

Bluetooth LE, Core Bluetooth, and a Glimpse Into Your Near Future

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< Livefront >



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FACTORY**



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<http://smartfactory.com>

@gosmartfactory

Plan

Introduce Bluetooth Low Energy

Convince you it's awesome

Do cool demos





Classic



Low Energy



Low Energy

Bluetooth Low Energy

Designed to maximize battery life

New architecture

New hardware

New class of peripherals

Small bits of data in short bursts



Low Energy

Adapted from  in 2001

Adapted from  in 2001

 4.0 in 2010

Adapted from  in 2001

 4.0 in 2010

iPhone 4S in 2011

Adapted from  in 2001

 4.0 in 2010

iPhone 4S in 2011

Awesome

What's it good for?

Sensors



Proximity Indicators

Remote Sensors

Automotive Sensors

Remote Controls



Electronics

Home Automation

Toys

Fitness & Healthcare



Weight Scales

Heart Rate Monitors

Blood Pressure Monitors

Pedometers

Remote Brain Peripherals

Remote Brain Peripherals

Simpler

Cheaper

More Efficient





No digital display
Battery lasts 10-20 years





1 Ubiquitous

1 Ubiquitous

2 Inexpensive

1 Ubiquitous

2 Inexpensive

3 Hackable

1 Ubiquitous

LE 2 Inexpensive

LE 3 Hackable

1 Ubiquitous

1 Ubiquitous

Bluetooth 4.0

1 Ubiquitous

67%

2013

100%

2016

Bluetooth Low Energy Capable Cell Phones

1 Ubiquitous

	Yes	No	
iOS	X		
Android			
Windows 8	X		
Windows RT	X		
Windows Phone		X	
Blackberry 10	X		

1 Ubiquitous

	Yes	No	It's Complicated
iOS	X		
Android			X
Windows 8	X		
Windows RT	X		
Windows Phone		X	
Blackberry 10	X		

