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Using iBeacons and Fingerprinting for Indoor Navigation

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Contents

Bluetooth Low Energy (BLE)

- Wireless personal area network technology
- Low consumption of energy and the low cost
- Transmit small amount of data
- Application friendly
- Easier developing for the Internet of the Things (IoT)
- Development of health, fitness and smart home sensor industry
- Development of indoor positioning system.
- iBeacon protocol gives special attention in proximity location with BLE beacons

The Project

In this project an indoor positioning system was to implement

- based on Bluetooth Low Energy beacons and
- iBeacon protocol
- Controlled by an Android application

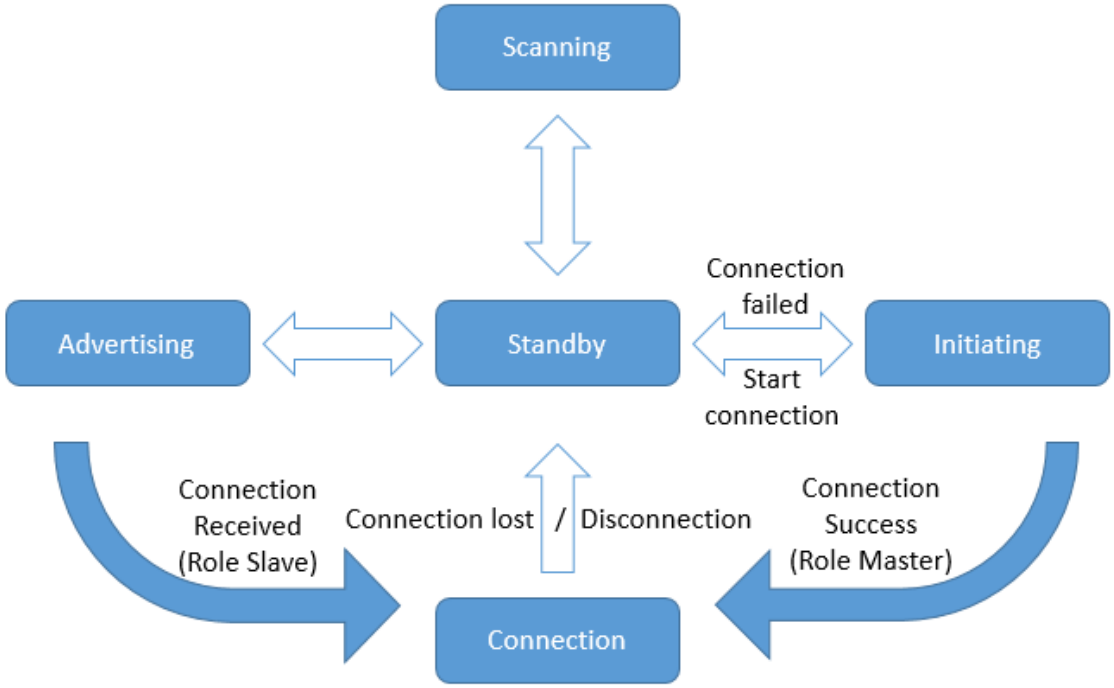
The system uses a Fingerprint based method to

- estimate the position with the use of the Received Signal Strength Indicator (RSSI).

Fingerprinting

- Uses RSSI values for estimating the position of a device.
- Dividing a map of the indoor environment into segments or grids
- Two phases
  - Offline phase or training phase
    - Associates each RSSI value to every segment or grid cell in the map.
    - Then these values are stored in a database and an average of RSSI per segment is computed.
  - Online phase
    - New RSSI values are being gathered in real time at unknown positions
    - They are compared to the stored values.
    - The best match is decided through a proper algorithm and the mobile device is located.

State of Art - Operating states of BLE devices



State of Art - BLE protocol stack

Controller: transmitting and receiving radio signal and interprets it as packets with information.

