



Bluetooth Low Energy (BLE) Beacon Design

ECE 480—Design Team 6

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RCPD

Maximizing Ability & Opportunity

Project Introduction

The Michigan State University East Lansing campus consists of 538 buildings spread out over 8.125 square miles. Navigating the campus is a daunting task, even for normally-sighted people. The challenge for blind and visually-impaired members of the Michigan State community is significantly greater while they are becoming familiar with the campus. Twenty minute class change intervals are inadequate for blind students and the risks of injury to anyone are increased by rushing through unfamiliar locations.

Project Background

With the release of iOS 7, Apple announced iBeacons, a feature that allows an iOS device to calculate its location relative to Bluetooth beacons. The MSU RCPD is looking to utilize this technology for assistive navigation by placing Bluetooth Low Energy beacons inside building entrances and hallways. These beacons will allow iOS and Android based smart phones to calculate their position inside of a building.

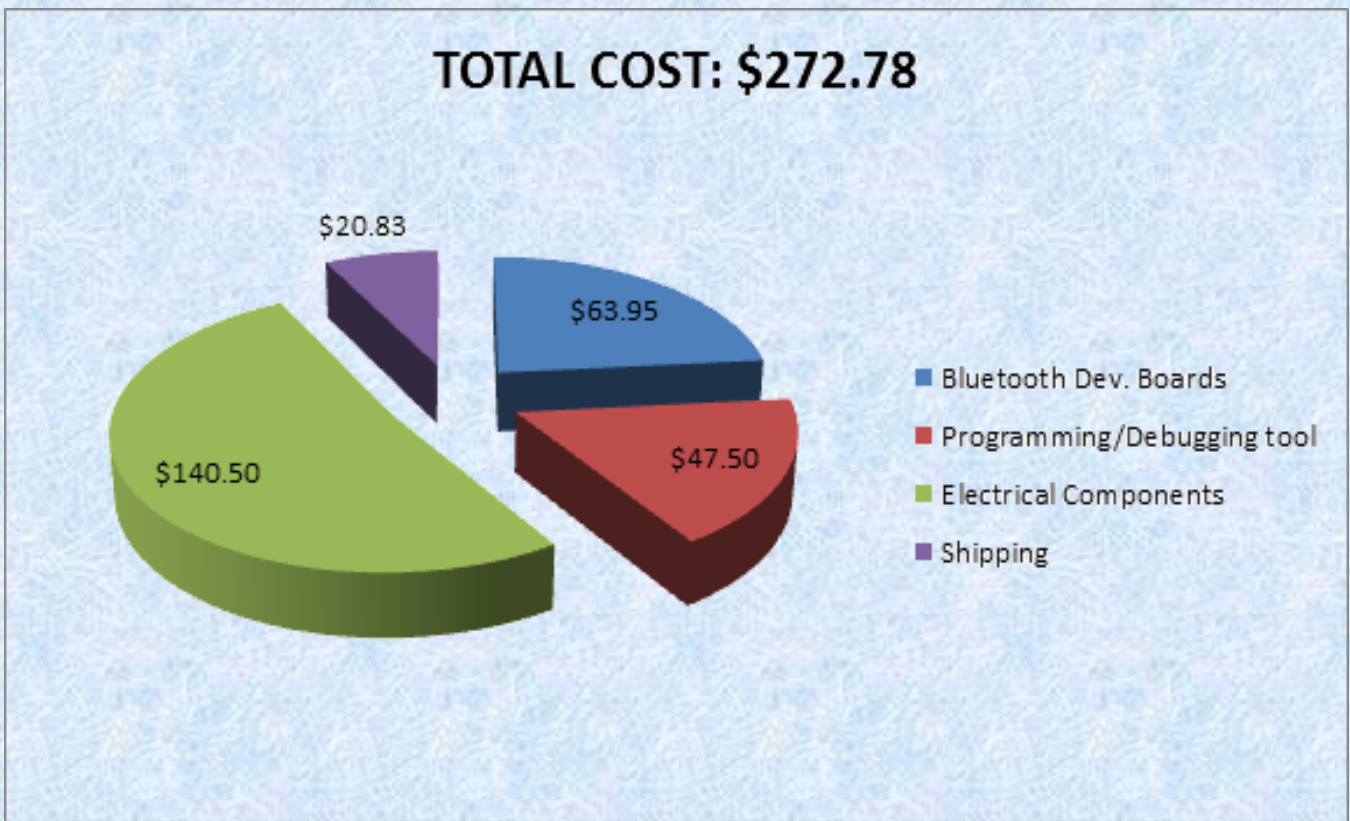


iBeacon Interacts with iDevices

Project Specification

- Bluetooth Low Energy based beacon
- Compatible with Apple's iBeacon protocol
- Cost less than \$20 per beacon
- Resistant to tampering and reprogramming
- Powered by AC outlets
- Applications for iOS and Android devices

