
OPEN SOURCE SUMMIT
China 2019

Unfit Story of Fitness Trackers : Hacking the BLE devices

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#whoami

Yogesh Ojha

- From Nepal 

- Cyber Security Analyst @ Tata Consultancy Services, India
- IOT & Mobile Application Security
- Love to Build and Play with Robots and break them very often

Expectations

You can expect to learn about:

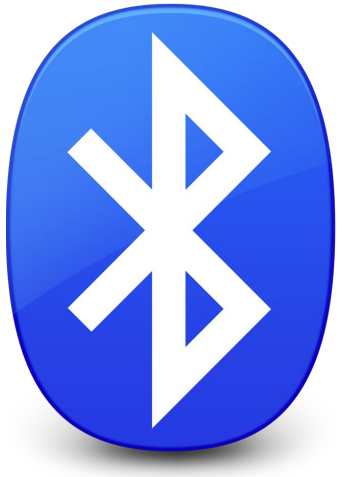
- Basic Understanding of Bluetooth
- Bluetooth Classic vs Bluetooth Low Energy
- BLE Stack
- Capturing BLE Packets/BLE MiTM
- Reverse Engineering the Mobile Applications of Fitness trackers
- Uploading the firmware over the air

Bluetooth Story...

Bluetooth is a short-range wireless communication protocol and allows devices such as smartphones, headsets, to transfer data and/or voice wirelessly.

Developed in 1994 as a replacement for cables.

Uses 2.4GHz frequency and creates 10 meters radius called piconet!



Bluetooth Low Energy

(4.0)

Bluetooth low energy aka Bluetooth Smart

- Designed to be power efficient
- Low cost and easy to implement
- Used in sensors, lightbulbs, medical devices, wearables and many other “smart” products.

Bluetooth
SMART

Bluetooth classic vs BLE

Bluetooth Classic

- Great for products that requires continuous streaming of data
- High power consumption
- Faster data rate
- High application throughput
- Best Suited for:
  - Headsets, Speakers
  - Bluetooth Hotspot etc

Bluetooth Low Energy

- Great for products that do not require continuous streaming of data.
- Ultra low power consumption
- Slower Data rate
- Low application throughput
- Best Suited for:
  - Home Automation
  - Fitness trackers etc

It is designed to operate in sleep mode and waken up only when connection is initiated. Like maybe your light is on or off or a quick command to turn on or off the light.

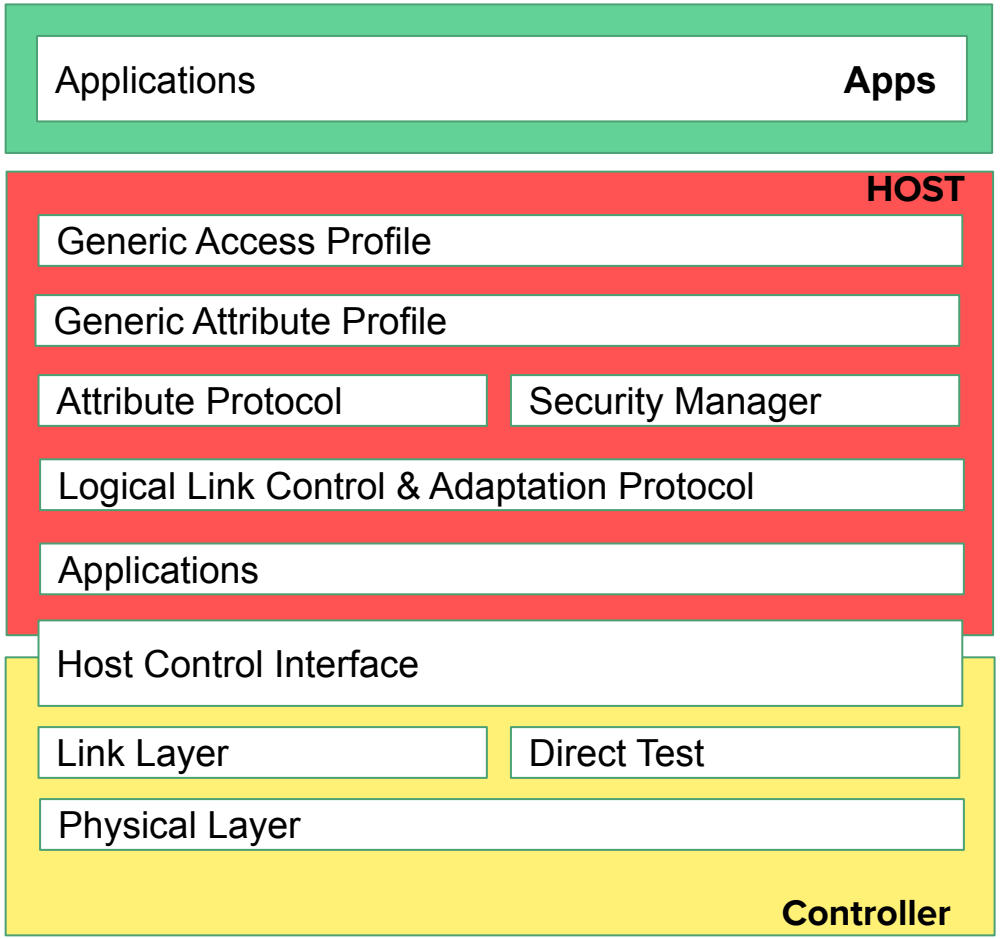
Bluetooth Low Energy

(4.0)

