



Path Navigation using Bluetooth Low Energy-Beacon

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Abstract: Beacons turn the physical world into a new digital channel. They bring digital content and engagement closer to the point of purchase. Beacon technology transmits small packets of data using Bluetooth Low Energy. When a customer's phone "hears" the beacon it knows how close it is and we can then send a message, a notice, a piece of media or other information. Beacons are low-power transmitters equipped with Bluetooth Low Energy or BLE. Bluetooth Low Energy help mobile devices to detect Proximity and determine micro-location. Advantages of Bluetooth low energy devices are it works up to 100 meters, doesn't drain the phone battery. In this paper problems with beacon are described and path navigation using Bluetooth Low

Keywords: Beacon, Internet of Things – Beacons The New Revolution, Bluetooth Low Energy, Path Navigation, Background Monitoring, Ranging Beacons, Proximity, Tracking

I. INTRODUCTION

Beacon technology transmits small packets of data using Bluetooth Low Energy. When a customer's phone "hears" the beacon it knows how close it is and we can then send a message, a notice, a piece of media or other information. Beacons are made from:



Fig 1. Beacon's made from BLE

A beacon is mainly designed to attract attention to a specific location. It can also be combined with indicators to provide important information, such as airport status, by the color and rotational pattern of its airport beacon. Features of Beacon:

- Proximity range between 2 – 100 meters.
- Mobile App will be notified when close to beacon.
- Opt-in technology.
- Does not drain mobile battery

iBeacon

In [2] details about iBeacon is described. "iBeacon" works same as beacon. This name is chosen by Apple that allow mobile apps to know how close they are to wireless transmitters called hardware iBeacons.

iBeacons are little operated radios one can place where ever he want, if your mobile is in iBeacons range then it will automatically sense it and locates itself.

iBeacons identify themselves with customizable IDs as they have no data payloads.

II. BLUETOOTH LOW ENERGY

Bluetooth Low Energy is an ultra-low power network that operates in the 2.4GHz spectrum, which is license-free around the world. It is designed for transferring small amount of data at low data rates. It consumes very small amount of energy, which means it does not drain device batteries. It is secure, power efficient and relatively cheap.

BLE Working:

BLE communication consists primarily of Advertisements, or small packets of data, broadcast at a regular interval by Beacons or other BLE enabled devices via radio waves.

BLE Advertising is a one-way communication method. Beacons that want to be discovered can broadcast, or Advertise self-contained packets of data in set intervals. These packets are meant to be collected by devices like smartphones, where they can be used for a variety of smartphone applications to trigger things like push messages, app actions, and prompts.

Difference between BLE and Wi-Fi:

- Consumer Privacy
- Deployment costs
- Proximity detection

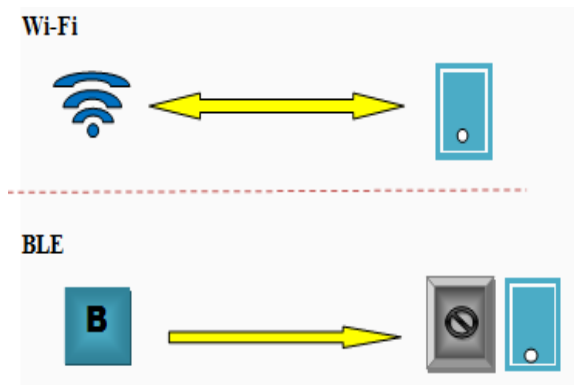


Fig 2. BLE and Wi-Fi interaction with device

In Wi-Fi tracking, mobile devices of consumers who have turned on their Wi-Fi will look out for Wi-Fi networks. Wi-Fi technology does not explicitly ask consumers for their permission, as it does not require any user intervention. On the other hand, for beacons tracking, Bluetooth of a device must be on to allow location detection through the relevant app to receive in-library or indoor notifications.

TECHNOLOGY	PROS	CONS
Wi-Fi	<ul style="list-style-type: none"> Can be used across all Smartphones. Relatively inexpensive. 	<ul style="list-style-type: none"> Requires an installed app by user to engage. Investments in Wi-Fi SW/HW to achieve accuracy.
BLE	<ul style="list-style-type: none"> Based on Bluetooth 4.0 and available on most new smartphones. 	<ul style="list-style-type: none"> Requires an app to be installed and bluetooth to be running. Requires investments and becomes complex to maintain.

Difference between BLE and GPS:

GPS is a location technology whereas Bluetooth Low Energy is a proximity technology.

This means that even if the beacon moves you will still be able to find it. Like a library shelf or a register or people.

III. BEACON PROBLEMS

As every coin has two sides same with Beacon too. It has lots of advantages lightweight location aware system, simple and easy to implement and reliable but it has problems[7] too which are stated below:

1. App must be installed :

Beacon can only work if app is installed in device to catch a beacon signal.

2. Spamming user risks :

User can automatically logged in when walked into a beacon zone which led to spook many people as it might delight other people.

3. Centralized System is not there :

There is no centralized system to operate all beacons at the same time as they have no serial number. User has to figure out its assigned major and minor number. Major tells which beacon it is and minor shows the location it was previously installed.

4. Mobile Bluetooth must be on : Mobile Bluetooth makes interaction with the beacon in the beacon range. Device battery will drain out fast by keeping it on for long period of time.

