

# Building a Mobile Location Aware System with Beacons



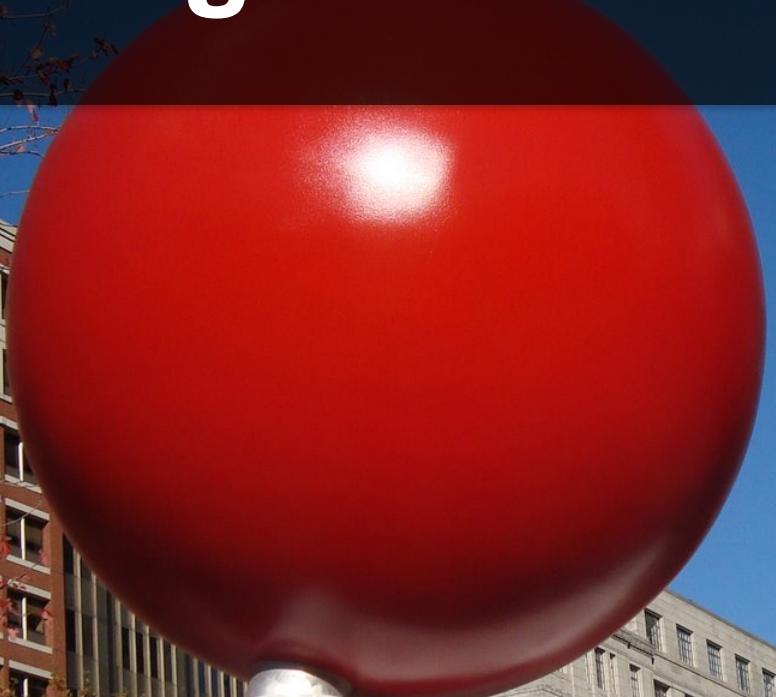
**Jonathan LeBlanc (@jcleblanc)**  
Head of Global Developer Advocacy at  
PayPal + Braintree

# Purpose of a Beacon



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# Being Location Aware



## COPLEY SQUARE

Just one of the many interesting things  
to see right here in your own backyard.  
Text "COPLEY" to 46305 to learn more.



THOMAS M. MENINO  
MAYOR

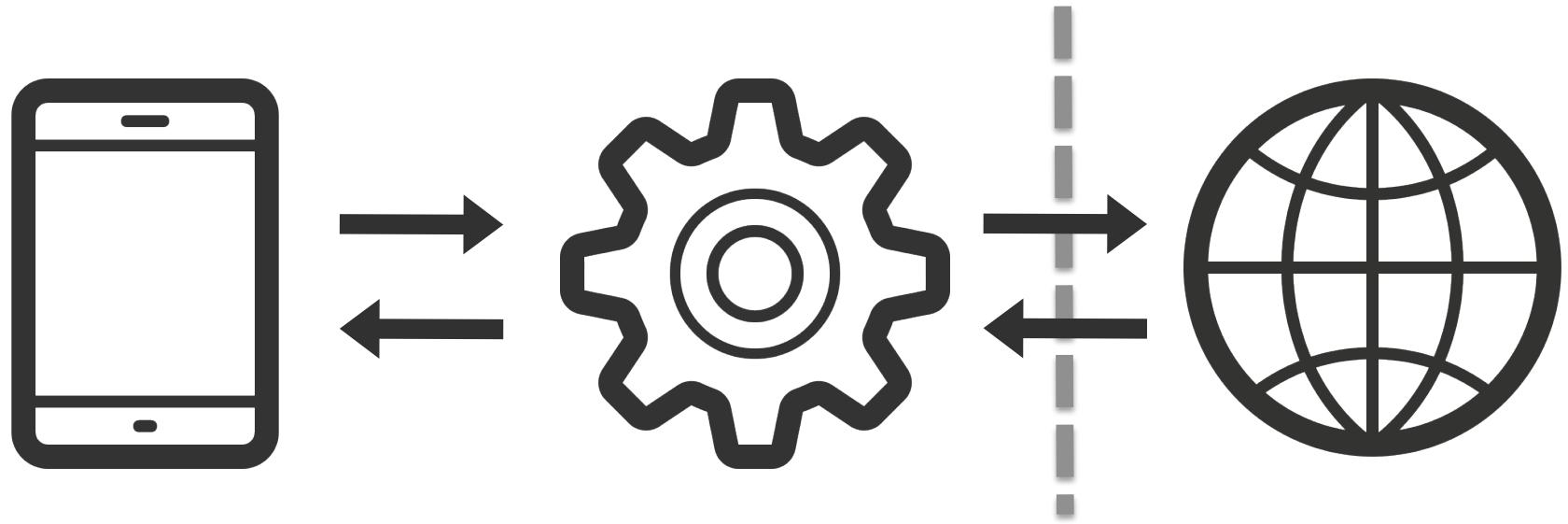
# The Bluetooth Spec

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# Bluetooth vs Bluetooth Smart

