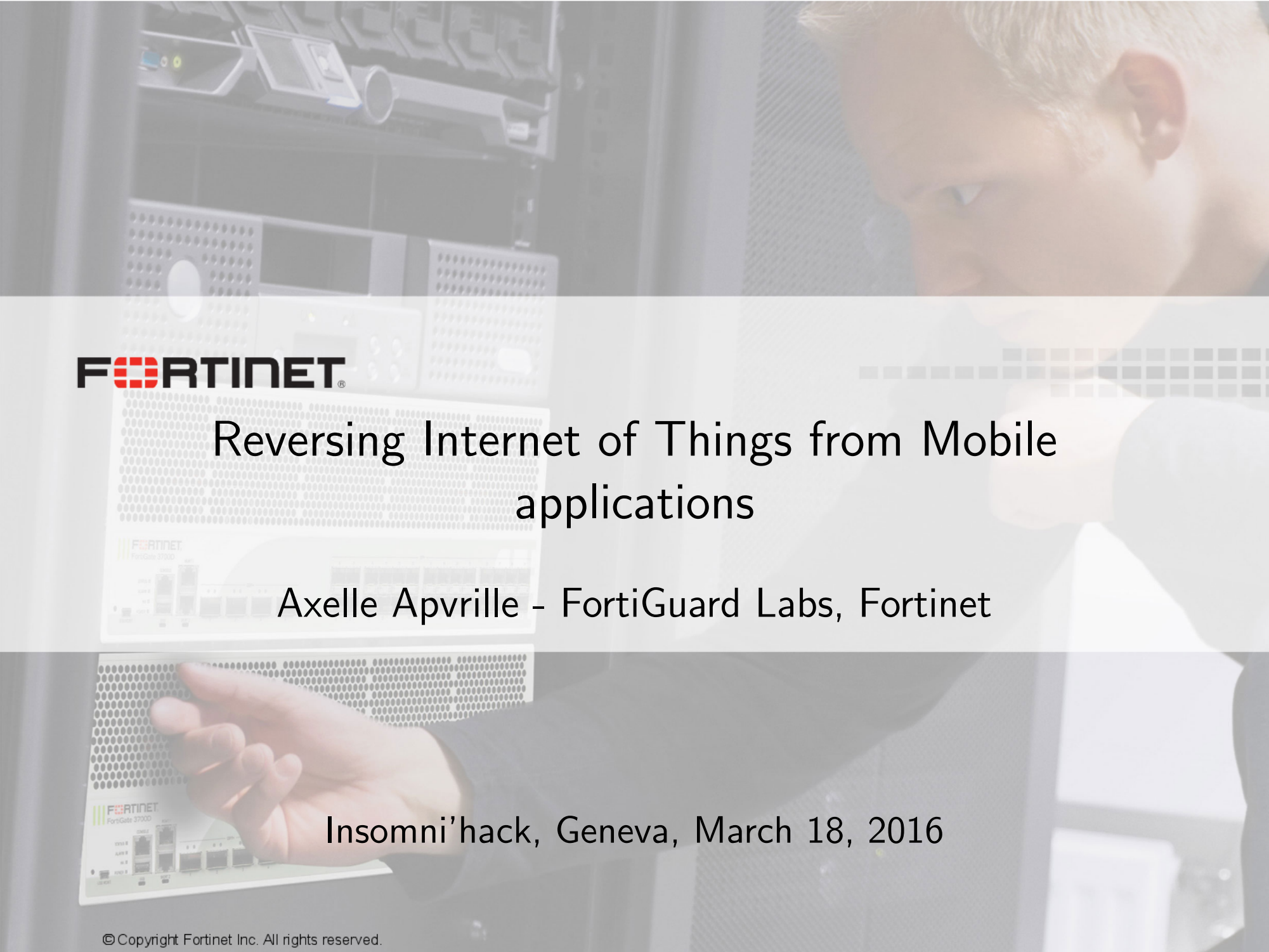


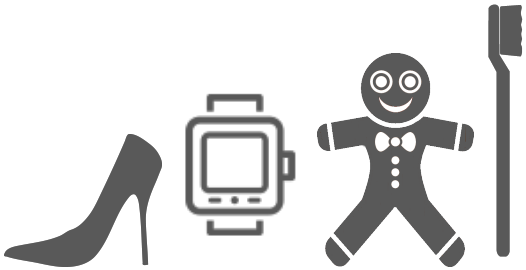
Reversing Internet of Things from Mobile applications

Axelle Apvrille - FortiGuard Labs, Fortinet

Insomni'hack, Geneva, March 18, 2016

Reversing Internet of Things (IoT) is difficult

Different hardware



Different OS

Linux, Windows Mobile, Android, Contiki, RIOT, TinyOS, Brillo...