October
November
2011



October
November
2011



May
2012

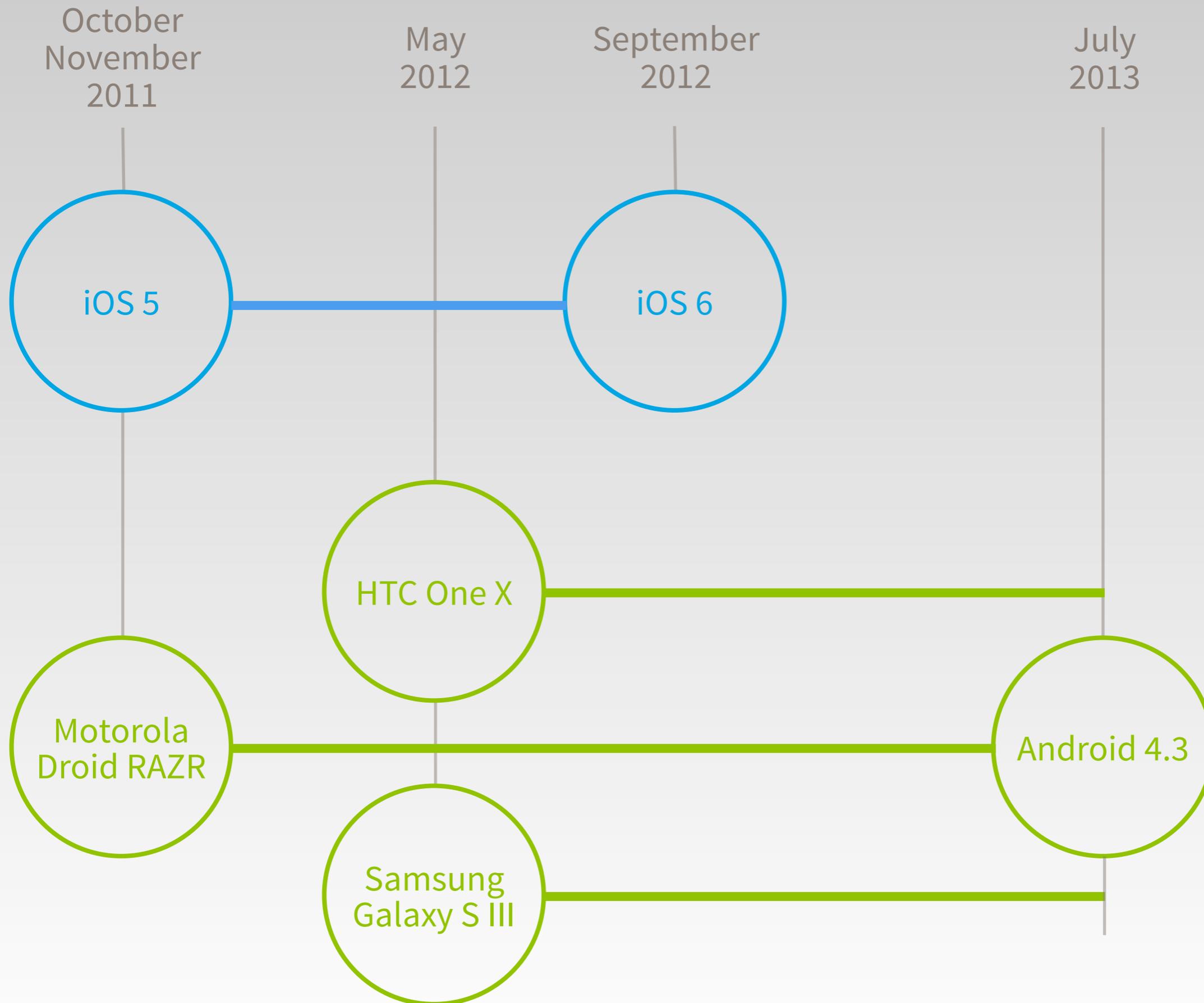


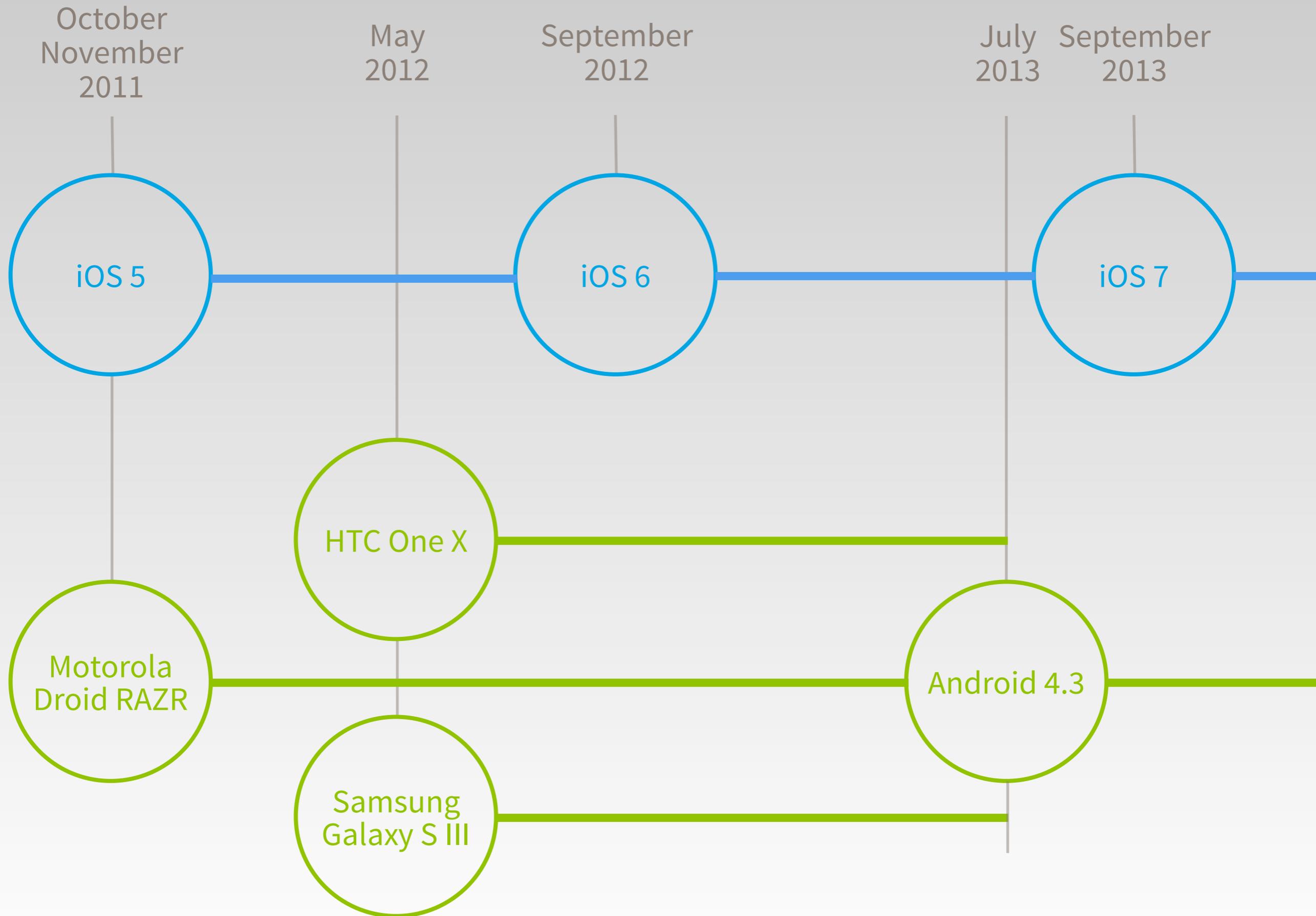
October
November
2011

May
2012

September
2012







1 Ubiquitous

2 Inexpensive

3 Hackable

2 Inexpensive

Made for iPhone (MFi)
Not Required

2 Inexpensive

Simpler Software
Cheaper Hardware

1 Ubiquitous

2 Inexpensive

3 Hackable

3 Hackable

Core Bluetooth

3 Hackable

Core Bluetooth

Few limitations

3 Hackable

