Internet of Things (IoT)

Lab 3: Using Beacons for indoor location

15th October 2020

I. What are Beacons?

A Beacon is a continuous Bluetooth low energy (BLE) transmitter device with a unique identifier. These devices have low energy consumption which gives them high autonomy (up to 5 years). The transmission range can reach up to 200 meters.

The Beacon's transmission unit (or packet) depends on the protocol used. There are three main protocols used nowadays:

- iBeacon: protocol developed by apple in 2013 (used in this lab)
- AltBeacon: protocol developed by Radius Network in 2014
- Eddystone: protocol developed by Google in 2015

Each one of the protocols mentioned above has its own packet structure. The beacons used in this lab are preconfigured to use **iBeacon** protocol (Figure 1)

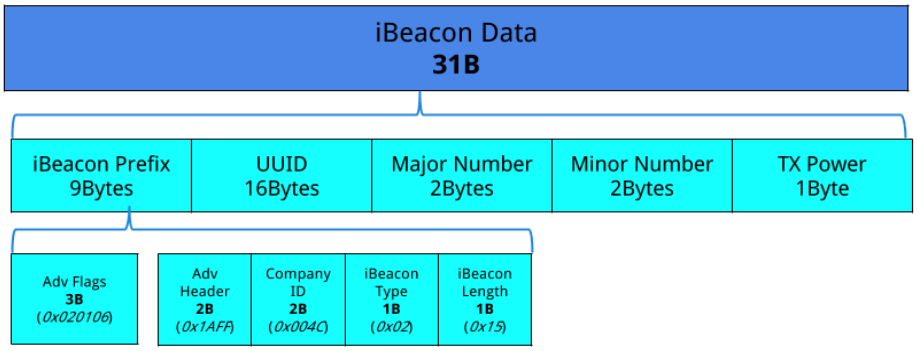

Figure 1 : iBeacon packet structure

Estimote Beacons broadcast tiny packets of data, containing their iBeacon ID and information about signal strength, so that the phone can understand which beacon it hears and how far it is.

Every iBeacon ID is 20 bytes long and is divided into three sections:

- UUID (16 bytes)
- major number (2 bytes)
- minor number (2 bytes)

Those values are hierarchical.

Beacons have many use cases like indoor localisation, inventory management, Marketing, etc. In this lab, we are going to use the beacons to do indoor localization to figure out in which room the user is, and which actuators he can command.

II. Indoor location

In this Lab you will use two beacons which represent two different locations (rooms for example). To know which beacon is the nearest (so in which room you are), you'll be using two parameters: the first is the "TXPower" (Transmission power) received in the advertised packet which represents the signal's strength at one meter from the beacon. The second parameter is the received signal strength on your Smartphone called "Received Signal Strength Indicator (RSSI). With these two parameters, you'll be able to estimate the distance between the Smartphone and the beacon and deduce the nearest beacon:

Basic Formula: D = 10 ^ ((TxPower - RSSI) / (10 * n)) ; $2 \leq n \leq 4$ (I)

n depends on the environment in which the beacon is placed.

iOS and Android environments support routines that calculate directly the distance between a beacon and your smartphone without having to implement the basic formula I.

III. Mobile application

The Mobile Application to develop detects in which room the user is located using the techniques mentioned above. Then the app should offer the possibility to control/read the actuators/sensors of the room without any indication from the user about the actuator's ID or location. We offer you a template that implements the GUI of the mobile application (Figure 2). This GUI monitors blinds, radiators and lamps. To download the template:

```
git clone https://githepia.hesge.ch/lsds/BeaconsApp.git
```

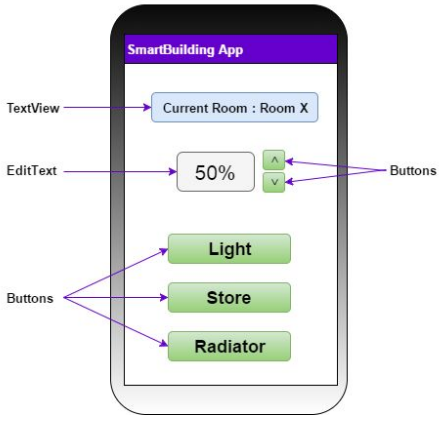

Figure 2 : Mobile Application interface

You should complete the application by adding the three functions related to the commands of the blinds, radiators and lights via KNX and Z-Wave REST servers.

We recommend using this environment to develop the application: https://developer.android.com/studio/install

The template provided above uses the “ranging” feature of the Estimote SDK: https://developer.estimote.com/android/tutorial/part-3-ranging-beacons/). “Ranging” provides more granular and comprehensive beacon data, but this comes at the expense of draining the battery faster than monitoring. Feel free to implement “monitoring” instead of “ranging” to automatically trigger an action when you enter a room where there is a beacon, see details in this URL:

https://developer.estimote.com/android/tutorial/part-2-background-monitoring/

Note: In the template, the `EstimoteSDK.initialize` routine asks you to introduce your "AppID" and "Token" to connect you to your account. This part is not necessary, you can use the Estimote SDK without introducing this information.