Different formats

ELF, BFLT...

Research

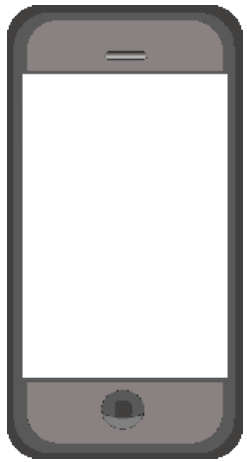
e.g firmware.re

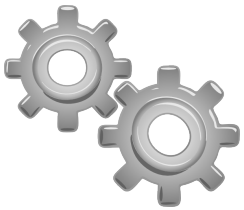
Why reverse IoT?

- To understand how (in)secure they are
- To detect and protect against viruses and exploits

So, how do we get started?

Focus first on the mobile app



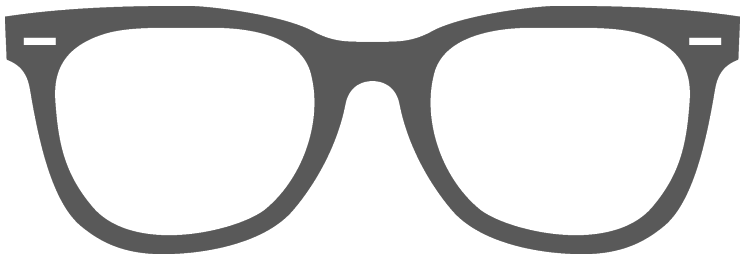


Apktool, dex2jar, IDA Pro...