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# How it Works

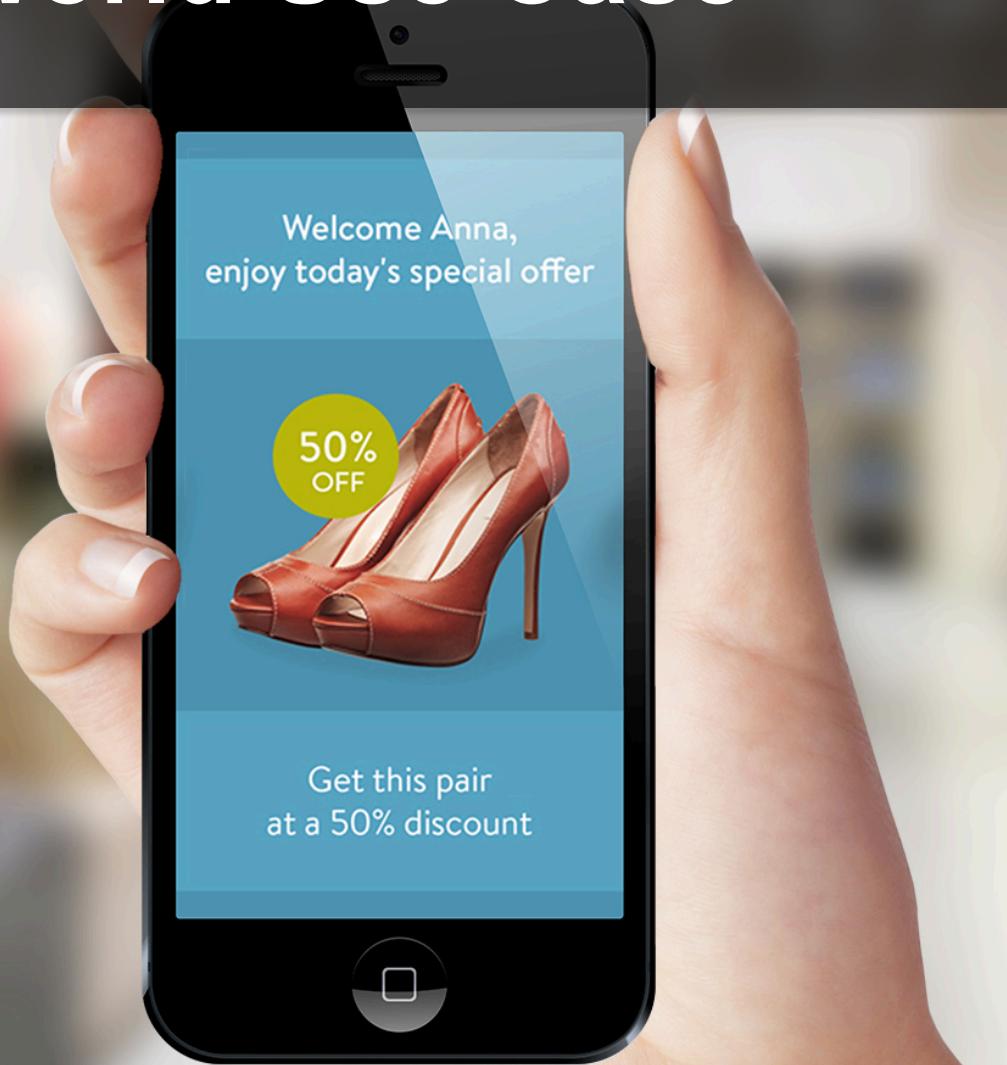


Central  
Device

Beacon  
Hardware

IP Address  
Endpoint

# Real World Use Case



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A photograph of a man with light brown hair, wearing glasses and a mustache, smiling and pointing his right index finger towards the camera. He is wearing a brown and white striped shirt.

**Don't be Creepy**

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# Bluetooth Smart Details

Connection Type: Intermittant

Battery Life: ~ 1.5 years (ha)