5. Lack of Precision : Beacon activates at the set of range and deactivate when user is out of range .But due to RSSI it almost never follows the precise range. Hence, signals can be received even away from the set of range or vice versa

IV. ESTIMATE BEACON

Estimate Beacons[1] are small wireless sensors that is attached to any location or object. They broadcast small radio signals which smartphone can receive and interpret, unlocking micro-location and contextual awareness.

With the help of Estimote SDK, apps on smartphone are able to understand their proximity to nearby locations and objects, recognizing their type, approximate location, temperature and motion. Working of Estimote Beacon[3]:

- Estimote Beacon have a powerful processor and good memory. It is powered by a coin battery which broadcast signals through built-in antennas.
- Smart devices in range receive those signals and compatible installed apps can then respond. The exact form of that response - whether a notification or another action - is up.

Estimote SDK and Cloud tie everything together by granting apps full access to the metadata, including beacon ownership, object type, and precise location. They also enable security and other services on top of the beacons.

V. BEACON MONITORING

Monitoring[5] an action captured on entering and exiting regions range. Beacon monitoring[9] is a virtual barrier that usually defined using a set of geographic coordinates. Moving in and out of the area it triggers "enter" and "exit" events, which the app can react to.

In iOS it will keep listening for those beacons at all time even if app is not and even if the iPhone/iPad is locked or rebooted. Once an “enter” or “exit” happens, iOS will launch the app into the background and let it execute some code for a few seconds to handle the event. CLLocationManager and monitoring for CLCircularRegion objects are used for locating path. Beacon monitoring is based on the exact same concepts and mechanisms it's just beacons, Bluetooth and CLBeaconRegion objects instead.

Beacon Regions

To define the set of beacons to use as a geofence beacon regions[9] are used. Beacon regions[4] are a fundamental concept of iBeacon. Beacon region is like a filter or a regular expression each beacon is identified by three values:

- UUID
- minor number, also an unsigned short integer, like the major number.
- major number, an unsigned short integer

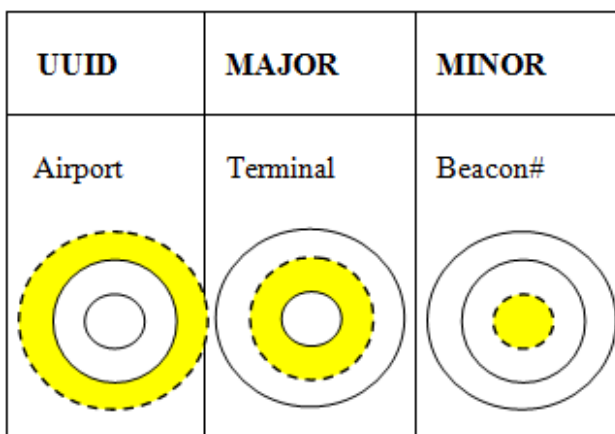


Fig 3. Parameterization of Beacon

Test Monitoring:

It is also known as “Flip To Sleep”. Steps involve in Test Monitoring are:

- 1) Launched the app with the initial state of the beacon region being inside,
- 2) move outside,
- 3) then, move back inside—and that's what's going to trigger the “enter” event

Now, move the beacon and the device physically away from each other, and then bring them back together. Result is constantly walking back and forth to test monitoring doesn't sound too convenient.

VI. PROJECT OVERVIEW

I have develop an android app for college Library which demonstrate beacon features. In [6] Android gives built-in platform support for Bluetooth Low Energy which I have used in my app.

Beacons in Library:

- 1) Greet students when they arrive.
- 2) Send them specials, new editions and updates at specific locations in the library.
- 3) Connect to research programs
- 4) Offer contactless knowledge
- 5) Library Upsell

A. Functional Overview

Indoor Navigation is an Android mobile application which is developed to view the demonstration how to make searching of books in library easier and user can get the latest book edition notification in his device. User will be notified once he passes through a library where deals are waiting for him. This demo application basically contain a Floor Image by which user can see the paths heading towards new editions available in the library. With the help of Beacons, application is able to show the current user position inside the library and direction to reach up to latest editions.

B. Notification updates

Whenever user passes through a specified library, he get a notification on his mobile. Clicking on this notification it navigates user to latest edition list that is being provided in the library and app starts working initializing with Welcome Screen including start button.

C. Welcome Screen

Welcome screen is a glimpse of space animation derived by the different beacon icons. Start button navigates user to latest edition list in the library.

D. Latest edition List

This screen lists all latest editions that are suggested by the library staff to inform visitors about the exciting deals in the library (including special latest editions). Visitor can select an latest edition and can see its location in the library on a Floor Plan in the next screen.

E. Floor Plan

Here is the Floor image with a shortest recommended path associated with selected latest edition in the previous screen. There are two markers on the floor map[8][10].

- 1) User location
- 2) Latest edition location

User location : This location shows where user activity is going on. This is the initial location or source point from where path is navigated between user and book.

Offer Location : This location shows the book location chosen by user. This is the destination point from where path ends between user and book. At this location user can finalize

the book, add it in the cart, go for online payment process, finally ordered it and can move out to another place.

F. Offer Popup Alert

As soon as user mobile device enters in a beacon's range the associated latest edition appears on mobile screen with useful information about that latest edition. In this way user can avail the benefits of grabbing best deals while he is walking on the floor.

VII. CONCLUSION

- Despite being available for a couple of years now, beacons are still very new technology and in future it will be use for indoor navigation in many areas.
- This research permits complex reception characteristics to be accurately modeled and provides a simple method for choosing beacon locations.

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