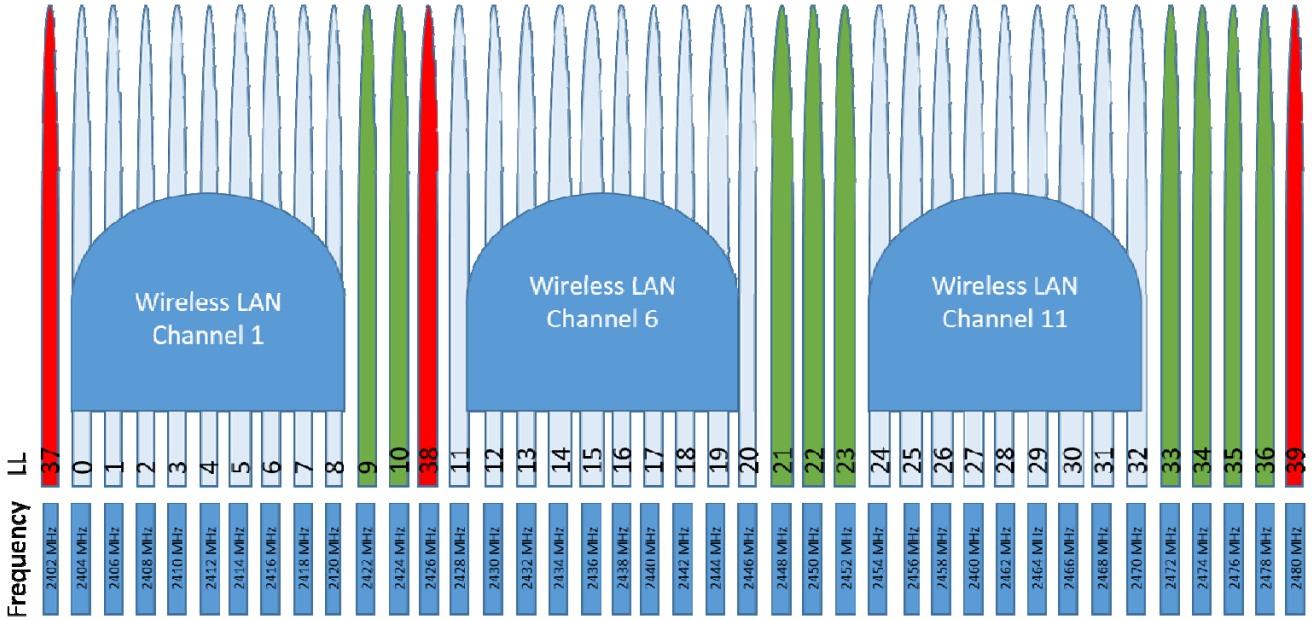
- Physical Layer (PHY)
- the Link Layer: low level communication. Responsible for the low consuming ability.
- the Host Controller interface: interacts with the upper layers of the stack.

Host: It includes the

- L2CAP: contains the security manager protocol and the attribute protocol. Also responsible for data's segmentation and multiplexing.
- GAP profile: the generic procedures for advertise or manage connections of the devices.
- GATT profile : allows the discovery service

Application: the interface of the Bluetooth protocol stack that can cover a particular use case.

State of Art - BLE radio channels

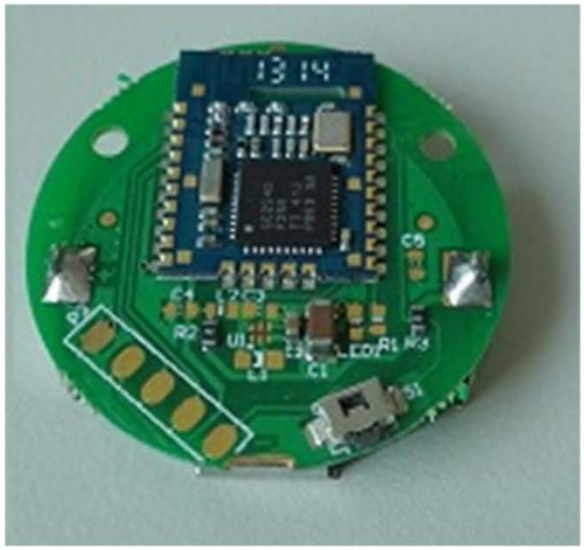


Implemantation

April Beacons are used for the implementation

- Nodes that integrate a CC2540 chip from Texas Instrumental, a low-power System-On-Chip (SoC), for BLE applications.
- April Beacons are
  - a low-cost solution
  - iBeacon Protocol based advertisements.
  - and hold a CR2477 coin battery and according the specifications can last up to 24 months.