Range: ~ 75-100 meters

Data Latency: 3ms



**iBeacon Specification** [https://  
developer.apple.com/ibeacon/](https://developer.apple.com/ibeacon/)

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# The Beacons



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# Beacon Comparison



Estimote: \$99 / 3, temp + motion



Bluecat: Trial, AA batteries



Gimbal Tag: \$5, small & deployable

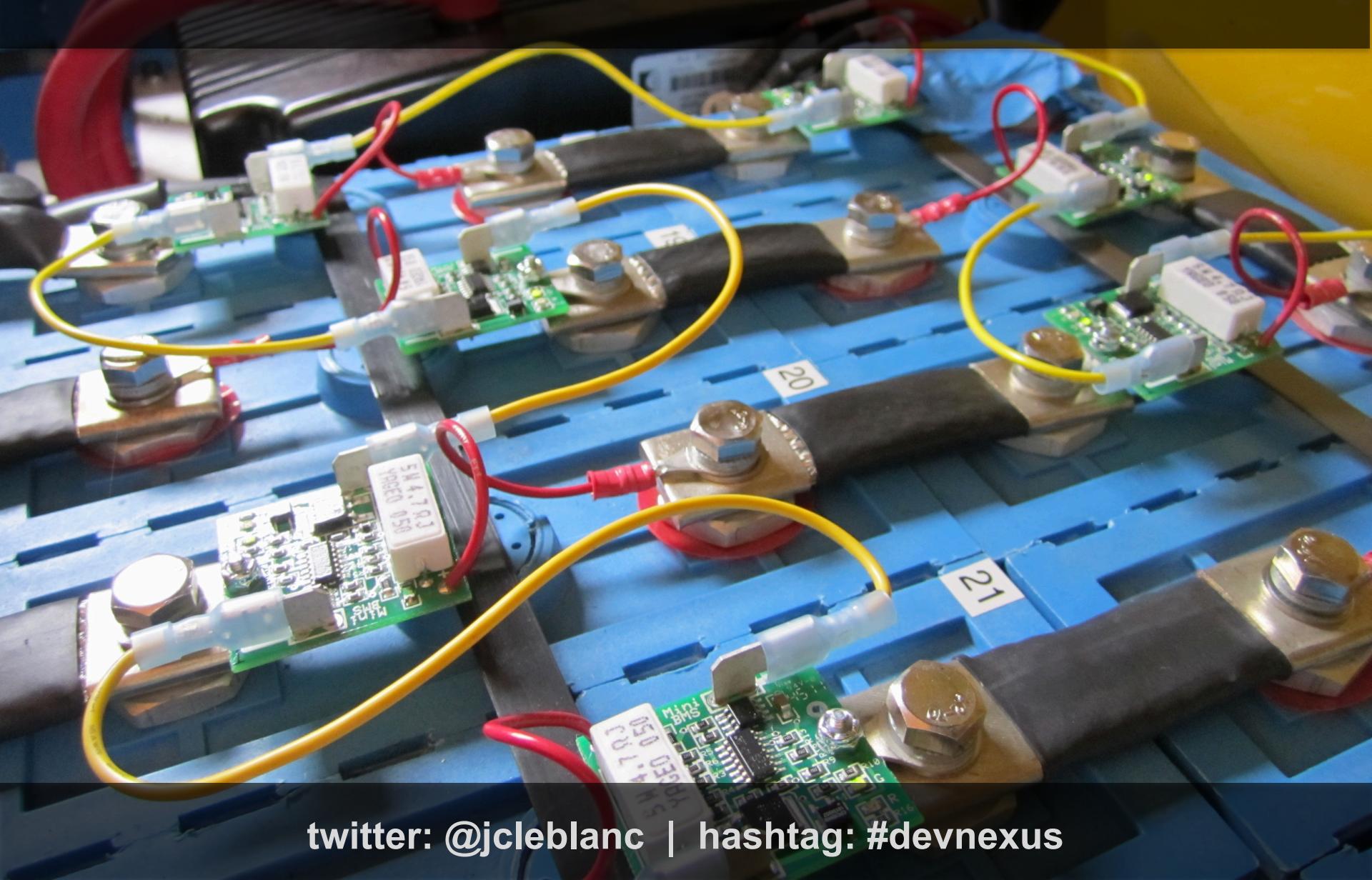


Kontakt.io: \$81 / 3, battery life

# Beacon Advertisement & ID

- **UUID** (16 bytes): Differentiates Large Group
- **Major** (2 bytes): Beacon Subset
- **Minor** (2 bytes): Individual Beacon
- **Tx Power**: Proximity from beacon