Fitness Tracker - BLE Applications

BLE Stack

- Generic Attribute Profile (GATT)
- Generic Access Profile(GAP)



Generic Attribute Profile (GATT)

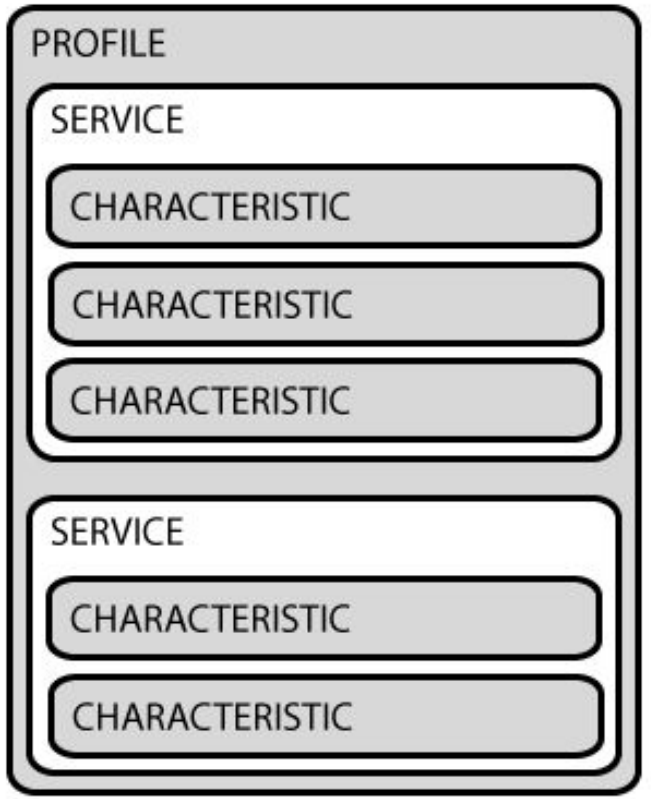
GATT defines the way that these BLE devices communicate with each (client & server) other using something called **Services** and **Characteristics**.

Here Connections are Exclusive! Means your BLE peripheral can only be connected to one central device at a time! It will stop advertising itself and other devices will no longer be able to see it or connect to it until the existing connection is broken.