Implemantation



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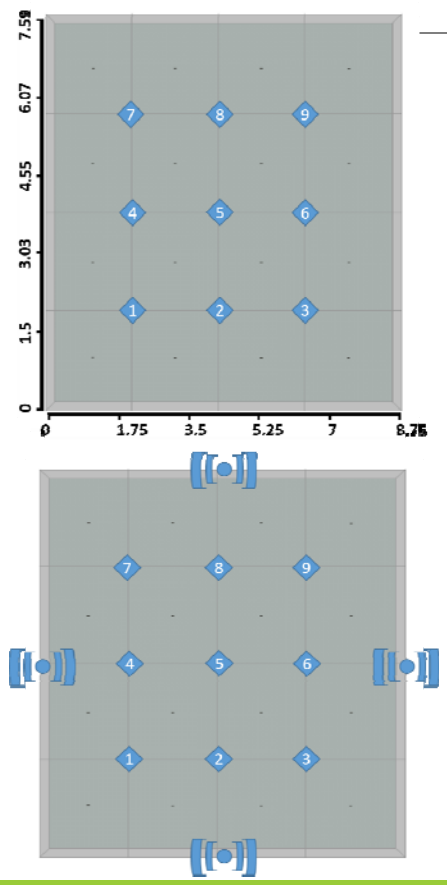
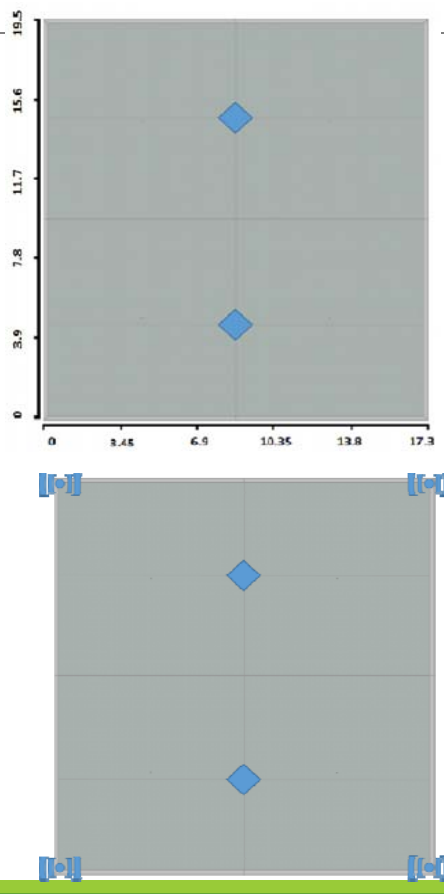
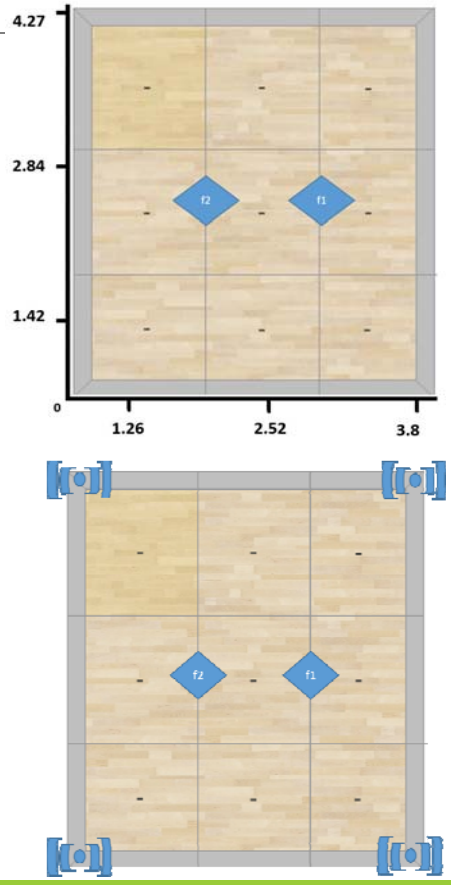
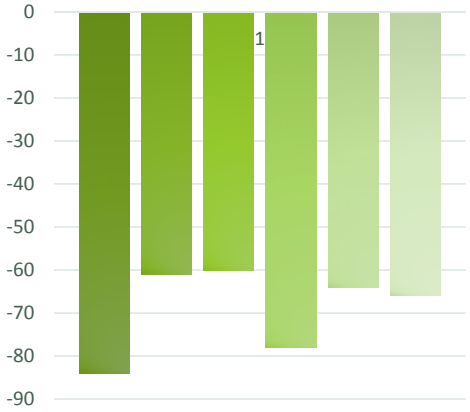
Scenarios