Core Bluetooth

Few limitations

Even in the background

3 Hackable

Core Bluetooth

Few limitations

Even in the background

iOS gets out of the way

3 Hackable

Core Bluetooth

Few limitations

Even in the background

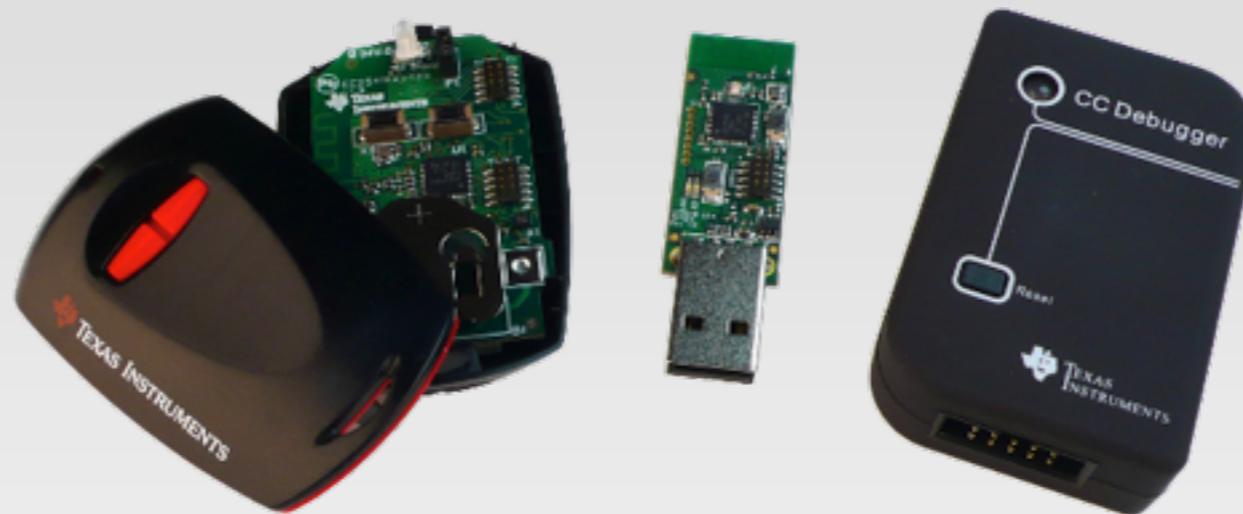
iOS gets out of the way

No MFi

3 Hackable

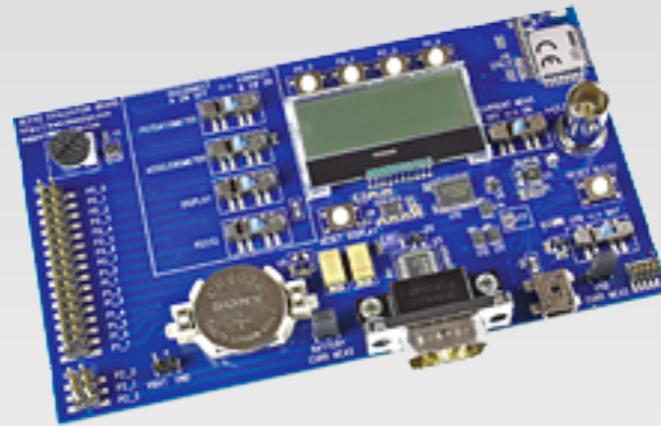
Hardware

3 Hackable



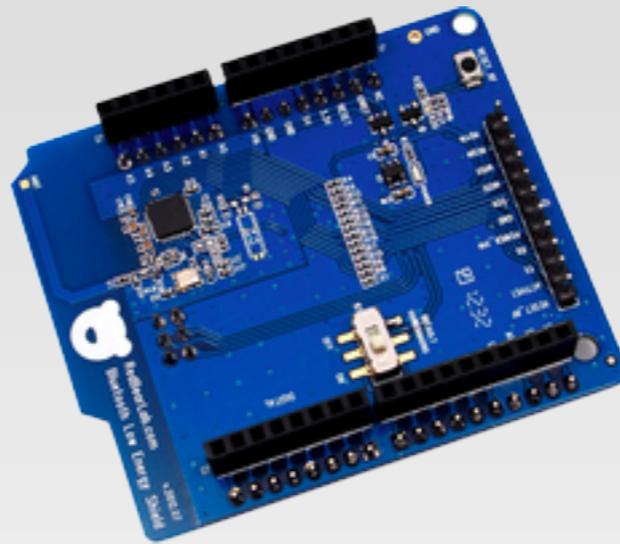
Texas Instruments
CC2540 Mini Development Kit
\$100

