Indoor navigation using **iBeacons**

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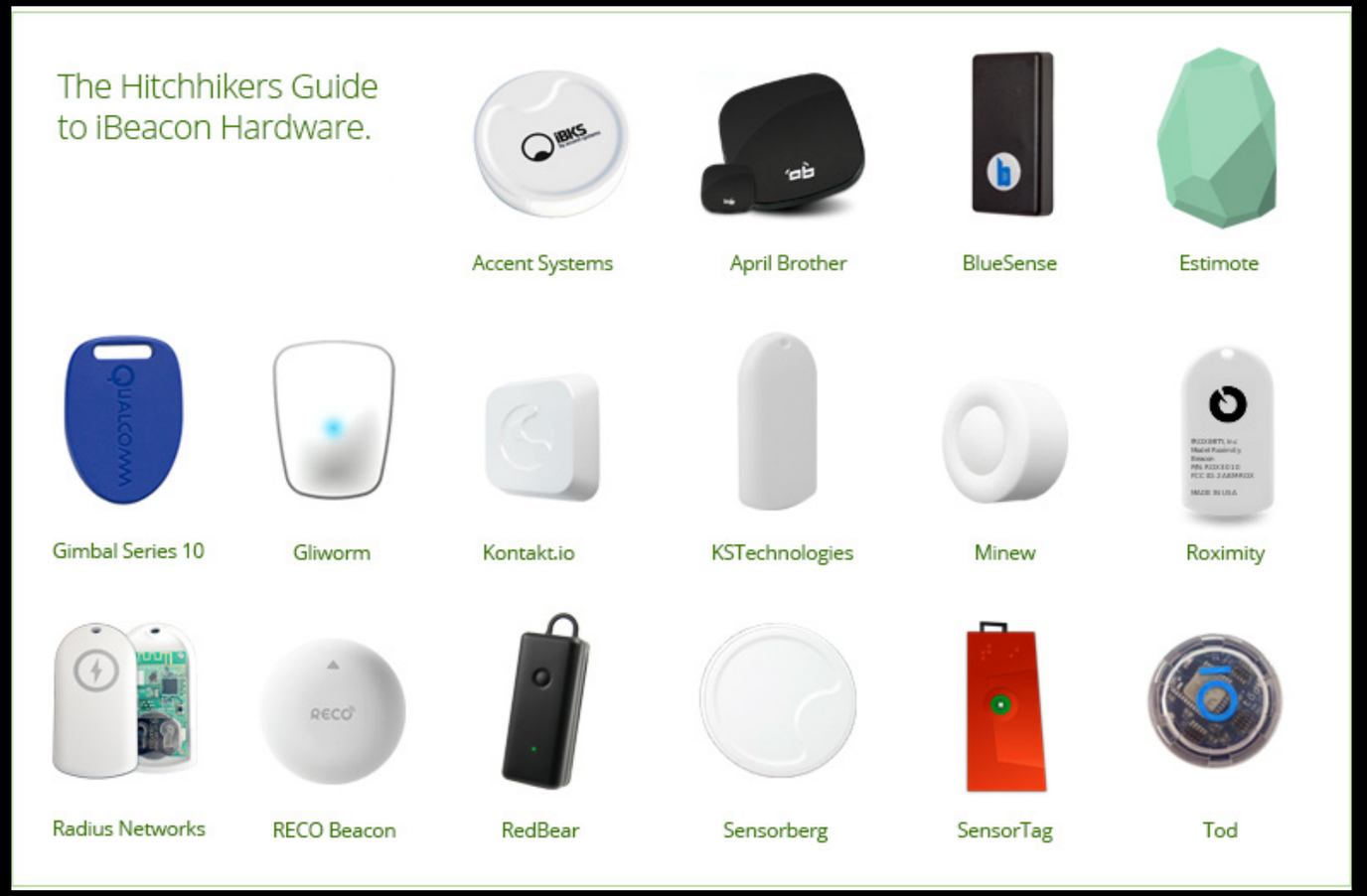
Compatible devices