# Battery Life vs Range



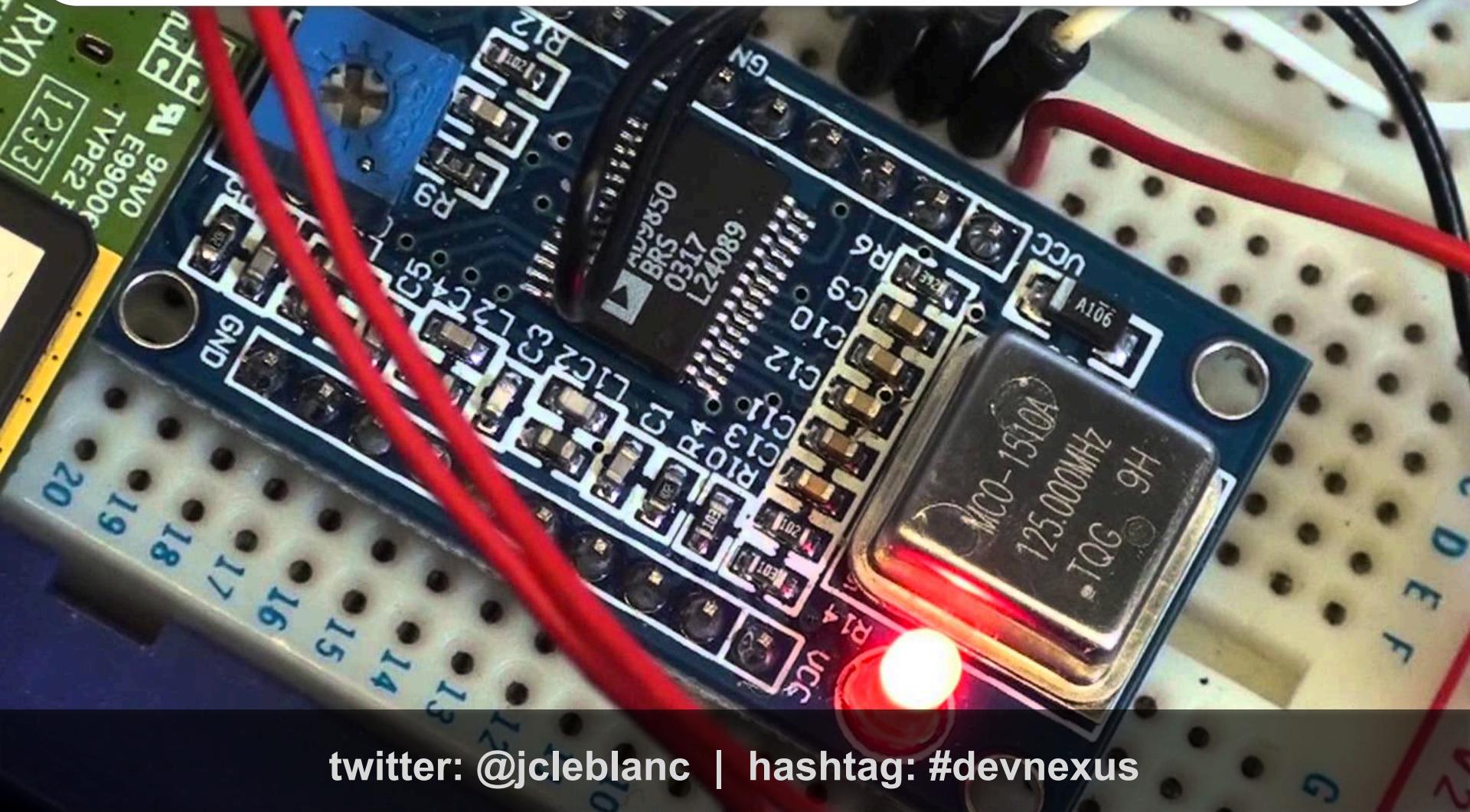
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# Battery Replacement



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# Creating Your Own Beacon



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# Component List

Microcontroller (Arduino, etc.)