3 Hackable



Bluegiga
BLE112 Evaluation Board
\$375

3 Hackable



RedBearLab
BLE-Shield for Arduino
\$30

1 Ubiquitous

2 Inexpensive

3 Hackable

Products

Products

Bluetooth Smart &
Bluetooth Smart Ready

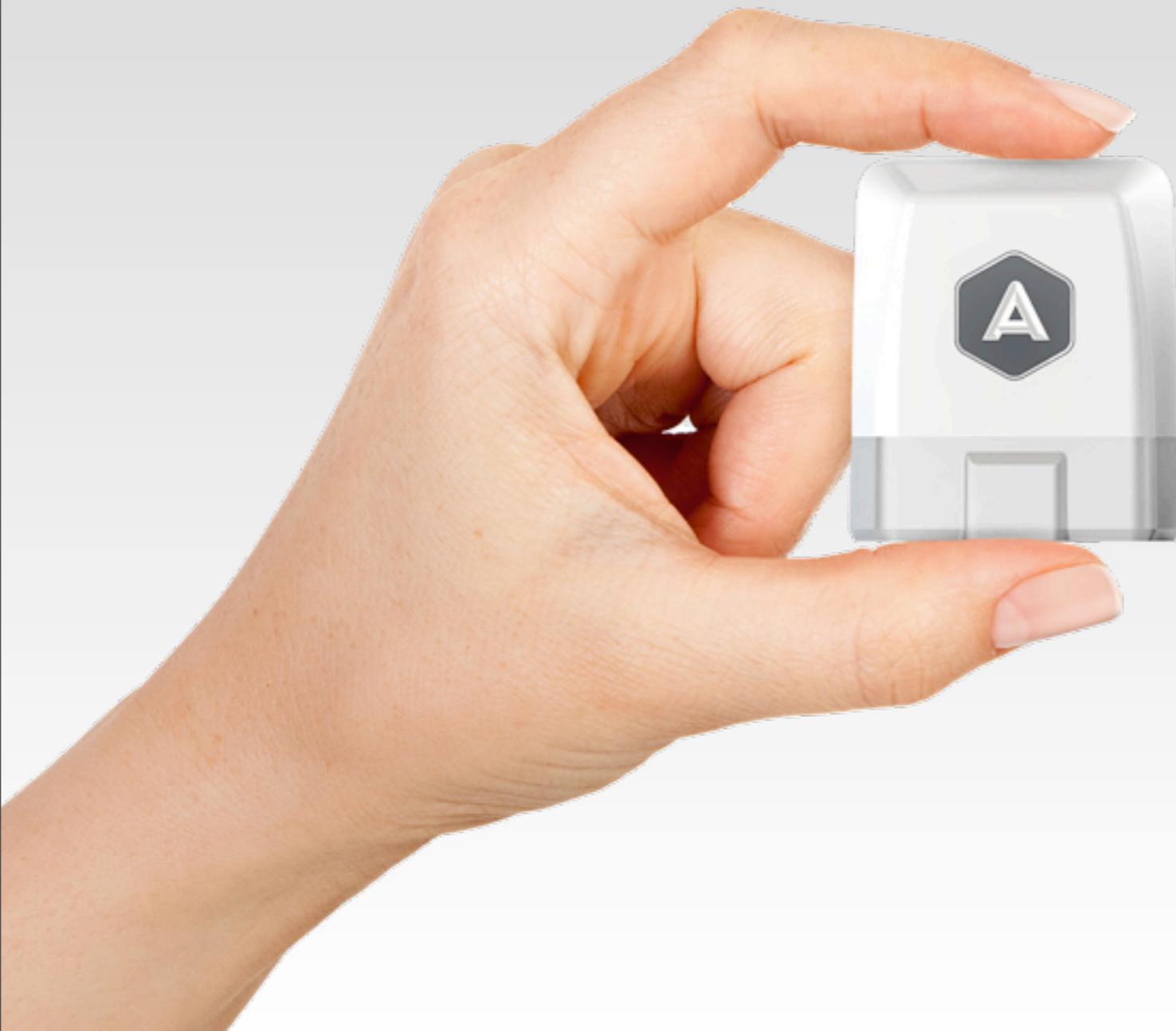
FitBit



hipKey



Automatic



COOKOO

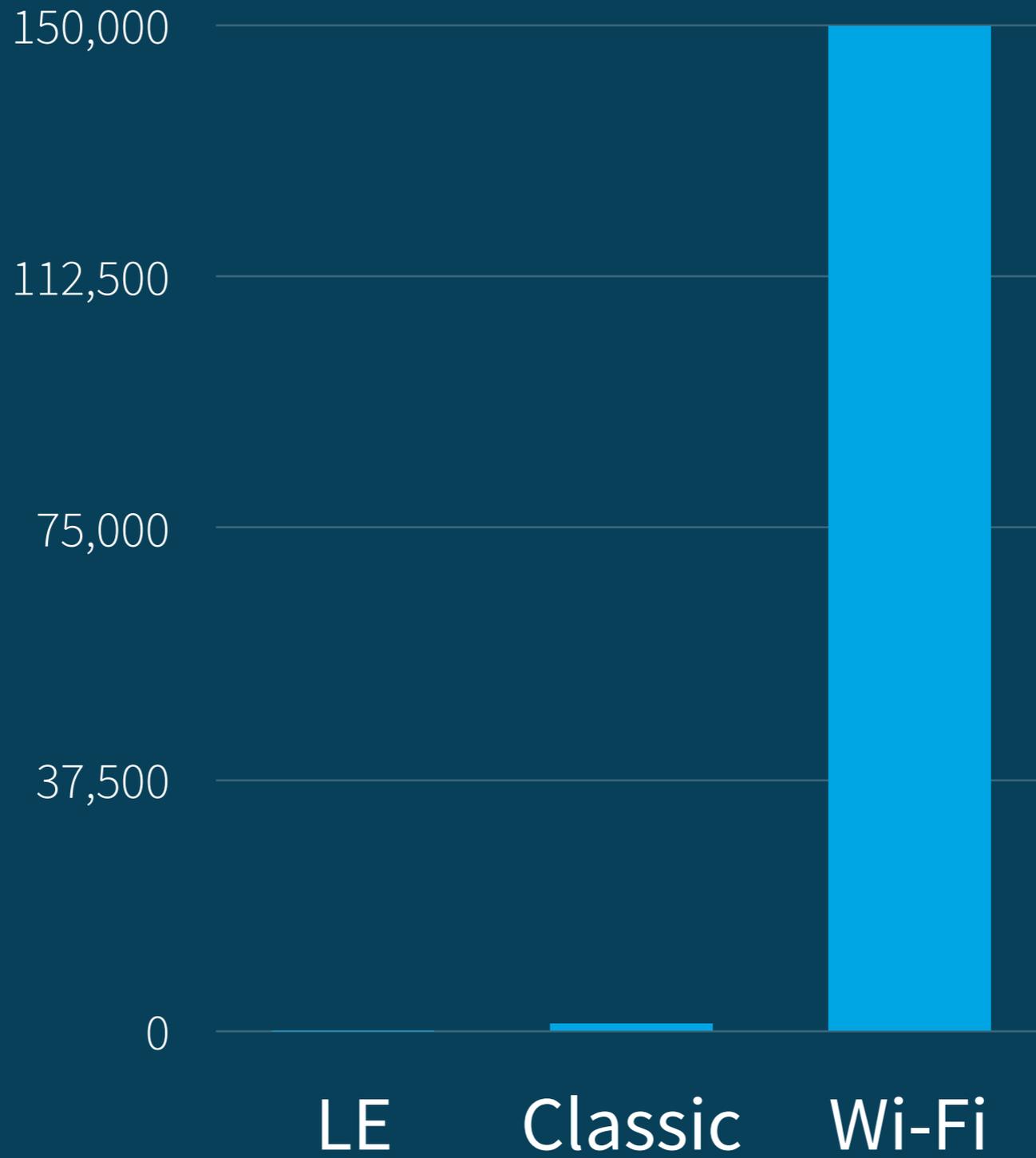


What's the catch?

It's slow.

It's really slow.

Data Rate (kbps)



Data Rate (kbps)

150,000

112,500

75,000

37,500

Carrier Pigeon →

LE

Classic

Wi-Fi



	Data Rate (kbps)		
Bluetooth LE	50		
Bluetooth Classic	1,200		

	Data Rate (kbps)	Wake Up (ms)	
Bluetooth LE	50	2–6	
Bluetooth Classic	1,200	1,000–6,000	

	Data Rate (kbps)	Wake Up (ms)	Range (ft)
Bluetooth LE	50	2–6	160
Bluetooth Classic	1,200	1,000–6,000	300

Demos

Demos

1. Scanning & Connecting
2. Signal Strength & Proximity
3. Discover Services & Read Data
4. Remote Brain

Core Bluetooth



Central



Peripheral

Scan

Hello?



Central



Peripheral

Advertise



Central



Peripheral



Central



Peripheral

CBCentralManager

CBCentralManager

CBCentralManagerDelegate

CBCentralManager

CBCentralManagerDelegate

central

scanForPeripheralsWithServices:options:

...

CBCentralManager

CBCentralManagerDelegate

central scanForPeripheralsWithServices:options:

...

delegate didDiscoverPeripheral:advertisementData:RSSI:

delegate didDiscoverPeripheral:advertisementData:RSSI:

CBCentralManager

CBCentralManagerDelegate

CBCentralManager

CBCentralManagerDelegate

delegate didDiscoverPeripheral:advertisementData:RSSI:

CBCentralManager

CBCentralManagerDelegate

delegate didDiscoverPeripheral:advertisementData:RSSI:

central connectPeripheral:options:

delegate didConnectPeripheral:

Your app can be
backgrounded.

