DEVELOPMENT OF iBEACON BASED EQUIPMENT INVENTORY SYSTEM AT STAR EXPERIMENT

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Abstract

An inventory system using iBeacon technology has been developed. Using a specially written iOS app, makes the location of the equipment easier to a workers during the routine access to the experiment. The use of iBeacons and iOS devices allow us to distinguish one equipment rack from another very easily. Combined with 2D barcode, the use of iBeacons may provide better inventory management of the equipment for experiments.

INTRODUCTION

STAR Collaboration (Brookhaven National Laboratory, Upton, NY) composed of 56 institutions from 11 different countries. During an annual data-taking period, nearly a hundred different members in the collaboration will come to participate in taking data each year. During the data-taking period, it sometimes is necessary to perform a hardware reset. While the experts of each subsystem are typically present during the data-taking period, not every expert is available for emergencies, and the reset must be handled by the workers. Not all workers are familiar with the hardware, and they may not be aware of where the hardware equipment is located. Having a method to guide them to the hardware which needs to be reset is be critical.

To accomplish this, we have briefly looked into the possibility of using GIS. In ICALECPS 2005, Larrieu et al. [1] and in ICALEPCS 2007, Yamashita et al [2] presented the potential use of GIS for accelerator site management. Unfortunately, GIS is not always useful in three-dimensional space in close proximity such as a high energy physics experiment detector. The idea was quickly abandoned.

Recently, with the widespread use of mobile phone with Bluetooth Low Energy technology, utilizing iBeacons can be used to locate equipment in the close proximity. We have developed a special iOS app using iBeacons as well as a 2D barcode.

THE SYSTEM

For the iBeacons, we deployed several Raspberry Pi [3] computers equipped with USB Bluetooth 4.0 dongles.

SYSTEM OVERVIEW

iBeacon

iBeacon is the technology standard developed by Apple, which allows mobile apps to listen for signals from beacons in the physical world and react accordingly. Essentially, iBeacons behave as lighthouses. Using Bluetooth Low Energy technology, it sends out a small string of information to identify the beacon. This information is received by a specifically written app for the beacon to show the information as well as measure the distance from the beacon to the mobile phone.

iOS Application

In order to effectively use iBeacons, a special app that has the beacon information has to be written. In our case, the equipment rack information is associated with the beacon information. Once the worker enters the proximity of the equipment rack with an iBeacon, the app will notify the worker what equipment are available in that particular rack. This will let the worker know that he/she is standing in front of the correct set of equipment.

QR Code

While iBeacons will help the users to know if they are in the proximity of where they need to be, it will not help them to identify the equipment in question. To deal with that, QR codes are used. The information on the QR code is kept relatively short, allowing us to miniaturize the QR code size, which is necessary to fit it on a VME face plate. The built-in camera on an iOS device functions as a QR code scanner. Figure 1 shows an example use of the QR code.

Figure 1: An example of equipment with the QR code.

This implementation provided both flexibility and the cost effectiveness.

The iBeacons were placed throughout the equipment platform. They are set to transmit slightly different

information allowing one to be distinguished from one another. The information that each iBeacon transmits are coded into each location of the platform and equipment in that location. The Figure 2 shows the actual iBeacon setup.

Figure 2: iBeacon hardware setup.

The app is written such that once a worker is are in the proximity of an iBeacon, it will beep and display the synaptic view of that location with all the inventoried equipment in that location. The user can tap each item on the mobile device screen to see more detailed information on the equipment.
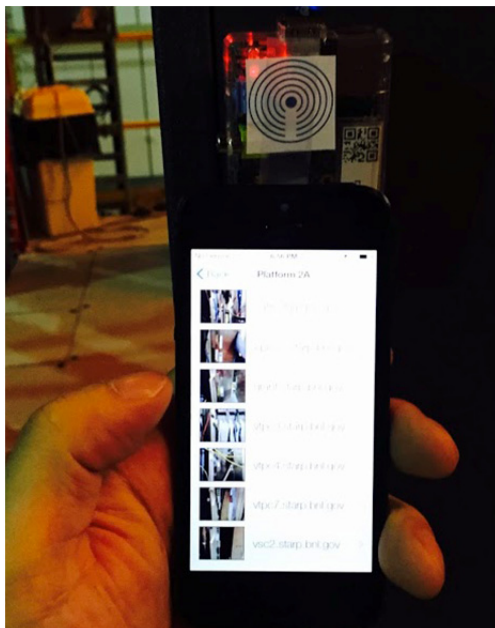

Figure 3: iBeacon setup and the iPhone app.