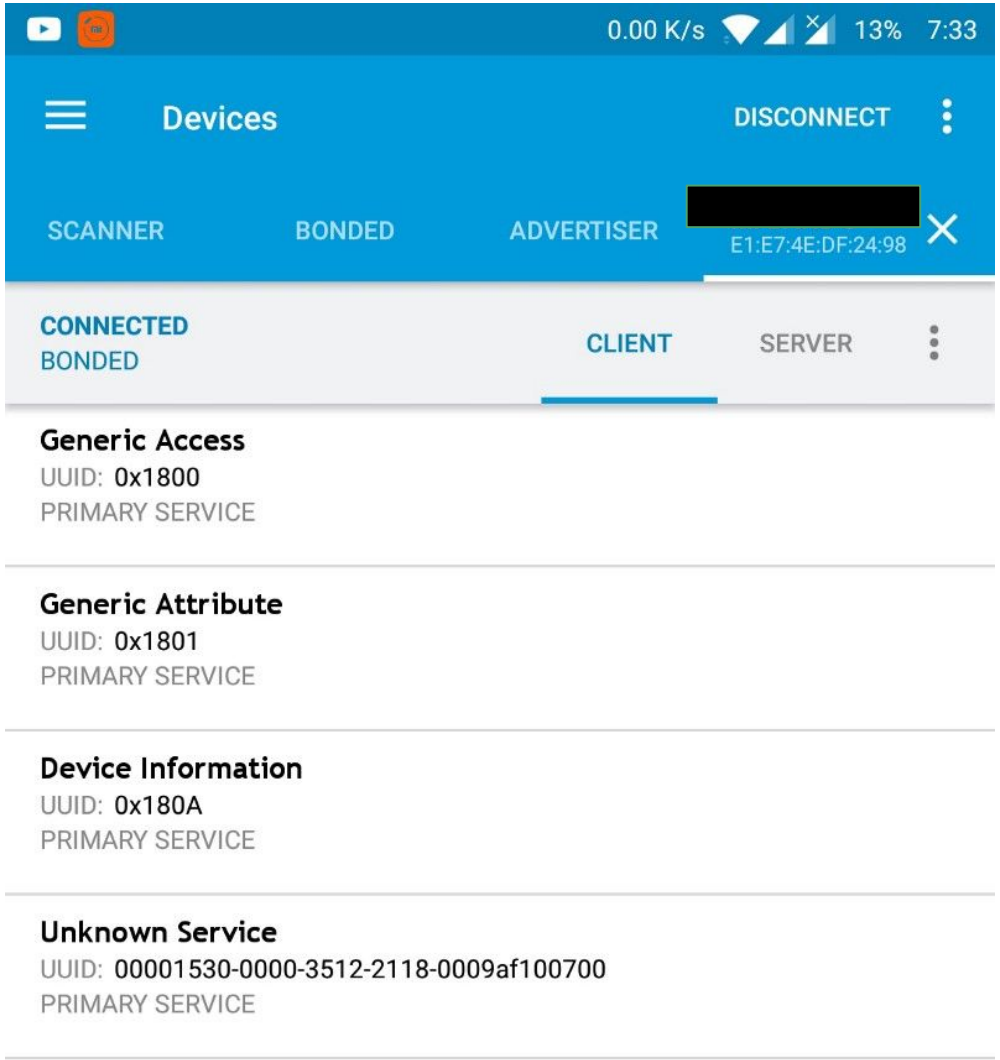
Services & Characteristics

Services: Set of provided features and associated behaviors to interact with the peripheral. Each service contains a collection of characteristics.

Characteristics: Characteristics are defined attribute types that contain a single logical value.



Services & Characteristics



Basic Process

0. Select the target
    a. Install Bluez stack, hcitool & gattool
1. Enumerate the **services** and **characteristics**
    a. Do the scan using hcitool
    b. Connect using gatttool
    c. List all the services and characteristics
2. Reverse Engineer the mobile application (if any)
    a. For reverse engineering android application use apktool.
3. Finally do some cool stuff!

0. Selecting the target

Goal: Finding the BLE devices near the vicinity

Tools Used: **Bluez, hcitool, gatttool**

Install Bluez: $ sudo apt-get install bluez

Install Hcitool: hcitool comes **preinstalled with bluez stack**

```
yogesh@yogesh:miBand3Hack$ sudo hcitool lescan
LE Scan ...
E1:E7:4E:DF:24:98 (unknown)
E1:E7:4E:DF:24:98 Mi Band 3
```

nRF Connect for Mobile

Nordic Semiconductor ASA Tools ★★★★★ 1,236

3+

This app is compatible with some of your devices.

Installed

App Store Preview

This app is only available on the App Store for iOS devices.