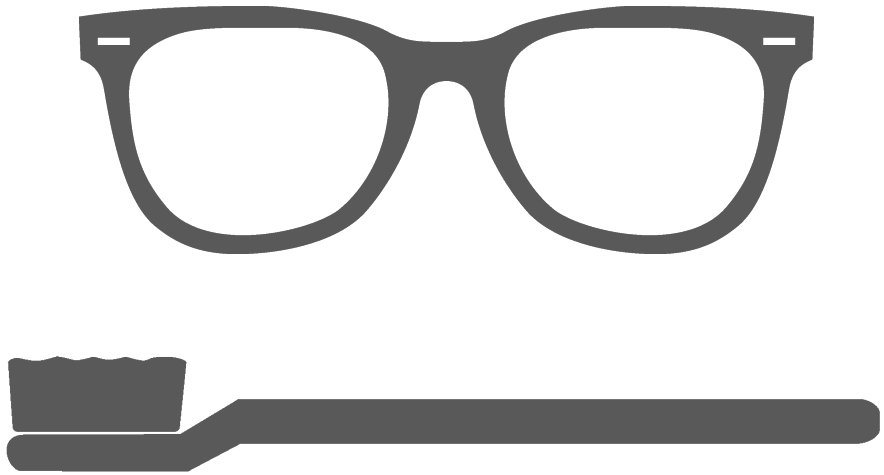
It's faster

First step

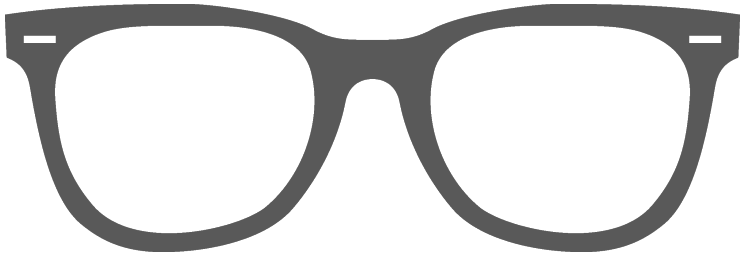
Real examples

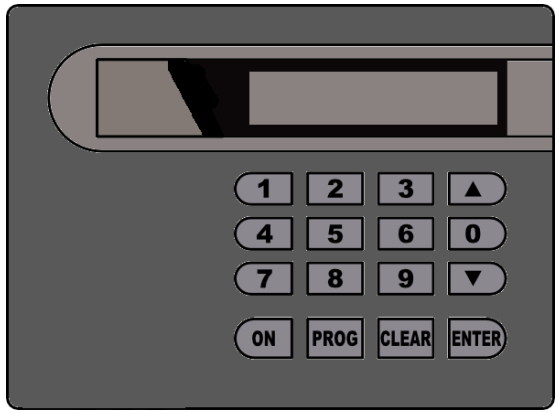


Real examples

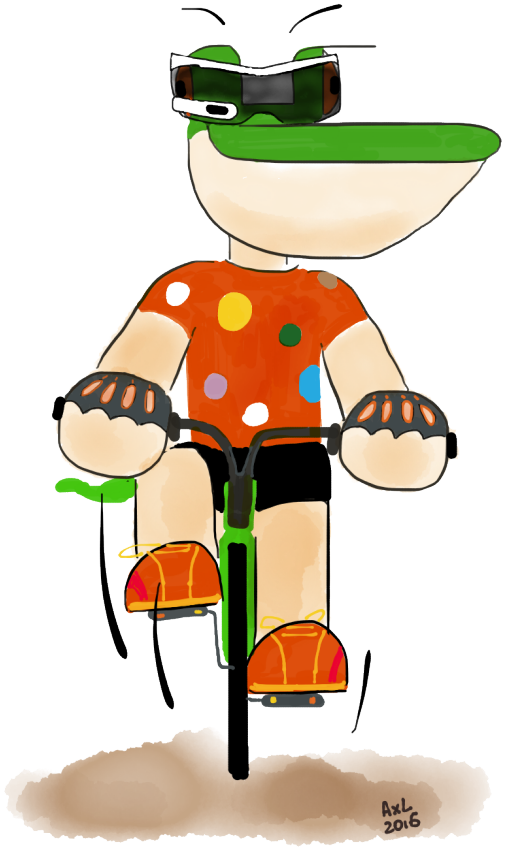


Real examples



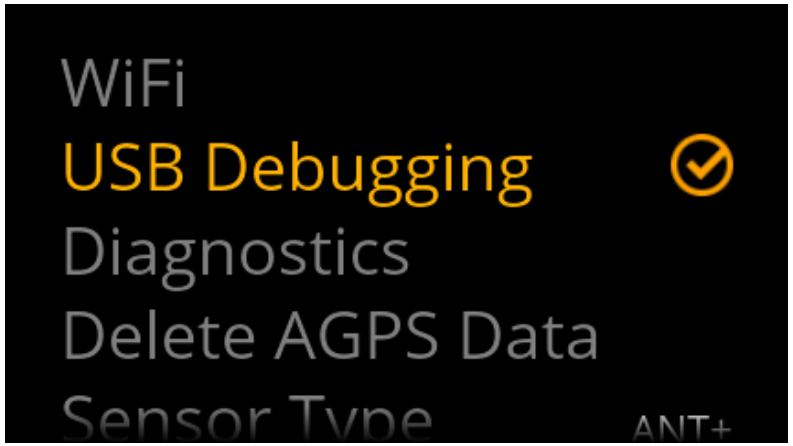


Recon Jet Smart Glasses - Toothbrush - Safety Alarm



A shell on the glasses

- Enable USB debugging on the glasses
- Add udev rule
- Add vendor in `/.android/adb_usb.ini`




```
$ adb devices
List of devices attached
291052171       device
$ adb -s 291052171 shell
shell@android:/ $
```

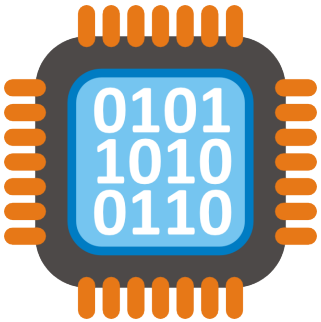
System properties

```
shell@android:/ $ getprop ro.boot.bootloader
U-Boot_1.1.4-4.4-SUN^0-dirty
shell@android:/ $ getprop ro.build.description
lean_jet_sun-user 4.1.2 JZ054K 11 release-keys
```

The glasses are using Android **4.1.2 - Jelly Bean**

Hardware investigations

Hey, what hardware is it using?