Your app can be
terminated.

iOS 7

iOS 7

Apple Notification Center Service

iBeacons

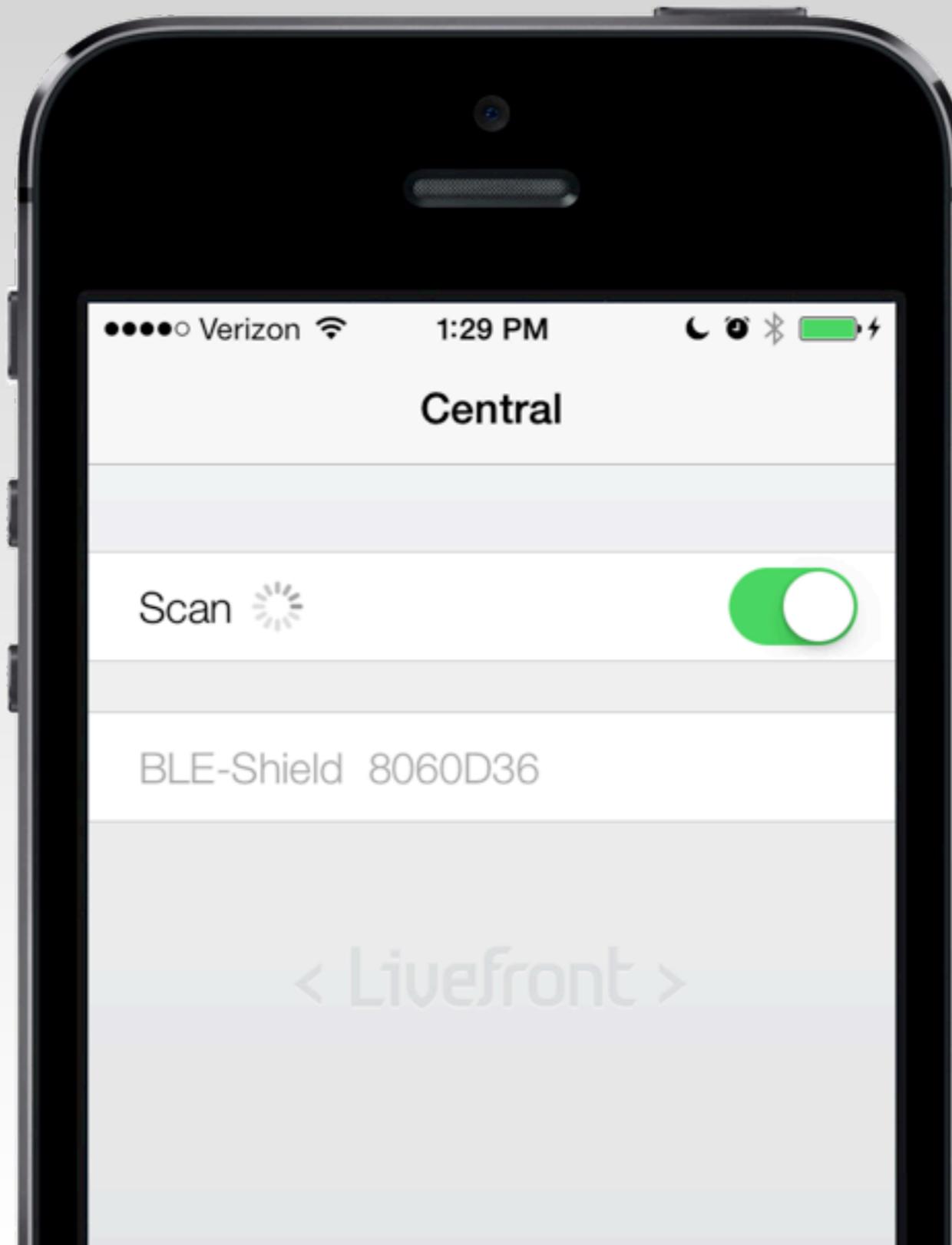
Dropped simulator support

Better performance & docs

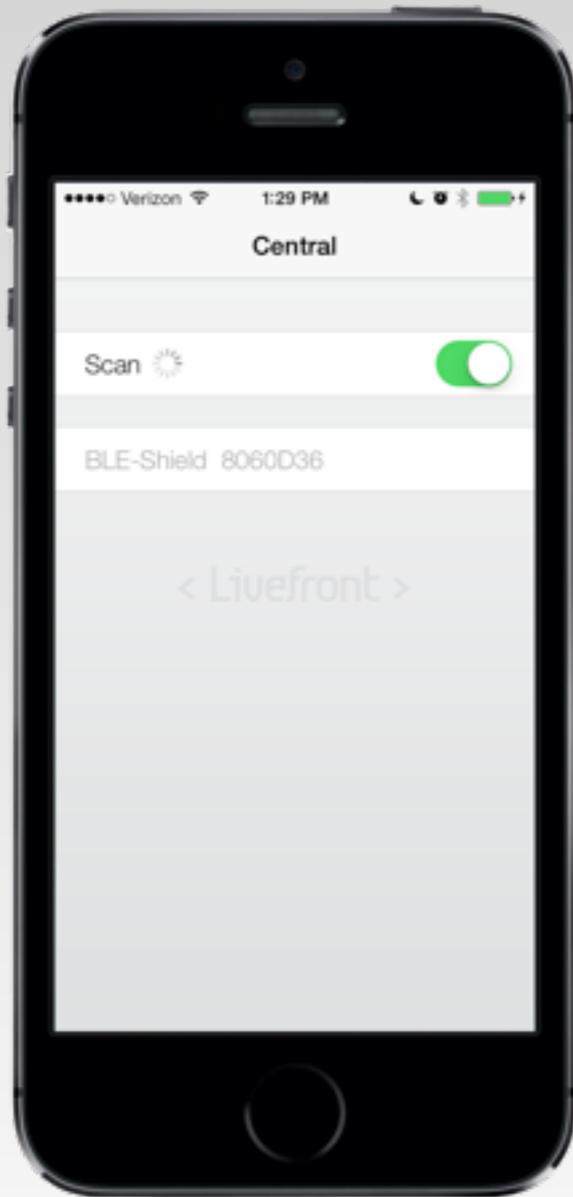
Demo

1. Scanning & Connecting

1 Scanning & Connecting



1 Scanning & Connecting



Demo App



Arduino

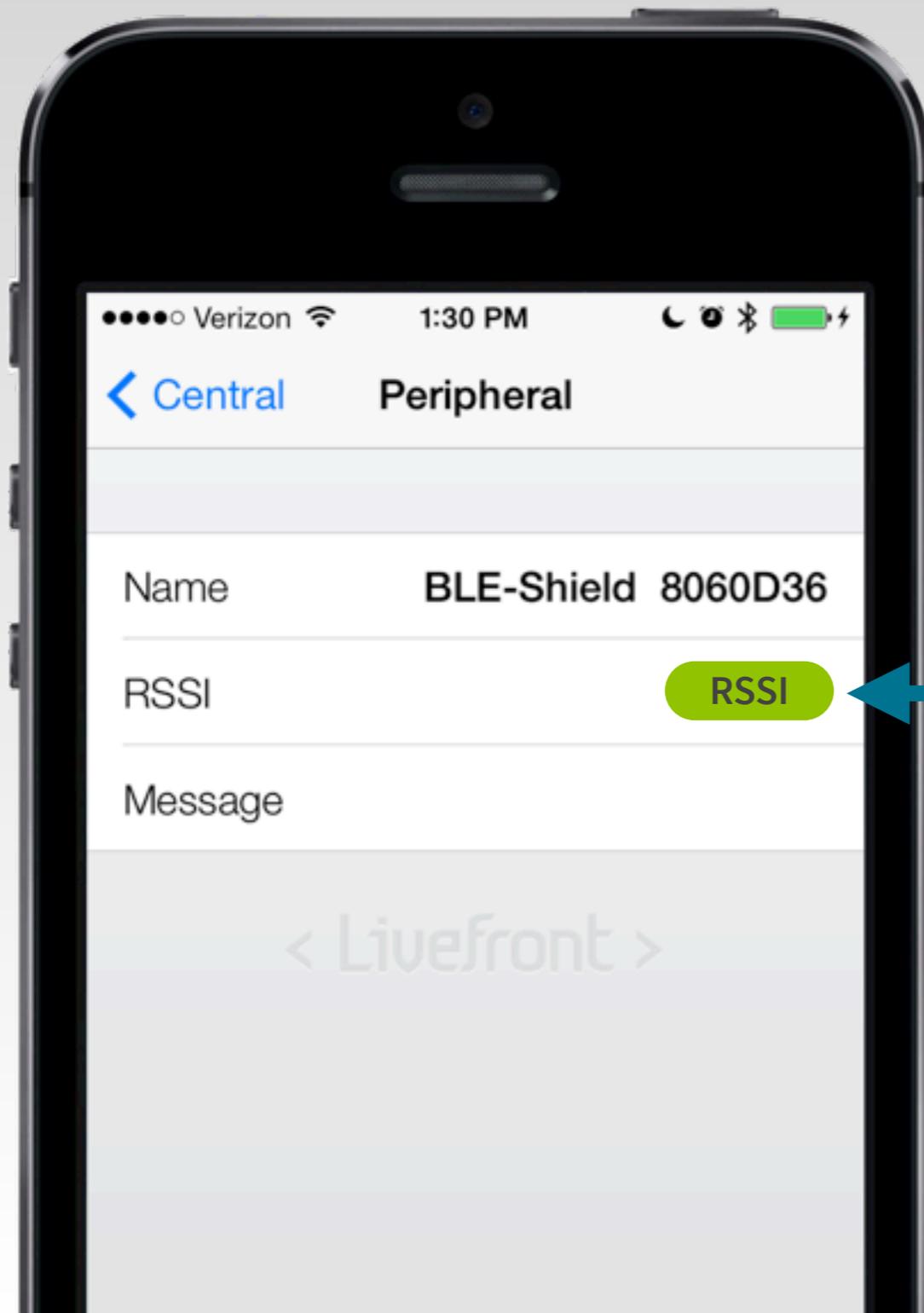
1 Scanning & Connecting

Code

Demo

2. Signal Strength & Proximity

2 Signal Strength & Proximity



RSSI



Arduino

CBPeripheral

CBPeripheralDelegate