LightBlue® Explorer 4+

The go-to BLE development tool

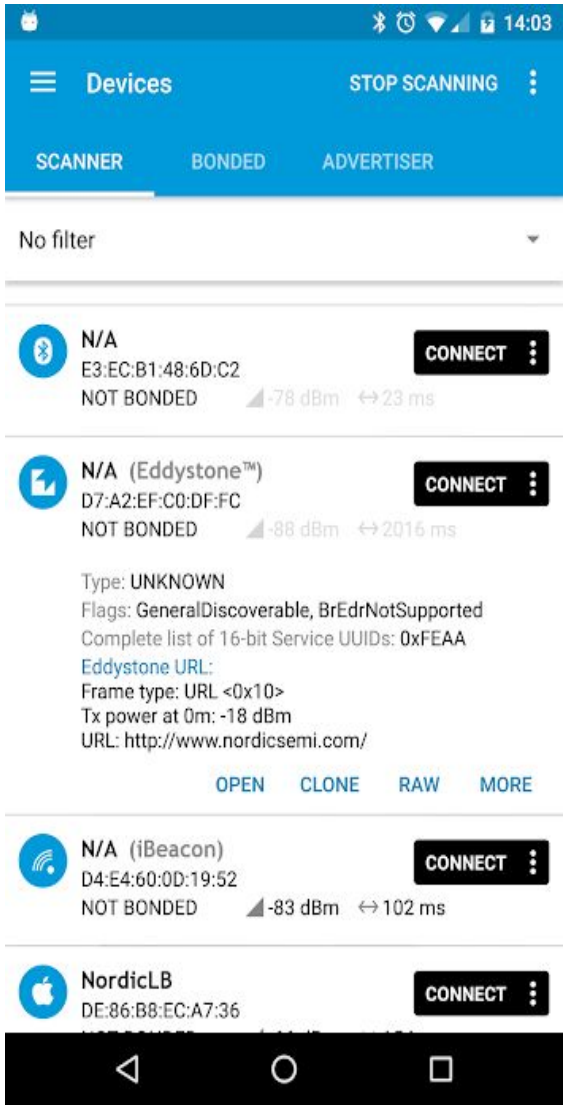
Punch Through

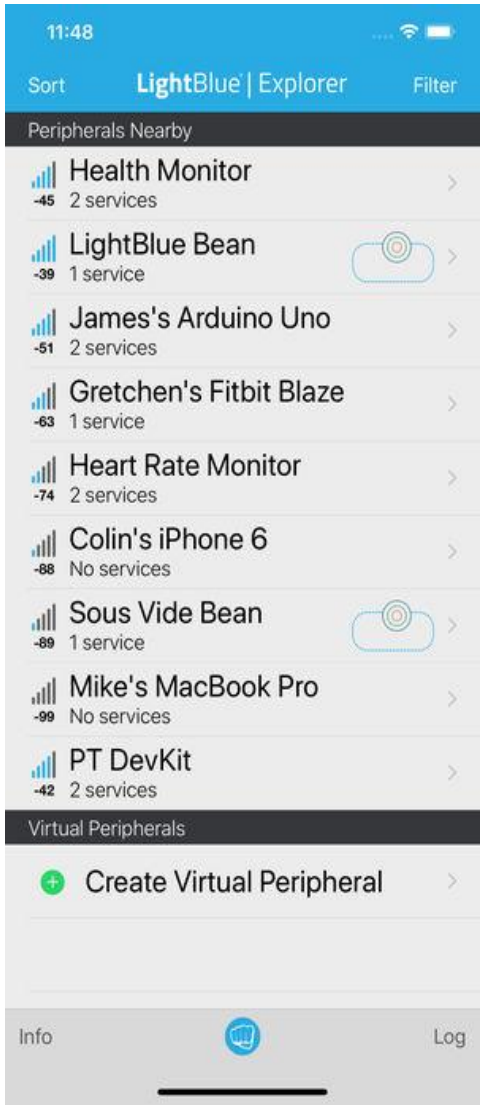
★★★★½ 4.3, 217 Ratings

Free

Scanning for BLE Devices


```
yogesh@yogesh:miBand3Hack$ sudo hcitool lescan
LE Scan ...
E1:E7:4E:DF:24:98 (unknown)
E1:E7:4E:DF:24:98 Mi Band 3
```





Enumerate the services and characteristics

sudo gatttool -b <BLE ADDRESS> -I

>connect

List down all primary services

> primary

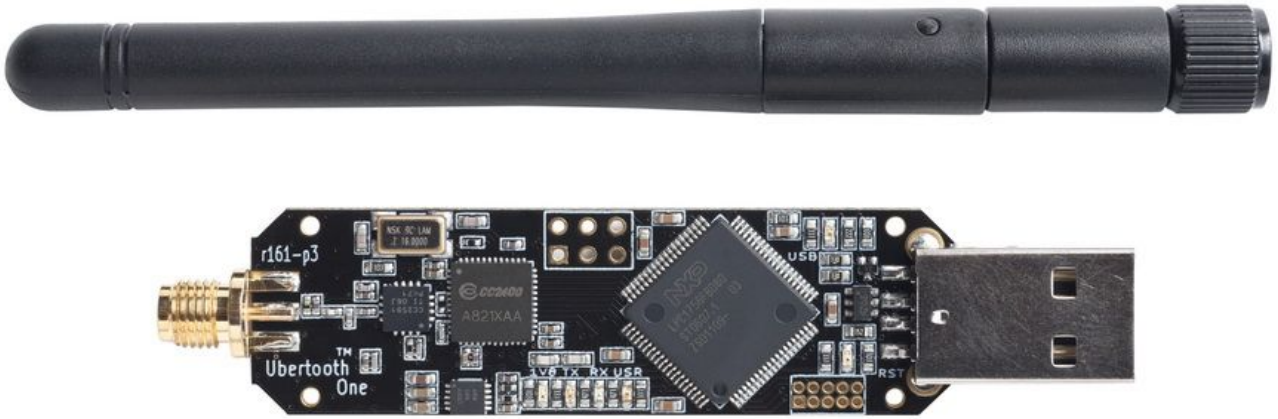
List down all characteristics

> characteristics

Sniffing BLE Packets

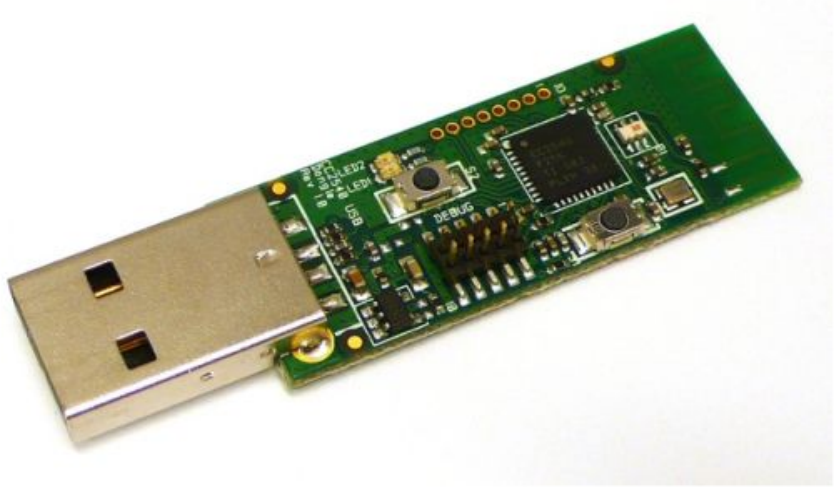
Ubertooth

- Works great for both Classic and BLE
- Open Source Hardware/Software
- About $100