`/system/board`
`properties/soc/revision`:
OMAP4430

`/system/lib/hw/sensors.conf`:

- STM LSM9DS0 accelerometer/gyroscope/compass
- STM LPS25 pressure
- TI TMP103 temperature
- Recon Free Fall
- Avago Tech APDS9900 ambient light

System applications

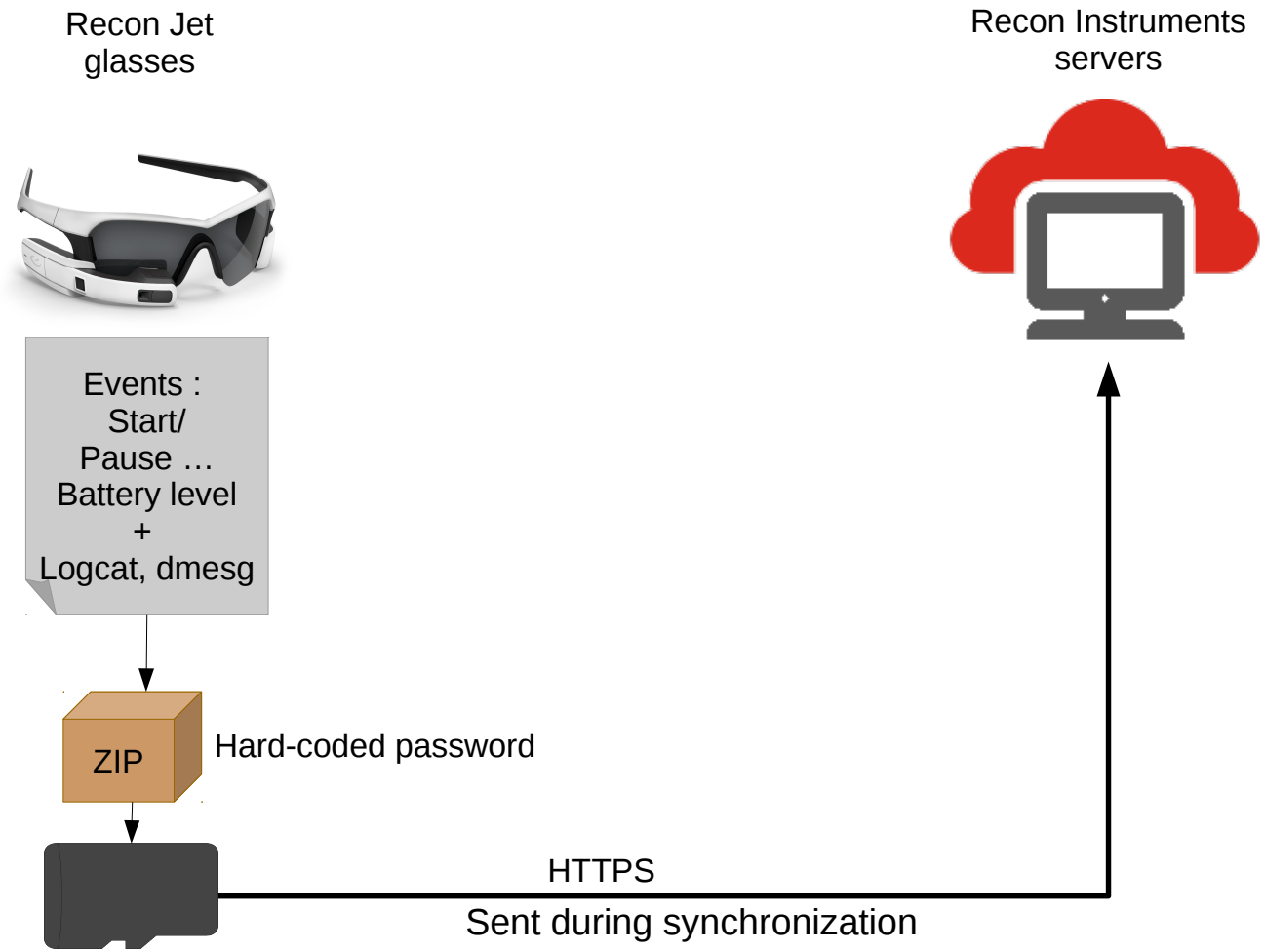
```
shell@android:/system/app $ ls
...
ReconCamera.apk
ReconCompass.apk
ReconItemHost.apk
...
```

Pull them, analyze them
Apktool, dex2jar, JEB, baksmali...

```
zipcreated:
    ArrayList list = new ArrayList();
    File logfile = new File(this.mContext.getFilesDir() + "/logcatout.txt");
    try {
        Runtime.getRuntime().exec("logcat -d -v threadtime -f " + logfile.getAbsolutePath(
        if(!logfile.exists()) {
            goto label_82;
        }

        list.add(logfile);
    }
```

Data leak


Recon Jet glasses
Recon Instruments servers
Events : Start/ Pause … Battery level + Logcat, dmesg
ZIP
Hard-coded password
HTTPS
Sent during synchronization