Budget

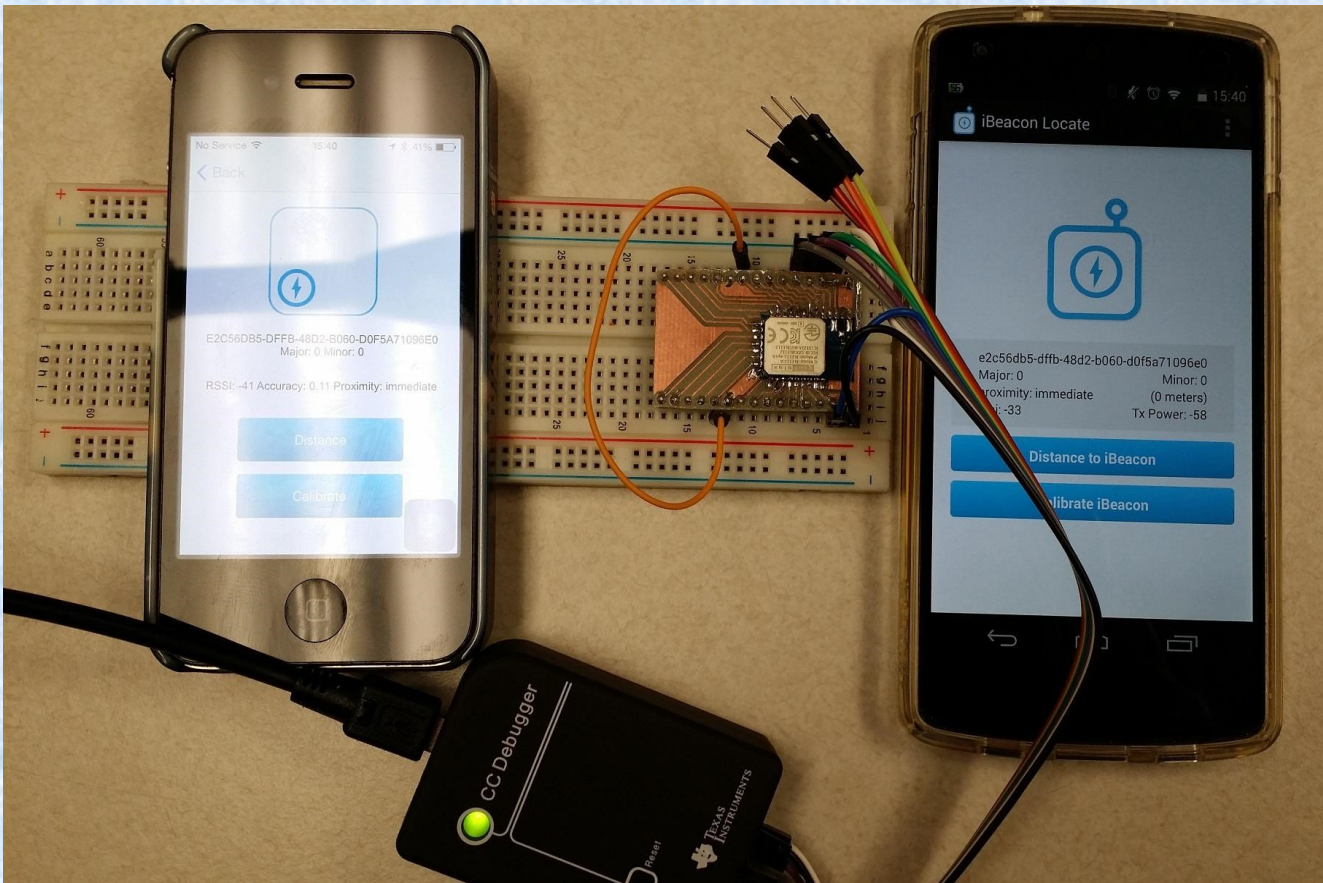


Resource Center for
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Design Phases

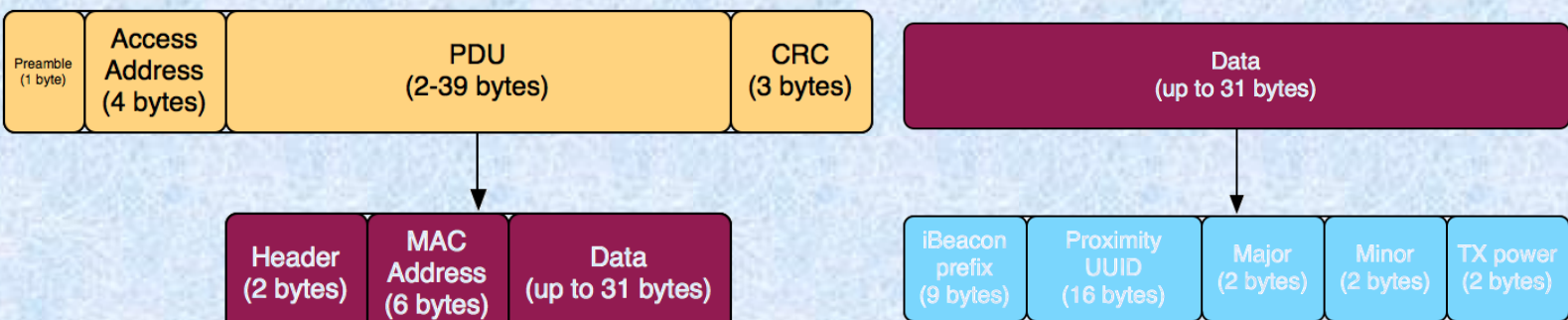
Phase One: Bluegiga Based Design

This design uses a Bluegiga BLE112 module designed to make implementing Bluetooth functionality straightforward. The BLE112 has a built in antenna and is based on the TI cc2540 BLE chip. The BLE112 requires a fewer number of external components and allowed earlier software development, but the cost is higher.