CBPeripheral

CBPeripheralDelegate

peripheral readRSSI

delegate didUpdateRSSI:

CBPeripheral

CBPeripheralDelegate

peripheral readRSSI

delegate didUpdateRSSI:

peripheral readRSSI

delegate didUpdateRSSI:

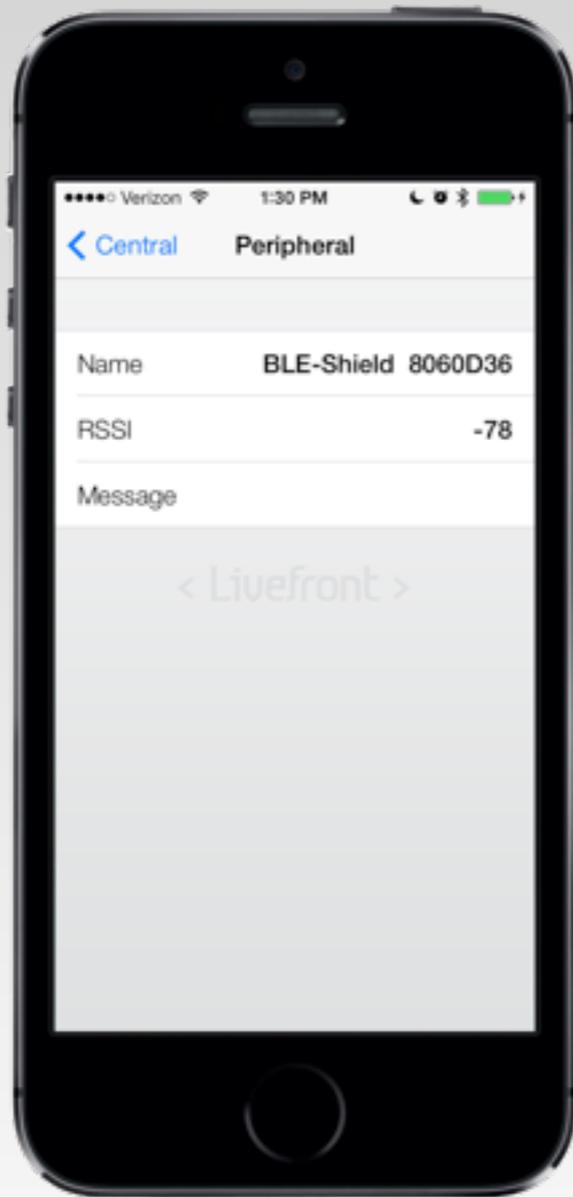
2 Signal Strength & Proximity

Code

Demo

3. Discover Services & Read Data

3 Discover Services & Read Data



Demo App



Arduino

Bluetooth Profiles

Profile

Profile

Service

Profile

Service



Profile

Service

Characteristic



Profile

Service

Characteristic

[Empty dashed box]