- iOS devices with Bluetooth 4.0 (iPhone 4S and later, iPad (3rd generation) and later, iPad Mini (1st generation) and later, iPod Touch (5th generation).
- Macintosh computers with OS X Mavericks (10.9) and Bluetooth 4.0

iBeacon Hardware companies



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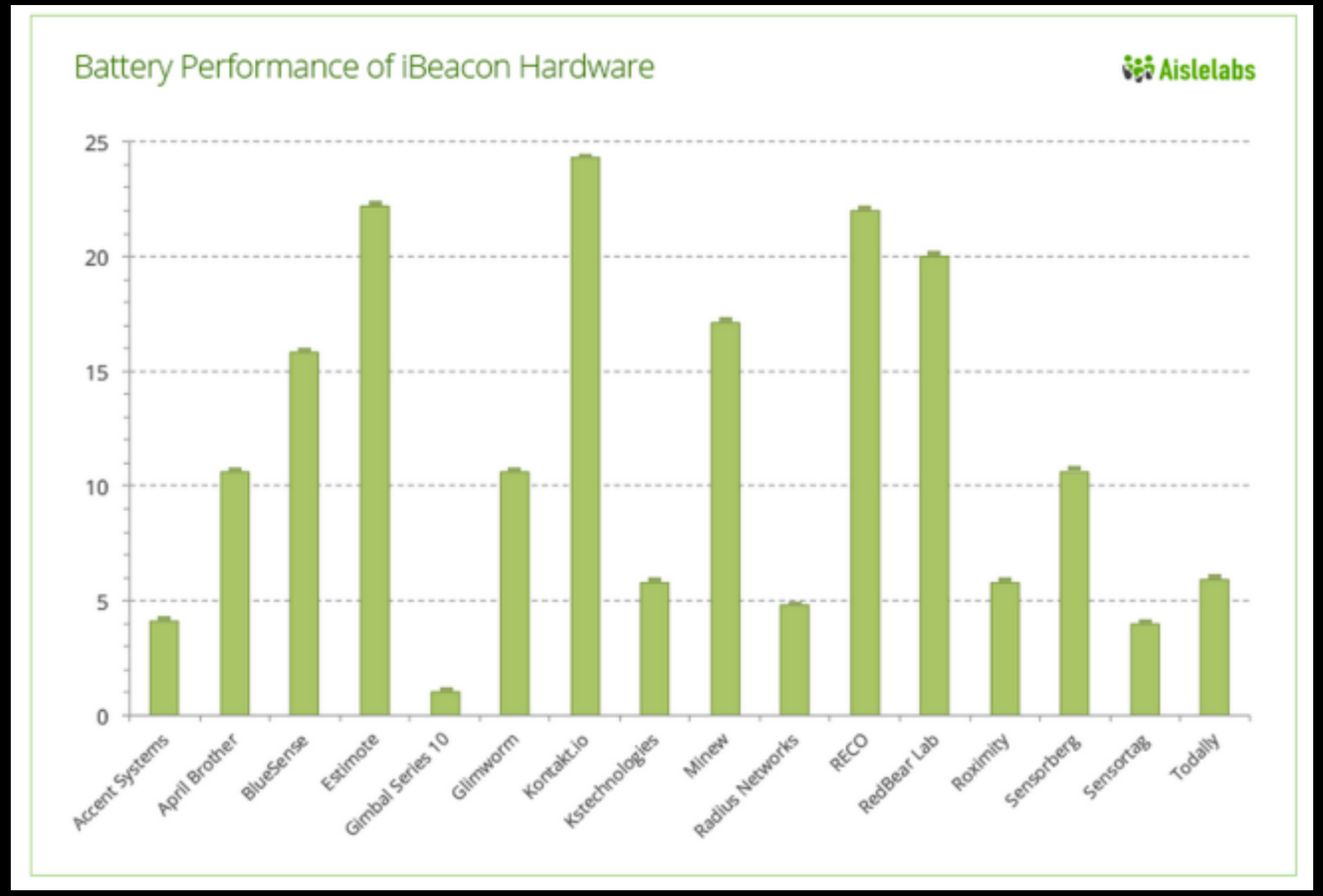
Battery Life of iBeacons