Bluegiga BLE Module Interacting with iPhone and An Android Phone

BLE Packet Breakdown



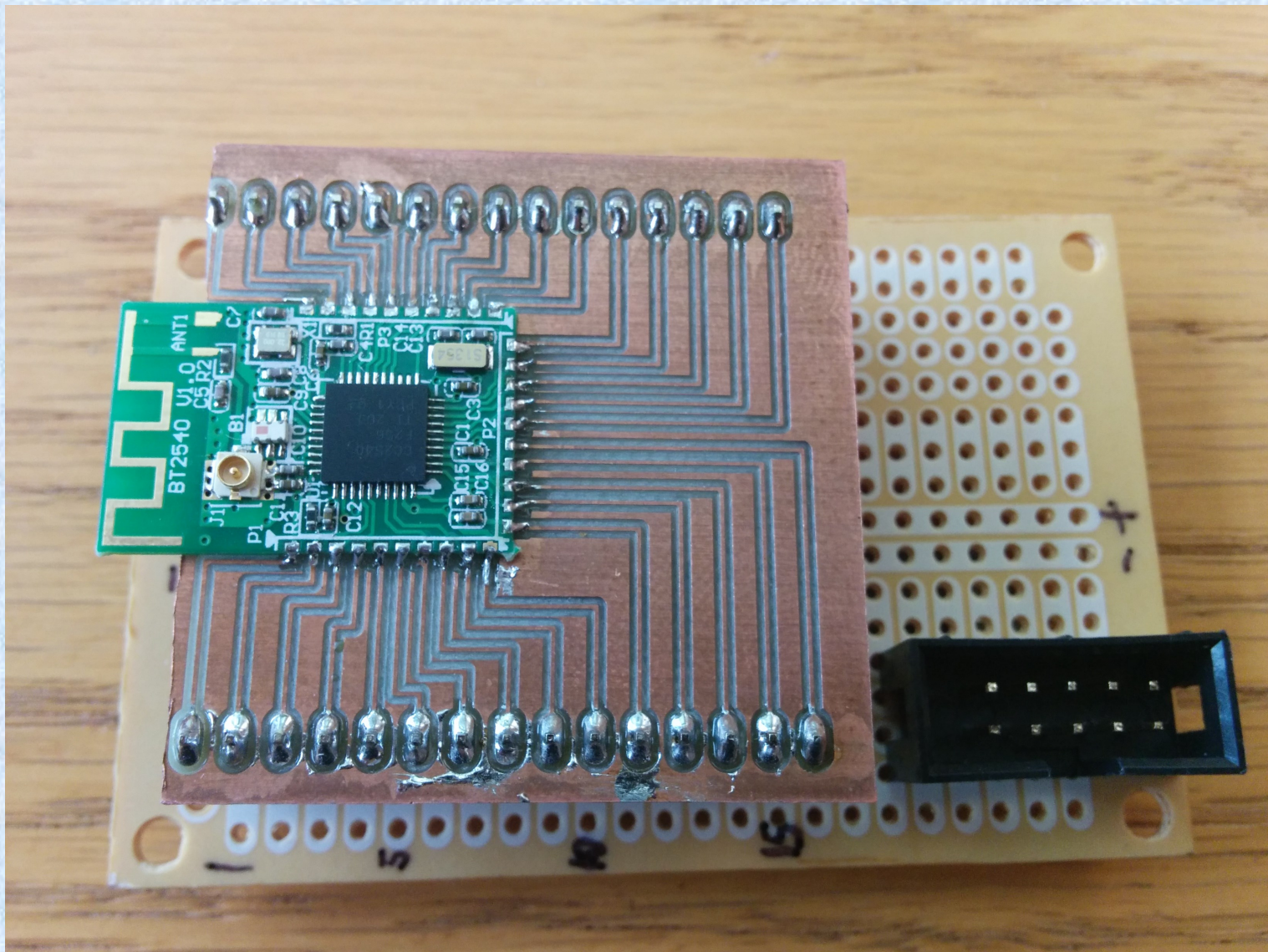
BLE Packet Detail

- Preamble: Either 10101010 or 01010101
- Access Address: Fixed for advertising packets
- Protocol Data Unit (PDU):
 - iBeacon prefix: Fixed value
 - UUID/Major/Minor: Used to identify beacons
 - Tx Power: Used to calculate distance
- CRC: Cyclic Redundancy Check