Example of data

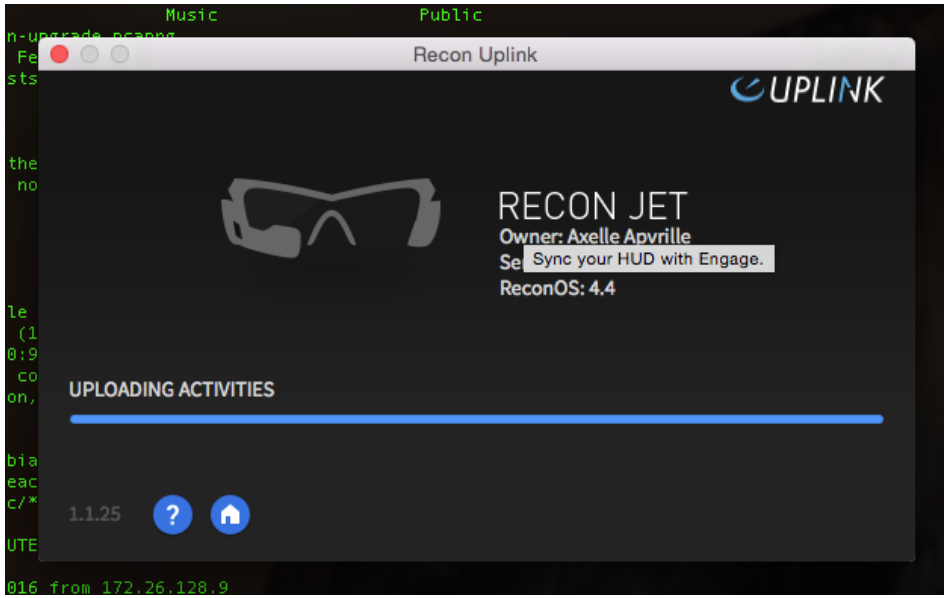

```
 {
            "component": "battery_monitor",
            "data1": "99%; 4172mV",
            "data2": "Charging USB",
            "data3": "29",
            "event_type": "BatteryMeasurement",
            "time_stamp": "1434115258015"
        },
 {
            "component": "ActivityManager",
            "data1": "com.reconinstruments.
jetconnectdevice/.ReconnectSmartphoneActivity",
            "data2": "",
            "data3": "",
            "event_type": "PauseActivity",
            "time_stamp": "1434115211239"
        },
```

Vulnerability status

Vulnerability found

Vendor contacted

Issue fixed in Recon OS 4.4 (February 2016)



Smart Glasses - Beam Toothbrush - Safety Alarm

Why are we investigating toothbrushes?!

Attackers don't care about your teeth, but ...

TRUE

TARGETED BUSINESS

Profile user & family
Sell health plans, hi-tech

PRIVACY ISSUES?

UNDESERVED REWARDS

Free toothpaste not attractive to attackers

Insurance fraud might become an incentive

WATCH THIS IN THE FUTURE?

RANSOMWARE

"*I'll tell your mom you don't brush your teeth!*"