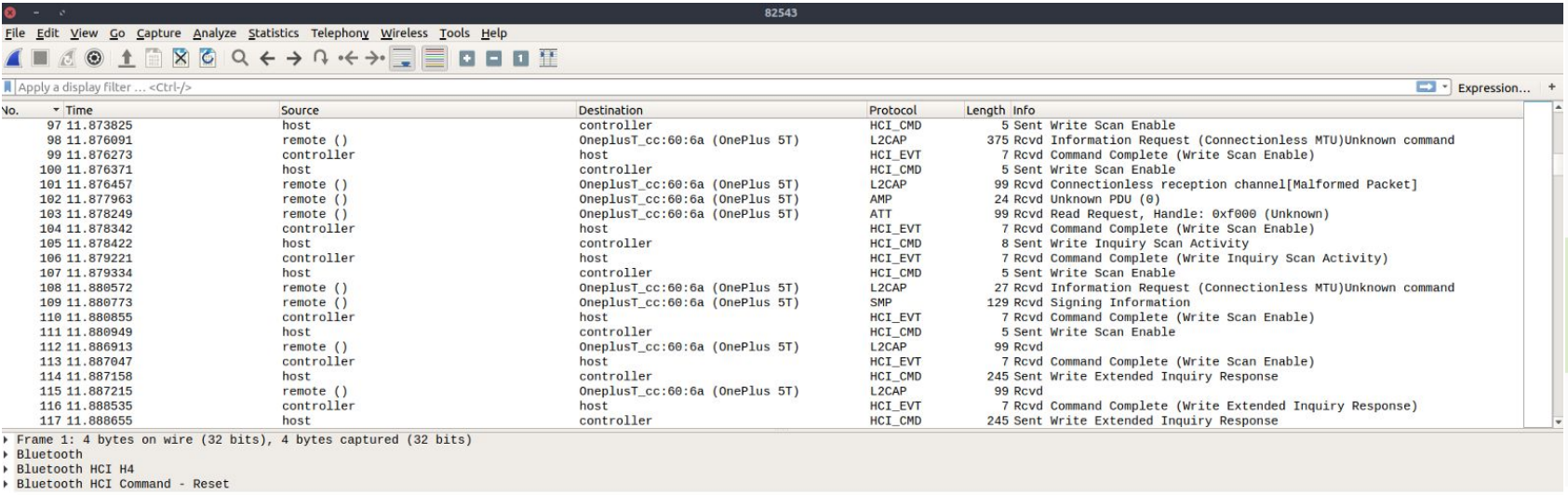
CC2540

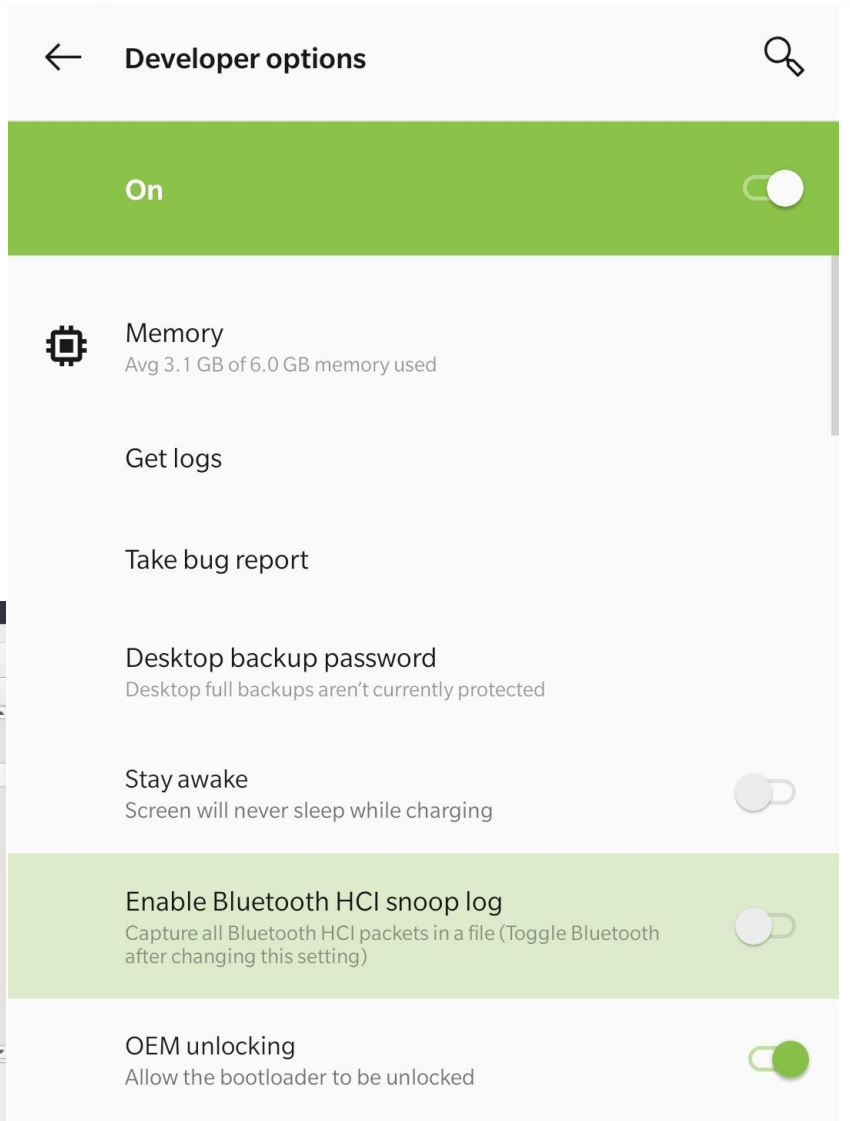
- Cheaper but limited configuration
- About $50