TI Packet Sniffer Showing Received Packets

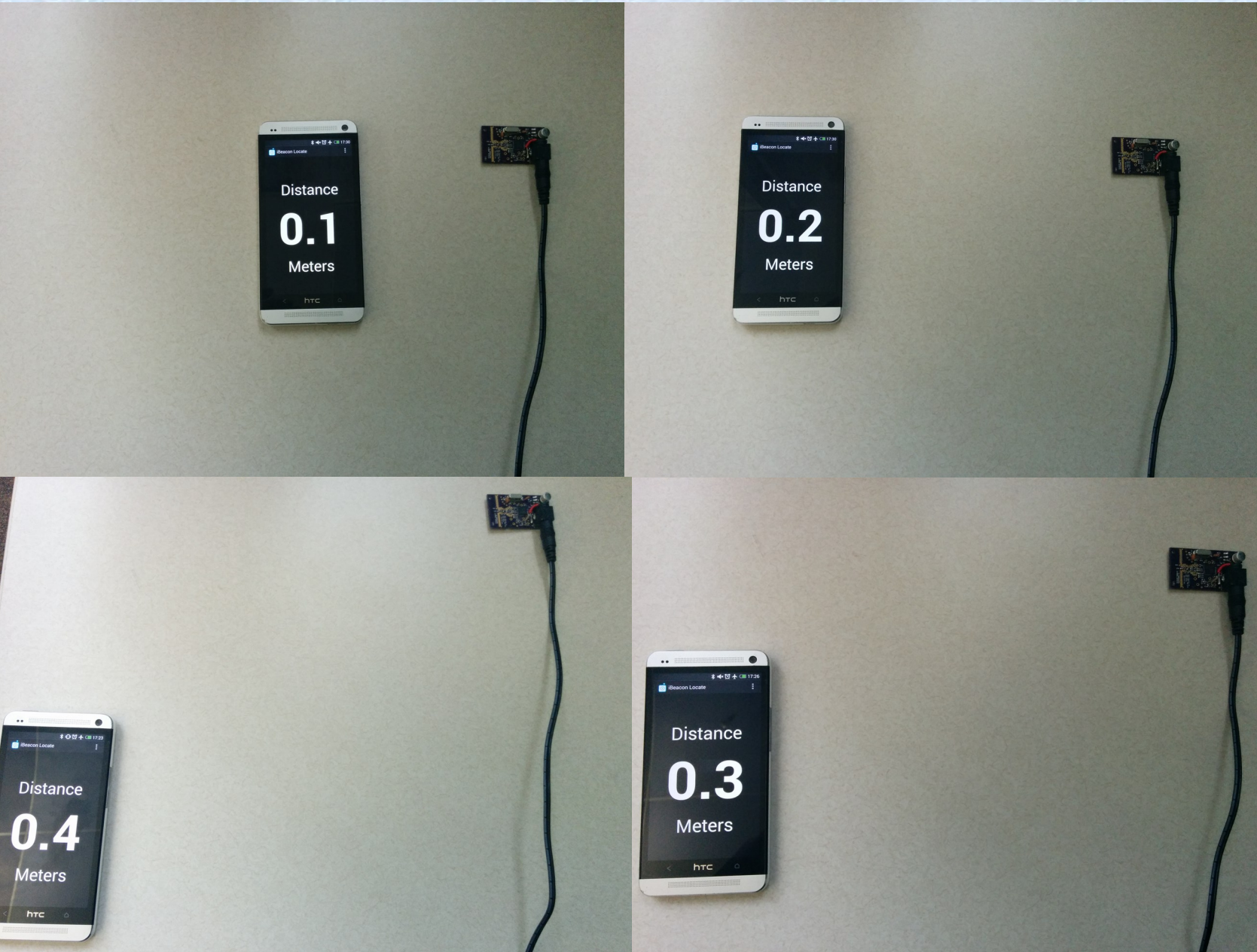
Phase Two: TI Based Design

This design uses a TI cc2540 BLE chip to implement the Bluetooth functionality. The TI cc2540 requires no external microcontroller keeping cost and size low. A PCB antenna was added to the design to allow signal broadcasting.

