© 2016 IJEDR | Volume 4, Issue 1 | ISSN: 2321-9939

Real time Localization System based on iBeacon Technology in Indoor Environment

[1]Ms. Shivangi V. Jain, [2]Dr. KiritKumar Bhatt, [3]Mr. Brijesh Kamani

[1]M.E. Scholar SVIT-Vasad, [2]Professor SVIT-Vasad, [3]CEO Teksun Microsys pvt ltd
[1]Electronics and Communication Engineering,
[1]Sardar Vallabhbhai Patel Institute of Technology, Vasad, India

---

***Abstract* - Indoor asset tracking is a unique specialty of many types of RTLS, as Global Positioning Systems (GPS) have difficulty providing asset locations within buildings. RTLS deployments generally address the problems of determining the location of equipment and products in a warehouse or even tracking employees and files in an office. The most common RTLS uses a WiFi infrastructure to determine the location of tagged assets. These systems employ Received Signal Strength Indication (RSSI) techniques to wirelessly determine asset location. This presents a new method for providing an accurate, low cost estimate of sub-room indoor Asset location. Recently proposed indoor localization solutions have required anywhere from zero additional infrastructure to customized RF hardware and have provided room-level to centimeter-level accuracy, typically in that respective order. An iBeacon based Bluetooth Low Energy (BLE) technology used to track and manage assets. Each asset to be tracked is tagged with an iBeacon tag, and tracked using BLE enabled device located throughout a facility. Based on the tracking information, the system allows users to manage assets and generate reports regarding the various tagged assets.**

***Index Terms* - iBeacon, Indoor, BLE, RTLS, RSSI.**

I. INTRODUCTION

Nowadays, Location Based Services (LBS) have been broadly applied in different areas and their location awareness has become an important part of our lives [15]. Recently, the Indoor LBS have gained more attention in market, as people spend more time in indoor places. Although outdoor positioning has been extensively studied and applied, indoor positioning is still facing big challenges and some of its techniques and methods have deficiencies [16]. Indoor positioning based on traditional Bluetooth has been both carefully evaluated and improved. According to the best of my knowledge, no academic work can be found which characterizes and evaluates Bluetooth low energy in a positioning setting. Meanwhile, commercial systems using the technology are rapidly emerging on the market promising different performance and properties. The technology and algorithms behind the commercial systems are often vaguely described and kept secret due to competition. This project thoroughly evaluates and investigates the properties of Bluetooth smart or iBeacon and describes its suitability and applicability for providing inexpensive widely available indoor positioning.

Since the introduction of GPS technology, services that rely on positioning and localization data have emerged in a rapid pace. Today positioning technologies are used in a variety of areas such as providing driving directions, recording running routes during training and tracking valuable goods in real-time to name a few. While GPS has become a de facto standard for outdoor positioning applications, no similar widespread technique is present for indoor positioning or in areas where GPS is not available. The topic of indoor positioning does not lack research: Several approaches and suggestions based on different technologies have been developed and introduced over the last two decades. What is common for all of them is that no approach has made any big impact within the area. A number of systems have been commercialized, produced and installed in different quantities but none of these have yet made a big penetration into society. The systems are usually proprietary and used in very small scale installations based on requirements of the specific use case, resulting in that no common universal standard such as GPS exists in the area of indoor positioning.

One proposed iBeacon based technique for indoor positioning is to use Bluetooth technology and provide positioning based on signal strength parameters that can be easily obtained. A major advantage of using Bluetooth is that it is a technology with high penetration in society. Devices such as cell phones, tablets and computers normally come equipped with the technology as standard. The large penetration rate also means that the required hardware is produced in large quantities, resulting in a very low unit cost. A Bluetooth chip combined with a microcontroller is typically available for less than 5$. Research on positioning based on Bluetooth has also made some progress in the past years, possibly making it a viable candidate for large scale deployment in several scenarios and applications.

