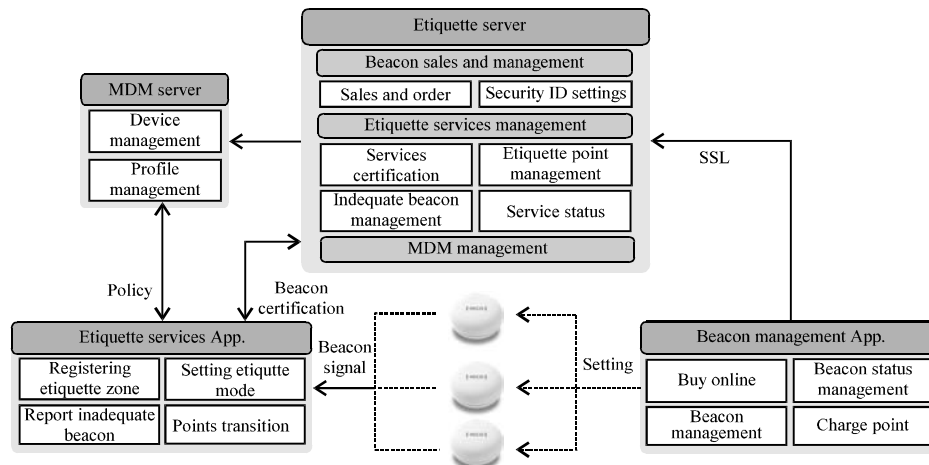


Fig. 1: Etiquette rules to comply and sets

**Etiquette beacon management:** Etiquette beacon management is a description of how to manage beacons for etiquette services. It is divided into etiquette beacon security ID management and etiquette beacon configuration.

**Etiquette beacon security ID management:** In order to determine what etiquette service is providing by beacon, there need a technique for discovering the service from the beacon signal and for defining an etiquette mode that can classify the service in the beacon signal. In this study, we used Eddystone UID to distinguish these etiquette modes which is composed with namespace and instance. We used namespace as a unique ID of the mobile etiquette service and instance is divided into first part for the unique ID of the beacon and second part for the etiquette mode that the beacon is to provide as shown in Table 1. Figure 1 shows that first part (Byte 0~3 is unique ID of the service type) and second part (4th byte and 5th byte are allocated for etiquette mode).

The etiquette service App. can determine the etiquette mode by using the instance of the received UID from beacon. The role of each bit in the 4 and 5th bytes to distinguish the etiquette modes is as follows in Table 2.

The fourth byte is used to indicate which etiquette mode of the smartphone is to be set automatically and restricted to use the functions. The fifth byte is used to tell the etiquette service to the smartphone user. The concept of setting and warning service is explained in this study.

A beacon that has instance as the above example means that the camera cannot be used in the area

and that the users should conform the etiquette by adjusting the silence and screen brightness of the smartphone.

**Etiquette beacon configuration:** Kind of the etiquette mode implemented in this study is silent, vibration, screen brightness, camera, screen lock, Wi-Fi, tethering, USB. In order for users to naturally follow etiquette services, a smartphones has to automatically be limited according to the beacon etiquette mode when they are in the beacon area or be alerted by a warning message. In order to provide the service by the etiquette mode to the user, we developed an App. for Android and iPhone. However, android and iPhone have different policies for smartphone control due to their device characteristics. Especially, in the case of iPhone, Apple’s policy has many limitations in controlling smartphone. That is why App. running on the iPhone cannot provide all the etiquette modes, we have to develop iPhone App. to support only some modes.

In this study, the service is classified into the restrict service and the warning service according to the mode that can be controlled by the device (Android and iPhone). The restrict service is a strong service that provide etiquette services to member in businesses, institutions and facility where was required more powerful restrictions that automatically block the functionality of smartphones and prevent users from releasing them. A warning service is a public etiquette service that raises civic awareness and encourages self-compliance with etiquette rather than forcefully complying with it.

Table 3 shows the warning and the restrict services that can be provided by Android and iPhone. While most services can be provided by Android, the iPhone cannot support all functions except brightness, camera and screen lock by Apple’s policy.

Table 1: Etiquette mode in instance

Modes	Bytes
Unique ID for the beacon	0, 1, 2
Etiquette mode	3, 4, 5

Table 2: Detailed bit format of etiquette mode

Discrimination	USB (0)	Tethering (1)	Wi-Fi (2)	Screen lock (3)	Camera (4)	Brightness (5)	Silence (6)	Vibration (7)
<b>Byte 4 (restrict)</b>								
Camera (restrict)	0	0	0	0	1	0	0	0
<b>Byte 5 (warning)</b>								
Silence and brightness (warning)	0	0	0	0	0	1	1	0

Table 3: Warning and limiting services in Android and iPhone

Items (category)	Vibration	Silence	Brightness	Camera	Screen lock	Wi-Fi	Tethering	USB
<b>Android</b>								
Warning	O	O	O	O	O	O	O	O
Restrict	O	O	O	O	O	O	O	O
<b>iPhone</b>								
Warning	O	O	O	O	O	O	O	O
Restrict	X	X	O	O	O	X	X	X

O: enable, X: disable

RESULTS AND DISCUSSION

This study set out to implement the public etiquette service of smartphone using BLE beacon signal. The following discussion will focus on the entire service flow and implemented screens and functions according to the proposed system.