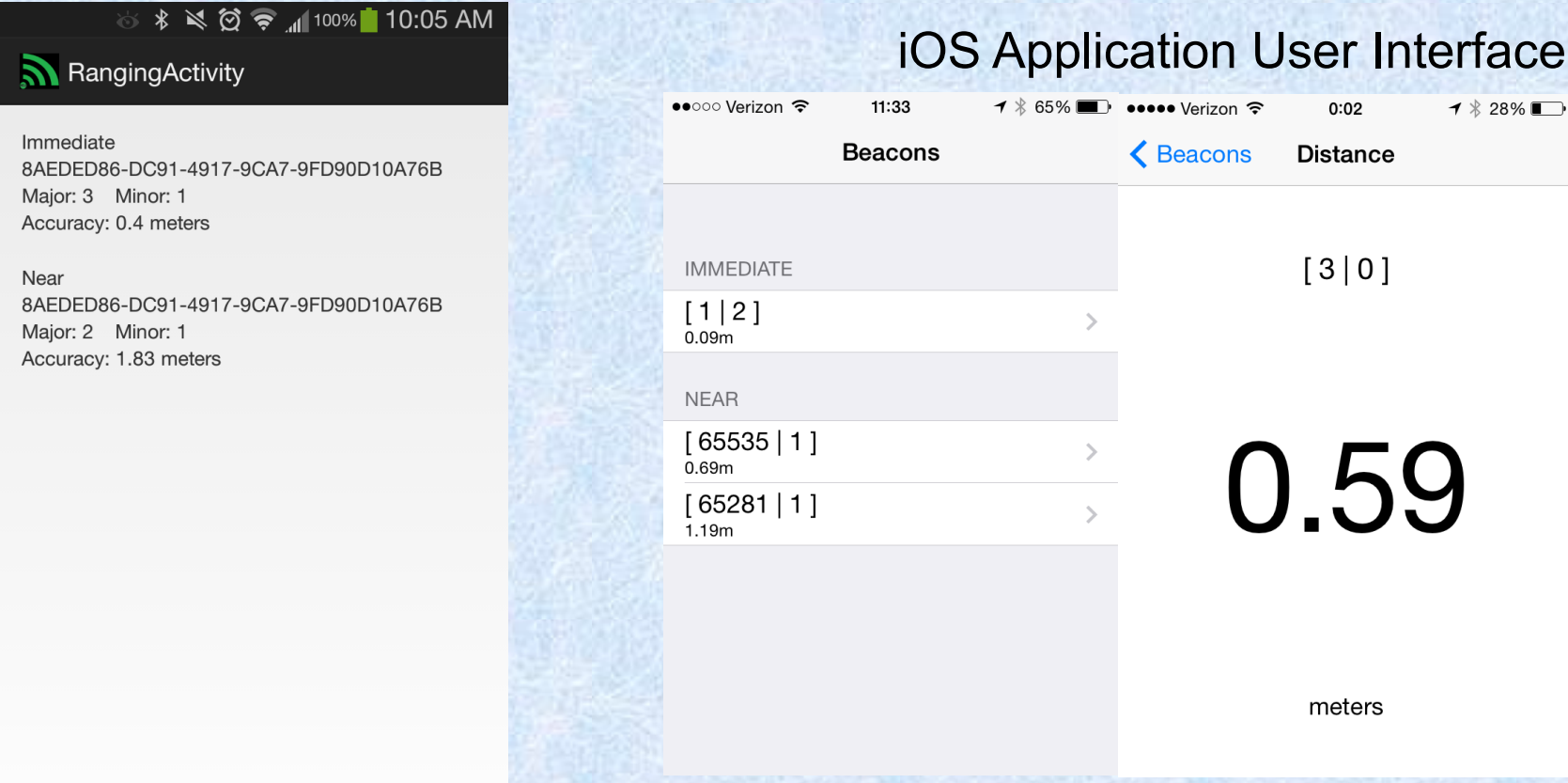


TI cc2540 Development Board

Mobile Application Demo



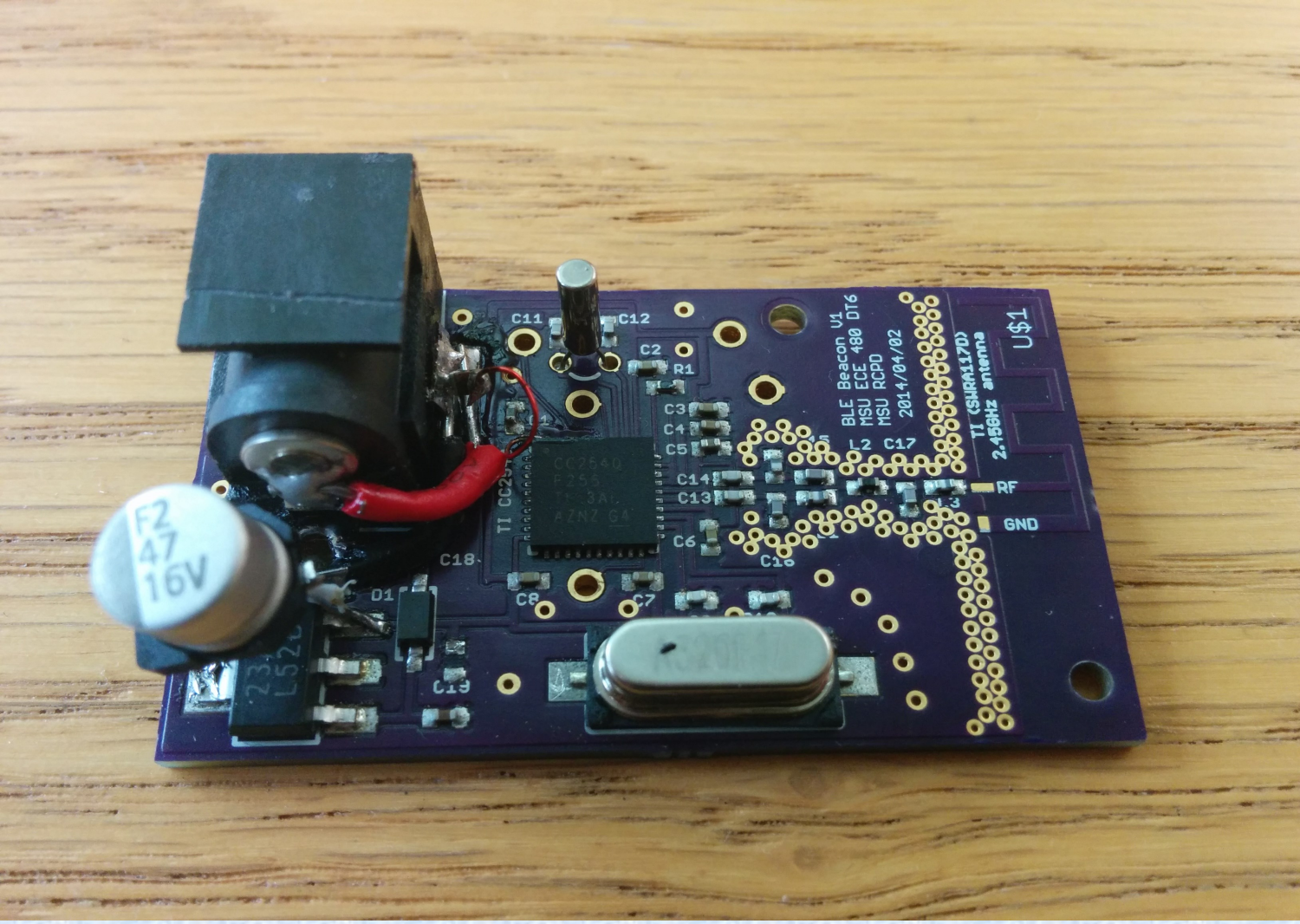
Android Phone Displaying Distance to Beacon



Android Application User Interface

Project Summary

The team was able to design a low cost BLE beacon to allow large scale deployment across the Michigan State University campus. The Texas Instruments cc2540 was selected as the core component of the design. Mobile applications for Apple's iOS and Google's Android operating systems were also developed to demonstrate the functionality of the BLE beacons. The final beacons have a component cost of roughly \$10 and are about 1" x 2" in size.



Final Design Layout