In June 2010, the specification for the Bluetooth 4.0 technology was released [13]. This specification introduced a new technology, named "Bluetooth low energy"(BLE) or "Bluetooth smart". The new technology contains some major differences compared to traditional Bluetooth. A variety of new services and roles are introduced, the RF-band usage is changed, a new software stack is introduced and as can be guessed from the name, power consumption is greatly reduced to between 50-99% of the classic Bluetooth power consumption [14]. A Bluetooth smart device could potentially operate for years powered by a single coin cell battery.

Table 1 Classic Bluetooth vs. Bluetooth Low Energy [17]

Technical specification	Classic *Bluetooth* technology	*Bluetooth* low energy technology
Radio frequency	2.4GHz	2.4GHz
Distance/Range	~10-100 meters	~10-100 meters
Symbol rate	1-3Mbps	1Mbps
Application throughput	0.7 – 2.1Mbps	305kbps
Nodes/Active slaves	7	Unlimited
Security	56 to 128 bit	128-bit AES
Robustness	FHSS	FHSS
Latency (from not connected state to send data)	100+ ms	<6ms
Government regulation	Worldwide	Worldwide
Certification body	Bluetooth SIG	Bluetooth SIG
Voice capable	Yes	No
Network topology	Point-to-point, scatternet	Point-to-point, star
Power consumption	1 (reference value)	0.01 to 0.5 (use case dependent)
Service discover	Yes	Yes
Profile concept	Yes	Yes
Primary use cases	Mobile phones, headsets, stereo audio, automotive, PCs etc.	Mobile phones, gaming, PCs, sport & fitness, medical, automotive, industrial, automation, home electronics etc.

II. Literature Survey

A RFID and WSNs based hybrid mechanism proposed in [1] for indoor precise localization. The dynamics of RSSI are obtained from the sparsely deployed wireless sensor networks, while the information of RSSI is obtained from the densely deployed RFID tags. In this paper two localization algorithms are proposed: SA-LANDMRAC and COCKTAIL. SA-LANDMRAC is easy to implement, while COCKTAIL has higher localization accuracy [1]. The RFID technology has become increasingly popular over recent years for tracking and positioning applications in indoor environments, as a cost-effective and power efficient solution which can be installed easily on the different object or people [2]. A novel hybrid WLAN-RFID indoor localization solution introduced in [2]. This hybrid solution is suitable for the indoor positioning in environments where both RFID and WLAN signals are available, since it takes advantage of both types signals. Their experimental results show that hybrid solution can enhance the probability to get errors below 2 meters with several percents even if only one RFID reader is available. A newly real-time locating system using active RFID for asset management in indoor environments proposed in [3].author introduce this system as the iLocate system, for the IoT. To eliminate the RFID RSSI noise, iLocate employed the frequency-hopping technique. To achieve the fine-grained localization accuracy, it took advantage of the virtual reference tags and the tag–tag communication protocol. To support a large-scale RFID network, iLocate used ZigBee[3]. [4] Present an experimental localization system consisting of two fused solutions. The Ultra-wideband Localization Platform based on the time difference of arrival technique provides accurate positioning in a limited indoor area. The tag integrating functionalities of both localization systems was mounted on a medical test device to demonstrate asset tracking. It was constantly tracked by s-net and, as long as the tag was located outside of the room covered by the UWB subsystem, positioning accuracy was 4 m in 2D. [7] Conducted research on the RF-based system for locating and tracking users in an in-building environment. In this study, RADAR were applied over a standard IEEE 802.11 based on [8] projected about a deployment of RF wireless LAN. NNSS (nearest neighbors in signal space) was the technique to get the distance between each the SS (signal strength) tuple. Through the empirical signal strength measurements and signal propagation modeling for signal strength information in advance, location-aware services and applications were available in the study. In spite of the hostile nature of the radio channels in side building, [7] provides that RADAR has an ability to locate and track users with a high degree of accuracy. [9] Presented several improvements on previous research [7]. First of all, their Viterbi-like algorithm was demonstrated to outperform both NNSS and NNSS-AVG in respect to accuracy. Facts of different environments such as the multipath phenomenon, the number of people in the building or different times of the day were affected to evaluate their system. Thus, [9] reinforced as using multiple Radio Maps that represent the various environmental conditions. To analyze the effect of multiple floors, RADAR implemented the measurement on multiple floors as well. Although some advantages, RADAR has nontrivial disadvantages. A wireless LAN, that may be impractical on small or power constrained devices, has to always assist the object to track. Also, the propagation model, which is preconfigured, must be reconstructed or created as a new model when the original environment is changed [10].The [11] presents an opportunity for the application of ZigBee technology for asset tracking**.** In cooperation with IEEE 802 Working Group 15, ZigBee is working to address the needs for a low-power and low-cost wireless networking solution for both residential and industrial applications. [12] Illustrates another approach based on infrared technology. This system tried to know the approximate position and orientation of the user's head by using infrared transmitters and Head-Mounted Displays. However, several drawbacks of this system, such as heavy weight of the head unit, restriction of head rotation range, and the large number of beacons in the ceiling, still exists. [5] Utilize the new iBeacon technology for quick deployment and positioning. Since iBeacon is based on Bluetooth LE, it is significantly more energy-efficient. A coin-sized beacon can function for months on a battery. Even with a small amount of training data and a very light-weight distance-based matching module, the positioning accuracy is shown to be fairly high. This allows indoor position service to be deployed quickly even if there is no RF infrastructure such as Wi-Fi. One important thing that should be noticed that for most cases, more training data yields a higher accuracy, but this is not always the case. The reason is that the distance-based match algorithm is not robust against noisy data. [6] Demonstrate that how iBeacon can track your luggage at the airport. Tracking a suitcase with iBeacon has three use cases: First is to know when the suitcase is nearby. So when the device that is searching for the suitcase detects the specific one, it pushes a notification, so that the user knows that the suitcase is in a region of about 30 meters. The second case is when the suitcase is within reach and we need to calculate the distance between the suitcase and user. The last case applies if the suitcase leaves the tracking region. In this case the user needs a notification that the luggage is more than 30 meters away. When we check in and hand over the luggage it is clear that we get a notification that the luggage has left the region. From [6] paper it is clears that iBeacon are proximity devices and to detect regions they are working really well The notifications for entering and leaving a region work well, but the accuracy could be improved with better iBeacon. To calculate distances it requires better technology to improve their accuracy.