Alternate to Sniffers

- Enable Developer Option
- Enable Bluetooth HCI Snoop Log
- $ adb pull /sdcard/btsnoop_hci.log





Authentication in BLE devices

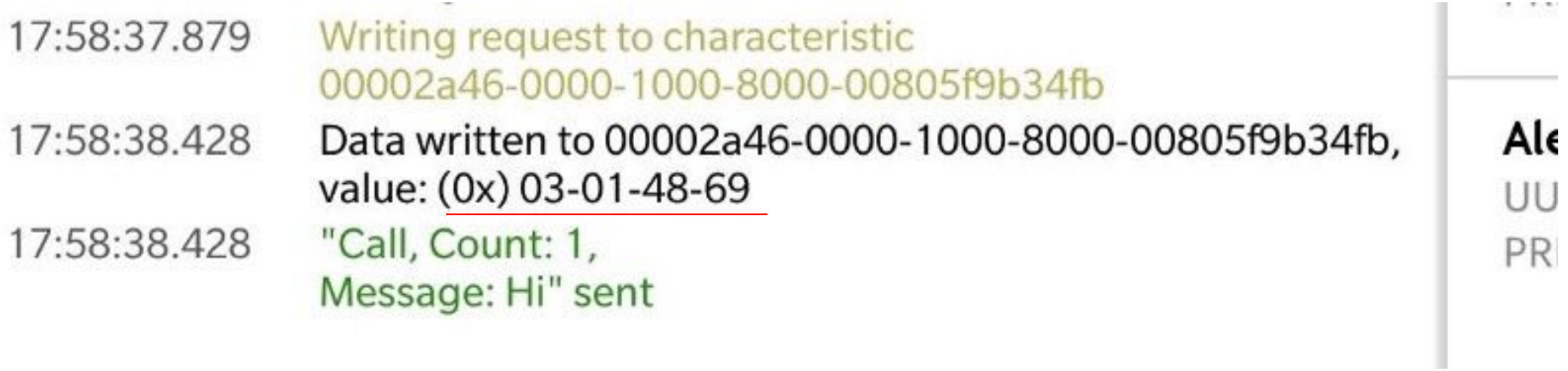
3 devices, out of 5 devices that I tested, do not implement link layer encryption.

Authentication in fitness trackers.

What's next after authentication?

You can really do some cool stuffs ;)

Send some Notification? ;)



First Two Byte is Notification Type

01 -> Email

03 -> Call

04 -> Missed Call

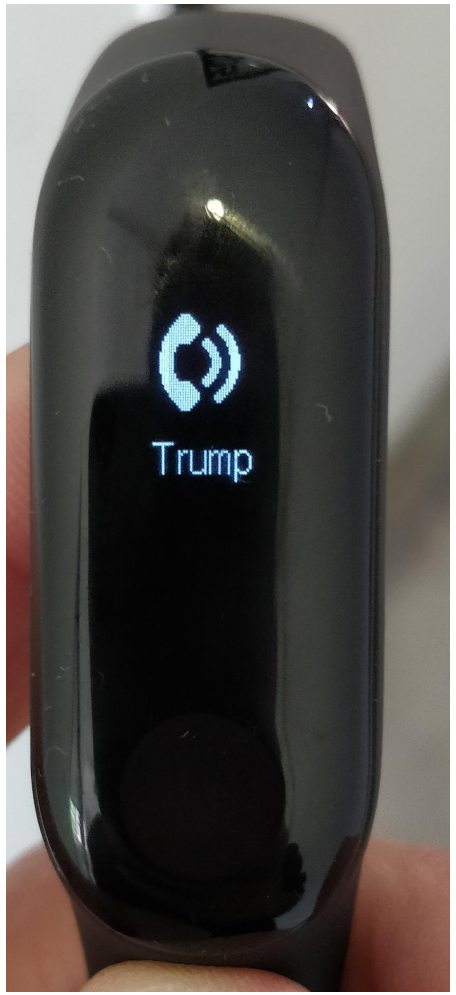
05 -> SMS/MMS

Next Two Byte is numbers of notification

And remaining is the hex value of the notification title that you are sending.