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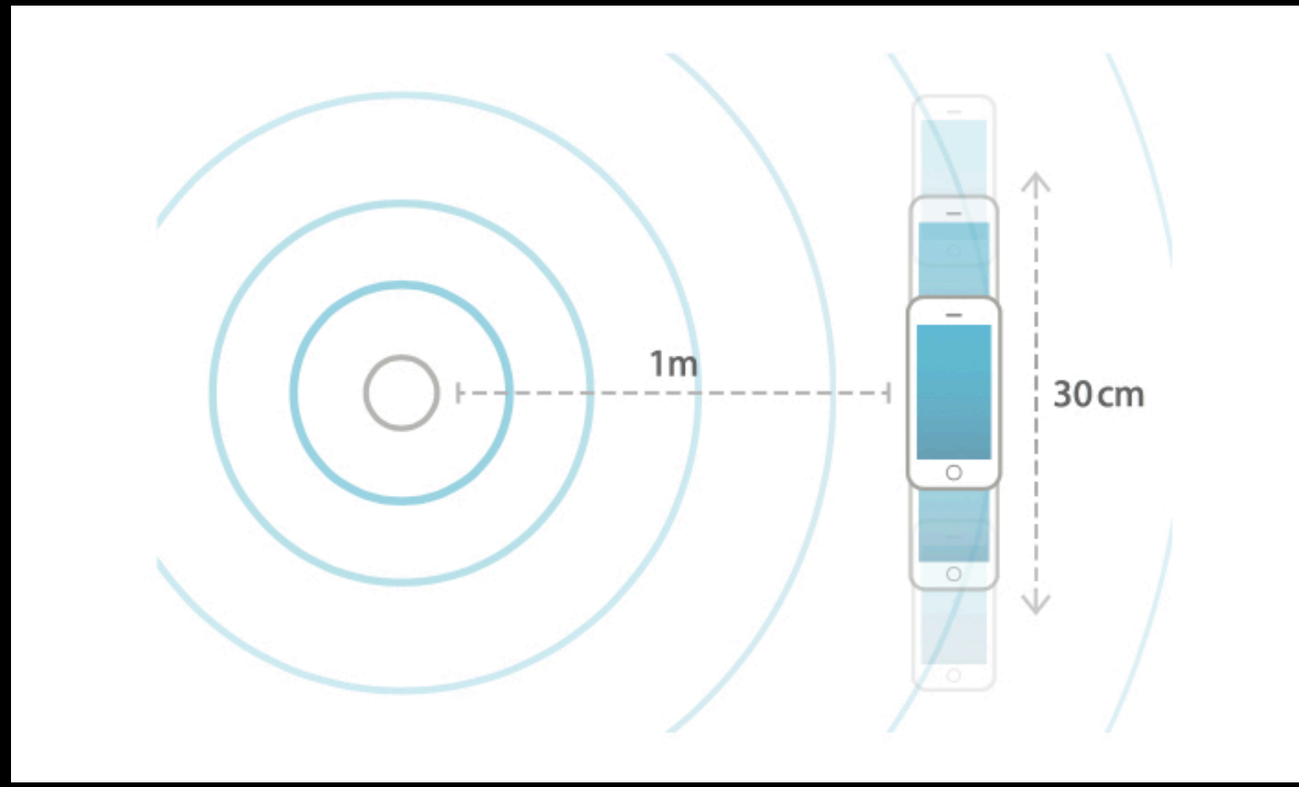
Conclusions

http://www.aislelabs.com/reports/beacon-guide/

- Most Stylish beacon is: **Estimote**
- High Performance beacon is: **Kontakt**
- Value for Money beacon is: **Minew**
- Beacon with Built-in Spoof Protection is: **Gimbal**

Calibrating iBeacon

- Move the device slowly back and forth on a 30cm line, maintaining orientation, and 1m remaining equidistant from the measuring device (see diagram)
- Gather the values reported in the CLBeacon's rssi property.
- Average the collected rssi values.
- Apply this Measured Power value to the beacon.