III. PROPOSED WORK

The aim is to make Real Time Location Systems (RTLS) capable of remotely determining the location of tagged assets in an environment within a relatively short time frame (real time). Signals from tags are received wirelessly by readers, which use information about the signal, to continuously determine the location of the tag relative to each reader. Using readers positioned at several locations around a tag offers multiple location readings, which can be compiled together at a central host to estimate the location of a tag in a two dimensional space.

Real time Localization System consists of mainly three parts:

A. iBeacon: it is a one type of Beacon tag. Tag is attached on a particular asset which we want to track.
B. Scanning Module: this module is used to scan the iBeacon tag and send the related information to the router.
C. Web application: This is specially design for the specific project. Web application shows the location of tagged asset.

Figure 1 shows the system block Diagram.

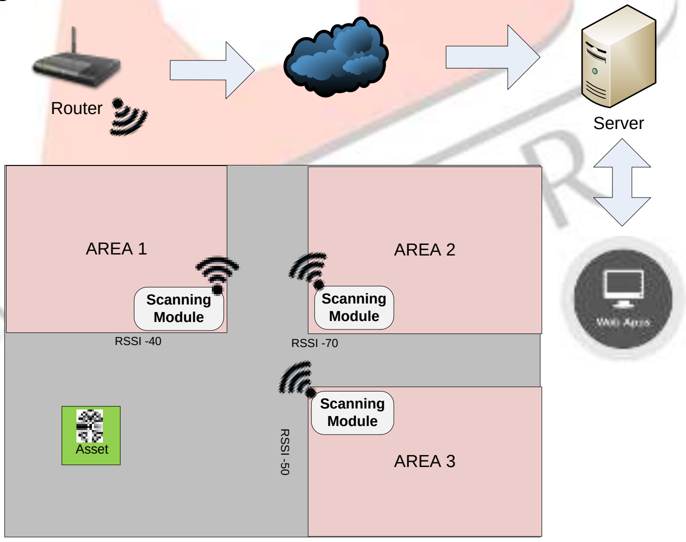

Figure 1proposed System Block Diagram

System Overview

The function of various Components shown in figure 1 are described below.