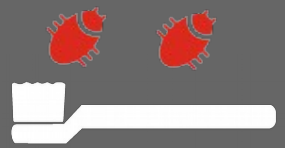
Ransom kids pocket money

LOW REVENUE

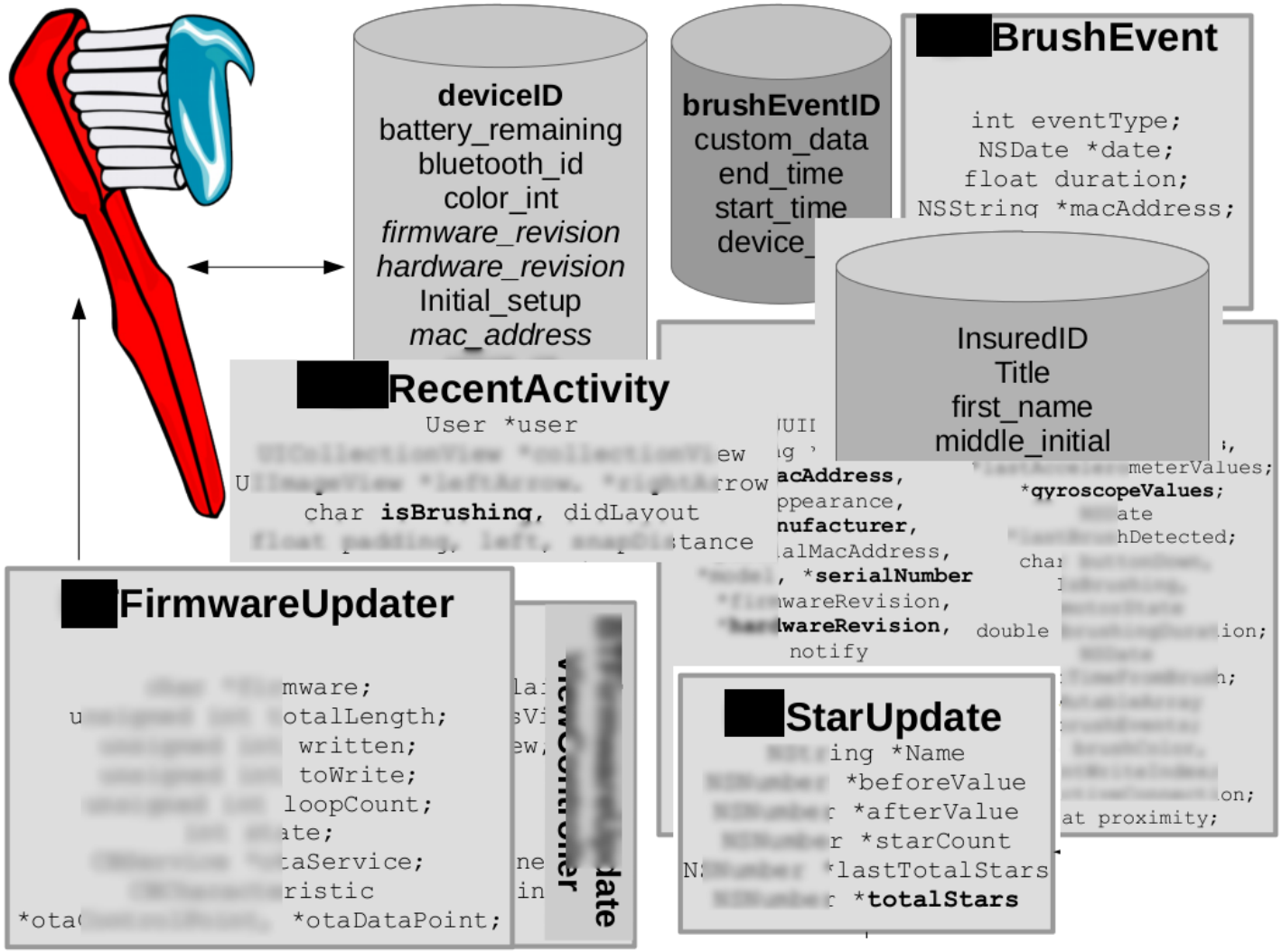
INFECTION VECTOR

Your toothbrush infects other devices

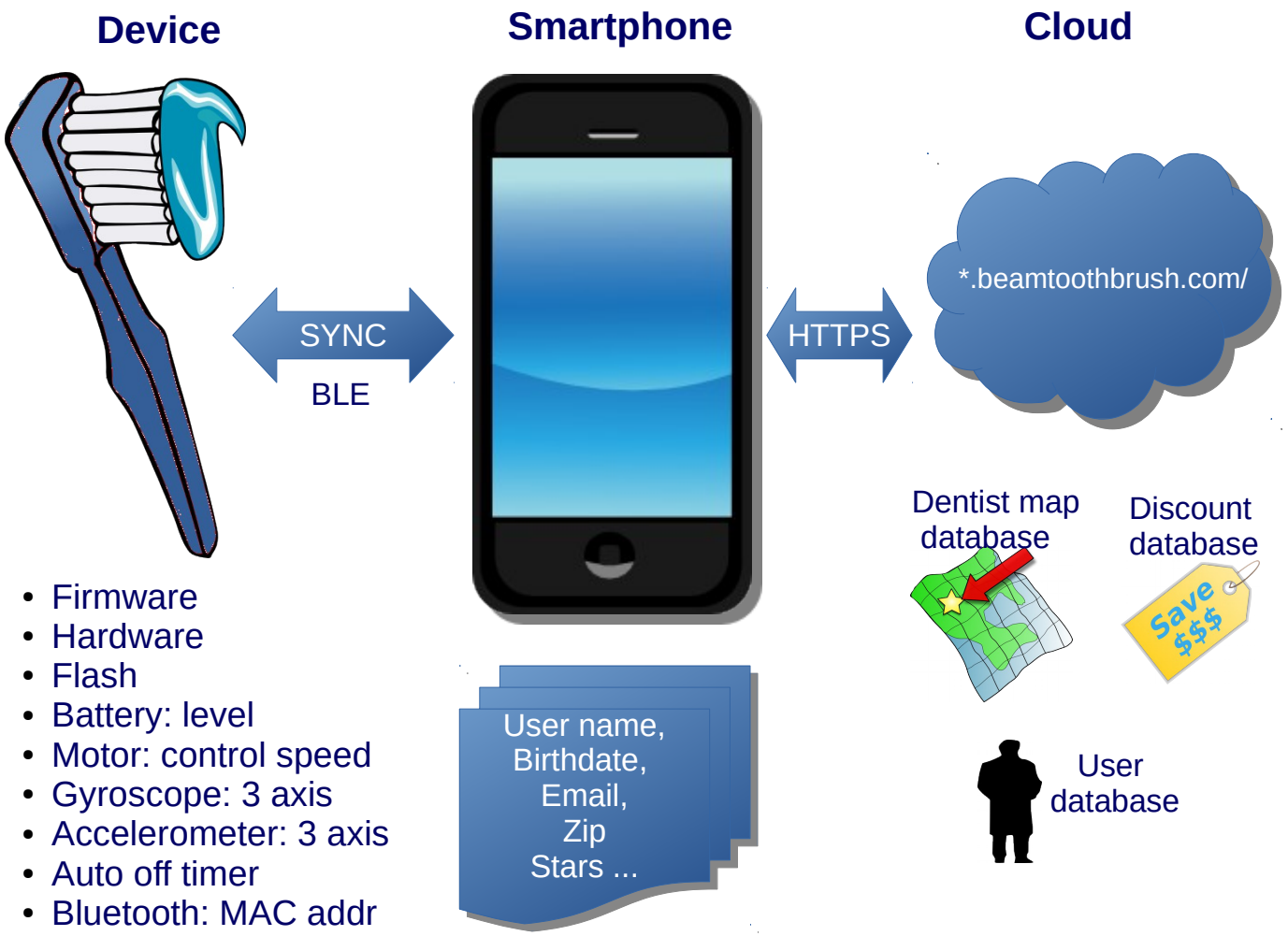
WATCH THIS IN THE FUTURE?



Classes and fields: we work out the mappings



So, what?


Device
Smartphone
Cloud
SYNC
BLE
HTTPS
*.beamtoothbrush.com/
Dentist map database
Discount database
Save $$$
User database
User name,
Birthdate,
Email,
Zip
Stars ...
• Firmware
• Hardware
• Flash
• Battery: level
• Motor: control speed
• Gyroscope: 3 axis
• Accelerometer: 3 axis
• Auto off timer
• Bluetooth: MAC addr