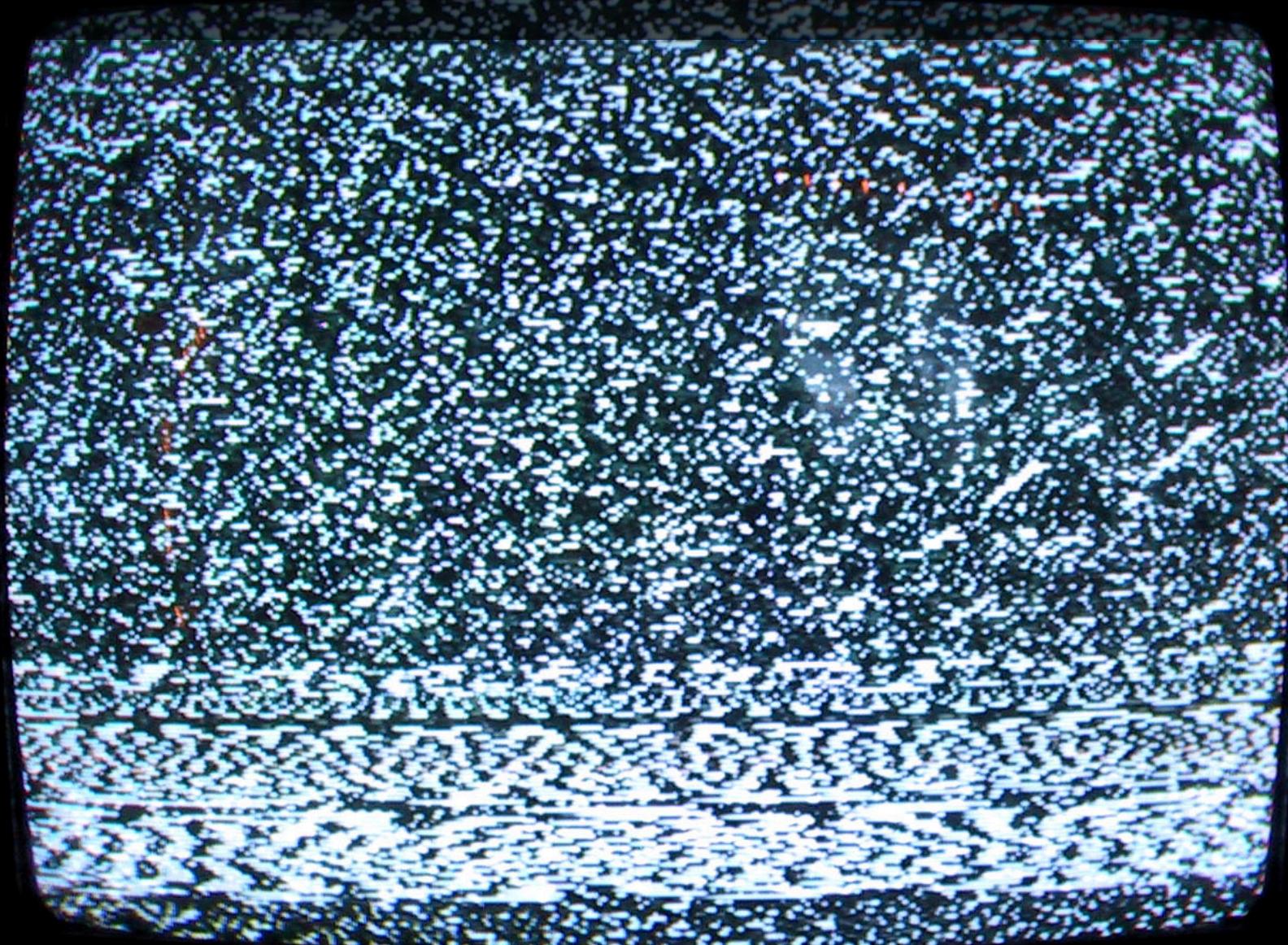
Bluetooth Low Energy shield

Wi-Fi shield (optional)

Accelerometer (optional)

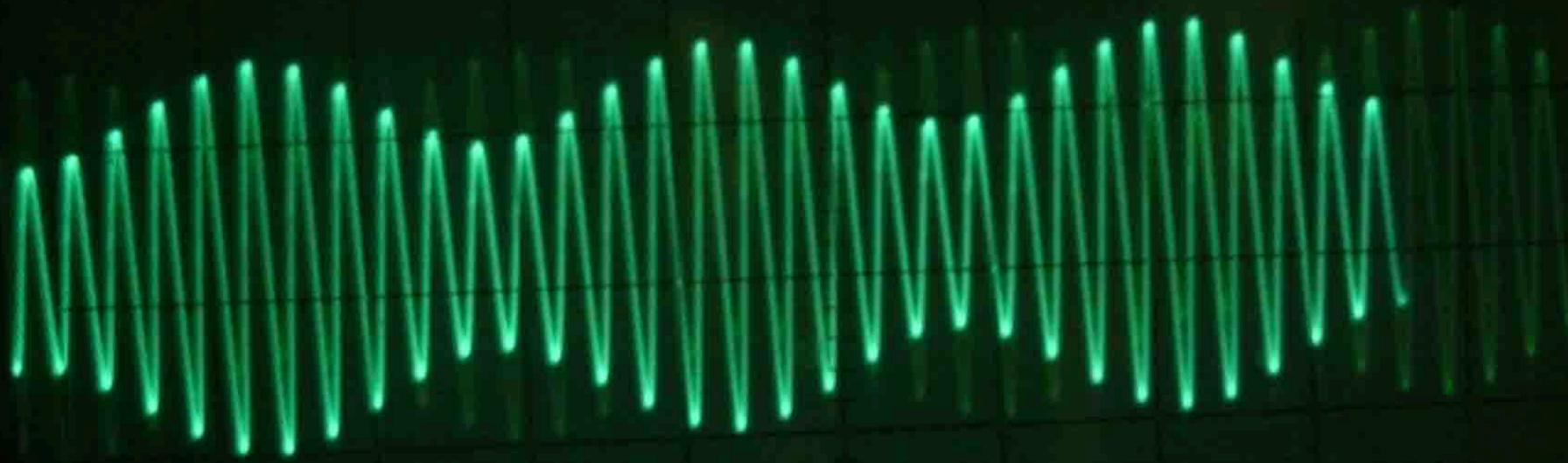
Human Sensor (optional)

# Signal Interference



- Microwave ovens
- Direct Satellite Service (DSS)
- Certain external electrical sources
- 2.4 GHz or 5 GHz phones
- Video transmitters/receivers that operate in the 2.4 GHz or 5 GHz bandwidth
- Wireless speakers that operate in the 2.4 GHz or 5 GHz band
- Certain external monitors and LCD displays
- Any other wireless devices that operate in the 2.4 GHz or 5 GHz bandwidth

# Signal Degradation



## **Low Interference**

**Wood**

**Synthetic Material**

**Glass**

## **Medium Interference**

**Water**

**Bricks**

**Marble**

## **High Interference**

**Plaster**

**Concrete**

**Bulletproof Glass**

## **Very High Interference**

**Metal**

# Considerations

Trilateration algorithm

- <http://everything2.com/title/>
- <http://stackoverflow.com/questions/20332856/triangulate-example-for-ibeacons>

Band switching on degradation / interference

Secure and external communication

# Getting Started



android

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# Beacon SDK or Open SDK?

Estimote: <http://estimote.com/api/>

Kontakt.io: <http://docs.kontakt.io/>

AltBeacon: <http://altbeacon.org/>

examples/

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# The Android Emulator

Bluetooth LE not available

Sorry, this device does not support  
Bluetooth LE.