A. iBeacon: it is used to track valuable asset. Any asset which we want to track, we have to just attach an iBeacon tag on it. iBeacon is working in advertising mode so that it sends the relevant data continuously in predefined time.
B. Scanning Module: it is used to scan the iBeacon tag. Scanning module consist of two main components which are BLE enable module and Wi-Fi module.BLE chipset is used to scan the iBeacon tag and send the information to the Wi-Fi module. Wi-Fi Module send the information to router
C. Router: It provides Wi-Fi connectivity to the Scanning Module. Once WiFi sends data to router, It sends the data to server Database and the beacon tag data store in database.
D. Web Application: It shows the location of beacon attached tag in 2 dimension space.

Project Implementation

As per the proposed work, the complete Project is divided in four parts:

1. Programming of Scanning Module
2. Store Asset Related information on Server Database
3. Design an accurate Algorithm for Tracking Asset in Real time
4. Show tracked asset information in 2 dimensional view using Web Application.

Work flow of the complete Project is as shown in figure 2:

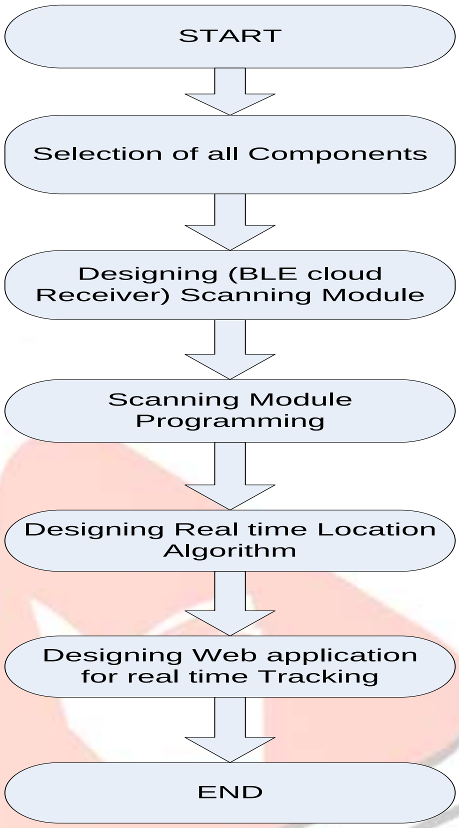

Figure 2 System Work flow Diagram

Future Work

Scanning Modules which scans the different assets and make entry in server Database with different RSSI value; Based on this RSSI values stored in server database that is used in tracking algorithm; which shows the distance between tag attached on asset and reference node (scanning Module). We can use this distance information for tracking a valuable asset. The GUI architecture of Tracking is shown on Web Page. Figure 3 shows the sample example of tracking that how the location of asset shown on web page in 2 dimensional view.

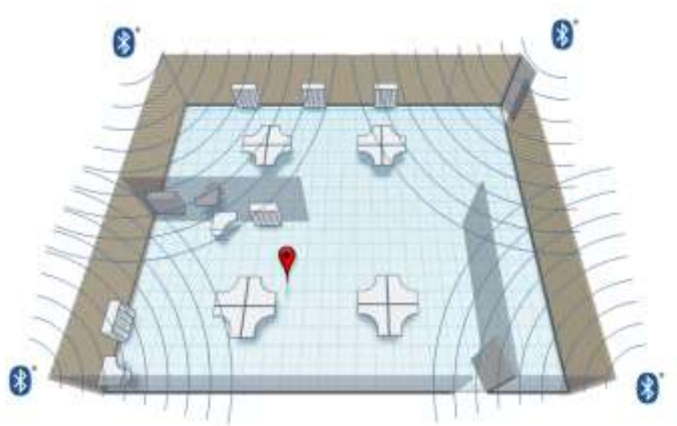

Figure 3Sample GUI view Shown on Web App.