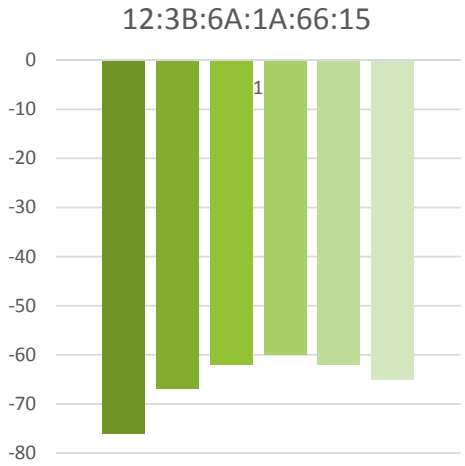


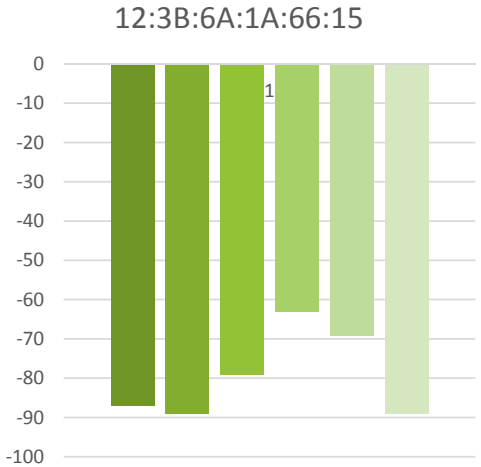




Behavior of RSSIs



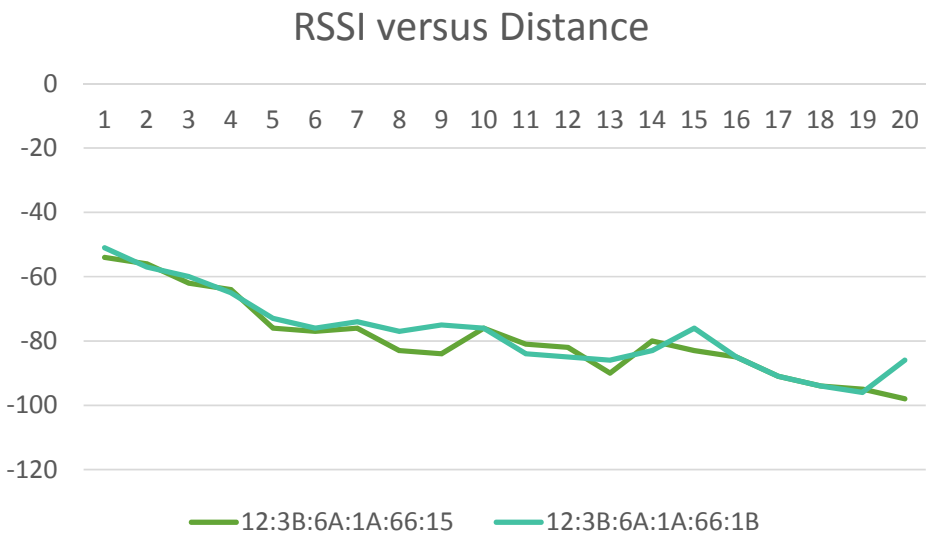




- Gathered RSSIs from the same node in 1 , 3 and 7 meters distance

Behavior of RSSIs

- Comparison of two nodes from the same manufacturer and the values they give until the 20 meters.



Results

- Rapidly changes of RSSIs , even when there is a static setting.
- The neighboring fingerprints are overlapping with each other often.
- The way the user is going to navigate through the room should be better known.
- Difficult implementation in real life
- Satisfactory accuracy in 3 meters

Future Improvements

- A path loss model that mends the RSSI values must be implemented.
- More positioning techniques must be tested.
- Fingerprint and Proximity based method could give good results.
- Beacon placement needs to further evaluated.
- The number of the beacons on the walls of the indoor environment should be taken in consider.
- BLE and Wi-Fi can coexist in indoor environment and can be further tested.

Related Work

iBeacon

- an Apple's Trademark
- also available for Android since a SDK has developed.

Estimote

- uses the iBeacon technology
- comes with an API, in which a developer can use to create his own application and use cases.

Indoo.rs

- does not use the proximity based method
- guarantees an accuracy of less than 5m radius in 95% of the cases.

Thank You!

Any Questions?