The app is also equipped with QR code scanner. If a worker scans the QR code attached to each pieces of equipment via built-in camera, the detailed information of the equipment is displayed on the mobile device.

The app was written initially in Beacondo Designer [4]. This toolkit allowed us to write a simple iBeacon aware iOS app very quickly without writing a single line of code. Once the prototype app was developed in Beacondo, then, the project was built for Xcode for tweaking as well as to produce a binary application to evaluation to a real iOS device.

The app was tested on an iPhone 5 as well as an iPhone 6. Although not tested, the app should run on other Bluetooth 4 equipped iOS devices as well. Figure 3 shows the iBeacon and the iPhone app during the performance testing at STAR Experiment. Figure 4 and 5 shows the screen shot of the app.
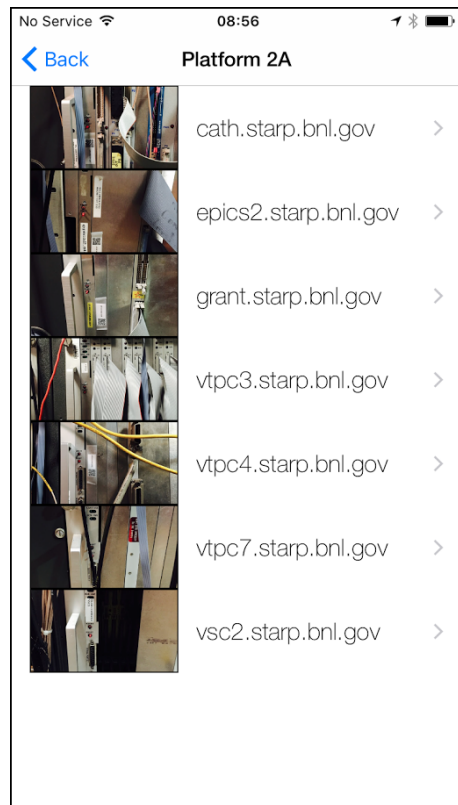

Figure 4: Screenshot of the iBeacon app.

Future Plan

Currently, due to the beacon power issues, the user is required to hold the iOS device fairly close to trigger the beacon information. The beacon power/distance issue must be carefully studied.

The same template generated by Beacondo app is capable of producing Android version of the app, but this has not yet been tested.

Finally, while preparing for the actual test at STAR Experiment, Google announced its "Eddystone" [5] beacon. We have briefly looked into the technology. While we have found some strength in Eddystone technology, it is too early to determine if Eddystone will be widely accepted or not.
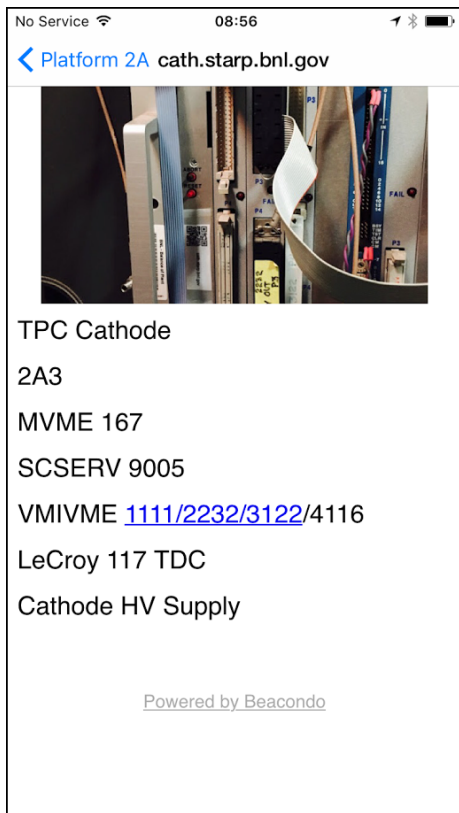
Figure 5: Detailed information on a single VME processor as displayed in the iOS app.

CONCLUSION

The prototype system was tested at STAR Experiment. The limited test performed at STAR Experiment at Brookhaven National Laboratory shows that the system is capable of correctly identifying the equipment nearby. It has been determined that he system should help guiding the workers identify the necessary hardware equipment easily.

ACKNOWLEDGMENT

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