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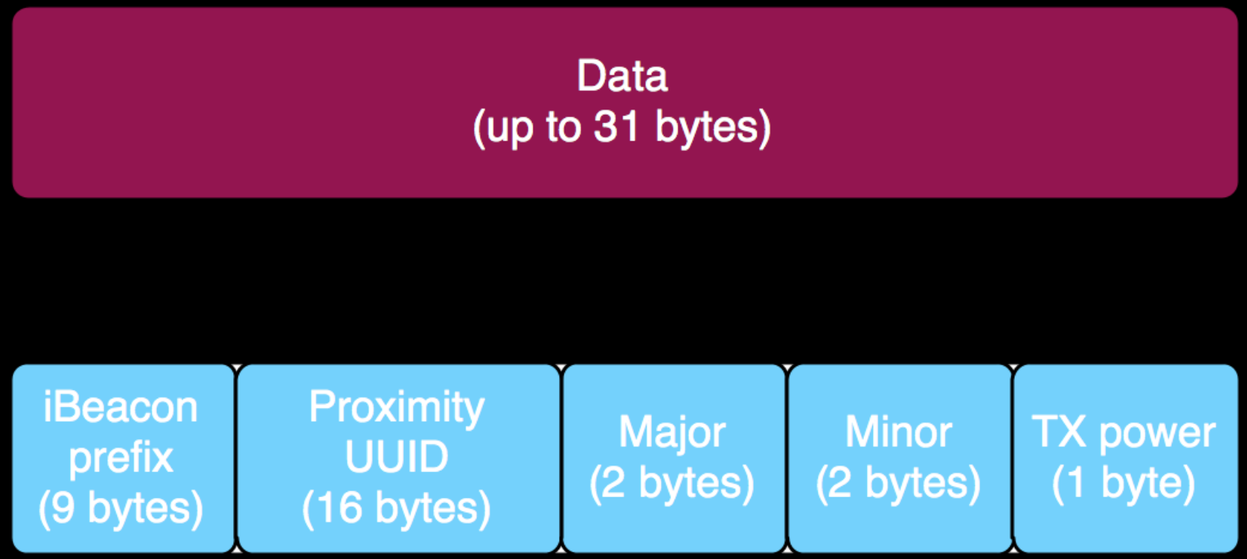
iBeacon vs NFC

- NFC range is up to 20 cm (7.87 inches) but the optimal range is < 4 cm (1.57 inches). iBeacons have a significantly larger range.
- NFC can be either passive or active. When using passive mode, the power is sent from the reader device.
- Most smartphones ship with both Bluetooth 4.0 LE and NFC support.

Bluetooth LE iBeacon packet

http://stackoverflow.com/questions/18906988/what-is-the-ibeacon-bluetooth-profile



BLE advertisement

02 01 06 1A FF 4C 00 02 15: iBeacon prefix (fixed)

B9 40 7F 30 F5 F8 46 6E AF F9 25 55 6B 57 FE 6D

proximity UUID (here: Estimote’s fixed UUID)

00 49: major

00 0A: minor

C5: 2’s complement of measured TX power

iBeacon Security | Spoofing

```
hcitool -i hci0 lescan-passive
D6:EE:D4:16:ED:FC (unknown)
F6:BE:90:32:3C:5E (unknown)
...

hcidump -R -i hci0
> 04 3E 2A 02 01 00 01 FC ED 16 D4 EE D6 1E 02 01 06 1A FF 4C
  00 02 15 B9 40 7F 30 F5 F8 46 6E AF F9 25 55 6B 57 FE 6D ED
  FC D4 16 B6 B4
...
```

CoreLocation && CoreBluetooth

```
import CoreLocation
import CoreBluetooth

// CLBeacon
// CLBeaconRegion
// CLLocationManager
// CBCentralManager
```

[CLBeaconRegion] init

```
init(proximityUUID proximityUUID: NSUUID!,
          identifier identifier: String!)

init(proximityUUID proximityUUID: NSUUID!,
                     major major: CLBeaconMajorValue,
          identifier identifier: String!)

init(proximityUUID proximityUUID: NSUUID!,
                     major major: CLBeaconMajorValue,
                     minor minor: CLBeaconMinorValue,
          identifier identifier: String!)
```

CLBeaconRegion params

```
var notifyOnEntry: Bool // By default is true
var notifyOnExit: Bool // By default is true
var notifyEntryStateOnDisplay: Bool // By default is false.
```

Discussion

- When set to true, the location manager sends beacon notifications when the user turns on the display and the device is already inside the region.
- Calls **locationManager:didDetermineState:forRegion:**

CLBeacon

Identifying the Beacon

```
var proximityUUID: NSUUID! { get }
var major: NSNumber! { get }
var minor: NSNumber! { get }
```

Determining the Beacon Distance

```
var accuracy: CLLocationAccuracy { get }
var rssi: Int { get }
var proximity: CLProximity { get }

enum CLProximity : Int {
    case Unknown
    case Immediate
    case Near
    case Far
}
```

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What to check before start?