Send some Notification? ;)


```
def send_custom_alert(self, type):
        if type == 5:
            base_value = '\x05\x01'
        elif type == 4:
            base_value = '\x04\x01'
        elif type == 3:
                base_value = '\x03\x01'
        phone = raw_input('Sender Name or Caller ID')
        svc = self.getServiceByUUID('"00001811-0000-1000-8000-00805f9b34fb')
        char = svc.getCharacteristics('00002a46-0000-1000-8000-00805f9b34fb')[0]
        char.write(base_value+phone, withResponse=True)
```


Trump

My aim was to display this!

Firmware

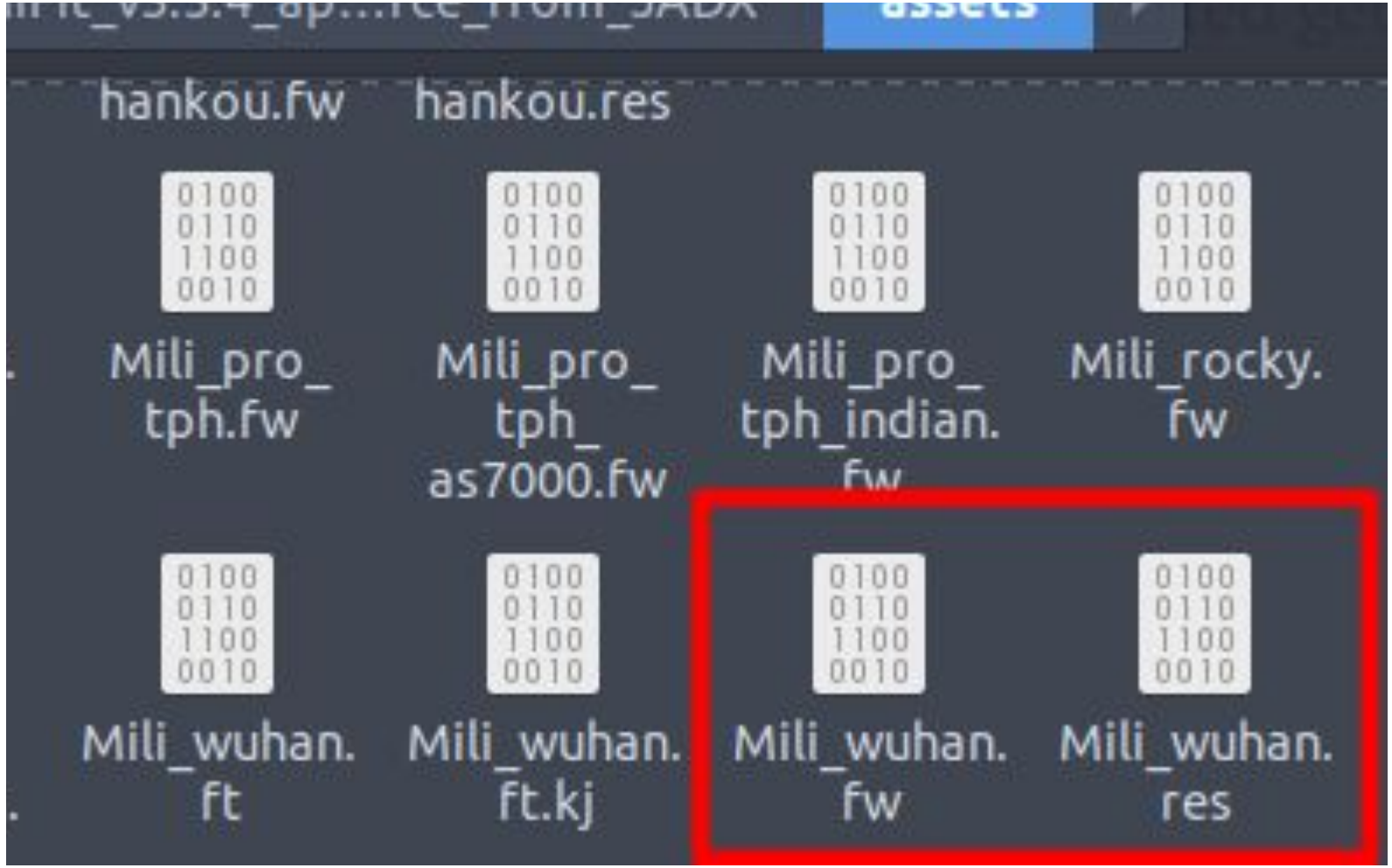
A **firmware** is a piece of Software that runs on embedded CPU!

How do I get firmware?