**Etiquette service:** Figure 2 shows the service procedure to provide etiquette services according to the proposed system. First, In order to provide the etiquette service the beacon manager purchases the etiquette service beacon at the beacon market. In the purchase process the manager select the etiquette service type (etiquette mode). When the ordered beacon is arrived, it has to be deployed in the place they want.

When a user enters the public etiquette zone with smart phone which the etiquette service App. is installed, etiquette service App. show the etiquette which should be followed in the area and then the user decides whether or not to comply it. We defined the area where the beacon signal is received as the public etiquette zone. If user follow the etiquette in this zone, points will be saved up according to the time of entering and leaving this zone and the accumulated points can be converted into things that user want(cash, other site point, etc.).

**Etiquette server:** The etiquette server serves beacon sales and beacon management function, etiquette service management function and MDM management function. Figure 3 shows homepage of the point information that a user or a manager has when they

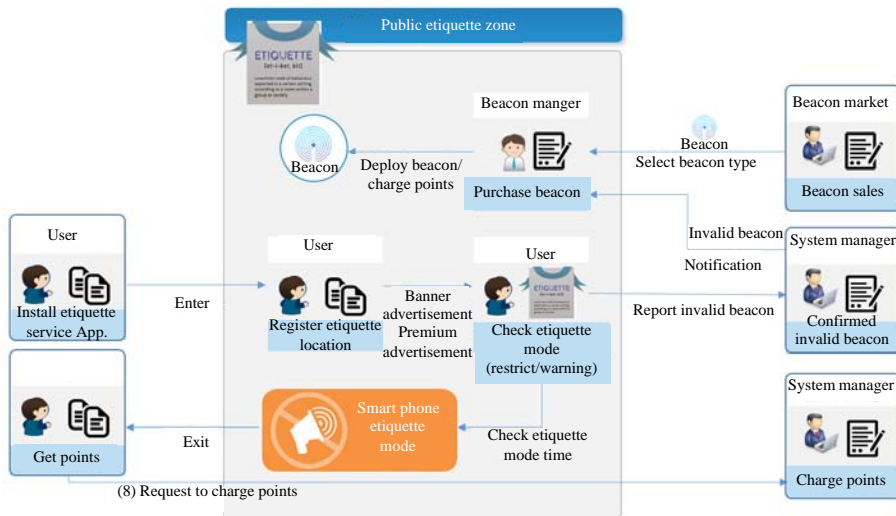


Fig. 2: Etiquette service flow

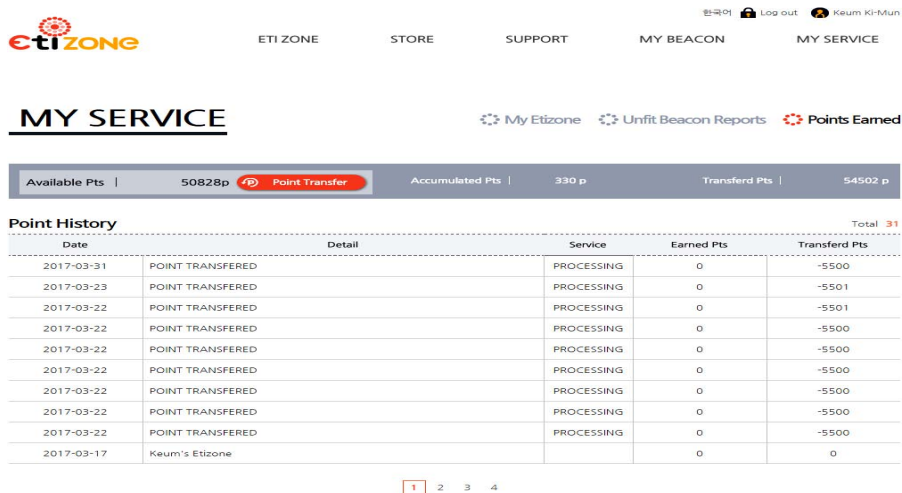


Fig. 3: Etiquette server

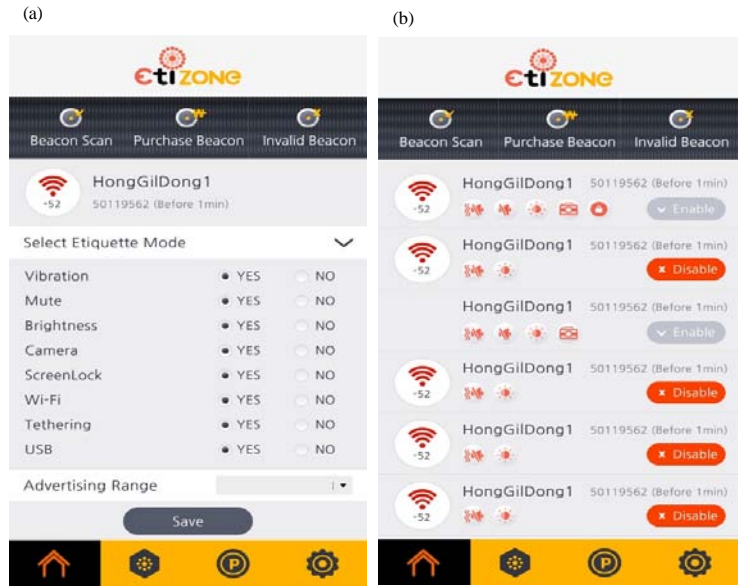


Fig. 4: a, b) Beacon management App.