IV. Conclusion

The Real time Localization System has been aimed to design in such a way that it can fulfil the needs of the user for particular Indoor area. It has countless applications and can be used in different industries and application. For instance, at one scenario it can be used by any industry to track any single valuable inventory to be aware of the activity that where the inventory actually placed, and from which place it is moved and when it is move from one place to another.

V. References

[1] Zhang Dian ; Lu Kezhong ; Mao Rui; "A precise RFID indoor localization system with sensor network assistance" Communications, IEEE Journals & Magazines, Volume: 12, Issue: 4 Pages: 13 - 22, 2015.

[2] Hasani, M.; Talvitie, J.; Sydanheimo, L.; Lohan, E.-S.; Ukkonen, L. “Hybrid WLAN-RFID Indoor Localization Solution Utilizing Textile Tag”, Antennas and Wireless Propagation Letters, IEEE Journals & Magazines, Volume: 14, Pages: 1358 - 1361, 2015.

[3] Zhang, D.; Yang, L.T.; Chen, M.; Zhao, S.; Guo, M.; Zhang, Y.; “Real-Time Locating Systems Using Active RFID for Internet of Things”, IEEE Systems Journal, Volume: PP, Issue: 99, Pages: 1 - 10, 2014.

[4] Krukar, Grzegorz; Wenzel, Marco; karbowwnik, Piotr; Franke, Norbert; von der Grun, Thomas “Proof-of-concept real time localization system based on the UWB and the WSN technologies”, International Conference on Indoor Positioning and Indoor Navigation (IPIN), IEEE , Pages: 756 - 757,2014.

[5] Fard, Hadis Kakanejadi; Chen, Yuanzhu; Son, Kyung Kook “Indoor positioning of mobile devices with agile iBeacon deployment” 28th Canadian Conference on Electrical and Computer Engineering (CCECE), IEEE, Pages: 275 - 279, 2015.

[6] Kohne, M.; Sieck, J. “Location-Based Services with iBeacon Technology” 2nd International Conference on Artificial Intelligence, Modelling and Simulation (AIMS), Pages: 315 – 321, 2014

[7] P. Bahl and V. N. Padmanabhan, “RADAR: An In-Building RF-based User Location and Tracking System,” in Proc. IEEE Nineteenth Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM 2000), Pages: 775-784, 2000.

[8] V. Hayes, S. J. Kerry, and A. Petrick, Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification, New York: IEEE Standards, 1999.

[9] P. Bahl, V. N. Padmanabhan, and A. Balachandran, “Enhancements to the RADAR User Location and Tracking System,” Tech. Rep., Microsoft Corporation, Redmond, WA, Feb. 2000.

[10] J. Hightower and G. Borriello, “A Survey and Taxonomy of Location Systems for Ubiquiitous Computing,” Tech. Rep., University of Washington, Seattle, WA, Aug. 2001.

[11] Sun-Jin Kim, Jung Hae Seo, Jonnalagadda Krishna, Sun-Joong Kim; “Wireless Sensor Network based Asset Tracking Service” PICMET 2008 Proceedings, 27-31 July, Cape Town, South Africa (c),pages: 2643-2647,2008.

[12] R. Azuma, “Tracking requirements for augmented reality,” Communications of the ACM, vol. 36, Pages: 50-51, 1993.

[13] Specification of the Bluetooth system, Tech. rep., Bluetooth special interest group, version 4.0 (may 2010).

[14] http://www.bluetooth.com/Pages/Basics.aspx

[15] http://apsima.com/blog/ibeacon-for-logistics-facilities-asset-inventory-management/

[16] http://apsima.com/beacons/bluetooth-proximity-beacons

[17] http://www.mt-system.ru/sites/default/files/docs/documents/bluetooth_le_comparison.pdf