OK

# Emulating Android & BLE

Virtual Machine Software +  
USB BLE adapter

<http://chrislarson.me/blog/emulate-android-and-bluetooth-le-hardware.html>

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# Beacon Scavenger Hunt



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# How it Works

1. Phone to Beacon Connections
2. Distance feedback system
3. Badges on beacon capture
4. Unlock on hunt completion



Your Beacons



Bulk Edit Settings

Transfer Ownership

Share Beacons



Apps



Account Settings

# Adjusting Beacon Settings Estimote Site and App

**blueberry**

Proximity UUID: B9407F30-F5F8-466E-AFF9-25556B57FE6D

Major: 7873 Interval: unknown Battery life: 22 months

Minor: 42132 Power: unknown Firmware: unknown



Major: 61871 Interval: unknown Battery life: 22 months

Minor: 54660 Power: unknown Firmware: unknown

**ice**

Proximity UUID: B9407F30-F5F8-466E-AFF9-25556B57FE6D

Major: 51746 Interval: unknown Battery life: 22 months

Minor: 39575 Power: unknown Firmware: unknown

**blueberry**

Proximity UUID: B9407F30-F5F8-466E-AFF9-25556B57FE6D

Major: 15042 Interval: 950 ms Battery life: 34 months

Minor: 57481 Power: -12 dBm Firmware: A2.1

**blueberry**

Proximity UUID: B9407F30-F5F8-466E-AFF9-25556B57FE6D

Major: 54675 Interval: 950 ms Battery life: 34 months

Minor: 46376 Power: -12 dBm Firmware: A2.1

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Current Power:

Weak (-30 dBm)

Maximum Range:

~ 1.5m / 5ft

Estimated Lifetime:

38 months

Low



High

High broadcasting power will improve range  
but may negatively impact battery life.

# AndroidManifest.xml

```
<uses-permission android:name=
    "android.permission.BLUETOOTH"/>

<uses-permission android:name=
    "android.permission.BLUETOOTH_ADMIN"/>

<service android:name=
    "com.estimote.sdk.service.BeaconService"
    android:exported="false"/>
```

# Setting the Beacon Manager

```
private static final String ESTIMOTE_PROXIMITY_UUID =  
    "B9402F30-F5F7-466E-AFD9-25556B57GE6D";
```

```
private static final Region ALL_ESTIMOTE_BEACONS = new  
Region("regionId", ESTIMOTE_PROXIMITY_UUID, null,  
null);
```

```
private BeaconManager beaconManager = new  
BeaconManager(activity);
```

# Setting the Listener

```
beaconManager.setRangingListener(new BeaconManager.RangingListene
{
    @Override public void onBeaconsDiscovered(Region
        region, List<Beacon> beacons) {
        ...
    }
});

beaconManager.stopRanging(ALL_ESTIMOTE_BEACONS);
```

# The Beacon Object

- **getProximityUUID**: Proximity UUID of the Beacon
- **getMajor**: Major version of the beacon
- **getMinor**: Minor version of the beacon
- **getMeasuredPower**: Beacon measured power (in dBm)
- **getMacAddress**: Beacon MAC address
- **getName**: Display friendly beacon name
- **getRssi**: Received Signal Strength Indication

# Getting Beacon Range

```
double distance = 1000.0;  
Beacon beacon = null;  
for (Beacon rangedBeacon : beacons) {  
    double currentDistance =  
        Utils.computeAccuracy(rangedBeacon);  
    if (currentDistance < distance && !  
        discovered.contains(rangedBeacon)){  
        distance = currentDistance;  
        beacon = rangedBeacon;  
    }  
}
```