• Serial no

Now you're ready for wiser investigations...

Now, it's going to be easier & faster to continue the reverse engineering.

Talk to your toothbrush?

Send BLE ATT packets to service/characteristics

- **Firmware OTA** service `C05FC343-C076-...`
- Beam service `04234F8E-75...`
- **Battery level** 6DAC0185-E...
- **Accelerometer** 0227F1B0-FF...
- Auto off and quadrant buzz 19DC94FA-7B...
- ...

Smart Glasses - Toothbrush - Meian Home Safety Alarm

There's an Android app for the alarm

- Protect your house against burglars
- Controllable by SMS

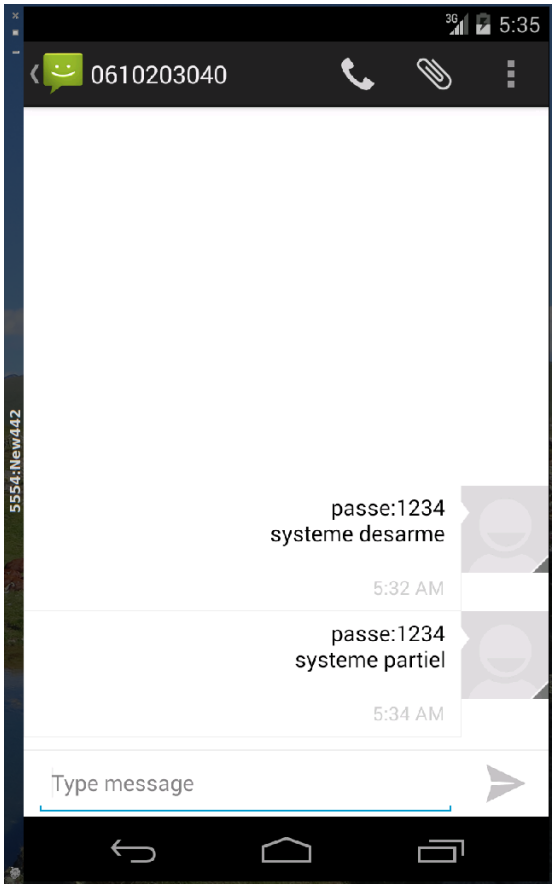
But it's not very user friendly...