CLLocationManager

```
func requestAlwaysAuthorization()
class func locationServicesEnabled() -> Bool
```

CBCentralManager

```
var state: CBCentralManagerState { get }
enum CBCentralManagerState : Int {
    case Unknown
    case Resetting
    case Unsupported
    case Unauthorized
    case PoweredOff
    case PoweredOn
}
```

Requesting Multiple Permissions

```
switch CLLocationManager.authorizationStatus() {
    case .Authorized:
        // ...
    case .NotDetermined:
        manager.requestAlwaysAuthorization()
    case .AuthorizedWhenInUse, .Restricted, .Denied:
        let alertController = UIAlertController(
            title: "Background Location Access Disabled",
            message: "In order to be notified about excibitions near you, please open this app's settings and set location access to 'Always'.",
            preferredStyle: .Alert)

        let cancelAction = UIAlertAction(title: "Cancel", style: .Cancel, handler: nil)
        alertController.addAction(cancelAction)

        let openAction = UIAlertAction(title: "Open Settings", style: .Default) { (action) in
            if let url = NSURL(string:UIApplicationOpenSettingsURLString) {
                UIApplication.sharedApplication().openURL(url)
            }
        }
        alertController.addAction(openAction)

        self.presentViewController(alertController, animated: true, completion: nil)
}
```

iOS 8 support

```
//describes the reason why the app accesses the user's location information
```

NSLocationAlwaysUsageDescription

This key is required when you use the **requestAlwaysAuthorization** method of the **CLLocationManager** class to request authorization for location services.

CLLocationManager

Monitoring

```
func startMonitoringForRegion(_ region: CLRegion!)
func stopMonitoringForRegion(_ region: CLRegion!)
func requestStateForRegion(_ region: CLRegion!)
@NSCopying var monitoredRegions: NSSet! { get }
```

Ranging

```
func startRangingBeaconsInRegion(_ region: CLBeaconRegion!)
func stopRangingBeaconsInRegion(_ region: CLBeaconRegion!)
@NSCopying var rangedRegions: NSSet! { get }
```

CLLocationManager | Responding to Region Events

```
optional func locationManager(_ manager: CLLocationManager!,
                 didEnterRegion region: CLRegion!)

optional func locationManager(_ manager: CLLocationManager!,
                  didExitRegion region: CLRegion!)

optional func locationManager(_ manager: CLLocationManager!,
     didStartMonitoringForRegion region: CLRegion!)


optional func locationManager(_ manager: CLLocationManager!,
                didDetermineState state: CLRegionState,
                       forRegion region: CLRegion!)

enum CLRegionState : Int {
    case Unknown
    case Inside
    case Outside
}
```

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CLLocationManager | Responding to Ranging Events

```
optional func locationManager(_ manager: CLLocationManager!,
                 didRangeBeacons beacons: [AnyObject]!,
                         inRegion region: CLBeaconRegion!)

optional func locationManager(_ manager: CLLocationManager!,
  rangingBeaconsDidFailForRegion region: CLBeaconRegion!,
                         withError error: NSError!)
```