# Playing with Location



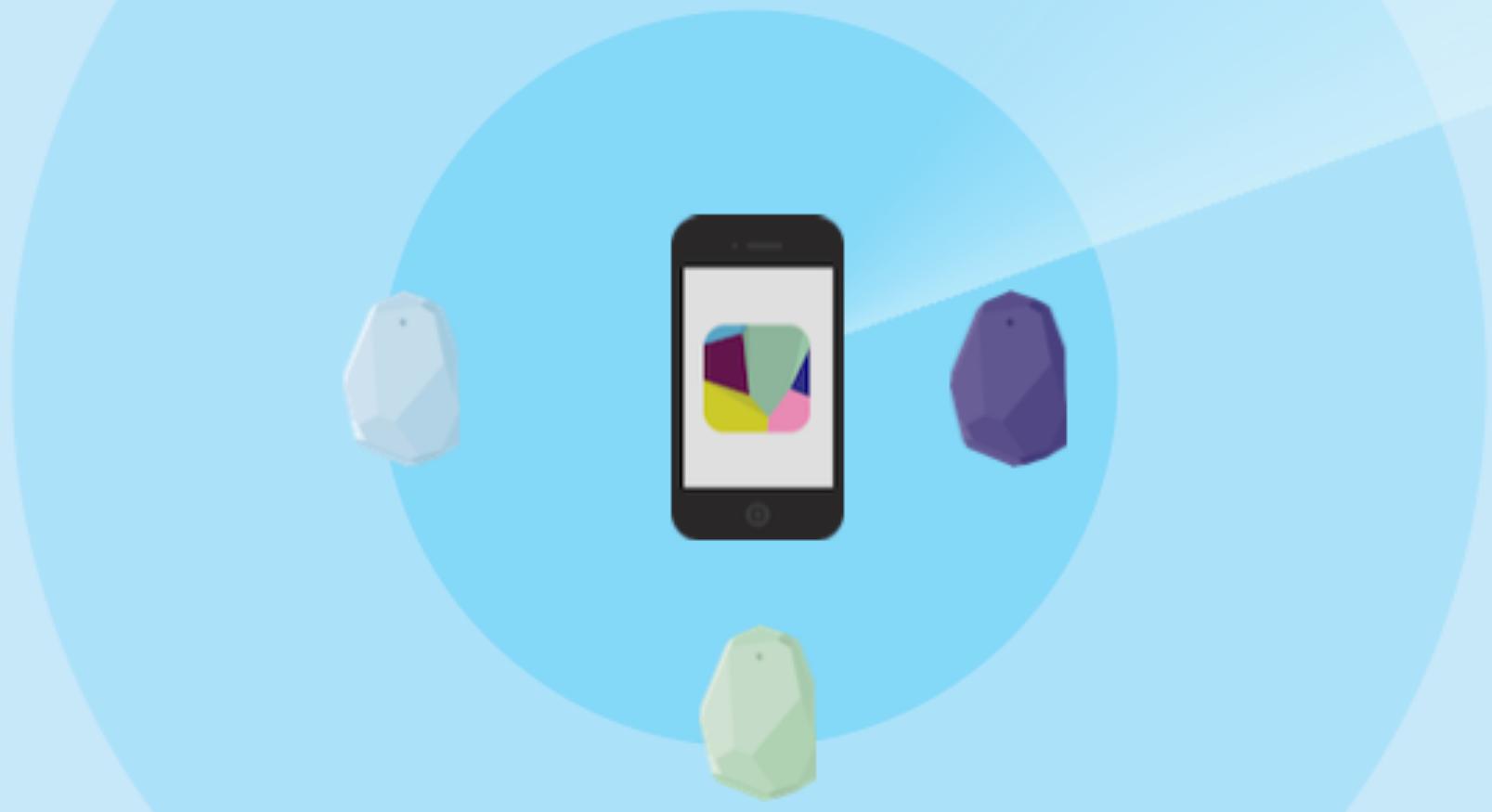
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# The Single Beacon



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# Indoor Accuracy Issues



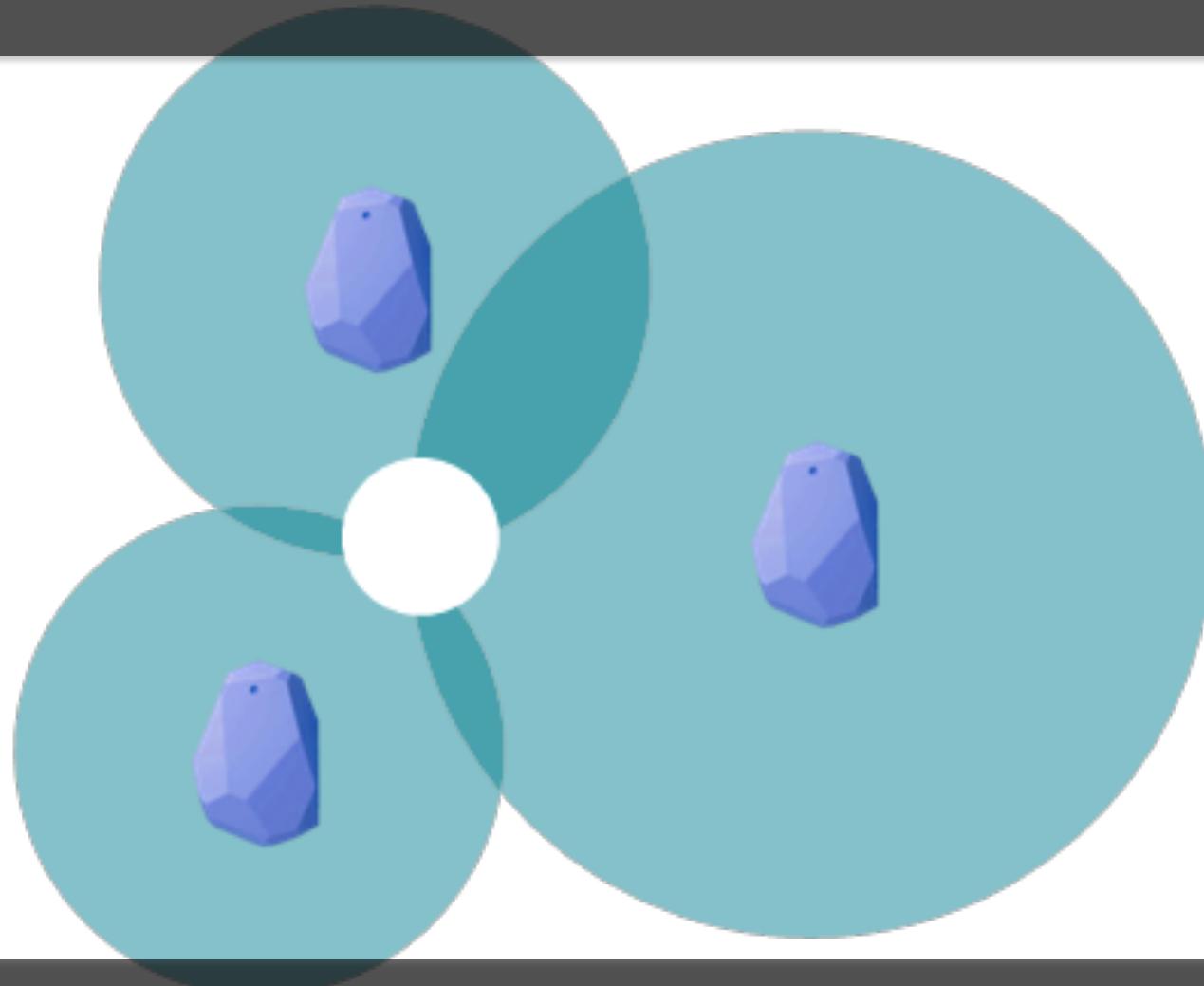
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# Improving Accuracy