[Empty dashed box]

[Empty dashed box]

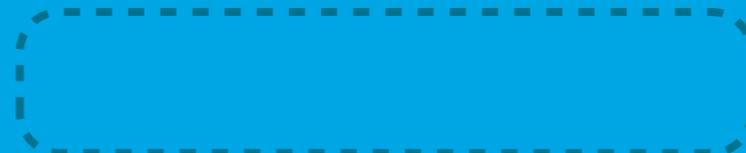
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Profile

Service

Characteristic

Descriptor

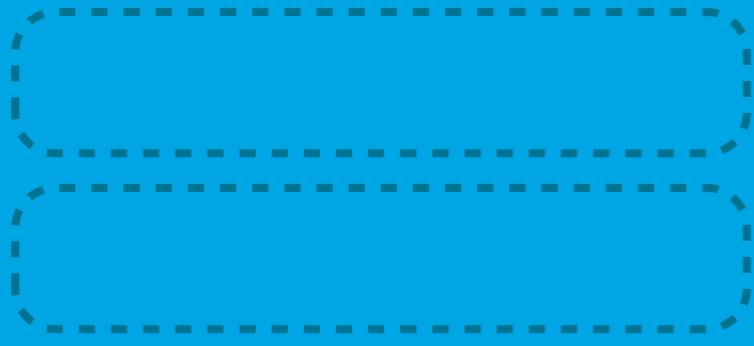


Profile

Service

Characteristic

Descriptor



Profile

Thermometer

Measurement

Location

Interval

Profile

BLE-Shield

RX

TX

Profile

BLE-Shield

RX

New message every 3 seconds

TX

Receives incoming data

Profile

BLE-Shield

RX

TX

f9266fd7-ef07-45d6-8eb6-bd74f13620f9

4585c102-7784-40b4-88e1-3cb5c4fd37a3

e788d73b-e793-4d9e-a608-2f2bafc59a00

CBPeripheral

CBPeripheralDelegate

CBPeripheral

CBPeripheralDelegate

peripheral discoverServices:

delegate didDiscoverServices:

CBPeripheral

CBPeripheralDelegate

peripheral discoverServices:

delegate didDiscoverServices:

peripheral discoverCharacteristics:forService:

delegate didDiscoverCharacteristicsForService:error:

CBPeripheral

CBPeripheralDelegate

peripheral setNotifyValue:forCharacteristic:

...

CBPeripheral

CBPeripheralDelegate

peripheral setNotifyValue:forCharacteristic:

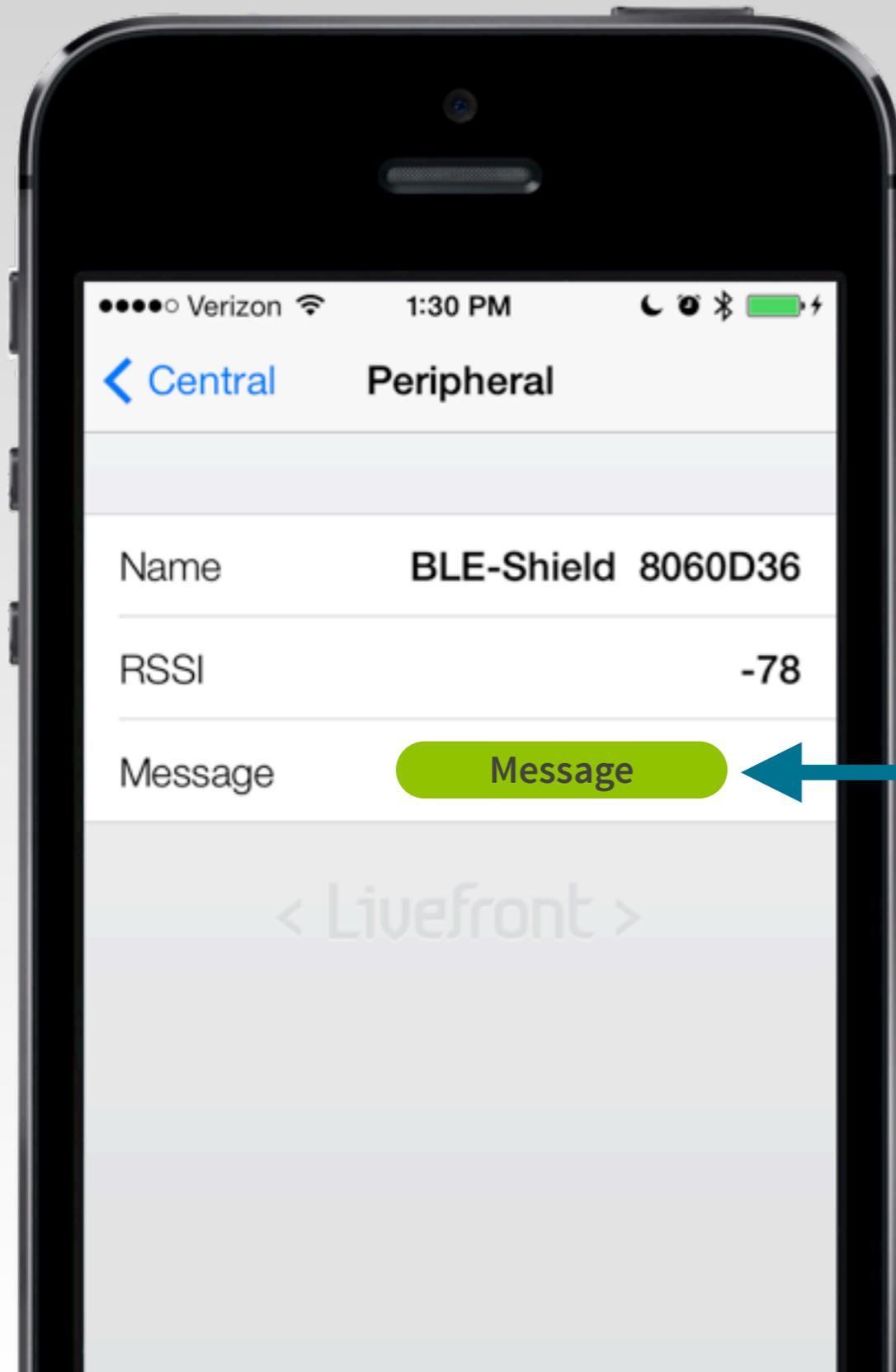
...

