Internet of Thing: Lab 1

A Smart Building Software based on three home automation communication protocols: KNX, Z-WAVE and BLE (Beacons)

Part 3: Using Beacons for indoor location

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I. What are Beacons?

A Beacon is continuous Bluetooth low energy (BLE) transmitter device with 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.

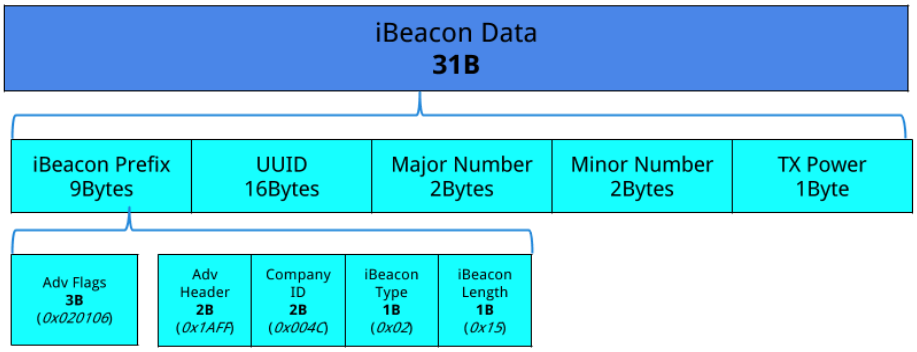

Figure 1 : iBeacon packet structure

Note: The beacons used in this lab are preconfigured to use **iBeacon** protocol.

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 localization, 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 to command.

II. The lab

During this lab, we assume that you are monitoring a building: blinds, radiators and lamps according to different inputs such as temperature, light, humidity and physical presence. Each room of the building has a sensor, a lamp, a store, a radiator and a beacon. The global architecture is presented in the picture below:

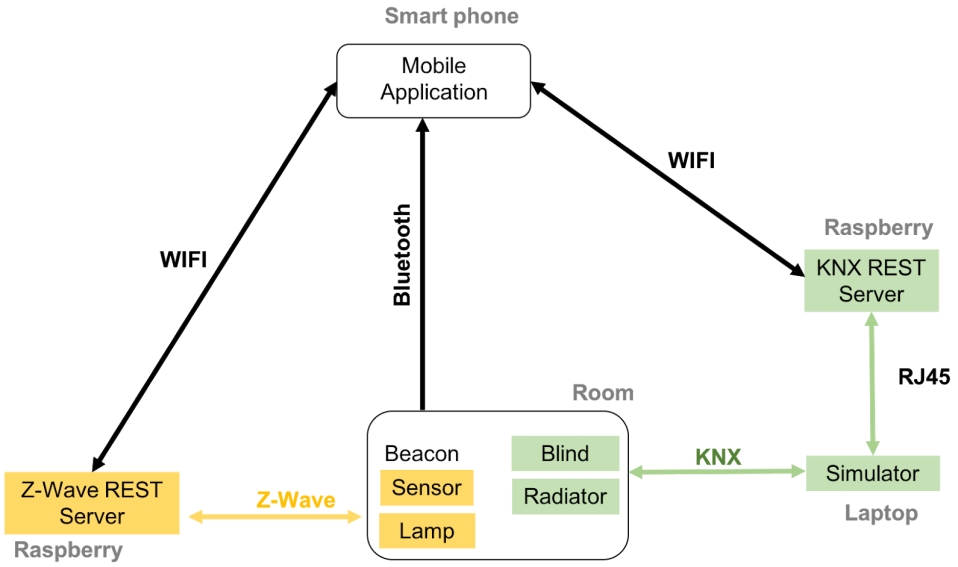

Figure 2 : Global architecture (will be extended in the session: 25 Oct. 2018)

The system to develop in this lab is composed of two REST servers and one mobile application:

- Z-Wave REST server: this server is already developed in lab 1, part 2. It enables users to:
  - retrieve data from the sensors and lamps
  - monitor the lamps
- KNX REST server: This server is to be developed from the code of lab 1, part 1 (read section V of the Lab1, Part 1 document : https://cyberlearn.hes-so.ch/pluginfile.php/2802525/mod_resource/content/3/Lab1-Part1-KNX.pdf.

  It enables users to retrieve and monitor the states of blinds and radiators.
- Mobile application: thanks to the beacons, the mobile application identifies the closest beacon to the smartphone. Then, the mobile application sends the appropriate requests to the Z-Wave and/or the KNX REST servers according to his location.

III. Indoor location

Indoor location is supported by Beacons. You'll place a beacon in each room of your building. 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.

IV. 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. Figure 3 give an example of GUI related to the monitoring of the blinds, the radiators and the lamps. You can design a second interface to read sensors.

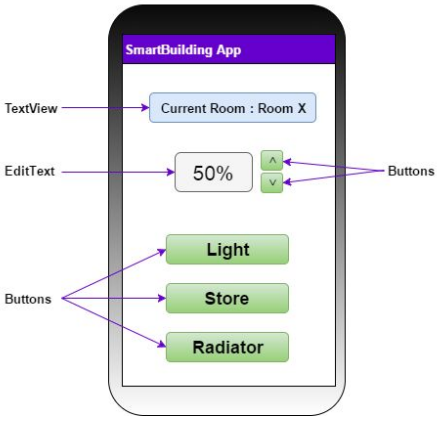

Figure 3 : Mobile Application interface

We offer you a template that implements the GUI of the mobile application. You can download the template using this command :

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

You should complete the application by adding :

- Indoor location using the “Estimote SDK” (see next section).
- Command the stores, radiators and lights via KNX and Z-Wave REST servers.

V. Get started

Feel free to use any SDK you want but we recommend you "Estimote SDK" which is the SDK of the manufacturer of the beacons used in this lab. Keep in mind that we are only using the beacons to get the nearest beacon. We recommend to use these environments:

- **SDK Estimote**: https://github.com/Estimote
- **Android SDK**: https://github.com/Estimote/Android-SDK
- **iOS SDK**: https://github.com/Estimote/iOS-SDK

Note: When you start using the Estimote SDK, there is a part called "Initialize SDK" which 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.