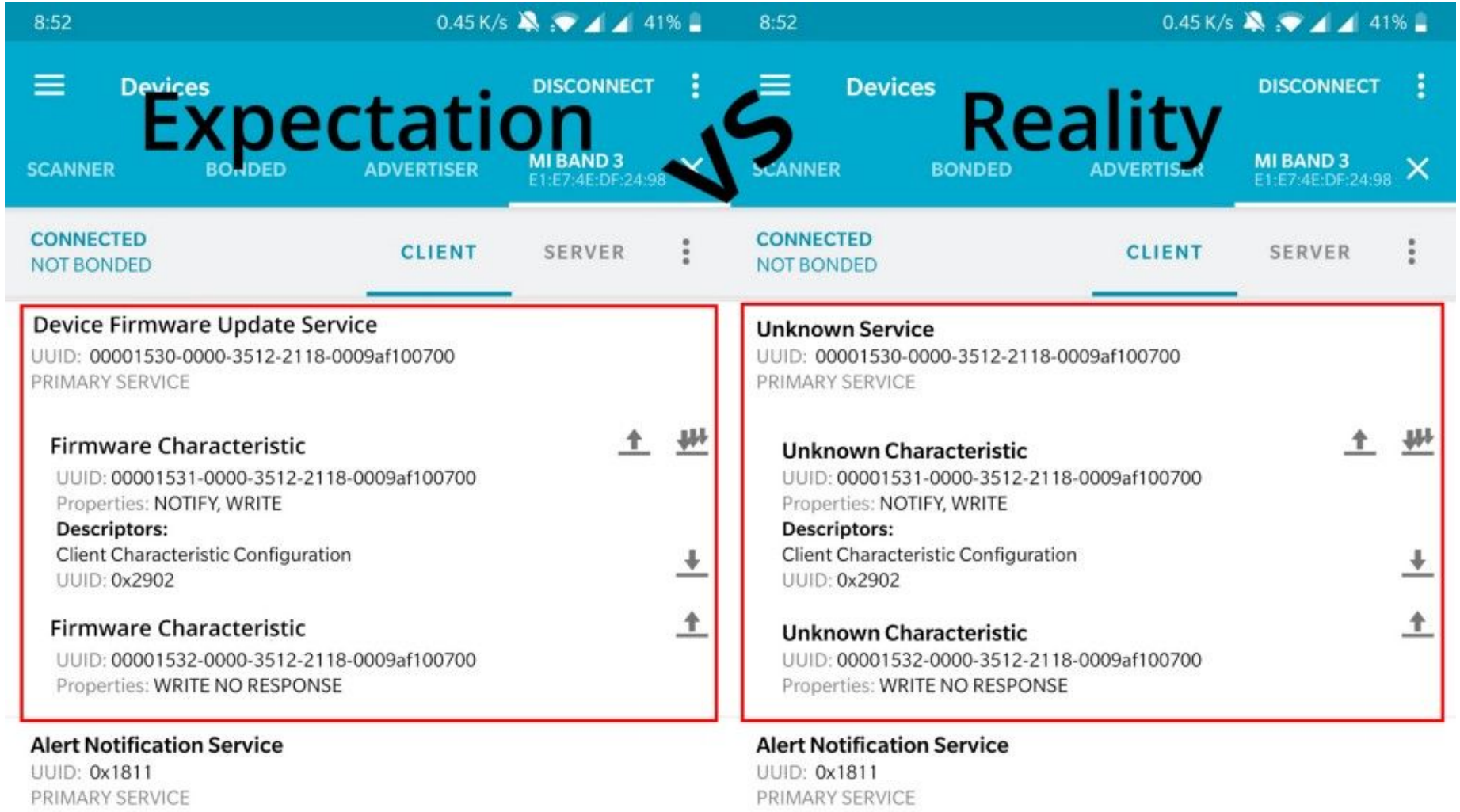
Reverse Engineering the Mobile application maybe? Or during the DFU update?

Let’s reverse engineer the mobile application!

$ apktool d cool_app.apk


hankou.fw
hankou.res
Mili_pro_tph.fw
Mili_pro_tph_as7000.fw
Mili_pro_tph_indian.fw
Mili_rocky.fw
Mili_wuhan.ft
Mili_wuhan.ft.kj
Mili_wuhan.fw
Mili_wuhan.res

Uploading the firmware



How does firmware upload works? For this fitness tracker

- Initialize the firmware/resource Update On Characteristic 1531 with write command of 4-byte
- **\x01** + fileSize in Hex(3-byte)
- But, for the resource, its **5-byte**!
  \x01 + **fileSize** in Hex(3-byte) + **\x02**
- Last byte **\x02** is for letting the firmware update service know that it's a resource and not the firmware file.

Doesn’t accept 0x5EFAC but accepts 0xAcEF05

How does firmware upload works? For this fitness tracker

What is **Checksum?**

Calculated value that is used to determine the integrity of data during the transmission.

BLE does not perform error correction but can only perform error detection. Bluetooth 5.0 introduces error correction.

How does firmware upload works? For this fitness tracker

Once the CRC is calculated, write the checksum to Characteristic “1531” of 3 bytes. The checksum must begin with \x04 and your checksum value

\x04 + checksum

If the checksum matches the resource will be accepted and updated. But for firmware, you need to send reboot command as well.

On Characteristic “1531” send \x05 for the reboot.

And yes, the firmware update is done!

What about the skull Icon? ;)

Q&A

More about this hack is on Medium & Github!

https://medium.com/@yogeshojha

https://github.com/yogeshojha/MiBand3/