delegate didUpdateValueForCharacteristic:error:

delegate didUpdateValueForCharacteristic:error:

delegate didUpdateValueForCharacteristic:error:

3 Discover Services & Read Data



RX Notify



Arduino

3 Discover Services & Read Data

Code

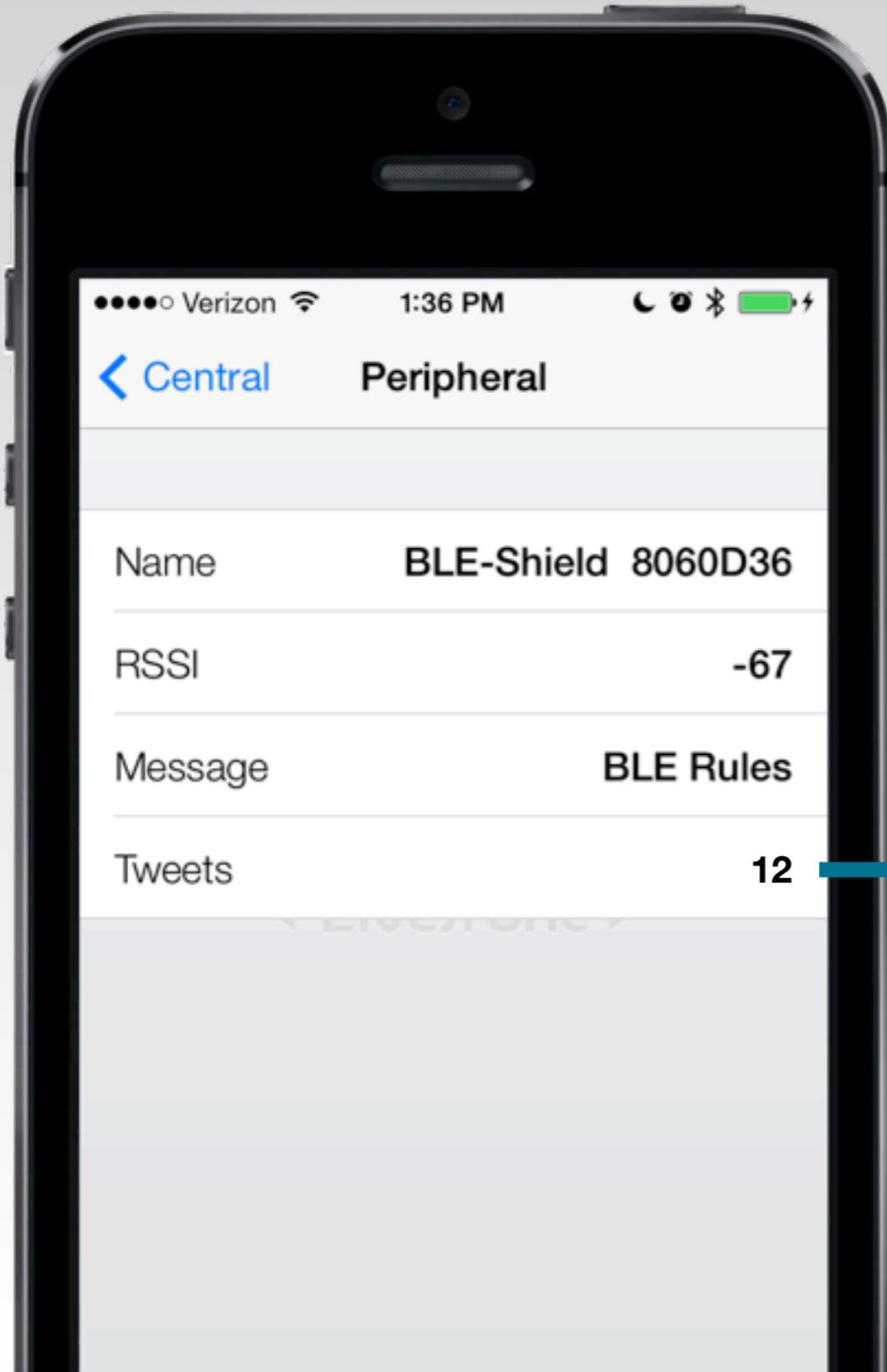
Demo

4. Remote Brain

4 Remote Brain



4 Remote Brain



Update TX



Arduino

4 Remote Brain

#blerules

4 Remote Brain

Code

Recap

Introduced Bluetooth Low Energy

Convinced you it's awesome

Did cool demos

Thanks!

#blerules

<https://github.com/livefront/blerules>

@skirchmeier

#blerules

<https://github.com/livefront/blerules>

References

References, source code, and more information can be found in the Readme that accompanies these slides at <https://github.com/livefront/blerules>.

Slide 10

Jonathan Cassell, IMS Research — http://www.imsresearch.com/press-release/Is_the_Google_Platform_Delaying_the_Bluetooth_Smart_Train&cat_id=188&from=

Slide 10

Alex West, IMS Research — http://www.imsresearch.com/press-release/The_Slow_Road_from_Classic_Bluetooth_to_Bluetooth_Smart_in_Consumer_Medical_Devices&cat_id=165&from=

Slide 32

Joakim Linde, Apple — <https://developer.apple.com/videos/wwdc/2012/>

Slide 33

Various, Wikipedia — http://en.wikipedia.org/wiki/Bluetooth_low_energy