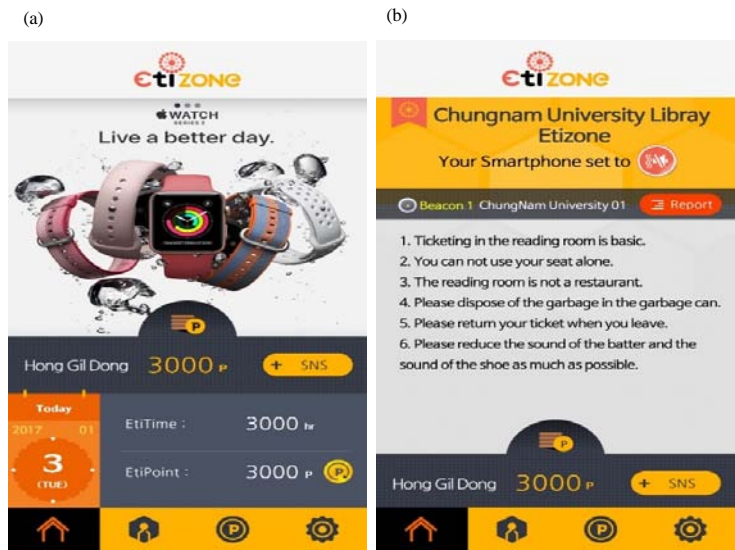


Fig. 5: a, b) Etiquette service App.

access the etiquette server. It shows user's available point amount, total saved-up point amount, transition point amount.

**Etiquette service beacon management App.:** The etiquette service beacon management App. provides beacon purchasing function, beacon status management function, etiquette beacon management function and point charge management function. Figure 4 shows the app's display interface for checking the beacon and deciding whether to apply the etiquette service of purchased beacon. Also, the App. has functions for beacon check and scan,

beacon purchase, inadequate beacon report on top, information of beacon TX power, beacon owner name, beacon etiquette mode, etiquette service on/off button on middle.

**Etiquette service App.:** When a user enters to an etiquette zone, etiquette service App. show etiquette status and it sets mobile device to follow the etiquette mode. When the user exits the etiquette zone, it unsets mobile device to original state. If the beacon is unfit in the area, the user reports the beacon. Figure 5 shows etiquettes service app's interface in normal place and in an etiquette zone.

**Power consumption issue of etiquette service App.:** Since, the etiquette service App. must receive the beacon signal periodically, it should always be in the background or foreground. Therefore, the etiquette service App. is always running and consumes the power of the smartphone. So, there can be a problem that excessive power consumption may cause inconvenience to the user. Finding the optimal beacon scan period is the most important issue because the power consumption of an App. that scans a beacon can depend on how often it scans the beacon. In this study, we separated the public etiquette zone where the etiquette service is started and the other area where does not receive etiquette beacon signal and differently applied the scan time. In the normal area etiquette service App. has applied a relatively long scan period and in the etiquette zone it has applied a shorter scan period to check whether a user is out the etiquette zone.

### CONCLUSION

In this study, we propose for the etiquette service of smartphone in public places using BLE beacon. Simply by installing etiquette beacons, the manager of public facilities (Movie theaters, public institutions, corporations, schools, libraries, etc.) are able to set the necessary etiquette mode to the user's smartphone within those places. The users could accumulate the etiquette points according to their compliant time and it would stimulate them to follow etiquette.

So, the suggested etiquette service and system in this study could improve the quality of cultural life to reduce interference by smartphone during education and performance (musical, classical concerts). Also in tourist attractions, museums and relics, camera's flash could be restricted with the useful information about the art research. In this way, this service can be extended to new services according to the public places.

### RECOMMENDATIONS

In a future research, we will test the performance of the proposed system, measure the power consumption of the user application installed on the smartphone and test how accurately the etiquette service is provided in the beacon area. Also, in case of selling beacons that can serve as mobile etiquette services, it is required to technology for checking the validation beacon and managing beacon ID because invalid beacons can be used for malicious behavior (beacon modulation signal, smart phone malfunction). For this reason, they generally use Google's Eddystone-EID but there is a problem that they need to use Google's cloud API to identify beacons which generate EID signals. Therefore, if Eddystone-EID is used for enhancing security of beacon, they will be

necessary to develop a security server for verifying the EID signal and checking the beacon information according to the corresponding EID signal. So, we will carry out to develop a server for processing security verification and confirming beacon information by using an EID signal.

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