Comply to a strict SMS formatting

So, they created an **Android app** to assist end-users

(Known?) Security issue

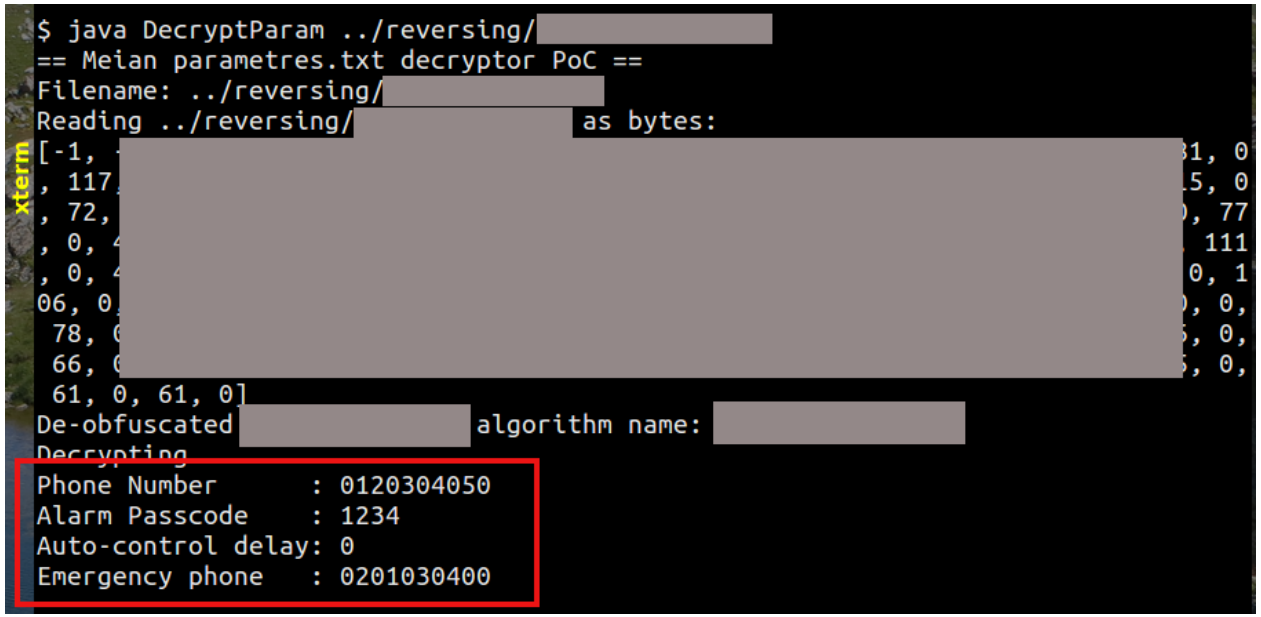
In the **outbox**, the SMS contains the **password** and **phone number** of the alarm.
You get it? You control the alarm!



Fake data, of course :D

Let's suppose you are a **wise person** and **erase the SMS**
You are wise, aren't you?

With the Android app, it's **worse**!



Weak protection for password: we can recover alarm's phone number, password, delay, emergency phone...

Your credentials are at risk even if you erased the SMS!

Without the app, **1** security issue.
With the app, **2 security issues** !!!

Recap' (1/2)

How to reverse Internet of Things

1. Get the **mobile application**, reverse it
2. Then, use what you have learned to go deeper down and e.g. inspect hardware, protocols etc.

Recap' (2/2)

- One vulnerability found and fixed
- We know what hardware is used

- We know how to communicate with the toothbrush!
- We know where stars and challenges are handled

- One vulnerability found, advisory published
- Don't use the app!

Thanks for your attention!

@cryptax or aapvrille (at) fortinet (dot) com

http://www.fortiguard.com

http://blog.fortinet.com

Awesome slides? Thanks! That's LaTeX