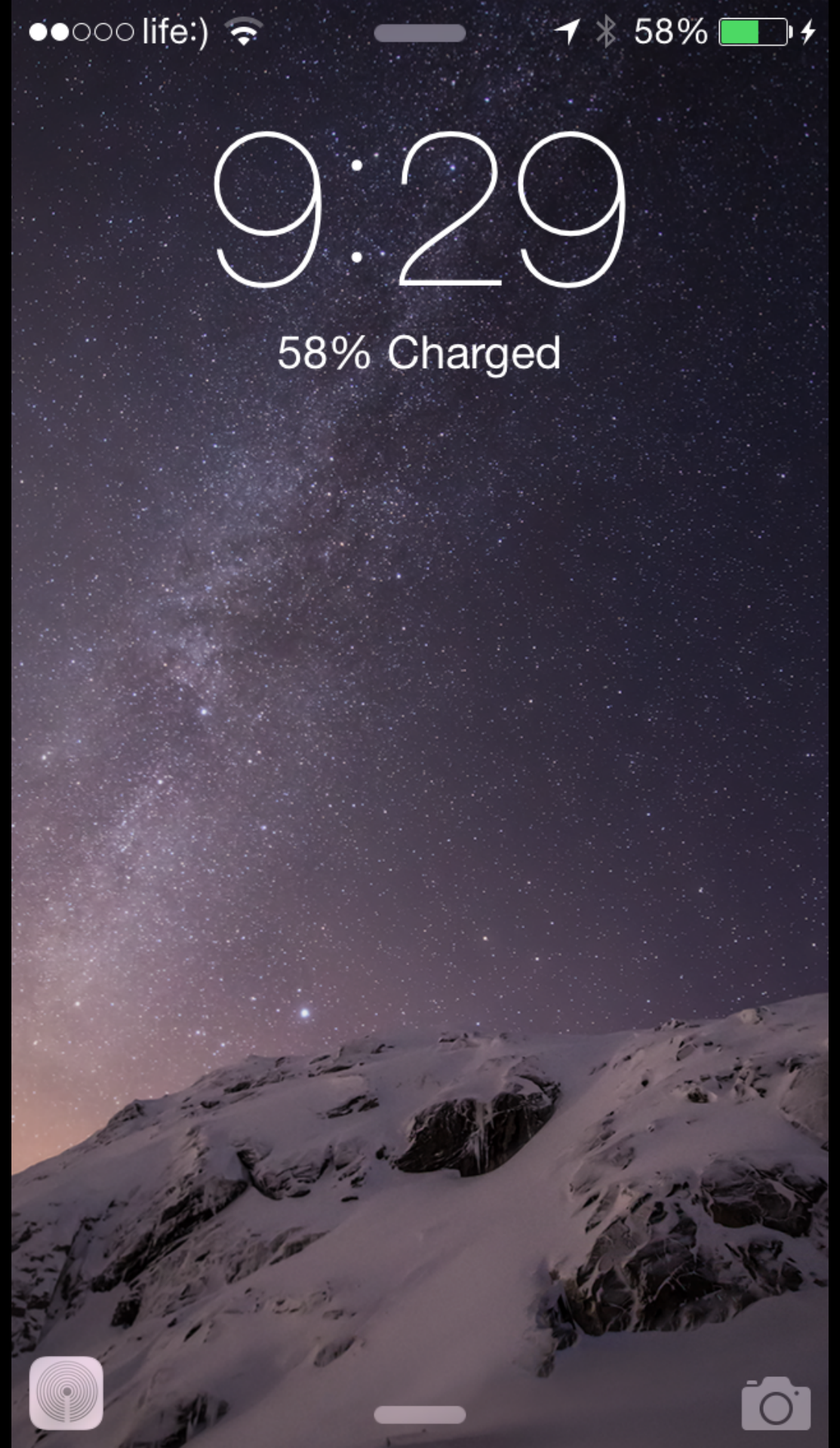
Passbook Integration

major Major identifier of a Bluetooth Low Energy location beacon.
minor Minor identifier of a Bluetooth Low Energy location beacon.
proximityUUID Unique identifier of a Bluetooth Low Energy location beacon.
relevantText Text displayed on the lock screen when the pass is currently relevant. “Store nearby on 1st and Main.”

Suggested Apps are now powered by iBeacon

iOS 8 Suggested Apps was solely powered by GPS geofences - similar to how the “Popular Near Me”, however, can now also be triggered by iBeacon.

Beacon-triggered Apps work slightly differently than GPS-triggered ones. The app does need to be installed on your device.



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Limits

- Regions are a shared system resource, and the total number of regions available systemwide is limited. For this reason, Core Location limits to 20 per app.
- In the background, you only have around 5 seconds of ranging time, which does not give you as much time to average RSSI

Background

```
optional func locationManager(_ manager: CLLocationManager!,
                    didEnterRegion region: CLRegion!)
```

```
UIApplication.sharedApplication().beginBackgroundTaskWithExpirationHandler({})
UIApplication.sharedApplication().endBackgroundTask(taskID)
```

Extending Background ranging

http://developer.radiusnetworks.com/2014/11/13/extending-background-ranging-on-ios.html

Questions?

Fedya Skitsko,
Lead iOS Developer

Demo project
https://github.com/XBeg9/iBeaconDemo

fedya@skitsko.com
https://twitter.com/XBeg9
https://github.com/XBeg9

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