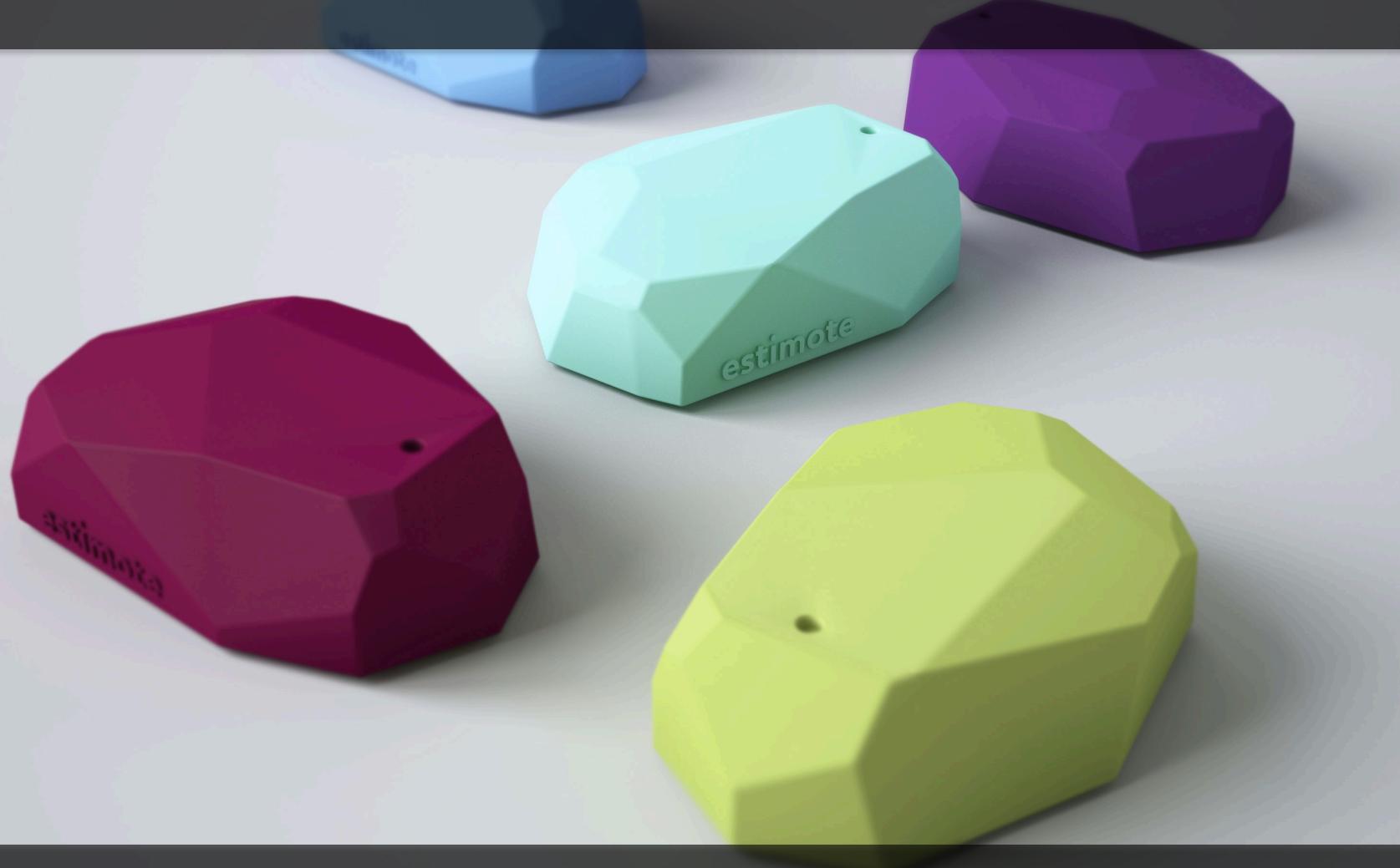
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# Beacon Triangulation



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# Deploying at Scale



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# Beacon Wrap-up



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# Thank You!

[http://bit.ly/beacon\\_talk](http://bit.ly/beacon_talk)

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